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Xizhi Dist., New Taipei City 22101, Taiwan
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886-2-8698-3699
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Product name	Description	Version
LS23030-UDG	Multiple GNSS mouse, 2m, USB, 115200BPS	0.6
LS23032-UDG	Multiple GNSS mouse, 2m, PS2, 115200BPS	
LS23035-UDG	Multiple GNSS mouse, 5m, PS2 with lock, 115200BPS	
LS23036-UDG	Multiple GNSS mouse, 3m, RJ11, 115200BPS	

Datasheet of multiple GNSS DR mouse, LS2303x-UDG series

LS23030-UDG LS23032-UDG LS23035-UDG LS23036-UDG

1 Introduction

LS2303x-UDG series products are complete GNSS receivers based on the proven technology. The series products are embedded with LOCOSYS MC-1612-DG module, 3D accelerometer and 3D gyroscope, as well as dead reckoning software. They can provide dead reckoning navigation without any odometer connection. The extended Kalman filter algorithm combines GNSS and MEMS sensor data with a weighting function that relies on GNSS signal quality. In poor signal reception and multipath environments, position errors are reduced by dead reckoning. The series products can simultaneously acquire and track multiple satellite constellations that include GPS, GLONASS, GALILEO, QZSS and SBAS. Besides, they feature high sensitivity, low power, and provide user the superior performance. The far-reaching capability meets the sensitivity requirements of car navigation as well as other location-based applications.

2 Features

- High sensitivity GNSS
- Support GPS, GLONASS, GALILEO, QZSS
- Capable of SBAS (WAAS, EGNOS, GAGAN, MSAS)
- Fast TTFF at low signal level
- Built-in Odometer-less Dead Reckoning (DR) software

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- Built-in MEMS sensor (3-axis Gyroscope and 3-axis Accelerometer)
- Up to 100Hz MEMS raw data output
- Great anti-jamming performance (due to multi-tone active interference canceller)
- Build-in backup battery for reserve system data and rapid satellite reacquisition
- LED indicator for GNSS positioning status
- Build-in magnet for mounting
- Waterproof

3 Application

- Automotive navigation
- Fleet management
- UAV drone

4 GNSS receiver

Chip	GNSS chip	
Frequency	GPS, GALILEO(1), QZSS: L1 1575.42MHz, C/A code GLONASS: L1 1598.0625MHz ~ 1605.375MHz, C/A code	
Channels	Support 99 channels (33 Tracking, 99 Acquisition)	
Update rate	1Hz default, up to 10Hz (Option)	
MEMS raw data	100Hz	
Acquisition Time	Hot start (Open Sky)	<1 s (typical)
	Cold Start (Open Sky)	26 s (typical)
Position Accuracy	Autonomous	2.5m (CEP)
	SBAS	2.5m (CEP, depends on accuracy of correction data)
	UDR Mode(2)	Avg 5%(3)
Max. Altitude	< 18,000 m	
Max. Velocity	< 515 m/s	
Protocol Support	NMEA 0183 v4.10	115200 bps(4), 8 data bits, no parity, 1 stop bits (default) 1Hz: GGA, GLL, GSA, GSV, RMC, VTG, GST, PLSVD, PINVMSLOPE, PINVMINR(5) and PINVMATTIT

Note (1): LS2303x-UDG series products are default configured for concurrent GPS, GLONASS, QZSS and SBAS reception. Please contact us for different default configuration, such as concurrent GPS, GLONASS, GALILEO,QZSS and SBAS.
Note (2): Typical Error incurred without GNSS as a percentage of distance travelled.
Note (3): Distance travelled (without GNSS)
Note (4): Both baud rate and output message rate are configurable to be factory default.
Note (5): Output calibration status message when GNSS 3D is repaired.

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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.

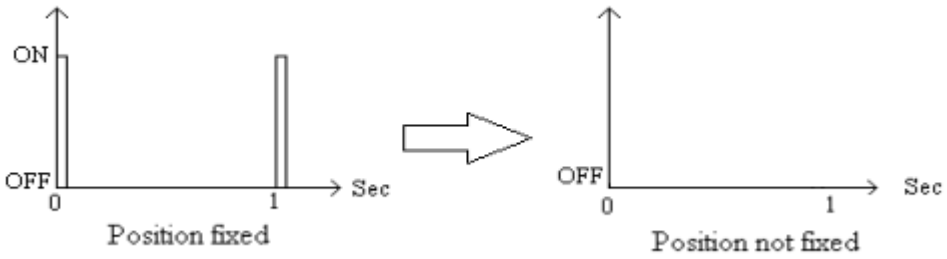
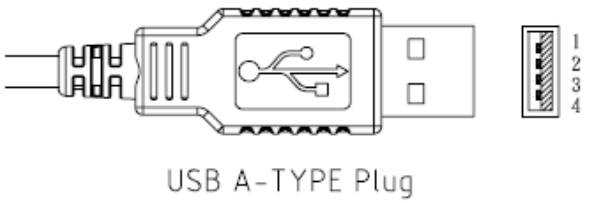


Fig 5.1 LED indicator of positioning status

6 Pin assignment and descriptions

- **LS23030-UDG**

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



- **LS23032-UDG**

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

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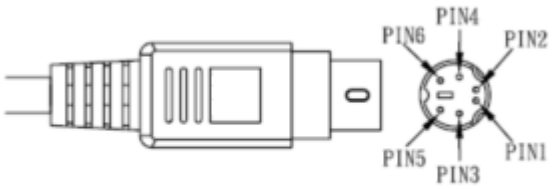
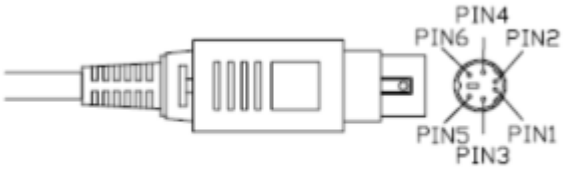


PS2 MALE

- **LS23035-UDG**

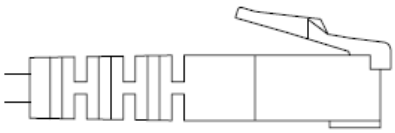
Pin #	Name	Type	Description
1	VDD	P	Power input
2	GND	P	Ground
3	NC		Not connect
4	TX	O	Data output (RS232 level)
5	RX	I	Data input (RS232 level)
6	NC		Not connect

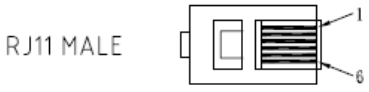


PS2 MALE
with lock

- **LS23036-UDG**

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





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7 DC & Temperature characteristics

7.1 Power consumption (continuous mode)

Parameter	Symbol	Interface	Min.	Typ.	Max.	Units
Input voltage	VCC	LS23030-UDG LS23032-UDG LS23035-UDG LS23036-UDG	4.75 4.00 4.00 4.00	5.00	5.25 6.00 6.00 6.00	V
Input current	Icc	LS23030-UDG LS23032-UDG LS23035-UDG LS23036-UDG		106(1) 88(1) 88(1) 88(1)		mA

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

7.2 Temperature characteristics

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

Note (1): Backup battery: -20 ~ 60℃
Note (2): Backup battery: -40 ~ 60℃

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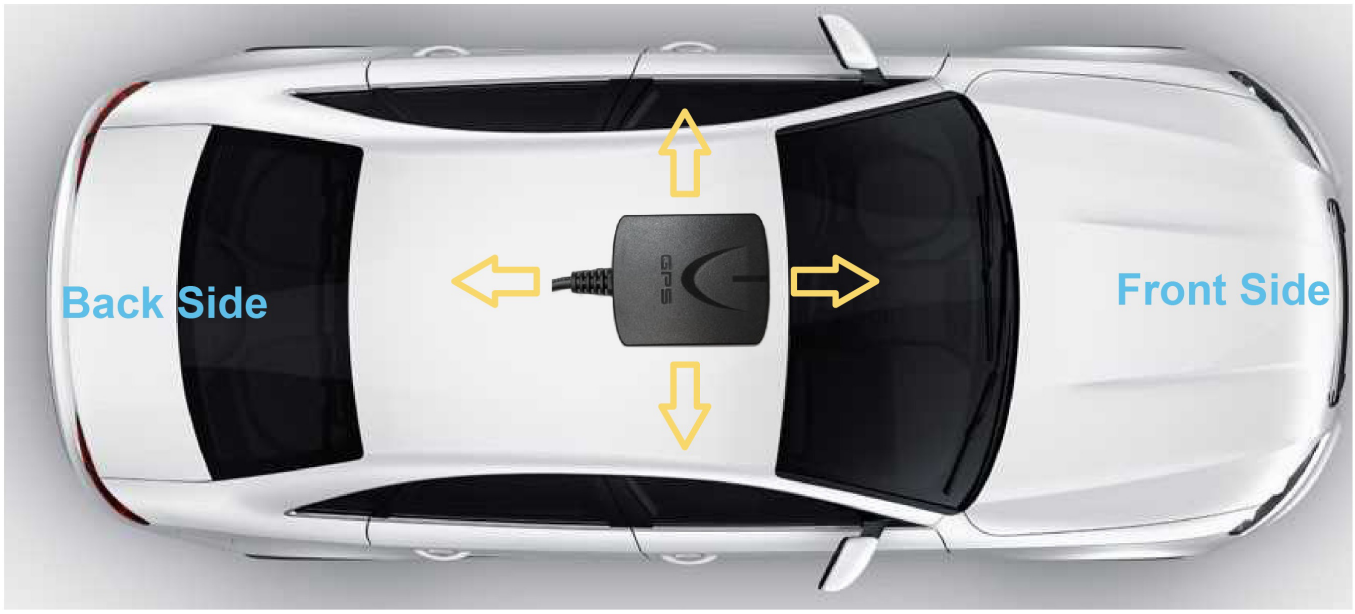
8 Installation and calibration

Please refer to the following figure to mount LS2303x-UDG on vehicle. The GNSS mouse should be securely mounted to a stable part of the vehicle.

In order to get the better fused navigation, the initialization and calibration steps are suggested in the following.

1. Power on the module and wait GNSS position fix in the open sky environment.
2. Stay still for about 180 second or more.
3. Drive in the straight road at the speed above 30km/h for more than 5 minutes in the open sky environment.
4. Accelerate and decelerate linearly more than 5 times in the open sky environment.
5. Complete 2 or more 90-degree turns in the open sky environment.
6. The system ready flag in the message “$PINVMINR” shows if the fused PVT is ready.



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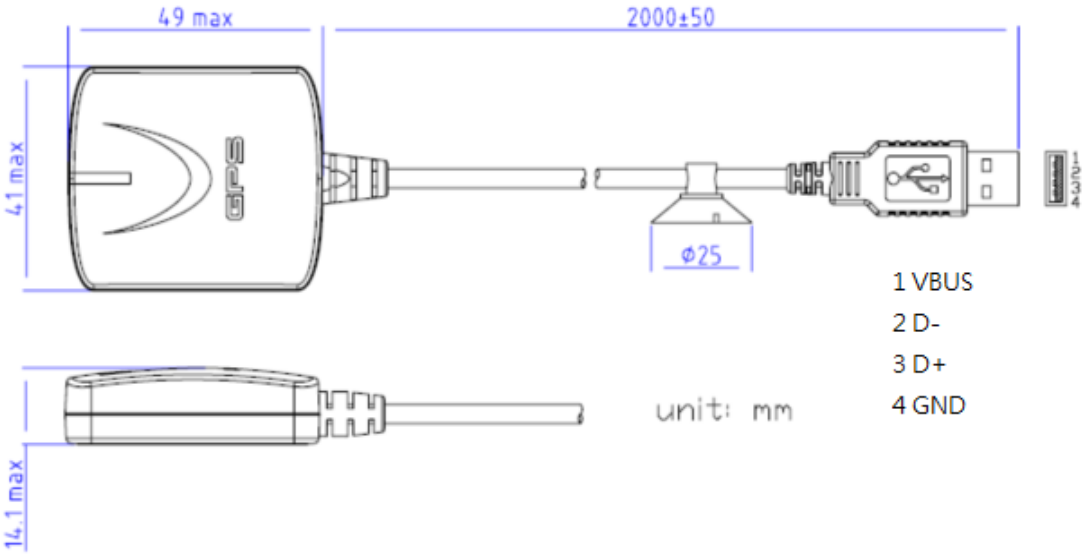
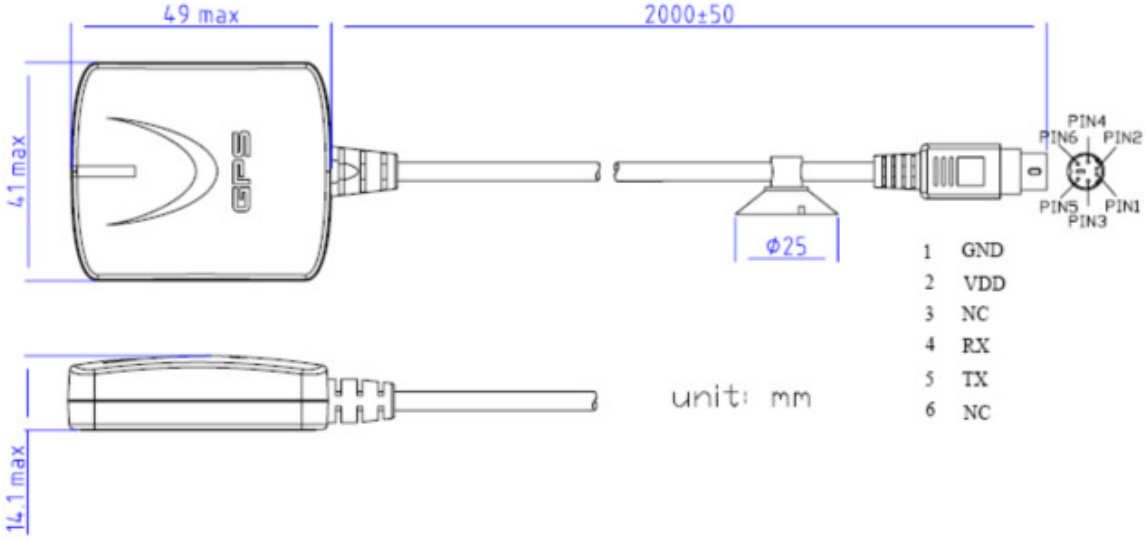
9 Mechanical specification

- **LS23030-UDG (USB interface)**



- **LS23032-UDG (RS232 interface)**



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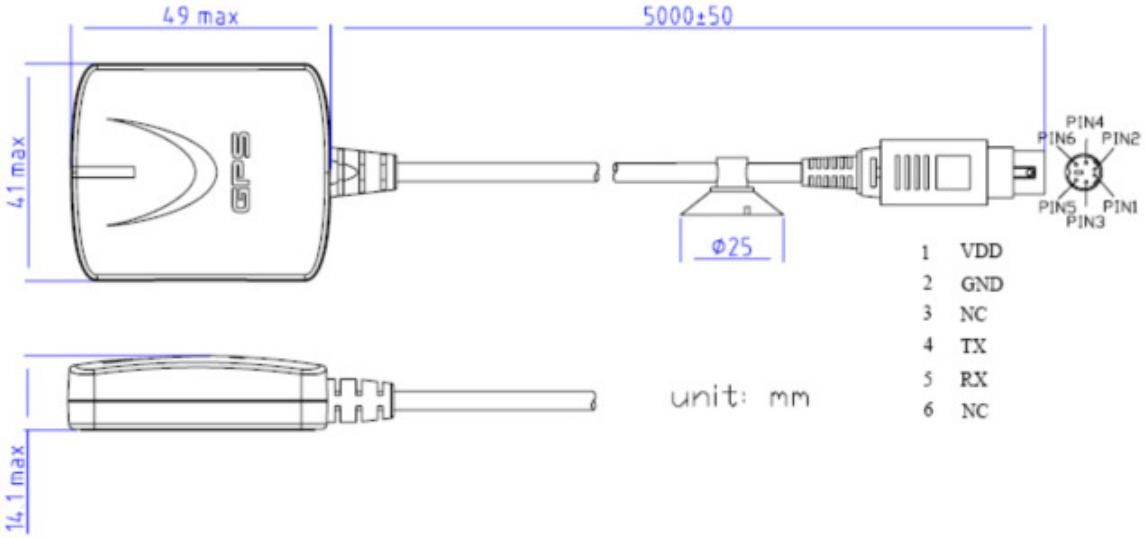
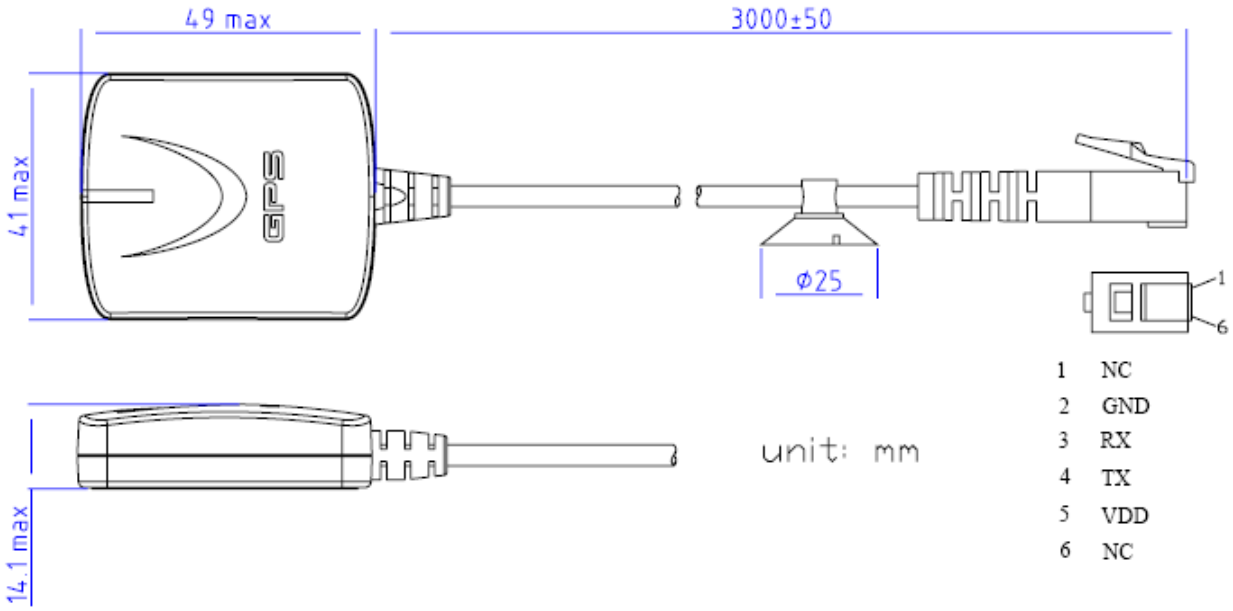
- **LS23035-UDG (RS232 interface)**



- **LS23036-UDG (RS232 interface)**



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10 Software interface

10.1 NMEA output message

Table 10.1-1 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
PLSVD	3D velocity & deviation information
GST	Estimated Position Error

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

Table 10.1-2 contains the values for the following example:

$GNGGA,075754.00,2503.71213,N,12138.74302,E,2,16,0.81,143.20,M,15.32,M,,0000*43

Table10.1- 2 GGA Data Format

Name	Example	Units	Description
Message ID	$GNGGA		GGA protocol header
UTC Time	075754.00		hhmmss.ss
Latitude	2503.71213		ddmm.mmmmm
N/S indicator	N		N=north or S=south
Longitude	12138.74302		dddmm.mmmmm
E/W Indicator	E		E=east or W=west
Position Fix Indicator	2		See Table 10.1-3
Satellites Used	16		Range 0 to 33
HDOP	0.81		Horizontal Dilution of Precision
MSL Altitude	143.20	meters	
Units	M	meters	
Geoid Separation	15.32	meters	
Units	M	meters	
DGPS Age			Not supported
DGPS Reference	0000		
Checksum	*43		
<CR> <LF>			End of message termination

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Table 10.1-3 Position Fix Indicators

Value	Description
0	Fix not available or invalid
1	GNSS fix valid
2	Differential GNSS fix valid
3-5	Not supported
6	Estimated (Dead Reckoning) Mode

Note: It can bet DGPS (RTCM) or SBAS

● GLL--- Geographic Position – Latitude/Longitude

Table 10.1-4 contains the values for the following example:

$GNGLL,2503.71214,N,12138.74300,E,075755.00,A,D*7B

Table 10.1-4 GLL Data Format

Name	**Example**	**Units**	**Description**
Message ID	$GNGLL		GLL protocol header
Latitude	2503.71214		ddmm.mmmmm
N/S indicator	N		N=north or S=south
Longitude	12138.74300		dddmm.mmmmm
E/W indicator	E		E=east or W=west
UTC Time	075755.00		hhmmss.ss
Status	A		A=data valid or V=data not valid
Mode	D		N = No position fix A = Autonomous GNSS fix D = Differential GNSS fix R = RTK fixed F = RTK float E = Estimated/Dead reckoning fix
Checksum	*7B		
<CR> <LF>			End of message termination

● GSA---GNSS DOP and Active Satellites

Table 10.1-5 contains the values for the following example:

$GNGSA,A,3,13,15,02,29,05,06,195,193,,,,,1.96,0.97,1.70,1*0D
$GNGSA,A,3,85,71,70,,,,,,,,,,1.96,0.97,1.70,2*08
$GNGSA,A,3,03,15,08,,,,,,,,,,1.96,0.97,1.70,3*0A

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Table 10.1-5 GSA Data Format

Name	**Example**	**Units**	**Description**
Message ID	$GNGSA		GSA protocol header
Mode 1	A		See Table 10.1-6
Mode 2	3		See Table 10.1-7
ID of satellite used	13		Sv on Channel 1
ID of satellite used	15		Sv on Channel 2
….			….
ID of satellite used			Sv on Channel 12
PDOP	1.96		Position Dilution of Precision
HDOP	0.97		Horizontal Dilution of Precision
VDOP	1.70		Vertical Dilution of Precision
System ID	1		1: GPS, 2: GLONASS, 3: GALILEO, 4: BEIDOU, 5-F: Reserved
Checksum	*0D		
<CR> <LF>			End of message termination

Table 10.1-6 Mode 1

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

Table 10.1-7 Mode 2

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

● GSV---GNSS Satellites in View

Table 10.1-8 contains the values for the following example:

$GPGSV,4,1,13,193,71,045,35,02,66,048,39,195,61,164,37,50,60,167,33,0*62
$GPGSV,4,2,13,13,56,184,36,05,55,341,37,06,35,100,35,15,28,215,35,0*66
$GPGSV,4,3,13,29,26,316,34,30,18,098,21,07,10,068,28,25,05,266,,0*66
$GPGSV,4,4,13,194,,,,0*5B
$GLGSV,2,1,06,85,76,024,35,71,55,261,29,70,52,004,30,84,34,137,,1*70
$GLGSV,2,2,06,72,12,230,24,69,02,035,,1*74
$GAGSV,2,1,06,03,68,033,37,15,68,000,36,08,54,226,35,13,20,322,,0*7D

Table 10.1-8 GSV Data Format

Name	Example	Units	Description
Message ID	$GPGSV		GSV protocol header GP=GPS/QZSS, GL=GLONASS, GA=GALILEO, BD=BEIDOU
Total number of messages(1)	4		Range 1 to 6
Message number(1)	1		Range 1 to 6
Satellites in view	13		
Satellite ID(2)	193		Channel 1 (Range 01 to 196)
Elevation	71	degrees	Channel 1 (Range 00 to 90)
Azimuth	045	degrees	Channel 1 (Range 000 to 359)
SNR (C/No)	35	dB-Hz	Channel 1 (Range 00 to 99, null when not tracking)
….			….
Satellite ID	50		Channel 4 (Range 01 to 196)
Elevation	60	degrees	Channel 4 (Range 00 to 90)
Azimuth	167	degrees	Channel 4 (Range 000 to 359)
SNR (C/No)	33	dB-Hz	Channel 4 (Range 00 to 99, null when not tracking)
Signal ID	0		See Table 10.1-9
Checksum	*62		
<CR> <LF>			End of message termination

Note (1): Depending on the number of satellites tracked multiple messages of GSV data may be required.
Note (2): GPS ID: 01~32, SBAS ID: 33~64, GLONASS ID: 65~96, QZSS ID: 193~196, BEIDOU ID: 01~32, GALILEO ID: 01~32.

Table 10.1-9 GNSS Identification:

System	System ID	Satellite ID	Signal ID	Signal Channel
GPS	1 (GP)	1 - 32 is reserved for GPS 33 - 64 is reserved for SBAS	0	All signals
GLONASS	2 (GL)	65 - 96 is reserved for GLONASS	0 1	All signals L1 C/A
GALILEO	3 (GA)	1 - 32 is reserved for GALILEO	0	All signals

● RMC---Recommended Minimum Specific GNSS Data

Table 10.1-10 contains the values for the following example:

$GNRMC,075806.00,A,2503.71220,N,12138.74293,E,0.05,0.00,240720,,,D,V*35

Table 10.1-10 RMC Data Format

Name	Example	Units	Description
Message ID	$GNRMC		RMC protocol header
UTC Time	075806.00		hhmmss.ss
Status	A		A=data valid or V=data not valid
Latitude	2503.71216		ddmm.mmmmm
N/S Indicator	N		N=north or S=south
Longitude	12138.74293		dddmm.mmmmm
E/W Indicator	E		E=east or W=west
Speed over ground	0.05	knots	True
Course over ground	0.00	degrees	
Date	240720		ddmmyy
Magnetic variation		degrees	(Not shown)
Variation sense			E=east or W=west (Not shown)
Mode	D		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	V		S = Safe C = Caution U = Unsafe V = Void
Checksum	*35		
<CR> <LF>			End of message termination

● VTG---Course Over Ground and Ground Speed

Table 10.1-11 contains the values for the following example:

$GNVTG,0.00,T,,M,0.04,N,0.07,K,D*25

Table 10.1-11 VTG Data Format

Name	Example	Units	Description
Message ID	$GNVTG		VTG protocol header
Course over ground	0.00	degrees	Measured heading
Reference	T		True
Course over ground		degrees	Measured heading (Not shown)

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Reference	M		Magnetic (Not shown)
Speed over ground	0.04	knots	Measured speed
Units	N		Knots
Speed over ground	0.07	km/hr	Measured speed
Units	K		Kilometer per hour
Mode	D		N = No position fix A = Autonomous GNSS fix D = Differential GNSS fix R = RTK fixed F = RTK float E = Estimated/Dead reckoning fix
Checksum	*25		
<CR> <LF>			End of message termination

● PLSVD---3D velocity & deviation information

Table 10.1-12 contains the values for the following example:

$PLSVD,1,0,-16,16,15,13*77

Table 10.1-12 PLSVD Data Format

Name	**Example**	**Units**	**Description**
Message ID	$PLSVD		PLSVD protocol header
True east velocity	1	cm/s	-51500~51500
True north velocity	0	cm/s	-51500~51500
True down velocity	-16	cm/s	-10000~10000
Deviation of east velocity	16	cm/s	
Deviation of north velocity	15	cm/s	
Deviation of down velocity	13	cm/s	
Checksum	*77		
<CR> <LF>			End of message termination

● GST---Estimated Position Error

Table 10.1-13 contains the values for the following example:

$GNGST,075849.000,5.4,4.8,1.5,40.2,0.56,0.61,0.60*73

Table 10.1-13 GST Data Format

Name	**Example**	**Units**	**Description**
Message ID	$GNGST		GST protocol header

UTC Time	075849.000		hhmmss.sss
RMS value of the standard deviation of the ranges	5.4		
Standard deviation of semi-major axis of error ellipse	4.8	meters	0~9999999.99
Standard deviation of semi-minor axis of error ellipse	1.5	meters	0~9999999.99
Orientation of semi-major axis of error ellipse	40.2	degree	
Standard deviation of Latitude error	0.56	meters	
Standard deviation of Longitude error	0.61	meters	
Standard deviation of altitude error	0.60	meters	
Checksum	*73		
<CR> <LF>			End of message termination

10.2 Proprietary Dead Reckoning input/output messages

Table 10.2-1 The table below summarizes the set of proprietary command sets for the LS2303x-UDG

NMEA record	**Description**
$PINVMINR	Calibration status
$PINVCRES	Clear the NVM data
$PINVCSTR	Start session
$PINVMSLOPE	SLOPE information
$PINVMIMU	MEMS RAW-DATA message information
$PINVMATTIT	ATTIT information

- **$PINVMINR --- Calibration status**

Table 10.2-2 contains the values for the following example:

$PINVMINR,1*04

Table 10.2-2 $PINVMINR Data Format

Name	**Example**	**Units**	**Description**
Message ID	$PINVMINR		$PINVMINR protocol header

Status	1		0:not initialized 1、2:calibrating/initializing 3:calibration done
Checksum	*04		
<CR> <LF>			End of message termination

Note: When GNSS positioning is valid, the message appears at NMEA sentence.

- **$PINVCRES ---Clear the NVM data**

Table 10.2-3 contains the values for the following example:

$PINVCRES,0*1A

Table 10.2-3 $PINVCRES Data Format

Name	Example	Units	Description
Message ID	$PINVCRES		$PINVCRES protocol header
Value	0		Clear the NVM data
Checksum	*1A		
<CR> <LF>			End of message termination

Note: The command need collocation start session command.

- **$PINVCSTR --- Start session**

Table 10.2-4 contains the values for the following example:

$PINVCSTR,14*3E

Table 10.2-4 $PINVCSTR Data Format

Name	Example	Units	Description
Message ID	$PINVCSTR		$PINVCSTR protocol header
Value	14		Start session
Checksum	*3E		
<CR> <LF>			End of message termination

Note 1: The command need collocation clear NVM data command.
Note 2: First time to use needs to do DR calibration, please follow below chart.

A Command example for DR recalibration:

$PINVCRES,0*1A (Response : $PINVMSTR,0*05)
↓
$PINVCSTR,14*3E (Response : $PINVMSTR,2*07)

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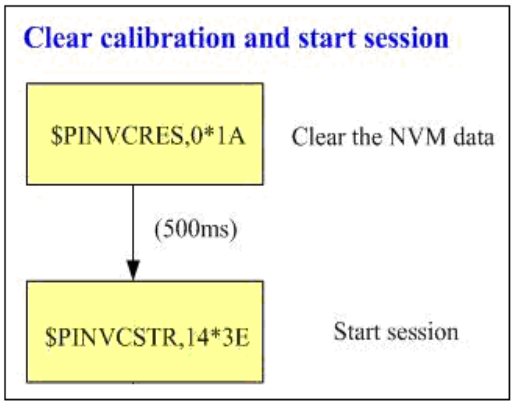

- **$PINVMSLOPE --- SLOPE information**

Table 10.2-5 contains the values for the following example:

a. Enable SLOPE (Default Enable)
$PLSC,SLOPE,1*78
$PLSR,SLOPE,1,OK*41

b. Disable SLOPE
$PLSC,SLOPE,0*79
$PLSR,SLOPE,0,OK*40

*Table 10.2-**5** $PLSC,SLOPE Data Format*

Name	Example	Units	Description
Message ID	$PLSC,SLOPE		$PLSC,SLOPE protocol header
Enable/Disable	1		Enable : 1 ; Disable : 0
Checksum	*78		
<CR> <LF>			End of message termination

$PINVMSLOPE,-3.13,-0.05,0.93,54.42,2.60,1.86*3B
$PINVMSLOPE,2.07,0.38,10.66,55.95,2.20,1.49*06

Table 10.2-5-1 $PINVMSLOPE Data Format

Name	Example	Units	Description
Message ID	$PINVMSLOPE		$PINVMSLOPE protocol header
Slope	-3.13	degree	slope + : up ; - : down
Alt_Diff	-0.05	meters	altitude difference , + : up ; - : down
Move_Dist	0.93	meters	move distance
Slope_Accu	54.42	degree	slope accuracy
Alt_Diff_Accu	2.60	meters	altitude difference accuracy
Move_Dist_Accu	1.86	meters	move distance accuracy

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Checksum	*3B		
<CR> <LF>			End of message termination

Note: Before testing can be done, make sure that the initialization and calibration have been completed.

● $PINVMIMU --- MEMS RAW-DATA message information

Table 10.2-6 contains the values for the following example:

a. Enable MEMS RAW-DATA
$PLSC,MEMS,1*2B
$PLSR,MEMS,1,OK*12

b. Disable MEMS RAW-DATA (Default Disable)
$PLSC,MEMS,0*2A
$PLSR,MEMS,0,OK*13

Table 10.2-6 $PLSC,MEMS Data Format

Name	**Example**	**Units**	**Description**
Message ID	$PLSC,MEMS		$PLSC,MEMS protocol header
Enable/Disable	1		Enable : 1 ; Disable : 0
Checksum	*2B		
<CR> <LF>			End of message termination

※ MEMS RAW-DATA output message (Default 100Hz output)
Table 10.2-6-1 contains the values for the following example:

$PINVMIMU,1114.106,-0.36990,1.51074,9.81383,0.67139,0.61035,-0.30518*22

Table 10.2-6-1 $PINVMIMU Data Format

Name	**Example**	**Units**	**Description**
Message ID	$PINVMIMU		$PINVMIMU protocol header
Time_Second	1114.106	sec	Time stamp
Accel_X	-0.36990	m/s^2	Accel_X output data
Accel_Y	1.51074	m/s^2	Accel_Y output data
Accel_Z	9.81383	m/s^2	Accel_Z output data
Gyro_X	0.67139	degree /s	Gyro_X output data
Gyro_Y	0.61035	degree /s	Gyro_Y output data
Gyro_Z	-0.30518	degree /s	Gyro_Z output data
Checksum	*22		
<CR> <LF>			End of message termination

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- **$PINVMATTIT --- ATTIT information**

Table 10.2-7 contains the values for the following example:

a. Enable ATTIT (Default Enable)
$PLSC,ATTIT,1*61
$PLSR,ATTIT,1,OK*58

b. Disable ATTIT
$PLSC,ATTIT,0*60
$PLSR,ATTIT,0,OK*59

Table 10.2-7 $PLSC,ATTIT Data Format

Name	Example	Units	Description
Message ID	$PLSC,ATTIT		$PLSC,ATTIT protocol header
Enable/Disable	1		Enable : 1 ; Disable : 0
Checksum	*61		
<CR> <LF>			End of message termination

$PINVMATTIT,-20.652,32.265,0.000*3C

Table 10.2-7-1 $PINVMATTIT Data Format

Name	Example	Units	Description
Message ID	$PINVMATTIT		$PINVMATTIT protocol header
Roll	-20.652	degree	Vehicle roll.
Pitch	32.265	degree	Vehicle pitch.
Heading(Yaw)	0.000	degree	Vehicle heading.
Checksum	*3C		
<CR> <LF>			End of message termination

Note: Before testing can be done, make sure that the initialization and calibration have been completed.

10.3 Proprietary command sets

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

Table 10.3-1 The table below summarizes the set of proprietary command sets for the LS2303x-UDG

Command descriptions	Software command
Perform a Cold start	$PMTK103*30
Perform a Warm start	$PMTK102*31
Perform a Hot start	$PMTK101*32
Perform a Full Cold start	$PMTK104*37
Disable GLL message	$PMTK314,0,1,1,1,1,1,0,0,0,0,0,0,0,0,0,0,0,0,0*29
Disable GSV message	$PMTK314,1,1,1,1,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0*29
Disable GLL & GSV message	$PMTK314,0,1,1,1,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0*28

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Factory default output message	$PMTK314,-1*04
Navigate with GPS+GALILEO	$PMTK353,1,0,1,0,0*2B
Navigate with GPS+GLONASS+GALILEO	$PMTK353,1,1,1,0,0*2A
Navigate with GPS+BEIDOU	$PMTK353,1,0,0,0,1*2B
Entering Standby Mode1	$PMTK161,0*28
Query firmware version	$PLSC,VER*61
Clear the NVM data	$PINVCRES,0*1A
Start session	$PINVCSTR,14*3E

Note 1: GNSS DR module will be awaked when it receives any byte.

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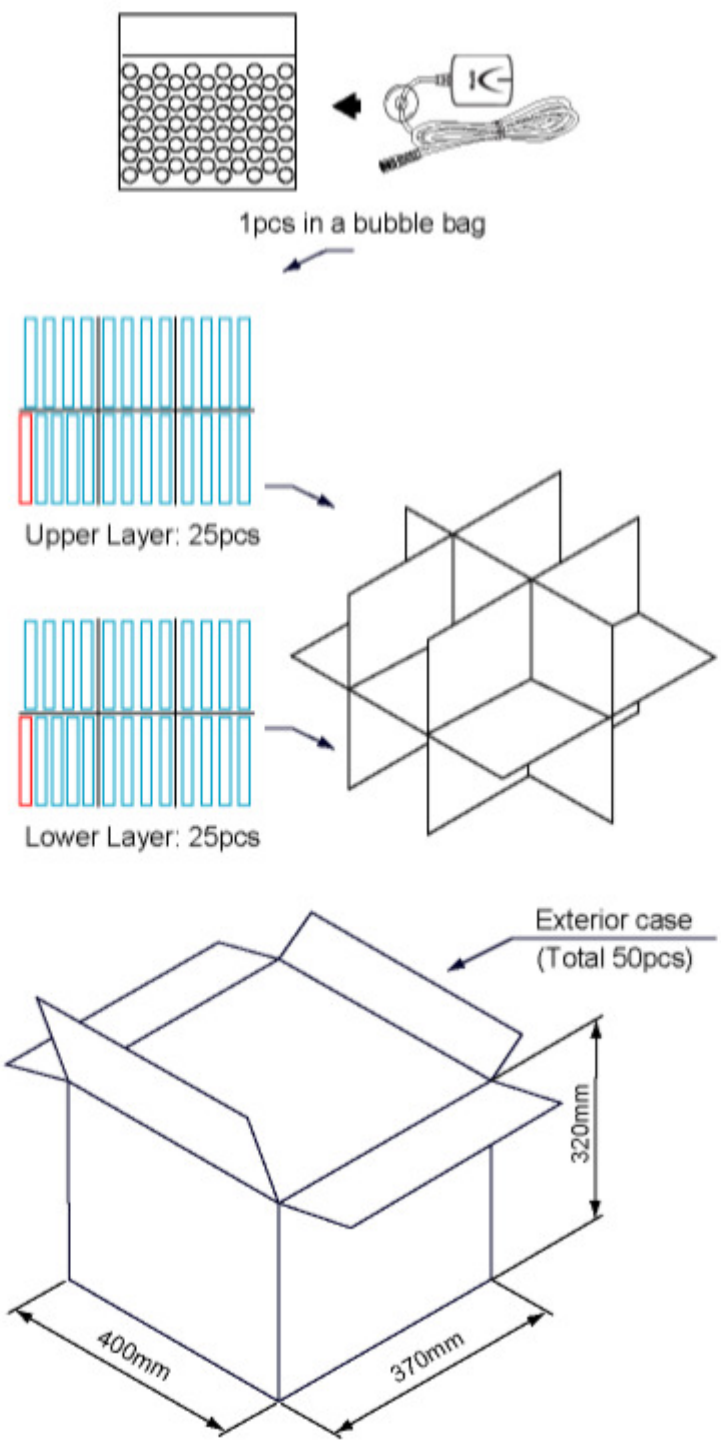
11 Packing information



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Document change list

Revision 0.1

- Draft release on October 23, 2019.

Revision 0.2 (Nov.05, 2019)

- Added the Dead Reckoning input/output messages in the section 10.2.

Revision 0.3 (Apr.29, 2020)

- Added “Note 1” in the section 4.

Revision 0.4 (Jul.30, 2020)

- Revised section 10.1 NMEA output message.

Revision 0.5 (Jan.21, 2021)

- Added “calibration step description” in the section 8.

Revision 0.6 (Feb.22, 2021)

- Added the output message of PINVMINR in section 4.
- Revised the note of GSV Satellite ID in section 10.1.
- Revised the description of $PINVMINR Calibration status in section 10.2.
- Revised the description of from “$PLSC,MEMS” to “PINVMIMU” in section 10.2.
- Added the description of $PINVCSTR DR recalibration (response) in section 10.2.
- Added the table of 10.2-5 $PLSC,SLOPE Data Format in section 10.2.
- Added the table of 10.2-7 $PLSC,ATTIT Data Format in section 10.2.
- Added the proprietary command sets in section 10.3.