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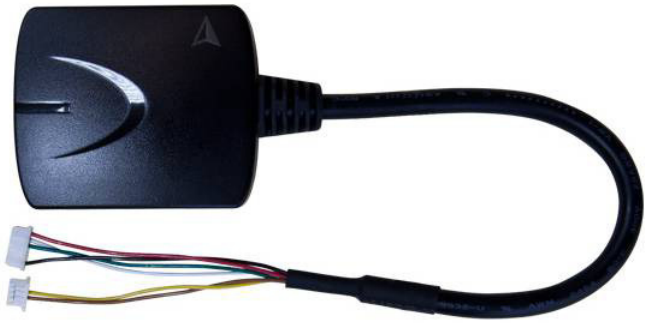
Product name	Description	Version
LS2313I(R)-G	GNSS mouse/ MT3333/22.5cm,TTL,38400BPS	1.0

GNSS integrated magnetic sensor mouse



1 Introduction

An LS2313I(R)-G product is complete GPS, GLONASS and built-in magnetic sensor for use in automotive, unmanned aerial vehicle and fleet vehicle. The GNSS receiver will track up to 33 satellites at a time while providing fast Time-To-First-Fix, one-second navigation updates and low power consumption. Besides, it builds in a saw filter and an embedded 12 multi-tone active interference canceller for anti-jamming. It can provide you with superior drone flight experience. The product makes drone possible some incredible capabilities as: Self-Leveling, Altitude Hold, Return Home, Waypoint Navigation, Fail Safe Returning Home, Cycling mode and Loiter Mode

2 Features

- MediaTek high sensitivity solution
- Support GPS, GLONASS and QZSS
- Capable of SBAS (WAAS, EGNOS, MSAS, GAGAN)
- Support 99-channel GNSS
- 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
- Up to 10 Hz update rate
- Support part of ubx protocol
- Outdoor multi-path detection and compensation
- Fix indicator LED
- Power indicator LED
- Build-in gold capacitor to reserve system data for rapid satellite acquisition.
- Build-in magnetic sensor Honeywell HMC5883L.
- Two option cables; Five-position cable for APM or six-position cable for Pixhawk.

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3 Application

- Drone, Quadcopter application
- Robotic, Rover, or Boat navigation, model aircraft navigation
- Unmanned aerial vehicle
- Surveying and mapping

4 GNSS specifications

Chip	MediaTek MT3333	
Frequency	GPS, GALILEO, 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	5Hz default, up to 10Hz	
Acquisition Time	Hot start (Open Sky)	1s (typical)
	Cold Start (Open Sky)	34s (typical)
Position Accuracy	Autonomous	2.5m CEP
	SBAS	2.5m (depends on accuracy of correction data)
Datum	WGS-84 (default)	
Max. Altitude	< 18,000 m (for NMEA 0183 Protocol), up to 50,000m by request	
	< 10,000 m (for Ubx binary Protocol)	
Max. Velocity	< 515 m/s	
Protocol Support	NMEA 0183 ver 4.0	38400 bps, 8 data bits, no parity, 1 stop bits (default) 1Hz: GGA,GLL, GSA, RMC, VTG, GSV
	Ubx binary Ver 14	38400 bps, 8 data bits, no parity, 1 stop bits 5Hz: NAV-POSLLH, NAV-SOL, NAV-STATUS, NAV-VELNED, and MON-HW

5 Magnetic sensor specifications

Magnetic Sensor	Honeywell HMC5883L
Measuring magnetic field range	-8 ~ +8 Gauss
Sensitivity	230 ~ 1370 LSB/gauss
Heading accuracy	2 degrees
Output rate	0.75~75 Hz (Continuous Measurement Mode) 160Hz max. (Single Measurement Mode)
Measurement Period	6 ms (From receiving command to data ready)
Turn-on Time	200uS (Ready for I2C commands) 50 ms (Analog Circuit Ready for Measurement)
I2C mode	Slave
I2C bus data rate (controlled by I2C master)	100kbps or 400kbps

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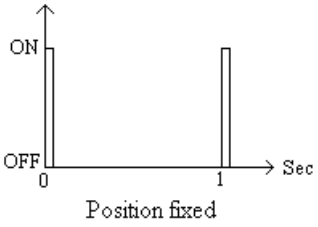
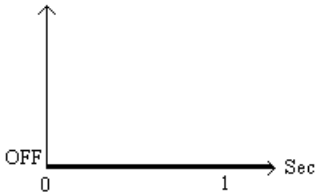
I2C bus bit format	An 8-bit data/address and a 1-bit acknowledge bit.
I2C bus address	0x3D for 8-bits read (default) 0x3C for 8-bits write. (default) 0x1E for 7-bits address

6 LED indicator

The green 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.



Position fixed

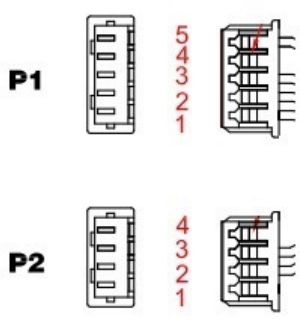


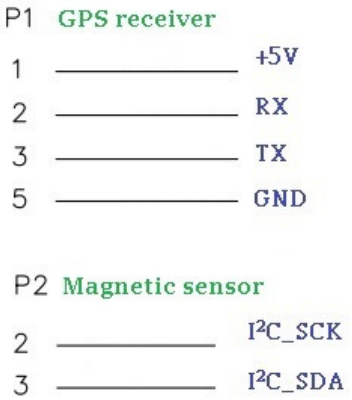
Position not fixed

7 Pin assignment and descriptions

- GNSS receiver (for APM 2.6 above & PX4)

Pin#	Name	Type	Description
1	VCC	P	+5V power input
2	RX	I	Data input (3.3V_TTL)
3	TX	O	Data ouput (3.3V_TTL)
4	N.C		No connection
5	GND	P	Ground





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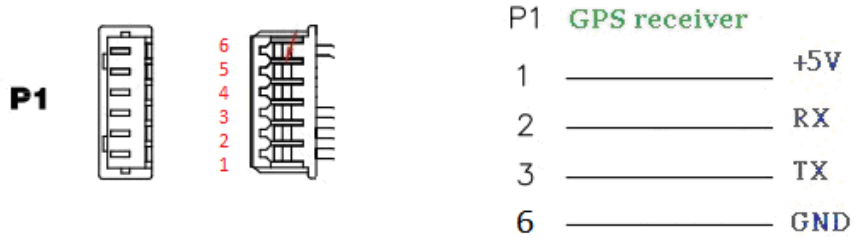
- GNSS receiver (for Pixhawk only)

Pin#	Name	Type	Description
1	VCC	P	+5V power input
2	RX	I	Data input (3.3V_TTL)
3	TX	O	Data ouput (3.3V_TTL)
4	N.C		No connection
5	N.C		No connection
6	GND	P	Ground



- Magnetic sensor (for APM, PX4, and Pixhawk)

Pin#	Name	Type	Description
1	N.C		No connection
2	SCK	I	I^2C Serial clock (3.3V)
3	SDA	I/O	I^2C Serial data (3.3V)
4	N.C		No connection

8 DC & Temperature characteristics

8.1 Power consumption (continuous mode)

Parameter	Symbol	Min.	Typ.	Max.	Units
Input voltage	VCC	3.8	5.0	5.5	V
Input current	Icc		29		mA

8.2 Temperature characteristics

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

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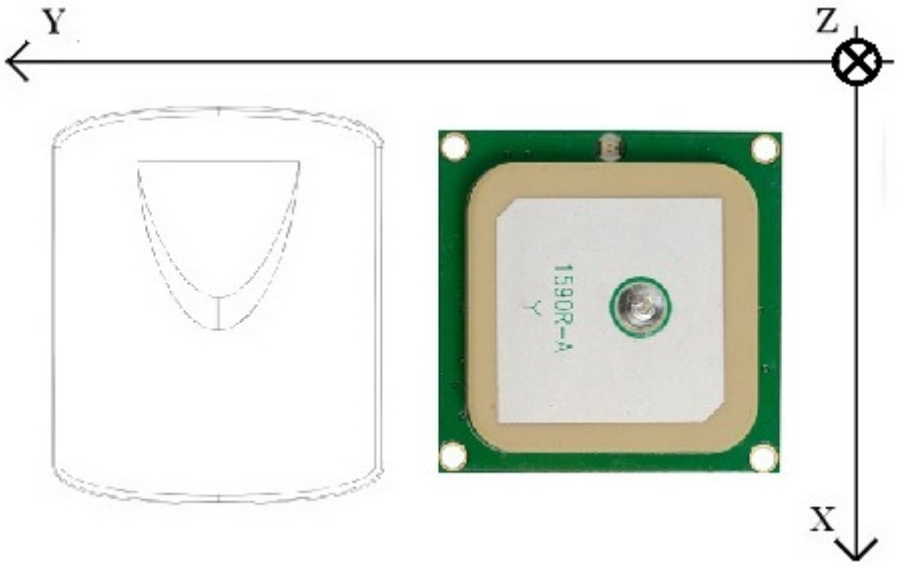
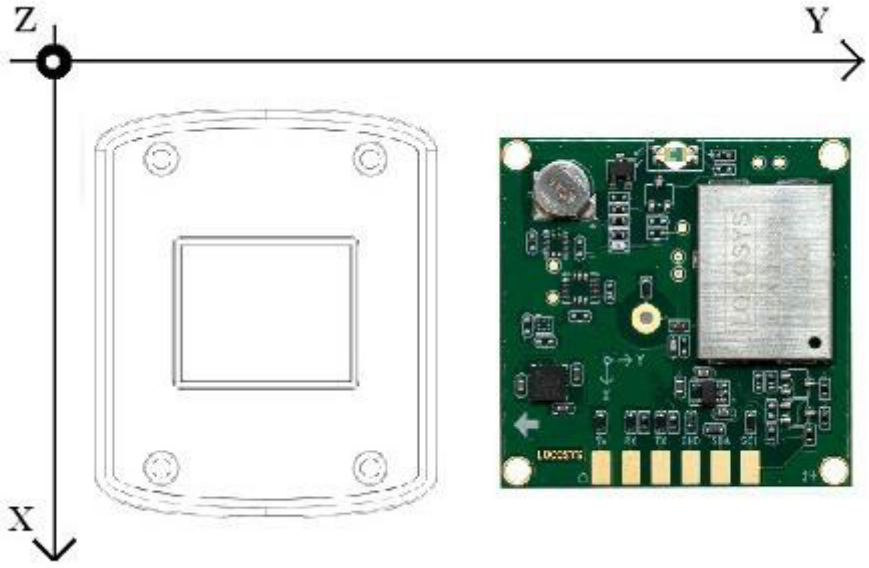
9 The receiver mounting orientation



Top View



Bottom View

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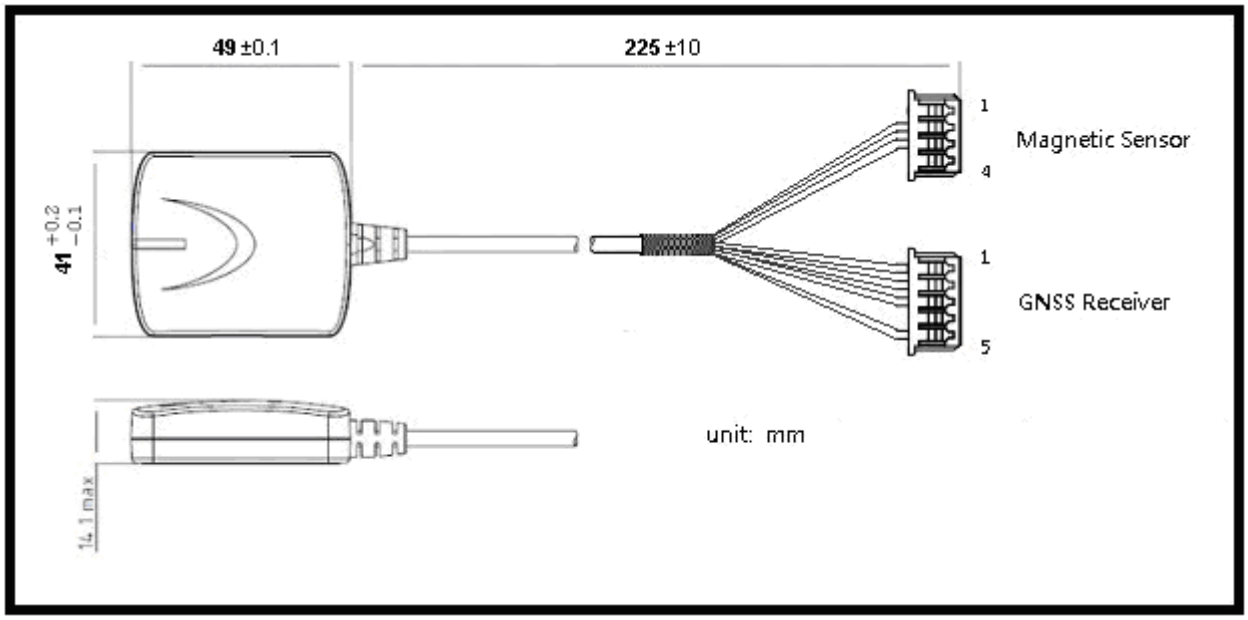
10 Mechanical specification

- LS2313I(R)-G (TTL interface for GNSS receiver and I^2C for magnetic sensor)



Retained 5-circuits and 4-circuits connector are suitable for 3DR APM and PX4 compatible autopilot system's GNSS and external compass.

Note: These connectors are Molex 1.25mm Pitch PicoBlade™ female connector.

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11 Software interface

11.1 NMEA output message

Table 11.1-1 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

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

Table 11.1-2 contains the values for the following example:

$GNGGA,053740.000,2503.6319,N,12136.0099,E,1,08,1.1,63.8,M,15.2,M,,*7A

Table 11.1- 2 GGA Data Format

Name	Example	Units	Description
Message ID	$GNGGA		GGA protocol header, GN for GPS+GLONASS, GP for GPS only, GL for GLONASS only
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 11.1-3
Satellites Used	08		Range 0 to 33
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.	0000	second	Null fields when DGPS is not used
Diff. Ref. Station ID	0000		
Checksum	*7A		
<CR> <LF>			End of message termination

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Table 11.1-3 Position Fix Indicators

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

Note 1: Differential GPS contains RTCM or SBAS.

● GLL--- Geographic Position – Latitude/Longitude

Table 11.1-4 contains the values for the following example:

$GNGLL,2503.7150,N,12138.7463,E,081419.000,A,A*4A

Table 11.1-4 GLL Data Format

Name	**Example**	**Units**	**Description**
Message ID	$GNGLL		GLL protocol header, GN means GPS+GLONASS, GP means GPS only GL means GLONASS only
Latitude	2503.7150		ddmm.mmmm
N/S indicator	N		N=north or S=south
Longitude	12138.7463		dddmm.mmmm
E/W indicator	E		E=east or W=west
UTC Time	081419.000		hhmmss.sss
Status	A		A=data valid or V=data not valid
Mode	A		A=autonomous, D=DGPS, E=DR, N=Data not valid
Checksum	*4A		
<CR> <LF>			End of message termination

● GSA---GNSS DOP and Active Satellites

Table 11.1-5 contains the values for the following example:

*$GPGSA,A,3,23,21,16,19,09,27,31,,,,,,1.10,0.78,0.78*01*

*$GLGSA,A,3,88,87,65,84,71,,,,,,,,1.10,0.78,0.78*18*

Table 11.1-5 GSA Data Format

Name	**Example**	**Units**	**Description**
Message ID	$GPGSA		GSA protocol header, GP means GPS & GL means GLONASS
Mode 1	A		See Table 11.1-6
Mode 2	3		See Table 11.1-7

ID of satellite used	23		Sv on Channel 1
ID of satellite used	21		Sv on Channel 2
….			….
ID of satellite used			Sv on Channel 12
PDOP	1.10		Position Dilution of Precision
HDOP	0.78		Horizontal Dilution of Precision
VDOP	0.78		Vertical Dilution of Precision
Checksum	*01		
<CR> <LF>			End of message termination

Table 11.1-6 Mode 1

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

Table 11.1-7 Mode 2

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

● GSV---GNSS Satellites in View

Table 11.1-8 contains the values for the following example:

*$GPGSV,3,1,10,27,85,205,49,42,54,141,41,16,51,356,47,19,49,208,47*72*

*$GPGSV,3,2,10,23,46,281,46,31,33,111,45,09,25,308,43,21,12,059,39*75*

*$GPGSV,3,3,10,193,,,40,04,,,33*43*

*$GLGSV,2,1,06,85,71,078,37,75,43,003,38,86,41,186,43,74,35,076,44*6A*

*$GLGSV,2,2,06,84,26,032,30,66,07,306,35*6D*

Table 11.1-8 GSV Data Format

Name	**Example**	**Units**	**Description**
Message ID	$GPGSV		GSV protocol header, GP means GPS which contains SBAS and QZSS satellites & GL means GLONASS.
Total number of messages[1]	3		Range 1 to 4
Message number[1]	1		Range 1 to 4
Satellites in view	10		
Satellite ID	27		Channel 1 (Range 01 to 196) GPS Satellites ID : 01~32, SBAS Satellites ID : 33~64, GLONASS Satellites ID : 65~96, & QZSS Satellites ID : 193~196
Elevation	85	degrees	Channel 1 (Range 00 to 90)

Azimuth	205	degrees	Channel 1 (Range 000 to 359)
SNR (C/No)	49	dB-Hz	Channel 1 (Range 00 to 99, null when not tracking)
….			….
Satellite ID	42		Channel 4 (Range 01 to 196)
Elevation	54	degrees	Channel 4 (Range 00 to 90)
Azimuth	141	degrees	Channel 4 (Range 000 to 359)
SNR (C/No)	41	dB-Hz	Channel 4 (Range 00 to 99, null when not tracking)
Checksum	*72		
<CR> <LF>			End of message termination

Note: Depending on the number of satellites tracked multiple messages of GSV data may be required.

● RMC---Recommended Minimum Specific GNSS Data

Table 11.1-9 contains the values for the following example:

$GNRMC,081419.000,A,2503.7150,N,12138.7463,E,0.01,0.00,160415,,,A*7B

Table 11.1-9 RMC Data Format

Name	**Example**	**Units**	**Description**
Message ID	$GNRMC		RMC protocol header, GN means GPS+GLONASS GP means GPS only GL means GLONASS only
UTC Time	081419.000		hhmmss.sss
Status	A		A=data valid or V=data not valid
Latitude	2503.7150		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	12138.7463,		dddmm.mmmm
E/W Indicator	E		E=east or W=west
Speed over ground	0.01	knots	True
Course over ground	0.00	degrees	
Date	160415		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
Checksum	*7B		
<CR> <LF>			End of message termination

● VTG---Course Over Ground and Ground Speed

Table 11.1-10 contains the values for the following example:

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

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Table 11.1-10 VTG Data Format

Name	**Example**	**Units**	**Description**
Message ID	$GPVTG		VTG protocol header, GN means GPS+GLONASS GP means GPS only GL means GLONASS only
Course over ground	79.65	degrees	Measured heading
Reference	T		True
Course over ground		degrees	Measured heading (Not shown)
Reference	M		Magnetic (Not shown)
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
Checksum	*38		
<CR> <LF>			End of message termination

11.2 Proprietary NMEA input/output message

Please refer to MTK proprietary message.

11.3 Examples to configure the power mode of GNSS module

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

11.3.1 Standby mode

User can issue software command to make GNSS module go into standby mode that consumes less than 570uA current. GNSS module will be awaked when receiving any byte. The following flow chart is an example to make GNSS module go into standby mode and then wake up.

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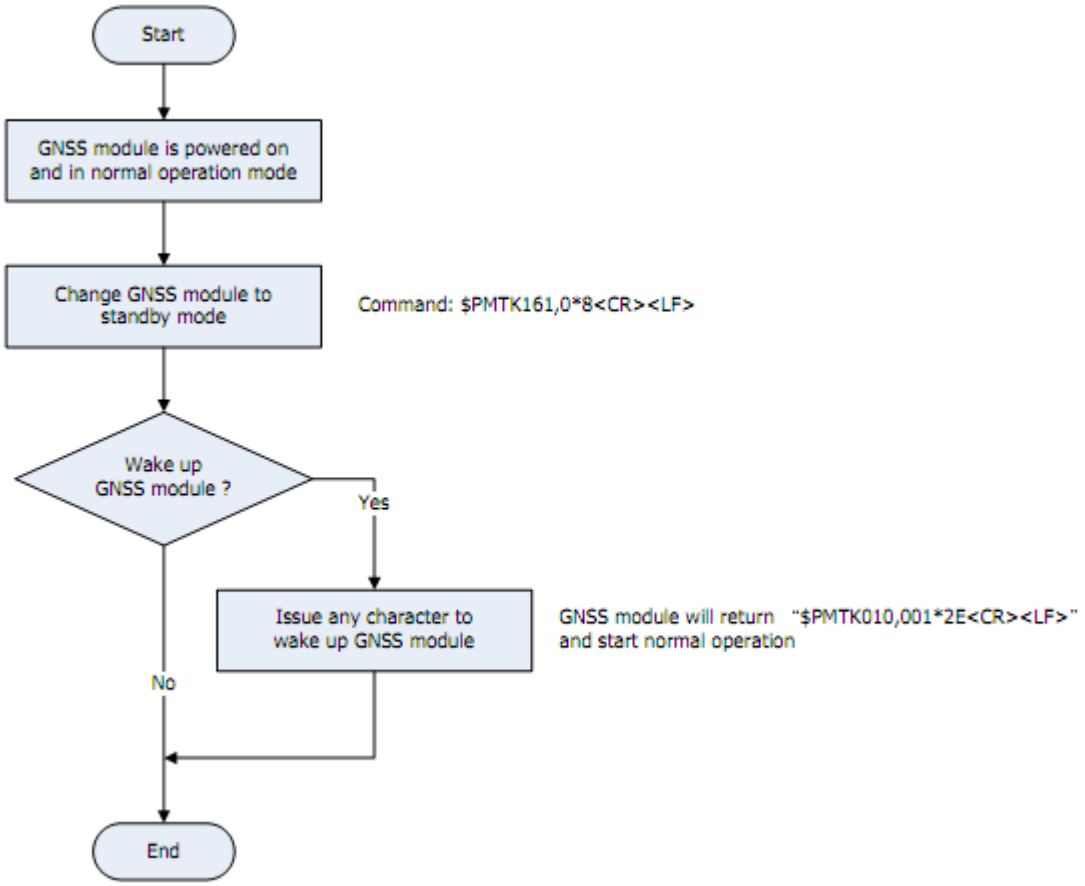

11.4 Examples to configure the update rate of GNSS module

The GNSS 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, GNSS 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.

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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*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*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*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*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*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*29<CR><LF>
Only ZDA at 1Hz	$PMTK314,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0*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*2C<CR><LF>
If the command is correct and executed, GNSS module will output message $PMTK001,314,3*36<CR><LF>	

After the GNSS 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, GNSS 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.

11.5 UBX output messages

Table 11.5-1 UBX output messages

Name	**Description**
NAV-POSLLH	Geodetic Position Solution
NAV-SOL	Navigation Solution Information
NAV-STATUS	Receiver Navigation Status
NAV-VELNED	Velocity Solution in NED
MON-HW	Monitor Hardware Status

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- **NAV-POSLLH ---** Geodetic Position Solution **(0x01 0x02)**

This message outputs the Geodetic position in the currently selected ellipsoid. The default is the WGS84 Ellipsoid.

	Header	ID	Length (Bytes)	Payload	Checksum
Message Structure	0xB5 0x62	0x01 0x02	28	Please see the UBLOX-6 Protocol Specification for possible UBX data packets and formats.	CK_A CK_B

- **NAV-SOL ---** Navigation Solution Information **(0x01 0x06)**

This message combines position, velocity and time solution in ECEF, including accuracy figures. This message has only been retained for backwards compatibility.

	Header	ID	Length (Bytes)	Payload	Checksum
Message Structure	0xB5 0x62	0x01 0x06	52	Please see the UBLOX-6 Protocol Specification for possible UBX data packets and formats.	CK_A CK_B

- **NAV-STATUS ---** Navigation Solution Information **(0x01 0x03)**

This message reports whether a fix is valid in their gpsFixOK flags. This message have only been retained for backwards compatibility

	Header	ID	Length (Bytes)	Payload	Checksum
Message Structure	0xB5 0x62	0x01 0x03	52	Please see the UBLOX-6 Protocol Specification for possible UBX data packets and formats.	CK_A CK_B

- **NAV-VELNED ---** Velocity Solution in NED **(0x01 0x12)**

This message reports velocity of North, East and Down.

	Header	ID	Length (Bytes)	Payload	Checksum
Message Structure	0xB5 0x62	0x01 0x12	36	Please see the UBLOX-6 Protocol Specification for possible UBX data packets and formats.	CK_A CK_B

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- **MON-HW ---** Monitor Hardware Status **(0x0A 0x09)**

This message report status of different aspect of the hardware

	Header	ID	Length (Bytes)	Payload	Checksum
Message Structure	0xB5 0x62	0x0A 0x09	68	Please see the UBLOX-6 Protocol Specification for possible UBX data packets and formats.	CK_A CK_B

11.6 LOCOSYS Proprietary debug message

-$PLSC,UBX,2*71 //switch back to original default NMEA mode
-$PLSC,UBX,0*73 //switch to ubx binary mode
-$PLSC,VER*61 //query firmware version

12 I2C communication protocol

Please refer to Honeywell HMC5883L I2C communication protocol.

13 Compass configuration and calibration

After connecting the digital compass, you will need to follow different flight control system instructions to configure and calibrate the HMC5883L digital compass before you start to use it.

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Document change list

Revision 1.0

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