

Glonass/BD/GPS Module

Datasheet

Name: High-performance Glonass/BD/GPS Solution Module

Model No.: SKG09D

Revision: V3.01

Revision History:

| Revision | Description | Approved | Date |
|----------|------------------------|----------|----------|
| V1.01 | Initial Release to 001 | Woody | 20140225 |
| V2.01 | Change packaging | Woody | 20140826 |
| V3.01 | Update FW | Sunny | 20150312 |
| | | | |

General Description

The SKG09D is a high-performance GNSS all-in-one solution module that features super sensitivity, ultra low power and small form factor. The RF signal is applied to the antenna input of module, and a complete serial data message with position, velocity and time information is presented at the serial interface with NMEA protocol or custom protocol.

It is based on the high performance features of the MediaTek MT3333 single-chip architecture, Its -165dBm tracking sensitivity extends positioning coverage into place like urban canyons and dense foliage environment where the GNSS was not possible before. The small form factor and low power consumption make the module easy to integrate into portable device like PNDs, mobile phones, cameras and vehicle navigation systems.

Applications

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



Figure 1: SKG09D Top View

Features

- GPS/GLONASS/BD /GALILEO/QZSS receiver
- Ultra high sensitivity: -165dBm
- Extremely fast TTFF at low signal level
- Built-in 12 multi-tone active interference canceller
- Ultra low power consumption
- ±10ns high accuracy time pulse (1PPS)
- Advanced Features: AlwaysLocate; AIC; EPO;EASY
- SBAS (WAAS,EGNOS,MSAS,GAGAN)
- Indoor and outdoor multi-path detection and compensation
- Small form factor: 10.1 x 9.7 x 2.2mm
- RoHS compliant (Lead-free)

Pin Assignment

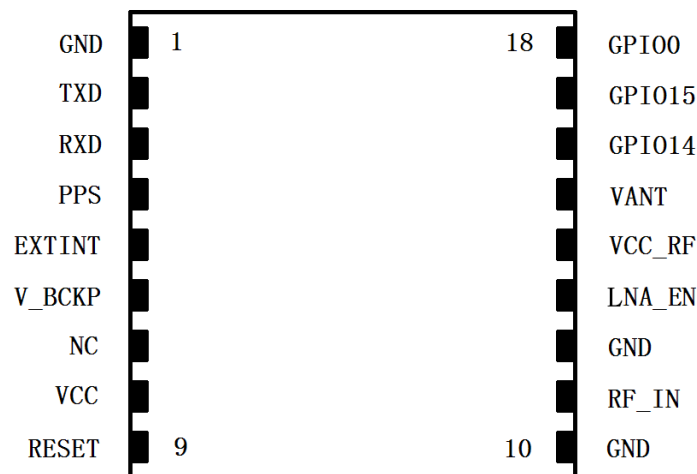


Figure 2: SKG09D Pin Package

Pin Description

| Pin No. | Pin name | I/O | Description | Remark |
|---------|----------|-----|--|--|
| 1 | GND | G | Ground | |
| 2 | TXD | O | UART serial data output. | Leave open if not used |
| 3 | RXD | I | UART serial data input. | Leave open if not used |
| 4 | PPS | O | Time pulse signal. | Leave open if not used |
| 5 | EXTINT | I | External Interrupt pin. | Leave open if not used |
| 6 | V_BCKP | I | RTC and backup SRAM power. | This pin may be connect to Battery or power supply(2.0~4.2V) |
| 7 | NC | | | |
| 8 | VCC | I | Module power supply. | Operating range: 3.0V to 4.2V |
| 9 | RESET | I | Module reset (Active Low). | Leave open if not used |
| 10 | GND | G | Ground | |
| 11 | RF_IN | I | GPS signal input. | 50Ω@1.57542GHz, DC block inside |
| 12 | GND | G | Ground | |
| 13 | LNA_EN | O | 2.8V output for optional control of external LNA bias switch, active high. | Leave open if not used |
| 14 | VCC_RF | O | VCC power output. | Leave open if not used |
| 15 | VANT | I | Active antenna voltage supply. | Leave open if not used |
| 16 | GPIO14 | I/O | General purpose I/O. | Leave open if not used |
| 17 | GPIO15 | I/O | General purpose I/O. | Leave open if not used |
| 18 | GPIO0 | I/O | General purpose I/O. | Leave open if not used |

Interfaces Configuration

Power Supply

Regulated power for the SKG09D is required. The input voltage Vcc should be 3.0V to 4.2V range, current is no less than 100mA. Suitable decoupling must be provided by external decoupling circuitry (10uF and 1uF). It can reduce the Noise from power supply and increase power stability.

Main power supply Vcc current varies according to the processor load and satellite acquisition. Maximum Vcc peak current is about 40 mA during acquisition.

Backup Battery Power

In case of a power failure on pin Vcc, real-time clock and backup RAM are supplied through pin V_BCKP. This enables the SKG09D GNSS Receiver to recover from power failure with either a hot start or a warm start (depending on the duration of Vcc outage). If no Backup Battery is connected, the receiver performs a cold start upon powered up. Backup Battery Power V_BCKP draws typically 15 uA current in backup state.

Reset

The SKG09D modules include a RESET pin. Driving RESET low activates a hardware reset of the system. RESET is only an input and will not reset external circuitry. At power down the reset is forced when the Vcc drops below 2.7V.

NOTE

If not used, leave RESET not connected (floating).

Antenna

The SKG09D GNSS receiver is designed for supporting the active antenna or passive antenna connected with pin RF_IN. The gain of active antenna should be no more than 25dB (18~20dB Typical). The maximum noise figure should be no more than 1.5dB and output impedance is at 50 Ohm.

NOTE

With passive antenna keep the cable loss at minimum(<1dB).

VCC_RF

Antenna power output pin. When user wants to use external active antenna. The pin supply power for active antenna.

UART Ports

The module supports one full duplex serial channels UART. The serial connections are at 2.85V LVTTTL logic levels, if need different voltage levels, use appropriate level shifters. the data format is however fixed: X, N, 8, 1, i.e. X baud rate, no parity, eight data bits and one stop bit, no other data formats are supported, LSB is sent first. The modules default baud rate is set up 9600bps. The RXD0 & TXD0 recommended to pull up (10KΩ). It can increase the stability of serial data.

EXTINT

The default EXTINT function is Standby mode control but the function is not supported; leave signal floating (not connected).

RF_IN

The transmission line must to be control impedance from RF_IN pin to the antenna or antenna connector of your choice. (Impedance 50Ω)

PPS

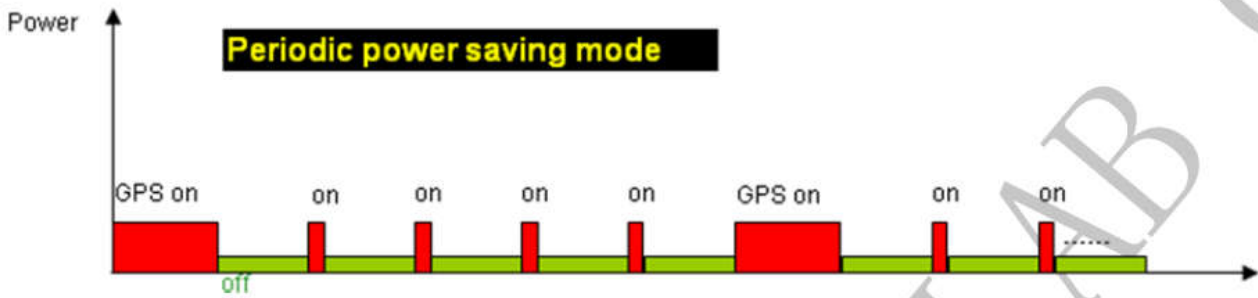
A pulse per second (1 PPS) is an electrical signal that very precisely indicates the start of a second. Depending on the source, properly operating PPS signals have an accuracy ranging 10ns. The PPS signals are used for precise timekeeping and time measurement.

Advanced Software Features**Standby Mode**

User can issue software command to make GNSS module go into standby mode that consumes less than 200uA current. GNSS module will be awaked when receiving any byte. The following flow chart is an example to make GNSS module go into standby mode and then wake up.

Periodic Mode

When GNSS module is commanded to periodic mode, it will be in operation and standby periodically. Its status of power consumption is as below chart



AlwaysLocate™

AlwaysLocate™ is an intelligent controller of periodic mode. Depending on the environment and motion conditions, GNSS module can adaptively adjust working/standby time to achieve balance of positioning accuracy and power consumption. In this mode, the host CPU does not need to control GNSS module until the host CPU needs the GNSS position data. The following flow chart is an example to make GNSS module go into AlwaysLocate™ mode and then back to normal operation mode.

AGPS Support for Fast TTFF (EPO™)

The AGPS (EPO™) supply the predicated Extended Prediction Orbit data to speed TTFF ,users can download the EPO data to GPS engine from the FTP server by internet or wireless network ,the GPS engine will use the EPO data to assist position calculation when the navigation information of satellites are not enough or weak signal zone .

EASY™

The EASY™ is embedded assist system for quick positioning, the GPS engine will calculate and predict automatically the single emperies (Max. up to 3 days)when power on ,and save the predict information into the memory , GPS engine will use these information for positioning if no enough information from satellites , so the function will be helpful for positioning and TTFF improvement under indoor or urban condition ,the Backup power (VBACKUP) is necessary .

Embedded Logger function

The Embedded Logger function don't need host CPU (MCU) and external flash to handle the operation , GNSS Engine will use internal flash (embedded in GNSS chipset) to log the GNSS data (Data format : UTC, Latitude , longitude, Valid ,Checksum), the max log days can up to 2 days under AlwaysLocate™ condition .

AIC_Multi-tone active interference canceller

Because different application (Wi-Fi , GSM/GPRS,3G/4G,Bluetooth)are integrated into navigation system , the

harmonic of RF signal will influence the GNSS reception , The multi- tone active-interference canceller can reject external RF interference which come from other active components on the main board , to improve the capacity of GNSS reception without any needed HW change in the design .SKG09D can cancel up to 12 independent channel interference continuous wave.

GNSS

The SKG09D GNSS modules can receive and track multiple GNSS systems (e.g. GPS, GLONASS and BeiDou signals). The SKG09D can be configure to start searching of which satellite system. By default the receivers are configured for concurrent GPS and BeiDou reception.

Performance Specification

| Parameter | Specification | |
|-----------------------------|-------------------------|---|
| Receiver Type | GPS/GLONASS/BD /GALILEO | |
| Sensitivity | Tracking | -165dBm Typical |
| | Acquisition | -148dBm Typical |
| Accuracy | Position | 3.0m CEP50 without SA(Typical Open Sky) |
| | Velocity | 0.1m/s without SA |
| | Timing (PPS) | 10ns RMS |
| Acquisition Time | Cold Start | 23s(Typical Open Sky) |
| | Warm Start | 2-3s |
| | Hot Start | 1s |
| | Re-Acquisition | <1s |
| Power Consumption | Tracking | 25mA @3.3V Typical |
| | Acquisition | 30mA @3.3V |
| Navigation Data Update Rate | Max 10Hz | Default 1Hz |
| Operational Limits | Altitude | Max 18,000m |
| | Velocity | Max 515m/s |
| | Acceleration | Less than 4g |

Electrical Characteristics

Absolute Maximum Rating

| Parameter | Symbol | Min | Max | Units |
|---------------------------------------|--------|------|-----|-------|
| Power Supply | | | | |
| Power Supply Volt. | VCC | -0.3 | 4.3 | V |
| Input Pins | | | | |
| Input voltage on any input connection | VIO | -0.3 | 3.6 | V |
| Backup Battery | V_BCKP | -0.3 | 4.3 | V |
| RF input power | RF_IN | | -40 | dBm |

| | | | | |
|--|-------|-----|------|----|
| Human Body Model ESD capability | RF_IN | | 2000 | V |
| Machine Model ESD capability | RF_IN | | 100 | V |
| Environment | | | | |
| Storage Temperature | Tstg | -40 | 125 | °C |
| Peak Reflow Soldering Temperature <10s | Tpeak | | 260 | °C |
| Humidity | | | 95 | % |

Note: Absolute maximum ratings are stress ratings only, and functional operation at the maxims 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, refer to the operating conditions tables as follow.

The SKG09D module is Electrostatic Sensitive Device (ESD) and may be damaged with ESD or spike voltage. Although it has built-in ESD protection circuitry at digital I/O, please handle with care to avoid permanent malfunction or performance degradation. Note that RFIN has no ESD protection circuits.

Operating Conditions

| Parameter | Symbol | Condition | Min | Typ | Max | Units |
|------------------------------|-----------------|-----------|------|-----|-----|-------|
| Power supply voltage | Vcc | | 3 | 3.3 | 4.2 | V |
| Backup Battery | V_BCKP | | 2 | 3.3 | 4.2 | V |
| Power supply voltage ripple | Vcc_PP | Vcc=3.3V | | | 30 | mV |
| Supply current, navigation | Icc | Vcc=3.3V | | 35 | 40 | mA |
| Supply current, backup state | Ibckp | Vcc=3.3V | | 15 | | uA |
| VCC_OUT Antenna bias supply | VCC_OUT | | | VCC | | V |
| Input high voltage | V _{IH} | | 2 | | 3.6 | V |
| Input low voltage | V _{IL} | | -0.3 | | 0.8 | V |
| Output high voltage | V _{OH} | | 2.4 | | 3.1 | V |
| Output low voltage | V _{OL} | | -0.3 | | 0.4 | V |
| Operating temperature | Topr | | -40 | | 85 | °C |

Mechanical Specification

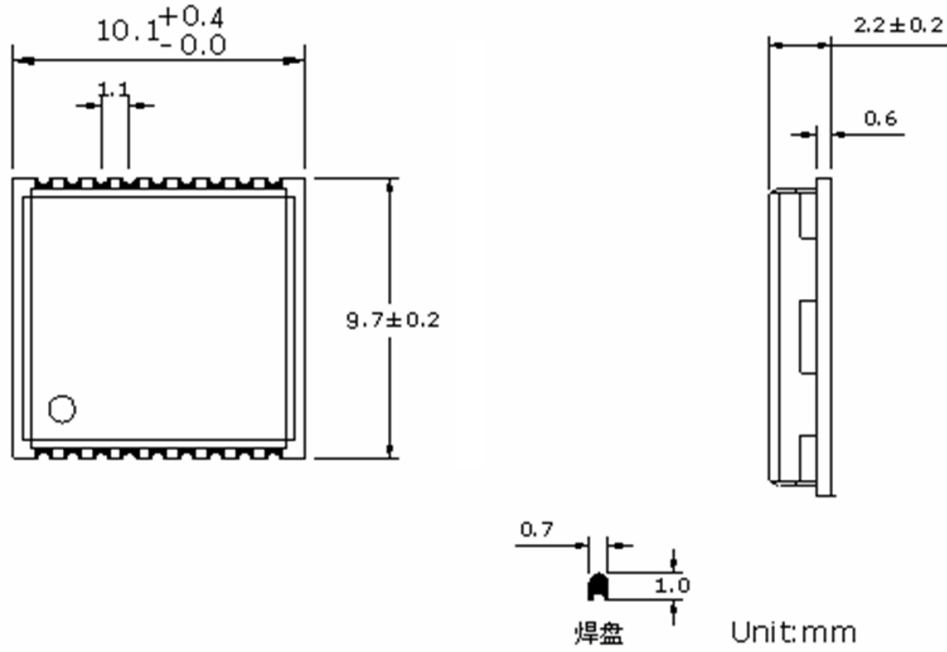


Figure 3: SKG09D Dimensions

Recommend Layout

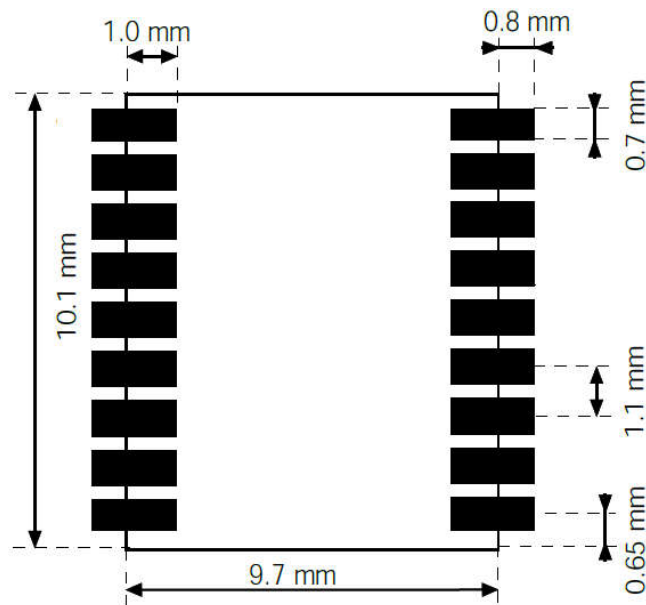


Figure 4: SKG09D Footprint

Reference design schematic

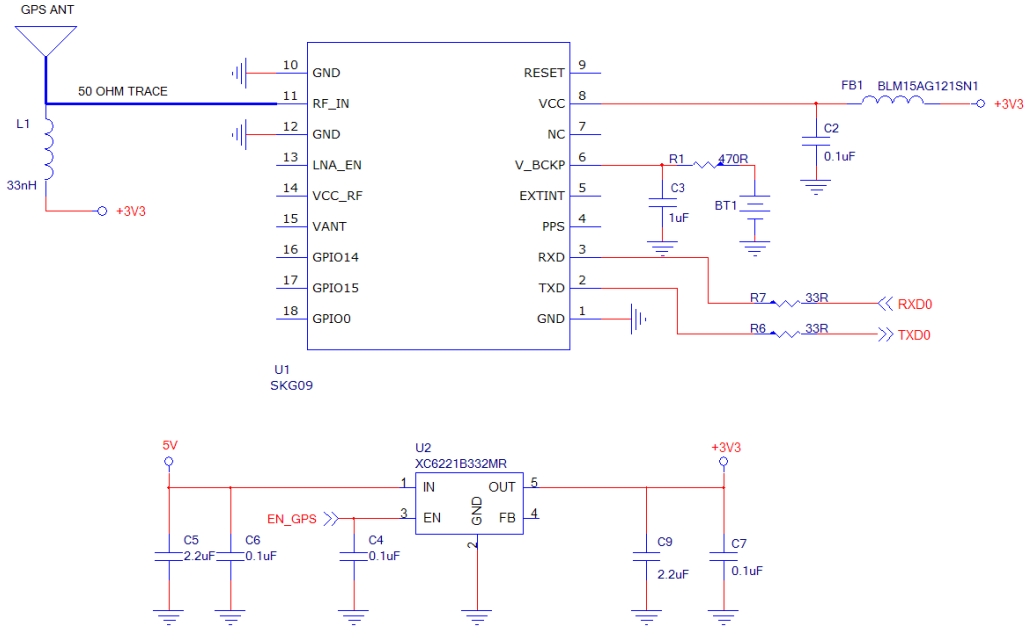


Figure 5: SKG09D Typical Reference design schematic

Packaging Specification

SKG09D modules are shipped in reel and with 2000 units per reel. Each tray is ‘dry’ package.

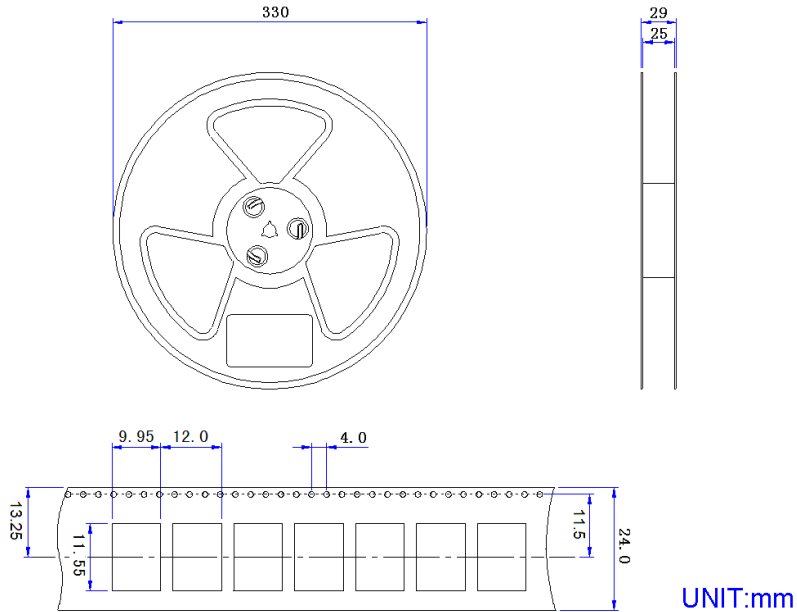


Figure 6: SKG09D Packaging

Manufacturing Process Recommendations

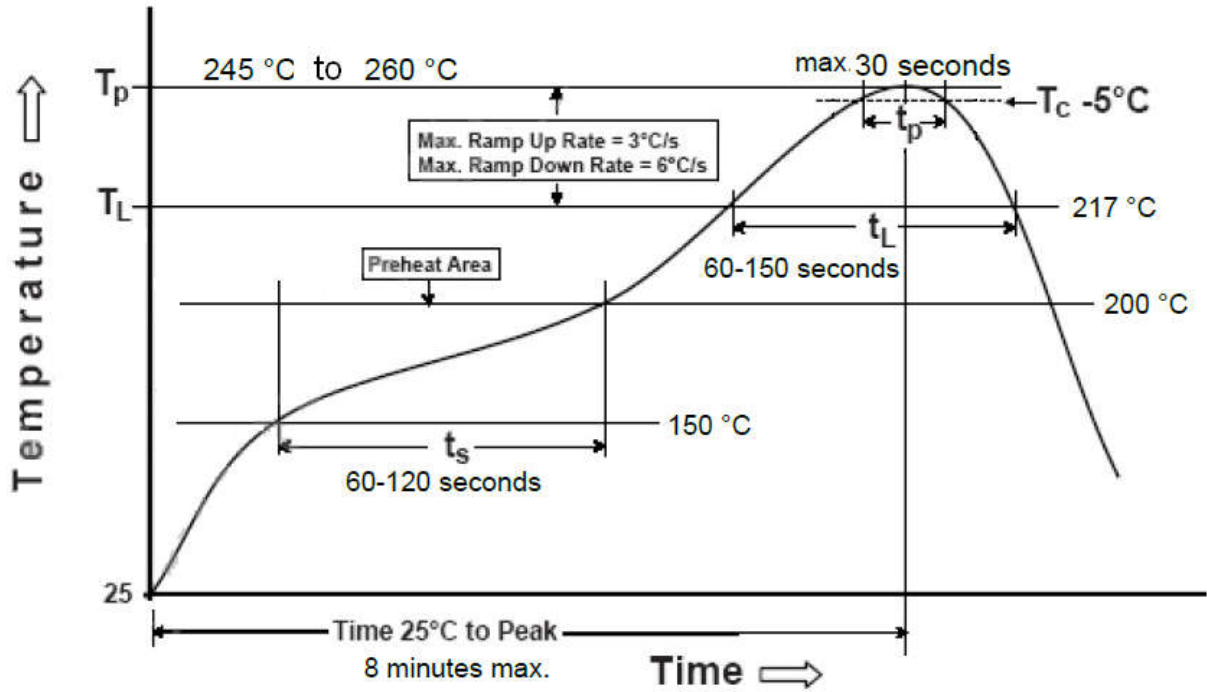


Figure 7: SKG09D Typical Leadfree Soldering Profile

Note: The final soldering temperature chosen at the factory depends on additional external factors like choice of soldering paste, size, thickness and properties of the baseboard, etc. Exceeding the maximum soldering temperature in the recommended soldering profile may permanently damage the module.

Software Protocol

NMEA 0183 Protocol

The NMEA protocol is an ASCII-based protocol, Records start with a \$ and with carriage return/line feed. GNSS specific messages all start with \$GNxxx where xxx is a three-letter identifier of the message data that follows. NMEA messages have a checksum, which allows detection of corrupted data transfers.

The Skylab SKG09D supports the following NMEA-0183 messages: GGA, GLL, GSA, GSV, RMC, VTG, ZDA. The module default NMEA-0183 output is set up GGA, GSA, RMC, GSV, and default baud rate is set up 9600bps.

Table 1: NMEA-0183 Output Messages

| NMEA Record | Description | Default |
|-------------|--|---------|
| GNGGA | Global positioning system fixed data | Y |
| GNGLL | Geographic position—latitude/longitude | N |
| GPGSA | GPS DOP and active satellites for GPS | Y |
| BDGSA | Beidou DOP and active satellites for BD | Y |
| GLGSA | GNSS DOP and active satellites for GLONASS | N |
| GPGSV | GPS satellites in view for GPS | Y |
| BDGSV | Beidou satellites in view for BD | Y |
| GLGSV | GNSS satellites in view for GLONASS | N |
| GNRMC | Recommended minimum specific GNSS data | Y |
| GNTVG | Course over ground and ground speed | N |
| GNZDA | Date and Time | N |

GGA-Global Positioning System Fixed Data

This sentence contains the position, time and quality of the navigation fix.

See RMC for Fix Status, Fix Mode, Fix Date, Speed, and True Course.

See GSA for Fix Type, PDOP, and VDOP.

\$GNGGA,021514.000,2232.1799,N,11401.1823,E,1,6,1.25,84.0,M,-2.2,M,*,*6A

Table 2: GGA Data Format

| Name | Example | Units | Description |
|------------------------|------------|-------|----------------------------------|
| Message ID | \$GNGGA | | GGA protocol header |
| UTC Position | 021514.000 | | hhmmss.sss |
| Latitude | 2232.1799 | | ddmm.mmmm |
| N/S indicator | N | | N=north or S=south |
| Longitude | 11401.1823 | | dddmm.mmmm |
| E/W Indicator | E | | E=east or W=west |
| Position Fix Indicator | 1 | | See Table 2-1 |
| Satellites Used | 6 | | Range 0 to 12 |
| HDOP | 1.25 | | Horizontal Dilution of Precision |

| | | | |
|---------------------|-----------|--------|--|
| MSL Altitude | 84.0 | meters | Altitude (referenced to the Ellipsoid) |
| AltUnit | M | meters | Altitude Unit |
| GeoSep | -2.2 | meters | Geoidal Separation |
| GeoSepUnit | M | meters | Geoidal Separation Unit |
| Age of Diff.Corr. | <Null> | second | Null fields when it is not Used |
| Diff.Ref.Station ID | <Null> | | Null fields when it is not Used |
| Checksum | *6A | | |
| EOL | <CR> <LF> | | End of message termination |

Table 2-1: Position Fix Indicators

| Value | Description |
|-------|------------------------------|
| 0 | Fix not available or invalid |
| 1 | fix valid |
| 2 | Differential GPS, fix valid |

GLL-Geographic Position – Latitude/Longitude

This sentence contains the fix latitude and longitude.

\$GNGLL,2232.1799,N,11401.1824,E,021513.000,A,A*4E

Table 3: GLL Data Format

| Name | Example | Units | Description |
|---------------|------------|-------|--|
| Message ID | \$GNGLL | | GLL protocol header |
| Latitude | 2232.1799 | | ddmm.mmmm |
| N/S Indicator | N | | N=north or S=south |
| Longitude | 11401.1824 | | dddmm.mmmm |
| E/W Indicator | E | | E=east or W=west |
| UTC Position | 021513.000 | | hhmmss.sss |
| Fix Status | A | | A=data valid or V=data not valid |
| Fix Mode | A | | A=autonomous, N = No fix, D=DGPS, E=DR |
| Checksum | *4E | | |
| EOL | <CR> <LF> | | End of message termination |

GSA-GNSS DOP and Active Satellites

This sentence contains the mode of operation, type of fix, PRNs of the satellites used in the solution as well as PDOP, HDOP and VDOP.

GPS GSA message: \$GPGSA,.....

\$GPGSA,A,3,28,20,04,17,10,193,08,,,,,1.14,0.75,0.85*31

GLONASS GSA message: \$GLGSA,.....

\$GLGSA,A,3,67,81,80,66,82,79,,,,,1.14,0.75,0.85*11

BD GSA message: \$BDGSA,.....

\$BDGSA,A,3,10,,,,,,1.54,1.26,0.88*17

Table 4: GSA Data Format

| Name | Example | Units | Description |
|----------------------|-----------|-------|--|
| Message | \$GPGSA | | GSA protocol header |
| Mode 1 | A | | See Table 4-2 |
| Mode 2 | 3 | | See Table 4-1 |
| ID of satellite used | 28 | | Sv on Channel 1 |
| ID of satellite used | 20 | | Sv on Channel 2 |
| ... | ... | | ... |
| ID of satellite used | <Null> | | Sv on Channel 12 (Null fields when it is not Used) |
| PDOP | 1.14 | | Position Dilution of Precision |
| HDOP | 0.75 | | Horizontal Dilution of Precision |
| VDOP | 0.85 | | Vertical Dilution of Precision |
| Checksum | *31 | | |
| EOL | <CR> <LF> | | End of message termination |

Table 4-1: Mode 2

| Value | Description |
|-------|-------------------|
| 1 | Fix not available |
| 2 | 2D Fix |
| 3 | 3D Fix |

Table 4-2: Mode 1

| Value | Description |
|-------|---|
| M | Manual-forced to operate in 2D or 3D mode |
| A | Automatic-allowed to automatically switch 2D/3D |

GSV-GNSS Satellites in View

This sentence contains the PRNs, azimuth, elevation, and signal strength of all satellites in view.

GPS GSV message: \$GPGSV,.....

\$GPGSV,4,1,14,28,86,009,35,193,70,056,38,04,44,258,29,17,44,338,44*48

GLONASS GSV message: \$GLGSV,.....

\$GLGSV,3,1,10,79,42,239,15,66,40,076,31,67,37,143,29,81,33,025,14*66

BD GSV message: \$BDGSV,.....

\$BDGSV,1,1,03,10,46,329,31,08,43,161,,09,40,217,*52

Table 5: GSV Data Format

| Name | Example | Units | Description |
|------------|---------|-------|---------------------|
| Message ID | \$GPGSV | | GSV protocol header |

| | | | |
|--------------------|-----------|---------|---|
| Number of Message | 4 | | Total number of GSV sentences (Range 1 to 3) |
| Message Number | 1 | | Sentence number of the total (Range 1 to 3) |
| Satellites in View | 14 | | Number of satellites in view |
| Satellite ID | 28 | | Channel 1 |
| Elevation | 86 | degrees | Channel 1(Range 00 to 90) |
| Azimuth | 009 | degrees | Channel 1(Range 000 to 359) |
| SNR(C/NO) | 35 | dB-Hz | Channel 1(Range 00 to 99, null when not tracking) |
| ... | | | ... |
| Satellite ID | 17 | | Channel 4 |
| Elevation | 44 | degrees | Channel 4(Range 00 to 90) |
| Azimuth | 338 | degrees | Channel 4(Range 000 to 359) |
| SNR(C/NO) | 44 | dB-Hz | Channel 4(Range 00 to 99, null when not tracking) |
| Checksum | *48 | | |
| EOL | <CR> <LF> | | End of message termination |

Depending on the number of satellites tracked multiple messages of GSV data may be required.

RMC-Recommended Minimum Specific GNSS Data

This sentence contains the recommended minimum fix information.

See GGA for Fix Quality, Sats Used, HDOP, Altitude, Geoidal Separation, and DGPS data.

See GSA for Fix Type, PDOP and VDOP.

\$GNRMC,023345.000,A,2232.1767,N,11401.1953,E,0.18,151.55,100410,,,A*76

Table 6: RMC Data Format

| Name | Example | Units | Description |
|------------------------------|------------|---------|--|
| Message ID | \$GNRMC | | RMC protocol header |
| UTS Position | 023345.000 | | hhmmss.sss |
| Status | A | | A=data valid or V=data not valid |
| Latitude | 2232.1767 | | ddmm.mmmm |
| N/S Indicator | N | | N=north or S=south |
| Longitude | 11401.1953 | | dddmm.mmmm |
| E/W Indicator | E | | E=east or W=west |
| Speed Over Ground | 0.18 | Knots | |
| Course Over Ground | 151.55 | Degrees | True Course |
| Date(UTC) | 100410 | | ddmmyy |
| Magnetic variation | <Null> | Degrees | Null fields when it is not Used |
| Magnetic Variation Direction | <Null> | | E=east or W=west (Null fields when it is not Used) |
| Fix Mode | A | | A=autonomous, N = No fix, D=DGPS, E=DR |
| Checksum | *76 | | |
| EOL | <CR> <LF> | | End of message termination |

VTG-Course Over Ground and Ground Speed

This sentence contains the course and speed of the navigation solution.

\$GNVTG,148.81,T,,M,0.13,N,0.24,K,A*23

Table 7: VTG Data Format

| Name | Example | Units | Description |
|-------------------|-----------|---------|---|
| Message ID | \$GPVTG | | VTG protocol header |
| Tcourse | 148.81 | Degrees | True Course |
| Reference | T | | T = True |
| Mcourse | <Null> | Degrees | Magnetic Course (Null fields when it is not Used) |
| Reference | M | | M = Magnetic (Null fields when it is not Used) |
| Speed over ground | 0.13 | Knots | Nautical Miles per Hour |
| Units | N | | Knots |
| Speed over ground | 0.24 | Km/hr | in Kilometers per Hour |
| Units | K | | Kilometer per hour |
| Mode | A | | A=Autonomous, N=No fix, D=DGPS, E=DR |
| Checksum | *23 | | |
| EOL | <CR> <LF> | | End of message termination |

ZDA-Date and Time

This sentence contains UTC date & time, and local time zone offset information.

\$GNZDA,023345.000,10,04,2010,,*4D

Table 8: ZDA Data Format

| Name | Example | Units | Description |
|--------------------|------------|-------|--|
| Message ID | \$GPZDA | | ZDA protocol header |
| UTC Time | 023345.000 | | hhmmss.sss |
| Day | 10 | | UTC time: day (01 ... 31) dd |
| Month | 04 | | UTC time: month (01 ... 12) mm |
| Year | 2010 | | UTC time: year (4 digit year) yyyy |
| local zone hours | <null> | | Local Time Zone Offset Hours (Null fields when it is not Used) |
| local zone minutes | <null> | | Local Time Zone Offset Minutes (Null fields when it is not Used) |
| Checksum | *4D | | |
| EOL | <CR> <LF> | | End of message termination |

CMD List

Table 9: CMD List

| CMD TYPE | CMD Example: |
|-----------------------------------|--------------------------------|
| Hot Restart | \$PMTK101*32<CR><LF> |
| Warm Restart | \$PMTK102*31<CR><LF> |
| Cold Restart | \$PMTK103*30<CR><LF> |
| Full Cold Restart | \$PMTK104*37<CR><LF> |
| Search GLONASS satellites only | \$PMTK353,0,1,0,0,0*2A<CR><LF> |
| Search GPS satellites only | \$PMTK353,1,0,0,0,0*2A<CR><LF> |
| Search GPS and GLONASS satellites | \$PMTK353,1,1,0,0,0*2B<CR><LF> |
| Search BEIDOU satellites only | \$PMTK353,0,0,0,0,1*2A<CR><LF> |
| Search GPS and BEIDOU satellites | \$PMTK353,1,0,0,0,1*2B<CR><LF> |

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