NS-HP-GN User's Guide

Rev. 0.1

June 28, 2018

Table of Contents

1. INTRODUCTION

NS-HP-GN is a high performance RTK capable GNSS receiver. It can accept RTCM 3.x message or SkyTraq carrier phase raw measurement data from a base station to perform carrier phase RTK processing, achieving centimeter-level accuracy relative positioning.

For UAV aerial survey applications that require camera shutter trigger signal synchronized precision time & position stamp, NS-HP-GN-S provide precise time having better than 100nsec accuracy, and precise position having maximum error less than 1 millisecond traveled distance on top of RTK 1cm + 1ppm positioning error; i.e. if 50km/h speed then maximum 1.4cm error on top of RTK 1cm + 1ppm positioning error.

NS-HP-GN Models:

Models	RTK Rate	Precision Time/Position Stamp
NS-HP-GN	1 / 2 / 4 / 5 / 8 / 10	
NS-HP-GN-S	1 / 2 / 4 / 5 / 8 / 10	X

When used with RTCM base station, the supported RTCM message types are:
Type 1002 – Extended L1-Only GPS RTK Observables
Type 1004 – Extended L1&L2 GPS RTK Observables
Type 1005 – Stationary RTK Reference Station ARP
Type 1006 – Stationary RTK Reference Station ARP with Antenna Height
Type 1074 – GPS MSM4
Type 1075 – GPS MSM5
Type 1076 – GPS MSM6
Type 1077 – GPS MSM7
Type 1084 – GLONASS MSM4
Type 1085 –GLONASS MSM5
Type 1086 –GLONASS MSM6
Type 1087 –GLONASS MSM7
Type 1104 – SBAS MSM4
Type 1105 – SBAS MSM5
Type 1106 – SBAS MSM6
Type 1107 – SBAS MSM7
Type 1114 – QZSS MSM4
Type 1115 – QZSS MSM5
Type 1116 – QZSS MSM6

Type 1117 – QZSS MSM7

For centimeter-level RTK accuracy, NS-HP-GN requires much better operating condition than conventional meter-level accuracy GPS receiver:

* Baseline distance between base and rover should be under 10Km
* Under open sky without interference
* Signal level over 37dB/Hz
* 12 or more satellites above 15 degree elevation angle with good satellite geometry

If above condition is not met, NS-HP-GN will not get centimeter-level accuracy RTK solution. With less than 10 common satellites seen by both base and rover meeting the above requirement, RTK fix can still be achieved at longer convergence time, but incorrect RTK Fix can happen, higher the probability with lesser number of satellites.

Without base station data input, NS-HP-GN works like a normal GPS/GNSS receiver.

When used with a RTCM 3.x RTK base station within 10Km operating range, one rover NS-HP-GN is needed. If one wishes to setup a local base station to work with rover, then two NS-HP-GN will be needed, one for base and another for rover.

Default NMEA output baud rate is 115200.
Rover expects RTCM 3.x or SkyTraq raw measurement data at input baud rate of 115200

2. FEATURES OF NS-HP-GN

RTK Receiver Features

* Support RTK base and rover modes

* Supports (L1 GPS/GLONASS) RTK or (L1 GPS + B1 BDS) RTK depending on loaded firmware

* 16 channel GPS/SBAS/QZSS + 12 channel GLONASS or BDS

* RTK position accuracy: centimeter-level

* 70mA @ 3.3V

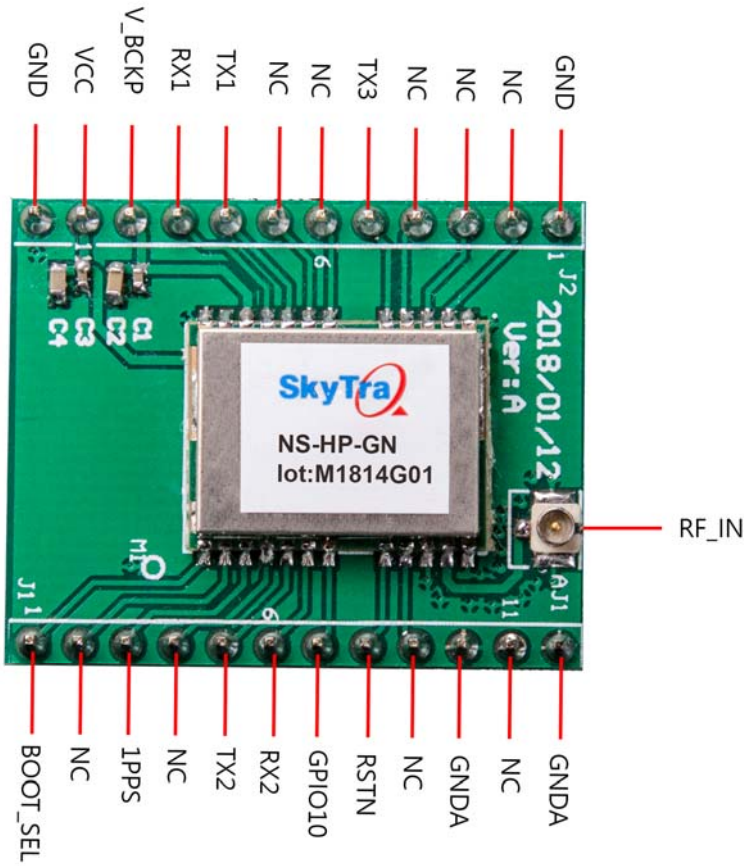
* Carrier phase raw measurement output on TX3 pin

3. APPLICATIONS

NS-HP-GN may be used for:

1. Precision farming machine guidance
2. Precision grass cutting machine guidance
3. Precision guidance of unmanned aerial vehicles
4. Aerial survey precision position stamping without needing ground control points
5. Precise position tracking of race cars for performance measurement

4. PIN OUT DESCRIPTION



Pin No.	Name	Description
J1		
1	BOOT_SEL	No connection for normal use. Pull-low for loading firmware into empty or corrupted Flash memory from ROM mode for the master processor.
2	NC	No connection, empty pin
3	1PPS	One-pulse-per-second (1PPS) time mark output, 3.3V LVTTL. The rising edge synchronized to UTC second when getting 3D position fix. The pulse duration is about 800usec at rate of 1 Hz.
4	NC	No connection, empty pin
5	TX2	UART serial data output, 3.3V LVTTL. Currently not used.
6	RX2	UART serial data input, 3.3V LVTTL. One full-duplex asynchronous serial UART port is implemented. This UART input is used for receiving RTCM-SC104 data or SkyTraq raw measurement data from the base at 115200.
7	GPIO10	GPIO pin, 3.3V LVTTL. External trigger input for camera shutter synchronization*
8	RSTN	External active-low reset input to the receiver. Only needed when power supply rise time is very slow or software controlled reset is desired.
9	NC	No connection, empty pin

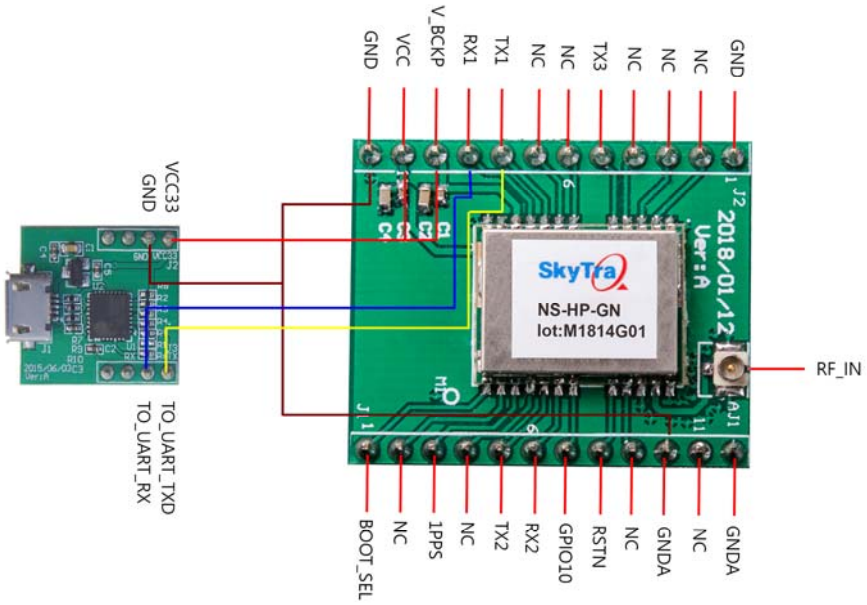
10	GNDA	Analog ground
11	NC	No connection, empty pin
12	GNDA	Analog ground

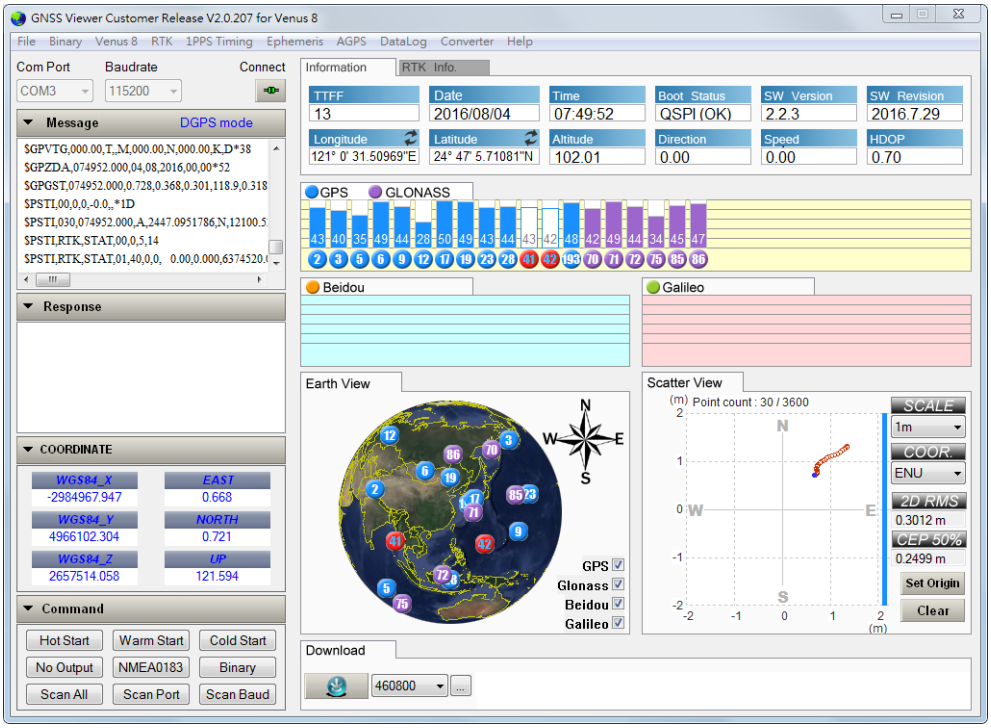
Pin No.	Name	Description
J2		
1	GND	Digital ground
2	NC	No connection, empty pin
3	NC	No connection, empty pin
4	NC	No connection, empty pin
5	TX3	UART serial data output, 3.3V LVTTL. Output carrier phase raw measurement data at 115200
6	NC	No connection, empty pin
7	NC	No connection, empty pin
8	TX1	UART serial data output, 3.3V LVTTL. One full-duplex asynchronous serial UART port is implemented. This UART output is used for sending position, time and velocity information from the receiver in NMEA-0183 format. When idle, this pin output HIGH.
9	RX1	UART serial data input, 3.3V LVTTL. One full-duplex asynchronous serial UART port is implemented. This UART input is for sending commands or information to the receiver in SkyTraq binary protocol. In the idle condition, this pin should be driven HIGH.
10	V_BCKP	Backup supply voltage for internal RTC and backup SRAM, 2.5V ~ 3.6V. VBAT must be applied whenever VCC is applied. This pin should be powered continuously to minimize the startup time. If VCC and V_BCKP are both removed, the receiver will be in factory default mode upon power up, all user configuration set is lost. For applications the does not care cold starting every time, this pin can be connect to VCC.
11	VCC	Power supply, 3.3V DC
12	GND	Digital ground

***** Available only for NS-HP-GN-S version with precision time/position stamping feature.

5. CHECK OUT BASIC GPS FUNCTIONALITY

Hook up as below, connect to an UART-to-USB bridge breakout board, connect antenna to RF_IN, and place antenna at a location having clear sky view. After driver for the UART-to-USB bridge chip has been installed, select proper COM port and 115200 baud rate on GNSS Viewer, click CLOSE, GNSS Viewer will show signal being acquired and tracked.



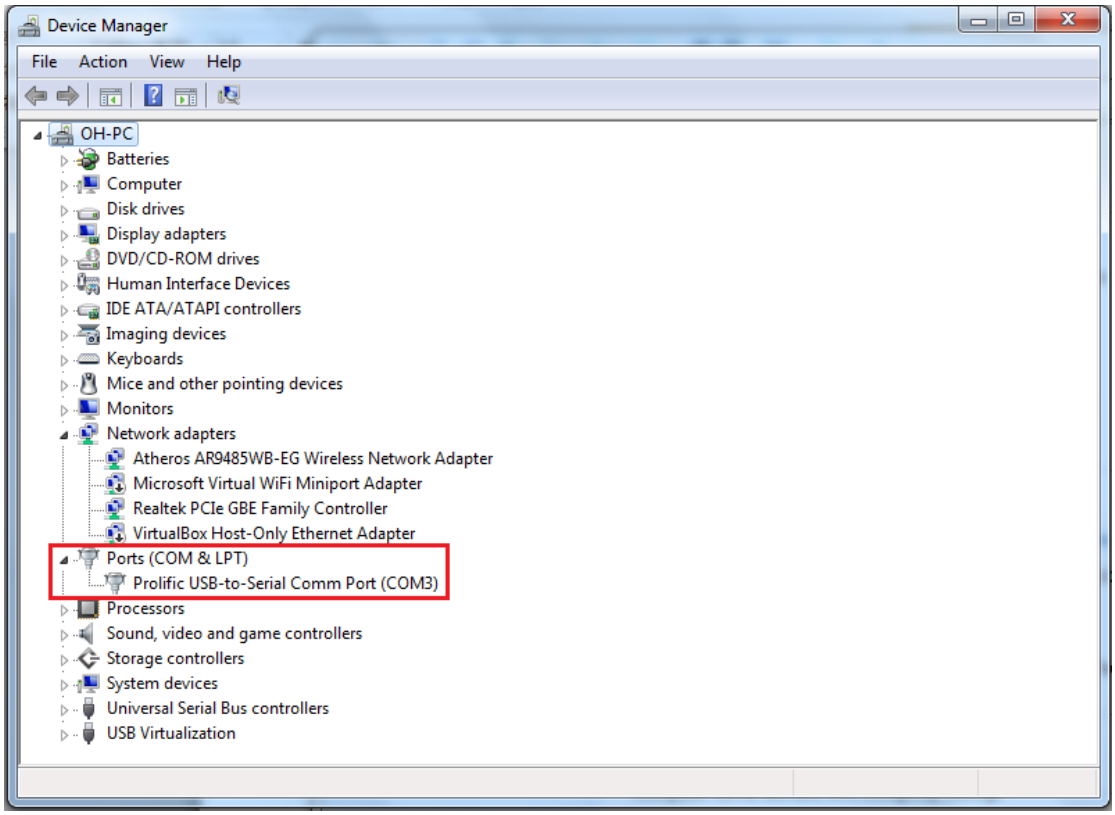


GNSS Viewer for Windows PC can be downloaded from:

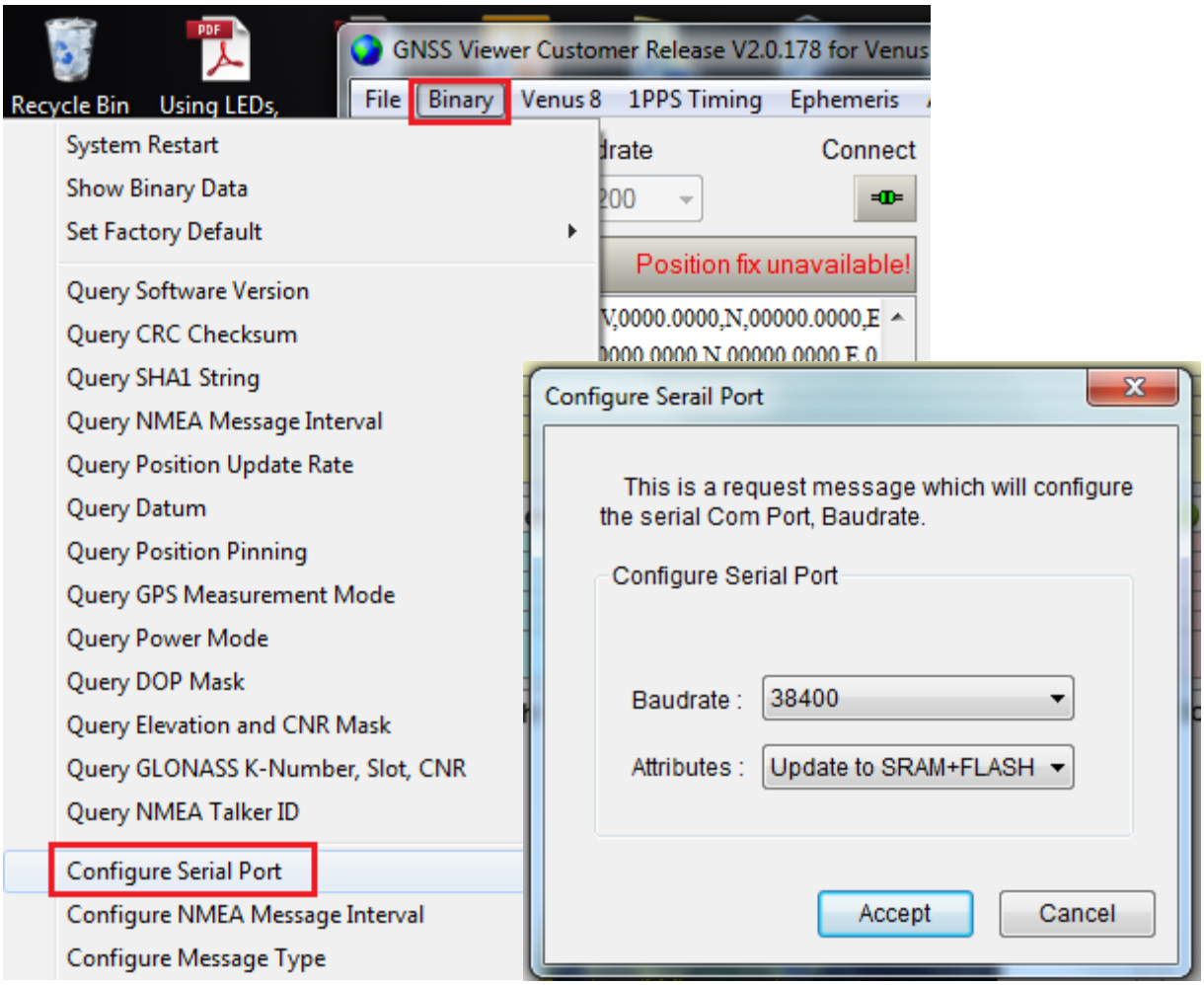
http://navspark.mybigcommerce.com/content/GNSS_Viewer.zip

http://navspark.mybigcommerce.com/content/GNSS-Viewer-User-Guide.rev0.2.pdf

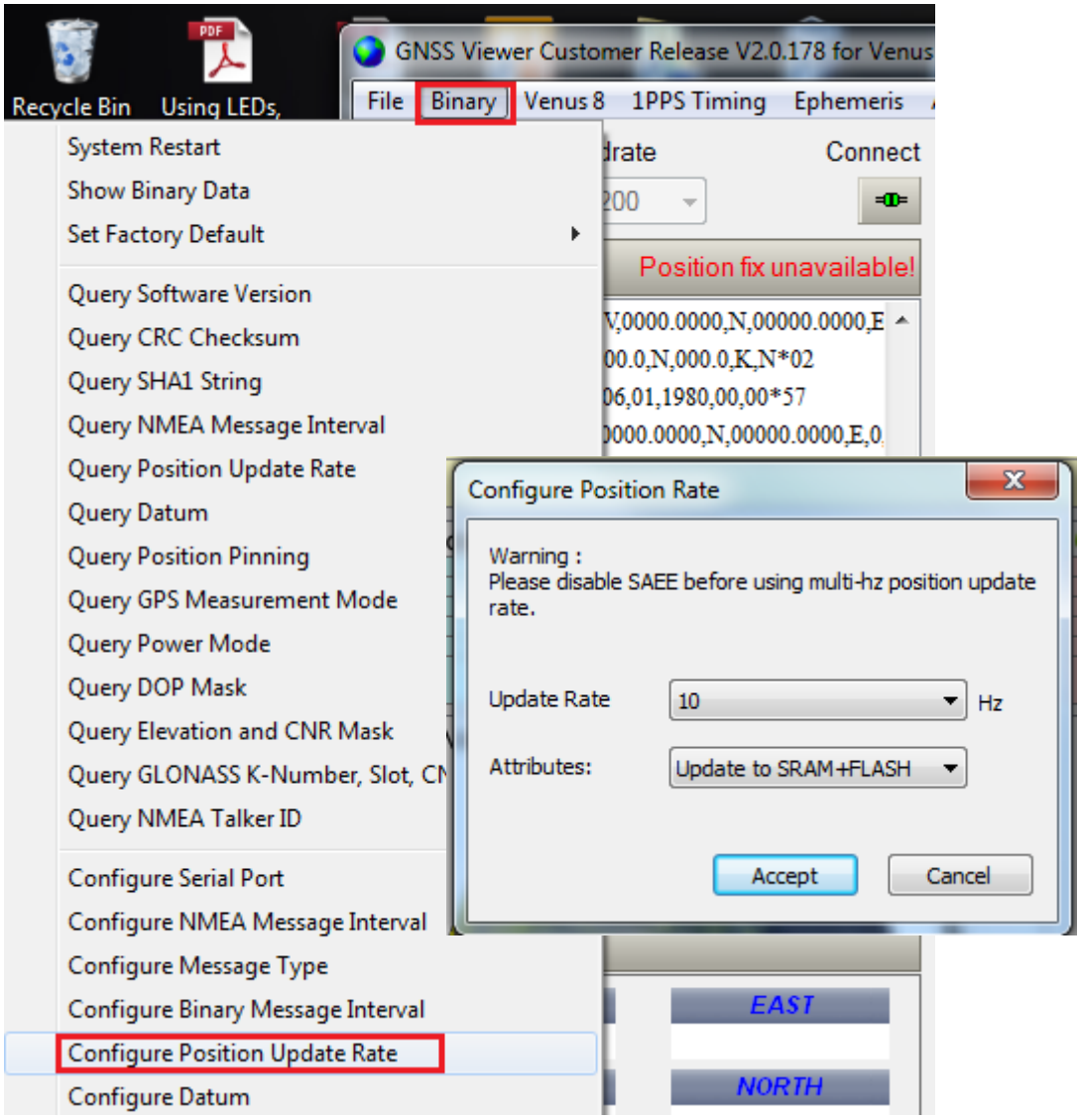
If uncertain of the COM port, it can be found from the Windows Device Manager.



If wishing to change NMEA output baud rate, from Binary pull-down menu select Configure Serial Port, select desired baud rate and Update to SRAM+Flash.



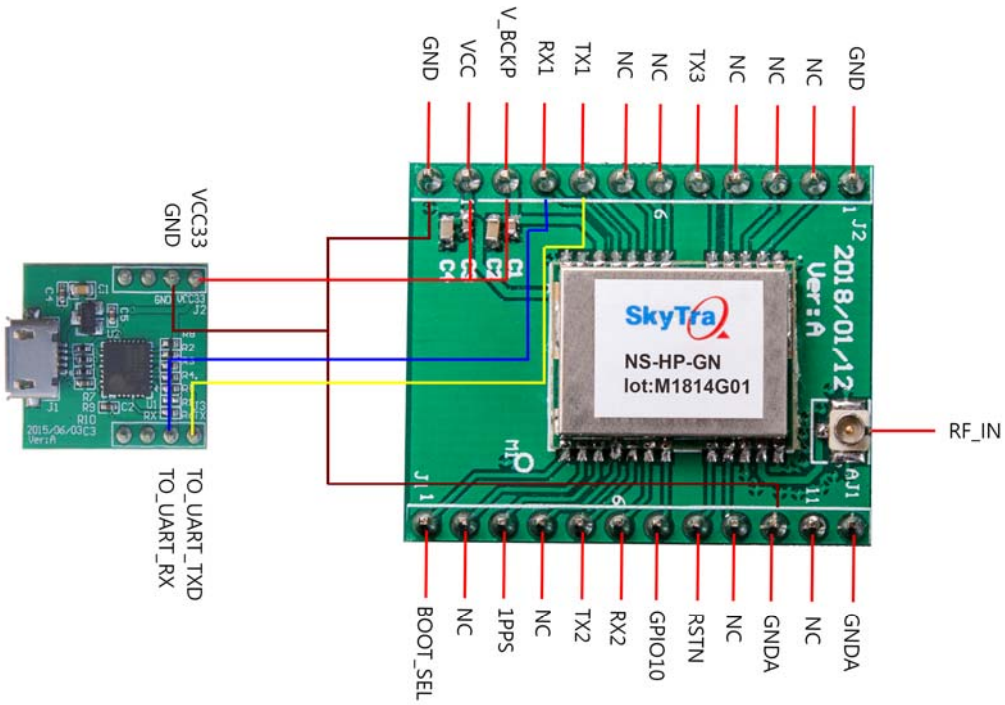
If wishing to change NMEA solution output updated rate, from Binary pull-down menu select Configure Position Update Rate, select desired update rate and Update to SRAM+Flash.



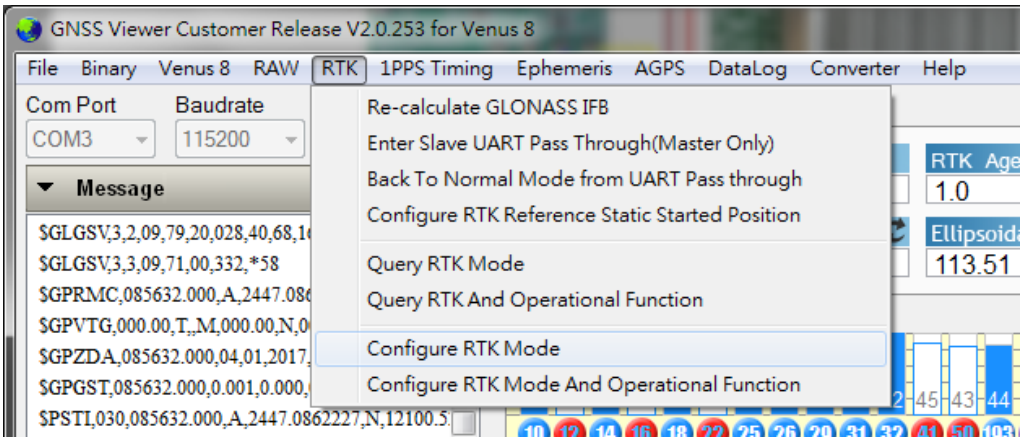
When changing to higher update rate, make sure baud rate in use can accommodate it. If baud rate is not fast enough, NMEA message output will be truncated.

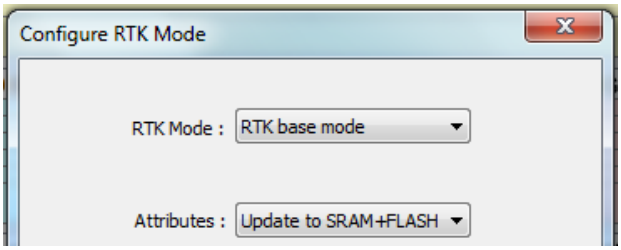
6. SET UP NS-HP-GN AS RTK BASE

Hook up as below; connect to an UART-to-USB bridge breakout board for connecting to GNSS Viewer running on a Windows PC.



From GNSS Viewer RTK pull down menu, select Configure RTK Mode, select RTK base mode and update to SRAM+Flash.

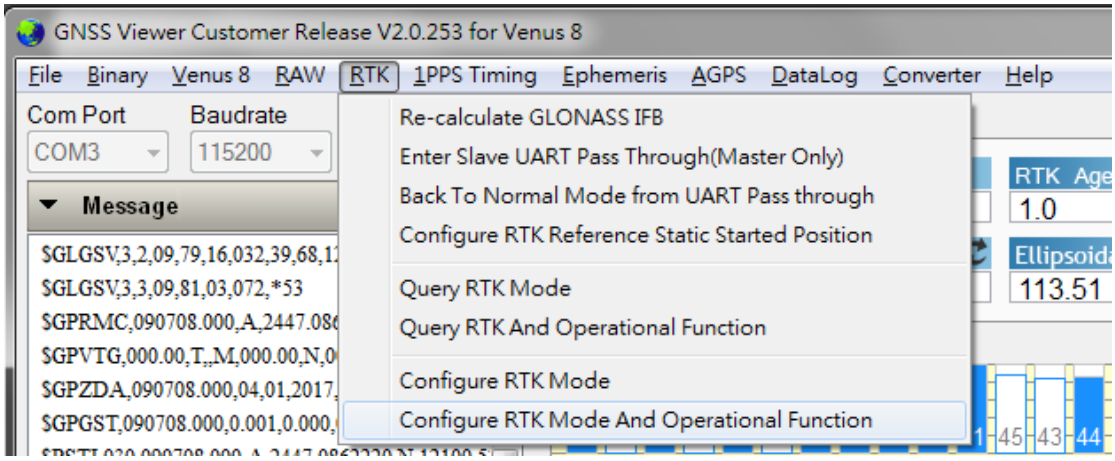


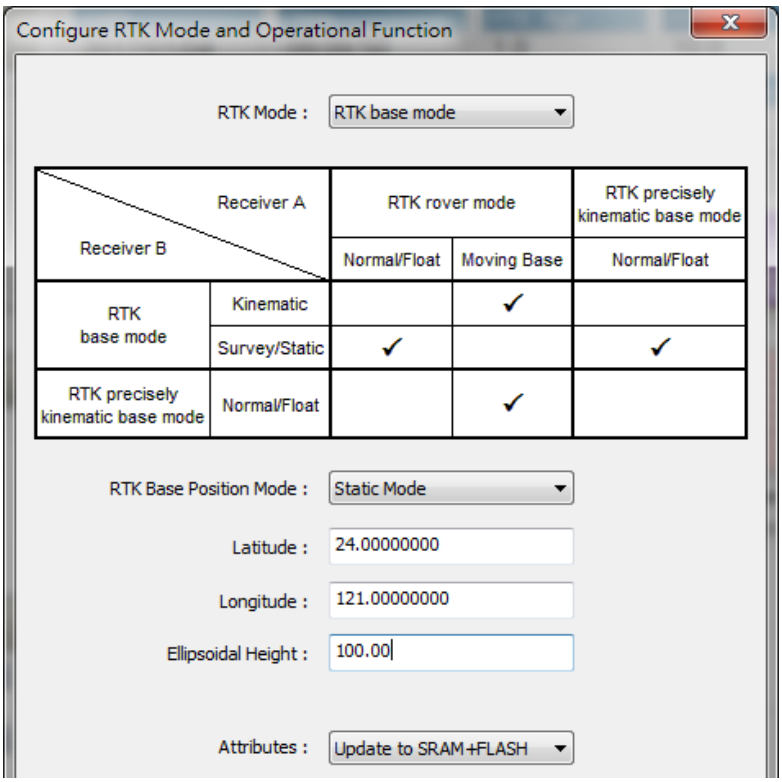


Known Base Antenna Position

When configured as base, NS-HP-GN will output its position along with carrier phase raw measurement data over UART TX1. If base NS-HP-GN antenna will be placed at a location with known position, the position information can be set into NS-HP-GN using GNSS Viewer.

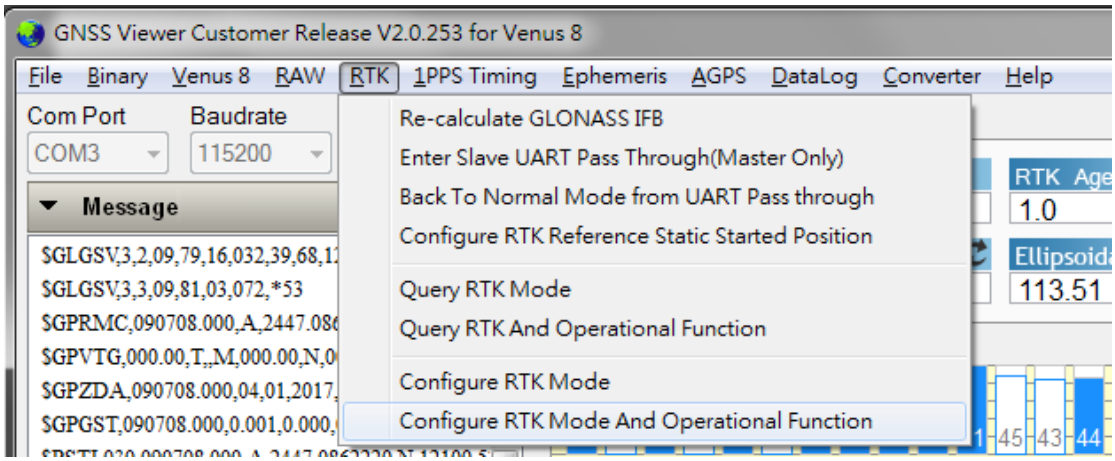
From RTK pull-down menu, select Configure RTK Mode And Operational Function, select RTK base mode, select Static Mode and enter antenna latitude/longitude in degrees and ellipsoidal height in meter, update to SRAM+Flash.

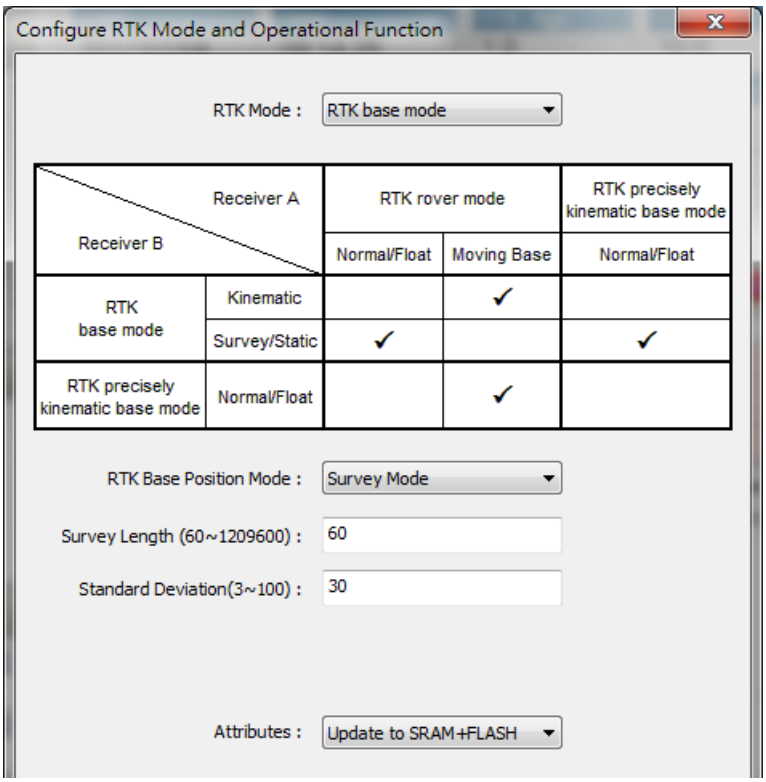




Unknown Base Antenna Position

If base antenna position is unknown, set to let it survey for 60sec upon power up. From GNSS Viewer RTK pull-down menu, select Configure RTK Mode And Operational Function, select Survey Mode and set Survey Length to 60 and Update to SRAM+Flash.



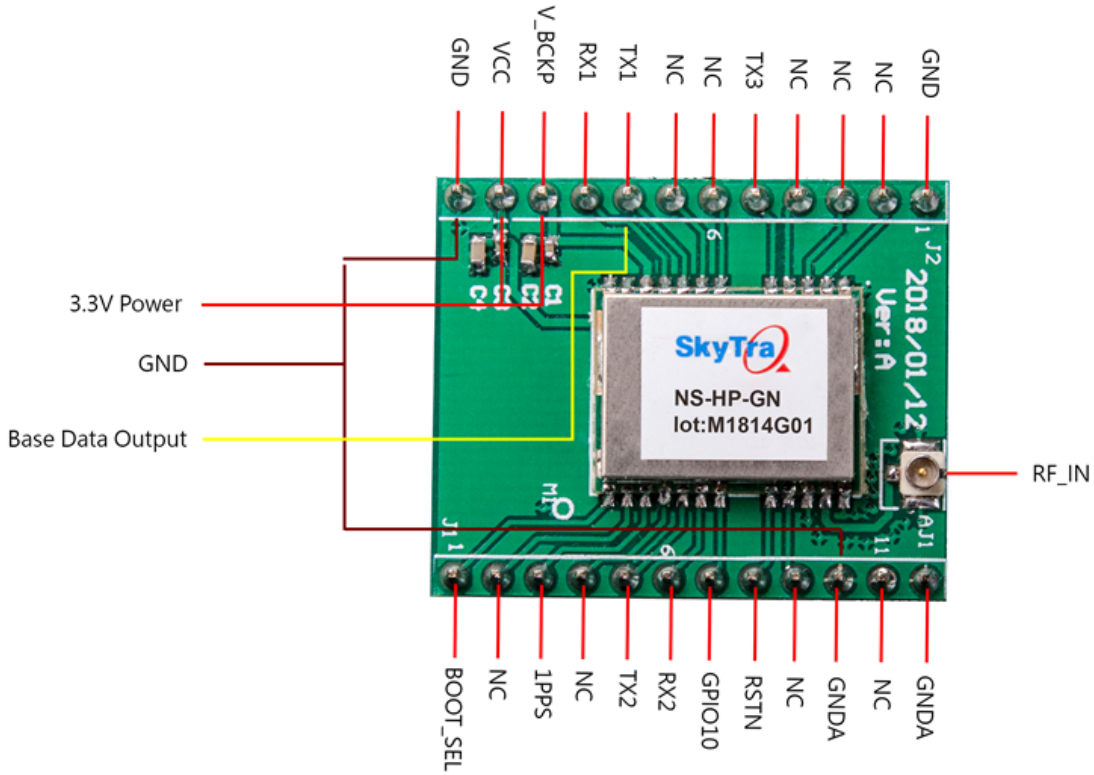


When later in use, after base NS-HP-GN gets position fix and self-surveyed for 60 seconds, it enters into static mode. On GNSS Viewer scatter plot view, one will see the blue dot stop drifting around after static mode is entered; Set Origin button may need to be clicked to center the view in order to see the scatter plot. *Next time powering on the base NS-HP-GN, it will still start from survey mode again, self-survey for 60 seconds, with self-surveyed antenna location at different location unless static mode is chosen and a constant position is entered. To see what the self-surveyed latitude, longitude, and altitude values are, from GNSS Viewer RTK pull-down menu, select Query RTK Mode And Operational Function.*

To use the base at some fixed location, use these steps to self-survey and retrieve surveyed antenna position, then set the antenna position into the base NS-HP-GN so that it'll have the same entered position every time it's powered on later. No need to set the antenna position into base NS-HP-GN if only testing and becoming acquainted with it.

Different from other NS-HP / NS-HP-BD / NS-HP-GL versions, NS-HP-GN rover expects 115200 baud rate base data on RX2.

Once base NS-HP-GN has been properly configured, later usage require only connecting an RTK antenna, apply power, and send TX1 base output data to the rover NS-HP-GN.

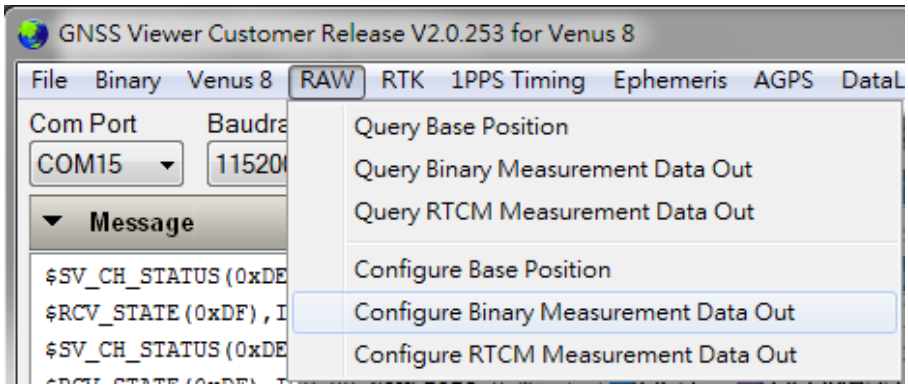


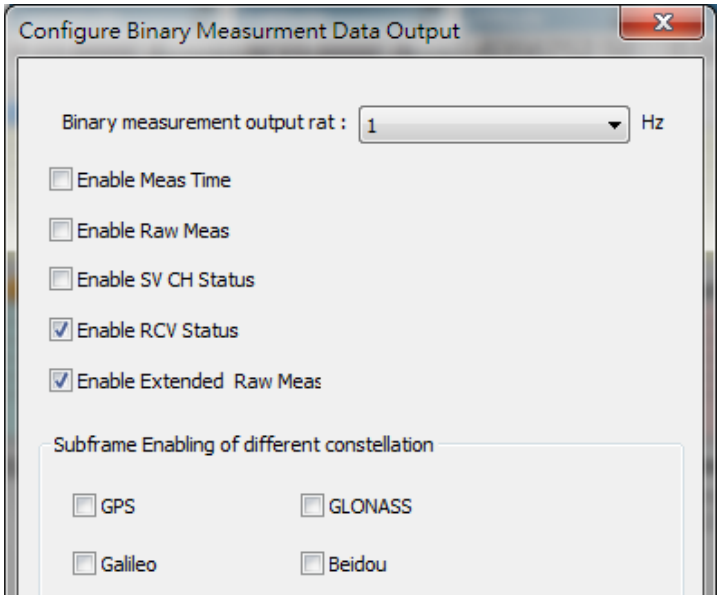
Base Stream Format

After configuring NS-HP-GN to RTK base mode, the default base stream outputs are packaged in SkyTraq RAW measurement protocol. The outputted messages include:

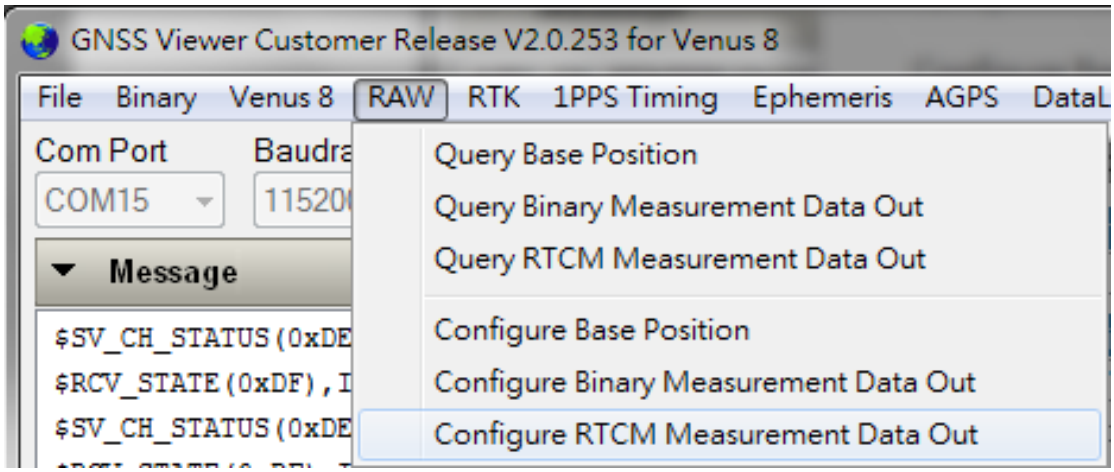
1) Message type 0xDE – SV and Channel Status
2) Message type 0xDF – Receiver Navigation Status
3) Message type 0xE0 – GPS Subframe Data
4) Message type 0xE1 – GLONASS String Data
5) Message type 0xE5 – Extended RAW Measurement

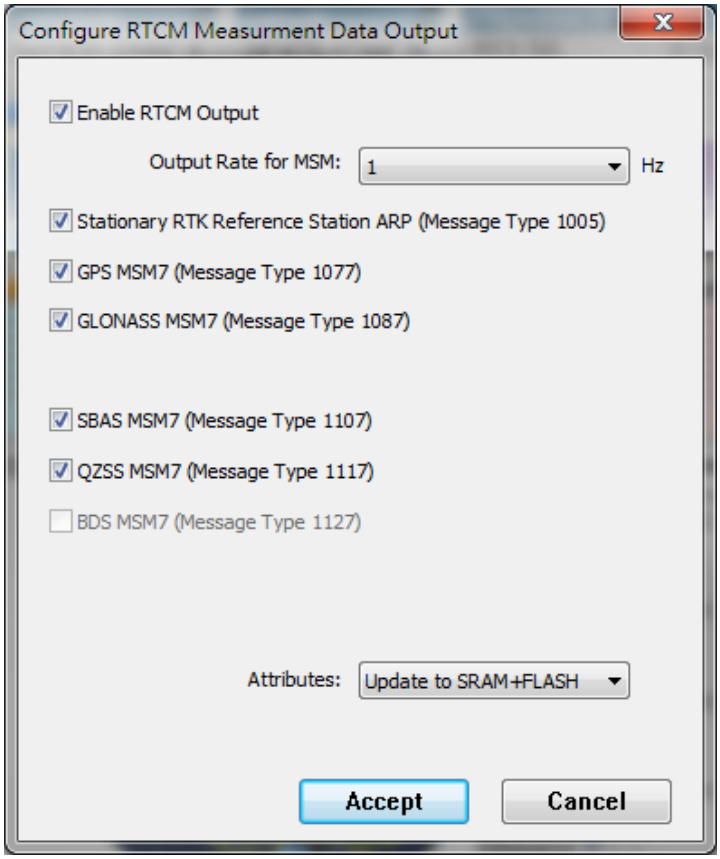
The necessary message types of base stream used for NS-HP-GN RTK rover mode are only “Receiver Navigation Status (0xDF)” and “Extended RAW Measurement (0xE5)”. To decrease the throughput of base stream, other unnecessary message types can be disabled from the base stream. From GNSS Viewer RAW pull-down menu, select Configure Binary Measurement Data Out, disable unnecessary message types, select necessary message types and Update to SRAM+FLASH.





In addition to SkyTraq RAW measurement protocol, NS-HP-GN also supports RTCM 3 format output. From GNSS viewer RAW pull-down menu, select Configure RTCM Measurement Data Out, select Enable RTCM Output, select Stationary RTK Reference Station ARP , select MSM7s and Update to SRAM+FLASH.



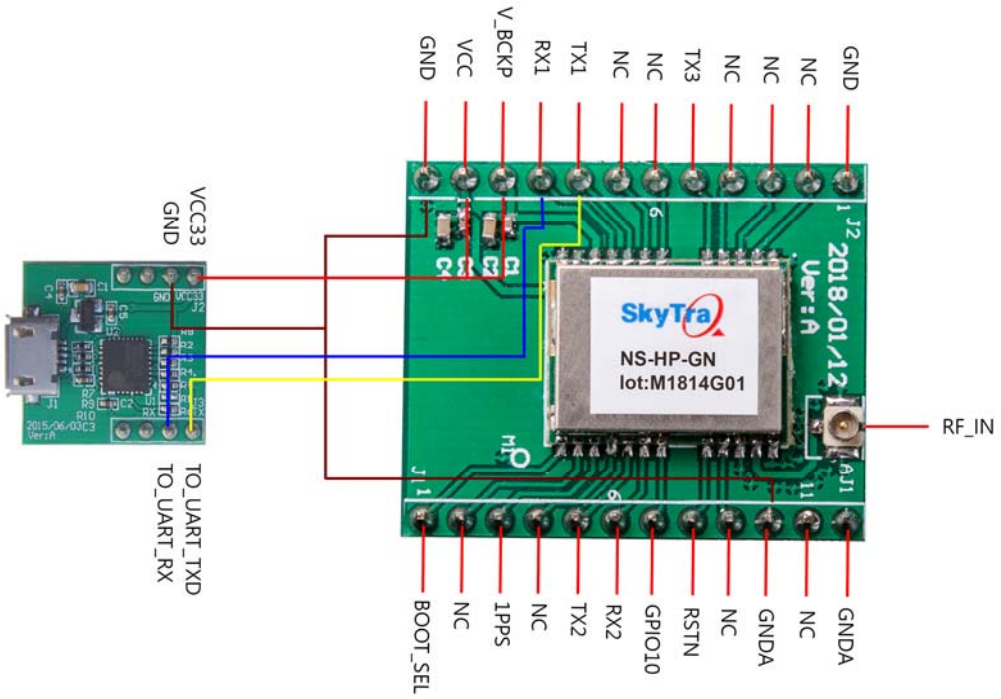


It’s deserved to be mentioned:

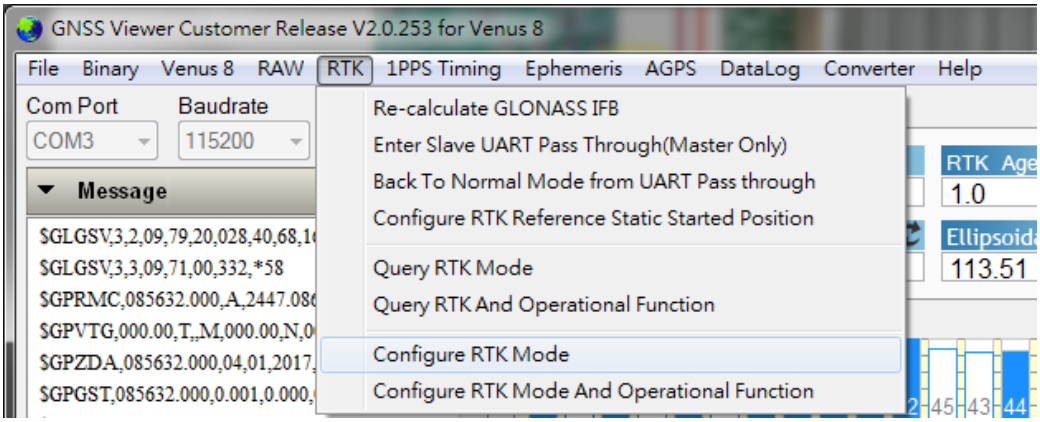
1) It’s necessary to restart rover receiver if the format of base stream is changed.
2) The format of base stream must be configured to SkyTraq RAW measurement protocol if the operational function of NS-HP-GN RTK rover mode is moving base mode.

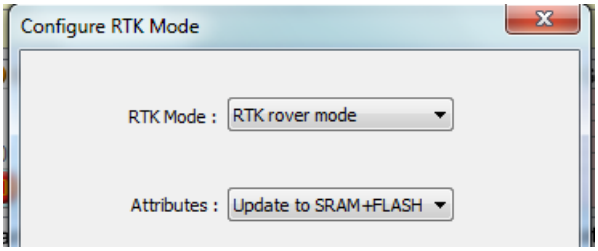
7. USE NS-HP-GN AS RTK ROVER

NS-HP-GN is configured as rover during production. If NS-HP-GN has been previously configured as base, to re-configure it as rover, hook up as below; connect to an UART-to-USB bridge breakout board for connecting to GNSS Viewer running on a Windows PC.

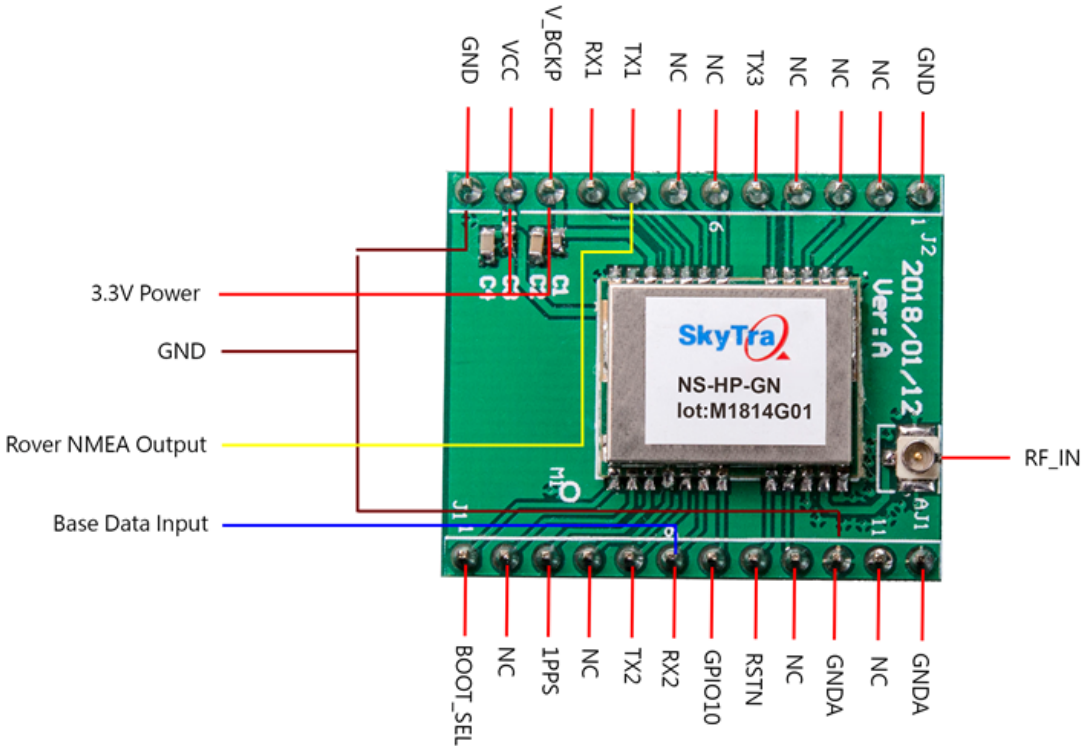


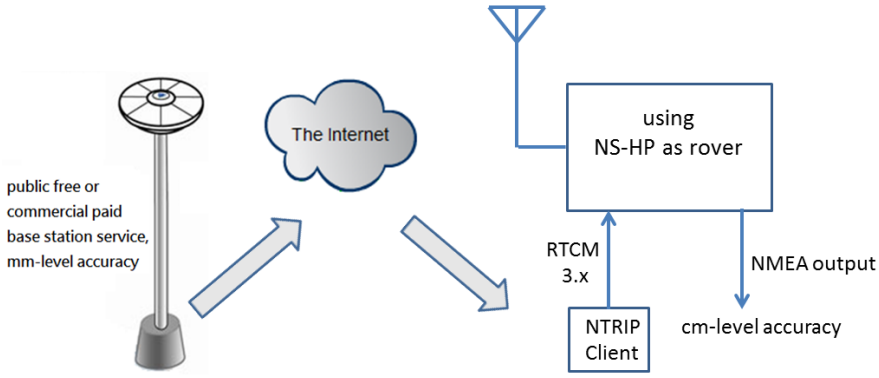
From GNSS Viewer RTK pull down menu, select Configure RTK Mode, select RTK rover mode and update to SRAM+Flash

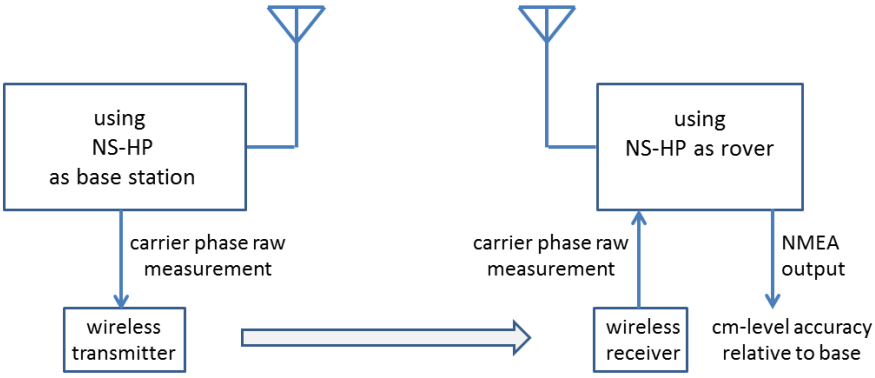




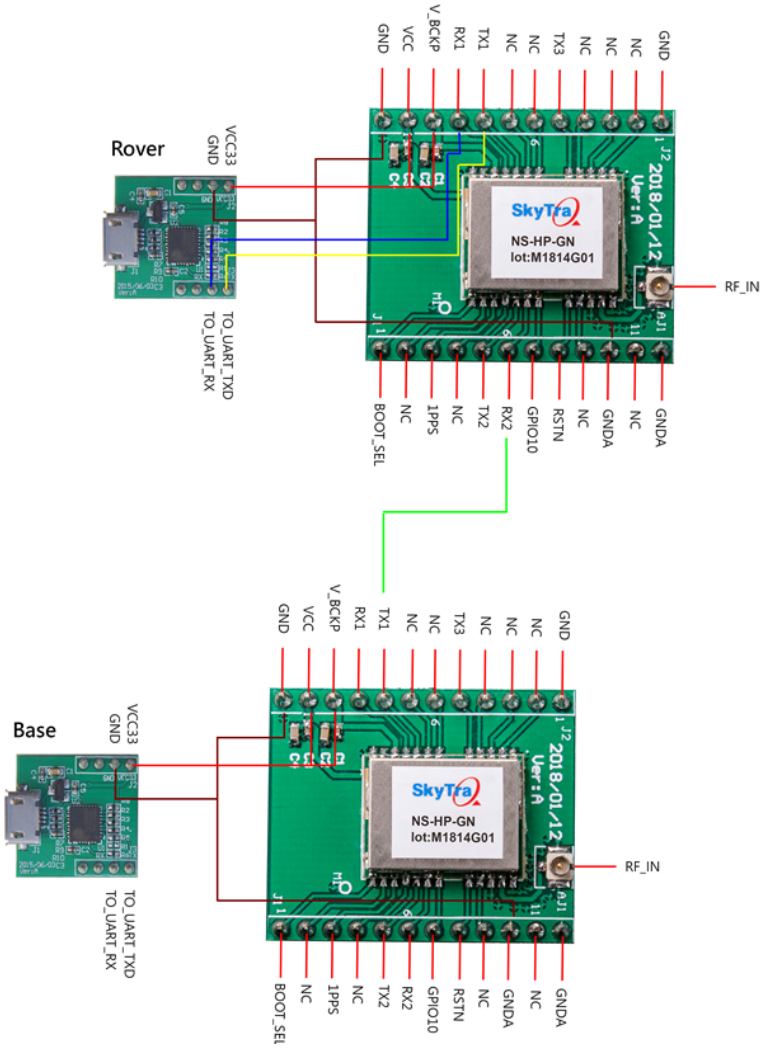
To use NS-HP-GN as RTK rover, connect antenna, place antenna at location with clear open sky view, apply base data to UART RX2 input and apply power, NMEA result will come out from UART TX1 output. The base data may come from a NS-HP-GN base sent over wireless radio, or a remote RTCM 3.x base station within 10Km range retrieved by NTRIP client over Internet and send over Bluetooth-to-Serial or USB-to-Serial interface.



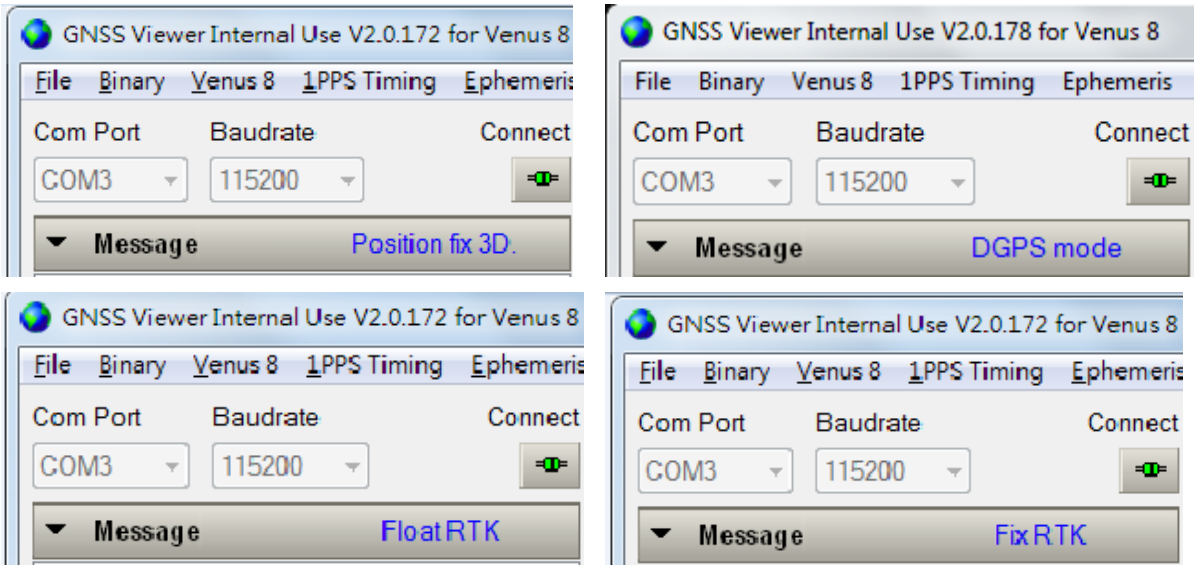




To become acquainted with NS-HP-GN RTK rover operation, it's best to first use GNSS Viewer to monitor and interact with it. One possible setup scenario is as below.

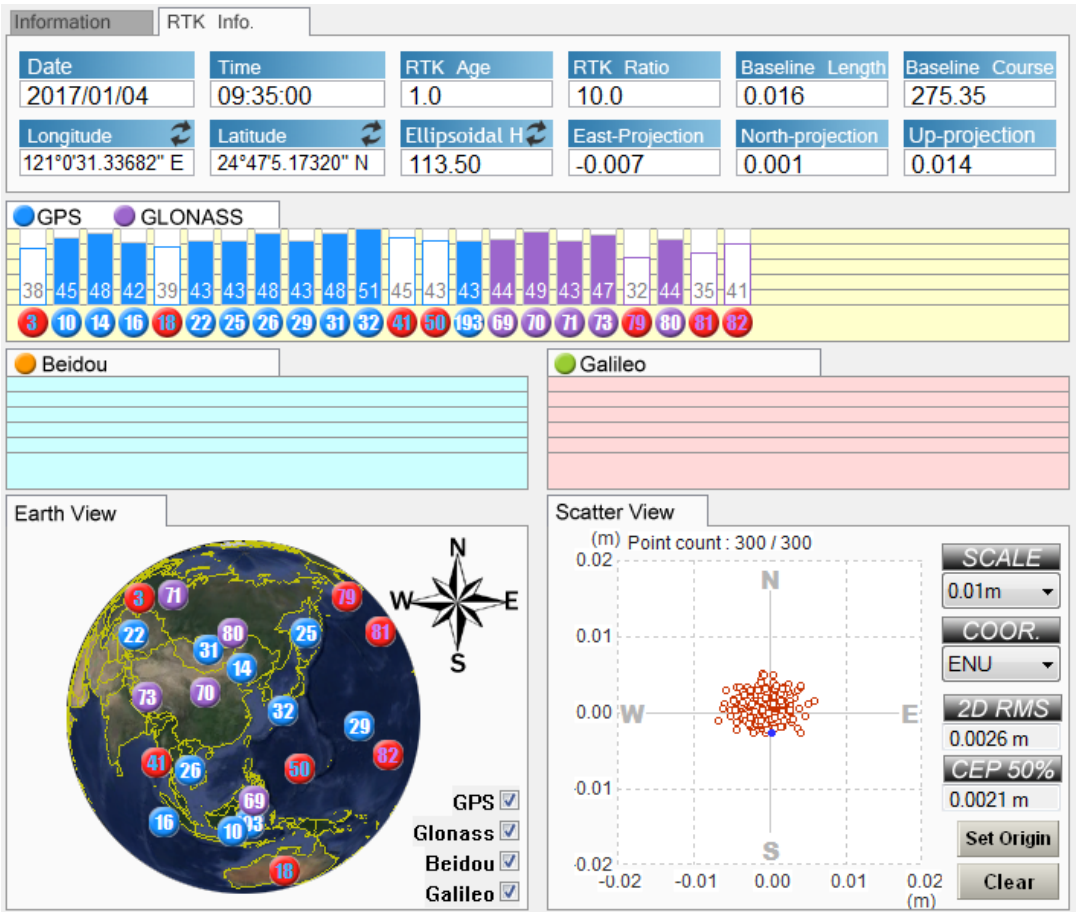


With two antennas connected and placed at location having clear sky view to receive GPS signal, base connected to laptop USB port for power, rover output NMEA data to GNSS Viewer, one should see rover state going from Position Fix 3D or DGPS mode, to Float RTK, to Fix RTK if earlier mentioned pre-conditions for RTK operation is met.



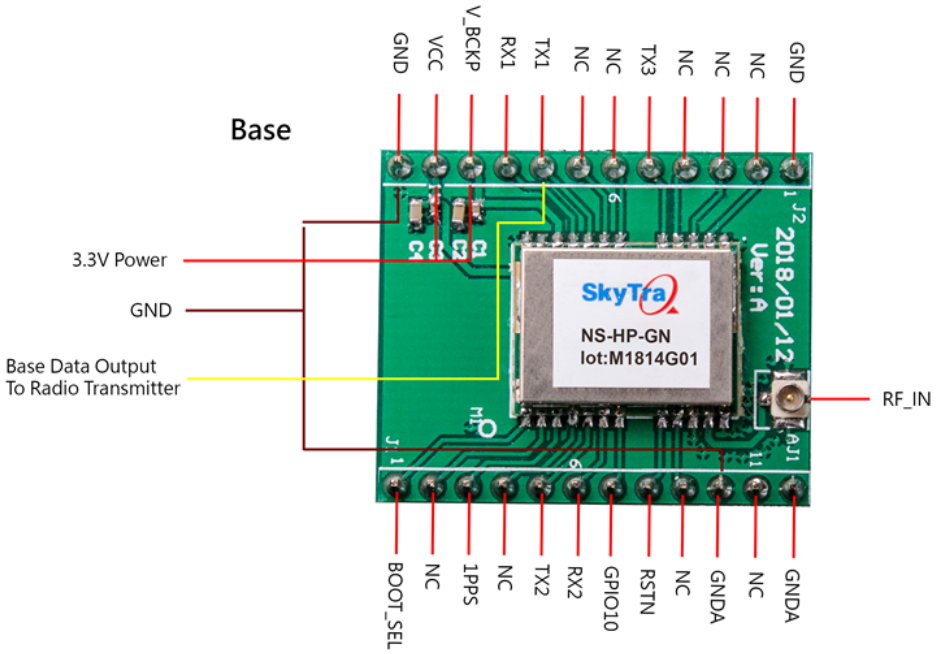
Number values (RTK Age, RTK Ratio, etc.) will be displayed on RTK Info label after Float RTK state is entered. When RTK Ratio number is over 3.0, receiver state changes to Fix RTK; below 3.0, receiver state shows Float RTK.

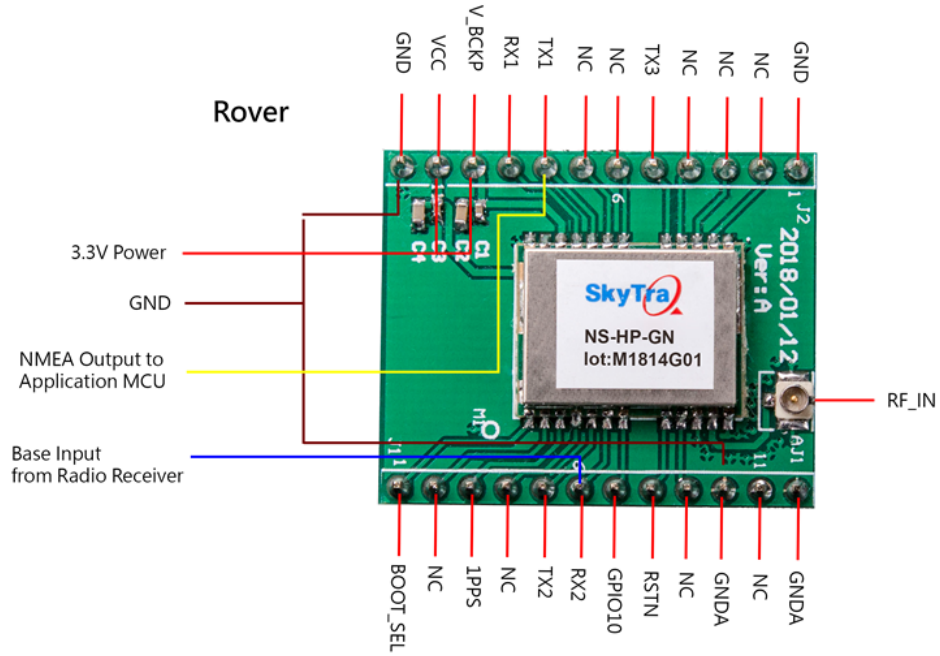
RTK Age indicates the lag delay in received base data. If RTK Age is 30 or more, indicating lag of 30 second or more, receiver state will show Position Fix 3D, NS-HP-GN will not try to compute RTK solution. Large RTK Age indicates some problem with transmission causing severe lag delay.



Although a minimum of 6 GPS satellites could result in Fix RTK solution during zero-baseline GPS simulator testing, 10 or more satellites spread across 4 quadrants of the sky is preferred in getting faster RTK fix with reliable result; lesser number of satellites will take longer time getting RTK fix and may sometimes have reported position decimeters off from true location.

Once becoming acquainted with NS-HP-GN RTK operation, one can replace base/rover wire connection with wireless radio connection to operate over distance as below shows. The rover NMEA output, besides sending to application microcontroller, can also be sent to a wireless transmitter for monitoring using GNSS Viewer on a laptop with wireless receiver.



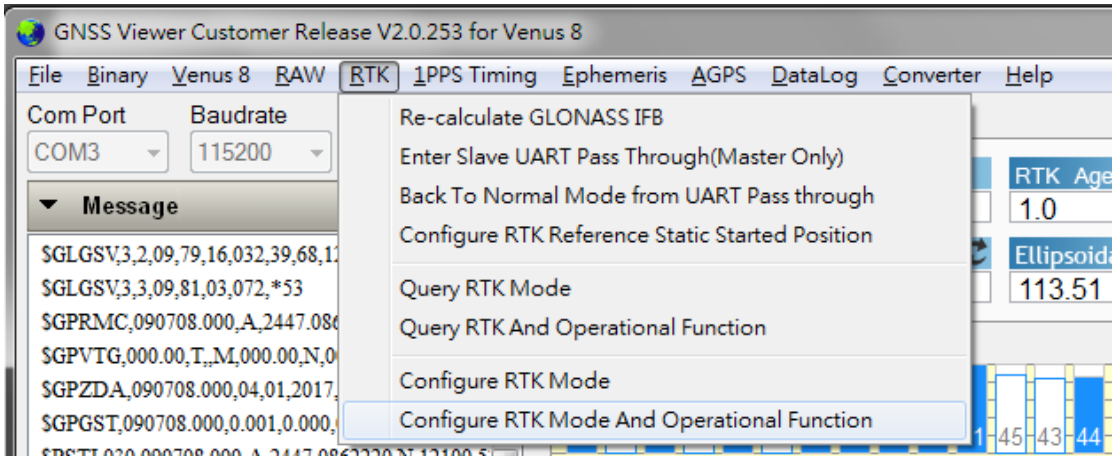


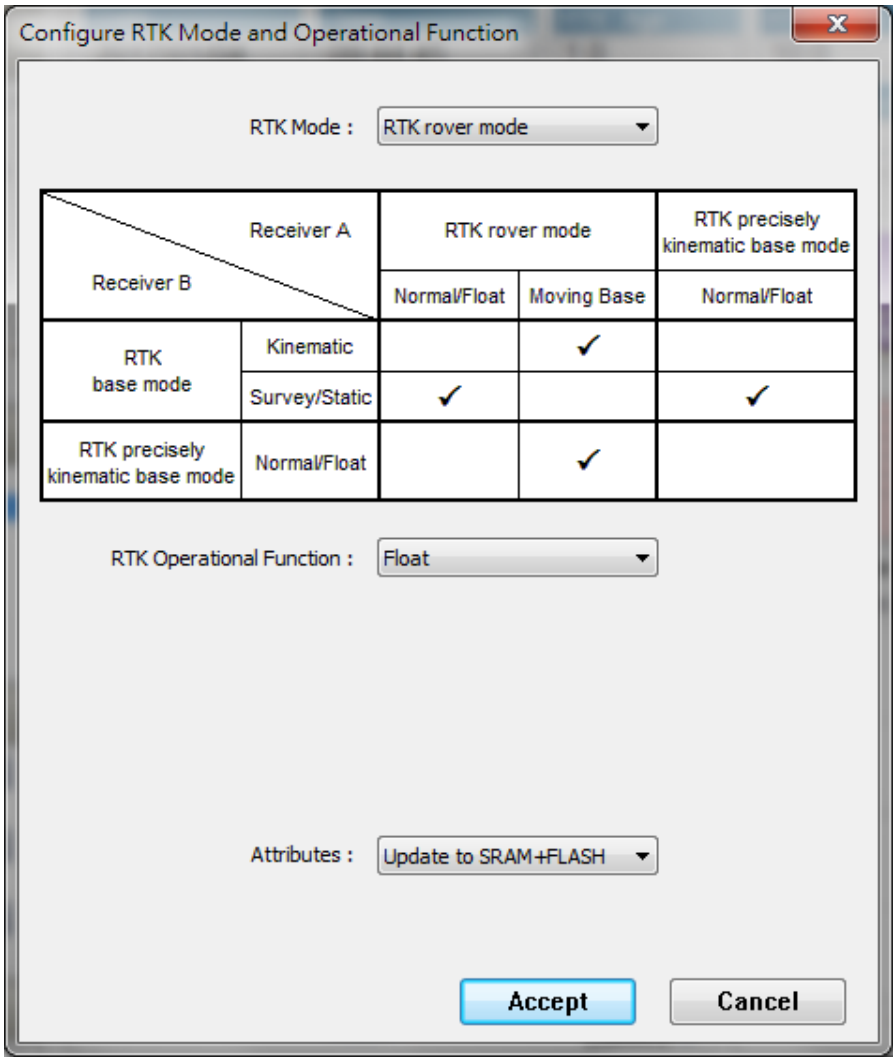
To use NS-HP-GN with Android smartphone or tablet, improving its GPS accuracy 100-fold to centimeter-level RTK for the Apps, a tutorial is available here:

http://www.navspark.com.tw/high-precision/#20151204_1

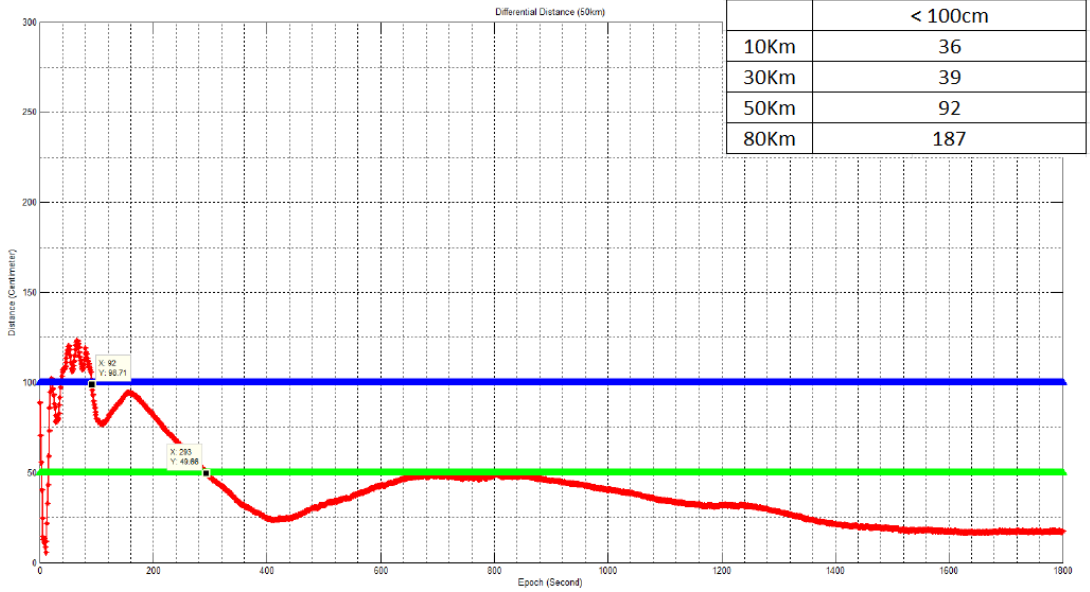
8. FLOAT RTK MODE

In application environment where RTK fix is not possible and sub-meter or decimeter-level accuracy is sufficient, Float RTK mode can be selected.



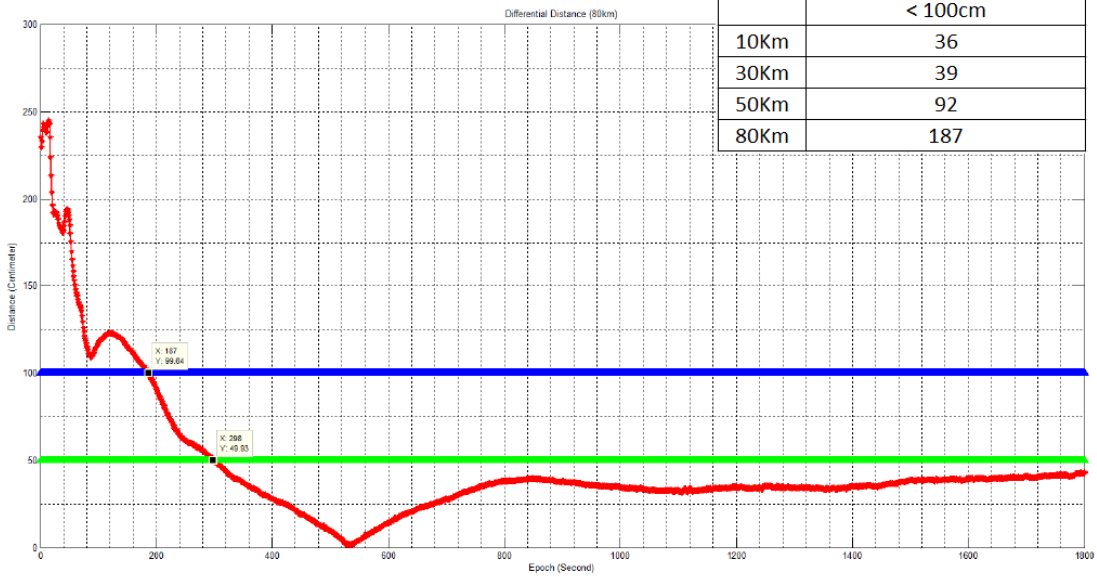


50km(49888m)



Float RTK Convergence Time (sec)	
	< 100cm
10Km	36
30Km	39
50Km	92
80Km	187

80km(79982m)

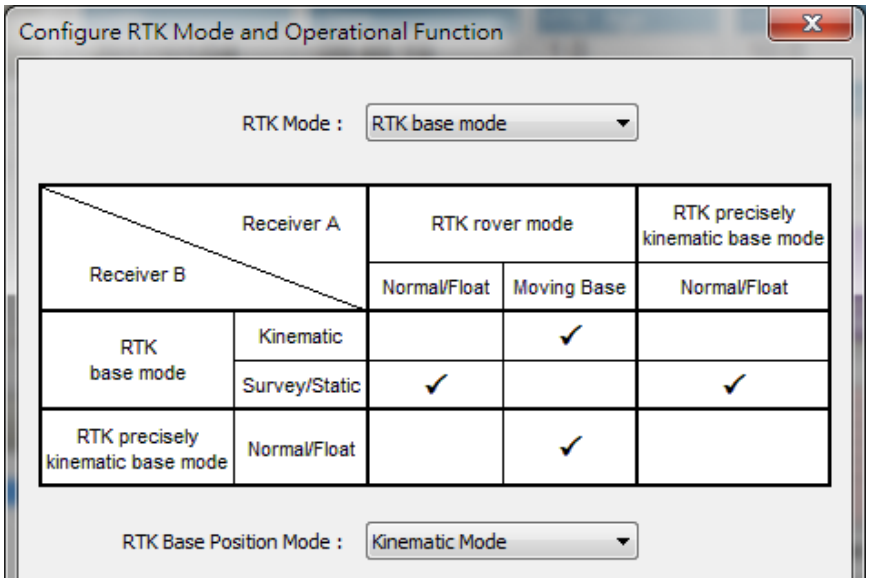


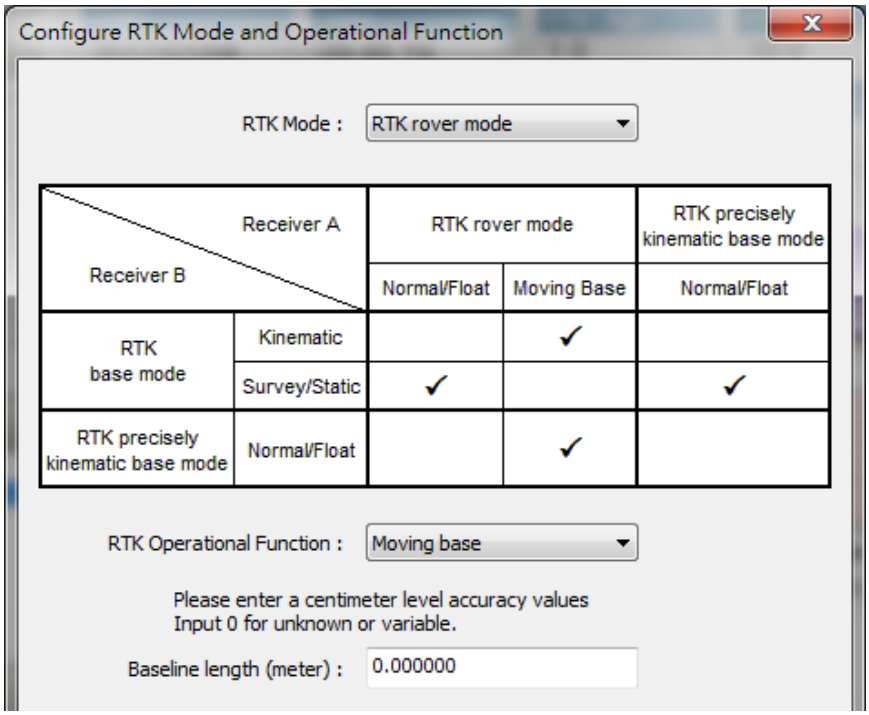
Float RTK Convergence Time (sec)	
	< 100cm
10Km	36
30Km	39
50Km	92
80Km	187

9. MOVING BASE MODE

Normally GPS heading is derived from velocity; when GPS receiver is not moving, it could not have correct heading information. Moving base mode allows reporting of highly accurate heading direction, from base antenna to rover antenna, even when the antennas are static. PSTI,032 message output this heading and baseline information; see S1216F8-RTK datasheet for details.

The base needs to be set to Kinematic Mode and the rover needs to be set to Moving Base Mode. With the two antennas are at fixed distance from each other, the distance number is entered as the baseline length information.





RTK Mode	Remark
Normal & Float	* 1 / 2 / 4 / 5 / 8 / 10 Hz rover only require 1Hz base
	* NS-HP-GN-S support STI,005 position stamp
Moving Base	* rover require matching update rate base
	* maximum 5Hz update rate
	* NS-HP-GN-S does not support STI,005 position stamp in moving base mode

For N-Hz NS-HP-GN in Normal or Float RTK mode, it needs to work with 1Hz base. For N-Hz rover in moving base mode, it needs to work with N-Hz base.

For rover in moving base mode, format of the base stream output must be configured to SkyTraq RAW measurement protocol.

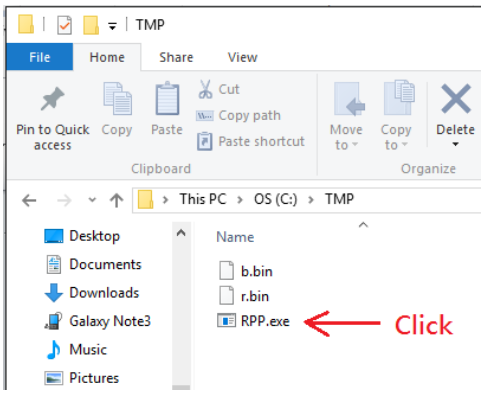
10. RTK POST PROCESSING

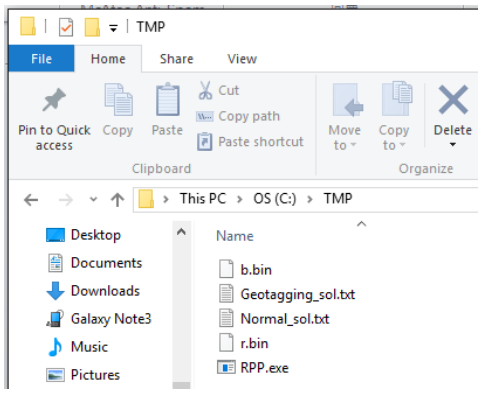
For NS-HP-GN-S aerial mapping users wishing to post-process without the need of radio link sending base data to rover on the UAV, carrier phase raw measurements of base and rover can be logged separately and later processed by RPP.EXE, a Windows PC RTK Post-Process program.

After setting up base as described in section 6, carrier phase raw measurement can be logged using TX3 pin; raw measurement and antenna position are output on TX3 pin.

The rover needs to be set to base mode in order to output carrier phase raw measurement data; carrier phase raw measurement can be logged using TX3 pin. Update rate can be changed from default 1Hz of base mode.

To use RPP.EXE, put both base and rover raw measurement files under the same directory. Rename base raw measurement file to b.bin; rename rover raw measurement file to r.bin; click to execute RPP.EXE; Normal_sol.txt and Geotagging_sol.txt files are generated. Normal_sol.txt contains date / time / position of the rover at regular interval. Geotagging_sol.txt contains TRIG pin generated date / time / position of the rover.





EPOCH	DATE	UTC	STATUS	AGE_OF_DIFF	RATIO	LAT	LON	ALT	X	Y	
2	2016/06/22	08:05:24.001	SINGLE	0.00	0.00	24.78479206	121.00871642	112.064	-2984963.388	4966101.865	265
4	2016/06/22	08:05:25.001	SINGLE	0.00	0.00	24.78479059	121.00871826	111.760	-2984963.435	4966101.584	265
6	2016/06/22	08:05:26.001	FLOAT	-1.00	2.99	24.78477030	121.00870472	113.492	-2984963.557	4966104.445	265
8	2016/06/22	08:05:27.001	FLOAT	-1.00	2.99	24.78477032	121.00870469	113.485	-2984963.556	4966104.447	265
10	2016/06/22	08:05:28.001	FIX	-1.00	6.57	24.78477033	121.00870468	113.486	-2984963.555	4966104.448	265
12	2016/06/22	08:05:29.001	FIX	-1.00	6.08	24.78477031	121.00870471	113.487	-2984963.559	4966104.448	265
14	2016/06/22	08:05:30.001	FIX	-1.00	5.72	24.78477033	121.00870471	113.482	-2984963.555	4966104.443	265
16	2016/06/22	08:05:31.001	FIX	-1.00	10.00	24.78477030	121.00870469	113.488	-2984963.557	4966104.451	265
18	2016/06/22	08:05:32.001	FIX	-1.00	10.00	24.78477033	121.00870470	113.485	-2984963.557	4966104.446	265
20	2016/06/22	08:05:33.001	FIX	-1.00	10.00	24.78477034	121.00870470	113.483	-2984963.556	4966104.445	265
22	2016/06/22	08:05:34.001	FIX	-1.00	10.00	24.78477034	121.00870471	113.479	-2984963.554	4966104.441	265
24	2016/06/22	08:05:35.001	FIX	-1.00	10.00	24.78477034	121.00870470	113.487	-2984963.557	4966104.448	265
26	2016/06/22	08:05:36.001	FIX	-1.00	10.00	24.78477033	121.00870470	113.480	-2984963.554	4966104.442	265
28	2016/06/22	08:05:37.001	FIX	-1.00	10.00	24.78477031	121.00870470	113.487	-2984963.558	4966104.449	265
30	2016/06/22	08:05:38.001	FIX	-1.00	10.00	24.78477033	121.00870471	113.479	-2984963.554	4966104.441	265
32	2016/06/22	08:05:39.001	FIX	-1.00	10.00	24.78477035	121.00870471	113.487	-2984963.557	4966104.447	265

11. ACTIVE ANTENNA CONSIDERATION

External Survey Grade Helix



For RTK application, the active antenna must be able to provide signal over 37dB under open sky. Antennas vary in price, from under $30 to over $300; they mainly differ in interference rejection capability, multipath rejection capability, antenna phase center stability, and weight. Usually more expensive antenna claims to have superior interference and multipath rejection capability. Phase center of expensive survey grade antenna remains constant as the azimuth and elevation angle of the satellites change; signal reception is unaffected by the rotation of the antenna or satellite elevation. Helix antennas are expensive mostly due to light weight feature for UAV applications.

Under open sky no interference no multipath environments, performance difference between the wide price range of antennas may not be much. Depending on budget and application environment signal conditions, user can choose appropriate antenna for the required application.

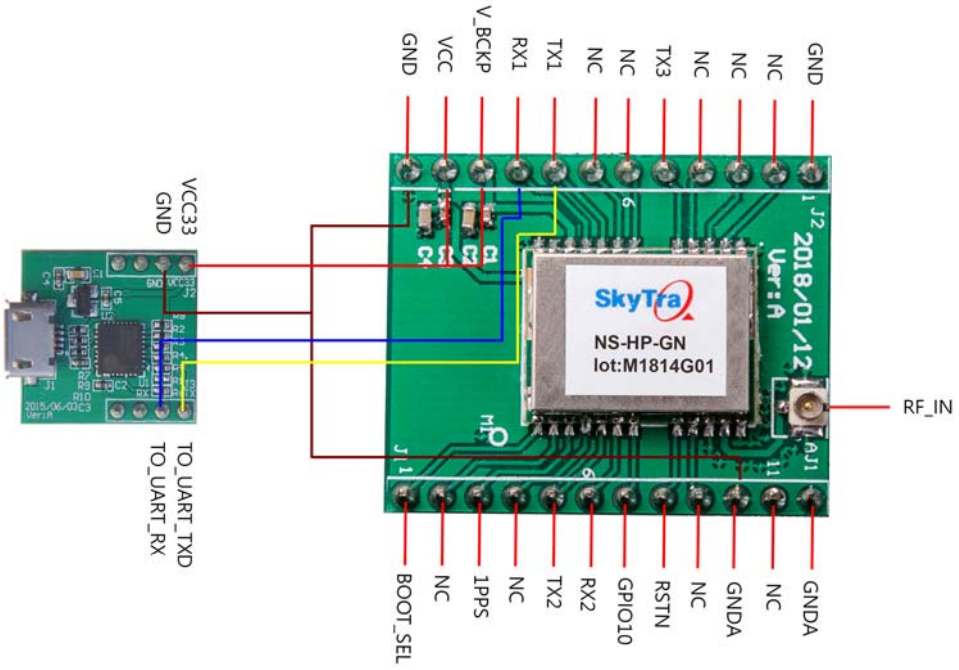
12. FIRMWARE UPDATE

When there is firmware update release, it'll be made available on the NS-HP-GN web store product page.

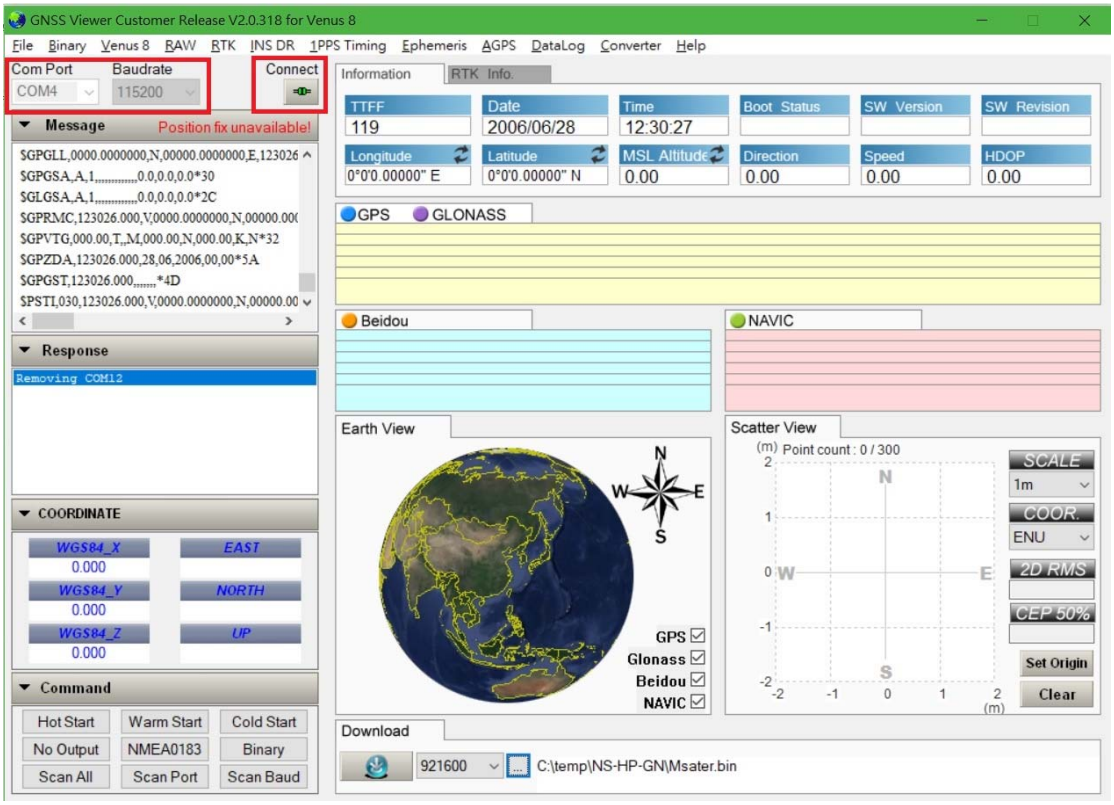
There are two 32bit RISC controllers inside NS-HP-GN module, one act as master, the other as slave. Different firmware is used to program master and slave controllers. Firmware for master controller has "master" in the filename. Firmware for slave controller has "slave" in the filename.

To update firmware using GNSS Viewer:

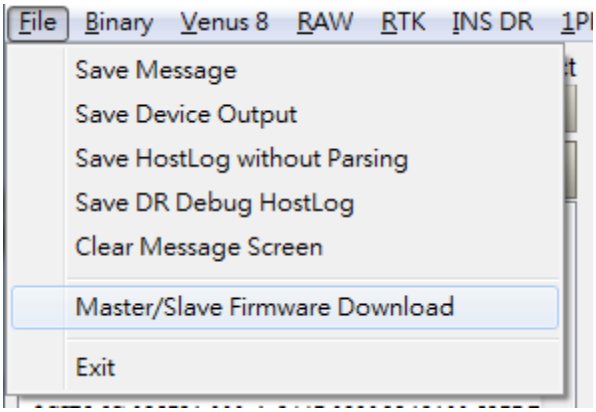
1. Connect TX1 and RX1 to an UART-to-USB bridge breakout board for connecting to a Windows PC



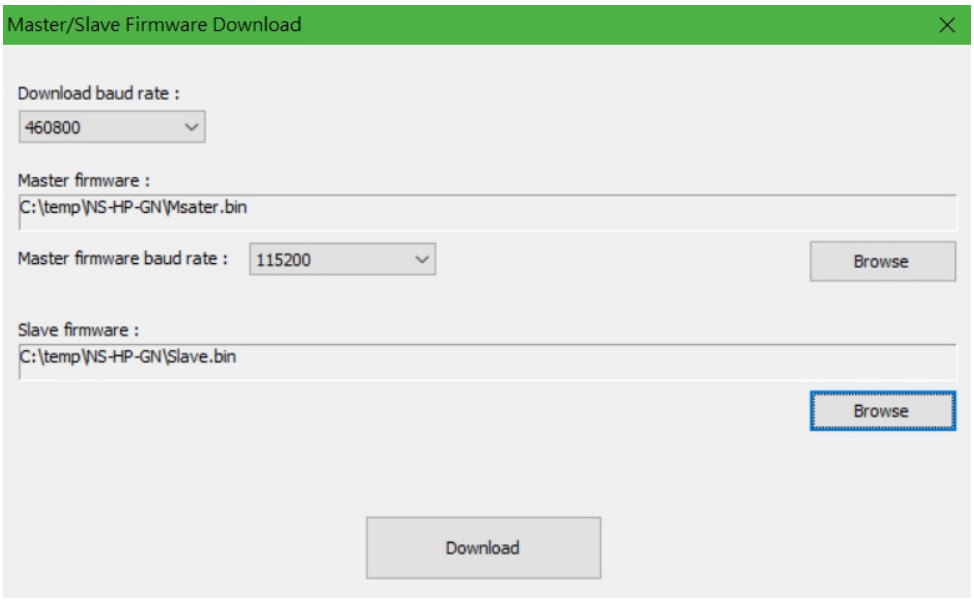
2. Connect GNSS Viewer with NS-HP-GN using correct COM port and set **Baudrate 115200**, then click the icon under **Connect**. The icon becomes green if they connect correctly.



3. Click **File ➔ Master/Slave Firmware Download**



4. Select Master and Slave firmware (.bin) to download. **Master firmware baud rate** must be set to **115200**. Then click **Download.**

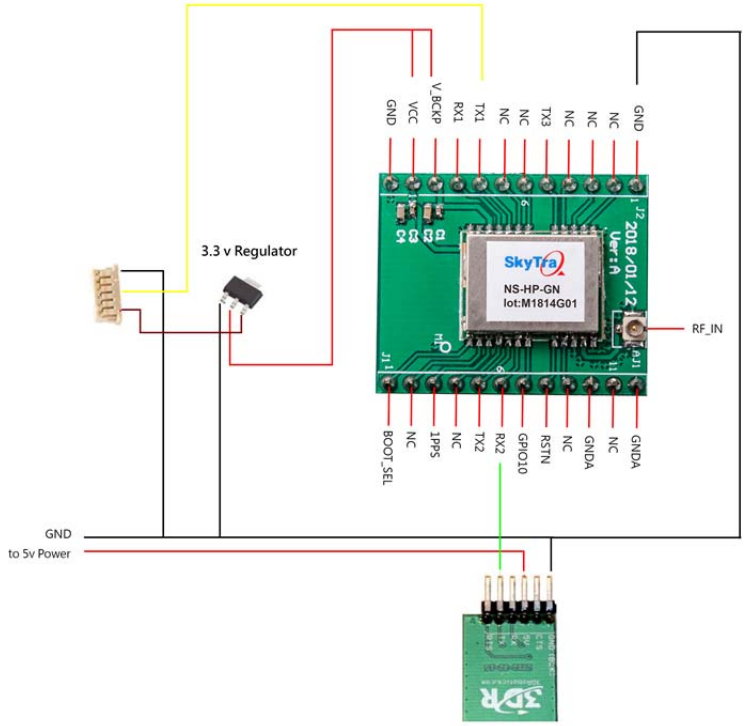


5. A message box will show when the firmware update is finished successfully.

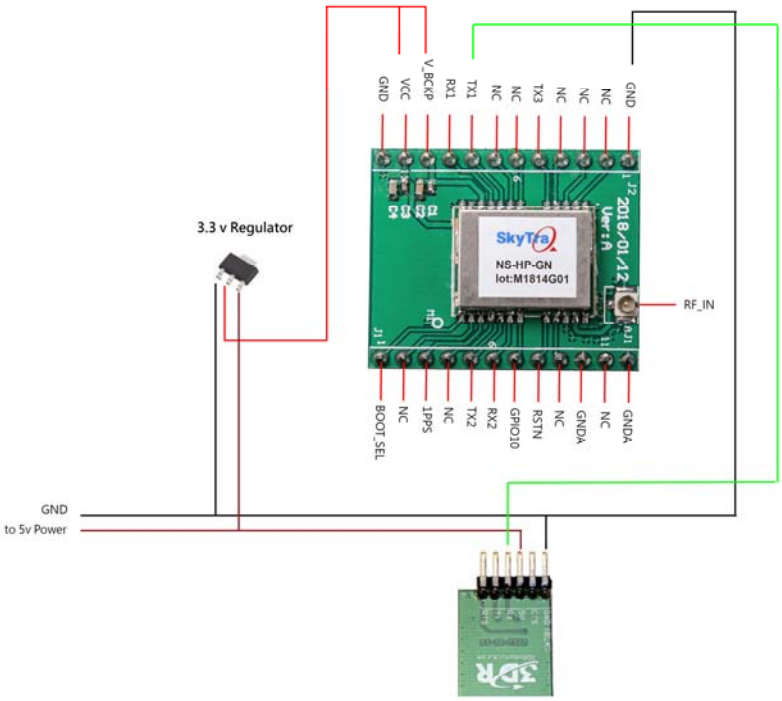
6. Master firmware has default set to rover mode. If using NS-HP-GN as base, procedure for setting up base mode and antenna position needs to be done again after firmware update,

13. POSSIBLE CONNECTION FOR QUADCOPTER APPLICATION

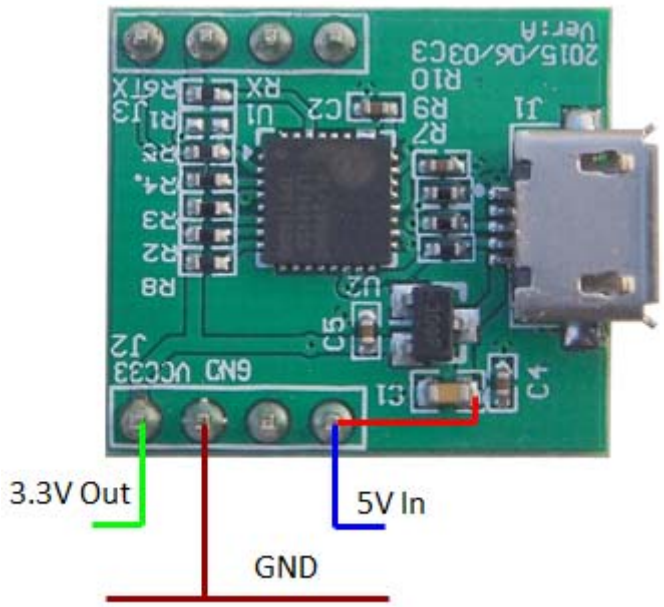
Pixhawk Rover Connection



Ground Base Connection

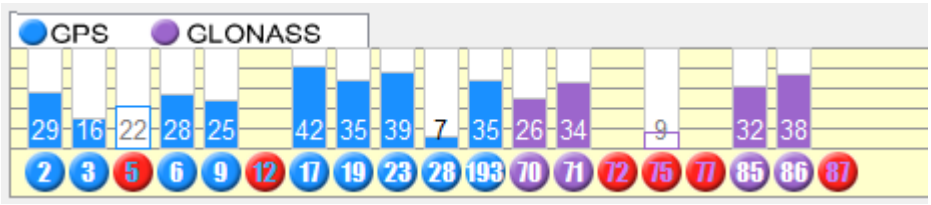


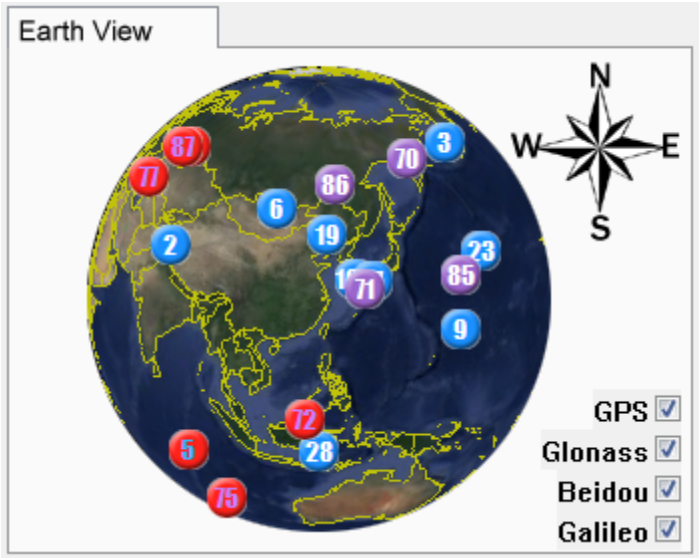
For the 3.3V Regulator in above figure, if you already have the UART-to-USB Adapter breakout board from the web-store freebie, you can modify as below adding a wire connecting pin-stick to capacitor (red wire) and have a 5V-to-3.3V LDO regulator to use.



FAQ

Q1: Why I cannot receive RTK fix for a long time? My received signal is as below.





A1: NS-HP-GN require at least 10 satellites, signal level above 37dB, elevation angle above 15 degrees, and good geometry to have position fix; more satellites the better. Currently there is only 3 satellites with 37dB or higher signal, thus cannot have RTK fix.

Keep antenna at least 10cm away from NS-HP-GN, farther the better, to avoid picking up its radiated digital noise, signal level will be higher if placed at distance. 7cm x 7cm or larger metallic sheet (or tin foil) placed underneath the antenna could also boost signal couple dB more.

CHANGE LOG

Version 0.1, June 28, 2018
1. Initial release