
kRPC

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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*.

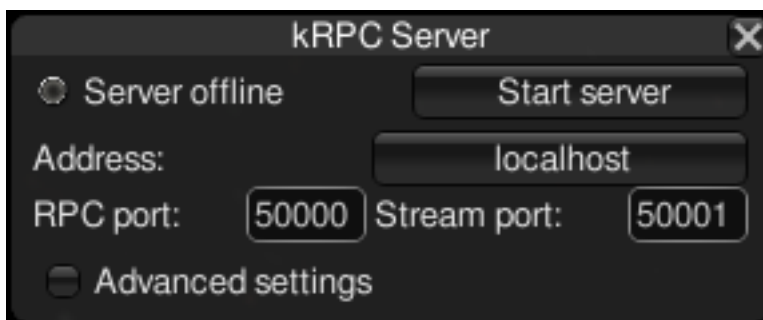
GETTING STARTED

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.

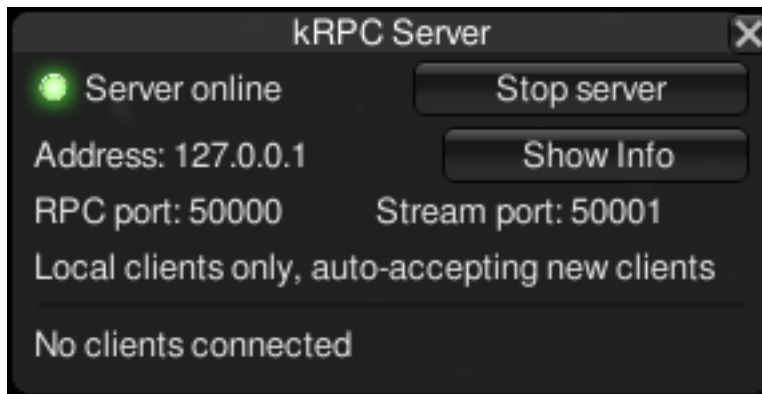
1.1 The Server Plugin

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 using the window displayed in-game:

1. **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.
2. **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 the 'Advanced settings' box:

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. Note that the game must be running and unpaused for this program to work, otherwise it will fail to connect.

```
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 – as long as it can do network I/O.

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:

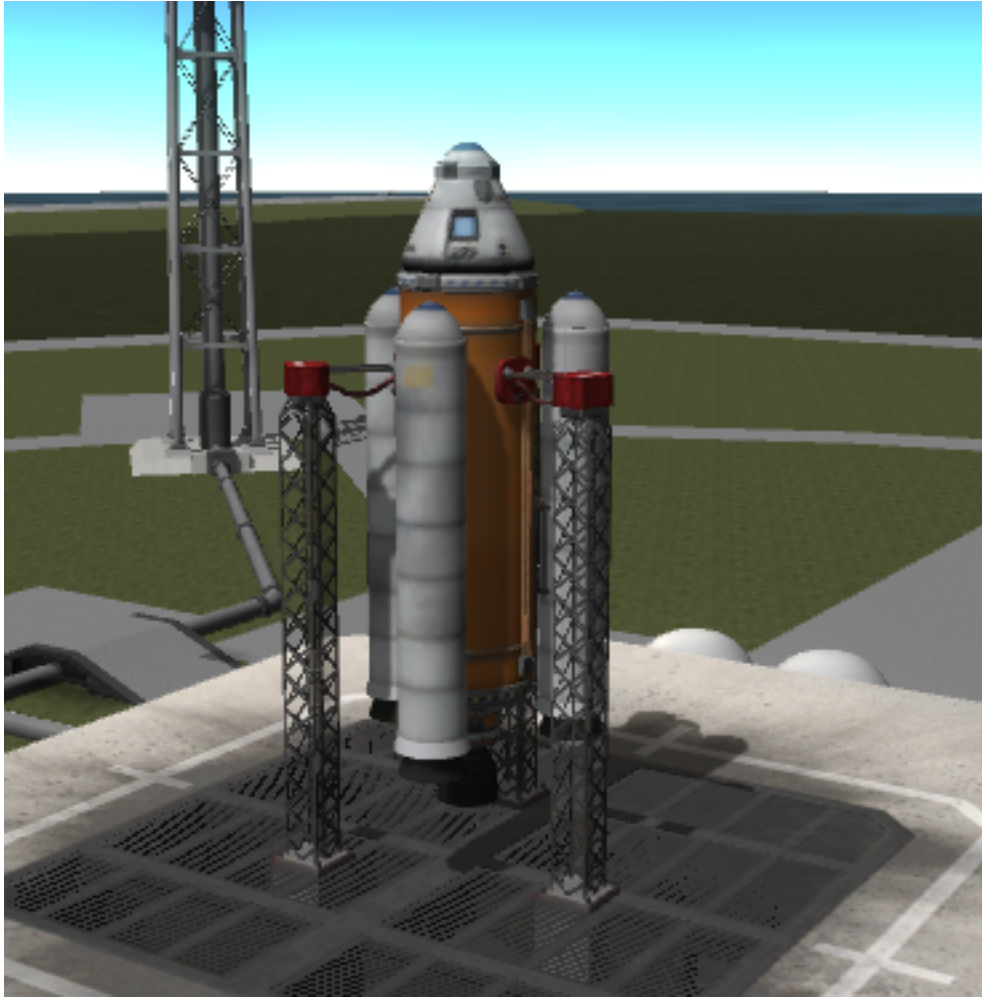
- Controlling a rocket (activating stages, setting the throttle)
- Using the auto pilot to point the vessel in a specific direction
- Tracking the amount of resources in the vessel
- Tracking flight and orbital data (such as altitude and apoapsis altitude)

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++JavaLuaPython

```
1 using System;
2 using KRPC.Client;
3 using KRPC.Client.Services.SpaceCenter;
4
5 class SubOrbitalFlight
6 {
7     public static void Main ()
8     {
9         var conn = new Connection ("Sub-orbital flight");
```

```
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("Sub-orbital flight");
9   krpc::services::SpaceCenter space_center(&conn);

```

```

1   import krpc.client.Connection;
2   import krpc.client.RPCException;
3   import krpc.client.services.SpaceCenter;
4   import krpc.client.services.SpaceCenter.Flight;
5   import krpc.client.services.SpaceCenter.Node;
6   import krpc.client.services.SpaceCenter.ReferenceFrame;
7   import krpc.client.services.SpaceCenter.Resources;
8
9   import org.javatuples.Triplet;
10
11  import java.io.IOException;
12
13  public class SubOrbitalFlight {
14      public static void main(String[] args) throws IOException, RPCException,
15      ↪ InterruptedException {
16          Connection connection = Connection.newInstance("Sub-orbital flight");
17          SpaceCenter spaceCenter = SpaceCenter.newInstance(connection);

```

```

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

```

```

1   import time
2   import krpc
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++JavaLuaPython

```

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

```

```

11   auto vessel = space_center.active_vessel();

```

```

18   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++JavaLuaPython

```

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

```

```

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

```

```
21     vessel.getAutoPilot().targetPitchAndHeading(90, 90);
22     vessel.getAutoPilot().engage();
23     vessel.getControl().setThrottle(1);
24     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++JavaLuaPython

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

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

```
26     System.out.println("Launch!");
27     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 a while loop that repeatedly checks how much solid fuel there is left in the rocket. When the loop exits, we will activate the next stage to jettison the boosters: C#C++JavaLuaPython

```
21     while (vessel.Resources.Amount("SolidFuel") > 0.1)
22         System.Threading.Thread.Sleep (1000);
23     Console.WriteLine ("Booster separation");
24     vessel.Control.ActivateNextStage ();
```

```
21     while (vessel.resources().amount("SolidFuel") > 0.1)
22         std::this_thread::sleep_for(std::chrono::seconds(1));
23     std::cout << "Booster separation" << std::endl;
24     vessel.control().activate_next_stage();
```

```
29     while (vessel.getResources().amount("SolidFuel") > 0.1)
30         Thread.sleep(1000);
31     System.out.println("Booster separation");
32     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 while vessel.resources.amount('SolidFuel') > 0.1:
16     time.sleep(1)
17 print('Booster separation')
18 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.

2.1.3 Part Three: Reaching Apoapsis

Next we will execute a gravity turn when the rocket reaches a sufficiently high altitude. The following loop repeatedly checks the altitude and exits when the rocket reaches 10km: C#C++JavaLuaPython

```

26 while (vessel.Flight ().MeanAltitude < 10000)
27     System.Threading.Thread.Sleep (1000);

```

```

26 while (vessel.flight().mean_altitude() < 10000)
27     std::this_thread::sleep_for(std::chrono::seconds(1));

```

```

34 while (vessel.flight(refFrame).getMeanAltitude() < 10000)
35     Thread.sleep(1000);

```

```

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

```

```

20 while vessel.flight().mean_altitude < 10000:
21     time.sleep(1)

```

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++JavaLuaPython

```

29 Console.WriteLine ("Gravity turn");
30 vessel.AutoPilot.TargetPitchAndHeading (60, 90);

```

```

29 std::cout << "Gravity turn" << std::endl;
30 vessel.auto_pilot().target_pitch_and_heading(60, 90);

```

```

38 System.out.println("Gravity turn");
39 vessel.getAutoPilot().targetPitchAndHeading(60, 90);

```

```

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

```

```

23 print('Gravity turn')
24 vessel.auto_pilot.target_pitch_and_heading(60, 90)

```

Now we wait until the apoapsis reaches 100km, then reduce the throttle to zero, jettison the launch stage and turn off the auto-pilot: C#C++JavaLuaPython

```

32 while (vessel.Orbit.ApoapsisAltitude < 100000)
33     System.Threading.Thread.Sleep (1000);
34     Console.WriteLine ("Launch stage separation");
35     vessel.Control.Throttle = 0;
36     System.Threading.Thread.Sleep (1000);
37     vessel.Control.ActivateNextStage ();
38     vessel.AutoPilot.Disengage ();

```

```

32 while (vessel.orbit().apoapsis_altitude() < 100000)
33     std::this_thread::sleep_for(std::chrono::seconds(1));
34     std::cout << "Launch stage separation" << std::endl;
35     vessel.control().set_throttle(0);
36     std::this_thread::sleep_for(std::chrono::seconds(1));
37     vessel.control().activate_next_stage();
38     vessel.auto_pilot().disengage();

```

```

40 while (vessel.getOrbit().getApoapsisAltitude() < 100000)
41     Thread.sleep(1000);
42     System.out.println("Launch stage separation");
43     vessel.getControl().setThrottle(0);
44     Thread.sleep(1000);
45     vessel.getControl().activateNextStage();
46     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()

```

```

26 while vessel.orbit.apoapsis_altitude < 100000:
27     time.sleep(1)
28     print('Launch stage separation')
29     vessel.control.throttle = 0
30     time.sleep(1)
31     vessel.control.activate_next_stage()
32     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++JavaLuaPython


```

40     while (vessel.Flight ().SurfaceAltitude > 1000)
41         System.Threading.Thread.Sleep (1000);
42     vessel.Control.ActivateNextStage ();

```

```

40     while (vessel.flight().surface_altitude() > 1000)
41         std::this_thread::sleep_for(std::chrono::seconds(1));
42     vessel.control().activate_next_stage();

```

```

48     while (vessel.flight(refFrame).getSurfaceAltitude() > 1000)
49         Thread.sleep(1000);
50     vessel.getControl().activateNextStage();

```

```

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

```

```

34 while vessel.flight().surface_altitude > 1000:
35     time.sleep(1)
36 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++JavaLuaPython

```

44     while (vessel.Flight (vessel.Orbit.Body.ReferenceFrame).VerticalSpeed < -0.1)
45     ↪{
46         Console.WriteLine ("Altitude = {0:F1} meters", vessel.Flight ().
47         ↪SurfaceAltitude);
48         System.Threading.Thread.Sleep (1000);
49     }
50     Console.WriteLine ("Landed!");
51     conn.Dispose();

```

```

44     while (vessel.flight(vessel.orbit().body().reference_frame()).vertical_speed() < -0.
45     ↪1) {
46         std::cout << "Altitude = " << vessel.flight().surface_altitude() << " meters" <<
47         ↪std::endl;
48         std::this_thread::sleep_for(std::chrono::seconds(1));
49     }
50     std::cout << "Landed!" << std::endl;
51 }

```

```

52     while (vessel.flight(vessel.getOrbit().getBody().getReferenceFrame()).
53     ↪getVerticalSpeed() < -0.1) {
54         System.out.printf("Altitude = %.1f meters\n", vessel.flight(refFrame).
55         ↪getSurfaceAltitude());
56         Thread.sleep(1000);
57     }
58     System.out.println("Landed!");
59     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!')

```

```

38 while vessel:flight(vessel.orbit.body.reference_frame).vertical_speed < -0.1:
39     print('Altitude = %.1f meters' % vessel:flight().surface_altitude)
40     time.sleep(1)
41 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*
- *Available Reference Frames*
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- *Visual Debugging*
- *Examples*
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 - *Orbital directions*
 - *Surface ‘prograde’*
 - *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++JavaLuaPython

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

class VesselPosition
{
    public static void Main ()
    {
        using (var connection = new Connection ()) {
```

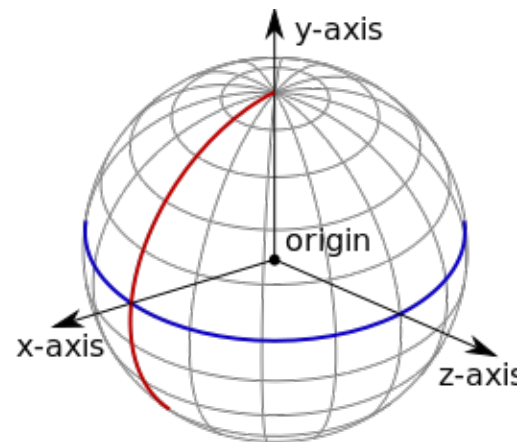


Fig. 2.1: The reference frame for a celestial body, such as Kerbin. The equator is shown in blue, and the prime meridian in red. The black arrows show the coordinate axes, and the origin is at the center of the planet.

```

        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;
}

```

```

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,
- 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.

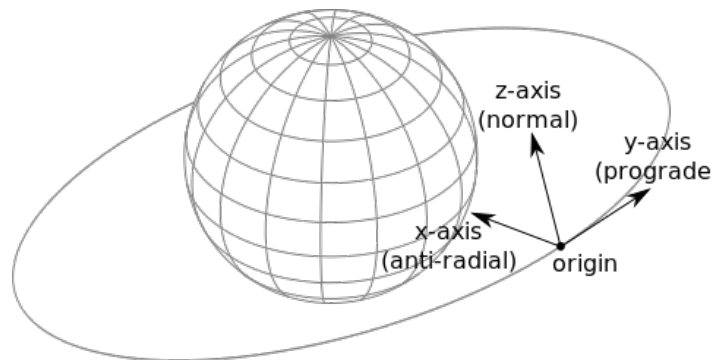
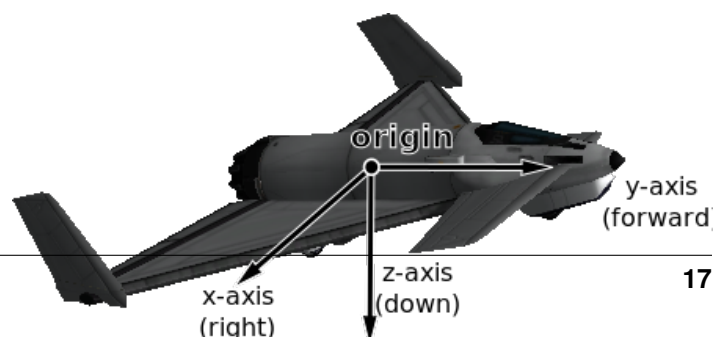


Fig. 2.2: The orbital reference frame for a vessel.

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.

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++JavaLuaPython

- *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()`
- `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++JavaLuaPython

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

- `SpaceCenter::transform_rotation()`
- `SpaceCenter::transform_velocity()`
- `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, kRPC's 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++JavaLuaPython

```
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) {
    }
}
```

```
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++JavaLuaPython

```
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();
}

```

```

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()

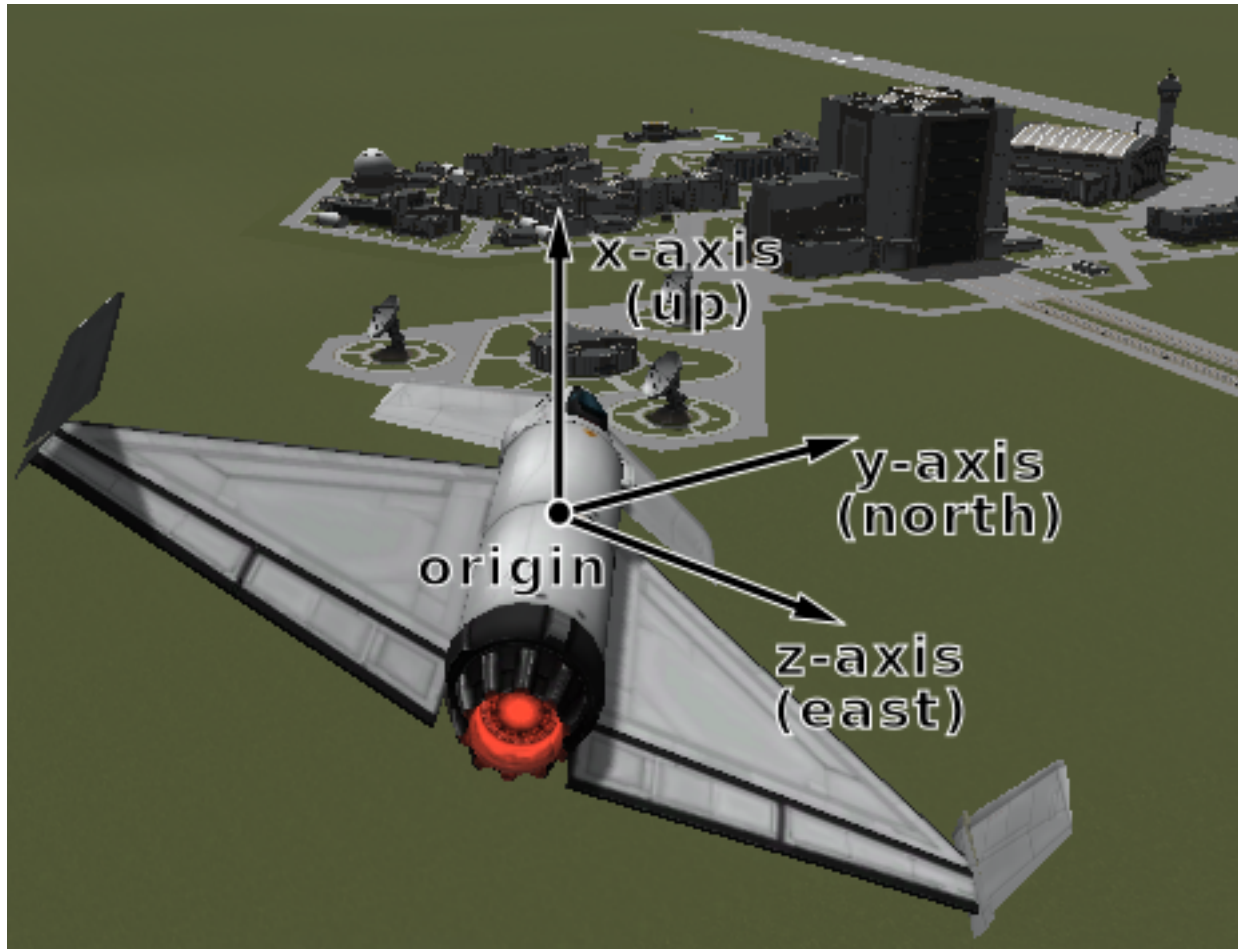
# Point the vessel vertically upwards on the navball
ap.target_direction = (1, 0, 0)
ap.wait()

# 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++JavaLuaPython

```
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();
}

```

```

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()

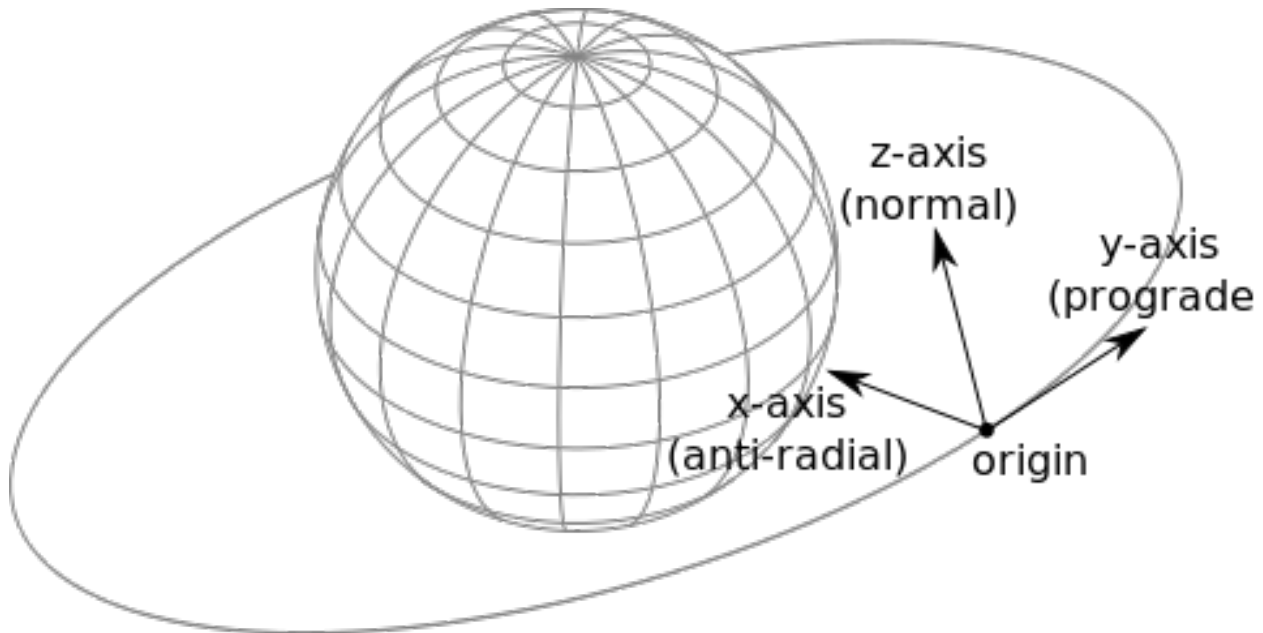
# Point the vessel in the orbit normal direction
ap.target_direction = (0, 0, 1)
ap.wait()

# 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++JavaLuaPython

```

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();
}
```

```
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()

```

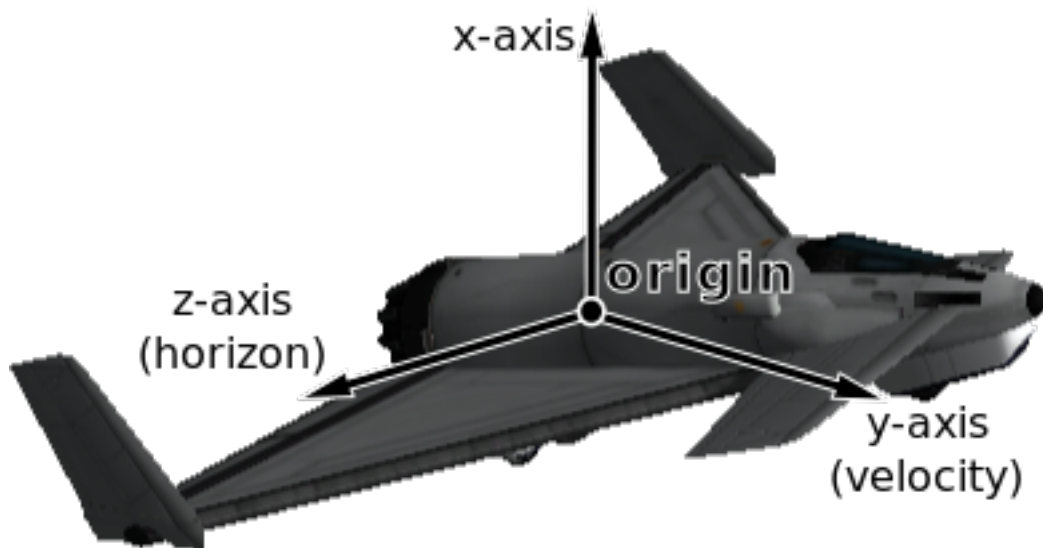
```

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++JavaLuaPython

```

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 <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));
    }
}

```

```

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++JavaLuaPython

```

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 <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));
    }
}

```

```

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++JavaLuaPython

```
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));
}

```

```

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++JavaLuaPython

```

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));
}

```

```

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++JavaLuaPython


```

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++JavaLuaPython

```

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++JavaLuaPython

```

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++JavaLuaPython

```

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;

```



```
double burnTime = (m0 - m1) / flowRate;
```

```
// Plan circularization burn (using vis-viva equation)
std::cout << "Planning circularization burn" << std::endl;
double mu = vessel.orbit().body().gravitational_parameter();
double r = vessel.orbit().apoapsis();
double a1 = vessel.orbit().semi_major_axis();
double a2 = r;
double v1 = sqrt(mu * ((2.0 / r) - (1.0 / a1)));
double v2 = sqrt(mu * ((2.0 / r) - (1.0 / a2)));
double delta_v = v2 - v1;
auto node = vessel.control().add_node(
    ut() + vessel.orbit().time_to_apoapsis(), delta_v);

// Calculate burn time (using rocket equation)
double F = vessel.available_thrust();
double Isp = vessel.specific_impulse() * 9.82;
double m0 = vessel.mass();
double m1 = m0 / exp(delta_v / Isp);
double flow_rate = F / Isp;
double burn_time = (m0 - m1) / flow_rate;
```

```
// Plan circularization burn (using vis-viva equation)
System.out.println("Planning circularization burn");
double mu = vessel.getOrbit().getBody().getGravitationalParameter();
double r = vessel.getOrbit().getApoapsis();
double a1 = vessel.getOrbit().getSemiMajorAxis();
double a2 = r;
double v1 = Math.sqrt(mu * ((2.0 / r) - (1.0 / a1)));
double v2 = Math.sqrt(mu * ((2.0 / r) - (1.0 / a2)));
double deltaV = v2 - v1;
Node node = vessel.getControl().addNode(
    ut.get() + vessel.getOrbit().getTimeToApoapsis(), (float)deltaV, 0, 0);

// Calculate burn time (using rocket equation)
double force = vessel.getAvailableThrust();
double isp = vessel.getSpecificImpulse() * 9.82;
double m0 = vessel.getMass();
double m1 = m0 / Math.exp(deltaV / isp);
double flowRate = force / isp;
```

```
---- Plan circularization burn (using vis-viva equation)
print('Planning circularization burn')
local mu = vessel.orbit.body.gravitational_parameter
local r = vessel.orbit.apoapsis
local a1 = vessel.orbit.semi_major_axis
local a2 = r
local v1 = math.sqrt(mu*((2./r)-(1./a1)))
local v2 = math.sqrt(mu*((2./r)-(1./a2)))
local delta_v = v2 - v1
local node = vessel.control:add_node(conn.space_center.ut + vessel.orbit.time_to_
→apoapsis, delta_v, 0, 0)

---- Calculate burn time (using rocket equation)
local F = vessel.available_thrust
local Isp = vessel.specific_impulse * 9.82
local m0 = vessel.mass
```

```

93 local m1 = m0 / math.exp(delta_v/Isp)
94 local flow_rate = F / Isp
95 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++JavaLuaPython

```

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++JavaLuaPython

```

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++JavaLuaPython

```

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));
}
}

```

```

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
end

```

```

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 = %1.f, heading = %1.f, roll = %1.f',
        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++JavaLuaPython

- *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++JavaLuaPython

```
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();
}
```

```
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
```

```
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++JavaLuaPython

```
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);
}
```

```
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 for a description of the maths: http://wiki.kerbalspaceprogram.com/wiki/Specific_impulse#Multiple_engines
C#C++JavaLuaPython

```

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;
}

```

```

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++JavaLuaPython

```
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

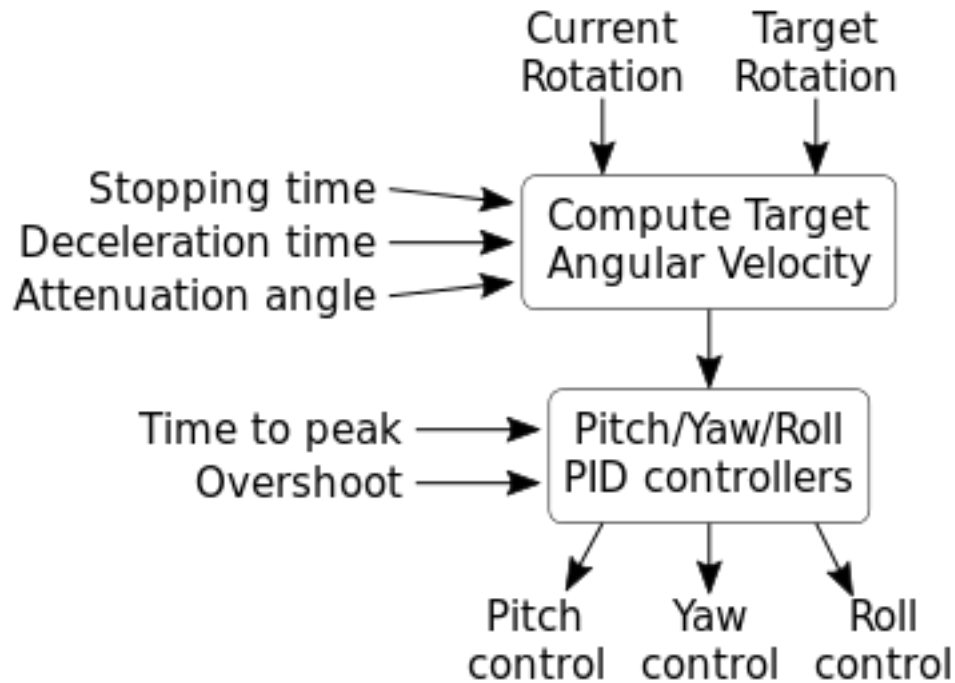
The inputs to the autopilot are:

- 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.

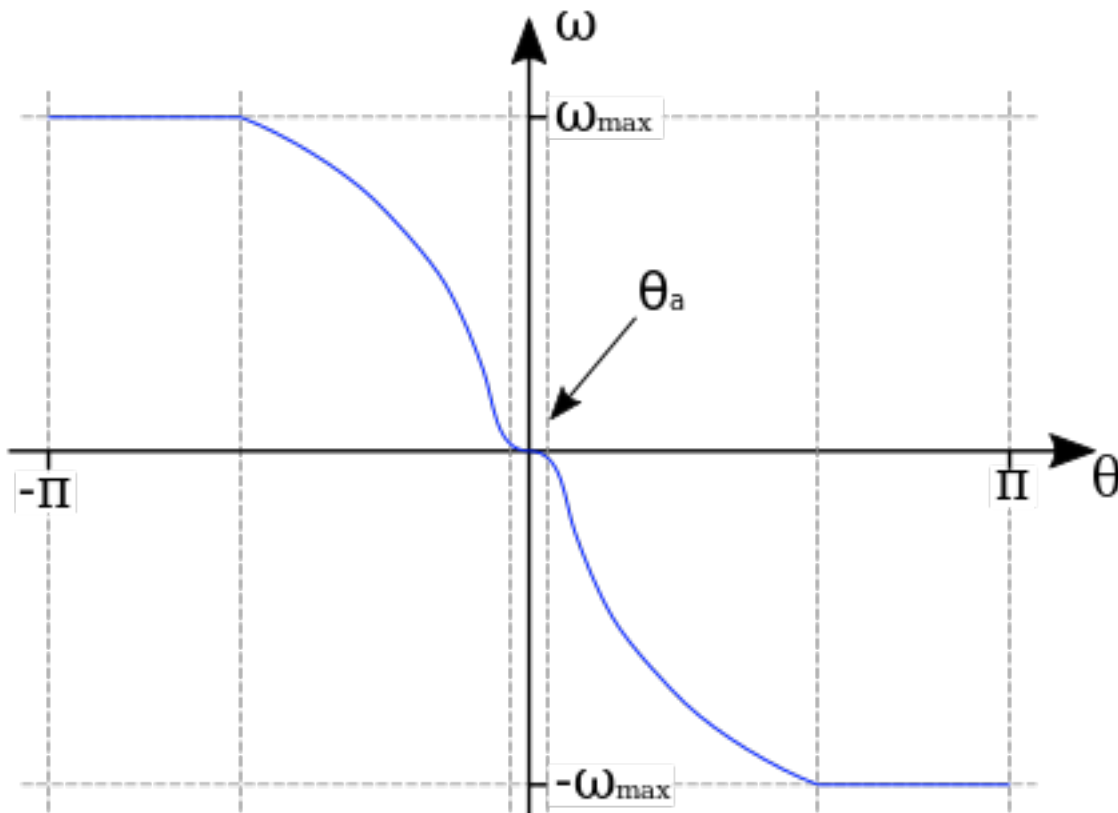
- The **stopping time** is the maximum amount of time that the vessel should need to come to a complete stop. This limits the maximum angular velocity of the vessel. It is a vector of three stopping times, one for each of the pitch, roll and yaw axes. The default value is 0.5 seconds for each axis.
- 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

$$\alpha = \frac{\omega_{max}}{t_{decel}}$$

$$\omega_{max} = \frac{\tau_{max} t_{stop}}{I}$$

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

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:

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

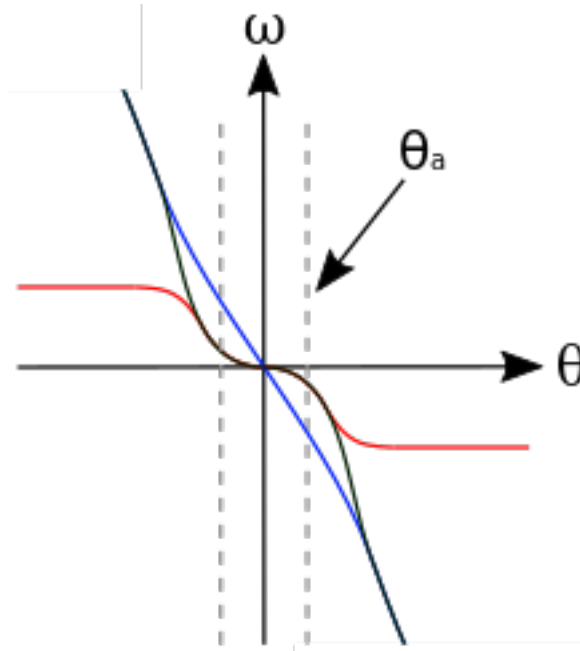
where τ_{max} is the maximum torque the vessel can generate, and I is its moment of inertia.

- 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:

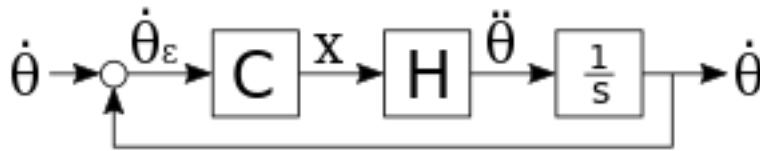
$$f_a(\theta) = \frac{1}{1 + e^{-6/\theta_a(|\theta| - \theta_a)}}$$

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 :

$$\begin{aligned} K_P &= \frac{2\zeta\omega_0 I}{\tau_{max}} \\ K_I &= \frac{I\omega_0^2}{\tau_{max}} \end{aligned}$$

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.

3.1 C# Client

This client provides functionality to interact with a kRPC server from programs written in C#. The `KRPC.Client.dll` assembly can be [installed using NuGet](#) or [downloaded from GitHub](#).

3.1.1 Installing the Library

Install the client [using NuGet](#) or download the assembly [from GitHub](#) and reference it in your project. You also need to install [Google.Protobuf](#) using NuGet.

Note: The copy of `Google.Protobuf.dll` in the GameData folder shipped with the kRPC server plugin should be *avoided*. It is a modified version to work within KSP. Specifically, it is built to support .NET 3.5.

3.1.2 Connecting to the Server

To connect to a server, create a `Connection` object. For example to connect to a server running on the local machine:

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

class Program
{
    public static void Main ()
    {
        using (var connection = new Connection (name : "Example")) {
            var krpc = connection.KRPC ();
            System.Console.WriteLine (krpc.GetStatus ().Version);
        }
    }
}
```

The connection object implements the `IDisposable` interface, and therefore needs to be disposed when finished with. This can be done with a `using` block, as in the example above, or by calling `Connection.Dispose` directly.

The class constructor also accepts arguments that specify what address and port numbers to connect to. For example:

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

```
class Program
{
    public static void Main ()
    {
        using (var connection = new Connection (
            name : "Example", address: IPAddress.Parse ("10.0.2.2"),
            rpcPort: 1000, streamPort: 1001)) {
            var krpc = connection.KRPC ();
            System.Console.WriteLine (krpc.GetStatus ().Version);
        }
    }
}
```

3.1.3 Interacting with the Server

kRPC groups remote procedures into services. The functionality for the services are defined in namespace `KRPC.Client.Services.*`.

To interact with a service, you must first instantiate it. The following example connects to the server, instantiates the `SpaceCenter` service, and outputs the name of the active vessel:

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

class Program
{
    public static void Main ()
    {
        using (var connection = new Connection (name : "Vessel Name")) {
            var spaceCenter = connection.SpaceCenter ();
            var vessel = spaceCenter.ActiveVessel;
            System.Console.WriteLine (vessel.Name);
        }
    }
}
```

3.1.4 Streaming Data from the Server

A stream repeatedly executes a function on the server, with a fixed set of argument values. It provides a more efficient way of repeatedly getting the result of a function, avoiding the network overhead of having to invoke it directly.

For example, consider the following loop that continuously prints out the position of the active vessel. This loop incurs significant communication overheads, as the `KRPC.Client.Services.SpaceCenter.Vessel.Position` method is called repeatedly.

```
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.Out.WriteLine (vessel.Position (refframe));
}

```

The following code achieves the same thing, but is far more efficient. It calls *Connection.AddStream* once at the start of the program to create a stream, and then repeatedly gets the position from the stream.

```

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 position = connection.AddStream (() => vessel.Position (refframe));
        while (true)
            Console.Out.WriteLine (position.Get ());
    }
}

```

Streams are created for any method call by calling *Connection.AddStream* and passing it a lambda expression calling the desired method. This lambda expression must take zero arguments and be either a method call expression or a parameter call expression. It returns an instance of the *Stream* class from which the latest value 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.

3.1.5 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 on the specified IP address and port numbers. If streamPort is 0, does not connect to the stream server. Passes an optional name to the server to identify the client (up to 32 bytes of UTF-8 encoded text).

Stream<*ReturnType*> **AddStream**<*ReturnType*> (*LambdaExpression* expression)

Create a new stream from the given lambda expression. Returns a stream object that can be used to obtain the latest value of the stream.

void **Dispose** ()

Close the connection and free any resources associated with it.

class Stream<ReturnType>

Object representing a stream.

ReturnType **Get** ()
 Get the most recent value of the stream.

void **Remove** ()
 Remove the stream from the server.

3.2 KRPC API

class KRPC

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

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.

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.

GameScene **CurrentGameScene** { *get*; }
 Get the current game scene.

UInt32 **AddStream** (KRPC.Schema.KRPC.Request *request*)
 Add a streaming request and return its identifier.

Parameters

Note: Do not call this method from client code. Use *streams* provided by the C# client library.

void **RemoveStream** (*UInt32 id*)
 Remove a streaming request.

Parameters

Note: Do not call this method from client code. Use *streams* provided by the C# client library.

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.

3.3 SpaceCenter API

3.3.1 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 RAILS_WARP_FACTOR { 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 PHYSICS_WARP_FACTOR { 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 CAN_RAILS_WARP_AT (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 MAXIMUM_RAILS_WARP_FACTOR { 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 WARP_TO (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> TRANSFORM_POSITION (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> TRANSFORM_DIRECTION (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*.

`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.

3.3.2 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.

Resources Resources { **get**; }

A *Resources* object, that can be used to get information about resources stored in the vessel.

Resources ResourcesInDecoupleStage (*Int32 stage*, *Boolean 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** { **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 coordi-

nate 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.

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.
- 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.

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.

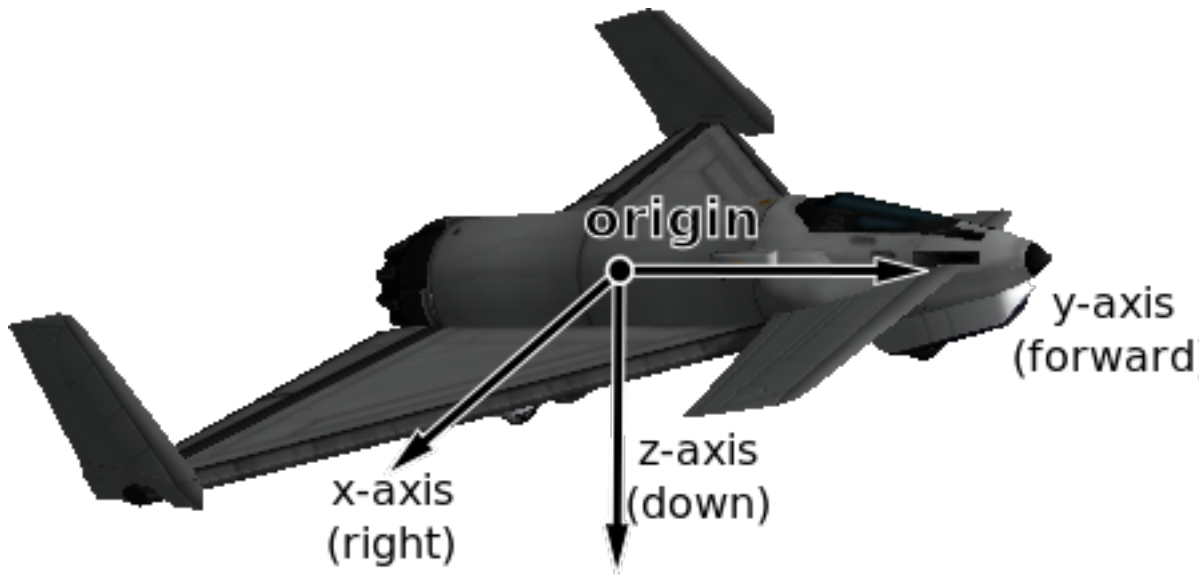


Fig. 3.1: Vessel reference frame origin and axes for the Aegis 3A aircraft

- 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.
- 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.

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.

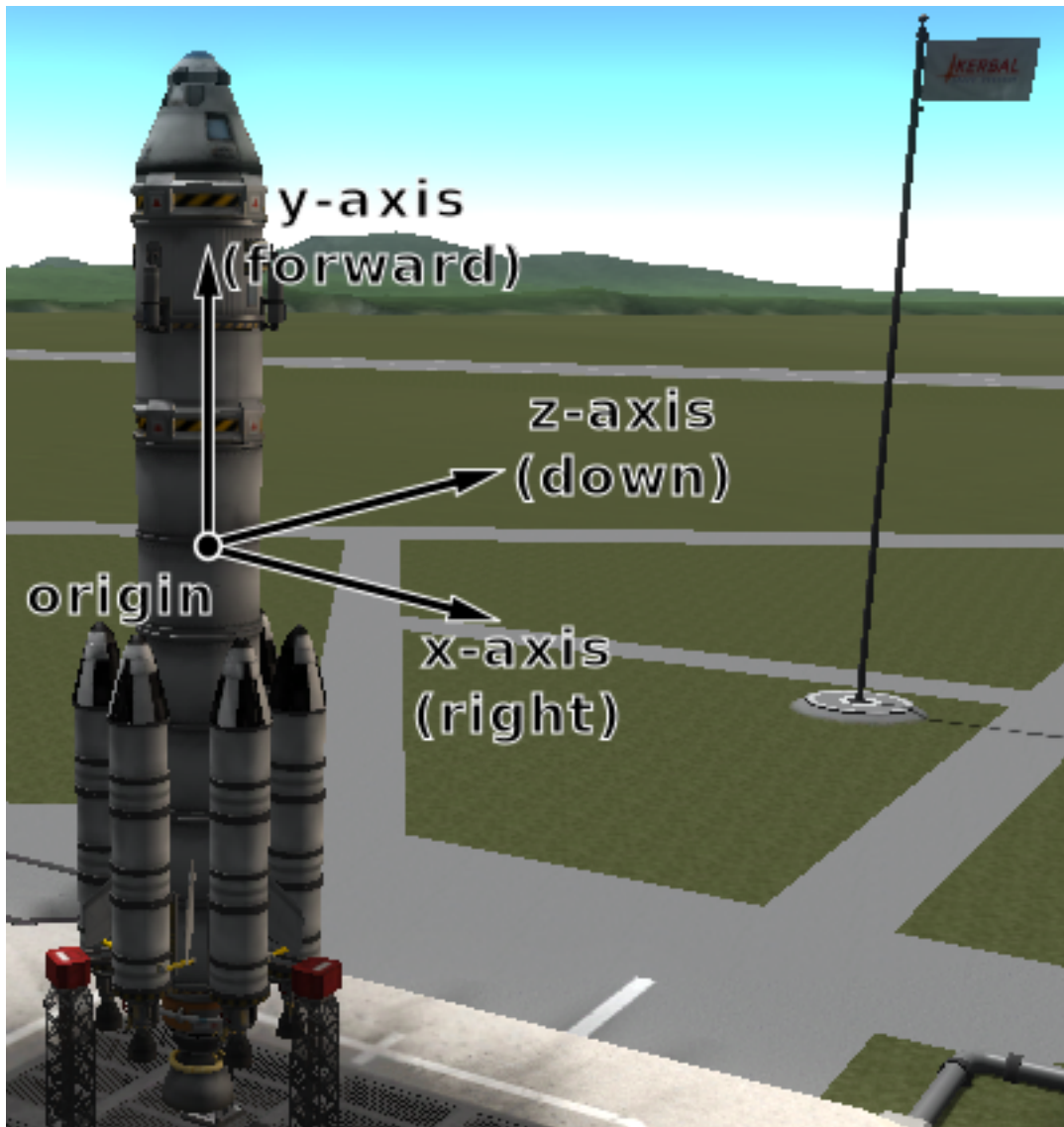


Fig. 3.2: Vessel reference frame origin and axes for the Kerbal-X rocket

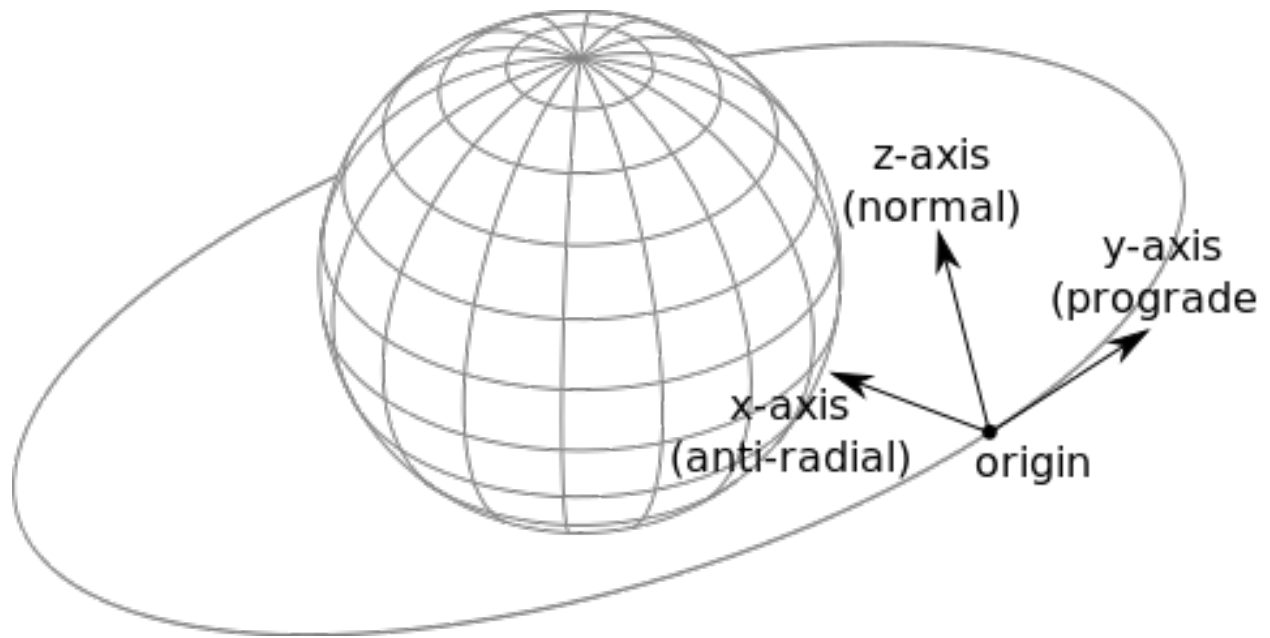


Fig. 3.3: Vessel orbital reference frame origin and axes

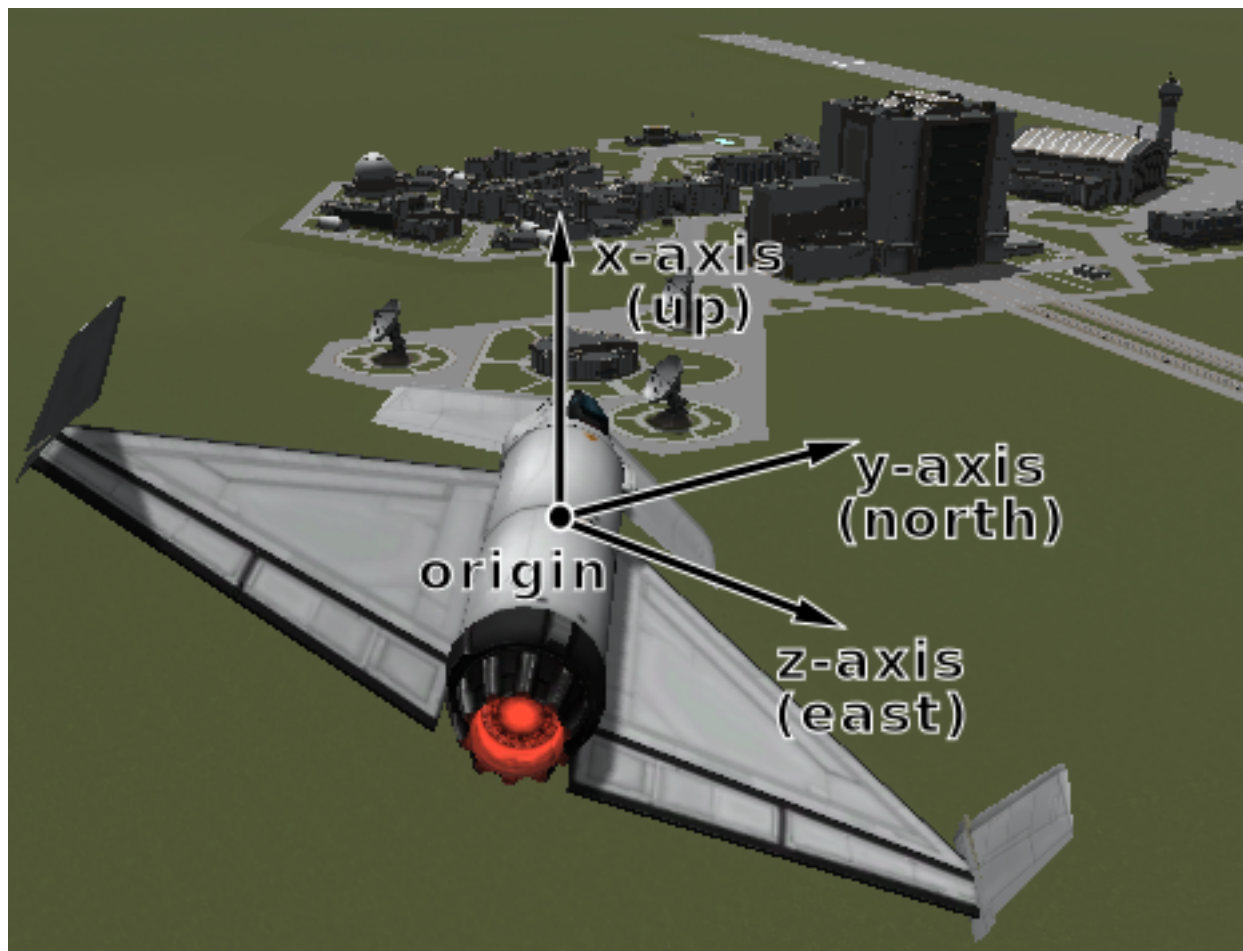


Fig. 3.4: Vessel surface reference frame origin and axes

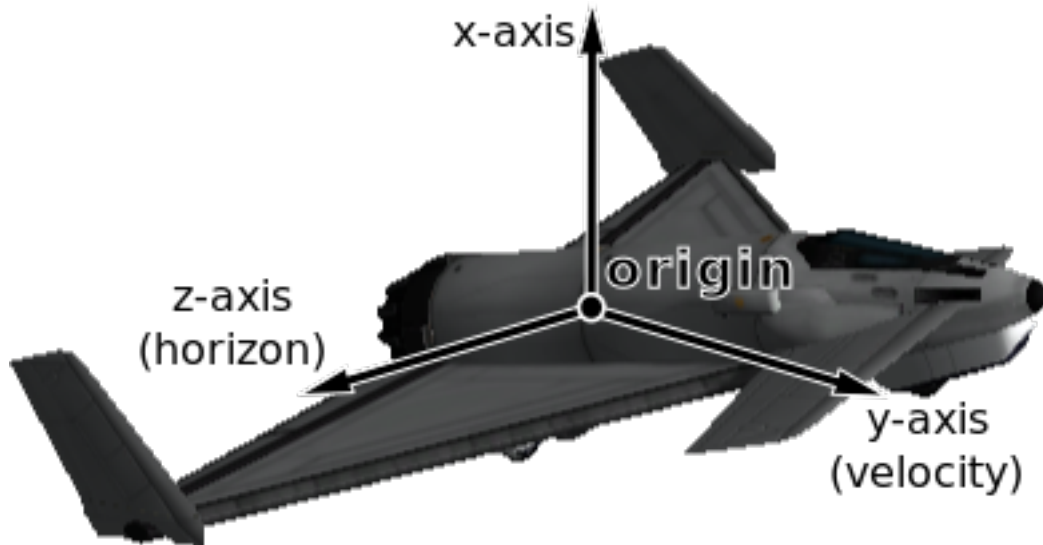


Fig. 3.5: Vessel surface velocity reference frame origin and axes

`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.

3.3.3 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.

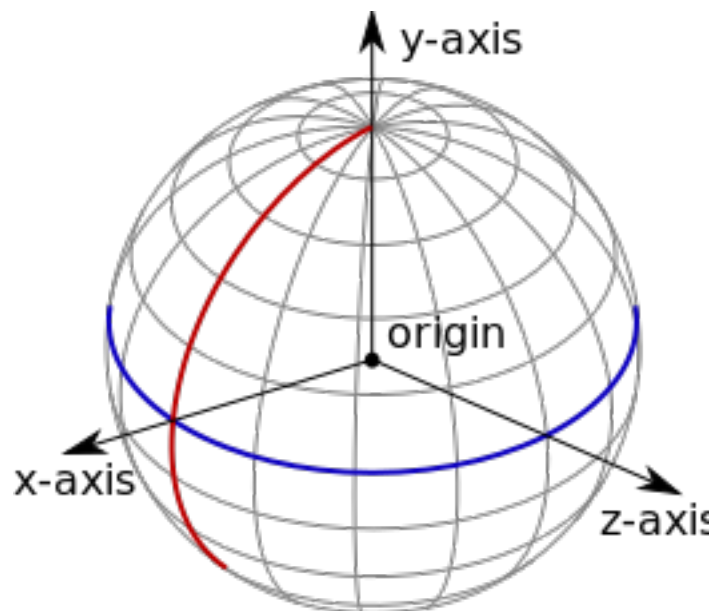


Fig. 3.6: Celestial body reference frame origin and axes. The equator is shown in blue, and the prime meridian in red.

`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.

3.3.4 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°.

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°.

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 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.

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](#).

3.3.5 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.

3.3.6 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.

3.3.7 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.

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

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.

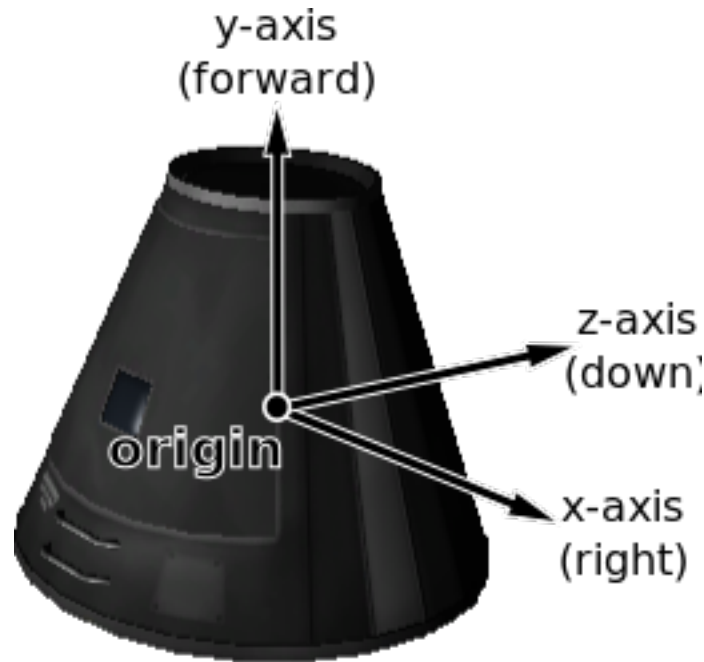


Fig. 3.7: Mk1 Command Pod reference frame origin and axes

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`.

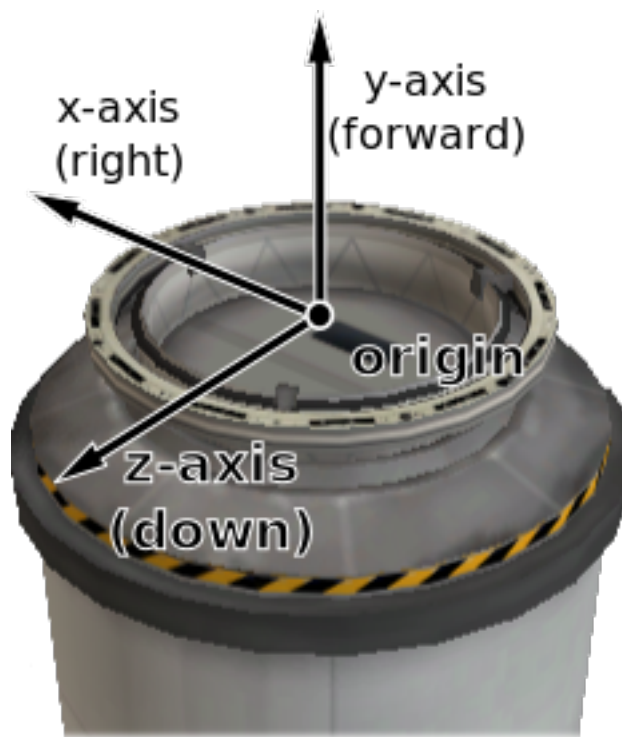


Fig. 3.8: Docking port reference frame origin and axes

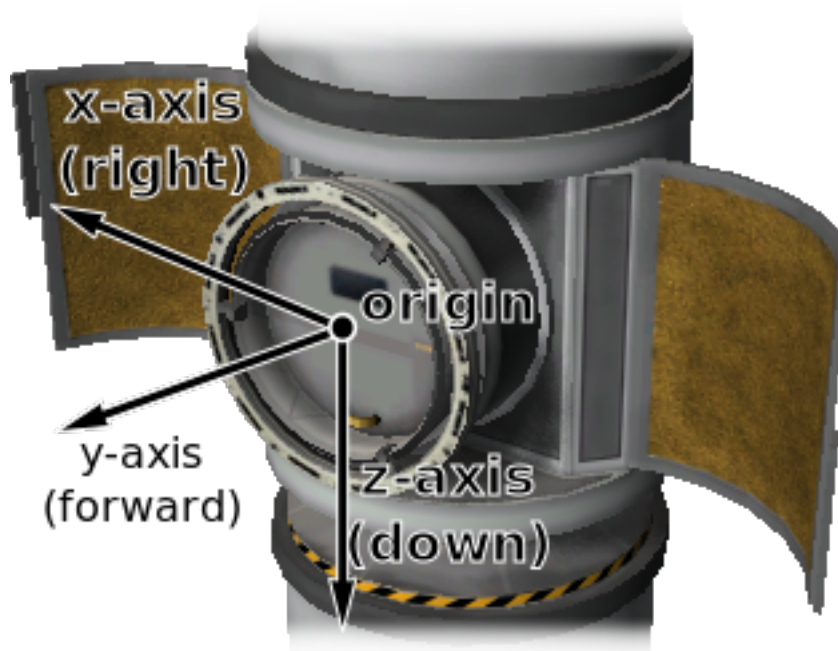


Fig. 3.9: Inline docking port reference frame origin and axes

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.

ICollection<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 Gimballled { **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](#).

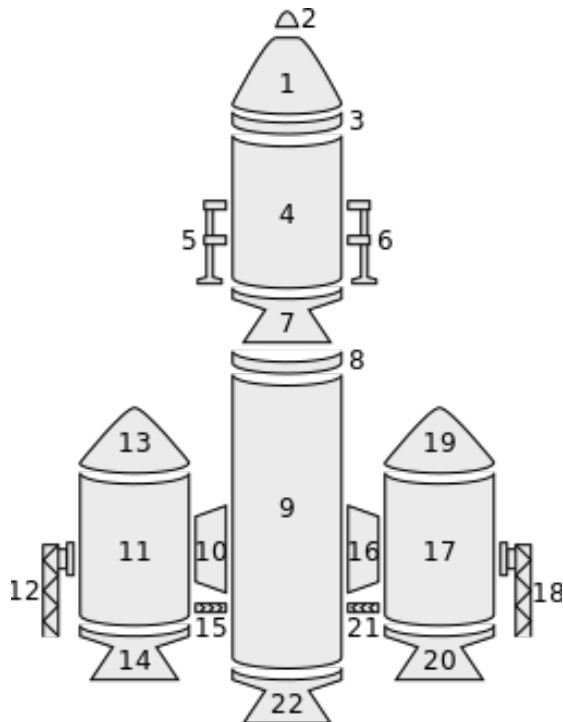


Fig. 3.10: **Figure 1** – Example parts making up a vessel.

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 Traverse(
    {
        using (var connection = new KRPCClient(
            var vessel = connection.SpaceCenter().GetVessel(
            var root = vessel.rootPart;

            var stack = new Stack<Part>();
            stack.Push(root);
            while (stack.Count > 0)
            {
                var part = stack.Pop();
                foreach (var child in part.Children)
                {
                    stack.Push(child);
                }
            }
        }
    }
}
```

```
while (s
    var
    Part
    int
    Cons
    ↪(new String (' ',
    ↪
    foreach (v
    ↪(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));
            }
        }
    }
}
```

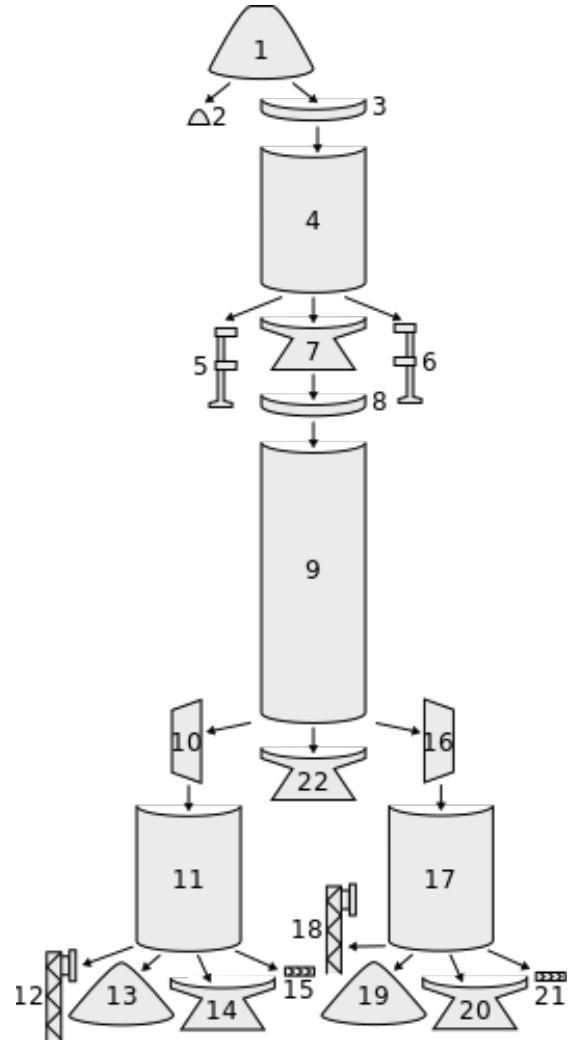


Fig. 3.11: **Figure 2** – Tree of parts for the vessel in Figure 1. Arrows point from the parent part to the child part.

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

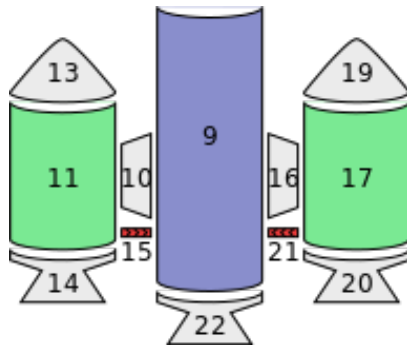


Fig. 3.12: **Figure 5** – Fuel lines from the example in Figure 1. Fuel flows from the parts highlighted in green, into the part highlighted in blue.

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 *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.

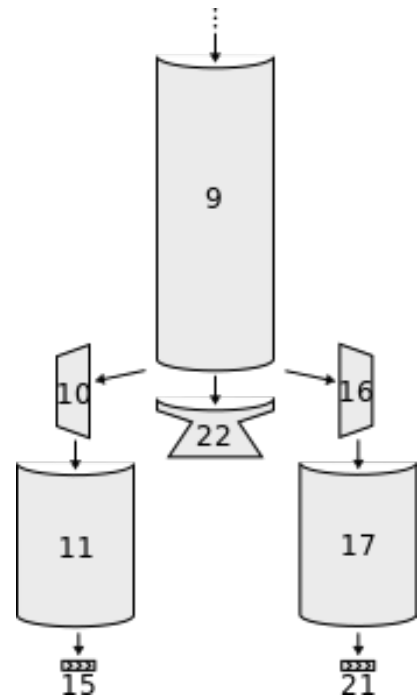


Fig. 3.13: **Figure 4** – A subset of the parts tree from Figure 2 above.

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*.

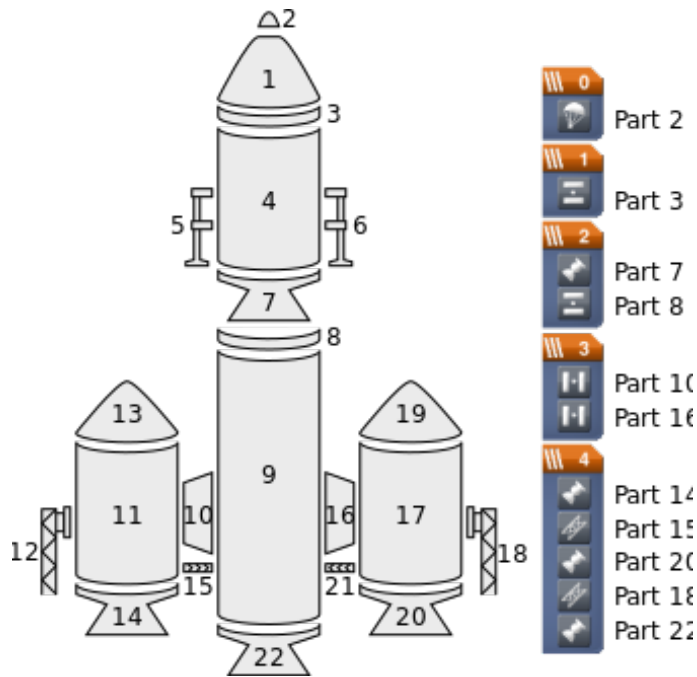


Fig. 3.14: **Figure 6** – Example vessel from Figure 1 with a staging sequence.

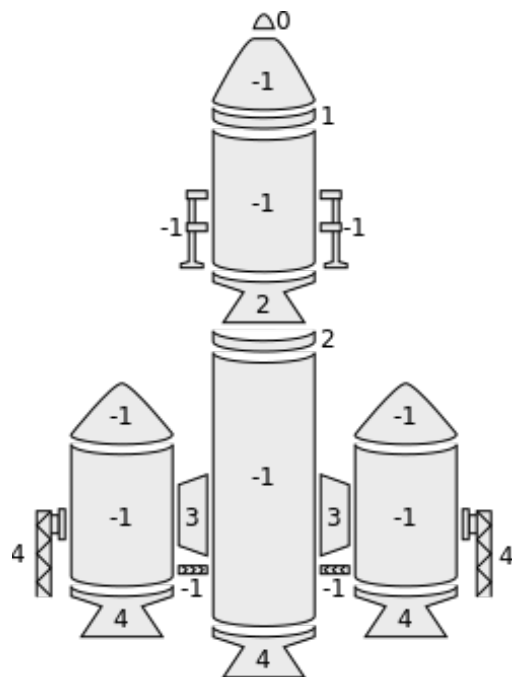


Fig. 3.15: **Figure 7** – The stage in which each part is *activated*.

3.3.9 Resources

class Resources

Represents the collection of resources stored in a vessel, stage or part. Created by calling *Vessel.Resources*, *Vessel.ResourcesInDecoupleStage* or *Part.Resources*.

IList<Resource> All { **get**; }

All the individual resources that can be stored.

IList<Resource> WithResource (*String name*)

All the individual resources with the given name that can be stored.

Parameters

IList<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 (*ICconnection connection*, *String name*)

Returns the density of a resource, in *kg/l*.

Parameters

- **name** – The name of the resource.

static ResourceFlowMode FlowMode (*ICconnection 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.

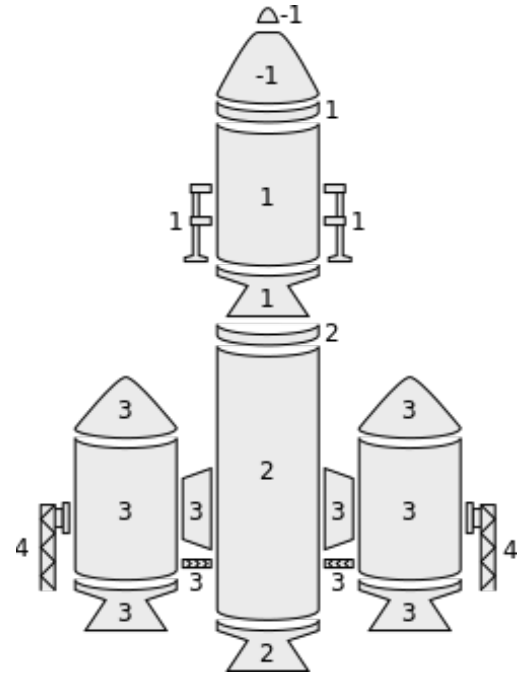


Fig. 3.16: **Figure 8** – The stage in which each part is *decoupled*.

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.

3.3.10 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.

3.3.11 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.

3.3.12 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).

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. Returns zero 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. Returns zero if the auto-pilot has not been engaged.

Single **HeadingError** { **get**; }
The error, in degrees, between the vessels current and target heading. Returns zero if the auto-pilot has not been engaged.

Single **RollError** { **get**; }
The error, in degrees, between the vessels current and target roll. Returns zero 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.

3.3.13 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.

3.3.14 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*.

IList<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.

IList<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.

3.3.15 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.

ICollection<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.

IList<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.

3.3.16 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);
        }
    }
}
```

3.4 Drawing API

3.4.1 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.

3.4.2 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.

3.4.3 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

3.4.4 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

IList<String> AvailableFonts { get; }
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.

3.5 InfernalRobotics API

Provides RPCs to interact with the [InfernalRobotics](#) mod. Provides the following classes:

3.5.1 InfernalRobotics

class InfernalRobotics
This service provides functionality to interact with [InfernalRobotics](#).

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.

3.5.2 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.

3.5.3 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.

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.

```
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 ();
}
}
}

```

3.6 Kerbal Alarm Clock API

Provides RPCs to interact with the [Kerbal Alarm Clock](#) mod. Provides the following classes:

3.6.1 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.

3.6.2 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.

3.6.3 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*.

3.6.4 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.

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.

```
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;
            }
        }
    }
}
```


3.7 RemoteTech API

Provides RPCs to interact with the [RemoteTech](#) mod. Provides the following classes:

3.7.1 RemoteTech

class RemoteTech

This service provides functionality to interact with [RemoteTech](#).

Boolean Available { **get**; }

Whether RemoteTech is installed.

IList<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

3.7.2 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

`ICollection<Antenna> Antennas { get; }`
The antennas for this vessel.

3.7.3 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.

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.

```
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);
        }
    }
}

```

3.8 User Interface API

3.8.1 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.

3.8.2 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.

3.8.3 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.

3.8.4 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.

3.8.5 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.

3.8.6 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.

3.8.7 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.

4.1 C++ Client

This client provides functionality to interact with a kRPC server from programs written in C++. It can be [downloaded from GitHub](#).

4.1.1 Installing the Library

Installing 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 [via the ASIO website](#).

Protobuf version 3 is also required, and can be [downloaded from GitHub](#). Installation instructions [can be found here](#).

Note: The version of protobuf currently provided in Ubuntu's apt repositories is version 2. This will *not* work with kRPC.

Install 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
```

Install 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
```

Install manually

The library is fairly simple to build manually if you can't use the configure script or CMake. The headers are in the `include` folder and the source files are in `src`.

4.1.2 Using the Library

kRPC programs need to be compiled with C++ 2011 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() {
    krpc::Client 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 to force GCC to use the correct version of the library.

Connecting to the Server

To connect to a server, use the `krpc::connect()` function. This returns a client object 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, including a descriptive name for the client, as follows:

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

int main() {
    krpc::Client conn = krpc::connect("Remote example", "my.domain.name", 1000, 1001);
    krpc::services::KRPC krpc(&conn);
    std::cout << krpc.get_status().version() << std::endl;
}
```

Interacting with the Server

kRPC groups remote procedures into services. 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 connects to the server, instantiates the SpaceCenter service and outputs the name of the active vessel:

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

using SpaceCenter = krpc::services::SpaceCenter;

int main() {
    krpc::Client conn = krpc::connect("Vessel Name");
    SpaceCenter sc(&conn);
    SpaceCenter::Vessel vessel = sc.active_vessel();
    std::cout << vessel.name() << std::endl;
}
```

Streaming Data from the Server

A stream repeatedly executes a function on the server, with a fixed set of argument values. It provides a more efficient way of repeatedly getting the result of a function, avoiding the network overhead of having to invoke it directly.

For example, consider the following loop that continuously prints out the position of the active vessel. This loop incurs significant communication overheads, as the `vessel.position()` function is called repeatedly.

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

using SpaceCenter = krpc::services::SpaceCenter;

int main() {
    krpc::Client conn = krpc::connect();
    krpc::services::KRPC krpc(&conn);
    SpaceCenter sc(&conn);
    SpaceCenter::Vessel vessel = sc.active_vessel();
    SpaceCenter::ReferenceFrame ref_frame = vessel.orbit().body().reference_frame();
    while (true) {
        std::tuple<double, double, double> 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;
    }
}
```

The following code achieves the same thing, but is far more efficient. It calls `vessel.position_stream()` once at the start of the program to create a stream, and then repeatedly gets the position from the stream.

```

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

using SpaceCenter = krpc::services::SpaceCenter;

int main() {
    krpc::Client conn = krpc::connect();
    krpc::services::KRPC krpc(&conn);
    SpaceCenter sc(&conn);
    SpaceCenter::Vessel vessel = sc.active_vessel();
    SpaceCenter::ReferenceFrame ref_frame = vessel.orbit().body().reference_frame();
    krpc::Stream<std::tuple<double, double, double>> pos_stream = vessel.position_
→stream(ref_frame);
    while (true) {
        std::tuple<double, double, double> 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;
    }
}

```

A stream can be created for any function call (except property setters) by adding `_stream` to the end of the function's 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 client's 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.

4.1.3 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, for example, in the client connection dialog on 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.
- **stream_port** (*unsigned int*) – The port number of the Stream Server. Defaults to 50001. Set it to 0 to disable connection to the stream server.

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()`.

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.

class KRPC

This class provides access to the basic server functionality provided by the KRPC service. Most of this functionality is used internally by the client (for example to create and remove streams) and therefore does not need to be used directly from application code. The only exception that may be useful is `KRPC::get_status()`.

KRPC (`krpc::Client *client`)

Construct an instance of this service from the given `krpc::Client` object.

`krpc::schema::Status` **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:

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

int main() {
    krpc::Client conn = krpc::connect("Remote example", "my.domain.name", 1000,
    ↪1001);
    krpc::services::KRPC krpc(&conn);
    std::cout << krpc.get_status().version() << std::endl;
}
```

Or to get the rate at which the server is sending and receiving data over the network:

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

int main() {
    krpc::Client conn = krpc::connect();
    krpc::services::KRPC krpc(&conn);
    krpc::schema::Status status = krpc.get_status();
    std::cout << std::fixed << std::setprecision(1);
    std::cout << "Data in = "
    << (status.bytes_read_rate()/1024.0) << " KB/s" << std::endl;
    std::cout << "Data out = "
    << (status.bytes_written_rate()/1024.0) << " KB/s" << std::endl;
}
```

template<typename T>

class Stream

A stream object. Streams are created by calling a function 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.

Stream()

Create a stream object that is not bound to any stream.

T operator()()

Get the most recently received value from the stream.

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.

void **remove()**

Manually remove the stream from the server.

4.2 KRPC API

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.

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.

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.

GameScene **current_game_scene()**

Get the current game scene.

uint32_t **add_stream** (krpc::schema::Request request)

Add a streaming request and return its identifier.

Parameters

Note: Do not call this method from client code. Use *streams* provided by the C++ client library.

void **remove_stream** (uint32_t id)

Remove a streaming request.

Parameters

Note: Do not call this method from client code. Use *streams* provided by the C++ client library.

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.

4.3 SpaceCenter API

4.3.1 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*.

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.

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 *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.

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, 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 **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.

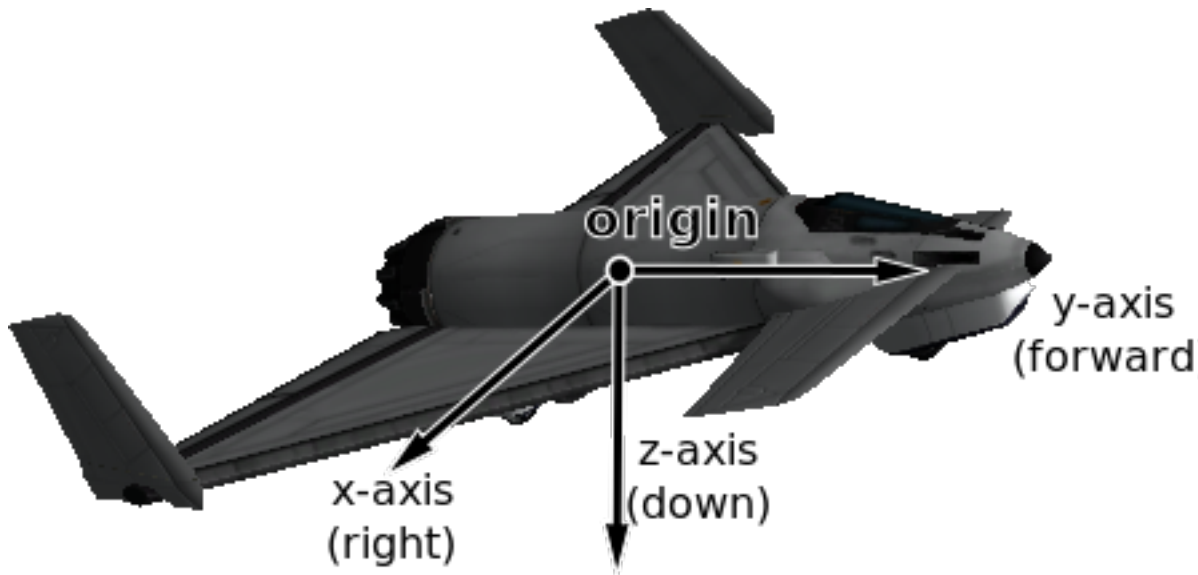


Fig. 4.1: Vessel reference frame origin and axes for the Aeris 3A aircraft

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.

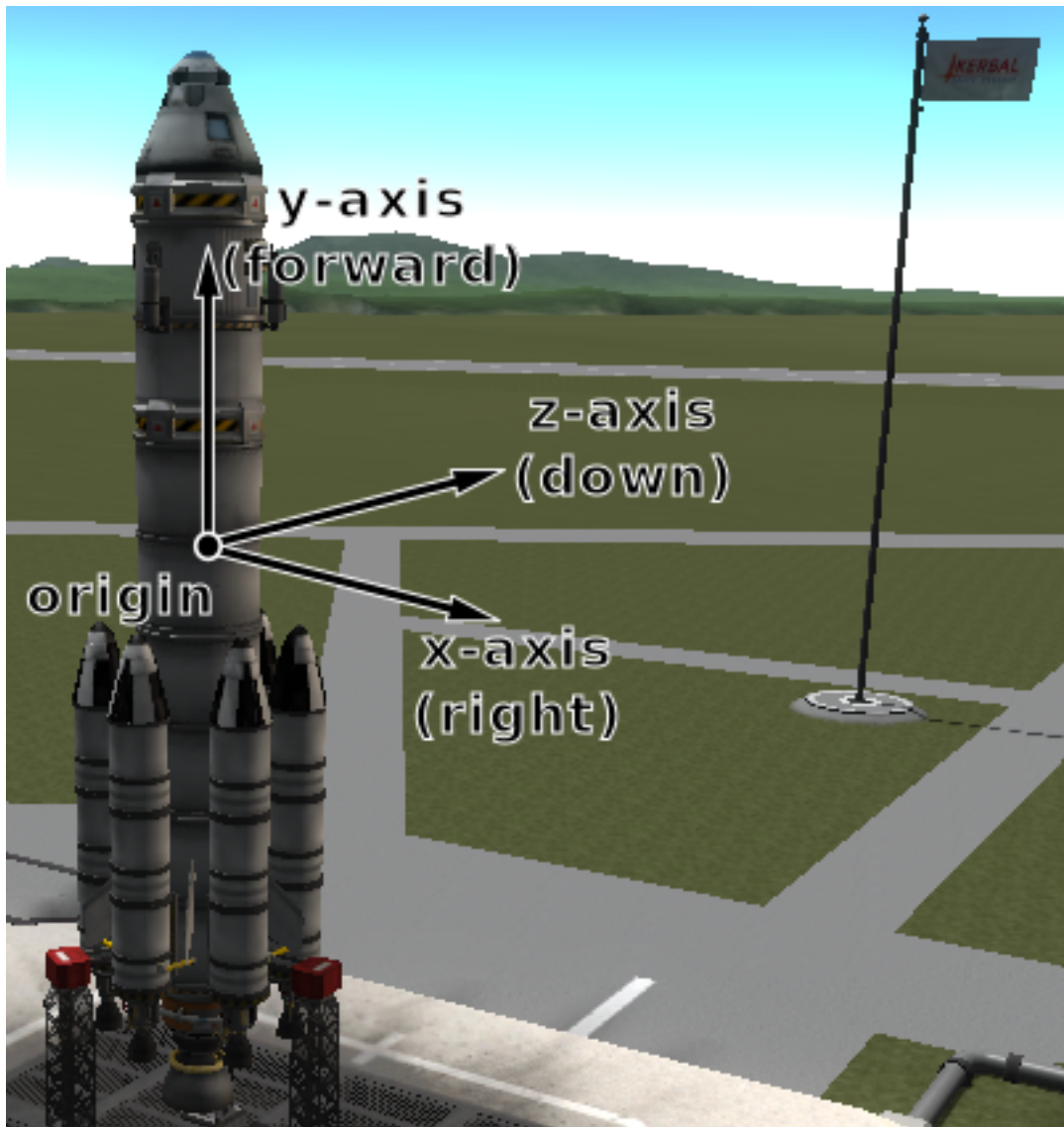


Fig. 4.2: Vessel reference frame origin and axes for the Kerbal-X rocket

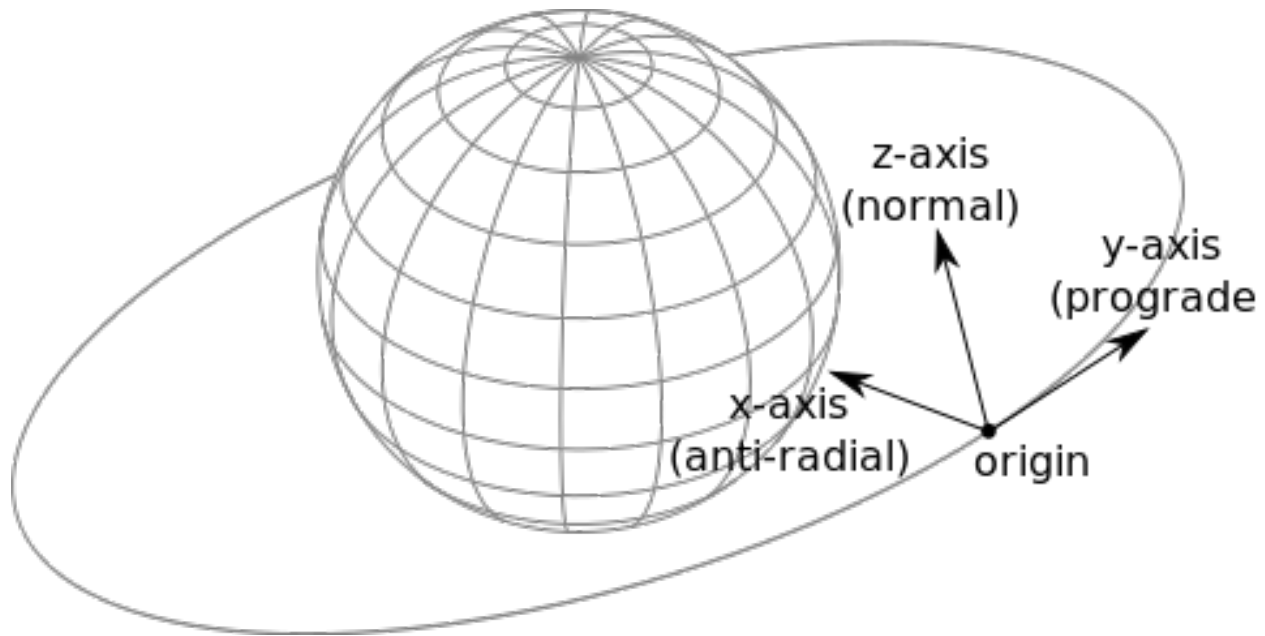


Fig. 4.3: Vessel orbital reference frame origin and axes

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.

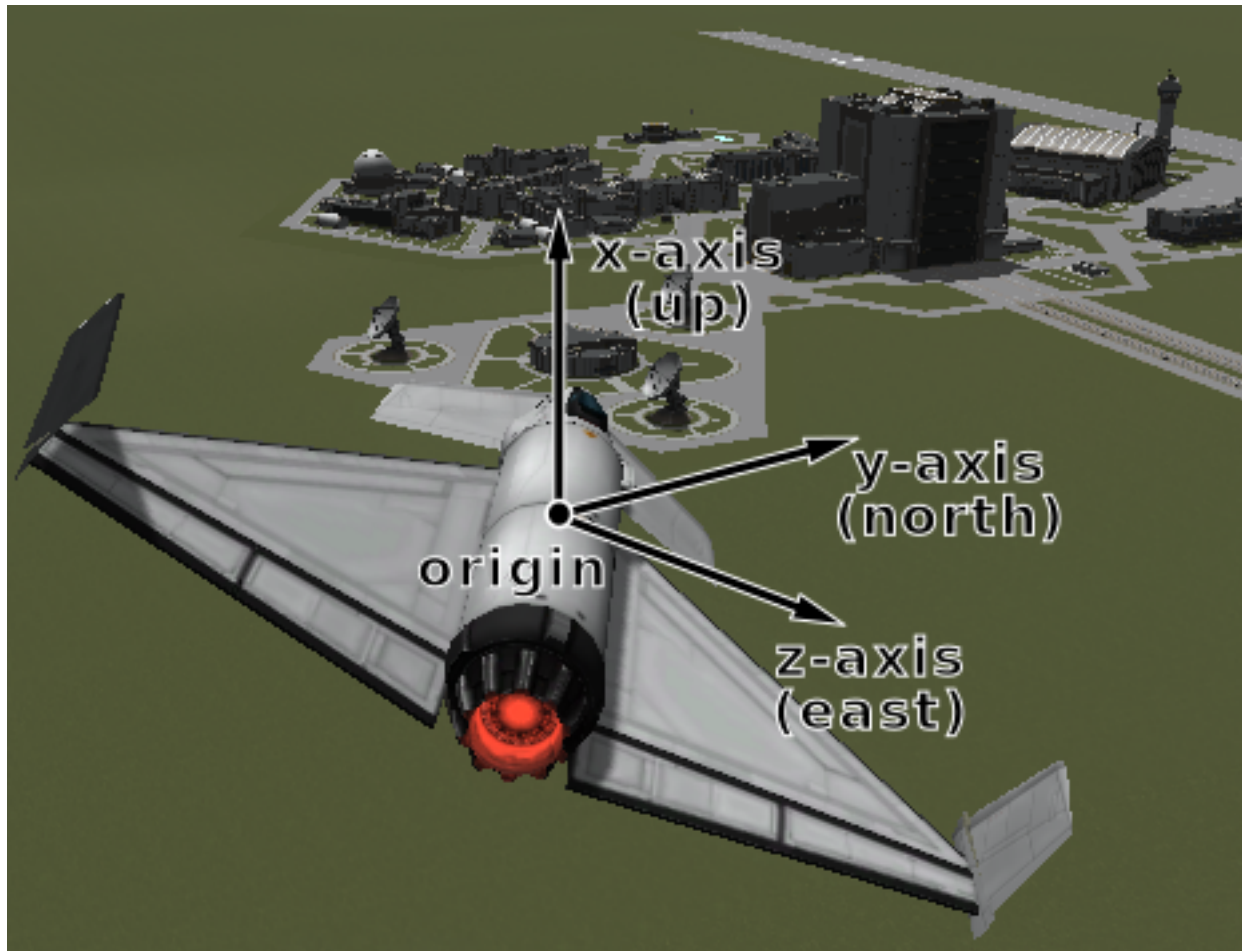


Fig. 4.4: Vessel surface reference frame origin and axes

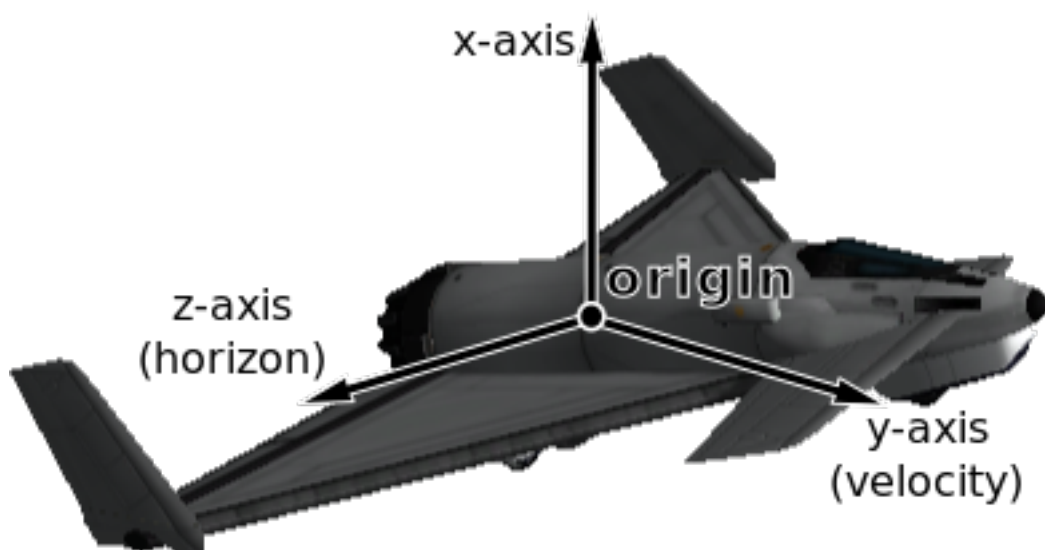


Fig. 4.5: Vessel surface velocity reference frame origin and axes

`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 VesselSituationThe 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.

4.3.3 CelestialBody

class CelestialBodyRepresents 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 $m^3 s^{-2}$.

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.

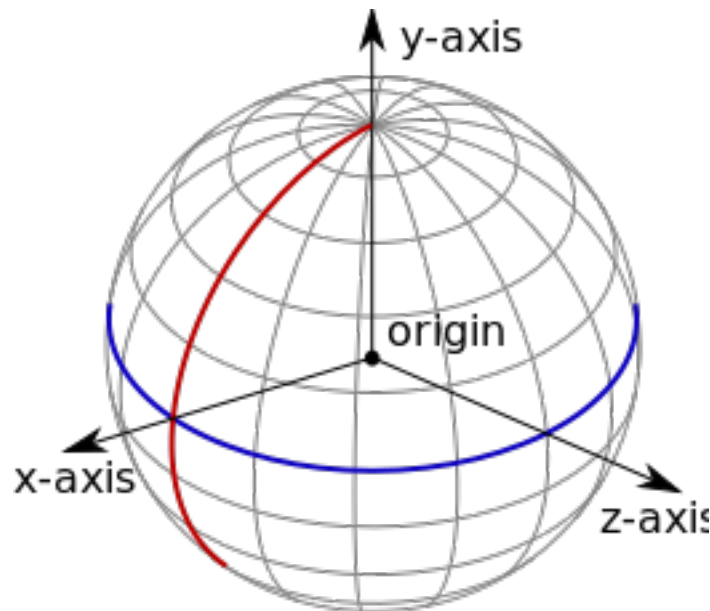


Fig. 4.6: Celestial body reference frame origin and axes. The equator is shown in blue, and the prime meridian in red.

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.

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`.

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 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.

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](#).

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** ()

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 *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** – 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 *reference_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.

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** ()

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 ControlSource
The 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 SASMode
The 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 SpeedMode
The 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.

4.3.7 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.

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()`.

`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> racs ()
    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 **rcs** ()

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.

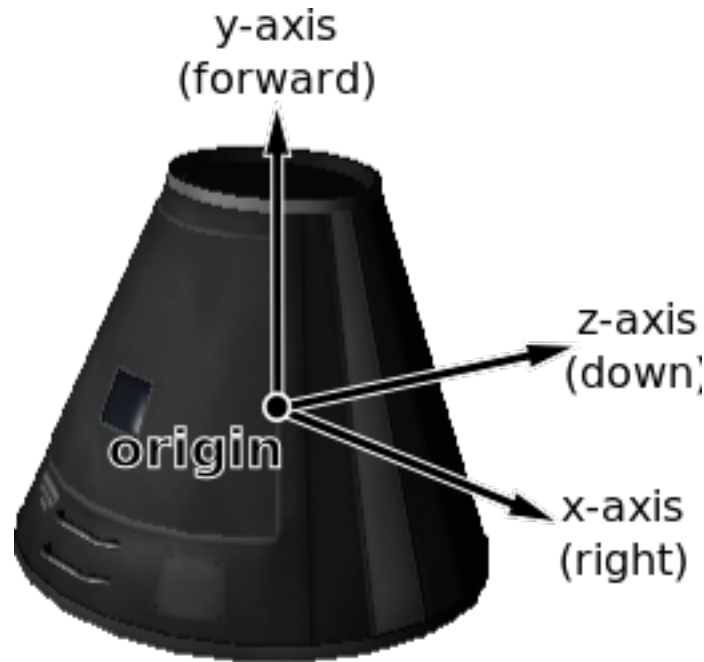


Fig. 4.7: Mk1 Command Pod reference frame origin and axes

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.

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()`).

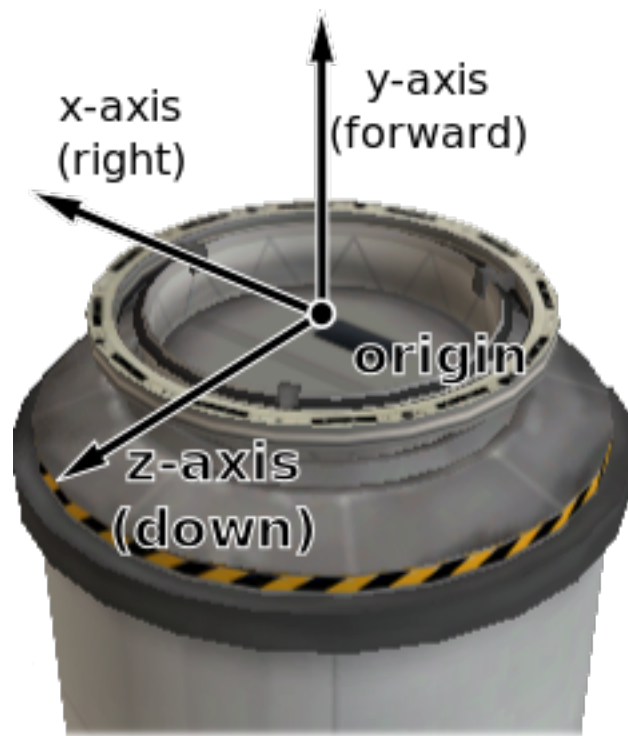


Fig. 4.8: Docking port reference frame origin and axes

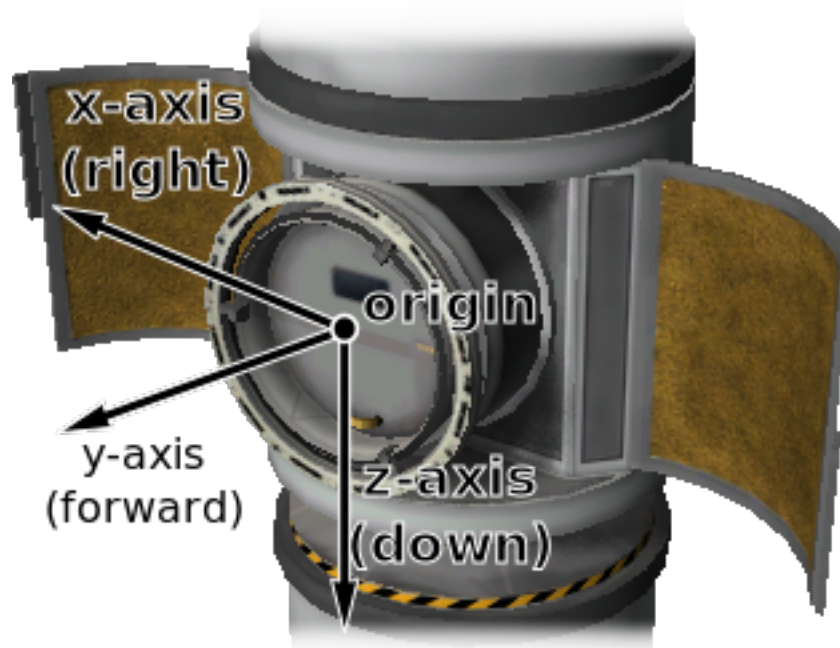


Fig. 4.9: Inline docking port reference frame origin and axes

enumerator shielded

The docking port has a shield, and the shield is closed.

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

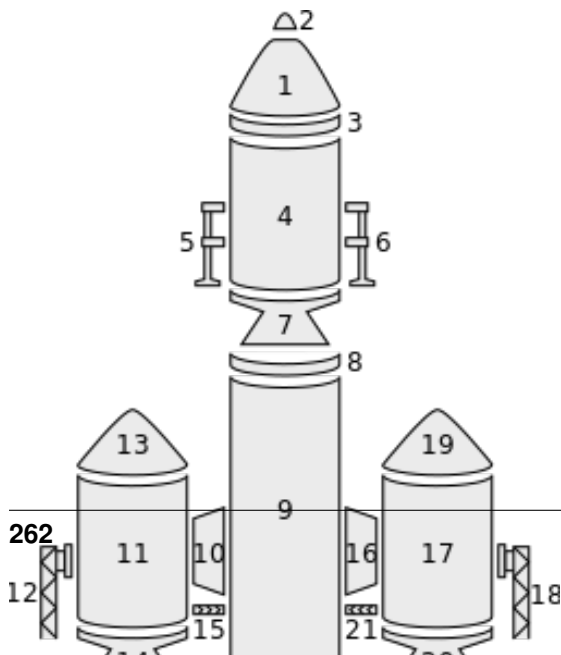
The motor is inoperable.

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 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:

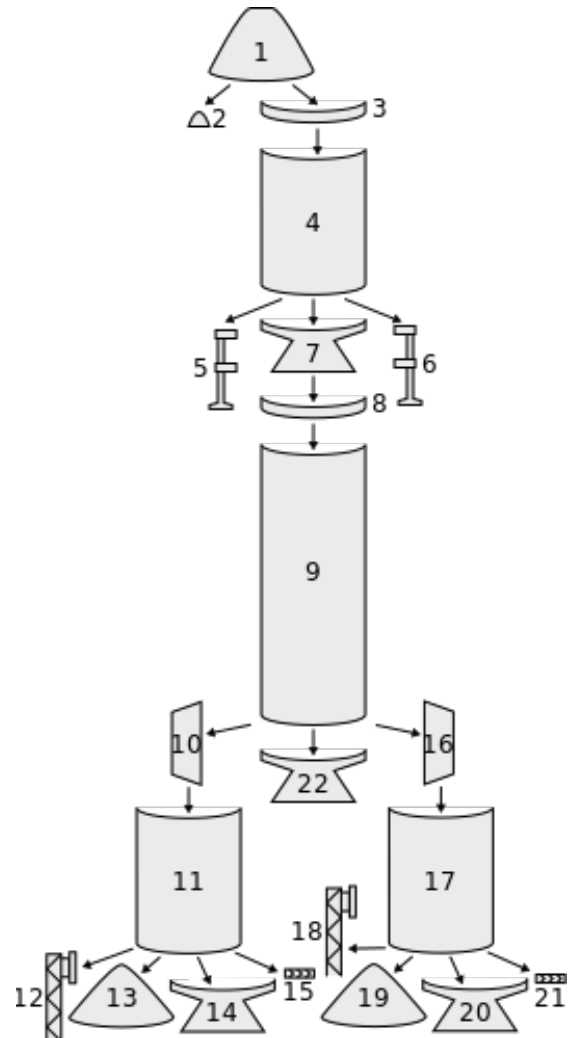
```
#include <iostream>
#include <stack>
#include <string>
#include <utility>
#include <krpc.hpp>
#include <krpc/services/space_center.hpp>

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_
↳ << " - " << attach_mode << std::endl;
        auto children = part.children();
        for (auto child : children) {
            stack.push(std::pair
↳ <SpaceCenter::Part, int>(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

```

Fuel Lines

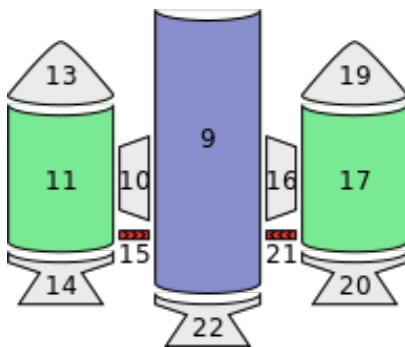


Fig. 4.12: **Figure 5** – Fuel lines from the example in Figure 1. Fuel flows from the parts highlighted in green, into the part highlighted in blue.

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::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*.

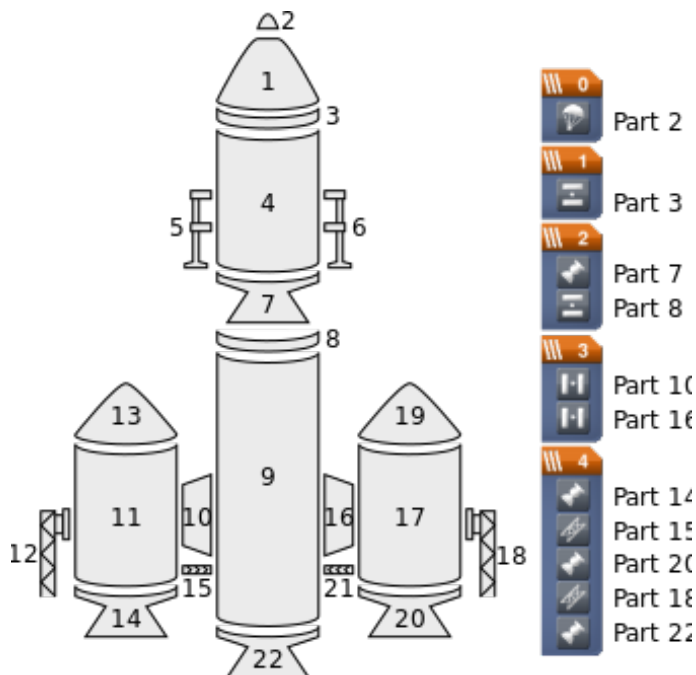


Fig. 4.14: **Figure 6** – Example vessel from Figure 1 with a staging sequence.

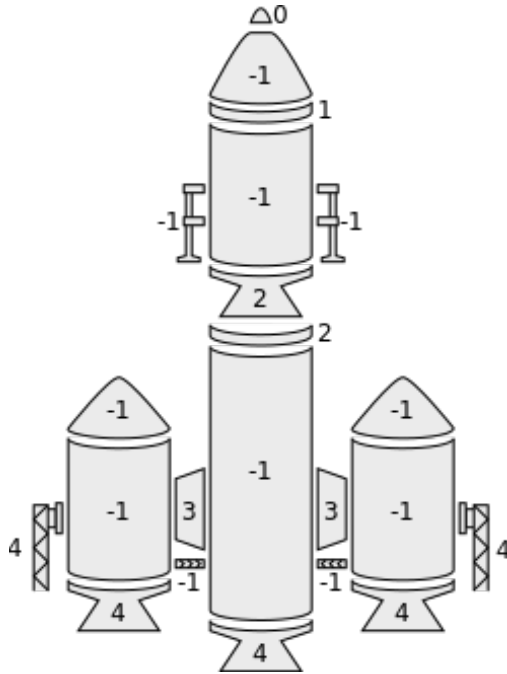


Fig. 4.15: **Figure 7** – The stage in which each part is *activated*.

4.3.9 Resources

class **Resources**

Represents the collection of resources stored in a vessel, stage or part. Created by calling `Vessel::resources()`, `Vessel::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.

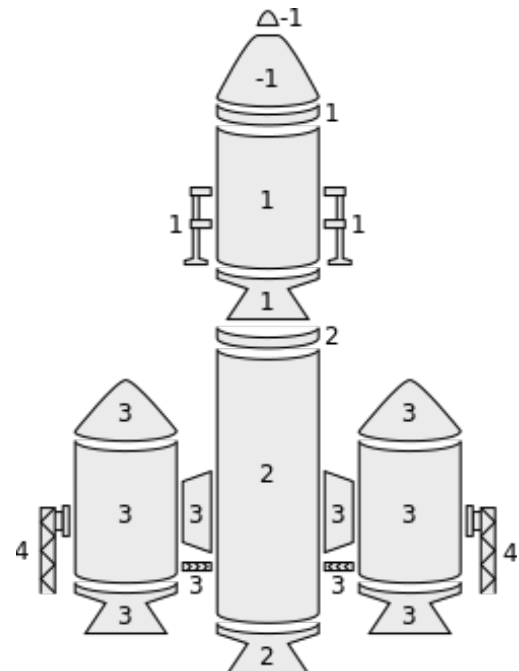


Fig. 4.16: **Figure 8** – The stage in which each part is *decoupled*.

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.

4.3.10 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.

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 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> rotation  
                                     = (0.0, 0.0, 0.0, 1.0), std::tuple<double, double, double>  
                                     velocity = (0.0, 0.0, 0.0), std::tuple<double, double, dou-  
                                     ble> 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, Reference-  
                                     Frame rotation = ReferenceFrame(), ReferenceFrame veloc-  
                                     ity = ReferenceFrame(), ReferenceFrame angular_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.

4.3.12 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).

float **error** ()
The error, in degrees, between the direction the ship has been asked to point in and the direction it is pointing in. Returns zero 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. Returns zero if the auto-pilot has not been engaged.

float **heading_error** ()
The error, in degrees, between the vessels current and target heading. Returns zero if the auto-pilot has not been engaged.

float **roll_error** ()
The error, in degrees, between the vessels current and target roll. Returns zero 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.

4.3.13 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.

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 `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.

4.3.15 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.

4.3.16 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;
}
```

4.4 Drawing API

4.4.1 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.

4.4.2 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.

4.4.3 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

4.4.4 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

std::vector<std::string> available_fonts ()
    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.

4.5 InfernalRobotics API

Provides RPCs to interact with the [InfernalRobotics](#) mod. Provides the following classes:

4.5.1 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.

4.5.2 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.

4.5.3 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.

```

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.

```

#include <iostream>
#include <vector>
#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();
    sleep(1);
    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 : 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.

4.6.2 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.

4.6.3 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*.

4.6.4 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.

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.

```
#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);
}
```

4.7 RemoteTech API

Provides RPCs to interact with the [RemoteTech](#) mod. Provides the following classes:

4.7.1 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

4.7.2 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.

4.7.3 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.

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.

```
#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;
}

```

4.8 User Interface API

4.8.1 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.

4.8.2 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.

4.8.3 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.

4.8.4 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.

4.8.5 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.

4.8.6 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.

4.8.7 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.

5.1 Java Client

This client provides functionality to interact with a kRPC server from programs written in Java. A jar containing the `krpc.client` package can be [downloaded from GitHub](#). It requires Java version 1.7.

5.1.1 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-3.1.0.jar:javatuples-1.2.jar Example.java
```

You may need to change the paths to the JAR files.

5.1.2 Connecting to the Server

To connect to a server, use the `Connection.newInstance()` function. This returns a connection object 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, including a descriptive name for the client, 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();
    }
}
```

5.1.3 Interacting with the Server

Interaction with the server is performed via a connection object. Functionality for services are defined in the packages `krpc.client.services.*`. Before a service can be used it must first be instantiated. The following example connects to the server, instantiates the `SpaceCenter` service, and outputs the name of the active vessel:

```
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 Interacting {
    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();
    }
}
```

5.1.4 Streaming Data from the Server

A stream repeatedly executes a function on the server, with a fixed set of argument values. It provides a more efficient way of repeatedly getting the result of a function, avoiding the network overhead of having to invoke it directly.

For example, consider the following loop that continuously prints out the position of the active vessel. This loop incurs significant communication overheads, as the `vessel.position()` function is called repeatedly.

```
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 Streaming {
    public static void main(String[] args) throws IOException, RPCEException {
        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));
        }
    }
}

```

The following code achieves the same thing, but is far more efficient. It calls *Connection.addStream* once at the start of the program to create a stream, and then repeatedly gets the position from the stream.

```

import krpc.client.Connection;
import krpc.client.RPCEException;
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, RPCEException,
↳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());
        }
    }
}

```

Streams are created 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). The most recent value for the stream can be obtained by calling *Stream.get*.

Streams can also be added for static methods as follows:

```
Stream<Double> time_stream = connection.addStream(SpaceCenter.class, "getUt");
```

A stream can be removed by calling *Stream.remove()*. All of a clients streams are automatically stopped when it disconnects.

5.1.5 Client API Reference

class **Connection**

This class provides the interface for communicating with the server.

`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, 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, 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.
- **stream_port** (int) – The port number of the Stream Server. Defaults to 50001.

`void close ()`

Close the connection.

`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.

`class Stream<T>`

A stream object.

`T get ()`

Get the most recent value for the stream.

`void remove ()`

Remove the stream from the server.

`abstract class RemoteObject`

The abstract base class for all remote objects.

5.2 KRPC API

`public class KRPC`

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

`krcp.schema.KRPC.Status getStatus ()`

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

`krcp.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.

`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.

GameScene **getCurrentGameScene** ()

Get the current game scene.

int **addStream** (krpc.schema.KRPC.Request *request*)

Add a streaming request and return its identifier.

Parameters

- **request** (*krpc.schema.KRPC.Request*) –

Note: Do not call this method from client code. Use *streams* provided by the Java client library.

void **removeStream** (int *id*)

Remove a streaming request.

Parameters

- **id** (*int*) –

Note: Do not call this method from client code. Use *streams* provided by the Java client library.

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.

5.3 SpaceCenter API

5.3.1 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*.

`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.

5.3.2 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.

VesselSituation **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.

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 be 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>> **getAv**

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 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.

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, 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.

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.

ReferenceFrame **getOrbitalReferenceFrame** ()

The reference frame that is fixed relative to the vessel, and orientated with the vessels orbital pro-grade/normal/radial directions.

- The origin is at the center of mass of the vessel.

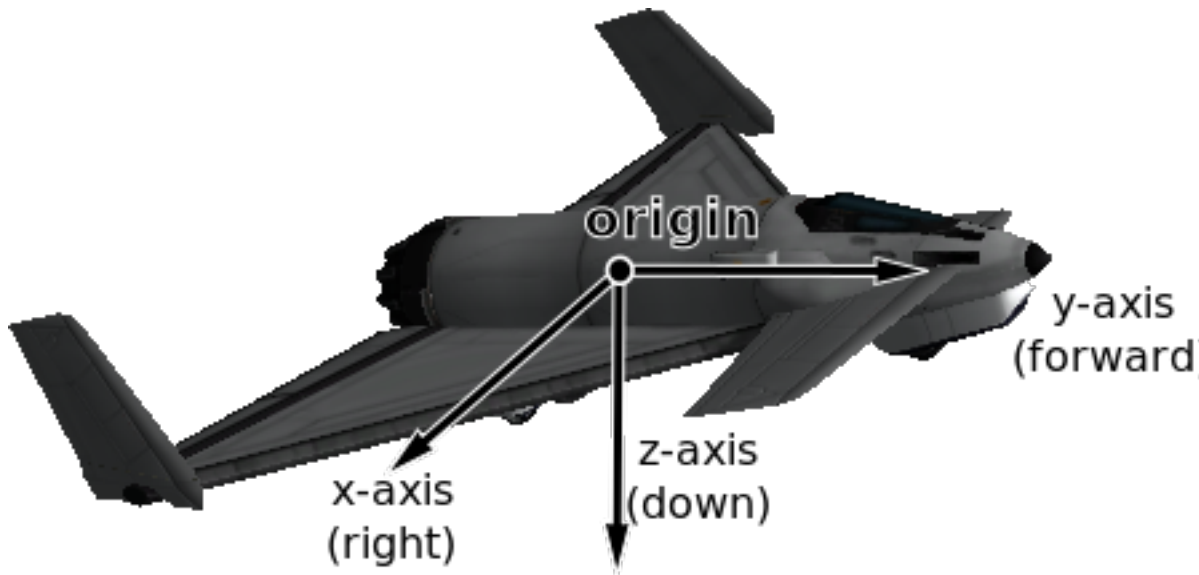


Fig. 5.1: Vessel reference frame origin and axes for the Aegis 3A aircraft

- 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.

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.

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.

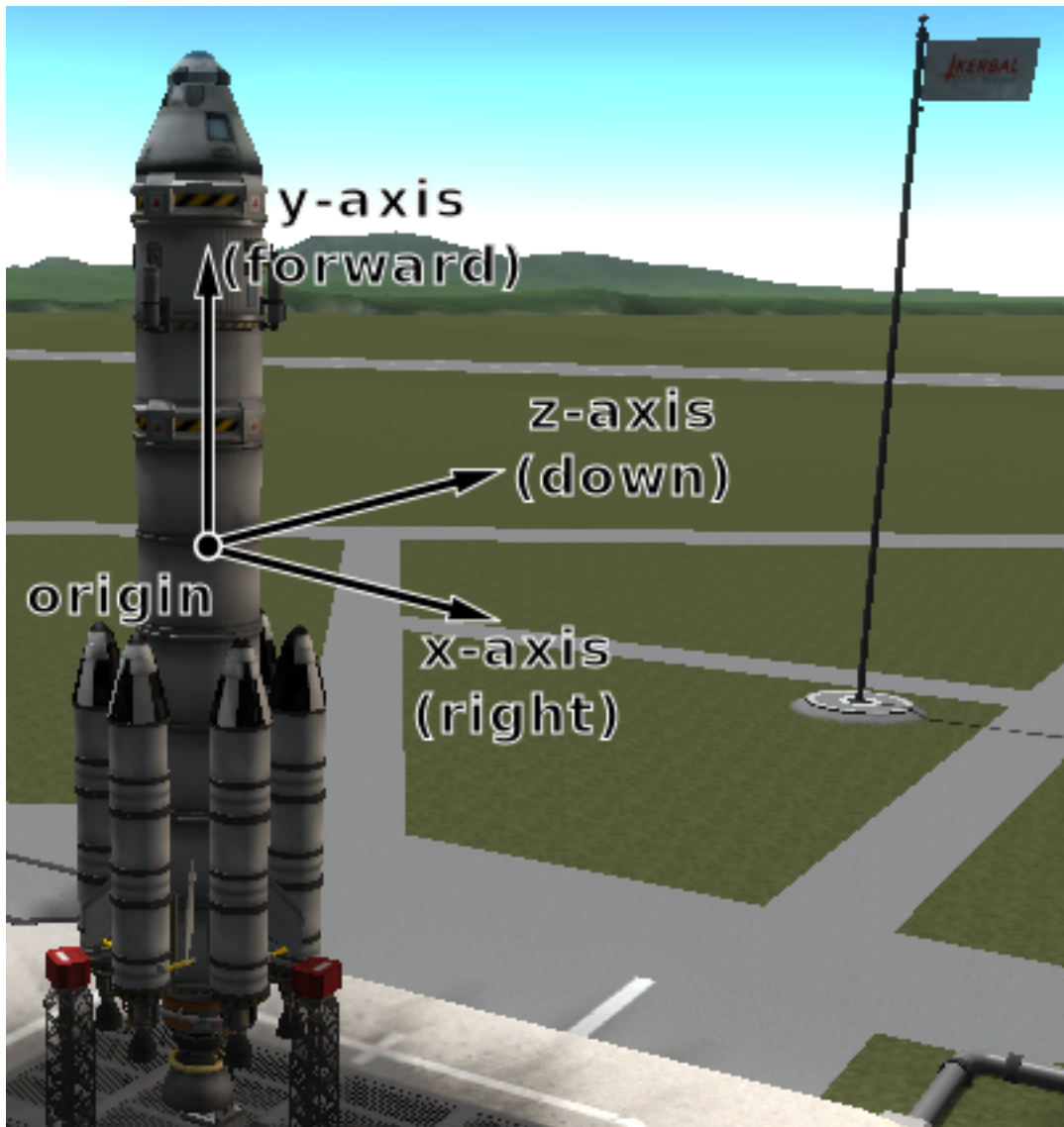


Fig. 5.2: Vessel reference frame origin and axes for the Kerbal-X rocket

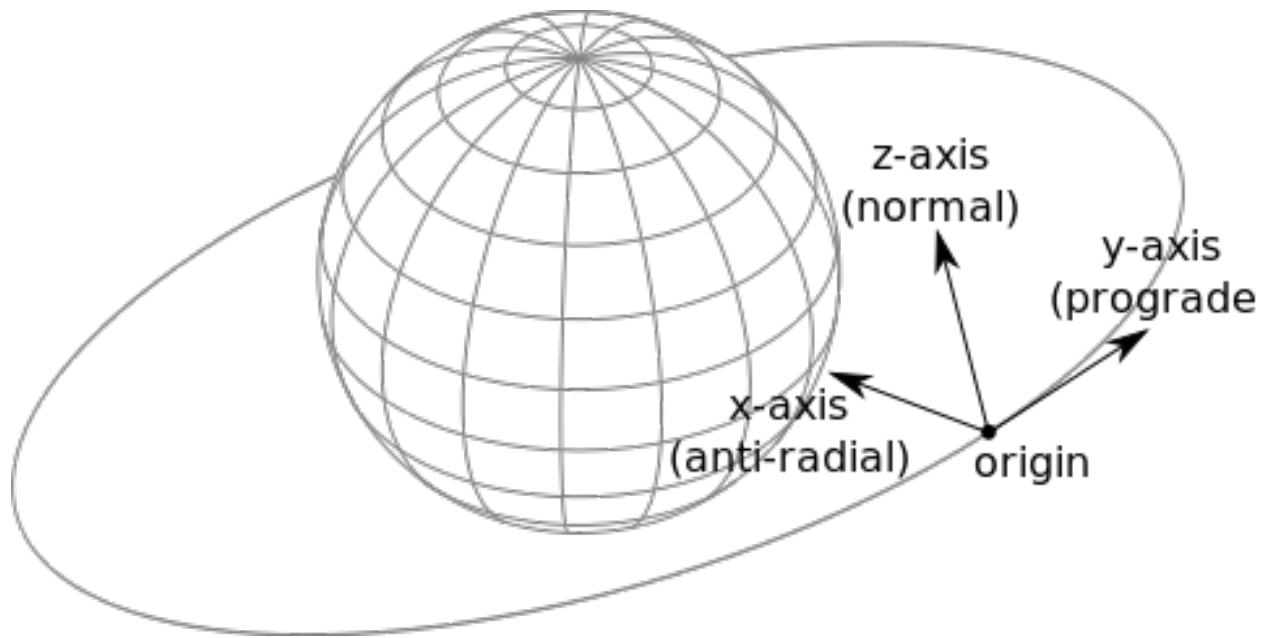


Fig. 5.3: Vessel orbital reference frame origin and axes

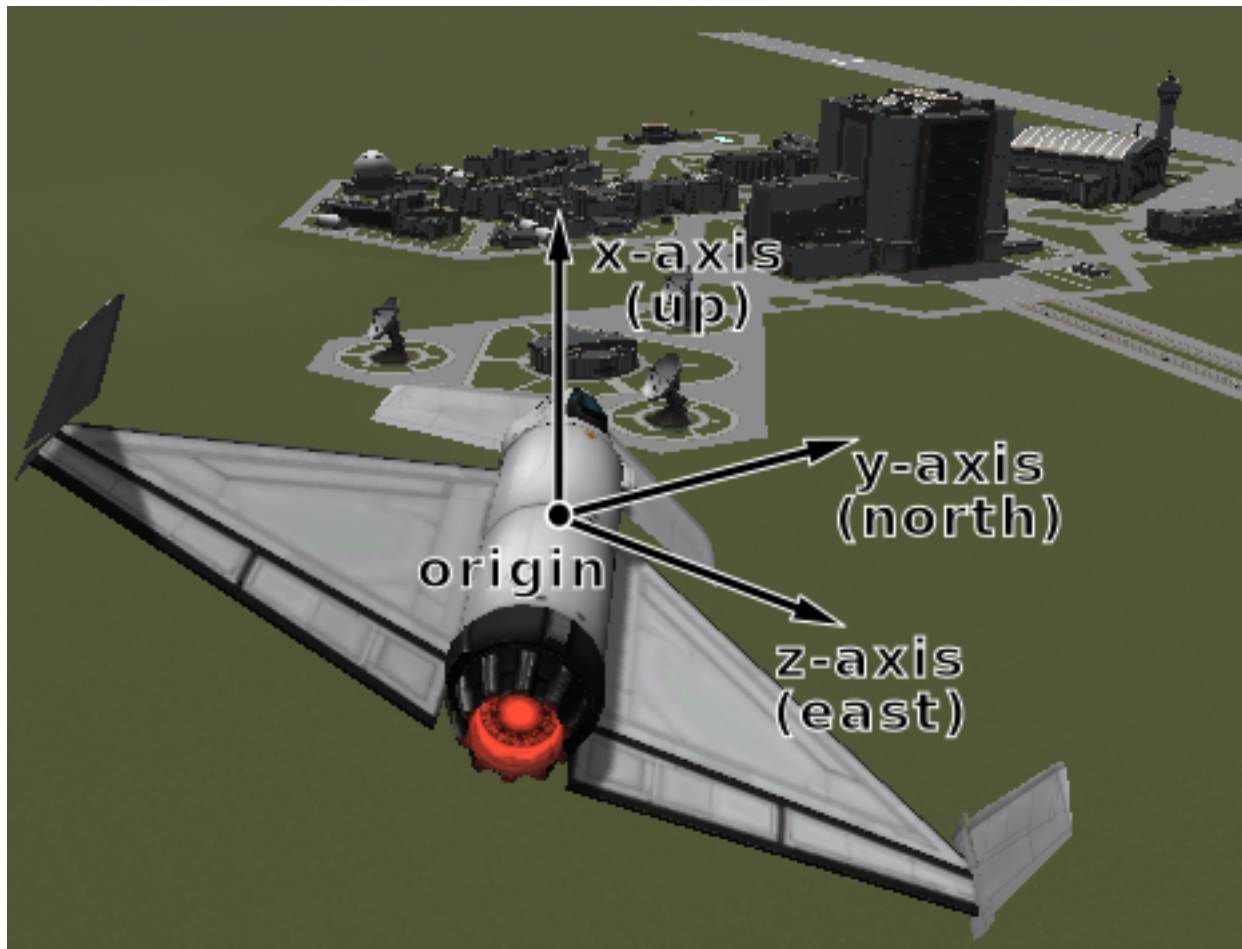


Fig. 5.4: Vessel surface reference frame origin and axes

- 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.

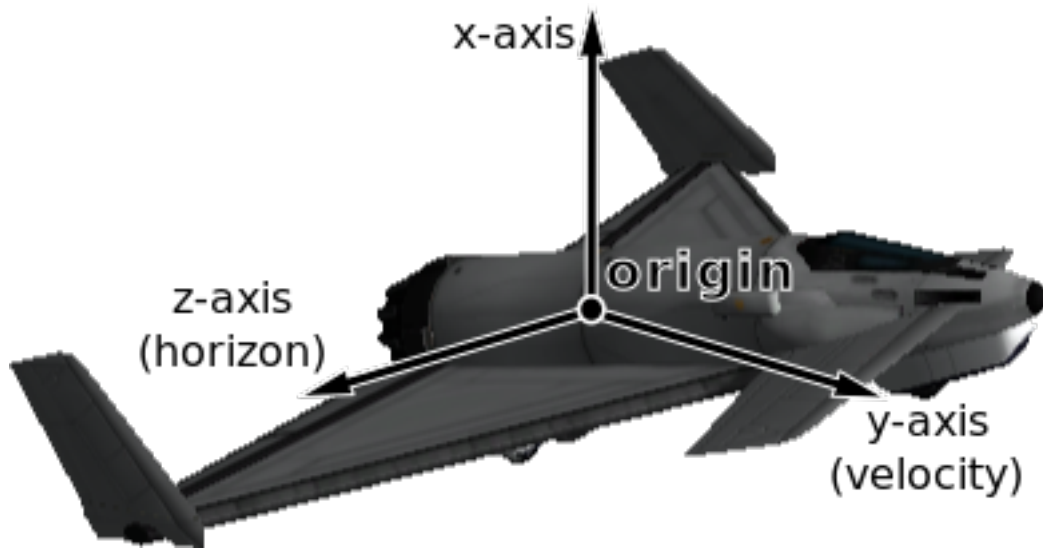


Fig. 5.5: Vessel surface velocity reference frame origin and axes

`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.
```

5.3.3 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  $2\pi$ 
```


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.

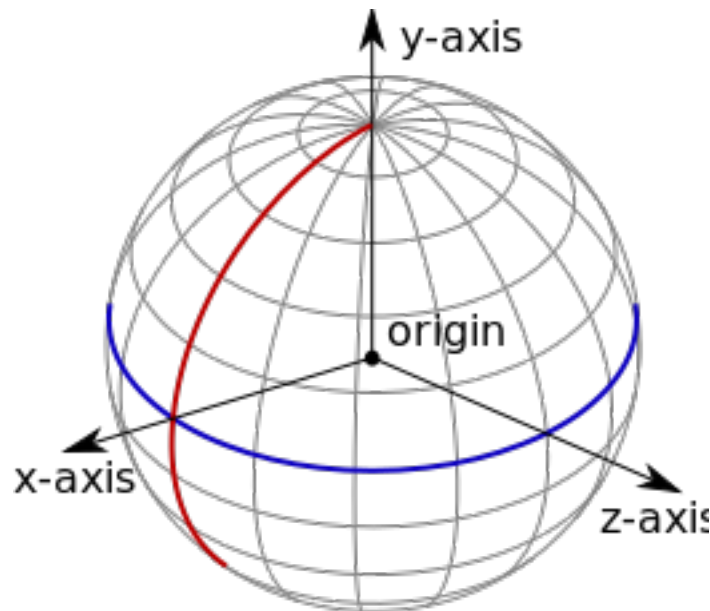


Fig. 5.6: Celestial body reference frame origin and axes. The equator is shown in blue, and the prime meridian in red.

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.

5.3.4 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°.

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](#).

5.3.5 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.

5.3.6 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.
```

5.3.7 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.

```

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

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 s 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 reference-Frame)`

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 ()`.

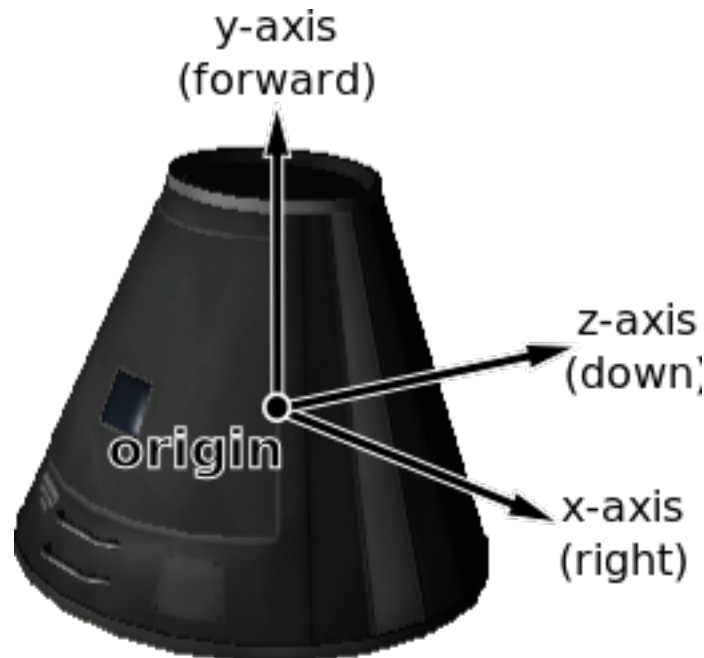


Fig. 5.7: Mk1 Command Pod reference frame origin and axes

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 Mits.

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>> **getAv**

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()`.

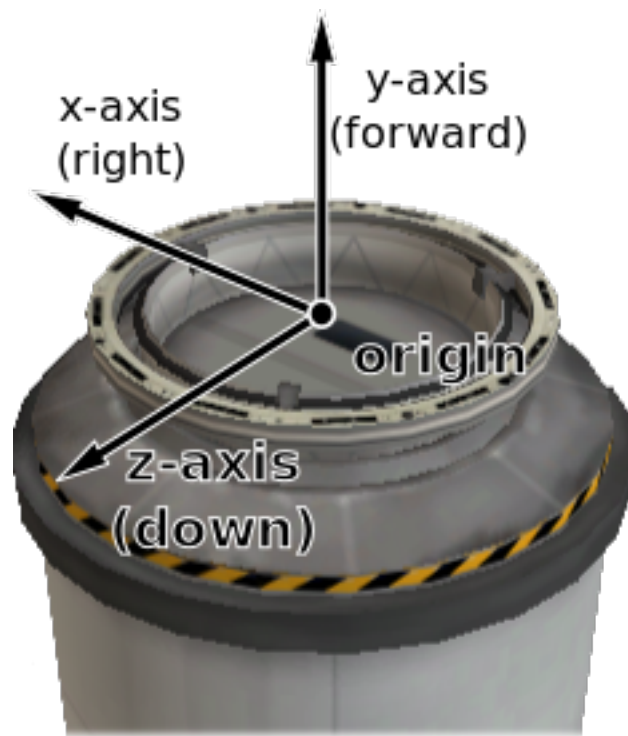


Fig. 5.8: Docking port reference frame origin and axes

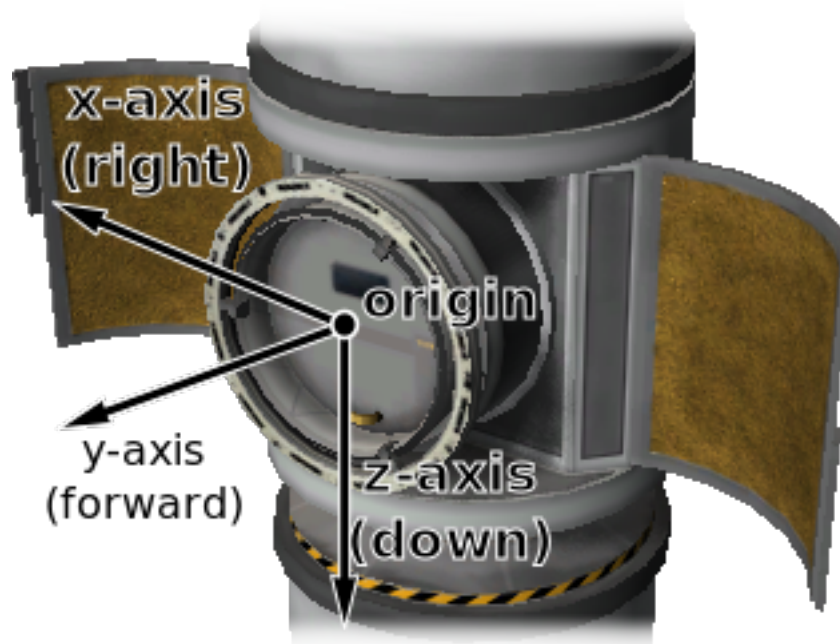


Fig. 5.9: Inline docking port reference frame origin and axes

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.

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, Single> **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<Single, Single, Single> getColor ()

    void setColor (org.javatuples.Triplet<Single, Single, Single> 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, Single> 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 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 (*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 (*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 getGimballed ()
```

Whether the thruster is gimballed.

org.javatuples.Triplet<Double, Double, Double> **gimbalPosition** (*ReferenceFrame referenceFrame*)

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](#).

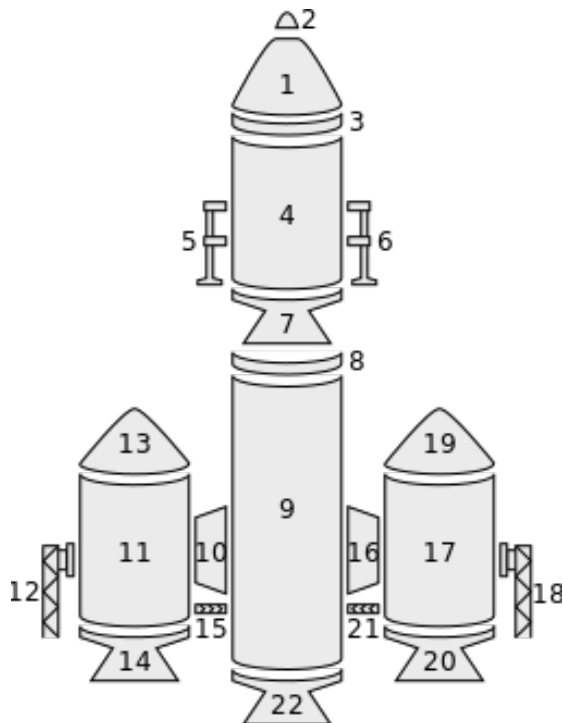


Fig. 5.10: **Figure 1** – Example parts making up a vessel.

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 vessels *root* part (part number 1 in the example above) and can be obtained by calling `Parts.getRoot()`. A parts children can be obtained by calling `Part.getChildren()`. If the part does not have any children, `Part.getChildren()` returns an empty list. A parts 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 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 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);
```

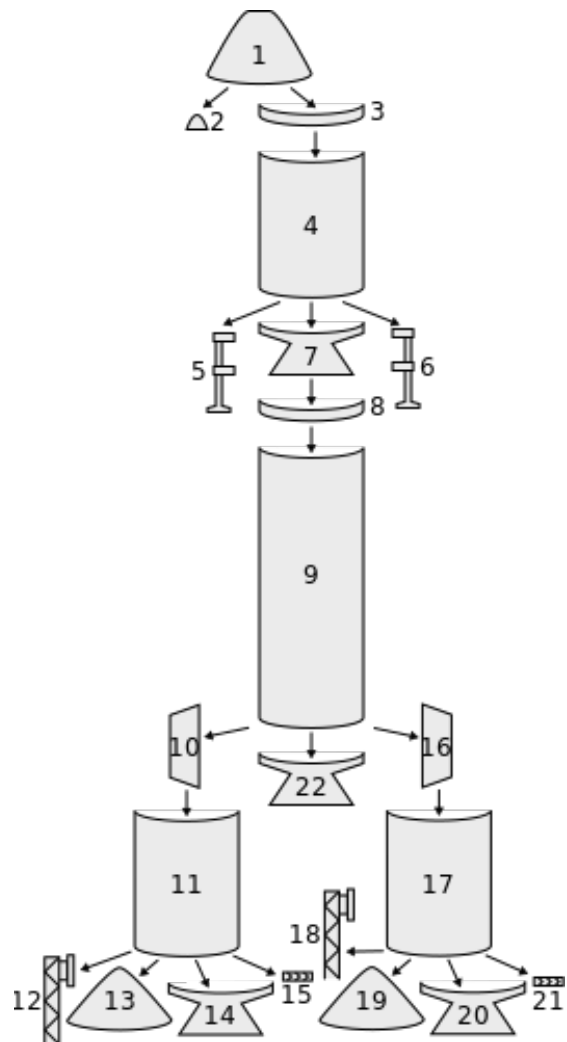


Fig. 5.11: **Figure 2** – Tree of parts for the vessel in Figure 1. Arrows point from the parent part to the child part.

```
↪      for (Part child : part.getChildren()) {  
            stack.push(new  
↪Pair<Part, Integer>(child, depth + 1));  
        }  
        connection.close();  
    }  
}
```

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

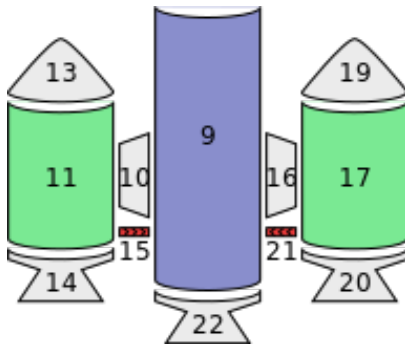


Fig. 5.12: **Figure 5** – Fuel lines from the example in Figure 1. Fuel flows from the parts highlighted in green, into the part highlighted in blue.

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.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*.

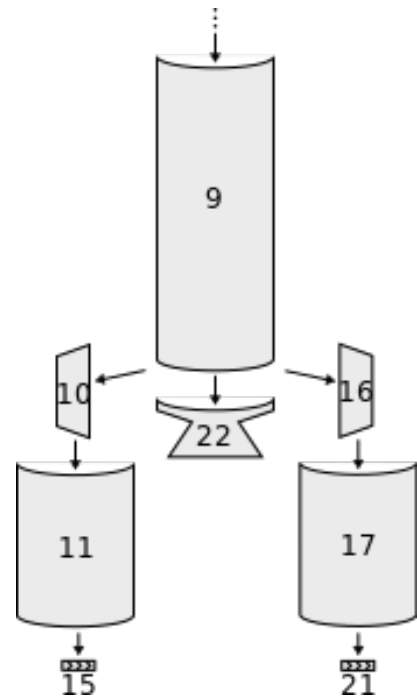


Fig. 5.13: **Figure 4** – A subset of the parts tree from Figure 2 above.

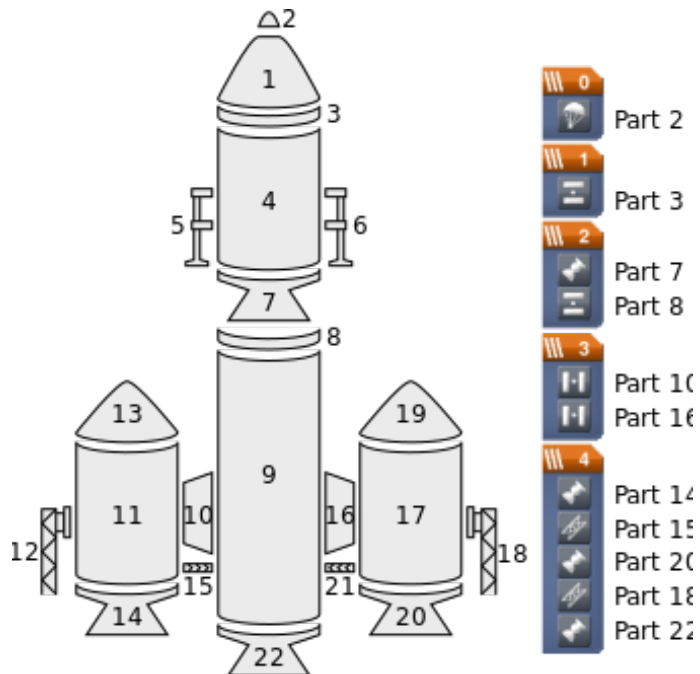


Fig. 5.14: **Figure 6** – Example vessel from Figure 1 with a staging sequence.

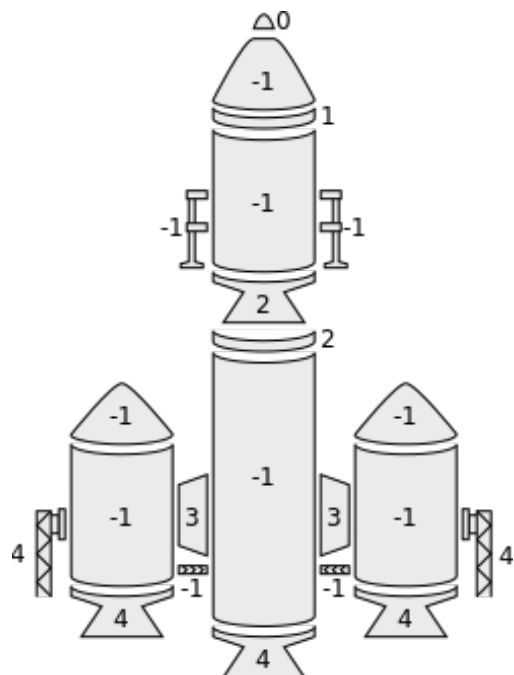
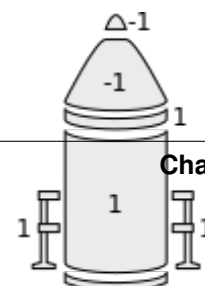


Fig. 5.15: **Figure 7** – The stage in which each part is *activated*.

5.3.9 Resources

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

- **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.

5.3.10 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.

5.3.11 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, ReferenceFrame rotation, ReferenceFrame velocity, ReferenceFrame angularVelocity*)

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.

5.3.12 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).

float **getError** ()
The error, in degrees, between the direction the ship has been asked to point in and the direction it is pointing in. Returns zero 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.
Returns zero if the auto-pilot has not been engaged.

float **getHeadingError** ()

The error, in degrees, between the vessels current and target heading.
Returns zero if the auto-pilot has not been engaged.

float **getRollError** ()

The error, in degrees, between the vessels current and target roll.
Returns zero 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.

5.3.13 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 if 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 if 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 if 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.

5.3.14 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.

5.3.15 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.

5.3.16 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();
    }
}
```

5.4 Drawing API

5.4.1 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.

5.4.2 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.

5.4.3 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

5.4.4 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
java.util.List<String> getAvailableFonts ()
    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.

5.5 InfernalRobotics API

Provides RPCs to interact with the [InfernalRobotics](#) mod. Provides the following classes:

5.5.1 InfernalRobotics

public class **InfernalRobotics**
This service provides functionality to interact with [InfernalRobotics](#).

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.

5.5.2 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.

5.5.3 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.

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.

```
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();
    }
}
```

5.6 Kerbal Alarm Clock API

Provides RPCs to interact with the [Kerbal Alarm Clock](#) mod. Provides the following classes:

5.6.1 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.

5.6.2 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.

5.6.3 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*.

5.6.4 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.

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.

```
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, RPCException {
        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();
    }
}
```

5.7 RemoteTech API

Provides RPCs to interact with the `RemoteTech` mod. Provides the following classes:

5.7.1 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*) –

5.7.2 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.

5.7.3 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.

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.

```
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);

        setTargetBody(sc.getBodies().get("Jool"));

        // Get info about the vessels communications
        Comms comms = rt.comms(vessel);
        System.out.printf("Signal delay\n", comms.getSignalDelay());
        connection.close();
    }
}
```

5.8 User Interface API

5.8.1 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 KSPs 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.

5.8.2 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.

5.8.3 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.

5.8.4 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.

5.8.5 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.

5.8.6 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.

5.8.7 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.

6.1 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](#).

6.1.1 Installing the Library

The Lua client and all of its dependencies can be installed using `luarocks` with a single command:

```
luarocks install krpc
```

6.1.2 Using the Library

Once it's installed, simply `require 'krpc'` and you are good to go!

6.1.3 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)
```

6.1.4 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.

6.1.5 Streaming Data from the Server

Streams are not yet supported by the Lua client.

6.1.6 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))

```

6.2 KRPC API

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

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`

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)

current_game_scene

Get the current game scene.

Attribute Read-only, cannot be set

Return type `KRPC.GameScene`

static `add_stream(request)`

Add a streaming request and return its identifier.

Parameters `request` (`krpc.schema.KRPC.Request`) –

Return type number

Note: Streams are not supported by the Lua client.

static `remove_stream(id)`

Remove a streaming request.

Parameters `id` (*number*) –

Note: Streams are not supported by the Lua client.

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.

6.3 SpaceCenter API

6.3.1 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)

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.

6.3.2 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*

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 be 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 be 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, gim-balled 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*

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.

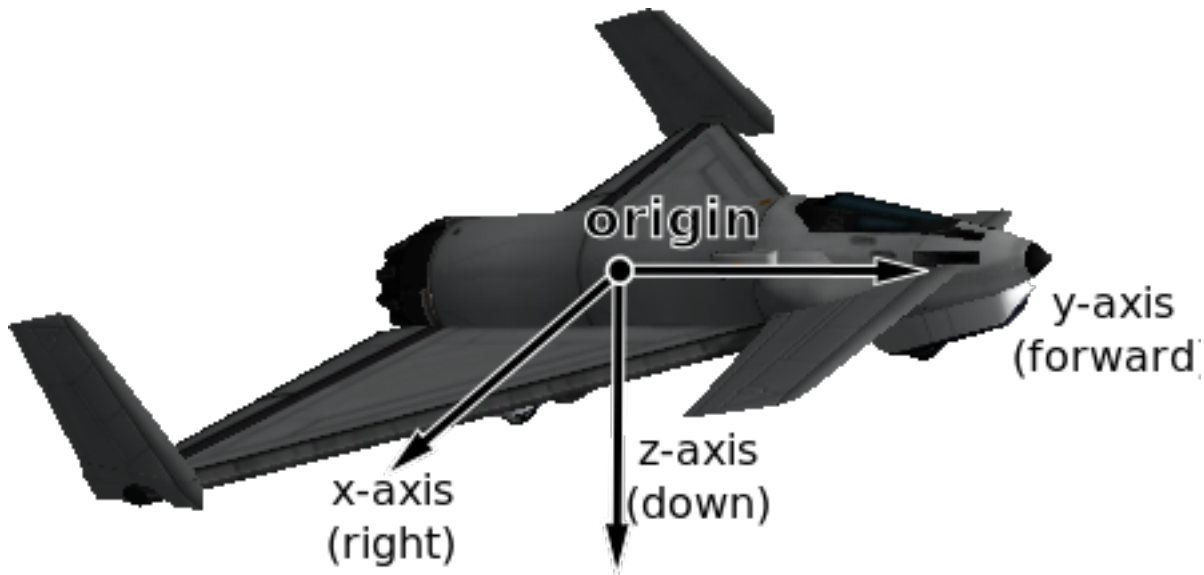


Fig. 6.1: Vessel reference frame origin and axes for the Aeris 3A aircraft

- 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).
- 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*

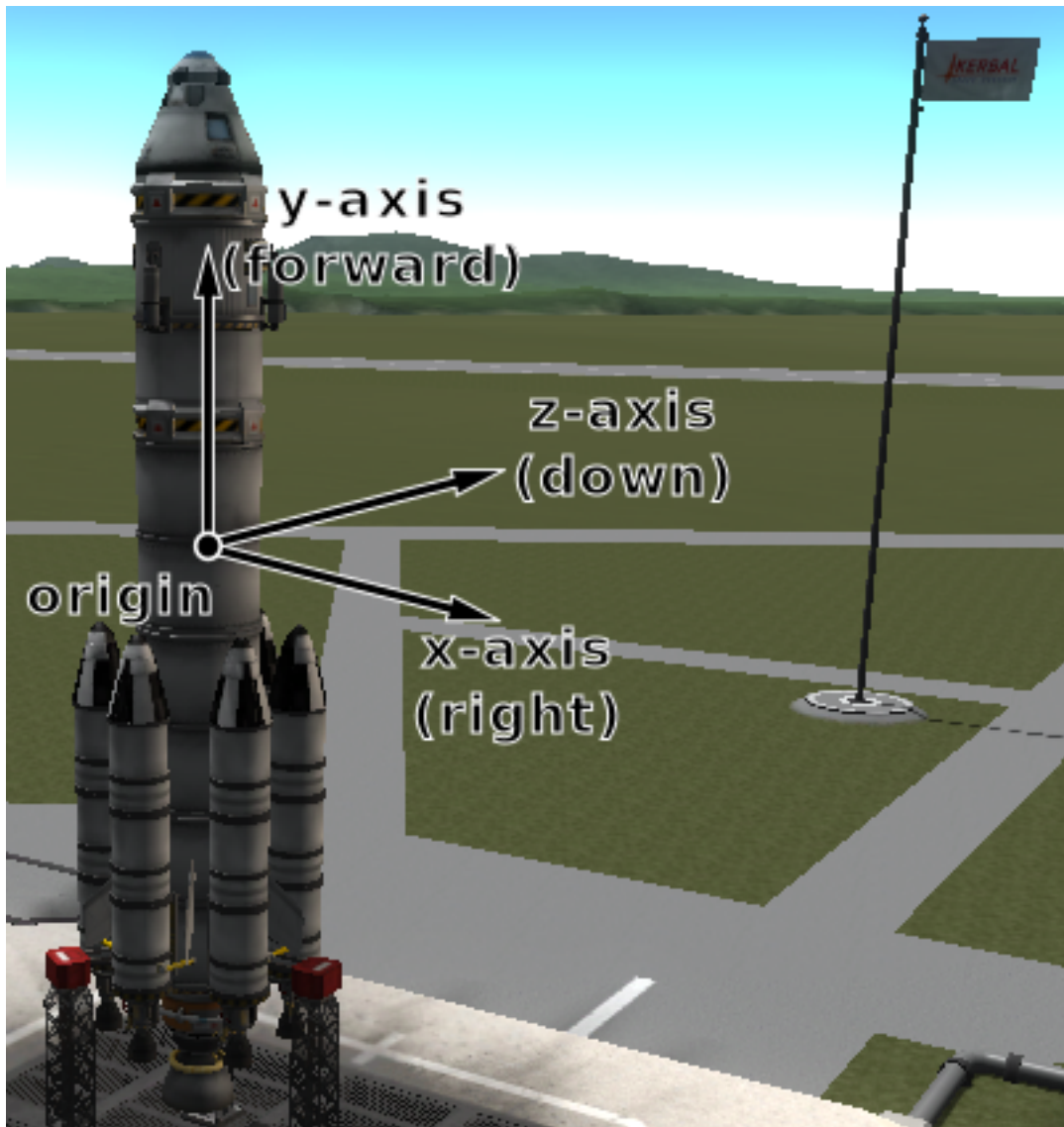


Fig. 6.2: Vessel reference frame origin and axes for the Kerbal-X rocket

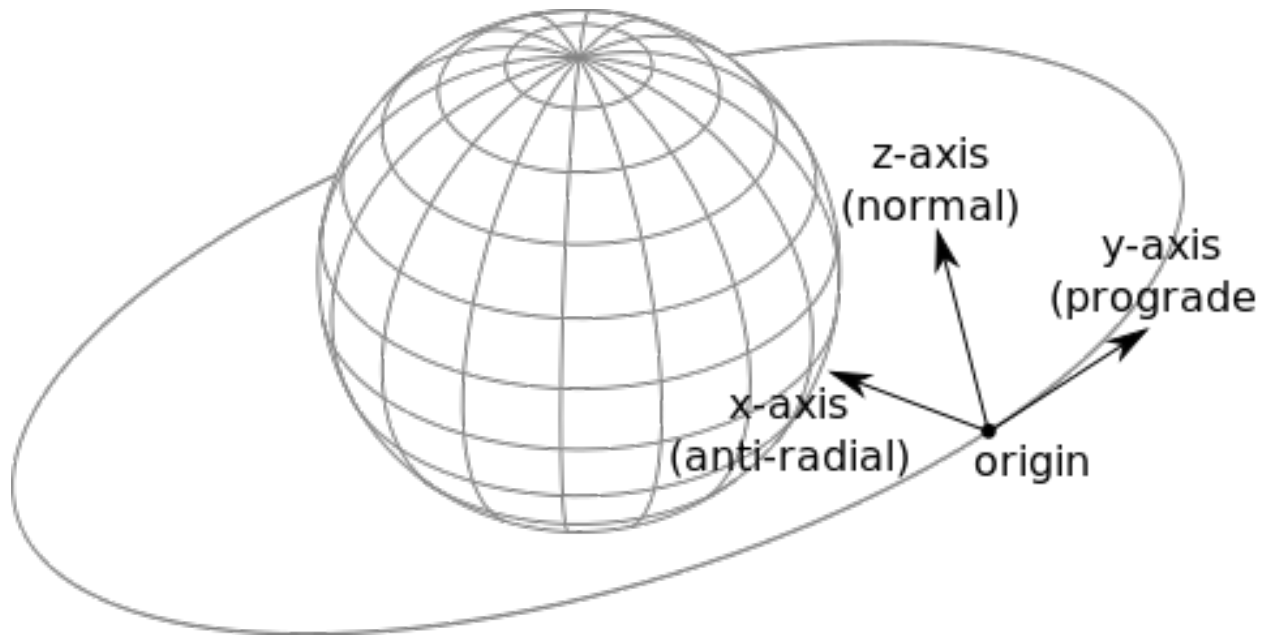


Fig. 6.3: Vessel orbital reference frame origin and axes

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.

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.

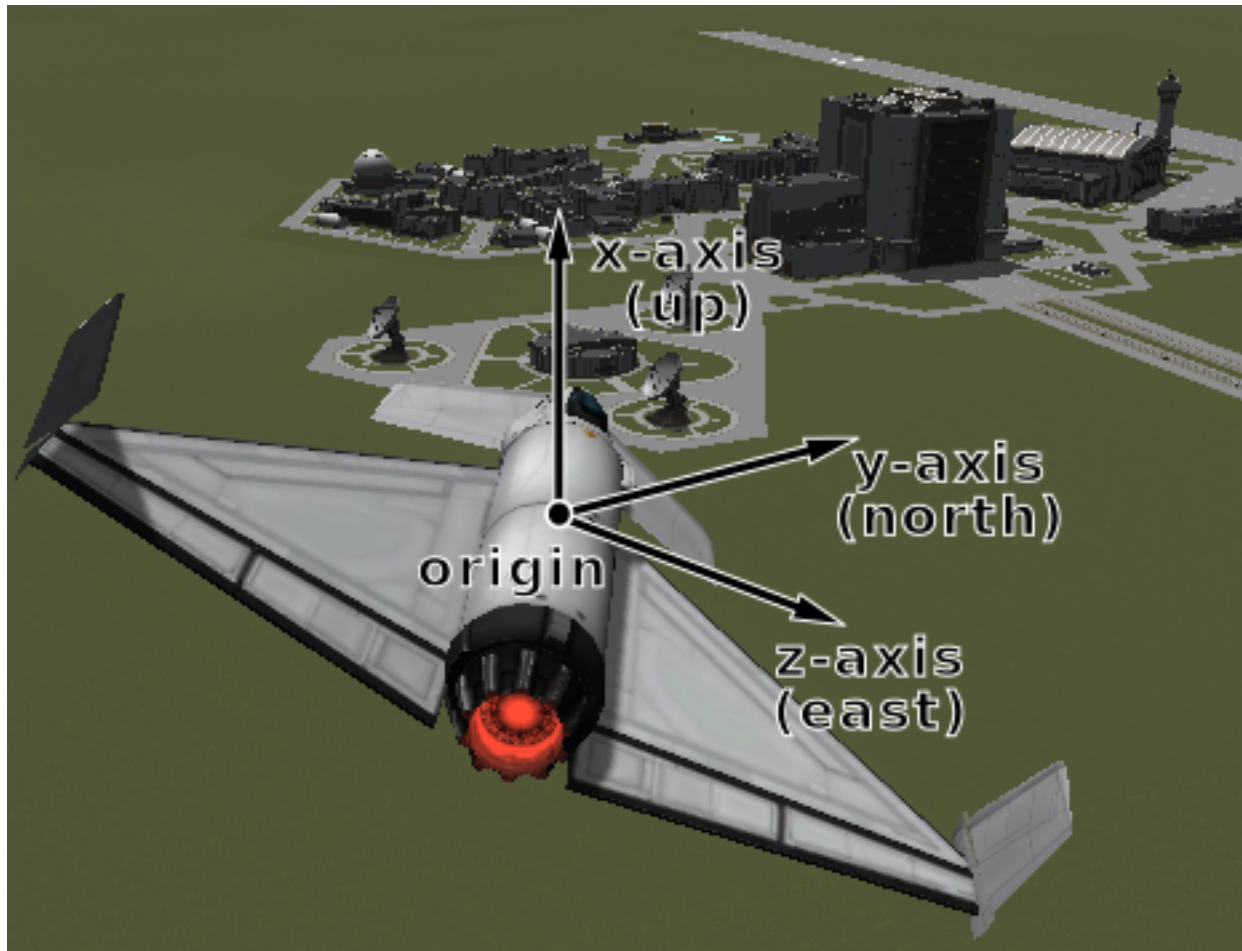


Fig. 6.4: Vessel surface reference frame origin and axes

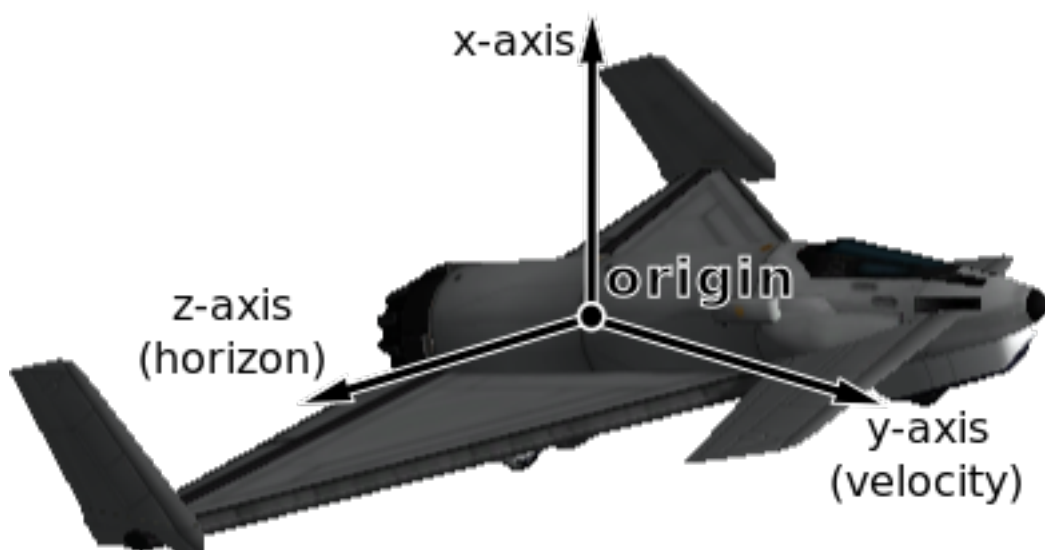


Fig. 6.5: Vessel surface velocity reference frame origin and axes

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.

6.3.3 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.
- 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.

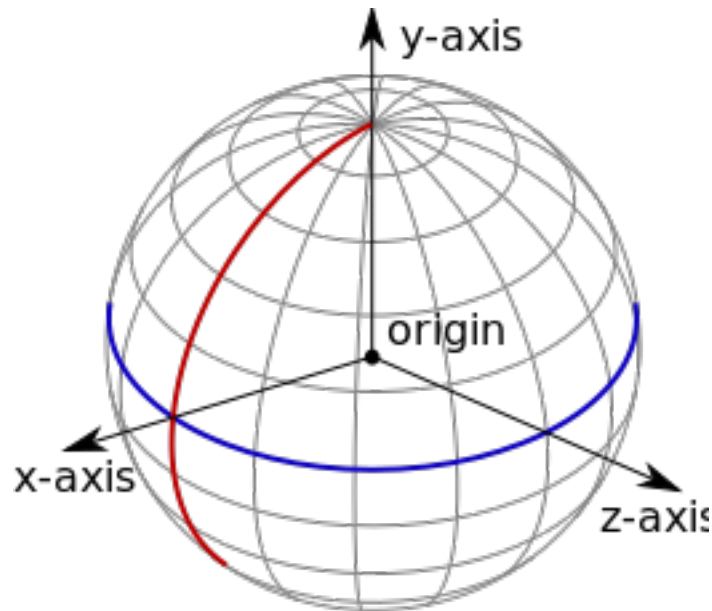


Fig. 6.6: Celestial body reference frame origin and axes. The equator is shown in blue, and the prime meridian in red.

- The origin is at the center of the body.
- The axes 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)

6.3.4 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°.

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°.

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](#).

6.3.5 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

6.3.6 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.

6.3.7 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*

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

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 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 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 is 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*.

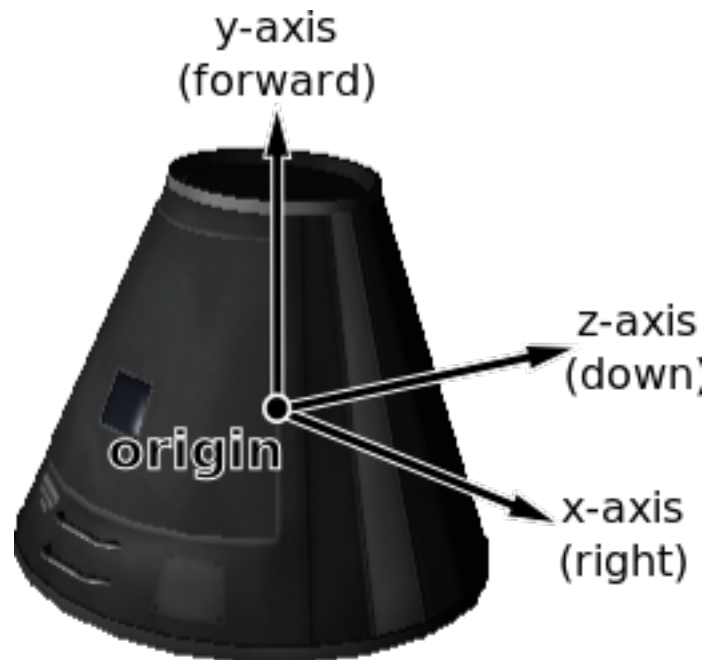


Fig. 6.7: Mk1 Command Pod reference frame origin and axes

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 Mits.

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`.

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.

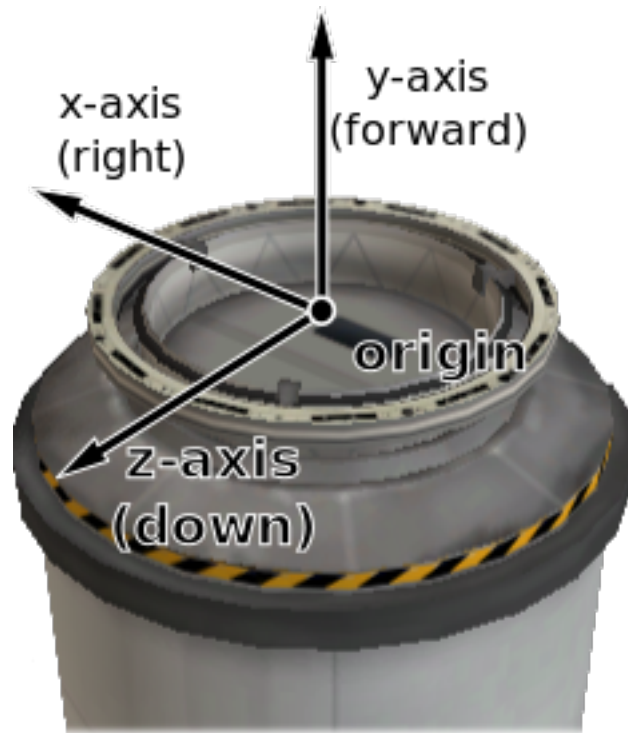


Fig. 6.8: Docking port reference frame origin and axes

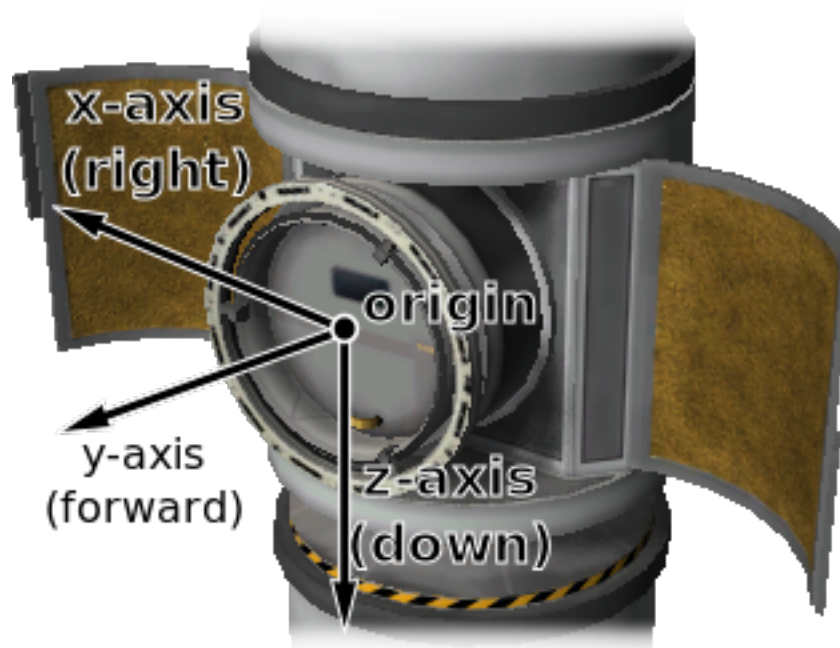


Fig. 6.9: Inline docking port reference frame origin and axes

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 gimballed 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 gimbaling), 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](#).

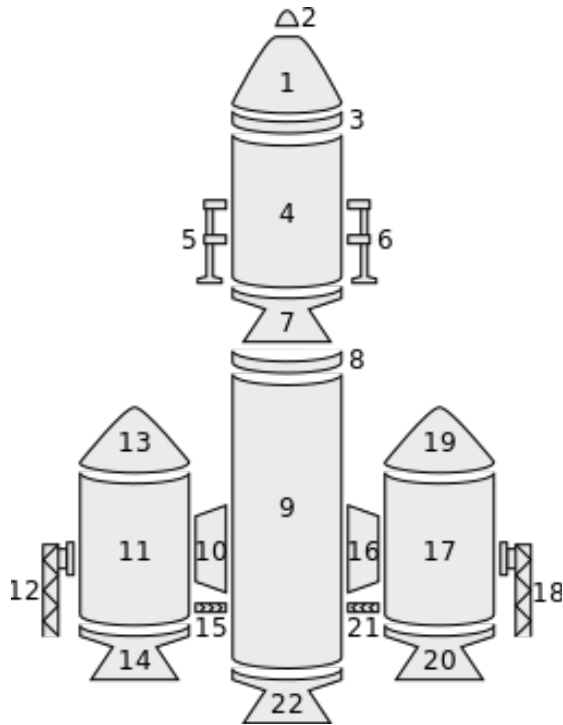


Fig. 6.10: **Figure 1** – Example parts making up a vessel.

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 = stack.pop()
    print(string.rep(' ', depth) .. part.name)
    for _, child in ipairs(part.children) do
        stack.push(child)
    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
TR-18A Stack Decoupler
FL-T400 Fuel Tank
LV-909 Liquid Fuel Tank
TR-18A Stack Decoupler
FL-T800 Fuel Tank
LV-909 Liquid Fuel Tank
TT-70 Radial Decoupler
FL-T400 Fuel Tank
TT18-A Launch Pad
FTX-2 External Tank
LV-909 Liquid Fuel Tank
Aerodynamic
TT-70 Radial Decoupler
FL-T400 Fuel Tank
TT18-A Launch Pad
FTX-2 External Tank
LV-909 Liquid Fuel Tank
```

	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 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)
  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 - 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
```

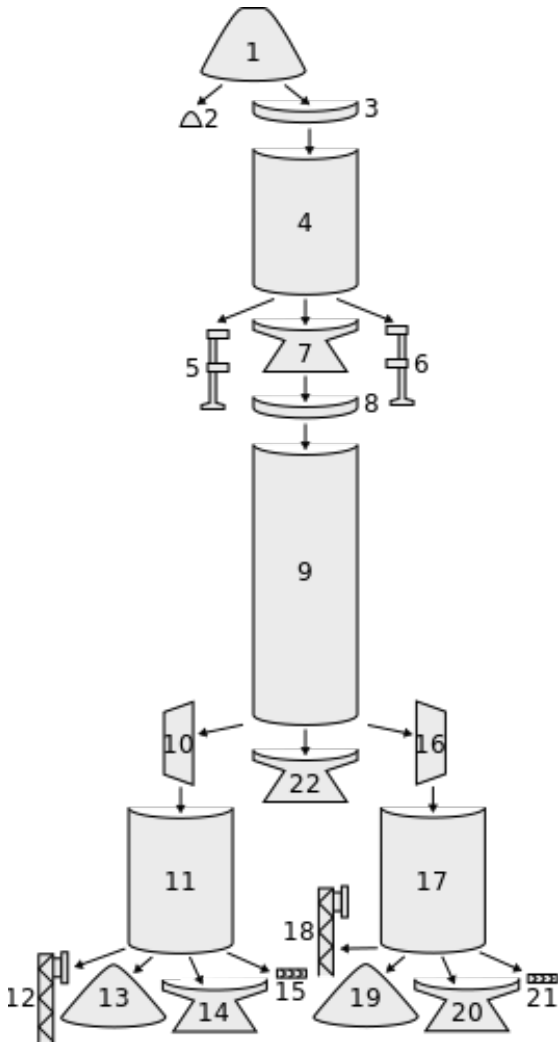


Fig. 6.11: **Figure 2** – Tree of parts for the vessel in Figure 1. Arrows point from the parent part to the child part.

```

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

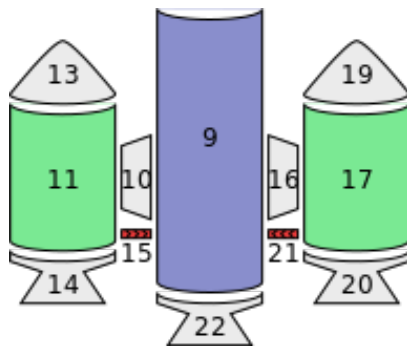
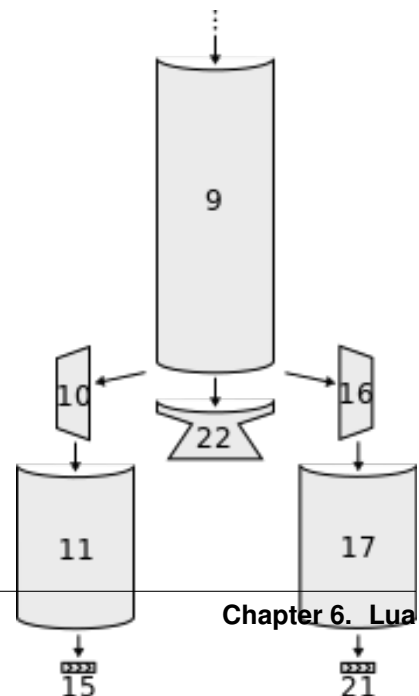


Fig. 6.12: **Figure 5** – Fuel lines from the example in Figure 1. Fuel flows from the parts highlighted in green, into the part highlighted in blue.

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 `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*.

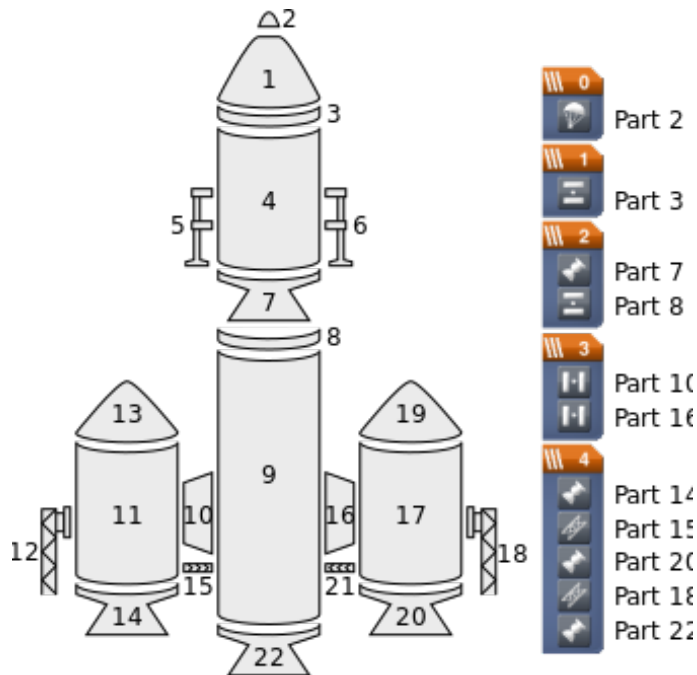


Fig. 6.14: **Figure 6** – Example vessel from Figure 1 with a staging sequence.

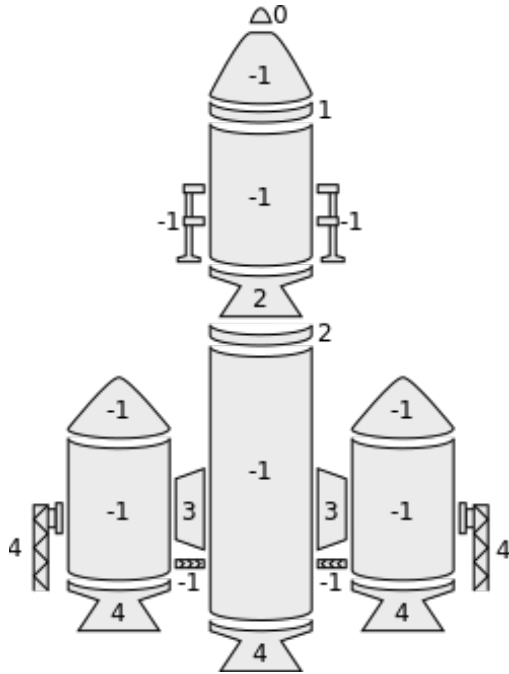


Fig. 6.15: **Figure 7** – The stage in which each part is *activated*.

6.3.9 Resources

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.

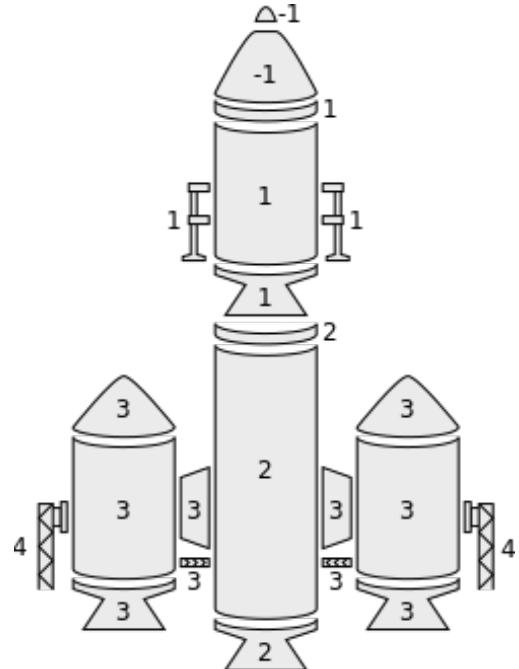


Fig. 6.16: **Figure 8** – The stage in which each part is *decoupled*.

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.

6.3.10 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)

6.3.11 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.

6.3.12 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).

error

The error, in degrees, between the direction the ship has been asked to point in and the direction it is pointing in. Returns zero 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. Returns zero 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. Returns zero 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. Returns zero 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.

6.3.13 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.

6.3.14 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.

6.3.15 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

6.3.16 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])

```

6.4 Drawing API

6.4.1 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.

6.4.2 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.

6.4.3 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

6.4.4 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

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

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*

6.5 InfernalRobotics API

Provides RPCs to interact with the [InfernalRobotics](#) mod. Provides the following classes:

6.5.1 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`

6.5.2 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.

6.5.3 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.

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.

```
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()
```

6.6 Kerbal Alarm Clock API

Provides RPCs to interact with the [Kerbal Alarm Clock](#) mod. Provides the following classes:

6.6.1 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*

6.6.2 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.

6.6.3 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 *KerbAlarmClock.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 *KerbAlarmClock.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`.

6.6.4 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.

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.

```
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
```

6.7 RemoteTech API

Provides RPCs to interact with the [RemoteTech](#) mod. Provides the following classes:

6.7.1 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*

6.7.2 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*

6.7.3 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.

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.

```
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)
```

6.8 User Interface API

6.8.1 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.

6.8.2 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.

6.8.3 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.

6.8.4 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.

6.8.5 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.

6.8.6 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.

6.8.7 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)

7.1 Python Client

This client provides functionality to interact with a kRPC server from programs written in Python. It can be [installed](#) using PyPI or [downloaded from GitHub](#).

7.1.1 Installing the Library

The python client and all of its dependencies can be installed using pip with a single command. It supports Python 2.7+ and 3.x

On linux:

```
pip install krpc
```

On Windows:

```
C:\Python27\Scripts\pip.exe install krpc
```

7.1.2 Using the Library

Once it's installed, simply `import krpc` and you are good to go! You can check what version you have installed by running the following script:

```
import krpc
print(krpc.__version__)
```

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:

```
import krpc
conn = krpc.connect(name='Example')
print(conn.krpc.get_status().version)
```

This function also accepts arguments that specify what address and port numbers to connect to. For example:

```
import krpc
conn = krpc.connect(
    name='Remote example', address='my.domain.name', rpc_port=1000, stream_port=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.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*. 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. Or for a class, such as the vessel class provided by the SpaceCenter service by calling *help(conn.space_center.Vessel)*.

Calling methods, getting or setting properties, etc. are mapped to remote procedure calls and passed to the server by the python client.

7.1.5 Streaming Data from the Server

A stream repeatedly executes a function on the server, with a fixed set of argument values. It provides a more efficient way of repeatedly getting the result of a function, avoiding the network overhead of having to invoke it directly.

For example, consider the following loop that continuously prints out the position of the active vessel. This loop incurs significant communication overheads, as the *vessel.position* function is called repeatedly.

```
import krpc
conn = krpc.connect()
vessel = conn.space_center.active_vessel
refframe = vessel.orbit.body.reference_frame
while True:
    print(vessel.position(refframe))
```

The following code achieves the same thing, but is far more efficient. It calls *krpc.client.Client.add_stream()* once at the start of the program to create a stream, and then repeatedly gets the position from the stream.

```
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())
```

A stream can be created by calling *krpc.client.Client.add_stream()* or using the *with* statement applied to *krpc.client.Client.stream()*. Both of these approaches return an instance of the *krpc.stream.Stream* class.

Both methods and attributes can be streamed. The example given above demonstrates how to stream methods. The following example shows how to stream an attribute (in this case *vessel.control.abort*):


```
import krpc
conn = krpc.connect()
vessel = conn.space_center.active_vessel
abort = conn.add_stream(getattr, vessel.control, 'abort')
while not abort():
    pass
```

7.1.6 Client API Reference

connect ([*address*='127.0.0.1'][, *rpc_port*=50000][, *stream_port*=50001][, *name*=None])

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

- **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.
- **stream_port** (*int*) – The port number of the Stream Server. Defaults to 50001.
- **name** (*str*) – 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.

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()*.

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*.

For example, to stream the result of method call *vessel.position(refframe)*:

```
import krpc
conn = krpc.connect()
vessel = conn.space_center.active_vessel
refframe = vessel.orbit.body.reference_frame
with conn.stream(vessel.position, refframe) as pos:
    print('Position =', pos())
```

Or to stream the property *conn.space_center.ut*:

```
import krpc
conn = krpc.connect()
with conn.stream(getattr, conn.space_center, 'ut') as ut:
    print('Universal Time =', ut())
```

close()

Closes the connection to the server.

krpc

The built-in kRPC class, providing basic interactions with the server.

Return type *krpc.client.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.Client.krpc*. Most 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. 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:

```
import krpc
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:

```
import krpc
conn = krpc.connect()
status = conn.krpc.get_status()
print('Data in = %.1f KB/s' % (status.bytes_read_rate/1024.0))
print('Data out = %.1f KB/s' % (status.bytes_written_rate/1024.0))
```

class Stream

__call__()

Gets the most recently received value for the stream.

remove()

Remove the stream from the server.

7.2 KRPC API

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

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*

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))*

current_game_scene

Get the current game scene.

Attribute Read-only, cannot be set

Return type *GameScene*

static add_stream (*request*)

Add a streaming request and return its identifier.

Parameters **request** (*krpc.schema.KRPC.Request*) –

Return type *int*

Note: Do not call this method from client code. Use *streams* provided by the Python client library.

static remove_stream (*id*)

Remove a streaming request.

Parameters **id** (*int*) –

Note: Do not call this method from client code. Use *streams* provided by the Python client library.

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.

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 *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 convert 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 convert 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 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(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)

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.

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 *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*

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, 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.

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 gimballed 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, 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.

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*

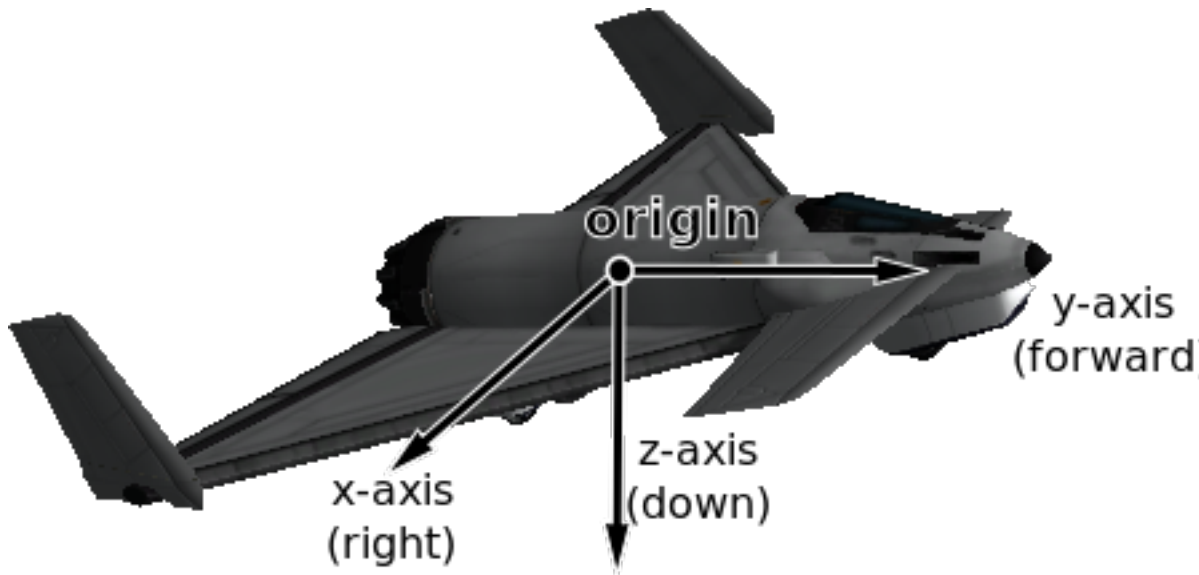


Fig. 7.1: Vessel reference frame origin and axes for the Aeris 3A aircraft

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 *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).
- 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).

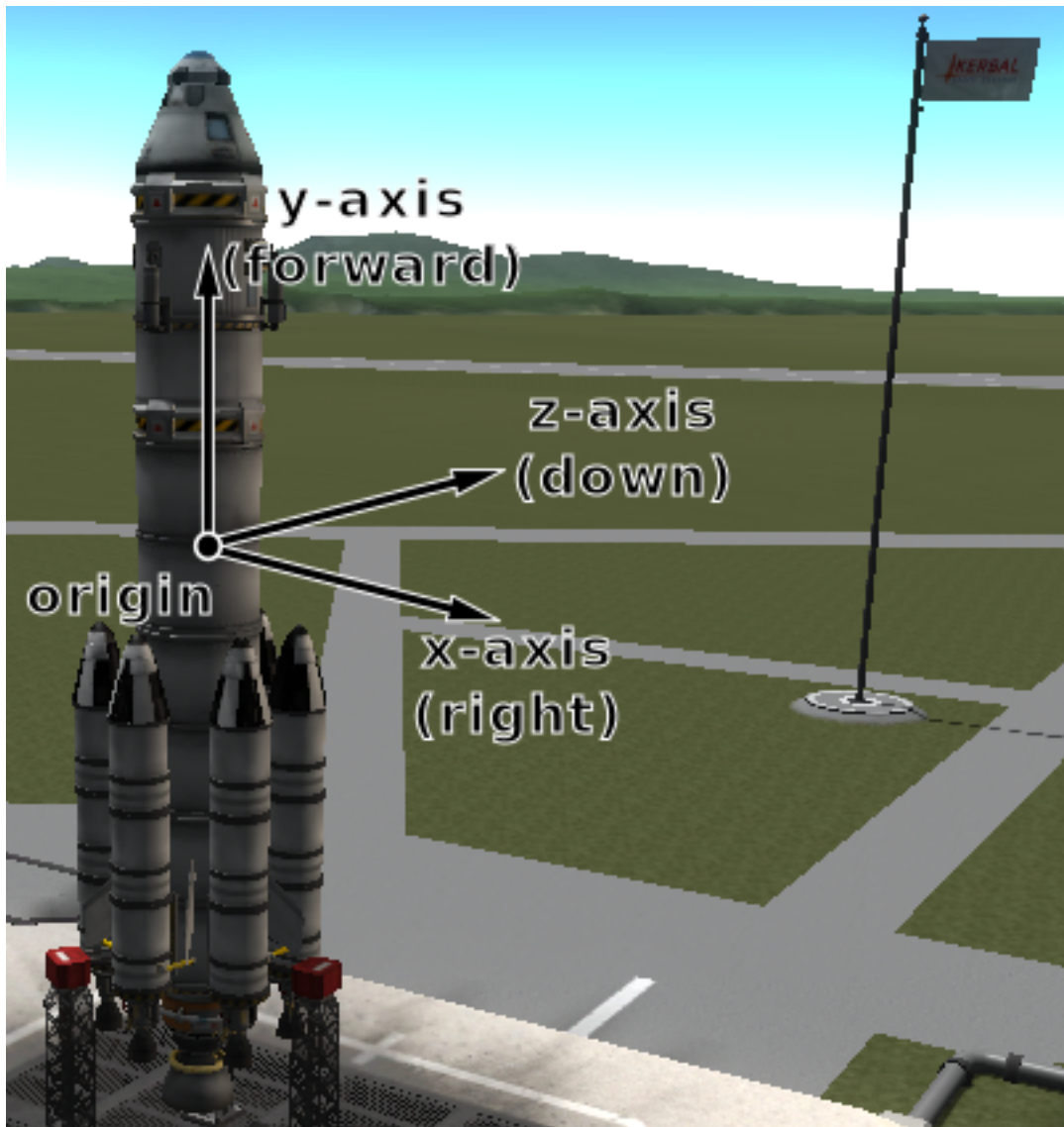


Fig. 7.2: Vessel reference frame origin and axes for the Kerbal-X rocket

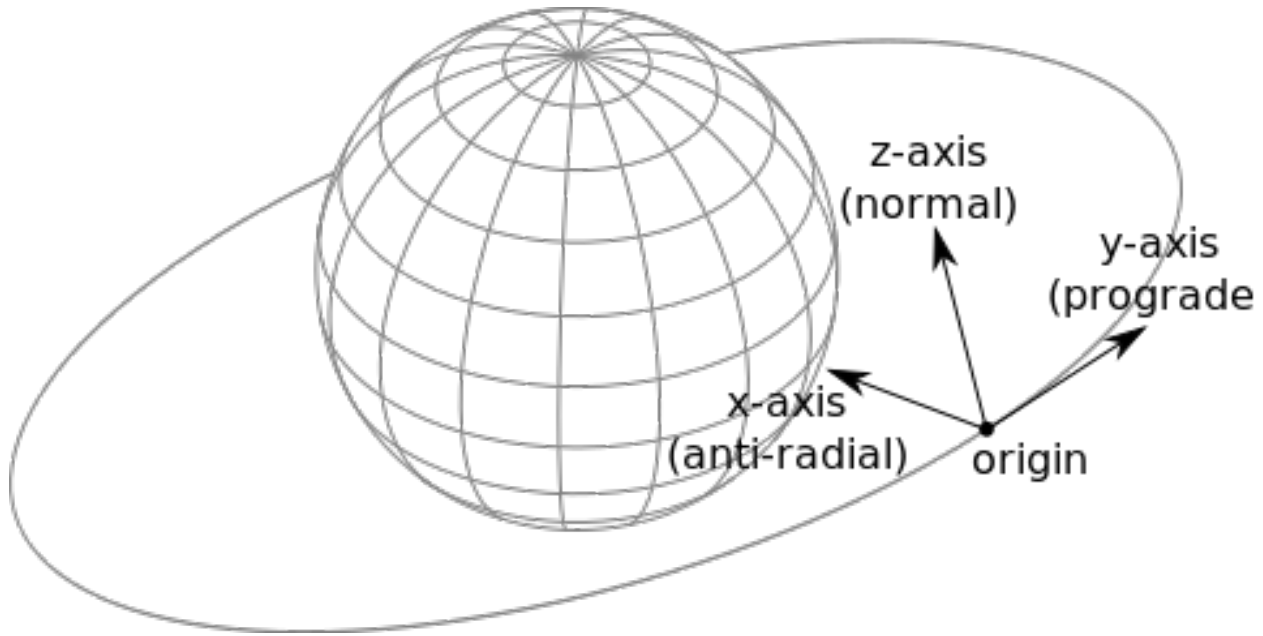


Fig. 7.3: Vessel orbital reference frame origin and axes

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*

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)

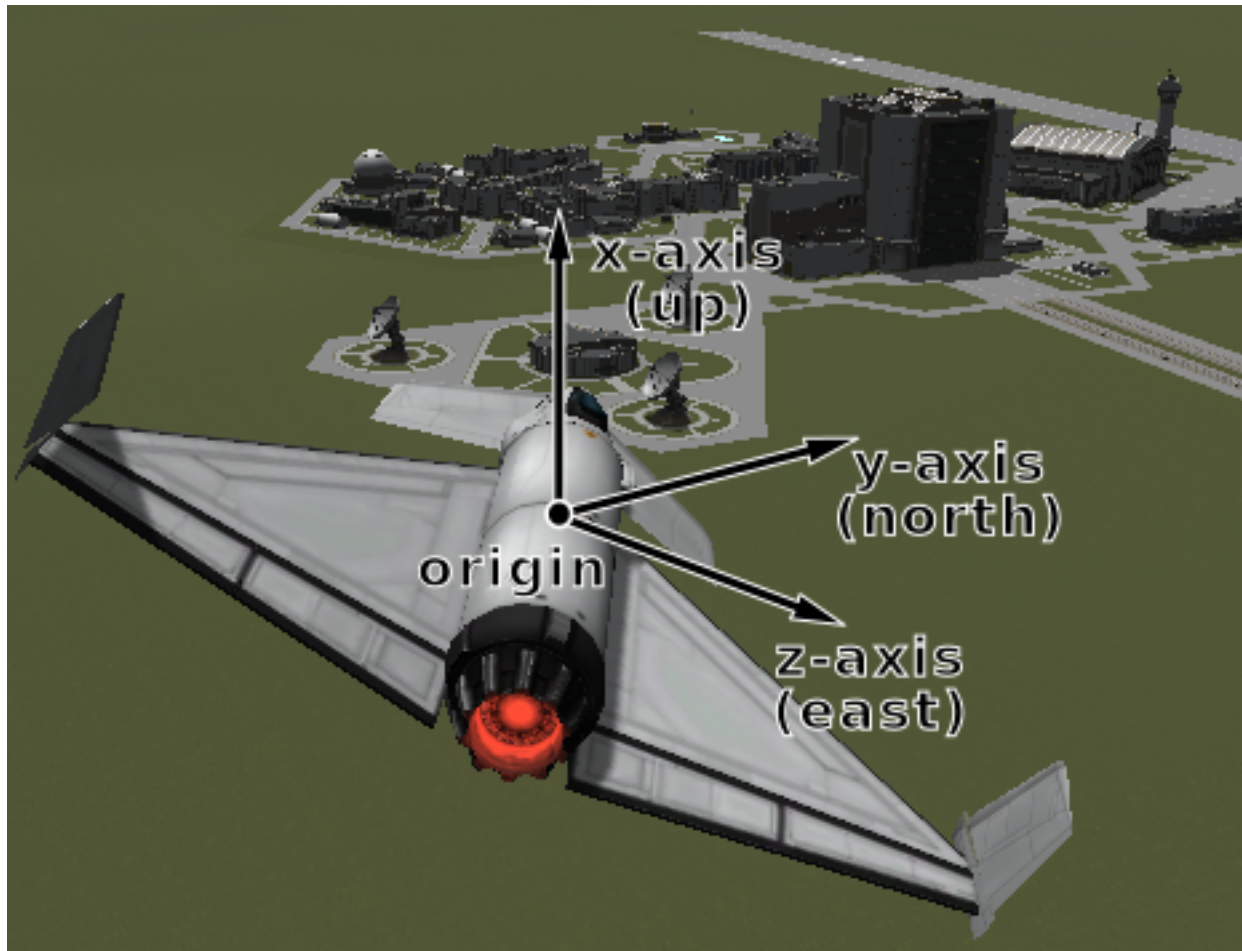


Fig. 7.4: Vessel surface reference frame origin and axes

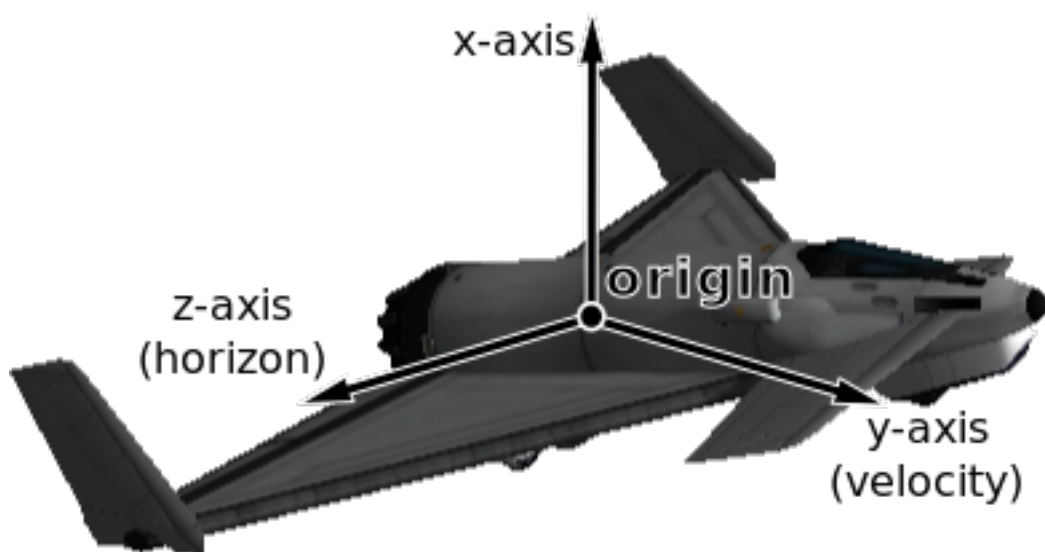


Fig. 7.5: Vessel surface velocity reference frame origin and axes

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.

7.3.3 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 $m^3 s^{-2}$.

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.
- 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.

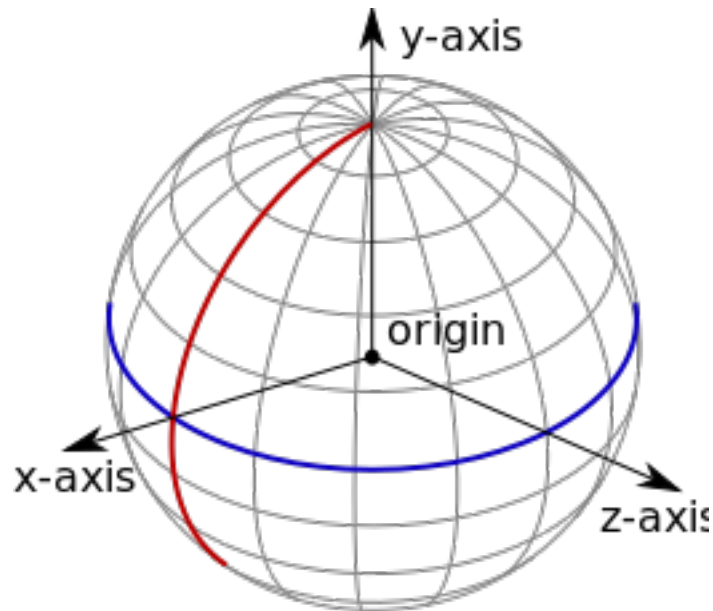


Fig. 7.6: Celestial body reference frame origin and axes. The equator is shown in blue, and the prime meridian in red.

- 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)

7.3.4 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](#).

7.3.5 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))

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 *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 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.

class SASMode

The 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 SpeedMode

The 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.

7.3.7 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*

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 `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 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 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`.

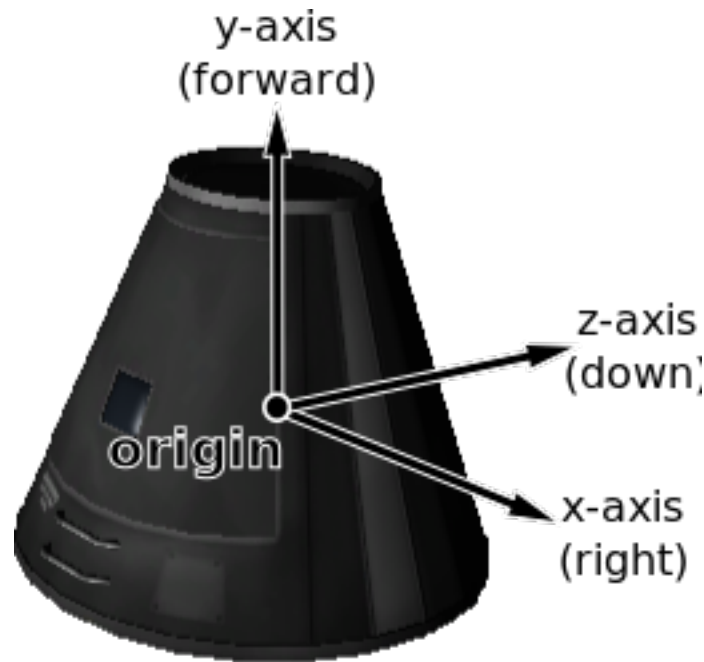


Fig. 7.7: Mk1 Command Pod reference frame origin and axes

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 `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 Mbits.

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*.

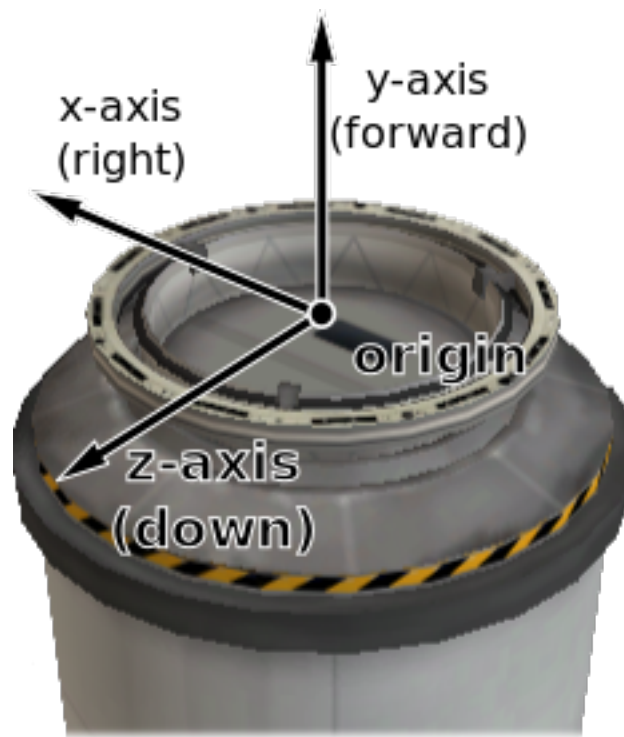


Fig. 7.8: Docking port reference frame origin and axes

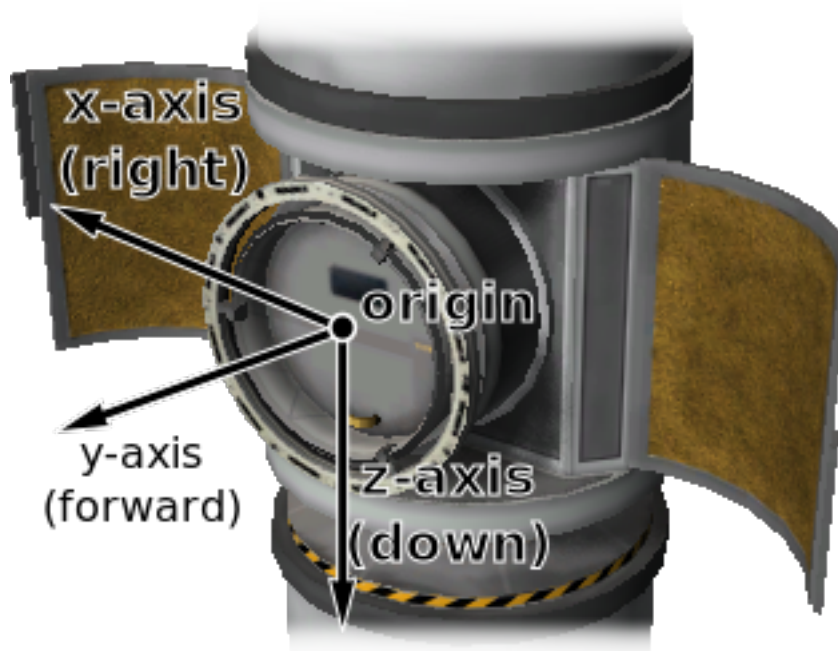


Fig. 7.9: Inline docking port reference frame origin and axes

class **DockingPortState**

The state of a docking port. See *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.

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 gimballing), 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 gimballing), 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 MotorStateThe 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

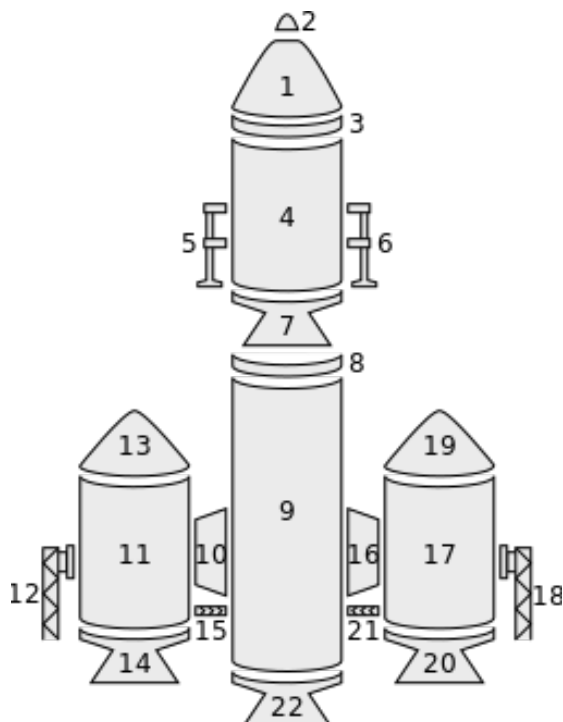
The motor is inoperable.

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.space_

root = vessel.parts.
```

```
stack = [(root, 0)]
while len(stack) > 0:
    part, depth = stack.pop()
    print(' '*depth, part)
    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
TR-18A Stack Decoupler
FL-T400 Fuel Tank
LV-909 Liquid Fuel Engine
TR-18A Stack Decoupler
FL-T800 Fuel Tank
LV-909 Liquid Fuel Engine
TT-70 Radial Decoupler
FL-T400 Fuel Tank
TT18-A Launch Pad
FTX-2 External Tank
LV-909 Liquid Fuel Engine
Aerodynamic
TT-70 Radial Decoupler
FL-T400 Fuel Tank
TT18-A Launch Pad
FTX-2 External Tank
LV-909 Liquid Fuel Engine
Aerodynamic
LT-1 Landing Struts
LT-1 Landing Struts
Mk16 Parachute
```

Attachment Modes

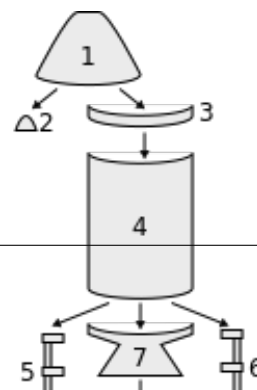
Parts can be attached to other parts either *radially* (on the side of the parent part) or *axially* (on the end of the parent part, to form a stack).

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 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 len(stack) > 0:
    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
```


Fuel Lines

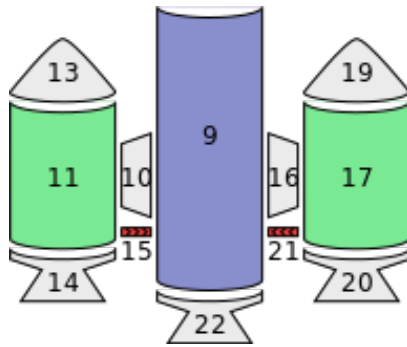


Fig. 7.12: **Figure 5** – Fuel lines from the example in Figure 1. Fuel flows from the parts highlighted in green, into the part highlighted in blue.

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 `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*.

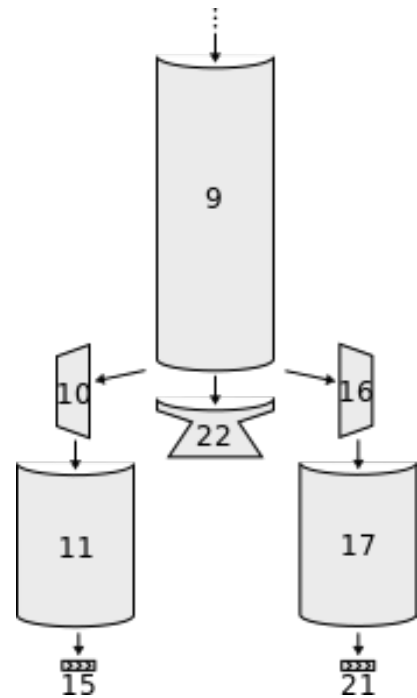


Fig. 7.13: **Figure 4** – A subset of the parts tree from Figure 2 above.

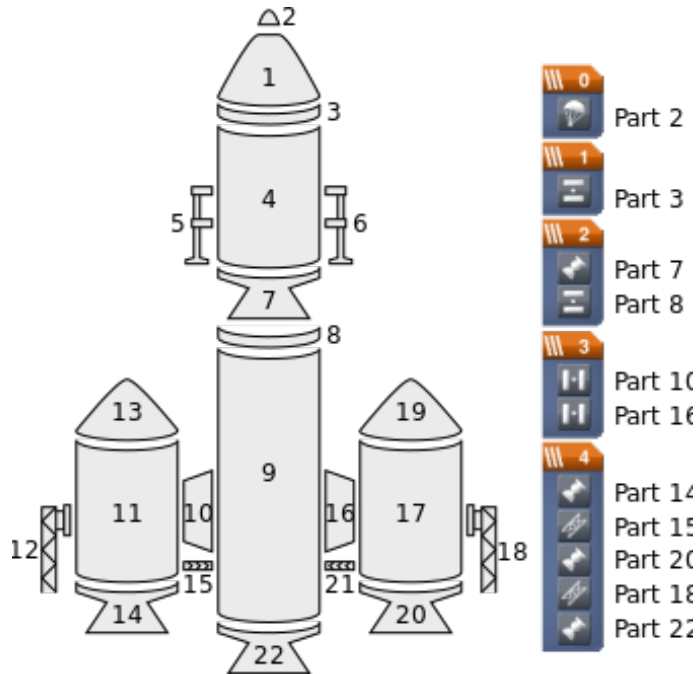


Fig. 7.14: **Figure 6** – Example vessel from Figure 1 with a staging sequence.

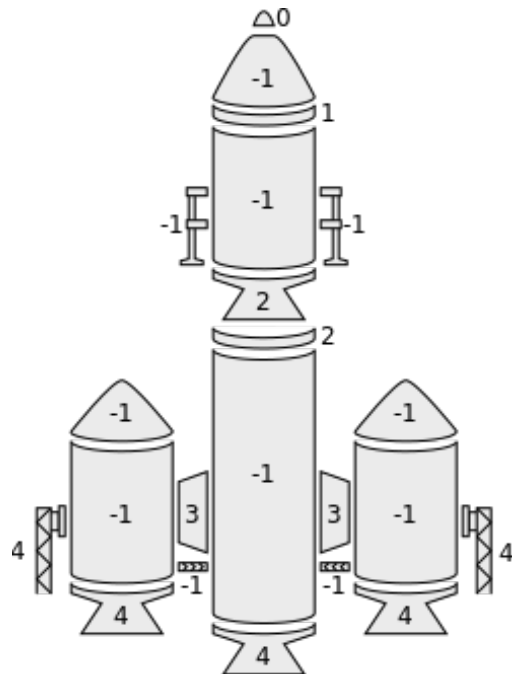
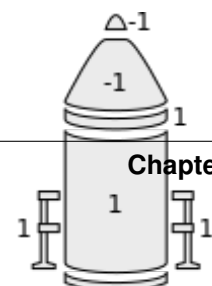


Fig. 7.15: **Figure 7** – The stage in which each part is *activated*.

7.3.9 Resources

class Resources

Represents the collection of resources stored in a vessel,



stage or part. Created by calling `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.

7.3.10 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)

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** (`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.

7.3.12 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).

error

The error, in degrees, between the direction the ship has been asked to point in and the direction it is pointing in. Returns zero 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.
Returns zero 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.
Returns zero 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.
Returns zero 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.

7.3.13 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.

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 *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

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*.

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.

7.3.15 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

7.3.16 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])
```

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** (*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.

7.4.2 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.

7.4.3 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

7.4.4 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

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

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*

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 `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`

7.5.2 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.

7.5.3 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.

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.

```
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()
```

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 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*

7.6.2 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.

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 *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*.

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.

```
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
```

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 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*

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 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*)

7.7.3 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.

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.

```
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)
```

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 *Canvas*

static add_canvas()

Add a new canvas.

Return type *Canvas*

Note: If you want to add UI elements to KSPs 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.

7.8.2 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.

7.8.3 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.

7.8.4 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.

7.8.5 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.

7.8.6 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.

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(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](#).

8.1 Clients

- [Ruby client](#)
- [Haskell client](#)
- [Node.js client](#) (requires the v0.4.0 pre-release version of kRPC)
- [Using the plugin in F#](#)

8.2 Services

- [krpcmj](#) – remote procedures to interact with MechJeb

8.3 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

9.1 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 http://github.com/krpc/krpc
```

9.2 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
```

9.3 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.

9.4 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`.

9.5 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.

9.5.1 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

10.1 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 a *communication protocol*. kRPC comes with several client libraries that implement this communication protocol, 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`.

10.2 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.

10.2.1 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

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.

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

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.

Example

Declare a `Remove` method in the `Flag` class:

```
[KRPCClass (Service = "EVA")]
public class Flag {
    [KRPCMethod]
    void Remove()
```

```

{
    ...
}

```

KRPCProperty

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*.

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
```

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")
{
    ...
}
```

10.2.2 Identifiers

An identifier must only contain alphanumeric characters and underscores. An identifier must not start with an underscore. Identifiers should follow [CamelCase](#) capitalization conventions.

Note: Although underscores are permitted, they should be avoided as they are used for internal name mangling.

10.2.3 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.Schema.KRPC`

10.2.4 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 {
    ...
}
```

10.3 Documentation

Documentation can be added using [C# XML documentation](#). The documentation will be automatically exported to clients when they connect.

10.4 Further Examples

See the [SpaceCenter service implementation](#) for more extensive examples.

10.5 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.

10.5.1 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 PROTOCOL

Clients invoke Remote Procedure Calls (RPCs) by communicating with the server using [Protocol Buffer v3 messages](#) sent over a TCP/IP connection. 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](#).

The following sections describe how to communicate with kRPC using snippets of Python code. A complete example script made from these snippets can be [downloaded here](#).

11.1 Establishing a Connection

kRPC consists of two servers: an *RPC server* (over which clients send and receive RPCs) and a *stream server* (over which clients receive *Streams*). A client first connects to the *RPC Server*, then (optionally) to the *Stream Server*.

11.1.1 Connecting to the RPC Server

To establish a connection to the RPC server, a client must do the following:

1. Open a TCP socket to the server on its RPC port (which defaults to 50000).
2. Send this 12 byte hello message: 0x48 0x45 0x4C 0x4C 0x4F 0x2D 0x52 0x50 0x43 0x00 0x00 0x00
3. Send a 32 byte message containing a name for the connection, that will be displayed on the in-game server window. This should be a UTF-8 encoded string, up to a maximum of 32 bytes in length. If the string is shorter than 32 bytes, it should be padded with zeros.
4. Receive a 16 byte unique client identifier. This is sent to the client when the connection is granted, for example after the user has clicked accept on the in-game UI.

For example, this python code will connect to the RPC server at address 127.0.0.1:50000 using the identifier Jeb:

```
import socket
rpc_conn = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
rpc_conn.connect(('127.0.0.1', 50000))
# Send the 12 byte hello message
rpc_conn.sendall(b'\x48\x45\x4C\x4C\x4F\x2D\x52\x50\x43\x00\x00\x00')
# Send the 32 byte client name 'Jeb' padded with zeroes
name = 'Jeb'.encode('utf-8')
name += (b'\x00' * (32-len(name)))
rpc_conn.sendall(name)
# Receive the 16 byte client identifier
```

```
identifier = b''
while len(identifier) < 16:
    identifier += rpc_conn.recv(16 - len(identifier))
# Connection successful. Print out a message along with the client identifier.
import binascii
printable_identifier = binascii.hexlify(bytearray(identifier))
print('Connected to RPC server, client identifier = %s' % printable_identifier)
```

11.1.2 Connecting to the Stream Server

To establish a connection to the stream server, a client must first *connect to the RPC Server* then do the following:

1. Open a TCP socket to the server on its stream port (which defaults to 50001).
2. Send this 12 byte hello message: 0x48 0x45 0x4C 0x4C 0x4F 0x2D 0x53 0x54 0x52 0x45 0x41 0x4D
3. Send a 16 byte message containing the client's unique identifier. This identifier is given to the client after it successfully connects to the RPC server.
4. Receive a 2 byte OK message: 0x4F 0x4B This indicates a successful connection.

Note: Connecting to the Stream Server is optional. If the client doesn't require stream functionality, there is no need to connect.

For example, this python code will connect to the stream server at address 127.0.0.1:50001. Note that *identifier* is the unique client identifier received when *connecting to the RPC server*.

```
stream_conn = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
stream_conn.connect(('127.0.0.1', 50001))
# Send the 12 byte hello message
stream_conn.sendall(b'\x48\x45\x4C\x4C\x4F\x2D\x53\x54\x52\x45\x41\x4D')
# Send the 16 byte client identifier
stream_conn.sendall(identifier)
# Receive the 2 byte OK message
ok_message = b''
while len(ok_message) < 2:
    ok_message += stream_conn.recv(2 - len(ok_message))
# Connection successful
print('Connected to stream server')
```

11.2 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.

11.2.1 Invoking Remote Procedures

Remote procedures are invoked by sending a request message to the RPC server, and waiting for a response message. These messages are encoded as Protocol Buffer messages.

The request message contains the name of the procedure to invoke, and the values of any arguments to pass it. The response message contains the value returned by the procedure (if any) 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.

11.2.2 Anatomy of a Request

A request is sent to the server using a Request Protocol Buffer message with the following format:

```
message Request {
  string service = 1;
  string procedure = 2;
  repeated Argument arguments = 3;
}

message Argument {
  uint32 position = 1;
  bytes value = 2;
}
```

The fields are:

- `service` - The name of the service in which the remote procedure is defined.
- `procedure` - The name of the remote procedure to invoke.
- `arguments` - A sequence of `Argument` messages containing the values of the procedure's arguments. The fields 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 `Argument` messages have a `position` field to allow values for default arguments to be omitted. See *Protocol Buffer Encoding* for details on how to serialize the argument values.

11.2.3 Anatomy of a Response

A response is sent to the client using a Response Protocol Buffer message with the following format:

```
message Response {
  double time = 1;
  bool has_error = 2;
  string error = 3;
  bool has_return_value = 4;
  bytes return_value = 5;
}
```

The fields are:

- `time` - The universal time (in seconds) when the request completed processing.
- `has_error` - True if there was an error executing the remote procedure.
- `error` - If `has_error` is true, contains a description of the error.
- `has_return_value` - True if the remote procedure returned a value.

- `return_value` - If `has_return_value` is true and `has_error` is false, contains the value returned by the remote procedure, encoded in protocol buffer format.

See *Protocol Buffer Encoding* for details on how to unserialize the return value.

11.2.4 Encoding and Sending Requests and Responses

To send a request:

1. Encode a Request message using the *Protocol Buffer Encoding*.
2. Send the size in bytes of the encoded Request message, encoded as a Protocol Buffer varint.
3. Send the message data.

To receive a response:

1. Read a Protocol Buffer varint, which contains the length of the Response message data in bytes.
2. Receive and decode the Response message.

11.2.5 Example RPC invocation

The following Python script 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 Protocol Buffer message formats `Request`, `Response` and `Status` compiled to python code using the Protocol Buffer compiler. The `EncodeVarint` and `DecodeVarint` functions are used to encode/decode integers to/from the Protocol Buffer varint format.

```
# import the krpc.proto schema
import krpc.schema

# Utility functions to encode and decode integers to protobuf format
import google.protobuf

def EncodeVarint(value):
    data = []
    def write(x):
        data.append(x)
    google.protobuf.internal.encoder._SignedVarintEncoder()(write, value)
    return b''.join(data)

def DecodeVarint(data):
    return google.protobuf.internal.decoder._DecodeSignedVarint(data, 0)[0]

# Create Request message
request = krpc.schema.KRPC.Request()
request.service = 'KRPC'
request.procedure = 'GetStatus'

# Encode and send the request
data = request.SerializeToString()
header = EncodeVarint(len(data))
rpc_conn.sendall(header + data)

# Receive the size of the response data
data = b''
while True:
```

```

data += rpc_conn.recv(1)
try:
    size = DecodeVarint(data)
    break
except IndexError:
    pass

# Receive the response data
data = b''
while len(data) < size:
    data += rpc_conn.recv(size - len(data))

# Decode the response message
response = krpc.schema.KRPC.Response()
response.ParseFromString(data)

# Check for an error response
if response.has_error:
    print('ERROR:', response.error)

# Decode the return value as a Status message
else:
    status = krpc.schema.KRPC.Status()
    assert response.has_return_value
    status.ParseFromString(response.return_value)

    # Print out the version string from the Status message
    print(status.version)

```

11.3 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>

11.4 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*. 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 message*. This is then sent to the client over the stream server's TCP/IP connection. If the value returned by a stream's 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.

11.4.1 Anatomy of a Stream Message

A stream message is sent to the client using a `StreamMessage` Protocol Buffer message with the following format:

```
message StreamMessage {  
    repeated StreamResponse responses = 1;  
}
```

This contains a list of `StreamResponse` 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 StreamResponse {  
    uint32 id = 1;  
    Response response = 2;  
}
```

The fields are:

- `id` - The identifier of the stream. This is the value returned by *AddStream* when the stream is created.
- `response` - A `Response` message containing the result of the stream's RPC. This is identical to the `Response` message returned when calling the RPC directly. See *Anatomy of a Response* for details on the format and contents of this message.

11.5 KRPC Service

The server provides a service called `KRPC` containing procedures that are used to retrieve information about the server and to manage streams.

11.5.1 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.

11.5.2 GetServices

The `GetServices` procedure returns a Protocol Buffer message containing information about all of the services and procedures provided by the server. It also provides type information about each procedure, in the form of *attributes*. 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*.

11.5.3 AddStream

The `AddStream` procedure adds a new stream to the server. It takes a single argument containing the RPC to invoke, encoded as a `Request` object. See *Anatomy of a Request* for the format and contents of this object. See *Streams* for more information on working with streams.

11.5.4 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.

11.6 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;
  string documentation = 5;
}
```

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.
- `documentation` - Documentation for the service, as [C# XML documentation](#).

Note: See the *Extending kRPC* documentation for more details about *KRPCClass* and *KRPCEnum*.

11.6.1 Procedures

Details about a procedure are given by a `Procedure` message, with the format:

```
message Procedure {
  string name = 1;
  repeated Parameter parameters = 2;
  bool has_return_type = 3;
  string return_type = 4;
  repeated string attributes = 5;
  string documentation = 6;
}

message Parameter {
  string name = 1;
  string type = 2;
  bool has_default_value = 3;
  bytes default_value = 4;
}
```

The fields are:

- `name` - The name of the procedure.
- `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.
 - `has_default_value` - True if the parameter has a default value.
 - `default_value` - If `has_default_value` is true, contains the value of the default value of the parameter, *encoded using Protocol Buffer format*.
- `has_return_type` - True if the procedure returns a value.
- `return_type` - If `has_return_type` is true, contains the *return type* of the procedure.
- `attributes` - The procedure's *attributes*.
- `documentation` - Documentation for the procedure, as [C# XML documentation](#).

11.6.2 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](#).

11.6.3 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](#).

11.6.4 Attributes

Additional type information about a procedure is encoded as a list of attributes, and included in the *Procedure* message. For example, if the procedure implements a method for a class (see *proxy objects*) this fact will be specified in the attributes.

The following attributes specify what the procedure implements:

- `Property.Get (property-name)`
Indicates that the procedure is a property getter (for the service) with the given `property-name`.
- `Property.Set (property-name)`
Indicates that the procedure is a property setter (for the service) with the given `property-name`.
- `Class.Method (class-name, method-name)`
Indicates that the procedure is a method for a class with the given `class-name` and `method-name`.
- `Class.StaticMethod (class-name, method-name)`
Indicates that the procedure is a static method for a class with the given `class-name` and `method-name`.
- `Class.Property.Get (class-name, property-name)`
Indicates that the procedure is a property getter for a class with the given `class-name` and `property-name`.

- `Class.Property.Set(class-name,property-name)`

Indicates that the procedure is a property setter for a class with the given `class-name` and `property-name`.

The following attributes specify more details about the return and parameter types of the procedure.

- `ReturnType.type-name`

Specifies the actual *return type* of the procedure, if it differs to the type specified in the `Procedure` message. For example, this is used with *proxy objects*.

- `ParameterType(parameter-position).type-name`

Specifies the actual *parameter type* of the procedure, if it differs to the type of the corresponding parameter specified in the `Parameter` message. For example, this is used with *proxy objects*.

11.6.5 Type Names

The `GetServices` procedure returns type information about parameters and return values as strings. Type names can be any of the following:

- A Protocol Buffer value type. One of `float`, `double`, `int32`, `int64`, `uint32`, `uint64`, `bool`, `string` or `bytes`.
- A *KRPCClass* in the format `Class(ClassName)`
- A *KRPCEnum* in the format `Enum(ClassName)`
- A Protocol Buffer message type, in the format `KRPC.MessageType`. Only message types defined in `krpc.proto` are permitted.

11.6.6 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, the procedure will have the attribute `ReturnType.Class(ClassName)` where `ClassName` is the name of the class.

When a procedure takes a proxy object as a parameter, the procedure will have the attribute `ParameterType(n).Class(ClassName)` where `n` is the position of the parameter and `ClassName` is the name of the class.

INTERNALS OF KRPC

12.1 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 allow 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



Fig. 12.1: Server window showing the advanced settings.

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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