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Product name	Description	Version
LS2003G-G-T	GNSS smart antenna module/TTL,9600BPS,30x30mm	1.2
LS2003G-G-R	GNSS smart antenna module/RS232,9600BPS,30x30mm	

Datasheet of GNSS smart antenna module, LS2003G-G

Top View

LS2003G-G-T

LS2003G-G-R

1 Introduction

LS2003G-G series products are complete standalone GNSS smart antenna modules, including an embedded antenna and GNSS receiver circuits, designed for a broad spectrum of OEM system applications. The product is based on the proven technology found in LOCOSYS GNSS SMD type receiver MC-1612-G that uses MediaTek chip solution. It can simultaneously acquire and track multiple satellite constellations that include GPS, GLONASS, GALILEO, QZSS and SBAS. Besides, 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.

2 Features

- MediaTek high sensitivity solution
- Support GPS, GLONASS, GALILEO 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 ephemeries prediction to achieve faster cold start
- Built-in data logger
- Up to 10 Hz update rate
- ±11ns high accuracy time pulse (1PPS)
- Indoor and outdoor multi-path detection and compensation
- Build-in micro battery to reserve system data for rapid satellite acquisition

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- LED indicator for position fix or not fix

3 Application

- Personal positioning and navigation
- Automotive navigation
- Marine navigation

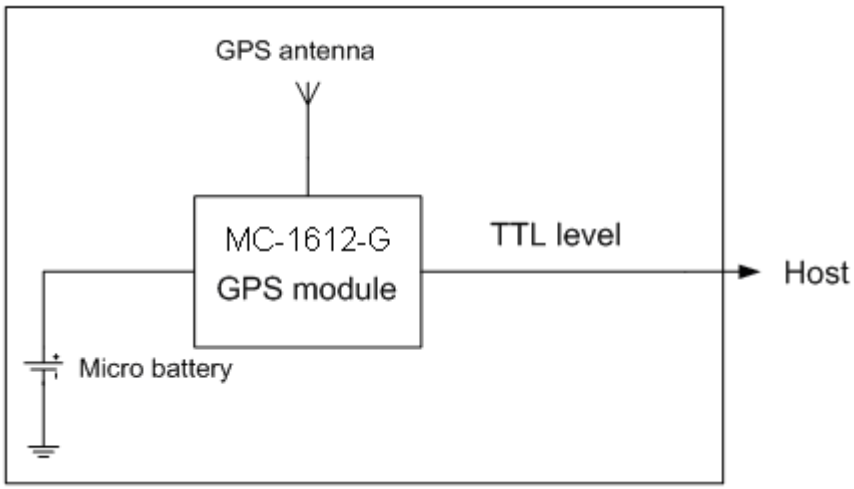

Fig 3-1 System block diagram of LS2003G-G-T

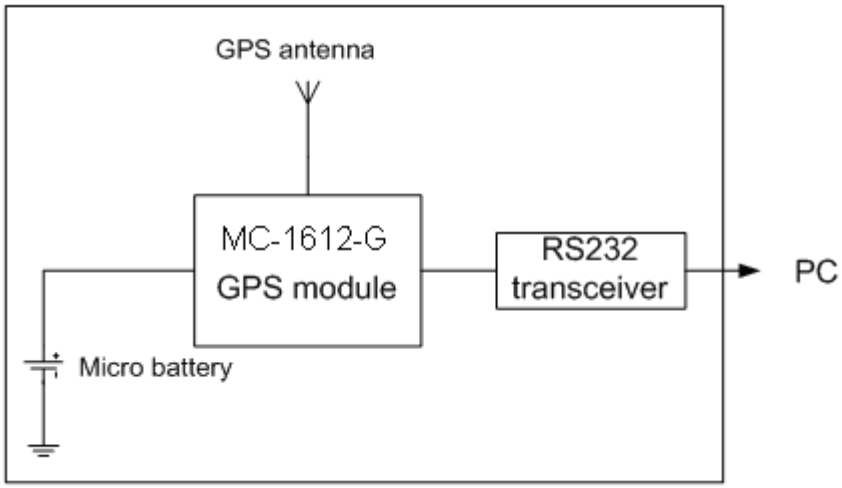

Fig 3-2 System block diagram of LS2003G-G-R

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4 GNSS receiver

Chip	MediaTek MT3333	
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	
Acquisition Time	Hot start (Open Sky)	1s (typical)
	Cold Start (Open Sky)	33s (typical) without AGPS
		< 15s (typical) with AGPS (hybrid ephemeris prediction)
Position Accuracy	Autonomous	2.5 m CEP
	SBAS	2.5m (depends on accuracy of correction data)
Datum	WGS-84 (default)	
Max. Altitude	< 18,000 m, up to 50,000m by request	
Max. Velocity	< 515 m/s	
Protocol	NMEA 0183 ver 4.00(2)	9600 bps(3), 8 data bits, no parity, 1 stop bits (default) 1Hz: GGA, GLL, GSA, GSV, RMC, VTG

Note (1): LS2003G-G series module is 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): The default NMEA version is 4.00 and it also can configure to 4.10. If customers want to the product to support 4.10 please contact us in advance.

Note (3): Both baud rate and output message rate are configurable to be factory default.

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.

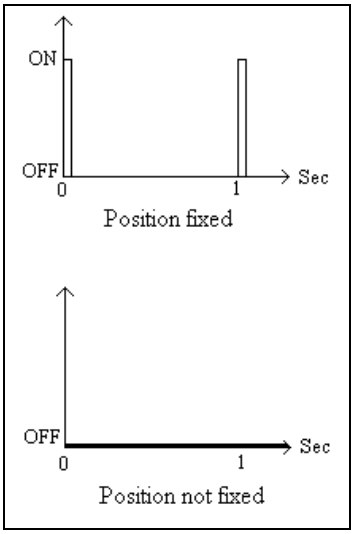

Fig 5.1 LED indicator of positioning status

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6 Pin assignment and descriptions

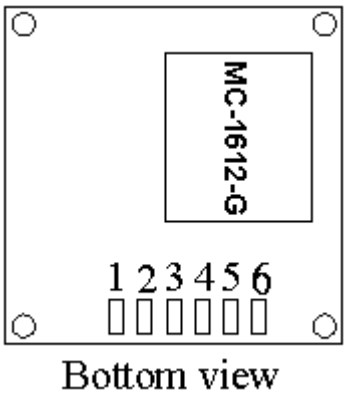

Fig 6.1 Pin assignment of LS2003G-G-T, LS2003G-G-R

- **LS2003G-G-T**

Pin #	Name	Type	Description
1	VCC	P	Power input
2	RX	I	Data input (TTL level)
3	TX	O	Data output (TTL level)
4	GND	P	Ground
5	1PPS Output	O	1PPS output , 100ms pulse/sec
6	N.C		No Connection

- **LS2003G-G-R**

Pin #	Name	Type	Description
1	VCC	P	Power input
2	RX	I	Data input (RS232 level)
3	TX	O	Data output (RS232 level)
4	GND	P	Ground
5	1PPS Output	O	1PPS output , 100ms pulse/sec
6	N.C		No Connection

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7 DC & Temperature characteristics

7.1 DC Electrical characteristics

Parameter	Symbol	Product	Min.	Typ.	Max.	Units
Input voltage	VCC	LS2003G-G-T LS2003G-G-R	3 4	3.3 5	4.3 6	V
Input current	Icc	LS2003G-G-T LS2003G-G-R		27(1) 31(1)		mA
High Level Input Voltage	V_{IH}	LS2003G-G-T	2.0		3.6	V
Low Level Input Voltage	V_{IL}	LS2003G-G-T	-0.3		0.8	V
High Level Input Current	I_{IH}	LS2003G-G-T	-1		1	uA
Low Level Input Current	I_{IL}	LS2003G-G-T	-1		1	uA
High Level Output Voltage	V_{OH}	LS2003G-G-T	2.4		3.3	V
Low Level Output Voltage	V_{OL}	LS2003G-G-T			0.4	V
High Level Output Current	I_{OH}	LS2003G-G-T		2		mA
Low Level Output Current	I_{OL}	LS2003G-G-T		2		mA

Note (1): Measured when position fix is available,the function of self-generated ephemerisprediction is inactive.

7.2 Temperature characteristics

Parameter	Symbol	Product	Min.	Typ.	Max.	Units
Operating Temperature	Topr	LS2003G-G-T LS2003G-G-R	-40	-	85	℃
Storage Temperature	Tstg	LS2003G-G-T LS2003G-G-R	-40	25	85	℃

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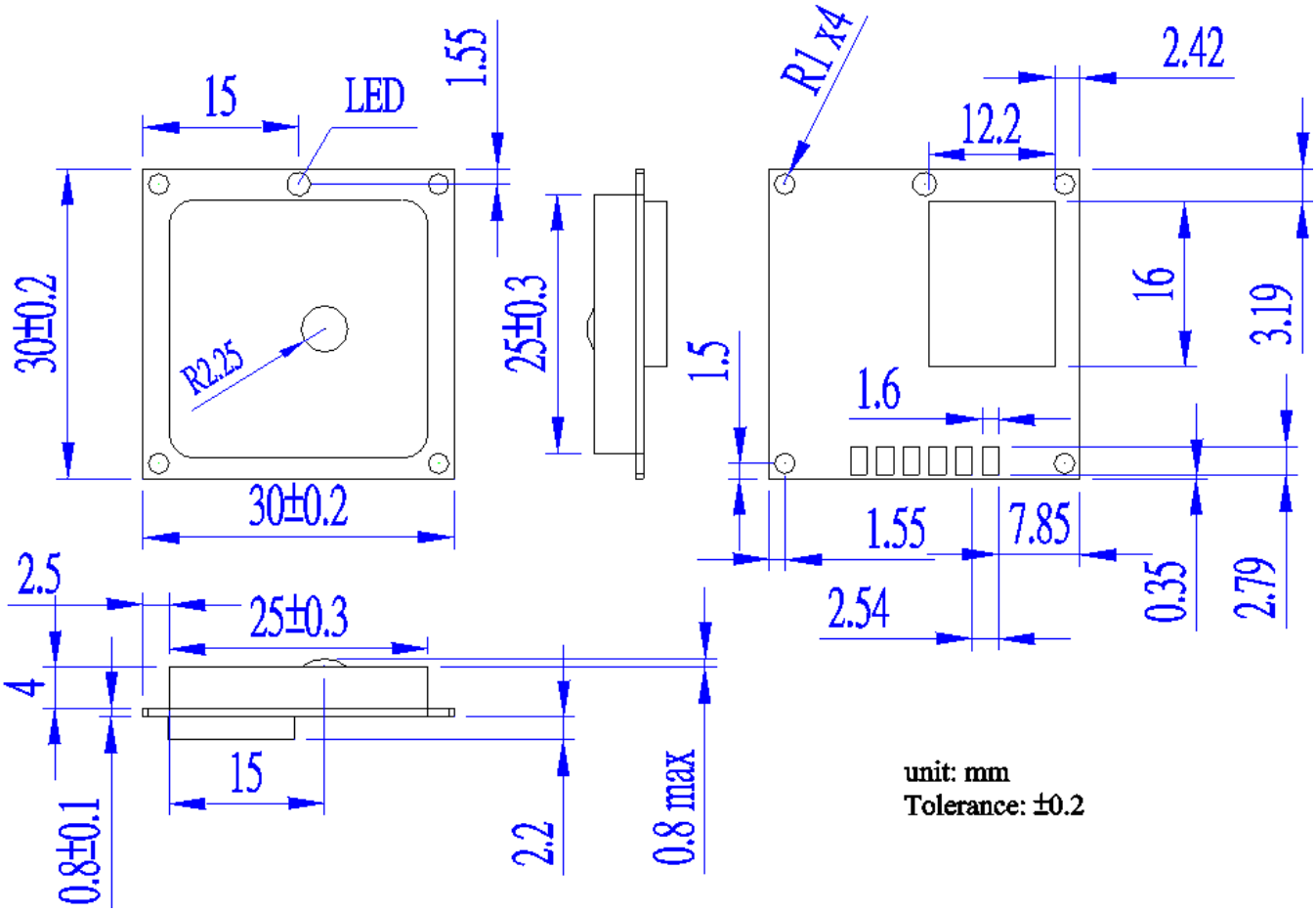
8 Mechanical specification

- LS2003G-G-T, LS2003G-G-R



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9 Software interface

9.1 NMEA output message

Table 9.1-1 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 9.1-2 contains the values for the following example:

$GNGGA,183015.000,2503.7123,N,12138.7446,E,2,16,0.68,123.2,M,15.3,M,,*78

Table9.1- 2 GGA Data Format

Name	Example	Units	Description
Message ID	$GNGGA		GGA protocol header
UTC Time	183015.000		hhmmss.sss
Latitude	2503.7123		ddmm.mmmm
N/S indicator	N		N=north or S=south
Longitude	12138.7446		dddmm.mmmm
E/W Indicator	E		E=east or W=west
Position Fix Indicator	2		See Table 5.1-3
Satellites Used	16		Range 0 to 33
HDOP	0.68		Horizontal Dilution of Precision
MSL Altitude	123.2	mters	
Units	M	mters	
Geoid Separation	15.3	mters	
Units	M	mters	
Age of Diff. Corr.		second	Null fields when DGPS is not used
Diff. Ref. Station ID			
Checksum	*78		
<CR> <LF>			End of message termination

Table 9.1-3 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 9.1-4 contains the values for the following example:

$GNGLL,2503.7135,N,12138.7448,E,055757.000,A,D*45

Table 9.1-4 GLL Data Format

Name	**Example**	**Units**	**Description**
Message ID	$GNGLL		GLL protocol header
Latitude	2503.7135		ddmm.mmmm
N/S indicator	N		N=north or S=south
Longitude	12138.7448		dddmm.mmmm
E/W indicator	E		E=east or W=west
UTC Time	055757.000		hhmmss.sss
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	*45		
<CR> <LF>			End of message termination

● GSA---GNSS DOP and Active Satellites

Table 9.1-5 contains the values for the following example:

NMEA V4.0

$GPGSA,A,3,193,19,06,05,02,17,09,12,13,195,,,1.23,0.92,0.81*01

$GLGSA,A,3,69,,,,,,,,,,,1.23,0.92,0.81*13

$GAGSA,A,3,,,,,,,,,,,,1.23,0.92,0.81*11

NMEA V4.10

$GNGSA,A,3,02,06,17,19,09,05,28,193,195,,,,1.34,1.02,0.87,1*01

$GNGSA,A,3,69,,,,,,,,,,,1.34,1.02,0.87,2*07

$GNGSA,A,3,,,,,,,,,,,,1.34,1.02,0.87,3*09

Table 9.1-5 GSA Data Format

Name	**Example**	**Units**	**Description**

Message ID	$GNGSA		GSA protocol header, GP=GPS/QZSS, GL=GLONASS, GA=GALILEO, BD=BEIDOU **(GN for NMEA Ver 4.10)**
Mode 1	A		See Table 5.1-6
Mode 2	3		See Table 5.1-7
ID of satellite used	02		Sv on Channel 1
ID of satellite used	06		Sv on Channel 2
….			….
ID of satellite used			Sv on Channel 12
PDOP	1.34		Position Dilution of Precision
HDOP	1.02		Horizontal Dilution of Precision
VDOP	0.87		Vertical Dilution of Precision
System ID	1		1: GPS, 2:GLONASS, 3:GALILEO, 4:BEIDOU **(NMEA Ver 4.10 support only)**
Checksum	*01		
<CR> <LF>			End of message termination

Table 9.1-6 Mode 1

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

Table 9.1-7 Mode 2

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

● GSV---GNSS Satellites in View

Table 9.1-8 contains the values for the following example:

$GPGSV,3,1,11,18,67,344,48,09,55,031,50,42,54,142,40,193,47,174,45,0*51

$GPGSV,3,2,11,21,44,219,46,27,39,035,48,12,34,131,44,15,30,057,46,0*6A

$GPGSV,3,3,11,22,27,319,47,14,22,285,42,25,19,171,40,0*58

$GLGSV,2,1,07,76,71,201,44,65,57,041,40,75,48,028,39,72,27,108,39,1*75

$GLGSV,2,2,07,66,25,333,43,77,17,207,37,81,02,280,29,1*41

$GAGSV,2,1,05,01,83,026,35,26,53,024,35,21,38,134,30,12,16,233,21,0*70

$GAGSV,2,2,05,18,,,30,0*7B

Table 9.1-8 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)	3		Range 1 to 6
Message number(1)	1		Range 1 to 6
Satellites in view	11		
Satellite ID(2)	18		Channel 1 (Range 01 to 196)
Elevation	67	degrees	Channel 1 (Range 00 to 90)
Azimuth	344	degrees	Channel 1 (Range 000 to 359)
SNR (C/No)	48	dB-Hz	Channel 1 (Range 00 to 99, null when not tracking)
Satellite ID	09		Channel 4 (Range 01 to 196)
Elevation	55	degrees	Channel 4 (Range 00 to 90)
Azimuth	031	degrees	Channel 4 (Range 000 to 359)
SNR (C/No)	50	dB-Hz	Channel 4 (Range 00 to 99, null when not tracking)
	…		
Signal ID	0		GPS/QZSS: All signal=0, GLONASS: All signal=0, G1 C/A=1 GALILEO: All signal=0, BEIDOU: All signal=0 **(NMEA Ver 4.10 support only)**
Checksum	*51		
<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, QZSS ID: 193~196, BEIDOU ID: 01~32, GALILEO ID: 01~32

● RMC---Recommended Minimum Specific GNSS Data

Table 9.1-9 contains the values for the following example:

$GNRMC,183015.000,A,2503.7123,N,12138.7446,E,0.01,34.92,270812,,,D,V*39

Table 9.1-9 RMC Data Format

Name	**Example**	**Units**	**Description**
Message ID	$GNRMC		RMC protocol header
UTC Time	183015.000		hhmmss.sss
Status	A		A=data valid or V=data not valid
Latitude	2503.7123		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	12138.7446		dddmm.mmmm
E/W Indicator	E		E=east or W=west
Speed over ground	0.01	knots	True

Course over ground	34.92	degrees	
Date	270812		ddmmyy
Magnetic variation		degrees	
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 indicator	V		S = Safe C = Caution U = Unsafe V = Void **(NMEA Ver 4.10 support only)**
Checksum	*39		
<CR> <LF>			End of message termination

● VTG---Course Over Ground and Ground Speed

Table 9.1-10 contains the values for the following example:

$GNVTG,196.90,T,,M,0.01,N,0.01,K,D*21

Table 9.1-10 VTG Data Format

Name	**Example**	**Units**	**Description**
Message ID	$GNVTG		VTG protocol header
Course over ground	196.90	degrees	Measured heading
Reference	T		True
Course over ground		degrees	Measured heading
Reference	M		Magnetic
Speed over ground	0.01	knots	Measured speed
Units	N		Knots
Speed over ground	0.01	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	*21		
<CR> <LF>			End of message termination

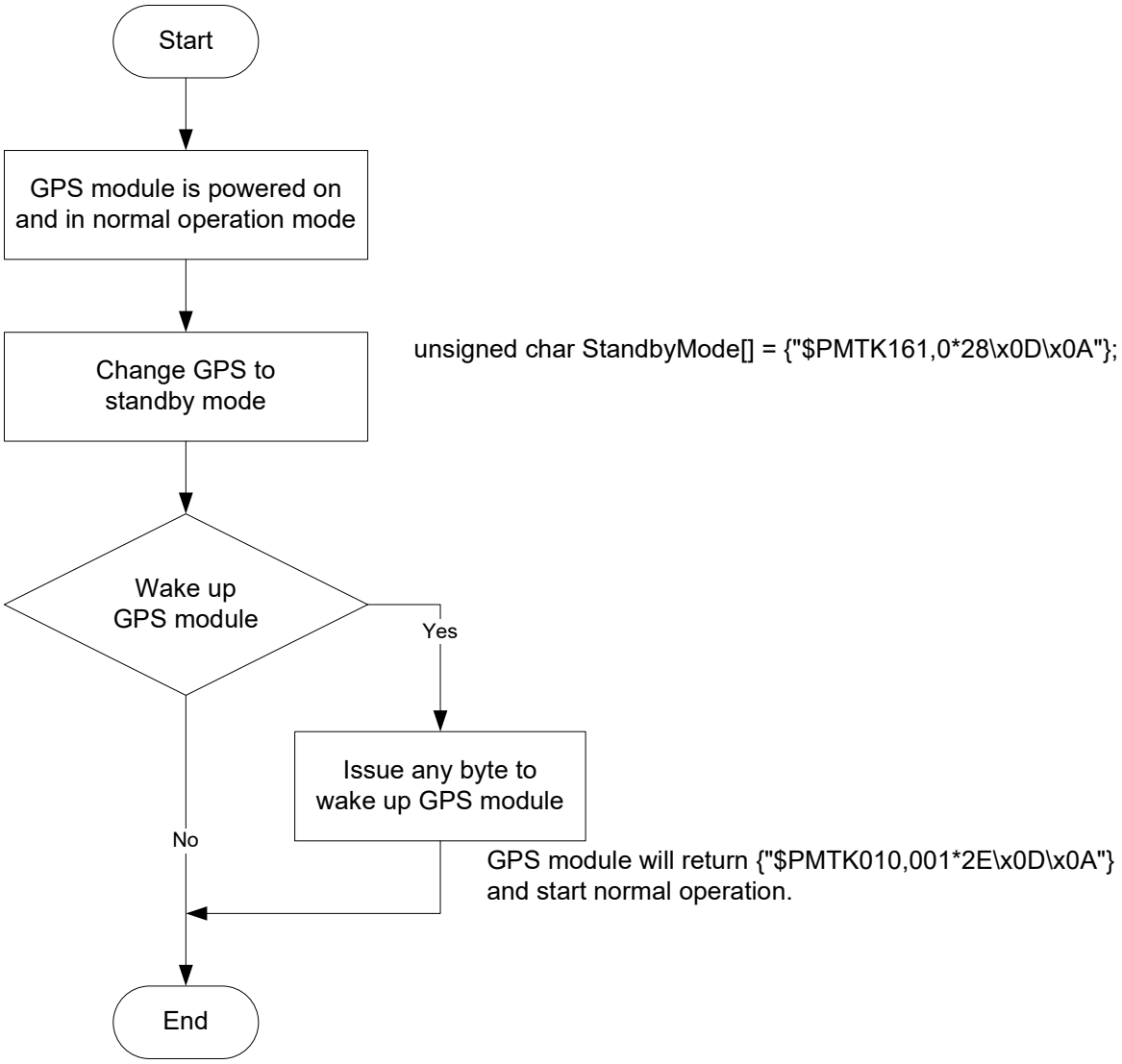
9.2 Proprietary NMEA input message

Please refer to MTK proprietary message.

9.3 Examples to configure the power mode of GNSS module

9.3.1 Standby mode

User can issue software command to make GNSS module go into standby mode that consumes less than 500uA 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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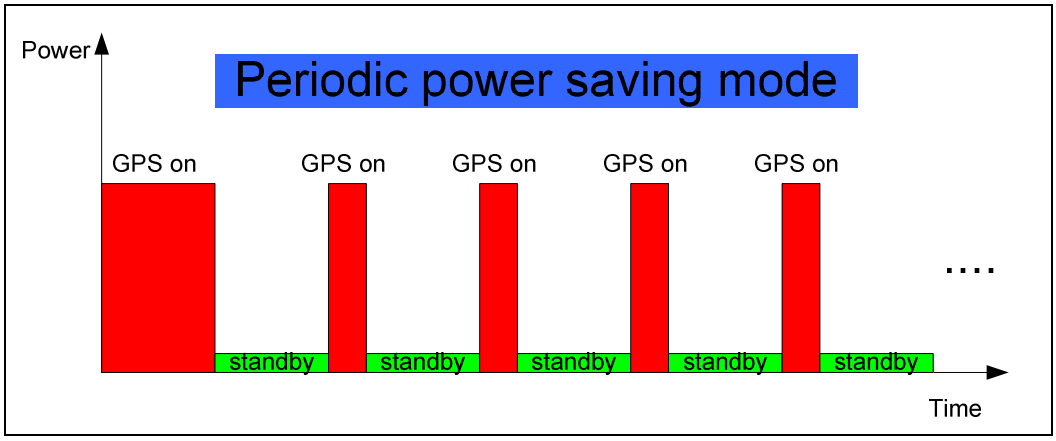
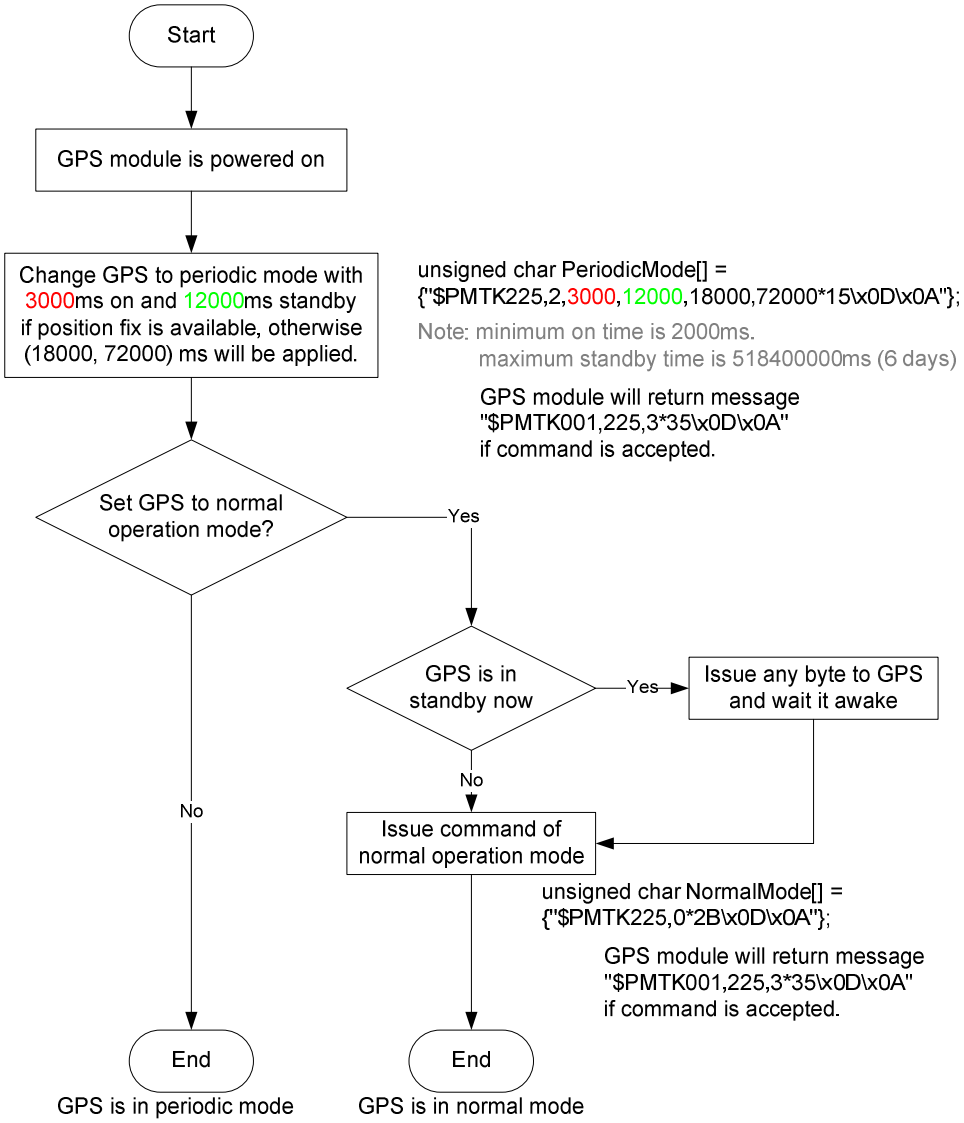
9.3.2 Periodic mode

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



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



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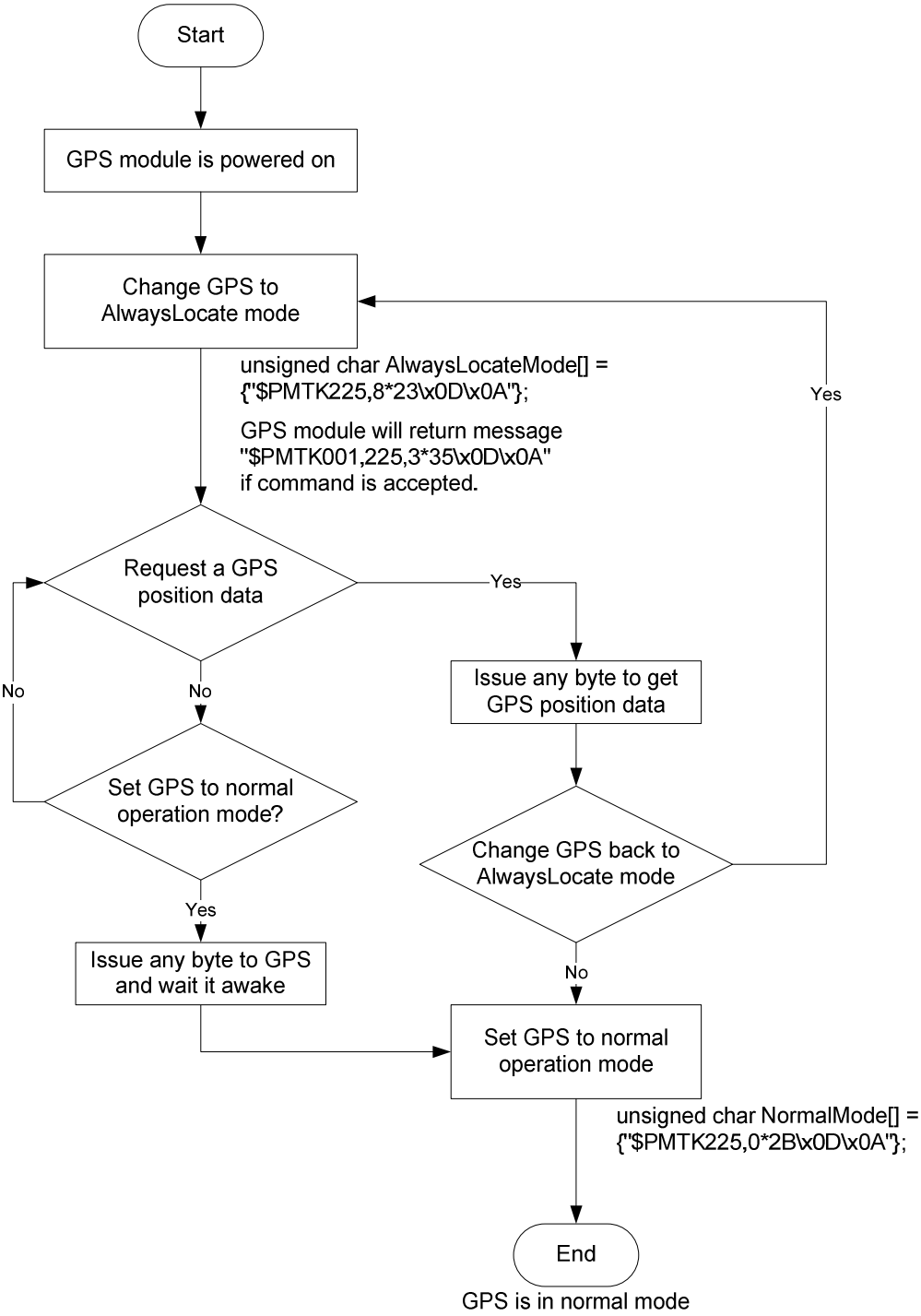
9.3.3 AlwaysLocate™ mode

AlwaysLocate™ is an intelligent controller of periodic mode. Depending on the environment and motion conditions, GNSS 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 GNSS module until the host CPU needs the GNSS position data. The following flow chart is an example to make GNSS module go into AlwaysLocate™ mode and then back to normal operation mode.

Note: AlwaysLocate™ is a trade mark of MTK.



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9.4 Data logger

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

9.5 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.

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	$PMTK314,0,1,0,1,1,5,0,0,0,0,0,0,0,0,0,0,0,0*2C<CR><LF>

0.2Hz	
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.

9.6 Configure the static navigation parameter

The output position of GNSS module will keep the same and output speed will be zero if the actual speed is below the threshold of the static navigation parameter. This is useful for different applications. For example, the car stopped at a red light will get stationary GNSS position if the threshold is 1.5m/s. It is better to disable this function by setting threshold to 0 for pedestrian navigation.

The format of the software command is as below.

$PMTK386,speed threshold*checksum<CR><LF>

The unit of speed threshold is meter per second. The range of speed threshold is from 0.1m/s to 2.0m/s. Value 0 is to disable the function.

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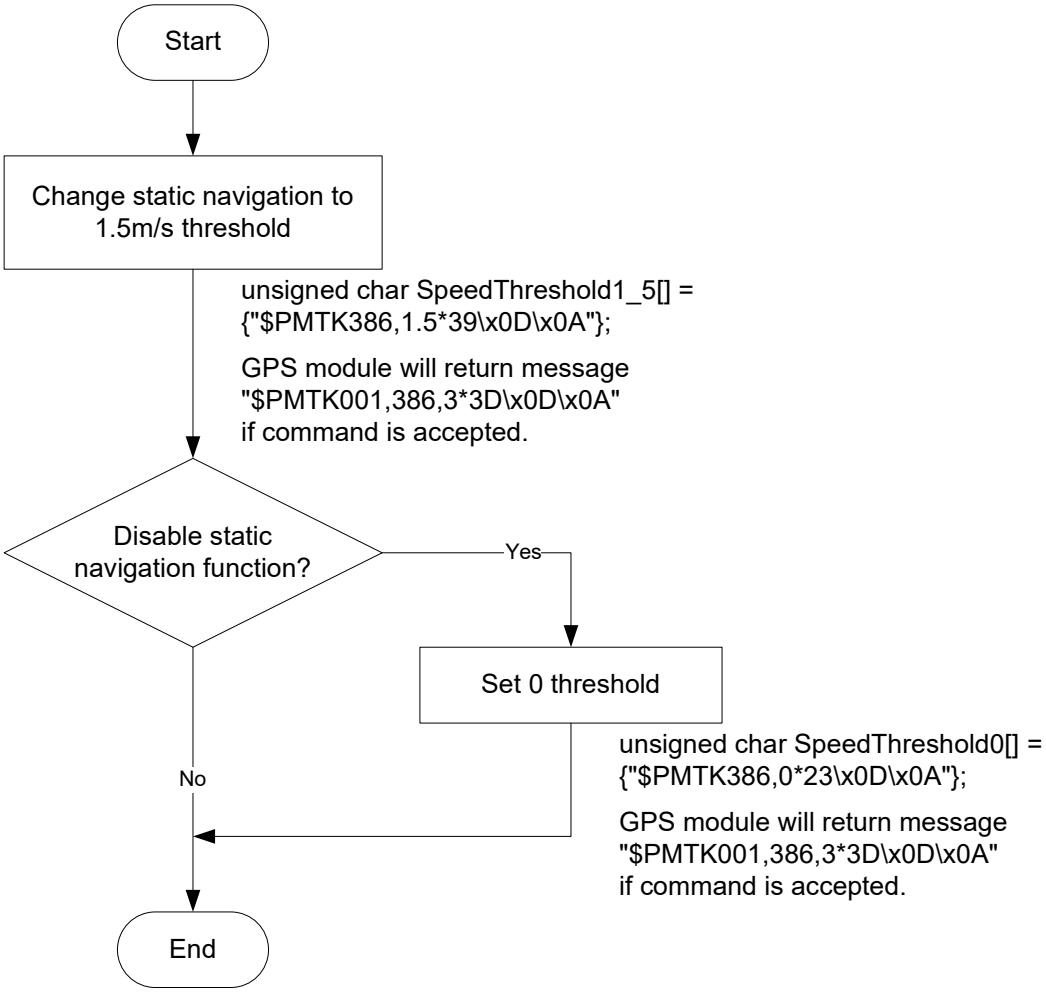

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Document change list

Revision 1.0

- First release on Dec.03. , 2014.

Revision 1.0 to revision 1.1 (April 29, 2020)

- Added “Note 1” in the section 4.

Revision 1.1 to revision 1.2 (July 24, 2020)

- Revised protocol support NMEA 0183 version from 4.10 to 4.00 in the section 4.
- Added “Note 2” in the section 4.
- Revised section 9.1 NMEA output message.