

Piksi Multi - GNSS RTK Position with Stationary Base

Caution: Piksi Multi uses a powerful processor that can generate a significant amount of heat. Use caution when handling the board, as components may reach upwards of 140° F (60° C).

This procedure must be performed outdoors and does not require an Internet connection.

Overview

This article details the RTK Position with Stationary Base feature available on Piksi® Multi and Duro. This article provides instructions to obtain an RTK Position solution using hardware from the Piksi® Multi Evaluation Kit. Please be sure to complete all prerequisites before proceeding with the guide.

Prerequisites

Installing Swift Console

<http://support.swiftnav.com/customer/en/portal/articles/2756825>

Installing USB to Serial Adapter Drivers

<http://support.swiftnav.com/customer/en/portal/articles/2757197>

Powering Piksi Multi

<http://support.swiftnav.com/customer/en/portal/articles/2746937>

Connecting to Piksi Multi - USB to Serial Adapter

<http://support.swiftnav.com/customer/en/portal/articles/2747195>

Upgrading Piksi Multi Firmware

<http://support.swiftnav.com/customer/en/portal/articles/2757403>

GNSS Antenna Placement Guidelines

<http://support.swiftnav.com/customer/en/portal/articles/2770372>

Piksi Multi - Standalone Position

<http://support.swiftnav.com/customer/en/portal/articles/2770419>

GNSS RTK Position

Note: The **RTK Position Solution** is a high-precision GNSS position solution, with an accuracy of a few centimeters. This is a relative position between two Piksi Multi receivers, which are both required to calculate the solution.

To learn more about RTK technology read [Understanding Piksi RTK GPS Technology](http://support.swiftnav.com/customer/en/portal/articles/2492803-understanding-gps-rtk-technology) article.
(<http://support.swiftnav.com/customer/en/portal/articles/2492803-understanding-gps-rtk-technology>)

This test must be performed outdoors and does not require an Internet connection.

Goal

In this section, you will setup two Piksi Multi outdoors. One will work as a base station (stationary) and another as a rover (moving). The base station will transmit GNSS correction data over the radio link to rover. You will be able to display a rover RTK position solution on the Swift Console.

Radio Configuration

In order to achieve an RTK solution, the rover receiver will need to receive correction data from a base station receiver. The Piksi Multi Evaluation Kit includes two radios to provide this link.

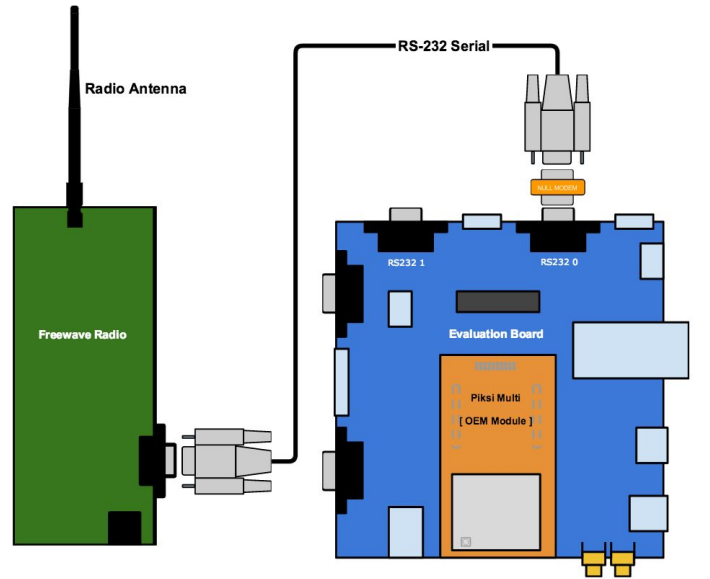
The radios must be configured properly before continuing with this guide.

Please follow the Radio Configuration Guide found here:
<http://support.swiftnav.com/customer/en/portal/articles/2739642>

Base Station Setup

Connect the radio to the evaluation board.

- Connect the radio antenna to the radio module.
- Connect the DE-9 Null Modem Adapter to the Piksi Multi Evaluation RS232 0 port.
- Connect the straight RS-232 serial cable to the Null Modem Adapter
- Connect the other end of the serial cable to the radio module



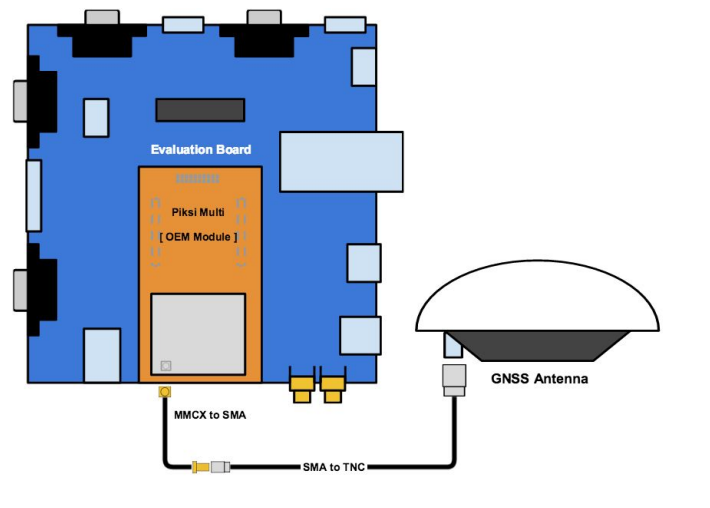
Place the GNSS antenna on a tripod or on other stable structure with an unobstructed sky view.

(See *GNSS Antenna Placement Guidelines*)

It is recommended to secure Piksi Multi and the radio to the antenna tripod or structure.

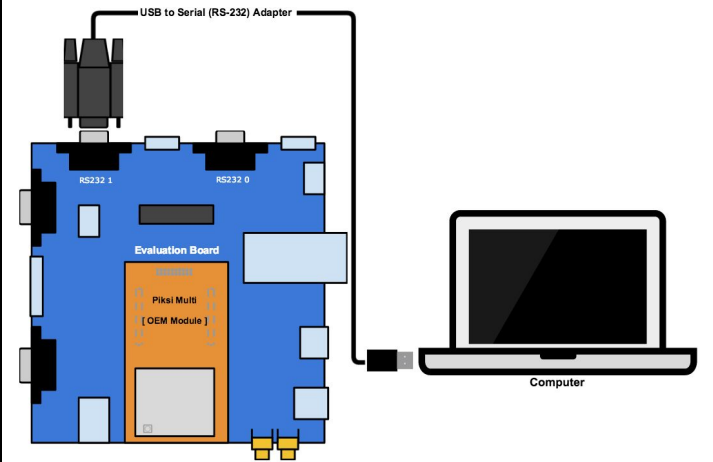
Connect the GNSS Antenna to Piksi Multi.

- Connect the short MMCX to SMA adapter cable to the primary antenna connector on the Piksi Multi GNSS module.
- Connect the SMA to TNC cable to the SMA female connector of the MMCX to SMA cable.
- Connect the TNC connector to the GNSS antenna.



Connect the Evaluation Board to your computer.

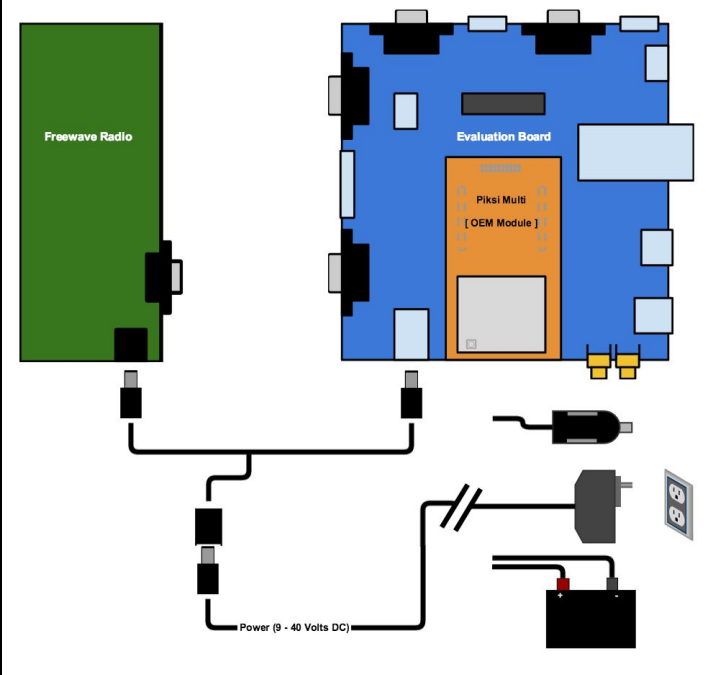
- Connect the USB to Serial Adapter cable to the RS232 1 port of the Evaluation Board.
- Connect the opposite end of the USB to Serial cable to your computer.



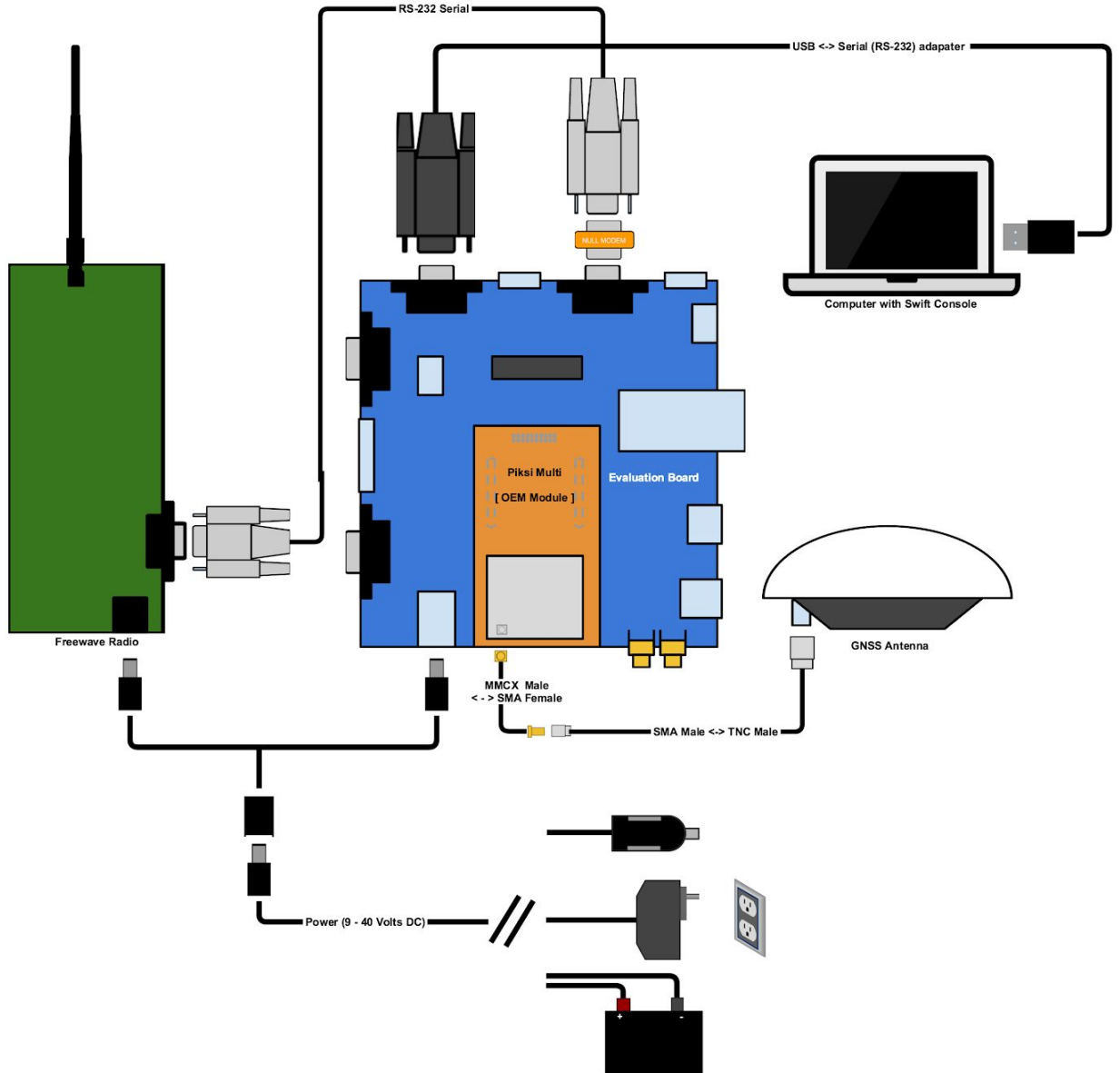
Connect power to the system.

- Connect the included power adapter splitter to the radio and Evaluation Board
- Connect your power source to the splitter.

Once powered - the LED indicators of Piksi Multi will illuminate.



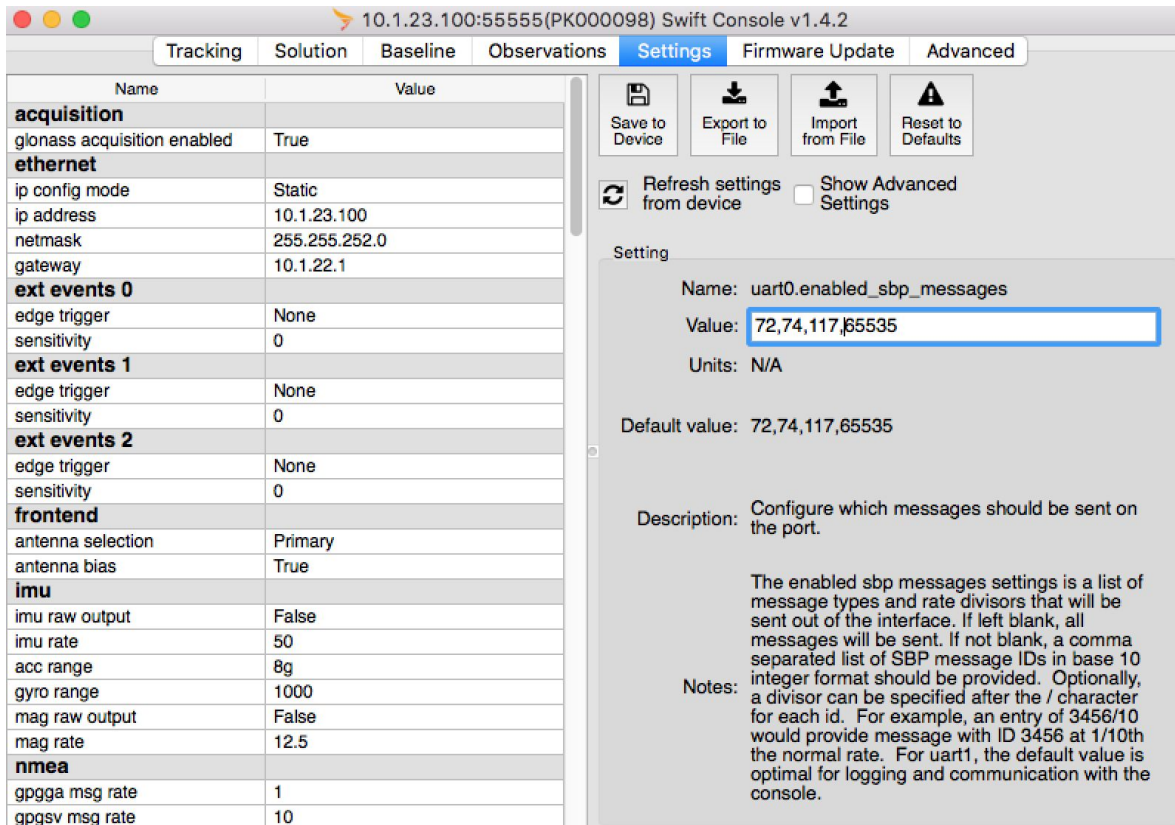
Base Station Wiring Diagram - Overview



Configuring Base Station Radio Messages

In the RTK system, the Base Station transmits its observations and its position to the Rover. The following steps will configure transmission of the base data to the rover.

- Open the *Settings* tab
- Locate the *uart0* section
- Set *enabled_sbp_messages* to *72,74,117,65535*
- Click *Save to Device* button



The screenshot shows the Swift Console v1.4.2 interface with the Settings tab selected. The left pane displays a list of settings categories and their values. The right pane shows the configuration for the 'uart0.enabled_sbp_messages' setting.

Name	Value
acquisition	
glonass acquisition enabled	True
ethernet	
ip config mode	Static
ip address	10.1.23.100
netmask	255.255.252.0
gateway	10.1.22.1
ext events 0	
edge trigger	None
sensitivity	0
ext events 1	
edge trigger	None
sensitivity	0
ext events 2	
edge trigger	None
sensitivity	0
frontend	
antenna selection	Primary
antenna bias	True
imu	
imu raw output	False
imu rate	50
acc range	8g
gyro range	1000
mag raw output	False
mag rate	12.5
nmea	
gpgga msg rate	1
gpgsv msg rate	10

Settings pane details:

- Name: `uart0.enabled_sbp_messages`
- Value: `72,74,117,65535`
- Units: N/A
- Default value: `72,74,117,65535`
- Description: Configure which messages should be sent on the port.
- Notes: The enabled sbp messages settings is a list of message types and rate divisors that will be sent out of the interface. If left blank, all messages will be sent. If not blank, a comma separated list of SBP message IDs in base 10 integer format should be provided. Optionally, a divisor can be specified after the / character for each id. For example, an entry of 3456/10 would provide message with ID 3456 at 1/10th the normal rate. For uart1, the default value is optimal for logging and communication with the console.

The value of the “*enabled_sbp_messages*” setting in the *uart0* section is used to configure which SBP messages are sent over *uart0*. Other communications interfaces may also feature this setting, and are configured independently.

Configuring Base Station Location

GNSS RTK provides a very precise baseline measurement between the base station and the rover. For the rover to provide precise latitude, longitude and altitude, however, the base station must be programmed with its own location. Accuracy of the computed rover's location directly depends on the base station position accuracy. For the best results, position of the base station antenna should be surveyed. To enter the base station location:

- Open *Settings* tab
- Locate *surveyed position* section
- Set *surveyed lat*, *surveyed lon*, and *surveyed alt* to their corresponding values

- Select *broadcast* and change it's value to *True* using the drop down menu.
- Click *Save to Device*

10.1.23.100:55555(PK000098) Swift Console v1.4.2

Tracking Solution Baseline Observations **Settings** Firmware Update Advanced

Name	Value
soln freq	10
output every n obs	10
dgnss solution mode	Low Latency
send heading	False
heading offset	0
enable glonass	True
correction age max	30
standalone logging	
enable	False
output directory	/media/sda1/
max fill	95
file duration	10
surveyed position	
broadcast	True
surveyed lat	37.7710319417
surveyed lon	-122.403166381
surveyed alt	-5.727
system info	
firmware build id	v1.3.11
firmware version	v1.3.11
firmware build date	2018-03-08 03:10:32 UTC
sbp sender id	59B3
serial number	00108051217000098
hw revision	Piksi Multi
mac address	8C-C8-F4-90-05-79
uuid	A516AB02-32DE-441C-9BE7-2A...
tcp client0	
mode	Disabled
address	

Save to Device Export to File Import from File Reset to Defaults Auto Survey

Refresh settings from device Show Advanced Settings

Setting
Name: surveyed position.broadcast
Value: **True**
Default value: False

Description: Broadcast surveyed base station position.

Notes: This flag ultimately determines whether the SBP message with identifier MSG_BASE_POS_ECEF will be calculated and sent. Logically, setting this attribute to "true" sets the Local receiver as a base station and configures the unit to send its surveyed position coordinates to the other receiver(s) with which the base station is communicating. If "true", the remote receiver that receives the surveyed position will calculate and communicate a pseudo absolute RTK position based upon the received position.

If the surveyed position is not available, you can use the *Auto Survey* button. This is based on an average of the last 1000 SPP position solutions and therefore not as accurate as a proper survey of the base station location. To use *Auto Survey* for the base station position:

- Open *Settings* tab
- Locate *surveyed position* section
- Select *broadcast*
- Click the *Auto Survey* button the upper right hand corner
- Click *Auto Survey* - note the *surveyed lat*, *surveyed lon*, and *surveyed alt* fields are now populated.
- Select *broadcast* and change it's value to *True* using the drop down menu.
- Click *Save to Device*

10.1.23.100:55555(PK000098) Swift Console v1.4.2

Tracking Solution Baseline Observations Settings Firmware Update Advanced

Name	Value
soln freq	10
output every n obs	10
dgss solution mode	Low Latency
send heading	False
heading offset	0
enable glonass	True
correction age max	30
standalone logging	
enable	
output directory	
max fill	
file duration	
surveyed position	
broadcast	
surveyed lat	
surveyed lon	
surveyed alt	
system info	
firmware build id	
firmware version	
firmware build date	
sbp sender id	
serial number	00108051217000098
hw revision	Piksi Multi
mac address	8C-C8-F4-90-05-79
uuid	A516AB02-32DE-441C-9BE7-2A...
tcp client0	
mode	Disabled
address	

Save to Device Export to File Import from File Reset to Defaults Auto Survey

Refresh settings from device Show Advanced Settings

Setting Name: surveyed_position.broadcast

Auto populate surveyed position?

This will set the Surveyed Position section to the mean position of the last 1000 position solutions.

The fields that will be auto-populated are:
 Surveyed Lat
 Surveyed Lon
 Surveyed Alt

The surveyed position will be an approximate value. This may affect the relative accuracy of Piksi.

Are you sure you want to auto-populate the Surveyed Position section?

Close Auto Survey

Notes: true sets the Local receiver as a base station and configures the unit to send its surveyed position coordinates to the other receiver(s) with which the base station is communicating. If "true", the remote receiver that receives the surveyed position will calculate and communicate a pseudo absolute RTK position based upon the received position.

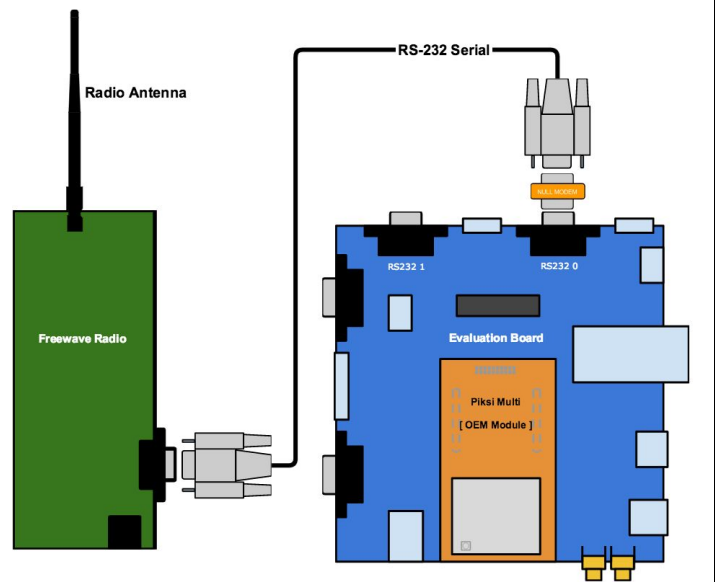
Finishing Base Station Setup

At this point the Piksi Multi base station setup is complete. Close Console, disconnect Piksi Multi from the computer. Leave the base station powered, so that it can continue to provide corrections to the rover.

Rover Setup

Connect the radio to the evaluation board.

- Connect the radio antenna to the radio module.
- Connect the DE-9 Null Modem Adapter to the Piksi Multi Evaluation *RS232 0* port.
- Connect the straight RS-232 serial cable to the Null Modem Adapter
- Connect the other end of the serial cable to the radio module



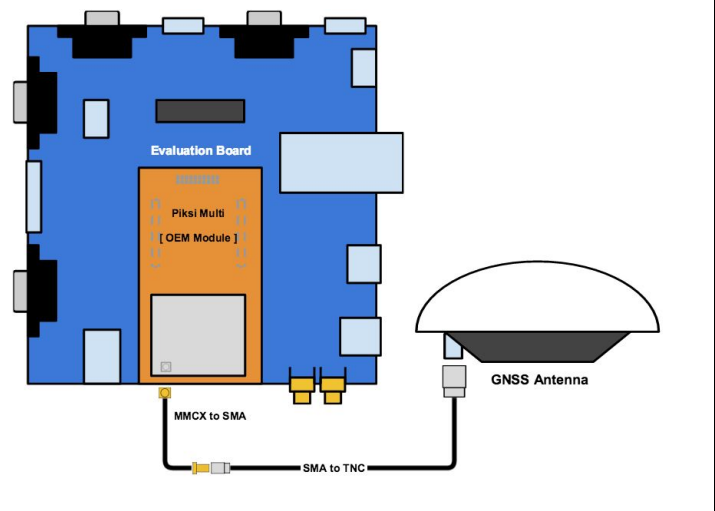
Place the GNSS antenna on a tripod or on other stable structure with an unobstructed sky view.

(See *GNSS Antenna Placement Guidelines*)

It is recommended to secure Piksi Multi and the radio to the antenna tripod or structure.

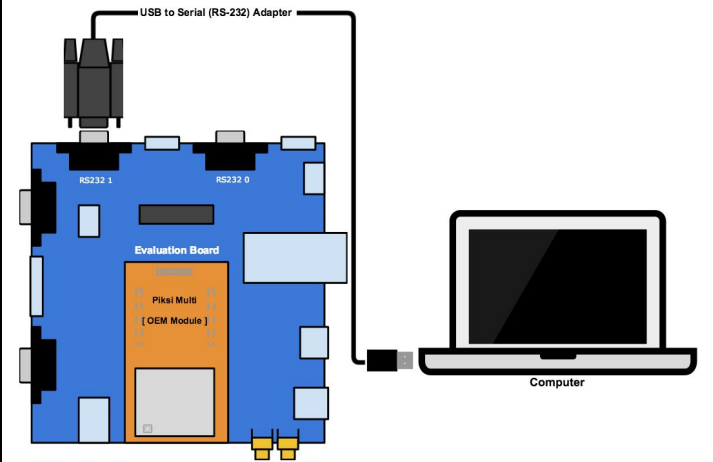
Connect the GNSS Antenna to Piksi Multi.

- Connect the short MMCX to SMA adapter cable to the primary antenna connector on the Piksi Multi GNSS module.
- Connect the SMA to TNC cable to the SMA female connector of the MMCX to SMA cable.
- Connect the TNC connector to the GNSS antenna.



Connect the Evaluation Board to your computer.

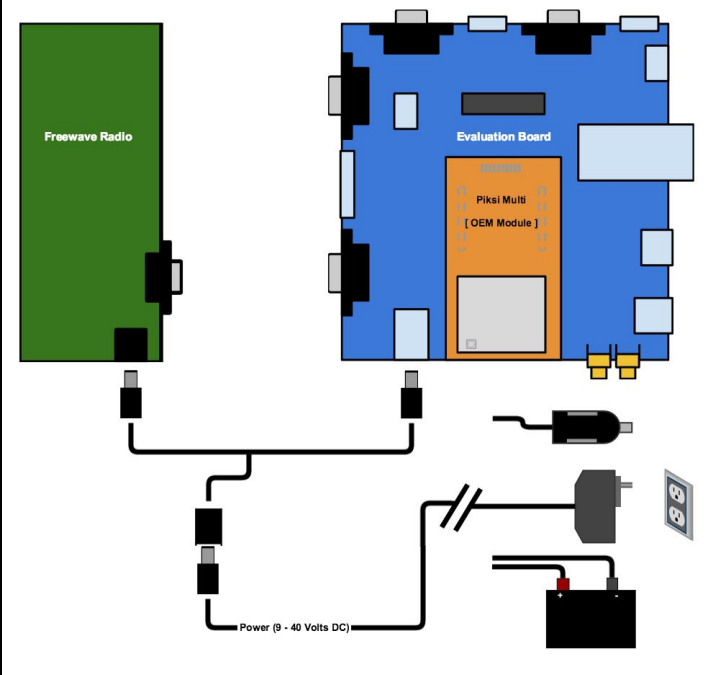
- Connect the USB to Serial Adapter cable to the RS232 1 port of the Evaluation Board.
- Connect the opposite end of the USB to Serial cable to your computer.



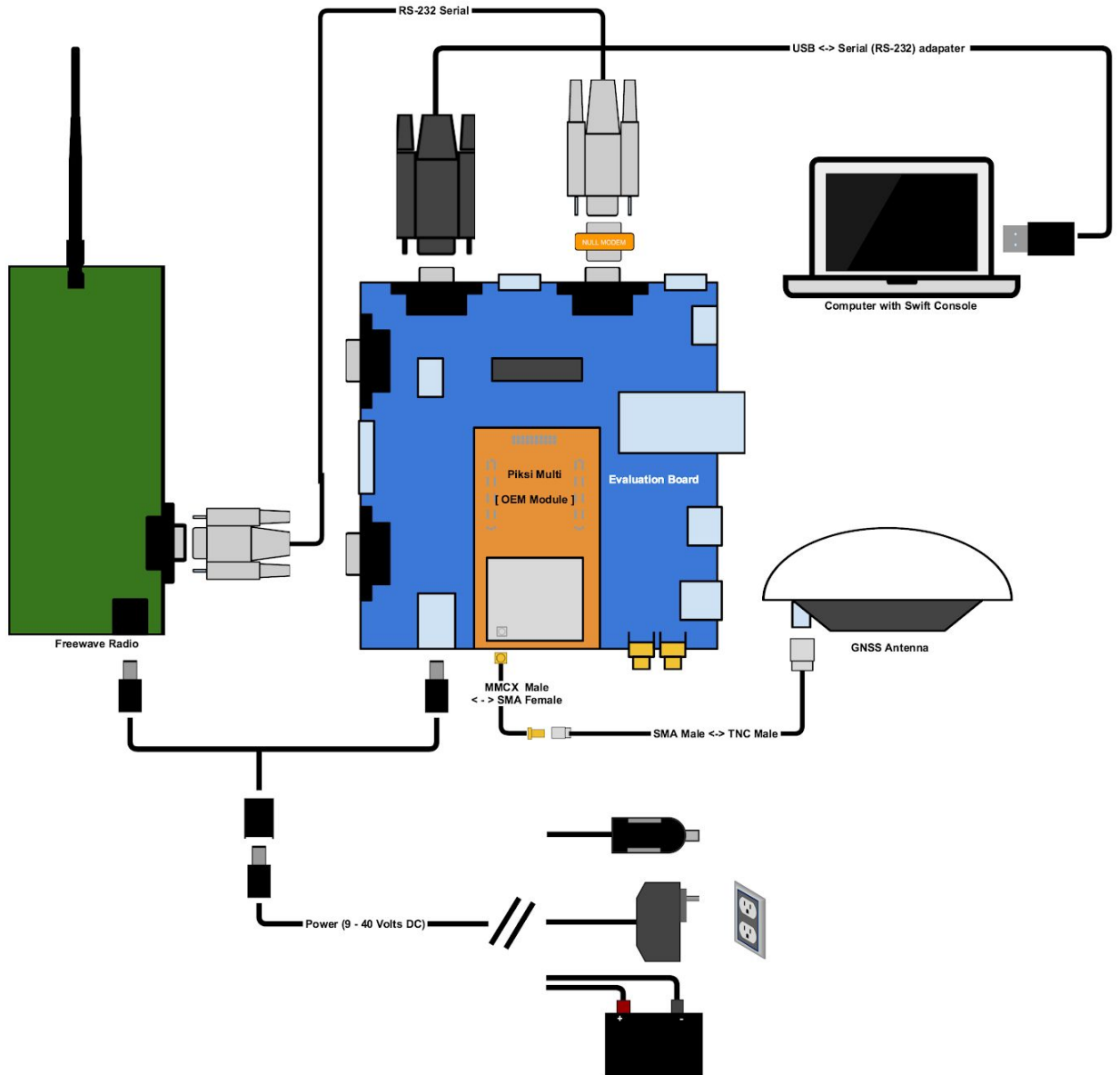
Connect power to the system.

- Connect the included power adapter splitter to the radio and Evaluation Board
- Connect your power source to the splitter.

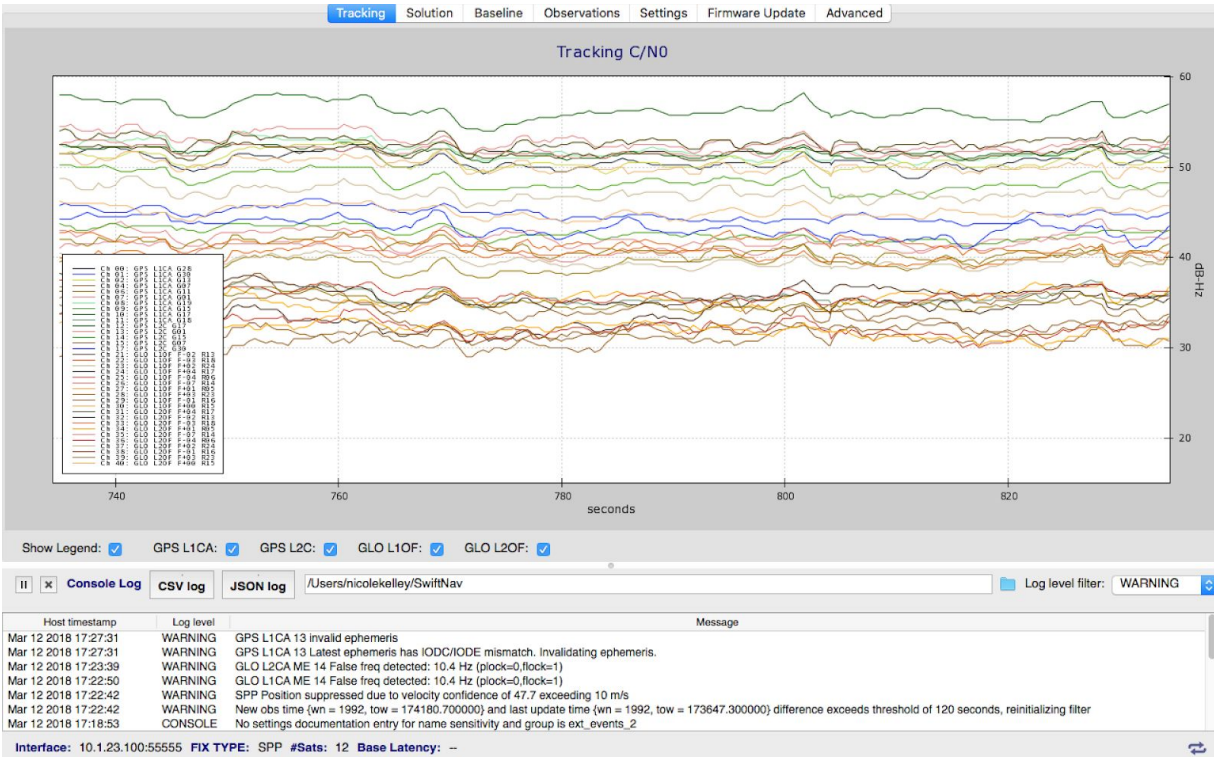
Once powered - the LED indicators of Piksi Multi will illuminate.



Rover Wiring Diagram - Overview



Checking Rover Satellite Signals

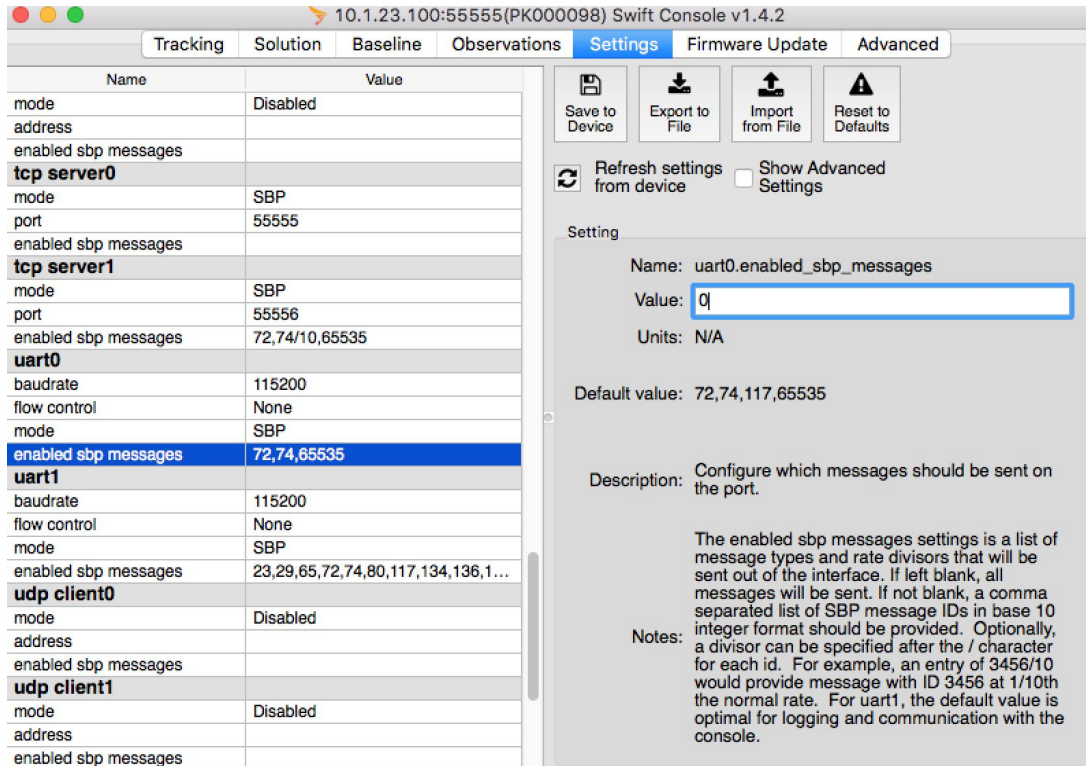


Open *Tracking* tab. Wait until at least 5 satellites have signal strength above 33 dB-Hz and Piksi computes a Single Point Solution or SBAS solution. The POS LED on Piksi Multi will show solid orange once it has a position solution.

Configuring Rover Radio Messages

In a typical RTK system, the Rover is only receiving observations (corrections) from the Base Station. The following steps will disable transmission of the rover observations.

- Open *Settings* tab
- Set *uart0 enabled_sbp_messages* to 0
- Click *Save to Device* button



The screenshot shows the Swift Console v1.4.2 interface with the Settings tab selected. The left pane displays a list of settings for various components, including tcp servers and UARTs. The 'uart0 enabled_sbp_messages' setting is highlighted in blue. The right pane shows the configuration details for this setting, with the value '0' entered in the text box.

Name	Value
mode	Disabled
address	
enabled_sbp_messages	
tcp server0	
mode	SBP
port	55555
enabled_sbp_messages	
tcp server1	
mode	SBP
port	55556
enabled_sbp_messages	72,74/10,65535
uart0	
baudrate	115200
flow control	None
mode	SBP
enabled_sbp_messages	72,74,65535
uart1	
baudrate	115200
flow control	None
mode	SBP
enabled_sbp_messages	23,29,65,72,74,80,117,134,136,1...
udp client0	
mode	Disabled
address	
enabled_sbp_messages	
udp client1	
mode	Disabled
address	
enabled_sbp_messages	

Setting

Name: uart0.enabled_sbp_messages
Value:
Units: N/A

Default value: 72,74,117,65535

Description: Configure which messages should be sent on the port.

Notes: The enabled_sbp_messages settings is a list of message types and rate divisors that will be sent out of the interface. If left blank, all messages will be sent. If not blank, a comma separated list of SBP message IDs in base 10 integer format should be provided. Optionally, a divisor can be specified after the / character for each id. For example, an entry of 3456/10 would provide message with ID 3456 at 1/10th the normal rate. For uart1, the default value is optimal for logging and communication with the console.

Checking Communication Between Piksi Receivers

The red LINK LED on Piksi Multi rover board will flash when it correctly receives an observation data from the other Piksi Multi (base station). This LED may be solidly illuminated in the case that your piksi or Duro has a route to the internet, but it will still blink when an observation is received.

Open Observations tab. You will see the rover's observations in the upper *Local* table, and the observations that have been received over the radio from the other Piksi in the lower *Remote* table. Wait until you can see at least 5 satellites in common between the Base and Rover.

COM10(PK000234) Swift Console v.1.0.11

Tracking Solution Baseline Observations Settings Firmware Update Advanced

Local

GPS Week: 1935 GPS TOW: 518009.0 Total obs: 14 L1 obs: 8 L2 obs: 6

PRN	azimuth (°)	el. Phase (cy)	C/N0 (dB-Hz)	is. Doppler	rp. Doppler	Lock	Flags
23 (L1CA)	23125013...	1215228...	48.0	-3253.50	-3253.38	13	0x000F = PR CP 1/2C MD
27 (L1CA)	23395307...	1229431...	43.5	-1429.73	-1429.66	13	0x000F = PR CP 1/2C MD
27 (L2CM)	23395307...	957998...	44.2	-1114.27	-1114.02	13	0x000F = PR CP 1/2C MD
28 (L1CA)	22026652...	1157506...	50.2	2470.22	2470.42	13	0x000F = PR CP 1/2C MD
30 (L1CA)	21380452...	1123549...	51.5	1579.20	1579.23	13	0x000F = PR CP 1/2C MD
30 (L2CM)	21380452...	875492...	46.2	1230.43	1230.58	13	0x000F = PR CP 1/2C MD
5 (L1CA)	23618160...	1241141...	45.8	807.01	807.48	13	0x000F = PR CP 1/2C MD

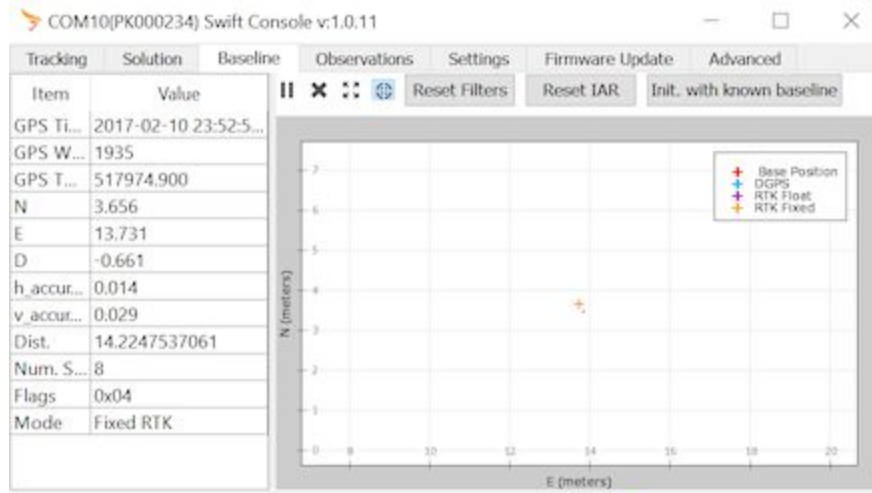
Remote

GPS Week: 1935 GPS TOW: 518009.0 Total obs: 14 L1 obs: 8 L2 obs: 6

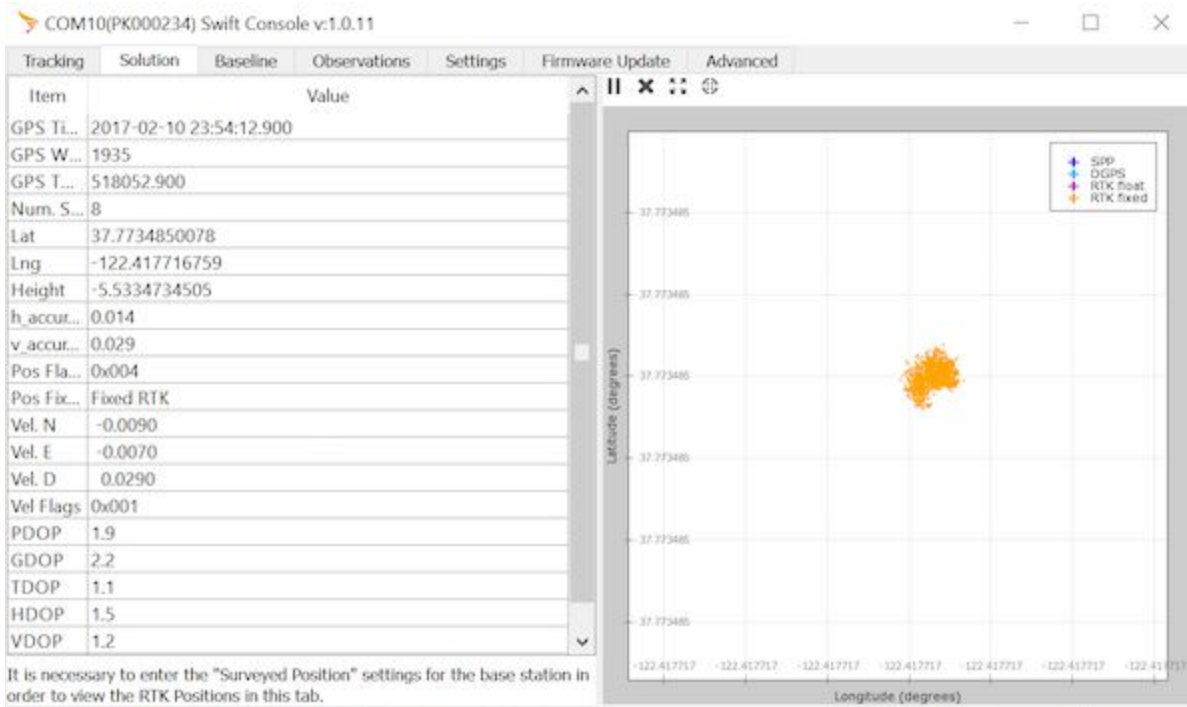
PRN	azimuth (°)	el. Phase (cy)	C/N0 (dB-Hz)	is. Doppler	rp. Doppler	Lock	Flags
23 (L1CA)	23125018...	1215228...	50.2	-3253.73	-3253.17	13	0x000F = PR CP 1/2C MD
27 (L1CA)	23395319...	1229432...	45.5	-1429.83	-1429.48	13	0x000F = PR CP 1/2C MD
27 (L2CM)	23395320...	957999...	39.8	-1114.38	-1113.87	13	0x000F = PR CP 1/2C MD
28 (L1CA)	22026643...	1157507...	51.2	2470.11	2470.62	13	0x000F = PR CP 1/2C MD
30 (L1CA)	21380445...	1123549...	52.8	1578.98	1579.42	13	0x000F = PR CP 1/2C MD
30 (L2CM)	21380447...	875493...	49.2	1230.27	1230.71	13	0x000F = PR CP 1/2C MD
5 (L1CA)	23618151...	1241142...	49.5	807.15	807.68	13	0x000F = PR CP 1/2C MD

Viewing RTK Position Solution

Once at least 5 satellites are in common between the Rover and Base, Piksi will start producing differential solutions. Open the Baseline tab and you will see differential solutions being outputted. Initially Piksi will begin in *Float* mode (less accurate) and will transition to *Fixed* mode (most accurate). When this happens, your Piksi has a fixed RTK lock. You should now see a centimeter-accurate distance between your base Piksi and rover Piksi, visualized on the Baseline tab, like in the example shown below.



If the surveyed position was programmed on the base station and broadcasting was enabled (see *Configuring Base Station Radio Messages* above) you can see the rover's position on the Solution - RTK Position tab.



Congratulations!

You now know how to setup and use Piksi Multi. To learn more, visit the Swift Navigation Support Center - <http://support.swiftnav.com/>.

