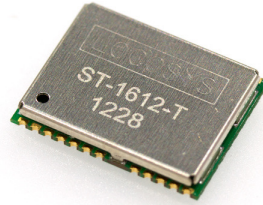


Product name	Description	Version
ST-1612-T	Datasheet of ST-1612-T precision timing GNSS module	1.0



1 Introduction

LOCOSYS ST-1612-T module can simultaneously acquire and track multiple satellite constellations that include GPS and GLONASS. The ST-1612-T has timing features of T-RAIM algorithm and position hold auto survey mode. Besides, 1PPS output is available with only one visible satellite. Its precision GNSS timing is suitable for applications such as communication base stations and electrical power grids.

2 Features

- Support GPS and GLONASS
- Capable of SBAS (WAAS, EGNOS, MSAS)
- 32 tracking channels and 2 fast acquisition channels
- T-RAIM provides high PPS integrity
- Position hold auto survey mode
- GNSS raw data is available (by request).
- Support interface of UART, USB and CAN bus
- Operation temperature range: -40°C to 85°C
- Small form factor 16 x 12.2 x 2.2 mm
- SMD type with stamp holes; RoHS compliant

3 Application

- Communication base stations, Femto cells.
- Electrical power grids
- Financial networks

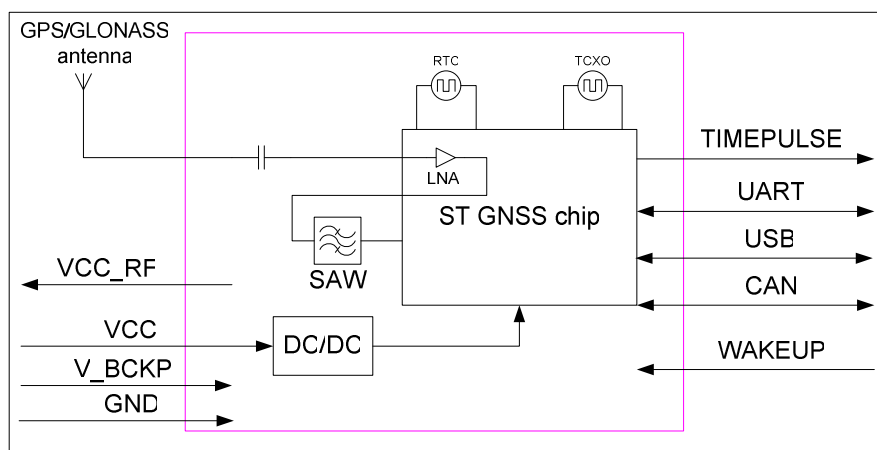


Fig 3-1 System block diagram.

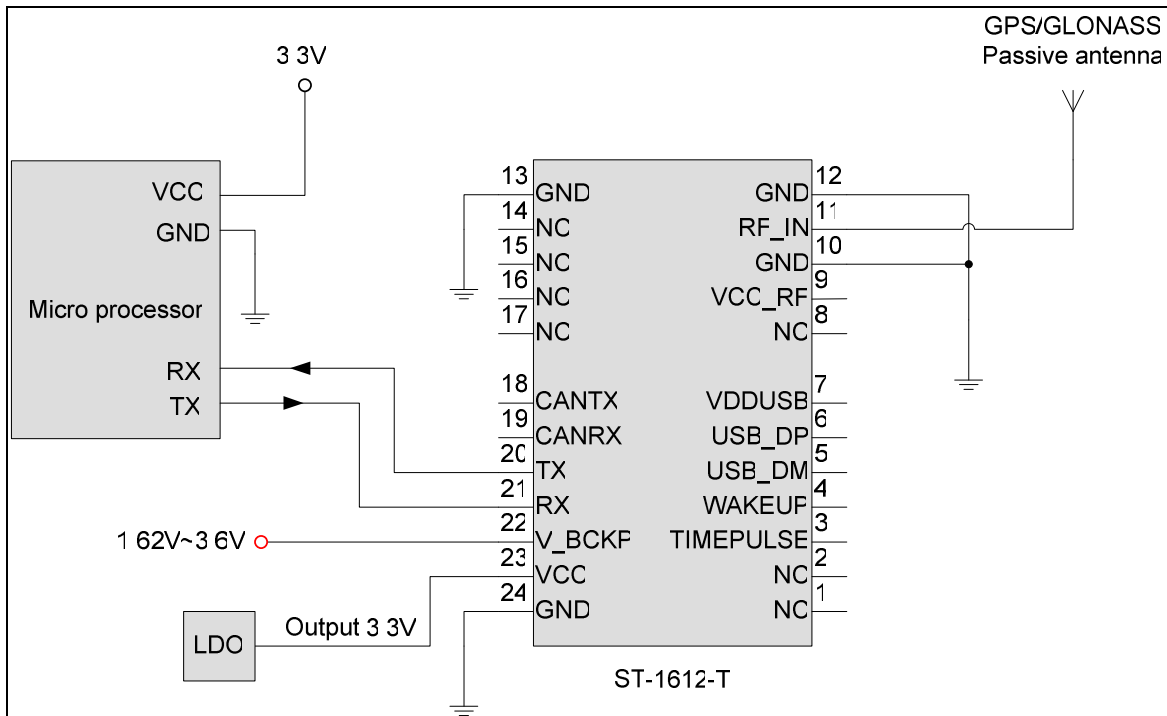


Fig 3-2 Typical application circuit that uses a passive antenna.

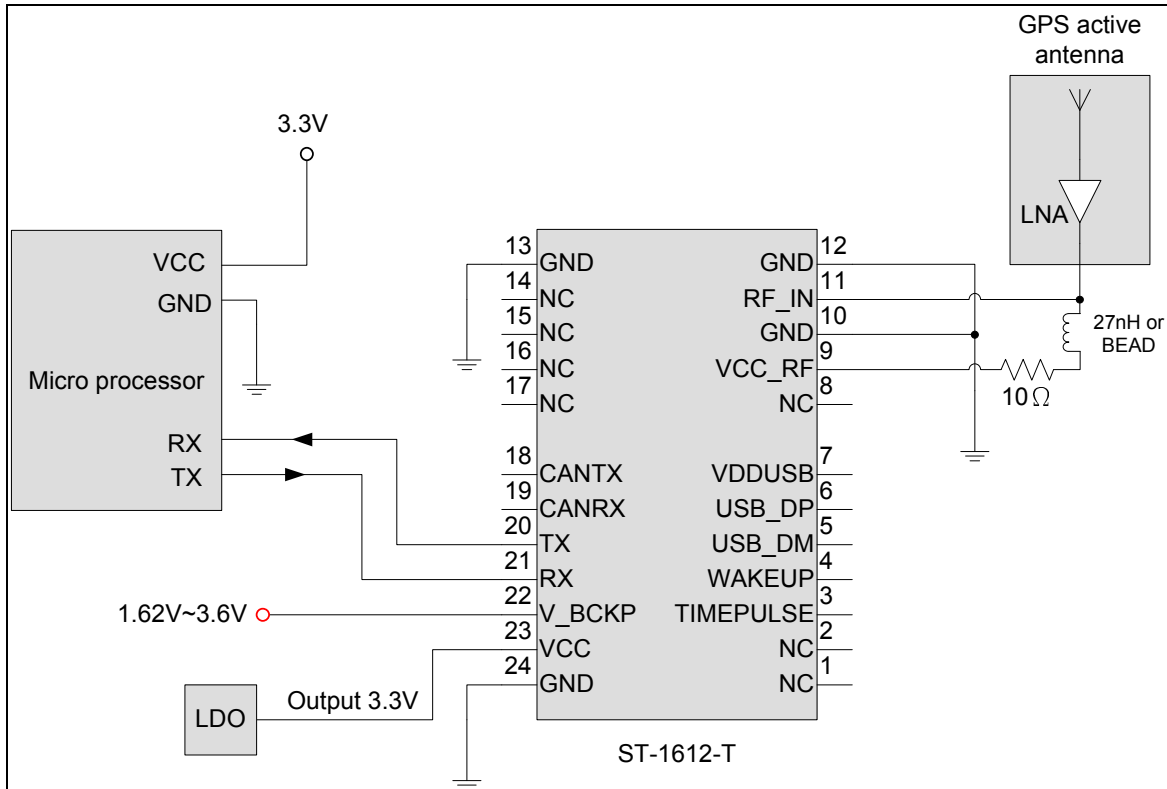


Fig 3-3 Typical application circuit that uses an active antenna.

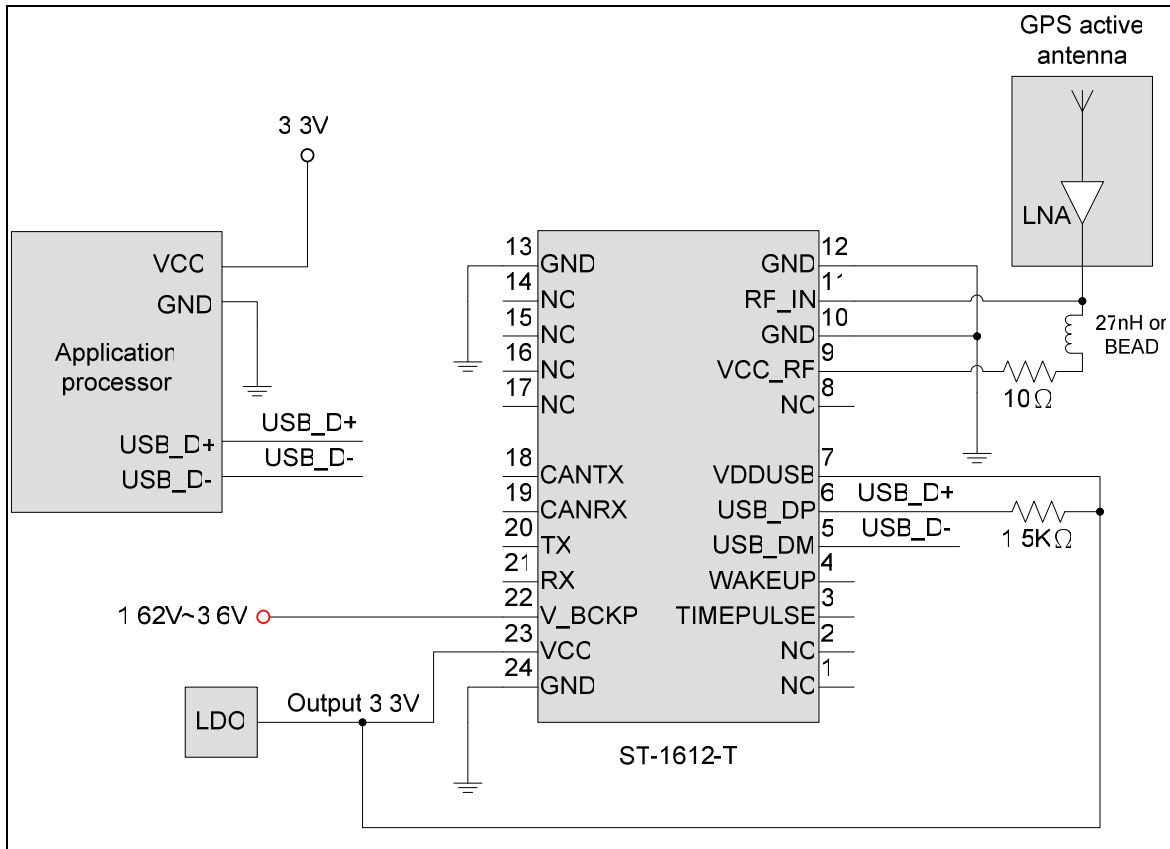
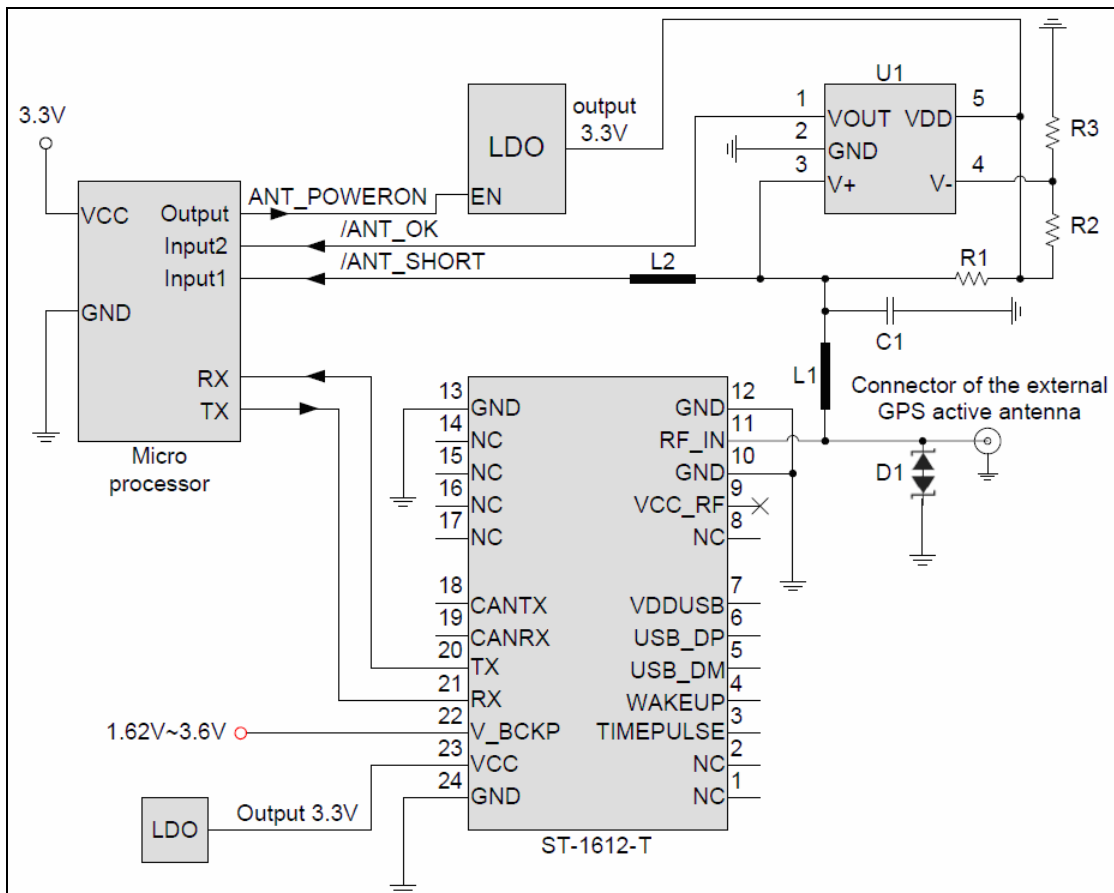


Fig 3-4 Typical application circuit that uses USB interface.



Logic table			
/ANT_SHORT	/ANT_OK	Status of the external GPS active antenna	Description
LOW	X	Short	Antenna is short.
HIGH	LOW	OK	Antenna is properly connected.
HIGH	HIHG	Open	Antenna is not connected

Reference BOM			
Part	Spec/value	Vendor	Remark
C1	18pF±5%, size 0402/0603		
D1	SUC0402-240E0R05P-LF	SFI	Input capacitance ≤ 0.5pF
L1	BEAD, 300R, size 0603 PBY16080T-301Y-N	YAGEO	Must use 0603 size or larger
L2	BEAD, 300R, size 0402/0603		
R1	10R±5%, size 0603		Must use 0603 size or larger
R2	1K±5%, size 0402/0603		
R3	100K±5%, size 0402/0603		
U1	MCP6001T-IOT	Microchip	
	SGM8541XN5/TR	SG Micro	

Fig 3-4 Typical application circuit that has supervisor of the external active antenna.

4 GNSS receiver

4.1 GNSS receiver

Chip	STA8088FG series	
Frequency	GPS: L1 1575.42MHz, C/A code GLONASS: L1 1598.0625MHz ~ 1605.375MHz, C/A code	
Channels	Support 32 channels	
Update rate	1Hz default, up to 10Hz.	
Sensitivity	Tracking	up to -161dBm (with external LNA)
	Cold start	up to -147dBm (with external LNA)
Acquisition Time	Cold Start (Open Sky)	32s (typical)
Position Accuracy	Autonomous	2.5m CEP
	SBAS	2.5m (depends on accuracy of correction data).
Max. Altitude	< 50,000 m	
Max. Velocity	< 515 m/s	
Protocol Support	NMEA 0183 ver 3.01	9600 bps ⁽¹⁾ , 8 data bits, no parity, 1 stop bits (default)
		1Hz: GGA, GSA, GSV, RMC
		1Hz: \$PSTMPPSDATA, \$PSTMPOSHOLD

Note 1: Both baud rate and output message rate are configurable to be factory default.

Note 2: Default interface is UART. For USB and CAN, please contact us.

4.2 Timing performance

PPS accuracy	Synchronized to UTC or GPS	1 δ	25ns ⁽¹⁾
	Cumulative Distribution Function ⁽²⁾	50%	5 ns
		RMS	7 ns
		99%	15 ns

Note 1: For reference only.

Note 2: Tested at -40°C, 25°C and 85°C.

5 Software interface

5.1 NMEA output message

Table 5.1-1 NMEA output message

NMEA record	Description
GGA	Global positioning system fixed data
GSA	GNSS DOP and active satellites
GSV	GNSS satellites in view
RMC	Recommended minimum specific GNSS data

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

Table 5.1-2 contains the values for the following example:

\$GPGGA,061633.000,2503.71436,N,12138.74524,E,2,18,0.7,125.69,M,15.3,M,,*64

Table 5.1- 2 GGA Data Format

Name	Example	Units	Description
Message ID	\$GPGGA		GGA protocol header
UTC Time	061633.000		hhmmss.sss
Latitude	2503.71436		ddmm.mmmmm
N/S indicator	N		N=north or S=south
Longitude	12138.74524		dddmm.mmmmm
E/W Indicator	E		E=east or W=west
Position Fix Indicator	2		See Table 5.1-3
Satellites Used	18		Range 0 to 32
HDOP	0.7		Horizontal Dilution of Precision
MSL Altitude	125.69	mters	
Units	M	mters	
Geoid Separation	15.3	mters	
Units	M	mters	
Age of Diff. Corr.		second	Null fields when DGPS is not used
Diff. Ref. Station ID			
Checksum	*64		
<CR> <LF>			End of message termination

Table 5.1-3 Position Fix Indicators

Value	Description
0	Fix not available or invalid
1	GPS SPS Mode, fix valid
2	Differential GPS, SPS Mode, fix valid
3-5	Not supported
6	Dead Reckoning Mode, fix valid

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

Table 5.1-5 contains the values for the following example:

\$GNGSA,A,3,09,27,19,08,20,03,07,28,16,01,11,32,1.1,0.7,0.9*25

\$GNGSA,A,3,78,86,77,76,88,87,,,,,1.1,0.7,0.9*2D

Table 5.1-5 GSA Data Format

Name	Example	Units	Description
------	---------	-------	-------------

Message ID	\$GNGSA		GSA protocol header
Mode 1	A		See Table 5.1-6
Mode 2	3		See Table 5.1-7
ID of satellite used	09		Sv on Channel 1
ID of satellite used	27		Sv on Channel 2
....		
ID of satellite used			Sv on Channel 12
PDOP	1.1		Position Dilution of Precision
HDOP	0.7		Horizontal Dilution of Precision
VDOP	0.9		Vertical Dilution of Precision
Checksum	*25		
<CR> <LF>			End of message termination

Table 5.1-6 Mode 1

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

Table 5.1-7 Mode 2

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

● GSV---GNSS Satellites in View

Table 5.1-8 contains the values for the following example:

```
$GPGSV,3,1,12,01,76,175,49,03,19,059,44,07,63,255,46,08,44,308,46*72
$GPGSV,3,2,12,09,38,306,46,11,77,028,47,16,11,111,41,19,34,037,49*72
$GPGSV,3,3,12,20,15,166,43,27,11,058,42,28,19,317,44,32,17,135,42*75
$GLGSV,2,1,06,76,58,166,46,78,11,334,37,86,18,032,43,77,61,322,47*66
$GLGSV,2,2,06,88,32,266,46,87,51,337,47,,,,,,*6D
```

Table 5.1-8 GSV Data Format

Name	Example	Units	Description
Message ID	\$GPGSV		GSV protocol header (GPGSV and GLGSV)
Total number of messages ¹	3		Range 1 to 4
Message number ¹	1		Range 1 to 4
Satellites in view	12		
Satellite ID	01		Channel 1 (Range 01 to 196)
Elevation	76	degrees	Channel 1 (Range 00 to 90)

Azimuth	175	degrees	Channel 1 (Range 000 to 359)
SNR (C/No)	49	dB-Hz	Channel 1 (Range 00 to 99, null when not tracking)
Satellite ID	03		Channel 4 (Range 01 to 32)
Elevation	19	degrees	Channel 4 (Range 00 to 90)
Azimuth	059	degrees	Channel 4 (Range 000 to 359)
SNR (C/No)	44	dB-Hz	Channel 4 (Range 00 to 99, null when not tracking)
Checksum	*46		
<CR> <LF>			End of message termination

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

● RMC---Recommended Minimum Specific GNSS Data

Table 5.1-9 contains the values for the following example:

\$GPRMC,061633.000,A,2503.71436,N,12138.74524,E,0.0,0.0,0,020813,,D*68

Table 5.1-9 RMC Data Format

Name	Example	Units	Description
Message ID	\$GPRMC		RMC protocol header
UTC Time	061633.000		hhmmss.sss
Status	A		A=data valid or V=data not valid
Latitude	2503.71436		ddmm.mmmmm
N/S Indicator	N		N=north or S=south
Longitude	12138.74524		dddmm.mmmmm
E/W Indicator	E		E=east or W=west
Speed over ground	0.0	knots	True
Course over ground	0.0	degrees	
Date	020813		ddmmyy
Magnetic variation		degrees	
Variation sense			E=east or W=west (Not shown)
Mode	D		A=autonomous, D=DGPS, E=DR, N=Data not valid, R=Coarse Position, S=Simulator
Checksum	*68		
<CR> <LF>			End of message termination

5.2 Proprietary NMEA output message

Table 5.2-1 Proprietary NMEA output message

NMEA record	Description
PSTMPPSDATA	Reports the Pulse Per Second data
PSTMPOSHOLD	Reports the Position Hold status and position

● **PSTMPPSDATA--- Reports the Pulse Per Second data**

Table 5.2-2 contains the values for the following example:

\$PSTMPPSDATA,1,1,1,0,0,0,0.100000,0,713,248,0,1,1,10,0,33,3,11,16,-1,0,1.319e-08,65473962.80,26000001.78*0D

Table 5.2- 2 PSTMPPSDATA Data Format

Name	Example	Units	Description
Message ID	\$PSTMPPSDATA		PSTMPPSDATA protocol header
On_off	1		PPS signal ON/OFF status 0: OFF 1: ON
PPS_valid	1		Global PPS validity flag 0: PPS not valid 1: PPS valid
Synch_valid	1		PPS synchronization validity 0: Not valid 1: valid
Out_mode	0		0 = PPS_OUT_MODE_ALWAYS 1 = PPS_OUT_MODE_ON_EVEN_SECONDS 2 = PPS_OUT_MODE_ON_ODD_SECONDS
Ref_time	0		0 = UTC 1 = GPS.UTC (GPS Time) 2 = GLONASS.UTC (GLONASS Time) 3 = UTC_SU 4 = GPS.UTC_FROM_GLONASS NOTES: UTC(SU) is the Soviet Union UTC, it is derived from GLONASS time applying the UTC delta time downloaded from GLONASS satellites. GPS.UTC_FROM_GLONASS is the GPS time derived from GLONASS time applying the GPS delta time downloaded from GLONASS satellites. If the software is configured to work in GLONASS only mode, UTC(SU) is identical to UTC and GPS.UTC_FROM_GLONASS is identical to GPS.UTC.
Ref_constellation	0		0 = GPS 1 = GLONASS NOTE: the reference constellation reports which reference time has been used for the PPS generation.

Pulse_duration	0.100000	second	Pulse duration (s)
Pulse_delay	0	ns	Pulse delay (ns)
GPS_delay	713	ns	GPS path RF delay (ns)
GLONASS_delay	248	ns	GLONASS path RF delay (ns)
Inverted_polarity	0		Pulse polarity inversion: 0 = not inverted 1 = inverted
Fix_cond	1		Selected GNSS fix condition for PPS signal generation: 1 = NO_FIX 2 = 2D_FIX 3 = 3D_FIX
Sat_th	1		Selected minimum number of satellites for PPS signal generation.
Elev_mask	10		Selected minimum satellite elevation for time correction.
Const_mask	0		Selected constellations for time correction.
Ref_sec	33		Second at which the reported PPS data is applied. According to the reference time configuration it could be a UTC or a GPS or a GLONASS time second.
Fix_status	3		GNSS position fix status when the time has been corrected. 1 = NO_FIX 2 = 2D_FIX 3 = 3D_FIX
Used_sats	11		Used satellites for time correction.
GPS_utc_delta_s	16	second	UTC leap seconds (s)
GPS_utc_delta_ns	-1	ns	UTC – GPS delta time (ns)
GLONASS_utc_delta_ns	0	ns	UTC – GLONASS delta time (ns)
Quantization_error	1.319e-08	second	Quantization error (s)
PPS_clock_freq	65473962.80	Hz	PPS clock frequency (Hz)
TCXO_clock_freq	26000001.78	Hz	TCXO clock frequency (Hz)
Checksum	*0D		
<CR> <LF>			End of message termination

● PSTMPOSHOLD--- Reports the Position Hold status and position

Table 5.2-3 contains the values for the following example:

\$PSTMPOSHOLD,1,2503.71420,N,12138.74540,E,122.49*4E

Table 5.2-3 PSTMPOSHOLD Data Format

Name	Example	Units	Description
------	---------	-------	-------------

Message ID	\$PSTMPOSHOLD		PSTMPPSDATA protocol header
On_off	1		Position Hold enabling/disabling status 0: disabled 1: enabled
Latitude	2503.71420		ddmm.mmmmm
N/S Indicator	N		N=north or S=south
Longitude	12138.74540		dddmm.mmmmm
E/W Indicator	E		E=east or W=west
Alt	122.49	meter	Height above WGS-84 Elipsoid. (maximum 100,000)
Checksum	*4E		
<CR> <LF>			End of message termination

5.3 Proprietary NMEA commands

Proprietary NMEA commands work until next system startup. All settings described in the section can be configured as factory default. Please contact us for your settings.

5.3.1 \$PSTMSETCONSTMASK

Set the GNSS constellation mask. It allows switch the GNSS constellation at run-time.

Synopsis:

```
$PSTMSETCONSTMASK,<constellation_mask><cr><lf>
```

Arguments:

Parameter	Format	Description
constellation_mask	%d	It is a bit mask where each bit enable/disable a specific constellation independently by the others: bit 0: GPS constellation enabling/disabling bit 1: GLONASS constellation enabling/disabling bit 2: QZSS constellation enabling/disabling

Results:

- If success, the following message is sent:

```
$PSTMSETCONSTMASKOK,<constellation_mask>*<checksum><cr><lf>
```

- In case of error, the following message will be sent:

```
$PSTMSETCONSTMASKERROR*<checksum><cr><lf>
```

Examples:

- Enabling GPS only:

```
$PSTMSETCONSTMASK,1*14
```

- Enabling GLONASS only:

```
$PSTMSETCONSTMASK,2*17
```

- Enabling GPS and GLONASS:

```
$PSTMSETCONSTMASK,3*16
```

5.3.2 \$PSTMPPS

Allow interfacing all parameters for Pulse Per Second management. This is a parametric command.

Synopsis:

```
$PSTMPPS,<cmd_mode>,<cmd_type>,<par_1>,...,<par_N><cr><lf>
```

Arguments:

Parameter	Format	Description
cmd_mode	Decimal, 1 digit	Select the command operation mode: 1 = GET operation (to get data from PPS manager) 2 = SET operation (to set data into PPS manager)
cmd_type	Decimal	1 = PPS_IF_ON_OFF_CMD 2 = PPS_IF_OUT_MODE_CMD 3 = PPS_IF_REFERENCE_CONSTELLATION_CMD 4 = PPS_IF_PULSE_DELAY_CMD 5 = PPS_IF_PULSE_DURATION_CMD 6 = PPS_IF_PULSE_POLARITY_CMD 7 = PPS_IF_PULSE_DATA_CMD 8 = PPS_IF_FIX_CONDITION_CMD 9 = PPS_IF_SAT_TRHESHOLD_CMD 10 = PPS_IF_ELEVATION_MASK_CMD 11 = PPS_IF_COSTELLATION_MASK_CMD 12 = PPS_IF_TIMING_DATA_CMD 13 = PPS_IF_POSITION_HOLD_DATA_CMD 14 = PPS_IF_AUTO_HOLD_SAMPLES_CMD 15 = PPS_IF_TRAIM_CMD 16 = PPS_IF_TRAIM_USED_CMD 17 = PPS_IF_TRAIM_RES_CMD 18 = PPS_IF_TRAIM_REMOVED_CMD 19 = PPS_IF_REFERENCE_TIME_CMD 20 = PPS_IF_CONSTELLATION_RF_DELAY_CMD
par_1 ... par_N		Parameters list according to the command type specification (see below).

5.3.2.1 Getting PPS Data (cmd_mode = 1)

5.3.2.1.1 PPS_IF_PULSE_DATA_CMD

```
$PSTMPPS,1,7<cr><lf>
```

Response:

```
$PSTMPPS,1,7,<out_mode>,<reference_time>,<pulse_delay>,<pulse_duration>,<pulse_polarity>  
<cr><lf>
```

Parameter	Format	Description
out_mode	Decimal, 1 digit	0 = PPS always generated. 1 = PPS generated on even seconds. 2 = PPS generated on odd seconds.
reference_time	Decimal, 1 digit	0 = UTC 1 = GPS.UTC 2 = GLONASS.UTC 3 = UTC.SU 4 = GPS.UTC.FROM.GLONASS NOTES: UTC(SU) is the Soviet Union UTC, it is derived from GLONASS time applying the UTC delta time downloaded from GLONASS satellites. GPS.UTC.FROM.GLONASS is the GPS time derived from GLONASS time applying the GPS delta time downloaded from GLONASS satellites. If the software is configured to work in GLONASS only mode, UTC(SU) is identical to UTC and GPS.UTC.FROM.GLONASS is identical to GPS.UTC.
pulse_delay	Decimal	Pulse delay (ns)
pulse_duration	Double	Pulse duration (s)
pulse_polarity	Decimal, 1 digit	0 = not inverted 1 = inverted

5.3.2.1.2 PPS_IF_TIMING_DATA_CMD

```
$PSTMPPS,1,12<cr><lf>
```

Response:

```
$PSTMPPS,1,12,<fix_condition>,<sat_th>,<elevation_mask>,<constellation_mask>,<gps_rf_delay>,<glonass_rf_delay><cr><lf>
```

Parameter	Format	Description
fix_condition	Decimal, 1 digit	1 = NOFIX 2 = 2DFIX 3 = 3DFIX
sat_th	Decimal	Minimum number of satellites for the PPS generation.
elevation_mask	Decimal	Minimum satellite elevation for satellite usage in timing filtering.
constellation_mask	Decimal (bit mask)	Satellite constellation selection for usage in timing filtering. bit0 = GPS bit1 = GLONASS
GPS_rf_delay	Decimal	GPS path RF delay (ns)
GLONASS_rf_delay	Decimal	GLONASS path RF delay (ns)

5.3.2.1.3 PPS_IF_POSITION_HOLD_DATA_CMD

```
$PSTMPPS,1,13,<on_off>,<lat>,<lat_dir>,<lon>,<lon_dir>,<h_msl><cr><lf>
```

Response:

```
$PSTMPPS,1,13<cr><lf>
```

Parameter	Format	Description
on_off	Decimal, 1 digit	0 = Position Hold disabled. 1 = Position Hold enabled.
lat	DDmm.mmmmm	Position Hold position latitude.
lat_dir	N or S	North or South direction.
lon	DDDmm.mmmmm	Position Hold position longitude.
lon_dir	E or W	East or West direction.
h_msl	Double	Position Hold mean see level altitude.

5.3.2.1.4 PPS_IF_TRAIM_CMD

```
$PSTMPPS,1,15<cr><lf>
```

Response:

```
$PSTMPPS,1,15,<traim_enabled>,<traim_solution>,<ave_error>,<used_sats>,<removed_sats>  
<cr><lf>
```

Parameter	Format	Description
traim_enabled	Decimal, 1 digit	TRAIM ON/OFF status 0 = OFF 1 = ON
traim_solution	Decimal, 1 digit	TRAIM Algorithm status: 0 = UNDER Alarm 1 = OVER Alarm 2 = UNKNOWN
ave_error	Decimal	Average time error (ns)
used_sats	Decimal	Number of satellite used for timing correction.
removed_sats	Decimal	Number of satellites removed by the timing correction.

5.3.2.1.5 PPS_IF_TRAIM_USED_CMD

```
$PSTMPPS,1,16<cr><lf>
```

Response:

```
$PSTMPPS,1,16,<traim_enabled>,<used_sats>,<sat1>,...,<satN><cr><lf>
```

Parameter	Format	Description
traim_enabled	Decimal, 1 digit	TRAIM ON/OFF status 0 = OFF 1 = ON
used_sats	Decimal	Number of satellite used for timing correction.
sat1 .. satN	Decimal	List of satellites IDs

5.3.2.1.6 PPS_IF_TRAIM_RES_CMD

```
$PSTMPPS,1,17<cr><lf>
```

Response:

```
$PSTMPPS,1,17,<traim_enabled>,<used_sats>,<res1>,...,<resN><cr><lf>
```

Parameter	Format	Description
traim_enabled	Decimal, 1 digit	TRAIM ON/OFF status 0 = OFF 1 = ON
used_sats	Decimal	Number of satellite used for timing correction.
Res1 .. resN	Decimal	List of satellites residuals [ns]. Each residual corresponds to the satellite in the used sat list at the same message position.

5.3.2.1.7 PPS_IF_TRAIM_REMOVED_CMD

```
$PSTMPPS,1,18<cr><lf>
```

Response:

```
$PSTMPPS,1,18,<traim_enabled>,<rem_sats>,<sat1>,...,<satN><cr><lf>
```

Parameter	Format	Description
traim_enabled	Decimal, 1 digit	TRAIM ON/OFF status 0 = OFF 1 = ON
rem_sats	Decimal	Number of satellite removed by timing correction.
sat1 .. satN	Decimal	List of satellites IDs.

5.3.2.2 setting PPS Data (cmd_mode = 2)

5.3.2.2.1 PPS_IF_ON_OFF_CMD

```
$PSTMPPS,2,1,<on_off><cr><lf>
```

Parameter	Format	Description
on_off	Decimal, 1 digit	0 = PPS disabled. 1 = PPS enabled.

5.3.2.2.2 PPS_IF_OUT_MODE_CMD

```
$PSTMPPS,2,2,<out_mode><cr><lf>
```

Parameter	Format	Description
out_mode	Decimal, 1 digit	0 = PPS always generated. 1 = PPS generated on even seconds. 2 = PPS generated on odd seconds.

5.3.2.2.3 PPS_IF_REFERECNE_TIME_CMD

```
$PSTMPPS,2,19,<reference_time><cr><lf>
```

Parameter	Format	Description
reference_time	Decimal, 1 digit	0 = UTC 1 = GPS.UTC. 2 = GLONASS.UTC. 3 = UTC_SU 4 = GPS.UTC_FROM_GLONASS NOTES: UTC(SU) is the Soviet Union UTC, it is derived from GLONASS time applying the UTC delta time downloaded from GLONASS satellites. GPS.UTC_FROM_GLONASS is the GPS time derived from GLONASS time applying the GPS delta time downloaded from GLONASS satellites. If the software is configured to work in GLONASS only mode, UTC(SU) is identical to UTC and GPS.UTC_FROM_GLONASS is identical to GPS.UTC.

5.3.2.2.4 PPS_IF_PULSE_DELAY_CMD

```
$PSTMPPS,2,4,<pulse_delay><cr><lf>
```

Parameter	Format	Description
pulse_delay	Decimal	Pulse delay (ns)

Note: User can use this parameter to compensate the delay both from the antenna cable and PPS output cable. For example, the delay of the antenna cable and PPS output cable are 15ns and 6ns, respectively. That is total 21ns. Then the command is \$PSTMPPS,2,4,-21.

5.3.2.2.5 PPS_IF_CONSTELLATION_RF_DELAY_CMD

```
$PSTMPPS,2,20,<sat_type><time_delay><cr><lf>
```

Parameter	Format	Description
sat_type	Decimal	Satellite constellation type: 0 = GPS 1 = GLONASS
time_delay	Decimal	Time delay (ns)

Note: User should not change these parameters that are for internal compensation of GNSS module.

5.3.2.2.6 PPS_IF_PULSE_DURATION_CMD

```
$PSTMPPS,2,5,<pulse_duration><cr><lf>
```

Parameter	Format	Description
pulse_duration	Double	Pulse duration (s)

5.3.2.2.7 PPS_IF_PULSE_POLARITY_CMD

```
$PSTMPPS,2,6,<pulse_polarity><cr><lf>
```

Parameter	Format	Description
pulse_polarity	Decimal, 1 digit	0 = not inverted. 1 = inverted.

5.3.2.2.8 PPS_IF_PULSE_DATA_CMD

```
$PSTMPPS,2,7,<out_mode>,<reference_time>,<pulse_delay>,<pulse_duration>,<pulse_polarity>
<cr><lf>
```

Parameter	Format	Description
out_mode	Decimal, 1 digit	0 = PPS always generated. 1 = PPS generated on even seconds. 2 = PPS generated on odd seconds.
reference_time	Decimal, 1 digit	0 = UTC 1 = GPS_UTC 2 = GLONASS_UTC
pulse_delay	Decimal	Pulse delay (ns)
pulse_duration	Double	Pulse duration (s)
pulse_polarity	Decimal, 1 digit	0 = not inverted. 1 = inverted.

5.3.2.2.9 PPS_IF_FIX_CONDITION_CMD

```
$PSTMPPS,2,8,<fix_condition><cr><lf>
```

Parameter	Format	Description
fix_condition	Decimal, 1 digit	1 = NOFIX. 2 = 2DFIX. 3 = 3DFIX.

5.3.2.2.10 PPS_IF_SAT_TRHESHOLD_CMD

```
$PSTMPPS,2,9,<sat_th><cr><lf>
```

Parameter	Format	Description
sat_th	Decimal	Minimum number of satellites for the PPS generation.

5.3.2.2.11 PPS_IF_ELEVATION_MASK_CMD

```
$PSTMPPS,2,10,<elevation_mask><cr><lf>
```

Parameter	Format	Description
elevation_mask	Decimal	Minimum satellite elevation for satellite usage in timing filtering.

5.3.2.2.12 PPS_IF_COSTELLATION_MASK_CMD

```
$PSTMPPS,2,11,<constellation_mask><cr><lf>
```

Parameter	Format	Description
constellation_mask	Decimal (bit mask)	<p>Satellite constellation selection for usage in timing filtering.</p> <p>bit0 = GPS bit1 = GLONASS</p> <p>NOTES:</p> <p>This parameter enables the usage of mixed constellations satellites in the timing filtering. If bit0 is enabled GPS satellites are used to correct the GLONASS reference time together with GLONASS satellites. If bit1 is enabled, GLONASS satellites are used to correct the GPS reference time together with the GPS satellites. When constellation mask is zero (default) only GPS sats are used to correct the GPS reference time and only GLONASS sats are used to correct the GLONASS reference time.</p>

5.3.2.2.13 PPS_IF_TIMING_DATA_CMD

```
$PSTMPPS,2,12,<fix_condition>,<sat_th>,<elevation_mask>,<constellation_mask><cr><lf>
```

Parameter	Format	Description
fix_condition	Decimal, 1 digit	<p>1 = NOFIX. 2 = 2DFIX. 3 = 3DFIX.</p>
sat_th	Decimal	Minimum number of satellites for the PPS generation.
elevation_mask	Decimal	Minimum satellite elevation for satellite usage in timing filtering.
constellation_mask	Decimal (bit mask)	<p>Satellite constellation selection for usage in timing filtering.</p> <p>bit0 = GPS bit1 = GLONASS</p>

5.3.2.2.14 PPS_IF_POSITION_HOLD_DATA_CMD

```
$PSTMPPS,2,13,<on_off>,<lat>,<lat_dir>,<lon>,<lon_dir>,<h_msl><cr><lf>
```

Parameter	Format	Description
on_off	Decimal, 1 digit	0 = Position Hold disabled. 1 = Position Hold enabled.
lat	DDmm.mmmmm	Position Hold position latitude.
lat_dir	N or S	North or South direction.
lon	DDDmm.mmmmm	Position Hold position longitude.
lon_dir	E or W	East or West direction
h_msl	Double	Position Hold mean sea level altitude.

5.3.2.2.15 PPS_IF_AUTO_HOLD_SAMPLES_CMD

```
$PSTMPPS,2,14,<auto_ph_samples><cr><lf>
```

Parameter	Format	Description
auto_ph_samples	Decimal	Number of position samples for the auto position algorithm. If the number of samples is set to “0” the auto position hold feature is disabled. The position average evaluation is restarted every time the command is executed.

5.3.2.2.16 PPS_IF_TRAIM_CMD

```
$PSTMPPS,2,15,<on_off>,<alarm><cr><lf>
```

Parameter	Format	Description
on_off	Decimal, 1 digit	0 = TRAIM disabled. 1 = TRAIM enabled.
alarm	Double	TRAIM alarm [s] – scientific notation is allowed.

6 Pin assignment and descriptions

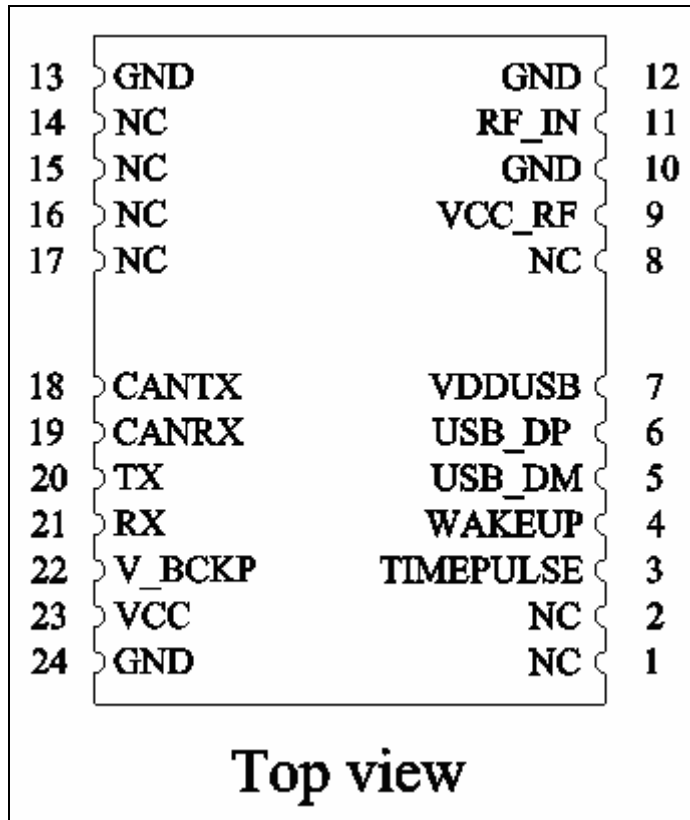


Table 6-1 Pin descriptions

Pin #	Name	Type	Description	Note
1	NC		Not connected	
2	NC		Not connected	
3	TIMEPULSE	O	Time pulse (1PPS, default 100 ms pulse/sec)	
4	WAKEUP	I	Wakeup from standby mode (1.2V I/O voltage). Internal 10K ohm pull-down resistor. If this pin is not used, leave it floating.	
5	USB_DM	I/O	USB data (D-)	
6	USB_DP	I/O	USB data (D+). Connect a 1.5K ohm resistor between USB_DP and VDDUSB.	
7	VDDUSB/ VDDCAN	P	Supply voltage of USB transceiver or CAN bus (3V~3.6V)	1
8	NC		Not connected	
9	VCC_RF	O	Output voltage for active antenna	2
10	GND	P	Ground	
11	RF_IN	I	GPS RF signal input	
12	GND	P	Ground	

13	GND	P	Ground	
14	NC		Not connected	
15	NC		Not connected	
16	NC		Not connected	
17	NC		Not connected	
18	CANTX	O	CAN bus transmit data output	
19	CANRX	I	CAN bus receive data input	
20	TX	O	Serial output (Default NMEA)	
21	RX	I	Serial input (Default NMEA)	
22	V_BCKP	P	Backup battery supply voltage This pin must be powered to enable the module.	
23	VCC	P	DC supply voltage	
24	GND	P	Ground	

<Note>

1. Supply power 3.0 ~ 3.6V to enable USB/CAN or leave open to disable. The firmware for UART, USB and CAN is different, please contact us.
2. VCC_RF does not have short circuit protection.

7 DC & Temperature characteristics

7.1 Absolute maximum ratings

Parameter	Symbol	Ratings	Units
Input Voltage	VCC	3.6	V
Input Backup Battery Voltage	V_BCKP	3.6	V
Operating Temperature Range	Topr	-40 ~ 85	°C
Storage Temperature Range	Tstg	-40 ~ 85	°C

7.2 DC Electrical characteristics

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Input Voltage	VCC		3.0	3.3	3.6	V
Input Backup Battery Voltage	V_BCKP		1.62		3.6	V
VCC_RF Output Voltage	VCC_RF			VCC		V
Supply Current	I _{ss}	VCC = 3.3V, w/o active antenna, Peak Acquisition Tracking		70 38 ^(1,2)	120	mA mA mA
Backup Battery Current	I _{bat}	VCC = 0V		69		uA
High Level Input Voltage	V _{IH}		2.0		3.6	V
Low Level Input Voltage	V _{IL}		-0.3		0.8	V
High Level Output Voltage	V _{OH}		2.6			V
Low Level Output Voltage	V _{OL}				0.4	V

Note 1. Measured for 12 hours when position fix (1Hz) is available and input voltage is 3.3V with UART interface.

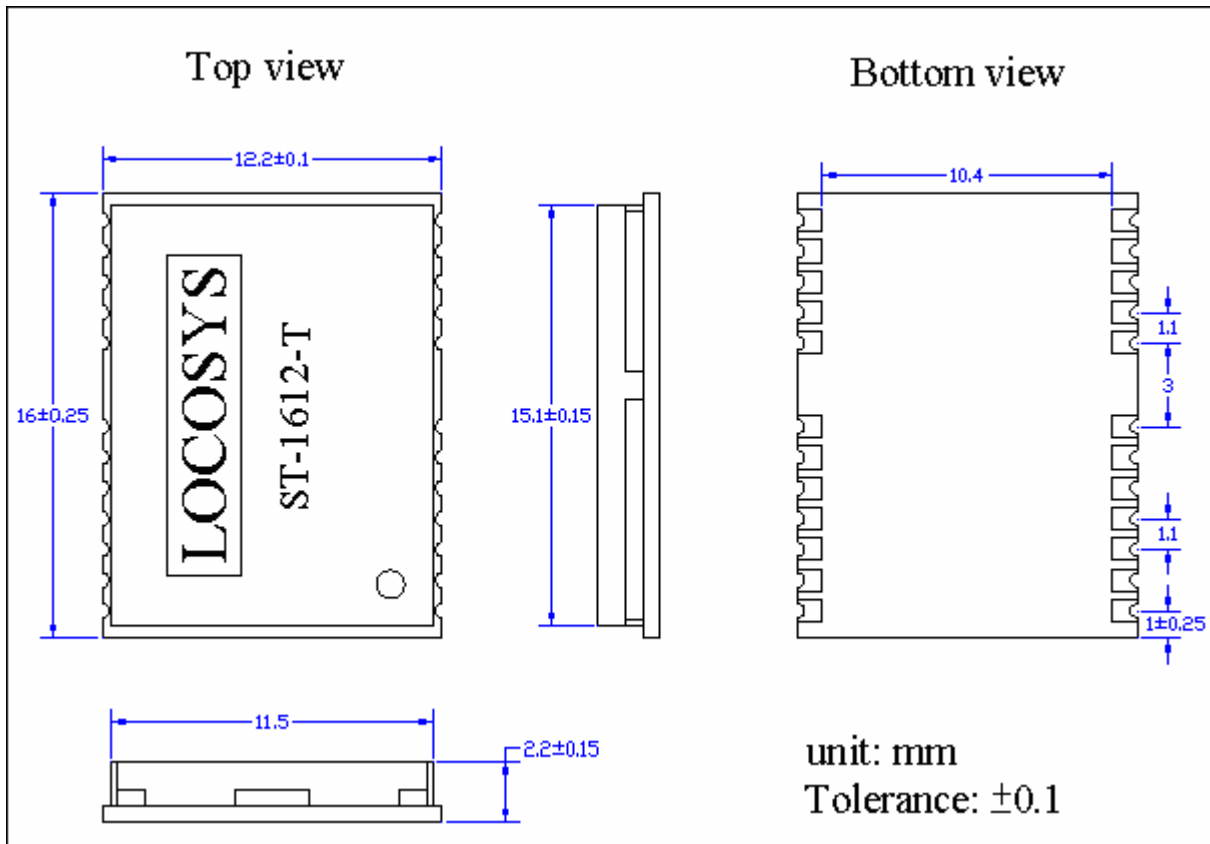
Note 2. In the first 10 minutes after boot, the current consumption is about 65mA.

7.3 Temperature characteristics

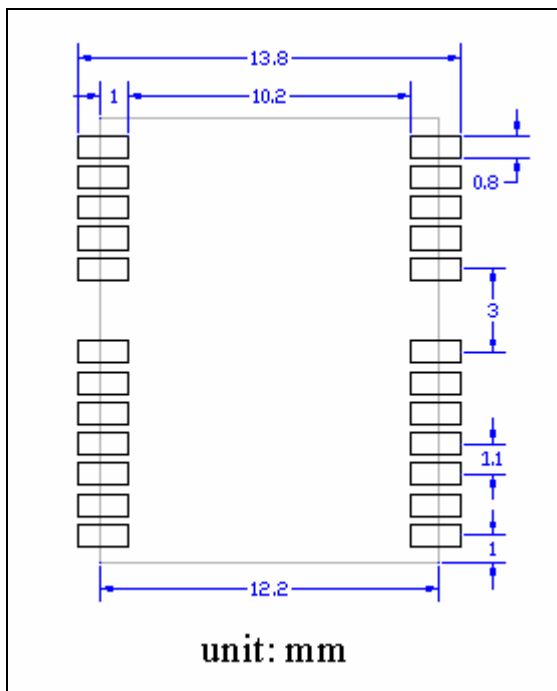
Parameter	Symbol	Min.	Typ.	Max.	Units
Operating Temperature	Topr	-40	-	85	°C
Storage Temperature	Tstg	-40	25	85	°C

8 Mechanical specification

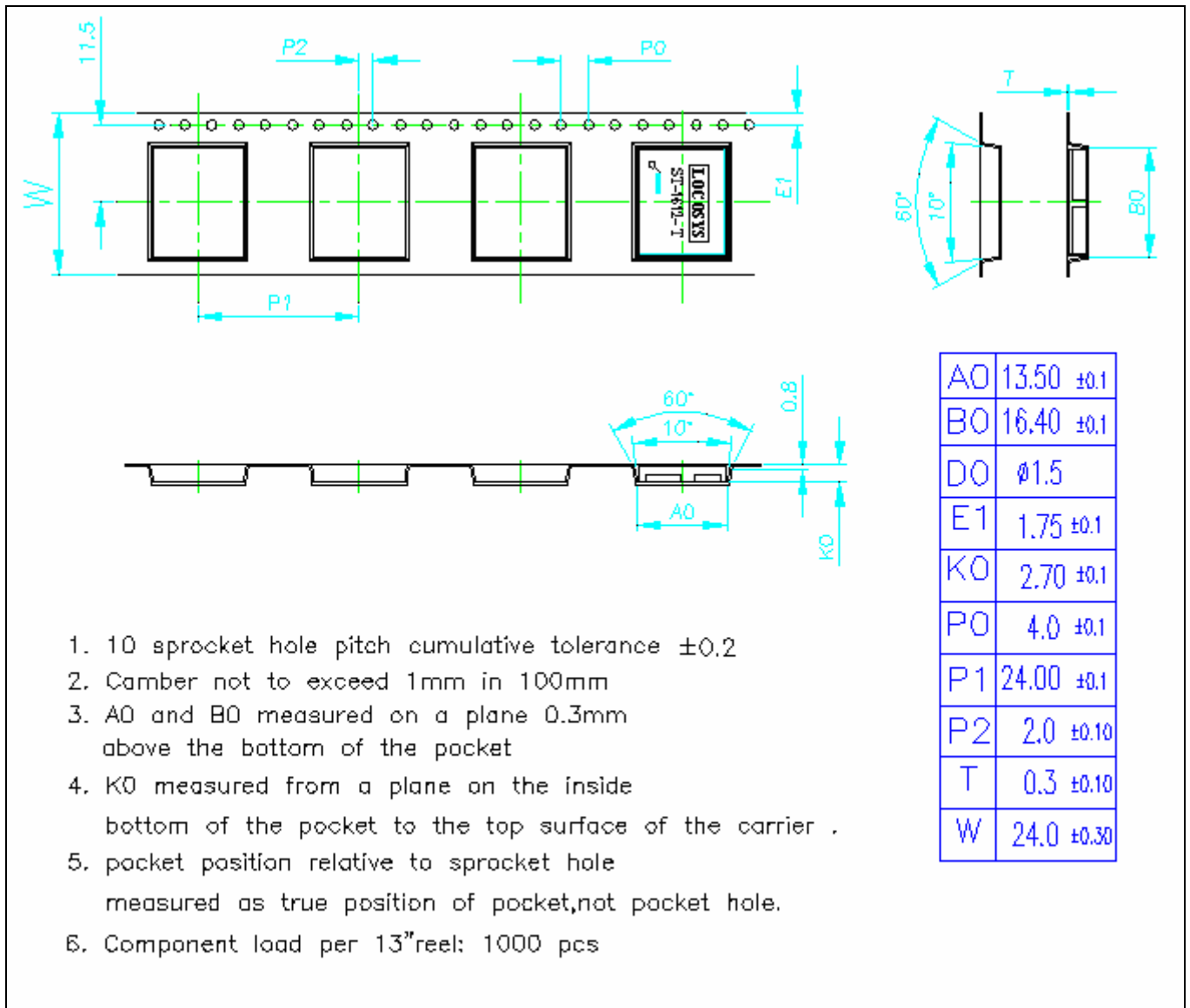
8.1 Outline dimensions



8.2 Recommended land pattern dimensions



9 Reel Packing information



Document change list

Revision 1.0

- First release on October 7, 2013.