

## **KNCTEK GPS Smart Antenna Module SBS-1533 Specification**

Version 2.1  
2016/01/15

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**SBS-1533 Specification**

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## **Revision History**

1. 2011-05-04 : Initiated Version 1.0
2. 2011-10-04 : Updated Version 1.1 for specific Update of Navigation Data Update Rate Specification on page 7.
3. 2013-11-05 : Updated Version 2.0 Due to Main Chip change from Venus 6 version to Venus 8 version.
4. 2016-01-15 : Updated Version 2.1 for Specification renewal.

# SBS-1533 Operational Manual

## INTRODUCTION

The **SBS-1533** is the newest generation of KNCTEK GPS Smart Antenna Receiver which was integrated with GPS function and Patch antenna into one module. The GPS Smart Antenna receiver is powered by SkyTraq technology and KNCTEK proprietary navigation algorithm that providing you more stable navigation data. The miniature design is the best choice to be embedded in a portable device various Trackers, various Vehicle & personal Locaters & Trackers and etc. The excellent sensitivity of **SBS-1533** gets the great performance when going though the urban canyon and foliage environmental condition.

## PRODUCT FEATURES

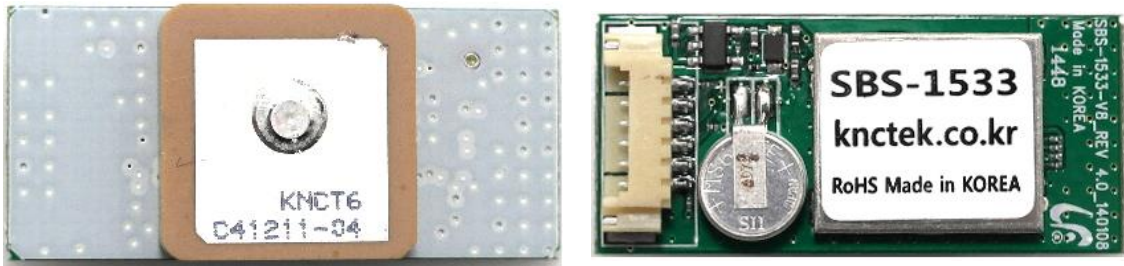
- ✧ GPS L1 C/A Code
- ✧ Total 167 channels: 137 Channels for Acquisition, 30 Channels for Tracking
- ✧ Operable from 3.3V/Typ 48mA for Acquisition and 31mA for Tracking Mode
- ✧ A-GPS and QZSS, SBAS(WAAS, EGNOS, GAGAN) supported
- ✧ Perform 16million time-frequency hypothesis testing per second
- ✧ Signal Detection better than -165dBm in Ultra High Tracking Sensitivity
- ✧ Enhanced Warm/Hot Acquisition Sensitivity at -157dBm
- ✧ Fast TTFF <25 seconds in Warm start and 29 seconds for Cold start
- ✧ Multipath detection and suppression
- ✧ Jamming detection and mitigation
- ✧ Excellent Sensitive for Urban Canyon and Foliage Environmental condition
- ✧ NMEA-0183 compliant protocol
- ✧ Automotive-grade Quality GPS solution
- ✧ Small form factor\_15X33X7.3mm( without Antenna feed height : 0.8max)
- ✧ ODM/OEM development is fully supported Application Engineering
- ✧ RoHS compliant

## PRODUCT APPLICATION

- ✧ Automotive applications
- ✧ Speed camera detector
- ✧ Personal and Car navigation

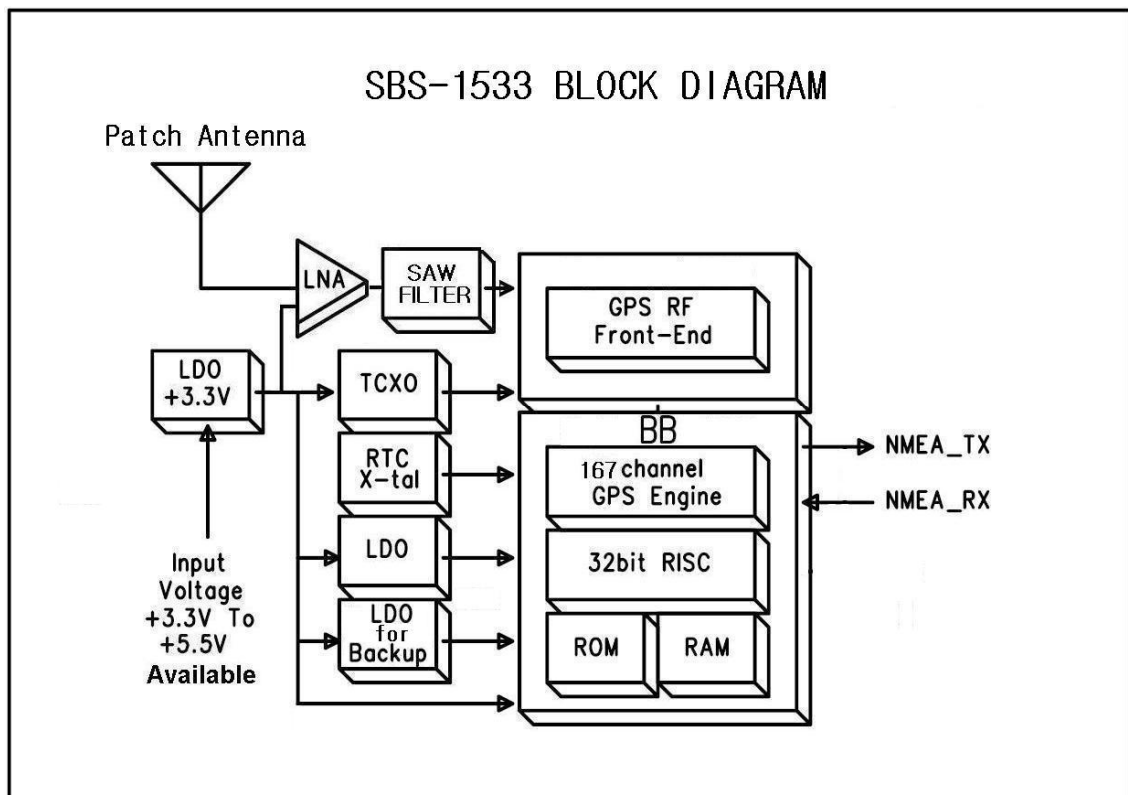
- ✧ Marine navigation
- ✧ Timing application and the others

**PRODUCT PICTURE**



**SBS-1533 SYSTEM BLOCK DIAGRAM**

The SBS-1533 consists of SkyTraq chipsets Technology, KNCTEK LNA and proprietary software. The system is described as follows.



**TECHNICAL SPECIFICATION**
**1. Electrical Characteristics**
**1.1 Absolute Maximum Rating**

| Parameter   | Symbol | Min  | Max | Units |
|---|--------|------|-----|-------|
| <b>Power Supply</b>                               |        |      |     |       |
| Power Supply Volt.                                | VCC    | -0.3 | 6   | V     |
| <b>Input Pins</b>                                 |        |      |     |       |
| Input Pin Voltage I/O                             | RX     | -0.3 | 3.6 | V     |
| Backup Battery                                    | Vbat   | 1.8  | 3.6 | V     |
| <b>Environment</b>                                |        |      |     |       |
| Operating Temperature                             | Topr   | -30  | 85  | °C    |
| Storage Temperature                               | Tstg   | -40  | 85  | °C    |
| Backup Battery operating temperature <sup>1</sup> | Tbat   | -20  | 65  | °C    |
| Humidity  |        |      | 95  | %     |

\*\* <sup>1</sup> Backup Battery operating temperature depends on Battery characteristics

Note : Absolute maximum ratings are stress ratings only, and functional operation at the maximums is not guaranteed. Stress beyond the limits specified in this table may affect device reliability or cause permanent damage to the device.

For functional operating conditions, please refer to the operating conditions tables as follow.

**1.2 Operating Condition**

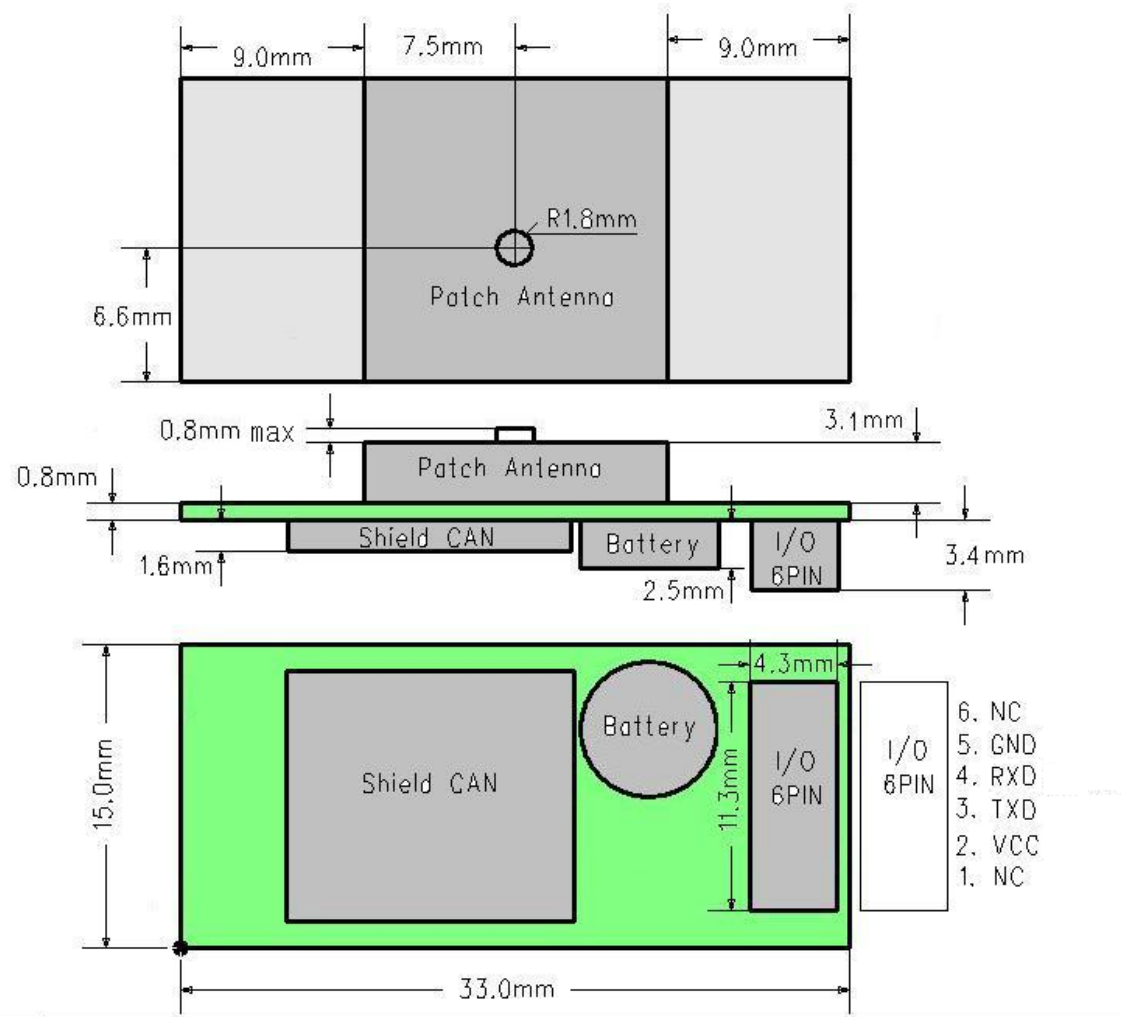
| Parameter                   | Symbol          | Condition  | Min | Typ | Max | Units |
|-----------------------------|-----------------|------------|-----|-----|-----|-------|
| Power supply voltage        | Vcc             |            | 3.3 | 5.0 | 5.5 | V     |
| Power Supply voltage ripple | Vcc_PP          | Vcc = 5.0V |     |     | 30  | mV    |
| Acquisition current         | IccA            | Vcc = 3.3V |     | 48  |     | mA    |
| Tracking current            | IccT            | Vcc = 3.3V |     | 31  |     | mA    |
| Input high voltage          | V <sub>IH</sub> |            | 2.0 |     |     | V     |
| Input low voltage           | V <sub>IL</sub> |            |     |     | 0.8 | V     |
| Output high voltage         | V <sub>OH</sub> |            | 2.9 |     |     | V     |
| Output low voltage          | V <sub>OL</sub> |            |     |     | 0.4 | V     |

**2. General & Performance Specification**

| Parameter                   | Specification  |
|-----------------------------|--|
| Receiver Type               | L1 frequency band C/A code, 137 Channel Acquisition, 30 Channel Tracking   |
| Sensitivity                 | Tracking -165dBm<br>Re-acquisition -157dBm<br>Cold start -148dBm   |
| Accuracy                    | Position 2.5m CEP<br>Velocity 0.1m/s<br>Timing(PPS) 10ns RMS   |
| Acquisition Time            | Cold Start 29 sec. typical (Open sky <sup>1</sup> )<br>Warm Start 28 sec. typical (Open sky)<br>Hot Start 1 sec. typical (Open sky)<br>Reacquisition Time 1 sec(Open sky, re-appear after some seconds)<br>A-GPS Support 4 sec average |
| Power Consumption           | Tracking 31mA @ 3.3V<br>Acquisition 48mA<br>Back-up 9uA @ 3V   |
| Navigation Data Update Rate | 1Hz_Default<br>In case of using Binary input : Max 40Hz<br>** Please refer to the Binary Input Message   |
| Operational Limits          | Velocity Max 515 m/s<br>Altitude Max 18,000m<br>Acceleration Less than 4g( 39.2m/sec <sup>2</sup> )  |
| Mechanical data             | Dimension 15X33X7.3mm +/- 0.3mm( without Antenna feed height : 0.8max)<br>Weight 5.8grams ±5%  |
| Protocol                    | NMEA-0183 V3.01<br>GPGGA 1Hz<br>GPGLL 1Hz<br>GPGSA 1Hz<br>GPGSV 1/3Hz( one time per 3sec)<br>GPRMC 1Hz<br>GPVTG 1Hz<br>GPZDA 1Hz   |

\*\* <sup>1</sup>Open Sky means no obstructions in the sky

MECHANICAL LAYOUT





**HARDWARE INTERFACE**
**Pin Description**

| PIN | SIGNAL NAME | I/O | DESCRIPTION                   | CHARACTER                |
|-----|-------------|-----|-------------------------------|--------------------------|
| 1   | NC          | -   | Do not use (NC)               |                          |
| 2   | VCC         | P   | DC Power Supply Voltage input | DC 3.3V to 5V $\pm$ 10%  |
| 3   | TXD         | O   | NMEA TXD                      | 3.3V LVTTTL              |
| 4   | RXD         | I   | NMEA RXD                      | 3.3V LVTTTL              |
| 5   | GND         | P   | Digital Reference Ground      | Digital Reference Ground |
| 6   | NC          | -   | Do not use (NC)               |                          |

**VCC DC Power Input**

This is the main power supply for the Engine board. The power range is **DC +5V  $\pm$ 10%** ( 3.3V to 5.5V Acceptable ). Suitable decoupling must be provided by external decoupling circuitry.

**GND**

GND provides the ground for the Engine board. Connect all grounds.

**TXD**

NMEA\_TX, UART output, 3.3V LVTTTL logic level. This is the main transmit channel and is used to output navigation and measurement data to user written software. The default setup is NMEA Output, 9600bps, 8 data bits, no parity, 1 stop bit. The default sentences are GPGGA, GPGLL, GPGSA, GPGSV, GPRMC, GPVTG, GPZDA.

GPGGA, GPGLL, GPGSA, GPRMC, GPVTG, GPZDA are once per second and GPGSV is once per 3 second.

**RXD**

NMEA\_RX, UART input, 3.3V LVTTTL logic level. This is the main receiving channel and is used to receive software commands to the Engine board from user written software.

**Note. As for SkyTraq Binary Input Message with ROM version, user should be reload the Binary Input Message whenever GPS power is off because ROM version could not reserve any of user Binary Input Message once GPS power is off.**

**Packing Information**

- 1. Tray Packing**  
TBD : To be determined
  
- 2. Inner Box Packing**  
TBD : To be determined

### GPS Receiver User's Tip

1. GPS signal will be affected by weather and environment conditions, thus suggest to use the GPS receiver under less shielding environments to ensure GPS receiver has better receiving performance.
2. When GPS receiver is moving, it will prolong the time to fix the position, so suggest to wait for the satellite signals to be locked at a fixed point when first power-on the GPS receiver to ensure to lock the GPS signal at the shortest time.
3. The following situation will affect the GPS receiving performance:
  - a. Solar control filmed windows.
  - b. Metal shielded, such as umbrella, or in vehicle.
  - c. Among high buildings.
  - d. Under bridges or tunnels.
  - e. Under high voltage cables or near by radio wave sources, such as mobile phone base stations.
  - f. Bad or heavy cloudy weather.
4. If the satellite signals can not be locked or encounter receiving problem (while in the urban area), the following steps are suggested:
  - a. Move to another open space or reposition GPS receiver toward the direction with fewer blockages.
  - b. Move the GPS receiver away from the interference resources.
  - c. Wait until the weather condition is improved.

While a GPS with a backup battery, the GPS receiver can fix a position immediately at next power-on if the build-in backup battery is full-recharged.

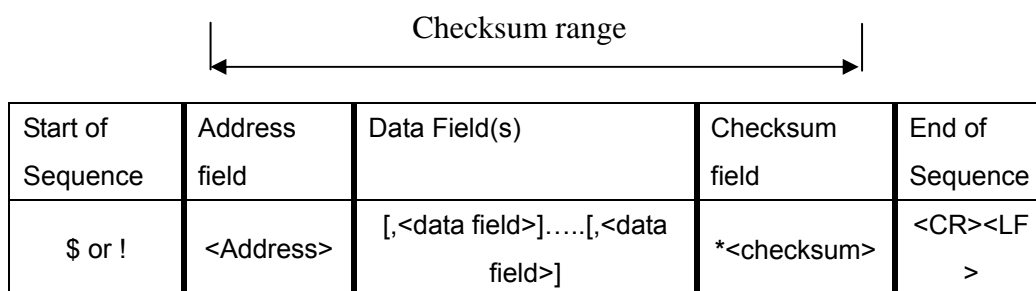
## Introduction for NMEA

The SkyTraq NMEA 0183 protocol is designed based on NMEA(National Marine Electronics Association) 0183 Standard which is a standard protocol for interfacing navigational devices, e.g. GPS and DGPS receivers over serial interface. The SkyTraq NMEA 0183 protocol is fully compliant with “NMEA 0183 Standard for Interfacing Marine Electronic Devices, Version 3.0.1”. The standard may be obtained from NMEA at <http://www.nmea.org>.

## NMEA Protocol Overview

### Message Format

The structure of a NMEA message is shown below.



### Start of Sequence

All sentences begin with the sentence start delimiter character “\$” or “!”.

### Address Field

The address Field is served to define the sentence. Characters with digits and upper case letters are permitted to be in the address field. It can not be a null field. This field is subdivided into 2 fields.

|                   |                    |
|-------------------|--------------------|
| <XX>              | <XXX>              |
| Talker Identifier | Sentence Formatter |

Talker Identifier is always **GP** for a GPS receiver. The sentence formatter defines the format and the type of data.

### Data Field(s)

Data Fields are delimited by a “,” and contain valid characters specified in NMEA 0183 standard. It can be variable length fields.

### Checksum

Checksum field is the 8-bit exclusive OR (no start or stop bits) of all characters in the sentence. Checksum consists of 2 characters and is represented as a hex number.

### End of Sequence

All sentences always end with sentence termination delimiter <CR><LF>.

## SUPPORTED MESSAGE LIST

The following NMEA messages are supported.

| Sentence | Descriptions                              |
|----------|---|
| GGA      | Global Positioning System Fix Data        |
| GLL      | Geographic Position – Latitude/Longitude  |
| GSA      | GNSS DOP and Active Satellites            |
| GSV      | GNS Satellites in View                    |
| RMC      | Recommended Minimum Specific GNSS Data    |
| VTG      | Course Over Ground and Ground Speed       |
| ZDA      | UTC, Day, Month, Year and Local Time Zone |

### NMEA MESSAGES

The full descriptions of supported NMEA messages are provided at the following paragraphs.

#### **GGA - Global Positioning System Fix Data**

Time, position and fix related data for a GPS receiver.

Structure:

\$GPGGA,hhmmss.sss,ddmm.mmmm,a,dddmm.mmmm,a,x,xx,x.x,x.x,M,,,,,xxxx\*hh<CR><LF>

1            2            3            4            5 6 7 8 9            10 11

Example:

\$GPGGA,111636.932,2447.0949,N,12100.5223,E,1,11,0.8,118.2,M,,,,,0000\*02<CR><LF>

| Field | Name                  | Example    | Description  |
|-------|-----------------------|------------|--|
| 1     | UTC Time              | 111636.932 | UTC of position in hhmmss.sss format,<br>(000000.000 ~ 235959.999)   |
| 2     | Latitude              | 2447.0949  | Latitude in ddmm.mmmm format<br>Leading zeros transmitted  |
| 3     | N/S Indicator         | N          | Latitude hemisphere indicator, 'N' = North, 'S' = South  |
| 4     | Longitude             | 12100.5223 | Longitude in dddmm.mmmm format<br>Leading zeros transmitted  |
| 5     | E/W Indicator         | E          | Longitude hemisphere indicator, 'E' = East, 'W' = West   |
| 6     | GPS quality indicator | 1          | GPS quality indicator<br>0: position fix unavailable<br>1: valid position fix, SPS mode<br>2: valid position fix, differential GPS mode<br>3: GPS PPS Mode, fix valid<br>4: Real Time Kinematic. System used in RTK mode with fixed integers<br>5: Float RTK. Satellite system used in RTK mode. Floating integers<br>6: Estimated (dead reckoning) Mode<br>7: Manual Input Mode |

|    |                 |       |   |
|----|-----------------|-------|---|
|    |                 |       | 8: Simulator Mode   |
| 7  | Satellites Used | 11    | Number of satellites in use, (00 ~ 12)                                    |
| 8  | HDOP            | 0.8   | Horizontal dilution of precision, (00.0 ~ 99.9)                           |
| 9  | Altitude        | 108.2 | mean sea level (geoid), (-9999.9 ~ 17999.9)                               |
| 10 | DGPS Station ID | 0000  | Differential reference station ID, 0000 ~ 1023<br>NULL when DGPS not used |
| 11 | Checksum        | 02    |   |

**GLL – Latitude/Longitude**

Latitude and longitude of current position, time, and status.

Structure:

```
$GPGLL,ddmm.mmmm,a,dddmm.mmmm,a,hhmmss.sss,A,a*hh<CR><LF>
```

1        2        3        4        5    6 7 8

Example:

```
$GPGLL,2447.0944,N,12100.5213,E,112609.932,A,A*57<CR><LF>
```

| Field | Name           | Example    | Description  |
|-------|----------------|------------|--|
| 1     | Latitude       | 2447.0944  | Latitude in ddmm.mmmm format<br>Leading zeros transmitted  |
| 2     | N/S Indicator  | N          | Latitude hemisphere indicator<br>'N' = North<br>'S' = South  |
| 3     | Longitude      | 12100.5213 | Longitude in dddmm.mmmm format<br>Leading zeros transmitted  |
| 4     | E/W Indicator  | E          | Longitude hemisphere indicator<br>'E' = East<br>'W' = West   |
| 5     | UTC Time       | 112609.932 | UTC time in hhmmss.sss format (000000.000 ~ 235959.999)  |
| 6     | Status         | A          | Status, 'A' = Data valid, 'V' = Data not valid   |
| 7     | Mode Indicator | A          | Mode indicator<br>'N' = Data not valid<br>'A' = Autonomous mode<br>'D' = Differential mode<br>'E' = Estimated (dead reckoning) mode<br>'M' = Manual input mode<br>'S' = Simulator mode |
| 8     | Checksum       | 57         |  |



**GSA – GNSS DOP and Active Satellites**

GPS receiver operating mode, satellites used in the navigation solution reported by the GGA or GNS sentence and DOP values.

Structure:

```
$GPGSA,A,x,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,x.x,x.x,x.x*hh<CR><LF>
  1 2 3 3 3 3 3 3 3 3 3 3 3 3 4 5 6 7
```

Example:

```
$GPGSA,A,3,05,12,21,22,30,09,18,06,14,01,31,,1.2,0.8,0.9*36<CR><LF>
```

| Field | Name                | Example                            | Description  |
|-------|---------------------|------------------------------------|--|
| 1     | Mode                | A                                  | Mode<br>'M' = Manual, forced to operate in 2D or 3D mode<br>'A' = Automatic, allowed to automatically switch 2D/3D |
| 2     | Mode                | 3                                  | Fix type<br>1 = Fix not available<br>2 = 2D<br>3 = 3D  |
| 3     | Satellite used 1~16 | 05,12,21,22,30,09,18,06,14,01,31,, | Satellite ID number, 01 to 32, 193 to 197, of satellite used in solution, up to 16 transmitted                     |
| 4     | PDOP                | 1.2                                | Position dilution of precision (00.0 to 99.9)  |
| 5     | HDOP                | 0.8                                | Horizontal dilution of precision (00.0 to 99.9)  |
| 6     | VDOP                | 0.9                                | Vertical dilution of precision (00.0 to 99.9)  |
| 7     | Checksum            | 36                                 |  |

**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,xxx,xx,...,xx,xx,xxx,xx *hh<CR><LF>
    1 2 3 4 5 6 7 4 5 6 7 8
```

Example:

```
$GPGSV,4,1,16,05,54,069,45,12,44,061,44,21,07,184,46,22,78,289,47*72<CR><LF>
$GPGSV,4,2,16,30,65,118,45,09,12,047,37,18,62,157,47,06,08,144,45*7C<CR><LF>
$GPGSV,4,3,16,14,39,330,42,01,06,299,38,31,30,256,44,32,36,320,47*7B<CR><LF>
$GPGSV,4,4,16,42,64,169,45,50,74,261,44,21,07,184,46,193,68,189,47*72<CR><LF>
```

| Field | Name               | Example | Description  |
|-------|--------------------|---------|--|
| 1     | Number of message  | 4       | Total number of GSV messages to be transmitted (1-4)                             |
| 2     | Sequence number    | 1       | Sequence number of current GSV message   |
| 3     | Satellites in view | 16      | Total number of satellites in view (00 ~ 16)                                     |
| 4     | Satellite ID       | 05      | Satellite ID number, GPS: 01 ~ 32, SBAS: 33 ~ 64 (33 = PRN120), QZSS : 193 ~ 197 |
| 5     | Elevation          | 54      | Satellite elevation in degrees, (00 ~ 90)  |
| 6     | Azimuth            | 069     | Satellite azimuth angle in degrees, (000 ~ 359 )                                 |
| 7     | SNR                | 45      | C/No in dB (00 ~ 99)<br>Null when not tracking                                   |
| 8     | Checksum           | 72      |  |

**RMC – Recommended Minimum Specific GNSS Data**

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

Structure:

```
$GPRMC,hhmmss.sss,A,dddmm.mmmm,a,dddmm.mmmm,a,x.x,x.x,ddmmy,,a*hh<CR><LF>
```

1    2        3        4        5        6 7 8    9    10 11

Example:

```
$GPRMC,111636.932,A,2447.0949,N,12100.5223,E,000.0,000.0,030407,,A*61<CR><LF>
```

| Field | Name               | Example     | Description  |
|-------|--------------------|-------------|--|
| 1     | UTC time           | 0111636.932 | UTC time in hhmmss.sss format (000000.000 ~ 235959.999)  |
| 2     | Status             | A           | Status<br>'V' = Navigation receiver warning<br>'A' = Data Valid  |
| 3     | Latitude           | 2447.0949   | Latitude in dddmm.mmmm format<br>Leading zeros transmitted   |
| 4     | N/S indicator      | N           | Latitude hemisphere indicator<br>'N' = North<br>'S' = South  |
| 5     | Longitude          | 12100.5223  | Longitude in dddmm.mmmm format<br>Leading zeros transmitted  |
| 6     | E/W Indicator      | E           | Longitude hemisphere indicator<br>'E' = East<br>'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           | 030407      | UTC date of position fix, ddmmyy format  |
| 10    | Mode indicator     | A           | Mode indicator<br>'N' = Data not valid<br>'A' = Autonomous mode<br>'D' = Differential mode<br>'E' = Estimated (dead reckoning) mode<br>'M' = Manual input mode<br>'S' = Simulator mode |
| 11    | checksum           | 61          |  |

**VTG – Course Over Ground and Ground Speed**

The Actual course and speed relative to the ground.

Structure:

GPVTG,x.x,T,,M,x.x,N,x.x,K,a\*hh<CR><LF>

1 2 3 4 5

Example:

\$GPVTG, 000.0,T,,M,000.0,N,0000.0,K,A\*3D<CR><LF>

| 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    | 0000.0  | Speed over ground in kilometers per hour (0000.0 ~ 1800.0)  |
| 4     | Mode     | A       | Mode indicator<br>'N' = not valid<br>'A' = Autonomous mode<br>'D' = Differential mode<br>'E' = Estimated (dead reckoning) mode<br>'M' = Manual input mode<br>'S' = Simulator mode |
| 5     | Checksum | 3D      |   |

**ZDA – Time & Date**

UTC, day, month, year and local time zone.

Structure:

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

1 2 3 4 5 6 7

Example:

\$GPZDA,052633.376,13,07,2012,00,00\*51<CR><LF>

| Field | Name               | Example     | Description   |
|-------|--------------------|-------------|---|
| 1     | UTC time           | 0111636.932 | UTC time in hhmmss.sss format (000000.000 ~ 235959.999) |
| 2     | Day                | 13          | Day, 01 to 31   |
| 3     | Month              | 07          | Month, 01 to 12   |
| 4     | Year               | 2012        | Year in yyyy format                                     |
| 5     | Local zone hours   | 00          | Local zone hours, 00 to +/- 13 hrs                      |
| 6     | Local zone minutes | 00          | Local zone minutes, 00 to +59                           |
| 7     | checksum           | 51          |   |

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