

Product name	Description	Version
LS23030-Vx	Dual-frequency multi-constellation GNSS mouse / 2m, PPS through USB	0.3
LS23032-Vx	Dual-frequency multi-constellation GNSS mouse / 2m, PS2	
LS23033-Vx	Dual-frequency multi-constellation GNSS mouse / 3m, RJ11	
LS23035-Vx	Dual-frequency multi-constellation GNSS mouse / 5m, PS2 with lock	
LS23036-Vx	Dual-frequency multi-constellation GNSS mouse / 3m, RJ11	

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

Datasheet of GPS mouse, LS2303x-Vx series



1 Introduction

LS2303x-Vx series products are high-performance dual-band GNSS receivers (also known as GNSS mouse) that are capable of tracking all global civil navigation systems (GPS, GLONASS, BDS, GALILEO, QZSS and IRNSS). The GNSS mouse will acquire both L1 and L5 signals at a time while providing the better position accuracy. It can provide you with fast Time-To-First-Fix, superior sensitivity and low power consumption. Its far-reaching capability meets the sensitivity requirements of car navigation as well as other location-based applications.

The receivers support hybrid ephemeris prediction to achieve faster cold start. One is self-generated ephemeris prediction (called EASY) 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 GNSS module is powered on and satellites are available. The other is server-generated ephemeris prediction (called EPO) 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.

The RF front ends of LS2303x-V3 are specifically designed to comply with sensitivity specification contained in AIS 140 standard. They are the best solution to those customers that design tracking applications in compliance with AIS 140.

2 Features

- Concurrent reception of L1 and L5 band signals
- Support GPS, GLONASS, BEIDOU, GALILEO, QZSS and IRNSS (NavIC)
- Capable of SBAS (WAAS, EGNOS, MSAS, GAGAN) and QZSS SLAS
- Support 135-channel GNSS

- Fast TTFF at low signal level
- Up to 10 Hz update rate
- Smart jammer detection and suppression
- Support PPS through USB
- Build-in micro battery to reserve system data for rapid satellite acquisition
- LED indicator for GNSS 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 GNSS specification

Frequency	LS2303x-V2	GPS/QZSS: L1 C/A, L5C GLONASS: L1OF BEIDOU: B1I, B2a GALILEO: E1, E5a
	LS2303x-V3	GPS/QZSS: L1 C/A GLONASS: L1OF BEIDOU: B1I GALILEO: E1 IRNSS L5
Channels	Support 135 channels	
Update rate	1Hz default, up to 10Hz	
Acquisition time	Hot start (Open Sky)	1s (typical)
	Cold Start (Open Sky)	28s (typical) without AGPS
Position accuracy	LS2303x-V2	Autonomous: 1.5m (CEP)
	LS2303x-V3	Autonomous: 2.5m (CEP)
PPS signal accuracy	Typical ±1ms for PPS through USB ⁽¹⁾	
Datum	WGS-84 (default)	
Max. altitude	< 18,000 m	
Max. velocity	< 500m/s	
Protocol support	NMEA 0183 ver. 4.1	115200 bps ⁽²⁾ , 8 data bits, no parity, 1 stop bits (default)
		1Hz: GGA, GLL, GSA, GSV, RMC, VTG, GST

Note 1: The user can get PPS by checking DCD status. PPS accuracy is limited to USB poll interval.

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

5 Software interface

5.1 NMEA output message

Table 5.1-1 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
GST	Estimated error in position solution

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

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

\$GNGGA,091250.000,2503.71250,N,12138.74514,E,1,32,0.55,119.0,M,17.2,M,,*7E

Table 5.1-2 GGA Data Format

Name	Example	Units	Description
Message ID	\$GNGGA		GGA protocol header
UTC Time	091250.000		hhmmss.sss
Latitude	2503.71250		ddmm.mmmmm
N/S indicator	N		N=north or S=south
Longitude	12138.74514		dddmm.mmmmm
E/W Indicator	E		E=east or W=west
Position Fix Indicator	1		See Table 5.1-3
Satellites Used	32		Number of satellites in view
HDOP	0.55		Horizontal Dilution of Precision (meters)
MSL Altitude	119.0	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			Differential reference station ID, 0000-1023
Checksum	*7E		Checksum
<CR> <LF>			End of message termination

Table 5.1-3 Position Fix Indicators

Value	Description
-------	-------------

0	No position fix
1	Autonomous GNSS fix
2	Differential GNSS fix
4	RTK fixed
5	RTK float
6	Estimated/Dead reckoning fix

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

Table 5.1-4 contains the values for the following example:

\$GNGLL,2503.71193,N,12138.74582,E,094450.000,A,A*47

Table 5.1-4 GLL Data Format

Name	Example	Units	Description
Message ID	\$GNGLL		GLL protocol header
Latitude	2503.71193		ddmm.mmmmm
N/S indicator	N		N=north or S=south
Longitude	12138.74582		dddmm.mmmmm
E/W indicator	E		E=east or W=west
UTC Time	094450.000		hhmmss.sss
Status	A		A=data valid or V=data not valid
Mode	A		N = No position fix A = Autonomous GNSS fix D = Differential GNSS fix R = RTK fixed F = RTK float E = Estimated/Dead reckoning fix
Checksum	*47		
<CR> <LF>			End of message termination

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

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

\$GNGSA,A,3,11,195,194,199,08,07,01,27,16,09,23,,1.19,0.64,1.00,1*3F

\$GNGSA,A,3,87,81,76,,,,,,,,,1.19,0.64,1.00,2*0F

\$GNGSA,A,3,,,,,,,,,,,,,1.19,0.64,1.00,3*09

\$GNGSA,A,3,34,24,12,07,11,10,08,38,25,09,13,16,1.19,0.64,1.00,4*02

Table 5.1-5 GSA Data Format

Name	Example	Units	Description
Message ID	\$GNGSA		GSA protocol header

Mode 1	A		See Table 5.1-6
Mode 2	3		See Table 5.1-7
ID of satellite used	11		SV on Channel 1
ID of satellite used	195		SV on Channel 2
....		
ID of satellite used			SV on Channel 12
PDOP	1.19		Position Dilution of Precision
HDOP	0.64		Horizontal Dilution of Precision
VDOP	1.00		Vertical Dilution of Precision
GNSS system ID	4		See Table 5.1-8
Checksum	*3F		
<CR> <LF>			End of message termination

Table 5.1-6 Mode 1

Value	Description
M	Manually set to operate in 2D or 3D mode
A	Automatically switching between 2D or 3D mode

Table 5.1-7 Mode 2

Value	Description
1	No position fix
2	2D fix
3	3D fix

Table 5.1-8 GNSS system ID

Value	Description
1	GPS
2	GLONASS
3	GALILEO
4	BEIDOU
6	IRNSS

- **GSV---GNSS Satellites in View**

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

```
$GPGSV,3,1,09,8,71,268,47,27,63,18,49,11,44,191,46,4,41,237,46,1*54
$GPGSV,3,2,09,16,38,42,42,9,32,279,39,26,22,70,38,31,15,131,36,1*56
$GPGSV,3,3,09,7,15,320,40,1*6B
$GPGSV,1,1,04,8,71,268,50,27,63,18,49,9,32,279,43,26,22,70,42,8*6C
$GLGSV,2,1,05,82,63,47,47,83,56,182,36,80,47,9,42,79,33,85,45,1*71
$GLGSV,2,2,05,81,15,27,37,1*71
```

\$GAGSV,1,1,04,08,48,300,43,03,47,025,45,13,36,309,42,05,06,061,34,7*79
 \$GAGSV,1,1,04,08,48,300,43,03,47,025,47,13,36,309,43,05,06,061,33,1*7B
 \$GBGSV,5,1,17,12,80,182,47,24,64,5,51,7,58,355,44,3,57,205,45,1*7C
 \$GBGSV,5,2,17,1,54,141,44,34,52,211,49,9,48,230,45,10,47,316,42,1*79
 \$GBGSV,5,3,17,26,44,100,47,16,39,207,43,4,38,117,41,2,37,240,41,1*77
 \$GBGSV,5,4,17,39,37,210,43,6,36,198,41,38,27,173,41,25,18,317,42,1*4E
 \$GBGSV,5,5,17,35,16,39,40,1*7F
 \$GBGSV,1,1,02,24,64,5,50,26,44,100,43,4*77

Table 5.1-9 GSV Data Format

Name	Example	Units	Description
Message ID	\$GPGSV		GSV protocol header. GP=GPS/QZSS, GL=GLONSS, GA=GALILEO, GB=BEIDOU, GI=IRNSS.
Total number of messages	3		Range 1 to 9
Message number	1		Range 1 to 9
Satellites in view	09		
Satellite ID	8		Channel 1
Elevation	71	degrees	Channel 1 (Range 00 to 90)
Azimuth	268	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	4		Channel 4 (Range 01 to 196)
Elevation	41	degrees	Channel 4 (Range 00 to 90)
Azimuth	237	degrees	Channel 4 (Range 000 to 359)
SNR (C/No)	46	dB-Hz	Channel 4 (Range 00 to 99, null when not tracking)
Signal ID	1		GPS/QZSS: L1 C/A=1, L5Q=8 GLONASS: L1 C/A=1 GALILEO: E1=7, E5a=1 BEIDOU: B1=1, B2a=4 IRNSS: L6=1
Checksum	*54		
<CR> <LF>			End of message termination

● **RMC---Recommended Minimum Specific GNSS Data**

Table 5.1-10 contains the values for the following example:

\$GNRMC,070143.000,A,2503.71317,N,12138.74533,E,0.002,70.50,130220,,,A,V*01

Table 5.1-10 RMC Data Format

Name	Example	Units	Description
Message ID	\$GNRMC		RMC protocol header
UTC Time	070143.000		hhmmss.sss
Status	A		A=data valid or V=data not valid
Latitude	2503.7117		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	12138.74533		dddmm.mmmmm
E/W Indicator	E		E=east or W=west
Speed over ground	0.002	knots	True
Course over ground	70.50	degrees	
Date	130220		ddmmyy
Magnetic variation		degrees	
Variation sense			E=east or W=west
Mode	A		N = No position fix A = Autonomous GNSS fix D = Differential GNSS fix R = RTK fixed F = RTK float E = Estimated/Dead reckoning fix
Navigational status indicator	V		S = Safe C = Caution U = Unsafe V = Void
Checksum	*01		
<CR> <LF>			End of message termination

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

Table 5.1-11 contains the values for the following example:

\$GNVTG,0.00,T,,M,0.003,N,0.006,K,A*26

Table 5.1-11 VTG Data Format

Name	Example	Units	Description
Message ID	\$GPVTG		VTG protocol header
Course over ground	0.00	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	A		N = No position fix A = Autonomous GNSS fix D = Differential GNSS fix R = RTK fixed F = RTK float E = Estimated/Dead reckoning fix
Checksum	*26		
<CR> <LF>			End of message termination

● **GST---Estimated error in position solution**

Table 5.1-12 contains the values for the following example:

\$GNGST,075707.000,2.9,1.8,1.5,113.3,1.6,1.8,5.9*7F

Table 5.1-12 GST Data Format

Name	Example	Units	Description
Message ID	\$GNGST		GST protocol header
UTC Time	075707.000		hhmmss.sss
RangeRMS	2.9	meters	RMS value of the standard deviation of the ranges
stdMajor	1.8	meters	Standard deviation of semi-major axis of error ellipse
stdMinor	1.5	meters	Standard deviation of semi-minor axis of error ellipse
Orient	113.3	degrees	Orientation of semi-major axis of error ellipse
stdLat	1.6	meters	Standard deviation of latitude error
stdLong	1.8	meters	Standard deviation of longitude error
stdAlt	5.9	meters	Standard deviation of altitude error
Checksum	*7F		
<CR> <LF>			End of message termination

5.2 Proprietary command sets

The following table shows the most common use proprietary command sets.

Table 5.2-1 The table below summarizes the set of proprietary command sets for the LS2303x-Vx

Command descriptions	Software command
Perform HOT_START	\$PAIR004*3E\r\n
Perform WARM_START	\$PAIR005*3F\r\n
Perform COLD_START	\$PAIR006*3C\r\n
Perform FULL_COLD_START	\$PAIR007*3D\r\n
Set OUTPUT BAUDRATE [Note] Must reboot the device after changing the port baud rate. The change will valid after reboot.	\$PAIR864,0,0,115200*1B\r\n \$PAIR864,0,0,230400*19\r\n \$PAIR864,0,0,460800*16\r\n \$PAIR864,0,0,921600*10\r\n \$PAIR864,0,0,3000000*2F\r\n
Set SPEED THRESHOLD [NOTE] Speed_threshold. 0~20 dm/s. Default value is 0 dm/s. The minimum is 1 dm/s, the maximum is 20 dm/s. 1 dm/s = 0.1m/s	\$PAIR070,15*15\r\n --- 1.5m/s
Query SPEED_THRESHOLD	Send: \$PAIR071*3C\r\n Response: \$PAIR001,071,0*3D\r\n ==> Success \$PAIR071,1.5*3A\r\n
Set DGPS MODE [NOTE] Mode: DGPS data source mode. '0': No DGPS source '1': RTCM '2': SBAS(Include WAAS/EGNOS/GAGAN/ MSAS)	\$PAIR400,0*22\r\n ==> Set No DGPS source \$PAIR400,1*23\r\n ==> Set RTCM \$PAIR400,2*20\r\n ==> Set SBAS Mode
Query DGPS MODE [NOTE] Mode: DGPS data source mode. '0': No DGPS source '1': RTCM '2': SBAS(Include WAAS/EGNOS/GAGAN/ MSAS)	Send: \$PAIR401*3F\r\n Response: \$PAIR001,401,0*3E\r\n ==> Success \$PAIR401,2*21\r\n ==> SBAS Mode
Enable or Disable SBAS SATELLITE SEARCHING	\$PAIR410,0*23\r\n ==> Disable SBAS \$PAIR410,1*22\r\n ==> Enable SBAS

6 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.

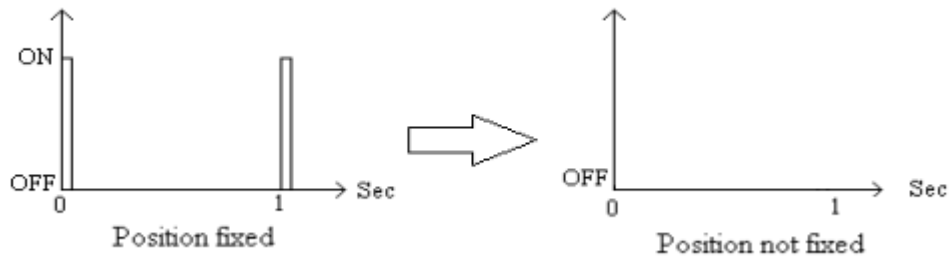
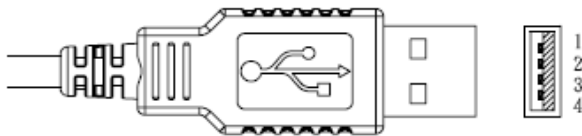


Fig 6.1 LED indicator of positioning status

7 Pin assignment and descriptions

- **LS23030-Vx**

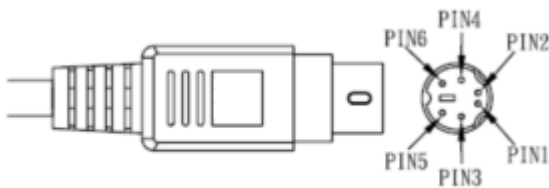
Pin #	Name	Type	Description
1	VBUS	P	USB power input
2	D-		D- line
3	D+		D+ line
4	GND	P	Ground



USB A-TYPE Plug

- **LS23032-Vx**

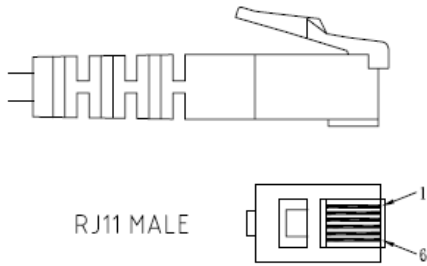
Pin #	Name	Type	Description
1	GND	P	Ground
2	VDD	P	Power input
3	NC		Not connect
4	RX	I	Data input (RS232 level)
5	TX	O	Data output (RS232 level)
6	NC		Not connect



PS2 MALE

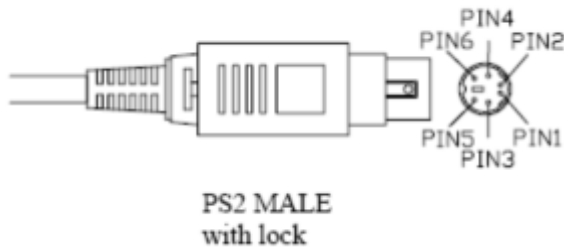
- **LS23033-Vx**

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



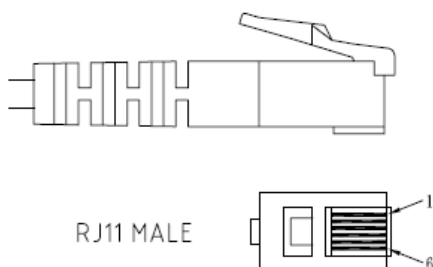
● **LS23035-Vx**

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



● **LS23036-Vx**

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



8 DC & Temperature characteristics

8.1 Power consumption (continuous mode)

Parameter	Symbol	Product	Min.	Typ.	Max.	Units
Input voltage	VCC	LS23030-Vx	4.75	5	5.25	V
		LS23032-Vx	4	5	6	
		LS23033-Vx	4	5	6	
		LS23035-Vx	4	5	6	
		LS23036-Vx	4	5	6	
Input current	Icc	LS23030-V2		72		mA
		LS23032-V2		63		
		LS23033-V2		63		
		LS23035-V2		63		
		LS23036-V2		63		
		LS23030-V3		50		
		LS23032-V3		41		
		LS23033-V3		41		
		LS23035-V3		41		
		LS23036-V3		41		

Note 1: Measured when position fix (1Hz) is available.

8.2 Temperature characteristics

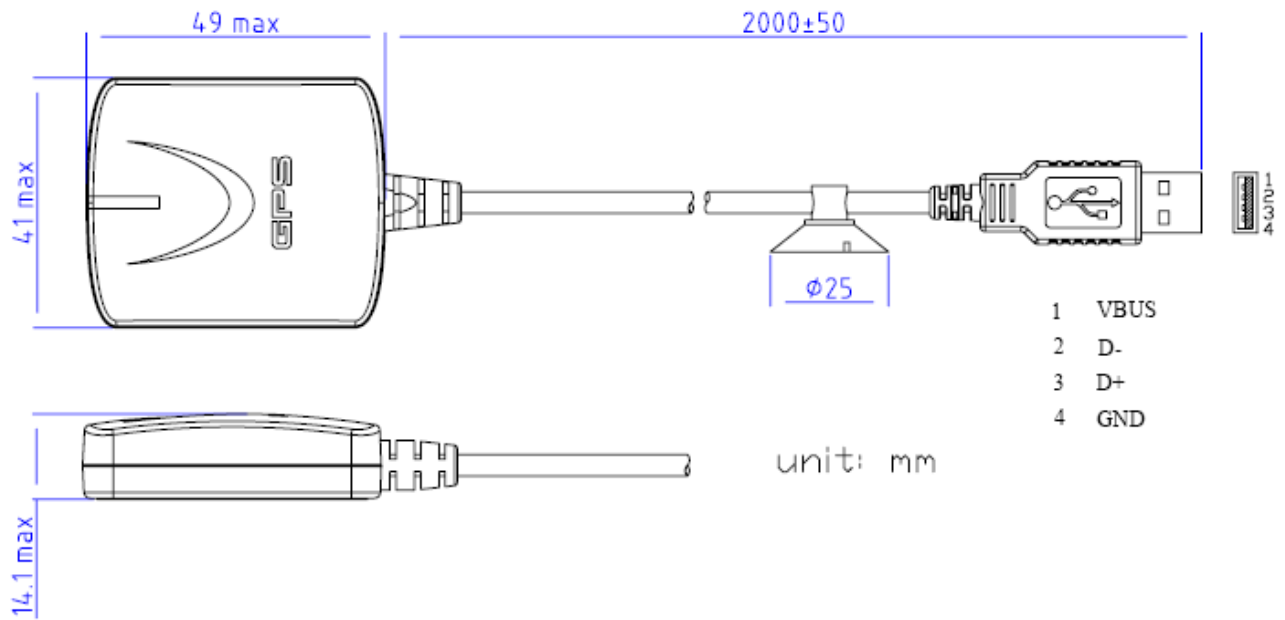
Parameter	Symbol	Min.	Typ.	Max.	Units
Operating Temperature	Topr ⁽¹⁾	-40	-	85	°C
Storage Temperature	Tstg ⁽²⁾	-40	25	85	°C

Note 1: built-in micro battery: -20 ~ 60°C

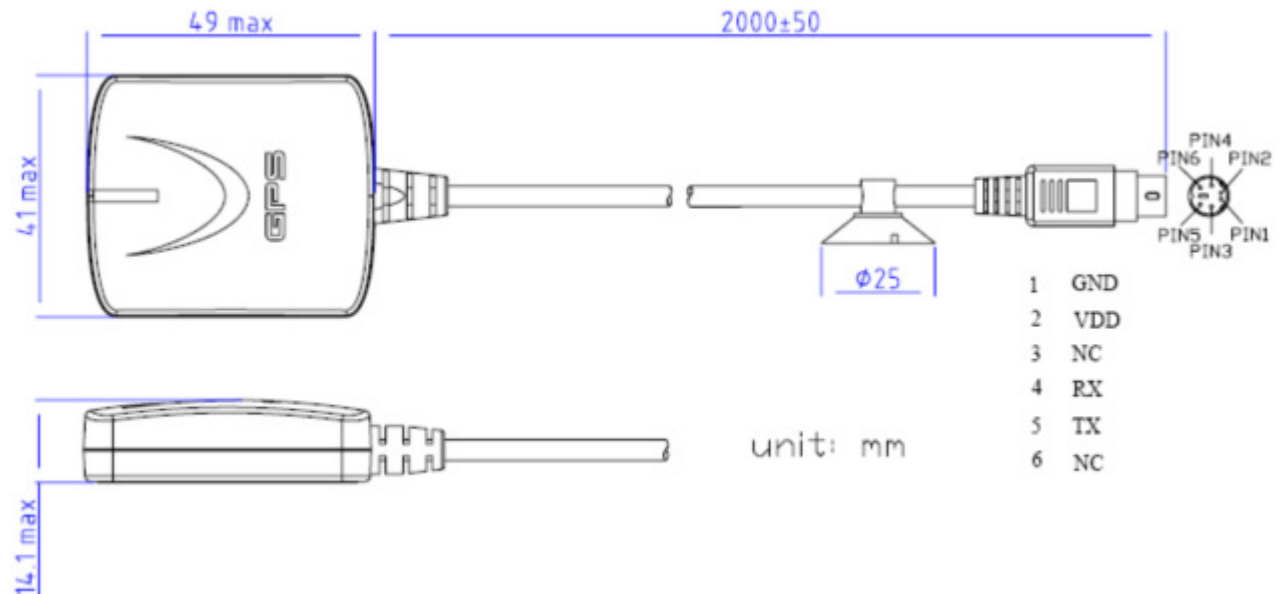
Note 2: built-in micro battery: -40 ~ 60°C

9 Mechanical specification

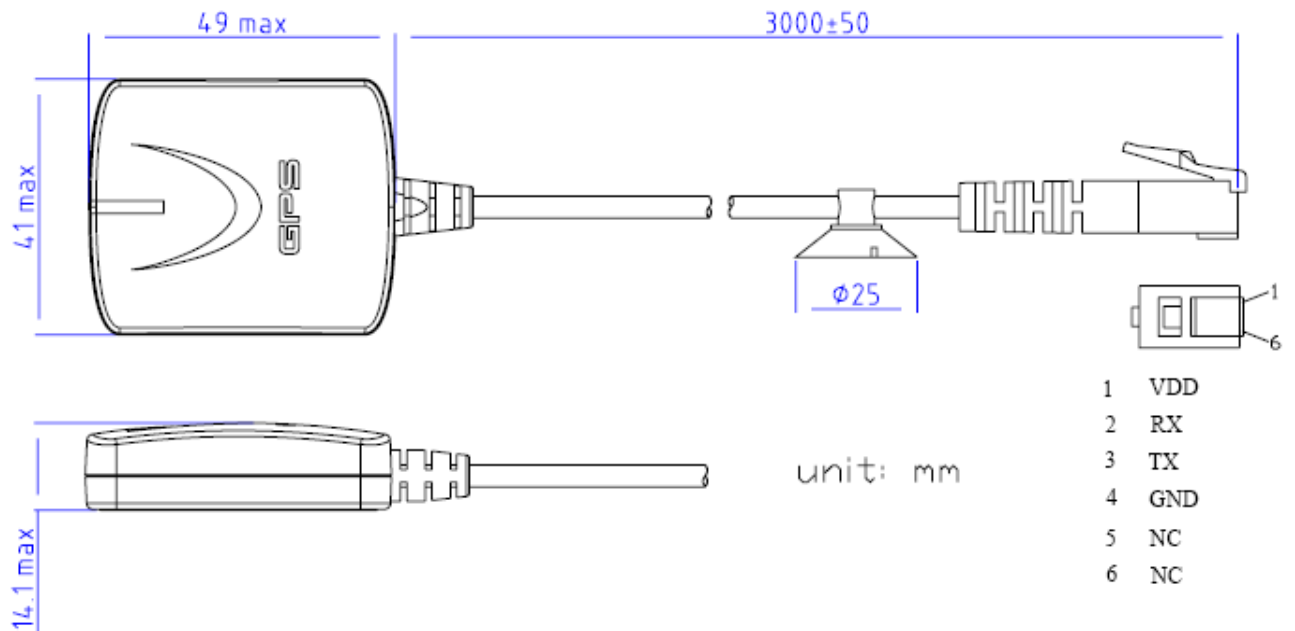
- **LS23030-Vx (USB interface)**



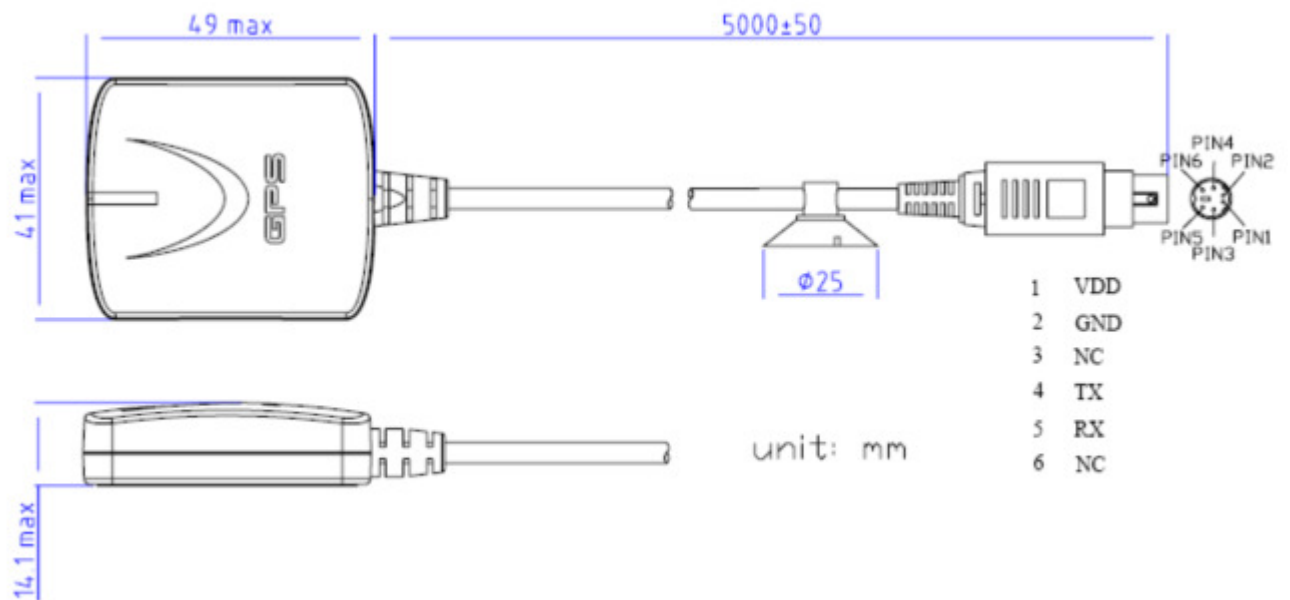
- **LS23032-Vx (RS232 interface)**



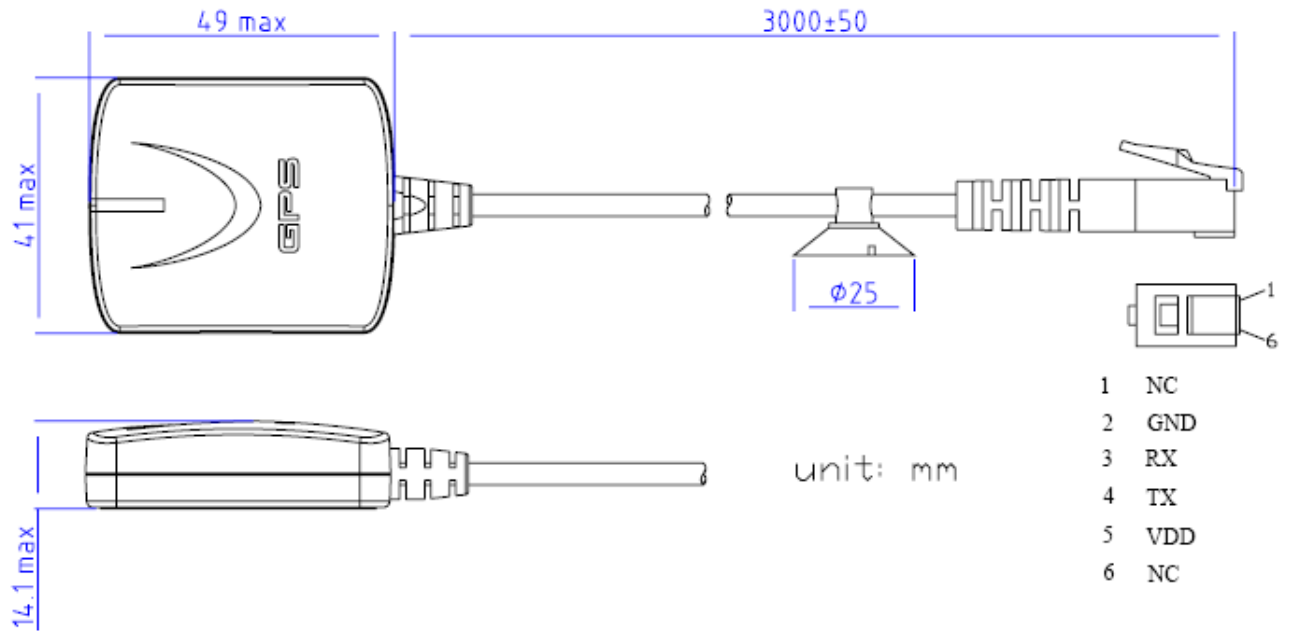
- **LS23033-Vx (RS232 interface)**



- **LS23035-Vx (RS232 interface)**



- **LS23036-Vx (RS232 interface)**



10 Ordering information

Product name	Description	Remark
LS23030-V2	Dual-frequency multi-constellation GNSS mouse / 2m, PPS through USB	GPS/QZSS: L1 C/A, L5C GLONASS: L1OF BEIDOU: B1I, B2a GALILEO: E1, E5a
LS23032-V2	Dual-frequency multi-constellation GNSS mouse / 2m, PS2	
LS23033-V2	Dual-frequency multi-constellation GNSS mouse / 3m, RJ11	
LS23035-V2	Dual-frequency multi-constellation GNSS mouse / 5m, PS2 with lock	
LS23036-V2	Dual-frequency multi-constellation GNSS mouse / 3m, RJ11	
LS23030-V3	Dual-frequency multi-constellation GNSS mouse / 2m, PPS through USB	GPS/QZSS: L1 C/A GLONASS: L1OF BEIDOU: B1I GALILEO: E1 IRNSS: L5
LS23032-V3	Dual-frequency multi-constellation GNSS mouse / 2m, PS2	
LS23033-V3	Dual-frequency multi-constellation GNSS mouse / 3m, RJ11	
LS23035-V3	Dual-frequency multi-constellation GNSS mouse / 5m, PS2 with lock	
LS23036-V3	Dual-frequency multi-constellation GNSS mouse / 3m, RJ11	

Document change list

Revision 0.1

- Draft release on September 22, 2020.

Revision 0.2 (September 24, 2020)

- Added the proprietary command sets in section 5.2.

Revision 0.3 (April 27, 2021)

- Remove sub-meter position accuracy in section 2
- Added support of QZSS SLAS
- Changed the max. velocity from 515 m/s to 500 m/s in section 4
- Changed autonomous position accuracy from 1m CEP to 1.5m CEP
- Added GST to default output message
- Revised the input current in section 8.1