

Product name	Description	Version
LS26090-GT	GNSS timing module of PCIe Full-Mini card	0.2
LS26091-GT	GNSS timing module of PCIe Half-Mini card	

**LS26090-GT****LS26091-GT**

1 Introduction

LOCOSYS LS26090-GT and LS26091-GT are GNSS modules incorporated into the PCIe Full-Mini card or PCIe Half-Mini card. These GNSS modules are powered by STMicro, it can provide you with superior sensitivity and performance even in urban canyon and dense foliage environment. Besides, the USB interface makes these modules easy to integrate into the laptop.

These modules support multiple satellite constellations that include GPS, GLONASS, GALILEO and QZSS. It features accurate PPS for timing applications. It has 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 radio base stations, femtocell and smart grid.

2 Features

- STMicro high sensitivity solution
- Support GPS, GLONASS, GALILEO and QZSS
- Capable of SBAS (WAAS, EGNOS, MSAS, GAGAN)
- Support 48-channel GNSS
- Support USB interface
- T-RAIM provides high PPS integrity
- PPS accuracy 50% CEP 3.858ns
- Position hold auto survey mode
- Built-in micro battery to reserve system data for rapid satellite acquisition
- 1 PPS over USB for timing application
- Linux/Android support

- Compatible with GPSD PPS support

3 Application

- 5G Femtocell/Microcell
- 5G Routers
- 5G Switches
- Microwave relay stations
- Financial exchange data system
- Traffic control system
- Traffic intersection monitoring DVR system
- Energy control system
- Industrial computer system

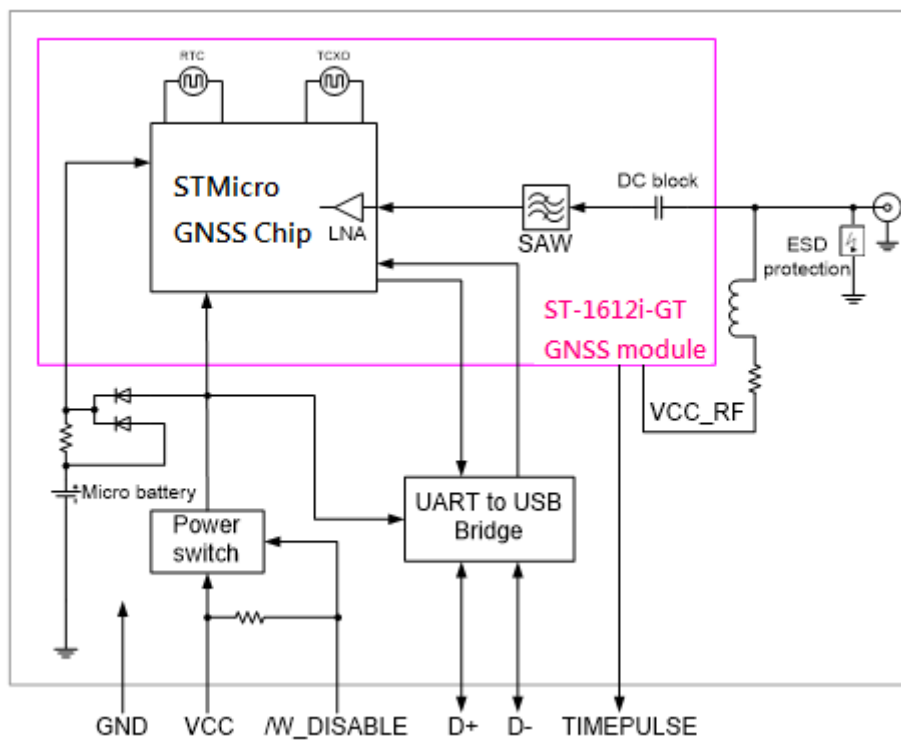


Fig 3-1 System block diagram

4 GNSS receiver

4.1 GNSS receiver

Chip	Teseo III series	
Frequency	GPS: L1C/A (1575.42MHz) GLONASS L1OF (1598.0625MHz ~ 1605.375MHz) GALILEO: E1B/C (1575.42MHz) QZSS: L1C/A (1575.42MHz)	
Channels	Support 48 channels	
Update rate	1Hz default, up to 10Hz.	
Sensitivity	Tracking	up to -163dBm (with external LNA)
	Cold start	up to -147dBm (with external LNA)
Acquisition Time	Cold Start (Open Sky)	36s (typical)
	Hot Start (Open Sky)	1s (typical)
Position Accuracy	Autonomous	1.8m CEP
	SBAS	1.5m CEP (depends on accuracy of correction data).
Max. Altitude	< 18,000 m	
Max. Velocity	< 515 m/s	
Protocol Support	NMEA 0183 ver. 3.01	38400 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.

4.2 Timing performance

PPS accuracy	Synchronized to UTC or GPS	1δ	15 ns
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PPS accuracy	Cumulative Distribution Function ⁽¹⁾	Temperature	50% CEP	RMS	99%
		Room temperature	3.858 ns	6 ns	10.951 ns
		-40°C	3.884 ns		10.876 ns
		85°C	3.915 ns		12.905 ns

Note 1: 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,051951.000,2503.71325,N,12138.74397,E,2,30,0.6,113.69,M,15.3,M,,*69

Table 5.1-2 GGA Data Format

Name	Example	Units	Description
Message ID	\$GPGGA		GGA protocol header
UTC Time	051951.000		hhmmss.sss
Latitude	2503.71325		ddmm.mmmmm
N/S indicator	N		N=north or S=south
Longitude	12138.74397		dddmm.mmmmm
E/W Indicator	E		E=east or W=west
Position Fix Indicator	2		See Table 5.1-3
Satellites Used	30		Satellites in use
HDOP	0.6		Horizontal Dilution of Precision
MSL Altitude	113.69	meters	Height above mean sea level, max: 100000.0 m
Units	M	meters	Unit for MSL Altitude
Geoid Separation	15.3	meters	Geoidal separation measure in “M” = meters
Units	M	meters	
Age of Diff. Corr.		second	Null. Not supported.
Diff. Ref. Station ID			Null. Not supported.
Checksum	*69		
<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 5.1-4 contains the values for the following example:

\$GNGSA,A,3,09,19,02,05,06,17,12,,,,,1.2,0.6,1.0*2D

\$GNGSA,A,3,195,199,193,,,,,,,1.2,0.6,1.0*1F

\$GNGSA,A,3,307,308,313,315,326,,,,,,,1.2,0.6,1.0*16

\$GNGSA,A,3,173,141,142,143,144,146,148,150,151,153,154,156,1.2,0.6,1.0*23

\$GNGSA,A,3,161,174,152,,,,,,,1.2,0.6,1.0*1A

Table 5.1-4 GSA Data Format

Name	Example	Units	Description
Message ID	\$GNGSA		GSA protocol header
Mode 1	A		See Table 5.1-5
Mode 2	3		See Table 5.1-6
ID of satellite used	09		Sv on Channel 1
ID of satellite used	19		Sv on Channel 2
....			
ID of satellite used			Sv on Channel 12
PDOP	1.2		Position Dilution of Precision
HDOP	0.6		Horizontal Dilution of Precision
VDOP	1.0		Vertical Dilution of Precision
Checksum	*23		
<CR> <LF>			End of message termination

Table 5.1-5 Mode 1

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

Table 5.1-6 Mode 2

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

● GSV---GNSS Satellites in View

Table 5.1-7 contains the values for the following example:

\$GPGSV,3,1,10,19,53,141,47,06,48,048,46,05,47,266,46,02,45,335,47*74

\$GPGSV,3,2,10,17,37,145,47,09,29,052,41,12,26,272,41,13,15,190,*73

\$GPGSV,3,3,10,42,54,141,41,50,51,134,42,,,,,,*7F

\$QZGSV,1,1,03,193,75,062,47,195,65,146,47,199,60,167,42,,,,*67

\$GAGSV,2,1,05,313,62,027,48,307,61,190,45,308,57,054,46,315,32,100,42*63

\$GAGSV,2,2,05,326,28,322,41,,,,,,*66

\$BDGSV,4,1,15,154,80,293,48,174,75,096,51,151,69,352,50,143,59,206,45*6A

\$BDGSV,4,2,15,148,54,012,46,141,54,141,46,153,46,335,47,146,47,178,44*69

\$BDGSV,4,3,15,156,43,183,45,161,40,035,47,142,40,243,42,144,39,117,42*68

\$BDGSV,4,4,15,173,27,231,43,150,23,220,40,152,23,129,40,,,,*63

Table 5.1-7 GSV Data Format

Name	Example	Units	Description
Message ID	\$GPGSV		GSV protocol header
Total number of messages ¹	3		Range 1 to 8
Message number ¹	1		Range 1 to 8
Satellites in view	10		
Satellite ID	19		Channel 1 (Range 01 to 196)
Elevation	53	degrees	Channel 1 (Range 00 to 90)
Azimuth	141	degrees	Channel 1 (Range 000 to 359)
SNR (C/No)	47	dB-Hz	Channel 1 (Range 00 to 99, null when not tracking)
....			
Satellite ID	02		Channel 4 (Range 01 to 32)
Elevation	45	degrees	Channel 4 (Range 00 to 90)
Azimuth	335	degrees	Channel 4 (Range 000 to 359)
SNR (C/No)	47	dB-Hz	Channel 4 (Range 00 to 99, null when not tracking)
Checksum	*74		
<CR> <LF>			End of message termination

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

● RMC---Recommended Minimum Specific GNSS Data

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

\$GPRMC,051951.000,A,2503.71325,N,12138.74397,E,0.0,0.0,260819,,,D*67

Table 5.1-8 RMC Data Format

Name	Example	Units	Description
Message ID	\$GPRMC		RMC protocol header
UTC Time	051951.000		hhmmss.sss
Status	A		A=data valid or V=data not valid
Latitude	2503.71325		ddmm.mmmmm
N/S Indicator	N		N=north or S=south

Longitude	12138.74397		ddmm.mmmmm
E/W Indicator	E		E=east or W=west
Speed over ground	0.0	knots	True
Course over ground	0.0	degrees	
Date	260819		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	*67		
<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,1,1,1,0,0,0,0.100000,0,633,420,420,633,0,1,1,10,0,38,3,6,18,2,0,0,7.040e-09,65473905.37,25999978.97,4*16

Table5.2- 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 7 = BEIDOU 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	633	ns	GPS path RF delay (ns)
GLO_delay	420	ns	GLONASS path RF delay (ns)
BEI_delay	420	ns	BEIDOU path RF delay (ns) Note: this parameter is always zero if Beidou constellation is not supported by the hardware platform.
GAL_delay	633	ns	GALILEO 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	38		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 or a BEIDOU 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	6		Used satellites for time correction.
GPS_utc_delta_s	18	second	UTC leap seconds (s)
GPS_utc_delta_ns	2	ns	UTC – GPS delta time (ns)
GLONASS_utc_delta_ns	0	ns	UTC – GLONASS delta time (ns)
GALILEO_utc_delta_ns	0	ns	UTC-GALILEO delta time (ns)
Quantization_error	7.040e-09	second	Quantization error (s)
PPS_clock_freq	65473905.37	Hz	PPS clock frequency (Hz)
TCXO_clock_freq	25999978.97	Hz	TCXO clock frequency (Hz)
Checksum	*16		
<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,1,2503.71236,N,12138.74569,E,120.19*43

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	2503.71236		ddmm.mmmmm
N/S Indicator	N		N=north or S=south
Longitude	12138.74569		dddmm.mmmmm
E/W Indicator	E		E=east or W=west
Alt	120.19	meter	Height above WGS-84 Ellipsoid. (maximum 100,000)
Checksum	*43		
<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 \$PSTMENABLEPOSITIONHOLD

Enable/disable and set position for the Position Hold feature.

Synopsis:

```
$PSTMENABLEPOSITIONHOLD,<on_off>,<Lat>,<LatRef>,<Lon>,<LonRef>,<Alt><cr><lf>
```

Arguments:

Parameter	Format	Description
on_off	Decimal, 1 digit	Set the position hold enable/disable status: 0: disabled. 1: enabled.
Lat	DDMM.MMMMM	Latitude (Degree-Minute.Minute decimals)
LatRef	'N' or 'S'	Latitude direction (North or South)
Lon	DDDMM.MMMMM	Longitude (Degree-Minute.Minute decimals)
LonRef	'E' or 'W'	Longitude Direction (East or West)
Alt	Dddddd.dddd	Altitude in meters (-1500 to 100000).

The altitude value must be reported without any geoid correction. It means that if the altitude value is retrieved by the \$GPGLL message, it must be added to the geoid correction before using it in the \$PSTMENABLEPOSITIONHOLD command.

Results:

- If success, the following message is sent:

If on_off = 1

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

If on_off = 0

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

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

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

Examples:

```
$PSTMENABLEPOSITIONHOLD,1,4811.365,N,01164.123,E,0530.0
```

5.3.2 \$PSTMSETCONSTMASK

Set the GNSS constellation mask. It allows switching the GNSS constellation at run-time. In case of reset, constellation mask is restored to default value.

Synopsis:

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

Arguments:

Parameter	Format	Description
constellation_mask	Decimal, 1-9999	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 bit 3: GALILEO constellation enabling/disabling bit 7: BEIDOU 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
```

5.3.3 \$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).

5.3.3.1 Getting PPS Data (cmd_mode = 1)

5.3.3.1.1 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 5 = COMPASS_UTC 6 = UTC_NTSC 7 = GST 8 = UTC_GST 9 = GPS_FROM_GST

		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

5.3.3.1.2 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 bit 7 = BEIDOU
GPS_rf_delay	Decimal	GPS path RF delay (ns)
GLONASS_rf_delay	Decimal	GLONASS path RF delay (ns)

5.3.3.1.3 PPS_IF_POSITION_HOLD_DATA_CMD

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

Response:

```
$PSTMPPS,1,13,<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.

5.3.3.1.4 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.

5.3.3.1.5 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

5.3.3.1.6 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.

5.3.3.1.7 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.

5.3.3.2 setting PPS Data (cmd_mode = 2)

5.3.3.2.1 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.

5.3.3.2.2 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.
--	--	---

5.3.3.2.3 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.

5.3.3.2.4 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

5.3.3.2.5 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

		3 = GALILEO 7 = BEIDOU
time_delay	Decimal	Time delay (ns)

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

5.3.3.2.6 PPS_IF_PULSE_DURATION_CMD

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

Parameter	Format	Description
pulse_duration	Double	Pulse duration (s)

5.3.3.2.7 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.

5.3.3.2.8 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 3 = UTC_SU 4 = GPS_UTC_FROM_GLONASS 5 = COMPASS_UTC 6 = UTC_NTSC 7 = GST 8 = UTC_GST 9 = GPS_FROM_GST
pulse_delay	Decimal	Pulse delay (ns)
pulse_duration	Double	Pulse duration (s)
pulse_polarity	Decimal, 1 digit	0 = not inverted.

		1 = inverted.
--	--	---------------

5.3.3.2.9 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.

5.3.3.2.10 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.

5.3.3.2.11 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.

5.3.3.2.12 PPS_IF_COSTELLATION_MASK_CMD

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

Parameter	Format	Description
constellation_mask	Decimal (bit mask)	Satellite constellation selection for usage in timing filtering. bit0 = GPS bit1 = GLONASS bit7 = BEIDOU NOTES: 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. Same description is valid also for GPS and BEIDOU constellations enabling/disabling bit0 and bit7.
--	--	--

5.3.3.2.13 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	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 bit7 = BEIDOU

5.3.3.2.14 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.

5.3.3.2.15 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.
--	--	--

The position hold auto survey mode is default enabled. Default position samples are 2000 points.

5.3.3.2.16 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.

5.3.4 \$PSTMFORCESTANDBY

Force the platform to go in standby mode.

Synopsis:

```
$PSTMFORCESTANDBY,<duration><cr><lf>
```

Arguments:

Parameter	Format	Description
duration	Decimal, 5 digits	Duration of the standby time in seconds

Results:

- If the command is executed with success the following message is sent:

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

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

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

Arguments:

Same description as reported in previous table.

6 How to make sure LS2609x-GT's PPS over USB is working in Linux Ubuntu?

GPSD is daemon which uses to handle the NMEA and PPS information on Linux system. The GPSD client application called "gpsmon" could be used to check if PPS is working in Linux Ubuntu version 16.04.4. "gpsmon" is a monitor that watches packets coming from a GPS and displays them along with diagnostic information. Here provides some steps for installation of GPSD and verifying PPS performance on Linux system. User can check if a GPSD program has been installation on the Ubuntu. Using following command to determine if GPSD is running in system.

\$ps ax | grep gps

```
cloud@CloudxUBT: ~
cloud@CloudxUBT:~$ ps ax | grep gps
19446 ?        S<sl    0:00 /usr/sbin/gpsd -N -n /dev/ttyUSB0
19482 pts/4    S+      0:00 gpsmon
19504 pts/17    S+      0:00 grep --color=auto gps
```

User should install the GPSD package by following commands if it does not installation in Ubuntu.

\$sudo apt-get update

\$sudo apt-get install gpsd-clients gpsd

```
cloud@CloudxUBT:~$ sudo apt-get update
Hit:1 http://tw.archive.ubuntu.com/ubuntu xenial InRelease
Hit:2 http://tw.archive.ubuntu.com/ubuntu xenial-updates InRelease
Hit:3 http://tw.archive.ubuntu.com/ubuntu xenial-backports InRelease
Hit:4 http://security.ubuntu.com/ubuntu xenial-security InRelease
Reading package lists... Done
cloud@CloudxUBT:~$ sudo apt-get install gpsd-clients gpsd
Reading package lists... Done
Building dependency tree
Reading state information... Done
```

Before starting GPSD, LS2609x-GT should connect to USB port. It normally enumerates a USB device such as "/dev/ttyUSB0" in this case. By using following command to determine device name if module is connecting to host by USB.

\$ls /dev/ttyU*

```
cloud@CloudxUBT:~$ ls /dev/ttyU*
/dev/ttyUSB0
```

Now customer gets the device name as "/dev/ttyUSB0" and checks the GPSD file. By using following command to configure host file at "/etc/default/gpsd".

\$sudo gedit /etc/default/gpsd

```
cloud@CloudxUBT: ~
cloud@CloudxUBT:~$ sudo gedit /etc/default/gpsd
[sudo] password for cloud:
```

Please set the device name (DEVICE="/dev/ttyUSB0") and set GPSD options with the nowait (-n) parameter (GPSD_OPTIONS="-n") as following example then restart the GPSD service.

```
gpsd (/etc/default) - gedit
# Default settings for the gpsd init script and the hotplug wrapper.

# Start the gpsd daemon automatically at boot time
START_DAEMON="true"

# Use USB hotplugging to add new USB devices automatically to the daemon
USB_AUTO="true"

# Devices gpsd should collect to at boot time.
# They need to be read/writeable, either by user gpsd or the group dialout.
DEVICES="/dev/ttyUSB0"

# Other options you want to pass to gpsd
GPSD_OPTIONS="-n"
```

\$sudo service gpsd restart

```
cloud@CloudxUBT:~$ sudo service gpsd restart
[sudo] password for cloud:
```

By using following command to check GPSD is working as expected. (“-n” and “/dev/ttyUSB0” parameters)

\$ps aux | grep gpsd

```
cloud@CloudxUBT:~$ ps aux | grep gpsd
gpsd      2786  0.1  0.2 115980 4104 ?        S<sl 10:04   0:12 /usr/sbin/gpsd -N -n /dev/ttyUSB0
cloud    3412  0.0  0.0 21572 1084 pts/17    S+   13:37   0:00 grep --color=auto gpsd
```

Execute the GPSD client program.

\$gpsmon

```
cloud@CloudxUBT: ~
/dev/ttyUSB0 u-blox>
Ch PRN Az El S/N Flag U
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
NAV_SVINFO
00000000000010000000000000006900ff0cfff000000f722
(26) b5620104120010144d0c750069003300440050000f270f27a510
(24) b5620120100010144d0c90c40500cb07120700000000f208
```

ECEF Pos: -3033216.97m +4921615.83m +2685348.87m		
ECEF Vel: +0.00m/s +0.00m/s +0.01m/s		
LTP Pos: 25.061926663° 121.645740207° 121.75m		
LTP Vel: 0.01m/s 0.0° 0.00m/s		
Time: 23 21:16:20.00		
Time GPS: 1995+206378.000 Day: 2		
Est Pos Err 2.58m Est Vel Err 0.00m/s		
PRNs: 12 PDOP: 1.1 Fix 0x03 Flags 0x0f		
NAV_SOL		
DOP [H] 0.8 [V] 0.7 [P] 1.1 [T] 0.5 [G] 1.2	NAV_DOP	
TOFF: 0.236903389	PPS: 0.009320523	

As shown above, PPS is detected with delay of 0.009320523 seconds to the local clock while delay of GPS is 0.236903389 seconds (shown by TOFF)

7 Pin assignment and descriptions

Table 7-1 Pin descriptions of PCIe Mini card

Pin #	Name	Type	Description	Note
1	NC			
2	NC			
3	NC			
4	GND	P	Ground	
5	NC			
6	NC			
7	NC			
8	NC			
9	GND	P	Ground	
10	NC			
11	NC			
12	NC			
13	NC			
14	NC			
15	GND	P	Ground	
16	NC			
17	NC			
18	GND	P	Ground	
19	NC			
20	/W_DISABLE	I	Power control input pin. Internal pull-up resistor. High: power on; Low: power off	
21	GND	P	Ground	
22	NC			
23	NC			
24	NC			
25	NC			
26	GND	P	Ground	
27	GND	P	Ground	
28	NC			
29	GND	P	Ground	
30	NC			
31	NC			
32	NC			
33	NC			

34	GND	P	Ground	
35	GND	P	Ground	
36	USB_D-		USB D- line	
37	GND	P	Ground	
38	USB_D+		USB D+ line	
39	NC			
40	GND	P	Ground	
41	NC			
42	NC			
43	GND	P	Ground	
44	NC			
45	NC			
46	NC			
47	NC			
48	NC			
49	TIMEMARK	O	Time pulse (1PPS, default 100 ms pulse/sec when 3D position fix is available)	
50	GND	P	Ground	
51	NC			
52	VCC	P	Power input	

8 DC & Temperature characteristics

8.1 DC Electrical characteristics

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Input Voltage	VCC		3.0		3.6	V
Supply Current	I _{ss}	VCC = 3.3V, Peak Acquisition Tracking Standby Power off		77 81 ⁽¹⁾ 17 <1 ⁽²⁾	208	mA mA mA mA uA
High Level Input Voltage	V _{IH}	/W_DISABLE pin	1.3		VCC	V
Low Level Input Voltage	V _{IL}	/W_DISABLE pin			0.25	V
High Level Input Current	I _{IH}	/W_DISABLE pin	-5		1	uA
Low Level Input Current	I _{IL}	/W_DISABLE pin	-5		1	uA

Note 1: Measured when position fix (1Hz) is available, input voltage is 3.3V and the function of self-generated ephemeris prediction is inactive.

Note 2: Measured when /W_DISABLE pin is at low level.

8.2 Temperature characteristics

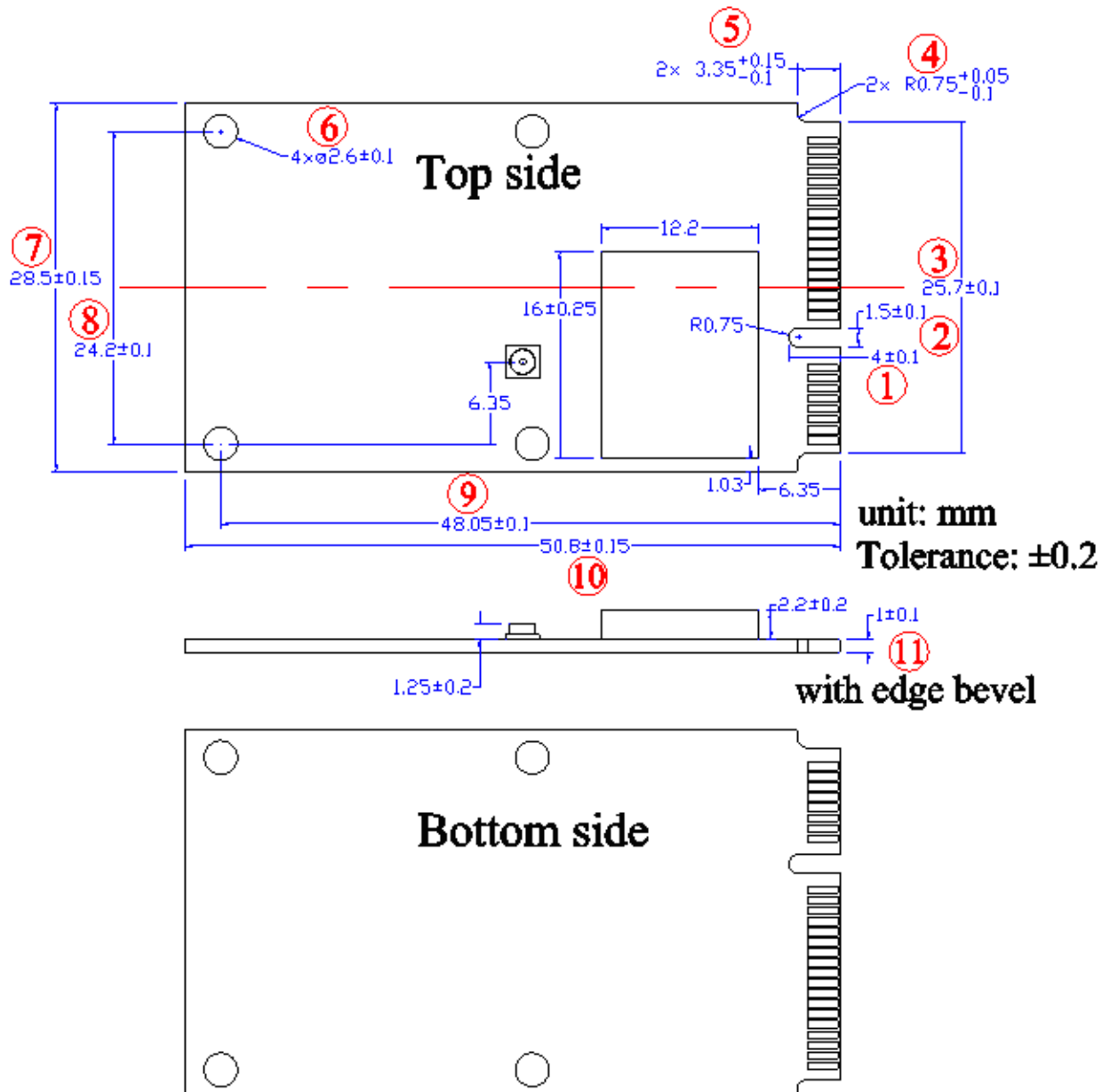
Parameter	Symbol	Min.	Typ.	Max.	Units
Operating Temperature	T _{opr}	-40	-	85	°C
Storage Temperature	T _{stg}	-40	25	85	°C

Note: The operating and storage temperature of the built-in micro battery are -20 ~ +60 °C and -40 ~ +60 °C respectively. GNSS module will still work even the battery is broken or short due to temperature or other issues.

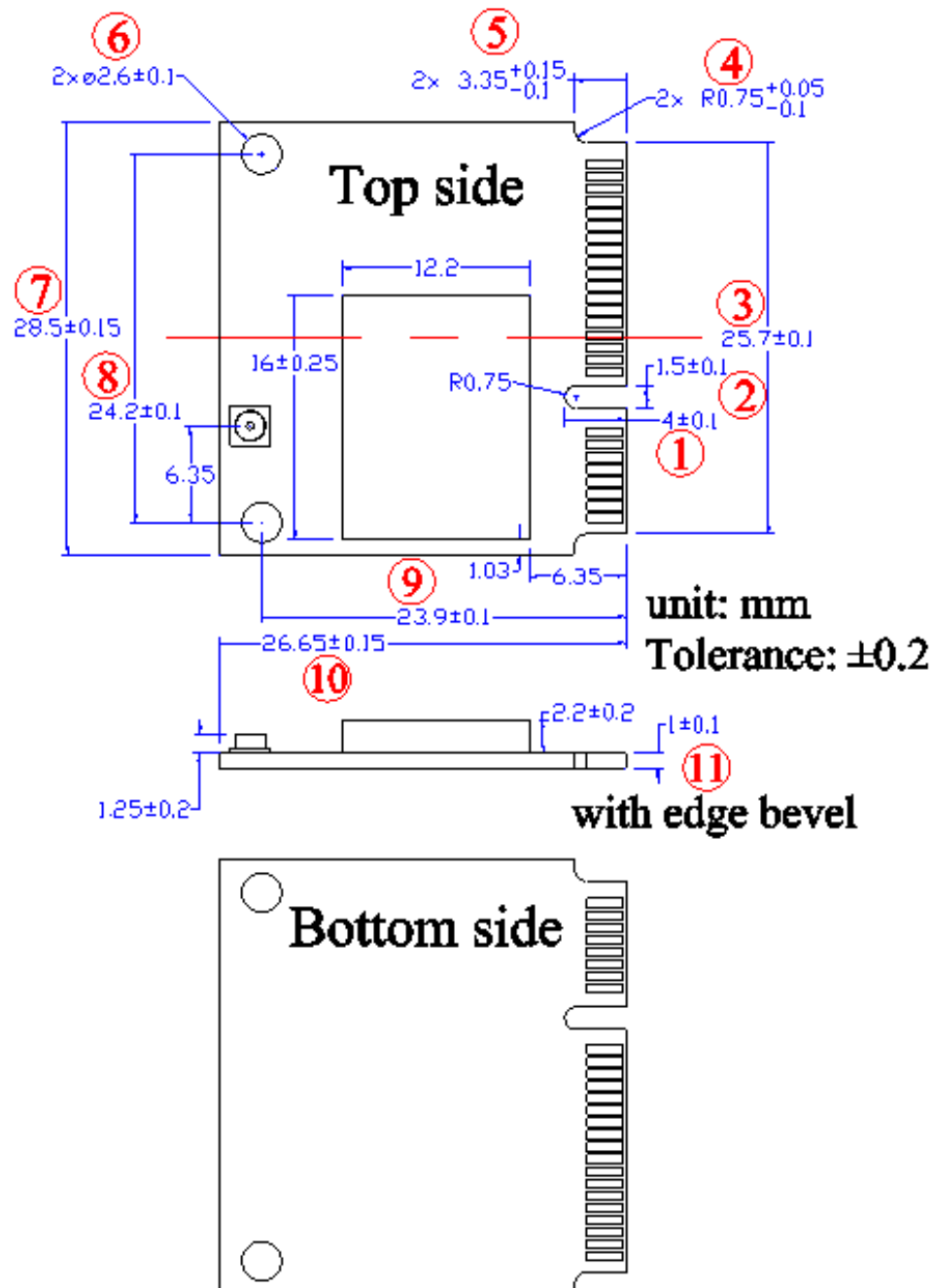
9 Mechanical specification

The dimension and pin definition are compliant with PCI Express Mini Card Revision 1.2.

9.1 Outline dimensions of LS26090-GT



9.2 Outline dimensions of LS26091-GT

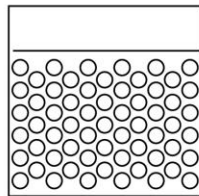


10 Packing information

Both LS26090-GT and LS26091-GT use the same package.

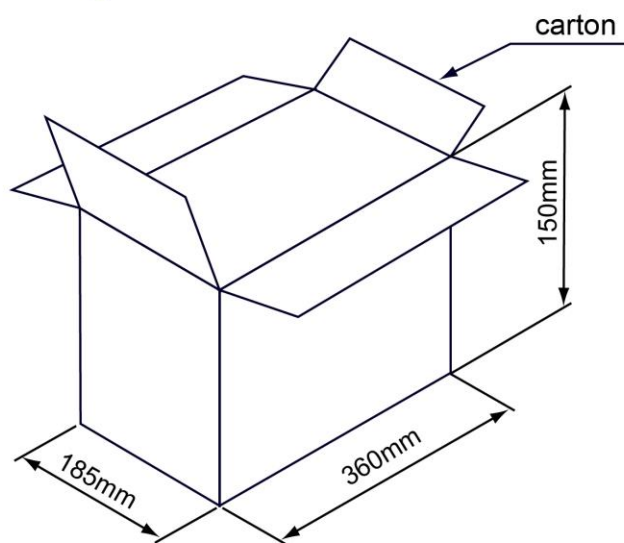


1pcs in an antistatic bag



6pcs in a bubble bag

30 bubble bags in a carton
(180pcs)



Tolerance: ± 10 mm

Document change list

Revision 0.1

- Draft release on Dec. 17, 2019

Revision 0.2 (December 22, 2021)

- Changed the packaging in section 10.