Product name	Description	Version
LS23030	GPS mouse/ MTK3339,2m,USB,9600BPS (PPS over USB)	
LS23032	GPS mouse/ MTK3339,2m,PS2,9600BPS	
LS23033	GPS mouse/ MTK3339,3m,RJ11,9600BPS	1.5
LS23035	GPS mouse/ MTK3339,5m,PS2 with lock,9600BPS	
LS23036	GPS mouse/ MTK3339,3m,RJ11,9600BPS	

Note: LS23036 is most popular. We recommend customers to use for their new design.

Datasheet of GPS mouse, LS2303x series

1 Introduction

LS2303x series products are complete GPS receivers (also known as GPS mouse) based on the proven technology found in LOCOSYS 66 channel GPS SMD type receivers MC-1612 that use MediaTek chip solution. The GPS mouse will acquire up to 66 satellites at a time while providing fast Time-To-First-Fix, one-second navigation update and low power consumption. 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.

These products support hybrid ephemeris prediction to achieve faster cold start. One is self-generated ephemeris prediction that is no need of both network assistance and host CPU's intervention. This is valid for up to 3 days and updates automatically from time to time when GPS module is powered on and satellites are available. The other is server-generated ephemeris prediction that gets from an internet server. This is valid for up to 14 days. Both ephemeris predictions are stored in the on-board flash memory and perform a cold start time less than 15 seconds.

2 Features

- MediaTek high sensitivity solution
- Support 66-channel GPS
- Low power consumption
- Fast TTFF at low signal level
- Built-in 12 multi-tone active interference canceller
- Free hybrid ephemeris prediction to achieve faster cold start
- Built-in data logger

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- Support AGPS
- Up to 10 Hz update rate
- Capable of SBAS (WAAS, EGNOS, MSAS)
- Support Japan QZSS
- 1 PPS over USB for timing application
- Linux/Android support
- Compatible with GPSD PPS support
- Indoor and outdoor multi-path detection and compensation
- Build-in micro battery to reserve system data for rapid satellite acquisition
- LED indicator for GPS fix or not fix
- Magnet for mounting on the car
- Waterproof

3 Application

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

4 GPS specification

GPS Chip	MediaTek MT3339	
Frequency	L1 1575.42MHz, C/A code	
Channels	Support 66 channels (22 Tracking, 66 Acquisition)	
Update rate	1Hz default, up to 10Hz	
Acquisition Time	Hot start (Open Sky)	< 1s (typical)
	Cold Start (Open Sky)	32s (typical) without AGPS
		<15s (typical) with AGPS (hybrid ephemeris prediction)
Position Accuracy	Autonomous	2.5m (CEP)
	SBAS	2.5m (depends on accuracy of correction data)
PPS Signal Accuracy	Chip level +/- 25ns , 1ms for PPS over USB [2]	
Datum	WGS-84 (default)	
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, GLL, GSA, GSV, RMC, VTG

Note 1: Both baud rate and output message rate are configurable to be factory default.
Note 2: The LS23030 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.

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5   Software interface

5.1   NMEA output message

Table 5-1 NMEA output message

NMEA record	Description
GGA	Global positioning system fixed data
GLL	Geographic position - latitude/longitude
GSA	GNSS DOP and active satellites
GSV	GNSS satellites in view
RMC	Recommended minimum specific GNSS data
VTG	Course over ground and ground speed

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

Table 5-2 contains the values for the following example:

$GPGGA,053740.000,2503.6319,N,12136.0099,E,1,08,1.1,63.8,M,15.2,M,,*64

Table5- 2 GGA Data Format

Name	Example	Units	Description
Message ID	$GPGGA		GGA protocol header
UTC Time	053740.000		hhmmss.sss
Latitude	2503.6319		ddmm.mmmm
N/S indicator	N		N=north or S=south
Longitude	12136.0099		dddmm.mmmm
E/W Indicator	E		E=east or W=west
Position Fix Indicator	1		See Table 5-3
Satellites Used	08		Range 0 to 12
HDOP	1.1		Horizontal Dilution of Precision
MSL Altitude	63.8	meters	
Units	M	meters	
Geoid Separation	15.2	meters	
Units	M	meters	
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 5-3 Position Fix Indicators

Value	Description
0	Fix not available or invalid
1	GPS SPS Mode, fix valid

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2	Differential GPS, SPS Mode, fix valid
3-5	Not supported
6	Dead Reckoning Mode, fix valid

● **GLL--- Geographic Position – Latitude/Longitude**

Table 5-4 contains the values for the following example:

$GPGLL,2503.6319,N,12136.0099,E,053740.000,A,A*52

Table 5-4 GLL Data Format

Name	Example	Units	Description
Message ID	$GPGLL		GLL protocol header
Latitude	2503.6319		ddmm.mmmm
N/S indicator	N		N=north or S=south
Longitude	12136.0099		dddmm.mmmm
E/W indicator	E		E=east or W=west
UTC Time	053740.000		hhmmss.sss
Status	A		A=data valid or V=data not valid
Mode	A		A=autonomous, D=DGPS, E=DR, N=Data not valid, R=Coarse Position, S=Simulator
Checksum	*52		
<CR> <LF>			End of message termination

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

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

$GPGSA,A,3,24,07,17,11,28,08,20,04,,,,,2.0,1.1,1.7*35

Table 5-5 GSA Data Format

Name	Example	Units	Description
Message ID	$GPGSA		GSA protocol header
Mode 1	A		See Table 5-6
Mode 2	3		See Table 5-7
ID of satellite used	24		Sv on Channel 1
ID of satellite used	07		Sv on Channel 2
….			….
ID of satellite used			Sv on Channel 12
PDOP	2.0		Position Dilution of Precision
HDOP	1.1		Horizontal Dilution of Precision
VDOP	1.7		Vertical Dilution of Precision
Checksum	*35		

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<CR> <LF>			End of message termination

Table 5-6 Mode 1

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

Table 5-7 Mode 2

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

● **GSV---GNSS Satellites in View**

Table 5-8 contains the values for the following example:

$GPGSV,3,1,12,28,81,285,42,24,67,302,46,31,54,354,,20,51,077,46*73

$GPGSV,3,2,12,17,41,328,45,07,32,315,45,04,31,250,40,11,25,046,41*75

$GPGSV,3,3,12,08,22,214,38,27,08,190,16,19,05,092,33,23,04,127,*7B

Table 5-8 GSV Data Format

Name	Example	Units	Description
Message ID	$GPGSV		GSV protocol header
Total number of messages[1]	3		Range 1 to 3
Message number[1]	1		Range 1 to 3
Satellites in view	12		
Satellite ID	28		Channel 1 (Range 01 to 196)
Elevation	81	degrees	Channel 1 (Range 00 to 90)
Azimuth	285	degrees	Channel 1 (Range 000 to 359)
SNR (C/No)	42	dB-Hz	Channel 1 (Range 00 to 99, null when not tracking)
Satellite ID	20		Channel 4 (Range 01 to 32)
Elevation	51	degrees	Channel 4 (Range 00 to 90)
Azimuth	077	degrees	Channel 4 (Range 000 to 359)
SNR (C/No)	46	dB-Hz	Channel 4 (Range 00 to 99, null when not tracking)
Checksum	*73		
<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 5-9 contains the values for the following example:

$GPRMC,053740.000,A,2503.6319,N,12136.0099,E,2.69,79.65,100106,,,A*53

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Table 5-9 RMC Data Format

Name	Example	Units	Description
Message ID	$GPRMC		RMC protocol header
UTC Time	053740.000		hhmmss.sss
Status	A		A=data valid or V=data not valid
Latitude	2503.6319		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	12136.0099		dddmm.mmmm
E/W Indicator	E		E=east or W=west
Speed over ground	2.69	knots	True
Course over ground	79.65	degrees	
Date	100106		Ddmmyy
Magnetic variation		degrees	Not shown
Variation sense			E=east or W=west (Not shown)
Mode	A		A=autonomous, D=DGPS, E=DR, N=Data not valid, R=Coarse Position, S=Simulator
Checksum	*53		
<CR> <LF>			End of message termination

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

Table 5-10 contains the values for the following example:

$GPVTG,79.65,T,,M,2.69,N,5.0,K,A*38

Table 5-10 VTG Data Format

Name	Example	Units	Description
Message ID	$GPVTG		VTG protocol header
Course over ground	79.65	degrees	Measured heading
Reference	T		True
Course over ground		degrees	Measured heading
Reference	M		Magnetic
Speed over ground	2.69	knots	Measured speed
Units	N		Knots
Speed over ground	5.0	km/hr	Measured speed
Units	K		Kilometer per hour
Mode	A		A=autonomous, D=DGPS, E=DR, N=Data not valid, R=Coarse Position, S=Simulator
Checksum	*38		
<CR> <LF>			End of message termination

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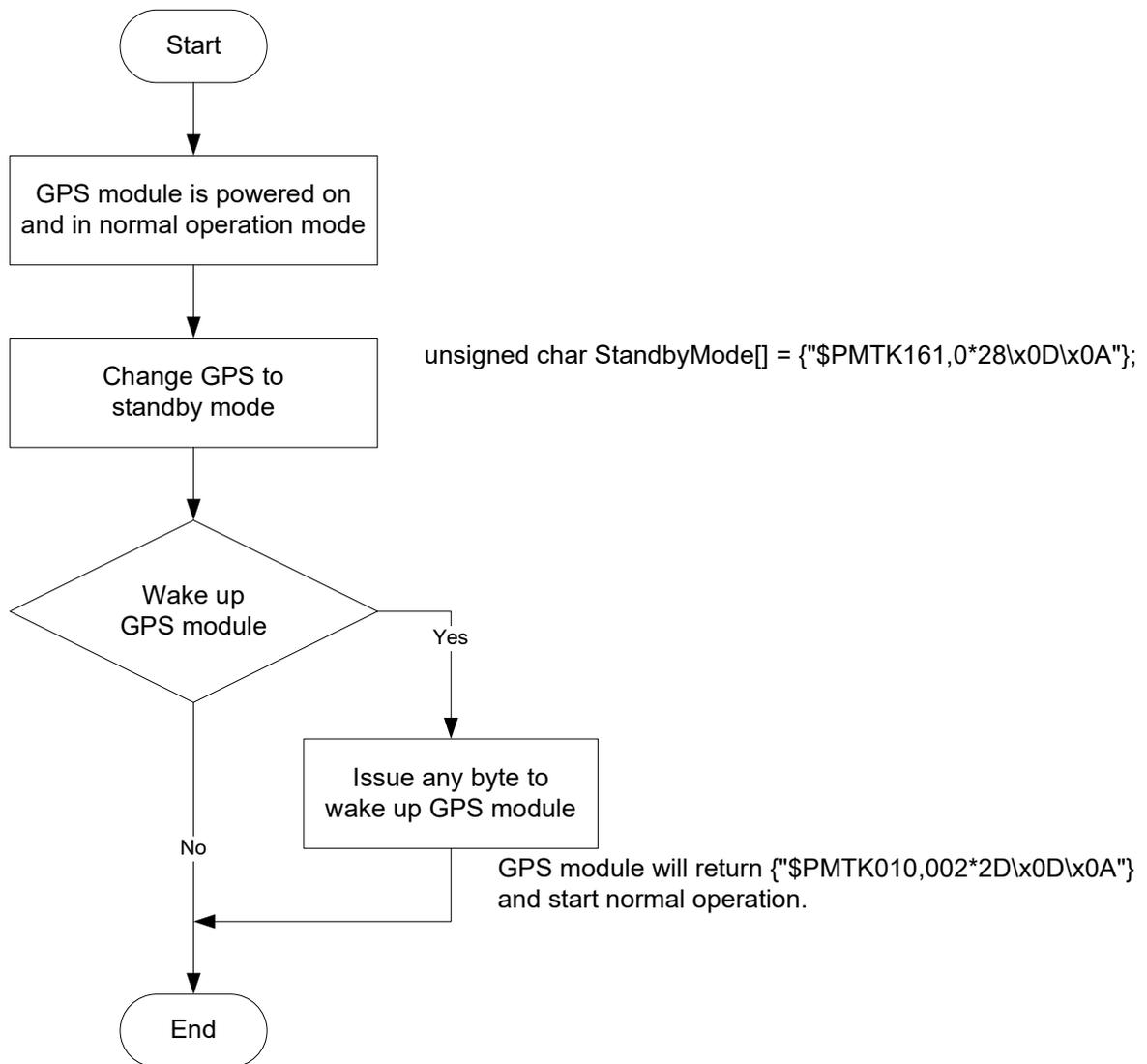## 5.2   Proprietary NMEA input message

Please refer to MTK proprietary message.

5.3   Examples to configure the power mode of GPS module

The GPS module supports different power modes that user can configure by issuing software commands.

5.3.1 Standby mode

User can issue software command to make GPS module go into standby mode that consumes less than 200uA current. GPS module will be awaked when receiving any byte. The following flow chart is an example to make GPS module go into standby mode and then wake up.

```
                    ┌─────────────┐
                    │    Start    │
                    └──────┬──────┘
                           │
            ┌──────────────▼──────────────┐
            │  GPS module is powered on    │
            │  and in normal operation mode│
            └──────────────┬──────────────┘
                           │
            ┌──────────────▼──────────────┐        unsigned char StandbyMode[] = {"$PMTK161,0*28\x0D\x0A"};
            │   Change GPS to              │
            │   standby mode               │
            └──────────────┬──────────────┘
                           │
                        ◇ Wake up
                          GPS module ◇────── Yes
                           │                  │
                           │        ┌─────────▼─────────┐
                           │        │  Issue any byte to │
                        No │        │  wake up GPS module│
                           │        └─────────┬─────────┘
                           │                  │    GPS module will return {"$PMTK010,002*2D\x0D\x0A"}
                           │◄─────────────────┘    and start normal operation.
                    ┌──────▼──────┐
                    │     End     │
                    └─────────────┘
```
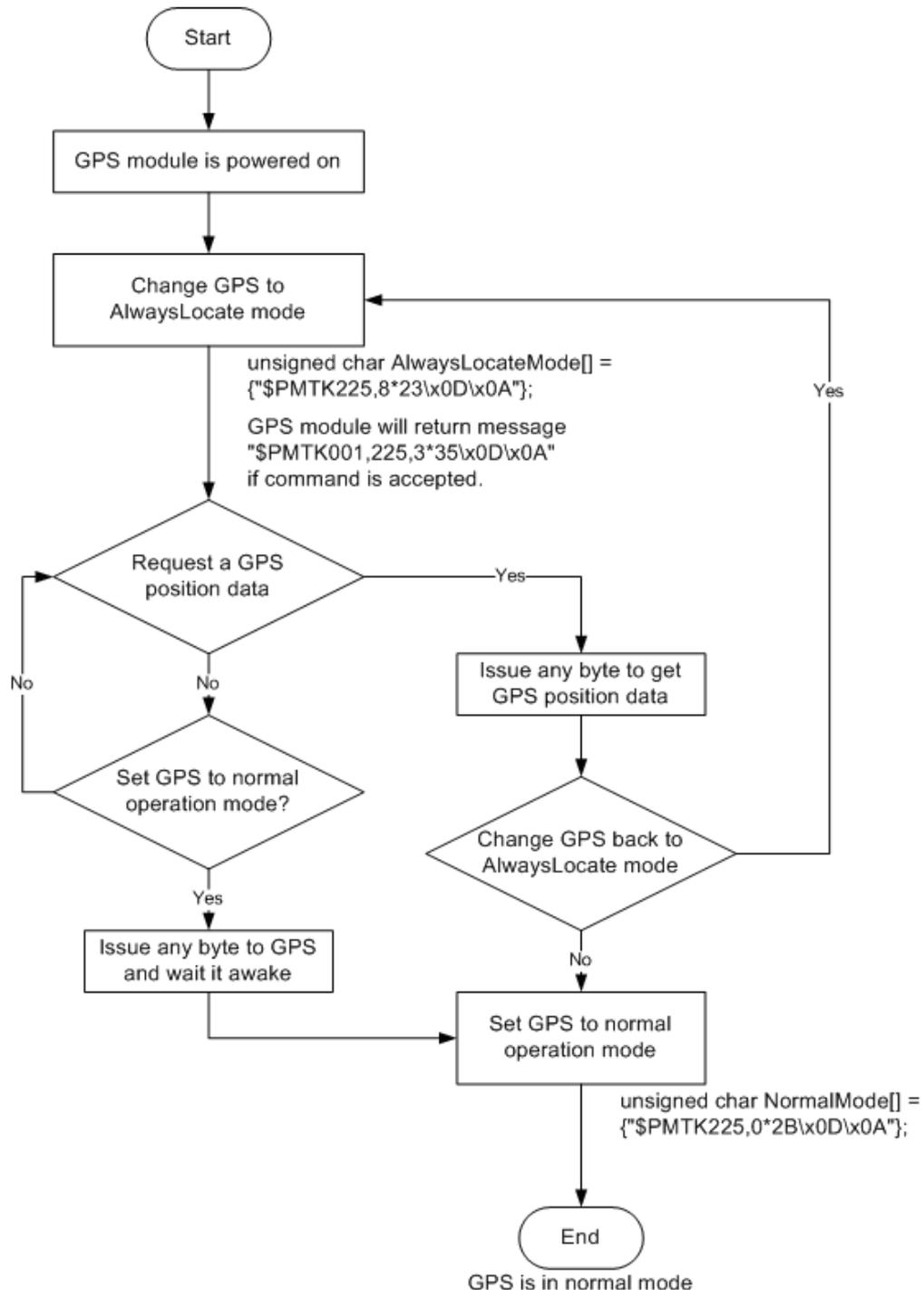
5.3.2 Periodic mode

When GPS module is commanded to periodic mode, it will be in operation and standby periodically. Its status of power consumption is as below chart.

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Periodic power saving mode

The following flow chart is an example to make GPS module go into periodic mode and then back to normal operation mode.


```
unsigned char PeriodicMode[] =
{"$PMTK225,2,3000,12000,18000,72000*15\x0D\x0A"};
```

Note: minimum on time is 1000ms.
maximum standby time is 518400000ms (6 days)

GPS module will return message
"$PMTK001,225,3*35\x0D\x0A"
if command is accepted.

```
unsigned char NormalMode[] =
{"$PMTK225,0*2B\x0D\x0A"};
```

GPS module will return message
"$PMTK001,225,3*35\x0D\x0A"
if command is accepted.

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5.3.3 AlwaysLocate^{TM} mode

AlwaysLocate^{TM} is an intelligent controller of periodic mode. Depending on the environment and motion conditions, GPS module can adaptively adjust working/standby time to achieve balance of positioning accuracy and power consumption. In this mode, the host CPU does not need to control GPS module until the host CPU needs the GPS position data. The following flow chart is an example to make GPS module go into AlwaysLocate^{Tm} mode and then back to normal operation mode.

Note: AlwaysLocate^{TM} is a trade mark of MTK.

```
                           ┌─────────┐
                           │  Start  │
                           └─────────┘
                                │
                    ┌───────────────────────┐
                    │ GPS module is powered on │
                    └───────────────────────┘
                                │
                    ┌───────────────────────┐        Yes
                    │    Change GPS to       │◄──────────────┐
                    │  AlwaysLocate mode     │               │
                    └───────────────────────┘               │
```

unsigned char AlwaysLocateMode[] =
{"$PMTK225,8*23\x0D\x0A"};

GPS module will return message
"$PMTK001,225,3*35\x0D\x0A"
if command is accepted.

Request a GPS position data — Yes → Issue any byte to get GPS position data → Change GPS back to AlwaysLocate mode — No → Set GPS to normal operation mode

No → Set GPS to normal operation mode? — Yes → Issue any byte to GPS and wait it awake → Set GPS to normal operation mode

unsigned char NormalMode[] =
{"$PMTK225,0*2B\x0D\x0A"};

End
GPS is in normal mode

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5.4 Data logger

The GPS module has internal flash memory for logging GPS data. The configurations include time interval, distance, speed, logging mode, and … etc. For more information, please contact us.

5.5 Examples to configure the update rate of GPS module

The GPS module supports up to 10Hz update rate that user can configure by issuing software commands. Note that the configurations by software commands are stored in the battery-backed SRAM that is powered through VBACKUP pin. Once it drains out, the default/factory settings will be applied.

Due to the transmitting capacity per second of the current baud rate, GPS module has to be changed to higher baud rate for high update rate of position fix. The user can use the following software commands to change baud rate.

Baud rate	Software command
Factory default	$PMTK251,0*28<CR><LF>
4800	$PMTK251,4800*14<CR><LF>
9600	$PMTK251,9600*17<CR><LF>
19200	$PMTK251,19200*22<CR><LF>
38400	$PMTK251,38400*27<CR><LF>
57600	$PMTK251,57600*2C<CR><LF>
115200	$PMTK251,115200*1F<CR><LF>

Note: <CR> means Carriage Return, i.e. 0x0D in hexadecimal. <LF> means Line Feed, i.e. 0x0A in hexadecimal.

If the user does not want to change baud rate, you can reduce the output NMEA sentences by the following software commands.

NMEA sentence	Software command
Factory default	$PMTK314,-1*04<CR><LF>
Only GLL at 1Hz	$PMTK314,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0*29<CR><LF>
Only RMC at 1Hz	$PMTK314,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0*29<CR><LF>
Only VTG at 1Hz	$PMTK314,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0*29<CR><LF>
Only GGA at 1Hz	$PMTK314,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0*29<CR><LF>
Only GSA at 1Hz	$PMTK314,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0*29<CR><LF>
Only GSV at 1Hz	$PMTK314,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0*29<CR><LF>
Only ZDA at 1Hz	$PMTK314,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0*29<CR><LF>
RMC, GGA, GSA at 1Hz and GSV at 0.2Hz	$PMTK314,0,1,0,1,1,5,0,0,0,0,0,0,0,0,0,0,0,0,0*2C<CR><LF>

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If the command is correct and executed, GPS module will output message $PMTK001,314,3*36<CR><LF>

After the GPS module is changed to higher baud rate or reduced NMEA sentence, the user can configure it to high update rate of position fix by the following commands.

Interval of position fix	Software command
Every 100ms (10Hz)[1]	$PMTK220,100*2F<CR><LF>
Every 200ms (5Hz)	$PMTK220,200*2C<CR><LF>
Every 500ms (2Hz)	$PMTK220,500*2B<CR><LF>
Every 1000ms (1Hz)	$PMTK220,1000*1F<CR><LF>
Every 2000ms (0.5Hz)[2]	$PMTK220,2000*1C<CR><LF>
If the command is correct and executed, GPS module will output message $PMTK001,220,3*30<CR><LF>	

Note 1: The minimum interval of position fix is 100ms, i.e. the maximum update rate is 10Hz.

Note 2: The current consumption is the same with the update rate of 1Hz.

6 How to make sure LS23030'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

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Before starting GPSD, LS23030 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 ▼   ⊞                                    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 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.

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$gpsmon

```
😣 ⊜ ⊡    cloud@CloudxUBT: ~
/dev/ttyUSB0                    u-blox>

Ch PRN  Az  El S/N Flag U    ECEF Pos: -3033216.97m +4921615.83m +2685348.87m
 0                            ECEF Vel:    +0.00m/s     +0.00m/s     +0.01m/s
 1
 2                            LTP Pos:  25.061926663° 121.645740207°   121.75m
 3                            LTP Vel:    0.01m/s   0.0°   0.00m/s
 4
 5                            Time: 23 21:16:20.00
 6                            Time GPS: 1995+206378.000     Day: 2
 7
 8                            Est Pos Err   2.58m Est Vel Err   0.00m/s
 9                            PRNs: 12 PDOP:  1.1 Fix 0x03 Flags 0x0f
10                            ─────────────── NAV_SOL ───────────────
11
12                            DOP [H]  0.8 [V]  0.7 [P]  1.1 [T]  0.5 [G]  1.2
13                            ─────────────── NAV_DOP ───────────────
14
15                            TOFF:  0.236903389      PPS:  0.009320523
        ── NAV_SVINFO ──
00000000000100000000000000006900ff0cff000000f722
(26) b5620104120010144d0c75006900330044050000f270f27a510
(24) b5620120100010144d0c90c40500cb07120700000000f208
```
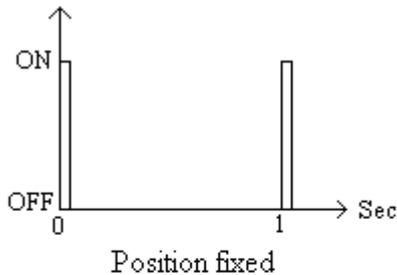
As shown above, PPS is detected with delay of 0.009320523 seconds to the local clock while delay of GPS is 0.236903389 seconds (shown by TOFF)

7   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.

Position fixed

Position not fixed

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8   Pin assignment and descriptions

- **LS23030**

Pin #	Name	Type	Description
1	VBUS	P	USB power input
2	D-		D- line
3	D+		D+ line
4	GND	P	Ground
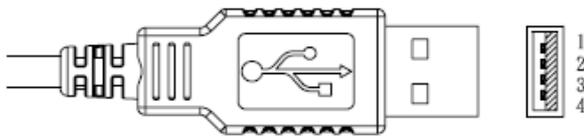
USB A-TYPE Plug

- **LS23032**

Pin #	Name	Type	Description
1	GND	P	Ground
2	VDD	P	Power input
3	NC		Not connect
4	RX	I	Data input (RS232 level)
5	TX	O	Data output (RS232 level)
6	NC		Not connect
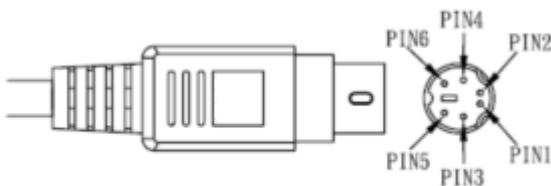
PS2 MALE

- **LS23033**

Pin #	Name	Type	Description
1	VDD	P	Power input
2	RX	I	Data input (RS232 level)
3	TX	O	Data output (RS232 level)
4	GND	P	Ground
5	NC		Not connect
6	NC		Not connect

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RJ11 MALE
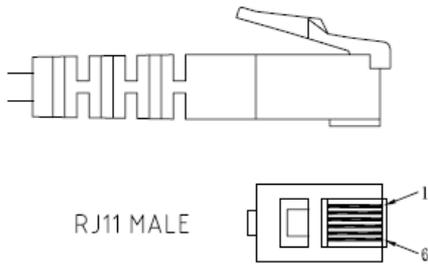
- **LS23035**

Pin #	Name	Type	Description
1	VDD	P	Power input
2	GND	P	Ground
3	NC		Not connect
4	TX	O	Data output (RS232 level)
5	RX	I	Data input (RS232 level)
6	NC		Not connect

PS2 MALE
with lock
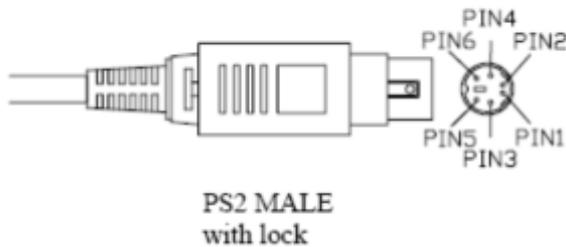
- **LS23036**

Pin #	Name	Type	Description
1	NC		Not connect
2	GND	P	Ground
3	RX	I	Data input (RS232 level)
4	TX	O	Data output (RS232 level)
5	VDD	P	Power input
6	NC		Not connect

RJ11 MALE

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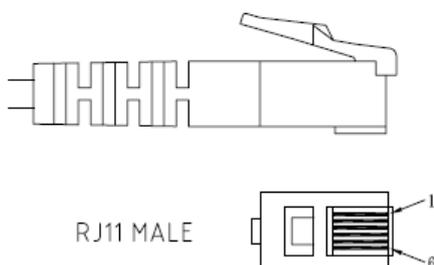
9 DC & Temperature characteristics

9.1 Power consumption (continuous mode)

Parameter	Symbol	Product	Min.	Typ.	Max.	Units
Input voltage	VCC	LS23030	4.75	5	5.25	V
		LS23032	4	5	6	
		LS23033	4	5	6	
		LS23035	4	5	6	
		LS23036	4	5	6	
Input current	Icc	LS23030		37[1]		mA
		LS23032		24[1]		
		LS23033		24[1]		
		LS23035		24[1]		
		LS23036		24[1]		

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

9.2 Temperature characteristics

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

10 Mechanical specification

- **LS23030 (USB interface)**

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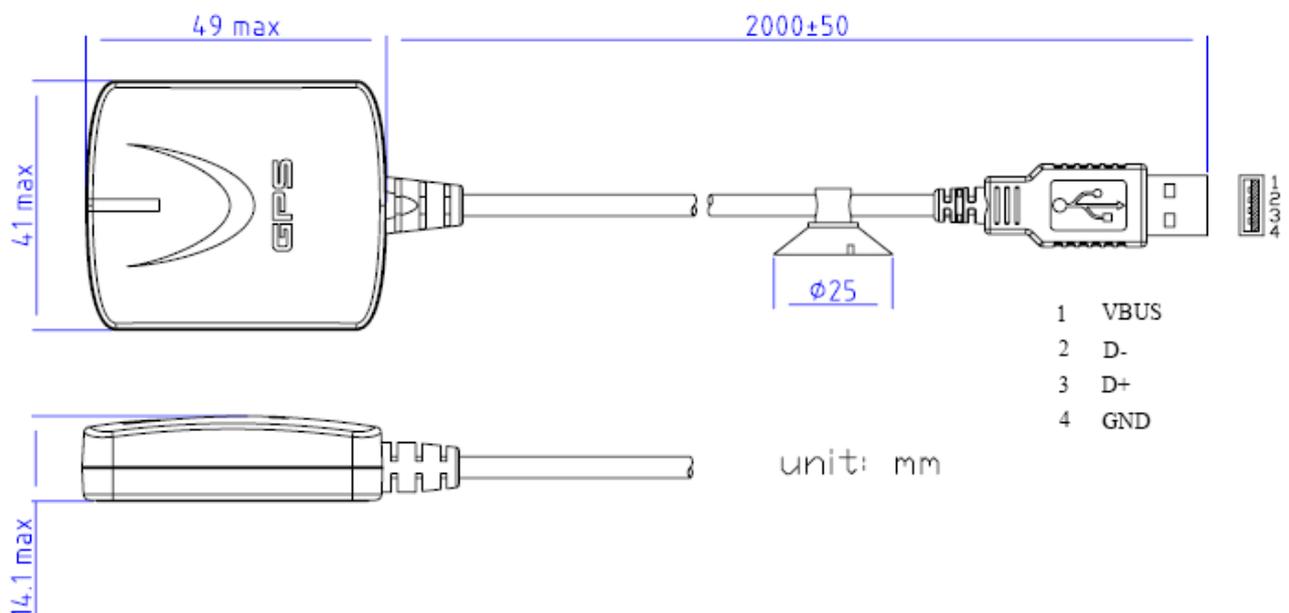
● **LS23032 (RS232 interface)**

1	GND
2	VDD
3	NC
4	RX
5	TX
6	NC
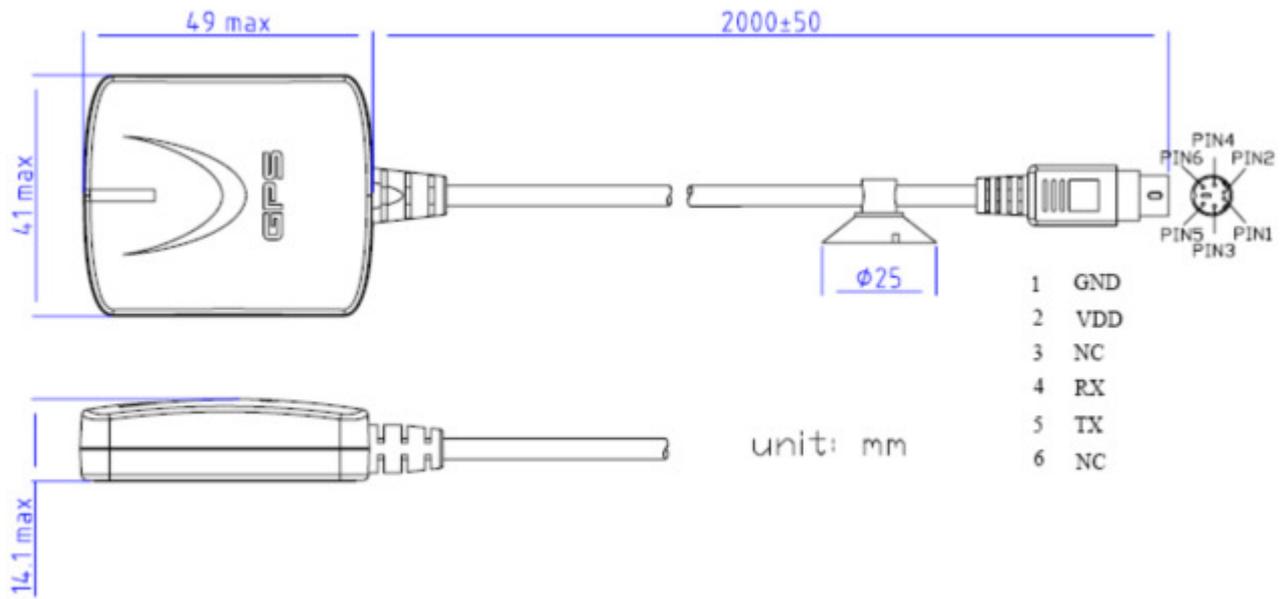
● **LS23033 (RS232 interface)**

1	VDD
2	RX
3	TX
4	GND
5	NC
6	NC
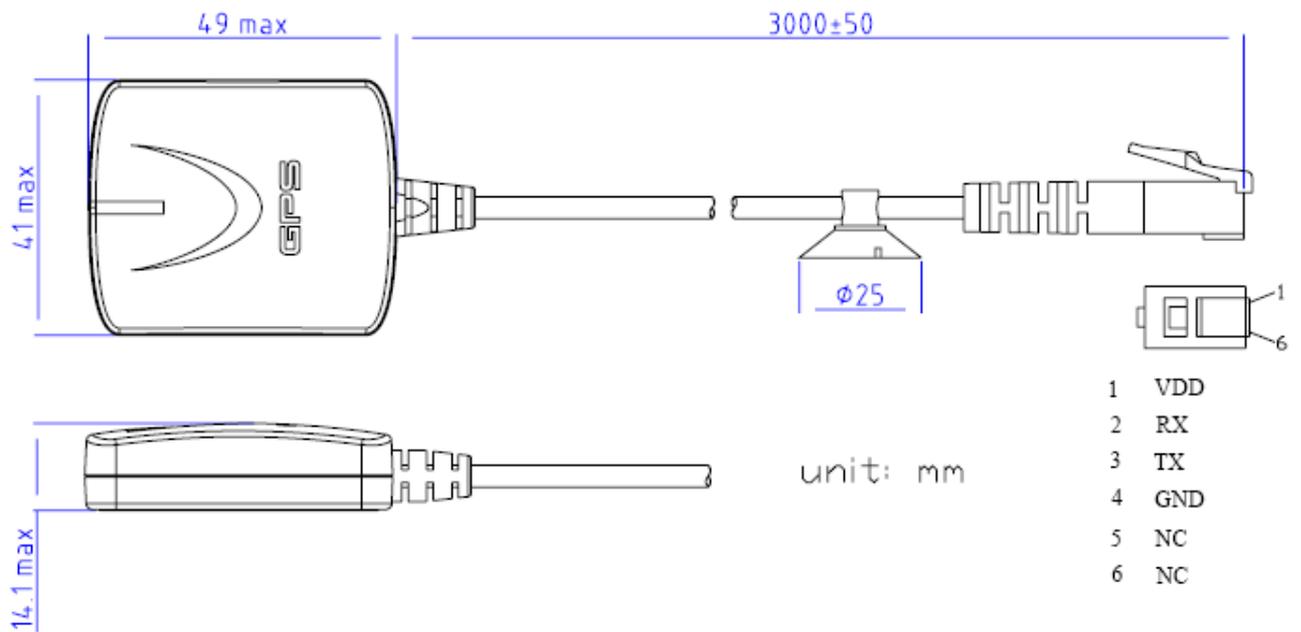
● **LS23035 (RS232 interface)**

1	VDD
2	GND
3	NC
4	TX
5	RX
6	NC

unit: mm
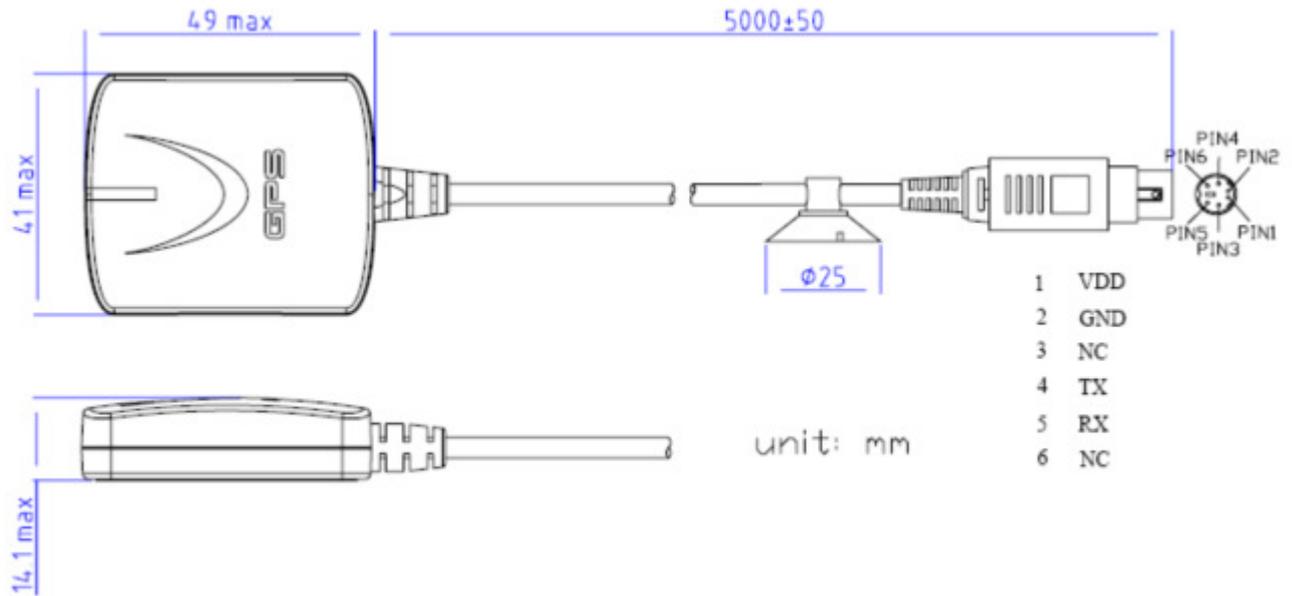
● **LS23036 (RS232 interface)**

1	NC
2	GND
3	RX
4	TX
5	VDD
6	NC

unit: mm
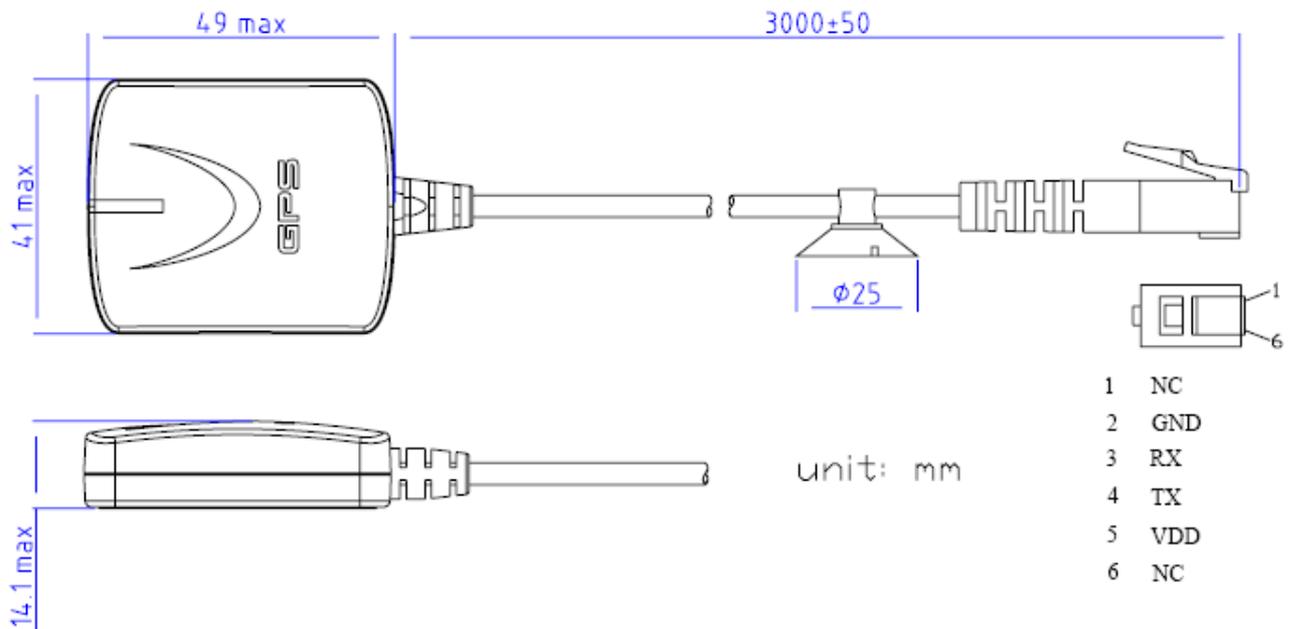
Document change list

Revision 1.0

- First release on Oct. 25, 2007.

Revision 1.0 to Revision 1.1 (July 20, 2009)

- Changed GPS chip from MT3318 to MT3329 on page 2.
- Added "Support AGPS" on page 1.
- Changed channels from 32 to 66 on page 2.
- Changed update rate from "up to 5Hz" to "up to 10Hz" on page 2.
- Changed hot start time from "2s (typical)" to "<2s (typical)" on page 2.
- Changed cold start time from 36s to 35s on page 2.
- Added "Note 1" on page 2.
- Changed typical current of LS23030 from 47mA to 29mA on page 9.
- Changed typical current of LS23032 from 46mA to 34mA on page 9.
- Changed typical current of LS23033 from 46mA to 34mA on page 10.
- Changed typical current of LS23035 from 46mA to 34mA on page 10.
- Changed typical current of LS23036 from 46mA to 34mA on page 10.

Revision 1.1 to Revision 1.2 (February 10, 2012)

- Changed GPS chip from MT3329 to MT3339 on page 2.
- Added the description of hybrid ephemeris prediction in the section 1.
- Added several new features in the section 2.
- Changed hot start time from < 2s to < 1s on page 2.
- Changed cold start time from 35s to 32s on page 2.
- Changed Max. Altitude from 18,000m to 50,000m on page 2.
- Changed the range of satellite ID in GSV message from 32 to 196 on page 5.
- Added "N = data not valid, R=Coarse Position, S=Simulator" in GLL, RMC and VTG message.
- Added section 5.3, 5.4 and 5.5.
- Changed typical current of LS23030 from 29mA to 22mA in the section 8.1.
- Changed typical current of LS23032, LS23033, LS23035 and LS23036 from 34mA to 19mA in the section 8.1.

Revision 1.2 to Revision 1.3 (April 19, 2018)

- Added "PPS over USB" on page1
- Added 1 PPS over USB for timing application feature in section 2
- Added Linux/Android support feature in section 2
- Added Compatible with GPSD PPS support feature in section 2
- Added High-Quality NTP time server application in section 3
- Added PPS Signal Accuracy specification in section 4
- Added "Note 2" on page 2.

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- Added section 6 "How to make sure LS23030's PPS over USB is working in Linux Ubuntu?"

Revision 1.3 to Revision 1.4 (October 5, 2018)

- Added alternative cable pictures because the alternative appearance of cable strain relief of connector side has slight differences with original. If customer concerns with this part dimensions, please contact with us in advance.

Revision 1.4 to Revision 1.5 (August 23, 2019)

- Removed the skid resistant pad and replaced it with a product label
- Changed the position of magnet from internal to external to improve magnetic force
- Remove the feature of skid resistant pad on the bottom
- Changed internal SMD receiver from MC-1513 to MC-1612
- Changed the typical power consumption of LS23030 from 22mA to 37mA in section 9.1
- Changed the typical power consumption of LS23032, LS23033, LS23035 and LS23036 from 19mA to 24mA in section 9.1