Product name	Description	Version
MC-1513	Datasheet of MC-1513 GPS module	1.6

1 Introduction

Locosys GPS MC-1513 module features high sensitivity, low power and ultra small form factor. This GPS module is powered by MediaTek, it can provide you with superior sensitivity and performance even in urban canyon and dense foliage environment. The miniature size makes the module easy and the best choice to integrate into portable device like mobile phone, PDAs, camera and vehicle locators.

This module supports hybrid ephemeris prediction to achieve faster cold start. One is self-generated ephemeris prediction 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 GPS module is powered on and satellites are available. The other is server-generated ephemeris prediction 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.

2 Features

- MediaTek high sensitivity solution
- Support 66-channel GPS
- Ultra 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
- Built-in data logger
- Built-in DC/DC converter to save power
- Up to 10 Hz update rate
- ±11ns high accuracy time pulse (1PPS)
- Capable of SBAS (WAAS, EGNOS, MSAS, GAGAN)
- Support Japan QZSS
- Indoor and outdoor multi-path detection and compensation
- Support both UART and I2C interface
- Small form factor 15 x 13 x 2.2 mm
- SMD type with stamp holes; RoHS compliant

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3   Application

- Personal positioning and navigation
- Automotive navigation
- Marine navigation
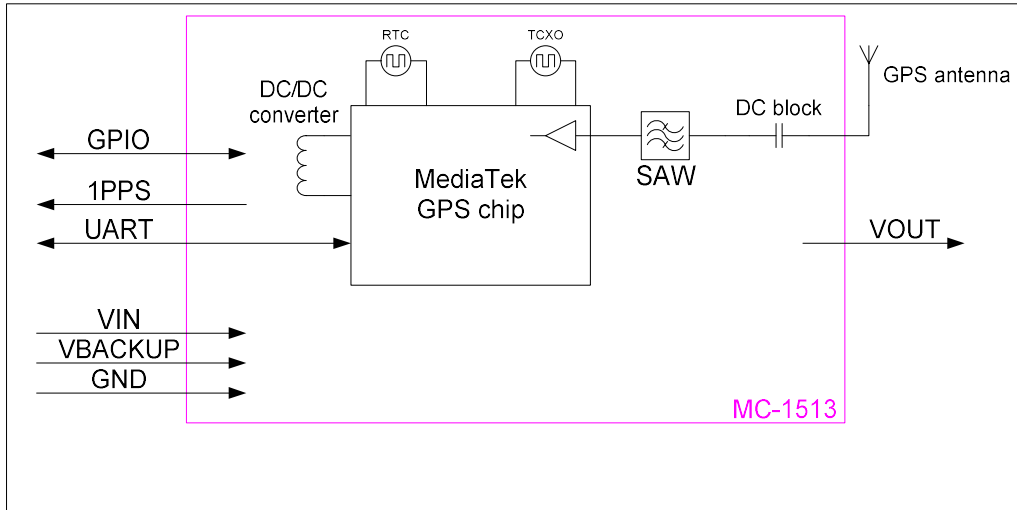
Fig 3-1 System block diagram.

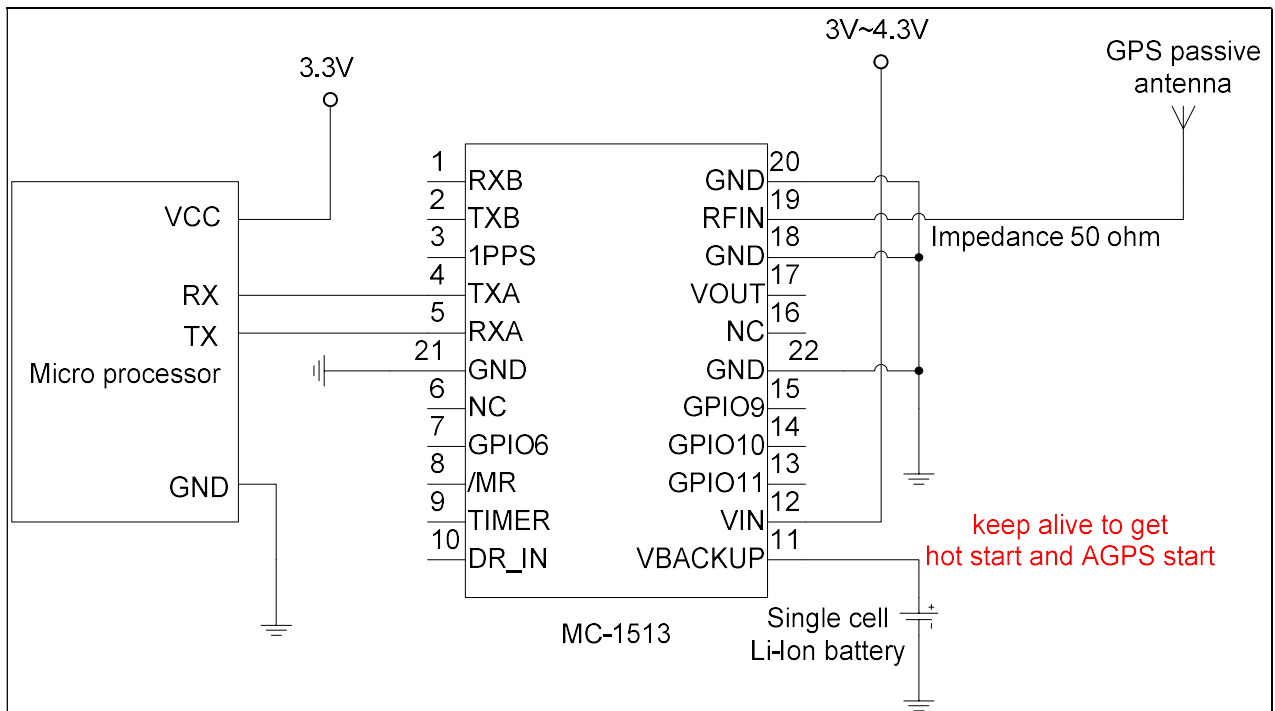Fig 3-2 Typical application circuit that uses passive antenna.

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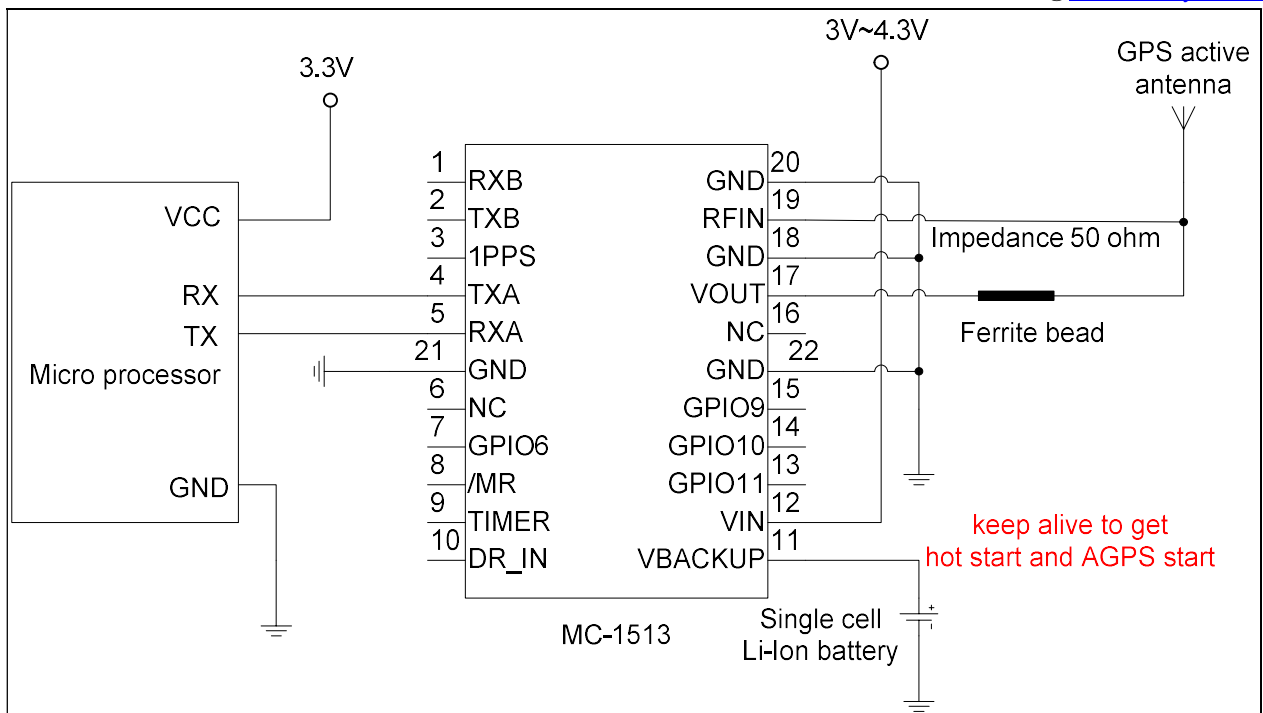☏ 886-2-8698-3698
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Fig 3-3 Typical application circuit that uses active antenna.
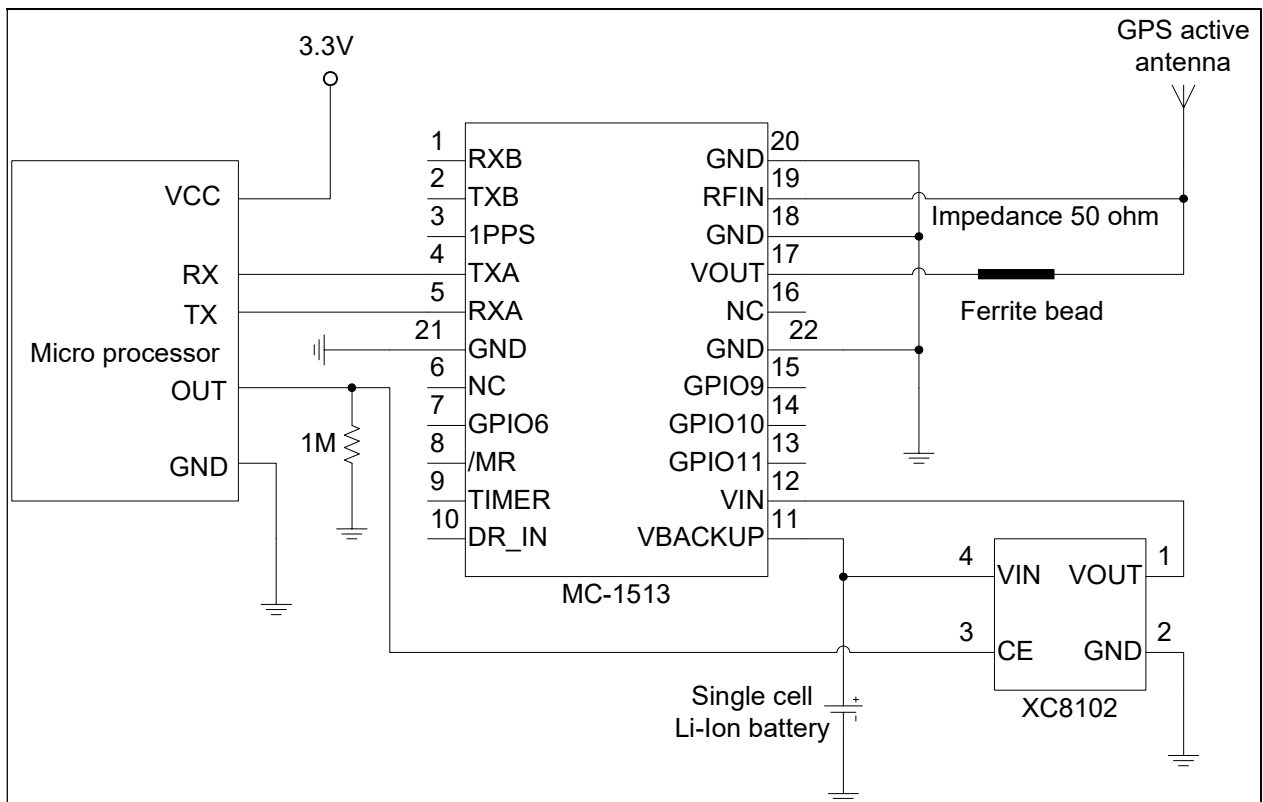
Fig 3-4 Typical application circuit that directly uses a Li-Ion battery as power source to save power.
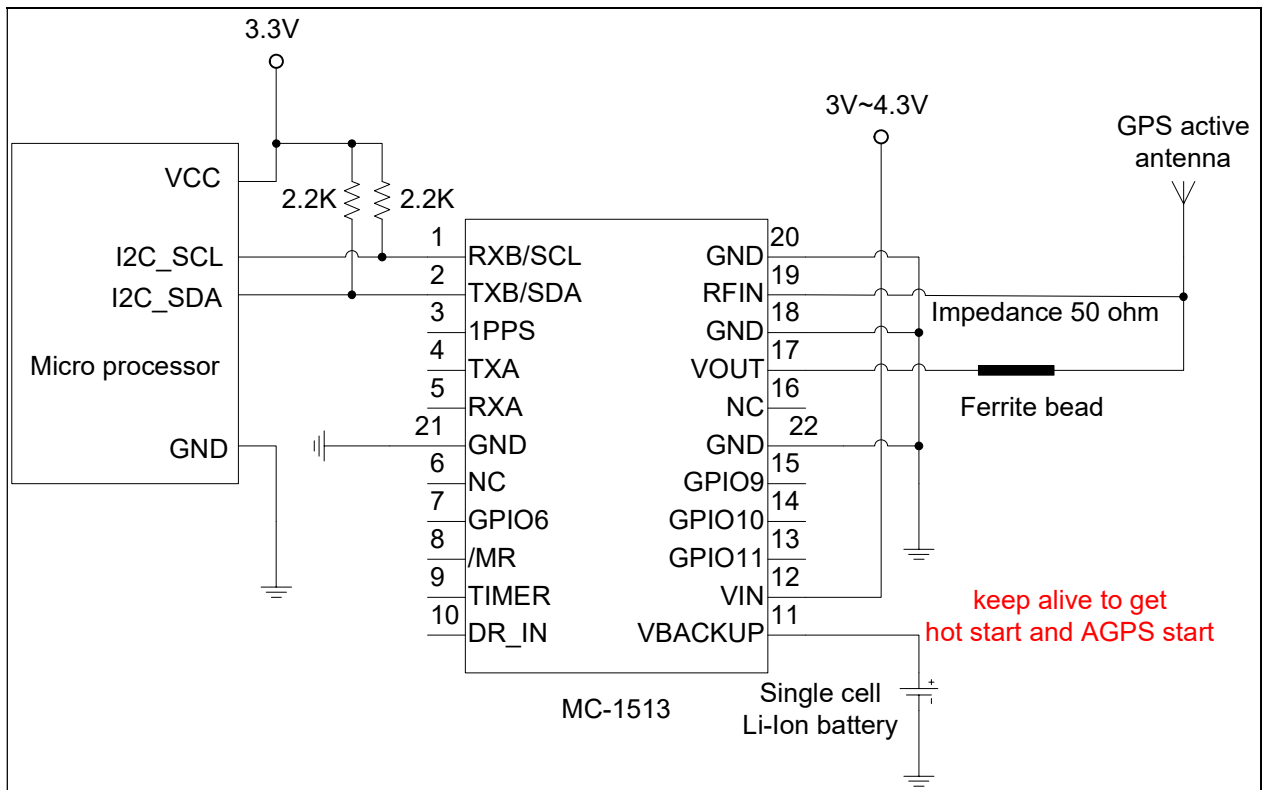
Fig 3-5 Use I2C interface to communicate with MC-1513.

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4　GPS receiver

Chip	MediaTek MT3339	
Frequency	L1 1575.42MHz, C/A code	
Channels	Support 66 channels	
Update rate	1Hz default, up to 10Hz	
Sensitivity	Tracking	-161dBm, up to -165dBm (with external LNA)
	Cold start	-142.5dBm, up to -148dBm (with external LNA)
Acquisition Time	Hot start (Open Sky)	< 1s (typical)
	Hot start (Indoor)	< 30s
	Cold Start (Open Sky)	32s (typical) without AGPS
		< 15s (typical) with AGPS (hybrid ephemeris prediction)
Position Accuracy	Autonomous	2.5m CEP
	SBAS	2.5m (depends on accuracy of correction data).
Max. Altitude	< 50,000 m	
Max. Velocity	< 515 m/s	
Protocol Support	NMEA 0183 ver 3.01	9600 bps, 8 data bits, no parity, 1 stop bits (default)
		1Hz: GGA, GLL, GSA, GSV, RMC, VTG

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

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

Table 5.1-2 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

Table5.1- 2 GGA Data Format

Name	Example	Units	Description
Message ID	$GPGGA		GGA protocol header
UTC Time	053740.000		hhmmss.sss

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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 5.1-3
Satellites Used	08		Range 0 to 12
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.		second	Null fields when DGPS is not used
Diff. Ref. Station ID	0000		
Checksum	*64		
<CR> <LF>			End of message termination

Table 5.1-3 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 5.1-4 contains the values for the following example:

$GPGLL,2503.6319,N,12136.0099,E,053740.000,A,A*52

Table 5.1-4 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
UTC Time	053740.000		hhmmss.sss
Status	A		A=data valid or V=data not valid
Mode	A		A=autonomous, D=DGPS, E=DR, N=Data not valid,

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			R=Coarse Position, S=Simulator
Checksum	*52		
<CR> <LF>			End of message termination

- ## GSA---GNSS DOP and Active Satellites

Table 5.1-5 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 5.1-5 GSA Data Format

Name	Example	Units	Description
Message ID	$GPGSA		GSA protocol header
Mode 1	A		See Table 5.1-6
Mode 2	3		See Table 5.1-7
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 5.1-6 Mode 1

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

Table 5.1-7 Mode 2

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

- ## GSV---GNSS Satellites in View

Table 5.1-8 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

$GPGSV,3,3,12,08,22,214,38,27,08,190,16,19,05,092,33,23,04,127,*7B

Table 5.1-8 GSV Data Format

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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 196)
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 196)
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 5.1-9 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 5.1-9 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	
Variation sense			E=east or W=west (Not shown)
Mode	A		A=autonomous, D=DGPS, E=DR, N=Data not valid, R=Coarse Position, S=Simulator
Checksum	*53		

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<CR> <LF>			End of message termination

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

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

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

Table 5.1-10 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, N=Data not valid, R=Coarse Position, S=Simulator
Checksum	*38		
<CR> <LF>			End of message termination

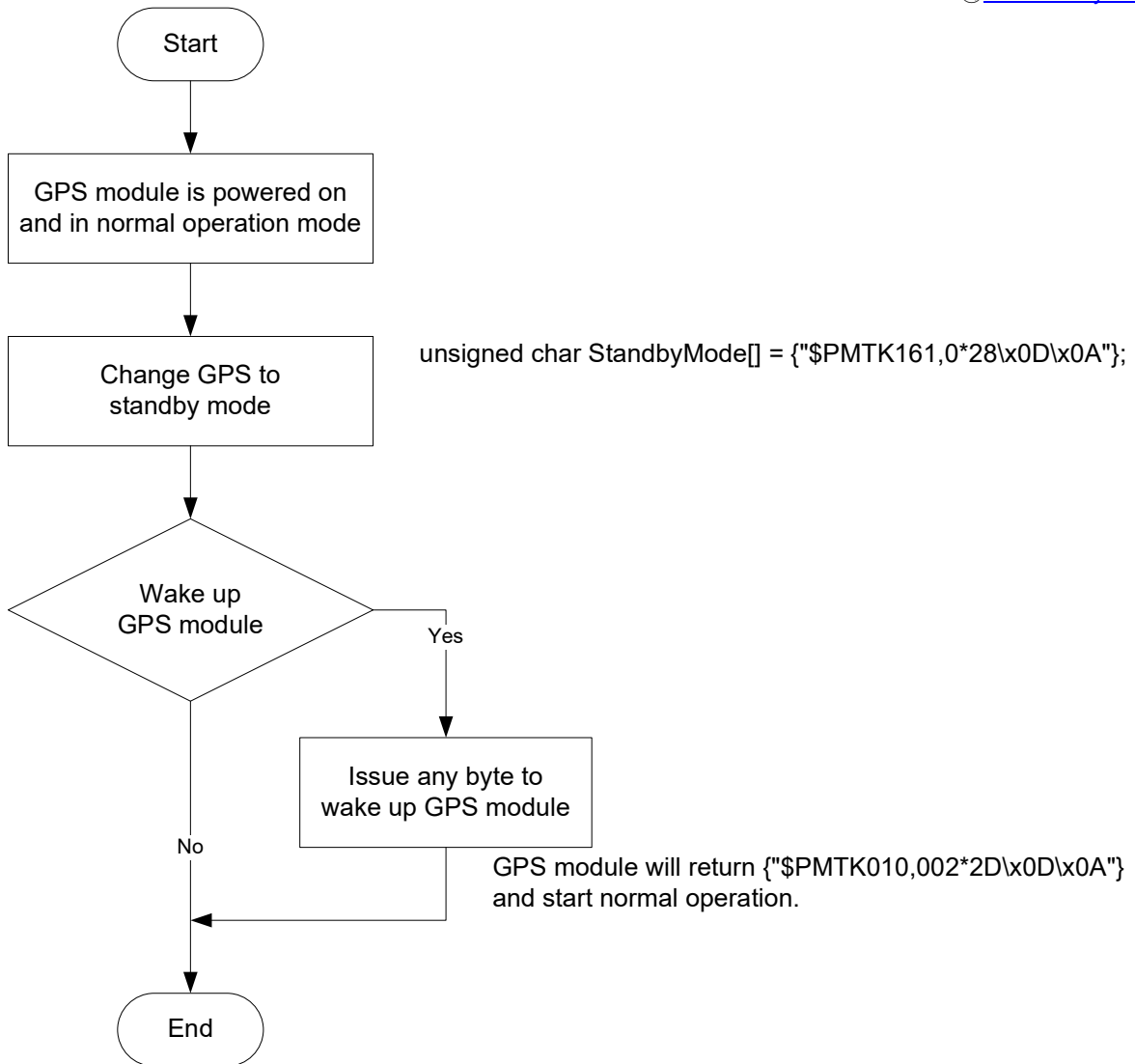## 5.2 Proprietary NMEA input/output message

Please refer to MTK proprietary message.

5.3 Examples to configure the power mode of GPS module

The GPS module supports different power modes that user can configure by issuing software commands.
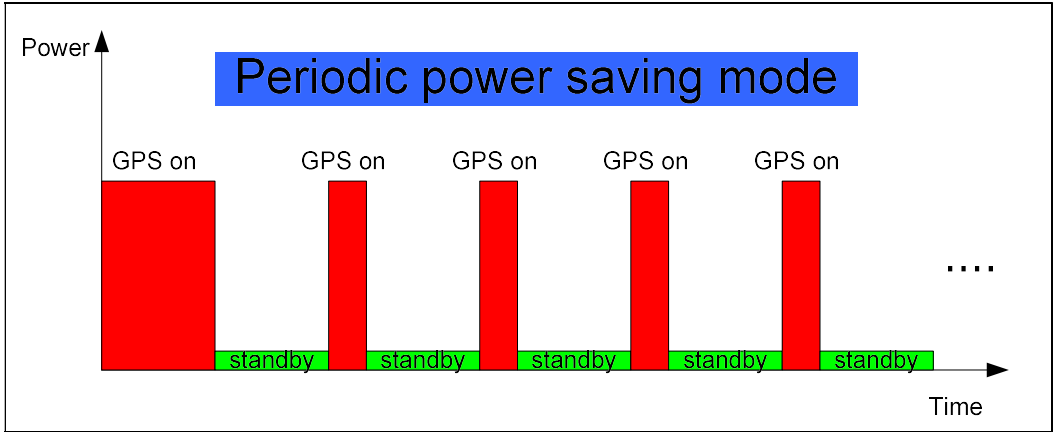
5.3.1 Standby mode

User can issue software command to make GPS module go into standby mode that consumes less than 200uA current. GPS module will be awaked when receiving any byte. The following flow chart is an example to make GPS module go into standby mode and then wake up.
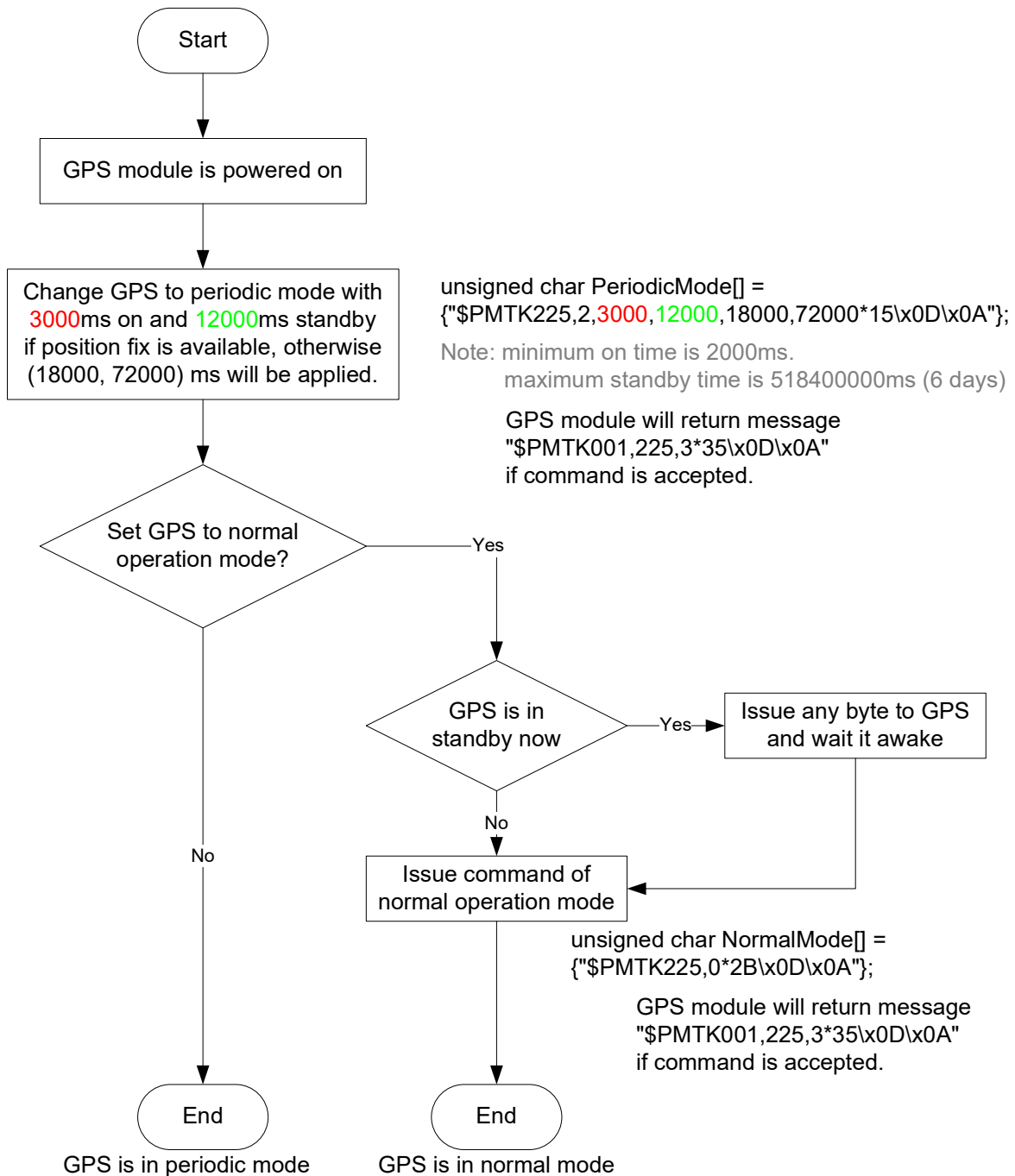
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```
              ┌─────────┐
              │  Start  │
              └─────────┘
                   │
                   ▼
        ┌──────────────────────────┐
        │ GPS module is powered on │
        │ and in normal operation  │
        │           mode           │
        └──────────────────────────┘
                   │
                   ▼
        ┌──────────────────────────┐        unsigned char StandbyMode[] = {"$PMTK161,0*28\x0D\x0A"};
        │     Change GPS to        │
        │     standby mode         │
        └──────────────────────────┘
                   │
                   ▼
             ◇ Wake up ◇ ──── Yes
             ◇ GPS module ◇          │
                   │                 ▼
                   No        ┌──────────────────┐
                   │         │  Issue any byte  │
                   │         │ to wake up GPS   │
                   │         │     module       │
                   │         └──────────────────┘
                   │                 │
                   │         GPS module will return {"$PMTK010,002*2D\x0D\x0A"}
                   │         and start normal operation.
                   ▼◄────────────────┘
              ┌─────────┐
              │   End   │
              └─────────┘
```

5.3.2 Periodic mode

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

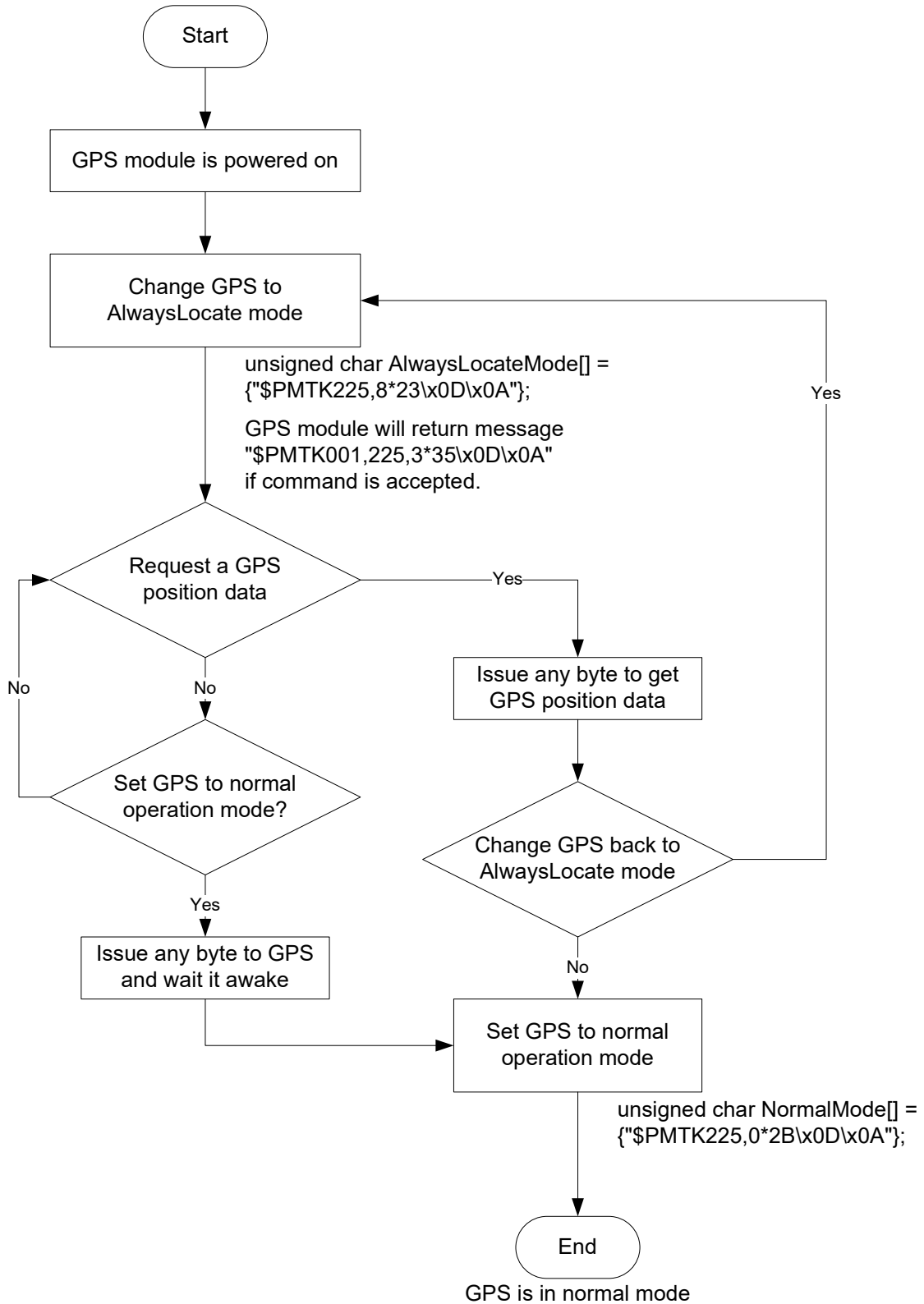The following flow chart is an example to make GPS module go into periodic mode

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and then back to normal operation mode.

```
                    ┌─────────┐
                    │  Start  │
                    └────┬────┘
                         │
                         ▼
              ┌──────────────────────┐
              │ GPS module is powered │
              │          on           │
              └──────────┬───────────┘
                         │
                         ▼
```

Change GPS to periodic mode with 3000ms on and 12000ms standby if position fix is available, otherwise (18000, 72000) ms will be applied.

unsigned char PeriodicMode[] =
{"$PMTK225,2,3000,12000,18000,72000*15\x0D\x0A"};

Note: minimum on time is 2000ms.
maximum standby time is 518400000ms (6 days)

GPS module will return message
"$PMTK001,225,3*35\x0D\x0A"
if command is accepted.

Set GPS to normal operation mode? — Yes

GPS is in standby now — Yes → Issue any byte to GPS and wait it awake

No

Issue command of normal operation mode

unsigned char NormalMode[] =
{"$PMTK225,0*2B\x0D\x0A"};

GPS module will return message
"$PMTK001,225,3*35\x0D\x0A"
if command is accepted.

No

End — GPS is in periodic mode

End — GPS is in normal mode

5.3.3 AlwaysLocate[TM] mode

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

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Note: AlwaysLocate^{TM} is a trade mark of MTK.

```
                    ┌─────────┐
                    │  Start  │
                    └────┬────┘
                         │
                         ▼
          ┌──────────────────────────┐
          │ GPS module is powered on │
          └──────────────┬───────────┘
                         │
                         ▼
          ┌──────────────────────────┐
          │    Change GPS to         │◄──────────────┐
          │   AlwaysLocate mode      │               │
          └──────────────┬───────────┘               │ Yes
```

unsigned char AlwaysLocateMode[] =
{"$PMTK225,8*23\x0D\x0A"};

GPS module will return message
"$PMTK001,225,3*35\x0D\x0A"
if command is accepted.

Request a GPS position data — Yes → Issue any byte to get GPS position data

Request a GPS position data — No → Set GPS to normal operation mode?

Set GPS to normal operation mode? — Yes → Issue any byte to GPS and wait it awake

Change GPS back to AlwaysLocate mode — Yes → Change GPS to AlwaysLocate mode

Change GPS back to AlwaysLocate mode — No → Set GPS to normal operation mode

unsigned char NormalMode[] =
{"$PMTK225,0*2B\x0D\x0A"};

End

GPS is in normal mode

5.4 Data logger

The GPS module has internal flash memory for logging GPS data. The configurations

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include time interval, distance, speed, logging mode, and … etc. For more information, please contact us.

5.5 Examples to configure the update rate of GPS module

The GPS 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, GPS 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	$PMTK314,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0*29<CR><LF>
Only RMC at 1Hz	$PMTK314,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0*29<CR><LF>
Only VTG at 1Hz	$PMTK314,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0*29<CR><LF>
Only GGA at 1Hz	$PMTK314,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0*29<CR><LF>
Only GSA at 1Hz	$PMTK314,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0*29<CR><LF>
Only GSV at 1Hz	$PMTK314,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0*29<CR><LF>
Only ZDA at 1Hz	$PMTK314,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0*29<CR><LF>
RMC, GGA, GSA at 1Hz and GSV at 0.2Hz	$PMTK314,0,1,0,1,1,5,0,0,0,0,0,0,0,0,0,0,0,0,0*2C<CR><LF>
If the command is correct and executed, GPS module will output message	

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$PMTK001,314,3*36<CR><LF>

After the GPS 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, GPS 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.

5.6 Configure the static navigation parameter

The output position of GPS 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 GPS 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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```
                    ┌─────────┐
                    │  Start  │
                    └─────────┘
                         │
                         ▼
          ┌──────────────────────────────┐
          │ Change static navigation to   │
          │ 1.5m/s threshold              │
          └──────────────────────────────┘
```

unsigned char SpeedThreshold1_5[] =
{"$PMTK386,1.5*39\x0D\x0A"};

GPS module will return message
"$PMTK001,386,3*3D\x0D\x0A"
if command is accepted.

```
            ◇ Disable static
              navigation function?  ──── Yes ───┐
                         │                      │
                         │                      ▼
                         │          ┌──────────────────────┐
                         │          │   Set 0 threshold     │
                         │          └──────────────────────┘
```

unsigned char SpeedThreshold0[] =
{"$PMTK386,0*23\x0D\x0A"};

GPS module will return message
"$PMTK001,386,3*3D\x0D\x0A"
if command is accepted.

```
                        No
                         │
                         ▼
                    ┌─────────┐
                    │   End   │
                    └─────────┘
```

5.7   Receive NMEA data through I2C interface

I2C slave address is 0x10. I2C TX buffer of GPS module has 255 bytes. Master can read one I2C data packet maximum 255 bytes at a time. In order to read entire NMEA packet of one second, master needs to read several I2C data packets and extract valid NMEA data from them.

After reading one I2C data packet, master needs to sleep 5ms to read next I2C data packet because GPS module spends 5ms to upload new I2C data into its I2C buffer.

5.7.1   I2C data packet format in slave buffer

I2C data packet in slave buffer has 254 valid NMEA bytes at most and one end character <LF>, so master must read maximum 255 bytes as an I2C data packet at a time. When slave buffer is empty, master will read one I2C data packet with all garbage byte, i.e. <LF>.

Packet format in slave buffer:

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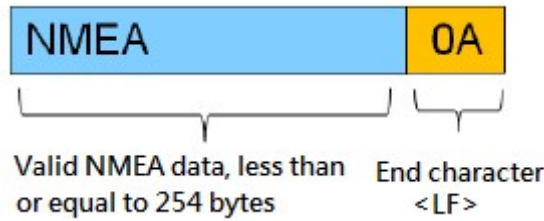
Example:

There are 254 valid NMEA bytes and 1 end character <LF> in I2C slave buffer as follwing figure.

5.7.2 Three types of I2C packet that master may read

I. When slave buffer already has some data, master read one I2C packet (255 bytes). It includes some valid data in the header of packet and some garbage bytes in the end of packet.

One I2C packet, total 255 bytes
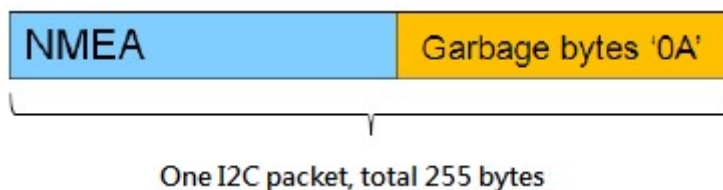
Example:

If slave buffer has 202 bytes NMEA data, master reads one I2C packet (255 bytes), the read packet format is as following.

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Note: Why garbage byte is '0A'? Because if I2C slave buffer is empty, GPS module will output last valid byte repeatedly until new data upload into I2C buffer, '0A' is the last valid byte in the last NMEA packet.

II. When slave buffer is empty, master read one I2C packet (255 bytes). All data in packet are gargabe bytes.

Example:

III. If slave buffer is empty, master start to read one I2C packet (will read garbage bytes

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in the beginning). When this reading procedure is not over, master will read valid N

One IC packet, total 255 bytes

Example:

5.8 Write command through I2C interface

User can input MTK proprietary message through I2C bus. The maximum input bytes of one I2C packet is 255. The time interval of two input I2C packets can't be less than 30 milliseconds because GPS module needs 30 milliseconds to process input data.
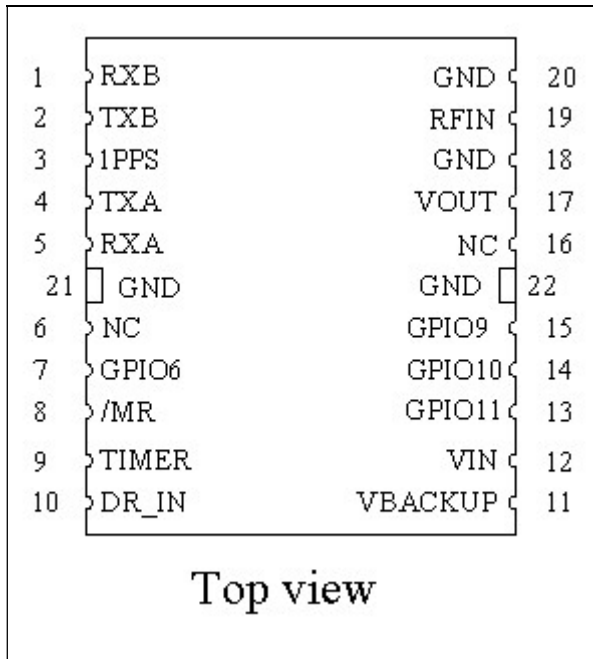
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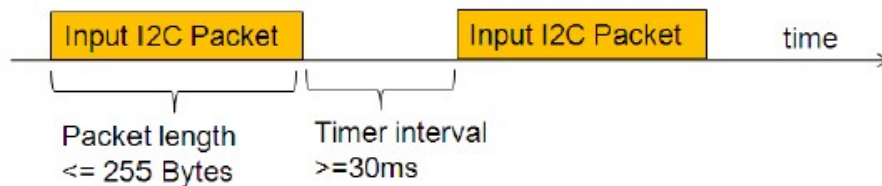
6 Pin assignment and descriptions

```
 1  ⊳RXB              GND⊲  20
 2  ⊳TXB             RFIN⊲  19
 3  ⊳1PPS             GND⊲  18
 4  ⊳TXA             VOUT⊲  17
 5  ⊳RXA               NC⊲  16
21  ☐ GND             GND☐  22
 6  ⊳NC             GPIO9⊲  15
 7  ⊳GPIO6         GPIO10⊲  14
 8  ⊳/MR           GPIO11⊲  13
 9  ⊳TIMER            VIN⊲  12
10  ⊳DR_IN        VBACKUP⊲  11

            Top view
```

Table 6-1 Pin descriptions

Pin #	Name	Type	Description	Note
1	RXB/ I2C_SCL	I	Serial input for channel B, or NMEA I2C_SCL	1
2	TXB/ I2C_SDA	O/I	Serial output for channel B, or NMEA I2C_SDA	1
3	1PPS	O	Pulse per second (default 100 ms pulse/sec when 3D fix is available)	
4	TXA	O	Serial output for channel A (Default NMEA)	
5	RXA	I	Serial input for channel A (Default NMEA)	
6	NC		Not connect	
7	GPIO6	I/O	General purpose I/O (Default status indicator. When GPS position fix is available, it outputs 50ms high per second, otherwise it outputs low.)	
8	/MR	I	Manual reset input pin. Active at "L" input. Internal pulled up via a resistor. If /MR pin is not necessary, open this node.	
9	TIMER	OD	Open drain. Wake up other device from RTC.	
10	DR_IN	I	Wakeup signal input from such a G sensor	
11	VBACKUP	P	Backup battery supply voltage This pin must be powered to enable the module.	
12	VIN	P	DC supply voltage	

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13	GPIO11	I/O	General purpose I/O	
14	GPIO10	I/O	General purpose I/O	
15	GPIO9	I/O	General purpose I/O	
16	NC		Not connect	
17	VOUT	P	Linear regulator power output, 2.85V (Do not use this as power source of backup battery)	
18	GND	P	Ground	
19	RFIN	I	GPS RF signal input	
20	GND	P	Ground	
21	GND	P	Ground	
22	GND	P	Ground	

＜Note＞

1. Work on I2C slave mode with slave address 0x10. The bit rate is up to 400K bit/s. I2C function is default disabled. Please contact us to enable it.
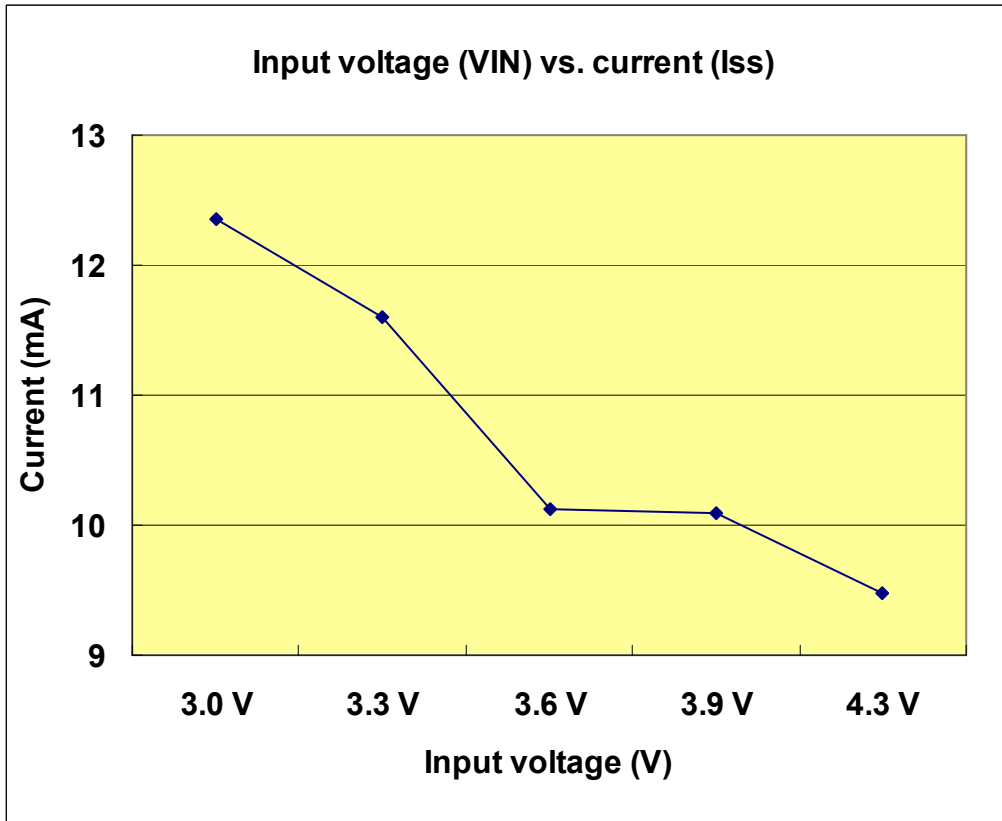
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7 DC & Temperature characteristics

7.1 Absolute maximum ratings

Parameter	Symbol	Ratings	Units
Input Voltage	VIN	4.3	V
Input Backup Battery Voltage	VBACKUP	4.3	V
2.85V Output Current	Iout	50	mA
Operating Temperature Range	Topr	-40 ~ 85	℃
Storage Temperature Range	Tstg	-40 ~ 85	℃

7.2 DC Electrical characteristics

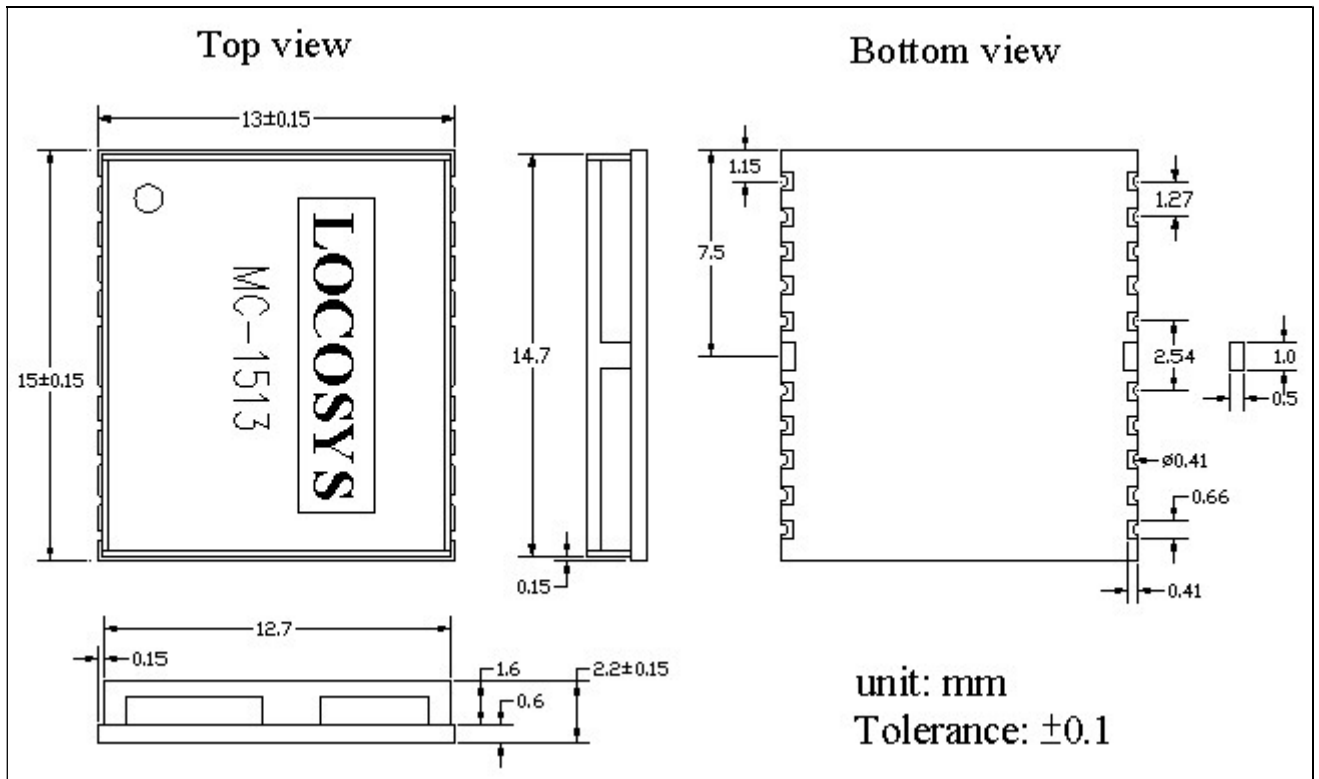| Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Input Voltage	VIN	Iout = 0	3.0		4.3	V
Input Backup Battery Voltage	VBACKUP		2.0		4.3	V
2.85V Output Voltage	VOUT		2.7	2.8	2.9	V
Supply Current	Iss	VIN = 3.3V, Iout = 0, Peak Acquisition Tracking Standby		14 $12^{(1)}$ 150	66	mA mA mA uA
Backup Battery Current	Ibat	VIN = 0V		6		uA
2.85V Output Current	Iout	VIN = 3.3V			30	mA
High Level Input Voltage	V_{IH}		2.0		3.6	V
Low Level Input Voltage	V_{IL}		-0.3		0.8	V
High Level Input Current	I_{IH}	no pull-up or down	-1		1	uA
Low Level Input Current	I_{IL}	no pull-up or down	-1		1	uA
High Level Output Voltage	V_{OH}		2.4			V
Low Level Output Voltage	V_{OL}				0.4	V
High Level Output Current	I_{OH}			2		mA
Low Level Output Current	I_{OL}			2		mA
Minimum Pulse Width	T_{MPW}	For /MR pin	1			mS

Note 1. Measured when position fix (1Hz) is available, input voltage is 3.3V and the function of self-generated ephemeris prediction is inactive. For different input voltage, the current consumption is as below chart. This is because MC-1513 is built-in DC/DC converter.
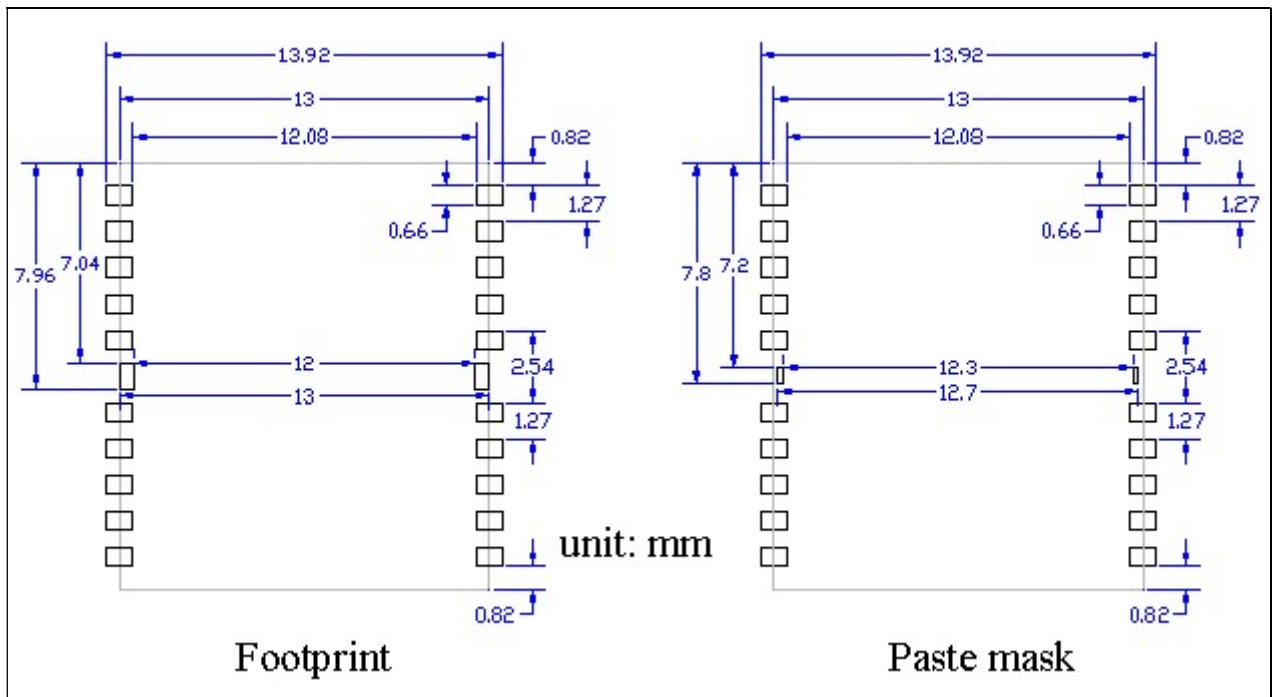
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Input voltage (VIN) vs. current (Iss)

7.3   Temperature characteristics

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

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8 Mechanical specification

8.1 Outline dimensions

8.2 Recommended land pattern dimensions

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9 Reel Packing information

ITEM	DIM	ALTERNATE
A0	$13.5^{+0.10}_{-0.10}$	
B0	$15.5^{+0.10}_{-0.10}$	
K0	$2.5^{+0.10}_{-0.10}$	
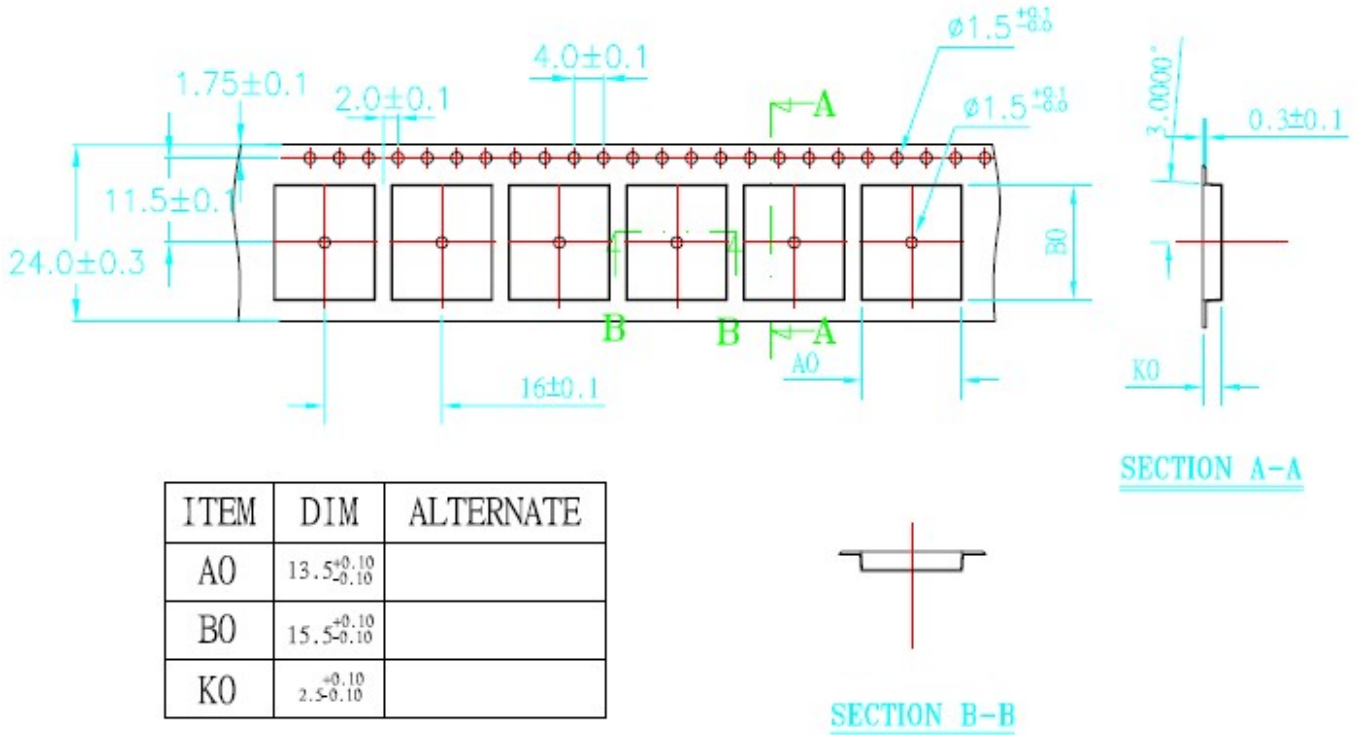
1. 10 sprocket hole pitch cumulative tolerance ±0.20mm.
2. Carrier camber not to exceed 1mm in 100mm.
3. A0 and B0 measured on a plane 0.3mm above the bottom of the pocket.
4. K0 measured from a plane on the inside bottom of the pocket to the top surface of the carrier.
5. All dimensions meet EIA-481-2 requirements.
6. Material: Black Anti-Static Polystyrene.
7. Component load per 13" reel :1000 pcs.

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Document change list

Revision 1.0

- First release on Oct. 19, 2007.

Revision 1.0 to Revision 1.1 (June 19, 2009)

- Changed GPS chip from MT3318 to MT3329 on page 4. The units with date code after 0924 will be changed to new chip.
- Added "Support AGPS" on page 1.
- Added Fig 3-4 on page 4.
- Changed channels from 32 to 66 on page 5.
- Changed update rate from "up to 5Hz" to "up to 10Hz" on page 5.
- Changed tracking sensitivity from "-157.5dBm, up to -159dBm" to "-164dBm, up to -165dBm" on page 5.
- Changed cold start sensitivity from "-144.5dBm, up to -146dBm" to "-147dBm, up to -148dBm" on page 5.
- Changed hot start time from "2s (typical)" to "<2s (typical)" on page 5.
- Changed cold start time from 36s to 35s on page 5.
- Changed pin number 9 from GPIO1 to NC on page 9.
- Changed pin number 13 from GPIO3 to VDD_USB on page 9.
- Changed pin number 14 from GPIO4 to USB_DM on page 9.
- Changed pin number 15 from GPIO5 to USB_DP on page 9.
- Changed absolute maximum Input Voltage from 6.5V to 4.3V on page 11
- Changed absolute maximum Input Battery Backup Voltage from 7V to 4.3V on page 11
- Changed Input Battery Backup Voltage from "1.1V~6.0V" to "2.0V~4.3V" on page 11
- Changed 2.85V Output Voltage from "2.79V~2.91V" to "2.7V~2.9V" on page 11
- Changed Battery Backup Current from 2.8uA to 5uA on page 11
- Changed the peak supply current from 71mA to 56mA on page 11.
- Changed typical acquisition current from 56mA to 32mA on page 11.
- Changed typical tracking current from 40mA to 28mA on page 11.

Revision 1.1 to Revision 1.2 (April 11, 2011)

- Upgraded GPS firmware to version AXN1.5.
- Changed cold start time from 35s to 33s on page 5.
- Added "< 15s (typical) with AGPS (Long Term Orbit)" on page 5.
- Revised tracking current from 28mA to 26mA on page 11

Revision 1.2 to Revision 1.3 (November 24, 2011)

- Changed GPS chip from MT3329 to MT3339 on page 5. The units with a capital T after the date code on the metal shield have been changed to new chip.
- Added the description of hybrid ephemeris prediction in section 1.

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- Added several new features in section 2.

- Changed Fig 3-1, Fig 3-2, Fig 3-3 and Fig 3-4

- Removed Fig 3-5

- Changed tracking sensitivity from -164dBm to -161dBm on page 4

- Changed Cold sensitivity from -147dBm to -142.5dBm on page 4

- Changed hot start time from < 2s to < 1s on page 4.

- Changed cold start time from 33s to 32s on page 4.

- Changed Max. Altitude from 18,000m to 50,000m on page 4.

- Changed the range of satellite ID in GSV message from 32 to 196 on page 7.

- Added "N = data not valid, R=Coarse Position, S=Simulator" in GLL, RMC and VTG message.

- Added section 5.3 and 5.4

- Changed the definition of pin 6 to NC in the Table 6-1.

- Changed the name of pin 7 to GPIO6 in the Table 6-1.

- Changed the definition of pin 9 to TIMER in the Table 6-1.

- Changed the definition of pin 10 to DR_IN in the Table 6-1.

- Changed the definition of pin 13 to GPIO11 in the Table 6-1.

- Changed the definition of pin 14 to GPIO10 in the Table 6-1.

- Changed the definition of pin 15 to GPIO9 in the Table 6-1.

- Changed the maximum input voltage of VCC from 4.2V to 4.3V in the section 7.2.

- Changed the peak supply current from 56mA to 66mA in the section 7.2.

- Changed the acquisition current from 32mA to 14mA in the section 7.2.

- Changed the tracking current from 26mA to 12mA in the section 7.2.

- Added standby current, 150uA in the section 7.2.

- Changed the backup battery current from 5uA to 6uA in the section 7.2

- Changed the picture of input voltage vs. current in the section 7.2

- Remove the section of LNA characteristics

- Changed the minimum operation temperature from -30℃ to -40℃ in the section 7.3

- Added dimension tolerance in the section 8.1

- Added dimension of paste mask in the section 8.2

Revision 1.3 to Revision 1.4 (January 19, 2012)

- Revised 10ns to 11ns in the section 2

- Added section 5.5

Revision 1.4 to Revision 1.5 (March 10, 2014)

- Added I2C interface.

- Added Fig 3-5

- Added section 5.6, 5.7 and 5.8.

Revision 1.5 to Revision 1.6 (November 18, 2021)

- Revised autonomous position accuracy in section 4.