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Product name	Description	Version
LS2302L	GPS mouse with data logger/SiRF3,9600BPS,3 meter,RJ11	1.1

Datasheet of LS2302L GPS mouse with data logger

1 Introduction

LS2302L is a GPS receiver (also known as GPS mouse) with 8-megabyte flash memory for GPS data logger. It can record up to 260,096 data points in a circular or FIFO format. At the same time, it also outputs real time GPS NMEA data for navigation. In addition, it is based on SiRF star3 high sensitivity solution that can provide you with superior sensitivity and performance even in urban canyon and dense foliage environment. Besides, waterproof and compact size makes it the best choice of vehicle navigation as well as passive tracking applications.

2 Features

- SiRF Star III high sensitivity solution
- Capable of SBAS (WAAS, EGNOS, MSAS)
- 8-megabyte flash memory for up to 260,096 data points
- Able to record data in a circular or FIFO format.
- Data can be password protected
- Unique electronic serial number
- 2-color LED indicator for GPS fix and data logging
- Built-in super capacitor to reserve system data for rapid satellite acquisition
- Magnet for mounting on the vehicle
- Skid resistant pad on the bottom
- Waterproof

3 Application

- Automotive navigation
- Marine navigation
- Passive tracking application

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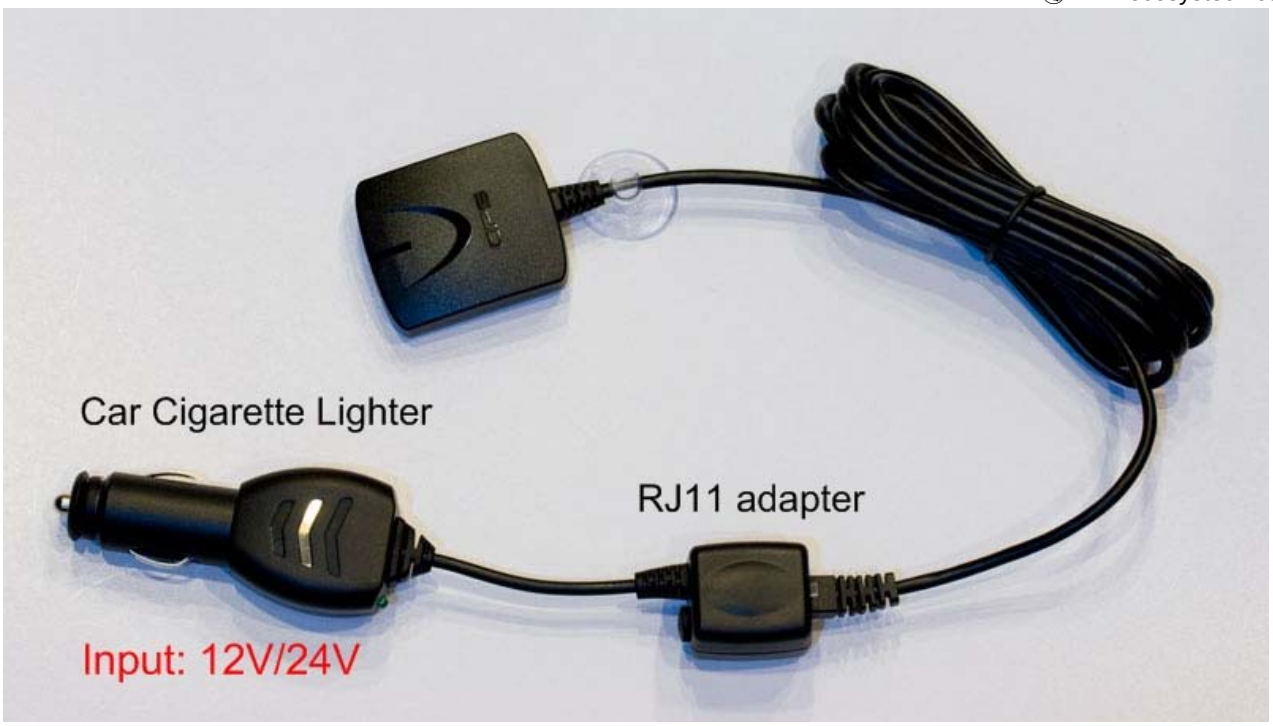

Fig 3-1. Use a car cigarette lighter to power LS2302L in the vehicle.

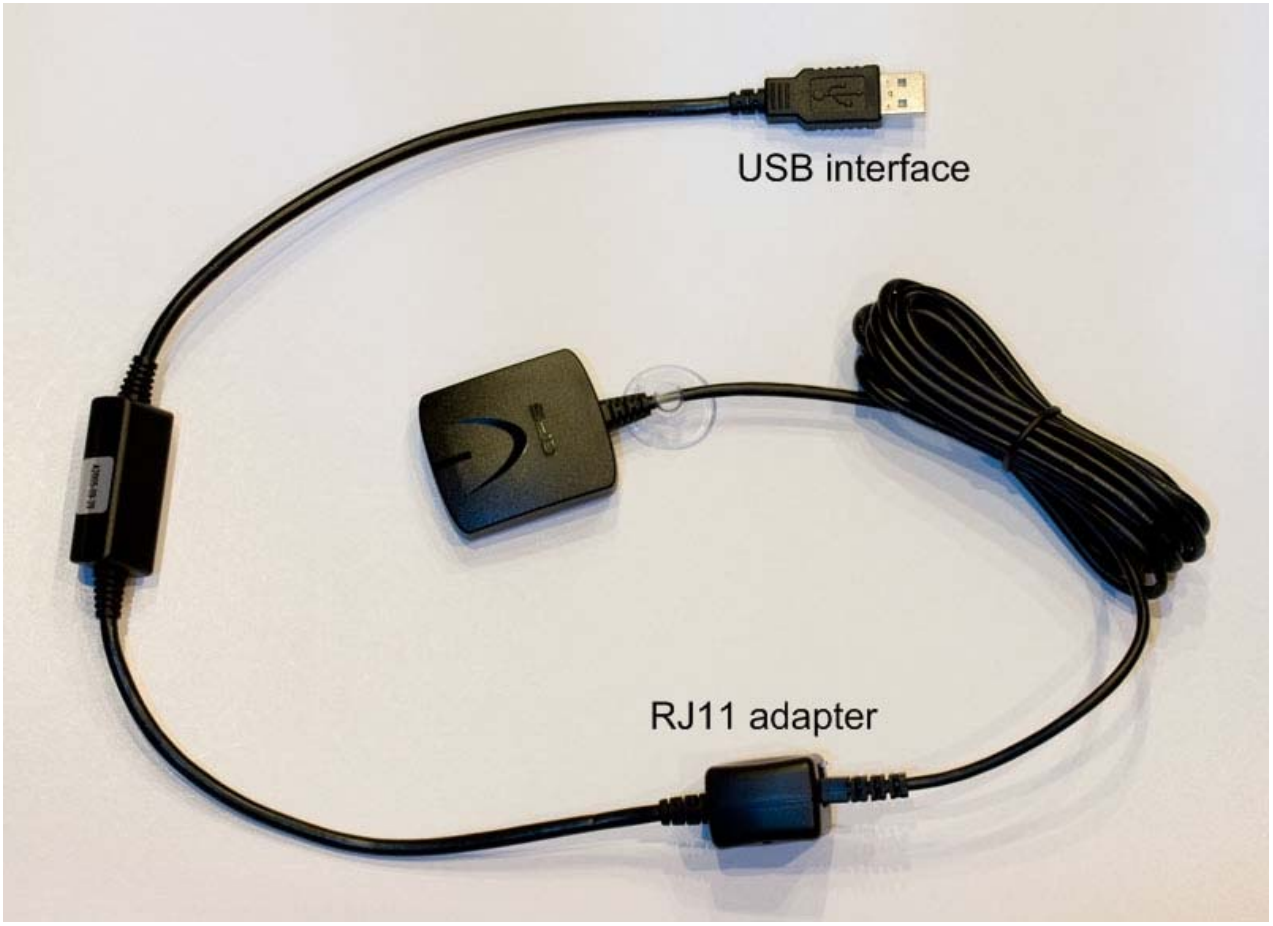

Fig 3-2. Use a USB-to-RS232 cable to download logged data of LS2302L to PC.

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4 GPS specification

GPS Chip	SiRF Star III GSC3f/LPx-7989	
Frequency	L1 1575.42MHz, C/A code	
Channels	Support 20 channels	
Update rate	1Hz	
Acquisition Time	Hot start (Open Sky)	< 2s
	Cold Start (Open Sky)	35s (typical)
Position Accuracy	Autonomous	< 10m (2D RMS)
	SBAS	< 5m (2D RMS)
Datum	WGS-84 (default)	
Max. Altitude	< 60,000 ft	
Max. Velocity	< 1,000 knots	
Protocol Support	NMEA 0183 ver 3.0	9600 bps(1), 8 data bits, no parity, 1 stop bits (default) 1Hz (2): GGA, GLL, GSA, GSV, RMC, VTG

Note 1: Both baud rate and output message rate are configurable.

Note 2: When a new point was logged, the receiver will output a message to notify the host. Please see section 5.3.

Table 4.1 Navigation Parameters

Track smooth mode	Disabled
Static navigation mode	Enabled

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,,0000*64

Table5- 2 GGA Data Format

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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	mters	
Units	M	mters	
Geoid Separation	15.2	mters	
Units	M	mters	
Age of Diff. Corr.		second	Null fields when DGPS is not used
Diff. Ref. Station ID	0000		
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
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

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UTC Time	053740.000		hhmmss.sss
Status	A		A=data valid or V=data not valid
Mode	A		A=autonomous, D=DGPS, E=DR
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		
<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

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$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 32)
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

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

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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
Checksum	*38		
<CR> <LF>			End of message termination

5.2 SiRF proprietary NMEA input message

Table 5.2-1 Message Parameters

Start Sequence	Payload	Checksum	End Sequence
$PSRF<MID>[1]	Data[2]	*CKSUM[3]	<CR><LF>[4]

1. Message Identifier consisting of three numeric characters. Input messages begin at MID 100.
2. Message specific data. Refer to a specific message section for <data>…<data> definition.
3. CKSUM is a two-hex character checksum as defined in the NMEA specification, *NMEA-0183Standard For Interfacing Marine Electronic Devices.* Use of checksums is required on all input messages.
4. Each message is terminated using Carriage Return (CR) Line Feed (LF) which is \r\n which is hex 0D0A. Because \r\n are not printable ASCII characters, they are omitted from the example strings, but must be sent to terminate the message and cause the receiver to process that input message.

Note: All fields in all proprietary NMEA messages are required, none are optional. All NMEA messages are comma delimited.

Table 5.2-2 Proprietary NMEA input messages

Message	MID[1]	Description

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SetSerialPort	100	Set PORT A parameters and protocol
NavigationInitialization	101	Parameters required for start using X/Y/Z[2]
SetDGPSPort	102	Set PORT B parameters for DGPS input
Query/Rate Control	103	Query standard NMEA message and/or set output rate
LLANavigationInitialization	104	Parameters required for start using Lat/Lon/Alt[3]
Development Data On/Off	105	Development Data messages On/Off
Select Datum	106	Selection of datum to be used for coordinate transformations

1. Message Identification (MID).
2. Input coordinates must be WGS84.
3. Input coordinates must be WGS84

● 100---SetSerialPort

This command message is used to set the protocol (SiRF binary or NMEA) and/or the communication parameters (Baud, data bits, stop bits, and parity). Generally, this command is used to switch the module back to SiRF binary protocol mode where a more extensive command message set is available. When a valid message is received, the parameters are stored in battery-backed SRAM and the Evaluation Receiver restarts using the saved parameters.

Table 5.2-3 contains the input values for the following example:

Switch to SiRF binary protocol at 9600,8,N,1

$PSRF100,0,9600,8,1,0*0C

Table 5.2-3 Set Serial Port Data Format

Name	**Example**	**Units**	**Description**
Message ID	$PSRF100		PSRF100 protocol header
Protocol	0		0=SiRF binary, 1=NMEA
Baud	9600		4800,9600,19200,38400,57600
DataBits	8		8,7[1]
StopBits	1		0,1
Parity	0		0=None, 1=Odd, 2=Even
Checksum	*0C		
<CR><LF>			End of message termination

1. SiRF protocol is only valid for 8 data bits, 1 stop bit, and no parity.

● 101---NavigationInitialization

This command is used to initialize the Evaluation Receiver by providing current position (in X, Y, Z coordinates), clock offset, and time. This enables the Evaluation Receiver to search for the correct satellite signals at the correct signal parameters. Correct initialization parameters enable the Evaluation Receiver to acquire signals quickly.

Table 5.2-4 contains the input values for the following example:

Start using known position and time

$PSRF101,-2686700,-4304200,3851624,96000,497260,921,12,3*1C

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Table 5.2-4 Navigation Initialization Data Format

Name	**Example**	**Units**	**Description**
Message ID	$PSRF101		PSRF101 protocol header
ECEF X	-2686700	meters	X coordinate position
ECEF Y	-4304200	meters	Y coordinate position
ECEF Z	3851624	meters	Z coordinate position
ClkOffset	96000	Hz	Clock Offset of the Evaluation Receiver[1]
TimeOfWeek	497260	seconds	GPS Time Of Week
WeekNo	921		GPS Week Number
ChannelCount	12		Range 1 to 12
ResetCfg	3		See Table 5.2-5
Checksum	*1C		
<CR><LF>			End of message termination

1. Use 0 for last saved value if available. If this is unavailable, a default value of 96000 is used.

Table 5.2-5 Reset Configuration

Hex	Description
0x01	Hot Start – All data valid
0x02	Warm Start – Ephemeris cleared
0x03	Warm Start (with Init) – Ephemeris cleared, initialization data loaded
0x04	Cold Start – Clears all data in memory
0x08	Clear Memory – Clears all data in memory and resets the receiver back to factory defaults

● 102---SetDGPSPort

This command is used to control the serial port used to receive RTCM differential corrections. Differential receivers may output corrections using different communication parameters. If a DGPS receiver is used that has different communication parameters, use this command to allow the receiver to correctly decode the data. When a valid message is received, the parameters are stored in battery-backed SRAM and the receiver restarts using the saved parameters. Table 5.2-6 contains the input values for the following example:

Set DGPS Port to be 9600,8,N,1.

$PSRF102,9600,8,1,0*12

Table 5.2-6 Set GPS Port Data Format

Name	**Example**	**Units**	**Description**
Message ID	$PSRF102		PSRF102 protocol header
Baud	9600		4800,9600,19200,38400
DataBits	8		8,7
StopBits	1		0,1

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Parity	0		0=None, 1=Odd, 2=Even
Checksum	*12		
<CR><LF>			End of message termination

Note: RTCM is not supported.

● 103---Query/Rate Control

This command is used to control the output of standard NMEA messages GGA, GLL, GSA, GSV, RMC, and VTG. Using this command message, standard NMEA messages may be polled once, or setup for periodic output. Checksums may also be enabled or disabled depending on the needs of the receiving program. NMEA message settings are saved in battery-backed memory for each entry when the message is accepted.

Table 5.2-7 contains the input values for the following example:

1. Query the GGA message with checksum enabled

   $PSRF103,00,01,00,01*25

2. Enable VTG message for a 1 Hz constant output with checksum enabled

   $PSRF103,05,00,01,01*20

3. Disable VTG message

   $PSRF103,05,00,00,01*21

Table 5.2-7 Query/Rate Control Data Format (See example 1)

Name	**Example**	**Units**	**Description**
Message ID	$PSRF103		PSRF103 protocol header
Msg	00		See Table 5.2-8
Mode	01		0=SetRate, 1=Query
Rate	00	seconds	Output – off=0, max=255
CksumEnable	01		0=Disable Checksum, 1=Enable Checksum
Checksum	*25		
<CR><LF>			End of message termination

Table 5.2-8 Messages

Value	**Description**
0	GGA
1	GLL
2	GSA
3	GSV
4	RMC
5	VTG
6	MSS (If internal beacon is supported)

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7	Not defined
8	ZDA (if 1PPS output is supported)
9	Not defined

- **104---LLANavigationInitialization**

This command is used to initialize the Evaluation Receiver by providing current position (in latitude, longitude, and altitude coordinates), clock offset, and time. This enables the receiver to search for the correct satellite signals at the correct signal parameters. Correct initialization parameters enable the receiver to acquire signals quickly.

Table 5.2-9 contains the input values for the following example:

Start using known position and time.

$PSRF104,37.3875111,-121.97232,0,96000,237759,1946,12,1*07

Table 5.2-9 LLA Navigation Initialization Data Format

Name	Example	Units	Description
Message ID	$PSRF104		PSRF104 protocol header
Lat	37.3875111	degrees	Latitude position (Range 90 to –90)
Lon	-121.97232	degrees	Longitude position (Range 180 to –180)
Alt	0	meters	Altitude position
ClkOffset	96000	Hz	Clock Offset of the Evaluation Receiver[1]
TimeOfWeek	237759	seconds	GPS Time Of Week
WeekNo	1946		Extended GPS Week Number (1024 added)
ChannelCount	12		Range 1 to 12
ResetCfg	1		See Table 5.2-10
Checksum	*07		
<CR><LF>			End of message termination

1. Use 0 for last saved value if available. If this is unavailable, a default value of 96000 is used.

Table 5.2-10 Messages

Hex	Description
0x01	Hot Start – All data valid
0x02	Warm Start – Ephemeris cleared
0x03	Warm Start (with Init) – Ephemeris cleared, initialization data loaded
0x04	Cold Start – Clears all data in memory
0x08	Clear Memory – Clears all data in memory and resets receiver back to factory defaults

- **105---Development Data On/Off**

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Use this command to enable development data information if you are having trouble getting commands accepted. Invalid commands generate debug information that enables you to determine the source of the command rejection. Common reasons for input command rejection are invalid checksum or parameter out of specified range.

Table 5.2-11 contains the input values for the following example:

1. Debug On

   $PSRF105,1*3E

2. Debug Off

   $PSRF105,0*3F

Table 5.2-11 Development Data On/Off Data Format

Name	**Example**	**Units**	**Description**
Message ID	$PSRF105		PSRF105 protocol header
Debug	1		0=Off, 1=On
Checksum	*3E		
<CR><LF>			End of message termination

● 106---Select Datum

$PSGPS receivers perform initial position and velocity calculations using an earth-centered earth-fixed (ECEF) coordinate system. Results may be converted to an earth model (geoid) defined by the selected datum. The default datum is WGS 84 (World Geodetic System 1984) which provides a worldwide common grid system that may be translated into local coordinate systems or map datums. (Local map datums are a best fit to the local shape of the earth and not valid worldwide.)

Table 5.2-12 contains the input values for the following example:

Datum select TOKYO_MEAN

$PSRF106,178*32

Table 5.2-12 Development Data On/Off Data Format

Name	**Example**	**Units**	**Description**
Message ID	$PSRF106		PSRF106 protocol header
Datum	178		21=WGS84 178=TOKYO_MEAN 179=TOKYO_JAPAN 180=TOKYO_KOREA 181=TOKYO_OKINAWA
Checksum	*32		
<CR><LF>			End of message termination

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5.3 Output message $PLSR,239

The receiver will automatically output a message when a new point was logged.

Table 5.3 contains the values for the following example:

$PLSR,239,1,900000107,0,0,0,0,1,100,9600,24704,36289,248864,000ah,0012b820h*05

Name	**Example**	**Description**	**Remark**
MID	239	Message ID	
Valid	1	1: command valid 0: command invalid	Always 1
SNO	900000107	Device serial number. 000000000..999999999	
Log Mode	0	0: log on fix with time interval 1: log on fix with distance interval	
Cyclic Mode	0	Current cyclic mode 0: stop logging when memory full 1: cyclic mode, will overwrite oldest record when memory full.	
Minimum Speed	0	Current threshold speed for logging data. 0..255KMH	
Tag Time	0	Current tag time. 0: disabled 0..255 seconds	
Time Interval	1	Current time interval. 1..65535 seconds	
Distance Interval	100	Current distance interval. 1..65535 meters	
Baud Rate	9600	NMEA output baud rate after device power on. 4800,9600,19200,38400,57600,115200	
Point Count #1	24704	Points logged since power on. 0..1000000	
Point Count #2	36289	Total points logged. 0..1000000	
Reserved	248864		
Reserved	000ah		
Reserved	0012b820h		
Checksum	05		
<CR><LF>			

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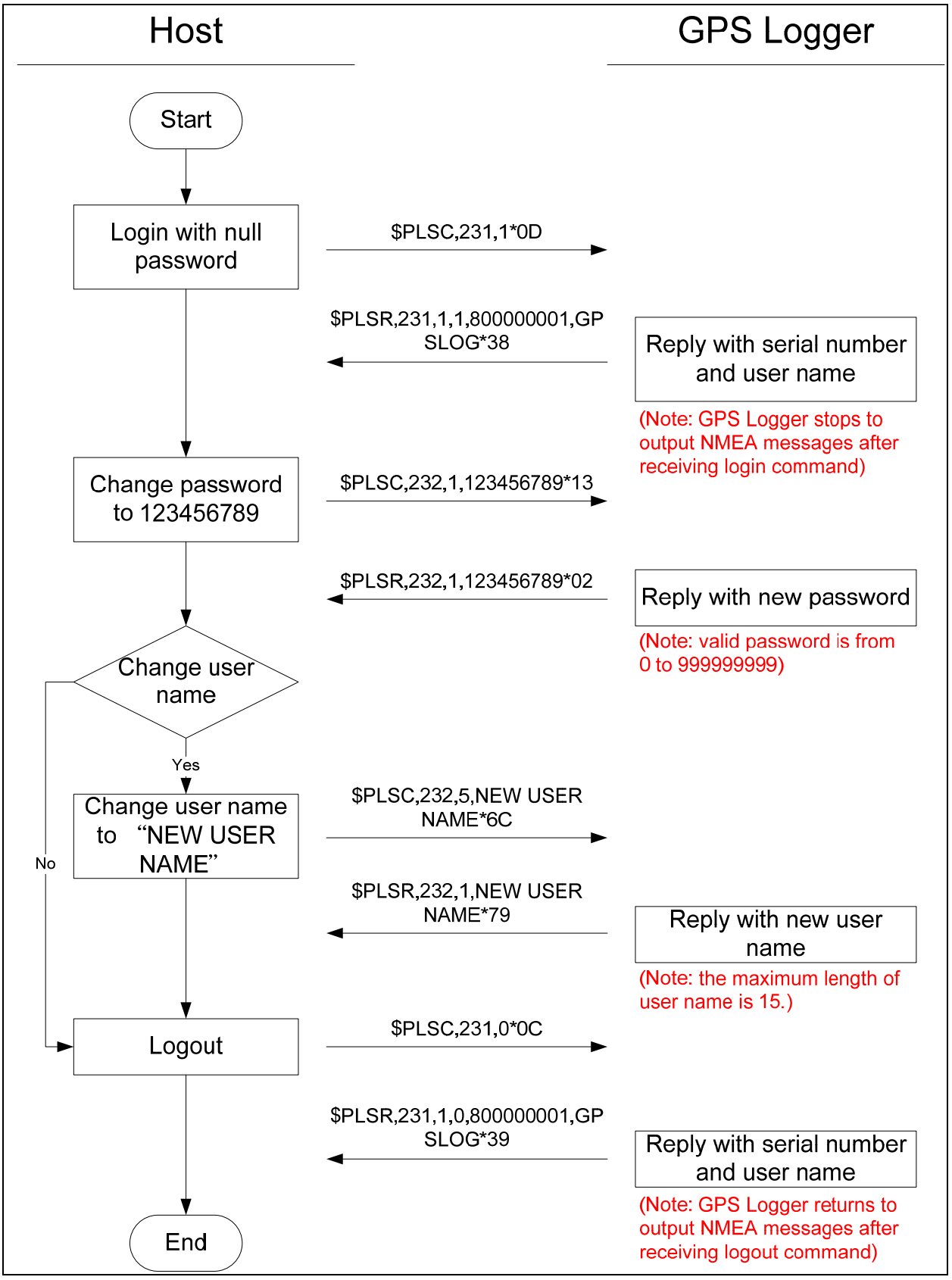
5.4 How to set password

The GPS logger/receiver is default not password protected. Users can enable and set new password protection by the following method.



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5.5 How to change configuration

There are some configurations that user can set, such as log mode, log interval, speed threshold, etc. All configurations can be changed by using one software command. Then they are saved into the flash memory. The default configuration is as below.

Table 5.4 Default configuration

	Value	Description	Default
Log Mode	0..1	0:log on fix with time interval 1:log on fix with distance interval	0
Time Interval	1..65535 seconds		1
Distance Interval	1..65535 meters	The highest log rate is still limited to 1HZ no matter what distance interval is set.	32
Cyclic Mode	0..1	0: stop logging when memory full 1: cyclic mode, will overwrite oldest record when memory full (circular or FIFO format)	1
Minimum Speed	0..255KMH 0:disabled	Threshold speed for logging data	0
Tag Time	0..255 seconds 0:disabled	When enabled, the device will log data within Tag Time no matter position fix available or not	0
Baud Rate	4800,9600,19200, 38400,57600,115200	NMEA output baud rate after device power on. This value will overwrite the baud rate selected in command PLSC205.	9600

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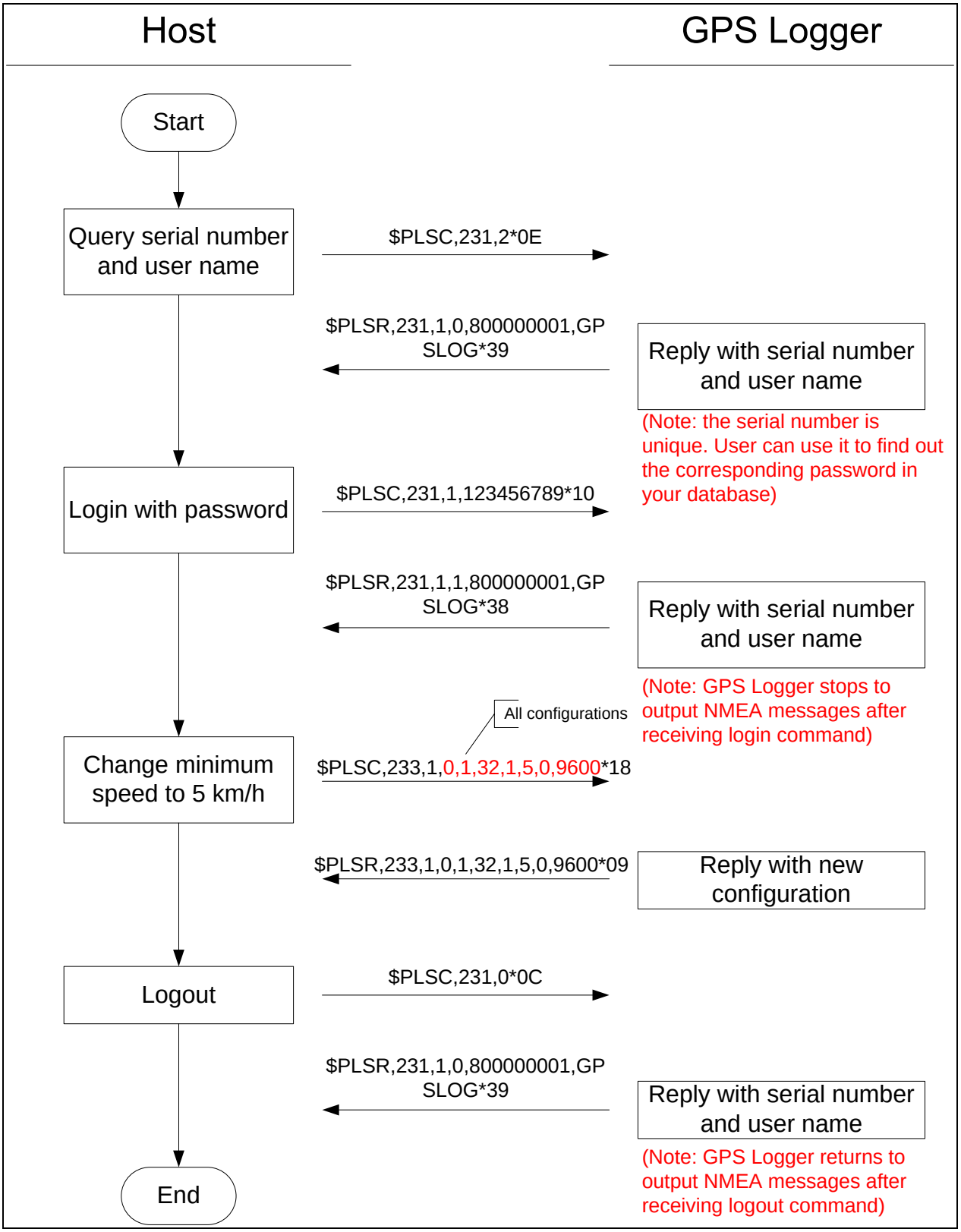
The following flow chart is an example to set minimum speed to 5 km/h.



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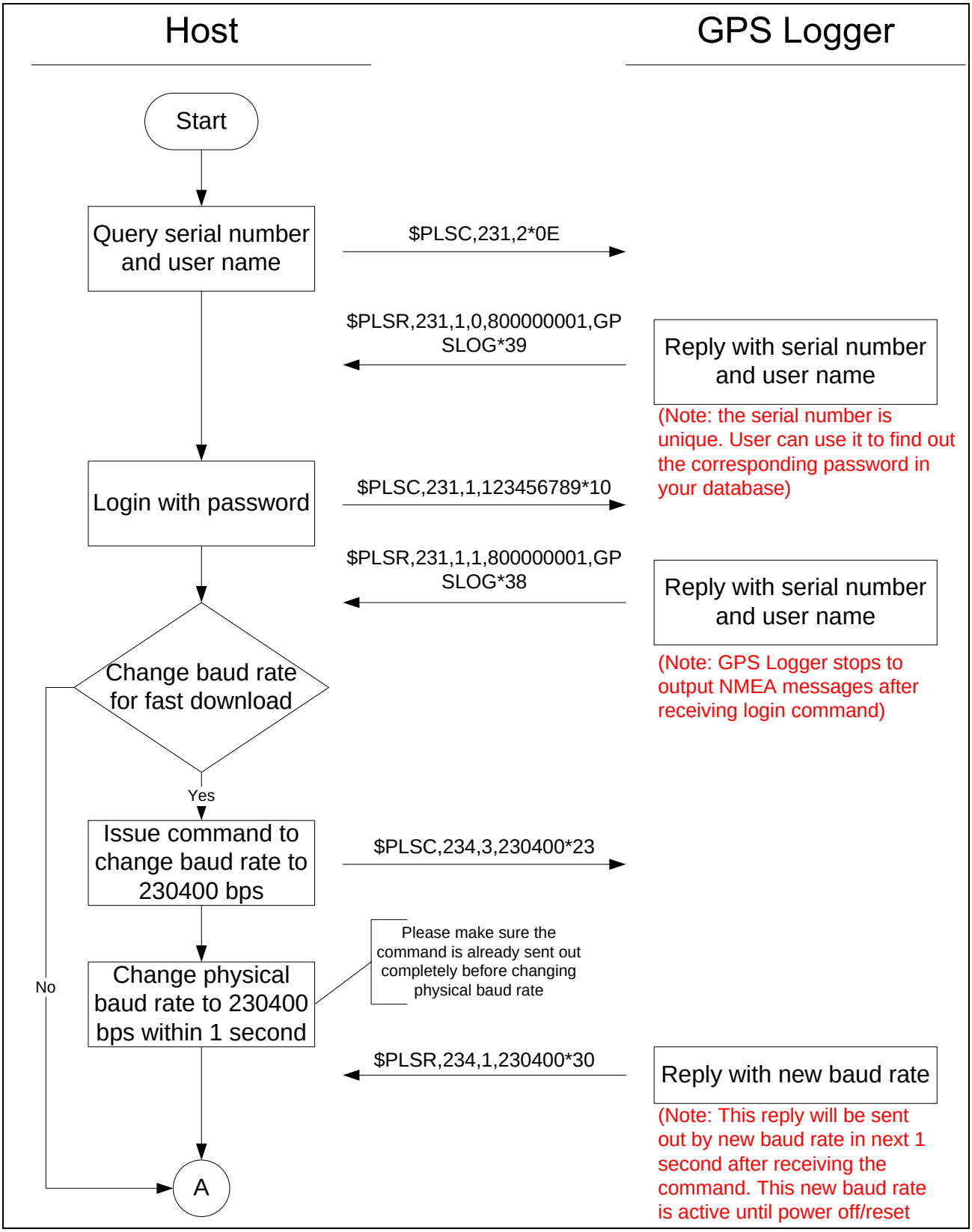
5.6 How to download data

The following flow chart is an example to download whole logged records in binary SBP format. Please refer to the document of "GPS logger protocol" for detailed SBP format.



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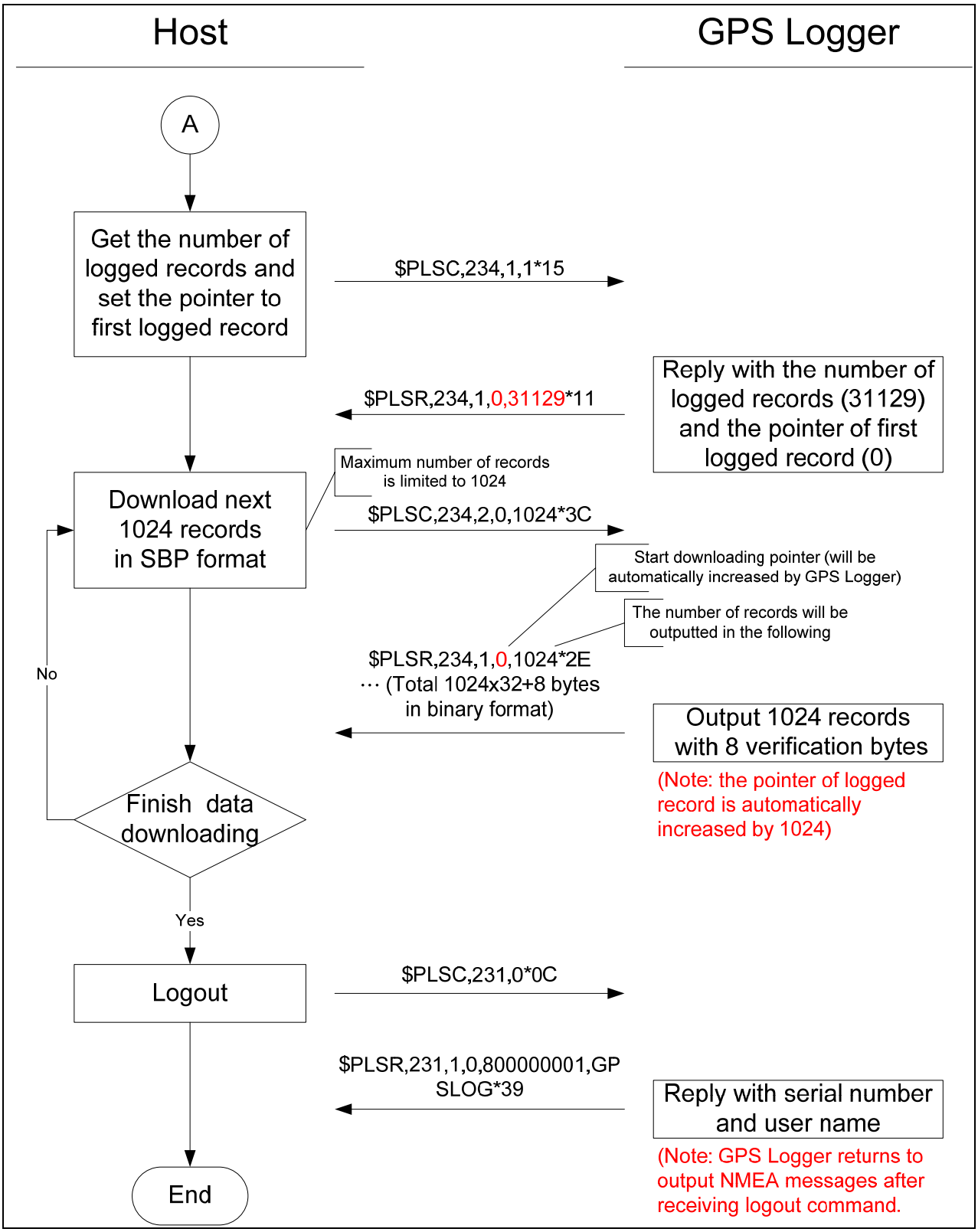

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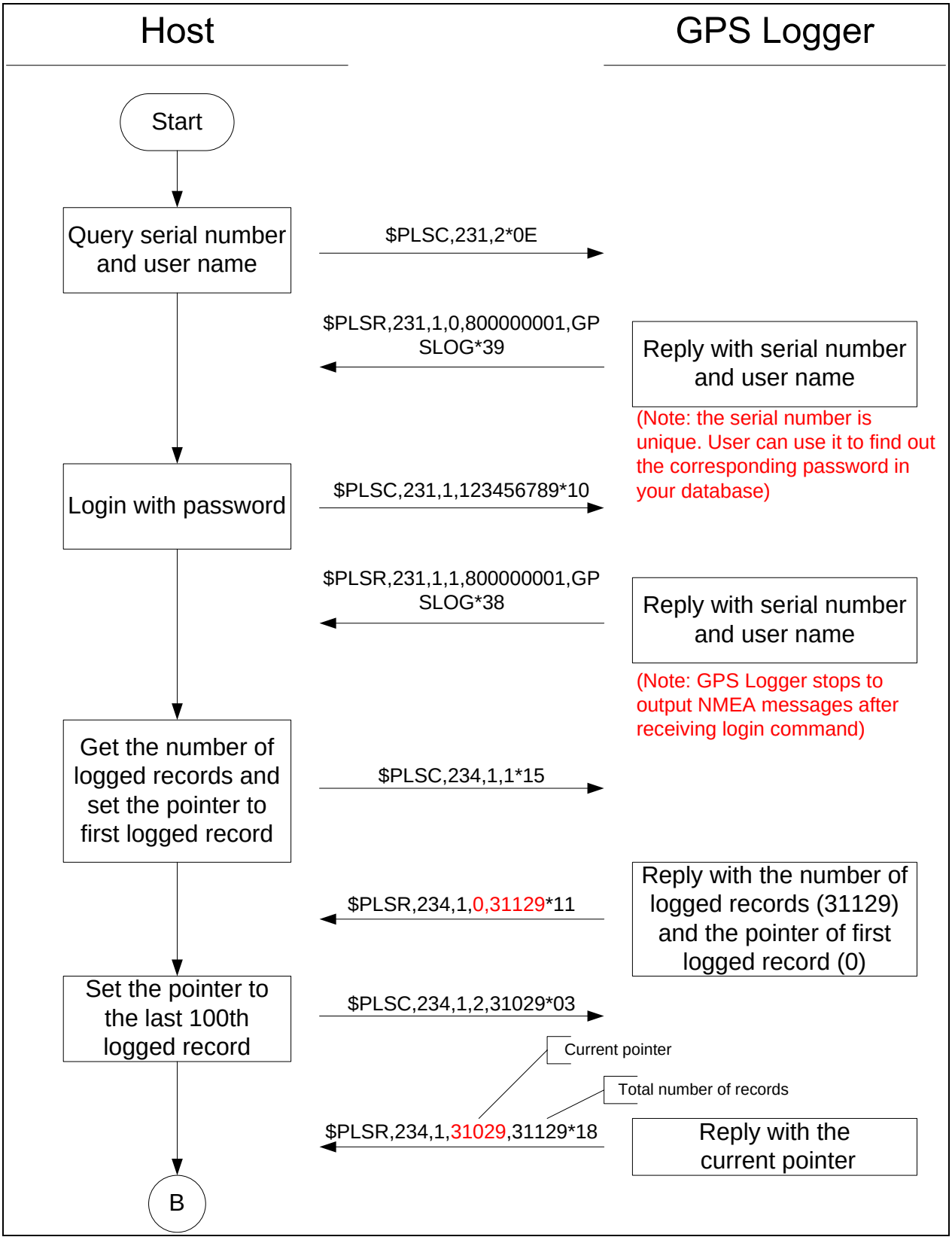
The following flow chart is an example to download the last 100 logged records in NMEA $GPRMC format.



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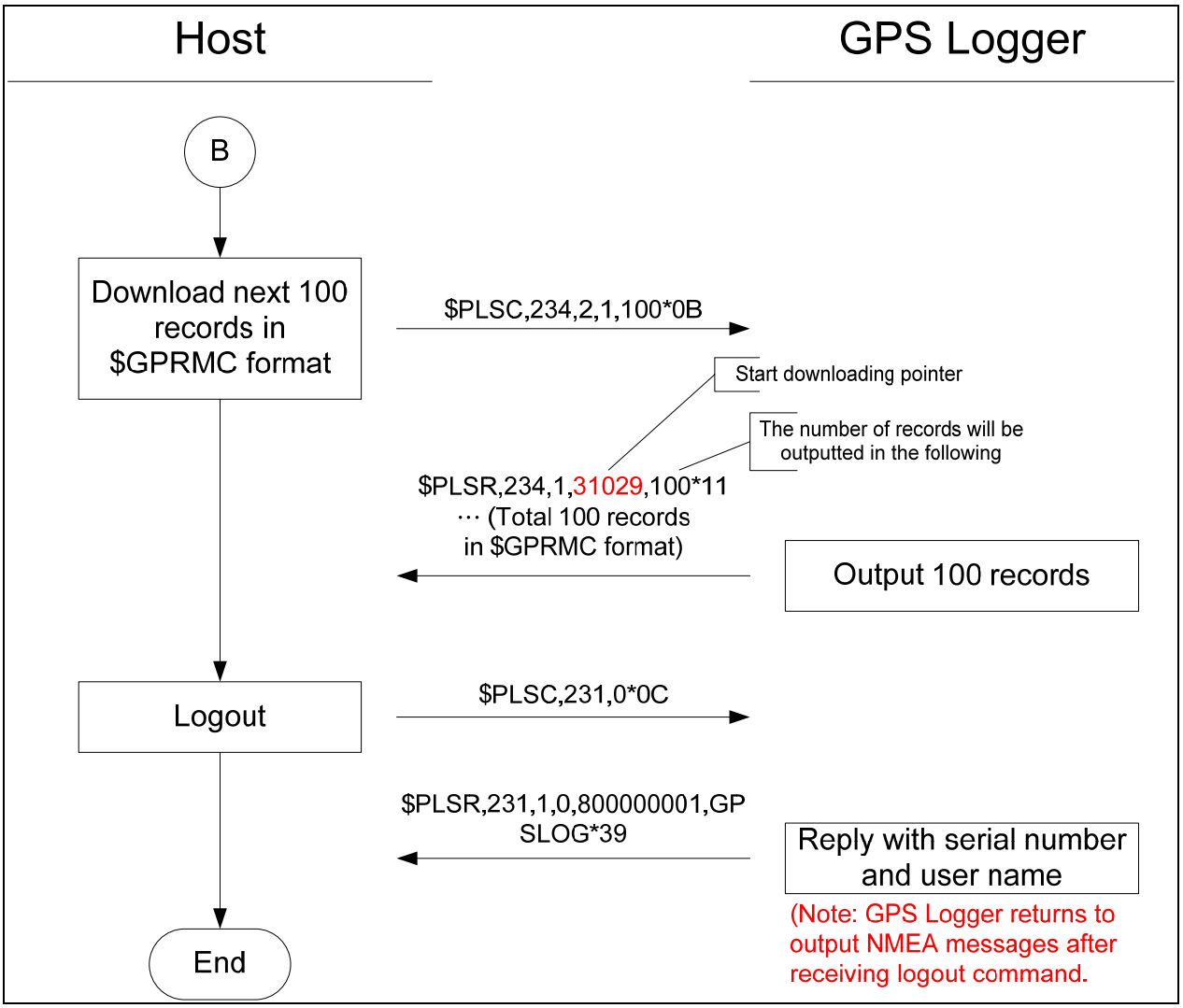

6 LED indicator

There is a 2-color LED indicator. One is red and another is green. The red LED is an indication of GPS positioning status. In continuous power mode, it flashes once per second when position is fixed. Otherwise it flashes fast. The green LED flashes only when data is logging into flash memory. Once the flash memory is full, the green LED is always on.

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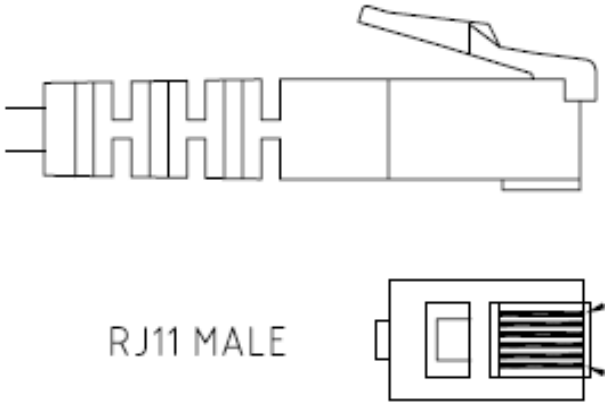
7 Pin assignment and descriptions

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

Note: Pin assignment is the same with LOCOSYS's models, **LS23026, LS23036** and **LS23066**.



8 DC & Temperature characteristics

8.1 Power consumption (continuous mode)

Parameter	Symbol	Min.	Typ.	Max.	Units
Input voltage	VCC	4	5	5.5	V
Input current	Icc		30(1)	80	mA

1. Measured when position fix is available and input voltage is 5V.

8.2 Temperature characteristics

Parameter	Symbol	Min.	Typ.	Max.	Units
Operating Temperature	Topr	-30	-	85	℃
Storage Temperature	Tstg	-40	25	85	℃

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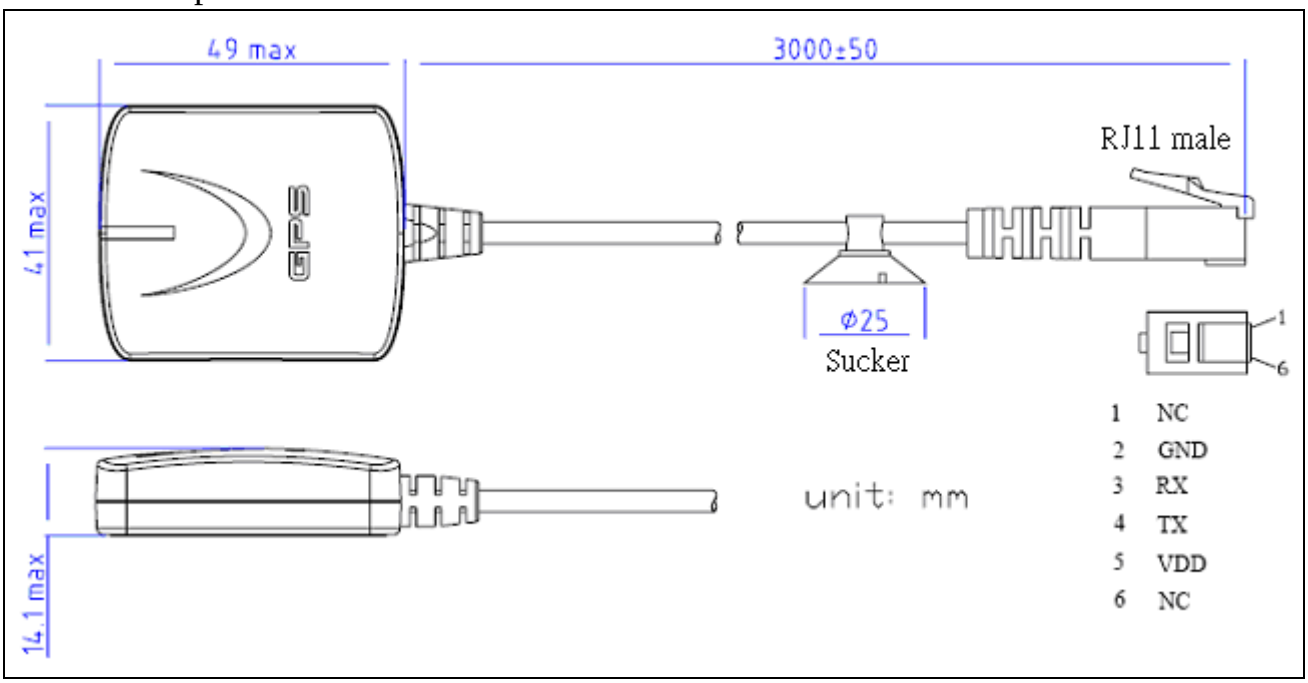
9 Mechanical specification



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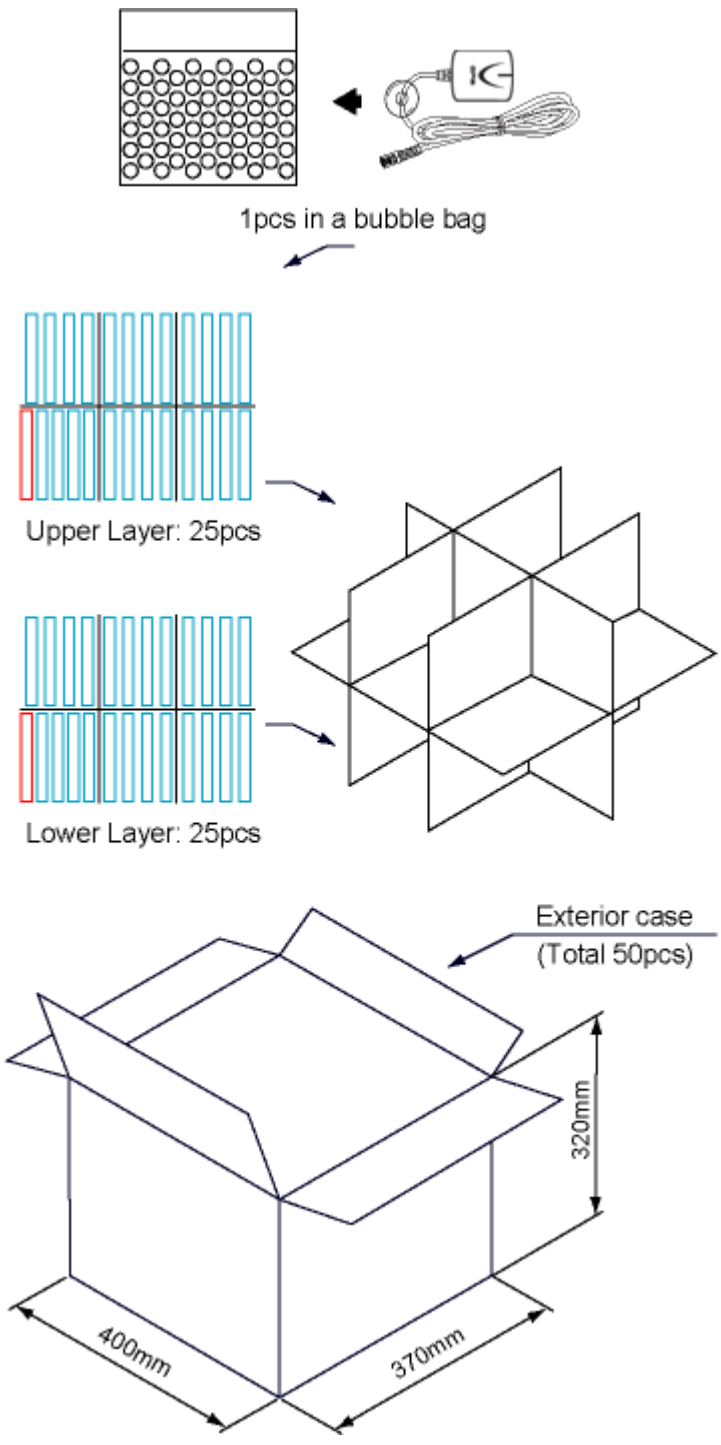
10 Packing information



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Document change list

Revision 1.0

- First release on Aug. 6, 2008.

Revision 1.1 (Sep. 9, 2008)

- Changed “built-in micro battery” to “built-in super capacitor” on page 1.
- Cancel supported baud rate for 1200, 2400 on page 13 and 15.