Piksi User Getting Started Guide

THIS DOCUMENT IS ONLY APPLICABLE TO THE PIKSI v2 RECEIVER

The Piksi Multi Getting Started Guide is at http://support.swiftnav.com/customer/en/portal/articles/2771182-piksi-multi-getting-started-guide.

Welcome to the Getting Started Guide for the Swift Navigation Piksi® RTK GPS Receiver! This guide is intended for first time Piksi users and provides an overview of how to install the required software, connect to and configure Piksi and acquire position solutions.

Note: This guide was tested on:

- Windows 7 and 10
- OS X (10.8.5)
- Ubuntu Linux (12.10 32-bit, kernel version 3.5.0-17)

By the end of this guide, you will be able to acquire a fixed RTK solution using two Piksi receivers. The steps in this guide should take you about two hours in total, and the last two steps need to be performed outdoors.

Guide Content:

It is useful to start by watching the 5 minute Getting Started Video that covers the topics in this guide at a high level. If anything in this guide is incorrect or unclear, please contact us (https://www.swiftnav.com/contact-us) and give us your feedback!

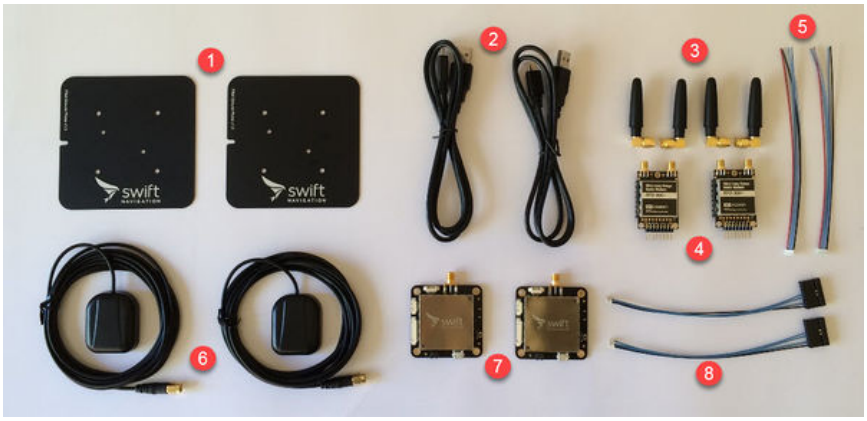
Note: The following additional equipment is recommended for the outdoor exercises:

Tripod for the base station antenna
Tripod or monopod for the rover antenna
Battery pack with USB connector to power the base station
Small table and chair

Piksi RTK Kit Contents

Note: Two kits are available: 915 MHz and 433 MHz. They use different radios.

The items listed below are included in the Piksi RTK Kit.



915 MHz RTK Kit Contents:

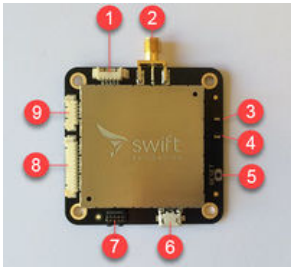
1. Two GPS antenna ground planes
2. Two micro USB cables
3. Four radio antennas (see Notes)
4. Two radio modems (see Notes)
5. Four spare UART cables

6. Two GPS antennas
7. Two Piksi RTK GPS receivers
8. Two radio cables (see Notes)

Notes:

- 915 MHz kits shipped before May 2016 were containing 3DR radios and two antennas
- 433 MHz kits use 3DR radios and two antennas

Piksi GPS Receiver Connectors and Indicators



> **Caution:** Piksi board is sensitive to electrostatic discharge (ESD). Handle board with caution to prevent damage.

1. UART A (primary for radio)
2. GPS antenna input
3. Green LED
4. Red LED
5. Reset button
6. Micro USB
7. JTAG debug
8. Debug and expansion port
9. UART B

```
Warning: Piksi maximum supply voltage is 5.5V. Higher voltage will permanently damage the receiver.
```

The Piksi Datasheet (http://docs.swift-nav.com/pdfs/piksi_datasheet_v2.3.1.pdf) provides a more detailed description of Piksi hardware.

Installing the Piksi Console

This can be done indoors and requires an Internet connection.

The Piksi Console is a Graphical User Interface (GUI) program that runs on your computer and allows you to communicate with Piksi. It displays the position and other status information. To run the Piksi Console, you need to install the Piksi USB drivers and download the Piksi Console Installer.

> **Caution:** Running the Piksi Console on a virtual machine (e.g. VMWare, VirtualBox, Parallels) is strongly discouraged. This is due to imperfections in the USB pass-through functionality, which can lead to symptoms such as freezing during firmware updates and glitches in regular operation.

Installing the Piksi USB Drivers

Windows

Install FTDI's VCP drivers (http://www.ftdichip.com/Drivers/CDM/CDM21216_Setup.exe) to communicate with Piksi over USB.

Notes:

- Two drivers are available: VCP and D2XX. You only need the VCP driver. Do not install D2XX driver.

Mac OS X

Install version 2.2.18 of FTDI's VCP driver (http://www.ftdichip.com/Drivers/VCP/MacOSX/FTDIUSBSerialDriver_v2_2_18.dmg).

Notes:

- Two drivers are available: VCP and D2XX. You only need the VCP driver. Do not install D2XX driver.
- Piksi requires FTDI driver version 2.2.18, not version 2.3.
- When you run the installer, choose the option for OS X versions 10.4—10.7 (not 10.3).
- On Mac OS X 10.7.5 or later, you may need to open the driver .dmg file as explained here (https://support.apple.com/kb/PH14369) if Gatekeeper (https://en.wikipedia.org/wiki/Gatekeeper_(OS_X)) displays an "unidentified developer" warning and prevents the driver from installing.

After installing the FTDI VCP driver, you must unload the Apple driver and load the FTDI driver by running the following commands from the Terminal application:

```
sudo kextunload /System/Library/Extensions/IOUSBFamily.kext/Contents/PlugIns/AppleUSBFTDI.kext
sudo kextload /System/Library/Extensions/FTDIUSBSerialDriver.kext
```

After unloading the Apple driver, you might get one of the messages below in your command window.

```
(kernel) Kext com.apple.driver.AppleUSBFTDI not found for unload request.
Failed to unload com.apple.driver.AppleUSBFTDI (libkern/kext) not found.
```

or

```
Can't open CFBundle for /System/Library/Extensions/IOUSBFamily.kext/Contents/PlugIns/AppleUSBFTDI.kext.
```

Ignore those messages and load the FTDI driver. The Piksi Console will still work as it should.

Linux

Recent versions of Linux (kernel > 3.0) have built-in native kernel support for the FTDI devices and do not require the above drivers.

Getting the Piksi Console Installer

Windows

Download and install the "Windows Console Installer" from the link below:

> https://www.swiftnav.com/downloads

Mac OS X

Download and install the "OS X Console Installer" from the link below:

> https://www.swiftnav.com/downloads

Be sure to drag the Piksi Console application into your Applications folder. Later when you try to run the console, launch it from the Piksi Console icon located in your Applications Folder.

Linux

Recent versions of the Piksi and Swift console are distributed as binaries for Linux. The process for installing are as follows:

1. Obtain the package for the console from the website: http://support.swiftnav.com/customer/en/portal/articles/2492795-swift-console-piksi-console-
2. Untar the package
    1. tar xvfz piksi_console_*.tar.gz
3. Configure your permissions on the piksi device for read and write access (chmod 777 /dev/ttyUSB9)
4. Configure file permissions for the console executable for execute permissions (chmod 777 console)
5. run the console

```
  ./console
```

You can also consider running from source: HOW-TO: Running the Piksi Console from source.

Running the Piksi Console

This step can be done indoors and requires an Internet connection.

With the USB driver and Piksi Console installed, the first thing to do is to connect the receiver to your computer and check the firmware version.

Hardware Setup

Connect Piksi into your computer via the micro-USB cable.

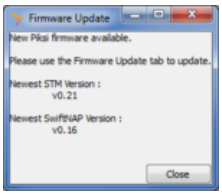
Starting the Console Software

With the Piksi connected to your computer, launch the Piksi Console using the installed icon.

When the console starts, it will prompt you to select which port to use. Select the port that corresponds to Piksi from the drop down menu:

Verify Firmware Versions

If new firmware is available, the console displays a dialog box like the one below. The console automatically checks for firmware and software updates over the Internet.



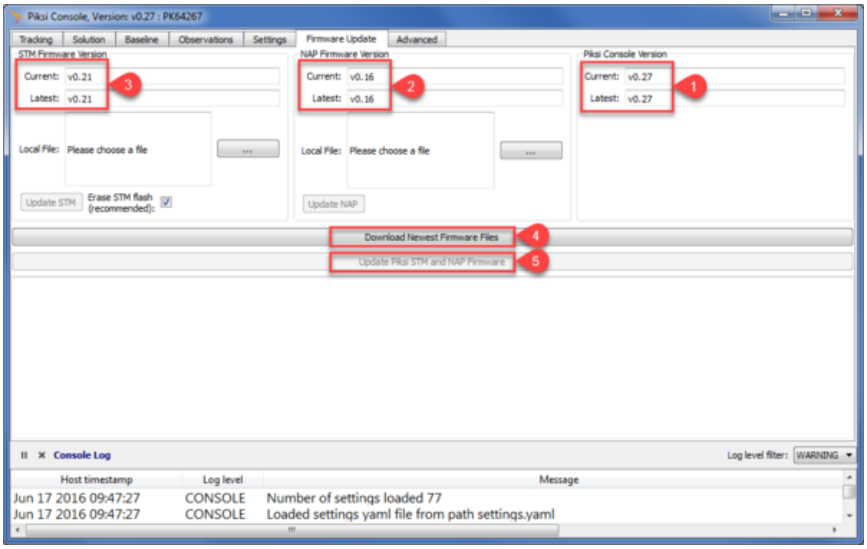
Whether or not you see this dialog box, open the Firmware Update tab of the Console and check for updates.

- Check to see if you have the latest version of the Console (1). The versions in these boxes should match. If they don't, close the Console and follow the instructions above to install the latest Console.
- Check to see if you have the latest NAP (Navigation Acceleration Processor) firmware (2). The versions in these boxes should match. If they don't, update this firmware as described below.
- Check to see if you have the latest STM (ST microcontroller) firmware (3). The versions in these boxes should match. If they don't, update this firmware as described below.

If new STM or NAP versions are needed follow this procedure:

- Click **Download Newest Firmware Files** button (4). This may take a few seconds. Wait until the *Update Status* dialog box has two messages, one for STM and one for NAP, reading "*Saved file to... .hex*"
- Click **Update Piksi STM and NAP Firmware** (5) and wait until all the updates are installed. This may take a few minutes. Wait until you see the confirmation stating all updates are installed in the *Update Status* box.

Repeat above for each Piksi you own. Always update all of your Piksis when new firmware is available.



Simulation Mode

This step can be done indoors and does not require an Internet connection.

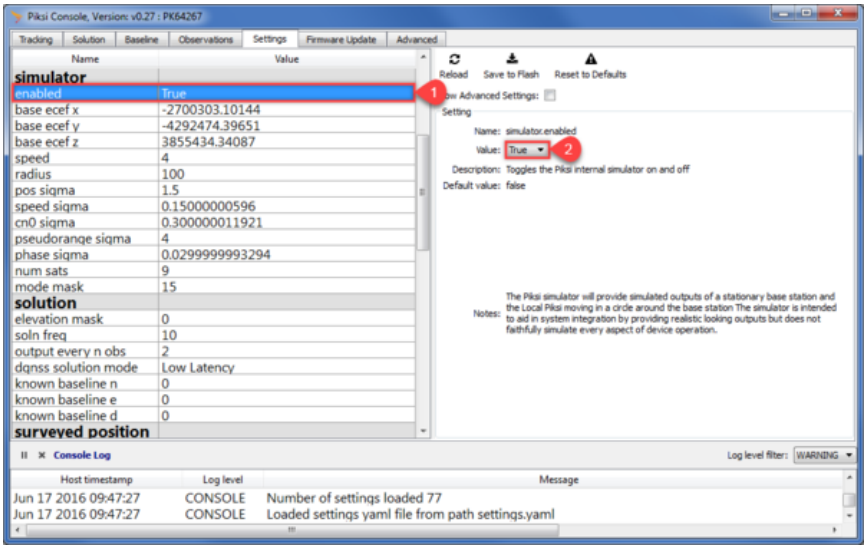
Goal

Simulation mode will allow you to become familiar with the Piksi Console operation before testing outside with Piksi receiving real GPS signals. In simulation mode, Piksi will output simulated position solutions, status information and differential corrections as if Piksi was mounted on a vehicle flying in a large circle.

Enabling Simulation Mode

Connect Piksi to your computer, start Piksi Console program, open the Settings tab and do the following:

- In the Simulator section, you will see a value for *enabled* (1). Click on this.
- Set the value of *enabled* to *True* by selecting *True* (2) on the selection at the right part of the tab.



Your Piksi will now be running in a Simulation Mode. If you view the Tracking, Solution and Baseline tabs, you can now see the simulated output.

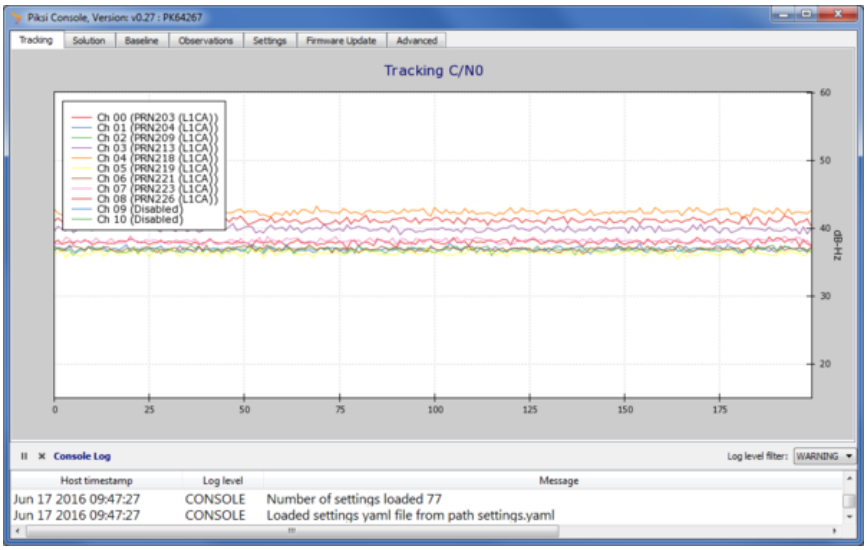
Viewing Position Solutions

In this simulated set of solutions, the simulated rover is traveling counter-clockwise around the simulated base station in a 100 meter radius circle. The way to view these results are through three primary screens in the Piksi Console: Tracking Tab, Solution Tab and Baseline Tab.

> **Piksi Console manual** provides a complete description of the program.

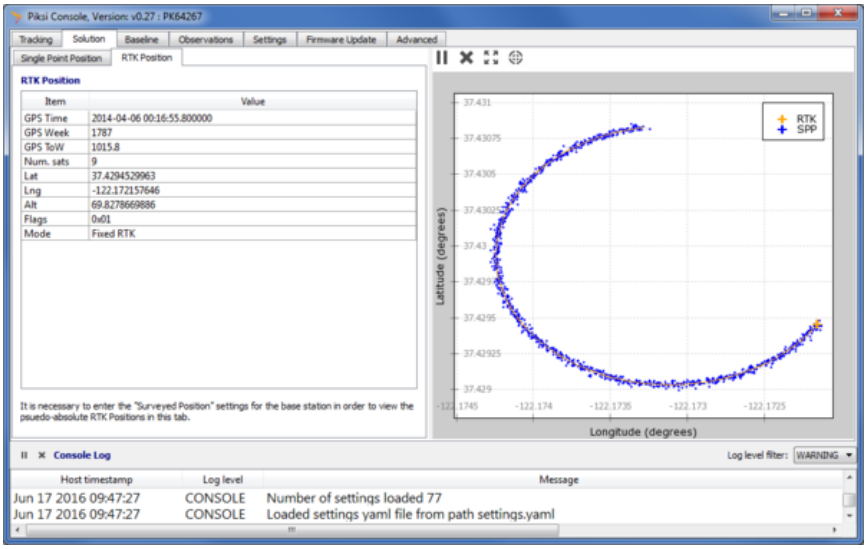
Tracking Tab

This tab shows the satellites Piksi is tracking (receiving signal). Each satellite is represented by a colored line on the graph, and the line's position on the graph represents the strength of the satellite's signal over time. The *x axis* is the last 200 messages that Piksi sent to the Console and the *y axis* is *Carrier to Noise Ratio* (C/No), in dB-Hz, which is the signal strength of the satellite. The most recent time is on the right hand side and the graph scrolls to the left. This simulation shows that you are tracking 9 satellites; you know this because you will see consistent C/No of over 33 dB-Hz.



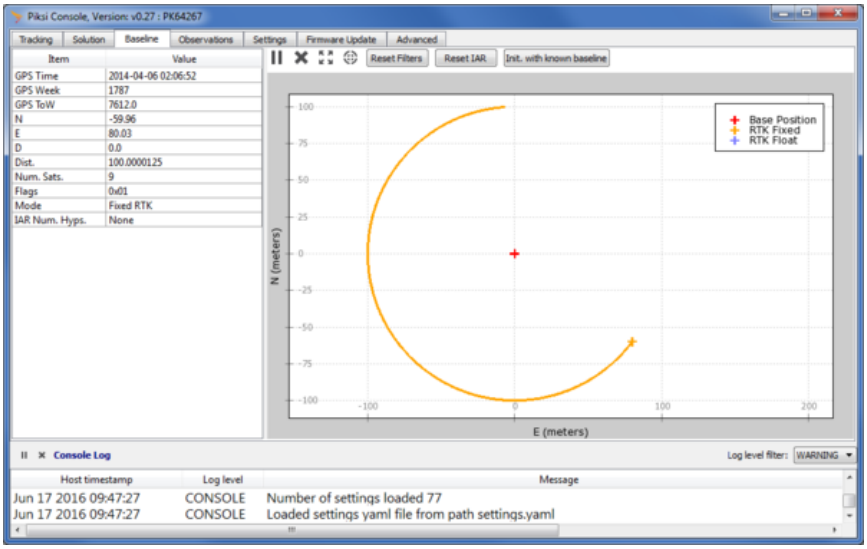
Solution Tab

This tab shows Piksi's Single Point Position, a standard GPS position solution with an absolute position accuracy of several meters and RTK Position, a few centimeters high-accuracy GPS position. The graph shows blue dots (Single Point Solution) and an orange line (RTK Solution). The blue dots will have less precise positions and therefore will appear as a noisy cluster around the orange RTK line.



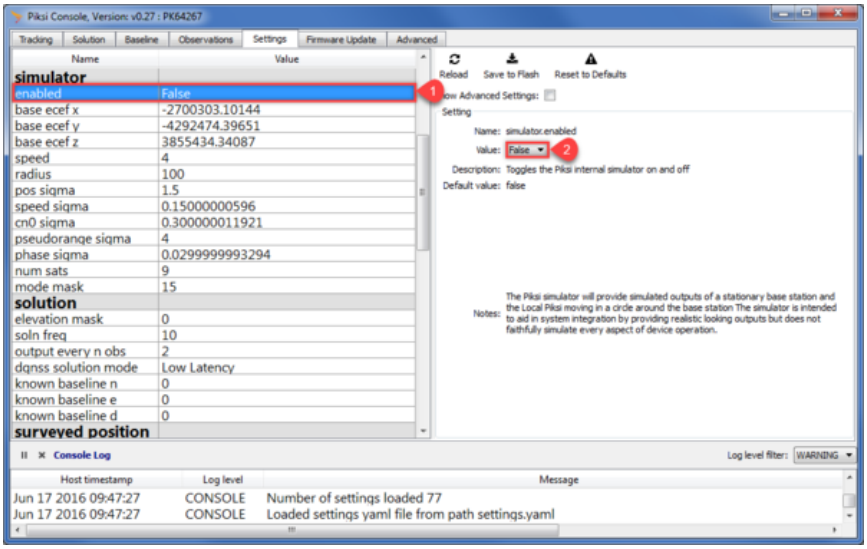
Baseline Tab

This tab shows Piksi's RTK Baseline, a high-precision GPS position solution, with a relative position accuracy of few centimeters. This data visualization will show the base station as a red cross and the rover path in orange or blue. The Piksi that is connected to the Console is always the *Rover* and the remote Piksi (not directly connected to this Console) is always the *Base*. Also, the base is always considered to be at coordinate [0,0,0]. The rover position data is a relative vector between the base and the rover, given as a distance North (graphed on the vertical axis, in meters), East (graphed on the horizontal axis, in meters), and Down (not graphed). Here you will notice that the rover path is the same exact circle as shown in the Solution tab, but it is much more precise than the path shown by the Single Point Position solution.



Disabling Simulation Mode

Disable the simulation mode by changing the *enabled* value (1) back to *False* (2) on the *Settings* tab.



Antenna Placement Guidelines

For all outdoor testing, you must use the **external antenna** and a **ground plane**. Using the screws provided in the kit, mount the antenna on top of the ground plane. Position the antenna as indicated by the blue marker, at a spot with a sky view that is unobstructed above 30 degrees up from the horizon in every direction. For the best results, install the antenna on the top of a tripod or other stable structure.

Piksi's high-precision GPS antenna is sensitive to its environment. Since Piksi needs to track carrier phase information from GPS satellites, it is much more sensitive to obstructions than standard consumer GPS of the type found in, for example, smartphones. Thus, the Piksi antenna must be kept away from *any* obstructions to its sky view.

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- Do place the ground plane underneath the antenna.
- Do place the antenna on a tripod.
- Do not test inside a building.
- Do not place the antenna near buildings.
- Do not place the antenna near trees and other cover.
- Do not stand near the antenna or put your hand over the antenna during testing.
- Do not place an open laptop near the antenna so that the laptop itself is blocking the sky view.

Antenna on a ground plane

Not indoor

Not near buildings

Not near trees

Not near people

Not near laptop

Standalone GPS Position

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

> **Note:** A **Single Point Position** solution is a standalone autonomous GPS position solution, with an accuracy of few meters. This is an absolute position and only one Piksi is required to calculate it.

Goal

In this section, you will use one Piksi to display a Single Point Position on the Piksi Console.

Hardware Setup

- Place the antenna on a ground plane and secure it on a tripod or on other stable structure with an unobstructed sky view (follow the Antenna Placement Guidelines in section above).
- Connect the antenna cable to the Piksi board.
- Connect Piksi into your computer via the micro-USB cable.

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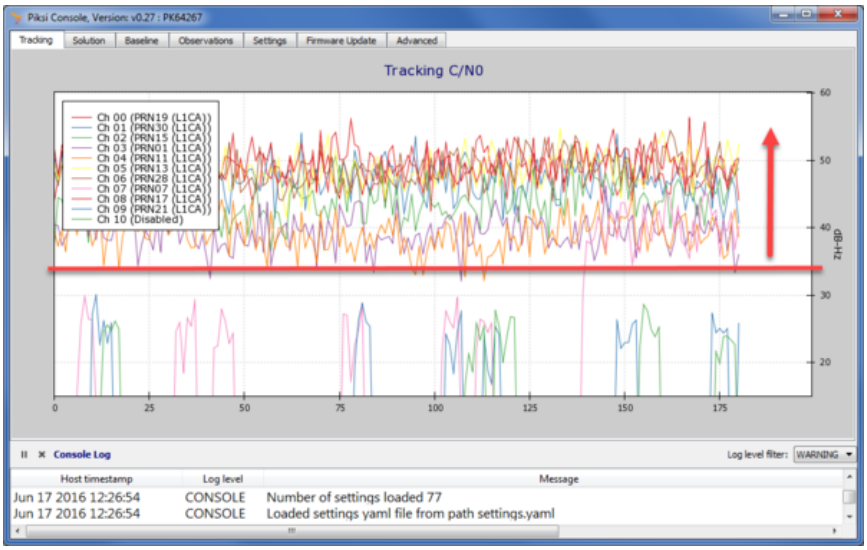
Running the Console Software

- Launch the Piksi Console using the installed icon as described in the previous section.
- Ensure that you have simulation mode disabled, per the instructions from the previous section.

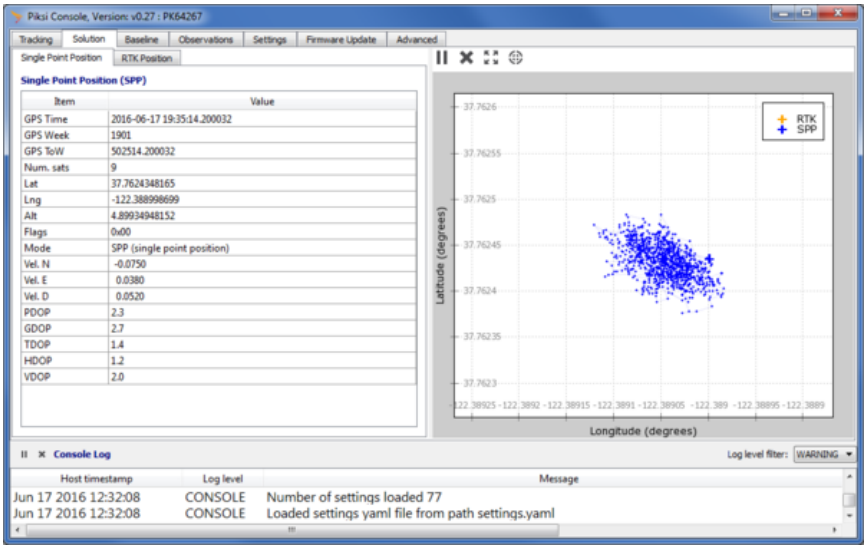
Checking Satellite Signals

Open the Tracking tab. If a satellite has been successfully acquired, it will be assigned to a tracking channel and transitioned to tracking. In the Tracking tab you will see a line added to the plot indicating the signal strength of that satellite. Wait until at least 4 satellites are tracking with signal strengths above 33 dB-Hz, as indicated by the red line in the image below.



Viewing Position Solutions

Once at least 4 satellites are tracking, the green LED light on Piksi will start flashing. The green LED light will flash the number of satellites Piksi has successfully tracked, then pause and repeat. Piksi will receive the data it needs to compute the position solution from the satellites. This data is called the *ephemeris* and it takes approximately 30 seconds to collect. Open the Solution tab and you should see Piksi outputting position solutions represented as a cloud of blue points on the graph.



GPS RTK Position

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

Goal

In this section, you will setup two Piksis outdoors. One will work as a base station (stationary) and another as a rover (moving). You will be able to display a rover RTK position solution on the Piksi Console.

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

To learn more about RTK technology read Understanding Piksi RTK GPS Technology article.

Base Station Setup

- Place the antenna on a ground plane and secure it on a tripod or on other stable structure with an unobstructed sky view (follow the Antenna Placement Guidelines in section above).
- Connect the antenna cable to the Piksi board.
- Connect the radio antennas to the radio modem.
- Connect the radio modem to the Piksi UART A port.
    - If your kit contains RFD900+ radios, follow the RFD900+ Radio Integration Guide.

- If your kit contains 3DR radios, follow the 3DR Radio Integration Guide.
- It is recommended to secure Piksi and radio together and attach them to the antenna tripod or a mast.
- Connect the Piksi board to your computer with the USB cable.

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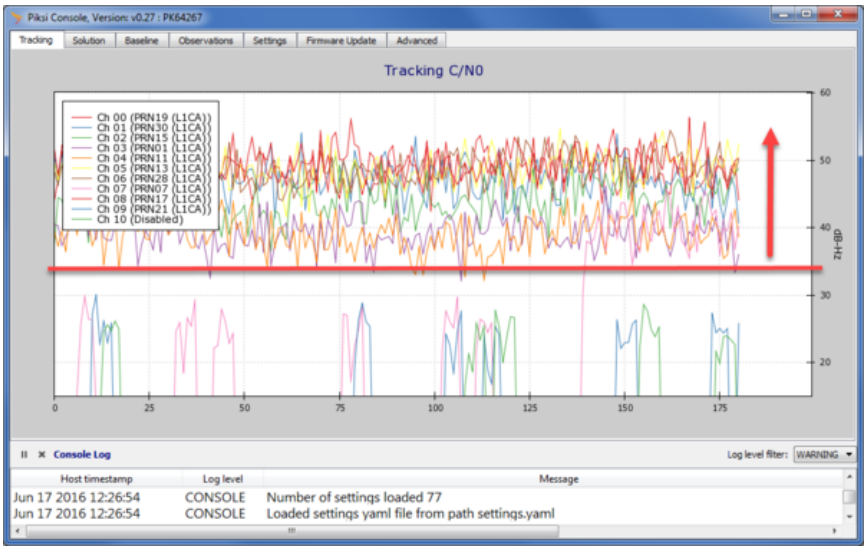
- Start the console software and connect to the Piksi receiver.

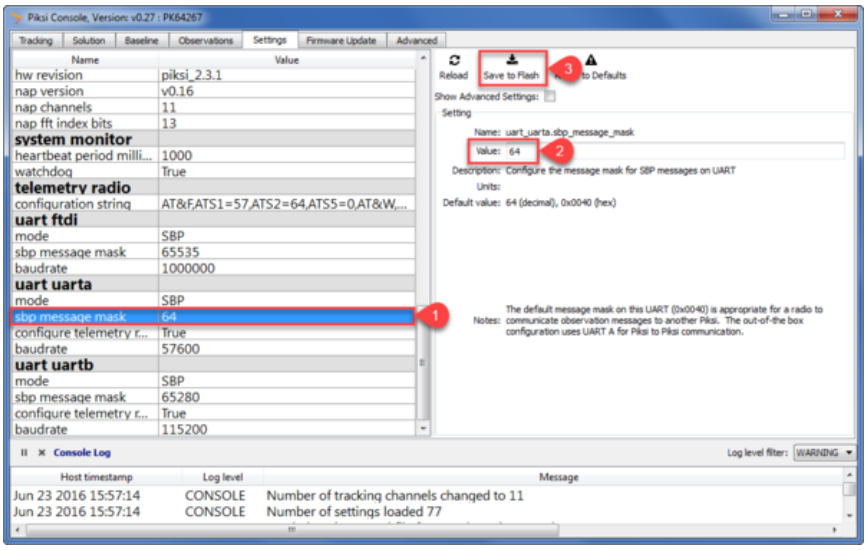
Checking Base Station Satellite Signals

Open Tracking tab. Wait until at least 5 satellites have signal strengths above 33 dB-Hz. The green LED light on Piksi will flash slowly once it has a Single Point Position solution.

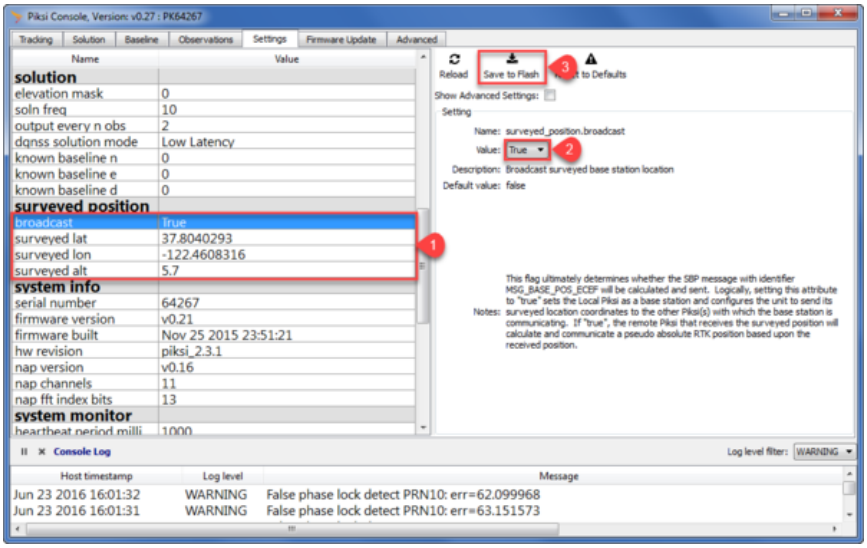


Configuring Base Station Messages

In the RTK system, the Base Station is transmitting its observations to the Rover. Open *Settings* tab, set UART A *sbp message mask* (1) to 64 (2) and click Save to Flash button (3). This will enable transmission of the base observations and this value is configured by default.



RTK GPS 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 and in *Surveyed Position* section (1) enter latitude, longitude, altitude and set broadcast to True (2). After setting all values click Save to Flash button (3).



Note: if the surveyed position is not available, you can use latitude, longitude and altitude from a *Single Point Position* on Solution tab. However, please remember that this is not a very accurate location and therefore your rover position will also not be very accurate.

Finishing Base Station Setup

At this point the Piksi base station setup is complete. Close Console, disconnect Piksi from the computer and power it up with a Power Pack. The green LED will flash when Piksi is receiving GPS signals.

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Rover Setup

- Place the antenna on a ground plane and secure it on a monopod or on other structure with an unobstructed sky view (follow the Antenna Placement Guidelines in section above).
- Connect the antenna cable to the Piksi board.
- Connect the radio antennas to the radio modem.
- Connect the radio modem to the Piksi UART A port.
  - If your kit contains RFD900+ radios, follow the RFD900+ Radio Integration Guide.
  - If your kit contains 3DR radios, follow the 3DR Radio Integration Guide.
- It is recommended to secure Piksi and radio together and attach them to the antenna monopod or a mast.
- Connect the Piksi board to your computer with the USB cable.

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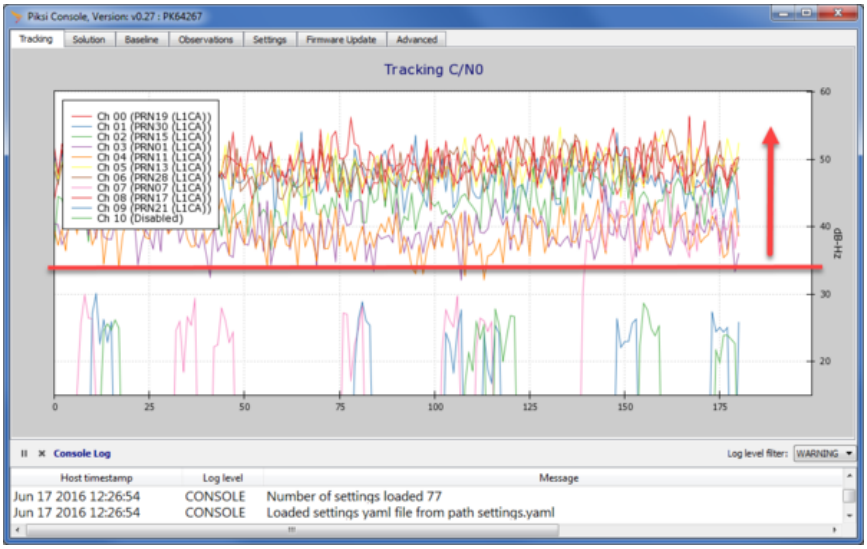
- Start the console software and connect to the Piksi receiver.

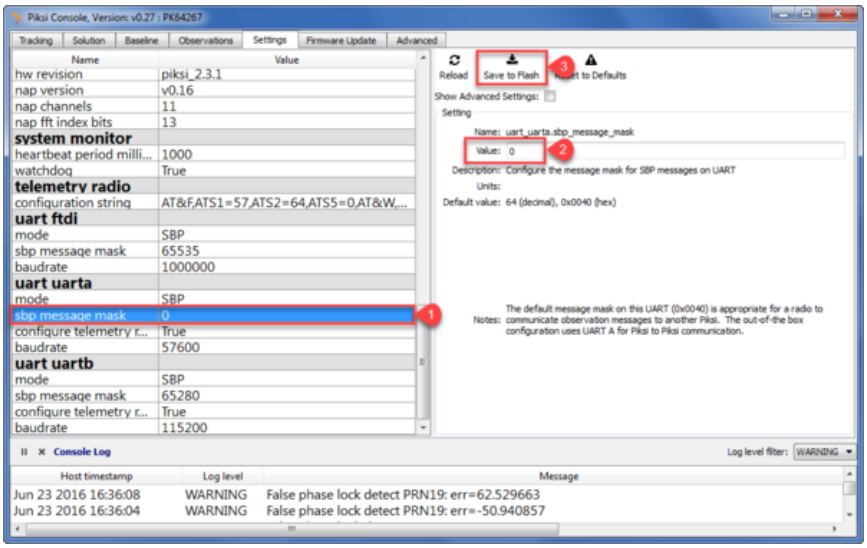
Checking Rover Satellite Signals

Open Tracking tab. Wait until at least 5 satellites have signal strength above 33 dB-Hz and Piksi computes a Single Point Solution. The green LED on Piksi will flash slowly once it has a solution (fix).



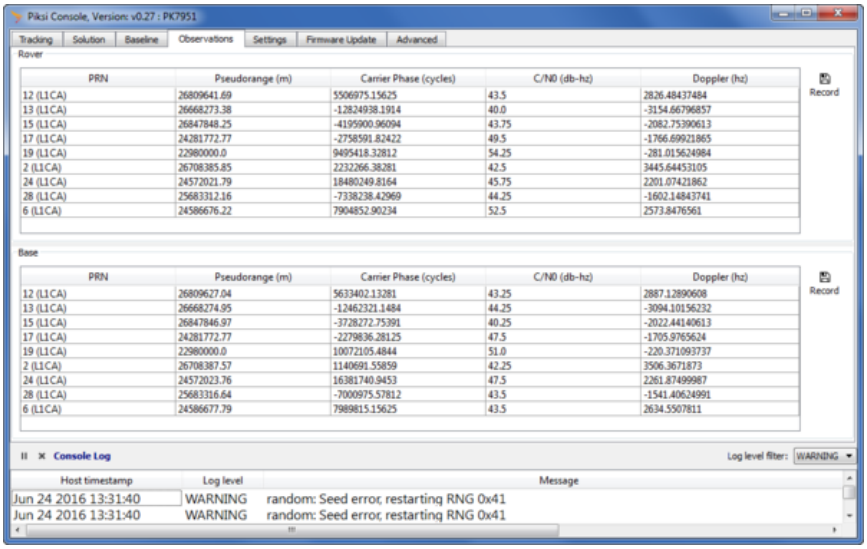
Configuring Rover Radio Messages

In the RTK system, the Rover is only receiving observations (corrections) from the Base Station. Open *Settings* tab, set UART A *sbp message mask* (1) to 0 (2) and click Save to Flash button (3). This will disable transmission of the rover observations.



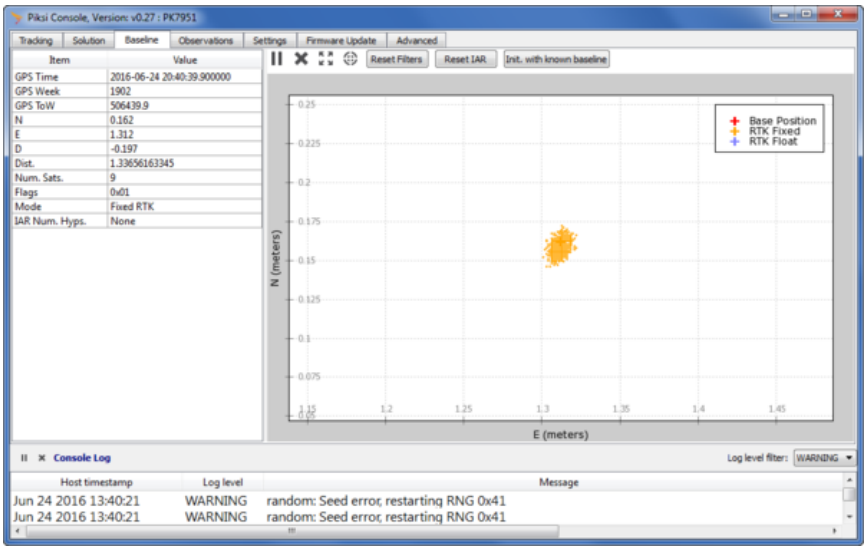
Checking Communication Between Piksis

The red LED on Piksi will flash when it correctly receives an observation data from the other Piksi (base station). Open Observations tab. You will see the rover's (Piksi connected directly) observations in the upper *Rover* table, and the observations that have been received over the radio from the other Piksi in the lower *Base* table. Wait until you can see at least 5 satellites in common between the Base and Rover.

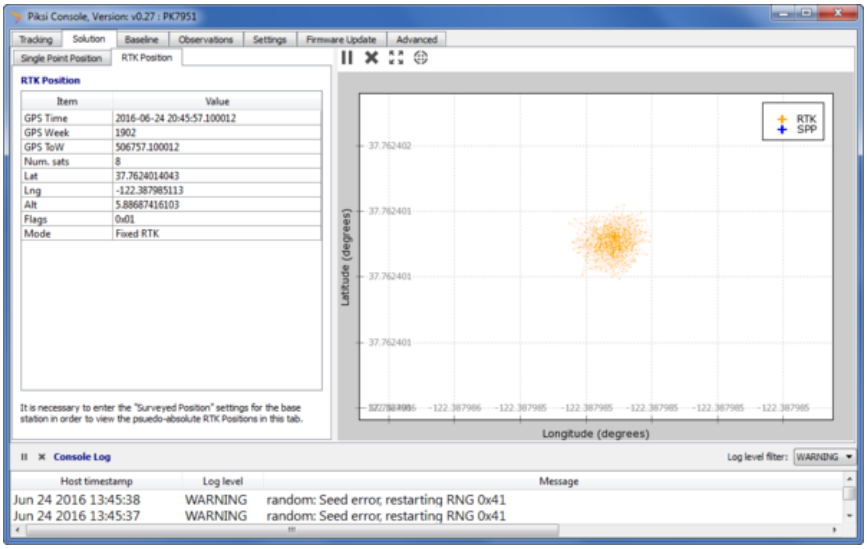


Viewing RTK Position Solution

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 eventually change to *Fixed* mode (most accurate). This transition should take about 10 minutes, but the exact time to get to Fixed will vary between a few minutes, up to 15 minutes. 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 Radio Messages in the Base Station setup above) you can see rover's position on the Solution - RTK Position tab.



Now you may take rover antenna, Piksi and computer to your hands and move around.

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Congratulations! You now know how to setup and use Piksi. To learn more, read the documentation posted here. If you are a developer and want to setup the toolchain to build firmware for Piksi, see the Piksi Developer Getting Started Guide.
