S100 RTK RECEIVER USER GUIDE

Version 1.17

October 26, 2020

Table of Contents

1 Overview

1-1 Introduction

S100 is a high performance dual-frequency RTK receiver with Bluetooth and USB interface. It offers centimeter-level positioning accuracy suitable for surveying, mapping, and GIS data collection.

By default, S100 is shipped as RTK rover to accept RTCM3.x message or SkyTraq carrier phase raw measurement data from an RTK base, and provides centimeter-level accurate position result relative to the RTK base in standard NMEA message format.

S100 can also be configured as a RTK base to provide RTCM3.x message or SkyTraq carrier phase raw measurement output.

S100 has two major interface for different applications: USB and Bluetooth. The USB interface is mainly for configuration, monitoring, and supplying power. With Bluetooth V2.1+EDR function built-in, S100 can be used as external Bluetooth RTK receiver for Android Mobile Device to provide higher accuracy positioning than internal GPS.

1-2 RTK Operation Guideline

To provide centimeter-level RTK accuracy, S100 requires much better operating condition than conventional meter-level accuracy GPS receiver:

- Baseline distance between base and rover should be under 30Km.
- Open sky environment without interference and signal blockage
- Received signal level should be no less than 40dB/Hz.
- 10 or more satellites with elevation angles over 15 degrees
- Good satellite geometry with satellites spread over four quadrants of the sky.

1-3 S100 RTK Receiver Features

- Base or Rover Mode Configurable Using Polaris Connect App
- Supports GPS/QZSS L1/L2C, Beidou B1I/B2I, Galileo E1/E5b, GLONASS L1/L2 RTK Operation
- Supports USB and Bluetooth V2.1+EDR Interface
- On-Board 256MByte Flash Memory for Data Logging Post Processing
- RTK Position Horizontal Accuracy 7mm + 1ppm, Vertical Accuracy 14mm + 1ppm
- Maximum RTK Update Rate 10Hz
- Supports RTCM 3.x Messages
- NMEA Output
  - Update Rates：1 / 2 / 4 / 5 / 8 / 10 Hz for RMC / GGA / VTG / PSTI-030
  - Messages：GGA / GLL / GSA / GSV / RMC / VTG / ZDA / PSTI
- Baud Rate
  - Bluetooth：115200
  - USB：4800 / 9600 / 19200 / 38400 / 57600 / 115200, default 115200
- Power Consumption
  - 280 mA @ 5V
- Weight：460 g

2 USB Interface

a

b

c

d

Figure 2-1

Connect S100's 4-pin socket (Figure 2-1 a) with the included accessory USB cable (Figure 2-1 b). The S100 USB cable is used for

1. Supplying power from power bank (Figure 2-1 d)
2. Firmware update using Windows PC (Figure 2-1 c)

3 Preparing for First-Time Use

A tutorial video showing the process of setting up S100 to perform RTK surveying with Mobile Topographer from very beginning can be found here

https://www.youtube.com/watch?v=6FXFHmiqboE

3-1 Install "Polaris Connect" App

Install Android app "Polaris Connect for S100 RTK Receiver" from Google Play. It can be found with this QR Code.

3-2 Install USB Driver

USB driver needs to be installed before updating S100 Receiver firmware. Download it from:

https://www.silabs.com/products/development-tools/software/usb-to-uart-bridge-vcp-drivers

3-3 Check S100 Receives Satellite Signal

Below steps bring up S100 as a normal USB-interface GNSS receiver to receive satellite signal:

1. Place S100 at a location having good sky view. Connect S100 with PC using the included USB cable.
2. Pair phone with the S100, which has a Bluetooth device name starting with "S100". See Figure 3-1.

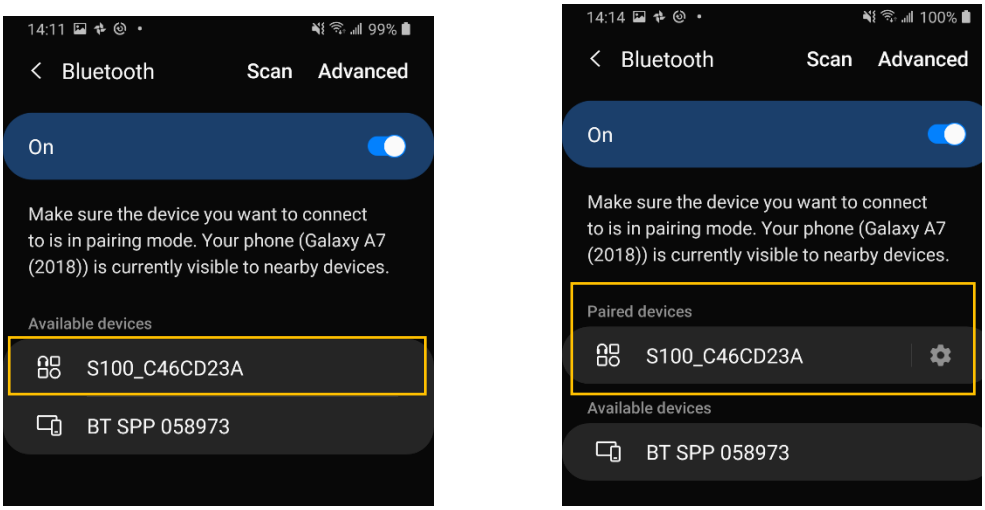


Figure 3-1

3. Launch Android app “Polaris Connect”, and selected the paired S100 device. See Figure 3-2.

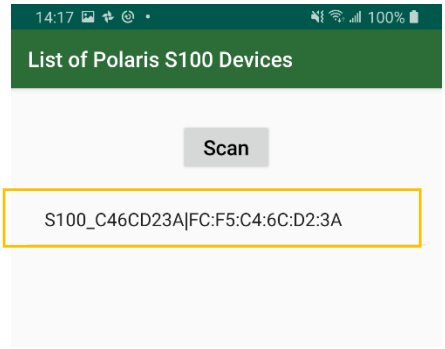


Figure 3-2

4. Start “USB Input Rover” mode. The app closes when S100 is configured to USB Rover. See Figure 3-3.

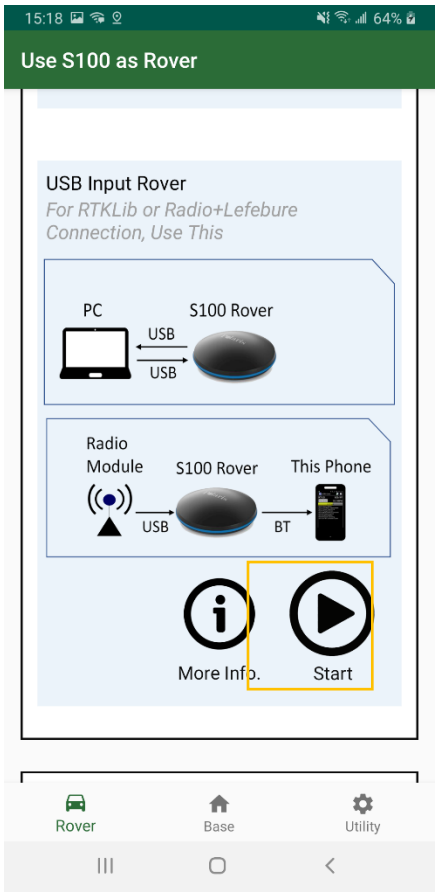


Figure 3-3

5. On a PC, install and open S100 Viewer. In S100 Viewer, a dialog box for COM port and baud rate will appear. Click “Connect”. See Figure 3-4.

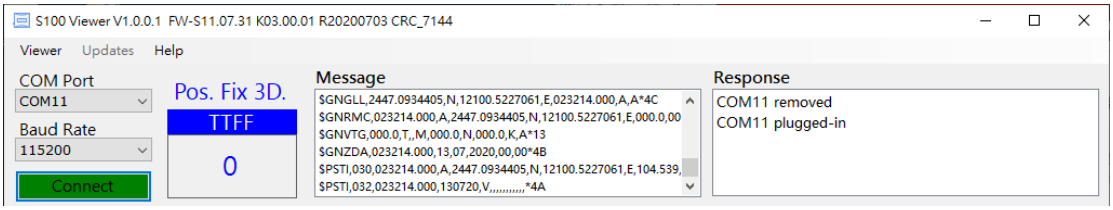


Figure 3-4

6. NMEA output should be seen on the Message screen. If having good sky view with sufficient number of satellites tracked, the signal bar will turn solid and have position fix. See Figure 3-5.

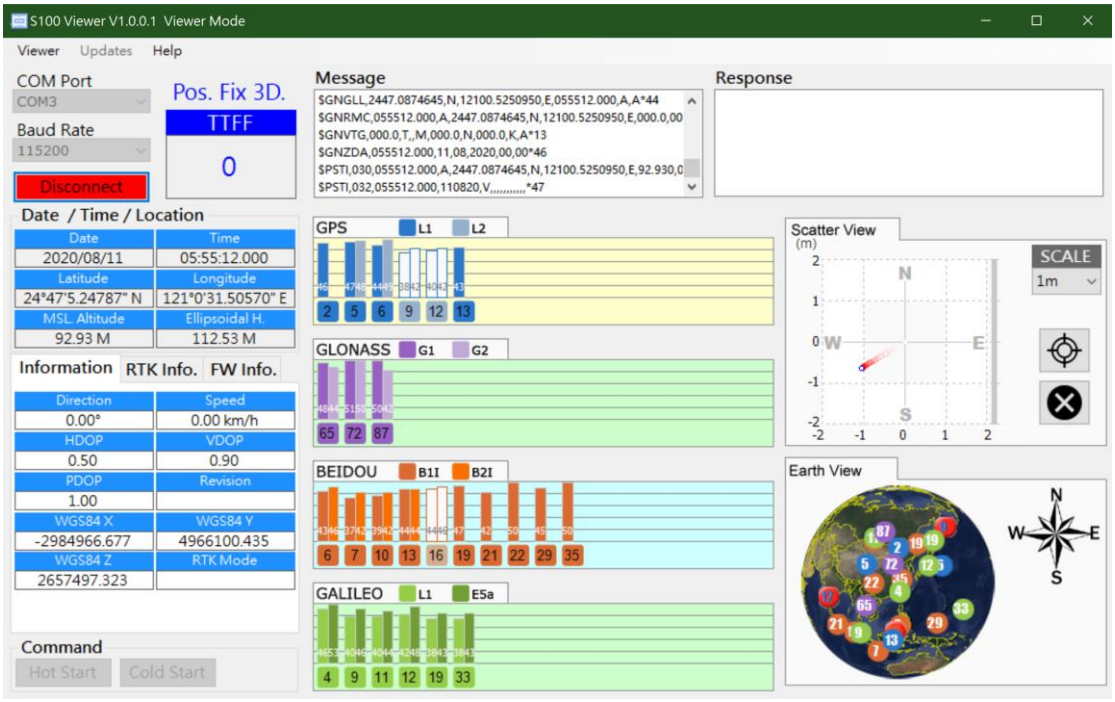


Figure 3-5

4 RTK Rover Operation

S100 RTK rover works with carrier phase measurement, using fractional part of ~19 centimeter wave length GNSS signals and differential principles to achieve centimeter-level position accuracy relative to the RTK base.

Referring to figure 4-1, S100 receives RTK base correction data over Internet via NTRIP Client running on the Android phone. S100 uses this correction data along with signals received from satellites to calculate its precise position and output position / velocity / time information in NMEA-0183 format.

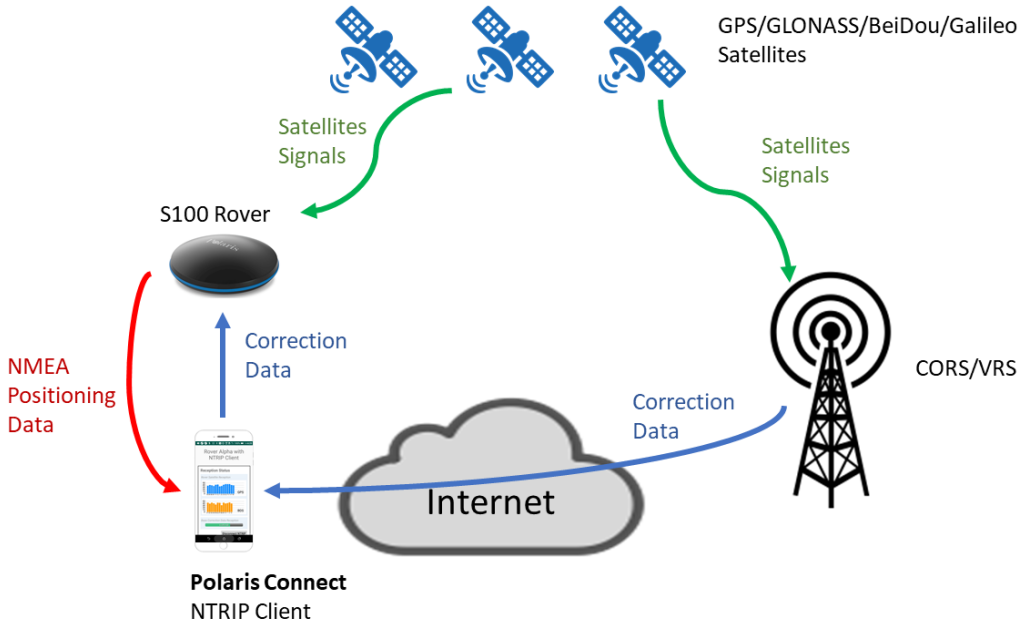


Figure 4-1

The most common way to use S100 for RTK surveying is to adopt a 3rd party RTK correction service, then only one S100 RTK receiver is needed.

S100 is configured as RTK rover and connects to an Android smartphone via Bluetooth. User can then run the free "Polaris Connect" app, or "Lefebure NTRIP Client" app, on the smartphone for retrieving 3rd-party RTK base correction data over Internet and sending it to the S100 RTK receiver. ***With "MOCK Location" option enabled on the Android smartphone, 3rd party GIS app for survey data collection can be used, achieving centimeter-level RTK accuracy.***

The S100 can be used as Bluetooth RTK rover or USB RTK rover. The operations to configure and start RTK rover are described in this section.

For Bluetooth RTK rover, user can choose to use Polaris Connect app's built-in NTRIP client feature (section 4-1) or third-party NTRIP client like Lefebure NTRIP Client app (section 4-2).

For USB RTK rover, the operations are described in section 4-3..

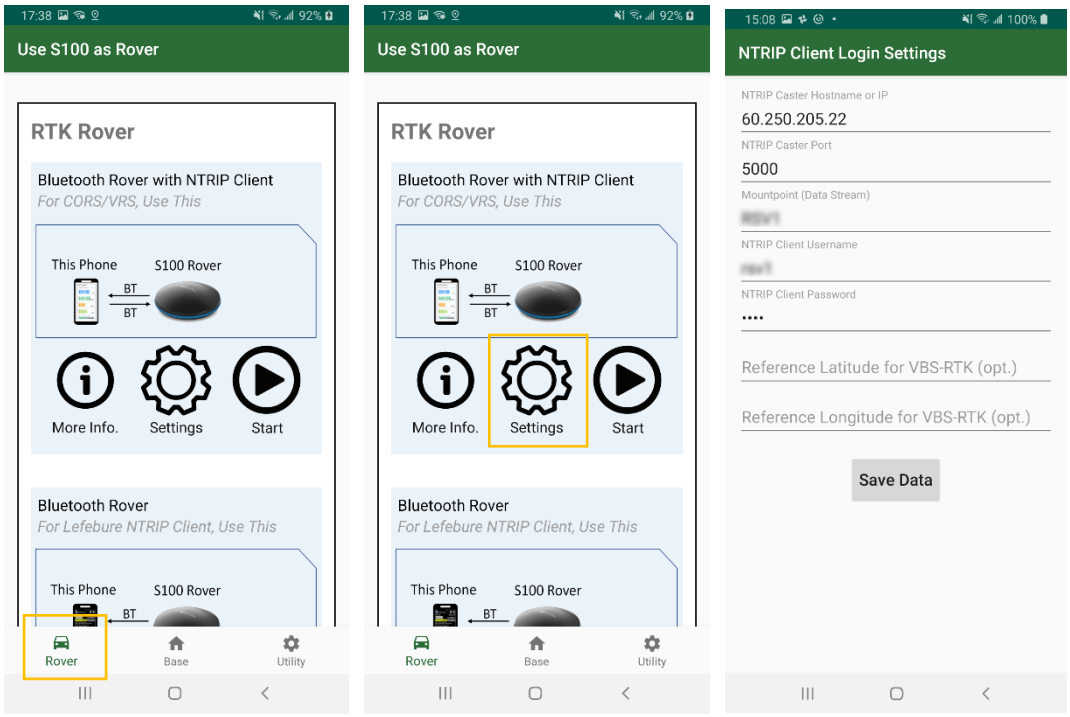
Other possible but less used RTK usage scenarios are described in Appendix A-1.

4-1 Bluetooth RTK Rover to Work with App-Built-In NTRIP Client

The S100 RTK Receiver, when configured as a Bluetooth RTK Rover, can receive RTK correction data from RTK correction service, going through Polaris Connect app, as previously shown in Figure 4-1.

Follow below steps to configure S100 to receive correction data via Bluetooth interface with built-in NTRIP client of the Polaris Connect app.

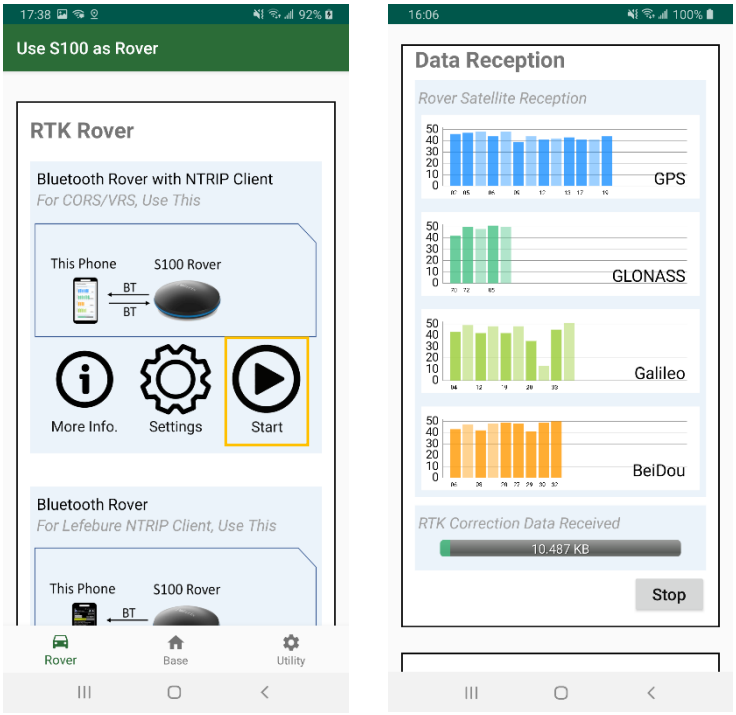
1. Switch to Rover tab in the app. See Figure 4-2 a
2. Click Settings (Figure 4-2 b) and configure NTRIP log-in information (Figure 4-2 c). The log-in information should be obtained from RTK correction service provider.



a b c

Figure 4-2

3. Click Start of “Bluetooth Rover with NTRIP Client” and then app starts receiving correction data. See Figure 4-3 a b.



a b

Figure 4-3

4-2 Bluetooth Rover to Work with Third-party NTRIP Client App

The S100 RTK Receiver, when configured as a Bluetooth RTK Rover, can receive RTK correction data from RTK correction service, going through a third-party NTRIP client service, e.g. Lefebure NTRIP Client app, as shown in Figure 4-4.

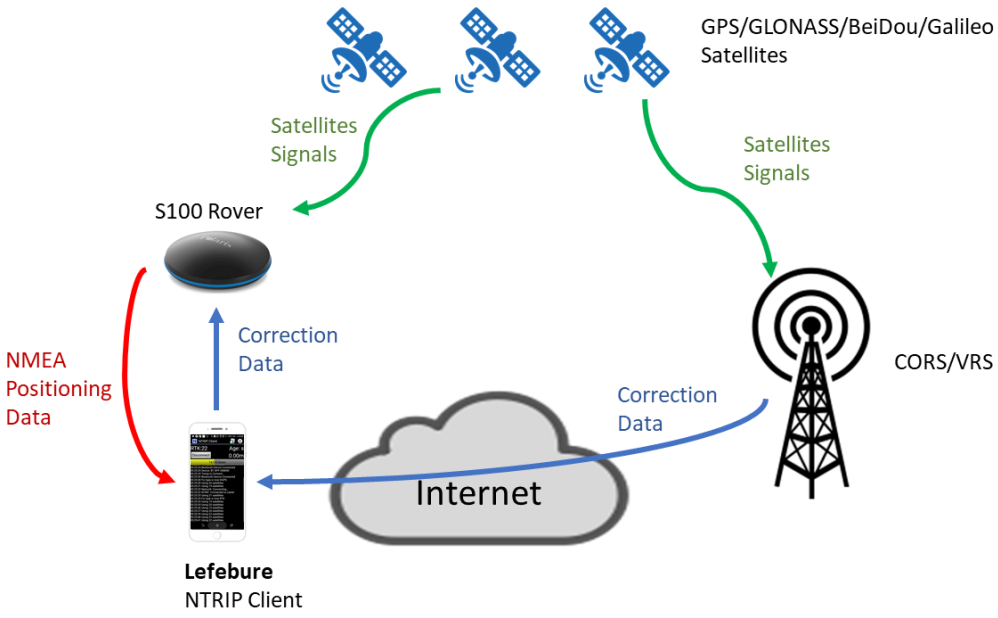
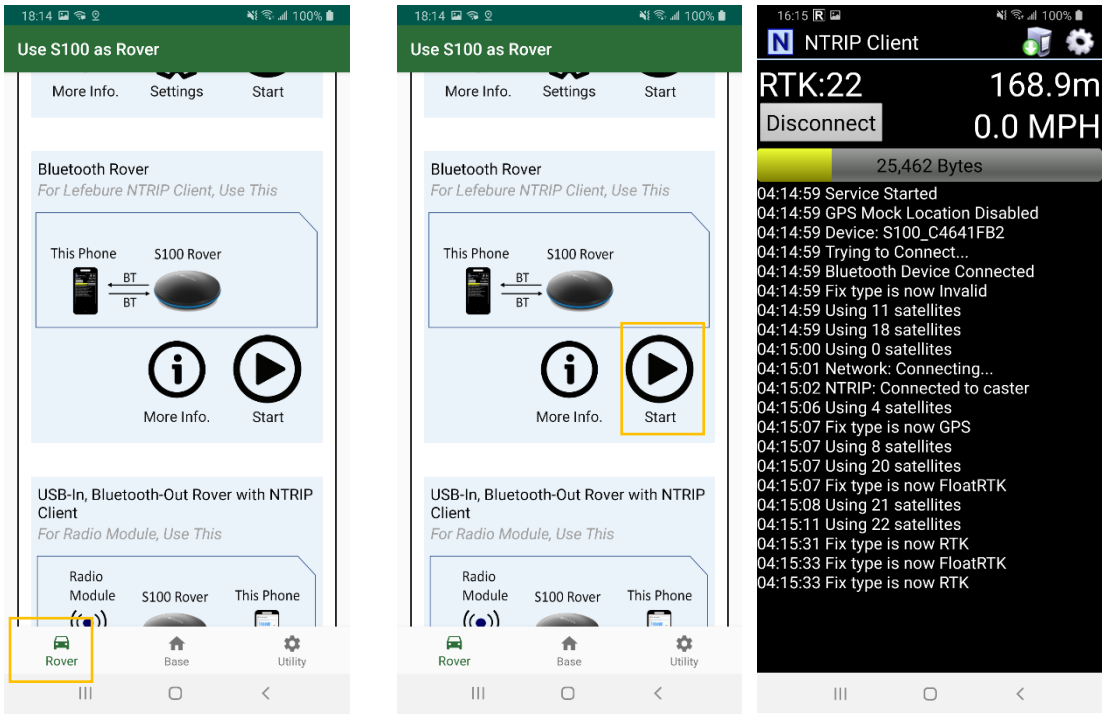


Figure 4-4

Follow below steps to configure S100 to receive correction data from third-party NTRIP client app like Lefebure NTRIP Client, via Bluetooth. The Polaris Connect app closes as soon as the S100 starts to work as Bluetooth RTK rover.

1. Switch to Rover tab in the app. See Figure 4-5 a
2. Click Start of “Bluetooth Rover”; the app Polaris Connect will be closed. See Figure 4-5 b
3. Start third-party NTRIP client app to receive RTK correction data, sends it to S100, and receive position data stream from S100. See Figure 4-5 c.
4. If needing more information on how to use Lefebure NTRIP client app, refer to Appendix A-2-4.



a b c

Figure 4-5

4-3 USB Rover

The S100 RTK Receiver, when configured as USB RTK Rover, can receive RTK correction data from NTRIP client running on a PC, e.g. strsvr of RTKLIB, as shown in Figure 4-6.

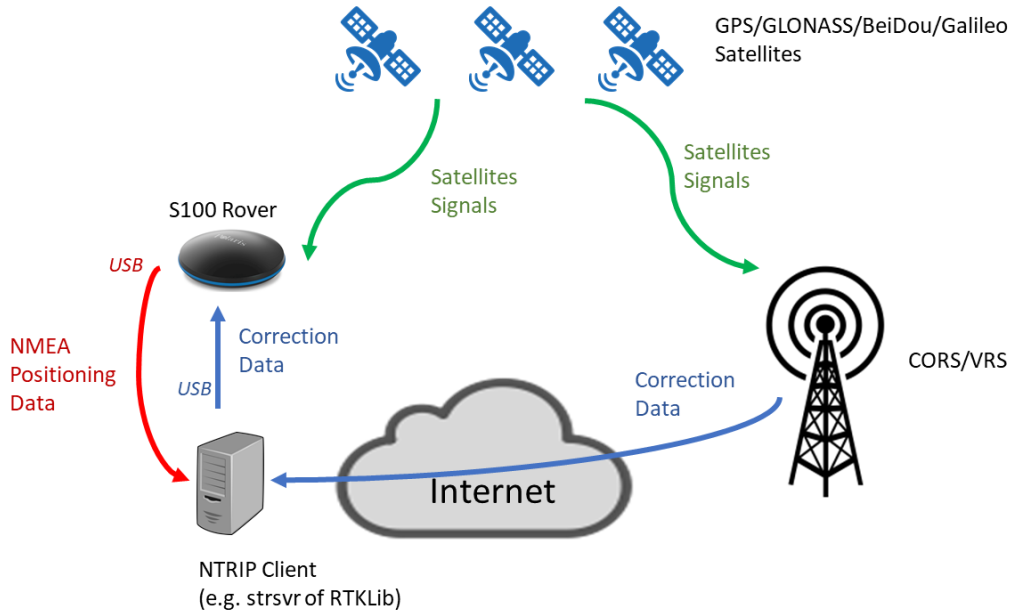


Figure 4-6

Follow below steps to configure S100 to receive correction data via USB interface. The app closes when the S100 starts to work as USB RTK rover.

1. Make sure S100 is connecting with PC via USB interface.
2. Switch to Rover tab in app. See Figure 4-7 a
3. Click Start of “USB Input Rover”; the Polaris Connect app will close. See Figure 4-7 b
4. Start third-party tool, e.g. strsvr of RTKLIB, to receive RTK correction data, sends it to S100, and receive position data stream from S100. See Figure 4-7 c.

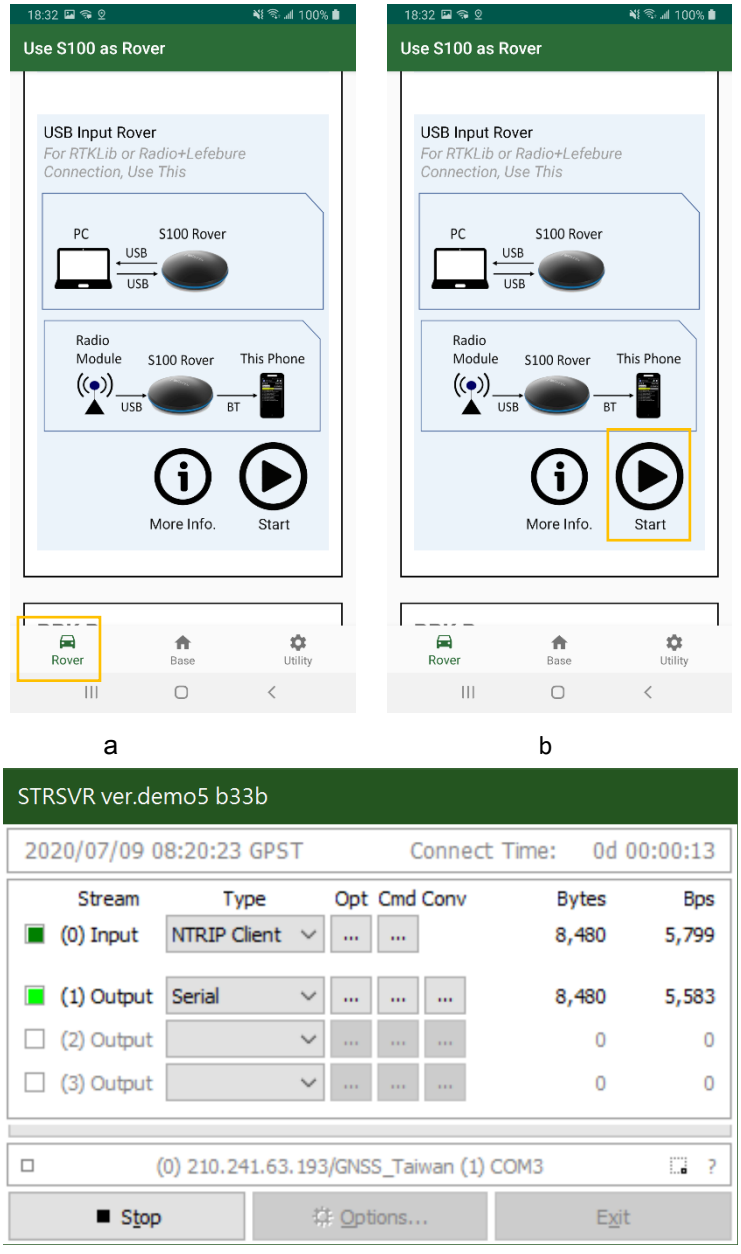


Figure 4-7

5. COM port splitter program will be needed to enable another program to share the same COM port to use the NMEA output.

5 Raw Measurement Recording and Post Processing

Raw measurement data logged on S100 RTK receiver is used for PPK and PPP processing. Sections 5-1 and 5-2 relate to these two types of post processing. How to obtain raw measurement data from S100 is described in section 5-3.

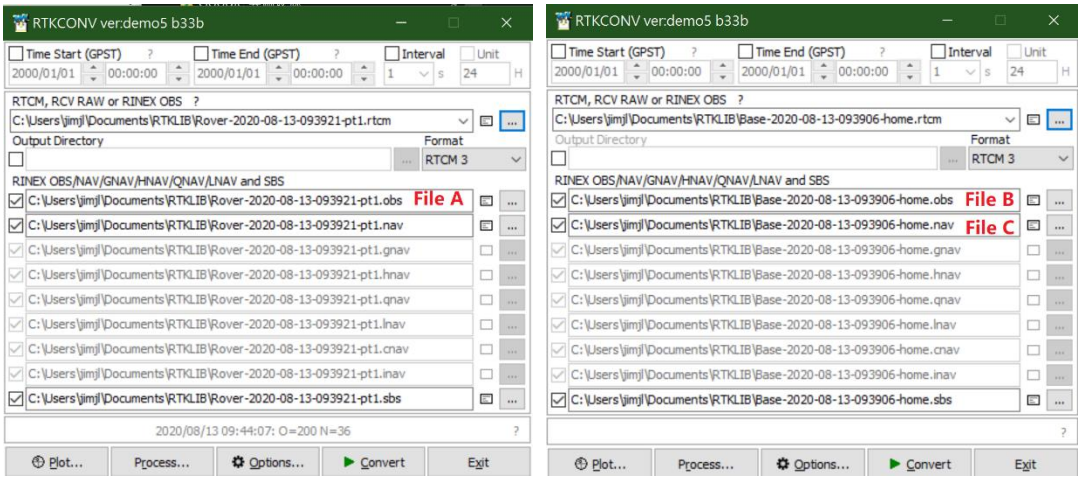
5-1 Preparing for PPK

For Post-Processed Kinematic (PPK) calculations, both **base data** and **rover data** need to be available. The base data can be (1) stored RTCM data received from RTK correction service or (2) stored RTCM data received from another S100 RTK base; the rover data is the stored RTCM data from S100 RTK rover.

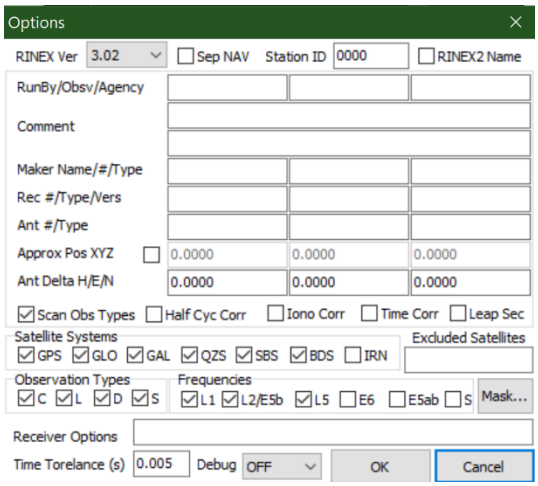
Refer to section 5-3 on how to log and obtain RTCM data on S100 receiver.

To perform PPK, files in standard RINEX format are needed. The logged RTCM data can be converted to RINEX formats (2.01 – 3.03) using RTKLIB's RTKCONV program. See Figure 5-1 a, b.

For reference Options window of RTKCONV is shown in Figure 5-1 c.



a b



c

Figure 5-1

Converting the RTCM file with rtkconv.exe, user can get a RINEX file with extension "**obs**" and a RINEX file with extension "**nav**". The three files (two OBS files and either one of the two NAV files) are used in RTKLib PPK tool "rtkpost.exe". See Figure 5-2.

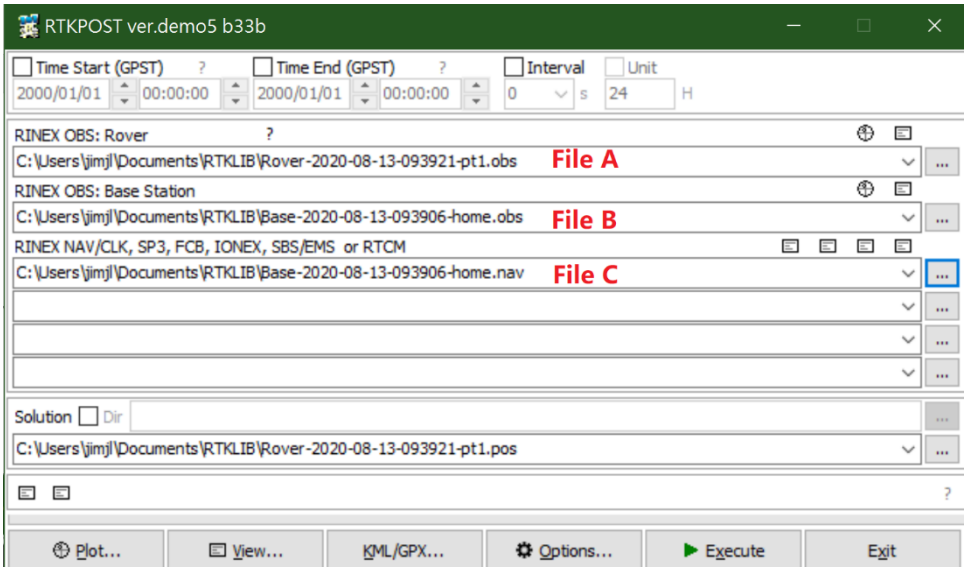
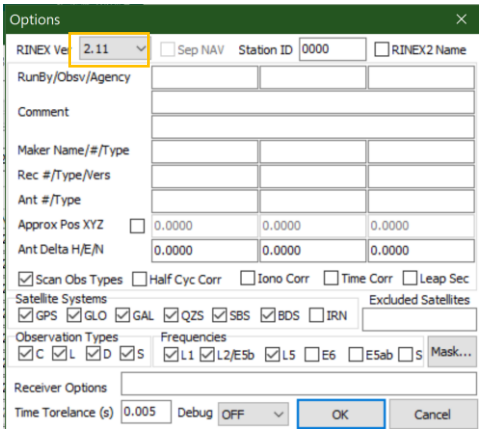


Figure 5-2

5-2 Preparing for PPP

For some online Precise Point Positioning (PPP) service, older RINEX 2.11 format data is required; a minor modification on converted RINEX file may be needed. Follow below steps to prepare RINEX file for sending to online PPP service.

1. Log and obtain RTCM data (see section 5-3)
2. Use v.2.4.3 RTKLib's RTKCONV program to convert the logged RTCM data to RINEX 2.11. Select proper constellations and frequency bands the online PPP service uses; will then get a RINEX format file *.obs. See Figure 5-3 a.
3. Edit the output *.obs file, and modify the string "C2" to "P2" on about 13th line. See Figure 5-3 b.



a

```
     2.11           OBSERVATION DATA    M (MIXED)           RINEX VERSION / TYPE
RTKCONV demo5 b33b                      20200730 031254 UTC PGM / RUN BY / DATE
log: C:¥Users¥jimjl¥Desktop¥Base-2020-07-29-114351-ppp.rtc  COMMENT
format: RTCM 3, station ID: 0                               COMMENT
0000                                                        MARKER NAME
                                                            MARKER NUMBER
                                                            OBSERVER / AGENCY
unknown             SKYTRAQ             03.00.01,11.07.31,9bREC # / TYPE / VERS
                                                            ANT # / TYPE
 -2984969.8489  4966110.7650  2657494.8769                  APPROX POSITION XYZ
       0.0000        0.0000        0.0000                  ANTENNA: DELTA H/E/N
    1    1                    P2                            WAVELENGTH FACT L1/2
   12   C1    L1    D1    S1   C2    L2    D2    S2    C7# / TYPES OF OBSERV
        L7    D7    S7                                      # / TYPES OF OBSERV
 2020    7   29   11   44   24.0000000     GPS         TIME OF FIRST OBS
 2020    7   30    1   59   55.0000000     GPS         TIME OF LAST OBS
                                                            END OF HEADER
20  7 29 11 44 24.0000000  0 22G15G18G20G21G24R 5R 6R15R16R20R21E 1
                           E 4E 9E11E36C 8C13C19C21C22C36
 21861149.323  114881103.796       -931.501         45.000    21861151.906
 89517772.697       -725.851         43.000
```

b

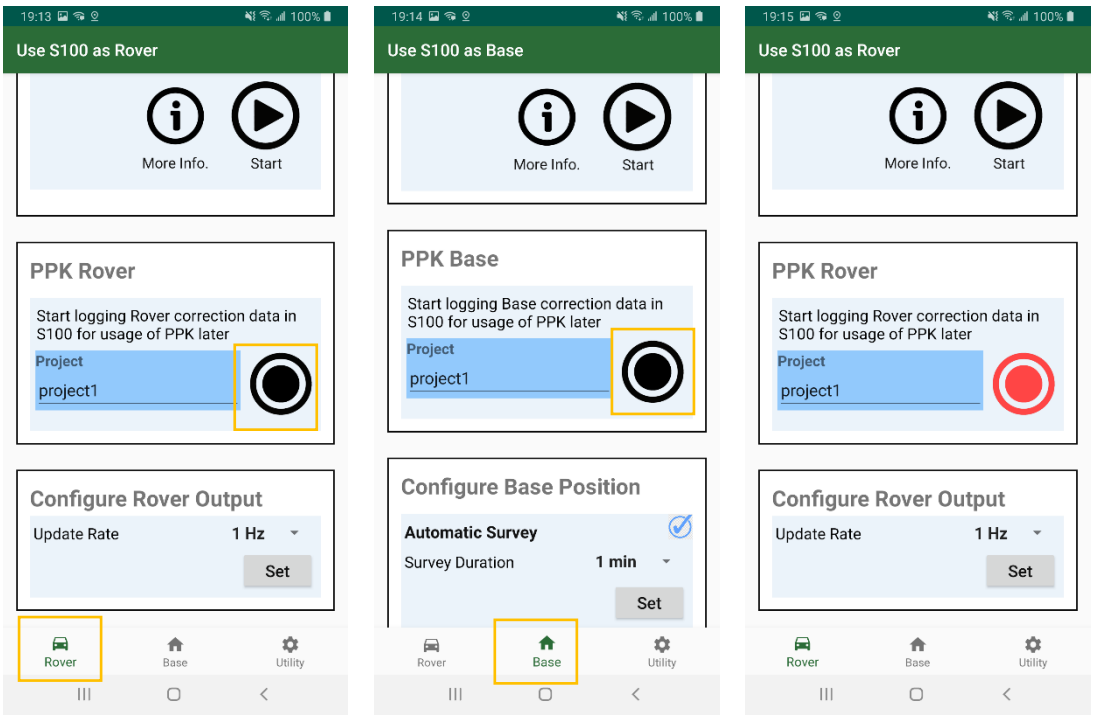
Figure 5-3

5-3 Obtaining Log Data from S100

The steps to generate, access, and manage log data with S100 are described below.

To generate log data of base and rover, follow below steps.

1. In rover or base tab, click the black REC button to start S100 to record raw measurement data in its flash memory. See Figure 5-4 a, b.
2. When S100 start to record raw measurement data, the REC button becomes red and flicks. See Figure 5-4 c.
3. Click red REC button again to stop recording.

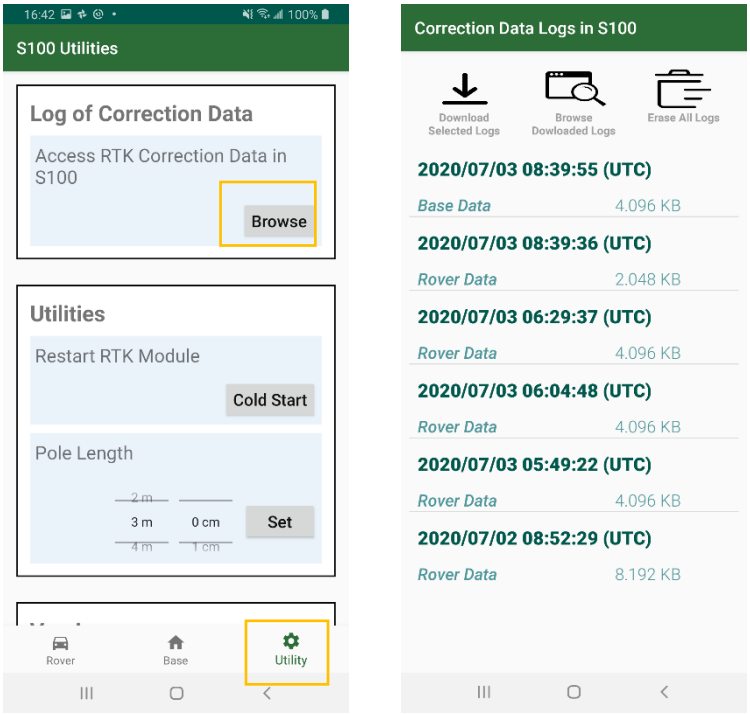


a b c

Figure 5-4

To check the log data in S100's flash memory, follow below steps.

1. Click Utility and Browse. See Figure 7-5 a.
2. The information of recorded measurement data, including the start time, base or rover and file size, is then displayed. See Figure 7-5 b.

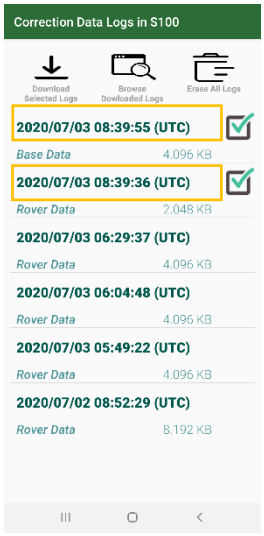


a b

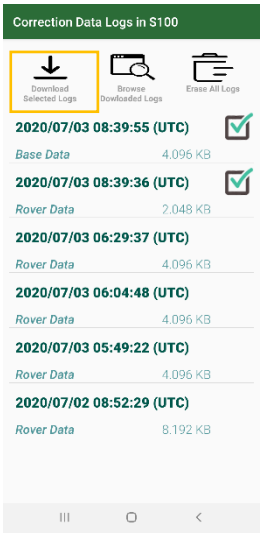
Figure 7-5

To download the log data to smartphone, follow below steps.

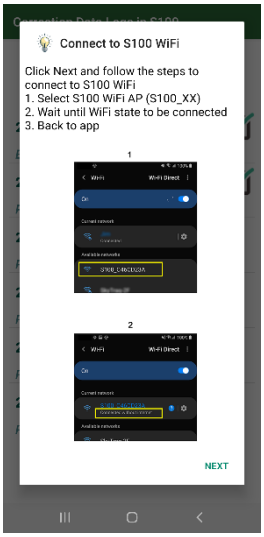
1. Select the log data to download by clicking its date field. The selected files are then marked. See Figure 7-6 a.
2. Click “Download Selected Logs”. See Figure 7-6 b.
3. A pop-up window shows how to connect to S100 via WiFi connection. Read the instructions and click Next. See Figure 7-6 c.
4. You’ll be brought to system’s WiFi configuration screen. Select the WiFi AP whose name starts with “S100” and make sure the phone is connected with it (no Internet capability during log file transfer). See Figure 7-6 d.
5. Click Back button. See Figure 7-6 e.
6. The file transfer starts, and you will be prompted when it finishes. See Figure 7-6 f.



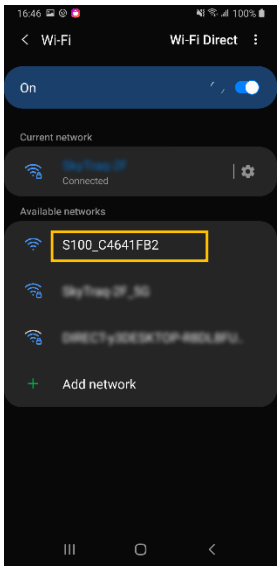
a



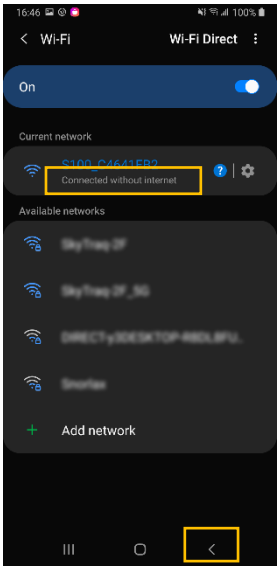
b



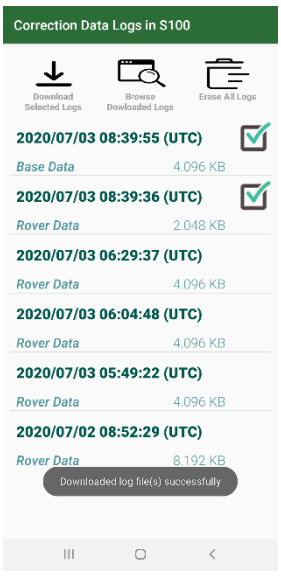
c



d



e

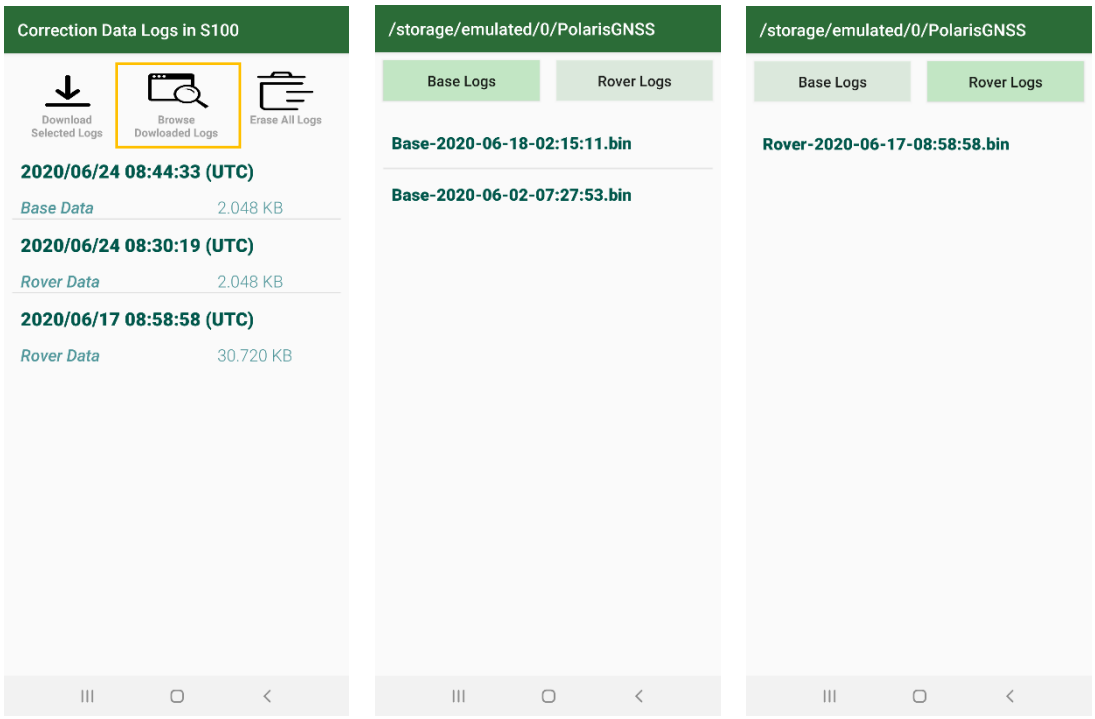


f

Figure 7-6

To check the downloaded log data on smartphone's memory, follow below steps.

1. Click "Browse Downloaded Logs". See Figure 7-7 a.
2. The downloaded raw measurement base data is then displayed. See Figure 7-7 b.
3. Click "Rover Logs" to check rover raw measurement data. See Figure 7-7 c.



a b c

Figure 7-7

To access the raw measurement data from PC, follow below steps.

1. Connect the phone with PC, then select the folder "PolarisGNSS" in the popped-out File Explorer. See Figure 7-8
2. Copy/Move/Delete operation can be performed on the measurement data.

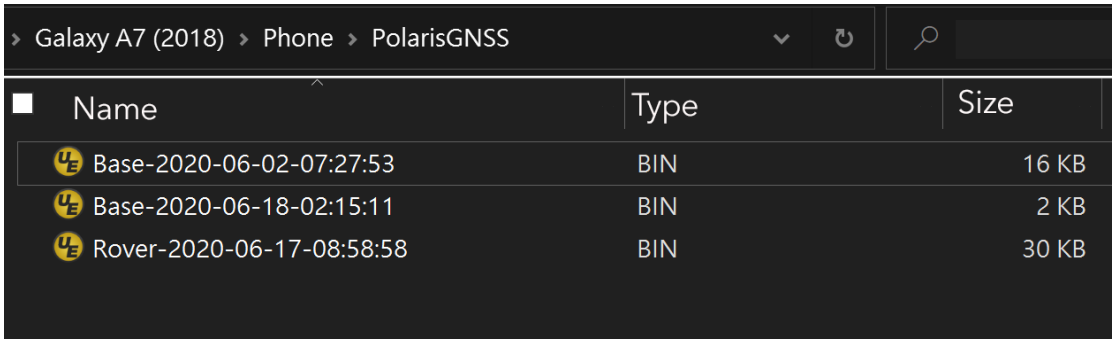


Figure 7-8

To erase all the recorded raw measurement data on S100, follow below steps.

1. Click “Erase All Logs”. See Figure 7-9.
2. All log files will be eased.

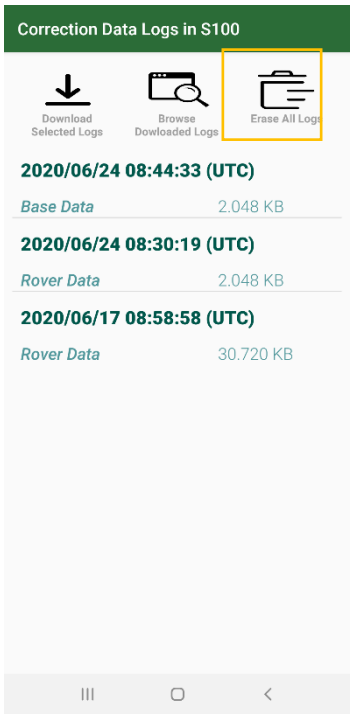


Figure 7-9

6 Software and Firmware Update

S100 Viewer is a PC software for S100 RTK Receiver firmware update. It can be downloaded form http://www.polaris-gnss.com/s100/s100-viewer.zip

Occasionally, for improved product performance and user experience, there may be updates for

1. S100 Viewer software
2. S100 RTK receiver firmware
3. S100 Bluetooth module firmware

User can manually check and update them using Polaris Connect app and S100 Viewer on computer with Internet connection.

6-1 S100 Viewer Software Update

Select “Check S100 Viewer Update” from the Viewer pull-down menu and follow the instruction to update S100 Viewer if an update is released.

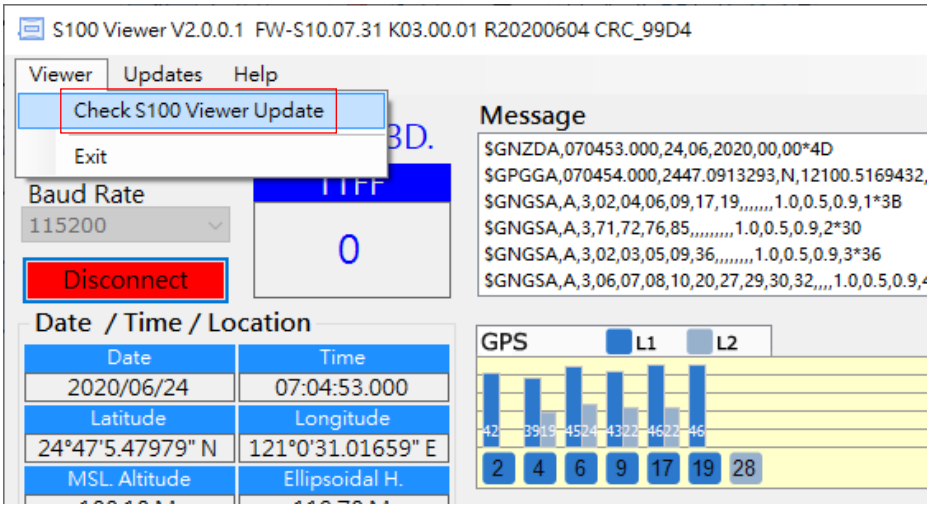


Figure 8-1

6-2 S100 RTK Receiver Firmware Update

Videos showing procedure of updating S100 RTK Receiver firmware can be found here:

https://www.youtube.com/watch?v=WrAUKF84KZU(1/2)

https://www.youtube.com/watch?v=A3NPLYP_EKA(2/2)

Follow below steps to update S100 firmware.

1. USB driver needs to be installed for updating S100 receiver firmware. Download it from: https://www.silabs.com/products/development-tools/software/usb-to-uart-bridge-vcp-drivers

2 Connect S100 with PC and start S100 Viewer software on PC. See Figure 6-2.

Figure 6-2

3 On Polaris Connect app, click Connect button on Utility-Version screen, this enables S100 RTK Receiver's firmware to be updated. The app will then be closed. See Figure 6-3.

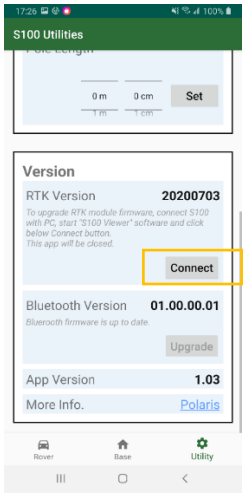


Figure 6-3

4 From S100 Viewer “Updates” pull-down menu, select “Check Firmware Update”, then a message box showing “checking for updates” will pop up. See Figure 6-4.

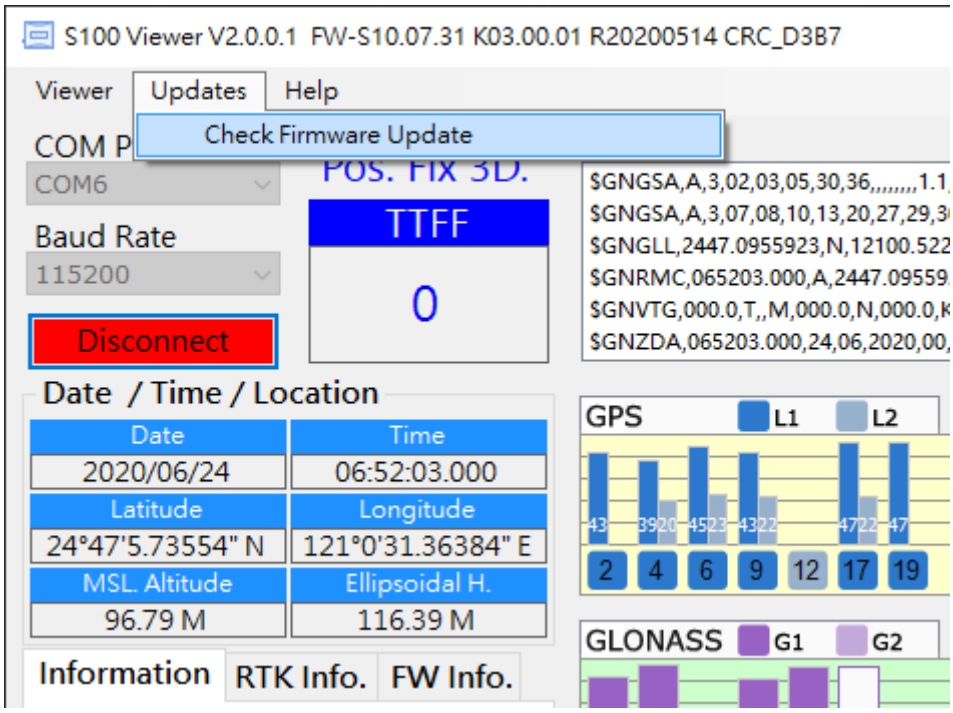


Figure 6-4

5 In case new update software is found, a dialog box will appear. Press “Download and Update” to update, or “No” to cancel update. See Figure 6-5.

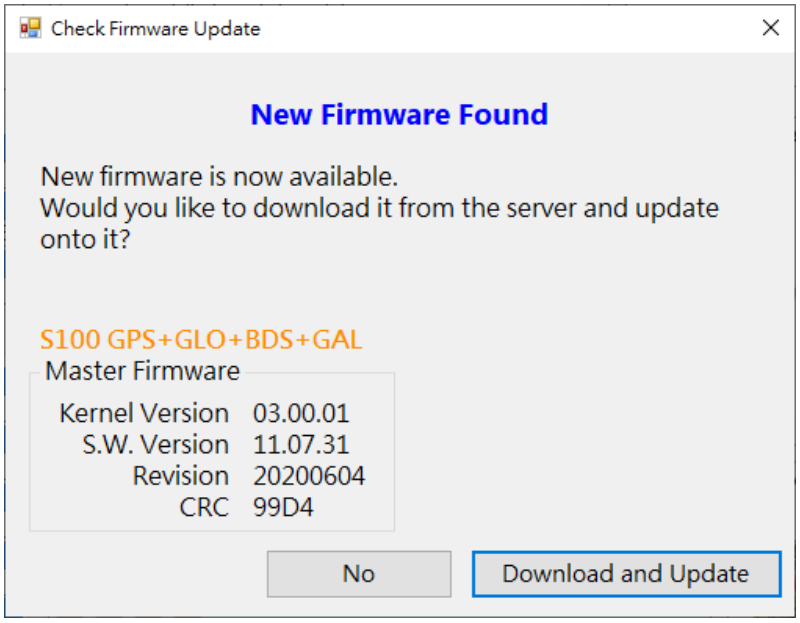


Figure 6-5

6 S100 Viewer will download the new firmware from Polaris' server and load it to S100, with the message box indicating software update status shown in Figure 6-6.

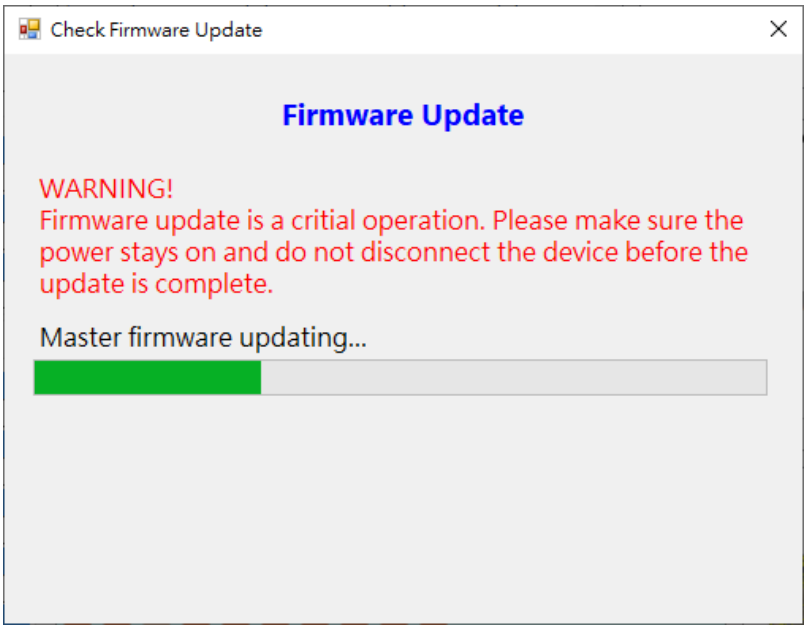


Figure 6-6

7 When software update is in progress, **DO NOT** remove the USB cable until software update is completed. See Figure 6-7.

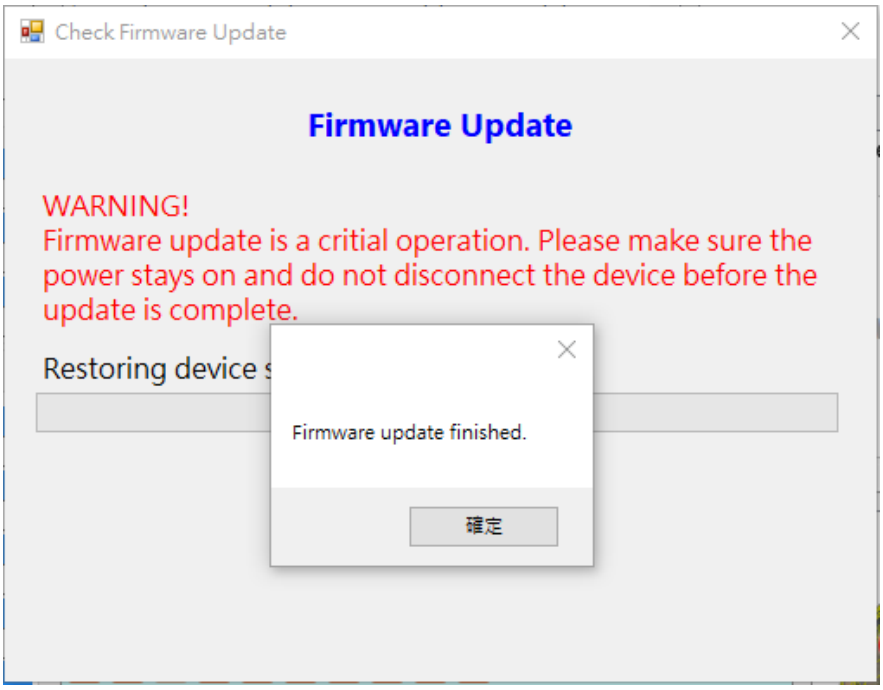
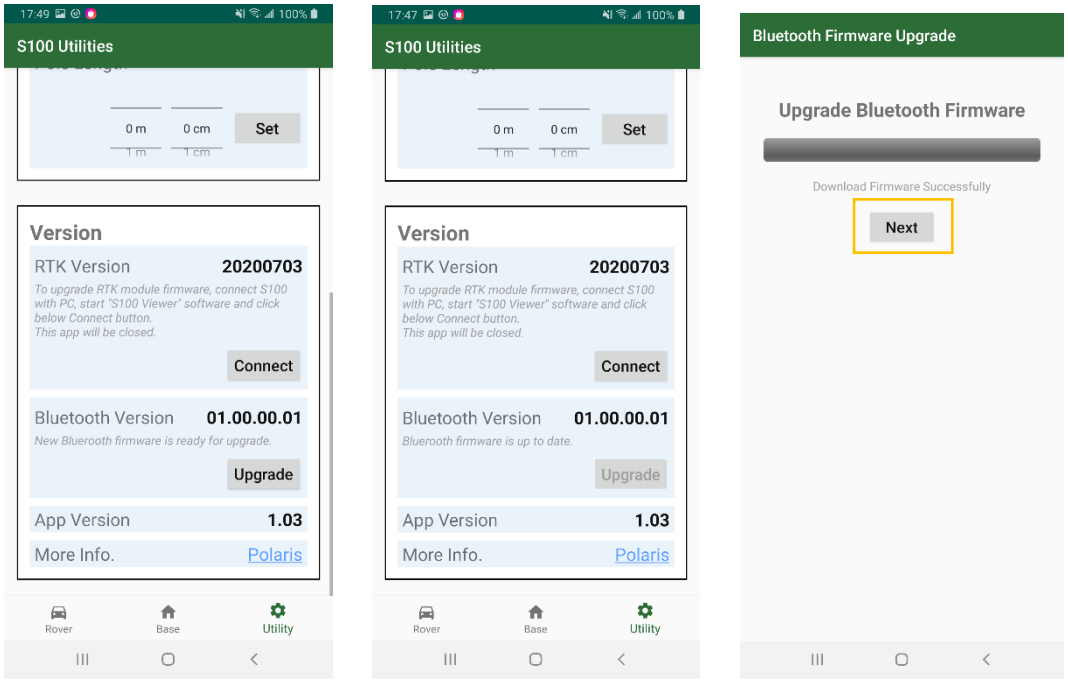


Figure 6-7

6-3 S100 Bluetooth Module Firmware Update

Bluetooth firmware is upgraded via WiFi connection. Follow below steps to update S100's Bluetooth module firmware.

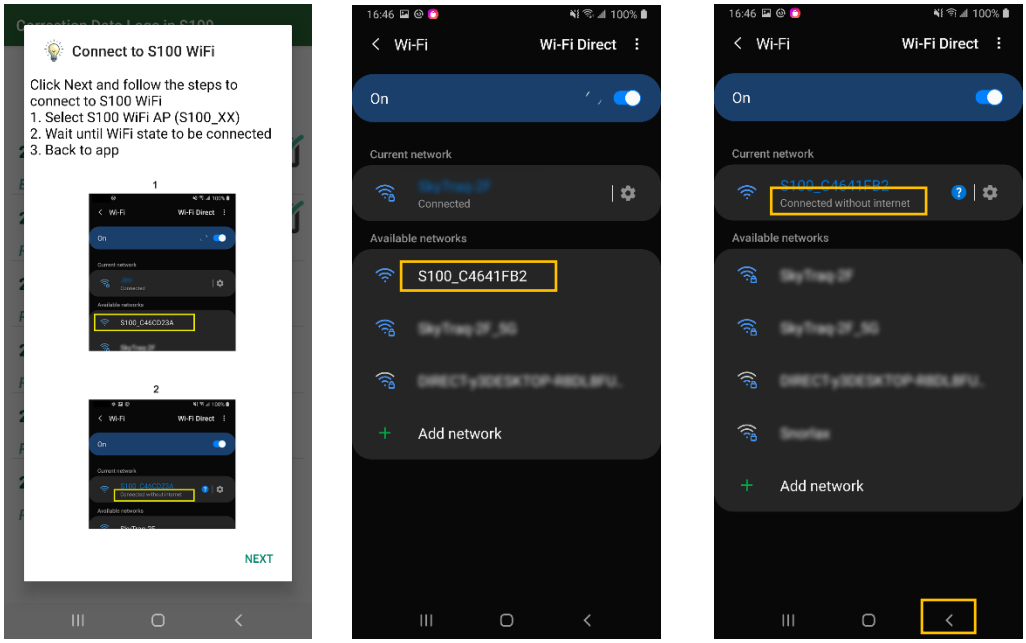
1. If a new version of Bluetooth firmware is available, the Upgrade button on Polaris Connect app's screen Utility-Version-Bluetooth Version becomes clickable (Figure 6-8 a), otherwise it is unclickable (Figure 6-8 b).
2. Clicking Upgrade button leads to Bluetooth firmware download page. Once the Bluetooth firmware is downloaded from server, a Next button appears. Click it to continue to do WiFi connection. See Figure 6-8 c.



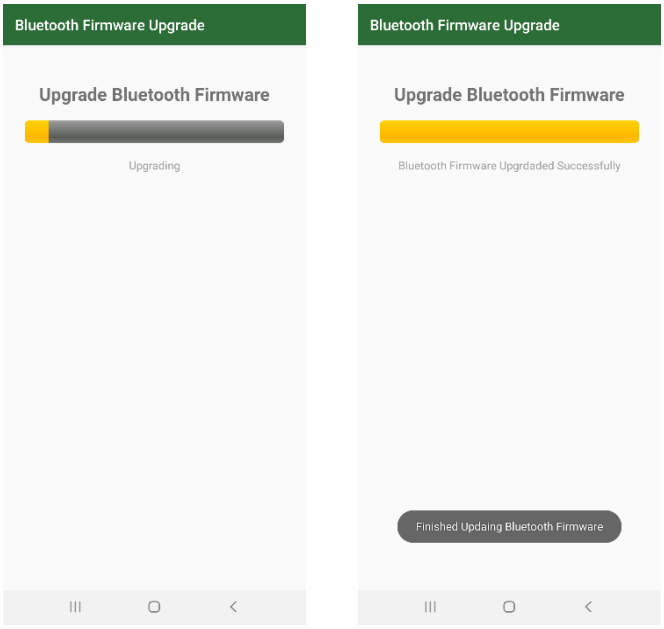
a b c

Figure 6-8

3. A pop-up window shows how to connect to S100 via WiFi connection. Read the instruction and click Next. See Figure 6-9 a.
4. You are brought to system's WiFi configuration screen. Select the WiFi AP whose name starts with S100 and make sure the phone is connected with it (without internet). Click Back button. See Figure 6-9 b c.
5. The Bluetooth firmware upgrade starts. You'll be prompted when it is in progress and finishes. See Figure 6-9 d e.



a b c



d e

Figure 6-9

7 Troubleshooting

Question #1: Why I'm unable to get RTK Fix when connecting to my local RTK correction service?

Answer #1: RTK correction service has several mountpoint options to select from, mountpoint with compatible format need to be chosen to work correctly. The mountpoint to choose for S100 are Virtual Reference Station **VRS** type, Nearest Station **NRT** type, or basic **RTCM3.x** type supporting 1004 / 1012 sentence, or MSM4 / MSM5 / MSM6 / MSM7 messages, but non-**FKP, non-MAC, non-MAX, non-iMAX, non-SSR, non-CMR, non-CMR+** ones.

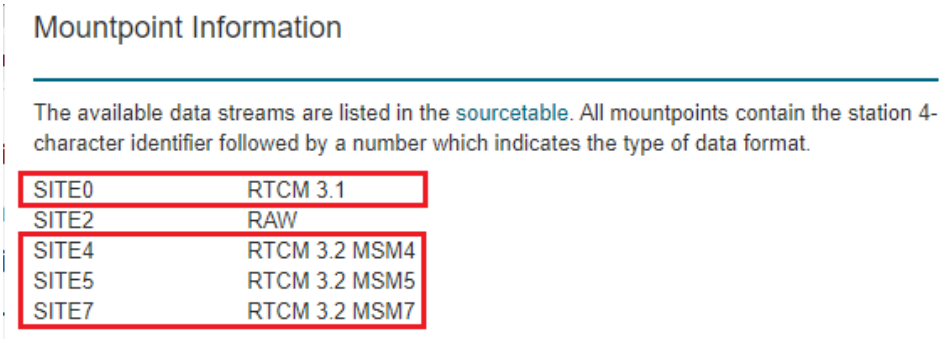
Supported MSM4 messages are 1074, 1084, 1094, 1124.

Supported MSM5 messages are 1075, 1085, 1095, 1125.

Supported MSM6 messages are 1076, 1086, 1096, 1126.

Supported MSM7 messages are 1077, 1087, 1097, 1127.

Example 1. Newer MSM4 / MSM5 / MSM7 formats are preferred over older RTCM 3.1 format.



Mountpoint Information

The available data streams are listed in the sourcetable. All mountpoints contain the station 4-character identifier followed by a number which indicates the type of data format.

SITE0	RTCM 3.1
SITE2	RAW
SITE4	RTCM 3.2 MSM4
SITE5	RTCM 3.2 MSM5
SITE7	RTCM 3.2 MSM7

Example 2. VRS (Virtual Reference Station) type is preferred over NRT (closest physical base station) type, as VRS has no operating range limit. S100 being GPS+GLO+GAL+BDS receiver, RTK base supporting more satellite constellation (GPS+GLO+GAL) is preferred over one supporting lesser satellite constellation (GPS+GLO).

Service	Mountpoint	Constellations	Stream data format
MAC RTCM 3.x	RTK_MAC/MAX_RTCM3	GPS+GLO	RTCM 3
VRS Galileo	GAL_VRS_MSM5	GPS+GLO+GAL	RTCM 3 (MSM5)
VRS RTCM 3.x	RTK_VRS_RTCM3	GPS+GLO	RTCM 3
VRS RTCM 2.3	RTK_VRS_RTCM2	GPS+GLO	RTCM 2.3
VRS CMR	RTK_VRS_CMR	GPS+GLO	CMR
VRS CMR+	RTK_VRS_CMR+	GPS+GLO	CMR+
iMAX Galileo	GAL_iMAX_MSM5	GPS+GLO+GAL	RTCM 3 (MSM5)
iMAX RTCM 3.x	RTK_iMAX_RTCM3	GPS+GLO	RTCM 3
FKP RTCM 2.3	RTK_FKP_RTCM2	GPS+GLO	RTCM 2.3
NRT Galileo	GAL_NRT_MSM5	GPS+GLO+GAL	RTCM 3 (MSM5)
NRT RTCM 3.x	RTK_NRT_RTCM3	GPS+GLO	RTCM 3

Example 3. FKP, MAC, RTCM23, SSR, VRS23, RTCM2.2 ones are not to be used. RTCM 3.2 with 1071 GPS MSM1 and 1081 GLONASS MSM1 are of incompatible type, not be used.

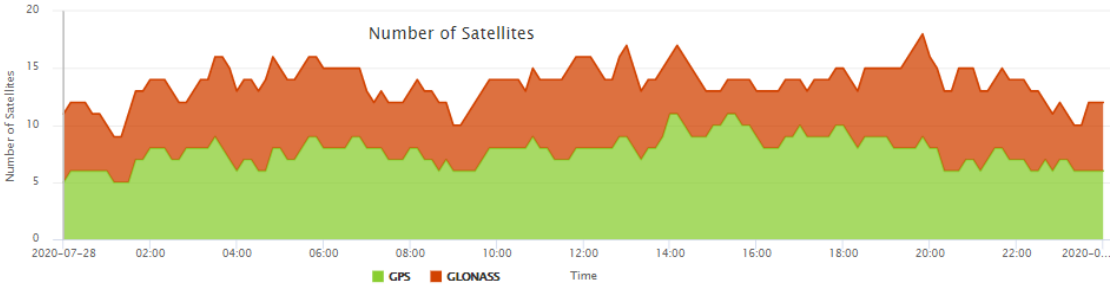
Mountpoint	Identifier / Description	Format	Format Details (Rate)	Carrier Phase	GNSS
FKP2	FKP23	RTCM 2.3	1, 3(10), 14(60), 16(300), 20, 21, 22(10) 23(10), 24(10)	L1 L2	GPS
FKP2_raw	FKP23 raw	RTCM 2.3	1, 3(10), 14(60), 16(300), 18, 19, 22(10) 23(10), 24(10)	L1 L2	GPS+GLO
FKP3	FKP31	RTCM 3.1	1004, 1006(10), 1007(30), 1012, 1030(30), 1031(30), 1033(10), 1034(10), 1035(10)	L1 L2	GPS+GLO
MAC	MAC	RTCM 3.1	1004, 1006(10), 1007(10), 1012, 1014(10), 1017(10), 1030(30), 1031(30), 1033(60), 1039(10)	L1 L2	GPS+GLO
RTCM23	RTCM23	RTCM 2.3	1, 3(17), 14(61), 16(300), 20(1), 21(1), 22(17), 23(17), 24(17)	L1 L2	GPS
RTCM23_raw	RTCM23 raw	RTCM 2.3	1, 3(17), 14(61), 16(300), 18(1), 19(1), 22(17), 23(17), 24(17)	L1 L2	GPS+GLO
RTCM30	RTCM30	RTCM 3.0	1004(1), 1006(10), 1012, 1033(10)	L1 L2	GPS+GLO
SSR	SSR	RTCM 3.1	1004, 1006(10), 1007(30), 1012(1), 1030(30), 1031(30), 1032(60), 1033(60)	L1 L2	GPS+GLO
VRS2	VRS23	RTCM 2.3	1, 3(10), 14(60), 16(300), 20, 21, 22(10), 23(10), 24(10)	L1 L2	GPS
VRS2_raw	VRS23 raw	RTCM 2.3	1, 3(10), 14(60), 16(300), 18, 19, 22(10), 23(10), 24(10)	L1 L2	GPS+GLO
VRS3	VRS30	RTCM 3.0	1004(1), 1006(10), 1007(30), 1012, 1030(30), 1031(30), 1032(10), 1033(60)	L1 L2	GPS+GLO
DGNSS_NET_2	DGNSS_NET_RTCM2.2	RTCM 2.2	1, 3(10), 16(300), 31(1)	L1 L2	GPS+GLONASS
DGNSS_2	DGNSS_RTCM2.2	RTCM 2.2	1, 3(10), 16(300), 31(1)	L1 L2	GPS+GLONASS
DGNSS_NET_3	DGNSS_NET_RTCM3.2	RTCM 3.2	1006(10), 1007(10), 1071(1), 1081(1)	L1 L2	GPS+GLONASS
DGNSS_3	DGNSS_RTCM3.2	RTCM 3.2	1006(10), 1007(10), 1071(1), 1081(1)	L1 L2	GPS+GLONASS

Question #2: I've used correct mountpoint, but still unable to get RTK Fix, why?

Answer #2: RTK require strong signal to work. Make sure S100 is used outdoors under clear open sky unblocked signal environment.

Although S100 is GPS/GLONASS/Galileo/Beidou quad-GNSS, only common set of satellite signals tracked by both base and rover are used for RTK computation, thus when used with GPS/GLONASS RTK base, effectively S100 is no different from GPS/GLONASS-only RTK receiver, and actual RTK used satellite number will be less than total tracked satellite number.

On initial use, it's good to choose time of day when there are more satellites overhead, avoid least number of satellite situation, because if blocked by distant trees then actual usable satellites becomes fewer, and it'll be more difficult to get RTK Fix. https://www.gnssplanning.com/



RTK is susceptible to interference. Normally the signal should fluctuate not more than 1dB-Hz in short period. If seeing signal fluctuating by several dB in short time, it means there is interference affecting RTK operation. A different location or different time of day without interference affecting RTK operation will get RTK Fix.

Appendix

A-1 More Usage Scenarios

A-1-1 Base-Rover RTK with PPP-Corrected Base

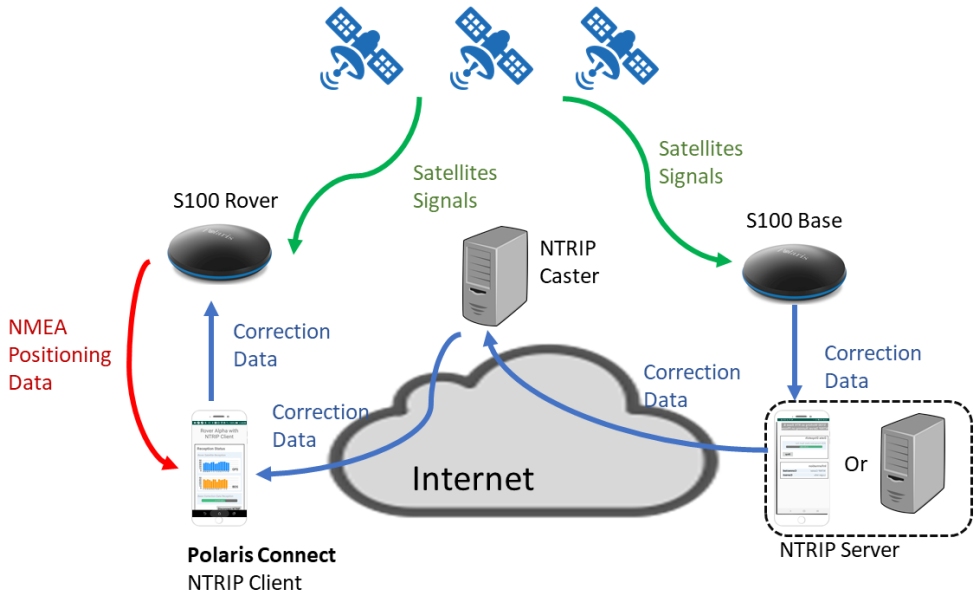


Figure A-1

In places without RTK base correction service but with cellular phone network, one can do RTK surveying by setting up a mobile RTK base with initial approximate base position coordinates, later upload base measurement data to online PPP service to get accurate base position coordinates, then later correct rover collected data set by the offset determined from initial approximate base position and PPP derived accurate base position.

A pair of S100 RTK receivers is needed to perform this operation as shown in Figure A-1.

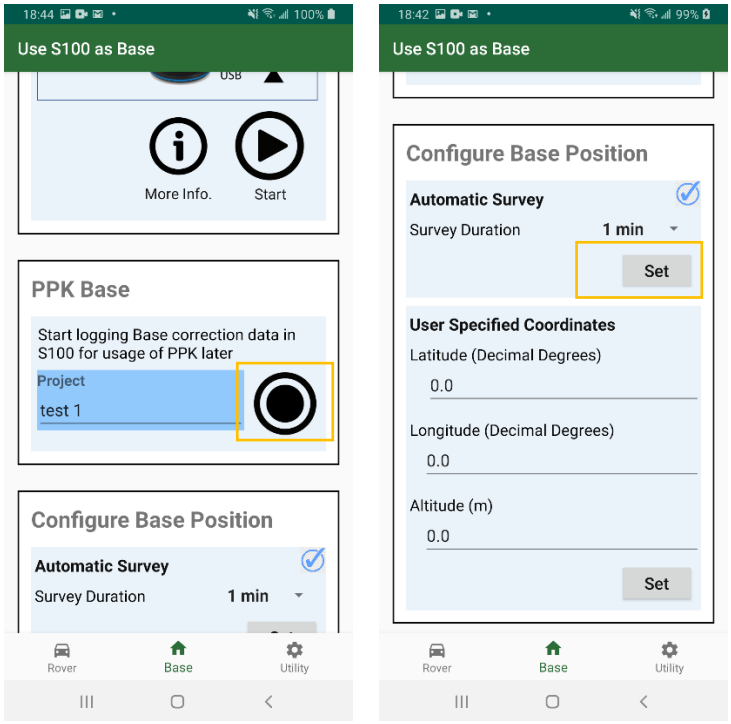
See section A-2-1 and A-2-3 on setting up mobile Bluetooth RTK base.

See this blog on working with online PPP service.

The procedure steps to do this:

1. Setup mobile RTK base to log data for later uploading to online PPP service to derive accurate base position. See Figure A-2 a.
2. Setup mobile RTK base to work with RTK rover, with base having approximate position $\mathbf{P_0}$. $\mathbf{P_0}$ can be 1 minute automatic surveyed approximate position. See Figure A-2 b.
3. Perform RTK surveying
4. After RTK surveying is completed, continue data logging if data logging time duration is still insufficient.

5. Back in office, convert log file to RINEX format, and upload to online PPP service to obtain accurate position coordinate $\mathbf{P_1}$ of the mobile RTK base.
6. The offset **delta** between approximate base position $\mathbf{P_0}$ and PPP-derived accurate position $\mathbf{P_1}$ is **delta** = $\mathbf{P_0 - P_1}$
7. Subsequently correct all rover surveyed points by **– delta**, i.e. $\mathbf{P'_M = P_M - delta}$



a b

Figure A-2

A-1-2 PPK with PPP-Derived Base

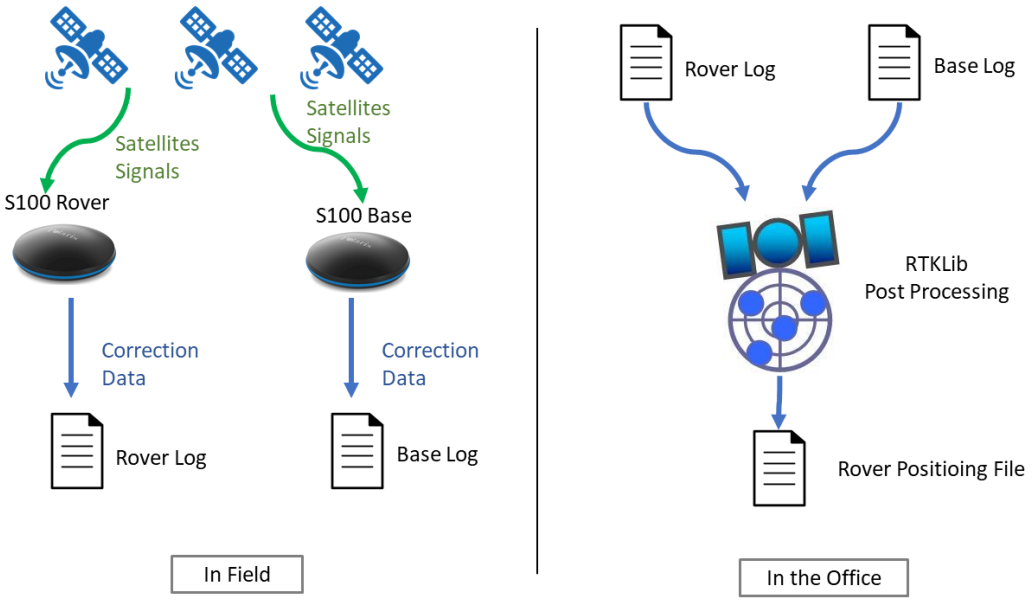


Figure A-3

At places where there is no cellular phone network, PPK post-processing can be performed to derive accurate position of the collected rover data logs.

A pair of S100 RTK receivers are needed to perform this operation as shown in Figure A-3.

The procedure steps to do this:

1. The base logs data for longer time period for online PPP processing to derive accurate base position.
2. The rover logs data for a minute or two for each survey point.
3. Back in office, convert base log file to RINEX format, and upload to online PPP service to obtain accurate position coordinate $\mathbf{P_1}$ of the mobile RTK base.
4. Use RTKLIB's RTKPOST to post-process each rover log file against base log file, using $\mathbf{P_1}$ as base position, to derive accurate rover position. Do this for all survey point collected rover log files.

A-2 Other RTK Related Operations

NTRIP is a protocol to deliver RTK correction data from RTK Base to RTK Rover, which is comprise of three services (1) NTRIP Server (2) NTRIP Caster (3) NTRIP Client. The three services run on three internet-enabled machines which are apart from one another in most cases. The general structure of NTRIP can be illustrated in Figure A-4.

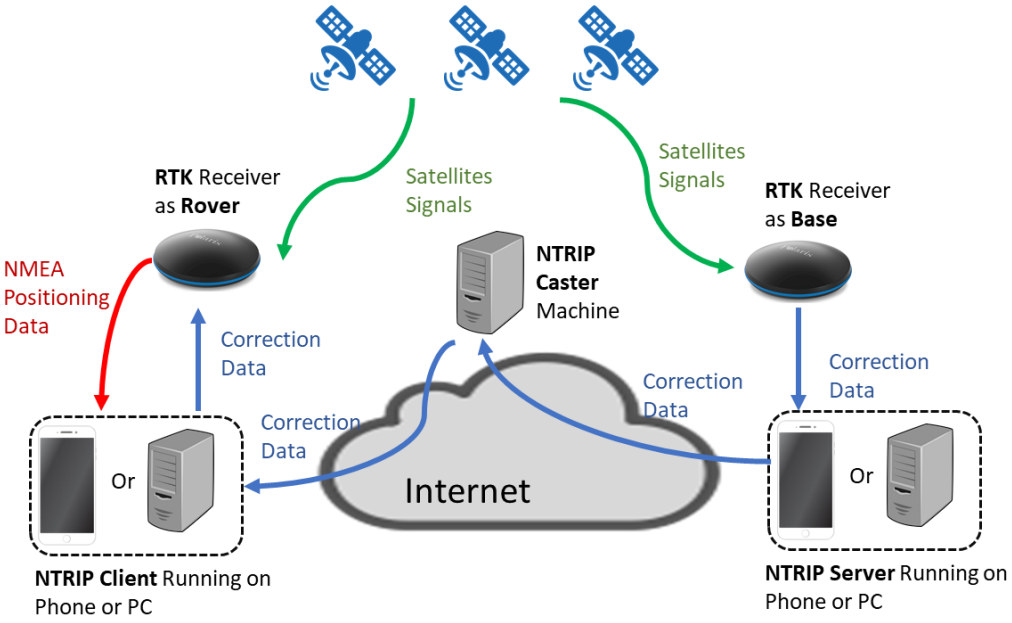


Figure A-4

Beside the RTK rover usage scenarios mentioned in section 4, user can also use S100 as a RTK base in the following scenarios:

1. Use **App-built-in NTRIP Server** on phone (section A-2-1) or
2. Use strsvr of RTKLIB on PC (section A-2-2)

Setup of **NTRIP Caster** is described in section A-2-3.

Usage of **Third-Party NTRIP Client App** (Lefebure NTRIP Client) can be found in section A-2-4.

A-2-1 Bluetooth RTK Base with App-Built-in NTRIP Server

The S100 RTK Receiver, when configured as a Bluetooth RTK base, can output RTK correction data with the NTRIP server built inside the “Polaris Connect” app, as shown in Figure A-5.

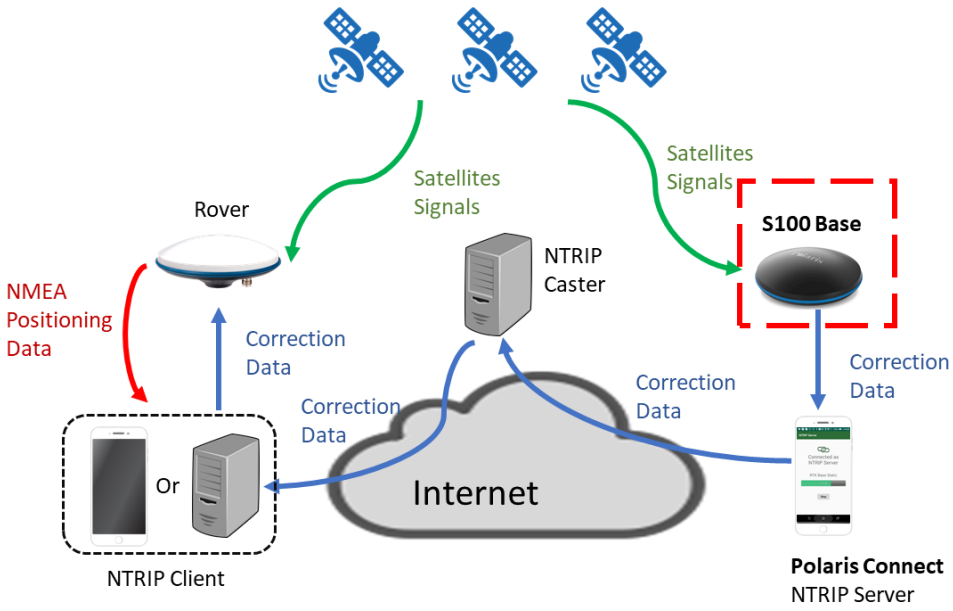
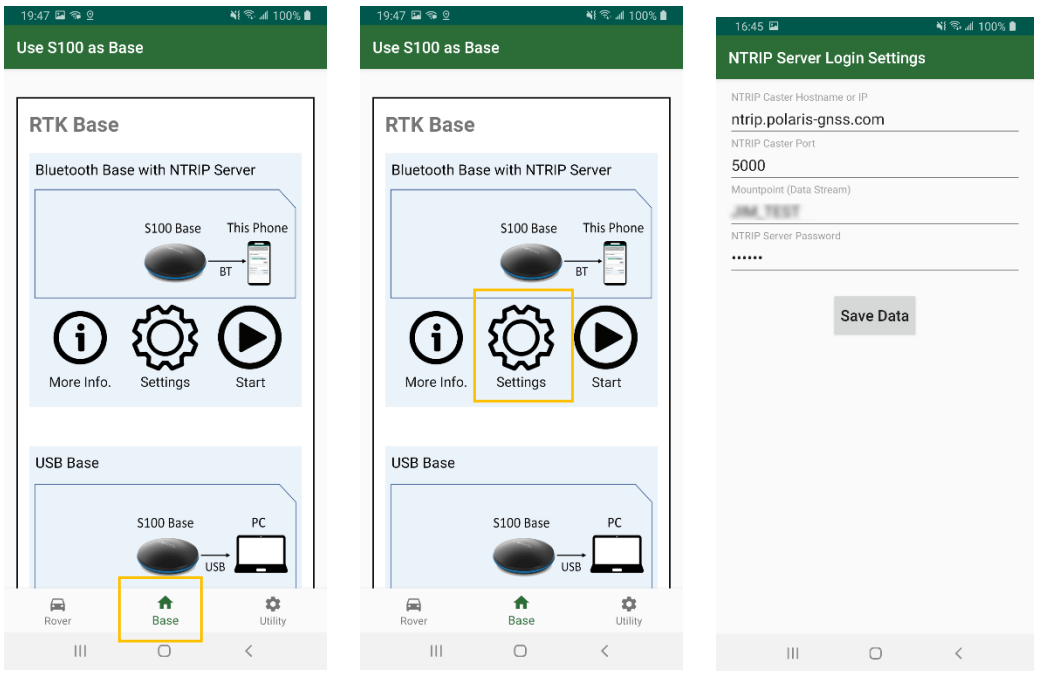


Figure A-5

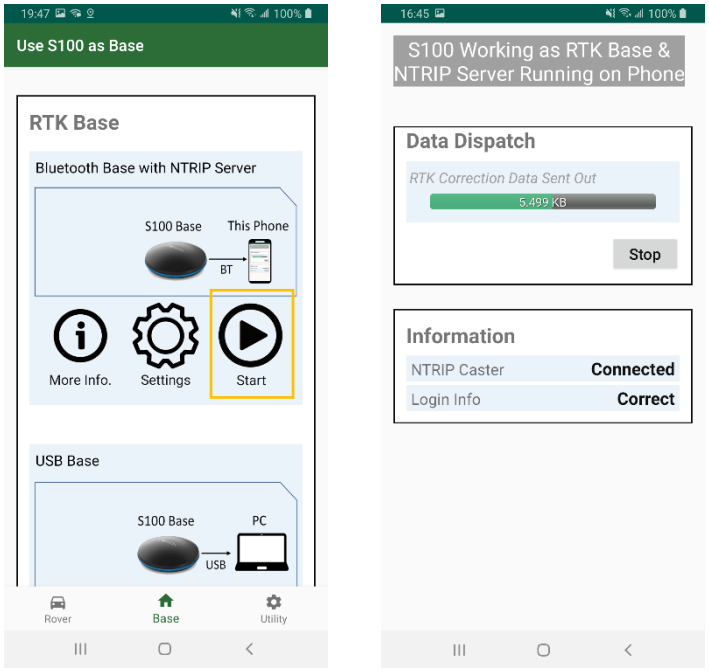
Follow below steps to configure S100 to send out RTK correction data via Bluetooth with built-in NTRIP server.

1. Click Base tab. See Figure A-6 a
2. Click Settings (Figure A-6 b) and configure NTRIP log-in information (Figure A-6 c).
3. Click Start of “Bluetooth Base with NTRIP Server”. See Figure A-7 a.
4. The NTRIP server starts. See Figure A-7 b.



a b c

Figure A-6



a b

Figure A-7

A-2-2 USB RTK Base

The S100 RTK Receiver, when configured as a USB RTK Base, can send out RTK correction data to a connected PC's NTRIP server software, e.g. strsvr of RTKLIB, as shown in Figure A-8.

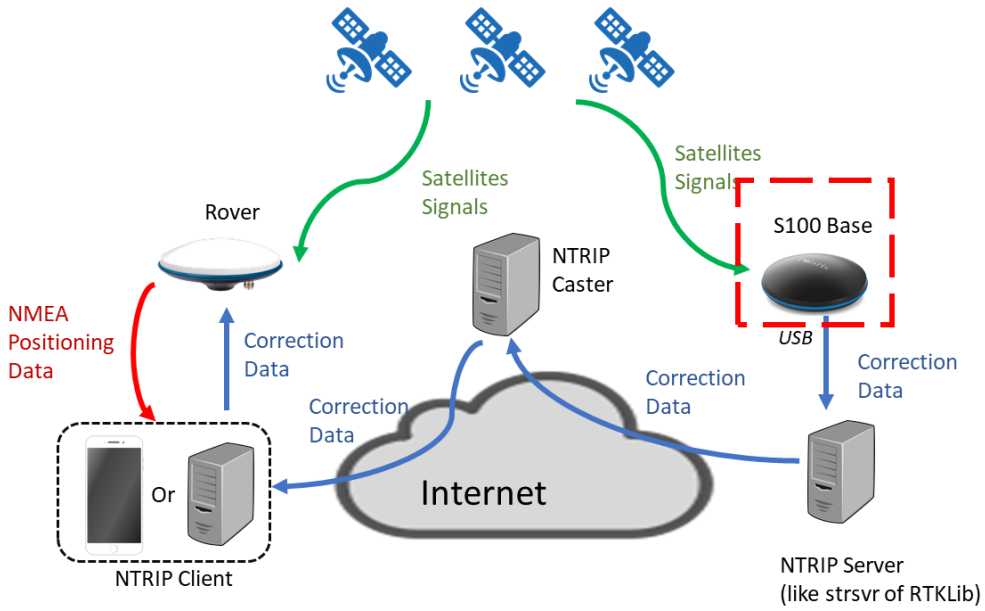
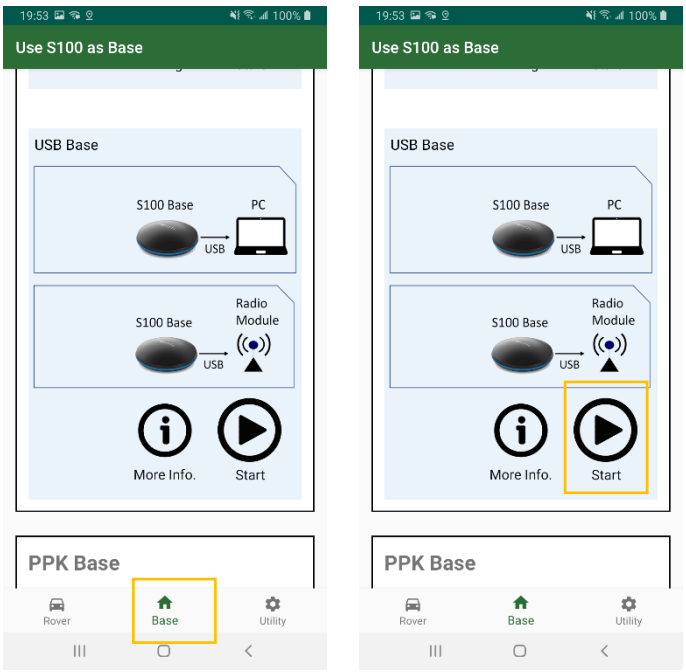


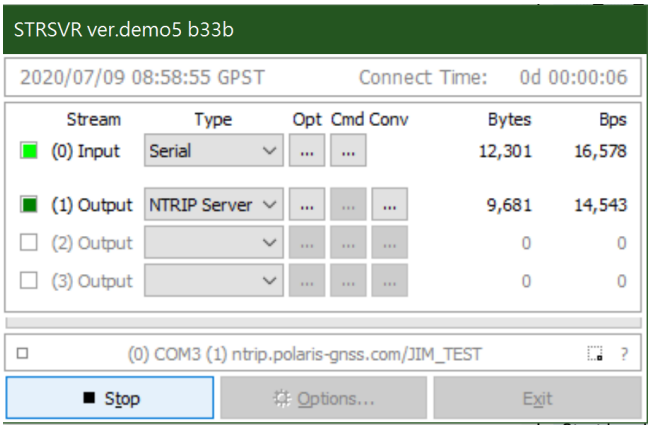
Figure A-8

Follow below steps to configure S100 to send out RTK correction data via USB. The app closes when S100 starts to work as USB RTK base.

1. Connect S100 with PC using the USB cable.
2. Click Base tab, select USB interface. See Figure A-9 a
3. Click Start of "USB Base"; the Polaris Connect app will close. See Figure A-9 b.
4. Start third-party NTRIP server tool, e.g. strsvr of RTKLIB, to send out RTK correction data. See Figure A-9 c.



a b



c

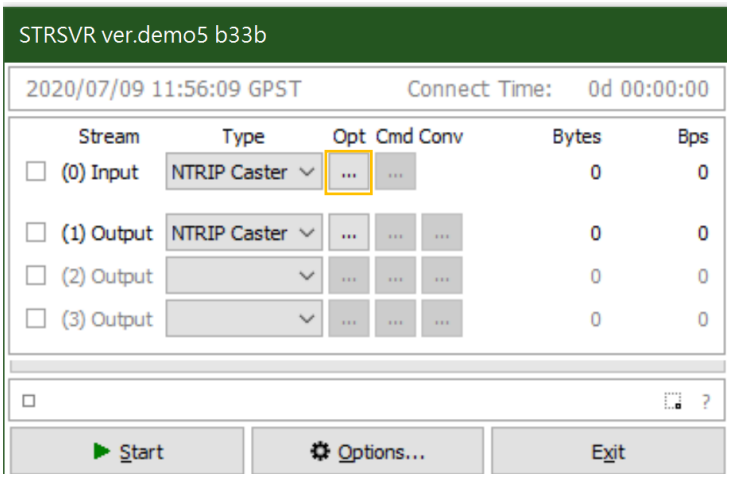
Figure A-9

A-2-3 Setting Up NTRIP Caster

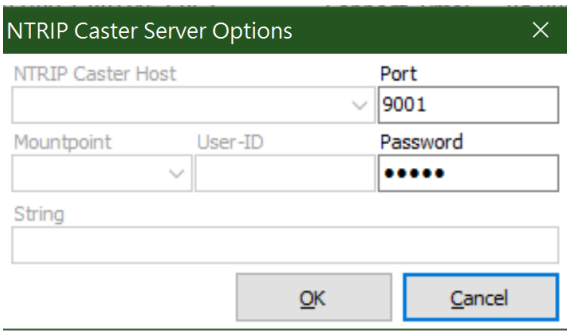
NTRIP requires a NTRIP Caster running on an Internet-connected computer with a fixed IP address so that both NTRIP Server and NTRIP Client can connect with it, thus making correction data delivery from NTRIP Server to NTRIP Client possible.

There are two ways to set up a NTRIP Caster.

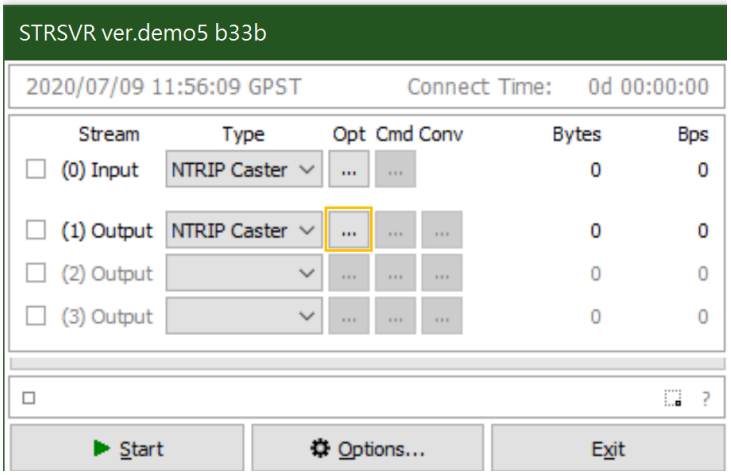
1. The easiest method to set up a 24/7 running NTRIP Caster is subscribing to
   SIX MONTH FLOATING IP RTK BASE REDIRECT SERVICE.
   A subscriber will get NTRIP Caster login information: IP/port/mount point/user name/password, and simply use it with “Polaris Connect” or “Lefebure NTRIP Client” app.
2. The other approach is to have an Internet connection with Fixed IP address to use with strsvr of RTKLIB running on a PC.
   Follow below steps to set up an NTRIP Caster.
   a. Get RTKLIB binary from
   http://rtkexplorer.com/downloads/rtklib-code/
   b. Run strsvr.exe
   c. Configure Input Stream to be Type NTRIP Caster, and set up its options (by clicking Opt).



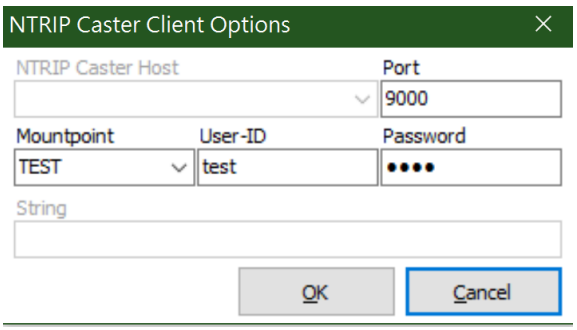
   d. Set input stream **Port** to be an available port number on this PC, 9001 for example. Set **Password** to be your preferred NTRIP upload password. Then click OK.



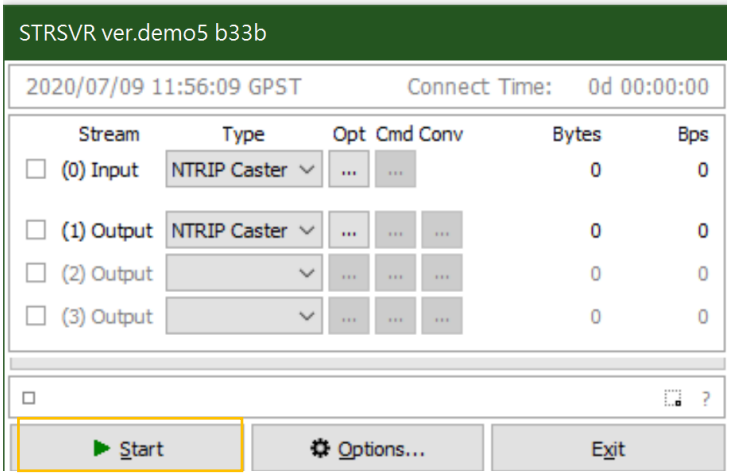
e. Continue to configure Output Stream.



f. Set output stream **Port** to be an available port number on this PC, 9000 for example (need to be different from input stream port). Set **Mountpoint/User-ID/Password** to be your preferred NTRIP download login information. Then click OK.



g. Click Start



A-2-4 Third-Party NTRIP Client App Operations

Follow below steps to use Lefebure NTRIP Client app to send RTK correction data to S100.

1. Install Lefebure NTRIP Client from Google Play Store, open it.

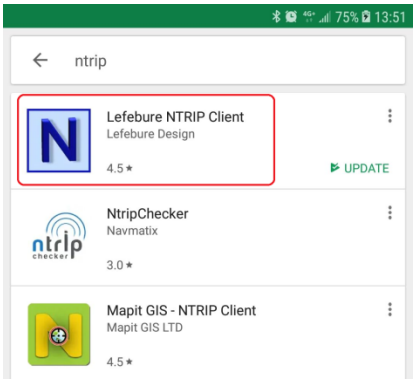
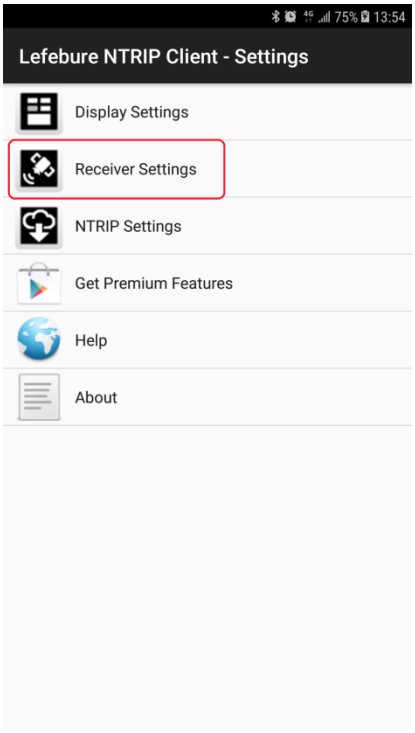
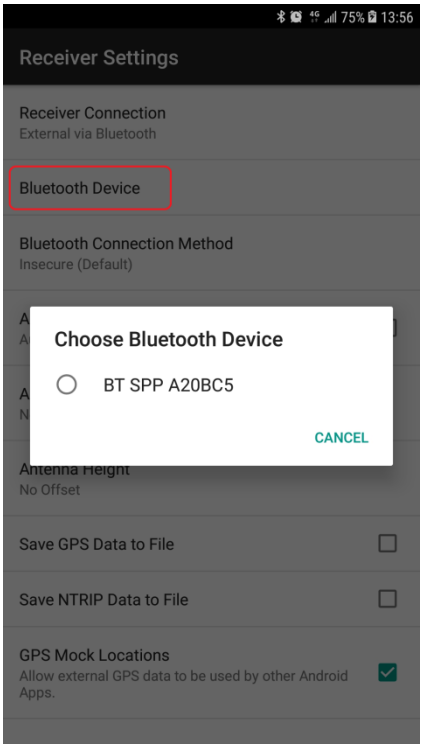


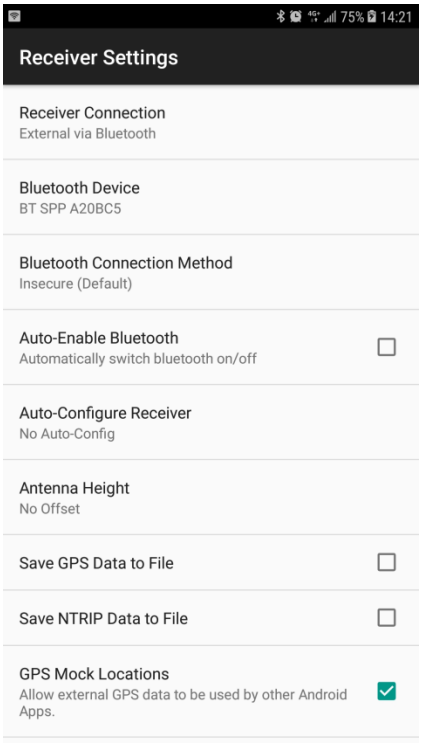
Figure 6-6

2. Select the gear setup icon on the upper right corner. Select “Receiver Settings”.

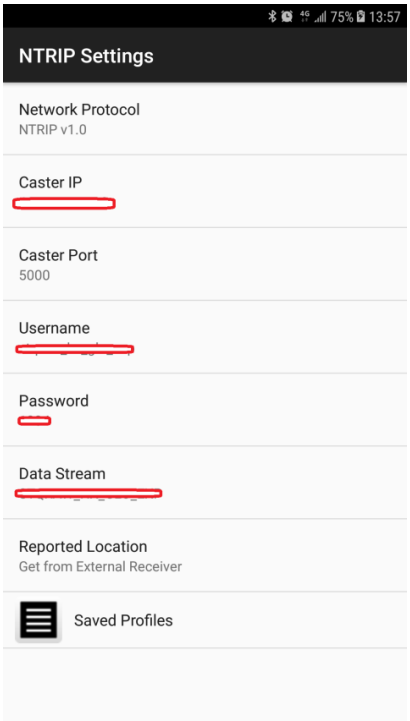


3. For “Receiver Connection” select “External via Bluetooth”. For “Bluetooth Device” select the “BT SPP xxxxxx” device. Check “GPS Mock Locations”.

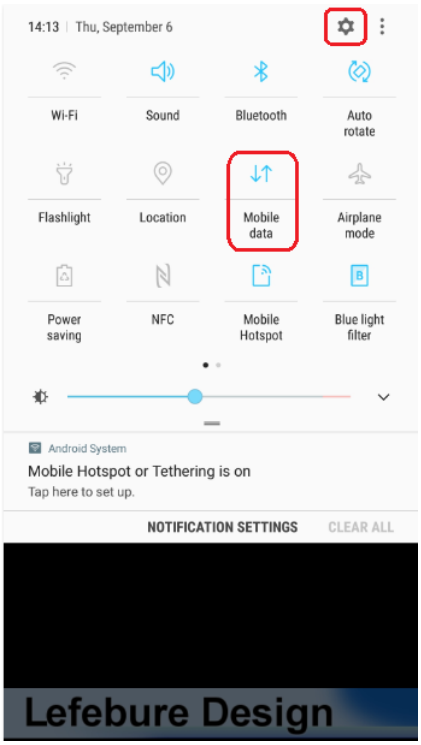




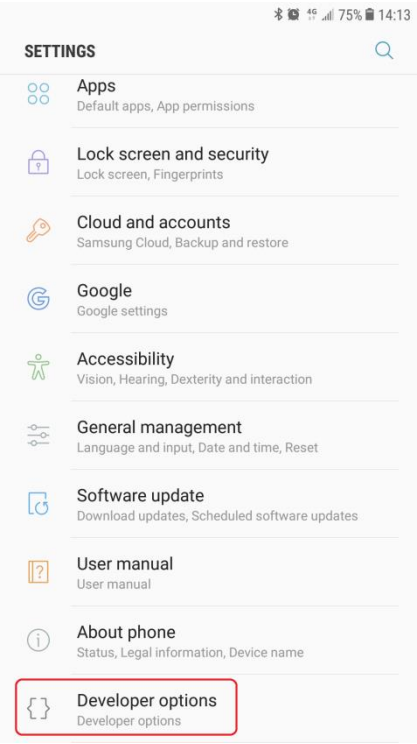
4. Select “NTRIP Settings”. Network Protocol select “NTRIP v1.0”. Enter base station and account information for Caster IP / Caster Port / Username / Password / Data Stream. Report Location select “Get From External Receiver”.

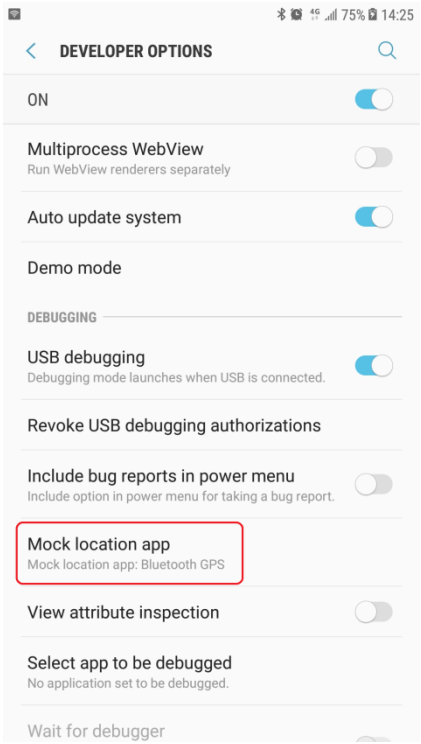


5. Enable phone's Mobile Data connection. Select the gear icon on upper right to enter phone Settings configuration page.

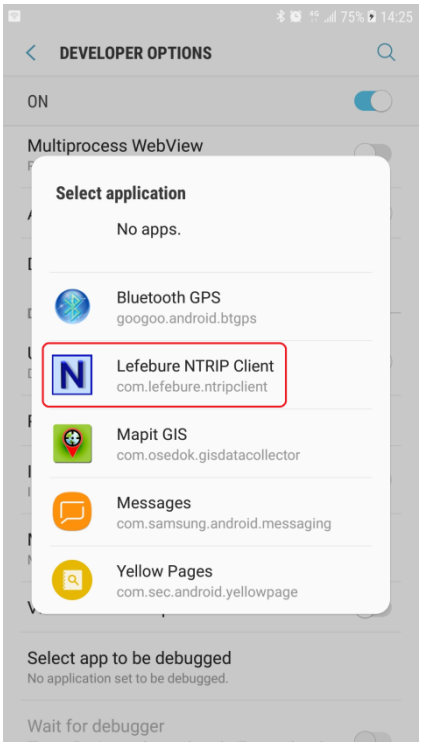


6. Select "Developer Options" near the bottom of Settings page. Sliding down Developer Options page, select "Mock Location App".



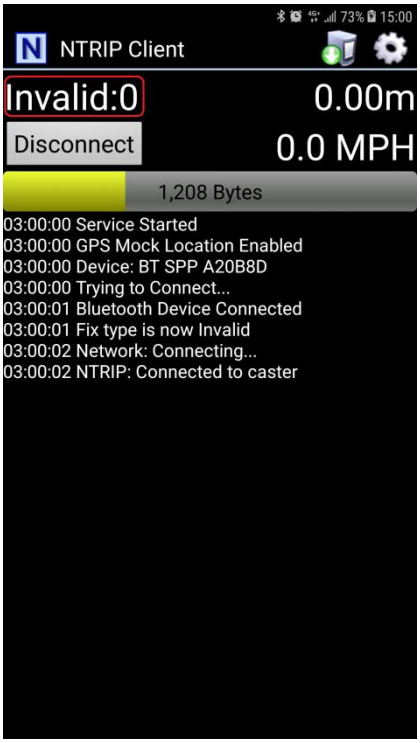


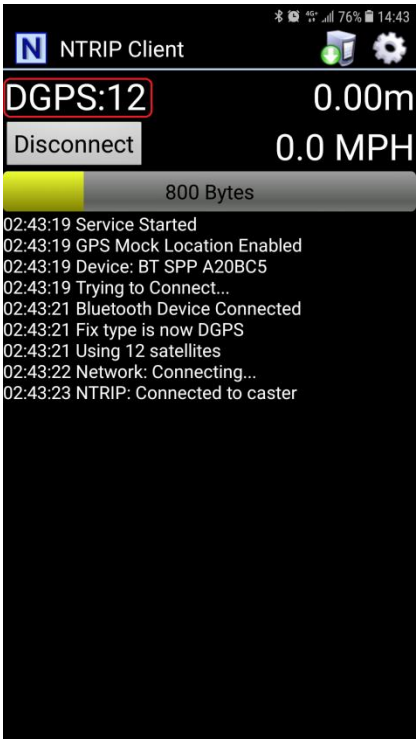
7. Select “Lefebure NTRIP Client”.

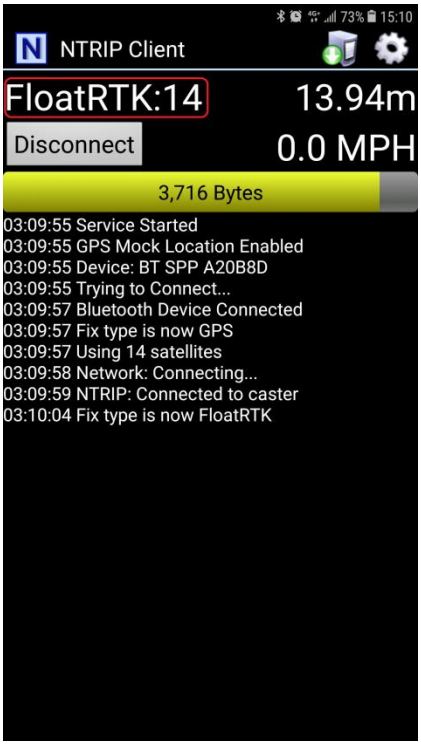


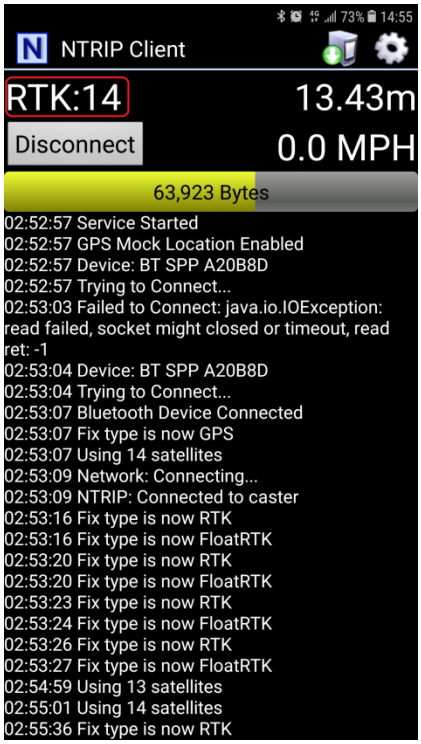
8. Return to Lefebure NTRIP Client App, click “Connect” to connect with S100 RTK receiver via Bluetooth and RTK base station via Internet.

9. After connection is made, upper left screen will first show Invalid, denoting receiver does not have position fix yet. Next it'll show GPS or DGPS and number of satellites used, denoting receiver has meter-level accuracy position fix. Then it'll show FloatRTK for some time, denoting the receiver is trying to converge to centimeter-level accuracy position. When the receiver has centimeter-level accuracy position it'll show steady RTK status. Afterwards third party Data Collector Apps can next be used to record the position.







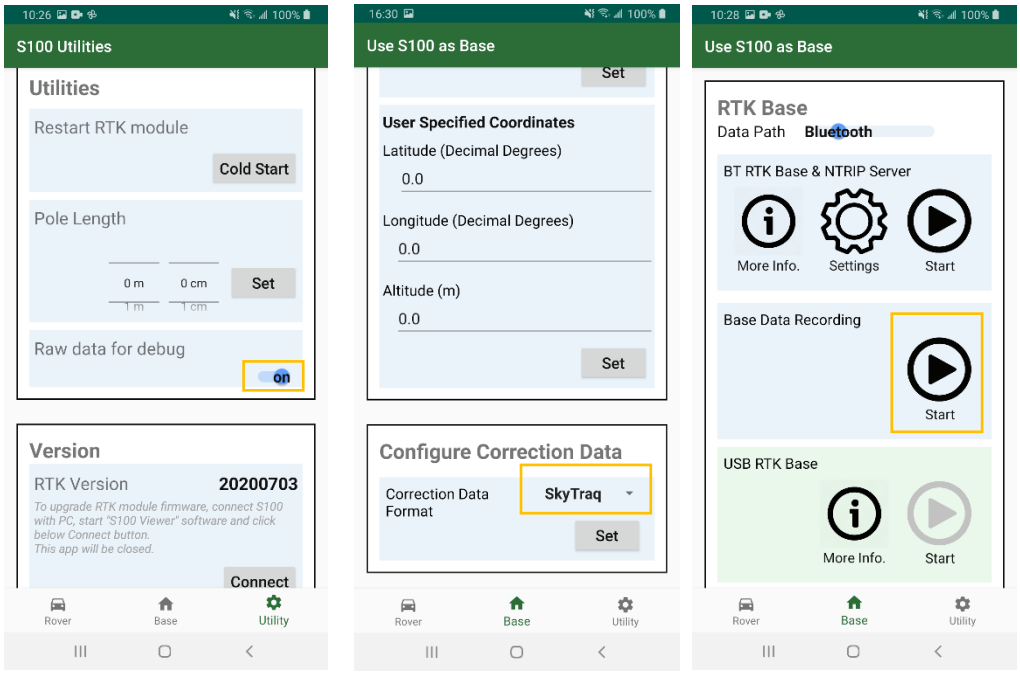


10. When surveying a group of locations within walking distance, can leave S100 powered up, taking the range pole or tripod to next location to survey. Switch to the Lefebure NTRIP Client App to check if S100 is in RTK Fix state before recording the next location position with Data Collector App. The setup procedure only needs to be performed once. Later use only need to run Lefebure NTRIP Client and connect.

A-3 Problem Reporting

In the rare case that connection is made to 3rd party RTK base, but unable to get RTK Fix, only getting RTK Float, follow the procedure steps shown in this video https://youtu.be/v3G3jGASJN8 to simultaneously log 15 minutes of (1) RTK base RTCM data and (2) S100 raw measurement data for us to analyze the issue. Upload the two log files to your Google Drive folder and send us a shareable link to info@polaris-gnss.com By default the log files are stored in the NTRIP directory of your phone. The steps are

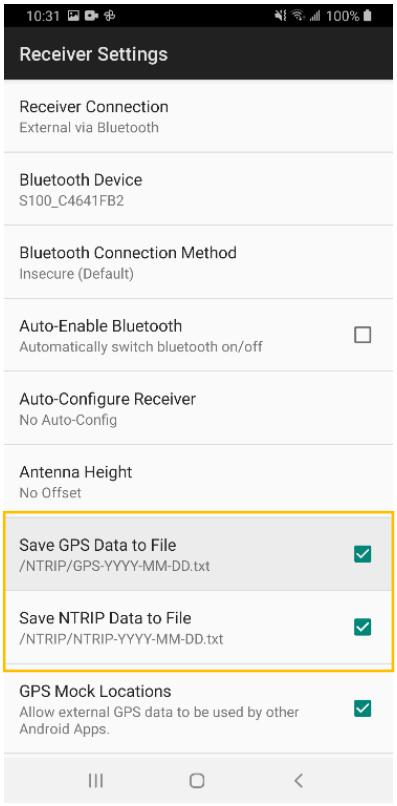
1. Enable S100 to send out raw data by switching on Utility->Raw data for debug. See Figure A-11 a.
2. Make sure data format SkyTraq is selected. See Figure A-11 b.
3. Press Start of Base->Base Data Recording. The app will close afterwards. See Figure A-11 c.



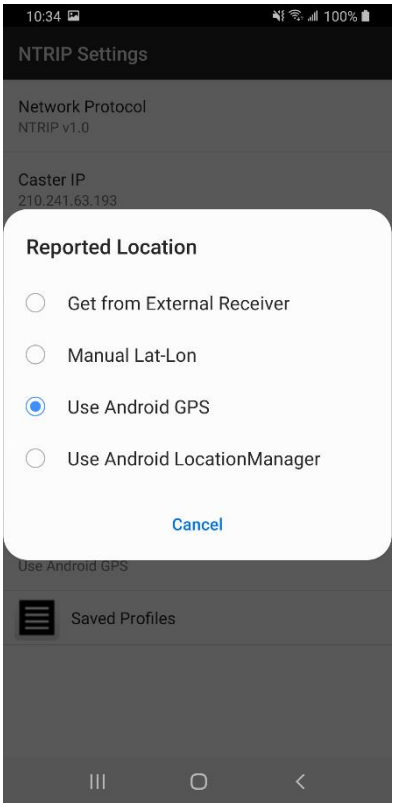
a b c

Figure A-11

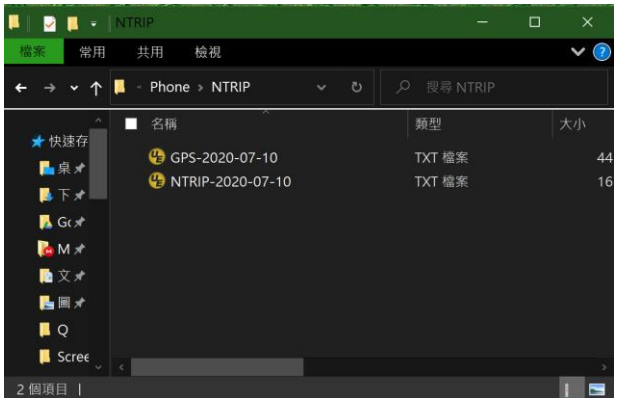
4. In Lefebure app, enable “Save GPS Data” and “Save NTRIP Data” in “Receiver Settings”. See Figure A-12 a.
5. Configure "NTRIP Settings -> Reported Location" to "Use Android GPS". See Figure A-12 b.
6. Start recording of Lefebure, and stop it after 15 minutes. The saved files can be found from connected PC browser. See Figure A-12 c.



a



b



c

Figure A-12