TG621S Family GNSS Module

Data Sheet

GPS : TG621S

GPS/Beidou : TG621S-BD

Revision 0.3

Features

- 167 Acquisition/Tracking Channels
- Support QZSS, WAAS, MSAS, EGNOS, GAGAN
- 16 million time-frequency hypothesis testing per sec
- -148dBm cold start sensitivity
- -165dBm tracking sensitivity
- 29 second cold start TTFF
- 3.5 second TTFF with AGPS
- 1 second hot start
- 2.5m CEP accuracy
- Multipath detection and suppression
- Jamming detection and mitigation
- Self-Aided Ephemeris Estimation
- Contains LNA, SAW Filter, TCXO, RTC Xtal, Regulator
- Works with active and passive antenna
- Complete receiver in 12.2mm x 16.0mm size
- Operating temperature -40 ~ +85ºC
- Pb-free RoHS compliant

Applications

- Navigation and asset tracking
- Timing reference

TG621S

High-Performance Low-Cost 167 Channel SMD Global Positioning Receiver Module

The TG621S family is state-of-the-art global navigation satellite system receivers capable of using GPS or GPS/ Beidou signal under the same footprint. User can upgrade from GPS navigation system to GPS/Beidou dual-satellite navigation systems by choosing appropriate model type without hardware redesign.

The TG621S-BD tracks up to 24 GPS/Beidou satellite signals combined respectively.

Dual-satellite navigation receiver module receives greater number of satellites than available for GPS-only receivers. The increased satellite number offers superior performance in challenging urban canyon and multipath environments.

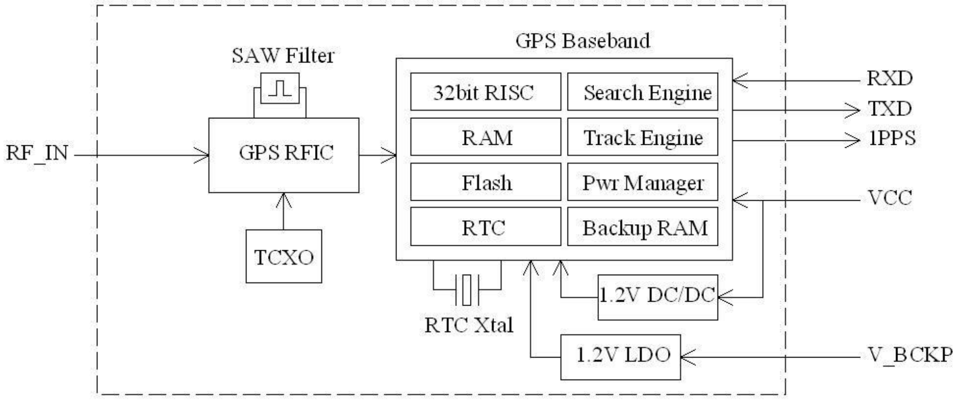
The TG621S module contains XND2200CQM positioning engine inside, featuring high sensitivity for indoor fix, low power consumption, and fast TTFF. The superior -148dBm cold start sensitivity allows it to acquire, track, and get position fix autonomously in difficult weak signal environment. The receiver's -165dBm tracking sensitivity allows continuous position coverage in nearly all application environments. The high performance signal parameter search engine is capable of testing 16 million time-frequency hypotheses per second, offering industry-leading signal acquisition and TTFF speed.

The TG621S module contains LNA for easy integration with passive antenna and a SAW filter for increased jamming immunity. It works with both passive and active antenna.

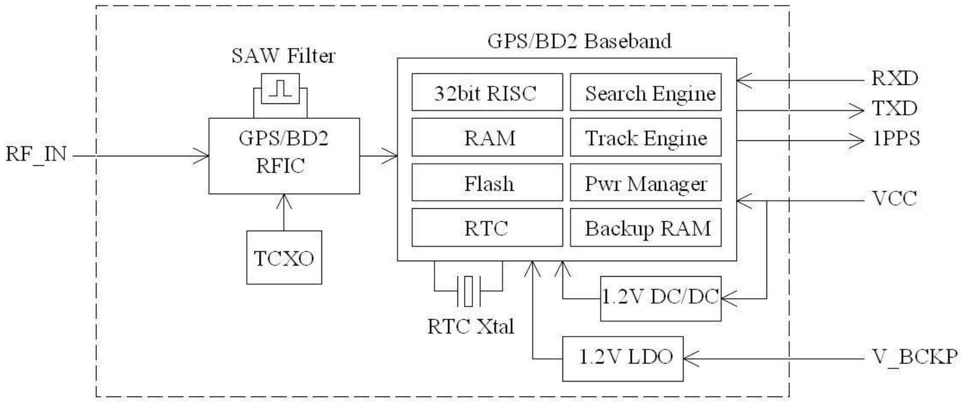
TECHNICAL SPECIFICATIONS

Receiver Type	L1 C/A code, 167-channel Venus 8 engine
Receiver Modes	GPS or GPS/Beidou, depending on model selection
Augmentation System	QZSS, WAAS, EGNOS, MSAS, GAGAN
Accuracy	Position 2.5m CEP Velocity 0.1m/sec Time 10ns
Startup Time	1 / 28 / 29 second hot / warm / cold start under open sky average
Reacquisition	1s
Sensitivity	-148dBm cold-start -160dBm re-acquisition -165dBm tracking
Multi-path Mitigation	Advanced multi-path detection and suppression
A-GPS	Self-aided ephemeris estimation (Flash type)
Update Rate	1 / 2 / 4 / 5 / 8 / 10 / 20 / 25 / 40 / 50 Hz for GPS (default 1Hz) 1 / 2 / 4 / 5 / 8 / 10 / 20 Hz for GPS/Beidou (default 1Hz)
Dynamics	4G (39.2m/sec^2)
Operational Limits	Altitude < 18,000m or velocity < 515m/s, not exceeding both
Serial Interface	3.3V LVTTL level
Protocol	NMEA-0183 V3.01, SWID binary, 9600 baud, 8, N, 1
Datum	Default WGS-84, User definable
Input Voltage	3.3V DC +/-10%
Current Consumption	45mA acquisition, 39mA tracking
Dimension	16.0mm L x 12.2mm W
Weight:	1.6g
Operating Temperature	-40°C ~ +85°C
Storage Temperature	-55 ~ +100°C
Humidity	5% ~ 95%

BLOCK DIAGRAM



TG621S



TG621S-BD

The TG621S is a high performance satellite navigation receiver in a compact surface mount package. It is based on the XND2200CQM positioning technology, providing exceptional signal acquisition performance, and continuous operation even in dense foliage and urban canyons. The module includes internal SAW filter and high performance integrated LNA, works with both active and passive antenna. The simple UART serial interface and the standard NMEA-0183 protocol make usage of TG621S very easy and straightforward.

The TG621S module performs all the necessary system initialization, signal acquisition, signal tracking, data demodulation, and calculation of navigation solution autonomously.

ELECTRICAL SPECIFICATIONS

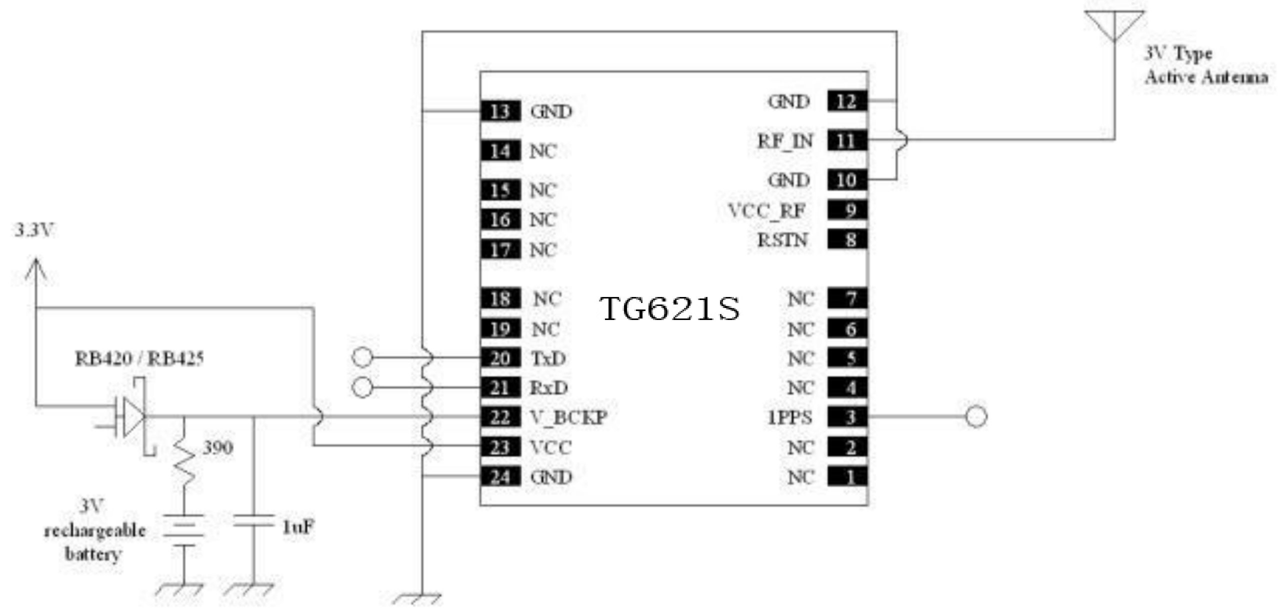
ABSOLUTE MAXIMUM RATINGS

Parameter	Minimum	Maximum	Condition
Supply Voltage (VCC)	-0.5	3.6	Volt
Backup Battery Voltage (V_BCKP)	-0.5	3.6	Volt
Input Pin Voltage	-0.5	VCC+0.5	Volt
Input Power at RF_IN		+5	dBm
Storage Temperature	-55	+100	degC

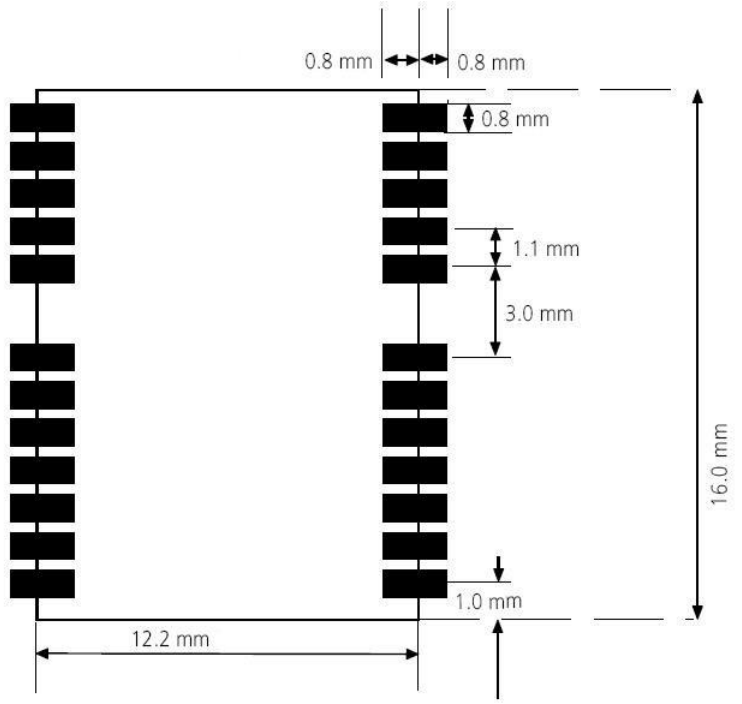
OPERATING CONDITIONS

Parameter	Min	Typ	Max	Unit
Supply Voltage (VCC)	3	3.3	3.6	Volt
Acquisition Current (exclude active antenna current)		45		mA
Tracking Current (exclude active antenna current)		39		mA
Backup Voltage (V_BCKP)	2.5		3.6	Volt
Backup Current (VCC voltage applied)			0.5	mA
Backup Current (VCC voltage off)			35	uA
Output Low Voltage			0.4	Volt
Output HIGH Voltage	2.4			Volt
Input LOW Voltage			0.8	Volt
Input HIGH Voltage	2			Volt
Input LOW Current	-10		10	uA
Input HIGH Current	-10		10	uA
RF Input Impedance (RF_IN)		50		Ohm

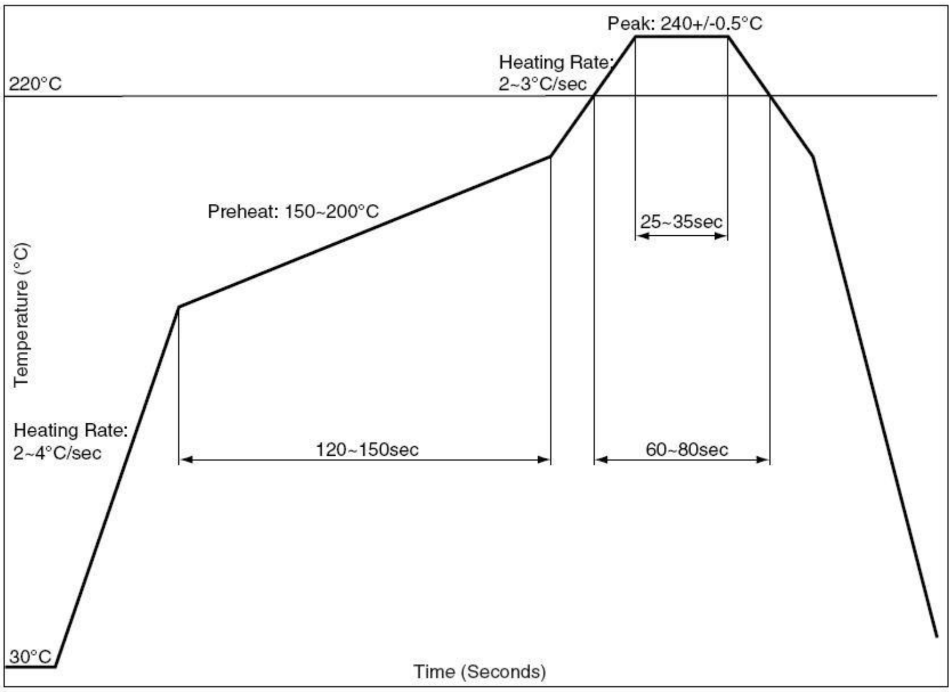
APPLICATION CIRCUIT



RECOMMANDED FOOTPRINT



RECOMMANDED REFLOW PROFILE



The reflow profile shown above should not be exceeded, since excessive temperatures or transport times during reflow can damage the module. Cooling temperature fall rate: max 3°C / sec

ANTENNA CONSIDERATIONS

The TG621S is designed to use with a wide variety of active and passive antennas, but care must be taken during antenna selection to ensure optimum signal reception performance. There are many choices of antenna configurations; the best choice is often a tradeoff between size, gain, bandwidth and cost. The best way is to test multiple antenna solutions in the configuration of the final system to determine which provides the best overall performance.

Ceramic patch antenna is low-cost and provides good sensitivity. 50-ohm output ceramic patch antenna can be connected directly to RF input of the module. Usually the antenna and TG621S 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 GPS/Beidou or GPS operation, frequency bandwidth of the antenna needs to cover 1559MHz ~ 1577MHz or 1574MHz ~ 1577MHz 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.

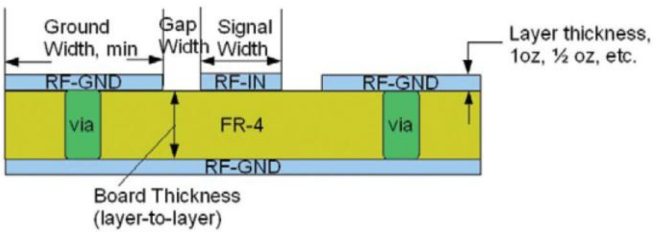
Active antenna is essentially a passive antenna with built-in LNA and a coaxial cable to connect the antenna to the module. It has the flexibility of being located remotely from the module, but requires antenna power. Active antenna usually costs more than passive patch antenna, but the performance in low signal environments is usually better. When using active antenna, an external bias choke inductor is used to provide DC bias for the active antenna. Active antenna with gain up to 30dB and noise figure less than 1.5dB can be used with TG621S.

Chip antenna is often desired for its small size. Matching element of the chip antenna needs to be designed-in according to the chip antenna datasheet. If application doesn’t have a large ground plane as shown in the datasheet for the measured performance spec condition, testing will be needed to determine if it can provide acceptable performance with the smaller sized application PCB.

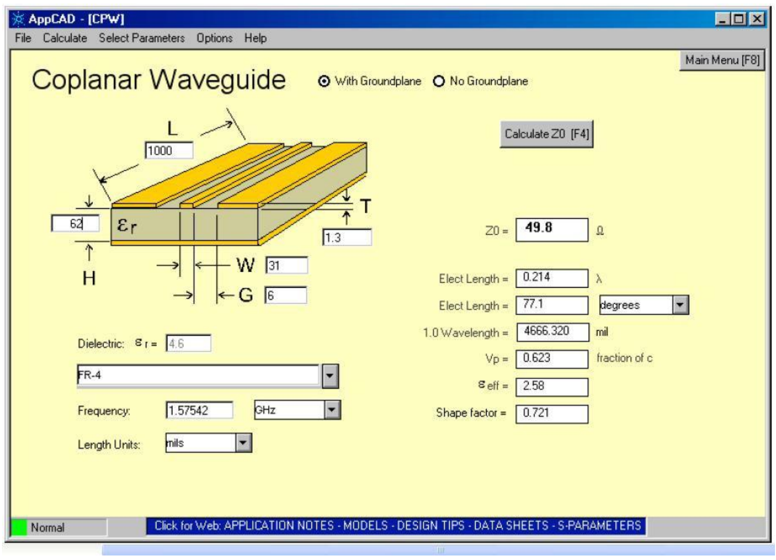
	TG621S		TG621S-BD	
Antenna Type	Passive	Active	Passive	Active
GPS Frequency (MHz)	1575.42 +/- 2	1575.42 +/- 2	1575.42 +/- 2	1575.42 +/- 2
Beidou Frequency (MHz)			1561.098 +/- 3	1561.098 +/- 3
GLONASS Frequency (MHz)				

VSWR	< 2 (typical)	< 2 (typical)	< 2 (typical)	< 2 (typical)
Polarization	RHCP or Linear	RHCP or Linear	RHCP or Linear	RHCP or Linear
Antenna Gain	> 0dBi	> -2dBi	> 0dBi	> -2dBi
LNA Gain		20dB (typical)		20dB (typical)
Noise Figure		< 1.5dB		< 1.5dB
Total Gain		> 18dBi		> 18dBi

The signal path from antenna to RF input of TG621S is the most critical part of application design. The goal is to provide optimal 50-ohm match between a 50Ω antenna and the module 50-ohm RF input for maximum power transfer. The 50-ohm grounded coplanar wave guide, consisting of the RF input signal with RF ground on either sides and a RF ground underneath, is a good choice for efficiency.



For a two-layer FR4 PCB design with 1.6mm thickness, 4.6 dielectric constant, and 1oz copper the RF-input trace should be 31mil in width, the gap to the adjacent grounds should be 6mil, and each of the RF grounds should be at least twice the width of the input signal trace (62mil). Freeware program such as AppCAD can be used to calculate values required for other configurations.



POWER SUPPLY REQUIREMENT

TG621S 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.

BACKUP SUPPLY

The purpose of backup supply voltage pin (V_BCKP) 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 35µA. In normal powered on state, the internal processor access the SRAM and current drain is higher in active mode

1PPS OUTPUT

A 1 pulse per second signal (4ms HIGH duration) is generated on 1PPS pin when the receiver has 3D position fix using 4 or more satellites. The rising edge of the pulse is aligned with UTC second, with accuracy of about 10nsec. It outputs constant LOW when no position fix is available.

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 TG621S), 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 vias with RF signal path whenever possible. Every via adds inductive impedance. Vias are acceptable for connecting the RF grounds between different layers. Each of the module's ground pins should have short trace tying immediately to the ground plane below through a via.

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

HANDLING GUIDELINE

The TG621S modules are rated MSL4, must be used for SMT reflow mounting within 72 hours after taken out from the vacuumed ESD-protective moisture barrier bag in factory condition < 30degC / 60% RH. If this floor life time is exceeded, or if the received ESD-protective moisture barrier bag is not in vacuumed state, then the device need to be pre-baked before SMT reflow process. Baking is to be done at 85degC for 8 to 12 hours. Once baked, floor life counting begins from 0, and has 72 hours of floor life at factory condition < 30degC / 60% RH.

TG621S module is ESD sensitive device and should be handled with care.

NMEA Output Description

The output protocol supports NMEA-0183 standard. The implemented messages include GGA, GLL, GSA, GSV, VTG, RMC, ZDA and GNS messages. The NMEA message output has the following sentence structure:

$aaccc,c–c*hh<CR><LF>

The detail of the sentence structure is explained in Table 1.

Table 1: The NMEA sentence structure

character	HEX	Description
"$"	24	Start of sentence.
Aaccc		Address field. "aa" is the talker identifier. "ccc" identifies the sentence type.
","	2C	Field delimiter.
C–c		Data sentence block.
"*"	2A	Checksum delimiter.
Hh		Checksum field.
<CR><LF>	0D0A	Ending of sentence. (carriage return, line feed)

Table 2: Overview of SWID receiver's NMEA messages for TG621S

$GPGGA	Time, position, and fix related data of the receiver.
$GPGLL	Position, time and fix status.
$GPGSA	Used to represent the ID's of satellites which are used for position fix.
$GPGSV	Satellite information about elevation, azimuth and CNR
$GPRMC	Time, date, position, course and speed data.
$GPVTG	Course and speed relative to the ground.
$GPZDA	UTC, day, month and year and time zone.

Table 3: Overview of SWID receiver's NMEA messages for TG621S-BD

$GNGGA	Time, position, and fix related data of the receiver.
$GNGLL	Position, time and fix status.
$GNGSA **$GPGSA** **$BDGSA**	Used to represent the ID's of satellites which are used for position fix. When both GPS and Beidou satellites are used in position solution, a $GNGSA sentence is used for GPS satellites and another $GNGSA sentence is used for Beidou satellites. When only GPS satellites are used for position fix, a single $GPGSA sentence is output. When only Beidou satellites are used, a single $BDGSA sentence is output.
$GPGSV **$BDGSV**	Satellite information about elevation, azimuth and CNR, $GPGSV is used for GPS satellites, while $BDGSV is used for Beidou satellites
$GNRMC	Time, date, position, course and speed data.
$GNVTG	Course and speed relative to the ground.
$GNZDA	UTC, day, month and year and time zone.

The formats of the supported NMEA messages are described as follows:

GGA – Global Positioning System Fix Data

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

Format:

$--GGA,hhmmss.sss,llll.llll,a,yyyyy.yyyy,a,x,uu,v.v,w.w,M,x.x,M,,zzzz*hh<CR><LF>

Field	**Name**	**Description**
hhmmss.sss	UTC Time	UTC of position in hhmmss.sss format, (000000.000 ~ 235959.999)
llll.llll	Latitude	Latitude in ddmm.mmmm format. Leading zeros are inserted.
A	N/S Indicator	'N' = North, 'S' = South
yyyyy.yyyy	Longitude	Longitude in dddmm.mmmm format. Leading zeros are inserted.
A	E/W Indicator	'E' = East, 'W' = West
x	GPS quality indicator	GPS quality indicator 0: position fix unavailable 1: valid position fix, SPS mode 2: valid position fix, differential GPS mode
uu	Satellites Used	Number of satellites in use, (00 ~ 24)
v.v	HDOP	Horizontal dilution of precision, (0.0 ~ 99.9)
w.w	Altitude	Mean sea level altitude (-9999.9 ~ 17999.9) in meter
x.x	Geoidal Separation	In meter
zzzz	DGPS Station ID	Differential reference station ID, 0000 ~ 1023 NULL when DGPS not used
hh	Checksum	

GLL – Geographic Position – Latitude/Longitude

Latitude and longitude of vessel position, time of position fix and status.

Format:

$--GLL,llll.llll,a,yyyyy.yyyy,b,hhmmss.sss,A,a*hh<CR><LF>

Field	**Name**	**Description**
llll.llll	Latitude	Latitude in ddmm.mmmm format. Leading zeros are inserted.
A	N/S Indicator	'N' = North, 'S' = South
yyyyy.yyyy	Longitude	Longitude in dddmm.mmmm format. Leading zeros are inserted.
B	E/W Indicator	'E' = East, 'W' = West
hhmmss.sss	UTC Time	UTC of position in hhmmss.sss format, (000000.000 ~ 235959.999)
A	Status	A= data valid, V= Data not valid
hh	Checksum	

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.

Format:

$--GSA,a,x,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,u.u,v.v,z.z*hh<CR><LF>

Field	Name	Description
a	Mode	Mode 'M' = Manual, forced to operate in 2D or 3D mode 'A' = Automatic, allowed to automatically switch 2D/3D
x	Mode	Fix type 1 = Fix not available 2 = 2D 3 = 3D
xx's	Satellite ID	01 ~ 32 are for GPS; 33 ~ 64 are for WAAS (PRN minus 87); 65 ~ 96 are for GLONASS (64 plus slot numbers); 193 ~ 197 are for QZSS; 01 ~ 37 are for Beidou (BD PRN). GPS and Beidou satellites are differentiated by the GP and BD prefix. Maximally 12 satellites are included in each GSA sentence.
u.u	PDOP	Position dilution of precision (0.0 to 99.9)
v.v	HDOP	Horizontal dilution of precision (0.0 to 99.9)
z.z	VDOP	Vertical dilution of precision (0.0 to 99.9)
hh	Checksum	

GSV – GNSS Satellites in View

Number of satellites (SV) in view, satellite ID numbers, elevation, azimuth, and SNR value. Four satellites maximum per transmission.

Format:

$--GSV,x,u,xx,uu,vv,zzz,ss,uu,vv,zzz,ss,…,uu,vv,zzz,ss*hh<CR><LF>

Field	Name	Description
x	Number of message	Total number of GSV messages to be transmitted (1-4)
u	Sequence number	Sequence number of current GSV message
xx	Satellites in view	Total number of satellites in view (00 ~ 16)
uu	Satellite ID	01 ~ 32 are for GPS; 33 ~ 64 are for WAAS (PRN minus 87); 65 ~ 96 are for GLONASS (64 plus slot numbers); 193 ~ 197 are for QZSS; 01 ~ 37 are for Beidou (BD PRN). GPS and Beidou satellites are differentiated by the GP and BD prefix. Maximally 4 satellites are included in each GSV sentence.
vv	Elevation	Satellite elevation in degrees, (00 ~ 90)
zzz	Azimuth	Satellite azimuth angle in degrees, (000 ~ 359)
ss	SNR	C/No in dB (00 ~ 99) Null when not tracking
hh	Checksum	

RMC – Recommended Minimum Specific GNSS Data

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

Format:

$--RMC,hhmmss.sss,x,llll.llll,a,yyyyy.yyyy,a,x.x,u.u,xxxxxx,,,v*hh<CR><LF>

Field	Name	Description
hhmmss.sss	UTC time	UTC time in hhmmss.sss format (000000.000 ~ 235959.999)
x	Status	Status 'V' = Navigation receiver warning 'A' = Data Valid
llll.llll	Latitude	Latitude in dddmm.mmmm format. Leading zeros are inserted.
A	N/S indicator	'N' = North; 'S' = South
yyyyy.yyyy	Longitude	Longitude in dddmm.mmmm format. Leading zeros are inserted.
A	E/W Indicator	'E' = East; 'W' = West
x.x	Speed over ground	Speed over ground in knots (000.0 ~ 999.9)
u.u	Course over ground	Course over ground in degrees (000.0 ~ 359.9)
xxxxxx	UTC Date	UTC date of position fix, ddmmyy format
v	Mode indicator	Mode indicator 'N' = Data not valid 'A' = Autonomous mode 'D' = Differential mode 'E' = Estimated (dead reckoning) mode
hh	checksum	

VTG – Course Over Ground and Ground Speed

The actual course and speed relative to the ground.

Format:

$--VTG,x.x,T,y.y,M,u.u,N,v.v,K,m*hh<CR><LF>

Field	Name	Description
x.x	Course	Course over ground, degrees True (000.0 ~ 359.9)
y.y	Course	Course over ground, degrees Magnetic (000.0 ~ 359.9)
u.u	Speed	Speed over ground in knots (000.0 ~ 999.9)
v.v	Speed	Speed over ground in kilometers per hour (0000.0 ~ 1800.0)
m	Mode	Mode indicator 'N' = not valid 'A' = Autonomous mode 'D' = Differential mode 'E' = Estimated (dead reckoning) mode
hh	Checksum	

ZDA – Time and Date

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

Format:

$--ZDA,hhmmss.sss,dd,mm,yyyy,xx,yy*hh<CR><LF>

Field	**Name**	**Description**
hhmmss.sss	UTC time	UTC time in hhmmss.sss format (000000.000 ~ 235959.999)
dd	UTC day	01 to 31
mm	UTC month	01 to 12
yyyy	UTC year	Four-digit year number
xx	Local zone hours	00 to +-13
yy	Local zone minutes	00 to +59
hh	Checksum	

ORDERING INFORMATION

Model Name	Description
TG621S	Flash Version GPS Receiver Module
TG621S-BD	Flash Version GPS/Beidou Receiver Module

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