YIC

GPS / GNSS Receiver (G-Mouse)

(L1+L5,Dead Reckoning GNSS)

GR-505GGBL5-DR

Datasheet

www.yic.com.tw

Revision History

Date	Reversion	Description
2023/07/20	1.0	First Draft, Based on YIC
2024/03/18	2.0	Update Rate default 1Hz changed to 10Hz
2024/04/11	2.1	Modify the wire length to 3 meters ; Add MX4 (Molex Connector)

Directory

1. Product Information

1.1 Product Description

The GR-505GGBL5-DR is a receiving module that supports dual frequency and multi-mode. It has built-in highly integrated GNSS receiver chip, supports multi band and multi system cm4f (main frequency 530 mhz, 12nm Technology) chip of Third- generation BeiDou Navigation Satellite System (BDS-3). Besides, it is capable of tracking all global civil navigation systems (GPS, GLONASS, Galileo, BDS, QZSS and SBAS) in all bands.

GR-505GGBL5-DR is based on the state of art BDS-3 architecture, integrating multi-band and multi-system GNSS RF and baseband. This newly designed architecture makes this chip achieve sub-meter level position accuracy without correction data from ground-based augmentation station and higher sensitivity, greater for improved jam resistance and multipath, provide a highly robust service in complicated environment.

GR-505GGBL5-DR contain MediaTek positioning engine inside with Dead Reckoning, featuring high sensitivity, low power consumption, and fast TTFF. The superior cold start sensitivity allows it to acquire, track, and get position fix autonomously in difficult weak signal environment. The receiver's superior tracking sensitivity allows continuous position coverage in nearly all outdoor application environments. The high performance signal parameter search engine is capable of testing 16 million time-frequency hypotheses per second, offering superior signal acquisition and TTFF speed.

Applications

- LBS (Location Based Service)
- PND (Portable Navigation Device)
- Vehicle navigation system
- Mobile phone

1.2 Product Features

- Build on high performance, low-power MediaTek chip set
- Dead Reckoning, automatically inertial navigation positioning without GNSS signal
- Built-in TDK-42670 of 6-Axis acceleration sensor to define various gravity algorithms
- Concurrent reception of multi-band and multi-systemsatellite signals
- Supports BDS-3 signal
- Support satellite systems: GPS L1/L5,GLONASS, Galileo, BDS, QZSS and SBAS
- Supports all civil GNSS signals
- Ultra high track sensitivity: -165dBm
- Extremely fast TTFF at low signal level(Cold start ≤25s, Hot start ≤5s).
- Multipath detection and suppression
- Works with passive and active antenna
- Low power consumption: Max 58mA@3.3V
- NMEA-0183 compliant protocol or custom protocol
- Operating voltage:3.0V ~ 5.5V
- Patch Antenna Size:35x35x4 & 25x25x4 mm
- Small form factor: 52.7±0.5x57.6±0.5x20.72±0.5mm
- Communication type: RS232
- Waterproof grade: IP67
- Recommended operating temperature range:-40°C to 80°C
- RoHS compliant (Lead-free)
- PPS LED

1.3 Product Specifications

Parameter	Specification
GNSS engine	GNSS engine has 135 channels and DSP accelerators
GNSS reception	GPS/QZSS: L1 C/A, L5 GLONASS: L1OF GALILEO: E1(E1B+E1C), E5A BEIDOU: B1I, B2A SBAS: WAAS, EGNOS, MSAS, GAGAN
Update Rate	10Hz Default
Position accuracy	<1m CEP
	<1m CEP
Velocity & Time accuracy	GNSS 0.01m/s CEP
	SBAS 0.05 m/s
	1PPS 10 ns
Time to First Fix(TTFF)	Hot start ≤5 sec
	Cold start≤25 secs
	Cold start -149dBm
Sensitivity	Hot start -155dBm
	Reacquisition -158dBm
	Tracking & navigation -165dBm
GNSS Operating limit	Velocity 100m/s (10m/s Minimum)
	Altitude 10000m (80000m Maximum)
Datum	Default WGS-84 / Customized
Horizontal Locating Accuracy	GNSS inertial navigation <1.5m CEP @-130 dBm
	Without aid Sub-meter (3% CEP)
RS232 Port	RS232 Port: TXD and RXD
	Supports baud rate from 9600bps to 961200bps. (Default:115200bps)
	NMEA 0183 Protocol Ver. 4.00/4.10,MTK GNSS Receiver Protocol

Temperature Range	Normal operation: -40°C ~ +80°C
	Storage temperature: -40°C ~ +105°C
	Humidity: 5% ~ 95%
Physical Characteristics	Small form factor: 52.7±0.5x57.6±0.5x20.72±0.5mm
	Wire interface type: 5Pin , L=300cm
	Weight: Approx. 92.0g

Attentions

As a high-performance vehicle integrated navigation system, GR-505GGBL5-DR system also requires users to pay attention to some matters during application

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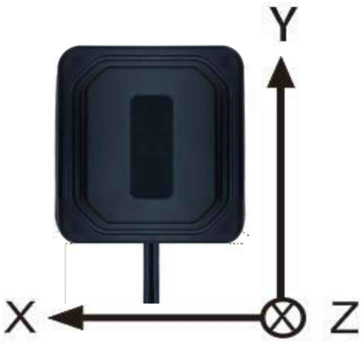

Figure 1-1: Coordinate System

No	Initialization process of integrated navigation	Importance
1	No installation Angle requirements. Refer to **Figure 1-1**	
2	Before power on ,Fixed connected GR-505GGBL5-DR and vehicle	Required
3	After power on, don't move GR-505GGBL5-DR	Required
4	Before the vehicle moves, please make sure the GNSS system output the correct protocol	Required
No	**Initialization process of integrated navigation**	**Importance**
1	After power on, make static at least 5-10 seconds to complete the attitude initialization ofthe navigation system;	Required
2	In the course of the vehicle, it is necessary to keep the GR-505GGBL5-DR navigation system moves in an open area for some time, for the algorithm convergence of integrated navigation system, and then test it in complex environments such as tunnels.	Required

Further Explain：

Summary : In integrated navigation system initialization, it is suggested that the vehicle drive under unobstructed environment for about a few minutes, then go into obstructed environment, the positioning effect will be better.

1.4 Block Diagram

The GR-505GGBL5-DR is a high performance (GPS, GLONASS, Galileo, BDS, QZSS and SBAS) in all bands (L1,L5). satellite navigation receiver in a compact surface mount package. It is based on the MediaTek positioning technology, providing high performance signal acquisition and tracking. The simple RS232 serial interface and the standard NMEA-0183 protocol make usage of GR-505GGBL5-DR very easy and straightforward.

The GR-505GGBL5-DR module can performs all the necessary system initialization, signal acquisition, signal tracking, data demodulation, and calculation of navigation solution autonomously.

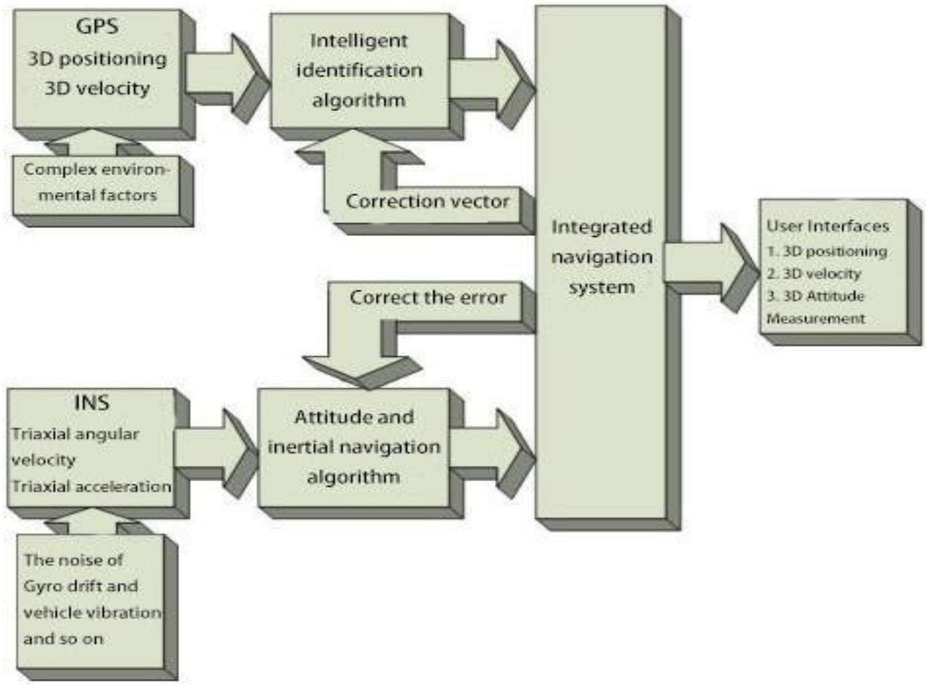

Figure 1-2： Block Diagram

2. Mechanical Dimensions and Pin Assignment

The module is equipped with a 5-pin wire that connects to your application platform. Mechanical Dimensions and Pin Assignment are described in details at the following chapters.

(Different Cables & Connectors can be Specified According to Requirements)

2.1 GR-505GGBL5-DR-N

2.1.1 Physical Dimensions

P/N	Mount	Description
GR-505GGBL5-DR-N	Adhesive	No Connector, 5 Wire Open End

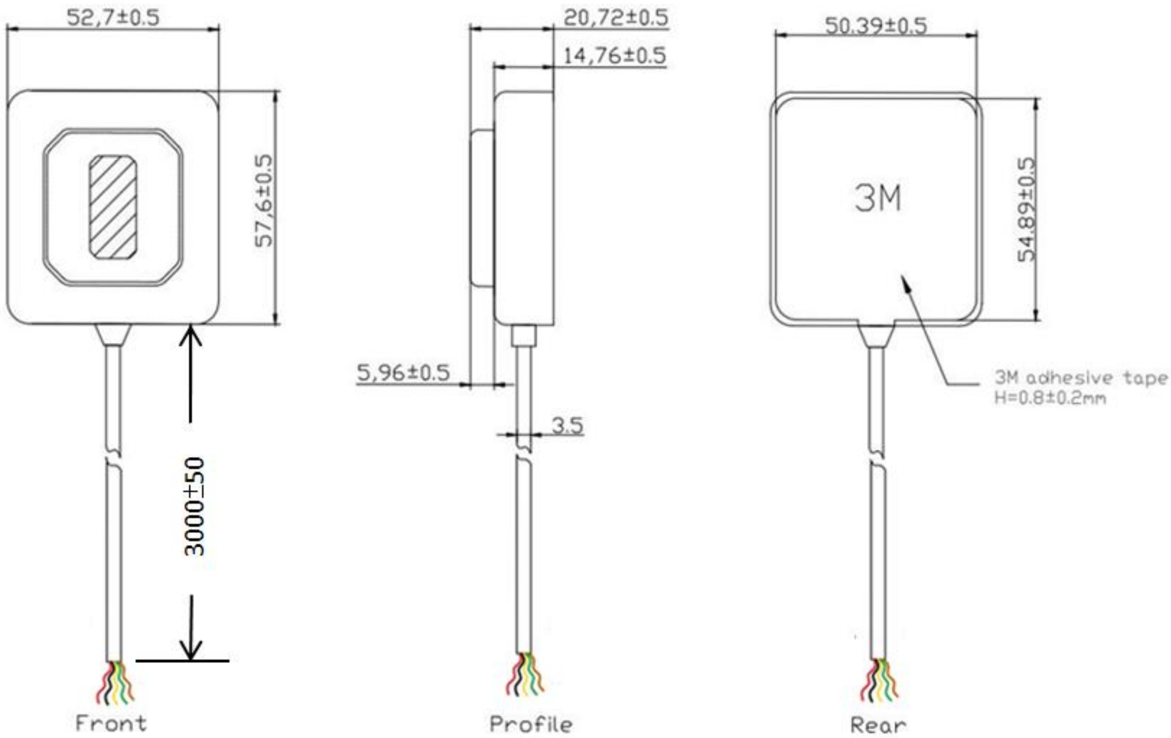

Figure1-3： Mechanical Dimensions (Unit： mm)

2.1.2 Pin Definition

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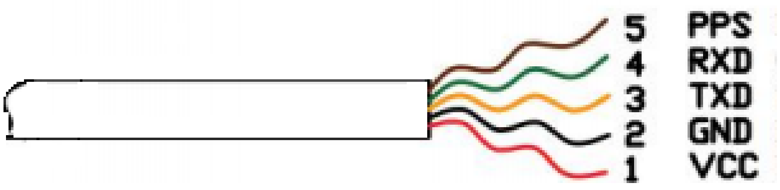

Figure1-4：Pin Assignment

Table: Pin Description

Pin No.	Pin name	Pin wire color	Description	Remark
1	VCC	Red	Module Power Supply	Voltage range: 3.0V~5.5V
2	GND	Black	Ground	
3	TXD	Orange	RS232 Serial Data output	
4	RXD	Green	RS232 Serial Data input	
5	PPS	Brown	Time Pulse(1PPS)	

2.2 GR-505GGBL5-DR-MX4

2.2.1 Physical Dimensions

P/N	Mount	Description
GR-505GGBL5-DR-MX4	Adhesive	(4 pin Molex Connector)

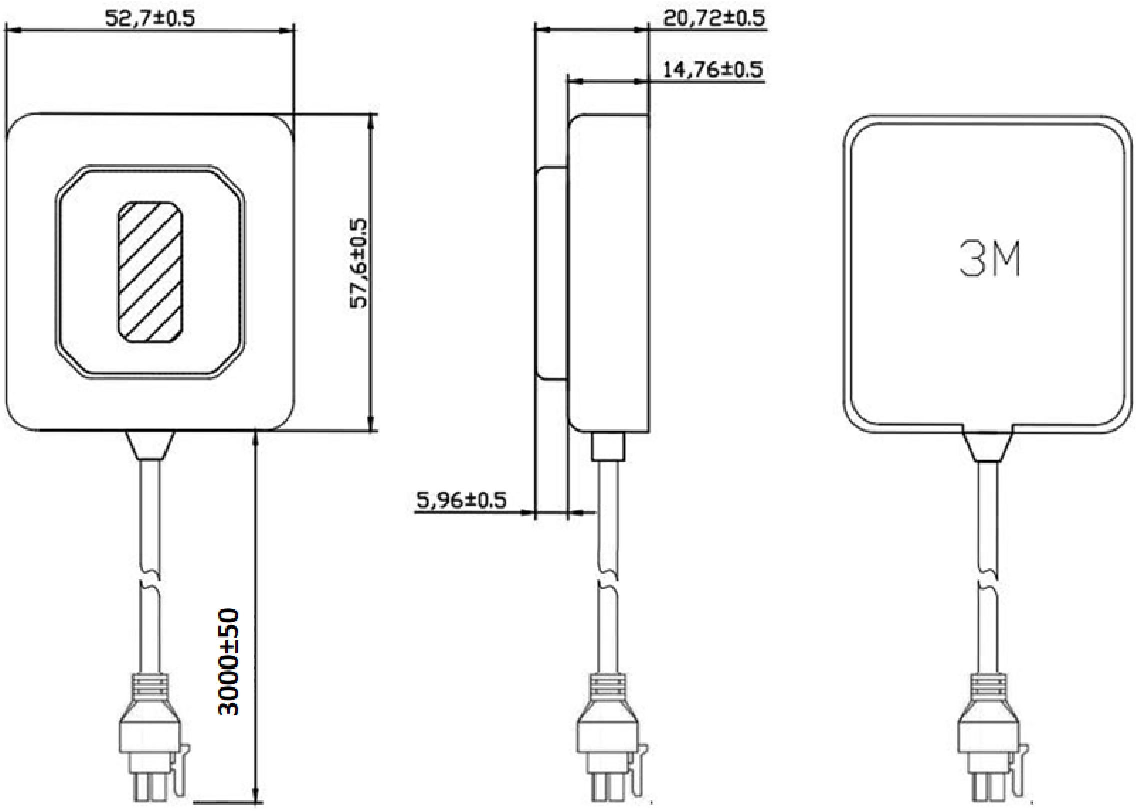

Figure1-5： Mechanical Dimensions (Unit： mm)

2.2.2 Pin Definition

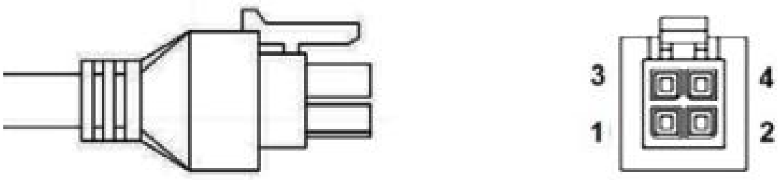

Figure1-6：Pin Assignment

Table: Pin Description

Pin NO.	Pin Name	I/O	Description	Remark
1	RX	I	RS232 Serial Data Input	
2	GND	G	Ground	
3	TX	O	RS232 Serial Data Output	
4	VCC	I	Module Power Supply	Voltage range: 3.0v~5.5V
LED	GPS Status		LED Off: G-Mouse is No Power LED On: Searching for GPS Signals LED Blinking: Position Fixed	

3. NMEA 0183 Protocol

The output protocol supports NMEA-0183 standard. The implemented messages include GGA, GLL, GSA, GSV, RMC, VTG, ZDA, and PAIRMSG messages. The NMEA message output has the following sentence structure:
$AACCC,c-c*hh
The detail of the sentence structure is explained in Table 1.

Table 1: The NMEA sentence structure

character	HEX	Description
"$"	24	Start of sentence.
Aaccc		Address field. "aa" is the talker identifier. "ccc" identifies the sentence type.
","	2C	Field delimiter.
C–c		Data sentence block.
"*"	2A	Checksum delimiter.
Hh		Checksum field.
<CR><LF>	0D0A	Ending of sentence. (carriage return, line feed)

Table 2: Overview of NMEA messages

$GNGGA	Time, position, and fix related data of the receiver.
$GNGLL	Position, time and fix status.
$GNGSA	Used to represent the ID of satellites which are used for position fix. When GPS&GLONASS&Galileo &BDS satellites are used for positioning solutions, the ID of available positioning satellites is counted and output with multiple statements.
$GPGSV **$GLGSV** **$GAGSV** **$GBGSV**	Satellite information about elevation, azimuth and CNR, satellites are used in position solution, a $GPGSV sentence is used for GPS satellites, a $GLGSVsentence is used for GLONASS satellites, a $GAGSV sentence is used for GALILEO satellites. And $BDGSV sentence is used for BDS satellites.
$GNRMC	Time, date, position, course and speed data.
$GNVTG	Course and speed relative to the ground.
$GNZDA	UTC, day, month and year and time zone.
$PAIRMSG	Inertial navigation status.

✧ **The formats of the supported NMEA messages are described as follows:**

$GNGGA,$GNGLL,$GNGSA,$GPGSV,$GLGSV,$GAGSV,$GBGSV,$GNRMC,$GNVTG,$GNZDA,$PAIRMSG

3.1 GGA – Global Positioning System Fix Data

Time, position and fix related data for a GNSS receiver.Structure:
$GNGGA,hhmmss.sss,ddmm.mmmm,a,dddmm.mmmm,a,x,xx,x.x,x.x,M,x.x,M,x.x,xxxx*hh
For example:
$GNGGA,175258.000,2447.0870,N,12100.5221,E,2,15,0.7,95.2,M,19.6,M,,0000*72

Field	Name	Example	Description
1	UTC Time	175258.000	UTC of position in hhmmss.sss format, (000000.000 ~ 235959.999)
2	Latitude	2447.08700	Latitude in ddmm.mmmmm format Leading zeros transmitted
3	N/S Indicator	N	Latitude hemisphere indicator, 'N' = North, 'S' = South
4	Longitude	12100.5221 0	Longitude in dddmm.mmmmm format Leading zeros transmitted
5	E/W Indicator	E	Longitude hemisphere indicator, 'E' = East, 'W' = West
6	Quality Indicator	2	Quality Indicator 0: position fix unavailable 1: valid position fix, SPS mode 2: valid position fix, differential GPS mode 3: GPS PPS Mode, fix valid 6: Estimated (dead reckoning) Mode
7	Satellites Used	15	Number of satellites in use, (00 ~ 56)
8	HDOP	0.7	Horizontal dilution of precision, (0.0 ~ 99.9)
9	Altitude	95.2	mean sea level (geoid), (-9999.9 ~ 17999.9)
10	Geoidal Separation	19.6	Geoidal separation in meters
11	Age of Differential GPS data		Age of Differential GPS data NULL when DGPS not used
12	DGPS Station ID	0000	Differential reference station ID, 0000 ~ 1023
13	Checksum	72	

3.2 GLL – Latitude/Longitude

Latitude and longitude of current position, time, and status.Structure:
$GNGLL,ddmm.mmmm,a,dddmm.mmmm,a,hhmmss.sss,A,a*hh
For example:
$GNGLL,2447.0870,N,12100.5221,E,175258.000,A,D*42

Field	Name	Example	Description
1	Latitude	2447.08700	Latitude in ddmm.mmmmm format Leading zeros transmitted
2	N/S Indicator	N	Latitude hemisphere indicator 'N' =North 'S' = South
3	Longitude	12100.52210	Longitude in dddmm.mmmmm formatLeading zeros transmitted
4	E/W Indicator	E	Longitude hemisphere indicator 'E' =East 'W' = West
5	UTC Time	175258.000	UTC time in hhmmss.sss format (000000.000 ~ 235959.999)
6	Status	A	Status, 'A' = Data valid, 'V' = Data not valid
7	Mode Indicator	D	Mode indicator 'N' = Data not valid 'A' = Autonomous mode 'D' = Differential mode 'E' = Estimated (dead reckoning) mode
8	Checksum	42	

3.3 GSA – GNSS DOP and Active Satellites

GNSS receiver operating mode, satellites used in the navigation solution reported by the GGA sentence and DOP values.
Structure:
$GNGSA,A,x,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,x.x,x.x,x.x,x*hh

example:

$GNGSA,A,3,21, 12,15,18,20,24,10,32,25,13,,,1.2,0.7,1.0,1*18

Field	Name	Example	Description
1	Mode	A	Mode 'M' = Manual, forced to operate in 2D or 3D mode 'A' = Automatic, allowed to automatically switch 2D/3D
2	Mode	3	Fix type 1 = Fix not available 2 = 2D 3 = 3D
3	Satellite used 1~12	21, 12, 15, 18, 20, 24, 10, 32, 25, 13	01 ~ 32 are for GPS; 33 ~ 64 are for WAAS (PRN minus 87); 193 ~ 197 are for QZSS; 65 ~ 88 are for GLONASS (GL PRN) ; 01 ~ 36 are for GALILEO (GA PRN); 01 ~ 37 are for BDS (BD PRN). GPS, GLONASS, GALILEO and BDS satellites are differentiated by the GNSS system ID in table 3. Maximally 12 satellites are included in each GSA sentence
4	PDOP	1.2	Position dilution of precision (0.0 to 99.9)
5	HDOP	0.7	Horizontal dilution of precision (0.0 to 99.9)
6	VDOP	1.0	Vertical dilution of precision (0.0 to 99.9)
7	GNSS System ID	1	1 for GPS, 2 for GLONASS, 3 for GALILEO, 4 for BDS
8	Checksum	18	

3.4 GSV – GNSS Satellites in View

Number of satellites (SV) in view, satellite ID numbers, elevation, azimuth, and SNR value.
Four satellites maximum per transmission.
Structure:

$GPGSV,x,x,xx,xx,xx,xx,xx,...,xx,xx,xx,xx,xx,x*hh

For example： $GPGSV,4,1,13,02,72,109,43,24,69,035,48,18,52,330,42,21,49,246,43,1*69

Field	Name	Example	Description
1	Number of message	4	Total number of GSV messages to be transmitted (1-5)
2	Sequence number	1	Sequence number of current GSV message
3	Satellites in view	13	Total number of satellites in view (00 ~ 20)
4	Satellite ID	02	01 ~ 32 are for GPS; 33 ~ 64 are for WAAS (PRN minus 87); 193 ~ 197 are for QZSS; 65 ~ 88 are for GLONASS (GL PRN) ; 01 ~ 36 are for GALILEO (GA PRN); 01 ~ 37 are for BDS (BD PRN). GPS, GLONASS, GALILEO and BDS satellites are differentiated by the GNSS system ID in table 3. Maximally 12 satellites are included in each GSA sentence
5	Elevation	72	Satellite elevation in degrees, (00 ~ 90)
6	Azimuth	109	Satellite azimuth angle in degrees, (000 ~ 359)
7	SNR	43	C/No in dB (00 ~ 99) Null when not tracking
8	Signal ID	1	1 for L1/CA, 4 for L5/CA
9	Checksum	69	

3.5 RMC – Recommended Minimum Specific GNSS Data

Time, date, position, course and speed data provided by a GNSS navigation receiver.Structure:

$GNRMC,hhmmss.sss,A,dddmm.mmmm,a,dddmm.mmmm,a,x.x,x.x,ddmmyy,,,a*hh

For example: $GNRMC,175258.000,A,2447.0870,N,12100.5220,E,000.0,000.0,220617,,,D*75

Field	Name	Example	Description
1	UTC time	175258.000	UTC time in hhmmss.sss format (000000.00 ~ 235959.999)
2	Status	A	Status 'V' = Navigation receiver warning'A' = Data Valid
3	Latitude	2447.08700	Latitude in dddmm.mmmmm formatLeading zeros transmitted
4	N/S indicator	N	Latitude hemisphere indicator 'N' =North 'S' = South
5	Longitude	12100.52210	Longitude in dddmm.mmmmm format Leading zeros transmitted
6	E/W Indicator	E	Longitude hemisphere indicator 'E' = East 'W' = West
7	Speed over ground	000.0	Speed over ground in knots (000.0 ~ 999.9)
8	Course over ground	000.0	Course over ground in degrees (000.0 ~ 359.9)
9	UTC Date	220617	UTC date of position fix, ddmmyy format
10	Mode indicator	D	Mode indicator 'N' = Data not valid 'A' = Autonomous mode 'D' = Differential mode 'E' = Estimated (dead reckoning) mode
11	checksum	75	

3.6 VTG – Course Over Ground and Ground Speed

The actual course and speed relative to the ground.Structure:

GNVTG,x.x,T,,M,x.x,N,x.x,K,a*hh

For example: $GNVTG,000.0,T,,M,000.0,N,000.0,K,D*16

Field	Name	Example	Description
1	Course	000.0	True course over ground in degrees (000.0 ~ 359.9)
2	Speed	000.0	Speed over ground in knots (000.0 ~ 999.9)
3	Speed	000.0	Speed over ground in kilometers per hour (000.0 ~ 1800.0)
4	Mode	D	Mode indicator 'N' = Data not valid 'A' = Autonomous mode 'D' = Differential mode 'E' = Estimated (dead reckoning) mode
5	Checksum	16	

3.7 ZDA – TIME AND DATE

UTC, day, month, year and local time zone
Structure:

$GNZDA,hhmmss.sss,xx,xx,xxxx,xx,xx*hh<CR><LF>

For example: $GNZDA,175258.000,22,06,2017,00,00*46<CR><LF>

Field	Name	Example	Descripti on
1	UTC time	175258.000	UTC time in hhmmss.ss format (000000.00 ~ 235959.99)
2	UTC Day	22	UTC time: day (01 ~ 31)
3	UTC Month	06	UTC time: month (01 ~ 12)
4	UTC Year	2017	UTC time: year (4 digit format)
5	Local zone hour	00	Local zone hours (00 ~ +/-13)
6	Local zone minutes	00	Local zone minutes (00 ~59)
7	Checksum	46	Checksum

3.8 $PAIRMSG – Inertial navigation status.

Inertial navigation status.
$PAIRMSG,90
For Example ： $PAIRMSG,90,072520.000,3*59
Statu 1： UTC
Statu 2： DR STAGE (Refer to table A)

Table A

Field	Name	Example	Descr iption
1	UTC	072520.000	UTC time
2	DR stage	3	DR_SOLUTION_UNKNOWN = 0 DR_SOLUTION_INIT = 1 DR_SOLUTION_COARSE = 2 DR_SOLUTION_STABLE = 3
3	Checksum	59	Checksum

$PAIRMSG,91
For Example ： $PAIRMSG,91,072520.000,1,0*46
Statu 1： UTC
Statu 2： Dynamic status (Refer to table B)
Statu 3： Alarm status (Refer to table C)

Table B

Field	Name	Example	Description
1	UTC	072520.000	UTC time
2	Dynamic status	1	UNKNOWN = 0 STATIC = 0x01 DYNAMIC = 0x02

Table C

Field	Name	Example	Description	Vehicle status alarm
3	Alarm status	0	UNKNOWN = 0	0: UNKNOWN
			HARSH_ACCELERATION = 0x01 (1)	1: Harsh acceleration Straight harsh acceleration > 2.5m/s²
			HARSH_DECELERATION = 0x02 (2)	2: Harsh deceleration Straight harsh deceleration < -4.5m/s²
			HARSH_TURN = 0x04 (4)	4: Harsh turn Lateral turning acceleration > 4m/s²Heading angle > 45°
			HARSH_LANE_CHANGE = 0x08 (8)	8: Harsh line change Lateral turning deceleration > 4m/s²Heading angle < 20°
			HORIZONTAL_COLLISION = 0x10 (16)	16: Horizontal collision Straight harsh acceleration > 20m/s²pitch angle < 20° Flip angle< 20°
			ROLLOVER = 0x20 (32)	32: Rollover Pitch angle >70°Flip angle>70°
			STABILITY_WARNING = 0x40 (64)	64: Stability warning The vehicle continuously changes heading Angle at a speed greater than50°/ s for a period of more than 3 seconds.
			EULER_ANOMALY = 0x80 (128)	125: Euler_anomaly The pitch Angle and dump Angle of thevehicle, the larger value is greater than 20° and less than 70°.
4	Checksum	46	Checksum	

4. Appendix References

Terms and Abbreviations

Abbreviation	Description
AGNSS	Assisted GNSS
AIC	Active Interference Cancellation
CEP	Circular Error Probable
DGPS	Differential GPS
EASY	Embedded Assist System
EGNOS	European Geostationary Navigation Overlay Service
EPO	Extended Prediction Orbit
ESD	Electrostatic Discharge
GPS	Global Positioning System
GNSS	Global Navigation Satellite System
GGA	GNSS Fix Data
GLL	Geographic Position – Latitude/Longitude
GLONASS	Global Navigation Satellite System
GSA	GNSS DOP and Active Satellites
GSV	GNSS Satellites in View
HDOP	Horizontal Dilution of Precision
I/O	Input / Output
Kbps	Kilo Bits Per Second
LNA	Low Noise Amplifier
MSAS	Multi-Functional Satellite Augmentation System
MOQ	Minimum Order Quantity
NMEA	National Marine Electronics Association
PDOP	Position Dilution of Precision
PMTK	MTK Proprietary Protocol
PPS	Pulse Per Second
PRN	Pseudo Random Noise Code
QZSS	Quasi-Zenith Satellite System
RHCP	Right Hand Circular Polarization
RMC	Recommended Minimum Specific GNSS Data
SBAS	Satellite-based Augmentation System
SAW	Surface Acoustic Wave
SPDT	Single-Pole Double-Throw
TTFF	Time To First Fix
UART	Universal Asynchronous Receiver & Transmitter
VDOP	Vertical Dilution of Precision
VTG	Course over Ground and Ground Speed, Horizontal Course and Horizontal Velocity
WAAS	Wide Area Augmentation System
Inom	Nominal Current
Imax	Maximum Load Current
Vmax	Maximum Voltage Value
Vnom	Nominal Voltage Value

Vmin	Minimum Voltage Value
VIHmax	Maximum Input High Level Voltage Value
VIHmin	Minimum Input High Level Voltage Value
VILmax	Maximum Input Low Level Voltage Value
VILmin	Minimum Input Low Level Voltage Value
VImax	Absolute Maximum Input Voltage Value
VImin	Absolute Minimum Input Voltage Value
VOHmax	Maximum Output High Level Voltage Value
VOHmin	Minimum Output High Level Voltage Value
VOLmax	Maximum Output Low Level Voltage Value
VOLmin	Minimum Output Low Level Voltage Value