



Datasheet of SO-1612-15


Version 0.1


2024/11/8

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1. Introduction

SO-1612-15 is a dual-band GNSS positioning receiving modules that a capable of tracking all global civil navigation systems (BDS, GPS, GLONASS, Galileo, QZSS, IRNSS and SBAS) in all band bands. Built-in highly integrated GNSS receiving chip supports the third generation Beidou Satellite Navigation System (BDS-3).

SO-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 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.

SO-1612-15 module contains CXD5610GF 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.

2. Features

- Build on high performance, low-power CXD5610GF chip set
- Build-in LNA & SAW filter
- Ultra high Track sensitivity: -167dBm
- Concurrent reception of dual-band and multi- system satellite signals
- Supports all global civil GNSS signals
- Supports BDS-3 signal
- Extremely fast TTFF at low signal level
- Multipath detection and suppression
- Works with passive and active antenna

- NMEA-0183 4.11 compliant protocol
- Operating voltage: 2.8V to 3.6V
- SMD type with stamp holes
- Small form factor: 16×12.2×2.4mm
- Operating temperature -40 ~ +85°C
- 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"> 80 tracking channels with fast search engine
GNSS reception	<ul style="list-style-type: none"> GPS/QZSS : L1C/A,L5 GLONASS : L1OF GALILEO : E1B/C,E5a BEIDOU : B1I, B2A,BIC QZSS : L1C/A, L1C/B ,L5 IRNSS : L5 SBAS : WAAS, EGNOS, MSAS, GAGAN
NMEA Messages	<ul style="list-style-type: none"> GGA/GLL/GSA/GSV/RMC/VTG/ZDA
Update rate	<ul style="list-style-type: none"> GNSS : 1Hz Maximum
Position accuracy ⁽¹⁾ ,	<ul style="list-style-type: none"> GNSS : 1.5m CEP SBAS : 1.5m CEP
Velocity ⁽²⁾ & Time accuracy	<ul style="list-style-type: none"> GNSS : 0.1m/s CEP SBAS : 0.05 m/s 1PPS : 20 ns
Time to First Fix (TTFF) ^{(1),(3)}	<ul style="list-style-type: none"> Hot start : 1 s Cold start : 20 s AGPS : 1.5 s
Sensitivity ⁽¹⁾	<ul style="list-style-type: none"> Cold start : -149dBm Hot start : -156dBm Tracking & navigation : -167dBm
GNSS Operating limit	<ul style="list-style-type: none"> Velocity : 150 m/s Altitude : 18,000 m
Dynamics	<ul style="list-style-type: none"> ≤4G 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 961200bps, 115200bps by default. NMEA 0183 Protocol Ver. 4.11, Sony GNSS Receiver Protocol Supports batch data report mode
Temperature Range	<ul style="list-style-type: none"> Normal operation : -40°C ~ +85°C Storage temperature : -40°C ~ +85°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

Note (1): Demonstrated using a good external LNA and measured at room temperature.

The external LNA gain, including cable losses, should be from 15 dB to 50 dB (15 dB to 25 dB is recommended for noise)

Note (2): 50% at 30 m/s for dynamic operation.

Note (3): All satellites at -130 dBm. GPS always in combination with QZSS and SBAS. Measured at room temperature.

4.2 Block Diagram

The SO-1612-15 is a high performance (BDS, GPS, GLONASS, Galileo, QZSS, IRNSS and SBAS) in all bands (L1, L5). satellite navigation receiver in a compact surface mount package. It is based on the CXD5610GF positioning technology, providing high performance signal acquisition and tracking. The simple UART serial interface and the standard NMEA-0183 protocol make usage of SO-1612-15 very easy and straightforward.

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

Block Diagram

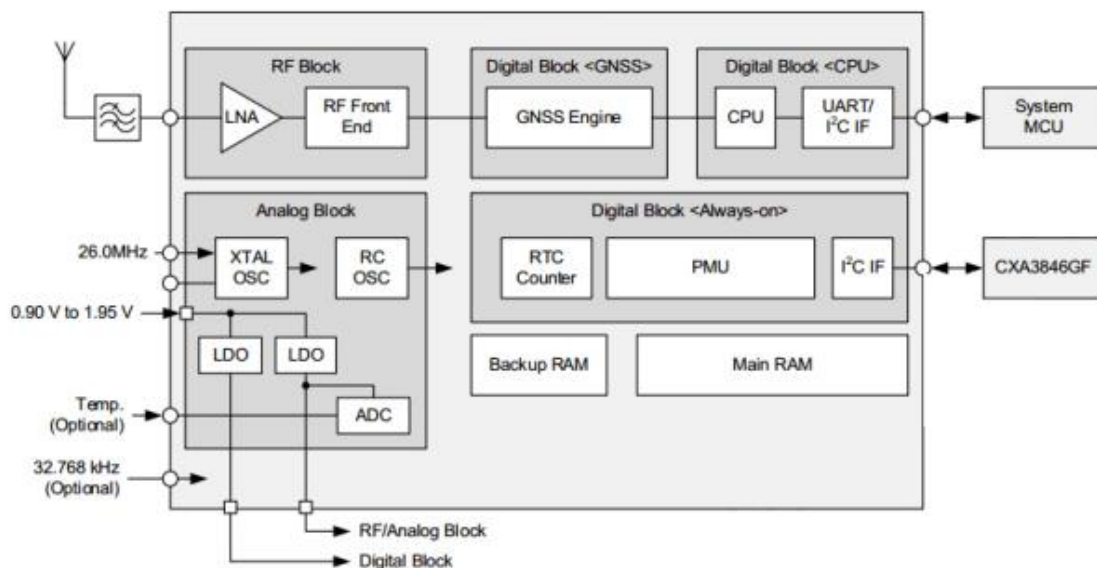


Figure 1: Block Diagram

4.3 Reference Circuit

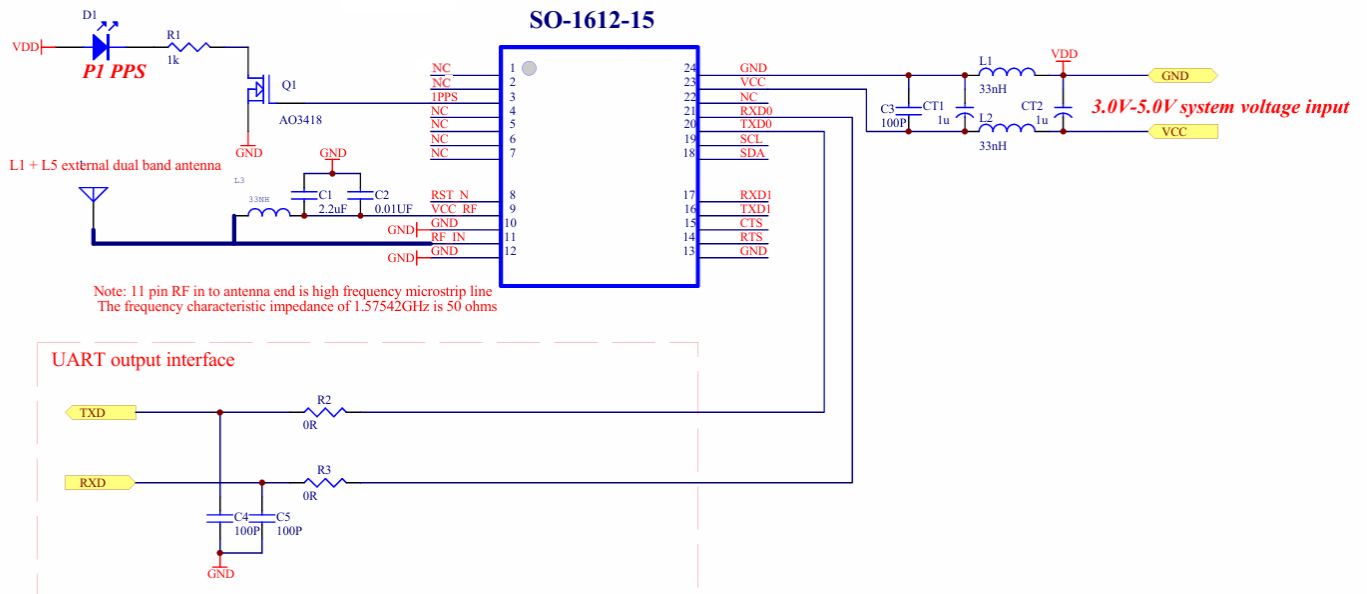


Figure 2: Reference Circuit

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

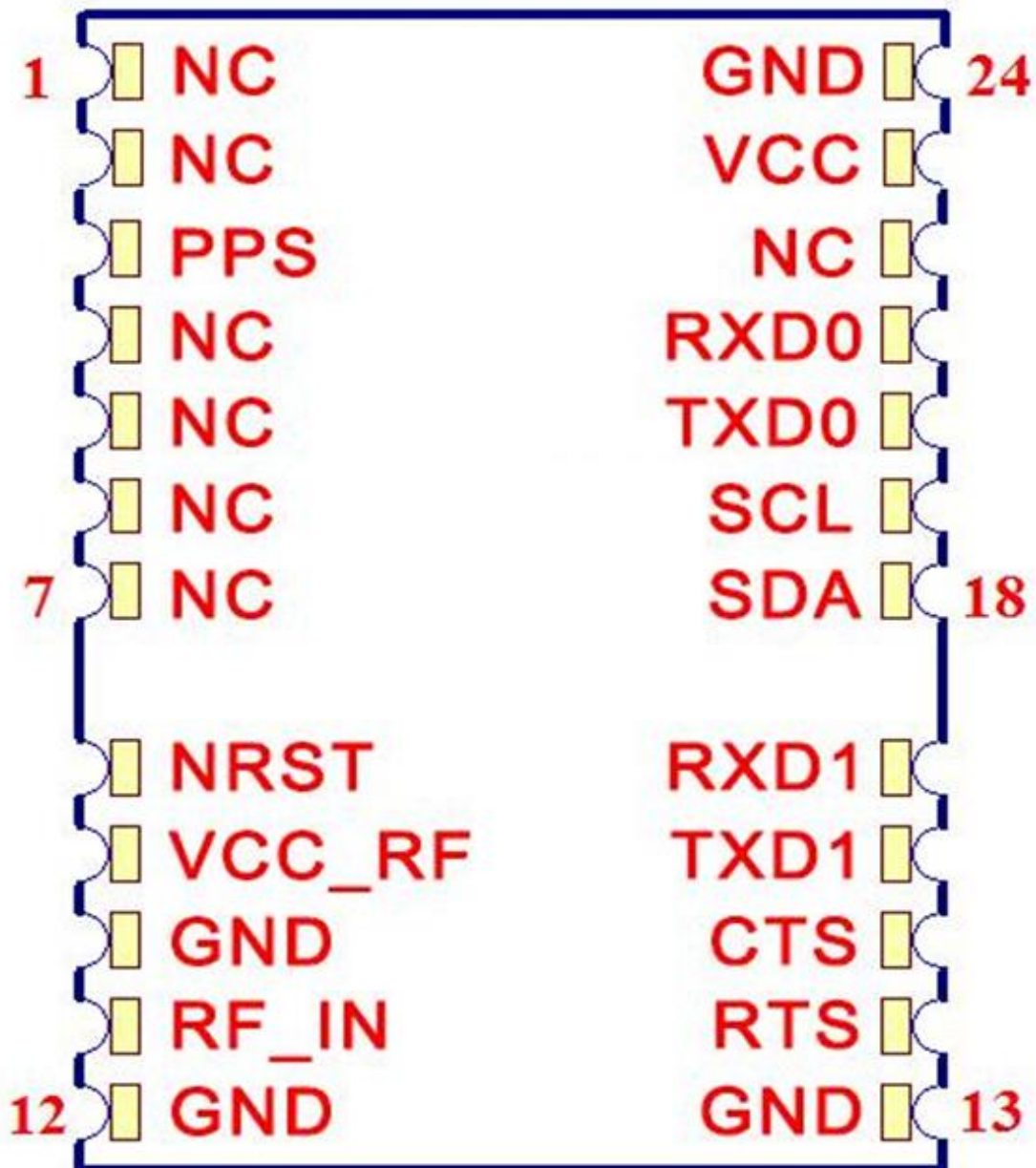


Figure 3: Pin Assignment

5.2 Pin Definition

Table 2: Pin Definition

Pin No.	Name	Description
1	NC	No connect
2	NC	No connect
3	PPS	PPS output (default pulse width 200ms , the range 125ms~900ms)
4,5,6,7	NC	No connect
8	NRST	RESET (active high 1.8V), leave it vacant when not in use
9	VCC_RF	Active antenna power supply, 3.0-3.6V
10	GND	Power GND
11	RF_IN	L1+L5 RF input
12	GND	Power GND
13	GND	Power GND
14	RTS	Serial port UART_RTS port, leave it vacant when not in use
15	CTS	Serial port UART_CTS port, leave it vacant when not in use
16	TXD1	Serial port UART_TXD1 port, leave it vacant when not in use
17	RXD1	Serial port UART_RXD1 port, leave it vacant when not in use
18	SDA	Serial port I2C_SDA port, leave it vacant when not in use
19	SCL	Serial port I2C_SCL port, leave it vacant when not in use
20	TXD0	Serial port UART_TXD0 port
21	RXD0	Serial port UART_RXD0 port
22	NC	No connect
23	VCC	Working voltage : 2.8-3.6V, Recommended use : 3.3V
24	GND	Power GND

6. DC Electrical Specification

Table 3: Operating Conditions

Parameter	Min	Typ	Max	Unit
Supply Voltage (VCC)	2.8	3.3	3.6	Volt
Acquisition Current (exclude active antenna current)		29		mA
Tracking Current (exclude active antenna current)		23		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		+25	dBm
Storage Temperature	-40	+85	°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.

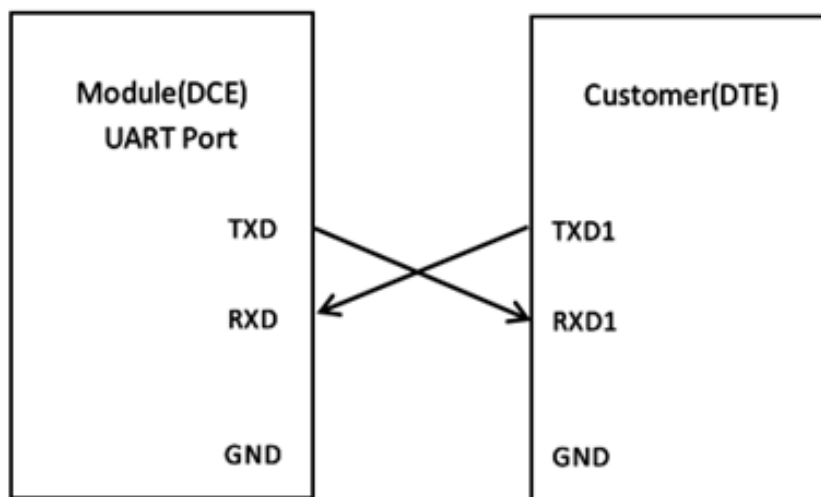


Figure 4: Serial Port connection

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, GLL, GSA, GSV, RMC, VTG, ZDA
- UART port supports the following data rates:
9600, 14400, 19200, 38400, 57600, 115200, 961200 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.

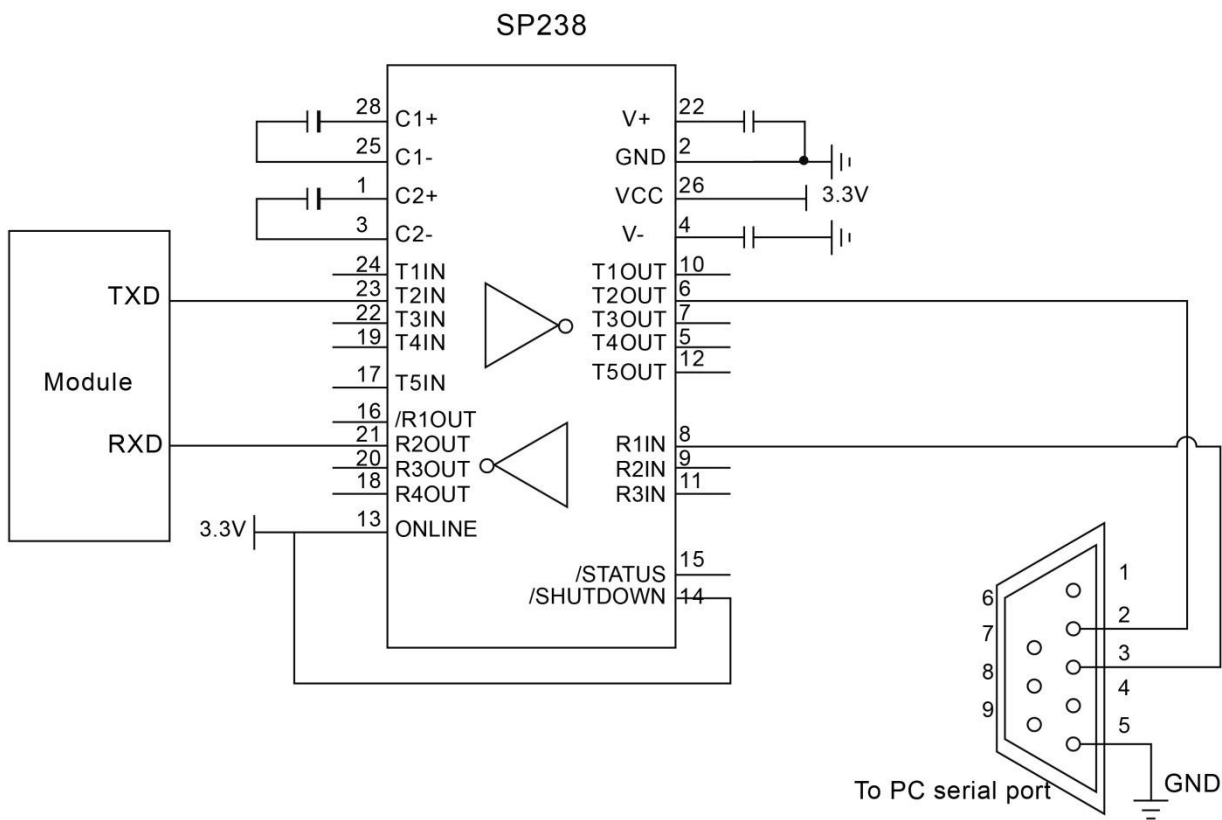


Figure 5: RS-232 Level Shift Circuit

8. Antenna Consideration

The SO-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 SO-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 15 ~ 25dB and noise figure less than 1.5dB can be used with SO-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) 1176.45 +/- 2 (B2A)	1561.098 +/- 2 (B1I) 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)
IRNSS Frequency (MHz)	1176.45 +/-12 (L5)	1176.45 +/-12 (L5)
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

SO-1612-15 requires a stable power supply, avoid ripple on VCC pin (<50mVpp). Power supply noise can affect the receiver's sensitivity. Bypass capacitors of 10uF and 0.1uF is recommended to be placed 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. 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.

11. 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 SO-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.

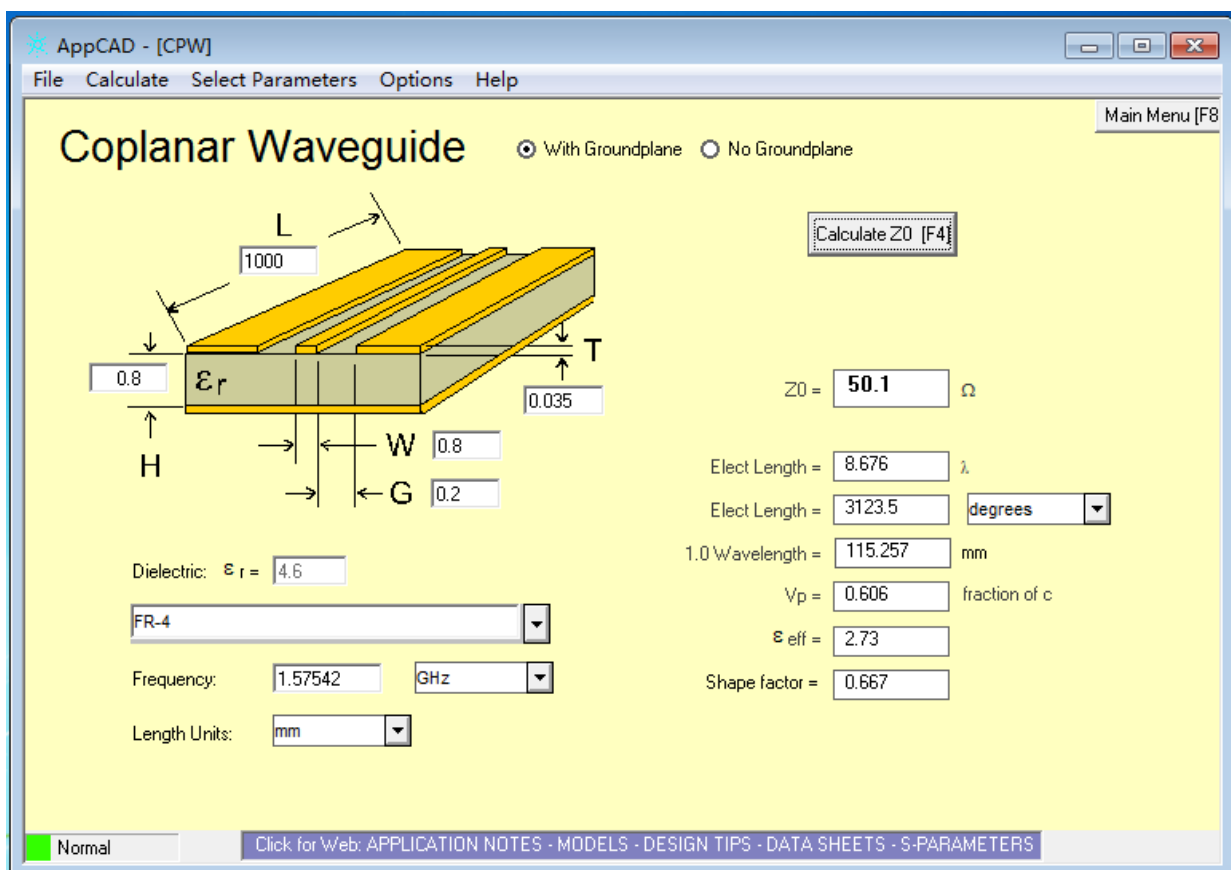


Figure 6: Requires of Antenna Design

12. ESD handling precautions

SO-1612-15 module are Electrostatic Sensitive Devices (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

13. Mechanical Dimensions

This chapter describes the mechanical dimensions of the module.

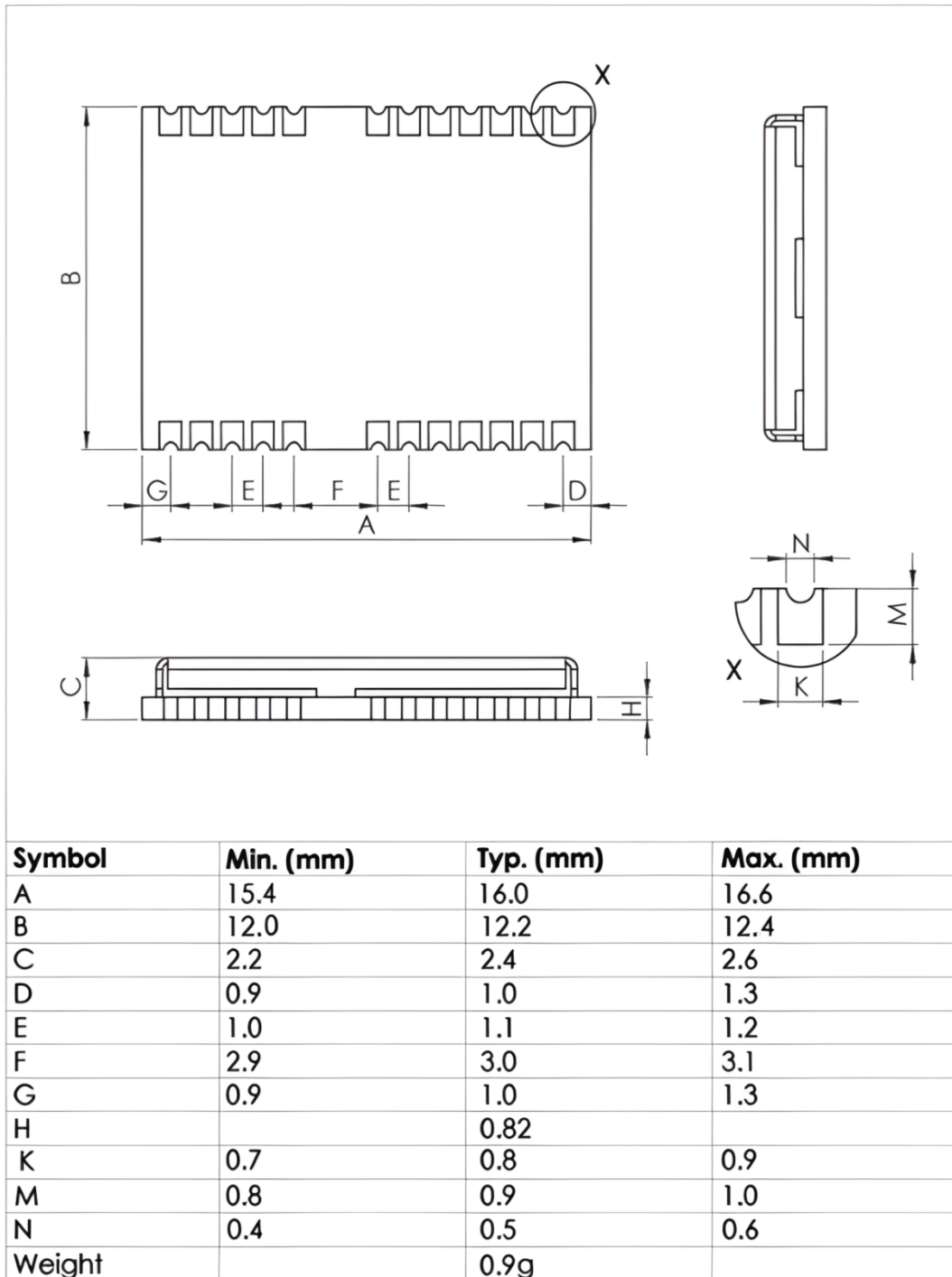


Figure 7: Top view Dimensions

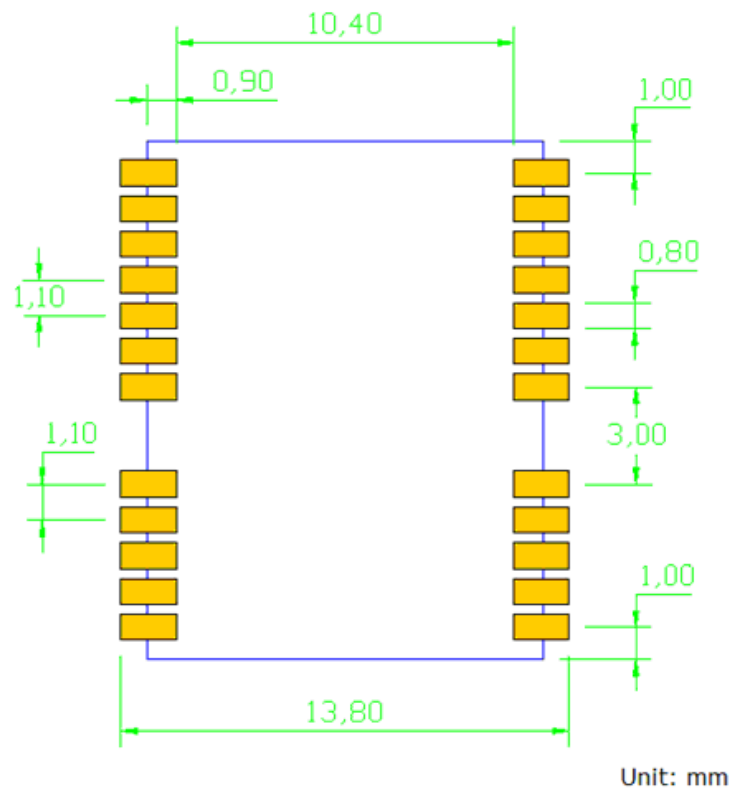


Figure 8: Footprint of Recommendation

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

14. Manufacturing, Packaging and Ordering Information

14.1 Assembly and Soldering

SO-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:

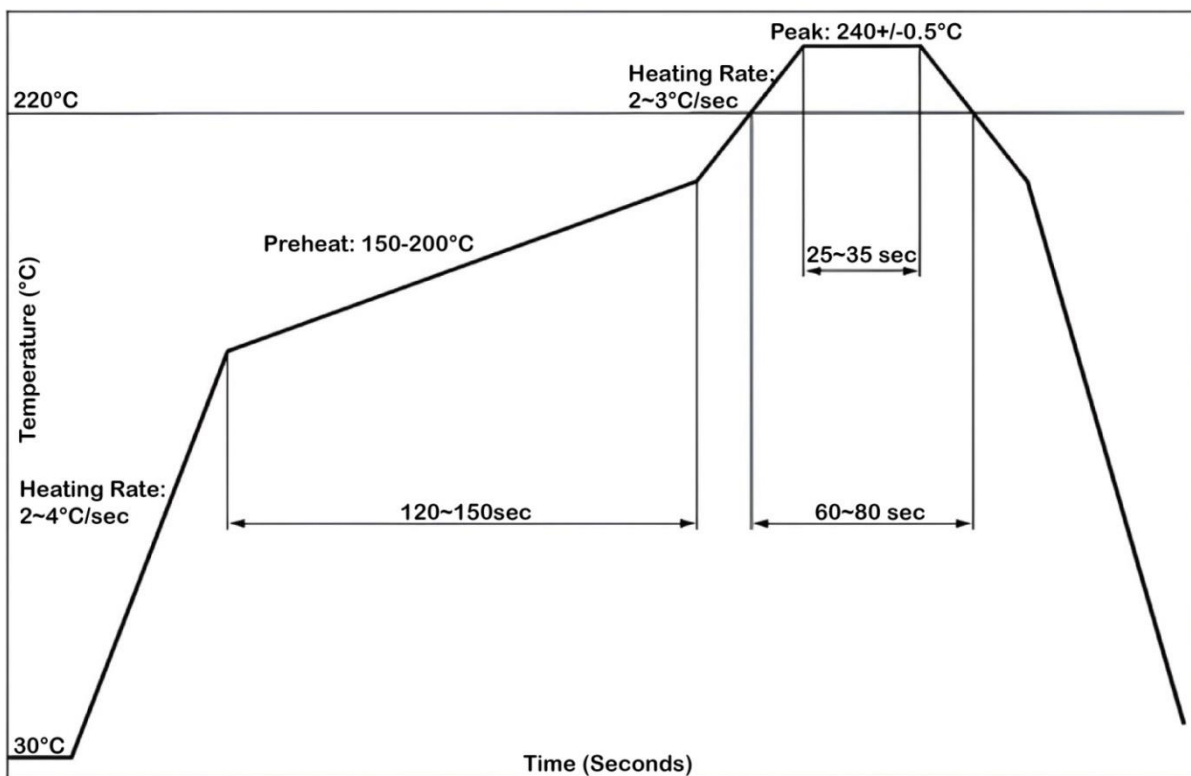


Figure 9: Recommended Reflow Soldering Thermal Profile

14.2 Moisture Sensitivity

SO-1612-15 module is sensitive to moisture, Level 3. To prevent SO-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.

SO-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.

14.3 Tape and Reel Specifications

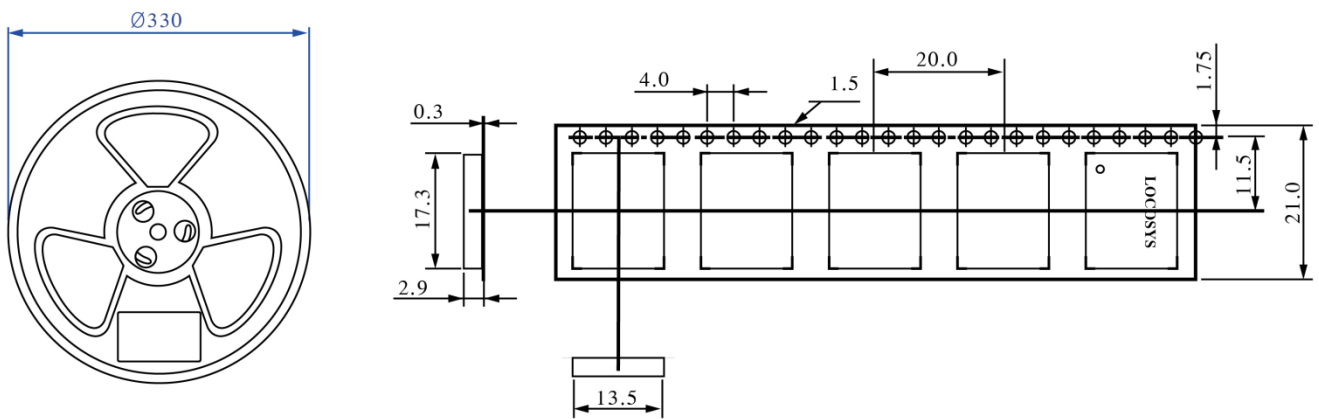


Figure 10: Tape and Reel Specifications



Figure 11: Packaging physical Figure

Table 6: Reel Packaging

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

15. Software Interface

15.1 NMEA output message

Table 7: NMEA output message

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

- **GGA---** Global Positioning System Fixed Data

Contains the values for the following example:

\$GPGGA,071921.00,2503.7110,N,12138.7440,E,1,23,0.6,133.2,M,17.0,M,,*6F

Table 8: GGA Data Format

Name	Example	Units	Description
Message ID	\$GPGGA		GGA protocol header
UTC Time	071921.00		hhmmss.ss
Latitude	2503.7110		ddmm.mmmm
N/S indicator	N		N=north or S=south
Longitude	12138.7440		dddmm.mmmm
E/W Indicator	E		E=east or W=west
Position Fix Indicator	1		See Table 9
Satellites Used	23		Number of satellites in view
HDOP	0.6	meters	Horizontal Dilution of Precision
MSL Altitude	133.2	meters	Antenna Altitude above/below mean-sea-level (geoid)
Units	M	meters	Units of antenna altitude
Geoidal Separation	17.0	meters	
Units	M	meters	Units of geoidal separation
Age of diff. GNSS data		second	Null fields when DGPS is not used
Diff. Ref. Station ID			Differential reference station ID, 0000-1023

Checksum	*6F		Checksum
<CR> <LF>			End of message termination

Table 9: Position Fix Indicators

Value	Description
0	No position fix
1	Autonomous GNSS fix
2	Differential GNSS fix
6	Estimated/Dead reckoning fix

● **GLL--- Geographic Position – Latitude/Longitude**

Contains the values for the following example:

\$GNGLL,2503.7110,N,12138.7440,E,071921.00,A,A*76

Table 10: GLL Data Format

Name	Example	Units	Description
Message ID	\$GNGLL		GLL protocol header
Latitude	2503.7110		ddmm.mmmm
N/S indicator	N		N=north or S=south
Longitude	12138.7440		dddmm.mmmm
E/W indicator	E		E=east or W=west
UTC Time	071921.00		hhmmss.ss
Status	A		A=data valid or V=data not valid
Mode	A		N = No position fix A = Autonomous GNSS fix D = Differential GNSS fix E = Estimated/Dead reckoning fix
Checksum	*76		
<CR> <LF>			End of message termination

● **GSA---GNSS DOP and Active Satellites**

Contains the values for the following example:

\$GNRSA,A,3,10,12,15,18,23,24,25,28,32,,1.2,0.6,1.0,1*31

\$GNRSA,A,3,73,,,,,,,,,1.2,0.6,1.0,2*32

\$GNRSA,A,3,04,09,,,,,,,,,1.2,0.6,1.0,3*3A

\$GNGSA,A,3,13,16,21,26,38,39,45,,,,,1.2,0.6,1.0,4*32

\$GNGSA,A,3,02,03,04,07,,,,,,1.2,0.6,1.0,5*33

Table 11: GSA Data Format

Name	Example	Units	Description
Message ID	\$GNGSA		GSA protocol header
Mode 1	A		See Table 12
Mode 2	3		See Table 13
ID of satellite used	19		SV on Channel 1
ID of satellite used	195		SV on Channel 2
ID of satellite used			SV on Channel 12
PDOP	0.81		Position Dilution of Precision
HDOP	0.44		Horizontal Dilution of Precision
VDOP	0.68		Vertical Dilution of Precision
GNSS system ID	1		See Table 14
Checksum	*31		
<CR> <LF>			End of message termination

Table 12: Mode 1

Value	Description
M	Manually set to operate in 2D or 3D mode
A	Automatically switching between 2D or 3D mode

Table 13: Mode 2

Value	Description
1	No position fix
2	2D fix
3	3D fix

Table 14: GNSS system ID

Value	Description
1	GPS
2	GLONASS
3	GALILEO
4	BEIDOU
5	QZSS
6	IRNSS

- GSV---GNSS Satellites in View

Contains the values for the following example:

```
$GPGSV,3,1,10,10,43,327,46,12,41,108,45,15,19,081,,18,28,199,40,1*68
$GPGSV,3,2,10,23,82,012,46,24,38,036,43,25,37,156,41,28,22,234,39,1*60
$GPGSV,3,3,10,32,27,302,42,45,,42,,,,,,,,,1*51
$GPGSV,3,1,9,10,43,327,,12,41,108,,15,19,081,,18,28,199,,7*51
$GPGSV,3,2,9,23,82,012,,24,38,036,,25,37,156,,28,22,234,32,7*55
$GPGSV,3,3,9,32,27,302,,,,,,,,,,,,,7*6E
$GLGSV,3,1,9,70,10,101,,71,40,057,,72,38,350,,73,33,037,46,1*4F
$GLGSV,3,2,9,74,69,091,,75,35,185,,86,11,215,,87,20,263,,1*4E
$GLGSV,3,3,9,88,06,316,,,,,,,,,,,,,1*73
$GQGSV,1,1,4,02,36,135,42,03,27,175,41,04,77,067,44,07,60,167,38,1*58
$GQGSV,1,1,1,56,,43,,,,,,,,,,,,,4*55
$GQGSV,1,1,4,02,36,135,35,03,27,175,33,04,77,067,41,07,60,167,41,7*50
$GBGSV,5,1,17,06,63,265,,07,07,187,,08,86,000,,09,50,247,,1*73
$GBGSV,5,2,17,11,12,258,,12,08,207,,13,72,324,46,16,67,275,45,1*72
$GBGSV,5,3,17,21,60,043,,22,25,102,,24,22,207,,26,71,173,48,1*78
$GBGSV,5,4,17,34,10,234,,38,76,152,47,39,70,303,47,42,36,326,,1*77
$GBGSV,5,5,17,45,43,049,,,,,,,,,,,,,1*4B
$GBGSV,5,1,17,06,63,265,,07,07,187,,08,86,000,,09,50,247,,3*71
$GBGSV,5,2,17,11,12,258,,12,08,207,,13,72,324,,16,67,275,,3*73
$GBGSV,5,3,17,21,60,043,46,22,25,102,,24,22,207,,26,71,173,45,3*75
$GBGSV,5,4,17,34,10,234,,38,76,152,44,39,70,303,45,42,36,326,43,3*73
$GBGSV,5,5,17,45,43,049,43,,,,,,,,,,,,,3*4E
$GBGSV,5,1,17,06,63,265,,07,07,187,,08,86,000,,09,50,247,,5*77
$GBGSV,5,2,17,11,12,258,,12,08,207,,13,72,324,,16,67,275,,5*75
$GBGSV,5,3,17,21,60,043,40,22,25,102,35,24,22,207,35,26,71,173,39,5*7E
$GBGSV,5,4,17,34,10,234,28,38,76,152,40,39,70,303,40,42,36,326,38,5*72
$GBGSV,5,5,17,45,43,049,38,,,,,,,,,,,,,5*44
$GAGSV,3,1,10,04,40,046,43,05,12,285,,09,48,332,45,10,23,188,,7*7B
$GAGSV,3,2,10,11,38,215,40,12,06,171,,24,17,180,,31,42,127,43,7*76
$GAGSV,3,3,10,34,05,323,,36,37,281,43,,,,,,,,,7*7F
$GAGSV,3,1,10,04,40,046,37,05,12,285,29,09,48,332,39,10,23,188,32,1*7F
$GAGSV,3,2,10,11,38,215,32,12,06,171,,24,17,180,29,31,42,127,36,1*7C
$GAGSV,3,3,10,34,05,323,31,36,37,281,35,,,,,,,,,1*7A
$GIGSV,1,1,1,03,,37,,,,,,,,,,,,,1*4B
```

Table 15: GSV Data Format

Name	Example	Units	Description
Message ID	\$GPGSV		GSV protocol header GP=GPS, GL=GLONSS, GA=GALILEO, GB=BEIDOU, GQ=QZSS, GI=IRNSS.
Total number of messages	3		Range 1 to 9
Message number	1		Range 1 to 9
Satellites in view	10		
Satellite ID	10		Channel 1
Elevation	43	degrees	Channel 1 (Range 00 to 90)
Azimuth	327	degrees	Channel 1 (Range 000 to 359)
SNR (C/No)	46	dB-Hz	Channel 1 (Range 00 to 99, null when not tracking)
Satellite ID	12		Channel 4
Elevation	41	degrees	Channel 4 (Range 00 to 90)
Azimuth	108	degrees	Channel 4 (Range 000 to 359)
SNR (C/No)	45	dB-Hz	Channel 4 (Range 00 to 99, null when not tracking)
Signal ID	1		GPS: L1 C/A=1, L5-I=7 GLONASS: L1 C/A=1 GALILEO: L1-BC=7,E5a=1 BEIDOU: B1I=1, B1C=3, B2a=5 QZSS : L1 C/A=1, LIS=4, L5-I=7 IRNSS : L5-SPS=1
Checksum	*68		
<CR> <LF>			End of message termination

- **RMC---Recommended Minimum Specific GNSS Data**

Contains the values for the following example:

```
$GNRMC,091424.00,A,2503.7151,N,12138.7485,E,0.0,126.4,230824,,A,V*3F
```

Table 16: RMC Data Format

Name	Example	Units	Description
Message ID	\$GNRMC		RMC protocol header
UTC Time	091424.00		hhmmss.ss
Status	A		A=data valid or V=data not valid
Latitude	2503.7151		ddmm.mmm
N/S Indicator	N		N=north or S=south
Longitude	12138.7485		dddmm.mmmm
E/W Indicator	E		E=east or W=west
Speed over ground	0.0	knots	True
Course over ground	126.4	degrees	
Date	230824		ddmmyy
Magnetic variation		degrees	
Variation sense			E=east or W=west
Mode	A		N = No position fix A = Autonomous GNSS fix D = Differential GNSS fix E = Estimated/Dead reckoning fix
Navigational status indicator	V		S = Safe C = Caution U = Unsafe V = Void
Checksum	*3F		
<CR> <LF>			End of message termination

● **VTG---Course Over Ground and Ground Speed**

Contains the values for the following example:

\$GNVTG,126.4,T,,M,0.0,N,0.0,K,A*12

Table 17: VTG Data Format

Name	Example	Units	Description
Message ID	\$GNVTG		VTG protocol header
Course over ground	126.4	degrees	Measured heading
Reference	T		True
Course over ground		degrees	Measured heading

Reference	M		Magnetic
Speed over ground	0.0	knots	Measured speed
Units	N		Knots
Speed over ground	0.0	km/hr	Measured speed
Units	K		Kilometer per hour
Mode	A		N = No position fix A = Autonomous GNSS fix D = Differential GNSS fix E = Estimated/Dead reckoning fix
Checksum	*12		
<CR> <LF>			End of message termination

● ZDA---GNSS time and date

Contains the values for the following example:

\$GNZDA,091424.00,23,08,2024,*,*7F

Table 18: ZDA Data Format

Name	Example	Units	Description
Message ID	\$GNZDA		ZDA protocol header
UTC Time	091424.00		hhmmss.ss
Day	23		UTC day ,dd
Month	08		UTC Month,mm
Year	2024		UTC Year,yyyy
Local zone hours			
Local zone minutes			
Checksum	*7F		
<CR> <LF>			End of message termination

16. Document change list

Revision 0.1

- Draft release on Nov 08, 2024.