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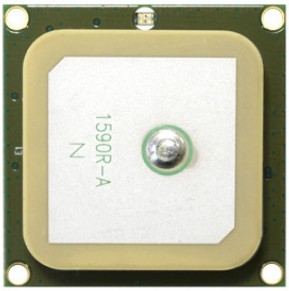
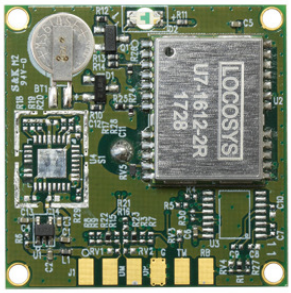
Product name	Description	Version
LS20070(1)	GPS smart antenna module/USB,9600BPS,30x30mm	1.0
LS20071	GPS smart antenna module/TTL,9600BPS,30x30mm	
LS20072	GPS smart antenna module/RS232,9600BPS,30x30mm	

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

Datasheet of GPS smart antenna module, LS2007x series



Top View



LS20070

LS20071

LS20072

1 Introduction

LS2007x series products are complete standalone GPS smart antenna modules, including an embedded antenna and GPS receiver circuits, designed for a broad spectrum of OEM system applications. The product is based on the proven technology built-in u-blox7 chip solution. It can simultaneously acquire and track multiple satellite constellations that include GPS, QZSS and SBAS. Besides, it can provide user 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-blox7 high sensitivity and low power solution
- Support GPS and QZSS (configurable)
- Capable of SBAS (WAAS, EGNOS, MSAS) support
- Support up to 56-channels
- 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 GPS positioning status

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3 Application

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

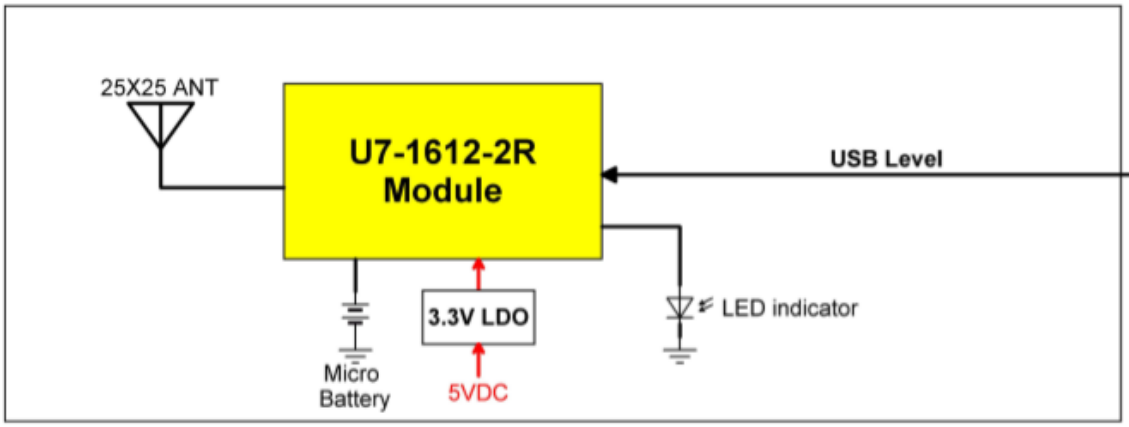

Fig 3-1 System block diagram of LS20070

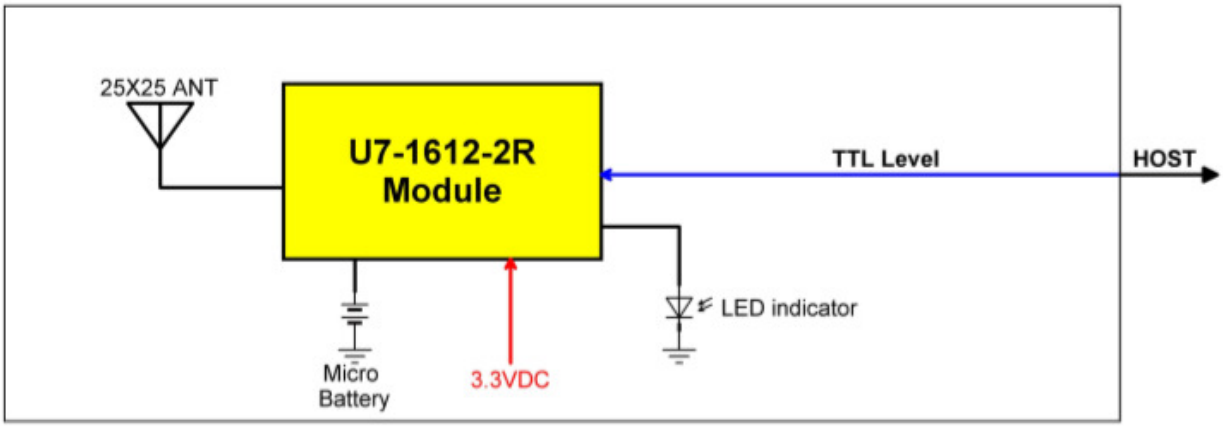

Fig 3-2 System block diagram of LS20071

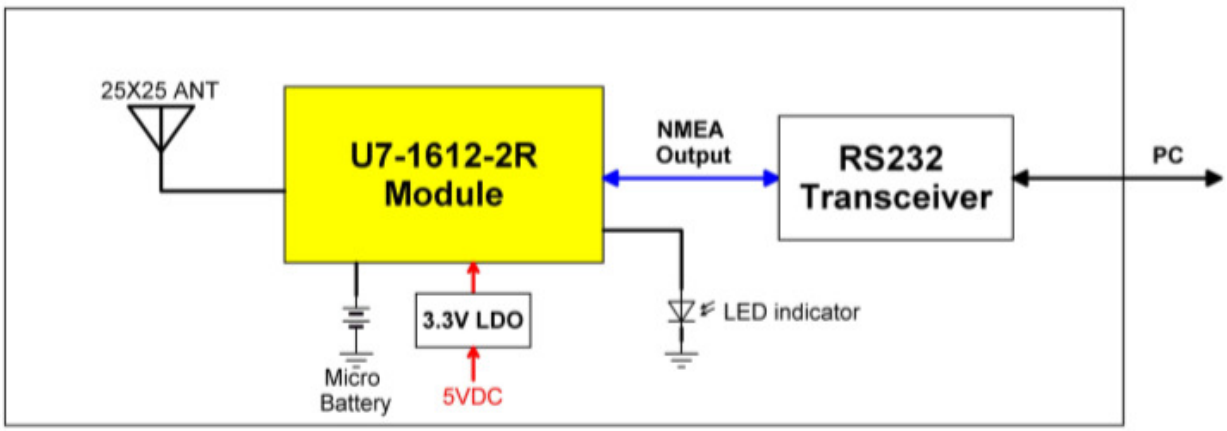

Fig 3-3 System block diagram of LS20072

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4 GPS receiver

Chip	UBX-G7020	
Frequency	L1 1575.42MHz, C/A code	
Channels	Support 56 channels	
Update rate	1Hz default, up to 10Hz	
Acquisition Time	Hot start (Open Sky)	< 1s (typical)
	Cold Start (Open Sky)	29s (typical)
Position Accuracy	Autonomous	2.5m CEP
Max. Altitude	< 50,000 m	
Max. Velocity	< 500 m/s	
Velocity Accuracy(1)	0.1 m/s	
Heading Accuracy(1)	0.5 degrees	
PPS Signal Accuracy	30ns (RMS) in chip level; 1ms for PPS over USB(2)	
Protocol Support	NMEA 0183 ver 2.3	9600bps (3), 8 data bits, no parity, 1 stop bits (default) 1Hz: GGA, GLL, GSA, GSV, RMC, VTG and TXT
	UBX Protocol Spec. ver 14	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 (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.

5 LED indicator

The red LED is an indicator of GPS 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.

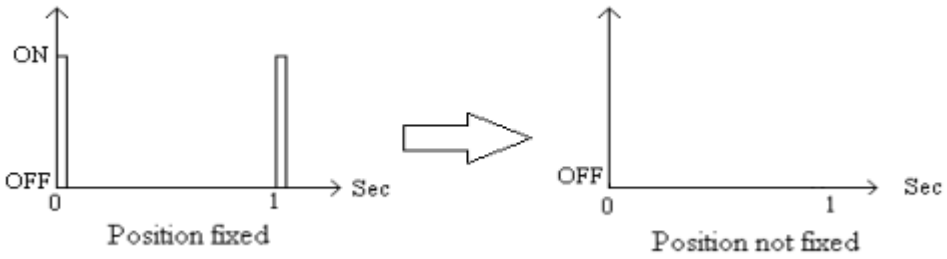

Fig 5.1 LED indicator of positioning status

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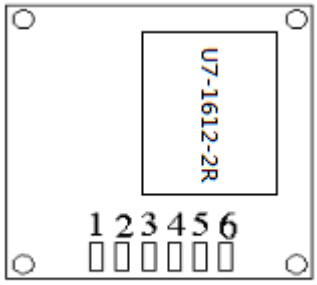
6 Pin assignment and descriptions



Top View

- **LS20070**

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**

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**

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

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7 DC & Temperature characteristics

7.1 DC Electrical characteristics

Parameter	Symbol	Product	Min.	Typ.	Max.	Units
Input voltage	VCC	LS20070 LS20071 LS20072	4.5 3.0 4.5	5.0 3.3 5.0	5.5 3.6 5.5	V
Input current	Icc	LS20070 LS20071 LS20072		26(1,2) 25(1) 28(1)		mA
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 41mA.

7.2 Temperature characteristics

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

Note 1: Backup battery: -20 ~ 60℃

2: Backup battery: -40 ~ 60℃

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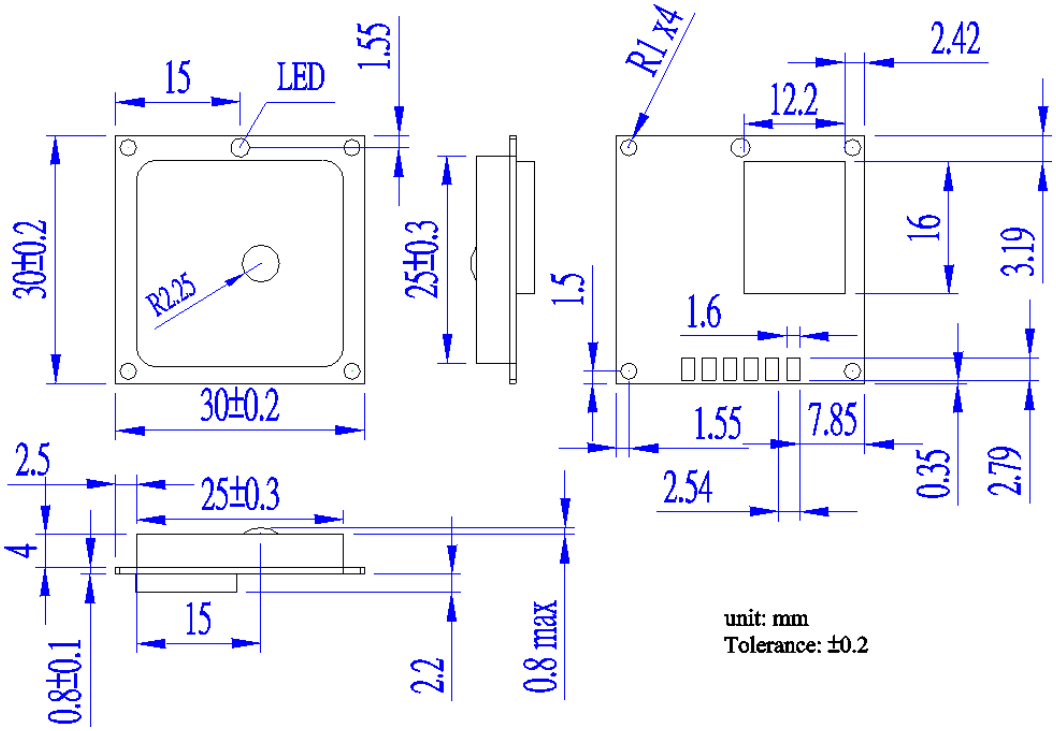
8 Mechanical specification

- LS2007x



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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:

$GPGGA,092725.00,4717.11399,N,00833.91590,E,1,08,1.01,499.6,M,48.0,M,,*5B

Table 9.1-2 GGA Data Format

Name	Example	Units	Description
Message ID	$GPGGA		GGA Message ID (GP = current Talker ID)
UTC Time	092725.00		hhmmss.ss
Latitude	4717.113999		ddmm.mmmmm
N/S indicator	N		N=north or S=south
Longitude	00833.91590		dddmm.mmmmm
E/W Indicator	E		E=east or W=west
Position Fix Indicator	1		See Table 9.1-3
Satellites Used	08		Number of satellites in view, 00-24
HDOP	1.01		Horizontal Dilution of Precision (meters)
MSL Altitude	499.6	meters	Antenna Altitude above/below mean-sea-level (geoid) (in meters)
Units	M	meters	Units of antenna altitude, meters
Geoidal Separation	48.0	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	*5B		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:

$GPGLL,2503.71286,N,12138.74702,E,034518.00,A,A*63

Table 9.1-4 GLL Data Format

Name	Example	Units	Description
Message ID	$GPGLL		GLL protocol header
Latitude	2503.71286		ddmm.mmmmm
N/S indicator	N		N=north or S=south
Longitude	12138.74702		dddmm.mmmmm
E/W indicator	E		E=east or W=west
UTC Time	034518.00		hhmmss.ss
Status	A		A=data valid or V=data not valid
Mode	A		V = Invalid, A= Autonomous and D =Differential
Checksum	*63		
<CR> <LF>			End of message termination

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

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

$GPGSA,A,3,08,23,09,16,27,,,,,,,,6.61,3.36,5.69*0D

Table 9.1-5 GSA Data Format

Name	Example	Units	Description
Message ID	$GPGSA		GSA protocol header
Mode 1	A		See Table 9.1-6
Mode 2	3		See Table 9.1-7
ID of satellite used	08		Sv on Channel 1
ID of satellite used	23		Sv on Channel 2
….			….
ID of satellite used			Sv on Channel 12
PDOP	6.61		Position Dilution of Precision
HDOP	3.36		Horizontal Dilution of Precision
VDOP	5.69		Vertical Dilution of Precision
Checksum	*0D		
<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,4,1,16,04,47,095,36,07,,,35,08,53,223,39,09,25,305,34*4C

$GPGSV,4,2,16,10,,,22,11,,,32,12,,,16,16,47,016,36*4A

$GPGSV,4,3,16,19,,,22,20,,,21,21,,,29,23,46,273,36*48

$GPGSV,4,4,16,26,32,049,33,27,87,000,39,28,,,22,31,,,36*7B

Table 9.1-8 GSV Data Format

Name	Example	Units	Description
Message ID	$GPGSV		GSV protocol header
Total number of messages[1]	4		Range 1 to 6
Message number[1]	1		Range 1 to 6
Satellites in view	16		
Satellite ID[2]	04		Channel 1
Elevation	47	degrees	Channel 1 (Range 00 to 90)
Azimuth	095	degrees	Channel 1 (Range 000 to 359)
SNR (C/No)	36	dB-Hz	Channel 1 (Range 00 to 99, null when not tracking)
….			….
Satellite ID	09		Channel 4 (Range 01 to 196)
Elevation	25	degrees	Channel 4 (Range 00 to 90)
Azimuth	305	degrees	Channel 4 (Range 000 to 359)
SNR (C/No)	34	dB-Hz	Channel 4 (Range 00 to 99, null when not tracking)
Checksum	*4C		
<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:

$GPRMC,034519.00,A,2503.71293,N,12138.74692,E,0.123,,260517,,,A*70

Table 9.1-9 RMC Data Format

Name	Example	Units	Description
Message ID	$GPRMC		RMC protocol header
UTC Time	034519.00		hhmmss.ss
Status	A		A=data valid or V=data not valid
Latitude	2503.71293		ddmm.mmmmm
N/S Indicator	N		N=north or S=south

Longitude	12138.74692		dddmm.mmmmm
E/W Indicator	E		E=east or W=west
Speed over ground	0.123	knots	True
Course over ground		degrees	
Date	260517		ddmmyy
Magnetic variation		degrees	
Variation sense			E=east or W=west
Mode	A		V=Invalid A=autonomous, D=Differential.
Checksum	*70		
<CR> <LF>			End of message termination

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

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

$GPVTG,,T,,M,0.023,N,0.043,K,A*25

Table 9.1-10 VTG Data Format

Name	**Example**	**Units**	**Description**
Message ID	$GPVTG		VTG protocol header
Course over ground		degrees	Measured heading
Reference	T		True
Course over ground		degrees	Measured heading
Reference	M		Magnetic
Speed over ground	0.023	knots	Measured speed
Units	N		Knots
Speed over ground	0.043	km/hr	Measured speed
Units	K		Kilometer per hour
Mode	A		V=Invalid A=autonomous, D=Differential.
Checksum	*25		
<CR> <LF>			End of message termination

- **TXT--- Text Transmission**

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

$GPTXT,01,01,02,ANTSTATUS=INIT*25

$GPTXT,01,01,02,ANTSTATUS=OK*3B

Table 9.1-11 TXT Data Format

Name	**Example**	**Units**	**Description**
Message ID	$GPTXT		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 GPS 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	*25		
<CR> <LF>			End of message termination

9.2 UBX Protocol

The GPS smart antenna module supports u-blox proprietary protocol to communicate with a host computer. Detail proprietary protocol descriptions should refer to ubx protocol specification V14.

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 0C 00 00 23 00 02 00 00 00 00 01 00 00 00 4F F8
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.

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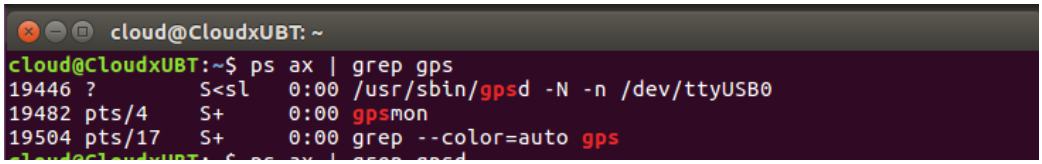
10 How to make sure LS20070's PPS over USB is working in Linux Ubuntu?

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.

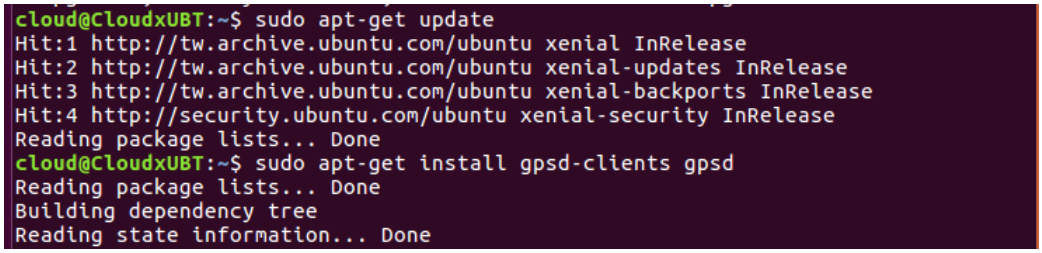
$ps ax | grep gps



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

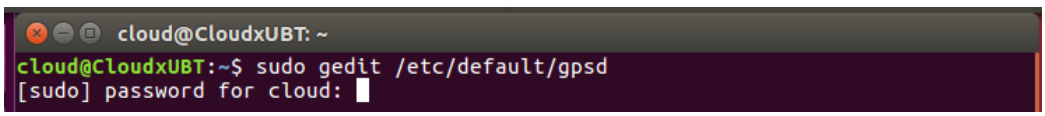


Before starting GPSD, LS20070 should connect to USB port. It normally enumerates a USB device such as "/dev/ttyUSB0" in this case. By using following command to determine device name if module is connecting to host by USB.

$ls /dev/ttyU*

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



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.

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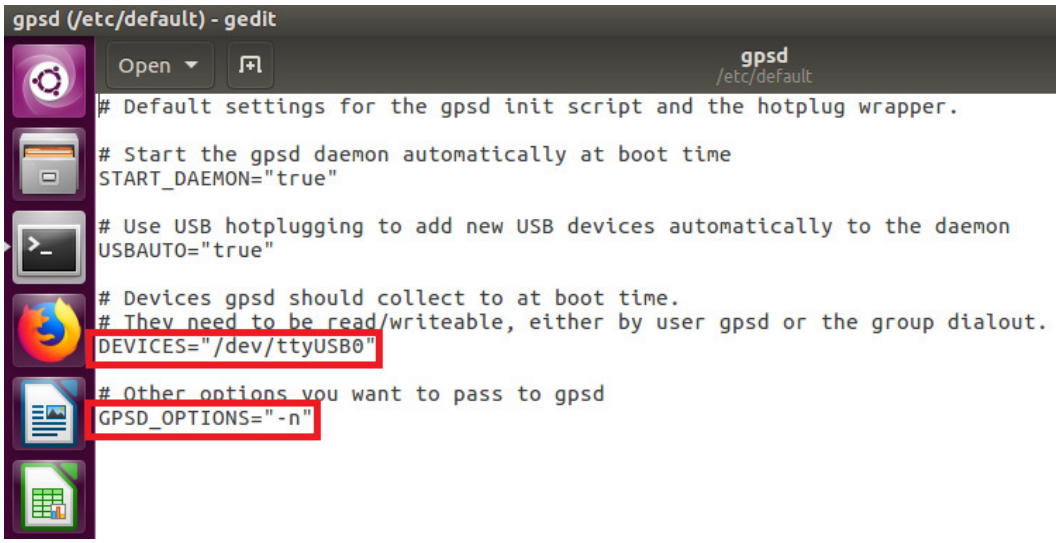
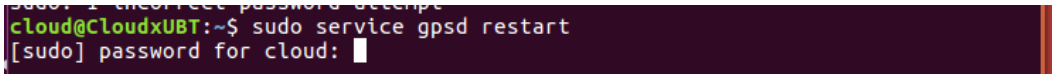
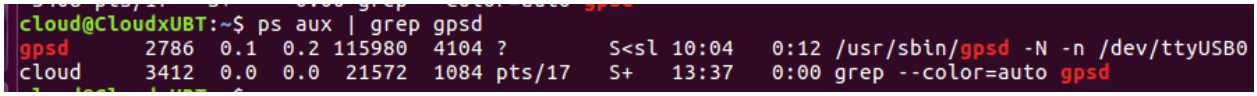


$sudo service gpsd restart



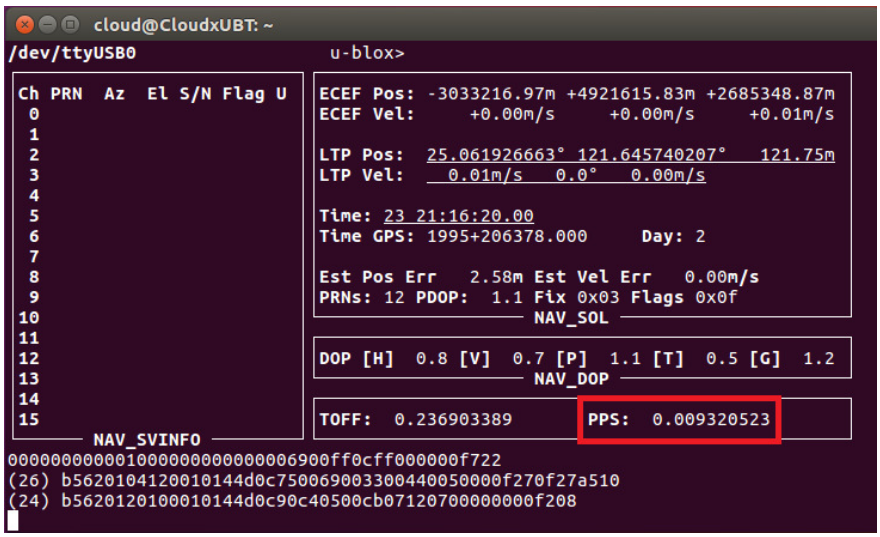
By using following command to check GPSD is working as expected. ("-n" and "/dev/ttyUSB0" parameters)

$ps aux | grep gpsd



Execute the GPSD client program.

$gpsmon



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)

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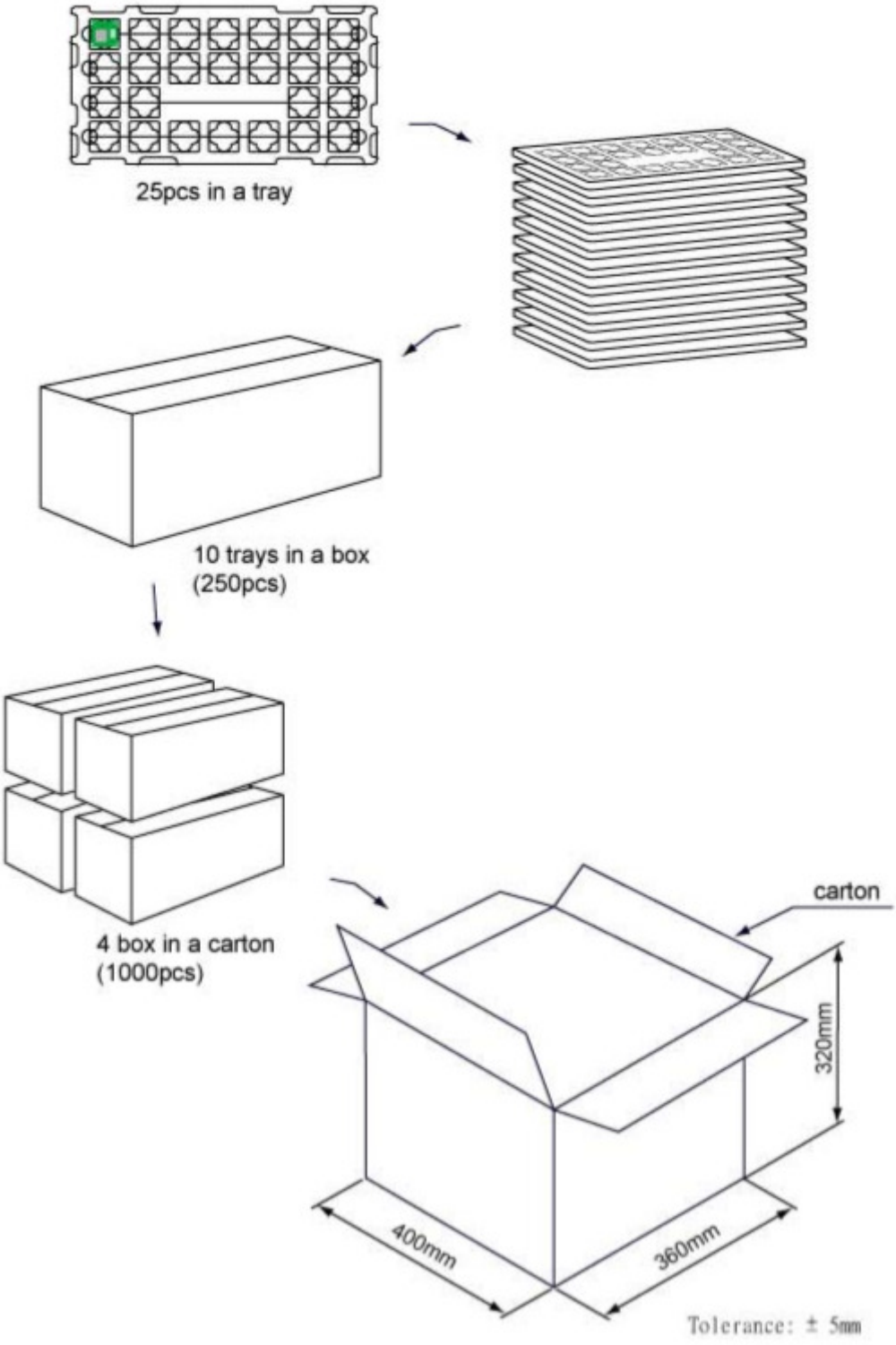
11 Packing and Handling

11.1 Packing



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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)

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Document change list

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