

Product name	Description	Version
LS20070-G ⁽¹⁾	Multiple GNSS smart antenna module/USB,9600BPS,30x30mm	1.0
LS20071-G	Multiple GNSS smart antenna module/TTL,9600BPS,30x30mm	
LS20072-G	Multiple GNSS smart antenna module/RS232,9600BPS,30x30mm	

Note 1: Required details of product LS20070-G's "PPS over USB", please contact LOCOSYS sale directly.

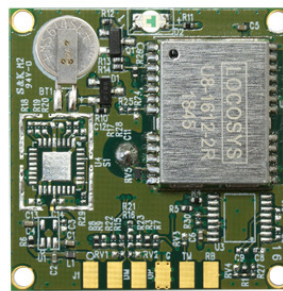
Datasheet of Multiple GNSS smart antenna module, LS2007x-G series



Top View



LS20070-G



LS20071-G



LS20072-G

1 Introduction

LS2007x-G series products are complete standalone GNSS smart antenna modules, including an embedded antenna and GNSS receiver circuits, designed for a broad spectrum of OEM system applications. The product is based on the proven technology built-in u-blox8 chip solution. It can simultaneously acquire and track multiple satellite constellations that include GPS, GLONASS, GALILEO, QZSS and SBAS. Besides, it can provide you with superior sensitivity and performance even in urban canyon and dense foliage environment. Its far-reaching capability meets the sensitivity requirements of car navigation as well as other location-based applications.

2 Features

- u-blox8 high sensitivity and low power solution
- Support GPS, GLONASS, GALILEO and QZSS
- Capable of SBAS (WAAS, EGNOS, MSAS) support
- Support 72- channel GNSS
- Fast TTFF at low signal level
- 1PPS over USB for timing application
- Linux/Android driver support
- Compatible with GPSD PPS support
- Support RTCM data input
- Build-in backup battery for reserve system data & rapid satellite reacquisition
- LED indicator for GNSS positioning status

3 Application

- Personal positioning and navigation
- Automotive navigation
- Fleet management
- Marine navigation
- High-Quality NTP time server

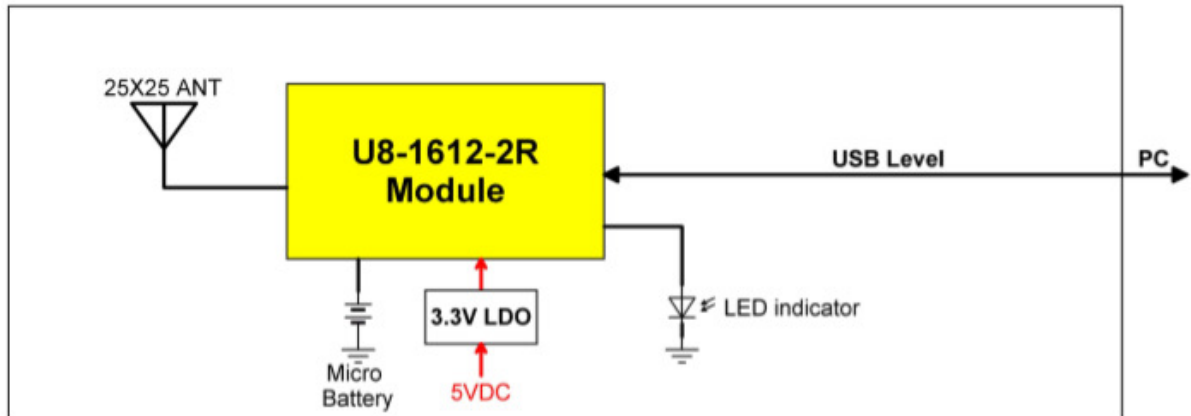


Fig 3-1 System block diagram of LS20070-G

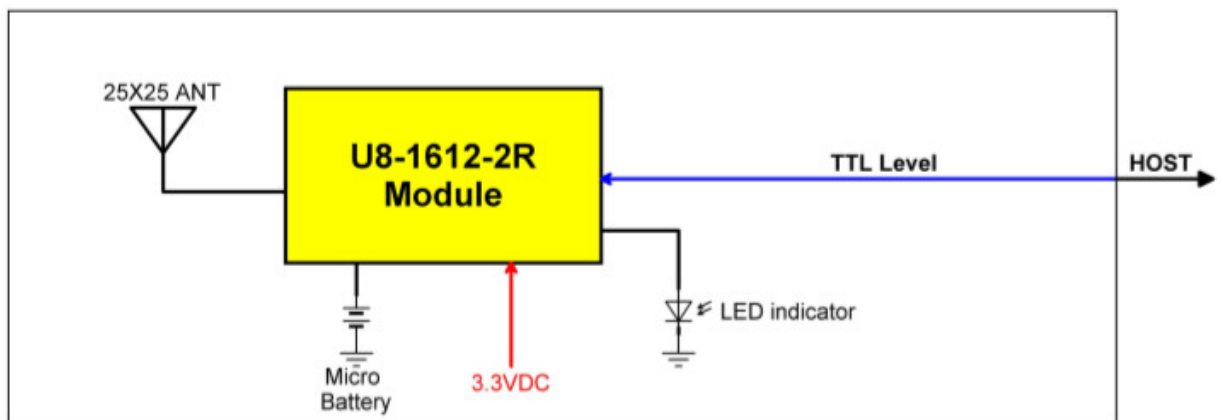


Fig 3-2 System block diagram of LS20071-G

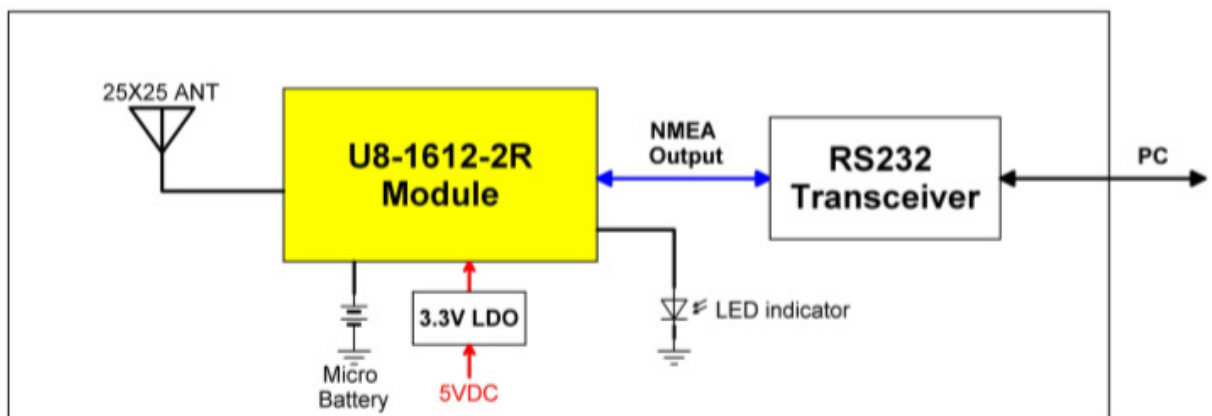


Fig 3-3 System block diagram of LS20072-G

4 GNSS receiver

Chip	UBX-M8030	
Frequency	GPS, QZSS: L1 1575.42MHz, C/A code GLONASS: L1 1598.0625MHz ~ 1605.375MHz, C/A code	
Channels	Support 72 channels	
Update rate	1Hz default, up to 10Hz	
Acquisition Time	Hot start (Open Sky)	< 1s (typical)
	Cold Start (Open Sky)	30s (typical)
Position Accuracy	Autonomous	2.5m CEP
Max. Altitude	< 50,000 m	
Max. Velocity	< 500 m/s	
Velocity Accuracy ⁽¹⁾	0.05 m/s	
Heading Accuracy ⁽¹⁾	0.3 degrees	
PPS Signal Accuracy	30ns (RMS) in chip level; 1ms for PPS over USB ⁽²⁾	
Protocol Support	NMEA 0183 ver 4.0	9600bps ⁽³⁾ , 8 data bits, no parity, 1 stop bits (default) 1Hz: GGA, GLL, GSA, GSV, RMC, VTG and TXT
	UBX Protocol ver 18.00	9600 bps (configurable), 8 data bits, no parity, 1 stop bits
	RTCM SC-104 ver 2.3	message types type 1, 2, 3, & 9

Note 1: 50% @30 m/s.

- 2: The LS20070-G (PPS over USB) makes PPS events visible for a compatible USB host system; they appear DCD state changes to the PL2303 driver. Its time precision will be limited by the USB pooling interval, usually 1 millisecond.
- 3: Both baud rate and output message rate are configurable to be factory default.

4.1 Supported GNSS Constellations

The module can be configured to receive any single GNSS constellation or within the set of permissible combinations shown below.

GPS	GLONASS	GALILEO
•	-	-
•	-	•
•	•	-
•	•	•
-	•	-
-	•	•
-	-	•

Note: 1. Permissible GNSS combinations (• = enabled)

2. The default GNSS combination is GPS+GLONASS+QZSS constellation but QZSS cannot viewing

5 LED indicator

The red LED is an indicator of GNSS positioning status. In continuous power mode, it flashes once per second when position is fixed. Otherwise it is off. The timing in detail is as below.

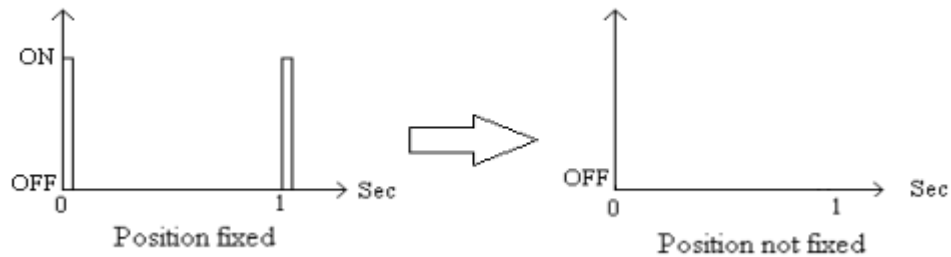
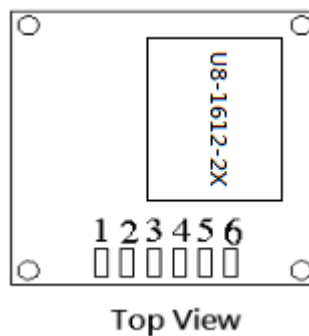


Fig 5.1 LED indicator of positioning status

6 Pin assignment and descriptions



● LS20070-G

Pin #	Name	Type	Description
1	VCC	P	Power input
2	D-	I	D- Line
3	D+	O	D+ Line
4	GND	P	Ground
5	TIMEPULSE	O	1PPS, default 100 ms pulse/sec when 3D fix is available)
6	NC	-	Reserved, keep open.

● LS20071-G

Pin #	Name	Type	Description
1	VCC	P	Power input
2	RX	I	Data input (TTL level)
3	TX	O	Data output (TTL level)
4	GND	P	Ground
5	TIMEPULSE	O	1PPS, default 100 ms pulse/sec when 3D fix is available)
6	NC	-	Reserved, keep open.

● **LS20072-G**

Pin #	Name	Type	Description
1	VCC	P	Power input
2	RX	I	Data input (RS232 level)
3	TX	O	Data output (RS232 level)
4	GND	P	Ground
5	TIMEPULSE	O	1PPS, default 100 ms pulse/sec when 3D fix is available)
6	NC	-	Reserved, keep open.

7 DC & Temperature characteristics

7.1 DC Electrical characteristics

Parameter	Symbol	Product	Min.	Typ.	Max.	Units
Input voltage	VCC	LS20070-G	4.75	5.0	5.25	V
		LS20071-G	3.0	3.3	3.6	
		LS20072-G	4.75	5.0	5.25	
Input current	Icc	LS20070-G		28 ^(1, 2)		mA
		LS20071-G		26 ⁽¹⁾		
		LS20072-G		33 ⁽¹⁾		
High Level Input Voltage	V _{IH}		0.7*VCC		VCC	V
Low Level Input Voltage	V _{IL}		0		0.2*VCC	V
High Level Output Voltage	V _{OH}		VCC-0.4			V
Low Level Output Voltage	V _{OL}				0.4	V
High Level Output Current	I _{OH}			4		mA
Low Level Output Current	I _{OL}			4		mA

Note 1: Measured when position fix is available at 1Hz updating rate and the function of AssistNow Autonomous is inactive.

2: Typical power consumption of PPS over USB will be 43mA.

7.2 Temperature characteristics

Parameter	Symbol	Product	Min.	Typ.	Max.	Units
Operating Temperature	Topr ⁽¹⁾	LS20070-G	-40	-	85	°C
		LS20071-G				
		LS20072-G				
Storage Temperature	Tstg ⁽²⁾	LS20070-G	-40	25	85	°C
		LS20071-G				
		LS20072-G				

Note 1: Backup battery: -20 ~ 60°C

2: Backup battery: -40 ~ 60°C

9 Software interface

9.1 NMEA output message

Table 9.1-1 NMEA output message

NMEA	Description
GGA	Global positioning system fixed data
GLL	Geographic position - latitude/longitude
GSA	GNSS Overall satellite data
GSV	GNSS Detailed satellite data
RMC	Recommended minimal data for GNSS
VTG	Course over ground and ground speed
TXT	Text Transmission

● GGA Global positioning system fixed data

Table 9.1-2 contains the values for the following example:

\$GNGGA,052135.00,2503.71325,N,12138.74587,E,2,12,0.59,124.5,M,17.2,M,,0000*4E

Table 9.1-2 GGA Data Format

Name	Example	Units	Description
Message ID	\$GNGGA		GGA Message ID (GN = current Talker ID)
UTC Time	052132.00		hhmmss.ss
Latitude	2503.71325		ddmm.mmmmm
N/S indicator	N		N=north or S=south
Longitude	12138.74587		dddmm.mmmmm
E/W Indicator	E		E=east or W=west
Position Fix Indicator	2		See Table 9.1-3
Satellites Used	12		Number of satellites in view, 00-24
HDOP	0.59		Horizontal Dilution of Precision (meters)
MSL Altitude	124.5	meters	Antenna Altitude above/below mean-sea-level (geoid) (in meters)
Units	M	meters	Units of antenna altitude, meters
Geoidal Separation	17.2	meters	
Units	M	meters	Units of geoidal separation, meters
Age of diff. GNSS data		second	Null fields when DGPS is not used
Diff. Ref. Station ID	0000		Differential reference station ID, 0000-1023
Checksum	*4E		Checksum
<CR> <LF>			End of message termination

Table 9.1-3 Position Fix Indicators

Value	Description
0	Fix not available
1	GNSS fix

2	Differential GNSS fix
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● GLL--- Geographic Position – Latitude/Longitude

Table 9.1-4 contains the values for the following example:

\$GNGLL,2503.71325,N,12138.74587,E,052135.00,A,D*74

Table 9.1-4 GLL Data Format

Name	Example	Units	Description
Message ID	\$GNGLL		GLL protocol header
Latitude	2503.71325		ddmm.mmmmm
N/S indicator	N		N=north or S=south
Longitude	12138.74587		dddmm.mmmmm
E/W indicator	E		E=east or W=west
UTC Time	052135		hhmmss.ss
Status	A		A=data valid or V=data not valid
Mode	D		V = Invalid, A= Autonomous and D =Differential
Checksum	*74		
<CR> <LF>			End of message termination

● GSA--GNSS DOP and Active Satellites

Table 9.1-5 contains the values for the following example:

\$GNGSA,A,3,01,03,11,17,19,22,28,30,06,07,41,,1.30,0.59,1.16*15

\$GNGSA,A,3,74,84,73,80,83,85,69,,,,,1.30,0.59,1.16*1E

Table 9.1-5 GSA Data Format

Name	Example	Units	Description
Message ID	\$GNGSA		GSA protocol header
Mode 1	A		See Table 9.1-6
Mode 2	3		See Table 9.1-7
ID of satellite used	01		Sv on Channel 1
ID of satellite used	03		Sv on Channel 2
....			
ID of satellite used	41		Sv on Channel 11
PDOP	1.30		Position Dilution of Precision
HDOP	0.59		Horizontal Dilution of Precision
VDOP	1.16		Vertical Dilution of Precision
Checksum	*15		
<CR> <LF>			End of message termination

Table 9.1-6 Mode 1

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

Table 9.1-7 Mode 2

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

Note 1: 2D fix hint that the receiver position error meets the 2D level. Maybe under this condition the used satellite number is little more than 4

● GSV---GNSS Satellites in View

Table 9.1-8 contains the values for the following example:

\$GPGSV,4,1,15,01,40,032,45,03,52,108,42,06,22,241,37,07,16,190,40*7F

\$GPGSV,4,2,15,08,10,087,,11,29,047,40,17,35,316,44,19,18,297,37*7C

\$GPGSV,4,3,15,22,41,070,42,28,70,335,43,30,33,225,42,40,13,260,*73

\$GPGSV,4,4,15,41,38,242,38,42,51,134,35,50,51,134,35*4F

\$GLGSV,3,1,11,67,01,029,20,68,26,074,25,69,26,131,33,73,49,208,37*6F

\$GLGSV,3,2,11,74,45,303,41,75,02,334,,80,09,174,35,83,26,033,31*6F

\$GLGSV,3,3,11,84,39,326,34,85,12,277,29,,,43*63

Table 9.1-8 GSV Data Format

Name	Example	Units	Description
Message ID	\$GNGSV		GSV protocol header
Total number of messages ¹	4		Range 1 to 6
Message number ¹	1		Range 1 to 6
Satellites in view	15		
Satellite ID ²	01		Channel 1
Elevation	40	degrees	Channel 1 (Range 00 to 90)
Azimuth	032	degrees	Channel 1 (Range 000 to 359)
SNR (C/No)	45	dB-Hz	Channel 1 (Range 00 to 99, null when not tracking)
....			
Satellite ID	07		Channel 4 (Range 01 to 196)
Elevation	16	degrees	Channel 4 (Range 00 to 90)
Azimuth	190	degrees	Channel 4 (Range 000 to 359)
SNR (C/No)	40	dB-Hz	Channel 4 (Range 00 to 99, null when not tracking)
Checksum	*7F		
<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 9.1-9 contains the values for the following example:

\$GNRMC,052136.00,A,2503.71326,N,12138.74586,E,0.003,,200717,,,D*6C

Table 9.1-9 RMC Data Format

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

Message ID	\$GNRMC		RMC protocol header
UTC Time	052136.00		hhmmss.ss
Status	A		A=data valid or V=data not valid
Latitude	2503.71326		ddmm.mmmmm
N/S Indicator	N		N=north or S=south
Longitude	12138.74586		dddmm.mmmmm
E/W Indicator	E		E=east or W=west
Speed over ground	0.003	knots	True
Course over ground		degrees	
Date	200717		ddmmyy
Magnetic variation		degrees	
Variation sense			E=east or W=west
Mode	D		V=Invalid A=autonomous, D=Differential.
Checksum	*6C		
<CR> <LF>			End of message termination

● VTG---Course Over Ground and Ground Speed

Table 9.1-10 contains the values for the following example:

\$GNVTG,,T,,M,0.003,N,0.006,K,D*3D

Table 9.1-10 VTG Data Format

Name	Example	Units	Description
Message ID	\$GNVTG		VTG protocol header
Course over ground		degrees	Measured heading
Reference	T		True
Course over ground		degrees	Measured heading
Reference	M		Magnetic
Speed over ground	0.003	knots	Measured speed
Units	N		Knots
Speed over ground	0.006	km/hr	Measured speed
Units	K		Kilometer per hour
Mode	D		V=Invalid A=autonomous, D=Differential.
Checksum	*3D		
<CR> <LF>			End of message termination

● TXT--- Text Transmission

Table 9.1-11 contains the values for the following example:

\$GNTXT,01,01,02,ANTSTATUS=INIT*3B

\$GNTXT,01,01,02,ANTSTATUS=OK*25

Table 9.1-11 TXT Data Format

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

Message ID	\$GNTXT		TXT protocol header
numMsg	01		Total number of messages in this transmission, 01.. 99
msgNum	01		Message number in this transmission, range 01..xx
msgType	02		Text identifier, u-blox GNSS receivers specify the type of the message with this number. 00: Error 01: Warning 02: Notice 07: User
text	ANTSTATUS=INT		Any ASCII text
Checksum	*3B		
<CR> <LF>			End of message termination

9.2 UBX Protocol

The GNSS smart antenna module supports u-blox proprietary protocol to communicate with a host computer. Detail proprietary protocol descriptions should refer to ubx protocol version 18.00.

Table 9.2-1 The table below summarizes the set of proprietary commands for ublox chip solution

Command descriptions	Software command
Perform a Cold start	B5 62 06 04 04 00 FF FF 02 00 0E 61
Perform a Warm start	B5 62 06 04 04 00 01 00 02 00 11 6C
Perform a Hot start	B5 62 06 04 04 00 00 00 02 00 10 68
Perform a Factory reset	B5 62 06 04 04 00 FF B9 00 00 C6 8B
Enable QZSS viewing	B5 62 06 17 14 00 00 40 00 02 00 00 00 00 01 00 00 01 00 00 00 00 00 00 00 75 50
UART configures as 115200bps	B5 62 06 00 14 00 01 00 00 00 D0 08 00 00 00 C2 01 00 07 00 07 00 00 00 00 00 C4 96 B5 62 06 00 01 00 01 08 22
UART configures as 9600bps	B5 62 06 00 14 00 01 00 00 00 D0 08 00 00 80 25 00 00 07 00 07 00 00 00 00 00 A6 CD B5 62 06 00 01 00 01 08 22
Enable ZDA message	24 45 49 47 50 51 2C 5A 44 41 2A 33 39 0d 0A B5 62 06 01 03 00 f0 08 01 03 20
Disable ZDA message	24 45 49 47 50 51 2C 5A 44 41 2A 33 39 0D 0A B5 62 06 01 03 00 f0 08 00 02 1F
Switch to 5Hz NMEA output mode	B5 62 06 08 06 00 C8 00 01 00 01 00 DE 6A B5 62 06 08 00 00 0E 30
Switch to 10Hz NMEA output mode	B5 62 06 08 06 00 64 00 01 00 01 00 7A 12 B5 62 06 08 00 00 0E 30
Switch to 1Hz NMEA output mode	B5 62 06 08 06 00 E8 03 01 00 01 00 01 39

Note 1: Add **0D 0A** at the end of command.

10 How to make sure LS20070-G'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, LS20070-G 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*

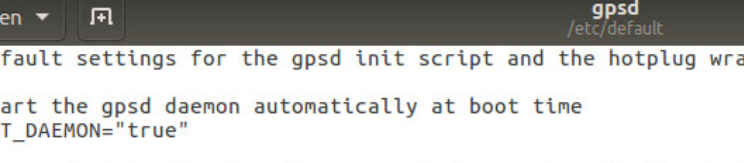
```
cloud@CloudxUBT:~$ ls /dev/ttyU*  
/dev/ttyUSB0
```

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

Open [icon] gpsd /etc/default

```
# 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
USBAUTO="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 gpssd restart

```
cloud@CloudxUBT:~$ sudo service gpds 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.

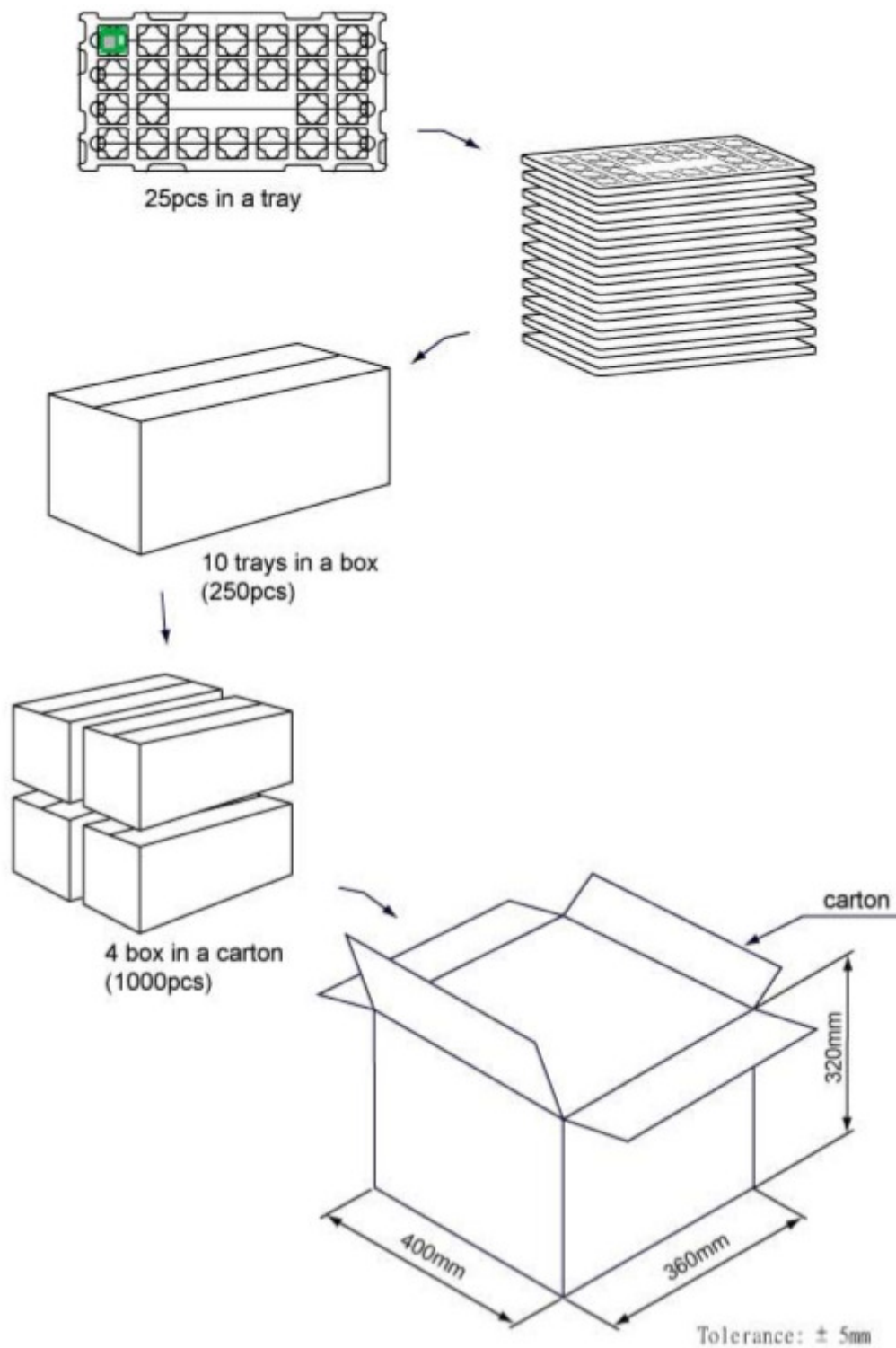
\$gpsmon

```
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  
0000000000010000000000006900ff0cfff00000f722  
(26) b5620104120010144d0c750069003300440050000f270f27a510  
(24) b5620120100010144d0c90c40500cb07120700000000f208  
  
ECEP Pos: -3033216.97m +4921615.83m +2685348.87m  
ECEP 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 Flx 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)

11 Packing and Handling

11.1 Packing



11.2 Moisture Sensitivity

The module belongs to moisture sensitive device (IPC/JEDEC J-STD-020C Level III). If it is not used by then, we strong recommended storing the GNSS modules in dry places such as dry cabinet. The approximate shelf life for LOCOSYS GNSS modules packages is 6 months from the bag seal date, when store in a non-condensing storage environment (<30°C/60% RH)

11.3 ESD Handling



Please carefully follow the following precautions to prevent severe damage to GNSS modules.

LOCOSYS GNSS modules are sensitive to electrostatic discharges, and thus are Electrostatic Sensitive Devices (ESD). Careful handling of the GNSS modules and in particular RFIN pin must follow the standard ESD safety protections:

- Unless there is a galvanic coupling between the local GND and the PCB GND, then the first point of contact when handling the PCB shall always be between the local GND and PCB GND.
- Before working with RFIN pin, please make sure the GND is connected.
- When working with RFIN pin, do not contact any charges capacitors or materials that can easily develop or store charges such as patch antenna, coax cable, soldering iron.
- When soldering RFIN pin, please make sure to use an ESD safe soldering iron (tip)

Document change list

Revision 1.0

- First release on December 12, 2018.