Data Sheet / GE-926

RTK GNSS

PCI Express Half-Mini Card

w/ I-PEX MHF RF Connector

Version 1.0

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CAUTION：

RISK OF EXPLOSION IF BATTERY IS REPLACED BY AN INCORRECT TYPE. DISPOSE OF USED BATTERIES ACCORDING TO THE INSTRUCTIONS.

Revision History

Ver.	Date	Description
1.0	July 22nd, 2025	First release

Contents

1 Introduction

1.1 Overview

The GE-926 features the high-sensitivity u-blox F9P engine, an RF connector, and an optional backup battery. Its Mini PCI Express standard design enables easy integration into devices with PC architecture. The half-length form factor makes it suitable for space-constrained environments. In addition to the standard USB interface, the device also supports an optional UART/TTL interface.

The GE-926 can simultaneously track L1 and L5 band signals from all major civil navigation systems, including GPS, GLONASS, Galileo, BeiDou, QZSS, and SBAS satellites. Thanks to this capability, a large number of satellites are visible at any time, making positioning easier and more accurate—even in challenging environments where GPS signals are typically weak or obstructed.

The optional backup battery enables faster position fixes and can be omitted if an extended temperature range is required.

1.2 Main Features

Our experienced design exhibits the full performance of NEO-F9P-15B

- PCI Express Mini Card standard compliant
- Powered by u-blox NEO-F9P-15B RTK engine
- Supporting L1/L5 band and multiple constellations simultaneously
    - GPS+Galileo+GLONASS+BeiDou
    - SBAS, QZSS
- Augmentation support:
    - DGNSS RTCM 10403.3 version 3 messages support for RTK fix.
    - SBAS (WAAS, EGNOS, MSAS, GAGAN),
    - QZSS (L1 C/A and L5 signals & L1S SLAS, Sub-meter Level Augmentation Service)
    - CLAS (Centimeter level augmentation service)
- SPARTN 2.0.1 support
- High sensitivity

  - Acquisition: -148dBm
  - Tracking: -167dBm
- RTK convergence in 12 sec for multi-GNSS.
- Max. RTK update rate (default 1Hz), up to
  - 7 Hz for GPS+GAL+GLO+BDS
  - 8 Hz for GPS+GAL+BDS
  - 14 Hz for GPS+GAL
  - 15 Hz for GPS+GLO
  - 10 Hz for GPS+BDS
  - 25 Hz for GPS only
- Spoofing detection / monitoring
  - Multiple constellations should be enabled.
- Jamming / interference indicator
  - For continuous wave (narrow-band) jammers/interference only
- The tiny I-PEX MHF RF connector allows flexibly placing GNSS antenna at a suitable location.
- External active antenna short circuit protection
- Optional backup battery for faster position fix.
- Support USB or UART/TTL interface.
- Windows location sensor support
- OMA SUPL compliant A-GPS support
- Excellent EMI protection
- Industrial operating temperature range: -40 ~ 85℃

1.3 Technical Specification/ Receiver Performance Data

Features	Specifications[!]
Supported GNSS Constellations	u-blox NEO-F9P-15B GPS/SBAS/QZSS: (MHz) L1 C/A (1575.42), L5 (1176.45) GLONASS: (MHz) L1OF (1602+k*0.5625, k= -7,…,5,6), Galileo: (MHz) E1-B/C (1575.42), E5a (1176.45)

	BeiDou: (MHz) B1I (1561.098) B2a (1176.45) NavIC: (MHz) SPS-L5 (1176.450)
Position Accuracy (1ppm for RTK baseline up to 20km))	Horizontal: (CEP) RTK: 1 cm+1ppm (1km baseline) SBAS: 1 m PVT: 1.5 m Vertical: (using 1km baseline) RTK: 1 cm+1ppm Median SBAS: 1.5 m PVT: 2 m
Velocity Accuracy	0.05 m/s (speed) 0.3° (heading) (50% @ 30 m/s for dynamic operation)
Time Pulse Signal	0.25Hz...10MHz3 RMS: 30ns, 99%: 60ns
Time To First Fix (TTFF) Hot start Aided start Cold start	Autonomous (All at -130dBm) 3sec (GPS+Glonass+Galileo+BeiDou) 4sec (GPS+Glonass+Galileo+BeiDou) 27sec (GPS+Glonass+Galileo+BeiDou)
Sensitivity	GPS+Glonass+Galileo+BeiDou Acquisition: -148 dBm Reacquisition: -160 dBm Tracking & navigation: -167 dBm
Max. Update Rate RTK Convergence Time	a. GPS+Glonass+Galileo+BeiDou b. GPS+Galileo+BeiDou c. GPS RTK: 7Hz@a, 8Hz@b, 25Hz@c PVT: 7Hz@a, 8Hz@b, 25Hz@c RAW: 10Hz@a, 10Hz@b, 25Hz@c <12s@a&b, <30s@c Depends on atmospheric conditions, baseline length, GNSS antenna, multipath conditions, satellite visibility and geometry
Max. Altitude	80,000 m
Max. Velocity	500 m/s
Protocol Support	NMEA 0183 up to v 4.11, ASCII GGA, GLL, GSA, GSV, RMC, VTG UBX: input/output, u-blox proprietary, binary RTCM 3.3: input/output, binary SPARTN 2.0.1: input, binary

Default Settings	UART1 & 2: 38400bps, N-8-1 UART1: NMEA, UBX, RTCM 3.3 enabled Only NMEA output UART2: RTCM 3.3 enabled, No output, NMEA disabled, UBX output disabled, input enabled SPARTN input enabled
Augmentation System Support	QZSS: Track QZSS L1 C/A and L5 concurrently Receive L1S SLAS on L1 SBAS: WAAS, EGNOS, MSAS, GAGAN DGNSS: RTCM 10403.3 ● Rover mode messages: (RTCM) 1005~1007, 1033, 1074, 1075, 1077, 1084, 1085, 1087, 1094, 1095, 1097, 1124, 1125, 1127, 1230 ● Base mode messages: (RTCM) 1005, 1074, 1077, 1084, 1087, 1094, 1097, 1124, 1127, 1230 ● SPARTN 2.0.1 messages: (SM) 0-0, 0-1, 0-2, 0-3, 1-0, 1-1, 1-2, 1-3, 2-0
Dynamics	< 4g

! Based on data from chip vendor.

1.4 Protocols

The NMEA protocol is supported via serial UART (RX/TX). The default supported protocol is NMEA.

1. Serial communication channel – UART/TTL
   i. No parity, 8-data bit, 1-stop bit (N-8-1)
   ii. 38400 bps.
2. NMEA 0183 up to version 4.11, ASCII output
   i. Default RMC, VTG, GGA, GSA, GSV, GLL
3. u-blox binary protocol (UBX)
4. RTK mode supported RTCM 3.3 messages according to RTCM 10403.3

➢Operating as a rover, the GE-926 can decode the following RTCM 3.3 messages:

Message	*Description*
1005	Stationary RTK reference station ARP (Input/output)

1006	Stationary RTK reference station ARP with antenna height
1007	Antenna descriptor
1033	Receiver and antenna descriptors
1074	GPS MSM4
1075	GPS MSM5
1077	GPS MSM7
1084	GLONASS MSM4
1085	GLONASS MSM5
1087	GLONASS MSM7
1094	Galileo MSM4
1095	Galileo MSM5
1097	Galileo MSM7
1124	BeiDou MSM4
1125	BeiDou MSM5
1127	BeiDou MSM7
1230	GLONASS L1 and L2 code-phase biases

- Operating as a base station, the GE-926 can generate the following RTCM 3.3 output messages:

Message	*Description*
1005	Stationary RTK reference station ARP
1074	GPS MSM4
1077	GPS MSM7
1084	GLONASS MSM4
1087	GLONASS MSM7
1094	Galileo MSM4
1097	Galileo MSM7
1124	BeiDou MSM4
1127	BeiDou MSM7
1230	GLONASS L1 and L2 code-phase biases

5. SPARTN 2.0.1

Operating as a rover, the GE-926 can decode the following SPARTN 2.0.1 messages:

Message	*Description*
SM 0-0	GPS orbit, clock, bias (OCB)
SM 0-1	GLONASS orbit, clock, bias (OCB)
SM 0-2	Galileo orbit, clock, bias (OCB)
SM 0-3	BeiDou orbit, clock, bias (OCB)
SM 1-0	GPS high-precision atmosphere correction (HPAC)
SM 1-1	GLONASS high-precision atmosphere correction (HPAC)
SM 1-2	Galileo high-precision atmosphere correction (HPAC)
SM 1-3	BeiDou high-precision atmosphere correction (HPAC)
SM 2-0	Geographic area definition (GAD)

1.5 Navigation Mode

There are 3 navigation modes. One can expect cm-level accuracy only for RTK fixed mode.

- Traditional standalone fixed mode
  - Fixed position without RTCM correction messages. Accuracy is in meters.
    - Pin, RTK_ST, value is equal to 1.
- RTK float mode
  - When it receives an input stream of RTCM 3 messages, it enters this mode. It then tries to resolve the carrier phase ambiguity based on the received RTCM messages and the observed satellites.
    - RTK_ST value switches between 0 and 1 before RTK fixed
  - If the RTCM 3 messages become unavailable, it goes back to the traditional standalone fixed mode.
    - RTK_ST value switches between 0 and 1.
- RTK fixed mode
  - It enters RTK fixed mode as soon as it has resolved the carrier phase ambiguity. In this mode, relative accuracy can be expected correct to cm-level.
    - Pin, RTK_ST, value is equal to 0.
  - It takes less time from RTK float mode to RTK fixed mode (convergence time) if both the base and rover receive signals from numerous and common satellites. Otherwise, the convergence time would be longer depending on the base and rover's signal reception status. That is to say, if a rover receives a satellite that is not received by a base, then this satellite could not be used for RTK fix.
  - It will try to provide RTK fixed mode if sufficient ambiguities can be estimated.
    - For single constellation, 6 or more satellites with continuous phase lock above the elevation mask (default 10°) is required.
    - For GPS + BEIDOU, at least 3 BEIDOU satellites is required to form the double difference measurement because there are two BEIDOU satellite variants. That

is to say, minimum of 8 satellites is required, e.g. 5 GPS + 3 BEIDOU).

- For GPS + GLONASS, at least 2 GLNASS satellites is required to form the double difference measurement. That is to say, minimum of 7 satellites is required, e.g. 5 GPS + 2 GLONASS).

It drops back to RTK float mode if it loses carrier phase lock and sufficient ambiguities cannot be estimated. It goes back to RTK fixed mode once the minimum number of signals has been recovered.

1.6 Raw Data

The GE-926 can output all GNSS broadcast data received from tracked satellites, encompassing all supported GNSS signals as well as augmentation services such as QZSS and SBAS. This information is conveyed via the UBX-RXM-SFRBX message. Additionally, the receiver provides detailed tracked satellite signal data—including raw code phase and Doppler measurements—formatted in accordance with the Radio Resource LCS Protocol (RRLP). For detailed specifications of the UBX-RXM-SFRBX message, please refer to the u-blox NEO-F9P Interface Description.

The GE-926 provides raw carrier phase data for all supported signals, along with pseudorange, Doppler, and measurement quality information. The data output in the UBX-RXM-RAWX message adheres to the conventions of a multi-GNSS RINEX 3 observation file. For detailed specifications of the UBX-RXM-RAWX message, refer to the u-blox NEO-F9P Interface Description. Raw measurement data become available once the receiver has achieved data bit synchronization and established time-of-week.

1.7 Relative and Absolute Accuracy

In RTK mode, the position of the rover is relative to the location of the base position. The cm-level accuracy is also relative to the base.

If the accuracy of the base station is absolute correct, then the rover would be cm-level absolute correct, too.

1.8 Leap Second

Because of the synchronization between atomic clocks and earth rotation, there is leap second adjustments every a few years. Such kind of adjustment would be calibrated before chip release. There might be multiple leap second adjustments after chip release. The chip will adjust such kind of leap seconds automatically after it acquires the accurate clock and leap second information.

To know if a leap second has been calibrated, one can send following binary command to query (UBX-NAV-TIMEGPS).

B5 62 01 20 00 00 21 64

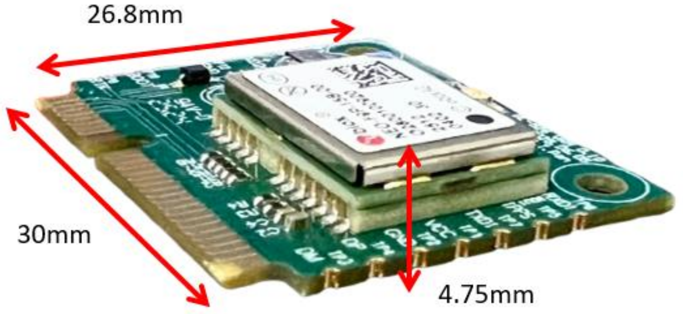
The chip will return binary message similar to following two.

B5 62 01 20 10 00 80 09 47 07 87 6A 06 00 22 07 0F 03 0C 00 00 00 46 50
B5 62 01 20 10 00 60 DB 56 07 AC 5F FF FF 22 07 10 07 09 00 00 00 18 45

Check the value of byte 18 which is marked in red, if the value is 07, the GPS time is correct. Otherwise (e.g. 3, 1, 0), the GPS time is still not correct.

2 Hardware Interface

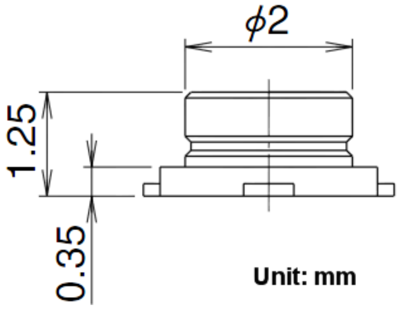
2.1 Mechanical Data



The dimension of GE-926 is 30 mm (W) x 26.8 mm (L) x 4.75 mm (H) (+/- 0.25mm)

2.2 RF Connector

Refer to the highlighted area in the image above for the I-PEX connector location. Detailed dimensions are shown in the following diagram.



To connect an antenna, you need the followings:

1. I-PEX-to-SMA cable

2. Antenna with SMA connector

2.3 Pin Assignment

PCI Express Mini Card Interface

52-Pin definition

Name	PINs	Function	I/O
VCC	2,24,39,41, 52	3.3V power supply, Min 3.0V, Max 3.6V	Input

GND	4,9,15,18,21,26,27,29,34,35,37,40,43,50	Ground	Input
USB_DM	36	USB data signal minus	I/O
USB_DP	38	USB data signal plus	I/O
1PPS/LED	42	1PPS, serves as GNSS fix indication GNSS fix: switching between 0 and 1 GNSS not fix: 0	Output
RTK_ST[!]	7	RTK fix state indication RTK fix: 0 RTK receiving and correction: switching 0/1 No correction: 1	Output
NC/VBAT[!]	6	NC if backup battery equipped or for 1.8 ~3.6V backup power if backup battery absent	Input
TXD2[!]	3	UART2 TX from card	Output
RXD2[!]	5	UART2 RX into card	Input
RXD1[!]	45	UART1 RX into card	Input
TXD1[!]	47	UART1 TX from card	Output
NC	Remaining pins	No connection	-

[!] Proprietary; reserved pins of PCIe Mini Rev. 1.2 are used

1	NC	VCC	2
3	TXD2	GND	4
5	RXD2	NC/VBAT	6
7	RTK_ST	NC	8
9	GND	NC	10
11	NC	NC	12
13	NC	NC	14
15	GND	NC	16
17	NC	GND	18
19	NC	NC	20
21	GND	NC	22
23	NC	VCC	24
25	NC	GND	26
27	GND	NC	28
29	GND	NC	30
31	NC	NC	32
33	NC	GND	34
35	GND	USB_DM	36
37	GND	USB_DP	38
39	VCC	GND	40
41	VCC	1PPS	42
43	GND	NC	44
45	RXD1	NC	46
47	TXD1	NC	48
49	NC	GND	50
51	NC	VCC	52

3 Software Interface

GE-926 supports both NMEA text messages and UBX binary messages. In this section, the NMEA output messages are discussed. For UBX binary messages, please refer to NEO-F9P Interface description.

3.1 NMEA Output Messages

Multi-talker IDs are used in GNSS multi-satellite positioning systems.

- Talker ID is 'GP' for GPS,SBAS-specific sentences since NMEA 2.3
- Talker ID is 'GL' for GLONASS-specific sentences since NMEA 2.3
- Talker ID is 'GA' for Galileo-specific sentences since NMEA 4.10
- Talker ID is 'GB' for BEIDOU-specific sentences since NMEA 4.10
- Talker ID is 'GQ' for QZSS-specific sentences since NMEA 4.11 ('GP' for NMEA 2.3~4.10)
- Talker ID is 'GI' for NavIC-specific sentences since NMEA 4.11
- Talker ID is 'GN' is used for generic GNSS sentences

System\Sentence	GGA	GLL	GSA	GSV	RMC	VTG
GPS	GPGGA	GPGLL	GPGSA	GPGSV	GPRMC	GPVTG
GLONASS	GLGGA	GLGLL	GLGSA	GLGSV	GLRMC	GLVTG
BEIDOU	GBGGA	GBGLL	GBGSA	GBGSV	GBRMC	GBVTG
Galileo	GAGGA	GAGLL	GAGSA	GAGSV	GARMC	GAVTG
NavIC	GIGGA	GIGLL	GIGSA	GIGSV	GIRMC	GIVTG
Multi-	GNGGA	GNGLL	GNGSA	Mix of above	GNRMC	GNVTG

The NMEA-0183 Output Messages are shown as below:

NMEA Record	Descriptions
GxGGA	Global positioning system fixed data: time, position, fixed type
GxGLL	Geographic position: latitude, longitude, UTC time of position fix and status
GxGSA	GPS receiver operating mode, active satellites, and DOP values
GxGSV	GNSS satellites in view: ID number, elevation, azimuth, and SNR values

GxRMC	Recommended minimum specific GNSS data: time, date, position, course, speed
GxVTG	Course over ground and ground speed
GxGNS	GNSS fix data
GxGRS	GNSS range residuals
GxGST	GNSS pseudo range error statistics
GxTXT	u-blox message

The GE-926 adopts interface protocol of National Marine Electronics Association's NMEA-0183 Version up to 4.11. GE-926 supports multiple types of NMEA sentences (GxGGA, GxGLL, GxGSA, GxGSV, GxRMC, GxVTG, GxGNS, GxGRS, GxGST, GxZDA, and GxTXT).

The default output sentences are RMC, VTG, GGA, GSA, GSV, GLL.

GPS+GLONASS+Galileo+BEIDOU message examples:

$GNRMC,065356.14,A,2446.41394,N,12100.43552,E,0.053,,090625,,,R,V*07
$GNVTG,,T,,M,0.053,N,0.099,K,D*3E
$GNGGA,065356.14,2446.41394,N,12100.43552,E,4,12,0.52,141.6,M,16.3,M,1.1,0004*61
$GNGSA,A,3,06,11,13,15,20,30,29,05,,,,,1.12,0.52,0.99,1*0B
$GNGSA,A,3,86,65,87,72,88,,,,,,,,1.12,0.52,0.99,2*00
$GNGSA,A,3,26,07,08,13,,,,,,,,,1.12,0.52,0.99,3*0F
$GNGSA,A,3,39,07,08,10,11,13,14,42,43,28,33,38,1.12,0.52,0.99,4*02
$GNGSA,A,3,,,,,,,,,,,,,1.12,0.52,0.99,5*00
$GNGSA,A,3,,,,,,,,,,,,,1.12,0.52,0.99,6*03
$GPGSV,3,1,11,05,50,337,43,06,22,117,36,11,52,094,43,13,77,174,44,1*6F
$GPGSV,3,2,11,15,42,230,40,20,46,029,42,29,34,304,41,30,23,079,38,1*66
$GPGSV,3,3,11,41,39,242,40,42,60,166,40,50,60,166,41,1*59
$GPGSV,1,1,04,06,22,117,42,11,52,094,50,13,77,174,16,30,23,079,44,8*6A
$GPGSV,1,1,04,07,06,050,,12,04,220,,21,41,033,,40,13,259,,0*6C
$GLGSV,2,1,05,65,51,260,44,72,50,006,46,86,40,133,46,87,77,052,46,1*7A
$GLGSV,2,2,05,88,24,333,42,1*4E
$GLGSV,1,1,01,66,10,228,,0*41
$GAGSV,2,1,05,07,73,192,48,08,49,044,46,13,63,044,48,15,27,108,42,1*74
$GAGSV,2,2,05,26,34,327,43,1*42
$GAGSV,2,1,06,07,73,192,43,08,49,044,42,13,63,044,44,15,27,108,38,7*7F

$GAGSV,2,2,06,26,34,327,39,29,20,213,37,7*77

$GAGSV,1,1,04,03,00,037,,21,07,233,,23,02,280,,27,01,185,,0*70

$GBGSV,5,1,18,07,47,211,38,08,46,328,38,10,49,232,40,11,43,146,42,1*77

$GBGSV,5,2,18,13,42,309,40,14,55,012,43,16,16,173,35,24,05,123,35,1*75

$GBGSV,5,3,18,28,44,317,42,33,66,315,46,34,18,147,37,38,52,342,42,1*72

$GBGSV,5,4,18,39,24,166,37,40,48,197,43,41,30,251,39,42,32,035,41,1*79

$GBGSV,5,5,18,43,68,165,46,49,77,298,46,1*7A

$GBGSV,2,1,08,28,44,317,44,33,66,315,49,38,52,342,46,39,24,166,40,5*7E

$GBGSV,2,2,08,40,48,197,45,41,30,251,43,42,32,035,44,43,68,165,46,5*73

$GBGSV,2,1,08,09,05,189,,26,00,079,,27,03,322,,50,09,046,,0*71

$GBGSV,2,2,08,59,55,139,,60,37,246,,61,60,205,,62,37,118,,0*74

$GQGSV,1,1,04,02,18,169,37,03,72,094,44,04,75,063,43,07,60,166,37,1*6B

$GIGSV,2,1,07,01,,,40,02,,,42,03,,,44,05,,,49,1*73

$GIGSV,2,2,07,07,,,49,09,,,42,10,57,162,49,1*44

$GNGLL,2446.41394,N,12100.43552,E,065356.14,A,D*7C

3.2 GxGGA - Global Positioning System Fix Data

- Example

  $GPGGA,065500.00,2447.65027,N,12100.78318,E,2,12,0.91,69.8,M,16.3,M,,*65

- Explanation

Contents	Example	Unit	Explanation
Message ID	$GPGGA		GGA protocol header
UTC Time	065500.00		hhmmss.ss hh: hour, mm: minute, ss: second
Latitude	2447.65027		ddmm.mmmmm dd: degree, mm.mmmmm: minute
North/South	N		N: North Latitude, S: South Latitude
Longitude	12100.78318		dddmm.mmmmm dd: degree, mm.mmmmm: minute
East/West	E		E: East Longitude, W: West Longitude
Position Fix Indicator	2		0: Fix not available or invalid, 1: GPS SPS Mode, fix valid, 2: Differential GPS, SPS Mode, fix valid, 3: Not supported, 4: RTK fixed 5: RTK float 6: Estimated/Dead Reckoning fix
Satellites Used	12		Number of satellites used in positioning calculation (0 to 12)
HDOP	0.91		Horizontal Dilution of Precision
MSL Altitude	69.8	meters	
Unit	M		Meters
Geoidal	16.3	meters	Geoid separation: difference between

separation			ellipsoid and mean sea level
Units	M		Meters
Age of Diff. Corr.		second	Age of differential corrections. Null when DGPS is not used
Diff. Ref. Station ID			ID of station providing differential corrections (null when DGPS is not used)
checksum	*65		
<CR><LF>			End of sentence

3.3 GxGLL - Geographic Position - Latitude / Longitude

- Example

$GPGLL,2447.65027,N,12100.78318,E,065500.00,A,D*6E

- Explanation

Contents	Example	Unit	Explanation
Message ID	$GPGLL		GLL protocol header
Latitude	2447.65027		ddmm.mmmmm dd: degree, mm.mmmmm: minute
North/South	N		N: North Latitude, S: South Latitude
Longitude	12100.78318		dddmm.mmmmm dd: degree, mm.mmmmm: minute
East/West	E		E: East Longitude, W: West Longitude
UTC Time	065500.00		hhmmss.ss hh: hour, mm: minute, ss: second
Status	A		A: Data valid, V: Data invalid
Mode Indicator	D		A: Autonomous GNSS fix N: No position fix D: Differential GNSS fix E: Estimated/Dead reckoning fix F: RTK float R: RTK fixed
checksum	*6E		
<CR><LF>			End of sentence

3.4 GxGSA - GNSS DOP and Active Satellites

- Example

$GNGSA,A,3,05,13,15,24,29,18,20,23,,,,,0.98,0.51,0.84,1*0C

$GNGSA,A,3,88,81,66,82,76,65,67,,,,,,0.98,0.51,0.84,2*0B

$GNGSA,A,3,03,24,15,36,05,,,,,,,,0.98,0.51,0.84,3*0B

$GNGSA,A,3,13,22,06,08,36,16,09,35,,,,,0.98,0.51,0.84,4*0C

- Explanation

Contents	Example	Explanation
Message ID	$GNGSA	GSA protocol header
Operation Mode	A	M: Manual—forced to operate in 2D or 3D mode A: 2D Automatic—allowed to automatically switch 2D/3D
Navigation Mode	3	1: Fix not available 2: 2D (<= 4 Satellites used) 3: 3D (>= 4 Satellites used)

Satellite used in solution	05	Satellite on Channel 1
Satellite used in solution	13	Satellite on Channel 2
…		Display of quantity used (12 max) If less than 12 SVs are used for navigation, the remaining fields are left empty. If more than 12 SVs are used for navigation, only the IDs of the first 12 are output.
PDOP	0.98	Position Dilution of Precision
HDOP	0.51	Horizontal Dilution of Precision
VDOP	0.84	Vertical Dilution of Precision
System ID	1	1: GPS/SBAS, 2: GLONASS 3: Galileo, 4: BeiDou 5: QZSS, 6: NavIC
checksum	*0C	
<CR><LF>		End of sentence

3.5 GxGSV - GNSS Satellites in View

- Example

$GPGSV,3,1,11,05,50,337,43,06,22,117,36,11,52,094,43,13,77,174,44,1*6F

$GPGSV,3,2,11,15,42,230,40,20,46,029,42,29,34,304,41,30,23,079,38,1*66

$GPGSV,3,3,11,41,39,242,40,42,60,166,40,50,60,166,41,1*59

$GPGSV,1,1,04,06,22,117,42,11,52,094,50,13,77,174,16,30,23,079,44,8*6A

$GPGSV,1,1,04,07,06,050,,12,04,220,,21,41,033,,40,13,259,,0*6C

- Explanation

Contents	Example	Unit	Explanation
Message ID	$GPGSV		GSV protocol header
Number of messages	3		Range 1 to 9
Message number	1		Range 1 to 9
Satellites in view	12		Number of satellites visible from receiver regarding both the talker ID and the signal Id.
Satellite ID number	02		Channel 2 (Range 1 to 64) The satellite ID numbers are in the range of 1 to 32 for GPS satellites, and 33 to 64 for SBAS satellites (ID=120-PRN; e.g. SV ID 33 is SBAS PRN 120, 34 is SBAS PRN 121, and so on). ID numbers 65~96 for GLONASS. ID numbers 193~197 for QZSS. ID numbers 401~437 for BEIDOU.
Elevation	08	degrees	Elevation angle of satellite as seen from receiver channel 1 (00 to 90)
Azimuth	153	degrees	Satellite azimuth as seen from receiver channel 1 (000 to 359)
SNR (C/No)	36	dBHz	Received signal level C/No from receiver channel 1 (00 to 99, null when not tracking)
…			
Satellite ID number	15		Channel 4 (Range 1 to 32) The satellite ID numbers are in the range of 1 to 32 for GPS satellites, and 33 to 64 for SBAS satellites (ID=120-PRN; e.g. SV ID 33 is SBAS PRN 120, 34 is SBAS PRN 121,

			and so on). ID numbers 65~96 for GLONASS. ID numbers 193~197 for QZSS. ID numbers 401~437 for BEIDOU.
Elevation	55	degrees	Elevation angle of satellite as seen from receiver channel 4 (00 to 90)
Azimuth	009	degrees	Satellite azimuth as seen from receiver channel 4 (000 to 359)
SNR (C/No)	44	dBHz	Received signal level C/No from receiver channel 4 (00 to 99, null when not tracking)
Signal Id[!]	1		1: GPS L1C/A, SBAS L1C/A, QZSS L1C/A, GLONASS L1OF, GALILEO E5aI, E5aQ, BeiDou B1I D1 & D2, NavIC L5 A 5: BeiDou B2ap, B2ad 7: GPS L5I, QZSS L5I, GALILEO E1B/C 8: GPS L5Q, QZSS L5Q
checksum	*63		
<CR><LF>			End of sentence

Note. [!] Signal Id of 0 is not defined. However, it is used as the exact Signal Id is still unknown.

3.6 GxRMC - Recommended Minimum Specific GNSS Data

- Example

  $GNRMC,025015.00,A,2446.41433,N,12100.43602,E,0.002,,091121,,,D,V*1E

- Explanation

Contents	Example	Unit	Explanation
Message ID	$GNRMC		RMC protocol header
UTC Time	025015.00		hhmmss.ss hh: hour, mm: minute, ss: second
Status	A		A: Data valid, V: Data invalid
Latitude	2446.41433		ddmm.mmmmm dd: degree, mm.mmmmm: minute
North/South	N		N: North Latitude, S: South Latitude
Longitude	12100.43602		dddmm.mmmmm dd: degree, mm.mmmmm: minute
East/West	E		E: East Longitude, W: West Longitude
Speed over ground	0.002	knots	Receiver's speed
Course over ground		degrees	Receiver's direction of travel Moving clockwise starting at due north
Date	091121		ddmmyy dd: Day, mm: Month, yy: Year
Magnetic variation value		degrees	This receiver does not support magnetic declination. All "course over ground" data are geodetic WGS84 directions.
Magnetic variation E/W indication			
Mode Indicator	D		A: Autonomous GNSS fix N: No position fix D: Differential GNSS fix E: Estimated/Dead reckoning fix F: RTK float R: RTK fixed
Navigation Status	V		V (Equipment is not providing navigational status information, fixed field, only available in NMEA 4.10 and later)
checksum	*1E		

<CR><LF>			End of sentence

3.7 GxVTG - Course over Ground and Ground Speed

- Example

$GPVTG,189.32,T,,M,15.869,N,29.405,K,D*30

Explanation

Contents	Example	Unit	Explanation
Message ID	$GPVTG		VTG protocol header
Course over ground	189.32	degrees	Receiver's direction of travel Moving clockwise starting at due north (geodetic WGS84 directions)
Reference	T		True
Course over ground		degrees	Receiver's direction of travel
Reference	M		Magnetic
Speed over ground	15.869	knots	Measured horizontal speed
Unit	N		Knots
Speed over ground	29.405	km/hr	Measured horizontal speed
Unit	K		km/hr
Mode Indicator	D		A: Autonomous GNSS fix N: No position fix D: Differential GNSS fix E: Estimated/Dead reckoning fix F: RTK float R: RTK fixed
checksum	*30		
<CR><LF>			End of sentence

3.8 GxGNS – GNSS Fix Data

- Example

$GNGNS,025015.00,2446.41433,N,12100.43602,E,DDDD,28,0.51,122.6,16.3,,0000,V*18

Explanation

Contents	Example	Unit	Explanation
Message ID	$GNGNS		GNS protocol header
Time	025015.00		hhmmss.ss hh: hour, mm: minute, ss: second
Latitude	2446.41433		ddmm.mmmmm dd: degree, mm.mmmmm: minute
North/South	N		N: North Latitude, S: South Latitude
Longitude	12100.43602		dddmm.mmmmm dd: degree, mm.mmmmm: minute
East/West	E		E: East Longitude, W: West Longitude
Position Mode	DDDD		A: Autonomous GNSS fix N: No position fix D: Differential GNSS fix E: Estimated/Dead reckoning fix F: RTK float R: RTK fixed First character for GPS, second one

			for GLONASS, Third one for Galileo, Fourth one for BeiDou
Satellites Used	28		Number of satellites used in positioning calculation (0 to 99)
HDOP	0.51		Horizontal Dilution of Precision
Altitude	122.6	meters	Altitude above mean sea level
Separation	16.3	meters	Geoid separation: difference between ellipsoid and mean sea level
Differential Age	-		Age of differential corrections (null when DGPS is not used)
Differential Station	0000		ID of station providing differential corrections (null when DGPS is not used)
Navigation Status	V		V (Equipment is not providing navigational status information, fixed field, only available in NMEA 4.10 and later)
Checksum	*18		Checksum
<CR><LF>			End of sentence

3.9 GxGRS – GNSS Range Residuals

This messages relates to associated GGA and GSA messages. If less than 12 SVs are available, the remaining fields are output empty. If more than 12 SVs are used, only the residuals of the first 12 SVs are output, in order to remain consistent with the NMEA standard. **In a multi-GNSS system this message will be output multiple times, once for each GNSS.**

- Example

$GNGRS,025015.00,1,-0.3,0.0,0.0,1.2,-1.2,0.5,-0.4,0.5,,,,,1,1*79

$GNGRS,025015.00,1,,,,,,,0.0,,,,,,1,5*79

$GNGRS,025015.00,1,-0.4,,-0.9,-0.5,-1.5,-0.6,,-0.1,,,,,1,1*3B

$GNGRS,025015.00,1,-0.7,-4.0,4.1,4.4,1.3,-1.7,-5.3,,,,,,2,1*7A

$GNGRS,025015.00,1,-0.1,-1.8,2.6,2.3,-0.3,-4.1,-1.2,,,,,,2,3*59

$GNGRS,025015.00,1,-0.1,0.3,-0.2,0.4,-0.2,,,,,,,,3,2*57

$GNGRS,025015.00,1,0.8,0.3,0.5,0.7,0.8,,,,,,,,3,1*1D

$GNGRS,025015.00,1,0.7,-0.4,-1.2,-1.5,0.8,-0.1,0.1,0.6,,,,,4,1*5C

$GNGRS,025015.00,1,-0.1,,-0.4,-0.3,0.0,-1.8,-1.7,,,,,,4,3*70

Explanation

Contents	Example	Unit	Explanation
Message ID	$GNGRS		GRS protocol header
Time	025015.00		hhmmss.ss hh: hour, mm: minute, ss: second
Mode	1		Computation method used: 1: Residuals were recomputed after the GGA position was computed (fixed)
Residual 1	-0.3	meters	Range residuals for SVs used in navigation. The SV order matches the

			order from the GSA sentence
Residual 2	0.0	meters	Same as above
Residual 3	0.0	meters	Same as above
Residual 4	1.2	meters	Same as above
Residual 5	-1.2	meters	Same as above
Residual 6	0.5	meters	Same as above
Residual 7	-0.4	meters	Same as above
Residual 8	0.5	meters	Same as above
Residual 9	-	meters	Same as above
Residual 10	-	meters	Same as above
Residual 11	-	meters	Same as above
Residual 12	-	meters	Same as above
System Id	1		1: GPS/SBAS, 2: GLONASS 3: Galileo, 4: BeiDou 5: QZSS, 6: NavIC
Signal Id	1		1: GPS L1C/A, SBAS L1C/A, QZSS L1C/A, GLONASS L1OF, GALILEO E5aI, E5aQ, BeiDou B1I D1 & D2, NavIC L5 A 5: BeiDou B2ap, B2ad 7: GPS L5I, QZSS L5I, GALILEO E1B/C 8: GPS L5Q, QZSS L5Q
Checksum	*79		Checksum
<CR><LF>			End of sentence

3.10 GxGST – GNSS Pseudo Range Error Statistics

- Example

  $GNGST,025029.00,15,0.92,0.78,43,0.34,0.34,0.91*7A

Explanation

Contents	Example	Unit	Explanation
Message ID	$GNGST		GST protocol header
Time	025029.00		hhmmss.ss hh: hour, mm: minute, ss: second
Range of RMS	15	meters	RMS value of the standard deviation of the ranges
Standard Deviation of Semi-Major Axis	0.92	meters	Standard deviation of semi-major axis (only supported in ADR 4.10 and later)
Standard Deviation of Semi-Minor Axis	0.78	meters	Standard deviation of semi-minor axis (only supported in ADR 4.10 and later)
Orientation	43	degrees	Orientation of semi-major axis (only supported in ADR 4.10 and later)
Standard deviation of latitude error	0.34	meters	Standard deviation of latitude error
Standard deviation of longitude error	0.34	meters	Standard deviation of longitude error
Standard deviation of altitude error	0.91	meters	Standard deviation of altitude error
Checksum	*7A		Checksum
<CR><LF>			End of sentence

3.11 GxTXT – Text Transmission

- Example

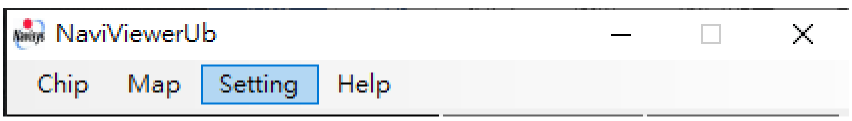
  $GPTXT,01,01,02,u-blox ag - www.u-blox.com*50

Explanation

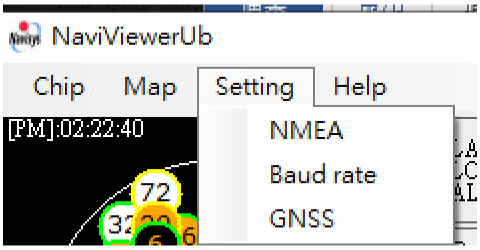
Contents	Example	Unit	Explanation
Message ID	$GPTXT		TXT protocol header
Number of messages	01		Total number of messages in this transmission, 01..99
Message number	01		Message number in this transmission, range 01..xx
Message type	02		Text identifier, u-blox GPS receivers specify the type of the message with this number. 00: Error 01: Warning 02: Notice 07: User
Text	u-blox ag - www.u-blox.com		Any ASCII text
Checksum	*50		Checksum
<CR><LF>			End of sentence

3.12 GNSS Configuration

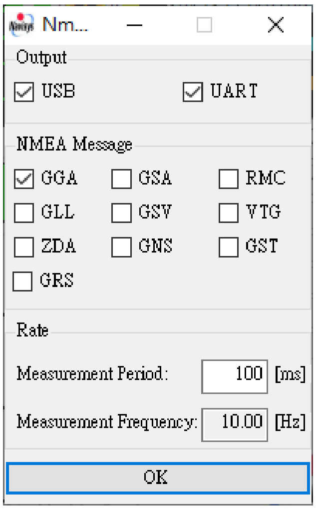
- Higher update rate usually results in better performance. If power consumption is not a major concern, 7Hz is suggested for all satellite systems.
- If power consumption is a major concern, one may want to reduce the used satellite systems or update rate.
- Higher update and more used satellite systems will output more data. That is to say, higher baud rate would be required to communicate with GE-926.
- If the focus is only on the position itself, one can have high update, say 7Hz, to all satellite systems. However, just output only limited NMEA sentence, say GGA only. In this case, small baud rate is allowed to talk to GE-926.
- To support configuration change for above mentioned purposes, one can use u-blox's u-center tool or just download NaviViewerUb from Navisys support page to perform the configuration management.
- Configured by NaviViewerUb: Click the Setting menu bar of it,

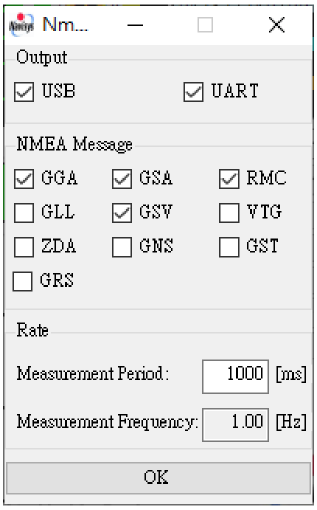


One can see 3 sets of functions for above mentioned configuration manageement.



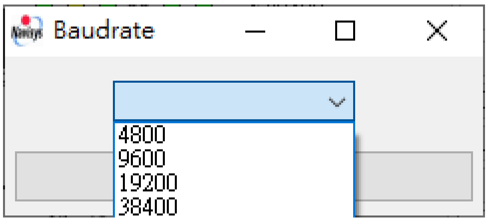
- NMEA is for a) enable/disable a NMEA sentence and/or b) change the update rate:





➔Please be noted that send OK leaving NMEA Message **blank** would cause **null outpu**t of NMEA messages. In case of update rate change, please remember to also check NMEA sentences.

- Baud rate is for changing the baud rate.



Please remember to reconnect if baud rate has been changed.

- GNSS is for enable/disable satellite systems.

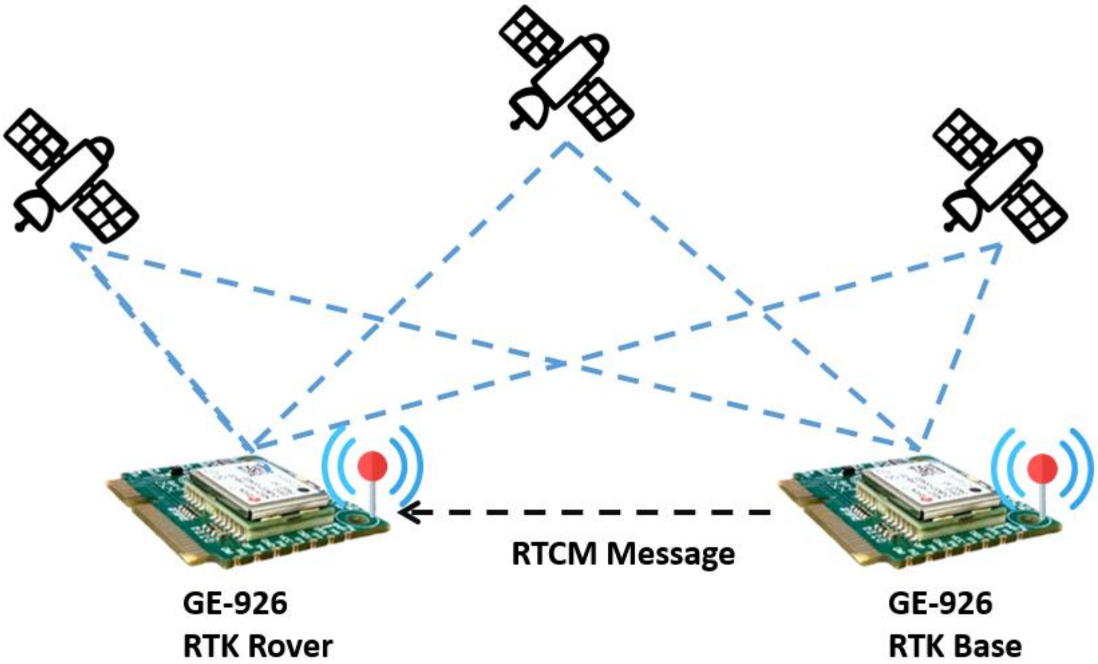
poll config will update the current setting.

OK will send the command.

4 RTK Base Setup with u-center

GE-926 could be configured as a base station using the tool u-center. u-center is available from https://www.u-blox.com/en/product/u-center.

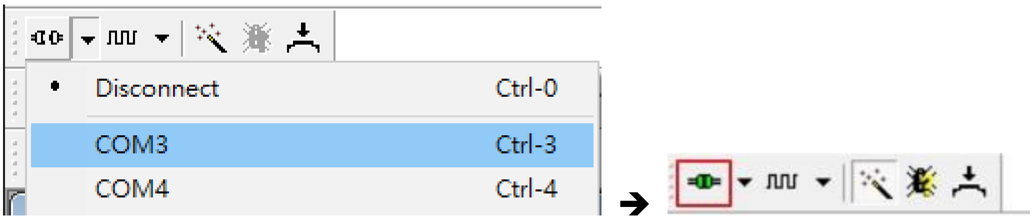
As shown in following figure, the GE-926 RTK base receives the satellite information and then sends the correction data to the GE-926 rover via RTCM messages as mentioned in section 1.4, RTK mode supported RTCM 3.3 messages according to RTCM 10403..



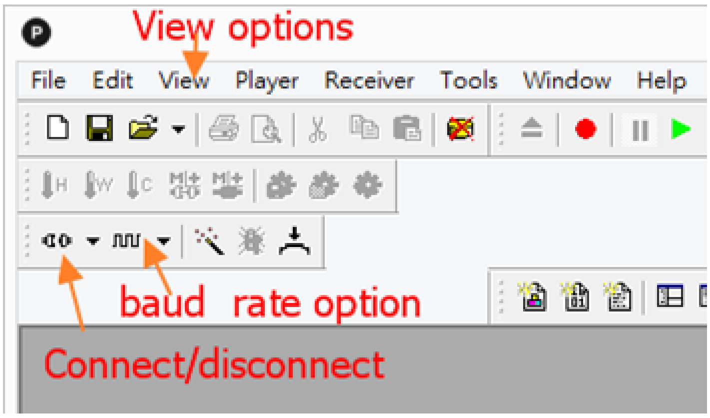
In this chapter, base setup is described while in next chapter, rover setup.

4.1 Connection

Connect GE-926 via USB interface or UART/TTL interface and use its corresponding COM port to connect the u-center. Normally, u-center will detect the COM port automatically. E.g.



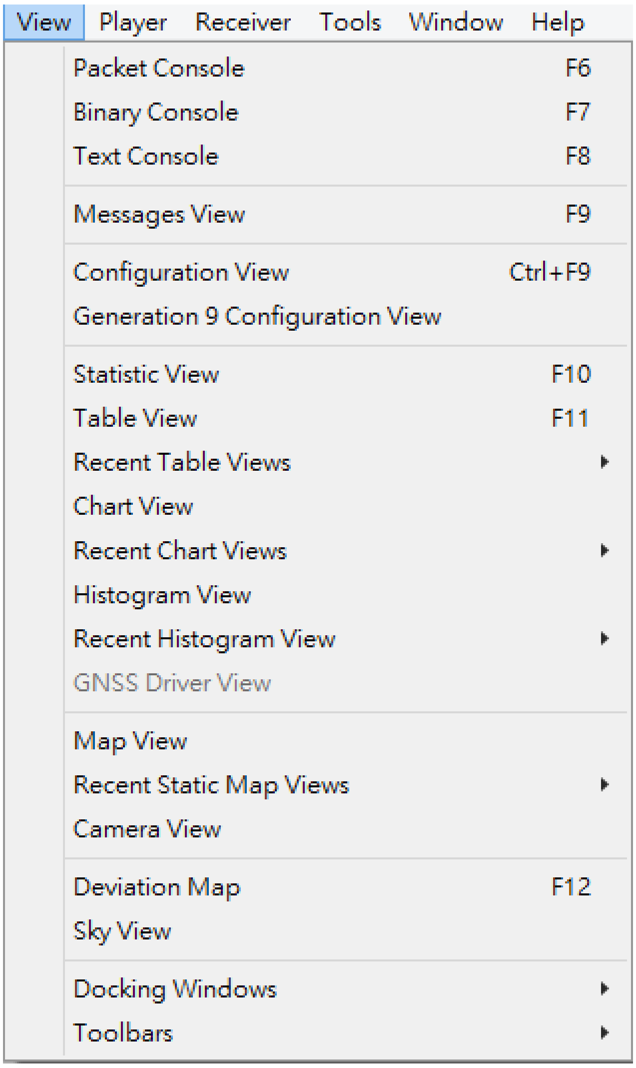
Click the connection icon and it becomes as it is connected as shown above. The default baud rate is 38400 bps.



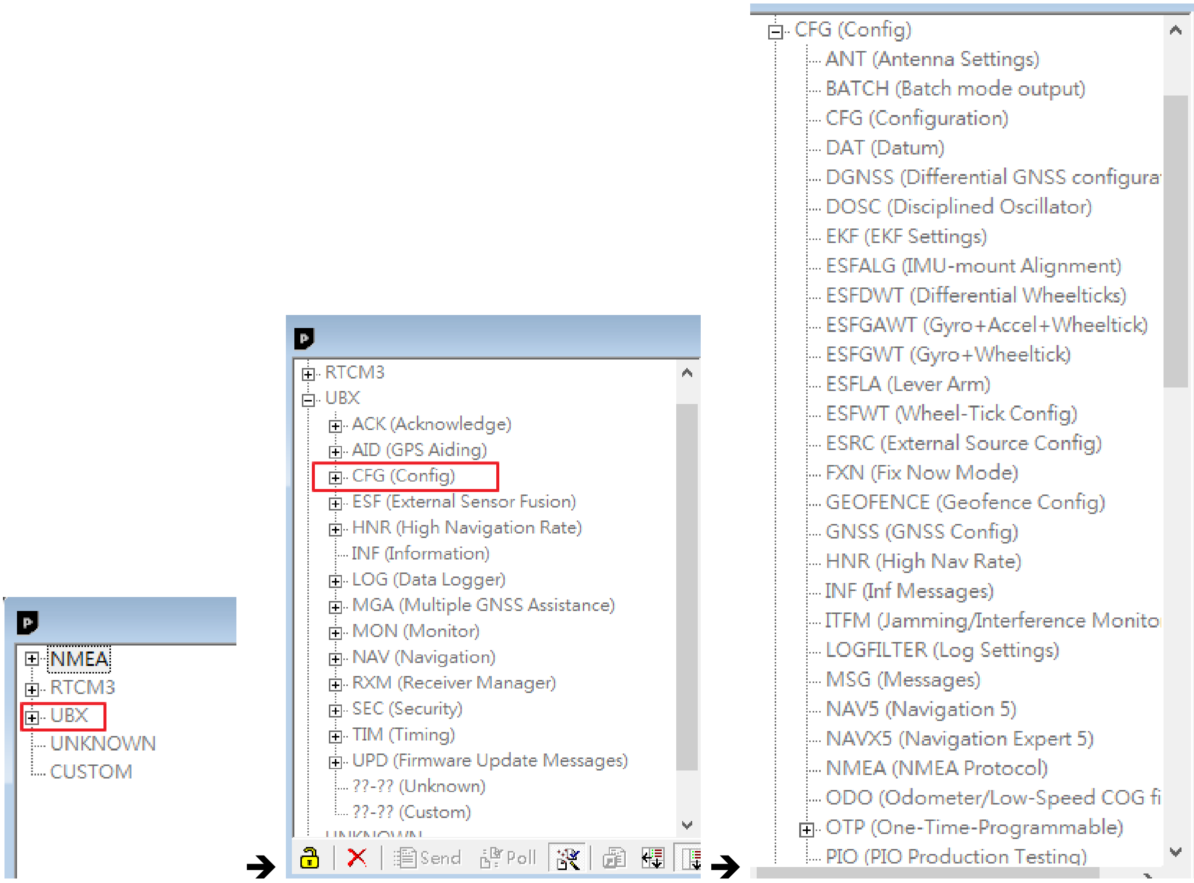
➔In case u-center is not able to find a corresponding COM port, right USB driver is required.

4.2 View Commands

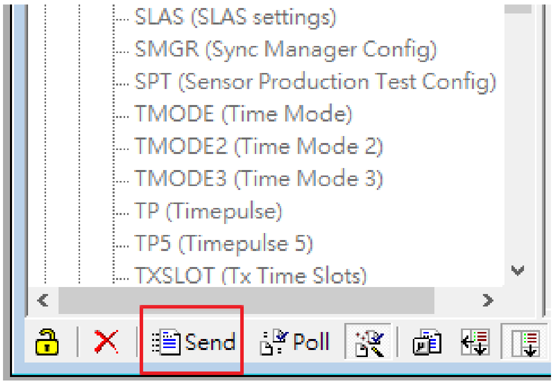
Many RTK commands could be found under View pulldown menu. Select the “Messages View” first.



One would see left menu below. Collapse the UBX option and scroll to see more command options of it as shown in the middle menu below. In this documet, options chosen at different menus are separated by '-'. E.g. If you want to change the USB port setting, UBX-CFG-PRT would be chosen step by step.



Finally, after your setting is done, be sure to send the command as shown below.



4.3 Survey the Position of a Base Station

The base station would broadcast its position together with the correction data via RTCM messages. Its position could be obtained in two ways.

- Survey in by the base station itself
  - The accuracy of base is not required to be cm-level if just relative accuracy is required by the rover. The rover's position accuracy would be **relative to** this position with cm-level precision.
  - The more accurate the position is, the longer time would be required to finish

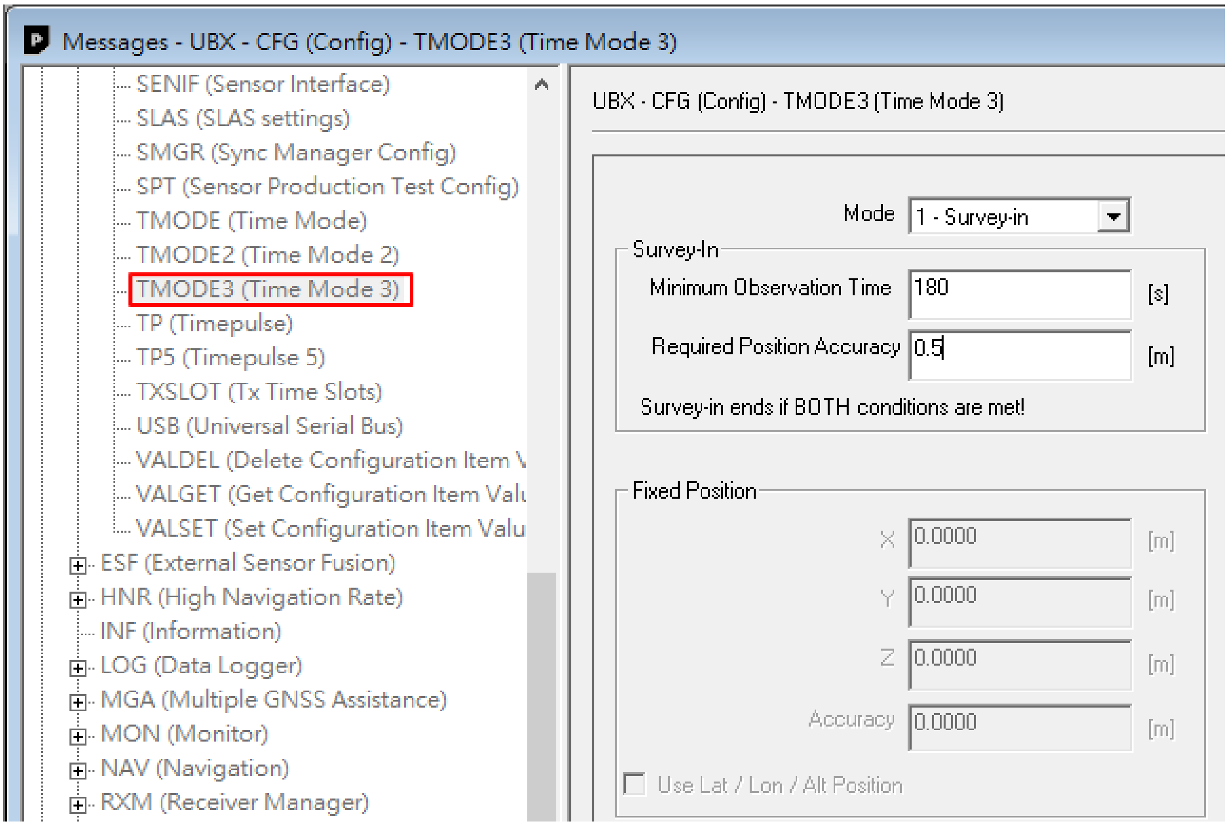
the survey-in process.

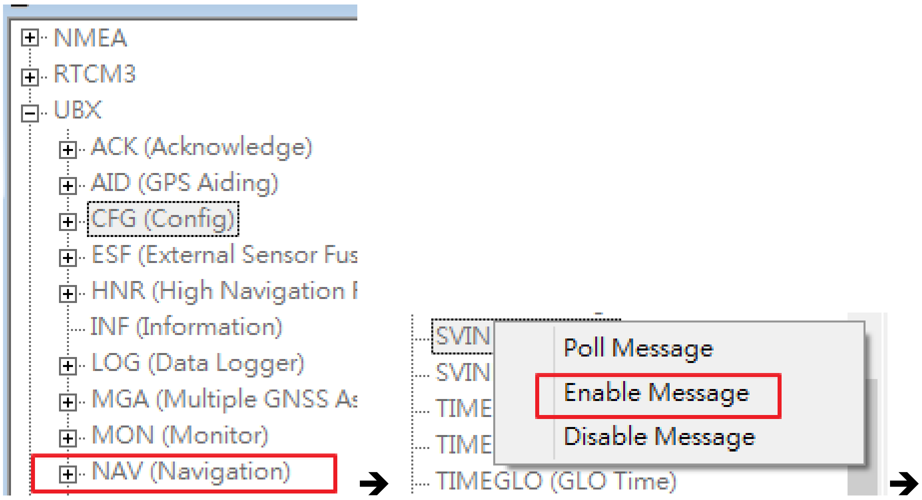
- Give the known-position of the base station

The survey in process could be achieved by

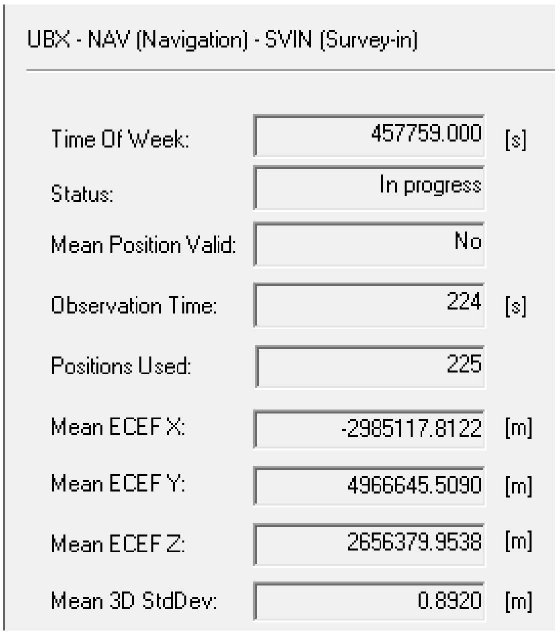
- The UBX-CFG-TMODE3 command to define the survey parameters.

- The UBX-NAV-SVIN command to enable the survey status display.

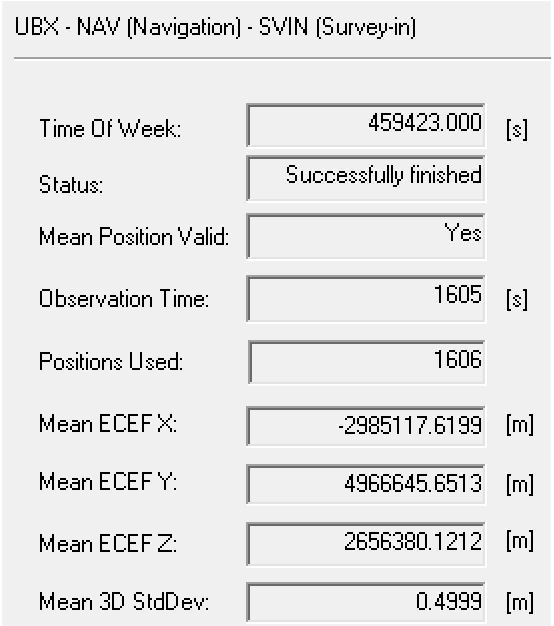




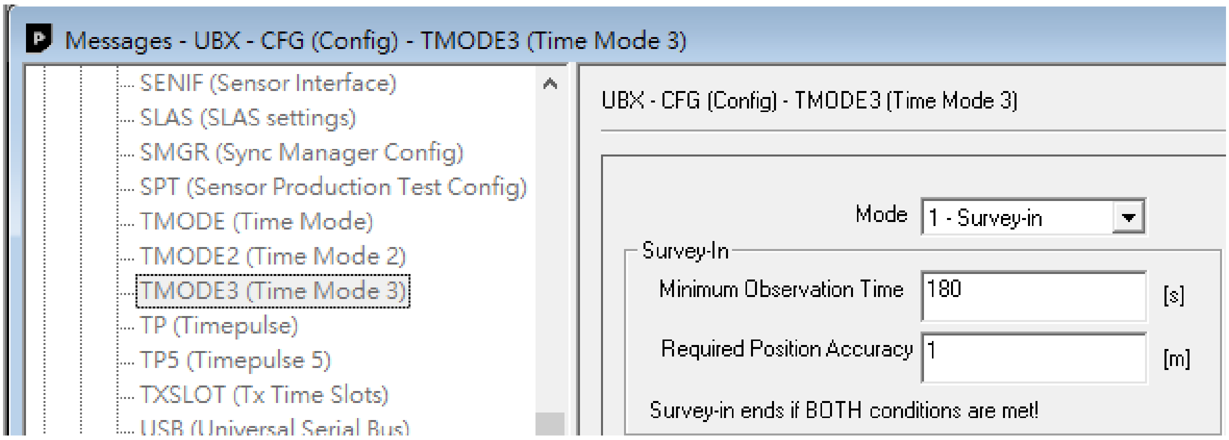
Right click on NAV (Navigation) and then select Enable Message, the SVIN window starts to show the status.



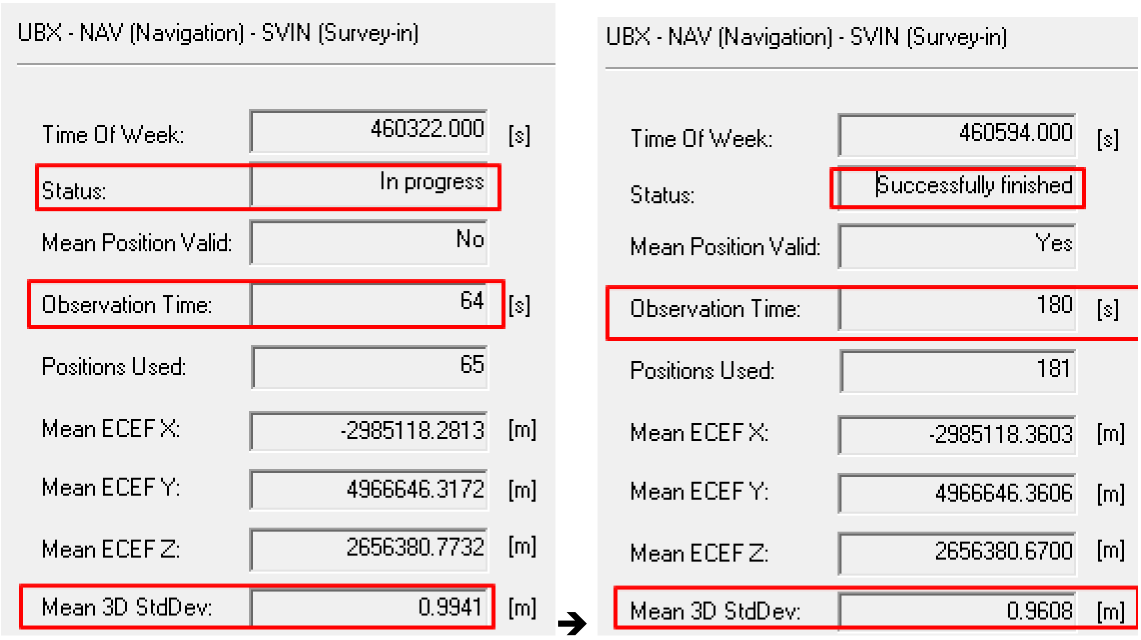
➔



- As time elapses, the 3D StdDev becomes smaller (better). As shown above, observation time from seconds 224 to 1605.
- In this case of the UBX-CFG-TMODE3 command, the minimum observation time is 180 seconds and accuracy is 0.5m. The survey process would not stop until both conditions are met.
- In above left picture, accuracy is 0.892 (< 2)m while time is 224, the survey keeps going on. At second 1605 the condition is met and the survey stops.
- If you want to survey with different accuracy, use the UBX-CFG-TMODE3 command to redefine the accuracy and send the command to restart the survey in process. E.g. set the accuracy to 1m and survey in finished at 180th second.



The accuracy reached at second 64. However, the min observation time is 180 seconds and thus the survey in keeps on going until both time (≥180) and accuracy (≤1) criteria are met.



Please be noted that

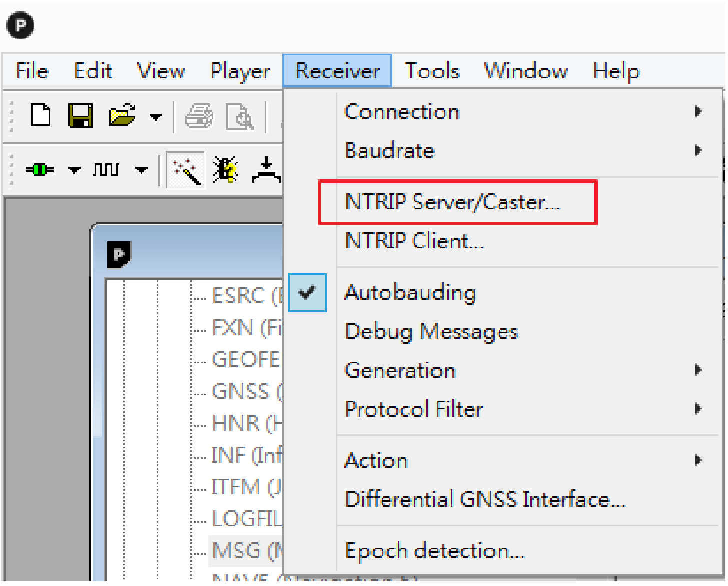
- The GNSS signal condition determines how accurate the survey could achieve.
  - The better the signal condition, the more accurate it could achieve.
  - Surrounding electrical interference might also affect the GNSS signal reception and thus worsen the accuracy.

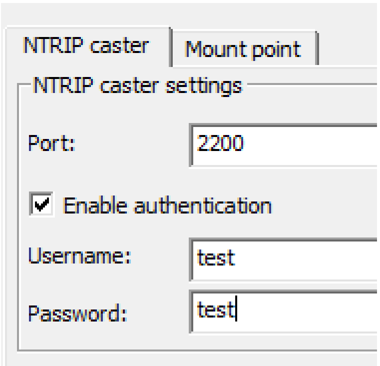
4.4 Setting the Caster

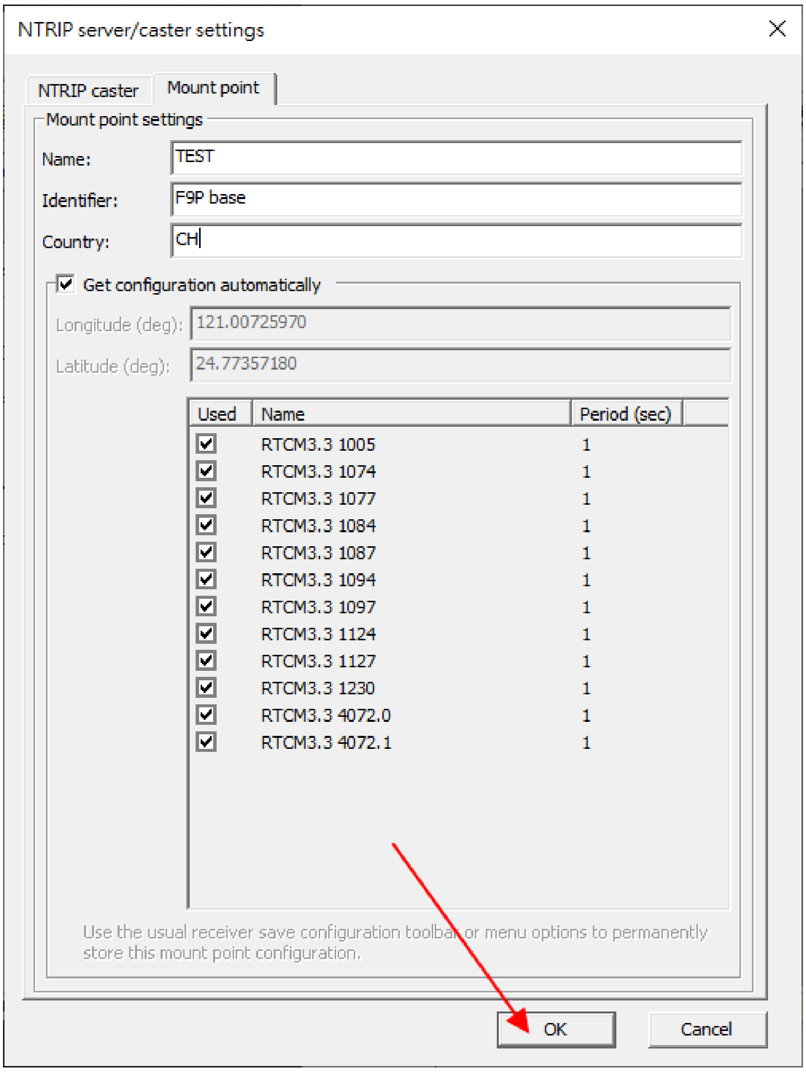
Caster is the base that would broadcast RTCM messages so that a rover can connect to it to receive these RTCM messages. Before the caster could be used, we have to define the port number, mount point, authentication options so that rover could connect to it.

Under the “Receiver” menu, choose the “NTRIP Server/Caster” option for configuration as shown below.

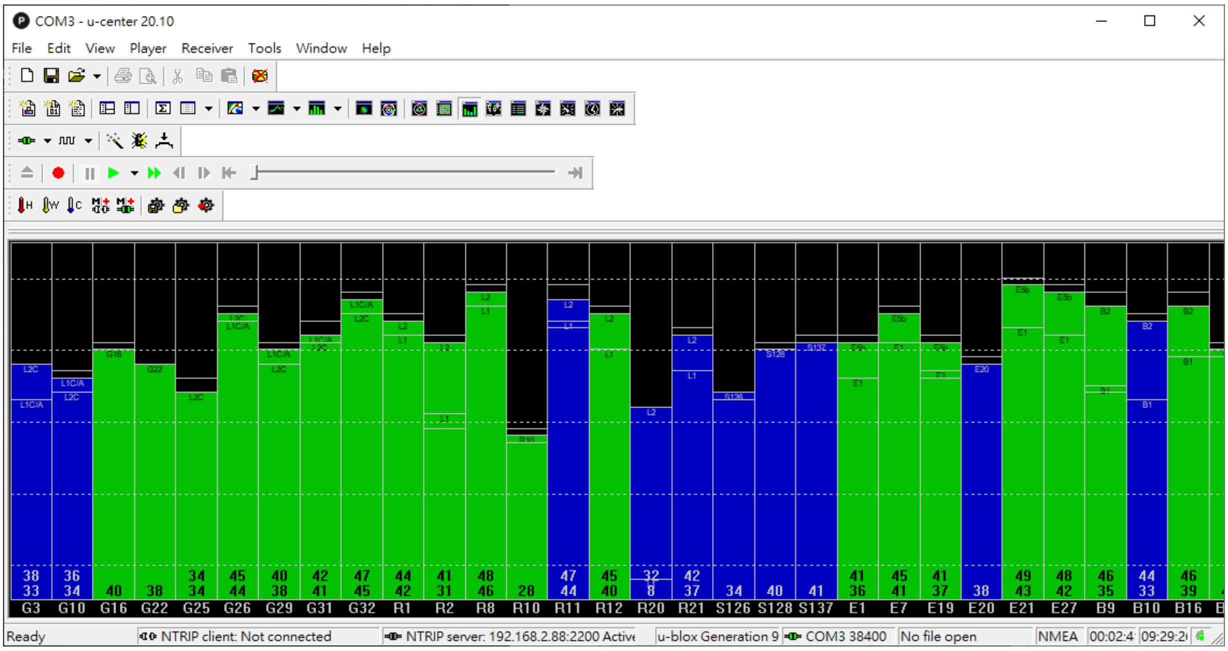
Here is just an example. You can define your own settings (port number etc.). Check option of Get configuration automatically to use longitude, latitude and RTCM message configuration of the currently connected GE-926 that will be sent out on the mount point.



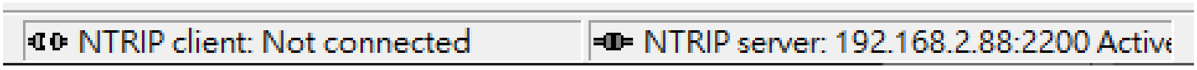




After configuration, the server is ready for broadcasting correction data.

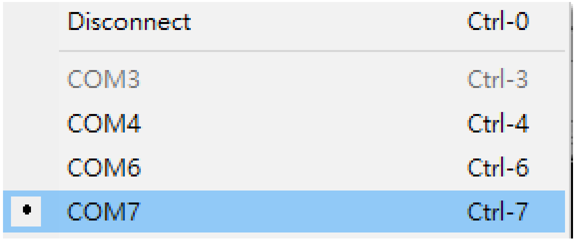


You should be able to see the NTRIP server status bar showing Active on the bottom of the u-center window as also enlarged shown below.

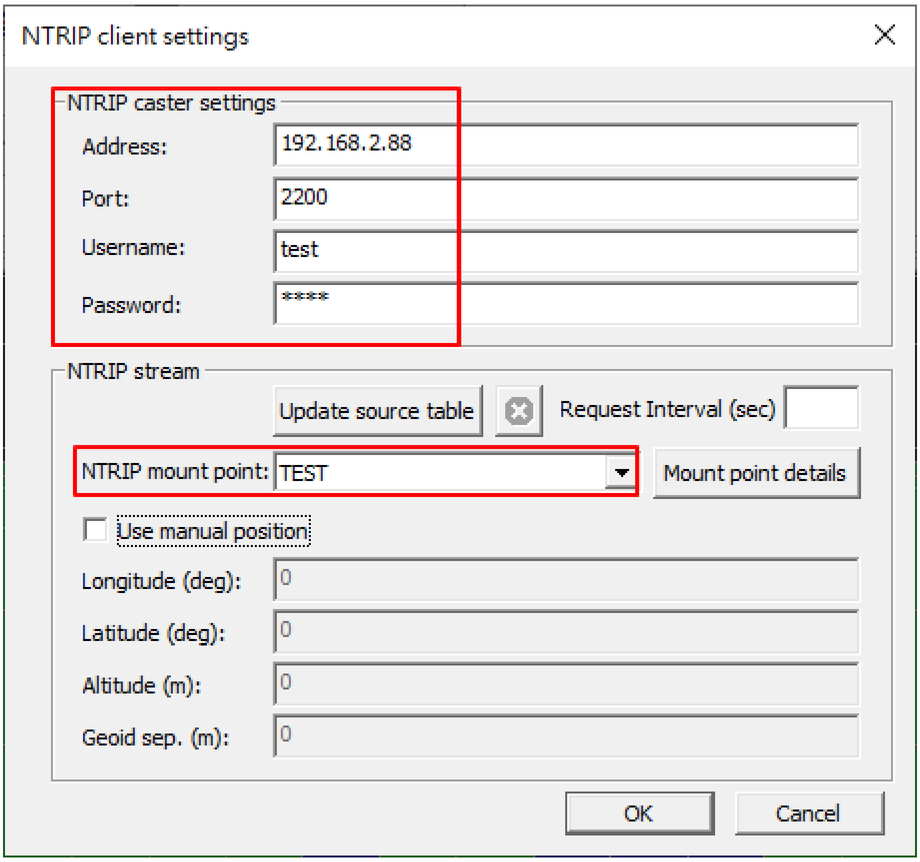


5 Connecting Rover to Caster with u-center

Establish the communication between u-center and GE-926 rover.



Open NTRIP client settings dialog by clicking on Receiver | NTRIP Client.



Mount Point details:

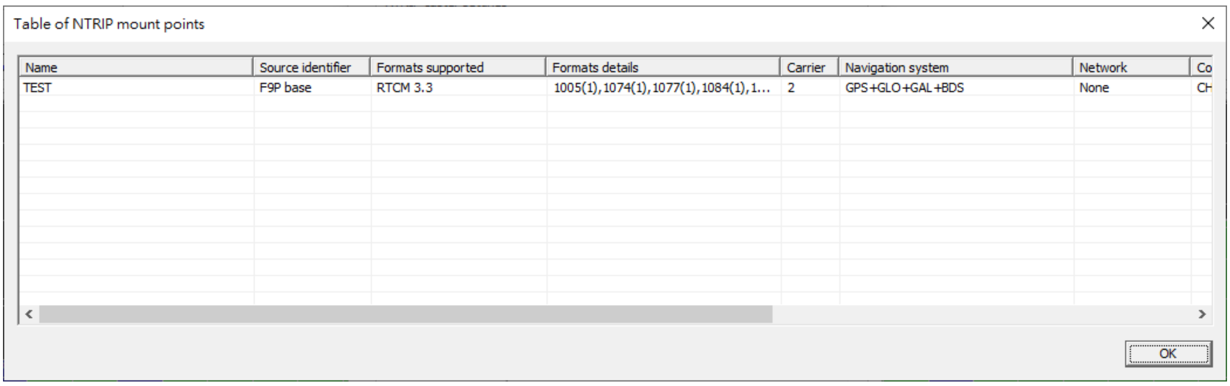


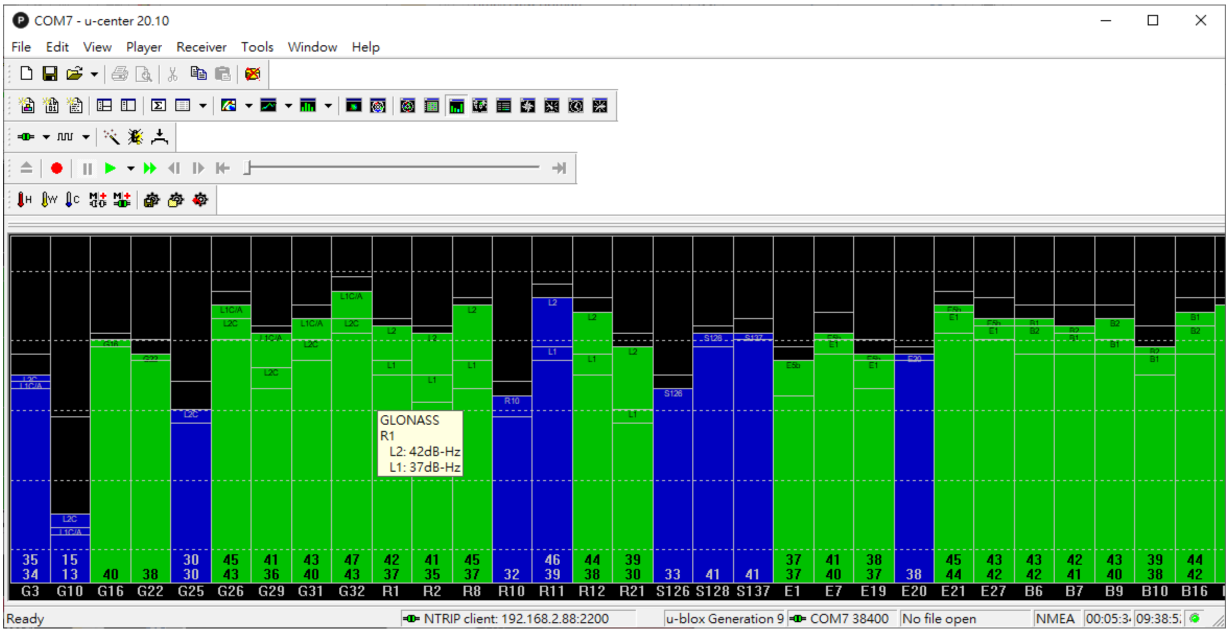
Table of NTRIP mount points

Name	Source identifier	Formats supported	Formats details	Carrier	Navigation system	Network	Co
TEST	F9P base	RTCM 3.3	1005(1),1074(1),1077(1),1084(1),1...	2	GPS+GLO+GAL+BDS	None	CH

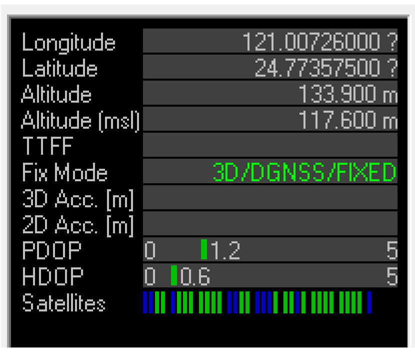
OK

Enter the address, port number, username, and password of the NTRIP caster. If authentication is not required by the caster, then leave username/password fields empty.

Click on Update source table to get an up to date list of all available mount points from the caster. Click on Mount Point Details to know its detailed information. Click on OK to start receiving correction data. The NTRIP client becomes connected ( ) to the caster.



The fix mode will display FIXED if the GE-926 rover calculates an RTK position using correction data from the caster successfully.



Tips:

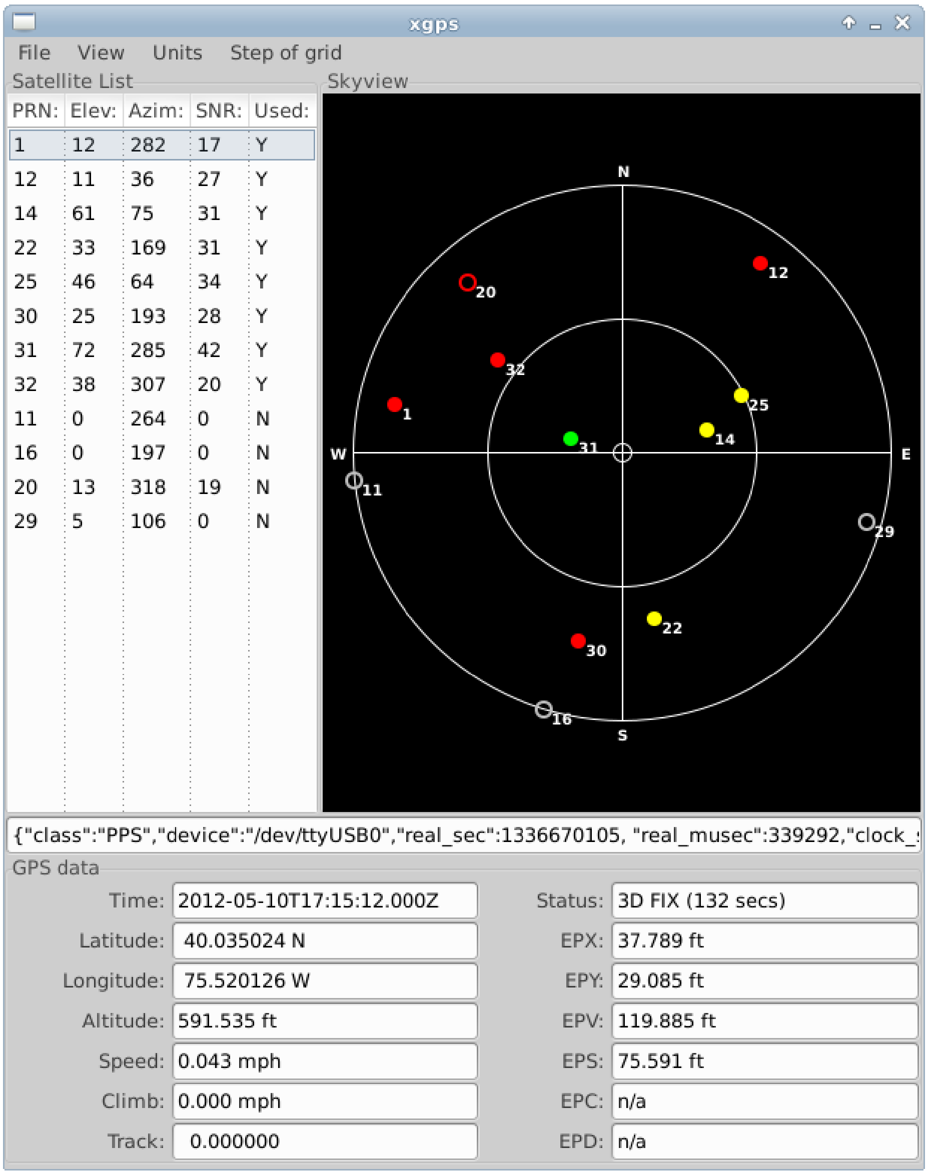
☞ The GE-926 rover can connect to any NTRIP caster. In this document, the GE-926 is used as an example caster for illustration purposes.

6 Evaluation Information

6.1 Overview

Under Windows, connect the GE-926 to your PC and check its performance using the Navisys GPS viewer tool. You can download the Navisys GPS viewer tool for u-blox from our web site as shown in next section.

Under Linux or *BSD, install GPSD and ensure that the gpsd daemon is running (under Linux, a hot-plug will launch it when you plug the device into a USB port). Then run the xgps or cgps test client.



6.2 Tips in Designing

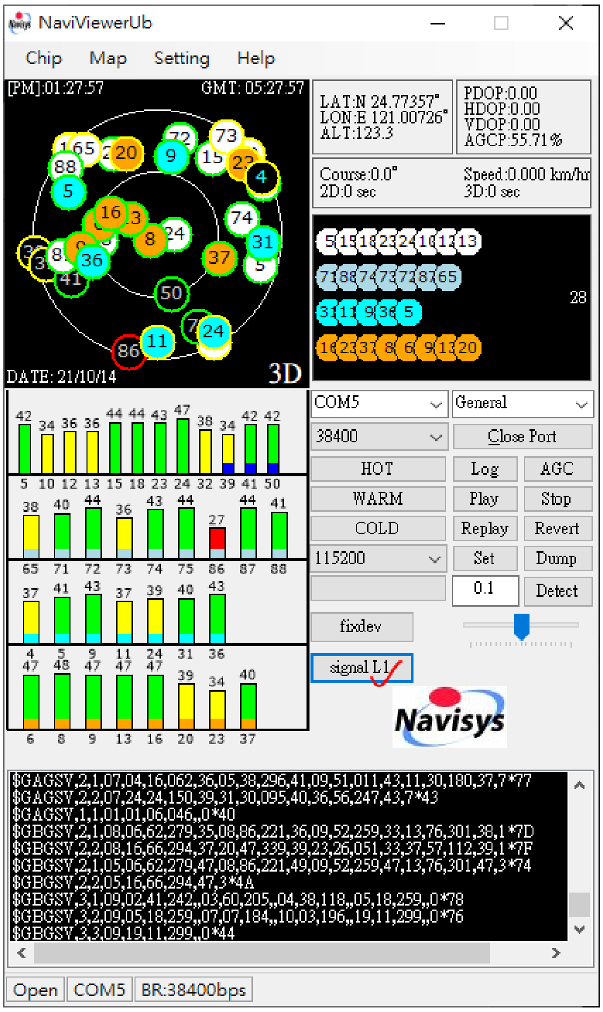
The GNSS signal is pretty low, less than -130 dBm, which is easily interfered by the EMI of application circuit.

Interference checking

1. Check the signal reception status of GNSS standalone with GNSS viewer tool.
2. Observe the performance when the receiver moves around the host machine.
3. If you want to find a location for installing GNSS unit, choose the location with best signal reception displayed by NaviViewerUb.
4. If the location of the receiver has determined, this tool could be used to check the interference severity.

NaviViewerUb GNSS Viewer Tool

L1



1. Signal strength is represented by the bar length and color. At the bottom, different colors are for different satellite systems as shown next. Please note that for GPS, it is one color only.
   - Blue: ≧ 50, green: ≧ 40, yellow: ≧ 30, red: < 30
2. Satellites of different systems are displayed by different bar colors. Please see also Help.

6.3 Ordering Information

GE-926X; X=A/B, default: GE-926B

X=	Description
A	Backup battery absent
B	Backup battery built-in

7 Electrical and Environmental Data

Electrical Data

Power Supply	3.3 ± 0.3V
Power Consumption	95 mA / average tracking (29 SVs)
Backup power	VBAT: 1.8~3.6V; 45 μA
TTL I/O	V_{IH}: ≧ 2.64V, V_{IL}: ≦ 0.4V V_{OH}: ≧ 2.9V, V_{OL}: ≦ 0.4V

Environmental Data

Operating temperature	-40 ~ 85℃ (-20~60℃ with backup battery)
Storage temperature	-40 ~ 85℃ (-40~60℃ with backup battery)
RoHS compliant	Yes