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Product name	Description	Version
MC-1613	Datasheet of MC-1613 stand-alone GPS module	1.2

1 Introduction

LOCOSYS GPS MC-1613 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.

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
- 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
- Up to 10 Hz update rate
- Capable of SBAS (WAAS, EGNOS, MSAS, GAGAN)
- Support SBAS ranging
- Support Japan QZSS
- Indoor and outdoor multi-path detection and compensation
- Small form factor 15.9 x 13.1 x 2.2 mm
- SMD type with stamp holes; RoHS compliant

3 Application

- Personal positioning and navigation
- Automotive navigation
- Marine navigation

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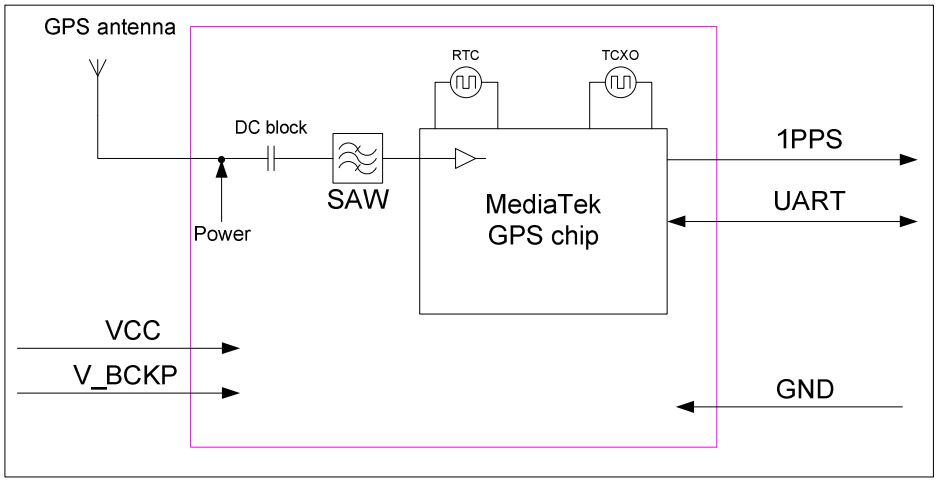

Fig 3-1 System block diagram.

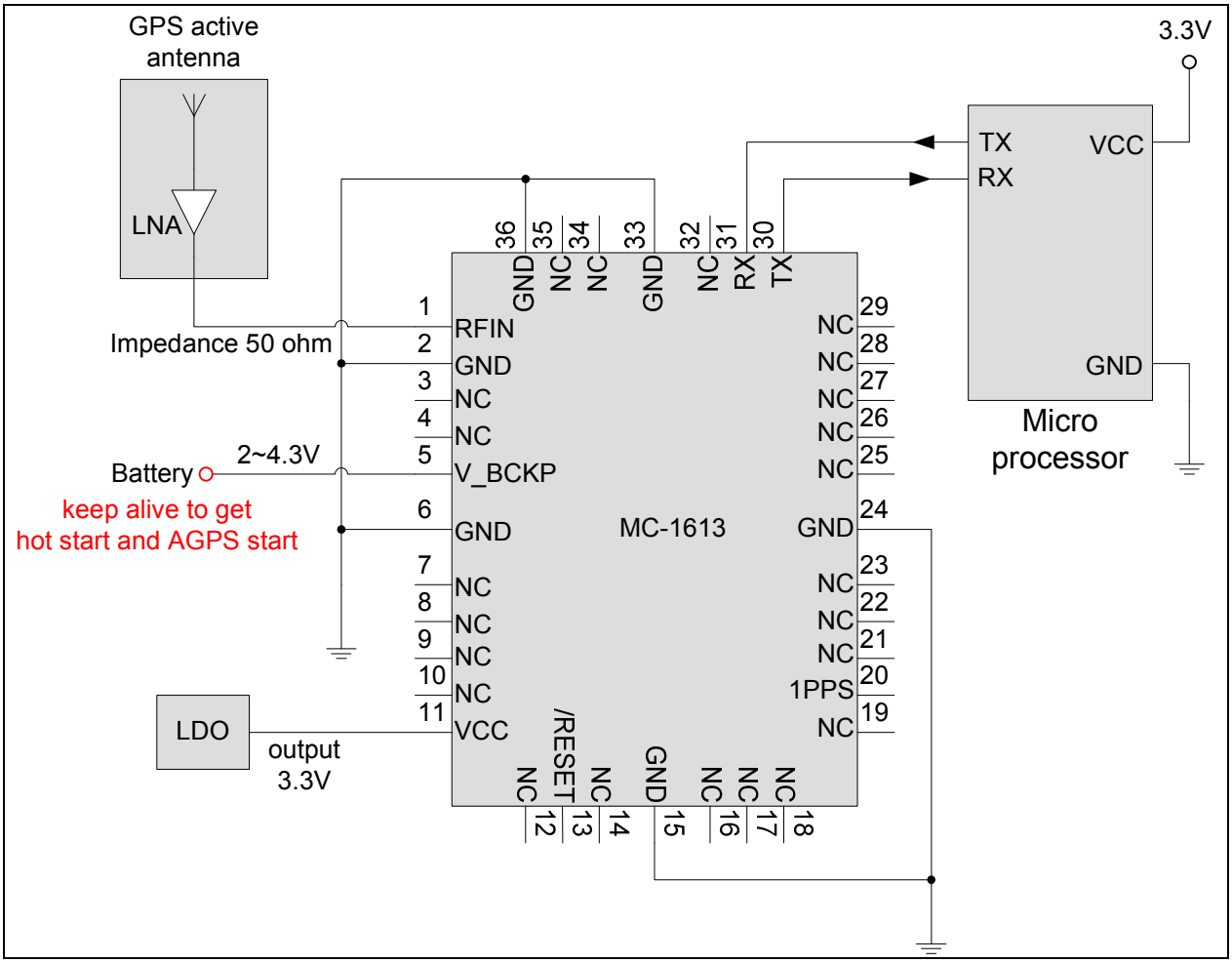

Fig 3-2 Typical application circuit that uses an active antenna

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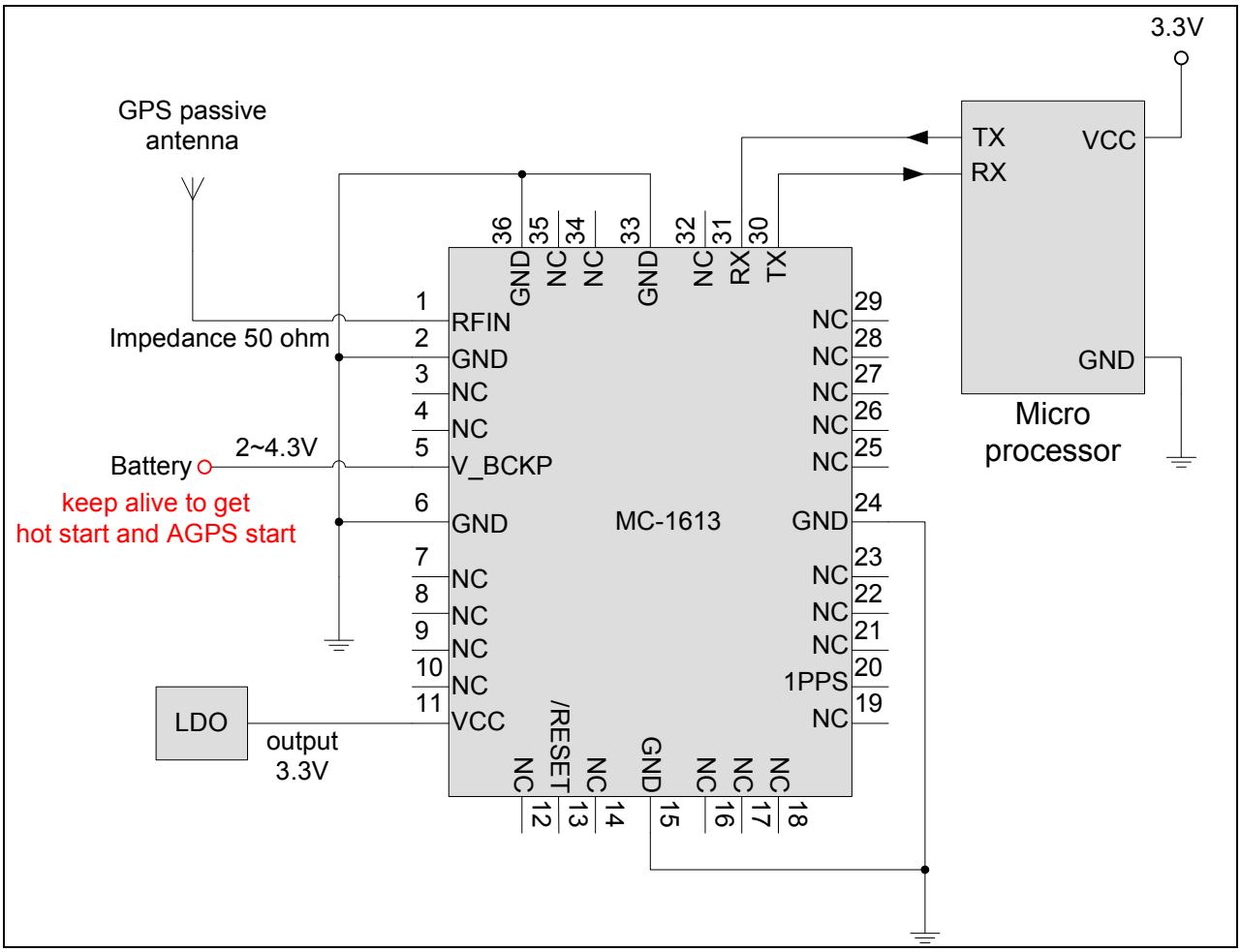

Fig 3-3 Typical application circuit that uses a passive antenna.

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4 GPS receiver and antenna

4.1 GPS receiver

Chip	MediaTek MT3339	
Frequency	L1 1575.42MHz, C/A code	
Channels	Support 66 channels (22 Tracking, 66 Acquisition)	
Update rate	1Hz default, up to 10Hz	
Sensitivity	Tracking	up to -165dBm (with external LNA)
	Cold start	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	3m (2D RMS).
	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(1), 8 data bits, no parity, 1 stop bits (default) 1Hz: GGA, GLL, GSA, GSV, RMC, VTG

Note 1: Both baud rate and output message rate are configurable to be factory default.

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

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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 5.1-3
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 5.1-3 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

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Mode	A		A=autonomous, D=DGPS, E=DR, N=Data not valid, R=Coarse Position(1), 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

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Table 5.1-8 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 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

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Checksum	*53		
<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(1), 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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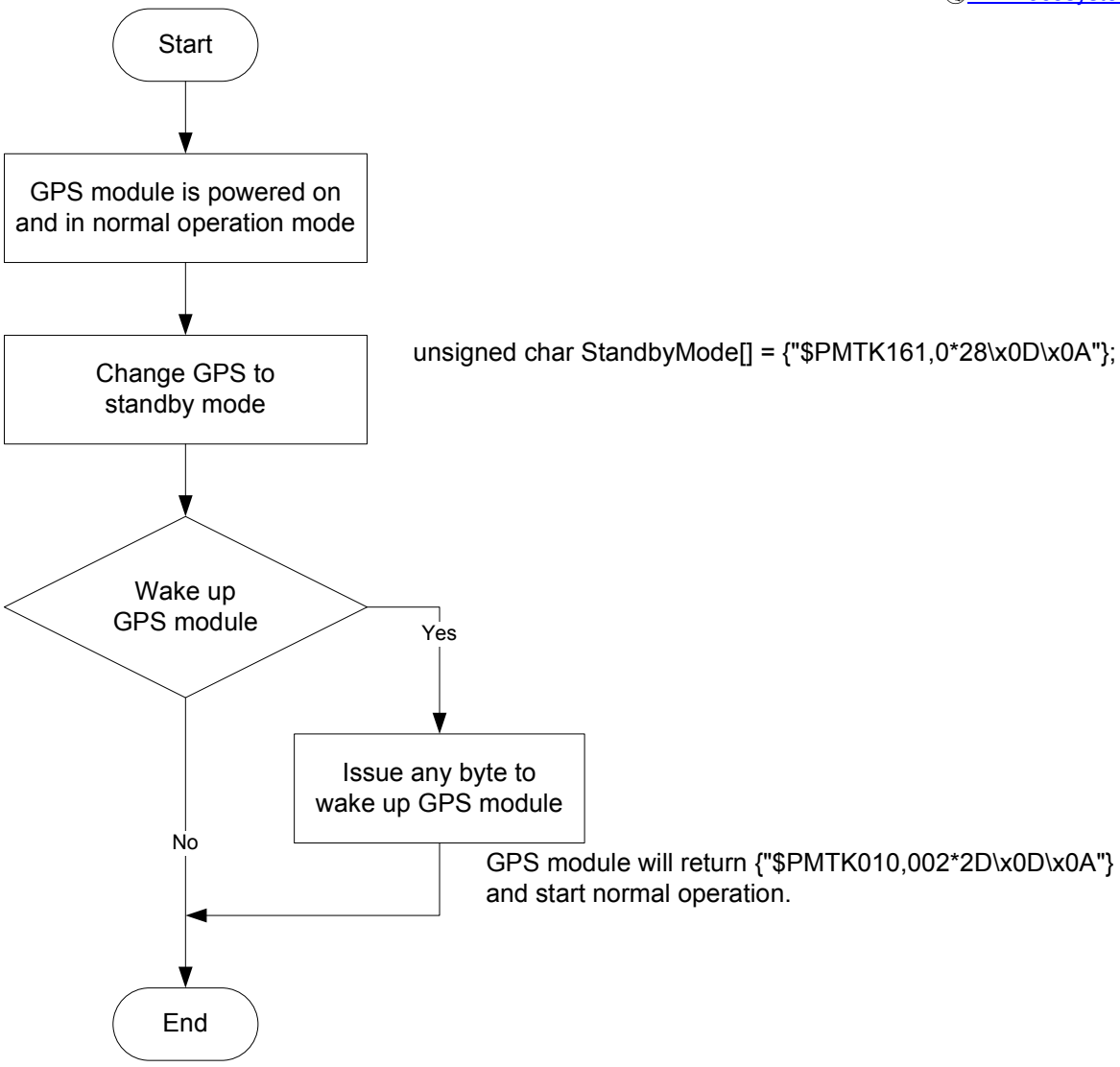
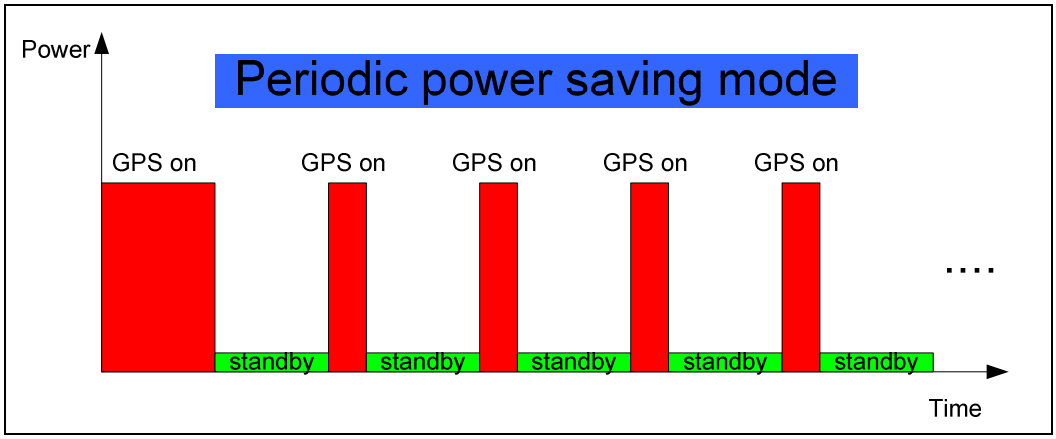


5.3.2 Periodic mode

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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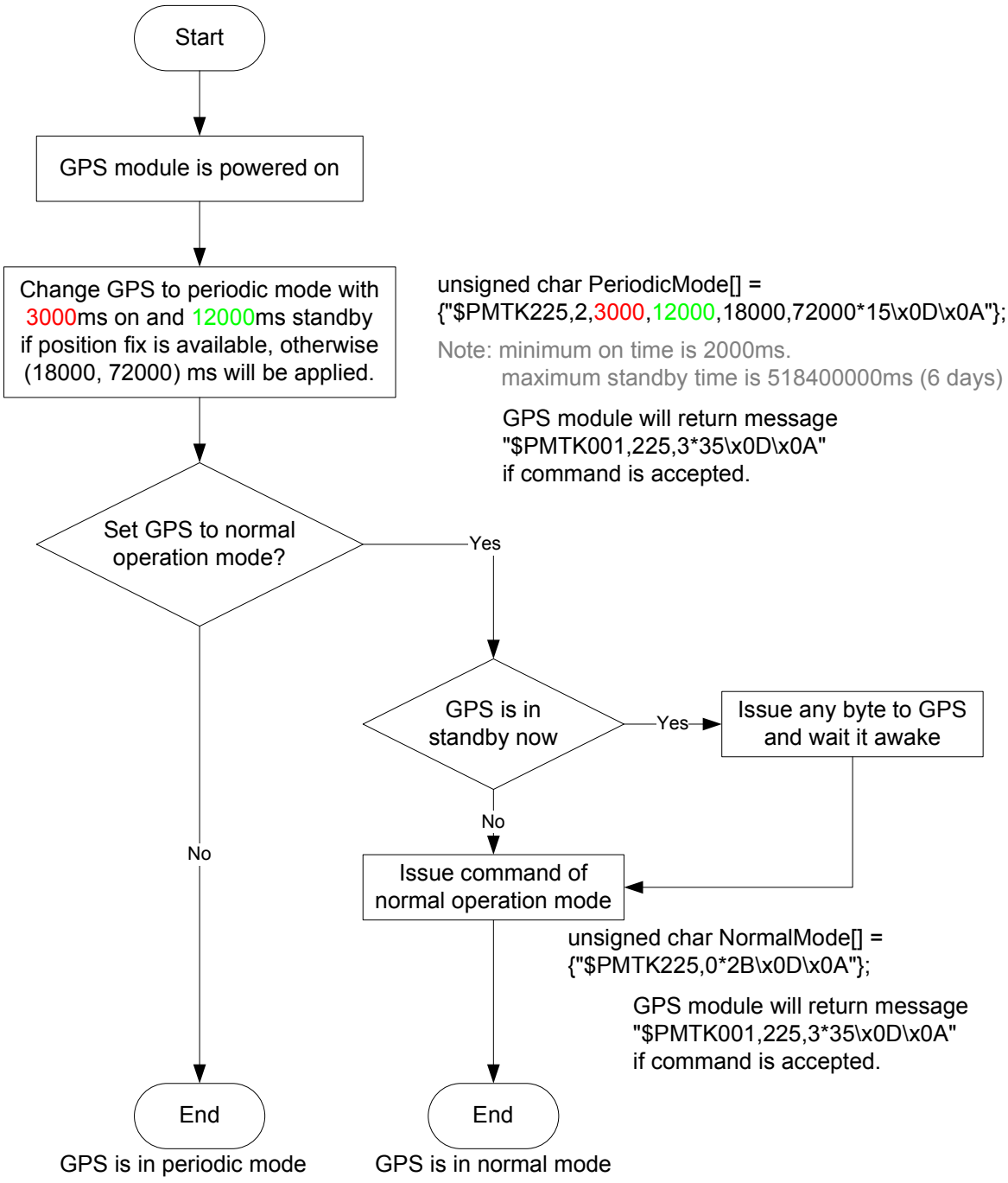
and then back to normal operation mode.



5.3.3 AlwaysLocate™ mode

AlwaysLocate™ 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™ mode and then back to normal operation mode.

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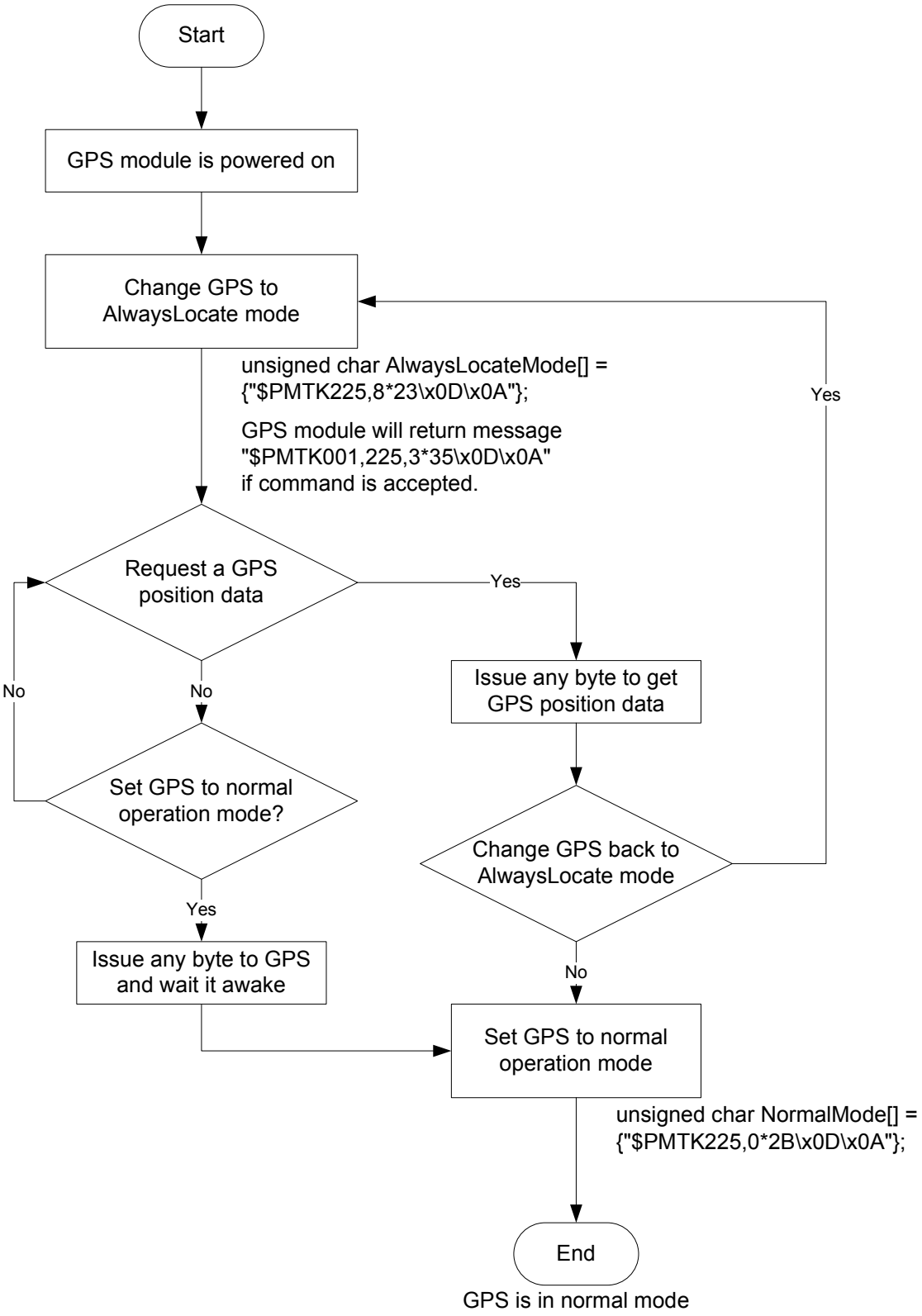
Note: AlwaysLocate™ is a trade mark of MTK.



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.

6 Pin assignment and descriptions

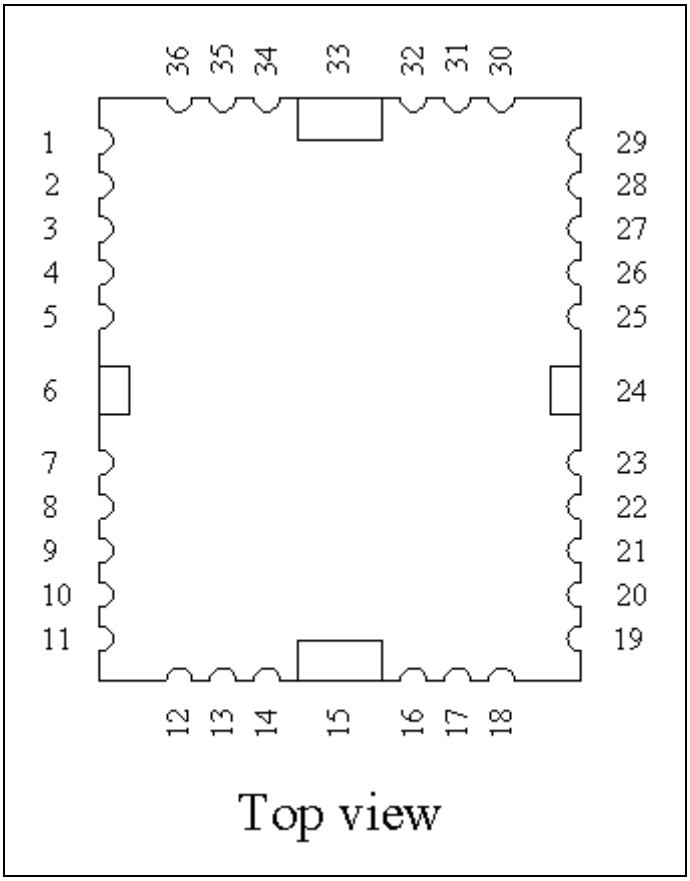

Table 6-1 Pin descriptions

Pin #	Name	Type	Description	Note
1	RFIN	I	GPS RF signal input	1
2	GND	P	Ground	
3	NC		Not connected	
4	NC		Not connected	
5	V_BCKP	P	Backup battery supply voltage **This pin must be powered to enable the module.**	2
6	GND	P	Ground	
7	NC		Not connected	
8	NC		Not connected	
9	NC		Not connected	
10	NC		Not connected	
11	VCC	P	DC supply voltage	

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12	NC		Not connected	
13	/RESET	I	Reset input, active low. GPS module has internal power-on reset circuit, user can leave this pin floating.	
14	NC		Not connected	
15	GND	P	Ground	
16	NC		Not connected	
17	NC		Not connected	
18	NC		Not connected	
19	NC		Not connected	
20	1PPS	O	Pulse per second (default 100ms pulse/sec)	
21	NC		Not connected	
22	NC		Not connected	
23	NC		Not connected	
24	GND	P	Ground	
25	NC		Not connected	
26	NC		Not connected	
27	NC		Not connected	
28	NC		Not connected	
29	NC		Not connected	
30	TX	O	Serial output (Default NMEA)	
31	RX	I	Serial input (Default NMEA)	
32	NC		Not connected	
33	GND	P	Ground	
34	NC		Not connected	
35	NC		Not connected	
36	GND	P	Ground	

<Note>

1. RFIN does not have short circuit protection.
2. In order to get AGPS (Long Term Orbit) advantage, this pin must be always powered during the period of effective AGPS.

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7 DC & Temperature characteristics

7.1 Absolute maximum ratings

Parameter	Symbol	Ratings	Units
Input Voltage	VCC	4.3	V
Input Backup Battery Voltage	V_BCKP	4.3	V
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	VCC		3.0	3.3	4.3	V
Input Backup Battery Voltage	V_BCKP		2.0		4.3	V
Supply Current	Iss	VCC = 3.3V, w/o active antenna, Peak Acquisition Tracking Standby		 26 18(2) 170	87(1)	 mA mA mA uA
Backup Battery Current	Ibat	VCC = 0V		6		uA
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

Note 1. This happens when downloading AGPS data to MC-1613.

Note 2. Measured when position fix (1Hz) is available, input voltage is 3.3V and the function of self-generated ephemeris prediction is inactive.

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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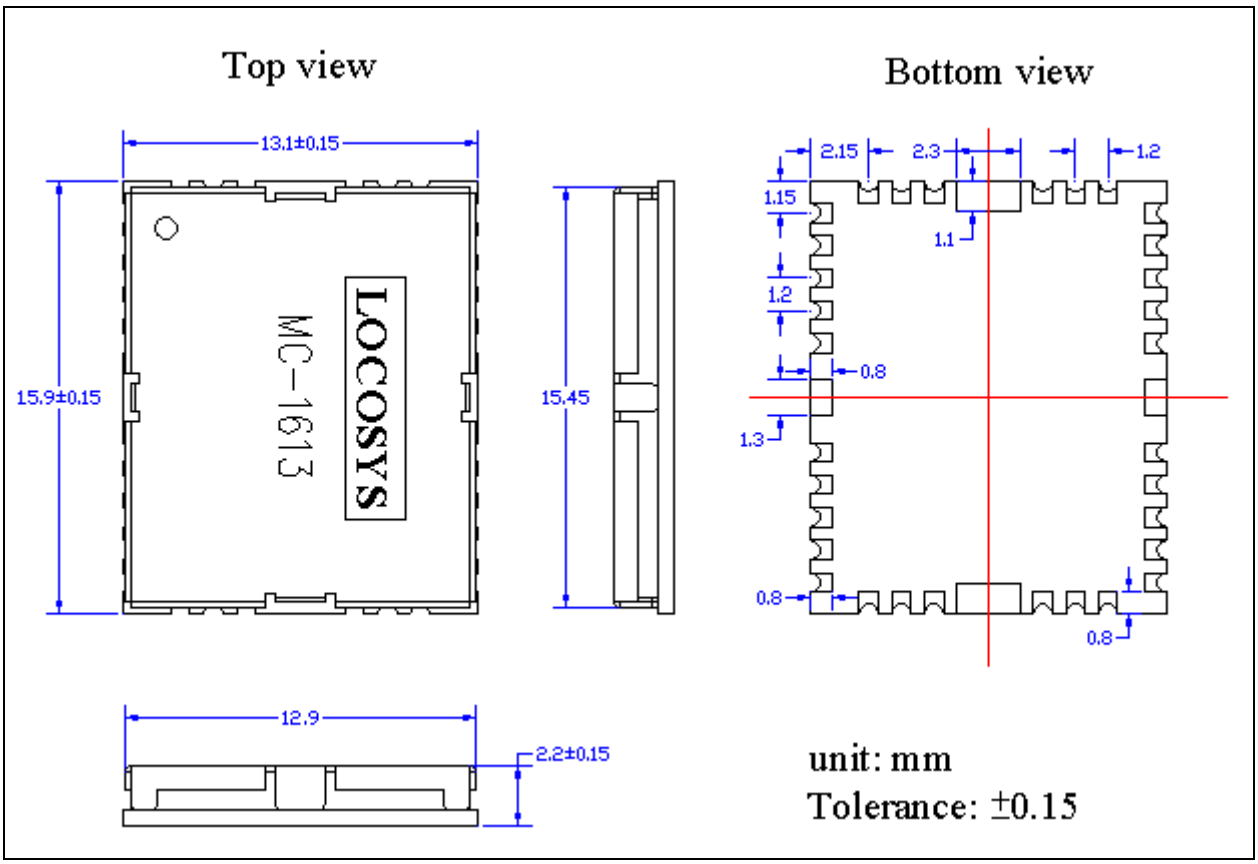
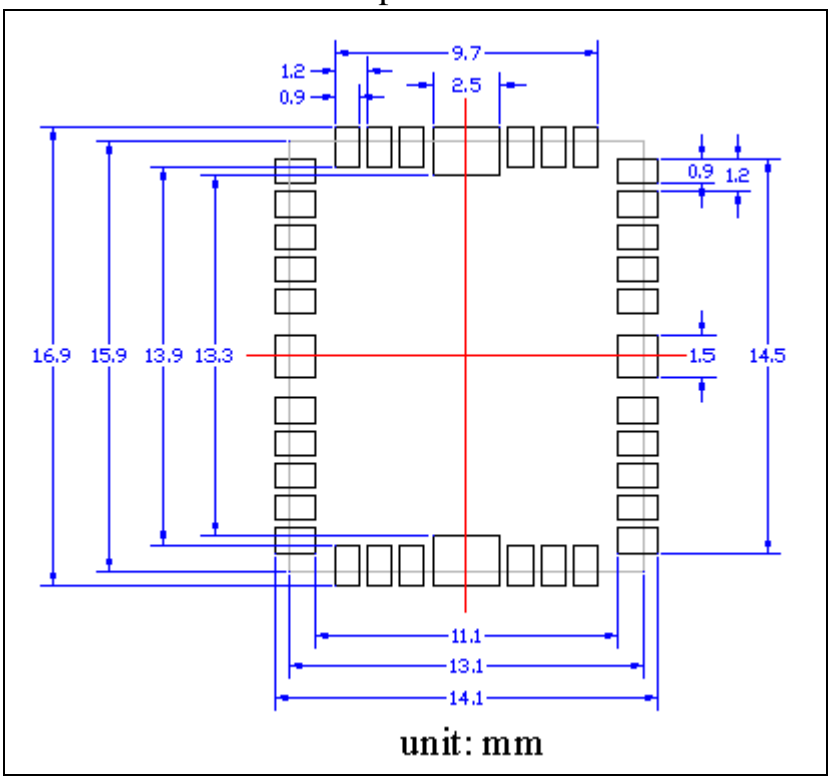
8 Mechanical specification

8.1 Outline dimensions



8.2 Recommended land pattern dimensions



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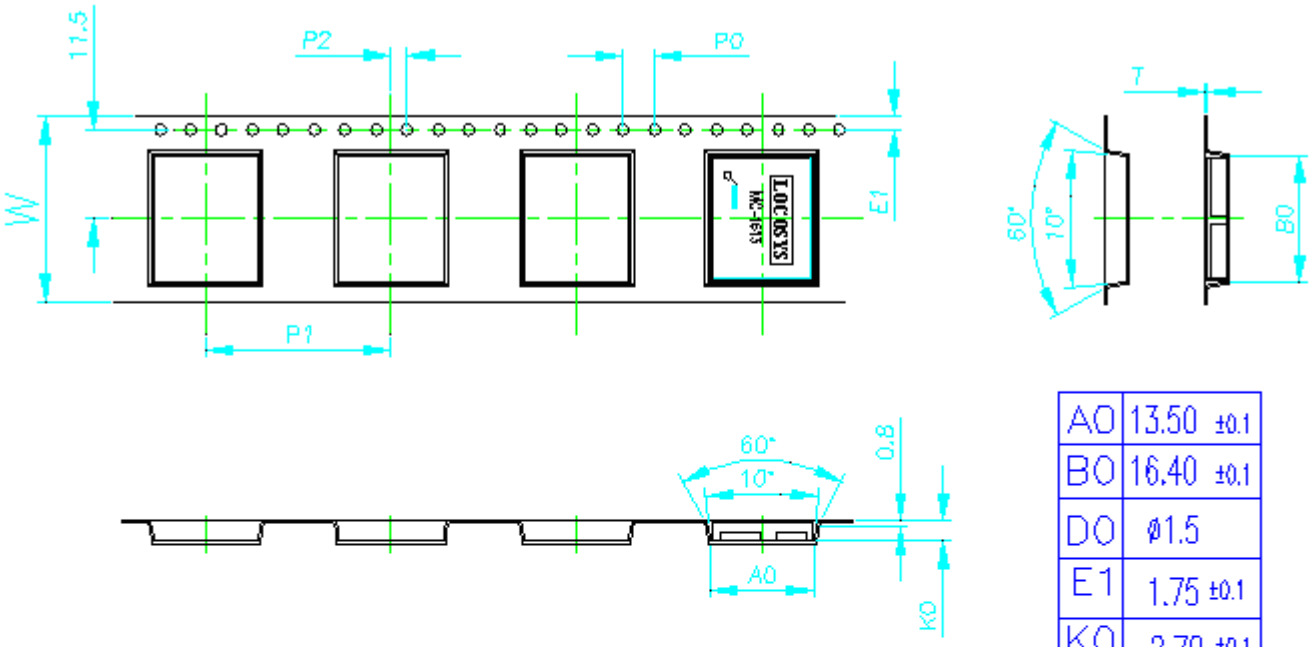
9 Reel packing information



A0	13.50 ±0.1
B0	16.40 ±0.1
D0	ø1.5
E1	1.75 ±0.1
K0	2.70 ±0.1
P0	4.0 ±0.1
P1	24.00 ±0.1
P2	2.0 ±0.10
T	0.3 ±0.10
W	24.0 ±0.30

1. 10 sprocket hole pitch cumulative tolerance ±0.2
2. 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. pocket position relative to sprocket hole measured as true position of pocket,not pocket hole.
6. Component load per 13"reel: 1000 pcs
7. Packimg length per 22"reel: 75 M

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Document change list

Revision 1.0

- First release on Dec. 24, 2010.

Revision 1.0 to Revision 1.1 (April 11, 2011)

- Upgraded GPS firmware to version AXN1.5.
- Changed cold start time from 35s to 33s on page 3
- Changed full cold start time from 38s to 34s on page 3
- Revised RFIN (pin11) to RFIN (pin1) on page 3.
- Changed default 1PPS as 100ms pulse/sec on page 10

Revision 1.1 to Revision 1.2 (November 21, 2011)

- Changed GPS chip from MT3329 to MT3339 on page 4. 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.
- Added several new features in section 2.
- Changed Fig 3-1 and Fig 3-2
- Added Fig 3-3
- Changed hot start time from < 2s to < 1s on page 5.
- Changed cold start time from 33s to 32s on page 5.
- Changed Max. Altitude from 18,000m to 50,000m on page 5.
- Removed the section 4.2
- 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 maximum input voltage of VCC from 3.6V to 4.3V in the section 7.2.
- Changed the peak supply current from 160mA to 87mA in the section 7.2.
- Changed the acquisition current from 35mA to 26mA in the section 7.2.
- Changed the tracking current from 33mA to 18mA in the section 7.2.
- Added standby current, 170uA in the section 7.2.
- Changed the minimum operation temperature from -30℃ to -40℃ in the section 7.3