Data Sheet / GM-M02

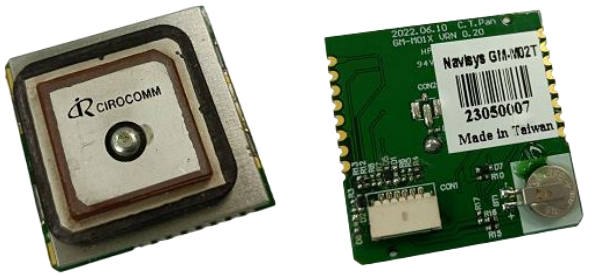
AG3335-based

L1/L5 Dual-band

Concurrent All Civil Navigation Systems

Easy to Use / Ultra-High Performance

GPS/GNSS Smart Antenna Module



RoHS
Compliant

Version 1.1

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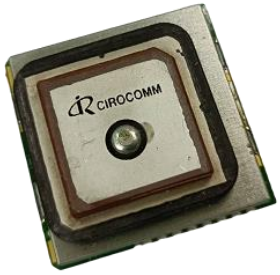
Revision History

Ver.	Date	Description
1.0	Dec.28th, 2023	First release
1.1	Oct. 11th, 2024	NavIC info added

Contents

1 Introduction

1.1 Overview



NaviSys GM-M02 is built based on Airoha's 12nm technology single chip – AG3335. As shown in above picture, GM-M02 is a thin, all in one, compact GNSS smart antenna module, which is able to concurrently track all civil satellite systems, i.e. GPS/ GLONASS/ GALILEO/ BEIDOU/ QZSS/ NavIC and SBAS of L1 and L5 bands. Thanks to this capability, positioning becomes easy and accurate even in the typical GPS difficult environments. In addition, both reception of L1 and L5 bands allows cancellation of errors introduced when signal passing ionosphere and troposphere. This leads to better accuracy.

GM-M02 embeds antenna, LED, and all circuits necessary for G3B$^{=}$ high quality positioning making it a plug-and-play all-in-one GNSS smart antenna module.

Its high performance enables the rapid deployment of AVL, timing, and other location-based applications. It supports different electrical interfaces such as USB, RS232, UART TTL etc.

The integrated antenna design helps reduce the RF and EMI issues to minimum. Fast adoption and high yield production becomes possible.

The receiver reports position using version 3.01 and 4.10 of the NMEA0183 standard referenced to the WGS-84 datum.

=G3B: GPS/GLONASS/GALILEO/BEIDOU

*Airoha is a subsidiary of MTK

1.2 Main Features

Our experienced design exhibits the full performance of Airoha AG3335 chip.

- Easy adoption with best performance
- Concurrently tracking of all L1 and L5 band civil satellite navigation systems.
  1. GPS/GALILEO/GLONASS/BEIDOU/QZSS/NavIC
  2. SBAS (WAAS, EGNOS, MSAS, GAGAN)
- SLAS (Sub-meter Level Augmentation Service) support in Japan
- Built-in 25x25x6 (mm) dual-band patch antenna
- 12 multi-tone AIC (active interference canceller) in both L1/L5 bands for removing unwanted signals.
- Indoor and outdoor multi-path detection and compensation
- PPS of ±10ns accuracy with adjustable duty cycle
- Up to 10Hz GNSS update rate (default 1Hz)
- RTCM V2.3 and V3.3 support
- AGPS/AGNSS
  1. EPO™ (Extended Prediction Orbit) orbit prediction
  2. EASY™ (Embedded Assist System) self-generated orbit prediction
- LOCUS™ logger function
- External backup power option via I/O pin is available for special application of high working temperature.
- Easy deployment
- High sensitivity with excellent indoor performance
- Tracking sensitivity of -165 dBm
- Acquisition sensitivity of -148 dBm!
- USB/UART TTL/RS232 interface support
- PPS accuracy: ± 10 ns clear sky, 1-sigma
- Compatible with GPSD
- Full implementation of ultra-high performance Airoha AG3335 single chip architecture
- Low power consumption of 59mA for average tracking
- Hardware power saving control pin allowing power on/off GNSS via GPIO
- Linux/Android support

- LED for position fix indication
- Fully EMI shielded
- Industrial operating temperature range: -40 ~ 85℃

1.3 Receiver Specifications

Features	Specifications!
GNSS receiver type	135-channel Airoha AG3335 engine L1: 1602 MHz: GLONASS:L1OF 1575.42 MHz GPS & QZSS: L1 C/A SBAS: L1 QZSS L1 SAIF Galileo: E1 (E1B+E1C) 1561.098 MHz BEIDOU B1I L5: 1176.45 MHz GPS & QZSS: L5 Galileo: E5a BEIDOU: B2a NavIC SPS
Horizontal Position Accuracy	Autonomous:1.5m (L1+L5 dual-band) (CEP, 50%, 24hr static, -130dBm)
Vertical Position Accuracy	Autonomous:2.25m (L1+L5 dual-band) (CEP, 50%, 24hr static, -130dBm)
Velocity Accuracy	<0.05 m/s (speed) (50%@30m/s)
Accuracy of PPS Time Pulse	± 10 ns clear sky, 1-sigma
Time To First Fix Hot start Warm start Cold start	Autonomous (50% -130dBm) 1sec 24sec 24sec
Sensitivity (Autonomous)	-148dBm (acquisition) -165dBm (tracking)
Measurement data output	Max. update rate: 10Hz (default 1 Hz), NMEA output protocol: Ver. 3.01 and 4.10 UART default baud rate: 115200 bps, (N-8-1) Datum: WGS-84 Default: GGA, GSA, GSV, RMC, VTG
Max. altitude	< 50,000 m
Max. velocity	< 500m/s or 1,852 km/hr
SBAS support	WAAS, EGNOS, MSAS, GAGAN

Dynamics	< 4g
Power consumption Average tracking (77 SVs used in fix)	56mA (TTL) 59mA (RS232) 94 mA / USB,
Power supply	3.3 ~ 5 VDC (TTL, RS232) 4.5 ~ 5.5 VDC (USB)
Dimension	30 (W) x 30 (L) x 11.8) (mm)
Operating temperature	-40°C +85°C
Storage temperature	-40°C ~ +85°C

[!]Note: Data is from chip vendor.

1.4 Protocols

The NMEA protocol is supported via serial UART (RX/TX), RS232 or USB (DM/DP) I/O port. The default supported protocol is NMEA.

1. Serial communication channel – UART/RS232
    i. No parity, 8-data bit, 1-stop bit (N-8-1)
    ii. User selectable baud rate among 4800, 9600, 19200, 38400, 115200 (default) bps.
2. NMEA 0183 Version 3.01 and 4.10 ASCII output
    i. Default GGA, GLL, GSA, GSV, RMC, VTG
3. Proprietary PAIR ASCII command
4. Proprietary binary command
5. RTCM2

    RTCM is one of the methods for the differential GNSS application. To achieve high-accuracy positioning, the RTCM data provides corrections to the GNSS satellite ranging measurements, which are broadcasted by reference stations located at known nearby positions. RTCM2 is the corresponding protocol for the differential GNSS service. For the further information, please refer to RTCM DGNSS, Version 2.3, August, 2001 at www.rtcm.org.

    i. Supported input message types: 1,2,3,9
        1. Differential GPS Corrections
        2. Delta Differential GPS Corrections
        3. GPS Reference Station Parameters
        9. GPS Partial Correction Set
6. RTCM3

    The RTCM3 describes messages and techniques for supporting GNSS operation with one reference station or a network of reference stations. It focus on the optimization of the use of bandwidth, on higher integrity and on the management of RTK networks. For the further information, please refer to RTCM DGNSS, Version 3 + Amendment 1, April,

2020 at www.rtcm.org. Following table shows the supported RTCM3.3 output messages.

Message types	Descriptions
1005	Stationary Antenna Reference Point
1019	Contents of GPS Ephemeris Data
1020	Contents of GLONASS Ephemeris Data
1042	Contents of Beidou Ephemeris Data
1044	Contents of QZSS Ephemeris Data
1046	Contents of Galileo Inav Ephemeris Data
1074	GPS MSM4
1077	GPS MSM7
1084	GLONASS MSM4
1087	GLONASS MSM7
1094	Galileo MSM4
1097	Galileo MSM7
1114	QZSS MSM4
1117	QZSS MSM7
1124	Beidou MSM4
1127	Beidou MSM7

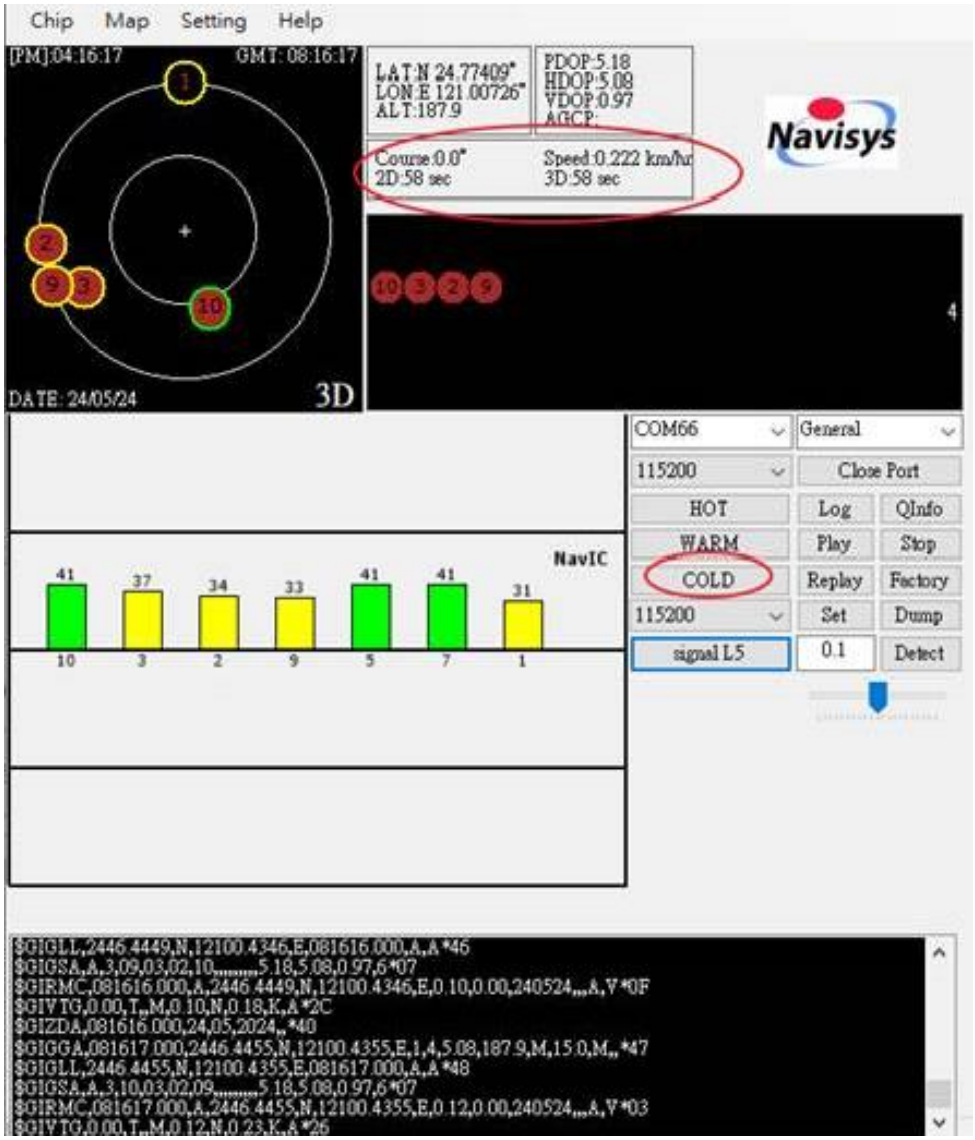
1.5 SLAS (Sub-meter Level Augmentation Service)

QZSS SLAS (Sub-meter Level Augmentation Service) is a service providing pseudorange correction data of GNSS satellites, i.e., GPS, GLONASS, Galileo, BeiDou, and QZSS. In Japan, Ground monitoring stations (GMS) will provide different corrections for the same satellite, which are broadcasted by QZSS satellites. When the SLAS function is enabled, the receiver selects the closest and healthy GMS based on the user's position. The correction data provided by the GMS will then be applied to the positioning, in addition to the measurements. If the distance between the closest GMS and user's location exceeds 200 km, the corresponding correction data will not be used for positioning. In addition, SLAS provides the reports for disaster and crisis management (DC Reports) to users. Please be noted that **SLAS is valid only within the borders of Japan**.

1.6 Fix Position by NavIC Only

In addition to the 4 known global navigational satellite systems, GPS/ GLONASS/ Galileo/ BeiDou, it's also possible to fix position by pure NavIC. However, please be noted that it does not work worldwide because NavIC is an India-based regional satellite system. In addition, it may not be on full operational during your testing. States of some satellites may be unhealthy or still on validation. Following picture is a

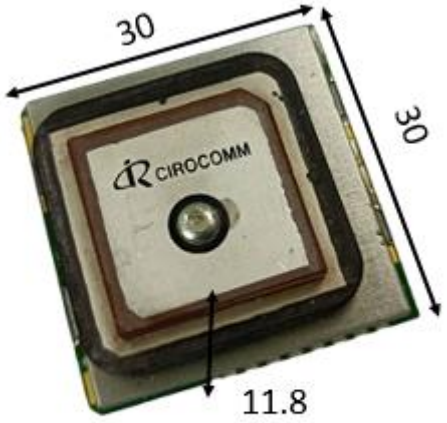
snapshot of NavIC only position fix after cold start.



2 Hardware Interface

2.1 Module Dimension

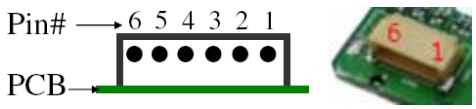
The dimension of GM-M02 is 30 mm (W) x 30 mm (L) x 11.8 mm (H) as shown below.



Unit mm
Tolerance ± 0.5

2.2 Connector and Pin Assignment

6-pin Interface, pitch 1.0mm



GM-M02R

Pin	Name	Function	I/O
1	GND	Ground	Input
2	VCC	Power supply	Input
3	TXD-TTL	TTL level serial data output	Output
4	RX-RS232	RS232 level serial data input	Input
5	TX-RS232	RS232 level serial data output	Output
6	RXD-TTL	TTL level serial data input	Input

GM-M02T

Pin	Name	Function	I/O
1	GND	Ground	Input
2	VCC	Power supply	Input
3	TXD-TTL	TTL level serial data output	Output
4	PWR_CTRL	Power control, high/floating: ON, low: OFF	Input
5	1PPS-TTL	Pulse Per Second signal	Output

6	RXD-TTL	TTL level serial data input	Input

GM-M02P

Pin	Name	Function	I/O
1	GND	Ground	Input
2	VCC	Power supply	Input
3	TX-RS232	Serial data output	Output
4	RX-RS232	Serial data input	Input
5	1PPS-TTL	Pulse Per Second signal	Output
6	NC	No connection	-

GM-M02Q

Pin	Name	Function	I/O
1	GND	Ground	Input
2	VCC	Power supply	Input
3	TX-RS232	Serial data output	Output
4	RX-RS232	Serial data input	Input
5	1PPS-RS232 &	Pulse Per Second signal	Output
6	NC	No connection	-

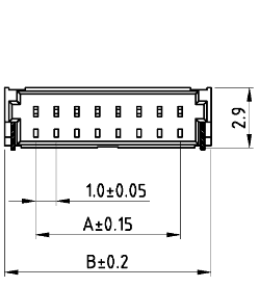
GM-M02U/W

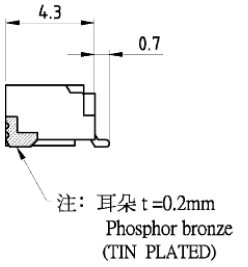
Pin	Name	Function	I/O
1	GND	Ground	Input
2	VCC	Power supply	Input
3	D+	USB D+	I/O
4	D-	USB D-	I/O
5	NC	No connection	-
6	NC	No connection	-

& Please be noted that the RS232 line transceiver would introduce 0.3 us pulse skew to the 1PPS signal of RS232 model

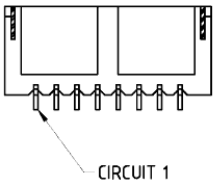
*MOQ-based customization of H/W, F/W are welcome.

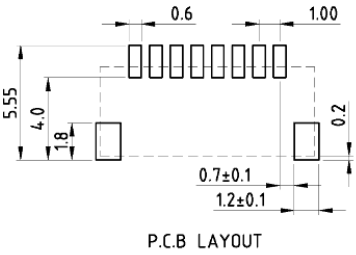
Connector Dimension (TU1001WNR-1x06S is adopted)





SPECIFICATION:
PITCH BETWEEN POLES : 1.0mm
CURRENT RATING : 1A AC/DC
VOLTAGE RATING : 50V AC/DC
CONTACT RESISTANCE :30mΩ(max.)
INSULATION RESISTANCE : 100MΩMIN
WITHSTAND VOLTAGE : 500V AC/MINUTE
TEMPERATURE RANGE : -25°C TO +85°C
FEATURES:
AVAILABLE NUMBER OF CIRCUITS : 2 TO 20
MATERIAL : NYLON 46 UL94V-0
CONTACT : 0.2mm(.008") FLAT PIN ,
PHOSPHOR BRANZE, GOLD FLASH OR TIN PLATED.
MATES WITH TU1001 SERIES HOUSING





Dimensional and Order Information

Poles	Part No	DIM:(mm) A	DIM:(mm) B	Poles	Part No	DIM:(mm) A	DIM:(mm) B
2	TU1001WNR-1x02S	1.00	4.00	12	TU1001WNR-1x12S	11.00	14.00
3	TU1001WNR-1x03S	2.00	5.00	13	TU1001WNR-1x13S	12.00	15.00
4	TU1001WNR-1x04S	3.00	6.00	14	TU1001WNR-1x14S	13.00	16.00
5	TU1001WNR-1x05S	4.00	7.00	15	TU1001WNR-1x15S	14.00	17.00
6	TU1001WNR-1x06S	5.00	8.00	16	TU1001WNR-1x16S	15.00	18.00
7	TU1001WNR-1x07S	6.00	9.00	17	TU1001WNR-1x17S	16.00	19.00
8	TU1001WNR-1x08S	7.00	10.00	18	TU1001WNR-1x18S	17.00	20.00
9	TU1001WNR-1x09S	8.00	11.00	19	TU1001WNR-1x19S	18.00	21.00
10	TU1001WNR-1x10S	9.00	12.00	20	TU1001WNR-1x20S	19.00	22.00
11	TU1001WNR-1x11S	10.00	13.00				

2.3 LED

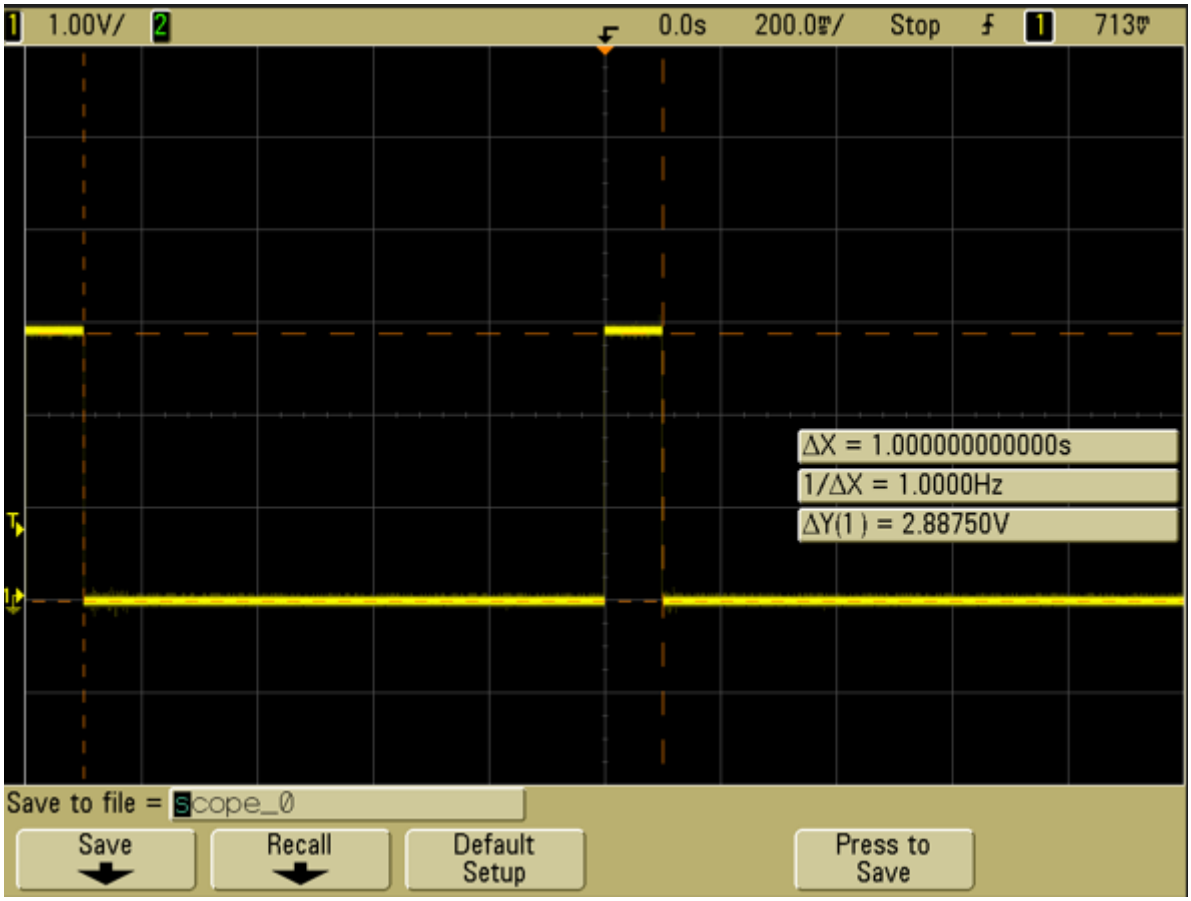
An embedded LED is used to indicate the GNSS position fixing status as following:

LED always ON: Position is not fixed, under fixing

LED Blinking: Position is fixed

2.4 1PPS

The default pulse width of the 1PPS signal is 100ms. The duty cycle could be customized on demand.



2.5 Power Saving

For models with PWR_CTRL pin, to control the power of GM-M02, connect the PWR_CTRL pin to a GPIO of a micro-processor. To cut off the power of GM-M02 (VCC is always connected to power source), just pull the PWR_CTRL pin low (in this case, GM-M02 only keeps power of RTC and RAM). During normal run, pull it high or leave it floating (in this case, GM-M02 is fully powered).

3 Software Interface - NMEA Output

GR-M02 supports both NMEA and proprietary PAIR text messages. In this section, the NMEA output messages are discussed.

3.1 NMEA Output Messages

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

- Talker ID is 'GP' for GPS-specific sentences
- Talker ID is 'GL' for GLONASS-specific sentences
- Talker ID is 'GA' for GALILEO-specific sentences
- Talker ID is 'GB' for BEIDOU-specific sentences
- Talker ID is 'GI' for NavIC-specific sentences
- 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
GALILEO	GAGGA	GAGLL	GAGSA	GAGSV	GARMC	GAVTG
BEIDOU	GBGGA	GBGLL	GBGSA	GBGSV	GBRMC	GBVTG
NavIC	GIGGA	GIGLL	GIGSA	GIGSV	GIRMC	GIVTG
GPS+GLONASS+ GALILEO+BEIDOU+ NavIC	GNGGA	GNGLL	GNGSA	GPGSV GLGSV GAGSV GBGSV GIGSV	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

The GR-M02 adopts interface protocol of National Marine Electronics Association's NMEA-0183 Version 3.01 & 4.10 interface specification. GR-M02 supports multiple types of NMEA sentences (GxGGA, GxGLL, GxGSA, GxGSV, GxRMC, GxVTG).

The default output sentences are GxGGA, GxGSA, GxGSV, GxRMC, GxVTG and GxGLL.

GPS+GALILEO+BEIDOU message examples:

$GNGGA,074846.000,2446.4144,N,12100.4360,E,2,61,0.46,125.4,M,15.0,M,,*79
$GNGSA,A,3,194,26,22,199,16,31,196,195,32,27,03,29,0.80,0.46,0.66,1*08
$GNGSA,A,3,04,,,,,,,,,,,,0.80,0.46,0.66,1*0F
$GNGSA,A,3,19,21,04,31,26,13,,,,,,0.80,0.46,0.66,3*02
$GNGSA,A,3,39,40,16,06,07,59,09,37,20,10,28,46,0.80,0.46,0.66,4*0C
$GNGSA,A,3,32,27,23,19,43,,,,,,,0.80,0.46,0.66,4*04
$GPGSV,4,1,16,194,68,041,45,26,65,340,47,22,64,145,46,199,60,166,40,1*61
$GPGSV,4,2,16,16,55,264,46,31,49,048,45,41,38,241,42,196,38,177,41,1*5C
$GPGSV,4,3,16,195,31,143,41,32,30,148,42,27,28,187,40,03,21,276,38,1*5C
$GPGSV,4,4,16,29,18,045,37,04,17,321,36,18,02,104,20,08,01,203,30,1*64
$GPGSV,3,1,10,194,68,041,49,26,65,340,51,199,60,166,50,196,38,177,45,8*56
$GPGSV,3,2,10,195,31,143,45,32,30,148,44,27,28,187,44,03,21,276,43,8*5F
$GPGSV,3,3,10,04,17,321,42,08,01,203,30,8*63
$GAGSV,2,1,06,19,73,181,40,21,44,027,41,04,40,315,40,31,18,250,35,7*7C
$GAGSV,2,2,06,26,08,137,33,13,06,087,33,7*77
$GAGSV,2,1,06,19,73,181,44,21,44,027,46,04,40,315,45,31,18,250,38,1*71
$GAGSV,2,2,06,26,08,137,37,13,06,087,39,1*7F
$GBGSV,7,1,27,39,73,038,34,40,70,208,33,16,69,019,33,06,65,355,31,1*7A
$GBGSV,7,2,27,07,60,223,29,61,59,204,,03,57,203,29,59,54,141,30,1*73
$GBGSV,7,3,27,09,54,337,29,56,53,245,,37,52,010,33,01,50,135,28,1*7E
$GBGSV,7,4,27,20,48,262,32,10,46,224,26,04,38,118,25,60,35,242,28,1*74
$GBGSV,7,5,27,28,35,104,31,46,31,293,28,32,31,189,30,27,24,161,28,1*77
$GBGSV,7,6,27,23,19,063,26,19,18,312,24,05,17,258,,43,12,051,23,1*70
$GBGSV,7,7,27,13,03,213,,38,02,188,,31,02,193,,1*41
$GBGSV,3,1,11,39,73,038,49,40,70,208,48,37,52,010,49,20,48,262,47,4*78
$GBGSV,3,2,11,28,35,104,44,32,31,189,45,46,31,293,43,27,24,161,41,4*76
$GBGSV,3,3,11,23,19,063,43,19,18,312,40,43,12,051,38,4*46
$GNRMC,074846.000,A,2446.4144,N,12100.4360,E,0.00,0.00,021222,,,D,V*05
$GNVTG,0.00,T,,M,0.00,N,0.01,K,D*27

GPS+GLONASS+GALILEO+BEIDOU message examples:

$GNGGA,074203.000,2446.4150,N,12100.4364,E,2,68,0.42,119.8,M,15.0,M,,*7D
$GNGSA,A,3,22,194,26,199,16,31,196,32,195,27,03,29,0.72,0.42,0.59,1*0D
$GNGSA,A,3,04,,,,,,,,,,,,0.72,0.42,0.59,1*0A
$GNGSA,A,3,66,77,67,76,65,78,,,,,,0.72,0.42,0.59,2*01

$GNGSA,A,3,19,21,04,31,26,13,,,,,,0.72,0.42,0.59,3*07
$GNGSA,A,3,39,40,16,06,07,59,09,37,20,10,32,28,0.72,0.42,0.59,4*0A
$GNGSA,A,3,46,27,23,19,43,,,,,,,0.72,0.42,0.59,4*02
$GPGSV,4,1,15,22,68,140,46,194,68,042,46,26,67,332,47,199,60,166,40,1*6C
$GPGSV,4,2,15,16,53,258,45,31,49,043,46,196,39,177,41,41,38,241,42,1*5C
$GPGSV,4,3,15,32,33,146,45,195,30,143,41,27,25,187,39,03,21,278,37,1*56
$GPGSV,4,4,15,29,20,047,39,04,15,321,35,18,01,107,,1*58
$GPGSV,3,1,09,194,68,042,49,26,67,332,51,199,60,166,50,196,39,177,45,8*5B
$GPGSV,3,2,09,32,33,146,45,195,30,143,45,27,25,187,42,03,21,278,44,8*58
$GPGSV,3,3,09,04,15,321,41,8*51
$GLGSV,2,1,07,66,64,232,40,77,39,313,27,67,36,318,20,76,35,017,37,1*7E
$GLGSV,2,2,07,65,20,175,28,85,08,042,,78,06,265,34,1*4B
$GAGSV,2,1,08,19,76,181,40,01,61,296,44,21,46,025,43,04,38,317,40,7*79
$GAGSV,2,2,08,31,16,247,35,26,06,139,29,13,05,090,36,27,01,051,08,7*78
$GAGSV,2,1,07,19,76,181,44,01,61,296,49,21,46,025,47,04,38,317,44,1*79
$GAGSV,2,2,07,31,16,247,40,26,06,139,36,13,05,090,36,1*45
$GBGSV,7,1,28,39,72,036,33,40,69,205,31,16,68,017,32,06,64,354,30,1*75
$GBGSV,7,2,28,07,59,220,28,61,59,204,,03,57,203,28,59,54,141,30,1*75
$GBGSV,7,3,28,56,53,243,,09,53,337,27,37,52,007,33,01,50,135,27,1*77
$GBGSV,7,4,28,20,49,267,32,10,46,222,25,04,38,118,,60,35,242,27,1*72
$GBGSV,7,5,28,32,34,190,28,28,33,108,30,46,30,291,27,27,21,163,28,1*7C
$GBGSV,7,6,28,23,21,061,25,19,17,314,22,05,17,258,,43,12,053,22,1*79
$GBGSV,7,7,28,13,04,214,,38,02,189,,31,02,194,,08,01,201,,1*72
$GBGSV,3,1,11,39,72,036,49,40,69,205,48,37,52,007,49,20,49,267,47,4*70
$GBGSV,3,2,11,32,34,190,44,28,33,108,43,46,30,291,44,27,21,163,40,4*75
$GBGSV,3,3,11,23,21,061,42,19,17,314,40,43,12,053,39,4*44
$GNRMC,074203.000,A,2446.4150,N,12100.4364,E,0.00,309.13,021222,,,D,V*07
$GNVTG,309.13,T,,M,0.00,N,0.00,K,D*2E

GPS+GLONASS+GALILEO+BEIDOU+NavIC message examples:

$GNGGA,090125.000,2446.4142,N,12100.4353,E,2,74,0.37,120.6,M,15.0,M,,*7C
$GNGLL,2446.4142,N,12100.4353,E,090125.000,A,D*49
$GNGSA,A,3,23,13,20,29,24,196,199,195,194,18,15,05,0.67,0.37,0.56,1*0D
$GNGSA,A,3,82,68,78,67,69,,,,,,,0.67,0.37,0.56,2*01
$GNGSA,A,3,08,03,05,09,15,36,24,25,34,,,,0.67,0.37,0.56,3*05
$GNGSA,A,3,39,38,08,16,06,13,33,14,24,09,28,42,0.67,0.37,0.56,4*0E
$GNGSA,A,3,43,25,26,41,11,07,27,40,,,,,0.67,0.37,0.56,4*05
$GNGSA,A,3,09,,,,,,,,,,,0.67,0.37,0.56,6*09

$GPGSV,4,1,15,23,26,319,33,13,23,041,32,20,15,113,29,29,15,214,28,1*60
$GPGSV,4,2,15,12,05,162,16,32,01,250,17,24,73,160,40,196,72,043,36,1*5B
$GPGSV,4,3,15,199,60,166,32,195,51,172,36,194,18,147,29,18,61,296,37,1*53
$GPGSV,4,4,15,15,49,020,38,41,38,241,32,05,34,092,36,1*54
$GPGSV,2,1,08,24,73,160,51,18,61,296,51,23,26,319,45,32,01,250,27,8*6D
$GPGSV,2,2,08,196,72,043,49,199,60,166,50,195,51,172,48,194,18,147,41,8*64
$GLGSV,3,1,10,81,03,173,,83,55,272,17,82,40,204,32,68,38,336,26,1*70
$GLGSV,3,2,10,78,33,123,36,67,27,036,24,77,23,056,16,69,15,286,23,1*76
$GLGSV,3,3,10,84,11,331,,79,08,170,,1*74
$GAGSV,3,1,09,08,11,252,24,03,52,287,34,05,49,021,35,09,06,053,11,7*79
$GAGSV,3,2,09,15,34,318,31,36,33,159,31,24,11,094,25,25,11,143,25,7*70
$GAGSV,3,3,09,34,76,236,37,7*4F
$GAGSV,3,1,09,36,33,159,43,08,11,252,38,24,11,094,40,25,11,143,40,1*7D
$GAGSV,3,2,09,09,06,053,26,34,76,236,49,03,52,287,47,05,49,021,47,1*7E
$GAGSV,3,3,09,15,34,318,43,1*42
$GBGSV,7,1,28,10,10,212,17,39,68,203,32,38,66,031,32,03,61,205,28,1*78
$GBGSV,7,2,28,08,58,005,26,16,57,202,28,06,55,203,27,13,53,347,28,1*7E
$GBGSV,7,3,28,01,52,133,27,33,49,343,30,14,47,028,29,24,43,110,30,1*75
$GBGSV,7,4,28,02,41,244,,09,39,205,23,04,39,116,,28,36,278,27,1*70
$GBGSV,7,5,28,42,32,056,27,43,30,202,26,25,26,174,24,26,20,055,25,1*79
$GBGSV,7,6,28,41,19,293,22,05,17,259,,11,17,181,21,07,11,201,16,1*7B
$GBGSV,7,7,28,27,08,316,22,40,06,193,,34,02,166,,62,,,28,1*46
$GBGSV,3,1,12,24,43,110,47,42,32,056,45,43,30,202,42,25,26,174,41,4*73
$GBGSV,3,2,12,26,20,055,40,41,19,293,42,27,08,316,38,40,06,193,20,4*79
$GBGSV,3,3,12,39,68,203,48,38,66,031,48,33,49,343,48,28,36,278,42,4*7D
$GIGSV,2,1,08,10,,,26,07,63,158,50,03,41,245,46,04,30,189,,1*48
$GIGSV,2,2,08,09,16,273,42,02,01,245,37,01,,,41,05,78,314,50,1*42
$GNRMC,090125.000,A,2446.4142,N,12100.4353,E,0.01,0.00,030724,,,D,V*07
$GNVTG,0.00,T,,M,0.01,N,0.01,K,D*26
$GNZDA,090125.000,03,07,2024,,*47

3.2 GGA - Global Positioning System Fix Data

- Example
  $GNGGA,000122.000,2446.4134,N,12100.4357,E,2,46,0.41,124.5,M,15.0,M,,*70
- Explanation

Contents	Example	Unit	Explanation
Message ID	$GNGGA		GGA protocol header
UTC Time	000122.000		hhmmss.sss

			hh: hour, mm: minute, ss.sss: second
Latitude	2446.4134		ddmm.mmmm dd: degree, mm.mmmm: minute
North/South	N		N: North Latitude, S: South Latitude
Longitude	12100.4357		dddmm.mmmm dd: degree, mm.mmmm: minute
East/West	E		E: East Longitude, W: West Longitude
Position Fix Indicator	2		0: Fix not available or invalid, 1: SPS Mode, fix valid, 2: Differential GNSS, fix valid, 4: RTK fixed, 5: RTK float
Satellites Used	46		Number of satellites used in positioning calculation
HDOP	0.41		Horizontal Dilution of Precision
MSL Altitude	124.5	meters	
Unit	M		Meters
Geoidal separation	15.0	meters	
Units	M		Meters
Age of Diff. Corr.		second	Null fields when DGPS is not used
Diff. Ref. Station ID			
checksum	*70		
<CR><LF>			End of sentence

3.3 GLL - Geographic Position - Latitude / Longitude

- Example

  $GNGLL,2446.4134,N,12100.4357,E,000122.000,A,D*42

- Explanation

Contents	Example	Unit	Explanation
Message ID	$GNGLL		GLL protocol header
Latitude	2446.4134		ddmm.mmmm dd: degree, mm.mmmm: minute
North/South	N		N: North Latitude, S: South Latitude
Longitude	12100.4357		dddmm.mmmmm dd: degree, mm.mmmmm: minute
East/West	E		E: East Longitude, W: West Longitude
UTC Time	000122.000		hhmmss.sss hh: hour, mm: minute, ss.sss: second
Status	A		A: Data valid, V: Data invalid
Mode Indicator	D		A: Autonomous, D: DGPS, E: DR
checksum	*42		
<CR><LF>			End of sentence

3.4 GSA - GNSS DOP and Active Satellites

- Example

  $GNGSA,A,3,195,194,14,199,01,03,196,17,30,07,21,06,0.64,0.41,0.49,1*05

- Explanation

Contents	Example		Explanation
Message ID	$GNGSA		GSA protocol header
Mode 1	A		M: Manual—forced to operate in 2D or 3D mode A: 2D Automatic—allowed to automatically switch 2D/3D
Mode 2	3		1: Fix not available 2: 2D (<= 4 Satellites used) 3: 3D (>= 4 Satellites used)
Satellite used in solution	195		Satellite on Channel 1
Satellite used in solution	194		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, multiple sentences would be used..
PDOP	0.64		Position Dilution of Precision
HDOP	0.41		Horizontal Dilution of Precision
VDOP	0.49		Vertical Dilution of Precision
GNSS System ID	1		1: GPS, 2: GLONASS, 3: GALILEO, 4: BEIDOU, 6: NavIC NMEA v4.1 and above only
checksum	*05		
<CR><LF>			End of sentence

3.5 GSV - GNSS Satellites in View

- Example

  $GPGSV,4,1,15,195,69,033,44,194,64,140,44,14,62,330,43,199,60,166,38,1*57

- Explanation

Contents	Example	Unit	Explanation
Message ID	$GPGSV		GSV protocol header
Number of messages	4		Total number of sentences
Message number	1		Sentence number
Satellites in view	15		Number of satellites visible from receiver
Satellite ID number	195		The satellite ID number in view from receiver channel 1

Elevation	69	degrees	Elevation angle of satellite as seen from receiver channel 1 (00 to 90)
Azimuth	033	degrees	Satellite azimuth as seen from receiver channel 1 (000 to 359)
SNR (C/No)	44	dBHz	Received signal level C/No from receiver channel 1 (00 to 99, null when not tracking)
…			
Satellite ID number	199		The satellite ID number in view from receiver channel 4
Elevation	60	degrees	Elevation angle of satellite as seen from receiver channel 4 (00 to 90)
Azimuth	166	degrees	Satellite azimuth as seen from receiver channel 4 (000 to 359)
SNR (C/No)	38	dBHz	Received signal level C/No from receiver channel 4 (00 to 99, null when not tracking)
Signal ID	1		1: GPS L1 C/A, GLONASS L1, GALILEO E5a, BEIDOU B1I, NavIC L5 3: BEIDOU B1C 4: BEIDOU B2a 7: GALILEO E1-BC 8: GPS L5Q NMEA v4.1 and above only
checksum	*7		
<CR><LF>			End of sentence

3.6 RMC - Recommended Minimum Specific GNSS Data

- Example

  $GNRMC,000123.000,A,2446.4134,N,12100.4357,E,0.04,0.00,230722,,,D,V*0C

- Explanation

Contents	Example	Unit	Explanation
Message ID	$GNRMC		RMC protocol header
UTC Time	000123.000		hhmmss.sss hh: hour, mm: minute, ss.sss: second
Status	A		A: Data valid, V: Data invalid
Latitude	2446.4134		ddmm.mmmm dd: degree, mm.mmmm: minute
North/South	N		N: North Latitude, S: South Latitude
Longitude	12100.4357		dddmm.mmmm dd: degree, mm.mmmm: minute
East/West	E		E: East Longitude, W: West Longitude
Speed over ground	0.04	knots	Receiver's speed
Course over ground	0.00	degrees	Receiver's direction of travel Moving clockwise starting at due north
Date	230722		ddmmyy

			dd: Day, mm: Month, yy: Year
Magnetic variation		degrees	This receiver does not support magnetic declination. All “course over ground” data are geodetic WGS84 directions.
Mode Indicator	D		A: Autonomous M: Manual D: DGPS S: Simulation E: Dead Reckoning N: Data Invalid
Navigation status	V		Navigational status indicator (V = Equipment is not providing navigational status information) NMEA v4.1 and above only
checksum	*0C		
<CR><LF>			End of sentence

3.7 VTG - Course over Ground and Ground Speed

- Example

  $GNVTG,0.00,T,,M,0.04,N,0.07,K,D*25

- Explanation

Contents	Example	Unit	Explanation
Message ID	$GNVTG		VTG protocol header
Course over ground	0.00	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	0.04	knots	Measured horizontal speed
Unit	N		Knots
Speed over ground	0.07	km/hr	Measured horizontal speed
Unit	K		km/hr
Mode Indicator	D		A: Autonomous, D: DGPS, E: DR
checksum	*25		
<CR><LF>			End of sentence

3.8 ZDA - GNSS Time and Date

- Example

  $GNZDA,031804.000,02,09,2022,,*4F

- Explanation

Contents	Example	Unit	Explanation
Message ID	$GNZDA		ZDA protocol header
UTC time	031804.000		hhmmss.sss hh: hour, mm: minute, ss.sss: second
Day	02		Day according to UTC time (01 to 31)

Month	09		Month according to UTC time (01 to 12)
Year	2022		Year according to UTC time (1980 to 2079)
Local zone hour		hour	Offset from UTC (set to 00)
Local zone minutes		minute	Offset from UTC (set to 00)
checksum	*4F		
<CR><LF>			End of sentence

3.9 GRS – GNSS Range Residuals

- Example

  $GNGRS,031804.000,1,-0.8,-2.9,1.2,-1.3,-2.9,1.8,-2.1,1.4,-1.6,0.2,1.9,0.2,1,1*67

- Explanation

Contents	Example	Unit	Explanation
Message ID	$GNGRS		GNS protocol header;
UTC time	031804.000		hhmmss.sss hh: hour, mm: minute, ss.sss: second
Mode	1		1 = Residuals are recomputed after the GGA is computed
Residual	-0.8	m	Range residuals (m) for SVs used in the navigation solution. SV order must match the order of GSA
…	…	m	Range residuals (m) for SVs used in the navigation solution. SV order must match the order of GSA
Residual	-0.8	m	Range residuals (m) for SVs used in the navigation solution. SV order must match the order of GSA
GNSS system ID	1		1: GPS, 2: GLONASS, 3: GALILEO, 4: BEIDOU, 6: NavIC NMEA v4.1 and above only
Signal ID	1		1: GPS L1 C/A, GLONASS L1, GALILEO E5a, BEIDOU B1I, NavIC L5 4: BEIDOU B2a 7: GALILEO E1-BC 8: GPS L5Q NMEA v4.1 and above only
checksum	*67		
<CR><LF>			End of sentence

3.10 GST – GNSS Psuedorange Error Statistics

- Example

  $GNGST,031804.000,2.4,2.1,1.8,79.2,1.8,2.1,6.4*4F

- Explanation

Contents	Example	Unit	Explanation
Message ID	$GNGST		GST protocol header;
UTC time	031804.000		hhmmss.sss hh: hour, mm: minute, ss.sss: second
Range RMS	2.4	m	RMS value of the standard deviation of the ranges
Std dev. major	2.1	m	Standard deviation of semi-major axis of error-ellipse
Std dev. minor	1.8	m	Standard deviation of semi-minor axis of error-ellipse
Orient	79.2	degrees	Orientation of semi-major axis of error ellipse, degrees from true north.
Std dev. latitude	1.8	m	Standard deviation of latitude error
Std dev. longitude	2.1	m	Standard deviation of longitude error,
Std dev. altitude	6.4	m	Standard deviation of altitude error
checksum	*4F		
<CR><LF>			End of sentence

3.11 GNS – GNSS Fix Data

- Example

  $GNGNS,022825.000,2446.4161,N,12100.4360,E,AAAA,46,0.39,126.2,M,15.0,M,,,V*23

- Explanation

Contents	Example	Unit	Explanation
Message ID	$GNGNS		GNS protocol header;
UTC time	022825.000		hhmmss.sss hh: hour, mm: minute, ss: second
Latitude	2446.4161		ddmm.mmmm dd: degree, mm.mmmm: minute
North/South	N		N: North Latitude, S: South Latitude
Longitude	12100.4360		dddmm.mmmm dd: degree, mm.mmmm: minute
East/West	E		E: East Longitude, W: West Longitude
Mode indicator	AAAA		The order of characters from left to right stands for GPS, GLONASS, Galileo, Beidou A: Autonomous M: Manual D: DGPS S: Simulation E: Dead Reckoning N: Data Invalid
Satellites used	46		Number of satellites used in positioning calculation (0 to 99)
HDOP	0.39		Horizontal Dilution of Precision
MSL altitude	126.2	meters	
Unit	M		
Geoidal separation	15.0	meters	
Unit	M		

Age of Diff. Corr.		second	Null fields when DGPS is not used
Diff. Ref. Station ID			
Navigation status	V		Navigational status indicator (V = Equipment is not providing navigational status information) NMEA v4.1 and above only
Checksum	*23		
<CR><LF>			End of sentence

4 Software Interface – PAIR Commands

GR-M02 supports both NMEA and proprietary PAIR text messages. In this section, the PAIR commands are discussed. The PAIR command set is big. Only part of them were written here. In case of special demand, please contact Navisys for technical support.

4.1 Command Format

There are four parts in each PAIR command and response:

Start Sequence	Payload	Checksum	End Sequence
$PAIR<CID>[1]	Data[2]	*CKSUM[3]	<CR><LF>[4]

[Example] $PAIR005*3F\r\n and its response $PAIR001,005,0*3E\r\n

1. Command Identifier consisting of reserved word "$PAIR" and three numeric characters.
2. Command-specific data. Refer to a specific command section described in following sections.
3. CKSUM is a two-hex character checksum as defined in the NMEA specification, NMEA-0183 Standard for Interfacing Marine Electronic Devices. Use of checksums is required on all input messages.
4. Each message is terminated using Carriage Return (CR) and Line Feed (LF) which is \r\n or hexadecimal 0D 0A. Because \r and \n are not printable ASCII characters, they are usually omitted from an example, but must be sent to terminate the message and cause the receiver to process that input message.

4.2 Response

Response is the Acknowledge of a PAIR command. It uses command identifier 1. The response was sent by the GNSS system automatically. Do not directly send it to the GNSS system.

- **Format>** $PAIR001,<CID>,<Result>*CS<CR><LF>
  <CID> is the command identifier that it responds to
  <Result> is the execution result of the corresponding command as shown below.

Result	Description
0	The command was successfully sent.
1	The command is processing. You must wait for the result.
2	Sending the command failed.
3	This command ID is not supported.

4	Command parameter error. Out of range / some parameters were lost / checksum error.
5	Service is busy. You can try again soon.

- **Example>**

Send $PAIR666*3C\r\n ➔Command 666

Response $PAIR001,666,0*3D\r\n ➔Result of command 666: 0 (success)

4.3 Summary of Frequently Used Commands

Please note that following input messages are Airoha proprietary NMEA messages.

#	Command Name	CID	Description
1	Hot start	004	Use the available data in the NVRAM.
2	Warm start	005	Not using Ephemeris data at the start.
3	Cold start	006	Not using the Position, Almanac or Ephemeris data at the start.
4	Full Cold start	007	Reset the GNSS module to the factory default.
5	Set fix rate	050	Set Position Fix Interval.
6	Get fix rate	051	Get Position Fix Interval.
7	Set the SNR threshold	058	Set the minimum SNR of used satellites.
8	Get the SNR threshold	059	Query the minimum SNR of used satellites
9	Set the DR limit	060	Set the number of estimated fixes, i.e. blind dead reckoning, when entering the tunnel.
10	Get the DR limit	061	Get the number of estimated fixes, i.e. blind dead reckoning, when entering the tunnel.
11	Set NMEA output rate	062	Set the NMEA sentence output interval of corresponding NMEA type.
12	Get NMEA output rate	063	Get the NMEA sentence output interval of corresponding NMEA type.
13	Set GNSS search mode	066	Set the satellite systems to be used in fix
14	Get GNSS search mode	067	Get the satellite systems to be used in fix
15	Set HDOP threshold	068	Set HDOP threshold for discarding fix
16	Get HDOP threshold	069	Get HDOP threshold for discarding fix
17	Set the static threshold	070	Set the speed threshold for static navigation.
18	Get the static threshold	071	Get the speed threshold for static navigation.
19	Set elevation mask	072	Set satellite elevation mask
20	Get elevation mask	073	Get satellite elevation mask
21	Set datum	076	Set the default datum
22	Get datum	077	Get the default datum
23	Set static mode	092	Enable/disable static mode
24	Get static mode	093	Query if current mode is static mode
25	Set DGPS correction	400	Set DGPS correction source

26	Get DGPS correction	401	Get DGPS correction source
27	Set SBAS status	410	Set status of SBAS searching enabled or not
28	Get SBAS status	411	Get status of SBAS searching enabled or not
29	Get SBAS satellite info.	412	Get the information of the used SBAS satellite
30	Set SLAS status	420	Enable/disable the QZSS SLAS (Sub-meter Level Augmentation Service) operation.
31	Get SLAS status	421	Query whether SLAS is enabled or not.
32	Save NVRAM setting	513	Save the current configuration from RTC RAM to flash.
33	Set baud rate	864	Set port baud rate configuration.
34	Get baud rate	865	Get port baud rate configuration.
35	Get UID	997	Get the chip-unique identifier

4.4 Commands

4.4.1 Hot Start

- **Description>**

  Use the available data in the NVRAM.

- **Example>**

  Send $PAIR004*3E\r\n ➔ Hot Start Command 004

  Response $PAIR001,004,0*3F\r\n ➔Result: 0 (success)

4.4.2 Warm Start

- **Description>**

  Not using Ephemeris data at the start.

- **Example>**

  Send $PAIR005*3F\r\n ➔ Warm Start Command 005

  Response $PAIR001,005,0*3E\r\n ➔Result: 0 (success)

4.4.3 Cold Start

- **Description>**

  Not using the Position, Almanac and Ephemeris data at the start.

- **Example>**

  Send $PAIR006*3C\r\n ➔ Cold Start Command 006

Response $PAIR001,006,0*3D\r\n ➔Result: 0 (success)

4.4.4 Full Cold Start

- **Description>**

In addition to Cold start, this command clears the system/user configurations at the start. It resets the GNSS module to the factory default.

- **Example>**

Send $PAIR007*3D\r\n ➔ Full Cold Start Command 007
Response $PAIR001,007,0*3C\r\n ➔Result: 0 (success)

4.4.5 Set Fix Rate

- **Format>** $PAIR050,<time>*CS<CR><LF>

<time> is the position fix interval in milliseconds (ms). [Range: 100 ~ 10000]

- For time <= 1000ms, position fix interval is as setting value (time).
- For time > 1000ms and time <= 10000ms, position fix interval will be rounded to integral sec (1000ms, 2000ms, ... , 10000ms).

- **Description>**

Please be noted that ULP mode (NOT default) only supports 1Hz. In addition, higher fix rate, say 10Hz (100ms), results more sentence output per second. The NMEA output should match the baud rate.

- **Example>**

Send $PAIR050,3000*10\r\n ➔ 1/3 Hz (once every 3000ms)
Response $PAIR001,050,0*3E\r\n ➔ Result: 0 (success)

4.4.6 Get Fix Rate

- **Description>**

Get Position Fix Interval.

- **Example>**

Send $PAIR051*3E\r\n ➔ Get fix rate command 051
Response $PAIR001,051,0*3F\r\n ➔ Result: 0 (success)
$PAIR051,3000*11\r\n ➔ 1/3 Hz (once every 3000ms)

4.4.7 Set the SNR Threshold

- **Format>** $PAIR058,<min_snr>*CS<CR><LF>
  <min_snr> is the Minimum SNR threshold of used satellites. Satellite with SNR less than <min_snr> would not be used in position fix. (Valid range: 9~37, default value: 9)

- **Description>**
  Set the minimum SNR of used satellites.

- **Example>**

Send	$PAIR058,15*1F\r\n	➔ Set min used SNR threshold to 15
Response	$PAIR001,058,0*36\r\n	➔ Result: 0 (success)

4.4.8 Get the SNR Threshold

- **Description>**
  Get the minimum SNR of used satellites.

- **Example>**

Send	$PAIR059*36\r\n	➔ Get min used SNR threshold
Response	$PAIR001,059,0*37\r\n	➔ Result: 0 (success)
	$PAIR059,15*1E\r\n	➔ SNR threshold is 15

4.4.9 Set the DR Limit

- **Format>** $PAIR060,<DR_limit>*CS<CR><LF>
  <DR_limit> is the maximum number of estimated fixes after entering a tunnel.number of estimated fixes after entering a tunnel. (Valid range: 0~500, default value: 0)

- **Description>**
  Set the maximum number of estimated fixes after entering a tunnel..

- **Example>**

Send	$PAIR060,0*20\r\n	➔ Disable DR after entering a tunnel.
Response	$PAIR001,060,0*3D\r\n	➔ Result: 0 (success)
Send	$PAIR060,3*23\r\n	➔ Output 3 fixes after entering a tunnel.
Response	$PAIR001,060,0*3D\r\n	➔ Result: 0 (success)

4.4.10 Get the DR Limit

- **Description>**

Get the maximum number of estimated fixes after entering a tunnel..

- **Example>**

Send $PAIR061,0*3D\r\n ➔ Get DR limit after entering a tunnel.
Response $PAIR001,061,0*3C\r\n ➔ Result: 0 (success)
$PAIR061,0*21\r\n ➔ DR is diabled (0).

4.4.11 Set NMEA Output Rate

- **Description>**

Set the NMEA sentence output interval of corresponding NMEA type.

- **Format>** $PAIR062,<Type>,<Output_Rate>*CS<CR><LF>

<Type> is the NMEA sentence type as shown below.

Type	Description
-1	Reset all sentence to default value.
0	GGA
1	GLL
2	GSA
3	GSV
4	RMC
5	VTG
6	ZDA

<Output_Rate> is the output interval setting (Valid range: 0~20, default value: 1)

Rate	Description
0	Disabled or not supported sentence
1	Output once every one position fix
2	Output once every two position fixes
3	Output once every three position fixes
4	Output once every four position fixes
5	Output once every five position fixes

- **Example>**

Send $PAIR062,0,3*3D\r\n ➔ Set GGA output once every 3 fixes
Response $PAIR001,062,0*3F\r\n ➔Result: 0 (success)

4.4.12 Get NMEA Output Rate

- **Description>**

Get the NMEA sentence output interval of corresponding NMEA type.

- **Format>** $PAIR063,<Type>*CS<CR><LF>
- **Return>** $PAIR063,<Type>,<Output_Rate>*CS<CR><LF>

<Type> is the NMEA sentence type as shown below.

Type	Description
-1	Return all sentence configuration
0	GGA
1	GLL
2	GSA
3	GSV
4	RMC
5	VTG
6	ZDA

<Output_Rate> is the output interval setting (Valid range: 0~20, default value: 1)

Rate	Description
0	Disabled or not supported sentence
1	Output once every one position fix
2	Output once every two position fixes
3	Output once every three position fixes
4	Output once every four position fixes
5	Output once every five position fixes

- **Example>**

Send	$PAIR063,0*23r\n	➔ Get GGA output rate
Response	$PAIR001,063,0*3E\r\n	➔ Result: 0 (success)
	$PAIR063,0,3*3C\r\n	➔ GGA output once every 3 fixes

4.4.13 Set GNSS Search Mode

Format>

$PAIR066,<GPS>,<GLONASS>,<Galileo>,<BeiDou>,<QZSS>,<NavIC>*CS<CR><LF>

0: corresponding satellite systems is disabled

1: corresponding satellite systems is enabled

- **Description>**

Configure the device to search specified satellite systems. The device restarts as it receives this command. Please be noted that only following combinations are available. In addition, QZSS is always switchable in any of following combinations.

L1: G/ GR/ GE/ GB/ GREB (e.g. GR-M01)

L1+L5: GREB / GEB (e.g. GR-M02)

L1+NavIC: G/ I/ GEI/ GREB/ GREBI (e.g. GR-M03)

Where G: GPS, R: GLONASS, E: Galileo, B: BeiDou, I: NavIC

- **Example>**

Send	$PAIR066,1,0,0,0,0,0*3B\r\n	➔ Search GPS satellites only
Response	$PAIR001,066,0*3B\r\n	➔ Result: 0 (success)
Send	$PAIR066,1,1,1,1,1,0*3B\r\n	➔ Search GPS, GLONASS, Galileo, BeiDou, QZSS satellites
Response	$PAIR001,066,0*3B\r\n	➔ Result: 0 (success)
Send	$PAIR066,1,1,0,0,0,0*3B\r\n	➔ Search GPS/GLONASS satellites
Response	$PAIR001,066,0*3B\r\n	➔ Result: 0 (success)

4.4.14 Get GNSS Search Mode

Format>

$PAIR067,<GPS>,<GLONASS>,<Galileo>,<BeiDou>,<QZSS>,<NavIC>*CS<CR><LF>

0: corresponding satellite systems is disabled

1: corresponding satellite systems is enabled

- **Description>**

To get the search setting of all satellite systems. **Example>**

Send	$PAIR067*3B\r\n	➔ To get the GNSS search setting
Response	$PAIR001,067,0*3A\r\n	➔ Result: 0 (success)
	$PAIR067,1,0,0,0,0,0*3A\r\n	➔ Search GPS satellites only

4.4.15 Set the HDOP Threshold

- **Format>** $PAIR068,<HDOP_threshold>*CS<CR><LF>

<HDOP_threshold> 0: disable this function. Other values enable this function.

- **Description>**

If the HDOP value is larger than this threshold value, the position fix would not be used.

- **Example>**

Send	$PAIR068,0.8*3E\r\n	➔ Set the HDOP threshold to 0.8
Response	$PAIR001,068,0*35\r\n	➔ Result: 0 (success)

4.4.16 Get the HDOP Threshold

- **Description>**

Get the HDOP threshold. 0: this function is disabled. Others, if current value is greater than this value, the position fix would be discarded.

➢ **Example>**

Send	$PAIR069*35\r\n	➔ Get the HDOP threshold
Response	$PAIR001,069,0*34\r\n	➔ Result: 0 (success)
	$PAIR069,0.8*3F\r\n	➔ HDOP threshold is 0.8

4.4.17 Set the Static Threshold

➢ **Format>** $PAIR070,<speed_threshold>*CS<CR><LF>

<speed_threshold> valid range 0~20 dm/s. Default value is 0 dm/s. The minimum is 1 dm/s, the maximum is 20 dm/s. 1 dm/s = 0.1m/s

➢ **Description>**

Set the speed threshold for static navigation. If the actual speed is less than the threshold, the output position remains the same and the output speed will be zero. If the threshold value is set to 0, this function is disabled.

➢ **Example>**

Send	$PAIR070,4*25\r\n	➔ Set the static threshold at 4 dm/s
Response	$PAIR001,070,0*3C\r\n	➔ Result: 0 (success)

4.4.18 Get the Static Threshold

➢ **Description>**

Get the speed threshold for static navigation. If the actual speed is less than the threshold, the output position remains the same and the output speed will be zero. If the threshold value is set to 0, this function is disabled.

➢ **Example>**

Send	$PAIR071*3C\r\n	➔ Get the speed of static threshold
Response	$PAIR001,071,0*3D\r\n	➔ Result: 0 (success)
	$PAIR071,0.4*3A\r\n	➔ static threshold at speed 0.4 m/s

4.4.19 Set Elevation Mask

➢ **Format>** $PAIR072,<degree>*CS<CR><LF>

< degree> Satellite elevation-mask. (Valid range: -90 ~ 90, default value: 5)

➢ **Description>**

Set the satellite elevation mask. Satellites below the elevation mask are not used.

➢ **Example>**

Send	$PAIR072,5*26\r\n	➔ Set the elevation mask to 5°
Response	$PAIR001,072,0*3E\r\n	➔ Result: 0 (success)

4.4.20 Get Elevation Mask

- **Description>**

  Get the satellite elevation mask..

- **Example>**

Send	$PAIR073*3E\r\n	➔ Get the default datum
Response	$PAIR001,073,0*3F\r\n	➔ Result: 0 (success)
	$PAIR073,5*27\r\n	➔ Elevation mask 5°

4.4.21 Set Datum

- **Format>** $PAIR076,<datum>*CS<CR><LF>

  <datum> 0: WGS84, 1: TOKYO-M, 2:TOKYO-A…

- **Description>**

  Set the default datum.

- **Example>**

Send	$PAIR076,0*27\r\n	➔ Set the default datum to WGS84
Response	$PAIR001,076,0*3A\r\n	➔ Result: 0 (success)

4.4.22 Get Datum

- **Description>**

  Get the default datum.

- **Example>**

Send	$PAIR076*3A\r\n	➔ Get the default datum
Response	$PAIR001,077,0*36\r\n	➔ Result: 0 (success)
	$PAIR077,0*26\r\n	➔ Default datum WGS84 (0)

4.4.23 Set Static Mode

- **Format>** $PAIR092,<enable>*CS<CR><LF>

  <enable> 0: Disable static mode, 1: Enable static mode

- **Description>**

Set the static mode

- **Example>**

Send	$PAIR092,1*2C\r\n	➔ Enable static mode
Response	$PAIR001,092,0*30\r\n	➔ Result: 0 (success)

4.4.24 Get Static Mode

- **Description>**

Query if the static mode is enabled or not.

- **Example>**

Send	$PAIR093*30\r\n	➔ Get the static mode
Response	$PAIR001,093,0*31\r\n	➔ Result: 0 (success)
	$PAIR093,1*20\r\n	➔ Static mode enabled

<enable> 0: Disabled static mode, 1: Enabled static mode

4.4.25 Set DGPS Correction Source

- **Format>** $PAIR400,<mode>*CS<CR><LF>

<mode> 0: No DGPS source, 1: RTCM, 2: SBAS, 3: SLAS

- **Description>**

Set the DGPS correction source.

- **Example>**

Send	$PAIR400,2*20\r\n	➔ Set SBAS as DGPS correction source
Response	$PAIR001,400,0*3F\r\n	➔ Result: 0 (success)

4.4.26 Get DGPS Correction Source

- **Description>**

Query the DGPS correction source

- **Example>**

Send	$PAIR401*3F\r\n	➔ Query DGPS source
Response	$PAIR001,401,0*3E\r\n	➔ Result: 0 (success)
	$PAIR401,2*21\r\n	➔ SBAS as DGPS source.

4.4.27 Set SBAS Status

- **Format>** $PAIR410,<enable>*CS<CR><LF>

  <enable> 0: Disable, 1: Enable

- **Description>**

  Enable searching of SBAS satellites or not.

- **Example>**

Send	$PAIR410,1*22\r\n	➔ Enable SBAS
Response	$PAIR001,410,0*3E\r\n	➔ Result: 0 (success)

4.4.28 Get SBAS Status

- **Description>**

  Query the SBAS status

- **Example>**

Send	$PAIR411*3E\r\n	➔ Query SBAS status
Response	$PAIR001,411,0*3F\r\n	➔ Result: 0 (success)
	$PAIR411,1*23\r\n	➔ SBAS is enabled.

4.4.29 Get SBAS Satellite Information

- **Description>**

  Get the information of the used SBAS satellites such as SVid, SNR, azimuth, and elevation.

- **Example>**

Send	$PAIR412*3D\r\n	➔ Query used SBAS satellites
Response	$PAIR001,412,0*3C\r\n	➔ Result: 0 (success)
	$PAIR412,50,42,134,50*0D\r\n	➔ SBAS SVid 50, SNR 42, azimuth 134, elevation 50.

Set SLAS Status

- **Format>** $PAIR420,<enable>*CS<CR><LF>

  <enable> 0: Disable, 1: Enable

- **Description>**

  Enable the QZSS SLAS (Sub-meter Level Augmentation Service) operation

- **Example>**

Send	$PAIR420,1*21\r\n	➔ Enable QZSS SLAS
Response	$PAIR001,420,0*3D\r\n	➔ Result: 0 (success)

4.4.30 Get SLAS Status

- **Description>**

  Query the QZSS SLAS (Sub-meter Level Augmentation Service) operation status

- **Example>**

Send	$PAIR421*3D\r\n	➔ Query QZSS SLAS
Response	$PAIR001,421,0*3C\r\n	➔ Result: 0 (success)
	$PAIR421,1*20\r\n	➔ QZSS SLAS is enabled.

4.4.31 Save NVRAM Settings to Flash

- **Description>**

  Save the current configuration from RTC RAM to flash. Please be noted that if there was no backup power for RTC, current configuration would be lost as main power was lost. In this case, save NVRAM to flash every time as you have a new setting to avoid setting loss as main power was lost.

  Please also be noted that this command is valid only at 1Hz update rate.

- **Example>**

Send	$PAIR513*3D\r\n	➔ Save NVRAM to flash
Response	$PAIR001,513,0*3C\r\n	➔ Result: 0 (success)

4.4.32 Set Baud Rate

- **Format>** $PAIR864,<Port_Type>,<Port_Index>,<Baudrate>*CS<CR><LF>

  <Port_Type> is the hardware port type.

  0: UART

  <Port_Index> is the hardware port index.

  0: UART0,

  1: UART1,

  2: UART2

  <Baudrate> Support 4800 ~ 115200, 230400, 460800, 921600, 3000000 etc. in bps

- **Description>**

  Set the baud rate of the hardware port. Please be noted that the new baud rate would be valid only after reboot.

- **Example>**

  Send $PAIR864,0,0,115200*1B\r\n ➔ Set UART0 to 115200bps

  Response $PAIR001,864,0*31\r\n ➔ Result: 0 (success)

4.4.33 Get Baud Rate

- **Format>** $PAIR865,<Port_Type>,<Port_Index>*CS<CR><LF>

<Port_Type> is the hardware port type.

0: UART

<Port_Index> is the hardware port index.

0: UART0,

1: UART1,

2: UART2

Description>

Get the baud rate of the hardware port. Please be noted that the new baud rate would be valid only after reboot.

- **Example>**

  Send $PAIR865,0,0*31\r\n ➔ Get UART0 baud rate

  Response $PAIR001,865,0*30\r\n ➔ Result: 0 (success)

  $PAIR865,115200*1A\r\n ➔ (UART0) baud rate 115200bps

4.4.34 Get Chip-Unique Identifier

- **Format>** $PAIR997*CS<CR><LF>

Description>

Get the unique identifier of this chip.

- **Example>**

  Send $PAIR997*3D\r\n ➔ Get this chip's unique identifier

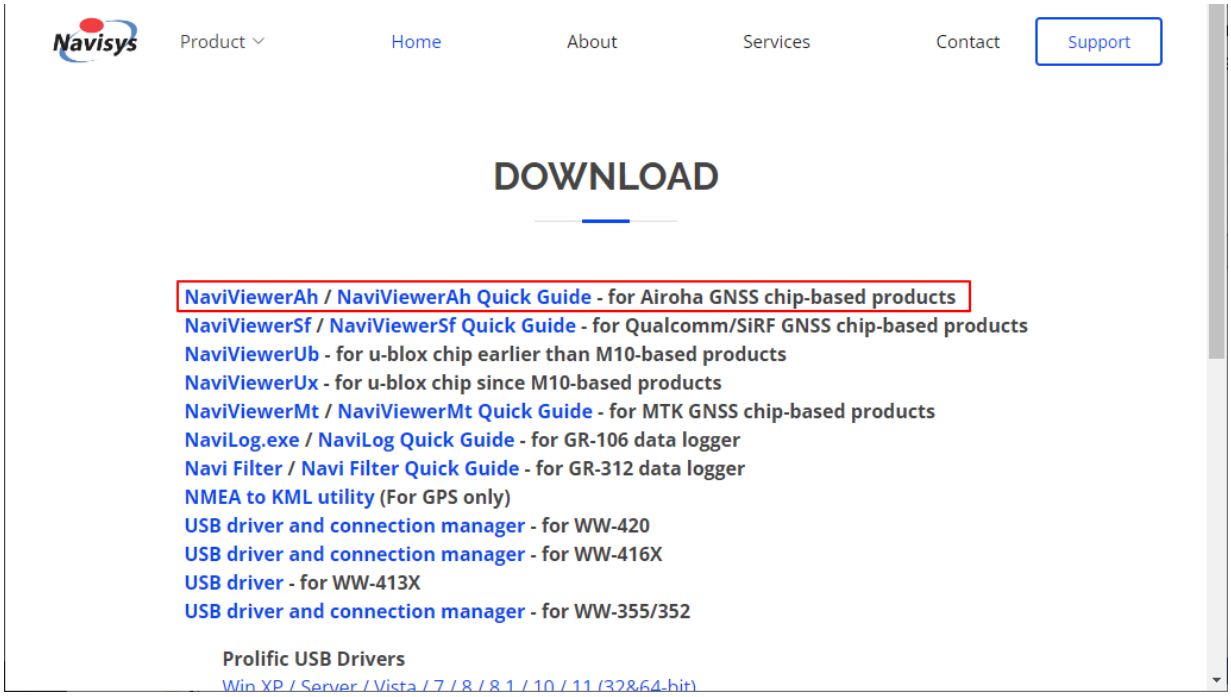
  Response $PAIR001,997,0*3C\r\n ➔ Result: 0 (success)

  $PAIR997,6380336403AF6B85CABBF6AFC6BEBDE6*11\r\n➔ID 63..E6

5 Evaluation Information

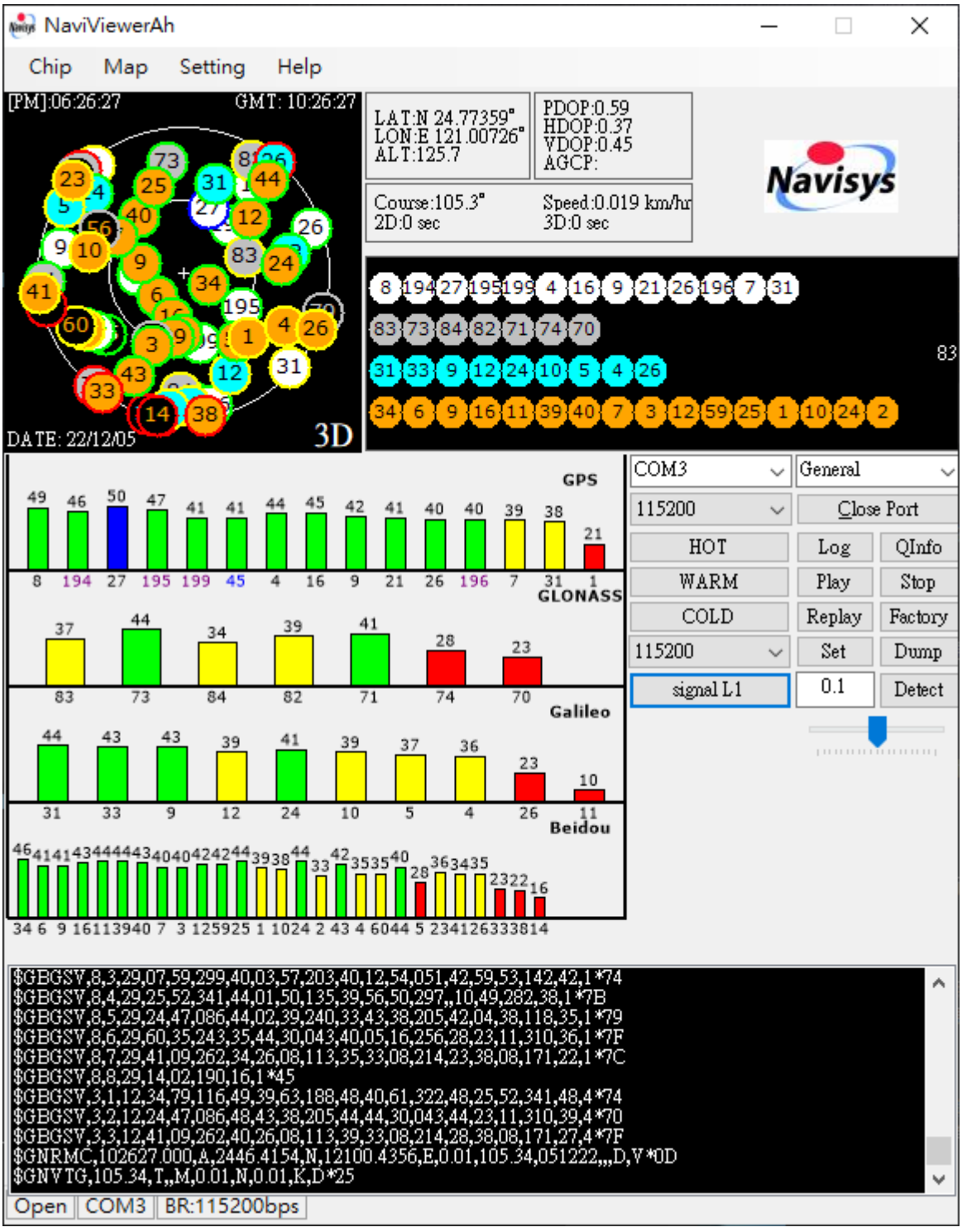
5.1 Overview

Under Windows, connect the GM-M02 to your PC and check its performance using the Navisys GNSS viewer tool dedicated for GM-M02 - **NaviViewerAh**. You can download **NaviViewerAh** from Navisys support page as shown below.

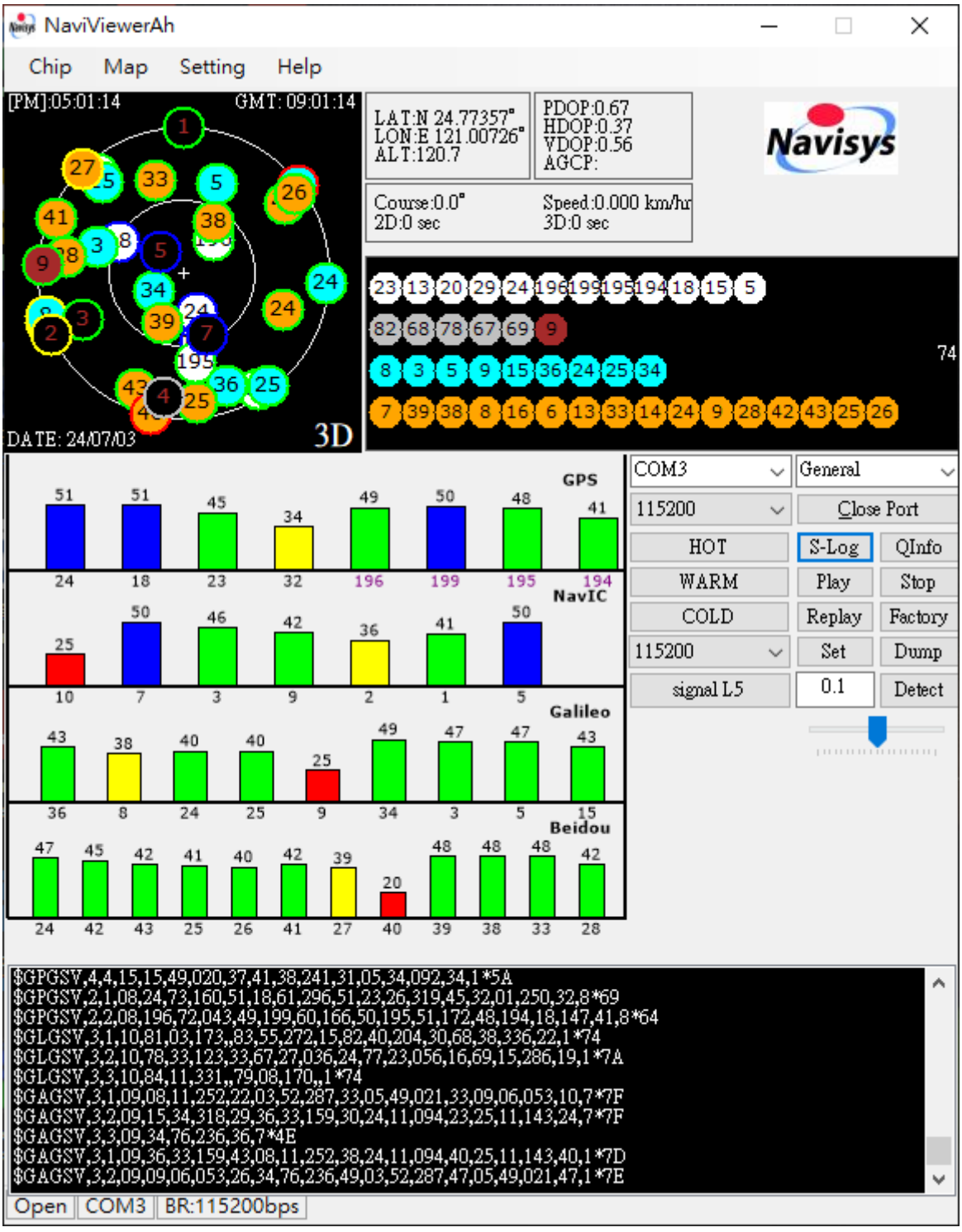


NaviViewerAh GNSS Viewer

1. L1 band:


NaviViewerAh
Chip
Map
Setting
Help
[PM]:06:26:27
GMT: 10:26:27
DATE: 22/12/05
3D
LAT:N 24.77359°
LON:E 121.00726°
ALT:125.7
PDOP:0.59
HDOP:0.37
VDOP:0.45
AGCP:
Course:105.3°
2D:0 sec
Speed:0.019 km/hr
3D:0 sec
Navisys
GPS
GLONASS
Galileo
Beidou
COM3
General
115200
Close Port
HOT
Log
QInfo
WARM
Play
Stop
COLD
Replay
Factory
115200
Set
Dump
signal L1
0.1
Detect
$GBGSV,8,3,29,07,59,299,40,03,57,203,40,12,54,051,42,59,53,142,42,1*74
$GBGSV,8,4,29,25,52,341,44,01,50,135,39,56,50,297,,10,49,282,38,1*7B
$GBGSV,8,5,29,24,47,086,44,02,39,240,33,43,38,205,42,04,38,118,35,1*79
$GBGSV,8,6,29,60,35,243,35,44,30,043,40,05,16,256,28,23,11,310,36,1*7F
$GBGSV,8,7,29,41,09,262,34,26,08,113,35,33,08,214,23,38,08,171,22,1*7C
$GBGSV,8,8,29,14,02,190,16,1*45
$GBGSV,3,1,12,34,79,116,49,39,63,188,48,40,61,322,48,25,52,341,48,4*74
$GBGSV,3,2,12,24,47,086,48,43,38,205,44,44,30,043,44,23,11,310,39,4*70
$GBGSV,3,3,12,41,09,262,40,26,08,113,39,33,08,214,28,38,08,171,27,4*7F
$GNRMC,102627.000,A,2446.4154,N,12100.4356,E,0.01,105.34,051222,,,D,V*0D
$GNVTG,105.34,T,,M,0.01,N,0.01,K,D*25
Open
COM3
BR:115200bps

2. L5 band:



1. Signal strength is represented by the bar length and color

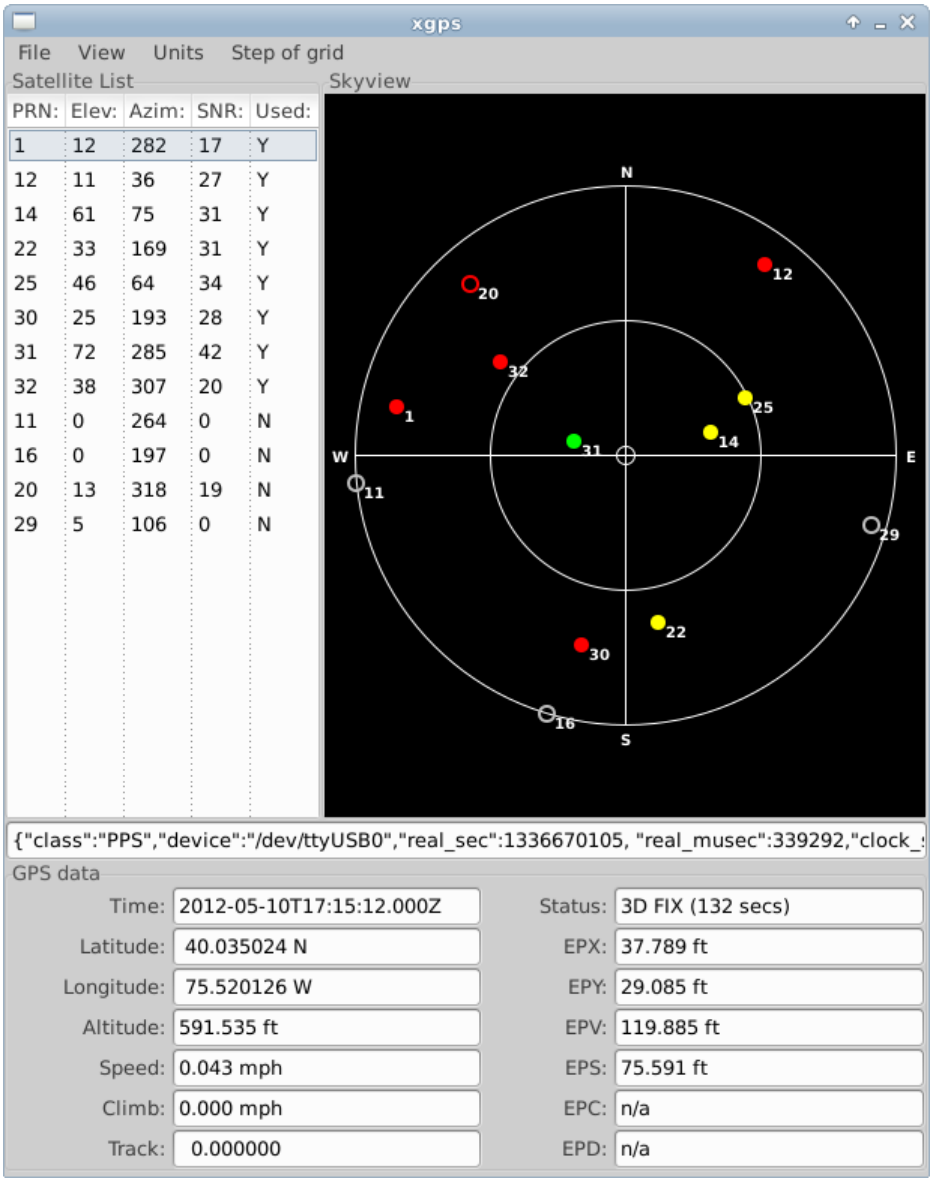
   - Blue: ≧ 50, green: ≧ 40, yellow: ≧ 30, red: < 30

2. Notes on SV number:

   GPS: 1~32, SBAS: 33~51, Galileo: 1~36, QZSS: 193~199

Beidou: 1~63 GLONASS: 65~88, NavIC: 1~14

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

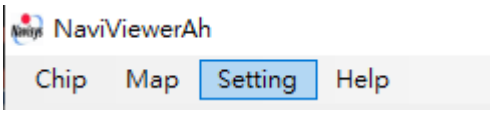


5.2 GNSS Configuration by NaviViewerAh

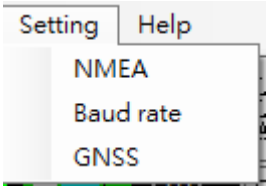
NaviViewerAh is a convenient tool for configuring NMEA sentence, update rate, baud rate, used navigation systems etc.

- Higher update rate is required for high-speed moving application. If power consumption is not a major concern, higher update rate could be configured up to 10Hz.
- If power consumption is a major concern, one may want to reduce the used satellite systems or update rate.

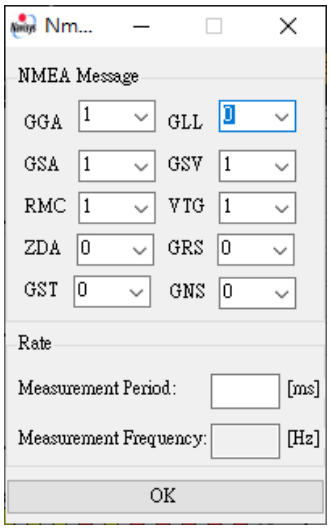
- Higher update and more used satellite systems will output more data. That is to say, higher baud rate would be required.
- If the focus is only on the position itself, one can have high update, just output only limited NMEA sentence, say GGA only. In this case, small baud rate is ok.
- To support configuration change for above mentioned purposes, one can use NaviViewerAh to perform the configuration management.
- Configured by NaviViewerAh: Click the Setting menu bar of it,

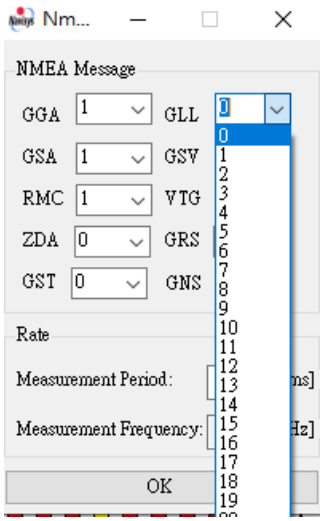


One can see 3 sets of functions for above mentioned configuration management.



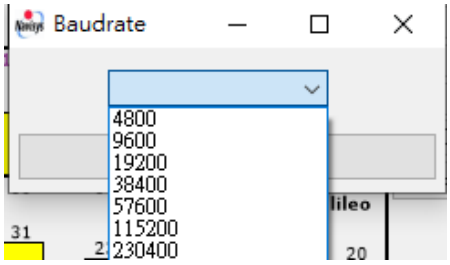
- **NMEA** is for a) enable/disable a NMEA sentence and/or b) change the update rate:





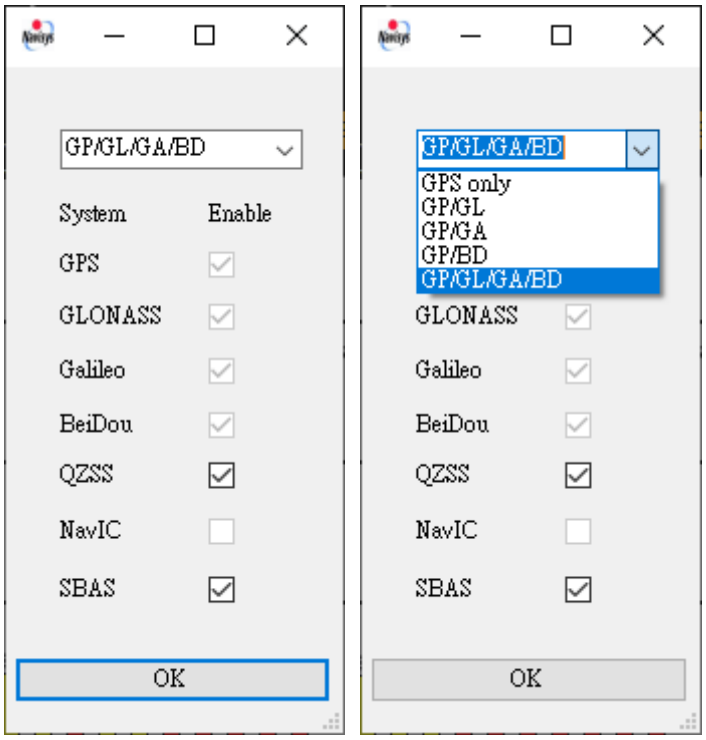
➔Please be noted that send OK leaving NMEA Message **blank** would cause **null output** of NMEA messages. In case of update rate change, please remember to check each NMEA sentences.

- **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.
  - Please be noted that because of satellite searching strategy, satellites in order of GPS/BeiDou/GLONASS/Galileo would be acquired.
  - If all 4 navigation systems are enabled, not satellites of all 4 would be seen at the beginning. Instead, one would see them in above sequence.
    - That is to say, only GPS/Beidou satellites would be seen at the beginning. Finally, all 4 would be seen.

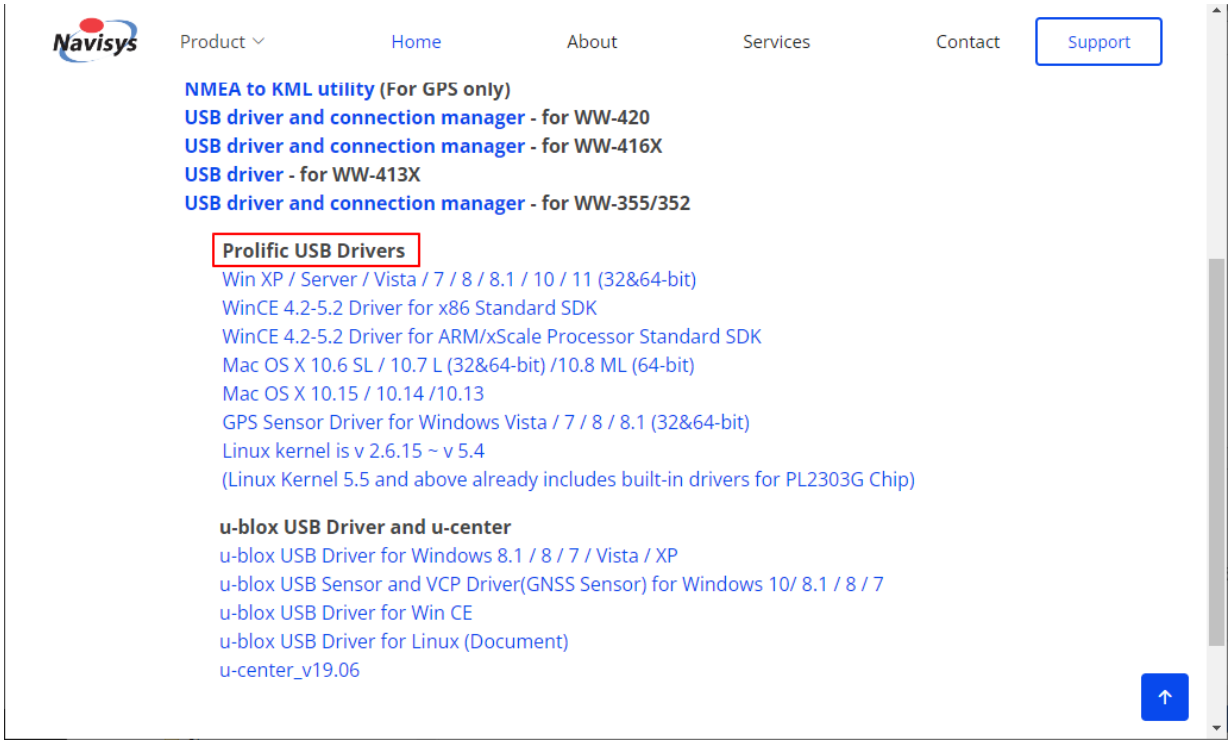


5.3 USB Drivers

USB drivers are available from Navisys support page as aforementioned.

Please select the Prolific USB driver.

The USB drivers for Linux and *BSD are embedded in the kernel.



5.4 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 NaviViewerAh.
4. If the location of the module has determined, this tool could be used to check the interference severity.

For more interesting news, please visit Navisys web site.

5.5 Indicative Accuracy

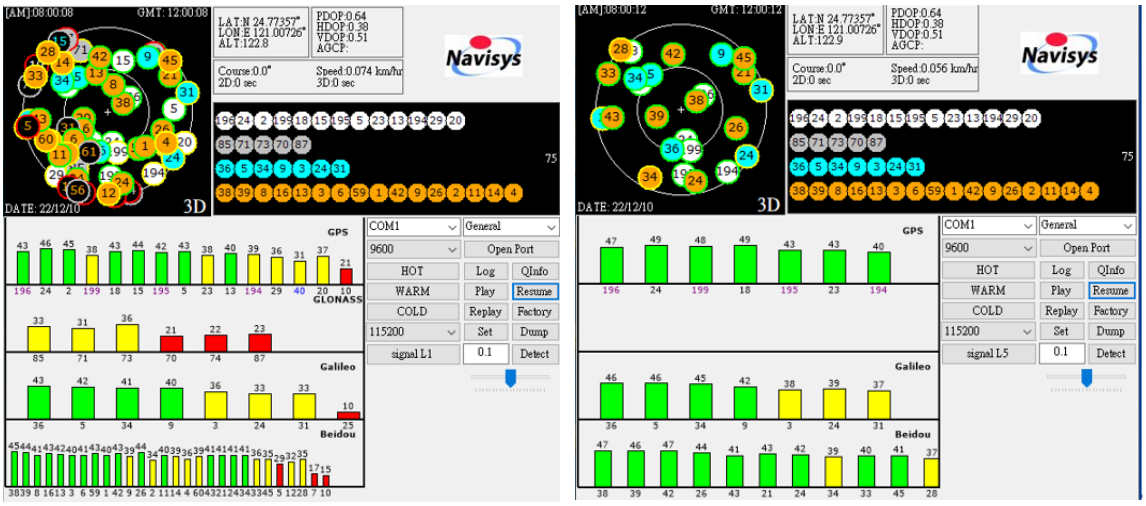
Two kinds of accuracy tests are performed for reference purpose – static and road. The result might be different as the test environment changes.

Static Test

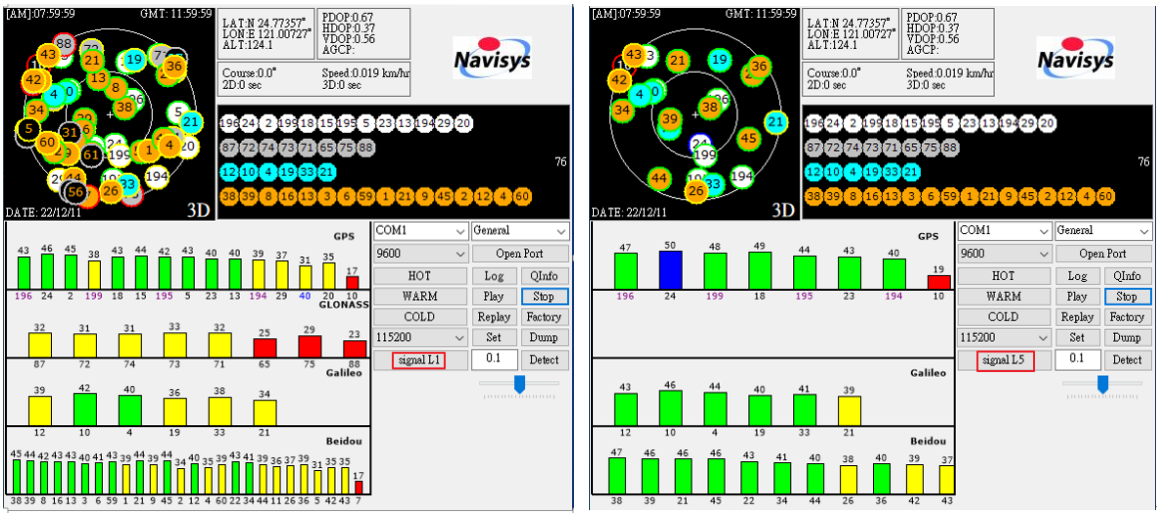
Following 24-hour static test was done in an indoor repeater environment.

Here are snapshots of the test for L1 and L5 bands respectively.

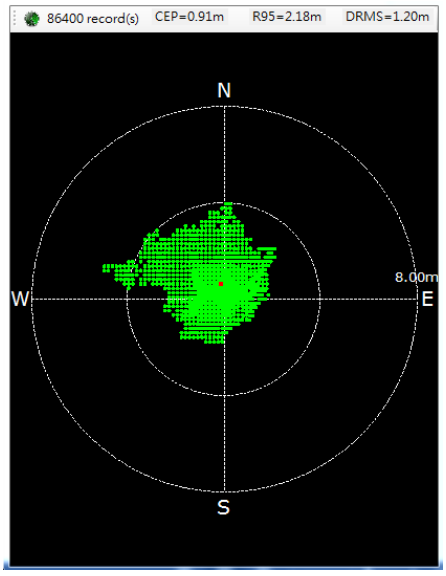
Beginning of the test:



At the end of test:



The accuracy data for the 24-hour test is CEP: 0.91m, R95: 2.18m, DRMS: 1.20m.



Road Test

Background: Distance and scatter plot share the same characteristic

1. Use the cm-level RTK receiver, GR-901, as the reference location. Calculate the distance of GR-M02 to it. Because the RTK receiver is cm-level precise, its deviation could be ignored when compared with meter level accuracy. The distance to it is thus similar to the scatter plot of a static test.
2. The 1-sigma of distance deviations is the same as DRMS (distance root mean square).
3. According to normal distribution, both 2-sigma and R95 are with the probability of 95% and thus could be referred interchangeably.

Purpose: To see if both tests coincide by checking

- if the 1-sigma distance deviation of road test is at the same level as DRMS of static test (1.2m as shown above).
- if the 2-sigma distance deviation of road test is at the same level as R95 of static test (2.18m as shown above).

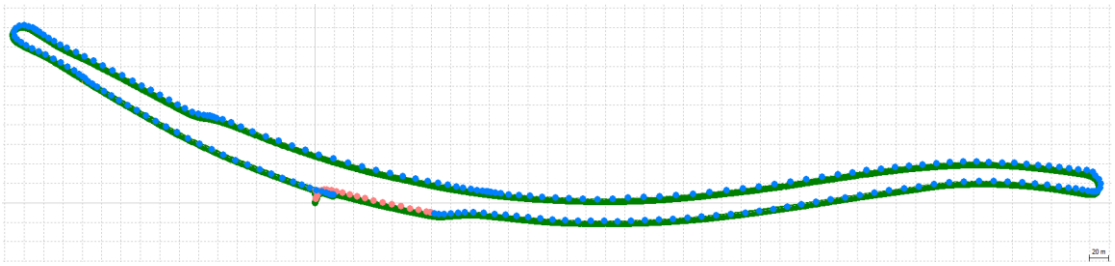
Method:

4. Fix GR-901 and GR-M02 on car's rooftop at distance 50cm. Log the NMEA sentences, positions, of both receivers during the trip for distance analysis.

5. Drive on the city road with a round trip as shown by **Location** below.
6. Calculate the distance deviations of 1/2-sigma for comparison.

Date: Dec. 14th, 2022, chilly (16℃)

Location: The road test was conducted on Gongdao 5th Road, Hsinchu, Taiwan. The driving path was shown by dots on the road below. RTK 10Hz, while GR-M02 1Hz.



Result: 426 positions of GR-M02 logged. The test result shows

7. 1-sigma at 106.62 cm with probability of 80.75%
8. 2-sigma at 213.24 cm with probability of 91.54%
9. 3-sigma at 319.86 cm with probability of 99.29%

Summary: Basically, the result shows both tests coincide.

10. DRMS static test 1.2m, 1-sigma road test 1.06m
11. R95 static test 2.18m, 2-sigma road test 2.13m

5.6 Ordering Information

Software options of different baud rates, NMEA sentence output rate, position fix update rate, and many other options are available. Each product has a default configuration. Customer is highly advised to check the product configuration before ordering.

Please see sec 2.2 for detailed pin descriptions for different models.

% By default, the USB model is equipped with backup battery while other models not.

6 Electrical and Environmental Data

Electrical Data

Power Supply	3.3 ~ 5 VDC (TTL, RS232) 4.5 ~ 5.5 VDC (USB)
Power Consumption (Average Tracking)	75±5 mA (USB) 45 mA (RS232, 50 SVs used in fix)
TTL Digital I/O	V_{IH}: 2 ~ 3.15V, V_{IL}: 0 ~ 0.8V, V_{OH}: ≧ 2.1 V V_{OL}: ≦ 0.72V

Environmental Data

Operating temperature	-40 ~ 85℃ (battery: -20 ~ 60℃)
Storage temperature	-40 ~ 85℃ (battery: -40 ~ 60℃)
Vibration	5Hz to 500Hz, 5g
Shock	Half sine 30g/11ms

7 Package Information

1000 pcs per carton box -

- 40 pcs in one tray plate

- 5 tray plates in one vacuum bag, totally 200pcs

- 5 vacuum bags in one carton box, totally 1000pcs

  - Carton box size is 503x353x234 in mm.

- Weight for 1000pcs is 20.8Kg.