



Datasheet of BK-1612-15


Version 0.4


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1. Introduction

The BK-1612-15 is a receiving module that supports Dual-Band & Multi-Mode. It has built-in highly integrated GNSS receiver chip, supports multi band and multi system cm4f (main frequency 350Mhz, 22nm 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, BEIDOU, QZSS, and SBAS) in all bands.

BK-1612-15 module 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 single chip achieve sub-meter level positioning 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.

BK-1612-15 module contains positioning engine inside, 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 searching engine is capable of testing 16 million time-frequency hypotheses per second, offering superior signal acquisition and TTFF speed.

2. Features

- Build on high performance
- Ultra high Track sensitivity: -165dBm
- Concurrent reception of dual-band and multi-system satellite signals
- Supports-GPS, GLONASS, GALILEO, BEIDOU and QZSS
- Built in LNA and SAW filter
- Supports BDS-3 signal
- Up to 10 Hz update rate

- Extremely fast TTFF at low signal level
- Multipath detection and suppression
- Works with passive and active antenna
- Low power consumption: Max25mA@3.3V
- NMEA-0183 compliant protocol or custom protocol
- Operating voltage:2.7V to 3.6V
- SMD type with stamp holes
- Small form factor: 16×12.2×2.4mm
- Operating temperature -40 ~ +85°C
- Use GNSS chip qualified according to AEC-Q100
- RoHS compliant (Lead-free)

3. Applications

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

4. Functional Description

4.1 Key Features

Table 1: Key Features

| Parameter | Specification |
|--------------------------|--|
| GNSS engine | <ul style="list-style-type: none"> 200 tracking channels with fast search engine |
| GNSS reception | <ul style="list-style-type: none"> GPS/QZSS : L1,L5 GLONASS : L1 GALILEO : E1,E5 BEIDOU : B1I,B1C, B2A SBAS : WAAS, EGNOS, MSAS, GAGAN |
| Update rate | <ul style="list-style-type: none"> GNSS : 1Hz (default) up to 10Hz |
| Position accuracy | <ul style="list-style-type: none"> GNSS : 1.5m CEP SBAS : 1.5m CEP |
| Velocity & Time accuracy | <ul style="list-style-type: none"> GNSS : 0.01m/s CEP SBAS : 0.05 m/s 1PPS : 20 ns |
| Time to First Fix (TTFF) | <ul style="list-style-type: none"> Hot start : 1 s Cold start : 28 s AGPS : 1.5 s |
| Sensitivity | <ul style="list-style-type: none"> Cold start : -148dBm Hot start : -165dBm Reacquisition : -159dBm Tracking & navigation : -165dBm |
| GNSS Operating limit | <ul style="list-style-type: none"> Velocity : 515m/s Altitude : 18,000m |
| Dynamics | <ul style="list-style-type: none"> 4G (39.2m/sec²) acceleration |
| Datum | <ul style="list-style-type: none"> Default WGS-84, User definable |
| UART Port | <ul style="list-style-type: none"> UART Port : TX and RX Supports baud rate from 9600bps to 1000000bps (115200bps by default) NMEA 0183 Protocol Ver. 4.00/4.10, BK GNSS Receiver Protocol Supports batch data report mode |
| Temperature Range | <ul style="list-style-type: none"> Normal operation : -40°C ~ +85°C Storage temperature : -55°C ~ +125°C Humidity : 5% ~ 95% |
| Physical Characteristics | <ul style="list-style-type: none"> Size : 16±0.6×12.2±0.2×2.4±0.2mm Weight : Approx. 0.9g |

4.2 Block Diagram

The BK-1612-15 is a high performance (GPS, GLONASS, GALILEO, BEIDOU, QZSS, and SBAS) in all bands (L1, L5). Satellite navigation receiver in a compact surface mount package. It is providing high performance signal acquisition and tracking. The simple UART serial interface and the standard NMEA-0183 protocol make usage of BK-1612-15 very easy and straightforward.

The BK-1612-15 module performs all the necessary system initialization, signal acquisition, signal tracking, data demodulation, and calculation of navigation solution autonomously.

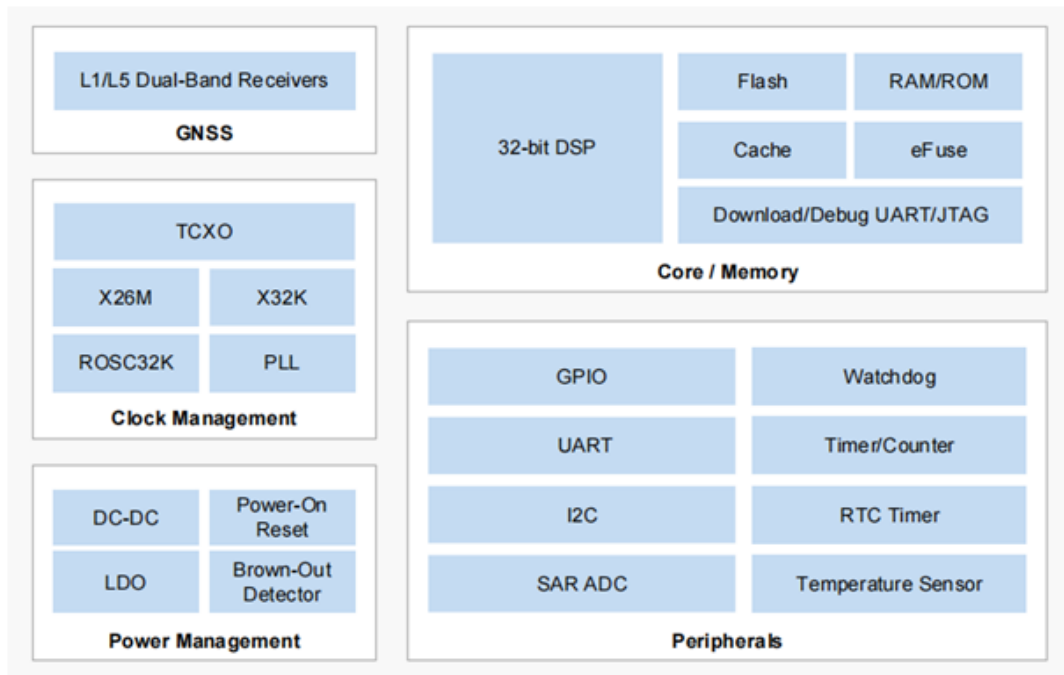


Figure 1: Block Diagram

4.3 Reference Circuit

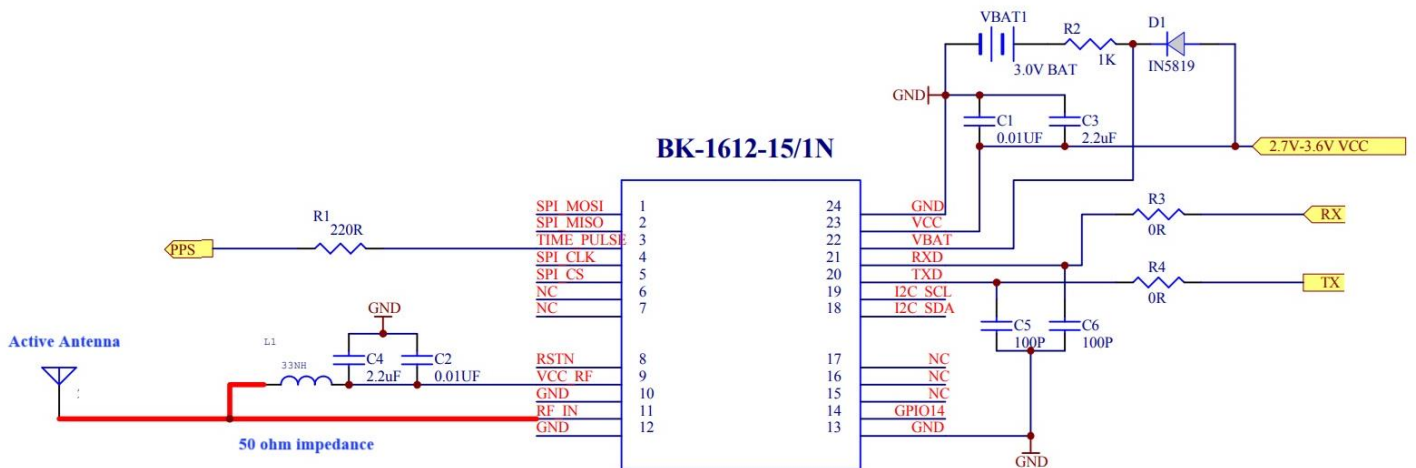


Figure 2: Reference Circuit

5. Pin Assignment and Definition

The module is equipped with a 24-pin SMT pad that connects to your application platform. Sub-interfaces included in the pad are described in details in the following chapters.

5.1 Pin Assignment

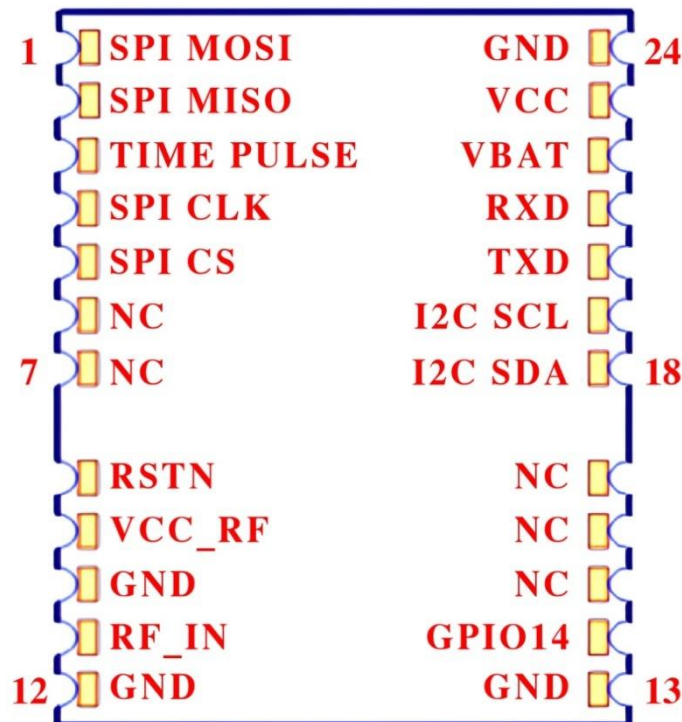


Figure 3: Pin Assignment

5.2 Pin Definition

Table 2: Pin Definition

| Pin No. | Name | Description |
|--------------|------------|--|
| 1 | SPI MOSI | Serial port SPI MOSI port, leave it vacant when not in use |
| 2 | SPI MISO | Serial port SPI MISO port, leave it vacant when not in use |
| 3 | TIME PULSE | PPS output |
| 4 | SPI CLK | Serial port SPI CLK port, leave it vacant when not in use |
| 5 | SPI CS | Serial port SPI CS port, leave it vacant when not in use |
| 6,7,15,16,17 | NC | No connect |

| | | |
|----|---------|--|
| 8 | RSTN | RESET leave it vacant when not in use |
| 9 | VCC_RF | Active antenna power supply |
| 10 | GND | GND |
| 11 | RF_IN | RF input |
| 12 | GND | GND |
| 13 | GND | GND |
| 14 | GPIO14 | JTAG_TDO, leave it vacant when not in use |
| 18 | I2C SDA | Serial port I2C SDA port, leave it vacant when not in use |
| 19 | I2C SCL | Serial port I2C SCL port, leave it vacant when not in use |
| 20 | TXD | Serial port TXD port |
| 21 | RXD | Serial port RXD port |
| 22 | VBAT | Backup battery : 2.8V--3.3V, leave it vacant when not in use |
| 23 | VCC | Working voltage : 2.8-3.6V, Recommended use : 3.3V |
| 24 | GND | GND |

6. DC Electrical Specification

Table 3: Operating Conditions

| Parameter | Min | Typ | Max | Unit |
|--|-----|-----|-----|------|
| Supply Voltage (VCC) | 2.7 | 3.3 | 3.6 | Volt |
| Acquisition Current (exclude active antenna current) | | 24 | | mA |
| Tracking Current (exclude active antenna current) | | 32 | | mA |
| I/O port & UART port working voltage | | | | |
| Output Low Voltage | - | | 0.4 | Volt |
| Output HIGH Voltage | 2.4 | | - | Volt |
| Input LOW Voltage | 0.3 | | 0.7 | Volt |
| Input HIGH Voltage | 2.1 | | 4.2 | Volt |
| Input LOW Current | -10 | | 10 | uA |
| Input HIGH Current | -10 | | 10 | uA |
| RF Input Impedance (RFIN) | | 50 | | Ohm |

Table 4: Absolute Maximum Ratings

| Parameter | Minimum | Maximum | Condition |
|----------------------|---------|---------|-----------|
| Supply Voltage (VCC) | -0.5 | 3.6 | Volt |
| Input Pin Voltage | -0.5 | VCC+0.5 | Volt |
| Input Power at RF_IN | | +20 | dBm |
| Storage Temperature | -55 | +100 | °C |

7. UART Interface

The module provides one universal asynchronous receiver& transmitter serial port. The module is designed as DCE (Data Communication Equipment), following the traditional DCE-DTE (Data Terminal Equipment) connection. The module and the client (DTE) are connected through the signals shown in the following figure. It supports data baud-rate from 9600bps to 961200bps.

UART port:

TXD: Send data to the RXD1 signal line of DTE.

RXD: Receive data from the TXD1 signal line of DTE.

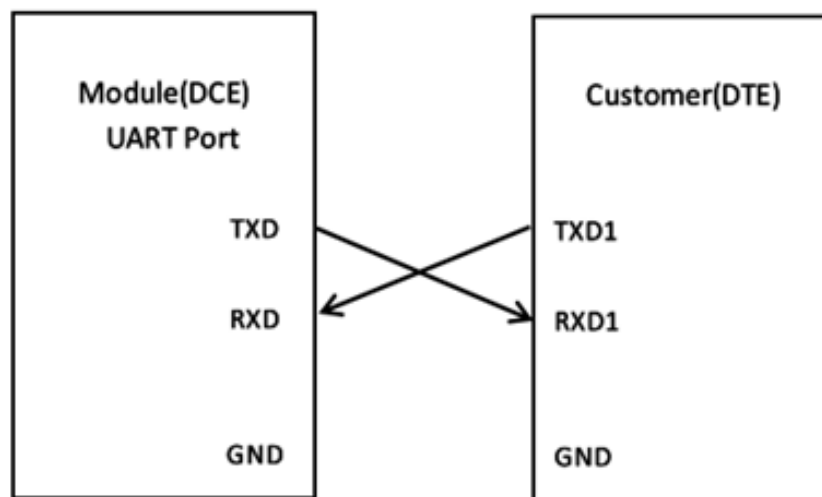


Figure 4: Serial Port connection

This UART port has the following features:

- UART port can be used for NMEA Protocol output and proprietary commands input.
- The default output NMEA type setting is GGA, GSA, GSV, VTG, RMC, GLL, ZDA
- UART port supports the following data rates:
9600, 14400, 19200, 38400, 57600, 115200, 230400, 460800, 1000000 bps.
115200bps by default, 8 bits, no parity bit, 1 stop bit.
- Hardware flow control and synchronous operation are not supported.

The UART port does not support the RS-232 level but only CMOS level. If the module's UART port is connected to the UART port of a computer, it is necessary to add a level shift circuit between the module and the computer. Please refer to the following figure.

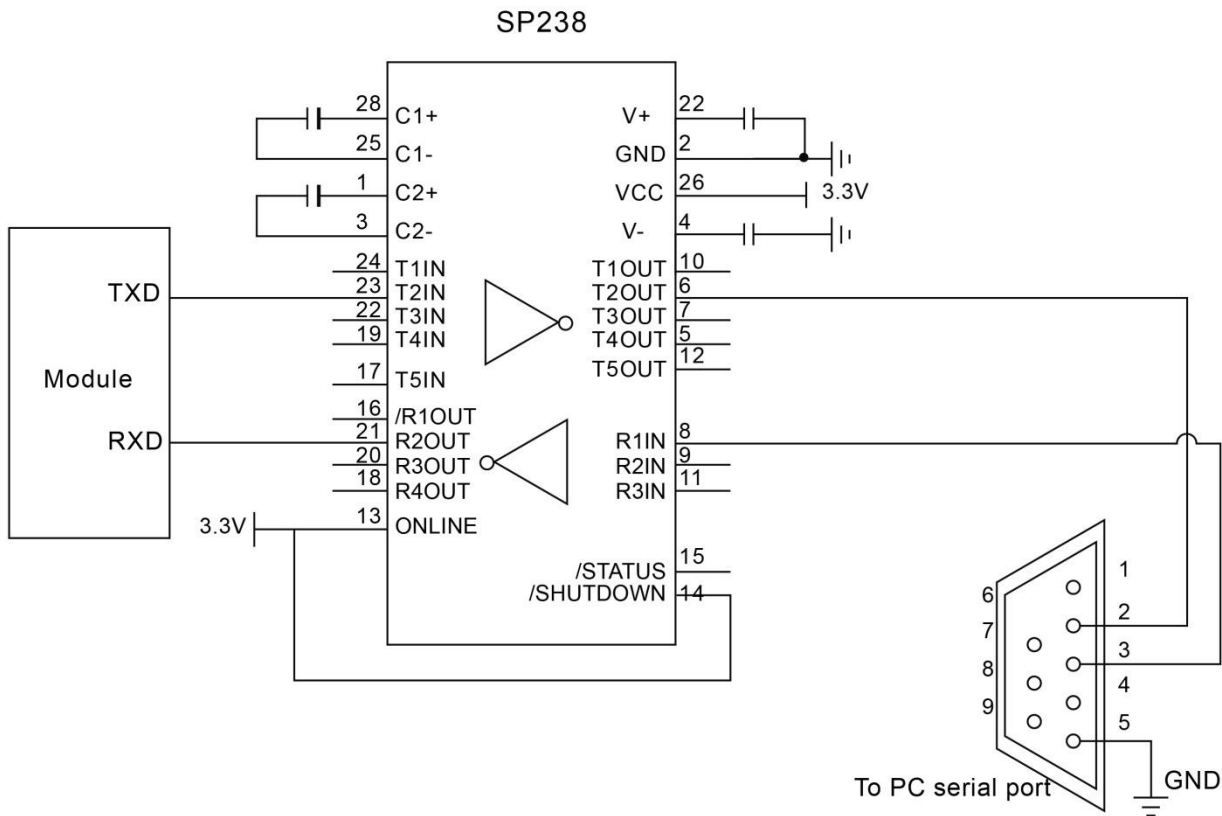


Figure 5: RS-232 Level Shift Circuit

8. Antenna Consideration

The BK-1612-15 is designed to use with active antenna, and passive antenna with higher antenna gain.

Passive ceramic patch antenna is low-cost and provides good sensitivity. 50-ohm output larger size ceramic patch antenna with higher antenna gain can be connected directly to RF input of the module. Usually the ceramic patch antenna and BK-1612-15 are mounted on opposite side of the PCB to reduce possibility of picking up digital noise. To improve signal reception performance, use larger ground plane under the patch antenna if possible; larger the ground plane, larger the overall antenna gain. The center frequency of the ceramic patch antenna changes with ground plane size. For optimal L1+L5 operation, frequency bandwidth of the antenna needs to cover 1174MHz ~ 1179MHz and 1573MHz ~ 1606MHz respectively when mounted on the PCB. It is usual to ask the ceramic patch antenna vendor to select or tune a patch antenna that best matches the customer PCB.

Active antenna is essentially a passive antenna with built-in LNA and a coaxial cable to connect the antenna to the module. It has the flexibility of being located remotely from the module, but requires antenna power. Active antenna usually costs more than passive patch antenna, but the performance in low signal environments is usually better. Active antenna with gain of 10 ~ 20dB and noise figure less than 1.5dB can be used with BK-1612-15.

| Antenna Type | Passive | Active |
|--------------------------|--|--|
| GPS&QZSS Frequency (MHz) | 1575.42 +/-2 (L1) 1176.45 +/-12 (L5) | 1575.42 +/-2 (L1) 1176.45 +/-12 (L5) |
| BDS Frequency (MHz) | 1561.098 +/- 2 (B1I) 1575.42 +/- 2 (B1C) 1176.45 +/- 2 (B2A) | 1561.098 +/- 2 (B1I) 1575.42 +/- 2 (B1C) 1176.45 +/- 2 (B2A) |
| GLONASS Frequency (MHz) | 1602MHz +/- 4 (L1) | 1602MHz +/- 4 (L1) |
| GALILEO Frequency (MHz) | 1575.42 +/-2 (E1) 1176.45 +/-12 (E5) | 1575.42 +/-2 (E1) 1176.45 +/-12 (E5) |
| VSWR | < 2 (typical) | < 2 (typical) |
| Polarization | RHCP | RHCP |
| Antenna Gain | >0dBi | >-2dBi |
| LNA Gain | | 20dB(typical) |
| Noise Figure | | <1.5dB |
| Total Gain | | > 18 dBi |

9. Power Supply Requirement

BK-1612-15 requires a stable power supply, to avoid ripple on VCC pin (<50mVpp). Power supply noise can affect the receiver's sensitivity. Bypass capacitors of 10uF and 0.1uF is recommended placing close to the module VCC pin; the values could be adjusted according to the amount and type of noise present on the supply line.

10. Backup Supply

The purpose of backup supply voltage pin (VBAT) is to keep the SRAM memory and the RTC powered when the module is powered down. This enables the module to have a faster time-to-first-fix when the module is powered on again. The backup current drain is less than 12μA. In normal powered on state, the internal processor access the SRAM and current drain is higher in active mode.

11. 1pps Output

When using four or more satellites for 3D positioning , the rising edge of the pulse generating 1 pulse per second on 1PPS pins is aligned with the UTC seconds , and the accuracy is about 20nS. When it is not positioned, it outputs a constant low pulse.

12. Layout Guidelines

Separate RF and digital circuits into different PCB regions.

It is necessary to maintain 50-ohm impedance throughout the entire RF signal path. Try keeping the RF signal path as short as possible.

Do not route the RF signal line near noisy sources such as digital signals, oscillators, switching power supplies, or other RF transmitting circuit. Do not route the RF signal under or over any other components (including BK-1612-15), or other signal traces. Do not route the RF signal path on an inner layer of a multi-layer PCB to minimize signal loss. Avoid sharp bends for RF signal path. Make two 45-deg bends or a circular bend instead of a single 90-degree bend if needed.

Avoid via hole with RF signal path whenever possible. Every via adds inductive impedance. Via holes are acceptable for connecting the RF grounds between different layers. Each of the module's ground pins should have a short trace tying immediately to the ground plane below through a via hole.

The bypass capacitors should be low ESR ceramic types and located directly adjacent to the pin they are for.

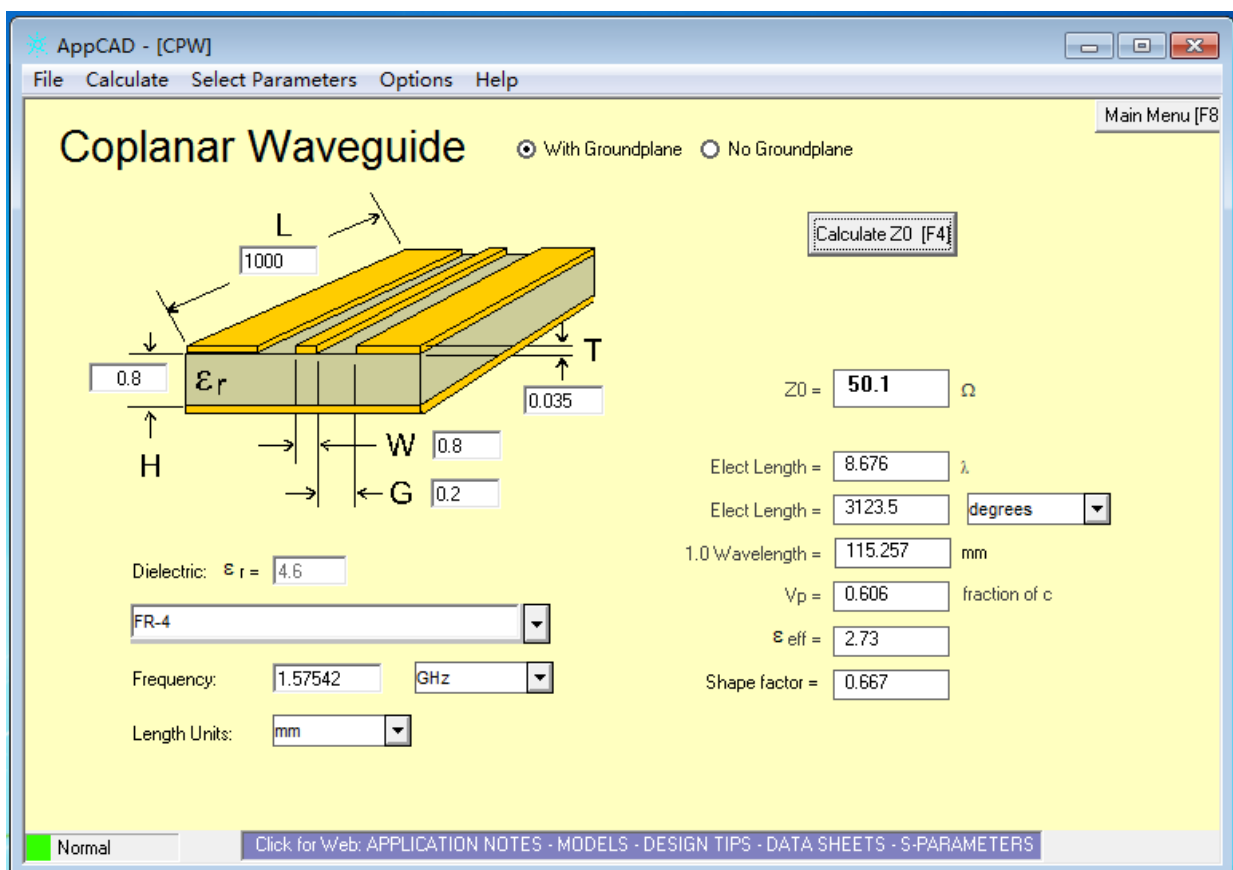


Figure 6: Requires of Antenna Design

13. ESD handling precautions

BK-1612-15 module is an Electrostatic Sensitive Device (ESD). Observe precautions for handling! Failure to observe these precautions can result in severe damage to the GPS receiver!

GPS receivers are Electrostatic Sensitive Devices (ESD) and require special precautions when handling. Particular care must be exercised when handling patch antennas, due to the risk of electrostatic charges. In addition to standard ESD safety practices, the following measures should be taken into account whenever handling the receiver:

- ✧ Unless there is a galvanic coupling between the local GND (i.e. the work table) and the PCB GND, then the first point of contact when handling the PCB must always be between the local GND and PCB GND.
- ✧ Before mounting antenna patch, connect ground of the device. When handling the RF pin, do not come into contact with any charged capacitors and be careful when contacting materials that can develop charges (e.g. patch antenna ~10pF, coax cable ~50-80pF/m, soldering iron.....)
- ✧ To prevent electrostatic discharge through the RF input, do not touch any exposed antenna area. If there is any risk that such exposed antenna area is touched in non-ESD protected work area, implement proper ESD protection measures in the design.
- ✧ When soldering RF connectors and patch antennas to the receiver’s RF pin, make sure to use an ESD safe soldering iron (tip).



Table 5: ESD Endurance Table (Temperature: 25°C, Humidity: 45%)

| Pin | Contact Discharge | Air Discharge |
|--------|-------------------|---------------|
| RF_IN | ±5KV | ±10KV |
| VCC | ±5KV | ±10KV |
| UART | ±3KV | ±6KV |
| Others | ±2KV | ±4KV |

14. Mechanical Dimensions

This chapter describes the mechanical dimensions of the module.

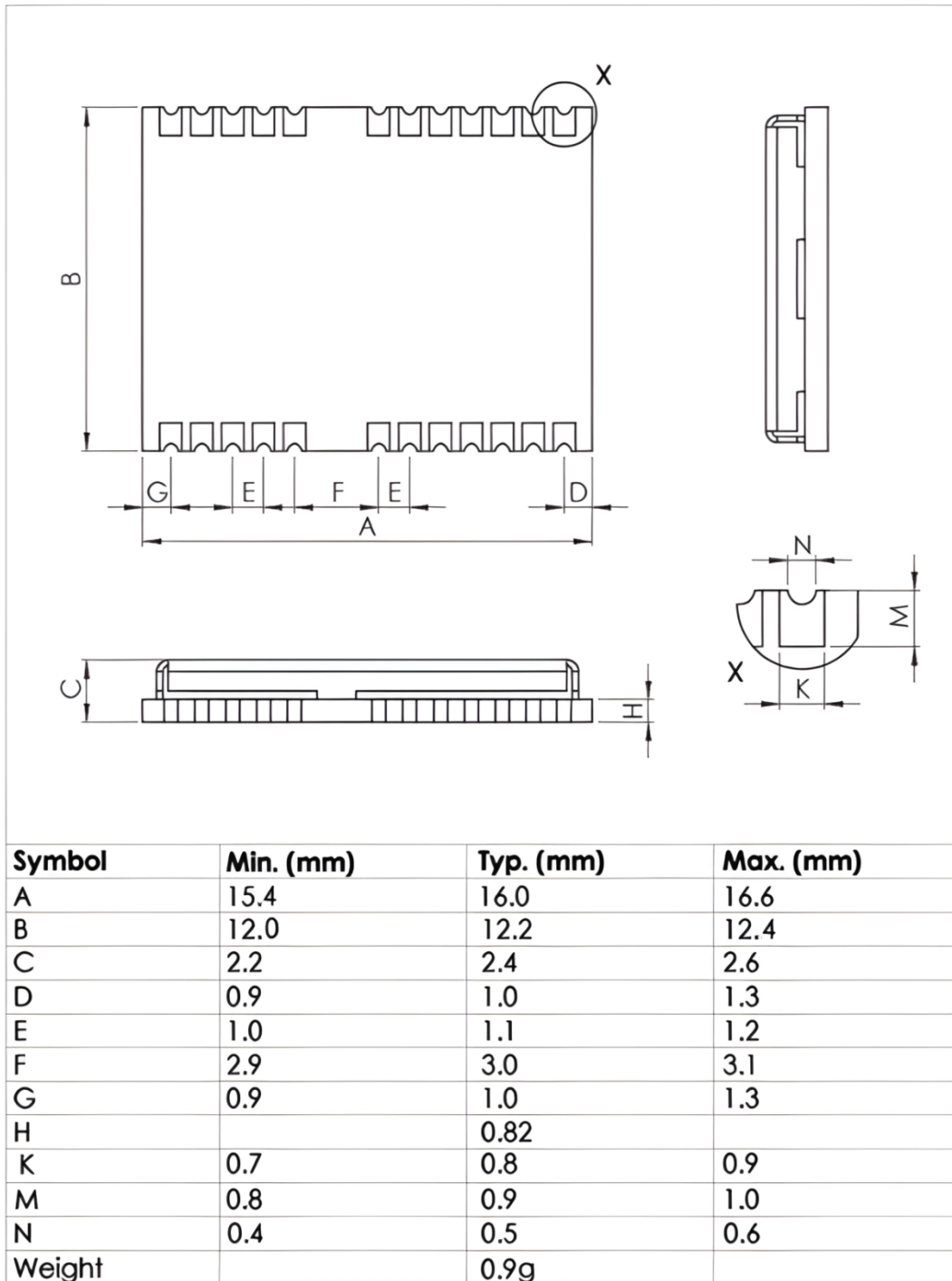


Figure 7: Top view Dimensions

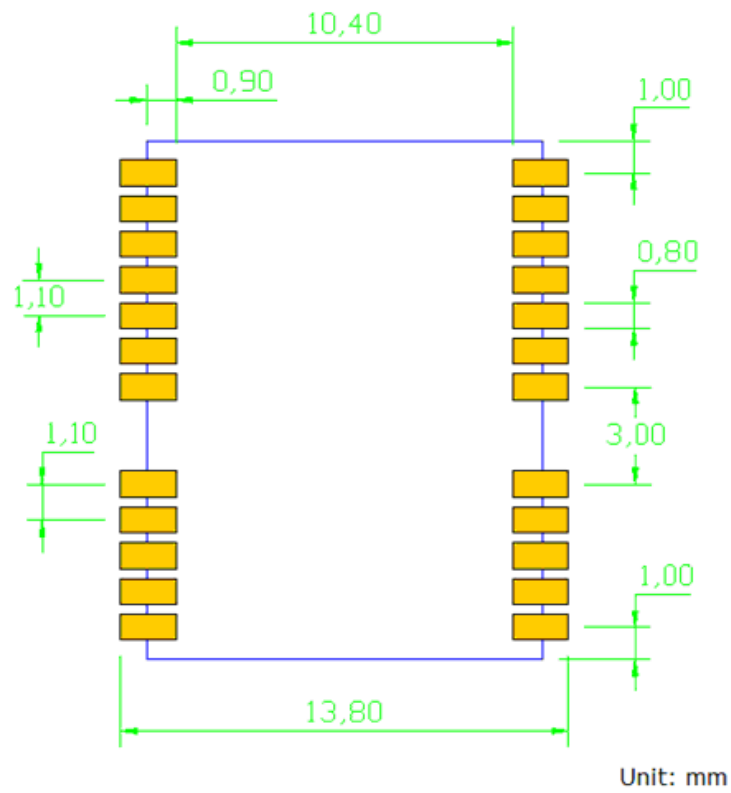


Figure 8: Footprint of Recommendation

Note: The recommended land pattern dimensions are shown for reference only, as actual pad layouts may vary depending on application.

15. Manufacturing, Packaging and Ordering Information

15.1 Assembly and Soldering

BK-1612-15 module is intended for SMT assembly and soldering in a Pb-free reflow process on the top side of the PCB. It is suggested that the minimum height of solder paste stencil is 100um to ensure sufficient solder volume. Pad openings of paste mask can be increased to ensure proper soldering and solder wetting over pads. It is suggested that the peak reflow temperature is 240°C (for Sn96.5Ag3.0Cu0.5 alloy). The absolute maximum reflow temperature is 260°C. To avoid damage to the module when it is repeatedly heated, it is suggested that the module should be mounted after reflow soldering for the other side of PCB has been completed. Recommended reflow soldering thermal profile is shown below:

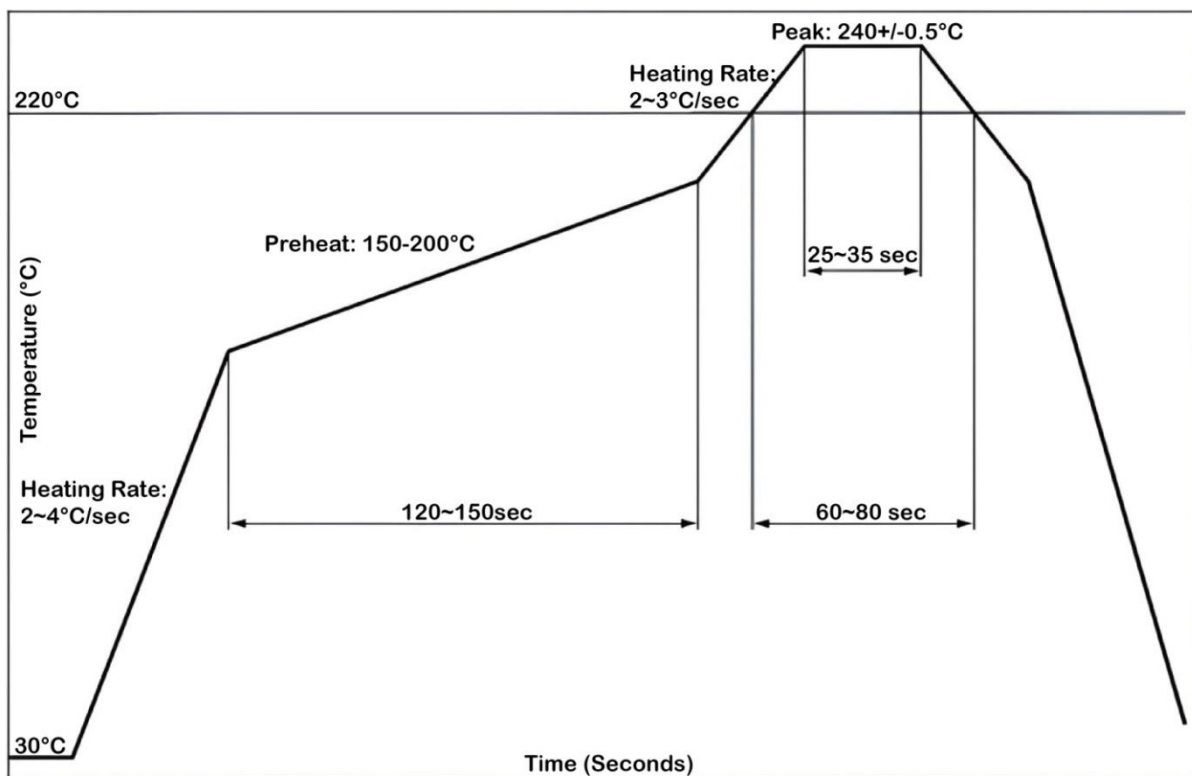


Figure 9: Recommended Reflow Soldering Thermal Profile

15.2 Moisture Sensitivity

BK-1612-15 module is sensitive to moisture, Level 3. To prevent BK-1612-15 from permanent damage during reflow soldering, baking before reflow soldering is required in the following cases:

- ✧ Humidity indicator card: One or more indicating spots are no longer blue.
- ✧ The seal is opened and the module is exposed to excessive humidity.

BK-1612-15 shall be baked for 192 hours in a cryogenic environment at 40°C+5°C/-0°C and <5%RH, or for 24 hours in a high-temperature environment at 125°C±5°C.

As the plastic packaging tape is not heat-resistant, the module should be removed from the tape before baking, otherwise, the tape will be damaged due to high temperature heating, you can also refer to the actual production technology of the SMT factory.

15.3 Tape and Reel Packaging

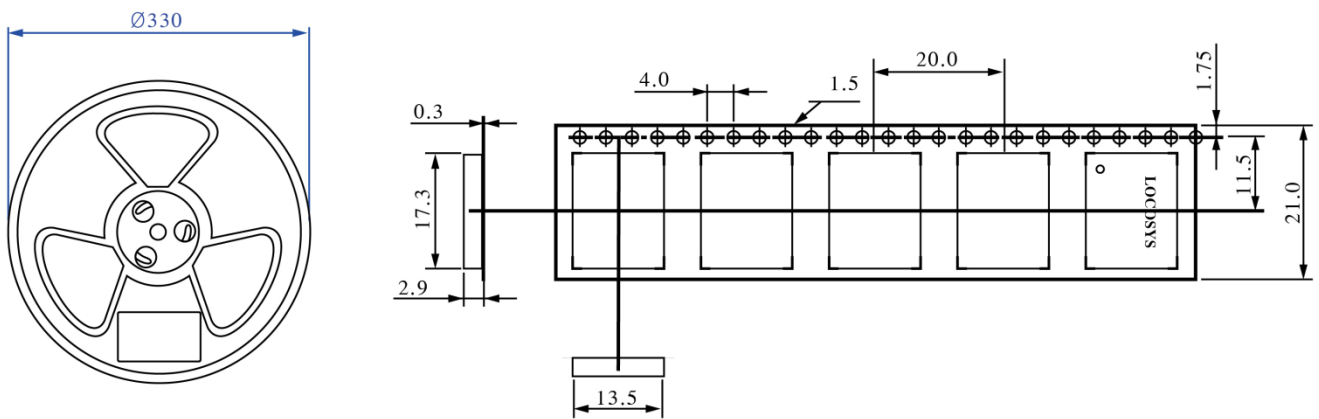


Figure 10: Tape and Reel Specifications



Figure 11: Packaging physical Figure

Table 6: Reel Packaging

| Model Name | MOQ for MP | Minimum Package: 1000pcs |
|------------|------------|--|
| BK-1612-15 | 1,000 pcs | Size: 365mm × 350mm × 53mm N.W: 0.90 kg G.W: 1.30 kg |

16. Software Interface

16.1 NMEA output message

Table 7: NMEA output message

| NMEA record | Description |
|-------------|--|
| GGA | Global Positioning System Fix Data |
| GSA | GNSS DOP and Active Satellites |
| GSV | GNSS Satellites in View |
| VTG | Course Over Ground and Ground Speed |
| RMC | Recommended Minimum Specific GNSS Data |
| GLL | Geographic position – Latitude / Longitude |
| ZDA | Time and Date |

- GGA – Global Positioning System Fix Data

Contains the values for the following example:

\$GNGGA,024954.000,2503.7126,N,12138.7464,E,2,55,0.4,144.070,M,0.000,M,,*73

| Name | Example | Description |
|-------------------|------------|---|
| Message ID | \$GNGGA | GGA protocol header |
| UTC Time | 024954.000 | UTC of position in hhmmss.sss format, (000000.000 ~ 235959.999) |
| Latitude | 2503.7126 | Latitude in ddmm.mmmm format Leading zeros transmitted |
| N/S Indicator | N | Latitude hemisphere indicator, 'N' = North, 'S' = South |
| Longitude | 12138.7464 | Longitude in dddmm.mmmm format Leading zeros transmitted |
| E/W Indicator | E | Longitude hemisphere indicator, 'E' = East, 'W' = West |
| Quality Indicator | 2 | Quality Indicator 0: position fix unavailable 1: valid position fix, SPS mode 2: valid position fix, differential GPS mode |
| Satellites Used | 55 | Number of satellites in use, (00 ~ 56) |
| HDOP | 0.4 | Horizontal dilution of precision, (0.0 ~ 99.9) |
| Altitude | 144.070 | mean sea level (geoid), |

| | | |
|------------------------------|-------|---|
| Units | M | Units of antenna altitude, meters |
| Geoidal Separation | 0.000 | Geoidal separation in meters |
| Units | M | Units of geoidal separation, meters |
| Age of Differential GPS data | | Age of Differential GPS data NULL when DGPS not used |
| DGPS Station ID | | Differential reference station ID, 0000 ~ 1023 |
| Checksum | 73 | |

● GSA – GNSS DOP and Active Satellites

Contains the values for the following example:

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

```
$GNGSA,A,3,01,02,03,04,06,07,08,09,10,11,12,13,0.7,0.4,0.6,4*35
```

```
$GNGSA,A,3,74,73,75,69,84,83,85,68,,,,0.7,0.4,0.6,2*39
```

```
$GNGSA,A,3,10,11,12,24,25,31,33,,,,,0.7,0.4,0.6,3*37
```

| Name | Example | Description |
|---------------------|--|---|
| Message ID | \$GNGSA | GSA protocol header |
| Mode | A | Mode 'M' = Manual, forced to operate in 2D or 3D mode 'A' = Automatic, allowed to automatically switch 2D/3D |
| Mode | 3 | Fix type 1 = Fix not available 2 = 2D 3 = 3D |
| Satellite used 1~12 | 21, 12, 15, 18, 20, 24, 10, 32, 25, 13 | 01 ~ 32 are for GPS 33 ~ 64 are for SBAS (PRN minus 87) 193 ~ 199 are for QZSS 65 ~ 88 are for GLONASS (GL PRN) 01 ~ 36 are for GALILEO (GA PRN) 01~ 37 are for BDS (BD PRN) |
| PDOP | 1.2 | Position dilution of precision (0.0 to 99.9) |
| HDOP | 0.7 | Horizontal dilution of precision (0.0 to 99.9) |
| VDOP | 1.0 | Vertical dilution of precision (0.0 to 99.9) |
| GNSS System ID | 1 | See below Table 8 |
| Checksum | 18 | |

Table 8: GNSS system ID

| Value | Description |
|-------|-------------|
| 1 | GPS |
| 2 | GLONASS |
| 3 | GALILEO |
| 4 | BEIDOU |

● GSV – GNSS Satellites in View

Contains the values for the following example:

```

$GPGSV,4,1,16,02,37,033,34,03,48,113,32,06,20,234,19,07,24,198,33,1*62
$GPGSV,4,2,16,14,63,328,28,17,38,315,28,18,00,000,00,19,19,291,26,1*61
$GPGSV,4,3,16,21,22,040,34,22,40,325,24,30,36,234,35,194,71,113,38,1*55
$GPGSV,4,4,16,195,71,045,37,196,31,148,30,199,60,168,33,57,00,000,31,1*57
$GPGSV,4,1,14,02,37,033,00,03,48,113,37,06,20,234,29,07,24,198,00,8*68
$GPGSV,4,2,14,14,63,328,40,17,38,315,00,19,19,291,00,21,22,040,00,8*64
$GPGSV,4,3,14,22,40,325,00,30,36,234,36,194,71,113,39,195,71,045,38,8*6B
$GPGSV,4,4,14,196,31,148,34,199,60,168,39,,,,,,,,,8*6C
$GBGSV,6,1,24,01,51,136,38,02,37,239,32,03,57,204,39,04,39,118,35,1*7C
$GBGSV,6,2,24,05,00,000,32,06,26,210,37,07,62,344,40,08,37,182,34,1*72
$GBGSV,6,3,24,09,31,224,37,10,51,323,40,11,17,264,34,12,53,316,41,1*7B
$GBGSV,6,4,24,13,27,191,36,16,23,203,37,19,07,057,35,21,13,158,34,1*78
$GBGSV,6,5,24,22,22,106,39,24,62,258,45,25,22,314,37,26,38,176,42,1*7D
$GBGSV,6,6,24,34,34,282,40,35,00,000,39,38,48,176,41,39,17,198,38,1*76
$GBGSV,3,1,12,19,07,057,23,21,13,158,29,22,22,106,30,24,62,258,38,3*7E
$GBGSV,3,2,12,25,22,314,29,26,38,176,33,34,34,282,31,35,00,000,30,3*7F
$GBGSV,3,3,12,38,48,176,34,39,17,198,28,40,56,008,35,44,55,360,36,3*7B
$GLGSV,2,1,08,74,71,294,38,73,52,175,42,75,19,330,29,69,09,111,35,1*74
$GLGSV,2,2,08,84,48,346,25,83,06,040,22,85,31,270,40,68,07,064,23,1*7B
$GAGSV,2,1,07,10,67,264,37,11,41,239,29,12,73,350,25,24,63,331,34,7*76
$GAGSV,2,2,07,25,11,320,25,31,60,126,31,33,23,037,26,,,,,7*47
$GAGSV,2,1,07,10,67,264,38,11,41,239,29,12,73,350,34,24,63,331,37,1*7C
$GAGSV,2,2,07,25,11,320,28,31,60,126,37,33,23,037,32,,,,,1*4F
    
```

| Name | Example | Description |
|--------------------|---------|---|
| Message ID | \$GPGSV | GSV protocol header GP=GPS/QZSS, GL=GLONASS, GA=GALILEO, GB=BEIDOU |
| Number of message | 4 | Total number of GSV messages to be transmitted |
| Sequence number | 1 | Sequence number of current GSV message |
| Satellites in view | 16 | Total number of satellites in view |

| | | |
|--------------|-----|---|
| Satellite ID | 02 | 01 ~ 32 are for GPS 33 ~ 64 are for SBAS (PRN minus 87) 193~ 199 are for QZSS 65 ~ 88 are for GLONASS (GL PRN) 01 ~ 36 are for GALILEO (GA PRN) 01 ~ 37 are for BDS (BD PRN) |
| Elevation | 37 | Satellite elevation in degrees, (00 ~ 90) |
| Azimuth | 033 | Satellite azimuth angle in degrees, (000 ~ 359) |
| SNR | 33 | C/No in dB (00 ~ 99) Null when not tracking |
| Signal ID | 1 | GPS/QZSS: L1 C/A=1, L5Q=8 GLONASS: L1 C/A=1 GALILEO: E1=7, E5a=1 BEIDOU: B1=1, B2a=3 |
| Checksum | 62 | |

● VTG – Course Over Ground and Ground Speed

Contains the values for the following example:

\$GNVTG,0.00,T,,M,0.00,N,0.00,K,D*26

| Name | Example | Description |
|--------------------|---------|--|
| Message ID | \$GNVTG | VTG protocol header |
| Course over ground | 0.00 | Course over ground, degrees True |
| Reference | T | True |
| Course over ground | | Course over ground, degrees Magnetic |
| Reference | M | Magnetic |
| Speed | 0.00 | Speed over ground in knots |
| Reference | N | Knots |
| Speed | 0.00 | Speed over ground in kilometers per hour |
| Reference | K | Kilometer per hour |
| Mode | D | Mode indicator 'N' = Data not valid 'A' = Autonomous mode 'D' = Differential mode |
| Checksum | 26 | |

● **RMC – Recommended Minimum Specific GNSS Data**

Contains the values for the following example:

```
$GNRMC,024954.000,A,2503.7126,N,12138.7464,E,0.00,0.00,140524,,,D,V*09
```

| Name | Example | Description |
|-------------------------------|------------|--|
| Message ID | \$GNRMC | RMC protocol header |
| UTC time | 024954.000 | UTC time in hhmmss.sss format (000000.00 ~ 235959.999) |
| Status | A | Status 'V' = Navigation receiver warning 'A' = Data Valid |
| Latitude | 2503.7126 | Latitude in ddmm.mmmm format Leading zeros transmitted |
| N/S indicator | N | Latitude hemisphere indicator 'N' = North 'S' = South |
| Longitude | 12138.7464 | Longitude in dddmm.mmmmm format Leading zeros transmitted |
| E/W Indicator | E | Longitude hemisphere indicator 'E' = East 'W' = West |
| Speed over ground | 0.00 | Speed over ground in knots |
| Course over ground | 0.00 | Course over ground in degrees |
| UTC Date | 140524 | UTC date of position fix, ddmmyy format |
| Magnetic variation | | degrees |
| Variation sense | | |
| Mode indicator | D | Mode indicator 'N' = Data not valid 'A' = Autonomous mode 'D' = Differential mode |
| Navigational status indicator | V | S = Safe C = Caution U = Unsafe V = Void |
| Checksum | 09 | |

● **GLL – Geographic position – Latitude / Longitude**

Contains the values for the following example:

\$GNGLL,2447.0870,N,12100.5221,E,175258.000,A,D*42

| Name | Example | Description |
|----------------|------------|--|
| Message ID | \$GNGLL | \$GNGLL protocol header |
| Latitude | 2447.0870 | Latitude in ddmm.mmmm format Leading zeros transmitted |
| N/S Indicator | N | Latitude hemisphere indicator 'N' = North 'S' = South |
| Longitude | 12100.5221 | Longitude in dddmm.mmmm format Leading zeros transmitted |
| E/W Indicator | E | Longitude hemisphere indicator 'E' = East 'W' = West |
| UTC Time | 175258.000 | UTC time in hhmmss.sss format (000000.000 ~ 235959.999) |
| Status | A | Status, 'A' = Data valid, 'V' = Data not valid |
| Mode Indicator | D | Mode indicator 'N' = Data not valid 'A' = Autonomous mode 'D' = Differential mode |
| Checksum | 42 | |

● **ZDA – Time and Date**

Contains the values for the following example:

\$GNZDA,091100.000,14,05,24,00,00*47

| Name | Example | Description |
|-----------------|------------|--|
| Message ID | \$GNZDA | ZDA protocol header |
| UTC time | 091100.000 | UTC time in hhmmss.ss format (000000.00 ~ 235959.99) |
| UTC Day | 14 | UTC time: day (01 ~ 31) |
| UTC Month | 05 | UTC time: month (01 ~ 12) |
| UTC Year | 24 | UTC time: year (2 last digit format) |
| Local zone hour | 00 | Local zone hours (00 ~ +/- 13) |
| one minutes | 00 | Local zone minutes (00 ~59) |
| Checksum | 47 | |

17. Document change list

Revision 0.1

- Draft release on May 16, 2024.

Revision 0.2 (May 23, 2024)

- Added section 4.3.

Revision 0.3 (Aug 09, 2024)

- Added the description of GNSS chip compliant with AEC-Q100 in section 2.

Revision 0.4 (Aug 19, 2024)

- Changed the acquisition current from 12mA to 24mA in section 6.
- Changed the tracking current from 25mA to 32mA in section 6.
- Revised the GSV protocol header from BD=BEIDOU to GB=BEIDOU in section 16.1.