
kRPC

Release 0.4.3

Dec 12, 2017

CONTENTS

kRPC allows you to control Kerbal Space Program from scripts running outside of the game. It comes with client libraries for many popular languages including *C#*, *C++*, *Java*, *Lua* and *Python*. Clients, made by others, are also available for [Ruby](#) and [Haskell](#).

- *Getting Started Guide*
- *Tutorials and Examples*
- *Clients, services and tools made by others*

The mod exposes most of KSP's API for controlling and interacting with rockets, and also includes support several popular mods including Ferram Aerospace Research, Kerbal Alarm Clock and Infernal Robotics.

This functionality is provided to client programs via a server running in the game. Client scripts connect to this server and use it to execute 'remote procedures'. This communication can be done on local machine only, over a local network, or even over the wider internet if configured correctly. The server is extensible - additional remote procedures (grouped into "services") can be added to the server using the *Service API*.

GETTING STARTED

This short guide explains the basics for getting the kRPC server set up and running, and writing a basic Python script to interact with the game.

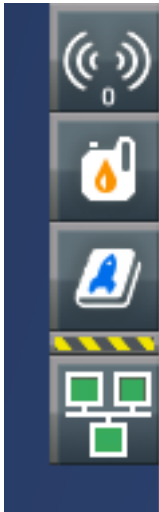
1.1 The Server Plugin

1.1.1 Installation

1. Download and install the kRPC server plugin from one of these locations:
 - [Github](#)
 - [SpaceDock](#)
 - [Curse](#)
 - Or the install it using [CKAN](#)
2. Start up KSP and load a save game.
3. You should be greeted by the server window:



4. Click “Start server” to, erm... start the server! If all goes well, the light should turn a happy green color.
5. You can hide the window by clicking the close button in the top right. The window can also be shown/hidden by clicking on the icon in the top right:



This icon will also turn green when the server is online.

1.1.2 Configuration

The server is configured by clicking edit on the window displayed in-game:

1. **Protocol:** this is the protocol used by the server. This affects type of client can connect to the server. For Python, and most other clients that communicate over TCP/IP you want to select “Protobuf over TCP”.
2. **Address:** this is the IP address that the server will listen on. To only allow connections from the local machine, select ‘localhost’ (the default). To allow connections over a network, either select the local IP address of your machine, or choose ‘Manual’ and enter the local IP address manually.
3. **RPC and Stream port numbers:** These need to be set to port numbers that are available on your machine. In most cases, they can just be left as the default.

There are also several advanced settings, which are hidden by default, but can be revealed by checking “Show advanced settings”:

1. **Auto-start server:** When enabled, the server will start automatically when the game loads.
2. **Auto-accept new clients:** When enabled, new client connections are automatically allowed. When disabled, a pop-up is displayed asking whether the new client connection should be allowed.

The other advanced settings control the *performance of the server*.

1.2 The Python Client

Note: kRPC supports both Python 2.7 and Python 3.x.

1.2.1 On Windows

1. If you don’t already have python installed, download the python installer and run it: <https://www.python.org/downloads/windows> When running the installer, make sure that pip is installed as well.
2. Install the kRPC python module, by opening command prompt and running the following command:
`C:\Python27\Scripts\pip.exe install krpc` You might need to replace C:\Python27 with the location of your python installation.
3. Run Python IDLE (or your favorite editor) and start coding!

1.2.2 On Linux

1. Your linux distribution likely already comes with python installed. If not, install python using your favorite package manager, or get it from here: <https://www.python.org/downloads>
2. You also need to install pip, either using your package manager, or from here: <https://pypi.python.org/pypi/pip>
3. Install the kRPC python module by running the following from a terminal: `sudo pip install krpc`
4. Start coding!

1.3 ‘Hello World’ Script

Run KSP and start the server with the default settings. Then run the following python script.

```

1 import krpc
2 conn = krpc.connect(name='Hello World')
3 vessel = conn.space_center.active_vessel
4 print(vessel.name)

```

This does the following: line 1 loads the kRPC python module, line 2 opens a new connection to the server, line 3 gets the active vessel and line 4 prints out the name of the vessel. You should see something like the following:



Congratulations! You've written your first script that communicates with KSP.

1.4 Going further...

- For some more interesting examples of what you can do with kRPC, check out the *tutorials*.
- Client libraries are available for other languages too, including *C#*, *C++*, *Java* and *Lua*.
- It is also possible to *communicate with the server manually* from any language you like.

TUTORIALS AND EXAMPLES

This collection of tutorials and example scripts explain how to use the features of kRPC.

2.1 Sub-Orbital Flight

This introductory tutorial uses kRPC to send some Kerbals on a sub-orbital flight, and (hopefully) returns them safely back to Kerbin. It covers the following topics:

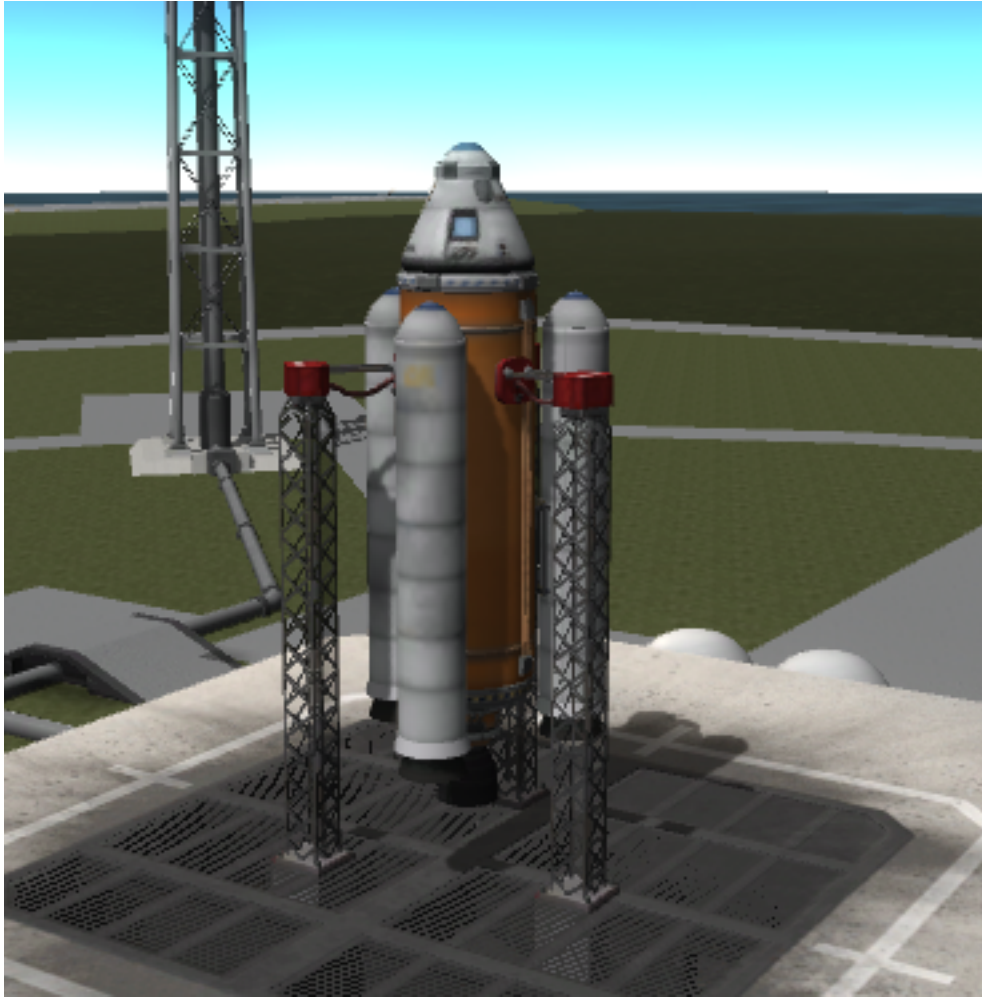
- Controlling a rocket (activating stages, setting the throttle)
- Using the auto pilot to point the vessel in a specific direction
- Using events to wait for things to happen in game
- Tracking the amount of resources in the vessel
- Tracking flight and orbital data (such as altitude and apoapsis altitude)

Note: For details on how to write scripts and connect to kRPC, see the *Getting Started* guide.

This tutorial uses the two stage rocket pictured below. The craft file for this rocket can be downloaded [here](#).

This tutorial includes source code examples for the main client languages that kRPC supports. The entire program, for your chosen language can be downloaded from [here](#):

C#, C++, Java, Lua, Python



2.1.1 Part One: Preparing for Launch

The first thing we need to do is open a connection to the server. We can also pass a descriptive name for our script that will appear in the server window in game:

C#

C++

Java

Lua

Python

```
10  var conn = new Connection ("Sub-orbital flight");
```

```
9   krpc::Client conn = krpc::connect("Sub-orbital flight");
10  krpc::services::KRPC krpc(&conn);
11  krpc::services::SpaceCenter space_center(&conn);
```

```

20 Connection connection = Connection.newInstance("Sub-orbital flight");
21 KRPC krpc = KRPC.newInstance(connection);
22 SpaceCenter spaceCenter = SpaceCenter.newInstance(connection);

```

```

1 local krpc = require 'krpc'
2 local platform = require 'krpc.platform'
3 local conn = krpc.connect('Sub-orbital flight')

```

```

3 conn = krpc.connect(name='Sub-orbital flight')

```

Next we need to get an object representing the active vessel. It's via this object that we will send instructions to the rocket:

C#

C++

Java

Lua

Python

```

12 var vessel = conn.SpaceCenter ().ActiveVessel;

```

```

13 auto vessel = space_center.active_vessel();

```

```

24 SpaceCenter.Vessel vessel = spaceCenter.getActiveVessel();

```

```

5 local vessel = conn.space_center.active_vessel

```

```

5 vessel = conn.space_center.active_vessel

```

We then need to prepare the rocket for launch. The following code sets the throttle to maximum and instructs the auto-pilot to hold a pitch and heading of 90° (vertically upwards). It then waits for 1 second for these settings to take effect.

C#

C++

Java

Lua

Python

```

14 vessel.AutoPilot.TargetPitchAndHeading (90, 90);
15 vessel.AutoPilot.Engage ();
16 vessel.Control.Throttle = 1;
17 System.Threading.Thread.Sleep (1000);

```

```

15 vessel.auto_pilot().target_pitch_and_heading(90, 90);
16 vessel.auto_pilot().engage();
17 vessel.control().set_throttle(1);
18 std::this_thread::sleep_for(std::chrono::seconds(1));

```

```
26     vessel.getAutoPilot().targetPitchAndHeading(90, 90);
27     vessel.getAutoPilot().engage();
28     vessel.getControl().setThrottle(1);
29     Thread.sleep(1000);
```

```
7  vessel.auto_pilot:target_pitch_and_heading(90, 90)
8  vessel.auto_pilot:engage()
9  vessel.control.throttle = 1
10 platform.sleep(1)
```

```
7  vessel.auto_pilot.target_pitch_and_heading(90, 90)
8  vessel.auto_pilot.engage()
9  vessel.control.throttle = 1
10 time.sleep(1)
```

2.1.2 Part Two: Lift-off!

We're now ready to launch by activating the first stage (equivalent to pressing the space bar):

C#

C++

Java

Lua

Python

```
19     Console.WriteLine ("Launch!");
20     vessel.Control.ActivateNextStage ();
```

```
20     std::cout << "Launch!" << std::endl;
21     vessel.control().activate_next_stage();
```

```
31     System.out.println("Launch!");
32     vessel.getControl().activateNextStage();
```

```
12 print('Launch!')
13 vessel.control:activate_next_stage()
```

```
12 print('Launch!')
13 vessel.control.activate_next_stage()
```

The rocket has a solid fuel stage that will quickly run out, and will need to be jettisoned. We can monitor the amount of solid fuel in the rocket using an event that is triggered when there is very little solid fuel left in the rocket. When the event is triggered, we can activate the next stage to jettison the boosters:

C#

C++

Java

Lua

Python

```

23         var solidFuel = Connection.GetCall(() => vessel.Resources.Amount(
↳ "SolidFuel"));
24         var expr = Expression.LessThan(
25             conn, Expression.Call(conn, solidFuel), Expression.ConstantFloat(conn,
↳ 0.1f));
26         var evnt = conn.KRPC().AddEvent(expr);
27         lock (evnt.Condition) {
28             evnt.Wait();
29         }

```

```

26     auto solid_fuel = vessel.resources().amount_call("SolidFuel");
27     auto expr = Expr::less_than(
28         conn, Expr::call(conn, solid_fuel), Expr::constant_float(conn, 0.1));
29     auto event = krpc.add_event(expr);
30     event.acquire();
31     event.wait();
32     event.release();

```

```

34     {
35         ProcedureCall solidFuel = connection.getCall(vessel.getResources(), "amount",
↳ "SolidFuel");
36         Expression expr = Expression.lessThan(
37             connection,
38             Expression.call(connection, solidFuel),
39             Expression.constantFloat(connection, 0.1f));
40         Event event = krpc.addEvent(expr);
41         synchronized (event.getCondition()) {
42             event.waitFor();
43         }
44     }
45
46     System.out.println("Booster separation");
47     vessel.getControl().activateNextStage();

```

```

15 while vessel.resources:amount('SolidFuel') > 0.1 do
16     platform.sleep(1)
17 end
18 print('Booster separation')
19 vessel.control:activate_next_stage()

```

```

15 fuel_amount = conn.get_call(vessel.resources.amount, 'SolidFuel')
16 expr = conn.krpc.Expression.less_than(
17     conn.krpc.Expression.call(fuel_amount),
18     conn.krpc.Expression.constant_float(0.1))
19 event = conn.krpc.add_event(expr)
20 with event.condition:
21     event.wait()
22 print('Booster separation')
23 vessel.control.activate_next_stage()

```

In this bit of code, `vessel.resources` returns a *Resources* object that is used to get information about the resources in the rocket. The code creates the expression `vessel.resources.amount('SolidFuel') < 0.1` on the server, using the expression API. This expression is then used to drive an event, which is triggered when the expression returns true.

2.1.3 Part Three: Reaching Apoapsis

Next we will execute a gravity turn when the rocket reaches a sufficiently high altitude. The following uses an event to wait until the altitude of the rocket reaches 10km:

C#

C++

Java

Lua

Python

```

36         var meanAltitude = Connection.GetCall(() => vessel.Flight(null).
↪MeanAltitude);
37         var expr = Expression.GreaterThan(
38             conn, Expression.Call(conn, meanAltitude), Expression.
↪ConstantDouble(conn, 10000));
39         var evnt = conn.KRPC().AddEvent(expr);
40         lock (evnt.Condition) {
41             evnt.Wait();
42         }

```

```

39     auto mean_altitude = vessel.flight().mean_altitude_call();
40     auto expr = Expr::greater_than(
41         conn, Expr::call(conn, mean_altitude), Expr::constant_double(conn, 10000));
42     auto event = krpc.add_event(expr);
43     event.acquire();
44     event.wait();
45     event.release();

```

```

50     ProcedureCall meanAltitude = connection.getCall(vessel.flight(null),
↪"getMeanAltitude");
51     Expression expr = Expression.greaterThan(
52         connection,
53         Expression.call(connection, meanAltitude),
54         Expression.constantDouble(connection, 10000));
55     Event event = krpc.addEvent(expr);
56     synchronized (event.getCondition()) {
57         event.waitFor();
58     }

```

```

21 while vessel:flight().mean_altitude < 10000 do
22     platform.sleep(1)
23 end

```

```

25 mean_altitude = conn.get_call(getattr, vessel.flight(), 'mean_altitude')
26 expr = conn.krpc.Expression.greater_than(
27     conn.krpc.Expression.call(mean_altitude),
28     conn.krpc.Expression.constant_double(10000))
29 event = conn.krpc.add_event(expr)
30 with event.condition:
31     event.wait()

```

In this bit of code, calling `vessel.flight()` returns a *Flight* object that is used to get all sorts of information about the rocket, such as the direction it is pointing in and its velocity.

Now we need to angle the rocket over to a pitch of 60° and maintain a heading of 90° (west). To do this, we simply reconfigure the auto-pilot:

C#

C++

Java

Lua

Python

```
45 Console.WriteLine ("Gravity turn");
46 vessel.AutoPilot.TargetPitchAndHeading (60, 90);
```

```
48 std::cout << "Gravity turn" << std::endl;
49 vessel.auto_pilot().target_pitch_and_heading(60, 90);
```

```
61 System.out.println("Gravity turn");
62 vessel.getAutoPilot().targetPitchAndHeading(60, 90);
```

```
25 print('Gravity turn')
26 vessel.auto_pilot:target_pitch_and_heading(60, 90)
```

```
33 print('Gravity turn')
34 vessel.auto_pilot.target_pitch_and_heading(60, 90)
```

Now we wait until the apoapsis reaches 100km (again, using an event), then reduce the throttle to zero, jettison the launch stage and turn off the auto-pilot:

C#

C++

Java

Lua

Python

```
32 {
33     var apoapsisAltitude = Connection.GetCall(() => vessel.Orbit.
↪ApoapsisAltitude);
34     var expr = Expression.GreaterThan(
35         conn, Expression.Call(conn, apoapsisAltitude), Expression.
↪ConstantDouble(conn, 100000));
36     var evnt = conn.KRPC().AddEvent(expr);
37     lock (evnt.Condition) {
38         evnt.Wait();
39     }
40 }
41
42 Console.WriteLine ("Launch stage separation");
43 vessel.Control.Throttle = 0;
44 System.Threading.Thread.Sleep (1000);
45 vessel.Control.ActivateNextStage ();
46 vessel.AutoPilot.Disengage ();
```

```

51 {
52     auto apoapsis_altitude = vessel.orbit().apoapsis_altitude_call();
53     auto expr = Expr::greater_than(
54         conn, Expr::call(conn, apoapsis_altitude), Expr::constant_double(conn, 100000));
55     auto event = krpc.add_event(expr);
56     event.acquire();
57     event.wait();
58     event.release();
59 }
60
61 std::cout << "Launch stage separation" << std::endl;
62 vessel.control().set_throttle(0);
63 std::this_thread::sleep_for(std::chrono::seconds(1));
64 vessel.control().activate_next_stage();
65 vessel.auto_pilot().disengage();

```

```

64 {
65     ProcedureCall apoapsisAltitude = connection.getCall(
66         vessel.getOrbit(), "getApoapsisAltitude");
67     Expression expr = Expression.greaterThan(
68         connection,
69         Expression.call(connection, apoapsisAltitude),
70         Expression.constantDouble(connection, 100000));
71     Event event = krpc.addEvent(expr);
72     synchronized (event.getCondition()) {
73         event.waitFor();
74     }
75 }
76
77 System.out.println("Launch stage separation");
78 vessel.getControl().setThrottle(0);
79 Thread.sleep(1000);
80 vessel.getControl().activateNextStage();
81 vessel.getAutoPilot().disengage();

```

```

28 while vessel.orbit.apoapsis_altitude < 100000 do
29     platform.sleep(1)
30 end
31 print('Launch stage separation')
32 vessel.control.throttle = 0
33 platform.sleep(1)
34 vessel.control.activate_next_stage()
35 vessel.auto_pilot.disengage()

```

```

36 apoapsis_altitude = conn.get_call(getattr, vessel.orbit, 'apoapsis_altitude')
37 expr = conn.krpc.Expression.greater_than(
38     conn.krpc.Expression.call(apoapsis_altitude),
39     conn.krpc.Expression.constant_double(100000))
40 event = conn.krpc.add_event(expr)
41 with event.condition:
42     event.wait()
43
44 print('Launch stage separation')
45 vessel.control.throttle = 0
46 time.sleep(1)
47 vessel.control.activate_next_stage()
48 vessel.auto_pilot.disengage()

```

In this bit of code, `vessel.orbit` returns an *Orbit* object that contains all the information about the orbit of the rocket.

2.1.4 Part Four: Returning Safely to Kerbin

Our Kerbals are now heading on a sub-orbital trajectory and are on a collision course with the surface. All that remains to do is wait until they fall to 1km altitude above the surface, and then deploy the parachutes. If you like, you can use time acceleration to skip ahead to just before this happens - the script will continue to work.

C#

C++

Java

Lua

Python

```

64         {
65             var srfAltitude = Connection.GetCall(() => vessel.Flight(null).
↪SurfaceAltitude);
66             var expr = Expression.LessThan(
67                 conn, Expression.Call(conn, srfAltitude), Expression.
↪ConstantDouble(conn, 1000));
68             var evnt = conn.KRPC().AddEvent(expr);
69             lock (evnt.Condition) {
70                 evnt.Wait();
71             }
72         }
73
74         vessel.Control.ActivateNextStage ();

```

```

67     {
68         auto srf_altitude = vessel.flight().surface_altitude_call();
69         auto expr = Expr::less_than(
70             conn, Expr::call(conn, srf_altitude), Expr::constant_double(conn, 1000));
71         auto event = krpc.add_event(expr);
72         event.acquire();
73         event.wait();
74         event.release();
75     }
76
77     vessel.control().activate_next_stage();

```

```

83     {
84         ProcedureCall srfAltitude = connection.getCall(
85             vessel.flight(null), "getSurfaceAltitude");
86         Expression expr = Expression.lessThan(
87             connection,
88             Expression.call(connection, srfAltitude),
89             Expression.constantDouble(connection, 1000));
90         Event event = krpc.addEvent(expr);
91         synchronized (event.getCondition()) {
92             event.waitFor();
93         }
94     }

```

```

95
96     vessel.getControl().activateNextStage();

```

```

37 while vessel:flight().surface_altitude > 1000 do
38     platform.sleep(1)
39 end
40 vessel.control:activate_next_stage()

```

```

50 srf_altitude = conn.get_call(getattr, vessel.flight(), 'surface_altitude')
51 expr = conn.krpc.Expression.less_than(
52     conn.krpc.Expression.call(srf_altitude),
53     conn.krpc.Expression.constant_double(1000))
54 event = conn.krpc.add_event(expr)
55 with event.condition:
56     event.wait()
57
58 vessel.control.activate_next_stage()

```

The parachutes should have now been deployed. The next bit of code will repeatedly print out the altitude of the capsule until its speed reaches zero – which will happen when it lands:

C#

C++

Java

Lua

Python

```

76     while (vessel.Flight (vessel.Orbit.Body.ReferenceFrame).VerticalSpeed < -0.1)
↪ {
77         Console.WriteLine ("Altitude = {0:F1} meters", vessel.Flight ().
↪ SurfaceAltitude);
78         System.Threading.Thread.Sleep (1000);
79     }
80     Console.WriteLine ("Landed!");
81     conn.Dispose();

```

```

79     while (vessel.flight(vessel.orbit().body().reference_frame()).vertical_speed() < -0.
↪ 1) {
80         std::cout << "Altitude = " << vessel.flight().surface_altitude() << " meters" <<
↪ std::endl;
81         std::this_thread::sleep_for(std::chrono::seconds(1));
82     }
83     std::cout << "Landed!" << std::endl;

```

```

98     while (vessel.flight(vessel.getOrbit().getBody().getReferenceFrame()).
↪ getVerticalSpeed() < -0.1) {
99         System.out.printf("Altitude = %.1f meters\n", vessel.flight(null).
↪ getSurfaceAltitude());
100         Thread.sleep(1000);
101     }
102     System.out.println("Landed!");
103     connection.close();

```

```

42 while vessel:flight(vessel.orbit.body.reference_frame).vertical_speed < -0.1 do
43     print(string.format('Altitude = %.1f meters',
44                         vessel:flight().surface_altitude))
45     platform.sleep(1)
46 end
47 print('Landed!')

```

```

60 while vessel:flight(vessel.orbit.body.reference_frame).vertical_speed < -0.1:
61     print('Altitude = %.1f meters' % vessel:flight().surface_altitude)
62     time.sleep(1)
63 print('Landed!')

```

This bit of code uses the `vessel:flight()` function, as before, but this time it is passed a *ReferenceFrame* parameter. We want to get the vertical speed of the capsule relative to the surface of Kerbin, so the values returned by the flight object need to be relative to the surface of Kerbin. We therefore pass `vessel.orbit.body.reference_frame` to `vessel:flight()` as this reference frame has its origin at the center of Kerbin and it rotates with the planet. For more information, check out the tutorial on *Reference Frames*.

Your Kerbals should now have safely landed back on the surface.

2.2 Reference Frames

- *Introduction*
 - *Origin Position and Axis Orientation*
 - * *Celestial Body Reference Frame*
 - * *Vessel Orbital Reference Frame*
 - * *Vessel Surface Reference Frame*
 - *Linear Velocity and Angular Velocity*
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- *Custom Reference Frames*
- *Converting Between Reference Frames*
- *Visual Debugging*
- *Examples*
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 - *Orbital directions*
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 - *Vessel Speed*
 - *Vessel Velocity*
 - *Angle of attack*
 - *Landing Site*

2.2.1 Introduction

All of the positions, directions, velocities and rotations in kRPC are relative to something, and *reference frames* define what that something is.

A reference frame specifies:

- The position of the origin at (0,0,0)
- the direction of the coordinate axes x, y, and z
- the linear velocity of the origin (if the reference frame moves)
- The angular velocity of the coordinate axes (the speed and direction of rotation of the axes)

Note: KSP and kRPC use a left handed coordinate system

Origin Position and Axis Orientation

The following gives some examples of the position of the origin and the orientation of the coordinate axes for various reference frames.

Celestial Body Reference Frame

The reference frame obtained by calling `CelestialBody.reference_frame` for Kerbin has the following properties:

- The origin is at the center of Kerbin,
- the y-axis points from the center of Kerbin to the north pole,
- the x-axis points from the center of Kerbin to the intersection of the prime meridian and equator (the surface position at 0° longitude, 0° latitude),
- the z-axis points from the center of Kerbin to the equator at 90°E longitude,
- and the axes rotate with the planet, i.e. the reference frame has the same rotational/angular velocity as Kerbin.

This means that the reference frame is *fixed* relative to Kerbin – it moves with the center of the planet, and also rotates with the planet. Therefore, positions in this reference frame are relative to the center of the planet. The following code prints out the position of the active vessel in Kerbin's reference frame:

C#

C++

C

Java

Lua

Python

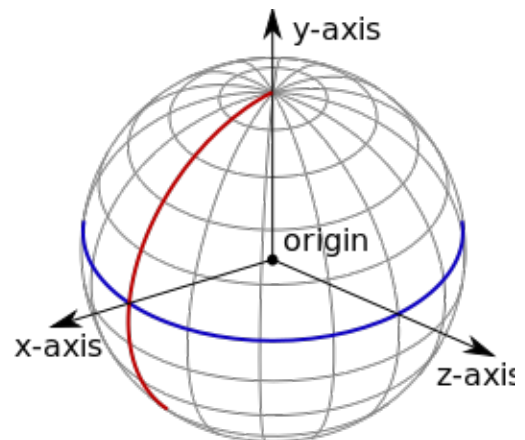


Fig. 2.1: The reference frame for a celestial body, such as Kerbin. The equator is shown in blue, and the prime meridian in red. The black arrows show the coordinate axes, and the origin is at the center of the planet.

```

using System;
using KRPC.Client;
using KRPC.Client.Services.SpaceCenter;

class VesselPosition
{
    public static void Main ()
    {
        using (var connection = new Connection ()) {
            var vessel = connection.SpaceCenter ().ActiveVessel;
            var position = vessel.Position (vessel.Orbit.Body.ReferenceFrame);
            Console.WriteLine ("({0:F1}, {1:F1}, {2:F1})",
                               position.Item1, position.Item2, position.Item3);
        }
    }
}

```

```

#include <iostream>
#include <iomanip>
#include <krpc.hpp>
#include <krpc/services/space_center.hpp>

int main() {
    krpc::Client conn = krpc::connect();
    krpc::services::SpaceCenter spaceCenter(&conn);
    auto vessel = spaceCenter.active_vessel();
    auto position = vessel.position(vessel.orbit().body().reference_frame());
    std::cout << std::fixed << std::setprecision(1);
    std::cout << std::get<0>(position) << ", "
              << std::get<1>(position) << ", "
              << std::get<2>(position) << std::endl;
}

```

```

#include <unistd.h>
#include <math.h>
#include <krpc.h>
#include <krpc/services/space_center.h>

int main() {
    krpc_connection_t conn;
    krpc_open(&conn, "COM0");
    krpc_connect(conn, "Vessel position");

    krpc_SpaceCenter_Vessel_t vessel;
    krpc_SpaceCenter_ActiveVessel(conn, &vessel);
    krpc_SpaceCenter_Orbit_t orbit;
    krpc_SpaceCenter_Vessel_Orbit(conn, &orbit, vessel);
    krpc_SpaceCenter_CelestialBody_t body;
    krpc_SpaceCenter_Orbit_Body(conn, &body, orbit);
    krpc_SpaceCenter_ReferenceFrame_t body_frame;
    krpc_SpaceCenter_CelestialBody_ReferenceFrame(conn, &body_frame, body);

    krpc_tuple_double_double_double_t position;
    krpc_SpaceCenter_Vessel_Position(conn, &position, vessel, body_frame);
    printf("%.2f, %.2f, %.2f\n", position.e0, position.e1, position.e2);
}

```

```

import krpc.client.Connection;
import krpc.client.RPCException;
import krpc.client.services.SpaceCenter;
import krpc.client.services.SpaceCenter.Vessel;

import org.javatuples.Triplet;

import java.io.IOException;

public class VesselPosition {
    public static void main(String[] args) throws IOException, RPCException {
        Connection connection = Connection.newInstance();
        SpaceCenter spaceCenter = SpaceCenter.newInstance(connection);
        Vessel vessel = spaceCenter.getActiveVessel();
        Triplet<Double, Double, Double> position =
            vessel.position(vessel.getOrbit().getBody().getReferenceFrame());
        System.out.printf("(%.1f, %.1f, %.1f)\n",
            position.getValue0(),
            position.getValue1(),
            position.getValue2());
        connection.close();
    }
}

```

```

local krpc = require 'krpc'
local conn = krpc.connect()
local vessel = conn.space_center.active_vessel
print(vessel:position(vessel.orbit.body.reference_frame))

```

```

import krpc
conn = krpc.connect()
vessel = conn.space_center.active_vessel
print('("%.1f, %.1f, %.1f)' % vessel.position(vessel.orbit.body.reference_frame))

```

For a vessel sat on the launchpad, the magnitude of this position vector will be roughly 600,000 meters (equal to the radius of Kerbin). The position vector will also not change over time, because the vessel is sat on the surface of Kerbin and the reference frame also rotates with Kerbin.

Vessel Orbital Reference Frame

Another example is the orbital reference frame for a vessel, obtained by calling `Vessel.orbital_reference_frame`. This is fixed to the vessel (the origin moves with the vessel) and is orientated so that the axes point in the orbital prograde/normal/radial directions.

- The origin is at the center of mass of the vessel,
- the y-axis points in the prograde direction of the vessels orbit,
- the x-axis points in the anti-radial direction of the vessels orbit,

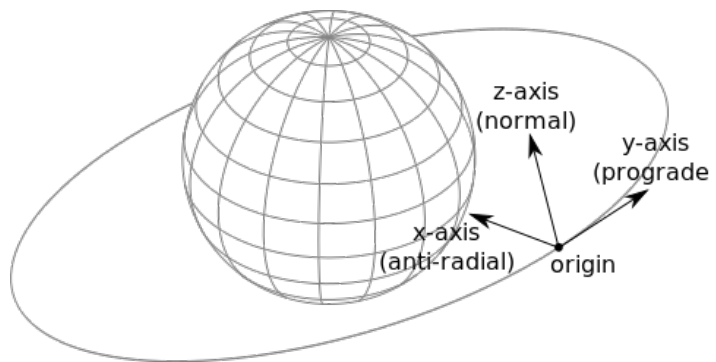


Fig. 2.2: The orbital reference frame for a vessel.

- the z-axis points in the normal direction of the vessels orbit,
- and the axes rotate to match any changes to the prograde/normal/radial directions, for example when the prograde direction changes as the vessel continues on its orbit.

Vessel Surface Reference Frame

Another example is `Vessel.reference_frame`. As with the previous example, it is fixed to the vessel (the origin moves with the vessel), however the orientation of the coordinate axes is different. They track the orientation of the vessel:

- The origin is at the center of mass of the vessel,
- the y-axis points in the same direction that the vessel is pointing,
- the x-axis points out of the right side of the vessel,
- the z-axis points downwards out of the bottom of the vessel,
- and the axes rotate with any changes to the direction of the vessel.

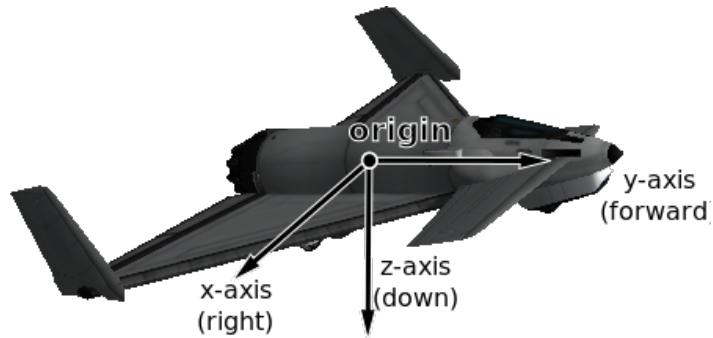


Fig. 2.3: The reference frame for an aircraft.

Linear Velocity and Angular Velocity

Reference frames move and rotate relative to one another. For example, the reference frames discussed previously all have their origin position fixed to some object (such as a vessel or a planet). This means that they move and rotate to track the object, and so have a linear and angular velocity associated with them.

For example, the reference frame obtained by calling `CelestialBody.reference_frame` for Kerbin is fixed relative to Kerbin. This means the angular velocity of the reference frame is identical to Kerbin's angular velocity, and the linear velocity of the reference frame matches the current orbital velocity of Kerbin.

2.2.2 Available Reference Frames

kRPC provides the following reference frames:

C#

C++

C

Java

Lua

Python

- `Vessel.ReferenceFrame`

- *Vessel.OrbitalReferenceFrame*
- *Vessel.SurfaceReferenceFrame*
- *Vessel.SurfaceVelocityReferenceFrame*
- *CelestialBody.ReferenceFrame*
- *CelestialBody.NonRotatingReferenceFrame*
- *CelestialBody.OrbitalReferenceFrame*
- *Node.ReferenceFrame*
- *Node.OrbitalReferenceFrame*
- *Part.ReferenceFrame*
- *Part.CenterOfMassReferenceFrame*
- *DockingPort.ReferenceFrame*
- *Thruster.ThrustReferenceFrame*
- *Vessel::reference_frame()*
- *Vessel::orbital_reference_frame()*
- *Vessel::surface_reference_frame()*
- *Vessel::surface_velocity_reference_frame()*
- *CelestialBody::reference_frame()*
- *CelestialBody::non_rotating_reference_frame()*
- *CelestialBody::orbital_reference_frame()*
- *Node::reference_frame()*
- *Node::orbital_reference_frame()*
- *Part::reference_frame()*
- *Part::center_of_mass_reference_frame()*
- *DockingPort::reference_frame()*
- *Thruster::thrust_reference_frame()*
- *krpc_SpaceCenter_Vessel_ReferenceFrame()*
- *krpc_SpaceCenter_Vessel_OrbitalReferenceFrame()*
- *krpc_SpaceCenter_Vessel_SurfaceReferenceFrame()*
- *krpc_SpaceCenter_Vessel_SurfaceVelocityReferenceFrame()*
- *krpc_SpaceCenter_CelestialBody_ReferenceFrame()*
- *krpc_SpaceCenter_CelestialBody_NonRotatingReferenceFrame()*
- *krpc_SpaceCenter_CelestialBody_OrbitalReferenceFrame()*
- *krpc_SpaceCenter_Node_ReferenceFrame()*
- *krpc_SpaceCenter_Node_OrbitalReferenceFrame()*
- *krpc_SpaceCenter_Part_ReferenceFrame()*
- *krpc_SpaceCenter_Part_CenterOfMassReferenceFrame()*

- `krpc_SpaceCenter_DockingPort_ReferenceFrame()`
- `krpc_SpaceCenter_Thruster_ThrustReferenceFrame()`
- `Vessel.getReferenceFrame`
- `Vessel.getOrbitalReferenceFrame`
- `Vessel.getSurfaceReferenceFrame`
- `Vessel.getSurfaceVelocityReferenceFrame`
- `CelestialBody.getReferenceFrame`
- `CelestialBody.getNonRotatingReferenceFrame`
- `CelestialBody.getOrbitalReferenceFrame`
- `Node.getReferenceFrame`
- `Node.getOrbitalReferenceFrame`
- `Part.getReferenceFrame`
- `Part.getCenterOfMassReferenceFrame`
- `DockingPort.getReferenceFrame`
- `Thruster.getThrustReferenceFrame`
- `Vessel.reference_frame`
- `Vessel.orbital_reference_frame`
- `Vessel.surface_reference_frame`
- `Vessel.surface_velocity_reference_frame`
- `CelestialBody.reference_frame`
- `CelestialBody.non_rotating_reference_frame`
- `CelestialBody.orbital_reference_frame`
- `Node.reference_frame`
- `Node.orbital_reference_frame`
- `Part.reference_frame`
- `Part.center_of_mass_reference_frame`
- `DockingPort.reference_frame`
- `Thruster.thrust_reference_frame`
- `Vessel.reference_frame`
- `Vessel.orbital_reference_frame`
- `Vessel.surface_reference_frame`
- `Vessel.surface_velocity_reference_frame`
- `CelestialBody.reference_frame`
- `CelestialBody.non_rotating_reference_frame`
- `CelestialBody.orbital_reference_frame`
- `Node.reference_frame`

- `Node.orbital_reference_frame`
- `Part.reference_frame`
- `Part.center_of_mass_reference_frame`
- `DockingPort.reference_frame`
- `Thruster.thrust_reference_frame`

Relative and hybrid reference frames can also be constructed from the above.

2.2.3 Custom Reference Frames

Custom reference frames can be constructed from the built in frames listed above. They come in two varieties: 'relative' and 'hybrid'.

A relative reference frame is constructed from a parent reference frame, a fixed position offset and a fixed rotation offset. For example, this could be used to construct a reference frame whose origin is 10m below the vessel as follows, by applying a position offset of 10 along the z-axis to `Vessel.reference_frame`. Relative reference frames can be constructed by calling `ReferenceFrame.create_relative()`.

A hybrid reference frame inherits its components (position, rotation, velocity and angular velocity) from the components of other reference frames. Note that these components need not be fixed. For example, you could construct a reference frame whose position is the center of mass of the vessel (inherited from `Vessel.reference_frame`) and whose rotation is that of the planet being orbited (inherited from `CelestialBody.reference_frame`). Relative reference frames can be constructed by calling `ReferenceFrame.create_hybrid()`.

The parent reference frame(s) of a custom reference frame can also be other custom reference frames. For example, you could combine the two example frames from above: construct a hybrid reference frame, centered on the vessel and rotated with the planet being orbited, and then create a relative reference that offsets the position of this 10m along the z-axis. The resulting frame will have its origin 10m below the vessel, and will be rotated with the planet being orbited.

2.2.4 Converting Between Reference Frames

kRPC provides utility methods to convert positions, directions, rotations and velocities between the different reference frames:

C#

C++

C

Java

Lua

Python

- `SpaceCenter.TransformPosition`
- `SpaceCenter.TransformDirection`
- `SpaceCenter.TransformRotation`
- `SpaceCenter.TransformVelocity`
- `SpaceCenter::transform_position()`
- `SpaceCenter::transform_direction()`

- `SpaceCenter::transform_rotation()`
- `SpaceCenter::transform_velocity()`
- `krpc_SpaceCenter_TransformPosition()`
- `krpc_SpaceCenter_TransformDirection()`
- `krpc_SpaceCenter_TransformRotation()`
- `krpc_SpaceCenter_TransformVelocity()`
- `SpaceCenter.transformPosition`
- `SpaceCenter.transformDirection`
- `SpaceCenter.transformRotation`
- `SpaceCenter.transformVelocity`
- `SpaceCenter.transform_position()`
- `SpaceCenter.transform_direction()`
- `SpaceCenter.transform_rotation()`
- `SpaceCenter.transform_velocity()`
- `SpaceCenter.transform_position()`
- `SpaceCenter.transform_direction()`
- `SpaceCenter.transform_rotation()`
- `SpaceCenter.transform_velocity()`

2.2.5 Visual Debugging

Reference frames can be confusing, and choosing the correct one is a challenge in itself. To aid debugging, kRPCs drawing functionality can be used to visualize direction vectors in-game.

`Drawing.add_direction()` will draw a direction vector, starting from the origin of the given reference frame. For example, the following code draws the direction of the current vessel's velocity relative to the surface of the body it is orbiting:

C#

C++

C

Java

Lua

Python

```
using System;
using KRPC.Client;
using KRPC.Client.Services.Drawing;
using KRPC.Client.Services.SpaceCenter;

class VisualDebugging
{
    public static void Main ()
    {
```

```

var conn = new Connection ("Visual Debugging");
var vessel = conn.SpaceCenter ().ActiveVessel;

var refFrame = vessel.SurfaceVelocityReferenceFrame;
conn.Drawing ().AddDirection(
    new Tuple<double, double, double>(0, 1, 0), refFrame);
while (true) {
}
}

```

```

#include <krpc.hpp>
#include <krpc/services/space_center.hpp>
#include <krpc/services/ui.hpp>
#include <krpc/services/drawing.hpp>

int main() {
    krpc::Client conn = krpc::connect("Visual Debugging");
    krpc::services::SpaceCenter space_center(&conn);
    krpc::services::Drawing drawing(&conn);
    auto vessel = space_center.active_vessel();

    auto ref_frame = vessel.surface_velocity_reference_frame();
    drawing.add_direction(std::make_tuple(0, 1, 0), ref_frame);
    while (true) {
    }
}

```

```

#include <krpc.h>
#include <krpc/services/space_center.h>
#include <krpc/services/ui.h>
#include <krpc/services/drawing.h>

int main() {
    krpc_connection_t conn;
    krpc_open(&conn, "COM0");
    krpc_connect(conn, "Visual debugging");

    krpc_SpaceCenter_Vessel_t vessel;
    krpc_SpaceCenter_ActiveVessel(conn, &vessel);

    krpc_SpaceCenter_ReferenceFrame_t ref_frame;
    krpc_SpaceCenter_Vessel_SurfaceVelocityReferenceFrame(conn, &ref_frame, vessel);
    krpc_tuple_double_double_double_t direction = { 0, 1, 0 };
    krpc_Drawing_AddDirection(conn, NULL, &direction, ref_frame, 10, true);
    while (true) {
    }
}

```

```

import krpc.client.Connection;
import krpc.client.RPCException;
import krpc.client.services.SpaceCenter;
import krpc.client.services.SpaceCenter.ReferenceFrame;
import krpc.client.services.Drawing;

import org.javatuples.Triplet;

```

```
import java.io.IOException;

public class VisualDebugging {
    public static void main(String[] args) throws IOException, RPCException {
        Connection connection = Connection.newInstance("Visual Debugging");
        SpaceCenter spaceCenter = SpaceCenter.newInstance(connection);
        Drawing drawing = Drawing.newInstance(connection);
        SpaceCenter.Vessel vessel = spaceCenter.getActiveVessel();

        ReferenceFrame refFrame = vessel.getSurfaceVelocityReferenceFrame();
        drawing.addDirection(
            new Triplet<Double, Double, Double>(0.0, 1.0, 0.0), refFrame, 10, true);
        while (true) {
        }
    }
}
```

```
local krpc = require 'krpc'
local conn = krpc.connect('Visual Debugging')
local vessel = conn.space_center.active_vessel

local ref_frame = vessel.surface_velocity_reference_frame
conn.drawing.add_direction(List{0, 1, 0}, ref_frame)
while true do
end
```

```
import krpc
conn = krpc.connect(name='Visual Debugging')
vessel = conn.space_center.active_vessel

ref_frame = vessel.surface_velocity_reference_frame
conn.drawing.add_direction((0, 1, 0), ref_frame)
while True:
    pass
```

Note: The client must remain connected for the line to continue to be drawn, hence the infinite loop at the end of this example.

2.2.6 Examples

The following examples demonstrate various uses of reference frames.

Navball directions

This example demonstrates how to make the vessel point in various directions on the navball:

C#
C++
C
Java

Lua

Python

```
using System;
using System.Collections.Generic;
using System.Net;
using KRPC.Client;
using KRPC.Client.Services.SpaceCenter;

class NavballDirections
{
    public static void Main ()
    {
        using (var conn = new Connection ("Navball directions")) {
            var vessel = conn.SpaceCenter ().ActiveVessel;
            var ap = vessel.AutoPilot;
            ap.ReferenceFrame = vessel.SurfaceReferenceFrame;
            ap.Engage();

            // Point the vessel north on the navball, with a pitch of 0 degrees
            ap.TargetDirection = Tuple.Create (0.0, 1.0, 0.0);
            ap.Wait();

            // Point the vessel vertically upwards on the navball
            ap.TargetDirection = Tuple.Create (1.0, 0.0, 0.0);
            ap.Wait();

            // Point the vessel west (heading of 270 degrees), with a pitch of 0_
            ↪degrees
            ap.TargetDirection = Tuple.Create (0.0, 0.0, -1.0);
            ap.Wait();

            ap.Disengage();
        }
    }
}
```

```
#include <kRPC.hpp>
#include <kRPC/services/space_center.hpp>

int main() {
    kRPC::Client conn = kRPC::connect("Navball directions");
    kRPC::services::SpaceCenter space_center(&conn);
    auto vessel = space_center.active_vessel();
    auto ap = vessel.auto_pilot();
    ap.set_reference_frame(vessel.surface_reference_frame());
    ap.engage();

    // Point the vessel north on the navball, with a pitch of 0 degrees
    ap.set_target_direction(std::make_tuple(0, 1, 0));
    ap.wait();

    // Point the vessel vertically upwards on the navball
    ap.set_target_direction(std::make_tuple(1, 0, 0));
    ap.wait();

    // Point the vessel west (heading of 270 degrees), with a pitch of 0 degrees
    ap.set_target_direction(std::make_tuple(0, 0, -1));
}
```

```

    ap.wait();

    ap.disengage();
}

```

```

#include <unistd.h>
#include <math.h>
#include <krpc.h>
#include <krpc/services/space_center.h>

typedef krpc_tuple_double_double_double_t vector3;

int main() {
    krpc_connection_t conn;
    krpc_open(&conn, "COM0");
    krpc_connect(conn, "Navball directions");

    krpc_SpaceCenter_Vessel_t vessel;
    krpc_SpaceCenter_ActiveVessel(conn, &vessel);
    krpc_SpaceCenter_ReferenceFrame_t vessel_srf_ref;
    krpc_SpaceCenter_Vessel_SurfaceReferenceFrame(conn, &vessel_srf_ref, vessel);

    krpc_SpaceCenter_AutoPilot_t ap;
    krpc_SpaceCenter_Vessel_AutoPilot(conn, &ap, vessel);
    krpc_SpaceCenter_AutoPilot_set_ReferenceFrame(conn, ap, vessel_srf_ref);
    krpc_SpaceCenter_AutoPilot_Engage(conn, ap);

    // Point the vessel north on the navball, with a pitch of 0 degrees
    {
        krpc_tuple_double_double_double_t direction = { 0, 1, 0 };
        krpc_SpaceCenter_AutoPilot_set_TargetDirection(conn, ap, &direction);
        krpc_SpaceCenter_AutoPilot_Wait(conn, ap);
    }

    // Point the vessel vertically upwards on the navball
    {
        krpc_tuple_double_double_double_t direction = { 1, 0, 0 };
        krpc_SpaceCenter_AutoPilot_set_TargetDirection(conn, ap, &direction);
        krpc_SpaceCenter_AutoPilot_Wait(conn, ap);
    }

    // Point the vessel west (heading of 270 degrees), with a pitch of 0 degrees
    {
        krpc_tuple_double_double_double_t direction = { 0, 0, -1 };
        krpc_SpaceCenter_AutoPilot_set_TargetDirection(conn, ap, &direction);
        krpc_SpaceCenter_AutoPilot_Wait(conn, ap);
    }

    krpc_SpaceCenter_AutoPilot_Disengage(conn, ap);
}

```

```

import krpc.client.Connection;
import krpc.client.RPCException;
import krpc.client.services.SpaceCenter;
import krpc.client.services.SpaceCenter.AutoPilot;
import krpc.client.services.SpaceCenter.Vessel;

```

```
import org.javatuples.Triplet;

import java.io.IOException;

public class NavballDirections {
    public static void main(String[] args) throws IOException, RPCException {
        Connection connection = Connection.newInstance("Navball directions");
        SpaceCenter spaceCenter = SpaceCenter.newInstance(connection);
        Vessel vessel = spaceCenter.getActiveVessel();
        AutoPilot ap = vessel.getAutoPilot();
        ap.setReferenceFrame(vessel.getSurfaceReferenceFrame());
        ap.engage();

        // Point the vessel north on the navball, with a pitch of 0 degrees
        ap.setTargetDirection(new Triplet<Double,Double,Double> (0.0, 1.0, 0.0));
        ap.wait_();

        // Point the vessel vertically upwards on the navball
        ap.setTargetDirection(new Triplet<Double,Double,Double> (1.0, 0.0, 0.0));
        ap.wait_();

        // Point the vessel west (heading of 270 degrees), with a pitch of 0 degrees
        ap.setTargetDirection(new Triplet<Double,Double,Double> (0.0, 0.0, -1.0));
        ap.wait_();

        ap.disengage();
        connection.close();
    }
}
```

```
local krpc = require 'krpc'
local List = require 'pl.List'
local conn = krpc.connect('Navball directions')
local vessel = conn.space_center.active_vessel
local ap = vessel.auto_pilot
ap.reference_frame = vessel.surface_reference_frame
ap:engage()

-- Point the vessel north on the navball, with a pitch of 0 degrees
ap.target_direction = List{0, 1, 0}
ap:wait()

-- Point the vessel vertically upwards on the navball
ap.target_direction = List{1, 0, 0}
ap:wait()

-- Point the vessel west (heading of 270 degrees), with a pitch of 0 degrees
ap.target_direction = List{0, 0, -1}
ap:wait()

ap:disengage()
```

```
import krpc
conn = krpc.connect(name='Navball directions')
vessel = conn.space_center.active_vessel
ap = vessel.auto_pilot
ap.reference_frame = vessel.surface_reference_frame
```

```

ap.engage()

# Point the vessel north on the navball, with a pitch of 0 degrees
ap.target_direction = (0, 1, 0)
ap.wait()

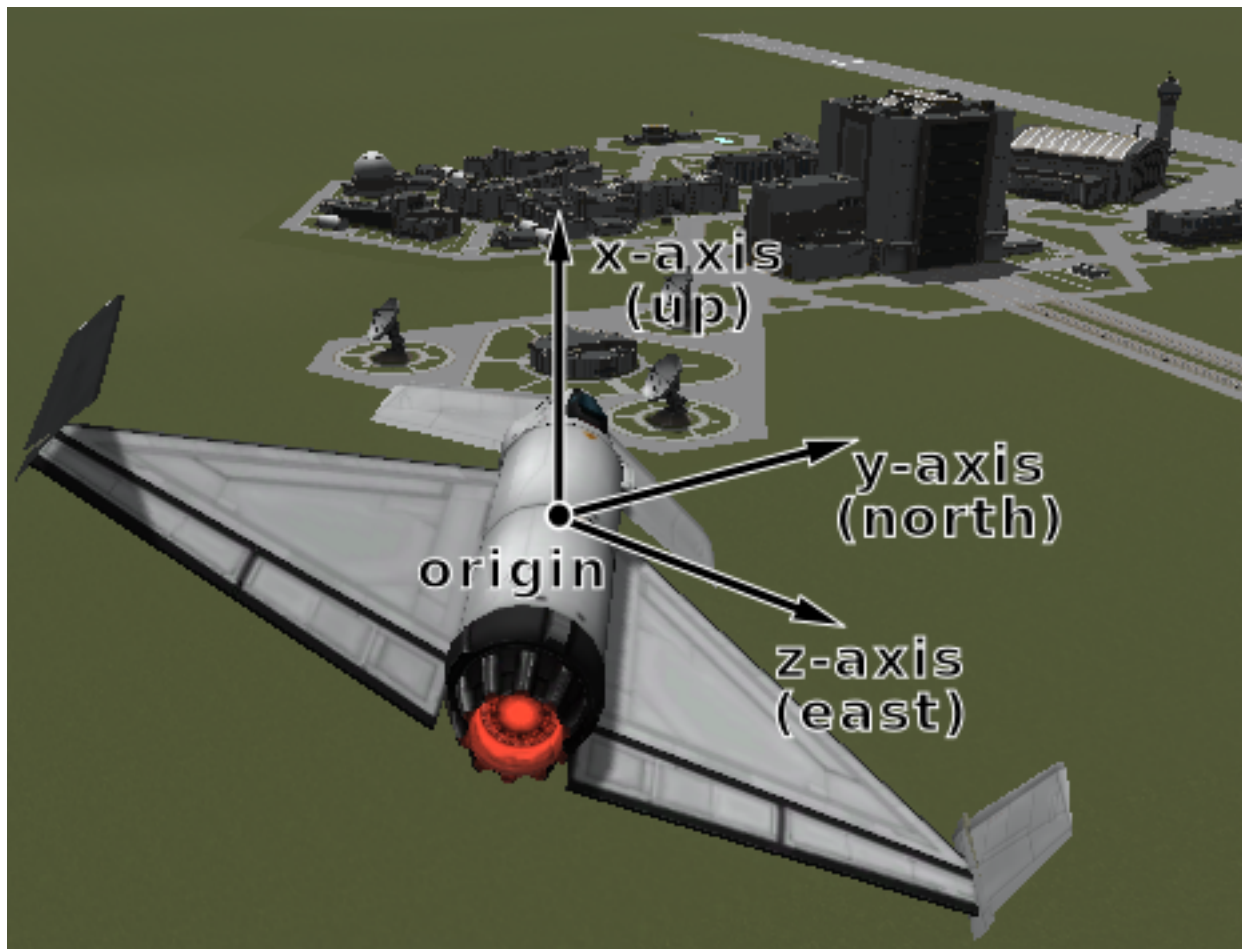
# Point the vessel vertically upwards on the navball
ap.target_direction = (1, 0, 0)
ap.wait()

# Point the vessel west (heading of 270 degrees), with a pitch of 0 degrees
ap.target_direction = (0, 0, -1)
ap.wait()

ap.disengage()

```

The code uses the vessel's surface reference frame (*Vessel.surface_reference_frame*), pictured below:



The first part instructs the auto-pilot to point in direction $(0, 1, 0)$ (i.e. along the y-axis) in the vessel's surface reference frame. The y-axis of the reference frame points in the north direction, as required.

The second part instructs the auto-pilot to point in direction $(1, 0, 0)$ (along the x-axis) in the vessel's surface reference frame. This x-axis of the reference frame points upwards (away from the planet) as required.

Finally, the code instructs the auto-pilot to point in direction $(0, 0, -1)$ (along the negative z axis). The z-axis of the reference frame points east, so the requested direction points west – as required.

Orbital directions

This example demonstrates how to make the vessel point in the various orbital directions, as seen on the navball when it is in ‘orbit’ mode. It uses `Vessel.orbital_reference_frame`.

C#

C++

C

Java

Lua

Python

```
using System;
using System.Collections.Generic;
using System.Net;
using KRPC.Client;
using KRPC.Client.Services.SpaceCenter;

class NavballDirections
{
    public static void Main ()
    {
        using (var conn = new Connection ("Orbital directions")) {
            var vessel = conn.SpaceCenter ().ActiveVessel;
            var ap = vessel.AutoPilot;
            ap.ReferenceFrame = vessel.OrbitalReferenceFrame;
            ap.Engage();

            // Point the vessel in the prograde direction
            ap.TargetDirection = Tuple.Create (0.0, 1.0, 0.0);
            ap.Wait();

            // Point the vessel in the orbit normal direction
            ap.TargetDirection = Tuple.Create (0.0, 0.0, 1.0);
            ap.Wait();

            // Point the vessel in the orbit radial direction
            ap.TargetDirection = Tuple.Create (-1.0, 0.0, 0.0);
            ap.Wait();

            ap.Disengage();
        }
    }
}
```

```
#include <kRPC.hpp>
#include <kRPC/services/space_center.hpp>

int main() {
    kRPC::Client conn = kRPC::connect("Orbital directions");
    kRPC::services::SpaceCenter space_center(&conn);
    auto vessel = space_center.active_vessel();
    auto ap = vessel.auto_pilot();
    ap.set_reference_frame(vessel.orbital_reference_frame());
    ap.engage();
}
```

```

// Point the vessel in the prograde direction
ap.set_target_direction(std::make_tuple(0, 1, 0));
ap.wait();

// Point the vessel in the orbit normal direction
ap.set_target_direction(std::make_tuple(0, 0, 1));
ap.wait();

// Point the vessel in the orbit radial direction
ap.set_target_direction(std::make_tuple(-1, 0, 0));
ap.wait();

ap.disengage();
}

```

```

#include <unistd.h>
#include <math.h>
#include <krpc.h>
#include <krpc/services/space_center.h>

typedef krpc_tuple_double_double_double_t vector3;

int main() {
    krpc_connection_t conn;
    krpc_open(&conn, "COM0");
    krpc_connect(conn, "Orbital directions");

    krpc_SpaceCenter_Vessel_t vessel;
    krpc_SpaceCenter_ActiveVessel(conn, &vessel);
    krpc_SpaceCenter_ReferenceFrame_t vessel_obt_ref;
    krpc_SpaceCenter_Vessel_OrbitalReferenceFrame(conn, &vessel_obt_ref, vessel);

    krpc_SpaceCenter_AutoPilot_t ap;
    krpc_SpaceCenter_Vessel_AutoPilot(conn, &ap, vessel);
    krpc_SpaceCenter_AutoPilot_set_ReferenceFrame(conn, ap, vessel_obt_ref);
    krpc_SpaceCenter_AutoPilot_Engage(conn, ap);

    // Point the vessel in the prograde direction
    {
        krpc_tuple_double_double_double_t direction = { 0, 1, 0 };
        krpc_SpaceCenter_AutoPilot_set_TargetDirection(conn, ap, &direction);
        krpc_SpaceCenter_AutoPilot_Wait(conn, ap);
    }

    // Point the vessel in the orbit normal direction
    {
        krpc_tuple_double_double_double_t direction = { 0, 0, 1 };
        krpc_SpaceCenter_AutoPilot_set_TargetDirection(conn, ap, &direction);
        krpc_SpaceCenter_AutoPilot_Wait(conn, ap);
    }

    // Point the vessel in the orbit radial direction
    {
        krpc_tuple_double_double_double_t direction = { -1, 0, 0 };
        krpc_SpaceCenter_AutoPilot_set_TargetDirection(conn, ap, &direction);
        krpc_SpaceCenter_AutoPilot_Wait(conn, ap);
    }
}

```

```
krpc_SpaceCenter_AutoPilot_Disengage(conn, ap);
}
```

```
import krpc.client.Connection;
import krpc.client.RPCException;
import krpc.client.services.SpaceCenter;
import krpc.client.services.SpaceCenter.AutoPilot;
import krpc.client.services.SpaceCenter.Vessel;

import org.javatuples.Triplet;

import java.io.IOException;

public class OrbitalDirections {
    public static void main(String[] args) throws IOException, RPCException {
        Connection connection = Connection.newInstance("Orbital directions");
        SpaceCenter spaceCenter = SpaceCenter.newInstance(connection);
        Vessel vessel = spaceCenter.getActiveVessel();
        AutoPilot ap = vessel.getAutoPilot();
        ap.setReferenceFrame(vessel.getOrbitalReferenceFrame());
        ap.engage();

        // Point the vessel in the prograde direction
        ap.setTargetDirection(new Triplet<Double,Double,Double> (0.0, 1.0, 0.0));
        ap.wait_();

        // Point the vessel in the orbit normal direction
        ap.setTargetDirection(new Triplet<Double,Double,Double> (0.0, 0.0, 1.0));
        ap.wait_();

        // Point the vessel in the orbit radial direction
        ap.setTargetDirection(new Triplet<Double,Double,Double> (-1.0, 0.0, 0.0));
        ap.wait_();

        ap.disengage();
        connection.close();
    }
}
```

```
local krpc = require 'krpc'
local List = require 'pl.List'
local conn = krpc.connect('Orbital directions')
local vessel = conn.space_center.active_vessel
local ap = vessel.auto_pilot
ap.reference_frame = vessel.orbital_reference_frame
ap:engage()

-- Point the vessel in the prograde direction
ap.target_direction = List{0, 1, 0}
ap:wait()

-- Point the vessel in the orbit normal direction
ap.target_direction = List{0, 0, 1}
ap:wait()

-- Point the vessel in the orbit radial direction
```

```

ap.target_direction = List{-1, 0, 0}
ap.wait()

ap.disengage()

```

```

import krpc
conn = krpc.connect(name='Orbital directions')
vessel = conn.space_center.active_vessel
ap = vessel.auto_pilot
ap.reference_frame = vessel.orbital_reference_frame
ap.engage()

# Point the vessel in the prograde direction
ap.target_direction = (0, 1, 0)
ap.wait()

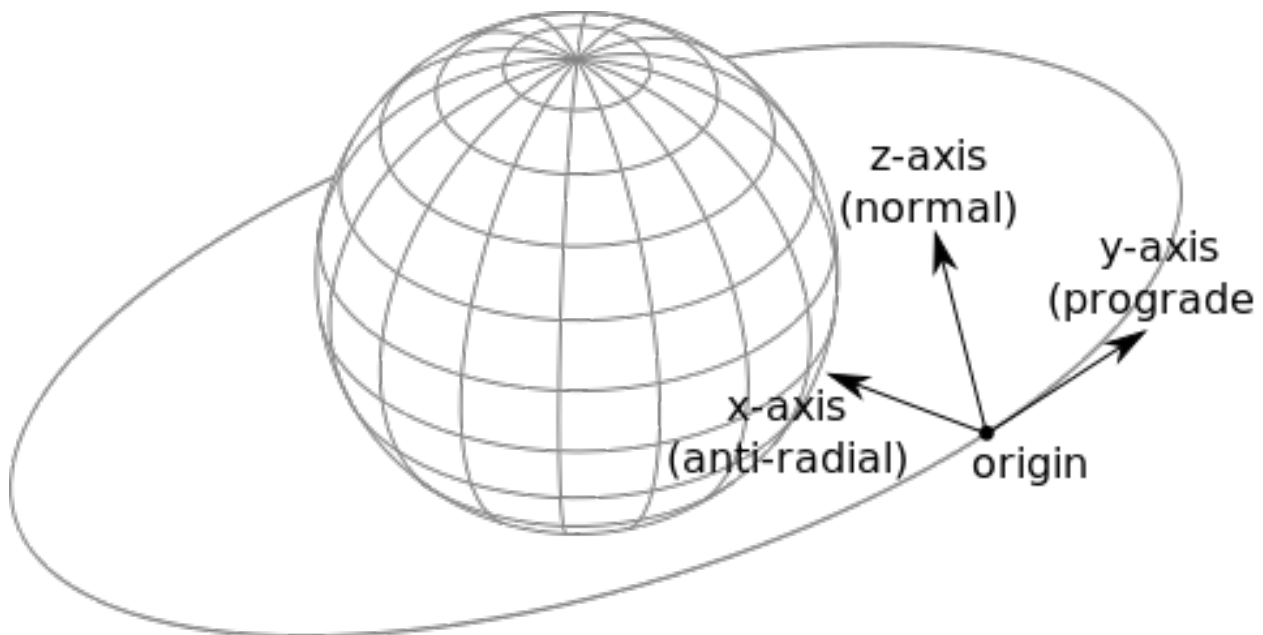
# Point the vessel in the orbit normal direction
ap.target_direction = (0, 0, 1)
ap.wait()

# Point the vessel in the orbit radial direction
ap.target_direction = (-1, 0, 0)
ap.wait()

ap.disengage()

```

This code uses the vessel's orbital reference frame, pictured below:



Surface 'prograde'

This example demonstrates how to point the vessel in the 'prograde' direction on the navball, when in 'surface' mode. This is the direction of the vessels velocity relative to the surface:

C#

C++

C

Java

Lua

Python

```
using System;
using KRPC.Client;
using KRPC.Client.Services.SpaceCenter;

class SurfacePrograde
{
    public static void Main ()
    {
        using (var connection = new Connection (name : "Surface prograde")) {
            var vessel = connection.SpaceCenter ().ActiveVessel;
            var ap = vessel.AutoPilot;

            ap.ReferenceFrame = vessel.SurfaceVelocityReferenceFrame;
            ap.TargetDirection = new Tuple<double,double,double> (0, 1, 0);
            ap.Engage ();
            ap.Wait ();
            ap.Disengage ();
        }
    }
}
```

```
#include <iostream>
#include <krpc.hpp>
#include <krpc/services/space_center.hpp>

int main() {
    krpc::Client conn = krpc::connect("Surface prograde");
    krpc::services::SpaceCenter spaceCenter(&conn);
    auto vessel = spaceCenter.active_vessel();
    auto ap = vessel.auto_pilot();

    ap.set_reference_frame(vessel.surface_velocity_reference_frame());
    ap.set_target_direction(std::make_tuple(0.0, 1.0, 0.0));
    ap.engage();
    ap.wait();
    ap.disengage();
}
```

```
#include <unistd.h>
#include <math.h>
#include <krpc.h>
#include <krpc/services/space_center.h>

typedef krpc_tuple_double_double_double_t vector3;

int main() {
    krpc_connection_t conn;
    krpc_open(&conn, "COM0");
    krpc_connect(conn, "Surface prograde");
}
```

```

krpc_SpaceCenter_Vessel_t vessel;
krpc_SpaceCenter_ActiveVessel(conn, &vessel);
krpc_SpaceCenter_ReferenceFrame_t vessel_srf_vel_ref;
krpc_SpaceCenter_Vessel_SurfaceVelocityReferenceFrame(conn, &vessel_srf_vel_ref,
↳vessel);

krpc_SpaceCenter_AutoPilot_t ap;
krpc_SpaceCenter_Vessel_AutoPilot(conn, &ap, vessel);

krpc_SpaceCenter_AutoPilot_set_ReferenceFrame(conn, ap, vessel_srf_vel_ref);
krpc_tuple_double_double_double_t direction = { 0, 1, 0 };
krpc_SpaceCenter_AutoPilot_set_TargetDirection(conn, ap, &direction);
krpc_SpaceCenter_AutoPilot_Engage(conn, ap);
krpc_SpaceCenter_AutoPilot_Wait(conn, ap);
krpc_SpaceCenter_AutoPilot_Disengage(conn, ap);
}

```

```

import krpc.client.Connection;
import krpc.client.RPCException;
import krpc.client.services.SpaceCenter;
import krpc.client.services.SpaceCenter.AutoPilot;
import krpc.client.services.SpaceCenter.Vessel;

import org.javatuples.Triplet;

import java.io.IOException;

public class SurfacePrograde {
    public static void main(String[] args) throws IOException, RPCException {
        Connection connection = Connection.newInstance("Surface prograde");
        SpaceCenter spaceCenter = SpaceCenter.newInstance(connection);
        Vessel vessel = spaceCenter.getActiveVessel();
        AutoPilot ap = vessel.getAutoPilot();

        ap.setReferenceFrame(vessel.getSurfaceVelocityReferenceFrame());
        ap.setTargetDirection(new Triplet<Double,Double,Double>(0.0, 1.0, 0.0));
        ap.engage();
        ap.wait_();
        ap.disengage();
        connection.close();
    }
}

```

```

local krpc = require 'krpc'
local List = require 'pl.List'
local conn = krpc.connect('Surface prograde')
local vessel = conn.space_center.active_vessel
local ap = vessel.auto_pilot

ap.reference_frame = vessel.surface_velocity_reference_frame
ap.target_direction = List{0, 1, 0}
ap:engage()
ap:wait()
ap:disengage()

```

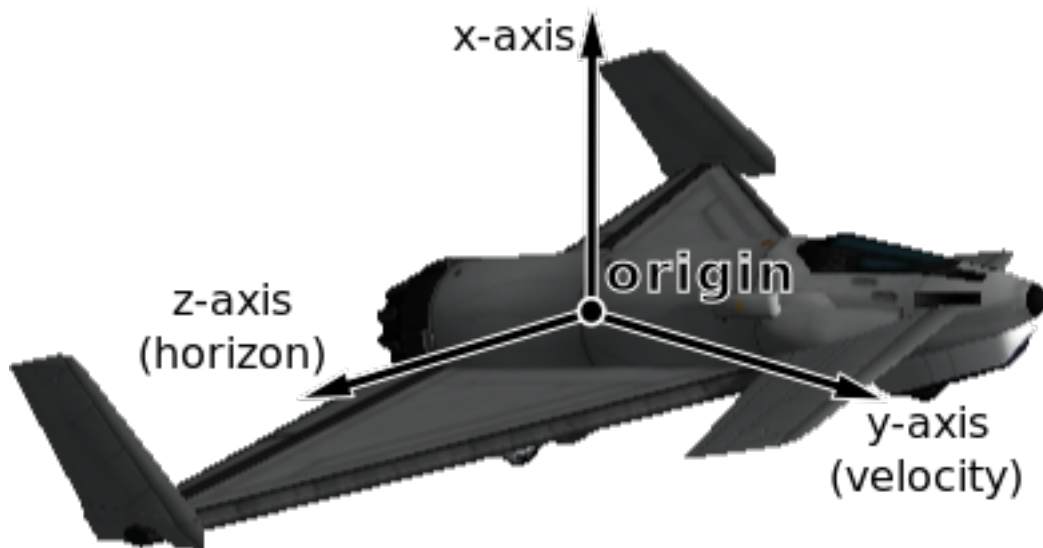
```

import krpc
conn = krpc.connect(name='Surface prograde')
vessel = conn.space_center.active_vessel
ap = vessel.auto_pilot

ap.reference_frame = vessel.surface_velocity_reference_frame
ap.target_direction = (0, 1, 0)
ap.engage()
ap.wait()
ap.disengage()

```

This code uses the `Vessel.surface_velocity_reference_frame`, pictured below:



Vessel Speed

This example demonstrates how to get the orbital and surface speeds of the vessel, equivalent to the values displayed by the navball.

To compute the orbital speed of a vessel, you need to get the velocity relative to the planet's *non-rotating* reference frame (`CelestialBody.non_rotating_reference_frame`). This reference frame is fixed relative to the body, but does not rotate.

For the surface speed, the planet's reference frame (`CelestialBody.reference_frame`) is required, as this reference frame rotates with the body.

C#

C++

C

Java

Lua

Python

```

using System;
using KRPC.Client;
using KRPC.Client.Services.SpaceCenter;

```

```

class VesselSpeed
{
    public static void Main ()
    {
        var connection = new Connection (name : "Vessel speed");
        var vessel = connection.SpaceCenter ().ActiveVessel;
        var obtFrame = vessel.Orbit.Body.NonRotatingReferenceFrame;
        var srfFrame = vessel.Orbit.Body.ReferenceFrame;
        while (true) {
            var obtSpeed = vessel.Flight (obtFrame).Speed;
            var srfSpeed = vessel.Flight (srfFrame).Speed;
            Console.WriteLine (
                "Orbital speed = {0:F1} m/s, Surface speed = {1:F1} m/s",
                obtSpeed, srfSpeed);
            System.Threading.Thread.Sleep (1000);
        }
    }
}

```

```

#include <iostream>
#include <iomanip>
#include <thread>
#include <krpc.hpp>
#include <krpc/services/space_center.hpp>

int main() {
    krpc::Client conn = krpc::connect("Vessel speed");
    krpc::services::SpaceCenter spaceCenter(&conn);
    auto vessel = spaceCenter.active_vessel();
    auto obt_frame = vessel.orbit().body().non_rotating_reference_frame();
    auto srf_frame = vessel.orbit().body().reference_frame();

    while (true) {
        auto obt_speed = vessel.flight(obt_frame).speed();
        auto srf_speed = vessel.flight(srf_frame).speed();
        std::cout << std::fixed << std::setprecision(1)
            << "Orbital speed = " << obt_speed << " m/s, "
            << "Surface speed = " << srf_speed << " m/s" << std::endl;
        std::this_thread::sleep_for(std::chrono::seconds(1));
    }
}

```

```

#include <unistd.h>
#include <math.h>
#include <krpc.h>
#include <krpc/services/space_center.h>

typedef krpc_tuple_double_double_double_t vector3;

int main() {
    krpc_connection_t conn;
    krpc_open(&conn, "COM0");
    krpc_connect(conn, "Vessel speed");

    krpc_SpaceCenter_Vessel_t vessel;
    krpc_SpaceCenter_ActiveVessel(conn, &vessel);
}

```

```

krpc_SpaceCenter_Orbit_t orbit;
krpc_SpaceCenter_Vessel_Orbit(conn, &orbit, vessel);
krpc_SpaceCenter_CelestialBody_t body;
krpc_SpaceCenter_Orbit_Body(conn, &body, orbit);

krpc_SpaceCenter_ReferenceFrame_t obt_frame;
krpc_SpaceCenter_ReferenceFrame_t srf_frame;
krpc_SpaceCenter_CelestialBody_NonRotatingReferenceFrame(conn, &obt_frame, body);
krpc_SpaceCenter_CelestialBody_ReferenceFrame(conn, &srf_frame, body);

while (true) {
    double obt_speed;
    double srf_speed;
    krpc_SpaceCenter_Flight_t flight;
    krpc_SpaceCenter_Vessel_Flight(conn, &flight, vessel, obt_frame);
    krpc_SpaceCenter_Flight_Speed(conn, &obt_speed, flight);
    krpc_SpaceCenter_Vessel_Flight(conn, &flight, vessel, srf_frame);
    krpc_SpaceCenter_Flight_Speed(conn, &srf_speed, flight);
    printf("Orbital speed = %.1f m/s, Surface speed = %.1f m/s\n", obt_speed, srf_
↪speed);
    sleep(1);
}
}

```

```

import krpc.client.Connection;
import krpc.client.RPCException;
import krpc.client.services.SpaceCenter;
import krpc.client.services.SpaceCenter.ReferenceFrame;
import krpc.client.services.SpaceCenter.Vessel;

import org.javatuples.Triplet;

import java.io.IOException;

public class VesselSpeed {
    public static void main(String[] args)
        throws IOException, RPCException, InterruptedException {
        Connection connection = Connection.newInstance("Vessel speed");
        SpaceCenter spaceCenter = SpaceCenter.newInstance(connection);
        Vessel vessel = spaceCenter.getActiveVessel();
        ReferenceFrame obtFrame = vessel.getOrbit().getBody().
↪getNonRotatingReferenceFrame();
        ReferenceFrame srfFrame = vessel.getOrbit().getBody().getReferenceFrame();
        while (true) {
            double obtSpeed = vessel.flight(obtFrame).getSpeed();
            double srfSpeed = vessel.flight(srfFrame).getSpeed();
            System.out.printf(
                "Orbital speed = %.1f m/s, Surface speed = %.1f m/s\n",
                obtSpeed, srfSpeed);
            Thread.sleep(1000);
        }
    }
}

```

```

local krpc = require 'krpc'
local platform = require 'krpc.platform'
local conn = krpc.connect('Vessel speed')

```

```

local vessel = conn.space_center.active_vessel
local obt_frame = vessel.orbit.body.non_rotating_reference_frame
local srf_frame = vessel.orbit.body.reference_frame

while true do
    obt_speed = vessel:flight(obt_frame).speed
    srf_speed = vessel:flight(srf_frame).speed
    print(string.format(
        'Orbital speed = %.1f m/s, Surface speed = %.1f m/s',
        obt_speed, srf_speed))
    platform.sleep(1)
end

```

```

import time
import krpc

conn = krpc.connect(name='Vessel speed')
vessel = conn.space_center.active_vessel
obt_frame = vessel.orbit.body.non_rotating_reference_frame
srf_frame = vessel.orbit.body.reference_frame

while True:
    obt_speed = vessel.flight(obt_frame).speed
    srf_speed = vessel.flight(srf_frame).speed
    print('Orbital speed = %.1f m/s, Surface speed = %.1f m/s' %
        (obt_speed, srf_speed))
    time.sleep(1)

```

Vessel Velocity

This example demonstrates how to get the velocity of the vessel (as a vector), relative to the surface of the body being orbited.

To do this, a hybrid reference frame is required. This is because we want a reference frame that is centered on the vessel, but whose linear velocity is fixed relative to the ground.

We therefore create a hybrid reference frame with its rotation set to the vessel's surface reference frame (*Vessel.surface_reference_frame*), and all other properties (including position and velocity) set to the body's reference frame (*CelestialBody.reference_frame*) – which rotates with the body.

C#

C++

C

Java

Lua

Python

```

using System;
using KRPC.Client;
using KRPC.Client.Services.SpaceCenter;

class VesselVelocity
{
    public static void Main ()

```

```

{
    var connection = new Connection (name : "Vessel velocity");
    var vessel = connection.SpaceCenter ().ActiveVessel;
    var refFrame = ReferenceFrame.CreateHybrid(
        connection,
        vessel.Orbit.Body.ReferenceFrame,
        vessel.SurfaceReferenceFrame);

    while (true) {
        var velocity = vessel.Flight (refFrame).Velocity;
        Console.WriteLine ("Surface velocity = ({0:F1}, {1:F1}, {2:F1})",
            velocity.Item1, velocity.Item2, velocity.Item3);
        System.Threading.Thread.Sleep (1000);
    }
}

```

```

#include <iostream>
#include <iomanip>
#include <thread>
#include <krpc.hpp>
#include <krpc/services/space_center.hpp>

int main() {
    krpc::Client connection = krpc::connect("Vessel velocity");
    krpc::services::SpaceCenter spaceCenter(&connection);
    auto vessel = spaceCenter.active_vessel();
    auto ref_frame = krpc::services::SpaceCenter::ReferenceFrame::create_hybrid(
        connection,
        vessel.orbit().body().reference_frame(),
        vessel.surface_reference_frame()
    );

    while (true) {
        auto velocity = vessel.flight(ref_frame).velocity();
        std::cout
            << std::fixed << std::setprecision(1)
            << "Surface velocity = ("
            << std::get<0>(velocity) << ", "
            << std::get<1>(velocity) << ", "
            << std::get<2>(velocity)
            << ")" << std::endl;
        std::this_thread::sleep_for(std::chrono::seconds(1));
    }
}

```

```

#include <unistd.h>
#include <math.h>
#include <krpc.h>
#include <krpc/services/space_center.h>

typedef krpc_tuple_double_double_double_t vector3;

int main() {
    krpc_connection_t conn;
    krpc_open(&conn, "COM0");
    krpc_connect(conn, "Vessel velocity");
}

```

```

krpc_SpaceCenter_Vessel_t vessel;
krpc_SpaceCenter_ActiveVessel(conn, &vessel);
krpc_SpaceCenter_Orbit_t orbit;
krpc_SpaceCenter_Vessel_Orbit(conn, &orbit, vessel);
krpc_SpaceCenter_CelestialBody_t body;
krpc_SpaceCenter_Orbit_Body(conn, &body, orbit);

krpc_SpaceCenter_ReferenceFrame_t vessel_srf_frame;
krpc_SpaceCenter_Vessel_SurfaceReferenceFrame(conn, &vessel_srf_frame, vessel);
krpc_SpaceCenter_ReferenceFrame_t body_frame;
krpc_SpaceCenter_CelestialBody_ReferenceFrame(conn, &body_frame, body);

krpc_SpaceCenter_ReferenceFrame_t ref_frame;
krpc_SpaceCenter_ReferenceFrame_CreateHybrid(
    conn, &ref_frame, body_frame, vessel_srf_frame, KRPC_NULL, KRPC_NULL);

while (true) {
    krpc_tuple_double_double_double_t velocity;
    krpc_SpaceCenter_Flight_t flight;
    krpc_SpaceCenter_Vessel_Flight(conn, &flight, vessel, ref_frame);
    krpc_SpaceCenter_Flight_Velocity(conn, &velocity, flight);
    printf("Surface velocity = %.1f, %.1f, %.1f\n", velocity.e0, velocity.e1,
↳velocity.e2);
    sleep(1);
}
}

```

```

import krpc.client.Connection;
import krpc.client.RPCException;
import krpc.client.services.SpaceCenter;
import krpc.client.services.SpaceCenter.ReferenceFrame;
import krpc.client.services.SpaceCenter.Vessel;

import org.javatuples.Triplet;

import java.io.IOException;

public class VesselVelocity {
    public static void main(String[] args)
        throws IOException, RPCException, InterruptedException {
        Connection connection = Connection.newInstance("Vessel velocity");
        SpaceCenter spaceCenter = SpaceCenter.newInstance(connection);
        Vessel vessel = spaceCenter.getActiveVessel();
        ReferenceFrame refFrame = ReferenceFrame.createHybrid(
            connection,
            vessel.getOrbit().getBody().getReferenceFrame(),
            vessel.getSurfaceReferenceFrame(),
            vessel.getOrbit().getBody().getReferenceFrame(),
            vessel.getOrbit().getBody().getReferenceFrame());
        while (true) {
            Triplet<Double, Double, Double> velocity =
                vessel.flight(refFrame).getVelocity();
            System.out.printf("Surface velocity = (%.1f, %.1f, %.1f)\n",
                velocity.getValue0(),
                velocity.getValue1(),
                velocity.getValue2());
            Thread.sleep(1000);
        }
    }
}

```

```
}  
}  
}
```

```
local krpc = require 'krpc'  
local platform = require 'krpc.platform'  
local conn = krpc.connect('Orbital speed')  
local vessel = conn.space_center.active_vessel  
local ref_frame = conn.SpaceCenter.ReferenceFrame.CreateHybrid(  
    vessel.orbit.body.reference_frame,  
    vessel.surface_reference_frame)  
  
while true do  
    velocity = vessel:flight(ref_frame).velocity  
    print(string.format('Surface velocity = (%.1f, %.1f, %.1f)',  
        velocity[1], velocity[2], velocity[3]))  
    platform.sleep(1)  
end
```

```
import time  
import krpc  
  
conn = krpc.connect(name='Orbital speed')  
vessel = conn.space_center.active_vessel  
ref_frame = conn.space_center.ReferenceFrame.create_hybrid(  
    position=vessel.orbit.body.reference_frame,  
    rotation=vessel.surface_reference_frame)  
  
while True:  
    velocity = vessel.flight(ref_frame).velocity  
    print('Surface velocity = (%.1f, %.1f, %.1f)' % velocity)  
    time.sleep(1)
```

Angle of attack

This example computes the angle between the direction the vessel is pointing in, and the direction that the vessel is moving in (relative to the surface):

C#

C++

C

Java

Lua

Python

```
using System;  
using KRPC.Client;  
using KRPC.Client.Services.SpaceCenter;  
  
class AngleOfAttack  
{  
    public static void Main ()  
    {  
    }
```

```

var conn = new Connection ("Angle of attack");
var vessel = conn.SpaceCenter ().ActiveVessel;

while (true) {
    var d = vessel.Direction (vessel.Orbit.Body.ReferenceFrame);
    var v = vessel.Velocity (vessel.Orbit.Body.ReferenceFrame);

    // Compute the dot product of d and v
    var dotProd = d.Item1 * v.Item1 + d.Item2 * v.Item2 + d.Item3 * v.Item3;

    // Compute the magnitude of v
    var vMag = Math.Sqrt (
        v.Item1 * v.Item1 + v.Item2 * v.Item2 + v.Item3 * v.Item3);
    // Note: don't need to magnitude of d as it is a unit vector

    // Compute the angle between the vectors
    double angle = 0;
    if (dotProd > 0)
        angle = Math.Abs (Math.Acos (dotProd / vMag) * (180.0 / Math.PI));

    Console.WriteLine (
        "Angle of attack = " + Math.Round (angle, 2) + " degrees");

    System.Threading.Thread.Sleep (1000);
}
}

```

```

#include <iostream>
#include <iomanip>
#include <cmath>
#include <chrono>
#include <thread>
#include <krpc.hpp>
#include <krpc/services/space_center.hpp>

static const double pi = 3.1415926535897;

int main() {
    krpc::Client conn = krpc::connect("Angle of attack");
    krpc::services::SpaceCenter space_center(&conn);
    auto vessel = space_center.active_vessel();

    while (true) {
        auto d = vessel.direction(vessel.orbit().body().reference_frame());
        auto v = vessel.velocity(vessel.orbit().body().reference_frame());

        // Compute the dot product of d and v
        double dotProd =
            std::get<0>(d)*std::get<0>(v) +
            std::get<1>(d)*std::get<1>(v) +
            std::get<2>(d)*std::get<2>(v);

        // Compute the magnitude of v
        double vMag = sqrt(
            std::get<0>(v)*std::get<0>(v) +
            std::get<1>(v)*std::get<1>(v) +
            std::get<2>(v)*std::get<2>(v));
    }
}

```

```

    // Note: don't need to magnitude of d as it is a unit vector

    // Compute the angle between the vectors
    double angle = 0;
    if (dotProd > 0)
        angle = fabs(acos(dotProd / vMag) * (180.0 / pi));

    std::cout << "Angle of attack = "
               << std::fixed << std::setprecision(1)
               << angle << " degrees" << std::endl;

    std::this_thread::sleep_for(std::chrono::seconds(1));
}
}

#include <unistd.h>
#include <math.h>
#include <krpc.h>
#include <krpc/services/space_center.h>

typedef krpc_tuple_double_double_double_t vector3;

static double pi = 3.1415926535897;

int main() {
    krpc_connection_t conn;
    krpc_open(&conn, "COM0");
    krpc_connect(conn, "Angle of attack");

    krpc_SpaceCenter_Vessel_t vessel;
    krpc_SpaceCenter_ActiveVessel(conn, &vessel);
    krpc_SpaceCenter_Orbit_t orbit;
    krpc_SpaceCenter_Vessel_Orbit(conn, &orbit, vessel);
    krpc_SpaceCenter_CelestialBody_t body;
    krpc_SpaceCenter_Orbit_Body(conn, &body, orbit);
    krpc_SpaceCenter_ReferenceFrame_t body_ref;
    krpc_SpaceCenter_CelestialBody_ReferenceFrame(conn, &body_ref, body);

    while (true) {
        vector3 d;
        vector3 v;
        krpc_SpaceCenter_Vessel_Direction(conn, &d, vessel, body_ref);
        krpc_SpaceCenter_Vessel_Velocity(conn, &d, vessel, body_ref);

        // Compute the dot product of d and v
        double dotProd = d.e0*v.e0 + d.e1*v.e1 + d.e2*v.e2;

        // Compute the magnitude of v
        double vMag = sqrt(v.e0*v.e0 + v.e1*v.e1 + v.e2*v.e2);
        // Note: don't need to magnitude of d as it is a unit vector

        // Compute the angle between the vectors
        double angle = 0;
        if (dotProd > 0)
            angle = fabs(acos(dotProd / vMag) * (180.0 / pi));

        printf("Angle of attack = %.1f degrees\n", angle);
    }
}

```

```

    sleep(1);
}
}

```

```

import krpc.client.Connection;
import krpc.client.RPCException;
import krpc.client.services.SpaceCenter;

import org.javatuples.Triplet;

import java.io.IOException;
import java.lang.Math;

public class AngleOfAttack {
    public static void main(String[] args)
        throws IOException, RPCException, InterruptedException {
        Connection connection = Connection.newInstance("Angle of attack");
        SpaceCenter spaceCenter = SpaceCenter.newInstance(connection);
        SpaceCenter.Vessel vessel = spaceCenter.getActiveVessel();

        while (true) {
            Triplet<Double,Double,Double> d =
                vessel.direction(vessel.getOrbit().getBody().getReferenceFrame());
            Triplet<Double,Double,Double> v =
                vessel.velocity(vessel.getOrbit().getBody().getReferenceFrame());

            // Compute the dot product of d and v
            double dotProd =
                d.getValue0() * v.getValue0()
                + d.getValue1() * v.getValue1()
                + d.getValue2() * v.getValue2();

            // Compute the magnitude of v
            double vMag = Math.sqrt(
                v.getValue0() * v.getValue0()
                + v.getValue1() * v.getValue1()
                + v.getValue2() * v.getValue2()
            );
            // Note: don't need to magnitude of d as it is a unit vector

            // Compute the angle between the vectors
            double angle = 0;
            if (dotProd > 0) {
                angle = Math.abs(Math.acos(dotProd / vMag) * (180.0 / Math.PI));
            }

            System.out.printf("Angle of attack = %.1f degrees\n", angle);

            Thread.sleep(1000);
        }
    }
}

```

```

local krpc = require 'krpc'
local platform = require 'krpc.platform'
local math = require 'math'
local conn = krpc.connect('Angle of attack')

```

```

local vessel = conn.space_center.active_vessel

while true do

    d = vessel:direction(vessel.orbit.body.reference_frame)
    v = vessel:velocity(vessel.orbit.body.reference_frame)

    -- Compute the dot product of d and v
    dotprod = d[1]*v[1] + d[2]*v[2] + d[3]*v[3]

    -- Compute the magnitude of v
    vmag = math.sqrt(v[1]*v[1] + v[2]*v[2] + v[3]*v[3])
    -- Note: don't need to magnitude of d as it is a unit vector

    -- Compute the angle between the vectors
    angle = 0
    if dotprod > 0 then
        angle = math.abs(math.acos (dotprod / vmag) * (180. / math.pi))
    end

    print(string.format('Angle of attack = %.1f', angle))

    platform.sleep(1)

end

```

```

import math
import time
import krpc

conn = krpc.connect(name='Angle of attack')
vessel = conn.space_center.active_vessel

while True:

    d = vessel.direction(vessel.orbit.body.reference_frame)
    v = vessel.velocity(vessel.orbit.body.reference_frame)

    # Compute the dot product of d and v
    dotprod = d[0]*v[0] + d[1]*v[1] + d[2]*v[2]

    # Compute the magnitude of v
    vmag = math.sqrt(v[0]**2 + v[1]**2 + v[2]**2)
    # Note: don't need to magnitude of d as it is a unit vector

    # Compute the angle between the vectors
    angle = 0
    if dotprod > 0:
        angle = abs(math.acos(dotprod / vmag) * (180.0 / math.pi))

    print('Angle of attack = %.1f degrees' % angle)

    time.sleep(1)

```

Note that the orientation of the reference frame used to get the direction and velocity vectors does not matter, as the angle between two vectors is the same regardless of the orientation of the axes. However, if we were to use a reference frame that moves with the vessel, the velocity would return (0, 0, 0). We therefore need a reference frame that is

not fixed relative to the vessel. *CelestialBody.reference_frame* fits these requirements.

Landing Site

This example computes a reference frame that is located on the surface of a body at a given altitude, which could be used as the target for a landing auto pilot.

C#

C++

C

Java

Lua

Python

```
using System;
using KRPC.Client;
using KRPC.Client.Services.SpaceCenter;
using KRPC.Client.Services.Drawing;

class LandingSite
{
    public static void Main ()
    {
        var conn = new Connection ("Landing Site");
        var vessel = conn.SpaceCenter ().ActiveVessel;
        var body = vessel.Orbit.Body;

        // Define the landing site as the top of the VAB
        double landingLatitude = -(0.0+(5.0/60.0)+(48.38/60.0/60.0));
        double landingLongitude = -(74.0+(37.0/60.0)+(12.2/60.0/60.0));
        double landingAltitude = 111;

        // Determine landing site reference frame
        // (orientation: x=zenith, y=north, z=east)
        var landingPosition = body.SurfacePosition(
            landingLatitude, landingLongitude, body.ReferenceFrame);
        var qLong = Tuple.Create(
            0.0,
            Math.Sin(-landingLongitude * 0.5 * Math.PI / 180.0),
            0.0,
            Math.Cos(-landingLongitude * 0.5 * Math.PI / 180.0)
        );
        var qLat = Tuple.Create(
            0.0,
            0.0,
            Math.Sin(landingLatitude * 0.5 * Math.PI / 180.0),
            Math.Cos(landingLatitude * 0.5 * Math.PI / 180.0)
        );
        var landingReferenceFrame =
            ReferenceFrame.CreateRelative(
                conn,
                ReferenceFrame.CreateRelative(
                    conn,
                    ReferenceFrame.CreateRelative(
                        conn,
```

```

        body.ReferenceFrame,
        landingPosition,
        qLong),
        Tuple.Create(0.0, 0.0, 0.0),
        qLat),
        Tuple.Create(landingAltitude, 0.0, 0.0));

    // Draw axes
    var zero = Tuple.Create(0.0, 0.0, 0.0);
    conn.Drawing().AddLine(
        zero, Tuple.Create(1.0, 0.0, 0.0), landingReferenceFrame);
    conn.Drawing().AddLine(
        zero, Tuple.Create(0.0, 1.0, 0.0), landingReferenceFrame);
    conn.Drawing().AddLine(
        zero, Tuple.Create(0.0, 0.0, 1.0), landingReferenceFrame);

    while (true)
        System.Threading.Thread.Sleep (1000);
}
}

```

```

#include <iostream>
#include <iomanip>
#include <cmath>
#include <chrono>
#include <thread>
#include <krpc.hpp>
#include <krpc/services/space_center.hpp>
#include <krpc/services/ui.hpp>
#include <krpc/services/drawing.hpp>

static const double pi = 3.1415926535897;

int main() {
    krpc::Client conn = krpc::connect("Landing Site");
    krpc::services::SpaceCenter space_center(&conn);
    krpc::services::Drawing drawing(&conn);
    auto vessel = space_center.active_vessel();
    auto body = vessel.orbit().body();

    // Define the landing site as the top of the VAB
    double landing_latitude = -(0.0+(5.0/60.0)+(48.38/60.0/60.0));
    double landing_longitude = -(74.0+(37.0/60.0)+(12.2/60.0/60.0));
    double landing_altitude = 111;

    // Determine landing site reference frame
    // (orientation: x=zenith, y=north, z=east)
    auto landing_position = body.surface_position(
        landing_latitude, landing_longitude, body.reference_frame());
    auto q_long = std::make_tuple(
        0.0,
        sin(-landing_longitude * 0.5 * pi / 180.0),
        0.0,
        cos(-landing_longitude * 0.5 * pi / 180.0)
    );
    auto q_lat = std::make_tuple(
        0.0,
        0.0,

```

```

    sin(landing_latitude * 0.5 * pi / 180.0),
    cos(landing_latitude * 0.5 * pi / 180.0)
);
auto landing_reference_frame =
    krpc::services::SpaceCenter::ReferenceFrame::create_relative(
        conn,
        krpc::services::SpaceCenter::ReferenceFrame::create_relative(
            conn,
            krpc::services::SpaceCenter::ReferenceFrame::create_relative(
                conn,
                body.reference_frame(),
                landing_position,
                q_long),
            std::make_tuple(0, 0, 0),
            q_lat),
        std::make_tuple(landing_altitude, 0, 0));

// Draw axes
drawing.add_line(
    std::make_tuple(0, 0, 0), std::make_tuple(1, 0, 0), landing_reference_frame);
drawing.add_line(
    std::make_tuple(0, 0, 0), std::make_tuple(0, 1, 0), landing_reference_frame);
drawing.add_line(
    std::make_tuple(0, 0, 0), std::make_tuple(0, 0, 1), landing_reference_frame);

while (true)
    std::this_thread::sleep_for(std::chrono::seconds(1));
}

```

```

#include <unistd.h>
#include <math.h>
#include <krpc.h>
#include <krpc/services/space_center.h>
#include <krpc/services/ui.h>
#include <krpc/services/drawing.h>

typedef krpc_tuple_double_double_double_t vector3;
typedef krpc_tuple_double_double_double_double_t quaternion;

static double pi = 3.1415926535897;

int main() {
    krpc_connection_t conn;
    krpc_open(&conn, "COM0");
    krpc_connect(conn, "Landing site");

    krpc_SpaceCenter_Vessel_t vessel;
    krpc_SpaceCenter_ActiveVessel(conn, &vessel);
    krpc_SpaceCenter_Orbit_t orbit;
    krpc_SpaceCenter_Vessel_Orbit(conn, &orbit, vessel);
    krpc_SpaceCenter_CelestialBody_t body;
    krpc_SpaceCenter_Orbit_Body(conn, &body, orbit);
    krpc_SpaceCenter_ReferenceFrame_t body_ref;
    krpc_SpaceCenter_CelestialBody_ReferenceFrame(conn, &body_ref, body);

    // Define the landing site as the top of the VAB
    double landing_latitude = -(0.0+(5.0/60.0)+(48.38/60.0/60.0));
    double landing_longitude = -(74.0+(37.0/60.0)+(12.2/60.0/60.0));
}

```

```

double landing_altitude = 111;

// Determine landing site reference frame
// (orientation: x=zenith, y=north, z=east)
vector3 landing_position;
krpc_SpaceCenter_CelestialBody_SurfacePosition(
    conn, &landing_position, body, landing_latitude, landing_longitude, body_ref);
quaternion q_long = {
    0.0,
    sin(-landing_longitude * 0.5 * pi / 180.0),
    0.0,
    cos(-landing_longitude * 0.5 * pi / 180.0)
};
quaternion q_lat = {
    0.0,
    0.0,
    sin(landing_latitude * 0.5 * pi / 180.0),
    cos(landing_latitude * 0.5 * pi / 180.0)
};

krpc_SpaceCenter_ReferenceFrame_t landing_reference_frame;
{
    vector3 zero = {0, 0, 0};
    quaternion q_zero = {0, 0, 0, 1};
    krpc_SpaceCenter_ReferenceFrame_t parent_ref;
    krpc_SpaceCenter_ReferenceFrame_CreateRelative(
        conn, &parent_ref, body_ref, &landing_position, &q_long, &zero, &zero);
    krpc_SpaceCenter_ReferenceFrame_CreateRelative(
        conn, &parent_ref, parent_ref, &zero, &q_lat, &zero, &zero);
    vector3 position = { landing_altitude, 0, 0 };
    krpc_SpaceCenter_ReferenceFrame_CreateRelative(
        conn, &landing_reference_frame, parent_ref, &position, &q_zero, &zero, &zero);
}

// Draw axes
vector3 zero = {0, 0, 0};
vector3 x_axis = {1, 0, 0};
vector3 y_axis = {0, 1, 0};
vector3 z_axis = {0, 0, 1};
krpc_Drawing_AddLine(conn, NULL, &zero, &x_axis, landing_reference_frame, true);
krpc_Drawing_AddLine(conn, NULL, &zero, &y_axis, landing_reference_frame, true);
krpc_Drawing_AddLine(conn, NULL, &zero, &z_axis, landing_reference_frame, true);

while (true)
    sleep(1);
}

```

```

import krpc.client.Connection;
import krpc.client.RPCException;
import krpc.client.services.Drawing;
import krpc.client.services.SpaceCenter;

import org.javatuples.Triplet;
import org.javatuples.Quartet;

import java.io.IOException;
import java.lang.Math;

```

```

public class LandingSite {
    public static void main(String[] args)
        throws IOException, RPCException, InterruptedException {
        Connection connection = Connection.newInstance("Landing Site");
        SpaceCenter spaceCenter = SpaceCenter.newInstance(connection);
        Drawing drawing = Drawing.newInstance(connection);
        SpaceCenter.Vessel vessel = spaceCenter.getActiveVessel();
        SpaceCenter.CelestialBody body = vessel.getOrbit().getBody();

        // Define the landing site as the top of the VAB
        double landingLatitude = -(0.0+(5.0/60.0)+(48.38/60.0/60.0));
        double landingLongitude = -(74.0+(37.0/60.0)+(12.2/60.0/60.0));
        double landingAltitude = 111;

        // Determine landing site reference frame
        // (orientation: x=zenith, y=north, z=east)
        Triplet<Double, Double, Double> landingPosition = body.surfacePosition(
            landingLatitude, landingLongitude, body.getReferenceFrame());
        Quartet<Double, Double, Double, Double> qLong =
            new Quartet<Double, Double, Double, Double>(
                0.0,
                Math.sin(-landingLongitude * 0.5 * Math.PI / 180.0),
                0.0,
                Math.cos(-landingLongitude * 0.5 * Math.PI / 180.0));
        Quartet<Double, Double, Double, Double> qLat =
            new Quartet<Double, Double, Double, Double>(
                0.0,
                0.0,
                Math.sin(landingLatitude * 0.5 * Math.PI / 180.0),
                Math.cos(landingLatitude * 0.5 * Math.PI / 180.0));
        Quartet<Double, Double, Double, Double> qIdentity =
            new Quartet<Double, Double, Double, Double>(0.0, 0.0, 0.0, 1.0);
        Triplet<Double, Double, Double> zero =
            new Triplet<Double, Double, Double>(0.0, 0.0, 0.0);
        SpaceCenter.ReferenceFrame landingReferenceFrame =
            SpaceCenter.ReferenceFrame.createRelative(
                connection,
                SpaceCenter.ReferenceFrame.createRelative(
                    connection,
                    SpaceCenter.ReferenceFrame.createRelative(
                        connection,
                        body.getReferenceFrame(),
                        landingPosition, qLong, zero, zero),
                    zero, qLat, zero, zero),
                new Triplet<Double, Double, Double>(landingAltitude, 0.0, 0.0),
                qIdentity, zero, zero);

        // Draw axes
        drawing.addLine(
            zero, new Triplet<Double, Double, Double>(1.0, 0.0, 0.0),
            landingReferenceFrame, true);
        drawing.addLine(
            zero, new Triplet<Double, Double, Double>(0.0, 1.0, 0.0),
            landingReferenceFrame, true);
        drawing.addLine(
            zero, new Triplet<Double, Double, Double>(0.0, 0.0, 1.0),
            landingReferenceFrame, true);
    }
}

```

```
        while (true)
            Thread.sleep(1000);
    }
}
```

```
local krpc = require 'krpc'
local platform = require 'krpc.platform'
local List = require 'pl.List'
local math = require 'math'

local conn = krpc.connect('Landing Site')
local vessel = conn.space_center.active_vessel
local body = vessel.orbit.body
local ReferenceFrame = conn.space_center.ReferenceFrame

-- Define the landing site as the top of the VAB
local landing_latitude = -(0+(5.0/60)+(48.38/60/60))
local landing_longitude = -(74+(37.0/60)+(12.2/60/60))
local landing_altitude = 111

-- Determine landing site reference frame
-- (orientation: x=zenith, y=north, z=east)
local landing_position = body:surface_position(
    landing_latitude, landing_longitude, body.reference_frame)
local q_long = List{
    0,
    math.sin(-landing_longitude * 0.5 * math.pi / 180),
    0,
    math.cos(-landing_longitude * 0.5 * math.pi / 180)
}
local q_lat = List{
    0,
    0,
    math.sin(landing_latitude * 0.5 * math.pi / 180),
    math.cos(landing_latitude * 0.5 * math.pi / 180)
}
local landing_reference_frame =
    ReferenceFrame.create_relative(
        ReferenceFrame.create_relative(
            ReferenceFrame.create_relative(
                body.reference_frame,
                landing_position,
                q_long),
            List{0, 0, 0},
            q_lat),
        List{landing_altitude, 0, 0})

-- Draw axes
conn.drawing.add_line(List{0, 0, 0}, List{1, 0, 0}, landing_reference_frame)
conn.drawing.add_line(List{0, 0, 0}, List{0, 1, 0}, landing_reference_frame)
conn.drawing.add_line(List{0, 0, 0}, List{0, 0, 1}, landing_reference_frame)

while true do
    platform.sleep(1)
end
```

```

import time
from math import sin, cos, pi
import krpc

conn = krpc.connect(name='Landing Site')
vessel = conn.space_center.active_vessel
body = vessel.orbit.body
create_relative = conn.space_center.ReferenceFrame.create_relative

# Define the landing site as the top of the VAB
landing_latitude = -(0+(5.0/60)+(48.38/60/60))
landing_longitude = -(74+(37.0/60)+(12.2/60/60))
landing_altitude = 111

# Determine landing site reference frame
# (orientation: x=zenith, y=north, z=east)
landing_position = body.surface_position(
    landing_latitude, landing_longitude, body.reference_frame)
q_long = (
    0,
    sin(-landing_longitude * 0.5 * pi / 180),
    0,
    cos(-landing_longitude * 0.5 * pi / 180)
)
q_lat = (
    0,
    0,
    sin(landing_latitude * 0.5 * pi / 180),
    cos(landing_latitude * 0.5 * pi / 180)
)
landing_reference_frame = \
    create_relative(
        create_relative(
            create_relative(
                body.reference_frame,
                landing_position,
                q_long),
            (0, 0, 0),
            q_lat),
        (landing_altitude, 0, 0))

# Draw axes
conn.drawing.add_line((0, 0, 0), (1, 0, 0), landing_reference_frame)
conn.drawing.add_line((0, 0, 0), (0, 1, 0), landing_reference_frame)
conn.drawing.add_line((0, 0, 0), (0, 0, 1), landing_reference_frame)

while True:
    time.sleep(1)

```

2.3 Launch into Orbit

This tutorial launches a two-stage rocket into a 150km circular orbit. The program assumes you are using this craft file.

The program is available in a variety of languages:

C#, C++, Java, Lua, Python

The following code connects to the server, gets the active vessel, sets up a bunch of streams to get flight telemetry then prepares the rocket for launch.

C#

C++

Java

Lua

Python

```
1 using System;
2 using System.Collections.Generic;
3 using System.Net;
4 using KRPC.Client;
5 using KRPC.Client.Services.SpaceCenter;
6
7 class LaunchIntoOrbit
8 {
9     public static void Main ()
10    {
11        var conn = new Connection ("Launch into orbit");
12        var vessel = conn.SpaceCenter ().ActiveVessel;
13
14        float turnStartAltitude = 250;
15        float turnEndAltitude = 45000;
16        float targetAltitude = 150000;
17
18        // Set up streams for telemetry
19        var ut = conn.AddStream (() => conn.SpaceCenter ().UT);
20        var flight = vessel.Flight ();
21        var altitude = conn.AddStream (() => flight.MeanAltitude);
22        var apoapsis = conn.AddStream (() => vessel.Orbit.ApoapsisAltitude);
23        var stage2Resources =
24            vessel.ResourcesInDecoupleStage (stage: 2, cumulative: false);
25        var srbFuel = conn.AddStream (() => stage2Resources.Amount ("SolidFuel"));
26
27        // Pre-launch setup
28        vessel.Control.SAS = false;
29        vessel.Control.RCS = false;
30        vessel.Control.Throttle = 1;
31
32        // Countdown...
33        Console.WriteLine ("3...");
34        System.Threading.Thread.Sleep (1000);
35        Console.WriteLine ("2...");
36        System.Threading.Thread.Sleep (1000);
37        Console.WriteLine ("1...");
38        System.Threading.Thread.Sleep (1000);
39        Console.WriteLine ("Launch!");
```

```
1 #include <iostream>
2 #include <chrono>
3 #include <thread>
4 #include <krpc.hpp>
5 #include <krpc/services/space_center.hpp>
```

```

6
7 int main() {
8     krpc::Client conn = krpc::connect("Launch into orbit");
9     krpc::services::SpaceCenter space_center(&conn);
10    auto vessel = space_center.active_vessel();
11
12    float turn_start_altitude = 250;
13    float turn_end_altitude = 45000;
14    float target_altitude = 150000;
15
16    // Set up streams for telemetry
17    auto ut = space_center.ut_stream();
18    auto altitude = vessel.flight().mean_altitude_stream();
19    auto apoapsis = vessel.orbit().apoapsis_altitude_stream();
20    auto stage_2_resources = vessel.resources_in_decouple_stage(2, false);
21    auto srb_fuel = stage_2_resources.amount_stream("SolidFuel");
22
23    // Pre-launch setup
24    vessel.control().set_sas(false);
25    vessel.control().set_rcs(false);
26    vessel.control().set_throttle(1);
27
28    // Countdown...
29    std::cout << "3..." << std::endl;
30    std::this_thread::sleep_for(std::chrono::seconds(1));
31    std::cout << "2..." << std::endl;
32    std::this_thread::sleep_for(std::chrono::seconds(1));
33    std::cout << "1..." << std::endl;
34    std::this_thread::sleep_for(std::chrono::seconds(1));
35    std::cout << "Launch!" << std::endl;

```

```

1 import krpc.client.Connection;
2 import krpc.client.RPCException;
3 import krpc.client.Stream;
4 import krpc.client.StreamException;
5 import krpc.client.services.SpaceCenter;
6 import krpc.client.services.SpaceCenter.Flight;
7 import krpc.client.services.SpaceCenter.Node;
8 import krpc.client.services.SpaceCenter.ReferenceFrame;
9 import krpc.client.services.SpaceCenter.Resources;
10
11 import org.javatuples.Triplet;
12
13 import java.io.IOException;
14 import java.lang.Math;
15
16 public class LaunchIntoOrbit {
17     public static void main(String[] args)
18         throws IOException, RPCException, InterruptedException, StreamException {
19         Connection connection = Connection.newInstance("Launch into orbit");
20         SpaceCenter spaceCenter = SpaceCenter.newInstance(connection);
21         SpaceCenter.Vessel vessel = spaceCenter.getActiveVessel();
22
23         float turnStartAltitude = 250;
24         float turnEndAltitude = 45000;
25         float targetAltitude = 150000;
26
27         // Set up streams for telemetry

```

```

28     spaceCenter.getUT();
29     Stream<Double> ut = connection.addStream(SpaceCenter.class, "getUT");
30     ReferenceFrame refFrame = vessel.getSurfaceReferenceFrame();
31     Flight flight = vessel.flight(refFrame);
32     Stream<Double> altitude = connection.addStream(flight, "getMeanAltitude");
33     Stream<Double> apoapsis =
34         connection.addStream(vessel.getOrbit(), "getApoapsisAltitude");
35     Resources stage2Resources = vessel.resourcesInDecoupleStage(2, false);
36     Stream<Float> srbFuel =
37         connection.addStream(stage2Resources, "amount", "SolidFuel");
38
39     // Pre-launch setup
40     vessel.getControl().setSAS(false);
41     vessel.getControl().setRCS(false);
42     vessel.getControl().setThrottle(1);
43
44     // Countdown...
45     System.out.println("3...");
46     Thread.sleep(1000);
47     System.out.println("2...");
48     Thread.sleep(1000);
49     System.out.println("1...");
50     Thread.sleep(1000);

```

```

1  local krpc = require 'krpc'
2  local platform = require 'krpc.platform'
3  local math = require 'math'
4  local List = require 'pl.List'
5
6  local turn_start_altitude = 250
7  local turn_end_altitude = 45000
8  local target_altitude = 150000
9
10 local conn = krpc.connect('Launch into orbit')
11 local vessel = conn.space_center.active_vessel
12
13 flight = vessel:flight()
14 stage_2_resources = vessel:resources_in_decouple_stage(2, False)
15
16 -- Pre-launch setup
17 vessel.control.sas = false
18 vessel.control.rcs = false
19 vessel.control.throttle = 1
20
21 -- Countdown...
22 print('3...')
23 platform.sleep(1)
24 print('2...')
25 platform.sleep(1)
26 print('1...')
27 platform.sleep(1)
28 print('Launch!')

```

```

1  import math
2  import time
3  import krpc
4

```

```

5  turn_start_altitude = 250
6  turn_end_altitude = 45000
7  target_altitude = 150000
8
9  conn = krpc.connect(name='Launch into orbit')
10 vessel = conn.space_center.active_vessel
11
12 # Set up streams for telemetry
13 ut = conn.add_stream(getattr, conn.space_center, 'ut')
14 altitude = conn.add_stream(getattr, vessel.flight(), 'mean_altitude')
15 apoapsis = conn.add_stream(getattr, vessel.orbit, 'apoapsis_altitude')
16 stage_2_resources = vessel.resources_in_decouple_stage(stage=2, cumulative=False)
17 srb_fuel = conn.add_stream(stage_2_resources.amount, 'SolidFuel')
18
19 # Pre-launch setup
20 vessel.control.sas = False
21 vessel.control.rcs = False
22 vessel.control.throttle = 1.0
23
24 # Countdown...
25 print('3...')
26 time.sleep(1)
27 print('2...')
28 time.sleep(1)
29 print('1...')
30 time.sleep(1)
31 print('Launch!')

```

The next part of the program launches the rocket. The main loop continuously updates the auto-pilot heading to gradually pitch the rocket towards the horizon. It also monitors the amount of solid fuel remaining in the boosters, separating them when they run dry. The loop exits when the rockets apoapsis is close to the target apoapsis.

C#

C++

Java

Lua

Python

```

41 // Activate the first stage
42 vessel.Control.ActivateNextStage ();
43 vessel.AutoPilot.Engage ();
44 vessel.AutoPilot.TargetPitchAndHeading (90, 90);
45
46 // Main ascent loop
47 bool srbsSeparated = false;
48 double turnAngle = 0;
49 while (true) {
50
51     // Gravity turn
52     if (altitude.Get () > turnStartAltitude &&
53         altitude.Get () < turnEndAltitude) {
54         double frac = (altitude.Get () - turnStartAltitude)
55                     / (turnEndAltitude - turnStartAltitude);
56         double newTurnAngle = frac * 90.0;
57         if (Math.Abs (newTurnAngle - turnAngle) > 0.5) {
58             turnAngle = newTurnAngle;

```

```

59         vessel.AutoPilot.TargetPitchAndHeading (
60             (float)(90 - turnAngle), 90);
61     }
62 }
63
64 // Separate SRBs when finished
65 if (!srbsSeparated) {
66     if (srbFuel.Get () < 0.1) {
67         vessel.Control.ActivateNextStage ();
68         srbsSeparated = true;
69         Console.WriteLine ("SRBs separated");
70     }
71 }
72
73 // Decrease throttle when approaching target apoapsis
74 if (apoapsis.Get () > targetAltitude * 0.9) {
75     Console.WriteLine ("Approaching target apoapsis");
76     break;
77 }
78 }

```

```

37 // Activate the first stage
38 vessel.control().activate_next_stage();
39 vessel.auto_pilot().engage();
40 vessel.auto_pilot().target_pitch_and_heading(90, 90);
41
42 // Main ascent loop
43 bool srbs_separated = false;
44 double turn_angle = 0;
45 while (true) {
46     // Gravity turn
47     if (altitude() > turn_start_altitude && altitude() < turn_end_altitude) {
48         double frac = (altitude() - turn_start_altitude)
49             / (turn_end_altitude - turn_start_altitude);
50         double new_turn_angle = frac * 90.0;
51         if (fabs(new_turn_angle - turn_angle) > 0.5) {
52             turn_angle = new_turn_angle;
53             vessel.auto_pilot().target_pitch_and_heading(90.0 - turn_angle, 90.0);
54         }
55     }
56
57     // Separate SRBs when finished
58     if (!srbs_separated) {
59         if (srb_fuel() < 0.1) {
60             vessel.control().activate_next_stage();
61             srbs_separated = true;
62             std::cout << "SRBs separated" << std::endl;
63         }
64     }
65
66     // Decrease throttle when approaching target apoapsis
67     if (apoapsis() > target_altitude * 0.9) {
68         std::cout << "Approaching target apoapsis" << std::endl;
69         break;
70     }
71 }

```

```

52 // Activate the first stage
53 vessel.getControl().activateNextStage();
54 vessel.getAutoPilot().engage();
55 vessel.getAutoPilot().targetPitchAndHeading(90, 90);
56
57 // Main ascent loop
58 boolean srbsSeparated = false;
59 double turnAngle = 0;
60 while (true) {
61
62     // Gravity turn
63     if (altitude.get() > turnStartAltitude &&
64         altitude.get() < turnEndAltitude) {
65         double frac = (altitude.get() - turnStartAltitude)
66                     / (turnEndAltitude - turnStartAltitude);
67         double newTurnAngle = frac * 90.0;
68         if (Math.abs(newTurnAngle - turnAngle) > 0.5) {
69             turnAngle = newTurnAngle;
70             vessel.getAutoPilot().targetPitchAndHeading(
71                 (float)(90 - turnAngle), 90);
72         }
73     }
74
75     // Separate SRBs when finished
76     if (!srbsSeparated) {
77         if (srbFuel.get() < 0.1) {
78             vessel.getControl().activateNextStage();
79             srbsSeparated = true;
80             System.out.println("SRBs separated");
81         }
82     }
83
84     // Decrease throttle when approaching target apoapsis
85     if (apoapsis.get() > targetAltitude * 0.9) {
86         System.out.println("Approaching target apoapsis");
87         break;
88     }

```

```

30 -- Activate the first stage
31 vessel.control:activate_next_stage()
32 vessel.auto_pilot:engage()
33 vessel.auto_pilot:target_pitch_and_heading(90, 90)
34
35 -- Main ascent loop
36 local srbs_separated = false
37 local turn_angle = 0
38 while true do
39
40     -- Gravity turn
41     if flight.mean_altitude > turn_start_altitude and flight.mean_altitude < turn_end_
↪altitude then
42         frac = (flight.mean_altitude - turn_start_altitude) / (turn_end_altitude -
↪turn_start_altitude)
43         new_turn_angle = frac * 90
44         if math.abs(new_turn_angle - turn_angle) > 0.5 then
45             turn_angle = new_turn_angle
46             vessel.auto_pilot:target_pitch_and_heading(90-turn_angle, 90)
47         end

```

```
48     end
49
50     -- Separate SRBs when finished
51     if not srbs_separated then
52         if stage_2_resources:amount('SolidFuel') < 0.1 then
53             vessel.control:activate_next_stage()
54             srbs_separated = true
55             print('SRBs separated')
56         end
57     end
58
59     -- Decrease throttle when approaching target apoapsis
60     if vessel.orbit.apoapsis_altitude > target_altitude*0.9 then
61         print('Approaching target apoapsis')
62         break
63     end
64 end
```

```
33 # Activate the first stage
34 vessel.control.activate_next_stage()
35 vessel.auto_pilot.engage()
36 vessel.auto_pilot.target_pitch_and_heading(90, 90)
37
38 # Main ascent loop
39 srbs_separated = False
40 turn_angle = 0
41 while True:
42
43     # Gravity turn
44     if altitude() > turn_start_altitude and altitude() < turn_end_altitude:
45         frac = ((altitude() - turn_start_altitude) /
46                 (turn_end_altitude - turn_start_altitude))
47         new_turn_angle = frac * 90
48         if abs(new_turn_angle - turn_angle) > 0.5:
49             turn_angle = new_turn_angle
50             vessel.auto_pilot.target_pitch_and_heading(90-turn_angle, 90)
51
52     # Separate SRBs when finished
53     if not srbs_separated:
54         if srb_fuel() < 0.1:
55             vessel.control.activate_next_stage()
56             srbs_separated = True
57             print('SRBs separated')
58
59     # Decrease throttle when approaching target apoapsis
60     if apoapsis() > target_altitude*0.9:
61         print('Approaching target apoapsis')
62         break
```

Next, the program fine tunes the apoapsis, using 10% thrust, then waits until the rocket has left Kerbin's atmosphere.

C#

C++

Java

Lua

Python

```

80      // Disable engines when target apoapsis is reached
81      vessel.Control.Throttle = 0.25f;
82      while (apoapsis.Get () < targetAltitude) {
83      }
84      Console.WriteLine ("Target apoapsis reached");
85      vessel.Control.Throttle = 0;
86
87      // Wait until out of atmosphere
88      Console.WriteLine ("Coasting out of atmosphere");
89      while (altitude.Get () < 70500) {
90      }

```

```

73      // Disable engines when target apoapsis is reached
74      vessel.control().set_throttle(0.25);
75      while (apoapsis() < target_altitude) {
76      }
77      std::cout << "Target apoapsis reached" << std::endl;
78      vessel.control().set_throttle(0);
79
80      // Wait until out of atmosphere
81      std::cout << "Coasting out of atmosphere" << std::endl;
82      while (altitude() < 70500) {
83      }

```

```

91      // Disable engines when target apoapsis is reached
92      vessel.getControl().setThrottle(0.25f);
93      while (apoapsis.get() < targetAltitude) {
94      }
95      System.out.println("Target apoapsis reached");
96      vessel.getControl().setThrottle(0);
97
98      // Wait until out of atmosphere
99      System.out.println("Coasting out of atmosphere");
100     while (altitude.get() < 70500) {

```

```

66  -- Disable engines when target apoapsis is reached
67  vessel.control.throttle = 0.25
68  while vessel.orbit.apoapsis_altitude < target_altitude do
69  end
70  print('Target apoapsis reached')
71  vessel.control.throttle = 0
72
73  -- Wait until out of atmosphere
74  print('Coasting out of atmosphere')
75  while flight.mean_altitude < 70500 do
76  end

```

```

64  # Disable engines when target apoapsis is reached
65  vessel.control.throttle = 0.25
66  while apoapsis() < target_altitude:
67      pass
68  print('Target apoapsis reached')
69  vessel.control.throttle = 0.0
70
71  # Wait until out of atmosphere

```

```

72 print('Coasting out of atmosphere')
73 while altitude() < 70500:
74     pass

```

It is now time to plan the circularization burn. First, we calculate the delta-v required to circularize the orbit using the [vis-viva equation](#). We then calculate the burn time needed to achieve this delta-v, using the [Tsiolkovsky rocket equation](#).

C#

C++

Java

Lua

Python

```

92 // Plan circularization burn (using vis-viva equation)
93 Console.WriteLine ("Planning circularization burn");
94 double mu = vessel.Orbit.Body.GravitationalParameter;
95 double r = vessel.Orbit.Apoapsis;
96 double a1 = vessel.Orbit.SemiMajorAxis;
97 double a2 = r;
98 double v1 = Math.Sqrt (mu * ((2.0 / r) - (1.0 / a1)));
99 double v2 = Math.Sqrt (mu * ((2.0 / r) - (1.0 / a2)));
100 double deltaV = v2 - v1;
101 var node = vessel.Control.AddNode (
102     ut.Get () + vessel.Orbit.TimeToApoapsis, prograde: (float)deltaV);
103
104 // Calculate burn time (using rocket equation)
105 double F = vessel.AvailableThrust;
106 double Isp = vessel.SpecificImpulse * 9.82;
107 double m0 = vessel.Mass;
108 double m1 = m0 / Math.Exp (deltaV / Isp);
109 double flowRate = F / Isp;
110 double burnTime = (m0 - m1) / flowRate;

```

```

85 // Plan circularization burn (using vis-viva equation)
86 std::cout << "Planning circularization burn" << std::endl;
87 double mu = vessel.orbit().body().gravitational_parameter();
88 double r = vessel.orbit().apoapsis();
89 double a1 = vessel.orbit().semi_major_axis();
90 double a2 = r;
91 double v1 = sqrt(mu * ((2.0 / r) - (1.0 / a1)));
92 double v2 = sqrt(mu * ((2.0 / r) - (1.0 / a2)));
93 double delta_v = v2 - v1;
94 auto node = vessel.control().add_node(
95     ut() + vessel.orbit().time_to_apoapsis(), delta_v);
96
97 // Calculate burn time (using rocket equation)
98 double F = vessel.available_thrust();
99 double Isp = vessel.specific_impulse() * 9.82;
100 double m0 = vessel.mass();
101 double m1 = m0 / exp(delta_v / Isp);
102 double flow_rate = F / Isp;
103 double burn_time = (m0 - m1) / flow_rate;

```

```

103 // Plan circularization burn (using vis-viva equation)
104 System.out.println("Planning circularization burn");
105 double mu = vessel.getOrbit().getBody().getGravitationalParameter();
106 double r = vessel.getOrbit().getApoapsis();
107 double a1 = vessel.getOrbit().getSemiMajorAxis();
108 double a2 = r;
109 double v1 = Math.sqrt(mu * ((2.0 / r) - (1.0 / a1)));
110 double v2 = Math.sqrt(mu * ((2.0 / r) - (1.0 / a2)));
111 double deltaV = v2 - v1;
112 Node node = vessel.getControl().addNode(
113     ut.get() + vessel.getOrbit().getTimeToApoapsis(), (float)deltaV, 0, 0);
114
115 // Calculate burn time (using rocket equation)
116 double force = vessel.getAvailableThrust();
117 double isp = vessel.getSpecificImpulse() * 9.82;
118 double m0 = vessel.getMass();
119 double m1 = m0 / Math.exp(deltaV / isp);
120 double flowRate = force / isp;

```

```

78 ---- Plan circularization burn (using vis-viva equation)
79 print('Planning circularization burn')
80 local mu = vessel.orbit.body.gravitational_parameter
81 local r = vessel.orbit.apoapsis
82 local a1 = vessel.orbit.semi_major_axis
83 local a2 = r
84 local v1 = math.sqrt(mu*((2./r)-(1./a1)))
85 local v2 = math.sqrt(mu*((2./r)-(1./a2)))
86 local delta_v = v2 - v1
87 local node = vessel.control.add_node(conn.space_center.ut + vessel.orbit.time_to_
88     ↪apoapsis, delta_v, 0, 0)
89
90 ---- Calculate burn time (using rocket equation)
91 local F = vessel.available_thrust
92 local Isp = vessel.specific_impulse * 9.82
93 local m0 = vessel.mass
94 local m1 = m0 / math.exp(delta_v/Isp)
95 local flow_rate = F / Isp
96 local burn_time = (m0 - m1) / flow_rate

```

```

76 # Plan circularization burn (using vis-viva equation)
77 print('Planning circularization burn')
78 mu = vessel.orbit.body.gravitational_parameter
79 r = vessel.orbit.apoapsis
80 a1 = vessel.orbit.semi_major_axis
81 a2 = r
82 v1 = math.sqrt(mu*((2./r)-(1./a1)))
83 v2 = math.sqrt(mu*((2./r)-(1./a2)))
84 delta_v = v2 - v1
85 node = vessel.control.add_node(
86     ut() + vessel.orbit.time_to_apoapsis, prograde=delta_v)
87
88 # Calculate burn time (using rocket equation)
89 F = vessel.available_thrust
90 Isp = vessel.specific_impulse * 9.82
91 m0 = vessel.mass
92 m1 = m0 / math.exp(delta_v/Isp)
93 flow_rate = F / Isp

```

```
94 burn_time = (m0 - m1) / flow_rate
```

Next, we need to rotate the craft and wait until the circularization burn. We orientate the ship along the y-axis of the maneuver node's reference frame (i.e. in the direction of the burn) then time warp to 5 seconds before the burn.

C#

C++

Java

Lua

Python

```
112 // Orientate ship
113 Console.WriteLine ("Orientating ship for circularization burn");
114 vessel.AutoPilot.ReferenceFrame = node.ReferenceFrame;
115 vessel.AutoPilot.TargetDirection = Tuple.Create (0.0, 1.0, 0.0);
116 vessel.AutoPilot.Wait ();
117
118 // Wait until burn
119 Console.WriteLine ("Waiting until circularization burn");
120 double burnUT = ut.Get () + vessel.Orbit.TimeToApoapsis - (burnTime / 2.0);
121 double leadTime = 5;
122 conn.SpaceCenter ().WarpTo (burnUT - leadTime);
```

```
105 // Orientate ship
106 std::cout << "Orientating ship for circularization burn" << std::endl;
107 vessel.auto_pilot().set_reference_frame(node.reference_frame());
108 vessel.auto_pilot().set_target_direction(std::make_tuple(0.0, 1.0, 0.0));
109 vessel.auto_pilot().wait();
110
111 // Wait until burn
112 std::cout << "Waiting until circularization burn" << std::endl;
113 double burn_ut = ut() + vessel.orbit().time_to_apoapsis() - (burn_time / 2.0);
114 double lead_time = 5;
115 space_center.warp_to(burn_ut - lead_time);
```

```
123 // Orientate ship
124 System.out.println("Orientating ship for circularization burn");
125 vessel.getAutoPilot().setReferenceFrame(node.getReferenceFrame());
126 vessel.getAutoPilot().setTargetDirection(
127     new Triplet<Double,Double,Double>(0.0, 1.0, 0.0));
128 vessel.getAutoPilot().wait_();
129
130 // Wait until burn
131 System.out.println("Waiting until circularization burn");
132 double burnUt =
133     ut.get() + vessel.getOrbit().getTimeToApoapsis() - (burnTime / 2.0);
134 double leadTime = 5;
```

```
97 -- Orientate ship
98 print('Orientating ship for circularization burn')
99 vessel.auto_pilot.reference_frame = node.reference_frame
100 vessel.auto_pilot.target_direction = List{0, 1, 0}
101 vessel.auto_pilot:wait()
102
```

```

103 -- Wait until burn
104 print('Waiting until circularization burn')
105 local burn_ut = conn.space_center.ut + vessel.orbit.time_to_apoapsis - (burn_time/2.)
106 local lead_time = 5
107 conn.space_center.warp_to(burn_ut - lead_time)

96 # Orientate ship
97 print('Orientating ship for circularization burn')
98 vessel.auto_pilot.reference_frame = node.reference_frame
99 vessel.auto_pilot.target_direction = (0, 1, 0)
100 vessel.auto_pilot.wait()
101
102 # Wait until burn
103 print('Waiting until circularization burn')
104 burn_ut = ut() + vessel.orbit.time_to_apoapsis - (burn_time/2.)
105 lead_time = 5
106 conn.space_center.warp_to(burn_ut - lead_time)

```

This next part executes the burn. It sets maximum throttle, then throttles down to 5% approximately a tenth of a second before the predicted end of the burn. It then monitors the remaining delta-v until it flips around to point retrograde (at which point the node has been executed).

C#

C++

Java

Lua

Python

```

124 // Execute burn
125 Console.WriteLine ("Ready to execute burn");
126 var timeToApoapsis = conn.AddStream (() => vessel.Orbit.TimeToApoapsis);
127 while (timeToApoapsis.Get () - (burnTime / 2.0) > 0) {
128 }
129 Console.WriteLine ("Executing burn");
130 vessel.Control.Throttle = 1;
131 System.Threading.Thread.Sleep ((int)((burnTime - 0.1) * 1000));
132 Console.WriteLine ("Fine tuning");
133 vessel.Control.Throttle = 0.05f;
134 var remainingBurn = conn.AddStream (
135     () => node.RemainingBurnVector (node.ReferenceFrame));
136 while (remainingBurn.Get ().Item1 > 0) {
137 }
138 vessel.Control.Throttle = 0;
139 node.Remove ();
140
141 Console.WriteLine ("Launch complete");
142 conn.Dispose();
143 }
144 }

```

```

115 // Execute burn
116 std::cout << "Ready to execute burn" << std::endl;
117 auto time_to_apoapsis = vessel.orbit().time_to_apoapsis_stream();
118 while (time_to_apoapsis() - (burn_time / 2.0) > 0) {
119 }

```

```

120     std::cout << "Executing burn" << std::endl;
121     vessel.control().set_throttle(1);
122     std::this_thread::sleep_for(
123         std::chrono::milliseconds(static_cast<int>((burn_time - 0.1) * 1000)));
124     std::cout << "Fine tuning" << std::endl;
125     vessel.control().set_throttle(0.05);
126     auto remaining_burn = node.remaining_burn_vector_stream(node.reference_frame());
127     while (std::get<0>(remaining_burn()) > 0) {
128     }
129     vessel.control().set_throttle(0);
130     node.remove();
131
132     std::cout << "Launch complete" << std::endl;
133 }

```

```

137     // Execute burn
138     System.out.println("Ready to execute burn");
139     Stream<Double> timeToApoapsis =
140         connection.addStream(vessel.getOrbit(), "getTimeToApoapsis");
141     while (timeToApoapsis.get() - (burnTime / 2.0) > 0) {
142     }
143     System.out.println("Executing burn");
144     vessel.getControl().setThrottle(1);
145     Thread.sleep((int)((burnTime - 0.1) * 1000));
146     System.out.println("Fine tuning");
147     vessel.getControl().setThrottle(0.05f);
148     Stream<Triplet<Double, Double, Double>> remainingBurn =
149         connection.addStream(
150             node, "remainingBurnVector", node.getReferenceFrame());
151     while (remainingBurn.get().getValue1() > 0) {
152     }
153     vessel.getControl().setThrottle(0);
154     node.remove();
155
156     System.out.println("Launch complete");
157     connection.close();
158 }
159 }

```

```

109 -- Execute burn
110 print('Ready to execute burn')
111 while vessel.orbit.time_to_apoapsis - (burn_time/2.) > 0 do
112 end
113 print('Executing burn')
114 vessel.control.throttle = 1
115 platform.sleep(burn_time - 0.1)
116 print('Fine tuning')
117 vessel.control.throttle = 0.05
118 while node.remaining_burn_vector(node.reference_frame)[2] > 0 do
119 end
120 vessel.control.throttle = 0
121 node.remove()
122
123 print('Launch complete')

```

```

108 # Execute burn
109 print('Ready to execute burn')

```

```

110 time_to_apoapsis = conn.add_stream(getattr, vessel.orbit, 'time_to_apoapsis')
111 while time_to_apoapsis() - (burn_time/2.) > 0:
112     pass
113 print('Executing burn')
114 vessel.control.throttle = 1.0
115 time.sleep(burn_time - 0.1)
116 print('Fine tuning')
117 vessel.control.throttle = 0.05
118 remaining_burn = conn.add_stream(node.remaining_burn_vector, node.reference_frame)
119 while remaining_burn()[1] > 0:
120     pass
121 vessel.control.throttle = 0.0
122 node.remove()
123
124 print('Launch complete')

```

The rocket should now be in a circular 150km orbit above Kerbin.

2.4 Pitch, Heading and Roll

This example calculates the pitch, heading and rolls angles of the active vessel once per second.

C#

C++

C

Java

Lua

Python

```

using System;
using KRPC.Client;
using KRPC.Client.Services.SpaceCenter;
using Vector3 = System.Tuple<double, double, double>;

class AngleOfAttack
{
    static Vector3 CrossProduct (Vector3 u, Vector3 v)
    {
        return new Vector3 (
            u.Item2 * v.Item3 - u.Item3 * v.Item2,
            u.Item3 * v.Item1 - u.Item1 * v.Item3,
            u.Item1 * v.Item2 - u.Item2 * v.Item1
        );
    }

    static double DotProduct (Vector3 u, Vector3 v)
    {
        return u.Item1 * v.Item1 + u.Item2 * v.Item2 + u.Item3 * v.Item3;
    }

    static double Magnitude (Vector3 v)
    {
        return Math.Sqrt (DotProduct (v, v));
    }
}

```

```

}

// Compute the angle between vector x and y
static double AngleBetweenVectors (Vector3 u, Vector3 v)
{
    double dp = DotProduct (u, v);
    if (dp == 0)
        return 0;
    double um = Magnitude (u);
    double vm = Magnitude (v);
    return Math.Acos (dp / (um * vm)) * (180f / Math.PI);
}

public static void Main ()
{
    var conn = new Connection ("Angle of attack");
    var vessel = conn.SpaceCenter ().ActiveVessel;

    while (true) {
        var vesselDirection = vessel.Direction (vessel.SurfaceReferenceFrame);

        // Get the direction of the vessel in the horizon plane
        var horizonDirection = new Vector3 (
            0, vesselDirection.Item2, vesselDirection.Item3);

        // Compute the pitch - the angle between the vessels direction and
        // the direction in the horizon plane
        double pitch = AngleBetweenVectors (vesselDirection, horizonDirection);
        if (vesselDirection.Item1 < 0)
            pitch = -pitch;

        // Compute the heading - the angle between north and
        // the direction in the horizon plane
        var north = new Vector3 (0, 1, 0);
        double heading = AngleBetweenVectors (north, horizonDirection);
        if (horizonDirection.Item3 < 0)
            heading = 360 - heading;

        // Compute the roll
        // Compute the plane running through the vessels direction
        // and the upwards direction
        var up = new Vector3 (1, 0, 0);
        var planeNormal = CrossProduct (vesselDirection, up);
        // Compute the upwards direction of the vessel
        var vesselUp = conn.SpaceCenter ().TransformDirection (
            new Vector3 (0, 0, -1),
            vessel.ReferenceFrame, vessel.SurfaceReferenceFrame);
        // Compute the angle between the upwards direction of
        // the vessel and the plane normal
        double roll = AngleBetweenVectors (vesselUp, planeNormal);
        // Adjust so that the angle is between -180 and 180 and
        // rolling right is +ve and left is -ve
        if (vesselUp.Item1 > 0)
            roll *= -1;
        else if (roll < 0)
            roll += 180;
        else
            roll -= 180;
    }
}

```

```

        Console.WriteLine ("pitch = {0:F1}, heading = {1:F1}, roll = {2:F1}",
                           pitch, heading, roll);

        System.Threading.Thread.Sleep (1000);
    }
}

```

```

#include <iostream>
#include <iomanip>
#include <tuple>
#include <thread>
#include <chrono>
#include <krpc.hpp>
#include <krpc/services/space_center.hpp>

static const double pi = 3.1415926535897;
typedef std::tuple<double, double, double> vector3;

vector3 cross_product(const vector3& u, const vector3& v) {
    return std::make_tuple(
        std::get<1>(u)*std::get<2>(v) - std::get<2>(u)*std::get<1>(v),
        std::get<2>(u)*std::get<0>(v) - std::get<0>(u)*std::get<2>(v),
        std::get<0>(u)*std::get<1>(v) - std::get<1>(u)*std::get<0>(v));
}

double dot_product(const vector3& u, const vector3& v) {
    return
        std::get<0>(u)*std::get<0>(v) +
        std::get<1>(u)*std::get<1>(v) +
        std::get<2>(u)*std::get<2>(v);
}

double magnitude(const vector3& v) {
    return sqrt(dot_product(v, v));
}

// Compute the angle between vector u and v
double angle_between_vectors(const vector3& u, const vector3& v) {
    double dp = dot_product(u, v);
    if (dp == 0)
        return 0;
    double um = magnitude(u);
    double vm = magnitude(v);
    return acos(dp / (um*vm)) * (180.0 / pi);
}

int main() {
    krpc::Client conn = krpc::connect("Pitch/Heading/Roll");
    krpc::services::SpaceCenter space_center(&conn);
    auto vessel = space_center.active_vessel();

    while (true) {
        vector3 vessel_direction = vessel.direction(vessel.surface_reference_frame());

        // Get the direction of the vessel in the horizon plane
        vector3 horizon_direction {

```

```

    0, std::get<1>(vessel_direction), std::get<2>(vessel_direction)
};

// Compute the pitch - the angle between the vessels direction
// and the direction in the horizon plane
double pitch = angle_between_vectors(vessel_direction, horizon_direction);
if (std::get<0>(vessel_direction) < 0)
    pitch = -pitch;

// Compute the heading - the angle between north
// and the direction in the horizon plane
vector3 north {0, 1, 0};
double heading = angle_between_vectors(north, horizon_direction);
if (std::get<2>(horizon_direction) < 0)
    heading = 360 - heading;

// Compute the roll
// Compute the plane running through the vessels direction
// and the upwards direction
vector3 up {1, 0, 0};
vector3 plane_normal = cross_product(vessel_direction, up);
// Compute the upwards direction of the vessel
vector3 vessel_up = space_center.transform_direction(
    std::make_tuple(0, 0, -1),
    vessel.reference_frame(),
    vessel.surface_reference_frame());
// Compute the angle between the upwards direction of
// the vessel and the plane normal
double roll = angle_between_vectors(vessel_up, plane_normal);
// Adjust so that the angle is between -180 and 180 and
// rolling right is +ve and left is -ve
if (std::get<0>(vessel_up) > 0)
    roll *= -1;
else if (roll < 0)
    roll += 180;
else
    roll -= 180;

std::cout << std::fixed << std::setprecision(1);
std::cout << "pitch = " << pitch << ", "
    << "heading = " << heading << ", "
    << "roll = " << roll << std::endl;

std::this_thread::sleep_for(std::chrono::seconds(1));
}
}

```

```

#include <math.h>
#include <unistd.h>
#include <krpc.h>
#include <krpc/services/space_center.h>

static double pi = 3.1415926535897;
typedef krpc_tuple_double_double_double_t vector3;

vector3 cross_product(vector3 u, vector3 v) {
    vector3 result = {
        u.e1*v.e2 - u.e2*v.e1,

```

```

    u.e2*v.e0 - u.e0*v.e2,
    u.e0*v.e1 - u.e1*v.e0
};
return result;
}

double dot_product(vector3 u, vector3 v) {
    return u.e0*v.e0 + u.e1*v.e1 + u.e2*v.e2;
}

double magnitude(vector3 v) {
    return sqrt(dot_product(v, v));
}

// Compute the angle between vector u and v
double angle_between_vectors(vector3 u, vector3 v) {
    double dp = dot_product(u, v);
    if (dp == 0)
        return 0;
    double um = magnitude(u);
    double vm = magnitude(v);
    return acos(dp / (um*vm)) * (180.0 / pi);
}

int main() {
    krpc_connection_t conn;
    krpc_open(&conn, "COM0");
    krpc_connect(conn, "");

    krpc_SpaceCenter_Vessel_t vessel;
    krpc_SpaceCenter_ActiveVessel(conn, &vessel);
    krpc_SpaceCenter_ReferenceFrame_t srf_ref;
    krpc_SpaceCenter_Vessel_SurfaceReferenceFrame(conn, &srf_ref, vessel);
    krpc_SpaceCenter_ReferenceFrame_t vessel_ref;
    krpc_SpaceCenter_Vessel_ReferenceFrame(conn, &vessel_ref, vessel);

    while (true) {
        vector3 vessel_direction;
        krpc_SpaceCenter_Vessel_Direction(conn, &vessel_direction, vessel, srf_ref);

        // Get the direction of the vessel in the horizon plane
        vector3 horizon_direction = {
            0, vessel_direction.e1, vessel_direction.e2
        };

        // Compute the pitch - the angle between the vessels direction
        // and the direction in the horizon plane
        double pitch = angle_between_vectors(vessel_direction, horizon_direction);
        if (vessel_direction.e0 < 0)
            pitch = -pitch;

        // Compute the heading - the angle between north
        // and the direction in the horizon plane
        vector3 north = {0, 1, 0};
        double heading = angle_between_vectors(north, horizon_direction);
        if (horizon_direction.e2 < 0)
            heading = 360 - heading;
    }
}

```

```

// Compute the roll
// Compute the plane running through the vessels direction
// and the upwards direction
vector3 up = {1, 0, 0};
vector3 plane_normal = cross_product(vessel_direction, up);
// Compute the upwards direction of the vessel
vector3 vessel_up;
vector3 tmp = { 0, 0, -1 };
krpc_SpaceCenter_TransformDirection(conn, &vessel_up, &tmp, vessel_ref, srf_ref);
// Compute the angle between the upwards direction of
// the vessel and the plane normal
double roll = angle_between_vectors(vessel_up, plane_normal);
// Adjust so that the angle is between -180 and 180 and
// rolling right is +ve and left is -ve
if (vessel_up.e0 > 0)
    roll *= -1;
else if (roll < 0)
    roll += 180;
else
    roll -= 180;

printf("pitch = %.1f, heading = %.1f, roll = %.1f\n", pitch, heading, roll);
sleep(1);
}
}

```

```

import krpc.client.Connection;
import krpc.client.RPCException;
import krpc.client.services.SpaceCenter;

import org.javatuples.Triplet;

import java.io.IOException;
import java.lang.Math;

public class PitchHeadingRoll {

    static Triplet<Double,Double,Double> crossProduct (
        Triplet<Double,Double,Double> u, Triplet<Double,Double,Double> v) {
        return new Triplet<Double,Double,Double> (
            u.getValue1() * v.getValue2() - u.getValue2() * v.getValue1(),
            u.getValue2() * v.getValue0() - u.getValue0() * v.getValue2(),
            u.getValue0() * v.getValue1() - u.getValue1() * v.getValue0()
        );
    }

    static double dotProduct (Triplet<Double,Double,Double> u,
        Triplet<Double,Double,Double> v) {
        return u.getValue0() * v.getValue0() +
            u.getValue1() * v.getValue1() +
            u.getValue2() * v.getValue2();
    }

    static double magnitude (Triplet<Double,Double,Double> v) {
        return Math.sqrt(dotProduct(v, v));
    }

    // Compute the angle between vector x and y

```

```

static double angleBetweenVectors(Triplet<Double,Double,Double> u,
                                Triplet<Double,Double,Double> v) {
    double dp = dotProduct(u, v);
    if (dp == 0) {
        return 0;
    }
    double um = magnitude(u);
    double vm = magnitude(v);
    return Math.acos(dp / (um * vm)) * (180f / Math.PI);
}

public static void main(String[] args)
    throws IOException, RPCEException, InterruptedException {
    Connection connection = Connection.newInstance();
    SpaceCenter spaceCenter = SpaceCenter.newInstance(connection);
    SpaceCenter.Vessel vessel = spaceCenter.getActiveVessel();

    while (true) {
        Triplet<Double,Double,Double> vesselDirection =
            vessel.direction(vessel.getSurfaceReferenceFrame());

        // Get the direction of the vessel in the horizon plane
        Triplet<Double,Double,Double> horizonDirection =
            new Triplet<Double,Double,Double>(
                0.0, vesselDirection.getValue1(), vesselDirection.getValue2());

        // Compute the pitch - the angle between the vessels direction
        // and the direction in the horizon plane
        double pitch = angleBetweenVectors(vesselDirection, horizonDirection);
        if (vesselDirection.getValue0() < 0) {
            pitch = -pitch;
        }

        // Compute the heading - the angle between north
        // and the direction in the horizon plane
        Triplet<Double,Double,Double> north =
            new Triplet<Double,Double,Double>(0.0,1.0,0.0);
        double heading = angleBetweenVectors(north, horizonDirection);
        if (horizonDirection.getValue2() < 0) {
            heading = 360 - heading;
        }

        // Compute the roll
        // Compute the plane running through the vessels direction
        // and the upwards direction
        Triplet<Double,Double,Double> up =
            new Triplet<Double,Double,Double>(1.0,0.0,0.0);
        Triplet<Double,Double,Double> planeNormal =
            crossProduct(vesselDirection, up);
        // Compute the upwards direction of the vessel
        Triplet<Double,Double,Double> vesselUp = spaceCenter.transformDirection(
            new Triplet<Double,Double,Double>(0.0,0.0,-1.0),
            vessel.getReferenceFrame(), vessel.getSurfaceReferenceFrame());
        // Compute the angle between the upwards direction
        // of the vessel and the plane normal
        double roll = angleBetweenVectors(vesselUp, planeNormal);
        // Adjust so that the angle is between -180 and 180 and
        // rolling right is +ve and left is -ve
    }
}

```

```
        if (vesselUp.getValue0() > 0) {
            roll *= -1;
        } else if (roll < 0) {
            roll += 180;
        } else {
            roll -= 180;
        }

        System.out.printf("pitch = %.1f, heading = %.1f, roll = %.1f\n",
                           pitch, heading, roll);
        Thread.sleep(1000);
    }
}
```

```
local krpc = require 'krpc'
local platform = require 'krpc.platform'
local math = require 'math'
local List = require 'pl.List'
local conn = krpc.connect('Pitch/Heading/Roll')
local vessel = conn.space_center.active_vessel

function cross_product(u, v)
    return List{u[3]*v[3] - u[3]*v[2],
                u[1]*v[1] - u[1]*v[3],
                u[2]*v[2] - u[2]*v[1]}
end

function dot_product(u, v)
    return u[1]*v[1] + u[2]*v[2] + u[3]*v[3]
end

function magnitude(v)
    return math.sqrt(dot_product(v, v))
end

function angle_between_vectors(u, v)
    -- Compute the angle between vector u and v
    dp = dot_product(u, v)
    if dp == 0 then
        return 0
    end
    um = magnitude(u)
    vm = magnitude(v)
    return math.acos(dp / (um*vm)) * (180. / math.pi)
end

while true do

    local vessel_direction = vessel:direction(vessel.surface_reference_frame)

    -- Get the direction of the vessel in the horizon plane
    local horizon_direction = List{0, vessel_direction[2], vessel_direction[3]}

    -- Compute the pitch - the angle between the vessels direction and
    -- the direction in the horizon plane
    local pitch = angle_between_vectors(vessel_direction, horizon_direction)
    if vessel_direction[1] < 0 then
```

```

        pitch = -pitch
    end

    -- Compute the heading - the angle between north and
    -- the direction in the horizon plane
    local north = List{0, 1, 0}
    local heading = angle_between_vectors(north, horizon_direction)
    if horizon_direction[3] < 0 then
        heading = 360 - heading
    end

    -- Compute the roll
    -- Compute the plane running through the vessels direction
    -- and the upwards direction
    local up = List{1, 0, 0}
    local plane_normal = cross_product(vessel_direction, up)
    -- Compute the upwards direction of the vessel
    local vessel_up = conn.space_center.transform_direction(
        List{0, 0, -1}, vessel.reference_frame, vessel.surface_reference_frame)
    -- Compute the angle between the upwards direction of
    -- the vessel and the plane normal
    local roll = angle_between_vectors(vessel_up, plane_normal)
    -- Adjust so that the angle is between -180 and 180 and
    -- rolling right is +ve and left is -ve
    if vessel_up[1] > 0 then
        roll = -roll
    elseif roll < 0 then
        roll = roll + 180
    else
        roll = roll - 180
    end

    print(string.format('pitch = %.1f, heading = %.1f, roll = %.1f',
        pitch, heading, roll))

    platform.sleep(1)
end

```

```

import math
import time
import krpc
conn = krpc.connect(name='Pitch/Heading/Roll')
vessel = conn.space_center.active_vessel

def cross_product(u, v):
    return (u[1]*v[2] - u[2]*v[1],
            u[2]*v[0] - u[0]*v[2],
            u[0]*v[1] - u[1]*v[0])

def dot_product(u, v):
    return u[0]*v[0] + u[1]*v[1] + u[2]*v[2]

def magnitude(v):
    return math.sqrt(dot_product(v, v))

```

```

def angle_between_vectors(u, v):
    """ Compute the angle between vector u and v """
    dp = dot_product(u, v)
    if dp == 0:
        return 0
    um = magnitude(u)
    vm = magnitude(v)
    return math.acos(dp / (um*vm)) * (180. / math.pi)

while True:

    vessel_direction = vessel.direction(vessel.surface_reference_frame)

    # Get the direction of the vessel in the horizon plane
    horizon_direction = (0, vessel_direction[1], vessel_direction[2])

    # Compute the pitch - the angle between the vessels direction and
    # the direction in the horizon plane
    pitch = angle_between_vectors(vessel_direction, horizon_direction)
    if vessel_direction[0] < 0:
        pitch = -pitch

    # Compute the heading - the angle between north and
    # the direction in the horizon plane
    north = (0, 1, 0)
    heading = angle_between_vectors(north, horizon_direction)
    if horizon_direction[2] < 0:
        heading = 360 - heading

    # Compute the roll
    # Compute the plane running through the vessels direction
    # and the upwards direction
    up = (1, 0, 0)
    plane_normal = cross_product(vessel_direction, up)
    # Compute the upwards direction of the vessel
    vessel_up = conn.space_center.transform_direction(
        (0, 0, -1), vessel.reference_frame, vessel.surface_reference_frame)
    # Compute the angle between the upwards direction of
    # the vessel and the plane normal
    roll = angle_between_vectors(vessel_up, plane_normal)
    # Adjust so that the angle is between -180 and 180 and
    # rolling right is +ve and left is -ve
    if vessel_up[0] > 0:
        roll *= -1
    elif roll < 0:
        roll += 180
    else:
        roll -= 180

    print('pitch = % 5.1f, heading = % 5.1f, roll = % 5.1f' %
          (pitch, heading, roll))

    time.sleep(1)

```

2.5 Interacting with Parts

The following examples demonstrate use of the *Parts* functionality to achieve various tasks. More details on specific topics can also be found in the API documentation:

C#

C++

C

Java

Lua

Python

- *Trees of Parts*
- *Attachment Modes*
- *Fuel Lines*
- *Staging*
- *Trees of Parts*
- *Attachment Modes*
- *Fuel Lines*
- *Staging*
- *Trees of Parts*
- *Attachment Modes*
- *Fuel Lines*
- *Staging*
- *Trees of Parts*
- *Attachment Modes*
- *Fuel Lines*
- *Staging*
- *Trees of Parts*
- *Attachment Modes*
- *Fuel Lines*
- *Staging*
- *Trees of Parts*
- *Attachment Modes*
- *Fuel Lines*
- *Staging*

2.5.1 Deploying all Parachutes

Sometimes things go horribly wrong. The following script does its best to save your Kerbals by deploying all the parachutes:

C#

C++

C

Java

Lua

Python

```
using KRPC.Client;
using KRPC.Client.Services.SpaceCenter;

class DeployParachutes
{
    public static void Main ()
    {
        using (var connection = new Connection ()) {
            var vessel = connection.SpaceCenter ().ActiveVessel;
            foreach (var parachute in vessel.Parts.Parachutes)
                parachute.Deploy ();
        }
    }
}
```

```
#include <krpc.hpp>
#include <krpc/services/space_center.hpp>

int main() {
    krpc::Client conn = krpc::connect();
    krpc::services::SpaceCenter space_center(&conn);
    auto vessel = space_center.active_vessel();
    for (auto parachute : vessel.parts().parachutes())
        parachute.deploy();
}
```

```
#include <krpc.h>
#include <krpc/services/space_center.h>

int main() {
    krpc_connection_t conn;
    krpc_open(&conn, "COM0");
    krpc_connect(conn, "DeployParachutes");

    krpc_SpaceCenter_Vessel_t vessel;
    krpc_SpaceCenter_ActiveVessel(conn, &vessel);

    krpc_SpaceCenter_Parts_t parts;
    krpc_SpaceCenter_Vessel_Parts(conn, &parts, vessel);

    krpc_list_object_t parachutes;
    krpc_SpaceCenter_Parts_Parachutes(conn, &parachutes, parts);
    for (size_t i = 0; i < parachutes.size; i++) {
```

```

    krpc_SpaceCenter_Parachute_t parachute = parachutes.items[i];
    krpc_SpaceCenter_Parachute_Deploy(conn, parachute);
}
}

```

```

import krpc.client.Connection;
import krpc.client.RPCException;
import krpc.client.services.SpaceCenter;
import krpc.client.services.SpaceCenter.Parachute;
import krpc.client.services.SpaceCenter.Vessel;

import java.io.IOException;

public class DeployParachutes {
    public static void main(String[] args) throws IOException, RPCException {
        Connection connection = Connection.newInstance();
        SpaceCenter spaceCenter = SpaceCenter.newInstance(connection);
        Vessel vessel = spaceCenter.getActiveVessel();
        for (Parachute parachute : vessel.getParts().getParachutes()) {
            parachute.deploy();
        }
        connection.close();
    }
}

```

```

local krpc = require 'krpc'
local conn = krpc.connect('Example')
local vessel = conn.space_center.active_vessel

for _, parachute in ipairs(vessel.parts.parachutes) do
    parachute:deploy()
end

```

```

import krpc
conn = krpc.connect()
vessel = conn.space_center.active_vessel

for parachute in vessel.parts.parachutes:
    parachute.deploy()

```

2.5.2 ‘Control From Here’ for Docking Ports

The following example will find a standard sized Clamp-O-Tron docking port, and control the vessel from it:

C#

C++

C

Java

Lua

Python

```
using System;
using System.Linq;
using KRPC.Client;
using KRPC.Client.Services.SpaceCenter;

class ControlFromHere
{
    public static void Main ()
    {
        using (var conn = new Connection ()) {
            var vessel = conn.SpaceCenter ().ActiveVessel;
            var part = vessel.Parts.WithTitle ("Clamp-O-Tron Docking Port") [0];
            vessel.Parts.Controlling = part;
        }
    }
}
```

```
#include <iostream>
#include <krpc.hpp>
#include <krpc/services/space_center.hpp>

int main() {
    krpc::Client conn = krpc::connect();
    krpc::services::SpaceCenter space_center(&conn);
    auto vessel = space_center.active_vessel();
    auto part = vessel.parts().with_title("Clamp-O-Tron Docking Port").front();
    vessel.parts().set_controlling(part);
}
```

```
#include <krpc.h>
#include <krpc/services/space_center.h>

int main() {
    krpc_connection_t conn;
    krpc_open(&conn, "COM0");
    krpc_connect(conn, "ControlFromHere");

    krpc_SpaceCenter_Vessel_t vessel;
    krpc_SpaceCenter_ActiveVessel(conn, &vessel);

    krpc_SpaceCenter_Parts_t parts;
    krpc_SpaceCenter_Vessel_Parts(conn, &parts, vessel);

    krpc_list_object_t docking_port_parts;
    krpc_SpaceCenter_Parts_WithTitle(conn, &docking_port_parts, parts, "Clamp-O-Tron_
↪Docking Port");
    krpc_object_t part = docking_port_parts.items[0];
    krpc_SpaceCenter_Parts_set_Controlling(conn, parts, part);
}
```

```
import krpc.client.Connection;
import krpc.client.RPCException;
import krpc.client.services.SpaceCenter;
import krpc.client.services.SpaceCenter.Part;
import krpc.client.services.SpaceCenter.Vessel;

import java.io.IOException;
```

```

public class ControlFromHere {
    public static void main(String[] args) throws IOException, RPCException {
        Connection connection = Connection.newInstance();
        Vessel vessel = SpaceCenter.newInstance(connection).getActiveVessel();
        Part part = vessel.getParts().withTitle("Clamp-O-Tron Docking Port").get(0);
        vessel.getParts().setControlling(part);
        connection.close();
    }
}

```

```

local krpc = require 'krpc'
local conn = krpc.connect()
local vessel = conn.space_center.active_vessel
local part = vessel.parts.with_title('Clamp-O-Tron Docking Port')[1]
vessel.parts.controlling = part

```

```

import krpc
conn = krpc.connect()
vessel = conn.space_center.active_vessel
part = vessel.parts.with_title('Clamp-O-Tron Docking Port')[0]
vessel.parts.controlling = part

```

2.5.3 Combined Specific Impulse

The following script calculates the combined specific impulse of all currently active and fueled engines on a rocket. See [here](https://wiki.kerbalspaceprogram.com/wiki/Specific_impulse#Multiple_engines) for a description of the maths: https://wiki.kerbalspaceprogram.com/wiki/Specific_impulse#Multiple_engines

C#

C++

C

Java

Lua

Python

```

using System;
using System.Linq;
using KRPC.Client;
using KRPC.Client.Services.SpaceCenter;

class CombinedIsp
{
    public static void Main ()
    {
        using (var connection = new Connection ()) {
            var vessel = connection.SpaceCenter ().ActiveVessel;

            var activeEngines = vessel.Parts.Engines
                .Where (e => e.Active && e.HasFuel).ToList ();

            Console.WriteLine ("Active engines:");
            foreach (var engine in activeEngines)
                Console.WriteLine ("    " + engine.Part.Title +

```

```

        " in stage " + engine.Part.Stage);

    double thrust = activeEngines.Sum (e => e.Thrust);
    double fuel_consumption =
        activeEngines.Sum (e => e.Thrust / e.SpecificImpulse);
    double isp = thrust / fuel_consumption;
    Console.WriteLine ("Combined vacuum Isp = {0:F0} seconds", isp);
    }
}
}

```

```

#include <iostream>
#include <vector>
#include <krpc.hpp>
#include <krpc/services/space_center.hpp>

using SpaceCenter = krpc::services::SpaceCenter;

int main() {
    auto conn = krpc::connect();
    SpaceCenter sc(&conn);
    auto vessel = sc.active_vessel();

    auto engines = vessel.parts().engines();

    std::vector<SpaceCenter::Engine> active_engines;
    for (auto engine : engines)
        if (engine.active() && engine.has_fuel())
            active_engines.push_back(engine);

    std::cout << "Active engines:" << std::endl;
    for (auto engine : active_engines)
        std::cout << "    " << engine.part().title() << " in stage "
            << engine.part().stage() << std::endl;

    double thrust = 0;
    double fuel_consumption = 0;
    for (auto engine : active_engines) {
        thrust += engine.thrust();
        fuel_consumption += engine.thrust() / engine.specific_impulse();
    }
    double isp = thrust / fuel_consumption;
    std::cout << "Combined vacuum Isp = " << isp << " seconds" << std::endl;
}

```

```

#include <krpc.h>
#include <krpc/services/space_center.h>

int main() {
    krpc_connection_t conn;
    krpc_open(&conn, "COM0");
    krpc_connect(conn, "CombinedISP");

    krpc_SpaceCenter_Vessel_t vessel;
    krpc_SpaceCenter_ActiveVessel(conn, &vessel);

    krpc_SpaceCenter_Parts_t parts;

```

```

krpc_SpaceCenter_Vessel_Parts(conn, &parts, vessel);

krpc_list_object_t engines = KRPC_NULL_LIST;
krpc_SpaceCenter_Parts_Engines(conn, &engines, parts);

krpc_list_object_t active_engines = KRPC_NULL_LIST;
active_engines.size = 0;
active_engines.items = krpc_malloc(engines.size, sizeof(krpc_object_t));

for (size_t i = 0; i < engines.size; i++) {
    krpc_SpaceCenter_Engine_t engine = engines.items[i];
    bool active;
    bool has_fuel;
    krpc_SpaceCenter_Engine_Active(conn, &active, engine);
    krpc_SpaceCenter_Engine_HasFuel(conn, &has_fuel, engine);
    if (active && has_fuel) {
        active_engines.items[active_engines.size] = engine;
        active_engines.size++;
    }
}

printf("Active engines:\n");
for (size_t i = 0; i < active_engines.size; i++) {
    krpc_SpaceCenter_Engine_t engine = active_engines.items[i];
    krpc_SpaceCenter_Part_t part;
    krpc_SpaceCenter_Engine_Part(conn, &part, engine);
    char * title = NULL;
    int stage;
    krpc_SpaceCenter_Part_Title(conn, &title, part);
    krpc_SpaceCenter_Part_Stage(conn, &stage, part);
    printf("    %s in stage %d\n", title, stage);
}

double thrust = 0;
double fuel_consumption = 0;
for (size_t i = 0; i < active_engines.size; i++) {
    krpc_SpaceCenter_Engine_t engine = active_engines.items[i];
    float engine_thrust;
    float engine_isp;
    krpc_SpaceCenter_Engine_Thrust(conn, &engine_thrust, engine);
    krpc_SpaceCenter_Engine_SpecificImpulse(conn, &engine_isp, engine);
    thrust += engine_thrust;
    fuel_consumption += engine_thrust / engine_isp;
}
double isp = thrust / fuel_consumption;
printf("Combined vacuum Isp = %.2f seconds\n", isp);

KRPC_FREE_LIST(engines);
KRPC_FREE_LIST(active_engines);
}

```

```

import krpc.client.Connection;
import krpc.client.RPCException;
import krpc.client.services.SpaceCenter;
import krpc.client.services.SpaceCenter.Engine;
import krpc.client.services.SpaceCenter.Vessel;

import java.io.IOException;

```

```
import java.util.LinkedList;
import java.util.List;

public class CombinedIsp {
    public static void main(String[] args) throws IOException, RPCException {
        Connection connection = Connection.newInstance();
        Vessel vessel = SpaceCenter.newInstance(connection).getActiveVessel();

        List<Engine> engines = vessel.getParts().getEngines();
        List<Engine> activeEngines = new LinkedList<Engine>();
        for (Engine engine : engines) {
            if (engine.getActive() && engine.getHasFuel()) {
                activeEngines.add(engine);
            }
        }

        System.out.println("Active engines:");
        for (Engine engine : activeEngines) {
            System.out.println("    " + engine.getPart().getTitle() +
                               " in stage " + engine.getPart().getStage());
        }

        double thrust = 0;
        double fuelConsumption = 0;
        for (Engine engine : activeEngines) {
            thrust += engine.getThrust();
            fuelConsumption += engine.getThrust() / engine.getSpecificImpulse();
        }
        double isp = thrust / fuelConsumption;
        System.out.printf("Combined vacuum Isp = %.0f\n", isp);
        connection.close();
    }
}
```

```
local krpc = require 'krpc'
local math = require 'math'
local conn = krpc.connect()
local vessel = conn.space_center.active_vessel

local active_engines = {}
for _,engine in ipairs(vessel.parts.engines) do
    if engine.active and engine.has_fuel then
        table.insert(active_engines, engine)
    end
end

print('Active engines:')
for _,engine in ipairs(active_engines) do
    print('    ' .. engine.part.title .. ' in stage ' .. engine.part.stage)
end

thrust = 0
fuel_consumption = 0
for _,engine in ipairs(active_engines) do
    thrust = thrust + engine.thrust
    fuel_consumption = fuel_consumption + engine.thrust / engine.specific_impulse
end
isp = thrust / fuel_consumption
```

```
print(string.format('Combined vacuum Isp = %.1f seconds', isp))
```

```
import krpc
conn = krpc.connect()
vessel = conn.space_center.active_vessel

active_engines = [e for e in vessel.parts.engines if e.active and e.has_fuel]

print('Active engines:')
for engine in active_engines:
    print('    %s in stage %d' % (engine.part.title, engine.part.stage))

thrust = sum(engine.thrust for engine in active_engines)
fuel_consumption = sum(engine.thrust / engine.specific_impulse
                        for engine in active_engines)
isp = thrust / fuel_consumption

print('Combined vacuum Isp = %d seconds' % isp)
```

2.6 Docking Guidance

The following script outputs docking guidance information. It waits until the vessel is being controlled from a docking port, and a docking port is set as the current target. It then prints out information about speeds and distances relative to the docking axis.

It uses `numpy` to do linear algebra on the vectors returned by kRPC – for example computing the dot product or length of a vector – and uses `curses` for terminal output.

```
import curses
import time
import numpy as np
import numpy.linalg as la
import krpc

# Set up curses
stdscr = curses.initscr()
curses.nocbreak()
stdscr.keypad(1)
curses.noecho()

try:
    # Connect to kRPC
    conn = krpc.connect(name='Docking Guidance')
    vessel = conn.space_center.active_vessel
    current = None
    target = None

    while True:
        stdscr.clear()
        stdscr.addstr(0, 0, '-- Docking Guidance --')

        current = conn.space_center.active_vessel.parts.controlling.docking_port
        target = conn.space_center.target_docking_port
```

```

if current is None:
    stdscr.addstr(2, 0, 'Awaiting control from docking port...')

elif target is None:
    stdscr.addstr(2, 0, 'Awaiting target docking port...')

else:
    # Get positions, distances, velocities and
    # speeds relative to the target docking port
    current_position = current.position(target.reference_frame)
    velocity = current.part.velocity(target.reference_frame)
    displacement = np.array(current_position)
    distance = la.norm(displacement)
    speed = la.norm(np.array(velocity))

    # Get speeds and distances relative to the docking axis
    # (the direction the target docking port is facing in)

    # Axial = along the docking axis
    axial_displacement = np.copy(displacement)
    axial_displacement[0] = 0
    axial_displacement[2] = 0
    axial_distance = axial_displacement[1]
    axial_velocity = np.copy(velocity)
    axial_velocity[0] = 0
    axial_velocity[2] = 0
    axial_speed = axial_velocity[1]
    if axial_distance > 0:
        axial_speed *= -1

    # Radial = perpendicular to the docking axis
    radial_displacement = np.copy(displacement)
    radial_displacement[1] = 0
    radial_distance = la.norm(radial_displacement)
    radial_velocity = np.copy(velocity)
    radial_velocity[1] = 0
    radial_speed = la.norm(radial_velocity)
    if np.dot(radial_velocity, radial_displacement) > 0:
        radial_speed *= -1

    # Get the docking port state
    if current.state == conn.space_center.DockingPortState.ready:
        state = 'Ready to dock'
    elif current.state == conn.space_center.DockingPortState.docked:
        state = 'Docked'
    elif current.state == conn.space_center.DockingPortState.docking:
        state = 'Docking...'
    else:
        state = 'Unknown'

    # Output information
    stdscr.addstr(2, 0, 'Current ship: {:30}'.format(current.part.vessel.
↪name[:30]))
    stdscr.addstr(3, 0, 'Current port: {:30}'.format(current.part.title[:30]))
    stdscr.addstr(5, 0, 'Target ship:  {:30}'.format(target.part.vessel.
↪name[:30]))
    stdscr.addstr(6, 0, 'Target port:  {:30}'.format(target.part.title[:30]))
    stdscr.addstr(8, 0, 'Status: {:10}'.format(state))

```

```

stdscr.addstr(10, 0, '          +-----+')
stdscr.addstr(11, 0, '          | Distance | Speed      |')
stdscr.addstr(12, 0, '+-----+-----+')
stdscr.addstr(13, 0, '|          | {:>+6.2f} m | {:>+6.2f} m/s |'
               .format(distance, speed))
stdscr.addstr(14, 0, '| Axial | {:>+6.2f} m | {:>+6.2f} m/s |'
               .format(axial_distance, axial_speed))
stdscr.addstr(15, 0, '| Radial | {:>+6.2f} m | {:>+6.2f} m/s |'
               .format(radial_distance, radial_speed))
stdscr.addstr(16, 0, '+-----+-----+')

stdscr.refresh()
time.sleep(0.25)

finally:
    # Shutdown curses
    curses.nocbreak()
    stdscr.keypad(0)
    curses.echo()
    curses.endwin()

```

2.7 User Interface

The following script demonstrates how to use the UI service to display text and handle basic user input. It adds a panel to the left side of the screen, displaying the current thrust produced by the vessel and a button to set the throttle to maximum.

C#

C++

Java

Lua

Python

```

using System;
using KRPC.Client;
using KRPC.Client.Services.SpaceCenter;
using KRPC.Client.Services.UI;

class UserInterface
{
    public static void Main ()
    {
        var conn = new Connection ("User Interface Example");
        var canvas = conn.UI ().StockCanvas;

        // Get the size of the game window in pixels
        var screenSize = canvas.RectTransform.Size;

        // Add a panel to contain the UI elements
        var panel = canvas.AddPanel ();

        // Position the panel on the left of the screen
        var rect = panel.RectTransform;
    }
}

```

```

rect.Size = Tuple.Create (200.0, 100.0);
rect.Position = Tuple.Create ((110-(screenSize.Item1)/2), 0.0);

// Add a button to set the throttle to maximum
var button = panel.AddButton ("Full Throttle");
button.RectTransform.Position = Tuple.Create (0.0, 20.0);

// Add some text displaying the total engine thrust
var text = panel.AddText ("Thrust: 0 kN");
text.RectTransform.Position = Tuple.Create (0.0, -20.0);
text.Color = Tuple.Create (1.0, 1.0, 1.0);
text.Size = 18;

// Set up a stream to monitor the throttle button
var buttonClicked = conn.AddStream (() => button.Clicked);

var vessel = conn.SpaceCenter ().ActiveVessel;
while (true) {
    // Handle the throttle button being clicked
    if (buttonClicked.Get ()) {
        vessel.Control.Throttle = 1;
        button.Clicked = false;
    }

    // Update the thrust text
    text.Content = "Thrust: " + (vessel.Thrust/1000) + " kN";

    System.Threading.Thread.Sleep (1000);
}
}

```

```

#include <chrono>
#include <thread>
#include <krpc.hpp>
#include <krpc/services/space_center.hpp>
#include <krpc/services/ui.hpp>

int main() {
    krpc::Client conn = krpc::connect("User Interface Example");
    krpc::services::SpaceCenter space_center(&conn);
    krpc::services::UI ui(&conn);
    auto canvas = ui.stock_canvas();

    // Get the size of the game window in pixels
    auto screen_size = canvas.rect_transform().size();

    // Add a panel to contain the UI elements
    auto panel = canvas.add_panel();

    // Position the panel on the left of the screen
    auto rect = panel.rect_transform();
    rect.set_size(std::make_tuple(200, 100));
    rect.set_position(std::make_tuple(110-(std::get<0>(screen_size)/2), 0));

    // Add a button to set the throttle to maximum
    auto button = panel.add_button("Full Throttle");
    button.rect_transform().set_position(std::make_tuple(0, 20));
}

```

```

// Add some text displaying the total engine thrust
auto text = panel.add_text("Thrust: 0 kN");
text.rect_transform().set_position(std::make_tuple(0, -20));
text.set_color(std::make_tuple(1, 1, 1));
text.set_size(18);

// Set up a stream to monitor the throttle button
auto button_clicked = button.clicked_stream();

auto vessel = space_center.active_vessel();
while (true) {
    // Handle the throttle button being clicked
    if (button_clicked()) {
        vessel.control().set_throttle(1);
        button.set_clicked(false);
    }

    // Update the thrust text
    text.set_content("Thrust: " + std::to_string((int)(vessel.thrust()/1000)) + " kN
↪");

    std::this_thread::sleep_for(std::chrono::seconds(1));
}
}

```

```

import krpc.client.Connection;
import krpc.client.RPCException;
import krpc.client.Stream;
import krpc.client.StreamException;
import krpc.client.services.SpaceCenter;
import krpc.client.services.SpaceCenter.Vessel;
import krpc.client.services.UI;
import krpc.client.services.UI.Button;
import krpc.client.services.UI.Canvas;
import krpc.client.services.UI.Panel;
import krpc.client.services.UI.RectTransform;
import krpc.client.services.UI.Text;

import org.javatuples.Pair;
import org.javatuples.Triplet;

import java.io.IOException;

public class UserInterface {
    public static void main(String[] args)
        throws IOException, RPCException, InterruptedException, StreamException {
        Connection connection = Connection.newInstance("User Interface Example");
        SpaceCenter spaceCenter = SpaceCenter.newInstance(connection);
        UI ui = UI.newInstance(connection);
        Canvas canvas = ui.getStockCanvas();

        // Get the size of the game window in pixels
        Pair<Double, Double> screenSize = canvas.getRectTransform().getSize();

        // Add a panel to contain the UI elements
        Panel panel = canvas.addPanel(true);
    }
}

```

```

// Position the panel on the left of the screen
RectTransform rect = panel.getRectTransform();
rect.setSize(new Pair<Double,Double>(200.0, 100.0));
rect.setPosition(
    new Pair<Double,Double>((110-(screenSize.getValue0())/2), 0.0));

// Add a button to set the throttle to maximum
Button button = panel.addButton("Full Throttle", true);
button.getRectTransform().setPosition(new Pair<Double,Double>(0.0, 20.0));

// Add some text displaying the total engine thrust
Text text = panel.addText("Thrust: 0 kN", true);
text.getRectTransform().setPosition(new Pair<Double,Double>(0.0, -20.0));
text.setColor(new Triplet<Double,Double,Double>(1.0, 1.0, 1.0));
text.setSize(18);

// Set up a stream to monitor the throttle button
Stream<Boolean> buttonClicked = connection.addStream(button, "getClicked");

Vessel vessel = spaceCenter.getActiveVessel();
while (true) {
    // Handle the throttle button being clicked
    if (buttonClicked.get ()) {
        vessel.getControl().setThrottle(1);
        button.setClicked(false);
    }

    // Update the thrust text
    text.setContent(String.format("Thrust: %.0f kN", (vessel.getThrust()/
↪1000)));

    Thread.sleep(1000);
}
}

```

```

local krpc = require 'krpc'
local platform = require 'krpc.platform'
local List = require 'pl.List'
local conn = krpc.connect('User Interface Example')
local canvas = conn.ui.stock_canvas

-- Get the size of the game window in pixels
local screen_size = canvas.rect_transform.size

-- Add a panel to contain the UI elements
local panel = canvas:add_panel()

-- Position the panel on the left of the screen
local rect = panel.rect_transform
rect.size = List{200, 100}
rect.position = List{110-(screen_size[1]/2), 0}

-- Add a button to set the throttle to maximum
local button = panel:add_button("Full Throttle")
button.rect_transform.position = List{0, 20}

-- Add some text displaying the total engine thrust

```

```

local text = panel:add_text("Thrust: 0 kN")
text.rect_transform.position = List{0, -20}
text.color = List{1, 1, 1}
text.size = 18

local vessel = conn.space_center.active_vessel
while true do
    -- Handle the throttle button being clicked
    if button.clicked then
        vessel.control.throttle = 1
        button.clicked = false
    end

    -- Update the thrust text
    text.content = string.format('Thrust: %.1f kN', vessel.thrust/1000)

    platform.sleep(0.1)
end

```

```

import time
import krpc

conn = krpc.connect(name='User Interface Example')
canvas = conn.ui.stock_canvas

# Get the size of the game window in pixels
screen_size = canvas.rect_transform.size

# Add a panel to contain the UI elements
panel = canvas.add_panel()

# Position the panel on the left of the screen
rect = panel.rect_transform
rect.size = (200, 100)
rect.position = (110-(screen_size[0]/2), 0)

# Add a button to set the throttle to maximum
button = panel.add_button("Full Throttle")
button.rect_transform.position = (0, 20)

# Add some text displaying the total engine thrust
text = panel.add_text("Thrust: 0 kN")
text.rect_transform.position = (0, -20)
text.color = (1, 1, 1)
text.size = 18

# Set up a stream to monitor the throttle button
button_clicked = conn.add_stream(getattr, button, 'clicked')

vessel = conn.space_center.active_vessel
while True:
    # Handle the throttle button being clicked
    if button_clicked():
        vessel.control.throttle = 1
        button.clicked = False

    # Update the thrust text
    text.content = 'Thrust: %d kN' % (vessel.thrust/1000)

```

```
time.sleep(0.1)
```

2.8 AutoPilot

kRPC provides an autopilot that can be used to hold a vessel in a chosen orientation. It automatically tunes itself to cope with vessels of differing size and control authority. This tutorial explains how the autopilot works, how to configure it and mathematics behind it.

2.8.1 Overview

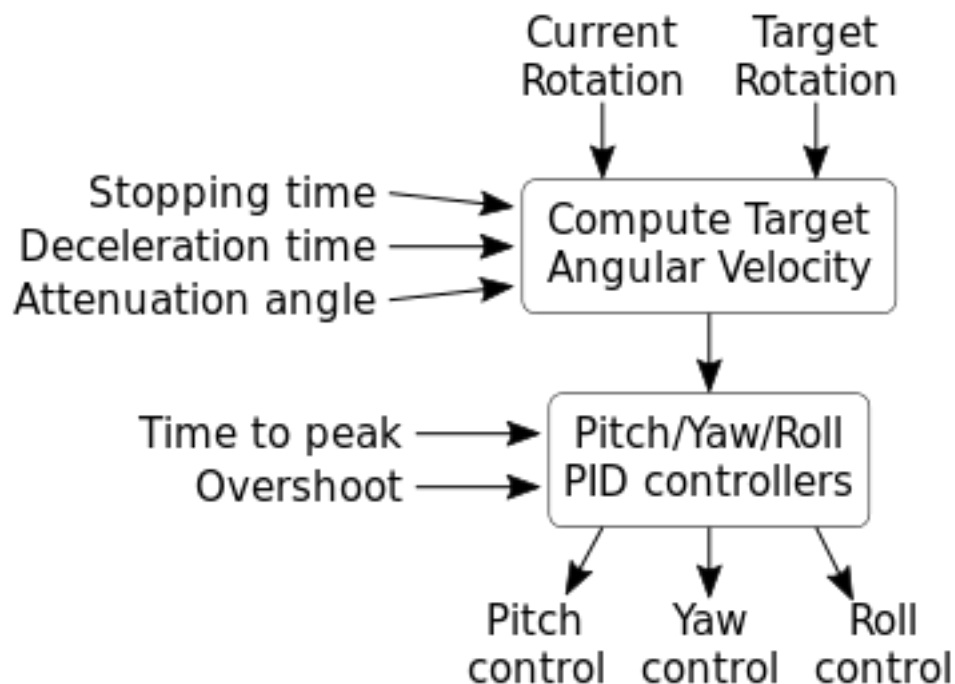
The inputs to the autopilot are:

- A reference frame defining where zero rotation is,
- target pitch and heading angles,
- and an (optional) target roll angle.

When a roll angle is not specified, the autopilot will try to zero out any rotation around the roll axis but will not try to hold a specific roll angle.

The diagram below shows a high level overview of the autopilot. First, the current rotation and target rotation are used to compute the *target angular velocity* that is needed to rotate the vessel to face the target. Next, the components of this angular velocity in the pitch, yaw and roll axes of the vessel are passed to three PID controllers. The outputs of these controllers are used as the control inputs for the vessel.

There are several parameters affecting the operation of the autopilot, shown the the left of the diagram. They are covered in the next section.



2.8.2 Configuring the AutoPilot

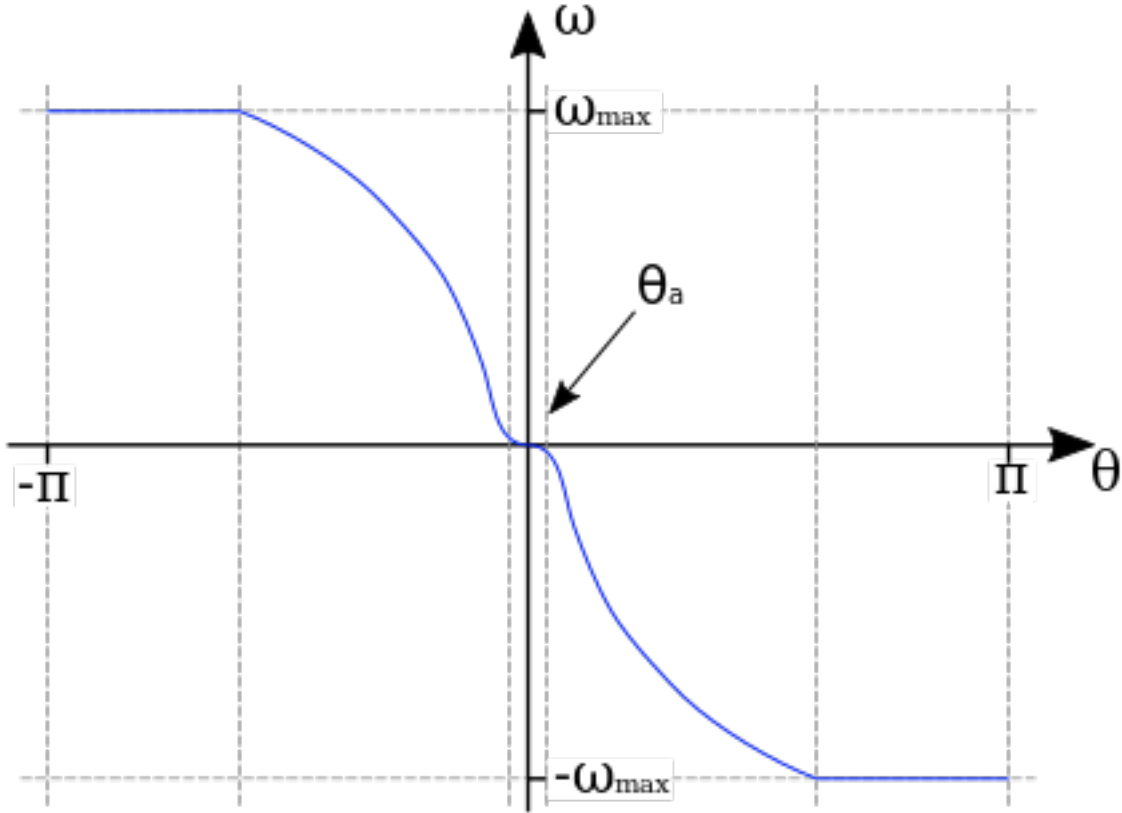
There are several parameters that affect the behavior of the autopilot. The default values for these should suffice in most cases, but they can be adjusted to fit your needs.

- The **stopping time** is the maximum amount of time that the vessel should need to come to a complete stop. This limits the maximum angular velocity of the vessel. It is a vector of three stopping times, one for each of the pitch, roll and yaw axes. The default value is 0.5 seconds for each axis.
- The **deceleration time** is the minimum time the autopilot should take to decelerate the vessel to a stop, as it approaches the target direction. This is a minimum value, as the time required may be higher if the vessel does not have sufficient angular acceleration. It is a vector of three deceleration times, in seconds, for each of the pitch, roll and yaw axes. The default value is 5 seconds for each axis. A smaller value will make the autopilot decelerate more aggressively, turning the vessel towards the target more quickly. However, decreasing the value too much could result in overshoot.
- In order to avoid overshoot, the stopping time should be smaller than the deceleration time. This gives the autopilot some 'spare' acceleration, to adjust for errors in the vessels rotation, for example due to changing aerodynamic forces.
- The **attenuation angle** sets the region in which the autopilot considers the vessel to be 'close' to the target direction. In this region, the target velocity is attenuated based on how close the vessel is to the target. It is an angle, in degrees, for each of the pitch, roll and yaw axes. The default value is 1 degree in each axis. This attenuation prevents the controls from oscillating when the vessel is pointing in the correct direction. If you find that the vessel still oscillates, try increasing this value.
- The **time to peak**, in seconds, that the PID controllers take to adjust the angular velocity of the vessel to the target angular velocity. Decreasing this value will make the controllers try to match the target velocity more aggressively. It is a vector of three times, one for each of the pitch, roll and yaw axes. The default is 3 seconds in each axis.
- The **overshoot** is the percentage by which the PID controllers are allowed to overshoot the target angular velocity. Increasing this value will make the controllers try to match the target velocity more aggressively, but will cause more overshoot. It is a vector of three values, between 0 and 1, for each of the pitch, roll and yaw axes. The default is 0.01 in each axis.

2.8.3 Computing the Target Angular Velocity

The target angular velocity is the angular velocity needed to the vessel to rotate it towards the target direction. It is computed by summing a target angular speed for each of pitch, yaw and roll axes. If no roll angle is set, then the target angular velocity in the roll axis is simply set to 0.

The target angular speed ω in a given axis is computed from the angular error θ using the following function:



The equation for this function is:

$$\omega = -\frac{\theta}{|\theta|} \min(\omega_{max}, \sqrt{2\alpha|\theta|} \cdot f_a(\theta))$$

where

$$\begin{aligned} \alpha &= \frac{\omega_{max}}{t_{decel}} \\ \omega_{max} &= \frac{\tau_{max} t_{stop}}{I} \\ f_a(\theta) &= \frac{1}{1 + e^{-6/\theta_a(|\theta| - \theta_a)}} \end{aligned}$$

The reasoning and derivation for this is as follows:

- The vessel needs to rotate towards $\theta = 0$. This means that the target angular speed ω needs to be positive when θ is negative, and negative when θ is positive. This is done by multiplying by the term $-\frac{\theta}{|\theta|}$, which is 1 when $\theta < 0$ and -1 when $\theta \geq 0$
- We want the vessel to rotate at a maximum angular speed ω_{max} , which is determined by the stopping time t_{stop} . Using the equations of motion under constant acceleration we can derive it as follows:

$$\begin{aligned} \omega &= \alpha t \\ \Rightarrow \omega_{max} &= \alpha_{max} t_{stop} \\ &= \frac{\tau_{max} t_{stop}}{I} \end{aligned}$$

where τ_{max} is the maximum torque the vessel can generate, and I is its moment of inertia.

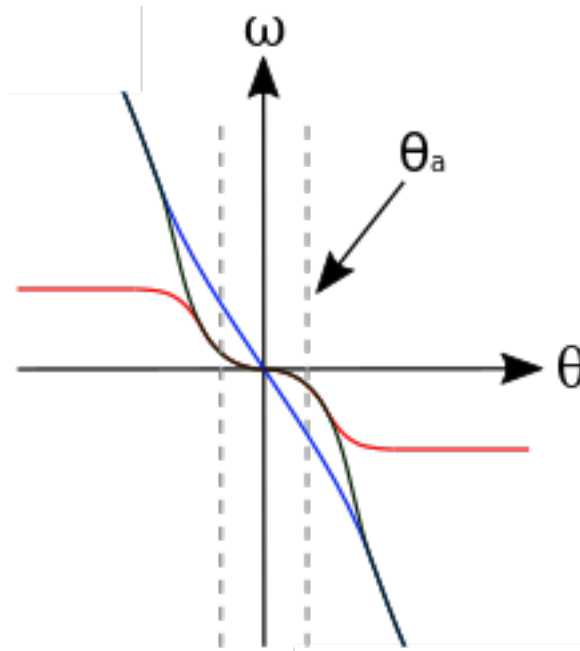
- We want the vessel to take time t_{decel} (the deceleration time) to go from moving at speed ω_{max} to rest, when facing the target. And we want it to do this using a constant acceleration α . Using the equations of motion under

constant acceleration we can derive the target velocity ω in terms of the current angular error θ :

$$\begin{aligned}\omega &= \alpha t \\ \Rightarrow \alpha &= \frac{\omega}{t} = \frac{\omega_{max}}{t_{decel}} \\ \theta &= \frac{1}{2}\alpha t^2 \Rightarrow t = \sqrt{\frac{2\theta}{\alpha}} \\ \Rightarrow \omega &= \alpha \sqrt{\frac{2\theta}{\alpha}} = \sqrt{2\alpha\theta}\end{aligned}$$

- To prevent the vessel from oscillating when it is pointing in the target direction, the gradient of the target angular speed curve at $\theta = 0$ needs to be 0, and increase/decrease smoothly with increasing/decreasing θ .

This is not the case for the target angular speed calculated above. To correct this, we multiply by an attenuation function which has the required shape. The following diagram shows the shape of the attenuation function (line in red), the target velocity as calculated previously (line in blue) and the result of multiplying these together (dashed line in black):



The formula for the attenuation function is a logistic function, with the following formula:

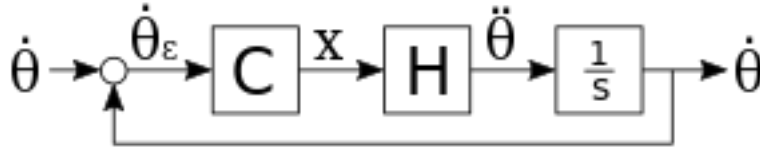
$$f_a(\theta) = \frac{1}{1 + e^{-6/\theta_a(|\theta| - \theta_a)}}$$

Note that the original function, derived from the equations of motion under constant acceleration, is only affected by the attenuation function close to the attenuation angle. This means that autopilot will use a constant acceleration to slow the vessel, until it gets close to the target direction.

2.8.4 Tuning the Controllers

Three PID controllers, one for each of the pitch, roll and yaw control axes, are used to control the vessel. Each controller takes the relevant component of the target angular velocity as input. The following describes how the gains for these controllers are automatically tuned based on the vessels available torque and moment of inertia.

The schematic for the entire system, in a single control axis, is as follows:



The input to the system is the angular speed around the control axis, denoted ω . The error in the angular speed ω_ϵ is calculated from this and passed to controller C . This is a PID controller that we need to tune. The output of the controller is the control input, x , that is passed to the vessel. The plant H describes the physical system, i.e. how the control input affects the angular acceleration of the vessel. The derivative of this is computed to get the new angular speed of the vessel, which is then fed back to compute the new error.

For the controller, C , we use a proportional-integral controller. Note that the controller does not have a derivative term, so that the system behaves like a second order system and is therefore easy to tune.

The transfer function for the controller in the s domain is:

$$C(s) = K_P + K_I s^{-1}$$

From the schematic, the transfer function for the plant H is:

$$H(s) = \frac{\omega_\epsilon(s)}{X(s)}$$

x is the control input to the vessel, which is the percentage of the available torque τ_{max} that is being applied to the vessel. Call this the current torque, denoted τ . This can be written mathematically as:

$$\tau = x\tau_{max}$$

Combining this with the angular equation of motion gives the angular acceleration in terms of the control input:

$$\begin{aligned} I &= \text{moment of inertia of the vessel} \\ \tau &= I\omega_\epsilon \\ \Rightarrow \omega_\epsilon &= \frac{x\tau_{max}}{I} \end{aligned}$$

Taking the laplace transform of this gives us:

$$\begin{aligned} \mathcal{L}(\omega_\epsilon(t)) &= s\omega_\epsilon(s) \\ &= \frac{sX(s)\tau_{max}}{I} \\ \Rightarrow \frac{\omega_\epsilon(s)}{X(s)} &= \frac{\tau_{max}}{I} \end{aligned}$$

We can now rewrite the transfer function for H as:

$$H(s) = \frac{\tau_{max}}{I}$$

The open loop transfer function for the entire system is:

$$\begin{aligned} G_{OL}(s) &= C(s) \cdot H(s) \cdot s^{-1} \\ &= (K_P + K_I s^{-1}) \frac{\tau_{max}}{I s} \end{aligned}$$

The closed loop transfer function is then:

$$\begin{aligned} G(s) &= \frac{G_{OL}(s)}{1 + G_{OL}(s)} \\ &= \frac{aK_P s + aK_I}{s^2 + aK_P s + aK_I} \text{ where } a = \frac{\tau_{max}}{I} \end{aligned}$$

The characteristic equation for the system is therefore:

$$\Phi = s^2 + \frac{\tau_{max}}{I} K_P s + \frac{\tau_{max}}{I} K_I$$

The characteristic equation for a standard second order system is:

$$\Phi_{standard} = s^2 + 2\zeta\omega_0 s + \omega_0^2$$

where ζ is the damping ratio and ω_0 is the natural frequency of the system.

Equating coefficients between these equations, and rearranging, gives us the gains for the PI controller in terms of ζ and ω_0 :

$$K_P = \frac{2\zeta\omega_0 I}{\tau_{max}}$$

$$K_I = \frac{I\omega_0^2}{\tau_{max}}$$

We now need to choose some performance requirements to place on the system, which will allow us to determine the values of ζ and ω_0 , and therefore the gains for the controller.

The percentage by which a second order system overshoots is:

$$O = e^{-\frac{\pi\zeta}{\sqrt{1-\zeta^2}}}$$

And the time it takes to reach the first peak in its output is:

$$T_P = \frac{\pi}{\omega_0\sqrt{1-\zeta^2}}$$

These can be rearranged to give us ζ and ω_0 in terms of overshoot and time to peak:

$$\zeta = \sqrt{\frac{\ln^2(O)}{\pi^2 + \ln^2(O)}}$$

$$\omega_0 = \frac{\pi}{T_P\sqrt{1-\zeta^2}}$$

By default, kRPC uses the values $O = 0.01$ and $T_P = 3$.

2.8.5 Corner Cases

When sitting on the launchpad

In this situation, the autopilot cannot rotate the vessel. This means that the integral term in the controllers will build up to a large value. This is even true if the vessel is pointing in the correct direction, as small floating point variations in the computed error will also cause the integral term to increase. The integral terms are therefore fixed at zero to overcome this.

When the available angular acceleration is zero

This could be caused, for example, by the reaction wheels on a vessel running out of electricity resulting in the vessel having no torque.

In this situation, the autopilot also has little or no control over the vessel. This means that the integral terms in the controllers will build up to a large value over time. This is overcome by fixing the integral terms to zero when the available angular acceleration falls below a small threshold.

This situation also causes an issue with the controller gain auto-tuning: as the available angular acceleration tends towards zero, the controller gains tend towards infinity. When it equals zero, the auto-tuning would cause a division by zero. Therefore, auto-tuning is also disabled when the available acceleration falls below the threshold. This leaves the controller gains at their current values until the available acceleration rises again.

C-NANO

3.1 C-nano Client

This client provides a C API for interacting with a kRPC server. It is intended for use on embedded systems with tight resource constraints, hence the “nano” in its name.

3.1.1 Installing the Library

Manually include the source in your project

The source files can be included in your project manually, by downloading and extracting the [source archive](#). The header files can be found in the `include` directory and the source files are in `src`.

Arduino Library Manager

If you are writing an Arduino sketch, the library can be installed using the Arduino Library Manager by searching for and installing “kRPC”.

Note: The source files installed by the Arduino Library Manager are renamed to end with `.cpp` so that they are built using the C++ compiler. This allows the library to use the C++ only `HardwareSerial` class for communication.

Using the configure script

You can build and install the client library and headers using the configure script provided with the source. [Download the source archive](#), extract it and then execute the following:

```
./configure
make
sudo make install
sudo ldconfig
```

Using CMake

Alternatively, you can install the client library and headers using CMake. [Download the source archive](#), extract it and execute the following:

```
cmake .
make
sudo make install
sudo ldconfig
```

Compilation Options

The following options control how the library operates. They must be specified at compile time as an argument to the compiler.

- Error handling
 - `KRPC_ERROR_CHECK_RETURN` (the default) – when a remote procedure call gets an error, it returns the error code.
 - `KRPC_ERROR_CHECK_EXIT` – terminates the program (by calling `exit()`) when an error occurs in a remote procedure call.
 - `KRPC_ERROR_CHECK_ASSERT` – fails a debug assertion (by calling `assert()`) when an error occurs in a remote procedure call.
 - `KRPC_ERROR_CHECK_FN` – specifies the `krpc_error_handler` function should be called when an error occurs in a remote procedure call. This should be set to a pointer to a function that takes a single parameter of type `krpc_error_t`.
 - `KRPC_PRINT_ERRORS_TO_STDERR` – enables printing of a descriptive error message to `stderr` when an error occurs
 - `PB_NO_ERRMSG` – disables error messages in the `nanopb` library, which `kRPC` uses to communicate with the server. Enabled by default on in the Arduino version of the library.
- Communication
 - `KRPC_COMMUNICATION_POSIX` – Specifies that the library should be built to communicate over a serial port using POSIX read/write functions communication mechanisms. This is the default, unless the a different platform is detected.
 - `KRPC_COMMUNICATION_ARDUINO` – Specifies that the library should be built using Arduino serial communication mechanisms. The Arduino platform will be auto-detected so you do not need to specify this manually.
 - `KRPC_COMMUNICATION_CUSTOM` – Allows you to provide your own implementation for the communication mechanism.
- Memory allocation
 - `KRPC_ALLOC_BLOCK_SIZE` – The size of collections (lists, sets, etc.) are not know ahead of time, so when they are received from the server they are decoded into dynamically allocated memory on the heap. This option controls how many items to increase the capacity of the collection by when its space is exhausted. Setting this to 1 will consume the least amount of heap memory, but will require one heap allocation call per item. Setting this to a higher value will consume more memory, but require fewer allocations.
 - `KRPC_CUSTOM_MEMORY_ALLOC` – Disables the default implementation of memory allocation functions `krpc_malloc`, `krpc_calloc`, `krpc_realloc` and `krpc_free` so that you can provide your own implementation.

Note: On embedded systems you probably want to define `KRPC_NO_PRINT_ERROR` and `PB_NO_ERRMSG` to minimize the memory footprint of kRPC.

3.1.2 Using the Library

The following example program connects to the server, queries it for its version and prints it out:

```
#include <krpc.h>
#include <krpc/services/krpc.h>

int main() {
    krpc_connection_t conn;
    krpc_open(&conn, "COM0");
    krpc_connect(conn, "Basic example");
    krpc_schema_Status status;
    krpc_KRPC_GetStatus(conn, &status);
    printf("Connected to kRPC server version %s\n", status.version);
}
```

To compile this program using GCC, save the source as `main.c` and run the following:

```
gcc main.c -lkRPC_cnano
```

3.1.3 Connecting to the Server

The `krpc_connect()` function is used to open a connection to a server. It takes as its first argument a connection object into which the connection information is written. This is passed to subsequent calls to interact with the server. The second argument is a name for the connection (displayed in game) and the third is the name of the serial port to connect over.

3.1.4 Calling Remote Procedures

The kRPC server provides *procedures* that a client can run. These procedures are arranged in groups called *services* to keep things organized. The functionality for the services are defined in the header files in `krpc/services/...`. For example, all of the functionality provided by the SpaceCenter service is contained in the header file `krpc/services/space_center.h`.

The following example demonstrates how to invoke remote procedures using the Cnano client. It calls `krpc_SpaceCenter_ActiveVessel()` to get a handle to the active vessel (of type `krpc_SpaceCenter_Vessel_t`). It sets the name of the vessel and then prints out its altitude:

```
#include <krpc.h>
#include <krpc/services/space_center.h>

int main() {
    krpc_connection_t conn;
    krpc_open(&conn, "COM0");
    krpc_connect(conn, "Remote Procedures example");

    krpc_SpaceCenter_Vessel_t vessel;
    krpc_SpaceCenter_ActiveVessel(conn, &vessel);
}
```

```
krpc_SpaceCenter_Vessel_set_Name(conn, vessel, "My Vessel");

// Get a handle to a Flight object for the vessel
krpc_SpaceCenter_Flight_t flight;
krpc_SpaceCenter_Vessel_Flight(conn, &flight, vessel, KRPC_NULL);
// Get the altitude
double altitude;
krpc_SpaceCenter_Flight_MeanAltitude(conn, &altitude, flight);
printf("%.2f\n", altitude);
}
```

3.1.5 Streams and Events

These features are not yet supported by this client.

3.1.6 Client API Reference

krpc_error_t **krpc_open** (*krpc_connection_t* * *connection*, void * *arg*)

Create a communication handle over which the client can talk to a server.

When the library is built using `KRPC_COMMUNICATION_POSIX` (which is defined by default) calling this function opens a serial port using the port name passed as *arg*, using a call to `open(arg, ...)`.

When the library is built using `KRPC_COMMUNICATION_ARDUINO`, *connection* must be a pointer to a `HardwareSerial` object. Calling this function opens the serial port using `(* (HardwareSerial*) connection) -> begin(9600)`. *arg* is not used.

krpc_error_t **krpc_connect** (*krpc_connection_t* *connection*, const char * *name*)

Connect to a kRPC server.

Parameters

- **connection** (*krpc_connection_t*) – A connection handle, created using a call to `krpc_open()`.
- **name** (*const char**) – A descriptive name for the connection. This is passed to the server and appears in the in-game server window.

krpc_error_t **krpc_close** (*krpc_connection_t* *connection*)

Closes the communication handle.

krpc_error_t

All kRPC functions return error codes of this type.

KRPC_OK

The function completed successfully and no error occurred.

KRPC_ERROR_IO

An input/output error occurred when communicating with the server.

KRPC_ERROR_EOF

End of file was received from the server.

KRPC_ERROR_CONNECTION_FAILED

Failed to establish a connection to the server.

KRPC_ERROR_NO_RESULTS

The remote procedure call did not return a result.

KRPC_ERROR_RPC_FAILED

The remote procedure call threw an exception.

KRPC_ERROR_ENCODING_FAILED

The encoder failed to construct the remote procedure call.

KRPC_ERROR_DECODING_FAILED

The decoder failed to interpret a result sent by the server.

const char * **krpc_get_error** (*krpc_error_t error*)

Returns a descriptive string for the given error code.

3.2 KRPC API

3.2.1 KRPC

None None None None

Service KRPC

Main kRPC service, used by clients to interact with basic server functionality.

krpc_error_t **krpc_KRPC_GetClientID** (*krpc_connection_t connection*, *krpc_bytes_t * result*)

Returns the identifier for the current client.

krpc_error_t **krpc_KRPC_GetClientName** (*krpc_connection_t connection*, *char ** result*)

Returns the name of the current client. This is an empty string if the client has no name.

krpc_error_t **krpc_KRPC_Clients** (*krpc_connection_t connection*,
*krpc_list_tuple_bytes_string_string_t * result*)

A list of RPC clients that are currently connected to the server. Each entry in the list is a clients identifier, name and address.

krpc_error_t **krpc_KRPC_GetStatus** (*krpc_connection_t connection*, *krpc_schema_Status * result*)

Returns some information about the server, such as the version.

krpc_error_t **krpc_KRPC_GetServices** (*krpc_connection_t connection*,
*krpc_schema_Services * result*)

Returns information on all services, procedures, classes, properties etc. provided by the server. Can be used by client libraries to automatically create functionality such as stubs.

krpc_error_t **krpc_KRPC_SetStreamRate** (*krpc_connection_t connection*, *uint64_t id*,
float rate)

Set the update rate for a stream in Hz.

Parameters

krpc_error_t **krpc_KRPC_CurrentGameScene** (*krpc_connection_t connection*,
*krpc_KRPC_GameScene_t * result*)

Get the current game scene.

krpc_error_t **krpc_KRPC_Paused** (*krpc_connection_t connection*, *bool * result*)

void **krpc_KRPC_set_Paused** (*bool value*)

Whether the game is paused.

krpc_KRPC_GameScene_t

The game scene. See *krpc_KRPC_CurrentGameScene()*.

KRPC_KRPC_GAMESCENE_SPACECENTER

The game scene showing the Kerbal Space Center buildings.

KRPC_KRPC_GAMESCENE_FLIGHT

The game scene showing a vessel in flight (or on the launchpad/runway).

KRPC_KRPC_GAMESCENE_TRACKINGSTATION

The tracking station.

KRPC_KRPC_GAMESCENE_EDITORVAB

The Vehicle Assembly Building.

KRPC_KRPC_GAMESCENE_EDITORSPH

The Space Plane Hangar.

Exception class `InvalidOperationException`

A method call was made to a method that is invalid given the current state of the object.

Exception class `ArgumentException`

A method was invoked where at least one of the passed arguments does not meet the parameter specification of the method.

Exception class `ArgumentNullException`

A null reference was passed to a method that does not accept it as a valid argument.

Exception class `ArgumentOutOfRangeException`

The value of an argument is outside the allowable range of values as defined by the invoked method.

3.2.2 Expressions

krpc_KRPC_Expression_t

A server side expression.

krpc_error_t **krpc_KRPC_Expression_ConstantDouble** (*krpc_connection_t* *connection*,
krpc_KRPC_Expression_t * *result*,
double *value*)

A constant value of type double.

Parameters

krpc_error_t **krpc_KRPC_Expression_ConstantFloat** (*krpc_connection_t* *connection*,
krpc_KRPC_Expression_t * *result*,
float *value*)

A constant value of type float.

Parameters

krpc_error_t **krpc_KRPC_Expression_ConstantInt** (*krpc_connection_t* *connection*,
krpc_KRPC_Expression_t * *result*,
int32_t *value*)

A constant value of type int.

Parameters

krpc_error_t **krpc_KRPC_Expression_ConstantString** (*krpc_connection_t* *connection*,
krpc_KRPC_Expression_t * *result*,
const char * *value*)

A constant value of type string.

Parameters

```
krpc_error_t krpc_KRPC_Expression_Call (krpc_connection_t connection,
                                         krpc_KRPC_Expression_t * result, const
                                         krpc_schema_ProcedureCall * call)
```

An RPC call.

Parameters

```
krpc_error_t krpc_KRPC_Expression_Equal (krpc_connection_t connection,
                                           krpc_KRPC_Expression_t * re-
                                           sult, krpc_KRPC_Expression_t arg0,
                                           krpc_KRPC_Expression_t arg1)
```

Equality comparison.

Parameters

```
krpc_error_t krpc_KRPC_Expression_NotEqual (krpc_connection_t connection,
                                              krpc_KRPC_Expression_t * re-
                                              sult, krpc_KRPC_Expression_t arg0,
                                              krpc_KRPC_Expression_t arg1)
```

Inequality comparison.

Parameters

```
krpc_error_t krpc_KRPC_Expression_GreaterThan (krpc_connection_t connection,
                                                  krpc_KRPC_Expression_t * re-
                                                  sult, krpc_KRPC_Expression_t arg0,
                                                  krpc_KRPC_Expression_t arg1)
```

Greater than numerical comparison.

Parameters

```
krpc_error_t krpc_KRPC_Expression_GreaterThanOrEqualTo (krpc_connection_t connection,
                                                           krpc_KRPC_Expression_t
                                                           * result,
                                                           krpc_KRPC_Expression_t arg0,
                                                           krpc_KRPC_Expression_t arg1)
```

Greater than or equal numerical comparison.

Parameters

```
krpc_error_t krpc_KRPC_Expression_LessThan (krpc_connection_t connection,
                                              krpc_KRPC_Expression_t * re-
                                              sult, krpc_KRPC_Expression_t arg0,
                                              krpc_KRPC_Expression_t arg1)
```

Less than numerical comparison.

Parameters

```
krpc_error_t krpc_KRPC_Expression_LessThanOrEqualTo (krpc_connection_t connection,
                                                         krpc_KRPC_Expression_t * result,
                                                         krpc_KRPC_Expression_t arg0,
                                                         krpc_KRPC_Expression_t arg1)
```

Less than or equal numerical comparison.

Parameters

```
krpc_error_t krpc_KRPC_Expression_And (krpc_connection_t connection,
                                         krpc_KRPC_Expression_t * re-
                                         sult, krpc_KRPC_Expression_t arg0,
                                         krpc_KRPC_Expression_t arg1)
```

Boolean and operator.

Parameters

```
krpc_error_t krpc_KRPC_Expression_Or (krpc_connection_t connection,  
                                         krpc_KRPC_Expression_t * re-  
                                         sult, krpc_KRPC_Expression_t arg0,  
                                         krpc_KRPC_Expression_t arg1)
```

Boolean or operator.

Parameters

```
krpc_error_t krpc_KRPC_Expression_ExclusiveOr (krpc_connection_t connection,  
                                                  krpc_KRPC_Expression_t * re-  
                                                  sult, krpc_KRPC_Expression_t arg0,  
                                                  krpc_KRPC_Expression_t arg1)
```

Boolean exclusive-or operator.

Parameters

```
krpc_error_t krpc_KRPC_Expression_Not (krpc_connection_t connection,  
                                         krpc_KRPC_Expression_t * result,  
                                         krpc_KRPC_Expression_t arg)
```

Boolean negation operator.

Parameters

```
krpc_error_t krpc_KRPC_Expression_Add (krpc_connection_t connection,  
                                         krpc_KRPC_Expression_t * re-  
                                         sult, krpc_KRPC_Expression_t arg0,  
                                         krpc_KRPC_Expression_t arg1)
```

Numerical addition.

Parameters

```
krpc_error_t krpc_KRPC_Expression_Subtract (krpc_connection_t connection,  
                                              krpc_KRPC_Expression_t * re-  
                                              sult, krpc_KRPC_Expression_t arg0,  
                                              krpc_KRPC_Expression_t arg1)
```

Numerical subtraction.

Parameters

```
krpc_error_t krpc_KRPC_Expression_Multiply (krpc_connection_t connection,  
                                              krpc_KRPC_Expression_t * re-  
                                              sult, krpc_KRPC_Expression_t arg0,  
                                              krpc_KRPC_Expression_t arg1)
```

Numerical multiplication.

Parameters

```
krpc_error_t krpc_KRPC_Expression_Divide (krpc_connection_t connection,  
                                             krpc_KRPC_Expression_t * re-  
                                             sult, krpc_KRPC_Expression_t arg0,  
                                             krpc_KRPC_Expression_t arg1)
```

Numerical division.

Parameters

```
krpc_error_t krpc_KRPC_Expression_Modulo (krpc_connection_t connection,  
                                             krpc_KRPC_Expression_t * re-  
                                             sult, krpc_KRPC_Expression_t arg0,  
                                             krpc_KRPC_Expression_t arg1)
```

Numerical modulo operator.

Parameters

Returns The remainder of arg0 divided by arg1

```
krpc_error_t krpc_KRPC_Expression_Power (krpc_connection_t connection,
                                             krpc_KRPC_Expression_t * re-
                                             sult, krpc_KRPC_Expression_t arg0,
                                             krpc_KRPC_Expression_t arg1)
```

Numerical power operator.

Parameters

Returns arg0 raised to the power of arg1

```
krpc_error_t krpc_KRPC_Expression_LeftShift (krpc_connection_t connection,
                                                 krpc_KRPC_Expression_t * re-
                                                 sult, krpc_KRPC_Expression_t arg0,
                                                 krpc_KRPC_Expression_t arg1)
```

Bitwise left shift.

Parameters

```
krpc_error_t krpc_KRPC_Expression_RightShift (krpc_connection_t connection,
                                                  krpc_KRPC_Expression_t * re-
                                                  sult, krpc_KRPC_Expression_t arg0,
                                                  krpc_KRPC_Expression_t arg1)
```

Bitwise right shift.

Parameters

```
krpc_error_t krpc_KRPC_Expression_ToDouble (krpc_connection_t connection,
                                                krpc_KRPC_Expression_t * result,
                                                krpc_KRPC_Expression_t arg)
```

Convert to a double type.

Parameters

```
krpc_error_t krpc_KRPC_Expression_ToFloat (krpc_connection_t connection,
                                              krpc_KRPC_Expression_t * result,
                                              krpc_KRPC_Expression_t arg)
```

Convert to a float type.

Parameters

```
krpc_error_t krpc_KRPC_Expression_ToInt (krpc_connection_t connection,
                                             krpc_KRPC_Expression_t * result,
                                             krpc_KRPC_Expression_t arg)
```

Convert to an int type.

Parameters

3.3 SpaceCenter API

3.3.1 SpaceCenter

Service SpaceCenter

Provides functionality to interact with Kerbal Space Program. This includes controlling the active vessel, managing its resources, planning maneuver nodes and auto-piloting.

```
krpc_error_t krpc_SpaceCenter_ActiveVessel (krpc_connection_t connection,
                                              krpc_SpaceCenter_Vessel_t * result)
```

void **krpc_SpaceCenter_set_ActiveVessel** (*krpc_SpaceCenter_Vessel_t* value)

The currently active vessel.

krpc_error_t **krpc_SpaceCenter_Vessels** (*krpc_connection_t* connection,
krpc_list_object_t * result)

A list of all the vessels in the game.

krpc_error_t **krpc_SpaceCenter_Bodies** (*krpc_connection_t* connection,
krpc_dictionary_string_object_t * result)

A dictionary of all celestial bodies (planets, moons, etc.) in the game, keyed by the name of the body.

krpc_error_t **krpc_SpaceCenter_TargetBody** (*krpc_connection_t* connection,
krpc_SpaceCenter_CelestialBody_t * result)

void **krpc_SpaceCenter_set_TargetBody** (*krpc_SpaceCenter_CelestialBody_t* value)

The currently targeted celestial body.

krpc_error_t **krpc_SpaceCenter_TargetVessel** (*krpc_connection_t* connection,
krpc_SpaceCenter_Vessel_t * result)

void **krpc_SpaceCenter_set_TargetVessel** (*krpc_SpaceCenter_Vessel_t* value)

The currently targeted vessel.

krpc_error_t **krpc_SpaceCenter_TargetDockingPort** (*krpc_connection_t* connection,
krpc_SpaceCenter_DockingPort_t * result)

void **krpc_SpaceCenter_set_TargetDockingPort** (*krpc_SpaceCenter_DockingPort_t* value)

The currently targeted docking port.

krpc_error_t **krpc_SpaceCenter_ClearTarget** (*krpc_connection_t* connection)

Clears the current target.

krpc_error_t **krpc_SpaceCenter_LaunchableVessels** (*krpc_connection_t* connection,
krpc_list_string_t * result, const
char * craftDirectory)

Returns a list of vessels from the given *craftDirectory* that can be launched.

Parameters

- **craftDirectory** – Name of the directory in the current saves “Ships” directory. For example "VAB" or "SPH".

krpc_error_t **krpc_SpaceCenter_LaunchVessel** (*krpc_connection_t* connection, const
char * craftDirectory, const char * name,
const char * launchSite)

Launch a vessel.

Parameters

- **craftDirectory** – Name of the directory in the current saves “Ships” directory, that contains the craft file. For example "VAB" or "SPH".
- **name** – Name of the vessel to launch. This is the name of the “.craft” file in the save directory, without the “.craft” file extension.
- **launchSite** – Name of the launch site. For example "LaunchPad" or "Runway".

krpc_error_t **krpc_SpaceCenter_LaunchVesselFromVAB** (*krpc_connection_t* connection,
const char * name)

Launch a new vessel from the VAB onto the launchpad.

Parameters

- **name** – Name of the vessel to launch.

Note: This is equivalent to calling `krpc_SpaceCenter_LaunchVessel()` with the craft directory set to “VAB” and the launch site set to “LaunchPad”.

`krpc_error_t krpc_SpaceCenter_LaunchVesselFromSPH(krpc_connection_t connection, const char * name)`

Launch a new vessel from the SPH onto the runway.

Parameters

- **name** – Name of the vessel to launch.

Note: This is equivalent to calling `krpc_SpaceCenter_LaunchVessel()` with the craft directory set to “SPH” and the launch site set to “Runway”.

`krpc_error_t krpc_SpaceCenter_Save(krpc_connection_t connection, const char * name)`

Save the game with a given name. This will create a save file called `name.sfs` in the folder of the current save game.

Parameters

`krpc_error_t krpc_SpaceCenter_Load(krpc_connection_t connection, const char * name)`

Load the game with the given name. This will create a load a save file called `name.sfs` from the folder of the current save game.

Parameters

`krpc_error_t krpc_SpaceCenter_Quicksave(krpc_connection_t connection)`

Save a quicksave.

Note: This is the same as calling `krpc_SpaceCenter_Save()` with the name “quicksave”.

`krpc_error_t krpc_SpaceCenter_Quickload(krpc_connection_t connection)`

Load a quicksave.

Note: This is the same as calling `krpc_SpaceCenter_Load()` with the name “quicksave”.

`krpc_error_t krpc_SpaceCenter_UIVisible(krpc_connection_t connection, bool * result)`

void `krpc_SpaceCenter_set_UIVisible(bool value)`

Whether the UI is visible.

`krpc_error_t krpc_SpaceCenter_Navball(krpc_connection_t connection, bool * result)`

void `krpc_SpaceCenter_set_Navball(bool value)`

Whether the navball is visible.

`krpc_error_t krpc_SpaceCenter_UT(krpc_connection_t connection, double * result)`

The current universal time in seconds.

`krpc_error_t krpc_SpaceCenter_G(krpc_connection_t connection, double * result)`

The value of the [gravitational constant](#) G in $N(m/kg)^2$.

`krpc_error_t krpc_SpaceCenter_WarpRate(krpc_connection_t connection, float * result)`

The current warp rate. This is the rate at which time is passing for either on-rails or physical time

warp. For example, a value of 10 means time is passing 10x faster than normal. Returns 1 if time warp is not active.

krpc_error_t **krpc_SpaceCenter_WarpFactor** (*krpc_connection_t connection*, float * *result*)

The current warp factor. This is the index of the rate at which time is passing for either regular “on-rails” or physical time warp. Returns 0 if time warp is not active. When in on-rails time warp, this is equal to *krpc_SpaceCenter_RailsWarpFactor()*, and in physics time warp, this is equal to *krpc_SpaceCenter_PhysicsWarpFactor()*.

krpc_error_t **krpc_SpaceCenter_RailsWarpFactor** (*krpc_connection_t connection*, int32_t * *result*)

void **krpc_SpaceCenter_set_RailsWarpFactor** (int32_t *value*)

The time warp rate, using regular “on-rails” time warp. A value between 0 and 7 inclusive. 0 means no time warp. Returns 0 if physical time warp is active.

If requested time warp factor cannot be set, it will be set to the next lowest possible value. For example, if the vessel is too close to a planet. See [the KSP wiki](#) for details.

krpc_error_t **krpc_SpaceCenter_PhysicsWarpFactor** (*krpc_connection_t connection*, int32_t * *result*)

void **krpc_SpaceCenter_set_PhysicsWarpFactor** (int32_t *value*)

The physical time warp rate. A value between 0 and 3 inclusive. 0 means no time warp. Returns 0 if regular “on-rails” time warp is active.

krpc_error_t **krpc_SpaceCenter_CanRailsWarpAt** (*krpc_connection_t connection*, bool * *result*, int32_t *factor*)

Returns `true` if regular “on-rails” time warp can be used, at the specified warp *factor*. The maximum time warp rate is limited by various things, including how close the active vessel is to a planet. See [the KSP wiki](#) for details.

Parameters

- **factor** – The warp factor to check.

krpc_error_t **krpc_SpaceCenter_MaximumRailsWarpFactor** (*krpc_connection_t connection*, int32_t * *result*)

The current maximum regular “on-rails” warp factor that can be set. A value between 0 and 7 inclusive. See [the KSP wiki](#) for details.

krpc_error_t **krpc_SpaceCenter_WarpTo** (*krpc_connection_t connection*, double *ut*, float *maxRailsRate*, float *maxPhysicsRate*)

Uses time acceleration to warp forward to a time in the future, specified by universal time *ut*. This call blocks until the desired time is reached. Uses regular “on-rails” or physical time warp as appropriate. For example, physical time warp is used when the active vessel is traveling through an atmosphere. When using regular “on-rails” time warp, the warp rate is limited by *maxRailsRate*, and when using physical time warp, the warp rate is limited by *maxPhysicsRate*.

Parameters

- **ut** – The universal time to warp to, in seconds.
- **maxRailsRate** – The maximum warp rate in regular “on-rails” time warp.
- **maxPhysicsRate** – The maximum warp rate in physical time warp.

Returns When the time warp is complete.

```
krpc_error_t krpc_SpaceCenter_TransformPosition (krpc_connection_t connection,
                                                    krpc_tuple_double_double_double_t
                                                    * result, const
                                                    krpc_tuple_double_double_double_t
                                                    * position,
                                                    krpc_SpaceCenter_ReferenceFrame_t from,
                                                    krpc_SpaceCenter_ReferenceFrame_t to)
```

Converts a position from one reference frame to another.

Parameters

- **position** – Position, as a vector, in reference frame *from*.
- **from** – The reference frame that the position is in.
- **to** – The reference frame to convert the position to.

Returns The corresponding position, as a vector, in reference frame *to*.

```
krpc_error_t krpc_SpaceCenter_TransformDirection (krpc_connection_t connection,
                                                    krpc_tuple_double_double_double_t
                                                    * result, const
                                                    krpc_tuple_double_double_double_t
                                                    * direction,
                                                    krpc_SpaceCenter_ReferenceFrame_t from,
                                                    krpc_SpaceCenter_ReferenceFrame_t to)
```

Converts a direction from one reference frame to another.

Parameters

- **direction** – Direction, as a vector, in reference frame *from*.
- **from** – The reference frame that the direction is in.
- **to** – The reference frame to convert the direction to.

Returns The corresponding direction, as a vector, in reference frame *to*.

```
krpc_error_t krpc_SpaceCenter_TransformRotation (krpc_connection_t connection,
                                                    krpc_tuple_double_double_double_double_t
                                                    * result, const
                                                    krpc_tuple_double_double_double_double_t
                                                    * rotation,
                                                    krpc_SpaceCenter_ReferenceFrame_t from,
                                                    krpc_SpaceCenter_ReferenceFrame_t to)
```

Converts a rotation from one reference frame to another.

Parameters

- **rotation** – Rotation, as a quaternion of the form (x, y, z, w) , in reference frame *from*.
- **from** – The reference frame that the rotation is in.
- **to** – The reference frame to convert the rotation to.

Returns The corresponding rotation, as a quaternion of the form (x, y, z, w) , in reference frame *to*.

```
krpc_error_t krpc_SpaceCenter_TransformVelocity (krpc_connection_t connection,
                                                    krpc_tuple_double_double_double_t
                                                    * result, const
                                                    krpc_tuple_double_double_double_t
                                                    * position, const
                                                    krpc_tuple_double_double_double_t
                                                    * velocity,
                                                    krpc_SpaceCenter_ReferenceFrame_t from,
                                                    krpc_SpaceCenter_ReferenceFrame_t to)
```

Converts a velocity (acting at the specified position) from one reference frame to another. The position is required to take the relative angular velocity of the reference frames into account.

Parameters

- **position** – Position, as a vector, in reference frame *from*.
- **velocity** – Velocity, as a vector that points in the direction of travel and whose magnitude is the speed in meters per second, in reference frame *from*.
- **from** – The reference frame that the position and velocity are in.
- **to** – The reference frame to convert the velocity to.

Returns The corresponding velocity, as a vector, in reference frame *to*.

```
krpc_error_t krpc_SpaceCenter_RaycastDistance (krpc_connection_t connection,
                                                    double * result, const
                                                    krpc_tuple_double_double_double_t
                                                    * position, const
                                                    krpc_tuple_double_double_double_t
                                                    * direction,
                                                    krpc_SpaceCenter_ReferenceFrame_t referenceFrame)
```

Cast a ray from a given position in a given direction, and return the distance to the hit point. If no hit occurs, returns infinity.

Parameters

- **position** – Position, as a vector, of the origin of the ray.
- **direction** – Direction of the ray, as a unit vector.
- **referenceFrame** – The reference frame that the position and direction are in.

Returns The distance to the hit, in meters, or infinity if there was no hit.

```
krpc_error_t krpc_SpaceCenter_RaycastPart (krpc_connection_t connection,
                                                    krpc_SpaceCenter_Part_t * result, const
                                                    krpc_tuple_double_double_double_t
                                                    * position, const
                                                    krpc_tuple_double_double_double_t
                                                    * direction,
                                                    krpc_SpaceCenter_ReferenceFrame_t referenceFrame)
```

Cast a ray from a given position in a given direction, and return the part that it hits. If no hit occurs, returns `nullptr`.

Parameters

- **position** – Position, as a vector, of the origin of the ray.
- **direction** – Direction of the ray, as a unit vector.

- **referenceFrame** – The reference frame that the position and direction are in.

Returns The part that was hit or `nullptr` if there was no hit.

`krpc_error_t krpc_SpaceCenter_FARAvailable` (`krpc_connection_t connection`, `bool * result`)

Whether Ferram Aerospace Research is installed.

`krpc_error_t krpc_SpaceCenter_WarpMode` (`krpc_connection_t connection`, `krpc_SpaceCenter_WarpMode_t * result`)

The current time warp mode. Returns `KRPC_SPACECENTER_WARPMODE_NONE` if time warp is not active, `KRPC_SPACECENTER_WARPMODE_RAILS` if regular “on-rails” time warp is active, or `KRPC_SPACECENTER_WARPMODE_PHYSICS` if physical time warp is active.

`krpc_error_t krpc_SpaceCenter_Camera` (`krpc_connection_t connection`, `krpc_SpaceCenter_Camera_t * result`)

An object that can be used to control the camera.

`krpc_error_t krpc_SpaceCenter_WaypointManager` (`krpc_connection_t connection`, `krpc_SpaceCenter_WaypointManager_t * result`)

The waypoint manager.

`krpc_error_t krpc_SpaceCenter_ContractManager` (`krpc_connection_t connection`, `krpc_SpaceCenter_ContractManager_t * result`)

The contract manager.

krpc_SpaceCenter_WarpMode_t

The time warp mode. Returned by `krpc_SpaceCenter_WarpMode_t`

KRPC_SPACECENTER_WARPMODE_RAILS

Time warp is active, and in regular “on-rails” mode.

KRPC_SPACECENTER_WARPMODE_PHYSICS

Time warp is active, and in physical time warp mode.

KRPC_SPACECENTER_WARPMODE_NONE

Time warp is not active.

3.3.2 Vessel

krpc_SpaceCenter_Vessel_t

These objects are used to interact with vessels in KSP. This includes getting orbital and flight data, manipulating control inputs and managing resources. Created using `krpc_SpaceCenter_ActiveVessel()` or `krpc_SpaceCenter_Vessels()`.

`krpc_error_t krpc_SpaceCenter_Vessel_Name` (`krpc_connection_t connection`, `char ** result`)

void `krpc_SpaceCenter_Vessel_set_Name` (`const char * value`)

The name of the vessel.

`krpc_error_t krpc_SpaceCenter_Vessel_Type` (`krpc_connection_t connection`, `krpc_SpaceCenter_VesselType_t * result`)

void `krpc_SpaceCenter_Vessel_set_Type` (`krpc_SpaceCenter_VesselType_t value`)

The type of the vessel.

`krpc_error_t krpc_SpaceCenter_Vessel_Situation` (`krpc_connection_t connection`, `krpc_SpaceCenter_VesselSituation_t * result`)

The situation the vessel is in.

krpc_error_t **krpc_SpaceCenter_Vessel_Recoverable** (*krpc_connection_t connection*, bool * *result*)

Whether the vessel is recoverable.

krpc_error_t **krpc_SpaceCenter_Vessel_Recover** (*krpc_connection_t connection*)

Recover the vessel.

krpc_error_t **krpc_SpaceCenter_Vessel_MET** (*krpc_connection_t connection*, double * *result*)

The mission elapsed time in seconds.

krpc_error_t **krpc_SpaceCenter_Vessel_Biome** (*krpc_connection_t connection*, char ** *result*)

The name of the biome the vessel is currently in.

krpc_error_t **krpc_SpaceCenter_Vessel_Flight** (*krpc_connection_t connection*,
krpc_SpaceCenter_Flight_t * *result*,
krpc_SpaceCenter_ReferenceFrame_t *referenceFrame*)

Returns a *krpc_SpaceCenter_Flight_t* object that can be used to get flight telemetry for the vessel, in the specified reference frame.

Parameters

- **referenceFrame** – Reference frame. Defaults to the vessel's surface reference frame (*krpc_SpaceCenter_Vessel_SurfaceReferenceFrame()*).

Note: When this is called with no arguments, the vessel's surface reference frame is used. This reference frame moves with the vessel, therefore velocities and speeds returned by the flight object will be zero. See the *reference frames tutorial* for examples of getting *the orbital and surface speeds of a vessel*.

krpc_error_t **krpc_SpaceCenter_Vessel_Orbit** (*krpc_connection_t connection*,
krpc_SpaceCenter_Orbit_t * *result*)

The current orbit of the vessel.

krpc_error_t **krpc_SpaceCenter_Vessel_Control** (*krpc_connection_t connection*,
krpc_SpaceCenter_Control_t * *result*)

Returns a *krpc_SpaceCenter_Control_t* object that can be used to manipulate the vessel's control inputs. For example, its pitch/yaw/roll controls, RCS and thrust.

krpc_error_t **krpc_SpaceCenter_Vessel_Comms** (*krpc_connection_t connection*,
krpc_SpaceCenter_Comms_t * *result*)

Returns a *krpc_SpaceCenter_Comms_t* object that can be used to interact with CommNet for this vessel.

krpc_error_t **krpc_SpaceCenter_Vessel_AutoPilot** (*krpc_connection_t connection*,
krpc_SpaceCenter_AutoPilot_t * *result*)

An *krpc_SpaceCenter_AutoPilot_t* object, that can be used to perform simple auto-piloting of the vessel.

krpc_error_t **krpc_SpaceCenter_Vessel_CrewCapacity** (*krpc_connection_t connection*,
int32_t * *result*)

The number of crew that can occupy the vessel.

krpc_error_t **krpc_SpaceCenter_Vessel_CrewCount** (*krpc_connection_t connection*, int32_t * *result*)

The number of crew that are occupying the vessel.

krpc_error_t **krpc_SpaceCenter_Vessel_Crew** (*krpc_connection_t connection*,
krpc_list_object_t * *result*)

The crew in the vessel.

krpc_error_t **krpc_SpaceCenter_Vessel_Resources** (*krpc_connection_t* *connection*,
krpc_SpaceCenter_Resources_t * *result*)

A *krpc_SpaceCenter_Resources_t* object, that can used to get information about resources stored in the vessel.

krpc_error_t **krpc_SpaceCenter_Vessel_ResourcesInDecoupleStage** (*krpc_connection_t* *connection*,
krpc_SpaceCenter_Resources_t * *result*,
int32_t *stage*,
bool *cumulative*)

Returns a *krpc_SpaceCenter_Resources_t* object, that can used to get information about resources stored in a given *stage*.

Parameters

- **stage** – Get resources for parts that are decoupled in this stage.
- **cumulative** – When *false*, returns the resources for parts decoupled in just the given stage. When *true* returns the resources decoupled in the given stage and all subsequent stages combined.

Note: For details on stage numbering, see the discussion on *Staging*.

krpc_error_t **krpc_SpaceCenter_Vessel_Parts** (*krpc_connection_t* *connection*,
krpc_SpaceCenter_Parts_t * *result*)

A *krpc_SpaceCenter_Parts_t* object, that can used to interact with the parts that make up this vessel.

krpc_error_t **krpc_SpaceCenter_Vessel_Mass** (*krpc_connection_t* *connection*, *float* * *result*)

The total mass of the vessel, including resources, in kg.

krpc_error_t **krpc_SpaceCenter_Vessel_DryMass** (*krpc_connection_t* *connection*, *float* * *result*)

The total mass of the vessel, excluding resources, in kg.

krpc_error_t **krpc_SpaceCenter_Vessel_Thrust** (*krpc_connection_t* *connection*, *float* * *result*)

The total thrust currently being produced by the vessel's engines, in Newtons. This is computed by summing *krpc_SpaceCenter_Engine_Thrust()* for every engine in the vessel.

krpc_error_t **krpc_SpaceCenter_Vessel_AvailableThrust** (*krpc_connection_t* *connection*,
float * *result*)

Gets the total available thrust that can be produced by the vessel's active engines, in Newtons. This is computed by summing *krpc_SpaceCenter_Engine_AvailableThrust()* for every active engine in the vessel.

krpc_error_t **krpc_SpaceCenter_Vessel_MaxThrust** (*krpc_connection_t* *connection*, *float* * *result*)

The total maximum thrust that can be produced by the vessel's active engines, in Newtons. This is computed by summing *krpc_SpaceCenter_Engine_MaxThrust()* for every active engine.

krpc_error_t **krpc_SpaceCenter_Vessel_MaxVacuumThrust** (*krpc_connection_t* *connection*,
float * *result*)

The total maximum thrust that can be produced by the vessel's active engines when the vessel is in a vacuum, in Newtons. This is computed by summing *krpc_SpaceCenter_Engine_MaxVacuumThrust()* for every active engine.

krpc_error_t **krpc_SpaceCenter_Vessel_SpecificImpulse** (*krpc_connection_t* *connection*,
float * *result*)

The combined specific impulse of all active engines, in seconds. This is computed using the formula [described here](#).

krpc_error_t **krpc_SpaceCenter_Vessel_VacuumSpecificImpulse** (*krpc_connection_t* *connection*, float * *result*)

The combined vacuum specific impulse of all active engines, in seconds. This is computed using the formula [described here](#).

krpc_error_t **krpc_SpaceCenter_Vessel_KerbinSeaLevelSpecificImpulse** (*krpc_connection_t* *connection*, float * *result*)

The combined specific impulse of all active engines at sea level on Kerbin, in seconds. This is computed using the formula [described here](#).

krpc_error_t **krpc_SpaceCenter_Vessel_MomentOfInertia** (*krpc_connection_t* *connection*, *krpc_tuple_double_double_double_t* * *result*)

The moment of inertia of the vessel around its center of mass in $kg.m^2$. The inertia values in the returned 3-tuple are around the pitch, roll and yaw directions respectively. This corresponds to the vessels reference frame (*krpc_SpaceCenter_ReferenceFrame_t*).

krpc_error_t **krpc_SpaceCenter_Vessel_InertiaTensor** (*krpc_connection_t* *connection*, *krpc_list_double_t* * *result*)

The inertia tensor of the vessel around its center of mass, in the vessels reference frame (*krpc_SpaceCenter_ReferenceFrame_t*). Returns the 3x3 matrix as a list of elements, in row-major order.

krpc_error_t **krpc_SpaceCenter_Vessel_AvailableTorque** (*krpc_connection_t* *connection*, *krpc_tuple_tuple_double_double_double_tuple_double_t* * *result*)

The maximum torque that the vessel generates. Includes contributions from reaction wheels, RCS, gimballled engines and aerodynamic control surfaces. Returns the torques in $N.m$ around each of the coordinate axes of the vessels reference frame (*krpc_SpaceCenter_ReferenceFrame_t*). These axes are equivalent to the pitch, roll and yaw axes of the vessel.

krpc_error_t **krpc_SpaceCenter_Vessel_AvailableReactionWheelTorque** (*krpc_connection_t* *connection*, *krpc_tuple_tuple_double_double_double_tuple_double_t* * *result*)

The maximum torque that the currently active and powered reaction wheels can generate. Returns the torques in $N.m$ around each of the coordinate axes of the vessels reference frame (*krpc_SpaceCenter_ReferenceFrame_t*). These axes are equivalent to the pitch, roll and yaw axes of the vessel.

krpc_error_t **krpc_SpaceCenter_Vessel_AvailableRCSTorque** (*krpc_connection_t* *connection*, *krpc_tuple_tuple_double_double_double_tuple_double_t* * *result*)

The maximum torque that the currently active RCS thrusters can generate. Returns the torques in $N.m$ around each of the coordinate axes of the vessels reference frame (*krpc_SpaceCenter_ReferenceFrame_t*). These axes are equivalent to the pitch, roll and yaw axes of the vessel.

krpc_error_t **krpc_SpaceCenter_Vessel_AvailableEngineTorque** (*krpc_connection_t* *connection*, *krpc_tuple_tuple_double_double_double_tuple_double_t* * *result*)

The maximum torque that the currently active and gimballled engines can generate. Returns the torques in $N.m$ around each of the coordinate axes of the vessels reference frame

(*krcp_SpaceCenter_ReferenceFrame_t*). These axes are equivalent to the pitch, roll and yaw axes of the vessel.

krcp_error_t **krcp_SpaceCenter_Vessel_AvailableControlSurfaceTorque** (*krcp_connection_t* *connection*,
krcp_tuple_tuple_double_double_double_t *result*)

The maximum torque that the aerodynamic control surfaces can generate. Returns the torques in *N.m* around each of the coordinate axes of the vessels reference frame (*krcp_SpaceCenter_ReferenceFrame_t*). These axes are equivalent to the pitch, roll and yaw axes of the vessel.

krcp_error_t **krcp_SpaceCenter_Vessel_AvailableOtherTorque** (*krcp_connection_t* *connection*,
krcp_tuple_tuple_double_double_double_t *result*)

The maximum torque that parts (excluding reaction wheels, gimbaled engines, RCS and control surfaces) can generate. Returns the torques in *N.m* around each of the coordinate axes of the vessels reference frame (*krcp_SpaceCenter_ReferenceFrame_t*). These axes are equivalent to the pitch, roll and yaw axes of the vessel.

krcp_error_t **krcp_SpaceCenter_Vessel_ReferenceFrame** (*krcp_connection_t* *connection*,
krcp_SpaceCenter_ReferenceFrame_t *result*)

The reference frame that is fixed relative to the vessel, and orientated with the vessel.

- The origin is at the center of mass of the vessel.
- The axes rotate with the vessel.
- The x-axis points out to the right of the vessel.
- The y-axis points in the forward direction of the vessel.
- The z-axis points out of the bottom off the vessel.

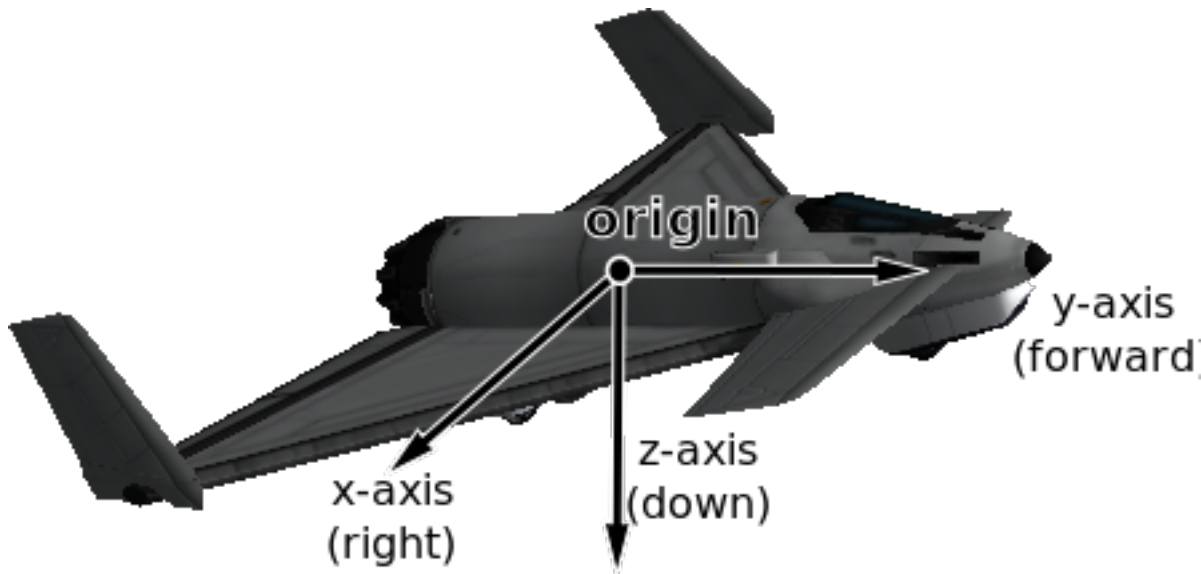


Fig. 3.1: Vessel reference frame origin and axes for the Aerie 3A aircraft

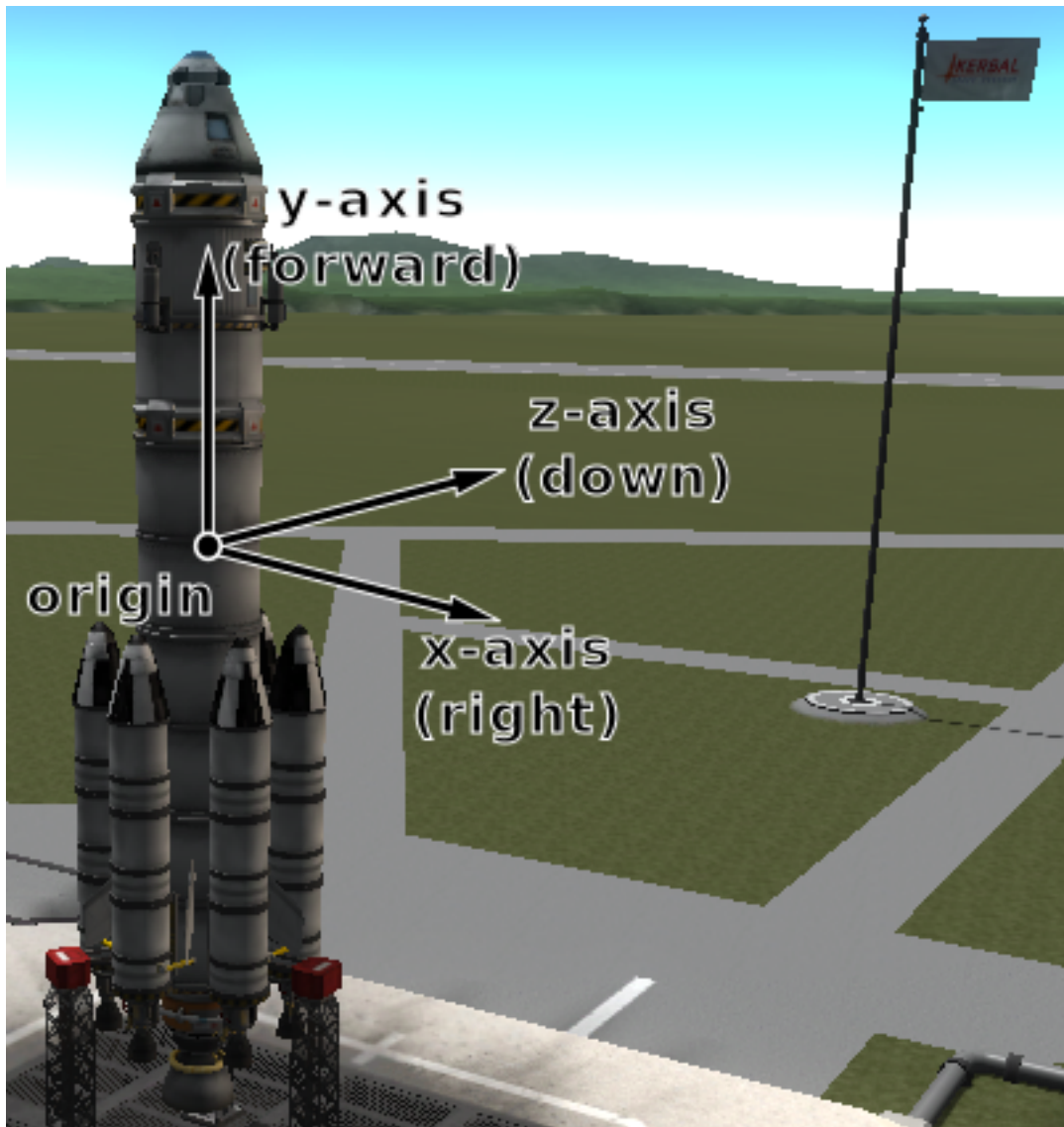


Fig. 3.2: Vessel reference frame origin and axes for the Kerbal-X rocket

```
krpc_error_t krpc_SpaceCenter_Vessel_OrbitalReferenceFrame (krpc_connection_t con-
                                                            nection,
                                                            krpc_SpaceCenter_ReferenceFrame_t
                                                            * result)
```

The reference frame that is fixed relative to the vessel, and orientated with the vessels orbital prograde/normal/radial directions.

- The origin is at the center of mass of the vessel.
- The axes rotate with the orbital prograde/normal/radial directions.
- The x-axis points in the orbital anti-radial direction.
- The y-axis points in the orbital prograde direction.
- The z-axis points in the orbital normal direction.

Note: Be careful not to confuse this with ‘orbit’ mode on the navball.

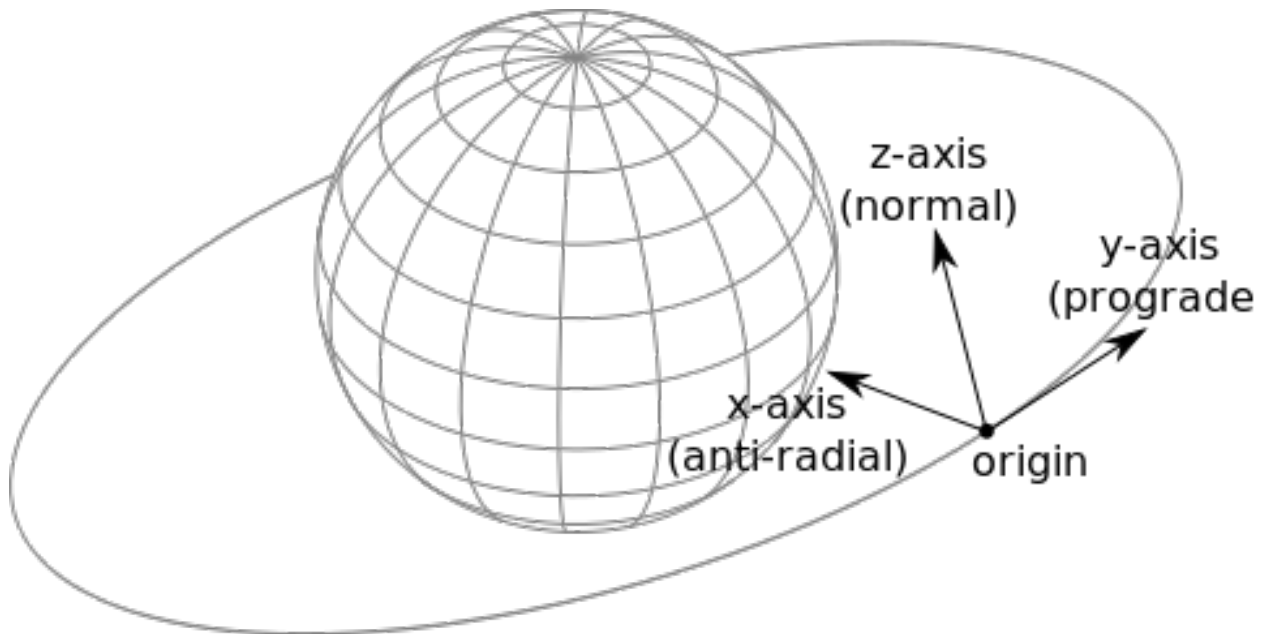


Fig. 3.3: Vessel orbital reference frame origin and axes

```
krpc_error_t krpc_SpaceCenter_Vessel_SurfaceReferenceFrame (krpc_connection_t con-
                                                            nection,
                                                            krpc_SpaceCenter_ReferenceFrame_t
                                                            * result)
```

The reference frame that is fixed relative to the vessel, and orientated with the surface of the body being orbited.

- The origin is at the center of mass of the vessel.
- The axes rotate with the north and up directions on the surface of the body.
- The x-axis points in the [zenith](#) direction (upwards, normal to the body being orbited, from the center of the body towards the center of mass of the vessel).
- The y-axis points northwards towards the [astronomical horizon](#) (north, and tangential to the surface of the body – the direction in which a compass would point when on the surface).

- The z-axis points eastwards towards the [astronomical horizon](#) (east, and tangential to the surface of the body – east on a compass when on the surface).

Note: Be careful not to confuse this with ‘surface’ mode on the navball.

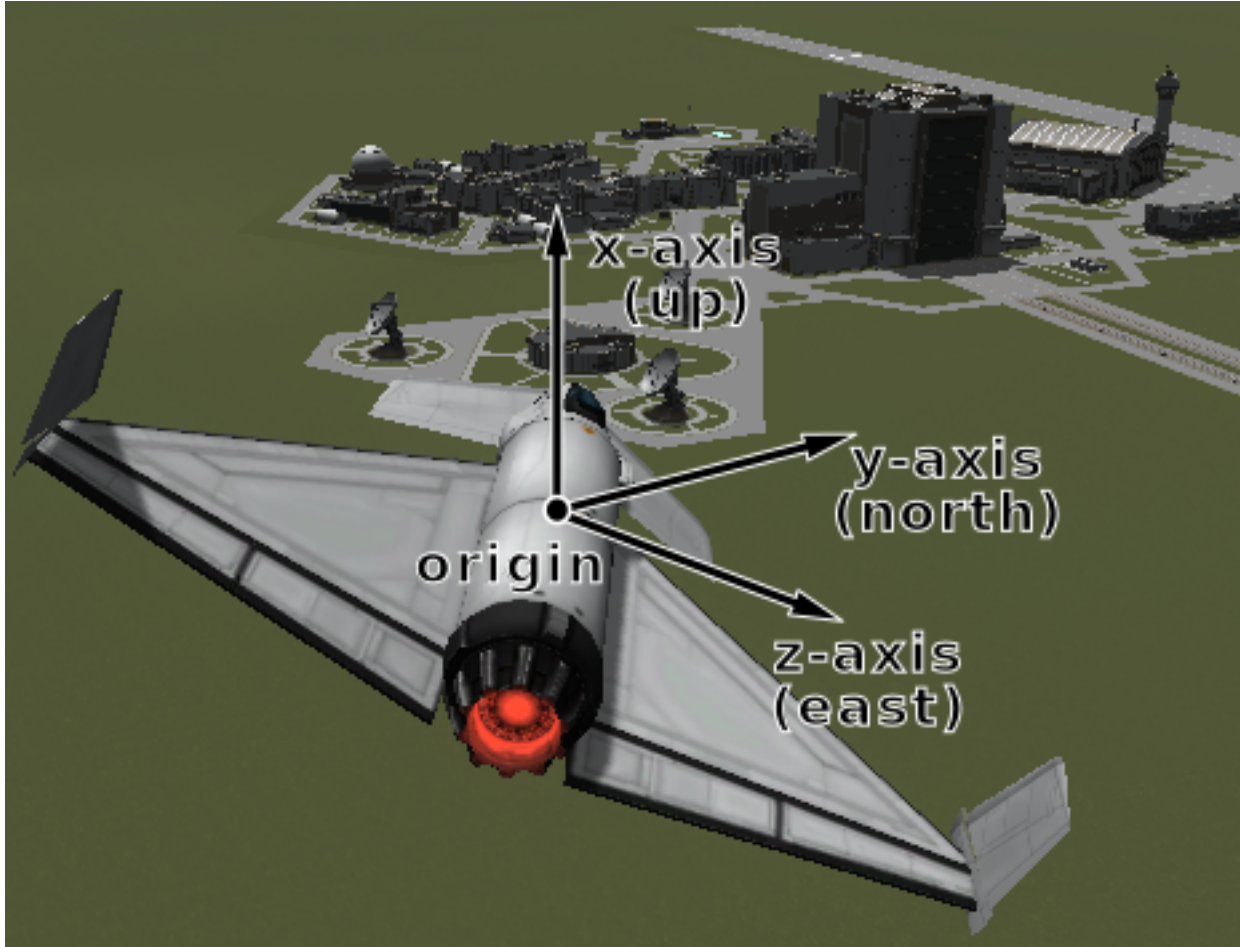


Fig. 3.4: Vessel surface reference frame origin and axes

```
krpc_error_t krpc_SpaceCenter_Vessel_SurfaceVelocityReferenceFrame (krpc_connection_t connection,  
                                                                    krpc_SpaceCenter_ReferenceFrame  
                                                                    * result)
```

The reference frame that is fixed relative to the vessel, and orientated with the velocity vector of the vessel relative to the surface of the body being orbited.

- The origin is at the center of mass of the vessel.
- The axes rotate with the vessel’s velocity vector.
- The y-axis points in the direction of the vessel’s velocity vector, relative to the surface of the body being orbited.
- The z-axis is in the plane of the [astronomical horizon](#).
- The x-axis is orthogonal to the other two axes.

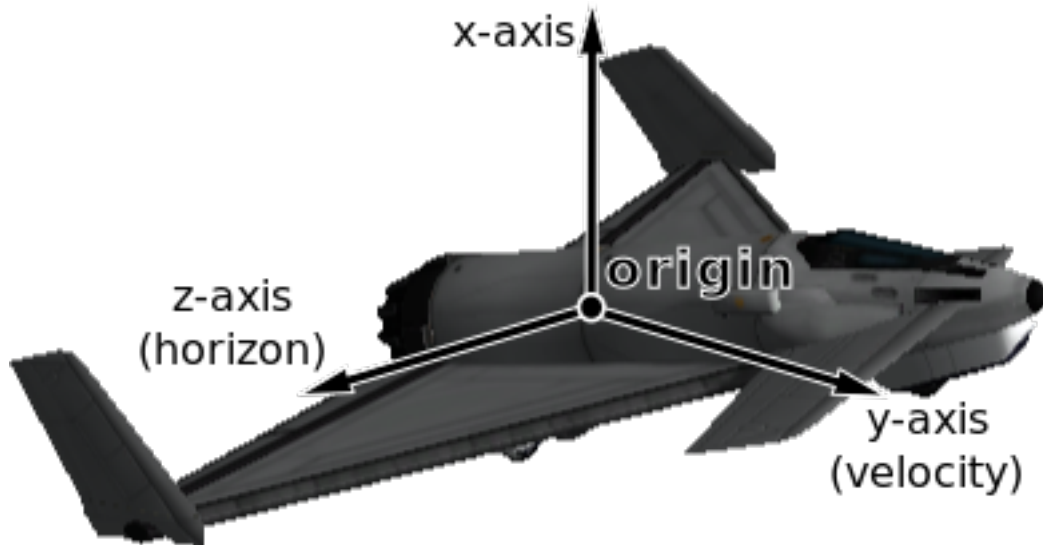


Fig. 3.5: Vessel surface velocity reference frame origin and axes

```
krpc_error_t krpc_SpaceCenter_Vessel_Position (krpc_connection_t connection,
                                                krpc_tuple_double_double_double_t * result, krpc_SpaceCenter_ReferenceFrame_t referenceFrame)
```

The position of the center of mass of the vessel, in the given reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned position vector is in.

Returns The position as a vector.

```
krpc_error_t krpc_SpaceCenter_Vessel_BoundingBox (krpc_connection_t connection,
                                                    krpc_tuple_tuple_double_double_double_tuple_double_double_t * result,
                                                    krpc_SpaceCenter_ReferenceFrame_t referenceFrame)
```

The axis-aligned bounding box of the vessel in the given reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned position vectors are in.

Returns The positions of the minimum and maximum vertices of the box, as position vectors.

```
krpc_error_t krpc_SpaceCenter_Vessel_Velocity (krpc_connection_t connection,
                                                krpc_tuple_double_double_double_t * result, krpc_SpaceCenter_ReferenceFrame_t referenceFrame)
```

The velocity of the center of mass of the vessel, in the given reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned velocity vector is in.

Returns The velocity as a vector. The vector points in the direction of travel, and its magnitude is the speed of the body in meters per second.

```
krpc_error_t krpc_SpaceCenter_Vessel_Rotation (krpc_connection_t connection,  
                                                krpc_tuple_double_double_double_double_t  
                                                * result, krpc_SpaceCenter_ReferenceFrame_t referenceFrame)
```

The rotation of the vessel, in the given reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned rotation is in.

Returns The rotation as a quaternion of the form (x, y, z, w) .

```
krpc_error_t krpc_SpaceCenter_Vessel_Direction (krpc_connection_t connection,  
                                                krpc_tuple_double_double_double_t  
                                                * result,  
                                                krpc_SpaceCenter_ReferenceFrame_t referenceFrame)
```

The direction in which the vessel is pointing, in the given reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

```
krpc_error_t krpc_SpaceCenter_Vessel_AngularVelocity (krpc_connection_t connection,  
                                                krpc_tuple_double_double_double_t  
                                                * result,  
                                                krpc_SpaceCenter_ReferenceFrame_t referenceFrame)
```

The angular velocity of the vessel, in the given reference frame.

Parameters

- **referenceFrame** – The reference frame the returned angular velocity is in.

Returns The angular velocity as a vector. The magnitude of the vector is the rotational speed of the vessel, in radians per second. The direction of the vector indicates the axis of rotation, using the right-hand rule.

krpc_SpaceCenter_VesselType_t

The type of a vessel. See *krpc_SpaceCenter_Vessel_Type()*.

KRPC_SPACECENTER_VESSELTYPE_BASE

Base.

KRPC_SPACECENTER_VESSELTYPE_DEBRIS

Debris.

KRPC_SPACECENTER_VESSELTYPE_LANDER

Lander.

KRPC_SPACECENTER_VESSELTYPE_PLANE

Plane.

KRPC_SPACECENTER_VESSELTYPE_PROBE

Probe.

KRPC_SPACECENTER_VESSELTYPE_RELAY

Relay.

KRPC_SPACECENTER_VESSELTYPE_ROVER

Rover.

KRPC_SPACECENTER_VESSELTYPE_SHIP

Ship.

KRPC_SPACECENTER_VESSELTYPE_STATION

Station.

krpc_SpaceCenter_VesselSituation_t

The situation a vessel is in. See *krpc_SpaceCenter_Vessel_Situation()*.

KRPC_SPACECENTER_VESSELSITUATION_DOCKED

Vessel is docked to another.

KRPC_SPACECENTER_VESSELSITUATION_ESCAPING

Escaping.

KRPC_SPACECENTER_VESSELSITUATION_FLYING

Vessel is flying through an atmosphere.

KRPC_SPACECENTER_VESSELSITUATION_LANDED

Vessel is landed on the surface of a body.

KRPC_SPACECENTER_VESSELSITUATION_ORBITING

Vessel is orbiting a body.

KRPC_SPACECENTER_VESSELSITUATION_PRELAUNCH

Vessel is awaiting launch.

KRPC_SPACECENTER_VESSELSITUATION_SPLASHED

Vessel has splashed down in an ocean.

KRPC_SPACECENTER_VESSELSITUATION_SUBORBITAL

Vessel is on a sub-orbital trajectory.

krpc_SpaceCenter_CrewMember_t

Represents crew in a vessel. Can be obtained using *krpc_SpaceCenter_Vessel_Crew()*.

krpc_error_t **krpc_SpaceCenter_CrewMember_Name** (*krpc_connection_t* *connection*, *char ** result*)

void **krpc_SpaceCenter_CrewMember_set_Name** (*const char * value*)

The crew members name.

krpc_error_t **krpc_SpaceCenter_CrewMember_Type** (*krpc_connection_t* *connection*,
krpc_SpaceCenter_CrewMemberType_t
** result*)

The type of crew member.

krpc_error_t **krpc_SpaceCenter_CrewMember_OnMission** (*krpc_connection_t* *connection*,
*bool * result*)

Whether the crew member is on a mission.

krpc_error_t **krpc_SpaceCenter_CrewMember_Courage** (*krpc_connection_t* *connection*, *float*
** result*)

void **krpc_SpaceCenter_CrewMember_set_Courage** (*float value*)

The crew members courage.

krpc_error_t **krpc_SpaceCenter_CrewMember_Stupidity** (*krpc_connection_t* *connection*,
*float * result*)

void **krpc_SpaceCenter_CrewMember_set_Stupidity** (*float value*)

The crew members stupidity.

krpc_error_t **krpc_SpaceCenter_CrewMember_Experience** (*krpc_connection_t* *connection*,
*float * result*)

void **krpc_SpaceCenter_CrewMember_set_Experience** (float *value*)

The crew members experience.

krpc_error_t **krpc_SpaceCenter_CrewMember_Badass** (*krpc_connection_t connection*, bool
* *result*)

void **krpc_SpaceCenter_CrewMember_set_Badass** (bool *value*)

Whether the crew member is a badass.

krpc_error_t **krpc_SpaceCenter_CrewMember_Veteran** (*krpc_connection_t connection*, bool
* *result*)

void **krpc_SpaceCenter_CrewMember_set_Veteran** (bool *value*)

Whether the crew member is a veteran.

krpc_SpaceCenter_CrewMemberType_t

The type of a crew member. See *krpc_SpaceCenter_CrewMember_Type()*.

KRPC_SPACECENTER_CREWMEMBERTYPE_APPLICANT

An applicant for crew.

KRPC_SPACECENTER_CREWMEMBERTYPE_CREW

Rocket crew.

KRPC_SPACECENTER_CREWMEMBERTYPE_TOURIST

A tourist.

KRPC_SPACECENTER_CREWMEMBERTYPE_UNOWNED

An unowned crew member.

3.3.3 CelestialBody

krpc_SpaceCenter_CelestialBody_t

Represents a celestial body (such as a planet or moon). See *krpc_SpaceCenter_Bodies()*.

krpc_error_t **krpc_SpaceCenter_CelestialBody_Name** (*krpc_connection_t connection*, char *
* *result*)

The name of the body.

krpc_error_t **krpc_SpaceCenter_CelestialBody_Satellites** (*krpc_connection_t connection*, *krpc_list_object_t*
* *result*)

A list of celestial bodies that are in orbit around this celestial body.

krpc_error_t **krpc_SpaceCenter_CelestialBody_Orbit** (*krpc_connection_t connection*,
krpc_SpaceCenter_Orbit_t * *result*)

The orbit of the body.

krpc_error_t **krpc_SpaceCenter_CelestialBody_Mass** (*krpc_connection_t connection*, float
* *result*)

The mass of the body, in kilograms.

krpc_error_t **krpc_SpaceCenter_CelestialBody_GravitationalParameter** (*krpc_connection_t connection*,
float
* *result*)

The standard gravitational parameter of the body in m^3s^{-2} .

krpc_error_t **krpc_SpaceCenter_CelestialBody_SurfaceGravity** (*krpc_connection_t connection*, float * *result*)

The acceleration due to gravity at sea level (mean altitude) on the body, in m/s^2 .

krpc_error_t **krpc_SpaceCenter_CelestialBody_RotationalPeriod** (*krpc_connection_t* *connection*, *float* * *result*)

The sidereal rotational period of the body, in seconds.

krpc_error_t **krpc_SpaceCenter_CelestialBody_RotationalSpeed** (*krpc_connection_t* *connection*, *float* * *result*)

The rotational speed of the body, in radians per second.

krpc_error_t **krpc_SpaceCenter_CelestialBody_RotationAngle** (*krpc_connection_t* *connection*, *double* * *result*)

The current rotation angle of the body, in radians. A value between 0 and 2π

krpc_error_t **krpc_SpaceCenter_CelestialBody_InitialRotation** (*krpc_connection_t* *connection*, *double* * *result*)

The initial rotation angle of the body (at UT 0), in radians. A value between 0 and 2π

krpc_error_t **krpc_SpaceCenter_CelestialBody_EquatorialRadius** (*krpc_connection_t* *connection*, *float* * *result*)

The equatorial radius of the body, in meters.

krpc_error_t **krpc_SpaceCenter_CelestialBody_SurfaceHeight** (*krpc_connection_t* *connection*, *double* * *result*, *double* *latitude*, *double* *longitude*)

The height of the surface relative to mean sea level, in meters, at the given position. When over water this is equal to 0.

Parameters

- **latitude** – Latitude in degrees.
- **longitude** – Longitude in degrees.

krpc_error_t **krpc_SpaceCenter_CelestialBody_BedrockHeight** (*krpc_connection_t* *connection*, *double* * *result*, *double* *latitude*, *double* *longitude*)

The height of the surface relative to mean sea level, in meters, at the given position. When over water, this is the height of the sea-bed and is therefore negative value.

Parameters

- **latitude** – Latitude in degrees.
- **longitude** – Longitude in degrees.

krpc_error_t **krpc_SpaceCenter_CelestialBody_MSLPosition** (*krpc_connection_t* *connection*, *krpc_tuple_double_double_double_t* * *result*, *double* *latitude*, *double* *longitude*, *krpc_SpaceCenter_ReferenceFrame_t* *referenceFrame*)

The position at mean sea level at the given latitude and longitude, in the given reference frame.

Parameters

- **latitude** – Latitude in degrees.
- **longitude** – Longitude in degrees.

- **referenceFrame** – Reference frame for the returned position vector.

Returns Position as a vector.

```
krcp_error_t krcp_SpaceCenter_CelestialBody_SurfacePosition (krcp_connection_t con-  
nection,  
krcp_tuple_double_double_double_t  
* result, double latitude, double  
longitude,  
krcp_SpaceCenter_ReferenceFrame_t referenceFrame)
```

The position of the surface at the given latitude and longitude, in the given reference frame. When over water, this is the position of the surface of the water.

Parameters

- **latitude** – Latitude in degrees.
- **longitude** – Longitude in degrees.
- **referenceFrame** – Reference frame for the returned position vector.

Returns Position as a vector.

```
krcp_error_t krcp_SpaceCenter_CelestialBody_BedrockPosition (krcp_connection_t con-  
nection,  
krcp_tuple_double_double_double_t  
* result, double latitude, double  
longitude,  
krcp_SpaceCenter_ReferenceFrame_t referenceFrame)
```

The position of the surface at the given latitude and longitude, in the given reference frame. When over water, this is the position at the bottom of the sea-bed.

Parameters

- **latitude** – Latitude in degrees.
- **longitude** – Longitude in degrees.
- **referenceFrame** – Reference frame for the returned position vector.

Returns Position as a vector.

```
krcp_error_t krcp_SpaceCenter_CelestialBody_PositionAtAltitude (krcp_connection_t con-  
nection,  
krcp_tuple_double_double_double_t  
* result, double latitude, double  
longitude,  
double altitude,  
krcp_SpaceCenter_ReferenceFrame_t referenceFrame)
```

The position at the given latitude, longitude and altitude, in the given reference frame.

Parameters

- **latitude** – Latitude in degrees.
- **longitude** – Longitude in degrees.
- **altitude** – Altitude in meters above sea level.

- **referenceFrame** – Reference frame for the returned position vector.

Returns Position as a vector.

```
krpc_error_t krpc_SpaceCenter_CelestialBody_AltitudeAtPosition (krpc_connection_t connection, double
* result, const
krpc_tuple_double_double_double_t
* position,
krpc_SpaceCenter_ReferenceFrame_t referenceFrame)
```

The altitude, in meters, of the given position in the given reference frame.

Parameters

- **position** – Position as a vector.
- **referenceFrame** – Reference frame for the position vector.

```
krpc_error_t krpc_SpaceCenter_CelestialBody_LatitudeAtPosition (krpc_connection_t connection, double
* result, const
krpc_tuple_double_double_double_t
* position,
krpc_SpaceCenter_ReferenceFrame_t referenceFrame)
```

The latitude of the given position, in the given reference frame.

Parameters

- **position** – Position as a vector.
- **referenceFrame** – Reference frame for the position vector.

```
krpc_error_t krpc_SpaceCenter_CelestialBody_LongitudeAtPosition (krpc_connection_t connection, double
* result, const
krpc_tuple_double_double_double_t
* position,
krpc_SpaceCenter_ReferenceFrame_t referenceFrame)
```

The longitude of the given position, in the given reference frame.

Parameters

- **position** – Position as a vector.
- **referenceFrame** – Reference frame for the position vector.

```
krpc_error_t krpc_SpaceCenter_CelestialBody_SphereOfInfluence (krpc_connection_t connection, float
* result)
```

The radius of the sphere of influence of the body, in meters.

```
krpc_error_t krpc_SpaceCenter_CelestialBody_HasAtmosphere (krpc_connection_t connection, bool * result)
```

true if the body has an atmosphere.

```
krpc_error_t krpc_SpaceCenter_CelestialBody_AtmosphereDepth (krpc_connection_t connection, float * result)
```

The depth of the atmosphere, in meters.

krpc_error_t **krpc_SpaceCenter_CelestialBody_AtmosphericDensityAtPosition** (*krpc_connection_t* *connection*,
double * *result*,
const *krpc_tuple_double_double_double_t* * *position*,
krpc_SpaceCenter_ReferenceFrame_t *referenceFrame*)

The atmospheric density at the given position, in kg/m^3 , in the given reference frame.

Parameters

- **position** – The position vector at which to measure the density.
- **referenceFrame** – Reference frame that the position vector is in.

krpc_error_t **krpc_SpaceCenter_CelestialBody_HasAtmosphericOxygen** (*krpc_connection_t* *connection*, bool * *result*)

true if there is oxygen in the atmosphere, required for air-breathing engines.

krpc_error_t **krpc_SpaceCenter_CelestialBody_TemperatureAt** (*krpc_connection_t* *connection*, double * *result*, const *krpc_tuple_double_double_double_t* * *position*,
krpc_SpaceCenter_ReferenceFrame_t *referenceFrame*)

The temperature on the body at the given position, in the given reference frame.

Parameters

- **position** – Position as a vector.
- **referenceFrame** – The reference frame that the position is in.

Note: This calculation is performed using the bodies current position, which means that the value could be wrong if you want to know the temperature in the far future.

krpc_error_t **krpc_SpaceCenter_CelestialBody_DensityAt** (*krpc_connection_t* *connection*, double * *result*, double *altitude*)

Gets the air density, in kg/m^3 , for the specified altitude above sea level, in meters.

Parameters

Note: This is an approximation, because actual calculations, taking sun exposure into account to compute air temperature, require us to know the exact point on the body where the density is to be computed

(knowing the altitude is not enough). However, the difference is small for high altitudes, so it makes very little difference for trajectory prediction.

krpc_error_t **krpc_SpaceCenter_CelestialBody_PressureAt** (*krpc_connection_t* *connection*, *double* * *result*, *double* *altitude*)

Gets the air pressure, in Pascals, for the specified altitude above sea level, in meters.

Parameters

krpc_error_t **krpc_SpaceCenter_CelestialBody_Biomes** (*krpc_connection_t* *connection*, *krpc_set_string_t* * *result*)

The biomes present on this body.

krpc_error_t **krpc_SpaceCenter_CelestialBody_BiomeAt** (*krpc_connection_t* *connection*, *char* * * *result*, *double* *latitude*, *double* *longitude*)

The biome at the given latitude and longitude, in degrees.

Parameters

krpc_error_t **krpc_SpaceCenter_CelestialBody_FlyingHighAltitudeThreshold** (*krpc_connection_t* *connection*, *float* * *result*)

The altitude, in meters, above which a vessel is considered to be flying “high” when doing science.

krpc_error_t **krpc_SpaceCenter_CelestialBody_SpaceHighAltitudeThreshold** (*krpc_connection_t* *connection*, *float* * *result*)

The altitude, in meters, above which a vessel is considered to be in “high” space when doing science.

krpc_error_t **krpc_SpaceCenter_CelestialBody_ReferenceFrame** (*krpc_connection_t* *connection*, *krpc_SpaceCenter_ReferenceFrame_t* * *result*)

The reference frame that is fixed relative to the celestial body.

- The origin is at the center of the body.
- The axes rotate with the body.
- The x-axis points from the center of the body towards the intersection of the prime meridian and equator (the position at 0° longitude, 0° latitude).
- The y-axis points from the center of the body towards the north pole.
- The z-axis points from the center of the body towards the equator at 90°E longitude.

krpc_error_t **krpc_SpaceCenter_CelestialBody_NonRotatingReferenceFrame** (*krpc_connection_t* *connection*, *krpc_SpaceCenter_ReferenceFrame_t* * *result*)

The reference frame that is fixed relative to this celestial body, and orientated in a fixed direction (it does not rotate with the body).

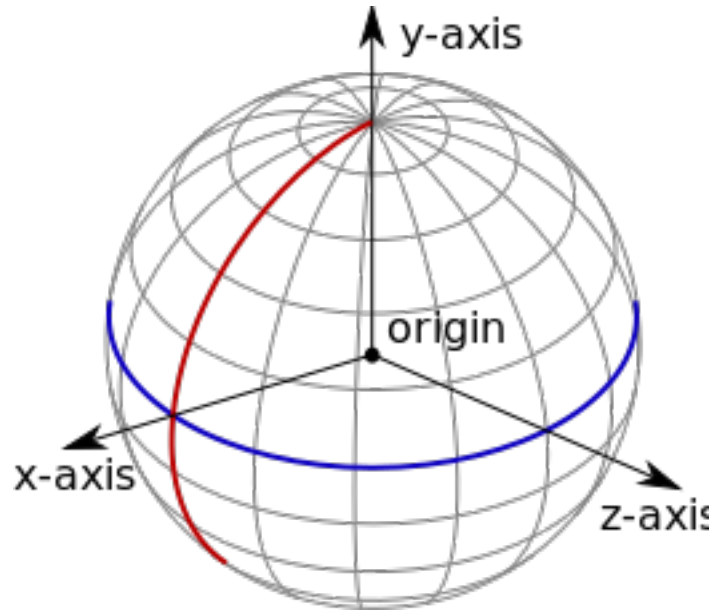


Fig. 3.6: Celestial body reference frame origin and axes. The equator is shown in blue, and the prime meridian in red.

- The origin is at the center of the body.
- The axes do not rotate.
- The x-axis points in an arbitrary direction through the equator.
- The y-axis points from the center of the body towards the north pole.
- The z-axis points in an arbitrary direction through the equator.

krpc_error_t **krpc_SpaceCenter_CelestialBody_OrbitalReferenceFrame** (*krpc_connection_t* *connection*,
krpc_SpaceCenter_ReferenceFrame_t *referenceFrame*,
krpc_error_t * *result*)

The reference frame that is fixed relative to this celestial body, but orientated with the body's orbital prograde/normal/radial directions.

- The origin is at the center of the body.
- The axes rotate with the orbital prograde/normal/radial directions.
- The x-axis points in the orbital anti-radial direction.
- The y-axis points in the orbital prograde direction.
- The z-axis points in the orbital normal direction.

krpc_error_t **krpc_SpaceCenter_CelestialBody_Position** (*krpc_connection_t* *connection*,
krpc_tuple_double_double_double_t *referenceFrame*,
krpc_error_t * *result*,
krpc_SpaceCenter_ReferenceFrame_t *referenceFrame*)

The position of the center of the body, in the specified reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned position vector is in.

Returns The position as a vector.

```
krpc_error_t krpc_SpaceCenter_CelestialBody_Velocity (krpc_connection_t connection,
                                                         krpc_tuple_double_double_double_t
                                                         * result,
                                                         krpc_SpaceCenter_ReferenceFrame_t ref-
                                                         erenceFrame)
```

The linear velocity of the body, in the specified reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned velocity vector is in.

Returns The velocity as a vector. The vector points in the direction of travel, and its magnitude is the speed of the body in meters per second.

```
krpc_error_t krpc_SpaceCenter_CelestialBody_Rotation (krpc_connection_t connection,
                                                         krpc_tuple_double_double_double_double_t
                                                         * result,
                                                         krpc_SpaceCenter_ReferenceFrame_t ref-
                                                         erenceFrame)
```

The rotation of the body, in the specified reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned rotation is in.

Returns The rotation as a quaternion of the form (x, y, z, w) .

```
krpc_error_t krpc_SpaceCenter_CelestialBody_Direction (krpc_connection_t connection,
                                                         krpc_tuple_double_double_double_t
                                                         * result,
                                                         krpc_SpaceCenter_ReferenceFrame_t ref-
                                                         erenceFrame)
```

The direction in which the north pole of the celestial body is pointing, in the specified reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

```
krpc_error_t krpc_SpaceCenter_CelestialBody_AngularVelocity (krpc_connection_t con-
                                                         nection,
                                                         krpc_tuple_double_double_double_t
                                                         * result,
                                                         krpc_SpaceCenter_ReferenceFrame_t ref-
                                                         erenceFrame)
```

The angular velocity of the body in the specified reference frame.

Parameters

- **referenceFrame** – The reference frame the returned angular velocity is in.

Returns The angular velocity as a vector. The magnitude of the vector is the rotational speed of the body, in radians per second. The direction of the vector indicates the axis of rotation, using the right-hand rule.

3.3.4 Flight

krpc_SpaceCenter_Flight_t

Used to get flight telemetry for a vessel, by calling `krpc_SpaceCenter_Vessel_Flight()`. All of the information returned by this class is given in the reference frame passed to that method. Obtained by calling `krpc_SpaceCenter_Vessel_Flight()`.

Note: To get orbital information, such as the apoapsis or inclination, see `krpc_SpaceCenter_Orbit_t`.

`krpc_error_t krpc_SpaceCenter_Flight_GForce` (`krpc_connection_t connection`, `float * result`)
 The current G force acting on the vessel in m/s^2 .

`krpc_error_t krpc_SpaceCenter_Flight_MeanAltitude` (`krpc_connection_t connection`, `double * result`)
 The altitude above sea level, in meters. Measured from the center of mass of the vessel.

`krpc_error_t krpc_SpaceCenter_Flight_SurfaceAltitude` (`krpc_connection_t connection`, `double * result`)
 The altitude above the surface of the body or sea level, whichever is closer, in meters. Measured from the center of mass of the vessel.

`krpc_error_t krpc_SpaceCenter_Flight_BedrockAltitude` (`krpc_connection_t connection`, `double * result`)
 The altitude above the surface of the body, in meters. When over water, this is the altitude above the sea floor. Measured from the center of mass of the vessel.

`krpc_error_t krpc_SpaceCenter_Flight_Elevation` (`krpc_connection_t connection`, `double * result`)
 The elevation of the terrain under the vessel, in meters. This is the height of the terrain above sea level, and is negative when the vessel is over the sea.

`krpc_error_t krpc_SpaceCenter_Flight_Latitude` (`krpc_connection_t connection`, `double * result`)
 The `latitude` of the vessel for the body being orbited, in degrees.

`krpc_error_t krpc_SpaceCenter_Flight_Longitude` (`krpc_connection_t connection`, `double * result`)
 The `longitude` of the vessel for the body being orbited, in degrees.

`krpc_error_t krpc_SpaceCenter_Flight_Velocity` (`krpc_connection_t connection`, `krpc_tuple_double_double_double_t * result`)
 The velocity of the vessel, in the reference frame `krpc_SpaceCenter_ReferenceFrame_t`.

Returns The velocity as a vector. The vector points in the direction of travel, and its magnitude is the speed of the vessel in meters per second.

`krpc_error_t krpc_SpaceCenter_Flight_Speed` (`krpc_connection_t connection`, `double * result`)
 The speed of the vessel in meters per second, in the reference frame `krpc_SpaceCenter_ReferenceFrame_t`.

`krpc_error_t krpc_SpaceCenter_Flight_HorizontalSpeed` (`krpc_connection_t connection`, `double * result`)
 The horizontal speed of the vessel in meters per second, in the reference frame `krpc_SpaceCenter_ReferenceFrame_t`.

`krpc_error_t krpc_SpaceCenter_Flight_VerticalSpeed` (`krpc_connection_t connection`, `double * result`)
 The vertical speed of the vessel in meters per second, in the reference frame `krpc_SpaceCenter_ReferenceFrame_t`.

`krpc_error_t krpc_SpaceCenter_Flight_CenterOfMass` (`krpc_connection_t connection`, `krpc_tuple_double_double_double_t * result`)
 The position of the center of mass of the vessel, in the reference frame `krpc_SpaceCenter_ReferenceFrame_t`

Returns The position as a vector.

krpc_error_t **krpc_SpaceCenter_Flight_Rotation** (*krpc_connection_t* *connection*,
krpc_tuple_double_double_double_double_t
** result*)

The rotation of the vessel, in the reference frame *krpc_SpaceCenter_ReferenceFrame_t*

Returns The rotation as a quaternion of the form (x, y, z, w) .

krpc_error_t **krpc_SpaceCenter_Flight_Direction** (*krpc_connection_t* *connection*,
krpc_tuple_double_double_double_t
** result*)

The direction that the vessel is pointing in, in the reference frame *krpc_SpaceCenter_ReferenceFrame_t*.

Returns The direction as a unit vector.

krpc_error_t **krpc_SpaceCenter_Flight_Pitch** (*krpc_connection_t* *connection*, *float * result*)

The pitch of the vessel relative to the horizon, in degrees. A value between -90° and $+90^\circ$.

krpc_error_t **krpc_SpaceCenter_Flight_Heading** (*krpc_connection_t* *connection*, *float * result*)

The heading of the vessel (its angle relative to north), in degrees. A value between 0° and 360° .

krpc_error_t **krpc_SpaceCenter_Flight_Roll** (*krpc_connection_t* *connection*, *float * result*)

The roll of the vessel relative to the horizon, in degrees. A value between -180° and $+180^\circ$.

krpc_error_t **krpc_SpaceCenter_Flight_Prograde** (*krpc_connection_t* *connection*,
krpc_tuple_double_double_double_t
** result*)

The prograde direction of the vessels orbit, in the reference frame *krpc_SpaceCenter_ReferenceFrame_t*.

Returns The direction as a unit vector.

krpc_error_t **krpc_SpaceCenter_Flight_Retrograde** (*krpc_connection_t* *connection*,
krpc_tuple_double_double_double_t
** result*)

The retrograde direction of the vessels orbit, in the reference frame *krpc_SpaceCenter_ReferenceFrame_t*.

Returns The direction as a unit vector.

krpc_error_t **krpc_SpaceCenter_Flight_Normal** (*krpc_connection_t* *connection*,
krpc_tuple_double_double_double_t * *result*)

The direction normal to the vessels orbit, in the reference frame *krpc_SpaceCenter_ReferenceFrame_t*.

Returns The direction as a unit vector.

krpc_error_t **krpc_SpaceCenter_Flight_AntiNormal** (*krpc_connection_t* *connection*,
krpc_tuple_double_double_double_t
** result*)

The direction opposite to the normal of the vessels orbit, in the reference frame *krpc_SpaceCenter_ReferenceFrame_t*.

Returns The direction as a unit vector.

krpc_error_t **krpc_SpaceCenter_Flight_Radial** (*krpc_connection_t* *connection*,
krpc_tuple_double_double_double_t * *result*)

The radial direction of the vessels orbit, in the reference frame *krpc_SpaceCenter_ReferenceFrame_t*.

Returns The direction as a unit vector.

krpc_error_t **krpc_SpaceCenter_Flight_AntiRadial** (*krpc_connection_t* *connection*,
krpc_tuple_double_double_double_t
** result*)

The direction opposite to the radial direction of the vessels orbit, in the reference frame *krpc_SpaceCenter_ReferenceFrame_t*.

Returns The direction as a unit vector.

krpc_error_t **krpc_SpaceCenter_Flight_AtmosphereDensity** (*krpc_connection_t* *connection*, *float * result*)

The current density of the atmosphere around the vessel, in kg/m^3 .

krpc_error_t **krpc_SpaceCenter_Flight_DynamicPressure** (*krpc_connection_t* *connection*, *float * result*)

The dynamic pressure acting on the vessel, in Pascals. This is a measure of the strength of the aerodynamic forces. It is equal to $\frac{1}{2} \cdot \text{air density} \cdot \text{velocity}^2$. It is commonly denoted Q .

krpc_error_t **krpc_SpaceCenter_Flight_StaticPressure** (*krpc_connection_t* *connection*, *float * result*)

The static atmospheric pressure acting on the vessel, in Pascals.

krpc_error_t **krpc_SpaceCenter_Flight_StaticPressureAtMSL** (*krpc_connection_t* *connection*, *float * result*)

The static atmospheric pressure at mean sea level, in Pascals.

krpc_error_t **krpc_SpaceCenter_Flight_AerodynamicForce** (*krpc_connection_t* *connection*,
krpc_tuple_double_double_double_t
** result*)

The total aerodynamic forces acting on the vessel, in reference frame *krpc_SpaceCenter_ReferenceFrame_t*.

Returns A vector pointing in the direction that the force acts, with its magnitude equal to the strength of the force in Newtons.

krpc_error_t **krpc_SpaceCenter_Flight_SimulateAerodynamicForceAt** (*krpc_connection_t* *connection*,
krpc_tuple_double_double_double_t
** result*,
krpc_SpaceCenter_CelestialBody_t *body*,
const
krpc_tuple_double_double_double_t
** position*, *const*
krpc_tuple_double_double_double_t
** velocity*)

Simulate and return the total aerodynamic forces acting on the vessel, if it were to be traveling with the given velocity at the given position in the atmosphere of the given celestial body.

Parameters

Returns A vector pointing in the direction that the force acts, with its magnitude equal to the strength of the force in Newtons.

krpc_error_t **krpc_SpaceCenter_Flight_Lift** (*krpc_connection_t* *connection*,
*krpc_tuple_double_double_double_t * result*)

The aerodynamic lift currently acting on the vessel.

Returns A vector pointing in the direction that the force acts, with its magnitude equal to the strength of the force in Newtons.

krpc_error_t **krpc_SpaceCenter_Flight_Drag** (*krpc_connection_t* *connection*,
krpc_tuple_double_double_double_t * *result*)

The aerodynamic drag currently acting on the vessel.

Returns A vector pointing in the direction of the force, with its magnitude equal to the strength of the force in Newtons.

krpc_error_t **krpc_SpaceCenter_Flight_SpeedOfSound** (*krpc_connection_t* *connection*, float
* *result*)

The speed of sound, in the atmosphere around the vessel, in *m/s*.

krpc_error_t **krpc_SpaceCenter_Flight_Mach** (*krpc_connection_t* *connection*, float * *result*)

The speed of the vessel, in multiples of the speed of sound.

krpc_error_t **krpc_SpaceCenter_Flight_ReynoldsNumber** (*krpc_connection_t* *connection*,
float * *result*)

The vessels Reynolds number.

Note: Requires [Ferram Aerospace Research](#).

krpc_error_t **krpc_SpaceCenter_Flight_TrueAirSpeed** (*krpc_connection_t* *connection*, float
* *result*)

The true air speed of the vessel, in meters per second.

krpc_error_t **krpc_SpaceCenter_Flight_EquivalentAirSpeed** (*krpc_connection_t* *connection*, float * *result*)

The equivalent air speed of the vessel, in meters per second.

krpc_error_t **krpc_SpaceCenter_Flight_TerminalVelocity** (*krpc_connection_t* *connection*,
float * *result*)

An estimate of the current terminal velocity of the vessel, in meters per second. This is the speed at which the drag forces cancel out the force of gravity.

krpc_error_t **krpc_SpaceCenter_Flight_AngleOfAttack** (*krpc_connection_t* *connection*,
float * *result*)

The pitch angle between the orientation of the vessel and its velocity vector, in degrees.

krpc_error_t **krpc_SpaceCenter_Flight_SideslipAngle** (*krpc_connection_t* *connection*,
float * *result*)

The yaw angle between the orientation of the vessel and its velocity vector, in degrees.

krpc_error_t **krpc_SpaceCenter_Flight_TotalAirTemperature** (*krpc_connection_t* *connection*, float * *result*)

The total air temperature of the atmosphere around the vessel, in Kelvin. This includes the *krpc_SpaceCenter_Flight_StaticAirTemperature()* and the vessel's kinetic energy.

krpc_error_t **krpc_SpaceCenter_Flight_StaticAirTemperature** (*krpc_connection_t* *connection*, float * *result*)

The static (ambient) temperature of the atmosphere around the vessel, in Kelvin.

krpc_error_t **krpc_SpaceCenter_Flight_StallFraction** (*krpc_connection_t* *connection*,
float * *result*)

The current amount of stall, between 0 and 1. A value greater than 0.005 indicates a minor stall and a value greater than 0.5 indicates a large-scale stall.

Note: Requires [Ferram Aerospace Research](#).

krpc_error_t **krpc_SpaceCenter_Flight_DragCoefficient** (*krpc_connection_t* *connection*,
float * *result*)

The coefficient of drag. This is the amount of drag produced by the vessel. It depends on air speed, air

density and wing area.

Note: Requires [Ferram Aerospace Research](#).

krpc_error_t **krpc_SpaceCenter_Flight_LiftCoefficient** (*krpc_connection_t connection,*
float * *result*)

The coefficient of lift. This is the amount of lift produced by the vessel, and depends on air speed, air density and wing area.

Note: Requires [Ferram Aerospace Research](#).

krpc_error_t **krpc_SpaceCenter_Flight_BallisticCoefficient** (*krpc_connection_t con-*
nection, float * *result*)

The ballistic coefficient.

Note: Requires [Ferram Aerospace Research](#).

krpc_error_t **krpc_SpaceCenter_Flight_ThrustSpecificFuelConsumption** (*krpc_connection_t con-*
nection,
float
* *result*)

The thrust specific fuel consumption for the jet engines on the vessel. This is a measure of the efficiency of the engines, with a lower value indicating a more efficient vessel. This value is the number of Newtons of fuel that are burned, per hour, to produce one newton of thrust.

Note: Requires [Ferram Aerospace Research](#).

3.3.5 Orbit

krpc_SpaceCenter_Orbit_t

Describes an orbit. For example, the orbit of a vessel, obtained by calling *krpc_SpaceCenter_Vessel_Orbit()*, or a celestial body, obtained by calling *krpc_SpaceCenter_CelestialBody_Orbit()*.

krpc_error_t **krpc_SpaceCenter_Orbit_Body** (*krpc_connection_t connection,*
krpc_SpaceCenter_CelestialBody_t * *result*)

The celestial body (e.g. planet or moon) around which the object is orbiting.

krpc_error_t **krpc_SpaceCenter_Orbit_Apoapsis** (*krpc_connection_t connection,* double * *re-*
sult)

Gets the apoapsis of the orbit, in meters, from the center of mass of the body being orbited.

Note: For the apoapsis altitude reported on the in-game map view, use *krpc_SpaceCenter_Orbit_ApoapsisAltitude()*.

krpc_error_t **krpc_SpaceCenter_Orbit_Periapsis** (*krpc_connection_t connection,* double
* *result*)

The periapsis of the orbit, in meters, from the center of mass of the body being orbited.

Note: For the periapsis altitude reported on the in-game map view, use `krpc_SpaceCenter_Orbit_PeriapsisAltitude()`.

`krpc_error_t krpc_SpaceCenter_Orbit_ApoapsisAltitude` (`krpc_connection_t connection`,
double * *result*
The apoapsis of the orbit, in meters, above the sea level of the body being orbited.

Note: This is equal to `krpc_SpaceCenter_Orbit_Apoapsis()` minus the equatorial radius of the body.

`krpc_error_t krpc_SpaceCenter_Orbit_PeriapsisAltitude` (`krpc_connection_t connection`,
double * *result*
The periapsis of the orbit, in meters, above the sea level of the body being orbited.

Note: This is equal to `krpc_SpaceCenter_Orbit_Periapsis()` minus the equatorial radius of the body.

`krpc_error_t krpc_SpaceCenter_Orbit_SemiMajorAxis` (`krpc_connection_t connection`,
double * *result*
The semi-major axis of the orbit, in meters.

`krpc_error_t krpc_SpaceCenter_Orbit_SemiMinorAxis` (`krpc_connection_t connection`,
double * *result*
The semi-minor axis of the orbit, in meters.

`krpc_error_t krpc_SpaceCenter_Orbit_Radius` (`krpc_connection_t connection`, double * *result*)
The current radius of the orbit, in meters. This is the distance between the center of mass of the object in orbit, and the center of mass of the body around which it is orbiting.

Note: This value will change over time if the orbit is elliptical.

`krpc_error_t krpc_SpaceCenter_Orbit_RadiusAt` (`krpc_connection_t connection`, double * *result*, double *ut*)
The orbital radius at the given time, in meters.

Parameters

- **ut** – The universal time to measure the radius at.

`krpc_error_t krpc_SpaceCenter_Orbit_PositionAt` (`krpc_connection_t connection`,
krpc_tuple_double_double_double_t
* *result*, double *ut*,
krpc_SpaceCenter_ReferenceFrame_t referenceFrame)

The position at a given time, in the specified reference frame.

Parameters

- **ut** – The universal time to measure the position at.
- **referenceFrame** – The reference frame that the returned position vector is in.

Returns The position as a vector.

krpc_error_t **krpc_SpaceCenter_Orbit_Speed** (*krpc_connection_t connection*, double * *result*)
The current orbital speed of the object in meters per second.

Note: This value will change over time if the orbit is elliptical.

krpc_error_t **krpc_SpaceCenter_Orbit_Period** (*krpc_connection_t connection*, double * *result*)
The orbital period, in seconds.

krpc_error_t **krpc_SpaceCenter_Orbit_TimeToApoapsis** (*krpc_connection_t connection*, double * *result*)
The time until the object reaches apoapsis, in seconds.

krpc_error_t **krpc_SpaceCenter_Orbit_TimeToPeriapsis** (*krpc_connection_t connection*, double * *result*)
The time until the object reaches periapsis, in seconds.

krpc_error_t **krpc_SpaceCenter_Orbit_Eccentricity** (*krpc_connection_t connection*, double * *result*)
The [eccentricity](#) of the orbit.

krpc_error_t **krpc_SpaceCenter_Orbit_Inclination** (*krpc_connection_t connection*, double * *result*)
The [inclination](#) of the orbit, in radians.

krpc_error_t **krpc_SpaceCenter_Orbit_LongitudeOfAscendingNode** (*krpc_connection_t connection*, double * *result*)
The [longitude of the ascending node](#), in radians.

krpc_error_t **krpc_SpaceCenter_Orbit_ArgumentOfPeriapsis** (*krpc_connection_t connection*, double * *result*)
The [argument of periapsis](#), in radians.

krpc_error_t **krpc_SpaceCenter_Orbit_MeanAnomalyAtEpoch** (*krpc_connection_t connection*, double * *result*)
The [mean anomaly at epoch](#).

krpc_error_t **krpc_SpaceCenter_Orbit_Epoch** (*krpc_connection_t connection*, double * *result*)
The time since the epoch (the point at which the [mean anomaly at epoch](#) was measured, in seconds.

krpc_error_t **krpc_SpaceCenter_Orbit_MeanAnomaly** (*krpc_connection_t connection*, double * *result*)
The [mean anomaly](#).

krpc_error_t **krpc_SpaceCenter_Orbit_MeanAnomalyAtUT** (*krpc_connection_t connection*, double * *result*, double *ut*)
The mean anomaly at the given time.

Parameters

- **ut** – The universal time in seconds.

krpc_error_t **krpc_SpaceCenter_Orbit_EccentricAnomaly** (*krpc_connection_t connection*, double * *result*)
The [eccentric anomaly](#).

krpc_error_t **krpc_SpaceCenter_Orbit_EccentricAnomalyAtUT** (*krpc_connection_t connection*, double * *result*, double *ut*)
The eccentric anomaly at the given universal time.

Parameters

- **ut** – The universal time, in seconds.

krpc_error_t **krpc_SpaceCenter_Orbit_TrueAnomaly** (*krpc_connection_t connection*, double * *result*)

The true anomaly.

krpc_error_t **krpc_SpaceCenter_Orbit_TrueAnomalyAtUT** (*krpc_connection_t connection*, double * *result*, double *ut*)

The true anomaly at the given time.

Parameters

- **ut** – The universal time in seconds.

krpc_error_t **krpc_SpaceCenter_Orbit_TrueAnomalyAtRadius** (*krpc_connection_t connection*, double * *result*, double *radius*)

The true anomaly at the given orbital radius.

Parameters

- **radius** – The orbital radius in meters.

krpc_error_t **krpc_SpaceCenter_Orbit_UTAtTrueAnomaly** (*krpc_connection_t connection*, double * *result*, double *trueAnomaly*)

The universal time, in seconds, corresponding to the given true anomaly.

Parameters

- **trueAnomaly** – True anomaly.

krpc_error_t **krpc_SpaceCenter_Orbit_RadiusAtTrueAnomaly** (*krpc_connection_t connection*, double * *result*, double *trueAnomaly*)

The orbital radius at the point in the orbit given by the true anomaly.

Parameters

- **trueAnomaly** – The true anomaly.

krpc_error_t **krpc_SpaceCenter_Orbit_TrueAnomalyAtAN** (*krpc_connection_t connection*, double * *result*, *krpc_SpaceCenter_Vessel_t target*)

The true anomaly of the ascending node with the given target vessel.

Parameters

- **target** – Target vessel.

krpc_error_t **krpc_SpaceCenter_Orbit_TrueAnomalyAtDN** (*krpc_connection_t connection*, double * *result*, *krpc_SpaceCenter_Vessel_t target*)

The true anomaly of the descending node with the given target vessel.

Parameters

- **target** – Target vessel.

krpc_error_t **krpc_SpaceCenter_Orbit_OrbitalSpeed** (*krpc_connection_t connection*, double * *result*)

The current orbital speed in meters per second.

krpc_error_t **krpc_SpaceCenter_Orbit_OrbitalSpeedAt** (*krpc_connection_t* *connection*,
double * *result*, double *time*)

The orbital speed at the given time, in meters per second.

Parameters

- **time** – Time from now, in seconds.

krpc_error_t **krpc_SpaceCenter_Orbit_ReferencePlaneNormal** (*krpc_connection_t* *con-*
nection,
krpc_tuple_double_double_double_t
* *result*,
krpc_SpaceCenter_ReferenceFrame_t *ref-*
erenceFrame)

The direction that is normal to the orbits reference plane, in the given reference frame. The reference plane is the plane from which the orbits inclination is measured.

Parameters

- **referenceFrame** – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

krpc_error_t **krpc_SpaceCenter_Orbit_ReferencePlaneDirection** (*krpc_connection_t* *con-*
nection,
krpc_tuple_double_double_double_t
* *result*,
krpc_SpaceCenter_ReferenceFrame_t *ref-*
erenceFrame)

The direction from which the orbits longitude of ascending node is measured, in the given reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

krpc_error_t **krpc_SpaceCenter_Orbit_RelativeInclination** (*krpc_connection_t* *con-*
nection, double * *result*,
krpc_SpaceCenter_Vessel_t *tar-*
get)

Relative inclination of this orbit and the orbit of the given target vessel, in radians.

Parameters

- **target** – Target vessel.

krpc_error_t **krpc_SpaceCenter_Orbit_TimeToSOIChange** (*krpc_connection_t* *connection*,
double * *result*)

The time until the object changes sphere of influence, in seconds. Returns NaN if the object is not going to change sphere of influence.

krpc_error_t **krpc_SpaceCenter_Orbit_NextOrbit** (*krpc_connection_t* *connection*,
krpc_SpaceCenter_Orbit_t * *result*)

If the object is going to change sphere of influence in the future, returns the new orbit after the change. Otherwise returns `nullptr`.

krpc_error_t **krpc_SpaceCenter_Orbit_TimeOfClosestApproach** (*krpc_connection_t* *con-*
nection, double * *result*,
krpc_SpaceCenter_Vessel_t *tar-*
get)

Estimates and returns the time at closest approach to a target vessel.

Parameters

- **target** – Target vessel.

Returns The universal time at closest approach, in seconds.

krpc_error_t **krpc_SpaceCenter_Orbit_DistanceAtClosestApproach** (*krpc_connection_t* *connection*, *double* * *result*, *krpc_SpaceCenter_Vessel_t* *target*)

Estimates and returns the distance at closest approach to a target vessel, in meters.

Parameters

- **target** – Target vessel.

krpc_error_t **krpc_SpaceCenter_Orbit_ListClosestApproaches** (*krpc_connection_t* *connection*, *krpc_list_list_double_t* * *result*, *krpc_SpaceCenter_Vessel_t* *target*, *int32_t* *orbits*)

Returns the times at closest approach and corresponding distances, to a target vessel.

Parameters

- **target** – Target vessel.
- **orbits** – The number of future orbits to search.

Returns A list of two lists. The first is a list of times at closest approach, as universal times in seconds. The second is a list of corresponding distances at closest approach, in meters.

3.3.6 Control

krpc_SpaceCenter_Control_t

Used to manipulate the controls of a vessel. This includes adjusting the throttle, enabling/disabling systems such as SAS and RCS, or altering the direction in which the vessel is pointing. Obtained by calling *krpc_SpaceCenter_Vessel_Control()*.

Note: Control inputs (such as pitch, yaw and roll) are zeroed when all clients that have set one or more of these inputs are no longer connected.

krpc_error_t **krpc_SpaceCenter_Control_Source** (*krpc_connection_t* *connection*, *krpc_SpaceCenter_ControlSource_t* * *result*)

The source of the vessels control, for example by a kerbal or a probe core.

krpc_error_t **krpc_SpaceCenter_Control_State** (*krpc_connection_t* *connection*, *krpc_SpaceCenter_ControlState_t* * *result*)

The control state of the vessel.

krpc_error_t **krpc_SpaceCenter_Control_SAS** (*krpc_connection_t* *connection*, *bool* * *result*)

void **krpc_SpaceCenter_Control_set_SAS** (*bool* *value*)

The state of SAS.

Note: Equivalent to `krpc_SpaceCenter_AutoPilot_SAS()`

`krpc_error_t krpc_SpaceCenter_Control_SASMode` (`krpc_connection_t` *connection*,
`krpc_SpaceCenter_SASMode_t` * *result*)

void `krpc_SpaceCenter_Control_set_SASMode` (`krpc_SpaceCenter_SASMode_t` *value*)

The current `krpc_SpaceCenter_SASMode_t`. These modes are equivalent to the mode buttons to the left of the navball that appear when SAS is enabled.

Note: Equivalent to `krpc_SpaceCenter_AutoPilot_SASMode()`

`krpc_error_t krpc_SpaceCenter_Control_SpeedMode` (`krpc_connection_t` *connection*,
`krpc_SpaceCenter_SpeedMode_t` * *result*)

void `krpc_SpaceCenter_Control_set_SpeedMode` (`krpc_SpaceCenter_SpeedMode_t` *value*)

The current `krpc_SpaceCenter_SpeedMode_t` of the navball. This is the mode displayed next to the speed at the top of the navball.

`krpc_error_t krpc_SpaceCenter_Control_RCS` (`krpc_connection_t` *connection*, bool * *result*)

void `krpc_SpaceCenter_Control_set_RCS` (bool *value*)

The state of RCS.

`krpc_error_t krpc_SpaceCenter_Control_ReactionWheels` (`krpc_connection_t` *connection*,
bool * *result*)

void `krpc_SpaceCenter_Control_set_ReactionWheels` (bool *value*)

Returns whether all reactive wheels on the vessel are active, and sets the active state of all reaction wheels. See `krpc_SpaceCenter_ReactionWheel_Active()`.

`krpc_error_t krpc_SpaceCenter_Control_Gear` (`krpc_connection_t` *connection*, bool * *result*)

void `krpc_SpaceCenter_Control_set_Gear` (bool *value*)

The state of the landing gear/legs.

`krpc_error_t krpc_SpaceCenter_Control_Legs` (`krpc_connection_t` *connection*, bool * *result*)

void `krpc_SpaceCenter_Control_set_Legs` (bool *value*)

Returns whether all landing legs on the vessel are deployed, and sets the deployment state of all landing legs. Does not include wheels (for example landing gear). See `krpc_SpaceCenter_Leg_Deployed()`.

`krpc_error_t krpc_SpaceCenter_Control_Wheels` (`krpc_connection_t` *connection*, bool * *result*)

void `krpc_SpaceCenter_Control_set_Wheels` (bool *value*)

Returns whether all wheels on the vessel are deployed, and sets the deployment state of all wheels. Does not include landing legs. See `krpc_SpaceCenter_Wheel_Deployed()`.

`krpc_error_t krpc_SpaceCenter_Control_Lights` (`krpc_connection_t` *connection*, bool * *result*)

void `krpc_SpaceCenter_Control_set_Lights` (bool *value*)

The state of the lights.

`krpc_error_t krpc_SpaceCenter_Control_Brakes` (`krpc_connection_t` *connection*, bool * *result*)

void **krpc_SpaceCenter_Control_set_Brakes** (bool *value*)
The state of the wheel brakes.

krpc_error_t **krpc_SpaceCenter_Control_Antennas** (*krpc_connection_t connection*, bool * *result*)

void **krpc_SpaceCenter_Control_set_Antennas** (bool *value*)
Returns whether all antennas on the vessel are deployed, and sets the deployment state of all antennas. See *krpc_SpaceCenter_Antenna_Deployed()*.

krpc_error_t **krpc_SpaceCenter_Control_CargoBays** (*krpc_connection_t connection*, bool * *result*)

void **krpc_SpaceCenter_Control_set_CargoBays** (bool *value*)
Returns whether any of the cargo bays on the vessel are open, and sets the open state of all cargo bays. See *krpc_SpaceCenter_CargoBay_Open()*.

krpc_error_t **krpc_SpaceCenter_Control_Intakes** (*krpc_connection_t connection*, bool * *result*)

void **krpc_SpaceCenter_Control_set_Intakes** (bool *value*)
Returns whether all of the air intakes on the vessel are open, and sets the open state of all air intakes. See *krpc_SpaceCenter_Intake_Open()*.

krpc_error_t **krpc_SpaceCenter_Control_Parachutes** (*krpc_connection_t connection*, bool * *result*)

void **krpc_SpaceCenter_Control_set_Parachutes** (bool *value*)
Returns whether all parachutes on the vessel are deployed, and sets the deployment state of all parachutes. Cannot be set to false. See *krpc_SpaceCenter_Parachute_Deployed()*.

krpc_error_t **krpc_SpaceCenter_Control_Radiators** (*krpc_connection_t connection*, bool * *result*)

void **krpc_SpaceCenter_Control_set_Radiators** (bool *value*)
Returns whether all radiators on the vessel are deployed, and sets the deployment state of all radiators. See *krpc_SpaceCenter_Radiator_Deployed()*.

krpc_error_t **krpc_SpaceCenter_Control_ResourceHarvesters** (*krpc_connection_t connection*, bool * *result*)

void **krpc_SpaceCenter_Control_set_ResourceHarvesters** (bool *value*)
Returns whether all of the resource harvesters on the vessel are deployed, and sets the deployment state of all resource harvesters. See *krpc_SpaceCenter_ResourceHarvester_Deployed()*.

krpc_error_t **krpc_SpaceCenter_Control_ResourceHarvestersActive** (*krpc_connection_t connection*, bool * *result*)

void **krpc_SpaceCenter_Control_set_ResourceHarvestersActive** (bool *value*)
Returns whether any of the resource harvesters on the vessel are active, and sets the active state of all resource harvesters. See *krpc_SpaceCenter_ResourceHarvester_Active()*.

krpc_error_t **krpc_SpaceCenter_Control_SolarPanels** (*krpc_connection_t connection*, bool * *result*)

void **krpc_SpaceCenter_Control_set_SolarPanels** (bool *value*)
Returns whether all solar panels on the vessel are deployed, and sets the deployment state of all solar panels. See *krpc_SpaceCenter_SolarPanel_Deployed()*.

krpc_error_t **krpc_SpaceCenter_Control_Abort** (*krpc_connection_t connection*, bool * *result*)

void **krpc_SpaceCenter_Control_set_Abort** (bool *value*)
The state of the abort action group.

krpc_error_t **krpc_SpaceCenter_Control_Throttle** (*krpc_connection_t connection*, float * *result*)

void **krpc_SpaceCenter_Control_set_Throttle** (float *value*)

The state of the throttle. A value between 0 and 1.

krpc_error_t **krpc_SpaceCenter_Control_InputMode** (*krpc_connection_t connection*,
krpc_SpaceCenter_ControlInputMode_t
* *result*)

void **krpc_SpaceCenter_Control_set_InputMode** (*krpc_SpaceCenter_ControlInputMode_t value*)

Sets the behavior of the pitch, yaw, roll and translation control inputs. When set to additive, these inputs are added to the vessels current inputs. This mode is the default. When set to override, these inputs (if non-zero) override the vessels inputs. This mode prevents keyboard control, or SAS, from interfering with the controls when they are set.

krpc_error_t **krpc_SpaceCenter_Control_Pitch** (*krpc_connection_t connection*, float * *result*)

void **krpc_SpaceCenter_Control_set_Pitch** (float *value*)

The state of the pitch control. A value between -1 and 1. Equivalent to the w and s keys.

krpc_error_t **krpc_SpaceCenter_Control_Yaw** (*krpc_connection_t connection*, float * *result*)

void **krpc_SpaceCenter_Control_set_Yaw** (float *value*)

The state of the yaw control. A value between -1 and 1. Equivalent to the a and d keys.

krpc_error_t **krpc_SpaceCenter_Control_Roll** (*krpc_connection_t connection*, float * *result*)

void **krpc_SpaceCenter_Control_set_Roll** (float *value*)

The state of the roll control. A value between -1 and 1. Equivalent to the q and e keys.

krpc_error_t **krpc_SpaceCenter_Control_Forward** (*krpc_connection_t connection*, float * *result*)

void **krpc_SpaceCenter_Control_set_Forward** (float *value*)

The state of the forward translational control. A value between -1 and 1. Equivalent to the h and n keys.

krpc_error_t **krpc_SpaceCenter_Control_Up** (*krpc_connection_t connection*, float * *result*)

void **krpc_SpaceCenter_Control_set_Up** (float *value*)

The state of the up translational control. A value between -1 and 1. Equivalent to the i and k keys.

krpc_error_t **krpc_SpaceCenter_Control_Right** (*krpc_connection_t connection*, float * *result*)

void **krpc_SpaceCenter_Control_set_Right** (float *value*)

The state of the right translational control. A value between -1 and 1. Equivalent to the j and l keys.

krpc_error_t **krpc_SpaceCenter_Control_WheelThrottle** (*krpc_connection_t connection*,
float * *result*)

void **krpc_SpaceCenter_Control_set_WheelThrottle** (float *value*)

The state of the wheel throttle. A value between -1 and 1. A value of 1 rotates the wheels forwards, a value of -1 rotates the wheels backwards.

krpc_error_t **krpc_SpaceCenter_Control_WheelSteering** (*krpc_connection_t connection*,
float * *result*)

void **krpc_SpaceCenter_Control_set_WheelSteering** (float *value*)

The state of the wheel steering. A value between -1 and 1. A value of 1 steers to the left, and a value of -1 steers to the right.

krpc_error_t **krpc_SpaceCenter_Control_CurrentStage** (*krpc_connection_t connection*,
int32_t * *result*)

The current stage of the vessel. Corresponds to the stage number in the in-game UI.

krpc_error_t **krpc_SpaceCenter_Control_ActivateNextStage** (*krpc_connection_t connection*, *krpc_list_object_t * result*)

Activates the next stage. Equivalent to pressing the space bar in-game.

Returns A list of vessel objects that are jettisoned from the active vessel.

Note: When called, the active vessel may change. It is therefore possible that, after calling this function, the object(s) returned by previous call(s) to *krpc_SpaceCenter_ActiveVessel()* no longer refer to the active vessel.

krpc_error_t **krpc_SpaceCenter_Control_GetActionGroup** (*krpc_connection_t connection*, *bool * result*, *uint32_t group*)

Returns `true` if the given action group is enabled.

Parameters

- **group** – A number between 0 and 9 inclusive, or between 0 and 250 inclusive when the [Extended Action Groups mod](#) is installed.

krpc_error_t **krpc_SpaceCenter_Control_SetActionGroup** (*krpc_connection_t connection*, *uint32_t group*, *bool state*)

Sets the state of the given action group.

Parameters

- **group** – A number between 0 and 9 inclusive, or between 0 and 250 inclusive when the [Extended Action Groups mod](#) is installed.

krpc_error_t **krpc_SpaceCenter_Control_ToggleActionGroup** (*krpc_connection_t connection*, *uint32_t group*)

Toggles the state of the given action group.

Parameters

- **group** – A number between 0 and 9 inclusive, or between 0 and 250 inclusive when the [Extended Action Groups mod](#) is installed.

krpc_error_t **krpc_SpaceCenter_Control_AddNode** (*krpc_connection_t connection*, *krpc_SpaceCenter_Node_t * result*, *double ut*, *float prograde*, *float normal*, *float radial*)

Creates a maneuver node at the given universal time, and returns a *krpc_SpaceCenter_Node_t* object that can be used to modify it. Optionally sets the magnitude of the delta-v for the maneuver node in the prograde, normal and radial directions.

Parameters

- **ut** – Universal time of the maneuver node.
- **prograde** – Delta-v in the prograde direction.
- **normal** – Delta-v in the normal direction.
- **radial** – Delta-v in the radial direction.

krpc_error_t **krpc_SpaceCenter_Control_Nodes** (*krpc_connection_t connection*, *krpc_list_object_t * result*)

Returns a list of all existing maneuver nodes, ordered by time from first to last.

krpc_error_t **krpc_SpaceCenter_Control_RemoveNodes** (*krpc_connection_t connection*)

Remove all maneuver nodes.

`krpc_SpaceCenter_ControlState_t`

The control state of a vessel. See *`krpc_SpaceCenter_Control_State()`*.

`KRPC_SPACECENTER_CONTROLSTATE_FULL`

Full controllable.

`KRPC_SPACECENTER_CONTROLSTATE_PARTIAL`

Partially controllable.

`KRPC_SPACECENTER_CONTROLSTATE_NONE`

Not controllable.

`krpc_SpaceCenter_ControlSource_t`

The control source of a vessel. See *`krpc_SpaceCenter_Control_Source()`*.

`KRPC_SPACECENTER_CONTROLSOURCE_KERBAL`

Vessel is controlled by a Kerbal.

`KRPC_SPACECENTER_CONTROLSOURCE_PROBE`

Vessel is controlled by a probe core.

`KRPC_SPACECENTER_CONTROLSOURCE_NONE`

Vessel is not controlled.

`krpc_SpaceCenter_SASMode_t`

The behavior of the SAS auto-pilot. See *`krpc_SpaceCenter_AutoPilot_SASMode()`*.

`KRPC_SPACECENTER_SASMODE_STABILITYASSIST`

Stability assist mode. Dampen out any rotation.

`KRPC_SPACECENTER_SASMODE_MANEUVER`

Point in the burn direction of the next maneuver node.

`KRPC_SPACECENTER_SASMODE_PROGRADE`

Point in the prograde direction.

`KRPC_SPACECENTER_SASMODE_RETROGRADE`

Point in the retrograde direction.

`KRPC_SPACECENTER_SASMODE_NORMAL`

Point in the orbit normal direction.

`KRPC_SPACECENTER_SASMODE_ANTINORMAL`

Point in the orbit anti-normal direction.

`KRPC_SPACECENTER_SASMODE_RADIAL`

Point in the orbit radial direction.

`KRPC_SPACECENTER_SASMODE_ANTIRADIAL`

Point in the orbit anti-radial direction.

`KRPC_SPACECENTER_SASMODE_TARGET`

Point in the direction of the current target.

`KRPC_SPACECENTER_SASMODE_ANTITARGET`

Point away from the current target.

`krpc_SpaceCenter_SpeedMode_t`

The mode of the speed reported in the navball. See *`krpc_SpaceCenter_Control_SpeedMode()`*.

`KRPC_SPACECENTER_SPEEDMODE_ORBIT`

Speed is relative to the vessel's orbit.

KRPC_SPACECENTER_SPEEDMODE_SURFACE

Speed is relative to the surface of the body being orbited.

KRPC_SPACECENTER_SPEEDMODE_TARGET

Speed is relative to the current target.

krpc_SpaceCenter_ControlInputMode_t

See `krpc_SpaceCenter_Control_InputMode()`.

KRPC_SPACECENTER_CONTROLINPUTMODE_ADDITIVE

Control inputs are added to the vessels current control inputs.

KRPC_SPACECENTER_CONTROLINPUTMODE_OVERRIDE

Control inputs (when they are non-zero) override the vessels current control inputs.

3.3.7 Communications

krpc_SpaceCenter_Comms_t

Used to interact with CommNet for a given vessel. Obtained by calling `krpc_SpaceCenter_Vessel_Comms()`.

`krpc_error_t krpc_SpaceCenter_Comms_CanCommunicate` (`krpc_connection_t connection`, `bool * result`)

Whether the vessel can communicate with KSC.

`krpc_error_t krpc_SpaceCenter_Comms_CanTransmitScience` (`krpc_connection_t connection`, `bool * result`)

Whether the vessel can transmit science data to KSC.

`krpc_error_t krpc_SpaceCenter_Comms_SignalStrength` (`krpc_connection_t connection`, `double * result`)

Signal strength to KSC.

`krpc_error_t krpc_SpaceCenter_Comms_SignalDelay` (`krpc_connection_t connection`, `double * result`)

Signal delay to KSC in seconds.

`krpc_error_t krpc_SpaceCenter_Comms_Power` (`krpc_connection_t connection`, `double * result`)

The combined power of all active antennae on the vessel.

`krpc_error_t krpc_SpaceCenter_Comms_ControlPath` (`krpc_connection_t connection`, `krpc_list_object_t * result`)

The communication path used to control the vessel.

krpc_SpaceCenter_CommLink_t

Represents a communication node in the network. For example, a vessel or the KSC.

`krpc_error_t krpc_SpaceCenter_CommLink_Type` (`krpc_connection_t connection`, `krpc_SpaceCenter_CommLinkType_t * result`)

The type of link.

`krpc_error_t krpc_SpaceCenter_CommLink_SignalStrength` (`krpc_connection_t connection`, `double * result`)

Signal strength of the link.

`krpc_error_t krpc_SpaceCenter_CommLink_Start` (`krpc_connection_t connection`, `krpc_SpaceCenter_CommNode_t * result`)

Start point of the link.

krpc_error_t **krpc_SpaceCenter_CommLink_End** (*krpc_connection_t* *connection*,
krpc_SpaceCenter_CommNode_t * *result*)

Start point of the link.

krpc_SpaceCenter_CommLinkType_t

The type of a communication link. See *krpc_SpaceCenter_CommLink_Type()*.

KRPC_SPACECENTER_COMMLINKTYPE_HOME

Link is to a base station on Kerbin.

KRPC_SPACECENTER_COMMLINKTYPE_CONTROL

Link is to a control source, for example a manned spacecraft.

KRPC_SPACECENTER_COMMLINKTYPE_RELAY

Link is to a relay satellite.

krpc_SpaceCenter_CommNode_t

Represents a communication node in the network. For example, a vessel or the KSC.

krpc_error_t **krpc_SpaceCenter_CommNode_Name** (*krpc_connection_t* *connection*, char * * *result*)

Name of the communication node.

krpc_error_t **krpc_SpaceCenter_CommNode_IsHome** (*krpc_connection_t* *connection*, bool * *result*)

Whether the communication node is on Kerbin.

krpc_error_t **krpc_SpaceCenter_CommNode_IsControlPoint** (*krpc_connection_t* *connection*,
bool * *result*)

Whether the communication node is a control point, for example a manned vessel.

krpc_error_t **krpc_SpaceCenter_CommNode_IsVessel** (*krpc_connection_t* *connection*, bool
* *result*)

Whether the communication node is a vessel.

krpc_error_t **krpc_SpaceCenter_CommNode_Vessel** (*krpc_connection_t* *connection*,
krpc_SpaceCenter_Vessel_t * *result*)

The vessel for this communication node.

3.3.8 Parts

The following classes allow interaction with a vessels individual parts.

- *Parts*
- *Part*
- *Module*
- *Specific Types of Part*
 - *Antenna*
 - *Cargo Bay*
 - *Control Surface*
 - *Decoupler*
 - *Docking Port*
 - *Engine*

- *Experiment*
- *Fairing*
- *Intake*
- *Leg*
- *Launch Clamp*
- *Light*
- *Parachute*
- *Radiator*
- *Resource Converter*
- *Resource Harvester*
- *Reaction Wheel*
- *RCS*
- *Sensor*
- *Solar Panel*
- *Thruster*
- *Wheel*
- *Trees of Parts*
 - *Traversing the Tree*
 - *Attachment Modes*
- *Fuel Lines*
- *Staging*

Parts

krpc_SpaceCenter_Parts_t

Instances of this class are used to interact with the parts of a vessel. An instance can be obtained by calling `krpc_SpaceCenter_Vessel_Parts()`.

`krpc_error_t krpc_SpaceCenter_Parts_All` (`krpc_connection_t connection`, `krpc_list_object_t * result`)

A list of all of the vessels parts.

`krpc_error_t krpc_SpaceCenter_Parts_Root` (`krpc_connection_t connection`, `krpc_SpaceCenter_Part_t * result`)

The vessels root part.

Note: See the discussion on *Trees of Parts*.

`krpc_error_t krpc_SpaceCenter_Parts_Controlling` (`krpc_connection_t connection`, `krpc_SpaceCenter_Part_t * result`)

`void krpc_SpaceCenter_Parts_set_Controlling` (`krpc_SpaceCenter_Part_t value`)

The part from which the vessel is controlled.

krpc_error_t **krpc_SpaceCenter_Parts_WithName** (*krpc_connection_t* *connection*,
krpc_list_object_t * *result*, const char
* *name*)

A list of parts whose *krpc_SpaceCenter_Part_Name()* is *name*.

Parameters

krpc_error_t **krpc_SpaceCenter_Parts_WithTitle** (*krpc_connection_t* *connection*,
krpc_list_object_t * *result*, const char
* *title*)

A list of all parts whose *krpc_SpaceCenter_Part_Title()* is *title*.

Parameters

krpc_error_t **krpc_SpaceCenter_Parts_WithTag** (*krpc_connection_t* *connection*,
krpc_list_object_t * *result*, const char
* *tag*)

A list of all parts whose *krpc_SpaceCenter_Part_Tag()* is *tag*.

Parameters

krpc_error_t **krpc_SpaceCenter_Parts_WithModule** (*krpc_connection_t* *connection*,
krpc_list_object_t * *result*, const char
* *moduleName*)

A list of all parts that contain a *krpc_SpaceCenter_Module_t* whose
krpc_SpaceCenter_Module_Name() is *moduleName*.

Parameters

krpc_error_t **krpc_SpaceCenter_Parts_InStage** (*krpc_connection_t* *connection*,
krpc_list_object_t * *result*, int32_t *stage*)

A list of all parts that are activated in the given *stage*.

Parameters

Note: See the discussion on *Staging*.

krpc_error_t **krpc_SpaceCenter_Parts_InDecoupleStage** (*krpc_connection_t* *connection*,
krpc_list_object_t * *result*,
int32_t *stage*)

A list of all parts that are decoupled in the given *stage*.

Parameters

Note: See the discussion on *Staging*.

krpc_error_t **krpc_SpaceCenter_Parts_ModulesWithName** (*krpc_connection_t* *connection*,
krpc_list_object_t * *result*, const
char * *moduleName*)

A list of modules (combined across all parts in the vessel) whose
krpc_SpaceCenter_Module_Name() is *moduleName*.

Parameters

krpc_error_t **krpc_SpaceCenter_Parts_Antennas** (*krpc_connection_t* *connection*,
krpc_list_object_t * *result*)

A list of all antennas in the vessel.

krpc_error_t **krpc_SpaceCenter_Parts_CargoBays** (*krpc_connection_t* *connection*,
krpc_list_object_t * *result*)

A list of all cargo bays in the vessel.

krpc_error_t **krpc_SpaceCenter_Parts_ControlSurfaces** (*krpc_connection_t* *connection*,
krpc_list_object_t * *result*)

A list of all control surfaces in the vessel.

krpc_error_t **krpc_SpaceCenter_Parts_Decouplers** (*krpc_connection_t* *connection*,
krpc_list_object_t * *result*)

A list of all decouplers in the vessel.

krpc_error_t **krpc_SpaceCenter_Parts_DockingPorts** (*krpc_connection_t* *connection*,
krpc_list_object_t * *result*)

A list of all docking ports in the vessel.

krpc_error_t **krpc_SpaceCenter_Parts_Engines** (*krpc_connection_t* *connection*,
krpc_list_object_t * *result*)

A list of all engines in the vessel.

Note: This includes any part that generates thrust. This covers many different types of engine, including liquid fuel rockets, solid rocket boosters, jet engines and RCS thrusters.

krpc_error_t **krpc_SpaceCenter_Parts_Experiments** (*krpc_connection_t* *connection*,
krpc_list_object_t * *result*)

A list of all science experiments in the vessel.

krpc_error_t **krpc_SpaceCenter_Parts_Fairings** (*krpc_connection_t* *connection*,
krpc_list_object_t * *result*)

A list of all fairings in the vessel.

krpc_error_t **krpc_SpaceCenter_Parts_Intakes** (*krpc_connection_t* *connection*,
krpc_list_object_t * *result*)

A list of all intakes in the vessel.

krpc_error_t **krpc_SpaceCenter_Parts_Legs** (*krpc_connection_t* *connection*, *krpc_list_object_t*
* *result*)

A list of all landing legs attached to the vessel.

krpc_error_t **krpc_SpaceCenter_Parts_LaunchClamps** (*krpc_connection_t* *connection*,
krpc_list_object_t * *result*)

A list of all launch clamps attached to the vessel.

krpc_error_t **krpc_SpaceCenter_Parts_Lights** (*krpc_connection_t* *connection*,
krpc_list_object_t * *result*)

A list of all lights in the vessel.

krpc_error_t **krpc_SpaceCenter_Parts_Parachutes** (*krpc_connection_t* *connection*,
krpc_list_object_t * *result*)

A list of all parachutes in the vessel.

krpc_error_t **krpc_SpaceCenter_Parts_Radiators** (*krpc_connection_t* *connection*,
krpc_list_object_t * *result*)

A list of all radiators in the vessel.

krpc_error_t **krpc_SpaceCenter_Parts_RCS** (*krpc_connection_t* *connection*, *krpc_list_object_t*
* *result*)

A list of all RCS blocks/thrusters in the vessel.

krpc_error_t **krpc_SpaceCenter_Parts_ReactionWheels** (*krpc_connection_t* *connection*,
krpc_list_object_t * *result*)

A list of all reaction wheels in the vessel.

krpc_error_t **krpc_SpaceCenter_Parts_ResourceConverters** (*krpc_connection_t* *connection*, *krpc_list_object_t* * *result*)

A list of all resource converters in the vessel.

krpc_error_t **krpc_SpaceCenter_Parts_ResourceHarvesters** (*krpc_connection_t* *connection*, *krpc_list_object_t* * *result*)

A list of all resource harvesters in the vessel.

krpc_error_t **krpc_SpaceCenter_Parts_Sensors** (*krpc_connection_t* *connection*, *krpc_list_object_t* * *result*)

A list of all sensors in the vessel.

krpc_error_t **krpc_SpaceCenter_Parts_SolarPanels** (*krpc_connection_t* *connection*, *krpc_list_object_t* * *result*)

A list of all solar panels in the vessel.

krpc_error_t **krpc_SpaceCenter_Parts_Wheels** (*krpc_connection_t* *connection*, *krpc_list_object_t* * *result*)

A list of all wheels in the vessel.

Part

krpc_SpaceCenter_Part_t

Represents an individual part. Vessels are made up of multiple parts. Instances of this class can be obtained by several methods in *krpc_SpaceCenter_Parts_t*.

krpc_error_t **krpc_SpaceCenter_Part_Name** (*krpc_connection_t* *connection*, char * * *result*)
Internal name of the part, as used in [part cfg files](#). For example “Mark1-2Pod”.

krpc_error_t **krpc_SpaceCenter_Part_Title** (*krpc_connection_t* *connection*, char * * *result*)
Title of the part, as shown when the part is right clicked in-game. For example “Mk1-2 Command Pod”.

krpc_error_t **krpc_SpaceCenter_Part_Tag** (*krpc_connection_t* *connection*, char * * *result*)

void **krpc_SpaceCenter_Part_set_Tag** (const char * *value*)
The name tag for the part. Can be set to a custom string using the in-game user interface.

Note: This requires either the [NameTag](#) or [kOS](#) mod to be installed.

krpc_error_t **krpc_SpaceCenter_Part_Highlighted** (*krpc_connection_t* *connection*, bool * *result*)

void **krpc_SpaceCenter_Part_set_Highlighted** (bool *value*)
Whether the part is highlighted.

krpc_error_t **krpc_SpaceCenter_Part_HighlightColor** (*krpc_connection_t* *connection*, *krpc_tuple_double_double_double_t* * *result*)

void **krpc_SpaceCenter_Part_set_HighlightColor** (const *krpc_tuple_double_double_double_t* * *value*)
The color used to highlight the part, as an RGB triple.

krpc_error_t **krpc_SpaceCenter_Part_Cost** (*krpc_connection_t* *connection*, double * *result*)
The cost of the part, in units of funds.

krpc_error_t **krpc_SpaceCenter_Part_Vessel** (*krpc_connection_t* *connection*, *krpc_SpaceCenter_Vessel_t* * *result*)
The vessel that contains this part.

```
krpc_error_t krpc_SpaceCenter_Part_Parent (krpc_connection_t connection,
                                             krpc_SpaceCenter_Part_t * result)
```

The parts parent. Returns `nullptr` if the part does not have a parent. This, in combination with `krpc_SpaceCenter_Part_Children()`, can be used to traverse the vessels parts tree.

Note: See the discussion on *Trees of Parts*.

```
krpc_error_t krpc_SpaceCenter_Part_Children (krpc_connection_t connection,
                                              krpc_list_object_t * result)
```

The parts children. Returns an empty list if the part has no children. This, in combination with `krpc_SpaceCenter_Part_Parent()`, can be used to traverse the vessels parts tree.

Note: See the discussion on *Trees of Parts*.

```
krpc_error_t krpc_SpaceCenter_Part_AxiallyAttached (krpc_connection_t connection,
                                                     bool * result)
```

Whether the part is axially attached to its parent, i.e. on the top or bottom of its parent. If the part has no parent, returns `false`.

Note: See the discussion on *Attachment Modes*.

```
krpc_error_t krpc_SpaceCenter_Part_RadiallyAttached (krpc_connection_t connection,
                                                     bool * result)
```

Whether the part is radially attached to its parent, i.e. on the side of its parent. If the part has no parent, returns `false`.

Note: See the discussion on *Attachment Modes*.

```
krpc_error_t krpc_SpaceCenter_Part_Stage (krpc_connection_t connection, int32_t * result)
```

The stage in which this part will be activated. Returns -1 if the part is not activated by staging.

Note: See the discussion on *Staging*.

```
krpc_error_t krpc_SpaceCenter_Part_DecoupleStage (krpc_connection_t connection,
                                                    int32_t * result)
```

The stage in which this part will be decoupled. Returns -1 if the part is never decoupled from the vessel.

Note: See the discussion on *Staging*.

```
krpc_error_t krpc_SpaceCenter_Part_Massless (krpc_connection_t connection, bool * result)
```

Whether the part is [massless](#).

```
krpc_error_t krpc_SpaceCenter_Part_Mass (krpc_connection_t connection, double * result)
```

The current mass of the part, including resources it contains, in kilograms. Returns zero if the part is massless.

```
krpc_error_t krpc_SpaceCenter_Part_DryMass (krpc_connection_t connection, double * result)
```

The mass of the part, not including any resources it contains, in kilograms. Returns zero if the part is massless.

krpc_error_t **krpc_SpaceCenter_Part_Shielded** (*krpc_connection_t connection*, *bool * result*)

Whether the part is shielded from the exterior of the vessel, for example by a fairing.

krpc_error_t **krpc_SpaceCenter_Part_DynamicPressure** (*krpc_connection_t connection*,
*float * result*)

The dynamic pressure acting on the part, in Pascals.

krpc_error_t **krpc_SpaceCenter_Part_ImpactTolerance** (*krpc_connection_t connection*,
*double * result*)

The impact tolerance of the part, in meters per second.

krpc_error_t **krpc_SpaceCenter_Part_Temperature** (*krpc_connection_t connection*, *double * result*)

Temperature of the part, in Kelvin.

krpc_error_t **krpc_SpaceCenter_Part_SkinTemperature** (*krpc_connection_t connection*,
*double * result*)

Temperature of the skin of the part, in Kelvin.

krpc_error_t **krpc_SpaceCenter_Part_MaxTemperature** (*krpc_connection_t connection*, *double * result*)

Maximum temperature that the part can survive, in Kelvin.

krpc_error_t **krpc_SpaceCenter_Part_MaxSkinTemperature** (*krpc_connection_t connection*,
*double * result*)

Maximum temperature that the skin of the part can survive, in Kelvin.

krpc_error_t **krpc_SpaceCenter_Part_ThermalMass** (*krpc_connection_t connection*, *float * result*)

A measure of how much energy it takes to increase the internal temperature of the part, in Joules per Kelvin.

krpc_error_t **krpc_SpaceCenter_Part_ThermalSkinMass** (*krpc_connection_t connection*,
*float * result*)

A measure of how much energy it takes to increase the skin temperature of the part, in Joules per Kelvin.

krpc_error_t **krpc_SpaceCenter_Part_ThermalResourceMass** (*krpc_connection_t connection*, *float * result*)

A measure of how much energy it takes to increase the temperature of the resources contained in the part, in Joules per Kelvin.

krpc_error_t **krpc_SpaceCenter_Part_ThermalConductionFlux** (*krpc_connection_t connection*, *float * result*)

The rate at which heat energy is conducting into or out of the part via contact with other parts. Measured in energy per unit time, or power, in Watts. A positive value means the part is gaining heat energy, and negative means it is losing heat energy.

krpc_error_t **krpc_SpaceCenter_Part_ThermalConvectionFlux** (*krpc_connection_t connection*, *float * result*)

The rate at which heat energy is convecting into or out of the part from the surrounding atmosphere. Measured in energy per unit time, or power, in Watts. A positive value means the part is gaining heat energy, and negative means it is losing heat energy.

krpc_error_t **krpc_SpaceCenter_Part_ThermalRadiationFlux** (*krpc_connection_t connection*, *float * result*)

The rate at which heat energy is radiating into or out of the part from the surrounding environment. Measured in energy per unit time, or power, in Watts. A positive value means the part is gaining heat energy, and negative means it is losing heat energy.

krpc_error_t **krpc_SpaceCenter_Part_ThermalInternalFlux** (*krpc_connection_t connection*, *float * result*)

The rate at which heat energy is begin generated by the part. For example, some engines generate heat by combusting fuel. Measured in energy per unit time, or power, in Watts. A positive value means the part is gaining heat energy, and negative means it is losing heat energy.

krpc_error_t **krpc_SpaceCenter_Part_ThermalSkinToInternalFlux** (*krpc_connection_t* *connection*, *float* ** result*)

The rate at which heat energy is transferring between the part's skin and its internals. Measured in energy per unit time, or power, in Watts. A positive value means the part's internals are gaining heat energy, and negative means its skin is gaining heat energy.

krpc_error_t **krpc_SpaceCenter_Part_Resources** (*krpc_connection_t* *connection*, *krpc_SpaceCenter_Resources_t* ** result*)
A *krpc_SpaceCenter_Resources_t* object for the part.

krpc_error_t **krpc_SpaceCenter_Part_Crossfeed** (*krpc_connection_t* *connection*, *bool* ** result*)

Whether this part is crossfeed capable.

krpc_error_t **krpc_SpaceCenter_Part_IsFuelLine** (*krpc_connection_t* *connection*, *bool* ** result*)

Whether this part is a fuel line.

krpc_error_t **krpc_SpaceCenter_Part_FuelLinesFrom** (*krpc_connection_t* *connection*, *krpc_list_object_t* ** result*)

The parts that are connected to this part via fuel lines, where the direction of the fuel line is into this part.

Note: See the discussion on *Fuel Lines*.

krpc_error_t **krpc_SpaceCenter_Part_FuelLinesTo** (*krpc_connection_t* *connection*, *krpc_list_object_t* ** result*)

The parts that are connected to this part via fuel lines, where the direction of the fuel line is out of this part.

Note: See the discussion on *Fuel Lines*.

krpc_error_t **krpc_SpaceCenter_Part_Modules** (*krpc_connection_t* *connection*, *krpc_list_object_t* ** result*)

The modules for this part.

krpc_error_t **krpc_SpaceCenter_Part_Antenna** (*krpc_connection_t* *connection*, *krpc_SpaceCenter_Antenna_t* ** result*)

A *krpc_SpaceCenter_Antenna_t* if the part is an antenna, otherwise *nullptr*.

krpc_error_t **krpc_SpaceCenter_Part_CargoBay** (*krpc_connection_t* *connection*, *krpc_SpaceCenter_CargoBay_t* ** result*)

A *krpc_SpaceCenter_CargoBay_t* if the part is a cargo bay, otherwise *nullptr*.

krpc_error_t **krpc_SpaceCenter_Part_ControlSurface** (*krpc_connection_t* *connection*, *krpc_SpaceCenter_ControlSurface_t* ** result*)

A *krpc_SpaceCenter_ControlSurface_t* if the part is an aerodynamic control surface, otherwise *nullptr*.

krpc_error_t **krpc_SpaceCenter_Part_Decoupler** (*krpc_connection_t* *connection*, *krpc_SpaceCenter_Decoupler_t* ** result*)

A *krpc_SpaceCenter_Decoupler_t* if the part is a decoupler, otherwise *nullptr*.

krpc_error_t **krpc_SpaceCenter_Part_DockingPort** (*krpc_connection_t* *connection*, *krpc_SpaceCenter_DockingPort_t* ** result*)

A *krpc_SpaceCenter_DockingPort_t* if the part is a docking port, otherwise *nullptr*.

```

krpc_error_t krpc_SpaceCenter_Part_Engine (krpc_connection_t          connection,
                                              krpc_SpaceCenter_Engine_t * result)
    An krpc_SpaceCenter_Engine_t if the part is an engine, otherwise nullptr.

krpc_error_t krpc_SpaceCenter_Part_Experiment (krpc_connection_t          connection,
                                                  krpc_SpaceCenter_Experiment_t * re-
                                                  sult)
    An krpc_SpaceCenter_Experiment_t if the part is a science experiment, otherwise nullptr.

krpc_error_t krpc_SpaceCenter_Part_Fairing (krpc_connection_t          connection,
                                              krpc_SpaceCenter_Fairing_t * result)
    A krpc_SpaceCenter_Fairing_t if the part is a fairing, otherwise nullptr.

krpc_error_t krpc_SpaceCenter_Part_Intake (krpc_connection_t          connection,
                                              krpc_SpaceCenter_Intake_t * result)
    An krpc_SpaceCenter_Intake_t if the part is an intake, otherwise nullptr.

```

Note: This includes any part that generates thrust. This covers many different types of engine, including liquid fuel rockets, solid rocket boosters and jet engines. For RCS thrusters see *krpc_SpaceCenter_RCS_t*.

```

krpc_error_t krpc_SpaceCenter_Part_Leg (krpc_connection_t connection,
                                           krpc_SpaceCenter_Leg_t * result)
    A krpc_SpaceCenter_Leg_t if the part is a landing leg, otherwise nullptr.

krpc_error_t krpc_SpaceCenter_Part_LaunchClamp (krpc_connection_t connection,
                                                  krpc_SpaceCenter_LaunchClamp_t
                                                  * result)
    A krpc_SpaceCenter_LaunchClamp_t if the part is a launch clamp, otherwise nullptr.

krpc_error_t krpc_SpaceCenter_Part_Light (krpc_connection_t connection,
                                             krpc_SpaceCenter_Light_t * result)
    A krpc_SpaceCenter_Light_t if the part is a light, otherwise nullptr.

krpc_error_t krpc_SpaceCenter_Part_Parachute (krpc_connection_t connection,
                                                krpc_SpaceCenter_Parachute_t * result)
    A krpc_SpaceCenter_Parachute_t if the part is a parachute, otherwise nullptr.

krpc_error_t krpc_SpaceCenter_Part_Radiator (krpc_connection_t connection,
                                                krpc_SpaceCenter_Radiator_t * result)
    A krpc_SpaceCenter_Radiator_t if the part is a radiator, otherwise nullptr.

krpc_error_t krpc_SpaceCenter_Part_RCS (krpc_connection_t connection,
                                           krpc_SpaceCenter_RCS_t * result)
    A krpc_SpaceCenter_RCS_t if the part is an RCS block/thruster, otherwise nullptr.

krpc_error_t krpc_SpaceCenter_Part_ReactionWheel (krpc_connection_t connection,
                                                     krpc_SpaceCenter_ReactionWheel_t
                                                     * result)
    A krpc_SpaceCenter_ReactionWheel_t if the part is a reaction wheel, otherwise nullptr.

krpc_error_t krpc_SpaceCenter_Part_ResourceConverter (krpc_connection_t connection,
                                                         krpc_SpaceCenter_ResourceConverter_t
                                                         * result)
    A krpc_SpaceCenter_ResourceConverter_t if the part is a resource converter, otherwise
    nullptr.

krpc_error_t krpc_SpaceCenter_Part_ResourceHarvester (krpc_connection_t connection,
                                                         krpc_SpaceCenter_ResourceHarvester_t
                                                         * result)
    A krpc_SpaceCenter_ResourceHarvester_t if the part is a resource harvester, otherwise

```

```

    nullptr.

krpc_error_t krpc_SpaceCenter_Part_Sensor (krpc_connection_t      connection,
                                             krpc_SpaceCenter_Sensor_t * result)
    A krpc_SpaceCenter_Sensor_t if the part is a sensor, otherwise nullptr.

krpc_error_t krpc_SpaceCenter_Part_SolarPanel (krpc_connection_t      connection,
                                                  krpc_SpaceCenter_SolarPanel_t * result)
    A krpc_SpaceCenter_SolarPanel_t if the part is a solar panel, otherwise nullptr.

krpc_error_t krpc_SpaceCenter_Part_Wheel (krpc_connection_t      connection,
                                             krpc_SpaceCenter_Wheel_t * result)
    A krpc_SpaceCenter_Wheel_t if the part is a wheel, otherwise nullptr.

krpc_error_t krpc_SpaceCenter_Part_Position (krpc_connection_t      connection,
                                              krpc_tuple_double_double_double_t * result,
                                              krpc_SpaceCenter_ReferenceFrame_t referenceFrame)

```

The position of the part in the given reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned position vector is in.

Returns The position as a vector.

Note: This is a fixed position in the part, defined by the parts model. It is not necessarily the same as the parts center of mass. Use *krpc_SpaceCenter_Part_CenterOfMass()* to get the parts center of mass.

```

krpc_error_t krpc_SpaceCenter_Part_CenterOfMass (krpc_connection_t      connection,
                                                  krpc_tuple_double_double_double_t * result,
                                                  krpc_SpaceCenter_ReferenceFrame_t referenceFrame)

```

The position of the parts center of mass in the given reference frame. If the part is physicsless, this is equivalent to *krpc_SpaceCenter_Part_Position()*.

Parameters

- **referenceFrame** – The reference frame that the returned position vector is in.

Returns The position as a vector.

```

krpc_error_t krpc_SpaceCenter_Part_BoundingBox (krpc_connection_t      connection,
                                                  krpc_tuple_tuple_double_double_double_tuple_double_double_t * result,
                                                  krpc_SpaceCenter_ReferenceFrame_t referenceFrame)

```

The axis-aligned bounding box of the part in the given reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned position vectors are in.

Returns The positions of the minimum and maximum vertices of the box, as position vectors.

Note: This is computed from the collision mesh of the part. If the part is not collidable, the box has zero volume and is centered on the *krpc_SpaceCenter_Part_Position()* of the part.

```
krpc_error_t krpc_SpaceCenter_Part_Direction (krpc_connection_t connection,  
                                                krpc_tuple_double_double_double_t * result,  
                                                krpc_SpaceCenter_ReferenceFrame_t referenceFrame)
```

The direction the part points in, in the given reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

```
krpc_error_t krpc_SpaceCenter_Part_Velocity (krpc_connection_t connection,  
                                                krpc_tuple_double_double_double_t * result,  
                                                krpc_SpaceCenter_ReferenceFrame_t referenceFrame)
```

The linear velocity of the part in the given reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned velocity vector is in.

Returns The velocity as a vector. The vector points in the direction of travel, and its magnitude is the speed of the body in meters per second.

```
krpc_error_t krpc_SpaceCenter_Part_Rotation (krpc_connection_t connection,  
                                                krpc_tuple_double_double_double_double_t * result,  
                                                krpc_SpaceCenter_ReferenceFrame_t referenceFrame)
```

The rotation of the part, in the given reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned rotation is in.

Returns The rotation as a quaternion of the form (x, y, z, w) .

```
krpc_error_t krpc_SpaceCenter_Part_MomentOfInertia (krpc_connection_t connection,  
                                                krpc_tuple_double_double_double_t * result)
```

The moment of inertia of the part in $kg.m^2$ around its center of mass in the parts reference frame (*krpc_SpaceCenter_ReferenceFrame_t*).

```
krpc_error_t krpc_SpaceCenter_Part_InertiaTensor (krpc_connection_t connection,  
                                                krpc_list_double_t * result)
```

The inertia tensor of the part in the parts reference frame (*krpc_SpaceCenter_ReferenceFrame_t*). Returns the 3x3 matrix as a list of elements, in row-major order.

```
krpc_error_t krpc_SpaceCenter_Part_ReferenceFrame (krpc_connection_t connection,  
                                                krpc_SpaceCenter_ReferenceFrame_t * result)
```

The reference frame that is fixed relative to this part, and centered on a fixed position within the part, defined by the parts model.

- The origin is at the position of the part, as returned by *krpc_SpaceCenter_Part_Position()*.
- The axes rotate with the part.
- The x, y and z axis directions depend on the design of the part.

Note: For docking port parts, this reference frame is not necessarily equivalent to the reference frame for the docking port, returned by `krpc_SpaceCenter_DockingPort_ReferenceFrame()`.

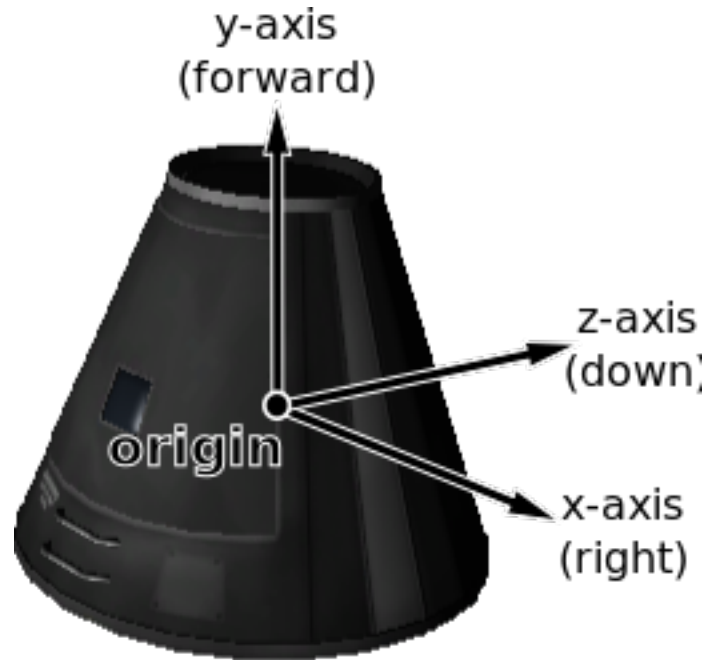


Fig. 3.7: Mk1 Command Pod reference frame origin and axes

`krpc_error_t krpc_SpaceCenter_Part_CenterOfMassReferenceFrame` (`krpc_connection_t connection`,
`krpc_SpaceCenter_ReferenceFrame_t * result`)

The reference frame that is fixed relative to this part, and centered on its center of mass.

- The origin is at the center of mass of the part, as returned by `krpc_SpaceCenter_Part_CenterOfMass()`.
- The axes rotate with the part.
- The x, y and z axis directions depend on the design of the part.

Note: For docking port parts, this reference frame is not necessarily equivalent to the reference frame for the docking port, returned by `krpc_SpaceCenter_DockingPort_ReferenceFrame()`.

`krpc_error_t krpc_SpaceCenter_Part_AddForce` (`krpc_connection_t connection`,
`krpc_SpaceCenter_Force_t * result`,
`const krpc_tuple_double_double_double_t * force`,
`const krpc_tuple_double_double_double_t * position`,
`krpc_SpaceCenter_ReferenceFrame_t referenceFrame`)

Exert a constant force on the part, acting at the given position.

Parameters

- **force** – A vector pointing in the direction that the force acts, with its magnitude equal to the strength of the force in Newtons.
- **position** – The position at which the force acts, as a vector.
- **referenceFrame** – The reference frame that the force and position are in.

Returns An object that can be used to remove or modify the force.

```
krpc_error_t krpc_SpaceCenter_Part_InstantaneousForce (krpc_connection_t      con-  
                                                         nection,      const  
                                                         krpc_tuple_double_double_double_t  
                                                         * force,      const  
                                                         krpc_tuple_double_double_double_t  
                                                         * position,  
                                                         krpc_SpaceCenter_ReferenceFrame_t ref-  
                                                         erenceFrame)
```

Exert an instantaneous force on the part, acting at the given position.

Parameters

- **force** – A vector pointing in the direction that the force acts, with its magnitude equal to the strength of the force in Newtons.
- **position** – The position at which the force acts, as a vector.
- **referenceFrame** – The reference frame that the force and position are in.

Note: The force is applied instantaneously in a single physics update.

krpc_SpaceCenter_Force_t

Obtained by calling *krpc_SpaceCenter_Part_AddForce()*.

```
krpc_error_t krpc_SpaceCenter_Force_Part (krpc_connection_t      connection,  
                                                         krpc_SpaceCenter_Part_t * result)
```

The part that this force is applied to.

```
krpc_error_t krpc_SpaceCenter_Force_ForceVector (krpc_connection_t      connection,  
                                                         krpc_tuple_double_double_double_t  
                                                         * result)
```

```
void krpc_SpaceCenter_Force_set_ForceVector (const krpc_tuple_double_double_double_t  
                                                         * value)
```

The force vector, in Newtons.

Returns A vector pointing in the direction that the force acts, with its magnitude equal to the strength of the force in Newtons.

```
krpc_error_t krpc_SpaceCenter_Force_Position (krpc_connection_t      connection,  
                                                         krpc_tuple_double_double_double_t  
                                                         * result)
```

```
void krpc_SpaceCenter_Force_set_Position (const      krpc_tuple_double_double_double_t  
                                                         * value)
```

The position at which the force acts, in reference frame *krpc_SpaceCenter_ReferenceFrame_t*.

Returns The position as a vector.

```
krpc_error_t krpc_SpaceCenter_Force_ReferenceFrame (krpc_connection_t      connection,  
                                                         krpc_SpaceCenter_ReferenceFrame_t  
                                                         * result)
```

void **krpc_SpaceCenter_Force_set_ReferenceFrame** (*krpc_SpaceCenter_ReferenceFrame_t value*)
The reference frame of the force vector and position.

krpc_error_t **krpc_SpaceCenter_Force_Remove** (*krpc_connection_t connection*)
Remove the force.

Module

krpc_SpaceCenter_Module_t

This can be used to interact with a specific part module. This includes part modules in stock KSP, and those added by mods.

In KSP, each part has zero or more [PartModules](#) associated with it. Each one contains some of the functionality of the part. For example, an engine has a “ModuleEngines” part module that contains all the functionality of an engine.

krpc_error_t **krpc_SpaceCenter_Module_Name** (*krpc_connection_t connection*, *char ** result*)
Name of the PartModule. For example, “ModuleEngines”.

krpc_error_t **krpc_SpaceCenter_Module_Part** (*krpc_connection_t connection*,
*krpc_SpaceCenter_Part_t * result*)
The part that contains this module.

krpc_error_t **krpc_SpaceCenter_Module_Fields** (*krpc_connection_t connection*,
*krpc_dictionary_string_string_t * result*)
The modules field names and their associated values, as a dictionary. These are the values visible in the right-click menu of the part.

krpc_error_t **krpc_SpaceCenter_Module_HasField** (*krpc_connection_t connection*, *bool * result*, *const char * name*)
Returns `true` if the module has a field with the given name.

Parameters

- **name** – Name of the field.

krpc_error_t **krpc_SpaceCenter_Module_GetField** (*krpc_connection_t connection*, *char ** result*, *const char * name*)
Returns the value of a field.

Parameters

- **name** – Name of the field.

krpc_error_t **krpc_SpaceCenter_Module_SetFieldInt** (*krpc_connection_t connection*, *const char * name*, *int32_t value*)
Set the value of a field to the given integer number.

Parameters

- **name** – Name of the field.
- **value** – Value to set.

krpc_error_t **krpc_SpaceCenter_Module_SetFieldFloat** (*krpc_connection_t connection*,
*const char * name*, *float value*)
Set the value of a field to the given floating point number.

Parameters

- **name** – Name of the field.
- **value** – Value to set.

```
krpc_error_t krpc_SpaceCenter_Module_SetFieldString (krpc_connection_t connection,  
                                                    const char * name, const char  
                                                    * value)
```

Set the value of a field to the given string.

Parameters

- **name** – Name of the field.
- **value** – Value to set.

```
krpc_error_t krpc_SpaceCenter_Module_ResetField (krpc_connection_t connection, const  
                                                    char * name)
```

Set the value of a field to its original value.

Parameters

- **name** – Name of the field.

```
krpc_error_t krpc_SpaceCenter_Module_Events (krpc_connection_t connection,  
                                                    krpc_list_string_t * result)
```

A list of the names of all of the modules events. Events are the clickable buttons visible in the right-click menu of the part.

```
krpc_error_t krpc_SpaceCenter_Module_HasEvent (krpc_connection_t connection, bool * re-  
                                                    sult, const char * name)
```

true if the module has an event with the given name.

Parameters

```
krpc_error_t krpc_SpaceCenter_Module_TriggerEvent (krpc_connection_t connection, const  
                                                    char * name)
```

Trigger the named event. Equivalent to clicking the button in the right-click menu of the part.

Parameters

```
krpc_error_t krpc_SpaceCenter_Module_Actions (krpc_connection_t connection,  
                                                    krpc_list_string_t * result)
```

A list of all the names of the modules actions. These are the parts actions that can be assigned to action groups in the in-game editor.

```
krpc_error_t krpc_SpaceCenter_Module_HasAction (krpc_connection_t connection, bool * re-  
                                                    sult, const char * name)
```

true if the part has an action with the given name.

Parameters

```
krpc_error_t krpc_SpaceCenter_Module_SetAction (krpc_connection_t connection, const  
                                                    char * name, bool value)
```

Set the value of an action with the given name.

Parameters

Specific Types of Part

The following classes provide functionality for specific types of part.

- *Antenna*
- *Cargo Bay*
- *Control Surface*

- *Decoupler*
- *Docking Port*
- *Engine*
- *Experiment*
- *Fairing*
- *Intake*
- *Leg*
- *Launch Clamp*
- *Light*
- *Parachute*
- *Radiator*
- *Resource Converter*
- *Resource Harvester*
- *Reaction Wheel*
- *RCS*
- *Sensor*
- *Solar Panel*
- *Thruster*
- *Wheel*

Antenna

krpc_SpaceCenter_Antenna_t

An antenna. Obtained by calling *krpc_SpaceCenter_Part_Antenna()*.

krpc_error_t **krpc_SpaceCenter_Antenna_Part** (*krpc_connection_t* *connection*,
krpc_SpaceCenter_Part_t * *result*)

The part object for this antenna.

krpc_error_t **krpc_SpaceCenter_Antenna_State** (*krpc_connection_t* *connection*,
krpc_SpaceCenter_AntennaState_t * *result*)

The current state of the antenna.

krpc_error_t **krpc_SpaceCenter_Antenna_Deployable** (*krpc_connection_t* *connection*, bool
* *result*)

Whether the antenna is deployable.

krpc_error_t **krpc_SpaceCenter_Antenna_Deployed** (*krpc_connection_t* *connection*, bool * *result*)

void **krpc_SpaceCenter_Antenna_set_Deployed** (bool *value*)

Whether the antenna is deployed.

Note: Fixed antennas are always deployed. Returns an error if you try to deploy a fixed antenna.

krpc_error_t **krpc_SpaceCenter_Antenna_CanTransmit** (*krpc_connection_t connection*, bool * *result*)

Whether data can be transmitted by this antenna.

krpc_error_t **krpc_SpaceCenter_Antenna_Transmit** (*krpc_connection_t connection*)

Transmit data.

krpc_error_t **krpc_SpaceCenter_Antenna_Cancel** (*krpc_connection_t connection*)

Cancel current transmission of data.

krpc_error_t **krpc_SpaceCenter_Antenna_AllowPartial** (*krpc_connection_t connection*, bool * *result*)

void **krpc_SpaceCenter_Antenna_set_AllowPartial** (bool *value*)

Whether partial data transmission is permitted.

krpc_error_t **krpc_SpaceCenter_Antenna_Power** (*krpc_connection_t connection*, double * *result*)

The power of the antenna.

krpc_error_t **krpc_SpaceCenter_Antenna_Combinable** (*krpc_connection_t connection*, bool * *result*)

Whether the antenna can be combined with other antennae on the vessel to boost the power.

krpc_error_t **krpc_SpaceCenter_Antenna_CombinableExponent** (*krpc_connection_t connection*, double * *result*)

Exponent used to calculate the combined power of multiple antennae on a vessel.

krpc_error_t **krpc_SpaceCenter_Antenna_PacketInterval** (*krpc_connection_t connection*, float * *result*)

Interval between sending packets in seconds.

krpc_error_t **krpc_SpaceCenter_Antenna_PacketSize** (*krpc_connection_t connection*, float * *result*)

Amount of data sent per packet in Mits.

krpc_error_t **krpc_SpaceCenter_Antenna_PacketResourceCost** (*krpc_connection_t connection*, double * *result*)

Units of electric charge consumed per packet sent.

krpc_SpaceCenter_AntennaState_t

The state of an antenna. See *krpc_SpaceCenter_Antenna_State()*.

KRPC_SPACECENTER_ANTENNASTATE_DEPLOYED

Antenna is fully deployed.

KRPC_SPACECENTER_ANTENNASTATE_RETRACTED

Antenna is fully retracted.

KRPC_SPACECENTER_ANTENNASTATE_DEPLOYING

Antenna is being deployed.

KRPC_SPACECENTER_ANTENNASTATE_RETRACTING

Antenna is being retracted.

KRPC_SPACECENTER_ANTENNASTATE_BROKEN

Antenna is broken.

Cargo Bay

krpc_SpaceCenter_CargoBay_t

A cargo bay. Obtained by calling *krpc_SpaceCenter_Part_CargoBay()*.

krpc_error_t **krpc_SpaceCenter_CargoBay_Part** (*krpc_connection_t* *connection*,
krpc_SpaceCenter_Part_t * *result*)

The part object for this cargo bay.

krpc_error_t **krpc_SpaceCenter_CargoBay_State** (*krpc_connection_t* *connection*,
krpc_SpaceCenter_CargoBayState_t
 * *result*)

The state of the cargo bay.

krpc_error_t **krpc_SpaceCenter_CargoBay_Open** (*krpc_connection_t* *connection*, *bool* * *result*)

void **krpc_SpaceCenter_CargoBay_set_Open** (*bool* *value*)

Whether the cargo bay is open.

krpc_SpaceCenter_CargoBayState_t

The state of a cargo bay. See *krpc_SpaceCenter_CargoBay_State()*.

KRPC_SPACECENTER_CARGOBAYSTATE_OPEN

Cargo bay is fully open.

KRPC_SPACECENTER_CARGOBAYSTATE_CLOSED

Cargo bay closed and locked.

KRPC_SPACECENTER_CARGOBAYSTATE_OPENING

Cargo bay is opening.

KRPC_SPACECENTER_CARGOBAYSTATE_CLOSING

Cargo bay is closing.

Control Surface

krpc_SpaceCenter_ControlSurface_t

An aerodynamic control surface. Obtained by calling *krpc_SpaceCenter_Part_ControlSurface()*.

krpc_error_t **krpc_SpaceCenter_ControlSurface_Part** (*krpc_connection_t* *connection*,
krpc_SpaceCenter_Part_t * *result*)

The part object for this control surface.

krpc_error_t **krpc_SpaceCenter_ControlSurface_PitchEnabled** (*krpc_connection_t* *connection*, *bool* * *result*)

void **krpc_SpaceCenter_ControlSurface_set_PitchEnabled** (*bool* *value*)

Whether the control surface has pitch control enabled.

krpc_error_t **krpc_SpaceCenter_ControlSurface_YawEnabled** (*krpc_connection_t* *connection*, *bool* * *result*)

void **krpc_SpaceCenter_ControlSurface_set_YawEnabled** (*bool* *value*)

Whether the control surface has yaw control enabled.

krpc_error_t **krpc_SpaceCenter_ControlSurface_RollEnabled** (*krpc_connection_t* *connection*, *bool* * *result*)

void **krpc_SpaceCenter_ControlSurface_set_RollEnabled** (*bool* *value*)

Whether the control surface has roll control enabled.

krpc_error_t **krpc_SpaceCenter_ControlSurface_AuthorityLimiter** (*krpc_connection_t* *connection*, *float*
 * *result*)

void **krpc_SpaceCenter_ControlSurface_set_AuthorityLimiter** (*float* *value*)

The authority limiter for the control surface, which controls how far the control surface will move.

krpc_error_t **krpc_SpaceCenter_ControlSurface_Inverted** (*krpc_connection_t connection*,
bool * *result*)

void **krpc_SpaceCenter_ControlSurface_set_Inverted** (bool *value*)

Whether the control surface movement is inverted.

krpc_error_t **krpc_SpaceCenter_ControlSurface_Deployed** (*krpc_connection_t connection*,
bool * *result*)

void **krpc_SpaceCenter_ControlSurface_set_Deployed** (bool *value*)

Whether the control surface has been fully deployed.

krpc_error_t **krpc_SpaceCenter_ControlSurface_SurfaceArea** (*krpc_connection_t connection*, float * *result*)

Surface area of the control surface in m^2 .

krpc_error_t **krpc_SpaceCenter_ControlSurface_AvailableTorque** (*krpc_connection_t connection*,
krpc_tuple_tuple_double_double_double_t * *result*)

The available torque, in Newton meters, that can be produced by this control surface, in the positive and negative pitch, roll and yaw axes of the vessel. These axes correspond to the coordinate axes of the *krpc_SpaceCenter_Vessel_ReferenceFrame* ().

Decoupler

krpc_SpaceCenter_Decoupler_t

A decoupler. Obtained by calling *krpc_SpaceCenter_Part_Decoupler* ()

krpc_error_t **krpc_SpaceCenter_Decoupler_Part** (*krpc_connection_t connection*,
krpc_SpaceCenter_Part_t * *result*)

The part object for this decoupler.

krpc_error_t **krpc_SpaceCenter_Decoupler_Decouple** (*krpc_connection_t connection*,
krpc_SpaceCenter_Vessel_t * *result*)

Fires the decoupler. Returns the new vessel created when the decoupler fires. Throws an exception if the decoupler has already fired.

Note: When called, the active vessel may change. It is therefore possible that, after calling this function, the object(s) returned by previous call(s) to *krpc_SpaceCenter_ActiveVessel* () no longer refer to the active vessel.

krpc_error_t **krpc_SpaceCenter_Decoupler_Decoupled** (*krpc_connection_t connection*, bool * *result*)

Whether the decoupler has fired.

krpc_error_t **krpc_SpaceCenter_Decoupler_Staged** (*krpc_connection_t connection*, bool * *result*)

Whether the decoupler is enabled in the staging sequence.

krpc_error_t **krpc_SpaceCenter_Decoupler_Impulse** (*krpc_connection_t connection*, float * *result*)

The impulse that the decoupler imparts when it is fired, in Newton seconds.

Docking Port

krpc_SpaceCenter_DockingPort_t

A docking port. Obtained by calling *krpc_SpaceCenter_Part_DockingPort* ()

```
krpc_error_t krpc_SpaceCenter_DockingPort_Part (krpc_connection_t connection,
                                                  krpc_SpaceCenter_Part_t * result)
```

The part object for this docking port.

```
krpc_error_t krpc_SpaceCenter_DockingPort_State (krpc_connection_t connection,
                                                  krpc_SpaceCenter_DockingPortState_t
                                                  * result)
```

The current state of the docking port.

```
krpc_error_t krpc_SpaceCenter_DockingPort_DockedPart (krpc_connection_t connection,
                                                       krpc_SpaceCenter_Part_t * re-
                                                       sult)
```

The part that this docking port is docked to. Returns `nullptr` if this docking port is not docked to anything.

```
krpc_error_t krpc_SpaceCenter_DockingPort_Undock (krpc_connection_t connection,
                                                    krpc_SpaceCenter_Vessel_t * result)
```

Undocks the docking port and returns the new `krpc_SpaceCenter_Vessel_t` that is created. This method can be called for either docking port in a docked pair. Throws an exception if the docking port is not docked to anything.

Note: When called, the active vessel may change. It is therefore possible that, after calling this function, the object(s) returned by previous call(s) to `krpc_SpaceCenter_ActiveVessel()` no longer refer to the active vessel.

```
krpc_error_t krpc_SpaceCenter_DockingPort_ReengageDistance (krpc_connection_t con-
                                                            nection, float * result)
```

The distance a docking port must move away when it undocks before it becomes ready to dock with another port, in meters.

```
krpc_error_t krpc_SpaceCenter_DockingPort_HasShield (krpc_connection_t connection,
                                                       bool * result)
```

Whether the docking port has a shield.

```
krpc_error_t krpc_SpaceCenter_DockingPort_Shielded (krpc_connection_t connection,
                                                      bool * result)
```

```
void krpc_SpaceCenter_DockingPort_set_Shielded (bool value)
```

The state of the docking ports shield, if it has one.

Returns `true` if the docking port has a shield, and the shield is closed. Otherwise returns `false`. When set to `true`, the shield is closed, and when set to `false` the shield is opened. If the docking port does not have a shield, setting this attribute has no effect.

```
krpc_error_t krpc_SpaceCenter_DockingPort_Position (krpc_connection_t connection,
                                                     krpc_tuple_double_double_double_t
                                                     * result,
                                                     krpc_SpaceCenter_ReferenceFrame_t ref-
                                                     erenceFrame)
```

The position of the docking port, in the given reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned position vector is in.

Returns The position as a vector.

krpc_error_t **krpc_SpaceCenter_DockingPort_Direction** (*krpc_connection_t* *connection*,
krpc_tuple_double_double_double_t
* *result*,
krpc_SpaceCenter_ReferenceFrame_t *referenceFrame*)

The direction that docking port points in, in the given reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

krpc_error_t **krpc_SpaceCenter_DockingPort_Rotation** (*krpc_connection_t* *connection*,
krpc_tuple_double_double_double_double_t
* *result*,
krpc_SpaceCenter_ReferenceFrame_t *referenceFrame*)

The rotation of the docking port, in the given reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned rotation is in.

Returns The rotation as a quaternion of the form (x, y, z, w) .

krpc_error_t **krpc_SpaceCenter_DockingPort_ReferenceFrame** (*krpc_connection_t* *connection*,
krpc_SpaceCenter_ReferenceFrame_t
* *result*)

The reference frame that is fixed relative to this docking port, and oriented with the port.

- The origin is at the position of the docking port.
- The axes rotate with the docking port.
- The x-axis points out to the right side of the docking port.
- The y-axis points in the direction the docking port is facing.
- The z-axis points out of the bottom off the docking port.

Note: This reference frame is not necessarily equivalent to the reference frame for the part, returned by *krpc_SpaceCenter_Part_ReferenceFrame()*.

krpc_SpaceCenter_DockingPortState_t

The state of a docking port. See *krpc_SpaceCenter_DockingPort_State()*.

KRPC_SPACECENTER_DOCKINGPORTSTATE_READY

The docking port is ready to dock to another docking port.

KRPC_SPACECENTER_DOCKINGPORTSTATE_DOCKED

The docking port is docked to another docking port, or docked to another part (from the VAB/SPH).

KRPC_SPACECENTER_DOCKINGPORTSTATE_DOCKING

The docking port is very close to another docking port, but has not docked. It is using magnetic force to acquire a solid dock.

KRPC_SPACECENTER_DOCKINGPORTSTATE_UNDOCKING

The docking port has just been undocked from another docking port, and is disabled until it moves away by a sufficient distance (*krpc_SpaceCenter_DockingPort_ReengageDistance()*).



Fig. 3.8: Docking port reference frame origin and axes

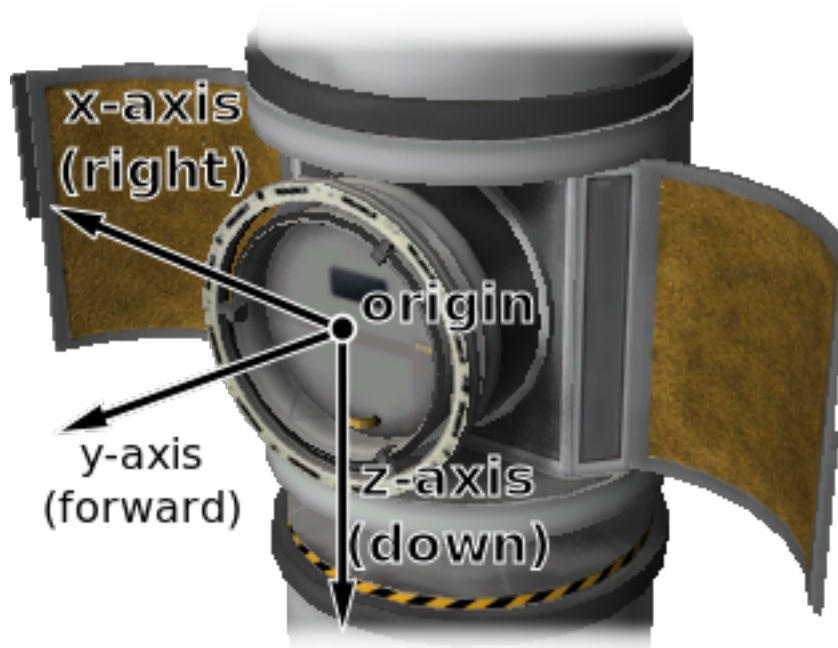


Fig. 3.9: Inline docking port reference frame origin and axes

KRPC_SPACECENTER_DOCKINGPORTSTATE_SHIELDED

The docking port has a shield, and the shield is closed.

KRPC_SPACECENTER_DOCKINGPORTSTATE_MOVING

The docking ports shield is currently opening/closing.

Engine

krpc_SpaceCenter_Engine_t

An engine, including ones of various types. For example liquid fuelled gimballed engines, solid rocket boosters and jet engines. Obtained by calling *krpc_SpaceCenter_Part_Engine()*.

Note: For RCS thrusters *krpc_SpaceCenter_Part_RCS()*.

krpc_error_t **krpc_SpaceCenter_Engine_Part** (*krpc_connection_t* *connection*,
krpc_SpaceCenter_Part_t * *result*)

The part object for this engine.

krpc_error_t **krpc_SpaceCenter_Engine_Active** (*krpc_connection_t* *connection*, *bool* * *result*)

void **krpc_SpaceCenter_Engine_set_Active** (*bool* *value*)

Whether the engine is active. Setting this attribute may have no effect, depending on *krpc_SpaceCenter_Engine_CanShutdown()* and *krpc_SpaceCenter_Engine_CanRestart()*.

krpc_error_t **krpc_SpaceCenter_Engine_Thrust** (*krpc_connection_t* *connection*, *float* * *result*)

The current amount of thrust being produced by the engine, in Newtons.

krpc_error_t **krpc_SpaceCenter_Engine_AvailableThrust** (*krpc_connection_t* *connection*,
float * *result*)

The amount of thrust, in Newtons, that would be produced by the engine when activated and with its throttle set to 100%. Returns zero if the engine does not have any fuel. Takes the engine's current *krpc_SpaceCenter_Engine_ThrustLimit()* and atmospheric conditions into account.

krpc_error_t **krpc_SpaceCenter_Engine_MaxThrust** (*krpc_connection_t* *connection*, *float* * *result*)

The amount of thrust, in Newtons, that would be produced by the engine when activated and fueled, with its throttle and throttle limiter set to 100%.

krpc_error_t **krpc_SpaceCenter_Engine_MaxVacuumThrust** (*krpc_connection_t* *connection*,
float * *result*)

The maximum amount of thrust that can be produced by the engine in a vacuum, in Newtons. This is the amount of thrust produced by the engine when activated, *krpc_SpaceCenter_Engine_ThrustLimit()* is set to 100%, the main vessel's throttle is set to 100% and the engine is in a vacuum.

krpc_error_t **krpc_SpaceCenter_Engine_ThrustLimit** (*krpc_connection_t* *connection*, *float*
* *result*)

void **krpc_SpaceCenter_Engine_set_ThrustLimit** (*float* *value*)

The thrust limiter of the engine. A value between 0 and 1. Setting this attribute may have no effect, for example the thrust limit for a solid rocket booster cannot be changed in flight.

krpc_error_t **krpc_SpaceCenter_Engine_Thrusters** (*krpc_connection_t* *connection*,
krpc_list_object_t * *result*)

The components of the engine that generate thrust.

Note: For example, this corresponds to the rocket nozzle on a solid rocket booster, or the individual nozzles on a RAPIER engine. The overall thrust produced by the engine, as reported by `krpc_SpaceCenter_Engine_AvailableThrust()`, `krpc_SpaceCenter_Engine_MaxThrust()` and others, is the sum of the thrust generated by each thruster.

`krpc_error_t krpc_SpaceCenter_Engine_SpecificImpulse` (`krpc_connection_t connection`,
float * *result*)

The current specific impulse of the engine, in seconds. Returns zero if the engine is not active.

`krpc_error_t krpc_SpaceCenter_Engine_VacuumSpecificImpulse` (`krpc_connection_t connection`, float * *result*)

The vacuum specific impulse of the engine, in seconds.

`krpc_error_t krpc_SpaceCenter_Engine_KerbinSeaLevelSpecificImpulse` (`krpc_connection_t connection`,
float
* *result*)

The specific impulse of the engine at sea level on Kerbin, in seconds.

`krpc_error_t krpc_SpaceCenter_Engine_PropellantNames` (`krpc_connection_t connection`,
krpc_list_string_t * *result*)

The names of the propellants that the engine consumes.

`krpc_error_t krpc_SpaceCenter_Engine_PropellantRatios` (`krpc_connection_t connection`,
krpc_dictionary_string_float_t
* *result*)

The ratio of resources that the engine consumes. A dictionary mapping resource names to the ratio at which they are consumed by the engine.

Note: For example, if the ratios are 0.6 for LiquidFuel and 0.4 for Oxidizer, then for every 0.6 units of LiquidFuel that the engine burns, it will burn 0.4 units of Oxidizer.

`krpc_error_t krpc_SpaceCenter_Engine_Propellants` (`krpc_connection_t connection`,
krpc_list_object_t * *result*)

The propellants that the engine consumes.

`krpc_error_t krpc_SpaceCenter_Engine_HasFuel` (`krpc_connection_t connection`, bool * *result*)

Whether the engine has any fuel available.

Note: The engine must be activated for this property to update correctly.

`krpc_error_t krpc_SpaceCenter_Engine_Throttle` (`krpc_connection_t connection`, float * *result*)

The current throttle setting for the engine. A value between 0 and 1. This is not necessarily the same as the vessel's main throttle setting, as some engines take time to adjust their throttle (such as jet engines).

`krpc_error_t krpc_SpaceCenter_Engine_ThrottleLocked` (`krpc_connection_t connection`,
bool * *result*)

Whether the `krpc_SpaceCenter_Control_Throttle()` affects the engine. For example, this is `true` for liquid fueled rockets, and `false` for solid rocket boosters.

`krpc_error_t krpc_SpaceCenter_Engine_CanRestart` (`krpc_connection_t connection`, bool
* *result*)

Whether the engine can be restarted once shutdown. If the engine cannot be shutdown, returns `false`.

For example, this is `true` for liquid fueled rockets and `false` for solid rocket boosters.

`krpc_error_t krpc_SpaceCenter_Engine_CanShutdown` (`krpc_connection_t connection`, `bool * result`)

Whether the engine can be shutdown once activated. For example, this is `true` for liquid fueled rockets and `false` for solid rocket boosters.

`krpc_error_t krpc_SpaceCenter_Engine_HasModes` (`krpc_connection_t connection`, `bool * result`)

Whether the engine has multiple modes of operation.

`krpc_error_t krpc_SpaceCenter_Engine_Mode` (`krpc_connection_t connection`, `char ** result`)

`void krpc_SpaceCenter_Engine_set_Mode` (`const char * value`)

The name of the current engine mode.

`krpc_error_t krpc_SpaceCenter_Engine_Modes` (`krpc_connection_t connection`, `krpc_dictionary_string_object_t * result`)

The available modes for the engine. A dictionary mapping mode names to `krpc_SpaceCenter_Engine_t` objects.

`krpc_error_t krpc_SpaceCenter_Engine_ToggleMode` (`krpc_connection_t connection`)

Toggle the current engine mode.

`krpc_error_t krpc_SpaceCenter_Engine_AutoModeSwitch` (`krpc_connection_t connection`, `bool * result`)

`void krpc_SpaceCenter_Engine_set_AutoModeSwitch` (`bool value`)

Whether the engine will automatically switch modes.

`krpc_error_t krpc_SpaceCenter_Engine_Gimballed` (`krpc_connection_t connection`, `bool * result`)

Whether the engine is gimbaled.

`krpc_error_t krpc_SpaceCenter_Engine_GimbalRange` (`krpc_connection_t connection`, `float * result`)

The range over which the gimbal can move, in degrees. Returns 0 if the engine is not gimbaled.

`krpc_error_t krpc_SpaceCenter_Engine_GimbalLocked` (`krpc_connection_t connection`, `bool * result`)

`void krpc_SpaceCenter_Engine_set_GimbalLocked` (`bool value`)

Whether the engines gimbal is locked in place. Setting this attribute has no effect if the engine is not gimbaled.

`krpc_error_t krpc_SpaceCenter_Engine_GimbalLimit` (`krpc_connection_t connection`, `float * result`)

`void krpc_SpaceCenter_Engine_set_GimbalLimit` (`float value`)

The gimbal limiter of the engine. A value between 0 and 1. Returns 0 if the gimbal is locked.

`krpc_error_t krpc_SpaceCenter_Engine_AvailableTorque` (`krpc_connection_t connection`, `krpc_tuple_tuple_double_double_double_tuple_double * result`)

The available torque, in Newton meters, that can be produced by this engine, in the positive and negative pitch, roll and yaw axes of the vessel. These axes correspond to the coordinate axes of the `krpc_SpaceCenter_Vessel_ReferenceFrame()`. Returns zero if the engine is inactive, or not gimbaled.

`krpc_SpaceCenter_Propellant_t`

A propellant for an engine. Obtains by calling `krpc_SpaceCenter_Engine_Propellants()`.

`krpc_error_t krpc_SpaceCenter_Propellant_Name` (`krpc_connection_t connection`, `char ** result`)

The name of the propellant.

krpc_error_t **krpc_SpaceCenter_Propellant_CurrentAmount** (*krpc_connection_t* *connection*, *double * result*)

The current amount of propellant.

krpc_error_t **krpc_SpaceCenter_Propellant_CurrentRequirement** (*krpc_connection_t* *connection*, *double * result*)

The required amount of propellant.

krpc_error_t **krpc_SpaceCenter_Propellant_TotalResourceAvailable** (*krpc_connection_t* *connection*, *double * result*)

The total amount of the underlying resource currently reachable given resource flow rules.

krpc_error_t **krpc_SpaceCenter_Propellant_TotalResourceCapacity** (*krpc_connection_t* *connection*, *double * result*)

The total vehicle capacity for the underlying propellant resource, restricted by resource flow rules.

krpc_error_t **krpc_SpaceCenter_Propellant_IgnoreForIsp** (*krpc_connection_t* *connection*, *bool * result*)

If this propellant should be ignored when calculating required mass flow given specific impulse.

krpc_error_t **krpc_SpaceCenter_Propellant_IgnoreForThrustCurve** (*krpc_connection_t* *connection*, *bool * result*)

If this propellant should be ignored for thrust curve calculations.

krpc_error_t **krpc_SpaceCenter_Propellant_DrawStackGauge** (*krpc_connection_t* *connection*, *bool * result*)

If this propellant has a stack gauge or not.

krpc_error_t **krpc_SpaceCenter_Propellant_IsDeprived** (*krpc_connection_t* *connection*, *bool * result*)

If this propellant is deprived.

krpc_error_t **krpc_SpaceCenter_Propellant_Ratio** (*krpc_connection_t* *connection*, *float * result*)

The propellant ratio.

Experiment

krpc_SpaceCenter_Experiment_t

Obtained by calling *krpc_SpaceCenter_Part_Experiment()*.

krpc_error_t **krpc_SpaceCenter_Experiment_Part** (*krpc_connection_t* *connection*, *krpc_SpaceCenter_Part_t * result*)

The part object for this experiment.

krpc_error_t **krpc_SpaceCenter_Experiment_Run** (*krpc_connection_t* *connection*)

Run the experiment.

krpc_error_t **krpc_SpaceCenter_Experiment_Transmit** (*krpc_connection_t* *connection*)

Transmit all experimental data contained by this part.

krpc_error_t **krpc_SpaceCenter_Experiment_Dump** (*krpc_connection_t* *connection*)

Dump the experimental data contained by the experiment.

krpc_error_t **krpc_SpaceCenter_Experiment_Reset** (*krpc_connection_t* *connection*)

Reset the experiment.

krpc_error_t **krpc_SpaceCenter_Experiment_Deployed** (*krpc_connection_t* *connection*, *bool* * *result*)

Whether the experiment has been deployed.

krpc_error_t **krpc_SpaceCenter_Experiment_Rerunnable** (*krpc_connection_t* *connection*, *bool* * *result*)

Whether the experiment can be re-run.

krpc_error_t **krpc_SpaceCenter_Experiment_Inoperable** (*krpc_connection_t* *connection*, *bool* * *result*)

Whether the experiment is inoperable.

krpc_error_t **krpc_SpaceCenter_Experiment_HasData** (*krpc_connection_t* *connection*, *bool* * *result*)

Whether the experiment contains data.

krpc_error_t **krpc_SpaceCenter_Experiment_Data** (*krpc_connection_t* *connection*, *krpc_list_object_t* * *result*)

The data contained in this experiment.

krpc_error_t **krpc_SpaceCenter_Experiment_Biome** (*krpc_connection_t* *connection*, *char* * * *result*)

The name of the biome the experiment is currently in.

krpc_error_t **krpc_SpaceCenter_Experiment_Available** (*krpc_connection_t* *connection*, *bool* * *result*)

Determines if the experiment is available given the current conditions.

krpc_error_t **krpc_SpaceCenter_Experiment_ScienceSubject** (*krpc_connection_t* *connection*, *krpc_SpaceCenter_ScienceSubject_t* * *result*)

Containing information on the corresponding specific science result for the current conditions. Returns `nullptr` if the experiment is unavailable.

krpc_SpaceCenter_ScienceData_t

Obtained by calling *krpc_SpaceCenter_Experiment_Data()*.

krpc_error_t **krpc_SpaceCenter_ScienceData_DataAmount** (*krpc_connection_t* *connection*, *float* * *result*)

Data amount.

krpc_error_t **krpc_SpaceCenter_ScienceData_ScienceValue** (*krpc_connection_t* *connection*, *float* * *result*)

Science value.

krpc_error_t **krpc_SpaceCenter_ScienceData_TransmitValue** (*krpc_connection_t* *connection*, *float* * *result*)

Transmit value.

krpc_SpaceCenter_ScienceSubject_t

Obtained by calling *krpc_SpaceCenter_Experiment_ScienceSubject()*.

krpc_error_t **krpc_SpaceCenter_ScienceSubject_Title** (*krpc_connection_t* *connection*, *char* * * *result*)

Title of science subject, displayed in science archives

krpc_error_t **krpc_SpaceCenter_ScienceSubject_IsComplete** (*krpc_connection_t* *connection*, *bool* * *result*)

Whether the experiment has been completed.

krpc_error_t **krpc_SpaceCenter_ScienceSubject_Science** (*krpc_connection_t* *connection*, *float* * *result*)

Amount of science already earned from this subject, not updated until after transmission/recovery.

krpc_error_t **krpc_SpaceCenter_ScienceSubject_ScienceCap** (*krpc_connection_t connection*, float * *result*)

Total science allowable for this subject.

krpc_error_t **krpc_SpaceCenter_ScienceSubject_DataScale** (*krpc_connection_t connection*, float * *result*)

Multiply science value by this to determine data amount in mits.

krpc_error_t **krpc_SpaceCenter_ScienceSubject_SubjectValue** (*krpc_connection_t connection*, float * *result*)

Multiplier for specific Celestial Body/Experiment Situation combination.

krpc_error_t **krpc_SpaceCenter_ScienceSubject_ScientificValue** (*krpc_connection_t connection*, float * *result*)

Diminishing value multiplier for decreasing the science value returned from repeated experiments.

Fairing

krpc_SpaceCenter_Fairing_t

A fairing. Obtained by calling *krpc_SpaceCenter_Part_Fairing()*.

krpc_error_t **krpc_SpaceCenter_Fairing_Part** (*krpc_connection_t connection*, *krpc_SpaceCenter_Part_t* * *result*)

The part object for this fairing.

krpc_error_t **krpc_SpaceCenter_Fairing_Jettison** (*krpc_connection_t connection*)

Jettison the fairing. Has no effect if it has already been jettisoned.

krpc_error_t **krpc_SpaceCenter_Fairing_Jettisoned** (*krpc_connection_t connection*, bool * *result*)

Whether the fairing has been jettisoned.

Intake

krpc_SpaceCenter_Intake_t

An air intake. Obtained by calling *krpc_SpaceCenter_Part_Intake()*.

krpc_error_t **krpc_SpaceCenter_Intake_Part** (*krpc_connection_t connection*, *krpc_SpaceCenter_Part_t* * *result*)

The part object for this intake.

krpc_error_t **krpc_SpaceCenter_Intake_Open** (*krpc_connection_t connection*, bool * *result*)

void **krpc_SpaceCenter_Intake_set_Open** (bool *value*)

Whether the intake is open.

krpc_error_t **krpc_SpaceCenter_Intake_Speed** (*krpc_connection_t connection*, float * *result*)

Speed of the flow into the intake, in *m/s*.

krpc_error_t **krpc_SpaceCenter_Intake_Flow** (*krpc_connection_t connection*, float * *result*)

The rate of flow into the intake, in units of resource per second.

krpc_error_t **krpc_SpaceCenter_Intake_Area** (*krpc_connection_t connection*, float * *result*)

The area of the intake's opening, in square meters.

Leg

krpc_SpaceCenter_Leg_t

A landing leg. Obtained by calling *krpc_SpaceCenter_Part_Leg()*.

krpc_error_t **krpc_SpaceCenter_Leg_Part** (*krpc_connection_t* *connection*,
krpc_SpaceCenter_Part_t * *result*)

The part object for this landing leg.

krpc_error_t **krpc_SpaceCenter_Leg_State** (*krpc_connection_t* *connection*,
krpc_SpaceCenter_LegState_t * *result*)

The current state of the landing leg.

krpc_error_t **krpc_SpaceCenter_Leg_Deployable** (*krpc_connection_t* *connection*, *bool* * *result*)

Whether the leg is deployable.

krpc_error_t **krpc_SpaceCenter_Leg_Deployed** (*krpc_connection_t* *connection*, *bool* * *result*)

void **krpc_SpaceCenter_Leg_set_Deployed** (*bool* *value*)

Whether the landing leg is deployed.

Note: Fixed landing legs are always deployed. Returns an error if you try to deploy fixed landing gear.

krpc_error_t **krpc_SpaceCenter_Leg_IsGrounded** (*krpc_connection_t* *connection*, *bool* * *result*)

Returns whether the leg is touching the ground.

krpc_SpaceCenter_LegState_t

The state of a landing leg. See *krpc_SpaceCenter_Leg_State()*.

KRPC_SPACECENTER_LEGSTATE_DEPLOYED

Landing leg is fully deployed.

KRPC_SPACECENTER_LEGSTATE_RETRACTED

Landing leg is fully retracted.

KRPC_SPACECENTER_LEGSTATE_DEPLOYING

Landing leg is being deployed.

KRPC_SPACECENTER_LEGSTATE_RETRACTING

Landing leg is being retracted.

KRPC_SPACECENTER_LEGSTATE_BROKEN

Landing leg is broken.

Launch Clamp

krpc_SpaceCenter_LaunchClamp_t

A launch clamp. Obtained by calling *krpc_SpaceCenter_Part_LaunchClamp()*.

krpc_error_t **krpc_SpaceCenter_LaunchClamp_Part** (*krpc_connection_t* *connection*,
krpc_SpaceCenter_Part_t * *result*)

The part object for this launch clamp.

krpc_error_t **krpc_SpaceCenter_LaunchClamp_Release** (*krpc_connection_t* *connection*)

Releases the docking clamp. Has no effect if the clamp has already been released.

Light

krpc_SpaceCenter_Light_t

A light. Obtained by calling *krpc_SpaceCenter_Part_Light()*.

krpc_error_t **krpc_SpaceCenter_Light_Part** (*krpc_connection_t* *connection*,
krpc_SpaceCenter_Part_t * *result*)

The part object for this light.

krpc_error_t **krpc_SpaceCenter_Light_Active** (*krpc_connection_t* *connection*, *bool* * *result*)

void **krpc_SpaceCenter_Light_set_Active** (*bool* *value*)

Whether the light is switched on.

krpc_error_t **krpc_SpaceCenter_Light_Color** (*krpc_connection_t* *connection*,
krpc_tuple_float_float_float_t * *result*)

void **krpc_SpaceCenter_Light_set_Color** (*const* *krpc_tuple_float_float_float_t* * *value*)

The color of the light, as an RGB triple.

krpc_error_t **krpc_SpaceCenter_Light_PowerUsage** (*krpc_connection_t* *connection*, *float* * *result*)

The current power usage, in units of charge per second.

Parachute

krpc_SpaceCenter_Parachute_t

A parachute. Obtained by calling *krpc_SpaceCenter_Part_Parachute()*.

krpc_error_t **krpc_SpaceCenter_Parachute_Part** (*krpc_connection_t* *connection*,
krpc_SpaceCenter_Part_t * *result*)

The part object for this parachute.

krpc_error_t **krpc_SpaceCenter_Parachute_Deploy** (*krpc_connection_t* *connection*)

Deploys the parachute. This has no effect if the parachute has already been deployed.

krpc_error_t **krpc_SpaceCenter_Parachute_Deployed** (*krpc_connection_t* *connection*, *bool* * *result*)

Whether the parachute has been deployed.

krpc_error_t **krpc_SpaceCenter_Parachute_Arm** (*krpc_connection_t* *connection*)

Deploys the parachute. This has no effect if the parachute has already been armed or deployed. Only applicable to RealChutes parachutes.

krpc_error_t **krpc_SpaceCenter_Parachute_Armed** (*krpc_connection_t* *connection*, *bool* * *result*)

Whether the parachute has been armed or deployed. Only applicable to RealChutes parachutes.

krpc_error_t **krpc_SpaceCenter_Parachute_State** (*krpc_connection_t* *connection*,
krpc_SpaceCenter_ParachuteState_t * *result*)

The current state of the parachute.

krpc_error_t **krpc_SpaceCenter_Parachute_DeployAltitude** (*krpc_connection_t* *connection*, *float* * *result*)

void **krpc_SpaceCenter_Parachute_set_DeployAltitude** (*float* *value*)

The altitude at which the parachute will full deploy, in meters. Only applicable to stock parachutes.

krpc_error_t **krpc_SpaceCenter_Parachute_DeployMinPressure** (*krpc_connection_t* *connection*, *float* * *result*)

void **krpc_SpaceCenter_Parachute_set_DeployMinPressure** (float *value*)

The minimum pressure at which the parachute will semi-deploy, in atmospheres. Only applicable to stock parachutes.

krpc_SpaceCenter_ParachuteState_t

The state of a parachute. See *krpc_SpaceCenter_Parachute_State()*.

KRPC_SPACECENTER_PARACHUTESTATE_STOWED

The parachute is safely tucked away inside its housing.

KRPC_SPACECENTER_PARACHUTESTATE_ARMED

The parachute is armed for deployment. (RealChutes only)

KRPC_SPACECENTER_PARACHUTESTATE_ACTIVE

The parachute is still stowed, but ready to semi-deploy. (Stock parachutes only)

KRPC_SPACECENTER_PARACHUTESTATE_SEMIDEPLOYED

The parachute has been deployed and is providing some drag, but is not fully deployed yet. (Stock parachutes only)

KRPC_SPACECENTER_PARACHUTESTATE_DEPLOYED

The parachute is fully deployed.

KRPC_SPACECENTER_PARACHUTESTATE_CUT

The parachute has been cut.

Radiator

krpc_SpaceCenter_Radiator_t

A radiator. Obtained by calling *krpc_SpaceCenter_Part_Radiator()*.

krpc_error_t **krpc_SpaceCenter_Radiator_Part** (krpc_connection_t *connection*,
krpc_SpaceCenter_Part_t * *result*)

The part object for this radiator.

krpc_error_t **krpc_SpaceCenter_Radiator_Deployable** (krpc_connection_t *connection*, bool
* *result*)

Whether the radiator is deployable.

krpc_error_t **krpc_SpaceCenter_Radiator_Deployed** (krpc_connection_t *connection*, bool
* *result*)

void **krpc_SpaceCenter_Radiator_set_Deployed** (bool *value*)

For a deployable radiator, `true` if the radiator is extended. If the radiator is not deployable, this is always `true`.

krpc_error_t **krpc_SpaceCenter_Radiator_State** (krpc_connection_t *connection*,
krpc_SpaceCenter_RadiatorState_t * *result*)

The current state of the radiator.

Note: A fixed radiator is always *KRPC_SPACECENTER_RADIATORSTATE_EXTENDED*.

krpc_SpaceCenter_RadiatorState_t

The state of a radiator. *krpc_SpaceCenter_RadiatorState_t*

KRPC_SPACECENTER_RADIATORSTATE_EXTENDED

Radiator is fully extended.

KRPC_SPACECENTER_RADIATORSTATE_RETRACTED

Radiator is fully retracted.

KRPC_SPACECENTER_RADIATORSTATE_EXTENDING

Radiator is being extended.

KRPC_SPACECENTER_RADIATORSTATE_RETRACTING

Radiator is being retracted.

KRPC_SPACECENTER_RADIATORSTATE_BROKEN

Radiator is being broken.

Resource Converter

krpc_SpaceCenter_ResourceConverter_t

A resource converter. Obtained by calling *krpc_SpaceCenter_Part_ResourceConverter()*.

krpc_error_t **krpc_SpaceCenter_ResourceConverter_Part** (*krpc_connection_t connection*,
*krpc_SpaceCenter_Part_t * result*)

The part object for this converter.

krpc_error_t **krpc_SpaceCenter_ResourceConverter_Count** (*krpc_connection_t connection*,
*int32_t * result*)

The number of converters in the part.

krpc_error_t **krpc_SpaceCenter_ResourceConverter_Name** (*krpc_connection_t connection*,
*char ** result*, *int32_t index*)

The name of the specified converter.

Parameters

- **index** – Index of the converter.

krpc_error_t **krpc_SpaceCenter_ResourceConverter_Active** (*krpc_connection_t connection*, *bool * result*,
int32_t index)

True if the specified converter is active.

Parameters

- **index** – Index of the converter.

krpc_error_t **krpc_SpaceCenter_ResourceConverter_Start** (*krpc_connection_t connection*,
int32_t index)

Start the specified converter.

Parameters

- **index** – Index of the converter.

krpc_error_t **krpc_SpaceCenter_ResourceConverter_Stop** (*krpc_connection_t connection*,
int32_t index)

Stop the specified converter.

Parameters

- **index** – Index of the converter.

krpc_error_t **krpc_SpaceCenter_ResourceConverter_State** (*krpc_connection_t connection*,
*krpc_SpaceCenter_ResourceConverterState_t * result*, *int32_t index*)

The state of the specified converter.

Parameters

- **index** – Index of the converter.

krpc_error_t **krpc_SpaceCenter_ResourceConverter_StatusInfo** (*krpc_connection_t* *connection*, *char* * * *result*, *int32_t* *index*)

Status information for the specified converter. This is the full status message shown in the in-game UI.

Parameters

- **index** – Index of the converter.

krpc_error_t **krpc_SpaceCenter_ResourceConverter_Inputs** (*krpc_connection_t* *connection*, *krpc_list_string_t* * *result*, *int32_t* *index*)

List of the names of resources consumed by the specified converter.

Parameters

- **index** – Index of the converter.

krpc_error_t **krpc_SpaceCenter_ResourceConverter_Outputs** (*krpc_connection_t* *connection*, *krpc_list_string_t* * *result*, *int32_t* *index*)

List of the names of resources produced by the specified converter.

Parameters

- **index** – Index of the converter.

krpc_SpaceCenter_ResourceConverterState_t

The state of a resource converter. See *krpc_SpaceCenter_ResourceConverter_State()*.

KRPC_SPACECENTER_RESOURCECONVERTERSTATE_RUNNING

Converter is running.

KRPC_SPACECENTER_RESOURCECONVERTERSTATE_IDLE

Converter is idle.

KRPC_SPACECENTER_RESOURCECONVERTERSTATE_MISSINGRESOURCE

Converter is missing a required resource.

KRPC_SPACECENTER_RESOURCECONVERTERSTATE_STORAGEFULL

No available storage for output resource.

KRPC_SPACECENTER_RESOURCECONVERTERSTATE_CAPACITY

At preset resource capacity.

KRPC_SPACECENTER_RESOURCECONVERTERSTATE_UNKNOWN

Unknown state. Possible with modified resource converters. In this case, check *krpc_SpaceCenter_ResourceConverter_StatusInfo()* for more information.

Resource Harvester

krpc_SpaceCenter_ResourceHarvester_t

A resource harvester (drill). Obtained by calling *krpc_SpaceCenter_Part_ResourceHarvester()*.

krpc_error_t **krpc_SpaceCenter_ResourceHarvester_Part** (*krpc_connection_t* *connection*, *krpc_SpaceCenter_Part_t* * *result*)

The part object for this harvester.

krpc_error_t **krpc_SpaceCenter_ResourceHarvester_State** (*krpc_connection_t* *connection*,
krpc_SpaceCenter_ResourceHarvesterState_t
** result*)

The state of the harvester.

krpc_error_t **krpc_SpaceCenter_ResourceHarvester_Deployed** (*krpc_connection_t* *con-*
nection, *bool * result*)

void **krpc_SpaceCenter_ResourceHarvester_set_Deployed** (*bool value*)

Whether the harvester is deployed.

krpc_error_t **krpc_SpaceCenter_ResourceHarvester_Active** (*krpc_connection_t* *connec-*
tion, *bool * result*)

void **krpc_SpaceCenter_ResourceHarvester_set_Active** (*bool value*)

Whether the harvester is actively drilling.

krpc_error_t **krpc_SpaceCenter_ResourceHarvester_ExtractionRate** (*krpc_connection_t* *con-*
nection, *float*
** result*)

The rate at which the drill is extracting ore, in units per second.

krpc_error_t **krpc_SpaceCenter_ResourceHarvester_ThermalEfficiency** (*krpc_connection_t* *con-*
nection,
*float * re-*
sult)

The thermal efficiency of the drill, as a percentage of its maximum.

krpc_error_t **krpc_SpaceCenter_ResourceHarvester_CoreTemperature** (*krpc_connection_t* *con-*
nection, *float*
** result*)

The core temperature of the drill, in Kelvin.

krpc_error_t **krpc_SpaceCenter_ResourceHarvester_OptimumCoreTemperature** (*krpc_connection_t* *con-*
nec-
tion,
float
** re-*
sult)

The core temperature at which the drill will operate with peak efficiency, in Kelvin.

krpc_SpaceCenter_ResourceHarvesterState_t

The state of a resource harvester. See *krpc_SpaceCenter_ResourceHarvester_State()*.

KRPC_SPACECENTER_RESOURCEHARVESTERSTATE_DEPLOYING

The drill is deploying.

KRPC_SPACECENTER_RESOURCEHARVESTERSTATE_DEPLOYED

The drill is deployed and ready.

KRPC_SPACECENTER_RESOURCEHARVESTERSTATE_RETRACTING

The drill is retracting.

KRPC_SPACECENTER_RESOURCEHARVESTERSTATE_RETRACTED

The drill is retracted.

KRPC_SPACECENTER_RESOURCEHARVESTERSTATE_ACTIVE

The drill is running.

Reaction Wheel

krpc_SpaceCenter_ReactionWheel_t

A reaction wheel. Obtained by calling *krpc_SpaceCenter_Part_ReactionWheel()*.

krpc_error_t **krpc_SpaceCenter_ReactionWheel_Part** (*krpc_connection_t* *connection*,
krpc_SpaceCenter_Part_t * *result*)

The part object for this reaction wheel.

krpc_error_t **krpc_SpaceCenter_ReactionWheel_Active** (*krpc_connection_t* *connection*,
bool * *result*)

void **krpc_SpaceCenter_ReactionWheel_set_Active** (bool *value*)

Whether the reaction wheel is active.

krpc_error_t **krpc_SpaceCenter_ReactionWheel_Broken** (*krpc_connection_t* *connection*,
bool * *result*)

Whether the reaction wheel is broken.

krpc_error_t **krpc_SpaceCenter_ReactionWheel_AvailableTorque** (*krpc_connection_t* *con-*
nection,
krpc_tuple_tuple_double_double_double_tuple
* *result*)

The available torque, in Newton meters, that can be produced by this reaction wheel, in the positive and negative pitch, roll and yaw axes of the vessel. These axes correspond to the coordinate axes of the *krpc_SpaceCenter_Vessel_ReferenceFrame()*. Returns zero if the reaction wheel is inactive or broken.

krpc_error_t **krpc_SpaceCenter_ReactionWheel_MaxTorque** (*krpc_connection_t* *connection*,
krpc_tuple_tuple_double_double_double_tuple_double
* *result*)

The maximum torque, in Newton meters, that can be produced by this reaction wheel, when it is active, in the positive and negative pitch, roll and yaw axes of the vessel. These axes correspond to the coordinate axes of the *krpc_SpaceCenter_Vessel_ReferenceFrame()*.

RCS

krpc_SpaceCenter_RCS_t

An RCS block or thruster. Obtained by calling *krpc_SpaceCenter_Part_RCS()*.

krpc_error_t **krpc_SpaceCenter_RCS_Part** (*krpc_connection_t* *connection*,
krpc_SpaceCenter_Part_t * *result*)

The part object for this RCS.

krpc_error_t **krpc_SpaceCenter_RCS_Active** (*krpc_connection_t* *connection*, bool * *result*)

Whether the RCS thrusters are active. An RCS thruster is inactive if the RCS action group is disabled (*krpc_SpaceCenter_Control_RCS()*), the RCS thruster itself is not enabled (*krpc_SpaceCenter_RCS_Enabled()*) or it is covered by a fairing (*krpc_SpaceCenter_Part_Shielded()*).

krpc_error_t **krpc_SpaceCenter_RCS_Enabled** (*krpc_connection_t* *connection*, bool * *result*)

void **krpc_SpaceCenter_RCS_set_Enabled** (bool *value*)

Whether the RCS thrusters are enabled.

krpc_error_t **krpc_SpaceCenter_RCS_PitchEnabled** (*krpc_connection_t* *connection*, bool * *re-*
sult)

void **krpc_SpaceCenter_RCS_set_PitchEnabled** (bool *value*)

Whether the RCS thruster will fire when pitch control input is given.

krpc_error_t **krpc_SpaceCenter_RCS_YawEnabled** (*krpc_connection_t connection*, *bool * result*)

void **krpc_SpaceCenter_RCS_set_YawEnabled** (*bool value*)
Whether the RCS thruster will fire when yaw control input is given.

krpc_error_t **krpc_SpaceCenter_RCS_RollEnabled** (*krpc_connection_t connection*, *bool * result*)

void **krpc_SpaceCenter_RCS_set_RollEnabled** (*bool value*)
Whether the RCS thruster will fire when roll control input is given.

krpc_error_t **krpc_SpaceCenter_RCS_ForwardEnabled** (*krpc_connection_t connection*, *bool * result*)

void **krpc_SpaceCenter_RCS_set_ForwardEnabled** (*bool value*)
Whether the RCS thruster will fire when pitch control input is given.

krpc_error_t **krpc_SpaceCenter_RCS_UpEnabled** (*krpc_connection_t connection*, *bool * result*)

void **krpc_SpaceCenter_RCS_set_UpEnabled** (*bool value*)
Whether the RCS thruster will fire when yaw control input is given.

krpc_error_t **krpc_SpaceCenter_RCS_RightEnabled** (*krpc_connection_t connection*, *bool * result*)

void **krpc_SpaceCenter_RCS_set_RightEnabled** (*bool value*)
Whether the RCS thruster will fire when roll control input is given.

krpc_error_t **krpc_SpaceCenter_RCS_AvailableTorque** (*krpc_connection_t connection*,
*krpc_tuple_tuple_double_double_double_tuple_double_double_double * result*)

The available torque, in Newton meters, that can be produced by this RCS, in the positive and negative pitch, roll and yaw axes of the vessel. These axes correspond to the coordinate axes of the *krpc_SpaceCenter_Vessel_ReferenceFrame()*. Returns zero if RCS is disable.

krpc_error_t **krpc_SpaceCenter_RCS_MaxThrust** (*krpc_connection_t connection*, *float * result*)

The maximum amount of thrust that can be produced by the RCS thrusters when active, in Newtons.

krpc_error_t **krpc_SpaceCenter_RCS_MaxVacuumThrust** (*krpc_connection_t connection*, *float * result*)

The maximum amount of thrust that can be produced by the RCS thrusters when active in a vacuum, in Newtons.

krpc_error_t **krpc_SpaceCenter_RCS_Thrusters** (*krpc_connection_t connection*,
*krpc_list_object_t * result*)

A list of thrusters, one of each nozzle in the RCS part.

krpc_error_t **krpc_SpaceCenter_RCS_SpecificImpulse** (*krpc_connection_t connection*, *float * result*)

The current specific impulse of the RCS, in seconds. Returns zero if the RCS is not active.

krpc_error_t **krpc_SpaceCenter_RCS_VacuumSpecificImpulse** (*krpc_connection_t connection*, *float * result*)

The vacuum specific impulse of the RCS, in seconds.

krpc_error_t **krpc_SpaceCenter_RCS_KerbinSeaLevelSpecificImpulse** (*krpc_connection_t connection*, *float * result*)

The specific impulse of the RCS at sea level on Kerbin, in seconds.

krpc_error_t **krpc_SpaceCenter_RCS_Propellants** (*krpc_connection_t connection*,
*krpc_list_string_t * result*)

The names of resources that the RCS consumes.

krpc_error_t **krpc_SpaceCenter_RCS_PropellantRatios** (*krpc_connection_t connection,*
krpc_dictionary_string_float_t
** result*)

The ratios of resources that the RCS consumes. A dictionary mapping resource names to the ratios at which they are consumed by the RCS.

krpc_error_t **krpc_SpaceCenter_RCS_HasFuel** (*krpc_connection_t connection,* *bool * result*)
 Whether the RCS has fuel available.

Note: The RCS thruster must be activated for this property to update correctly.

Sensor

krpc_SpaceCenter_Sensor_t

A sensor, such as a thermometer. Obtained by calling *krpc_SpaceCenter_Part_Sensor()*.

krpc_error_t **krpc_SpaceCenter_Sensor_Part** (*krpc_connection_t connection,*
*krpc_SpaceCenter_Part_t * result*)

The part object for this sensor.

krpc_error_t **krpc_SpaceCenter_Sensor_Active** (*krpc_connection_t connection,* *bool * result*)

void **krpc_SpaceCenter_Sensor_set_Active** (*bool value*)

Whether the sensor is active.

krpc_error_t **krpc_SpaceCenter_Sensor_Value** (*krpc_connection_t connection,* *char ** result*)
 The current value of the sensor.

Solar Panel

krpc_SpaceCenter_SolarPanel_t

A solar panel. Obtained by calling *krpc_SpaceCenter_Part_SolarPanel()*.

krpc_error_t **krpc_SpaceCenter_SolarPanel_Part** (*krpc_connection_t connection,*
*krpc_SpaceCenter_Part_t * result*)

The part object for this solar panel.

krpc_error_t **krpc_SpaceCenter_SolarPanel_Deployable** (*krpc_connection_t connection,*
*bool * result*)

Whether the solar panel is deployable.

krpc_error_t **krpc_SpaceCenter_SolarPanel_Deployed** (*krpc_connection_t connection,* *bool*
** result*)

void **krpc_SpaceCenter_SolarPanel_set_Deployed** (*bool value*)

Whether the solar panel is extended.

krpc_error_t **krpc_SpaceCenter_SolarPanel_State** (*krpc_connection_t connection,*
krpc_SpaceCenter_SolarPanelState_t
** result*)

The current state of the solar panel.

krpc_error_t **krpc_SpaceCenter_SolarPanel_EnergyFlow** (*krpc_connection_t connection,*
*float * result*)

The current amount of energy being generated by the solar panel, in units of charge per second.

```
krpc_error_t krpc_SpaceCenter_SolarPanel_SunExposure (krpc_connection_t connection,
                                                         float * result)
```

The current amount of sunlight that is incident on the solar panel, as a percentage. A value between 0 and 1.

krpc_SpaceCenter_SolarPanelState_t

The state of a solar panel. See *krpc_SpaceCenter_SolarPanel_State()*.

KRPC_SPACECENTER_SOLARPANELSTATE_EXTENDED

Solar panel is fully extended.

KRPC_SPACECENTER_SOLARPANELSTATE_RETRACTED

Solar panel is fully retracted.

KRPC_SPACECENTER_SOLARPANELSTATE_EXTENDING

Solar panel is being extended.

KRPC_SPACECENTER_SOLARPANELSTATE_RETRACTING

Solar panel is being retracted.

KRPC_SPACECENTER_SOLARPANELSTATE_BROKEN

Solar panel is broken.

Thrusters

krpc_SpaceCenter_Thruster_t

The component of an *krpc_SpaceCenter_Engine_t* or *krpc_SpaceCenter_RCS_t* part that generates thrust. Can be obtained by calling *krpc_SpaceCenter_Engine_Thrusters()* or *krpc_SpaceCenter_RCS_Thrusters()*.

Note: Engines can consist of multiple thrusters. For example, the S3 KS-25x4 “Mammoth” has four rocket nozzles, and so consists of four thrusters.

```
krpc_error_t krpc_SpaceCenter_Thruster_Part (krpc_connection_t connection,
                                                         krpc_SpaceCenter_Part_t * result)
```

The *krpc_SpaceCenter_Part_t* that contains this thruster.

```
krpc_error_t krpc_SpaceCenter_Thruster_ThrustPosition (krpc_connection_t connection,
                                                         krpc_tuple_double_double_double_t
                                                         * result,
                                                         krpc_SpaceCenter_ReferenceFrame_t referenceFrame)
```

The position at which the thruster generates thrust, in the given reference frame. For gimbaled engines, this takes into account the current rotation of the gimbal.

Parameters

- **referenceFrame** – The reference frame that the returned position vector is in.

Returns The position as a vector.

```
krpc_error_t krpc_SpaceCenter_Thruster_ThrustDirection (krpc_connection_t connection,
                                                         krpc_tuple_double_double_double_t
                                                         * result,
                                                         krpc_SpaceCenter_ReferenceFrame_t referenceFrame)
```

The direction of the force generated by the thruster, in the given reference frame. This is opposite to the

direction in which the thruster expels propellant. For gimballed engines, this takes into account the current rotation of the gimbal.

Parameters

- **referenceFrame** – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

```
krpc_error_t krpc_SpaceCenter_Thruster_ThrustReferenceFrame (krpc_connection_t con-  
                                                             nection,  
                                                             krpc_SpaceCenter_ReferenceFrame_t  
                                                             * result)
```

A reference frame that is fixed relative to the thruster and orientated with its thrust direction (*krpc_SpaceCenter_Thruster_ThrustDirection()*). For gimballed engines, this takes into account the current rotation of the gimbal.

- The origin is at the position of thrust for this thruster (*krpc_SpaceCenter_Thruster_ThrustPosition()*).
- The axes rotate with the thrust direction. This is the direction in which the thruster expels propellant, including any gimbaling.
- The y-axis points along the thrust direction.
- The x-axis and z-axis are perpendicular to the thrust direction.

```
krpc_error_t krpc_SpaceCenter_Thruster_Gimballed (krpc_connection_t connection, bool  
                                                             * result)
```

Whether the thruster is gimballed.

```
krpc_error_t krpc_SpaceCenter_Thruster_GimbalPosition (krpc_connection_t connection,  
                                                         krpc_tuple_double_double_double_t  
                                                         * result,  
                                                         krpc_SpaceCenter_ReferenceFrame_t ref-  
                                                         erenceFrame)
```

Position around which the gimbal pivots.

Parameters

- **referenceFrame** – The reference frame that the returned position vector is in.

Returns The position as a vector.

```
krpc_error_t krpc_SpaceCenter_Thruster_GimbalAngle (krpc_connection_t connection,  
                                                         krpc_tuple_double_double_double_t  
                                                         * result)
```

The current gimbal angle in the pitch, roll and yaw axes, in degrees.

```
krpc_error_t krpc_SpaceCenter_Thruster_InitialThrustPosition (krpc_connection_t con-  
                                                             nection,  
                                                             krpc_tuple_double_double_double_t  
                                                             * result,  
                                                             krpc_SpaceCenter_ReferenceFrame_t ref-  
                                                             erenceFrame)
```

The position at which the thruster generates thrust, when the engine is in its initial position (no gimbaling), in the given reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned position vector is in.

Returns The position as a vector.

Note: This position can move when the gimbal rotates. This is because the thrust position and gimbal position are not necessarily the same.

krpc_error_t **krpc_SpaceCenter_Thruster_InitialThrustDirection** (*krpc_connection_t* *connection*,
krpc_tuple_double_double_double_t
** result*,
krpc_SpaceCenter_ReferenceFrame_t *referenceFrame*)

The direction of the force generated by the thruster, when the engine is in its initial position (no gimballing), in the given reference frame. This is opposite to the direction in which the thruster expels propellant.

Parameters

- **referenceFrame** – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

Wheel

krpc_SpaceCenter_Wheel_t

A wheel. Includes landing gear and rover wheels. Obtained by calling *krpc_SpaceCenter_Part_Wheel()*. Can be used to control the motors, steering and deployment of wheels, among other things.

krpc_error_t **krpc_SpaceCenter_Wheel_Part** (*krpc_connection_t* *connection*,
krpc_SpaceCenter_Part_t * *result*)

The part object for this wheel.

krpc_error_t **krpc_SpaceCenter_Wheel_State** (*krpc_connection_t* *connection*,
krpc_SpaceCenter_WheelState_t * *result*)

The current state of the wheel.

krpc_error_t **krpc_SpaceCenter_Wheel_Radius** (*krpc_connection_t* *connection*, float * *result*)

Radius of the wheel, in meters.

krpc_error_t **krpc_SpaceCenter_Wheel_Grounded** (*krpc_connection_t* *connection*, bool * *result*)

Whether the wheel is touching the ground.

krpc_error_t **krpc_SpaceCenter_Wheel_HasBrakes** (*krpc_connection_t* *connection*, bool * *result*)

Whether the wheel has brakes.

krpc_error_t **krpc_SpaceCenter_Wheel_Brakes** (*krpc_connection_t* *connection*, float * *result*)

void **krpc_SpaceCenter_Wheel_set_Brakes** (float *value*)

The braking force, as a percentage of maximum, when the brakes are applied.

krpc_error_t **krpc_SpaceCenter_Wheel_AutoFrictionControl** (*krpc_connection_t* *connection*, bool * *result*)

void **krpc_SpaceCenter_Wheel_set_AutoFrictionControl** (bool *value*)

Whether automatic friction control is enabled.

krpc_error_t **krpc_SpaceCenter_Wheel_ManualFrictionControl** (*krpc_connection_t* *connection*, float * *result*)

void **krpc_SpaceCenter_Wheel_set_ManualFrictionControl** (float *value*)
Manual friction control value. Only has an effect if automatic friction control is disabled. A value between 0 and 5 inclusive.

krpc_error_t **krpc_SpaceCenter_Wheel_Deployable** (*krpc_connection_t connection*, bool * *result*)
Whether the wheel is deployable.

krpc_error_t **krpc_SpaceCenter_Wheel_Deployed** (*krpc_connection_t connection*, bool * *result*)

void **krpc_SpaceCenter_Wheel_set_Deployed** (bool *value*)
Whether the wheel is deployed.

krpc_error_t **krpc_SpaceCenter_Wheel_Powered** (*krpc_connection_t connection*, bool * *result*)
Whether the wheel is powered by a motor.

krpc_error_t **krpc_SpaceCenter_Wheel_MotorEnabled** (*krpc_connection_t connection*, bool * *result*)

void **krpc_SpaceCenter_Wheel_set_MotorEnabled** (bool *value*)
Whether the motor is enabled.

krpc_error_t **krpc_SpaceCenter_Wheel_MotorInverted** (*krpc_connection_t connection*, bool * *result*)

void **krpc_SpaceCenter_Wheel_set_MotorInverted** (bool *value*)
Whether the direction of the motor is inverted.

krpc_error_t **krpc_SpaceCenter_Wheel_MotorState** (*krpc_connection_t connection*, *krpc_SpaceCenter_MotorState_t* * *result*)
Whether the direction of the motor is inverted.

krpc_error_t **krpc_SpaceCenter_Wheel_MotorOutput** (*krpc_connection_t connection*, float * *result*)
The output of the motor. This is the torque currently being generated, in Newton meters.

krpc_error_t **krpc_SpaceCenter_Wheel_TractionControlEnabled** (*krpc_connection_t connection*, bool * *result*)

void **krpc_SpaceCenter_Wheel_set_TractionControlEnabled** (bool *value*)
Whether automatic traction control is enabled. A wheel only has traction control if it is powered.

krpc_error_t **krpc_SpaceCenter_Wheel_TractionControl** (*krpc_connection_t connection*, float * *result*)

void **krpc_SpaceCenter_Wheel_set_TractionControl** (float *value*)
Setting for the traction control. Only takes effect if the wheel has automatic traction control enabled. A value between 0 and 5 inclusive.

krpc_error_t **krpc_SpaceCenter_Wheel_DriveLimiter** (*krpc_connection_t connection*, float * *result*)

void **krpc_SpaceCenter_Wheel_set_DriveLimiter** (float *value*)
Manual setting for the motor limiter. Only takes effect if the wheel has automatic traction control disabled. A value between 0 and 100 inclusive.

krpc_error_t **krpc_SpaceCenter_Wheel_Steerable** (*krpc_connection_t connection*, bool * *result*)
Whether the wheel has steering.

krpc_error_t **krpc_SpaceCenter_Wheel_SteeringEnabled** (*krpc_connection_t connection*, bool * *result*)

void **krpc_SpaceCenter_Wheel_set_SteeringEnabled** (bool *value*)
Whether the wheel steering is enabled.

krpc_error_t **krpc_SpaceCenter_Wheel_SteeringInverted** (*krpc_connection_t* *connection*,
bool * *result*)

void **krpc_SpaceCenter_Wheel_set_SteeringInverted** (bool *value*)
Whether the wheel steering is inverted.

krpc_error_t **krpc_SpaceCenter_Wheel_HasSuspension** (*krpc_connection_t* *connection*, bool
* *result*)
Whether the wheel has suspension.

krpc_error_t **krpc_SpaceCenter_Wheel_SuspensionSpringStrength** (*krpc_connection_t* *con-*
nection, float
* *result*)
Suspension spring strength, as set in the editor.

krpc_error_t **krpc_SpaceCenter_Wheel_SuspensionDamperStrength** (*krpc_connection_t* *con-*
nection, float
* *result*)
Suspension damper strength, as set in the editor.

krpc_error_t **krpc_SpaceCenter_Wheel_Broken** (*krpc_connection_t* *connection*, bool * *result*)
Whether the wheel is broken.

krpc_error_t **krpc_SpaceCenter_Wheel_Repairable** (*krpc_connection_t* *connection*, bool * *re-*
sult)
Whether the wheel is repairable.

krpc_error_t **krpc_SpaceCenter_Wheel_Stress** (*krpc_connection_t* *connection*, float * *result*)
Current stress on the wheel.

krpc_error_t **krpc_SpaceCenter_Wheel_StressTolerance** (*krpc_connection_t* *connection*,
float * *result*)
Stress tolerance of the wheel.

krpc_error_t **krpc_SpaceCenter_Wheel_StressPercentage** (*krpc_connection_t* *connection*,
float * *result*)
Current stress on the wheel as a percentage of its stress tolerance.

krpc_error_t **krpc_SpaceCenter_Wheel_Deflection** (*krpc_connection_t* *connection*, float * *re-*
sult)
Current deflection of the wheel.

krpc_error_t **krpc_SpaceCenter_Wheel_Slip** (*krpc_connection_t* *connection*, float * *result*)
Current slip of the wheel.

krpc_SpaceCenter_WheelState_t
The state of a wheel. See *krpc_SpaceCenter_Wheel_State()*.

KRPC_SPACECENTER_WHEELSTATE_DEPLOYED
Wheel is fully deployed.

KRPC_SPACECENTER_WHEELSTATE_RETRACTED
Wheel is fully retracted.

KRPC_SPACECENTER_WHEELSTATE_DEPLOYING
Wheel is being deployed.

KRPC_SPACECENTER_WHEELSTATE_RETRACTING
Wheel is being retracted.

KRPC_SPACECENTER_WHEELSTATE_BROKEN
Wheel is broken.

krpc_SpaceCenter_MotorState_t

The state of the motor on a powered wheel. See *krpc_SpaceCenter_Wheel_MotorState()*.

KRPC_SPACECENTER_MOTORSTATE_IDLE

The motor is idle.

KRPC_SPACECENTER_MOTORSTATE_RUNNING

The motor is running.

KRPC_SPACECENTER_MOTORSTATE_DISABLED

The motor is disabled.

KRPC_SPACECENTER_MOTORSTATE_INOPERABLE

The motor is inoperable.

KRPC_SPACECENTER_MOTORSTATE_NOTENOUGHRESOURCES

The motor does not have enough resources to run.

Trees of Parts

Vessels in KSP are comprised of a number of parts, connected to one another in a *tree* structure. An example vessel is shown in Figure 1, and the corresponding tree of parts in Figure 2. The craft file for this example can also be downloaded [here](#).

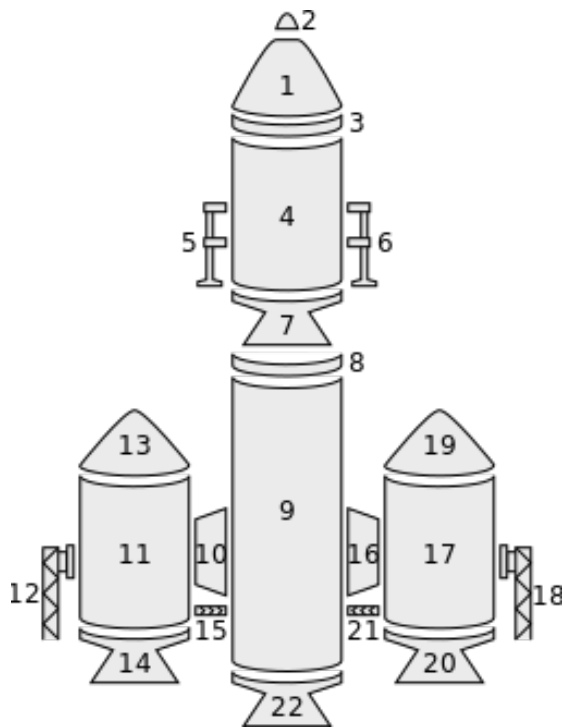


Fig. 3.10: **Figure 1** – Example parts making up a vessel.

Traversing the Tree

The tree of parts can be traversed using the attributes *krpc_SpaceCenter_Parts_Root()*, *krpc_SpaceCenter_Part_Parent()* and *krpc_SpaceCenter_Part_Children()*.

The root of the tree is the same as the vessels *root part* (part number 1 in the example above) and can be obtained by calling *krpc_SpaceCenter_Parts_Root()*. A parts children can be obtained by calling *krpc_SpaceCenter_Part_Children()*.

If the part does not have any children, *krpc_SpaceCenter_Part_Children()* returns an empty list. A parts parent can be obtained by calling *krpc_SpaceCenter_Part_Parent()*. If the part does not have a parent (as is the case for the root part), *krpc_SpaceCenter_Part_Parent()* returns *nullptr*.

The following Cnano example uses these attributes to perform a depth-first traversal over all of the parts in a vessel:

```
#include <krpc.h>
#include <krpc/servi

int main() {
    krpc_connection_t
    krpc_open(&conn, "
    krpc_connect(conn,
    krpc_SpaceCenter_V
    krpc_
    kSpaceCenter_Active
```

```
krpc_SpaceCenter_P
krpc_SpaceCenter_
↪Vessel_Parts(conn,
krpc_SpaceCenter_P
krpc_
↪SpaceCenter_Parts_

typedef struct {
krpc_SpaceCenter
int depth;
} StackEntry;
StackEntry stack[2
int stackPtr = 0;
stack[stackPtr].pa
stack[stackPtr].de

while (stackPtr >=
krpc_SpaceCenter
↪Part_t part = stac
int depth = stac
stackPtr--; //
char * title = N
krpc_
↪SpaceCenter_Part_T
for (int i = 0;
printf(" ");
printf("%s\n", t

krpc_
↪list_object_t chil
krpc_SpaceCenter
↪Part_Children(conn

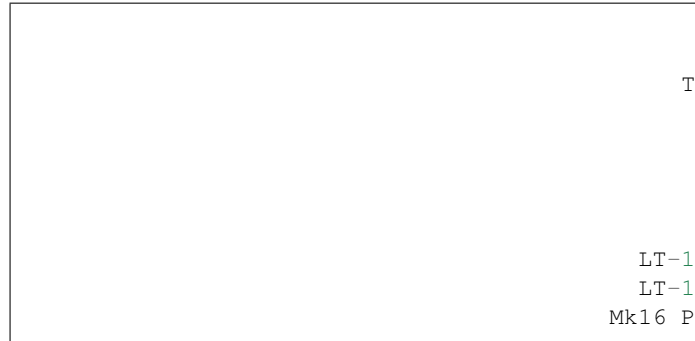
↪for (size_t i = 0;
// Push onto t
stackPtr++;

↪ stack[stackPtr]
stack[stackPtr

}
}
}
```

When this code is execute using the craft file for the example vessel pictured above, the following is printed out:

```
Command Pod Mk1
TR-18A Stack Decoup
FL-T400 Fuel Tank
LV-909 Liquid Fue
TR-18A Stack Dec
FL-T800 Fuel Ta
LV-909 Liquid
TT-70 Radial D
FL-T400 Fuel
TT18-A Launc
FTX-2 Extern
```



LV-909 Liqui
Aerodynamic
TT-70 Radial D
FL-T400 Fuel
TT18-A Launc
FTX-2 Extern
LV-909 Liqui
Aerodynamic
LT-1 Landing Stru
LT-1 Landing Stru
Mk16 Parachute

Attachment Modes

Parts can be attached to other parts either *radially* (on the side of the parent part) or *axially* (on the end of the parent part, to form a stack).

For example, in the vessel pictured above, the parachute (part 2) is *axially* connected to its parent (the command pod – part 1), and the landing leg (part 5) is *radially* connected to its parent (the fuel tank – part 4).

1), and the landing leg (part 5) is *radially* connected to its parent (the fuel tank – part 4).

The root part of a vessel (for example the command pod – part 1) does not have a parent part, so does not have an attachment mode. However, the part is consider to be *axially* attached to nothing.

The following Cnano example does a depth-first traversal as before, but also prints out the attachment mode used by the part:

```
#include <krpc.h>
#include <krpc/services/space_center.h>

int main() {
    krpc_connection_t conn;
    krpc_open(&conn, "COM0");
    krpc_
    ↪connect(conn, "InfernalRobotics Example");

    krpc_SpaceCenter_Vessel_t vessel;
    krpc_
    ↪SpaceCenter_ActiveVessel(conn, &vessel);

    krpc_SpaceCenter_Parts_t parts;
    krpc_SpaceCenter_
    ↪Vessel_Parts(conn, &parts, vessel);
    krpc_SpaceCenter_Part_t root;
    krpc_
    ↪SpaceCenter_Parts_Root(conn, &root, parts);

    typedef struct {
        krpc_SpaceCenter_Part_t part;
        int depth;
    } StackEntry;
    StackEntry stack[256];
    int stackPtr = 0;
    stack[stackPtr].part = root;
```

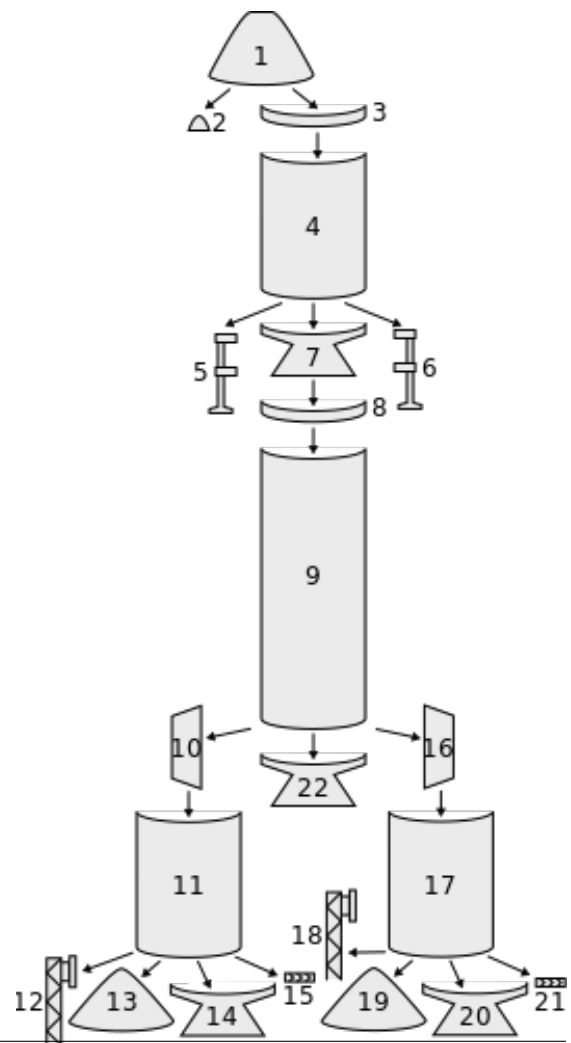


Fig. 3.11: **Figure 2** – Tree of parts for the vessel in Figure 1. Arrows point from the parent part to the child part.

```

stack[stackPtr].depth = 0;

while (stackPtr >= 0) {
    krpc_SpaceCenter_
    ↪Part_t part = stack[stackPtr].part;
    int depth = stack[stackPtr].depth;
    stackPtr--; // Pop the stack
    bool axially_attached;

    ↪
    ↪ krpc_SpaceCenter_Part_AxiallyAttached(conn,
    ↪ &axially_attached, part);
    const char * attach_mode ↪
    ↪= axially_attached ? "axial" : "radial";
    char * title = NULL;
    krpc_
    ↪SpaceCenter_Part_Title(conn, &title, part);
    for (int i = 0; i < depth; i++)
        printf(" ");
    printf("%s - %s\n", title, attach_mode);

    krpc_
    ↪list_object_t children = KRPC_NULL_LIST;
    krpc_SpaceCenter_
    ↪Part_Children(conn, &children, part);

    ↪
    ↪for (size_t i = 0; i < children.size; i++) {
    ↪    // Push onto the stack
    ↪    stackPtr++;

    ↪
    ↪    stack[stackPtr].part = children.items[i];
    ↪    stack[stackPtr].depth = depth+1;
    ↪}
    ↪}
}

```

When this code is execute using the craft file for the example vessel pictured above, the following is printed out:

```

Command Pod Mk1 - axial
TR-18A Stack Decoupler - axial
FL-T400 Fuel Tank - axial
LV-909 Liquid Fuel Engine - axial
TR-18A Stack Decoupler - axial
FL-T800 Fuel Tank - axial
LV-909 Liquid Fuel Engine - axial
TT-70 Radial Decoupler - radial
FL-T400 Fuel Tank - radial

↪
↪ TT18-A Launch Stability Enhancer - radial
↪   FTX-2 External Fuel Duct - radial
↪   LV-909 Liquid Fuel Engine - axial
↪   Aerodynamic Nose Cone - axial
↪   TT-70 Radial Decoupler - radial
↪   FL-T400 Fuel Tank - radial

↪
↪ TT18-A Launch Stability Enhancer - radial
↪   FTX-2 External Fuel Duct - radial
↪   LV-909 Liquid Fuel Engine - axial

```

```

Aerodynamic Nose Cone - axial
LT-1 Landing Struts - radial
LT-1 Landing Struts - radial
Mk16 Parachute - axial

```

Fuel Lines

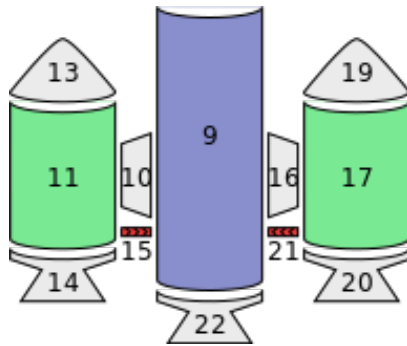


Fig. 3.12: **Figure 5** – Fuel lines from the example in Figure 1. Fuel flows from the parts highlighted in green, into the part highlighted in blue.

Fuel lines are considered parts, and are included in the parts tree (for example, as pictured in Figure 4). However, the parts tree does not contain information about which parts fuel lines connect to. The parent part of a fuel line is the part from which it will take fuel (as shown in Figure 4) however the part that it will send fuel to is not represented in the parts tree.

Figure 5 shows the fuel lines from the example vessel pictured earlier. Fuel line part 15 (in red) takes fuel from a fuel tank (part 11 – in green) and feeds it into another fuel tank (part 9 – in blue). The fuel line is therefore a child of part 11, but its connection to part 9 is not represented in the tree.

The attributes `krpc_SpaceCenter_Part_FuelLinesFrom()` and `krpc_SpaceCenter_Part_FuelLinesTo()` can be used to discover these connections. In the example in Figure 5, when `krpc_SpaceCenter_Part_FuelLinesTo()` is called on fuel tank part 11, it will return a list of parts containing just fuel tank part 9 (the blue part). When `krpc_SpaceCenter_Part_FuelLinesFrom()` is called on fuel tank part 9, it will return a list containing fuel tank parts 11 and 17 (the parts colored green).

Staging

Each part has two staging numbers associated with it: the stage in which the part is *activated* and the stage in which the part is *decoupled*. These values can be obtained using `krpc_SpaceCenter_Part_Stage()` and `krpc_SpaceCenter_Part_DecoupleStage()` respectively. For parts that are not activated by staging, `krpc_SpaceCenter_Part_Stage()` returns -1. For parts that

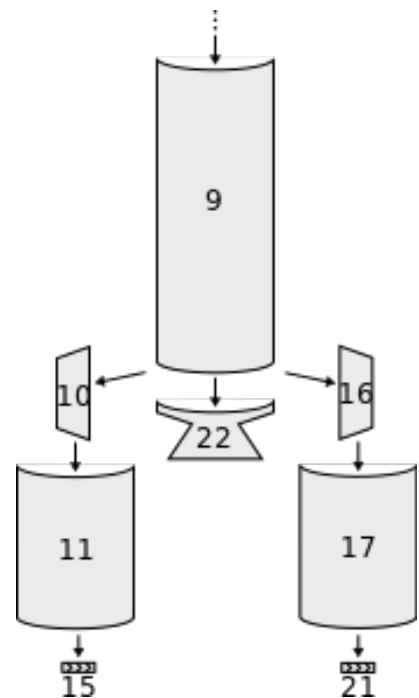


Fig. 3.13: **Figure 4** – A subset of the parts tree from Figure 2 above.

are never decoupled, `krpc_SpaceCenter_Part_DecoupleStage()` returns a value of -1.

Figure 6 shows an example staging sequence for a vessel. Figure 7 shows the stages in which each part of the vessel will be *activated*. Figure 8 shows the stages in which each part of the vessel will be *decoupled*.

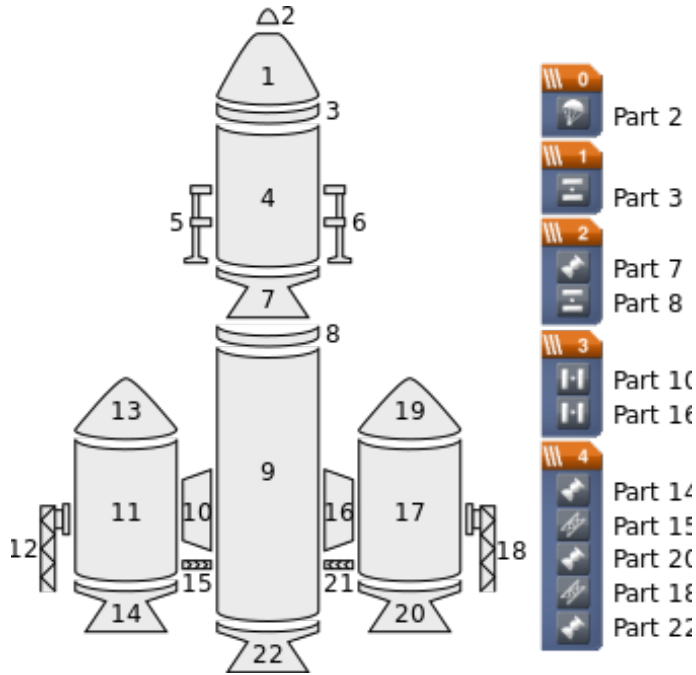


Fig. 3.14: **Figure 6** – Example vessel from Figure 1 with a staging sequence.

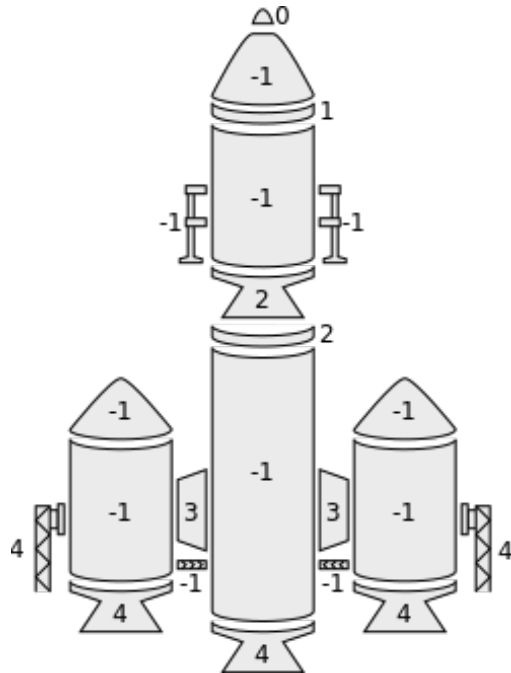


Fig. 3.15: **Figure 7** – The stage in which each part is *activated*.

3.3.9 Resources

krpc_SpaceCenter_Resources_t

Represents the collection of re-sources stored in a vessel, stage or part. Created by calling `krpc_SpaceCenter_Vessel_Resources()`, `krpc_SpaceCenter_Vessel_ResourcesInDecoupleStage()` or `krpc_SpaceCenter_Part_Resources()`.

krpc_error_t krpc_SpaceCenter_Resources_All (krpc_connection_t connection, krpc_list_object_t * result)

All the individual resources that can be stored.

krpc_error_t krpc_SpaceCenter_Resources_WithResource (krpc_connection_t connection, krpc_list_object_t * result, const char * name)

All the individual resources with the given name that can be stored.

Parameters

krpc_error_t krpc_SpaceCenter_Resources_Names (krpc_connection_t connection, krpc_list_string_t * result)

A list of resource names that can be stored.

krpc_error_t krpc_SpaceCenter_Resources_HasResource (krpc_connection_t connection, bool * result, const char * name)

Check whether the named resource can be stored.

Parameters

- **name** – The name of the resource.

krpc_error_t krpc_SpaceCenter_Resources_Amount (krpc_connection_t connection, float * result, const char * name)

Returns the amount of a resource that is currently stored.

Parameters

- **name** – The name of the resource.

krpc_error_t krpc_SpaceCenter_Resources_Max (krpc_connection_t connection, float * result, const char * name)

Returns the amount of a resource that can be stored.

Parameters

- **name** – The name of the resource.

krpc_error_t krpc_SpaceCenter_Resources_Density (krpc_connection_t connection, float * result, const char * name)

Returns the density of a resource, in *kg/l*.

Parameters

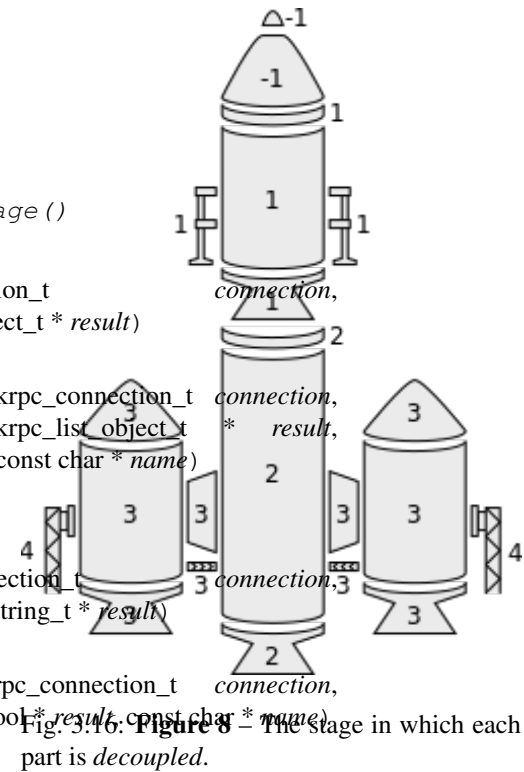
- **name** – The name of the resource.

krpc_error_t krpc_SpaceCenter_Resources_FlowMode (krpc_connection_t connection, krpc_SpaceCenter_ResourceFlowMode_t * result, const char * name)

Returns the flow mode of a resource.

Parameters

- **name** – The name of the resource.



```
krpc_error_t krpc_SpaceCenter_Resources_Enabled (krpc_connection_t connection, bool
* result)
```

```
void krpc_SpaceCenter_Resources_set_Enabled (bool value)
```

Whether use of all the resources are enabled.

Note: This is `true` if all of the resources are enabled. If any of the resources are not enabled, this is `false`.

krpc_SpaceCenter_Resource_t

An individual resource stored within a part. Created using methods in the *krpc_SpaceCenter_Resources_t* class.

```
krpc_error_t krpc_SpaceCenter_Resource_Name (krpc_connection_t connection, char * * re-
* sult)
```

The name of the resource.

```
krpc_error_t krpc_SpaceCenter_Resource_Part (krpc_connection_t connection,
* krpc_SpaceCenter_Part_t * result)
```

The part containing the resource.

```
krpc_error_t krpc_SpaceCenter_Resource_Amount (krpc_connection_t connection, float * re-
* sult)
```

The amount of the resource that is currently stored in the part.

```
krpc_error_t krpc_SpaceCenter_Resource_Max (krpc_connection_t connection, float * result)
```

The total amount of the resource that can be stored in the part.

```
krpc_error_t krpc_SpaceCenter_Resource_Density (krpc_connection_t connection, float * re-
* sult)
```

The density of the resource, in *kg/l*.

```
krpc_error_t krpc_SpaceCenter_Resource_FlowMode (krpc_connection_t connection,
* krpc_SpaceCenter_ResourceFlowMode_t
* result)
```

The flow mode of the resource.

```
krpc_error_t krpc_SpaceCenter_Resource_Enabled (krpc_connection_t connection, bool * re-
* sult)
```

```
void krpc_SpaceCenter_Resource_set_Enabled (bool value)
```

Whether use of this resource is enabled.

krpc_SpaceCenter_ResourceTransfer_t

Transfer resources between parts.

```
krpc_error_t krpc_SpaceCenter_ResourceTransfer_Start (krpc_connection_t connection,
* krpc_SpaceCenter_ResourceTransfer_t
* result,
* krpc_SpaceCenter_Part_t fromPart,
* krpc_SpaceCenter_Part_t toPart,
const char * resource, float max-
* Amount)
```

Start transferring a resource transfer between a pair of parts. The transfer will move at most *maxAmount* units of the resource, depending on how much of the resource is available in the source part and how much storage is available in the destination part. Use *krpc_SpaceCenter_ResourceTransfer_Complete()* to check if the transfer is complete. Use

krpc_SpaceCenter_ResourceTransfer_Amount()
to see how much of the resource has been transferred.

Parameters

- **fromPart** – The part to transfer to.
- **toPart** – The part to transfer from.
- **resource** – The name of the resource to transfer.
- **maxAmount** – The maximum amount of resource to transfer.

krpc_error_t **krpc_SpaceCenter_ResourceTransfer_Amount** (*krpc_connection_t* *connection*,
float * *result*)

The amount of the resource that has been transferred.

krpc_error_t **krpc_SpaceCenter_ResourceTransfer_Complete** (*krpc_connection_t* *connection*,
bool * *result*)

Whether the transfer has completed.

krpc_SpaceCenter_ResourceFlowMode_t

The way in which a resource flows between parts. See
krpc_SpaceCenter_Resources_FlowMode().

KRPC_SPACECENTER_RESOURCEFLOWMODE_VESSEL

The resource flows to any part in the vessel. For example, electric charge.

KRPC_SPACECENTER_RESOURCEFLOWMODE_STAGE

The resource flows from parts in the first stage, followed by the second, and so on. For example, mono-propellant.

KRPC_SPACECENTER_RESOURCEFLOWMODE_ADJACENT

The resource flows between adjacent parts within the vessel. For example, liquid fuel or oxidizer.

KRPC_SPACECENTER_RESOURCEFLOWMODE_NONE

The resource does not flow. For example, solid fuel.

3.3.10 Node

krpc_SpaceCenter_Node_t

Represents a maneuver node. Can be created using
krpc_SpaceCenter_Control_AddNode().

krpc_error_t **krpc_SpaceCenter_Node_Prograde** (*krpc_connection_t* *connection*, double * *result*)

void **krpc_SpaceCenter_Node_set_Prograde** (double *value*)
The magnitude of the maneuver nodes delta-v in the prograde direction, in meters per second.

krpc_error_t **krpc_SpaceCenter_Node_Normal** (*krpc_connection_t* *connection*, double * *result*)

void **krpc_SpaceCenter_Node_set_Normal** (double *value*)
The magnitude of the maneuver nodes delta-v in the normal direction, in meters per second.

krpc_error_t **krpc_SpaceCenter_Node_Radial** (*krpc_connection_t* *connection*, double * *result*)

void **krpc_SpaceCenter_Node_set_Radial** (double *value*)
The magnitude of the maneuver nodes delta-v in the radial direction,
in meters per second.

krpc_error_t **krpc_SpaceCenter_Node_DeltaV** (*krpc_connection_t connection*, double * *result*)

void **krpc_SpaceCenter_Node_set_DeltaV** (double *value*)
The delta-v of the maneuver node, in meters per second.

Note: Does not change when executing the maneuver node. See
krpc_SpaceCenter_Node_RemainingDeltaV().

krpc_error_t **krpc_SpaceCenter_Node_RemainingDeltaV** (*krpc_connection_t connection*,
double * *result*)
Gets the remaining delta-v of the maneuver node, in meters per
second. Changes as the node is executed. This is equivalent to the
delta-v reported in-game.

krpc_error_t **krpc_SpaceCenter_Node_BurnVector** (*krpc_connection_t connection*,
krpc_tuple_double_double_double_t * *re-*
sult, *krpc_SpaceCenter_ReferenceFrame_t ref-*
erenceFrame)
Returns the burn vector for the maneuver node.

Parameters

- **referenceFrame** – The reference
frame that the returned vector
is in. Defaults to *krpc_SpaceCenter_Vessel_OrbitalReferenceFrame()*.

Returns A vector whose direction is the direction of the maneuver node
burn, and magnitude is the delta-v of the burn in meters per second.

Note: Does not change when executing the maneuver node. See
krpc_SpaceCenter_Node_RemainingBurnVector().

krpc_error_t **krpc_SpaceCenter_Node_RemainingBurnVector** (*krpc_connection_t con-*
nection,
krpc_tuple_double_double_double_t
* *result*,
krpc_SpaceCenter_ReferenceFrame_t ref-
erenceFrame)

Returns the remaining burn vector for the maneuver node.

Parameters

- **referenceFrame** – The reference
frame that the returned vector
is in. Defaults to *krpc_SpaceCenter_Vessel_OrbitalReferenceFrame()*.

Returns A vector whose direction is the direction of the maneuver node
burn, and magnitude is the delta-v of the burn in meters per second.

Note: Changes as the maneuver node is executed. See
krpc_SpaceCenter_Node_BurnVector().

krpc_error_t **krpc_SpaceCenter_Node_UT** (*krpc_connection_t connection*, *double * result*)

void **krpc_SpaceCenter_Node_set_UT** (*double value*)

The universal time at which the maneuver will occur, in seconds.

krpc_error_t **krpc_SpaceCenter_Node_TimeTo** (*krpc_connection_t connection*, *double * result*)

The time until the maneuver node will be encountered, in seconds.

krpc_error_t **krpc_SpaceCenter_Node_Orbit** (*krpc_connection_t connection*,
*krpc_SpaceCenter_Orbit_t * result*)

The orbit that results from executing the maneuver node.

krpc_error_t **krpc_SpaceCenter_Node_Remove** (*krpc_connection_t connection*)

Removes the maneuver node.

krpc_error_t **krpc_SpaceCenter_Node_ReferenceFrame** (*krpc_connection_t connection*,
*krpc_SpaceCenter_ReferenceFrame_t * result*)

The reference frame that is fixed relative to the maneuver node's burn.

- The origin is at the position of the maneuver node.
- The y-axis points in the direction of the burn.
- The x-axis and z-axis point in arbitrary but fixed directions.

krpc_error_t **krpc_SpaceCenter_Node_OrbitalReferenceFrame** (*krpc_connection_t connection*,
*krpc_SpaceCenter_ReferenceFrame_t * result*)

The reference frame that is fixed relative to the maneuver node, and orientated with the orbital prograde/normal/radial directions of the original orbit at the maneuver node's position.

- The origin is at the position of the maneuver node.
- The x-axis points in the orbital anti-radial direction of the original orbit, at the position of the maneuver node.
- The y-axis points in the orbital prograde direction of the original orbit, at the position of the maneuver node.
- The z-axis points in the orbital normal direction of the original orbit, at the position of the maneuver node.

krpc_error_t **krpc_SpaceCenter_Node_Position** (*krpc_connection_t connection*,
*krpc_tuple_double_double_double_t * result*,
krpc_SpaceCenter_ReferenceFrame_t referenceFrame)

The position vector of the maneuver node in the given reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned position vector is in.

Returns The position as a vector.

```
krpc_error_t krpc_SpaceCenter_Node_Direction (krpc_connection_t connection,
krpc_tuple_double_double_double_t * result, krpc_SpaceCenter_ReferenceFrame_t ref-
erenceFrame)
```

The direction of the maneuver nodes burn.

Parameters

- **referenceFrame** – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

3.3.11 ReferenceFrame

krpc_SpaceCenter_ReferenceFrame_t

Represents a reference frame for positions, rotations and velocities.

Contains:

- The position of the origin.
- The directions of the x, y and z axes.
- The linear velocity of the frame.
- The angular velocity of the frame.

Note: This class does not contain any properties or methods. It is only used as a parameter to other functions.

```
krpc_error_t krpc_SpaceCenter_ReferenceFrame_CreateRelative (krpc_connection_t con-
nection,
krpc_SpaceCenter_ReferenceFrame_t
* result,
krpc_SpaceCenter_ReferenceFrame_t ref-
erenceFrame, const
krpc_tuple_double_double_double_t
* position, const
krpc_tuple_double_double_double_double_t
* rotation, const
krpc_tuple_double_double_double_t
* velocity, const
krpc_tuple_double_double_double_t
* angularVelocity)
```

Create a relative reference frame. This is a custom reference frame whose components offset the components of a parent reference frame.

Parameters

- **referenceFrame** – The parent reference frame on which to base this reference frame.
- **position** – The offset of the position of the origin, as a position vector. Defaults to (0, 0, 0)

- **rotation** – The rotation to apply to the parent frames rotation, as a quaternion of the form (x, y, z, w) . Defaults to $(0, 0, 0, 1)$ (i.e. no rotation)
- **velocity** – The linear velocity to offset the parent frame by, as a vector pointing in the direction of travel, whose magnitude is the speed in meters per second. Defaults to $(0, 0, 0)$.
- **angularVelocity** – The angular velocity to offset the parent frame by, as a vector. This vector points in the direction of the axis of rotation, and its magnitude is the speed of the rotation in radians per second. Defaults to $(0, 0, 0)$.

```
krpc_error_t krpc_SpaceCenter_ReferenceFrame_CreateHybrid (krpc_connection_t connection,
                                                           krpc_SpaceCenter_ReferenceFrame_t
                                                           * result,
                                                           krpc_SpaceCenter_ReferenceFrame_t position,
                                                           krpc_SpaceCenter_ReferenceFrame_t rotation,
                                                           krpc_SpaceCenter_ReferenceFrame_t velocity,
                                                           krpc_SpaceCenter_ReferenceFrame_t angularVelocity)
```

Create a hybrid reference frame. This is a custom reference frame whose components inherited from other reference frames.

Parameters

- **position** – The reference frame providing the position of the origin.
- **rotation** – The reference frame providing the rotation of the frame.
- **velocity** – The reference frame providing the linear velocity of the frame.
- **angularVelocity** – The reference frame providing the angular velocity of the frame.

Note: The *position* reference frame is required but all other reference frames are optional. If omitted, they are set to the *position* reference frame.

3.3.12 AutoPilot

krpc_SpaceCenter_AutoPilot_t

Provides basic auto-piloting utilities for a vessel. Created by calling `krpc_SpaceCenter_Vessel_AutoPilot()`.

Note: If a client engages the auto-pilot and then closes its connection to the server, the auto-pilot will be disengaged and its target reference frame, direction and roll reset to default.

krpc_error_t **krpc_SpaceCenter_AutoPilot_Engage** (*krpc_connection_t connection*)
Engage the auto-pilot.

krpc_error_t **krpc_SpaceCenter_AutoPilot_Disengage** (*krpc_connection_t connection*)
Disengage the auto-pilot.

krpc_error_t **krpc_SpaceCenter_AutoPilot_Wait** (*krpc_connection_t connection*)
Blocks until the vessel is pointing in the target direction and has the target roll (if set). Throws an exception if the auto-pilot has not been engaged.

krpc_error_t **krpc_SpaceCenter_AutoPilot_Error** (*krpc_connection_t connection*, float * *result*)
The error, in degrees, between the direction the ship has been asked to point in and the direction it is pointing in. Throws an exception if the auto-pilot has not been engaged and SAS is not enabled or is in stability assist mode.

krpc_error_t **krpc_SpaceCenter_AutoPilot_PitchError** (*krpc_connection_t connection*, float * *result*)
The error, in degrees, between the vessels current and target pitch. Throws an exception if the auto-pilot has not been engaged.

krpc_error_t **krpc_SpaceCenter_AutoPilot_HeadingError** (*krpc_connection_t connection*, float * *result*)
The error, in degrees, between the vessels current and target heading. Throws an exception if the auto-pilot has not been engaged.

krpc_error_t **krpc_SpaceCenter_AutoPilot_RollError** (*krpc_connection_t connection*, float * *result*)
The error, in degrees, between the vessels current and target roll. Throws an exception if the auto-pilot has not been engaged or no target roll is set.

krpc_error_t **krpc_SpaceCenter_AutoPilot_ReferenceFrame** (*krpc_connection_t connection*, *krpc_SpaceCenter_ReferenceFrame_t* * *result*)

void **krpc_SpaceCenter_AutoPilot_set_ReferenceFrame** (*krpc_SpaceCenter_ReferenceFrame_t value*)
The reference frame for the target direction (*krpc_SpaceCenter_AutoPilot_TargetDirection()*).

Note: An error will be thrown if this property is set to a reference frame that rotates with the vessel being controlled, as it is impossible to rotate the vessel in such a reference frame.

krpc_error_t **krpc_SpaceCenter_AutoPilot_TargetPitch** (*krpc_connection_t connection*, float * *result*)

void **krpc_SpaceCenter_AutoPilot_set_TargetPitch** (float *value*)
The target pitch, in degrees, between -90° and +90°.

krpc_error_t **krpc_SpaceCenter_AutoPilot_TargetHeading** (*krpc_connection_t connection*, float * *result*)

void **krpc_SpaceCenter_AutoPilot_set_TargetHeading** (float *value*)
The target heading, in degrees, between 0° and 360°.

krpc_error_t **krpc_SpaceCenter_AutoPilot_TargetRoll** (*krpc_connection_t* *connection*,
float * *result*)

void **krpc_SpaceCenter_AutoPilot_set_TargetRoll** (float *value*)

The target roll, in degrees. NaN if no target roll is set.

krpc_error_t **krpc_SpaceCenter_AutoPilot_TargetDirection** (*krpc_connection_t* *con-*
nection,
krpc_tuple_double_double_double_t
* *result*)

void **krpc_SpaceCenter_AutoPilot_set_TargetDirection** (const
krpc_tuple_double_double_double_t
* *value*)

Direction vector corresponding to the target pitch and heading. This is in the reference frame specified by *krpc_SpaceCenter_ReferenceFrame_t*.

krpc_error_t **krpc_SpaceCenter_AutoPilot_TargetPitchAndHeading** (*krpc_connection_t* *con-*
nection,
float *pitch*,
float *heading*)

Set target pitch and heading angles.

Parameters

- **pitch** – Target pitch angle, in degrees between -90° and +90°.
- **heading** – Target heading angle, in degrees between 0° and 360°.

krpc_error_t **krpc_SpaceCenter_AutoPilot_SAS** (*krpc_connection_t* *connection*, bool * *result*)

void **krpc_SpaceCenter_AutoPilot_set_SAS** (bool *value*)

The state of SAS.

Note: Equivalent to *krpc_SpaceCenter_Control_SAS()*

krpc_error_t **krpc_SpaceCenter_AutoPilot_SASMode** (*krpc_connection_t* *connection*,
krpc_SpaceCenter_SASMode_t * *re-*
sult)

void **krpc_SpaceCenter_AutoPilot_set_SASMode** (*krpc_SpaceCenter_SASMode_t* *value*)

The current *krpc_SpaceCenter_SASMode_t*. These modes are equivalent to the mode buttons to the left of the navball that appear when SAS is enabled.

Note: Equivalent to *krpc_SpaceCenter_Control_SASMode()*

krpc_error_t **krpc_SpaceCenter_AutoPilot_RollThreshold** (*krpc_connection_t* *connection*,
double * *result*)

void **krpc_SpaceCenter_AutoPilot_set_RollThreshold** (double *value*)

The threshold at which the autopilot will try to match the target roll angle, if any. Defaults to 5 degrees.

```
krpc_error_t krpc_SpaceCenter_AutoPilot_StoppingTime (krpc_connection_t connection,
                                                         krpc_tuple_double_double_double_t
                                                         * result)
```

```
void krpc_SpaceCenter_AutoPilot_set_StoppingTime (const
                                                    krpc_tuple_double_double_double_t
                                                    * value)
```

The maximum amount of time that the vessel should need to come to a complete stop. This determines the maximum angular velocity of the vessel. A vector of three stopping times, in seconds, one for each of the pitch, roll and yaw axes. Defaults to 0.5 seconds for each axis.

```
krpc_error_t krpc_SpaceCenter_AutoPilot_DecelerationTime (krpc_connection_t con-
                                                             nection,
                                                             krpc_tuple_double_double_double_t
                                                             * result)
```

```
void krpc_SpaceCenter_AutoPilot_set_DecelerationTime (const
                                                         krpc_tuple_double_double_double_t
                                                         * value)
```

The time the vessel should take to come to a stop pointing in the target direction. This determines the angular acceleration used to decelerate the vessel. A vector of three times, in seconds, one for each of the pitch, roll and yaw axes. Defaults to 5 seconds for each axis.

```
krpc_error_t krpc_SpaceCenter_AutoPilot_AttenuationAngle (krpc_connection_t con-
                                                             nection,
                                                             krpc_tuple_double_double_double_t
                                                             * result)
```

```
void krpc_SpaceCenter_AutoPilot_set_AttenuationAngle (const
                                                         krpc_tuple_double_double_double_t
                                                         * value)
```

The angle at which the autopilot considers the vessel to be pointing close to the target. This determines the midpoint of the target velocity attenuation function. A vector of three angles, in degrees, one for each of the pitch, roll and yaw axes. Defaults to 1° for each axis.

```
krpc_error_t krpc_SpaceCenter_AutoPilot_AutoTune (krpc_connection_t connection, bool
                                                         * result)
```

```
void krpc_SpaceCenter_AutoPilot_set_AutoTune (bool value)
```

Whether the rotation rate controllers PID parameters should be automatically tuned using the vessels moment of inertia and available torque. Defaults to true. See *krpc_SpaceCenter_AutoPilot_TimeToPeak()* and *krpc_SpaceCenter_AutoPilot_Overshoot()*.

```
krpc_error_t krpc_SpaceCenter_AutoPilot_TimeToPeak (krpc_connection_t connection,
                                                         krpc_tuple_double_double_double_t
                                                         * result)
```

```
void krpc_SpaceCenter_AutoPilot_set_TimeToPeak (const
                                                    krpc_tuple_double_double_double_t
                                                    * value)
```

The target time to peak used to autotune the PID controllers. A

vector of three times, in seconds, for each of the pitch, roll and yaw axes. Defaults to 3 seconds for each axis.

```
krpc_error_t krpc_SpaceCenter_AutoPilot_Overshoot (krpc_connection_t connection,  
                                                    krpc_tuple_double_double_double_t  
                                                    * result)
```

```
void krpc_SpaceCenter_AutoPilot_set_Overshoot (const krpc_tuple_double_double_double_t  
                                              * value)
```

The target overshoot percentage used to autotune the PID controllers. A vector of three values, between 0 and 1, for each of the pitch, roll and yaw axes. Defaults to 0.01 for each axis.

```
krpc_error_t krpc_SpaceCenter_AutoPilot_PitchPIDGains (krpc_connection_t connection,  
                                                         krpc_tuple_double_double_double_t  
                                                         * result)
```

```
void krpc_SpaceCenter_AutoPilot_set_PitchPIDGains (const  
                                                    krpc_tuple_double_double_double_t  
                                                    * value)
```

Gains for the pitch PID controller.

Note: When *krpc_SpaceCenter_AutoPilot_AutoTune()* is true, these values are updated automatically, which will overwrite any manual changes.

```
krpc_error_t krpc_SpaceCenter_AutoPilot_RollPIDGains (krpc_connection_t connection,  
                                                         krpc_tuple_double_double_double_t  
                                                         * result)
```

```
void krpc_SpaceCenter_AutoPilot_set_RollPIDGains (const  
                                                    krpc_tuple_double_double_double_t  
                                                    * value)
```

Gains for the roll PID controller.

Note: When *krpc_SpaceCenter_AutoPilot_AutoTune()* is true, these values are updated automatically, which will overwrite any manual changes.

```
krpc_error_t krpc_SpaceCenter_AutoPilot_YawPIDGains (krpc_connection_t connection,  
                                                         krpc_tuple_double_double_double_t  
                                                         * result)
```

```
void krpc_SpaceCenter_AutoPilot_set_YawPIDGains (const  
                                                    krpc_tuple_double_double_double_t  
                                                    * value)
```

Gains for the yaw PID controller.

Note: When *krpc_SpaceCenter_AutoPilot_AutoTune()* is true, these values are updated automatically, which will overwrite any manual changes.

3.3.13 Camera

krpc_SpaceCenter_Camera_t

Controls the game's camera. Obtained by calling
`krpc_SpaceCenter_Camera()`.

`krpc_error_t krpc_SpaceCenter_Camera_Mode` (`krpc_connection_t connection`,
`krpc_SpaceCenter_CameraMode_t * result`)

`void krpc_SpaceCenter_Camera_set_Mode` (`krpc_SpaceCenter_CameraMode_t value`)
 The current mode of the camera.

`krpc_error_t krpc_SpaceCenter_Camera_Pitch` (`krpc_connection_t connection`, `float * result`)

`void krpc_SpaceCenter_Camera_set_Pitch` (`float value`)
 The pitch of the camera, in degrees. A value between
`krpc_SpaceCenter_Camera_MinPitch()` and
`krpc_SpaceCenter_Camera_MaxPitch()`

`krpc_error_t krpc_SpaceCenter_Camera_Heading` (`krpc_connection_t connection`, `float * result`)

`void krpc_SpaceCenter_Camera_set_Heading` (`float value`)
 The heading of the camera, in degrees.

`krpc_error_t krpc_SpaceCenter_Camera_Distance` (`krpc_connection_t connection`, `float * result`)

`void krpc_SpaceCenter_Camera_set_Distance` (`float value`)
 The distance from the camera to the subject, in meters. A value
 between `krpc_SpaceCenter_Camera_MinDistance()`
 and `krpc_SpaceCenter_Camera_MaxDistance()`.

`krpc_error_t krpc_SpaceCenter_Camera_MinPitch` (`krpc_connection_t connection`, `float * result`)

The minimum pitch of the camera.

`krpc_error_t krpc_SpaceCenter_Camera_MaxPitch` (`krpc_connection_t connection`, `float * result`)

The maximum pitch of the camera.

`krpc_error_t krpc_SpaceCenter_Camera_MinDistance` (`krpc_connection_t connection`, `float * result`)

Minimum distance from the camera to the subject, in meters.

`krpc_error_t krpc_SpaceCenter_Camera_MaxDistance` (`krpc_connection_t connection`, `float * result`)

Maximum distance from the camera to the subject, in meters.

`krpc_error_t krpc_SpaceCenter_Camera_DefaultDistance` (`krpc_connection_t connection`,
`float * result`)

Default distance from the camera to the subject, in meters.

`krpc_error_t krpc_SpaceCenter_Camera_FocussedBody` (`krpc_connection_t connection`,
`krpc_SpaceCenter_CelestialBody_t * result`)

`void krpc_SpaceCenter_Camera_set_FocussedBody` (`krpc_SpaceCenter_CelestialBody_t value`)
 In map mode, the celestial body that the camera is focussed on.
 Returns `nullptr` if the camera is not focussed on a celestial body.
 Returns an error if the camera is not in map mode.

krpc_error_t **krpc_SpaceCenter_Camera_FocussedVessel** (*krpc_connection_t* *connection*,
krpc_SpaceCenter_Vessel_t
** result*)

void **krpc_SpaceCenter_Camera_set_FocussedVessel** (*krpc_SpaceCenter_Vessel_t* *value*)

In map mode, the vessel that the camera is focussed on. Returns
 nullptr if the camera is not focussed on a vessel. Returns an
 error if the camera is not in map mode.

krpc_error_t **krpc_SpaceCenter_Camera_FocussedNode** (*krpc_connection_t* *connection*,
krpc_SpaceCenter_Node_t ** result*)

void **krpc_SpaceCenter_Camera_set_FocussedNode** (*krpc_SpaceCenter_Node_t* *value*)

In map mode, the maneuver node that the camera is focussed on.
 Returns nullptr if the camera is not focussed on a maneuver
 node. Returns an error if the camera is not in map mode.

krpc_SpaceCenter_CameraMode_t

See *krpc_SpaceCenter_Camera_Mode()*.

KRPC_SPACECENTER_CAMERAMODE_AUTOMATIC

The camera is showing the active vessel, in “auto” mode.

KRPC_SPACECENTER_CAMERAMODE_FREE

The camera is showing the active vessel, in “free” mode.

KRPC_SPACECENTER_CAMERAMODE_CHASE

The camera is showing the active vessel, in “chase” mode.

KRPC_SPACECENTER_CAMERAMODE_LOCKED

The camera is showing the active vessel, in “locked” mode.

KRPC_SPACECENTER_CAMERAMODE_ORBITAL

The camera is showing the active vessel, in “orbital” mode.

KRPC_SPACECENTER_CAMERAMODE_IVA

The Intra-Vehicular Activity view is being shown.

KRPC_SPACECENTER_CAMERAMODE_MAP

The map view is being shown.

3.3.14 Waypoints

krpc_SpaceCenter_WaypointManager_t

Waypoints are the location markers you can see on the
 map view showing you where contracts are targeted for.
 With this structure, you can obtain coordinate data for
 the locations of these waypoints. Obtained by calling
krpc_SpaceCenter_WaypointManager().

krpc_error_t **krpc_SpaceCenter_WaypointManager_Waypoints** (*krpc_connection_t* *con-*
nection, *krpc_list_object_t*
** result*)

A list of all existing waypoints.

```
krpc_error_t krpc_SpaceCenter_WaypointManager_AddWaypoint (krpc_connection_t con-
                                                           nection,
                                                           krpc_SpaceCenter_Waypoint_t
                                                           * result, double lati-
                                                           tude, double longitude,
                                                           krpc_SpaceCenter_CelestialBody_t body,
                                                           const char * name)
```

Creates a waypoint at the given position at ground level, and returns a *krpc_SpaceCenter_Waypoint_t* object that can be used to modify it.

Parameters

- **latitude** – Latitude of the waypoint.
- **longitude** – Longitude of the waypoint.
- **body** – Celestial body the waypoint is attached to.
- **name** – Name of the waypoint.

```
krpc_error_t krpc_SpaceCenter_WaypointManager_AddWaypointAtAltitude (krpc_connection_t con-
                                                                       nection,
                                                                       krpc_SpaceCenter_Waypoint_t
                                                                       * result,
                                                                       dou-
                                                                       ble lat-
                                                                       itude,
                                                                       dou-
                                                                       ble lon-
                                                                       gitude,
                                                                       dou-
                                                                       ble al-
                                                                       titude,
                                                                       krpc_SpaceCenter_CelestialBody_t body,
                                                                       const
                                                                       char
                                                                       * name)
```

Creates a waypoint at the given position and altitude, and returns a *krpc_SpaceCenter_Waypoint_t* object that can be used to modify it.

Parameters

- **latitude** – Latitude of the waypoint.
- **longitude** – Longitude of the waypoint.
- **altitude** – Altitude (above sea level) of the waypoint.
- **body** – Celestial body the waypoint is attached to.
- **name** – Name of the waypoint.

```
krpc_error_t krpc_SpaceCenter_WaypointManager_Colors (krpc_connection_t connection,
                                                         krpc_dictionary_string_int32_t
                                                         * result)
```

An example map of known color - seed pairs. Any other integers may be used as seed.

krpc_error_t **krpc_SpaceCenter_WaypointManager_Icons** (*krpc_connection_t connection,*
*krpc_list_string_t * result*)

Returns all available icons (from “Game-Data/Squad/Contracts/Icons”).

krpc_SpaceCenter_Waypoint_t

Represents a waypoint. Can be created using *krpc_SpaceCenter_WaypointManager_AddWaypoint()*.

krpc_error_t **krpc_SpaceCenter_Waypoint_Body** (*krpc_connection_t connection,*
*krpc_SpaceCenter_CelestialBody_t * result*)

void **krpc_SpaceCenter_Waypoint_set_Body** (*krpc_SpaceCenter_CelestialBody_t value*)
 The celestial body the waypoint is attached to.

krpc_error_t **krpc_SpaceCenter_Waypoint_Name** (*krpc_connection_t connection,* *char * * result*)

void **krpc_SpaceCenter_Waypoint_set_Name** (*const char * value*)
 The name of the waypoint as it appears on the map and the contract.

krpc_error_t **krpc_SpaceCenter_Waypoint_Color** (*krpc_connection_t connection,* *int32_t * result*)

void **krpc_SpaceCenter_Waypoint_set_Color** (*int32_t value*)
 The seed of the icon color. See *krpc_SpaceCenter_WaypointManager_Colors()* for example colors.

krpc_error_t **krpc_SpaceCenter_Waypoint_Icon** (*krpc_connection_t connection,* *char * * result*)

void **krpc_SpaceCenter_Waypoint_set_Icon** (*const char * value*)
 The icon of the waypoint.

krpc_error_t **krpc_SpaceCenter_Waypoint_Latitude** (*krpc_connection_t connection,* *double * result*)

void **krpc_SpaceCenter_Waypoint_set_Latitude** (*double value*)
 The latitude of the waypoint.

krpc_error_t **krpc_SpaceCenter_Waypoint_Longitude** (*krpc_connection_t connection,* *double * result*)

void **krpc_SpaceCenter_Waypoint_set_Longitude** (*double value*)
 The longitude of the waypoint.

krpc_error_t **krpc_SpaceCenter_Waypoint_MeanAltitude** (*krpc_connection_t connection,* *double * result*)

void **krpc_SpaceCenter_Waypoint_set_MeanAltitude** (*double value*)
 The altitude of the waypoint above sea level, in meters.

krpc_error_t **krpc_SpaceCenter_Waypoint_SurfaceAltitude** (*krpc_connection_t connection,* *double * result*)

void **krpc_SpaceCenter_Waypoint_set_SurfaceAltitude** (*double value*)
 The altitude of the waypoint above the surface of the body or sea level, whichever is closer, in meters.

krpc_error_t **krpc_SpaceCenter_Waypoint_BedrockAltitude** (*krpc_connection_t* *connection*, *double * result*)

void **krpc_SpaceCenter_Waypoint_set_BedrockAltitude** (*double value*)

The altitude of the waypoint above the surface of the body, in meters.

When over water, this is the altitude above the sea floor.

krpc_error_t **krpc_SpaceCenter_Waypoint_NearSurface** (*krpc_connection_t* *connection*, *bool * result*)

true if the waypoint is near to the surface of a body.

krpc_error_t **krpc_SpaceCenter_Waypoint_Grounded** (*krpc_connection_t* *connection*, *bool * result*)

true if the waypoint is attached to the ground.

krpc_error_t **krpc_SpaceCenter_Waypoint_Index** (*krpc_connection_t* *connection*, *int32_t * result*)

The integer index of this waypoint within its cluster of sibling waypoints. In other words, when you have a cluster of waypoints called “Somewhere Alpha”, “Somewhere Beta” and “Somewhere Gamma”, the alpha site has index 0, the beta site has index 1 and the gamma site has index 2. When *krpc_SpaceCenter_Waypoint_Clustered()* is false, this is zero.

krpc_error_t **krpc_SpaceCenter_Waypoint_Clustered** (*krpc_connection_t* *connection*, *bool * result*)

true if this waypoint is part of a set of clustered waypoints with greek letter names appended (Alpha, Beta, Gamma, etc). If *true*, there is a one-to-one correspondence with the greek letter name and the *krpc_SpaceCenter_Waypoint_Index()*.

krpc_error_t **krpc_SpaceCenter_Waypoint_HasContract** (*krpc_connection_t* *connection*, *bool * result*)

Whether the waypoint belongs to a contract.

krpc_error_t **krpc_SpaceCenter_Waypoint_Contract** (*krpc_connection_t* *connection*, *krpc_SpaceCenter_Contract_t * result*)

The associated contract.

krpc_error_t **krpc_SpaceCenter_Waypoint_Remove** (*krpc_connection_t* *connection*)

Removes the waypoint.

3.3.15 Contracts

krpc_SpaceCenter_ContractManager_t

Contracts manager. Obtained by calling

krpc_SpaceCenter_WaypointManager().

krpc_error_t **krpc_SpaceCenter_ContractManager_Types** (*krpc_connection_t* *connection*, *krpc_set_string_t * result*)

A list of all contract types.

krpc_error_t **krpc_SpaceCenter_ContractManager_AllContracts** (*krpc_connection_t* *connection*, *krpc_list_object_t * result*)

A list of all contracts.

krpc_error_t **krpc_SpaceCenter_ContractManager_ActiveContracts** (*krpc_connection_t connection,*
krpc_list_object_t
** result*)

A list of all active contracts.

krpc_error_t **krpc_SpaceCenter_ContractManager_OfferedContracts** (*krpc_connection_t connection,*
krpc_list_object_t
** result*)

A list of all offered, but unaccepted, contracts.

krpc_error_t **krpc_SpaceCenter_ContractManager_CompletedContracts** (*krpc_connection_t connection,*
krpc_list_object_t
** result*)

A list of all completed contracts.

krpc_error_t **krpc_SpaceCenter_ContractManager_FailedContracts** (*krpc_connection_t connection,*
krpc_list_object_t
** result*)

A list of all failed contracts.

krpc_SpaceCenter_Contract_t
A contract. Can be accessed using
krpc_SpaceCenter_ContractManager().

krpc_error_t **krpc_SpaceCenter_Contract_Type** (*krpc_connection_t connection,* *char ** result*)

Type of the contract.

krpc_error_t **krpc_SpaceCenter_Contract_Title** (*krpc_connection_t connection,* *char ** result*)

Title of the contract.

krpc_error_t **krpc_SpaceCenter_Contract_Description** (*krpc_connection_t connection,*
*char ** result*)

Description of the contract.

krpc_error_t **krpc_SpaceCenter_Contract_Notes** (*krpc_connection_t connection,* *char ** result*)

Notes for the contract.

krpc_error_t **krpc_SpaceCenter_Contract_Synopsis** (*krpc_connection_t connection,* *char ** result*)

Synopsis for the contract.

krpc_error_t **krpc_SpaceCenter_Contract_Keywords** (*krpc_connection_t connection,*
*krpc_list_string_t * result*)

Keywords for the contract.

krpc_error_t **krpc_SpaceCenter_Contract_State** (*krpc_connection_t connection,*
*krpc_SpaceCenter_ContractState_t * result*)

State of the contract.

krpc_error_t **krpc_SpaceCenter_Contract_Seen** (*krpc_connection_t connection,* *bool * result*)

Whether the contract has been seen.

krpc_error_t **krpc_SpaceCenter_Contract_Read** (*krpc_connection_t connection,* *bool * result*)

Whether the contract has been read.

krpc_error_t **krpc_SpaceCenter_Contract_Active** (*krpc_connection_t connection*, *bool * result*)
 Whether the contract is active.

krpc_error_t **krpc_SpaceCenter_Contract_Failed** (*krpc_connection_t connection*, *bool * result*)
 Whether the contract has been failed.

krpc_error_t **krpc_SpaceCenter_Contract_CanBeCanceled** (*krpc_connection_t connection*,
*bool * result*)
 Whether the contract can be canceled.

krpc_error_t **krpc_SpaceCenter_Contract_CanBeDeclined** (*krpc_connection_t connection*,
*bool * result*)
 Whether the contract can be declined.

krpc_error_t **krpc_SpaceCenter_Contract_CanBeFailed** (*krpc_connection_t connection*,
*bool * result*)
 Whether the contract can be failed.

krpc_error_t **krpc_SpaceCenter_Contract_Accept** (*krpc_connection_t connection*)
 Accept an offered contract.

krpc_error_t **krpc_SpaceCenter_Contract_Cancel** (*krpc_connection_t connection*)
 Cancel an active contract.

krpc_error_t **krpc_SpaceCenter_Contract_Decline** (*krpc_connection_t connection*)
 Decline an offered contract.

krpc_error_t **krpc_SpaceCenter_Contract_FundsAdvance** (*krpc_connection_t connection*,
*double * result*)
 Funds received when accepting the contract.

krpc_error_t **krpc_SpaceCenter_Contract_FundsCompletion** (*krpc_connection_t connection*, *double * result*)
 Funds received on completion of the contract.

krpc_error_t **krpc_SpaceCenter_Contract_FundsFailure** (*krpc_connection_t connection*,
*double * result*)
 Funds lost if the contract is failed.

krpc_error_t **krpc_SpaceCenter_Contract_ReputationCompletion** (*krpc_connection_t connection*, *double * result*)
 Reputation gained on completion of the contract.

krpc_error_t **krpc_SpaceCenter_Contract_ReputationFailure** (*krpc_connection_t connection*, *double * result*)
 Reputation lost if the contract is failed.

krpc_error_t **krpc_SpaceCenter_Contract_ScienceCompletion** (*krpc_connection_t connection*, *double * result*)
 Science gained on completion of the contract.

krpc_error_t **krpc_SpaceCenter_Contract_Parameters** (*krpc_connection_t connection*,
*krpc_list_object_t * result*)
 Parameters for the contract.

krpc_SpaceCenter_ContractState_t
 The state of a contract. See *krpc_SpaceCenter_Contract_State()*.

KRPC_SPACECENTER_CONTRACTSTATE_ACTIVE
 The contract is active.

KRPC_SPACECENTER_CONTRACTSTATE_CANCELED

The contract has been canceled.

KRPC_SPACECENTER_CONTRACTSTATE_COMPLETED

The contract has been completed.

KRPC_SPACECENTER_CONTRACTSTATE_DEADLINEEXPIRED

The deadline for the contract has expired.

KRPC_SPACECENTER_CONTRACTSTATE_DECLINED

The contract has been declined.

KRPC_SPACECENTER_CONTRACTSTATE_FAILED

The contract has been failed.

KRPC_SPACECENTER_CONTRACTSTATE_GENERATED

The contract has been generated.

KRPC_SPACECENTER_CONTRACTSTATE_OFFERED

The contract has been offered to the player.

KRPC_SPACECENTER_CONTRACTSTATE_OFFEREXPIRED

The contract was offered to the player, but the offer expired.

KRPC_SPACECENTER_CONTRACTSTATE_WITHDRAWN

The contract has been withdrawn.

krpc_SpaceCenter_ContractParameter_t

A contract parameter. See *krpc_SpaceCenter_Contract_Parameters()*.

krpc_error_t **krpc_SpaceCenter_ContractParameter_Title** (*krpc_connection_t connection*,
char ** *result*)

Title of the parameter.

krpc_error_t **krpc_SpaceCenter_ContractParameter_Notes** (*krpc_connection_t connection*,
char ** *result*)

Notes for the parameter.

krpc_error_t **krpc_SpaceCenter_ContractParameter_Children** (*krpc_connection_t connection*,
krpc_list_object_t * *result*)

Child contract parameters.

krpc_error_t **krpc_SpaceCenter_ContractParameter_Completed** (*krpc_connection_t connection*, bool * *result*)

Whether the parameter has been completed.

krpc_error_t **krpc_SpaceCenter_ContractParameter_Failed** (*krpc_connection_t connection*, bool * *result*)

Whether the parameter has been failed.

krpc_error_t **krpc_SpaceCenter_ContractParameter_Optional** (*krpc_connection_t connection*, bool * *result*)

Whether the contract parameter is optional.

krpc_error_t **krpc_SpaceCenter_ContractParameter_FundsCompletion** (*krpc_connection_t connection*, double
* *result*)

Funds received on completion of the contract parameter.

krpc_error_t **krpc_SpaceCenter_ContractParameter_FundsFailure** (*krpc_connection_t* *connection*, *double* ** result*)

Funds lost if the contract parameter is failed.

krpc_error_t **krpc_SpaceCenter_ContractParameter_ReputationCompletion** (*krpc_connection_t* *connection*, *double* ** result*)

Reputation gained on completion of the contract parameter.

krpc_error_t **krpc_SpaceCenter_ContractParameter_ReputationFailure** (*krpc_connection_t* *connection*, *double* ** result*)

Reputation lost if the contract parameter is failed.

krpc_error_t **krpc_SpaceCenter_ContractParameter_ScienceCompletion** (*krpc_connection_t* *connection*, *double* ** result*)

Science gained on completion of the contract parameter.

3.3.16 Geometry Types

Vectors

3-dimensional vectors are represented as a 3-tuple. For example:

```
#include <krpc.h>
#include <krpc/services/space_center.h>

int main() {
    krpc_connection_t conn;
    krpc_open(&conn, "COM0");
    krpc_connect(conn, "");
    krpc_SpaceCenter_Vessel_t vessel;
    krpc_SpaceCenter_ActiveVessel(conn, &vessel);
    krpc_SpaceCenter_Flight_t flight;
    krpc_SpaceCenter_
↳ Vessel_Flight(conn, &flight, vessel, KRPC_NULL);
    krpc_tuple_double_double_double_t v;
    krpc_
↳ SpaceCenter_Flight_Prograde(conn, &v, flight);
    printf("%.2f %.2f %.2f\n", v.e0, v.e1, v.e2);
}
```

Quaternions

Quaternions (rotations in 3-dimensional space) are encoded as a 4-tuple containing the x, y, z and w components. For example:

```
#include <krpc.h>
#include <krpc/services/space_center.h>
```

```
int main() {
    krpc_connection_t conn;
    krpc_open(&conn, "COM0");
    krpc_connect(conn, "");
    krpc_SpaceCenter_Vessel_t vessel;
    krpc_SpaceCenter_ActiveVessel(conn, &vessel);
    krpc_SpaceCenter_Flight_t flight;
    krpc_SpaceCenter_
↳Vessel_Flight(conn, &flight, vessel, KRPC_NULL);
    krpc_tuple_double_double_double_double_t q;
    krpc_
↳SpaceCenter_Flight_Rotation(conn, &q, flight);
    printf("
↳%.2f %.2f %.2f %.2f\n", q.e0, q.e1, q.e2, q.e3);
}
```

3.4 Drawing API

3.4.1 Drawing

Service Drawing

Provides functionality for drawing objects in the flight scene.

krpc_error_t **krpc_Drawing_AddLine** (*krpc_connection_t connection*, *krpc_Drawing_Line_t*
* *result*, const *krpc_tuple_double_double_double_t*
* *start*, const *krpc_tuple_double_double_double_t*
* *end*, *krpc_SpaceCenter_ReferenceFrame_t referenceFrame*, bool *visible*)

Draw a line in the scene.

Parameters

- **start** – Position of the start of the line.
- **end** – Position of the end of the line.
- **referenceFrame** – Reference frame that the positions are in.
- **visible** – Whether the line is visible.

krpc_error_t **krpc_Drawing_AddDirection** (*krpc_connection_t connection*,
krpc_Drawing_Line_t * *result*, const
krpc_tuple_double_double_double_t * *direction*, *krpc_SpaceCenter_ReferenceFrame_t referenceFrame*, float *length*, bool *visible*)

Draw a direction vector in the scene, from the center of mass of the active vessel.

Parameters

- **direction** – Direction to draw the line in.
- **referenceFrame** – Reference frame that the direction is in.
- **length** – The length of the line.
- **visible** – Whether the line is visible.

```
krpc_error_t krpc_Drawing_AddPolygon (krpc_connection_t connection,
                                       krpc_Drawing_Polygon_t * result, const
                                       krpc_list_tuple_double_double_double_t * ver-
                                       tices, krpc_SpaceCenter_ReferenceFrame_t ref-
                                       erenceFrame, bool visible)
```

Draw a polygon in the scene, defined by a list of vertices.

Parameters

- **vertices** – Vertices of the polygon.
- **referenceFrame** – Reference frame that the vertices are in.
- **visible** – Whether the polygon is visible.

```
krpc_error_t krpc_Drawing_AddText (krpc_connection_t connection,
                                       krpc_Drawing_Text_t * result, const char * text,
                                       krpc_SpaceCenter_ReferenceFrame_t reference-
                                       Frame, const krpc_tuple_double_double_double_t
                                       * position, const krpc_tuple_double_double_double_double_t
                                       * rotation, bool visible)
```

Draw text in the scene.

Parameters

- **text** – The string to draw.
- **referenceFrame** – Reference frame that the text position is in.
- **position** – Position of the text.
- **rotation** – Rotation of the text, as a quaternion.
- **visible** – Whether the text is visible.

```
krpc_error_t krpc_Drawing_Clear (krpc_connection_t connection, bool clientOnly)
```

Remove all objects being drawn.

Parameters

- **clientOnly** – If true, only remove objects created by the calling client.

3.4.2 Line

krpc_Drawing_Line_t

A line. Created using *krpc_Drawing_AddLine()*.

```
krpc_error_t krpc_Drawing_Line_Start (krpc_connection_t connection,
                                       krpc_tuple_double_double_double_t * result)
```

```
void krpc_Drawing_Line_set_Start (const krpc_tuple_double_double_double_t * value)
```

Start position of the line.

```
krpc_error_t krpc_Drawing_Line_End (krpc_connection_t connection,
                                       krpc_tuple_double_double_double_t * result)
```

```
void krpc_Drawing_Line_set_End (const krpc_tuple_double_double_double_t * value)
```

End position of the line.

krpc_error_t **krpc_Drawing_Line_ReferenceFrame** (*krpc_connection_t connection,*
krpc_SpaceCenter_ReferenceFrame_t
** result*)

void **krpc_Drawing_Line_set_ReferenceFrame** (*krpc_SpaceCenter_ReferenceFrame_t value*)
Reference frame for the positions of the object.

krpc_error_t **krpc_Drawing_Line_Visible** (*krpc_connection_t connection, bool * result*)

void **krpc_Drawing_Line_set_Visible** (*bool value*)
Whether the object is visible.

krpc_error_t **krpc_Drawing_Line_Color** (*krpc_connection_t connection,*
*krpc_tuple_double_double_double_t * result*)

void **krpc_Drawing_Line_set_Color** (*const krpc_tuple_double_double_double_t * value*)
Set the color

krpc_error_t **krpc_Drawing_Line_Material** (*krpc_connection_t connection, char ** result*)

void **krpc_Drawing_Line_set_Material** (*const char * value*)
Material used to render the object. Creates the material from a
shader with the given name.

krpc_error_t **krpc_Drawing_Line_Thickness** (*krpc_connection_t connection, float * result*)

void **krpc_Drawing_Line_set_Thickness** (*float value*)
Set the thickness

krpc_error_t **krpc_Drawing_Line_Remove** (*krpc_connection_t connection*)
Remove the object.

3.4.3 Polygon

krpc_Drawing_Polygon_t
A polygon. Created using *krpc_Drawing_AddPolygon()*.

krpc_error_t **krpc_Drawing_Polygon_Vertices** (*krpc_connection_t connection,*
krpc_list_tuple_double_double_double_t
** result*)

void **krpc_Drawing_Polygon_set_Vertices** (*const krpc_list_tuple_double_double_double_t*
** value*)
Vertices for the polygon.

krpc_error_t **krpc_Drawing_Polygon_ReferenceFrame** (*krpc_connection_t connection,*
krpc_SpaceCenter_ReferenceFrame_t
** result*)

void **krpc_Drawing_Polygon_set_ReferenceFrame** (*krpc_SpaceCenter_ReferenceFrame_t value*)
Reference frame for the positions of the object.

krpc_error_t **krpc_Drawing_Polygon_Visible** (*krpc_connection_t connection, bool * result*)

void **krpc_Drawing_Polygon_set_Visible** (*bool value*)
Whether the object is visible.

krpc_error_t **krpc_Drawing_Polygon_Remove** (*krpc_connection_t connection*)

Remove the object.

krpc_error_t **krpc_Drawing_Polygon_Color** (*krpc_connection_t connection*,
*krpc_tuple_double_double_double_t * result*)

void **krpc_Drawing_Polygon_set_Color** (const *krpc_tuple_double_double_double_t * value*)

Set the color

krpc_error_t **krpc_Drawing_Polygon_Material** (*krpc_connection_t connection*, char ** *result*)

void **krpc_Drawing_Polygon_set_Material** (const char * *value*)

Material used to render the object. Creates the material from a shader with the given name.

krpc_error_t **krpc_Drawing_Polygon_Thickness** (*krpc_connection_t connection*, float * *result*)

void **krpc_Drawing_Polygon_set_Thickness** (float *value*)

Set the thickness

3.4.4 Text

krpc_Drawing_Text_t

Text. Created using *krpc_Drawing_AddText()*.

krpc_error_t **krpc_Drawing_Text_Position** (*krpc_connection_t connection*,
*krpc_tuple_double_double_double_t * result*)

void **krpc_Drawing_Text_set_Position** (const *krpc_tuple_double_double_double_t * value*)

Position of the text.

krpc_error_t **krpc_Drawing_Text_Rotation** (*krpc_connection_t connection*,
*krpc_tuple_double_double_double_double_t * result*)

void **krpc_Drawing_Text_set_Rotation** (const *krpc_tuple_double_double_double_double_t * value*)

Rotation of the text as a quaternion.

krpc_error_t **krpc_Drawing_Text_ReferenceFrame** (*krpc_connection_t connection*,
*krpc_SpaceCenter_ReferenceFrame_t * result*)

void **krpc_Drawing_Text_set_ReferenceFrame** (*krpc_SpaceCenter_ReferenceFrame_t value*)

Reference frame for the positions of the object.

krpc_error_t **krpc_Drawing_Text_Visible** (*krpc_connection_t connection*, bool * *result*)

void **krpc_Drawing_Text_set_Visible** (bool *value*)

Whether the object is visible.

krpc_error_t **krpc_Drawing_Text_Remove** (*krpc_connection_t connection*)

Remove the object.

krpc_error_t **krpc_Drawing_Text_Content** (*krpc_connection_t connection*, char ** *result*)

void **krpc_Drawing_Text_set_Content** (const char * *value*)
The text string

krpc_error_t **krpc_Drawing_Text_Font** (*krpc_connection_t connection*, char ** *result*)

void **krpc_Drawing_Text_set_Font** (const char * *value*)
Name of the font

krpc_error_t **krpc_Drawing_Text_AvailableFonts** (*krpc_connection_t connection*,
*krpc_list_string_t * result*)
A list of all available fonts.

krpc_error_t **krpc_Drawing_Text_Size** (*krpc_connection_t connection*, int32_t * *result*)

void **krpc_Drawing_Text_set_Size** (int32_t *value*)
Font size.

krpc_error_t **krpc_Drawing_Text_CharacterSize** (*krpc_connection_t connection*, float * *result*)

void **krpc_Drawing_Text_set_CharacterSize** (float *value*)
Character size.

krpc_error_t **krpc_Drawing_Text_Style** (*krpc_connection_t connection*, *krpc_UI_FontStyle_t * result*)

void **krpc_Drawing_Text_set_Style** (*krpc_UI_FontStyle_t value*)
Font style.

krpc_error_t **krpc_Drawing_Text_Color** (*krpc_connection_t connection*,
*krpc_tuple_double_double_double_t * result*)

void **krpc_Drawing_Text_set_Color** (const *krpc_tuple_double_double_double_t * value*)
Set the color

krpc_error_t **krpc_Drawing_Text_Material** (*krpc_connection_t connection*, char ** *result*)

void **krpc_Drawing_Text_set_Material** (const char * *value*)
Material used to render the object. Creates the material from a
shader with the given name.

krpc_error_t **krpc_Drawing_Text_Alignment** (*krpc_connection_t connection*,
*krpc_UI_TextAlignment_t * result*)

void **krpc_Drawing_Text_set_Alignment** (*krpc_UI_TextAlignment_t value*)
Alignment.

krpc_error_t **krpc_Drawing_Text_LineSpacing** (*krpc_connection_t connection*, float * *result*)

void **krpc_Drawing_Text_set_LineSpacing** (float *value*)
Line spacing.

krpc_error_t **krpc_Drawing_Text_Anchor** (*krpc_connection_t connection*, *krpc_UI_TextAnchor_t * result*)

void **krpc_Drawing_Text_set_Anchor** (*krpc_UI_TextAnchor_t value*)
Anchor.

3.5 InfernalRobotics API

Provides RPCs to interact with the `InfernalRobotics` mod. Provides the following classes:

3.5.1 InfernalRobotics

Service `InfernalRobotics`

This service provides functionality to interact with `InfernalRobotics`.

`krpc_error_t krpc_InfernalRobotics_Available` (`krpc_connection_t connection`, `bool * result`)

Whether `InfernalRobotics` is installed.

`krpc_error_t krpc_InfernalRobotics_ServoGroups` (`krpc_connection_t connection`, `krpc_list_object_t * result`, `krpc_SpaceCenter_Vessel_t vessel`)

A list of all the servo groups in the given `vessel`.

Parameters

`krpc_error_t krpc_InfernalRobotics_ServoGroupWithName` (`krpc_connection_t connection`, `krpc_InfernalRobotics_ServoGroup_t * result`, `krpc_SpaceCenter_Vessel_t vessel`, `const char * name`)

Returns the servo group in the given `vessel` with the given `name`, or `nullptr` if none exists. If multiple servo groups have the same name, only one of them is returned.

Parameters

- **vessel** – Vessel to check.
- **name** – Name of servo group to find.

`krpc_error_t krpc_InfernalRobotics_ServoWithName` (`krpc_connection_t connection`, `krpc_InfernalRobotics_Servo_t * result`, `krpc_SpaceCenter_Vessel_t vessel`, `const char * name`)

Returns the servo in the given `vessel` with the given `name` or `nullptr` if none exists. If multiple servos have the same name, only one of them is returned.

Parameters

- **vessel** – Vessel to check.
- **name** – Name of the servo to find.

3.5.2 ServoGroup

`krpc_InfernalRobotics_ServoGroup_t`

A group of servos, obtained by calling

`krpc_InfernalRobotics_ServoGroups()` or
`krpc_InfernalRobotics_ServoGroupWithName()`.
 Represents the “Servo Groups” in the InfernalRobotics UI.

`krpc_error_t krpc_InfernalRobotics_ServoGroup_Name` (`krpc_connection_t connection`,
`char ** result`)

void `krpc_InfernalRobotics_ServoGroup_set_Name` (`const char * value`)
 The name of the group.

`krpc_error_t krpc_InfernalRobotics_ServoGroup_ForwardKey` (`krpc_connection_t connection`, `char ** result`)

void `krpc_InfernalRobotics_ServoGroup_set_ForwardKey` (`const char * value`)
 The key assigned to be the “forward” key for the group.

`krpc_error_t krpc_InfernalRobotics_ServoGroup_ReverseKey` (`krpc_connection_t connection`, `char ** result`)

void `krpc_InfernalRobotics_ServoGroup_set_ReverseKey` (`const char * value`)
 The key assigned to be the “reverse” key for the group.

`krpc_error_t krpc_InfernalRobotics_ServoGroup_Speed` (`krpc_connection_t connection`,
`float * result`)

void `krpc_InfernalRobotics_ServoGroup_set_Speed` (`float value`)
 The speed multiplier for the group.

`krpc_error_t krpc_InfernalRobotics_ServoGroup_Expanded` (`krpc_connection_t connection`, `bool * result`)

void `krpc_InfernalRobotics_ServoGroup_set_Expanded` (`bool value`)
 Whether the group is expanded in the InfernalRobotics UI.

`krpc_error_t krpc_InfernalRobotics_ServoGroup_Servos` (`krpc_connection_t connection`,
`krpc_list_object_t * result`)

The servos that are in the group.

`krpc_error_t krpc_InfernalRobotics_ServoGroup_ServoWithName` (`krpc_connection_t connection`,
`krpc_InfernalRobotics_Servo_t * result`, `const char * name`)

Returns the servo with the given *name* from this group, or `nullptr` if none exists.

Parameters

- **name** – Name of servo to find.

`krpc_error_t krpc_InfernalRobotics_ServoGroup_Parts` (`krpc_connection_t connection`,
`krpc_list_object_t * result`)

The parts containing the servos in the group.

`krpc_error_t krpc_InfernalRobotics_ServoGroup_MoveRight` (`krpc_connection_t connection`)

Moves all of the servos in the group to the right.

`krpc_error_t krpc_InfernalRobotics_ServoGroup_MoveLeft` (`krpc_connection_t connection`)

Moves all of the servos in the group to the left.

krpc_error_t **krpc_InfernalRobotics_ServoGroup_MoveCenter** (*krpc_connection_t connection*)

Moves all of the servos in the group to the center.

krpc_error_t **krpc_InfernalRobotics_ServoGroup_MoveNextPreset** (*krpc_connection_t connection*)

Moves all of the servos in the group to the next preset.

krpc_error_t **krpc_InfernalRobotics_ServoGroup_MovePrevPreset** (*krpc_connection_t connection*)

Moves all of the servos in the group to the previous preset.

krpc_error_t **krpc_InfernalRobotics_ServoGroup_Stop** (*krpc_connection_t connection*)

Stops the servos in the group.

3.5.3 Servo

krpc_InfernalRobotics_Servo_t

Represents a servo. Obtained using
krpc_InfernalRobotics_ServoGroup_Servos(),
krpc_InfernalRobotics_ServoGroup_ServoWithName()
 or *krpc_InfernalRobotics_ServoWithName()*.

krpc_error_t **krpc_InfernalRobotics_Servo_Name** (*krpc_connection_t connection*, *char ** result*)

void **krpc_InfernalRobotics_Servo_set_Name** (*const char * value*)

The name of the servo.

krpc_error_t **krpc_InfernalRobotics_Servo_Part** (*krpc_connection_t connection*,
*krpc_SpaceCenter_Part_t * result*)

The part containing the servo.

void **krpc_InfernalRobotics_Servo_set_Highlight** (*bool value*)

Whether the servo should be highlighted in-game.

krpc_error_t **krpc_InfernalRobotics_Servo_Position** (*krpc_connection_t connection*, *float * result*)

The position of the servo.

krpc_error_t **krpc_InfernalRobotics_Servo_MinConfigPosition** (*krpc_connection_t connection*, *float * result*)

The minimum position of the servo, specified by the part configuration.

krpc_error_t **krpc_InfernalRobotics_Servo_MaxConfigPosition** (*krpc_connection_t connection*, *float * result*)

The maximum position of the servo, specified by the part configuration.

krpc_error_t **krpc_InfernalRobotics_Servo_MinPosition** (*krpc_connection_t connection*,
*float * result*)

void **krpc_InfernalRobotics_Servo_set_MinPosition** (*float value*)

The minimum position of the servo, specified by the in-game tweak menu.

krpc_error_t **krpc_InfernalRobotics_Servo_MaxPosition** (*krpc_connection_t connection*,
*float * result*)

void **krpc_InfernalRobotics_Servo_set_MaxPosition** (float *value*)

The maximum position of the servo, specified by the in-game tweak menu.

krpc_error_t **krpc_InfernalRobotics_Servo_ConfigSpeed** (*krpc_connection_t connection*,
float * *result*)

The speed multiplier of the servo, specified by the part configuration.

krpc_error_t **krpc_InfernalRobotics_Servo_Speed** (*krpc_connection_t connection*, float * *result*)

void **krpc_InfernalRobotics_Servo_set_Speed** (float *value*)

The speed multiplier of the servo, specified by the in-game tweak menu.

krpc_error_t **krpc_InfernalRobotics_Servo_CurrentSpeed** (*krpc_connection_t connection*,
float * *result*)

void **krpc_InfernalRobotics_Servo_set_CurrentSpeed** (float *value*)

The current speed at which the servo is moving.

krpc_error_t **krpc_InfernalRobotics_Servo_Acceleration** (*krpc_connection_t connection*,
float * *result*)

void **krpc_InfernalRobotics_Servo_set_Acceleration** (float *value*)

The current speed multiplier set in the UI.

krpc_error_t **krpc_InfernalRobotics_Servo_IsMoving** (*krpc_connection_t connection*, bool
* *result*)

Whether the servo is moving.

krpc_error_t **krpc_InfernalRobotics_Servo_IsFreeMoving** (*krpc_connection_t connection*,
bool * *result*)

Whether the servo is freely moving.

krpc_error_t **krpc_InfernalRobotics_Servo_IsLocked** (*krpc_connection_t connection*, bool
* *result*)

void **krpc_InfernalRobotics_Servo_set_IsLocked** (bool *value*)

Whether the servo is locked.

krpc_error_t **krpc_InfernalRobotics_Servo_IsAxisInverted** (*krpc_connection_t connection*, bool * *result*)

void **krpc_InfernalRobotics_Servo_set_IsAxisInverted** (bool *value*)

Whether the servos axis is inverted.

krpc_error_t **krpc_InfernalRobotics_Servo_MoveRight** (*krpc_connection_t connection*)

Moves the servo to the right.

krpc_error_t **krpc_InfernalRobotics_Servo_MoveLeft** (*krpc_connection_t connection*)

Moves the servo to the left.

krpc_error_t **krpc_InfernalRobotics_Servo_MoveCenter** (*krpc_connection_t connection*)

Moves the servo to the center.

krpc_error_t **krpc_InfernalRobotics_Servo_MoveNextPreset** (*krpc_connection_t connection*)

Moves the servo to the next preset.

krpc_error_t **krpc_InfernalRobotics_Servo_MovePrevPreset** (*krpc_connection_t connection*)

Moves the servo to the previous preset.

`krpc_error_t krpc_InfernalRobotics_Servo_MoveTo` (`krpc_connection_t connection`, `float position`, `float speed`)

Moves the servo to *position* and sets the speed multiplier to *speed*.

Parameters

- **position** – The position to move the servo to.
- **speed** – Speed multiplier for the movement.

`krpc_error_t krpc_InfernalRobotics_Servo_Stop` (`krpc_connection_t connection`)

Stops the servo.

3.5.4 Example

The following example gets the control group named “MyGroup”, prints out the names and positions of all of the servos in the group, then moves all of the servos to the right for 1 second.

```
#include <unistd.h>
#include <krpc.h>
#include <krpc/services/space_center.h>
#include <krpc/services/infernal_robotics.h>

int main() {
    krpc_connection_t conn;
    krpc_open(&conn, "COMO");
    krpc_connect(conn, "InfernalRobotics Example");
    krpc_SpaceCenter_Vessel_t vessel;
    krpc_SpaceCenter_ActiveVessel(conn, &vessel);

    krpc_InfernalRobotics_ServoGroup_t group;
    krpc_InfernalRobotics_ServoGroupWithName(conn,
↪ &group, vessel, "MyGroup");
    if (!group)
        printf("Group not found\n");

    krpc_list_object_t servos = KRPC_NULL_LIST;
    krpc_InfernalRobotics_
↪ ServoGroup_Servos(conn, &servos, group);
    for (size_t i = 0; i < servos.size; i++) {
        krpc_InfernalRobotics_
↪ Servo_t servo = servos.items[i];
        char * name = NULL;
        krpc_
↪ InfernalRobotics_Servo_Name(conn, &name, servo);
        float position;
        krpc_InfernalRobotics_
↪ Servo_Position(conn, &position, servo);
        printf("%s %.2f\n", name, position);
    }

    krpc_InfernalRobotics_
↪ ServoGroup_MoveRight(conn, group);
    sleep(1);
    krpc_
↪ InfernalRobotics_ServoGroup_Stop(conn, group);
}
```

3.6 Kerbal Alarm Clock API

Provides RPCs to interact with the [Kerbal Alarm Clock](#) mod. Provides the following classes:

3.6.1 KerbalAlarmClock

Service KerbalAlarmClock

This service provides functionality to interact with [Kerbal Alarm Clock](#).

krpc_error_t **krpc_KerbalAlarmClock_Available** (*krpc_connection_t connection*, bool
* *result*)

Whether Kerbal Alarm Clock is available.

krpc_error_t **krpc_KerbalAlarmClock_Alarms** (*krpc_connection_t connection*,
krpc_list_object_t * *result*)

A list of all the alarms.

krpc_error_t **krpc_KerbalAlarmClock_AlarmWithName** (*krpc_connection_t connection*,
krpc_KerbalAlarmClock_Alarm_t
* *result*, const char * *name*)

Get the alarm with the given *name*, or `nullptr` if no alarms have that name. If more than one alarm has the name, only returns one of them.

Parameters

- **name** – Name of the alarm to search for.

krpc_error_t **krpc_KerbalAlarmClock_AlarmsWithType** (*krpc_connection_t connection*,
krpc_list_object_t
* *result*,
krpc_KerbalAlarmClock_AlarmType_t *type*)

Get a list of alarms of the specified *type*.

Parameters

- **type** – Type of alarm to return.

krpc_error_t **krpc_KerbalAlarmClock_CreateAlarm** (*krpc_connection_t connection*,
krpc_KerbalAlarmClock_Alarm_t
* *result*,
krpc_KerbalAlarmClock_AlarmType_t *type*,
const char * *name*, double *ut*)

Create a new alarm and return it.

Parameters

- **type** – Type of the new alarm.
- **name** – Name of the new alarm.
- **ut** – Time at which the new alarm should trigger.

3.6.2 Alarm

krpc_KerbalAlarmClock_Alarm_t

Represents an alarm. Obtained by call-

```

ing          krpc_KerbalAlarmClock_Alarms (),
krpc_KerbalAlarmClock_AlarmWithName ()          or
krpc_KerbalAlarmClock_AlarmsWithType ().

krpc_error_t krpc_KerbalAlarmClock_Alarm_Action (krpc_connection_t      connection,
                                                  krpc_KerbalAlarmClock_AlarmAction_t
                                                  * result)

void krpc_KerbalAlarmClock_Alarm_set_Action (krpc_KerbalAlarmClock_AlarmAction_t value)
    The action that the alarm triggers.

krpc_error_t krpc_KerbalAlarmClock_Alarm_Margin (krpc_connection_t connection, double
                                                  * result)

void krpc_KerbalAlarmClock_Alarm_set_Margin (double value)
    The number of seconds before the event that the alarm will fire.

krpc_error_t krpc_KerbalAlarmClock_Alarm_Time (krpc_connection_t connection, double
                                                  * result)

void krpc_KerbalAlarmClock_Alarm_set_Time (double value)
    The time at which the alarm will fire.

krpc_error_t krpc_KerbalAlarmClock_Alarm_Type (krpc_connection_t      connection,
                                                  krpc_KerbalAlarmClock_AlarmType_t
                                                  * result)

    The type of the alarm.

krpc_error_t krpc_KerbalAlarmClock_Alarm_ID (krpc_connection_t connection, char * * re-
                                                  sult)

    The unique identifier for the alarm.

krpc_error_t krpc_KerbalAlarmClock_Alarm_Name (krpc_connection_t connection, char * * re-
                                                  sult)

void krpc_KerbalAlarmClock_Alarm_set_Name (const char * value)
    The short name of the alarm.

krpc_error_t krpc_KerbalAlarmClock_Alarm_Notes (krpc_connection_t connection, char *
                                                  * result)

void krpc_KerbalAlarmClock_Alarm_set_Notes (const char * value)
    The long description of the alarm.

krpc_error_t krpc_KerbalAlarmClock_Alarm_Remaining (krpc_connection_t connection,
                                                  double * result)

    The number of seconds until the alarm will fire.

krpc_error_t krpc_KerbalAlarmClock_Alarm_Repeat (krpc_connection_t connection, bool
                                                  * result)

void krpc_KerbalAlarmClock_Alarm_set_Repeat (bool value)
    Whether the alarm will be repeated after it has fired.

krpc_error_t krpc_KerbalAlarmClock_Alarm_RepeatPeriod (krpc_connection_t connection,
                                                  double * result)

void krpc_KerbalAlarmClock_Alarm_set_RepeatPeriod (double value)
    The time delay to automatically create an alarm after it has fired.

krpc_error_t krpc_KerbalAlarmClock_Alarm_Vessel (krpc_connection_t      connection,
                                                  krpc_SpaceCenter_Vessel_t * result)

```

void **krpc_KerbalAlarmClock_Alarm_set_Vessel** (*krpc_SpaceCenter_Vessel_t* value)

The vessel that the alarm is attached to.

krpc_error_t **krpc_KerbalAlarmClock_Alarm_XferOriginBody** (*krpc_connection_t* connection,
krpc_SpaceCenter_CelestialBody_t
* result)

void **krpc_KerbalAlarmClock_Alarm_set_XferOriginBody** (*krpc_SpaceCenter_CelestialBody_t* value)

The celestial body the vessel is departing from.

krpc_error_t **krpc_KerbalAlarmClock_Alarm_XferTargetBody** (*krpc_connection_t* connection,
krpc_SpaceCenter_CelestialBody_t
* result)

void **krpc_KerbalAlarmClock_Alarm_set_XferTargetBody** (*krpc_SpaceCenter_CelestialBody_t* value)

The celestial body the vessel is arriving at.

krpc_error_t **krpc_KerbalAlarmClock_Alarm_Remove** (*krpc_connection_t* connection)

Removes the alarm.

3.6.3 AlarmType

krpc_KerbalAlarmClock_AlarmType_t

The type of an alarm.

KRPC_KERBALALARMCLOCK_ALARMTYPE_RAW

An alarm for a specific date/time or a specific period in the future.

KRPC_KERBALALARMCLOCK_ALARMTYPE_MANEUVER

An alarm based on the next maneuver node on the current ships flight path. This node will be stored and can be restored when you come back to the ship.

KRPC_KERBALALARMCLOCK_ALARMTYPE_MANEUVERAUTO

See *KRPC_KERBALALARMCLOCK_ALARMTYPE_MANEUVER*.

KRPC_KERBALALARMCLOCK_ALARMTYPE_APOAPSIS

An alarm for furthest part of the orbit from the planet.

KRPC_KERBALALARMCLOCK_ALARMTYPE_PERIAPSIS

An alarm for nearest part of the orbit from the planet.

KRPC_KERBALALARMCLOCK_ALARMTYPE_ASCENDINGNODE

Ascending node for the targeted object, or equatorial ascending node.

KRPC_KERBALALARMCLOCK_ALARMTYPE_DESCENDINGNODE

Descending node for the targeted object, or equatorial descending node.

KRPC_KERBALALARMCLOCK_ALARMTYPE_CLOSEST

An alarm based on the closest approach of this vessel to the targeted vessel, some number of orbits into the future.

KRPC_KERBALALARMCLOCK_ALARMTYPE_CONTRACT

An alarm based on the expiry or deadline of contracts in career modes.

KRPC_KERBALALARMCLOCK_ALARMTYPE_CONTRACTAUTO

See *KRPC_KERBALALARMCLOCK_ALARMTYPE_CONTRACT*.

KRPC_KERBALALARMCLOCK_ALARMTYPE_CREW

An alarm that is attached to a crew member.

KRPC_KERBALALARMCLOCK_ALARMTYPE_DISTANCE

An alarm that is triggered when a selected target comes within a chosen distance.

KRPC_KERBALALARMCLOCK_ALARMTYPE_EARTHTIME

An alarm based on the time in the “Earth” alternative Universe (aka the Real World).

KRPC_KERBALALARMCLOCK_ALARMTYPE_LAUNCHRENDEVOUS

An alarm that fires as your landed craft passes under the orbit of your target.

KRPC_KERBALALARMCLOCK_ALARMTYPE_SOICHANGE

An alarm manually based on when the next SOI point is on the flight path or set to continually monitor the active flight path and add alarms as it detects SOI changes.

KRPC_KERBALALARMCLOCK_ALARMTYPE_SOICHANGEAUTO

See *KRPC_KERBALALARMCLOCK_ALARMTYPE_SOICHANGE*.

KRPC_KERBALALARMCLOCK_ALARMTYPE_TRANSFER

An alarm based on Interplanetary Transfer Phase Angles, i.e. when should I launch to planet X? Based on Kosmo Not’s post and used in Olex’s Calculator.

KRPC_KERBALALARMCLOCK_ALARMTYPE_TRANSFERMODELLED

See *KRPC_KERBALALARMCLOCK_ALARMTYPE_TRANSFER*.

3.6.4 AlarmAction

krpc_KerbalAlarmClock_AlarmAction_t

The action performed by an alarm when it fires.

KRPC_KERBALALARMCLOCK_ALARMACTION_DONOTHING

Don’t do anything at all. . .

KRPC_KERBALALARMCLOCK_ALARMACTION_DONOTHINGDELETEWHENPASSED

Don’t do anything, and delete the alarm.

KRPC_KERBALALARMCLOCK_ALARMACTION_KILLWARP

Drop out of time warp.

KRPC_KERBALALARMCLOCK_ALARMACTION_KILLWARPONLY

Drop out of time warp.

KRPC_KERBALALARMCLOCK_ALARMACTION_MESSAGEONLY

Display a message.

KRPC_KERBALALARMCLOCK_ALARMACTION_PAUSEGAME

Pause the game.

3.6.5 Example

The following example creates a new alarm for the active vessel. The alarm is set to trigger after 10 seconds have passed, and display a message.

```
#include <krpc.h>
#include <krpc/services/space_center.h>
#include <krpc/services/kerbal_alarm_clock.h>

int main() {
    krpc_connection_t conn;
    krpc_open(&conn, "COM0");
    krpc_
    ↪connect(conn, "Kerbal Alarm Clock Example");

    double ut;
    krpc_SpaceCenter_UT(conn, &ut);
    krpc_KerbalAlarmClock_Alarm_t alarm;
    krpc_KerbalAlarmClock_CreateAlarm(
        conn, &alarm, KRPC_KERBALALARMCLOCK_
    ↪ALARMTYPE_RAW, "My New Alarm", ut+10);

    krpc_KerbalAlarmClock_Alarm_set_Notes(
        conn, alarm, "10 seconds_
    ↪have now passed since the alarm was created.");
    krpc_KerbalAlarmClock_Alarm_set_Action(
        conn, alarm,
    ↪ KRPC_KERBALALARMCLOCK_ALARMACTION_MESSAGEONLY);
}
```

3.7 RemoteTech API

Provides RPCs to interact with the [RemoteTech](#) mod. Provides the following classes:

3.7.1 RemoteTech

Service RemoteTech

This service provides functionality to interact with [RemoteTech](#).

krpc_error_t **krpc_RemoteTech_Available** (*krpc_connection_t connection*, *bool * result*)
Whether RemoteTech is installed.

krpc_error_t **krpc_RemoteTech_GroundStations** (*krpc_connection_t connection*,
*krpc_list_string_t * result*)
The names of the ground stations.

krpc_error_t **krpc_RemoteTech_Antenna** (*krpc_connection_t connection*,
*krpc_RemoteTech_Antenna_t * result*,
krpc_SpaceCenter_Part_t part)
Get the antenna object for a particular part.

Parameters

```
krpc_error_t krpc_RemoteTech_Comms (krpc_connection_t      connection,
                                   krpc_RemoteTech_Comms_t * result,
                                   krpc_SpaceCenter_Vessel_t vessel)
```

Get a communications object, representing the communication capability of a particular vessel.

Parameters

3.7.2 Comms

krpc_RemoteTech_Comms_t
Communications for a vessel.

```
krpc_error_t krpc_RemoteTech_Comms_Vessel (krpc_connection_t      connection,
                                           krpc_SpaceCenter_Vessel_t * result)
```

Get the vessel.

```
krpc_error_t krpc_RemoteTech_Comms_HasLocalControl (krpc_connection_t      connection,
                                                    bool * result)
```

Whether the vessel can be controlled locally.

```
krpc_error_t krpc_RemoteTech_Comms_HasFlightComputer (krpc_connection_t      connection,
                                                       bool * result)
```

Whether the vessel has a flight computer on board.

```
krpc_error_t krpc_RemoteTech_Comms_HasConnection (krpc_connection_t      connection, bool
                                                    * result)
```

Whether the vessel has any connection.

```
krpc_error_t krpc_RemoteTech_Comms_HasConnectionToGroundStation (krpc_connection_t con-
                                                                    nection,  bool
                                                                    * result)
```

Whether the vessel has a connection to a ground station.

```
krpc_error_t krpc_RemoteTech_Comms_SignalDelay (krpc_connection_t      connection, double
                                                  * result)
```

The shortest signal delay to the vessel, in seconds.

```
krpc_error_t krpc_RemoteTech_Comms_SignalDelayToGroundStation (krpc_connection_t con-
                                                                nection,  double
                                                                * result)
```

The signal delay between the vessel and the closest ground station, in seconds.

```
krpc_error_t krpc_RemoteTech_Comms_SignalDelayToVessel (krpc_connection_t      con-
                                                         nection, double * result,
                                                         krpc_SpaceCenter_Vessel_t other)
```

The signal delay between the this vessel and another vessel, in seconds.

Parameters

```
krpc_error_t krpc_RemoteTech_Comms_Antennas (krpc_connection_t      connection,
                                              krpc_list_object_t * result)
```

The antennas for this vessel.

3.7.3 Antenna

krpc_RemoteTech_Antenna_t
A RemoteTech antenna.

Obtained by calling

krpc_RemoteTech_Comms_Antennas() or
krpc_RemoteTech_Antenna().

krpc_error_t **krpc_RemoteTech_Antenna_Part** (*krpc_connection_t* *connection*,
krpc_SpaceCenter_Part_t * *result*)

Get the part containing this antenna.

krpc_error_t **krpc_RemoteTech_Antenna_HasConnection** (*krpc_connection_t* *connection*,
bool * *result*)

Whether the antenna has a connection.

krpc_error_t **krpc_RemoteTech_Antenna_Target** (*krpc_connection_t* *connection*,
krpc_RemoteTech_Target_t * *result*)

void **krpc_RemoteTech_Antenna_set_Target** (*krpc_RemoteTech_Target_t* *value*)

The object that the antenna is targetting. This property can be used to set the target to *KRPC_REMOTETECH_TARGET_NONE* or *KRPC_REMOTETECH_TARGET_ACTIVEVESSEL*. To set the target to a celestial body, ground station or vessel see *krpc_RemoteTech_Antenna_TargetBody()*, *krpc_RemoteTech_Antenna_TargetGroundStation()* and *krpc_RemoteTech_Antenna_TargetVessel()*.

krpc_error_t **krpc_RemoteTech_Antenna_TargetBody** (*krpc_connection_t* *connection*,
krpc_SpaceCenter_CelestialBody_t * *result*)

void **krpc_RemoteTech_Antenna_set_TargetBody** (*krpc_SpaceCenter_CelestialBody_t* *value*)

The celestial body the antenna is targetting.

krpc_error_t **krpc_RemoteTech_Antenna_TargetGroundStation** (*krpc_connection_t* *connection*, *char* * * *result*)

void **krpc_RemoteTech_Antenna_set_TargetGroundStation** (*const char* * *value*)

The ground station the antenna is targetting.

krpc_error_t **krpc_RemoteTech_Antenna_TargetVessel** (*krpc_connection_t* *connection*,
krpc_SpaceCenter_Vessel_t * *result*)

void **krpc_RemoteTech_Antenna_set_TargetVessel** (*krpc_SpaceCenter_Vessel_t* *value*)

The vessel the antenna is targetting.

krpc_RemoteTech_Target_t

The type of object an antenna is targetting. See *krpc_RemoteTech_Antenna_Target()*.

KRPC_REMOTETECH_TARGET_ACTIVEVESSEL

The active vessel.

KRPC_REMOTETECH_TARGET_CELESTIALBODY

A celestial body.

KRPC_REMOTETECH_TARGET_GROUNDSTATION

A ground station.

KRPC_REMOTETECH_TARGET_VESSEL

A specific vessel.

KRPC_REMOTETECH_TARGET_NONE

No target.

3.7.4 Example

The following example sets the target of a dish on the active vessel then prints out the signal delay to the active vessel.

```
#include <krpc.h>
#include <krpc/services/space_center.h>
#include <krpc/services/remote_tech.h>

int main() {
    krpc_connection_t conn;
    krpc_open(&conn, "COM0");
    krpc_connect(conn, "RemoteTech Example");
    krpc_SpaceCenter_Vessel_t vessel;
    krpc_SpaceCenter_ActiveVessel(conn, &vessel);

    // Set a dish target
    krpc_SpaceCenter_Parts_t parts;
    krpc_SpaceCenter_Vessel_Parts(conn, &parts, vessel);
    krpc_list_object_t parts_with_title;
    krpc_SpaceCenter_Parts_WithTitle(conn,
    ↪ &parts_with_title, parts, "Reflectron KR-7");
    krpc_SpaceCenter_Part_t part = parts_with_title.items[0];

    krpc_RemoteTech_Antenna_t antenna;
    krpc_RemoteTech_Antenna(conn, &antenna, part);

    krpc_dictionary_string_object_t bodies = KRPC_NULL_DICTIONARY;
    ↪ krpc_SpaceCenter_Bodies(conn, &bodies);
    krpc_SpaceCenter_CelestialBody_t jool;
    for (size_t i = 0; i < bodies.size; i++)
        if (!strcmp(bodies.entries[i].key, "Jool"))
            jool = bodies.entries[i].value;

    krpc_RemoteTech_Antenna_set_TargetBody(conn, antenna, jool);
    ↪

    // Get info about the vessels communications
    krpc_RemoteTech_Comms_t comms;
    krpc_RemoteTech_Comms(conn, &comms, vessel);
    double signal_delay;
    krpc_RemoteTech_Comms_SignalDelay(conn, &signal_delay, comms);
    ↪ printf("Signal delay = %.2f\n", signal_delay);
}
```

3.8 User Interface API

3.8.1 UI

Service UI

Provides functionality for drawing and interacting with in-game user interface elements.

krpc_error_t **krpc_UI_StockCanvas** (*krpc_connection_t connection*, *krpc_UI_Canvas_t * result*)

The stock UI canvas.

krpc_error_t **krpc_UI_AddCanvas** (*krpc_connection_t connection*, *krpc_UI_Canvas_t * result*)

Add a new canvas.

Note: If you want to add UI elements to KSP's stock UI canvas, use *krpc_UI_StockCanvas()*.

krpc_error_t **krpc_UI_Message** (*krpc_connection_t connection*, *const char * content*, *float duration*, *krpc_UI_MessagePosition_t position*)

Display a message on the screen.

Parameters

- **content** – Message content.
- **duration** – Duration before the message disappears, in seconds.
- **position** – Position to display the message.

Note: The message appears just like a stock message, for example quicksave or quickload messages.

krpc_error_t **krpc_UI_Clear** (*krpc_connection_t connection*, *bool clientOnly*)

Remove all user interface elements.

Parameters

- **clientOnly** – If true, only remove objects created by the calling client.

krpc_UI_MessagePosition_t

Message position.

KRPC_UI_MESSAGEPOSITION_TOPLEFT

Top left.

KRPC_UI_MESSAGEPOSITION_TOPCENTER

Top center.

KRPC_UI_MESSAGEPOSITION_TOPRIGHT

Top right.

KRPC_UI_MESSAGEPOSITION_BOTTOMCENTER

Bottom center.

3.8.2 Canvas

krpc_UI_Canvas_t

A canvas for user interface elements. See *krpc_UI_StockCanvas()* and *krpc_UI_AddCanvas()*.

krpc_error_t **krpc_UI_Canvas_RectTransform** (*krpc_connection_t* *connection*,
krpc_UI_RectTransform_t * *result*)

The rect transform for the canvas.

krpc_error_t **krpc_UI_Canvas_Visible** (*krpc_connection_t* *connection*, *bool* * *result*)

void **krpc_UI_Canvas_set_Visible** (*bool* *value*)

Whether the UI object is visible.

krpc_error_t **krpc_UI_Canvas_AddPanel** (*krpc_connection_t* *connection*, *krpc_UI_Panel_t* * *result*,
bool *visible*)

Create a new container for user interface elements.

Parameters

- **visible** – Whether the panel is visible.

krpc_error_t **krpc_UI_Canvas_AddText** (*krpc_connection_t* *connection*, *krpc_UI_Text_t* * *result*,
const char * *content*, *bool* *visible*)

Add text to the canvas.

Parameters

- **content** – The text.
- **visible** – Whether the text is visible.

krpc_error_t **krpc_UI_Canvas_AddInputField** (*krpc_connection_t* *connection*,
krpc_UI_InputField_t * *result*, *bool* *visible*)

Add an input field to the canvas.

Parameters

- **visible** – Whether the input field is visible.

krpc_error_t **krpc_UI_Canvas_AddButton** (*krpc_connection_t* *connection*, *krpc_UI_Button_t* * *result*,
const char * *content*, *bool* *visible*)

Add a button to the canvas.

Parameters

- **content** – The label for the button.
- **visible** – Whether the button is visible.

krpc_error_t **krpc_UI_Canvas_Remove** (*krpc_connection_t* *connection*)

Remove the UI object.

3.8.3 Panel

krpc_UI_Panel_t

A container for user interface elements. See

krpc_UI_Canvas_AddPanel ().

krpc_error_t **krpc_UI_Panel_RectTransform** (*krpc_connection_t* *connection*,
krpc_UI_RectTransform_t * *result*)

The rect transform for the panel.

krpc_error_t **krpc_UI_Panel_Visible** (*krpc_connection_t* *connection*, *bool* * *result*)

void **krpc_UI_Panel_set_Visible** (*bool* *value*)

Whether the UI object is visible.

krpc_error_t **krpc_UI_Panel_AddPanel** (*krpc_connection_t* *connection*, *krpc_UI_Panel_t* * *result*,
bool *visible*)

Create a panel within this panel.

Parameters

- **visible** – Whether the new panel is visible.

krpc_error_t **krpc_UI_Panel_AddText** (*krpc_connection_t* *connection*, *krpc_UI_Text_t* * *result*,
const char * *content*, bool *visible*)

Add text to the panel.

Parameters

- **content** – The text.
- **visible** – Whether the text is visible.

krpc_error_t **krpc_UI_Panel_AddInputField** (*krpc_connection_t* *connection*,
krpc_UI_InputField_t * *result*, bool *visible*)

Add an input field to the panel.

Parameters

- **visible** – Whether the input field is visible.

krpc_error_t **krpc_UI_Panel_AddButton** (*krpc_connection_t* *connection*, *krpc_UI_Button_t* * *result*,
const char * *content*, bool *visible*)

Add a button to the panel.

Parameters

- **content** – The label for the button.
- **visible** – Whether the button is visible.

krpc_error_t **krpc_UI_Panel_Remove** (*krpc_connection_t* *connection*)

Remove the UI object.

3.8.4 Text

krpc_UI_Text_t

A text label. See *krpc_UI_Panel_AddText()*.

krpc_error_t **krpc_UI_Text_RectTransform** (*krpc_connection_t* *connection*,
krpc_UI_RectTransform_t * *result*)

The rect transform for the text.

krpc_error_t **krpc_UI_Text_Visible** (*krpc_connection_t* *connection*, bool * *result*)

void **krpc_UI_Text_set_Visible** (bool *value*)

Whether the UI object is visible.

krpc_error_t **krpc_UI_Text_Content** (*krpc_connection_t* *connection*, char ** *result*)

void **krpc_UI_Text_set_Content** (const char * *value*)

The text string

krpc_error_t **krpc_UI_Text_Font** (*krpc_connection_t* *connection*, char ** *result*)

void **krpc_UI_Text_set_Font** (const char * *value*)

Name of the font

krpc_error_t **krpc_UI_Text_AvailableFonts** (*krpc_connection_t connection*, *krpc_list_string_t* * *result*)

A list of all available fonts.

krpc_error_t **krpc_UI_Text_Size** (*krpc_connection_t connection*, *int32_t* * *result*)

void **krpc_UI_Text_set_Size** (*int32_t value*)

Font size.

krpc_error_t **krpc_UI_Text_Style** (*krpc_connection_t connection*, *krpc_UI_FontStyle_t* * *result*)

void **krpc_UI_Text_set_Style** (*krpc_UI_FontStyle_t value*)

Font style.

krpc_error_t **krpc_UI_Text_Color** (*krpc_connection_t connection*, *krpc_tuple_double_double_double_t* * *result*)

void **krpc_UI_Text_set_Color** (*const krpc_tuple_double_double_double_t* * *value*)

Set the color

krpc_error_t **krpc_UI_Text_Alignment** (*krpc_connection_t connection*, *krpc_UI_TextAnchor_t* * *result*)

void **krpc_UI_Text_set_Alignment** (*krpc_UI_TextAnchor_t value*)

Alignment.

krpc_error_t **krpc_UI_Text_LineSpacing** (*krpc_connection_t connection*, *float* * *result*)

void **krpc_UI_Text_set_LineSpacing** (*float value*)

Line spacing.

krpc_error_t **krpc_UI_Text_Remove** (*krpc_connection_t connection*)

Remove the UI object.

krpc_UI_FontStyle_t

Font style.

KRPC_UI_FONTSTYLE_NORMAL

Normal.

KRPC_UI_FONTSTYLE_BOLD

Bold.

KRPC_UI_FONTSTYLE_ITALIC

Italic.

KRPC_UI_FONTSTYLE_BOLDANDITALIC

Bold and italic.

krpc_UI_TextAlignment_t

Text alignment.

KRPC_UI_TEXTALIGNMENT_LEFT

Left aligned.

KRPC_UI_TEXTALIGNMENT_RIGHT

Right aligned.

KRPC_UI_TEXTALIGNMENT_CENTER

Center aligned.

krpc_UI_TextAnchor_t

Text alignment.

KRPC_UI_TEXTANCHOR_LOWERCENTER

Lower center.

KRPC_UI_TEXTANCHOR_LOWERLEFT

Lower left.

KRPC_UI_TEXTANCHOR_LOWERRIGHT

Lower right.

KRPC_UI_TEXTANCHOR_MIDDLECENTER

Middle center.

KRPC_UI_TEXTANCHOR_MIDDLELEFT

Middle left.

KRPC_UI_TEXTANCHOR_MIDDLERIGHT

Middle right.

KRPC_UI_TEXTANCHOR_UPPERCENTER

Upper center.

KRPC_UI_TEXTANCHOR_UPPERLEFT

Upper left.

KRPC_UI_TEXTANCHOR_UPPERRIGHT

Upper right.

3.8.5 Button

krpc_UI_Button_t

A text label. See *krpc_UI_Panel_AddButton()*.

krpc_error_t **krpc_UI_Button_RectTransform** (*krpc_connection_t* *connection*,
krpc_UI_RectTransform_t * *result*)

The rect transform for the text.

krpc_error_t **krpc_UI_Button_Visible** (*krpc_connection_t* *connection*, *bool* * *result*)

void **krpc_UI_Button_set_Visible** (*bool* *value*)

Whether the UI object is visible.

krpc_error_t **krpc_UI_Button_Text** (*krpc_connection_t* *connection*, *krpc_UI_Text_t* * *result*)

The text for the button.

krpc_error_t **krpc_UI_Button_Clicked** (*krpc_connection_t* *connection*, *bool* * *result*)

void **krpc_UI_Button_set_Clicked** (*bool* *value*)

Whether the button has been clicked.

Note: This property is set to true when the user clicks the button.
A client script should reset the property to false in order to detect
subsequent button presses.

krpc_error_t **krpc_UI_Button_Remove** (*krpc_connection_t* *connection*)

Remove the UI object.

3.8.6 InputField

krpc_UI_InputField_t

An input field. See *krpc_UI_Panel_AddInputField()*.

krpc_error_t **krpc_UI_InputField_RectTransform** (*krpc_connection_t* *connection*,
krpc_UI_RectTransform_t * *result*)

The rect transform for the input field.

krpc_error_t **krpc_UI_InputField_Visible** (*krpc_connection_t* *connection*, *bool* * *result*)

void **krpc_UI_InputField_set_Visible** (*bool* *value*)

Whether the UI object is visible.

krpc_error_t **krpc_UI_InputField_Value** (*krpc_connection_t* *connection*, *char* * * *result*)

void **krpc_UI_InputField_set_Value** (*const char* * *value*)

The value of the input field.

krpc_error_t **krpc_UI_InputField_Text** (*krpc_connection_t* *connection*, *krpc_UI_Text_t* * *result*)

The text component of the input field.

Note: Use *krpc_UI_InputField_Value()* to get and set the value in the field. This object can be used to alter the style of the input field's text.

krpc_error_t **krpc_UI_InputField_Changed** (*krpc_connection_t* *connection*, *bool* * *result*)

void **krpc_UI_InputField_set_Changed** (*bool* *value*)

Whether the input field has been changed.

Note: This property is set to true when the user modifies the value of the input field. A client script should reset the property to false in order to detect subsequent changes.

krpc_error_t **krpc_UI_InputField_Remove** (*krpc_connection_t* *connection*)

Remove the UI object.

3.8.7 Rect Transform

krpc_UI_RectTransform_t

A Unity engine Rect Transform for a UI object. See the [Unity manual](#) for more details.

krpc_error_t **krpc_UI_RectTransform_Position** (*krpc_connection_t* *connection*,
krpc_tuple_double_double_t * *result*)

void **krpc_UI_RectTransform_set_Position** (*const* *krpc_tuple_double_double_t* * *value*)

Position of the rectangles pivot point relative to the anchors.

krpc_error_t **krpc_UI_RectTransform_LocalPosition** (*krpc_connection_t* *connection*,
krpc_tuple_double_double_double_t * *result*)

void **krpc_UI_RectTransform_set_LocalPosition** (const krpc_tuple_double_double_double_t
* *value*)

Position of the rectangles pivot point relative to the anchors.

krpc_error_t **krpc_UI_RectTransform_Size** (krpc_connection_t *connection*,
krpc_tuple_double_double_t * *result*)

void **krpc_UI_RectTransform_set_Size** (const krpc_tuple_double_double_t * *value*)
Width and height of the rectangle.

krpc_error_t **krpc_UI_RectTransform_UpperRight** (krpc_connection_t *connection*,
krpc_tuple_double_double_t * *result*)

void **krpc_UI_RectTransform_set_UpperRight** (const krpc_tuple_double_double_t * *value*)
Position of the rectangles upper right corner relative to the anchors.

krpc_error_t **krpc_UI_RectTransform_LowerLeft** (krpc_connection_t *connection*,
krpc_tuple_double_double_t * *result*)

void **krpc_UI_RectTransform_set_LowerLeft** (const krpc_tuple_double_double_t * *value*)
Position of the rectangles lower left corner relative to the anchors.

void **krpc_UI_RectTransform_set_Anchor** (const krpc_tuple_double_double_t * *value*)
Set the minimum and maximum anchor points as a fraction of the
size of the parent rectangle.

krpc_error_t **krpc_UI_RectTransform_AnchorMax** (krpc_connection_t *connection*,
krpc_tuple_double_double_t * *result*)

void **krpc_UI_RectTransform_set_AnchorMax** (const krpc_tuple_double_double_t * *value*)
The anchor point for the lower left corner of the rectangle defined
as a fraction of the size of the parent rectangle.

krpc_error_t **krpc_UI_RectTransform_AnchorMin** (krpc_connection_t *connection*,
krpc_tuple_double_double_t * *result*)

void **krpc_UI_RectTransform_set_AnchorMin** (const krpc_tuple_double_double_t * *value*)
The anchor point for the upper right corner of the rectangle defined
as a fraction of the size of the parent rectangle.

krpc_error_t **krpc_UI_RectTransform_Pivot** (krpc_connection_t *connection*,
krpc_tuple_double_double_t * *result*)

void **krpc_UI_RectTransform_set_Pivot** (const krpc_tuple_double_double_t * *value*)
Location of the pivot point around which the rectangle rotates, de-
fined as a fraction of the size of the rectangle itself.

krpc_error_t **krpc_UI_RectTransform_Rotation** (krpc_connection_t *connection*,
krpc_tuple_double_double_double_double_t
* *result*)

void **krpc_UI_RectTransform_set_Rotation** (const krpc_tuple_double_double_double_double_t
* *value*)
Rotation, as a quaternion, of the object around its pivot point.

krpc_error_t **krpc_UI_RectTransform_Scale** (krpc_connection_t *connection*,
krpc_tuple_double_double_double_t * *result*)

void **krpc_UI_RectTransform_set_Scale** (const krpc_tuple_double_double_double_t * *value*)
Scale factor applied to the object in the x, y and z dimensions.

4.1 C# Client

This client provides a C# API for interacting with a kRPC server. It is distributed as an assembly named `KRPC.Client.dll`.

4.1.1 Installing the Library

The C# client can be [installed using NuGet](#) or [downloaded from GitHub](#). Two versions of the client are provided: one compatible with .NET 4.5 and one for .NET 3.5.

You also need to [install Google.Protobuf](#) using NuGet.

Note: The copy of `Google.Protobuf.dll` in the `GameData` folder included with the kRPC server plugin is *not* the official release of this assembly. It is a modified version built for .NET 3.5 so that it works within KSP.

4.1.2 Connecting to the Server

To connect to a server, create a *Connection* object. All interaction with the server is done via this object. When constructed without any arguments, it will connect to the local machine on the default port numbers. You can specify different connection settings, and also a descriptive name for the connection, as follows:

```
using System;
using System.Net;
using KRPC.Client;
using KRPC.Client.Services.KRPC;

class Program {
    public static void Main() {
        using (var connection = new Connection(
            name: "My Example Program",
            address: IPAddress.Parse("192.168.0.10"),
            rpcPort: 1000,
            streamPort: 1001)) {
            var krpc = connection.KRPC();
            Console.WriteLine(krpc.GetStatus().Version);
        }
    }
}
```

The *Connection* object needs to be disposed of correctly when finished with, so that the network connection it manages can be released. This can be done with a `using` block (as in the example above) or by calling *Connection.Dispose* directly.

4.1.3 Calling Remote Procedures

The kRPC server provides *procedures* that a client can run. These procedures are arranged in groups called *services* to keep things organized. The functionality for the services are defined in the namespace `KRPC.Client.Services`. *. For example, all of the functionality provided by the `SpaceCenter` service is contained in the namespace `KRPC.Client.Services.SpaceCenter`.

To interact with a service, you must first instantiate it. You can then call its methods and properties to invoke remote procedures. The following example demonstrates how to do this. It instantiates the `SpaceCenter` service and calls `KRPC.Client.Services.SpaceCenter.SpaceCenter.ActiveVessel` to get an object representing the active vessel (of type `KRPC.Client.Services.SpaceCenter.Vessel`). It sets the name of the vessel and then prints out its altitude:

```
using System;
using KRPC.Client;
using KRPC.Client.Services.SpaceCenter;

class Program {
    public static void Main() {
        using (var connection = new Connection()) {
            var spaceCenter = connection.SpaceCenter();
            var vessel = spaceCenter.ActiveVessel;
            vessel.Name = "My Vessel";
            var flightInfo = vessel.Flight();
            Console.WriteLine(flightInfo.MeanAltitude);
        }
    }
}
```

4.1.4 Streaming Data from the Server

A common use case for kRPC is to continuously extract data from the game. The naive approach to do this would be to repeatedly call a remote procedure, such as in the following which repeatedly prints the position of the active vessel:

```
using System;
using KRPC.Client;
using KRPC.Client.Services.SpaceCenter;

class Program {
    public static void Main() {
        var connection = new Connection();
        var spaceCenter = connection.SpaceCenter();
        var vessel = spaceCenter.ActiveVessel;
        var refFrame = vessel.Orbit.Body.ReferenceFrame;
        while (true)
            Console.WriteLine(vessel.Position(refFrame));
    }
}
```

This approach requires significant communication overhead as request/response messages are repeatedly sent between the client and server. kRPC provides a more efficient mechanism to achieve this, called *streams*.

A stream repeatedly executes a procedure on the server (with a fixed set of argument values) and sends the result to the client. It only requires a single message to be sent to the server to establish the stream, which will then continuously send data to the client until the stream is closed.

The following example does the same thing as above using streams:

```
using System;
using KRPC.Client;
using KRPC.Client.Services.SpaceCenter;

class Program {
    public static void Main() {
        var connection = new Connection();
        var spaceCenter = connection.SpaceCenter();
        var vessel = spaceCenter.ActiveVessel;
        var refFrame = vessel.Orbit.Body.ReferenceFrame;
        var posStream = connection.AddStream(() => vessel.Position(refFrame));
        while (true)
            Console.WriteLine(posStream.Get());
    }
}
```

It calls *Connection.AddStream* once at the start of the program to create the stream, and then repeatedly prints the position returned by the stream. The stream is automatically closed when the client disconnects.

A stream can be created for any method call by calling *Connection.AddStream* and passing it a lambda expression that invokes the desired method. This lambda expression must take zero arguments and be either a method call expression or a parameter call expression. It returns a stream object of type *Stream*. The most recent value of the stream can be obtained by calling *Stream.Get*. A stream can be stopped and removed from the server by calling *Stream.Remove* on the stream object. All of a clients streams are automatically stopped when it disconnects.

4.1.5 Synchronizing with Stream Updates

A common use case for kRPC is to wait until the value returned by a method or attribute changes, and then take some action. kRPC provides two mechanisms to do this efficiently: *condition variables* and *callbacks*.

Condition Variables

Each stream has a condition variable associated with it, that is notified whenever the value of the stream changes. These can be used to block the current thread of execution until the value of the stream changes.

The following example waits until the abort button is pressed in game, by waiting for the value of *KRPC.Client.Services.SpaceCenter.Control.Abort* to change to true:

```
using System;
using KRPC.Client;
using KRPC.Client.Services.SpaceCenter;

class Program {
    public static void Main() {
        var connection = new Connection();
        var spaceCenter = connection.SpaceCenter();
        var control = spaceCenter.ActiveVessel.Control;
        var abort = connection.AddStream(() => control.Abort);
    }
}
```

```
        lock (abort.Condition) {  
            while (!abort.Get())  
                abort.Wait();  
        }  
    }  
}
```

This code creates a stream, acquires a lock on the streams condition variable (by using a `lock` statement) and then repeatedly checks the value of `Abort`. It leaves the loop when it changes to true.

The body of the loop calls `Wait` on the stream, which causes the program to block until the value changes. This prevents the loop from ‘spinning’ and so it does not consume processing resources whilst waiting.

Note: The stream does not start receiving updates until the first call to `Wait`. This means that the example code will not miss any updates to the streams value, as it will have already locked the condition variable before the first stream update is received.

Callbacks

Streams allow you to register callback functions that are called whenever the value of the stream changes. Callback functions should take a single argument, which is the new value of the stream, and should return nothing.

For example the following program registers two callbacks that are invoked when the value of `KRPC.Client.Services.SpaceCenter.Control.Abort` changes:

```
using System;  
using KRPC.Client;  
using KRPC.Client.Services.SpaceCenter;  
  
class Program {  
    public static void Main() {  
        var connection = new Connection();  
        var spaceCenter = connection.SpaceCenter();  
        var control = spaceCenter.ActiveVessel.Control;  
        var abort = connection.AddStream(() => control.Abort);  
  
        abort.AddCallback(  
            (bool x) => {  
                Console.WriteLine("Abort 1 called with a value of " + x);  
            }  
        );  
        abort.AddCallback(  
            (bool x) => {  
                Console.WriteLine("Abort 2 called with a value of " + x);  
            }  
        );  
        abort.Start();  
  
        // Keep the program running...  
        while (true) {  
        }  
    }  
}
```

Note: When a stream is created it does not start receiving updates until `Start` is called. This is implicitly called

when accessing the value of a stream, but as this example does not do this an explicit call to `Start` is required.

Note: The callbacks are registered before the call to `Start` so that stream updates are not missed.

Note: The callback function may be called from a different thread to that which created the stream. Any changes to shared state must therefore be protected with appropriate synchronization.

4.1.6 Custom Events

Some procedures return event objects of type *Event*. These allow you to wait until an event occurs, by calling *Event.Wait*. Under the hood, these are implemented using streams and condition variables.

Custom events can also be created. An expression API allows you to create code that runs on the server and these can be used to build a custom event. For example, the following creates the expression `MeanAltitude > 1000` and then creates an event that will be triggered when the expression returns true:

```
using System;
using KRPC.Client;
using KRPC.Client.Services.KRPC;
using KRPC.Client.Services.SpaceCenter;

class Program {
    public static void Main() {
        var connection = new Connection();
        var krpc = connection.KRPC();
        var spaceCenter = connection.SpaceCenter();
        var flight = spaceCenter.ActiveVessel.Flight();

        // Get the remote procedure call as a message object,
        // so it can be passed to the server
        var meanAltitude = Connection.GetCall(() => flight.MeanAltitude);

        // Create an expression on the server
        var expr = Expression.GreaterThan(connection,
            Expression.Call(connection, meanAltitude),
            Expression.ConstantDouble(connection, 1000));

        var evnt = krpc.AddEvent(expr);
        lock (evnt.Condition) {
            evnt.Wait();
            Console.WriteLine("Altitude reached 1000m");
        }
    }
}
```

4.1.7 Client API Reference

class `IConnection`

Interface implemented by the *Connection* class.

class Connection

A connection to the kRPC server. All interaction with kRPC is performed via an instance of this class.

Connection (*String name* = "", *Net.IPAddress address* = null, *Int32 rpcPort* = 50000, *Int32 streamPort* = 50001)

Connect to a kRPC server.

Parameters

- **name** – A descriptive name for the connection. This is passed to the server and appears in the in-game server window.
- **address** – The address of the server to connect to. Defaults to 127.0.0.1.
- **rpc_port** – The port number of the RPC Server. Defaults to 50000. This should match the RPC port number of the server you want to connect to.
- **stream_port** – The port number of the Stream Server. Defaults to 50001. This should match the stream port number of the server you want to connect to.

Stream<ReturnType> **AddStream***<ReturnType>* (*LambdaExpression expression*)

Create a new stream from the given lambda expression.

KRPC.Schema.KRPC.ProcedureCall **GetCall** (*LambdaExpression expression*)

Returns a procedure call message for the given lambda expression. This allows descriptions of procedure calls to be passed to the server, for example when constructing custom events. See *Custom Events*.

void **Dispose** ()

Closes the connection and frees the resources associated with it.

class Stream<ReturnType>

This class represents a stream. See *Streaming Data from the Server*.

Stream objects implement *GetHashCode*, *Equals*, *operator ==* and *operator !=* such that two stream objects are equal if they are bound to the same stream on the server.

void **Start** (*Boolean wait* = true)

Starts the stream. When a stream is created by calling *Connection.AddStream* it does not start sending updates to the client until this method is called.

If wait is true, this method will block until at least one update has been received from the server.

If wait is false, the method starts the stream and returns immediately. Subsequent calls to *Get* may raise an *InvalidOperationException* if the stream does not yet contain a value.

Single Rate { *get*; *set*; }

The update rate of the stream in Hertz. When set to zero, the rate is unlimited.

ReturnType **Get** ()

Returns the most recent value for the stream. If executing the remote procedure for the stream throws an exception, calling this method will rethrow the exception. Raises an *InvalidOperationException* if no update has been received from the server.

If the stream has not been started this method calls *Start(true)* to start the stream and wait until at least one update has been received.

object **Condition** { *get*; }

A condition variable that is notified (using *Monitor.PulseAll*) whenever the value of the stream changes.

void **Wait** (*Double timeout* = -1)

This method blocks until the value of the stream changes or the operation times out.

The streams condition variable must be locked before calling this method.

If *timeout* is specified and is greater than or equal to 0, it is the timeout in seconds for the operation.

If the stream has not been started this method calls `Start(false)` to start the stream (without waiting for at least one update to be received).

void **AddCallback** (Action<ReturnType> *callback*)

Adds a callback function that is invoked whenever the value of the stream changes. The callback function should take one argument, which is passed the new value of the stream.

Note: The callback function may be called from a different thread to that which created the stream. Any changes to shared state must therefore be protected with appropriate synchronization.

void **Remove** ()

Removes the stream from the server.

class Event

This class represents an event. See *Custom Events*. It is wrapper around a [Boolean](#) that indicates when the event occurs.

Event objects implement `GetHashCode`, `Equals`, `operator ==` and `operator !=` such that two event objects are equal if they are bound to the same underlying stream on the server.

void **Start** ()

Starts the event. When an event is created, it will not receive updates from the server until this method is called.

object **Condition** { **get**; }

The condition variable that is notified (using `Monitor.PulseAll`) whenever the event occurs.

void **Wait** (Double *timeout* = -1)

This method blocks until the event occurs or the operation times out.

The events condition variable must be locked before calling this method.

If *timeout* is specified and is greater than or equal to 0, it is the timeout in seconds for the operation.

If the event has not been started this method calls `Start()` to start the underlying stream.

void **AddCallback** (Action *callback*)

Adds a callback function that is invoked whenever the event occurs. The callback function should be a function that takes zero arguments.

void **Remove** ()

Removes the event from the server.

Stream<Boolean> **Stream** { **get**; }

Returns the underlying stream for the event.

4.2 KRPC API

4.2.1 KRPC

None None None None

class KRPC

Main kRPC service, used by clients to interact with basic server functionality.

Byte[] GetClientID ()

Returns the identifier for the current client.

String GetClientName ()

Returns the name of the current client. This is an empty string if the client has no name.

IList<Tuple<Byte[], String, String>> Clients { get; }

A list of RPC clients that are currently connected to the server. Each entry in the list is a clients identifier, name and address.

KRPC.Schema.KRPC.Status GetStatus ()

Returns some information about the server, such as the version.

KRPC.Schema.KRPC.Services GetServices ()

Returns information on all services, procedures, classes, properties etc. provided by the server. Can be used by client libraries to automatically create functionality such as stubs.

void SetStreamRate (UInt64 id, Single rate)

Set the update rate for a stream in Hz.

Parameters

GameScene CurrentGameScene { get; }

Get the current game scene.

Boolean Paused { get; set; }

Whether the game is paused.

enum GameScene

The game scene. See *KRPC.CurrentGameScene*.

SpaceCenter

The game scene showing the Kerbal Space Center buildings.

Flight

The game scene showing a vessel in flight (or on the launchpad/runway).

TrackingStation

The tracking station.

EditorVAB

The Vehicle Assembly Building.

EditorSPH

The Space Plane Hangar.

class InvalidOperationException

A method call was made to a method that is invalid given the current state of the object.

class ArgumentException

A method was invoked where at least one of the passed arguments does not meet the parameter specification of the method.

class ArgumentNullException

A null reference was passed to a method that does not accept it as a valid argument.

class ArgumentOutOfRangeException

The value of an argument is outside the allowable range of values as defined by the invoked method.

4.2.2 Expressions

class Expression

A server side expression.

static Expression **ConstantDouble** (*ICConnection connection*, *Double value*)

A constant value of type double.

Parameters

static Expression **ConstantFloat** (*ICConnection connection*, *Single value*)

A constant value of type float.

Parameters

static Expression **ConstantInt** (*ICConnection connection*, *Int32 value*)

A constant value of type int.

Parameters

static Expression **ConstantString** (*ICConnection connection*, *String value*)

A constant value of type string.

Parameters

static Expression **Call** (*ICConnection connection*, *KRPC.Schema.KRPC.ProcedureCall call*)

An RPC call.

Parameters

static Expression **Equal** (*ICConnection connection*, *Expression arg0*, *Expression arg1*)

Equality comparison.

Parameters

static Expression **NotEqual** (*ICConnection connection*, *Expression arg0*, *Expression arg1*)

Inequality comparison.

Parameters

static Expression **GreaterThan** (*ICConnection connection*, *Expression arg0*, *Expression arg1*)

Greater than numerical comparison.

Parameters

static Expression **GreaterThanOrEqual** (*ICConnection connection*, *Expression arg0*, *Expression arg1*)

Greater than or equal numerical comparison.

Parameters

static Expression **LessThan** (*ICConnection connection*, *Expression arg0*, *Expression arg1*)

Less than numerical comparison.

Parameters

static Expression **LessThanOrEqual** (*ICConnection connection*, *Expression arg0*, *Expression arg1*)

Less than or equal numerical comparison.

Parameters

static Expression **And** (*ICConnection connection*, *Expression arg0*, *Expression arg1*)

Boolean and operator.

Parameters

static Expression **Or** (*ICollection connection, Expression arg0, Expression arg1*)
Boolean or operator.

Parameters

static Expression **ExclusiveOr** (*ICollection connection, Expression arg0, Expression arg1*)
Boolean exclusive-or operator.

Parameters

static Expression **Not** (*ICollection connection, Expression arg*)
Boolean negation operator.

Parameters

static Expression **Add** (*ICollection connection, Expression arg0, Expression arg1*)
Numerical addition.

Parameters

static Expression **Subtract** (*ICollection connection, Expression arg0, Expression arg1*)
Numerical subtraction.

Parameters

static Expression **Multiply** (*ICollection connection, Expression arg0, Expression arg1*)
Numerical multiplication.

Parameters

static Expression **Divide** (*ICollection connection, Expression arg0, Expression arg1*)
Numerical division.

Parameters

static Expression **Modulo** (*ICollection connection, Expression arg0, Expression arg1*)
Numerical modulo operator.

Parameters

Returns The remainder of arg0 divided by arg1

static Expression **Power** (*ICollection connection, Expression arg0, Expression arg1*)
Numerical power operator.

Parameters

Returns arg0 raised to the power of arg1

static Expression **LeftShift** (*ICollection connection, Expression arg0, Expression arg1*)
Bitwise left shift.

Parameters

static Expression **RightShift** (*ICollection connection, Expression arg0, Expression arg1*)
Bitwise right shift.

Parameters

static Expression **ToDouble** (*ICollection connection, Expression arg*)
Convert to a double type.

Parameters

static Expression **ToFloat** (*ICollection connection, Expression arg*)
Convert to a float type.

Parameters

static Expression **ToInt** (*ICconnection connection, Expression arg*)
Convert to an int type.

Parameters

4.3 SpaceCenter API

4.3.1 SpaceCenter

class SpaceCenter

Provides functionality to interact with Kerbal Space Program. This includes controlling the active vessel, managing its resources, planning maneuver nodes and auto-piloting.

Vessel **ActiveVessel** { **get**; **set**; }
The currently active vessel.

IList<Vessel> **Vessels** { **get**; }
A list of all the vessels in the game.

IDictionary<String, CelestialBody> **Bodies** { **get**; }
A dictionary of all celestial bodies (planets, moons, etc.) in the game, keyed by the name of the body.

CelestialBody **TargetBody** { **get**; **set**; }
The currently targeted celestial body.

Vessel **TargetVessel** { **get**; **set**; }
The currently targeted vessel.

DockingPort **TargetDockingPort** { **get**; **set**; }
The currently targeted docking port.

void ClearTarget ()
Clears the current target.

IList<String> **LaunchableVessels** (*String craftDirectory*)
Returns a list of vessels from the given *craftDirectory* that can be launched.

Parameters

- **craftDirectory** – Name of the directory in the current saves “Ships” directory. For example "VAB" or "SPH".

void LaunchVessel (*String craftDirectory, String name, String launchSite*)
Launch a vessel.

Parameters

- **craftDirectory** – Name of the directory in the current saves “Ships” directory, that contains the craft file. For example "VAB" or "SPH".
- **name** – Name of the vessel to launch. This is the name of the “.craft” file in the save directory, without the “.craft” file extension.
- **launchSite** – Name of the launch site. For example "LaunchPad" or "Runway".

void LaunchVesselFromVAB (*String name*)
Launch a new vessel from the VAB onto the launchpad.

Parameters

- **name** – Name of the vessel to launch.

Note: This is equivalent to calling *SpaceCenter.LaunchVessel* with the craft directory set to “VAB” and the launch site set to “LaunchPad”.

void **LaunchVesselFromSPH** (*String name*)

Launch a new vessel from the SPH onto the runway.

Parameters

- **name** – Name of the vessel to launch.

Note: This is equivalent to calling *SpaceCenter.LaunchVessel* with the craft directory set to “SPH” and the launch site set to “Runway”.

void **Save** (*String name*)

Save the game with a given name. This will create a save file called *name.sfs* in the folder of the current save game.

Parameters

void **Load** (*String name*)

Load the game with the given name. This will create a load a save file called *name.sfs* from the folder of the current save game.

Parameters

void **Quicksave** ()

Save a quicksave.

Note: This is the same as calling *SpaceCenter.Save* with the name “quicksave”.

void **Quickload** ()

Load a quicksave.

Note: This is the same as calling *SpaceCenter.Load* with the name “quicksave”.

Boolean **UIVisible** { **get**; **set**; }

Whether the UI is visible.

Boolean **Navball** { **get**; **set**; }

Whether the navball is visible.

Double **UT** { **get**; }

The current universal time in seconds.

Double **G** { **get**; }

The value of the *gravitational constant* *G* in $N(m/kg)^2$.

Single **WarpRate** { **get**; }

The current warp rate. This is the rate at which time is passing for either on-rails or physical time warp. For example, a value of 10 means time is passing 10x faster than normal. Returns 1 if time warp is not active.

Single WarpFactor { get; }

The current warp factor. This is the index of the rate at which time is passing for either regular “on-rails” or physical time warp. Returns 0 if time warp is not active. When in on-rails time warp, this is equal to *SpaceCenter.RailsWarpFactor*, and in physics time warp, this is equal to *SpaceCenter.PhysicsWarpFactor*.

Int32 RailsWarpFactor { get; set; }

The time warp rate, using regular “on-rails” time warp. A value between 0 and 7 inclusive. 0 means no time warp. Returns 0 if physical time warp is active.

If requested time warp factor cannot be set, it will be set to the next lowest possible value. For example, if the vessel is too close to a planet. See [the KSP wiki](#) for details.

Int32 PhysicsWarpFactor { get; set; }

The physical time warp rate. A value between 0 and 3 inclusive. 0 means no time warp. Returns 0 if regular “on-rails” time warp is active.

Boolean CanRailsWarpAt (Int32 factor = 1)

Returns *true* if regular “on-rails” time warp can be used, at the specified warp *factor*. The maximum time warp rate is limited by various things, including how close the active vessel is to a planet. See [the KSP wiki](#) for details.

Parameters

- **factor** – The warp factor to check.

Int32 MaximumRailsWarpFactor { get; }

The current maximum regular “on-rails” warp factor that can be set. A value between 0 and 7 inclusive. See [the KSP wiki](#) for details.

void WarpTo (Double ut, Single maxRailsRate = 100000.0, Single maxPhysicsRate = 2.0)

Uses time acceleration to warp forward to a time in the future, specified by universal time *ut*. This call blocks until the desired time is reached. Uses regular “on-rails” or physical time warp as appropriate. For example, physical time warp is used when the active vessel is traveling through an atmosphere. When using regular “on-rails” time warp, the warp rate is limited by *maxRailsRate*, and when using physical time warp, the warp rate is limited by *maxPhysicsRate*.

Parameters

- **ut** – The universal time to warp to, in seconds.
- **maxRailsRate** – The maximum warp rate in regular “on-rails” time warp.
- **maxPhysicsRate** – The maximum warp rate in physical time warp.

Returns When the time warp is complete.

Tuple<Double, Double, Double> TransformPosition (Tuple<Double, Double, Double> position, ReferenceFrame from, ReferenceFrame to)

Converts a position from one reference frame to another.

Parameters

- **position** – Position, as a vector, in reference frame *from*.
- **from** – The reference frame that the position is in.
- **to** – The reference frame to convert the position to.

Returns The corresponding position, as a vector, in reference frame *to*.

Tuple<Double, Double, Double> TransformDirection (Tuple<Double, Double, Double> *direction*, ReferenceFrame *from*, ReferenceFrame *to*)

Converts a direction from one reference frame to another.

Parameters

- **direction** – Direction, as a vector, in reference frame *from*.
- **from** – The reference frame that the direction is in.
- **to** – The reference frame to convert the direction to.

Returns The corresponding direction, as a vector, in reference frame *to*.

Tuple<Double, Double, Double, Double> TransformRotation (Tuple<Double, Double, Double, Double> *rotation*, ReferenceFrame *from*, ReferenceFrame *to*)

Converts a rotation from one reference frame to another.

Parameters

- **rotation** – Rotation, as a quaternion of the form (x, y, z, w) , in reference frame *from*.
- **from** – The reference frame that the rotation is in.
- **to** – The reference frame to convert the rotation to.

Returns The corresponding rotation, as a quaternion of the form (x, y, z, w) , in reference frame *to*.

Tuple<Double, Double, Double> TransformVelocity (Tuple<Double, Double, Double> *position*, Tuple<Double, Double, Double> *velocity*, ReferenceFrame *from*, ReferenceFrame *to*)

Converts a velocity (acting at the specified position) from one reference frame to another. The position is required to take the relative angular velocity of the reference frames into account.

Parameters

- **position** – Position, as a vector, in reference frame *from*.
- **velocity** – Velocity, as a vector that points in the direction of travel and whose magnitude is the speed in meters per second, in reference frame *from*.
- **from** – The reference frame that the position and velocity are in.
- **to** – The reference frame to convert the velocity to.

Returns The corresponding velocity, as a vector, in reference frame *to*.

Double RaycastDistance (Tuple<Double, Double, Double> *position*, Tuple<Double, Double, Double> *direction*, ReferenceFrame *referenceFrame*)

Cast a ray from a given position in a given direction, and return the distance to the hit point. If no hit occurs, returns infinity.

Parameters

- **position** – Position, as a vector, of the origin of the ray.
- **direction** – Direction of the ray, as a unit vector.
- **referenceFrame** – The reference frame that the position and direction are in.

Returns The distance to the hit, in meters, or infinity if there was no hit.

Part RaycastPart (*Tuple<Double, Double, Double> position, Tuple<Double, Double, Double> direction, ReferenceFrame referenceFrame*)

Cast a ray from a given position in a given direction, and return the part that it hits. If no hit occurs, returns `null`.

Parameters

- **position** – Position, as a vector, of the origin of the ray.
- **direction** – Direction of the ray, as a unit vector.
- **referenceFrame** – The reference frame that the position and direction are in.

Returns The part that was hit or `null` if there was no hit.

Boolean FARAvailable { **get**; }

Whether *Ferram Aerospace Research* is installed.

WarpMode WarpMode { **get**; }

The current time warp mode. Returns *WarpMode.None* if time warp is not active, *WarpMode.Rails* if regular “on-rails” time warp is active, or *WarpMode.Physics* if physical time warp is active.

Camera Camera { **get**; }

An object that can be used to control the camera.

WaypointManager WaypointManager { **get**; }

The waypoint manager.

ContractManager ContractManager { **get**; }

The contract manager.

enum WarpMode

The time warp mode. Returned by *WarpMode*

Rails

Time warp is active, and in regular “on-rails” mode.

Physics

Time warp is active, and in physical time warp mode.

None

Time warp is not active.

4.3.2 Vessel

class Vessel

These objects are used to interact with vessels in KSP. This includes getting orbital and flight data, manipulating control inputs and managing resources. Created using *SpaceCenter.ActiveVessel* or *SpaceCenter.Vessels*.

String Name { **get**; **set**; }

The name of the vessel.

VesselType Type { **get**; **set**; }

The type of the vessel.

VesselSituation Situation { **get**; }

The situation the vessel is in.

Boolean Recoverable { **get**; }

Whether the vessel is recoverable.

void **Recover** ()

Recover the vessel.

Double **MET** { **get**; }

The mission elapsed time in seconds.

String **Biome** { **get**; }

The name of the biome the vessel is currently in.

Flight **Flight** (*ReferenceFrame referenceFrame = null*)

Returns a *Flight* object that can be used to get flight telemetry for the vessel, in the specified reference frame.

Parameters

- **referenceFrame** – Reference frame. Defaults to the vessel's surface reference frame (*Vessel.SurfaceReferenceFrame*).

Note: When this is called with no arguments, the vessel's surface reference frame is used. This reference frame moves with the vessel, therefore velocities and speeds returned by the flight object will be zero. See the *reference frames tutorial* for examples of getting *the orbital and surface speeds of a vessel*.

Orbit **Orbit** { **get**; }

The current orbit of the vessel.

Control **Control** { **get**; }

Returns a *Control* object that can be used to manipulate the vessel's control inputs. For example, its pitch/yaw/roll controls, RCS and thrust.

Comms **Comms** { **get**; }

Returns a *Comms* object that can be used to interact with CommNet for this vessel.

AutoPilot **AutoPilot** { **get**; }

An *AutoPilot* object, that can be used to perform simple auto-piloting of the vessel.

Int32 **CrewCapacity** { **get**; }

The number of crew that can occupy the vessel.

Int32 **CrewCount** { **get**; }

The number of crew that are occupying the vessel.

IList<CrewMember> **Crew** { **get**; }

The crew in the vessel.

Resources **Resources** { **get**; }

A *Resources* object, that can used to get information about resources stored in the vessel.

Resources **ResourcesInDecoupleStage** (Int32 *stage*, Boolean *cumulative = True*)

Returns a *Resources* object, that can used to get information about resources stored in a given *stage*.

Parameters

- **stage** – Get resources for parts that are decoupled in this stage.
- **cumulative** – When *false*, returns the resources for parts decoupled in just the given stage. When *true* returns the resources decoupled in the given stage and all subsequent stages combined.

Note: For details on stage numbering, see the discussion on *Staging*.

Parts Parts { get; }

A *Parts* object, that can used to interact with the parts that make up this vessel.

Single Mass { get; }

The total mass of the vessel, including resources, in kg.

Single DryMass { get; }

The total mass of the vessel, excluding resources, in kg.

Single Thrust { get; }

The total thrust currently being produced by the vessel's engines, in Newtons. This is computed by summing *Engine.Thrust* for every engine in the vessel.

Single AvailableThrust { get; }

Gets the total available thrust that can be produced by the vessel's active engines, in Newtons. This is computed by summing *Engine.AvailableThrust* for every active engine in the vessel.

Single MaxThrust { get; }

The total maximum thrust that can be produced by the vessel's active engines, in Newtons. This is computed by summing *Engine.MaxThrust* for every active engine.

Single MaxVacuumThrust { get; }

The total maximum thrust that can be produced by the vessel's active engines when the vessel is in a vacuum, in Newtons. This is computed by summing *Engine.MaxVacuumThrust* for every active engine.

Single SpecificImpulse { get; }

The combined specific impulse of all active engines, in seconds. This is computed using the formula [described here](#).

Single VacuumSpecificImpulse { get; }

The combined vacuum specific impulse of all active engines, in seconds. This is computed using the formula [described here](#).

Single KerbinSeaLevelSpecificImpulse { get; }

The combined specific impulse of all active engines at sea level on Kerbin, in seconds. This is computed using the formula [described here](#).

Tuple<Double, Double, Double> MomentOfInertia { get; }

The moment of inertia of the vessel around its center of mass in $kg.m^2$. The inertia values in the returned 3-tuple are around the pitch, roll and yaw directions respectively. This corresponds to the vessels reference frame (*ReferenceFrame*).

IList<Double> InertiaTensor { get; }

The inertia tensor of the vessel around its center of mass, in the vessels reference frame (*ReferenceFrame*). Returns the 3x3 matrix as a list of elements, in row-major order.

Tuple<Tuple<Double, Double, Double>, Tuple<Double, Double, Double>> AvailableTorque { get; }

The maximum torque that the vessel generates. Includes contributions from reaction wheels, RCS, gim-balled engines and aerodynamic control surfaces. Returns the torques in $N.m$ around each of the coordinate axes of the vessels reference frame (*ReferenceFrame*). These axes are equivalent to the pitch, roll and yaw axes of the vessel.

Tuple<Tuple<Double, Double, Double>, Tuple<Double, Double, Double>> AvailableReactionWheelTorque { get; }

The maximum torque that the currently active and powered reaction wheels can generate. Returns the torques in $N.m$ around each of the coordinate axes of the vessels reference frame (*ReferenceFrame*). These axes are equivalent to the pitch, roll and yaw axes of the vessel.

Tuple<Tuple<Double, Double, Double>, Tuple<Double, Double, Double>> AvailableRCSTorque { get; }

The maximum torque that the currently active RCS thrusters can generate. Returns the torques in $N.m$

around each of the coordinate axes of the vessels reference frame (*ReferenceFrame*). These axes are equivalent to the pitch, roll and yaw axes of the vessel.

`Tuple<Tuple<Double, Double, Double>, Tuple<Double, Double, Double>> AvailableEngineTorque { get; }`

The maximum torque that the currently active and gimbaled engines can generate. Returns the torques in *N.m* around each of the coordinate axes of the vessels reference frame (*ReferenceFrame*). These axes are equivalent to the pitch, roll and yaw axes of the vessel.

`Tuple<Tuple<Double, Double, Double>, Tuple<Double, Double, Double>> AvailableControlSurfaceTorque { get; }`

The maximum torque that the aerodynamic control surfaces can generate. Returns the torques in *N.m* around each of the coordinate axes of the vessels reference frame (*ReferenceFrame*). These axes are equivalent to the pitch, roll and yaw axes of the vessel.

`Tuple<Tuple<Double, Double, Double>, Tuple<Double, Double, Double>> AvailableOtherTorque { get; }`

The maximum torque that parts (excluding reaction wheels, gimbaled engines, RCS and control surfaces) can generate. Returns the torques in *N.m* around each of the coordinate axes of the vessels reference frame (*ReferenceFrame*). These axes are equivalent to the pitch, roll and yaw axes of the vessel.

`ReferenceFrame ReferenceFrame { get; }`

The reference frame that is fixed relative to the vessel, and orientated with the vessel.

- The origin is at the center of mass of the vessel.
- The axes rotate with the vessel.
- The x-axis points out to the right of the vessel.
- The y-axis points in the forward direction of the vessel.
- The z-axis points out of the bottom off the vessel.

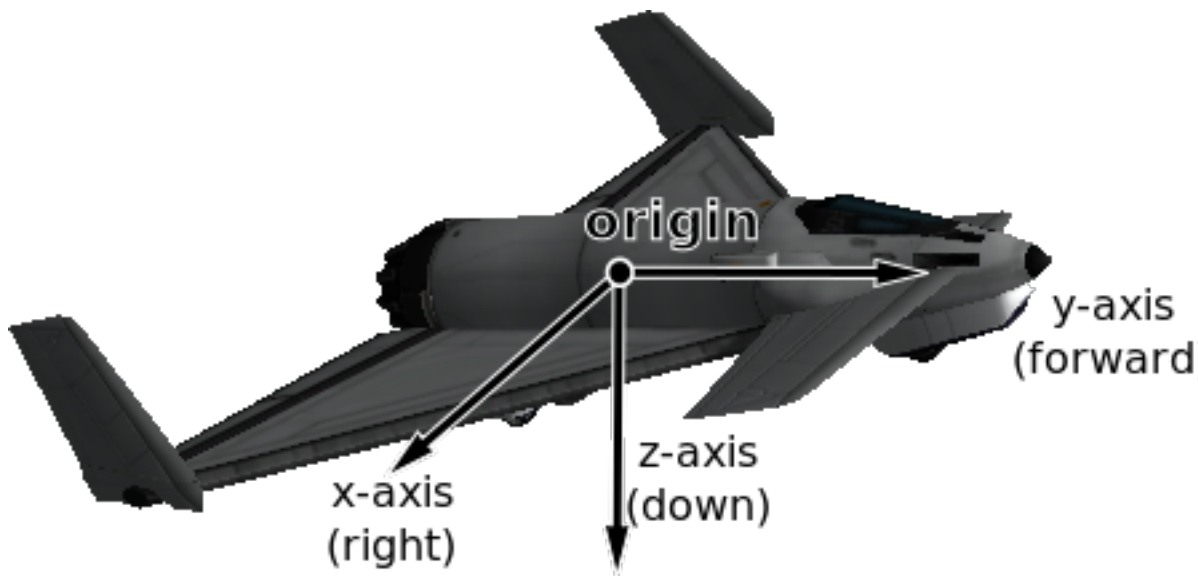


Fig. 4.1: Vessel reference frame origin and axes for the Aeris 3A aircraft

`ReferenceFrame OrbitalReferenceFrame { get; }`

The reference frame that is fixed relative to the vessel, and orientated with the vessels orbital prograde/normal/radial directions.

- The origin is at the center of mass of the vessel.
- The axes rotate with the orbital prograde/normal/radial directions.

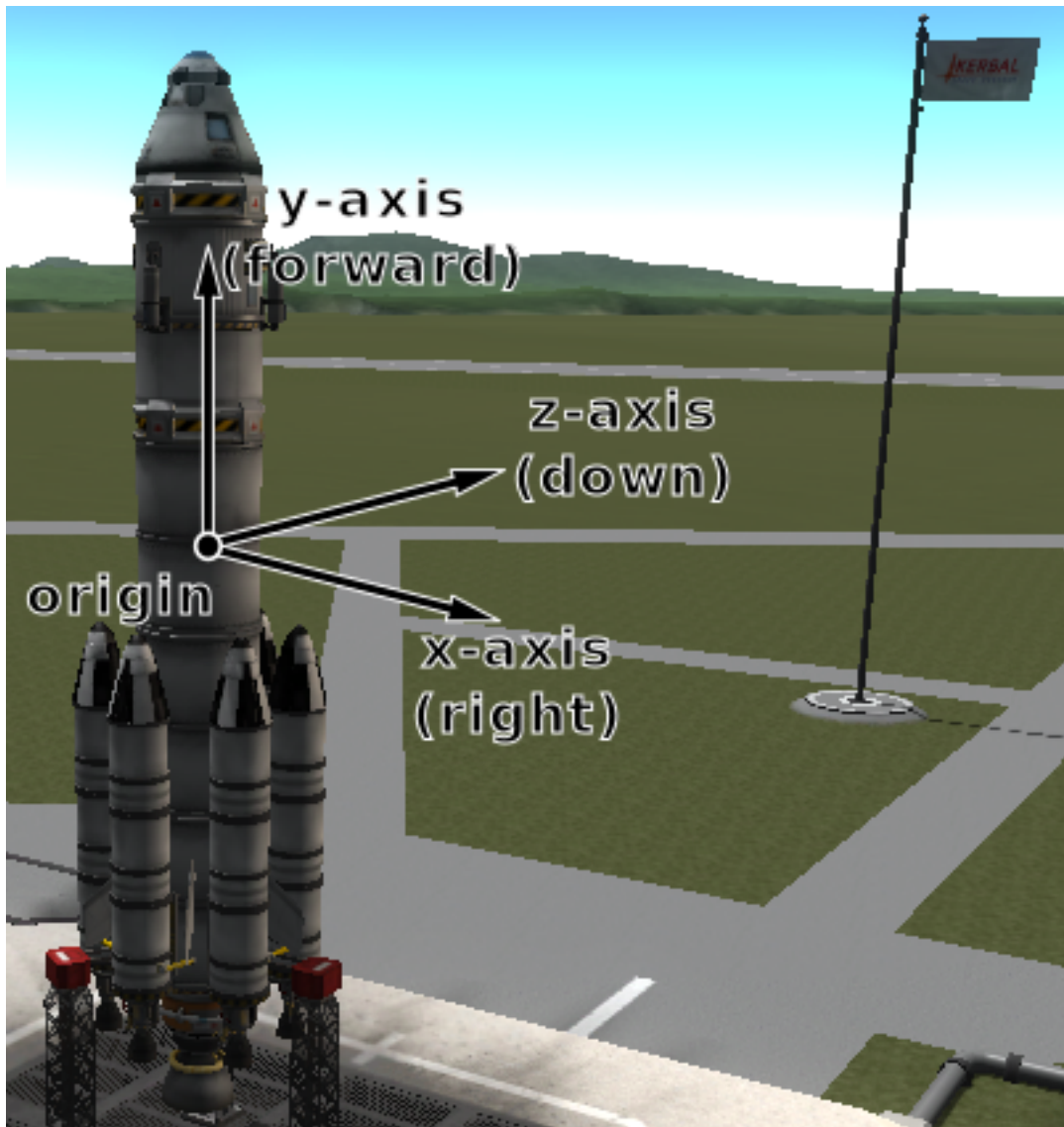


Fig. 4.2: Vessel reference frame origin and axes for the Kerbal-X rocket

- The x-axis points in the orbital anti-radial direction.
- The y-axis points in the orbital prograde direction.
- The z-axis points in the orbital normal direction.

Note: Be careful not to confuse this with ‘orbit’ mode on the navball.

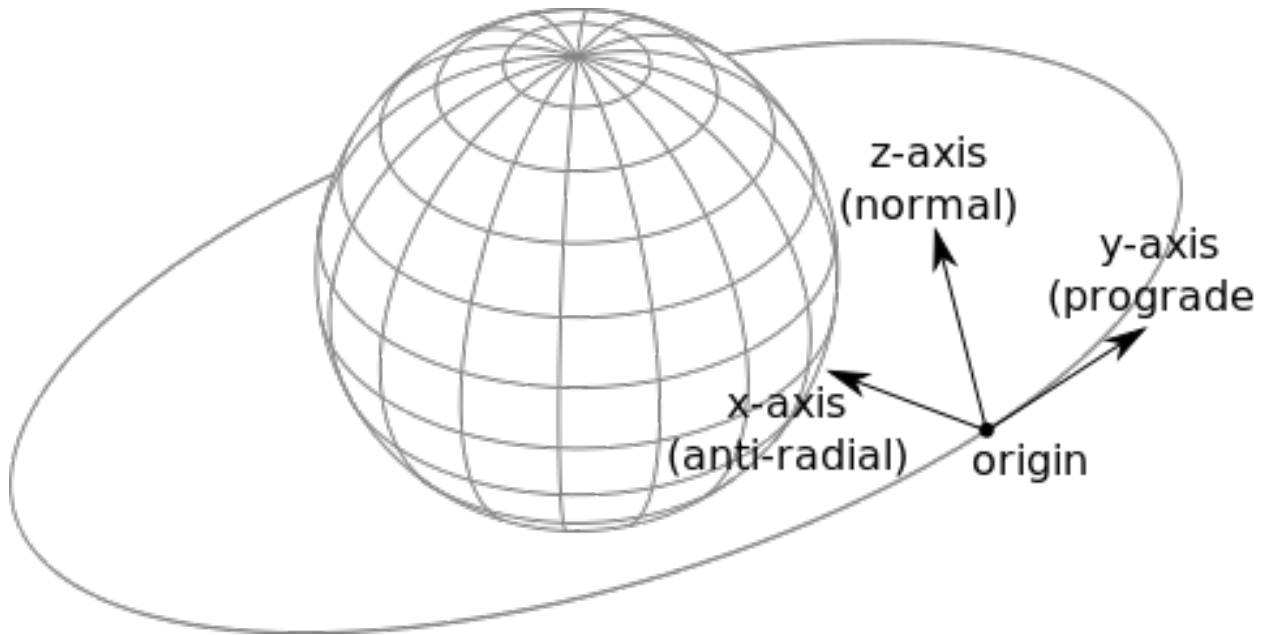


Fig. 4.3: Vessel orbital reference frame origin and axes

ReferenceFrame **SurfaceReferenceFrame** { **get**; }

The reference frame that is fixed relative to the vessel, and orientated with the surface of the body being orbited.

- The origin is at the center of mass of the vessel.
- The axes rotate with the north and up directions on the surface of the body.
- The x-axis points in the [zenith](#) direction (upwards, normal to the body being orbited, from the center of the body towards the center of mass of the vessel).
- The y-axis points northwards towards the [astronomical horizon](#) (north, and tangential to the surface of the body – the direction in which a compass would point when on the surface).
- The z-axis points eastwards towards the [astronomical horizon](#) (east, and tangential to the surface of the body – east on a compass when on the surface).

Note: Be careful not to confuse this with ‘surface’ mode on the navball.

ReferenceFrame **SurfaceVelocityReferenceFrame** { **get**; }

The reference frame that is fixed relative to the vessel, and orientated with the velocity vector of the vessel relative to the surface of the body being orbited.

- The origin is at the center of mass of the vessel.

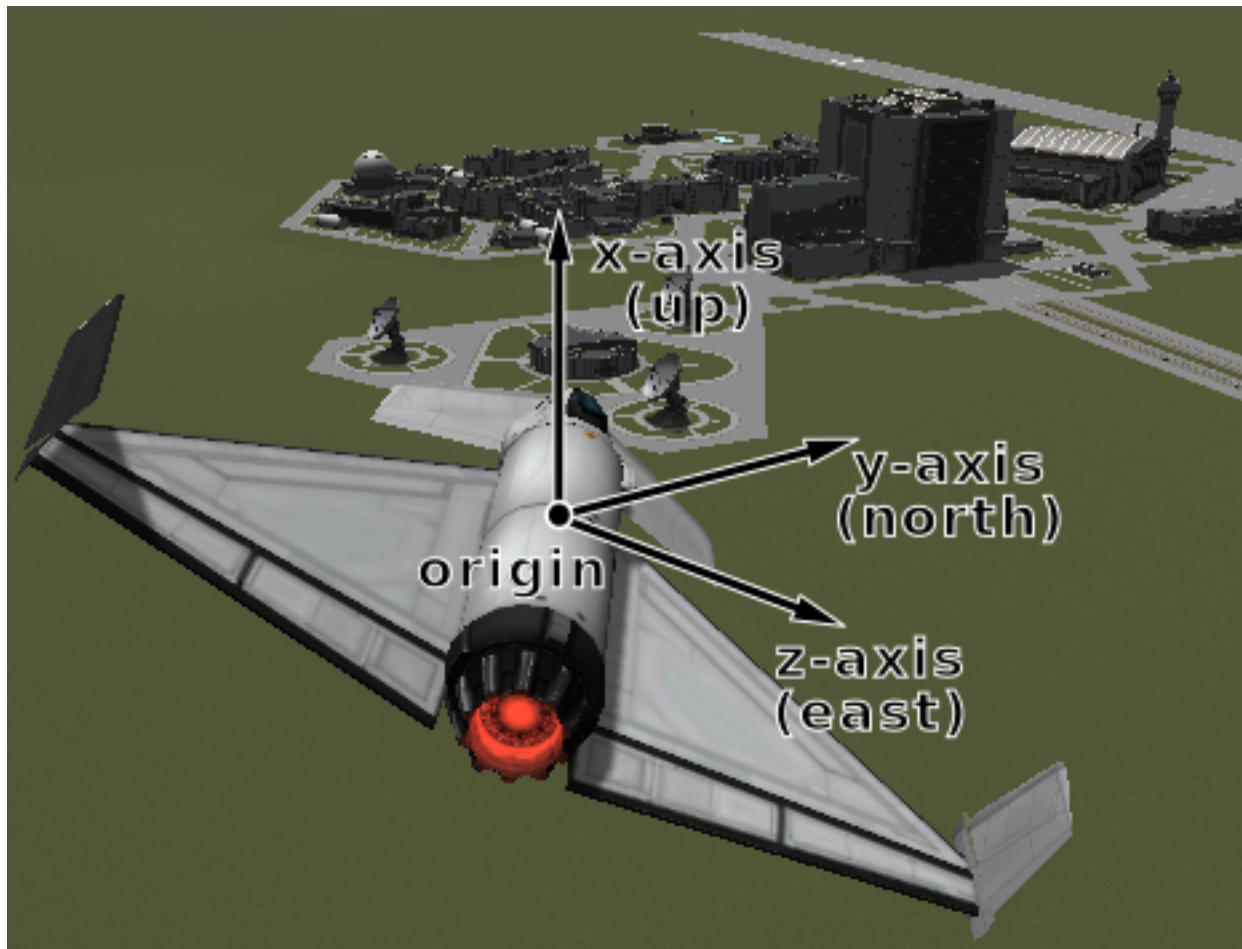


Fig. 4.4: Vessel surface reference frame origin and axes

- The axes rotate with the vessel's velocity vector.
- The y-axis points in the direction of the vessel's velocity vector, relative to the surface of the body being orbited.
- The z-axis is in the plane of the [astronomical horizon](#).
- The x-axis is orthogonal to the other two axes.

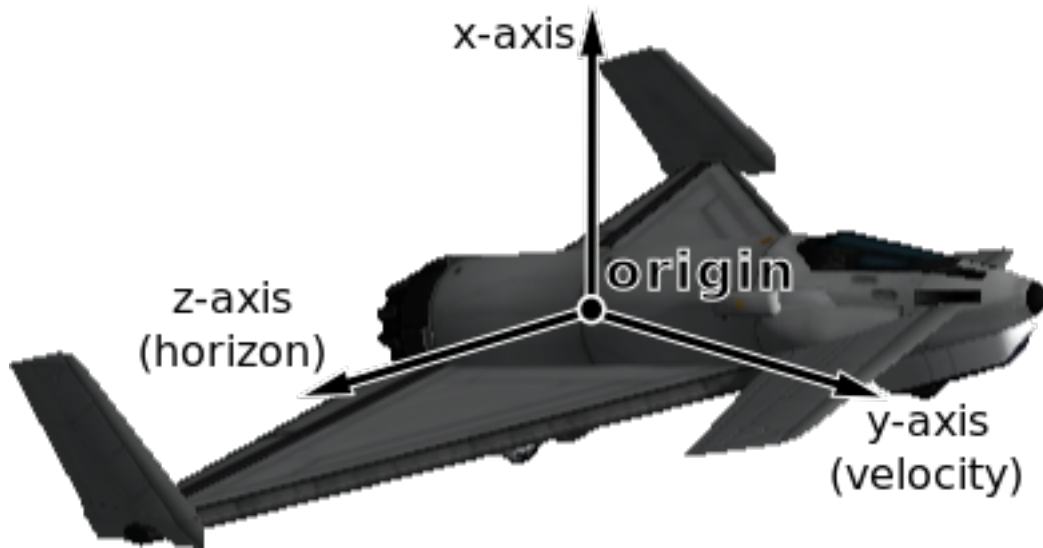


Fig. 4.5: Vessel surface velocity reference frame origin and axes

`Tuple<Double, Double, Double> Position (ReferenceFrame referenceFrame)`

The position of the center of mass of the vessel, in the given reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned position vector is in.

Returns The position as a vector.

`Tuple<Tuple<Double, Double, Double>, Tuple<Double, Double, Double>> BoundingBox (ReferenceFrame referenceFrame)`

The axis-aligned bounding box of the vessel in the given reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned position vectors are in.

Returns The positions of the minimum and maximum vertices of the box, as position vectors.

`Tuple<Double, Double, Double> Velocity (ReferenceFrame referenceFrame)`

The velocity of the center of mass of the vessel, in the given reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned velocity vector is in.

Returns The velocity as a vector. The vector points in the direction of travel, and its magnitude is the speed of the body in meters per second.

`Tuple<Double, Double, Double, Double> Rotation (ReferenceFrame referenceFrame)`

The rotation of the vessel, in the given reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned rotation is in.

Returns The rotation as a quaternion of the form (x, y, z, w) .

Tuple<Double, Double, Double> Direction (*ReferenceFrame referenceFrame*)

The direction in which the vessel is pointing, in the given reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

Tuple<Double, Double, Double> AngularVelocity (*ReferenceFrame referenceFrame*)

The angular velocity of the vessel, in the given reference frame.

Parameters

- **referenceFrame** – The reference frame the returned angular velocity is in.

Returns The angular velocity as a vector. The magnitude of the vector is the rotational speed of the vessel, in radians per second. The direction of the vector indicates the axis of rotation, using the right-hand rule.

enum VesselType

The type of a vessel. See *Vessel.Type*.

Base

Base.

Debris

Debris.

Lander

Lander.

Plane

Plane.

Probe

Probe.

Relay

Relay.

Rover

Rover.

Ship

Ship.

Station

Station.

enum VesselSituation

The situation a vessel is in. See *Vessel.Situation*.

Docked

Vessel is docked to another.

Escaping

Escaping.

Flying

Vessel is flying through an atmosphere.

Landed

Vessel is landed on the surface of a body.

Orbiting

Vessel is orbiting a body.

PreLaunch

Vessel is awaiting launch.

Splashed

Vessel has splashed down in an ocean.

SubOrbital

Vessel is on a sub-orbital trajectory.

class CrewMember

Represents crew in a vessel. Can be obtained using *Vessel.Crew*.

String Name { get; set; }

The crew members name.

CrewMemberType Type { get; }

The type of crew member.

Boolean OnMission { get; }

Whether the crew member is on a mission.

Single Courage { get; set; }

The crew members courage.

Single Stupidity { get; set; }

The crew members stupidity.

Single Experience { get; set; }

The crew members experience.

Boolean Badass { get; set; }

Whether the crew member is a badass.

Boolean Veteran { get; set; }

Whether the crew member is a veteran.

enum CrewMemberType

The type of a crew member. See *CrewMember.Type*.

Applicant

An applicant for crew.

Crew

Rocket crew.

Tourist

A tourist.

Unowned

An unowned crew member.

4.3.3 CelestialBody

class CelestialBody

Represents a celestial body (such as a planet or moon). See *SpaceCenter.Bodies*.

String Name { get; }

The name of the body.

IList<CelestialBody> Satellites { get; }

A list of celestial bodies that are in orbit around this celestial body.

Orbit Orbit { get; }

The orbit of the body.

Single Mass { get; }

The mass of the body, in kilograms.

Single GravitationalParameter { get; }

The standard gravitational parameter of the body in $m^3 s^{-2}$.

Single SurfaceGravity { get; }

The acceleration due to gravity at sea level (mean altitude) on the body, in m/s^2 .

Single RotationalPeriod { get; }

The sidereal rotational period of the body, in seconds.

Single RotationalSpeed { get; }

The rotational speed of the body, in radians per second.

Double RotationAngle { get; }

The current rotation angle of the body, in radians. A value between 0 and 2π

Double InitialRotation { get; }

The initial rotation angle of the body (at UT 0), in radians. A value between 0 and 2π

Single EquatorialRadius { get; }

The equatorial radius of the body, in meters.

Double SurfaceHeight (Double latitude, Double longitude)

The height of the surface relative to mean sea level, in meters, at the given position. When over water this is equal to 0.

Parameters

- **latitude** – Latitude in degrees.
- **longitude** – Longitude in degrees.

Double BedrockHeight (Double latitude, Double longitude)

The height of the surface relative to mean sea level, in meters, at the given position. When over water, this is the height of the sea-bed and is therefore negative value.

Parameters

- **latitude** – Latitude in degrees.
- **longitude** – Longitude in degrees.

Tuple<Double, Double, Double> MSLPosition (Double latitude, Double longitude, ReferenceFrame referenceFrame)

The position at mean sea level at the given latitude and longitude, in the given reference frame.

Parameters

- **latitude** – Latitude in degrees.

- **longitude** – Longitude in degrees.
- **referenceFrame** – Reference frame for the returned position vector.

Returns Position as a vector.

Tuple<Double, Double, Double> SurfacePosition (*Double latitude, Double longitude, ReferenceFrame referenceFrame*)

The position of the surface at the given latitude and longitude, in the given reference frame. When over water, this is the position of the surface of the water.

Parameters

- **latitude** – Latitude in degrees.
- **longitude** – Longitude in degrees.
- **referenceFrame** – Reference frame for the returned position vector.

Returns Position as a vector.

Tuple<Double, Double, Double> BedrockPosition (*Double latitude, Double longitude, ReferenceFrame referenceFrame*)

The position of the surface at the given latitude and longitude, in the given reference frame. When over water, this is the position at the bottom of the sea-bed.

Parameters

- **latitude** – Latitude in degrees.
- **longitude** – Longitude in degrees.
- **referenceFrame** – Reference frame for the returned position vector.

Returns Position as a vector.

Tuple<Double, Double, Double> PositionAtAltitude (*Double latitude, Double longitude, Double altitude, ReferenceFrame referenceFrame*)

The position at the given latitude, longitude and altitude, in the given reference frame.

Parameters

- **latitude** – Latitude in degrees.
- **longitude** – Longitude in degrees.
- **altitude** – Altitude in meters above sea level.
- **referenceFrame** – Reference frame for the returned position vector.

Returns Position as a vector.

Double AltitudeAtPosition (*Tuple<Double, Double, Double> position, ReferenceFrame referenceFrame*)

The altitude, in meters, of the given position in the given reference frame.

Parameters

- **position** – Position as a vector.
- **referenceFrame** – Reference frame for the position vector.

Double LatitudeAtPosition (*Tuple<Double, Double, Double> position, ReferenceFrame referenceFrame*)

The latitude of the given position, in the given reference frame.

Parameters

- **position** – Position as a vector.
- **referenceFrame** – Reference frame for the position vector.

Double LongitudeAtPosition (*Tuple<Double, Double, Double> position, ReferenceFrame referenceFrame*)

The longitude of the given position, in the given reference frame.

Parameters

- **position** – Position as a vector.
- **referenceFrame** – Reference frame for the position vector.

Single SphereOfInfluence { **get**; }

The radius of the sphere of influence of the body, in meters.

Boolean HasAtmosphere { **get**; }

true if the body has an atmosphere.

Single AtmosphereDepth { **get**; }

The depth of the atmosphere, in meters.

Double AtmosphericDensityAtPosition (*Tuple<Double, Double, Double> position, ReferenceFrame referenceFrame*)

The atmospheric density at the given position, in kg/m^3 , in the given reference frame.

Parameters

- **position** – The position vector at which to measure the density.
- **referenceFrame** – Reference frame that the position vector is in.

Boolean HasAtmosphericOxygen { **get**; }

true if there is oxygen in the atmosphere, required for air-breathing engines.

Double TemperatureAt (*Tuple<Double, Double, Double> position, ReferenceFrame referenceFrame*)

The temperature on the body at the given position, in the given reference frame.

Parameters

- **position** – Position as a vector.
- **referenceFrame** – The reference frame that the position is in.

Note: This calculation is performed using the bodies current position, which means that the value could be wrong if you want to know the temperature in the far future.

Double DensityAt (*Double altitude*)

Gets the air density, in kg/m^3 , for the specified altitude above sea level, in meters.

Parameters

Note: This is an approximation, because actual calculations, taking sun exposure into account to compute air temperature, require us to know the exact point on the body where the density is to be computed (knowing the altitude is not enough). However, the difference is small for high altitudes, so it makes very little difference for trajectory prediction.

Double PressureAt (*Double altitude*)

Gets the air pressure, in Pascals, for the specified altitude above sea level, in meters.

Parameters

`ISet<String> Biomes { get; }`

The biomes present on this body.

`String BiomeAt (Double latitude, Double longitude)`

The biome at the given latitude and longitude, in degrees.

Parameters

`Single FlyingHighAltitudeThreshold { get; }`

The altitude, in meters, above which a vessel is considered to be flying “high” when doing science.

`Single SpaceHighAltitudeThreshold { get; }`

The altitude, in meters, above which a vessel is considered to be in “high” space when doing science.

`ReferenceFrame ReferenceFrame { get; }`

The reference frame that is fixed relative to the celestial body.

- The origin is at the center of the body.
- The axes rotate with the body.
- The x-axis points from the center of the body towards the intersection of the prime meridian and equator (the position at 0° longitude, 0° latitude).
- The y-axis points from the center of the body towards the north pole.
- The z-axis points from the center of the body towards the equator at 90°E longitude.

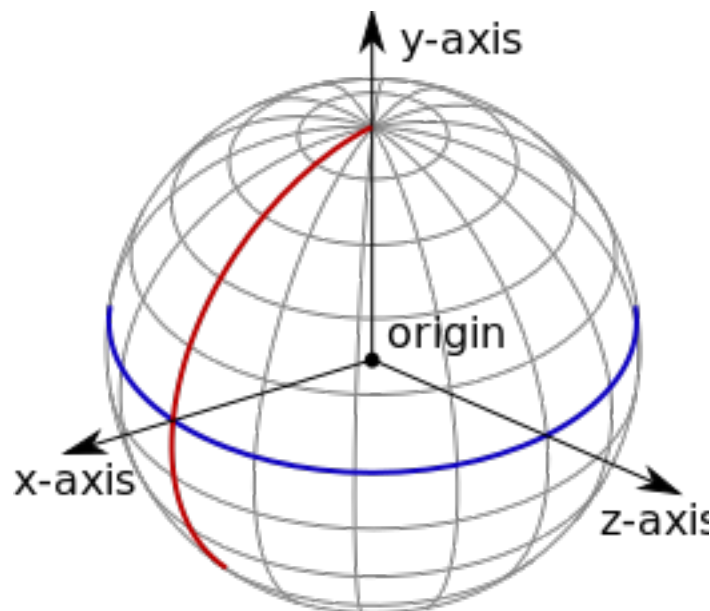


Fig. 4.6: Celestial body reference frame origin and axes. The equator is shown in blue, and the prime meridian in red.

`ReferenceFrame NonRotatingReferenceFrame { get; }`

The reference frame that is fixed relative to this celestial body, and orientated in a fixed direction (it does not rotate with the body).

- The origin is at the center of the body.
- The axes do not rotate.
- The x-axis points in an arbitrary direction through the equator.

- The y-axis points from the center of the body towards the north pole.
- The z-axis points in an arbitrary direction through the equator.

ReferenceFrame **OrbitalReferenceFrame** { **get**; }

The reference frame that is fixed relative to this celestial body, but orientated with the body's orbital prograde/normal/radial directions.

- The origin is at the center of the body.
- The axes rotate with the orbital prograde/normal/radial directions.
- The x-axis points in the orbital anti-radial direction.
- The y-axis points in the orbital prograde direction.
- The z-axis points in the orbital normal direction.

Tuple<*Double*, *Double*, *Double*> **Position** (*ReferenceFrame* *referenceFrame*)

The position of the center of the body, in the specified reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned position vector is in.

Returns The position as a vector.

Tuple<*Double*, *Double*, *Double*> **Velocity** (*ReferenceFrame* *referenceFrame*)

The linear velocity of the body, in the specified reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned velocity vector is in.

Returns The velocity as a vector. The vector points in the direction of travel, and its magnitude is the speed of the body in meters per second.

Tuple<*Double*, *Double*, *Double*, *Double*> **Rotation** (*ReferenceFrame* *referenceFrame*)

The rotation of the body, in the specified reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned rotation is in.

Returns The rotation as a quaternion of the form (x, y, z, w) .

Tuple<*Double*, *Double*, *Double*> **Direction** (*ReferenceFrame* *referenceFrame*)

The direction in which the north pole of the celestial body is pointing, in the specified reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

Tuple<*Double*, *Double*, *Double*> **AngularVelocity** (*ReferenceFrame* *referenceFrame*)

The angular velocity of the body in the specified reference frame.

Parameters

- **referenceFrame** – The reference frame the returned angular velocity is in.

Returns The angular velocity as a vector. The magnitude of the vector is the rotational speed of the body, in radians per second. The direction of the vector indicates the axis of rotation, using the right-hand rule.

4.3.4 Flight

class Flight

Used to get flight telemetry for a vessel, by calling *Vessel.Flight*. All of the information returned by this class is given in the reference frame passed to that method. Obtained by calling *Vessel.Flight*.

Note: To get orbital information, such as the apoapsis or inclination, see *Orbit*.

Single **GForce** { **get**; }

The current G force acting on the vessel in m/s^2 .

Double **MeanAltitude** { **get**; }

The altitude above sea level, in meters. Measured from the center of mass of the vessel.

Double **SurfaceAltitude** { **get**; }

The altitude above the surface of the body or sea level, whichever is closer, in meters. Measured from the center of mass of the vessel.

Double **BedrockAltitude** { **get**; }

The altitude above the surface of the body, in meters. When over water, this is the altitude above the sea floor. Measured from the center of mass of the vessel.

Double **Elevation** { **get**; }

The elevation of the terrain under the vessel, in meters. This is the height of the terrain above sea level, and is negative when the vessel is over the sea.

Double **Latitude** { **get**; }

The *latitude* of the vessel for the body being orbited, in degrees.

Double **Longitude** { **get**; }

The *longitude* of the vessel for the body being orbited, in degrees.

Tuple<Double, Double, Double> **Velocity** { **get**; }

The velocity of the vessel, in the reference frame *ReferenceFrame*.

Returns The velocity as a vector. The vector points in the direction of travel, and its magnitude is the speed of the vessel in meters per second.

Double **Speed** { **get**; }

The speed of the vessel in meters per second, in the reference frame *ReferenceFrame*.

Double **HorizontalSpeed** { **get**; }

The horizontal speed of the vessel in meters per second, in the reference frame *ReferenceFrame*.

Double **VerticalSpeed** { **get**; }

The vertical speed of the vessel in meters per second, in the reference frame *ReferenceFrame*.

Tuple<Double, Double, Double> **CenterOfMass** { **get**; }

The position of the center of mass of the vessel, in the reference frame *ReferenceFrame*

Returns The position as a vector.

Tuple<Double, Double, Double, Double> **Rotation** { **get**; }

The rotation of the vessel, in the reference frame *ReferenceFrame*

Returns The rotation as a quaternion of the form (x, y, z, w) .

Tuple<Double, Double, Double> **Direction** { **get**; }

The direction that the vessel is pointing in, in the reference frame *ReferenceFrame*.

Returns The direction as a unit vector.

Single Pitch { get; }

The pitch of the vessel relative to the horizon, in degrees. A value between -90° and $+90^\circ$.

Single Heading { get; }

The heading of the vessel (its angle relative to north), in degrees. A value between 0° and 360° .

Single Roll { get; }

The roll of the vessel relative to the horizon, in degrees. A value between -180° and $+180^\circ$.

Tuple<Double, Double, Double> Prograde { get; }

The prograde direction of the vessels orbit, in the reference frame *ReferenceFrame*.

Returns The direction as a unit vector.

Tuple<Double, Double, Double> Retrograde { get; }

The retrograde direction of the vessels orbit, in the reference frame *ReferenceFrame*.

Returns The direction as a unit vector.

Tuple<Double, Double, Double> Normal { get; }

The direction normal to the vessels orbit, in the reference frame *ReferenceFrame*.

Returns The direction as a unit vector.

Tuple<Double, Double, Double> AntiNormal { get; }

The direction opposite to the normal of the vessels orbit, in the reference frame *ReferenceFrame*.

Returns The direction as a unit vector.

Tuple<Double, Double, Double> Radial { get; }

The radial direction of the vessels orbit, in the reference frame *ReferenceFrame*.

Returns The direction as a unit vector.

Tuple<Double, Double, Double> AntiRadial { get; }

The direction opposite to the radial direction of the vessels orbit, in the reference frame *ReferenceFrame*.

Returns The direction as a unit vector.

Single AtmosphereDensity { get; }

The current density of the atmosphere around the vessel, in kg/m^3 .

Single DynamicPressure { get; }

The dynamic pressure acting on the vessel, in Pascals. This is a measure of the strength of the aerodynamic forces. It is equal to $\frac{1}{2} \cdot \text{air density} \cdot \text{velocity}^2$. It is commonly denoted Q .

Single StaticPressure { get; }

The static atmospheric pressure acting on the vessel, in Pascals.

Single StaticPressureAtMSL { get; }

The static atmospheric pressure at mean sea level, in Pascals.

Tuple<Double, Double, Double> AerodynamicForce { get; }

The total aerodynamic forces acting on the vessel, in reference frame *ReferenceFrame*.

Returns A vector pointing in the direction that the force acts, with its magnitude equal to the strength of the force in Newtons.

Tuple<Double, Double, Double> SimulateAerodynamicForceAt (*CelestialBody* *body*, *Tuple<Double, Double, Double>* *position*, *Tuple<Double, Double, Double>* *velocity*)

Simulate and return the total aerodynamic forces acting on the vessel, if it were to be traveling with the given velocity at the given position in the atmosphere of the given celestial body.

Parameters

Returns A vector pointing in the direction that the force acts, with its magnitude equal to the strength of the force in Newtons.

Tuple<Double, Double, Double> **Lift** { **get**; }

The aerodynamic lift currently acting on the vessel.

Returns A vector pointing in the direction that the force acts, with its magnitude equal to the strength of the force in Newtons.

Tuple<Double, Double, Double> **Drag** { **get**; }

The aerodynamic drag currently acting on the vessel.

Returns A vector pointing in the direction of the force, with its magnitude equal to the strength of the force in Newtons.

Single **SpeedOfSound** { **get**; }

The speed of sound, in the atmosphere around the vessel, in *m/s*.

Single **Mach** { **get**; }

The speed of the vessel, in multiples of the speed of sound.

Single **ReynoldsNumber** { **get**; }

The vessels Reynolds number.

Note: Requires [Ferram Aerospace Research](#).

Single **TrueAirSpeed** { **get**; }

The true air speed of the vessel, in meters per second.

Single **EquivalentAirSpeed** { **get**; }

The equivalent air speed of the vessel, in meters per second.

Single **TerminalVelocity** { **get**; }

An estimate of the current terminal velocity of the vessel, in meters per second. This is the speed at which the drag forces cancel out the force of gravity.

Single **AngleOfAttack** { **get**; }

The pitch angle between the orientation of the vessel and its velocity vector, in degrees.

Single **SideslipAngle** { **get**; }

The yaw angle between the orientation of the vessel and its velocity vector, in degrees.

Single **TotalAirTemperature** { **get**; }

The total air temperature of the atmosphere around the vessel, in Kelvin. This includes the *Flight*. *StaticAirTemperature* and the vessel's kinetic energy.

Single **StaticAirTemperature** { **get**; }

The static (ambient) temperature of the atmosphere around the vessel, in Kelvin.

Single **StallFraction** { **get**; }

The current amount of stall, between 0 and 1. A value greater than 0.005 indicates a minor stall and a value greater than 0.5 indicates a large-scale stall.

Note: Requires [Ferram Aerospace Research](#).

Single DragCoefficient { get; }

The coefficient of drag. This is the amount of drag produced by the vessel. It depends on air speed, air density and wing area.

Note: Requires [Ferram Aerospace Research](#).

Single LiftCoefficient { get; }

The coefficient of lift. This is the amount of lift produced by the vessel, and depends on air speed, air density and wing area.

Note: Requires [Ferram Aerospace Research](#).

Single BallisticCoefficient { get; }

The ballistic coefficient.

Note: Requires [Ferram Aerospace Research](#).

Single ThrustSpecificFuelConsumption { get; }

The thrust specific fuel consumption for the jet engines on the vessel. This is a measure of the efficiency of the engines, with a lower value indicating a more efficient vessel. This value is the number of Newtons of fuel that are burned, per hour, to produce one newton of thrust.

Note: Requires [Ferram Aerospace Research](#).

4.3.5 Orbit

class Orbit

Describes an orbit. For example, the orbit of a vessel, obtained by calling *Vessel.Orbit*, or a celestial body, obtained by calling *CelestialBody.Orbit*.

CelestialBody Body { get; }

The celestial body (e.g. planet or moon) around which the object is orbiting.

Double Apoapsis { get; }

Gets the apoapsis of the orbit, in meters, from the center of mass of the body being orbited.

Note: For the apoapsis altitude reported on the in-game map view, use *Orbit.ApoapsisAltitude*.

Double Periapsis { get; }

The periapsis of the orbit, in meters, from the center of mass of the body being orbited.

Note: For the periapsis altitude reported on the in-game map view, use *Orbit.PeriapsisAltitude*.

Double ApoapsisAltitude { get; }

The apoapsis of the orbit, in meters, above the sea level of the body being orbited.

Note: This is equal to *Orbit.Apoapsis* minus the equatorial radius of the body.

Double PeriapsisAltitude { get; }

The periapsis of the orbit, in meters, above the sea level of the body being orbited.

Note: This is equal to *Orbit.Periapsis* minus the equatorial radius of the body.

Double SemiMajorAxis { get; }

The semi-major axis of the orbit, in meters.

Double SemiMinorAxis { get; }

The semi-minor axis of the orbit, in meters.

Double Radius { get; }

The current radius of the orbit, in meters. This is the distance between the center of mass of the object in orbit, and the center of mass of the body around which it is orbiting.

Note: This value will change over time if the orbit is elliptical.

Double RadiusAt (Double ut)

The orbital radius at the given time, in meters.

Parameters

- **ut** – The universal time to measure the radius at.

Tuple<Double, Double, Double> PositionAt (Double ut, ReferenceFrame referenceFrame)

The position at a given time, in the specified reference frame.

Parameters

- **ut** – The universal time to measure the position at.
- **referenceFrame** – The reference frame that the returned position vector is in.

Returns The position as a vector.

Double Speed { get; }

The current orbital speed of the object in meters per second.

Note: This value will change over time if the orbit is elliptical.

Double Period { get; }

The orbital period, in seconds.

Double TimeToApoapsis { get; }

The time until the object reaches apoapsis, in seconds.

Double TimeToPeriapsis { get; }

The time until the object reaches periapsis, in seconds.

Double Eccentricity { get; }

The *eccentricity* of the orbit.

Double Inclination { get; }

The *inclination* of the orbit, in radians.

Double LongitudeOfAscendingNode { get; }

The longitude of the ascending node, in radians.

Double ArgumentOfPeriapsis { get; }

The argument of periapsis, in radians.

Double MeanAnomalyAtEpoch { get; }

The mean anomaly at epoch.

Double Epoch { get; }

The time since the epoch (the point at which the mean anomaly at epoch was measured, in seconds).

Double MeanAnomaly { get; }

The mean anomaly.

Double MeanAnomalyAtUT (Double ut)

The mean anomaly at the given time.

Parameters

- **ut** – The universal time in seconds.

Double EccentricAnomaly { get; }

The eccentric anomaly.

Double EccentricAnomalyAtUT (Double ut)

The eccentric anomaly at the given universal time.

Parameters

- **ut** – The universal time, in seconds.

Double TrueAnomaly { get; }

The true anomaly.

Double TrueAnomalyAtUT (Double ut)

The true anomaly at the given time.

Parameters

- **ut** – The universal time in seconds.

Double TrueAnomalyAtRadius (Double radius)

The true anomaly at the given orbital radius.

Parameters

- **radius** – The orbital radius in meters.

Double UTAtTrueAnomaly (Double trueAnomaly)

The universal time, in seconds, corresponding to the given true anomaly.

Parameters

- **trueAnomaly** – True anomaly.

Double RadiusAtTrueAnomaly (Double trueAnomaly)

The orbital radius at the point in the orbit given by the true anomaly.

Parameters

- **trueAnomaly** – The true anomaly.

Double TrueAnomalyAtAN (Vessel target)

The true anomaly of the ascending node with the given target vessel.

Parameters

- **target** – Target vessel.

Double TrueAnomalyAtDN (*Vessel target*)

The true anomaly of the descending node with the given target vessel.

Parameters

- **target** – Target vessel.

Double OrbitalSpeed { **get**; }

The current orbital speed in meters per second.

Double OrbitalSpeedAt (*Double time*)

The orbital speed at the given time, in meters per second.

Parameters

- **time** – Time from now, in seconds.

static Tuple<Double, Double, Double> ReferencePlaneNormal (*ICConnection connection, ReferenceFrame referenceFrame*)

The direction that is normal to the orbits reference plane, in the given reference frame. The reference plane is the plane from which the orbits inclination is measured.

Parameters

- **referenceFrame** – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

static Tuple<Double, Double, Double> ReferencePlaneDirection (*ICConnection connection, ReferenceFrame referenceFrame*)

The direction from which the orbits longitude of ascending node is measured, in the given reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

Double RelativeInclination (*Vessel target*)

Relative inclination of this orbit and the orbit of the given target vessel, in radians.

Parameters

- **target** – Target vessel.

Double TimeToSOIChange { **get**; }

The time until the object changes sphere of influence, in seconds. Returns NaN if the object is not going to change sphere of influence.

Orbit NextOrbit { **get**; }

If the object is going to change sphere of influence in the future, returns the new orbit after the change. Otherwise returns null.

Double TimeOfClosestApproach (*Vessel target*)

Estimates and returns the time at closest approach to a target vessel.

Parameters

- **target** – Target vessel.

Returns The universal time at closest approach, in seconds.

Double DistanceAtClosestApproach (*Vessel target*)

Estimates and returns the distance at closest approach to a target vessel, in meters.

Parameters

- **target** – Target vessel.

`IList<IList<Double>> ListClosestApproaches` (*Vessel target, Int32 orbits*)

Returns the times at closest approach and corresponding distances, to a target vessel.

Parameters

- **target** – Target vessel.
- **orbits** – The number of future orbits to search.

Returns A list of two lists. The first is a list of times at closest approach, as universal times in seconds. The second is a list of corresponding distances at closest approach, in meters.

4.3.6 Control

class Control

Used to manipulate the controls of a vessel. This includes adjusting the throttle, enabling/disabling systems such as SAS and RCS, or altering the direction in which the vessel is pointing. Obtained by calling *Vessel.Control*.

Note: Control inputs (such as pitch, yaw and roll) are zeroed when all clients that have set one or more of these inputs are no longer connected.

ControlSource **Source** { **get**; }

The source of the vessels control, for example by a kerbal or a probe core.

ControlState **State** { **get**; }

The control state of the vessel.

Boolean SAS { **get**; **set**; }

The state of SAS.

Note: Equivalent to *AutoPilot.SAS*

SASMode **SASMode** { **get**; **set**; }

The current *SASMode*. These modes are equivalent to the mode buttons to the left of the navball that appear when SAS is enabled.

Note: Equivalent to *AutoPilot.SASMode*

SpeedMode **SpeedMode** { **get**; **set**; }

The current *SpeedMode* of the navball. This is the mode displayed next to the speed at the top of the navball.

Boolean RCS { **get**; **set**; }

The state of RCS.

Boolean ReactionWheels { **get**; **set**; }

Returns whether all reactive wheels on the vessel are active, and sets the active state of all reaction wheels. See *ReactionWheel.Active*.

Boolean Gear { **get**; **set**; }

The state of the landing gear/legs.

Boolean Legs { get; set; }

Returns whether all landing legs on the vessel are deployed, and sets the deployment state of all landing legs. Does not include wheels (for example landing gear). See *Leg.Deployed*.

Boolean Wheels { get; set; }

Returns whether all wheels on the vessel are deployed, and sets the deployment state of all wheels. Does not include landing legs. See *Wheel.Deployed*.

Boolean Lights { get; set; }

The state of the lights.

Boolean Brakes { get; set; }

The state of the wheel brakes.

Boolean Antennas { get; set; }

Returns whether all antennas on the vessel are deployed, and sets the deployment state of all antennas. See *Antenna.Deployed*.

Boolean CargoBays { get; set; }

Returns whether any of the cargo bays on the vessel are open, and sets the open state of all cargo bays. See *CargoBay.Open*.

Boolean Intakes { get; set; }

Returns whether all of the air intakes on the vessel are open, and sets the open state of all air intakes. See *Intake.Open*.

Boolean Parachutes { get; set; }

Returns whether all parachutes on the vessel are deployed, and sets the deployment state of all parachutes. Cannot be set to *false*. See *Parachute.Deployed*.

Boolean Radiators { get; set; }

Returns whether all radiators on the vessel are deployed, and sets the deployment state of all radiators. See *Radiator.Deployed*.

Boolean ResourceHarvesters { get; set; }

Returns whether all of the resource harvesters on the vessel are deployed, and sets the deployment state of all resource harvesters. See *ResourceHarvester.Deployed*.

Boolean ResourceHarvestersActive { get; set; }

Returns whether any of the resource harvesters on the vessel are active, and sets the active state of all resource harvesters. See *ResourceHarvester.Active*.

Boolean SolarPanels { get; set; }

Returns whether all solar panels on the vessel are deployed, and sets the deployment state of all solar panels. See *SolarPanel.Deployed*.

Boolean Abort { get; set; }

The state of the abort action group.

Single Throttle { get; set; }

The state of the throttle. A value between 0 and 1.

ControlInputMode InputMode { get; set; }

Sets the behavior of the pitch, yaw, roll and translation control inputs. When set to *additive*, these inputs are added to the vessels current inputs. This mode is the default. When set to *override*, these inputs (if non-zero) override the vessels inputs. This mode prevents keyboard control, or SAS, from interfering with the controls when they are set.

Single Pitch { get; set; }

The state of the pitch control. A value between -1 and 1. Equivalent to the w and s keys.

Single Yaw { **get**; **set**; }

The state of the yaw control. A value between -1 and 1. Equivalent to the a and d keys.

Single Roll { **get**; **set**; }

The state of the roll control. A value between -1 and 1. Equivalent to the q and e keys.

Single Forward { **get**; **set**; }

The state of the forward translational control. A value between -1 and 1. Equivalent to the h and n keys.

Single Up { **get**; **set**; }

The state of the up translational control. A value between -1 and 1. Equivalent to the i and k keys.

Single Right { **get**; **set**; }

The state of the right translational control. A value between -1 and 1. Equivalent to the j and l keys.

Single WheelThrottle { **get**; **set**; }

The state of the wheel throttle. A value between -1 and 1. A value of 1 rotates the wheels forwards, a value of -1 rotates the wheels backwards.

Single WheelSteering { **get**; **set**; }

The state of the wheel steering. A value between -1 and 1. A value of 1 steers to the left, and a value of -1 steers to the right.

Int32 CurrentStage { **get**; }

The current stage of the vessel. Corresponds to the stage number in the in-game UI.

IList<Vessel> ActivateNextStage ()

Activates the next stage. Equivalent to pressing the space bar in-game.

Returns A list of vessel objects that are jettisoned from the active vessel.

Note: When called, the active vessel may change. It is therefore possible that, after calling this function, the object(s) returned by previous call(s) to *SpaceCenter.ActiveVessel* no longer refer to the active vessel.

Boolean GetActionGroup (UInt32 group)

Returns `true` if the given action group is enabled.

Parameters

- **group** – A number between 0 and 9 inclusive, or between 0 and 250 inclusive when the *Extended Action Groups mod* is installed.

void SetActionGroup (UInt32 group, Boolean state)

Sets the state of the given action group.

Parameters

- **group** – A number between 0 and 9 inclusive, or between 0 and 250 inclusive when the *Extended Action Groups mod* is installed.

void ToggleActionGroup (UInt32 group)

Toggles the state of the given action group.

Parameters

- **group** – A number between 0 and 9 inclusive, or between 0 and 250 inclusive when the *Extended Action Groups mod* is installed.

Node AddNode (Double ut, Single prograde = 0.0, Single normal = 0.0, Single radial = 0.0)

Creates a maneuver node at the given universal time, and returns a *Node* object that can be used to modify

it. Optionally sets the magnitude of the delta-v for the maneuver node in the prograde, normal and radial directions.

Parameters

- **ut** – Universal time of the maneuver node.
- **prograde** – Delta-v in the prograde direction.
- **normal** – Delta-v in the normal direction.
- **radial** – Delta-v in the radial direction.

`IList<Node> Nodes { get; }`

Returns a list of all existing maneuver nodes, ordered by time from first to last.

`void RemoveNodes ()`

Remove all maneuver nodes.

enum ControlState

The control state of a vessel. See *Control.State*.

Full

Full controllable.

Partial

Partially controllable.

None

Not controllable.

enum ControlSource

The control source of a vessel. See *Control.Source*.

Kerbal

Vessel is controlled by a Kerbal.

Probe

Vessel is controlled by a probe core.

None

Vessel is not controlled.

enum SASMode

The behavior of the SAS auto-pilot. See *AutoPilot.SASMode*.

StabilityAssist

Stability assist mode. Dampen out any rotation.

Maneuver

Point in the burn direction of the next maneuver node.

Prograde

Point in the prograde direction.

Retrograde

Point in the retrograde direction.

Normal

Point in the orbit normal direction.

AntiNormal

Point in the orbit anti-normal direction.

Radial

Point in the orbit radial direction.

AntiRadial

Point in the orbit anti-radial direction.

Target

Point in the direction of the current target.

AntiTarget

Point away from the current target.

enum SpeedMode

The mode of the speed reported in the navball. See *Control.SpeedMode*.

Orbit

Speed is relative to the vessel's orbit.

Surface

Speed is relative to the surface of the body being orbited.

Target

Speed is relative to the current target.

enum ControlInputMode

See *Control.InputMode*.

Additive

Control inputs are added to the vessels current control inputs.

Override

Control inputs (when they are non-zero) override the vessels current control inputs.

4.3.7 Communications

class Comms

Used to interact with CommNet for a given vessel. Obtained by calling *Vessel.Comms*.

Boolean CanCommunicate { get; }

Whether the vessel can communicate with KSC.

Boolean CanTransmitScience { get; }

Whether the vessel can transmit science data to KSC.

Double SignalStrength { get; }

Signal strength to KSC.

Double SignalDelay { get; }

Signal delay to KSC in seconds.

Double Power { get; }

The combined power of all active antennae on the vessel.

IList<CommLink> ControlPath { get; }

The communication path used to control the vessel.

class CommLink

Represents a communication node in the network. For example, a vessel or the KSC.

CommLinkType Type { get; }

The type of link.

Double SignalStrength { get; }

Signal strength of the link.

CommNode Start { get; }

Start point of the link.

CommNode End { get; }

Start point of the link.

enum CommLinkType

The type of a communication link. See *CommLink.Type*.

Home

Link is to a base station on Kerbin.

Control

Link is to a control source, for example a manned spacecraft.

Relay

Link is to a relay satellite.

class CommNode

Represents a communication node in the network. For example, a vessel or the KSC.

String Name { get; }

Name of the communication node.

Boolean IsHome { get; }

Whether the communication node is on Kerbin.

Boolean IsControlPoint { get; }

Whether the communication node is a control point, for example a manned vessel.

Boolean IsVessel { get; }

Whether the communication node is a vessel.

Vessel Vessel { get; }

The vessel for this communication node.

4.3.8 Parts

The following classes allow interaction with a vessels individual parts.

- *Parts*
- *Part*
- *Module*
- *Specific Types of Part*
 - *Antenna*
 - *Cargo Bay*
 - *Control Surface*
 - *Decoupler*
 - *Docking Port*
 - *Engine*

- *Experiment*
- *Fairing*
- *Intake*
- *Leg*
- *Launch Clamp*
- *Light*
- *Parachute*
- *Radiator*
- *Resource Converter*
- *Resource Harvester*
- *Reaction Wheel*
- *RCS*
- *Sensor*
- *Solar Panel*
- *Thruster*
- *Wheel*
- *Trees of Parts*
 - *Traversing the Tree*
 - *Attachment Modes*
- *Fuel Lines*
- *Staging*

Parts

class **Parts**

Instances of this class are used to interact with the parts of a vessel. An instance can be obtained by calling `Vessel.Parts`.

`IList<Part> All { get; }`

A list of all of the vessels parts.

`Part Root { get; }`

The vessels root part.

Note: See the discussion on *Trees of Parts*.

`Part Controlling { get; set; }`

The part from which the vessel is controlled.

`IList<Part> WithName (String name)`

A list of parts whose `Part.Name` is *name*.

Parameters

IList<Part> WithTitle (*String title*)

A list of all parts whose *Part.Title* is *title*.

Parameters

IList<Part> WithTag (*String tag*)

A list of all parts whose *Part.Tag* is *tag*.

Parameters

IList<Part> WithModule (*String moduleName*)

A list of all parts that contain a *Module* whose *Module.Name* is *moduleName*.

Parameters

IList<Part> InStage (*Int32 stage*)

A list of all parts that are activated in the given *stage*.

Parameters

Note: See the discussion on *Staging*.

IList<Part> InDecoupleStage (*Int32 stage*)

A list of all parts that are decoupled in the given *stage*.

Parameters

Note: See the discussion on *Staging*.

IList<Module> ModulesWithName (*String moduleName*)

A list of modules (combined across all parts in the vessel) whose *Module.Name* is *moduleName*.

Parameters

IList<Antenna> Antennas { **get**; }

A list of all antennas in the vessel.

IList<CargoBay> CargoBays { **get**; }

A list of all cargo bays in the vessel.

IList<ControlSurface> ControlSurfaces { **get**; }

A list of all control surfaces in the vessel.

IList<Decoupler> Decouplers { **get**; }

A list of all decouplers in the vessel.

IList<DockingPort> DockingPorts { **get**; }

A list of all docking ports in the vessel.

IList<Engine> Engines { **get**; }

A list of all engines in the vessel.

Note: This includes any part that generates thrust. This covers many different types of engine, including liquid fuel rockets, solid rocket boosters, jet engines and RCS thrusters.

IList<Experiment> Experiments { **get**; }

A list of all science experiments in the vessel.

IList<Fairing> Fairings { get; }
A list of all fairings in the vessel.

IList<Intake> Intakes { get; }
A list of all intakes in the vessel.

IList<Leg> Legs { get; }
A list of all landing legs attached to the vessel.

IList<LaunchClamp> LaunchClamps { get; }
A list of all launch clamps attached to the vessel.

IList<Light> Lights { get; }
A list of all lights in the vessel.

IList<Parachute> Parachutes { get; }
A list of all parachutes in the vessel.

IList<Radiator> Radiators { get; }
A list of all radiators in the vessel.

IList<RCS> RCS { get; }
A list of all RCS blocks/thrusters in the vessel.

IList<ReactionWheel> ReactionWheels { get; }
A list of all reaction wheels in the vessel.

IList<ResourceConverter> ResourceConverters { get; }
A list of all resource converters in the vessel.

IList<ResourceHarvester> ResourceHarvesters { get; }
A list of all resource harvesters in the vessel.

IList<Sensor> Sensors { get; }
A list of all sensors in the vessel.

IList<SolarPanel> SolarPanels { get; }
A list of all solar panels in the vessel.

IList<Wheel> Wheels { get; }
A list of all wheels in the vessel.

Part

class Part

Represents an individual part. Vessels are made up of multiple parts. Instances of this class can be obtained by several methods in *Parts*.

String Name { get; }
Internal name of the part, as used in *part* *cfg* files. For example “Mark1-2Pod”.

String Title { get; }
Title of the part, as shown when the part is right clicked in-game. For example “Mk1-2 Command Pod”.

String Tag { get; set; }
The name tag for the part. Can be set to a custom string using the in-game user interface.

Note: This requires either the [NameTag](#) or [kOS](#) mod to be installed.

Boolean Highlighted { get; set; }

Whether the part is highlighted.

Tuple<Double, Double, Double> HighlightColor { get; set; }

The color used to highlight the part, as an RGB triple.

Double Cost { get; }

The cost of the part, in units of funds.

Vessel Vessel { get; }

The vessel that contains this part.

Part Parent { get; }

The parts parent. Returns `null` if the part does not have a parent. This, in combination with `Part.Children`, can be used to traverse the vessels parts tree.

Note: See the discussion on *Trees of Parts*.

IList<Part> Children { get; }

The parts children. Returns an empty list if the part has no children. This, in combination with `Part.Parent`, can be used to traverse the vessels parts tree.

Note: See the discussion on *Trees of Parts*.

Boolean AxiallyAttached { get; }

Whether the part is axially attached to its parent, i.e. on the top or bottom of its parent. If the part has no parent, returns `false`.

Note: See the discussion on *Attachment Modes*.

Boolean RadiallyAttached { get; }

Whether the part is radially attached to its parent, i.e. on the side of its parent. If the part has no parent, returns `false`.

Note: See the discussion on *Attachment Modes*.

Int32 Stage { get; }

The stage in which this part will be activated. Returns -1 if the part is not activated by staging.

Note: See the discussion on *Staging*.

Int32 DecoupleStage { get; }

The stage in which this part will be decoupled. Returns -1 if the part is never decoupled from the vessel.

Note: See the discussion on *Staging*.

Boolean Massless { get; }

Whether the part is `massless`.

Double Mass { get; }

The current mass of the part, including resources it contains, in kilograms. Returns zero if the part is massless.

Double DryMass { get; }

The mass of the part, not including any resources it contains, in kilograms. Returns zero if the part is massless.

Boolean Shielded { get; }

Whether the part is shielded from the exterior of the vessel, for example by a fairing.

Single DynamicPressure { get; }

The dynamic pressure acting on the part, in Pascals.

Double ImpactTolerance { get; }

The impact tolerance of the part, in meters per second.

Double Temperature { get; }

Temperature of the part, in Kelvin.

Double SkinTemperature { get; }

Temperature of the skin of the part, in Kelvin.

Double MaxTemperature { get; }

Maximum temperature that the part can survive, in Kelvin.

Double MaxSkinTemperature { get; }

Maximum temperature that the skin of the part can survive, in Kelvin.

Single ThermalMass { get; }

A measure of how much energy it takes to increase the internal temperature of the part, in Joules per Kelvin.

Single ThermalSkinMass { get; }

A measure of how much energy it takes to increase the skin temperature of the part, in Joules per Kelvin.

Single ThermalResourceMass { get; }

A measure of how much energy it takes to increase the temperature of the resources contained in the part, in Joules per Kelvin.

Single ThermalConductionFlux { get; }

The rate at which heat energy is conducting into or out of the part via contact with other parts. Measured in energy per unit time, or power, in Watts. A positive value means the part is gaining heat energy, and negative means it is losing heat energy.

Single ThermalConvectionFlux { get; }

The rate at which heat energy is convecting into or out of the part from the surrounding atmosphere. Measured in energy per unit time, or power, in Watts. A positive value means the part is gaining heat energy, and negative means it is losing heat energy.

Single ThermalRadiationFlux { get; }

The rate at which heat energy is radiating into or out of the part from the surrounding environment. Measured in energy per unit time, or power, in Watts. A positive value means the part is gaining heat energy, and negative means it is losing heat energy.

Single ThermalInternalFlux { get; }

The rate at which heat energy is being generated by the part. For example, some engines generate heat by combusting fuel. Measured in energy per unit time, or power, in Watts. A positive value means the part is gaining heat energy, and negative means it is losing heat energy.

Single ThermalSkinToInternalFlux { get; }

The rate at which heat energy is transferring between the part's skin and its internals. Measured in energy

per unit time, or power, in Watts. A positive value means the part's internals are gaining heat energy, and negative means its skin is gaining heat energy.

Resources **Resources** { **get**; }

A *Resources* object for the part.

Boolean **Crossfeed** { **get**; }

Whether this part is crossfeed capable.

Boolean **IsFuelLine** { **get**; }

Whether this part is a fuel line.

IList<Part> **FuelLinesFrom** { **get**; }

The parts that are connected to this part via fuel lines, where the direction of the fuel line is into this part.

Note: See the discussion on *Fuel Lines*.

IList<Part> **FuelLinesTo** { **get**; }

The parts that are connected to this part via fuel lines, where the direction of the fuel line is out of this part.

Note: See the discussion on *Fuel Lines*.

IList<Module> **Modules** { **get**; }

The modules for this part.

Antenna **Antenna** { **get**; }

A *Antenna* if the part is an antenna, otherwise null.

CargoBay **CargoBay** { **get**; }

A *CargoBay* if the part is a cargo bay, otherwise null.

ControlSurface **ControlSurface** { **get**; }

A *ControlSurface* if the part is an aerodynamic control surface, otherwise null.

Decoupler **Decoupler** { **get**; }

A *Decoupler* if the part is a decoupler, otherwise null.

DockingPort **DockingPort** { **get**; }

A *DockingPort* if the part is a docking port, otherwise null.

Engine **Engine** { **get**; }

An *Engine* if the part is an engine, otherwise null.

Experiment **Experiment** { **get**; }

An *Experiment* if the part is a science experiment, otherwise null.

Fairing **Fairing** { **get**; }

A *Fairing* if the part is a fairing, otherwise null.

Intake **Intake** { **get**; }

An *Intake* if the part is an intake, otherwise null.

Note: This includes any part that generates thrust. This covers many different types of engine, including liquid fuel rockets, solid rocket boosters and jet engines. For RCS thrusters see *RCS*.

Leg **Leg** { **get**; }

A *Leg* if the part is a landing leg, otherwise null.

LaunchClamp **LaunchClamp** { **get**; }

A *LaunchClamp* if the part is a launch clamp, otherwise null.

Light **Light** { **get**; }

A *Light* if the part is a light, otherwise null.

Parachute **Parachute** { **get**; }

A *Parachute* if the part is a parachute, otherwise null.

Radiator **Radiator** { **get**; }

A *Radiator* if the part is a radiator, otherwise null.

RCS **RCS** { **get**; }

A *RCS* if the part is an RCS block/thruster, otherwise null.

ReactionWheel **ReactionWheel** { **get**; }

A *ReactionWheel* if the part is a reaction wheel, otherwise null.

ResourceConverter **ResourceConverter** { **get**; }

A *ResourceConverter* if the part is a resource converter, otherwise null.

ResourceHarvester **ResourceHarvester** { **get**; }

A *ResourceHarvester* if the part is a resource harvester, otherwise null.

Sensor **Sensor** { **get**; }

A *Sensor* if the part is a sensor, otherwise null.

SolarPanel **SolarPanel** { **get**; }

A *SolarPanel* if the part is a solar panel, otherwise null.

Wheel **Wheel** { **get**; }

A *Wheel* if the part is a wheel, otherwise null.

Tuple<Double, Double, Double> Position (*ReferenceFrame* *referenceFrame*)

The position of the part in the given reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned position vector is in.

Returns The position as a vector.

Note: This is a fixed position in the part, defined by the parts model. It s not necessarily the same as the parts center of mass. Use *Part.CenterOfMass* to get the parts center of mass.

Tuple<Double, Double, Double> CenterOfMass (*ReferenceFrame* *referenceFrame*)

The position of the parts center of mass in the given reference frame. If the part is physicsless, this is equivalent to *Part.Position*.

Parameters

- **referenceFrame** – The reference frame that the returned position vector is in.

Returns The position as a vector.

Tuple<Tuple<Double, Double, Double>, Tuple<Double, Double, Double>> BoundingBox (*ReferenceFrame* *referenceFrame*)

The axis-aligned bounding box of the part in the given reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned position vectors are in.

Returns The positions of the minimum and maximum vertices of the box, as position vectors.

Note: This is computed from the collision mesh of the part. If the part is not collidable, the box has zero volume and is centered on the *Part.Position* of the part.

Tuple<Double, Double, Double> Direction (*ReferenceFrame referenceFrame*)

The direction the part points in, in the given reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

Tuple<Double, Double, Double> Velocity (*ReferenceFrame referenceFrame*)

The linear velocity of the part in the given reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned velocity vector is in.

Returns The velocity as a vector. The vector points in the direction of travel, and its magnitude is the speed of the body in meters per second.

Tuple<Double, Double, Double, Double> Rotation (*ReferenceFrame referenceFrame*)

The rotation of the part, in the given reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned rotation is in.

Returns The rotation as a quaternion of the form (x, y, z, w) .

Tuple<Double, Double, Double> MomentOfInertia { **get**; }

The moment of inertia of the part in $kg.m^2$ around its center of mass in the parts reference frame (*ReferenceFrame*).

IList<Double> InertiaTensor { **get**; }

The inertia tensor of the part in the parts reference frame (*ReferenceFrame*). Returns the 3x3 matrix as a list of elements, in row-major order.

ReferenceFrame **ReferenceFrame** { **get**; }

The reference frame that is fixed relative to this part, and centered on a fixed position within the part, defined by the parts model.

- The origin is at the position of the part, as returned by *Part.Position*.
- The axes rotate with the part.
- The x, y and z axis directions depend on the design of the part.

Note: For docking port parts, this reference frame is not necessarily equivalent to the reference frame for the docking port, returned by *DockingPort.ReferenceFrame*.

ReferenceFrame **CenterOfMassReferenceFrame** { **get**; }

The reference frame that is fixed relative to this part, and centered on its center of mass.

- The origin is at the center of mass of the part, as returned by *Part.CenterOfMass*.
- The axes rotate with the part.
- The x, y and z axis directions depend on the design of the part.

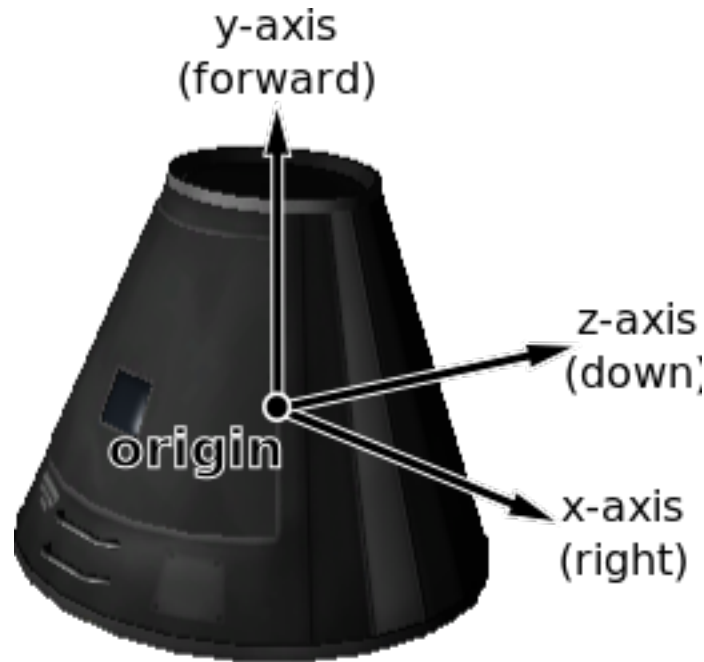


Fig. 4.7: Mk1 Command Pod reference frame origin and axes

Note: For docking port parts, this reference frame is not necessarily equivalent to the reference frame for the docking port, returned by *DockingPort.ReferenceFrame*.

Force **AddForce** (*Tuple*<Double, Double, Double> *force*, *Tuple*<Double, Double, Double> *position*, *ReferenceFrame* *referenceFrame*)

Exert a constant force on the part, acting at the given position.

Parameters

- **force** – A vector pointing in the direction that the force acts, with its magnitude equal to the strength of the force in Newtons.
- **position** – The position at which the force acts, as a vector.
- **referenceFrame** – The reference frame that the force and position are in.

Returns An object that can be used to remove or modify the force.

void **InstantaneousForce** (*Tuple*<Double, Double, Double> *force*, *Tuple*<Double, Double, Double> *position*, *ReferenceFrame* *referenceFrame*)

Exert an instantaneous force on the part, acting at the given position.

Parameters

- **force** – A vector pointing in the direction that the force acts, with its magnitude equal to the strength of the force in Newtons.
- **position** – The position at which the force acts, as a vector.
- **referenceFrame** – The reference frame that the force and position are in.

Note: The force is applied instantaneously in a single physics update.

class Force

Obtained by calling *Part.AddForce*.

Part **Part** { **get**; }

The part that this force is applied to.

Tuple<*Double*, *Double*, *Double*> **ForceVector** { **get**; **set**; }

The force vector, in Newtons.

Returns A vector pointing in the direction that the force acts, with its magnitude equal to the strength of the force in Newtons.

Tuple<*Double*, *Double*, *Double*> **Position** { **get**; **set**; }

The position at which the force acts, in reference frame *ReferenceFrame*.

Returns The position as a vector.

ReferenceFrame **ReferenceFrame** { **get**; **set**; }

The reference frame of the force vector and position.

void **Remove** ()

Remove the force.

Module

class Module

This can be used to interact with a specific part module. This includes part modules in stock KSP, and those added by mods.

In KSP, each part has zero or more *PartModules* associated with it. Each one contains some of the functionality of the part. For example, an engine has a “ModuleEngines” part module that contains all the functionality of an engine.

String **Name** { **get**; }

Name of the PartModule. For example, “ModuleEngines”.

Part **Part** { **get**; }

The part that contains this module.

IDictionary<*String*, *String*> **Fields** { **get**; }

The modules field names and their associated values, as a dictionary. These are the values visible in the right-click menu of the part.

Boolean **HasField** (*String name*)

Returns *true* if the module has a field with the given name.

Parameters

- **name** – Name of the field.

String **GetField** (*String name*)

Returns the value of a field.

Parameters

- **name** – Name of the field.

void **SetFieldInt** (*String name*, *Int32 value*)

Set the value of a field to the given integer number.

Parameters

- **name** – Name of the field.

- **value** – Value to set.

void **SetFieldFloat** (*String name*, *Single value*)
Set the value of a field to the given floating point number.

Parameters

- **name** – Name of the field.
- **value** – Value to set.

void **SetFieldString** (*String name*, *String value*)
Set the value of a field to the given string.

Parameters

- **name** – Name of the field.
- **value** – Value to set.

void **ResetField** (*String name*)
Set the value of a field to its original value.

Parameters

- **name** – Name of the field.

IList<String> **Events** { *get*; }

A list of the names of all of the modules events. Events are the clickable buttons visible in the right-click menu of the part.

Boolean **HasEvent** (*String name*)

true if the module has an event with the given name.

Parameters

void **TriggerEvent** (*String name*)

Trigger the named event. Equivalent to clicking the button in the right-click menu of the part.

Parameters

IList<String> **Actions** { *get*; }

A list of all the names of the modules actions. These are the parts actions that can be assigned to action groups in the in-game editor.

Boolean **HasAction** (*String name*)

true if the part has an action with the given name.

Parameters

void **SetAction** (*String name*, *Boolean value = True*)

Set the value of an action with the given name.

Parameters

Specific Types of Part

The following classes provide functionality for specific types of part.

- *Antenna*
- *Cargo Bay*

- *Control Surface*
- *Decoupler*
- *Docking Port*
- *Engine*
- *Experiment*
- *Fairing*
- *Intake*
- *Leg*
- *Launch Clamp*
- *Light*
- *Parachute*
- *Radiator*
- *Resource Converter*
- *Resource Harvester*
- *Reaction Wheel*
- *RCS*
- *Sensor*
- *Solar Panel*
- *Thruster*
- *Wheel*

Antenna

class Antenna

An antenna. Obtained by calling *Part.Antenna*.

Part **Part** { **get**; }

The part object for this antenna.

AntennaState **State** { **get**; }

The current state of the antenna.

Boolean Deployable { **get**; }

Whether the antenna is deployable.

Boolean Deployed { **get**; **set**; }

Whether the antenna is deployed.

Note: Fixed antennas are always deployed. Returns an error if you try to deploy a fixed antenna.

Boolean CanTransmit { **get**; }

Whether data can be transmitted by this antenna.

```

void Transmit ()
    Transmit data.

void Cancel ()
    Cancel current transmission of data.

Boolean AllowPartial { get; set; }
    Whether partial data transmission is permitted.

Double Power { get; }
    The power of the antenna.

Boolean Combinable { get; }
    Whether the antenna can be combined with other antennae on the vessel to boost the power.

Double CombinableExponent { get; }
    Exponent used to calculate the combined power of multiple antennae on a vessel.

Single PacketInterval { get; }
    Interval between sending packets in seconds.

Single PacketSize { get; }
    Amount of data sent per packet in Mits.

Double PacketResourceCost { get; }
    Units of electric charge consumed per packet sent.

```

```

enum AntennaState
    The state of an antenna. See Antenna.State.

    Deployed
        Antenna is fully deployed.

    Retracted
        Antenna is fully retracted.

    Deploying
        Antenna is being deployed.

    Retracting
        Antenna is being retracted.

    Broken
        Antenna is broken.

```

Cargo Bay

```

class CargoBay
    A cargo bay. Obtained by calling Part.CargoBay.

    Part Part { get; }
        The part object for this cargo bay.

    CargoBayState State { get; }
        The state of the cargo bay.

    Boolean Open { get; set; }
        Whether the cargo bay is open.

enum CargoBayState
    The state of a cargo bay. See CargoBay.State.

```

Open
Cargo bay is fully open.

Closed
Cargo bay closed and locked.

Opening
Cargo bay is opening.

Closing
Cargo bay is closing.

Control Surface

class ControlSurface

An aerodynamic control surface. Obtained by calling *Part.ControlSurface*.

Part Part { get; }
The part object for this control surface.

Boolean PitchEnabled { get; set; }
Whether the control surface has pitch control enabled.

Boolean YawEnabled { get; set; }
Whether the control surface has yaw control enabled.

Boolean RollEnabled { get; set; }
Whether the control surface has roll control enabled.

Single AuthorityLimiter { get; set; }
The authority limiter for the control surface, which controls how far the control surface will move.

Boolean Inverted { get; set; }
Whether the control surface movement is inverted.

Boolean Deployed { get; set; }
Whether the control surface has been fully deployed.

Single SurfaceArea { get; }
Surface area of the control surface in m^2 .

Tuple<Tuple<Double, Double, Double>, Tuple<Double, Double, Double>> AvailableTorque { get; }
The available torque, in Newton meters, that can be produced by this control surface, in the positive and negative pitch, roll and yaw axes of the vessel. These axes correspond to the coordinate axes of the *Vessel.ReferenceFrame*.

Decoupler

class Decoupler

A decoupler. Obtained by calling *Part.Decoupler*

Part Part { get; }
The part object for this decoupler.

Vessel Decouple ()
Fires the decoupler. Returns the new vessel created when the decoupler fires. Throws an exception if the decoupler has already fired.

Note: When called, the active vessel may change. It is therefore possible that, after calling this function, the object(s) returned by previous call(s) to *SpaceCenter.ActiveVessel* no longer refer to the active vessel.

Boolean Decoupled { get; }

Whether the decoupler has fired.

Boolean Staged { get; }

Whether the decoupler is enabled in the staging sequence.

Single Impulse { get; }

The impulse that the decoupler imparts when it is fired, in Newton seconds.

Docking Port

class DockingPort

A docking port. Obtained by calling *Part.DockingPort*

Part Part { get; }

The part object for this docking port.

DockingPortState State { get; }

The current state of the docking port.

Part DockedPart { get; }

The part that this docking port is docked to. Returns `null` if this docking port is not docked to anything.

Vessel Undock ()

Undocks the docking port and returns the new *Vessel* that is created. This method can be called for either docking port in a docked pair. Throws an exception if the docking port is not docked to anything.

Note: When called, the active vessel may change. It is therefore possible that, after calling this function, the object(s) returned by previous call(s) to *SpaceCenter.ActiveVessel* no longer refer to the active vessel.

Single ReengageDistance { get; }

The distance a docking port must move away when it undocks before it becomes ready to dock with another port, in meters.

Boolean HasShield { get; }

Whether the docking port has a shield.

Boolean Shielded { get; set; }

The state of the docking ports shield, if it has one.

Returns `true` if the docking port has a shield, and the shield is closed. Otherwise returns `false`. When set to `true`, the shield is closed, and when set to `false` the shield is opened. If the docking port does not have a shield, setting this attribute has no effect.

Tuple<Double, Double, Double> Position (ReferenceFrame referenceFrame)

The position of the docking port, in the given reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned position vector is in.

Returns The position as a vector.

`Tuple<Double, Double, Double> Direction (ReferenceFrame referenceFrame)`

The direction that docking port points in, in the given reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

`Tuple<Double, Double, Double, Double> Rotation (ReferenceFrame referenceFrame)`

The rotation of the docking port, in the given reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned rotation is in.

Returns The rotation as a quaternion of the form (x, y, z, w) .

`ReferenceFrame ReferenceFrame { get; }`

The reference frame that is fixed relative to this docking port, and oriented with the port.

- The origin is at the position of the docking port.
- The axes rotate with the docking port.
- The x-axis points out to the right side of the docking port.
- The y-axis points in the direction the docking port is facing.
- The z-axis points out of the bottom off the docking port.

Note: This reference frame is not necessarily equivalent to the reference frame for the part, returned by `Part.ReferenceFrame`.

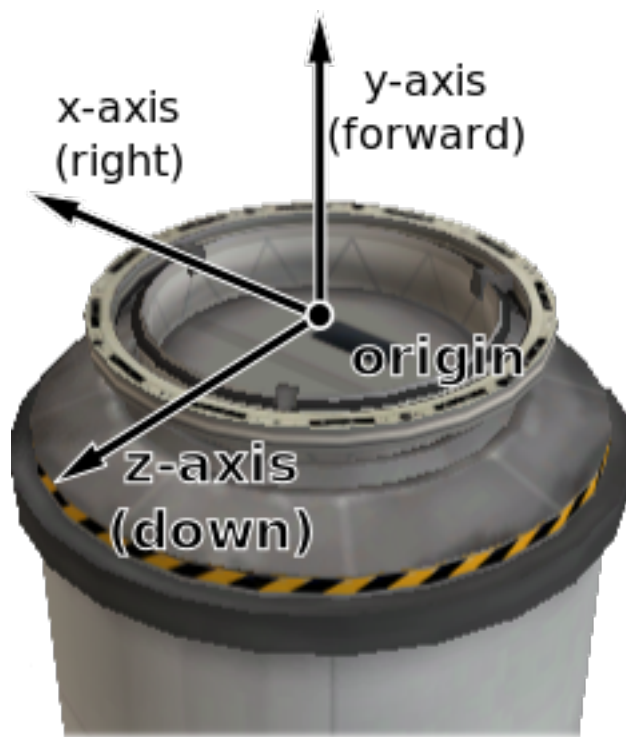


Fig. 4.8: Docking port reference frame origin and axes

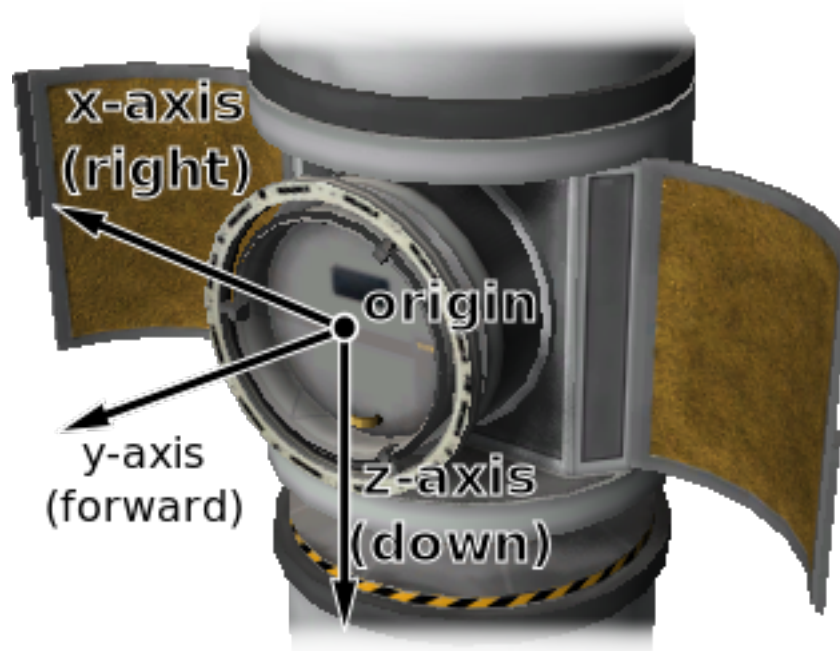


Fig. 4.9: Inline docking port reference frame origin and axes

enum DockingPortState

The state of a docking port. See *DockingPort.State*.

Ready

The docking port is ready to dock to another docking port.

Docked

The docking port is docked to another docking port, or docked to another part (from the VAB/SPH).

Docking

The docking port is very close to another docking port, but has not docked. It is using magnetic force to acquire a solid dock.

Undocking

The docking port has just been undocked from another docking port, and is disabled until it moves away by a sufficient distance (*DockingPort.ReengageDistance*).

Shielded

The docking port has a shield, and the shield is closed.

Moving

The docking ports shield is currently opening/closing.

Engine

class Engine

An engine, including ones of various types. For example liquid fuelled gimballed engines, solid rocket boosters and jet engines. Obtained by calling *Part.Engine*.

Note: For RCS thrusters *Part.RCS*.

Part Part { get; }

The part object for this engine.

Boolean Active { get; set; }

Whether the engine is active. Setting this attribute may have no effect, depending on *Engine.CanShutdown* and *Engine.CanRestart*.

Single Thrust { get; }

The current amount of thrust being produced by the engine, in Newtons.

Single AvailableThrust { get; }

The amount of thrust, in Newtons, that would be produced by the engine when activated and with its throttle set to 100%. Returns zero if the engine does not have any fuel. Takes the engine's current *Engine.ThrustLimit* and atmospheric conditions into account.

Single MaxThrust { get; }

The amount of thrust, in Newtons, that would be produced by the engine when activated and fueled, with its throttle and throttle limiter set to 100%.

Single MaxVacuumThrust { get; }

The maximum amount of thrust that can be produced by the engine in a vacuum, in Newtons. This is the amount of thrust produced by the engine when activated, *Engine.ThrustLimit* is set to 100%, the main vessel's throttle is set to 100% and the engine is in a vacuum.

Single ThrustLimit { get; set; }

The thrust limiter of the engine. A value between 0 and 1. Setting this attribute may have no effect, for example the thrust limit for a solid rocket booster cannot be changed in flight.

IList<Thruster> Thrusters { get; }

The components of the engine that generate thrust.

Note: For example, this corresponds to the rocket nozzle on a solid rocket booster, or the individual nozzles on a RAPIER engine. The overall thrust produced by the engine, as reported by *Engine.AvailableThrust*, *Engine.MaxThrust* and others, is the sum of the thrust generated by each thruster.

Single SpecificImpulse { get; }

The current specific impulse of the engine, in seconds. Returns zero if the engine is not active.

Single VacuumSpecificImpulse { get; }

The vacuum specific impulse of the engine, in seconds.

Single KerbinSeaLevelSpecificImpulse { get; }

The specific impulse of the engine at sea level on Kerbin, in seconds.

IList<String> PropellantNames { get; }

The names of the propellants that the engine consumes.

IDictionary<String, Single> PropellantRatios { get; }

The ratio of resources that the engine consumes. A dictionary mapping resource names to the ratio at which they are consumed by the engine.

Note: For example, if the ratios are 0.6 for LiquidFuel and 0.4 for Oxidizer, then for every 0.6 units of LiquidFuel that the engine burns, it will burn 0.4 units of Oxidizer.

IList<Propellant> Propellants { get; }

The propellants that the engine consumes.

Boolean HasFuel { get; }

Whether the engine has any fuel available.

Note: The engine must be activated for this property to update correctly.

Single Throttle { get; }

The current throttle setting for the engine. A value between 0 and 1. This is not necessarily the same as the vessel's main throttle setting, as some engines take time to adjust their throttle (such as jet engines).

Boolean ThrottleLocked { get; }

Whether the *Control.Throttle* affects the engine. For example, this is `true` for liquid fueled rockets, and `false` for solid rocket boosters.

Boolean CanRestart { get; }

Whether the engine can be restarted once shutdown. If the engine cannot be shutdown, returns `false`. For example, this is `true` for liquid fueled rockets and `false` for solid rocket boosters.

Boolean CanShutdown { get; }

Whether the engine can be shutdown once activated. For example, this is `true` for liquid fueled rockets and `false` for solid rocket boosters.

Boolean HasModes { get; }

Whether the engine has multiple modes of operation.

String Mode { get; set; }

The name of the current engine mode.

IDictionary<String, Engine> Modes { get; }

The available modes for the engine. A dictionary mapping mode names to *Engine* objects.

void ToggleMode ()

Toggle the current engine mode.

Boolean AutoModeSwitch { get; set; }

Whether the engine will automatically switch modes.

Boolean Gimballled { get; }

Whether the engine is gimballled.

Single GimbalRange { get; }

The range over which the gimbal can move, in degrees. Returns 0 if the engine is not gimballled.

Boolean GimbalLocked { get; set; }

Whether the engines gimbal is locked in place. Setting this attribute has no effect if the engine is not gimballled.

Single GimbalLimit { get; set; }

The gimbal limiter of the engine. A value between 0 and 1. Returns 0 if the gimbal is locked.

Tuple<Tuple<Double, Double, Double>, Tuple<Double, Double, Double>> AvailableTorque { get; }

The available torque, in Newton meters, that can be produced by this engine, in the positive and negative pitch, roll and yaw axes of the vessel. These axes correspond to the coordinate axes of the *Vessel.ReferenceFrame*. Returns zero if the engine is inactive, or not gimballled.

class Propellant

A propellant for an engine. Obtains by calling *Engine.Propellants*.

String Name { get; }

The name of the propellant.

Double CurrentAmount { get; }
The current amount of propellant.

Double CurrentRequirement { get; }
The required amount of propellant.

Double TotalResourceAvailable { get; }
The total amount of the underlying resource currently reachable given resource flow rules.

Double TotalResourceCapacity { get; }
The total vehicle capacity for the underlying propellant resource, restricted by resource flow rules.

Boolean IgnoreForIsp { get; }
If this propellant should be ignored when calculating required mass flow given specific impulse.

Boolean IgnoreForThrustCurve { get; }
If this propellant should be ignored for thrust curve calculations.

Boolean DrawStackGauge { get; }
If this propellant has a stack gauge or not.

Boolean IsDeprived { get; }
If this propellant is deprived.

Single Ratio { get; }
The propellant ratio.

Experiment

class Experiment
Obtained by calling *Part.Experiment*.

Part Part { get; }
The part object for this experiment.

void Run ()
Run the experiment.

void Transmit ()
Transmit all experimental data contained by this part.

void Dump ()
Dump the experimental data contained by the experiment.

void Reset ()
Reset the experiment.

Boolean Deployed { get; }
Whether the experiment has been deployed.

Boolean Rerunnable { get; }
Whether the experiment can be re-run.

Boolean Inoperable { get; }
Whether the experiment is inoperable.

Boolean HasData { get; }
Whether the experiment contains data.

IList<ScienceData> Data { get; }
The data contained in this experiment.

String Biome { get; }

The name of the biome the experiment is currently in.

Boolean Available { get; }

Determines if the experiment is available given the current conditions.

ScienceSubject ScienceSubject { get; }

Containing information on the corresponding specific science result for the current conditions. Returns `null` if the experiment is unavailable.

class ScienceData

Obtained by calling *Experiment.Data*.

Single DataAmount { get; }

Data amount.

Single ScienceValue { get; }

Science value.

Single TransmitValue { get; }

Transmit value.

class ScienceSubject

Obtained by calling *Experiment.ScienceSubject*.

String Title { get; }

Title of science subject, displayed in science archives

Boolean IsComplete { get; }

Whether the experiment has been completed.

Single Science { get; }

Amount of science already earned from this subject, not updated until after transmission/recovery.

Single ScienceCap { get; }

Total science allowable for this subject.

Single DataScale { get; }

Multiply science value by this to determine data amount in mits.

Single SubjectValue { get; }

Multiplier for specific Celestial Body/Experiment Situation combination.

Single ScientificValue { get; }

Diminishing value multiplier for decreasing the science value returned from repeated experiments.

Fairing

class Fairing

A fairing. Obtained by calling *Part.Fairing*.

Part Part { get; }

The part object for this fairing.

void Jettison ()

Jettison the fairing. Has no effect if it has already been jettisoned.

Boolean Jettisoned { get; }

Whether the fairing has been jettisoned.

Intake

class Intake

An air intake. Obtained by calling *Part.Intake*.

Part **Part** { **get**; }

The part object for this intake.

Boolean **Open** { **get**; **set**; }

Whether the intake is open.

Single **Speed** { **get**; }

Speed of the flow into the intake, in *m/s*.

Single **Flow** { **get**; }

The rate of flow into the intake, in units of resource per second.

Single **Area** { **get**; }

The area of the intake's opening, in square meters.

Leg

class Leg

A landing leg. Obtained by calling *Part.Leg*.

Part **Part** { **get**; }

The part object for this landing leg.

LegState **State** { **get**; }

The current state of the landing leg.

Boolean **Deployable** { **get**; }

Whether the leg is deployable.

Boolean **Deployed** { **get**; **set**; }

Whether the landing leg is deployed.

Note: Fixed landing legs are always deployed. Returns an error if you try to deploy fixed landing gear.

Boolean **IsGrounded** { **get**; }

Returns whether the leg is touching the ground.

enum LegState

The state of a landing leg. See *Leg.State*.

Deployed

Landing leg is fully deployed.

Retracted

Landing leg is fully retracted.

Deploying

Landing leg is being deployed.

Retracting

Landing leg is being retracted.

Broken

Landing leg is broken.

Launch Clamp

class LaunchClamp

A launch clamp. Obtained by calling *Part.LaunchClamp*.

Part **Part** { **get**; }

The part object for this launch clamp.

void **Release** ()

Releases the docking clamp. Has no effect if the clamp has already been released.

Light

class Light

A light. Obtained by calling *Part.Light*.

Part **Part** { **get**; }

The part object for this light.

Boolean **Active** { **get**; **set**; }

Whether the light is switched on.

Tuple<**Single**, **Single**, **Single**> **Color** { **get**; **set**; }

The color of the light, as an RGB triple.

Single **PowerUsage** { **get**; }

The current power usage, in units of charge per second.

Parachute

class Parachute

A parachute. Obtained by calling *Part.Parachute*.

Part **Part** { **get**; }

The part object for this parachute.

void **Deploy** ()

Deploys the parachute. This has no effect if the parachute has already been deployed.

Boolean **Deployed** { **get**; }

Whether the parachute has been deployed.

void **Arm** ()

Deploys the parachute. This has no effect if the parachute has already been armed or deployed. Only applicable to RealChutes parachutes.

Boolean **Armed** { **get**; }

Whether the parachute has been armed or deployed. Only applicable to RealChutes parachutes.

ParachuteState **State** { **get**; }

The current state of the parachute.

Single **DeployAltitude** { **get**; **set**; }

The altitude at which the parachute will full deploy, in meters. Only applicable to stock parachutes.

Single **DeployMinPressure** { **get**; **set**; }

The minimum pressure at which the parachute will semi-deploy, in atmospheres. Only applicable to stock parachutes.

enum ParachuteState

The state of a parachute. See *Parachute.State*.

Stowed

The parachute is safely tucked away inside its housing.

Armed

The parachute is armed for deployment. (RealChutes only)

Active

The parachute is still stowed, but ready to semi-deploy. (Stock parachutes only)

SemiDeployed

The parachute has been deployed and is providing some drag, but is not fully deployed yet. (Stock parachutes only)

Deployed

The parachute is fully deployed.

Cut

The parachute has been cut.

Radiator**class Radiator**

A radiator. Obtained by calling *Part.Radiator*.

Part **Part** { **get**; }

The part object for this radiator.

Boolean Deployable { **get**; }

Whether the radiator is deployable.

Boolean Deployed { **get**; **set**; }

For a deployable radiator, `true` if the radiator is extended. If the radiator is not deployable, this is always `true`.

RadiatorState **State** { **get**; }

The current state of the radiator.

Note: A fixed radiator is always *RadiatorState.Extended*.

enum RadiatorState

The state of a radiator. *RadiatorState*

Extended

Radiator is fully extended.

Retracted

Radiator is fully retracted.

Extending

Radiator is being extended.

Retracting

Radiator is being retracted.

Broken

Radiator is being broken.

Resource Converter

class ResourceConverter

A resource converter. Obtained by calling *Part.ResourceConverter*.

Part **Part** { **get**; }

The part object for this converter.

Int32 **Count** { **get**; }

The number of converters in the part.

String **Name** (*Int32 index*)

The name of the specified converter.

Parameters

- **index** – Index of the converter.

Boolean **Active** (*Int32 index*)

True if the specified converter is active.

Parameters

- **index** – Index of the converter.

void **Start** (*Int32 index*)

Start the specified converter.

Parameters

- **index** – Index of the converter.

void **Stop** (*Int32 index*)

Stop the specified converter.

Parameters

- **index** – Index of the converter.

ResourceConverterState **State** (*Int32 index*)

The state of the specified converter.

Parameters

- **index** – Index of the converter.

String **StatusInfo** (*Int32 index*)

Status information for the specified converter. This is the full status message shown in the in-game UI.

Parameters

- **index** – Index of the converter.

ICollection<String> **Inputs** (*Int32 index*)

List of the names of resources consumed by the specified converter.

Parameters

- **index** – Index of the converter.

ICollection<String> **Outputs** (*Int32 index*)

List of the names of resources produced by the specified converter.

Parameters

- **index** – Index of the converter.

enum ResourceConverterState

The state of a resource converter. See *ResourceConverter.State*.

Running

Converter is running.

Idle

Converter is idle.

MissingResource

Converter is missing a required resource.

StorageFull

No available storage for output resource.

Capacity

At preset resource capacity.

Unknown

Unknown state. Possible with modified resource converters. In this case, check *ResourceConverter.StatusInfo* for more information.

Resource Harvester

class ResourceHarvester

A resource harvester (drill). Obtained by calling *Part.ResourceHarvester*.

Part **Part** { **get**; }

The part object for this harvester.

ResourceHarvesterState **State** { **get**; }

The state of the harvester.

Boolean **Deployed** { **get**; **set**; }

Whether the harvester is deployed.

Boolean **Active** { **get**; **set**; }

Whether the harvester is actively drilling.

Single **ExtractionRate** { **get**; }

The rate at which the drill is extracting ore, in units per second.

Single **ThermalEfficiency** { **get**; }

The thermal efficiency of the drill, as a percentage of its maximum.

Single **CoreTemperature** { **get**; }

The core temperature of the drill, in Kelvin.

Single **OptimumCoreTemperature** { **get**; }

The core temperature at which the drill will operate with peak efficiency, in Kelvin.

enum ResourceHarvesterState

The state of a resource harvester. See *ResourceHarvester.State*.

Deploying

The drill is deploying.

Deployed

The drill is deployed and ready.

Retracting

The drill is retracting.

Retracted

The drill is retracted.

Active

The drill is running.

Reaction Wheel**class ReactionWheel**

A reaction wheel. Obtained by calling *Part.ReactionWheel*.

Part **Part** { **get**; }

The part object for this reaction wheel.

Boolean **Active** { **get**; **set**; }

Whether the reaction wheel is active.

Boolean **Broken** { **get**; }

Whether the reaction wheel is broken.

Tuple<**Tuple**<**Double**, **Double**, **Double**>, **Tuple**<**Double**, **Double**, **Double**>> **AvailableTorque** { **get**; }

The available torque, in Newton meters, that can be produced by this reaction wheel, in the positive and negative pitch, roll and yaw axes of the vessel. These axes correspond to the coordinate axes of the *Vessel.ReferenceFrame*. Returns zero if the reaction wheel is inactive or broken.

Tuple<**Tuple**<**Double**, **Double**, **Double**>, **Tuple**<**Double**, **Double**, **Double**>> **MaxTorque** { **get**; }

The maximum torque, in Newton meters, that can be produced by this reaction wheel, when it is active, in the positive and negative pitch, roll and yaw axes of the vessel. These axes correspond to the coordinate axes of the *Vessel.ReferenceFrame*.

RCS**class RCS**

An RCS block or thruster. Obtained by calling *Part.RCS*.

Part **Part** { **get**; }

The part object for this RCS.

Boolean **Active** { **get**; }

Whether the RCS thrusters are active. An RCS thruster is inactive if the RCS action group is disabled (*Control.RCS*), the RCS thruster itself is not enabled (*RCS.Enabled*) or it is covered by a fairing (*Part.Shielded*).

Boolean **Enabled** { **get**; **set**; }

Whether the RCS thrusters are enabled.

Boolean **PitchEnabled** { **get**; **set**; }

Whether the RCS thruster will fire when pitch control input is given.

Boolean **YawEnabled** { **get**; **set**; }

Whether the RCS thruster will fire when yaw control input is given.

Boolean **RollEnabled** { **get**; **set**; }

Whether the RCS thruster will fire when roll control input is given.

Boolean **ForwardEnabled** { **get**; **set**; }

Whether the RCS thruster will fire when pitch control input is given.

Boolean UpEnabled { get; set; }

Whether the RCS thruster will fire when yaw control input is given.

Boolean RightEnabled { get; set; }

Whether the RCS thruster will fire when roll control input is given.

Tuple<Tuple<Double, Double, Double>, Tuple<Double, Double, Double>> AvailableTorque { get; }

The available torque, in Newton meters, that can be produced by this RCS, in the positive and negative pitch, roll and yaw axes of the vessel. These axes correspond to the coordinate axes of the *Vessel.ReferenceFrame*. Returns zero if RCS is disable.

Single MaxThrust { get; }

The maximum amount of thrust that can be produced by the RCS thrusters when active, in Newtons.

Single MaxVacuumThrust { get; }

The maximum amount of thrust that can be produced by the RCS thrusters when active in a vacuum, in Newtons.

IList<Thruster> Thrusters { get; }

A list of thrusters, one of each nozzle in the RCS part.

Single SpecificImpulse { get; }

The current specific impulse of the RCS, in seconds. Returns zero if the RCS is not active.

Single VacuumSpecificImpulse { get; }

The vacuum specific impulse of the RCS, in seconds.

Single KerbinSeaLevelSpecificImpulse { get; }

The specific impulse of the RCS at sea level on Kerbin, in seconds.

IList<String> Propellants { get; }

The names of resources that the RCS consumes.

IDictionary<String, Single> PropellantRatios { get; }

The ratios of resources that the RCS consumes. A dictionary mapping resource names to the ratios at which they are consumed by the RCS.

Boolean HasFuel { get; }

Whether the RCS has fuel available.

Note: The RCS thruster must be activated for this property to update correctly.

Sensor

class Sensor

A sensor, such as a thermometer. Obtained by calling *Part.Sensor*.

Part Part { get; }

The part object for this sensor.

Boolean Active { get; set; }

Whether the sensor is active.

String Value { get; }

The current value of the sensor.

Solar Panel

class SolarPanel

A solar panel. Obtained by calling *Part.SolarPanel*.

Part **Part** { **get**; }

The part object for this solar panel.

Boolean Deployable { **get**; }

Whether the solar panel is deployable.

Boolean Deployed { **get**; **set**; }

Whether the solar panel is extended.

SolarPanelState **State** { **get**; }

The current state of the solar panel.

Single EnergyFlow { **get**; }

The current amount of energy being generated by the solar panel, in units of charge per second.

Single SunExposure { **get**; }

The current amount of sunlight that is incident on the solar panel, as a percentage. A value between 0 and 1.

enum SolarPanelState

The state of a solar panel. See *SolarPanel.State*.

Extended

Solar panel is fully extended.

Retracted

Solar panel is fully retracted.

Extending

Solar panel is being extended.

Retracting

Solar panel is being retracted.

Broken

Solar panel is broken.

Thruster

class Thruster

The component of an *Engine* or *RCS* part that generates thrust. Can obtained by calling *Engine.Thrusters* or *RCS.Thrusters*.

Note: Engines can consist of multiple thrusters. For example, the S3 KS-25x4 “Mammoth” has four rocket nozzels, and so consists of four thrusters.

Part **Part** { **get**; }

The *Part* that contains this thruster.

Tuple<Double, Double, Double> ThrustPosition (*ReferenceFrame referenceFrame*)

The position at which the thruster generates thrust, in the given reference frame. For gimballed engines, this takes into account the current rotation of the gimbal.

Parameters

- **referenceFrame** – The reference frame that the returned position vector is in.

Returns The position as a vector.

Tuple<Double, Double, Double> ThrustDirection (*ReferenceFrame referenceFrame*)

The direction of the force generated by the thruster, in the given reference frame. This is opposite to the direction in which the thruster expels propellant. For gimballed engines, this takes into account the current rotation of the gimbal.

Parameters

- **referenceFrame** – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

ReferenceFrame **ThrustReferenceFrame** { **get**; }

A reference frame that is fixed relative to the thruster and orientated with its thrust direction (*Thruster.ThrustDirection*). For gimballed engines, this takes into account the current rotation of the gimbal.

- The origin is at the position of thrust for this thruster (*Thruster.ThrustPosition*).
- The axes rotate with the thrust direction. This is the direction in which the thruster expels propellant, including any gimbaling.
- The y-axis points along the thrust direction.
- The x-axis and z-axis are perpendicular to the thrust direction.

Boolean Gimbaled { **get**; }

Whether the thruster is gimballed.

Tuple<Double, Double, Double> GimbalPosition (*ReferenceFrame referenceFrame*)

Position around which the gimbal pivots.

Parameters

- **referenceFrame** – The reference frame that the returned position vector is in.

Returns The position as a vector.

Tuple<Double, Double, Double> GimbalAngle { **get**; }

The current gimbal angle in the pitch, roll and yaw axes, in degrees.

Tuple<Double, Double, Double> InitialThrustPosition (*ReferenceFrame referenceFrame*)

The position at which the thruster generates thrust, when the engine is in its initial position (no gimbaling), in the given reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned position vector is in.

Returns The position as a vector.

Note: This position can move when the gimbal rotates. This is because the thrust position and gimbal position are not necessarily the same.

Tuple<Double, Double, Double> InitialThrustDirection (*ReferenceFrame referenceFrame*)

The direction of the force generated by the thruster, when the engine is in its initial position (no gimbaling), in the given reference frame. This is opposite to the direction in which the thruster expels propellant.

Parameters

- **referenceFrame** – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

Wheel

class Wheel

A wheel. Includes landing gear and rover wheels. Obtained by calling *Part.Wheel*. Can be used to control the motors, steering and deployment of wheels, among other things.

Part **Part** { **get**; }

The part object for this wheel.

WheelState **State** { **get**; }

The current state of the wheel.

Single **Radius** { **get**; }

Radius of the wheel, in meters.

Boolean **Grounded** { **get**; }

Whether the wheel is touching the ground.

Boolean **HasBrakes** { **get**; }

Whether the wheel has brakes.

Single **Brakes** { **get**; **set**; }

The braking force, as a percentage of maximum, when the brakes are applied.

Boolean **AutoFrictionControl** { **get**; **set**; }

Whether automatic friction control is enabled.

Single **ManualFrictionControl** { **get**; **set**; }

Manual friction control value. Only has an effect if automatic friction control is disabled. A value between 0 and 5 inclusive.

Boolean **Deployable** { **get**; }

Whether the wheel is deployable.

Boolean **Deployed** { **get**; **set**; }

Whether the wheel is deployed.

Boolean **Powered** { **get**; }

Whether the wheel is powered by a motor.

Boolean **MotorEnabled** { **get**; **set**; }

Whether the motor is enabled.

Boolean **MotorInverted** { **get**; **set**; }

Whether the direction of the motor is inverted.

MotorState **MotorState** { **get**; }

Whether the direction of the motor is inverted.

Single **MotorOutput** { **get**; }

The output of the motor. This is the torque currently being generated, in Newton meters.

Boolean **TractionControlEnabled** { **get**; **set**; }

Whether automatic traction control is enabled. A wheel only has traction control if it is powered.

Single **TractionControl** { **get**; **set**; }

Setting for the traction control. Only takes effect if the wheel has automatic traction control enabled. A value between 0 and 5 inclusive.

Single DriveLimiter { get; set; }

Manual setting for the motor limiter. Only takes effect if the wheel has automatic traction control disabled.
A value between 0 and 100 inclusive.

Boolean Steerable { get; }

Whether the wheel has steering.

Boolean SteeringEnabled { get; set; }

Whether the wheel steering is enabled.

Boolean SteeringInverted { get; set; }

Whether the wheel steering is inverted.

Boolean HasSuspension { get; }

Whether the wheel has suspension.

Single SuspensionSpringStrength { get; }

Suspension spring strength, as set in the editor.

Single SuspensionDamperStrength { get; }

Suspension damper strength, as set in the editor.

Boolean Broken { get; }

Whether the wheel is broken.

Boolean Repairable { get; }

Whether the wheel is repairable.

Single Stress { get; }

Current stress on the wheel.

Single StressTolerance { get; }

Stress tolerance of the wheel.

Single StressPercentage { get; }

Current stress on the wheel as a percentage of its stress tolerance.

Single Deflection { get; }

Current deflection of the wheel.

Single Slip { get; }

Current slip of the wheel.

enum WheelState

The state of a wheel. See *Wheel.State*.

Deployed

Wheel is fully deployed.

Retracted

Wheel is fully retracted.

Deploying

Wheel is being deployed.

Retracting

Wheel is being retracted.

Broken

Wheel is broken.

enum MotorState

The state of the motor on a powered wheel. See *Wheel.MotorState*.

- Idle**
The motor is idle.
- Running**
The motor is running.
- Disabled**
The motor is disabled.
- Inoperable**
The motor is inoperable.
- NotEnoughResources**
The motor does not have enough resources to run.

Trees of Parts

Vessels in KSP are comprised of a number of parts, connected to one another in a *tree* structure. An example vessel is shown in Figure 1, and the corresponding tree of parts in Figure 2. The craft file for this example can also be downloaded [here](#).

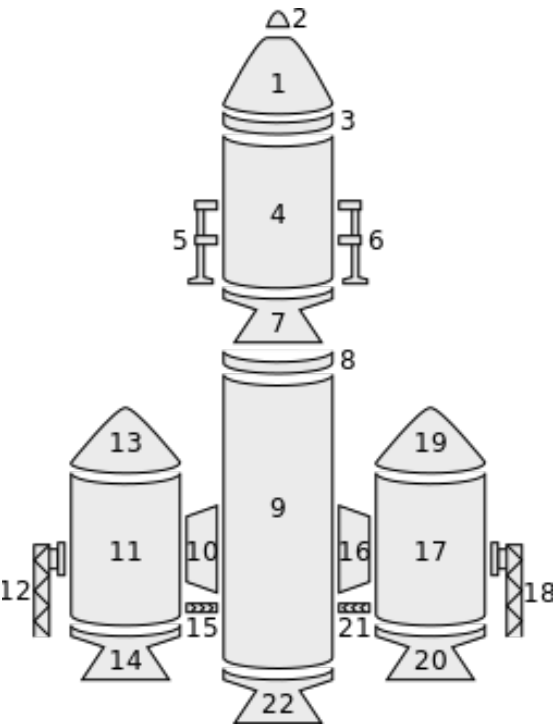


Fig. 4.10: **Figure 1** – Example parts making up a vessel.

Traversing the Tree

The tree of parts can be traversed using the attributes *Parts.Root*, *Part.Parent* and *Part.Children*.

The root of the tree is the same as the vessels *root part* (part number 1 in the example above) and can be obtained by calling *Parts.Root*. A parts children can be obtained by calling *Part.Children*. If the part does not have any children, *Part.Children* returns an empty list. A parts parent can be obtained by calling *Part.Parent*. If the part does not have a parent (as is the case for the root part), *Part.Parent* returns null.

The following C# example uses these attributes to perform a depth-first traversal over all of the parts in a vessel:

```
using System;
using System.Collections.Generic;
using System.Net;
using KRPC.Client;
using KRPC.Client.Sender;

class AttachmentMode
{
    public static void
    {
        using (var connect
            var vess
            = connection.Space
            var root
            var stack = new
            stack.Push (new T
```

```
while (s
    var
    Part
    int
    Cons
    ↪(new String (' ',
    ↪
    ↪(new Tuple<Part, in
        }
    }
}
```

When this code is execute using the craft file for the example vessel pictured above, the following is printed out:

```
Command Pod Mk1
TR-18A Stack Decoupl
FL-T400 Fuel Tank
LV-909 Liquid Fue
TR-18A Stack Dec
FL-T800 Fuel Ta
LV-909 Liquid
TT-70 Radial D
FL-T400 Fuel
TT18-A Launc
FTX-2 Extern
LV-909 Liqui
Aerodynamic
TT-70 Radial D
FL-T400 Fuel
TT18-A Launc
FTX-2 Extern
LV-909 Liqui
Aerodynamic
LT-1 Landing Stru
LT-1 Landing Stru
Mk16 Parachute
```

Attachment Modes

Parts can be attached to other parts either *radially* (on the side of the parent part) or *axially* (on the end of the parent part, to form a stack).

For example, in the vessel pictured above, the parachute (part 2) is *axially* connected to its parent (the command pod – part 1), and the landing leg (part 5) is *radially* connected to its parent (the fuel tank – part 4).

The root part of a vessel (for example the command pod – part 1) does not have a parent part, so does not have an attachment mode. However, the part is consider to be *axially* attached to nothing.

The following C# example does a depth-first traversal as before, but also prints out the attachment mode used by the part:

```
using System;
using System.Collections.Generic;
using System.Net;
using KRPC.Client;
using KRPC.Client.Services.SpaceCenter;

class AttachmentModes
{
    public static void Main ()
    {
        using (var connection = new Connection ()) {
            var vessel_
            = connection.SpaceCenter ().ActiveVessel;
            var root = vessel.Parts.Root;

            var stack = new Stack<Tuple<Part,int>> ();
            stack.Push (new Tuple<Part,int> (root, 0));
            while (stack.Count > 0) {
                var item = stack.Pop ();
                Part part = item.Item1;
                int depth = item.Item2;
                string attachMode =
            (part.AxiallyAttached ? "axial" : "radial");

                Console.WriteLine (new String (' ',
            depth) + part.Title + " - " + attachMode);

                foreach (var child in part.Children)
                    stack.Push_
            (new Tuple<Part,int> (child, depth + 1));
            }
        }
    }
}
```

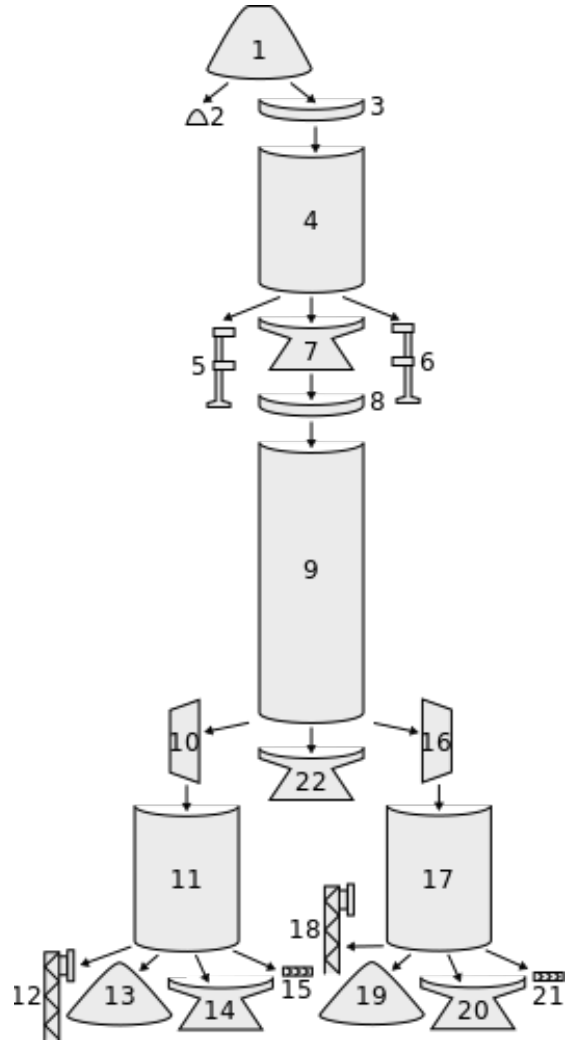


Fig. 4.11: **Figure 2** – Tree of parts for the vessel in Figure 1. Arrows point from the parent part to the child part.

When this code is executed using the craft file for the example vessel pictured above, the following is printed out:

```
Command Pod Mk1 - axial
TR-18A Stack Decoupler - axial
FL-T400 Fuel Tank - axial
LV-909 Liquid Fuel Engine - axial
TR-18A Stack Decoupler - axial
FL-T800 Fuel Tank - axial
LV-909 Liquid Fuel Engine - axial
TT-70 Radial Decoupler - radial
FL-T400 Fuel Tank - radial

TT18-A Launch Stability Enhancer - radial
FTX-2 External Fuel Duct - radial
LV-909 Liquid Fuel Engine - axial
Aerodynamic Nose Cone - axial
TT-70 Radial Decoupler - radial
```

```

FL-T400 Fuel Tank - radial
→ TT18-A Launch Stability Enhancer - radial
  FTX-2 External Fuel Duct - radial
  LV-909 Liquid Fuel Engine - axial
  Aerodynamic Nose Cone - axial
  LT-1 Landing Struts - radial
  LT-1 Landing Struts - radial
  Mk16 Parachute - axial

```

Fuel Lines

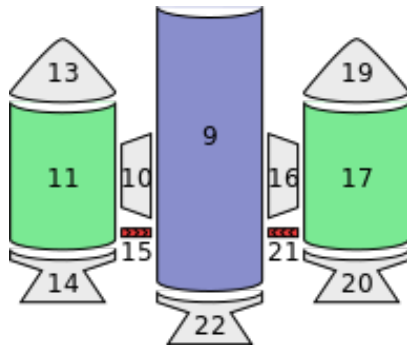


Fig. 4.12: **Figure 5** – Fuel lines from the example in Figure 1. Fuel flows from the parts highlighted in green, into the part highlighted in blue.

Fuel lines are considered parts, and are included in the parts tree (for example, as pictured in Figure 4). However, the parts tree does not contain information about which parts fuel lines connect to. The parent part of a fuel line is the part from which it will take fuel (as shown in Figure 4) however the part that it will send fuel to is not represented in the parts tree.

Figure 5 shows the fuel lines from the example vessel pictured earlier. Fuel line part 15 (in red) takes fuel from a fuel tank (part 11 – in green) and feeds it into another fuel tank (part 9 – in blue). The fuel line is therefore a child of part 11, but its connection to part 9 is not represented in the tree.

The attributes *Part.FuelLinesFrom* and *Part.FuelLinesTo* can be used to discover these connections. In the example in Figure 5, when *Part.FuelLinesTo* is called on fuel tank part 11, it will return a list of parts containing just fuel tank part 9 (the blue part). When *Part.FuelLinesFrom* is called on fuel tank part 9, it will return a list containing fuel tank parts 11 and 17 (the parts colored green).

Staging

Each part has two staging numbers associated with it: the stage in which the part is *activated* and the stage in which the part is *decoupled*. These values can be obtained using *Part.Stage* and *Part.DecoupleStage* respectively. For parts that are not activated by staging, *Part.Stage* returns -1. For parts that are never decoupled, *Part.DecoupleStage* returns a value of -1.

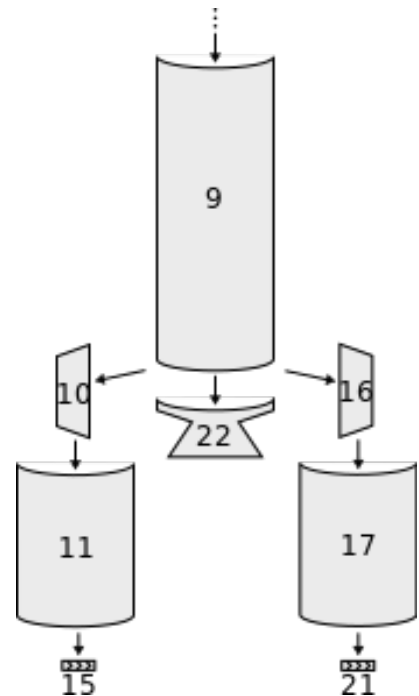


Fig. 4.13: **Figure 4** – A subset of the parts tree from Figure 2 above.

Figure 6 shows an example staging sequence for a vessel. Figure 7 shows the stages in which each part of the vessel will be *activated*. Figure 8 shows the stages in which each part of the vessel will be *decoupled*.

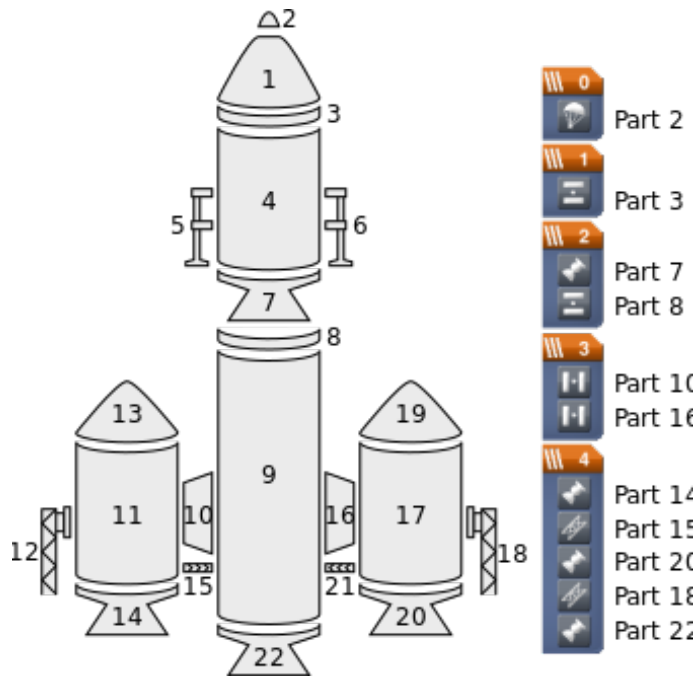


Fig. 4.14: **Figure 6** – Example vessel from Figure 1 with a staging sequence.

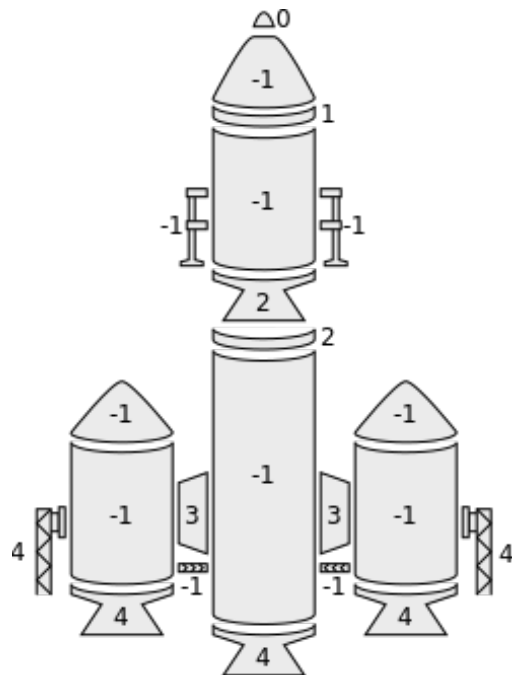


Fig. 4.15: **Figure 7** – The stage in which each part is *activated*.

4.3.9 Resources

class Resources

Represents the collection of resources stored in a vessel, stage or part. Created by calling *Vessel.Resources*, *Vessel.ResourcesInDecoupleStage* or *Part.Resources*.

ICollection<Resource> **All** { **get**; }

All the individual resources that can be stored.

ICollection<Resource> **WithResource** (*String name*)

All the individual resources with the given name that can be stored.

Parameters

ICollection<String> **Names** { **get**; }

A list of resource names that can be stored.

Boolean **HasResource** (*String name*)

Check whether the named resource can be stored.

Parameters

- **name** – The name of the resource.

Single **Amount** (*String name*)

Returns the amount of a resource that is currently stored.

Parameters

- **name** – The name of the resource.

Single **Max** (*String name*)

Returns the amount of a resource that can be stored.

Parameters

- **name** – The name of the resource.

static Single **Density** (*ICollection connection*, *String name*)

Returns the density of a resource, in *kg/l*.

Parameters

- **name** – The name of the resource.

static ResourceFlowMode **FlowMode** (*ICollection connection*, *String name*)

Returns the flow mode of a resource.

Parameters

- **name** – The name of the resource.

Boolean **Enabled** { **get**; **set**; }

Whether use of all the resources are enabled.

Note: This is *true* if all of the resources are enabled. If any of the resources are not enabled, this is *false*.

class Resource

An individual resource stored within a part. Created using methods in the *Resources* class.

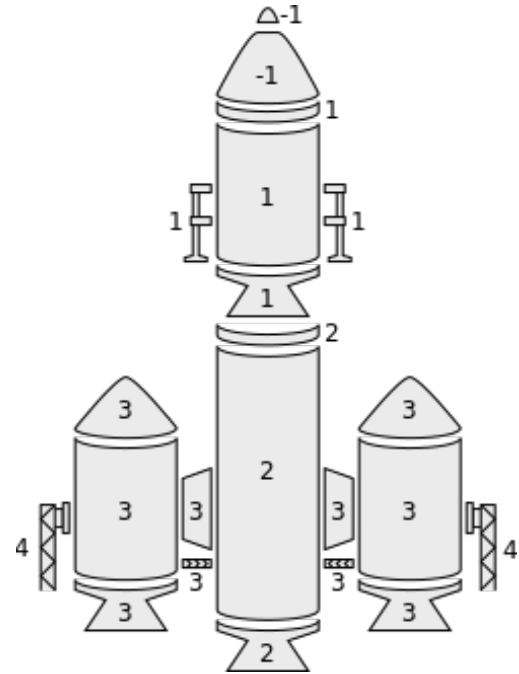


Fig. 4.16: **Figure 8** – The stage in which each part is *decoupled*.

String Name { get; }

The name of the resource.

Part Part { get; }

The part containing the resource.

Single Amount { get; }

The amount of the resource that is currently stored in the part.

Single Max { get; }

The total amount of the resource that can be stored in the part.

Single Density { get; }

The density of the resource, in *kg/l*.

ResourceFlowMode FlowMode { get; }

The flow mode of the resource.

Boolean Enabled { get; set; }

Whether use of this resource is enabled.

class ResourceTransfer

Transfer resources between parts.

static ResourceTransfer Start (*ICConnection connection, Part fromPart, Part toPart, String resource, Single maxAmount*)

Start transferring a resource transfer between a pair of parts. The transfer will move at most *maxAmount* units of the resource, depending on how much of the resource is available in the source part and how much storage is available in the destination part. Use *ResourceTransfer.Complete* to check if the transfer is complete. Use *ResourceTransfer.Amount* to see how much of the resource has been transferred.

Parameters

- **fromPart** – The part to transfer to.
- **toPart** – The part to transfer from.
- **resource** – The name of the resource to transfer.
- **maxAmount** – The maximum amount of resource to transfer.

Single Amount { get; }

The amount of the resource that has been transferred.

Boolean Complete { get; }

Whether the transfer has completed.

enum ResourceFlowMode

The way in which a resource flows between parts. See *Resources.FlowMode*.

Vessel

The resource flows to any part in the vessel. For example, electric charge.

Stage

The resource flows from parts in the first stage, followed by the second, and so on. For example, mono-propellant.

Adjacent

The resource flows between adjacent parts within the vessel. For example, liquid fuel or oxidizer.

None

The resource does not flow. For example, solid fuel.

4.3.10 Node

class Node

Represents a maneuver node. Can be created using *Control.AddNode*.

Double Prograde { get; set; }

The magnitude of the maneuver nodes delta-v in the prograde direction, in meters per second.

Double Normal { get; set; }

The magnitude of the maneuver nodes delta-v in the normal direction, in meters per second.

Double Radial { get; set; }

The magnitude of the maneuver nodes delta-v in the radial direction, in meters per second.

Double DeltaV { get; set; }

The delta-v of the maneuver node, in meters per second.

Note: Does not change when executing the maneuver node. See *Node.RemainingDeltaV*.

Double RemainingDeltaV { get; }

Gets the remaining delta-v of the maneuver node, in meters per second. Changes as the node is executed. This is equivalent to the delta-v reported in-game.

Tuple<Double, Double, Double> BurnVector (ReferenceFrame referenceFrame = null)

Returns the burn vector for the maneuver node.

Parameters

- **referenceFrame** – The reference frame that the returned vector is in. Defaults to *Vessel.OrbitalReferenceFrame*.

Returns A vector whose direction is the direction of the maneuver node burn, and magnitude is the delta-v of the burn in meters per second.

Note: Does not change when executing the maneuver node. See *Node.RemainingBurnVector*.

Tuple<Double, Double, Double> RemainingBurnVector (ReferenceFrame referenceFrame = null)

Returns the remaining burn vector for the maneuver node.

Parameters

- **referenceFrame** – The reference frame that the returned vector is in. Defaults to *Vessel.OrbitalReferenceFrame*.

Returns A vector whose direction is the direction of the maneuver node burn, and magnitude is the delta-v of the burn in meters per second.

Note: Changes as the maneuver node is executed. See *Node.BurnVector*.

Double UT { get; set; }

The universal time at which the maneuver will occur, in seconds.

Double TimeTo { get; }

The time until the maneuver node will be encountered, in seconds.

Orbit Orbit { get; }

The orbit that results from executing the maneuver node.

void Remove ()

Removes the maneuver node.

ReferenceFrame ReferenceFrame { get; }

The reference frame that is fixed relative to the maneuver node's burn.

- The origin is at the position of the maneuver node.
- The y-axis points in the direction of the burn.
- The x-axis and z-axis point in arbitrary but fixed directions.

ReferenceFrame OrbitalReferenceFrame { get; }

The reference frame that is fixed relative to the maneuver node, and orientated with the orbital prograde/normal/radial directions of the original orbit at the maneuver node's position.

- The origin is at the position of the maneuver node.
- The x-axis points in the orbital anti-radial direction of the original orbit, at the position of the maneuver node.
- The y-axis points in the orbital prograde direction of the original orbit, at the position of the maneuver node.
- The z-axis points in the orbital normal direction of the original orbit, at the position of the maneuver node.

Tuple<Double, Double, Double> Position (ReferenceFrame referenceFrame)

The position vector of the maneuver node in the given reference frame.

Parameters

- **referenceFrame** – The reference frame that the returned position vector is in.

Returns The position as a vector.

Tuple<Double, Double, Double> Direction (ReferenceFrame referenceFrame)

The direction of the maneuver nodes burn.

Parameters

- **referenceFrame** – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

4.3.11 ReferenceFrame

class ReferenceFrame

Represents a reference frame for positions, rotations and velocities.

Contains:

- The position of the origin.
- The directions of the x, y and z axes.
- The linear velocity of the frame.
- The angular velocity of the frame.

Note: This class does not contain any properties or methods. It is only used as a parameter to other functions.

static ReferenceFrame **CreateRelative** (*ICollection connection, ReferenceFrame referenceFrame, Tuple<Double, Double, Double> position = null, Tuple<Double, Double, Double, Double> rotation = null, Tuple<Double, Double, Double> velocity = null, Tuple<Double, Double, Double> angularVelocity = null*)

Create a relative reference frame. This is a custom reference frame whose components offset the components of a parent reference frame.

Parameters

- **referenceFrame** – The parent reference frame on which to base this reference frame.
- **position** – The offset of the position of the origin, as a position vector. Defaults to (0, 0, 0)
- **rotation** – The rotation to apply to the parent frames rotation, as a quaternion of the form (x, y, z, w) . Defaults to (0, 0, 0, 1) (i.e. no rotation)
- **velocity** – The linear velocity to offset the parent frame by, as a vector pointing in the direction of travel, whose magnitude is the speed in meters per second. Defaults to (0, 0, 0).
- **angularVelocity** – The angular velocity to offset the parent frame by, as a vector. This vector points in the direction of the axis of rotation, and its magnitude is the speed of the rotation in radians per second. Defaults to (0, 0, 0).

static ReferenceFrame **CreateHybrid** (*ICollection connection, ReferenceFrame position, ReferenceFrame rotation = null, ReferenceFrame velocity = null, ReferenceFrame angularVelocity = null*)

Create a hybrid reference frame. This is a custom reference frame whose components inherited from other reference frames.

Parameters

- **position** – The reference frame providing the position of the origin.

- **rotation** – The reference frame providing the rotation of the frame.
- **velocity** – The reference frame providing the linear velocity of the frame.
- **angularVelocity** – The reference frame providing the angular velocity of the frame.

Note: The *position* reference frame is required but all other reference frames are optional. If omitted, they are set to the *position* reference frame.

4.3.12 AutoPilot

class **AutoPilot**

Provides basic auto-piloting utilities for a vessel. Created by calling *Vessel.AutoPilot*.

Note: If a client engages the auto-pilot and then closes its connection to the server, the auto-pilot will be disengaged and its target reference frame, direction and roll reset to default.

void Engage ()
Engage the auto-pilot.

void Disengage ()
Disengage the auto-pilot.

void Wait ()
Blocks until the vessel is pointing in the target direction and has the target roll (if set). Throws an exception if the auto-pilot has not been engaged.

Single Error { get; }
The error, in degrees, between the direction the ship has been asked to point in and the direction it is pointing in. Throws an exception if the auto-pilot has not been engaged and SAS is not enabled or is in stability assist mode.

Single PitchError { get; }
The error, in degrees, between the vessels current and target pitch. Throws an exception if the auto-pilot has not been engaged.

Single HeadingError { get; }
The error, in degrees, between the vessels current and target heading. Throws an exception if the auto-pilot has not been engaged.

Single RollError { get; }
The error, in degrees, between the vessels current and target roll. Throws an exception if the auto-pilot has not been engaged or no target roll is set.

ReferenceFrame ReferenceFrame { get; set; }
The reference frame for the target direction (*AutoPilot.TargetDirection*).

Note: An error will be thrown if this property is set to a reference frame that rotates with the vessel being controlled, as it is impossible to rotate the vessel in such a reference frame.

Single TargetPitch { get; set; }

The target pitch, in degrees, between -90° and +90°.

Single TargetHeading { get; set; }

The target heading, in degrees, between 0° and 360°.

Single TargetRoll { get; set; }

The target roll, in degrees. NaN if no target roll is set.

Tuple<Double, Double, Double> TargetDirection { get; set; }

Direction vector corresponding to the target pitch and heading. This is in the reference frame specified by *ReferenceFrame*.

void TargetPitchAndHeading (Single pitch, Single heading)

Set target pitch and heading angles.

Parameters

- **pitch** – Target pitch angle, in degrees between -90° and +90°.
- **heading** – Target heading angle, in degrees between 0° and 360°.

Boolean SAS { get; set; }

The state of SAS.

Note: Equivalent to *Control.SAS*

SASMode SASMode { get; set; }

The current *SASMode*. These modes are equivalent to the mode buttons to the left of the navball that appear when SAS is enabled.

Note: Equivalent to *Control.SASMode*

Double RollThreshold { get; set; }

The threshold at which the autopilot will try to match the target roll angle, if any. Defaults to 5 degrees.

Tuple<Double, Double, Double> StoppingTime { get; set; }

The maximum amount of time that the vessel should need to come to a complete stop. This determines the maximum angular velocity of the vessel. A vector of three stopping times, in seconds, one for each of the pitch, roll and yaw axes. Defaults to 0.5 seconds for each axis.

Tuple<Double, Double, Double> DecelerationTime { get; set; }

The time the vessel should take to come to a stop pointing in the target direction. This determines the angular acceleration used to decelerate the vessel. A vector of three times, in seconds, one for each of the pitch, roll and yaw axes. Defaults to 5 seconds for each axis.

Tuple<Double, Double, Double> AttenuationAngle { get; set; }

The angle at which the autopilot considers the vessel to be pointing close to the target. This determines the midpoint of the target velocity attenuation function. A vector of three angles, in degrees, one for each of the pitch, roll and yaw axes. Defaults to 1° for each axis.

Boolean AutoTune { get; set; }

Whether the rotation rate controllers PID parameters should be automatically tuned using the vessels moment of inertia and available torque. Defaults to true. See *AutoPilot.TimeToPeak* and *AutoPilot.Overshoot*.

Tuple<Double, Double, Double> TimeToPeak { get; set; }

The target time to peak used to autotune the PID controllers. A vector of three times, in seconds, for each of the pitch, roll and yaw axes. Defaults to 3 seconds for each axis.

Tuple<Double, Double, Double> Overshoot { get; set; }

The target overshoot percentage used to autotune the PID controllers. A vector of three values, between 0 and 1, for each of the pitch, roll and yaw axes. Defaults to 0.01 for each axis.

Tuple<Double, Double, Double> PitchPIDGains { get; set; }

Gains for the pitch PID controller.

Note: When *AutoPilot.AutoTune* is true, these values are updated automatically, which will overwrite any manual changes.

Tuple<Double, Double, Double> RollPIDGains { get; set; }

Gains for the roll PID controller.

Note: When *AutoPilot.AutoTune* is true, these values are updated automatically, which will overwrite any manual changes.

Tuple<Double, Double, Double> YawPIDGains { get; set; }

Gains for the yaw PID controller.

Note: When *AutoPilot.AutoTune* is true, these values are updated automatically, which will overwrite any manual changes.

4.3.13 Camera

class Camera

Controls the game's camera. Obtained by calling *SpaceCenter.Camera*.

CameraMode Mode { get; set; }

The current mode of the camera.

Single Pitch { get; set; }

The pitch of the camera, in degrees. A value between *Camera.MinPitch* and *Camera.MaxPitch*

Single Heading { get; set; }

The heading of the camera, in degrees.

Single Distance { get; set; }

The distance from the camera to the subject, in meters. A value between *Camera.MinDistance* and *Camera.MaxDistance*.

Single MinPitch { get; }

The minimum pitch of the camera.

Single MaxPitch { get; }

The maximum pitch of the camera.

Single MinDistance { get; }

Minimum distance from the camera to the subject, in meters.

Single MaxDistance { get; }

Maximum distance from the camera to the subject, in meters.

Single DefaultDistance { get; }

Default distance from the camera to the subject, in meters.

CelestialBody FocussedBody { get; set; }

In map mode, the celestial body that the camera is focussed on. Returns *null* if the camera is not focussed on a celestial body. Returns an error if the camera is not in map mode.

Vessel FocussedVessel { get; set; }

In map mode, the vessel that the camera is focussed on. Returns *null* if the camera is not focussed on a vessel. Returns an error if the camera is not in map mode.

Node FocussedNode { get; set; }

In map mode, the maneuver node that the camera is focussed on. Returns *null* if the camera is not focussed on a maneuver node. Returns an error if the camera is not in map mode.

enum CameraMode

See *Camera.Mode*.

Automatic

The camera is showing the active vessel, in “auto” mode.

Free

The camera is showing the active vessel, in “free” mode.

Chase

The camera is showing the active vessel, in “chase” mode.

Locked

The camera is showing the active vessel, in “locked” mode.

Orbital

The camera is showing the active vessel, in “orbital” mode.

IVA

The Intra-Vehicular Activity view is being shown.

Map

The map view is being shown.

4.3.14 Waypoints

class WaypointManager

Waypoints are the location markers you can see on the map view showing you where contracts are targeted for. With this structure, you can obtain coordinate data for the locations of these waypoints.

Obtained by calling *SpaceCenter.WaypointManager*.

ICollection<Waypoint> **Waypoints** { **get**; }

A list of all existing waypoints.

Waypoint **AddWaypoint** (*Double latitude*, *Double longitude*, *CelestialBody body*, *String name*)

Creates a waypoint at the given position at ground level, and returns a *Waypoint* object that can be used to modify it.

Parameters

- **latitude** – Latitude of the waypoint.
- **longitude** – Longitude of the waypoint.
- **body** – Celestial body the waypoint is attached to.
- **name** – Name of the waypoint.

Waypoint **AddWaypointAtAltitude** (*Double latitude*, *Double longitude*, *Double altitude*, *Celestial-Body body*, *String name*)

Creates a waypoint at the given position and altitude, and returns a *Waypoint* object that can be used to modify it.

Parameters

- **latitude** – Latitude of the waypoint.
- **longitude** – Longitude of the waypoint.
- **altitude** – Altitude (above sea level) of the waypoint.
- **body** – Celestial body the waypoint is attached to.
- **name** – Name of the waypoint.

IDictionary<String, Int32> **Colors** { **get**; }

An example map of known color - seed pairs. Any other integers may be used as seed.

ICollection<String> **Icons** { **get**; }

Returns all available icons (from “Game-Data/Squad/Contracts/Icons”).

class Waypoint

Represents a waypoint. Can be created using *WaypointManager.AddWaypoint*.

CelestialBody **Body** { **get**; **set**; }

The celestial body the waypoint is attached to.

String **Name** { **get**; **set**; }

The name of the waypoint as it appears on the map and the contract.

Int32 **Color** { **get**; **set**; }

The seed of the icon color. See *WaypointManager.Colors* for example colors.

String Icon { get; set; }

The icon of the waypoint.

Double Latitude { get; set; }

The latitude of the waypoint.

Double Longitude { get; set; }

The longitude of the waypoint.

Double MeanAltitude { get; set; }

The altitude of the waypoint above sea level, in meters.

Double SurfaceAltitude { get; set; }

The altitude of the waypoint above the surface of the body or sea level, whichever is closer, in meters.

Double BedrockAltitude { get; set; }

The altitude of the waypoint above the surface of the body, in meters. When over water, this is the altitude above the sea floor.

Boolean NearSurface { get; }

true if the waypoint is near to the surface of a body.

Boolean Grounded { get; }

true if the waypoint is attached to the ground.

Int32 Index { get; }

The integer index of this waypoint within its cluster of sibling waypoints. In other words, when you have a cluster of waypoints called “Somewhere Alpha”, “Somewhere Beta” and “Somewhere Gamma”, the alpha site has index 0, the beta site has index 1 and the gamma site has index 2. When *Waypoint.Clustered* is false, this is zero.

Boolean Clustered { get; }

true if this waypoint is part of a set of clustered waypoints with greek letter names appended (Alpha, Beta, Gamma, etc). If true, there is a one-to-one correspondence with the greek letter name and the *Waypoint.Index*.

Boolean HasContract { get; }

Whether the waypoint belongs to a contract.

Contract Contract { get; }

The associated contract.

void Remove ()

Removes the waypoint.

4.3.15 Contracts

class ContractManager

Contracts manager. Obtained by calling *SpaceCenter.WaypointManager*.

ISet<String> Types { get; }

A list of all contract types.

IList<Contract> AllContracts { get; }

A list of all contracts.

`IList<Contract> ActiveContracts { get; }`

A list of all active contracts.

`IList<Contract> OfferedContracts { get; }`

A list of all offered, but unaccepted, contracts.

`IList<Contract> CompletedContracts { get; }`

A list of all completed contracts.

`IList<Contract> FailedContracts { get; }`

A list of all failed contracts.

class Contract

A contract. Can be accessed using *SpaceCenter.ContractManager*.

`String Type { get; }`

Type of the contract.

`String Title { get; }`

Title of the contract.

`String Description { get; }`

Description of the contract.

`String Notes { get; }`

Notes for the contract.

`String Synopsis { get; }`

Synopsis for the contract.

`IList<String> Keywords { get; }`

Keywords for the contract.

`ContractState State { get; }`

State of the contract.

`Boolean Seen { get; }`

Whether the contract has been seen.

`Boolean Read { get; }`

Whether the contract has been read.

`Boolean Active { get; }`

Whether the contract is active.

`Boolean Failed { get; }`

Whether the contract has been failed.

`Boolean CanBeCanceled { get; }`

Whether the contract can be canceled.

`Boolean CanBeDeclined { get; }`

Whether the contract can be declined.

`Boolean CanBeFailed { get; }`

Whether the contract can be failed.

`void Accept ()`

Accept an offered contract.

`void Cancel ()`

Cancel an active contract.

void Decline ()
Decline an offered contract.

Double FundsAdvance { get; }
Funds received when accepting the contract.

Double FundsCompletion { get; }
Funds received on completion of the contract.

Double FundsFailure { get; }
Funds lost if the contract is failed.

Double ReputationCompletion { get; }
Reputation gained on completion of the contract.

Double ReputationFailure { get; }
Reputation lost if the contract is failed.

Double ScienceCompletion { get; }
Science gained on completion of the contract.

IList<ContractParameter> Parameters { get; }
Parameters for the contract.

enum ContractState
The state of a contract. See *Contract.State*.

Active
The contract is active.

Canceled
The contract has been canceled.

Completed
The contract has been completed.

DeadlineExpired
The deadline for the contract has expired.

Declined
The contract has been declined.

Failed
The contract has been failed.

Generated
The contract has been generated.

Offered
The contract has been offered to the player.

OfferExpired
The contract was offered to the player, but the offer expired.

Withdrawn
The contract has been withdrawn.

class ContractParameter
A contract parameter. See *Contract.Parameters*.

String Title { get; }
Title of the parameter.

String Notes { get; }
Notes for the parameter.

ICollection<ContractParameter> Children { get; }
Child contract parameters.

Boolean Completed { get; }
Whether the parameter has been completed.

Boolean Failed { get; }
Whether the parameter has been failed.

Boolean Optional { get; }
Whether the contract parameter is optional.

Double FundsCompletion { get; }
Funds received on completion of the contract parameter.

Double FundsFailure { get; }
Funds lost if the contract parameter is failed.

Double ReputationCompletion { get; }
Reputation gained on completion of the contract parameter.

Double ReputationFailure { get; }
Reputation lost if the contract parameter is failed.

Double ScienceCompletion { get; }
Science gained on completion of the contract parameter.

4.3.16 Geometry Types

Vectors

3-dimensional vectors are represented as a 3-tuple. For example:

```
using System;
using System.Net;
using KRPC.Client;
using KRPC.Client.Services.SpaceCenter;

class VectorExample
{
    public static void Main ()
    {
        using (var connection = new Connection ()) {
            var
            vessel = connection.SpaceCenter ().ActiveVessel;
            Tuple<double,
            double, double> v = vessel.Flight ().Prograde;
            Console.WriteLine
            (v.Item1 + ", " + v.Item2 + ", " + v.Item3);
        }
    }
}
```

Quaternions

Quaternions (rotations in 3-dimensional space) are encoded as a 4-tuple containing the x, y, z and w components. For example:

```
using System;
using System.Net;
using KRPC.Client;
using KRPC.Client.Services.SpaceCenter;

class QuaternionExample
{
    public static void Main ()
    {
        using (var connection = new Connection ()) {
            var spaceCenter = connection.SpaceCenter ();
            var vessel = spaceCenter.ActiveVessel;
            Tuple<double, double, double, double> q = vessel.Flight ().Rotation;
            Console.WriteLine (q.Item1 + ", " + q.Item2 + ", " + q.Item3 + ", " + q.Item4);
        }
    }
}
```

4.4 Drawing API

4.4.1 Drawing

class Drawing

Provides functionality for drawing objects in the flight scene.

Line **AddLine** (Tuple<Double, Double, Double> start, Tuple<Double, Double, Double> end, SpaceCenter.ReferenceFrame referenceFrame, Boolean visible = True)
Draw a line in the scene.

Parameters

- **start** – Position of the start of the line.
- **end** – Position of the end of the line.
- **referenceFrame** – Reference frame that the positions are in.
- **visible** – Whether the line is visible.

Line **AddDirection** (Tuple<Double, Double, Double> direction, SpaceCenter.ReferenceFrame referenceFrame, Single length = 10.0, Boolean visible = True)
Draw a direction vector in the scene, from the center of mass of the active vessel.

Parameters

- **direction** – Direction to draw the line in.
- **referenceFrame** – Reference frame that the direction is in.

- **length** – The length of the line.
- **visible** – Whether the line is visible.

Polygon **AddPolygon** (*ICollection<Tuple<Double, Double, Double>> vertices, SpaceCenter.ReferenceFrame referenceFrame, Boolean visible = True*)

Draw a polygon in the scene, defined by a list of vertices.

Parameters

- **vertices** – Vertices of the polygon.
- **referenceFrame** – Reference frame that the vertices are in.
- **visible** – Whether the polygon is visible.

Text **AddText** (*String text, SpaceCenter.ReferenceFrame referenceFrame, Tuple<Double, Double, Double> position, Tuple<Double, Double, Double, Double> rotation, Boolean visible = True*)

Draw text in the scene.

Parameters

- **text** – The string to draw.
- **referenceFrame** – Reference frame that the text position is in.
- **position** – Position of the text.
- **rotation** – Rotation of the text, as a quaternion.
- **visible** – Whether the text is visible.

void **Clear** (*Boolean clientOnly = False*)

Remove all objects being drawn.

Parameters

- **clientOnly** – If true, only remove objects created by the calling client.

4.4.2 Line

class Line

A line. Created using *Drawing.AddLine*.

Tuple<Double, Double, Double> **Start** { *get; set;* }

Start position of the line.

Tuple<Double, Double, Double> **End** { *get; set;* }

End position of the line.

SpaceCenter.ReferenceFrame **ReferenceFrame** { *get; set;* }

Reference frame for the positions of the object.

Boolean **Visible** { *get; set;* }

Whether the object is visible.

Tuple<Double, Double, Double> **Color** { *get; set;* }

Set the color

String **Material** { *get; set;* }

Material used to render the object. Creates the material from a shader with the given name.

Single Thickness { **get**; **set**; }
Set the thickness

void Remove ()
Remove the object.

4.4.3 Polygon

class Polygon
A polygon. Created using *Drawing.AddPolygon*.

ICollection<Tuple<Double, Double, Double>> Vertices { **get**; **set**; }
Vertices for the polygon.

SpaceCenter.ReferenceFrame **ReferenceFrame** { **get**; **set**; }
Reference frame for the positions of the object.

Boolean Visible { **get**; **set**; }
Whether the object is visible.

void Remove ()
Remove the object.

Tuple<Double, Double, Double> Color { **get**; **set**; }
Set the color

String Material { **get**; **set**; }
Material used to render the object. Creates the material from a shader with the given name.

Single Thickness { **get**; **set**; }
Set the thickness

4.4.4 Text

class Text
Text. Created using *Drawing.AddText*.

Tuple<Double, Double, Double> Position { **get**; **set**; }
Position of the text.

Tuple<Double, Double, Double, Double> Rotation { **get**; **set**; }
Rotation of the text as a quaternion.

SpaceCenter.ReferenceFrame **ReferenceFrame** { **get**; **set**; }
Reference frame for the positions of the object.

Boolean Visible { **get**; **set**; }
Whether the object is visible.

void Remove ()
Remove the object.

String Content { **get**; **set**; }
The text string

String Font { **get**; **set**; }
Name of the font

static **IList<String> AvailableFonts** (*ICConnection connection*)
A list of all available fonts.

Int32 Size { **get**; **set**; }
Font size.

Single CharacterSize { **get**; **set**; }
Character size.

UI.FontStyle **Style** { **get**; **set**; }
Font style.

Tuple<Double, Double, Double> Color { **get**; **set**; }
Set the color

String Material { **get**; **set**; }
Material used to render the object. Creates the material from a shader with the given name.

UI.TextAlignment **Alignment** { **get**; **set**; }
Alignment.

Single LineSpacing { **get**; **set**; }
Line spacing.

UI.TextAnchor **Anchor** { **get**; **set**; }
Anchor.

4.5 InfernalRobotics API

Provides RPCs to interact with the [InfernalRobotics](#) mod. Provides the following classes:

4.5.1 InfernalRobotics

class InfernalRobotics
This service provides functionality to interact with [Infernal Robotics](#).

Boolean Available { **get**; }
Whether Infernal Robotics is installed.

IList<ServoGroup> ServoGroups (*SpaceCenter.Vessel vessel*)
A list of all the servo groups in the given *vessel*.

Parameters

ServoGroup **ServoGroupWithName** (*SpaceCenter.Vessel vessel*, **String name**)
Returns the servo group in the given *vessel* with the given *name*, or `null` if none exists. If multiple servo groups have the same name, only one of them is returned.

Parameters

- **vessel** – Vessel to check.
- **name** – Name of servo group to find.

Servo **ServoWithName** (*SpaceCenter.Vessel vessel*, *String name*)

Returns the servo in the given *vessel* with the given *name* or `null` if none exists. If multiple servos have the same name, only one of them is returned.

Parameters

- **vessel** – Vessel to check.
- **name** – Name of the servo to find.

4.5.2 ServoGroup

class ServoGroup

A group of servos, obtained by calling *InfernalRobotics.ServoGroups* or *InfernalRobotics.ServoGroupWithName*. Represents the “Servo Groups” in the InfernalRobotics UI.

String **Name** { **get**; **set**; }

The name of the group.

String **ForwardKey** { **get**; **set**; }

The key assigned to be the “forward” key for the group.

String **ReverseKey** { **get**; **set**; }

The key assigned to be the “reverse” key for the group.

Single **Speed** { **get**; **set**; }

The speed multiplier for the group.

Boolean **Expanded** { **get**; **set**; }

Whether the group is expanded in the InfernalRobotics UI.

ICollection<Servo> **Servos** { **get**; }

The servos that are in the group.

Servo **ServoWithName** (*String name*)

Returns the servo with the given *name* from this group, or `null` if none exists.

Parameters

- **name** – Name of servo to find.

ICollection<SpaceCenter.Part> **Parts** { **get**; }

The parts containing the servos in the group.

void **MoveRight** ()

Moves all of the servos in the group to the right.

void **MoveLeft** ()

Moves all of the servos in the group to the left.

void **MoveCenter** ()

Moves all of the servos in the group to the center.

void **MoveNextPreset** ()

Moves all of the servos in the group to the next preset.

void **MovePrevPreset** ()

Moves all of the servos in the group to the previous preset.

void **Stop** ()
 Stops the servos in the group.

4.5.3 Servo

class Servo
 Represents a servo. Obtained using *ServoGroup.Servos*, *ServoGroup.ServoWithName* or *InfernalRobotics.ServoWithName*.

String Name { **get**; **set**; }
 The name of the servo.

SpaceCenter.Part Part { **get**; }
 The part containing the servo.

Boolean Highlight { **set**; }
 Whether the servo should be highlighted in-game.

Single Position { **get**; }
 The position of the servo.

Single MinConfigPosition { **get**; }
 The minimum position of the servo, specified by the part configuration.

Single MaxConfigPosition { **get**; }
 The maximum position of the servo, specified by the part configuration.

Single MinPosition { **get**; **set**; }
 The minimum position of the servo, specified by the in-game tweak menu.

Single MaxPosition { **get**; **set**; }
 The maximum position of the servo, specified by the in-game tweak menu.

Single ConfigSpeed { **get**; }
 The speed multiplier of the servo, specified by the part configuration.

Single Speed { **get**; **set**; }
 The speed multiplier of the servo, specified by the in-game tweak menu.

Single CurrentSpeed { **get**; **set**; }
 The current speed at which the servo is moving.

Single Acceleration { **get**; **set**; }
 The current speed multiplier set in the UI.

Boolean IsMoving { **get**; }
 Whether the servo is moving.

Boolean IsFreeMoving { **get**; }
 Whether the servo is freely moving.

Boolean IsLocked { **get**; **set**; }
 Whether the servo is locked.

Boolean IsAxisInverted { **get**; **set**; }

Whether the servos axis is inverted.

void MoveRight ()

Moves the servo to the right.

void MoveLeft ()

Moves the servo to the left.

void MoveCenter ()

Moves the servo to the center.

void MoveNextPreset ()

Moves the servo to the next preset.

void MovePrevPreset ()

Moves the servo to the previous preset.

void MoveTo (*Single position*, *Single speed*)

Moves the servo to *position* and sets the speed multiplier to *speed*.

Parameters

- **position** – The position to move the servo to.
- **speed** – Speed multiplier for the movement.

void Stop ()

Stops the servo.

4.5.4 Example

The following example gets the control group named “MyGroup”, prints out the names and positions of all of the servos in the group, then moves all of the servos to the right for 1 second.

```
using System;
using System.Net;
using System.Threading;
using KRPC.Client;
using KRPC.Client.Services.InfernalRobotics;
using KRPC.Client.Services.SpaceCenter;

class InfernalRoboticsExample
{
    public static void Main ()
    {
        using (var connection = new Connection (
            name: "InfernalRobotics Example")) {
            var
↪ vessel = connection.SpaceCenter ().ActiveVessel;
            ↪ var ir = connection.InfernalRobotics ();

            var group
↪ = ir.ServoGroupWithName (vessel, "MyGroup");
            if (group == null) {
                ↪ Console.WriteLine ("Group not found");
                return;
            }
        }
    }
}
```

```

    }

    foreach (var servo in group.Servos)
        Console.
↵WriteLine (servo.Name + " " + servo.Position);

    group.MoveRight ();
    Thread.Sleep (1000);
    group.Stop ();
}
}
}

```

4.6 Kerbal Alarm Clock API

Provides RPCs to interact with the [Kerbal Alarm Clock](#) mod. Provides the following classes:

4.6.1 KerbalAlarmClock

class KerbalAlarmClock

This service provides functionality to interact with [Kerbal Alarm Clock](#).

Boolean Available { get; }

Whether Kerbal Alarm Clock is available.

ICollection<Alarm> Alarms { get; }

A list of all the alarms.

Alarm AlarmWithName (String name)

Get the alarm with the given *name*, or null if no alarms have that name. If more than one alarm has the name, only returns one of them.

Parameters

- **name** – Name of the alarm to search for.

ICollection<Alarm> AlarmsWithType (AlarmType type)

Get a list of alarms of the specified *type*.

Parameters

- **type** – Type of alarm to return.

Alarm CreateAlarm (AlarmType type, String name, Double ut)

Create a new alarm and return it.

Parameters

- **type** – Type of the new alarm.
- **name** – Name of the new alarm.
- **ut** – Time at which the new alarm should trigger.

4.6.2 Alarm

class Alarm

Represents an alarm. Obtained by calling *KerbalAlarmClock*.
Alarms, *KerbalAlarmClock.AlarmWithName* or
KerbalAlarmClock.AlarmsWithType.

AlarmAction **Action** { **get**; **set**; }

The action that the alarm triggers.

Double **Margin** { **get**; **set**; }

The number of seconds before the event that the alarm will fire.

Double **Time** { **get**; **set**; }

The time at which the alarm will fire.

AlarmType **Type** { **get**; }

The type of the alarm.

String **ID** { **get**; }

The unique identifier for the alarm.

String **Name** { **get**; **set**; }

The short name of the alarm.

String **Notes** { **get**; **set**; }

The long description of the alarm.

Double **Remaining** { **get**; }

The number of seconds until the alarm will fire.

Boolean **Repeat** { **get**; **set**; }

Whether the alarm will be repeated after it has fired.

Double **RepeatPeriod** { **get**; **set**; }

The time delay to automatically create an alarm after it has fired.

SpaceCenter.Vessel **Vessel** { **get**; **set**; }

The vessel that the alarm is attached to.

SpaceCenter.CelestialBody **XferOriginBody** { **get**; **set**; }

The celestial body the vessel is departing from.

SpaceCenter.CelestialBody **XferTargetBody** { **get**; **set**; }

The celestial body the vessel is arriving at.

void **Remove** ()

Removes the alarm.

4.6.3 AlarmType

enum AlarmType

The type of an alarm.

Raw

An alarm for a specific date/time or a specific period in the future.

Maneuver

An alarm based on the next maneuver node on the current ships flight path. This node will be stored and can be restored when you come back to the ship.

ManeuverAuto

See *AlarmType.Maneuver*.

Apoapsis

An alarm for furthest part of the orbit from the planet.

Periapsis

An alarm for nearest part of the orbit from the planet.

AscendingNode

Ascending node for the targeted object, or equatorial ascending node.

DescendingNode

Descending node for the targeted object, or equatorial descending node.

Closest

An alarm based on the closest approach of this vessel to the targeted vessel, some number of orbits into the future.

Contract

An alarm based on the expiry or deadline of contracts in career modes.

ContractAuto

See *AlarmType.Contract*.

Crew

An alarm that is attached to a crew member.

Distance

An alarm that is triggered when a selected target comes within a chosen distance.

EarthTime

An alarm based on the time in the “Earth” alternative Universe (aka the Real World).

LaunchRendezvous

An alarm that fires as your landed craft passes under the orbit of your target.

SOIChange

An alarm manually based on when the next SOI point is on the flight path or set to continually monitor the active flight path and add alarms as it detects SOI changes.

SOIChangeAuto

See *AlarmType.SOIChange*.

Transfer

An alarm based on Interplanetary Transfer Phase Angles, i.e. when should I launch to planet X? Based on Kosmo Not’s post and used in Olex’s Calculator.

TransferModelled

See *AlarmType.Transfer*.

4.6.4 AlarmAction

enum AlarmAction

The action performed by an alarm when it fires.

DoNothing

Don't do anything at all...

DoNothingDeleteWhenPassed

Don't do anything, and delete the alarm.

KillWarp

Drop out of time warp.

KillWarpOnly

Drop out of time warp.

MessageOnly

Display a message.

PauseGame

Pause the game.

4.6.5 Example

The following example creates a new alarm for the active vessel. The alarm is set to trigger after 10 seconds have passed, and display a message.

```
using System;
using System.Net;
using KRPC.Client;
using KRPC.Client.Services.KerbalAlarmClock;
using KRPC.Client.Services.SpaceCenter;

class KerbalAlarmClockExample
{
    public static void Main ()
    {
        using (var connection = new Connection_
↪ (name: "Kerbal Alarm Clock Example")) {
            ↪
            ↪ var kac = connection.KerbalAlarmClock ();
            ↪ var alarm = kac.CreateAlarm (
            ↪     AlarmType.Raw, "My_
↪New Alarm", connection.SpaceCenter ().UT + 10);
            ↪ alarm.Notes = "10 seconds_
↪have now passed since the alarm was created.";
            ↪
            ↪ alarm.Action = AlarmAction.MessageOnly;
            ↪
            ↪ }
        }
    }
}
```

4.7 RemoteTech API

Provides RPCs to interact with the [RemoteTech](#) mod. Provides the following classes:

4.7.1 RemoteTech

class RemoteTech

This service provides functionality to interact with [RemoteTech](#).

Boolean Available { get; }

Whether RemoteTech is installed.

ICollection<String> GroundStations { get; }

The names of the ground stations.

Antenna Antenna (SpaceCenter.Part part)

Get the antenna object for a particular part.

Parameters

Comms Comms (SpaceCenter.Vessel vessel)

Get a communications object, representing the communication capability of a particular vessel.

Parameters

4.7.2 Comms

class Comms

Communications for a vessel.

SpaceCenter.Vessel Vessel { get; }

Get the vessel.

Boolean HasLocalControl { get; }

Whether the vessel can be controlled locally.

Boolean HasFlightComputer { get; }

Whether the vessel has a flight computer on board.

Boolean HasConnection { get; }

Whether the vessel has any connection.

Boolean HasConnectionToGroundStation { get; }

Whether the vessel has a connection to a ground station.

Double SignalDelay { get; }

The shortest signal delay to the vessel, in seconds.

Double SignalDelayToGroundStation { get; }

The signal delay between the vessel and the closest ground station, in seconds.

Double SignalDelayToVessel (SpaceCenter.Vessel other)

The signal delay between the this vessel and another vessel, in seconds.

Parameters

`IList<Antenna> Antennas { get; }`
The antennas for this vessel.

4.7.3 Antenna

class Antenna

A RemoteTech antenna. Obtained by calling `Comms.Antennas` or `RemoteTech.Antenna`.

`SpaceCenter.Part Part { get; }`
Get the part containing this antenna.

`Boolean HasConnection { get; }`
Whether the antenna has a connection.

`Target Target { get; set; }`
The object that the antenna is targetting. This property can be used to set the target to `Target.None` or `Target.ActiveVessel`. To set the target to a celestial body, ground station or vessel see `Antenna.TargetBody`, `Antenna.TargetGroundStation` and `Antenna.TargetVessel`.

`SpaceCenter.CelestialBody TargetBody { get; set; }`
The celestial body the antenna is targetting.

`String TargetGroundStation { get; set; }`
The ground station the antenna is targetting.

`SpaceCenter.Vessel TargetVessel { get; set; }`
The vessel the antenna is targetting.

enum Target

The type of object an antenna is targetting. See `Antenna.Target`.

ActiveVessel

The active vessel.

CelestialBody

A celestial body.

GroundStation

A ground station.

Vessel

A specific vessel.

None

No target.

4.7.4 Example

The following example sets the target of a dish on the active vessel then prints out the signal delay to the active vessel.

```
using System;
using KRPC.Client;
using KRPC.Client.Services.RemoteTech;
```

```

using KRPC.Client.Services.SpaceCenter;

class RemoteTechExample
{
    public static void Main ()
    {
        using (var connection_
↪ = new Connection ("RemoteTech Example")) {
            var sc = connection.SpaceCenter ();
            var rt = connection.RemoteTech ();
            var vessel = sc.ActiveVessel;

            // Set a dish target
            var part =_
↪vessel.Parts.WithTitle ("Reflectron KR-7") [0];
            var antenna = rt.Antenna (part);

            _
↪ antenna.TargetBody = sc.Bodies ["Jool"];

            _
↪ // Get info about the vessels communications
            var comms = rt.Comms (vessel);
            Console.WriteLine_
↪("Signal delay = " + comms.SignalDelay);
        }
    }
}

```

4.8 User Interface API

4.8.1 UI

class UI

Provides functionality for drawing and interacting with in-game user interface elements.

Canvas **StockCanvas** { **get**; }

The stock UI canvas.

Canvas **AddCanvas** ()

Add a new canvas.

Note: If you want to add UI elements to KSP's stock UI canvas, use *UI.StockCanvas*.

void **Message** (*String* content, *Single* duration = 1.0, *MessagePosition* position = 1)

Display a message on the screen.

Parameters

- **content** – Message content.
- **duration** – Duration before the message disappears, in seconds.
- **position** – Position to display the message.

Note: The message appears just like a stock message, for example quicksave or quickload messages.

void **Clear** (*Boolean clientOnly = False*)

Remove all user interface elements.

Parameters

- **clientOnly** – If true, only remove objects created by the calling client.

enum **MessagePosition**

Message position.

TopLeft

Top left.

TopCenter

Top center.

TopRight

Top right.

BottomCenter

Bottom center.

4.8.2 Canvas

class **Canvas**

A canvas for user interface elements. See *UI.StockCanvas* and *UI.AddCanvas*.

RectTransform **RectTransform** { **get**; }

The rect transform for the canvas.

Boolean **Visible** { **get**; **set**; }

Whether the UI object is visible.

Panel **AddPanel** (*Boolean visible = True*)

Create a new container for user interface elements.

Parameters

- **visible** – Whether the panel is visible.

Text **AddText** (*String content, Boolean visible = True*)

Add text to the canvas.

Parameters

- **content** – The text.
- **visible** – Whether the text is visible.

InputField **AddInputField** (*Boolean visible = True*)

Add an input field to the canvas.

Parameters

- **visible** – Whether the input field is visible.

Button **AddButton** (*String content*, *Boolean visible = True*)
Add a button to the canvas.

Parameters

- **content** – The label for the button.
- **visible** – Whether the button is visible.

void **Remove** ()
Remove the UI object.

4.8.3 Panel

class Panel
A container for user interface elements. See *Canvas.AddPanel*.

RectTransform **RectTransform** { **get**; }
The rect transform for the panel.

Boolean **Visible** { **get**; **set**; }
Whether the UI object is visible.

Panel **AddPanel** (*Boolean visible = True*)
Create a panel within this panel.

Parameters

- **visible** – Whether the new panel is visible.

Text **AddText** (*String content*, *Boolean visible = True*)
Add text to the panel.

Parameters

- **content** – The text.
- **visible** – Whether the text is visible.

InputField **AddInputField** (*Boolean visible = True*)
Add an input field to the panel.

Parameters

- **visible** – Whether the input field is visible.

Button **AddButton** (*String content*, *Boolean visible = True*)
Add a button to the panel.

Parameters

- **content** – The label for the button.
- **visible** – Whether the button is visible.

void **Remove** ()
Remove the UI object.

4.8.4 Text

class Text
A text label. See *Panel.AddText*.

RectTransform **RectTransform** { **get**; }
The rect transform for the text.

Boolean Visible { **get**; **set**; }
Whether the UI object is visible.

String Content { **get**; **set**; }
The text string

String Font { **get**; **set**; }
Name of the font

ICollection<String> AvailableFonts { **get**; }
A list of all available fonts.

Int32 Size { **get**; **set**; }
Font size.

FontStyle **Style** { **get**; **set**; }
Font style.

Tuple<Double, Double, Double> Color { **get**; **set**; }
Set the color

TextAnchor **Alignment** { **get**; **set**; }
Alignment.

Single LineSpacing { **get**; **set**; }
Line spacing.

void Remove ()
Remove the UI object.

enum FontStyle
Font style.

Normal
Normal.

Bold
Bold.

Italic
Italic.

BoldAndItalic
Bold and italic.

enum TextAlignment
Text alignment.

Left
Left aligned.

Right
Right aligned.

Center
Center aligned.

enum TextAnchor
Text alignment.

LowerCenter

Lower center.

LowerLeft

Lower left.

LowerRight

Lower right.

MiddleCenter

Middle center.

MiddleLeft

Middle left.

MiddleRight

Middle right.

UpperCenter

Upper center.

UpperLeft

Upper left.

UpperRight

Upper right.

4.8.5 Button

class ButtonA text label. See *Panel.AddButton*.*RectTransform* **RectTransform** { **get**; }

The rect transform for the text.

Boolean Visible { **get**; **set**; }

Whether the UI object is visible.

Text **Text** { **get**; }

The text for the button.

Boolean Clicked { **get**; **set**; }

Whether the button has been clicked.

Note: This property is set to true when the user clicks the button. A client script should reset the property to false in order to detect subsequent button presses.

void **Remove** ()

Remove the UI object.

4.8.6 InputField

class InputFieldAn input field. See *Panel.AddInputField*.*RectTransform* **RectTransform** { **get**; }

The rect transform for the input field.

Boolean Visible { get; set; }
Whether the UI object is visible.

String Value { get; set; }
The value of the input field.

Text Text { get; }
The text component of the input field.

Note: Use *InputField.Value* to get and set the value in the field. This object can be used to alter the style of the input field's text.

Boolean Changed { get; set; }
Whether the input field has been changed.

Note: This property is set to true when the user modifies the value of the input field. A client script should reset the property to false in order to detect subsequent changes.

void Remove ()
Remove the UI object.

4.8.7 Rect Transform

class RectTransform
A Unity engine Rect Transform for a UI object. See the [Unity manual](#) for more details.

Tuple<Double, Double> Position { get; set; }
Position of the rectangles pivot point relative to the anchors.

Tuple<Double, Double, Double> LocalPosition { get; set; }
Position of the rectangles pivot point relative to the anchors.

Tuple<Double, Double> Size { get; set; }
Width and height of the rectangle.

Tuple<Double, Double> UpperRight { get; set; }
Position of the rectangles upper right corner relative to the anchors.

Tuple<Double, Double> LowerLeft { get; set; }
Position of the rectangles lower left corner relative to the anchors.

Tuple<Double, Double> Anchor { set; }
Set the minimum and maximum anchor points as a fraction of the size of the parent rectangle.

Tuple<Double, Double> AnchorMax { get; set; }
The anchor point for the lower left corner of the rectangle defined as a fraction of the size of the parent rectangle.

Tuple<Double, Double> AnchorMin { get; set; }
The anchor point for the upper right corner of the rectangle defined as a fraction of the size of the parent rectangle.

`Tuple<Double, Double> Pivot { get; set; }`

Location of the pivot point around which the rectangle rotates, defined as a fraction of the size of the rectangle itself.

`Tuple<Double, Double, Double, Double> Rotation { get; set; }`

Rotation, as a quaternion, of the object around its pivot point.

`Tuple<Double, Double, Double> Scale { get; set; }`

Scale factor applied to the object in the x, y and z dimensions.

5.1 C++ Client

This client provides a C++ API for interacting with a kRPC server.

5.1.1 Installing the Library

Dependencies

First you need to install kRPC's dependencies: [ASIO](#) which is used for network communication and [protobuf](#) which is used to serialize messages.

ASIO is a headers-only library. The boost version is not required, installing the non-Boost variant is sufficient. On Ubuntu, this can be done using apt:

```
sudo apt-get install libasio-dev
```

Alternatively it can be downloaded [from the ASIO website](#).

Protobuf version 3 is also required, and can be [downloaded from GitHub](#). Installation instructions [can be found here](#).

Using the configure script

Once the dependencies have been installed, you can install the kRPC client library and headers using the configure script provided with the source. [Download the source archive](#), extract it and then execute the following:

```
./configure
make
sudo make install
sudo ldconfig
```

Using CMake

Alternatively, you can install the client library and headers using CMake. [Download the source archive](#), extract it and execute the following:

```
cmake .
make
sudo make install
sudo ldconfig
```

Manual installation

The library is fairly simple to build manually if you can't use the configure script or CMake. The headers are in the `include` directory and the source files are in `src`.

5.1.2 Using the Library

A kRPC program needs to be compiled with C++11 support enabled, and linked against `libkrpc` and `libprotobuf`. The following example program connects to the server, queries it for its version and prints it out:

```
#include <iostream>
#include <krpc.hpp>
#include <krpc/services/krpc.hpp>

int main() {
    auto conn = krpc::connect();
    krpc::services::KRPC krpc(&conn);
    std::cout << "Connected to kRPC server version " << krpc.get_status().version() << "\n";
    std::endl;
}
```

To compile this program using GCC, save the source as `main.cpp` and run the following:

```
g++ main.cpp -std=c++11 -lkrpc -lprotobuf
```

Note: If you get linker errors claiming that there are undefined references to `google::protobuf::...` you probably have an older version of protobuf installed on your system. In this case, replace `-lprotobuf` with `-l:libprotobuf.so.10` in the above command so that GCC uses the correct version of the library.

5.1.3 Connecting to the Server

The `krpc::connect()` function is used to open a connection to a server. It returns a client object (of type `krpc::Client`) through which you can interact with the server. When called without any arguments, it will connect to the local machine on the default port numbers. You can specify different connection settings, and also a descriptive name for the connection, as follows:

```
#include <iostream>
#include <krpc.hpp>
#include <krpc/services/krpc.hpp>

int main() {
    auto conn = krpc::connect("My Example Program", "192.168.1.10", 1000, 1001);
    krpc::services::KRPC krpc(&conn);
    std::cout << krpc.get_status().version() << std::endl;
}
```

5.1.4 Calling Remote Procedures

The kRPC server provides *procedures* that a client can run. These procedures are arranged in groups called *services* to keep things organized. The functionality for the services are defined in the header files in `krpc/services/...`

For example, all of the functionality provided by the SpaceCenter service is contained in the header file `krpc/services/space_center.hpp`.

To interact with a service, you must include its header file and create an instance of the service, passing a `krpc::Client` object to its constructor.

The following example demonstrates how to invoke remote procedures using the C++ client. It instantiates the SpaceCenter service and calls `krpc::services::SpaceCenter::active_vessel()` to get an object representing the active vessel (of type `krpc::services::SpaceCenter::Vessel`). It sets the name of the vessel and then prints out its altitude:

```
#include <iostream>
#include <krpc.hpp>
#include <krpc/services/space_center.hpp>

int main() {
    auto conn = krpc::connect();
    krpc::services::SpaceCenter sc(&conn);
    auto vessel = sc.active_vessel();
    vessel.set_name("My Vessel");
    auto flight_info = vessel.flight();
    std::cout << flight_info.mean_altitude() << std::endl;
}
```

5.1.5 Streaming Data from the Server

A common use case for kRPC is to continuously extract data from the game. The naive approach to do this would be to repeatedly call a remote procedure, such as in the following which repeatedly prints the position of the active vessel:

```
#include <iostream>
#include <iomanip>
#include <tuple>
#include <krpc.hpp>
#include <krpc/services/space_center.hpp>

int main() {
    auto conn = krpc::connect();
    krpc::services::SpaceCenter sc(&conn);
    auto vessel = sc.active_vessel();
    auto ref_frame = vessel.orbit().body().reference_frame();
    while (true) {
        auto pos = vessel.position(ref_frame);
        std::cout << std::fixed << std::setprecision(1);
        std::cout << std::get<0>(pos) << ", "
                  << std::get<1>(pos) << ", "
                  << std::get<2>(pos) << std::endl;
    }
}
```

This approach requires significant communication overhead as request/response messages are repeatedly sent between the client and server. kRPC provides a more efficient mechanism to achieve this, called *streams*.

A stream repeatedly executes a procedure on the server (with a fixed set of argument values) and sends the result to the client. It only requires a single message to be sent to the server to establish the stream, which will then continuously send data to the client until the stream is closed.

The following example does the same thing as above using streams:

```

#include <iostream>
#include <iomanip>
#include <tuple>
#include <krpc.hpp>
#include <krpc/services/space_center.hpp>

int main() {
    auto conn = krpc::connect();
    krpc::services::SpaceCenter sc(&conn);
    auto vessel = sc.active_vessel();
    auto ref_frame = vessel.orbit().body().reference_frame();
    auto pos_stream = vessel.position_stream(ref_frame);
    while (true) {
        auto pos = pos_stream();
        std::cout << std::fixed << std::setprecision(1);
        std::cout << std::get<0>(pos) << ", "
                  << std::get<1>(pos) << ", "
                  << std::get<2>(pos) << std::endl;
    }
}

```

It calls `position_stream` once at the start of the program to create the stream, and then repeatedly prints the position returned by the stream. The stream is automatically closed when the client disconnects.

A stream can be created for any function call (except property setters) by adding `_stream` to the end of the functions name. This returns a stream object of type `template <typename T> krpc::Stream`, where `T` is the return type of the original function. The most recent value of the stream can be obtained by calling `krpc::Stream::operator()()`. A stream can be stopped and removed from the server by calling `krpc::Stream::remove()` on the stream object. All of a clients streams are automatically stopped when it disconnects.

Updates to streams can be paused by calling `krpc::Client::freeze_streams()`. After this call, all streams will have their values frozen to values from the same physics tick. Updates can be resumed by calling `krpc::Client::thaw_streams()`. This is useful if you need to perform some computation using stream values and require all of the stream values to be from the same physics tick.

5.1.6 Synchronizing with Stream Updates

A common use case for kRPC is to wait until the value returned by a method or attribute changes, and then take some action. kRPC provides two mechanisms to do this efficiently: *condition variables* and *callbacks*.

Condition Variables

Each stream has a condition variable associated with it, that is notified whenever the value of the stream changes. The condition variables are instances of `std::condition_variable`. These can be used to block the current thread of execution until the value of the stream changes.

The following example waits until the abort button is pressed in game, by waiting for the value of `krpc::services::SpaceCenter::Control::abort()` to change to true:

```

#include <iostream>
#include <krpc.hpp>
#include <krpc/services/space_center.hpp>

int main() {

```

```

auto conn = krpc::connect();
krpc::services::SpaceCenter sc(&conn);
auto control = sc.active_vessel().control();
auto abort = control.abort_stream();
abort.acquire();
while (!abort())
    abort.wait();
abort.release();
}

```

This code creates a stream, acquires a lock on the streams condition variable (by calling `acquire`) and then repeatedly checks the value of `abort`. It leaves the loop when it changes to true.

The body of the loop calls `wait` on the stream, which causes the program to block until the value changes. This prevents the loop from ‘spinning’ and so it does not consume processing resources whilst waiting.

Note: The stream does not start receiving updates until the first call to `wait`. This means that the example code will not miss any updates to the streams value, as it will have already locked the condition variable before the first stream update is received.

Callbacks

Streams allow you to register callback functions that are called whenever the value of the stream changes. Callback functions should take a single argument, which is the new value of the stream, and should return nothing.

For example the following program registers two callbacks that are invoked when the value of `krpc::services::SpaceCenter::Control::abort()` changes:

```

#include <iostream>
#include <krpc.hpp>
#include <krpc/services/space_center.hpp>

void check_abort1(bool x) {
    std::cout << "Abort 1 called with a value of " << x << std::endl;
}

void check_abort2(bool x) {
    std::cout << "Abort 2 called with a value of " << x << std::endl;
}

int main() {
    auto conn = krpc::connect();
    krpc::services::SpaceCenter sc(&conn);
    auto control = sc.active_vessel().control();
    auto abort = control.abort_stream();

    abort.add_callback(check_abort1);
    abort.add_callback(check_abort2);
    abort.start();

    // Keep the program running...
    while (true) {
    }
}

```

Note: When a stream is created it does not start receiving updates until `start` is called. This is implicitly called when accessing the value of a stream, but as this example does not do this an explicit call to `start` is required.

Note: The callbacks are registered before the call to `start` so that stream updates are not missed.

Note: The callback function may be called from a different thread to that which created the stream. Any changes to shared state must therefore be protected with appropriate synchronization.

5.1.7 Custom Events

Some procedures return event objects of type `krpc::Event`. These allow you to wait until an event occurs, by calling `krpc::Event::wait()`. Under the hood, these are implemented using streams and condition variables.

Custom events can also be created. An expression API allows you to create code that runs on the server and these can be used to build a custom event. For example, the following creates the expression `mean_altitude > 1000` and then creates an event that will be triggered when the expression returns true:

```
#include <iostream>
#include <krpc.hpp>
#include <krpc/services/krpc.hpp>
#include <krpc/services/space_center.hpp>

int main() {
    auto conn = krpc::connect();
    krpc::services::KRPC krpc(&conn);
    krpc::services::SpaceCenter sc(&conn);
    auto flight = sc.active_vessel().flight();

    // Get the remote procedure call as a message object,
    // so it can be passed to the server
    auto mean_altitude = flight.mean_altitude_call();

    // Create an expression on the server
    typedef krpc::services::KRPC::Expression Expr;
    auto expr = Expr::greater_than(conn,
        Expr::call(conn, mean_altitude),
        Expr::constant_double(conn, 1000));

    auto event = krpc.add_event(expr);
    event.acquire();
    event.wait();
    std::cout << "Altitude reached 1000m" << std::endl;
    event.release();
}
```

5.1.8 Client API Reference

Client **connect** (**const** std::string &name = "", **const** std::string &address = "127.0.0.1", unsigned int *rpc_port* = 50000, unsigned int *stream_port* = 50001)

This function creates a connection to a kRPC server. It returns a `krpc::Client` object, through which the

server can be communicated with.

Parameters

- **name** (*std::string*) – A descriptive name for the connection. This is passed to the server and appears in the in-game server window.
- **address** (*std::string*) – The address of the server to connect to. Can either be a hostname or an IP address in dotted decimal notation. Defaults to '127.0.0.1'.
- **rpc_port** (*unsigned int*) – The port number of the RPC Server. Defaults to 50000. This should match the RPC port number of the server you want to connect to.
- **stream_port** (*unsigned int*) – The port number of the Stream Server. Defaults to 50001. This should match the stream port number of the server you want to connect to.

class Client

This class provides the interface for communicating with the server. It is used by service class instances to invoke remote procedure calls. Instances of this class can be obtained by calling *krpc::connect()*.

~Client()

Destructs the client object and closes the connection to the server.

void freeze_streams()

Pause stream updates, after the next stream update message is received. This function blocks until the streams have been frozen.

void thaw_streams()

Resume stream updates. Before this function returns, the last received update message is applied to the streams.

template<typename T>

class Stream

This class represents a stream. See *Streaming Data from the Server*.

Streams are created by calling a remove procedure with *_stream* appended to its name.

Stream objects are copy constructible and assignable. A stream is removed from the server when all stream objects that refer to it are destroyed.

void start (bool wait = true)

Starts the stream. When a stream is created it does not start sending updates to the client until this method is called.

If wait is true, this method will block until at least one update has been received from the server.

If wait is false, the method starts the stream and returns immediately. Subsequent calls to *operator()* may throw a *krpc::StreamError* exception.

float rate() const

void setRate (float rate)

The update rate of the stream in Hertz. When set to zero, the rate is unlimited.

T operator() ()

Get the most recently received value from the stream.

std::condition_variable &get_condition() const

A condition variable that is notified whenever the value of the stream changes.

std::unique_lock<std::mutex> &get_condition_lock() const

The lock for the condition variable.

void **acquire** ()

Acquires a lock on the mutex for the condition variable.

void **release** ()

Releases the lock on the mutex for the condition variable.

void **wait** (double *timeout* = -1)

This method blocks until the value of the stream changes or the operation times out.

The streams condition variable must be locked (by calling `acquire`) before calling this method.

If *timeout* is specified and is greater than or equal to 0, it is the timeout in seconds for the operation.

If the stream has not been started this method calls `start(false)` to start the stream (without waiting for at least one update to be received).

void **add_callback** (const std::function<void> T

> &*callback* Adds a callback function that is invoked whenever the value of the stream changes. The callback function should take one argument, which is passed the new value of the stream.

Note: The callback function may be called from a different thread to that which created the stream. Any changes to shared state must therefore be protected with appropriate synchronization.

void **remove** ()

Removes the stream from the server.

bool **operator==** (const Stream<T> &*rhs*)

Returns true if the two stream objects are bound to the same stream.

bool **operator!=** (const Stream<T> &*rhs*)

Returns true if the two stream objects are bound to different streams.

operator bool ()

Returns whether the stream object is bound to a stream.

class Event

This class represents an event. See *Custom Events*. It is wrapper around a `Stream<bool>` that indicates when the event occurs.

Event objects are copy constructible and assignable. An event is removed from the server when all event objects that refer to it are destroyed.

void **start** ()

Starts the event. When an event is created, it will not receive updates from the server until this method is called.

std::condition_variable &**get_condition** () const

The condition variable that is notified whenever the event occurs.

std::unique_lock<std::mutex> &**get_condition_lock** () const

The lock for the condition variable.

void **acquire** ()

Acquires a lock on the mutex for the condition variable.

void **release** ()

Releases the lock on the mutex for the condition variable.

void **wait** (double *timeout* = -1)

This method blocks until the event occurs or the operation times out.

The events condition variable must be locked before calling this method.

If *timeout* is specified and is greater than or equal to 0, it is the timeout in seconds for the operation.

If the event has not been started this method calls `start()` to start the underlying stream.

```
void add_callback (const std::function<void>
    > &callback) Adds a callback function that is invoked whenever the event occurs. The callback function
    should be a function that takes zero arguments.

void remove ()
    Removes the event from the server.

Stream<bool> stream ()
    Returns the underlying stream for the event.

bool operator== (const Event &rhs)
    Returns true if the two event objects are bound to the same underlying stream.

bool operator!= (const Event &rhs)
    Returns true if the two event objects are bound to different underlying streams.

operator bool ()
    Returns whether the event object is bound to a stream.
```

5.2 KRPC API

5.2.1 KRPC

None None None None

```
class KRPC : public krpc::Service
    Main kRPC service, used by clients to interact with basic server functionality.

KRPC (krpc::Client *client)
    Construct an instance of this service.

std::string get_client_id ()
    Returns the identifier for the current client.

std::string get_client_name ()
    Returns the name of the current client. This is an empty string if the client has no name.

std::vector<std::tuple<std::string, std::string, std::string>> clients ()
    A list of RPC clients that are currently connected to the server. Each entry in the list is a clients identifier,
    name and address.

krpc::schema::Status get_status ()
    Returns some information about the server, such as the version.

krpc::schema::Services get_services ()
    Returns information on all services, procedures, classes, properties etc. provided by the server. Can be
    used by client libraries to automatically create functionality such as stubs.

void set_stream_rate (uint64_t id, float rate)
    Set the update rate for a stream in Hz.

    Parameters

GameScene current_game_scene ()
    Get the current game scene.

bool paused ()
```

void **set_paused** (bool *value*)
Whether the game is paused.

enum struct GameScene

The game scene. See *current_game_scene()*.

enumerator space_center

The game scene showing the Kerbal Space Center buildings.

enumerator flight

The game scene showing a vessel in flight (or on the launchpad/runway).

enumerator tracking_station

The tracking station.

enumerator editor_vab

The Vehicle Assembly Building.

enumerator editor_sph

The Space Plane Hangar.

class InvalidOperationException

A method call was made to a method that is invalid given the current state of the object.

class ArgumentException

A method was invoked where at least one of the passed arguments does not meet the parameter specification of the method.

class ArgumentNullException

A null reference was passed to a method that does not accept it as a valid argument.

class ArgumentOutOfRangeException

The value of an argument is outside the allowable range of values as defined by the invoked method.

5.2.2 Expressions

class Expression

A server side expression.

static Expression constant_double (*Client &connection*, double *value*)

A constant value of type double.

Parameters

static Expression constant_float (*Client &connection*, float *value*)

A constant value of type float.

Parameters

static Expression constant_int (*Client &connection*, int32_t *value*)

A constant value of type int.

Parameters

static Expression constant_string (*Client &connection*, std::string *value*)

A constant value of type string.

Parameters

static Expression call (*Client &connection*, krpc::schema::ProcedureCall *call*)

An RPC call.

Parameters

static Expression equal (*Client &connection, Expression arg0, Expression arg1*)
Equality comparison.

Parameters

static Expression not_equal (*Client &connection, Expression arg0, Expression arg1*)
Inequality comparison.

Parameters

static Expression greater_than (*Client &connection, Expression arg0, Expression arg1*)
Greater than numerical comparison.

Parameters

static Expression greater_than_or_equal (*Client &connection, Expression arg0, Expression arg1*)
Greater than or equal numerical comparison.

Parameters

static Expression less_than (*Client &connection, Expression arg0, Expression arg1*)
Less than numerical comparison.

Parameters

static Expression less_than_or_equal (*Client &connection, Expression arg0, Expression arg1*)
Less than or equal numerical comparison.

Parameters

static Expression and__ (*Client &connection, Expression arg0, Expression arg1*)
Boolean and operator.

Parameters

static Expression or__ (*Client &connection, Expression arg0, Expression arg1*)
Boolean or operator.

Parameters

static Expression exclusive_or (*Client &connection, Expression arg0, Expression arg1*)
Boolean exclusive-or operator.

Parameters

static Expression not__ (*Client &connection, Expression arg*)
Boolean negation operator.

Parameters

static Expression add (*Client &connection, Expression arg0, Expression arg1*)
Numerical addition.

Parameters

static Expression subtract (*Client &connection, Expression arg0, Expression arg1*)
Numerical subtraction.

Parameters

static Expression multiply (*Client &connection, Expression arg0, Expression arg1*)
Numerical multiplication.

Parameters

static Expression divide (*Client &connection, Expression arg0, Expression arg1*)
Numerical division.

Parameters

static Expression modulo (*Client &connection, Expression arg0, Expression arg1*)
Numerical modulo operator.

Parameters

Returns The remainder of arg0 divided by arg1

static Expression power (*Client &connection, Expression arg0, Expression arg1*)
Numerical power operator.

Parameters

Returns arg0 raised to the power of arg1

static Expression left_shift (*Client &connection, Expression arg0, Expression arg1*)
Bitwise left shift.

Parameters

static Expression right_shift (*Client &connection, Expression arg0, Expression arg1*)
Bitwise right shift.

Parameters

static Expression to_double (*Client &connection, Expression arg*)
Convert to a double type.

Parameters

static Expression to_float (*Client &connection, Expression arg*)
Convert to a float type.

Parameters

static Expression to_int (*Client &connection, Expression arg*)
Convert to an int type.

Parameters

5.3 SpaceCenter API

5.3.1 SpaceCenter

class SpaceCenter : public *krpc::Service*

Provides functionality to interact with Kerbal Space Program. This includes controlling the active vessel, managing its resources, planning maneuver nodes and auto-piloting.

SpaceCenter (*krpc::Client *client*)
Construct an instance of this service.

Vessel **active_vessel** ()

void **set_active_vessel** (*Vessel value*)
The currently active vessel.

std::vector<*Vessel*> **vessels** ()
A list of all the vessels in the game.

`std::map<std::string, CelestialBody> bodies ()`

A dictionary of all celestial bodies (planets, moons, etc.) in the game, keyed by the name of the body.

CelestialBody **target_body** ()

void **set_target_body** (*CelestialBody* value)

The currently targeted celestial body.

Vessel **target_vessel** ()

void **set_target_vessel** (*Vessel* value)

The currently targeted vessel.

DockingPort **target_docking_port** ()

void **set_target_docking_port** (*DockingPort* value)

The currently targeted docking port.

void **clear_target** ()

Clears the current target.

`std::vector<std::string> launchable_vessels (std::string craft_directory)`

Returns a list of vessels from the given *craft_directory* that can be launched.

Parameters

- **craft_directory** – Name of the directory in the current saves “Ships” directory. For example "VAB" or "SPH".

void **launch_vessel** (std::string *craft_directory*, std::string *name*, std::string *launch_site*)

Launch a vessel.

Parameters

- **craft_directory** – Name of the directory in the current saves “Ships” directory, that contains the craft file. For example "VAB" or "SPH".
- **name** – Name of the vessel to launch. This is the name of the “.craft” file in the save directory, without the “.craft” file extension.
- **launch_site** – Name of the launch site. For example "LaunchPad" or "Runway".

void **launch_vessel_from_vab** (std::string *name*)

Launch a new vessel from the VAB onto the launchpad.

Parameters

- **name** – Name of the vessel to launch.

Note: This is equivalent to calling `launch_vessel()` with the craft directory set to “VAB” and the launch site set to “LaunchPad”.

void **launch_vessel_from_sph** (std::string *name*)

Launch a new vessel from the SPH onto the runway.

Parameters

- **name** – Name of the vessel to launch.

Note: This is equivalent to calling `launch_vessel()` with the craft directory set to “SPH” and the launch site set to “Runway”.

void **save** (std::string *name*)

Save the game with a given name. This will create a save file called `name.sfs` in the folder of the current save game.

Parameters

void **load** (std::string *name*)

Load the game with the given name. This will create a load a save file called `name.sfs` from the folder of the current save game.

Parameters

void **quicksave** ()

Save a quicksave.

Note: This is the same as calling `save()` with the name “quicksave”.

void **quickload** ()

Load a quicksave.

Note: This is the same as calling `load()` with the name “quicksave”.

bool **ui_visible** ()

void **set_ui_visible** (bool *value*)

Whether the UI is visible.

bool **navball** ()

void **set_navball** (bool *value*)

Whether the navball is visible.

double **ut** ()

The current universal time in seconds.

double **g** ()

The value of the [gravitational constant](#) G in $N(m/kg)^2$.

float **warp_rate** ()

The current warp rate. This is the rate at which time is passing for either on-rails or physical time warp. For example, a value of 10 means time is passing 10x faster than normal. Returns 1 if time warp is not active.

float **warp_factor** ()

The current warp factor. This is the index of the rate at which time is passing for either regular “on-rails” or physical time warp. Returns 0 if time warp is not active. When in on-rails time warp, this is equal to `rails_warp_factor()`, and in physics time warp, this is equal to `physics_warp_factor()`.

int32_t **rails_warp_factor** ()

void **set_rails_warp_factor** (int32_t *value*)

The time warp rate, using regular “on-rails” time warp. A value between 0 and 7 inclusive. 0 means no time warp. Returns 0 if physical time warp is active.

If requested time warp factor cannot be set, it will be set to the next lowest possible value. For example, if the vessel is too close to a planet. See [the KSP wiki](#) for details.

int32_t **physics_warp_factor** ()

void **set_physics_warp_factor** (int32_t *value*)

The physical time warp rate. A value between 0 and 3 inclusive. 0 means no time warp. Returns 0 if regular “on-rails” time warp is active.

bool **can_rails_warp_at** (int32_t *factor* = 1)

Returns `true` if regular “on-rails” time warp can be used, at the specified warp *factor*. The maximum time warp rate is limited by various things, including how close the active vessel is to a planet. See [the KSP wiki](#) for details.

Parameters

- **factor** – The warp factor to check.

int32_t **maximum_rails_warp_factor** ()

The current maximum regular “on-rails” warp factor that can be set. A value between 0 and 7 inclusive. See [the KSP wiki](#) for details.

void **warp_to** (double *ut*, float *max_rails_rate* = 100000.0, float *max_physics_rate* = 2.0)

Uses time acceleration to warp forward to a time in the future, specified by universal time *ut*. This call blocks until the desired time is reached. Uses regular “on-rails” or physical time warp as appropriate. For example, physical time warp is used when the active vessel is traveling through an atmosphere. When using regular “on-rails” time warp, the warp rate is limited by *max_rails_rate*, and when using physical time warp, the warp rate is limited by *max_physics_rate*.

Parameters

- **ut** – The universal time to warp to, in seconds.
- **max_rails_rate** – The maximum warp rate in regular “on-rails” time warp.
- **max_physics_rate** – The maximum warp rate in physical time warp.

Returns When the time warp is complete.

std::tuple<double, double, double> **transform_position** (std::tuple<double, double, double> *position*, *ReferenceFrame from*, *ReferenceFrame to*)

Converts a position from one reference frame to another.

Parameters

- **position** – Position, as a vector, in reference frame *from*.
- **from** – The reference frame that the position is in.
- **to** – The reference frame to convert the position to.

Returns The corresponding position, as a vector, in reference frame *to*.

std::tuple<double, double, double> **transform_direction** (std::tuple<double, double, double> *direction*, *ReferenceFrame from*, *ReferenceFrame to*)

Converts a direction from one reference frame to another.

Parameters

- **direction** – Direction, as a vector, in reference frame *from*.
- **from** – The reference frame that the direction is in.
- **to** – The reference frame to convert the direction to.

Returns The corresponding direction, as a vector, in reference frame *to*.

`std::tuple<double, double, double, double> transform_rotation` (`std::tuple<double, double, double, double> rotation`, *ReferenceFrame from*, *ReferenceFrame to*)

Converts a rotation from one reference frame to another.

Parameters

- **rotation** – Rotation, as a quaternion of the form (x, y, z, w) , in reference frame *from*.
- **from** – The reference frame that the rotation is in.
- **to** – The reference frame to convert the rotation to.

Returns The corresponding rotation, as a quaternion of the form (x, y, z, w) , in reference frame *to*.

`std::tuple<double, double, double> transform_velocity` (`std::tuple<double, double, double> position`, `std::tuple<double, double, double> velocity`, *ReferenceFrame from*, *ReferenceFrame to*)

Converts a velocity (acting at the specified position) from one reference frame to another. The position is required to take the relative angular velocity of the reference frames into account.

Parameters

- **position** – Position, as a vector, in reference frame *from*.
- **velocity** – Velocity, as a vector that points in the direction of travel and whose magnitude is the speed in meters per second, in reference frame *from*.
- **from** – The reference frame that the position and velocity are in.
- **to** – The reference frame to convert the velocity to.

Returns The corresponding velocity, as a vector, in reference frame *to*.

`double raycast_distance` (`std::tuple<double, double, double> position`, `std::tuple<double, double, double> direction`, *ReferenceFrame reference_frame*)

Cast a ray from a given position in a given direction, and return the distance to the hit point. If no hit occurs, returns infinity.

Parameters

- **position** – Position, as a vector, of the origin of the ray.
- **direction** – Direction of the ray, as a unit vector.
- **reference_frame** – The reference frame that the position and direction are in.

Returns The distance to the hit, in meters, or infinity if there was no hit.

Part `raycast_part` (`std::tuple<double, double, double> position`, `std::tuple<double, double, double> direction`, *ReferenceFrame reference_frame*)

Cast a ray from a given position in a given direction, and return the part that it hits. If no hit occurs, returns `NULL`.

Parameters

- **position** – Position, as a vector, of the origin of the ray.
- **direction** – Direction of the ray, as a unit vector.
- **reference_frame** – The reference frame that the position and direction are in.

Returns The part that was hit or `NULL` if there was no hit.

bool **far_available** ()

Whether [Ferram Aerospace Research](#) is installed.

WarpMode **warp_mode** ()

The current time warp mode. Returns *WarpMode::none* if time warp is not active, *WarpMode::rails* if regular “on-rails” time warp is active, or *WarpMode::physics* if physical time warp is active.

Camera **camera** ()

An object that can be used to control the camera.

WaypointManager **waypoint_manager** ()

The waypoint manager.

ContractManager **contract_manager** ()

The contract manager.

enum struct WarpMode

The time warp mode. Returned by *WarpMode*

enumerator rails

Time warp is active, and in regular “on-rails” mode.

enumerator physics

Time warp is active, and in physical time warp mode.

enumerator none

Time warp is not active.

5.3.2 Vessel

class Vessel

These objects are used to interact with vessels in KSP. This includes getting orbital and flight data, manipulating control inputs and managing resources. Created using *active_vessel()* or *vessels()*.

std::string **name** ()

void **set_name** (std::string value)

The name of the vessel.

VesselType **type** ()

void **set_type** (*VesselType* value)

The type of the vessel.

VesselSituation **situation** ()

The situation the vessel is in.

bool **recoverable** ()

Whether the vessel is recoverable.

void **recover** ()

Recover the vessel.

double **met** ()

The mission elapsed time in seconds.

std::string **biome** ()

The name of the biome the vessel is currently in.

Flight **flight** (*ReferenceFrame* *reference_frame* = *ReferenceFrame*())

Returns a *Flight* object that can be used to get flight telemetry for the vessel, in the specified reference frame.

Parameters

- **reference_frame** – Reference frame. Defaults to the vessel's surface reference frame (*Vessel::surface_reference_frame()*).

Note: When this is called with no arguments, the vessel's surface reference frame is used. This reference frame moves with the vessel, therefore velocities and speeds returned by the flight object will be zero. See the *reference frames tutorial* for examples of getting *the orbital and surface speeds of a vessel*.

Orbit **orbit** ()

The current orbit of the vessel.

Control **control** ()

Returns a *Control* object that can be used to manipulate the vessel's control inputs. For example, its pitch/yaw/roll controls, RCS and thrust.

Comms **comms** ()

Returns a *Comms* object that can be used to interact with CommNet for this vessel.

AutoPilot **auto_pilot** ()

An *AutoPilot* object, that can be used to perform simple auto-piloting of the vessel.

int32_t **crew_capacity** ()

The number of crew that can occupy the vessel.

int32_t **crew_count** ()

The number of crew that are occupying the vessel.

std::vector<*CrewMember*> **crew** ()

The crew in the vessel.

Resources **resources** ()

A *Resources* object, that can be used to get information about resources stored in the vessel.

Resources **resources_in_decouple_stage** (int32_t *stage*, bool *cumulative* = true)

Returns a *Resources* object, that can be used to get information about resources stored in a given *stage*.

Parameters

- **stage** – Get resources for parts that are decoupled in this stage.
- **cumulative** – When *false*, returns the resources for parts decoupled in just the given stage. When *true* returns the resources decoupled in the given stage and all subsequent stages combined.

Note: For details on stage numbering, see the discussion on *Staging*.

Parts **parts** ()

A *Parts* object, that can be used to interact with the parts that make up this vessel.

float **mass** ()

The total mass of the vessel, including resources, in kg.

float **dry_mass** ()

The total mass of the vessel, excluding resources, in kg.

float **thrust** ()

The total thrust currently being produced by the vessel's engines, in Newtons. This is computed by summing `Engine::thrust()` for every engine in the vessel.

float **available_thrust** ()

Gets the total available thrust that can be produced by the vessel's active engines, in Newtons. This is computed by summing `Engine::available_thrust()` for every active engine in the vessel.

float **max_thrust** ()

The total maximum thrust that can be produced by the vessel's active engines, in Newtons. This is computed by summing `Engine::max_thrust()` for every active engine.

float **max_vacuum_thrust** ()

The total maximum thrust that can be produced by the vessel's active engines when the vessel is in a vacuum, in Newtons. This is computed by summing `Engine::max_vacuum_thrust()` for every active engine.

float **specific_impulse** ()

The combined specific impulse of all active engines, in seconds. This is computed using the formula [described here](#).

float **vacuum_specific_impulse** ()

The combined vacuum specific impulse of all active engines, in seconds. This is computed using the formula [described here](#).

float **kerbin_sea_level_specific_impulse** ()

The combined specific impulse of all active engines at sea level on Kerbin, in seconds. This is computed using the formula [described here](#).

std::tuple<double, double, double> **moment_of_inertia** ()

The moment of inertia of the vessel around its center of mass in $kg.m^2$. The inertia values in the returned 3-tuple are around the pitch, roll and yaw directions respectively. This corresponds to the vessels reference frame (*ReferenceFrame*).

std::vector<double> **inertia_tensor** ()

The inertia tensor of the vessel around its center of mass, in the vessels reference frame (*ReferenceFrame*). Returns the 3x3 matrix as a list of elements, in row-major order.

std::tuple<std::tuple<double, double, double>, std::tuple<double, double, double>> **available_torque** ()

The maximum torque that the vessel generates. Includes contributions from reaction wheels, RCS, gimbaled engines and aerodynamic control surfaces. Returns the torques in $N.m$ around each of the coordinate axes of the vessels reference frame (*ReferenceFrame*). These axes are equivalent to the pitch, roll and yaw axes of the vessel.

std::tuple<std::tuple<double, double, double>, std::tuple<double, double, double>> **available_reaction_wheel_torque** ()

The maximum torque that the currently active and powered reaction wheels can generate. Returns the torques in $N.m$ around each of the coordinate axes of the vessels reference frame (*ReferenceFrame*). These axes are equivalent to the pitch, roll and yaw axes of the vessel.

std::tuple<std::tuple<double, double, double>, std::tuple<double, double, double>> **available_rcs_torque** ()

The maximum torque that the currently active RCS thrusters can generate. Returns the torques in $N.m$ around each of the coordinate axes of the vessels reference frame (*ReferenceFrame*). These axes are equivalent to the pitch, roll and yaw axes of the vessel.

std::tuple<std::tuple<double, double, double>, std::tuple<double, double, double>> **available_engine_torque** ()

The maximum torque that the currently active and gimbaled engines can generate. Returns the torques in $N.m$ around each of the coordinate axes of the vessels reference frame (*ReferenceFrame*). These axes are equivalent to the pitch, roll and yaw axes of the vessel.

`std::tuple<std::tuple<double, double, double>, std::tuple<double, double, double>> available_control_surface_torque()`

The maximum torque that the aerodynamic control surfaces can generate. Returns the torques in $N.m$ around each of the coordinate axes of the vessels reference frame (*ReferenceFrame*). These axes are equivalent to the pitch, roll and yaw axes of the vessel.

`std::tuple<std::tuple<double, double, double>, std::tuple<double, double, double>> available_other_torque()`

The maximum torque that parts (excluding reaction wheels, gimballed engines, RCS and control surfaces) can generate. Returns the torques in $N.m$ around each of the coordinate axes of the vessels reference frame (*ReferenceFrame*). These axes are equivalent to the pitch, roll and yaw axes of the vessel.

ReferenceFrame **reference_frame** ()

The reference frame that is fixed relative to the vessel, and orientated with the vessel.

- The origin is at the center of mass of the vessel.
- The axes rotate with the vessel.
- The x-axis points out to the right of the vessel.
- The y-axis points in the forward direction of the vessel.
- The z-axis points out of the bottom of the vessel.

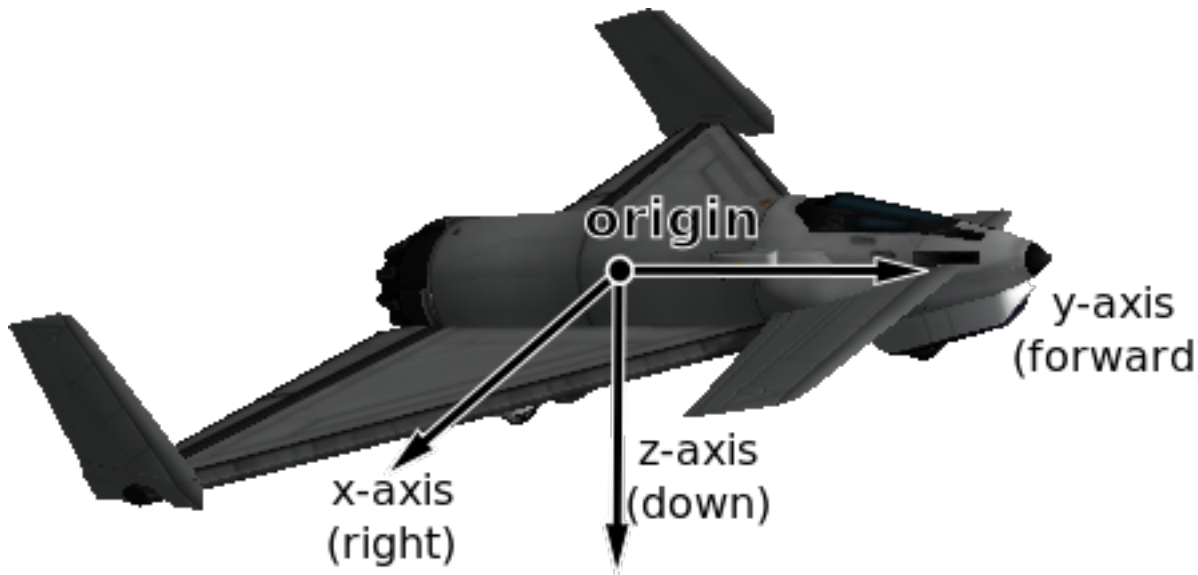


Fig. 5.1: Vessel reference frame origin and axes for the Aeris 3A aircraft

ReferenceFrame **orbital_reference_frame** ()

The reference frame that is fixed relative to the vessel, and orientated with the vessels orbital prograde/normal/radial directions.

- The origin is at the center of mass of the vessel.
- The axes rotate with the orbital prograde/normal/radial directions.
- The x-axis points in the orbital anti-radial direction.
- The y-axis points in the orbital prograde direction.
- The z-axis points in the orbital normal direction.

Note: Be careful not to confuse this with ‘orbit’ mode on the navball.

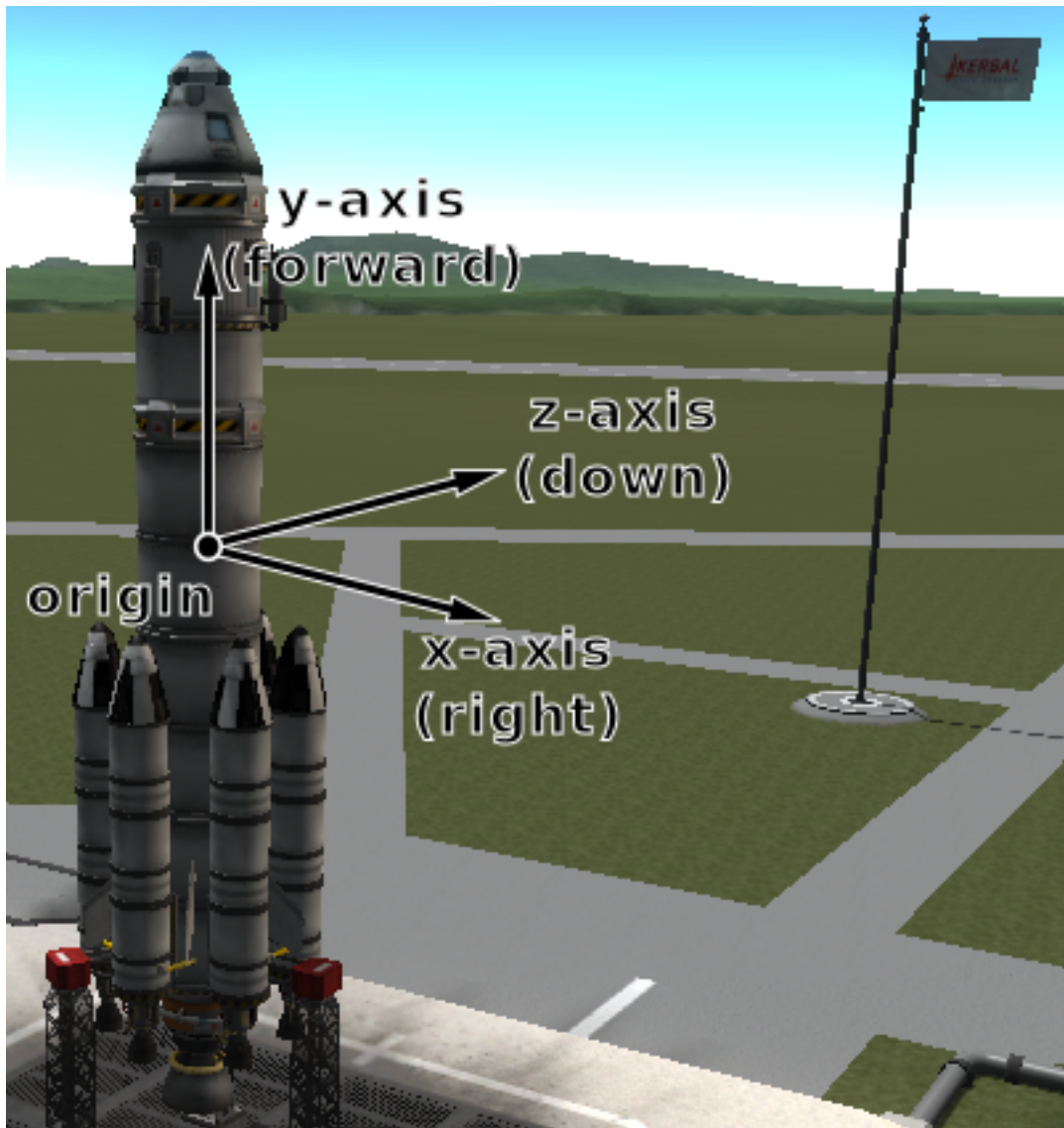


Fig. 5.2: Vessel reference frame origin and axes for the Kerbal-X rocket

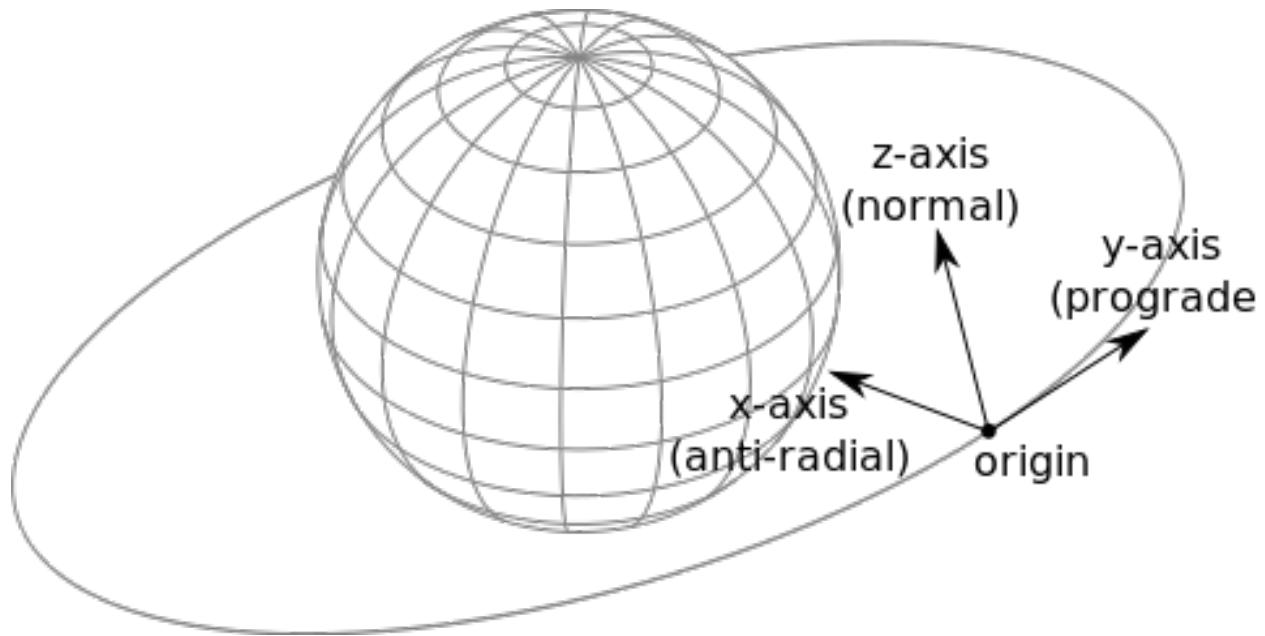


Fig. 5.3: Vessel orbital reference frame origin and axes

ReferenceFrame **surface_reference_frame** ()

The reference frame that is fixed relative to the vessel, and orientated with the surface of the body being orbited.

- The origin is at the center of mass of the vessel.
- The axes rotate with the north and up directions on the surface of the body.
- The x-axis points in the [zenith](#) direction (upwards, normal to the body being orbited, from the center of the body towards the center of mass of the vessel).
- The y-axis points northwards towards the [astronomical horizon](#) (north, and tangential to the surface of the body – the direction in which a compass would point when on the surface).
- The z-axis points eastwards towards the [astronomical horizon](#) (east, and tangential to the surface of the body – east on a compass when on the surface).

Note: Be careful not to confuse this with ‘surface’ mode on the navball.

ReferenceFrame **surface_velocity_reference_frame** ()

The reference frame that is fixed relative to the vessel, and orientated with the velocity vector of the vessel relative to the surface of the body being orbited.

- The origin is at the center of mass of the vessel.
- The axes rotate with the vessel’s velocity vector.
- The y-axis points in the direction of the vessel’s velocity vector, relative to the surface of the body being orbited.
- The z-axis is in the plane of the [astronomical horizon](#).
- The x-axis is orthogonal to the other two axes.

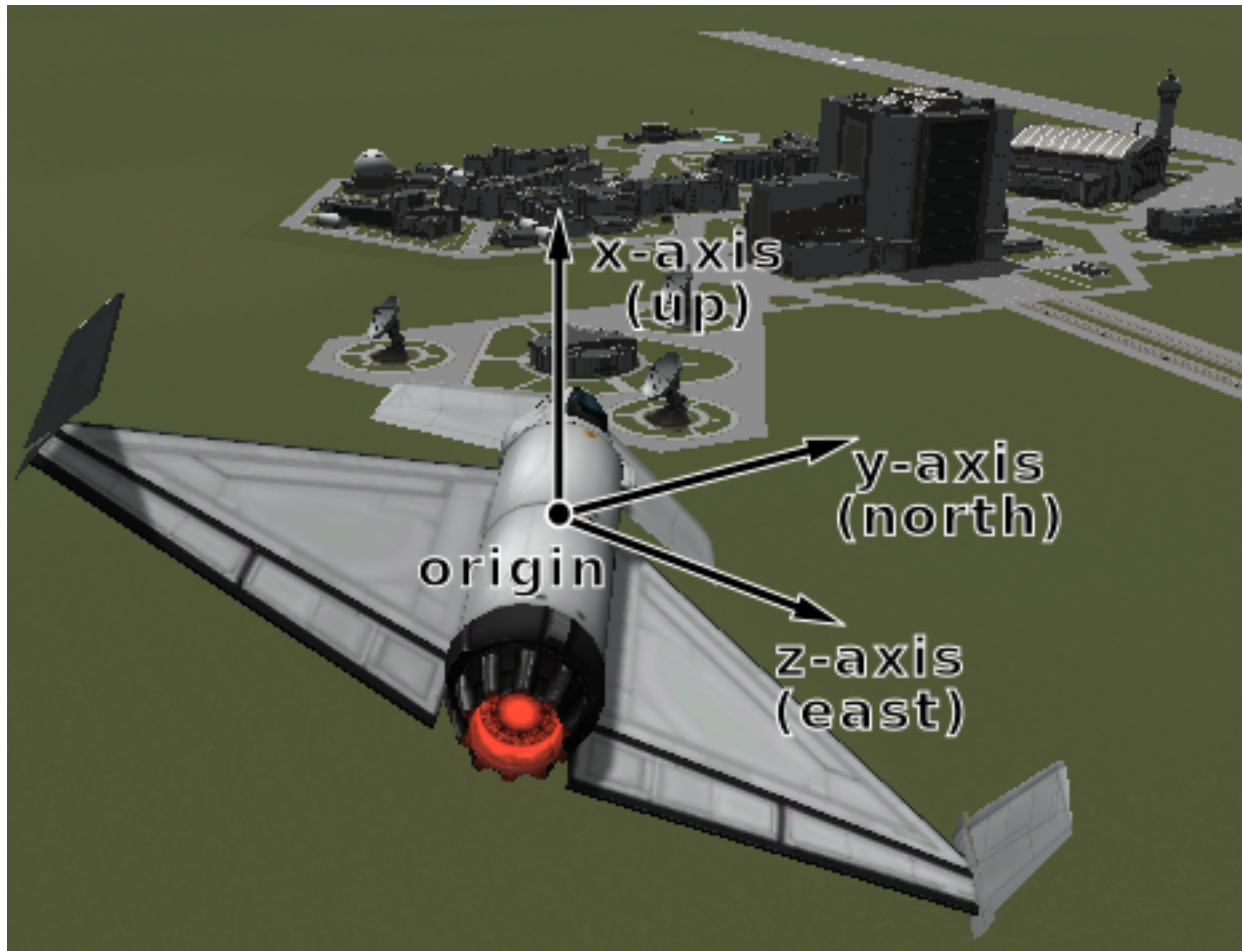


Fig. 5.4: Vessel surface reference frame origin and axes

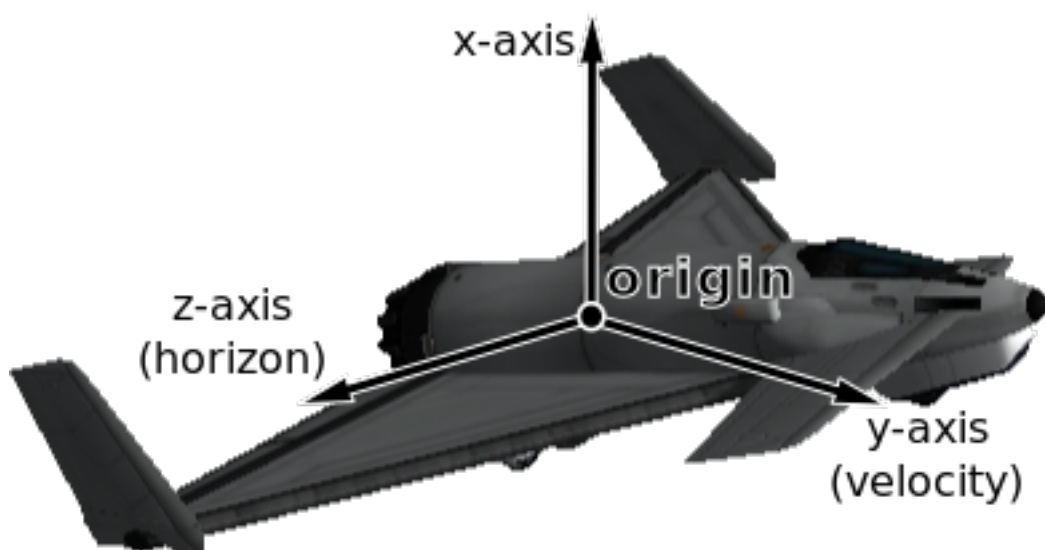


Fig. 5.5: Vessel surface velocity reference frame origin and axes

`std::tuple<double, double, double> position (ReferenceFrame reference_frame)`

The position of the center of mass of the vessel, in the given reference frame.

Parameters

- **reference_frame** – The reference frame that the returned position vector is in.

Returns The position as a vector.

`std::tuple<std::tuple<double, double, double>, std::tuple<double, double, double>> bounding_box (ReferenceFrame ref-
er-
ence_frame)`

The axis-aligned bounding box of the vessel in the given reference frame.

Parameters

- **reference_frame** – The reference frame that the returned position vectors are in.

Returns The positions of the minimum and maximum vertices of the box, as position vectors.

`std::tuple<double, double, double> velocity (ReferenceFrame reference_frame)`

The velocity of the center of mass of the vessel, in the given reference frame.

Parameters

- **reference_frame** – The reference frame that the returned velocity vector is in.

Returns The velocity as a vector. The vector points in the direction of travel, and its magnitude is the speed of the body in meters per second.

`std::tuple<double, double, double, double> rotation (ReferenceFrame reference_frame)`

The rotation of the vessel, in the given reference frame.

Parameters

- **reference_frame** – The reference frame that the returned rotation is in.

Returns The rotation as a quaternion of the form (x, y, z, w) .

`std::tuple<double, double, double> direction (ReferenceFrame reference_frame)`

The direction in which the vessel is pointing, in the given reference frame.

Parameters

- **reference_frame** – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

`std::tuple<double, double, double> angular_velocity (ReferenceFrame reference_frame)`

The angular velocity of the vessel, in the given reference frame.

Parameters

- **reference_frame** – The reference frame the returned angular velocity is in.

Returns The angular velocity as a vector. The magnitude of the vector is the rotational speed of the vessel, in radians per second. The direction of the vector indicates the axis of rotation, using the right-hand rule.

enum struct VesselType

The type of a vessel. See `Vessel::type()`.

enumerator base

Base.

enumerator debris

Debris.

enumerator lander

Lander.

enumerator plane

Plane.

enumerator probe

Probe.

enumerator relay

Relay.

enumerator rover

Rover.

enumerator ship

Ship.

enumerator station

Station.

enum struct VesselSituation

The situation a vessel is in. See *Vessel::situation()*.

enumerator docked

Vessel is docked to another.

enumerator escaping

Escaping.

enumerator flying

Vessel is flying through an atmosphere.

enumerator landed

Vessel is landed on the surface of a body.

enumerator orbiting

Vessel is orbiting a body.

enumerator pre_launch

Vessel is awaiting launch.

enumerator splashed

Vessel has splashed down in an ocean.

enumerator sub_orbital

Vessel is on a sub-orbital trajectory.

class CrewMember

Represents crew in a vessel. Can be obtained using *Vessel::crew()*.

std::string **name**()

void **set_name**(std::string *value*)

The crew members name.

CrewMemberType **type**()

The type of crew member.

bool **on_mission**()

Whether the crew member is on a mission.

float **courage** ()
void **set_courage** (float *value*)
 The crew members courage.
float **stupidity** ()
void **set_stupidity** (float *value*)
 The crew members stupidity.
float **experience** ()
void **set_experience** (float *value*)
 The crew members experience.
bool **badass** ()
void **set_badass** (bool *value*)
 Whether the crew member is a badass.
bool **veteran** ()
void **set_veteran** (bool *value*)
 Whether the crew member is a veteran.

enum struct CrewMemberType
 The type of a crew member. See *CrewMember::type()*.

enumerator applicant
 An applicant for crew.
enumerator crew
 Rocket crew.
enumerator tourist
 A tourist.
enumerator unowned
 An unowned crew member.

5.3.3 CelestialBody

class CelestialBody
 Represents a celestial body (such as a planet or moon). See *bodies()*.

std::string **name** ()
 The name of the body.
std::vector<*CelestialBody*> **satellites** ()
 A list of celestial bodies that are in orbit around this celestial body.
Orbit **orbit** ()
 The orbit of the body.
float **mass** ()
 The mass of the body, in kilograms.
float **gravitational_parameter** ()
 The *standard gravitational parameter* of the body in m^3s^{-2} .
float **surface_gravity** ()
 The acceleration due to gravity at sea level (mean altitude) on the body, in m/s^2 .

float **rotational_period**()

The sidereal rotational period of the body, in seconds.

float **rotational_speed**()

The rotational speed of the body, in radians per second.

double **rotation_angle**()

The current rotation angle of the body, in radians. A value between 0 and 2π

double **initial_rotation**()

The initial rotation angle of the body (at UT 0), in radians. A value between 0 and 2π

float **equatorial_radius**()

The equatorial radius of the body, in meters.

double **surface_height**(double *latitude*, double *longitude*)

The height of the surface relative to mean sea level, in meters, at the given position. When over water this is equal to 0.

Parameters

- **latitude** – Latitude in degrees.
- **longitude** – Longitude in degrees.

double **bedrock_height**(double *latitude*, double *longitude*)

The height of the surface relative to mean sea level, in meters, at the given position. When over water, this is the height of the sea-bed and is therefore negative value.

Parameters

- **latitude** – Latitude in degrees.
- **longitude** – Longitude in degrees.

std::tuple<double, double, double> **msl_position**(double *latitude*, double *longitude*, *ReferenceFrame* *reference_frame*)

The position at mean sea level at the given latitude and longitude, in the given reference frame.

Parameters

- **latitude** – Latitude in degrees.
- **longitude** – Longitude in degrees.
- **reference_frame** – Reference frame for the returned position vector.

Returns Position as a vector.

std::tuple<double, double, double> **surface_position**(double *latitude*, double *longitude*, *ReferenceFrame* *reference_frame*)

The position of the surface at the given latitude and longitude, in the given reference frame. When over water, this is the position of the surface of the water.

Parameters

- **latitude** – Latitude in degrees.
- **longitude** – Longitude in degrees.
- **reference_frame** – Reference frame for the returned position vector.

Returns Position as a vector.

`std::tuple<double, double, double> bedrock_position (double latitude, double longitude, ReferenceFrame reference_frame)`

The position of the surface at the given latitude and longitude, in the given reference frame. When over water, this is the position at the bottom of the sea-bed.

Parameters

- **latitude** – Latitude in degrees.
- **longitude** – Longitude in degrees.
- **reference_frame** – Reference frame for the returned position vector.

Returns Position as a vector.

`std::tuple<double, double, double> position_at_altitude (double latitude, double longitude, double altitude, ReferenceFrame reference_frame)`

The position at the given latitude, longitude and altitude, in the given reference frame.

Parameters

- **latitude** – Latitude in degrees.
- **longitude** – Longitude in degrees.
- **altitude** – Altitude in meters above sea level.
- **reference_frame** – Reference frame for the returned position vector.

Returns Position as a vector.

`double altitude_at_position (std::tuple<double, double, double> position, ReferenceFrame reference_frame)`

The altitude, in meters, of the given position in the given reference frame.

Parameters

- **position** – Position as a vector.
- **reference_frame** – Reference frame for the position vector.

`double latitude_at_position (std::tuple<double, double, double> position, ReferenceFrame reference_frame)`

The latitude of the given position, in the given reference frame.

Parameters

- **position** – Position as a vector.
- **reference_frame** – Reference frame for the position vector.

`double longitude_at_position (std::tuple<double, double, double> position, ReferenceFrame reference_frame)`

The longitude of the given position, in the given reference frame.

Parameters

- **position** – Position as a vector.
- **reference_frame** – Reference frame for the position vector.

`float sphere_of_influence ()`

The radius of the sphere of influence of the body, in meters.

`bool has_atmosphere ()`

`true` if the body has an atmosphere.

float **atmosphere_depth** ()

The depth of the atmosphere, in meters.

double **atmospheric_density_at_position** (std::tuple<double, double, double> *position*, *ReferenceFrame reference_frame*)

The atmospheric density at the given position, in kg/m^3 , in the given reference frame.

Parameters

- **position** – The position vector at which to measure the density.
- **reference_frame** – Reference frame that the position vector is in.

bool **has_atmospheric_oxygen** ()

true if there is oxygen in the atmosphere, required for air-breathing engines.

double **temperature_at** (std::tuple<double, double, double> *position*, *ReferenceFrame reference_frame*)

The temperature on the body at the given position, in the given reference frame.

Parameters

- **position** – Position as a vector.
- **reference_frame** – The reference frame that the position is in.

Note: This calculation is performed using the bodies current position, which means that the value could be wrong if you want to know the temperature in the far future.

double **density_at** (double *altitude*)

Gets the air density, in kg/m^3 , for the specified altitude above sea level, in meters.

Parameters

Note: This is an approximation, because actual calculations, taking sun exposure into account to compute air temperature, require us to know the exact point on the body where the density is to be computed (knowing the altitude is not enough). However, the difference is small for high altitudes, so it makes very little difference for trajectory prediction.

double **pressure_at** (double *altitude*)

Gets the air pressure, in Pascals, for the specified altitude above sea level, in meters.

Parameters

std::set<std::string> **biomes** ()

The biomes present on this body.

std::string **biome_at** (double *latitude*, double *longitude*)

The biome at the given latitude and longitude, in degrees.

Parameters

float **flying_high_altitude_threshold** ()

The altitude, in meters, above which a vessel is considered to be flying “high” when doing science.

float **space_high_altitude_threshold** ()

The altitude, in meters, above which a vessel is considered to be in “high” space when doing science.

ReferenceFrame **reference_frame** ()

The reference frame that is fixed relative to the celestial body.

- The origin is at the center of the body.
- The axes rotate with the body.
- The x-axis points from the center of the body towards the intersection of the prime meridian and equator (the position at 0° longitude, 0° latitude).
- The y-axis points from the center of the body towards the north pole.
- The z-axis points from the center of the body towards the equator at 90° E longitude.

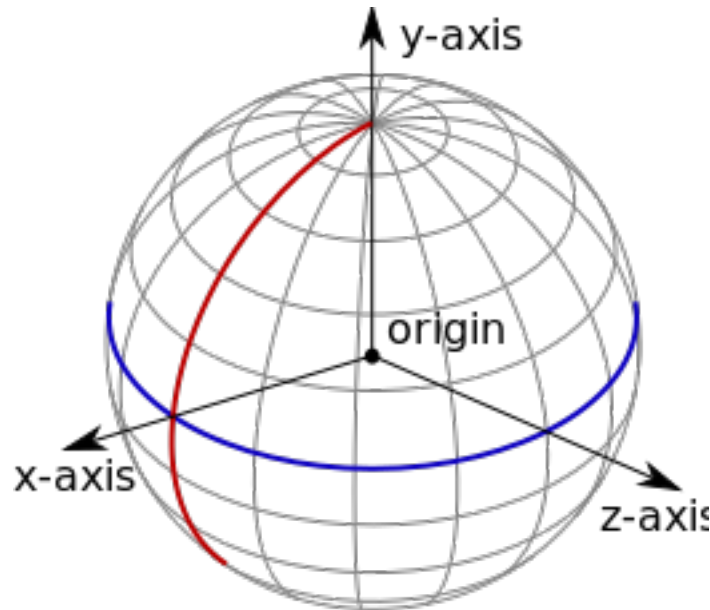


Fig. 5.6: Celestial body reference frame origin and axes. The equator is shown in blue, and the prime meridian in red.

ReferenceFrame **non_rotating_reference_frame** ()

The reference frame that is fixed relative to this celestial body, and orientated in a fixed direction (it does not rotate with the body).

- The origin is at the center of the body.
- The axes do not rotate.
- The x-axis points in an arbitrary direction through the equator.
- The y-axis points from the center of the body towards the north pole.
- The z-axis points in an arbitrary direction through the equator.

ReferenceFrame **orbital_reference_frame** ()

The reference frame that is fixed relative to this celestial body, but orientated with the body's orbital prograde/normal/radial directions.

- The origin is at the center of the body.
- The axes rotate with the orbital prograde/normal/radial directions.
- The x-axis points in the orbital anti-radial direction.
- The y-axis points in the orbital prograde direction.
- The z-axis points in the orbital normal direction.

`std::tuple<double, double, double> position (ReferenceFrame reference_frame)`

The position of the center of the body, in the specified reference frame.

Parameters

- **reference_frame** – The reference frame that the returned position vector is in.

Returns The position as a vector.

`std::tuple<double, double, double> velocity (ReferenceFrame reference_frame)`

The linear velocity of the body, in the specified reference frame.

Parameters

- **reference_frame** – The reference frame that the returned velocity vector is in.

Returns The velocity as a vector. The vector points in the direction of travel, and its magnitude is the speed of the body in meters per second.

`std::tuple<double, double, double, double> rotation (ReferenceFrame reference_frame)`

The rotation of the body, in the specified reference frame.

Parameters

- **reference_frame** – The reference frame that the returned rotation is in.

Returns The rotation as a quaternion of the form (x, y, z, w) .

`std::tuple<double, double, double> direction (ReferenceFrame reference_frame)`

The direction in which the north pole of the celestial body is pointing, in the specified reference frame.

Parameters

- **reference_frame** – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

`std::tuple<double, double, double> angular_velocity (ReferenceFrame reference_frame)`

The angular velocity of the body in the specified reference frame.

Parameters

- **reference_frame** – The reference frame the returned angular velocity is in.

Returns The angular velocity as a vector. The magnitude of the vector is the rotational speed of the body, in radians per second. The direction of the vector indicates the axis of rotation, using the right-hand rule.

5.3.4 Flight

class Flight

Used to get flight telemetry for a vessel, by calling `Vessel::flight()`. All of the information returned by this class is given in the reference frame passed to that method. Obtained by calling `Vessel::flight()`.

Note: To get orbital information, such as the apoapsis or inclination, see *Orbit*.

float **g_force**()

The current G force acting on the vessel in m/s^2 .

double **mean_altitude**()

The altitude above sea level, in meters. Measured from the center of mass of the vessel.

double **surface_altitude** ()

The altitude above the surface of the body or sea level, whichever is closer, in meters. Measured from the center of mass of the vessel.

double **bedrock_altitude** ()

The altitude above the surface of the body, in meters. When over water, this is the altitude above the sea floor. Measured from the center of mass of the vessel.

double **elevation** ()

The elevation of the terrain under the vessel, in meters. This is the height of the terrain above sea level, and is negative when the vessel is over the sea.

double **latitude** ()

The *latitude* of the vessel for the body being orbited, in degrees.

double **longitude** ()

The *longitude* of the vessel for the body being orbited, in degrees.

std::tuple<double, double, double> **velocity** ()

The velocity of the vessel, in the reference frame *ReferenceFrame*.

Returns The velocity as a vector. The vector points in the direction of travel, and its magnitude is the speed of the vessel in meters per second.

double **speed** ()

The speed of the vessel in meters per second, in the reference frame *ReferenceFrame*.

double **horizontal_speed** ()

The horizontal speed of the vessel in meters per second, in the reference frame *ReferenceFrame*.

double **vertical_speed** ()

The vertical speed of the vessel in meters per second, in the reference frame *ReferenceFrame*.

std::tuple<double, double, double> **center_of_mass** ()

The position of the center of mass of the vessel, in the reference frame *ReferenceFrame*

Returns The position as a vector.

std::tuple<double, double, double, double> **rotation** ()

The rotation of the vessel, in the reference frame *ReferenceFrame*

Returns The rotation as a quaternion of the form (x, y, z, w) .

std::tuple<double, double, double> **direction** ()

The direction that the vessel is pointing in, in the reference frame *ReferenceFrame*.

Returns The direction as a unit vector.

float **pitch** ()

The pitch of the vessel relative to the horizon, in degrees. A value between -90° and $+90^\circ$.

float **heading** ()

The heading of the vessel (its angle relative to north), in degrees. A value between 0° and 360° .

float **roll** ()

The roll of the vessel relative to the horizon, in degrees. A value between -180° and $+180^\circ$.

std::tuple<double, double, double> **prograde** ()

The prograde direction of the vessels orbit, in the reference frame *ReferenceFrame*.

Returns The direction as a unit vector.

std::tuple<double, double, double> **retrograde** ()

The retrograde direction of the vessels orbit, in the reference frame *ReferenceFrame*.

Returns The direction as a unit vector.

std::tuple<double, double, double> **normal** ()

The direction normal to the vessels orbit, in the reference frame *ReferenceFrame*.

Returns The direction as a unit vector.

std::tuple<double, double, double> **anti_normal** ()

The direction opposite to the normal of the vessels orbit, in the reference frame *ReferenceFrame*.

Returns The direction as a unit vector.

std::tuple<double, double, double> **radial** ()

The radial direction of the vessels orbit, in the reference frame *ReferenceFrame*.

Returns The direction as a unit vector.

std::tuple<double, double, double> **anti_radial** ()

The direction opposite to the radial direction of the vessels orbit, in the reference frame *ReferenceFrame*.

Returns The direction as a unit vector.

float **atmosphere_density** ()

The current density of the atmosphere around the vessel, in kg/m^3 .

float **dynamic_pressure** ()

The dynamic pressure acting on the vessel, in Pascals. This is a measure of the strength of the aerodynamic forces. It is equal to $\frac{1}{2} \cdot \text{air density} \cdot \text{velocity}^2$. It is commonly denoted Q .

float **static_pressure** ()

The static atmospheric pressure acting on the vessel, in Pascals.

float **static_pressure_at_msl** ()

The static atmospheric pressure at mean sea level, in Pascals.

std::tuple<double, double, double> **aerodynamic_force** ()

The total aerodynamic forces acting on the vessel, in reference frame *ReferenceFrame*.

Returns A vector pointing in the direction that the force acts, with its magnitude equal to the strength of the force in Newtons.

std::tuple<double, double, double> **simulate_aerodynamic_force_at** (*CelestialBody* *body*,
std::tuple<double, double, double> *position*,
std::tuple<double, double, double> *velocity*)

Simulate and return the total aerodynamic forces acting on the vessel, if it where to be traveling with the given velocity at the given position in the atmosphere of the given celestial body.

Parameters

Returns A vector pointing in the direction that the force acts, with its magnitude equal to the strength of the force in Newtons.

std::tuple<double, double, double> **lift** ()

The aerodynamic lift currently acting on the vessel.

Returns A vector pointing in the direction that the force acts, with its magnitude equal to the strength of the force in Newtons.

std::tuple<double, double, double> **drag** ()

The aerodynamic drag currently acting on the vessel.

Returns A vector pointing in the direction of the force, with its magnitude equal to the strength of the force in Newtons.

float **speed_of_sound** ()

The speed of sound, in the atmosphere around the vessel, in m/s .

float **mach** ()

The speed of the vessel, in multiples of the speed of sound.

float **reynolds_number** ()

The vessels Reynolds number.

Note: Requires [Ferram Aerospace Research](#).

float **true_air_speed** ()

The [true air speed](#) of the vessel, in meters per second.

float **equivalent_air_speed** ()

The [equivalent air speed](#) of the vessel, in meters per second.

float **terminal_velocity** ()

An estimate of the current terminal velocity of the vessel, in meters per second. This is the speed at which the drag forces cancel out the force of gravity.

float **angle_of_attack** ()

The pitch angle between the orientation of the vessel and its velocity vector, in degrees.

float **sideslip_angle** ()

The yaw angle between the orientation of the vessel and its velocity vector, in degrees.

float **total_air_temperature** ()

The [total air temperature](#) of the atmosphere around the vessel, in Kelvin. This includes the *Flight::static_air_temperature()* and the vessel's kinetic energy.

float **static_air_temperature** ()

The [static \(ambient\) temperature](#) of the atmosphere around the vessel, in Kelvin.

float **stall_fraction** ()

The current amount of stall, between 0 and 1. A value greater than 0.005 indicates a minor stall and a value greater than 0.5 indicates a large-scale stall.

Note: Requires [Ferram Aerospace Research](#).

float **drag_coefficient** ()

The coefficient of drag. This is the amount of drag produced by the vessel. It depends on air speed, air density and wing area.

Note: Requires [Ferram Aerospace Research](#).

float **lift_coefficient** ()

The coefficient of lift. This is the amount of lift produced by the vessel, and depends on air speed, air density and wing area.

Note: Requires [Ferram Aerospace Research](#).

float **ballistic_coefficient** ()
The ballistic coefficient.

Note: Requires [Ferram Aerospace Research](#).

float **thrust_specific_fuel_consumption** ()
The thrust specific fuel consumption for the jet engines on the vessel. This is a measure of the efficiency of the engines, with a lower value indicating a more efficient vessel. This value is the number of Newtons of fuel that are burned, per hour, to produce one newton of thrust.

Note: Requires [Ferram Aerospace Research](#).

5.3.5 Orbit

class Orbit

Describes an orbit. For example, the orbit of a vessel, obtained by calling *Vessel::orbit()*, or a celestial body, obtained by calling *CelestialBody::orbit()*.

CelestialBody **body** ()

The celestial body (e.g. planet or moon) around which the object is orbiting.

double **apoapsis** ()

Gets the apoapsis of the orbit, in meters, from the center of mass of the body being orbited.

Note: For the apoapsis altitude reported on the in-game map view, use *Orbit::apoapsis_altitude()*.

double **periapsis** ()

The periapsis of the orbit, in meters, from the center of mass of the body being orbited.

Note: For the periapsis altitude reported on the in-game map view, use *Orbit::periapsis_altitude()*.

double **apoapsis_altitude** ()

The apoapsis of the orbit, in meters, above the sea level of the body being orbited.

Note: This is equal to *Orbit::apoapsis()* minus the equatorial radius of the body.

double **periapsis_altitude** ()

The periapsis of the orbit, in meters, above the sea level of the body being orbited.

Note: This is equal to *Orbit::periapsis()* minus the equatorial radius of the body.

double **semi_major_axis** ()

The semi-major axis of the orbit, in meters.

double **semi_minor_axis** ()

The semi-minor axis of the orbit, in meters.

double **radius** ()

The current radius of the orbit, in meters. This is the distance between the center of mass of the object in orbit, and the center of mass of the body around which it is orbiting.

Note: This value will change over time if the orbit is elliptical.

double **radius_at** (double *ut*)

The orbital radius at the given time, in meters.

Parameters

- **ut** – The universal time to measure the radius at.

std::tuple<double, double, double> **position_at** (double *ut*, *ReferenceFrame reference_frame*)

The position at a given time, in the specified reference frame.

Parameters

- **ut** – The universal time to measure the position at.
- **reference_frame** – The reference frame that the returned position vector is in.

Returns The position as a vector.

double **speed** ()

The current orbital speed of the object in meters per second.

Note: This value will change over time if the orbit is elliptical.

double **period** ()

The orbital period, in seconds.

double **time_to_apoapsis** ()

The time until the object reaches apoapsis, in seconds.

double **time_to_periapsis** ()

The time until the object reaches periapsis, in seconds.

double **eccentricity** ()

The *eccentricity* of the orbit.

double **inclination** ()

The *inclination* of the orbit, in radians.

double **longitude_of_ascending_node** ()

The *longitude of the ascending node*, in radians.

double **argument_of_periapsis** ()

The *argument of periapsis*, in radians.

double **mean_anomaly_at_epoch** ()

The *mean anomaly at epoch*.

double **epoch** ()

The time since the epoch (the point at which the *mean anomaly at epoch* was measured, in seconds.

double **mean_anomaly** ()

The *mean anomaly*.

double **mean_anomaly_at_ut** (double *ut*)

The mean anomaly at the given time.

Parameters

- **ut** – The universal time in seconds.

double **eccentric_anomaly** ()

The *eccentric anomaly*.

double **eccentric_anomaly_at_ut** (double *ut*)

The eccentric anomaly at the given universal time.

Parameters

- **ut** – The universal time, in seconds.

double **true_anomaly** ()

The *true anomaly*.

double **true_anomaly_at_ut** (double *ut*)

The true anomaly at the given time.

Parameters

- **ut** – The universal time in seconds.

double **true_anomaly_at_radius** (double *radius*)

The true anomaly at the given orbital radius.

Parameters

- **radius** – The orbital radius in meters.

double **ut_at_true_anomaly** (double *true_anomaly*)

The universal time, in seconds, corresponding to the given true anomaly.

Parameters

- **true_anomaly** – True anomaly.

double **radius_at_true_anomaly** (double *true_anomaly*)

The orbital radius at the point in the orbit given by the true anomaly.

Parameters

- **true_anomaly** – The true anomaly.

double **true_anomaly_at_an** (*Vessel target*)

The true anomaly of the ascending node with the given target vessel.

Parameters

- **target** – Target vessel.

double **true_anomaly_at_dn** (*Vessel target*)

The true anomaly of the descending node with the given target vessel.

Parameters

- **target** – Target vessel.

double **orbital_speed** ()

The current orbital speed in meters per second.

double **orbital_speed_at** (double *time*)

The orbital speed at the given time, in meters per second.

Parameters

- **time** – Time from now, in seconds.

static std::tuple<double, double, double> **reference_plane_normal** (*Client* &connection,
ReferenceFrame refer-
ence_frame)

The direction that is normal to the orbits reference plane, in the given reference frame. The reference plane is the plane from which the orbits inclination is measured.

Parameters

- **reference_frame** – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

static std::tuple<double, double, double> **reference_plane_direction** (*Client* &connection,
ReferenceFrame ref-
erence_frame)

The direction from which the orbits longitude of ascending node is measured, in the given reference frame.

Parameters

- **reference_frame** – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

double **relative_inclination** (*Vessel target*)

Relative inclination of this orbit and the orbit of the given target vessel, in radians.

Parameters

- **target** – Target vessel.

double **time_to_soi_change** ()

The time until the object changes sphere of influence, in seconds. Returns NaN if the object is not going to change sphere of influence.

Orbit **next_orbit** ()

If the object is going to change sphere of influence in the future, returns the new orbit after the change. Otherwise returns NULL.

double **time_of_closest_approach** (*Vessel target*)

Estimates and returns the time at closest approach to a target vessel.

Parameters

- **target** – Target vessel.

Returns The universal time at closest approach, in seconds.

double **distance_at_closest_approach** (*Vessel target*)

Estimates and returns the distance at closest approach to a target vessel, in meters.

Parameters

- **target** – Target vessel.

std::vector<std::vector<double>> **list_closest_approaches** (*Vessel target*, int32_t orbits)

Returns the times at closest approach and corresponding distances, to a target vessel.

Parameters

- **target** – Target vessel.
- **orbits** – The number of future orbits to search.

Returns A list of two lists. The first is a list of times at closest approach, as universal times in seconds. The second is a list of corresponding distances at closest approach, in meters.

5.3.6 Control

class Control

Used to manipulate the controls of a vessel. This includes adjusting the throttle, enabling/disabling systems such as SAS and RCS, or altering the direction in which the vessel is pointing. Obtained by calling `Vessel::control()`.

Note: Control inputs (such as pitch, yaw and roll) are zeroed when all clients that have set one or more of these inputs are no longer connected.

ControlSource **source** ()

The source of the vessels control, for example by a kerbal or a probe core.

ControlState **state** ()

The control state of the vessel.

bool **sas** ()

void **set_sas** (bool *value*)

The state of SAS.

Note: Equivalent to `AutoPilot::sas()`

SASMode **sas_mode** ()

void **set_sas_mode** (*SASMode value*)

The current *SASMode*. These modes are equivalent to the mode buttons to the left of the navball that appear when SAS is enabled.

Note: Equivalent to `AutoPilot::sas_mode()`

SpeedMode **speed_mode** ()

void **set_speed_mode** (*SpeedMode value*)

The current *SpeedMode* of the navball. This is the mode displayed next to the speed at the top of the navball.

bool **rcs** ()

void **set_rcs** (bool *value*)

The state of RCS.

bool **reaction_wheels** ()

void **set_reaction_wheels** (bool *value*)

Returns whether all reactive wheels on the vessel are active, and sets the active state of all reaction wheels. See `ReactionWheel::active()`.

bool **gear** ()

void **set_gear** (bool *value*)

The state of the landing gear/legs.

bool **legs** ()

void **set_legs** (bool *value*)
Returns whether all landing legs on the vessel are deployed, and sets the deployment state of all landing legs. Does not include wheels (for example landing gear). See *Leg::deployed()*.

bool **wheels** ()

void **set_wheels** (bool *value*)
Returns whether all wheels on the vessel are deployed, and sets the deployment state of all wheels. Does not include landing legs. See *Wheel::deployed()*.

bool **lights** ()

void **set_lights** (bool *value*)
The state of the lights.

bool **brakes** ()

void **set_brakes** (bool *value*)
The state of the wheel brakes.

bool **antennas** ()

void **set_antennas** (bool *value*)
Returns whether all antennas on the vessel are deployed, and sets the deployment state of all antennas. See *Antenna::deployed()*.

bool **cargo_bays** ()

void **set_cargo_bays** (bool *value*)
Returns whether any of the cargo bays on the vessel are open, and sets the open state of all cargo bays. See *CargoBay::open()*.

bool **intakes** ()

void **set_intakes** (bool *value*)
Returns whether all of the air intakes on the vessel are open, and sets the open state of all air intakes. See *Intake::open()*.

bool **parachutes** ()

void **set_parachutes** (bool *value*)
Returns whether all parachutes on the vessel are deployed, and sets the deployment state of all parachutes. Cannot be set to *false*. See *Parachute::deployed()*.

bool **radiators** ()

void **set_radiators** (bool *value*)
Returns whether all radiators on the vessel are deployed, and sets the deployment state of all radiators. See *Radiator::deployed()*.

bool **resource_harvesters** ()

void **set_resource_harvesters** (bool *value*)
Returns whether all of the resource harvesters on the vessel are deployed, and sets the deployment state of all resource harvesters. See *ResourceHarvester::deployed()*.

bool **resource_harvesters_active** ()

void **set_resource_harvesters_active** (bool *value*)
Returns whether any of the resource harvesters on the vessel are active, and sets the active state of all resource harvesters. See *ResourceHarvester::active()*.

bool **solar_panels** ()

void **set_solar_panels** (bool *value*)
Returns whether all solar panels on the vessel are deployed, and sets the deployment state of all solar panels. See *SolarPanel::deployed()*.

bool **abort** ()

void **set_abort** (bool *value*)
The state of the abort action group.

float **throttle** ()

void **set_throttle** (float *value*)
The state of the throttle. A value between 0 and 1.

ControlInputMode **input_mode** ()

void **set_input_mode** (*ControlInputMode* *value*)
Sets the behavior of the pitch, yaw, roll and translation control inputs. When set to additive, these inputs are added to the vessels current inputs. This mode is the default. When set to override, these inputs (if non-zero) override the vessels inputs. This mode prevents keyboard control, or SAS, from interfering with the controls when they are set.

float **pitch** ()

void **set_pitch** (float *value*)
The state of the pitch control. A value between -1 and 1. Equivalent to the w and s keys.

float **yaw** ()

void **set_yaw** (float *value*)
The state of the yaw control. A value between -1 and 1. Equivalent to the a and d keys.

float **roll** ()

void **set_roll** (float *value*)
The state of the roll control. A value between -1 and 1. Equivalent to the q and e keys.

float **forward** ()

void **set_forward** (float *value*)
The state of the forward translational control. A value between -1 and 1. Equivalent to the h and n keys.

float **up** ()

void **set_up** (float *value*)
The state of the up translational control. A value between -1 and 1. Equivalent to the i and k keys.

float **right** ()

void **set_right** (float *value*)
The state of the right translational control. A value between -1 and 1. Equivalent to the j and l keys.

float **wheel_throttle** ()

void **set_wheel_throttle** (float *value*)
The state of the wheel throttle. A value between -1 and 1. A value of 1 rotates the wheels forwards, a value of -1 rotates the wheels backwards.

float **wheel_steering** ()

void **set_wheel_steering** (float *value*)
The state of the wheel steering. A value between -1 and 1. A value of 1 steers to the left, and a value of -1 steers to the right.

`int32_t current_stage ()`

The current stage of the vessel. Corresponds to the stage number in the in-game UI.

`std::vector<Vessel> activate_next_stage ()`

Activates the next stage. Equivalent to pressing the space bar in-game.

Returns A list of vessel objects that are jettisoned from the active vessel.

Note: When called, the active vessel may change. It is therefore possible that, after calling this function, the object(s) returned by previous call(s) to `active_vessel ()` no longer refer to the active vessel.

`bool get_action_group (uint32_t group)`

Returns `true` if the given action group is enabled.

Parameters

- **group** – A number between 0 and 9 inclusive, or between 0 and 250 inclusive when the [Extended Action Groups mod](#) is installed.

`void set_action_group (uint32_t group, bool state)`

Sets the state of the given action group.

Parameters

- **group** – A number between 0 and 9 inclusive, or between 0 and 250 inclusive when the [Extended Action Groups mod](#) is installed.

`void toggle_action_group (uint32_t group)`

Toggles the state of the given action group.

Parameters

- **group** – A number between 0 and 9 inclusive, or between 0 and 250 inclusive when the [Extended Action Groups mod](#) is installed.

Node `add_node (double ut, float prograde = 0.0, float normal = 0.0, float radial = 0.0)`

Creates a maneuver node at the given universal time, and returns a *Node* object that can be used to modify it. Optionally sets the magnitude of the delta-v for the maneuver node in the prograde, normal and radial directions.

Parameters

- **ut** – Universal time of the maneuver node.
- **prograde** – Delta-v in the prograde direction.
- **normal** – Delta-v in the normal direction.
- **radial** – Delta-v in the radial direction.

`std::vector<Node> nodes ()`

Returns a list of all existing maneuver nodes, ordered by time from first to last.

`void remove_nodes ()`

Remove all maneuver nodes.

`enum struct ControlState`

The control state of a vessel. See `Control::state ()`.

`enumerator full`

Full controllable.

enumerator partial

Partially controllable.

enumerator none

Not controllable.

enum struct ControlSourceThe control source of a vessel. See *Control::source()*.**enumerator kerbal**

Vessel is controlled by a Kerbal.

enumerator probe

Vessel is controlled by a probe core.

enumerator none

Vessel is not controlled.

enum struct SASModeThe behavior of the SAS auto-pilot. See *AutoPilot::sas_mode()*.**enumerator stability_assist**

Stability assist mode. Dampen out any rotation.

enumerator maneuver

Point in the burn direction of the next maneuver node.

enumerator prograde

Point in the prograde direction.

enumerator retrograde

Point in the retrograde direction.

enumerator normal

Point in the orbit normal direction.

enumerator anti_normal

Point in the orbit anti-normal direction.

enumerator radial

Point in the orbit radial direction.

enumerator anti_radial

Point in the orbit anti-radial direction.

enumerator target

Point in the direction of the current target.

enumerator anti_target

Point away from the current target.

enum struct SpeedModeThe mode of the speed reported in the navball. See *Control::speed_mode()*.**enumerator orbit**

Speed is relative to the vessel's orbit.

enumerator surface

Speed is relative to the surface of the body being orbited.

enumerator target

Speed is relative to the current target.

enum struct ControlInputMode

See *Control::input_mode()*.

enumerator additive

Control inputs are added to the vessels current control inputs.

enumerator override

Control inputs (when they are non-zero) override the vessels current control inputs.

5.3.7 Communications

class Comms

Used to interact with CommNet for a given vessel. Obtained by calling *Vessel::comms()*.

bool **can_communicate**()

Whether the vessel can communicate with KSC.

bool **can_transmit_science**()

Whether the vessel can transmit science data to KSC.

double **signal_strength**()

Signal strength to KSC.

double **signal_delay**()

Signal delay to KSC in seconds.

double **power**()

The combined power of all active antennae on the vessel.

std::vector<CommLink> **control_path**()

The communication path used to control the vessel.

class CommLink

Represents a communication node in the network. For example, a vessel or the KSC.

CommLinkType **type**()

The type of link.

double **signal_strength**()

Signal strength of the link.

CommNode **start**()

Start point of the link.

CommNode **end**()

Start point of the link.

enum struct CommLinkType

The type of a communication link. See *CommLink::type()*.

enumerator home

Link is to a base station on Kerbin.

enumerator control

Link is to a control source, for example a manned spacecraft.

enumerator relay

Link is to a relay satellite.

class CommNode

Represents a communication node in the network. For example, a vessel or the KSC.

std::string **name** ()
 Name of the communication node.

bool **is_home** ()
 Whether the communication node is on Kerbin.

bool **is_control_point** ()
 Whether the communication node is a control point, for example a manned vessel.

bool **is_vessel** ()
 Whether the communication node is a vessel.

Vessel **vessel** ()
 The vessel for this communication node.

5.3.8 Parts

The following classes allow interaction with a vessels individual parts.

- *Parts*
- *Part*
- *Module*
- *Specific Types of Part*
 - *Antenna*
 - *Cargo Bay*
 - *Control Surface*
 - *Decoupler*
 - *Docking Port*
 - *Engine*
 - *Experiment*
 - *Fairing*
 - *Intake*
 - *Leg*
 - *Launch Clamp*
 - *Light*
 - *Parachute*
 - *Radiator*
 - *Resource Converter*
 - *Resource Harvester*
 - *Reaction Wheel*
 - *RCS*
 - *Sensor*

- *Solar Panel*
 - *Thruster*
 - *Wheel*
- *Trees of Parts*
 - *Traversing the Tree*
 - *Attachment Modes*
- *Fuel Lines*
- *Staging*

Parts

class Parts

Instances of this class are used to interact with the parts of a vessel. An instance can be obtained by calling `Vessel::parts()`.

`std::vector<Part> all()`

A list of all of the vessels parts.

`Part root()`

The vessels root part.

Note: See the discussion on *Trees of Parts*.

`Part controlling()`

`void set_controlling(Part value)`

The part from which the vessel is controlled.

`std::vector<Part> with_name(std::string name)`

A list of parts whose `Part::name()` is *name*.

Parameters

`std::vector<Part> with_title(std::string title)`

A list of all parts whose `Part::title()` is *title*.

Parameters

`std::vector<Part> with_tag(std::string tag)`

A list of all parts whose `Part::tag()` is *tag*.

Parameters

`std::vector<Part> with_module(std::string module_name)`

A list of all parts that contain a *Module* whose `Module::name()` is *module_name*.

Parameters

`std::vector<Part> in_stage(int32_t stage)`

A list of all parts that are activated in the given *stage*.

Parameters

Note: See the discussion on *Staging*.

`std::vector<Part> in_decouple_stage (int32_t stage)`
 A list of all parts that are decoupled in the given *stage*.

Parameters

Note: See the discussion on *Staging*.

`std::vector<Module> modules_with_name (std::string module_name)`
 A list of modules (combined across all parts in the vessel) whose `Module::name()` is *module_name*.

Parameters

`std::vector<Antenna> antennas ()`
 A list of all antennas in the vessel.

`std::vector<CargoBay> cargo_bays ()`
 A list of all cargo bays in the vessel.

`std::vector<ControlSurface> control_surfaces ()`
 A list of all control surfaces in the vessel.

`std::vector<Decoupler> decouplers ()`
 A list of all decouplers in the vessel.

`std::vector<DockingPort> docking_ports ()`
 A list of all docking ports in the vessel.

`std::vector<Engine> engines ()`
 A list of all engines in the vessel.

Note: This includes any part that generates thrust. This covers many different types of engine, including liquid fuel rockets, solid rocket boosters, jet engines and RCS thrusters.

`std::vector<Experiment> experiments ()`
 A list of all science experiments in the vessel.

`std::vector<Fairing> fairings ()`
 A list of all fairings in the vessel.

`std::vector<Intake> intakes ()`
 A list of all intakes in the vessel.

`std::vector<Leg> legs ()`
 A list of all landing legs attached to the vessel.

`std::vector<LaunchClamp> launch_clamps ()`
 A list of all launch clamps attached to the vessel.

`std::vector<Light> lights ()`
 A list of all lights in the vessel.

`std::vector<Parachute> parachutes ()`
 A list of all parachutes in the vessel.

`std::vector<Radiator> radiators ()`
 A list of all radiators in the vessel.

`std::vector<RCS> rcs ()`
A list of all RCS blocks/thrusters in the vessel.

`std::vector<ReactionWheel> reaction_wheels ()`
A list of all reaction wheels in the vessel.

`std::vector<ResourceConverter> resource_converters ()`
A list of all resource converters in the vessel.

`std::vector<ResourceHarvester> resource_harvesters ()`
A list of all resource harvesters in the vessel.

`std::vector<Sensor> sensors ()`
A list of all sensors in the vessel.

`std::vector<SolarPanel> solar_panels ()`
A list of all solar panels in the vessel.

`std::vector<Wheel> wheels ()`
A list of all wheels in the vessel.

Part

class Part

Represents an individual part. Vessels are made up of multiple parts. Instances of this class can be obtained by several methods in *Parts*.

`std::string name ()`
Internal name of the part, as used in [part cfg files](#). For example “Mark1-2Pod”.

`std::string title ()`
Title of the part, as shown when the part is right clicked in-game. For example “Mk1-2 Command Pod”.

`std::string tag ()`

`void set_tag (std::string value)`
The name tag for the part. Can be set to a custom string using the in-game user interface.

Note: This requires either the [NameTag](#) or [kOS](#) mod to be installed.

`bool highlighted ()`

`void set_highlighted (bool value)`
Whether the part is highlighted.

`std::tuple<double, double, double> highlight_color ()`

`void set_highlight_color (std::tuple<double, double, double> value)`
The color used to highlight the part, as an RGB triple.

`double cost ()`
The cost of the part, in units of funds.

`Vessel vessel ()`
The vessel that contains this part.

`Part parent ()`
The parts parent. Returns NULL if the part does not have a parent. This, in combination with `Part::children()`, can be used to traverse the vessels parts tree.

Note: See the discussion on *Trees of Parts*.

std::vector<Part> **children** ()

The parts children. Returns an empty list if the part has no children. This, in combination with `Part::parent()`, can be used to traverse the vessels parts tree.

Note: See the discussion on *Trees of Parts*.

bool **axially_attached** ()

Whether the part is axially attached to its parent, i.e. on the top or bottom of its parent. If the part has no parent, returns `false`.

Note: See the discussion on *Attachment Modes*.

bool **radially_attached** ()

Whether the part is radially attached to its parent, i.e. on the side of its parent. If the part has no parent, returns `false`.

Note: See the discussion on *Attachment Modes*.

int32_t **stage** ()

The stage in which this part will be activated. Returns -1 if the part is not activated by staging.

Note: See the discussion on *Staging*.

int32_t **decouple_stage** ()

The stage in which this part will be decoupled. Returns -1 if the part is never decoupled from the vessel.

Note: See the discussion on *Staging*.

bool **massless** ()

Whether the part is `massless`.

double **mass** ()

The current mass of the part, including resources it contains, in kilograms. Returns zero if the part is massless.

double **dry_mass** ()

The mass of the part, not including any resources it contains, in kilograms. Returns zero if the part is massless.

bool **shielded** ()

Whether the part is shielded from the exterior of the vessel, for example by a fairing.

float **dynamic_pressure** ()

The dynamic pressure acting on the part, in Pascals.

double **impact_tolerance** ()

The impact tolerance of the part, in meters per second.

double **temperature** ()
Temperature of the part, in Kelvin.

double **skin_temperature** ()
Temperature of the skin of the part, in Kelvin.

double **max_temperature** ()
Maximum temperature that the part can survive, in Kelvin.

double **max_skin_temperature** ()
Maximum temperature that the skin of the part can survive, in Kelvin.

float **thermal_mass** ()
A measure of how much energy it takes to increase the internal temperature of the part, in Joules per Kelvin.

float **thermal_skin_mass** ()
A measure of how much energy it takes to increase the skin temperature of the part, in Joules per Kelvin.

float **thermal_resource_mass** ()
A measure of how much energy it takes to increase the temperature of the resources contained in the part, in Joules per Kelvin.

float **thermal_conduction_flux** ()
The rate at which heat energy is conducting into or out of the part via contact with other parts. Measured in energy per unit time, or power, in Watts. A positive value means the part is gaining heat energy, and negative means it is losing heat energy.

float **thermal_convection_flux** ()
The rate at which heat energy is convecting into or out of the part from the surrounding atmosphere. Measured in energy per unit time, or power, in Watts. A positive value means the part is gaining heat energy, and negative means it is losing heat energy.

float **thermal_radiation_flux** ()
The rate at which heat energy is radiating into or out of the part from the surrounding environment. Measured in energy per unit time, or power, in Watts. A positive value means the part is gaining heat energy, and negative means it is losing heat energy.

float **thermal_internal_flux** ()
The rate at which heat energy is begin generated by the part. For example, some engines generate heat by combusting fuel. Measured in energy per unit time, or power, in Watts. A positive value means the part is gaining heat energy, and negative means it is losing heat energy.

float **thermal_skin_to_internal_flux** ()
The rate at which heat energy is transferring between the part's skin and its internals. Measured in energy per unit time, or power, in Watts. A positive value means the part's internals are gaining heat energy, and negative means its skin is gaining heat energy.

Resources **resources** ()
A *Resources* object for the part.

bool **crossfeed** ()
Whether this part is crossfeed capable.

bool **is_fuel_line** ()
Whether this part is a fuel line.

std::vector<Part> **fuel_lines_from** ()
The parts that are connected to this part via fuel lines, where the direction of the fuel line is into this part.

Note: See the discussion on *Fuel Lines*.

`std::vector<Part> fuel_lines_to ()`

The parts that are connected to this part via fuel lines, where the direction of the fuel line is out of this part.

Note: See the discussion on *Fuel Lines*.

`std::vector<Module> modules ()`

The modules for this part.

Antenna **antenna** ()

A *Antenna* if the part is an antenna, otherwise NULL.

CargoBay **cargo_bay** ()

A *CargoBay* if the part is a cargo bay, otherwise NULL.

ControlSurface **control_surface** ()

A *ControlSurface* if the part is an aerodynamic control surface, otherwise NULL.

Decoupler **decoupler** ()

A *Decoupler* if the part is a decoupler, otherwise NULL.

DockingPort **docking_port** ()

A *DockingPort* if the part is a docking port, otherwise NULL.

Engine **engine** ()

An *Engine* if the part is an engine, otherwise NULL.

Experiment **experiment** ()

An *Experiment* if the part is a science experiment, otherwise NULL.

Fairing **fairing** ()

A *Fairing* if the part is a fairing, otherwise NULL.

Intake **intake** ()

An *Intake* if the part is an intake, otherwise NULL.

Note: This includes any part that generates thrust. This covers many different types of engine, including liquid fuel rockets, solid rocket boosters and jet engines. For RCS thrusters see *RCS*.

Leg **leg** ()

A *Leg* if the part is a landing leg, otherwise NULL.

LaunchClamp **launch_clamp** ()

A *LaunchClamp* if the part is a launch clamp, otherwise NULL.

Light **light** ()

A *Light* if the part is a light, otherwise NULL.

Parachute **parachute** ()

A *Parachute* if the part is a parachute, otherwise NULL.

Radiator **radiator** ()

A *Radiator* if the part is a radiator, otherwise NULL.

RCS **racs** ()

A *RCS* if the part is an RCS block/thruster, otherwise NULL.

ReactionWheel **reaction_wheel** ()

A *ReactionWheel* if the part is a reaction wheel, otherwise NULL.

ResourceConverter **resource_converter** ()

A *ResourceConverter* if the part is a resource converter, otherwise NULL.

ResourceHarvester **resource_harvester** ()

A *ResourceHarvester* if the part is a resource harvester, otherwise NULL.

Sensor **sensor** ()

A *Sensor* if the part is a sensor, otherwise NULL.

SolarPanel **solar_panel** ()

A *SolarPanel* if the part is a solar panel, otherwise NULL.

Wheel **wheel** ()

A *Wheel* if the part is a wheel, otherwise NULL.

std::tuple<double, double, double> **position** (*ReferenceFrame* *reference_frame*)

The position of the part in the given reference frame.

Parameters

- **reference_frame** – The reference frame that the returned position vector is in.

Returns The position as a vector.

Note: This is a fixed position in the part, defined by the parts model. It is not necessarily the same as the parts center of mass. Use *Part::center_of_mass* () to get the parts center of mass.

std::tuple<double, double, double> **center_of_mass** (*ReferenceFrame* *reference_frame*)

The position of the parts center of mass in the given reference frame. If the part is physicsless, this is equivalent to *Part::position* ().

Parameters

- **reference_frame** – The reference frame that the returned position vector is in.

Returns The position as a vector.

std::tuple<std::tuple<double, double, double>, std::tuple<double, double, double>> **bounding_box** (*ReferenceFrame* *reference_frame*)

The axis-aligned bounding box of the part in the given reference frame.

Parameters

- **reference_frame** – The reference frame that the returned position vectors are in.

Returns The positions of the minimum and maximum vertices of the box, as position vectors.

Note: This is computed from the collision mesh of the part. If the part is not collidable, the box has zero volume and is centered on the *Part::position* () of the part.

std::tuple<double, double, double> **direction** (*ReferenceFrame* *reference_frame*)

The direction the part points in, in the given reference frame.

Parameters

- **reference_frame** – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

`std::tuple<double, double, double> velocity (ReferenceFrame reference_frame)`
 The linear velocity of the part in the given reference frame.

Parameters

- **reference_frame** – The reference frame that the returned velocity vector is in.

Returns The velocity as a vector. The vector points in the direction of travel, and its magnitude is the speed of the body in meters per second.

`std::tuple<double, double, double, double> rotation (ReferenceFrame reference_frame)`
 The rotation of the part, in the given reference frame.

Parameters

- **reference_frame** – The reference frame that the returned rotation is in.

Returns The rotation as a quaternion of the form (x, y, z, w) .

`std::tuple<double, double, double> moment_of_inertia ()`
 The moment of inertia of the part in $kg.m^2$ around its center of mass in the parts reference frame (*ReferenceFrame*).

`std::vector<double> inertia_tensor ()`
 The inertia tensor of the part in the parts reference frame (*ReferenceFrame*). Returns the 3x3 matrix as a list of elements, in row-major order.

ReferenceFrame **reference_frame** ()

The reference frame that is fixed relative to this part, and centered on a fixed position within the part, defined by the parts model.

- The origin is at the position of the part, as returned by *Part::position()*.
- The axes rotate with the part.
- The x, y and z axis directions depend on the design of the part.

Note: For docking port parts, this reference frame is not necessarily equivalent to the reference frame for the docking port, returned by *DockingPort::reference_frame()*.

ReferenceFrame **center_of_mass_reference_frame** ()

The reference frame that is fixed relative to this part, and centered on its center of mass.

- The origin is at the center of mass of the part, as returned by *Part::center_of_mass()*.
- The axes rotate with the part.
- The x, y and z axis directions depend on the design of the part.

Note: For docking port parts, this reference frame is not necessarily equivalent to the reference frame for the docking port, returned by *DockingPort::reference_frame()*.

Force **add_force** (`std::tuple<double, double, double> force`, `std::tuple<double, double, double> position`, *ReferenceFrame reference_frame*)

Exert a constant force on the part, acting at the given position.

Parameters

- **force** – A vector pointing in the direction that the force acts, with its magnitude equal to the strength of the force in Newtons.

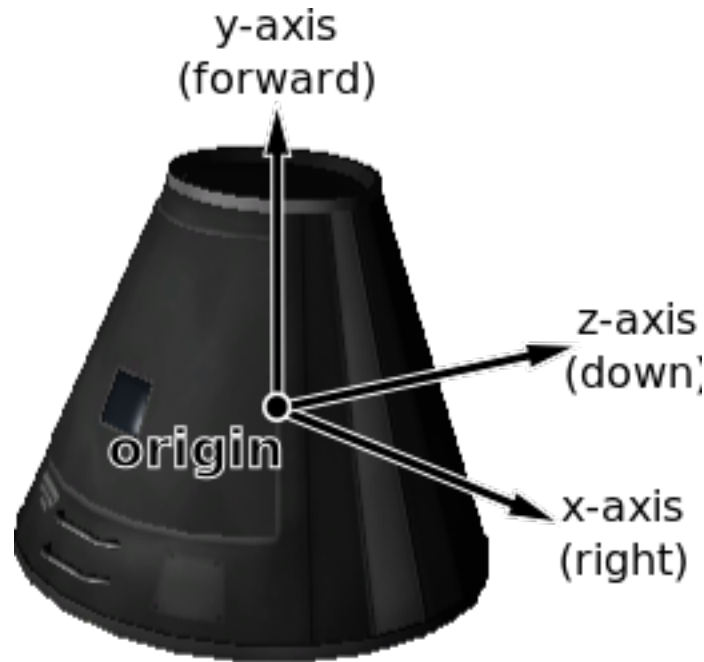


Fig. 5.7: Mk1 Command Pod reference frame origin and axes

- **position** – The position at which the force acts, as a vector.
- **reference_frame** – The reference frame that the force and position are in.

Returns An object that can be used to remove or modify the force.

void **instantaneous_force** (std::tuple<double, double, double> *force*, std::tuple<double, double, double> *position*, *ReferenceFrame* *reference_frame*)
Exert an instantaneous force on the part, acting at the given position.

Parameters

- **force** – A vector pointing in the direction that the force acts, with its magnitude equal to the strength of the force in Newtons.
- **position** – The position at which the force acts, as a vector.
- **reference_frame** – The reference frame that the force and position are in.

Note: The force is applied instantaneously in a single physics update.

class Force

Obtained by calling *Part::add_force()*.

Part **part** ()

The part that this force is applied to.

std::tuple<double, double, double> **force_vector** ()

void **set_force_vector** (std::tuple<double, double, double> *value*)

The force vector, in Newtons.

Returns A vector pointing in the direction that the force acts, with its magnitude equal to the strength of the force in Newtons.

```
std::tuple<double, double, double> position ()
```

void **set_position** (std::tuple<double, double, double> *value*)
 The position at which the force acts, in reference frame *ReferenceFrame*.

Returns The position as a vector.

```
ReferenceFrame reference_frame ()
```

void **set_reference_frame** (*ReferenceFrame value*)
 The reference frame of the force vector and position.

void **remove** ()
 Remove the force.

Module

class Module

This can be used to interact with a specific part module. This includes part modules in stock KSP, and those added by mods.

In KSP, each part has zero or more [PartModules](#) associated with it. Each one contains some of the functionality of the part. For example, an engine has a “ModuleEngines” part module that contains all the functionality of an engine.

```
std::string name ()
```

Name of the PartModule. For example, “ModuleEngines”.

```
Part part ()
```

The part that contains this module.

```
std::map<std::string, std::string> fields ()
```

The modules field names and their associated values, as a dictionary. These are the values visible in the right-click menu of the part.

```
bool has_field (std::string name)
```

Returns `true` if the module has a field with the given name.

Parameters

- **name** – Name of the field.

```
std::string get_field (std::string name)
```

Returns the value of a field.

Parameters

- **name** – Name of the field.

```
void set_field_int (std::string name, int32_t value)
```

Set the value of a field to the given integer number.

Parameters

- **name** – Name of the field.
- **value** – Value to set.

```
void set_field_float (std::string name, float value)
```

Set the value of a field to the given floating point number.

Parameters

- **name** – Name of the field.

- **value** – Value to set.

void **set_field_string** (std::string *name*, std::string *value*)
Set the value of a field to the given string.

Parameters

- **name** – Name of the field.
- **value** – Value to set.

void **reset_field** (std::string *name*)
Set the value of a field to its original value.

Parameters

- **name** – Name of the field.

std::vector<std::string> **events** ()
A list of the names of all of the modules events. Events are the clickable buttons visible in the right-click menu of the part.

bool **has_event** (std::string *name*)
`true` if the module has an event with the given name.

Parameters

void **trigger_event** (std::string *name*)
Trigger the named event. Equivalent to clicking the button in the right-click menu of the part.

Parameters

std::vector<std::string> **actions** ()
A list of all the names of the modules actions. These are the parts actions that can be assigned to action groups in the in-game editor.

bool **has_action** (std::string *name*)
`true` if the part has an action with the given name.

Parameters

void **set_action** (std::string *name*, bool *value* = true)
Set the value of an action with the given name.

Parameters

Specific Types of Part

The following classes provide functionality for specific types of part.

- *Antenna*
- *Cargo Bay*
- *Control Surface*
- *Decoupler*
- *Docking Port*
- *Engine*
- *Experiment*

- *Fairing*
- *Intake*
- *Leg*
- *Launch Clamp*
- *Light*
- *Parachute*
- *Radiator*
- *Resource Converter*
- *Resource Harvester*
- *Reaction Wheel*
- *RCS*
- *Sensor*
- *Solar Panel*
- *Thruster*
- *Wheel*

Antenna

class Antenna

An antenna. Obtained by calling *Part::antenna()*.

Part **part** ()

The part object for this antenna.

AntennaState **state** ()

The current state of the antenna.

bool **deployable** ()

Whether the antenna is deployable.

bool **deployed** ()

void **set_deployed** (bool *value*)

Whether the antenna is deployed.

Note: Fixed antennas are always deployed. Returns an error if you try to deploy a fixed antenna.

bool **can_transmit** ()

Whether data can be transmitted by this antenna.

void **transmit** ()

Transmit data.

void **cancel** ()

Cancel current transmission of data.

bool **allow_partial** ()

void **set_allow_partial** (bool *value*)

Whether partial data transmission is permitted.

double **power** ()

The power of the antenna.

bool **combinable** ()

Whether the antenna can be combined with other antennae on the vessel to boost the power.

double **combinable_exponent** ()

Exponent used to calculate the combined power of multiple antennae on a vessel.

float **packet_interval** ()

Interval between sending packets in seconds.

float **packet_size** ()

Amount of data sent per packet in Mits.

double **packet_resource_cost** ()

Units of electric charge consumed per packet sent.

enum struct AntennaState

The state of an antenna. See *Antenna::state()*.

enumerator deployed

Antenna is fully deployed.

enumerator retracted

Antenna is fully retracted.

enumerator deploying

Antenna is being deployed.

enumerator retracting

Antenna is being retracted.

enumerator broken

Antenna is broken.

Cargo Bay

class CargoBay

A cargo bay. Obtained by calling *Part::cargo_bay()*.

Part **part** ()

The part object for this cargo bay.

CargoBayState **state** ()

The state of the cargo bay.

bool **open** ()

void **set_open** (bool *value*)

Whether the cargo bay is open.

enum struct CargoBayState

The state of a cargo bay. See *CargoBay::state()*.

enumerator open

Cargo bay is fully open.

enumerator closed
Cargo bay closed and locked.

enumerator opening
Cargo bay is opening.

enumerator closing
Cargo bay is closing.

Control Surface

class ControlSurface

An aerodynamic control surface. Obtained by calling *Part::control_surface()*.

Part part ()
The part object for this control surface.

bool pitch_enabled ()

void set_pitch_enabled (bool *value*)
Whether the control surface has pitch control enabled.

bool yaw_enabled ()

void set_yaw_enabled (bool *value*)
Whether the control surface has yaw control enabled.

bool roll_enabled ()

void set_roll_enabled (bool *value*)
Whether the control surface has roll control enabled.

float authority_limiter ()

void set_authority_limiter (float *value*)
The authority limiter for the control surface, which controls how far the control surface will move.

bool inverted ()

void set_inverted (bool *value*)
Whether the control surface movement is inverted.

bool deployed ()

void set_deployed (bool *value*)
Whether the control surface has been fully deployed.

float surface_area ()
Surface area of the control surface in m^2 .

std::tuple<std::tuple<double, double, double>, std::tuple<double, double, double>> available_torque ()
The available torque, in Newton meters, that can be produced by this control surface, in the positive and negative pitch, roll and yaw axes of the vessel. These axes correspond to the coordinate axes of the *Vessel::reference_frame()*.

Decoupler

class Decoupler

A decoupler. Obtained by calling *Part::decoupler()*

Part **part** ()

The part object for this decoupler.

Vessel **decouple** ()

Fires the decoupler. Returns the new vessel created when the decoupler fires. Throws an exception if the decoupler has already fired.

Note: When called, the active vessel may change. It is therefore possible that, after calling this function, the object(s) returned by previous call(s) to *active_vessel* () no longer refer to the active vessel.

bool **decoupled** ()

Whether the decoupler has fired.

bool **staged** ()

Whether the decoupler is enabled in the staging sequence.

float **impulse** ()

The impulse that the decoupler imparts when it is fired, in Newton seconds.

Docking Port

class DockingPort

A docking port. Obtained by calling *Part::docking_port* ()

Part **part** ()

The part object for this docking port.

DockingPortState **state** ()

The current state of the docking port.

Part **docked_part** ()

The part that this docking port is docked to. Returns NULL if this docking port is not docked to anything.

Vessel **undock** ()

Undocks the docking port and returns the new *Vessel* that is created. This method can be called for either docking port in a docked pair. Throws an exception if the docking port is not docked to anything.

Note: When called, the active vessel may change. It is therefore possible that, after calling this function, the object(s) returned by previous call(s) to *active_vessel* () no longer refer to the active vessel.

float **reengage_distance** ()

The distance a docking port must move away when it undocks before it becomes ready to dock with another port, in meters.

bool **has_shield** ()

Whether the docking port has a shield.

bool **shielded** ()

void **set_shielded** (bool *value*)

The state of the docking ports shield, if it has one.

Returns `true` if the docking port has a shield, and the shield is closed. Otherwise returns `false`. When set to `true`, the shield is closed, and when set to `false` the shield is opened. If the docking port does not have a shield, setting this attribute has no effect.

`std::tuple<double, double, double> position (ReferenceFrame reference_frame)`

The position of the docking port, in the given reference frame.

Parameters

- **reference_frame** – The reference frame that the returned position vector is in.

Returns The position as a vector.

`std::tuple<double, double, double> direction (ReferenceFrame reference_frame)`

The direction that docking port points in, in the given reference frame.

Parameters

- **reference_frame** – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

`std::tuple<double, double, double, double> rotation (ReferenceFrame reference_frame)`

The rotation of the docking port, in the given reference frame.

Parameters

- **reference_frame** – The reference frame that the returned rotation is in.

Returns The rotation as a quaternion of the form (x, y, z, w) .

ReferenceFrame **reference_frame** ()

The reference frame that is fixed relative to this docking port, and oriented with the port.

- The origin is at the position of the docking port.
- The axes rotate with the docking port.
- The x-axis points out to the right side of the docking port.
- The y-axis points in the direction the docking port is facing.
- The z-axis points out of the bottom off the docking port.

Note: This reference frame is not necessarily equivalent to the reference frame for the part, returned by *Part::reference_frame()*.

enum struct DockingPortState

The state of a docking port. See *DockingPort::state()*.

enumerator ready

The docking port is ready to dock to another docking port.

enumerator docked

The docking port is docked to another docking port, or docked to another part (from the VAB/SPH).

enumerator docking

The docking port is very close to another docking port, but has not docked. It is using magnetic force to acquire a solid dock.

enumerator undocking

The docking port has just been undocked from another docking port, and is disabled until it moves away by a sufficient distance (*DockingPort::reengage_distance()*).

enumerator shielded

The docking port has a shield, and the shield is closed.

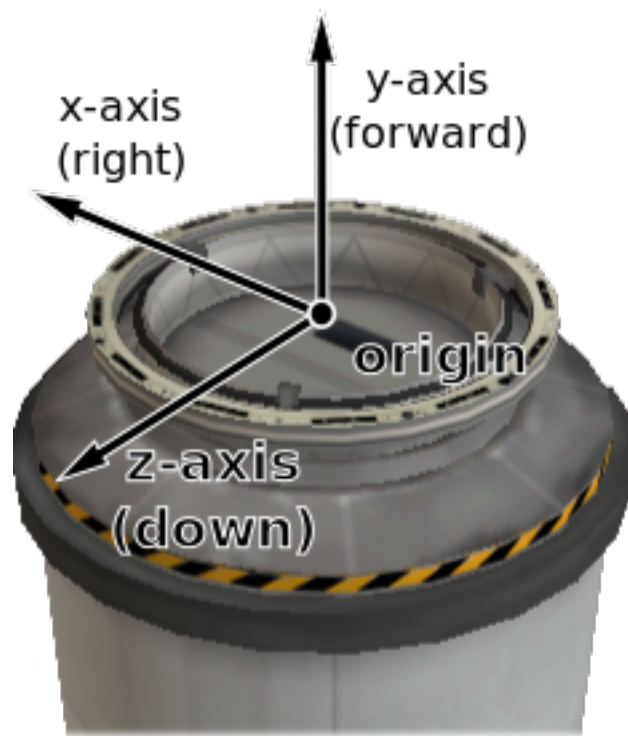


Fig. 5.8: Docking port reference frame origin and axes

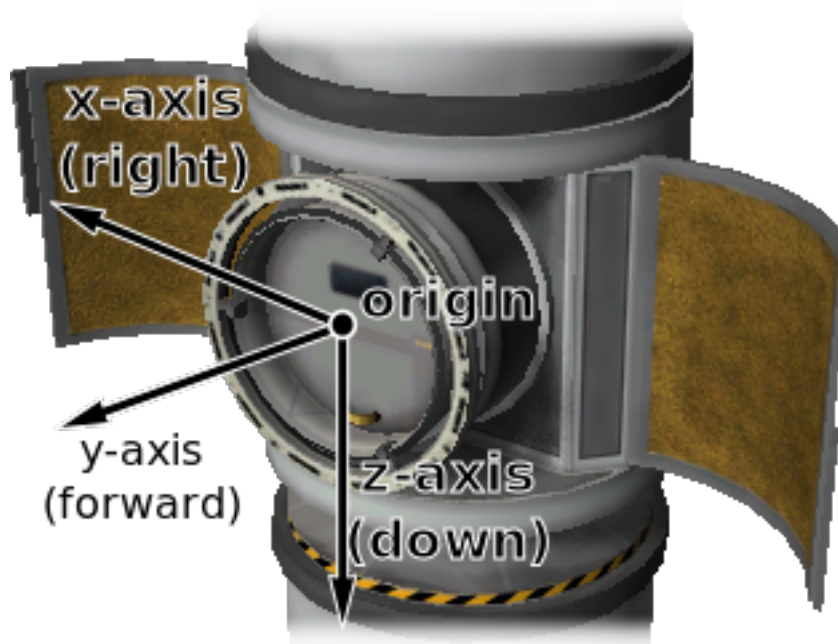


Fig. 5.9: Inline docking port reference frame origin and axes

enumerator moving

The docking ports shield is currently opening/closing.

Engine**class Engine**

An engine, including ones of various types. For example liquid fuelled gimballed engines, solid rocket boosters and jet engines. Obtained by calling *Part::engine()*.

Note: For RCS thrusters *Part::rcs()*.

Part **part** ()

The part object for this engine.

bool **active** ()

void **set_active** (bool *value*)

Whether the engine is active. Setting this attribute may have no effect, depending on *Engine::can_shutdown()* and *Engine::can_restart()*.

float **thrust** ()

The current amount of thrust being produced by the engine, in Newtons.

float **available_thrust** ()

The amount of thrust, in Newtons, that would be produced by the engine when activated and with its throttle set to 100%. Returns zero if the engine does not have any fuel. Takes the engine's current *Engine::thrust_limit()* and atmospheric conditions into account.

float **max_thrust** ()

The amount of thrust, in Newtons, that would be produced by the engine when activated and fueled, with its throttle and throttle limiter set to 100%.

float **max_vacuum_thrust** ()

The maximum amount of thrust that can be produced by the engine in a vacuum, in Newtons. This is the amount of thrust produced by the engine when activated, *Engine::thrust_limit()* is set to 100%, the main vessel's throttle is set to 100% and the engine is in a vacuum.

float **thrust_limit** ()

void **set_thrust_limit** (float *value*)

The thrust limiter of the engine. A value between 0 and 1. Setting this attribute may have no effect, for example the thrust limit for a solid rocket booster cannot be changed in flight.

std::vector<Thruster> **thrusters** ()

The components of the engine that generate thrust.

Note: For example, this corresponds to the rocket nozzle on a solid rocket booster, or the individual nozzles on a RAPIER engine. The overall thrust produced by the engine, as reported by *Engine::available_thrust()*, *Engine::max_thrust()* and others, is the sum of the thrust generated by each thruster.

float **specific_impulse** ()

The current specific impulse of the engine, in seconds. Returns zero if the engine is not active.

float **vacuum_specific_impulse** ()

The vacuum specific impulse of the engine, in seconds.

float **kerbin_sea_level_specific_impulse** ()

The specific impulse of the engine at sea level on Kerbin, in seconds.

std::vector<std::string> **propellant_names** ()

The names of the propellants that the engine consumes.

std::map<std::string, float> **propellant_ratios** ()

The ratio of resources that the engine consumes. A dictionary mapping resource names to the ratio at which they are consumed by the engine.

Note: For example, if the ratios are 0.6 for LiquidFuel and 0.4 for Oxidizer, then for every 0.6 units of LiquidFuel that the engine burns, it will burn 0.4 units of Oxidizer.

std::vector<*Propellant*> **propellants** ()

The propellants that the engine consumes.

bool **has_fuel** ()

Whether the engine has any fuel available.

Note: The engine must be activated for this property to update correctly.

float **throttle** ()

The current throttle setting for the engine. A value between 0 and 1. This is not necessarily the same as the vessel's main throttle setting, as some engines take time to adjust their throttle (such as jet engines).

bool **throttle_locked** ()

Whether the *Control::throttle()* affects the engine. For example, this is `true` for liquid fueled rockets, and `false` for solid rocket boosters.

bool **can_restart** ()

Whether the engine can be restarted once shutdown. If the engine cannot be shutdown, returns `false`. For example, this is `true` for liquid fueled rockets and `false` for solid rocket boosters.

bool **can_shutdown** ()

Whether the engine can be shutdown once activated. For example, this is `true` for liquid fueled rockets and `false` for solid rocket boosters.

bool **has_modes** ()

Whether the engine has multiple modes of operation.

std::string **mode** ()

void **set_mode** (std::string *value*)

The name of the current engine mode.

std::map<std::string, *Engine*> **modes** ()

The available modes for the engine. A dictionary mapping mode names to *Engine* objects.

void **toggle_mode** ()

Toggle the current engine mode.

bool **auto_mode_switch** ()

void **set_auto_mode_switch** (bool *value*)

Whether the engine will automatically switch modes.

bool **gimballed** ()

Whether the engine is gimballed.

float **gimbal_range** ()
 The range over which the gimbal can move, in degrees. Returns 0 if the engine is not gimballed.

bool **gimbal_locked** ()

void **set_gimbal_locked** (bool *value*)
 Whether the engines gimbal is locked in place. Setting this attribute has no effect if the engine is not gimballed.

float **gimbal_limit** ()

void **set_gimbal_limit** (float *value*)
 The gimbal limiter of the engine. A value between 0 and 1. Returns 0 if the gimbal is locked.

std::tuple<std::tuple<double, double, double>, std::tuple<double, double, double>> **available_torque** ()
 The available torque, in Newton meters, that can be produced by this engine, in the positive and negative pitch, roll and yaw axes of the vessel. These axes correspond to the coordinate axes of the *Vessel::reference_frame()*. Returns zero if the engine is inactive, or not gimballed.

class Propellant

A propellant for an engine. Obtains by calling *Engine::propellants()*.

std::string **name** ()
 The name of the propellant.

double **current_amount** ()
 The current amount of propellant.

double **current_requirement** ()
 The required amount of propellant.

double **total_resource_available** ()
 The total amount of the underlying resource currently reachable given resource flow rules.

double **total_resource_capacity** ()
 The total vehicle capacity for the underlying propellant resource, restricted by resource flow rules.

bool **ignore_for_isp** ()
 If this propellant should be ignored when calculating required mass flow given specific impulse.

bool **ignore_for_thrust_curve** ()
 If this propellant should be ignored for thrust curve calculations.

bool **draw_stack_gauge** ()
 If this propellant has a stack gauge or not.

bool **is_deprived** ()
 If this propellant is deprived.

float **ratio** ()
 The propellant ratio.

Experiment

class Experiment

Obtained by calling *Part::experiment()*.

Part **part** ()
 The part object for this experiment.

void **run** ()
 Run the experiment.

```
void transmit ()
    Transmit all experimental data contained by this part.

void dump ()
    Dump the experimental data contained by the experiment.

void reset ()
    Reset the experiment.

bool deployed ()
    Whether the experiment has been deployed.

bool rerunnable ()
    Whether the experiment can be re-run.

bool inoperable ()
    Whether the experiment is inoperable.

bool has_data ()
    Whether the experiment contains data.

std::vector<ScienceData> data ()
    The data contained in this experiment.

std::string biome ()
    The name of the biome the experiment is currently in.

bool available ()
    Determines if the experiment is available given the current conditions.

ScienceSubject science_subject ()
    Containing information on the corresponding specific science result for the current conditions. Returns
    NULL if the experiment is unavailable.

class ScienceData
    Obtained by calling Experiment::data().

    float data_amount ()
        Data amount.

    float science_value ()
        Science value.

    float transmit_value ()
        Transmit value.

class ScienceSubject
    Obtained by calling Experiment::science_subject().

    std::string title ()
        Title of science subject, displayed in science archives

    bool is_complete ()
        Whether the experiment has been completed.

    float science ()
        Amount of science already earned from this subject, not updated until after transmission/recovery.

    float science_cap ()
        Total science allowable for this subject.

    float data_scale ()
        Multiply science value by this to determine data amount in mits.
```

float **subject_value** ()
Multiplier for specific Celestial Body/Experiment Situation combination.

float **scientific_value** ()
Diminishing value multiplier for decreasing the science value returned from repeated experiments.

Fairing

class Fairing
A fairing. Obtained by calling *Part::fairing()*.

Part **part** ()
The part object for this fairing.

void **jettison** ()
Jettison the fairing. Has no effect if it has already been jettisoned.

bool **jettisoned** ()
Whether the fairing has been jettisoned.

Intake

class Intake
An air intake. Obtained by calling *Part::intake()*.

Part **part** ()
The part object for this intake.

bool **open** ()

void **set_open** (bool *value*)
Whether the intake is open.

float **speed** ()
Speed of the flow into the intake, in *m/s*.

float **flow** ()
The rate of flow into the intake, in units of resource per second.

float **area** ()
The area of the intake's opening, in square meters.

Leg

class Leg
A landing leg. Obtained by calling *Part::leg()*.

Part **part** ()
The part object for this landing leg.

LegState **state** ()
The current state of the landing leg.

bool **deployable** ()
Whether the leg is deployable.

bool **deployed** ()

void **set_deployed** (bool *value*)
Whether the landing leg is deployed.

Note: Fixed landing legs are always deployed. Returns an error if you try to deploy fixed landing gear.

bool **is_grounded** ()
Returns whether the leg is touching the ground.

enum struct LegState

The state of a landing leg. See *Leg::state()*.

enumerator deployed
Landing leg is fully deployed.

enumerator retracted
Landing leg is fully retracted.

enumerator deploying
Landing leg is being deployed.

enumerator retracting
Landing leg is being retracted.

enumerator broken
Landing leg is broken.

Launch Clamp

class LaunchClamp

A launch clamp. Obtained by calling *Part::launch_clamp()*.

Part **part** ()
The part object for this launch clamp.

void **release** ()
Releases the docking clamp. Has no effect if the clamp has already been released.

Light

class Light

A light. Obtained by calling *Part::light()*.

Part **part** ()
The part object for this light.

bool **active** ()

void **set_active** (bool *value*)
Whether the light is switched on.

std::tuple<float, float, float> **color** ()

void **set_color** (std::tuple<float, float, float> *value*)
The color of the light, as an RGB triple.

float **power_usage** ()
The current power usage, in units of charge per second.

Parachute

class Parachute

A parachute. Obtained by calling *Part::parachute()*.

Part **part** ()

The part object for this parachute.

void **deploy** ()

Deploys the parachute. This has no effect if the parachute has already been deployed.

bool **deployed** ()

Whether the parachute has been deployed.

void **arm** ()

Deploys the parachute. This has no effect if the parachute has already been armed or deployed. Only applicable to RealChutes parachutes.

bool **armed** ()

Whether the parachute has been armed or deployed. Only applicable to RealChutes parachutes.

ParachuteState **state** ()

The current state of the parachute.

float **deploy_altitude** ()

void **set_deploy_altitude** (float *value*)

The altitude at which the parachute will full deploy, in meters. Only applicable to stock parachutes.

float **deploy_min_pressure** ()

void **set_deploy_min_pressure** (float *value*)

The minimum pressure at which the parachute will semi-deploy, in atmospheres. Only applicable to stock parachutes.

enum struct ParachuteState

The state of a parachute. See *Parachute::state()*.

enumerator stowed

The parachute is safely tucked away inside its housing.

enumerator armed

The parachute is armed for deployment. (RealChutes only)

enumerator active

The parachute is still stowed, but ready to semi-deploy. (Stock parachutes only)

enumerator semi_deployed

The parachute has been deployed and is providing some drag, but is not fully deployed yet. (Stock parachutes only)

enumerator deployed

The parachute is fully deployed.

enumerator cut

The parachute has been cut.

Radiator

class Radiator

A radiator. Obtained by calling *Part::radiator()*.

Part **part** ()

The part object for this radiator.

bool **deployable** ()

Whether the radiator is deployable.

bool **deployed** ()

void **set_deployed** (bool *value*)

For a deployable radiator, `true` if the radiator is extended. If the radiator is not deployable, this is always `true`.

RadiatorState **state** ()

The current state of the radiator.

Note: A fixed radiator is always *RadiatorState::extended*.

enum struct RadiatorState

The state of a radiator. *RadiatorState*

enumerator extended

Radiator is fully extended.

enumerator retracted

Radiator is fully retracted.

enumerator extending

Radiator is being extended.

enumerator retracting

Radiator is being retracted.

enumerator broken

Radiator is being broken.

Resource Converter

class ResourceConverter

A resource converter. Obtained by calling *Part::resource_converter()*.

Part **part** ()

The part object for this converter.

int32_t **count** ()

The number of converters in the part.

std::string **name** (int32_t *index*)

The name of the specified converter.

Parameters

- **index** – Index of the converter.

bool **active** (int32_t *index*)

True if the specified converter is active.

Parameters

- **index** – Index of the converter.

void **start** (int32_t *index*)
Start the specified converter.

Parameters

- **index** – Index of the converter.

void **stop** (int32_t *index*)
Stop the specified converter.

Parameters

- **index** – Index of the converter.

ResourceConverterState **state** (int32_t *index*)
The state of the specified converter.

Parameters

- **index** – Index of the converter.

std::string **status_info** (int32_t *index*)
Status information for the specified converter. This is the full status message shown in the in-game UI.

Parameters

- **index** – Index of the converter.

std::vector<std::string> **inputs** (int32_t *index*)
List of the names of resources consumed by the specified converter.

Parameters

- **index** – Index of the converter.

std::vector<std::string> **outputs** (int32_t *index*)
List of the names of resources produced by the specified converter.

Parameters

- **index** – Index of the converter.

enum struct ResourceConverterState
The state of a resource converter. See *ResourceConverter::state()*.

enumerator running
Converter is running.

enumerator idle
Converter is idle.

enumerator missing_resource
Converter is missing a required resource.

enumerator storage_full
No available storage for output resource.

enumerator capacity
At preset resource capacity.

enumerator unknown
Unknown state. Possible with modified resource converters. In this case, check *ResourceConverter::status_info()* for more information.

Resource Harvester

class ResourceHarvester

A resource harvester (drill). Obtained by calling *Part::resource_harvester()*.

Part **part** ()

The part object for this harvester.

ResourceHarvesterState **state** ()

The state of the harvester.

bool **deployed** ()

void **set_deployed** (bool *value*)

Whether the harvester is deployed.

bool **active** ()

void **set_active** (bool *value*)

Whether the harvester is actively drilling.

float **extraction_rate** ()

The rate at which the drill is extracting ore, in units per second.

float **thermal_efficiency** ()

The thermal efficiency of the drill, as a percentage of its maximum.

float **core_temperature** ()

The core temperature of the drill, in Kelvin.

float **optimum_core_temperature** ()

The core temperature at which the drill will operate with peak efficiency, in Kelvin.

enum struct ResourceHarvesterState

The state of a resource harvester. See *ResourceHarvester::state()*.

enumerator deploying

The drill is deploying.

enumerator deployed

The drill is deployed and ready.

enumerator retracting

The drill is retracting.

enumerator retracted

The drill is retracted.

enumerator active

The drill is running.

Reaction Wheel

class ReactionWheel

A reaction wheel. Obtained by calling *Part::reaction_wheel()*.

Part **part** ()

The part object for this reaction wheel.

bool **active** ()

```

void set_active (bool value)
    Whether the reaction wheel is active.

bool broken ()
    Whether the reaction wheel is broken.

std::tuple<std::tuple<double, double, double>, std::tuple<double, double, double>> available_torque ()
    The available torque, in Newton meters, that can be produced by this reaction wheel, in the positive and
    negative pitch, roll and yaw axes of the vessel. These axes correspond to the coordinate axes of the
    Vessel::reference_frame(). Returns zero if the reaction wheel is inactive or broken.

std::tuple<std::tuple<double, double, double>, std::tuple<double, double, double>> max_torque ()
    The maximum torque, in Newton meters, that can be produced by this reaction wheel, when it is active, in
    the positive and negative pitch, roll and yaw axes of the vessel. These axes correspond to the coordinate
    axes of the Vessel::reference_frame().

```

RCS

class RCS

```

    An RCS block or thruster. Obtained by calling Part::rcs().

    Part part ()
        The part object for this RCS.

    bool active ()
        Whether the RCS thrusters are active. An RCS thruster is inactive if the RCS action group is disabled
        (Control::rcs()), the RCS thruster itself is not enabled (RCS::enabled()) or it is covered by a
        fairing (Part::shielded()).

    bool enabled ()

    void set_enabled (bool value)
        Whether the RCS thrusters are enabled.

    bool pitch_enabled ()

    void set_pitch_enabled (bool value)
        Whether the RCS thruster will fire when pitch control input is given.

    bool yaw_enabled ()

    void set_yaw_enabled (bool value)
        Whether the RCS thruster will fire when yaw control input is given.

    bool roll_enabled ()

    void set_roll_enabled (bool value)
        Whether the RCS thruster will fire when roll control input is given.

    bool forward_enabled ()

    void set_forward_enabled (bool value)
        Whether the RCS thruster will fire when pitch control input is given.

    bool up_enabled ()

    void set_up_enabled (bool value)
        Whether the RCS thruster will fire when yaw control input is given.

    bool right_enabled ()

```

void **set_right_enabled** (bool *value*)

Whether the RCS thruster will fire when roll control input is given.

std::tuple<std::tuple<double, double, double>, std::tuple<double, double, double>> **available_torque** ()

The available torque, in Newton meters, that can be produced by this RCS, in the positive and negative pitch, roll and yaw axes of the vessel. These axes correspond to the coordinate axes of the *Vessel::reference_frame()*. Returns zero if RCS is disable.

float **max_thrust** ()

The maximum amount of thrust that can be produced by the RCS thrusters when active, in Newtons.

float **max_vacuum_thrust** ()

The maximum amount of thrust that can be produced by the RCS thrusters when active in a vacuum, in Newtons.

std::vector<Thruster> **thrusters** ()

A list of thrusters, one of each nozzle in the RCS part.

float **specific_impulse** ()

The current specific impulse of the RCS, in seconds. Returns zero if the RCS is not active.

float **vacuum_specific_impulse** ()

The vacuum specific impulse of the RCS, in seconds.

float **kerbin_sea_level_specific_impulse** ()

The specific impulse of the RCS at sea level on Kerbin, in seconds.

std::vector<std::string> **propellants** ()

The names of resources that the RCS consumes.

std::map<std::string, float> **propellant_ratios** ()

The ratios of resources that the RCS consumes. A dictionary mapping resource names to the ratios at which they are consumed by the RCS.

bool **has_fuel** ()

Whether the RCS has fuel available.

Note: The RCS thruster must be activated for this property to update correctly.

Sensor

class Sensor

A sensor, such as a thermometer. Obtained by calling *Part::sensor()*.

Part **part** ()

The part object for this sensor.

bool **active** ()

void **set_active** (bool *value*)

Whether the sensor is active.

std::string **value** ()

The current value of the sensor.

Solar Panel

class SolarPanel

A solar panel. Obtained by calling `Part::solar_panel()`.

Part **part** ()

The part object for this solar panel.

bool **deployable** ()

Whether the solar panel is deployable.

bool **deployed** ()

void **set_deployed** (bool *value*)

Whether the solar panel is extended.

SolarPanelState **state** ()

The current state of the solar panel.

float **energy_flow** ()

The current amount of energy being generated by the solar panel, in units of charge per second.

float **sun_exposure** ()

The current amount of sunlight that is incident on the solar panel, as a percentage. A value between 0 and 1.

enum struct SolarPanelState

The state of a solar panel. See `SolarPanel::state()`.

enumerator extended

Solar panel is fully extended.

enumerator retracted

Solar panel is fully retracted.

enumerator extending

Solar panel is being extended.

enumerator retracting

Solar panel is being retracted.

enumerator broken

Solar panel is broken.

Thruster

class Thruster

The component of an *Engine* or *RCS* part that generates thrust. Can obtained by calling `Engine::thrusters()` or `RCS::thrusters()`.

Note: Engines can consist of multiple thrusters. For example, the S3 KS-25x4 “Mammoth” has four rocket nozzels, and so consists of four thrusters.

Part **part** ()

The *Part* that contains this thruster.

std::tuple<double, double, double> **thrust_position** (*ReferenceFrame reference_frame*)

The position at which the thruster generates thrust, in the given reference frame. For gimballed engines, this takes into account the current rotation of the gimbal.

Parameters

- **reference_frame** – The reference frame that the returned position vector is in.

Returns The position as a vector.

`std::tuple<double, double, double> thrust_direction (ReferenceFrame reference_frame)`

The direction of the force generated by the thruster, in the given reference frame. This is opposite to the direction in which the thruster expels propellant. For gimballed engines, this takes into account the current rotation of the gimbal.

Parameters

- **reference_frame** – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

ReferenceFrame **thrust_reference_frame** ()

A reference frame that is fixed relative to the thruster and orientated with its thrust direction (*Thruster::thrust_direction()*). For gimballed engines, this takes into account the current rotation of the gimbal.

- The origin is at the position of thrust for this thruster (*Thruster::thrust_position()*).
- The axes rotate with the thrust direction. This is the direction in which the thruster expels propellant, including any gimbaling.
- The y-axis points along the thrust direction.
- The x-axis and z-axis are perpendicular to the thrust direction.

`bool gimballed ()`

Whether the thruster is gimballed.

`std::tuple<double, double, double> gimbal_position (ReferenceFrame reference_frame)`

Position around which the gimbal pivots.

Parameters

- **reference_frame** – The reference frame that the returned position vector is in.

Returns The position as a vector.

`std::tuple<double, double, double> gimbal_angle ()`

The current gimbal angle in the pitch, roll and yaw axes, in degrees.

`std::tuple<double, double, double> initial_thrust_position (ReferenceFrame reference_frame)`

The position at which the thruster generates thrust, when the engine is in its initial position (no gimbaling), in the given reference frame.

Parameters

- **reference_frame** – The reference frame that the returned position vector is in.

Returns The position as a vector.

Note: This position can move when the gimbal rotates. This is because the thrust position and gimbal position are not necessarily the same.

`std::tuple<double, double, double> initial_thrust_direction (ReferenceFrame reference_frame)`

The direction of the force generated by the thruster, when the engine is in its initial position (no gim-

balling), in the given reference frame. This is opposite to the direction in which the thruster expels propellant.

Parameters

- **reference_frame** – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

Wheel

class Wheel

A wheel. Includes landing gear and rover wheels. Obtained by calling `Part::wheel()`. Can be used to control the motors, steering and deployment of wheels, among other things.

Part **part** ()

The part object for this wheel.

WheelState **state** ()

The current state of the wheel.

float **radius** ()

Radius of the wheel, in meters.

bool **grounded** ()

Whether the wheel is touching the ground.

bool **has_brakes** ()

Whether the wheel has brakes.

float **brakes** ()

void **set_brakes** (float *value*)

The braking force, as a percentage of maximum, when the brakes are applied.

bool **auto_friction_control** ()

void **set_auto_friction_control** (bool *value*)

Whether automatic friction control is enabled.

float **manual_friction_control** ()

void **set_manual_friction_control** (float *value*)

Manual friction control value. Only has an effect if automatic friction control is disabled. A value between 0 and 5 inclusive.

bool **deployable** ()

Whether the wheel is deployable.

bool **deployed** ()

void **set_deployed** (bool *value*)

Whether the wheel is deployed.

bool **powered** ()

Whether the wheel is powered by a motor.

bool **motor_enabled** ()

void **set_motor_enabled** (bool *value*)

Whether the motor is enabled.

bool **motor_inverted** ()

void **set_motor_inverted** (bool *value*)

Whether the direction of the motor is inverted.

MotorState **motor_state** ()

Whether the direction of the motor is inverted.

float **motor_output** ()

The output of the motor. This is the torque currently being generated, in Newton meters.

bool **traction_control_enabled** ()

void **set_traction_control_enabled** (bool *value*)

Whether automatic traction control is enabled. A wheel only has traction control if it is powered.

float **traction_control** ()

void **set_traction_control** (float *value*)

Setting for the traction control. Only takes effect if the wheel has automatic traction control enabled. A value between 0 and 5 inclusive.

float **drive_limiter** ()

void **set_drive_limiter** (float *value*)

Manual setting for the motor limiter. Only takes effect if the wheel has automatic traction control disabled. A value between 0 and 100 inclusive.

bool **steerable** ()

Whether the wheel has steering.

bool **steering_enabled** ()

void **set_steering_enabled** (bool *value*)

Whether the wheel steering is enabled.

bool **steering_inverted** ()

void **set_steering_inverted** (bool *value*)

Whether the wheel steering is inverted.

bool **has_suspension** ()

Whether the wheel has suspension.

float **suspension_spring_strength** ()

Suspension spring strength, as set in the editor.

float **suspension_damper_strength** ()

Suspension damper strength, as set in the editor.

bool **broken** ()

Whether the wheel is broken.

bool **repairable** ()

Whether the wheel is repairable.

float **stress** ()

Current stress on the wheel.

float **stress_tolerance** ()

Stress tolerance of the wheel.

float **stress_percentage** ()

Current stress on the wheel as a percentage of its stress tolerance.

float **deflection** ()

Current deflection of the wheel.

float **slip**()
Current slip of the wheel.

enum struct WheelState
The state of a wheel. See *Wheel::state()*.

enumerator deployed
Wheel is fully deployed.

enumerator retracted
Wheel is fully retracted.

enumerator deploying
Wheel is being deployed.

enumerator retracting
Wheel is being retracted.

enumerator broken
Wheel is broken.

enum struct MotorState
The state of the motor on a powered wheel. See *Wheel::motor_state()*.

enumerator idle
The motor is idle.

enumerator running
The motor is running.

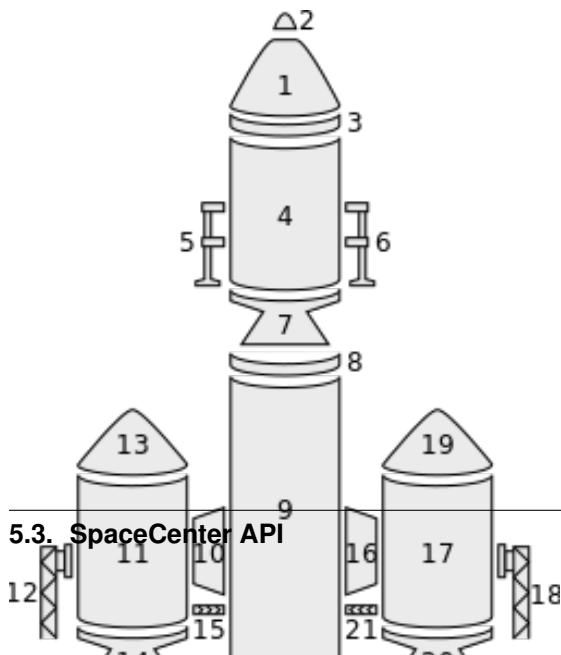
enumerator disabled
The motor is disabled.

enumerator inoperable
The motor is inoperable.

enumerator not_enough_resources
The motor does not have enough resources to run.

Trees of Parts

Vessels in KSP are comprised of a number of parts, connected to one another in a *tree* structure. An example vessel is shown in Figure 1, and the corresponding tree of parts in Figure 2. The craft file for this example can also be downloaded [here](#).



Traversing the Tree

The tree of parts can be traversed using the attributes *Parts::root()*, *Part::parent()* and *Part::children()*.

The root of the tree is the same as the vessels *root part* (part number 1 in the example above) and can be obtained by calling *Parts::root()*. A parts children can be obtained by calling *Part::children()*. If the part does not have any children, *Part::children()* returns an empty list. A parts parent can be obtained by calling *Part::parent()*. If the

part does not have a parent (as is the case for the root part), `Part::parent()` returns `NULL`.

The following C++ example uses these attributes to perform a depth-first traversal over all of the parts in a vessel:

```
#include <iostream>
#include <stack>
#include <string>
#include <utility>
#include <krpc.hpp>
#include <krpc/servi

using
↳ SpaceCenter = krpc

int main() {
    krpc::Client conn
    SpaceCenter sc(&co
    auto vessel = sc.a

    auto root = vessel
    std::stack
    ↳ <std::pair<SpaceCe
    stack.push(std::pa
    ↳ <SpaceCenter::Part
    while (!stack.empty
        auto part = stac
        auto depth = sta
        stack.pop();
        std::cout << std
    ↳ ' ' ) << part.titl
        for (auto child
            stack.push(std
    ↳ <SpaceCenter::Part
    }
}
```

When this code is execute using the craft file for the example vessel pictured above, the following is printed out:

```
Command Pod Mk1
TR-18A Stack Decoup
FL-T400 Fuel Tank
LV-909 Liquid Fue
TR-18A Stack Dec
FL-T800 Fuel Ta
LV-909 Liquid
TT-70 Radial D
FL-T400 Fuel
TT18-A Launc
FTX-2 Extern
LV-909 Liqui
Aerodynamic
TT-70 Radial D
FL-T400 Fuel
TT18-A Launc
FTX-2 Extern
LV-909 Liqui
```

	Aerodynamic
LT-1	Landing Stru
LT-1	Landing Stru
Mk16	Parachute

Attachment Modes

Parts can be attached to other parts either *radially* (on the side of the parent part) or *axially* (on the end of the parent part, to form a stack).

For example, in the vessel pictured above, the parachute (part 2) is *axially* connected to its parent (the command pod – part 1), and the landing leg (part 5) is *radially* connected to its parent (the fuel tank – part 4).

The root part of a vessel (for example the command pod – part 1) does not have a parent part, so does not have an attachment mode. However, the part is consider to be *axially* attached to

nothing.

The following C++ example does a depth-first traversal as before, but also prints out the attachment mode used by the part:

```
#include <iostream>
#include <stack>
#include <string>
#include <utility>
#include <krpc.hpp>
#include <krpc/services/space_center.hpp>

using_
↳SpaceCenter = krpc::services::SpaceCenter;

int main() {
    auto conn = krpc::connect();
    SpaceCenter sc(&conn);
    auto vessel = sc.active_vessel();

    auto root = vessel.parts().root();
    std::stack
↳<std::pair<SpaceCenter::Part, int> > stack;
    stack.push(std::pair
↳<SpaceCenter::Part, int>(root, 0));
    while (!stack.empty()) {
        auto part = stack.top().first;
        auto depth = stack.top().second;
        stack.pop();
        std::string attach_mode = part.
↳axially_attached() ? "axial" : "radial";
        std::cout_
↳<< std::string(depth, ' ') << part.title()_
↳<< " - " << attach_mode << std::endl;
        auto children = part.children();
        for (auto child : children) {
            stack.push(std::pair
↳<SpaceCenter::Part, int>(child, depth+1));

```

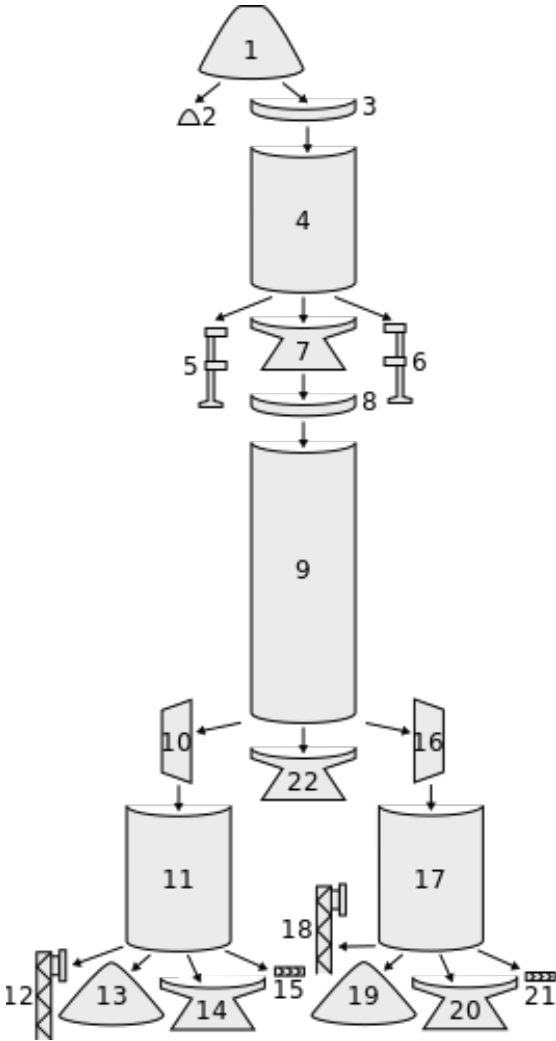


Fig. 5.11: **Figure 2** – Tree of parts for the vessel 437
Figure 1. Arrows point from the parent part to the child part.

```

    }
  }
}

```

When this code is execute using the craft file for the example vessel pictured above, the following is printed out:

```

Command Pod Mk1 - axial
TR-18A Stack Decoupler - axial
FL-T400 Fuel Tank - axial
LV-909 Liquid Fuel Engine - axial
TR-18A Stack Decoupler - axial
FL-T800 Fuel Tank - axial
LV-909 Liquid Fuel Engine - axial
TT-70 Radial Decoupler - radial
FL-T400 Fuel Tank - radial

↳ TT18-A Launch Stability Enhancer - radial
   FTX-2 External Fuel Duct - radial
   LV-909 Liquid Fuel Engine - axial
   Aerodynamic Nose Cone - axial
   TT-70 Radial Decoupler - radial
   FL-T400 Fuel Tank - radial

↳ TT18-A Launch Stability Enhancer - radial
   FTX-2 External Fuel Duct - radial
   LV-909 Liquid Fuel Engine - axial
   Aerodynamic Nose Cone - axial
   LT-1 Landing Struts - radial
   LT-1 Landing Struts - radial
Mk16 Parachute - axial

```

Fuel Lines

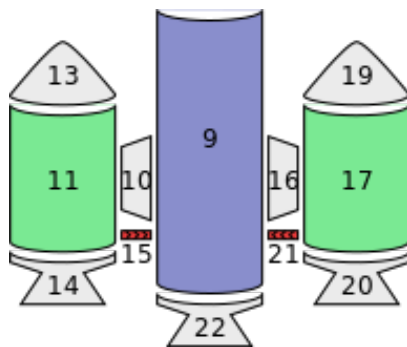


Fig. 5.12: **Figure 5** – Fuel lines from the example in Figure 1. Fuel flows from the parts highlighted in green, into the part highlighted in blue.

Fuel lines are considered parts, and are included in the parts tree (for example, as pictured in Figure 4). However, the parts tree does not contain information about which parts fuel lines connect to. The parent part of a fuel line is the



part from which it will take fuel (as shown in Figure 4) however the part that it will send fuel to is not represented in the parts tree.

Figure 5 shows the fuel lines from the example vessel pictured earlier. Fuel line part 15 (in red) takes fuel from a fuel tank (part 11 – in green) and feeds it into another fuel tank (part 9 – in blue). The fuel line is therefore a child of part 11, but its connection to part 9 is not represented in the tree.

The attributes `Part::fuel_lines_from()` and `Part::fuel_lines_to()` can be used to discover these connections. In the example in Figure 5, when `Part::fuel_lines_to()` is called on fuel tank part 11, it will return a list of parts containing just fuel tank part 9 (the blue part). When `Part::fuel_lines_from()` is called on fuel tank part 9, it will return a list containing fuel tank parts 11 and 17 (the parts colored green).

Staging

Each part has two staging numbers associated with it: the stage in which the part is *activated* and the stage in which the part is *decoupled*. These values can be obtained using `Part::stage()` and `Part::decouple_stage()` respectively. For parts that are not activated by staging, `Part::stage()` returns -1. For parts that are never decoupled, `Part::decouple_stage()` returns a value of -1.

Figure 6 shows an example staging sequence for a vessel. Figure 7 shows the stages in which each part of the vessel will be *activated*. Figure 8 shows the stages in which each part of the vessel will be *decoupled*.

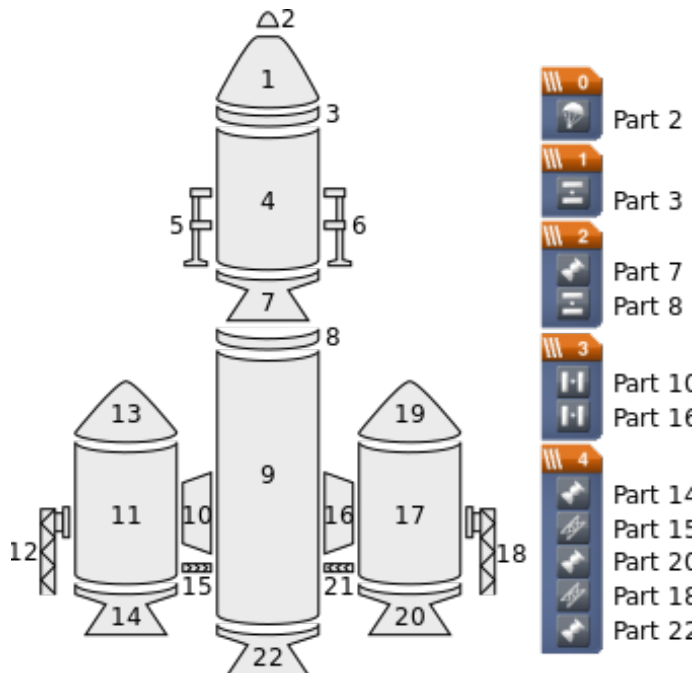


Fig. 5.14: **Figure 6** – Example vessel from Figure 1 with a staging sequence.

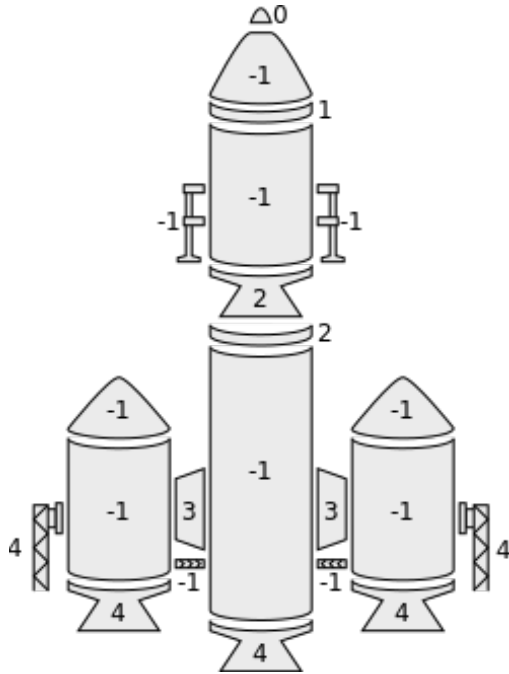


Fig. 5.15: **Figure 7** – The stage in which each part is *activated*.

5.3.9 Resources

class Resources

Represents the collection of resources stored in a vessel, stage or part. Created by calling `Vessel::resources()`, `Vessel::resources_in_decouple_stage()` or `Part::resources()`.

`std::vector<Resource> all()`

All the individual resources that can be stored.

`std::vector<Resource> with_resource(std::string name)`

All the individual resources with the given name that can be stored.

Parameters

`std::vector<std::string> names()`

A list of resource names that can be stored.

`bool has_resource(std::string name)`

Check whether the named resource can be stored.

Parameters

- **name** – The name of the resource.

`float amount(std::string name)`

Returns the amount of a resource that is currently stored.

Parameters

- **name** – The name of the resource.

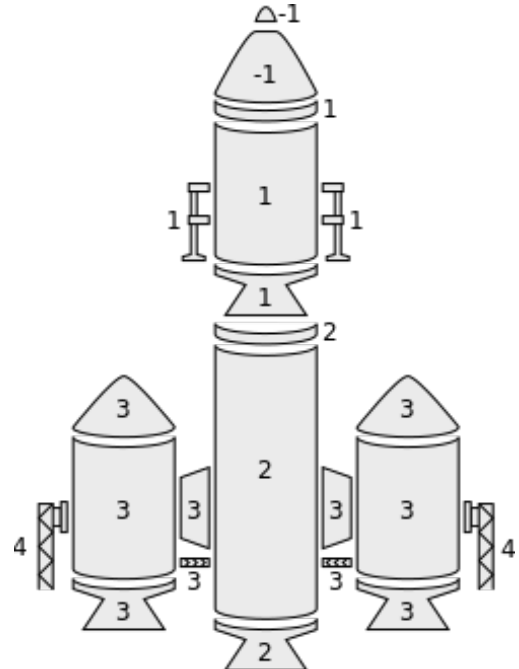


Fig. 5.16: **Figure 8** – The stage in which each part is *decoupled*.

float **max** (std::string *name*)

Returns the amount of a resource that can be stored.

Parameters

- **name** – The name of the resource.

static float **density** (*Client &connection*, std::string *name*)

Returns the density of a resource, in *kg/l*.

Parameters

- **name** – The name of the resource.

static *ResourceFlowMode* **flow_mode** (*Client &connection*, std::string *name*)

Returns the flow mode of a resource.

Parameters

- **name** – The name of the resource.

bool **enabled** ()

void **set_enabled** (bool *value*)

Whether use of all the resources are enabled.

Note: This is `true` if all of the resources are enabled. If any of the resources are not enabled, this is `false`.

class Resource

An individual resource stored within a part. Created using methods in the *Resources* class.

std::string **name** ()

The name of the resource.

Part **part** ()

The part containing the resource.

float **amount** ()

The amount of the resource that is currently stored in the part.

float **max** ()

The total amount of the resource that can be stored in the part.

float **density** ()

The density of the resource, in *kg/l*.

ResourceFlowMode **flow_mode** ()

The flow mode of the resource.

bool **enabled** ()

void **set_enabled** (bool *value*)

Whether use of this resource is enabled.

class ResourceTransfer

Transfer resources between parts.

static ResourceTransfer start (*Client &connection, Part from_part, Part to_part, std::string resource, float max_amount*)

Start transferring a resource transfer between a pair of parts. The transfer will move at most *max_amount* units of the resource, depending on how much of the resource is available in the source part and how much storage is available in the destination part. Use *ResourceTransfer::complete()* to check if the transfer is complete. Use *ResourceTransfer::amount()* to see how much of the resource has been transferred.

Parameters

- **from_part** – The part to transfer to.
- **to_part** – The part to transfer from.
- **resource** – The name of the resource to transfer.
- **max_amount** – The maximum amount of resource to transfer.

float **amount** ()

The amount of the resource that has been transferred.

bool **complete** ()

Whether the transfer has completed.

enum struct ResourceFlowMode

The way in which a resource flows between parts. See *Resources::flow_mode()*.

enumerator vessel

The resource flows to any part in the vessel. For example, electric charge.

enumerator stage

The resource flows from parts in the first stage, followed by the second, and so on. For example, mono-propellant.

enumerator adjacent

The resource flows between adjacent parts within the vessel. For example, liquid fuel or oxidizer.

enumerator none

The resource does not flow. For example, solid fuel.

5.3.10 Node

class Node

Represents a maneuver node. Can be created using *Control::add_node()*.

double **prograde** ()

void **set_prograde** (double *value*)

The magnitude of the maneuver nodes delta-v in the prograde direction, in meters per second.

double **normal** ()

void **set_normal** (double *value*)
 The magnitude of the maneuver nodes delta-v in the normal direction, in meters per second.

double **radial** ()

void **set_radial** (double *value*)
 The magnitude of the maneuver nodes delta-v in the radial direction, in meters per second.

double **delta_v** ()

void **set_delta_v** (double *value*)
 The delta-v of the maneuver node, in meters per second.

Note: Does not change when executing the maneuver node. See `Node::remaining_delta_v()`.

double **remaining_delta_v** ()
 Gets the remaining delta-v of the maneuver node, in meters per second. Changes as the node is executed. This is equivalent to the delta-v reported in-game.

std::tuple<double, double, double> **burn_vector** (*ReferenceFrame reference_frame* = ReferenceFrame())

Returns the burn vector for the maneuver node.

Parameters

- **reference_frame** – The reference frame that the returned vector is in. Defaults to `Vessel::orbital_reference_frame()`.

Returns A vector whose direction is the direction of the maneuver node burn, and magnitude is the delta-v of the burn in meters per second.

Note: Does not change when executing the maneuver node. See `Node::remaining_burn_vector()`.

std::tuple<double, double, double> **remaining_burn_vector** (*ReferenceFrame reference_frame* = ReferenceFrame())

Returns the remaining burn vector for the maneuver node.

Parameters

- **reference_frame** – The reference frame that the returned vector is in. Defaults to `Vessel::orbital_reference_frame()`.

Returns A vector whose direction is the direction of the maneuver node burn, and magnitude is the delta-v of the burn in meters per second.

Note: Changes as the maneuver node is executed. See `Node::burn_vector()`.

double **ut** ()

void **set_ut** (double *value*)

The universal time at which the maneuver will occur, in seconds.

double **time_to** ()

The time until the maneuver node will be encountered, in seconds.

Orbit **orbit** ()

The orbit that results from executing the maneuver node.

void **remove** ()

Removes the maneuver node.

ReferenceFrame **reference_frame** ()

The reference frame that is fixed relative to the maneuver node's burn.

- The origin is at the position of the maneuver node.
- The y-axis points in the direction of the burn.
- The x-axis and z-axis point in arbitrary but fixed directions.

ReferenceFrame **orbital_reference_frame** ()

The reference frame that is fixed relative to the maneuver node, and orientated with the orbital prograde/normal/radial directions of the original orbit at the maneuver node's position.

- The origin is at the position of the maneuver node.
- The x-axis points in the orbital anti-radial direction of the original orbit, at the position of the maneuver node.
- The y-axis points in the orbital prograde direction of the original orbit, at the position of the maneuver node.
- The z-axis points in the orbital normal direction of the original orbit, at the position of the maneuver node.

std::tuple<double, double, double> **position** (ReferenceFrame *reference_frame*)

The position vector of the maneuver node in the given reference frame.

Parameters

- **reference_frame** – The reference frame that the returned position vector is in.

Returns The position as a vector.

std::tuple<double, double, double> **direction** (ReferenceFrame *reference_frame*)

The direction of the maneuver nodes burn.

Parameters

- **reference_frame** – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

5.3.11 ReferenceFrame

class ReferenceFrame

Represents a reference frame for positions, rotations and velocities.

Contains:

- The position of the origin.
- The directions of the x, y and z axes.
- The linear velocity of the frame.
- The angular velocity of the frame.

Note: This class does not contain any properties or methods. It is only used as a parameter to other functions.

```
static ReferenceFrame create_relative (Client &connection, ReferenceFrame reference_frame,
                                         std::tuple<double, double, double> position = (0.0, 0.0,
                                         0.0), std::tuple<double, double, double, double> rota-
                                         tion = (0.0, 0.0, 0.0, 1.0), std::tuple<double, double,
                                         double> velocity = (0.0, 0.0, 0.0), std::tuple<double,
                                         double, double> angular_velocity = (0.0, 0.0, 0.0))
```

Create a relative reference frame. This is a custom reference frame whose components offset the components of a parent reference frame.

Parameters

- **reference_frame** – The parent reference frame on which to base this reference frame.
- **position** – The offset of the position of the origin, as a position vector. Defaults to (0, 0, 0)
- **rotation** – The rotation to apply to the parent frames rotation, as a quaternion of the form (x, y, z, w) . Defaults to (0, 0, 0, 1) (i.e. no rotation)
- **velocity** – The linear velocity to offset the parent frame by, as a vector pointing in the direction of travel, whose magnitude is the speed in meters per second. Defaults to (0, 0, 0).
- **angular_velocity** – The angular velocity to offset the parent frame by, as a vector. This vector points in the direction of the axis of rotation, and its magnitude is the speed of the rotation in radians per second. Defaults to (0, 0, 0).

```
static ReferenceFrame create_hybrid (Client &connection, ReferenceFrame position, Refer-
                                         enceFrame rotation = ReferenceFrame(), ReferenceFrame
                                         velocity = ReferenceFrame(), ReferenceFrame angu-
                                         lar_velocity = ReferenceFrame())
```

Create a hybrid reference frame. This is a custom reference frame whose components inherited from other reference frames.

Parameters

- **position** – The reference frame providing the position of the origin.
- **rotation** – The reference frame providing the rotation of the frame.
- **velocity** – The reference frame providing the linear velocity of the frame.

- **angular_velocity** – The reference frame providing the angular velocity of the frame.

Note: The *position* reference frame is required but all other reference frames are optional. If omitted, they are set to the *position* reference frame.

5.3.12 AutoPilot

class AutoPilot

Provides basic auto-piloting utilities for a vessel. Created by calling `Vessel::auto_pilot()`.

Note: If a client engages the auto-pilot and then closes its connection to the server, the auto-pilot will be disengaged and its target reference frame, direction and roll reset to default.

void **engage** ()

Engage the auto-pilot.

void **disengage** ()

Disengage the auto-pilot.

void **wait** ()

Blocks until the vessel is pointing in the target direction and has the target roll (if set). Throws an exception if the auto-pilot has not been engaged.

float **error** ()

The error, in degrees, between the direction the ship has been asked to point in and the direction it is pointing in. Throws an exception if the auto-pilot has not been engaged and SAS is not enabled or is in stability assist mode.

float **pitch_error** ()

The error, in degrees, between the vessels current and target pitch. Throws an exception if the auto-pilot has not been engaged.

float **heading_error** ()

The error, in degrees, between the vessels current and target heading. Throws an exception if the auto-pilot has not been engaged.

float **roll_error** ()

The error, in degrees, between the vessels current and target roll. Throws an exception if the auto-pilot has not been engaged or no target roll is set.

ReferenceFrame **reference_frame** ()

void **set_reference_frame** (*ReferenceFrame value*)

The reference frame for the target direction (`AutoPilot::target_direction()`).

Note: An error will be thrown if this property is set to a reference frame that rotates with the vessel being controlled, as it is impossible to rotate the vessel in such a reference frame.

float **target_pitch** ()

void **set_target_pitch** (float *value*)

The target pitch, in degrees, between -90° and +90°.

float **target_heading** ()

void **set_target_heading** (float *value*)

The target heading, in degrees, between 0° and 360°.

float **target_roll** ()

void **set_target_roll** (float *value*)

The target roll, in degrees. NaN if no target roll is set.

std::tuple<double, double, double> **target_direction** ()

void **set_target_direction** (std::tuple<double, double, double> *value*)

Direction vector corresponding to the target pitch and heading. This is in the reference frame specified by *ReferenceFrame*.

void **target_pitch_and_heading** (float *pitch*, float *heading*)

Set target pitch and heading angles.

Parameters

- **pitch** – Target pitch angle, in degrees between -90° and +90°.
- **heading** – Target heading angle, in degrees between 0° and 360°.

bool **sas** ()

void **set_sas** (bool *value*)

The state of SAS.

Note: Equivalent to *Control::sas* ()

SASMode **sas_mode** ()

void **set_sas_mode** (SASMode *value*)

The current *SASMode*. These modes are equivalent to the mode buttons to the left of the navball that appear when SAS is enabled.

Note: Equivalent to *Control::sas_mode* ()

double **roll_threshold** ()

void **set_roll_threshold** (double *value*)

The threshold at which the autopilot will try to match the target roll angle, if any. Defaults to 5 degrees.

std::tuple<double, double, double> **stopping_time** ()

void **set_stopping_time** (std::tuple<double, double, double> *value*)

The maximum amount of time that the vessel should need to come to a complete stop. This determines the maximum angular velocity of the vessel. A vector of three stopping times, in seconds, one for each of the pitch, roll and yaw axes. Defaults to 0.5 seconds for each axis.

std::tuple<double, double, double> **deceleration_time** ()

void **set_deceleration_time** (std::tuple<double, double, double> *value*)

The time the vessel should take to come to a stop pointing in the target direction. This determines the angular acceleration used to decelerate the vessel. A vector of three times, in seconds, one for each of the pitch, roll and yaw axes. Defaults to 5 seconds for each axis.

std::tuple<double, double, double> **attenuation_angle** ()

void **set_attenuation_angle** (std::tuple<double, double, double> *value*)

The angle at which the autopilot considers the vessel to be pointing close to the target. This determines the midpoint of the target velocity attenuation function. A vector of three angles, in degrees, one for each of the pitch, roll and yaw axes. Defaults to 1° for each axis.

bool **auto_tune** ()

void **set_auto_tune** (bool *value*)

Whether the rotation rate controllers PID parameters should be automatically tuned using the vessels moment of inertia and available torque. Defaults to true. See `AutoPilot::time_to_peak()` and `AutoPilot::overshoot()`.

std::tuple<double, double, double> **time_to_peak** ()

void **set_time_to_peak** (std::tuple<double, double, double> *value*)

The target time to peak used to autotune the PID controllers. A vector of three times, in seconds, for each of the pitch, roll and yaw axes. Defaults to 3 seconds for each axis.

std::tuple<double, double, double> **overshoot** ()

void **set_overshoot** (std::tuple<double, double, double> *value*)

The target overshoot percentage used to autotune the PID controllers. A vector of three values, between 0 and 1, for each of the pitch, roll and yaw axes. Defaults to 0.01 for each axis.

`std::tuple<double, double, double> pitch_pid_gains ()`

void **set_pitch_pid_gains** (std::tuple<double, double, double> *value*)
Gains for the pitch PID controller.

Note: When *AutoPilot::auto_tune()* is true, these values are updated automatically, which will overwrite any manual changes.

`std::tuple<double, double, double> roll_pid_gains ()`

void **set_roll_pid_gains** (std::tuple<double, double, double> *value*)
Gains for the roll PID controller.

Note: When *AutoPilot::auto_tune()* is true, these values are updated automatically, which will overwrite any manual changes.

`std::tuple<double, double, double> yaw_pid_gains ()`

void **set_yaw_pid_gains** (std::tuple<double, double, double> *value*)
Gains for the yaw PID controller.

Note: When *AutoPilot::auto_tune()* is true, these values are updated automatically, which will overwrite any manual changes.

5.3.13 Camera

class Camera

Controls the game's camera. Obtained by calling *camera()*.

CameraMode **mode** ()

void **set_mode** (*CameraMode value*)
The current mode of the camera.

float **pitch** ()

void **set_pitch** (float *value*)
The pitch of the camera, in degrees. A value between *Camera::min_pitch()* and *Camera::max_pitch()*

float **heading** ()

void **set_heading** (float *value*)
The heading of the camera, in degrees.

float **distance**()

void **set_distance**(float *value*)

The distance from the camera to the subject, in meters. A value between *Camera::min_distance()* and *Camera::max_distance()*.

float **min_pitch**()

The minimum pitch of the camera.

float **max_pitch**()

The maximum pitch of the camera.

float **min_distance**()

Minimum distance from the camera to the subject, in meters.

float **max_distance**()

Maximum distance from the camera to the subject, in meters.

float **default_distance**()

Default distance from the camera to the subject, in meters.

CelestialBody **focussed_body**()

void **set_focussed_body**(*CelestialBody value*)

In map mode, the celestial body that the camera is focussed on. Returns NULL if the camera is not focussed on a celestial body. Returns an error if the camera is not in map mode.

Vessel **focussed_vessel**()

void **set_focussed_vessel**(*Vessel value*)

In map mode, the vessel that the camera is focussed on. Returns NULL if the camera is not focussed on a vessel. Returns an error if the camera is not in map mode.

Node **focussed_node**()

void **set_focussed_node**(*Node value*)

In map mode, the maneuver node that the camera is focussed on. Returns NULL if the camera is not focussed on a maneuver node. Returns an error if the camera is not in map mode.

enum struct CameraMode

See *Camera::mode()*.

enumerator automatic

The camera is showing the active vessel, in “auto” mode.

enumerator free

The camera is showing the active vessel, in “free” mode.

enumerator chase

The camera is showing the active vessel, in “chase” mode.

enumerator locked

The camera is showing the active vessel, in “locked” mode.

enumerator orbital

The camera is showing the active vessel, in “orbital” mode.

enumerator iva

The Intra-Vehicular Activity view is being shown.

enumerator map

The map view is being shown.

5.3.14 Waypoints

class WaypointManager

Waypoints are the location markers you can see on the map view showing you where contracts are targeted for. With this structure, you can obtain coordinate data for the locations of these waypoints. Obtained by calling `waypoint_manager()`.

`std::vector<Waypoint> waypoints ()`

A list of all existing waypoints.

`Waypoint add_waypoint (double latitude, double longitude, CelestialBody body, std::string name)`

Creates a waypoint at the given position at ground level, and returns a *Waypoint* object that can be used to modify it.

Parameters

- **latitude** – Latitude of the waypoint.
- **longitude** – Longitude of the waypoint.
- **body** – Celestial body the waypoint is attached to.
- **name** – Name of the waypoint.

`Waypoint add_waypoint_at_altitude (double latitude, double longitude, double altitude, CelestialBody body, std::string name)`

Creates a waypoint at the given position and altitude, and returns a *Waypoint* object that can be used to modify it.

Parameters

- **latitude** – Latitude of the waypoint.
- **longitude** – Longitude of the waypoint.
- **altitude** – Altitude (above sea level) of the waypoint.
- **body** – Celestial body the waypoint is attached to.
- **name** – Name of the waypoint.

`std::map<std::string, int32_t> colors ()`

An example map of known color - seed pairs. Any other integers may be used as seed.

`std::vector<std::string> icons ()`

Returns all available icons (from “Game-Data/Squad/Contracts/Icons”).

class Waypoint

Represents a waypoint. Can be created using `WaypointManager::add_waypoint()`.

CelestialBody **body** ()

void **set_body** (*CelestialBody value*)

The celestial body the waypoint is attached to.

std::string **name** ()

void **set_name** (std::string *value*)

The name of the waypoint as it appears on the map and the contract.

int32_t **color** ()

void **set_color** (int32_t *value*)

The seed of the icon color. See *WaypointManager::colors()* for example colors.

std::string **icon** ()

void **set_icon** (std::string *value*)

The icon of the waypoint.

double **latitude** ()

void **set_latitude** (double *value*)

The latitude of the waypoint.

double **longitude** ()

void **set_longitude** (double *value*)

The longitude of the waypoint.

double **mean_altitude** ()

void **set_mean_altitude** (double *value*)

The altitude of the waypoint above sea level, in meters.

double **surface_altitude** ()

void **set_surface_altitude** (double *value*)

The altitude of the waypoint above the surface of the body or sea level, whichever is closer, in meters.

double **bedrock_altitude** ()

void **set_bedrock_altitude** (double *value*)

The altitude of the waypoint above the surface of the body, in meters. When over water, this is the altitude above the sea floor.

bool **near_surface** ()

true if the waypoint is near to the surface of a body.

bool **grounded** ()

true if the waypoint is attached to the ground.

int32_t index ()

The integer index of this waypoint within its cluster of sibling waypoints. In other words, when you have a cluster of waypoints called “Somewhere Alpha”, “Somewhere Beta” and “Somewhere Gamma”, the alpha site has index 0, the beta site has index 1 and the gamma site has index 2. When *Waypoint::clustered()* is *false*, this is zero.

bool clustered ()

true if this waypoint is part of a set of clustered waypoints with greek letter names appended (Alpha, Beta, Gamma, etc). If *true*, there is a one-to-one correspondence with the greek letter name and the *Waypoint::index()*.

bool has_contract ()

Whether the waypoint belongs to a contract.

Contract contract ()

The associated contract.

void remove ()

Removes the waypoint.

5.3.15 Contracts

class ContractManager

Contracts manager. Obtained by calling *waypoint_manager()*.

std::set<std::string> types ()

A list of all contract types.

std::vector<Contract> all_contracts ()

A list of all contracts.

std::vector<Contract> active_contracts ()

A list of all active contracts.

std::vector<Contract> offered_contracts ()

A list of all offered, but unaccepted, contracts.

std::vector<Contract> completed_contracts ()

A list of all completed contracts.

std::vector<Contract> failed_contracts ()

A list of all failed contracts.

class Contract

A contract. Can be accessed using *contract_manager()*.

std::string type ()

Type of the contract.

std::string title ()

Title of the contract.

std::string description ()

Description of the contract.

std::string notes ()

Notes for the contract.

`std::string synopsis ()`
Synopsis for the contract.

`std::vector<std::string> keywords ()`
Keywords for the contract.

`ContractState state ()`
State of the contract.

`bool seen ()`
Whether the contract has been seen.

`bool read ()`
Whether the contract has been read.

`bool active ()`
Whether the contract is active.

`bool failed ()`
Whether the contract has been failed.

`bool can_be_canceled ()`
Whether the contract can be canceled.

`bool can_be_declined ()`
Whether the contract can be declined.

`bool can_be_failed ()`
Whether the contract can be failed.

`void accept ()`
Accept an offered contract.

`void cancel ()`
Cancel an active contract.

`void decline ()`
Decline an offered contract.

`double funds_advance ()`
Funds received when accepting the contract.

`double funds_completion ()`
Funds received on completion of the contract.

`double funds_failure ()`
Funds lost if the contract is failed.

`double reputation_completion ()`
Reputation gained on completion of the contract.

`double reputation_failure ()`
Reputation lost if the contract is failed.

`double science_completion ()`
Science gained on completion of the contract.

`std::vector<ContractParameter> parameters ()`
Parameters for the contract.

`enum struct ContractState`
The state of a contract. See `Contract::state ()`.

enumerator active

The contract is active.

enumerator canceled

The contract has been canceled.

enumerator completed

The contract has been completed.

enumerator deadline_expired

The deadline for the contract has expired.

enumerator declined

The contract has been declined.

enumerator failed

The contract has been failed.

enumerator generated

The contract has been generated.

enumerator offered

The contract has been offered to the player.

enumerator offer_expired

The contract was offered to the player, but the offer expired.

enumerator withdrawn

The contract has been withdrawn.

class ContractParameter

A contract parameter. See *Contract::parameters()*.

std::string title()

Title of the parameter.

std::string notes()

Notes for the parameter.

std::vector<ContractParameter> children()

Child contract parameters.

bool completed()

Whether the parameter has been completed.

bool failed()

Whether the parameter has been failed.

bool optional()

Whether the contract parameter is optional.

double funds_completion()

Funds received on completion of the contract parameter.

double funds_failure()

Funds lost if the contract parameter is failed.

double reputation_completion()

Reputation gained on completion of the contract parameter.

double reputation_failure()

Reputation lost if the contract parameter is failed.

double **science_completion**()

Science gained on completion of the contract parameter.

5.3.16 Geometry Types

Vectors

3-dimensional vectors are represented as a 3-tuple. For example:

```
#include <iostream>
#include <tuple>
#include <krpc.hpp>
#include <krpc/services/space_center.hpp>

int main() {
    krpc::Client conn = krpc::connect();
    krpc::services::SpaceCenter sc(&conn);
    std::tuple<double, double, double>
    ↪ v = sc.active_vessel().flight().prograde();
    std::cout << std::get<0>(v) << " "
               << std::get<1>(v) << " "
               << std::get<2>(v) << std::endl;
}
```

Quaternions

Quaternions (rotations in 3-dimensional space) are encoded as a 4-tuple containing the x, y, z and w components. For example:

```
#include <iostream>
#include <tuple>
#include <krpc.hpp>
#include <krpc/services/space_center.hpp>

int main() {
    krpc::Client conn = krpc::connect();
    krpc::services::SpaceCenter sc(&conn);
    std::tuple<double, double, double, double>
    ↪ q = sc.active_vessel().flight().rotation();
    std::cout << std::get<0>(q) << " "
               << std::get<1>(q) << " "
               << std::get<2>(q) << " "
               << std::get<3>(q) << std::endl;
}
```

5.4 Drawing API

5.4.1 Drawing

class Drawing: public krpc::Service

Provides functionality for drawing objects in the flight scene.

Drawing (krpc::Client *client)

Construct an instance of this service.

Line **add_line** (std::tuple<double, double, double> start, std::tuple<double, double, double> end, SpaceCenter::ReferenceFrame reference_frame, bool visible = true)
 Draw a line in the scene.

Parameters

- **start** – Position of the start of the line.
- **end** – Position of the end of the line.
- **reference_frame** – Reference frame that the positions are in.
- **visible** – Whether the line is visible.

Line **add_direction** (std::tuple<double, double, double> direction, SpaceCenter::ReferenceFrame reference_frame, float length = 10.0, bool visible = true)
 Draw a direction vector in the scene, from the center of mass of the active vessel.

Parameters

- **direction** – Direction to draw the line in.
- **reference_frame** – Reference frame that the direction is in.
- **length** – The length of the line.
- **visible** – Whether the line is visible.

Polygon **add_polygon** (std::vector<std::tuple<double, double, double>> vertices, SpaceCenter::ReferenceFrame reference_frame, bool visible = true)
 Draw a polygon in the scene, defined by a list of vertices.

Parameters

- **vertices** – Vertices of the polygon.
- **reference_frame** – Reference frame that the vertices are in.
- **visible** – Whether the polygon is visible.

Text **add_text** (std::string text, SpaceCenter::ReferenceFrame reference_frame, std::tuple<double, double, double> position, std::tuple<double, double, double, double> rotation, bool visible = true)
 Draw text in the scene.

Parameters

- **text** – The string to draw.
- **reference_frame** – Reference frame that the text position is in.
- **position** – Position of the text.
- **rotation** – Rotation of the text, as a quaternion.
- **visible** – Whether the text is visible.

void **clear** (bool client_only = false)
 Remove all objects being drawn.

Parameters

- **client_only** – If true, only remove objects created by the calling client.

5.4.2 Line

class Line

A line. Created using *add_line()*.

std::tuple<double, double, double> **start** ()

void **set_start** (std::tuple<double, double, double> *value*)
Start position of the line.

std::tuple<double, double, double> **end** ()

void **set_end** (std::tuple<double, double, double> *value*)
End position of the line.

SpaceCenter::ReferenceFrame **reference_frame** ()

void **set_reference_frame** (*SpaceCenter::ReferenceFrame value*)
Reference frame for the positions of the object.

bool **visible** ()

void **set_visible** (bool *value*)
Whether the object is visible.

std::tuple<double, double, double> **color** ()

void **set_color** (std::tuple<double, double, double> *value*)
Set the color

std::string **material** ()

void **set_material** (std::string *value*)
Material used to render the object. Creates the material from a
shader with the given name.

float **thickness** ()

void **set_thickness** (float *value*)
Set the thickness

void **remove** ()
Remove the object.

5.4.3 Polygon

class Polygon

A polygon. Created using *add_polygon()*.

std::vector<std::tuple<double, double, double>> **vertices** ()

void **set_vertices** (std::vector<std::tuple<double, double, double>> *value*)
Vertices for the polygon.

SpaceCenter::ReferenceFrame **reference_frame** ()

void **set_reference_frame** (*SpaceCenter::ReferenceFrame value*)
Reference frame for the positions of the object.

bool **visible** ()

void **set_visible** (bool *value*)
Whether the object is visible.

void **remove** ()
Remove the object.

std::tuple<double, double, double> **color** ()

void **set_color** (std::tuple<double, double, double> *value*)
Set the color

std::string **material** ()

void **set_material** (std::string *value*)
Material used to render the object. Creates the material from a
shader with the given name.

float **thickness** ()

void **set_thickness** (float *value*)
Set the thickness

5.4.4 Text

class Text

Text. Created using *add_text* ().

std::tuple<double, double, double> **position** ()

void **set_position** (std::tuple<double, double, double> *value*)
Position of the text.

std::tuple<double, double, double, double> **rotation** ()

void **set_rotation** (std::tuple<double, double, double, double> *value*)
Rotation of the text as a quaternion.

SpaceCenter::ReferenceFrame **reference_frame** ()

void **set_reference_frame** (*SpaceCenter::ReferenceFrame value*)
Reference frame for the positions of the object.

bool **visible** ()

void **set_visible** (bool *value*)
Whether the object is visible.

void **remove** ()
Remove the object.

std::string **content** ()

void **set_content** (std::string *value*)
The text string

std::string **font** ()

void **set_font** (std::string *value*)
Name of the font

static std::vector<std::string> **available_fonts** (*Client &connection*)
A list of all available fonts.

int32_t **size** ()

void **set_size** (int32_t *value*)
Font size.

float **character_size** ()

void **set_character_size** (float *value*)
Character size.

UI::FontStyle **style** ()

void **set_style** (*UI::FontStyle value*)
Font style.

std::tuple<double, double, double> **color** ()

void **set_color** (std::tuple<double, double, double> *value*)
Set the color

std::string **material** ()

void **set_material** (std::string *value*)
Material used to render the object. Creates the material from a
shader with the given name.

UI::TextAlignment **alignment** ()

void **set_alignment** (*UI::TextAlignment value*)
Alignment.

float **line_spacing** ()

void **set_line_spacing** (float *value*)
Line spacing.

UI::TextAnchor **anchor** ()

void **set_anchor** (*UI::TextAnchor value*)
Anchor.

5.5 InfernalRobotics API

Provides RPCs to interact with the [InfernalRobotics](#) mod. Provides the following classes:

5.5.1 InfernalRobotics

class InfernalRobotics : public `krpc::Service`
This service provides functionality to interact with [InfernalRobotics](#).

InfernalRobotics (`krpc::Client *client`)
Construct an instance of this service.

bool **available** ()
Whether Infernal Robotics is installed.

std::vector<*ServoGroup*> **servo_groups** (*SpaceCenter::Vessel vessel*)
A list of all the servo groups in the given *vessel*.

Parameters

ServoGroup **servo_group_with_name** (*SpaceCenter::Vessel vessel*, std::string *name*)
Returns the servo group in the given *vessel* with the given *name*, or NULL if none exists. If multiple servo groups have the same name, only one of them is returned.

Parameters

- **vessel** – Vessel to check.
- **name** – Name of servo group to find.

Servo **servo_with_name** (*SpaceCenter::Vessel vessel*, std::string *name*)
Returns the servo in the given *vessel* with the given *name* or NULL if none exists. If multiple servos have the same name, only one of them is returned.

Parameters

- **vessel** – Vessel to check.
- **name** – Name of the servo to find.

5.5.2 ServoGroup

class ServoGroup
A group of servos, obtained by calling *servo_groups()* or *servo_group_with_name()*. Represents the “Servo Groups” in the InfernalRobotics UI.

std::string **name** ()

void **set_name** (std::string *value*)

The name of the group.

std::string **forward_key** ()

void **set_forward_key** (std::string *value*)

The key assigned to be the “forward” key for the group.

std::string **reverse_key** ()

void **set_reverse_key** (std::string *value*)

The key assigned to be the “reverse” key for the group.

float **speed** ()

void **set_speed** (float *value*)

The speed multiplier for the group.

bool **expanded** ()

void **set_expanded** (bool *value*)

Whether the group is expanded in the InfernalRobotics UI.

std::vector<Servo> **servos** ()

The servos that are in the group.

Servo **servo_with_name** (std::string *name*)

Returns the servo with the given *name* from this group, or NULL if none exists.

Parameters

- **name** – Name of servo to find.

std::vector<SpaceCenter::Part> **parts** ()

The parts containing the servos in the group.

void **move_right** ()

Moves all of the servos in the group to the right.

void **move_left** ()

Moves all of the servos in the group to the left.

void **move_center** ()

Moves all of the servos in the group to the center.

void **move_next_preset** ()

Moves all of the servos in the group to the next preset.

void **move_prev_preset** ()

Moves all of the servos in the group to the previous preset.

void **stop** ()

Stops the servos in the group.

5.5.3 Servo

class Servo

Represents a servo. Obtained using *ServoGroup::servos()*,

ServoGroup::servo_with_name() or
servo_with_name().

std::string **name**()

void **set_name**(std::string *value*)

The name of the servo.

SpaceCenter::Part **part**()

The part containing the servo.

void **set_highlight**(bool *value*)

Whether the servo should be highlighted in-game.

float **position**()

The position of the servo.

float **min_config_position**()

The minimum position of the servo, specified by the part configuration.

float **max_config_position**()

The maximum position of the servo, specified by the part configuration.

float **min_position**()

void **set_min_position**(float *value*)

The minimum position of the servo, specified by the in-game tweak menu.

float **max_position**()

void **set_max_position**(float *value*)

The maximum position of the servo, specified by the in-game tweak menu.

float **config_speed**()

The speed multiplier of the servo, specified by the part configuration.

float **speed**()

void **set_speed**(float *value*)

The speed multiplier of the servo, specified by the in-game tweak menu.

float **current_speed**()

void **set_current_speed**(float *value*)

The current speed at which the servo is moving.

float **acceleration**()

void **set_acceleration**(float *value*)

The current speed multiplier set in the UI.

bool **is_moving**()
Whether the servo is moving.

bool **is_free_moving**()
Whether the servo is freely moving.

bool **is_locked**()

void **set_is_locked**(bool *value*)
Whether the servo is locked.

bool **is_axis_inverted**()

void **set_is_axis_inverted**(bool *value*)
Whether the servos axis is inverted.

void **move_right**()
Moves the servo to the right.

void **move_left**()
Moves the servo to the left.

void **move_center**()
Moves the servo to the center.

void **move_next_preset**()
Moves the servo to the next preset.

void **move_prev_preset**()
Moves the servo to the previous preset.

void **move_to**(float *position*, float *speed*)
Moves the servo to *position* and sets the speed multiplier to *speed*.

Parameters

- **position** – The position to move the servo to.
- **speed** – Speed multiplier for the movement.

void **stop**()
Stops the servo.

5.5.4 Example

The following example gets the control group named “MyGroup”, prints out the names and positions of all of the servos in the group, then moves all of the servos to the right for 1 second.

```
#include <iostream>
#include <vector>
#include <thread>
#include <krpc.hpp>
#include <krpc/services/space_center.hpp>
#include <krpc/services/infernal_robotics.hpp>

using SpaceCenter = krpc::services::SpaceCenter;
using InfernalRobotics_
↳= krpc::services::InfernalRobotics;
```

```

int main() {
    auto conn_
    ↪= krpc::connect("InfernalRobotics Example");
    SpaceCenter space_center(&conn);
    InfernalRobotics infernal_robotics(&conn);

    InfernalRobotics::ServoGroup_
    ↪group = infernal_robotics.servo_group_with_
    ↪name(space_center.active_vessel(), "MyGroup");
    if (group == InfernalRobotics::ServoGroup())
        std::cout << "Group not found" << std::endl;

    std::vector<InfernalRobotics::Servo>
    ↪ servos = group.servos();
    for (auto servo : servos)
        std::cout << servo.
    ↪name() << " " << servo.position() << std::endl;

    group.move_right();
    std::this_
    ↪thread::sleep_for(std::chrono::seconds(1));
    group.stop();
}

```

5.6 Kerbal Alarm Clock API

Provides RPCs to interact with the [Kerbal Alarm Clock](#) mod. Provides the following classes:

5.6.1 KerbalAlarmClock

class KerbalAlarmClock : public krpc::Service
This service provides functionality to interact with [Kerbal Alarm Clock](#).

KerbalAlarmClock (krpc::Client *client)
Construct an instance of this service.

bool **available** ()
Whether Kerbal Alarm Clock is available.

std::vector<Alarm> **alarms** ()
A list of all the alarms.

Alarm **alarm_with_name** (std::string name)
Get the alarm with the given *name*, or NULL if no alarms have that name. If more than one alarm has the name, only returns one of them.

Parameters

- **name** – Name of the alarm to search for.

std::vector<Alarm> **alarms_with_type** (AlarmType type)
Get a list of alarms of the specified *type*.

Parameters

- **type** – Type of alarm to return.

Alarm **create_alarm** (*AlarmType* type, std::string name, double ut)
Create a new alarm and return it.

Parameters

- **type** – Type of the new alarm.
- **name** – Name of the new alarm.
- **ut** – Time at which the new alarm should trigger.

5.6.2 Alarm

class Alarm

Represents an alarm. Obtained by calling *alarms()*, *alarm_with_name()* or *alarms_with_type()*.

AlarmAction **action** ()

void **set_action** (*AlarmAction* value)
The action that the alarm triggers.

double **margin** ()

void **set_margin** (double value)
The number of seconds before the event that the alarm will fire.

double **time** ()

void **set_time** (double value)
The time at which the alarm will fire.

AlarmType **type** ()
The type of the alarm.

std::string **id** ()
The unique identifier for the alarm.

std::string **name** ()

void **set_name** (std::string value)
The short name of the alarm.

std::string **notes** ()

void **set_notes** (std::string value)
The long description of the alarm.

double **remaining** ()
The number of seconds until the alarm will fire.

bool **repeat** ()

void **set_repeat** (bool *value*)
Whether the alarm will be repeated after it has fired.

double **repeat_period** ()

void **set_repeat_period** (double *value*)
The time delay to automatically create an alarm after it has fired.

SpaceCenter::Vessel **vessel** ()

void **set_vessel** (*SpaceCenter::Vessel value*)
The vessel that the alarm is attached to.

SpaceCenter::CelestialBody **xfer_origin_body** ()

void **set_xfer_origin_body** (*SpaceCenter::CelestialBody value*)
The celestial body the vessel is departing from.

SpaceCenter::CelestialBody **xfer_target_body** ()

void **set_xfer_target_body** (*SpaceCenter::CelestialBody value*)
The celestial body the vessel is arriving at.

void **remove** ()
Removes the alarm.

5.6.3 AlarmType

enum struct AlarmType
The type of an alarm.

enumerator raw
An alarm for a specific date/time or a specific period in the future.

enumerator maneuver
An alarm based on the next maneuver node on the current ships flight path. This node will be stored and can be restored when you come back to the ship.

enumerator maneuver_auto
See *AlarmType::maneuver*.

enumerator apoapsis
An alarm for furthest part of the orbit from the planet.

enumerator periapsis
An alarm for nearest part of the orbit from the planet.

enumerator ascending_node
Ascending node for the targeted object, or equatorial ascending node.

enumerator descending_node
Descending node for the targeted object, or equatorial descending node.

enumerator closest

An alarm based on the closest approach of this vessel to the targeted vessel, some number of orbits into the future.

enumerator contract

An alarm based on the expiry or deadline of contracts in career modes.

enumerator contract_auto

See *AlarmType::contract*.

enumerator crew

An alarm that is attached to a crew member.

enumerator distance

An alarm that is triggered when a selected target comes within a chosen distance.

enumerator earth_time

An alarm based on the time in the “Earth” alternative Universe (aka the Real World).

enumerator launch_rendevous

An alarm that fires as your landed craft passes under the orbit of your target.

enumerator soi_change

An alarm manually based on when the next SOI point is on the flight path or set to continually monitor the active flight path and add alarms as it detects SOI changes.

enumerator soi_change_auto

See *AlarmType::soi_change*.

enumerator transfer

An alarm based on Interplanetary Transfer Phase Angles, i.e. when should I launch to planet X? Based on Kosmo Not’s post and used in Olex’s Calculator.

enumerator transfer_modelled

See *AlarmType::transfer*.

5.6.4 AlarmAction

enum struct AlarmAction

The action performed by an alarm when it fires.

enumerator do_nothing

Don’t do anything at all...

enumerator do_nothing_delete_when_passed

Don’t do anything, and delete the alarm.

enumerator kill_warp

Drop out of time warp.

enumerator kill_warp_only

Drop out of time warp.

enumerator message_only

Display a message.

enumerator pause_game

Pause the game.

5.6.5 Example

The following example creates a new alarm for the active vessel. The alarm is set to trigger after 10 seconds have passed, and display a message.

```
#include <iostream>
#include <krpc.hpp>
#include <krpc/services/space_center.hpp>
#include <krpc/services/kerbal_alarm_clock.hpp>

using KerbalAlarmClock_
↳= krpc::services::KerbalAlarmClock;

int main() {
    krpc::Client conn_
↳= krpc::connect("Kerbal Alarm Clock Example");
    krpc::services::SpaceCenter sc(&conn);
    KerbalAlarmClock kac(&conn);

    auto alarm = kac.
↳create_alarm(KerbalAlarmClock::AlarmType::raw,
               "My New Alarm",
               sc.ut()+10);

    alarm.set_notes("10 seconds_
↳have now passed since the alarm was created.");
    alarm.set_
↳action(KerbalAlarmClock::AlarmAction::message_
↳only);
}
```

5.7 RemoteTech API

Provides RPCs to interact with the [RemoteTech](#) mod. Provides the following classes:

5.7.1 RemoteTech

class RemoteTech: public krpc::Service

This service provides functionality to interact with [RemoteTech](#).

RemoteTech (krpc::Client *client)

Construct an instance of this service.

bool **available** ()

Whether RemoteTech is installed.

std::vector<std::string> **ground_stations** ()

The names of the ground stations.

Antenna **antenna** (*SpaceCenter::Part part*)

Get the antenna object for a particular part.

Parameters

Comms **comms** (*SpaceCenter::Vessel vessel*)

Get a communications object, representing the communication capability of a particular vessel.

Parameters

5.7.2 Comms

class Comms

Communications for a vessel.

SpaceCenter::Vessel **vessel** ()

Get the vessel.

bool **has_local_control** ()

Whether the vessel can be controlled locally.

bool **has_flight_computer** ()

Whether the vessel has a flight computer on board.

bool **has_connection** ()

Whether the vessel has any connection.

bool **has_connection_to_ground_station** ()

Whether the vessel has a connection to a ground station.

double **signal_delay** ()

The shortest signal delay to the vessel, in seconds.

double **signal_delay_to_ground_station** ()

The signal delay between the vessel and the closest ground station, in seconds.

double **signal_delay_to_vessel** (*SpaceCenter::Vessel other*)

The signal delay between the this vessel and another vessel, in seconds.

Parameters

std::vector<*Antenna*> **antennas** ()

The antennas for this vessel.

5.7.3 Antenna

class Antenna

A RemoteTech antenna. Obtained by calling *Comms::antennas* () or *antenna* ().

SpaceCenter::Part **part** ()

Get the part containing this antenna.

bool **has_connection** ()

Whether the antenna has a connection.

Target **target** ()

void **set_target** (*Target value*)

The object that the antenna is targetting. This property can be used to set the target to *Target::none* or *Target::active_vessel*. To set the target to a celestial body, ground station or vessel see *Antenna::target_body()*, *Antenna::target_ground_station()* and *Antenna::target_vessel()*.

SpaceCenter::CelestialBody **target_body** ()

void **set_target_body** (*SpaceCenter::CelestialBody value*)

The celestial body the antenna is targetting.

std::string **target_ground_station** ()

void **set_target_ground_station** (std::string *value*)

The ground station the antenna is targetting.

SpaceCenter::Vessel **target_vessel** ()

void **set_target_vessel** (*SpaceCenter::Vessel value*)

The vessel the antenna is targetting.

enum struct Target

The type of object an antenna is targetting. See *Antenna::target()*.

enumerator active_vessel

The active vessel.

enumerator celestial_body

A celestial body.

enumerator ground_station

A ground station.

enumerator vessel

A specific vessel.

enumerator none

No target.

5.7.4 Example

The following example sets the target of a dish on the active vessel then prints out the signal delay to the active vessel.

```
#include <iostream>
#include <krpc.hpp>
#include <krpc/services/space_center.hpp>
#include <krpc/services/remote_tech.hpp>

int main() {
    krpc::Client_
    ↪ conn = krpc::connect("RemoteTech Example");
```

```
krpc::services::SpaceCenter space_center(&conn);
krpc::services::RemoteTech remote_tech(&conn);
auto vessel = space_center.active_vessel();

// Set a dish target
auto part = vessel.
↳parts().with_title("Reflectron KR-7").front();
auto antenna = remote_tech.antenna(part);
antenna.
↳set_target_body(space_center.bodies()["Jool"]);

// Get info about the vessels communications
auto comms = remote_tech.comms(vessel);
std::cout << "Signal_
↳delay = " << comms.signal_delay() << std::endl;
}
```

5.8 User Interface API

5.8.1 UI

class UI : public krpc::Service

Provides functionality for drawing and interacting with in-game user interface elements.

UI (krpc::Client *client)

Construct an instance of this service.

Canvas **stock_canvas** ()

The stock UI canvas.

Canvas **add_canvas** ()

Add a new canvas.

Note: If you want to add UI elements to KSPs stock UI canvas, use `stock_canvas()`.

void **message** (std::string content, float duration = 1.0, MessagePosition position = static_cast<MessagePosition>(1))
Display a message on the screen.

Parameters

- **content** – Message content.
- **duration** – Duration before the message disappears, in seconds.
- **position** – Position to display the message.

Note: The message appears just like a stock message, for example quicksave or quickload messages.

void **clear** (bool client_only = false)

Remove all user interface elements.

Parameters

- **client_only** – If true, only remove objects created by the calling client.

enum struct MessagePosition

Message position.

enumerator top_left

Top left.

enumerator top_center

Top center.

enumerator top_right

Top right.

enumerator bottom_center

Bottom center.

5.8.2 Canvas

class Canvas

A canvas for user interface elements. See *stock_canvas()* and *add_canvas()*.

RectTransform **rect_transform()**

The rect transform for the canvas.

bool **visible()**

void **set_visible**(bool *value*)

Whether the UI object is visible.

Panel **add_panel**(bool *visible* = true)

Create a new container for user interface elements.

Parameters

- **visible** – Whether the panel is visible.

Text **add_text**(std::string *content*, bool *visible* = true)

Add text to the canvas.

Parameters

- **content** – The text.
- **visible** – Whether the text is visible.

InputField **add_input_field**(bool *visible* = true)

Add an input field to the canvas.

Parameters

- **visible** – Whether the input field is visible.

Button **add_button**(std::string *content*, bool *visible* = true)

Add a button to the canvas.

Parameters

- **content** – The label for the button.

- **visible** – Whether the button is visible.

void **remove** ()
Remove the UI object.

5.8.3 Panel

class Panel
A container for user interface elements. See
Canvas::add_panel().

RectTransform **rect_transform** ()
The rect transform for the panel.

bool **visible** ()

void **set_visible** (bool *value*)
Whether the UI object is visible.

Panel **add_panel** (bool *visible* = true)
Create a panel within this panel.

Parameters

- **visible** – Whether the new panel is visible.

Text **add_text** (std::string *content*, bool *visible* = true)
Add text to the panel.

Parameters

- **content** – The text.
- **visible** – Whether the text is visible.

InputField **add_input_field** (bool *visible* = true)
Add an input field to the panel.

Parameters

- **visible** – Whether the input field is visible.

Button **add_button** (std::string *content*, bool *visible* = true)
Add a button to the panel.

Parameters

- **content** – The label for the button.
- **visible** – Whether the button is visible.

void **remove** ()
Remove the UI object.

5.8.4 Text

class Text
A text label. See *Panel::add_text()*.

RectTransform **rect_transform** ()
The rect transform for the text.

```

bool visible ()

void set_visible (bool value)
    Whether the UI object is visible.

std::string content ()

void set_content (std::string value)
    The text string

std::string font ()

void set_font (std::string value)
    Name of the font

std::vector<std::string> available_fonts ()
    A list of all available fonts.

int32_t size ()

void set_size (int32_t value)
    Font size.

FontStyle style ()

void set_style (FontStyle value)
    Font style.

std::tuple<double, double, double> color ()

void set_color (std::tuple<double, double, double> value)
    Set the color

TextAnchor alignment ()

void set_alignment (TextAnchor value)
    Alignment.

float line_spacing ()

void set_line_spacing (float value)
    Line spacing.

void remove ()
    Remove the UI object.

enum struct FontStyle
    Font style.

enumerator normal
    Normal.

enumerator bold
    Bold.

```

enumerator italic

Italic.

enumerator bold_and_italic

Bold and italic.

enum struct TextAlignment

Text alignment.

enumerator left

Left aligned.

enumerator right

Right aligned.

enumerator center

Center aligned.

enum struct TextAnchor

Text alignment.

enumerator lower_center

Lower center.

enumerator lower_left

Lower left.

enumerator lower_right

Lower right.

enumerator middle_center

Middle center.

enumerator middle_left

Middle left.

enumerator middle_right

Middle right.

enumerator upper_center

Upper center.

enumerator upper_left

Upper left.

enumerator upper_right

Upper right.

5.8.5 Button

class Button

A text label. See *Panel::add_button()*.

RectTransform **rect_transform()**

The rect transform for the text.

bool **visible()**

void **set_visible**(bool *value*)

Whether the UI object is visible.

Text **text** ()

The text for the button.

bool **clicked** ()

void **set_clicked** (bool *value*)

Whether the button has been clicked.

Note: This property is set to true when the user clicks the button. A client script should reset the property to false in order to detect subsequent button presses.

void **remove** ()

Remove the UI object.

5.8.6 InputField

class InputField

An input field. See *Panel::add_input_field()*.

RectTransform **rect_transform** ()

The rect transform for the input field.

bool **visible** ()

void **set_visible** (bool *value*)

Whether the UI object is visible.

std::string **value** ()

void **set_value** (std::string *value*)

The value of the input field.

Text **text** ()

The text component of the input field.

Note: Use *InputField::value()* to get and set the value in the field. This object can be used to alter the style of the input field's text.

bool **changed** ()

void **set_changed** (bool *value*)

Whether the input field has been changed.

Note: This property is set to true when the user modifies the value of the input field. A client script should reset the property to false in order to detect subsequent changes.

void **remove** ()

Remove the UI object.

5.8.7 Rect Transform

class RectTransform

A Unity engine Rect Transform for a UI object. See the [Unity manual](#) for more details.

std::tuple<double, double> **position** ()

void **set_position** (std::tuple<double, double> *value*)
Position of the rectangles pivot point relative to the anchors.

std::tuple<double, double, double> **local_position** ()

void **set_local_position** (std::tuple<double, double, double> *value*)
Position of the rectangles pivot point relative to the anchors.

std::tuple<double, double> **size** ()

void **set_size** (std::tuple<double, double> *value*)
Width and height of the rectangle.

std::tuple<double, double> **upper_right** ()

void **set_upper_right** (std::tuple<double, double> *value*)
Position of the rectangles upper right corner relative to the anchors.

std::tuple<double, double> **lower_left** ()

void **set_lower_left** (std::tuple<double, double> *value*)
Position of the rectangles lower left corner relative to the anchors.

void **set_anchor** (std::tuple<double, double> *value*)
Set the minimum and maximum anchor points as a fraction of the size of the parent rectangle.

std::tuple<double, double> **anchor_max** ()

void **set_anchor_max** (std::tuple<double, double> *value*)
The anchor point for the lower left corner of the rectangle defined as a fraction of the size of the parent rectangle.

std::tuple<double, double> **anchor_min** ()

void **set_anchor_min** (std::tuple<double, double> *value*)
The anchor point for the upper right corner of the rectangle defined as a fraction of the size of the parent rectangle.

std::tuple<double, double> **pivot** ()

void **set_pivot** (std::tuple<double, double> *value*)
Location of the pivot point around which the rectangle rotates, defined as a fraction of the size of the rectangle itself.

std::tuple<double, double, double, double> **rotation** ()

void **set_rotation** (std::tuple<double, double, double, double> *value*)

Rotation, as a quaternion, of the object around its pivot point.

std::tuple<double, double, double> **scale** ()

void **set_scale** (std::tuple<double, double, double> *value*)

Scale factor applied to the object in the x, y and z dimensions.

6.1 Java Client

This client provides a Java API for interacting with a kRPC server. A jar containing the `krpc.client` package can be [downloaded from GitHub](#). It requires Java version 1.8.

6.1.1 Using the Library

The kRPC client library depends on the [protobuf](#) and [javatuples](#) libraries. A prebuilt jar for protobuf is available via [Maven](#). Note that you need protobuf version 3. Version 2 is not compatible with kRPC.

The following example program connects to the server, queries it for its version and prints it out:

```
import krpc.client.Connection;
import krpc.client.RPCException;
import krpc.client.services.KRPC;

import java.io.IOException;

public class Basic {
    public static void main(String[] args) throws IOException, RPCException {
        Connection connection = Connection.newInstance();
        KRPC krpc = KRPC.newInstance(connection);
        System.out.println("Connected to kRPC version " + krpc.getStatus().getVersion());
        connection.close();
    }
}
```

To compile this program using `javac` on the command line, save the source as `Example.java` and run the following:

```
javac -cp krpc-java-0.4.0.jar:protobuf-java-3.4.0.jar:javatuples-1.2.jar Example.java
```

You may need to change the paths to the JAR files.

6.1.2 Connecting to the Server

To connect to a server, call `Connection.newInstance()` which returns a connection object. All interaction with the server is done via this object. When constructed without any arguments, it will connect to the local machine on the default port numbers. You can specify different connection settings, and also a descriptive name for the connection, as follows:

```
import krpc.client.Connection;
import krpc.client.RPCException;
import krpc.client.services.KRPC;

import java.io.IOException;

public class Connecting {
    public static void main(String[] args) throws IOException, RPCException {
        Connection connection = Connection.newInstance("Remote example", "my.domain.name",
↪ 1000, 1001);
        System.out.println(KRPC.newInstance(connection).getStatus().getVersion());
        connection.close();
    }
}
```

6.1.3 Calling Remote Procedures

The kRPC server provides *procedures* that a client can run. These procedures are arranged in groups called *services* to keep things organized. The functionality for the services are defined in the package `krpc.client.services`. For example, all of the functionality provided by the `SpaceCenter` service is contained in the class `krpc.client.services.SpaceCenter`.

To interact with a service, you must first instantiate it. You can then call its methods and properties to invoke remote procedures. The following example demonstrates how to do this. It instantiates the `SpaceCenter` service and calls `krpc.client.services.SpaceCenter.SpaceCenter.getActiveVessel()` to get an object representing the active vessel (of type `krpc.client.services.SpaceCenter.Vessel`). It sets the name of the vessel and then prints out its altitude:

```
import krpc.client.Connection;
import krpc.client.RPCException;
import krpc.client.services.SpaceCenter;
import krpc.client.services.SpaceCenter.Vessel;

import java.io.IOException;

public class RemoteProcedures {
    public static void main(String[] args) throws IOException, RPCException {
        Connection connection = Connection.newInstance("Vessel Name");
        SpaceCenter spaceCenter = SpaceCenter.newInstance(connection);
        Vessel vessel = spaceCenter.getActiveVessel();
        System.out.println(vessel.getName());
        connection.close();
    }
}
```

6.1.4 Streaming Data from the Server

A common use case for kRPC is to continuously extract data from the game. The naive approach to do this would be to repeatedly call a remote procedure, such as in the following which repeatedly prints the position of the active vessel:

```
import krpc.client.Connection;
import krpc.client.RPCException;
import krpc.client.services.KRPC;
```

```

import krpc.client.services.SpaceCenter;
import krpc.client.services.SpaceCenter.ReferenceFrame;
import krpc.client.services.SpaceCenter.Vessel;

import java.io.IOException;

public class Streaming1 {
    public static void main(String[] args) throws IOException, RPCException {
        Connection connection = Connection.newInstance();
        SpaceCenter spaceCenter = SpaceCenter.newInstance(connection);
        Vessel vessel = spaceCenter.getActiveVessel();
        ReferenceFrame refframe = vessel.getOrbit().getBody().getReferenceFrame();
        while (true) {
            System.out.println(vessel.position(refframe));
        }
    }
}

```

This approach requires significant communication overhead as request/response messages are repeatedly sent between the client and server. kRPC provides a more efficient mechanism to achieve this, called *streams*.

A stream repeatedly executes a procedure on the server (with a fixed set of argument values) and sends the result to the client. It only requires a single message to be sent to the server to establish the stream, which will then continuously send data to the client until the stream is closed.

The following example does the same thing as above using streams:

```

import krpc.client.Connection;
import krpc.client.RPCException;
import krpc.client.Stream;
import krpc.client.StreamException;
import krpc.client.services.KRPC;
import krpc.client.services.SpaceCenter;
import krpc.client.services.SpaceCenter.ReferenceFrame;
import krpc.client.services.SpaceCenter.Vessel;

import org.javatuples.Triplet;

import java.io.IOException;

public class Streaming2 {
    public static void main(String[] args) throws IOException, RPCException,
↳StreamException {
        Connection connection = Connection.newInstance();
        SpaceCenter spaceCenter = SpaceCenter.newInstance(connection);
        Vessel vessel = spaceCenter.getActiveVessel();
        ReferenceFrame refframe = vessel.getOrbit().getBody().getReferenceFrame();
        Stream<Triplet<Double,Double,Double>> vesselStream = connection.addStream(vessel,
↳"position", refframe);
        while (true) {
            System.out.println(vesselStream.get());
        }
    }
}

```

It calls *Connection.addStream* once at the start of the program to create the stream, and then repeatedly prints the position returned by the stream. The stream is automatically closed when the client disconnects.

A stream can be created for any method call by calling *Connection.addStream* and passing it information about

which method to stream. The example above passes a remote object, the name of the method to call, followed by the arguments to pass to the method (if any). `Connection.addStream` returns a stream object of type `Stream`. The most recent value of the stream can be obtained by calling `Stream.get`. A stream can be stopped and removed from the server by calling `Stream.remove` on the stream object. All of a clients streams are automatically stopped when it disconnects.

6.1.5 Synchronizing with Stream Updates

A common use case for kRPC is to wait until the value returned by a method or attribute changes, and then take some action. kRPC provides two mechanisms to do this efficiently: *condition variables* and *callbacks*.

Condition Variables

Each stream has a condition variable associated with it, that is notified whenever the value of the stream changes. These can be used to block the current thread of execution until the value of the stream changes.

The following example waits until the abort button is pressed in game, by waiting for the value of `krpc.client.services.SpaceCenter.Control.getAbort()` to change to true:

```
import krpc.client.Connection;
import krpc.client.RPCException;
import krpc.client.Stream;
import krpc.client.StreamException;
import krpc.client.services.KRPC;
import krpc.client.services.SpaceCenter;
import krpc.client.services.SpaceCenter.Control;

import java.io.IOException;

public class ConditionVariables {
    public static void main(String[] args) throws IOException, RPCException,
↳StreamException {
        Connection connection = Connection.newInstance();
        SpaceCenter spaceCenter = SpaceCenter.newInstance(connection);
        Control control = spaceCenter.getActiveVessel().getControl();
        Stream<Boolean> abort = connection.addStream(control, "getAbort");
        synchronized (abort.getCondition()) {
            while (!abort.get()) {
                abort.waitForUpdate();
            }
        }
    }
}
```

This code creates a stream, acquires a lock on the streams condition variable (by using a `synchronized` block) and then repeatedly checks the value of `getAbort`. It leaves the loop when it changes to true.

The body of the loop calls `waitForUpdate` on the stream, which causes the program to block until the value changes. This prevents the loop from ‘spinning’ and so it does not consume processing resources whilst waiting.

Note: The stream does not start receiving updates until the first call to `waitForUpdate`. This means that the example code will not miss any updates to the streams value, as it will have already locked the condition variable before the first stream update is received.

Callbacks

Streams allow you to register callback functions that are called whenever the value of the stream changes. Callback functions should take a single argument, which is the new value of the stream, and should return nothing.

For example the following program registers two callbacks that are invoked when the value of `krpc.client.services.SpaceCenter.Control.getAbort()` changes:

```
import krpc.client.Connection;
import krpc.client.RPCException;
import krpc.client.Stream;
import krpc.client.StreamException;
import krpc.client.services.KRPC;
import krpc.client.services.SpaceCenter;
import krpc.client.services.SpaceCenter.Control;

import java.io.IOException;

public class Callbacks {
    public static void main(String[] args) throws IOException, RPCException,
↳StreamException {
        Connection connection = Connection.newInstance();
        SpaceCenter spaceCenter = SpaceCenter.newInstance(connection);
        Control control = spaceCenter.getActiveVessel().getControl();
        Stream<Boolean> abort = connection.addStream(control, "getAbort");
        abort.addCallback(
            (Boolean x) -> {
                System.out.println("Abort 1 called with a value of " + x);
            });
        abort.addCallback(
            (Boolean x) -> {
                System.out.println("Abort 2 called with a value of " + x);
            });
        abort.start();

        // Keep the program running...
        while (true) {
        }
    }
}
```

Note: When a stream is created it does not start receiving updates until `start` is called. This is implicitly called when accessing the value of a stream, but as this example does not do this an explicit call to `start` is required.

Note: The callbacks are registered before the call to `start` so that stream updates are not missed.

Note: The callback function may be called from a different thread to that which created the stream. Any changes to shared state must therefore be protected with appropriate synchronization.

6.1.6 Custom Events

Some procedures return event objects of type *Event*. These allow you to wait until an event occurs, by calling *Event.waitFor*. Under the hood, these are implemented using streams and condition variables.

Custom events can also be created. An expression API allows you to create code that runs on the server and these can be used to build a custom event. For example, the following creates the expression `MeanAltitude > 1000` and then creates an event that will be triggered when the expression returns true:

```
import krpc.client.Connection;
import krpc.client.RPCException;
import krpc.client.Event;
import krpc.client.StreamException;
import krpc.client.services.KRPC;
import krpc.client.services.KRPC.Expression;
import krpc.client.services.SpaceCenter;
import krpc.client.services.SpaceCenter.Flight;
import krpc.schema.KRPC.ProcedureCall;

import java.io.IOException;

public class CustomEvent {
    public static void main(String[] args) throws IOException, RPCException,
↳StreamException {
        Connection connection = Connection.newInstance();
        KRPC krpc = KRPC.newInstance(connection);
        SpaceCenter spaceCenter = SpaceCenter.newInstance(connection);
        Flight flight = spaceCenter.getActiveVessel().flight(null);

        // Get the remote procedure call as a message object,
        // so it can be passed to the server
        ProcedureCall meanAltitude = connection.getCall(flight, "getMeanAltitude");

        // Create an expression on the server
        Expression expr = Expression.greaterThan(connection,
            Expression.call(connection, meanAltitude),
            Expression.constantDouble(connection, 1000));

        Event event = krpc.addEvent(expr);
        synchronized (event.getCondition()) {
            event.waitFor();
            System.out.println("Altitude reached 1000m");
        }
    }
}
```

6.1.7 Client API Reference

class **Connection**

A connection to the kRPC server. All interaction with kRPC is performed via an instance of this class.

static *Connection* **newInstance** ()

static *Connection* **newInstance** (String name)

static *Connection* **newInstance** (String name, String address)

```
static Connection newInstance (String name, String address, int rpcPort, int streamPort)
static Connection newInstance (String name, java.net.InetAddress address)
static Connection newInstance (String name, java.net.InetAddress address, int rpcPort, int
                                streamPort)
```

Create a connection to the server, using the given connection details.

Parameters

- **name** (*String*) – A descriptive name for the connection. This is passed to the server and appears in the in-game server window.
- **address** (*String*) – The address of the server to connect to. Can either be a hostname, an IP address as a string or a `java.net.InetAddress` object. Defaults to 127.0.0.1.
- **rpc_port** (*int*) – The port number of the RPC Server. Defaults to 50000. This should match the RPC port number of the server you want to connect to.
- **stream_port** (*int*) – The port number of the Stream Server. Defaults to 50001. This should match the stream port number of the server you want to connect to.

```
Stream<T> addStream (Class<?> clazz, String method, Object... args)
```

Create a stream for a static method call to the given class.

```
Stream<T> addStream (RemoteObject instance, String method, Object... args)
```

Create a stream for a method call to the given remote object.

```
krpc.schema.KRPC.ProcedureCall getCall (Class<?> clazz, String method, Object... args)
```

Returns a procedure call message for the given static method call. This allows descriptions of procedure calls to be passed to the server, for example when constructing custom events. See *Custom Events*.

```
krpc.schema.KRPC.ProcedureCall getCall (RemoteObject instance, String method, Object... args)
```

Returns a procedure call message for the given method call. This allows descriptions of procedure calls to be passed to the server, for example when constructing custom events. See *Custom Events*.

```
void close ()
```

Close the connection.

```
class Stream<T>
```

This class represents a stream. See *Streaming Data from the Server*.

Stream objects implement `hashCode` and `equals` such that two stream objects are equal if they are bound to the same stream on the server.

```
void start ()
```

```
void startAndWait ()
```

Starts the stream. When a stream is created it does not start sending updates to the client until this method is called.

The `startAndWait` method will block until at least one update has been received from the server.

The `start` method starts the stream and returns immediately. Subsequent calls to `get()` may throw a `StreamException`.

```
float getRate ()
```

```
void setRate (float rate)
```

The update rate of the stream in Hertz. When set to zero, the rate is unlimited.

```
T get ()
```

Returns the most recent value for the stream. If executing the remote procedure for the stream throws an exception, calling this method will rethrow the exception. Raises a `StreamException` if no update has been received from the server.

If the stream has not been started this method calls `startAndWait()` to start the stream and wait until at least one update has been received.

Object `getCondition()`

A condition variable that is notified (using `notifyAll()`) whenever the value of the stream changes.

void `waitForUpdate()`

void `waitForUpdateWithTimeout` (double *timeout*)

These methods block until the value of the stream changes or the operation times out.

The streams condition variable must be locked before calling this method.

If *timeout* is specified it is the timeout in seconds for the operation.

If the stream has not been started this method calls `start` to start the stream (without waiting for at least one update to be received).

void `addCallback` (java.util.function.Consumer<T> *callback*)

Adds a callback function that is invoked whenever the value of the stream changes. The callback function should take one argument, which is passed the new value of the stream.

Note: The callback function may be called from a different thread to that which created the stream. Any changes to shared state must therefore be protected with appropriate synchronization.

void `remove()`

Remove the stream from the server.

class `Event`

This class represents an event. See *Custom Events*. It is wrapper around a `Stream` that indicates when the event occurs.

Event objects implement `hashCode` and `equals` such that two event objects are equal if they are bound to the same underlying stream on the server.

void `start()`

Starts the event. When an event is created, it will not receive updates from the server until this method is called.

Object `getCondition()`

The condition variable that is notified (using `notifyAll()`) whenever the event occurs.

void `waitFor()`

void `waitForWithTimeout` (double *timeout*)

These methods block until the event occurs or the operation times out.

The events condition variable must be locked before calling this method.

If *timeout* is specified it is the timeout in seconds for the operation.

If the event has not been started this method calls `start()` to start the underlying stream.

void `addCallback` (java.lang.Callable *callback*)

Adds a callback function that is invoked whenever the event occurs. The callback function should be a function that takes zero arguments.

void `remove()`

Removes the event from the server.

Stream<*Boolean*> `getStream()`

Returns the underlying stream for the event.

abstract class **RemoteObject**

The abstract base class for all remote objects.

6.2 KRPC API

6.2.1 KRPC

None None None None

public class **KRPC**

Main kRPC service, used by clients to interact with basic server functionality.

byte[] **getClientID** ()

Returns the identifier for the current client.

String **getClientName** ()

Returns the name of the current client. This is an empty string if the client has no name.

java.util.List<org.javatuples.Triplet<byte[], String, String>> **getClients** ()

A list of RPC clients that are currently connected to the server. Each entry in the list is a clients identifier, name and address.

krpc.schema.KRPC.Status **getStatus** ()

Returns some information about the server, such as the version.

krpc.schema.KRPC.Services **getServices** ()

Returns information on all services, procedures, classes, properties etc. provided by the server. Can be used by client libraries to automatically create functionality such as stubs.

void **setStreamRate** (long *id*, float *rate*)

Set the update rate for a stream in Hz.

Parameters

- **id** (*long*) –
- **rate** (*float*) –

GameScene **getCurrentGameScene** ()

Get the current game scene.

boolean **getPaused** ()

void **setPaused** (boolean *value*)

Whether the game is paused.

public enum **GameScene**

The game scene. See *getCurrentGameScene* ().

public GameScene **SPACE_CENTER**

The game scene showing the Kerbal Space Center buildings.

public GameScene **FLIGHT**

The game scene showing a vessel in flight (or on the launchpad/runway).

public GameScene **TRACKING_STATION**

The tracking station.

public GameScene **EDITOR_VAB**

The Vehicle Assembly Building.

public *GameScene* **EDITOR_SPH**

The Space Plane Hangar.

public class **InvalidOperationException**

A method call was made to a method that is invalid given the current state of the object.

public class **ArgumentException**

A method was invoked where at least one of the passed arguments does not meet the parameter specification of the method.

public class **ArgumentNullException**

A null reference was passed to a method that does not accept it as a valid argument.

public class **ArgumentOutOfRangeException**

The value of an argument is outside the allowable range of values as defined by the invoked method.

6.2.2 Expressions

public class **Expression**

A server side expression.

static *Expression* **constantDouble** (*Connection connection*, double *value*)

A constant value of type double.

Parameters

- **value** (*double*) –

static *Expression* **constantFloat** (*Connection connection*, float *value*)

A constant value of type float.

Parameters

- **value** (*float*) –

static *Expression* **constantInt** (*Connection connection*, int *value*)

A constant value of type int.

Parameters

- **value** (*int*) –

static *Expression* **constantString** (*Connection connection*, *String* *value*)

A constant value of type string.

Parameters

- **value** (*String*) –

static *Expression* **call** (*Connection connection*, *kRPC.schema.KRPC.ProcedureCall call*)

An RPC call.

Parameters

- **call** (*kRPC.schema.KRPC.ProcedureCall*) –

static *Expression* **equal** (*Connection connection*, *Expression arg0*, *Expression arg1*)

Equality comparison.

Parameters

- **arg0** (*Expression*) –
- **arg1** (*Expression*) –

static Expression **notEqual** (Connection connection, Expression arg0, Expression arg1)
Inequality comparison.

Parameters

- **arg0** (Expression) –
- **arg1** (Expression) –

static Expression **greaterThan** (Connection connection, Expression arg0, Expression arg1)
Greater than numerical comparison.

Parameters

- **arg0** (Expression) –
- **arg1** (Expression) –

static Expression **greaterThanOrEqualTo** (Connection connection, Expression arg0, Expression arg1)
Greater than or equal numerical comparison.

Parameters

- **arg0** (Expression) –
- **arg1** (Expression) –

static Expression **lessThan** (Connection connection, Expression arg0, Expression arg1)
Less than numerical comparison.

Parameters

- **arg0** (Expression) –
- **arg1** (Expression) –

static Expression **lessThanOrEqualTo** (Connection connection, Expression arg0, Expression arg1)
Less than or equal numerical comparison.

Parameters

- **arg0** (Expression) –
- **arg1** (Expression) –

static Expression **and** (Connection connection, Expression arg0, Expression arg1)
Boolean and operator.

Parameters

- **arg0** (Expression) –
- **arg1** (Expression) –

static Expression **or** (Connection connection, Expression arg0, Expression arg1)
Boolean or operator.

Parameters

- **arg0** (Expression) –
- **arg1** (Expression) –

static Expression **exclusiveOr** (Connection connection, Expression arg0, Expression arg1)
Boolean exclusive-or operator.

Parameters

- **arg0** (Expression) –

- **arg1** (Expression) –

static Expression **not** (Connection connection, Expression arg)
Boolean negation operator.

Parameters

- **arg** (Expression) –

static Expression **add** (Connection connection, Expression arg0, Expression arg1)
Numerical addition.

Parameters

- **arg0** (Expression) –
- **arg1** (Expression) –

static Expression **subtract** (Connection connection, Expression arg0, Expression arg1)
Numerical subtraction.

Parameters

- **arg0** (Expression) –
- **arg1** (Expression) –

static Expression **multiply** (Connection connection, Expression arg0, Expression arg1)
Numerical multiplication.

Parameters

- **arg0** (Expression) –
- **arg1** (Expression) –

static Expression **divide** (Connection connection, Expression arg0, Expression arg1)
Numerical division.

Parameters

- **arg0** (Expression) –
- **arg1** (Expression) –

static Expression **modulo** (Connection connection, Expression arg0, Expression arg1)
Numerical modulo operator.

Parameters

- **arg0** (Expression) –
- **arg1** (Expression) –

Returns The remainder of arg0 divided by arg1

static Expression **power** (Connection connection, Expression arg0, Expression arg1)
Numerical power operator.

Parameters

- **arg0** (Expression) –
- **arg1** (Expression) –

Returns arg0 raised to the power of arg1

static Expression **leftShift** (Connection connection, Expression arg0, Expression arg1)
Bitwise left shift.

Parameters

- **arg0** (Expression) –
- **arg1** (Expression) –

static Expression **rightShift** (Connection connection, Expression arg0, Expression arg1)
Bitwise right shift.

Parameters

- **arg0** (Expression) –
- **arg1** (Expression) –

static Expression **toDouble** (Connection connection, Expression arg)
Convert to a double type.

Parameters

- **arg** (Expression) –

static Expression **toFloat** (Connection connection, Expression arg)
Convert to a float type.

Parameters

- **arg** (Expression) –

static Expression **toInt** (Connection connection, Expression arg)
Convert to an int type.

Parameters

- **arg** (Expression) –

6.3 SpaceCenter API

6.3.1 SpaceCenter

public class **SpaceCenter**

Provides functionality to interact with Kerbal Space Program. This includes controlling the active vessel, managing its resources, planning maneuver nodes and auto-piloting.

Vessel **getActiveVessel** ()

void **setActiveVessel** (Vessel value)
The currently active vessel.

java.util.List<Vessel> **getVessels** ()
A list of all the vessels in the game.

java.util.Map<String, CelestialBody> **getBodies** ()
A dictionary of all celestial bodies (planets, moons, etc.) in the game, keyed by the name of the body.

CelestialBody **getTargetBody** ()

void **setTargetBody** (CelestialBody value)
The currently targeted celestial body.

Vessel **getTargetVessel** ()

void **setTargetVessel** (*Vessel value*)

The currently targeted vessel.

DockingPort **getTargetDockingPort** ()

void **setTargetDockingPort** (*DockingPort value*)

The currently targeted docking port.

void **clearTarget** ()

Clears the current target.

java.util.List<String> **launchableVessels** (*String craftDirectory*)

Returns a list of vessels from the given *craftDirectory* that can be launched.

Parameters

- **craftDirectory** (*String*) – Name of the directory in the current saves “Ships” directory. For example "VAB" or "SPH".

void **launchVessel** (*String craftDirectory*, *String name*, *String launchSite*)

Launch a vessel.

Parameters

- **craftDirectory** (*String*) – Name of the directory in the current saves “Ships” directory, that contains the craft file. For example "VAB" or "SPH".
- **name** (*String*) – Name of the vessel to launch. This is the name of the “.craft” file in the save directory, without the “.craft” file extension.
- **launchSite** (*String*) – Name of the launch site. For example "LaunchPad" or "Runway".

void **launchVesselFromVAB** (*String name*)

Launch a new vessel from the VAB onto the launchpad.

Parameters

- **name** (*String*) – Name of the vessel to launch.

Note: This is equivalent to calling *launchVessel(String, String, String)* with the craft directory set to “VAB” and the launch site set to “LaunchPad”.

void **launchVesselFromSPH** (*String name*)

Launch a new vessel from the SPH onto the runway.

Parameters

- **name** (*String*) – Name of the vessel to launch.

Note: This is equivalent to calling *launchVessel(String, String, String)* with the craft directory set to “SPH” and the launch site set to “Runway”.

void **save** (*String name*)

Save the game with a given name. This will create a save file called *name.sfs* in the folder of the current save game.

Parameters

- **name** (*String*) –

void **load** (*String name*)

Load the game with the given name. This will create a load a save file called `name.sfs` from the folder of the current save game.

Parameters

- **name** (*String*) –

void **quicksave** ()

Save a quicksave.

Note: This is the same as calling `save (String)` with the name “quicksave”.

void **quickload** ()

Load a quicksave.

Note: This is the same as calling `load (String)` with the name “quicksave”.

boolean **getUIVisible** ()

void **setUIVisible** (boolean *value*)

Whether the UI is visible.

boolean **getNavball** ()

void **setNavball** (boolean *value*)

Whether the navball is visible.

double **getUT** ()

The current universal time in seconds.

double **getG** ()

The value of the [gravitational constant](#) G in $N(m/kg)^2$.

float **getWarpRate** ()

The current warp rate. This is the rate at which time is passing for either on-rails or physical time warp. For example, a value of 10 means time is passing 10x faster than normal. Returns 1 if time warp is not active.

float **getWarpFactor** ()

The current warp factor. This is the index of the rate at which time is passing for either regular “on-rails” or physical time warp. Returns 0 if time warp is not active. When in on-rails time warp, this is equal to `getRailsWarpFactor()`, and in physics time warp, this is equal to `getPhysicsWarpFactor()`.

int **getRailsWarpFactor** ()

void **setRailsWarpFactor** (int *value*)

The time warp rate, using regular “on-rails” time warp. A value between 0 and 7 inclusive. 0 means no time warp. Returns 0 if physical time warp is active.

If requested time warp factor cannot be set, it will be set to the next lowest possible value. For example, if the vessel is too close to a planet. See [the KSP wiki](#) for details.

int **getPhysicsWarpFactor** ()

void **setPhysicsWarpFactor** (int *value*)

The physical time warp rate. A value between 0 and 3 inclusive. 0 means no time warp. Returns 0 if regular “on-rails” time warp is active.

boolean **canRailsWarpAt** (int *factor*)

Returns `true` if regular “on-rails” time warp can be used, at the specified warp *factor*. The maximum time warp rate is limited by various things, including how close the active vessel is to a planet. See [the KSP wiki](#) for details.

Parameters

- **factor** (*int*) – The warp factor to check.

int **getMaximumRailsWarpFactor** ()

The current maximum regular “on-rails” warp factor that can be set. A value between 0 and 7 inclusive. See [the KSP wiki](#) for details.

void **warpTo** (double *ut*, float *maxRailsRate*, float *maxPhysicsRate*)

Uses time acceleration to warp forward to a time in the future, specified by universal time *ut*. This call blocks until the desired time is reached. Uses regular “on-rails” or physical time warp as appropriate. For example, physical time warp is used when the active vessel is traveling through an atmosphere. When using regular “on-rails” time warp, the warp rate is limited by *maxRailsRate*, and when using physical time warp, the warp rate is limited by *maxPhysicsRate*.

Parameters

- **ut** (*double*) – The universal time to warp to, in seconds.
- **maxRailsRate** (*float*) – The maximum warp rate in regular “on-rails” time warp.
- **maxPhysicsRate** (*float*) – The maximum warp rate in physical time warp.

Returns When the time warp is complete.

org.javatuples.Triplet<Double, Double, Double> **transformPosition** (org.javatuples.Triplet<Double, Double, Double> *position*, ReferenceFrame *from*, ReferenceFrame *to*)

Converts a position from one reference frame to another.

Parameters

- **position** (*org.javatuples.Triplet<Double, Double, Double>*) – Position, as a vector, in reference frame *from*.
- **from** (ReferenceFrame) – The reference frame that the position is in.
- **to** (ReferenceFrame) – The reference frame to convert the position to.

Returns The corresponding position, as a vector, in reference frame *to*.

org.javatuples.Triplet<Double, Double, Double> **transformDirection** (org.javatuples.Triplet<Double, Double, Double> *direction*, ReferenceFrame *from*, ReferenceFrame *to*)

Converts a direction from one reference frame to another.

Parameters

- **direction** (*org.javatuples.Triplet<Double, Double, Double>*) – Direction, as a vector, in reference frame *from*.
- **from** (ReferenceFrame) – The reference frame that the direction is in.
- **to** (ReferenceFrame) – The reference frame to convert the direction to.

Returns The corresponding direction, as a vector, in reference frame *to*.

`org.javatuples.Quartet<Double, Double, Double, Double> transformRotation` (`org.javatuples.Quartet<Double, Double, Double, Double> rotation`, `ReferenceFrame from`, `ReferenceFrame to`)

Converts a rotation from one reference frame to another.

Parameters

- **rotation** (`org.javatuples.Quartet<Double, Double, Double, Double>`) – Rotation, as a quaternion of the form (x, y, z, w) , in reference frame *from*.
- **from** (`ReferenceFrame`) – The reference frame that the rotation is in.
- **to** (`ReferenceFrame`) – The reference frame to convert the rotation to.

Returns The corresponding rotation, as a quaternion of the form (x, y, z, w) , in reference frame *to*.

`org.javatuples.Triplet<Double, Double, Double> transformVelocity` (`org.javatuples.Triplet<Double, Double, Double> position`, `org.javatuples.Triplet<Double, Double, Double> velocity`, `ReferenceFrame from`, `ReferenceFrame to`)

Converts a velocity (acting at the specified position) from one reference frame to another. The position is required to take the relative angular velocity of the reference frames into account.

Parameters

- **position** (`org.javatuples.Triplet<Double, Double, Double>`) – Position, as a vector, in reference frame *from*.
- **velocity** (`org.javatuples.Triplet<Double, Double, Double>`) – Velocity, as a vector that points in the direction of travel and whose magnitude is the speed in meters per second, in reference frame *from*.
- **from** (`ReferenceFrame`) – The reference frame that the position and velocity are in.
- **to** (`ReferenceFrame`) – The reference frame to convert the velocity to.

Returns The corresponding velocity, as a vector, in reference frame *to*.

`double raycastDistance` (`org.javatuples.Triplet<Double, Double, Double> position`, `org.javatuples.Triplet<Double, Double, Double> direction`, `ReferenceFrame referenceFrame`)

Cast a ray from a given position in a given direction, and return the distance to the hit point. If no hit occurs, returns infinity.

Parameters

- **position** (`org.javatuples.Triplet<Double, Double, Double>`) – Position, as a vector, of the origin of the ray.
- **direction** (`org.javatuples.Triplet<Double, Double, Double>`) – Direction of the ray, as a unit vector.
- **referenceFrame** (`ReferenceFrame`) – The reference frame that the position and direction are in.

Returns The distance to the hit, in meters, or infinity if there was no hit.

Part **raycastPart** (*org.javatuples.Triplet<Double, Double, Double> position, org.javatuples.Triplet<Double, Double, Double> direction, ReferenceFrame referenceFrame*)

Cast a ray from a given position in a given direction, and return the part that it hits. If no hit occurs, returns null.

Parameters

- **position** (*org.javatuples.Triplet<Double, Double, Double>*) – Position, as a vector, of the origin of the ray.
- **direction** (*org.javatuples.Triplet<Double, Double, Double>*) – Direction of the ray, as a unit vector.
- **referenceFrame** (*ReferenceFrame*) – The reference frame that the position and direction are in.

Returns The part that was hit or null if there was no hit.

boolean **getFARAvailable** ()

Whether *Ferram Aerospace Research* is installed.

WarpMode **getWarpMode** ()

The current time warp mode. Returns *WarpMode.NONE* if time warp is not active, *WarpMode.RAILS* if regular “on-rails” time warp is active, or *WarpMode.PHYSICS* if physical time warp is active.

Camera **getCamera** ()

An object that can be used to control the camera.

WaypointManager **getWaypointManager** ()

The waypoint manager.

ContractManager **getContractManager** ()

The contract manager.

public enum **WarpMode**

The time warp mode. Returned by *WarpMode*

public *WarpMode* **RAILS**

Time warp is active, and in regular “on-rails” mode.

public *WarpMode* **PHYSICS**

Time warp is active, and in physical time warp mode.

public *WarpMode* **NONE**

Time warp is not active.

6.3.2 Vessel

public class **Vessel**

These objects are used to interact with vessels in KSP. This includes getting orbital and flight data, manipulating control inputs and managing resources. Created using *getActiveVessel()* or *getVessels()*.

String **getName** ()

void **setName** (*String value*)

The name of the vessel.

VesselType **getType** ()

void **setType** (*VesselType value*)

The type of the vessel.

Vessel **getSituation** ()

The situation the vessel is in.

boolean **getRecoverable** ()

Whether the vessel is recoverable.

void **recover** ()

Recover the vessel.

double **getMET** ()

The mission elapsed time in seconds.

String **getBiome** ()

The name of the biome the vessel is currently in.

Flight **flight** (*ReferenceFrame* *referenceFrame*)

Returns a *Flight* object that can be used to get flight telemetry for the vessel, in the specified reference frame.

Parameters

- **referenceFrame** (*ReferenceFrame*) – Reference frame. Defaults to the vessel's surface reference frame (*Vessel.getSurfaceReferenceFrame*()).

Note: When this is called with no arguments, the vessel's surface reference frame is used. This reference frame moves with the vessel, therefore velocities and speeds returned by the flight object will be zero. See the *reference frames tutorial* for examples of getting *the orbital and surface speeds of a vessel*.

Orbit **getOrbit** ()

The current orbit of the vessel.

Control **getControl** ()

Returns a *Control* object that can be used to manipulate the vessel's control inputs. For example, its pitch/yaw/roll controls, RCS and thrust.

Comms **getComms** ()

Returns a *Comms* object that can be used to interact with CommNet for this vessel.

AutoPilot **getAutoPilot** ()

An *AutoPilot* object, that can be used to perform simple auto-piloting of the vessel.

int **getCrewCapacity** ()

The number of crew that can occupy the vessel.

int **getCrewCount** ()

The number of crew that are occupying the vessel.

java.util.List<*CrewMember*> **getCrew** ()

The crew in the vessel.

Resources **getResources** ()

A *Resources* object, that can be used to get information about resources stored in the vessel.

Resources **resourcesInDecoupleStage** (int *stage*, boolean *cumulative*)

Returns a *Resources* object, that can be used to get information about resources stored in a given *stage*.

Parameters

- **stage** (*int*) – Get resources for parts that are decoupled in this stage.

- **cumulative** (*boolean*) – When `false`, returns the resources for parts decoupled in just the given stage. When `true` returns the resources decoupled in the given stage and all subsequent stages combined.

Note: For details on stage numbering, see the discussion on *Staging*.

Parts **getParts** ()

A *Parts* object, that can used to interact with the parts that make up this vessel.

float **getMass** ()

The total mass of the vessel, including resources, in kg.

float **getDryMass** ()

The total mass of the vessel, excluding resources, in kg.

float **getThrust** ()

The total thrust currently being produced by the vessel's engines, in Newtons. This is computed by summing *Engine.getThrust()* for every engine in the vessel.

float **getAvailableThrust** ()

Gets the total available thrust that can be produced by the vessel's active engines, in Newtons. This is computed by summing *Engine.getAvailableThrust()* for every active engine in the vessel.

float **getMaxThrust** ()

The total maximum thrust that can be produced by the vessel's active engines, in Newtons. This is computed by summing *Engine.getMaxThrust()* for every active engine.

float **getMaxVacuumThrust** ()

The total maximum thrust that can be produced by the vessel's active engines when the vessel is in a vacuum, in Newtons. This is computed by summing *Engine.getMaxVacuumThrust()* for every active engine.

float **getSpecificImpulse** ()

The combined specific impulse of all active engines, in seconds. This is computed using the formula [described here](#).

float **getVacuumSpecificImpulse** ()

The combined vacuum specific impulse of all active engines, in seconds. This is computed using the formula [described here](#).

float **getKerbinSeaLevelSpecificImpulse** ()

The combined specific impulse of all active engines at sea level on Kerbin, in seconds. This is computed using the formula [described here](#).

org.javatuples.Triplet<Double, Double, Double> **getMomentOfInertia** ()

The moment of inertia of the vessel around its center of mass in $kg.m^2$. The inertia values in the returned 3-tuple are around the pitch, roll and yaw directions respectively. This corresponds to the vessels reference frame (*ReferenceFrame*).

java.util.List<Double> **getInertiaTensor** ()

The inertia tensor of the vessel around its center of mass, in the vessels reference frame (*ReferenceFrame*). Returns the 3x3 matrix as a list of elements, in row-major order.

org.javatuples.Pair<org.javatuples.Triplet<Double, Double, Double>, org.javatuples.Triplet<Double, Double, Double>> **getAvaila**

The maximum torque that the vessel generates. Includes contributions from reaction wheels, RCS, gim-balled engines and aerodynamic control surfaces. Returns the torques in $N.m$ around each of the coordi-nate axes of the vessels reference frame (*ReferenceFrame*). These axes are equivalent to the pitch, roll and yaw axes of the vessel.

`org.javatuples.Pair<org.javatuples.Triplet<Double, Double, Double>, org.javatuples.Triplet<Double, Double, Double>> getAv`

The maximum torque that the currently active and powered reaction wheels can generate. Returns the torques in $N.m$ around each of the coordinate axes of the vessels reference frame (*ReferenceFrame*). These axes are equivalent to the pitch, roll and yaw axes of the vessel.

`org.javatuples.Pair<org.javatuples.Triplet<Double, Double, Double>, org.javatuples.Triplet<Double, Double, Double>> getAv`

The maximum torque that the currently active RCS thrusters can generate. Returns the torques in $N.m$ around each of the coordinate axes of the vessels reference frame (*ReferenceFrame*). These axes are equivalent to the pitch, roll and yaw axes of the vessel.

`org.javatuples.Pair<org.javatuples.Triplet<Double, Double, Double>, org.javatuples.Triplet<Double, Double, Double>> getAv`

The maximum torque that the currently active and gimbaled engines can generate. Returns the torques in $N.m$ around each of the coordinate axes of the vessels reference frame (*ReferenceFrame*). These axes are equivalent to the pitch, roll and yaw axes of the vessel.

`org.javatuples.Pair<org.javatuples.Triplet<Double, Double, Double>, org.javatuples.Triplet<Double, Double, Double>> getAv`

The maximum torque that the aerodynamic control surfaces can generate. Returns the torques in $N.m$ around each of the coordinate axes of the vessels reference frame (*ReferenceFrame*). These axes are equivalent to the pitch, roll and yaw axes of the vessel.

`org.javatuples.Pair<org.javatuples.Triplet<Double, Double, Double>, org.javatuples.Triplet<Double, Double, Double>> getAv`

The maximum torque that parts (excluding reaction wheels, gimbaled engines, RCS and control surfaces) can generate. Returns the torques in $N.m$ around each of the coordinate axes of the vessels reference frame (*ReferenceFrame*). These axes are equivalent to the pitch, roll and yaw axes of the vessel.

ReferenceFrame `getReferenceFrame ()`

The reference frame that is fixed relative to the vessel, and orientated with the vessel.

- The origin is at the center of mass of the vessel.
- The axes rotate with the vessel.
- The x-axis points out to the right of the vessel.
- The y-axis points in the forward direction of the vessel.
- The z-axis points out of the bottom off the vessel.

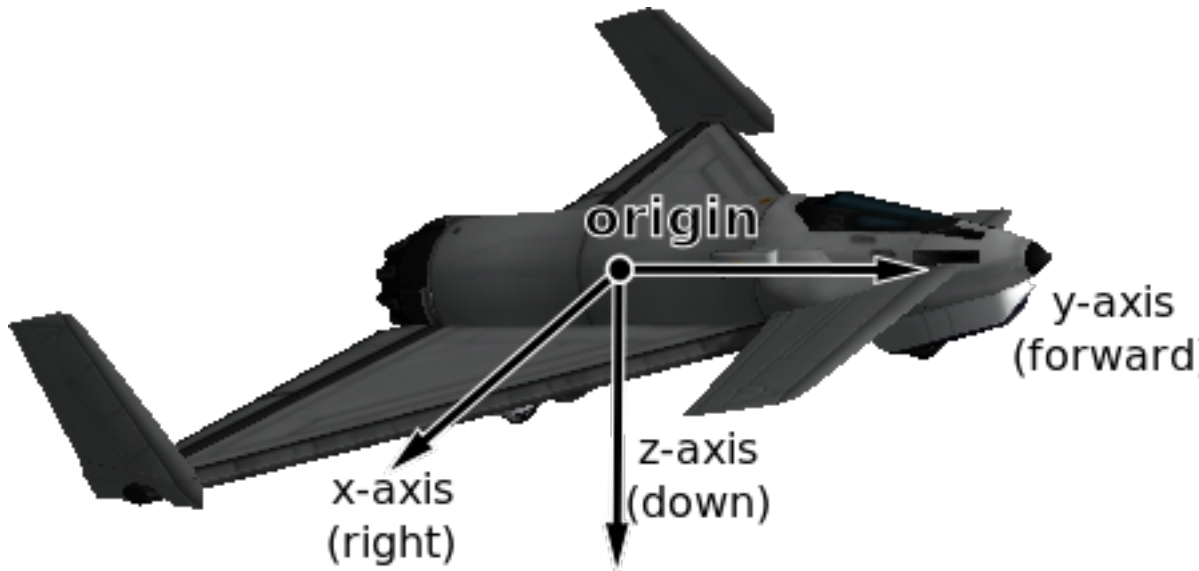


Fig. 6.1: Vessel reference frame origin and axes for the Aeris 3A aircraft

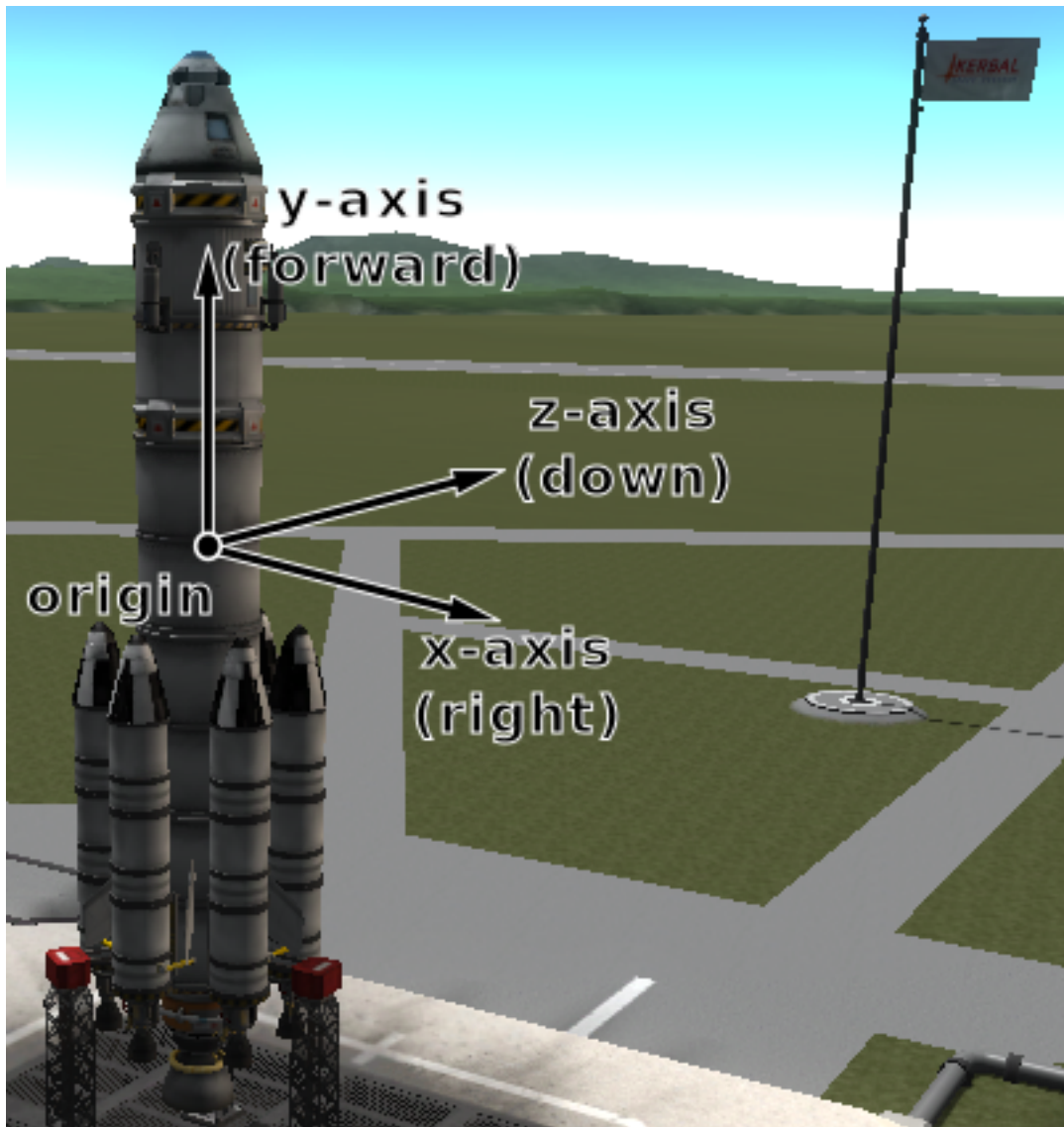


Fig. 6.2: Vessel reference frame origin and axes for the Kerbal-X rocket

ReferenceFrame `getOrbitalReferenceFrame()`

The reference frame that is fixed relative to the vessel, and orientated with the vessels orbital prograde/normal/radial directions.

- The origin is at the center of mass of the vessel.
- The axes rotate with the orbital prograde/normal/radial directions.
- The x-axis points in the orbital anti-radial direction.
- The y-axis points in the orbital prograde direction.
- The z-axis points in the orbital normal direction.

Note: Be careful not to confuse this with ‘orbit’ mode on the navball.

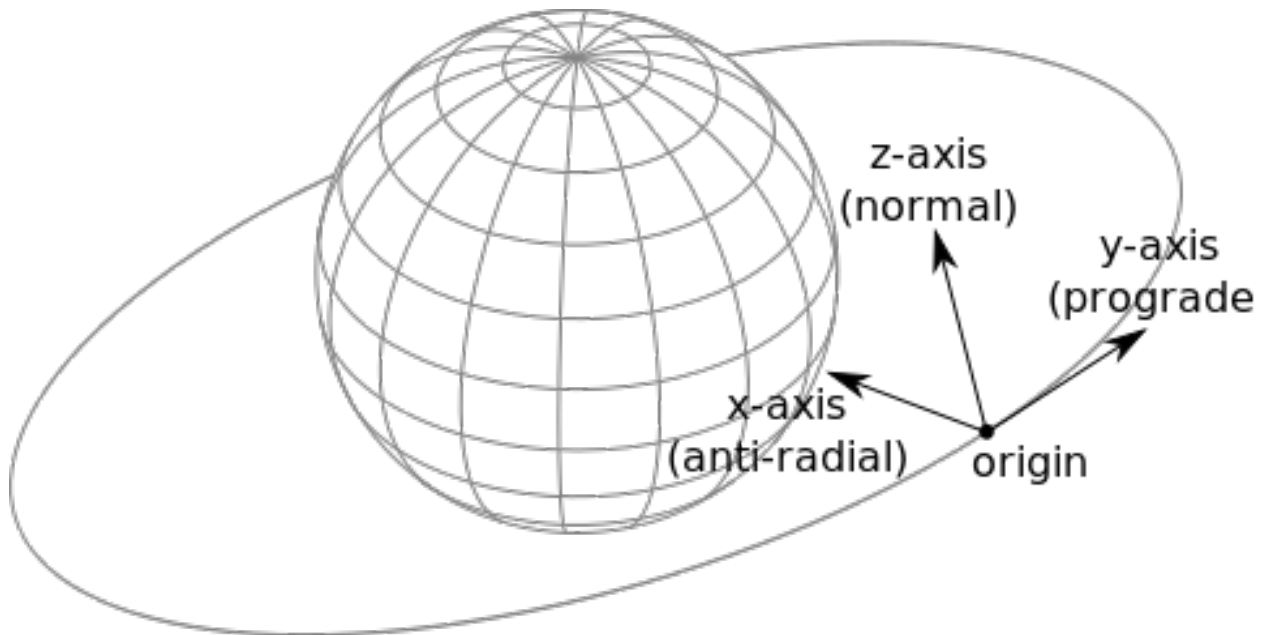


Fig. 6.3: Vessel orbital reference frame origin and axes

ReferenceFrame `getSurfaceReferenceFrame()`

The reference frame that is fixed relative to the vessel, and orientated with the surface of the body being orbited.

- The origin is at the center of mass of the vessel.
- The axes rotate with the north and up directions on the surface of the body.
- The x-axis points in the [zenith](#) direction (upwards, normal to the body being orbited, from the center of the body towards the center of mass of the vessel).
- The y-axis points northwards towards the [astronomical horizon](#) (north, and tangential to the surface of the body – the direction in which a compass would point when on the surface).
- The z-axis points eastwards towards the [astronomical horizon](#) (east, and tangential to the surface of the body – east on a compass when on the surface).

Note: Be careful not to confuse this with ‘surface’ mode on the navball.

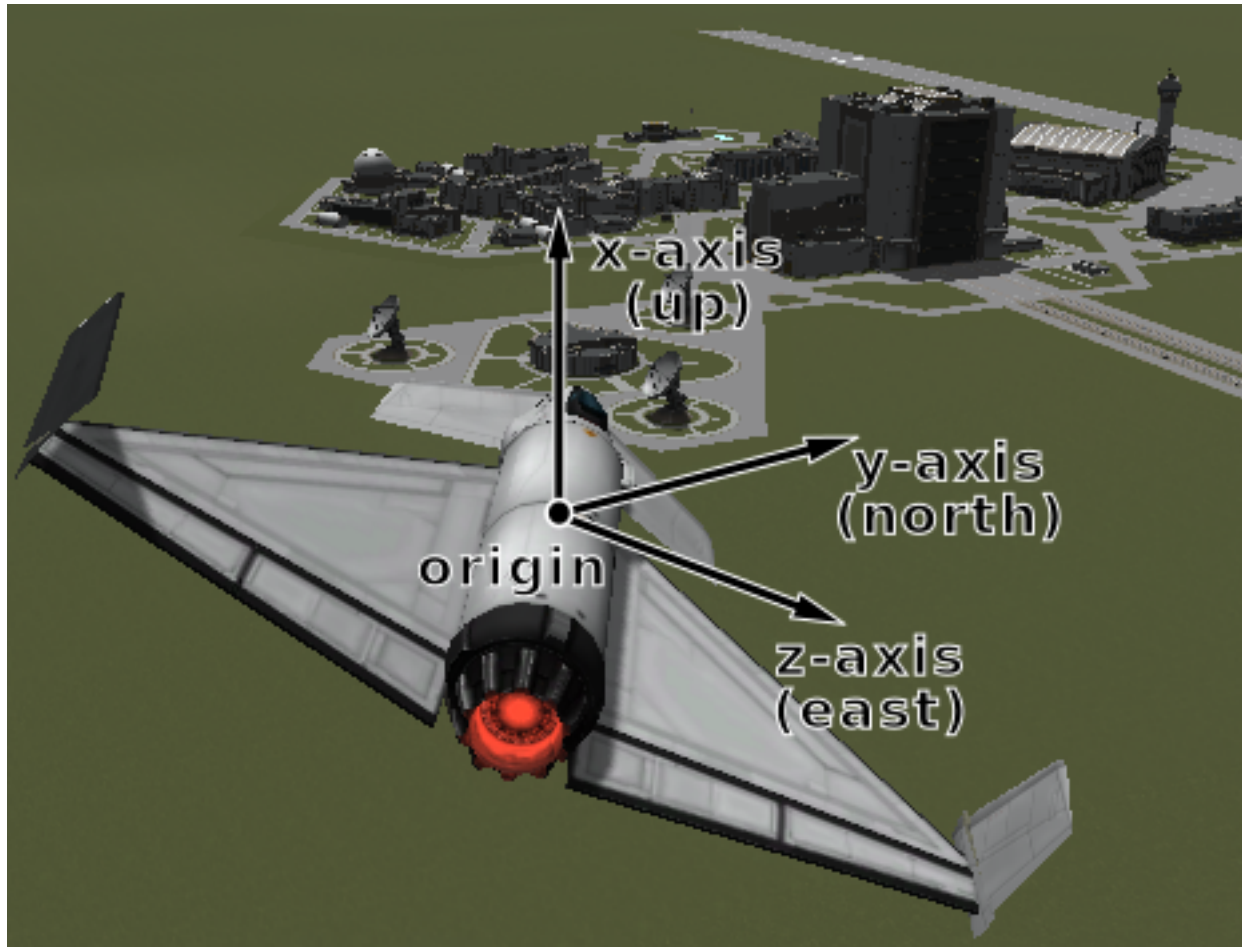


Fig. 6.4: Vessel surface reference frame origin and axes

ReferenceFrame **getSurfaceVelocityReferenceFrame** ()

The reference frame that is fixed relative to the vessel, and orientated with the velocity vector of the vessel relative to the surface of the body being orbited.

- The origin is at the center of mass of the vessel.
- The axes rotate with the vessel's velocity vector.
- The y-axis points in the direction of the vessel's velocity vector, relative to the surface of the body being orbited.
- The z-axis is in the plane of the [astronomical horizon](#).
- The x-axis is orthogonal to the other two axes.

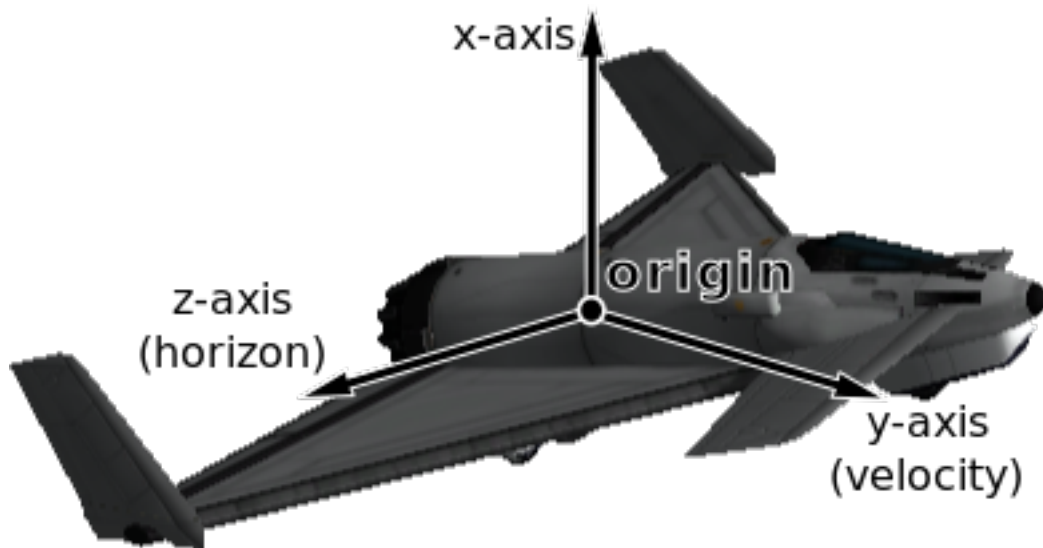


Fig. 6.5: Vessel surface velocity reference frame origin and axes

`org.javatuples.Triplet<Double, Double, Double> position (ReferenceFrame referenceFrame)`

The position of the center of mass of the vessel, in the given reference frame.

Parameters

- **referenceFrame** (*ReferenceFrame*) – The reference frame that the returned position vector is in.

Returns The position as a vector.

`org.javatuples.Pair<org.javatuples.Triplet<Double, Double, Double>, org.javatuples.Triplet<Double, Double, Double>> boundingBox (ReferenceFrame referenceFrame)`

The axis-aligned bounding box of the vessel in the given reference frame.

Parameters

- **referenceFrame** (*ReferenceFrame*) – The reference frame that the returned position vectors are in.

Returns The positions of the minimum and maximum vertices of the box, as position vectors.

`org.javatuples.Triplet<Double, Double, Double> velocity (ReferenceFrame referenceFrame)`

The velocity of the center of mass of the vessel, in the given reference frame.

Parameters

- **referenceFrame** (*ReferenceFrame*) – The reference frame that the returned velocity vector is in.

Returns The velocity as a vector. The vector points in the direction of travel, and its magnitude is the speed of the body in meters per second.

org.javatuples.*Quartet*<*Double*, *Double*, *Double*, *Double*> **rotation** (*ReferenceFrame* *referenceFrame*)

The rotation of the vessel, in the given reference frame.

Parameters

- **referenceFrame** (*ReferenceFrame*) – The reference frame that the returned rotation is in.

Returns The rotation as a quaternion of the form (x, y, z, w) .

org.javatuples.*Triplet*<*Double*, *Double*, *Double*> **direction** (*ReferenceFrame* *referenceFrame*)

The direction in which the vessel is pointing, in the given reference frame.

Parameters

- **referenceFrame** (*ReferenceFrame*) – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

org.javatuples.*Triplet*<*Double*, *Double*, *Double*> **angularVelocity** (*ReferenceFrame* *referenceFrame*)

The angular velocity of the vessel, in the given reference frame.

Parameters

- **referenceFrame** (*ReferenceFrame*) – The reference frame the returned angular velocity is in.

Returns The angular velocity as a vector. The magnitude of the vector is the rotational speed of the vessel, in radians per second. The direction of the vector indicates the axis of rotation, using the right-hand rule.

public enum **VesselType**

The type of a vessel. See *Vessel.getType()*.

public *VesselType* **BASE**
Base.

public *VesselType* **DEBRIS**
Debris.

public *VesselType* **LANDER**
Lander.

public *VesselType* **PLANE**
Plane.

public *VesselType* **PROBE**
Probe.

public *VesselType* **RELAY**
Relay.

public *VesselType* **ROVER**
Rover.

```

public VesselType SHIP
    Ship.

public VesselType STATION
    Station.

public enum VesselSituation
    The situation a vessel is in. See Vessel.getSituation().

    public VesselSituation DOCKED
        Vessel is docked to another.

    public VesselSituation ESCAPING
        Escaping.

    public VesselSituation FLYING
        Vessel is flying through an atmosphere.

    public VesselSituation LANDED
        Vessel is landed on the surface of a body.

    public VesselSituation ORBITING
        Vessel is orbiting a body.

    public VesselSituation PRE_LAUNCH
        Vessel is awaiting launch.

    public VesselSituation SPLASHED
        Vessel has splashed down in an ocean.

    public VesselSituation SUB_ORBITAL
        Vessel is on a sub-orbital trajectory.

public class CrewMember
    Represents crew in a vessel. Can be obtained using Vessel.getCrew().

    String getName ()

    void setName (String value)
        The crew members name.

    CrewMemberType getType ()
        The type of crew member.

    boolean getOnMission ()
        Whether the crew member is on a mission.

    float getCourage ()

    void setCourage (float value)
        The crew members courage.

    float getStupidity ()

    void setStupidity (float value)
        The crew members stupidity.

    float getExperience ()

    void setExperience (float value)
        The crew members experience.

    boolean getBadass ()

```

void **setBadass** (boolean *value*)
Whether the crew member is a badass.

boolean **getVeteran** ()

void **setVeteran** (boolean *value*)
Whether the crew member is a veteran.

public enum **CrewMemberType**

The type of a crew member. See *CrewMember.getType()*.

public *CrewMemberType* **APPLICANT**
An applicant for crew.

public *CrewMemberType* **CREW**
Rocket crew.

public *CrewMemberType* **TOURIST**
A tourist.

public *CrewMemberType* **UNOWNED**
An unowned crew member.

6.3.3 CelestialBody

public class **CelestialBody**

Represents a celestial body (such as a planet or moon). See *getBodies()*.

String **getName** ()
The name of the body.

java.util.List<CelestialBody> **getSatellites** ()
A list of celestial bodies that are in orbit around this celestial body.

Orbit **getOrbit** ()
The orbit of the body.

float **getMass** ()
The mass of the body, in kilograms.

float **getGravitationalParameter** ()
The *standard gravitational parameter* of the body in m^3s^{-2} .

float **getSurfaceGravity** ()
The acceleration due to gravity at sea level (mean altitude) on the body, in m/s^2 .

float **getRotationalPeriod** ()
The sidereal rotational period of the body, in seconds.

float **getRotationalSpeed** ()
The rotational speed of the body, in radians per second.

double **getRotationAngle** ()
The current rotation angle of the body, in radians. A value between 0 and 2π

double **getInitialRotation** ()
The initial rotation angle of the body (at UT 0), in radians. A value between 0 and 2π

float **getEquatorialRadius** ()
The equatorial radius of the body, in meters.

double **surfaceHeight** (double *latitude*, double *longitude*)

The height of the surface relative to mean sea level, in meters, at the given position. When over water this is equal to 0.

Parameters

- **latitude** (*double*) – Latitude in degrees.
- **longitude** (*double*) – Longitude in degrees.

double **bedrockHeight** (double *latitude*, double *longitude*)

The height of the surface relative to mean sea level, in meters, at the given position. When over water, this is the height of the sea-bed and is therefore negative value.

Parameters

- **latitude** (*double*) – Latitude in degrees.
- **longitude** (*double*) – Longitude in degrees.

org.javatuples.Triplet<Double, Double, Double> **mSLPosition** (double *latitude*, double *longitude*,
ReferenceFrame *referenceFrame*)

The position at mean sea level at the given latitude and longitude, in the given reference frame.

Parameters

- **latitude** (*double*) – Latitude in degrees.
- **longitude** (*double*) – Longitude in degrees.
- **referenceFrame** (ReferenceFrame) – Reference frame for the returned position vector.

Returns Position as a vector.

org.javatuples.Triplet<Double, Double, Double> **surfacePosition** (double *latitude*, double *longitude*,
ReferenceFrame *referenceFrame*)

The position of the surface at the given latitude and longitude, in the given reference frame. When over water, this is the position of the surface of the water.

Parameters

- **latitude** (*double*) – Latitude in degrees.
- **longitude** (*double*) – Longitude in degrees.
- **referenceFrame** (ReferenceFrame) – Reference frame for the returned position vector.

Returns Position as a vector.

org.javatuples.Triplet<Double, Double, Double> **bedrockPosition** (double *latitude*, double *longitude*,
ReferenceFrame *referenceFrame*)

The position of the surface at the given latitude and longitude, in the given reference frame. When over water, this is the position at the bottom of the sea-bed.

Parameters

- **latitude** (*double*) – Latitude in degrees.
- **longitude** (*double*) – Longitude in degrees.
- **referenceFrame** (ReferenceFrame) – Reference frame for the returned position vector.

Returns Position as a vector.

`org.javatuples.Triplet<Double, Double, Double> positionAtAltitude (double latitude, double longitude, double altitude, ReferenceFrame referenceFrame)`

The position at the given latitude, longitude and altitude, in the given reference frame.

Parameters

- **latitude** (*double*) – Latitude in degrees.
- **longitude** (*double*) – Longitude in degrees.
- **altitude** (*double*) – Altitude in meters above sea level.
- **referenceFrame** (*ReferenceFrame*) – Reference frame for the returned position vector.

Returns Position as a vector.

`double altitudeAtPosition (org.javatuples.Triplet<Double, Double, Double> position, ReferenceFrame referenceFrame)`

The altitude, in meters, of the given position in the given reference frame.

Parameters

- **position** (*org.javatuples.Triplet<Double, Double, Double>*) – Position as a vector.
- **referenceFrame** (*ReferenceFrame*) – Reference frame for the position vector.

`double latitudeAtPosition (org.javatuples.Triplet<Double, Double, Double> position, ReferenceFrame referenceFrame)`

The latitude of the given position, in the given reference frame.

Parameters

- **position** (*org.javatuples.Triplet<Double, Double, Double>*) – Position as a vector.
- **referenceFrame** (*ReferenceFrame*) – Reference frame for the position vector.

`double longitudeAtPosition (org.javatuples.Triplet<Double, Double, Double> position, ReferenceFrame referenceFrame)`

The longitude of the given position, in the given reference frame.

Parameters

- **position** (*org.javatuples.Triplet<Double, Double, Double>*) – Position as a vector.
- **referenceFrame** (*ReferenceFrame*) – Reference frame for the position vector.

`float getSphereOfInfluence ()`

The radius of the sphere of influence of the body, in meters.

`boolean getHasAtmosphere ()`

true if the body has an atmosphere.

`float getAtmosphereDepth ()`

The depth of the atmosphere, in meters.

`double atmosphericDensityAtPosition (org.javatuples.Triplet<Double, Double, Double> position, ReferenceFrame referenceFrame)`

The atmospheric density at the given position, in kg/m^3 , in the given reference frame.

Parameters

- **position** (*org.javatuples.Triplet<Double, Double, Double>*) – The position vector at which to measure the density.
- **referenceFrame** (*ReferenceFrame*) – Reference frame that the position vector is in.

boolean **getHasAtmosphericOxygen** ()

true if there is oxygen in the atmosphere, required for air-breathing engines.

double **temperatureAt** (*org.javatuples.Triplet<Double, Double, Double>* position, *ReferenceFrame* referenceFrame)

The temperature on the body at the given position, in the given reference frame.

Parameters

- **position** (*org.javatuples.Triplet<Double, Double, Double>*) – Position as a vector.
- **referenceFrame** (*ReferenceFrame*) – The reference frame that the position is in.

Note: This calculation is performed using the bodies current position, which means that the value could be wrong if you want to know the temperature in the far future.

double **densityAt** (double altitude)

Gets the air density, in kg/m^3 , for the specified altitude above sea level, in meters.

Parameters

- **altitude** (*double*) –

Note: This is an approximation, because actual calculations, taking sun exposure into account to compute air temperature, require us to know the exact point on the body where the density is to be computed (knowing the altitude is not enough). However, the difference is small for high altitudes, so it makes very little difference for trajectory prediction.

double **pressureAt** (double altitude)

Gets the air pressure, in Pascals, for the specified altitude above sea level, in meters.

Parameters

- **altitude** (*double*) –

java.util.Set<String> **getBiomes** ()

The biomes present on this body.

String **biomeAt** (double latitude, double longitude)

The biome at the given latitude and longitude, in degrees.

Parameters

- **latitude** (*double*) –
- **longitude** (*double*) –

float **getFlyingHighAltitudeThreshold** ()

The altitude, in meters, above which a vessel is considered to be flying “high” when doing science.

float **getSpaceHighAltitudeThreshold** ()

The altitude, in meters, above which a vessel is considered to be in “high” space when doing science.

ReferenceFrame **getReferenceFrame** ()

The reference frame that is fixed relative to the celestial body.

- The origin is at the center of the body.
- The axes rotate with the body.
- The x-axis points from the center of the body towards the intersection of the prime meridian and equator (the position at 0° longitude, 0° latitude).
- The y-axis points from the center of the body towards the north pole.
- The z-axis points from the center of the body towards the equator at 90°E longitude.

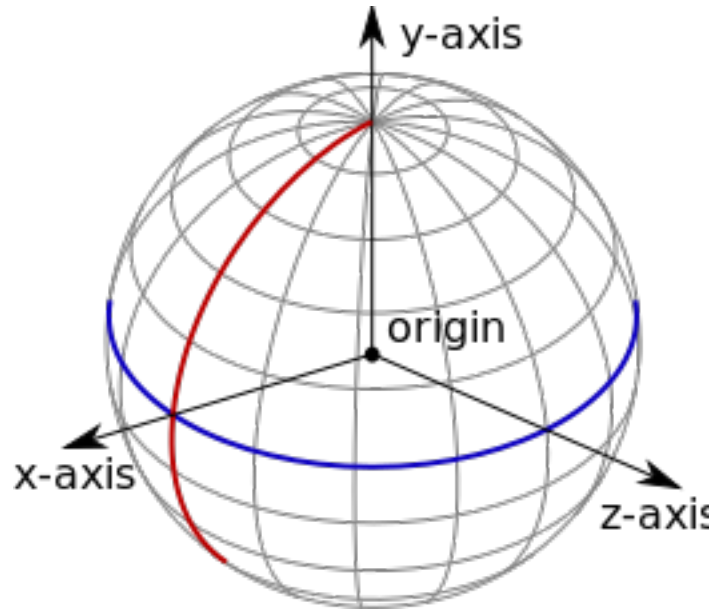


Fig. 6.6: Celestial body reference frame origin and axes. The equator is shown in blue, and the prime meridian in red.

ReferenceFrame **getNonRotatingReferenceFrame** ()

The reference frame that is fixed relative to this celestial body, and orientated in a fixed direction (it does not rotate with the body).

- The origin is at the center of the body.
- The axes do not rotate.
- The x-axis points in an arbitrary direction through the equator.
- The y-axis points from the center of the body towards the north pole.
- The z-axis points in an arbitrary direction through the equator.

ReferenceFrame **getOrbitalReferenceFrame** ()

The reference frame that is fixed relative to this celestial body, but orientated with the body's orbital prograde/normal/radial directions.

- The origin is at the center of the body.
- The axes rotate with the orbital prograde/normal/radial directions.
- The x-axis points in the orbital anti-radial direction.
- The y-axis points in the orbital prograde direction.

- The z-axis points in the orbital normal direction.

org.javatuples.Triplet<Double, Double, Double> **position** (ReferenceFrame referenceFrame)

The position of the center of the body, in the specified reference frame.

Parameters

- **referenceFrame** (ReferenceFrame) – The reference frame that the returned position vector is in.

Returns The position as a vector.

org.javatuples.Triplet<Double, Double, Double> **velocity** (ReferenceFrame referenceFrame)

The linear velocity of the body, in the specified reference frame.

Parameters

- **referenceFrame** (ReferenceFrame) – The reference frame that the returned velocity vector is in.

Returns The velocity as a vector. The vector points in the direction of travel, and its magnitude is the speed of the body in meters per second.

org.javatuples.Quartet<Double, Double, Double, Double> **rotation** (ReferenceFrame referenceFrame)

The rotation of the body, in the specified reference frame.

Parameters

- **referenceFrame** (ReferenceFrame) – The reference frame that the returned rotation is in.

Returns The rotation as a quaternion of the form (x, y, z, w) .

org.javatuples.Triplet<Double, Double, Double> **direction** (ReferenceFrame referenceFrame)

The direction in which the north pole of the celestial body is pointing, in the specified reference frame.

Parameters

- **referenceFrame** (ReferenceFrame) – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

org.javatuples.Triplet<Double, Double, Double> **angularVelocity** (ReferenceFrame referenceFrame)

The angular velocity of the body in the specified reference frame.

Parameters

- **referenceFrame** (ReferenceFrame) – The reference frame the returned angular velocity is in.

Returns The angular velocity as a vector. The magnitude of the vector is the rotational speed of the body, in radians per second. The direction of the vector indicates the axis of rotation, using the right-hand rule.

6.3.4 Flight

public class **Flight**

Used to get flight telemetry for a vessel, by calling `Vessel.flight (ReferenceFrame)`. All of the information returned by this class is given in the reference frame passed to that method. Obtained by calling `Vessel.flight (ReferenceFrame)`.

Note: To get orbital information, such as the apoapsis or inclination, see *Orbit*.

float **getGForce** ()
The current G force acting on the vessel in m/s^2 .

double **getMeanAltitude** ()
The altitude above sea level, in meters. Measured from the center of mass of the vessel.

double **getSurfaceAltitude** ()
The altitude above the surface of the body or sea level, whichever is closer, in meters. Measured from the center of mass of the vessel.

double **getBedrockAltitude** ()
The altitude above the surface of the body, in meters. When over water, this is the altitude above the sea floor. Measured from the center of mass of the vessel.

double **getElevation** ()
The elevation of the terrain under the vessel, in meters. This is the height of the terrain above sea level, and is negative when the vessel is over the sea.

double **getLatitude** ()
The *latitude* of the vessel for the body being orbited, in degrees.

double **getLongitude** ()
The *longitude* of the vessel for the body being orbited, in degrees.

org.javatuples.Triplet<Double, Double, Double> **getVelocity** ()
The velocity of the vessel, in the reference frame *ReferenceFrame*.

Returns The velocity as a vector. The vector points in the direction of travel, and its magnitude is the speed of the vessel in meters per second.

double **getSpeed** ()
The speed of the vessel in meters per second, in the reference frame *ReferenceFrame*.

double **getHorizontalSpeed** ()
The horizontal speed of the vessel in meters per second, in the reference frame *ReferenceFrame*.

double **getVerticalSpeed** ()
The vertical speed of the vessel in meters per second, in the reference frame *ReferenceFrame*.

org.javatuples.Triplet<Double, Double, Double> **getCenterOfMass** ()
The position of the center of mass of the vessel, in the reference frame *ReferenceFrame*

Returns The position as a vector.

org.javatuples.Quartet<Double, Double, Double, Double> **getRotation** ()
The rotation of the vessel, in the reference frame *ReferenceFrame*

Returns The rotation as a quaternion of the form (x, y, z, w) .

org.javatuples.Triplet<Double, Double, Double> **getDirection** ()
The direction that the vessel is pointing in, in the reference frame *ReferenceFrame*.

Returns The direction as a unit vector.

float **getPitch** ()
The pitch of the vessel relative to the horizon, in degrees. A value between -90° and $+90^\circ$.

float **getHeading** ()
The heading of the vessel (its angle relative to north), in degrees. A value between 0° and 360° .

float **getRoll** ()

The roll of the vessel relative to the horizon, in degrees. A value between -180° and +180°.

org.javatuples.Triplet<Double, Double, Double> **getPrograde** ()

The prograde direction of the vessels orbit, in the reference frame *ReferenceFrame*.

Returns The direction as a unit vector.

org.javatuples.Triplet<Double, Double, Double> **getRetrograde** ()

The retrograde direction of the vessels orbit, in the reference frame *ReferenceFrame*.

Returns The direction as a unit vector.

org.javatuples.Triplet<Double, Double, Double> **getNormal** ()

The direction normal to the vessels orbit, in the reference frame *ReferenceFrame*.

Returns The direction as a unit vector.

org.javatuples.Triplet<Double, Double, Double> **getAntiNormal** ()

The direction opposite to the normal of the vessels orbit, in the reference frame *ReferenceFrame*.

Returns The direction as a unit vector.

org.javatuples.Triplet<Double, Double, Double> **getRadial** ()

The radial direction of the vessels orbit, in the reference frame *ReferenceFrame*.

Returns The direction as a unit vector.

org.javatuples.Triplet<Double, Double, Double> **getAntiRadial** ()

The direction opposite to the radial direction of the vessels orbit, in the reference frame *ReferenceFrame*.

Returns The direction as a unit vector.

float **getAtmosphereDensity** ()

The current density of the atmosphere around the vessel, in kg/m^3 .

float **getDynamicPressure** ()

The dynamic pressure acting on the vessel, in Pascals. This is a measure of the strength of the aerodynamic forces. It is equal to $\frac{1}{2} \cdot \text{air density} \cdot \text{velocity}^2$. It is commonly denoted Q .

float **getStaticPressure** ()

The static atmospheric pressure acting on the vessel, in Pascals.

float **getStaticPressureAtMSL** ()

The static atmospheric pressure at mean sea level, in Pascals.

org.javatuples.Triplet<Double, Double, Double> **getAerodynamicForce** ()

The total aerodynamic forces acting on the vessel, in reference frame *ReferenceFrame*.

Returns A vector pointing in the direction that the force acts, with its magnitude equal to the strength of the force in Newtons.

org.javatuples.Triplet<Double, Double, Double> **simulateAerodynamicForceAt** (*CelestialBody* body,
org.javatuples.Triplet<Double, Double, Double> position,
org.javatuples.Triplet<Double, Double, Double> velocity)

Simulate and return the total aerodynamic forces acting on the vessel, if it where to be traveling with the given velocity at the given position in the atmosphere of the given celestial body.

Parameters

- **body** (*CelestialBody*) –
- **position** (*org.javatuples.Triplet<Double, Double, Double>*) –
- **velocity** (*org.javatuples.Triplet<Double, Double, Double>*) –

Returns A vector pointing in the direction that the force acts, with its magnitude equal to the strength of the force in Newtons.

org.javatuples.Triplet<Double, Double, Double> **getLift** ()

The *aerodynamic lift* currently acting on the vessel.

Returns A vector pointing in the direction that the force acts, with its magnitude equal to the strength of the force in Newtons.

org.javatuples.Triplet<Double, Double, Double> **getDrag** ()

The *aerodynamic drag* currently acting on the vessel.

Returns A vector pointing in the direction of the force, with its magnitude equal to the strength of the force in Newtons.

float **getSpeedOfSound** ()

The speed of sound, in the atmosphere around the vessel, in *m/s*.

float **getMach** ()

The speed of the vessel, in multiples of the speed of sound.

float **getReynoldsNumber** ()

The vessels Reynolds number.

Note: Requires *Ferram Aerospace Research*.

float **getTrueAirSpeed** ()

The *true air speed* of the vessel, in meters per second.

float **getEquivalentAirSpeed** ()

The *equivalent air speed* of the vessel, in meters per second.

float **getTerminalVelocity** ()

An estimate of the current terminal velocity of the vessel, in meters per second. This is the speed at which the drag forces cancel out the force of gravity.

float **getAngleOfAttack** ()

The pitch angle between the orientation of the vessel and its velocity vector, in degrees.

float **getSideslipAngle** ()

The yaw angle between the orientation of the vessel and its velocity vector, in degrees.

float **getTotalAirTemperature** ()

The *total air temperature* of the atmosphere around the vessel, in Kelvin. This includes the *Flight.getStaticAirTemperature()* and the vessel's kinetic energy.

float **getStaticAirTemperature** ()

The *static (ambient) temperature* of the atmosphere around the vessel, in Kelvin.

float **getStallFraction** ()

The current amount of stall, between 0 and 1. A value greater than 0.005 indicates a minor stall and a value greater than 0.5 indicates a large-scale stall.

Note: Requires [Ferram Aerospace Research](#).

float **getDragCoefficient** ()

The coefficient of drag. This is the amount of drag produced by the vessel. It depends on air speed, air density and wing area.

Note: Requires [Ferram Aerospace Research](#).

float **getLiftCoefficient** ()

The coefficient of lift. This is the amount of lift produced by the vessel, and depends on air speed, air density and wing area.

Note: Requires [Ferram Aerospace Research](#).

float **getBallisticCoefficient** ()

The ballistic coefficient.

Note: Requires [Ferram Aerospace Research](#).

float **getThrustSpecificFuelConsumption** ()

The thrust specific fuel consumption for the jet engines on the vessel. This is a measure of the efficiency of the engines, with a lower value indicating a more efficient vessel. This value is the number of Newtons of fuel that are burned, per hour, to produce one newton of thrust.

Note: Requires [Ferram Aerospace Research](#).

6.3.5 Orbit

public class **Orbit**

Describes an orbit. For example, the orbit of a vessel, obtained by calling *Vessel.getOrbit()*, or a celestial body, obtained by calling *CelestialBody.getOrbit()*.

CelestialBody **getBody** ()

The celestial body (e.g. planet or moon) around which the object is orbiting.

double **getApoapsis** ()

Gets the apoapsis of the orbit, in meters, from the center of mass of the body being orbited.

Note: For the apoapsis altitude reported on the in-game map view, use *Orbit.getApoapsisAltitude()*.

double **getPeriapsis** ()

The periapsis of the orbit, in meters, from the center of mass of the body being orbited.

Note: For the periapsis altitude reported on the in-game map view, use *Orbit.getPeriapsisAltitude()*.

double **getApoapsisAltitude** ()

The apoapsis of the orbit, in meters, above the sea level of the body being orbited.

Note: This is equal to *Orbit.getApoapsis()* minus the equatorial radius of the body.

double **getPeriapsisAltitude** ()

The periapsis of the orbit, in meters, above the sea level of the body being orbited.

Note: This is equal to *Orbit.getPeriapsis()* minus the equatorial radius of the body.

double **getSemiMajorAxis** ()

The semi-major axis of the orbit, in meters.

double **getSemiMinorAxis** ()

The semi-minor axis of the orbit, in meters.

double **getRadius** ()

The current radius of the orbit, in meters. This is the distance between the center of mass of the object in orbit, and the center of mass of the body around which it is orbiting.

Note: This value will change over time if the orbit is elliptical.

double **radiusAt** (double *ut*)

The orbital radius at the given time, in meters.

Parameters

- **ut** (*double*) – The universal time to measure the radius at.

org.javatuples.Triplet<Double, Double, Double> **positionAt** (double *ut*, *ReferenceFrame* *referenceFrame*)

The position at a given time, in the specified reference frame.

Parameters

- **ut** (*double*) – The universal time to measure the position at.
- **referenceFrame** (*ReferenceFrame*) – The reference frame that the returned position vector is in.

Returns The position as a vector.

double **getSpeed** ()

The current orbital speed of the object in meters per second.

Note: This value will change over time if the orbit is elliptical.

double **getPeriod** ()

The orbital period, in seconds.

double **getTimeToApoapsis** ()

The time until the object reaches apoapsis, in seconds.

double **getTimeToPeriapsis** ()

The time until the object reaches periapsis, in seconds.

double **getEccentricity** ()
The *eccentricity* of the orbit.

double **getInclination** ()
The *inclination* of the orbit, in radians.

double **getLongitudeOfAscendingNode** ()
The *longitude of the ascending node*, in radians.

double **getArgumentOfPeriapsis** ()
The *argument of periapsis*, in radians.

double **getMeanAnomalyAtEpoch** ()
The *mean anomaly at epoch*.

double **getEpoch** ()
The time since the epoch (the point at which the *mean anomaly at epoch* was measured, in seconds).

double **getMeanAnomaly** ()
The *mean anomaly*.

double **meanAnomalyAtUT** (double *ut*)
The mean anomaly at the given time.

Parameters

- **ut** (*double*) – The universal time in seconds.

double **getEccentricAnomaly** ()
The *eccentric anomaly*.

double **eccentricAnomalyAtUT** (double *ut*)
The eccentric anomaly at the given universal time.

Parameters

- **ut** (*double*) – The universal time, in seconds.

double **getTrueAnomaly** ()
The *true anomaly*.

double **trueAnomalyAtUT** (double *ut*)
The true anomaly at the given time.

Parameters

- **ut** (*double*) – The universal time in seconds.

double **trueAnomalyAtRadius** (double *radius*)
The true anomaly at the given orbital radius.

Parameters

- **radius** (*double*) – The orbital radius in meters.

double **uTAtTrueAnomaly** (double *trueAnomaly*)
The universal time, in seconds, corresponding to the given true anomaly.

Parameters

- **trueAnomaly** (*double*) – True anomaly.

double **radiusAtTrueAnomaly** (double *trueAnomaly*)
The orbital radius at the point in the orbit given by the true anomaly.

Parameters

- **trueAnomaly** (*double*) – The true anomaly.

double **trueAnomalyAtAN** (*Vessel target*)

The true anomaly of the ascending node with the given target vessel.

Parameters

- **target** (*Vessel*) – Target vessel.

double **trueAnomalyAtDN** (*Vessel target*)

The true anomaly of the descending node with the given target vessel.

Parameters

- **target** (*Vessel*) – Target vessel.

double **getOrbitalSpeed** ()

The current orbital speed in meters per second.

double **orbitalSpeedAt** (*double time*)

The orbital speed at the given time, in meters per second.

Parameters

- **time** (*double*) – Time from now, in seconds.

static org.javatuples.Triplet<Double, Double, Double> **referencePlaneNormal** (*Connection connection, ReferenceFrame referenceFrame*)

The direction that is normal to the orbits reference plane, in the given reference frame. The reference plane is the plane from which the orbits inclination is measured.

Parameters

- **referenceFrame** (*ReferenceFrame*) – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

static org.javatuples.Triplet<Double, Double, Double> **referencePlaneDirection** (*Connection connection, ReferenceFrame referenceFrame*)

The direction from which the orbits longitude of ascending node is measured, in the given reference frame.

Parameters

- **referenceFrame** (*ReferenceFrame*) – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

double **relativeInclination** (*Vessel target*)

Relative inclination of this orbit and the orbit of the given target vessel, in radians.

Parameters

- **target** (*Vessel*) – Target vessel.

double **getTimeToSOIChange** ()

The time until the object changes sphere of influence, in seconds. Returns NaN if the object is not going to change sphere of influence.

Orbit **getNextOrbit** ()

If the object is going to change sphere of influence in the future, returns the new orbit after the change. Otherwise returns `null`.

double **timeOfClosestApproach** (*Vessel target*)

Estimates and returns the time at closest approach to a target vessel.

Parameters

- **target** (*Vessel*) – Target vessel.

Returns The universal time at closest approach, in seconds.

double **distanceAtClosestApproach** (*Vessel target*)

Estimates and returns the distance at closest approach to a target vessel, in meters.

Parameters

- **target** (*Vessel*) – Target vessel.

java.util.List<java.util.List<Double>> **listClosestApproaches** (*Vessel target*, int *orbits*)

Returns the times at closest approach and corresponding distances, to a target vessel.

Parameters

- **target** (*Vessel*) – Target vessel.
- **orbits** (*int*) – The number of future orbits to search.

Returns A list of two lists. The first is a list of times at closest approach, as universal times in seconds. The second is a list of corresponding distances at closest approach, in meters.

6.3.6 Control

public class **Control**

Used to manipulate the controls of a vessel. This includes adjusting the throttle, enabling/disabling systems such as SAS and RCS, or altering the direction in which the vessel is pointing. Obtained by calling *Vessel.getControl()*.

Note: Control inputs (such as pitch, yaw and roll) are zeroed when all clients that have set one or more of these inputs are no longer connected.

ControlSource **getSource** ()

The source of the vessels control, for example by a kerbal or a probe core.

ControlState **getState** ()

The control state of the vessel.

boolean **getSAS** ()

void **setSAS** (boolean *value*)

The state of SAS.

Note: Equivalent to *AutoPilot.getSAS()*

SASMode **getSASMode** ()

void **setSASMode** (*SASMode value*)

The current *SASMode*. These modes are equivalent to the mode buttons to the left of the navball that appear when SAS is enabled.

Note: Equivalent to *AutoPilot.getSASMode()*

SpeedMode **getSpeedMode** ()

void **setSpeedMode** (*SpeedMode value*)

The current *SpeedMode* of the navball. This is the mode displayed next to the speed at the top of the navball.

boolean **getRCS** ()

void **setRCS** (boolean *value*)

The state of RCS.

boolean **getReactionWheels** ()

void **setReactionWheels** (boolean *value*)

Returns whether all reactive wheels on the vessel are active, and sets the active state of all reaction wheels. See *ReactionWheel.getActive()*.

boolean **getGear** ()

void **setGear** (boolean *value*)

The state of the landing gear/legs.

boolean **getLegs** ()

void **setLegs** (boolean *value*)

Returns whether all landing legs on the vessel are deployed, and sets the deployment state of all landing legs. Does not include wheels (for example landing gear). See *Leg.getDeployed()*.

boolean **getWheels** ()

void **setWheels** (boolean *value*)

Returns whether all wheels on the vessel are deployed, and sets the deployment state of all wheels. Does not include landing legs. See *Wheel.getDeployed()*.

boolean **getLights** ()

void **setLights** (boolean *value*)

The state of the lights.

boolean **getBrakes** ()

void **setBrakes** (boolean *value*)

The state of the wheel brakes.

boolean **getAntennas** ()

void **setAntennas** (boolean *value*)

Returns whether all antennas on the vessel are deployed, and sets the deployment state of all antennas. See *Antenna.getDeployed()*.

boolean **getCargoBays** ()

void **setCargoBays** (boolean *value*)

Returns whether any of the cargo bays on the vessel are open, and sets the open state of all cargo bays. See *CargoBay.getOpen()*.

boolean **getIntakes** ()

void **setIntakes** (boolean *value*)
Returns whether all of the air intakes on the vessel are open, and sets the open state of all air intakes. See *Intake.getOpen()*.

boolean **getParachutes** ()

void **setParachutes** (boolean *value*)
Returns whether all parachutes on the vessel are deployed, and sets the deployment state of all parachutes. Cannot be set to *false*. See *Parachute.getDeployed()*.

boolean **getRadiators** ()

void **setRadiators** (boolean *value*)
Returns whether all radiators on the vessel are deployed, and sets the deployment state of all radiators. See *Radiator.getDeployed()*.

boolean **getResourceHarvesters** ()

void **setResourceHarvesters** (boolean *value*)
Returns whether all of the resource harvesters on the vessel are deployed, and sets the deployment state of all resource harvesters. See *ResourceHarvester.getDeployed()*.

boolean **getResourceHarvestersActive** ()

void **setResourceHarvestersActive** (boolean *value*)
Returns whether any of the resource harvesters on the vessel are active, and sets the active state of all resource harvesters. See *ResourceHarvester.getActive()*.

boolean **getSolarPanels** ()

void **setSolarPanels** (boolean *value*)
Returns whether all solar panels on the vessel are deployed, and sets the deployment state of all solar panels. See *SolarPanel.getDeployed()*.

boolean **getAbort** ()

void **setAbort** (boolean *value*)
The state of the abort action group.

float **getThrottle** ()

void **setThrottle** (float *value*)
The state of the throttle. A value between 0 and 1.

ControlInputMode **getInputMode** ()

void **setInputMode** (*ControlInputMode* *value*)
Sets the behavior of the pitch, yaw, roll and translation control inputs. When set to additive, these inputs are added to the vessels current inputs. This mode is the default. When set to override, these inputs (if non-zero) override the vessels inputs. This mode prevents keyboard control, or SAS, from interfering with the controls when they are set.

float **getPitch** ()

void **setPitch** (float *value*)
The state of the pitch control. A value between -1 and 1. Equivalent to the w and s keys.

float **getYaw** ()

void **setYaw** (float *value*)
The state of the yaw control. A value between -1 and 1. Equivalent to the a and d keys.

float **getRoll** ()

void **setRoll** (float *value*)

The state of the roll control. A value between -1 and 1. Equivalent to the q and e keys.

float **getForward** ()

void **setForward** (float *value*)

The state of the forward translational control. A value between -1 and 1. Equivalent to the h and n keys.

float **getUp** ()

void **setUp** (float *value*)

The state of the up translational control. A value between -1 and 1. Equivalent to the i and k keys.

float **getRight** ()

void **setRight** (float *value*)

The state of the right translational control. A value between -1 and 1. Equivalent to the j and l keys.

float **getWheelThrottle** ()

void **setWheelThrottle** (float *value*)

The state of the wheel throttle. A value between -1 and 1. A value of 1 rotates the wheels forwards, a value of -1 rotates the wheels backwards.

float **getWheelSteering** ()

void **setWheelSteering** (float *value*)

The state of the wheel steering. A value between -1 and 1. A value of 1 steers to the left, and a value of -1 steers to the right.

int **getCurrentStage** ()

The current stage of the vessel. Corresponds to the stage number in the in-game UI.

java.util.List<Vessel> **activateNextStage** ()

Activates the next stage. Equivalent to pressing the space bar in-game.

Returns A list of vessel objects that are jettisoned from the active vessel.

Note: When called, the active vessel may change. It is therefore possible that, after calling this function, the object(s) returned by previous call(s) to *getActiveVessel* () no longer refer to the active vessel.

boolean **getActionGroup** (int *group*)

Returns `true` if the given action group is enabled.

Parameters

- **group** (*int*) – A number between 0 and 9 inclusive, or between 0 and 250 inclusive when the [Extended Action Groups mod](#) is installed.

void **setActionGroup** (int *group*, boolean *state*)

Sets the state of the given action group.

Parameters

- **group** (*int*) – A number between 0 and 9 inclusive, or between 0 and 250 inclusive when the [Extended Action Groups mod](#) is installed.
- **state** (*boolean*) –

void **toggleActionGroup** (int *group*)

Toggles the state of the given action group.

Parameters

- **group** (*int*) – A number between 0 and 9 inclusive, or between 0 and 250 inclusive when the [Extended Action Groups mod](#) is installed.

Node **addNode** (*double ut*, *float prograde*, *float normal*, *float radial*)

Creates a maneuver node at the given universal time, and returns a *Node* object that can be used to modify it. Optionally sets the magnitude of the delta-v for the maneuver node in the prograde, normal and radial directions.

Parameters

- **ut** (*double*) – Universal time of the maneuver node.
- **prograde** (*float*) – Delta-v in the prograde direction.
- **normal** (*float*) – Delta-v in the normal direction.
- **radial** (*float*) – Delta-v in the radial direction.

java.util.List<*Node*> **getNodes** ()

Returns a list of all existing maneuver nodes, ordered by time from first to last.

void **removeNodes** ()

Remove all maneuver nodes.

public enum **ControlState**

The control state of a vessel. See *Control.getState()*.

public ControlState **FULL**

Full controllable.

public ControlState **PARTIAL**

Partially controllable.

public ControlState **NONE**

Not controllable.

public enum **ControlSource**

The control source of a vessel. See *Control.getSource()*.

public ControlSource **KERBAL**

Vessel is controlled by a Kerbal.

public ControlSource **PROBE**

Vessel is controlled by a probe core.

public ControlSource **NONE**

Vessel is not controlled.

public enum **SASMode**

The behavior of the SAS auto-pilot. See *AutoPilot.getSASMode()*.

public SASMode **STABILITY_ASSIST**

Stability assist mode. Dampen out any rotation.

public SASMode **MANEUVER**

Point in the burn direction of the next maneuver node.

public SASMode **PROGRADE**

Point in the prograde direction.

public SASMode **RETROGRADE**

Point in the retrograde direction.

public SASMode **NORMAL**

Point in the orbit normal direction.

```
public SASMode ANTI_NORMAL
    Point in the orbit anti-normal direction.

public SASMode RADIAL
    Point in the orbit radial direction.

public SASMode ANTI_RADIAL
    Point in the orbit anti-radial direction.

public SASMode TARGET
    Point in the direction of the current target.

public SASMode ANTI_TARGET
    Point away from the current target.

public enum SpeedMode
    The mode of the speed reported in the navball. See Control.getSpeedMode().

    public SpeedMode ORBIT
        Speed is relative to the vessel's orbit.

    public SpeedMode SURFACE
        Speed is relative to the surface of the body being orbited.

    public SpeedMode TARGET
        Speed is relative to the current target.

public enum ControlInputMode
    See Control.getInputMode().

    public ControlInputMode ADDITIVE
        Control inputs are added to the vessels current control inputs.

    public ControlInputMode OVERRIDE
        Control inputs (when they are non-zero) override the vessels current control inputs.
```

6.3.7 Communications

```
public class Comms
    Used to interact with CommNet for a given vessel. Obtained by calling Vessel.getComms().

    boolean getCanCommunicate()
        Whether the vessel can communicate with KSC.

    boolean getCanTransmitScience()
        Whether the vessel can transmit science data to KSC.

    double getSignalStrength()
        Signal strength to KSC.

    double getSignalDelay()
        Signal delay to KSC in seconds.

    double getPower()
        The combined power of all active antennae on the vessel.

    java.util.List<CommLink> getControlPath()
        The communication path used to control the vessel.

public class CommLink
    Represents a communication node in the network. For example, a vessel or the KSC.
```

```

CommLinkType getType ()
    The type of link.

double getSignalStrength ()
    Signal strength of the link.

CommNode getStart ()
    Start point of the link.

CommNode getEnd ()
    Start point of the link.

public enum CommLinkType
    The type of a communication link. See CommLink.getType().

    public CommLinkType HOME
        Link is to a base station on Kerbin.

    public CommLinkType CONTROL
        Link is to a control source, for example a manned spacecraft.

    public CommLinkType RELAY
        Link is to a relay satellite.

public class CommNode
    Represents a communication node in the network. For example, a vessel or the KSC.

    String getName ()
        Name of the communication node.

    boolean getIsHome ()
        Whether the communication node is on Kerbin.

    boolean getIsControlPoint ()
        Whether the communication node is a control point, for example a manned vessel.

    boolean getIsVessel ()
        Whether the communication node is a vessel.

    Vessel getVessel ()
        The vessel for this communication node.

```

6.3.8 Parts

The following classes allow interaction with a vessels individual parts.

- *Parts*
- *Part*
- *Module*
- *Specific Types of Part*
 - *Antenna*
 - *Cargo Bay*
 - *Control Surface*
 - *Decoupler*

- *Docking Port*
- *Engine*
- *Experiment*
- *Fairing*
- *Intake*
- *Leg*
- *Launch Clamp*
- *Light*
- *Parachute*
- *Radiator*
- *Resource Converter*
- *Resource Harvester*
- *Reaction Wheel*
- *RCS*
- *Sensor*
- *Solar Panel*
- *Thruster*
- *Wheel*
- *Trees of Parts*
 - *Traversing the Tree*
 - *Attachment Modes*
- *Fuel Lines*
- *Staging*

Parts

public class **Parts**

Instances of this class are used to interact with the parts of a vessel. An instance can be obtained by calling `Vessel.getParts()`.

`java.util.List<Part> getAll()`

A list of all of the vessels parts.

`Part getRoot()`

The vessels root part.

Note: See the discussion on *Trees of Parts*.

`Part getControlling()`

`void setControlling(Part value)`

The part from which the vessel is controlled.

`java.util.List<Part> withName (String name)`
 A list of parts whose `Part.getName()` is `name`.

Parameters

- `name` (String) –

`java.util.List<Part> withTitle (String title)`
 A list of all parts whose `Part.getTitle()` is `title`.

Parameters

- `title` (String) –

`java.util.List<Part> withTag (String tag)`
 A list of all parts whose `Part.getTag()` is `tag`.

Parameters

- `tag` (String) –

`java.util.List<Part> withModule (String moduleName)`
 A list of all parts that contain a `Module` whose `Module.getName()` is `moduleName`.

Parameters

- `moduleName` (String) –

`java.util.List<Part> inStage (int stage)`
 A list of all parts that are activated in the given `stage`.

Parameters

- `stage` (int) –

Note: See the discussion on *Staging*.

`java.util.List<Part> inDecoupleStage (int stage)`
 A list of all parts that are decoupled in the given `stage`.

Parameters

- `stage` (int) –

Note: See the discussion on *Staging*.

`java.util.List<Module> modulesWithName (String moduleName)`
 A list of modules (combined across all parts in the vessel) whose `Module.getName()` is `moduleName`.

Parameters

- `moduleName` (String) –

`java.util.List<Antenna> getAntennas ()`
 A list of all antennas in the vessel.

`java.util.List<CargoBay> getCargoBays ()`
 A list of all cargo bays in the vessel.

`java.util.List<ControlSurface> getControlSurfaces ()`
 A list of all control surfaces in the vessel.

`java.util.List<Decoupler> getDecouplers ()`
A list of all decouplers in the vessel.

`java.util.List<DockingPort> getDockingPorts ()`
A list of all docking ports in the vessel.

`java.util.List<Engine> getEngines ()`
A list of all engines in the vessel.

Note: This includes any part that generates thrust. This covers many different types of engine, including liquid fuel rockets, solid rocket boosters, jet engines and RCS thrusters.

`java.util.List<Experiment> getExperiments ()`
A list of all science experiments in the vessel.

`java.util.List<Fairing> getFairings ()`
A list of all fairings in the vessel.

`java.util.List<Intake> getIntakes ()`
A list of all intakes in the vessel.

`java.util.List<Leg> getLegs ()`
A list of all landing legs attached to the vessel.

`java.util.List<LaunchClamp> getLaunchClamps ()`
A list of all launch clamps attached to the vessel.

`java.util.List<Light> getLights ()`
A list of all lights in the vessel.

`java.util.List<Parachute> getParachutes ()`
A list of all parachutes in the vessel.

`java.util.List<Radiator> getRadiators ()`
A list of all radiators in the vessel.

`java.util.List<RCS> getRCS ()`
A list of all RCS blocks/thrusters in the vessel.

`java.util.List<ReactionWheel> getReactionWheels ()`
A list of all reaction wheels in the vessel.

`java.util.List<ResourceConverter> getResourceConverters ()`
A list of all resource converters in the vessel.

`java.util.List<ResourceHarvester> getResourceHarvesters ()`
A list of all resource harvesters in the vessel.

`java.util.List<Sensor> getSensors ()`
A list of all sensors in the vessel.

`java.util.List<SolarPanel> getSolarPanels ()`
A list of all solar panels in the vessel.

`java.util.List<Wheel> getWheels ()`
A list of all wheels in the vessel.

Part

public class **Part**

Represents an individual part. Vessels are made up of multiple parts. Instances of this class can be obtained by several methods in *Parts*.

String getName ()

Internal name of the part, as used in *part* *cfg* files. For example “Mark1-2Pod”.

String getTitle ()

Title of the part, as shown when the part is right clicked in-game. For example “Mk1-2 Command Pod”.

String getTag ()

void setTag (String value)

The name tag for the part. Can be set to a custom string using the in-game user interface.

Note: This requires either the *NameTag* or *kOS* mod to be installed.

boolean getHighlighted ()

void setHighlighted (boolean value)

Whether the part is highlighted.

org.javatuples.Triplet<Double, Double, Double> getHighlightColor ()

void setHighlightColor (org.javatuples.Triplet<Double, Double, Double> value)

The color used to highlight the part, as an RGB triple.

double getCost ()

The cost of the part, in units of funds.

Vessel getVessel ()

The vessel that contains this part.

Part getParent ()

The parts parent. Returns *null* if the part does not have a parent. This, in combination with *Part.getChildren ()*, can be used to traverse the vessels parts tree.

Note: See the discussion on *Trees of Parts*.

java.util.List<Part> getChildren ()

The parts children. Returns an empty list if the part has no children. This, in combination with *Part.getParent ()*, can be used to traverse the vessels parts tree.

Note: See the discussion on *Trees of Parts*.

boolean getAxiallyAttached ()

Whether the part is axially attached to its parent, i.e. on the top or bottom of its parent. If the part has no parent, returns *false*.

Note: See the discussion on *Attachment Modes*.

boolean **getRadiallyAttached** ()

Whether the part is radially attached to its parent, i.e. on the side of its parent. If the part has no parent, returns `false`.

Note: See the discussion on *Attachment Modes*.

int **getStage** ()

The stage in which this part will be activated. Returns -1 if the part is not activated by staging.

Note: See the discussion on *Staging*.

int **getDecoupleStage** ()

The stage in which this part will be decoupled. Returns -1 if the part is never decoupled from the vessel.

Note: See the discussion on *Staging*.

boolean **getMassless** ()

Whether the part is `massless`.

double **getMass** ()

The current mass of the part, including resources it contains, in kilograms. Returns zero if the part is massless.

double **getDryMass** ()

The mass of the part, not including any resources it contains, in kilograms. Returns zero if the part is massless.

boolean **getShielded** ()

Whether the part is shielded from the exterior of the vessel, for example by a fairing.

float **getDynamicPressure** ()

The dynamic pressure acting on the part, in Pascals.

double **getImpactTolerance** ()

The impact tolerance of the part, in meters per second.

double **getTemperature** ()

Temperature of the part, in Kelvin.

double **getSkinTemperature** ()

Temperature of the skin of the part, in Kelvin.

double **getMaxTemperature** ()

Maximum temperature that the part can survive, in Kelvin.

double **getMaxSkinTemperature** ()

Maximum temperature that the skin of the part can survive, in Kelvin.

float **getThermalMass** ()

A measure of how much energy it takes to increase the internal temperature of the part, in Joules per Kelvin.

float **getThermalSkinMass** ()

A measure of how much energy it takes to increase the skin temperature of the part, in Joules per Kelvin.

float **getThermalResourceMass** ()

A measure of how much energy it takes to increase the temperature of the resources contained in the part, in Joules per Kelvin.

float **getThermalConductionFlux** ()

The rate at which heat energy is conducting into or out of the part via contact with other parts. Measured in energy per unit time, or power, in Watts. A positive value means the part is gaining heat energy, and negative means it is losing heat energy.

float **getThermalConvectionFlux** ()

The rate at which heat energy is convecting into or out of the part from the surrounding atmosphere. Measured in energy per unit time, or power, in Watts. A positive value means the part is gaining heat energy, and negative means it is losing heat energy.

float **getThermalRadiationFlux** ()

The rate at which heat energy is radiating into or out of the part from the surrounding environment. Measured in energy per unit time, or power, in Watts. A positive value means the part is gaining heat energy, and negative means it is losing heat energy.

float **getThermalInternalFlux** ()

The rate at which heat energy is begin generated by the part. For example, some engines generate heat by combusting fuel. Measured in energy per unit time, or power, in Watts. A positive value means the part is gaining heat energy, and negative means it is losing heat energy.

float **getThermalSkinToInternalFlux** ()

The rate at which heat energy is transferring between the part's skin and its internals. Measured in energy per unit time, or power, in Watts. A positive value means the part's internals are gaining heat energy, and negative means its skin is gaining heat energy.

Resources **getResources** ()

A *Resources* object for the part.

boolean **getCrossfeed** ()

Whether this part is crossfeed capable.

boolean **getIsFuelLine** ()

Whether this part is a fuel line.

java.util.List<Part> **getFuelLinesFrom** ()

The parts that are connected to this part via fuel lines, where the direction of the fuel line is into this part.

Note: See the discussion on *Fuel Lines*.

java.util.List<Part> **getFuelLinesTo** ()

The parts that are connected to this part via fuel lines, where the direction of the fuel line is out of this part.

Note: See the discussion on *Fuel Lines*.

java.util.List<Module> **getModules** ()

The modules for this part.

Antenna **getAntenna** ()

A *Antenna* if the part is an antenna, otherwise null.

CargoBay **getCargoBay** ()

A *CargoBay* if the part is a cargo bay, otherwise null.

ControlSurface **getControlSurface** ()

A *ControlSurface* if the part is an aerodynamic control surface, otherwise null.

Decoupler **getDecoupler** ()

A *Decoupler* if the part is a decoupler, otherwise null.

DockingPort **getDockingPort** ()

A *DockingPort* if the part is a docking port, otherwise null.

Engine **getEngine** ()

An *Engine* if the part is an engine, otherwise null.

Experiment **getExperiment** ()

An *Experiment* if the part is a science experiment, otherwise null.

Fairing **getFairing** ()

A *Fairing* if the part is a fairing, otherwise null.

Intake **getIntake** ()

An *Intake* if the part is an intake, otherwise null.

Note: This includes any part that generates thrust. This covers many different types of engine, including liquid fuel rockets, solid rocket boosters and jet engines. For RCS thrusters see *RCS*.

Leg **getLeg** ()

A *Leg* if the part is a landing leg, otherwise null.

LaunchClamp **getLaunchClamp** ()

A *LaunchClamp* if the part is a launch clamp, otherwise null.

Light **getLight** ()

A *Light* if the part is a light, otherwise null.

Parachute **getParachute** ()

A *Parachute* if the part is a parachute, otherwise null.

Radiator **getRadiator** ()

A *Radiator* if the part is a radiator, otherwise null.

RCS **getRCS** ()

A *RCS* if the part is an RCS block/thruster, otherwise null.

ReactionWheel **getReactionWheel** ()

A *ReactionWheel* if the part is a reaction wheel, otherwise null.

ResourceConverter **getResourceConverter** ()

A *ResourceConverter* if the part is a resource converter, otherwise null.

ResourceHarvester **getResourceHarvester** ()

A *ResourceHarvester* if the part is a resource harvester, otherwise null.

Sensor **getSensor** ()

A *Sensor* if the part is a sensor, otherwise null.

SolarPanel **getSolarPanel** ()

A *SolarPanel* if the part is a solar panel, otherwise null.

Wheel **getWheel** ()

A *Wheel* if the part is a wheel, otherwise null.

org.javatuples.Triplet<Double, Double, Double> **position** (*ReferenceFrame* referenceFrame)

The position of the part in the given reference frame.

Parameters

- **referenceFrame** (*ReferenceFrame*) – The reference frame that the returned position vector is in.

Returns The position as a vector.

Note: This is a fixed position in the part, defined by the parts model. It is not necessarily the same as the parts center of mass. Use *Part.centerOfMass (ReferenceFrame)* to get the parts center of mass.

org.javatuples.Triplet<Double, Double, Double> **centerOfMass** (*ReferenceFrame referenceFrame*)

The position of the parts center of mass in the given reference frame. If the part is physicsless, this is equivalent to *Part.position (ReferenceFrame)*.

Parameters

- **referenceFrame** (*ReferenceFrame*) – The reference frame that the returned position vector is in.

Returns The position as a vector.

org.javatuples.Pair<org.javatuples.Triplet<Double, Double, Double>, org.javatuples.Triplet<Double, Double, Double>> **boundingBox** (*ReferenceFrame referenceFrame*)

The axis-aligned bounding box of the part in the given reference frame.

Parameters

- **referenceFrame** (*ReferenceFrame*) – The reference frame that the returned position vectors are in.

Returns The positions of the minimum and maximum vertices of the box, as position vectors.

Note: This is computed from the collision mesh of the part. If the part is not collidable, the box has zero volume and is centered on the *Part.position (ReferenceFrame)* of the part.

org.javatuples.Triplet<Double, Double, Double> **direction** (*ReferenceFrame referenceFrame*)

The direction the part points in, in the given reference frame.

Parameters

- **referenceFrame** (*ReferenceFrame*) – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

org.javatuples.Triplet<Double, Double, Double> **velocity** (*ReferenceFrame referenceFrame*)

The linear velocity of the part in the given reference frame.

Parameters

- **referenceFrame** (*ReferenceFrame*) – The reference frame that the returned velocity vector is in.

Returns The velocity as a vector. The vector points in the direction of travel, and its magnitude is the speed of the body in meters per second.

org.javatuples.[Quartet](#)<[Double](#), [Double](#), [Double](#), [Double](#)> **rotation** (*ReferenceFrame* *referenceFrame*)

The rotation of the part, in the given reference frame.

Parameters

- **referenceFrame** (*ReferenceFrame*) – The reference frame that the returned rotation is in.

Returns The rotation as a quaternion of the form (x, y, z, w) .

org.javatuples.[Triplet](#)<[Double](#), [Double](#), [Double](#)> **getMomentOfInertia** ()

The moment of inertia of the part in $kg.m^2$ around its center of mass in the parts reference frame (*ReferenceFrame*).

java.util.[List](#)<[Double](#)> **getInertiaTensor** ()

The inertia tensor of the part in the parts reference frame (*ReferenceFrame*). Returns the 3x3 matrix as a list of elements, in row-major order.

ReferenceFrame **getReferenceFrame** ()

The reference frame that is fixed relative to this part, and centered on a fixed position within the part, defined by the parts model.

- The origin is at the position of the part, as returned by *Part.position* (*ReferenceFrame*).
- The axes rotate with the part.
- The x, y and z axis directions depend on the design of the part.

Note: For docking port parts, this reference frame is not necessarily equivalent to the reference frame for the docking port, returned by *DockingPort.getReferenceFrame* ().

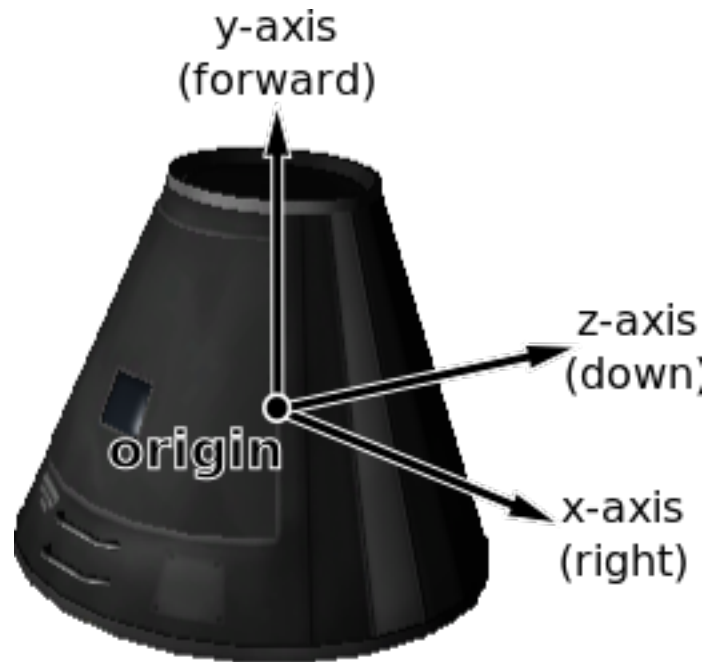


Fig. 6.7: Mk1 Command Pod reference frame origin and axes

ReferenceFrame **getCenterOfMassReferenceFrame** ()

The reference frame that is fixed relative to this part, and centered on its center of mass.

- The origin is at the center of mass of the part, as returned by *Part.centerOfMass (ReferenceFrame)*.
- The axes rotate with the part.
- The x, y and z axis directions depend on the design of the part.

Note: For docking port parts, this reference frame is not necessarily equivalent to the reference frame for the docking port, returned by *DockingPort.getReferenceFrame ()*.

Force **addForce** (org.javatuples.Triplet<Double, Double, Double> *force*,
org.javatuples.Triplet<Double, Double, Double> *position*, *ReferenceFrame* *referenceFrame*)

Exert a constant force on the part, acting at the given position.

Parameters

- **force** (*org.javatuples.Triplet<Double, Double, Double>*) – A vector pointing in the direction that the force acts, with its magnitude equal to the strength of the force in Newtons.
- **position** (*org.javatuples.Triplet<Double, Double, Double>*) – The position at which the force acts, as a vector.
- **referenceFrame** (*ReferenceFrame*) – The reference frame that the force and position are in.

Returns An object that can be used to remove or modify the force.

void **instantaneousForce** (org.javatuples.Triplet<Double, Double, Double> *force*,
org.javatuples.Triplet<Double, Double, Double> *position*, *ReferenceFrame* *referenceFrame*)

Exert an instantaneous force on the part, acting at the given position.

Parameters

- **force** (*org.javatuples.Triplet<Double, Double, Double>*) – A vector pointing in the direction that the force acts, with its magnitude equal to the strength of the force in Newtons.
- **position** (*org.javatuples.Triplet<Double, Double, Double>*) – The position at which the force acts, as a vector.
- **referenceFrame** (*ReferenceFrame*) – The reference frame that the force and position are in.

Note: The force is applied instantaneously in a single physics update.

public class **Force**

Obtained by calling *Part.addForce (org.javatuples.Triplet<Double, Double, Double>, org.javatuples.Triplet<Double, Double, Double>, ReferenceFrame)*.

Part **getPart** ()

The part that this force is applied to.

org.javatuples.Triplet<Double, Double, Double> **getForceVector** ()

void **setForceVector** (org.javatuples.Triplet<Double, Double, Double> *value*)

The force vector, in Newtons.

Returns A vector pointing in the direction that the force acts, with its magnitude equal to the strength of the force in Newtons.

`org.javatuples.Triplet<Double, Double, Double> getPosition ()`

`void setPosition (org.javatuples.Triplet<Double, Double, Double> value)`

The position at which the force acts, in reference frame *ReferenceFrame*.

Returns The position as a vector.

`ReferenceFrame getReferenceFrame ()`

`void setReferenceFrame (ReferenceFrame value)`

The reference frame of the force vector and position.

`void remove ()`

Remove the force.

Module

public class **Module**

This can be used to interact with a specific part module. This includes part modules in stock KSP, and those added by mods.

In KSP, each part has zero or more **PartModules** associated with it. Each one contains some of the functionality of the part. For example, an engine has a “ModuleEngines” part module that contains all the functionality of an engine.

`String getName ()`

Name of the PartModule. For example, “ModuleEngines”.

`Part getPart ()`

The part that contains this module.

`java.util.Map<String, String> getFields ()`

The modules field names and their associated values, as a dictionary. These are the values visible in the right-click menu of the part.

`boolean hasField (String name)`

Returns `true` if the module has a field with the given name.

Parameters

- **name** (*String*) – Name of the field.

`String getField (String name)`

Returns the value of a field.

Parameters

- **name** (*String*) – Name of the field.

`void setFieldInt (String name, int value)`

Set the value of a field to the given integer number.

Parameters

- **name** (*String*) – Name of the field.
- **value** (*int*) – Value to set.

`void setFieldFloat (String name, float value)`

Set the value of a field to the given floating point number.

Parameters

- **name** (*String*) – Name of the field.
- **value** (*float*) – Value to set.

void **setFieldString** (*String name*, *String value*)

Set the value of a field to the given string.

Parameters

- **name** (*String*) – Name of the field.
- **value** (*String*) – Value to set.

void **resetField** (*String name*)

Set the value of a field to its original value.

Parameters

- **name** (*String*) – Name of the field.

java.util.List<*String*> **getEvents** ()

A list of the names of all of the modules events. Events are the clickable buttons visible in the right-click menu of the part.

boolean **hasEvent** (*String name*)

true if the module has an event with the given name.

Parameters

- **name** (*String*) –

void **triggerEvent** (*String name*)

Trigger the named event. Equivalent to clicking the button in the right-click menu of the part.

Parameters

- **name** (*String*) –

java.util.List<*String*> **getActions** ()

A list of all the names of the modules actions. These are the parts actions that can be assigned to action groups in the in-game editor.

boolean **hasAction** (*String name*)

true if the part has an action with the given name.

Parameters

- **name** (*String*) –

void **setAction** (*String name*, boolean *value*)

Set the value of an action with the given name.

Parameters

- **name** (*String*) –
- **value** (*boolean*) –

Specific Types of Part

The following classes provide functionality for specific types of part.

- *Antenna*
- *Cargo Bay*
- *Control Surface*
- *Decoupler*
- *Docking Port*
- *Engine*
- *Experiment*
- *Fairing*
- *Intake*
- *Leg*
- *Launch Clamp*
- *Light*
- *Parachute*
- *Radiator*
- *Resource Converter*
- *Resource Harvester*
- *Reaction Wheel*
- *RCS*
- *Sensor*
- *Solar Panel*
- *Thruster*
- *Wheel*

Antenna

```
public class Antenna
    An antenna. Obtained by calling Part.getAntenna().

    Part getPart ()
        The part object for this antenna.

    AntennaState getState ()
        The current state of the antenna.

    boolean getDeployable ()
        Whether the antenna is deployable.

    boolean getDeployed ()

    void setDeployed (boolean value)
        Whether the antenna is deployed.
```

Note: Fixed antennas are always deployed. Returns an error if you try to deploy a fixed antenna.

```

boolean getCanTransmit ()
    Whether data can be transmitted by this antenna.

void transmit ()
    Transmit data.

void cancel ()
    Cancel current transmission of data.

boolean getAllowPartial ()

void setAllowPartial (boolean value)
    Whether partial data transmission is permitted.

double getPower ()
    The power of the antenna.

boolean getCombinable ()
    Whether the antenna can be combined with other antennae on the vessel to boost the power.

double getCombinableExponent ()
    Exponent used to calculate the combined power of multiple antennae on a vessel.

float getPacketInterval ()
    Interval between sending packets in seconds.

float getPacketSize ()
    Amount of data sent per packet in Mbits.

double getPacketResourceCost ()
    Units of electric charge consumed per packet sent.

public enum AntennaState
    The state of an antenna. See Antenna.getState().

    public AntennaState DEPLOYED
        Antenna is fully deployed.

    public AntennaState RETRACTED
        Antenna is fully retracted.

    public AntennaState DEPLOYING
        Antenna is being deployed.

    public AntennaState RETRACTING
        Antenna is being retracted.

    public AntennaState BROKEN
        Antenna is broken.

```

Cargo Bay

```

public class CargoBay
    A cargo bay. Obtained by calling Part.getCargoBay().

    Part getPart ()
        The part object for this cargo bay.

```

CargoBayState **getState** ()

The state of the cargo bay.

boolean **getOpen** ()

void **setOpen** (boolean *value*)

Whether the cargo bay is open.

public enum **CargoBayState**

The state of a cargo bay. See *CargoBay.getState()*.

public *CargoBayState* **OPEN**

Cargo bay is fully open.

public *CargoBayState* **CLOSED**

Cargo bay closed and locked.

public *CargoBayState* **OPENING**

Cargo bay is opening.

public *CargoBayState* **CLOSING**

Cargo bay is closing.

Control Surface

public class **ControlSurface**

An aerodynamic control surface. Obtained by calling *Part.getControlSurface()*.

Part **getPart** ()

The part object for this control surface.

boolean **getPitchEnabled** ()

void **setPitchEnabled** (boolean *value*)

Whether the control surface has pitch control enabled.

boolean **getYawEnabled** ()

void **setYawEnabled** (boolean *value*)

Whether the control surface has yaw control enabled.

boolean **getRollEnabled** ()

void **setRollEnabled** (boolean *value*)

Whether the control surface has roll control enabled.

float **getAuthorityLimiter** ()

void **setAuthorityLimiter** (float *value*)

The authority limiter for the control surface, which controls how far the control surface will move.

boolean **getInverted** ()

void **setInverted** (boolean *value*)

Whether the control surface movement is inverted.

boolean **getDeployed** ()

void **setDeployed** (boolean *value*)

Whether the control surface has been fully deployed.

float **getSurfaceArea** ()

Surface area of the control surface in m^2 .

`org.javatuples.Pair<org.javatuples.Triplet<Double, Double, Double>, org.javatuples.Triplet<Double, Double, Double>> getAvailableTorque()`
 The available torque, in Newton meters, that can be produced by this control surface, in the positive and negative pitch, roll and yaw axes of the vessel. These axes correspond to the coordinate axes of the `Vessel.getReferenceFrame()`.

Decoupler

public class **Decoupler**

A decoupler. Obtained by calling `Part.getDecoupler()`

Part **getPart** ()

The part object for this decoupler.

Vessel **decouple** ()

Fires the decoupler. Returns the new vessel created when the decoupler fires. Throws an exception if the decoupler has already fired.

Note: When called, the active vessel may change. It is therefore possible that, after calling this function, the object(s) returned by previous call(s) to `getActiveVessel()` no longer refer to the active vessel.

boolean **getDecoupled** ()

Whether the decoupler has fired.

boolean **getStaged** ()

Whether the decoupler is enabled in the staging sequence.

float **getImpulse** ()

The impulse that the decoupler imparts when it is fired, in Newton seconds.

Docking Port

public class **DockingPort**

A docking port. Obtained by calling `Part.getDockingPort()`

Part **getPart** ()

The part object for this docking port.

DockingPortState **getState** ()

The current state of the docking port.

Part **getDockedPart** ()

The part that this docking port is docked to. Returns `null` if this docking port is not docked to anything.

Vessel **undock** ()

Undocks the docking port and returns the new *Vessel* that is created. This method can be called for either docking port in a docked pair. Throws an exception if the docking port is not docked to anything.

Note: When called, the active vessel may change. It is therefore possible that, after calling this function, the object(s) returned by previous call(s) to `getActiveVessel()` no longer refer to the active vessel.

float **getReengageDistance** ()

The distance a docking port must move away when it undocks before it becomes ready to dock with another port, in meters.

boolean **getHasShield**()

Whether the docking port has a shield.

boolean **getShielded**()

void **setShielded**(boolean *value*)

The state of the docking ports shield, if it has one.

Returns `true` if the docking port has a shield, and the shield is closed. Otherwise returns `false`. When set to `true`, the shield is closed, and when set to `false` the shield is opened. If the docking port does not have a shield, setting this attribute has no effect.

org.javatuples.Triplet<Double, Double, Double> **position**(ReferenceFrame *referenceFrame*)

The position of the docking port, in the given reference frame.

Parameters

- **referenceFrame** (ReferenceFrame) – The reference frame that the returned position vector is in.

Returns The position as a vector.

org.javatuples.Triplet<Double, Double, Double> **direction**(ReferenceFrame *referenceFrame*)

The direction that docking port points in, in the given reference frame.

Parameters

- **referenceFrame** (ReferenceFrame) – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

org.javatuples.Quartet<Double, Double, Double, Double> **rotation**(ReferenceFrame *referenceFrame*)

The rotation of the docking port, in the given reference frame.

Parameters

- **referenceFrame** (ReferenceFrame) – The reference frame that the returned rotation is in.

Returns The rotation as a quaternion of the form (x, y, z, w) .

ReferenceFrame **getReferenceFrame**()

The reference frame that is fixed relative to this docking port, and oriented with the port.

- The origin is at the position of the docking port.
- The axes rotate with the docking port.
- The x-axis points out to the right side of the docking port.
- The y-axis points in the direction the docking port is facing.
- The z-axis points out of the bottom off the docking port.

Note: This reference frame is not necessarily equivalent to the reference frame for the part, returned by `Part.getReferenceFrame()`.

public enum **DockingPortState**

The state of a docking port. See `DockingPort.getState()`.

public *DockingPortState* **READY**

The docking port is ready to dock to another docking port.

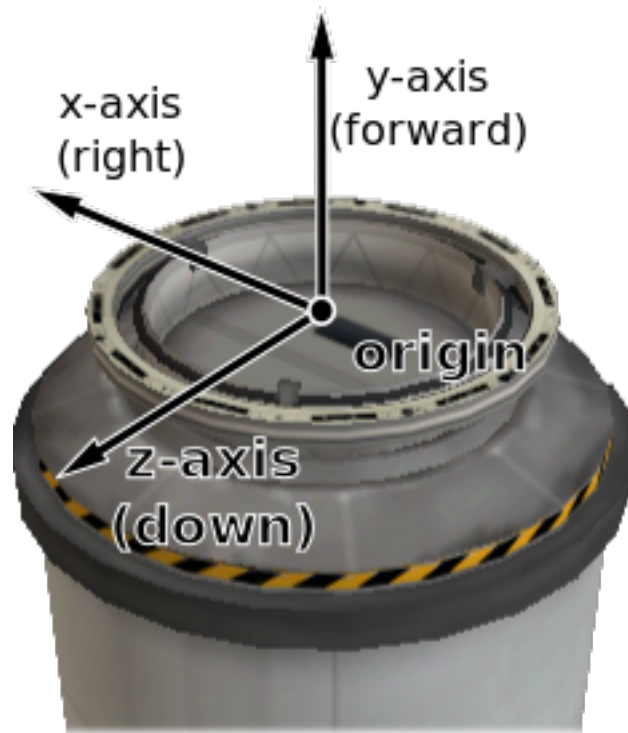


Fig. 6.8: Docking port reference frame origin and axes

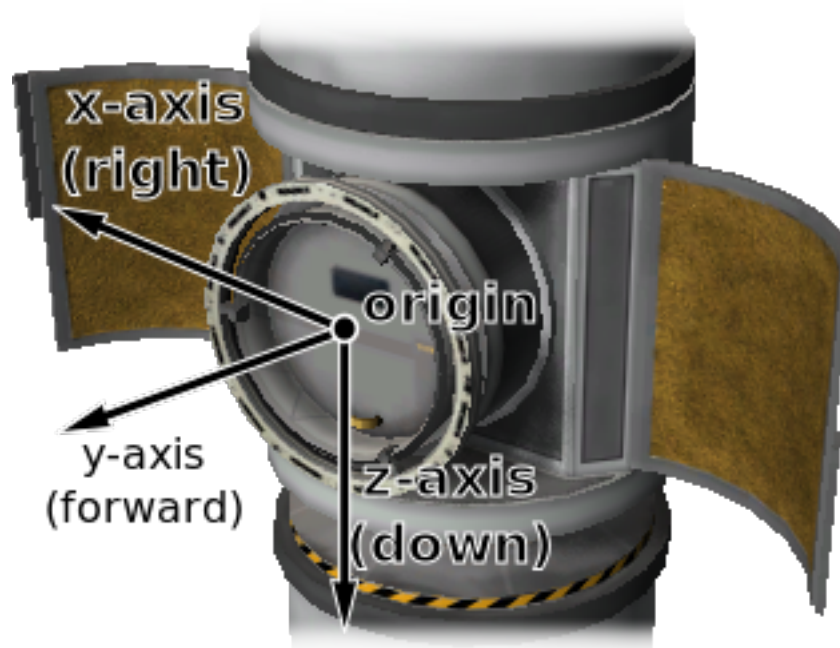


Fig. 6.9: Inline docking port reference frame origin and axes

public *DockingPortState* **DOCKED**

The docking port is docked to another docking port, or docked to another part (from the VAB/SPH).

public *DockingPortState* **DOCKING**

The docking port is very close to another docking port, but has not docked. It is using magnetic force to acquire a solid dock.

public *DockingPortState* **UNDOCKING**

The docking port has just been undocked from another docking port, and is disabled until it moves away by a sufficient distance (*DockingPort.getReengageDistance()*).

public *DockingPortState* **SHIELDED**

The docking port has a shield, and the shield is closed.

public *DockingPortState* **MOVING**

The docking ports shield is currently opening/closing.

Engine

public class **Engine**

An engine, including ones of various types. For example liquid fuelled gimballed engines, solid rocket boosters and jet engines. Obtained by calling *Part.getEngine()*.

Note: For RCS thrusters *Part.getRCS()*.

Part **getPart** ()

The part object for this engine.

boolean **getActive** ()

void **setActive** (boolean *value*)

Whether the engine is active. Setting this attribute may have no effect, depending on *Engine.getCanShutdown()* and *Engine.getCanRestart()*.

float **getThrust** ()

The current amount of thrust being produced by the engine, in Newtons.

float **getAvailableThrust** ()

The amount of thrust, in Newtons, that would be produced by the engine when activated and with its throttle set to 100%. Returns zero if the engine does not have any fuel. Takes the engine's current *Engine.getThrustLimit()* and atmospheric conditions into account.

float **getMaxThrust** ()

The amount of thrust, in Newtons, that would be produced by the engine when activated and fueled, with its throttle and throttle limiter set to 100%.

float **getMaxVacuumThrust** ()

The maximum amount of thrust that can be produced by the engine in a vacuum, in Newtons. This is the amount of thrust produced by the engine when activated, *Engine.getThrustLimit()* is set to 100%, the main vessel's throttle is set to 100% and the engine is in a vacuum.

float **getThrustLimit** ()

void **setThrustLimit** (float *value*)

The thrust limiter of the engine. A value between 0 and 1. Setting this attribute may have no effect, for example the thrust limit for a solid rocket booster cannot be changed in flight.

`java.util.List<Thruster> getThrusters ()`

The components of the engine that generate thrust.

Note: For example, this corresponds to the rocket nozzle on a solid rocket booster, or the individual nozzles on a RAPIER engine. The overall thrust produced by the engine, as reported by `Engine.getAvailableThrust()`, `Engine.getMaxThrust()` and others, is the sum of the thrust generated by each thruster.

`float getSpecificImpulse ()`

The current specific impulse of the engine, in seconds. Returns zero if the engine is not active.

`float getVacuumSpecificImpulse ()`

The vacuum specific impulse of the engine, in seconds.

`float getKerbinSeaLevelSpecificImpulse ()`

The specific impulse of the engine at sea level on Kerbin, in seconds.

`java.util.List<String> getPropellantNames ()`

The names of the propellants that the engine consumes.

`java.util.Map<String, Float> getPropellantRatios ()`

The ratio of resources that the engine consumes. A dictionary mapping resource names to the ratio at which they are consumed by the engine.

Note: For example, if the ratios are 0.6 for LiquidFuel and 0.4 for Oxidizer, then for every 0.6 units of LiquidFuel that the engine burns, it will burn 0.4 units of Oxidizer.

`java.util.List<Propellant> getPropellants ()`

The propellants that the engine consumes.

`boolean getHasFuel ()`

Whether the engine has any fuel available.

Note: The engine must be activated for this property to update correctly.

`float getThrottle ()`

The current throttle setting for the engine. A value between 0 and 1. This is not necessarily the same as the vessel's main throttle setting, as some engines take time to adjust their throttle (such as jet engines).

`boolean getThrottleLocked ()`

Whether the `Control.getThrottle()` affects the engine. For example, this is `true` for liquid fueled rockets, and `false` for solid rocket boosters.

`boolean getCanRestart ()`

Whether the engine can be restarted once shutdown. If the engine cannot be shutdown, returns `false`. For example, this is `true` for liquid fueled rockets and `false` for solid rocket boosters.

`boolean getCanShutdown ()`

Whether the engine can be shutdown once activated. For example, this is `true` for liquid fueled rockets and `false` for solid rocket boosters.

`boolean getHasModes ()`

Whether the engine has multiple modes of operation.

`String getMode ()`

```
void setMode (String value)
    The name of the current engine mode.

java.util.Map<String, Engine> getModes ()
    The available modes for the engine. A dictionary mapping mode names to Engine objects.

void toggleMode ()
    Toggle the current engine mode.

boolean getAutoModeSwitch ()

void setAutoModeSwitch (boolean value)
    Whether the engine will automatically switch modes.

boolean getGimballed ()
    Whether the engine is gimballed.

float getGimbalRange ()
    The range over which the gimbal can move, in degrees. Returns 0 if the engine is not gimballed.

boolean getGimbalLocked ()

void setGimbalLocked (boolean value)
    Whether the engines gimbal is locked in place. Setting this attribute has no effect if the engine is not gimballed.

float getGimbalLimit ()

void setGimbalLimit (float value)
    The gimbal limiter of the engine. A value between 0 and 1. Returns 0 if the gimbal is locked.

org.javatuples.Pair<org.javatuples.Triplet<Double, Double, Double>, org.javatuples.Triplet<Double, Double, Double>> getAvailableTorque ()
    The available torque, in Newton meters, that can be produced by this engine, in the positive and negative pitch, roll and yaw axes of the vessel. These axes correspond to the coordinate axes of the Vessel. getReferenceFrame (). Returns zero if the engine is inactive, or not gimballed.

public class Propellant
    A propellant for an engine. Obtains by calling Engine.getPropellants ().

    String getName ()
        The name of the propellant.

    double getCurrentAmount ()
        The current amount of propellant.

    double getCurrentRequirement ()
        The required amount of propellant.

    double getTotalResourceAvailable ()
        The total amount of the underlying resource currently reachable given resource flow rules.

    double getTotalResourceCapacity ()
        The total vehicle capacity for the underlying propellant resource, restricted by resource flow rules.

    boolean getIgnoreForIsp ()
        If this propellant should be ignored when calculating required mass flow given specific impulse.

    boolean getIgnoreForThrustCurve ()
        If this propellant should be ignored for thrust curve calculations.

    boolean getDrawStackGauge ()
        If this propellant has a stack gauge or not.
```

boolean **getIsDeprived** ()
 If this propellant is deprived.

float **getRatio** ()
 The propellant ratio.

Experiment

```
public class Experiment
  Obtained by calling Part.getExperiment ().

  Part getPart ()
    The part object for this experiment.

  void run ()
    Run the experiment.

  void transmit ()
    Transmit all experimental data contained by this part.

  void dump ()
    Dump the experimental data contained by the experiment.

  void reset ()
    Reset the experiment.

  boolean getDeployed ()
    Whether the experiment has been deployed.

  boolean getRerunnable ()
    Whether the experiment can be re-run.

  boolean getInoperable ()
    Whether the experiment is inoperable.

  boolean getHasData ()
    Whether the experiment contains data.

  java.util.List<ScienceData> getData ()
    The data contained in this experiment.

  String getBiome ()
    The name of the biome the experiment is currently in.

  boolean getAvailable ()
    Determines if the experiment is available given the current conditions.

  ScienceSubject getScienceSubject ()
    Containing information on the corresponding specific science result for the current conditions. Returns
    null if the experiment is unavailable.

public class ScienceData
  Obtained by calling Experiment.getData ().

  float getDataAmount ()
    Data amount.

  float getScienceValue ()
    Science value.

  float getTransmitValue ()
    Transmit value.
```

public class **ScienceSubject**

Obtained by calling *Experiment.getScienceSubject()*.

String getTitle()

Title of science subject, displayed in science archives

boolean getIsComplete()

Whether the experiment has been completed.

float getScience()

Amount of science already earned from this subject, not updated until after transmission/recovery.

float getScienceCap()

Total science allowable for this subject.

float getDataScale()

Multiply science value by this to determine data amount in mits.

float getSubjectValue()

Multiplier for specific Celestial Body/Experiment Situation combination.

float getScientificValue()

Diminishing value multiplier for decreasing the science value returned from repeated experiments.

Fairing

public class **Fairing**

A fairing. Obtained by calling *Part.getFairing()*.

Part getPart()

The part object for this fairing.

void jettison()

Jettison the fairing. Has no effect if it has already been jettisoned.

boolean getJettisoned()

Whether the fairing has been jettisoned.

Intake

public class **Intake**

An air intake. Obtained by calling *Part.getIntake()*.

Part getPart()

The part object for this intake.

boolean getOpen()

void setOpen(boolean value)

Whether the intake is open.

float getSpeed()

Speed of the flow into the intake, in *m/s*.

float getFlow()

The rate of flow into the intake, in units of resource per second.

float getArea()

The area of the intake's opening, in square meters.

Leg

public class **Leg**
A landing leg. Obtained by calling *Part.getLeg()*.

Part **getPart** ()
The part object for this landing leg.

LegState **getState** ()
The current state of the landing leg.

boolean **getDeployable** ()
Whether the leg is deployable.

boolean **getDeployed** ()

void **setDeployed** (boolean *value*)
Whether the landing leg is deployed.

Note: Fixed landing legs are always deployed. Returns an error if you try to deploy fixed landing gear.

boolean **getIsGrounded** ()
Returns whether the leg is touching the ground.

public enum **LegState**
The state of a landing leg. See *Leg.getState()*.

public *LegState* **DEPLOYED**
Landing leg is fully deployed.

public *LegState* **RETRACTED**
Landing leg is fully retracted.

public *LegState* **DEPLOYING**
Landing leg is being deployed.

public *LegState* **RETRACTING**
Landing leg is being retracted.

public *LegState* **BROKEN**
Landing leg is broken.

Launch Clamp

public class **LaunchClamp**
A launch clamp. Obtained by calling *Part.getLaunchClamp()*.

Part **getPart** ()
The part object for this launch clamp.

void **release** ()
Releases the docking clamp. Has no effect if the clamp has already been released.

Light

public class **Light**
A light. Obtained by calling *Part.getLight()*.

Part **getPart** ()
The part object for this light.

boolean **getActive** ()

void **setActive** (boolean *value*)
Whether the light is switched on.

org.javatuples.Triplet<Float, Float, Float> **getColor** ()

void **setColor** (org.javatuples.Triplet<Float, Float, Float> *value*)
The color of the light, as an RGB triple.

float **getPowerUsage** ()
The current power usage, in units of charge per second.

Parachute

```
public class Parachute
```

A parachute. Obtained by calling *Part.getParachute()*.

Part **getPart** ()
The part object for this parachute.

void **deploy** ()
Deploys the parachute. This has no effect if the parachute has already been deployed.

boolean **getDeployed** ()
Whether the parachute has been deployed.

void **arm** ()
Deploys the parachute. This has no effect if the parachute has already been armed or deployed. Only applicable to RealChutes parachutes.

boolean **getArmed** ()
Whether the parachute has been armed or deployed. Only applicable to RealChutes parachutes.

ParachuteState **getState** ()
The current state of the parachute.

float **getDeployAltitude** ()

void **setDeployAltitude** (float *value*)
The altitude at which the parachute will full deploy, in meters. Only applicable to stock parachutes.

float **getDeployMinPressure** ()

void **setDeployMinPressure** (float *value*)
The minimum pressure at which the parachute will semi-deploy, in atmospheres. Only applicable to stock parachutes.

```
public enum ParachuteState
```

The state of a parachute. See *Parachute.getState()*.

```
public ParachuteState STOWED
```

The parachute is safely tucked away inside its housing.

```
public ParachuteState ARMED
```

The parachute is armed for deployment. (RealChutes only)

```
public ParachuteState ACTIVE
```

The parachute is still stowed, but ready to semi-deploy. (Stock parachutes only)

```

public ParachuteState SEMI_DEPLOYED
    The parachute has been deployed and is providing some drag, but is not fully deployed yet. (Stock
    parachutes only)

public ParachuteState DEPLOYED
    The parachute is fully deployed.

public ParachuteState CUT
    The parachute has been cut.

```

Radiator

```

public class Radiator
    A radiator. Obtained by calling Part.getRadiator().

    Part getPart ()
        The part object for this radiator.

    boolean getDeployable ()
        Whether the radiator is deployable.

    boolean getDeployed ()

    void setDeployed (boolean value)
        For a deployable radiator, true if the radiator is extended. If the radiator is not deployable, this is always
        true.

    RadiatorState getState ()
        The current state of the radiator.

```

Note: A fixed radiator is always *RadiatorState.EXTENDED*.

```

public enum RadiatorState
    The state of a radiator. RadiatorState

    public RadiatorState EXTENDED
        Radiator is fully extended.

    public RadiatorState RETRACTED
        Radiator is fully retracted.

    public RadiatorState EXTENDING
        Radiator is being extended.

    public RadiatorState RETRACTING
        Radiator is being retracted.

    public RadiatorState BROKEN
        Radiator is being broken.

```

Resource Converter

```

public class ResourceConverter
    A resource converter. Obtained by calling Part.getResourceConverter().

    Part getPart ()
        The part object for this converter.

```

int **getCount** ()

The number of converters in the part.

String **name** (int *index*)

The name of the specified converter.

Parameters

- **index** (*int*) – Index of the converter.

boolean **active** (int *index*)

True if the specified converter is active.

Parameters

- **index** (*int*) – Index of the converter.

void **start** (int *index*)

Start the specified converter.

Parameters

- **index** (*int*) – Index of the converter.

void **stop** (int *index*)

Stop the specified converter.

Parameters

- **index** (*int*) – Index of the converter.

ResourceConverterState **state** (int *index*)

The state of the specified converter.

Parameters

- **index** (*int*) – Index of the converter.

String **statusInfo** (int *index*)

Status information for the specified converter. This is the full status message shown in the in-game UI.

Parameters

- **index** (*int*) – Index of the converter.

java.util.List<String> **inputs** (int *index*)

List of the names of resources consumed by the specified converter.

Parameters

- **index** (*int*) – Index of the converter.

java.util.List<String> **outputs** (int *index*)

List of the names of resources produced by the specified converter.

Parameters

- **index** (*int*) – Index of the converter.

public enum **ResourceConverterState**

The state of a resource converter. See *ResourceConverter.state(int)*.

public ResourceConverterState **RUNNING**

Converter is running.

public ResourceConverterState **IDLE**

Converter is idle.

```

public ResourceConverterState MISSING_RESOURCE
    Converter is missing a required resource.

public ResourceConverterState STORAGE_FULL
    No available storage for output resource.

public ResourceConverterState CAPACITY
    At preset resource capacity.

public ResourceConverterState UNKNOWN
    Unknown state. Possible with modified resource converters. In this case, check ResourceConverter.
    statusInfo(int) for more information.

```

Resource Harvester

```

public class ResourceHarvester
    A resource harvester (drill). Obtained by calling Part.getResourceHarvester().

    Part getPart ()
        The part object for this harvester.

    ResourceHarvesterState getState ()
        The state of the harvester.

    boolean getDeployed ()

    void setDeployed (boolean value)
        Whether the harvester is deployed.

    boolean getActive ()

    void setActive (boolean value)
        Whether the harvester is actively drilling.

    float getExtractionRate ()
        The rate at which the drill is extracting ore, in units per second.

    float getThermalEfficiency ()
        The thermal efficiency of the drill, as a percentage of its maximum.

    float getCoreTemperature ()
        The core temperature of the drill, in Kelvin.

    float getOptimumCoreTemperature ()
        The core temperature at which the drill will operate with peak efficiency, in Kelvin.

public enum ResourceHarvesterState
    The state of a resource harvester. See ResourceHarvester.getState().

    public ResourceHarvesterState DEPLOYING
        The drill is deploying.

    public ResourceHarvesterState DEPLOYED
        The drill is deployed and ready.

    public ResourceHarvesterState RETRACTING
        The drill is retracting.

    public ResourceHarvesterState RETRACTED
        The drill is retracted.

```

public *ResourceHarvesterState* **ACTIVE**
The drill is running.

Reaction Wheel

public class **ReactionWheel**

A reaction wheel. Obtained by calling *Part.getReactionWheel()*.

Part **getPart** ()

The part object for this reaction wheel.

boolean **getActive** ()

void **setActive** (boolean *value*)

Whether the reaction wheel is active.

boolean **getBroken** ()

Whether the reaction wheel is broken.

org.javatuples.*Pair*<org.javatuples.*Triplet*<*Double*, *Double*, *Double*>, org.javatuples.*Triplet*<*Double*, *Double*, *Double*>> **getAvailableTorque** ()

The available torque, in Newton meters, that can be produced by this reaction wheel, in the positive and negative pitch, roll and yaw axes of the vessel. These axes correspond to the coordinate axes of the *Vessel.getReferenceFrame()*. Returns zero if the reaction wheel is inactive or broken.

org.javatuples.*Pair*<org.javatuples.*Triplet*<*Double*, *Double*, *Double*>, org.javatuples.*Triplet*<*Double*, *Double*, *Double*>> **getMaximumTorque** ()

The maximum torque, in Newton meters, that can be produced by this reaction wheel, when it is active, in the positive and negative pitch, roll and yaw axes of the vessel. These axes correspond to the coordinate axes of the *Vessel.getReferenceFrame()*.

RCS

public class **RCS**

An RCS block or thruster. Obtained by calling *Part.getRCS()*.

Part **getPart** ()

The part object for this RCS.

boolean **getActive** ()

Whether the RCS thrusters are active. An RCS thruster is inactive if the RCS action group is disabled (*Control.getRCS()*), the RCS thruster itself is not enabled (*RCS.getEnabled()*) or it is covered by a fairing (*Part.getShielded()*).

boolean **getEnabled** ()

void **setEnabled** (boolean *value*)

Whether the RCS thrusters are enabled.

boolean **getPitchEnabled** ()

void **setPitchEnabled** (boolean *value*)

Whether the RCS thruster will fire when pitch control input is given.

boolean **getYawEnabled** ()

void **setYawEnabled** (boolean *value*)

Whether the RCS thruster will fire when yaw control input is given.

boolean **getRollEnabled** ()

void **setRollEnabled** (boolean *value*)
Whether the RCS thruster will fire when roll control input is given.

boolean **getForwardEnabled** ()

void **setForwardEnabled** (boolean *value*)
Whether the RCS thruster will fire when pitch control input is given.

boolean **getUpEnabled** ()

void **setUpEnabled** (boolean *value*)
Whether the RCS thruster will fire when yaw control input is given.

boolean **getRightEnabled** ()

void **setRightEnabled** (boolean *value*)
Whether the RCS thruster will fire when roll control input is given.

org.javatuples.[Pair](#)<org.javatuples.[Triplet](#)<[Double](#), [Double](#), [Double](#)>, org.javatuples.[Triplet](#)<[Double](#), [Double](#), [Double](#)>> **getAvailableTorque** ()
The available torque, in Newton meters, that can be produced by this RCS, in the positive and negative pitch, roll and yaw axes of the vessel. These axes correspond to the coordinate axes of the *Vessel*. [getReferenceFrame](#) (). Returns zero if RCS is disable.

float **getMaxThrust** ()
The maximum amount of thrust that can be produced by the RCS thrusters when active, in Newtons.

float **getMaxVacuumThrust** ()
The maximum amount of thrust that can be produced by the RCS thrusters when active in a vacuum, in Newtons.

java.util.[List](#)<[Thruster](#)> **getThrusters** ()
A list of thrusters, one of each nozzle in the RCS part.

float **getSpecificImpulse** ()
The current specific impulse of the RCS, in seconds. Returns zero if the RCS is not active.

float **getVacuumSpecificImpulse** ()
The vacuum specific impulse of the RCS, in seconds.

float **getKerbinSeaLevelSpecificImpulse** ()
The specific impulse of the RCS at sea level on Kerbin, in seconds.

java.util.[List](#)<[String](#)> **getPropellants** ()
The names of resources that the RCS consumes.

java.util.[Map](#)<[String](#), [Float](#)> **getPropellantRatios** ()
The ratios of resources that the RCS consumes. A dictionary mapping resource names to the ratios at which they are consumed by the RCS.

boolean **getHasFuel** ()
Whether the RCS has fuel available.

Note: The RCS thruster must be activated for this property to update correctly.

Sensor

public class **Sensor**

A sensor, such as a thermometer. Obtained by calling *Part*.[getSensor](#) ().

Part **getPart** ()

The part object for this sensor.

boolean **getActive** ()

void **setActive** (boolean *value*)

Whether the sensor is active.

String **getValue** ()

The current value of the sensor.

Solar Panel

public class **SolarPanel**

A solar panel. Obtained by calling *Part.getSolarPanel()*.

Part **getPart** ()

The part object for this solar panel.

boolean **getDeployable** ()

Whether the solar panel is deployable.

boolean **getDeployed** ()

void **setDeployed** (boolean *value*)

Whether the solar panel is extended.

SolarPanelState **getState** ()

The current state of the solar panel.

float **getEnergyFlow** ()

The current amount of energy being generated by the solar panel, in units of charge per second.

float **getSunExposure** ()

The current amount of sunlight that is incident on the solar panel, as a percentage. A value between 0 and 1.

public enum **SolarPanelState**

The state of a solar panel. See *SolarPanel.getState()*.

public *SolarPanelState* **EXTENDED**

Solar panel is fully extended.

public *SolarPanelState* **RETRACTED**

Solar panel is fully retracted.

public *SolarPanelState* **EXTENDING**

Solar panel is being extended.

public *SolarPanelState* **RETRACTING**

Solar panel is being retracted.

public *SolarPanelState* **BROKEN**

Solar panel is broken.

Thruster

public class **Thruster**

The component of an *Engine* or *RCS* part that generates thrust. Can be obtained by calling *Engine.getThrusters()* or *RCS.getThrusters()*.

Note: Engines can consist of multiple thrusters. For example, the S3 KS-25x4 “Mammoth” has four rocket nozzels, and so consists of four thrusters.

Part **getPart** ()

The *Part* that contains this thruster.

org.javatuples.Triplet<Double, Double, Double> **thrustPosition** (*ReferenceFrame* *reference-Frame*)

The position at which the thruster generates thrust, in the given reference frame. For gimballed engines, this takes into account the current rotation of the gimbal.

Parameters

- **referenceFrame** (*ReferenceFrame*) – The reference frame that the returned position vector is in.

Returns The position as a vector.

org.javatuples.Triplet<Double, Double, Double> **thrustDirection** (*ReferenceFrame* *reference-Frame*)

The direction of the force generated by the thruster, in the given reference frame. This is opposite to the direction in which the thruster expels propellant. For gimballed engines, this takes into account the current rotation of the gimbal.

Parameters

- **referenceFrame** (*ReferenceFrame*) – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

ReferenceFrame **getThrustReferenceFrame** ()

A reference frame that is fixed relative to the thruster and orientated with its thrust direction (*Thruster.thrustDirection* (*ReferenceFrame*)). For gimballed engines, this takes into account the current rotation of the gimbal.

- The origin is at the position of thrust for this thruster (*Thruster.thrustPosition* (*ReferenceFrame*)).
- The axes rotate with the thrust direction. This is the direction in which the thruster expels propellant, including any gimbaling.
- The y-axis points along the thrust direction.
- The x-axis and z-axis are perpendicular to the thrust direction.

boolean **getGimballed** ()

Whether the thruster is gimballed.

org.javatuples.Triplet<Double, Double, Double> **gimbalPosition** (*ReferenceFrame* *reference-Frame*)

Position around which the gimbal pivots.

Parameters

- **referenceFrame** (*ReferenceFrame*) – The reference frame that the returned position vector is in.

Returns The position as a vector.

org.javatuples.Triplet<Double, Double, Double> **getGimbalAngle** ()

The current gimbal angle in the pitch, roll and yaw axes, in degrees.

org.javatuples.Triplet<Double, Double, Double> **initialThrustPosition** (*ReferenceFrame referenceFrame*)

The position at which the thruster generates thrust, when the engine is in its initial position (no gimballing), in the given reference frame.

Parameters

- **referenceFrame** (*ReferenceFrame*) – The reference frame that the returned position vector is in.

Returns The position as a vector.

Note: This position can move when the gimbal rotates. This is because the thrust position and gimbal position are not necessarily the same.

org.javatuples.Triplet<Double, Double, Double> **initialThrustDirection** (*ReferenceFrame referenceFrame*)

The direction of the force generated by the thruster, when the engine is in its initial position (no gimballing), in the given reference frame. This is opposite to the direction in which the thruster expels propellant.

Parameters

- **referenceFrame** (*ReferenceFrame*) – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

Wheel

public class **Wheel**

A wheel. Includes landing gear and rover wheels. Obtained by calling *Part.getWheel()*. Can be used to control the motors, steering and deployment of wheels, among other things.

Part **getPart** ()

The part object for this wheel.

WheelState **getState** ()

The current state of the wheel.

float **getRadius** ()

Radius of the wheel, in meters.

boolean **getGrounded** ()

Whether the wheel is touching the ground.

boolean **getHasBrakes** ()

Whether the wheel has brakes.

float **getBrakes** ()

void **setBrakes** (float *value*)

The braking force, as a percentage of maximum, when the brakes are applied.

boolean **getAutoFrictionControl** ()

void **setAutoFrictionControl** (boolean *value*)

Whether automatic friction control is enabled.

float **getManualFrictionControl** ()

void **setManualFrictionControl** (float *value*)
 Manual friction control value. Only has an effect if automatic friction control is disabled. A value between 0 and 5 inclusive.

boolean **getDeployable** ()
 Whether the wheel is deployable.

boolean **getDeployed** ()

void **setDeployed** (boolean *value*)
 Whether the wheel is deployed.

boolean **getPowered** ()
 Whether the wheel is powered by a motor.

boolean **getMotorEnabled** ()

void **setMotorEnabled** (boolean *value*)
 Whether the motor is enabled.

boolean **getMotorInverted** ()

void **setMotorInverted** (boolean *value*)
 Whether the direction of the motor is inverted.

MotorState **getMotorState** ()
 Whether the direction of the motor is inverted.

float **getMotorOutput** ()
 The output of the motor. This is the torque currently being generated, in Newton meters.

boolean **getTractionControlEnabled** ()

void **setTractionControlEnabled** (boolean *value*)
 Whether automatic traction control is enabled. A wheel only has traction control if it is powered.

float **getTractionControl** ()

void **setTractionControl** (float *value*)
 Setting for the traction control. Only takes effect if the wheel has automatic traction control enabled. A value between 0 and 5 inclusive.

float **getDriveLimiter** ()

void **setDriveLimiter** (float *value*)
 Manual setting for the motor limiter. Only takes effect if the wheel has automatic traction control disabled. A value between 0 and 100 inclusive.

boolean **getSteerable** ()
 Whether the wheel has steering.

boolean **getSteeringEnabled** ()

void **setSteeringEnabled** (boolean *value*)
 Whether the wheel steering is enabled.

boolean **getSteeringInverted** ()

void **setSteeringInverted** (boolean *value*)
 Whether the wheel steering is inverted.

boolean **getHasSuspension** ()
 Whether the wheel has suspension.

float **getSuspensionSpringStrength** ()
Suspension spring strength, as set in the editor.

float **getSuspensionDamperStrength** ()
Suspension damper strength, as set in the editor.

boolean **getBroken** ()
Whether the wheel is broken.

boolean **getRepairable** ()
Whether the wheel is repairable.

float **getStress** ()
Current stress on the wheel.

float **getStressTolerance** ()
Stress tolerance of the wheel.

float **getStressPercentage** ()
Current stress on the wheel as a percentage of its stress tolerance.

float **getDeflection** ()
Current deflection of the wheel.

float **getSlip** ()
Current slip of the wheel.

public enum **WheelState**
The state of a wheel. See *Wheel.getState()*.

public *WheelState* **DEPLOYED**
Wheel is fully deployed.

public *WheelState* **RETRACTED**
Wheel is fully retracted.

public *WheelState* **DEPLOYING**
Wheel is being deployed.

public *WheelState* **RETRACTING**
Wheel is being retracted.

public *WheelState* **BROKEN**
Wheel is broken.

public enum **MotorState**
The state of the motor on a powered wheel. See *Wheel.getMotorState()*.

public *MotorState* **IDLE**
The motor is idle.

public *MotorState* **RUNNING**
The motor is running.

public *MotorState* **DISABLED**
The motor is disabled.

public *MotorState* **INOPERABLE**
The motor is inoperable.

public *MotorState* **NOT_ENOUGH_RESOURCES**
The motor does not have enough resources to run.

Trees of Parts

Vessels in KSP are comprised of a number of parts, connected to one another in a *tree* structure. An example vessel is shown in Figure 1, and the corresponding tree of parts in Figure 2. The craft file for this example can also be downloaded [here](#).

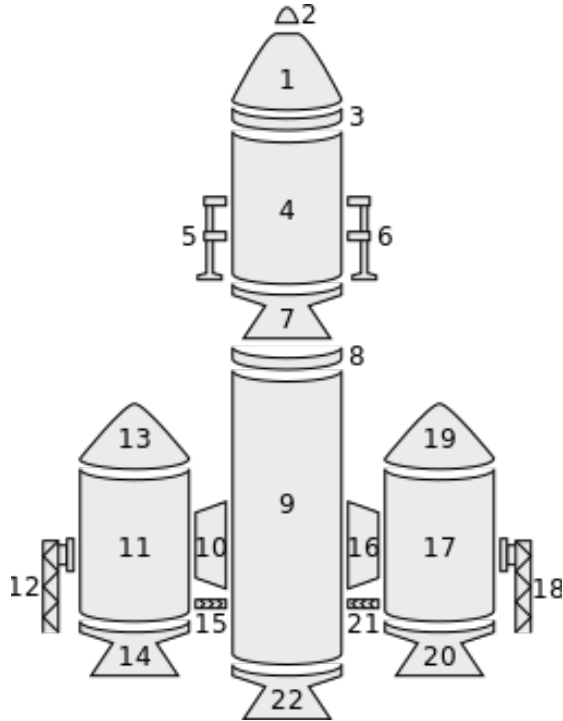


Fig. 6.10: **Figure 1** – Example parts making up a vessel.

Traversing the Tree

The tree of parts can be traversed using the attributes `Parts.getRoot()`, `Part.getParent()` and `Part.getChildren()`.

The root of the tree is the same as the vessel's *root part* (part number 1 in the example above) and can be obtained by calling `Parts.getRoot()`. A part's children can be obtained by calling `Part.getChildren()`. If the part does not have any children, `Part.getChildren()` returns an empty list. A part's parent can be obtained by calling `Part.getParent()`. If the part does not have a parent (as is the case for the root part), `Part.getParent()` returns null.

The following Java example uses these attributes to perform a depth-first traversal over all of the parts in a vessel:

```
import krpc.client.C
import krpc.client.R
import krpc.client.s
import krpc.client.s
import
↳krpc.client.servic

import org.javatuple

import java.io.IOExc
import java.util.Arr
import java.util.Deq

public class TreeTra
    public static vo
↳args) throws IOExc
    Connection_
↳connection = Conne
    Vessel vesse
↳newInstance(conne

↳
    Part root = ve
    Deque<Pair<P
↳= new ArrayDeque<P
    stack.
↳push(new Pair<Part
    while (stack

↳
    Pair<Part, In
        Part par
        int dept
        String p
```

```
for (int
    pref
    }
    System.
    out.println(prefix
    }
    for (Part chi
        stac
        Pair<Part, Integer
        }
    }
    connection.c
    }
}
```

When this code is execute using the craft file for the example vessel pictured above, the following is printed out:

```
Command Pod Mk1
TR-18A Stack Decoupl
FL-T400 Fuel Tank
LV-909 Liquid Fue
TR-18A Stack Dec
FL-T800 Fuel Ta
LV-909 Liquid
TT-70 Radial D
FL-T400 Fuel
TT18-A Launc
FTX-2 Extern
LV-909 Liqui
Aerodynamic
TT-70 Radial D
FL-T400 Fuel
TT18-A Launc
FTX-2 Extern
LV-909 Liqui
Aerodynamic
LT-1 Landing Stru
LT-1 Landing Stru
Mk16 Parachute
```

Attachment Modes

Parts can be attached to other parts either *radially* (on the side of the parent part) or *axially* (on the end of the parent part, to form a stack).

For example, in the vessel pictured above, the parachute (part 2) is *axially* connected to its parent (the command pod – part 1), and the landing leg (part 5) is *radially* connected to its parent (the fuel tank – part 4).

The root part of a vessel (for example the command pod – part 1) does not have a parent part, so does not have an attachment mode. However, the part is consider to be *axially* attached to

nothing.

The following Java example does a depth-first traversal as before, but also prints out the attachment mode used by the part:

```
import krpc.client.Connection;
import krpc.client.RPCException;
import krpc.client.services.SpaceCenter;
import krpc.client.services.SpaceCenter.Part;
import
↳krpc.client.services.SpaceCenter.Vessel;

import org.javatuples.Pair;

import java.io.IOException;
import java.util.ArrayDeque;
import java.util.Deque;

public class AttachmentModes {
    public static void main(String[]
↳args) throws IOException, RPCException {
        Connection
↳connection = Connection.newInstance();
        Vessel vessel = SpaceCenter.
↳newInstance(connection).getActiveVessel();

        Part root = vessel.getParts().getRoot();
        Deque<Pair<Part, Integer>> stack
↳= new ArrayDeque<Pair<Part, Integer>>();
        stack.
↳push(new Pair<Part, Integer>(root, 0));
        while (stack.size() > 0) {
            Pair<Part, Integer> item = stack.pop();
            Part part = item.getValue0();
            int depth = item.getValue1();
            String prefix = "";
            for (int i = 0; i < depth; i++) {
                prefix += " ";
            }
            String attachMode = part.
↳getAxiallyAttached() ? "axial" : "radial";
            System.out.println(prefix
↳+ part.getTitle() + " - " + attachMode);

            for (Part child : part.getChildren()) {
                stack.push(new
↳Pair<Part, Integer>(child, depth + 1));
            }
            connection.close();
        }
    }
}
```

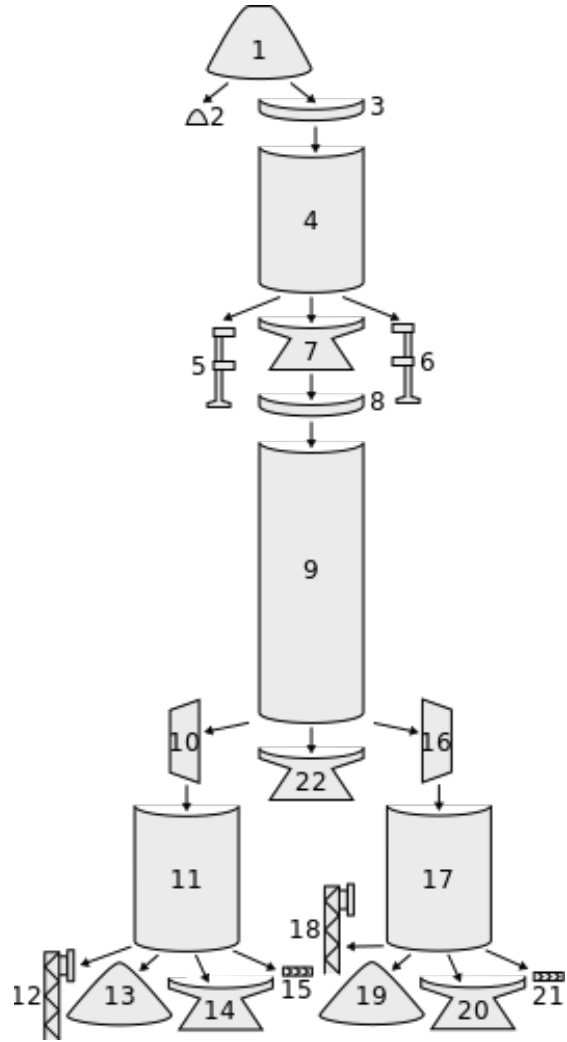


Fig. 6.11: **Figure 2** – Tree of parts for the vessel in Figure 1. Arrows point from the parent part to the child part.

When this code is execute using the craft file for the example vessel pictured above, the following is printed out:

```
Command Pod Mk1 - axial
  TR-18A Stack Decoupler - axial
    FL-T400 Fuel Tank - axial
```

```

LV-909 Liquid Fuel Engine - axial
TR-18A Stack Decoupler - axial
FL-T800 Fuel Tank - axial
LV-909 Liquid Fuel Engine - axial
TT-70 Radial Decoupler - radial
FL-T400 Fuel Tank - radial

↳ TT18-A Launch Stability Enhancer - radial
   FTX-2 External Fuel Duct - radial
   LV-909 Liquid Fuel Engine - axial
   Aerodynamic Nose Cone - axial
   TT-70 Radial Decoupler - radial
   FL-T400 Fuel Tank - radial

↳ TT18-A Launch Stability Enhancer - radial
   FTX-2 External Fuel Duct - radial
   LV-909 Liquid Fuel Engine - axial
   Aerodynamic Nose Cone - axial
LT-1 Landing Struts - radial
LT-1 Landing Struts - radial
Mk16 Parachute - axial

```

Fuel Lines

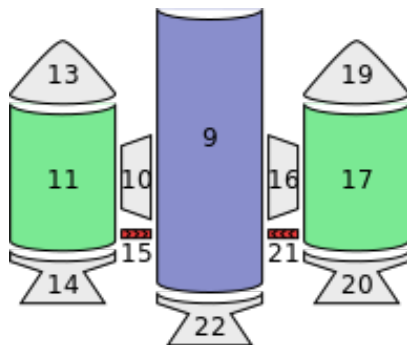
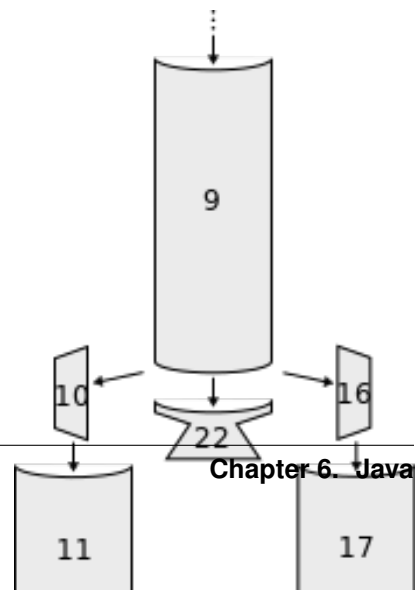


Fig. 6.12: **Figure 5** – Fuel lines from the example in Figure 1. Fuel flows from the parts highlighted in green, into the part highlighted in blue.

Fuel lines are considered parts, and are included in the parts tree (for example, as pictured in Figure 4). However, the parts tree does not contain information about which parts fuel lines connect to. The parent part of a fuel line is the part from which it will take fuel (as shown in Figure 4) however the part that it will send fuel to is not represented in the parts tree.

Figure 5 shows the fuel lines from the example vessel pictured earlier. Fuel line part 15 (in red) takes fuel from a fuel tank (part 11 – in green) and feeds it into another fuel tank (part 9 – in blue). The fuel line is therefore a child of part 11, but its connection to part 9 is not represented in the tree.

The attributes `Part.getFuelLinesFrom()` and `Part.getFuelLinesTo()` can be used to discover these connections. In the example in Figure 5, when `Part.getFuelLinesTo()` is called on



fuel tank part 11, it will return a list of parts containing just fuel tank part 9 (the blue part). When `Part.getFuelLinesFrom()` is called on fuel tank part 9, it will return a list containing fuel tank parts 11 and 17 (the parts colored green).

Staging

Each part has two staging numbers associated with it: the stage in which the part is *activated* and the stage in which the part is *decoupled*. These values can be obtained using `Part.getStage()` and `Part.getDecoupleStage()` respectively. For parts that are not activated by staging, `Part.getStage()` returns -1. For parts that are never decoupled, `Part.getDecoupleStage()` returns a value of -1.

Figure 6 shows an example staging sequence for a vessel. Figure 7 shows the stages in which each part of the vessel will be *activated*. Figure 8 shows the stages in which each part of the vessel will be *decoupled*.

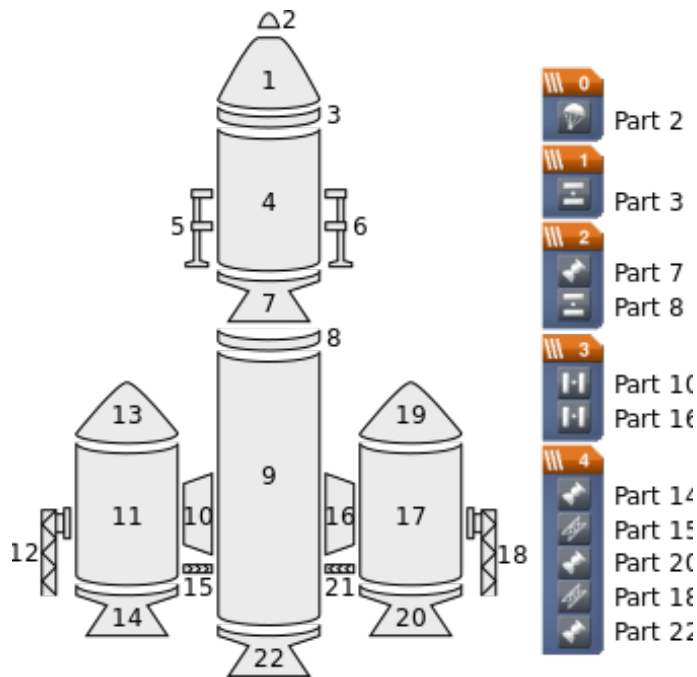


Fig. 6.14: **Figure 6** – Example vessel from Figure 1 with a staging sequence.

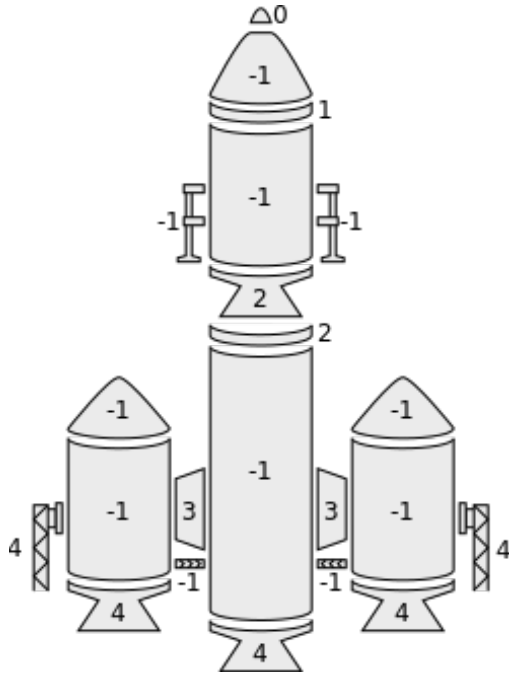


Fig. 6.15: **Figure 7** – The stage in which each part is *activated*.

6.3.9 Resources

public class **Resources**

Represents the collection of resources stored in a vessel, stage or part. Created by calling `Vessel.getResources()`, `Vessel.resourcesInDecoupleStage(int, boolean)` or `Part.getResources()`.

`java.util.List<Resource> getAll()`

All the individual resources that can be stored.

`java.util.List<Resource> withResource(String name)`

All the individual resources with the given name that can be stored.

Parameters

- **name** (*String*) –

`java.util.List<String> getNames()`

A list of resource names that can be stored.

boolean **hasResource** (*String name*)

Check whether the named resource can be stored.

Parameters

- **name** (*String*) – The name of the resource.

float **amount** (*String name*)

Returns the amount of a resource that is currently stored.

Parameters

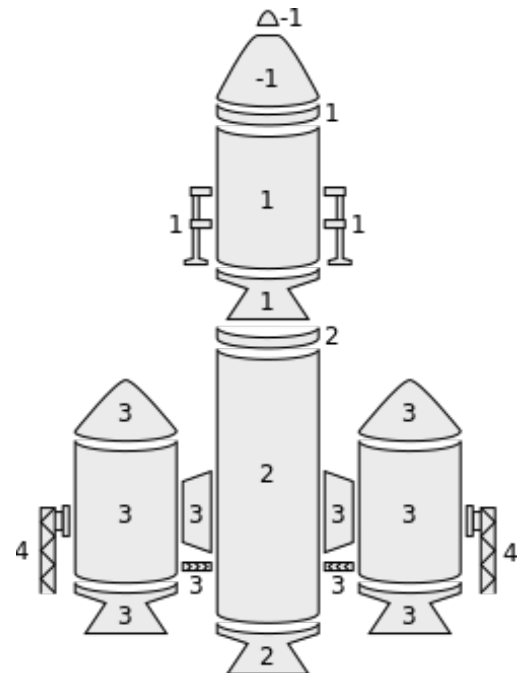


Fig. 6.16: **Figure 8** – The stage in which each part is *decoupled*.

- **name** (*String*) – The name of the resource.

float **max** (*String name*)

Returns the amount of a resource that can be stored.

Parameters

- **name** (*String*) – The name of the resource.

static float **density** (*Connection connection, String name*)

Returns the density of a resource, in *kg/l*.

Parameters

- **name** (*String*) – The name of the resource.

static *ResourceFlowMode* **flowMode** (*Connection connection, String name*)

Returns the flow mode of a resource.

Parameters

- **name** (*String*) – The name of the resource.

boolean **getEnabled** ()

void **setEnabled** (boolean *value*)

Whether use of all the resources are enabled.

Note: This is `true` if all of the resources are enabled. If any of the resources are not enabled, this is `false`.

public class **Resource**

An individual resource stored within a part. Created using methods in the *Resources* class.

String **getName** ()

The name of the resource.

Part **getPart** ()

The part containing the resource.

float **getAmount** ()

The amount of the resource that is currently stored in the part.

float **getMax** ()

The total amount of the resource that can be stored in the part.

float **getDensity** ()

The density of the resource, in *kg/l*.

ResourceFlowMode **getFlowMode** ()

The flow mode of the resource.

boolean **getEnabled** ()

void **setEnabled** (boolean *value*)

Whether use of this resource is enabled.

public class **ResourceTransfer**

Transfer resources between parts.

static *ResourceTransfer* **start** (*Connection connection*, *Part fromPart*, *Part toPart*, *String resource*, float *maxAmount*)

Start transferring a resource transfer between a pair of parts. The transfer will move at most *maxAmount* units of the resource, depending on how much of the resource is available in the source part and how much storage is available in the destination part. Use *ResourceTransfer.getComplete()* to check if the transfer is complete. Use *ResourceTransfer.getAmount()* to see how much of the resource has been transferred.

Parameters

- **fromPart** (*Part*) – The part to transfer to.
- **toPart** (*Part*) – The part to transfer from.
- **resource** (*String*) – The name of the resource to transfer.
- **maxAmount** (*float*) – The maximum amount of resource to transfer.

float **getAmount** ()

The amount of the resource that has been transferred.

boolean **getComplete** ()

Whether the transfer has completed.

public enum **ResourceFlowMode**

The way in which a resource flows between parts. See *Resources.flowMode(String)*.

public *ResourceFlowMode* **VESSEL**

The resource flows to any part in the vessel. For example, electric charge.

public *ResourceFlowMode* **STAGE**

The resource flows from parts in the first stage, followed by the second, and so on. For example, mono-propellant.

public *ResourceFlowMode* **ADJACENT**

The resource flows between adjacent parts within the vessel. For example, liquid fuel or oxidizer.

public *ResourceFlowMode* **NONE**

The resource does not flow. For example, solid fuel.

6.3.10 Node

public class **Node**

Represents a maneuver node. Can be created using *Control.addNode(double, float, float, float)*.

double **getPrograde** ()

void **setPrograde** (double *value*)

The magnitude of the maneuver nodes delta-v in the prograde direction, in meters per second.

double **getNormal** ()

void **setNormal** (double *value*)
 The magnitude of the maneuver nodes delta-v in the normal direction, in meters per second.

double **getRadial** ()

void **setRadial** (double *value*)
 The magnitude of the maneuver nodes delta-v in the radial direction, in meters per second.

double **getDeltaV** ()

void **setDeltaV** (double *value*)
 The delta-v of the maneuver node, in meters per second.

Note: Does not change when executing the maneuver node. See *Node.getRemainingDeltaV()*.

double **getRemainingDeltaV** ()
 Gets the remaining delta-v of the maneuver node, in meters per second. Changes as the node is executed. This is equivalent to the delta-v reported in-game.

org.javatuples.Triplet<Double, Double, Double> **burnVector** (*ReferenceFrame referenceFrame*)
 Returns the burn vector for the maneuver node.

Parameters

- **referenceFrame** (*ReferenceFrame*) – The reference frame that the returned vector is in. Defaults to *Vessel.getOrbitalReferenceFrame()*.

Returns A vector whose direction is the direction of the maneuver node burn, and magnitude is the delta-v of the burn in meters per second.

Note: Does not change when executing the maneuver node. See *Node.remainingBurnVector(ReferenceFrame)*.

org.javatuples.Triplet<Double, Double, Double> **remainingBurnVector** (*ReferenceFrame referenceFrame*)
 Returns the remaining burn vector for the maneuver node.

Parameters

- **referenceFrame** (*ReferenceFrame*) – The reference frame that the returned vector is in. Defaults to *Vessel.getOrbitalReferenceFrame()*.

Returns A vector whose direction is the direction of the maneuver node burn, and magnitude is the delta-v of the burn in meters per second.

Note: Changes as the maneuver node is executed. See *Node.burnVector(ReferenceFrame)*.

double **getUT** ()

void **setUT** (double *value*)

The universal time at which the maneuver will occur, in seconds.

double **getTimeTo** ()

The time until the maneuver node will be encountered, in seconds.

Orbit **getOrbit** ()

The orbit that results from executing the maneuver node.

void **remove** ()

Removes the maneuver node.

ReferenceFrame **getReferenceFrame** ()

The reference frame that is fixed relative to the maneuver node's burn.

- The origin is at the position of the maneuver node.
- The y-axis points in the direction of the burn.
- The x-axis and z-axis point in arbitrary but fixed directions.

ReferenceFrame **getOrbitalReferenceFrame** ()

The reference frame that is fixed relative to the maneuver node, and orientated with the orbital prograde/normal/radial directions of the original orbit at the maneuver node's position.

- The origin is at the position of the maneuver node.
- The x-axis points in the orbital anti-radial direction of the original orbit, at the position of the maneuver node.
- The y-axis points in the orbital prograde direction of the original orbit, at the position of the maneuver node.
- The z-axis points in the orbital normal direction of the original orbit, at the position of the maneuver node.

org.javatuples.Triplet<Double, Double, Double> **position** (*ReferenceFrame referenceFrame*)

The position vector of the maneuver node in the given reference frame.

Parameters

- **referenceFrame** (*ReferenceFrame*) – The reference frame that the returned position vector is in.

Returns The position as a vector.

org.javatuples.Triplet<Double, Double, Double> **direction** (*ReferenceFrame referenceFrame*)

The direction of the maneuver nodes burn.

Parameters

- **referenceFrame** (*ReferenceFrame*) – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

6.3.11 ReferenceFrame

public class **ReferenceFrame**

Represents a reference frame for positions, rotations and velocities.

Contains:

- The position of the origin.
- The directions of the x, y and z axes.
- The linear velocity of the frame.
- The angular velocity of the frame.

Note: This class does not contain any properties or methods. It is only used as a parameter to other functions.

```
static ReferenceFrame createRelative (Connection connection, ReferenceFrame referenceFrame,
                                     org.javatuples.Triplet<Double, Double, Double> position,
                                     org.javatuples.Quartet<Double, Double, Double, Double>
                                     rotation, org.javatuples.Triplet<Double, Double, Double>
                                     velocity, org.javatuples.Triplet<Double, Double, Double>
                                     angularVelocity)
```

Create a relative reference frame. This is a custom reference frame whose components offset the components of a parent reference frame.

Parameters

- **referenceFrame** (ReferenceFrame) – The parent reference frame on which to base this reference frame.
- **position** (*org.javatuples.Triplet<Double, Double, Double>*) – The offset of the position of the origin, as a position vector. Defaults to (0, 0, 0)
- **rotation** (*org.javatuples.Quartet<Double, Double, Double, Double>*) – The rotation to apply to the parent frames rotation, as a quaternion of the form (x, y, z, w). Defaults to (0, 0, 0, 1) (i.e. no rotation)
- **velocity** (*org.javatuples.Triplet<Double, Double, Double>*) – The linear velocity to offset the parent frame by, as a vector pointing in the direction of travel, whose magnitude is the speed in meters per second. Defaults to (0, 0, 0).
- **angularVelocity** (*org.javatuples.Triplet<Double, Double, Double>*) – The angular velocity to offset the parent frame by, as a vector. This vector points in the direction of the axis of rotation, and its magnitude is the speed of the rotation in radians per second. Defaults to (0, 0, 0).

```
static ReferenceFrame createHybrid (Connection connection, ReferenceFrame position, Reference-
                                   Frame rotation, ReferenceFrame velocity, ReferenceFrame an-
                                   gularVelocity)
```

Create a hybrid reference frame. This is a custom reference frame whose components inherited from other reference frames.

Parameters

- **position** (ReferenceFrame) – The reference frame providing the position of the origin.
- **rotation** (ReferenceFrame) – The reference frame providing the rotation of the frame.
- **velocity** (ReferenceFrame) – The reference frame providing the linear velocity of the frame.

- **angularVelocity** (*ReferenceFrame*) – The reference frame providing the angular velocity of the frame.

Note: The *position* reference frame is required but all other reference frames are optional. If omitted, they are set to the *position* reference frame.

6.3.12 AutoPilot

public class **AutoPilot**

Provides basic auto-piloting utilities for a vessel. Created by calling *Vessel.getAutoPilot()*.

Note: If a client engages the auto-pilot and then closes its connection to the server, the auto-pilot will be disengaged and its target reference frame, direction and roll reset to default.

void **engage** ()
Engage the auto-pilot.

void **disengage** ()
Disengage the auto-pilot.

void **wait_** ()
Blocks until the vessel is pointing in the target direction and has the target roll (if set). Throws an exception if the auto-pilot has not been engaged.

float **getError** ()
The error, in degrees, between the direction the ship has been asked to point in and the direction it is pointing in. Throws an exception if the auto-pilot has not been engaged and SAS is not enabled or is in stability assist mode.

float **getPitchError** ()
The error, in degrees, between the vessels current and target pitch. Throws an exception if the auto-pilot has not been engaged.

float **getHeadingError** ()
The error, in degrees, between the vessels current and target heading. Throws an exception if the auto-pilot has not been engaged.

float **getRollError** ()
The error, in degrees, between the vessels current and target roll. Throws an exception if the auto-pilot has not been engaged or no target roll is set.

ReferenceFrame **getReferenceFrame** ()

void **setReferenceFrame** (*ReferenceFrame* value)
The reference frame for the target direction (*AutoPilot.getTargetDirection()*).

Note: An error will be thrown if this property is set to a reference frame that rotates with the vessel being controlled, as it is impossible to rotate the vessel in such a reference frame.

float **getTargetPitch** ()

void **setTargetPitch** (float *value*)

The target pitch, in degrees, between -90° and +90°.

float **getTargetHeading** ()

void **setTargetHeading** (float *value*)

The target heading, in degrees, between 0° and 360°.

float **getTargetRoll** ()

void **setTargetRoll** (float *value*)

The target roll, in degrees. NaN if no target roll is set.

org.javatuples.Triplet<Double, Double, Double> **getTargetDirection** ()

void **setTargetDirection** (org.javatuples.Triplet<Double, Double, Double> *value*)

Direction vector corresponding to the target pitch and heading. This is in the reference frame specified by *ReferenceFrame*.

void **targetPitchAndHeading** (float *pitch*, float *heading*)

Set target pitch and heading angles.

Parameters

- **pitch** (*float*) – Target pitch angle, in degrees between -90° and +90°.
- **heading** (*float*) – Target heading angle, in degrees between 0° and 360°.

boolean **getSAS** ()

void **setSAS** (boolean *value*)

The state of SAS.

Note: Equivalent to *Control.getSAS* ()

SASMode **getSASMode** ()

void **setSASMode** (SASMode *value*)

The current *SASMode*. These modes are equivalent to the mode buttons to the left of the navball that appear when SAS is enabled.

Note: Equivalent to *Control.getSASMode* ()

double **getRollThreshold** ()

void **setRollThreshold** (double *value*)

The threshold at which the autopilot will try to match the target roll angle, if any. Defaults to 5 degrees.

org.javatuples.Triplet<Double, Double, Double> **getStoppingTime** ()

void **setStoppingTime** (org.javatuples.Triplet<Double, Double, Double> *value*)

The maximum amount of time that the vessel should need to come to a complete stop. This determines the maximum angular velocity of the vessel. A vector of three stopping times, in seconds, one for each of the pitch, roll and yaw axes. Defaults to 0.5 seconds for each axis.

org.javatuples.Triplet<Double, Double, Double> **getDecelerationTime** ()

void **setDecelerationTime** (org.javatuples.Triplet<Double, Double, Double> *value*)

The time the vessel should take to come to a stop pointing in the target direction. This determines the angular acceleration used to decelerate the vessel. A vector of three times, in seconds, one for each of the pitch, roll and yaw axes. Defaults to 5 seconds for each axis.

org.javatuples.Triplet<Double, Double, Double> **getAttenuationAngle** ()

void **setAttenuationAngle** (org.javatuples.Triplet<Double, Double, Double> *value*)

The angle at which the autopilot considers the vessel to be pointing close to the target. This determines the midpoint of the target velocity attenuation function. A vector of three angles, in degrees, one for each of the pitch, roll and yaw axes. Defaults to 1° for each axis.

boolean **getAutoTune** ()

void **setAutoTune** (boolean *value*)

Whether the rotation rate controllers PID parameters should be automatically tuned using the vessels moment of inertia and available torque. Defaults to `true`. See `AutoPilot.getTimeToPeak()` and `AutoPilot.getOvershoot()`.

org.javatuples.Triplet<Double, Double, Double> **getTimeToPeak** ()

void **setTimeToPeak** (org.javatuples.Triplet<Double, Double, Double> *value*)

The target time to peak used to autotune the PID controllers. A vector of three times, in seconds, for each of the pitch, roll and yaw axes. Defaults to 3 seconds for each axis.

org.javatuples.Triplet<Double, Double, Double> **getOvershoot** ()

void **setOvershoot** (org.javatuples.Triplet<Double, Double, Double> *value*)

The target overshoot percentage used to autotune the PID controllers. A vector of three values, between 0 and 1, for each of the pitch, roll and yaw axes. Defaults to 0.01 for each axis.

`org.javatuples.Triplet<Double, Double, Double> getPitchPIDGains ()`

void **setPitchPIDGains** (`org.javatuples.Triplet<Double, Double, Double> value`)
Gains for the pitch PID controller.

Note: When `AutoPilot.getAutoTune()` is true, these values are updated automatically, which will overwrite any manual changes.

`org.javatuples.Triplet<Double, Double, Double> getRollPIDGains ()`

void **setRollPIDGains** (`org.javatuples.Triplet<Double, Double, Double> value`)
Gains for the roll PID controller.

Note: When `AutoPilot.getAutoTune()` is true, these values are updated automatically, which will overwrite any manual changes.

`org.javatuples.Triplet<Double, Double, Double> getYawPIDGains ()`

void **setYawPIDGains** (`org.javatuples.Triplet<Double, Double, Double> value`)
Gains for the yaw PID controller.

Note: When `AutoPilot.getAutoTune()` is true, these values are updated automatically, which will overwrite any manual changes.

6.3.13 Camera

public class **Camera**

Controls the game's camera. Obtained by calling `getCamera()`.

`CameraMode` **getMode** ()

void **setMode** (`CameraMode value`)
The current mode of the camera.

float **getPitch** ()

void **setPitch** (`float value`)
The pitch of the camera, in degrees. A value between `Camera.getMinPitch()` and `Camera.getMaxPitch()`

float **getHeading** ()

void **setHeading** (`float value`)
The heading of the camera, in degrees.

float **getDistance** ()

void **setDistance** (float *value*)

The distance from the camera to the subject, in meters. A value between *Camera.getMinDistance()* and *Camera.getMaxDistance()*.

float **getMinPitch** ()

The minimum pitch of the camera.

float **getMaxPitch** ()

The maximum pitch of the camera.

float **getMinDistance** ()

Minimum distance from the camera to the subject, in meters.

float **getMaxDistance** ()

Maximum distance from the camera to the subject, in meters.

float **getDefaultDistance** ()

Default distance from the camera to the subject, in meters.

CelestialBody **getFocussedBody** ()

void **setFocussedBody** (*CelestialBody value*)

In map mode, the celestial body that the camera is focussed on. Returns *null* if the camera is not focussed on a celestial body. Returns an error is the camera is not in map mode.

Vessel **getFocussedVessel** ()

void **setFocussedVessel** (*Vessel value*)

In map mode, the vessel that the camera is focussed on. Returns *null* if the camera is not focussed on a vessel. Returns an error is the camera is not in map mode.

Node **getFocussedNode** ()

void **setFocussedNode** (*Node value*)

In map mode, the maneuver node that the camera is focussed on. Returns *null* if the camera is not focussed on a maneuver node. Returns an error is the camera is not in map mode.

public enum **CameraMode**

See *Camera.getMode()*.

public *CameraMode* **AUTOMATIC**

The camera is showing the active vessel, in “auto” mode.

public *CameraMode* **FREE**

The camera is showing the active vessel, in “free” mode.

public *CameraMode* **CHASE**

The camera is showing the active vessel, in “chase” mode.

public *CameraMode* **LOCKED**

The camera is showing the active vessel, in “locked” mode.

public *CameraMode* **ORBITAL**

The camera is showing the active vessel, in “orbital” mode.

public *CameraMode* **IVA**

The Intra-Vehicular Activity view is being shown.

public *CameraMode* **MAP**

The map view is being shown.

6.3.14 Waypoints

public class **WaypointManager**

Waypoints are the location markers you can see on the map view showing you where contracts are targeted for. With this structure, you can obtain coordinate data for the locations of these waypoints. Obtained by calling *getWaypointManager()*.

java.util.List<Waypoint> **getWaypoints** ()

A list of all existing waypoints.

Waypoint **addWaypoint** (double *latitude*, double *longitude*, *CelestialBody* *body*, *String* *name*)

Creates a waypoint at the given position at ground level, and returns a *Waypoint* object that can be used to modify it.

Parameters

- **latitude** (*double*) – Latitude of the waypoint.
- **longitude** (*double*) – Longitude of the waypoint.
- **body** (*CelestialBody*) – Celestial body the waypoint is attached to.
- **name** (*String*) – Name of the waypoint.

Waypoint **addWaypointAtAltitude** (double *latitude*, double *longitude*, double *altitude*, *CelestialBody* *body*, *String* *name*)

Creates a waypoint at the given position and altitude, and returns a *Waypoint* object that can be used to modify it.

Parameters

- **latitude** (*double*) – Latitude of the waypoint.
- **longitude** (*double*) – Longitude of the waypoint.
- **altitude** (*double*) – Altitude (above sea level) of the waypoint.
- **body** (*CelestialBody*) – Celestial body the waypoint is attached to.
- **name** (*String*) – Name of the waypoint.

java.util.Map<*String*, *Integer*> **getColors** ()

An example map of known color - seed pairs. Any other integers may be used as seed.

java.util.List<*String*> **getIcons** ()

Returns all available icons (from “Game-Data/Squad/Contracts/Icons”).

public class **Waypoint**

Represents a waypoint. Can be created using *WaypointManager.addWaypoint(double, double, CelestialBody, String)*.

CelestialBody **getBody** ()

void **setBody** (*CelestialBody value*)

The celestial body the waypoint is attached to.

String **getName** ()

void **setName** (String *value*)

The name of the waypoint as it appears on the map and the contract.

int **getColor** ()

void **setColor** (int *value*)

The seed of the icon color. See *WaypointManager*.
getColors () for example colors.

String **getIcon** ()

void **setIcon** (String *value*)

The icon of the waypoint.

double **getLatitude** ()

void **setLatitude** (double *value*)

The latitude of the waypoint.

double **getLongitude** ()

void **setLongitude** (double *value*)

The longitude of the waypoint.

double **getMeanAltitude** ()

void **setMeanAltitude** (double *value*)

The altitude of the waypoint above sea level, in meters.

double **getSurfaceAltitude** ()

void **setSurfaceAltitude** (double *value*)

The altitude of the waypoint above the surface of the body or sea level, whichever is closer, in meters.

double **getBedrockAltitude** ()

void **setBedrockAltitude** (double *value*)

The altitude of the waypoint above the surface of the body, in meters.
When over water, this is the altitude above the sea floor.

boolean **getNearSurface** ()

true if the waypoint is near to the surface of a body.

boolean **getGrounded** ()

true if the waypoint is attached to the ground.

int getIndex ()

The integer index of this waypoint within its cluster of sibling waypoints. In other words, when you have a cluster of waypoints called “Somewhere Alpha”, “Somewhere Beta” and “Somewhere Gamma”, the alpha site has index 0, the beta site has index 1 and the gamma site has index 2. When *Waypoint.getClustered()* is *false*, this is zero.

boolean getClustered ()

true if this waypoint is part of a set of clustered waypoints with greek letter names appended (Alpha, Beta, Gamma, etc). If *true*, there is a one-to-one correspondence with the greek letter name and the *Waypoint.getIndex()*.

boolean getHasContract ()

Whether the waypoint belongs to a contract.

Contract getContract ()

The associated contract.

void remove ()

Removes the waypoint.

6.3.15 Contracts

public class ContractManager

Contracts manager. Obtained by calling *getWaypointManager()*.

java.util.Set<String> getTypes ()

A list of all contract types.

java.util.List<Contract> getAllContracts ()

A list of all contracts.

java.util.List<Contract> getActiveContracts ()

A list of all active contracts.

java.util.List<Contract> getOfferedContracts ()

A list of all offered, but unaccepted, contracts.

java.util.List<Contract> getCompletedContracts ()

A list of all completed contracts.

java.util.List<Contract> getFailedContracts ()

A list of all failed contracts.

public class Contract

A contract. Can be accessed using *getContractManager()*.

String getType ()

Type of the contract.

String getTitle ()

Title of the contract.

String getDescription ()

Description of the contract.

String getNotes ()

Notes for the contract.

String **getSynopsis** ()
Synopsis for the contract.

java.util.List<String> **getKeywords** ()
Keywords for the contract.

ContractState **getState** ()
State of the contract.

boolean **getSeen** ()
Whether the contract has been seen.

boolean **getRead** ()
Whether the contract has been read.

boolean **getActive** ()
Whether the contract is active.

boolean **getFailed** ()
Whether the contract has been failed.

boolean **getCanBeCanceled** ()
Whether the contract can be canceled.

boolean **getCanBeDeclined** ()
Whether the contract can be declined.

boolean **getCanBeFailed** ()
Whether the contract can be failed.

void **accept** ()
Accept an offered contract.

void **cancel** ()
Cancel an active contract.

void **decline** ()
Decline an offered contract.

double **getFundsAdvance** ()
Funds received when accepting the contract.

double **getFundsCompletion** ()
Funds received on completion of the contract.

double **getFundsFailure** ()
Funds lost if the contract is failed.

double **getReputationCompletion** ()
Reputation gained on completion of the contract.

double **getReputationFailure** ()
Reputation lost if the contract is failed.

double **getScienceCompletion** ()
Science gained on completion of the contract.

java.util.List<ContractParameter> **getParameters** ()
Parameters for the contract.

public enum **ContractState**
The state of a contract. See *Contract.getState()*.

```

public ContractState ACTIVE
    The contract is active.

public ContractState CANCELED
    The contract has been canceled.

public ContractState COMPLETED
    The contract has been completed.

public ContractState DEADLINE_EXPIRED
    The deadline for the contract has expired.

public ContractState DECLINED
    The contract has been declined.

public ContractState FAILED
    The contract has been failed.

public ContractState GENERATED
    The contract has been generated.

public ContractState OFFERED
    The contract has been offered to the player.

public ContractState OFFER_EXPIRED
    The contract was offered to the player, but the offer expired.

public ContractState WITHDRAWN
    The contract has been withdrawn.

public class ContractParameter
    A contract parameter. See Contract.getParameters().

    String getTitle()
        Title of the parameter.

    String getNotes()
        Notes for the parameter.

    java.util.List<ContractParameter> getChildren()
        Child contract parameters.

    boolean getCompleted()
        Whether the parameter has been completed.

    boolean getFailed()
        Whether the parameter has been failed.

    boolean getOptional()
        Whether the contract parameter is optional.

    double getFundsCompletion()
        Funds received on completion of the contract parameter.

    double getFundsFailure()
        Funds lost if the contract parameter is failed.

    double getReputationCompletion()
        Reputation gained on completion of the contract parameter.

    double getReputationFailure()
        Reputation lost if the contract parameter is failed.

```

double **getScienceCompletion**()
Science gained on completion of the contract parameter.

6.3.16 Geometry Types

Vectors

3-dimensional vectors are represented as a 3-tuple. For example:

```
import krpc.client.Connection;
import krpc.client.RPCException;
import krpc.client.services.SpaceCenter;
import krpc.client.services.SpaceCenter.Vessel;

import org.javatuples.Triplet;

import java.io.IOException;

public class Vector3 {
    public static void main(String[] args)
        throws IOException, RPCException {
        Connection connection = Connection.newInstance();
        Vessel vessel = SpaceCenter.
            newInstance(connection).getActiveVessel();
        Triplet<Double, Double,
        Double> v = vessel.flight(null).getPrograde();
        System.out.println(v.getValue0() +
        ", " + v.getValue1() + ", " + v.getValue2());
        connection.close();
    }
}
```

Quaternions

Quaternions (rotations in 3-dimensional space) are encoded as a 4-tuple containing the x, y, z and w components. For example:

```
import krpc.client.Connection;
import krpc.client.RPCException;
import krpc.client.services.SpaceCenter;
import krpc.client.services.SpaceCenter.Vessel;

import org.javatuples.Quartet;

import java.io.IOException;

public class Quaternion {
    public static void main(String[] args)
        throws IOException, RPCException {
        Connection connection = Connection.newInstance();
        Vessel vessel = SpaceCenter.
            newInstance(connection).getActiveVessel();
        Quartet<Double, Double, Double,
        Double> q = vessel.flight(null).getRotation();
    }
}
```

```

        System.out.
↪println(q.getValue0() + ", " + q.getValue1()
↪+ ", " + q.getValue2() + ", " + q.getValue3());
        connection.close();
    }
}

```

6.4 Drawing API

6.4.1 Drawing

public class **Drawing**

Provides functionality for drawing objects in the flight scene.

Line **addLine** (*org.javatuples.Triplet<Double, Double, Double> start, org.javatuples.Triplet<Double, Double, Double> end, SpaceCenter.ReferenceFrame referenceFrame, boolean visible*)

Draw a line in the scene.

Parameters

- **start** (*org.javatuples.Triplet<Double, Double, Double>*) – Position of the start of the line.
- **end** (*org.javatuples.Triplet<Double, Double, Double>*) – Position of the end of the line.
- **referenceFrame** (*SpaceCenter.ReferenceFrame*) – Reference frame that the positions are in.
- **visible** (*boolean*) – Whether the line is visible.

Line **addDirection** (*org.javatuples.Triplet<Double, Double, Double> direction, SpaceCenter.ReferenceFrame referenceFrame, float length, boolean visible*)

Draw a direction vector in the scene, from the center of mass of the active vessel.

Parameters

- **direction** (*org.javatuples.Triplet<Double, Double, Double>*) – Direction to draw the line in.
- **referenceFrame** (*SpaceCenter.ReferenceFrame*) – Reference frame that the direction is in.
- **length** (*float*) – The length of the line.
- **visible** (*boolean*) – Whether the line is visible.

Polygon **addPolygon** (*java.util.List<org.javatuples.Triplet<Double, Double, Double>> vertices, SpaceCenter.ReferenceFrame referenceFrame, boolean visible*)

Draw a polygon in the scene, defined by a list of vertices.

Parameters

- **vertices** (*java.util.List<org.javatuples.Triplet<Double, Double, Double>>*) – Vertices of the polygon.
- **referenceFrame** (*SpaceCenter.ReferenceFrame*) – Reference frame that the vertices are in.

- **visible** (*boolean*) – Whether the polygon is visible.

Text **addText** (*String* *text*, *SpaceCenter.ReferenceFrame* *referenceFrame*,
org.javatuples.Triplet<Double, Double, Double> *position*,
org.javatuples.Quartet<Double, Double, Double, Double> *rotation*, *boolean* *visible*)
Draw text in the scene.

Parameters

- **text** (*String*) – The string to draw.
- **referenceFrame** (*SpaceCenter.ReferenceFrame*) – Reference frame that the text position is in.
- **position** (*org.javatuples.Triplet<Double, Double, Double>*) – Position of the text.
- **rotation** (*org.javatuples.Quartet<Double, Double, Double, Double>*) – Rotation of the text, as a quaternion.
- **visible** (*boolean*) – Whether the text is visible.

void **clear** (*boolean* *clientOnly*)
Remove all objects being drawn.

Parameters

- **clientOnly** (*boolean*) – If true, only remove objects created by the calling client.

6.4.2 Line

public class **Line**
A line. Created using *addLine*(*org.javatuples.Triplet<Double, Double, Double>*, *org.javatuples.Triplet<Double, Double, Double>*, *SpaceCenter.ReferenceFrame*, *boolean*).

org.javatuples.Triplet<Double, Double, Double> **getStart** ()

void **setStart** (*org.javatuples.Triplet<Double, Double, Double>* *value*)
Start position of the line.

org.javatuples.Triplet<Double, Double, Double> **getEnd** ()

void **setEnd** (*org.javatuples.Triplet<Double, Double, Double>* *value*)
End position of the line.

SpaceCenter.ReferenceFrame **getReferenceFrame** ()

void **setReferenceFrame** (*SpaceCenter.ReferenceFrame* *value*)
Reference frame for the positions of the object.

boolean **getVisible** ()

void **setVisible** (*boolean* *value*)
Whether the object is visible.

org.javatuples.Triplet<Double, Double, Double> **getColor** ()

void **setColor** (org.javatuples.Triplet<Double, Double, Double> *value*)
Set the color

String **getMaterial** ()

void **setMaterial** (String *value*)
Material used to render the object. Creates the material from a shader with the given name.

float **getThickness** ()

void **setThickness** (float *value*)
Set the thickness

void **remove** ()
Remove the object.

6.4.3 Polygon

public class **Polygon**
A polygon. Created using `addPolygon(java.util.List<org.javatuples.Triplet<Double, Double, Double>>, SpaceCenter.ReferenceFrame, boolean)`.

java.util.List<org.javatuples.Triplet<Double, Double, Double>> **getVertices** ()

void **setVertices** (java.util.List<org.javatuples.Triplet<Double, Double, Double>> *value*)
Vertices for the polygon.

SpaceCenter.ReferenceFrame **getReferenceFrame** ()

void **setReferenceFrame** (SpaceCenter.ReferenceFrame *value*)
Reference frame for the positions of the object.

boolean **getVisible** ()

void **setVisible** (boolean *value*)
Whether the object is visible.

void **remove** ()
Remove the object.

org.javatuples.Triplet<Double, Double, Double> **getColor** ()

void **setColor** (org.javatuples.Triplet<Double, Double, Double> *value*)
Set the color

String **getMaterial** ()

void **setMaterial** (String *value*)
Material used to render the object. Creates the material from a shader with the given name.

float **getThickness** ()

void **setThickness** (float *value*)
Set the thickness

6.4.4 Text

```
public class Text
    Text.          Created      using      addText (String,
    SpaceCenter.ReferenceFrame, org.javatuples.
    Triplet<Double,Double,Double>, org.
    javatuples.Quartet<Double,Double,Double,
    Double>, boolean).

    org.javatuples.Triplet<Double, Double, Double> getPosition ()

    void setPosition (org.javatuples.Triplet<Double, Double, Double> value)
        Position of the text.

    org.javatuples.Quartet<Double, Double, Double, Double> getRotation ()

    void setRotation (org.javatuples.Quartet<Double, Double, Double, Double> value)
        Rotation of the text as a quaternion.

    SpaceCenter.ReferenceFrame getReferenceFrame ()

    void setReferenceFrame (SpaceCenter.ReferenceFrame value)
        Reference frame for the positions of the object.

    boolean getVisible ()

    void setVisible (boolean value)
        Whether the object is visible.

    void remove ()
        Remove the object.

    String getContent ()

    void setContent (String value)
        The text string

    String getFont ()

    void setFont (String value)
        Name of the font

    static java.util.List<String> availableFonts (Connection connection)
        A list of all available fonts.

    int getSize ()

    void setSize (int value)
        Font size.
```

```
float getCharacterSize ()

void setCharacterSize (float value)
    Character size.

UI.FontStyle getStyle ()

void setStyle (UI.FontStyle value)
    Font style.

org.javatuples.Triplet<Double, Double, Double> getColor ()

void setColor (org.javatuples.Triplet<Double, Double, Double> value)
    Set the color

String getMaterial ()

void setMaterial (String value)
    Material used to render the object.  Creates the material from a
    shader with the given name.

UI.TextAlignment getAlignment ()

void setAlignment (UI.TextAlignment value)
    Alignment.

float getLineSpacing ()

void setLineSpacing (float value)
    Line spacing.

UI.TextAnchor getAnchor ()

void setAnchor (UI.TextAnchor value)
    Anchor.
```

6.5 InfernalRobotics API

Provides RPCs to interact with the [InfernalRobotics](#) mod. Provides the following classes:

6.5.1 InfernalRobotics

```
public class InfernalRobotics
    This service provides functionality to interact with Infernal
    Robotics.

boolean getAvailable ()
    Whether Infernal Robotics is installed.

java.util.List<ServoGroup> servoGroups (SpaceCenter.Vessel vessel)
    A list of all the servo groups in the given vessel.
```

Parameters

- **vessel** (`SpaceCenter.Vessel`) –

ServoGroup **servoGroupWithName** (*SpaceCenter.Vessel vessel*, *String name*)

Returns the servo group in the given *vessel* with the given *name*, or `null` if none exists. If multiple servo groups have the same name, only one of them is returned.

Parameters

- **vessel** (`SpaceCenter.Vessel`) – Vessel to check.
- **name** (*String*) – Name of servo group to find.

Servo **servoWithName** (*SpaceCenter.Vessel vessel*, *String name*)

Returns the servo in the given *vessel* with the given *name* or `null` if none exists. If multiple servos have the same name, only one of them is returned.

Parameters

- **vessel** (`SpaceCenter.Vessel`) – Vessel to check.
- **name** (*String*) – Name of the servo to find.

6.5.2 ServoGroup

public class **ServoGroup**

A group of servos, obtained by calling *servoGroups* (`SpaceCenter.Vessel`) or *servoGroupWithName* (`SpaceCenter.Vessel`, *String*). Represents the “Servo Groups” in the InfernalRobotics UI.

String **getName** ()

void **setName** (*String value*)
The name of the group.

String **getForwardKey** ()

void **setForwardKey** (*String value*)
The key assigned to be the “forward” key for the group.

String **getReverseKey** ()

void **setReverseKey** (*String value*)
The key assigned to be the “reverse” key for the group.

float **getSpeed** ()

void **setSpeed** (float *value*)
The speed multiplier for the group.

boolean **getExpanded** ()

void **setExpanded** (boolean *value*)
Whether the group is expanded in the InfernalRobotics UI.

java.util.List<Servo> **getServos** ()
The servos that are in the group.

Servo **servoWithName** (String *name*)
Returns the servo with the given *name* from this group, or null if none exists.

Parameters

- **name** (String) – Name of servo to find.

java.util.List<SpaceCenter.Part> **getParts** ()
The parts containing the servos in the group.

void **moveRight** ()
Moves all of the servos in the group to the right.

void **moveLeft** ()
Moves all of the servos in the group to the left.

void **moveCenter** ()
Moves all of the servos in the group to the center.

void **moveNextPreset** ()
Moves all of the servos in the group to the next preset.

void **movePrevPreset** ()
Moves all of the servos in the group to the previous preset.

void **stop** ()
Stops the servos in the group.

6.5.3 Servo

public class **Servo**
Represents a servo. Obtained using *ServoGroup.getServos()*, *ServoGroup.servoWithName(String)* or *servoWithName(SpaceCenter.Vessel, String)*.

String **getName** ()

void **setName** (String *value*)
The name of the servo.

SpaceCenter.Part **getPart** ()
The part containing the servo.

void **setHighlight** (boolean *value*)
Whether the servo should be highlighted in-game.

float **getPosition** ()
The position of the servo.

float **getMinConfigPosition** ()
The minimum position of the servo, specified by the part configuration.

float **getMaxConfigPosition** ()
The maximum position of the servo, specified by the part configuration.

float **getMinPosition** ()

void **setMinPosition** (float *value*)
The minimum position of the servo, specified by the in-game tweak menu.

float **getMaxPosition** ()

void **setMaxPosition** (float *value*)
The maximum position of the servo, specified by the in-game tweak menu.

float **getConfigSpeed** ()
The speed multiplier of the servo, specified by the part configuration.

float **getSpeed** ()

void **setSpeed** (float *value*)
The speed multiplier of the servo, specified by the in-game tweak menu.

float **getCurrentSpeed** ()

void **setCurrentSpeed** (float *value*)
The current speed at which the servo is moving.

float **getAcceleration** ()

void **setAcceleration** (float *value*)
The current speed multiplier set in the UI.

boolean **getIsMoving** ()
Whether the servo is moving.

boolean **getIsFreeMoving** ()
Whether the servo is freely moving.

boolean **getIsLocked** ()

void **setIsLocked** (boolean *value*)
Whether the servo is locked.

boolean **getIsAxisInverted** ()

void **setIsAxisInverted** (boolean *value*)
Whether the servos axis is inverted.

void **moveRight** ()
Moves the servo to the right.

void **moveLeft** ()
Moves the servo to the left.

void **moveCenter** ()
 Moves the servo to the center.

void **moveNextPreset** ()
 Moves the servo to the next preset.

void **movePrevPreset** ()
 Moves the servo to the previous preset.

void **moveTo** (float *position*, float *speed*)
 Moves the servo to *position* and sets the speed multiplier to *speed*.

Parameters

- **position** (*float*) – The position to move the servo to.
- **speed** (*float*) – Speed multiplier for the movement.

void **stop** ()
 Stops the servo.

6.5.4 Example

The following example gets the control group named “MyGroup”, prints out the names and positions of all of the servos in the group, then moves all of the servos to the right for 1 second.

```
import krpc.client.Connection;
import krpc.client.RPCException;
import krpc.client.services.InfernalRobotics;
import_
↳krpc.client.services.InfernalRobotics.Servo;
import krpc.
↳client.services.InfernalRobotics.ServoGroup;
import krpc.client.services.SpaceCenter;
import krpc.client.services.SpaceCenter.Vessel;

import java.io.IOException;

public class InfernalRoboticsExample {
    public static_
↳void main(String[] args) throws IOException,
↳ RPCException, InterruptedException {
        Connection connection = Connection.
↳newInstance("InfernalRobotics Example");
        Vessel vessel = SpaceCenter.
↳newInstance(connection).getActiveVessel();
        InfernalRobotics_
↳ir = InfernalRobotics.newInstance(connection);

        ServoGroup group_
↳= ir.servoGroupWithName(vessel, "MyGroup");
        if (group == null) {
            System.out.println("Group not found");
            return;
        }

        for (Servo servo : group.getServos()) {
            System.out.println(servo.
↳getName() + " " + servo.getPosition());
```

```
    }

    group.moveRight();
    Thread.sleep(1000);
    group.stop();
    connection.close();
}
}
```

6.6 Kerbal Alarm Clock API

Provides RPCs to interact with the [Kerbal Alarm Clock](#) mod. Provides the following classes:

6.6.1 KerbalAlarmClock

public class **KerbalAlarmClock**

This service provides functionality to interact with [Kerbal Alarm Clock](#).

boolean **getAvailable**()

Whether Kerbal Alarm Clock is available.

java.util.List<Alarm> **getAlarms**()

A list of all the alarms.

Alarm **alarmWithName**(String name)

Get the alarm with the given *name*, or null if no alarms have that name. If more than one alarm has the name, only returns one of them.

Parameters

- **name** (String) – Name of the alarm to search for.

java.util.List<Alarm> **alarmsWithType**(AlarmType type)

Get a list of alarms of the specified *type*.

Parameters

- **type** (AlarmType) – Type of alarm to return.

Alarm **createAlarm**(AlarmType type, String name, double ut)

Create a new alarm and return it.

Parameters

- **type** (AlarmType) – Type of the new alarm.
- **name** (String) – Name of the new alarm.
- **ut** (double) – Time at which the new alarm should trigger.

6.6.2 Alarm

public class **Alarm**

Represents an alarm. Obtained by calling

`getAlarms ()`, `alarmWithName (String)` or
`alarmsWithType (AlarmType)`.

AlarmAction **getAction** ()

void **setAction** (*AlarmAction value*)

The action that the alarm triggers.

double **getMargin** ()

void **setMargin** (double *value*)

The number of seconds before the event that the alarm will fire.

double **getTime** ()

void **setTime** (double *value*)

The time at which the alarm will fire.

AlarmType **getType** ()

The type of the alarm.

String **getID** ()

The unique identifier for the alarm.

String **getName** ()

void **setName** (String *value*)

The short name of the alarm.

String **getNotes** ()

void **setNotes** (String *value*)

The long description of the alarm.

double **getRemaining** ()

The number of seconds until the alarm will fire.

boolean **getRepeat** ()

void **setRepeat** (boolean *value*)

Whether the alarm will be repeated after it has fired.

double **getRepeatPeriod** ()

void **setRepeatPeriod** (double *value*)

The time delay to automatically create an alarm after it has fired.

SpaceCenter.Vessel **getVessel** ()

void **setVessel** (*SpaceCenter.Vessel value*)

The vessel that the alarm is attached to.

SpaceCenter.CelestialBody **getXferOriginBody** ()

void **setXferOriginBody** (*SpaceCenter.CelestialBody* value)
The celestial body the vessel is departing from.

SpaceCenter.CelestialBody **getXferTargetBody** ()

void **setXferTargetBody** (*SpaceCenter.CelestialBody* value)
The celestial body the vessel is arriving at.

void **remove** ()
Removes the alarm.

6.6.3 AlarmType

public enum **AlarmType**
The type of an alarm.

public *AlarmType* **RAW**
An alarm for a specific date/time or a specific period in the future.

public *AlarmType* **MANEUVER**
An alarm based on the next maneuver node on the current ships flight path. This node will be stored and can be restored when you come back to the ship.

public *AlarmType* **MANEUVER_AUTO**
See *AlarmType.MANEUVER*.

public *AlarmType* **APOAPSIS**
An alarm for furthest part of the orbit from the planet.

public *AlarmType* **PERIAPSIS**
An alarm for nearest part of the orbit from the planet.

public *AlarmType* **ASCENDING_NODE**
Ascending node for the targeted object, or equatorial ascending node.

public *AlarmType* **DESCENDING_NODE**
Descending node for the targeted object, or equatorial descending node.

public *AlarmType* **CLOSEST**
An alarm based on the closest approach of this vessel to the targeted vessel, some number of orbits into the future.

public *AlarmType* **CONTRACT**
An alarm based on the expiry or deadline of contracts in career modes.

public *AlarmType* **CONTRACT_AUTO**
See *AlarmType.CONTRACT*.

public *AlarmType* **CREW**
An alarm that is attached to a crew member.

public *AlarmType* **DISTANCE**
An alarm that is triggered when a selected target comes within a chosen distance.

public *AlarmType* **EARTH_TIME**
 An alarm based on the time in the “Earth” alternative Universe (aka the Real World).

public *AlarmType* **LAUNCH_RENDEVOUS**
 An alarm that fires as your landed craft passes under the orbit of your target.

public *AlarmType* **SOI_CHANGE**
 An alarm manually based on when the next SOI point is on the flight path or set to continually monitor the active flight path and add alarms as it detects SOI changes.

public *AlarmType* **SOI_CHANGE_AUTO**
 See *AlarmType.SOI_CHANGE*.

public *AlarmType* **TRANSFER**
 An alarm based on Interplanetary Transfer Phase Angles, i.e. when should I launch to planet X? Based on Kosmo Not’s post and used in Olex’s Calculator.

public *AlarmType* **TRANSFER_MODELLED**
 See *AlarmType.TRANSFER*.

6.6.4 AlarmAction

public enum **AlarmAction**
 The action performed by an alarm when it fires.

public *AlarmAction* **DO_NOTHING**
 Don’t do anything at all. . .

public *AlarmAction* **DO_NOTHING_DELETE_WHEN_PASSED**
 Don’t do anything, and delete the alarm.

public *AlarmAction* **KILL_WARP**
 Drop out of time warp.

public *AlarmAction* **KILL_WARP_ONLY**
 Drop out of time warp.

public *AlarmAction* **MESSAGE_ONLY**
 Display a message.

public *AlarmAction* **PAUSE_GAME**
 Pause the game.

6.6.5 Example

The following example creates a new alarm for the active vessel. The alarm is set to trigger after 10 seconds have passed, and display a message.

```
import krpc.client.Connection;
import krpc.client.RPCException;
import krpc.client.services.KerbalAlarmClock;
import
↳ krpc.client.services.KerbalAlarmClock.Alarm;
```

```
import krpc.  
↳ client.services.KerbalAlarmClock.AlarmAction;  
import   
↳ krpc.client.services.KerbalAlarmClock.AlarmType;  
import krpc.client.services.SpaceCenter;  
  
import java.io.IOException;  
  
public class KerbalAlarmClockExample {  
    public static void main(String[]   
↳ args) throws IOException, RPCEException {  
        Connection connection = Connection.  
↳ newInstance("Kerbal Alarm Clock Example");  
        KerbalAlarmClock   
↳ kac = KerbalAlarmClock.newInstance(connection);  
        Alarm alarm = kac.createAlarm(AlarmType.  
↳ RAW, "My New Alarm", SpaceCenter.  
↳ newInstance(connection).getUT() + 10);  
        alarm.setNotes("10 seconds   
↳ have now passed since the alarm was created.");  
        alarm.setAction(AlarmAction.MESSAGE_ONLY);  
        connection.close();  
    }  
}
```

6.7 RemoteTech API

Provides RPCs to interact with the `RemoteTech` mod. Provides the following classes:

6.7.1 RemoteTech

public class **RemoteTech**

This service provides functionality to interact with `RemoteTech`.

boolean **getAvailable** ()

Whether RemoteTech is installed.

java.util.List<String> **getGroundStations** ()

The names of the ground stations.

Antenna **antenna** (SpaceCenter.Part part)

Get the antenna object for a particular part.

Parameters

- **part** (SpaceCenter.Part) –

Comms **comms** (SpaceCenter.Vessel vessel)

Get a communications object, representing the communication capability of a particular vessel.

Parameters

- **vessel** (SpaceCenter.Vessel) –

6.7.2 Comms

public class **Comms**

Communications for a vessel.

SpaceCenter.Vessel **getVessel** ()

Get the vessel.

boolean **getHasLocalControl** ()

Whether the vessel can be controlled locally.

boolean **getHasFlightComputer** ()

Whether the vessel has a flight computer on board.

boolean **getHasConnection** ()

Whether the vessel has any connection.

boolean **getHasConnectionToGroundStation** ()

Whether the vessel has a connection to a ground station.

double **getSignalDelay** ()

The shortest signal delay to the vessel, in seconds.

double **getSignalDelayToGroundStation** ()

The signal delay between the vessel and the closest ground station, in seconds.

double **signalDelayToVessel** (*SpaceCenter.Vessel other*)

The signal delay between the this vessel and another vessel, in seconds.

Parameters

- **other** (*SpaceCenter.Vessel*) –

java.util.List<Antenna> **getAntennas** ()

The antennas for this vessel.

6.7.3 Antenna

public class **Antenna**

A RemoteTech antenna. Obtained by calling *Comms*.

getAntennas () or *antenna* (*SpaceCenter.Part*).

SpaceCenter.Part **getPart** ()

Get the part containing this antenna.

boolean **getHasConnection** ()

Whether the antenna has a connection.

Target **getTarget** ()

void **setTarget** (*Target value*)

The object that the antenna is targetting. This property can be used to set the target to *Target.NONE* or *Target.ACTIVE_VESSEL*. To set the target to a celestial body, ground station or vessel see *Antenna.getTargetBody()*, *Antenna.getTargetGroundStation()* and *Antenna.getTargetVessel()*.

SpaceCenter.CelestialBody **getTargetBody** ()

void **setTargetBody** (*SpaceCenter.CelestialBody value*)

The celestial body the antenna is targetting.

String **getTargetGroundStation** ()

void **setTargetGroundStation** (*String value*)

The ground station the antenna is targetting.

SpaceCenter.Vessel **getTargetVessel** ()

void **setTargetVessel** (*SpaceCenter.Vessel value*)

The vessel the antenna is targetting.

public enum **Target**

The type of object an antenna is targetting. See *Antenna.getTarget()*.

public *Target* **ACTIVE_VESSEL**

The active vessel.

public *Target* **CELESTIAL_BODY**

A celestial body.

public *Target* **GROUND_STATION**

A ground station.

public *Target* **VESSEL**

A specific vessel.

public *Target* **NONE**

No target.

6.7.4 Example

The following example sets the target of a dish on the active vessel then prints out the signal delay to the active vessel.

```
import krpc.client.Connection;
import krpc.client.RPCException;
import krpc.client.services.RemoteTech;
import krpc.client.services.RemoteTech.Antenna;
import krpc.client.services.RemoteTech.Comms;
import krpc.client.services.SpaceCenter;
import krpc.client.services.SpaceCenter.Part;
import krpc.client.services.SpaceCenter.Vessel;

import java.io.IOException;

public class RemoteTechExample {
    public static void main(String[] args) throws IOException, RPCException {
        Connection connection =
            Connection.newInstance("RemoteTech Example");
        SpaceCenter sc = SpaceCenter.newInstance(connection);
```

```

        RemoteTech_
↪ rt = RemoteTech.newInstance(connection);
        Vessel vessel = sc.getActiveVessel();

        // Set a dish target
        Part part = vessel.
↪ getParts().withTitle("Reflectron KR-7").get(0);
        Antenna antenna = rt.antenna(part);
        antenna.
↪ setTargetBody(sc.getBodies().get("Jool"));

        ↵
↪ // Get info about the vessels communications
        Comms comms = rt.comms(vessel);
        System.out.printf("Signal delay_
↪ = %.1f seconds\n", comms.getSignalDelay());
        connection.close();
    }
}

```

6.8 User Interface API

6.8.1 UI

public class **UI**

Provides functionality for drawing and interacting with in-game user interface elements.

Canvas **getStockCanvas** ()

The stock UI canvas.

Canvas **addCanvas** ()

Add a new canvas.

Note: If you want to add UI elements to KSP's stock UI canvas, use `getStockCanvas()`.

void **message** (*String* content, float duration, *MessagePosition* position)

Display a message on the screen.

Parameters

- **content** (*String*) – Message content.
- **duration** (*float*) – Duration before the message disappears, in seconds.
- **position** (*MessagePosition*) – Position to display the message.

Note: The message appears just like a stock message, for example quicksave or quickload messages.

void **clear** (boolean *clientOnly*)

Remove all user interface elements.

Parameters

- **clientOnly** (*boolean*) – If true, only remove objects created by the calling client.

public enum **MessagePosition**

Message position.

public *MessagePosition* **TOP_LEFT**

Top left.

public *MessagePosition* **TOP_CENTER**

Top center.

public *MessagePosition* **TOP_RIGHT**

Top right.

public *MessagePosition* **BOTTOM_CENTER**

Bottom center.

6.8.2 Canvas

public class **Canvas**

A canvas for user interface elements. See *getStockCanvas()* and *addCanvas()*.

RectTransform **getRectTransform()**

The rect transform for the canvas.

boolean **getVisible()**

void **setVisible** (*boolean value*)

Whether the UI object is visible.

Panel **addPanel** (*boolean visible*)

Create a new container for user interface elements.

Parameters

- **visible** (*boolean*) – Whether the panel is visible.

Text **addText** (*String content*, *boolean visible*)

Add text to the canvas.

Parameters

- **content** (*String*) – The text.
- **visible** (*boolean*) – Whether the text is visible.

InputField **addInputField** (*boolean visible*)

Add an input field to the canvas.

Parameters

- **visible** (*boolean*) – Whether the input field is visible.

Button **addButton** (*String content*, *boolean visible*)

Add a button to the canvas.

Parameters

- **content** (*String*) – The label for the button.
- **visible** (*boolean*) – Whether the button is visible.

void **remove** ()
Remove the UI object.

6.8.3 Panel

public class **Panel**
A container for user interface elements. See *Canvas*.
addPanel (boolean).

RectTransform **getRectTransform** ()
The rect transform for the panel.

boolean **getVisible** ()

void **setVisible** (boolean *value*)
Whether the UI object is visible.

Panel **addPanel** (boolean *visible*)
Create a panel within this panel.

Parameters

- **visible** (*boolean*) – Whether the new panel is visible.

Text **addText** (*String* *content*, boolean *visible*)
Add text to the panel.

Parameters

- **content** (*String*) – The text.
- **visible** (*boolean*) – Whether the text is visible.

InputField **addInputField** (boolean *visible*)
Add an input field to the panel.

Parameters

- **visible** (*boolean*) – Whether the input field is visible.

Button **addButton** (*String* *content*, boolean *visible*)
Add a button to the panel.

Parameters

- **content** (*String*) – The label for the button.
- **visible** (*boolean*) – Whether the button is visible.

void **remove** ()
Remove the UI object.

6.8.4 Text

public class **Text**
A text label. See *Panel.addText (String, boolean)*.

RectTransform **getRectTransform** ()
The rect transform for the text.

boolean **getVisible** ()

void **setVisible** (boolean *value*)
Whether the UI object is visible.

String **getContent** ()

void **setContent** (String *value*)
The text string

String **getFont** ()

void **setFont** (String *value*)
Name of the font

java.util.List<String> **getAvailableFonts** ()
A list of all available fonts.

int **getSize** ()

void **setSize** (int *value*)
Font size.

FontStyle **getStyle** ()

void **setStyle** (FontStyle *value*)
Font style.

org.javatuples.Triplet<Double, Double, Double> **getColor** ()

void **setColor** (org.javatuples.Triplet<Double, Double, Double> *value*)
Set the color

TextAnchor **getAlignment** ()

void **setAlignment** (TextAnchor *value*)
Alignment.

float **getLineSpacing** ()

void **setLineSpacing** (float *value*)
Line spacing.

void **remove** ()
Remove the UI object.

public enum **FontStyle**
Font style.

public FontStyle **NORMAL**
Normal.

public FontStyle **BOLD**
Bold.

```

public FontStyle ITALIC
    Italic.

public FontStyle BOLD_AND_ITALIC
    Bold and italic.

public enum TextAlignment
    Text alignment.

public TextAlignment LEFT
    Left aligned.

public TextAlignment RIGHT
    Right aligned.

public TextAlignment CENTER
    Center aligned.

public enum TextAnchor
    Text alignment.

public TextAnchor LOWER_CENTER
    Lower center.

public TextAnchor LOWER_LEFT
    Lower left.

public TextAnchor LOWER_RIGHT
    Lower right.

public TextAnchor MIDDLE_CENTER
    Middle center.

public TextAnchor MIDDLE_LEFT
    Middle left.

public TextAnchor MIDDLE_RIGHT
    Middle right.

public TextAnchor UPPER_CENTER
    Upper center.

public TextAnchor UPPER_LEFT
    Upper left.

public TextAnchor UPPER_RIGHT
    Upper right.

```

6.8.5 Button

```

public class Button
    A text label. See Panel.addButton(String, boolean).

    RectTransform getRectTransform()
        The rect transform for the text.

    boolean getVisible()

    void setVisible(boolean value)
        Whether the UI object is visible.

```

Text **getText** ()

The text for the button.

boolean **getClicked** ()

void **setClicked** (boolean *value*)

Whether the button has been clicked.

Note: This property is set to true when the user clicks the button. A client script should reset the property to false in order to detect subsequent button presses.

void **remove** ()

Remove the UI object.

6.8.6 InputField

public class **InputField**

An input field. See *Panel.addInputField(boolean)*.

RectTransform **getRectTransform** ()

The rect transform for the input field.

boolean **getVisible** ()

void **setVisible** (boolean *value*)

Whether the UI object is visible.

String **getValue** ()

void **setValue** (*String* *value*)

The value of the input field.

Text **getText** ()

The text component of the input field.

Note: Use *InputField.getValue()* to get and set the value in the field. This object can be used to alter the style of the input field's text.

boolean **getChanged** ()

void **setChanged** (boolean *value*)

Whether the input field has been changed.

Note: This property is set to true when the user modifies the value of the input field. A client script should reset the property to false in order to detect subsequent changes.

void **remove** ()

Remove the UI object.

6.8.7 Rect Transform

public class **RectTransform**

A Unity engine Rect Transform for a UI object. See the [Unity manual](#) for more details.

`org.javatuples.Pair<Double, Double> getPosition ()`

`void setPosition (org.javatuples.Pair<Double, Double> value)`
Position of the rectangles pivot point relative to the anchors.

`org.javatuples.Triplet<Double, Double, Double> getLocalPosition ()`

`void setLocalPosition (org.javatuples.Triplet<Double, Double, Double> value)`
Position of the rectangles pivot point relative to the anchors.

`org.javatuples.Pair<Double, Double> getSize ()`

`void setSize (org.javatuples.Pair<Double, Double> value)`
Width and height of the rectangle.

`org.javatuples.Pair<Double, Double> getUpperRight ()`

`void setUpperRight (org.javatuples.Pair<Double, Double> value)`
Position of the rectangles upper right corner relative to the anchors.

`org.javatuples.Pair<Double, Double> getLowerLeft ()`

`void setLowerLeft (org.javatuples.Pair<Double, Double> value)`
Position of the rectangles lower left corner relative to the anchors.

`void setAnchor (org.javatuples.Pair<Double, Double> value)`
Set the minimum and maximum anchor points as a fraction of the size of the parent rectangle.

`org.javatuples.Pair<Double, Double> getAnchorMax ()`

`void setAnchorMax (org.javatuples.Pair<Double, Double> value)`
The anchor point for the lower left corner of the rectangle defined as a fraction of the size of the parent rectangle.

`org.javatuples.Pair<Double, Double> getAnchorMin ()`

`void setAnchorMin (org.javatuples.Pair<Double, Double> value)`
The anchor point for the upper right corner of the rectangle defined as a fraction of the size of the parent rectangle.

`org.javatuples.Pair<Double, Double> getPivot ()`

`void setPivot (org.javatuples.Pair<Double, Double> value)`
Location of the pivot point around which the rectangle rotates, defined as a fraction of the size of the rectangle itself.

`org.javatuples.Quartet<Double, Double, Double, Double> getRotation ()`

void **setRotation** (org.javatuples.Quartet<Double, Double, Double, Double> *value*)

Rotation, as a quaternion, of the object around its pivot point.

org.javatuples.Triplet<Double, Double, Double> **getScale** ()

void **setScale** (org.javatuples.Triplet<Double, Double, Double> *value*)

Scale factor applied to the object in the x, y and z dimensions.

7.1 Lua Client

This client provides functionality to interact with a kRPC server from programs written in Lua. It can be [installed](#) using [LuaRocks](#) or downloaded from [GitHub](#).

7.1.1 Installing the Library

The Lua client and all of its dependencies can be installed using `luarocks` with a single command:

```
luarocks install krpc
```

7.1.2 Using the Library

Once it's installed, simply `require 'krpc'` and you are good to go!

7.1.3 Connecting to the Server

To connect to a server, use the `krpc.connect()` function. This returns a connection object through which you can interact with the server. For example to connect to a server running on the local machine:

```
local krpc = require 'krpc'
local conn = krpc.connect('Example')
print(conn.krpc:get_status().version)
```

This function also accepts arguments that specify what address and port numbers to connect to. For example:

```
local krpc = require 'krpc'
local conn = krpc.connect('Remote example', 'my.domain.name', 1000, 1001)
print(conn.krpc:get_status().version)
```

7.1.4 Interacting with the Server

Interaction with the server is performed via the client object (of type `krpc.Client`) returned when connecting to the server using `krpc.connect()`.

Upon connecting, the client interrogates the server to find out what functionality it provides and dynamically adds all of the classes, methods, properties to the client object.

For example, all of the functionality provided by the SpaceCenter service is accessible via `conn.space_center` and the functionality provided by the InfernalRobotics service is accessible via `conn.infernal_robotics`.

Calling methods, getting or setting properties, etc. are mapped to remote procedure calls and passed to the server by the lua client.

7.1.5 Streaming Data from the Server

Streams are not yet supported by the Lua client.

7.1.6 Reference

connect (*[name=nil]*, *[address='127.0.0.1']*, *[rpc_port=50000]*, *[stream_port=50001]*)

This function creates a connection to a kRPC server. It returns a *krpc.Client* object, through which the server can be communicated with.

Parameters

- **name** (*string*) – A descriptive name for the connection. This is passed to the server and appears, for example, in the client connection dialog on the in-game server window.
- **address** (*string*) – The address of the server to connect to. Can either be a hostname or an IP address in dotted decimal notation. Defaults to '127.0.0.1'.
- **rpc_port** (*number*) – The port number of the RPC Server. Defaults to 50000.
- **stream_port** (*number*) – The port number of the Stream Server. Defaults to 50001.

class Client

This class provides the interface for communicating with the server. It is dynamically populated with all the functionality provided by the server. Instances of this class should be obtained by calling *krpc.connect()*.

close()

Closes the connection to the server.

krpc

The built-in KRPC class, providing basic interactions with the server.

Return type *krpc.KRPC*

class KRPC

This class provides access to the basic server functionality provided by the KRPC service. An instance can be obtained by calling *krpc.Client.krpc*. Most of this functionality is used internally by the lua client and therefore does not need to be used directly from application code. The only exception that may be useful is:

get_status()

Gets a status message from the server containing information including the server's version string and performance statistics.

For example, the following prints out the version string for the server:

```
local krpc = require 'krpc'
local conn = krpc.connect()
print('Server version = ' .. conn.krpc:get_status().version)
```

Or to get the rate at which the server is sending and receiving data over the network:

```

local krpc = require 'krpc'
local conn = krpc.connect()
local status = conn.krpc.get_status()
print(string.format('Data in = %.2f KB/s', status.bytes_read_rate/1024))
print(string.format('Data out = %.2f KB/s', status.bytes_written_rate/1024))

```

7.2 KRPC API

7.2.1 KRPC

None None None None Main kRPC service, used by clients to interact with basic server functionality.

static `get_client_id()`

Returns the identifier for the current client.

Return type string

static `get_client_name()`

Returns the name of the current client. This is an empty string if the client has no name.

Return type string

clients

A list of RPC clients that are currently connected to the server. Each entry in the list is a clients identifier, name and address.

Attribute Read-only, cannot be set

Return type List of Tuple of (string, string, string)

static `get_status()`

Returns some information about the server, such as the version.

Return type `krpc.schema.KRPC.Status`

static `get_services()`

Returns information on all services, procedures, classes, properties etc. provided by the server. Can be used by client libraries to automatically create functionality such as stubs.

Return type `krpc.schema.KRPC.Services`

static `set_stream_rate(id, rate)`

Set the update rate for a stream in Hz.

Parameters

- **id** (*number*) –
- **rate** (*number*) –

current_game_scene

Get the current game scene.

Attribute Read-only, cannot be set

Return type `KRPC.GameScene`

paused

Whether the game is paused.

Attribute Can be read or written

Return type boolean

class **GameScene**

The game scene. See *KRPC.current_game_scene*.

space_center

The game scene showing the Kerbal Space Center buildings.

flight

The game scene showing a vessel in flight (or on the launchpad/runway).

tracking_station

The tracking station.

editor_vab

The Vehicle Assembly Building.

editor_sph

The Space Plane Hangar.

class **InvalidOperationException**

A method call was made to a method that is invalid given the current state of the object.

class **ArgumentException**

A method was invoked where at least one of the passed arguments does not meet the parameter specification of the method.

class **ArgumentNullException**

A null reference was passed to a method that does not accept it as a valid argument.

class **ArgumentOutOfRangeException**

The value of an argument is outside the allowable range of values as defined by the invoked method.

7.2.2 Expressions

class **Expression**

A server side expression.

static constant_double (*value*)

A constant value of type double.

Parameters *value* (*number*) –

Return type *KRPC.Expression*

static constant_float (*value*)

A constant value of type float.

Parameters *value* (*number*) –

Return type *KRPC.Expression*

static constant_int (*value*)

A constant value of type int.

Parameters *value* (*number*) –

Return type *KRPC.Expression*

static constant_string (*value*)

A constant value of type string.

Parameters *value* (*string*) –

Return type *KRPC.Expression*

static call (*call*)

An RPC call.

Parameters **call** (*krpc.schema.KRPC.ProcedureCall*) –

Return type *KRPC.Expression*

static equal (*arg0, arg1*)

Equality comparison.

Parameters

- **arg0** (*KRPC.Expression*) –
- **arg1** (*KRPC.Expression*) –

Return type *KRPC.Expression*

static not_equal (*arg0, arg1*)

Inequality comparison.

Parameters

- **arg0** (*KRPC.Expression*) –
- **arg1** (*KRPC.Expression*) –

Return type *KRPC.Expression*

static greater_than (*arg0, arg1*)

Greater than numerical comparison.

Parameters

- **arg0** (*KRPC.Expression*) –
- **arg1** (*KRPC.Expression*) –

Return type *KRPC.Expression*

static greater_than_or_equal (*arg0, arg1*)

Greater than or equal numerical comparison.

Parameters

- **arg0** (*KRPC.Expression*) –
- **arg1** (*KRPC.Expression*) –

Return type *KRPC.Expression*

static less_than (*arg0, arg1*)

Less than numerical comparison.

Parameters

- **arg0** (*KRPC.Expression*) –
- **arg1** (*KRPC.Expression*) –

Return type *KRPC.Expression*

static less_than_or_equal (*arg0, arg1*)

Less than or equal numerical comparison.

Parameters

- **arg0** (KRPC.Expression) –
- **arg1** (KRPC.Expression) –

Return type *KRPC.Expression*

static and (*arg0*, *arg1*)

Boolean and operator.

Parameters

- **arg0** (KRPC.Expression) –
- **arg1** (KRPC.Expression) –

Return type *KRPC.Expression*

static or (*arg0*, *arg1*)

Boolean or operator.

Parameters

- **arg0** (KRPC.Expression) –
- **arg1** (KRPC.Expression) –

Return type *KRPC.Expression*

static exclusive_or (*arg0*, *arg1*)

Boolean exclusive-or operator.

Parameters

- **arg0** (KRPC.Expression) –
- **arg1** (KRPC.Expression) –

Return type *KRPC.Expression*

static not (*arg*)

Boolean negation operator.

Parameters **arg** (KRPC.Expression) –

Return type *KRPC.Expression*

static add (*arg0*, *arg1*)

Numerical addition.

Parameters

- **arg0** (KRPC.Expression) –
- **arg1** (KRPC.Expression) –

Return type *KRPC.Expression*

static subtract (*arg0*, *arg1*)

Numerical subtraction.

Parameters

- **arg0** (KRPC.Expression) –
- **arg1** (KRPC.Expression) –

Return type *KRPC.Expression*

static multiply (*arg0*, *arg1*)

Numerical multiplication.

Parameters

- **arg0** (KRPC.Expression) –
- **arg1** (KRPC.Expression) –

Return type *KRPC.Expression*

static divide (*arg0*, *arg1*)

Numerical division.

Parameters

- **arg0** (KRPC.Expression) –
- **arg1** (KRPC.Expression) –

Return type *KRPC.Expression*

static modulo (*arg0*, *arg1*)

Numerical modulo operator.

Parameters

- **arg0** (KRPC.Expression) –
- **arg1** (KRPC.Expression) –

Returns The remainder of *arg0* divided by *arg1*

Return type *KRPC.Expression*

static power (*arg0*, *arg1*)

Numerical power operator.

Parameters

- **arg0** (KRPC.Expression) –
- **arg1** (KRPC.Expression) –

Returns *arg0* raised to the power of *arg1*

Return type *KRPC.Expression*

static left_shift (*arg0*, *arg1*)

Bitwise left shift.

Parameters

- **arg0** (KRPC.Expression) –
- **arg1** (KRPC.Expression) –

Return type *KRPC.Expression*

static right_shift (*arg0*, *arg1*)

Bitwise right shift.

Parameters

- **arg0** (KRPC.Expression) –
- **arg1** (KRPC.Expression) –

Return type *KRPC.Expression*

static to_double (*arg*)
Convert to a double type.

Parameters **arg** (*KRPC.Expression*) –

Return type *KRPC.Expression*

static to_float (*arg*)
Convert to a float type.

Parameters **arg** (*KRPC.Expression*) –

Return type *KRPC.Expression*

static to_int (*arg*)
Convert to an int type.

Parameters **arg** (*KRPC.Expression*) –

Return type *KRPC.Expression*

7.3 SpaceCenter API

7.3.1 SpaceCenter

Provides functionality to interact with Kerbal Space Program. This includes controlling the active vessel, managing its resources, planning maneuver nodes and auto-piloting.

active_vessel

The currently active vessel.

Attribute Can be read or written

Return type *SpaceCenter.Vessel*

vessels

A list of all the vessels in the game.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.Vessel*

bodies

A dictionary of all celestial bodies (planets, moons, etc.) in the game, keyed by the name of the body.

Attribute Read-only, cannot be set

Return type Map from string to *SpaceCenter.CelestialBody*

target_body

The currently targeted celestial body.

Attribute Can be read or written

Return type *SpaceCenter.CelestialBody*

target_vessel

The currently targeted vessel.

Attribute Can be read or written

Return type *SpaceCenter.Vessel*

target_docking_port

The currently targeted docking port.

Attribute Can be read or written

Return type *SpaceCenter.DockingPort*

static clear_target()

Clears the current target.

static launchable_vessels(craft_directory)

Returns a list of vessels from the given *craft_directory* that can be launched.

Parameters **craft_directory** (*string*) – Name of the directory in the current saves “Ships” directory. For example “VAB” or “SPH”.

Return type List of string

static launch_vessel(craft_directory, name, launch_site)

Launch a vessel.

Parameters

- **craft_directory** (*string*) – Name of the directory in the current saves “Ships” directory, that contains the craft file. For example “VAB” or “SPH”.
- **name** (*string*) – Name of the vessel to launch. This is the name of the “.craft” file in the save directory, without the “.craft” file extension.
- **launch_site** (*string*) – Name of the launch site. For example “LaunchPad” or “Runway”.

static launch_vessel_from_vab(name)

Launch a new vessel from the VAB onto the launchpad.

Parameters **name** (*string*) – Name of the vessel to launch.

Note: This is equivalent to calling *SpaceCenter.launch_vessel()* with the craft directory set to “VAB” and the launch site set to “LaunchPad”.

static launch_vessel_from_sph(name)

Launch a new vessel from the SPH onto the runway.

Parameters **name** (*string*) – Name of the vessel to launch.

Note: This is equivalent to calling *SpaceCenter.launch_vessel()* with the craft directory set to “SPH” and the launch site set to “Runway”.

static save(name)

Save the game with a given name. This will create a save file called *name.sfs* in the folder of the current save game.

Parameters **name** (*string*) –

static load(name)

Load the game with the given name. This will create a load a save file called *name.sfs* from the folder of the current save game.

Parameters **name** (*string*) –

static quicksave()

Save a quicksave.

Note: This is the same as calling *SpaceCenter.save()* with the name “quicksave”.

static quickload()

Load a quicksave.

Note: This is the same as calling *SpaceCenter.load()* with the name “quicksave”.

ui_visible

Whether the UI is visible.

Attribute Can be read or written

Return type boolean

navball

Whether the navball is visible.

Attribute Can be read or written

Return type boolean

ut

The current universal time in seconds.

Attribute Read-only, cannot be set

Return type number

g

The value of the [gravitational constant](#) G in $N(m/kg)^2$.

Attribute Read-only, cannot be set

Return type number

warp_rate

The current warp rate. This is the rate at which time is passing for either on-rails or physical time warp. For example, a value of 10 means time is passing 10x faster than normal. Returns 1 if time warp is not active.

Attribute Read-only, cannot be set

Return type number

warp_factor

The current warp factor. This is the index of the rate at which time is passing for either regular “on-rails” or physical time warp. Returns 0 if time warp is not active. When in on-rails time warp, this is equal to *SpaceCenter.rails_warp_factor*, and in physics time warp, this is equal to *SpaceCenter.physics_warp_factor*.

Attribute Read-only, cannot be set

Return type number

rails_warp_factor

The time warp rate, using regular “on-rails” time warp. A value between 0 and 7 inclusive. 0 means no time warp. Returns 0 if physical time warp is active.

If requested time warp factor cannot be set, it will be set to the next lowest possible value. For example, if the vessel is too close to a planet. See [the KSP wiki](#) for details.

Attribute Can be read or written

Return type number

physics_warp_factor

The physical time warp rate. A value between 0 and 3 inclusive. 0 means no time warp. Returns 0 if regular “on-rails” time warp is active.

Attribute Can be read or written

Return type number

static can_rails_warp_at (*[factor = 1]*)

Returns `True` if regular “on-rails” time warp can be used, at the specified warp *factor*. The maximum time warp rate is limited by various things, including how close the active vessel is to a planet. See [the KSP wiki](#) for details.

Parameters **factor** (*number*) – The warp factor to check.

Return type boolean

maximum_rails_warp_factor

The current maximum regular “on-rails” warp factor that can be set. A value between 0 and 7 inclusive. See [the KSP wiki](#) for details.

Attribute Read-only, cannot be set

Return type number

static warp_to (*ut*, *[max_rails_rate = 100000.0]*, *[max_physics_rate = 2.0]*)

Uses time acceleration to warp forward to a time in the future, specified by universal time *ut*. This call blocks until the desired time is reached. Uses regular “on-rails” or physical time warp as appropriate. For example, physical time warp is used when the active vessel is traveling through an atmosphere. When using regular “on-rails” time warp, the warp rate is limited by *max_rails_rate*, and when using physical time warp, the warp rate is limited by *max_physics_rate*.

Parameters

- **ut** (*number*) – The universal time to warp to, in seconds.
- **max_rails_rate** (*number*) – The maximum warp rate in regular “on-rails” time warp.
- **max_physics_rate** (*number*) – The maximum warp rate in physical time warp.

Returns When the time warp is complete.

static transform_position (*position*, *from*, *to*)

Converts a position from one reference frame to another.

Parameters

- **position** (*Tuple*) – Position, as a vector, in reference frame *from*.
- **from** (`SpaceCenter.ReferenceFrame`) – The reference frame that the position is in.
- **to** (`SpaceCenter.ReferenceFrame`) – The reference frame to convert the position to.

Returns The corresponding position, as a vector, in reference frame *to*.

Return type Tuple of (number, number, number)

static transform_direction (*direction, from, to*)

Converts a direction from one reference frame to another.

Parameters

- **direction** (*Tuple*) – Direction, as a vector, in reference frame *from*.
- **from** (*SpaceCenter.ReferenceFrame*) – The reference frame that the direction is in.
- **to** (*SpaceCenter.ReferenceFrame*) – The reference frame to convert the direction to.

Returns The corresponding direction, as a vector, in reference frame *to*.

Return type Tuple of (number, number, number)

static transform_rotation (*rotation, from, to*)

Converts a rotation from one reference frame to another.

Parameters

- **rotation** (*Tuple*) – Rotation, as a quaternion of the form (x, y, z, w) , in reference frame *from*.
- **from** (*SpaceCenter.ReferenceFrame*) – The reference frame that the rotation is in.
- **to** (*SpaceCenter.ReferenceFrame*) – The reference frame to convert the rotation to.

Returns The corresponding rotation, as a quaternion of the form (x, y, z, w) , in reference frame *to*.

Return type Tuple of (number, number, number, number)

static transform_velocity (*position, velocity, from, to*)

Converts a velocity (acting at the specified position) from one reference frame to another. The position is required to take the relative angular velocity of the reference frames into account.

Parameters

- **position** (*Tuple*) – Position, as a vector, in reference frame *from*.
- **velocity** (*Tuple*) – Velocity, as a vector that points in the direction of travel and whose magnitude is the speed in meters per second, in reference frame *from*.
- **from** (*SpaceCenter.ReferenceFrame*) – The reference frame that the position and velocity are in.
- **to** (*SpaceCenter.ReferenceFrame*) – The reference frame to convert the velocity to.

Returns The corresponding velocity, as a vector, in reference frame *to*.

Return type Tuple of (number, number, number)

static raycast_distance (*position, direction, reference_frame*)

Cast a ray from a given position in a given direction, and return the distance to the hit point. If no hit occurs, returns infinity.

Parameters

- **position** (*Tuple*) – Position, as a vector, of the origin of the ray.
- **direction** (*Tuple*) – Direction of the ray, as a unit vector.
- **reference_frame** (*SpaceCenter.ReferenceFrame*) – The reference frame that the position and direction are in.

Returns The distance to the hit, in meters, or infinity if there was no hit.

Return type number

static raycast_part (*position, direction, reference_frame*)

Cast a ray from a given position in a given direction, and return the part that it hits. If no hit occurs, returns `nil`.

Parameters

- **position** (*Tuple*) – Position, as a vector, of the origin of the ray.
- **direction** (*Tuple*) – Direction of the ray, as a unit vector.
- **reference_frame** (*SpaceCenter.ReferenceFrame*) – The reference frame that the position and direction are in.

Returns The part that was hit or `nil` if there was no hit.

Return type *SpaceCenter.Part*

far_available

Whether [Ferram Aerospace Research](#) is installed.

Attribute Read-only, cannot be set

Return type boolean

warp_mode

The current time warp mode. Returns *SpaceCenter.WarpMode.none* if time warp is not active, *SpaceCenter.WarpMode.rails* if regular “on-rails” time warp is active, or *SpaceCenter.WarpMode.physics* if physical time warp is active.

Attribute Read-only, cannot be set

Return type *SpaceCenter.WarpMode*

camera

An object that can be used to control the camera.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Camera*

waypoint_manager

The waypoint manager.

Attribute Read-only, cannot be set

Return type *SpaceCenter.WaypointManager*

contract_manager

The contract manager.

Attribute Read-only, cannot be set

Return type *SpaceCenter.ContractManager*

class WarpMode

The time warp mode. Returned by *SpaceCenter.WarpMode*

rails

Time warp is active, and in regular “on-rails” mode.

physics

Time warp is active, and in physical time warp mode.

none

Time warp is not active.

7.3.2 Vessel

class Vessel

These objects are used to interact with vessels in KSP. This includes getting orbital and flight data, manipulating control inputs and managing resources. Created using *SpaceCenter.active_vessel* or *SpaceCenter.vessels*.

name

The name of the vessel.

Attribute Can be read or written

Return type string

type

The type of the vessel.

Attribute Can be read or written

Return type *SpaceCenter.VesselType*

situation

The situation the vessel is in.

Attribute Read-only, cannot be set

Return type *SpaceCenter.VesselSituation*

recoverable

Whether the vessel is recoverable.

Attribute Read-only, cannot be set

Return type boolean

recover ()

Recover the vessel.

met

The mission elapsed time in seconds.

Attribute Read-only, cannot be set

Return type number

biome

The name of the biome the vessel is currently in.

Attribute Read-only, cannot be set

Return type string

flight (*[reference_frame = None]*)

Returns a *SpaceCenter.Flight* object that can be used to get flight telemetry for the vessel, in the specified reference frame.

Parameters **reference_frame** (*SpaceCenter.ReferenceFrame*) – Reference frame. Defaults to the vessel's surface reference frame (*SpaceCenter.Vessel.surface_reference_frame*).

Return type *SpaceCenter.Flight*

Note: When this is called with no arguments, the vessel's surface reference frame is used. This reference frame moves with the vessel, therefore velocities and speeds returned by the flight object will be zero. See the *reference frames tutorial* for examples of getting *the orbital and surface speeds of a vessel*.

orbit

The current orbit of the vessel.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Orbit*

control

Returns a *SpaceCenter.Control* object that can be used to manipulate the vessel's control inputs. For example, its pitch/yaw/roll controls, RCS and thrust.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Control*

comms

Returns a *SpaceCenter.Comms* object that can be used to interact with CommNet for this vessel.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Comms*

auto_pilot

An *SpaceCenter.AutoPilot* object, that can be used to perform simple auto-piloting of the vessel.

Attribute Read-only, cannot be set

Return type *SpaceCenter.AutoPilot*

crew_capacity

The number of crew that can occupy the vessel.

Attribute Read-only, cannot be set

Return type number

crew_count

The number of crew that are occupying the vessel.

Attribute Read-only, cannot be set

Return type number

crew

The crew in the vessel.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.CrewMember*

resources

A *SpaceCenter.Resources* object, that can be used to get information about resources stored in the vessel.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Resources*

resources_in_decouple_stage (*stage*[, *cumulative* = *True*])

Returns a *SpaceCenter.Resources* object, that can used to get information about resources stored in a given *stage*.

Parameters

- **stage** (*number*) – Get resources for parts that are decoupled in this stage.
- **cumulative** (*boolean*) – When *False*, returns the resources for parts decoupled in just the given stage. When *True* returns the resources decoupled in the given stage and all subsequent stages combined.

Return type *SpaceCenter.Resources*

Note: For details on stage numbering, see the discussion on *Staging*.

parts

A *SpaceCenter.Parts* object, that can used to interact with the parts that make up this vessel.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Parts*

mass

The total mass of the vessel, including resources, in kg.

Attribute Read-only, cannot be set

Return type *number*

dry_mass

The total mass of the vessel, excluding resources, in kg.

Attribute Read-only, cannot be set

Return type *number*

thrust

The total thrust currently being produced by the vessel's engines, in Newtons. This is computed by summing *SpaceCenter.Engine.thrust* for every engine in the vessel.

Attribute Read-only, cannot be set

Return type *number*

available_thrust

Gets the total available thrust that can be produced by the vessel's active engines, in Newtons. This is computed by summing *SpaceCenter.Engine.available_thrust* for every active engine in the vessel.

Attribute Read-only, cannot be set

Return type *number*

max_thrust

The total maximum thrust that can be produced by the vessel's active engines, in Newtons. This is computed by summing *SpaceCenter.Engine.max_thrust* for every active engine.

Attribute Read-only, cannot be set

Return type *number*

max_vacuum_thrust

The total maximum thrust that can be produced by the vessel's active engines when the vessel is in a vacuum, in Newtons. This is computed by summing *SpaceCenter.Engine.max_vacuum_thrust* for every active engine.

Attribute Read-only, cannot be set

Return type number

specific_impulse

The combined specific impulse of all active engines, in seconds. This is computed using the formula [described here](#).

Attribute Read-only, cannot be set

Return type number

vacuum_specific_impulse

The combined vacuum specific impulse of all active engines, in seconds. This is computed using the formula [described here](#).

Attribute Read-only, cannot be set

Return type number

kerbin_sea_level_specific_impulse

The combined specific impulse of all active engines at sea level on Kerbin, in seconds. This is computed using the formula [described here](#).

Attribute Read-only, cannot be set

Return type number

moment_of_inertia

The moment of inertia of the vessel around its center of mass in $kg.m^2$. The inertia values in the returned 3-tuple are around the pitch, roll and yaw directions respectively. This corresponds to the vessels reference frame (*SpaceCenter.ReferenceFrame*).

Attribute Read-only, cannot be set

Return type Tuple of (number, number, number)

inertia_tensor

The inertia tensor of the vessel around its center of mass, in the vessels reference frame (*SpaceCenter.ReferenceFrame*). Returns the 3x3 matrix as a list of elements, in row-major order.

Attribute Read-only, cannot be set

Return type List of number

available_torque

The maximum torque that the vessel generates. Includes contributions from reaction wheels, RCS, gimbaled engines and aerodynamic control surfaces. Returns the torques in $N.m$ around each of the coordinate axes of the vessels reference frame (*SpaceCenter.ReferenceFrame*). These axes are equivalent to the pitch, roll and yaw axes of the vessel.

Attribute Read-only, cannot be set

Return type Tuple of (Tuple of (number, number, number), Tuple of (number, number, number))

available_reaction_wheel_torque

The maximum torque that the currently active and powered reaction wheels can generate. Returns the

torques in $N.m$ around each of the coordinate axes of the vessels reference frame (*SpaceCenter.ReferenceFrame*). These axes are equivalent to the pitch, roll and yaw axes of the vessel.

Attribute Read-only, cannot be set

Return type Tuple of (Tuple of (number, number, number), Tuple of (number, number, number))

available_rcs_torque

The maximum torque that the currently active RCS thrusters can generate. Returns the torques in $N.m$ around each of the coordinate axes of the vessels reference frame (*SpaceCenter.ReferenceFrame*). These axes are equivalent to the pitch, roll and yaw axes of the vessel.

Attribute Read-only, cannot be set

Return type Tuple of (Tuple of (number, number, number), Tuple of (number, number, number))

available_engine_torque

The maximum torque that the currently active and gimballed engines can generate. Returns the torques in $N.m$ around each of the coordinate axes of the vessels reference frame (*SpaceCenter.ReferenceFrame*). These axes are equivalent to the pitch, roll and yaw axes of the vessel.

Attribute Read-only, cannot be set

Return type Tuple of (Tuple of (number, number, number), Tuple of (number, number, number))

available_control_surface_torque

The maximum torque that the aerodynamic control surfaces can generate. Returns the torques in $N.m$ around each of the coordinate axes of the vessels reference frame (*SpaceCenter.ReferenceFrame*). These axes are equivalent to the pitch, roll and yaw axes of the vessel.

Attribute Read-only, cannot be set

Return type Tuple of (Tuple of (number, number, number), Tuple of (number, number, number))

available_other_torque

The maximum torque that parts (excluding reaction wheels, gimballed engines, RCS and control surfaces) can generate. Returns the torques in $N.m$ around each of the coordinate axes of the vessels reference frame (*SpaceCenter.ReferenceFrame*). These axes are equivalent to the pitch, roll and yaw axes of the vessel.

Attribute Read-only, cannot be set

Return type Tuple of (Tuple of (number, number, number), Tuple of (number, number, number))

reference_frame

The reference frame that is fixed relative to the vessel, and orientated with the vessel.

- The origin is at the center of mass of the vessel.
- The axes rotate with the vessel.
- The x-axis points out to the right of the vessel.
- The y-axis points in the forward direction of the vessel.
- The z-axis points out of the bottom off the vessel.

Attribute Read-only, cannot be set

Return type *SpaceCenter.ReferenceFrame*

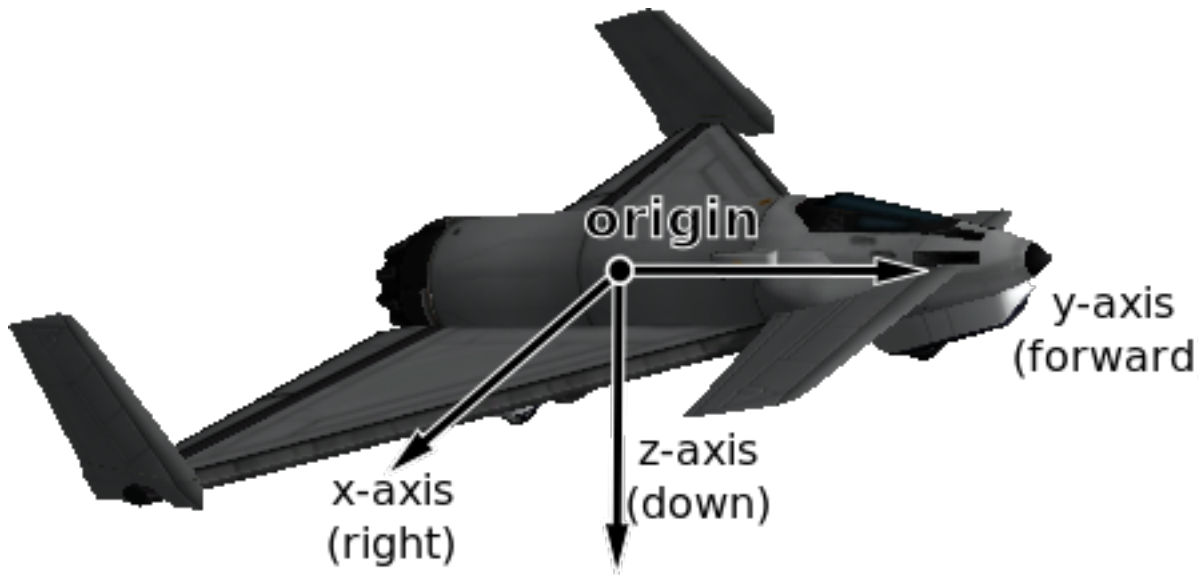


Fig. 7.1: Vessel reference frame origin and axes for the Aeris 3A aircraft

orbital_reference_frame

The reference frame that is fixed relative to the vessel, and orientated with the vessels orbital prograde/normal/radial directions.

- The origin is at the center of mass of the vessel.
- The axes rotate with the orbital prograde/normal/radial directions.
- The x-axis points in the orbital anti-radial direction.
- The y-axis points in the orbital prograde direction.
- The z-axis points in the orbital normal direction.

Attribute Read-only, cannot be set

Return type *SpaceCenter.ReferenceFrame*

Note: Be careful not to confuse this with ‘orbit’ mode on the navball.

surface_reference_frame

The reference frame that is fixed relative to the vessel, and orientated with the surface of the body being orbited.

- The origin is at the center of mass of the vessel.
- The axes rotate with the north and up directions on the surface of the body.
- The x-axis points in the [zenith](#) direction (upwards, normal to the body being orbited, from the center of the body towards the center of mass of the vessel).
- The y-axis points northwards towards the [astronomical horizon](#) (north, and tangential to the surface of the body – the direction in which a compass would point when on the surface).

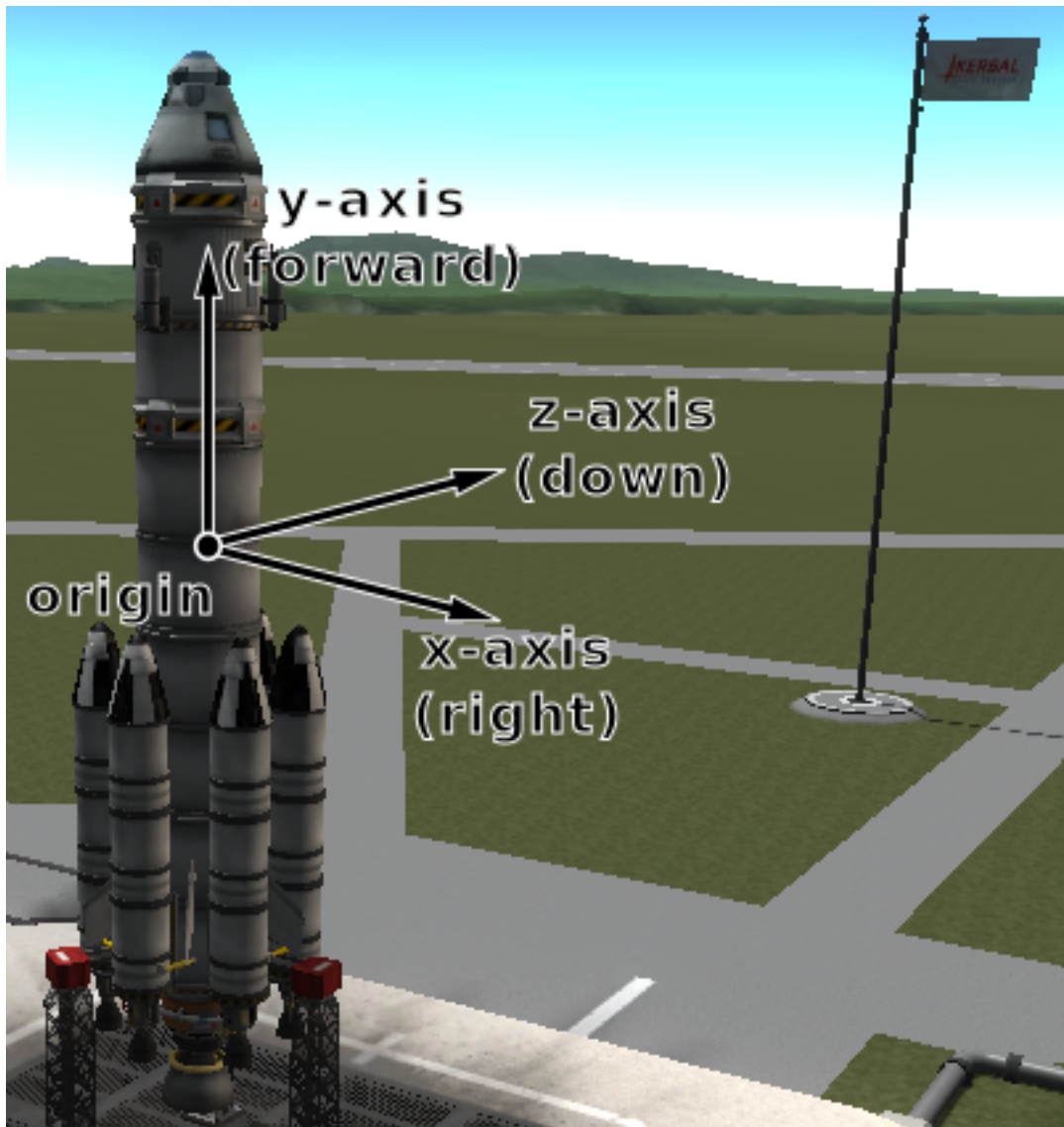


Fig. 7.2: Vessel reference frame origin and axes for the Kerbal-X rocket

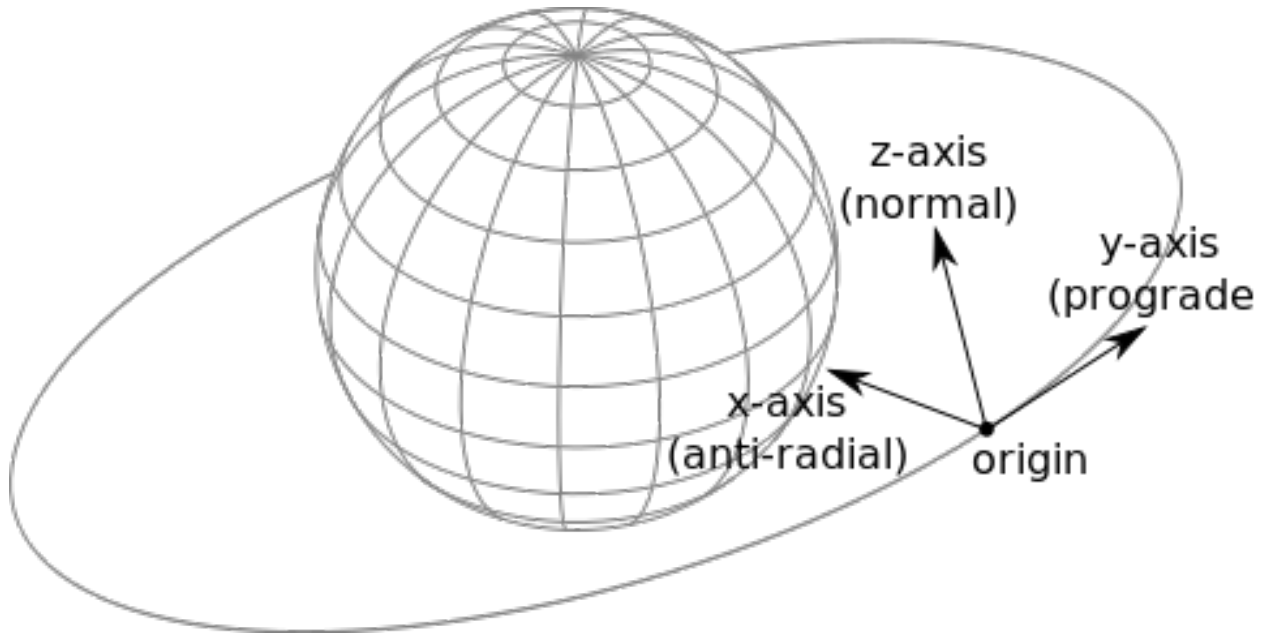


Fig. 7.3: Vessel orbital reference frame origin and axes

- The z-axis points eastwards towards the [astronomical horizon](#) (east, and tangential to the surface of the body – east on a compass when on the surface).

Attribute Read-only, cannot be set

Return type *SpaceCenter.ReferenceFrame*

Note: Be careful not to confuse this with ‘surface’ mode on the navball.

surface_velocity_reference_frame

The reference frame that is fixed relative to the vessel, and orientated with the velocity vector of the vessel relative to the surface of the body being orbited.

- The origin is at the center of mass of the vessel.
- The axes rotate with the vessel’s velocity vector.
- The y-axis points in the direction of the vessel’s velocity vector, relative to the surface of the body being orbited.
- The z-axis is in the plane of the [astronomical horizon](#).
- The x-axis is orthogonal to the other two axes.

Attribute Read-only, cannot be set

Return type *SpaceCenter.ReferenceFrame*

position (*reference_frame*)

The position of the center of mass of the vessel, in the given reference frame.

Parameters **reference_frame** (*SpaceCenter.ReferenceFrame*) – The reference frame that the returned position vector is in.

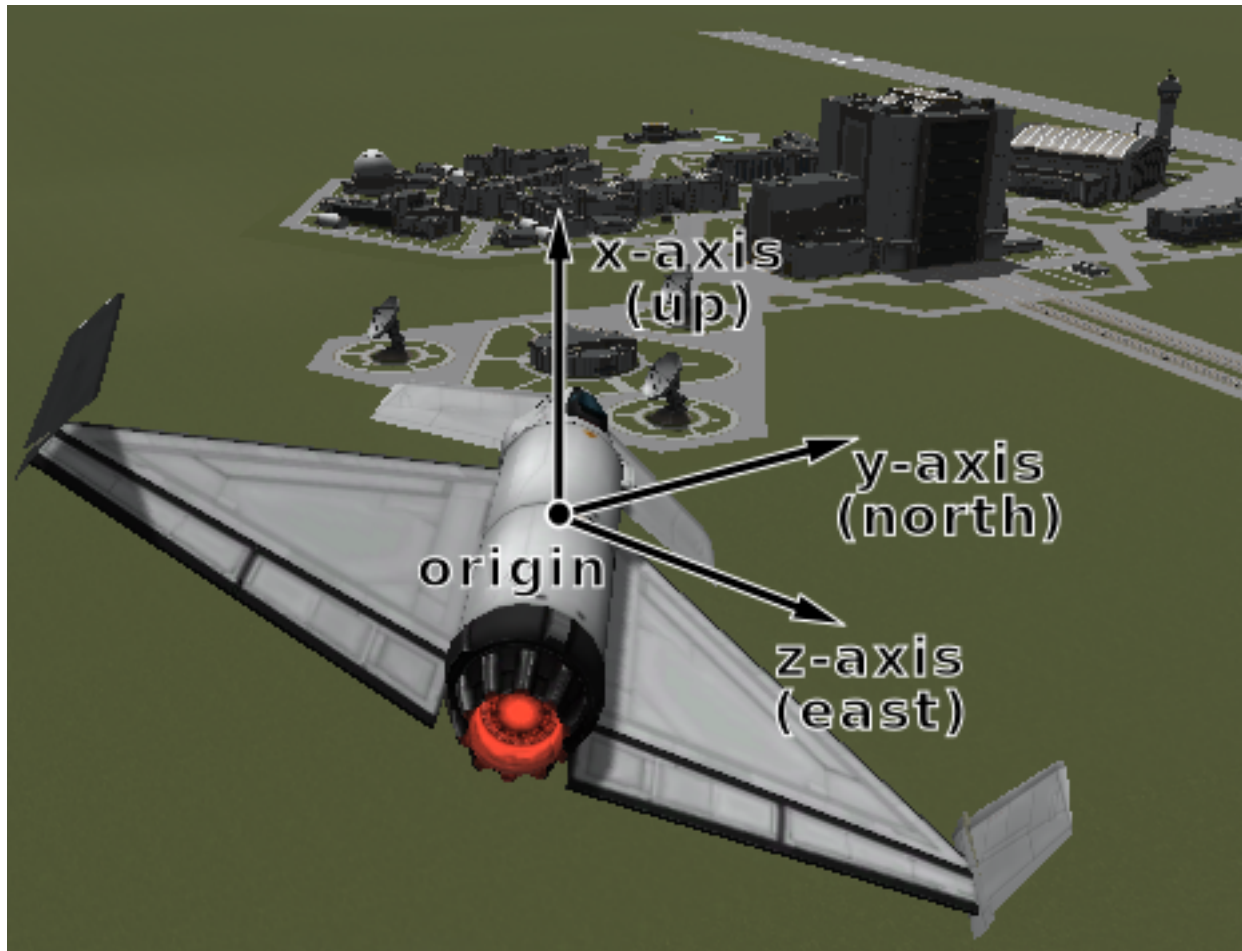


Fig. 7.4: Vessel surface reference frame origin and axes

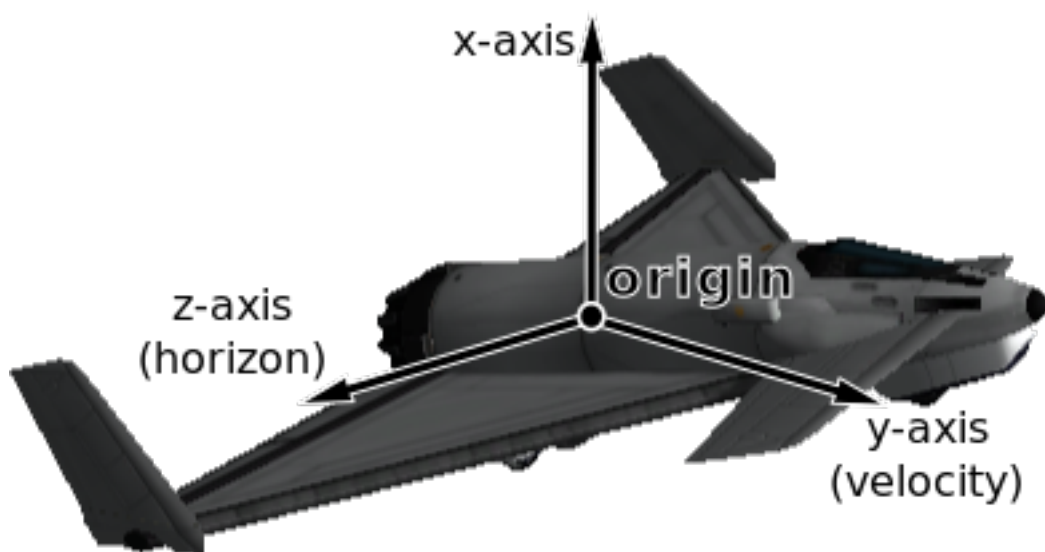


Fig. 7.5: Vessel surface velocity reference frame origin and axes

Returns The position as a vector.

Return type Tuple of (number, number, number)

bounding_box (*reference_frame*)

The axis-aligned bounding box of the vessel in the given reference frame.

Parameters **reference_frame** (`SpaceCenter.ReferenceFrame`) – The reference frame that the returned position vectors are in.

Returns The positions of the minimum and maximum vertices of the box, as position vectors.

Return type Tuple of (Tuple of (number, number, number), Tuple of (number, number, number))

velocity (*reference_frame*)

The velocity of the center of mass of the vessel, in the given reference frame.

Parameters **reference_frame** (`SpaceCenter.ReferenceFrame`) – The reference frame that the returned velocity vector is in.

Returns The velocity as a vector. The vector points in the direction of travel, and its magnitude is the speed of the body in meters per second.

Return type Tuple of (number, number, number)

rotation (*reference_frame*)

The rotation of the vessel, in the given reference frame.

Parameters **reference_frame** (`SpaceCenter.ReferenceFrame`) – The reference frame that the returned rotation is in.

Returns The rotation as a quaternion of the form (x, y, z, w) .

Return type Tuple of (number, number, number, number)

direction (*reference_frame*)

The direction in which the vessel is pointing, in the given reference frame.

Parameters **reference_frame** (`SpaceCenter.ReferenceFrame`) – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

Return type Tuple of (number, number, number)

angular_velocity (*reference_frame*)

The angular velocity of the vessel, in the given reference frame.

Parameters **reference_frame** (`SpaceCenter.ReferenceFrame`) – The reference frame the returned angular velocity is in.

Returns The angular velocity as a vector. The magnitude of the vector is the rotational speed of the vessel, in radians per second. The direction of the vector indicates the axis of rotation, using the right-hand rule.

Return type Tuple of (number, number, number)

class VesselType

The type of a vessel. See `SpaceCenter.Vessel.type`.

base

Base.

debris

Debris.

lander
Lander.

plane
Plane.

probe
Probe.

relay
Relay.

rover
Rover.

ship
Ship.

station
Station.

class VesselSituation

The situation a vessel is in. See *SpaceCenter.Vessel.situation*.

docked
Vessel is docked to another.

escaping
Escaping.

flying
Vessel is flying through an atmosphere.

landed
Vessel is landed on the surface of a body.

orbiting
Vessel is orbiting a body.

pre_launch
Vessel is awaiting launch.

splashed
Vessel has splashed down in an ocean.

sub_orbital
Vessel is on a sub-orbital trajectory.

class CrewMember

Represents crew in a vessel. Can be obtained using *SpaceCenter.Vessel.crew*.

name
The crew members name.

Attribute Can be read or written

Return type string

type
The type of crew member.

Attribute Read-only, cannot be set

Return type *SpaceCenter.CrewMemberType*

on_mission

Whether the crew member is on a mission.

Attribute Read-only, cannot be set

Return type boolean

courage

The crew members courage.

Attribute Can be read or written

Return type number

stupidity

The crew members stupidity.

Attribute Can be read or written

Return type number

experience

The crew members experience.

Attribute Can be read or written

Return type number

badass

Whether the crew member is a badass.

Attribute Can be read or written

Return type boolean

veteran

Whether the crew member is a veteran.

Attribute Can be read or written

Return type boolean

class CrewMemberType

The type of a crew member. See *SpaceCenter.CrewMember.type*.

applicant

An applicant for crew.

crew

Rocket crew.

tourist

A tourist.

unowned

An unowned crew member.

7.3.3 CelestialBody

class CelestialBody

Represents a celestial body (such as a planet or moon). See *SpaceCenter.bodies*.

name

The name of the body.

Attribute Read-only, cannot be set

Return type string

satellites

A list of celestial bodies that are in orbit around this celestial body.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.CelestialBody*

orbit

The orbit of the body.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Orbit*

mass

The mass of the body, in kilograms.

Attribute Read-only, cannot be set

Return type number

gravitational_parameter

The [standard gravitational parameter](#) of the body in m^3s^{-2} .

Attribute Read-only, cannot be set

Return type number

surface_gravity

The acceleration due to gravity at sea level (mean altitude) on the body, in m/s^2 .

Attribute Read-only, cannot be set

Return type number

rotational_period

The sidereal rotational period of the body, in seconds.

Attribute Read-only, cannot be set

Return type number

rotational_speed

The rotational speed of the body, in radians per second.

Attribute Read-only, cannot be set

Return type number

rotation_angle

The current rotation angle of the body, in radians. A value between 0 and 2π

Attribute Read-only, cannot be set

Return type number

initial_rotation

The initial rotation angle of the body (at UT 0), in radians. A value between 0 and 2π

Attribute Read-only, cannot be set

Return type number

equatorial_radius

The equatorial radius of the body, in meters.

Attribute Read-only, cannot be set

Return type number

surface_height (*latitude, longitude*)

The height of the surface relative to mean sea level, in meters, at the given position. When over water this is equal to 0.

Parameters

- **latitude** (*number*) – Latitude in degrees.
- **longitude** (*number*) – Longitude in degrees.

Return type number

bedrock_height (*latitude, longitude*)

The height of the surface relative to mean sea level, in meters, at the given position. When over water, this is the height of the sea-bed and is therefore negative value.

Parameters

- **latitude** (*number*) – Latitude in degrees.
- **longitude** (*number*) – Longitude in degrees.

Return type number

msl_position (*latitude, longitude, reference_frame*)

The position at mean sea level at the given latitude and longitude, in the given reference frame.

Parameters

- **latitude** (*number*) – Latitude in degrees.
- **longitude** (*number*) – Longitude in degrees.
- **reference_frame** (`SpaceCenter.ReferenceFrame`) – Reference frame for the returned position vector.

Returns Position as a vector.

Return type Tuple of (number, number, number)

surface_position (*latitude, longitude, reference_frame*)

The position of the surface at the given latitude and longitude, in the given reference frame. When over water, this is the position of the surface of the water.

Parameters

- **latitude** (*number*) – Latitude in degrees.
- **longitude** (*number*) – Longitude in degrees.
- **reference_frame** (`SpaceCenter.ReferenceFrame`) – Reference frame for the returned position vector.

Returns Position as a vector.

Return type Tuple of (number, number, number)

bedrock_position (*latitude, longitude, reference_frame*)

The position of the surface at the given latitude and longitude, in the given reference frame. When over water, this is the position at the bottom of the sea-bed.

Parameters

- **latitude** (*number*) – Latitude in degrees.
- **longitude** (*number*) – Longitude in degrees.
- **reference_frame** (`SpaceCenter.ReferenceFrame`) – Reference frame for the returned position vector.

Returns Position as a vector.

Return type Tuple of (number, number, number)

position_at_altitude (*latitude, longitude, altitude, reference_frame*)

The position at the given latitude, longitude and altitude, in the given reference frame.

Parameters

- **latitude** (*number*) – Latitude in degrees.
- **longitude** (*number*) – Longitude in degrees.
- **altitude** (*number*) – Altitude in meters above sea level.
- **reference_frame** (`SpaceCenter.ReferenceFrame`) – Reference frame for the returned position vector.

Returns Position as a vector.

Return type Tuple of (number, number, number)

altitude_at_position (*position, reference_frame*)

The altitude, in meters, of the given position in the given reference frame.

Parameters

- **position** (*Tuple*) – Position as a vector.
- **reference_frame** (`SpaceCenter.ReferenceFrame`) – Reference frame for the position vector.

Return type number

latitude_at_position (*position, reference_frame*)

The latitude of the given position, in the given reference frame.

Parameters

- **position** (*Tuple*) – Position as a vector.
- **reference_frame** (`SpaceCenter.ReferenceFrame`) – Reference frame for the position vector.

Return type number

longitude_at_position (*position, reference_frame*)

The longitude of the given position, in the given reference frame.

Parameters

- **position** (*Tuple*) – Position as a vector.
- **reference_frame** (`SpaceCenter.ReferenceFrame`) – Reference frame for the position vector.

Return type number

sphere_of_influence

The radius of the sphere of influence of the body, in meters.

Attribute Read-only, cannot be set

Return type number

has_atmosphere

True if the body has an atmosphere.

Attribute Read-only, cannot be set

Return type boolean

atmosphere_depth

The depth of the atmosphere, in meters.

Attribute Read-only, cannot be set

Return type number

atmospheric_density_at_position (*position*, *reference_frame*)

The atmospheric density at the given position, in kg/m^3 , in the given reference frame.

Parameters

- **position** (*Tuple*) – The position vector at which to measure the density.
- **reference_frame** (*SpaceCenter.ReferenceFrame*) – Reference frame that the position vector is in.

Return type number

has_atmospheric_oxygen

True if there is oxygen in the atmosphere, required for air-breathing engines.

Attribute Read-only, cannot be set

Return type boolean

temperature_at (*position*, *reference_frame*)

The temperature on the body at the given position, in the given reference frame.

Parameters

- **position** (*Tuple*) – Position as a vector.
- **reference_frame** (*SpaceCenter.ReferenceFrame*) – The reference frame that the position is in.

Return type number

Note: This calculation is performed using the bodies current position, which means that the value could be wrong if you want to know the temperature in the far future.

density_at (*altitude*)

Gets the air density, in kg/m^3 , for the specified altitude above sea level, in meters.

Parameters **altitude** (*number*) –

Return type number

Note: This is an approximation, because actual calculations, taking sun exposure into account to compute air temperature, require us to know the exact point on the body where the density is to be computed

(knowing the altitude is not enough). However, the difference is small for high altitudes, so it makes very little difference for trajectory prediction.

pressure_at (*altitude*)

Gets the air pressure, in Pascals, for the specified altitude above sea level, in meters.

Parameters **altitude** (*number*) –

Return type *number*

biomes

The biomes present on this body.

Attribute Read-only, cannot be set

Return type Set of string

biome_at (*latitude*, *longitude*)

The biome at the given latitude and longitude, in degrees.

Parameters

- **latitude** (*number*) –
- **longitude** (*number*) –

Return type *string*

flying_high_altitude_threshold

The altitude, in meters, above which a vessel is considered to be flying “high” when doing science.

Attribute Read-only, cannot be set

Return type *number*

space_high_altitude_threshold

The altitude, in meters, above which a vessel is considered to be in “high” space when doing science.

Attribute Read-only, cannot be set

Return type *number*

reference_frame

The reference frame that is fixed relative to the celestial body.

- The origin is at the center of the body.
- The axes rotate with the body.
- The x-axis points from the center of the body towards the intersection of the prime meridian and equator (the position at 0° longitude, 0° latitude).
- The y-axis points from the center of the body towards the north pole.
- The z-axis points from the center of the body towards the equator at 90°E longitude.

Attribute Read-only, cannot be set

Return type *SpaceCenter.ReferenceFrame*

non_rotating_reference_frame

The reference frame that is fixed relative to this celestial body, and orientated in a fixed direction (it does not rotate with the body).

- The origin is at the center of the body.

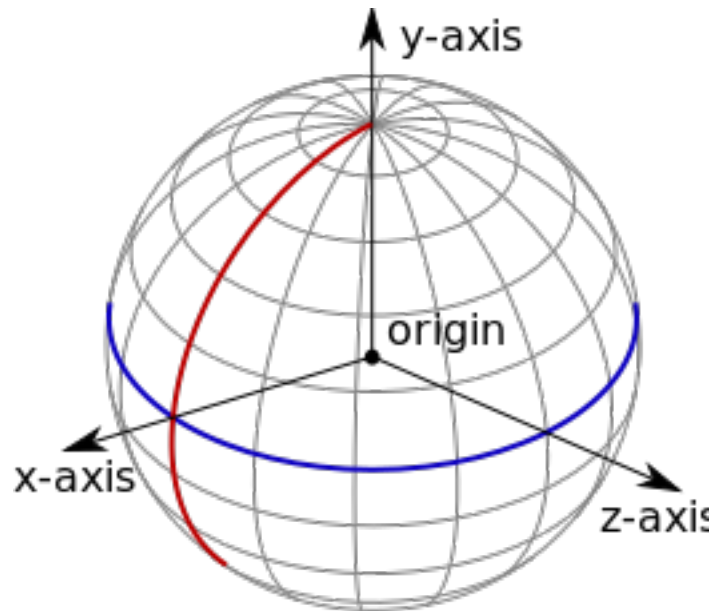


Fig. 7.6: Celestial body reference frame origin and axes. The equator is shown in blue, and the prime meridian in red.

- The axes do not rotate.
- The x-axis points in an arbitrary direction through the equator.
- The y-axis points from the center of the body towards the north pole.
- The z-axis points in an arbitrary direction through the equator.

Attribute Read-only, cannot be set

Return type *SpaceCenter.ReferenceFrame*

orbital_reference_frame

The reference frame that is fixed relative to this celestial body, but orientated with the body's orbital prograde/normal/radial directions.

- The origin is at the center of the body.
- The axes rotate with the orbital prograde/normal/radial directions.
- The x-axis points in the orbital anti-radial direction.
- The y-axis points in the orbital prograde direction.
- The z-axis points in the orbital normal direction.

Attribute Read-only, cannot be set

Return type *SpaceCenter.ReferenceFrame*

position (*reference_frame*)

The position of the center of the body, in the specified reference frame.

Parameters **reference_frame** (*SpaceCenter.ReferenceFrame*) – The reference frame that the returned position vector is in.

Returns The position as a vector.

Return type Tuple of (number, number, number)

velocity (*reference_frame*)

The linear velocity of the body, in the specified reference frame.

Parameters **reference_frame** (`SpaceCenter.ReferenceFrame`) – The reference frame that the returned velocity vector is in.

Returns The velocity as a vector. The vector points in the direction of travel, and its magnitude is the speed of the body in meters per second.

Return type Tuple of (number, number, number)

rotation (*reference_frame*)

The rotation of the body, in the specified reference frame.

Parameters **reference_frame** (`SpaceCenter.ReferenceFrame`) – The reference frame that the returned rotation is in.

Returns The rotation as a quaternion of the form (x, y, z, w) .

Return type Tuple of (number, number, number, number)

direction (*reference_frame*)

The direction in which the north pole of the celestial body is pointing, in the specified reference frame.

Parameters **reference_frame** (`SpaceCenter.ReferenceFrame`) – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

Return type Tuple of (number, number, number)

angular_velocity (*reference_frame*)

The angular velocity of the body in the specified reference frame.

Parameters **reference_frame** (`SpaceCenter.ReferenceFrame`) – The reference frame the returned angular velocity is in.

Returns The angular velocity as a vector. The magnitude of the vector is the rotational speed of the body, in radians per second. The direction of the vector indicates the axis of rotation, using the right-hand rule.

Return type Tuple of (number, number, number)

7.3.4 Flight

class Flight

Used to get flight telemetry for a vessel, by calling `SpaceCenter.Vessel.flight()`. All of the information returned by this class is given in the reference frame passed to that method. Obtained by calling `SpaceCenter.Vessel.flight()`.

Note: To get orbital information, such as the apoapsis or inclination, see `SpaceCenter.Orbit`.

g_force

The current G force acting on the vessel in m/s^2 .

Attribute Read-only, cannot be set

Return type number

mean_altitude

The altitude above sea level, in meters. Measured from the center of mass of the vessel.

Attribute Read-only, cannot be set

Return type number

surface_altitude

The altitude above the surface of the body or sea level, whichever is closer, in meters. Measured from the center of mass of the vessel.

Attribute Read-only, cannot be set

Return type number

bedrock_altitude

The altitude above the surface of the body, in meters. When over water, this is the altitude above the sea floor. Measured from the center of mass of the vessel.

Attribute Read-only, cannot be set

Return type number

elevation

The elevation of the terrain under the vessel, in meters. This is the height of the terrain above sea level, and is negative when the vessel is over the sea.

Attribute Read-only, cannot be set

Return type number

latitude

The [latitude](#) of the vessel for the body being orbited, in degrees.

Attribute Read-only, cannot be set

Return type number

longitude

The [longitude](#) of the vessel for the body being orbited, in degrees.

Attribute Read-only, cannot be set

Return type number

velocity

The velocity of the vessel, in the reference frame *SpaceCenter.ReferenceFrame*.

Attribute Read-only, cannot be set

Returns The velocity as a vector. The vector points in the direction of travel, and its magnitude is the speed of the vessel in meters per second.

Return type Tuple of (number, number, number)

speed

The speed of the vessel in meters per second, in the reference frame *SpaceCenter.ReferenceFrame*.

Attribute Read-only, cannot be set

Return type number

horizontal_speed

The horizontal speed of the vessel in meters per second, in the reference frame *SpaceCenter.ReferenceFrame*.

Attribute Read-only, cannot be set

Return type number

vertical_speed

The vertical speed of the vessel in meters per second, in the reference frame *SpaceCenter.ReferenceFrame*.

Attribute Read-only, cannot be set

Return type number

center_of_mass

The position of the center of mass of the vessel, in the reference frame *SpaceCenter.ReferenceFrame*.

Attribute Read-only, cannot be set

Returns The position as a vector.

Return type Tuple of (number, number, number)

rotation

The rotation of the vessel, in the reference frame *SpaceCenter.ReferenceFrame*

Attribute Read-only, cannot be set

Returns The rotation as a quaternion of the form (x, y, z, w) .

Return type Tuple of (number, number, number, number)

direction

The direction that the vessel is pointing in, in the reference frame *SpaceCenter.ReferenceFrame*.

Attribute Read-only, cannot be set

Returns The direction as a unit vector.

Return type Tuple of (number, number, number)

pitch

The pitch of the vessel relative to the horizon, in degrees. A value between -90° and $+90^\circ$.

Attribute Read-only, cannot be set

Return type number

heading

The heading of the vessel (its angle relative to north), in degrees. A value between 0° and 360° .

Attribute Read-only, cannot be set

Return type number

roll

The roll of the vessel relative to the horizon, in degrees. A value between -180° and $+180^\circ$.

Attribute Read-only, cannot be set

Return type number

prograde

The prograde direction of the vessels orbit, in the reference frame *SpaceCenter.ReferenceFrame*.

Attribute Read-only, cannot be set

Returns The direction as a unit vector.

Return type Tuple of (number, number, number)

retrograde

The retrograde direction of the vessels orbit, in the reference frame *SpaceCenter.ReferenceFrame*.

Attribute Read-only, cannot be set

Returns The direction as a unit vector.

Return type Tuple of (number, number, number)

normal

The direction normal to the vessels orbit, in the reference frame *SpaceCenter.ReferenceFrame*.

Attribute Read-only, cannot be set

Returns The direction as a unit vector.

Return type Tuple of (number, number, number)

anti_normal

The direction opposite to the normal of the vessels orbit, in the reference frame *SpaceCenter.ReferenceFrame*.

Attribute Read-only, cannot be set

Returns The direction as a unit vector.

Return type Tuple of (number, number, number)

radial

The radial direction of the vessels orbit, in the reference frame *SpaceCenter.ReferenceFrame*.

Attribute Read-only, cannot be set

Returns The direction as a unit vector.

Return type Tuple of (number, number, number)

anti_radial

The direction opposite to the radial direction of the vessels orbit, in the reference frame *SpaceCenter.ReferenceFrame*.

Attribute Read-only, cannot be set

Returns The direction as a unit vector.

Return type Tuple of (number, number, number)

atmosphere_density

The current density of the atmosphere around the vessel, in kg/m^3 .

Attribute Read-only, cannot be set

Return type number

dynamic_pressure

The dynamic pressure acting on the vessel, in Pascals. This is a measure of the strength of the aerodynamic forces. It is equal to $\frac{1}{2} \cdot \text{air density} \cdot \text{velocity}^2$. It is commonly denoted Q .

Attribute Read-only, cannot be set

Return type number

static_pressure

The static atmospheric pressure acting on the vessel, in Pascals.

Attribute Read-only, cannot be set

Return type number

static_pressure_at_msl

The static atmospheric pressure at mean sea level, in Pascals.

Attribute Read-only, cannot be set

Return type number

aerodynamic_force

The total aerodynamic forces acting on the vessel, in reference frame *SpaceCenter.ReferenceFrame*.

Attribute Read-only, cannot be set

Returns A vector pointing in the direction that the force acts, with its magnitude equal to the strength of the force in Newtons.

Return type Tuple of (number, number, number)

simulate_aerodynamic_force_at (*body, position, velocity*)

Simulate and return the total aerodynamic forces acting on the vessel, if it were to be traveling with the given velocity at the given position in the atmosphere of the given celestial body.

Parameters

- **body** (*SpaceCenter.CelestialBody*) –
- **position** (*Tuple*) –
- **velocity** (*Tuple*) –

Returns A vector pointing in the direction that the force acts, with its magnitude equal to the strength of the force in Newtons.

Return type Tuple of (number, number, number)

lift

The *aerodynamic lift* currently acting on the vessel.

Attribute Read-only, cannot be set

Returns A vector pointing in the direction that the force acts, with its magnitude equal to the strength of the force in Newtons.

Return type Tuple of (number, number, number)

drag

The *aerodynamic drag* currently acting on the vessel.

Attribute Read-only, cannot be set

Returns A vector pointing in the direction of the force, with its magnitude equal to the strength of the force in Newtons.

Return type Tuple of (number, number, number)

speed_of_sound

The speed of sound, in the atmosphere around the vessel, in *m/s*.

Attribute Read-only, cannot be set

Return type number

mach

The speed of the vessel, in multiples of the speed of sound.

Attribute Read-only, cannot be set

Return type number

reynolds_number

The vessels Reynolds number.

Attribute Read-only, cannot be set

Return type number

Note: Requires [Ferram Aerospace Research](#).

true_air_speed

The [true air speed](#) of the vessel, in meters per second.

Attribute Read-only, cannot be set

Return type number

equivalent_air_speed

The [equivalent air speed](#) of the vessel, in meters per second.

Attribute Read-only, cannot be set

Return type number

terminal_velocity

An estimate of the current terminal velocity of the vessel, in meters per second. This is the speed at which the drag forces cancel out the force of gravity.

Attribute Read-only, cannot be set

Return type number

angle_of_attack

The pitch angle between the orientation of the vessel and its velocity vector, in degrees.

Attribute Read-only, cannot be set

Return type number

sideslip_angle

The yaw angle between the orientation of the vessel and its velocity vector, in degrees.

Attribute Read-only, cannot be set

Return type number

total_air_temperature

The [total air temperature](#) of the atmosphere around the vessel, in Kelvin. This includes the *SpaceCenter.Flight.static_air_temperature* and the vessel's kinetic energy.

Attribute Read-only, cannot be set

Return type number

static_air_temperature

The [static \(ambient\) temperature](#) of the atmosphere around the vessel, in Kelvin.

Attribute Read-only, cannot be set

Return type number

stall_fraction

The current amount of stall, between 0 and 1. A value greater than 0.005 indicates a minor stall and a value greater than 0.5 indicates a large-scale stall.

Attribute Read-only, cannot be set

Return type number

Note: Requires [Ferram Aerospace Research](#).

drag_coefficient

The coefficient of drag. This is the amount of drag produced by the vessel. It depends on air speed, air density and wing area.

Attribute Read-only, cannot be set

Return type number

Note: Requires [Ferram Aerospace Research](#).

lift_coefficient

The coefficient of lift. This is the amount of lift produced by the vessel, and depends on air speed, air density and wing area.

Attribute Read-only, cannot be set

Return type number

Note: Requires [Ferram Aerospace Research](#).

ballistic_coefficient

The [ballistic coefficient](#).

Attribute Read-only, cannot be set

Return type number

Note: Requires [Ferram Aerospace Research](#).

thrust_specific_fuel_consumption

The thrust specific fuel consumption for the jet engines on the vessel. This is a measure of the efficiency of the engines, with a lower value indicating a more efficient vessel. This value is the number of Newtons of fuel that are burned, per hour, to produce one newton of thrust.

Attribute Read-only, cannot be set

Return type number

Note: Requires [Ferram Aerospace Research](#).

7.3.5 Orbit

class Orbit

Describes an orbit. For example, the orbit of a vessel, obtained by calling *SpaceCenter.Vessel.orbit*, or a celestial body, obtained by calling *SpaceCenter.CelestialBody.orbit*.

body

The celestial body (e.g. planet or moon) around which the object is orbiting.

Attribute Read-only, cannot be set

Return type *SpaceCenter.CelestialBody*

apoapsis

Gets the apoapsis of the orbit, in meters, from the center of mass of the body being orbited.

Attribute Read-only, cannot be set

Return type number

Note: For the apoapsis altitude reported on the in-game map view, use *SpaceCenter.Orbit.apoapsis_altitude*.

periapsis

The periapsis of the orbit, in meters, from the center of mass of the body being orbited.

Attribute Read-only, cannot be set

Return type number

Note: For the periapsis altitude reported on the in-game map view, use *SpaceCenter.Orbit.periapsis_altitude*.

apoapsis_altitude

The apoapsis of the orbit, in meters, above the sea level of the body being orbited.

Attribute Read-only, cannot be set

Return type number

Note: This is equal to *SpaceCenter.Orbit.apoapsis* minus the equatorial radius of the body.

periapsis_altitude

The periapsis of the orbit, in meters, above the sea level of the body being orbited.

Attribute Read-only, cannot be set

Return type number

Note: This is equal to *SpaceCenter.Orbit.periapsis* minus the equatorial radius of the body.

semi_major_axis

The semi-major axis of the orbit, in meters.

Attribute Read-only, cannot be set

Return type number

semi_minor_axis

The semi-minor axis of the orbit, in meters.

Attribute Read-only, cannot be set

Return type number

radius

The current radius of the orbit, in meters. This is the distance between the center of mass of the object in orbit, and the center of mass of the body around which it is orbiting.

Attribute Read-only, cannot be set

Return type number

Note: This value will change over time if the orbit is elliptical.

radius_at (*ut*)

The orbital radius at the given time, in meters.

Parameters **ut** (*number*) – The universal time to measure the radius at.

Return type number

position_at (*ut, reference_frame*)

The position at a given time, in the specified reference frame.

Parameters

- **ut** (*number*) – The universal time to measure the position at.
- **reference_frame** (`SpaceCenter.ReferenceFrame`) – The reference frame that the returned position vector is in.

Returns The position as a vector.

Return type Tuple of (number, number, number)

speed

The current orbital speed of the object in meters per second.

Attribute Read-only, cannot be set

Return type number

Note: This value will change over time if the orbit is elliptical.

period

The orbital period, in seconds.

Attribute Read-only, cannot be set

Return type number

time_to_apoapsis

The time until the object reaches apoapsis, in seconds.

Attribute Read-only, cannot be set

Return type number

time_to_periapsis

The time until the object reaches periapsis, in seconds.

Attribute Read-only, cannot be set

Return type number

eccentricity

The [eccentricity](#) of the orbit.

Attribute Read-only, cannot be set

Return type number

inclination

The [inclination](#) of the orbit, in radians.

Attribute Read-only, cannot be set

Return type number

longitude_of_ascending_node

The [longitude of the ascending node](#), in radians.

Attribute Read-only, cannot be set

Return type number

argument_of_periapsis

The [argument of periapsis](#), in radians.

Attribute Read-only, cannot be set

Return type number

mean_anomaly_at_epoch

The [mean anomaly at epoch](#).

Attribute Read-only, cannot be set

Return type number

epoch

The time since the epoch (the point at which the [mean anomaly at epoch](#) was measured, in seconds.

Attribute Read-only, cannot be set

Return type number

mean_anomaly

The [mean anomaly](#).

Attribute Read-only, cannot be set

Return type number

mean_anomaly_at_ut (*ut*)

The mean anomaly at the given time.

Parameters *ut* (*number*) – The universal time in seconds.

Return type number

eccentric_anomaly

The [eccentric anomaly](#).

Attribute Read-only, cannot be set

Return type number

eccentric_anomaly_at_ut (*ut*)

The eccentric anomaly at the given universal time.

Parameters **ut** (*number*) – The universal time, in seconds.

Return type *number*

true_anomaly

The *true anomaly*.

Attribute Read-only, cannot be set

Return type *number*

true_anomaly_at_ut (*ut*)

The true anomaly at the given time.

Parameters **ut** (*number*) – The universal time in seconds.

Return type *number*

true_anomaly_at_radius (*radius*)

The true anomaly at the given orbital radius.

Parameters **radius** (*number*) – The orbital radius in meters.

Return type *number*

ut_at_true_anomaly (*true_anomaly*)

The universal time, in seconds, corresponding to the given true anomaly.

Parameters **true_anomaly** (*number*) – True anomaly.

Return type *number*

radius_at_true_anomaly (*true_anomaly*)

The orbital radius at the point in the orbit given by the true anomaly.

Parameters **true_anomaly** (*number*) – The true anomaly.

Return type *number*

true_anomaly_at_an (*target*)

The true anomaly of the ascending node with the given target vessel.

Parameters **target** (*SpaceCenter.Vessel*) – Target vessel.

Return type *number*

true_anomaly_at_dn (*target*)

The true anomaly of the descending node with the given target vessel.

Parameters **target** (*SpaceCenter.Vessel*) – Target vessel.

Return type *number*

orbital_speed

The current orbital speed in meters per second.

Attribute Read-only, cannot be set

Return type *number*

orbital_speed_at (*time*)

The orbital speed at the given time, in meters per second.

Parameters **time** (*number*) – Time from now, in seconds.

Return type number

static reference_plane_normal (*reference_frame*)

The direction that is normal to the orbits reference plane, in the given reference frame. The reference plane is the plane from which the orbits inclination is measured.

Parameters **reference_frame** (`SpaceCenter.ReferenceFrame`) – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

Return type Tuple of (number, number, number)

static reference_plane_direction (*reference_frame*)

The direction from which the orbits longitude of ascending node is measured, in the given reference frame.

Parameters **reference_frame** (`SpaceCenter.ReferenceFrame`) – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

Return type Tuple of (number, number, number)

relative_inclination (*target*)

Relative inclination of this orbit and the orbit of the given target vessel, in radians.

Parameters **target** (`SpaceCenter.Vessel`) – Target vessel.

Return type number

time_to_soi_change

The time until the object changes sphere of influence, in seconds. Returns NaN if the object is not going to change sphere of influence.

Attribute Read-only, cannot be set

Return type number

next_orbit

If the object is going to change sphere of influence in the future, returns the new orbit after the change. Otherwise returns `nil`.

Attribute Read-only, cannot be set

Return type `SpaceCenter.Orbit`

time_of_closest_approach (*target*)

Estimates and returns the time at closest approach to a target vessel.

Parameters **target** (`SpaceCenter.Vessel`) – Target vessel.

Returns The universal time at closest approach, in seconds.

Return type number

distance_at_closest_approach (*target*)

Estimates and returns the distance at closest approach to a target vessel, in meters.

Parameters **target** (`SpaceCenter.Vessel`) – Target vessel.

Return type number

list_closest_approaches (*target, orbits*)

Returns the times at closest approach and corresponding distances, to a target vessel.

Parameters

- **target** (`SpaceCenter.Vessel`) – Target vessel.
- **orbits** (*number*) – The number of future orbits to search.

Returns A list of two lists. The first is a list of times at closest approach, as universal times in seconds. The second is a list of corresponding distances at closest approach, in meters.

Return type List of List of number

7.3.6 Control

class Control

Used to manipulate the controls of a vessel. This includes adjusting the throttle, enabling/disabling systems such as SAS and RCS, or altering the direction in which the vessel is pointing. Obtained by calling `SpaceCenter.Vessel.control`.

Note: Control inputs (such as pitch, yaw and roll) are zeroed when all clients that have set one or more of these inputs are no longer connected.

source

The source of the vessels control, for example by a kerbal or a probe core.

Attribute Read-only, cannot be set

Return type `SpaceCenter.ControlSource`

state

The control state of the vessel.

Attribute Read-only, cannot be set

Return type `SpaceCenter.ControlState`

sas

The state of SAS.

Attribute Can be read or written

Return type boolean

Note: Equivalent to `SpaceCenter.AutoPilot.sas`

sas_mode

The current `SpaceCenter.SASMode`. These modes are equivalent to the mode buttons to the left of the navball that appear when SAS is enabled.

Attribute Can be read or written

Return type `SpaceCenter.SASMode`

Note: Equivalent to `SpaceCenter.AutoPilot.sas_mode`

speed_mode

The current `SpaceCenter.SpeedMode` of the navball. This is the mode displayed next to the speed at the top of the navball.

Attribute Can be read or written

Return type *SpaceCenter.SpeedMode*

rcs

The state of RCS.

Attribute Can be read or written

Return type boolean

reaction_wheels

Returns whether all reactive wheels on the vessel are active, and sets the active state of all reaction wheels. See *SpaceCenter.ReactionWheel.active*.

Attribute Can be read or written

Return type boolean

gear

The state of the landing gear/legs.

Attribute Can be read or written

Return type boolean

legs

Returns whether all landing legs on the vessel are deployed, and sets the deployment state of all landing legs. Does not include wheels (for example landing gear). See *SpaceCenter.Leg.deployed*.

Attribute Can be read or written

Return type boolean

wheels

Returns whether all wheels on the vessel are deployed, and sets the deployment state of all wheels. Does not include landing legs. See *SpaceCenter.Wheel.deployed*.

Attribute Can be read or written

Return type boolean

lights

The state of the lights.

Attribute Can be read or written

Return type boolean

brakes

The state of the wheel brakes.

Attribute Can be read or written

Return type boolean

antennas

Returns whether all antennas on the vessel are deployed, and sets the deployment state of all antennas. See *SpaceCenter.Antenna.deployed*.

Attribute Can be read or written

Return type boolean

cargo_bays

Returns whether any of the cargo bays on the vessel are open, and sets the open state of all cargo bays. See *SpaceCenter.CargoBay.open*.

Attribute Can be read or written

Return type boolean

intakes

Returns whether all of the air intakes on the vessel are open, and sets the open state of all air intakes. See *SpaceCenter.Intake.open*.

Attribute Can be read or written

Return type boolean

parachutes

Returns whether all parachutes on the vessel are deployed, and sets the deployment state of all parachutes. Cannot be set to `False`. See *SpaceCenter.Parachute.deployed*.

Attribute Can be read or written

Return type boolean

radiators

Returns whether all radiators on the vessel are deployed, and sets the deployment state of all radiators. See *SpaceCenter.Radiator.deployed*.

Attribute Can be read or written

Return type boolean

resource_harvesters

Returns whether all of the resource harvesters on the vessel are deployed, and sets the deployment state of all resource harvesters. See *SpaceCenter.ResourceHarvester.deployed*.

Attribute Can be read or written

Return type boolean

resource_harvesters_active

Returns whether any of the resource harvesters on the vessel are active, and sets the active state of all resource harvesters. See *SpaceCenter.ResourceHarvester.active*.

Attribute Can be read or written

Return type boolean

solar_panels

Returns whether all solar panels on the vessel are deployed, and sets the deployment state of all solar panels. See *SpaceCenter.SolarPanel.deployed*.

Attribute Can be read or written

Return type boolean

abort

The state of the abort action group.

Attribute Can be read or written

Return type boolean

throttle

The state of the throttle. A value between 0 and 1.

Attribute Can be read or written

Return type number

input_mode

Sets the behavior of the pitch, yaw, roll and translation control inputs. When set to additive, these inputs are added to the vessels current inputs. This mode is the default. When set to override, these inputs (if non-zero) override the vessels inputs. This mode prevents keyboard control, or SAS, from interfering with the controls when they are set.

Attribute Can be read or written

Return type *SpaceCenter.ControlInputMode*

pitch

The state of the pitch control. A value between -1 and 1. Equivalent to the w and s keys.

Attribute Can be read or written

Return type number

yaw

The state of the yaw control. A value between -1 and 1. Equivalent to the a and d keys.

Attribute Can be read or written

Return type number

roll

The state of the roll control. A value between -1 and 1. Equivalent to the q and e keys.

Attribute Can be read or written

Return type number

forward

The state of the forward translational control. A value between -1 and 1. Equivalent to the h and n keys.

Attribute Can be read or written

Return type number

up

The state of the up translational control. A value between -1 and 1. Equivalent to the i and k keys.

Attribute Can be read or written

Return type number

right

The state of the right translational control. A value between -1 and 1. Equivalent to the j and l keys.

Attribute Can be read or written

Return type number

wheel_throttle

The state of the wheel throttle. A value between -1 and 1. A value of 1 rotates the wheels forwards, a value of -1 rotates the wheels backwards.

Attribute Can be read or written

Return type number

wheel_steering

The state of the wheel steering. A value between -1 and 1. A value of 1 steers to the left, and a value of -1 steers to the right.

Attribute Can be read or written

Return type number

current_stage

The current stage of the vessel. Corresponds to the stage number in the in-game UI.

Attribute Read-only, cannot be set

Return type number

activate_next_stage()

Activates the next stage. Equivalent to pressing the space bar in-game.

Returns A list of vessel objects that are jettisoned from the active vessel.

Return type List of *SpaceCenter.Vessel*

Note: When called, the active vessel may change. It is therefore possible that, after calling this function, the object(s) returned by previous call(s) to *SpaceCenter.active_vessel* no longer refer to the active vessel.

get_action_group(group)

Returns `True` if the given action group is enabled.

Parameters **group** (*number*) – A number between 0 and 9 inclusive, or between 0 and 250 inclusive when the [Extended Action Groups mod](#) is installed.

Return type boolean

set_action_group(group, state)

Sets the state of the given action group.

Parameters

- **group** (*number*) – A number between 0 and 9 inclusive, or between 0 and 250 inclusive when the [Extended Action Groups mod](#) is installed.
- **state** (*boolean*) –

toggle_action_group(group)

Toggles the state of the given action group.

Parameters **group** (*number*) – A number between 0 and 9 inclusive, or between 0 and 250 inclusive when the [Extended Action Groups mod](#) is installed.

add_node(ut[, prograde = 0.0][, normal = 0.0][, radial = 0.0])

Creates a maneuver node at the given universal time, and returns a *SpaceCenter.Node* object that can be used to modify it. Optionally sets the magnitude of the delta-v for the maneuver node in the prograde, normal and radial directions.

Parameters

- **ut** (*number*) – Universal time of the maneuver node.
- **prograde** (*number*) – Delta-v in the prograde direction.
- **normal** (*number*) – Delta-v in the normal direction.
- **radial** (*number*) – Delta-v in the radial direction.

Return type *SpaceCenter.Node*

nodes

Returns a list of all existing maneuver nodes, ordered by time from first to last.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.Node*

remove_nodes ()

Remove all maneuver nodes.

class ControlState

The control state of a vessel. See *SpaceCenter.Control.state*.

full

Full controllable.

partial

Partially controllable.

none

Not controllable.

class ControlSource

The control source of a vessel. See *SpaceCenter.Control.source*.

kerbal

Vessel is controlled by a Kerbal.

probe

Vessel is controlled by a probe core.

none

Vessel is not controlled.

class SASMode

The behavior of the SAS auto-pilot. See *SpaceCenter.AutoPilot.sas_mode*.

stability_assist

Stability assist mode. Dampen out any rotation.

maneuver

Point in the burn direction of the next maneuver node.

prograde

Point in the prograde direction.

retrograde

Point in the retrograde direction.

normal

Point in the orbit normal direction.

anti_normal

Point in the orbit anti-normal direction.

radial

Point in the orbit radial direction.

anti_radial

Point in the orbit anti-radial direction.

target

Point in the direction of the current target.

anti_target

Point away from the current target.

class SpeedMode

The mode of the speed reported in the navball. See *SpaceCenter.Control.speed_mode*.

orbit

Speed is relative to the vessel's orbit.

surface

Speed is relative to the surface of the body being orbited.

target

Speed is relative to the current target.

class ControlInputMode

See *SpaceCenter.Control.input_mode*.

additive

Control inputs are added to the vessels current control inputs.

override

Control inputs (when they are non-zero) override the vessels current control inputs.

7.3.7 Communications

class Comms

Used to interact with CommNet for a given vessel. Obtained by calling *SpaceCenter.Vessel.comms*.

can_communicate

Whether the vessel can communicate with KSC.

Attribute Read-only, cannot be set

Return type boolean

can_transmit_science

Whether the vessel can transmit science data to KSC.

Attribute Read-only, cannot be set

Return type boolean

signal_strength

Signal strength to KSC.

Attribute Read-only, cannot be set

Return type number

signal_delay

Signal delay to KSC in seconds.

Attribute Read-only, cannot be set

Return type number

power

The combined power of all active antennae on the vessel.

Attribute Read-only, cannot be set

Return type number

control_path

The communication path used to control the vessel.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.CommLink*

class CommLink

Represents a communication node in the network. For example, a vessel or the KSC.

type

The type of link.

Attribute Read-only, cannot be set

Return type *SpaceCenter.CommLinkType*

signal_strength

Signal strength of the link.

Attribute Read-only, cannot be set

Return type number

start

Start point of the link.

Attribute Read-only, cannot be set

Return type *SpaceCenter.CommNode*

end

Start point of the link.

Attribute Read-only, cannot be set

Return type *SpaceCenter.CommNode*

class CommLinkType

The type of a communication link. See *SpaceCenter.CommLink.type*.

home

Link is to a base station on Kerbin.

control

Link is to a control source, for example a manned spacecraft.

relay

Link is to a relay satellite.

class CommNode

Represents a communication node in the network. For example, a vessel or the KSC.

name

Name of the communication node.

Attribute Read-only, cannot be set

Return type string

is_home

Whether the communication node is on Kerbin.

Attribute Read-only, cannot be set

Return type boolean

is_control_point

Whether the communication node is a control point, for example a manned vessel.

Attribute Read-only, cannot be set

Return type boolean

is_vessel

Whether the communication node is a vessel.

Attribute Read-only, cannot be set

Return type boolean

vessel

The vessel for this communication node.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Vessel*

7.3.8 Parts

The following classes allow interaction with a vessels individual parts.

- *Parts*
- *Part*
- *Module*
- *Specific Types of Part*
 - *Antenna*
 - *Cargo Bay*
 - *Control Surface*
 - *Decoupler*
 - *Docking Port*
 - *Engine*
 - *Experiment*
 - *Fairing*
 - *Intake*
 - *Leg*
 - *Launch Clamp*
 - *Light*
 - *Parachute*
 - *Radiator*
 - *Resource Converter*
 - *Resource Harvester*
 - *Reaction Wheel*
 - *RCS*
 - *Sensor*
 - *Solar Panel*

- Thruster
- Wheel
- Trees of Parts
 - Traversing the Tree
 - Attachment Modes
- Fuel Lines
- Staging

Parts

class Parts

Instances of this class are used to interact with the parts of a vessel. An instance can be obtained by calling *SpaceCenter.Vessel.parts*.

all

A list of all of the vessels parts.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.Part*

root

The vessels root part.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Part*

Note: See the discussion on *Trees of Parts*.

controlling

The part from which the vessel is controlled.

Attribute Can be read or written

Return type *SpaceCenter.Part*

with_name (name)

A list of parts whose *SpaceCenter.Part.name* is *name*.

Parameters **name** (*string*) –

Return type List of *SpaceCenter.Part*

with_title (title)

A list of all parts whose *SpaceCenter.Part.title* is *title*.

Parameters **title** (*string*) –

Return type List of *SpaceCenter.Part*

with_tag (tag)

A list of all parts whose *SpaceCenter.Part.tag* is *tag*.

Parameters **tag** (*string*) –

Return type List of *SpaceCenter.Part*

with_module (*module_name*)

A list of all parts that contain a *SpaceCenter.Module* whose *SpaceCenter.Module.name* is *module_name*.

Parameters *module_name* (*string*) –

Return type List of *SpaceCenter.Part*

in_stage (*stage*)

A list of all parts that are activated in the given *stage*.

Parameters *stage* (*number*) –

Return type List of *SpaceCenter.Part*

Note: See the discussion on *Staging*.

in_decouple_stage (*stage*)

A list of all parts that are decoupled in the given *stage*.

Parameters *stage* (*number*) –

Return type List of *SpaceCenter.Part*

Note: See the discussion on *Staging*.

modules_with_name (*module_name*)

A list of modules (combined across all parts in the vessel) whose *SpaceCenter.Module.name* is *module_name*.

Parameters *module_name* (*string*) –

Return type List of *SpaceCenter.Module*

antennas

A list of all antennas in the vessel.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.Antenna*

cargo_bays

A list of all cargo bays in the vessel.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.CargoBay*

control_surfaces

A list of all control surfaces in the vessel.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.ControlSurface*

decouplers

A list of all decouplers in the vessel.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.Decoupler*

docking_ports

A list of all docking ports in the vessel.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.DockingPort*

engines

A list of all engines in the vessel.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.Engine*

Note: This includes any part that generates thrust. This covers many different types of engine, including liquid fuel rockets, solid rocket boosters, jet engines and RCS thrusters.

experiments

A list of all science experiments in the vessel.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.Experiment*

fairings

A list of all fairings in the vessel.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.Fairing*

intakes

A list of all intakes in the vessel.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.Intake*

legs

A list of all landing legs attached to the vessel.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.Leg*

launch_clamps

A list of all launch clamps attached to the vessel.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.LaunchClamp*

lights

A list of all lights in the vessel.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.Light*

parachutes

A list of all parachutes in the vessel.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.Parachute*

radiators

A list of all radiators in the vessel.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.Radiator*

rcs

A list of all RCS blocks/thrusters in the vessel.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.RCS*

reaction_wheels

A list of all reaction wheels in the vessel.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.ReactionWheel*

resource_converters

A list of all resource converters in the vessel.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.ResourceConverter*

resource_harvesters

A list of all resource harvesters in the vessel.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.ResourceHarvester*

sensors

A list of all sensors in the vessel.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.Sensor*

solar_panels

A list of all solar panels in the vessel.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.SolarPanel*

wheels

A list of all wheels in the vessel.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.Wheel*

Part

class Part

Represents an individual part. Vessels are made up of multiple parts. Instances of this class can be obtained by several methods in *SpaceCenter.Parts*.

name

Internal name of the part, as used in [part cfg files](#). For example “Mark1-2Pod”.

Attribute Read-only, cannot be set

Return type string

title

Title of the part, as shown when the part is right clicked in-game. For example “Mk1-2 Command Pod”.

Attribute Read-only, cannot be set

Return type string

tag

The name tag for the part. Can be set to a custom string using the in-game user interface.

Attribute Can be read or written

Return type string

Note: This requires either the [NameTag](#) or [kOS](#) mod to be installed.

highlighted

Whether the part is highlighted.

Attribute Can be read or written

Return type boolean

highlight_color

The color used to highlight the part, as an RGB triple.

Attribute Can be read or written

Return type Tuple of (number, number, number)

cost

The cost of the part, in units of funds.

Attribute Read-only, cannot be set

Return type number

vessel

The vessel that contains this part.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Vessel*

parent

The parts parent. Returns *nil* if the part does not have a parent. This, in combination with *SpaceCenter.Part.children*, can be used to traverse the vessels parts tree.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Part*

Note: See the discussion on *Trees of Parts*.

children

The parts children. Returns an empty list if the part has no children. This, in combination with *SpaceCenter.Part.parent*, can be used to traverse the vessels parts tree.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.Part*

Note: See the discussion on *Trees of Parts*.

axially_attached

Whether the part is axially attached to its parent, i.e. on the top or bottom of its parent. If the part has no parent, returns `False`.

Attribute Read-only, cannot be set

Return type boolean

Note: See the discussion on *Attachment Modes*.

radially_attached

Whether the part is radially attached to its parent, i.e. on the side of its parent. If the part has no parent, returns `False`.

Attribute Read-only, cannot be set

Return type boolean

Note: See the discussion on *Attachment Modes*.

stage

The stage in which this part will be activated. Returns -1 if the part is not activated by staging.

Attribute Read-only, cannot be set

Return type number

Note: See the discussion on *Staging*.

decouple_stage

The stage in which this part will be decoupled. Returns -1 if the part is never decoupled from the vessel.

Attribute Read-only, cannot be set

Return type number

Note: See the discussion on *Staging*.

massless

Whether the part is `massless`.

Attribute Read-only, cannot be set

Return type boolean

mass

The current mass of the part, including resources it contains, in kilograms. Returns zero if the part is massless.

Attribute Read-only, cannot be set

Return type number

dry_mass

The mass of the part, not including any resources it contains, in kilograms. Returns zero if the part is massless.

Attribute Read-only, cannot be set

Return type number

shielded

Whether the part is shielded from the exterior of the vessel, for example by a fairing.

Attribute Read-only, cannot be set

Return type boolean

dynamic_pressure

The dynamic pressure acting on the part, in Pascals.

Attribute Read-only, cannot be set

Return type number

impact_tolerance

The impact tolerance of the part, in meters per second.

Attribute Read-only, cannot be set

Return type number

temperature

Temperature of the part, in Kelvin.

Attribute Read-only, cannot be set

Return type number

skin_temperature

Temperature of the skin of the part, in Kelvin.

Attribute Read-only, cannot be set

Return type number

max_temperature

Maximum temperature that the part can survive, in Kelvin.

Attribute Read-only, cannot be set

Return type number

max_skin_temperature

Maximum temperature that the skin of the part can survive, in Kelvin.

Attribute Read-only, cannot be set

Return type number

thermal_mass

A measure of how much energy it takes to increase the internal temperature of the part, in Joules per Kelvin.

Attribute Read-only, cannot be set

Return type number

thermal_skin_mass

A measure of how much energy it takes to increase the skin temperature of the part, in Joules per Kelvin.

Attribute Read-only, cannot be set

Return type number

thermal_resource_mass

A measure of how much energy it takes to increase the temperature of the resources contained in the part, in Joules per Kelvin.

Attribute Read-only, cannot be set

Return type number

thermal_conduction_flux

The rate at which heat energy is conducting into or out of the part via contact with other parts. Measured in energy per unit time, or power, in Watts. A positive value means the part is gaining heat energy, and negative means it is losing heat energy.

Attribute Read-only, cannot be set

Return type number

thermal_convection_flux

The rate at which heat energy is convecting into or out of the part from the surrounding atmosphere. Measured in energy per unit time, or power, in Watts. A positive value means the part is gaining heat energy, and negative means it is losing heat energy.

Attribute Read-only, cannot be set

Return type number

thermal_radiation_flux

The rate at which heat energy is radiating into or out of the part from the surrounding environment. Measured in energy per unit time, or power, in Watts. A positive value means the part is gaining heat energy, and negative means it is losing heat energy.

Attribute Read-only, cannot be set

Return type number

thermal_internal_flux

The rate at which heat energy is begin generated by the part. For example, some engines generate heat by combusting fuel. Measured in energy per unit time, or power, in Watts. A positive value means the part is gaining heat energy, and negative means it is losing heat energy.

Attribute Read-only, cannot be set

Return type number

thermal_skin_to_internal_flux

The rate at which heat energy is transferring between the part's skin and its internals. Measured in energy per unit time, or power, in Watts. A positive value means the part's internals are gaining heat energy, and negative means its skin is gaining heat energy.

Attribute Read-only, cannot be set

Return type number

resources

A *SpaceCenter.Resources* object for the part.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Resources*

crossfeed

Whether this part is crossfeed capable.

Attribute Read-only, cannot be set

Return type boolean

is_fuel_line

Whether this part is a fuel line.

Attribute Read-only, cannot be set

Return type boolean

fuel_lines_from

The parts that are connected to this part via fuel lines, where the direction of the fuel line is into this part.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.Part*

Note: See the discussion on *Fuel Lines*.

fuel_lines_to

The parts that are connected to this part via fuel lines, where the direction of the fuel line is out of this part.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.Part*

Note: See the discussion on *Fuel Lines*.

modules

The modules for this part.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.Module*

antenna

A *SpaceCenter.Antenna* if the part is an antenna, otherwise nil.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Antenna*

cargo_bay

A *SpaceCenter.CargoBay* if the part is a cargo bay, otherwise nil.

Attribute Read-only, cannot be set

Return type *SpaceCenter.CargoBay*

control_surface

A *SpaceCenter.ControlSurface* if the part is an aerodynamic control surface, otherwise nil.

Attribute Read-only, cannot be set

Return type *SpaceCenter.ControlSurface*

decoupler

A *SpaceCenter.Decoupler* if the part is a decoupler, otherwise nil.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Decoupler*

docking_port

A *SpaceCenter.DockingPort* if the part is a docking port, otherwise nil.

Attribute Read-only, cannot be set

Return type *SpaceCenter.DockingPort*

engine

An *SpaceCenter.Engine* if the part is an engine, otherwise nil.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Engine*

experiment

An *SpaceCenter.Experiment* if the part is a science experiment, otherwise nil.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Experiment*

fairing

A *SpaceCenter.Fairing* if the part is a fairing, otherwise nil.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Fairing*

intake

An *SpaceCenter.Intake* if the part is an intake, otherwise nil.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Intake*

Note: This includes any part that generates thrust. This covers many different types of engine, including liquid fuel rockets, solid rocket boosters and jet engines. For RCS thrusters see *SpaceCenter.RCS*.

leg

A *SpaceCenter.Leg* if the part is a landing leg, otherwise nil.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Leg*

launch_clamp

A *SpaceCenter.LaunchClamp* if the part is a launch clamp, otherwise nil.

Attribute Read-only, cannot be set

Return type *SpaceCenter.LaunchClamp*

light

A *SpaceCenter.Light* if the part is a light, otherwise nil.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Light*

parachute

A *SpaceCenter.Parachute* if the part is a parachute, otherwise nil.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Parachute*

radiator

A *SpaceCenter.Radiator* if the part is a radiator, otherwise nil.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Radiator*

rcs

A *SpaceCenter.RCS* if the part is an RCS block/thruster, otherwise nil.

Attribute Read-only, cannot be set

Return type *SpaceCenter.RCS*

reaction_wheel

A *SpaceCenter.ReactionWheel* if the part is a reaction wheel, otherwise nil.

Attribute Read-only, cannot be set

Return type *SpaceCenter.ReactionWheel*

resource_converter

A *SpaceCenter.ResourceConverter* if the part is a resource converter, otherwise nil.

Attribute Read-only, cannot be set

Return type *SpaceCenter.ResourceConverter*

resource_harvester

A *SpaceCenter.ResourceHarvester* if the part is a resource harvester, otherwise nil.

Attribute Read-only, cannot be set

Return type *SpaceCenter.ResourceHarvester*

sensor

A *SpaceCenter.Sensor* if the part is a sensor, otherwise nil.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Sensor*

solar_panel

A *SpaceCenter.SolarPanel* if the part is a solar panel, otherwise nil.

Attribute Read-only, cannot be set

Return type *SpaceCenter.SolarPanel*

wheel

A *SpaceCenter.Wheel* if the part is a wheel, otherwise nil.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Wheel*

position (*reference_frame*)

The position of the part in the given reference frame.

Parameters **reference_frame** (*SpaceCenter.ReferenceFrame*) – The reference frame that the returned position vector is in.

Returns The position as a vector.

Return type Tuple of (number, number, number)

Note: This is a fixed position in the part, defined by the parts model. It s not necessarily the same as the parts center of mass. Use `SpaceCenter.Part.center_of_mass()` to get the parts center of mass.

center_of_mass (*reference_frame*)

The position of the parts center of mass in the given reference frame. If the part is physicsless, this is equivalent to `SpaceCenter.Part.position()`.

Parameters **reference_frame** (`SpaceCenter.ReferenceFrame`) – The reference frame that the returned position vector is in.

Returns The position as a vector.

Return type Tuple of (number, number, number)

bounding_box (*reference_frame*)

The axis-aligned bounding box of the part in the given reference frame.

Parameters **reference_frame** (`SpaceCenter.ReferenceFrame`) – The reference frame that the returned position vectors are in.

Returns The positions of the minimum and maximum vertices of the box, as position vectors.

Return type Tuple of (Tuple of (number, number, number), Tuple of (number, number, number))

Note: This is computed from the collision mesh of the part. If the part is not collidable, the box has zero volume and is centered on the `SpaceCenter.Part.position()` of the part.

direction (*reference_frame*)

The direction the part points in, in the given reference frame.

Parameters **reference_frame** (`SpaceCenter.ReferenceFrame`) – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

Return type Tuple of (number, number, number)

velocity (*reference_frame*)

The linear velocity of the part in the given reference frame.

Parameters **reference_frame** (`SpaceCenter.ReferenceFrame`) – The reference frame that the returned velocity vector is in.

Returns The velocity as a vector. The vector points in the direction of travel, and its magnitude is the speed of the body in meters per second.

Return type Tuple of (number, number, number)

rotation (*reference_frame*)

The rotation of the part, in the given reference frame.

Parameters **reference_frame** (`SpaceCenter.ReferenceFrame`) – The reference frame that the returned rotation is in.

Returns The rotation as a quaternion of the form (x, y, z, w) .

Return type Tuple of (number, number, number, number)

moment_of_inertia

The moment of inertia of the part in $kg.m^2$ around its center of mass in the parts reference frame (*SpaceCenter.ReferenceFrame*).

Attribute Read-only, cannot be set

Return type Tuple of (number, number, number)

inertia_tensor

The inertia tensor of the part in the parts reference frame (*SpaceCenter.ReferenceFrame*). Returns the 3x3 matrix as a list of elements, in row-major order.

Attribute Read-only, cannot be set

Return type List of number

reference_frame

The reference frame that is fixed relative to this part, and centered on a fixed position within the part, defined by the parts model.

- The origin is at the position of the part, as returned by *SpaceCenter.Part.position()*.
- The axes rotate with the part.
- The x, y and z axis directions depend on the design of the part.

Attribute Read-only, cannot be set

Return type *SpaceCenter.ReferenceFrame*

Note: For docking port parts, this reference frame is not necessarily equivalent to the reference frame for the docking port, returned by *SpaceCenter.DockingPort.reference_frame*.

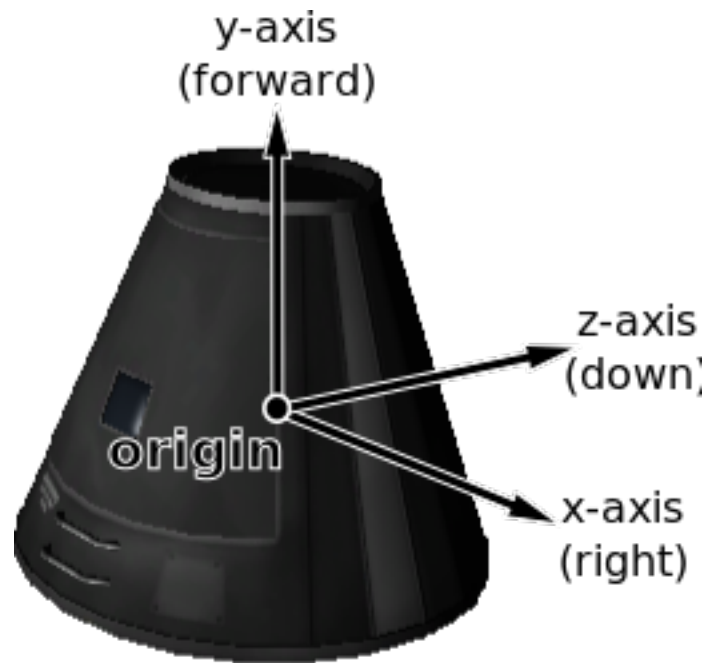


Fig. 7.7: Mk1 Command Pod reference frame origin and axes

center_of_mass_reference_frame

The reference frame that is fixed relative to this part, and centered on its center of mass.

- The origin is at the center of mass of the part, as returned by *SpaceCenter.Part.center_of_mass()*.
- The axes rotate with the part.
- The x, y and z axis directions depend on the design of the part.

Attribute Read-only, cannot be set

Return type *SpaceCenter.ReferenceFrame*

Note: For docking port parts, this reference frame is not necessarily equivalent to the reference frame for the docking port, returned by *SpaceCenter.DockingPort.reference_frame*.

add_force (*force, position, reference_frame*)

Exert a constant force on the part, acting at the given position.

Parameters

- **force** (*Tuple*) – A vector pointing in the direction that the force acts, with its magnitude equal to the strength of the force in Newtons.
- **position** (*Tuple*) – The position at which the force acts, as a vector.
- **reference_frame** (*SpaceCenter.ReferenceFrame*) – The reference frame that the force and position are in.

Returns An object that can be used to remove or modify the force.

Return type *SpaceCenter.Force*

instantaneous_force (*force, position, reference_frame*)

Exert an instantaneous force on the part, acting at the given position.

Parameters

- **force** (*Tuple*) – A vector pointing in the direction that the force acts, with its magnitude equal to the strength of the force in Newtons.
- **position** (*Tuple*) – The position at which the force acts, as a vector.
- **reference_frame** (*SpaceCenter.ReferenceFrame*) – The reference frame that the force and position are in.

Note: The force is applied instantaneously in a single physics update.

class Force

Obtained by calling *SpaceCenter.Part.add_force()*.

part

The part that this force is applied to.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Part*

force_vector

The force vector, in Newtons.

Attribute Can be read or written

Returns A vector pointing in the direction that the force acts, with its magnitude equal to the strength of the force in Newtons.

Return type Tuple of (number, number, number)

position

The position at which the force acts, in reference frame *SpaceCenter.ReferenceFrame*.

Attribute Can be read or written

Returns The position as a vector.

Return type Tuple of (number, number, number)

reference_frame

The reference frame of the force vector and position.

Attribute Can be read or written

Return type *SpaceCenter.ReferenceFrame*

remove()

Remove the force.

Module

class Module

This can be used to interact with a specific part module. This includes part modules in stock KSP, and those added by mods.

In KSP, each part has zero or more [PartModules](#) associated with it. Each one contains some of the functionality of the part. For example, an engine has a “ModuleEngines” part module that contains all the functionality of an engine.

name

Name of the PartModule. For example, “ModuleEngines”.

Attribute Read-only, cannot be set

Return type string

part

The part that contains this module.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Part*

fields

The modules field names and their associated values, as a dictionary. These are the values visible in the right-click menu of the part.

Attribute Read-only, cannot be set

Return type Map from string to string

has_field(name)

Returns `True` if the module has a field with the given name.

Parameters **name** (*string*) – Name of the field.

Return type boolean

get_field (*name*)

Returns the value of a field.

Parameters **name** (*string*) – Name of the field.

Return type string

set_field_int (*name*, *value*)

Set the value of a field to the given integer number.

Parameters

- **name** (*string*) – Name of the field.
- **value** (*number*) – Value to set.

set_field_float (*name*, *value*)

Set the value of a field to the given floating point number.

Parameters

- **name** (*string*) – Name of the field.
- **value** (*number*) – Value to set.

set_field_string (*name*, *value*)

Set the value of a field to the given string.

Parameters

- **name** (*string*) – Name of the field.
- **value** (*string*) – Value to set.

reset_field (*name*)

Set the value of a field to its original value.

Parameters **name** (*string*) – Name of the field.

events

A list of the names of all of the modules events. Events are the clickable buttons visible in the right-click menu of the part.

Attribute Read-only, cannot be set

Return type List of string

has_event (*name*)

True if the module has an event with the given name.

Parameters **name** (*string*) –

Return type boolean

trigger_event (*name*)

Trigger the named event. Equivalent to clicking the button in the right-click menu of the part.

Parameters **name** (*string*) –

actions

A list of all the names of the modules actions. These are the parts actions that can be assigned to action groups in the in-game editor.

Attribute Read-only, cannot be set

Return type List of string

has_action (*name*)

True if the part has an action with the given name.

Parameters *name* (*string*) –

Return type boolean

set_action (*name* [, *value* = *True*])

Set the value of an action with the given name.

Parameters

- **name** (*string*) –
- **value** (*boolean*) –

Specific Types of Part

The following classes provide functionality for specific types of part.

- *Antenna*
- *Cargo Bay*
- *Control Surface*
- *Decoupler*
- *Docking Port*
- *Engine*
- *Experiment*
- *Fairing*
- *Intake*
- *Leg*
- *Launch Clamp*
- *Light*
- *Parachute*
- *Radiator*
- *Resource Converter*
- *Resource Harvester*
- *Reaction Wheel*
- *RCS*
- *Sensor*
- *Solar Panel*
- *Thruster*
- *Wheel*

Antenna

class Antenna

An antenna. Obtained by calling *SpaceCenter.Part.antenna*.

part

The part object for this antenna.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Part*

state

The current state of the antenna.

Attribute Read-only, cannot be set

Return type *SpaceCenter.AntennaState*

deployable

Whether the antenna is deployable.

Attribute Read-only, cannot be set

Return type boolean

deployed

Whether the antenna is deployed.

Attribute Can be read or written

Return type boolean

Note: Fixed antennas are always deployed. Returns an error if you try to deploy a fixed antenna.

can_transmit

Whether data can be transmitted by this antenna.

Attribute Read-only, cannot be set

Return type boolean

transmit ()

Transmit data.

cancel ()

Cancel current transmission of data.

allow_partial

Whether partial data transmission is permitted.

Attribute Can be read or written

Return type boolean

power

The power of the antenna.

Attribute Read-only, cannot be set

Return type number

combinable

Whether the antenna can be combined with other antennae on the vessel to boost the power.

Attribute Read-only, cannot be set

Return type boolean

combinable_exponent

Exponent used to calculate the combined power of multiple antennae on a vessel.

Attribute Read-only, cannot be set

Return type number

packet_interval

Interval between sending packets in seconds.

Attribute Read-only, cannot be set

Return type number

packet_size

Amount of data sent per packet in Mbits.

Attribute Read-only, cannot be set

Return type number

packet_resource_cost

Units of electric charge consumed per packet sent.

Attribute Read-only, cannot be set

Return type number

class AntennaState

The state of an antenna. See *SpaceCenter.Antenna.state*.

deployed

Antenna is fully deployed.

retracted

Antenna is fully retracted.

deploying

Antenna is being deployed.

retracting

Antenna is being retracted.

broken

Antenna is broken.

Cargo Bay

class CargoBay

A cargo bay. Obtained by calling *SpaceCenter.Part.cargo_bay*.

part

The part object for this cargo bay.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Part*

state

The state of the cargo bay.

Attribute Read-only, cannot be set

Return type *SpaceCenter.CargoBayState*

open

Whether the cargo bay is open.

Attribute Can be read or written

Return type boolean

class CargoBayState

The state of a cargo bay. See *SpaceCenter.CargoBay.state*.

open

Cargo bay is fully open.

closed

Cargo bay closed and locked.

opening

Cargo bay is opening.

closing

Cargo bay is closing.

Control Surface

class ControlSurface

An aerodynamic control surface. Obtained by calling *SpaceCenter.Part.control_surface*.

part

The part object for this control surface.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Part*

pitch_enabled

Whether the control surface has pitch control enabled.

Attribute Can be read or written

Return type boolean

yaw_enabled

Whether the control surface has yaw control enabled.

Attribute Can be read or written

Return type boolean

roll_enabled

Whether the control surface has roll control enabled.

Attribute Can be read or written

Return type boolean

authority_limiter

The authority limiter for the control surface, which controls how far the control surface will move.

Attribute Can be read or written

Return type number

inverted

Whether the control surface movement is inverted.

Attribute Can be read or written

Return type boolean

deployed

Whether the control surface has been fully deployed.

Attribute Can be read or written

Return type boolean

surface_area

Surface area of the control surface in m^2 .

Attribute Read-only, cannot be set

Return type number

available_torque

The available torque, in Newton meters, that can be produced by this control surface, in the positive and negative pitch, roll and yaw axes of the vessel. These axes correspond to the coordinate axes of the *SpaceCenter.Vessel.reference_frame*.

Attribute Read-only, cannot be set

Return type Tuple of (Tuple of (number, number, number), Tuple of (number, number, number))

Decoupler

class Decoupler

A decoupler. Obtained by calling *SpaceCenter.Part.decoupler*

part

The part object for this decoupler.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Part*

decouple ()

Fires the decoupler. Returns the new vessel created when the decoupler fires. Throws an exception if the decoupler has already fired.

Return type *SpaceCenter.Vessel*

Note: When called, the active vessel may change. It is therefore possible that, after calling this function, the object(s) returned by previous call(s) to *SpaceCenter.active_vessel* no longer refer to the active vessel.

decoupled

Whether the decoupler has fired.

Attribute Read-only, cannot be set

Return type boolean

staged

Whether the decoupler is enabled in the staging sequence.

Attribute Read-only, cannot be set

Return type boolean

impulse

The impulse that the decoupler imparts when it is fired, in Newton seconds.

Attribute Read-only, cannot be set

Return type number

Docking Port

class DockingPort

A docking port. Obtained by calling *SpaceCenter.Part.docking_port*

part

The part object for this docking port.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Part*

state

The current state of the docking port.

Attribute Read-only, cannot be set

Return type *SpaceCenter.DockingPortState*

docked_part

The part that this docking port is docked to. Returns *nil* if this docking port is not docked to anything.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Part*

undock ()

Undocks the docking port and returns the new *SpaceCenter.Vessel* that is created. This method can be called for either docking port in a docked pair. Throws an exception if the docking port is not docked to anything.

Return type *SpaceCenter.Vessel*

Note: When called, the active vessel may change. It is therefore possible that, after calling this function, the object(s) returned by previous call(s) to *SpaceCenter.active_vessel* no longer refer to the active vessel.

reengage_distance

The distance a docking port must move away when it undocks before it becomes ready to dock with another port, in meters.

Attribute Read-only, cannot be set

Return type number

has_shield

Whether the docking port has a shield.

Attribute Read-only, cannot be set

Return type boolean

shielded

The state of the docking ports shield, if it has one.

Returns `True` if the docking port has a shield, and the shield is closed. Otherwise returns `False`. When set to `True`, the shield is closed, and when set to `False` the shield is opened. If the docking port does not have a shield, setting this attribute has no effect.

Attribute Can be read or written

Return type boolean

position (*reference_frame*)

The position of the docking port, in the given reference frame.

Parameters **reference_frame** (`SpaceCenter.ReferenceFrame`) – The reference frame that the returned position vector is in.

Returns The position as a vector.

Return type Tuple of (number, number, number)

direction (*reference_frame*)

The direction that docking port points in, in the given reference frame.

Parameters **reference_frame** (`SpaceCenter.ReferenceFrame`) – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

Return type Tuple of (number, number, number)

rotation (*reference_frame*)

The rotation of the docking port, in the given reference frame.

Parameters **reference_frame** (`SpaceCenter.ReferenceFrame`) – The reference frame that the returned rotation is in.

Returns The rotation as a quaternion of the form (x, y, z, w) .

Return type Tuple of (number, number, number, number)

reference_frame

The reference frame that is fixed relative to this docking port, and oriented with the port.

- The origin is at the position of the docking port.
- The axes rotate with the docking port.
- The x-axis points out to the right side of the docking port.
- The y-axis points in the direction the docking port is facing.
- The z-axis points out of the bottom off the docking port.

Attribute Read-only, cannot be set

Return type `SpaceCenter.ReferenceFrame`

Note: This reference frame is not necessarily equivalent to the reference frame for the part, returned by `SpaceCenter.Part.reference_frame`.

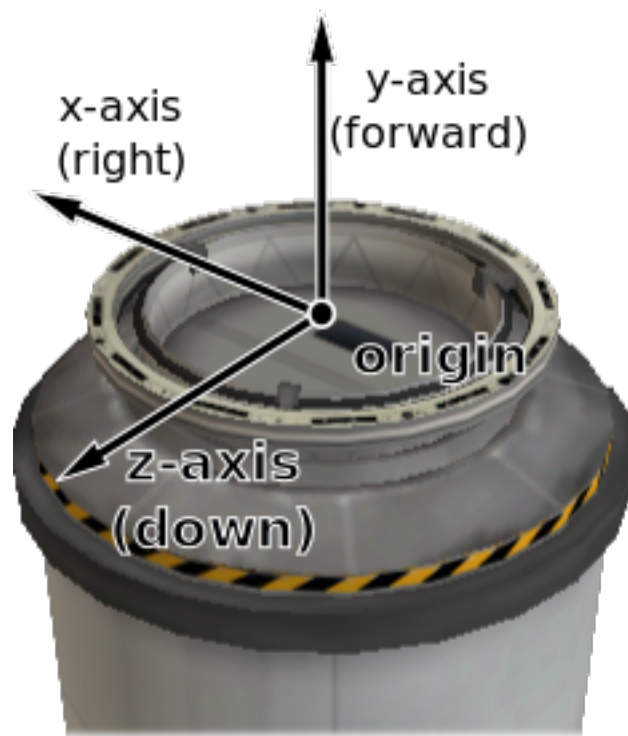


Fig. 7.8: Docking port reference frame origin and axes

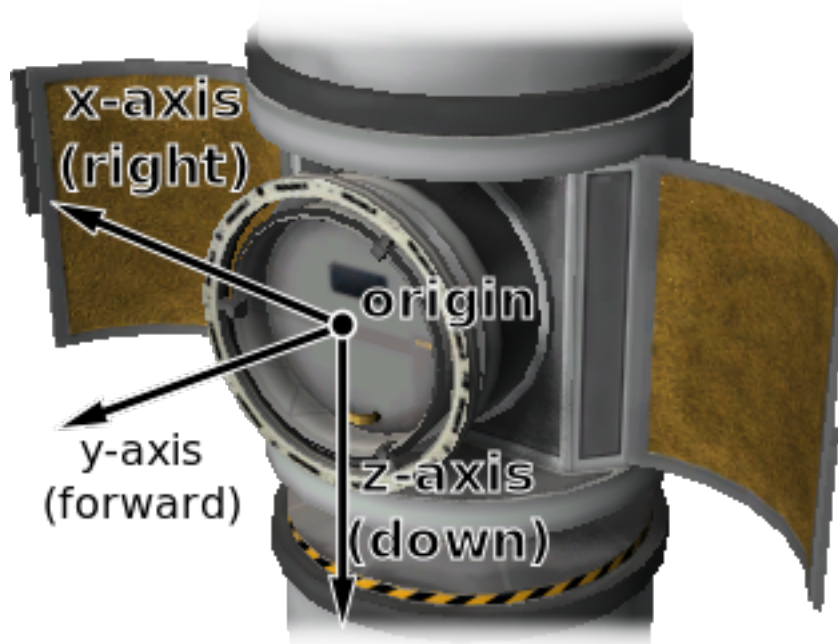


Fig. 7.9: Inline docking port reference frame origin and axes

class DockingPortState

The state of a docking port. See *SpaceCenter.DockingPort.state*.

ready

The docking port is ready to dock to another docking port.

docked

The docking port is docked to another docking port, or docked to another part (from the VAB/SPH).

docking

The docking port is very close to another docking port, but has not docked. It is using magnetic force to acquire a solid dock.

undocking

The docking port has just been undocked from another docking port, and is disabled until it moves away by a sufficient distance (*SpaceCenter.DockingPort.reengage_distance*).

shielded

The docking port has a shield, and the shield is closed.

moving

The docking ports shield is currently opening/closing.

Engine**class Engine**

An engine, including ones of various types. For example liquid fuelled gimballed engines, solid rocket boosters and jet engines. Obtained by calling *SpaceCenter.Part.engine*.

Note: For RCS thrusters *SpaceCenter.Part.rcs*.

part

The part object for this engine.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Part*

active

Whether the engine is active. Setting this attribute may have no effect, depending on *SpaceCenter.Engine.can_shutdown* and *SpaceCenter.Engine.can_restart*.

Attribute Can be read or written

Return type boolean

thrust

The current amount of thrust being produced by the engine, in Newtons.

Attribute Read-only, cannot be set

Return type number

available_thrust

The amount of thrust, in Newtons, that would be produced by the engine when activated and with its throttle set to 100%. Returns zero if the engine does not have any fuel. Takes the engine's current *SpaceCenter.Engine.thrust_limit* and atmospheric conditions into account.

Attribute Read-only, cannot be set

Return type number

max_thrust

The amount of thrust, in Newtons, that would be produced by the engine when activated and fueled, with its throttle and throttle limiter set to 100%.

Attribute Read-only, cannot be set

Return type number

max_vacuum_thrust

The maximum amount of thrust that can be produced by the engine in a vacuum, in Newtons. This is the amount of thrust produced by the engine when activated, *SpaceCenter.Engine.thrust_limit* is set to 100%, the main vessel's throttle is set to 100% and the engine is in a vacuum.

Attribute Read-only, cannot be set

Return type number

thrust_limit

The thrust limiter of the engine. A value between 0 and 1. Setting this attribute may have no effect, for example the thrust limit for a solid rocket booster cannot be changed in flight.

Attribute Can be read or written

Return type number

thrusters

The components of the engine that generate thrust.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.Thruster*

Note: For example, this corresponds to the rocket nozzle on a solid rocket booster, or the individual nozzles on a RAPIER engine. The overall thrust produced by the engine, as reported by *SpaceCenter.Engine.available_thrust*, *SpaceCenter.Engine.max_thrust* and others, is the sum of the thrust generated by each thruster.

specific_impulse

The current specific impulse of the engine, in seconds. Returns zero if the engine is not active.

Attribute Read-only, cannot be set

Return type number

vacuum_specific_impulse

The vacuum specific impulse of the engine, in seconds.

Attribute Read-only, cannot be set

Return type number

kerbin_sea_level_specific_impulse

The specific impulse of the engine at sea level on Kerbin, in seconds.

Attribute Read-only, cannot be set

Return type number

propellant_names

The names of the propellants that the engine consumes.

Attribute Read-only, cannot be set

Return type List of string

propellant_ratios

The ratio of resources that the engine consumes. A dictionary mapping resource names to the ratio at which they are consumed by the engine.

Attribute Read-only, cannot be set

Return type Map from string to number

Note: For example, if the ratios are 0.6 for LiquidFuel and 0.4 for Oxidizer, then for every 0.6 units of LiquidFuel that the engine burns, it will burn 0.4 units of Oxidizer.

propellants

The propellants that the engine consumes.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.Propellant*

has_fuel

Whether the engine has any fuel available.

Attribute Read-only, cannot be set

Return type boolean

Note: The engine must be activated for this property to update correctly.

throttle

The current throttle setting for the engine. A value between 0 and 1. This is not necessarily the same as the vessel's main throttle setting, as some engines take time to adjust their throttle (such as jet engines).

Attribute Read-only, cannot be set

Return type number

throttle_locked

Whether the *SpaceCenter.Control.throttle* affects the engine. For example, this is `True` for liquid fueled rockets, and `False` for solid rocket boosters.

Attribute Read-only, cannot be set

Return type boolean

can_restart

Whether the engine can be restarted once shutdown. If the engine cannot be shutdown, returns `False`. For example, this is `True` for liquid fueled rockets and `False` for solid rocket boosters.

Attribute Read-only, cannot be set

Return type boolean

can_shutdown

Whether the engine can be shutdown once activated. For example, this is `True` for liquid fueled rockets and `False` for solid rocket boosters.

Attribute Read-only, cannot be set

Return type boolean

has_modes

Whether the engine has multiple modes of operation.

Attribute Read-only, cannot be set

Return type boolean

mode

The name of the current engine mode.

Attribute Can be read or written

Return type string

modes

The available modes for the engine. A dictionary mapping mode names to *SpaceCenter.Engine* objects.

Attribute Read-only, cannot be set

Return type Map from string to *SpaceCenter.Engine*

toggle_mode()

Toggle the current engine mode.

auto_mode_switch

Whether the engine will automatically switch modes.

Attribute Can be read or written

Return type boolean

gimballed

Whether the engine is gimballed.

Attribute Read-only, cannot be set

Return type boolean

gimbal_range

The range over which the gimbal can move, in degrees. Returns 0 if the engine is not gimballed.

Attribute Read-only, cannot be set

Return type number

gimbal_locked

Whether the engines gimbal is locked in place. Setting this attribute has no effect if the engine is not gimballed.

Attribute Can be read or written

Return type boolean

gimbal_limit

The gimbal limiter of the engine. A value between 0 and 1. Returns 0 if the gimbal is locked.

Attribute Can be read or written

Return type number

available_torque

The available torque, in Newton meters, that can be produced by this engine, in the positive and negative pitch, roll and yaw axes of the vessel. These axes correspond to the coordinate axes of the *SpaceCenter.Vessel.reference_frame*. Returns zero if the engine is inactive, or not gimballed.

Attribute Read-only, cannot be set

Return type Tuple of (Tuple of (number, number, number), Tuple of (number, number, number))

class Propellant

A propellant for an engine. Obtains by calling *SpaceCenter.Engine.propellants*.

name

The name of the propellant.

Attribute Read-only, cannot be set

Return type string

current_amount

The current amount of propellant.

Attribute Read-only, cannot be set

Return type number

current_requirement

The required amount of propellant.

Attribute Read-only, cannot be set

Return type number

total_resource_available

The total amount of the underlying resource currently reachable given resource flow rules.

Attribute Read-only, cannot be set

Return type number

total_resource_capacity

The total vehicle capacity for the underlying propellant resource, restricted by resource flow rules.

Attribute Read-only, cannot be set

Return type number

ignore_for_isp

If this propellant should be ignored when calculating required mass flow given specific impulse.

Attribute Read-only, cannot be set

Return type boolean

ignore_for_thrust_curve

If this propellant should be ignored for thrust curve calculations.

Attribute Read-only, cannot be set

Return type boolean

draw_stack_gauge

If this propellant has a stack gauge or not.

Attribute Read-only, cannot be set

Return type boolean

is_deprived

If this propellant is deprived.

Attribute Read-only, cannot be set

Return type boolean

ratio

The propellant ratio.

Attribute Read-only, cannot be set

Return type number

Experiment

class Experiment

Obtained by calling *SpaceCenter.Part.experiment*.

part

The part object for this experiment.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Part*

run()

Run the experiment.

transmit()

Transmit all experimental data contained by this part.

dump()

Dump the experimental data contained by the experiment.

reset()

Reset the experiment.

deployed

Whether the experiment has been deployed.

Attribute Read-only, cannot be set

Return type boolean

rerunnable

Whether the experiment can be re-run.

Attribute Read-only, cannot be set

Return type boolean

inoperable

Whether the experiment is inoperable.

Attribute Read-only, cannot be set

Return type boolean

has_data

Whether the experiment contains data.

Attribute Read-only, cannot be set

Return type boolean

data

The data contained in this experiment.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.ScienceData*

biome

The name of the biome the experiment is currently in.

Attribute Read-only, cannot be set

Return type string

available

Determines if the experiment is available given the current conditions.

Attribute Read-only, cannot be set

Return type boolean

science_subject

Containing information on the corresponding specific science result for the current conditions. Returns *nil* if the experiment is unavailable.

Attribute Read-only, cannot be set

Return type *SpaceCenter.ScienceSubject*

class ScienceData

Obtained by calling *SpaceCenter.Experiment.data*.

data_amount

Data amount.

Attribute Read-only, cannot be set

Return type number

science_value

Science value.

Attribute Read-only, cannot be set

Return type number

transmit_value

Transmit value.

Attribute Read-only, cannot be set

Return type number

class ScienceSubject

Obtained by calling *SpaceCenter.Experiment.science_subject*.

title

Title of science subject, displayed in science archives

Attribute Read-only, cannot be set

Return type string

is_complete

Whether the experiment has been completed.

Attribute Read-only, cannot be set

Return type boolean

science

Amount of science already earned from this subject, not updated until after transmission/recovery.

Attribute Read-only, cannot be set

Return type number

science_cap

Total science allowable for this subject.

Attribute Read-only, cannot be set

Return type number

data_scale

Multiply science value by this to determine data amount in mits.

Attribute Read-only, cannot be set

Return type number

subject_value

Multiplier for specific Celestial Body/Experiment Situation combination.

Attribute Read-only, cannot be set

Return type number

scientific_value

Diminishing value multiplier for decreasing the science value returned from repeated experiments.

Attribute Read-only, cannot be set

Return type number

Fairing

class Fairing

A fairing. Obtained by calling *SpaceCenter.Part.fairing*.

part

The part object for this fairing.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Part*

jettison()

Jettison the fairing. Has no effect if it has already been jettisoned.

jettisoned

Whether the fairing has been jettisoned.

Attribute Read-only, cannot be set

Return type boolean

Intake

class Intake

An air intake. Obtained by calling *SpaceCenter.Part.intake*.

part

The part object for this intake.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Part*

open

Whether the intake is open.

Attribute Can be read or written

Return type boolean

speed

Speed of the flow into the intake, in *m/s*.

Attribute Read-only, cannot be set

Return type number

flow

The rate of flow into the intake, in units of resource per second.

Attribute Read-only, cannot be set

Return type number

area

The area of the intake's opening, in square meters.

Attribute Read-only, cannot be set

Return type number

Leg

class Leg

A landing leg. Obtained by calling *SpaceCenter.Part.leg*.

part

The part object for this landing leg.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Part*

state

The current state of the landing leg.

Attribute Read-only, cannot be set

Return type *SpaceCenter.LegState*

deployable

Whether the leg is deployable.

Attribute Read-only, cannot be set

Return type boolean

deployed

Whether the landing leg is deployed.

Attribute Can be read or written

Return type boolean

Note: Fixed landing legs are always deployed. Returns an error if you try to deploy fixed landing gear.

is_grounded

Returns whether the leg is touching the ground.

Attribute Read-only, cannot be set

Return type boolean

class LegState

The state of a landing leg. See *SpaceCenter.Leg.state*.

deployed

Landing leg is fully deployed.

retracted

Landing leg is fully retracted.

deploying

Landing leg is being deployed.

retracting

Landing leg is being retracted.

broken

Landing leg is broken.

Launch Clamp

class LaunchClamp

A launch clamp. Obtained by calling *SpaceCenter.Part.launch_clamp*.

part

The part object for this launch clamp.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Part*

release()

Releases the docking clamp. Has no effect if the clamp has already been released.

Light

class Light

A light. Obtained by calling *SpaceCenter.Part.light*.

part

The part object for this light.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Part*

active

Whether the light is switched on.

Attribute Can be read or written

Return type boolean

color

The color of the light, as an RGB triple.

Attribute Can be read or written

Return type Tuple of (number, number, number)

power_usage

The current power usage, in units of charge per second.

Attribute Read-only, cannot be set

Return type number

Parachute

class Parachute

A parachute. Obtained by calling *SpaceCenter.Part.parachute*.

part

The part object for this parachute.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Part*

deploy()

Deploys the parachute. This has no effect if the parachute has already been deployed.

deployed

Whether the parachute has been deployed.

Attribute Read-only, cannot be set

Return type boolean

arm()

Deploys the parachute. This has no effect if the parachute has already been armed or deployed. Only applicable to RealChutes parachutes.

armed

Whether the parachute has been armed or deployed. Only applicable to RealChutes parachutes.

Attribute Read-only, cannot be set

Return type boolean

state

The current state of the parachute.

Attribute Read-only, cannot be set

Return type *SpaceCenter.ParachuteState*

deploy_altitude

The altitude at which the parachute will full deploy, in meters. Only applicable to stock parachutes.

Attribute Can be read or written

Return type number

deploy_min_pressure

The minimum pressure at which the parachute will semi-deploy, in atmospheres. Only applicable to stock parachutes.

Attribute Can be read or written

Return type number

class ParachuteState

The state of a parachute. See *SpaceCenter.Parachute.state*.

stowed

The parachute is safely tucked away inside its housing.

armed

The parachute is armed for deployment. (RealChutes only)

active

The parachute is still stowed, but ready to semi-deploy. (Stock parachutes only)

semi_deployed

The parachute has been deployed and is providing some drag, but is not fully deployed yet. (Stock parachutes only)

deployed

The parachute is fully deployed.

cut

The parachute has been cut.

Radiator

class Radiator

A radiator. Obtained by calling *SpaceCenter.Part.radiator*.

part

The part object for this radiator.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Part*

deployable

Whether the radiator is deployable.

Attribute Read-only, cannot be set

Return type boolean

deployed

For a deployable radiator, `True` if the radiator is extended. If the radiator is not deployable, this is always `True`.

Attribute Can be read or written

Return type boolean

state

The current state of the radiator.

Attribute Read-only, cannot be set

Return type *SpaceCenter.RadiatorState*

Note: A fixed radiator is always *SpaceCenter.RadiatorState.extended*.

class RadiatorState

The state of a radiator. *SpaceCenter.RadiatorState*

extended

Radiator is fully extended.

retracted

Radiator is fully retracted.

extending

Radiator is being extended.

retracting

Radiator is being retracted.

broken

Radiator is being broken.

Resource Converter

class ResourceConverter

A resource converter. Obtained by calling *SpaceCenter.Part.resource_converter*.

part

The part object for this converter.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Part*

count

The number of converters in the part.

Attribute Read-only, cannot be set

Return type number

name (index)

The name of the specified converter.

Parameters **index** (*number*) – Index of the converter.

Return type string

active (index)

True if the specified converter is active.

Parameters **index** (*number*) – Index of the converter.

Return type boolean

start (index)

Start the specified converter.

Parameters **index** (*number*) – Index of the converter.

stop (index)

Stop the specified converter.

Parameters **index** (*number*) – Index of the converter.

state (*index*)

The state of the specified converter.

Parameters **index** (*number*) – Index of the converter.

Return type *SpaceCenter.ResourceConverterState*

status_info (*index*)

Status information for the specified converter. This is the full status message shown in the in-game UI.

Parameters **index** (*number*) – Index of the converter.

Return type *string*

inputs (*index*)

List of the names of resources consumed by the specified converter.

Parameters **index** (*number*) – Index of the converter.

Return type *List of string*

outputs (*index*)

List of the names of resources produced by the specified converter.

Parameters **index** (*number*) – Index of the converter.

Return type *List of string*

class ResourceConverterState

The state of a resource converter. See *SpaceCenter.ResourceConverter.state()*.

running

Converter is running.

idle

Converter is idle.

missing_resource

Converter is missing a required resource.

storage_full

No available storage for output resource.

capacity

At preset resource capacity.

unknown

Unknown state. Possible with modified resource converters. In this case, check *SpaceCenter.ResourceConverter.status_info()* for more information.

Resource Harvester

class ResourceHarvester

A resource harvester (drill). Obtained by calling *SpaceCenter.Part.resource_harvester*.

part

The part object for this harvester.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Part*

state

The state of the harvester.

Attribute Read-only, cannot be set

Return type *SpaceCenter.ResourceHarvesterState*

deployed

Whether the harvester is deployed.

Attribute Can be read or written

Return type boolean

active

Whether the harvester is actively drilling.

Attribute Can be read or written

Return type boolean

extraction_rate

The rate at which the drill is extracting ore, in units per second.

Attribute Read-only, cannot be set

Return type number

thermal_efficiency

The thermal efficiency of the drill, as a percentage of its maximum.

Attribute Read-only, cannot be set

Return type number

core_temperature

The core temperature of the drill, in Kelvin.

Attribute Read-only, cannot be set

Return type number

optimum_core_temperature

The core temperature at which the drill will operate with peak efficiency, in Kelvin.

Attribute Read-only, cannot be set

Return type number

class ResourceHarvesterState

The state of a resource harvester. See *SpaceCenter.ResourceHarvester.state*.

deploying

The drill is deploying.

deployed

The drill is deployed and ready.

retracting

The drill is retracting.

retracted

The drill is retracted.

active

The drill is running.

Reaction Wheel

class ReactionWheel

A reaction wheel. Obtained by calling *SpaceCenter.Part.reaction_wheel*.

part

The part object for this reaction wheel.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Part*

active

Whether the reaction wheel is active.

Attribute Can be read or written

Return type boolean

broken

Whether the reaction wheel is broken.

Attribute Read-only, cannot be set

Return type boolean

available_torque

The available torque, in Newton meters, that can be produced by this reaction wheel, in the positive and negative pitch, roll and yaw axes of the vessel. These axes correspond to the coordinate axes of the *SpaceCenter.Vessel.reference_frame*. Returns zero if the reaction wheel is inactive or broken.

Attribute Read-only, cannot be set

Return type Tuple of (Tuple of (number, number, number), Tuple of (number, number, number))

max_torque

The maximum torque, in Newton meters, that can be produced by this reaction wheel, when it is active, in the positive and negative pitch, roll and yaw axes of the vessel. These axes correspond to the coordinate axes of the *SpaceCenter.Vessel.reference_frame*.

Attribute Read-only, cannot be set

Return type Tuple of (Tuple of (number, number, number), Tuple of (number, number, number))

RCS

class RCS

An RCS block or thruster. Obtained by calling *SpaceCenter.Part.rcs*.

part

The part object for this RCS.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Part*

active

Whether the RCS thrusters are active. An RCS thruster is inactive if the RCS action group is disabled (*SpaceCenter.Control.rcs*), the RCS thruster itself is not enabled (*SpaceCenter.RCS.enabled*) or it is covered by a fairing (*SpaceCenter.Part.shielded*).

Attribute Read-only, cannot be set

Return type boolean

enabled

Whether the RCS thrusters are enabled.

Attribute Can be read or written

Return type boolean

pitch_enabled

Whether the RCS thruster will fire when pitch control input is given.

Attribute Can be read or written

Return type boolean

yaw_enabled

Whether the RCS thruster will fire when yaw control input is given.

Attribute Can be read or written

Return type boolean

roll_enabled

Whether the RCS thruster will fire when roll control input is given.

Attribute Can be read or written

Return type boolean

forward_enabled

Whether the RCS thruster will fire when pitch control input is given.

Attribute Can be read or written

Return type boolean

up_enabled

Whether the RCS thruster will fire when yaw control input is given.

Attribute Can be read or written

Return type boolean

right_enabled

Whether the RCS thruster will fire when roll control input is given.

Attribute Can be read or written

Return type boolean

available_torque

The available torque, in Newton meters, that can be produced by this RCS, in the positive and negative pitch, roll and yaw axes of the vessel. These axes correspond to the coordinate axes of the *SpaceCenter.Vessel.reference_frame*. Returns zero if RCS is disable.

Attribute Read-only, cannot be set

Return type Tuple of (Tuple of (number, number, number), Tuple of (number, number, number))

max_thrust

The maximum amount of thrust that can be produced by the RCS thrusters when active, in Newtons.

Attribute Read-only, cannot be set

Return type number

max_vacuum_thrust

The maximum amount of thrust that can be produced by the RCS thrusters when active in a vacuum, in Newtons.

Attribute Read-only, cannot be set

Return type number

thrusters

A list of thrusters, one of each nozzle in the RCS part.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.Thruster*

specific_impulse

The current specific impulse of the RCS, in seconds. Returns zero if the RCS is not active.

Attribute Read-only, cannot be set

Return type number

vacuum_specific_impulse

The vacuum specific impulse of the RCS, in seconds.

Attribute Read-only, cannot be set

Return type number

kerbin_sea_level_specific_impulse

The specific impulse of the RCS at sea level on Kerbin, in seconds.

Attribute Read-only, cannot be set

Return type number

propellants

The names of resources that the RCS consumes.

Attribute Read-only, cannot be set

Return type List of string

propellant_ratios

The ratios of resources that the RCS consumes. A dictionary mapping resource names to the ratios at which they are consumed by the RCS.

Attribute Read-only, cannot be set

Return type Map from string to number

has_fuel

Whether the RCS has fuel available.

Attribute Read-only, cannot be set

Return type boolean

Note: The RCS thruster must be activated for this property to update correctly.

Sensor

class Sensor

A sensor, such as a thermometer. Obtained by calling *SpaceCenter.Part.sensor*.

part

The part object for this sensor.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Part*

active

Whether the sensor is active.

Attribute Can be read or written

Return type boolean

value

The current value of the sensor.

Attribute Read-only, cannot be set

Return type string

Solar Panel

class SolarPanel

A solar panel. Obtained by calling *SpaceCenter.Part.solar_panel*.

part

The part object for this solar panel.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Part*

deployable

Whether the solar panel is deployable.

Attribute Read-only, cannot be set

Return type boolean

deployed

Whether the solar panel is extended.

Attribute Can be read or written

Return type boolean

state

The current state of the solar panel.

Attribute Read-only, cannot be set

Return type *SpaceCenter.SolarPanelState*

energy_flow

The current amount of energy being generated by the solar panel, in units of charge per second.

Attribute Read-only, cannot be set

Return type number

sun_exposure

The current amount of sunlight that is incident on the solar panel, as a percentage. A value between 0 and 1.

Attribute Read-only, cannot be set

Return type number

class SolarPanelState

The state of a solar panel. See *SpaceCenter.SolarPanel.state*.

extended

Solar panel is fully extended.

retracted

Solar panel is fully retracted.

extending

Solar panel is being extended.

retracting

Solar panel is being retracted.

broken

Solar panel is broken.

Thruster

class Thruster

The component of an *SpaceCenter.Engine* or *SpaceCenter.RCS* part that generates thrust. Can be obtained by calling *SpaceCenter.Engine.thrusters* or *SpaceCenter.RCS.thrusters*.

Note: Engines can consist of multiple thrusters. For example, the S3 KS-25x4 “Mammoth” has four rocket nozzles, and so consists of four thrusters.

part

The *SpaceCenter.Part* that contains this thruster.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Part*

thrust_position (*reference_frame*)

The position at which the thruster generates thrust, in the given reference frame. For gimbaled engines, this takes into account the current rotation of the gimbal.

Parameters **reference_frame** (*SpaceCenter.ReferenceFrame*) – The reference frame that the returned position vector is in.

Returns The position as a vector.

Return type Tuple of (number, number, number)

thrust_direction (*reference_frame*)

The direction of the force generated by the thruster, in the given reference frame. This is opposite to the direction in which the thruster expels propellant. For gimballed engines, this takes into account the current rotation of the gimbal.

Parameters **reference_frame** (`SpaceCenter.ReferenceFrame`) – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

Return type Tuple of (number, number, number)

thrust_reference_frame

A reference frame that is fixed relative to the thruster and orientated with its thrust direction (`SpaceCenter.Thruster.thrust_direction()`). For gimballed engines, this takes into account the current rotation of the gimbal.

- The origin is at the position of thrust for this thruster (`SpaceCenter.Thruster.thrust_position()`).
- The axes rotate with the thrust direction. This is the direction in which the thruster expels propellant, including any gimbaling.
- The y-axis points along the thrust direction.
- The x-axis and z-axis are perpendicular to the thrust direction.

Attribute Read-only, cannot be set

Return type `SpaceCenter.ReferenceFrame`

gimballed

Whether the thruster is gimballed.

Attribute Read-only, cannot be set

Return type boolean

gimbal_position (*reference_frame*)

Position around which the gimbal pivots.

Parameters **reference_frame** (`SpaceCenter.ReferenceFrame`) – The reference frame that the returned position vector is in.

Returns The position as a vector.

Return type Tuple of (number, number, number)

gimbal_angle

The current gimbal angle in the pitch, roll and yaw axes, in degrees.

Attribute Read-only, cannot be set

Return type Tuple of (number, number, number)

initial_thrust_position (*reference_frame*)

The position at which the thruster generates thrust, when the engine is in its initial position (no gimbaling), in the given reference frame.

Parameters **reference_frame** (`SpaceCenter.ReferenceFrame`) – The reference frame that the returned position vector is in.

Returns The position as a vector.

Return type Tuple of (number, number, number)

Note: This position can move when the gimbal rotates. This is because the thrust position and gimbal position are not necessarily the same.

initial_thrust_direction (*reference_frame*)

The direction of the force generated by the thruster, when the engine is in its initial position (no gimballing), in the given reference frame. This is opposite to the direction in which the thruster expels propellant.

Parameters **reference_frame** (*SpaceCenter.ReferenceFrame*) – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

Return type Tuple of (number, number, number)

Wheel

class Wheel

A wheel. Includes landing gear and rover wheels. Obtained by calling *SpaceCenter.Part.wheel*. Can be used to control the motors, steering and deployment of wheels, among other things.

part

The part object for this wheel.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Part*

state

The current state of the wheel.

Attribute Read-only, cannot be set

Return type *SpaceCenter.WheelState*

radius

Radius of the wheel, in meters.

Attribute Read-only, cannot be set

Return type number

grounded

Whether the wheel is touching the ground.

Attribute Read-only, cannot be set

Return type boolean

has_brakes

Whether the wheel has brakes.

Attribute Read-only, cannot be set

Return type boolean

brakes

The braking force, as a percentage of maximum, when the brakes are applied.

Attribute Can be read or written

Return type number

auto_friction_control

Whether automatic friction control is enabled.

Attribute Can be read or written

Return type boolean

manual_friction_control

Manual friction control value. Only has an effect if automatic friction control is disabled. A value between 0 and 5 inclusive.

Attribute Can be read or written

Return type number

deployable

Whether the wheel is deployable.

Attribute Read-only, cannot be set

Return type boolean

deployed

Whether the wheel is deployed.

Attribute Can be read or written

Return type boolean

powered

Whether the wheel is powered by a motor.

Attribute Read-only, cannot be set

Return type boolean

motor_enabled

Whether the motor is enabled.

Attribute Can be read or written

Return type boolean

motor_inverted

Whether the direction of the motor is inverted.

Attribute Can be read or written

Return type boolean

motor_state

Whether the direction of the motor is inverted.

Attribute Read-only, cannot be set

Return type *SpaceCenter.MotorState*

motor_output

The output of the motor. This is the torque currently being generated, in Newton meters.

Attribute Read-only, cannot be set

Return type number

traction_control_enabled

Whether automatic traction control is enabled. A wheel only has traction control if it is powered.

Attribute Can be read or written

Return type boolean

traction_control

Setting for the traction control. Only takes effect if the wheel has automatic traction control enabled. A value between 0 and 5 inclusive.

Attribute Can be read or written

Return type number

drive_limiter

Manual setting for the motor limiter. Only takes effect if the wheel has automatic traction control disabled. A value between 0 and 100 inclusive.

Attribute Can be read or written

Return type number

steerable

Whether the wheel has steering.

Attribute Read-only, cannot be set

Return type boolean

steering_enabled

Whether the wheel steering is enabled.

Attribute Can be read or written

Return type boolean

steering_inverted

Whether the wheel steering is inverted.

Attribute Can be read or written

Return type boolean

has_suspension

Whether the wheel has suspension.

Attribute Read-only, cannot be set

Return type boolean

suspension_spring_strength

Suspension spring strength, as set in the editor.

Attribute Read-only, cannot be set

Return type number

suspension_damper_strength

Suspension damper strength, as set in the editor.

Attribute Read-only, cannot be set

Return type number

broken

Whether the wheel is broken.

Attribute Read-only, cannot be set

Return type boolean

repairable

Whether the wheel is repairable.

Attribute Read-only, cannot be set

Return type boolean

stress

Current stress on the wheel.

Attribute Read-only, cannot be set

Return type number

stress_tolerance

Stress tolerance of the wheel.

Attribute Read-only, cannot be set

Return type number

stress_percentage

Current stress on the wheel as a percentage of its stress tolerance.

Attribute Read-only, cannot be set

Return type number

deflection

Current deflection of the wheel.

Attribute Read-only, cannot be set

Return type number

slip

Current slip of the wheel.

Attribute Read-only, cannot be set

Return type number

class WheelState

The state of a wheel. See *SpaceCenter.Wheel.state*.

deployed

Wheel is fully deployed.

retracted

Wheel is fully retracted.

deploying

Wheel is being deployed.

retracting

Wheel is being retracted.

broken

Wheel is broken.

class MotorState

The state of the motor on a powered wheel. See *SpaceCenter.Wheel.motor_state*.

idle

The motor is idle.

running

The motor is running.

disabled

The motor is disabled.

inoperable

The motor is inoperable.

not_enough_resources

The motor does not have enough resources to run.

Trees of Parts

Vessels in KSP are comprised of a number of parts, connected to one another in a *tree* structure. An example vessel is shown in Figure 1, and the corresponding tree of parts in Figure 2. The craft file for this example can also be downloaded [here](#).

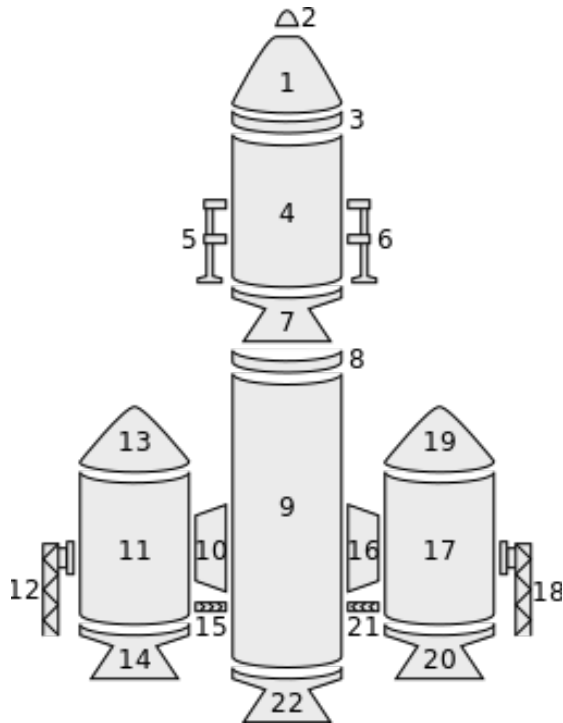


Fig. 7.10: **Figure 1** – Example parts making up a vessel.

Traversing the Tree

The tree of parts can be traversed using the attributes `SpaceCenter.Parts.root`, `SpaceCenter.Part.parent` and `SpaceCenter.Part.children`.

The root of the tree is the same as the vessels *root part* (part number 1 in the example above) and can be obtained by calling `SpaceCenter.Parts.root`. A parts children can be obtained by calling `SpaceCenter.Part.children`. If the part does not have any children, `SpaceCenter.Part.children` returns an empty list. A parts parent can be obtained by calling `SpaceCenter.Part.parent`. If the part does not have a parent (as is the case for the root part), `SpaceCenter.Part.parent` returns `nil`.

The following Lua example uses these attributes to perform a depth-first traversal over all of the parts in a vessel:

```
local krpc = require 'krpc'
local conn = krpc.connect()
local vessel = conn.vessel

local root = vessel.root
local stack = {{root}}
while #stack > 0 do
    local part, depth = unpack(stack[#stack])
    print(string.rep(' ', depth) .. part.name)
    for _, child in ipairs(part.children) do
        table.insert(stack, {child, depth + 1})
    end
end
```

When this code is execute using the craft file for the example vessel pictured above, the following is printed out:

	Command Pod Mk1
TR-18A	Stack Decoupler
FL-T400	Fuel Tank
LV-909	Liquid Fuel
TR-18A	Stack Decoupler
FL-T800	Fuel Tank
LV-909	Liquid Fuel
TT-70	Radial Decoupler
FL-T400	Fuel Tank
TT18-A	Launch Pad
FTX-2	External Tank
LV-909	Liquid Fuel
	Aerodynamic
TT-70	Radial Decoupler
FL-T400	Fuel Tank
TT18-A	Launch Pad
FTX-2	External Tank
LV-909	Liquid Fuel
	Aerodynamic
LT-1	Landing Struts
LT-1	Landing Struts
Mk16	Parachute

Attachment Modes

Parts can be attached to other parts either *radially* (on the side of the parent part) or *axially* (on the end of the parent part, to form a stack).

For example, in the vessel pictured above, the parachute (part 2) is *axially* connected to its parent (the command pod – part 1), and the landing leg (part 5) is *radially* connected to its parent (the fuel tank – part 4).

The root part of a vessel (for example the command pod – part 1) does not have a parent part, so does not have an attachment

mode. However, the part is consider to be *axially* attached to nothing.

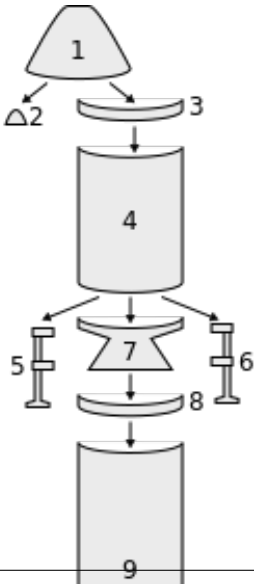
The following Lua example does a depth-first traversal as before, but also prints out the attachment mode used by the part:

```

local krpc = require 'krpc'
local conn = krpc.connect()
local vessel = conn.space_center.active_vessel

local root = vessel.parts.root
local stack = {{root, 0}}
while #stack > 0 do
    local
    ↪part,depth = unpack(table.remove(stack))
    local attach_mode
    if part.axially_attached then
        attach_mode = 'axial'
    else -- radially_attached
        attach_mode = 'radial'
    end
    print(string.rep(' ', depth) ..
    ↪.. part.title .. ' - ' .. attach_mode)
end

```



```

for _, child in ipairs(part.children) do
    table.insert(stack, {child, depth+1})
end
end

```

When this code is executed using the craft file for the example vessel pictured above, the following is printed out:

```

Command Pod Mk1 - axial
TR-18A Stack Decoupler - axial
FL-T400 Fuel Tank - axial
  LV-909 Liquid Fuel Engine - axial
    TR-18A Stack Decoupler - axial
      FL-T800 Fuel Tank - axial
        LV-909 Liquid Fuel Engine - axial
          TT-70 Radial Decoupler - radial
            FL-T400 Fuel Tank - radial
      ↪ TT18-A Launch Stability Enhancer - radial
        FTX-2 External Fuel Duct - radial
          LV-909 Liquid Fuel Engine - axial
            Aerodynamic Nose Cone - axial
              TT-70 Radial Decoupler - radial
                FL-T400 Fuel Tank - radial
          ↪ TT18-A Launch Stability Enhancer - radial
            FTX-2 External Fuel Duct - radial
              LV-909 Liquid Fuel Engine - axial
                Aerodynamic Nose Cone - axial
                  LT-1 Landing Struts - radial
                    LT-1 Landing Struts - radial
Mk16 Parachute - axial

```

Fuel Lines

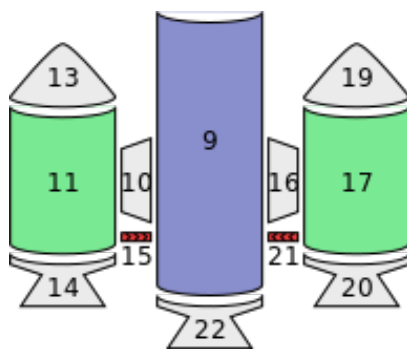
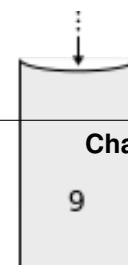


Fig. 7.12: **Figure 5** – Fuel lines from the example in Figure 1. Fuel flows from the parts highlighted in green, into the part highlighted in blue.

Fuel lines are considered parts, and are included in the parts tree (for example, as pictured in Figure 4). However, the parts tree does not contain information about which parts fuel lines connect to. The parent part of a fuel line is the



part from which it will take fuel (as shown in Figure 4) however the part that it will send fuel to is not represented in the parts tree.

Figure 5 shows the fuel lines from the example vessel pictured earlier. Fuel line part 15 (in red) takes fuel from a fuel tank (part 11 – in green) and feeds it into another fuel tank (part 9 – in blue). The fuel line is therefore a child of part 11, but its connection to part 9 is not represented in the tree.

The attributes `SpaceCenter.Part.fuel_lines_from` and `SpaceCenter.Part.fuel_lines_to` can be used to discover these connections. In the example in Figure 5, when `SpaceCenter.Part.fuel_lines_to` is called on fuel tank part 11, it will return a list of parts containing just fuel tank part 9 (the blue part). When `SpaceCenter.Part.fuel_lines_from` is called on fuel tank part 9, it will return a list containing fuel tank parts 11 and 17 (the parts colored green).

Staging

Each part has two staging numbers associated with it: the stage in which the part is *activated* and the stage in which the part is *decoupled*. These values can be obtained using `SpaceCenter.Part.stage` and `SpaceCenter.Part.decouple_stage` respectively. For parts that are not activated by staging, `SpaceCenter.Part.stage` returns -1. For parts that are never decoupled, `SpaceCenter.Part.decouple_stage` returns a value of -1.

Figure 6 shows an example staging sequence for a vessel. Figure 7 shows the stages in which each part of the vessel will be *activated*. Figure 8 shows the stages in which each part of the vessel will be *decoupled*.

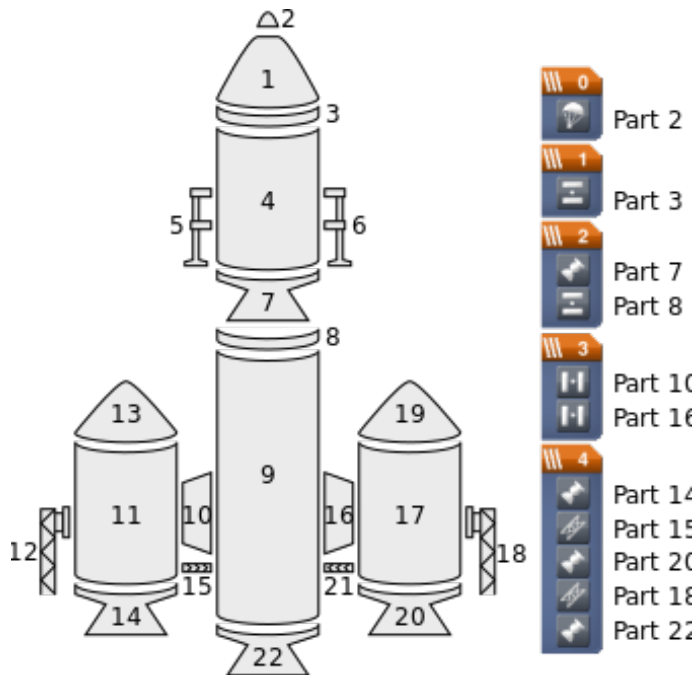


Fig. 7.14: **Figure 6** – Example vessel from Figure 1 with a staging sequence.

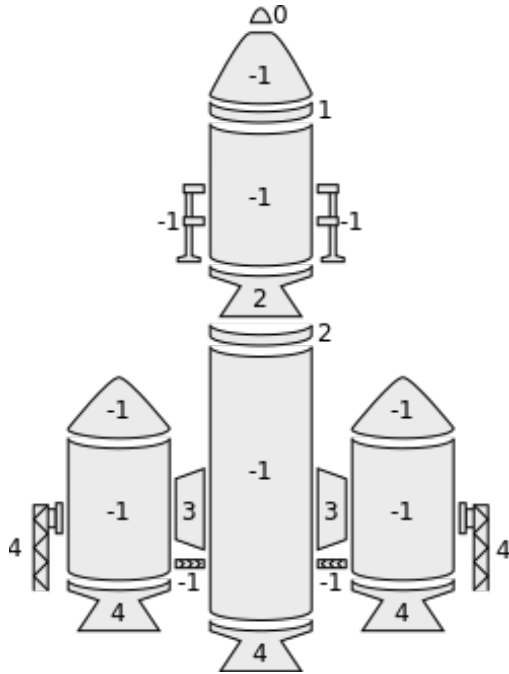


Fig. 7.15: **Figure 7** – The stage in which each part is *activated*.

7.3.9 Resources

class Resources

Represents the collection of resources stored in a vessel, stage or part. Created by calling `SpaceCenter.Vessel.resources`, `SpaceCenter.Vessel.resources_in_decouple_stage()` or `SpaceCenter.Part.resources`.

all

All the individual resources that can be stored.

Attribute Read-only, cannot be set

Return type List of `SpaceCenter.Resource`

with_resource(name)

All the individual resources with the given name that can be stored.

Parameters `name(string)` –

Return type List of `SpaceCenter.Resource`

names

A list of resource names that can be stored.

Attribute Read-only, cannot be set

Return type List of string

has_resource(name)

Check whether the named resource can be stored.

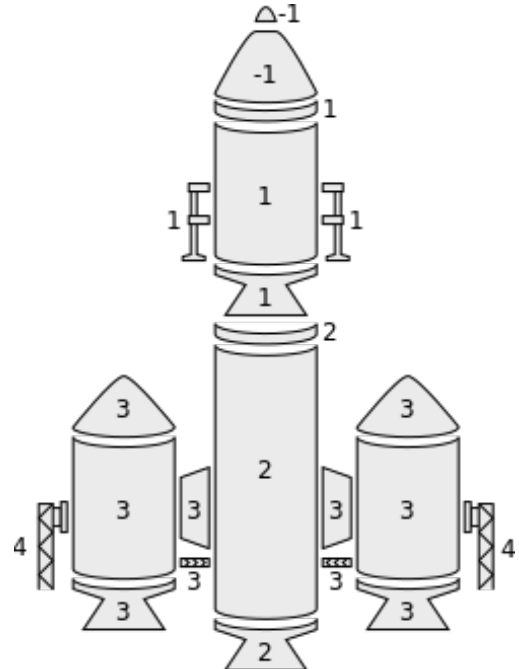


Fig. 7.16: **Figure 8** – The stage in which each part is *decoupled*.

Parameters **name** (*string*) – The name of the resource.

Return type boolean

amount (*name*)

Returns the amount of a resource that is currently stored.

Parameters **name** (*string*) – The name of the resource.

Return type number

max (*name*)

Returns the amount of a resource that can be stored.

Parameters **name** (*string*) – The name of the resource.

Return type number

static density (*name*)

Returns the density of a resource, in *kg/l*.

Parameters **name** (*string*) – The name of the resource.

Return type number

static flow_mode (*name*)

Returns the flow mode of a resource.

Parameters **name** (*string*) – The name of the resource.

Return type *SpaceCenter.ResourceFlowMode*

enabled

Whether use of all the resources are enabled.

Attribute Can be read or written

Return type boolean

Note: This is `True` if all of the resources are enabled. If any of the resources are not enabled, this is `False`.

class Resource

An individual resource stored within a part. Created using methods in the *SpaceCenter.Resources* class.

name

The name of the resource.

Attribute Read-only, cannot be set

Return type string

part

The part containing the resource.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Part*

amount

The amount of the resource that is currently stored in the part.

Attribute Read-only, cannot be set

Return type number

max

The total amount of the resource that can be stored in the part.

Attribute Read-only, cannot be set

Return type number

density

The density of the resource, in *kg/l*.

Attribute Read-only, cannot be set

Return type number

flow_mode

The flow mode of the resource.

Attribute Read-only, cannot be set

Return type *SpaceCenter.ResourceFlowMode*

enabled

Whether use of this resource is enabled.

Attribute Can be read or written

Return type boolean

class ResourceTransfer

Transfer resources between parts.

static start (*from_part, to_part, resource, max_amount*)

Start transferring a resource transfer between a pair of parts. The transfer will move at most *max_amount* units of the resource, depending on how much of the resource is available in the source part and how much storage is available in the destination part. Use *SpaceCenter.ResourceTransfer.complete* to check if the transfer is complete. Use *SpaceCenter.ResourceTransfer.amount* to see how much of the resource has been transferred.

Parameters

- **from_part** (*SpaceCenter.Part*) – The part to transfer to.
- **to_part** (*SpaceCenter.Part*) – The part to transfer from.
- **resource** (*string*) – The name of the resource to transfer.
- **max_amount** (*number*) – The maximum amount of resource to transfer.

Return type *SpaceCenter.ResourceTransfer*

amount

The amount of the resource that has been transferred.

Attribute Read-only, cannot be set

Return type number

complete

Whether the transfer has completed.

Attribute Read-only, cannot be set

Return type boolean

class ResourceFlowMode

The way in which a resource flows between parts. See *SpaceCenter.Resources.flow_mode()*.

vessel

The resource flows to any part in the vessel. For example, electric charge.

stage

The resource flows from parts in the first stage, followed by the second, and so on. For example, mono-propellant.

adjacent

The resource flows between adjacent parts within the vessel. For example, liquid fuel or oxidizer.

none

The resource does not flow. For example, solid fuel.

7.3.10 Node

class Node

Represents a maneuver node. Can be created using *SpaceCenter.Control.add_node()*.

prograde

The magnitude of the maneuver nodes delta-v in the prograde direction, in meters per second.

Attribute Can be read or written

Return type number

normal

The magnitude of the maneuver nodes delta-v in the normal direction, in meters per second.

Attribute Can be read or written

Return type number

radial

The magnitude of the maneuver nodes delta-v in the radial direction, in meters per second.

Attribute Can be read or written

Return type number

delta_v

The delta-v of the maneuver node, in meters per second.

Attribute Can be read or written

Return type number

Note: Does not change when executing the maneuver node. See *SpaceCenter.Node.remaining_delta_v*.

remaining_delta_v

Gets the remaining delta-v of the maneuver node, in meters per second. Changes as the node is executed. This is equivalent to the delta-v reported in-game.

Attribute Read-only, cannot be set

Return type number

burn_vector ([*reference_frame* = *None*])

Returns the burn vector for the maneuver node.

Parameters **reference_frame** (*SpaceCenter.ReferenceFrame*) – The reference frame that the returned vector is in. Defaults to *SpaceCenter.Vessel.orbital_reference_frame*.

Returns A vector whose direction is the direction of the maneuver node burn, and magnitude is the delta-v of the burn in meters per second.

Return type Tuple of (number, number, number)

Note: Does not change when executing the maneuver node. See *SpaceCenter.Node.remaining_burn_vector()*.

remaining_burn_vector ([*reference_frame* = *None*])

Returns the remaining burn vector for the maneuver node.

Parameters **reference_frame** (*SpaceCenter.ReferenceFrame*) – The reference frame that the returned vector is in. Defaults to *SpaceCenter.Vessel.orbital_reference_frame*.

Returns A vector whose direction is the direction of the maneuver node burn, and magnitude is the delta-v of the burn in meters per second.

Return type Tuple of (number, number, number)

Note: Changes as the maneuver node is executed. See *SpaceCenter.Node.burn_vector()*.

ut

The universal time at which the maneuver will occur, in seconds.

Attribute Can be read or written

Return type number

time_to

The time until the maneuver node will be encountered, in seconds.

Attribute Read-only, cannot be set

Return type number

orbit

The orbit that results from executing the maneuver node.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Orbit*

remove ()

Removes the maneuver node.

reference_frame

The reference frame that is fixed relative to the maneuver node's burn.

- The origin is at the position of the maneuver node.
- The y-axis points in the direction of the burn.
- The x-axis and z-axis point in arbitrary but fixed directions.

Attribute Read-only, cannot be set

Return type *SpaceCenter.ReferenceFrame*

orbital_reference_frame

The reference frame that is fixed relative to the maneuver node, and orientated with the orbital prograde/normal/radial directions of the original orbit at the maneuver node's position.

- The origin is at the position of the maneuver node.
- The x-axis points in the orbital anti-radial direction of the original orbit, at the position of the maneuver node.
- The y-axis points in the orbital prograde direction of the original orbit, at the position of the maneuver node.
- The z-axis points in the orbital normal direction of the original orbit, at the position of the maneuver node.

Attribute Read-only, cannot be set

Return type *SpaceCenter.ReferenceFrame*

position (*reference_frame*)

The position vector of the maneuver node in the given reference frame.

Parameters **reference_frame** (*SpaceCenter.ReferenceFrame*) – The reference frame that the returned position vector is in.

Returns The position as a vector.

Return type Tuple of (number, number, number)

direction (*reference_frame*)

The direction of the maneuver nodes burn.

Parameters **reference_frame** (*SpaceCenter.ReferenceFrame*) – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

Return type Tuple of (number, number, number)

7.3.11 ReferenceFrame

class ReferenceFrame

Represents a reference frame for positions, rotations and velocities.

Contains:

- The position of the origin.
- The directions of the x, y and z axes.
- The linear velocity of the frame.
- The angular velocity of the frame.

Note: This class does not contain any properties or methods. It is only used as a parameter to other functions.

```
static create_relative (reference_frame [, position = (0.0, 0.0, 0.0) ] [, rotation = (0.0, 0.0, 0.0, 1.0) ] [, velocity = (0.0, 0.0, 0.0) ] [, angular_velocity = (0.0, 0.0, 0.0) ] )
```

Create a relative reference frame. This is a custom reference frame whose components offset the components of a parent reference frame.

Parameters

- **reference_frame** (*SpaceCenter.ReferenceFrame*) – The parent reference frame on which to base this reference frame.
- **position** (*Tuple*) – The offset of the position of the origin, as a position vector. Defaults to (0, 0, 0)
- **rotation** (*Tuple*) – The rotation to apply to the parent frames rotation, as a quaternion of the form (*x, y, z, w*). Defaults to (0, 0, 0, 1) (i.e. no rotation)
- **velocity** (*Tuple*) – The linear velocity to offset the parent frame by, as a vector pointing in the direction of travel, whose magnitude is the speed in meters per second. Defaults to (0, 0, 0).
- **angular_velocity** (*Tuple*) – The angular velocity to offset the parent frame by, as a vector. This vector points in the direction of the axis of rotation, and its magnitude is the speed of the rotation in radians per second. Defaults to (0, 0, 0).

Return type *SpaceCenter.ReferenceFrame*

```
static create_hybrid (position [, rotation = None ] [, velocity = None ] [, angular_velocity = None ] )
```

Create a hybrid reference frame. This is a custom reference frame whose components inherited from other reference frames.

Parameters

- **position** (*SpaceCenter.ReferenceFrame*) – The reference frame providing the position of the origin.
- **rotation** (*SpaceCenter.ReferenceFrame*) – The reference frame providing the rotation of the frame.
- **velocity** (*SpaceCenter.ReferenceFrame*) – The reference frame providing the linear velocity of the frame.

- **angular_velocity** (`SpaceCenter.ReferenceFrame`) – The reference frame providing the angular velocity of the frame.

Return type `SpaceCenter.ReferenceFrame`

Note: The *position* reference frame is required but all other reference frames are optional. If omitted, they are set to the *position* reference frame.

7.3.12 AutoPilot

class `AutoPilot`

Provides basic auto-piloting utilities for a vessel. Created by calling `SpaceCenter.Vessel.auto_pilot`.

Note: If a client engages the auto-pilot and then closes its connection to the server, the auto-pilot will be disengaged and its target reference frame, direction and roll reset to default.

engage ()

Engage the auto-pilot.

disengage ()

Disengage the auto-pilot.

wait ()

Blocks until the vessel is pointing in the target direction and has the target roll (if set). Throws an exception if the auto-pilot has not been engaged.

error

The error, in degrees, between the direction the ship has been asked to point in and the direction it is pointing in. Throws an exception if the auto-pilot has not been engaged and SAS is not enabled or is in stability assist mode.

Attribute Read-only, cannot be set

Return type number

pitch_error

The error, in degrees, between the vessels current and target pitch. Throws an exception if the auto-pilot has not been engaged.

Attribute Read-only, cannot be set

Return type number

heading_error

The error, in degrees, between the vessels current and target heading. Throws an exception if the auto-pilot has not been engaged.

Attribute Read-only, cannot be set

Return type number

roll_error

The error, in degrees, between the vessels current and target roll.
Throws an exception if the auto-pilot has not been engaged or no target roll is set.

Attribute Read-only, cannot be set

Return type number

reference_frame

The reference frame for the target direction (*SpaceCenter.AutoPilot.target_direction*).

Attribute Can be read or written

Return type *SpaceCenter.ReferenceFrame*

Note: An error will be thrown if this property is set to a reference frame that rotates with the vessel being controlled, as it is impossible to rotate the vessel in such a reference frame.

target_pitch

The target pitch, in degrees, between -90° and +90°.

Attribute Can be read or written

Return type number

target_heading

The target heading, in degrees, between 0° and 360°.

Attribute Can be read or written

Return type number

target_roll

The target roll, in degrees. NaN if no target roll is set.

Attribute Can be read or written

Return type number

target_direction

Direction vector corresponding to the target pitch and heading.
This is in the reference frame specified by *SpaceCenter.ReferenceFrame*.

Attribute Can be read or written

Return type Tuple of (number, number, number)

target_pitch_and_heading (*pitch, heading*)

Set target pitch and heading angles.

Parameters

- **pitch** (*number*) – Target pitch angle, in degrees between -90° and +90°.
- **heading** (*number*) – Target heading angle, in degrees between 0° and 360°.

sas

The state of SAS.

Attribute Can be read or written

Return type boolean

Note: Equivalent to *SpaceCenter.Control.sas*

sas_mode

The current *SpaceCenter.SASMode*. These modes are equivalent to the mode buttons to the left of the navball that appear when SAS is enabled.

Attribute Can be read or written

Return type *SpaceCenter.SASMode*

Note: Equivalent to *SpaceCenter.Control.sas_mode*

roll_threshold

The threshold at which the autopilot will try to match the target roll angle, if any. Defaults to 5 degrees.

Attribute Can be read or written

Return type number

stopping_time

The maximum amount of time that the vessel should need to come to a complete stop. This determines the maximum angular velocity of the vessel. A vector of three stopping times, in seconds, one for each of the pitch, roll and yaw axes. Defaults to 0.5 seconds for each axis.

Attribute Can be read or written

Return type Tuple of (number, number, number)

deceleration_time

The time the vessel should take to come to a stop pointing in the target direction. This determines the angular acceleration used to decelerate the vessel. A vector of three times, in seconds, one for each of the pitch, roll and yaw axes. Defaults to 5 seconds for each axis.

Attribute Can be read or written

Return type Tuple of (number, number, number)

attenuation_angle

The angle at which the autopilot considers the vessel to be pointing close to the target. This determines the midpoint of the target velocity attenuation function. A vector of three angles, in degrees, one for each of the pitch, roll and yaw axes. Defaults to 1° for each axis.

Attribute Can be read or written

Return type Tuple of (number, number, number)

auto_tune

Whether the rotation rate controllers PID parameters should be automatically tuned using the vessels moment of inertia and

available torque. Defaults to `True`. See `SpaceCenter.AutoPilot.time_to_peak` and `SpaceCenter.AutoPilot.overshoot`.

Attribute Can be read or written

Return type `boolean`

time_to_peak

The target time to peak used to autotune the PID controllers. A vector of three times, in seconds, for each of the pitch, roll and yaw axes. Defaults to 3 seconds for each axis.

Attribute Can be read or written

Return type Tuple of (number, number, number)

overshoot

The target overshoot percentage used to autotune the PID controllers. A vector of three values, between 0 and 1, for each of the pitch, roll and yaw axes. Defaults to 0.01 for each axis.

Attribute Can be read or written

Return type Tuple of (number, number, number)

pitch_pid_gains

Gains for the pitch PID controller.

Attribute Can be read or written

Return type Tuple of (number, number, number)

Note: When `SpaceCenter.AutoPilot.auto_tune` is `true`, these values are updated automatically, which will overwrite any manual changes.

roll_pid_gains

Gains for the roll PID controller.

Attribute Can be read or written

Return type Tuple of (number, number, number)

Note: When `SpaceCenter.AutoPilot.auto_tune` is `true`, these values are updated automatically, which will overwrite any manual changes.

yaw_pid_gains

Gains for the yaw PID controller.

Attribute Can be read or written

Return type Tuple of (number, number, number)

Note: When `SpaceCenter.AutoPilot.auto_tune` is `true`, these values are updated automatically, which will overwrite any manual changes.

7.3.13 Camera

class Camera

Controls the game's camera. Obtained by calling *SpaceCenter.camera*.

mode

The current mode of the camera.

Attribute Can be read or written

Return type *SpaceCenter.CameraMode*

pitch

The pitch of the camera, in degrees. A value between *SpaceCenter.Camera.min_pitch* and *SpaceCenter.Camera.max_pitch*

Attribute Can be read or written

Return type number

heading

The heading of the camera, in degrees.

Attribute Can be read or written

Return type number

distance

The distance from the camera to the subject, in meters. A value between *SpaceCenter.Camera.min_distance* and *SpaceCenter.Camera.max_distance*.

Attribute Can be read or written

Return type number

min_pitch

The minimum pitch of the camera.

Attribute Read-only, cannot be set

Return type number

max_pitch

The maximum pitch of the camera.

Attribute Read-only, cannot be set

Return type number

min_distance

Minimum distance from the camera to the subject, in meters.

Attribute Read-only, cannot be set

Return type number

max_distance

Maximum distance from the camera to the subject, in meters.

Attribute Read-only, cannot be set

Return type number

default_distance

Default distance from the camera to the subject, in meters.

Attribute Read-only, cannot be set

Return type number

focussed_body

In map mode, the celestial body that the camera is focussed on.
Returns `nil` if the camera is not focussed on a celestial body.
Returns an error if the camera is not in map mode.

Attribute Can be read or written

Return type *SpaceCenter.CelestialBody*

focussed_vessel

In map mode, the vessel that the camera is focussed on. Returns `nil` if the camera is not focussed on a vessel. Returns an error if the camera is not in map mode.

Attribute Can be read or written

Return type *SpaceCenter.Vessel*

focussed_node

In map mode, the maneuver node that the camera is focussed on. Returns `nil` if the camera is not focussed on a maneuver node. Returns an error if the camera is not in map mode.

Attribute Can be read or written

Return type *SpaceCenter.Node*

class CameraMode

See *SpaceCenter.Camera.mode*.

automatic

The camera is showing the active vessel, in “auto” mode.

free

The camera is showing the active vessel, in “free” mode.

chase

The camera is showing the active vessel, in “chase” mode.

locked

The camera is showing the active vessel, in “locked” mode.

orbital

The camera is showing the active vessel, in “orbital” mode.

iva

The Intra-Vehicular Activity view is being shown.

map

The map view is being shown.

7.3.14 Waypoints

class WaypointManager

Waypoints are the location markers you can see on the map view showing you where contracts are targeted for. With this structure,

you can obtain coordinate data for the locations of these waypoints.
Obtained by calling *SpaceCenter.waypoint_manager*.

waypoints

A list of all existing waypoints.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.Waypoint*

add_waypoint (*latitude, longitude, body, name*)

Creates a waypoint at the given position at ground level, and returns
a *SpaceCenter.Waypoint* object that can be used to modify it.

Parameters

- **latitude** (*number*) – Latitude of the waypoint.
- **longitude** (*number*) – Longitude of the waypoint.
- **body** (*SpaceCenter.CelestialBody*) – Celestial body the waypoint is attached to.
- **name** (*string*) – Name of the waypoint.

Return type *SpaceCenter.Waypoint*

add_waypoint_at_altitude (*latitude, longitude, altitude, body, name*)

Creates a waypoint at the given position and altitude, and returns a
SpaceCenter.Waypoint object that can be used to modify it.

Parameters

- **latitude** (*number*) – Latitude of the waypoint.
- **longitude** (*number*) – Longitude of the waypoint.
- **altitude** (*number*) – Altitude (above sea level) of the waypoint.
- **body** (*SpaceCenter.CelestialBody*) – Celestial body the waypoint is attached to.
- **name** (*string*) – Name of the waypoint.

Return type *SpaceCenter.Waypoint*

colors

An example map of known color - seed pairs. Any other integers
may be used as seed.

Attribute Read-only, cannot be set

Return type Map from string to number

icons

Returns all available icons (from “Game-Data/Squad/Contracts/Icons”).

Attribute Read-only, cannot be set

Return type List of string

class Waypoint

Represents a waypoint. Can be created using *SpaceCenter.WaypointManager.add_waypoint()*.

body

The celestial body the waypoint is attached to.

Attribute Can be read or written

Return type *SpaceCenter.CelestialBody*

name

The name of the waypoint as it appears on the map and the contract.

Attribute Can be read or written

Return type string

color

The seed of the icon color. See *SpaceCenter.WaypointManager.colors* for example colors.

Attribute Can be read or written

Return type number

icon

The icon of the waypoint.

Attribute Can be read or written

Return type string

latitude

The latitude of the waypoint.

Attribute Can be read or written

Return type number

longitude

The longitude of the waypoint.

Attribute Can be read or written

Return type number

mean_altitude

The altitude of the waypoint above sea level, in meters.

Attribute Can be read or written

Return type number

surface_altitude

The altitude of the waypoint above the surface of the body or sea level, whichever is closer, in meters.

Attribute Can be read or written

Return type number

bedrock_altitude

The altitude of the waypoint above the surface of the body, in meters.
When over water, this is the altitude above the sea floor.

Attribute Can be read or written

Return type number

near_surface

True if the waypoint is near to the surface of a body.

Attribute Read-only, cannot be set

Return type boolean

grounded

True if the waypoint is attached to the ground.

Attribute Read-only, cannot be set

Return type boolean

index

The integer index of this waypoint within its cluster of sibling waypoints. In other words, when you have a cluster of waypoints called “Somewhere Alpha”, “Somewhere Beta” and “Somewhere Gamma”, the alpha site has index 0, the beta site has index 1 and the gamma site has index 2. When *SpaceCenter.Waypoint.clustered* is False, this is zero.

Attribute Read-only, cannot be set

Return type number

clustered

True if this waypoint is part of a set of clustered waypoints with greek letter names appended (Alpha, Beta, Gamma, etc). If True, there is a one-to-one correspondence with the greek letter name and the *SpaceCenter.Waypoint.index*.

Attribute Read-only, cannot be set

Return type boolean

has_contract

Whether the waypoint belongs to a contract.

Attribute Read-only, cannot be set

Return type boolean

contract

The associated contract.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Contract*

remove()

Removes the waypoint.

7.3.15 Contracts

class ContractManager

Contracts manager. Obtained by calling *SpaceCenter.waypoint_manager*.

types

A list of all contract types.

Attribute Read-only, cannot be set

Return type Set of string

all_contracts

A list of all contracts.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.Contract*

active_contracts

A list of all active contracts.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.Contract*

offered_contracts

A list of all offered, but unaccepted, contracts.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.Contract*

completed_contracts

A list of all completed contracts.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.Contract*

failed_contracts

A list of all failed contracts.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.Contract*

class Contract

A contract. Can be accessed using *SpaceCenter.contract_manager*.

type

Type of the contract.

Attribute Read-only, cannot be set

Return type string

title

Title of the contract.

Attribute Read-only, cannot be set

Return type string

description

Description of the contract.

Attribute Read-only, cannot be set

Return type string

notes

Notes for the contract.

Attribute Read-only, cannot be set

Return type string

synopsis

Synopsis for the contract.

Attribute Read-only, cannot be set

Return type string

keywords

Keywords for the contract.

Attribute Read-only, cannot be set

Return type List of string

state

State of the contract.

Attribute Read-only, cannot be set

Return type *SpaceCenter.ContractState*

seen

Whether the contract has been seen.

Attribute Read-only, cannot be set

Return type boolean

read

Whether the contract has been read.

Attribute Read-only, cannot be set

Return type boolean

active

Whether the contract is active.

Attribute Read-only, cannot be set

Return type boolean

failed

Whether the contract has been failed.

Attribute Read-only, cannot be set

Return type boolean

can_be_canceled

Whether the contract can be canceled.

Attribute Read-only, cannot be set

Return type boolean

can_be_declined

Whether the contract can be declined.

Attribute Read-only, cannot be set

Return type boolean

can_be_failed

Whether the contract can be failed.

Attribute Read-only, cannot be set

Return type boolean

accept ()

Accept an offered contract.

cancel ()

Cancel an active contract.

decline ()

Decline an offered contract.

funds_advance

Funds received when accepting the contract.

Attribute Read-only, cannot be set

Return type number

funds_completion

Funds received on completion of the contract.

Attribute Read-only, cannot be set

Return type number

funds_failure

Funds lost if the contract is failed.

Attribute Read-only, cannot be set

Return type number

reputation_completion

Reputation gained on completion of the contract.

Attribute Read-only, cannot be set

Return type number

reputation_failure

Reputation lost if the contract is failed.

Attribute Read-only, cannot be set

Return type number

science_completion

Science gained on completion of the contract.

Attribute Read-only, cannot be set

Return type number

parameters

Parameters for the contract.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.ContractParameter*

class ContractState

The state of a contract. See *SpaceCenter.Contract.state*.

active

The contract is active.

canceled

The contract has been canceled.

completed

The contract has been completed.

deadline_expired

The deadline for the contract has expired.

declined

The contract has been declined.

failed

The contract has been failed.

generated

The contract has been generated.

offered

The contract has been offered to the player.

offer_expired

The contract was offered to the player, but the offer expired.

withdrawn

The contract has been withdrawn.

class ContractParameter

A contract parameter. See *SpaceCenter.Contract.parameters*.

title

Title of the parameter.

Attribute Read-only, cannot be set

Return type string

notes

Notes for the parameter.

Attribute Read-only, cannot be set

Return type string

children

Child contract parameters.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.ContractParameter*

completed

Whether the parameter has been completed.

Attribute Read-only, cannot be set

Return type boolean

failed

Whether the parameter has been failed.

Attribute Read-only, cannot be set

Return type boolean

optional

Whether the contract parameter is optional.

Attribute Read-only, cannot be set

Return type boolean

funds_completion

Funds received on completion of the contract parameter.

Attribute Read-only, cannot be set

Return type number

funds_failure

Funds lost if the contract parameter is failed.

Attribute Read-only, cannot be set

Return type number

reputation_completion

Reputation gained on completion of the contract parameter.

Attribute Read-only, cannot be set

Return type number

reputation_failure

Reputation lost if the contract parameter is failed.

Attribute Read-only, cannot be set

Return type number

science_completion

Science gained on completion of the contract parameter.

Attribute Read-only, cannot be set

Return type number

7.3.16 Geometry Types

Vectors

3-dimensional vectors are represented as a 3-tuple. For example:

```
local krpc = require 'krpc'
local conn = krpc.connect()
local v = conn.
    ↪space_center.active_vessel:flight().prograde
print(v[1], v[2], v[3])
```

Quaternions

Quaternions (rotations in 3-dimensional space) are encoded as a 4-tuple containing the x, y, z and w components. For example:

```

local krpc = require 'krpc'
local conn = krpc.connect()
local q = conn.
↪space_center.active_vessel:flight().rotation
print(q[1], q[2], q[3], q[4])

```

7.4 Drawing API

7.4.1 Drawing

Provides functionality for drawing objects in the flight scene.

static add_line (*start*, *end*, *reference_frame* [, *visible* = *True*])
 Draw a line in the scene.

Parameters

- **start** (*Tuple*) – Position of the start of the line.
- **end** (*Tuple*) – Position of the end of the line.
- **reference_frame** (*SpaceCenter.ReferenceFrame*) – Reference frame that the positions are in.
- **visible** (*boolean*) – Whether the line is visible.

Return type *Drawing.Line*

static add_direction (*direction*, *reference_frame* [, *length* = *10.0*] [, *visible* = *True*])
 Draw a direction vector in the scene, from the center of mass of the active vessel.

Parameters

- **direction** (*Tuple*) – Direction to draw the line in.
- **reference_frame** (*SpaceCenter.ReferenceFrame*) – Reference frame that the direction is in.
- **length** (*number*) – The length of the line.
- **visible** (*boolean*) – Whether the line is visible.

Return type *Drawing.Line*

static add_polygon (*vertices*, *reference_frame* [, *visible* = *True*])
 Draw a polygon in the scene, defined by a list of vertices.

Parameters

- **vertices** (*List*) – Vertices of the polygon.
- **reference_frame** (*SpaceCenter.ReferenceFrame*) – Reference frame that the vertices are in.
- **visible** (*boolean*) – Whether the polygon is visible.

Return type *Drawing.Polygon*

static add_text (*text*, *reference_frame*, *position*, *rotation* [, *visible* = *True*])
 Draw text in the scene.

Parameters

- **text** (*string*) – The string to draw.
- **reference_frame** (*SpaceCenter.ReferenceFrame*) – Reference frame that the text position is in.
- **position** (*Tuple*) – Position of the text.
- **rotation** (*Tuple*) – Rotation of the text, as a quaternion.
- **visible** (*boolean*) – Whether the text is visible.

Return type *Drawing.Text*

static clear ([*client_only* = *False*])
Remove all objects being drawn.

Parameters **client_only** (*boolean*) – If true, only remove objects created by the calling client.

7.4.2 Line

class Line

A line. Created using *Drawing.add_line()*.

start

Start position of the line.

Attribute Can be read or written

Return type Tuple of (number, number, number)

end

End position of the line.

Attribute Can be read or written

Return type Tuple of (number, number, number)

reference_frame

Reference frame for the positions of the object.

Attribute Can be read or written

Return type *SpaceCenter.ReferenceFrame*

visible

Whether the object is visible.

Attribute Can be read or written

Return type boolean

color

Set the color

Attribute Can be read or written

Return type Tuple of (number, number, number)

material

Material used to render the object. Creates the material from a shader with the given name.

Attribute Can be read or written

Return type string

thickness

Set the thickness

Attribute Can be read or written

Return type number

remove ()

Remove the object.

7.4.3 Polygon

class Polygon

A polygon. Created using *Drawing.add_polygon()*.

vertices

Vertices for the polygon.

Attribute Can be read or written

Return type List of Tuple of (number, number, number)

reference_frame

Reference frame for the positions of the object.

Attribute Can be read or written

Return type *SpaceCenter.ReferenceFrame*

visible

Whether the object is visible.

Attribute Can be read or written

Return type boolean

remove ()

Remove the object.

color

Set the color

Attribute Can be read or written

Return type Tuple of (number, number, number)

material

Material used to render the object. Creates the material from a shader with the given name.

Attribute Can be read or written

Return type string

thickness

Set the thickness

Attribute Can be read or written

Return type number

7.4.4 Text

class Text

Text. Created using *Drawing.add_text()*.

position

Position of the text.

Attribute Can be read or written

Return type Tuple of (number, number, number)

rotation

Rotation of the text as a quaternion.

Attribute Can be read or written

Return type Tuple of (number, number, number, number)

reference_frame

Reference frame for the positions of the object.

Attribute Can be read or written

Return type *SpaceCenter.ReferenceFrame*

visible

Whether the object is visible.

Attribute Can be read or written

Return type boolean

remove()

Remove the object.

content

The text string

Attribute Can be read or written

Return type string

font

Name of the font

Attribute Can be read or written

Return type string

static available_fonts()

A list of all available fonts.

Return type List of string

size

Font size.

Attribute Can be read or written

Return type number

character_size

Character size.

Attribute Can be read or written

Return type number

style

Font style.

Attribute Can be read or written

Return type *UI.FontStyle*

color

Set the color

Attribute Can be read or written

Return type Tuple of (number, number, number)

material

Material used to render the object. Creates the material from a shader with the given name.

Attribute Can be read or written

Return type string

alignment

Alignment.

Attribute Can be read or written

Return type *UI.TextAlignment*

line_spacing

Line spacing.

Attribute Can be read or written

Return type number

anchor

Anchor.

Attribute Can be read or written

Return type *UI.TextAnchor*

7.5 InfernalRobotics API

Provides RPCs to interact with the [InfernalRobotics](#) mod. Provides the following classes:

7.5.1 InfernalRobotics

This service provides functionality to interact with [InfernalRobotics](#).

available

Whether Infernal Robotics is installed.

Attribute Read-only, cannot be set

Return type boolean

static servo_groups (*vessel*)

A list of all the servo groups in the given *vessel*.

Parameters **vessel** (`SpaceCenter.Vessel`) –

Return type List of `InfernalRobotics.ServoGroup`

static servo_group_with_name (*vessel*, *name*)

Returns the servo group in the given *vessel* with the given *name*, or `nil` if none exists. If multiple servo groups have the same name, only one of them is returned.

Parameters

- **vessel** (`SpaceCenter.Vessel`) – Vessel to check.
- **name** (*string*) – Name of servo group to find.

Return type `InfernalRobotics.ServoGroup`

static servo_with_name (*vessel*, *name*)

Returns the servo in the given *vessel* with the given *name* or `nil` if none exists. If multiple servos have the same name, only one of them is returned.

Parameters

- **vessel** (`SpaceCenter.Vessel`) – Vessel to check.
- **name** (*string*) – Name of the servo to find.

Return type `InfernalRobotics.Servo`

7.5.2 ServoGroup

class ServoGroup

A group of servos, obtained by calling `InfernalRobotics.servo_groups()` or `InfernalRobotics.servo_group_with_name()`. Represents the “Servo Groups” in the InfernalRobotics UI.

name

The name of the group.

Attribute Can be read or written

Return type `string`

forward_key

The key assigned to be the “forward” key for the group.

Attribute Can be read or written

Return type `string`

reverse_key

The key assigned to be the “reverse” key for the group.

Attribute Can be read or written

Return type `string`

speed

The speed multiplier for the group.

Attribute Can be read or written

Return type number

expanded

Whether the group is expanded in the InfernalRobotics UI.

Attribute Can be read or written

Return type boolean

servos

The servos that are in the group.

Attribute Read-only, cannot be set

Return type List of *InfernalRobotics.Servo*

servo_with_name (name)

Returns the servo with the given *name* from this group, or *nil* if none exists.

Parameters *name* (*string*) – Name of servo to find.

Return type *InfernalRobotics.Servo*

parts

The parts containing the servos in the group.

Attribute Read-only, cannot be set

Return type List of *SpaceCenter.Part*

move_right ()

Moves all of the servos in the group to the right.

move_left ()

Moves all of the servos in the group to the left.

move_center ()

Moves all of the servos in the group to the center.

move_next_preset ()

Moves all of the servos in the group to the next preset.

move_prev_preset ()

Moves all of the servos in the group to the previous preset.

stop ()

Stops the servos in the group.

7.5.3 Servo

class Servo

Represents a servo. Obtained using *InfernalRobotics.ServoGroup.servos*, *InfernalRobotics.ServoGroup.servo_with_name ()* or *InfernalRobotics.servo_with_name ()*.

name

The name of the servo.

Attribute Can be read or written

Return type string

part

The part containing the servo.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Part*

highlight

Whether the servo should be highlighted in-game.

Attribute Write-only, cannot be read

Return type boolean

position

The position of the servo.

Attribute Read-only, cannot be set

Return type number

min_config_position

The minimum position of the servo, specified by the part configuration.

Attribute Read-only, cannot be set

Return type number

max_config_position

The maximum position of the servo, specified by the part configuration.

Attribute Read-only, cannot be set

Return type number

min_position

The minimum position of the servo, specified by the in-game tweak menu.

Attribute Can be read or written

Return type number

max_position

The maximum position of the servo, specified by the in-game tweak menu.

Attribute Can be read or written

Return type number

config_speed

The speed multiplier of the servo, specified by the part configuration.

Attribute Read-only, cannot be set

Return type number

speed

The speed multiplier of the servo, specified by the in-game tweak menu.

Attribute Can be read or written

Return type number

current_speed

The current speed at which the servo is moving.

Attribute Can be read or written

Return type number

acceleration

The current speed multiplier set in the UI.

Attribute Can be read or written

Return type number

is_moving

Whether the servo is moving.

Attribute Read-only, cannot be set

Return type boolean

is_free_moving

Whether the servo is freely moving.

Attribute Read-only, cannot be set

Return type boolean

is_locked

Whether the servo is locked.

Attribute Can be read or written

Return type boolean

is_axis_inverted

Whether the servos axis is inverted.

Attribute Can be read or written

Return type boolean

move_right()

Moves the servo to the right.

move_left()

Moves the servo to the left.

move_center()

Moves the servo to the center.

move_next_preset()

Moves the servo to the next preset.

move_prev_preset()

Moves the servo to the previous preset.

move_to(*position*, *speed*)

Moves the servo to *position* and sets the speed multiplier to *speed*.

Parameters

- **position** (*number*) – The position to move the servo to.
- **speed** (*number*) – Speed multiplier for the movement.

stop()
Stops the servo.

7.5.4 Example

The following example gets the control group named “MyGroup”, prints out the names and positions of all of the servos in the group, then moves all of the servos to the right for 1 second.

```
local krpc = require 'krpc'

local _
↪conn = krpc.connect('InfernalRobotics Example')
local vessel = conn.space_center.active_vessel

local group = conn.infernal_robotics.
↪servo_group_with_name(vessel, 'MyGroup')
if group == krpc.types.none then
    print('Group not found')
    os.exit(1)
end

for _, servo in ipairs(group.servos) do
    print(servo.name, servo.position)
end

group:move_right()
krpc.platform.sleep(1)
group:stop()
```

7.6 Kerbal Alarm Clock API

Provides RPCs to interact with the [Kerbal Alarm Clock](#) mod. Provides the following classes:

7.6.1 KerbalAlarmClock

This service provides functionality to interact with [Kerbal Alarm Clock](#).

available

Whether Kerbal Alarm Clock is available.

Attribute Read-only, cannot be set

Return type boolean

alarms

A list of all the alarms.

Attribute Read-only, cannot be set

Return type List of *KerbalAlarmClock.Alarm*

static alarm_with_name (*name*)

Get the alarm with the given *name*, or `nil` if no alarms have that name. If more than one alarm has the name, only returns one of them.

Parameters **name** (*string*) – Name of the alarm to search for.

Return type *KerbalAlarmClock.Alarm*

static alarms_with_type (*type*)

Get a list of alarms of the specified *type*.

Parameters **type** (*KerbalAlarmClock.AlarmType*) – Type of alarm to return.

Return type List of *KerbalAlarmClock.Alarm*

static create_alarm (*type, name, ut*)

Create a new alarm and return it.

Parameters

- **type** (*KerbalAlarmClock.AlarmType*) – Type of the new alarm.
- **name** (*string*) – Name of the new alarm.
- **ut** (*number*) – Time at which the new alarm should trigger.

Return type *KerbalAlarmClock.Alarm*

7.6.2 Alarm

class Alarm

Represents an alarm. Obtained by calling *KerbalAlarmClock.alarms*, *KerbalAlarmClock.alarm_with_name()* or *KerbalAlarmClock.alarms_with_type()*.

action

The action that the alarm triggers.

Attribute Can be read or written

Return type *KerbalAlarmClock.AlarmAction*

margin

The number of seconds before the event that the alarm will fire.

Attribute Can be read or written

Return type *number*

time

The time at which the alarm will fire.

Attribute Can be read or written

Return type *number*

type

The type of the alarm.

Attribute Read-only, cannot be set

Return type *KerbalAlarmClock.AlarmType*

id

The unique identifier for the alarm.

Attribute Read-only, cannot be set

Return type string

name

The short name of the alarm.

Attribute Can be read or written

Return type string

notes

The long description of the alarm.

Attribute Can be read or written

Return type string

remaining

The number of seconds until the alarm will fire.

Attribute Read-only, cannot be set

Return type number

repeat

Whether the alarm will be repeated after it has fired.

Attribute Can be read or written

Return type boolean

repeat_period

The time delay to automatically create an alarm after it has fired.

Attribute Can be read or written

Return type number

vessel

The vessel that the alarm is attached to.

Attribute Can be read or written

Return type *SpaceCenter.Vessel*

xfer_origin_body

The celestial body the vessel is departing from.

Attribute Can be read or written

Return type *SpaceCenter.CelestialBody*

xfer_target_body

The celestial body the vessel is arriving at.

Attribute Can be read or written

Return type *SpaceCenter.CelestialBody*

remove ()

Removes the alarm.

7.6.3 AlarmType

class AlarmType

The type of an alarm.

raw

An alarm for a specific date/time or a specific period in the future.

maneuver

An alarm based on the next maneuver node on the current ships flight path. This node will be stored and can be restored when you come back to the ship.

maneuver_auto

See *KerbalAlarmClock.AlarmType.maneuver*.

apoapsis

An alarm for furthest part of the orbit from the planet.

periapsis

An alarm for nearest part of the orbit from the planet.

ascending_node

Ascending node for the targeted object, or equatorial ascending node.

descending_node

Descending node for the targeted object, or equatorial descending node.

closest

An alarm based on the closest approach of this vessel to the targeted vessel, some number of orbits into the future.

contract

An alarm based on the expiry or deadline of contracts in career modes.

contract_auto

See *KerbalAlarmClock.AlarmType.contract*.

crew

An alarm that is attached to a crew member.

distance

An alarm that is triggered when a selected target comes within a chosen distance.

earth_time

An alarm based on the time in the “Earth” alternative Universe (aka the Real World).

launch_rendevous

An alarm that fires as your landed craft passes under the orbit of your target.

soi_change

An alarm manually based on when the next SOI point is on the flight path or set to continually monitor the active flight path and add alarms as it detects SOI changes.

soi_change_auto

See `KerbAlarmClock.AlarmType.soi_change`.

transfer

An alarm based on Interplanetary Transfer Phase Angles, i.e. when should I launch to planet X? Based on Kosmo Not's post and used in Olex's Calculator.

transfer_modelled

See `KerbAlarmClock.AlarmType.transfer`.

7.6.4 AlarmAction

class AlarmAction

The action performed by an alarm when it fires.

do_nothing

Don't do anything at all...

do_nothing_delete_when_passed

Don't do anything, and delete the alarm.

kill_warp

Drop out of time warp.

kill_warp_only

Drop out of time warp.

message_only

Display a message.

pause_game

Pause the game.

7.6.5 Example

The following example creates a new alarm for the active vessel. The alarm is set to trigger after 10 seconds have passed, and display a message.

```
local krpc = require 'krpc'

local conn_
↪= krpc.connect('Kerb Alarm Clock Example')

local_
↪alarm = conn.kerb_alarm_clock.create_alarm(
    conn.kerb_alarm_clock.AlarmType.raw,
    'My New Alarm',
    conn.space_center.ut+10)

alarm.notes = '10 seconds_
↪have now passed since the alarm was created.'
alarm.action =_
↪conn.kerb_alarm_clock.AlarmAction.message_only
```

7.7 RemoteTech API

Provides RPCs to interact with the [RemoteTech](#) mod. Provides the following classes:

7.7.1 RemoteTech

This service provides functionality to interact with [RemoteTech](#).

available

Whether RemoteTech is installed.

Attribute Read-only, cannot be set

Return type boolean

ground_stations

The names of the ground stations.

Attribute Read-only, cannot be set

Return type List of string

static antenna (*part*)

Get the antenna object for a particular part.

Parameters **part** (`SpaceCenter.Part`) –

Return type *RemoteTech.Antenna*

static comms (*vessel*)

Get a communications object, representing the communication capability of a particular vessel.

Parameters **vessel** (`SpaceCenter.Vessel`) –

Return type *RemoteTech.Comms*

7.7.2 Comms

class Comms

Communications for a vessel.

vessel

Get the vessel.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Vessel*

has_local_control

Whether the vessel can be controlled locally.

Attribute Read-only, cannot be set

Return type boolean

has_flight_computer

Whether the vessel has a flight computer on board.

Attribute Read-only, cannot be set

Return type boolean

has_connection

Whether the vessel has any connection.

Attribute Read-only, cannot be set

Return type boolean

has_connection_to_ground_station

Whether the vessel has a connection to a ground station.

Attribute Read-only, cannot be set

Return type boolean

signal_delay

The shortest signal delay to the vessel, in seconds.

Attribute Read-only, cannot be set

Return type number

signal_delay_to_ground_station

The signal delay between the vessel and the closest ground station, in seconds.

Attribute Read-only, cannot be set

Return type number

signal_delay_to_vessel (*other*)

The signal delay between the this vessel and another vessel, in seconds.

Parameters **other** (*SpaceCenter.Vessel*) –

Return type number

antennas

The antennas for this vessel.

Attribute Read-only, cannot be set

Return type List of *RemoteTech.Antenna*

7.7.3 Antenna

class Antenna

A RemoteTech antenna. Obtained by calling *RemoteTech.Comms.antennas* or *RemoteTech.antenna()*.

part

Get the part containing this antenna.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Part*

has_connection

Whether the antenna has a connection.

Attribute Read-only, cannot be set

Return type boolean

target

The object that the antenna is targetting. This property can be used to set the target to *RemoteTech.Target.none* or *RemoteTech.Target.active_vessel*. To set the target to a celestial body, ground station or vessel see *RemoteTech.Antenna.target_body*, *RemoteTech.Antenna.target_ground_station* and *RemoteTech.Antenna.target_vessel*.

Attribute Can be read or written

Return type *RemoteTech.Target*

target_body

The celestial body the antenna is targetting.

Attribute Can be read or written

Return type *SpaceCenter.CelestialBody*

target_ground_station

The ground station the antenna is targetting.

Attribute Can be read or written

Return type string

target_vessel

The vessel the antenna is targetting.

Attribute Can be read or written

Return type *SpaceCenter.Vessel*

class Target

The type of object an antenna is targetting. See *RemoteTech.Antenna.target*.

active_vessel

The active vessel.

celestial_body

A celestial body.

ground_station

A ground station.

vessel

A specific vessel.

none

No target.

7.7.4 Example

The following example sets the target of a dish on the active vessel then prints out the signal delay to the active vessel.

```
local krpc = require 'krpc'
local math = require 'math'
local conn = krpc.connect('RemoteTech Example')
local vessel = conn.space_center.active_vessel
```

```
-- Set a dish target
local part_
↪= vessel.parts:with_title('Reflectron KR-7')[1]
local antenna = conn.remote_tech:antenna(part)
antenna.
↪target_body = conn.space_center.bodies['Jool']

-- Get info about the vessels communications
local comms = conn.remote_tech:comms(vessel)
print('Signal delay = ' .. comms.signal_delay)
```

7.8 User Interface API

7.8.1 UI

Provides functionality for drawing and interacting with in-game user interface elements.

stock_canvas

The stock UI canvas.

Attribute Read-only, cannot be set

Return type *UI.Canvas*

static add_canvas()

Add a new canvas.

Return type *UI.Canvas*

Note: If you want to add UI elements to KSPs stock UI canvas, use *UI.stock_canvas*.

static message(*content*[, *duration* = 1.0][, *position* = 1])

Display a message on the screen.

Parameters

- **content** (*string*) – Message content.
- **duration** (*number*) – Duration before the message disappears, in seconds.
- **position** (*UI.MessagePosition*) – Position to display the message.

Note: The message appears just like a stock message, for example quicksave or quickload messages.

static clear([*client_only* = False])

Remove all user interface elements.

Parameters **client_only** (*boolean*) – If true, only remove objects created by the calling client.

class MessagePosition

Message position.

top_left

Top left.

top_center

Top center.

top_right

Top right.

bottom_center

Bottom center.

7.8.2 Canvas

class Canvas

A canvas for user interface elements. See *UI.stock_canvas* and *UI.add_canvas()*.

rect_transform

The rect transform for the canvas.

Attribute Read-only, cannot be set

Return type *UI.RectTransform*

visible

Whether the UI object is visible.

Attribute Can be read or written

Return type boolean

add_panel (*[visible = True]*)

Create a new container for user interface elements.

Parameters **visible** (*boolean*) – Whether the panel is visible.

Return type *UI.Panel*

add_text (*content* [, *visible = True*])

Add text to the canvas.

Parameters

- **content** (*string*) – The text.
- **visible** (*boolean*) – Whether the text is visible.

Return type *UI.Text*

add_input_field (*[visible = True]*)

Add an input field to the canvas.

Parameters **visible** (*boolean*) – Whether the input field is visible.

Return type *UI.InputField*

add_button (*content* [, *visible = True*])

Add a button to the canvas.

Parameters

- **content** (*string*) – The label for the button.
- **visible** (*boolean*) – Whether the button is visible.

Return type *UI.Button*

remove ()

Remove the UI object.

7.8.3 Panel

class Panel

A container for user interface elements. See *UI.Canvas*.

add_panel ().

rect_transform

The rect transform for the panel.

Attribute Read-only, cannot be set

Return type *UI.RectTransform*

visible

Whether the UI object is visible.

Attribute Can be read or written

Return type *boolean*

add_panel ([*visible = True*])

Create a panel within this panel.

Parameters **visible** (*boolean*) – Whether the new panel is visible.

Return type *UI.Panel*

add_text (*content* [, *visible = True*])

Add text to the panel.

Parameters

- **content** (*string*) – The text.
- **visible** (*boolean*) – Whether the text is visible.

Return type *UI.Text*

add_input_field ([*visible = True*])

Add an input field to the panel.

Parameters **visible** (*boolean*) – Whether the input field is visible.

Return type *UI.InputField*

add_button (*content* [, *visible = True*])

Add a button to the panel.

Parameters

- **content** (*string*) – The label for the button.
- **visible** (*boolean*) – Whether the button is visible.

Return type *UI.Button*

remove ()

Remove the UI object.

7.8.4 Text

class Text

A text label. See *UI.Panel.add_text ()*.

rect_transform

The rect transform for the text.

Attribute Read-only, cannot be set

Return type *UI.RectTransform*

visible

Whether the UI object is visible.

Attribute Can be read or written

Return type boolean

content

The text string

Attribute Can be read or written

Return type string

font

Name of the font

Attribute Can be read or written

Return type string

available_fonts

A list of all available fonts.

Attribute Read-only, cannot be set

Return type List of string

size

Font size.

Attribute Can be read or written

Return type number

style

Font style.

Attribute Can be read or written

Return type *UI.FontStyle*

color

Set the color

Attribute Can be read or written

Return type Tuple of (number, number, number)

alignment

Alignment.

Attribute Can be read or written

Return type *UI.TextAnchor*

line_spacing
Line spacing.

Attribute Can be read or written

Return type number

remove ()
Remove the UI object.

class FontStyle
Font style.

normal
Normal.

bold
Bold.

italic
Italic.

bold_and_italic
Bold and italic.

class TextAlignment
Text alignment.

left
Left aligned.

right
Right aligned.

center
Center aligned.

class TextAnchor
Text alignment.

lower_center
Lower center.

lower_left
Lower left.

lower_right
Lower right.

middle_center
Middle center.

middle_left
Middle left.

middle_right
Middle right.

upper_center
Upper center.

upper_left
Upper left.

upper_right
Upper right.

7.8.5 Button

class Button
A text label. See *UI.Panel.add_button()*.

rect_transform
The rect transform for the text.

Attribute Read-only, cannot be set

Return type *UI.RectTransform*

visible
Whether the UI object is visible.

Attribute Can be read or written

Return type boolean

text
The text for the button.

Attribute Read-only, cannot be set

Return type *UI.Text*

clicked
Whether the button has been clicked.

Attribute Can be read or written

Return type boolean

Note: This property is set to true when the user clicks the button.
A client script should reset the property to false in order to detect subsequent button presses.

remove()
Remove the UI object.

7.8.6 InputField

class InputField
An input field. See *UI.Panel.add_input_field()*.

rect_transform
The rect transform for the input field.

Attribute Read-only, cannot be set

Return type *UI.RectTransform*

visible
Whether the UI object is visible.

Attribute Can be read or written

Return type boolean

value

The value of the input field.

Attribute Can be read or written

Return type string

text

The text component of the input field.

Attribute Read-only, cannot be set

Return type *UI.Text*

Note: Use *UI.InputField.value* to get and set the value in the field. This object can be used to alter the style of the input field's text.

changed

Whether the input field has been changed.

Attribute Can be read or written

Return type boolean

Note: This property is set to true when the user modifies the value of the input field. A client script should reset the property to false in order to detect subsequent changes.

remove ()

Remove the UI object.

7.8.7 Rect Transform

class RectTransform

A Unity engine Rect Transform for a UI object. See the [Unity manual](#) for more details.

position

Position of the rectangles pivot point relative to the anchors.

Attribute Can be read or written

Return type Tuple of (number, number)

local_position

Position of the rectangles pivot point relative to the anchors.

Attribute Can be read or written

Return type Tuple of (number, number, number)

size

Width and height of the rectangle.

Attribute Can be read or written

Return type Tuple of (number, number)

upper_right

Position of the rectangles upper right corner relative to the anchors.

Attribute Can be read or written

Return type Tuple of (number, number)

lower_left

Position of the rectangles lower left corner relative to the anchors.

Attribute Can be read or written

Return type Tuple of (number, number)

anchor

Set the minimum and maximum anchor points as a fraction of the size of the parent rectangle.

Attribute Write-only, cannot be read

Return type Tuple of (number, number)

anchor_max

The anchor point for the lower left corner of the rectangle defined as a fraction of the size of the parent rectangle.

Attribute Can be read or written

Return type Tuple of (number, number)

anchor_min

The anchor point for the upper right corner of the rectangle defined as a fraction of the size of the parent rectangle.

Attribute Can be read or written

Return type Tuple of (number, number)

pivot

Location of the pivot point around which the rectangle rotates, defined as a fraction of the size of the rectangle itself.

Attribute Can be read or written

Return type Tuple of (number, number)

rotation

Rotation, as a quaternion, of the object around its pivot point.

Attribute Can be read or written

Return type Tuple of (number, number, number, number)

scale

Scale factor applied to the object in the x, y and z dimensions.

Attribute Can be read or written

Return type Tuple of (number, number, number)

8.1 Python Client

This client provides a Python API for interacting with a kRPC server. It supports Python 2.7+ and 3.x

8.1.1 Installing the Library

The library can be found on [PyPI](#) or [downloaded from GitHub](#).

To install using pip on Linux:

```
pip install krpc
```

Or on Windows:

```
C:\Python27\Scripts\pip.exe install krpc
```

8.1.2 Connecting to the Server

The `krpc.connect()` function is used to open a connection to a server. It returns a connection object (of type `krpc.client.Client`) through which you can interact with the server. The following example connects to a server running on the local machine, queries its version and prints it out:

```
import krpc
conn = krpc.connect()
print(conn.krpc.get_status().version)
```

This function also accepts arguments that specify what address and port numbers to connect to, and an optional descriptive name for the connection which is displayed in the kRPC window in the game. For example:

```
import krpc
conn = krpc.connect(
    name='My Example Program',
    address='192.168.1.10',
    rpc_port=1000, stream_port=1001)
print(conn.krpc.get_status().version)
```

8.1.3 Calling Remote Procedures

The kRPC server provides *procedures* that a client can run. These procedures are arranged in groups called *services* to keep things organized. When connecting, the Python client interrogates the server to discover what procedures it provides, and dynamically creates class types, methods, properties etc. to call them.

The following example demonstrates how to invoke remote procedures using the Python client. It calls `SpaceCenter.active_vessel` to get an object representing the active vessel (of type `SpaceCenter.Vessel`). It sets the name of the vessel and then prints out its altitude:

```
import krpc
conn = krpc.connect()
vessel = conn.space_center.active_vessel

vessel.name = "My Vessel"

flight_info = vessel.flight()
print(flight_info.mean_altitude)
```

All of the functionality provided by the `SpaceCenter` service is accessible via `conn.space_center`. To explore the functionality provided by a service, you can use the `help()` function from an interactive terminal. For example, running `help(conn.space_center)` will list all of the classes, enumerations, procedures and properties provided by the `SpaceCenter` service. This works similarly for class types, for example: `help(conn.space_center.Vessel)`.

8.1.4 Streaming Data from the Server

A common use case for kRPC is to continuously extract data from the game. The naive approach to do this would be to repeatedly call a remote procedure, such as in the following which repeatedly prints the position of the active vessel:

```
import krpc
conn = krpc.connect()
vessel = conn.space_center.active_vessel
refframe = vessel.orbit.body.reference_frame
while True:
    print(vessel.position(refframe))
```

This approach requires significant communication overhead as request/response messages are repeatedly sent between the client and server. kRPC provides a more efficient mechanism to achieve this, called *streams*.

A stream repeatedly executes a procedure on the server (with a fixed set of argument values) and sends the result to the client. It only requires a single message to be sent to the server to establish the stream, which will then continuously send data to the client until the stream is closed.

The following example does the same thing as above using streams:

```
import krpc
conn = krpc.connect()
vessel = conn.space_center.active_vessel
refframe = vessel.orbit.body.reference_frame
position = conn.add_stream(vessel.position, refframe)
while True:
    print(position())
```

It calls `krpc.client.Client.add_stream()` once at the start of the program to create the stream, and then repeatedly prints the position returned by the stream. The stream is automatically closed when the client disconnects.

Streams can also be created using the `with` statement, which ensures that the stream is closed after leaving the block:

```
import krpc
conn = krpc.connect()
vessel = conn.space_center.active_vessel
refframe = vessel.orbit.body.reference_frame
with conn.stream(vessel.position, refframe) as position:
    while True:
        print(position())
```

A stream can be created for any procedure that returns a value. This includes both method calls and attribute accesses. The examples above demonstrated how to stream method calls. Attributes can be streamed as follows:

```
import krpc
conn = krpc.connect()
vessel = conn.space_center.active_vessel
flight_info = vessel.flight()
altitude = conn.add_stream(getattr, flight_info, 'mean_altitude')
while True:
    print(altitude())
```

A stream can be created for any function call (except property setters). The most recent value of a stream can be obtained by calling `krpc.stream.Stream.__call__()`. A stream can be stopped and removed from the server by calling `krpc.stream.Stream.remove()` on the stream object. All of a clients streams are automatically stopped when it disconnects.

8.1.5 Synchronizing with Stream Updates

A common use case for kRPC is to wait until the value returned by a method or attribute changes, and then take some action. kRPC provides two mechanisms to do this efficiently: *condition variables* and *callbacks*.

Condition Variables

Each stream has a condition variable associated with it, that is notified whenever the value of the stream changes. The condition variables are instances of `threading.Condition` from the Python standard library. These can be used to block the current thread of execution until the value of the stream changes.

The following example waits until the abort button is pressed in game, by waiting for the value of `vessel.control.abort` to change to true:

```
import krpc
conn = krpc.connect()
vessel = conn.space_center.active_vessel
with conn.stream(getattr, vessel.control, 'abort') as abort:
    with abort.condition:
        while not abort():
            abort.wait()
```

This code creates a stream, acquires a lock on the streams condition variable (using a `with` statement) and then repeatedly checks the value of `abort`. It leaves the loop when it changes to true.

The body of the loop calls `wait` on the stream, which causes the program to block until the value changes. This prevents the loop from ‘spinning’ and so it does not consume processing resources whilst waiting.

Note: The stream does not start receiving updates until the first call to `wait`. This means that the example code will

not miss any updates to the streams value, as it will have already locked the condition variable before the first stream update is received.

The example code above uses a `with` statement to acquire the lock on the condition variable. This can also be done explicitly using `acquire` and `release`:

```
import krpc
conn = krpc.connect()
vessel = conn.space_center.active_vessel
with conn.stream(getattr, vessel.control, 'abort') as abort:
    abort.condition.acquire()
    while not abort():
        abort.wait()
    abort.condition.release()
```

Callbacks

Streams allow you to register callback functions that are called whenever the value of the stream changes. Callback functions should take a single argument, which is the new value of the stream, and should return nothing.

For example the following program registers two callbacks that are invoked when the value of `vessel.control.abort` changes:

```
import krpc
conn = krpc.connect()
vessel = conn.space_center.active_vessel
abort = conn.add_stream(getattr, vessel.control, 'abort')

def check_abort1(x):
    print 'Abort 1 called with a value of', x

def check_abort2(x):
    print 'Abort 2 called with a value of', x

abort.add_callback(check_abort1)
abort.add_callback(check_abort2)
abort.start()

# Keep the program running...
while True:
    pass
```

Note: When a stream is created it does not start receiving updates until `start` is called. This is implicitly called when accessing the value of a stream, but as this example does not do this an explicit call to `start` is required.

Note: The callbacks are registered before the call to `start` so that stream updates are not missed.

Note: The callback function may be called from a different thread to that which created the stream. Any changes to shared state must therefore be protected with appropriate synchronization.

8.1.6 Custom Events

Some procedures return event objects of type `krpc.event.Event`. These allow you to wait until an event occurs, by calling `krpc.event.Event.wait`. Under the hood, these are implemented using streams and condition variables.

Custom events can also be created. An expression API allows you to create code that runs on the server and these can be used to build a custom event. For example, the following creates the expression `mean_altitude > 1000` and then creates an event that will be triggered when the expression returns true:

```
import krpc
conn = krpc.connect()
vessel = conn.space_center.active_vessel
flight = vessel.flight()

# Convert a remote procedure call to a message,
# so it can be passed to the server
mean_altitude = conn.get_call(getattr, flight, 'mean_altitude')

# Create an expression on the server
expr = conn.krpc.Expression.greater_than(
    conn.krpc.Expression.call(mean_altitude),
    conn.krpc.Expression.constant_double(1000))

# Create an event from the expression
event = conn.krpc.add_event(expr)

# Wait on the event
with event.condition:
    event.wait()
    print 'Altitude reached 1000m'
```

8.1.7 Client API Reference

`krpc.connect([name=None][, address='127.0.0.1'][, rpc_port=50000][, stream_port=50001])`

This function creates a connection to a kRPC server. It returns a `krpc.client.Client` object, through which the server can be communicated with.

Parameters

- **name** (*str*) – A descriptive name for the connection. This is passed to the server and appears in the in-game server window.
- **address** (*str*) – The address of the server to connect to. Can either be a hostname or an IP address in dotted decimal notation. Defaults to '127.0.0.1'.
- **rpc_port** (*int*) – The port number of the RPC Server. Defaults to 50000. This should match the RPC port number of the server you want to connect to.
- **stream_port** (*int*) – The port number of the Stream Server. Defaults to 50001. This should match the stream port number of the server you want to connect to.

class `krpc.client.Client`

This class provides the interface for communicating with the server. It is dynamically populated with all the functionality provided by the server. Instances of this class should be obtained by calling `krpc.connect()`.

add_stream (*func, *args, **kwargs*)

Create a stream for the function *func* called with arguments *args* and *kwargs*. Returns a *krpc.stream.Stream* object.

stream (*func*, **args*, ***kwargs*)

Allows use of the `with` statement to create a stream and automatically remove it from the server when it goes out of scope. The function to be streamed should be passed as *func*, and its arguments as *args* and *kwargs*.

get_call (*func*, **args*, ***kwargs*)

Converts a call to function *func* with arguments *args* and *kwargs* into a message object. This allows descriptions of procedure calls to be passed to the server, for example when constructing custom events. See *Custom Events*.

close ()

Closes the connection to the server.

krpc

The basic KRPC service, providing interaction with basic functionality of the server.

Return type *krpc.client.KRPC*

class *krpc.client.KRPC*

This class provides access to the basic server functionality provided by the *KRPC* service. An instance can be obtained by calling *krpc.client.Client.krpc*.

See *KRPC* for full documentation of this class.

Some of this functionality is used internally by the python client (for example to create and remove streams) and therefore does not need to be used directly from application code.

class *krpc.stream.Stream*

This class represents a stream. See *Streaming Data from the Server*.

start (*wait=True*)

Starts the stream. When a stream is created by calling *krpc.client.Client.add_stream()* it does not start sending updates to the client until this method is called.

If *wait* is true, this method will block until at least one update has been received from the server.

If *wait* is false, the method starts the stream and returns immediately. Subsequent calls to `__call__()` may raise a *StreamError* exception if the stream does not yet contain a value.

rate

The update rate of the stream in Hertz. When set to zero, the rate is unlimited.

__call__ ()

Returns the most recent value for the stream. If executing the remote procedure for the stream throws an exception, calling this method will rethrow the exception. Raises a *StreamError* exception if no update has been received from the server.

If the stream has not been started this method calls `start(True)` to start the stream and wait until at least one update has been received.

condition

A condition variable (of type `threading.Condition`) that is notified whenever the value of the stream changes.

wait (*timeout=None*)

This method blocks until the value of the stream changes or the operation times out.

The streams condition variable must be locked before calling this method.

If *timeout* is specified and is not `None`, it should be a floating point number specifying the timeout in seconds for the operation.

If the stream has not been started this method calls `start(False)` to start the stream (without waiting for at least one update to be received).

add_callback (*callback*)

Adds a callback function that is invoked whenever the value of the stream changes. The callback function should take one argument, which is passed the new value of the stream.

Note: The callback function may be called from a different thread to that which created the stream. Any changes to shared state must therefore be protected with appropriate synchronization.

remove ()

Removes the stream from the server.

class `krpc.event.Event`

This class represents an event. See *Custom Events*. It is wrapper around a stream of type `bool` that indicates when the event occurs.

start ()

Starts the event. When an event is created, it will not receive updates from the server until this method is called.

condition

The condition variable (of type `threading.Condition`) that is notified whenever the event occurs.

wait (*timeout=None*)

This method blocks until the event occurs or the operation times out.

The events condition variable must be locked before calling this method.

If *timeout* is specified and is not `None`, it should be a floating point number specifying the timeout in seconds for the operation.

If the event has not been started this method calls `start()` to start the underlying stream.

add_callback (*callback*)

Adds a callback function that is invoked whenever the event occurs. The callback function should be a function that takes zero arguments.

remove ()

Removes the event from the server.

stream

Returns the underlying stream for the event.

8.2 KRPC API

8.2.1 KRPC

None None None None Main kRPC service, used by clients to interact with basic server functionality.

static `get_client_id()`

Returns the identifier for the current client.

Return type `str`

static get_client_name()

Returns the name of the current client. This is an empty string if the client has no name.

Return type str

clients

A list of RPC clients that are currently connected to the server. Each entry in the list is a clients identifier, name and address.

Attribute Read-only, cannot be set

Return type list(tuple(str, str, str))

static get_status()

Returns some information about the server, such as the version.

Return type krpc.schema.KRPC.Status

static get_services()

Returns information on all services, procedures, classes, properties etc. provided by the server. Can be used by client libraries to automatically create functionality such as stubs.

Return type krpc.schema.KRPC.Services

static set_stream_rate(id, rate)

Set the update rate for a stream in Hz.

Parameters

- **id**(long) –
- **rate**(float) –

current_game_scene

Get the current game scene.

Attribute Read-only, cannot be set

Return type GameScene

paused

Whether the game is paused.

Attribute Can be read or written

Return type bool

class GameScene

The game scene. See *current_game_scene*.

space_center

The game scene showing the Kerbal Space Center buildings.

flight

The game scene showing a vessel in flight (or on the launchpad/runway).

tracking_station

The tracking station.

editor_vab

The Vehicle Assembly Building.

editor_sph

The Space Plane Hangar.

class InvalidOperationException

A method call was made to a method that is invalid given the current state of the object.

class ArgumentException

A method was invoked where at least one of the passed arguments does not meet the parameter specification of the method.

class ArgumentNullException

A null reference was passed to a method that does not accept it as a valid argument.

class ArgumentOutOfRangeException

The value of an argument is outside the allowable range of values as defined by the invoked method.

8.2.2 Expressions

class Expression

A server side expression.

static constant_double (*value*)

A constant value of type double.

Parameters *value* (*float*) –

Return type *Expression*

static constant_float (*value*)

A constant value of type float.

Parameters *value* (*float*) –

Return type *Expression*

static constant_int (*value*)

A constant value of type int.

Parameters *value* (*int*) –

Return type *Expression*

static constant_string (*value*)

A constant value of type string.

Parameters *value* (*str*) –

Return type *Expression*

static call (*call*)

An RPC call.

Parameters *call* (*krpc.schema.KRPC.ProcedureCall*) –

Return type *Expression*

static equal (*arg0*, *arg1*)

Equality comparison.

Parameters

- **arg0** (*Expression*) –
- **arg1** (*Expression*) –

Return type *Expression*

static not_equal (*arg0*, *arg1*)

Inequality comparison.

Parameters

- **arg0** (Expression) –
- **arg1** (Expression) –

Return type *Expression*

static greater_than (*arg0*, *arg1*)

Greater than numerical comparison.

Parameters

- **arg0** (Expression) –
- **arg1** (Expression) –

Return type *Expression*

static greater_than_or_equal (*arg0*, *arg1*)

Greater than or equal numerical comparison.

Parameters

- **arg0** (Expression) –
- **arg1** (Expression) –

Return type *Expression*

static less_than (*arg0*, *arg1*)

Less than numerical comparison.

Parameters

- **arg0** (Expression) –
- **arg1** (Expression) –

Return type *Expression*

static less_than_or_equal (*arg0*, *arg1*)

Less than or equal numerical comparison.

Parameters

- **arg0** (Expression) –
- **arg1** (Expression) –

Return type *Expression*

static and (*arg0*, *arg1*)

Boolean and operator.

Parameters

- **arg0** (Expression) –
- **arg1** (Expression) –

Return type *Expression*

static or (*arg0*, *arg1*)

Boolean or operator.

Parameters

- **arg0** (Expression) –
- **arg1** (Expression) –

Return type *Expression*

static exclusive_or (*arg0, arg1*)
 Boolean exclusive-or operator.

Parameters

- **arg0** (Expression) –
- **arg1** (Expression) –

Return type *Expression*

static not (*arg*)
 Boolean negation operator.

Parameters **arg** (Expression) –**Return type** *Expression*

static add (*arg0, arg1*)
 Numerical addition.

Parameters

- **arg0** (Expression) –
- **arg1** (Expression) –

Return type *Expression*

static subtract (*arg0, arg1*)
 Numerical subtraction.

Parameters

- **arg0** (Expression) –
- **arg1** (Expression) –

Return type *Expression*

static multiply (*arg0, arg1*)
 Numerical multiplication.

Parameters

- **arg0** (Expression) –
- **arg1** (Expression) –

Return type *Expression*

static divide (*arg0, arg1*)
 Numerical division.

Parameters

- **arg0** (Expression) –
- **arg1** (Expression) –

Return type *Expression*

static modulo (*arg0*, *arg1*)

Numerical modulo operator.

Parameters

- **arg0** (Expression) –
- **arg1** (Expression) –

Returns The remainder of *arg0* divided by *arg1*

Return type *Expression*

static power (*arg0*, *arg1*)

Numerical power operator.

Parameters

- **arg0** (Expression) –
- **arg1** (Expression) –

Returns *arg0* raised to the power of *arg1*

Return type *Expression*

static left_shift (*arg0*, *arg1*)

Bitwise left shift.

Parameters

- **arg0** (Expression) –
- **arg1** (Expression) –

Return type *Expression*

static right_shift (*arg0*, *arg1*)

Bitwise right shift.

Parameters

- **arg0** (Expression) –
- **arg1** (Expression) –

Return type *Expression*

static to_double (*arg*)

Convert to a double type.

Parameters **arg** (Expression) –

Return type *Expression*

static to_float (*arg*)

Convert to a float type.

Parameters **arg** (Expression) –

Return type *Expression*

static to_int (*arg*)

Convert to an int type.

Parameters **arg** (Expression) –

Return type *Expression*

8.3 SpaceCenter API

8.3.1 SpaceCenter

Provides functionality to interact with Kerbal Space Program. This includes controlling the active vessel, managing its resources, planning maneuver nodes and auto-piloting.

active_vessel

The currently active vessel.

Attribute Can be read or written

Return type *Vessel*

vessels

A list of all the vessels in the game.

Attribute Read-only, cannot be set

Return type list(*Vessel*)

bodies

A dictionary of all celestial bodies (planets, moons, etc.) in the game, keyed by the name of the body.

Attribute Read-only, cannot be set

Return type dict(str, *CelestialBody*)

target_body

The currently targeted celestial body.

Attribute Can be read or written

Return type *CelestialBody*

target_vessel

The currently targeted vessel.

Attribute Can be read or written

Return type *Vessel*

target_docking_port

The currently targeted docking port.

Attribute Can be read or written

Return type *DockingPort*

static clear_target()

Clears the current target.

static launchable_vessels(*craft_directory*)

Returns a list of vessels from the given *craft_directory* that can be launched.

Parameters **craft_directory** (*str*) – Name of the directory in the current saves “Ships” directory. For example "VAB" or "SPH".

Return type list(str)

static launch_vessel(*craft_directory*, *name*, *launch_site*)

Launch a vessel.

Parameters

- **craft_directory** (*str*) – Name of the directory in the current saves “Ships” directory, that contains the craft file. For example "VAB" or "SPH".
- **name** (*str*) – Name of the vessel to launch. This is the name of the “.craft” file in the save directory, without the “.craft” file extension.
- **launch_site** (*str*) – Name of the launch site. For example "LaunchPad" or "Runway".

static launch_vessel_from_vab (*name*)

Launch a new vessel from the VAB onto the launchpad.

Parameters **name** (*str*) – Name of the vessel to launch.

Note: This is equivalent to calling *launch_vessel()* with the craft directory set to “VAB” and the launch site set to “LaunchPad”.

static launch_vessel_from_sph (*name*)

Launch a new vessel from the SPH onto the runway.

Parameters **name** (*str*) – Name of the vessel to launch.

Note: This is equivalent to calling *launch_vessel()* with the craft directory set to “SPH” and the launch site set to “Runway”.

static save (*name*)

Save the game with a given name. This will create a save file called *name.sfs* in the folder of the current save game.

Parameters **name** (*str*) –

static load (*name*)

Load the game with the given name. This will create a load a save file called *name.sfs* from the folder of the current save game.

Parameters **name** (*str*) –

static quicksave ()

Save a quicksave.

Note: This is the same as calling *save()* with the name “quicksave”.

static quickload ()

Load a quicksave.

Note: This is the same as calling *load()* with the name “quicksave”.

ui_visible

Whether the UI is visible.

Attribute Can be read or written

Return type bool

navball

Whether the navball is visible.

Attribute Can be read or written

Return type bool

ut

The current universal time in seconds.

Attribute Read-only, cannot be set

Return type float

g

The value of the [gravitational constant](#) G in $N(m/kg)^2$.

Attribute Read-only, cannot be set

Return type float

warp_rate

The current warp rate. This is the rate at which time is passing for either on-rails or physical time warp. For example, a value of 10 means time is passing 10x faster than normal. Returns 1 if time warp is not active.

Attribute Read-only, cannot be set

Return type float

warp_factor

The current warp factor. This is the index of the rate at which time is passing for either regular “on-rails” or physical time warp. Returns 0 if time warp is not active. When in on-rails time warp, this is equal to *rails_warp_factor*, and in physics time warp, this is equal to *physics_warp_factor*.

Attribute Read-only, cannot be set

Return type float

rails_warp_factor

The time warp rate, using regular “on-rails” time warp. A value between 0 and 7 inclusive. 0 means no time warp. Returns 0 if physical time warp is active.

If requested time warp factor cannot be set, it will be set to the next lowest possible value. For example, if the vessel is too close to a planet. See [the KSP wiki](#) for details.

Attribute Can be read or written

Return type int

physics_warp_factor

The physical time warp rate. A value between 0 and 3 inclusive. 0 means no time warp. Returns 0 if regular “on-rails” time warp is active.

Attribute Can be read or written

Return type int

static can_rails_warp_at (*[factor = 1]*)

Returns `True` if regular “on-rails” time warp can be used, at the specified warp *factor*. The maximum time warp rate is limited by various things, including how close the active vessel is to a planet. See [the KSP wiki](#) for details.

Parameters **factor** (*int*) – The warp factor to check.

Return type bool

maximum_rails_warp_factor

The current maximum regular “on-rails” warp factor that can be set. A value between 0 and 7 inclusive. See [the KSP wiki](#) for details.

Attribute Read-only, cannot be set

Return type `int`

static warp_to (*ut* [, *max_rails_rate* = 100000.0] [, *max_physics_rate* = 2.0])

Uses time acceleration to warp forward to a time in the future, specified by universal time *ut*. This call blocks until the desired time is reached. Uses regular “on-rails” or physical time warp as appropriate. For example, physical time warp is used when the active vessel is traveling through an atmosphere. When using regular “on-rails” time warp, the warp rate is limited by *max_rails_rate*, and when using physical time warp, the warp rate is limited by *max_physics_rate*.

Parameters

- **ut** (*float*) – The universal time to warp to, in seconds.
- **max_rails_rate** (*float*) – The maximum warp rate in regular “on-rails” time warp.
- **max_physics_rate** (*float*) – The maximum warp rate in physical time warp.

Returns When the time warp is complete.

static transform_position (*position*, *from*, *to*)

Converts a position from one reference frame to another.

Parameters

- **position** (*tuple*) – Position, as a vector, in reference frame *from*.
- **from** (`ReferenceFrame`) – The reference frame that the position is in.
- **to** (`ReferenceFrame`) – The reference frame to covert the position to.

Returns The corresponding position, as a vector, in reference frame *to*.

Return type `tuple(float, float, float)`

static transform_direction (*direction*, *from*, *to*)

Converts a direction from one reference frame to another.

Parameters

- **direction** (*tuple*) – Direction, as a vector, in reference frame *from*.
- **from** (`ReferenceFrame`) – The reference frame that the direction is in.
- **to** (`ReferenceFrame`) – The reference frame to covert the direction to.

Returns The corresponding direction, as a vector, in reference frame *to*.

Return type `tuple(float, float, float)`

static transform_rotation (*rotation*, *from*, *to*)

Converts a rotation from one reference frame to another.

Parameters

- **rotation** (*tuple*) – Rotation, as a quaternion of the form (x, y, z, w) , in reference frame *from*.
- **from** (`ReferenceFrame`) – The reference frame that the rotation is in.
- **to** (`ReferenceFrame`) – The reference frame to covert the rotation to.

Returns The corresponding rotation, as a quaternion of the form (x, y, z, w) , in reference frame *to*.

Return type `tuple(float, float, float, float)`

static transform_velocity (*position, velocity, from, to*)

Converts a velocity (acting at the specified position) from one reference frame to another. The position is required to take the relative angular velocity of the reference frames into account.

Parameters

- **position** (*tuple*) – Position, as a vector, in reference frame *from*.
- **velocity** (*tuple*) – Velocity, as a vector that points in the direction of travel and whose magnitude is the speed in meters per second, in reference frame *from*.
- **from** (*ReferenceFrame*) – The reference frame that the position and velocity are in.
- **to** (*ReferenceFrame*) – The reference frame to convert the velocity to.

Returns The corresponding velocity, as a vector, in reference frame *to*.

Return type *tuple(float, float, float)*

static raycast_distance (*position, direction, reference_frame*)

Cast a ray from a given position in a given direction, and return the distance to the hit point. If no hit occurs, returns infinity.

Parameters

- **position** (*tuple*) – Position, as a vector, of the origin of the ray.
- **direction** (*tuple*) – Direction of the ray, as a unit vector.
- **reference_frame** (*ReferenceFrame*) – The reference frame that the position and direction are in.

Returns The distance to the hit, in meters, or infinity if there was no hit.

Return type *float*

static raycast_part (*position, direction, reference_frame*)

Cast a ray from a given position in a given direction, and return the part that it hits. If no hit occurs, returns *None*.

Parameters

- **position** (*tuple*) – Position, as a vector, of the origin of the ray.
- **direction** (*tuple*) – Direction of the ray, as a unit vector.
- **reference_frame** (*ReferenceFrame*) – The reference frame that the position and direction are in.

Returns The part that was hit or *None* if there was no hit.

Return type *Part*

far_available

Whether [Ferram Aerospace Research](#) is installed.

Attribute Read-only, cannot be set

Return type *bool*

warp_mode

The current time warp mode. Returns *WarpMode.none* if time warp is not active, *WarpMode.rails* if regular “on-rails” time warp is active, or *WarpMode.physics* if physical time warp is active.

Attribute Read-only, cannot be set

Return type *WarpMode*

camera

An object that can be used to control the camera.

Attribute Read-only, cannot be set

Return type *Camera*

waypoint_manager

The waypoint manager.

Attribute Read-only, cannot be set

Return type *WaypointManager*

contract_manager

The contract manager.

Attribute Read-only, cannot be set

Return type *ContractManager*

class WarpMode

The time warp mode. Returned by *WarpMode*

rails

Time warp is active, and in regular “on-rails” mode.

physics

Time warp is active, and in physical time warp mode.

none

Time warp is not active.

8.3.2 Vessel

class Vessel

These objects are used to interact with vessels in KSP. This includes getting orbital and flight data, manipulating control inputs and managing resources. Created using *active_vessel* or *vessels*.

name

The name of the vessel.

Attribute Can be read or written

Return type *str*

type

The type of the vessel.

Attribute Can be read or written

Return type *VesselType*

situation

The situation the vessel is in.

Attribute Read-only, cannot be set

Return type *VesselSituation*

recoverable

Whether the vessel is recoverable.

Attribute Read-only, cannot be set

Return type bool

recover ()

Recover the vessel.

met

The mission elapsed time in seconds.

Attribute Read-only, cannot be set

Return type float

biome

The name of the biome the vessel is currently in.

Attribute Read-only, cannot be set

Return type str

flight ([*reference_frame* = None])

Returns a *Flight* object that can be used to get flight telemetry for the vessel, in the specified reference frame.

Parameters **reference_frame** (ReferenceFrame) – Reference frame. Defaults to the vessel's surface reference frame (*Vessel.surface_reference_frame*).

Return type *Flight*

Note: When this is called with no arguments, the vessel's surface reference frame is used. This reference frame moves with the vessel, therefore velocities and speeds returned by the flight object will be zero. See the *reference frames tutorial* for examples of getting *the orbital and surface speeds of a vessel*.

orbit

The current orbit of the vessel.

Attribute Read-only, cannot be set

Return type *Orbit*

control

Returns a *Control* object that can be used to manipulate the vessel's control inputs. For example, its pitch/yaw/roll controls, RCS and thrust.

Attribute Read-only, cannot be set

Return type *Control*

comms

Returns a *Comms* object that can be used to interact with CommNet for this vessel.

Attribute Read-only, cannot be set

Return type *Comms*

auto_pilot

An *AutoPilot* object, that can be used to perform simple auto-piloting of the vessel.

Attribute Read-only, cannot be set

Return type *AutoPilot*

crew_capacity

The number of crew that can occupy the vessel.

Attribute Read-only, cannot be set

Return type `int`

crew_count

The number of crew that are occupying the vessel.

Attribute Read-only, cannot be set

Return type `int`

crew

The crew in the vessel.

Attribute Read-only, cannot be set

Return type `list(CrewMember)`

resources

A *Resources* object, that can used to get information about resources stored in the vessel.

Attribute Read-only, cannot be set

Return type *Resources*

resources_in_decouple_stage (*stage*`[, cumulative = True]`)

Returns a *Resources* object, that can used to get information about resources stored in a given *stage*.

Parameters

- **stage** (*int*) – Get resources for parts that are decoupled in this stage.
- **cumulative** (*bool*) – When `False`, returns the resources for parts decoupled in just the given stage. When `True` returns the resources decoupled in the given stage and all subsequent stages combined.

Return type *Resources*

Note: For details on stage numbering, see the discussion on *Staging*.

parts

A *Parts* object, that can used to interact with the parts that make up this vessel.

Attribute Read-only, cannot be set

Return type *Parts*

mass

The total mass of the vessel, including resources, in kg.

Attribute Read-only, cannot be set

Return type `float`

dry_mass

The total mass of the vessel, excluding resources, in kg.

Attribute Read-only, cannot be set

Return type `float`

thrust

The total thrust currently being produced by the vessel's engines, in Newtons. This is computed by summing *Engine.thrust* for every engine in the vessel.

Attribute Read-only, cannot be set

Return type float

available_thrust

Gets the total available thrust that can be produced by the vessel's active engines, in Newtons. This is computed by summing *Engine.available_thrust* for every active engine in the vessel.

Attribute Read-only, cannot be set

Return type float

max_thrust

The total maximum thrust that can be produced by the vessel's active engines, in Newtons. This is computed by summing *Engine.max_thrust* for every active engine.

Attribute Read-only, cannot be set

Return type float

max_vacuum_thrust

The total maximum thrust that can be produced by the vessel's active engines when the vessel is in a vacuum, in Newtons. This is computed by summing *Engine.max_vacuum_thrust* for every active engine.

Attribute Read-only, cannot be set

Return type float

specific_impulse

The combined specific impulse of all active engines, in seconds. This is computed using the formula [described here](#).

Attribute Read-only, cannot be set

Return type float

vacuum_specific_impulse

The combined vacuum specific impulse of all active engines, in seconds. This is computed using the formula [described here](#).

Attribute Read-only, cannot be set

Return type float

kerbin_sea_level_specific_impulse

The combined specific impulse of all active engines at sea level on Kerbin, in seconds. This is computed using the formula [described here](#).

Attribute Read-only, cannot be set

Return type float

moment_of_inertia

The moment of inertia of the vessel around its center of mass in $kg.m^2$. The inertia values in the returned 3-tuple are around the pitch, roll and yaw directions respectively. This corresponds to the vessels reference frame (*ReferenceFrame*).

Attribute Read-only, cannot be set

Return type tuple(float, float, float)

inertia_tensor

The inertia tensor of the vessel around its center of mass, in the vessels reference frame (*ReferenceFrame*). Returns the 3x3 matrix as a list of elements, in row-major order.

Attribute Read-only, cannot be set

Return type list(float)

available_torque

The maximum torque that the vessel generates. Includes contributions from reaction wheels, RCS, gimballled engines and aerodynamic control surfaces. Returns the torques in *N.m* around each of the coordinate axes of the vessels reference frame (*ReferenceFrame*). These axes are equivalent to the pitch, roll and yaw axes of the vessel.

Attribute Read-only, cannot be set

Return type tuple(tuple(float, float, float), tuple(float, float, float))

available_reaction_wheel_torque

The maximum torque that the currently active and powered reaction wheels can generate. Returns the torques in *N.m* around each of the coordinate axes of the vessels reference frame (*ReferenceFrame*). These axes are equivalent to the pitch, roll and yaw axes of the vessel.

Attribute Read-only, cannot be set

Return type tuple(tuple(float, float, float), tuple(float, float, float))

available_rcs_torque

The maximum torque that the currently active RCS thrusters can generate. Returns the torques in *N.m* around each of the coordinate axes of the vessels reference frame (*ReferenceFrame*). These axes are equivalent to the pitch, roll and yaw axes of the vessel.

Attribute Read-only, cannot be set

Return type tuple(tuple(float, float, float), tuple(float, float, float))

available_engine_torque

The maximum torque that the currently active and gimballled engines can generate. Returns the torques in *N.m* around each of the coordinate axes of the vessels reference frame (*ReferenceFrame*). These axes are equivalent to the pitch, roll and yaw axes of the vessel.

Attribute Read-only, cannot be set

Return type tuple(tuple(float, float, float), tuple(float, float, float))

available_control_surface_torque

The maximum torque that the aerodynamic control surfaces can generate. Returns the torques in *N.m* around each of the coordinate axes of the vessels reference frame (*ReferenceFrame*). These axes are equivalent to the pitch, roll and yaw axes of the vessel.

Attribute Read-only, cannot be set

Return type tuple(tuple(float, float, float), tuple(float, float, float))

available_other_torque

The maximum torque that parts (excluding reaction wheels, gimballled engines, RCS and control surfaces) can generate. Returns the torques in *N.m* around each of the coordinate axes of the vessels reference frame (*ReferenceFrame*). These axes are equivalent to the pitch, roll and yaw axes of the vessel.

Attribute Read-only, cannot be set

Return type tuple(tuple(float, float, float), tuple(float, float, float))

reference_frame

The reference frame that is fixed relative to the vessel, and orientated with the vessel.

- The origin is at the center of mass of the vessel.
- The axes rotate with the vessel.

- The x-axis points out to the right of the vessel.
- The y-axis points in the forward direction of the vessel.
- The z-axis points out of the bottom off the vessel.

Attribute Read-only, cannot be set

Return type *ReferenceFrame*

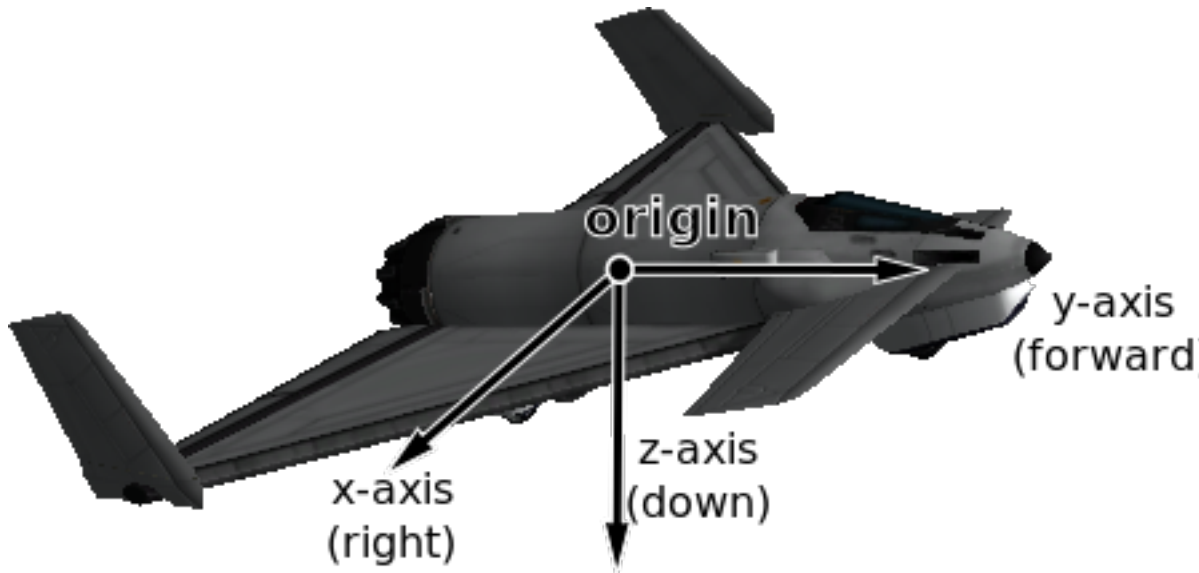


Fig. 8.1: Vessel reference frame origin and axes for the Aeris 3A aircraft

orbital_reference_frame

The reference frame that is fixed relative to the vessel, and orientated with the vessels orbital prograde/normal/radial directions.

- The origin is at the center of mass of the vessel.
- The axes rotate with the orbital prograde/normal/radial directions.
- The x-axis points in the orbital anti-radial direction.
- The y-axis points in the orbital prograde direction.
- The z-axis points in the orbital normal direction.

Attribute Read-only, cannot be set

Return type *ReferenceFrame*

Note: Be careful not to confuse this with 'orbit' mode on the navball.

surface_reference_frame

The reference frame that is fixed relative to the vessel, and orientated with the surface of the body being orbited.

- The origin is at the center of mass of the vessel.
- The axes rotate with the north and up directions on the surface of the body.

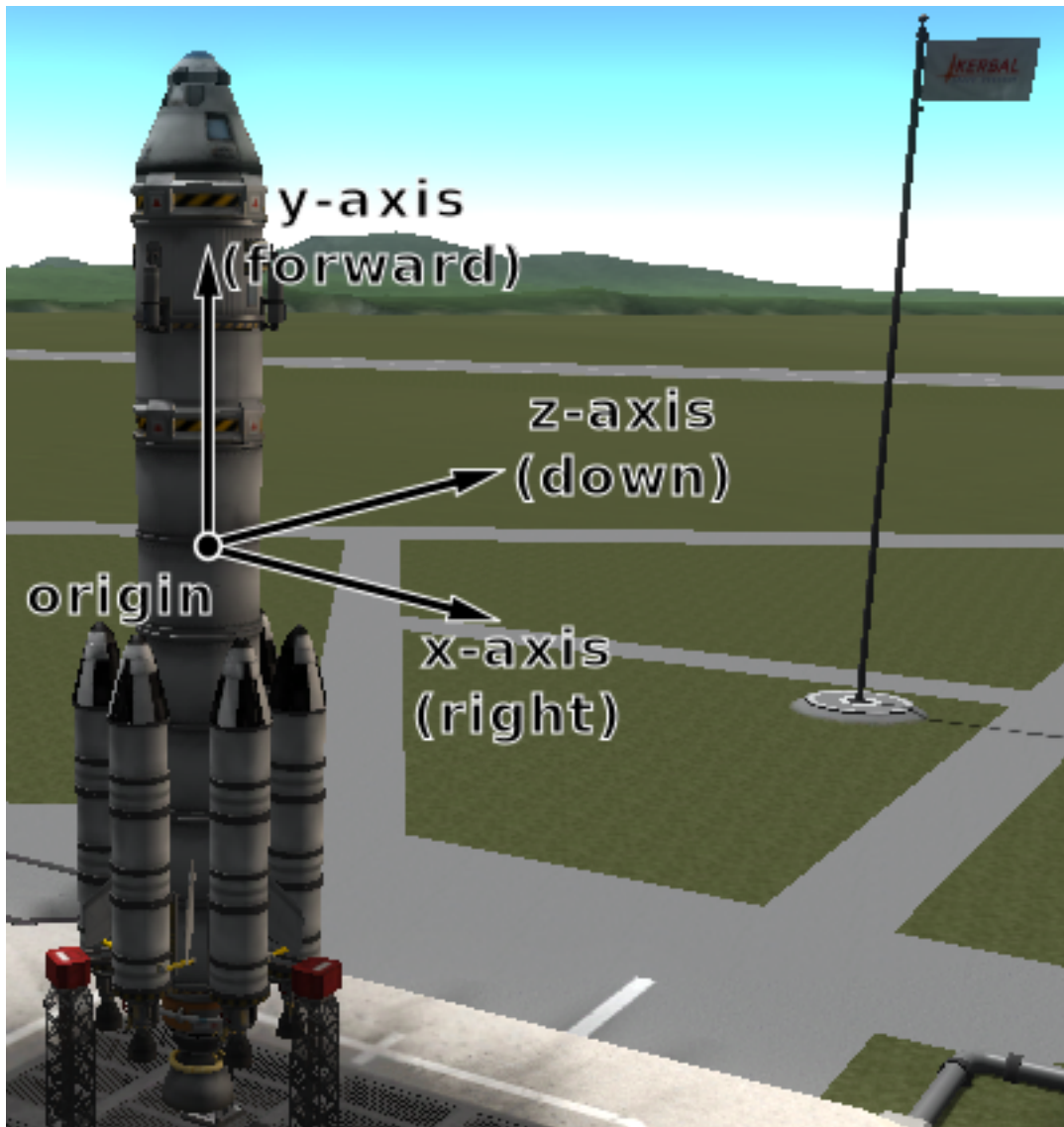


Fig. 8.2: Vessel reference frame origin and axes for the Kerbal-X rocket

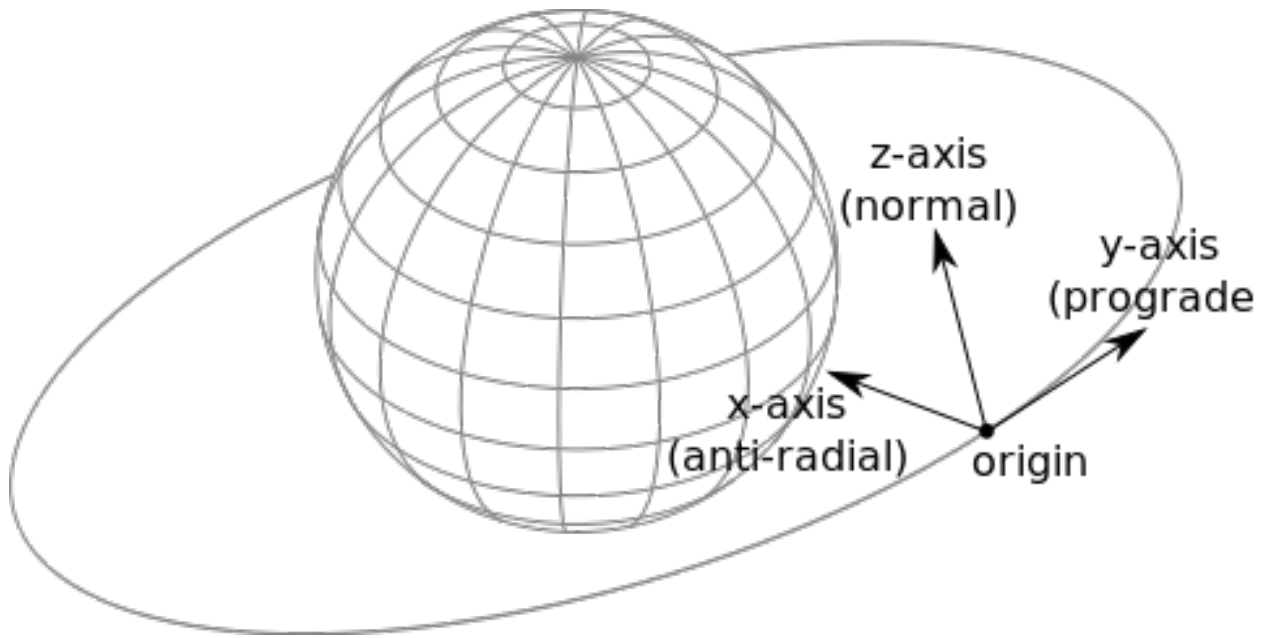


Fig. 8.3: Vessel orbital reference frame origin and axes

- The x-axis points in the [zenith](#) direction (upwards, normal to the body being orbited, from the center of the body towards the center of mass of the vessel).
- The y-axis points northwards towards the [astronomical horizon](#) (north, and tangential to the surface of the body – the direction in which a compass would point when on the surface).
- The z-axis points eastwards towards the [astronomical horizon](#) (east, and tangential to the surface of the body – east on a compass when on the surface).

Attribute Read-only, cannot be set

Return type *ReferenceFrame*

Note: Be careful not to confuse this with ‘surface’ mode on the navball.

surface_velocity_reference_frame

The reference frame that is fixed relative to the vessel, and orientated with the velocity vector of the vessel relative to the surface of the body being orbited.

- The origin is at the center of mass of the vessel.
- The axes rotate with the vessel’s velocity vector.
- The y-axis points in the direction of the vessel’s velocity vector, relative to the surface of the body being orbited.
- The z-axis is in the plane of the [astronomical horizon](#).
- The x-axis is orthogonal to the other two axes.

Attribute Read-only, cannot be set

Return type *ReferenceFrame*

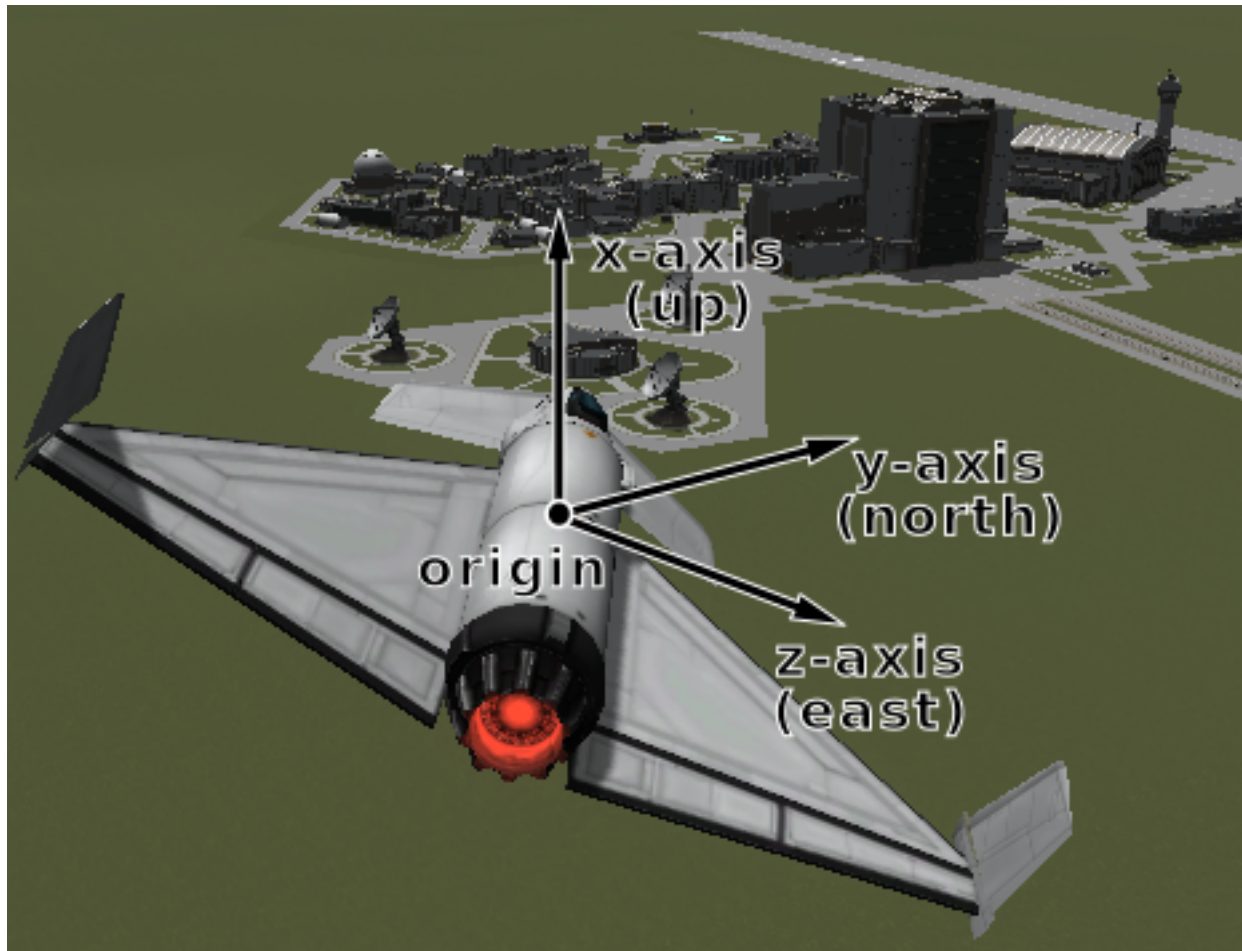


Fig. 8.4: Vessel surface reference frame origin and axes

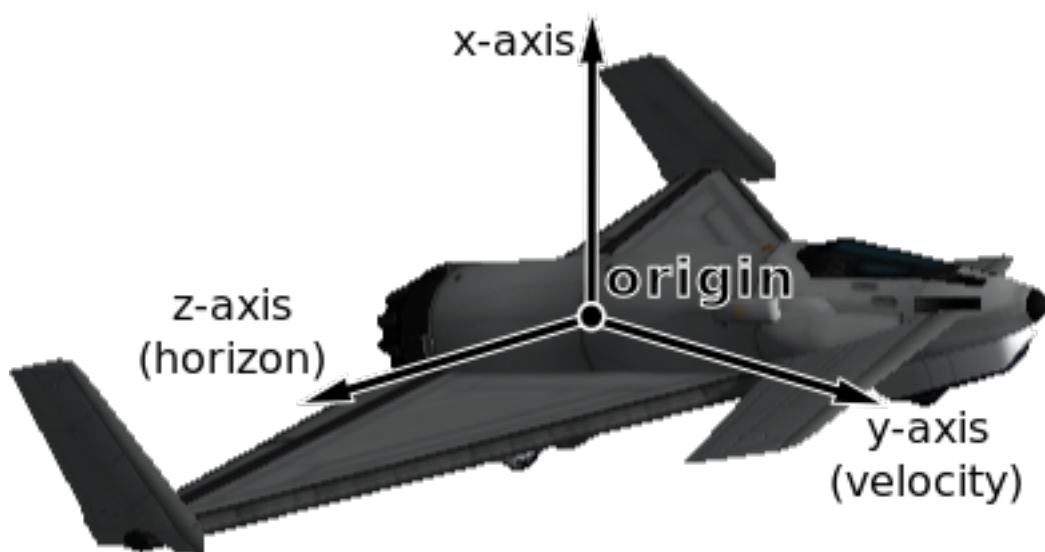


Fig. 8.5: Vessel surface velocity reference frame origin and axes

position (*reference_frame*)

The position of the center of mass of the vessel, in the given reference frame.

Parameters **reference_frame** (ReferenceFrame) – The reference frame that the returned position vector is in.

Returns The position as a vector.

Return type tuple(float, float, float)

bounding_box (*reference_frame*)

The axis-aligned bounding box of the vessel in the given reference frame.

Parameters **reference_frame** (ReferenceFrame) – The reference frame that the returned position vectors are in.

Returns The positions of the minimum and maximum vertices of the box, as position vectors.

Return type tuple(tuple(float, float, float), tuple(float, float, float))

velocity (*reference_frame*)

The velocity of the center of mass of the vessel, in the given reference frame.

Parameters **reference_frame** (ReferenceFrame) – The reference frame that the returned velocity vector is in.

Returns The velocity as a vector. The vector points in the direction of travel, and its magnitude is the speed of the body in meters per second.

Return type tuple(float, float, float)

rotation (*reference_frame*)

The rotation of the vessel, in the given reference frame.

Parameters **reference_frame** (ReferenceFrame) – The reference frame that the returned rotation is in.

Returns The rotation as a quaternion of the form (x, y, z, w) .

Return type tuple(float, float, float, float)

direction (*reference_frame*)

The direction in which the vessel is pointing, in the given reference frame.

Parameters **reference_frame** (ReferenceFrame) – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

Return type tuple(float, float, float)

angular_velocity (*reference_frame*)

The angular velocity of the vessel, in the given reference frame.

Parameters **reference_frame** (ReferenceFrame) – The reference frame the returned angular velocity is in.

Returns The angular velocity as a vector. The magnitude of the vector is the rotational speed of the vessel, in radians per second. The direction of the vector indicates the axis of rotation, using the right-hand rule.

Return type tuple(float, float, float)

class VesselType

The type of a vessel. See *Vessel.type*.

base
Base.

debris
Debris.

lander
Lander.

plane
Plane.

probe
Probe.

relay
Relay.

rover
Rover.

ship
Ship.

station
Station.

class VesselSituation

The situation a vessel is in. See *Vessel.situation*.

docked
Vessel is docked to another.

escaping
Escaping.

flying
Vessel is flying through an atmosphere.

landed
Vessel is landed on the surface of a body.

orbiting
Vessel is orbiting a body.

pre_launch
Vessel is awaiting launch.

splashed
Vessel has splashed down in an ocean.

sub_orbital
Vessel is on a sub-orbital trajectory.

class CrewMember

Represents crew in a vessel. Can be obtained using *Vessel.crew*.

name
The crew members name.

Attribute Can be read or written

Return type str

type

The type of crew member.

Attribute Read-only, cannot be set

Return type *CrewMemberType*

on_mission

Whether the crew member is on a mission.

Attribute Read-only, cannot be set

Return type bool

courage

The crew members courage.

Attribute Can be read or written

Return type float

stupidity

The crew members stupidity.

Attribute Can be read or written

Return type float

experience

The crew members experience.

Attribute Can be read or written

Return type float

badass

Whether the crew member is a badass.

Attribute Can be read or written

Return type bool

veteran

Whether the crew member is a veteran.

Attribute Can be read or written

Return type bool

class CrewMemberType

The type of a crew member. See *CrewMember.type*.

applicant

An applicant for crew.

crew

Rocket crew.

tourist

A tourist.

unowned

An unowned crew member.

8.3.3 CelestialBody

class CelestialBody

Represents a celestial body (such as a planet or moon). See *bodies*.

name

The name of the body.

Attribute Read-only, cannot be set

Return type str

satellites

A list of celestial bodies that are in orbit around this celestial body.

Attribute Read-only, cannot be set

Return type list(*CelestialBody*)

orbit

The orbit of the body.

Attribute Read-only, cannot be set

Return type *Orbit*

mass

The mass of the body, in kilograms.

Attribute Read-only, cannot be set

Return type float

gravitational_parameter

The [standard gravitational parameter](#) of the body in m^3s^{-2} .

Attribute Read-only, cannot be set

Return type float

surface_gravity

The acceleration due to gravity at sea level (mean altitude) on the body, in m/s^2 .

Attribute Read-only, cannot be set

Return type float

rotational_period

The sidereal rotational period of the body, in seconds.

Attribute Read-only, cannot be set

Return type float

rotational_speed

The rotational speed of the body, in radians per second.

Attribute Read-only, cannot be set

Return type float

rotation_angle

The current rotation angle of the body, in radians. A value between 0 and 2π

Attribute Read-only, cannot be set

Return type float

initial_rotation

The initial rotation angle of the body (at UT 0), in radians. A value between 0 and 2π

Attribute Read-only, cannot be set

Return type float

equatorial_radius

The equatorial radius of the body, in meters.

Attribute Read-only, cannot be set

Return type float

surface_height (*latitude, longitude*)

The height of the surface relative to mean sea level, in meters, at the given position. When over water this is equal to 0.

Parameters

- **latitude** (*float*) – Latitude in degrees.
- **longitude** (*float*) – Longitude in degrees.

Return type float

bedrock_height (*latitude, longitude*)

The height of the surface relative to mean sea level, in meters, at the given position. When over water, this is the height of the sea-bed and is therefore negative value.

Parameters

- **latitude** (*float*) – Latitude in degrees.
- **longitude** (*float*) – Longitude in degrees.

Return type float

msl_position (*latitude, longitude, reference_frame*)

The position at mean sea level at the given latitude and longitude, in the given reference frame.

Parameters

- **latitude** (*float*) – Latitude in degrees.
- **longitude** (*float*) – Longitude in degrees.
- **reference_frame** (*ReferenceFrame*) – Reference frame for the returned position vector.

Returns Position as a vector.

Return type tuple(float, float, float)

surface_position (*latitude, longitude, reference_frame*)

The position of the surface at the given latitude and longitude, in the given reference frame. When over water, this is the position of the surface of the water.

Parameters

- **latitude** (*float*) – Latitude in degrees.
- **longitude** (*float*) – Longitude in degrees.
- **reference_frame** (*ReferenceFrame*) – Reference frame for the returned position vector.

Returns Position as a vector.

Return type tuple(float, float, float)

bedrock_position (*latitude, longitude, reference_frame*)

The position of the surface at the given latitude and longitude, in the given reference frame. When over water, this is the position at the bottom of the sea-bed.

Parameters

- **latitude** (*float*) – Latitude in degrees.
- **longitude** (*float*) – Longitude in degrees.
- **reference_frame** (*ReferenceFrame*) – Reference frame for the returned position vector.

Returns Position as a vector.

Return type tuple(float, float, float)

position_at_altitude (*latitude, longitude, altitude, reference_frame*)

The position at the given latitude, longitude and altitude, in the given reference frame.

Parameters

- **latitude** (*float*) – Latitude in degrees.
- **longitude** (*float*) – Longitude in degrees.
- **altitude** (*float*) – Altitude in meters above sea level.
- **reference_frame** (*ReferenceFrame*) – Reference frame for the returned position vector.

Returns Position as a vector.

Return type tuple(float, float, float)

altitude_at_position (*position, reference_frame*)

The altitude, in meters, of the given position in the given reference frame.

Parameters

- **position** (*tuple*) – Position as a vector.
- **reference_frame** (*ReferenceFrame*) – Reference frame for the position vector.

Return type float

latitude_at_position (*position, reference_frame*)

The latitude of the given position, in the given reference frame.

Parameters

- **position** (*tuple*) – Position as a vector.
- **reference_frame** (*ReferenceFrame*) – Reference frame for the position vector.

Return type float

longitude_at_position (*position, reference_frame*)

The longitude of the given position, in the given reference frame.

Parameters

- **position** (*tuple*) – Position as a vector.
- **reference_frame** (*ReferenceFrame*) – Reference frame for the position vector.

Return type float

sphere_of_influence

The radius of the sphere of influence of the body, in meters.

Attribute Read-only, cannot be set

Return type float

has_atmosphere

True if the body has an atmosphere.

Attribute Read-only, cannot be set

Return type bool

atmosphere_depth

The depth of the atmosphere, in meters.

Attribute Read-only, cannot be set

Return type float

atmospheric_density_at_position (*position*, *reference_frame*)

The atmospheric density at the given position, in kg/m^3 , in the given reference frame.

Parameters

- **position** (*tuple*) – The position vector at which to measure the density.
- **reference_frame** (*ReferenceFrame*) – Reference frame that the position vector is in.

Return type float

has_atmospheric_oxygen

True if there is oxygen in the atmosphere, required for air-breathing engines.

Attribute Read-only, cannot be set

Return type bool

temperature_at (*position*, *reference_frame*)

The temperature on the body at the given position, in the given reference frame.

Parameters

- **position** (*tuple*) – Position as a vector.
- **reference_frame** (*ReferenceFrame*) – The reference frame that the position is in.

Return type float

Note: This calculation is performed using the bodies current position, which means that the value could be wrong if you want to know the temperature in the far future.

density_at (*altitude*)

Gets the air density, in kg/m^3 , for the specified altitude above sea level, in meters.

Parameters **altitude** (*float*) –

Return type float

Note: This is an approximation, because actual calculations, taking sun exposure into account to compute air temperature, require us to know the exact point on the body where the density is to be computed

(knowing the altitude is not enough). However, the difference is small for high altitudes, so it makes very little difference for trajectory prediction.

pressure_at (*altitude*)

Gets the air pressure, in Pascals, for the specified altitude above sea level, in meters.

Parameters **altitude** (*float*) –

Return type *float*

biomes

The biomes present on this body.

Attribute Read-only, cannot be set

Return type *set(str)*

biome_at (*latitude, longitude*)

The biome at the given latitude and longitude, in degrees.

Parameters

- **latitude** (*float*) –
- **longitude** (*float*) –

Return type *str*

flying_high_altitude_threshold

The altitude, in meters, above which a vessel is considered to be flying “high” when doing science.

Attribute Read-only, cannot be set

Return type *float*

space_high_altitude_threshold

The altitude, in meters, above which a vessel is considered to be in “high” space when doing science.

Attribute Read-only, cannot be set

Return type *float*

reference_frame

The reference frame that is fixed relative to the celestial body.

- The origin is at the center of the body.
- The axes rotate with the body.
- The x-axis points from the center of the body towards the intersection of the prime meridian and equator (the position at 0° longitude, 0° latitude).
- The y-axis points from the center of the body towards the north pole.
- The z-axis points from the center of the body towards the equator at 90°E longitude.

Attribute Read-only, cannot be set

Return type *ReferenceFrame*

non_rotating_reference_frame

The reference frame that is fixed relative to this celestial body, and orientated in a fixed direction (it does not rotate with the body).

- The origin is at the center of the body.

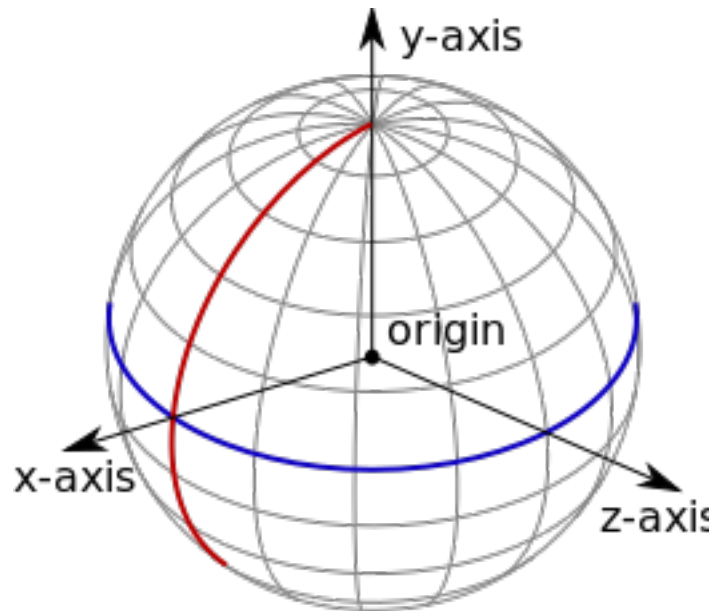


Fig. 8.6: Celestial body reference frame origin and axes. The equator is shown in blue, and the prime meridian in red.

- The axes do not rotate.
- The x-axis points in an arbitrary direction through the equator.
- The y-axis points from the center of the body towards the north pole.
- The z-axis points in an arbitrary direction through the equator.

Attribute Read-only, cannot be set

Return type *ReferenceFrame*

orbital_reference_frame

The reference frame that is fixed relative to this celestial body, but orientated with the body's orbital prograde/normal/radial directions.

- The origin is at the center of the body.
- The axes rotate with the orbital prograde/normal/radial directions.
- The x-axis points in the orbital anti-radial direction.
- The y-axis points in the orbital prograde direction.
- The z-axis points in the orbital normal direction.

Attribute Read-only, cannot be set

Return type *ReferenceFrame*

position (*reference_frame*)

The position of the center of the body, in the specified reference frame.

Parameters **reference_frame** (*ReferenceFrame*) – The reference frame that the returned position vector is in.

Returns The position as a vector.

Return type tuple(float, float, float)

velocity (*reference_frame*)

The linear velocity of the body, in the specified reference frame.

Parameters **reference_frame** (ReferenceFrame) – The reference frame that the returned velocity vector is in.

Returns The velocity as a vector. The vector points in the direction of travel, and its magnitude is the speed of the body in meters per second.

Return type tuple(float, float, float)

rotation (*reference_frame*)

The rotation of the body, in the specified reference frame.

Parameters **reference_frame** (ReferenceFrame) – The reference frame that the returned rotation is in.

Returns The rotation as a quaternion of the form (x, y, z, w) .

Return type tuple(float, float, float, float)

direction (*reference_frame*)

The direction in which the north pole of the celestial body is pointing, in the specified reference frame.

Parameters **reference_frame** (ReferenceFrame) – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

Return type tuple(float, float, float)

angular_velocity (*reference_frame*)

The angular velocity of the body in the specified reference frame.

Parameters **reference_frame** (ReferenceFrame) – The reference frame the returned angular velocity is in.

Returns The angular velocity as a vector. The magnitude of the vector is the rotational speed of the body, in radians per second. The direction of the vector indicates the axis of rotation, using the right-hand rule.

Return type tuple(float, float, float)

8.3.4 Flight

class Flight

Used to get flight telemetry for a vessel, by calling *Vessel.flight()*. All of the information returned by this class is given in the reference frame passed to that method. Obtained by calling *Vessel.flight()*.

Note: To get orbital information, such as the apoapsis or inclination, see *Orbit*.

g_force

The current G force acting on the vessel in m/s^2 .

Attribute Read-only, cannot be set

Return type float

mean_altitude

The altitude above sea level, in meters. Measured from the center of mass of the vessel.

Attribute Read-only, cannot be set

Return type float

surface_altitude

The altitude above the surface of the body or sea level, whichever is closer, in meters. Measured from the center of mass of the vessel.

Attribute Read-only, cannot be set

Return type float

bedrock_altitude

The altitude above the surface of the body, in meters. When over water, this is the altitude above the sea floor. Measured from the center of mass of the vessel.

Attribute Read-only, cannot be set

Return type float

elevation

The elevation of the terrain under the vessel, in meters. This is the height of the terrain above sea level, and is negative when the vessel is over the sea.

Attribute Read-only, cannot be set

Return type float

latitude

The [latitude](#) of the vessel for the body being orbited, in degrees.

Attribute Read-only, cannot be set

Return type float

longitude

The [longitude](#) of the vessel for the body being orbited, in degrees.

Attribute Read-only, cannot be set

Return type float

velocity

The velocity of the vessel, in the reference frame *ReferenceFrame*.

Attribute Read-only, cannot be set

Returns The velocity as a vector. The vector points in the direction of travel, and its magnitude is the speed of the vessel in meters per second.

Return type tuple(float, float, float)

speed

The speed of the vessel in meters per second, in the reference frame *ReferenceFrame*.

Attribute Read-only, cannot be set

Return type float

horizontal_speed

The horizontal speed of the vessel in meters per second, in the reference frame *ReferenceFrame*.

Attribute Read-only, cannot be set

Return type float

vertical_speed

The vertical speed of the vessel in meters per second, in the reference frame *ReferenceFrame*.

Attribute Read-only, cannot be set

Return type float

center_of_mass

The position of the center of mass of the vessel, in the reference frame *ReferenceFrame*

Attribute Read-only, cannot be set

Returns The position as a vector.

Return type tuple(float, float, float)

rotation

The rotation of the vessel, in the reference frame *ReferenceFrame*

Attribute Read-only, cannot be set

Returns The rotation as a quaternion of the form (x, y, z, w) .

Return type tuple(float, float, float, float)

direction

The direction that the vessel is pointing in, in the reference frame *ReferenceFrame*.

Attribute Read-only, cannot be set

Returns The direction as a unit vector.

Return type tuple(float, float, float)

pitch

The pitch of the vessel relative to the horizon, in degrees. A value between -90° and $+90^\circ$.

Attribute Read-only, cannot be set

Return type float

heading

The heading of the vessel (its angle relative to north), in degrees. A value between 0° and 360° .

Attribute Read-only, cannot be set

Return type float

roll

The roll of the vessel relative to the horizon, in degrees. A value between -180° and $+180^\circ$.

Attribute Read-only, cannot be set

Return type float

prograde

The prograde direction of the vessels orbit, in the reference frame *ReferenceFrame*.

Attribute Read-only, cannot be set

Returns The direction as a unit vector.

Return type tuple(float, float, float)

retrograde

The retrograde direction of the vessels orbit, in the reference frame *ReferenceFrame*.

Attribute Read-only, cannot be set

Returns The direction as a unit vector.

Return type tuple(float, float, float)

normal

The direction normal to the vessels orbit, in the reference frame *ReferenceFrame*.

Attribute Read-only, cannot be set

Returns The direction as a unit vector.

Return type tuple(float, float, float)

anti_normal

The direction opposite to the normal of the vessels orbit, in the reference frame *ReferenceFrame*.

Attribute Read-only, cannot be set

Returns The direction as a unit vector.

Return type tuple(float, float, float)

radial

The radial direction of the vessels orbit, in the reference frame *ReferenceFrame*.

Attribute Read-only, cannot be set

Returns The direction as a unit vector.

Return type tuple(float, float, float)

anti_radial

The direction opposite to the radial direction of the vessels orbit, in the reference frame *ReferenceFrame*.

Attribute Read-only, cannot be set

Returns The direction as a unit vector.

Return type tuple(float, float, float)

atmosphere_density

The current density of the atmosphere around the vessel, in kg/m^3 .

Attribute Read-only, cannot be set

Return type float

dynamic_pressure

The dynamic pressure acting on the vessel, in Pascals. This is a measure of the strength of the aerodynamic forces. It is equal to $\frac{1}{2} \cdot \text{air density} \cdot \text{velocity}^2$. It is commonly denoted Q .

Attribute Read-only, cannot be set

Return type float

static_pressure

The static atmospheric pressure acting on the vessel, in Pascals.

Attribute Read-only, cannot be set

Return type float

static_pressure_at_msl

The static atmospheric pressure at mean sea level, in Pascals.

Attribute Read-only, cannot be set

Return type float

aerodynamic_force

The total aerodynamic forces acting on the vessel, in reference frame *ReferenceFrame*.

Attribute Read-only, cannot be set

Returns A vector pointing in the direction that the force acts, with its magnitude equal to the strength of the force in Newtons.

Return type tuple(float, float, float)

simulate_aerodynamic_force_at (*body, position, velocity*)

Simulate and return the total aerodynamic forces acting on the vessel, if it were to be traveling with the given velocity at the given position in the atmosphere of the given celestial body.

Parameters

- **body** (*CelestialBody*) –
- **position** (*tuple*) –
- **velocity** (*tuple*) –

Returns A vector pointing in the direction that the force acts, with its magnitude equal to the strength of the force in Newtons.

Return type tuple(float, float, float)

lift

The *aerodynamic lift* currently acting on the vessel.

Attribute Read-only, cannot be set

Returns A vector pointing in the direction that the force acts, with its magnitude equal to the strength of the force in Newtons.

Return type tuple(float, float, float)

drag

The *aerodynamic drag* currently acting on the vessel.

Attribute Read-only, cannot be set

Returns A vector pointing in the direction of the force, with its magnitude equal to the strength of the force in Newtons.

Return type tuple(float, float, float)

speed_of_sound

The speed of sound, in the atmosphere around the vessel, in *m/s*.

Attribute Read-only, cannot be set

Return type float

mach

The speed of the vessel, in multiples of the speed of sound.

Attribute Read-only, cannot be set

Return type float

reynolds_number

The vessels Reynolds number.

Attribute Read-only, cannot be set

Return type float

Note: Requires [Ferram Aerospace Research](#).

true_air_speed

The [true air speed](#) of the vessel, in meters per second.

Attribute Read-only, cannot be set

Return type float

equivalent_air_speed

The [equivalent air speed](#) of the vessel, in meters per second.

Attribute Read-only, cannot be set

Return type float

terminal_velocity

An estimate of the current terminal velocity of the vessel, in meters per second. This is the speed at which the drag forces cancel out the force of gravity.

Attribute Read-only, cannot be set

Return type float

angle_of_attack

The pitch angle between the orientation of the vessel and its velocity vector, in degrees.

Attribute Read-only, cannot be set

Return type float

sideslip_angle

The yaw angle between the orientation of the vessel and its velocity vector, in degrees.

Attribute Read-only, cannot be set

Return type float

total_air_temperature

The [total air temperature](#) of the atmosphere around the vessel, in Kelvin. This includes the *Flight.static_air_temperature* and the vessel's kinetic energy.

Attribute Read-only, cannot be set

Return type float

static_air_temperature

The [static \(ambient\) temperature](#) of the atmosphere around the vessel, in Kelvin.

Attribute Read-only, cannot be set

Return type float

stall_fraction

The current amount of stall, between 0 and 1. A value greater than 0.005 indicates a minor stall and a value greater than 0.5 indicates a large-scale stall.

Attribute Read-only, cannot be set

Return type float

Note: Requires [Ferram Aerospace Research](#).

drag_coefficient

The coefficient of drag. This is the amount of drag produced by the vessel. It depends on air speed, air density and wing area.

Attribute Read-only, cannot be set

Return type float

Note: Requires [Ferram Aerospace Research](#).

lift_coefficient

The coefficient of lift. This is the amount of lift produced by the vessel, and depends on air speed, air density and wing area.

Attribute Read-only, cannot be set

Return type float

Note: Requires [Ferram Aerospace Research](#).

ballistic_coefficient

The [ballistic coefficient](#).

Attribute Read-only, cannot be set

Return type float

Note: Requires [Ferram Aerospace Research](#).

thrust_specific_fuel_consumption

The thrust specific fuel consumption for the jet engines on the vessel. This is a measure of the efficiency of the engines, with a lower value indicating a more efficient vessel. This value is the number of Newtons of fuel that are burned, per hour, to produce one newton of thrust.

Attribute Read-only, cannot be set

Return type float

Note: Requires [Ferram Aerospace Research](#).

8.3.5 Orbit

class Orbit

Describes an orbit. For example, the orbit of a vessel, obtained by calling *Vessel.orbit*, or a celestial body, obtained by calling *CelestialBody.orbit*.

body

The celestial body (e.g. planet or moon) around which the object is orbiting.

Attribute Read-only, cannot be set

Return type *CelestialBody*

apoapsis

Gets the apoapsis of the orbit, in meters, from the center of mass of the body being orbited.

Attribute Read-only, cannot be set

Return type float

Note: For the apoapsis altitude reported on the in-game map view, use *Orbit.apoapsis_altitude*.

periapsis

The periapsis of the orbit, in meters, from the center of mass of the body being orbited.

Attribute Read-only, cannot be set

Return type float

Note: For the periapsis altitude reported on the in-game map view, use *Orbit.periapsis_altitude*.

apoapsis_altitude

The apoapsis of the orbit, in meters, above the sea level of the body being orbited.

Attribute Read-only, cannot be set

Return type float

Note: This is equal to *Orbit.apoapsis* minus the equatorial radius of the body.

periapsis_altitude

The periapsis of the orbit, in meters, above the sea level of the body being orbited.

Attribute Read-only, cannot be set

Return type float

Note: This is equal to *Orbit.periapsis* minus the equatorial radius of the body.

semi_major_axis

The semi-major axis of the orbit, in meters.

Attribute Read-only, cannot be set

Return type float

semi_minor_axis

The semi-minor axis of the orbit, in meters.

Attribute Read-only, cannot be set

Return type float

radius

The current radius of the orbit, in meters. This is the distance between the center of mass of the object in orbit, and the center of mass of the body around which it is orbiting.

Attribute Read-only, cannot be set

Return type float

Note: This value will change over time if the orbit is elliptical.

radius_at (*ut*)

The orbital radius at the given time, in meters.

Parameters **ut** (*float*) – The universal time to measure the radius at.

Return type float

position_at (*ut, reference_frame*)

The position at a given time, in the specified reference frame.

Parameters

- **ut** (*float*) – The universal time to measure the position at.
- **reference_frame** (*ReferenceFrame*) – The reference frame that the returned position vector is in.

Returns The position as a vector.

Return type tuple(float, float, float)

speed

The current orbital speed of the object in meters per second.

Attribute Read-only, cannot be set

Return type float

Note: This value will change over time if the orbit is elliptical.

period

The orbital period, in seconds.

Attribute Read-only, cannot be set

Return type float

time_to_apoapsis

The time until the object reaches apoapsis, in seconds.

Attribute Read-only, cannot be set

Return type float

time_to_periapsis

The time until the object reaches periapsis, in seconds.

Attribute Read-only, cannot be set

Return type float

eccentricity

The [eccentricity](#) of the orbit.

Attribute Read-only, cannot be set

Return type float

inclination

The *inclination* of the orbit, in radians.

Attribute Read-only, cannot be set

Return type float

longitude_of_ascending_node

The *longitude of the ascending node*, in radians.

Attribute Read-only, cannot be set

Return type float

argument_of_periapsis

The *argument of periapsis*, in radians.

Attribute Read-only, cannot be set

Return type float

mean_anomaly_at_epoch

The *mean anomaly at epoch*.

Attribute Read-only, cannot be set

Return type float

epoch

The time since the epoch (the point at which the *mean anomaly at epoch* was measured, in seconds.

Attribute Read-only, cannot be set

Return type float

mean_anomaly

The *mean anomaly*.

Attribute Read-only, cannot be set

Return type float

mean_anomaly_at_ut (ut)

The mean anomaly at the given time.

Parameters *ut* (*float*) – The universal time in seconds.

Return type float

eccentric_anomaly

The *eccentric anomaly*.

Attribute Read-only, cannot be set

Return type float

eccentric_anomaly_at_ut (ut)

The eccentric anomaly at the given universal time.

Parameters *ut* (*float*) – The universal time, in seconds.

Return type float

true_anomaly

The *true anomaly*.

Attribute Read-only, cannot be set

Return type float

true_anomaly_at_ut (*ut*)

The true anomaly at the given time.

Parameters **ut** (*float*) – The universal time in seconds.

Return type float

true_anomaly_at_radius (*radius*)

The true anomaly at the given orbital radius.

Parameters **radius** (*float*) – The orbital radius in meters.

Return type float

ut_at_true_anomaly (*true_anomaly*)

The universal time, in seconds, corresponding to the given true anomaly.

Parameters **true_anomaly** (*float*) – True anomaly.

Return type float

radius_at_true_anomaly (*true_anomaly*)

The orbital radius at the point in the orbit given by the true anomaly.

Parameters **true_anomaly** (*float*) – The true anomaly.

Return type float

true_anomaly_at_an (*target*)

The true anomaly of the ascending node with the given target vessel.

Parameters **target** (*Vessel*) – Target vessel.

Return type float

true_anomaly_at_dn (*target*)

The true anomaly of the descending node with the given target vessel.

Parameters **target** (*Vessel*) – Target vessel.

Return type float

orbital_speed

The current orbital speed in meters per second.

Attribute Read-only, cannot be set

Return type float

orbital_speed_at (*time*)

The orbital speed at the given time, in meters per second.

Parameters **time** (*float*) – Time from now, in seconds.

Return type float

static reference_plane_normal (*reference_frame*)

The direction that is normal to the orbits reference plane, in the given reference frame. The reference plane is the plane from which the orbits inclination is measured.

Parameters **reference_frame** (*ReferenceFrame*) – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

Return type tuple(float, float, float)

static reference_plane_direction (*reference_frame*)

The direction from which the orbits longitude of ascending node is measured, in the given reference frame.

Parameters **reference_frame** (*ReferenceFrame*) – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

Return type tuple(float, float, float)

relative_inclination (*target*)

Relative inclination of this orbit and the orbit of the given target vessel, in radians.

Parameters **target** (*Vessel*) – Target vessel.

Return type float

time_to_soi_change

The time until the object changes sphere of influence, in seconds. Returns NaN if the object is not going to change sphere of influence.

Attribute Read-only, cannot be set

Return type float

next_orbit

If the object is going to change sphere of influence in the future, returns the new orbit after the change. Otherwise returns None.

Attribute Read-only, cannot be set

Return type *Orbit*

time_of_closest_approach (*target*)

Estimates and returns the time at closest approach to a target vessel.

Parameters **target** (*Vessel*) – Target vessel.

Returns The universal time at closest approach, in seconds.

Return type float

distance_at_closest_approach (*target*)

Estimates and returns the distance at closest approach to a target vessel, in meters.

Parameters **target** (*Vessel*) – Target vessel.

Return type float

list_closest_approaches (*target, orbits*)

Returns the times at closest approach and corresponding distances, to a target vessel.

Parameters

- **target** (*Vessel*) – Target vessel.
- **orbits** (*int*) – The number of future orbits to search.

Returns A list of two lists. The first is a list of times at closest approach, as universal times in seconds. The second is a list of corresponding distances at closest approach, in meters.

Return type list(list(float))

8.3.6 Control

class Control

Used to manipulate the controls of a vessel. This includes adjusting the throttle, enabling/disabling systems such as SAS and RCS, or altering the direction in which the vessel is pointing. Obtained by calling *Vessel.control*.

Note: Control inputs (such as pitch, yaw and roll) are zeroed when all clients that have set one or more of these inputs are no longer connected.

source

The source of the vessels control, for example by a kerbal or a probe core.

Attribute Read-only, cannot be set

Return type *ControlSource*

state

The control state of the vessel.

Attribute Read-only, cannot be set

Return type *ControlState*

sas

The state of SAS.

Attribute Can be read or written

Return type bool

Note: Equivalent to *AutoPilot.sas*

sas_mode

The current *SASMode*. These modes are equivalent to the mode buttons to the left of the navball that appear when SAS is enabled.

Attribute Can be read or written

Return type *SASMode*

Note: Equivalent to *AutoPilot.sas_mode*

speed_mode

The current *SpeedMode* of the navball. This is the mode displayed next to the speed at the top of the navball.

Attribute Can be read or written

Return type *SpeedMode*

rcs

The state of RCS.

Attribute Can be read or written

Return type bool

reaction_wheels

Returns whether all reactive wheels on the vessel are active, and sets the active state of all reaction wheels. See *ReactionWheel.active*.

Attribute Can be read or written

Return type bool

gear

The state of the landing gear/legs.

Attribute Can be read or written

Return type bool

legs

Returns whether all landing legs on the vessel are deployed, and sets the deployment state of all landing legs. Does not include wheels (for example landing gear). See *Leg.deployed*.

Attribute Can be read or written

Return type bool

wheels

Returns whether all wheels on the vessel are deployed, and sets the deployment state of all wheels. Does not include landing legs. See *Wheel.deployed*.

Attribute Can be read or written

Return type bool

lights

The state of the lights.

Attribute Can be read or written

Return type bool

brakes

The state of the wheel brakes.

Attribute Can be read or written

Return type bool

antennas

Returns whether all antennas on the vessel are deployed, and sets the deployment state of all antennas. See *Antenna.deployed*.

Attribute Can be read or written

Return type bool

cargo_bays

Returns whether any of the cargo bays on the vessel are open, and sets the open state of all cargo bays. See *CargoBay.open*.

Attribute Can be read or written

Return type bool

intakes

Returns whether all of the air intakes on the vessel are open, and sets the open state of all air intakes. See *Intake.open*.

Attribute Can be read or written

Return type bool

parachutes

Returns whether all parachutes on the vessel are deployed, and sets the deployment state of all parachutes. Cannot be set to `False`. See *Parachute.deployed*.

Attribute Can be read or written

Return type bool

radiators

Returns whether all radiators on the vessel are deployed, and sets the deployment state of all radiators. See *Radiator.deployed*.

Attribute Can be read or written

Return type bool

resource_harvesters

Returns whether all of the resource harvesters on the vessel are deployed, and sets the deployment state of all resource harvesters. See *ResourceHarvester.deployed*.

Attribute Can be read or written

Return type bool

resource_harvesters_active

Returns whether any of the resource harvesters on the vessel are active, and sets the active state of all resource harvesters. See *ResourceHarvester.active*.

Attribute Can be read or written

Return type bool

solar_panels

Returns whether all solar panels on the vessel are deployed, and sets the deployment state of all solar panels. See *SolarPanel.deployed*.

Attribute Can be read or written

Return type bool

abort

The state of the abort action group.

Attribute Can be read or written

Return type bool

throttle

The state of the throttle. A value between 0 and 1.

Attribute Can be read or written

Return type float

input_mode

Sets the behavior of the pitch, yaw, roll and translation control inputs. When set to additive, these inputs are added to the vessels current inputs. This mode is the default. When set to override, these inputs (if non-zero) override the vessels inputs. This mode prevents keyboard control, or SAS, from interfering with the controls when they are set.

Attribute Can be read or written

Return type *ControlInputMode*

pitch

The state of the pitch control. A value between -1 and 1. Equivalent to the w and s keys.

Attribute Can be read or written

Return type float

yaw

The state of the yaw control. A value between -1 and 1. Equivalent to the a and d keys.

Attribute Can be read or written

Return type float

roll

The state of the roll control. A value between -1 and 1. Equivalent to the q and e keys.

Attribute Can be read or written

Return type float

forward

The state of the forward translational control. A value between -1 and 1. Equivalent to the h and n keys.

Attribute Can be read or written

Return type float

up

The state of the up translational control. A value between -1 and 1. Equivalent to the i and k keys.

Attribute Can be read or written

Return type float

right

The state of the right translational control. A value between -1 and 1. Equivalent to the j and l keys.

Attribute Can be read or written

Return type float

wheel_throttle

The state of the wheel throttle. A value between -1 and 1. A value of 1 rotates the wheels forwards, a value of -1 rotates the wheels backwards.

Attribute Can be read or written

Return type float

wheel_steering

The state of the wheel steering. A value between -1 and 1. A value of 1 steers to the left, and a value of -1 steers to the right.

Attribute Can be read or written

Return type float

current_stage

The current stage of the vessel. Corresponds to the stage number in the in-game UI.

Attribute Read-only, cannot be set

Return type int

activate_next_stage()

Activates the next stage. Equivalent to pressing the space bar in-game.

Returns A list of vessel objects that are jettisoned from the active vessel.

Return type `list(Vessel)`

Note: When called, the active vessel may change. It is therefore possible that, after calling this function, the object(s) returned by previous call(s) to `active_vessel` no longer refer to the active vessel.

get_action_group (*group*)

Returns `True` if the given action group is enabled.

Parameters **group** (*int*) – A number between 0 and 9 inclusive, or between 0 and 250 inclusive when the [Extended Action Groups mod](#) is installed.

Return type `bool`

set_action_group (*group*, *state*)

Sets the state of the given action group.

Parameters

- **group** (*int*) – A number between 0 and 9 inclusive, or between 0 and 250 inclusive when the [Extended Action Groups mod](#) is installed.
- **state** (*bool*) –

toggle_action_group (*group*)

Toggles the state of the given action group.

Parameters **group** (*int*) – A number between 0 and 9 inclusive, or between 0 and 250 inclusive when the [Extended Action Groups mod](#) is installed.

add_node (*ut* [, *prograde* = 0.0] [, *normal* = 0.0] [, *radial* = 0.0])

Creates a maneuver node at the given universal time, and returns a *Node* object that can be used to modify it. Optionally sets the magnitude of the delta-v for the maneuver node in the prograde, normal and radial directions.

Parameters

- **ut** (*float*) – Universal time of the maneuver node.
- **prograde** (*float*) – Delta-v in the prograde direction.
- **normal** (*float*) – Delta-v in the normal direction.
- **radial** (*float*) – Delta-v in the radial direction.

Return type *Node*

nodes

Returns a list of all existing maneuver nodes, ordered by time from first to last.

Attribute Read-only, cannot be set

Return type `list(Node)`

remove_nodes ()

Remove all maneuver nodes.

class ControlState

The control state of a vessel. See *Control.state*.

full

Full controllable.

partial

Partially controllable.

none

Not controllable.

class ControlSourceThe control source of a vessel. See *Control.source*.**kerbal**

Vessel is controlled by a Kerbal.

probe

Vessel is controlled by a probe core.

none

Vessel is not controlled.

class SASModeThe behavior of the SAS auto-pilot. See *AutoPilot.sas_mode*.**stability_assist**

Stability assist mode. Dampen out any rotation.

maneuver

Point in the burn direction of the next maneuver node.

prograde

Point in the prograde direction.

retrograde

Point in the retrograde direction.

normal

Point in the orbit normal direction.

anti_normal

Point in the orbit anti-normal direction.

radial

Point in the orbit radial direction.

anti_radial

Point in the orbit anti-radial direction.

target

Point in the direction of the current target.

anti_target

Point away from the current target.

class SpeedModeThe mode of the speed reported in the navball. See *Control.speed_mode*.**orbit**

Speed is relative to the vessel's orbit.

surface

Speed is relative to the surface of the body being orbited.

target

Speed is relative to the current target.

class ControlInputMode

See *Control.input_mode*.

additive

Control inputs are added to the vessels current control inputs.

override

Control inputs (when they are non-zero) override the vessels current control inputs.

8.3.7 Communications

class Comms

Used to interact with CommNet for a given vessel. Obtained by calling *Vessel.comms*.

can_communicate

Whether the vessel can communicate with KSC.

Attribute Read-only, cannot be set

Return type bool

can_transmit_science

Whether the vessel can transmit science data to KSC.

Attribute Read-only, cannot be set

Return type bool

signal_strength

Signal strength to KSC.

Attribute Read-only, cannot be set

Return type float

signal_delay

Signal delay to KSC in seconds.

Attribute Read-only, cannot be set

Return type float

power

The combined power of all active antennae on the vessel.

Attribute Read-only, cannot be set

Return type float

control_path

The communication path used to control the vessel.

Attribute Read-only, cannot be set

Return type list(*CommLink*)

class CommLink

Represents a communication node in the network. For example, a vessel or the KSC.

type

The type of link.

Attribute Read-only, cannot be set

Return type *CommLinkType*

signal_strength

Signal strength of the link.

Attribute Read-only, cannot be set**Return type** float**start**

Start point of the link.

Attribute Read-only, cannot be set**Return type** *CommNode***end**

Start point of the link.

Attribute Read-only, cannot be set**Return type** *CommNode***class CommLinkType**The type of a communication link. See *CommLink.type*.**home**

Link is to a base station on Kerbin.

control

Link is to a control source, for example a manned spacecraft.

relay

Link is to a relay satellite.

class CommNode

Represents a communication node in the network. For example, a vessel or the KSC.

name

Name of the communication node.

Attribute Read-only, cannot be set**Return type** str**is_home**

Whether the communication node is on Kerbin.

Attribute Read-only, cannot be set**Return type** bool**is_control_point**

Whether the communication node is a control point, for example a manned vessel.

Attribute Read-only, cannot be set**Return type** bool**is_vessel**

Whether the communication node is a vessel.

Attribute Read-only, cannot be set**Return type** bool**vessel**

The vessel for this communication node.

Attribute Read-only, cannot be set

Return type *Vessel*

8.3.8 Parts

The following classes allow interaction with a vessels individual parts.

- *Parts*
- *Part*
- *Module*
- *Specific Types of Part*
 - *Antenna*
 - *Cargo Bay*
 - *Control Surface*
 - *Decoupler*
 - *Docking Port*
 - *Engine*
 - *Experiment*
 - *Fairing*
 - *Intake*
 - *Leg*
 - *Launch Clamp*
 - *Light*
 - *Parachute*
 - *Radiator*
 - *Resource Converter*
 - *Resource Harvester*
 - *Reaction Wheel*
 - *RCS*
 - *Sensor*
 - *Solar Panel*
 - *Thruster*
 - *Wheel*
- *Trees of Parts*
 - *Traversing the Tree*
 - *Attachment Modes*

- *Fuel Lines*
- *Staging*

Parts

class Parts

Instances of this class are used to interact with the parts of a vessel. An instance can be obtained by calling *Vessel.parts*.

all

A list of all of the vessels parts.

Attribute Read-only, cannot be set

Return type list(*Part*)

root

The vessels root part.

Attribute Read-only, cannot be set

Return type *Part*

Note: See the discussion on *Trees of Parts*.

controlling

The part from which the vessel is controlled.

Attribute Can be read or written

Return type *Part*

with_name (name)

A list of parts whose *Part.name* is *name*.

Parameters **name** (*str*) –

Return type list(*Part*)

with_title (title)

A list of all parts whose *Part.title* is *title*.

Parameters **title** (*str*) –

Return type list(*Part*)

with_tag (tag)

A list of all parts whose *Part.tag* is *tag*.

Parameters **tag** (*str*) –

Return type list(*Part*)

with_module (module_name)

A list of all parts that contain a *Module* whose *Module.name* is *module_name*.

Parameters **module_name** (*str*) –

Return type list(*Part*)

in_stage (*stage*)

A list of all parts that are activated in the given *stage*.

Parameters *stage* (*int*) –

Return type list(*Part*)

Note: See the discussion on *Staging*.

in_decouple_stage (*stage*)

A list of all parts that are decoupled in the given *stage*.

Parameters *stage* (*int*) –

Return type list(*Part*)

Note: See the discussion on *Staging*.

modules_with_name (*module_name*)

A list of modules (combined across all parts in the vessel) whose *Module.name* is *module_name*.

Parameters *module_name* (*str*) –

Return type list(*Module*)

antennas

A list of all antennas in the vessel.

Attribute Read-only, cannot be set

Return type list(*Antenna*)

cargo_bays

A list of all cargo bays in the vessel.

Attribute Read-only, cannot be set

Return type list(*CargoBay*)

control_surfaces

A list of all control surfaces in the vessel.

Attribute Read-only, cannot be set

Return type list(*ControlSurface*)

decouplers

A list of all decouplers in the vessel.

Attribute Read-only, cannot be set

Return type list(*Decoupler*)

docking_ports

A list of all docking ports in the vessel.

Attribute Read-only, cannot be set

Return type list(*DockingPort*)

engines

A list of all engines in the vessel.

Attribute Read-only, cannot be set

Return type `list(Engine)`

Note: This includes any part that generates thrust. This covers many different types of engine, including liquid fuel rockets, solid rocket boosters, jet engines and RCS thrusters.

experiments

A list of all science experiments in the vessel.

Attribute Read-only, cannot be set

Return type `list(Experiment)`

fairings

A list of all fairings in the vessel.

Attribute Read-only, cannot be set

Return type `list(Fairing)`

intakes

A list of all intakes in the vessel.

Attribute Read-only, cannot be set

Return type `list(Intake)`

legs

A list of all landing legs attached to the vessel.

Attribute Read-only, cannot be set

Return type `list(Leg)`

launch_clamps

A list of all launch clamps attached to the vessel.

Attribute Read-only, cannot be set

Return type `list(LaunchClamp)`

lights

A list of all lights in the vessel.

Attribute Read-only, cannot be set

Return type `list(Light)`

parachutes

A list of all parachutes in the vessel.

Attribute Read-only, cannot be set

Return type `list(Parachute)`

radiators

A list of all radiators in the vessel.

Attribute Read-only, cannot be set

Return type `list(Radiator)`

rcs

A list of all RCS blocks/thrusters in the vessel.

Attribute Read-only, cannot be set

Return type `list(RCS)`

reaction_wheels

A list of all reaction wheels in the vessel.

Attribute Read-only, cannot be set

Return type `list(ReactionWheel)`

resource_converters

A list of all resource converters in the vessel.

Attribute Read-only, cannot be set

Return type `list(ResourceConverter)`

resource_harvesters

A list of all resource harvesters in the vessel.

Attribute Read-only, cannot be set

Return type `list(ResourceHarvester)`

sensors

A list of all sensors in the vessel.

Attribute Read-only, cannot be set

Return type `list(Sensor)`

solar_panels

A list of all solar panels in the vessel.

Attribute Read-only, cannot be set

Return type `list(SolarPanel)`

wheels

A list of all wheels in the vessel.

Attribute Read-only, cannot be set

Return type `list(Wheel)`

Part

class Part

Represents an individual part. Vessels are made up of multiple parts. Instances of this class can be obtained by several methods in *Parts*.

name

Internal name of the part, as used in [part cfg files](#). For example “Mark1-2Pod”.

Attribute Read-only, cannot be set

Return type `str`

title

Title of the part, as shown when the part is right clicked in-game. For example “Mk1-2 Command Pod”.

Attribute Read-only, cannot be set

Return type `str`

tag

The name tag for the part. Can be set to a custom string using the in-game user interface.

Attribute Can be read or written

Return type str

Note: This requires either the [NameTag](#) or [kOS](#) mod to be installed.

highlighted

Whether the part is highlighted.

Attribute Can be read or written

Return type bool

highlight_color

The color used to highlight the part, as an RGB triple.

Attribute Can be read or written

Return type tuple(float, float, float)

cost

The cost of the part, in units of funds.

Attribute Read-only, cannot be set

Return type float

vessel

The vessel that contains this part.

Attribute Read-only, cannot be set

Return type *Vessel*

parent

The parts parent. Returns *None* if the part does not have a parent. This, in combination with *Part.children*, can be used to traverse the vessels parts tree.

Attribute Read-only, cannot be set

Return type *Part*

Note: See the discussion on *Trees of Parts*.

children

The parts children. Returns an empty list if the part has no children. This, in combination with *Part.parent*, can be used to traverse the vessels parts tree.

Attribute Read-only, cannot be set

Return type list(*Part*)

Note: See the discussion on *Trees of Parts*.

axially_attached

Whether the part is axially attached to its parent, i.e. on the top or bottom of its parent. If the part has no parent, returns *False*.

Attribute Read-only, cannot be set

Return type bool

Note: See the discussion on *Attachment Modes*.

radially_attached

Whether the part is radially attached to its parent, i.e. on the side of its parent. If the part has no parent, returns `False`.

Attribute Read-only, cannot be set

Return type bool

Note: See the discussion on *Attachment Modes*.

stage

The stage in which this part will be activated. Returns -1 if the part is not activated by staging.

Attribute Read-only, cannot be set

Return type int

Note: See the discussion on *Staging*.

decouple_stage

The stage in which this part will be decoupled. Returns -1 if the part is never decoupled from the vessel.

Attribute Read-only, cannot be set

Return type int

Note: See the discussion on *Staging*.

massless

Whether the part is `massless`.

Attribute Read-only, cannot be set

Return type bool

mass

The current mass of the part, including resources it contains, in kilograms. Returns zero if the part is massless.

Attribute Read-only, cannot be set

Return type float

dry_mass

The mass of the part, not including any resources it contains, in kilograms. Returns zero if the part is massless.

Attribute Read-only, cannot be set

Return type float

shielded

Whether the part is shielded from the exterior of the vessel, for example by a fairing.

Attribute Read-only, cannot be set

Return type bool

dynamic_pressure

The dynamic pressure acting on the part, in Pascals.

Attribute Read-only, cannot be set

Return type float

impact_tolerance

The impact tolerance of the part, in meters per second.

Attribute Read-only, cannot be set

Return type float

temperature

Temperature of the part, in Kelvin.

Attribute Read-only, cannot be set

Return type float

skin_temperature

Temperature of the skin of the part, in Kelvin.

Attribute Read-only, cannot be set

Return type float

max_temperature

Maximum temperature that the part can survive, in Kelvin.

Attribute Read-only, cannot be set

Return type float

max_skin_temperature

Maximum temperature that the skin of the part can survive, in Kelvin.

Attribute Read-only, cannot be set

Return type float

thermal_mass

A measure of how much energy it takes to increase the internal temperature of the part, in Joules per Kelvin.

Attribute Read-only, cannot be set

Return type float

thermal_skin_mass

A measure of how much energy it takes to increase the skin temperature of the part, in Joules per Kelvin.

Attribute Read-only, cannot be set

Return type float

thermal_resource_mass

A measure of how much energy it takes to increase the temperature of the resources contained in the part, in Joules per Kelvin.

Attribute Read-only, cannot be set

Return type float

thermal_conduction_flux

The rate at which heat energy is conducting into or out of the part via contact with other parts. Measured in energy per unit time, or power, in Watts. A positive value means the part is gaining heat energy, and negative means it is losing heat energy.

Attribute Read-only, cannot be set

Return type float

thermal_convection_flux

The rate at which heat energy is convecting into or out of the part from the surrounding atmosphere. Measured in energy per unit time, or power, in Watts. A positive value means the part is gaining heat energy, and negative means it is losing heat energy.

Attribute Read-only, cannot be set

Return type float

thermal_radiation_flux

The rate at which heat energy is radiating into or out of the part from the surrounding environment. Measured in energy per unit time, or power, in Watts. A positive value means the part is gaining heat energy, and negative means it is losing heat energy.

Attribute Read-only, cannot be set

Return type float

thermal_internal_flux

The rate at which heat energy is being generated by the part. For example, some engines generate heat by combusting fuel. Measured in energy per unit time, or power, in Watts. A positive value means the part is gaining heat energy, and negative means it is losing heat energy.

Attribute Read-only, cannot be set

Return type float

thermal_skin_to_internal_flux

The rate at which heat energy is transferring between the part's skin and its internals. Measured in energy per unit time, or power, in Watts. A positive value means the part's internals are gaining heat energy, and negative means its skin is gaining heat energy.

Attribute Read-only, cannot be set

Return type float

resources

A *Resources* object for the part.

Attribute Read-only, cannot be set

Return type *Resources*

crossfeed

Whether this part is crossfeed capable.

Attribute Read-only, cannot be set

Return type bool

is_fuel_line

Whether this part is a fuel line.

Attribute Read-only, cannot be set

Return type bool

fuel_lines_from

The parts that are connected to this part via fuel lines, where the direction of the fuel line is into this part.

Attribute Read-only, cannot be set

Return type list(*Part*)

Note: See the discussion on *Fuel Lines*.

fuel_lines_to

The parts that are connected to this part via fuel lines, where the direction of the fuel line is out of this part.

Attribute Read-only, cannot be set

Return type list(*Part*)

Note: See the discussion on *Fuel Lines*.

modules

The modules for this part.

Attribute Read-only, cannot be set

Return type list(*Module*)

antenna

A *Antenna* if the part is an antenna, otherwise None.

Attribute Read-only, cannot be set

Return type *Antenna*

cargo_bay

A *CargoBay* if the part is a cargo bay, otherwise None.

Attribute Read-only, cannot be set

Return type *CargoBay*

control_surface

A *ControlSurface* if the part is an aerodynamic control surface, otherwise None.

Attribute Read-only, cannot be set

Return type *ControlSurface*

decoupler

A *Decoupler* if the part is a decoupler, otherwise None.

Attribute Read-only, cannot be set

Return type *Decoupler*

docking_port

A *DockingPort* if the part is a docking port, otherwise None.

Attribute Read-only, cannot be set

Return type *DockingPort*

engine

An *Engine* if the part is an engine, otherwise *None*.

Attribute Read-only, cannot be set

Return type *Engine*

experiment

An *Experiment* if the part is a science experiment, otherwise *None*.

Attribute Read-only, cannot be set

Return type *Experiment*

fairing

A *Fairing* if the part is a fairing, otherwise *None*.

Attribute Read-only, cannot be set

Return type *Fairing*

intake

An *Intake* if the part is an intake, otherwise *None*.

Attribute Read-only, cannot be set

Return type *Intake*

Note: This includes any part that generates thrust. This covers many different types of engine, including liquid fuel rockets, solid rocket boosters and jet engines. For RCS thrusters see *RCS*.

leg

A *Leg* if the part is a landing leg, otherwise *None*.

Attribute Read-only, cannot be set

Return type *Leg*

launch_clamp

A *LaunchClamp* if the part is a launch clamp, otherwise *None*.

Attribute Read-only, cannot be set

Return type *LaunchClamp*

light

A *Light* if the part is a light, otherwise *None*.

Attribute Read-only, cannot be set

Return type *Light*

parachute

A *Parachute* if the part is a parachute, otherwise *None*.

Attribute Read-only, cannot be set

Return type *Parachute*

radiator

A *Radiator* if the part is a radiator, otherwise *None*.

Attribute Read-only, cannot be set

Return type *Radiator*

rcs

A *RCS* if the part is an RCS block/thruster, otherwise *None*.

Attribute Read-only, cannot be set

Return type *RCS*

reaction_wheel

A *ReactionWheel* if the part is a reaction wheel, otherwise *None*.

Attribute Read-only, cannot be set

Return type *ReactionWheel*

resource_converter

A *ResourceConverter* if the part is a resource converter, otherwise *None*.

Attribute Read-only, cannot be set

Return type *ResourceConverter*

resource_harvester

A *ResourceHarvester* if the part is a resource harvester, otherwise *None*.

Attribute Read-only, cannot be set

Return type *ResourceHarvester*

sensor

A *Sensor* if the part is a sensor, otherwise *None*.

Attribute Read-only, cannot be set

Return type *Sensor*

solar_panel

A *SolarPanel* if the part is a solar panel, otherwise *None*.

Attribute Read-only, cannot be set

Return type *SolarPanel*

wheel

A *Wheel* if the part is a wheel, otherwise *None*.

Attribute Read-only, cannot be set

Return type *Wheel*

position (*reference_frame*)

The position of the part in the given reference frame.

Parameters **reference_frame** (*ReferenceFrame*) – The reference frame that the returned position vector is in.

Returns The position as a vector.

Return type tuple(float, float, float)

Note: This is a fixed position in the part, defined by the parts model. It is not necessarily the same as the parts center of mass. Use *Part.center_of_mass()* to get the parts center of mass.

center_of_mass (*reference_frame*)

The position of the parts center of mass in the given reference frame. If the part is physicsless, this is equivalent to *Part.position()*.

Parameters `reference_frame` (`ReferenceFrame`) – The reference frame that the returned position vector is in.

Returns The position as a vector.

Return type `tuple(float, float, float)`

bounding_box (`reference_frame`)

The axis-aligned bounding box of the part in the given reference frame.

Parameters `reference_frame` (`ReferenceFrame`) – The reference frame that the returned position vectors are in.

Returns The positions of the minimum and maximum vertices of the box, as position vectors.

Return type `tuple(tuple(float, float, float), tuple(float, float, float))`

Note: This is computed from the collision mesh of the part. If the part is not collidable, the box has zero volume and is centered on the `Part.position()` of the part.

direction (`reference_frame`)

The direction the part points in, in the given reference frame.

Parameters `reference_frame` (`ReferenceFrame`) – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

Return type `tuple(float, float, float)`

velocity (`reference_frame`)

The linear velocity of the part in the given reference frame.

Parameters `reference_frame` (`ReferenceFrame`) – The reference frame that the returned velocity vector is in.

Returns The velocity as a vector. The vector points in the direction of travel, and its magnitude is the speed of the body in meters per second.

Return type `tuple(float, float, float)`

rotation (`reference_frame`)

The rotation of the part, in the given reference frame.

Parameters `reference_frame` (`ReferenceFrame`) – The reference frame that the returned rotation is in.

Returns The rotation as a quaternion of the form (x, y, z, w) .

Return type `tuple(float, float, float, float)`

moment_of_inertia

The moment of inertia of the part in $kg.m^2$ around its center of mass in the parts reference frame (`ReferenceFrame`).

Attribute Read-only, cannot be set

Return type `tuple(float, float, float)`

inertia_tensor

The inertia tensor of the part in the parts reference frame (`ReferenceFrame`). Returns the 3x3 matrix as a list of elements, in row-major order.

Attribute Read-only, cannot be set

Return type `list(float)`

reference_frame

The reference frame that is fixed relative to this part, and centered on a fixed position within the part, defined by the parts model.

- The origin is at the position of the part, as returned by `Part.position()`.
- The axes rotate with the part.
- The x, y and z axis directions depend on the design of the part.

Attribute Read-only, cannot be set

Return type `ReferenceFrame`

Note: For docking port parts, this reference frame is not necessarily equivalent to the reference frame for the docking port, returned by `DockingPort.reference_frame`.

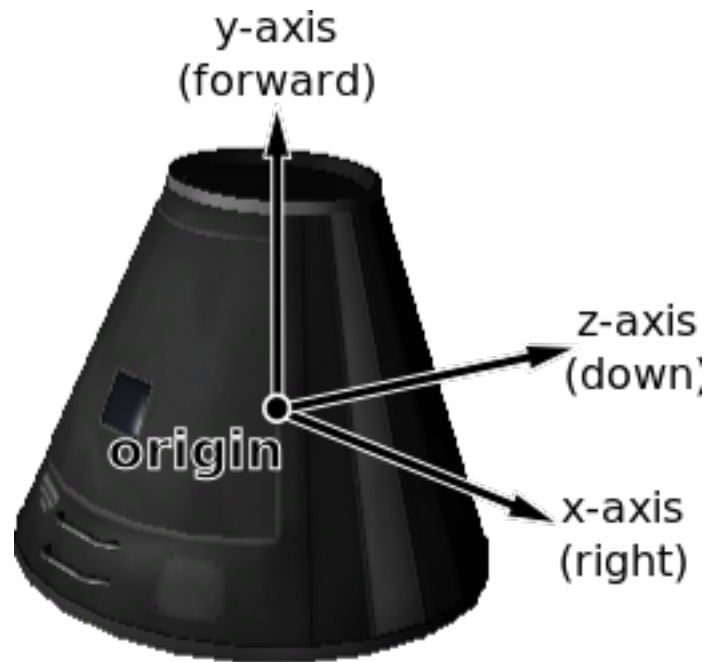


Fig. 8.7: Mk1 Command Pod reference frame origin and axes

center_of_mass_reference_frame

The reference frame that is fixed relative to this part, and centered on its center of mass.

- The origin is at the center of mass of the part, as returned by `Part.center_of_mass()`.
- The axes rotate with the part.
- The x, y and z axis directions depend on the design of the part.

Attribute Read-only, cannot be set

Return type `ReferenceFrame`

Note: For docking port parts, this reference frame is not necessarily equivalent to the reference frame for the docking port, returned by `DockingPort.reference_frame`.

add_force (*force, position, reference_frame*)

Exert a constant force on the part, acting at the given position.

Parameters

- **force** (*tuple*) – A vector pointing in the direction that the force acts, with its magnitude equal to the strength of the force in Newtons.
- **position** (*tuple*) – The position at which the force acts, as a vector.
- **reference_frame** (`ReferenceFrame`) – The reference frame that the force and position are in.

Returns An object that can be used to remove or modify the force.

Return type `Force`

instantaneous_force (*force, position, reference_frame*)

Exert an instantaneous force on the part, acting at the given position.

Parameters

- **force** (*tuple*) – A vector pointing in the direction that the force acts, with its magnitude equal to the strength of the force in Newtons.
- **position** (*tuple*) – The position at which the force acts, as a vector.
- **reference_frame** (`ReferenceFrame`) – The reference frame that the force and position are in.

Note: The force is applied instantaneously in a single physics update.

class Force

Obtained by calling `Part.add_force()`.

part

The part that this force is applied to.

Attribute Read-only, cannot be set

Return type `Part`

force_vector

The force vector, in Newtons.

Attribute Can be read or written

Returns A vector pointing in the direction that the force acts, with its magnitude equal to the strength of the force in Newtons.

Return type `tuple(float, float, float)`

position

The position at which the force acts, in reference frame `ReferenceFrame`.

Attribute Can be read or written

Returns The position as a vector.

Return type tuple(float, float, float)

reference_frame

The reference frame of the force vector and position.

Attribute Can be read or written

Return type *ReferenceFrame*

remove()

Remove the force.

Module

class Module

This can be used to interact with a specific part module. This includes part modules in stock KSP, and those added by mods.

In KSP, each part has zero or more [PartModules](#) associated with it. Each one contains some of the functionality of the part. For example, an engine has a “ModuleEngines” part module that contains all the functionality of an engine.

name

Name of the PartModule. For example, “ModuleEngines”.

Attribute Read-only, cannot be set

Return type str

part

The part that contains this module.

Attribute Read-only, cannot be set

Return type *Part*

fields

The modules field names and their associated values, as a dictionary. These are the values visible in the right-click menu of the part.

Attribute Read-only, cannot be set

Return type dict(str, str)

has_field(name)

Returns `True` if the module has a field with the given name.

Parameters **name** (*str*) – Name of the field.

Return type bool

get_field(name)

Returns the value of a field.

Parameters **name** (*str*) – Name of the field.

Return type str

set_field_int(name, value)

Set the value of a field to the given integer number.

Parameters

- **name** (*str*) – Name of the field.

- **value** (*int*) – Value to set.

set_field_float (*name*, *value*)

Set the value of a field to the given floating point number.

Parameters

- **name** (*str*) – Name of the field.
- **value** (*float*) – Value to set.

set_field_string (*name*, *value*)

Set the value of a field to the given string.

Parameters

- **name** (*str*) – Name of the field.
- **value** (*str*) – Value to set.

reset_field (*name*)

Set the value of a field to its original value.

Parameters **name** (*str*) – Name of the field.

events

A list of the names of all of the modules events. Events are the clickable buttons visible in the right-click menu of the part.

Attribute Read-only, cannot be set

Return type list(str)

has_event (*name*)

True if the module has an event with the given name.

Parameters **name** (*str*) –

Return type bool

trigger_event (*name*)

Trigger the named event. Equivalent to clicking the button in the right-click menu of the part.

Parameters **name** (*str*) –

actions

A list of all the names of the modules actions. These are the parts actions that can be assigned to action groups in the in-game editor.

Attribute Read-only, cannot be set

Return type list(str)

has_action (*name*)

True if the part has an action with the given name.

Parameters **name** (*str*) –

Return type bool

set_action (*name*[, *value* = *True*])

Set the value of an action with the given name.

Parameters

- **name** (*str*) –
- **value** (*bool*) –

Specific Types of Part

The following classes provide functionality for specific types of part.

- *Antenna*
- *Cargo Bay*
- *Control Surface*
- *Decoupler*
- *Docking Port*
- *Engine*
- *Experiment*
- *Fairing*
- *Intake*
- *Leg*
- *Launch Clamp*
- *Light*
- *Parachute*
- *Radiator*
- *Resource Converter*
- *Resource Harvester*
- *Reaction Wheel*
- *RCS*
- *Sensor*
- *Solar Panel*
- *Thruster*
- *Wheel*

Antenna

class *Antenna*

An antenna. Obtained by calling *Part.antenna*.

part

The part object for this antenna.

Attribute Read-only, cannot be set

Return type *Part*

state

The current state of the antenna.

Attribute Read-only, cannot be set

Return type *AntennaState*

deployable

Whether the antenna is deployable.

Attribute Read-only, cannot be set

Return type bool

deployed

Whether the antenna is deployed.

Attribute Can be read or written

Return type bool

Note: Fixed antennas are always deployed. Returns an error if you try to deploy a fixed antenna.

can_transmit

Whether data can be transmitted by this antenna.

Attribute Read-only, cannot be set

Return type bool

transmit ()

Transmit data.

cancel ()

Cancel current transmission of data.

allow_partial

Whether partial data transmission is permitted.

Attribute Can be read or written

Return type bool

power

The power of the antenna.

Attribute Read-only, cannot be set

Return type float

combinable

Whether the antenna can be combined with other antennae on the vessel to boost the power.

Attribute Read-only, cannot be set

Return type bool

combinable_exponent

Exponent used to calculate the combined power of multiple antennae on a vessel.

Attribute Read-only, cannot be set

Return type float

packet_interval

Interval between sending packets in seconds.

Attribute Read-only, cannot be set

Return type float

packet_size

Amount of data sent per packet in Mits.

Attribute Read-only, cannot be set

Return type float

packet_resource_cost

Units of electric charge consumed per packet sent.

Attribute Read-only, cannot be set

Return type float

class AntennaState

The state of an antenna. See *Antenna.state*.

deployed

Antenna is fully deployed.

retracted

Antenna is fully retracted.

deploying

Antenna is being deployed.

retracting

Antenna is being retracted.

broken

Antenna is broken.

Cargo Bay**class CargoBay**

A cargo bay. Obtained by calling *Part.cargo_bay*.

part

The part object for this cargo bay.

Attribute Read-only, cannot be set

Return type *Part*

state

The state of the cargo bay.

Attribute Read-only, cannot be set

Return type *CargoBayState*

open

Whether the cargo bay is open.

Attribute Can be read or written

Return type bool

class CargoBayState

The state of a cargo bay. See *CargoBay.state*.

open

Cargo bay is fully open.

closed

Cargo bay closed and locked.

opening

Cargo bay is opening.

closing

Cargo bay is closing.

Control Surface

class ControlSurface

An aerodynamic control surface. Obtained by calling *Part.control_surface*.

part

The part object for this control surface.

Attribute Read-only, cannot be set

Return type *Part*

pitch_enabled

Whether the control surface has pitch control enabled.

Attribute Can be read or written

Return type bool

yaw_enabled

Whether the control surface has yaw control enabled.

Attribute Can be read or written

Return type bool

roll_enabled

Whether the control surface has roll control enabled.

Attribute Can be read or written

Return type bool

authority_limiter

The authority limiter for the control surface, which controls how far the control surface will move.

Attribute Can be read or written

Return type float

inverted

Whether the control surface movement is inverted.

Attribute Can be read or written

Return type bool

deployed

Whether the control surface has been fully deployed.

Attribute Can be read or written

Return type bool

surface_area

Surface area of the control surface in m^2 .

Attribute Read-only, cannot be set

Return type float

available_torque

The available torque, in Newton meters, that can be produced by this control surface, in the positive and negative pitch, roll and yaw axes of the vessel. These axes correspond to the coordinate axes of the *Vessel.reference_frame*.

Attribute Read-only, cannot be set

Return type tuple(tuple(float, float, float), tuple(float, float, float))

Decoupler

class Decoupler

A decoupler. Obtained by calling *Part.decoupler*

part

The part object for this decoupler.

Attribute Read-only, cannot be set

Return type *Part*

decouple ()

Fires the decoupler. Returns the new vessel created when the decoupler fires. Throws an exception if the decoupler has already fired.

Return type *Vessel*

Note: When called, the active vessel may change. It is therefore possible that, after calling this function, the object(s) returned by previous call(s) to *active_vessel* no longer refer to the active vessel.

decoupled

Whether the decoupler has fired.

Attribute Read-only, cannot be set

Return type bool

staged

Whether the decoupler is enabled in the staging sequence.

Attribute Read-only, cannot be set

Return type bool

impulse

The impulse that the decoupler imparts when it is fired, in Newton seconds.

Attribute Read-only, cannot be set

Return type float

Docking Port

class DockingPort

A docking port. Obtained by calling *Part.docking_port*

part

The part object for this docking port.

Attribute Read-only, cannot be set

Return type *Part*

state

The current state of the docking port.

Attribute Read-only, cannot be set

Return type *DockingPortState*

docked_part

The part that this docking port is docked to. Returns *None* if this docking port is not docked to anything.

Attribute Read-only, cannot be set

Return type *Part*

undock ()

Undocks the docking port and returns the new *Vessel* that is created. This method can be called for either docking port in a docked pair. Throws an exception if the docking port is not docked to anything.

Return type *Vessel*

Note: When called, the active vessel may change. It is therefore possible that, after calling this function, the object(s) returned by previous call(s) to *active_vessel* no longer refer to the active vessel.

reengage_distance

The distance a docking port must move away when it undocks before it becomes ready to dock with another port, in meters.

Attribute Read-only, cannot be set

Return type *float*

has_shield

Whether the docking port has a shield.

Attribute Read-only, cannot be set

Return type *bool*

shielded

The state of the docking ports shield, if it has one.

Returns *True* if the docking port has a shield, and the shield is closed. Otherwise returns *False*. When set to *True*, the shield is closed, and when set to *False* the shield is opened. If the docking port does not have a shield, setting this attribute has no effect.

Attribute Can be read or written

Return type *bool*

position (reference_frame)

The position of the docking port, in the given reference frame.

Parameters **reference_frame** (*ReferenceFrame*) – The reference frame that the returned position vector is in.

Returns The position as a vector.

Return type tuple(float, float, float)

direction (*reference_frame*)

The direction that docking port points in, in the given reference frame.

Parameters **reference_frame** (ReferenceFrame) – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

Return type tuple(float, float, float)

rotation (*reference_frame*)

The rotation of the docking port, in the given reference frame.

Parameters **reference_frame** (ReferenceFrame) – The reference frame that the returned rotation is in.

Returns The rotation as a quaternion of the form (x, y, z, w) .

Return type tuple(float, float, float, float)

reference_frame

The reference frame that is fixed relative to this docking port, and oriented with the port.

- The origin is at the position of the docking port.
- The axes rotate with the docking port.
- The x-axis points out to the right side of the docking port.
- The y-axis points in the direction the docking port is facing.
- The z-axis points out of the bottom off the docking port.

Attribute Read-only, cannot be set

Return type *ReferenceFrame*

Note: This reference frame is not necessarily equivalent to the reference frame for the part, returned by *Part.reference_frame*.

class DockingPortState

The state of a docking port. See *DockingPort.state*.

ready

The docking port is ready to dock to another docking port.

docked

The docking port is docked to another docking port, or docked to another part (from the VAB/SPH).

docking

The docking port is very close to another docking port, but has not docked. It is using magnetic force to acquire a solid dock.

undocking

The docking port has just been undocked from another docking port, and is disabled until it moves away by a sufficient distance (*DockingPort.reengage_distance*).

shielded

The docking port has a shield, and the shield is closed.

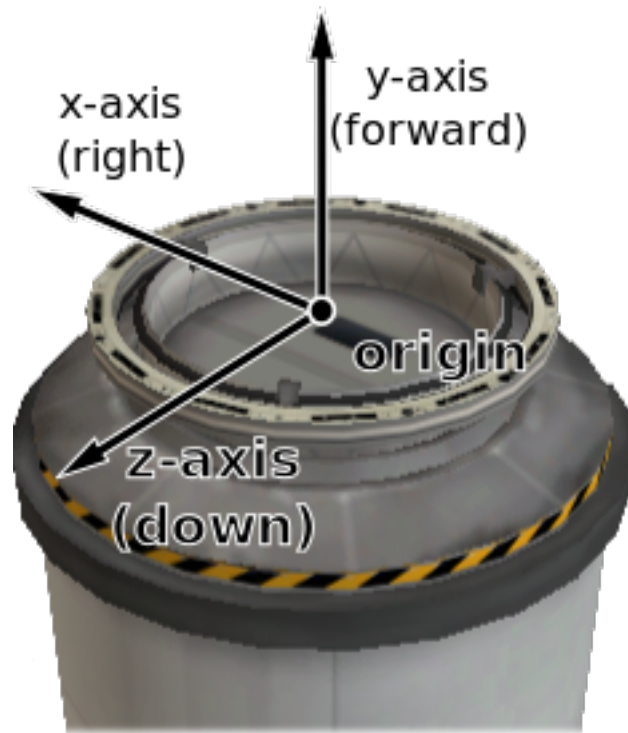


Fig. 8.8: Docking port reference frame origin and axes

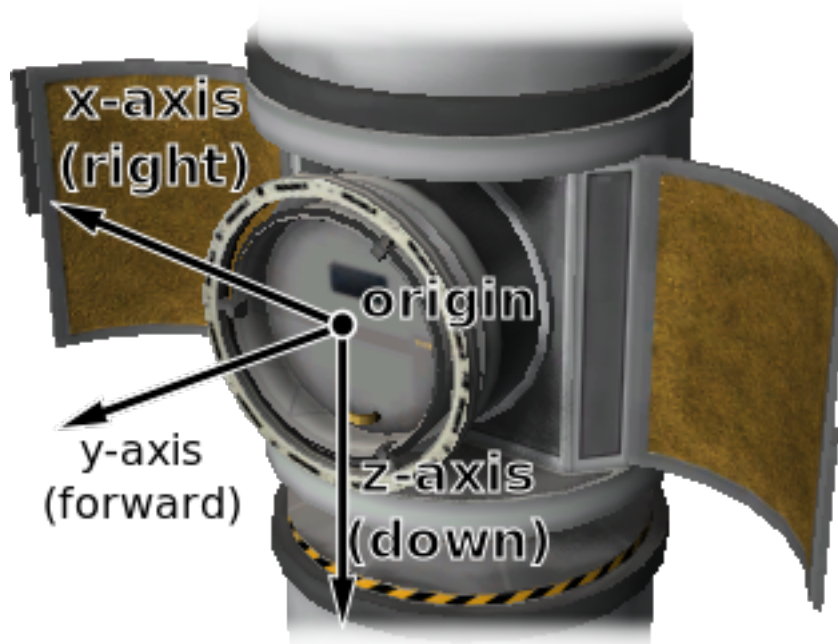


Fig. 8.9: Inline docking port reference frame origin and axes

moving

The docking ports shield is currently opening/closing.

Engine**class Engine**

An engine, including ones of various types. For example liquid fuelled gimballed engines, solid rocket boosters and jet engines. Obtained by calling *Part.engine*.

Note: For RCS thrusters *Part.rcs*.

part

The part object for this engine.

Attribute Read-only, cannot be set

Return type *Part*

active

Whether the engine is active. Setting this attribute may have no effect, depending on *Engine.can_shutdown* and *Engine.can_restart*.

Attribute Can be read or written

Return type bool

thrust

The current amount of thrust being produced by the engine, in Newtons.

Attribute Read-only, cannot be set

Return type float

available_thrust

The amount of thrust, in Newtons, that would be produced by the engine when activated and with its throttle set to 100%. Returns zero if the engine does not have any fuel. Takes the engine's current *Engine.thrust_limit* and atmospheric conditions into account.

Attribute Read-only, cannot be set

Return type float

max_thrust

The amount of thrust, in Newtons, that would be produced by the engine when activated and fueled, with its throttle and throttle limiter set to 100%.

Attribute Read-only, cannot be set

Return type float

max_vacuum_thrust

The maximum amount of thrust that can be produced by the engine in a vacuum, in Newtons. This is the amount of thrust produced by the engine when activated, *Engine.thrust_limit* is set to 100%, the main vessel's throttle is set to 100% and the engine is in a vacuum.

Attribute Read-only, cannot be set

Return type float

thrust_limit

The thrust limiter of the engine. A value between 0 and 1. Setting this attribute may have no effect, for example the thrust limit for a solid rocket booster cannot be changed in flight.

Attribute Can be read or written

Return type float

thrusters

The components of the engine that generate thrust.

Attribute Read-only, cannot be set

Return type list(*Thruster*)

Note: For example, this corresponds to the rocket nozzle on a solid rocket booster, or the individual nozzles on a RAPIER engine. The overall thrust produced by the engine, as reported by *Engine.available_thrust*, *Engine.max_thrust* and others, is the sum of the thrust generated by each thruster.

specific_impulse

The current specific impulse of the engine, in seconds. Returns zero if the engine is not active.

Attribute Read-only, cannot be set

Return type float

vacuum_specific_impulse

The vacuum specific impulse of the engine, in seconds.

Attribute Read-only, cannot be set

Return type float

kerbin_sea_level_specific_impulse

The specific impulse of the engine at sea level on Kerbin, in seconds.

Attribute Read-only, cannot be set

Return type float

propellant_names

The names of the propellants that the engine consumes.

Attribute Read-only, cannot be set

Return type list(str)

propellant_ratios

The ratio of resources that the engine consumes. A dictionary mapping resource names to the ratio at which they are consumed by the engine.

Attribute Read-only, cannot be set

Return type dict(str, float)

Note: For example, if the ratios are 0.6 for LiquidFuel and 0.4 for Oxidizer, then for every 0.6 units of LiquidFuel that the engine burns, it will burn 0.4 units of Oxidizer.

propellants

The propellants that the engine consumes.

Attribute Read-only, cannot be set

Return type `list(Propellant)`

has_fuel

Whether the engine has any fuel available.

Attribute Read-only, cannot be set

Return type `bool`

Note: The engine must be activated for this property to update correctly.

throttle

The current throttle setting for the engine. A value between 0 and 1. This is not necessarily the same as the vessel's main throttle setting, as some engines take time to adjust their throttle (such as jet engines).

Attribute Read-only, cannot be set

Return type `float`

throttle_locked

Whether the `Control.throttle` affects the engine. For example, this is `True` for liquid fueled rockets, and `False` for solid rocket boosters.

Attribute Read-only, cannot be set

Return type `bool`

can_restart

Whether the engine can be restarted once shutdown. If the engine cannot be shutdown, returns `False`. For example, this is `True` for liquid fueled rockets and `False` for solid rocket boosters.

Attribute Read-only, cannot be set

Return type `bool`

can_shutdown

Whether the engine can be shutdown once activated. For example, this is `True` for liquid fueled rockets and `False` for solid rocket boosters.

Attribute Read-only, cannot be set

Return type `bool`

has_modes

Whether the engine has multiple modes of operation.

Attribute Read-only, cannot be set

Return type `bool`

mode

The name of the current engine mode.

Attribute Can be read or written

Return type `str`

modes

The available modes for the engine. A dictionary mapping mode names to *Engine* objects.

Attribute Read-only, cannot be set

Return type `dict(str, Engine)`

toggle_mode()

Toggle the current engine mode.

auto_mode_switch

Whether the engine will automatically switch modes.

Attribute Can be read or written

Return type bool

gimballed

Whether the engine is gimballed.

Attribute Read-only, cannot be set

Return type bool

gimbal_range

The range over which the gimbal can move, in degrees. Returns 0 if the engine is not gimballed.

Attribute Read-only, cannot be set

Return type float

gimbal_locked

Whether the engines gimbal is locked in place. Setting this attribute has no effect if the engine is not gimballed.

Attribute Can be read or written

Return type bool

gimbal_limit

The gimbal limiter of the engine. A value between 0 and 1. Returns 0 if the gimbal is locked.

Attribute Can be read or written

Return type float

available_torque

The available torque, in Newton meters, that can be produced by this engine, in the positive and negative pitch, roll and yaw axes of the vessel. These axes correspond to the coordinate axes of the *Vessel.reference_frame*. Returns zero if the engine is inactive, or not gimballed.

Attribute Read-only, cannot be set

Return type tuple(tuple(float, float, float), tuple(float, float, float))

class Propellant

A propellant for an engine. Obtains by calling *Engine.propellants*.

name

The name of the propellant.

Attribute Read-only, cannot be set

Return type str

current_amount

The current amount of propellant.

Attribute Read-only, cannot be set

Return type float

current_requirement

The required amount of propellant.

Attribute Read-only, cannot be set

Return type float

total_resource_available

The total amount of the underlying resource currently reachable given resource flow rules.

Attribute Read-only, cannot be set

Return type float

total_resource_capacity

The total vehicle capacity for the underlying propellant resource, restricted by resource flow rules.

Attribute Read-only, cannot be set

Return type float

ignore_for_isp

If this propellant should be ignored when calculating required mass flow given specific impulse.

Attribute Read-only, cannot be set

Return type bool

ignore_for_thrust_curve

If this propellant should be ignored for thrust curve calculations.

Attribute Read-only, cannot be set

Return type bool

draw_stack_gauge

If this propellant has a stack gauge or not.

Attribute Read-only, cannot be set

Return type bool

is_deprived

If this propellant is deprived.

Attribute Read-only, cannot be set

Return type bool

ratio

The propellant ratio.

Attribute Read-only, cannot be set

Return type float

Experiment

class Experiment

Obtained by calling *Part.experiment*.

part

The part object for this experiment.

Attribute Read-only, cannot be set

Return type *Part*

run()
Run the experiment.

transmit()
Transmit all experimental data contained by this part.

dump()
Dump the experimental data contained by the experiment.

reset()
Reset the experiment.

deployed
Whether the experiment has been deployed.
Attribute Read-only, cannot be set
Return type bool

rerunnable
Whether the experiment can be re-run.
Attribute Read-only, cannot be set
Return type bool

inoperable
Whether the experiment is inoperable.
Attribute Read-only, cannot be set
Return type bool

has_data
Whether the experiment contains data.
Attribute Read-only, cannot be set
Return type bool

data
The data contained in this experiment.
Attribute Read-only, cannot be set
Return type list(*ScienceData*)

biome
The name of the biome the experiment is currently in.
Attribute Read-only, cannot be set
Return type str

available
Determines if the experiment is available given the current conditions.
Attribute Read-only, cannot be set
Return type bool

science_subject
Containing information on the corresponding specific science result for the current conditions. Returns None if the experiment is unavailable.
Attribute Read-only, cannot be set

Return type *ScienceSubject*

class ScienceData

Obtained by calling *Experiment.data*.

data_amount

Data amount.

Attribute Read-only, cannot be set

Return type float

science_value

Science value.

Attribute Read-only, cannot be set

Return type float

transmit_value

Transmit value.

Attribute Read-only, cannot be set

Return type float

class ScienceSubject

Obtained by calling *Experiment.science_subject*.

title

Title of science subject, displayed in science archives

Attribute Read-only, cannot be set

Return type str

is_complete

Whether the experiment has been completed.

Attribute Read-only, cannot be set

Return type bool

science

Amount of science already earned from this subject, not updated until after transmission/recovery.

Attribute Read-only, cannot be set

Return type float

science_cap

Total science allowable for this subject.

Attribute Read-only, cannot be set

Return type float

data_scale

Multiply science value by this to determine data amount in mits.

Attribute Read-only, cannot be set

Return type float

subject_value

Multiplier for specific Celestial Body/Experiment Situation combination.

Attribute Read-only, cannot be set

Return type float

scientific_value

Diminishing value multiplier for decreasing the science value returned from repeated experiments.

Attribute Read-only, cannot be set

Return type float

Fairing

class Fairing

A fairing. Obtained by calling *Part.fairing*.

part

The part object for this fairing.

Attribute Read-only, cannot be set

Return type *Part*

jettison()

Jettison the fairing. Has no effect if it has already been jettisoned.

jettisoned

Whether the fairing has been jettisoned.

Attribute Read-only, cannot be set

Return type bool

Intake

class Intake

An air intake. Obtained by calling *Part.intake*.

part

The part object for this intake.

Attribute Read-only, cannot be set

Return type *Part*

open

Whether the intake is open.

Attribute Can be read or written

Return type bool

speed

Speed of the flow into the intake, in *m/s*.

Attribute Read-only, cannot be set

Return type float

flow

The rate of flow into the intake, in units of resource per second.

Attribute Read-only, cannot be set

Return type float

area

The area of the intake's opening, in square meters.

Attribute Read-only, cannot be set

Return type float

Leg**class Leg**

A landing leg. Obtained by calling *Part.leg*.

part

The part object for this landing leg.

Attribute Read-only, cannot be set

Return type *Part*

state

The current state of the landing leg.

Attribute Read-only, cannot be set

Return type *LegState*

deployable

Whether the leg is deployable.

Attribute Read-only, cannot be set

Return type bool

deployed

Whether the landing leg is deployed.

Attribute Can be read or written

Return type bool

Note: Fixed landing legs are always deployed. Returns an error if you try to deploy fixed landing gear.

is_grounded

Returns whether the leg is touching the ground.

Attribute Read-only, cannot be set

Return type bool

class LegState

The state of a landing leg. See *Leg.state*.

deployed

Landing leg is fully deployed.

retracted

Landing leg is fully retracted.

deploying

Landing leg is being deployed.

retracting

Landing leg is being retracted.

broken

Landing leg is broken.

Launch Clamp

class LaunchClamp

A launch clamp. Obtained by calling *Part.launch_clamp*.

part

The part object for this launch clamp.

Attribute Read-only, cannot be set

Return type *Part*

release()

Releases the docking clamp. Has no effect if the clamp has already been released.

Light

class Light

A light. Obtained by calling *Part.light*.

part

The part object for this light.

Attribute Read-only, cannot be set

Return type *Part*

active

Whether the light is switched on.

Attribute Can be read or written

Return type bool

color

The color of the light, as an RGB triple.

Attribute Can be read or written

Return type tuple(float, float, float)

power_usage

The current power usage, in units of charge per second.

Attribute Read-only, cannot be set

Return type float

Parachute

class Parachute

A parachute. Obtained by calling *Part.parachute*.

part

The part object for this parachute.

Attribute Read-only, cannot be set

Return type *Part*

deploy()

Deploys the parachute. This has no effect if the parachute has already been deployed.

deployed

Whether the parachute has been deployed.

Attribute Read-only, cannot be set

Return type bool

arm()

Deploys the parachute. This has no effect if the parachute has already been armed or deployed. Only applicable to RealChutes parachutes.

armed

Whether the parachute has been armed or deployed. Only applicable to RealChutes parachutes.

Attribute Read-only, cannot be set

Return type bool

state

The current state of the parachute.

Attribute Read-only, cannot be set

Return type *ParachuteState*

deploy_altitude

The altitude at which the parachute will full deploy, in meters. Only applicable to stock parachutes.

Attribute Can be read or written

Return type float

deploy_min_pressure

The minimum pressure at which the parachute will semi-deploy, in atmospheres. Only applicable to stock parachutes.

Attribute Can be read or written

Return type float

class ParachuteState

The state of a parachute. See *Parachute.state*.

stowed

The parachute is safely tucked away inside its housing.

armed

The parachute is armed for deployment. (RealChutes only)

active

The parachute is still stowed, but ready to semi-deploy. (Stock parachutes only)

semi_deployed

The parachute has been deployed and is providing some drag, but is not fully deployed yet. (Stock parachutes only)

deployed

The parachute is fully deployed.

cut

The parachute has been cut.

Radiator**class Radiator**

A radiator. Obtained by calling *Part.radiator*.

part

The part object for this radiator.

Attribute Read-only, cannot be set

Return type *Part*

deployable

Whether the radiator is deployable.

Attribute Read-only, cannot be set

Return type *bool*

deployed

For a deployable radiator, *True* if the radiator is extended. If the radiator is not deployable, this is always *True*.

Attribute Can be read or written

Return type *bool*

state

The current state of the radiator.

Attribute Read-only, cannot be set

Return type *RadiatorState*

Note: A fixed radiator is always *RadiatorState.extended*.

class RadiatorState

The state of a radiator. *RadiatorState*

extended

Radiator is fully extended.

retracted

Radiator is fully retracted.

extending

Radiator is being extended.

retracting

Radiator is being retracted.

broken

Radiator is being broken.

Resource Converter

class ResourceConverter

A resource converter. Obtained by calling *Part.resource_converter*.

part

The part object for this converter.

Attribute Read-only, cannot be set

Return type *Part*

count

The number of converters in the part.

Attribute Read-only, cannot be set

Return type *int*

name (*index*)

The name of the specified converter.

Parameters **index** (*int*) – Index of the converter.

Return type *str*

active (*index*)

True if the specified converter is active.

Parameters **index** (*int*) – Index of the converter.

Return type *bool*

start (*index*)

Start the specified converter.

Parameters **index** (*int*) – Index of the converter.

stop (*index*)

Stop the specified converter.

Parameters **index** (*int*) – Index of the converter.

state (*index*)

The state of the specified converter.

Parameters **index** (*int*) – Index of the converter.

Return type *ResourceConverterState*

status_info (*index*)

Status information for the specified converter. This is the full status message shown in the in-game UI.

Parameters **index** (*int*) – Index of the converter.

Return type *str*

inputs (*index*)

List of the names of resources consumed by the specified converter.

Parameters **index** (*int*) – Index of the converter.

Return type *list(str)*

outputs (*index*)

List of the names of resources produced by the specified converter.

Parameters `index` (*int*) – Index of the converter.

Return type `list(str)`

class ResourceConverterState

The state of a resource converter. See *ResourceConverter.state()*.

running

Converter is running.

idle

Converter is idle.

missing_resource

Converter is missing a required resource.

storage_full

No available storage for output resource.

capacity

At preset resource capacity.

unknown

Unknown state. Possible with modified resource converters. In this case, check *ResourceConverter.status_info()* for more information.

Resource Harvester

class ResourceHarvester

A resource harvester (drill). Obtained by calling *Part.resource_harvester*.

part

The part object for this harvester.

Attribute Read-only, cannot be set

Return type *Part*

state

The state of the harvester.

Attribute Read-only, cannot be set

Return type *ResourceHarvesterState*

deployed

Whether the harvester is deployed.

Attribute Can be read or written

Return type `bool`

active

Whether the harvester is actively drilling.

Attribute Can be read or written

Return type `bool`

extraction_rate

The rate at which the drill is extracting ore, in units per second.

Attribute Read-only, cannot be set

Return type float

thermal_efficiency

The thermal efficiency of the drill, as a percentage of its maximum.

Attribute Read-only, cannot be set

Return type float

core_temperature

The core temperature of the drill, in Kelvin.

Attribute Read-only, cannot be set

Return type float

optimum_core_temperature

The core temperature at which the drill will operate with peak efficiency, in Kelvin.

Attribute Read-only, cannot be set

Return type float

class ResourceHarvesterState

The state of a resource harvester. See *ResourceHarvester.state*.

deploying

The drill is deploying.

deployed

The drill is deployed and ready.

retracting

The drill is retracting.

retracted

The drill is retracted.

active

The drill is running.

Reaction Wheel

class ReactionWheel

A reaction wheel. Obtained by calling *Part.reaction_wheel*.

part

The part object for this reaction wheel.

Attribute Read-only, cannot be set

Return type *Part*

active

Whether the reaction wheel is active.

Attribute Can be read or written

Return type bool

broken

Whether the reaction wheel is broken.

Attribute Read-only, cannot be set

Return type bool

available_torque

The available torque, in Newton meters, that can be produced by this reaction wheel, in the positive and negative pitch, roll and yaw axes of the vessel. These axes correspond to the coordinate axes of the *Vessel.reference_frame*. Returns zero if the reaction wheel is inactive or broken.

Attribute Read-only, cannot be set

Return type tuple(tuple(float, float, float), tuple(float, float, float))

max_torque

The maximum torque, in Newton meters, that can be produced by this reaction wheel, when it is active, in the positive and negative pitch, roll and yaw axes of the vessel. These axes correspond to the coordinate axes of the *Vessel.reference_frame*.

Attribute Read-only, cannot be set

Return type tuple(tuple(float, float, float), tuple(float, float, float))

RCS

class RCS

An RCS block or thruster. Obtained by calling *Part.rcs*.

part

The part object for this RCS.

Attribute Read-only, cannot be set

Return type *Part*

active

Whether the RCS thrusters are active. An RCS thruster is inactive if the RCS action group is disabled (*Control.rcs*), the RCS thruster itself is not enabled (*RCS.enabled*) or it is covered by a fairing (*Part.shielded*).

Attribute Read-only, cannot be set

Return type bool

enabled

Whether the RCS thrusters are enabled.

Attribute Can be read or written

Return type bool

pitch_enabled

Whether the RCS thruster will fire when pitch control input is given.

Attribute Can be read or written

Return type bool

yaw_enabled

Whether the RCS thruster will fire when yaw control input is given.

Attribute Can be read or written

Return type bool

roll_enabled

Whether the RCS thruster will fire when roll control input is given.

Attribute Can be read or written

Return type bool

forward_enabled

Whether the RCS thruster will fire when pitch control input is given.

Attribute Can be read or written

Return type bool

up_enabled

Whether the RCS thruster will fire when yaw control input is given.

Attribute Can be read or written

Return type bool

right_enabled

Whether the RCS thruster will fire when roll control input is given.

Attribute Can be read or written

Return type bool

available_torque

The available torque, in Newton meters, that can be produced by this RCS, in the positive and negative pitch, roll and yaw axes of the vessel. These axes correspond to the coordinate axes of the *Vessel.reference_frame*. Returns zero if RCS is disable.

Attribute Read-only, cannot be set

Return type tuple(tuple(float, float, float), tuple(float, float, float))

max_thrust

The maximum amount of thrust that can be produced by the RCS thrusters when active, in Newtons.

Attribute Read-only, cannot be set

Return type float

max_vacuum_thrust

The maximum amount of thrust that can be produced by the RCS thrusters when active in a vacuum, in Newtons.

Attribute Read-only, cannot be set

Return type float

thrusters

A list of thrusters, one of each nozzle in the RCS part.

Attribute Read-only, cannot be set

Return type list(*Thruster*)

specific_impulse

The current specific impulse of the RCS, in seconds. Returns zero if the RCS is not active.

Attribute Read-only, cannot be set

Return type float

vacuum_specific_impulse

The vacuum specific impulse of the RCS, in seconds.

Attribute Read-only, cannot be set

Return type float

kerbin_sea_level_specific_impulse

The specific impulse of the RCS at sea level on Kerbin, in seconds.

Attribute Read-only, cannot be set

Return type float

propellants

The names of resources that the RCS consumes.

Attribute Read-only, cannot be set

Return type list(str)

propellant_ratios

The ratios of resources that the RCS consumes. A dictionary mapping resource names to the ratios at which they are consumed by the RCS.

Attribute Read-only, cannot be set

Return type dict(str, float)

has_fuel

Whether the RCS has fuel available.

Attribute Read-only, cannot be set

Return type bool

Note: The RCS thruster must be activated for this property to update correctly.

Sensor

class Sensor

A sensor, such as a thermometer. Obtained by calling *Part.sensor*.

part

The part object for this sensor.

Attribute Read-only, cannot be set

Return type *Part*

active

Whether the sensor is active.

Attribute Can be read or written

Return type bool

value

The current value of the sensor.

Attribute Read-only, cannot be set

Return type str

Solar Panel

class SolarPanel

A solar panel. Obtained by calling *Part.solar_panel*.

part

The part object for this solar panel.

Attribute Read-only, cannot be set

Return type *Part*

deployable

Whether the solar panel is deployable.

Attribute Read-only, cannot be set

Return type bool

deployed

Whether the solar panel is extended.

Attribute Can be read or written

Return type bool

state

The current state of the solar panel.

Attribute Read-only, cannot be set

Return type *SolarPanelState*

energy_flow

The current amount of energy being generated by the solar panel, in units of charge per second.

Attribute Read-only, cannot be set

Return type float

sun_exposure

The current amount of sunlight that is incident on the solar panel, as a percentage. A value between 0 and 1.

Attribute Read-only, cannot be set

Return type float

class SolarPanelState

The state of a solar panel. See *SolarPanel.state*.

extended

Solar panel is fully extended.

retracted

Solar panel is fully retracted.

extending

Solar panel is being extended.

retracting

Solar panel is being retracted.

broken

Solar panel is broken.

Thruster

class Thruster

The component of an *Engine* or *RCS* part that generates thrust. Can obtained by calling *Engine.thrusters* or *RCS.thrusters*.

Note: Engines can consist of multiple thrusters. For example, the S3 KS-25x4 “Mammoth” has four rocket nozzels, and so consists of four thrusters.

part

The *Part* that contains this thruster.

Attribute Read-only, cannot be set

Return type *Part*

thrust_position(*reference_frame*)

The position at which the thruster generates thrust, in the given reference frame. For gimballed engines, this takes into account the current rotation of the gimbal.

Parameters **reference_frame** (*ReferenceFrame*) – The reference frame that the returned position vector is in.

Returns The position as a vector.

Return type tuple(float, float, float)

thrust_direction(*reference_frame*)

The direction of the force generated by the thruster, in the given reference frame. This is opposite to the direction in which the thruster expels propellant. For gimballed engines, this takes into account the current rotation of the gimbal.

Parameters **reference_frame** (*ReferenceFrame*) – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

Return type tuple(float, float, float)

thrust_reference_frame

A reference frame that is fixed relative to the thruster and orientated with its thrust direction (*Thruster.thrust_direction()*). For gimballed engines, this takes into account the current rotation of the gimbal.

- The origin is at the position of thrust for this thruster (*Thruster.thrust_position()*).
- The axes rotate with the thrust direction. This is the direction in which the thruster expels propellant, including any gimbaling.
- The y-axis points along the thrust direction.
- The x-axis and z-axis are perpendicular to the thrust direction.

Attribute Read-only, cannot be set

Return type *ReferenceFrame*

gimballed

Whether the thruster is gimballed.

Attribute Read-only, cannot be set

Return type bool

`gimbal_position` (*reference_frame*)

Position around which the gimbal pivots.

Parameters **`reference_frame`** (*ReferenceFrame*) – The reference frame that the returned position vector is in.

Returns The position as a vector.

Return type tuple(float, float, float)

`gimbal_angle`

The current gimbal angle in the pitch, roll and yaw axes, in degrees.

Attribute Read-only, cannot be set

Return type tuple(float, float, float)

`initial_thrust_position` (*reference_frame*)

The position at which the thruster generates thrust, when the engine is in its initial position (no gimbaling), in the given reference frame.

Parameters **`reference_frame`** (*ReferenceFrame*) – The reference frame that the returned position vector is in.

Returns The position as a vector.

Return type tuple(float, float, float)

Note: This position can move when the gimbal rotates. This is because the thrust position and gimbal position are not necessarily the same.

`initial_thrust_direction` (*reference_frame*)

The direction of the force generated by the thruster, when the engine is in its initial position (no gimbaling), in the given reference frame. This is opposite to the direction in which the thruster expels propellant.

Parameters **`reference_frame`** (*ReferenceFrame*) – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

Return type tuple(float, float, float)

Wheel

class `Wheel`

A wheel. Includes landing gear and rover wheels. Obtained by calling `Part.wheel`. Can be used to control the motors, steering and deployment of wheels, among other things.

part

The part object for this wheel.

Attribute Read-only, cannot be set

Return type *Part*

state

The current state of the wheel.

Attribute Read-only, cannot be set

Return type *WheelState*

radius

Radius of the wheel, in meters.

Attribute Read-only, cannot be set

Return type float

grounded

Whether the wheel is touching the ground.

Attribute Read-only, cannot be set

Return type bool

has_brakes

Whether the wheel has brakes.

Attribute Read-only, cannot be set

Return type bool

brakes

The braking force, as a percentage of maximum, when the brakes are applied.

Attribute Can be read or written

Return type float

auto_friction_control

Whether automatic friction control is enabled.

Attribute Can be read or written

Return type bool

manual_friction_control

Manual friction control value. Only has an effect if automatic friction control is disabled. A value between 0 and 5 inclusive.

Attribute Can be read or written

Return type float

deployable

Whether the wheel is deployable.

Attribute Read-only, cannot be set

Return type bool

deployed

Whether the wheel is deployed.

Attribute Can be read or written

Return type bool

powered

Whether the wheel is powered by a motor.

Attribute Read-only, cannot be set

Return type bool

motor_enabled

Whether the motor is enabled.

Attribute Can be read or written

Return type bool

motor_inverted

Whether the direction of the motor is inverted.

Attribute Can be read or written

Return type bool

motor_state

Whether the direction of the motor is inverted.

Attribute Read-only, cannot be set

Return type *MotorState*

motor_output

The output of the motor. This is the torque currently being generated, in Newton meters.

Attribute Read-only, cannot be set

Return type float

traction_control_enabled

Whether automatic traction control is enabled. A wheel only has traction control if it is powered.

Attribute Can be read or written

Return type bool

traction_control

Setting for the traction control. Only takes effect if the wheel has automatic traction control enabled. A value between 0 and 5 inclusive.

Attribute Can be read or written

Return type float

drive_limiter

Manual setting for the motor limiter. Only takes effect if the wheel has automatic traction control disabled. A value between 0 and 100 inclusive.

Attribute Can be read or written

Return type float

steerable

Whether the wheel has steering.

Attribute Read-only, cannot be set

Return type bool

steering_enabled

Whether the wheel steering is enabled.

Attribute Can be read or written

Return type bool

steering_inverted

Whether the wheel steering is inverted.

Attribute Can be read or written

Return type bool

has_suspension

Whether the wheel has suspension.

Attribute Read-only, cannot be set

Return type bool

suspension_spring_strength

Suspension spring strength, as set in the editor.

Attribute Read-only, cannot be set

Return type float

suspension_damper_strength

Suspension damper strength, as set in the editor.

Attribute Read-only, cannot be set

Return type float

broken

Whether the wheel is broken.

Attribute Read-only, cannot be set

Return type bool

repairable

Whether the wheel is repairable.

Attribute Read-only, cannot be set

Return type bool

stress

Current stress on the wheel.

Attribute Read-only, cannot be set

Return type float

stress_tolerance

Stress tolerance of the wheel.

Attribute Read-only, cannot be set

Return type float

stress_percentage

Current stress on the wheel as a percentage of its stress tolerance.

Attribute Read-only, cannot be set

Return type float

deflection

Current deflection of the wheel.

Attribute Read-only, cannot be set

Return type float

slip

Current slip of the wheel.

Attribute Read-only, cannot be set

Return type float

class WheelState

The state of a wheel. See *Wheel.state*.

deployed

Wheel is fully deployed.

retracted

Wheel is fully retracted.

deploying

Wheel is being deployed.

retracting

Wheel is being retracted.

broken

Wheel is broken.

class MotorState

The state of the motor on a powered wheel. See *Wheel.motor_state*.

idle

The motor is idle.

running

The motor is running.

disabled

The motor is disabled.

inoperable

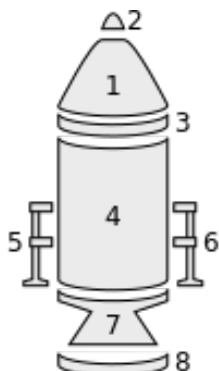
The motor is inoperable.

not_enough_resources

The motor does not have enough resources to run.

Trees of Parts

Vessels in KSP are comprised of a number of parts, connected to one another in a *tree* structure. An example vessel is shown in Figure 1, and the corresponding tree of parts in Figure 2. The craft file for this example can also be downloaded [here](#).



Traversing the Tree

The tree of parts can be traversed using the attributes *Parts.root*, *Part.parent* and *Part.children*.

The root of the tree is the same as the vessels *root part* (part number 1 in the example above) and can be obtained by calling *Parts.root*. A parts children can be obtained by calling *Part.children*. If the part does not have any children, *Part.children* returns an empty list. A parts parent can be

obtained by calling `Part.parent`. If the part does not have a parent (as is the case for the root part), `Part.parent` returns `None`.

The following Python example uses these attributes to perform a depth-first traversal over all of the parts in a vessel:

```
import krpc
conn = krpc.connect()
vessel = conn.spacecraft

root = vessel.parts.root
stack = [(root, 0)]
while stack:
    part, depth = stack.pop()
    print(' '*depth, part.name)
    for child in part.children:
        stack.append((child, depth + 1))
```

When this code is executed using the craft file for the example vessel pictured above, the following is printed out:

```
Command Pod Mk1
TR-18A Stack Decoupler
FL-T400 Fuel Tank
LV-909 Liquid Fuel
TR-18A Stack Decoupler
FL-T800 Fuel Tank
LV-909 Liquid Fuel
TT-70 Radial Duct
FL-T400 Fuel Tank
TT18-A Launcher
FTX-2 External Tank
LV-909 Liquid Fuel
Aerodynamic
TT-70 Radial Duct
FL-T400 Fuel Tank
TT18-A Launcher
FTX-2 External Tank
LV-909 Liquid Fuel
Aerodynamic
LT-1 Landing Strut
LT-1 Landing Strut
Mk16 Parachute
```

Attachment Modes

Parts can be attached to other parts either *radially* (on the side of the parent part) or *axially* (on the end of the parent part, to form a stack).

For example, in the vessel pictured above, the parachute (part 2) is *axially* connected to its parent (the command pod – part 1), and the landing leg (part 5) is *radially* connected to its parent (the fuel tank – part 4).

The root part of a vessel (for example the command pod – part

1) does not have a parent part, so does not have an attachment mode. However, the part is consider to be *axially* attached to nothing.

The following Python example does a depth-first traversal as before, but also prints out the attachment mode used by the part:

```
import krpc
conn = krpc.connect()
vessel = conn.space_center.active_vessel

root = vessel.parts.root
stack = [(root, 0)]
while stack:
    part, depth = stack.pop()
    if part.axially_attached:
        attach_mode = 'axial'
    else: # radially_attached
        attach_mode = 'radial'
    print(
        ↳ '*depth, part.title, '-', attach_mode)
    for child in part.children:
        stack.append((child, depth+1))
```

When this code is execute using the craft file for the example vessel pictured above, the following is printed out:

```
Command Pod Mk1 - axial
TR-18A Stack Decoupler - axial
FL-T400 Fuel Tank - axial
LV-909 Liquid Fuel Engine - axial
TR-18A Stack Decoupler - axial
FL-T800 Fuel Tank - axial
LV-909 Liquid Fuel Engine - axial
TT-70 Radial Decoupler - radial
FL-T400 Fuel Tank - radial

↳ TT18-A Launch Stability Enhancer - radial
   ↳ FTX-2 External Fuel Duct - radial
   ↳ LV-909 Liquid Fuel Engine - axial
   ↳ Aerodynamic Nose Cone - axial
   ↳ TT-70 Radial Decoupler - radial
   ↳ FL-T400 Fuel Tank - radial

↳ TT18-A Launch Stability Enhancer - radial
   ↳ FTX-2 External Fuel Duct - radial
   ↳ LV-909 Liquid Fuel Engine - axial
   ↳ Aerodynamic Nose Cone - axial
   ↳ LT-1 Landing Struts - radial
   ↳ LT-1 Landing Struts - radial
   ↳ Mk16 Parachute - axial
```

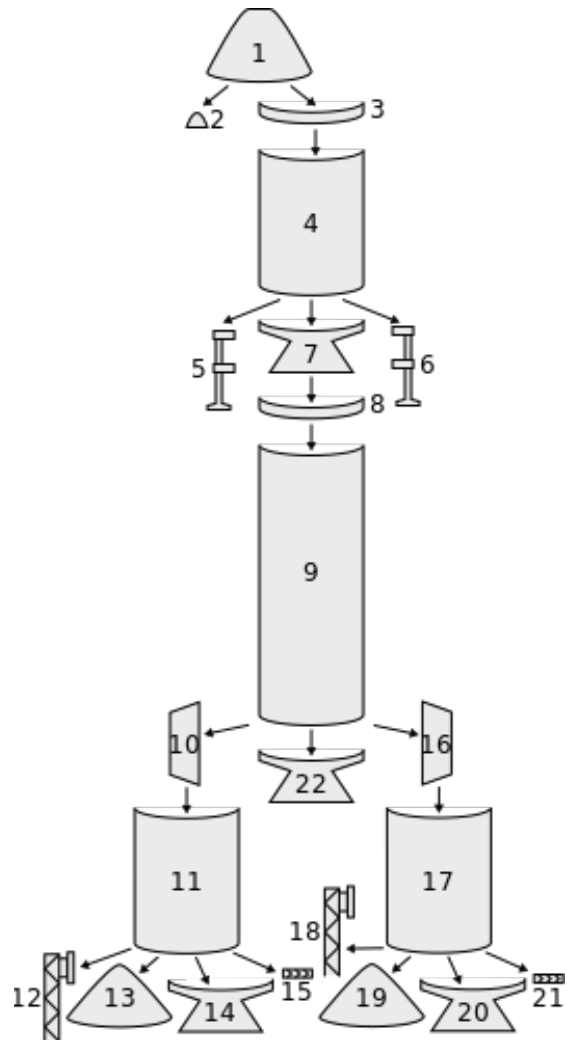


Fig. 8.11: **Figure 2** – Tree of parts for the vessel in Figure 1. Arrows point from the parent part to the child part.

Fuel Lines

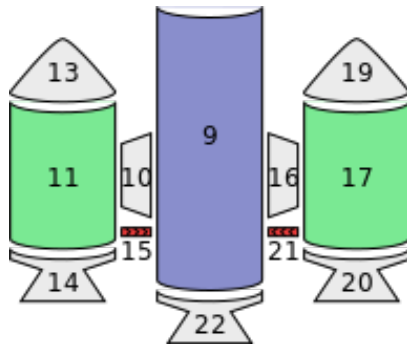


Fig. 8.12: **Figure 5** – Fuel lines from the example in Figure 1. Fuel flows from the parts highlighted in green, into the part highlighted in blue.

Fuel lines are considered parts, and are included in the parts tree (for example, as pictured in Figure 4). However, the parts tree does not contain information about which parts fuel lines connect to. The parent part of a fuel line is the part from which it will take fuel (as shown in Figure 4) however the part that it will send fuel to is not represented in the parts tree.

Figure 5 shows the fuel lines from the example vessel pictured earlier. Fuel line part 15 (in red) takes fuel from a fuel tank (part 11 – in green) and feeds it into another fuel tank (part 9 – in blue). The fuel line is therefore a child of part 11, but its connection to part 9 is not represented in the tree.

The attributes `Part.fuel_lines_from` and `Part.fuel_lines_to` can be used to discover these connections. In the example in Figure 5, when `Part.fuel_lines_to` is called on fuel tank part 11, it will return a list of parts containing just fuel tank part 9 (the blue part). When `Part.fuel_lines_from` is called on fuel tank part 9, it will return a list containing fuel tank parts 11 and 17 (the parts colored green).

Staging

Each part has two staging numbers associated with it: the stage in which the part is *activated* and the stage in which the part is *decoupled*. These values can be obtained using `Part.stage` and `Part.decouple_stage` respectively. For parts that are not activated by staging, `Part.stage` returns -1. For parts that are never decoupled, `Part.decouple_stage` returns a value of -1.

Figure 6 shows an example staging sequence for a vessel. Figure 7 shows the stages in which each part of the vessel will be *activated*. Figure 8 shows the stages in which each part of the vessel will be *decoupled*.

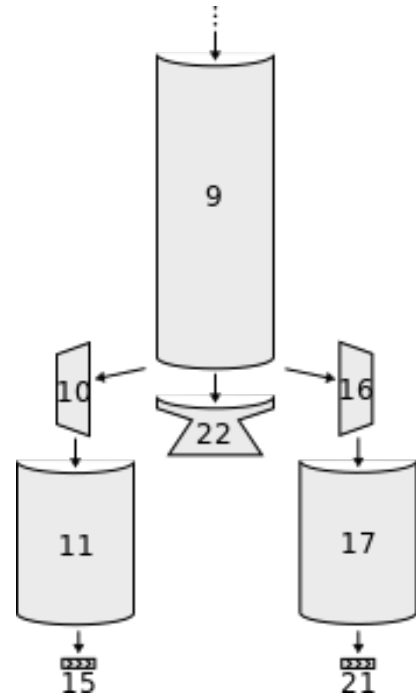


Fig. 8.13: **Figure 4** – A subset of the parts tree from Figure 2 above.

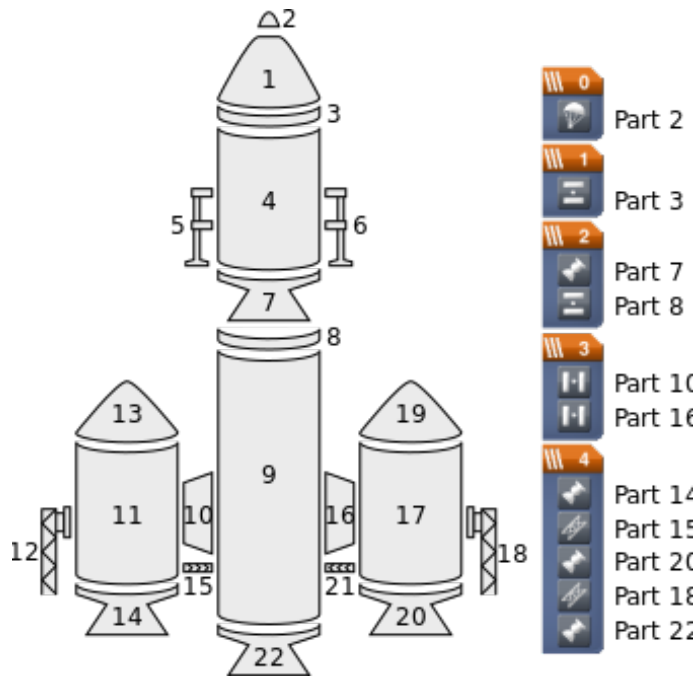


Fig. 8.14: **Figure 6** – Example vessel from Figure 1 with a staging sequence.

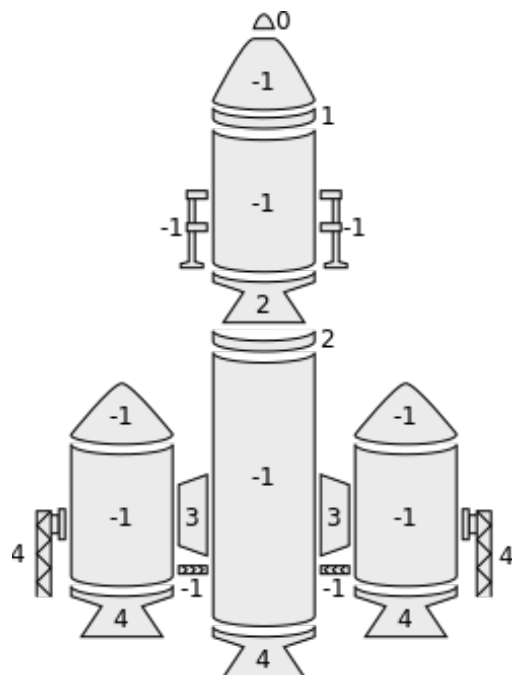


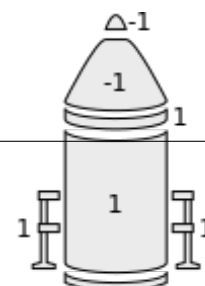
Fig. 8.15: **Figure 7** – The stage in which each part is *activated*.

8.3.9 Resources

```
class Resources
```

Represents the collection of resources stored in a vessel,

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stage or part. Created by calling *Vessel.resources*, *Vessel.resources_in_decouple_stage()* or *Part.resources*.

all

All the individual resources that can be stored.

Attribute Read-only, cannot be set

Return type *list(Resource)*

with_resource (*name*)

All the individual resources with the given name that can be stored.

Parameters **name** (*str*) –

Return type *list(Resource)*

names

A list of resource names that can be stored.

Attribute Read-only, cannot be set

Return type *list(str)*

has_resource (*name*)

Check whether the named resource can be stored.

Parameters **name** (*str*) – The name of the resource.

Return type *bool*

amount (*name*)

Returns the amount of a resource that is currently stored.

Parameters **name** (*str*) – The name of the resource.

Return type *float*

max (*name*)

Returns the amount of a resource that can be stored.

Parameters **name** (*str*) – The name of the resource.

Return type *float*

static_density (*name*)

Returns the density of a resource, in *kg/l*.

Parameters **name** (*str*) – The name of the resource.

Return type *float*

static_flow_mode (*name*)

Returns the flow mode of a resource.

Parameters **name** (*str*) – The name of the resource.

Return type *ResourceFlowMode*

enabled

Whether use of all the resources are enabled.

Attribute Can be read or written

Return type *bool*

Note: This is `True` if all of the resources are enabled. If any of the resources are not enabled, this is `False`.

class Resource

An individual resource stored within a part. Created using methods in the *Resources* class.

name

The name of the resource.

Attribute Read-only, cannot be set

Return type `str`

part

The part containing the resource.

Attribute Read-only, cannot be set

Return type *Part*

amount

The amount of the resource that is currently stored in the part.

Attribute Read-only, cannot be set

Return type `float`

max

The total amount of the resource that can be stored in the part.

Attribute Read-only, cannot be set

Return type `float`

density

The density of the resource, in *kg/l*.

Attribute Read-only, cannot be set

Return type `float`

flow_mode

The flow mode of the resource.

Attribute Read-only, cannot be set

Return type *ResourceFlowMode*

enabled

Whether use of this resource is enabled.

Attribute Can be read or written

Return type `bool`

class ResourceTransfer

Transfer resources between parts.

static start (*from_part, to_part, resource, max_amount*)

Start transferring a resource transfer between a pair of parts. The transfer will move at most *max_amount* units of the resource, depending on how much of the resource is available in the source part and how much storage is available in the destination part. Use

ResourceTransfer.complete to check if the transfer is complete. Use *ResourceTransfer.amount* to see how much of the resource has been transferred.

Parameters

- **from_part** (*Part*) – The part to transfer to.
- **to_part** (*Part*) – The part to transfer from.
- **resource** (*str*) – The name of the resource to transfer.
- **max_amount** (*float*) – The maximum amount of resource to transfer.

Return type *ResourceTransfer*

amount

The amount of the resource that has been transferred.

Attribute Read-only, cannot be set

Return type float

complete

Whether the transfer has completed.

Attribute Read-only, cannot be set

Return type bool

class ResourceFlowMode

The way in which a resource flows between parts. See *Resources.flow_mode()*.

vessel

The resource flows to any part in the vessel. For example, electric charge.

stage

The resource flows from parts in the first stage, followed by the second, and so on. For example, mono-propellant.

adjacent

The resource flows between adjacent parts within the vessel. For example, liquid fuel or oxidizer.

none

The resource does not flow. For example, solid fuel.

8.3.10 Node

class Node

Represents a maneuver node. Can be created using *Control.add_node()*.

prograde

The magnitude of the maneuver nodes delta-v in the prograde direction, in meters per second.

Attribute Can be read or written

Return type float

normal

The magnitude of the maneuver nodes delta-v in the normal direction, in meters per second.

Attribute Can be read or written

Return type float

radial

The magnitude of the maneuver nodes delta-v in the radial direction, in meters per second.

Attribute Can be read or written

Return type float

delta_v

The delta-v of the maneuver node, in meters per second.

Attribute Can be read or written

Return type float

Note: Does not change when executing the maneuver node. See *Node.remaining_delta_v*.

remaining_delta_v

Gets the remaining delta-v of the maneuver node, in meters per second. Changes as the node is executed. This is equivalent to the delta-v reported in-game.

Attribute Read-only, cannot be set

Return type float

burn_vector ([*reference_frame* = None])

Returns the burn vector for the maneuver node.

Parameters **reference_frame** (ReferenceFrame) – The reference frame that the returned vector is in. Defaults to *Vessel.orbital_reference_frame*.

Returns A vector whose direction is the direction of the maneuver node burn, and magnitude is the delta-v of the burn in meters per second.

Return type tuple(float, float, float)

Note: Does not change when executing the maneuver node. See *Node.remaining_burn_vector()*.

remaining_burn_vector ([*reference_frame* = None])

Returns the remaining burn vector for the maneuver node.

Parameters **reference_frame** (ReferenceFrame) – The reference frame that the returned vector is in. Defaults to *Vessel.orbital_reference_frame*.

Returns A vector whose direction is the direction of the maneuver node burn, and magnitude is the delta-v of the burn in meters per second.

Return type tuple(float, float, float)

Note: Changes as the maneuver node is executed. See *Node*.
burn_vector().

ut

The universal time at which the maneuver will occur, in seconds.

Attribute Can be read or written

Return type float

time_to

The time until the maneuver node will be encountered, in seconds.

Attribute Read-only, cannot be set

Return type float

orbit

The orbit that results from executing the maneuver node.

Attribute Read-only, cannot be set

Return type *Orbit*

remove()

Removes the maneuver node.

reference_frame

The reference frame that is fixed relative to the maneuver node's burn.

- The origin is at the position of the maneuver node.
- The y-axis points in the direction of the burn.
- The x-axis and z-axis point in arbitrary but fixed directions.

Attribute Read-only, cannot be set

Return type *ReferenceFrame*

orbital_reference_frame

The reference frame that is fixed relative to the maneuver node, and orientated with the orbital prograde/normal/radial directions of the original orbit at the maneuver node's position.

- The origin is at the position of the maneuver node.
- The x-axis points in the orbital anti-radial direction of the original orbit, at the position of the maneuver node.
- The y-axis points in the orbital prograde direction of the original orbit, at the position of the maneuver node.
- The z-axis points in the orbital normal direction of the original orbit, at the position of the maneuver node.

Attribute Read-only, cannot be set

Return type *ReferenceFrame*

position (*reference_frame*)

The position vector of the maneuver node in the given reference frame.

Parameters **reference_frame** (`ReferenceFrame`) – The reference frame that the returned position vector is in.

Returns The position as a vector.

Return type tuple(float, float, float)

direction (*reference_frame*)

The direction of the maneuver nodes burn.

Parameters **reference_frame** (`ReferenceFrame`) – The reference frame that the returned direction is in.

Returns The direction as a unit vector.

Return type tuple(float, float, float)

8.3.11 ReferenceFrame

class ReferenceFrame

Represents a reference frame for positions, rotations and velocities. Contains:

- The position of the origin.
- The directions of the x, y and z axes.
- The linear velocity of the frame.
- The angular velocity of the frame.

Note: This class does not contain any properties or methods. It is only used as a parameter to other functions.

static create_relative (*reference_frame* [, *position* = (0.0, 0.0, 0.0)] [, *rotation* = (0.0, 0.0, 0.0, 1.0)] [, *velocity* = (0.0, 0.0, 0.0)] [, *angular_velocity* = (0.0, 0.0, 0.0)])

Create a relative reference frame. This is a custom reference frame whose components offset the components of a parent reference frame.

Parameters

- **reference_frame** (`ReferenceFrame`) – The parent reference frame on which to base this reference frame.
- **position** (*tuple*) – The offset of the position of the origin, as a position vector. Defaults to (0, 0, 0)
- **rotation** (*tuple*) – The rotation to apply to the parent frames rotation, as a quaternion of the form (*x*, *y*, *z*, *w*). Defaults to (0, 0, 0, 1) (i.e. no rotation)
- **velocity** (*tuple*) – The linear velocity to offset the parent frame by, as a vector pointing in the direction of travel, whose magnitude is the speed in meters per second. Defaults to (0, 0, 0).

- **angular_velocity** (*tuple*) – The angular velocity to offset the parent frame by, as a vector. This vector points in the direction of the axis of rotation, and its magnitude is the speed of the rotation in radians per second. Defaults to (0, 0, 0).

Return type *ReferenceFrame*

static create_hybrid(*position*[, *rotation* = None][, *velocity* = None][, *angular_velocity* = None])

Create a hybrid reference frame. This is a custom reference frame whose components inherited from other reference frames.

Parameters

- **position** (*ReferenceFrame*) – The reference frame providing the position of the origin.
- **rotation** (*ReferenceFrame*) – The reference frame providing the rotation of the frame.
- **velocity** (*ReferenceFrame*) – The reference frame providing the linear velocity of the frame.
- **angular_velocity** (*ReferenceFrame*) – The reference frame providing the angular velocity of the frame.

Return type *ReferenceFrame*

Note: The *position* reference frame is required but all other reference frames are optional. If omitted, they are set to the *position* reference frame.

8.3.12 AutoPilot

class AutoPilot

Provides basic auto-piloting utilities for a vessel. Created by calling *Vessel.auto_pilot*.

Note: If a client engages the auto-pilot and then closes its connection to the server, the auto-pilot will be disengaged and its target reference frame, direction and roll reset to default.

engage ()

Engage the auto-pilot.

disengage ()

Disengage the auto-pilot.

wait ()

Blocks until the vessel is pointing in the target direction and has the target roll (if set). Throws an exception if the auto-pilot has not been engaged.

error

The error, in degrees, between the direction the ship has been asked to point in and the direction it is pointing in. Throws an exception

if the auto-pilot has not been engaged and SAS is not enabled or is in stability assist mode.

Attribute Read-only, cannot be set

Return type float

pitch_error

The error, in degrees, between the vessels current and target pitch. Throws an exception if the auto-pilot has not been engaged.

Attribute Read-only, cannot be set

Return type float

heading_error

The error, in degrees, between the vessels current and target heading. Throws an exception if the auto-pilot has not been engaged.

Attribute Read-only, cannot be set

Return type float

roll_error

The error, in degrees, between the vessels current and target roll. Throws an exception if the auto-pilot has not been engaged or no target roll is set.

Attribute Read-only, cannot be set

Return type float

reference_frame

The reference frame for the target direction (*AutoPilot.target_direction*).

Attribute Can be read or written

Return type *ReferenceFrame*

Note: An error will be thrown if this property is set to a reference frame that rotates with the vessel being controlled, as it is impossible to rotate the vessel in such a reference frame.

target_pitch

The target pitch, in degrees, between -90° and +90°.

Attribute Can be read or written

Return type float

target_heading

The target heading, in degrees, between 0° and 360°.

Attribute Can be read or written

Return type float

target_roll

The target roll, in degrees. NaN if no target roll is set.

Attribute Can be read or written

Return type float

target_direction

Direction vector corresponding to the target pitch and heading. This is in the reference frame specified by *ReferenceFrame*.

Attribute Can be read or written

Return type tuple(float, float, float)

target_pitch_and_heading (*pitch, heading*)

Set target pitch and heading angles.

Parameters

- **pitch** (*float*) – Target pitch angle, in degrees between -90° and +90°.
- **heading** (*float*) – Target heading angle, in degrees between 0° and 360°.

sas

The state of SAS.

Attribute Can be read or written

Return type bool

Note: Equivalent to *Control.sas*

sas_mode

The current *SASMode*. These modes are equivalent to the mode buttons to the left of the navball that appear when SAS is enabled.

Attribute Can be read or written

Return type *SASMode*

Note: Equivalent to *Control.sas_mode*

roll_threshold

The threshold at which the autopilot will try to match the target roll angle, if any. Defaults to 5 degrees.

Attribute Can be read or written

Return type float

stopping_time

The maximum amount of time that the vessel should need to come to a complete stop. This determines the maximum angular velocity of the vessel. A vector of three stopping times, in seconds, one for each of the pitch, roll and yaw axes. Defaults to 0.5 seconds for each axis.

Attribute Can be read or written

Return type tuple(float, float, float)

deceleration_time

The time the vessel should take to come to a stop pointing in the target direction. This determines the angular acceleration used to decelerate the vessel. A vector of three times, in seconds, one for

each of the pitch, roll and yaw axes. Defaults to 5 seconds for each axis.

Attribute Can be read or written

Return type tuple(float, float, float)

attenuation_angle

The angle at which the autopilot considers the vessel to be pointing close to the target. This determines the midpoint of the target velocity attenuation function. A vector of three angles, in degrees, one for each of the pitch, roll and yaw axes. Defaults to 1° for each axis.

Attribute Can be read or written

Return type tuple(float, float, float)

auto_tune

Whether the rotation rate controllers PID parameters should be automatically tuned using the vessels moment of inertia and available torque. Defaults to True. See *AutoPilot.time_to_peak* and *AutoPilot.overshoot*.

Attribute Can be read or written

Return type bool

time_to_peak

The target time to peak used to autotune the PID controllers. A vector of three times, in seconds, for each of the pitch, roll and yaw axes. Defaults to 3 seconds for each axis.

Attribute Can be read or written

Return type tuple(float, float, float)

overshoot

The target overshoot percentage used to autotune the PID controllers. A vector of three values, between 0 and 1, for each of the pitch, roll and yaw axes. Defaults to 0.01 for each axis.

Attribute Can be read or written

Return type tuple(float, float, float)

pitch_pid_gains

Gains for the pitch PID controller.

Attribute Can be read or written

Return type tuple(float, float, float)

Note: When *AutoPilot.auto_tune* is true, these values are updated automatically, which will overwrite any manual changes.

roll_pid_gains

Gains for the roll PID controller.

Attribute Can be read or written

Return type tuple(float, float, float)

Note: When *AutoPilot.auto_tune* is true, these values are updated automatically, which will overwrite any manual changes.

yaw_pid_gains

Gains for the yaw PID controller.

Attribute Can be read or written

Return type tuple(float, float, float)

Note: When *AutoPilot.auto_tune* is true, these values are updated automatically, which will overwrite any manual changes.

8.3.13 Camera

class Camera

Controls the game's camera. Obtained by calling *camera*.

mode

The current mode of the camera.

Attribute Can be read or written

Return type *CameraMode*

pitch

The pitch of the camera, in degrees. A value between *Camera.min_pitch* and *Camera.max_pitch*

Attribute Can be read or written

Return type float

heading

The heading of the camera, in degrees.

Attribute Can be read or written

Return type float

distance

The distance from the camera to the subject, in meters. A value between *Camera.min_distance* and *Camera.max_distance*.

Attribute Can be read or written

Return type float

min_pitch

The minimum pitch of the camera.

Attribute Read-only, cannot be set

Return type float

max_pitch

The maximum pitch of the camera.

Attribute Read-only, cannot be set

Return type float

min_distance

Minimum distance from the camera to the subject, in meters.

Attribute Read-only, cannot be set

Return type float

max_distance

Maximum distance from the camera to the subject, in meters.

Attribute Read-only, cannot be set

Return type float

default_distance

Default distance from the camera to the subject, in meters.

Attribute Read-only, cannot be set

Return type float

focussed_body

In map mode, the celestial body that the camera is focussed on.

Returns *None* if the camera is not focussed on a celestial body.

Returns an error if the camera is not in map mode.

Attribute Can be read or written

Return type *CelestialBody*

focussed_vessel

In map mode, the vessel that the camera is focussed on. Returns

None if the camera is not focussed on a vessel. Returns an error if the camera is not in map mode.

Attribute Can be read or written

Return type *Vessel*

focussed_node

In map mode, the maneuver node that the camera is focussed on.

Returns *None* if the camera is not focussed on a maneuver node.

Returns an error if the camera is not in map mode.

Attribute Can be read or written

Return type *Node*

class CameraMode

See *Camera.mode*.

automatic

The camera is showing the active vessel, in “auto” mode.

free

The camera is showing the active vessel, in “free” mode.

chase

The camera is showing the active vessel, in “chase” mode.

locked

The camera is showing the active vessel, in “locked” mode.

orbital

The camera is showing the active vessel, in “orbital” mode.

iva

The Intra-Vehicular Activity view is being shown.

map

The map view is being shown.

8.3.14 Waypoints

class WaypointManager

Waypoints are the location markers you can see on the map view showing you where contracts are targeted for. With this structure, you can obtain coordinate data for the locations of these waypoints. Obtained by calling *waypoint_manager*.

waypoints

A list of all existing waypoints.

Attribute Read-only, cannot be set

Return type *list(Waypoint)*

add_waypoint (*latitude, longitude, body, name*)

Creates a waypoint at the given position at ground level, and returns a *Waypoint* object that can be used to modify it.

Parameters

- **latitude** (*float*) – Latitude of the waypoint.
- **longitude** (*float*) – Longitude of the waypoint.
- **body** (*CelestialBody*) – Celestial body the waypoint is attached to.
- **name** (*str*) – Name of the waypoint.

Return type *Waypoint*

add_waypoint_at_altitude (*latitude, longitude, altitude, body, name*)

Creates a waypoint at the given position and altitude, and returns a *Waypoint* object that can be used to modify it.

Parameters

- **latitude** (*float*) – Latitude of the waypoint.
- **longitude** (*float*) – Longitude of the waypoint.
- **altitude** (*float*) – Altitude (above sea level) of the waypoint.
- **body** (*CelestialBody*) – Celestial body the waypoint is attached to.
- **name** (*str*) – Name of the waypoint.

Return type *Waypoint*

colors

An example map of known color - seed pairs. Any other integers may be used as seed.

Attribute Read-only, cannot be set

Return type *dict(str, int)*

icons

Returns all available icons (from “Game-Data/Squad/Contracts/Icons”).

Attribute Read-only, cannot be set

Return type list(str)

class Waypoint

Represents a waypoint. Can be created using *WaypointManager.add_waypoint()*.

body

The celestial body the waypoint is attached to.

Attribute Can be read or written

Return type *CelestialBody*

name

The name of the waypoint as it appears on the map and the contract.

Attribute Can be read or written

Return type str

color

The seed of the icon color. See *WaypointManager.colors* for example colors.

Attribute Can be read or written

Return type int

icon

The icon of the waypoint.

Attribute Can be read or written

Return type str

latitude

The latitude of the waypoint.

Attribute Can be read or written

Return type float

longitude

The longitude of the waypoint.

Attribute Can be read or written

Return type float

mean_altitude

The altitude of the waypoint above sea level, in meters.

Attribute Can be read or written

Return type float

surface_altitude

The altitude of the waypoint above the surface of the body or sea level, whichever is closer, in meters.

Attribute Can be read or written

Return type float

bedrock_altitude

The altitude of the waypoint above the surface of the body, in meters.
When over water, this is the altitude above the sea floor.

Attribute Can be read or written

Return type float

near_surface

True if the waypoint is near to the surface of a body.

Attribute Read-only, cannot be set

Return type bool

grounded

True if the waypoint is attached to the ground.

Attribute Read-only, cannot be set

Return type bool

index

The integer index of this waypoint within its cluster of sibling waypoints. In other words, when you have a cluster of waypoints called “Somewhere Alpha”, “Somewhere Beta” and “Somewhere Gamma”, the alpha site has index 0, the beta site has index 1 and the gamma site has index 2. When *Waypoint.clustering* is *False*, this is zero.

Attribute Read-only, cannot be set

Return type int

clustering

True if this waypoint is part of a set of clustered waypoints with greek letter names appended (Alpha, Beta, Gamma, etc). If *True*, there is a one-to-one correspondence with the greek letter name and the *Waypoint.index*.

Attribute Read-only, cannot be set

Return type bool

has_contract

Whether the waypoint belongs to a contract.

Attribute Read-only, cannot be set

Return type bool

contract

The associated contract.

Attribute Read-only, cannot be set

Return type *Contract*

remove()

Removes the waypoint.

8.3.15 Contracts

class ContractManager

Contracts manager. Obtained by calling *waypoint_manager*.

types

A list of all contract types.

Attribute Read-only, cannot be set

Return type set(str)

all_contracts

A list of all contracts.

Attribute Read-only, cannot be set

Return type list(*Contract*)

active_contracts

A list of all active contracts.

Attribute Read-only, cannot be set

Return type list(*Contract*)

offered_contracts

A list of all offered, but unaccepted, contracts.

Attribute Read-only, cannot be set

Return type list(*Contract*)

completed_contracts

A list of all completed contracts.

Attribute Read-only, cannot be set

Return type list(*Contract*)

failed_contracts

A list of all failed contracts.

Attribute Read-only, cannot be set

Return type list(*Contract*)

class Contract

A contract. Can be accessed using *contract_manager*.

type

Type of the contract.

Attribute Read-only, cannot be set

Return type str

title

Title of the contract.

Attribute Read-only, cannot be set

Return type str

description

Description of the contract.

Attribute Read-only, cannot be set

Return type str

notes

Notes for the contract.

Attribute Read-only, cannot be set

Return type str

synopsis

Synopsis for the contract.

Attribute Read-only, cannot be set

Return type str

keywords

Keywords for the contract.

Attribute Read-only, cannot be set

Return type list(str)

state

State of the contract.

Attribute Read-only, cannot be set

Return type *ContractState*

seen

Whether the contract has been seen.

Attribute Read-only, cannot be set

Return type bool

read

Whether the contract has been read.

Attribute Read-only, cannot be set

Return type bool

active

Whether the contract is active.

Attribute Read-only, cannot be set

Return type bool

failed

Whether the contract has been failed.

Attribute Read-only, cannot be set

Return type bool

can_be_canceled

Whether the contract can be canceled.

Attribute Read-only, cannot be set

Return type bool

can_be_declined

Whether the contract can be declined.

Attribute Read-only, cannot be set

Return type bool

can_be_failed

Whether the contract can be failed.

Attribute Read-only, cannot be set

Return type bool

accept ()

Accept an offered contract.

cancel ()

Cancel an active contract.

decline ()

Decline an offered contract.

funds_advance

Funds received when accepting the contract.

Attribute Read-only, cannot be set

Return type float

funds_completion

Funds received on completion of the contract.

Attribute Read-only, cannot be set

Return type float

funds_failure

Funds lost if the contract is failed.

Attribute Read-only, cannot be set

Return type float

reputation_completion

Reputation gained on completion of the contract.

Attribute Read-only, cannot be set

Return type float

reputation_failure

Reputation lost if the contract is failed.

Attribute Read-only, cannot be set

Return type float

science_completion

Science gained on completion of the contract.

Attribute Read-only, cannot be set

Return type float

parameters

Parameters for the contract.

Attribute Read-only, cannot be set

Return type list(*ContractParameter*)

class ContractState

The state of a contract. See *Contract.state*.

active

The contract is active.

canceled

The contract has been canceled.

completed

The contract has been completed.

deadline_expired

The deadline for the contract has expired.

declined

The contract has been declined.

failed

The contract has been failed.

generated

The contract has been generated.

offered

The contract has been offered to the player.

offer_expired

The contract was offered to the player, but the offer expired.

withdrawn

The contract has been withdrawn.

class ContractParameter

A contract parameter. See *Contract.parameters*.

title

Title of the parameter.

Attribute Read-only, cannot be set

Return type str

notes

Notes for the parameter.

Attribute Read-only, cannot be set

Return type str

children

Child contract parameters.

Attribute Read-only, cannot be set

Return type list(*ContractParameter*)

completed

Whether the parameter has been completed.

Attribute Read-only, cannot be set

Return type bool

failed

Whether the parameter has been failed.

Attribute Read-only, cannot be set

Return type bool

optional

Whether the contract parameter is optional.

Attribute Read-only, cannot be set

Return type bool

funds_completion

Funds received on completion of the contract parameter.

Attribute Read-only, cannot be set

Return type float

funds_failure

Funds lost if the contract parameter is failed.

Attribute Read-only, cannot be set

Return type float

reputation_completion

Reputation gained on completion of the contract parameter.

Attribute Read-only, cannot be set

Return type float

reputation_failure

Reputation lost if the contract parameter is failed.

Attribute Read-only, cannot be set

Return type float

science_completion

Science gained on completion of the contract parameter.

Attribute Read-only, cannot be set

Return type float

8.3.16 Geometry Types

Vectors

3-dimensional vectors are represented as a 3-tuple. For example:

```
import krpc
conn = krpc.connect()
v = conn.
↪space_center.active_vessel.flight().prograde
print(v[0], v[1], v[2])
```

Quaternions

Quaternions (rotations in 3-dimensional space) are encoded as a 4-tuple containing the x, y, z and w components. For example:

```
import krpc
conn = krpc.connect()
q = conn.
    ↳space_center.active_vessel.flight().rotation
print(q[0], q[1], q[2], q[3])
```

8.4 Drawing API

8.4.1 Drawing

Provides functionality for drawing objects in the flight scene.

static add_line (*start*, *end*, *reference_frame*[, *visible* = *True*])

Draw a line in the scene.

Parameters

- **start** (*tuple*) – Position of the start of the line.
- **end** (*tuple*) – Position of the end of the line.
- **reference_frame** (*SpaceCenter.ReferenceFrame*) – Reference frame that the positions are in.
- **visible** (*bool*) – Whether the line is visible.

Return type *Line*

static add_direction (*direction*, *reference_frame*[, *length* = *10.0*][, *visible* = *True*])

Draw a direction vector in the scene, from the center of mass of the active vessel.

Parameters

- **direction** (*tuple*) – Direction to draw the line in.
- **reference_frame** (*SpaceCenter.ReferenceFrame*) – Reference frame that the direction is in.
- **length** (*float*) – The length of the line.
- **visible** (*bool*) – Whether the line is visible.

Return type *Line*

static add_polygon (*vertices*, *reference_frame*[, *visible* = *True*])

Draw a polygon in the scene, defined by a list of vertices.

Parameters

- **vertices** (*list*) – Vertices of the polygon.
- **reference_frame** (*SpaceCenter.ReferenceFrame*) – Reference frame that the vertices are in.
- **visible** (*bool*) – Whether the polygon is visible.

Return type *Polygon*

static add_text (*text*, *reference_frame*, *position*, *rotation*[, *visible* = *True*])
 Draw text in the scene.

Parameters

- **text** (*str*) – The string to draw.
- **reference_frame** (*SpaceCenter.ReferenceFrame*) – Reference frame that the text position is in.
- **position** (*tuple*) – Position of the text.
- **rotation** (*tuple*) – Rotation of the text, as a quaternion.
- **visible** (*bool*) – Whether the text is visible.

Return type *Text*

static clear ([*client_only* = *False*])
 Remove all objects being drawn.

Parameters **client_only** (*bool*) – If true, only remove objects created by the calling client.

8.4.2 Line

class Line

A line. Created using *add_line()*.

start

Start position of the line.

Attribute Can be read or written

Return type *tuple(float, float, float)*

end

End position of the line.

Attribute Can be read or written

Return type *tuple(float, float, float)*

reference_frame

Reference frame for the positions of the object.

Attribute Can be read or written

Return type *SpaceCenter.ReferenceFrame*

visible

Whether the object is visible.

Attribute Can be read or written

Return type *bool*

color

Set the color

Attribute Can be read or written

Return type *tuple(float, float, float)*

material

Material used to render the object. Creates the material from a shader with the given name.

Attribute Can be read or written

Return type str

thickness

Set the thickness

Attribute Can be read or written

Return type float

remove ()

Remove the object.

8.4.3 Polygon

class Polygon

A polygon. Created using *add_polygon()*.

vertices

Vertices for the polygon.

Attribute Can be read or written

Return type list(tuple(float, float, float))

reference_frame

Reference frame for the positions of the object.

Attribute Can be read or written

Return type *SpaceCenter.ReferenceFrame*

visible

Whether the object is visible.

Attribute Can be read or written

Return type bool

remove ()

Remove the object.

color

Set the color

Attribute Can be read or written

Return type tuple(float, float, float)

material

Material used to render the object. Creates the material from a shader with the given name.

Attribute Can be read or written

Return type str

thickness

Set the thickness

Attribute Can be read or written

Return type float

8.4.4 Text

class Text

Text. Created using *add_text()*.

position

Position of the text.

Attribute Can be read or written

Return type tuple(float, float, float)

rotation

Rotation of the text as a quaternion.

Attribute Can be read or written

Return type tuple(float, float, float, float)

reference_frame

Reference frame for the positions of the object.

Attribute Can be read or written

Return type *SpaceCenter.ReferenceFrame*

visible

Whether the object is visible.

Attribute Can be read or written

Return type bool

remove()

Remove the object.

content

The text string

Attribute Can be read or written

Return type str

font

Name of the font

Attribute Can be read or written

Return type str

static available_fonts()

A list of all available fonts.

Return type list(str)

size

Font size.

Attribute Can be read or written

Return type int

character_size

Character size.

Attribute Can be read or written

Return type float

style

Font style.

Attribute Can be read or written

Return type *UI.FontStyle*

color

Set the color

Attribute Can be read or written

Return type tuple(float, float, float)

material

Material used to render the object. Creates the material from a shader with the given name.

Attribute Can be read or written

Return type str

alignment

Alignment.

Attribute Can be read or written

Return type *UI.TextAlignment*

line_spacing

Line spacing.

Attribute Can be read or written

Return type float

anchor

Anchor.

Attribute Can be read or written

Return type *UI.TextAnchor*

8.5 InfernalRobotics API

Provides RPCs to interact with the [InfernalRobotics](#) mod. Provides the following classes:

8.5.1 InfernalRobotics

This service provides functionality to interact with [InfernalRobotics](#).

available

Whether Infernal Robotics is installed.

Attribute Read-only, cannot be set

Return type bool

static servo_groups (*vessel*)

A list of all the servo groups in the given *vessel*.

Parameters **vessel** (`SpaceCenter.Vessel`) –

Return type list(*ServoGroup*)

static servo_group_with_name (*vessel*, *name*)

Returns the servo group in the given *vessel* with the given *name*, or `None` if none exists. If multiple servo groups have the same name, only one of them is returned.

Parameters

- **vessel** (`SpaceCenter.Vessel`) – Vessel to check.
- **name** (*str*) – Name of servo group to find.

Return type *ServoGroup*

static servo_with_name (*vessel*, *name*)

Returns the servo in the given *vessel* with the given *name* or `None` if none exists. If multiple servos have the same name, only one of them is returned.

Parameters

- **vessel** (`SpaceCenter.Vessel`) – Vessel to check.
- **name** (*str*) – Name of the servo to find.

Return type *Servo*

8.5.2 ServoGroup

class ServoGroup

A group of servos, obtained by calling *servo_groups()* or *servo_group_with_name()*. Represents the “Servo Groups” in the InfernalRobotics UI.

name

The name of the group.

Attribute Can be read or written

Return type str

forward_key

The key assigned to be the “forward” key for the group.

Attribute Can be read or written

Return type str

reverse_key

The key assigned to be the “reverse” key for the group.

Attribute Can be read or written

Return type str

speed

The speed multiplier for the group.

Attribute Can be read or written

Return type float

expanded

Whether the group is expanded in the InfernalRobotics UI.

Attribute Can be read or written

Return type bool

servos

The servos that are in the group.

Attribute Read-only, cannot be set

Return type list(*Servo*)

servo_with_name (*name*)

Returns the servo with the given *name* from this group, or None if none exists.

Parameters **name** (*str*) – Name of servo to find.

Return type *Servo*

parts

The parts containing the servos in the group.

Attribute Read-only, cannot be set

Return type list(*SpaceCenter.Part*)

move_right ()

Moves all of the servos in the group to the right.

move_left ()

Moves all of the servos in the group to the left.

move_center ()

Moves all of the servos in the group to the center.

move_next_preset ()

Moves all of the servos in the group to the next preset.

move_prev_preset ()

Moves all of the servos in the group to the previous preset.

stop ()

Stops the servos in the group.

8.5.3 Servo

class Servo

Represents a servo. Obtained using *ServoGroup.servos*, *ServoGroup.servo_with_name()* or *servo_with_name()*.

name

The name of the servo.

Attribute Can be read or written

Return type str

part

The part containing the servo.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Part*

highlight

Whether the servo should be highlighted in-game.

Attribute Write-only, cannot be read

Return type bool

position

The position of the servo.

Attribute Read-only, cannot be set

Return type float

min_config_position

The minimum position of the servo, specified by the part configuration.

Attribute Read-only, cannot be set

Return type float

max_config_position

The maximum position of the servo, specified by the part configuration.

Attribute Read-only, cannot be set

Return type float

min_position

The minimum position of the servo, specified by the in-game tweak menu.

Attribute Can be read or written

Return type float

max_position

The maximum position of the servo, specified by the in-game tweak menu.

Attribute Can be read or written

Return type float

config_speed

The speed multiplier of the servo, specified by the part configuration.

Attribute Read-only, cannot be set

Return type float

speed

The speed multiplier of the servo, specified by the in-game tweak menu.

Attribute Can be read or written

Return type float

current_speed

The current speed at which the servo is moving.

Attribute Can be read or written

Return type float

acceleration

The current speed multiplier set in the UI.

Attribute Can be read or written

Return type float

is_moving

Whether the servo is moving.

Attribute Read-only, cannot be set

Return type bool

is_free_moving

Whether the servo is freely moving.

Attribute Read-only, cannot be set

Return type bool

is_locked

Whether the servo is locked.

Attribute Can be read or written

Return type bool

is_axis_inverted

Whether the servos axis is inverted.

Attribute Can be read or written

Return type bool

move_right()

Moves the servo to the right.

move_left()

Moves the servo to the left.

move_center()

Moves the servo to the center.

move_next_preset()

Moves the servo to the next preset.

move_prev_preset()

Moves the servo to the previous preset.

move_to(*position*, *speed*)

Moves the servo to *position* and sets the speed multiplier to *speed*.

Parameters

- **position** (*float*) – The position to move the servo to.

- **speed** (*float*) – Speed multiplier for the movement.

stop()

Stops the servo.

8.5.4 Example

The following example gets the control group named “MyGroup”, prints out the names and positions of all of the servos in the group, then moves all of the servos to the right for 1 second.

```
import time
import krpc

conn_
↳= krpc.connect(name='InfernalRobotics Example')
vessel = conn.space_center.active_vessel

group = conn.infernal_robotics.
↳servo_group_with_name(vessel, 'MyGroup')
if group is None:
    print('Group not found')
    exit(1)

for servo in group.servos:
    print(servo.name, servo.position)

group.move_right()
time.sleep(1)
group.stop()
```

8.6 Kerbal Alarm Clock API

Provides RPCs to interact with the [Kerbal Alarm Clock](#) mod. Provides the following classes:

8.6.1 KerbalAlarmClock

This service provides functionality to interact with [Kerbal Alarm Clock](#).

available

Whether Kerbal Alarm Clock is available.

Attribute Read-only, cannot be set

Return type bool

alarms

A list of all the alarms.

Attribute Read-only, cannot be set

Return type list(*Alarm*)

static alarm_with_name (*name*)

Get the alarm with the given *name*, or `None` if no alarms have that name. If more than one alarm has the name, only returns one of them.

Parameters **name** (*str*) – Name of the alarm to search for.

Return type *Alarm*

static alarms_with_type (*type*)

Get a list of alarms of the specified *type*.

Parameters **type** (*AlarmType*) – Type of alarm to return.

Return type `list(Alarm)`

static create_alarm (*type, name, ut*)

Create a new alarm and return it.

Parameters

- **type** (*AlarmType*) – Type of the new alarm.
- **name** (*str*) – Name of the new alarm.
- **ut** (*float*) – Time at which the new alarm should trigger.

Return type *Alarm*

8.6.2 Alarm

class Alarm

Represents an alarm. Obtained by calling *alarms*, *alarm_with_name()* or *alarms_with_type()*.

action

The action that the alarm triggers.

Attribute Can be read or written

Return type *AlarmAction*

margin

The number of seconds before the event that the alarm will fire.

Attribute Can be read or written

Return type `float`

time

The time at which the alarm will fire.

Attribute Can be read or written

Return type `float`

type

The type of the alarm.

Attribute Read-only, cannot be set

Return type *AlarmType*

id

The unique identifier for the alarm.

Attribute Read-only, cannot be set

Return type str

name

The short name of the alarm.

Attribute Can be read or written

Return type str

notes

The long description of the alarm.

Attribute Can be read or written

Return type str

remaining

The number of seconds until the alarm will fire.

Attribute Read-only, cannot be set

Return type float

repeat

Whether the alarm will be repeated after it has fired.

Attribute Can be read or written

Return type bool

repeat_period

The time delay to automatically create an alarm after it has fired.

Attribute Can be read or written

Return type float

vessel

The vessel that the alarm is attached to.

Attribute Can be read or written

Return type *SpaceCenter.Vessel*

xfer_origin_body

The celestial body the vessel is departing from.

Attribute Can be read or written

Return type *SpaceCenter.CelestialBody*

xfer_target_body

The celestial body the vessel is arriving at.

Attribute Can be read or written

Return type *SpaceCenter.CelestialBody*

remove()

Removes the alarm.

8.6.3 AlarmType

class AlarmType

The type of an alarm.

raw

An alarm for a specific date/time or a specific period in the future.

maneuver

An alarm based on the next maneuver node on the current ships flight path. This node will be stored and can be restored when you come back to the ship.

maneuver_auto

See *AlarmType.maneuver*.

apoapsis

An alarm for furthest part of the orbit from the planet.

periapsis

An alarm for nearest part of the orbit from the planet.

ascending_node

Ascending node for the targeted object, or equatorial ascending node.

descending_node

Descending node for the targeted object, or equatorial descending node.

closest

An alarm based on the closest approach of this vessel to the targeted vessel, some number of orbits into the future.

contract

An alarm based on the expiry or deadline of contracts in career modes.

contract_auto

See *AlarmType.contract*.

crew

An alarm that is attached to a crew member.

distance

An alarm that is triggered when a selected target comes within a chosen distance.

earth_time

An alarm based on the time in the “Earth” alternative Universe (aka the Real World).

launch_rendevous

An alarm that fires as your landed craft passes under the orbit of your target.

soi_change

An alarm manually based on when the next SOI point is on the flight path or set to continually monitor the active flight path and add alarms as it detects SOI changes.

soi_change_auto

See *AlarmType.soi_change*.

transfer

An alarm based on Interplanetary Transfer Phase Angles, i.e. when should I launch to planet X? Based on Kosmo Not's post and used in Olex's Calculator.

transfer_modelled

See *AlarmType.transfer*.

8.6.4 AlarmAction

class AlarmAction

The action performed by an alarm when it fires.

do_nothing

Don't do anything at all...

do_nothing_delete_when_passed

Don't do anything, and delete the alarm.

kill_warp

Drop out of time warp.

kill_warp_only

Drop out of time warp.

message_only

Display a message.

pause_game

Pause the game.

8.6.5 Example

The following example creates a new alarm for the active vessel. The alarm is set to trigger after 10 seconds have passed, and display a message.

```

import krpc
conn = _
↳krpc.connect(name='Kerbal Alarm Clock Example')

alarm = conn.kerbal_alarm_clock.create_alarm(
    conn.kerbal_alarm_clock.AlarmType.raw,
    'My New Alarm',
    conn.space_center.ut+10)

alarm.notes = '10 seconds_
↳have now passed since the alarm was created.'
alarm.action = _
↳conn.kerbal_alarm_clock.AlarmAction.message_only

```

8.7 RemoteTech API

Provides RPCs to interact with the `RemoteTech` mod. Provides the following classes:

8.7.1 RemoteTech

This service provides functionality to interact with `RemoteTech`.

available

Whether RemoteTech is installed.

Attribute Read-only, cannot be set

Return type `bool`

ground_stations

The names of the ground stations.

Attribute Read-only, cannot be set

Return type `list(str)`

static antenna (*part*)

Get the antenna object for a particular part.

Parameters **part** (`SpaceCenter.Part`) –

Return type *Antenna*

static comms (*vessel*)

Get a communications object, representing the communication capability of a particular vessel.

Parameters **vessel** (`SpaceCenter.Vessel`) –

Return type *Comms*

8.7.2 Comms

class Comms

Communications for a vessel.

vessel

Get the vessel.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Vessel*

has_local_control

Whether the vessel can be controlled locally.

Attribute Read-only, cannot be set

Return type `bool`

has_flight_computer

Whether the vessel has a flight computer on board.

Attribute Read-only, cannot be set

Return type bool

has_connection

Whether the vessel has any connection.

Attribute Read-only, cannot be set

Return type bool

has_connection_to_ground_station

Whether the vessel has a connection to a ground station.

Attribute Read-only, cannot be set

Return type bool

signal_delay

The shortest signal delay to the vessel, in seconds.

Attribute Read-only, cannot be set

Return type float

signal_delay_to_ground_station

The signal delay between the vessel and the closest ground station, in seconds.

Attribute Read-only, cannot be set

Return type float

signal_delay_to_vessel (*other*)

The signal delay between the this vessel and another vessel, in seconds.

Parameters *other* (*SpaceCenter.Vessel*) –

Return type float

antennas

The antennas for this vessel.

Attribute Read-only, cannot be set

Return type list(*Antenna*)

8.7.3 Antenna

class Antenna

A RemoteTech antenna. Obtained by calling *Comms.antennas* or *antenna()*.

part

Get the part containing this antenna.

Attribute Read-only, cannot be set

Return type *SpaceCenter.Part*

has_connection

Whether the antenna has a connection.

Attribute Read-only, cannot be set

Return type bool

target

The object that the antenna is targetting. This property can be used to set the target to *Target.none* or *Target.active_vessel*. To set the target to a celestial body, ground station or vessel see *Antenna.target_body*, *Antenna.target_ground_station* and *Antenna.target_vessel*.

Attribute Can be read or written

Return type *Target*

target_body

The celestial body the antenna is targetting.

Attribute Can be read or written

Return type *SpaceCenter.CelestialBody*

target_ground_station

The ground station the antenna is targetting.

Attribute Can be read or written

Return type str

target_vessel

The vessel the antenna is targetting.

Attribute Can be read or written

Return type *SpaceCenter.Vessel*

class Target

The type of object an antenna is targetting. See *Antenna.target*.

active_vessel

The active vessel.

celestial_body

A celestial body.

ground_station

A ground station.

vessel

A specific vessel.

none

No target.

8.7.4 Example

The following example sets the target of a dish on the active vessel then prints out the signal delay to the active vessel.

```
import krpc
conn = krpc.connect(name='RemoteTech Example')
vessel = conn.space_center.active_vessel

# Set a dish target
```

```

part_
↳= vessel.parts.with_title('Reflectron KR-7')[0]
antenna = conn.remote_tech.antenna(part)
antenna.
↳target_body = conn.space_center.bodies['Jool']

# Get info about the vessels communications
comms = conn.remote_tech.comms(vessel)
print('Signal_
↳delay = %.4f seconds' % comms.signal_delay)

```

8.8 User Interface API

8.8.1 UI

Provides functionality for drawing and interacting with in-game user interface elements.

stock_canvas

The stock UI canvas.

Attribute Read-only, cannot be set

Return type *Canvas*

static add_canvas()

Add a new canvas.

Return type *Canvas*

Note: If you want to add UI elements to KSP's stock UI canvas, use *stock_canvas*.

static message(*content*[, *duration* = 1.0][, *position* = 1])

Display a message on the screen.

Parameters

- **content** (*str*) – Message content.
- **duration** (*float*) – Duration before the message disappears, in seconds.
- **position** (*MessagePosition*) – Position to display the message.

Note: The message appears just like a stock message, for example quicksave or quickload messages.

static clear([*client_only* = False])

Remove all user interface elements.

Parameters **client_only** (*bool*) – If true, only remove objects created by the calling client.

class MessagePosition

Message position.

top_left

Top left.

top_center

Top center.

top_right

Top right.

bottom_center

Bottom center.

8.8.2 Canvas

class Canvas

A canvas for user interface elements. See *stock_canvas* and *add_canvas()*.

rect_transform

The rect transform for the canvas.

Attribute Read-only, cannot be set

Return type *RectTransform*

visible

Whether the UI object is visible.

Attribute Can be read or written

Return type bool

add_panel ([*visible = True*])

Create a new container for user interface elements.

Parameters **visible** (*bool*) – Whether the panel is visible.

Return type *Panel*

add_text (*content* [, *visible = True*])

Add text to the canvas.

Parameters

- **content** (*str*) – The text.
- **visible** (*bool*) – Whether the text is visible.

Return type *Text*

add_input_field ([*visible = True*])

Add an input field to the canvas.

Parameters **visible** (*bool*) – Whether the input field is visible.

Return type *InputField*

add_button (*content* [, *visible = True*])

Add a button to the canvas.

Parameters

- **content** (*str*) – The label for the button.
- **visible** (*bool*) – Whether the button is visible.

Return type *Button*

remove ()

Remove the UI object.

8.8.3 Panel

class Panel

A container for user interface elements. See *Canvas*.

add_panel ().

rect_transform

The rect transform for the panel.

Attribute Read-only, cannot be set

Return type *RectTransform*

visible

Whether the UI object is visible.

Attribute Can be read or written

Return type bool

add_panel ([visible = True])

Create a panel within this panel.

Parameters **visible** (*bool*) – Whether the new panel is visible.

Return type *Panel*

add_text (content[, visible = True])

Add text to the panel.

Parameters

- **content** (*str*) – The text.
- **visible** (*bool*) – Whether the text is visible.

Return type *Text*

add_input_field ([visible = True])

Add an input field to the panel.

Parameters **visible** (*bool*) – Whether the input field is visible.

Return type *InputField*

add_button (content[, visible = True])

Add a button to the panel.

Parameters

- **content** (*str*) – The label for the button.
- **visible** (*bool*) – Whether the button is visible.

Return type *Button*

remove ()

Remove the UI object.

8.8.4 Text

class Text

A text label. See *Panel.add_text()*.

rect_transform

The rect transform for the text.

Attribute Read-only, cannot be set

Return type *RectTransform*

visible

Whether the UI object is visible.

Attribute Can be read or written

Return type bool

content

The text string

Attribute Can be read or written

Return type str

font

Name of the font

Attribute Can be read or written

Return type str

available_fonts

A list of all available fonts.

Attribute Read-only, cannot be set

Return type list(str)

size

Font size.

Attribute Can be read or written

Return type int

style

Font style.

Attribute Can be read or written

Return type *FontStyle*

color

Set the color

Attribute Can be read or written

Return type tuple(float, float, float)

alignment

Alignment.

Attribute Can be read or written

Return type *TextAnchor*

line_spacing

Line spacing.

Attribute Can be read or written

Return type float

remove ()

Remove the UI object.

class FontStyle

Font style.

normal

Normal.

bold

Bold.

italic

Italic.

bold_and_italic

Bold and italic.

class TextAlignment

Text alignment.

left

Left aligned.

right

Right aligned.

center

Center aligned.

class TextAnchor

Text alignment.

lower_center

Lower center.

lower_left

Lower left.

lower_right

Lower right.

middle_center

Middle center.

middle_left

Middle left.

middle_right

Middle right.

upper_center

Upper center.

upper_left

Upper left.

upper_right
Upper right.

8.8.5 Button

class Button
A text label. See *Panel.add_button()*.

rect_transform
The rect transform for the text.

Attribute Read-only, cannot be set

Return type *RectTransform*

visible
Whether the UI object is visible.

Attribute Can be read or written

Return type bool

text
The text for the button.

Attribute Read-only, cannot be set

Return type *Text*

clicked
Whether the button has been clicked.

Attribute Can be read or written

Return type bool

Note: This property is set to true when the user clicks the button.
A client script should reset the property to false in order to detect subsequent button presses.

remove()
Remove the UI object.

8.8.6 InputField

class InputField
An input field. See *Panel.add_input_field()*.

rect_transform
The rect transform for the input field.

Attribute Read-only, cannot be set

Return type *RectTransform*

visible
Whether the UI object is visible.

Attribute Can be read or written

Return type bool

value

The value of the input field.

Attribute Can be read or written

Return type str

text

The text component of the input field.

Attribute Read-only, cannot be set

Return type *Text*

Note: Use *InputField.value* to get and set the value in the field. This object can be used to alter the style of the input field's text.

changed

Whether the input field has been changed.

Attribute Can be read or written

Return type bool

Note: This property is set to true when the user modifies the value of the input field. A client script should reset the property to false in order to detect subsequent changes.

remove ()

Remove the UI object.

8.8.7 Rect Transform

class RectTransform

A Unity engine Rect Transform for a UI object. See the [Unity manual](#) for more details.

position

Position of the rectangles pivot point relative to the anchors.

Attribute Can be read or written

Return type tuple(float, float)

local_position

Position of the rectangles pivot point relative to the anchors.

Attribute Can be read or written

Return type tuple(float, float, float)

size

Width and height of the rectangle.

Attribute Can be read or written

Return type tuple(float, float)

upper_right

Position of the rectangles upper right corner relative to the anchors.

Attribute Can be read or written

Return type tuple(float, float)

lower_left

Position of the rectangles lower left corner relative to the anchors.

Attribute Can be read or written

Return type tuple(float, float)

anchor

Set the minimum and maximum anchor points as a fraction of the size of the parent rectangle.

Attribute Write-only, cannot be read

Return type tuple(float, float)

anchor_max

The anchor point for the lower left corner of the rectangle defined as a fraction of the size of the parent rectangle.

Attribute Can be read or written

Return type tuple(float, float)

anchor_min

The anchor point for the upper right corner of the rectangle defined as a fraction of the size of the parent rectangle.

Attribute Can be read or written

Return type tuple(float, float)

pivot

Location of the pivot point around which the rectangle rotates, defined as a fraction of the size of the rectangle itself.

Attribute Can be read or written

Return type tuple(float, float)

rotation

Rotation, as a quaternion, of the object around its pivot point.

Attribute Can be read or written

Return type tuple(float, float, float, float)

scale

Scale factor applied to the object in the x, y and z dimensions.

Attribute Can be read or written

Return type tuple(float, float, float)

OTHER CLIENTS, SERVICES AND SCRIPTS

This page links to clients, services, scripts, tools and other useful things for kRPC that have been made by others. If you want your own project added to this page, please feel free to ask [on the forum](#).

9.1 Clients

- [Ruby client](#)
- [Haskell client](#)
- [Node.js client](#) (requires the v0.4.0 pre-release version of kRPC)
- [Using the plugin in F#](#)

9.2 Services

- [krpcmj](#) – remote procedures to interact with MechJeb

9.3 Scripts/Tools/Libraries etc.

- [kIPC](#) - Inter-Process(or) Communication between kOS and kRPC
- [kautopilly](#) – an autopilot primarily intended for planes.
- [KNav](#) – a flexible platform for implementing computer-assisted navigation and control of vessels.
- [wernher](#) – a toolkit for flight control and orbit analysis.
- [A small logging script](#).

COMPILING KRPC

10.1 Getting the source code

First you need to download a copy of the source code, which is available from [GitHub](https://github.com/krpc/krpc) or using the following on the command line:

```
git clone https://github.com/krpc/krpc
```

10.2 Install Dependencies

Next you need to install [Bazel](#). This is the build system used to compile the project.

The Bazel build scripts will automatically download most of the required dependencies for the project, but the following need to be installed manually on your system:

- [Mono C# compiler, runtime and tools](#)
- Python and virtualenv
- Autotools
- LuaRocks
- pdflatex, rsvg, libxml, libxslt and python headers (for building the documentation)

To install these dependencies via apt on Ubuntu, first follow the instructions on [Mono's website](#) to add their apt repository. Then run the following command:

```
sudo apt-get install mono-complete python-setuptools python-virtualenv \
python-dev autoconf libtool luarocks texlive-latex-base \
texlive-latex-recommended texlive-fonts-recommended texlive-latex-extra \
libxml2-dev libxslt1-dev librsvg2-bin
```

10.3 Set Up your Environment

Before building kRPC you need to make `lib/ksp` point to a directory containing Kerbal Space Program. For example on Linux, if your KSP directory is at `/path/to/ksp` and your kRPC source tree is at `/path/to/krpc` you can create a symlink using `ln -s /path/to/ksp /path/to/krpc/lib/ksp`

You may also need to modify the symlink at `lib/mono-4.5` to point to the correct location of your Mono installation.

10.4 Building using Bazel

To build the kRPC release archive, run `bazel build //:krpc`. The resulting archive containing the GameData directory, client libraries etc will be created at `bazel-out/krpc-<version>.zip`.

The build scripts also define targets for the different parts of the project. They can be built using `bazel build <target>`:

- `//server` builds the server plugin and associated files
- Targets for building individual clients:
 - `//client/csharp`
 - `//client/cpp`
 - `//client/java`
 - `//client/lua`
 - `//client/python`
- Targets for building individual services:
 - `//service/SpaceCenter`
 - `//service/Drawing`
 - `//service/UI`
 - `//service/InfernalRobotics`
 - `//service/KerbalAlarmClock`
 - `//service/RemoteTech`
- Targets for building protobuf definitions for individual languages:
 - `//protobuf/csharp`
 - `//protobuf/cpp`
 - `//protobuf/java`
 - `//protobuf/lua`
 - `//protobuf/python`
- `//doc:html` builds the HTML documentation
- `//doc:pdf` builds the PDF documentation

There are also several convenience scripts:

- `tools/serve-docs.sh` – builds the documentation and serves it from `http://localhost:8080`
- `tools/install.sh` – builds the plugin and the testing tools, and installs them into the GameData directory of the copy of KSP found at `lib/ksp`.

10.5 Building the C# projects using an IDE

A C# solution file (`kRPC.sln`) is provided in the root of the project for use with MonoDevelop or a similar C# IDE.

Some of the C# source files it references are generated by the Bazel build scripts. You need to run `bazel build //:csproj` to generate these files before the solution can be built.

Alternatively, if you are unable to run Bazel to build these files, you can [download them from GitHub](#). Simply extract this archive over your copy of the source and you are good to go.

10.5.1 Running the Tests

kRPC contains a suite of tests for the server plugin, services, client libraries and others.

The tests, which do not require KSP to be running, can be executed using: `bazel test //:test`

kRPC also includes a suite of tests that require KSP to be running. First run `tools/install.sh` to build kRPC and a testing tools DLL, and install them into the GameData directory of the copy of KSP found at `lib/ksp`. Then run KSP, load a save game and start the server (with automatically accept client connections enabled). Then install the krpc python client, the krptest package (built by target `//tools/krptest`) and run the scripts to test a particular service, for example those found in `service/SpaceCenter/test`. These tests will automatically load a save game called `krptest`, launch a vessel and run various tests on it.

EXTENDING KRPC

11.1 The kRPC Architecture

kRPC consists of two components: a server and a client. The server plugin (provided by `KRPC.dll`) runs inside KSP. It provides a collection of *procedures* that clients can run. These procedures are arranged in groups called *services* to keep things organized. It also provides an in-game user interface that can be used to start/stop the server, change settings and monitor active clients.

Clients run outside of KSP. This gives you the freedom to run scripts in whatever environment you want. A client communicates with the server to run procedures using one of the supported *Communication Protocols*. kRPC comes with several client libraries that implement one of these protocols, making it easier to write programs in these languages.

kRPC comes with a collection of standard functionality for interacting with vessels, contained in a service called `SpaceCenter`. This service provides procedures for things like getting flight/orbital data and controlling the active vessel. This service is provided by `KRPC.SpaceCenter.dll`.

11.2 Service API

Third party mods can add functionality to kRPC using the *Service API*. This is done by adding *attributes* to your own classes, methods and properties to make them visible through the server. When the kRPC server starts, it scans all the assemblies loaded by the game, looking for classes, methods and properties with these attributes.

The following example implements a service that can control the throttle and staging of the active vessel. To add this to the server, compile the code and place the DLL in your GameData directory.

```
using KRPC.Service;
using KRPC.Service.Attributes;
using KSP.UI.Screens;

namespace LaunchControl
{
    /// <summary>
    /// Service for staging vessels and controlling their throttle.
    /// </summary>
    [KRPCService (GameScene = GameScene.Flight)]
    public static class LaunchControl
    {
        /// <summary>
        /// The current throttle setting for the active vessel, between 0 and 1.
        /// </summary>
        [KRPCProperty]
        public static float Throttle {
```

```
    get { return FlightInputHandler.state.mainThrottle; }
    set { FlightInputHandler.state.mainThrottle = value; }
}

/// <summary>
/// Activate the next stage in the vessel.
/// </summary>
[KRPCProcedure]
public static void ActivateStage ()
{
    StageManager.ActivateNextStage ();
}
}
```

The following example shows how this service can then be used from a python client:

```
import krpc
conn = krpc.connect()
conn.launch_control.throttle = 1
conn.launch_control.activate_stage()
```

Some of the client libraries automatically pick up changes to the functionality provided by the server, including the Python and Lua clients. However, some clients require code to be generated from the service assembly so that they can interact with new or changed functionality. See *clientgen* for details on how to generate this code.

11.2.1 Attributes

The following C# attributes can be used to add functionality to the kRPC server.

KRPCService (*String Name, KRPC.Service.GameScene GameScene*)

Parameters

- **Name** – Optional name for the service. If omitted, the service name is set to the name of the class this attribute is applied to.
- **GameScene** – The game scenes in which the services procedures are available.

This attribute is applied to a static class, to indicate that all methods, properties and classes declared within it are part of the the same service. The name of the service is set to the name of the class, or – if present – the Name parameter.

Multiple services with the same name can be declared, as long the classes, procedures and methods they contain have unique names. The classes will be merged to appear as a single service on the server.

The type to which this attribute is applied must satisfy the following criteria:

- The type must be a class.
- The class must be `public static`.
- The name of the class, or the Name parameter if specified, must be a valid *kRPC identifier*.
- The class must not be declared within another class that has the *KRPCService* attribute. Nesting of services is not permitted.

Services are configured to be available in specific *game scenes* via the GameScene parameter. If the GameScene parameter is not specified, the service is available in any scene. If a procedure is called when the service is not available, it will throw an exception.

Examples

- Declare a service called EVA:

```
[KRPCService]
public static class EVA {
    ...
}
```

- Declare a service called MyEVAService (different to the name of the class):

```
[KRPCService (Name = "MyEVAService")]
public static class EVA {
    ...
}
```

- Declare a service called FlightTools that is only available during the Flight game scene:

```
[KRPCService (GameScene = GameScene.Flight)]
public static class FlightTools {
    ...
}
```

KRPCProcedure

Parameters

- **Nullable** – Whether the return value of the procedure can be null. Defaults to false.

This `attribute` is applied to static methods, to add them to the server as procedures.

The method to which this attribute is applied must satisfy the following criteria:

- The method must be `public static`.
- The name of the method must be a valid *kRPC identifier*.
- The method must be declared inside a class that is a *KRPCService*.
- The parameter types and return type must be *types that kRPC knows how to serialize*.
- Parameters can have default arguments.

If the procedure might return a null value, the `Nullable` parameter of the attribute must be set to true.

Example

The following defines a service called EVA with a PlantFlag procedure that takes a name and an optional description, and returns a Flag object.

```
[KRPCService]
public static class EVA {
    [KRPCProcedure]
    public static Flag PlantFlag (string name, string description = "")
    {
        ...
    }
}
```

This can be called from a python client as follows:

```
import krpc
conn = krpc.connect()
flag = conn.eva.plant_flag('Landing Site', 'One small step for Kerbal-kind')
```

KRPCClass (String Service)

Parameters

- **Service** – Optional name of the service to add this class to. If omitted, the class is added to the service that contains its definition.

This [attribute](#) is applied to non-static classes. It adds the class to the server, so that references to instances of the class can be passed between client and server.

A *KRPCClass* must be part of a service, just like a *KRPCProcedure*. However, it would be restrictive if the class had to be declared as a nested class inside a class with the *KRPCService* attribute. Therefore, a *KRPCClass* can be declared outside of any service if it has the *Service* parameter set to the name of the service that it is part of. Also, the service that the *Service* parameter refers to does not have to exist. If it does not exist, a service with the given name is created.

The class to which this attribute is applied must satisfy the following criteria:

- The class must be `public` and *not* `static`.
- The name of the class must be a valid *kRPC identifier*.
- The class must either be declared inside a class that is a *KRPCService*, or have its *Service* parameter set to the name of the service it is part of.

Examples

- Declare a class called `Flag` in the EVA service:

```
[KRPCService]
public static class EVA {
    [KRPCClass]
    public class Flag {
        ...
    }
}
```

- Declare a class called `Flag`, without nesting the class definition in a service class:

```
[KRPCClass (Service = "EVA")]
public class Flag {
    ...
}
```

KRPCMethod

Parameters

- **Nullable** – Whether the return value of the procedure can be null. Defaults to false.

This [attribute](#) is applied to methods inside a *KRPCClass*. This allows a client to call methods on an instance, or static methods in the class.

The method to which this attribute is applied must satisfy the following criteria:

- The method must be `public`.
- The name of the method must be a valid *kRPC identifier*.

- The method must be declared in a *KRPCClass*.
- The parameter types and return type must be *types that kRPC can serialize*.
- Parameters can have default arguments.

If the method might return a null value, the `Nullable` parameter of the attribute must be set to true.

Example

Declare a `Remove` method in the `Flag` class:

```
[KRPCClass (Service = "EVA")]
public class Flag {
    [KRPCMethod]
    void Remove()
    {
        ...
    }
}
```

KRPCProperty

Parameters

- **Nullable** – Whether the return value of the procedure can be null. Defaults to false.

This `attribute` is applied to class properties, and comes in two flavors:

1. Applied to static properties in a *KRPCService*. In this case, the property must satisfy the following criteria:
 - Must be `public static` and have at least one publicly accessible getter or setter.
 - The name of the property must be a valid *kRPC identifier*.
 - Must be declared inside a *KRPCService*.
2. Applied to non-static properties in a *KRPCClass*. In this case, the property must satisfy the following criteria:
 - Must be `public` and *not static*, and have at least one publicly accessible getter or setter.
 - The name of the property must be a valid *kRPC identifier*.
 - Must be declared inside a *KRPCClass*.

If the property getter might return a null value, the `Nullable` parameter of the attribute must be set to true.

Examples

- Applied to a static property in a service:

```
[KRPCService]
public static class EVA {
    [KRPCProperty]
    public Flag LastFlag
    {
        get { ... }
    }
}
```

This property can be accessed from a python client as follows:

```
import krpc
conn = krpc.connect()
flag = conn.eva.last_flag
```

- Applied to a non-static property in a class:

```
[KRPCClass (Service = "EVA")]
public class Flag {
    [KRPCProperty]
    public void Name { get; set; }

    [KRPCProperty]
    public void Description { get; set; }
}
```

KRPCEnum (*String Service*)

Parameters

- **Service** – Optional name of the service to add this enum to. If omitted, the enum is added to the service that contains its definition.

This `attribute` is applied to enumeration types. It adds the enumeration and its permissible values to the server. This attribute works similarly to *KRPCClass*, but is applied to enumeration types.

A *KRPCEnum* must be part of a service, just like a *KRPCClass*. Similarly, a *KRPCEnum* can be declared outside of a service if it has its *Service* parameter set to the name of the service that it is part of.

The enumeration type to which this attribute is applied must satisfy the following criteria:

- The enumeration must be `public`.
- The name of the enumeration must be a valid *kRPC identifier*.
- The enumeration must either be declared inside a *KRPCService*, or have its *Service* parameter set to the name of the service it is part of.
- The *underlying C# type* must be an `int`.

Examples

- Declare an enumeration type with two values:

```
[KRPCEnum (Service = "EVA")]
public enum FlagState {
    Raised,
    Lowered
}
```

This can be used from a python client as follows:

```
import krpc
conn = krpc.connect()
state = conn.eva.FlagState.lowered
```

KRPCException (*String Service, Type MappedException*)

Parameters

- **Service** – Optional name of the service to add this enum to. If omitted, the enum is added to the service that contains its definition.

- **MappedException** – Optional type of an exception to map to this exception. For example, can be used to map a built-in C# exception type onto this kRPC exception type.

This `attribute` is applied to an exception class type.

A *KRPCException* must be part of a service, just like a *KRPCClass*. Similarly, a *KRPCException* can be declared outside of a service if it has its `Service` parameter set to the name of the service that it is part of.

The class type to which this attribute is applied must satisfy the following criteria:

- The class must be `public`.
- The name of the class must be a valid *kRPC identifier*.
- The class must either be declared inside a *KRPCService*, or have its `Service` parameter set to the name of the service it is part of.

KRPCDefaultValue (*String Name*, *Type ValueConstructor*)

Parameters

- **Name** – Name of the parameter to set the default value for.
- **ValueConstructor** – Type of a static class with a `Create` method that returns an instance of the default value.

This `attribute` can be applied to a kRPC method or procedure. It provides a workaround to set the default value of a parameter to a non-compile time constant. Ordinarily, C# only allows compile time constants to be used as the values of default arguments.

The `ValueConstructor` parameter is the type of a static class that contains a static method, called `Create`. When invoke, this method should return the default value.

Note: If you just want to set the default value to a compile time constant, use the C# syntax. kRPC will detect the default values and use them.

Examples

- Set the default value to a list:

```
public static class DefaultKerbals
{
    public static IList<string> Create ()
    {
        return new List<string> { "Jeb", "Bill", "Bob" };
    }
}

[KRPCProcedure]
[KRPCDefaultValue ("names", typeof(DefaultKerbals))]
public static void HireKerbals (IList<string> names)
{
    ...
}
```

- Set the default value to a compile time constant, which does not require the `KRPCDefaultValue` attribute:

```
[KRPCProcedure]
public static void HireKerbal (string name = "Jeb")
{
    ...
}
```

11.2.2 Identifiers

An identifier can only contain letters and numbers, and must start with an upper case letter. They should follow *CamelCase* capitalization conventions.

11.2.3 Serializable Types

A type can only be used as a parameter or return type if kRPC knows how to serialize it. The following types are serializable:

- The C# types `double`, `float`, `int`, `long`, `uint`, `ulong`, `bool`, `string` and `byte[]`
- Any type annotated with *KRPCClass*
- Any type annotated with *KRPCEnum*
- Collections of serializable types:
 - `System.Collections.Generic.IList<T>` where `T` is a serializable type
 - `System.Collections.Generic.IDictionary<K,V>` where `K` is one of `int`, `long`, `uint`, `ulong`, `bool` or `string` and `V` is a serializable type
 - `System.Collections.HashSet<V>` where `V` is a serializable type
- Return types can be `void`
- Protocol buffer message types from namespace `KRPC.Service.Messages`

11.2.4 Events

kRPC procedures, methods and properties can return event objects to clients. This is done using the class `KRPC.Services.Event`. This class supports two different types of event.

Manually Triggered Events

This type of event must be triggered by some other piece of code running somewhere in the game. It is created by calling the default constructor for type `KRPC.Services.Event`.

For example, the following example is a procedure that returns an event that triggers after a given number of milliseconds. When the event triggers it is removed.

```
[KRPCProcedure]
public static KRPC.Service.Messages.Event OnTimer(uint milliseconds) {
    // Create the event
    var evnt = new KRPC.Service.Event ();

    // Set up a timer that will trigger the event
    var timer = new System.Timers.Timer (milliseconds);
    timer.Elapsed += (s, e) => {
        evnt.Trigger ();
        evnt.Remove ();
        timer.Enabled = false;
    };
    timer.Start();

    // Return the message describing the event to the client
}
```

```

    return evnt.Message;
}

```

Actively Polled Events

This type of event contains a function that is evaluated once per game update. When the function returns true, the event is triggered. The event object is passed to the function so that it can manipulate it as desired.

For example the following creates an event that triggers when the active vessel reaches the given altitude. The event is removed the first time it triggers.

```

[KRPCProcedure]
public static KRPC.Service.Messages.Event OnAltitudeReached(uint altitude) {
    // Create the event
    var evnt = new KRPC.Service.Event ((KRPC.Service.Event e) => {
        bool result = FlightGlobals.ActiveVessel.terrainAltitude > altitude;
        if (result)
            e.Remove();
        return result;
    });

    // Return the message describing the event to the client
    return evnt.Message;
}

```

11.2.5 Game Scenes

Each service is configured to be available from a particular game scene, or scenes.

enum KRPC.Service.GameScene

SpaceCenter

The game scene showing the Kerbal Space Center buildings.

Flight

The game scene showing a vessel in flight (or on the launchpad/runway).

TrackingStation

The tracking station.

EditorVAB

The Vehicle Assembly Building.

EditorSPH

The Space Plane Hangar.

Editor

Either the VAB or the SPH.

All

All game scenes.

Examples

- Declare a service that is available in the `KRPC.Service.GameScene.Flight` game scene:

```
[KRPCService (GameScene = GameScene.Flight)]
public static class MyService {
    ...
}
```

- Declare a service that is available in the *KRPC.Service.GameScene.Flight* and *KRPC.Service.GameScene.Editor* game scenes:

```
[KRPCService (GameScene = (GameScene.Flight | GameScene.Editor))]]
public static class MyService {
    ...
}
```

11.3 Documentation

Documentation can be added using [C# XML documentation](#). For dynamic clients, such as the Python and Lua clients, the documentation will be automatically exported to clients when they connect.

11.4 Further Examples

See the [SpaceCenter service implementation](#) for more extensive examples.

11.5 Generating Service Code for Static Clients

Some of the client libraries dynamically construct the code necessary to interact with the server when they connect. This means that these libraries will automatically pick up changes to service code. Such client libraries include those for Python and Lua.

Other client libraries required code to be generated and compiled into them statically. They do not automatically pick up changes to service code. Such client libraries include those for C++ and C#.

Code for these ‘static’ libraries is generated using the `krpc-clientgen` tool. This is provided as part of the [krpctools python package](#). It can be installed using `pip`:

```
pip install krpctools
```

You can then run the script from the command line:

```
$ krpc-clientgen --help

usage: krpc-clientgen [-h] [-v] [-o OUTPUT] [--ksp KSP]
                    [--output-defs OUTPUT_DEFS]
                    {cpp,csharp,java} service input [input ...]

Generate client source code for kRPC services.

positional arguments:
  {cpp,csharp,java}    Language to generate
  service              Name of service to generate
  input                Path to service definition JSON file or assembly
                       DLL(s)
```

```

optional arguments:
  -h, --help            show this help message and exit
  -v, --version          show program's version number and exit
  -o OUTPUT, --output OUTPUT
                        Path to write source code to. If not specified, writes
                        source code to standard output.
  --ksp KSP             Path to Kerbal Space Program directory. Required when
                        reading from an assembly DLL(s)
  --output-defs OUTPUT_DEFS
                        When generating client code from a DLL, output the
                        service definitions to the given JSON file

```

Client code can be generated either directly from an assembly DLL containing the service, or from a JSON file that has previously been generated from an assembly DLL (using the `--output-defs` flag).

Generating client code from an assembly DLL requires a copy of Kerbal Space Program and a C# runtime to be available on the machine. In contrast, generating client code from a JSON file does not have these requirements and so is more portable.

11.5.1 Example

The following demonstrates how to generate code for the C++ and C# clients to interact with the LaunchControl service, given in an example previously.

`krpc-clientgen` expects to be passed the location of your copy of Kerbal Space Program, the name of the language to generate, the name of the service (from the *KRPCService* attribute), a path to the assembly containing the service and the path to write the generated code to.

For C++, run the following:

```
krpc-clientgen --ksp=/path/to/ksp cpp LaunchControl LaunchControl.dll
launch_control.hpp
```

To then use the LaunchControl service from C++, you need to link your code against the C++ client library, and include *launch_control.hpp*.

For C#, run the following:

```
krpc-clientgen --ksp=/path/to/ksp csharp LaunchControl LaunchControl.dll
LaunchControl.cs
```

To then use the LaunchControl service from a C# client, you need to reference the *KRPC.Client.dll* and include *LaunchControl.cs* in your project.

COMMUNICATION PROTOCOLS

kRPC provides two communication protocols:

- *Protocol Buffers over TCP/IP* for languages that can communicate over a TCP/IP socket.
- *Protocol Buffers over WebSockets* for web browsers.

In both protocols, clients invoke remote procedure calls by *sending and receiving protobuf messages*.

12.1 Protocol Buffers over TCP/IP

This communication protocol allows languages that can communication over a TCP/IP connection to interact with a kRPC server.

Note: If a client library is available for your language, you do not need to implement this protocol.

12.1.1 Sending and Receiving Messages

Communication with the server is performed via Protocol Buffer messages, encoded according to the protobuf binary format. When sending messages to and from the server, they are prefixed with their size, in bytes, encoded as a Protocol Buffers varint.

To send a message to the server:

1. Encode the message using the Protocol Buffers format.
2. Get the length of the encoded message data (in bytes) and encode that as a Protocol Buffers varint.
3. Send the encoded length followed by the encoded message data.

To receive a message from the server, do the reverse:

1. Receive the size of the message as a Protocol Buffers encoded varint.
2. Decode the message size.
3. Receive message size bytes of message data.
4. Decode the message data.

12.1.2 Connecting to the RPC Server

A client invokes remote procedures by communicating with the *RPC server*. To establish a connection, a client must do the following:

1. Open a TCP socket to the server on its RPC port (which defaults to 50000).
2. Send a `ConnectionRequest` message to the server. This message is defined as:

```
message ConnectionRequest {
  Type type = 1;
  string client_name = 2;
  bytes client_identifier = 3;
  enum Type {
    RPC = 0;
    STREAM = 1;
  };
}
```

The `type` field should be set to `ConnectionRequest.RPC` and the `client_name` field can be set to the name of the client to display on the in-game UI. The `client_identifier` should be left blank.

3. Receive a `ConnectionResponse` message from the server. This message is defined as:

```
message ConnectionResponse {
  Status status = 1;
  enum Status {
    OK = 0;
    MALFORMED_MESSAGE = 1;
    TIMEOUT = 2;
    WRONG_TYPE = 3;
  }
  string message = 2;
  bytes client_identifier = 3;
}
```

If the `status` field is set to `ConnectionResponse.OK` then the connection was successful. If not, the `message` field contains a description of what went wrong.

When the connection is successful, the `client_identifier` contains a unique 16-byte identifier for the client. This is required when connecting to the stream server (described below).

12.1.3 Connecting to the Stream Server

Clients can receive *Streams* from the *stream server*. To establish a connection, a client must first connect to the RPC server (as above) then do the following:

1. Open a TCP socket to the server on its stream port (which defaults to 50001).
2. Send a `ConnectionRequest` message, with its `type` field set to `ConnectionRequest.STREAM` and its `client_identifier` field set to the value received in the `client_identifier` field of the `ConnectionResponse` message received when connecting to the RPC server earlier.
3. **Receive a `ConnectionResponse` message, similarly to the RPC server, and check that the value of the `status` field is `ConnectionResponse.OK`.** If not, then the connection was not successful, and the `message` field contains a description of what went wrong.

Connecting to the stream server is optional. If the client doesn't require stream functionality, there is no need to connect.

12.1.4 Invoking Remote Procedures

See *Messaging Protocol*.

12.1.5 Examples

The following Python code connects to the RPC server at address 127.0.0.1 and port 50000 using the name “Jeb”. Next, it connects to the stream server on port 50001. It then invokes the `KRPC.GetStatus` RPC, receives and decodes the result and prints out the server version number from the response.

The following python code connects to the RPC server at address 127.0.0.1 and port 50000, using the name “Jeb”. Next, it connects to the stream server on port 50001. Finally it invokes the `KRPC.GetStatus` procedure, and receives, decodes and prints the result.

To send and receive messages to the server, they need to be encoded and decoded from their binary format:

- The `encode_varint` and `decode_varint` functions convert between Python integers and Protocol Buffer varint encoded integers.
- `send_message` encodes a message, sends the length of the message to the server as a Protocol Buffer varint encoded integer, and then sends the message data.
- `recv_message` receives the size of the message, decodes it, receives the message data, and decodes it.

```
import socket
from google.protobuf.internal.encoder import _VarintEncoder
from google.protobuf.internal.decoder import _DecodeVarint
from krpc.schema import KRPC

def encode_varint(value):
    """ Encode an int as a protobuf varint """
    data = []
    _VarintEncoder()(data.append, value)
    return b''.join(data)

def decode_varint(data):
    """ Decode a protobuf varint to an int """
    return _DecodeVarint(data, 0)[0]

def send_message(conn, msg):
    """ Send a message, prefixed with its size, to a TPC/IP socket """
    data = msg.SerializeToString()
    size = encode_varint(len(data))
    conn.sendall(size + data)

def recv_message(conn, msg_type):
    """ Receive a message, prefixed with its size, from a TCP/IP socket """
    # Receive the size of the message data
    data = b''
    while True:
        try:
            data += conn.recv(1)
            size = decode_varint(data)
            break
```

```
        except IndexError:
            pass
        # Receive the message data
        data = conn.recv(size)
        # Decode the message
        msg = msg_type()
        msg.ParseFromString(data)
        return msg

# Open a TCP/IP socket to the RPC server
rpc_conn = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
rpc_conn.connect(('127.0.0.1', 50000))

# Send an RPC connection request
request = KRPC.ConnectionRequest()
request.type = KRPC.ConnectionRequest.RPC
request.client_name = 'Jeb'
send_message(rpc_conn, request)

# Receive the connection response
response = recv_message(rpc_conn, KRPC.ConnectionResponse)

# Check the connection was successful
if response.status != KRPC.ConnectionResponse.OK:
    raise RuntimeError('Connection failed: ' + response.message)
print('Connected to RPC server')

# Invoke the KRPC.GetStatus RPC
call = KRPC.ProcedureCall()
call.service = 'KRPC'
call.procedure = 'GetStatus'
request = KRPC.Request()
request.calls.extend([call])
send_message(rpc_conn, request)

# Receive the response
response = recv_message(rpc_conn, KRPC.Response)

# Check for an error in the response
if response.HasField('error'):
    raise RuntimeError('ERROR: ' + str(response.error))

# Check for an error in the results
assert(len(response.results) == 1)
if response.results[0].HasField('error'):
    raise RuntimeError('ERROR: ' + str(response.error))

# Decode the return value as a Status message
status = KRPC.Status()
status.ParseFromString(response.results[0].value)

# Print out the Status message
print(status)
```

The following example demonstrates how to set up and receive data from the server over a stream:

```

import binascii
import socket
from google.protobuf.internal.encoder import _VarintEncoder
from google.protobuf.internal.decoder import _DecodeVarint
from krpc.schema import KRPC

def encode_varint(value):
    """ Encode an int as a protobuf varint """
    data = []
    _VarintEncoder()(data.append, value)
    return b''.join(data)

def decode_varint(data):
    """ Decode a protobuf varint to an int """
    return _DecodeVarint(data, 0)[0]

def send_message(conn, msg):
    """ Send a message, prefixed with its size, to a TPC/IP socket """
    data = msg.SerializeToString()
    size = encode_varint(len(data))
    conn.sendall(size + data)

def recv_message(conn, msg_type):
    """ Receive a message, prefixed with its size, from a TCP/IP socket """
    # Receive the size of the message data
    data = b''
    while True:
        try:
            data += conn.recv(1)
            size = decode_varint(data)
            break
        except IndexError:
            pass
    # Receive the message data
    data = conn.recv(size)
    # Decode the message
    msg = msg_type()
    msg.ParseFromString(data)
    return msg

# Open a TCP/IP socket to the RPC server
rpc_conn = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
rpc_conn.connect(('127.0.0.1', 50000))

# Send an RPC connection request
request = KRPC.ConnectionRequest()
request.type = KRPC.ConnectionRequest.RPC
request.client_name = 'Jeb'
send_message(rpc_conn, request)

# Receive the connection response
response = recv_message(rpc_conn, KRPC.ConnectionResponse)

```

```
# Check the connection was successful
if response.status != KRPC.ConnectionResponse.OK:
    raise RuntimeError('Connection failed: ' + response.message)
print('Connected to RPC server')

# Print out the clients identifier
print('RPC client identifier = %s' % binascii.hexlify(
    bytearray(response.client_identifier)).decode('utf8'))

# Open a TCP/IP socket to the Stream server
stream_conn = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
stream_conn.connect(('127.0.0.1', 50001))

# Send a stream connection request, containing the clients identifier
request = KRPC.ConnectionRequest()
request.type = KRPC.ConnectionRequest.STREAM
request.client_identifier = response.client_identifier
send_message(stream_conn, request)

# Receive the connection response
response = recv_message(stream_conn, KRPC.ConnectionResponse)

# Check the connection was successful
if response.status != KRPC.ConnectionResponse.OK:
    raise RuntimeError("Connection failed: " + response.message)
print('Connected to stream server')

# Build a KRPC.GetStatus call to be streamed
stream_call = KRPC.ProcedureCall()
stream_call.service = 'KRPC'
stream_call.procedure = 'GetStatus'

# Call KRPC.AddStream to add the stream
call = KRPC.ProcedureCall()
call.service = 'KRPC'
call.procedure = 'AddStream'
arg = KRPC.Argument()
arg.position = 0
arg.value = stream_call.SerializeToString()
call.arguments.extend([arg])
request = KRPC.Request()
request.calls.extend([call])
send_message(rpc_conn, request)

# Receive the response
response = recv_message(rpc_conn, KRPC.Response)

# Check for an error in the response
if response.HasField('error'):
    raise RuntimeError('ERROR: ' + str(response.error))

# Check for an error in the results
assert(len(response.results) == 1)
if response.results[0].HasField('error'):
    raise RuntimeError('ERROR: ' + str(response.error))

# Decode the return value as a Stream message
stream = KRPC.Stream()
```

```
stream.ParseFromString(response.results[0].value)

# Repeatedly receive stream updates from the stream server
while True:
    update = recv_message(stream_conn, KRPC.StreamUpdate)
    assert(len(update.results) == 1)
    assert(stream.id == update.results[0].id)
    # Decode and print the return value
    status = KRPC.Status()
    status.ParseFromString(update.results[0].result.value)
    print(status)
```

12.2 Protocol Buffers over WebSockets

This communication protocol allows web browsers to communicate with a kRPC over a websockets connection, for example from Javascript in a web browser.

Note: If a client library is available for your language, you do not need to implement this protocol.

12.2.1 Connecting to the RPC Server

A client invokes remote procedures by communicating with the *RPC server*. To establish a connection, open a websockets connection to the server on its RPC port (which defaults to 50000). The connection URI can also contain a `name` parameter with the name of the client to display in the on the in-game UI. For example: `ws://localhost:50000/?name=Jeb`

12.2.2 Connecting to the Stream Server

Clients can receive *Streams* from the *stream server*. To establish a connection, a client must first connect to the RPC server (as above) then do the following:

1. Get the identifier of the client by calling the `KRPC.GetClientID` remote procedure.
2. Open a websockets connection to the server on its stream port (which defaults to 50001), with an `id` query parameter set to the client identifier encoded in base64. For example: `ws://localhost:50001/?id=Eeh8Vbj2DkWTcJZTkY1EhQ==`

Connecting to the stream server is optional. If the client doesn't require stream functionality, there is no need to connect.

12.2.3 Sending and Receiving Messages

Communication with the server is performed via Protocol Buffer messages, encoded according to the protobuf binary format.

To send a message to the server:

1. Encode the message using the Protocol Buffers format.
2. Send a binary websockets message to the server, with payload containing the encoded message data.

To receive a message from the server, do the reverse:

1. Receive a binary websockets message from the server.
2. Decode the messages payload using the Protocol Buffers format.

12.2.4 Invoking Remote Procedures

See *Messaging Protocol*.

12.2.5 Examples

The following code connects to the RPC server at address 127.0.0.1 and port 50000 using the name “Jeb”. Next, it connects to the stream server on port 50001. It then invokes the `KRPC.GetStatus` RPC, receives and decodes the result and prints out the server version number from the response.

```
var websocket = require('ws');
var protobufjs = require('protobufjs')
var ByteBuffer = require('bytebuffer')
var proto = protobufjs.loadProtoFile('krpc.proto').build();

console.log('Connecting to RPC server')
let rpcConn = new websocket('ws://127.0.0.1:50000')
rpcConn.binaryType = 'arraybuffer'

rpcConn.onopen = (e) => {
  console.log('Successfully connected')
  let call = new proto.krpc.schema.ProcedureCall('KRPC', 'GetStatus');
  let request = new proto.krpc.schema.Request([call]);
  rpcConn.send(request.toArrayBuffer());
  rpcConn.onmessage = (e) => {
    let response = proto.krpc.schema.Response.decode(e.data)
    let status = proto.krpc.schema.Status.decode(response.results[0].value)
    console.log(status);
    process.exit(0);
  };
};
```

The following example demonstrates how to set up and receive data from the server over a stream:

```
'use strict'

var websocket = require('ws');
var protobufjs = require('protobufjs')
var proto = protobufjs.loadProtoFile('krpc.proto').build();

console.log('Connecting to RPC server')
let rpcConn = new websocket('ws://127.0.0.1:50000')
rpcConn.binaryType = 'arraybuffer'

rpcConn.onopen = (evnt) => {
  console.log('Successfully connected')
  console.log('Calling KRPC.GetClientID')
  let call = new proto.krpc.schema.ProcedureCall('KRPC', 'GetClientID');
  let request = new proto.krpc.schema.Request([call]);
  rpcConn.send(request.toArrayBuffer());
};
```

```

rpcConn.onmessage = (evnt) => {
  let response = proto.krpc.schema.Response.decode(evnt.data);
  response.results[0].value.readVarint32(); // skip size
  let client_identifier = response.results[0].value.toBase64();
  console.log('Client identifier =', client_identifier);

  console.log('Connecting to Stream server');
  let streamConn = new websocket('ws://127.0.0.1:50001?id=' + client_identifier);
  streamConn.binaryType = 'arraybuffer';

  streamConn.onopen = (evnt) => {
    console.log('Successfully connected');

    let call_to_stream = new proto.krpc.schema.ProcedureCall('KRPC', 'GetStatus');
    let arg = new proto.krpc.schema.Argument(0, call_to_stream.toArrayBuffer());
    let call = new proto.krpc.schema.ProcedureCall('KRPC', 'AddStream', [arg]);
    let request = new proto.krpc.schema.Request([call]);
    rpcConn.send(request.toArrayBuffer());
    rpcConn.onmessage = (evnt) => {
      let response = proto.krpc.schema.Response.decode(evnt.data);
      let stream = proto.krpc.schema.Stream.decode(response.results[0].value);
      console.log("added stream id =", stream.id.toString());
    };
  };

  streamConn.onmessage = (evnt) => {
    let value = new proto.krpc.schema.StreamUpdate.decode(evnt.data);
    let status = proto.krpc.schema.Status.decode(value.results[0].result.value);
    console.log(status);
  };
};

```

12.3 Messaging Protocol

Communication with a kRPC server is performed via Protocol Buffer messages. The kRPC download comes with a protocol buffer message definitions file ([schema/krpc.proto](#)) that defines the structure of these messages. It also contains versions of this file for C#, C++, Java, Lua and Python, compiled using [Google's protocol buffers compiler](#).

12.3.1 Invoking Remote Procedures

Remote procedures are arranged into groups called *services*. These act as a single-level namespacing to keep things organized. Each service has a unique name used to identify it, and within a service *each procedure has a unique name*.

Remote procedures are invoked by sending a request message to the RPC server, and waiting for a response message.

The request message contains one or more procedure calls to run, which include the names of the procedures and the values of their arguments. The response message contains the value(s) returned by the procedure(s) and any errors that were encountered.

Requests are processed in order of receipt. The next request from a client will not be processed until the previous one completes execution and its response has been received by the client. When there are multiple client connections, requests are processed in round-robin order.

Within a single request, the procedure calls are also processed in order of receipt. The results list in the response is also ordered so that the results match the calls.

Anatomy of a Request

A request is sent to the server using a Request Protocol Buffer message with the following format:

```
message Request {
  repeated ProcedureCall calls = 1;
}

message ProcedureCall {
  string service = 1;
  string procedure = 2;
  uint32 serviceId = 4;
  uint32 procedureId = 5;
  repeated Argument arguments = 3;
}

message Argument {
  uint32 position = 1;
  bytes value = 2;
}
```

A request message contains one or more procedure calls. This allows efficient batching of multiple calls in a single message, if desired.

The fields of a procedure call are:

- `service` - The name of the service in which the remote procedure is defined.
- `procedure` - The name of the remote procedure to invoke.
- `service_id` - The integer identifier of the service in which the remote procedure is defined.
- `procedure_id` - The integer identifier of the remote procedure to invoke.
- `arguments` - A sequence of `Argument` messages containing the values of the procedure's arguments. The fields of an argument message are:
 - `position` - The zero-indexed position of the of the argument in the procedure's signature.
 - `value` - The value of the argument, encoded in Protocol Buffer format.

The service containing the procedure to call is specified by setting either `service` or `service_id`. The procedure to call is specified by setting either `procedure` or `procedure_id`. Use of `service` and `procedure` (i.e. descriptive strings) should be preferred as these will not change between server versions. For clients where code size or communication overhead must be kept to an absolute minimum, `service_id` and `procedure_id` can be used. However, note that the identifiers may change between server versions.

The `Argument` messages have a `position` field to allow values for default arguments to be omitted. See *Protocol Buffer Encoding* for details on how to encode the argument values.

Anatomy of a Response

A response is sent to the client using a Response Protocol Buffer message with the following format:

```
message Response {
  Error error = 1;
  repeated ProcedureResult results = 2;
}

message ProcedureResult {
```

```

    Error error = 1;
    bytes value = 2;
}

message Error {
    string service = 1;
    string name = 2;
    string description = 3;
    string stack_trace = 4;
}

```

A response message contains one or more results, corresponding to the procedure calls made in the associated request message.

The value field of a procedure result message contains the value of the return value of the remote procedure, if any, encoded in protocol buffer format. See *Protocol Buffer Encoding* for details on how to decode the return value.

If an error occurs processing a request message, the `error` field in the response message will contain a description of the error. If an individual procedure call encounters an error, the `error` field in the corresponding procedure result message will contain a description of the error.

The fields of an error message are:

- `service` - If the error was caused by an exception, this is the name of the service in which the exception type is defined.
- `name` - If the error was caused by an exception, this is the name of the exception type.
- `description` - A human readable description of the error
- `stack_trace` - If the error was caused by an exception, this is a server-side stack trace for the exception.

Example RPC invocation

The following Python code invokes the `GetStatus` procedure from the *KRPC* service using an already established connection to the server (the `rpc_conn` variable).

The `kRPC.schema.KRPC` package contains the various Protocol Buffer message formats compiled to python code using the Protocol Buffer compiler. The `send_message` and `recv_message` are helper functions used to send/receive messages from the server.

```

call = KRPC.ProcedureCall()
call.service = 'KRPC'
call.procedure = 'GetStatus'
request = KRPC.Request()
request.calls.extend([call])
send_message(rpc_conn, request)

# Receive the response
response = recv_message(rpc_conn, KRPC.Response)

# Check for an error in the response
if response.HasField('error'):
    raise RuntimeError('ERROR: ' + str(response.error))

# Check for an error in the results
assert(len(response.results) == 1)
if response.results[0].HasField('error'):
    raise RuntimeError('ERROR: ' + str(response.error))

```

```
# Decode the return value as a Status message
status = KRPC.Status()
status.ParseFromString(response.results[0].value)

# Print out the Status message
print(status)
```

Protocol Buffer Encoding

Values passed as arguments or received as return values are encoded using the Protocol Buffer version 3 serialization format:

- Documentation for this encoding can be found here: <https://developers.google.com/protocol-buffers/docs/encoding>
- Protocol Buffer libraries in many languages are available here: <https://github.com/google/protobuf/releases>

12.3.2 Streams

Streams allow the client to repeatedly execute an RPC on the server and receive its results, without needing to repeatedly call the RPC directly, avoiding the communication overhead that this would involve.

A client can create a stream on the server by calling *AddStream*. This procedure takes an optional boolean argument that controls whether the stream starts sending data to the client or not. If not, *StartStream* can be called later on to start the stream. Once the client is finished with the stream, it can remove it from the server by calling *RemoveStream*. Streams are automatically removed when the client that created it disconnects from the server. Streams are local to each client and there is no way to share a stream between clients.

The RPC for each stream is invoked every *fixed update* and the return values for all of these RPCs are collected together into a stream update message. This is then sent to the client over its stream server connection. If the value returned by a streams RPC does not change since the last update that was sent, its value is omitted from the update message in order to minimize network traffic. A client can also control the rate of the stream, by specifying a target number of Hertz. The server computes a time delay from the target rate, and only updates the stream if at least that time has passed since the last time the stream was updated.

Anatomy of a Stream Update

Stream updates are sent to the client using a *StreamUpdate* Protocol Buffer message with the following format:

```
message StreamUpdate {
  repeated StreamResult results = 1;
}
```

This contains a list of *StreamResult* messages, one for each stream that exists on the server for that client, and whose return value changed since the last update was sent. It has the following format:

```
message StreamResult {
  uint64 id = 1;
  ProcedureResult result = 2;
}
```

The fields are:

- *id* - The identifier of the stream. This is the value returned by *AddStream* when the stream is created.

- `result` - A `ProcedureResult` message containing the result of the streams RPC. This is identical to the `ProcedureResult` message returned when calling the RPC directly. See *Anatomy of a Response* for details on the format and contents of this message.

12.3.3 Events

Events are a wrapper over a stream that returns a boolean value. The event is triggered when the stream returns to true. Remote procedures that return an event return an `Event` message that contains a `Stream` message describing the underlying stream for the event.

The format for an `Event` message is simply the following:

```
message Event {
  repeated Stream stream = 1;
}
```

12.3.4 KRPC Service

The server provides a service called KRPC containing procedures that are used to retrieve information about the server and to manage streams.

GetStatus

The `GetStatus` procedure returns status information about the server. It returns a `Protocol Buffer` message with the format:

```
message Status {
  string version = 1;
  uint64 bytes_read = 2;
  uint64 bytes_written = 3;
  float bytes_read_rate = 4;
  float bytes_written_rate = 5;
  uint64 rpcs_executed = 6;
  float rpc_rate = 7;
  bool one_rpc_per_update = 8;
  uint32 max_time_per_update = 9;
  bool adaptive_rate_control = 10;
  bool blocking_recv = 11;
  uint32 recv_timeout = 12;
  float time_per_rpc_update = 13;
  float poll_time_per_rpc_update = 14;
  float exec_time_per_rpc_update = 15;
  uint32 stream_rpcs = 16;
  uint64 stream_rpcs_executed = 17;
  float stream_rpc_rate = 18;
  float time_per_stream_update = 19;
}
```

The `version` field contains the version string of the server. The remaining fields contain performance information about the server.

GetServices

The `GetServices` procedure returns a Protocol Buffer message containing information about all of the services and procedures provided by the server. The format of the message is:

```
message Services {  
  repeated Service services = 1;  
}
```

This contains a single field, which is a list of `Service` messages with information about each service provided by the server. The content of these `Service` messages are *documented below*.

AddStream

The `AddStream` procedure adds a new stream to the server. Its first argument is the RPC to invoke, encoded as a `ProcedureCall` message. The second argument is a boolean value indicating whether the stream should start sending data to the client immediately. The procedure returns a `Stream` message describing the stream that was added. See *Anatomy of a Request* for the format and contents of this message. See *Streams* for more information on working with streams.

StartStream

The `StartStream` procedure starts a stream sending data to a client, if it has not yet been started. It takes a single argument – the identifier of the stream to start. This is the identifier returned when the stream was added by calling `AddStream`. See *Streams* for more information on working with streams.

RemoveStream

The `RemoveStream` procedure removes a stream from the server. It takes a single argument – the identifier of the stream to be removed. This is the identifier returned when the stream was added by calling `AddStream`. See *Streams* for more information on working with streams.

12.3.5 Service Description Message

The *GetServices procedure* returns information about all of the services provided by the server. Details about a service are given by a `Service` message, with the format:

```
message Service {  
  string name = 1;  
  repeated Procedure procedures = 2;  
  repeated Class classes = 3;  
  repeated Enumeration enumerations = 4;  
  repeated Exception exceptions = 5;  
  string documentation = 6;  
}
```

The fields are:

- `name` - The name of the service.
- `procedures` - A list of `Procedure` messages, one for each procedure defined by the service.
- `classes` - A list of `Class` messages, one for each *KRPCClass* defined by the service.

- `enumerations` - A list of Enumeration messages, one for each *KRPCEnum* defined by the service.
- `exceptions` - A list of Exception messages, one for each *KRPCException* defined by the service.
- `documentation` - Documentation for the service, as [C# XML documentation](#).

Note: See the *Extending kRPC* documentation for more details about *KRPCClass*, *KRPCEnum* and *KRPCException*.

Procedures

Details about a procedure are given by a Procedure message, with the format:

```
message Procedure {
  string name = 1;
  repeated Parameter parameters = 2;
  Type return_type = 3;
  string documentation = 4;
}

message Parameter {
  string name = 1;
  Type type = 2;
  bytes default_value = 3;
}
```

The fields are:

- `name` - The name of the procedure. See *Procedure Names* for more information.
- `parameters` - A list of Parameter messages containing details of the procedure's parameters, with the following fields:
 - `name` - The name of the parameter, to allow parameter passing by name.
 - `type` - The *type* of the parameter.
 - `default_value` - The value of the default value of the parameter, if any, *encoded using Protocol Buffer format*.
- `return_type` - The *return type* of the procedure. If the procedure does not return anything its type is set to NONE.
- `documentation` - Documentation for the procedure, as [C# XML documentation](#).

Classes

Details about each *KRPCClass* are specified in a Class message, with the format:

```
message Class {
  string name = 1;
  string documentation = 2;
}
```

The fields are:

- `name` - The name of the class.

- `documentation` - Documentation for the class, as [C# XML documentation](#).

Enumerations

Details about each *KRPCEnum* are specified in an *Enumeration* message, with the format:

```
message Enumeration {  
    string name = 1;  
    repeated EnumerationValue values = 2;  
    string documentation = 3;  
}  
  
message EnumerationValue {  
    string name = 1;  
    int32 value = 2;  
    string documentation = 3;  
}
```

The fields are:

- `name` - The name of the enumeration.
- `values` - A list of *EnumerationValue* messages, indicating the values that the enumeration can be assigned. The fields are:
 - `name` - The name associated with the value for the enumeration.
 - `value` - The possible value for the enumeration as a 32-bit integer.
 - `documentation` - Documentation for the enumeration value, as [C# XML documentation](#).
- `documentation` - Documentation for the enumeration, as [C# XML documentation](#).

Exceptions

Details about each *KRPCException* are specified in an *Exception* message, with the format:

```
message Exception {  
    string name = 1;  
    string documentation = 2;  
}
```

The fields are:

- `name` - The name of the exception type.
- `documentation` - Documentation for the exception, as [C# XML documentation](#).

12.3.6 Procedure Names

Procedures names are CamelCase. Whether a procedure is a service procedure, class method, class property, and what class (if any) it belongs to is determined by its name:

- `ProcedureName` - a standard procedure that is just part of a service.
- `get_PropertyName` - a procedure that returns the value of a property in a service.
- `set_PropertyName` - a procedure that sets the value of a property in a service.

- `ClassName_MethodName` - a class method.
- `ClassName_static_StaticMethodName` - a static class method.
- `ClassName_get_PropertyName` - a class property getter.
- `ClassName_set_PropertyName` - a class property setter.

Only letters and numbers are permitted in class, method and property names. Underscores can therefore be used to split the name into its constituent parts.

12.3.7 Type

The `GetServices` procedure returns type information about parameters, return values and others as `Type` messages. The format of these messages is as follows:

```
message Type {
  TypeCode code = 1;
  string service = 2;
  string name = 3;
  repeated Type types = 4;

  enum TypeCode {
    NONE = 0;

    // Values
    DOUBLE = 1;
    FLOAT = 2;
    SINT32 = 3;
    SINT64 = 4;
    UINT32 = 5;
    UINT64 = 6;
    BOOL = 7;
    STRING = 8;
    BYTES = 9;

    // Objects
    CLASS = 100;
    ENUMERATION = 101;

    // Messages
    PROCEDURE_CALL = 200;
    STREAM = 201;
    STATUS = 202;
    SERVICES = 203;

    // Collections
    TUPLE = 300;
    LIST = 301;
    SET = 302;
    DICTIONARY = 303;
  };
};
```

The `code` field specifies the type. `NONE` is used as the return type for procedures that do not return a value.

For `CLASS` and `ENUMERATION` types the `service` and `name` fields specify the service that defines the class/enumeration and the name of the class/enumeration. For all other types these fields are empty.

For collection types the `types` repeated field will contain the sub-types:

- `TUPLE` types contain 1 or more types in the `types` field.
- `LIST` and `SET` types contain a single type in the `types` field.
- `DICTIONARY` types contain a 2 types in the `types` field - the key and value types, in that order.

For all other types the `types` field is empty.

12.3.8 Proxy Objects

kRPC allows procedures to create objects on the server, and pass a unique identifier for them to the client. This allows the client to create a *proxy* object for the actual object, whose methods and properties make remote procedure calls to the server. Object identifiers have type `uint64`.

When a procedure returns a proxy object or takes one as a parameter, the type code will be set to `CLASS`.

INTERNALS OF KRPC

13.1 Server Performance Settings

kRPC processes its queue of remote procedures when its `FixedUpdate` method is invoked. This is called every fixed framerate frame, typically about 60 times a second. If kRPC were to only execute one RPC per `FixedUpdate`, it would only be able to execute at most 60 RPCs per second. In order to achieve a higher RPC throughput, it can execute multiple RPCs per `FixedUpdate`. However, if it is allowed to process too many RPCs per `FixedUpdate`, the game's framerate would be adversely affected. The following settings control this behavior, and the resulting tradeoff between RPC throughput and game FPS:

1. **One RPC per update.** When this is enabled, the server will execute at most one RPC per client per update. This will have minimal impact on the game's framerate, while still allowing kRPC to execute RPCs. If you don't need a high RPC throughput, this is a good option to use.
2. **Maximum time per update.** When one RPC per update is not enabled, this setting controls the maximum amount of time (in nanoseconds) that kRPC will spend executing RPCs per `FixedUpdate`. Setting this to a high value, for example 20000 ns, will allow the server to process many RPCs at the expense of the game's framerate. A low value, for example 1000 ns, won't al-

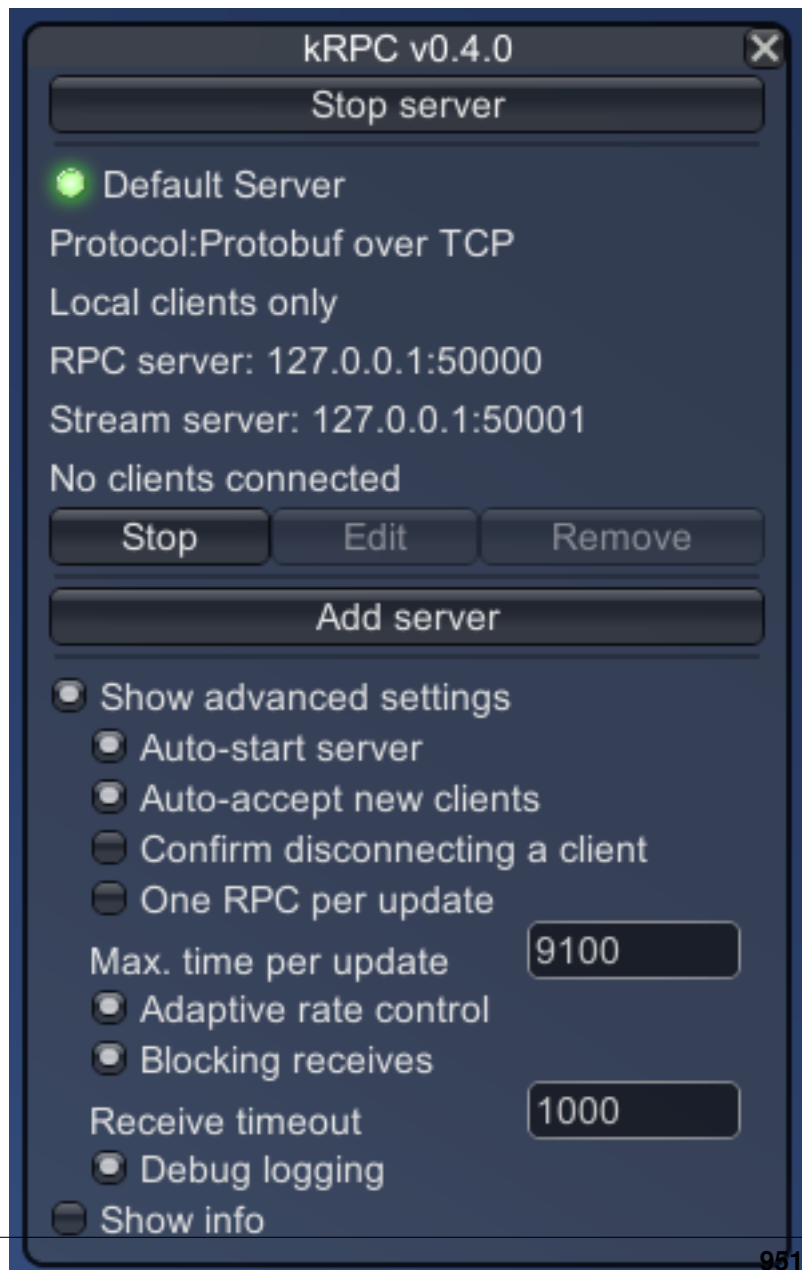


Fig. 13.1: Server window showing the advanced settings.

low the server to execute many RPCs per update, but will allow the game to run at a much higher framerate.

3. **Adaptive rate control.** When enabled, kRPC will automatically adjust the maximum time per update parameter, so that the game has a minimum framerate of 60 FPS. Enabling this setting provides a good tradeoff between RPC throughput and the game framerate.

Another consideration is the responsiveness of the server. Clients must execute RPCs in sequence, one after another, and there is usually a (short) delay between them. This means that when the server finishes executing an RPC, if it were to immediately check for a new RPC it will not find any and will return from the FixedUpdate. This means that any new RPCs will have to wait until the next FixedUpdate, and results in the server only executing a single RPC per FixedUpdate regardless of the maximum time per update setting.

Instead, higher RPC throughput can be obtained if the server waits briefly after finishing an RPC to see if any new RPCs are received. This is done in such a way that the maximum time per update setting (above) is still observed.

This behavior is enabled by the **blocking receives** option. **Receive timeout** sets the maximum amount of time the server will wait for a new RPC from a client.

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