

**Ultra Low Power Sub-1 Meter L1+L5 GNSS Module**  
**MR51009EBGGBL5**

## Revision History

Date	Reversion	Description
2021/12/27	1.0	First Draft, Based on MR51009EBGGBL5

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## 1. Product Information

### 1.1 Product Description

The MR51009EBGGBL5 module supports dual frequency and multi-mode. It has built-in highly integrated GNSS receiver chip, supporting multi band and multi system Cortex®-M4F. It is capable of tracking all global civil navigation systems (BeiDou, GPS, GLONASS, Galileo, QZSS and SBAS) in all bands. Besides, concurrent reception of L1 and L5 band signals mitigates the multipath delay and achieves sub-meter position accuracy.

The MR51009EBGGBL5 module offers superior sensitivity and outstanding performance, achieving rapid TTFF with an accuracy of approximately one meter and tracking sensitivity of -165dBm, which allows continuous position coverage in nearly all outdoor application environments.

### Applications

- Automotive Navigation
- Personal Positioning
- Fleet Management
- Mobile Phone Navigation
- Marine Navigation
- Wearable and Portable

### 1.2 Product Features

- Sub-1 Meter Position Accuracy
- Ultra-Low Power Consumption: 7 ~ 15mA typ.
- Integrated 12 Multi-Tone Active Interference Cancellers
- Ultra High Track Sensitivity: -165dBm
- Concurrent Reception of L1 and L5 Band Signals
- Supports all Civil GNSS Signals
- RTCM ready (RTCM v2.3 and v3.3)
- Extremely Fast TTFF at Low Signal Level (Cold start  $\leq 24s$ , Hot start  $\leq 1s$ )
- Multipath Detection and Suppression
- Works With Passive and Active Antenna
- NMEA-0183 Compliant Protocol or Custom Protocol
- RoHS Compliant

## 1.3 Product Specifications

GPS Receiver		
Chip	MediaTek	
GNSS Reception	GPS/QZSS	L1 C/A, L5
	BeiDou	B1, B2
	GLONASS	L1
	Galileo	E1, E5a
	SBAS	WAAS, EGNOS, MSAS, GAGAN
Update Rate	GNSS	10Hz Max.
Position Accuracy	GNSS	<1m CEP
	SBAS	<1m CEP
	D-GNSS	<50cm CEP
Velocity & Time Accuracy	GNSS	0.01m/s CEP
	SBAS	0.05 m/s
	D-GNSS	0.05 m/s
	1PPS	25 ns
Accuracy Time	Hot start	1 sec
	Cold start	24 sec
Sensitivity	Cold start	-148dBm
	Hot start	-155dBm
	Tracking	-165dBm
	Reacquisition	-158dBm
GNSS Operating limit	Velocity	515m/s
	Altitude	18,000m
Protocol Support	UART Port: TXD and RXD 115200bps (default), Supports baud rate 9600bps to 921600bps NMEA 0183 Protocol	
Environment	Operation temperature	-40°C ~ +85°C
	Storage temperature	-55°C ~ +100°C
Physical Characteristics	Size	10.1±0.15(L) × 9.7±0.15(W) × 2.2±0.1(H)mm
	Weight	Approx. 0.39g

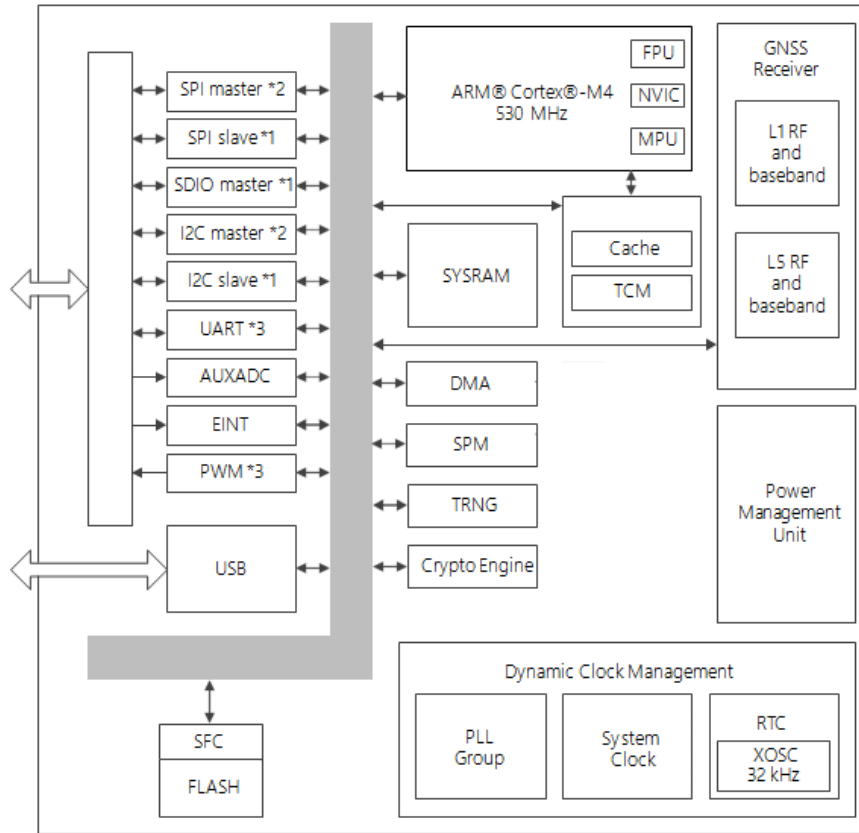
## 1.4 DC Electrical Characteristics

Parameter		Min.	Typ.	Max.	Units
Input Voltage		2.8	3.3	3.6	Volt
Input Pin Voltage		-0.5		+0.5	Volt
Input Power at RF_IN				+20	dBm
Power Supply Current <sup>1</sup>					
Acquisition	GPS L1		5.6		mA
	GPS L1 + GL + GA + BD		7.5		mA
	GPS L1+L5 + GL + GA + BD		12.7		mA
Tracking	GPS L1		5.5		mA
	GPS L1 + GL + GA + BD		7		mA
	GPS L1+L5 + GL + GA + BD		13.3		mA
UART Port Working Voltage					
Low Level Output Voltage (VOL)				0.4	Volt
High Level Output Voltage (VOH)		2.4			Volt
Low Level Input Voltage (VIL)				0.8	Volt
High Level Input Voltage (VIH)		2.1			Volt
Low Level Output Current (IOL)		100			uA
High Level Output Current (IOH)		-100			uA

Notes:

1. Typical values exclude active antenna current

## 2. Block Diagram



## 3. Module Pin Assignment

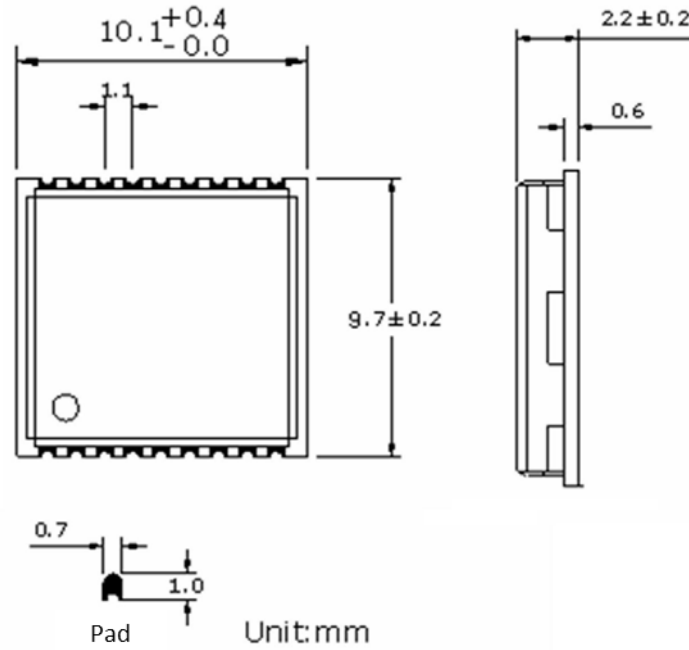
<b>10</b>	GND		RESET_N	<b>9</b>
<b>11</b>	RF_IN	<b>MR51009EBGGBL5</b>	VCC	<b>8</b>
<b>12</b>	GND	Top View	Reserved	<b>7</b>
<b>13</b>	Reserved		NC	<b>6</b>
<b>14</b>	VCC_RF		EXTINT	<b>5</b>
<b>15</b>	Reserved		PPS	<b>4</b>
<b>16</b>	SDA		RXD	<b>3</b>
<b>17</b>	SCL		TXD	<b>2</b>
<b>18</b>	RTC_EINT		GND	<b>1</b>

## 3.1 Pin Descriptions

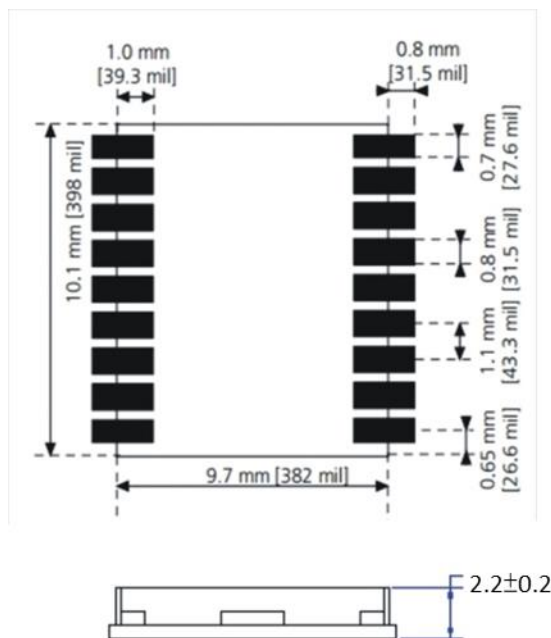
Pin NO.	Pin Name	Remark
1	GND	Ground
2	TXD	UART serial data output
3	RXD	UART serial data input
4	PPS	Time pulse (1PPS) (if not used, must be left floating)
5	EXTINT	External Interrupt Pin
6	NC	No connection
7	Reserved	No connection
8	VCC	Main power supply, 3.3V Typical
9	RESET_N	Leave it Open if not used
10	GND	Ground
11	RF_IN	RF signal input
12	GND	Ground
13	Reserved	No connection
14	VCC_RF	Output power supply for external LNA or active antenna
15	Reserved	No connection
16	SDA	I2C SDA Pin
17	SCL	I2C SCL Pin
18	RTC_EINT	RTC external interrupt, can using RTC_EINT Function to exit RTC Mode, when RTC_EINT pull high 1ms that IC will exit RTC mode.



## 4. Dimensions

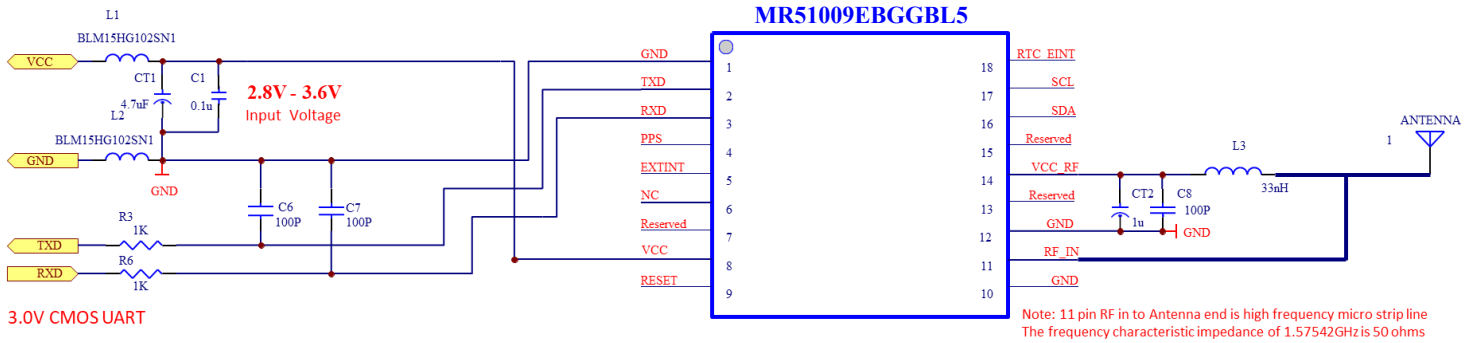


## 5. Recommended Footprint



## 6. Application Circuit

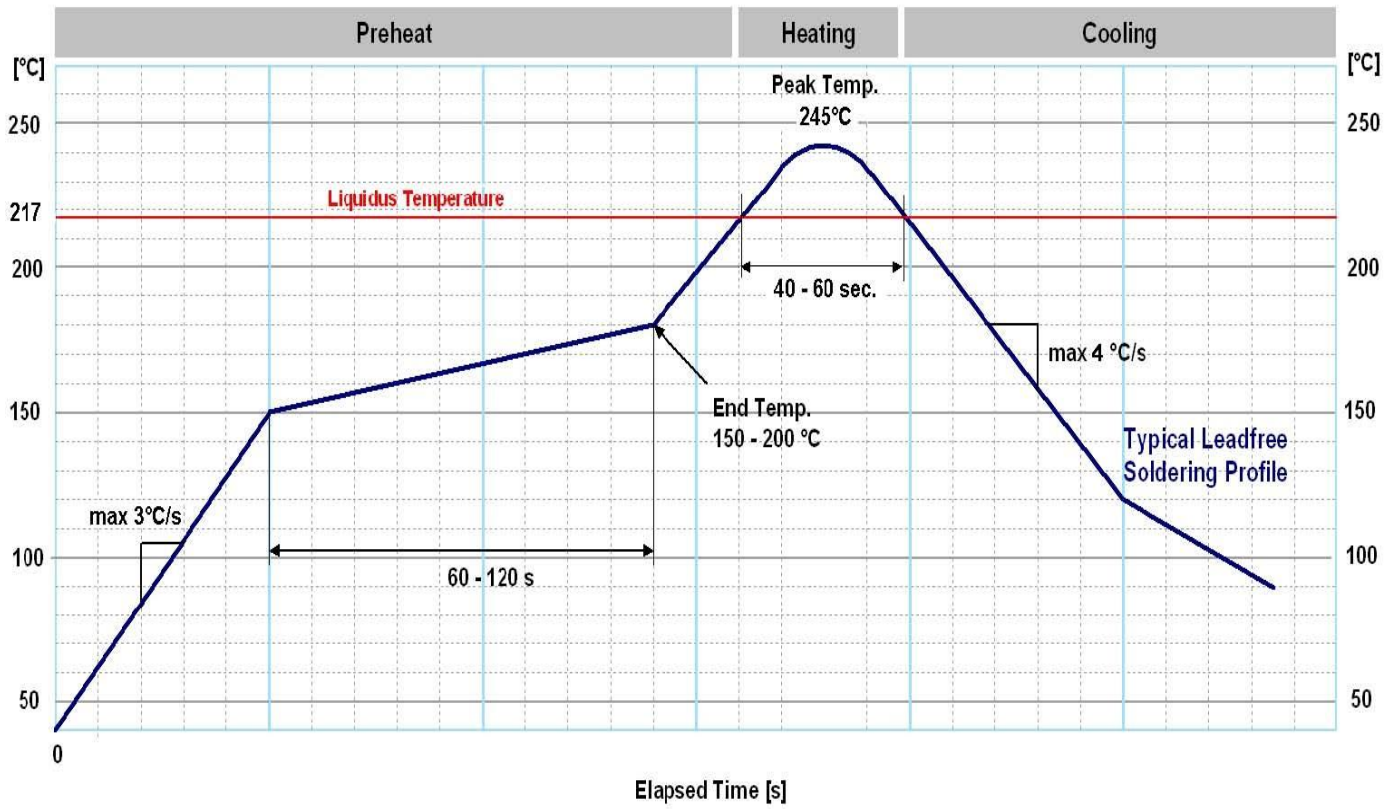
### 6.1 Application Circuit of MR51009EBGGBL5



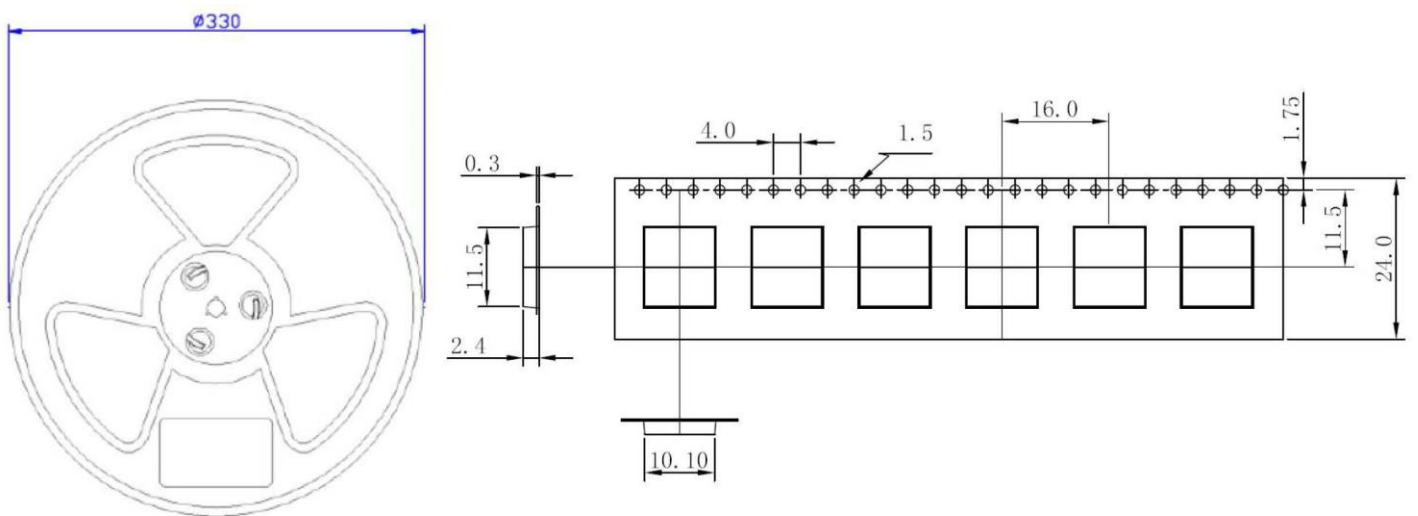
### 6.2 Layout Notes

1. A decoupling capacitor should be placed close to VDD pin of the module, and the width of power routing should be more than 0.5mm.
2. The characteristic impedance of RF routing between RF port to antenna should be controlled to 50  $\Omega$ .
3. Do not place the module close to any EMI source, RF routing, clock signal or other high-frequency switching signal, etc.

## 7. Reflow Profile



## 8. Tape & Reel



Unit : mm

## 9. Software Interface

NMEA	Description
\$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 \$BDGSV	Satellite information about elevation, azimuth and CNR, satellites are used in position solution. \$GPGSV sentence is used for GPS satellites \$GLGSV sentence is used for GLONASS satellites \$GAGSV sentence is used for GALILEO satellites \$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.

## 10. Protocol

### 10.1 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	12100.52210	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 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	

## 10.2 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 format Leading 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	

## 10.3 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,x.x,x.x,x.x,x\*hh

For example:

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

\$GNGSA,A,3,03,04,05,07,,,,,,,,,1.2,0.7,1.0,4\*34

\$GNGSA,A,3,76,86,71,72,65,85,87,77,,,,,1.0,0.5,0.9,2\*32

\$GNGSA,A,3,76,44,13,15,66,23,45,28,,,,,1.0,0.5,0.9,2\*32

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	

## 10.4 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

\$GPGSV , 4,2 , 13 , 20,47 , 118 , 42,15 , 39,046 , 44,41 , 39,242 , 41,12 , 28,129 , 42 , 1\*68

\$GBGSV , 4,3 , 13 , 10,25 , 321 , 38,25 , 15,170 , 35,32 , 14,278 , 36,136 , 063 , 35 , 1\*64

\$GBGSV , 4,4 , 13 , 05,04 , 126 , 36 , 1\*57

\$GBGSV , 2,1 , 07 , 67,63 , 158 , 46,05 , 61,202 , 44,04 , 57,199 , 44,03 , 39,243 , 42,4\*7f

\$GAGSV , 2,2 , 07 , 01 , 00,000 , 39,02 , 00,000 , 24,06 , 00,266 , 4\*44

\$GAGSV , 3,1 , 09 , 72,60 , 135,48 , 71,40 , 047 , 50,86 , 37,048 , 50,87 , 30,336 , 49 , 1\*7b

\$GLGSV , 3,2 , 09 , 65,24 , 184,477 , 23,278 , 43,76 , 16,218 , 44,85 , 05,095 , 40 , 1\*7e

\$GLGSV , 3,3 , 09 , 78,00 , 000 , 31,1\*4c

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	



## 10.5 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 format Leading 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	

## 10.6 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	

## 10.7 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	Units	Description
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