

| Product name | Description | Version |
|--------------|---------------------------------|---------|
| MC-1612 | Datasheet of MC-1612 GPS module | 1.1 |



1 Introduction

LOCOSYS GPS MC-1612 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
- ± 1 ns high accuracy time pulse (1PPS)
- Capable of SBAS (WAAS, EGNOS, MSAS, GAGAN)
- Support Japan QZSS
- Indoor and outdoor multi-path detection and compensation
- Small form factor 16 x 12.2 x 2.2 mm
- SMD type with stamp holes; RoHS compliant
- ISO/TS 16949 quality control

3 Application

- Personal positioning and navigation
- Automotive navigation
- Marine navigation

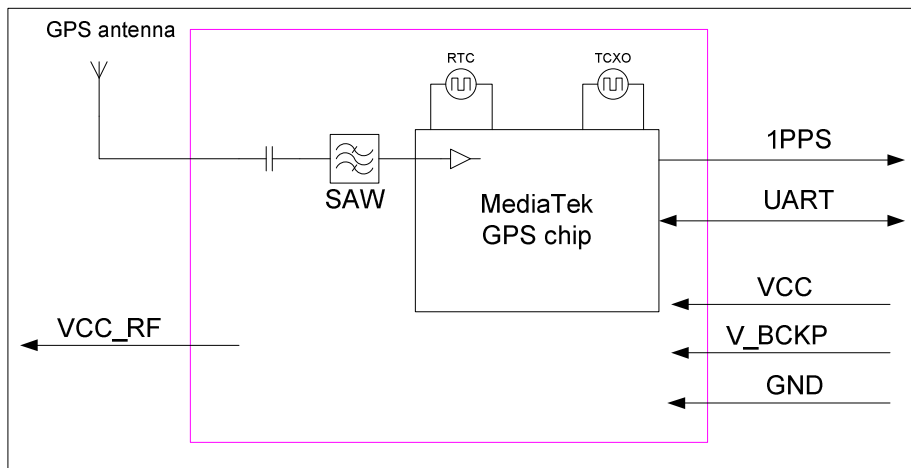


Fig 3-1 System block diagram.

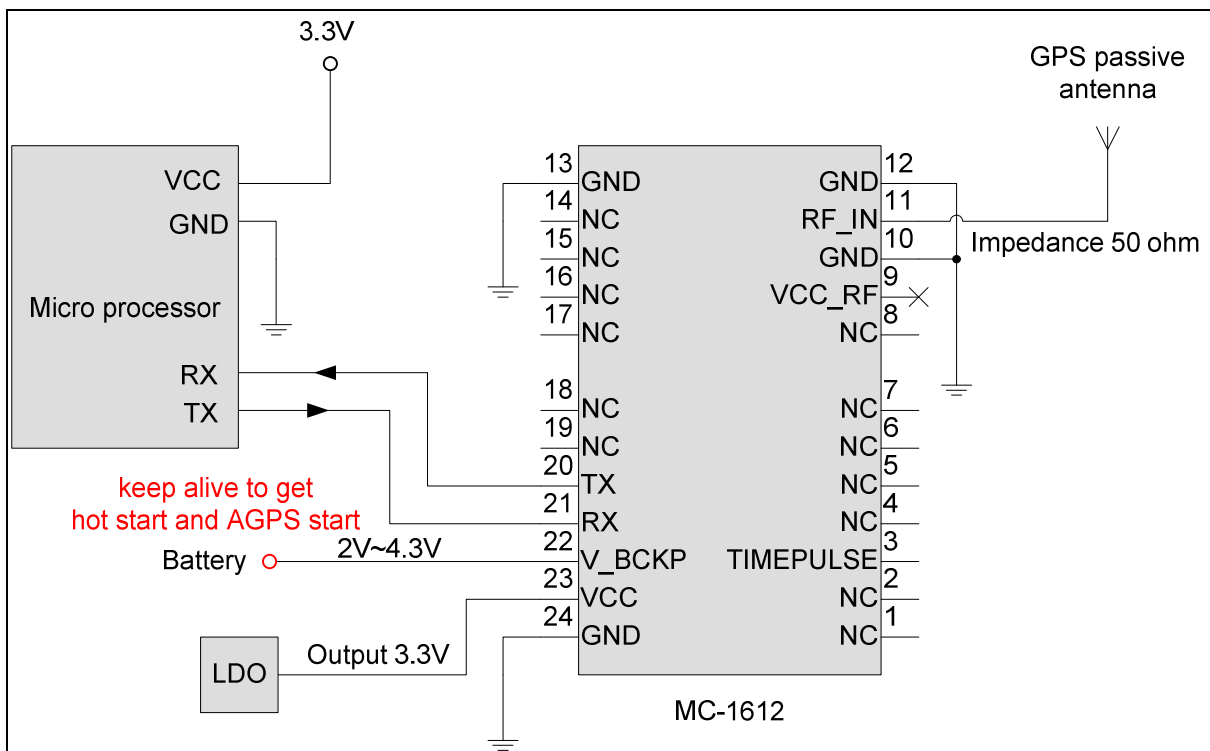


Fig 3-2 Typical application circuit that uses a passive antenna.

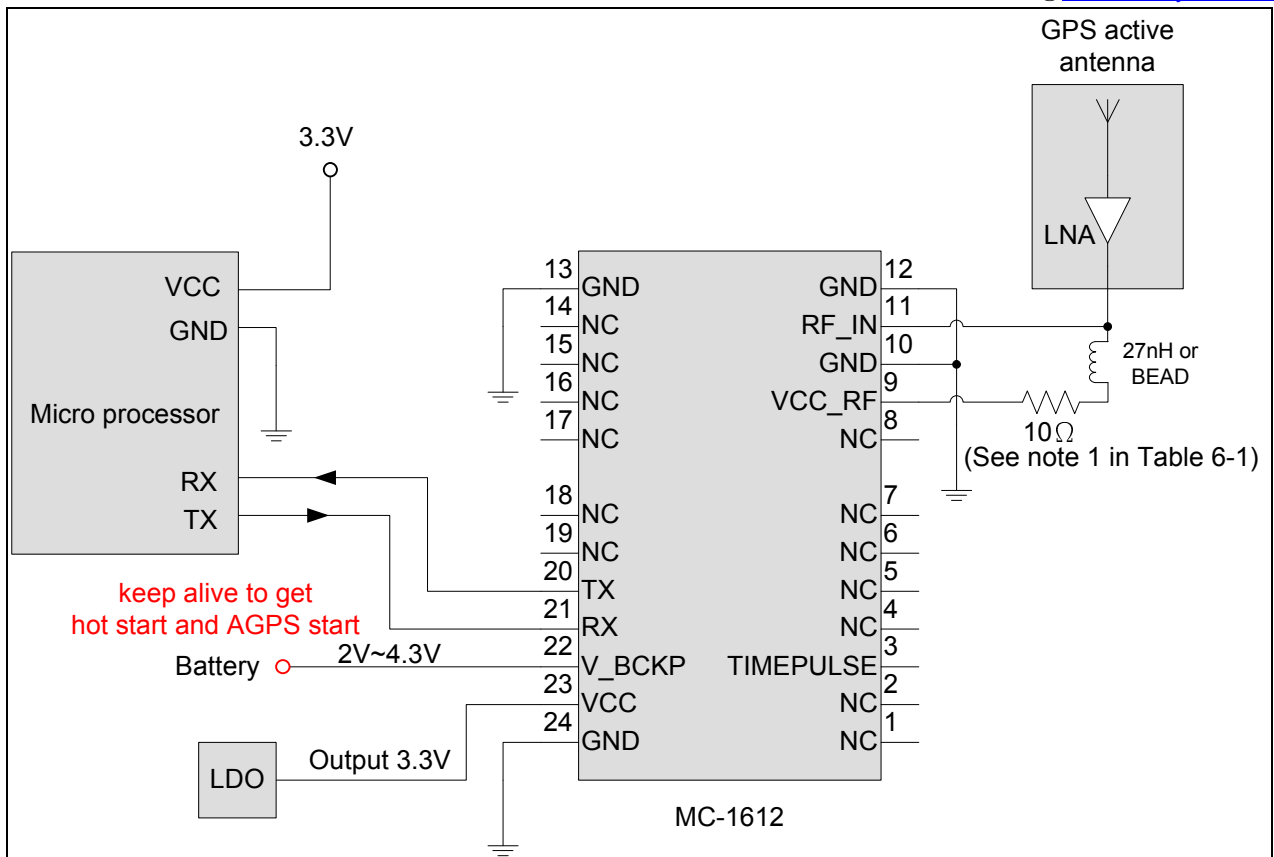


Fig 3-3 Typical application circuit that uses an active antenna.

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 | -162dBm, up to -165dBm (with external LNA) |
| | Cold start | -143.5dBm, 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 | 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

Table 5.1-2 GGA Data Format

| 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 5.1-3 |
| 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 |

| | | | |
|-----------|-----|--|----------------------------|
| Mode | A | | A=autonomous, D=DGPS, E=DR |
| 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

| 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 5.1-9 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 |
| 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 |
| Checksum | *38 | | |
| <CR> <LF> | | | End of message termination |

5.2 Proprietary NMEA input/output message

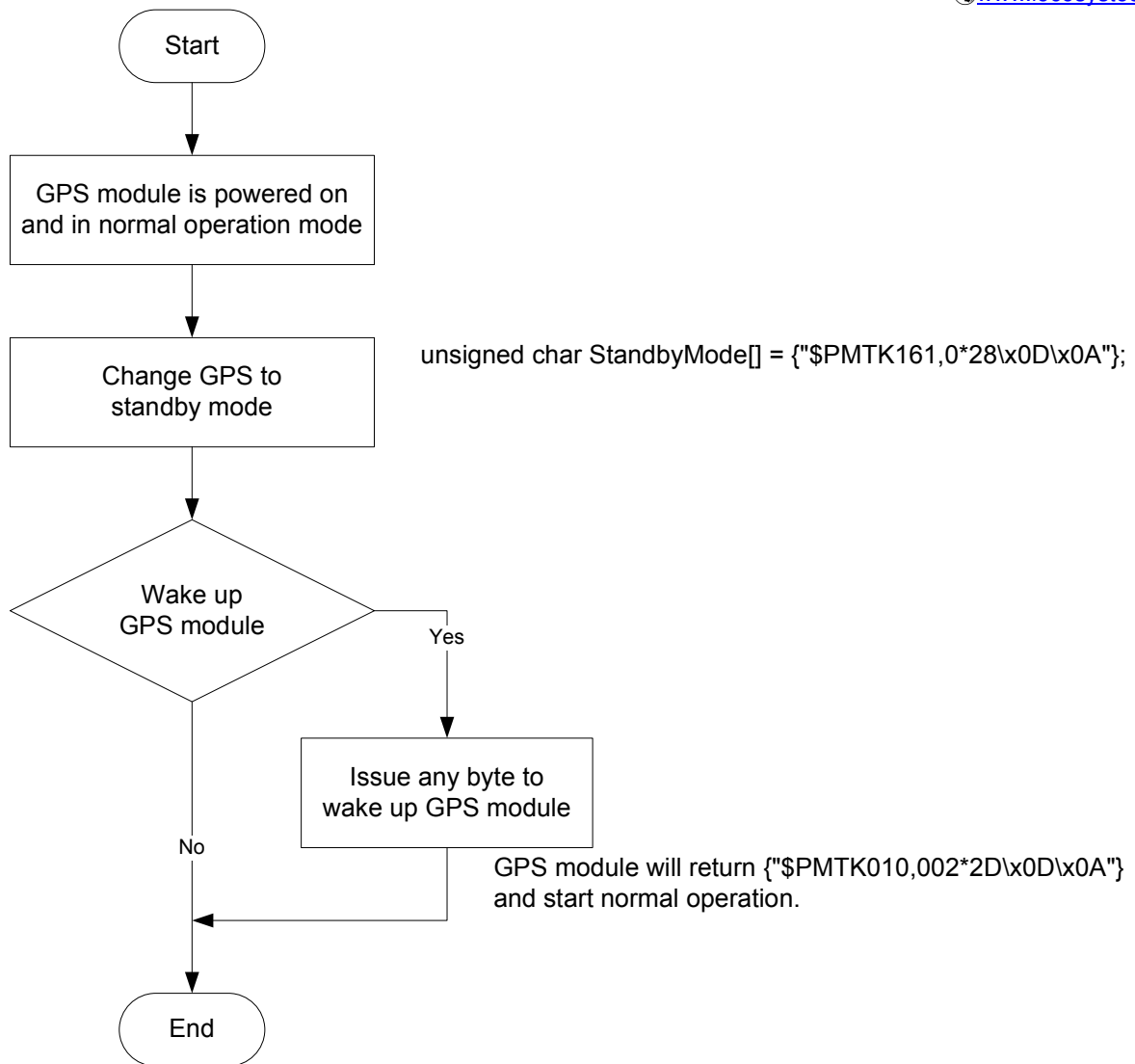
Please refer to MTK proprietary message.

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.

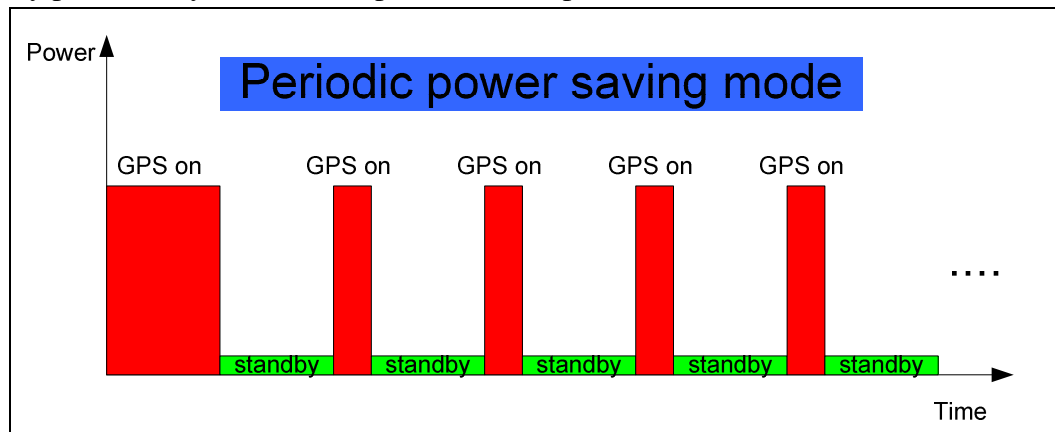
5.3.1 Standby mode

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.



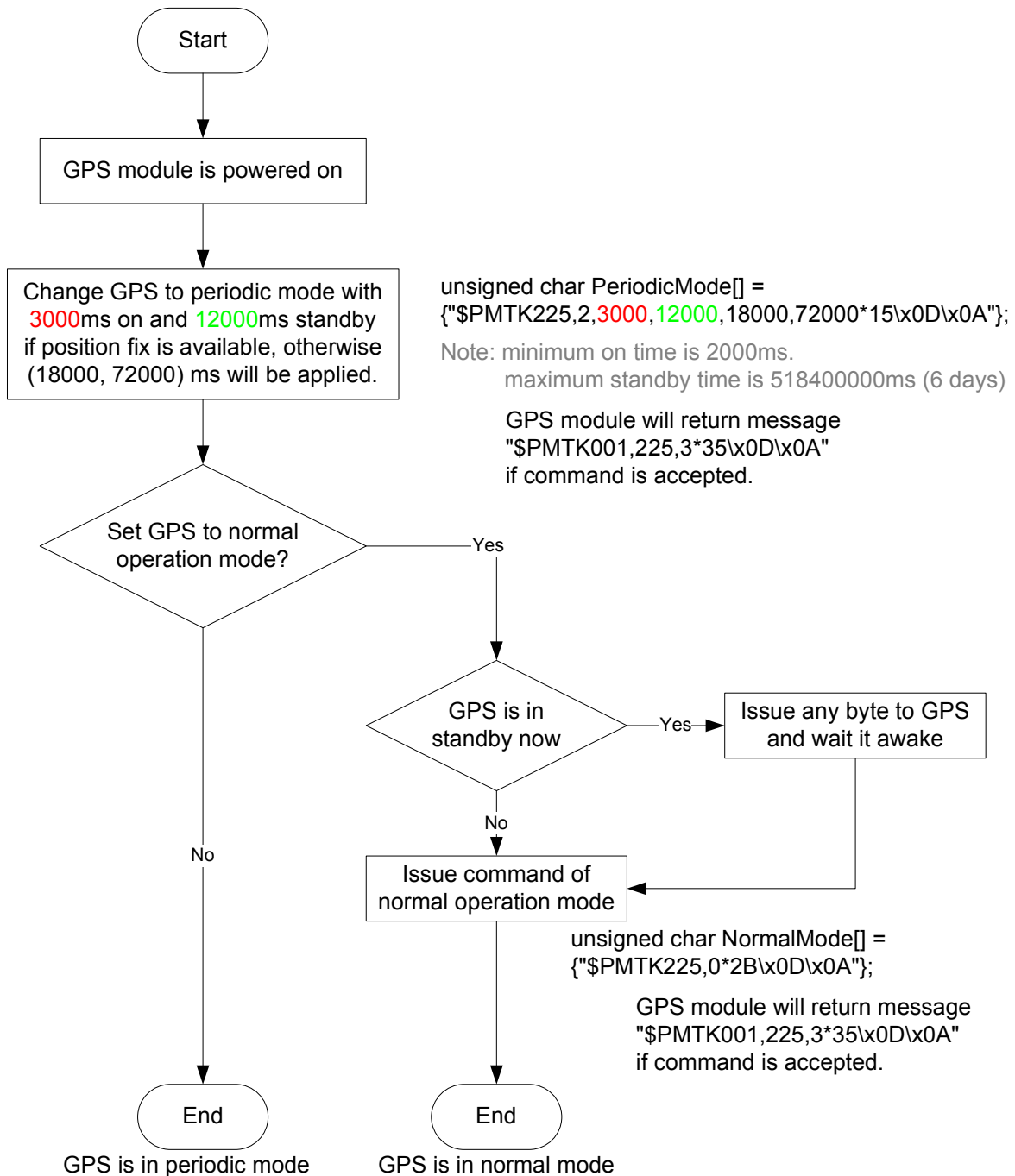
5.3.2 Periodic mode

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

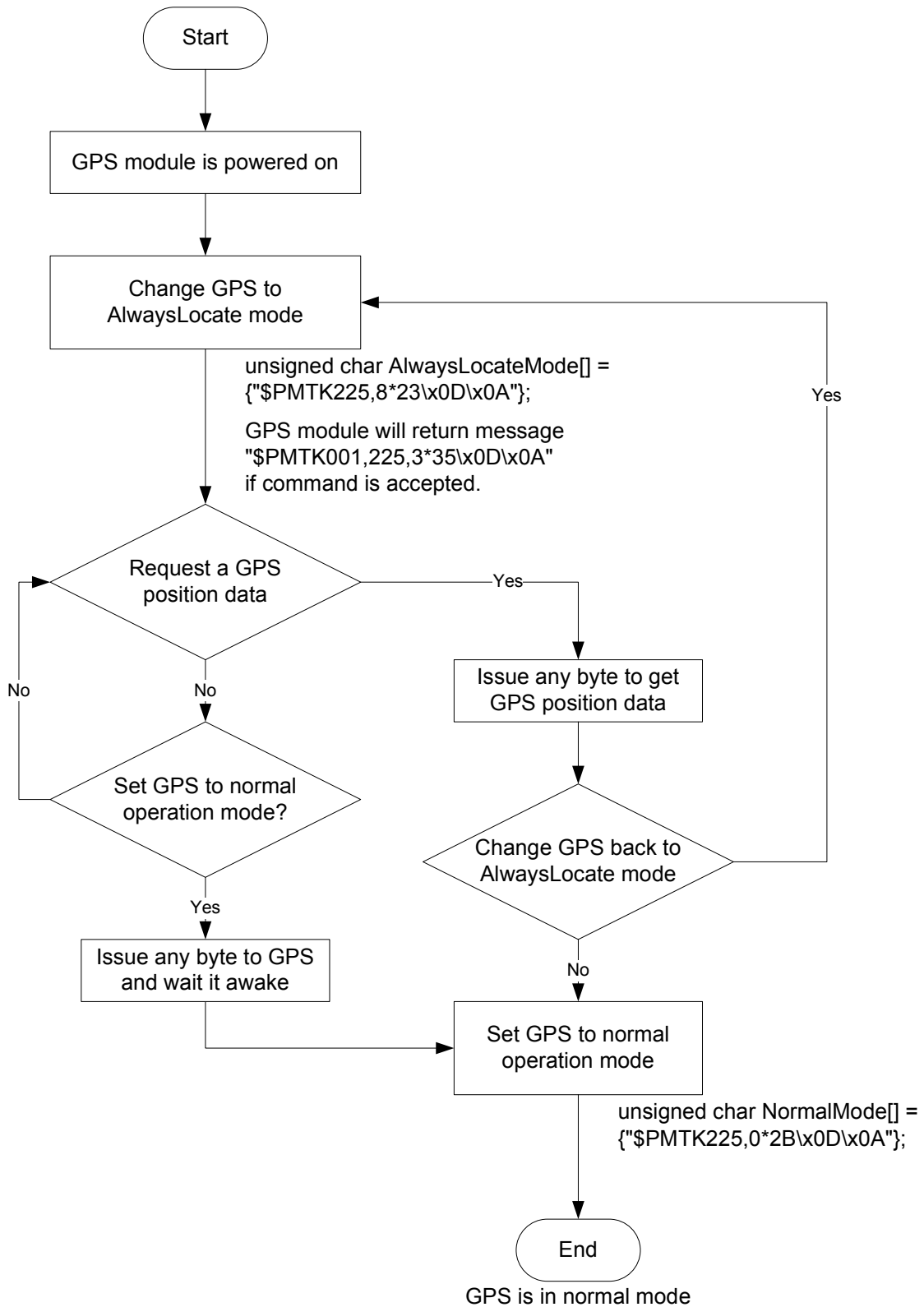
and then back to normal operation mode.



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.

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

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

6 Pin assignment and descriptions

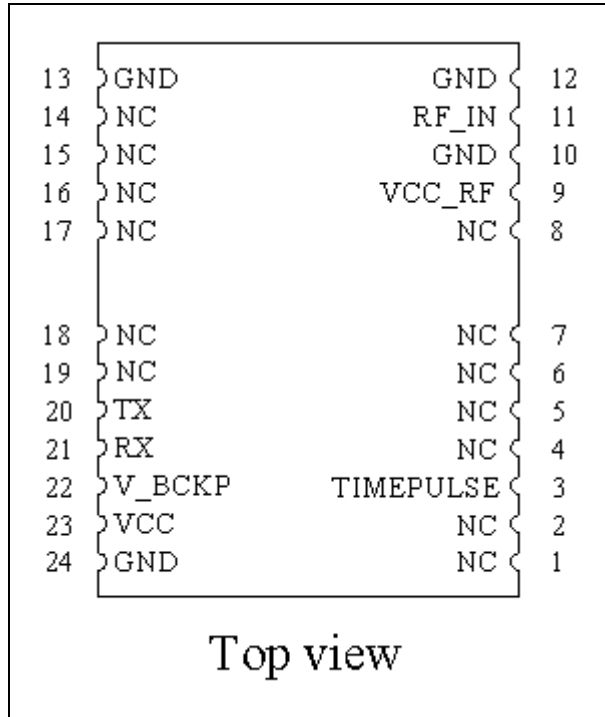


Table 6-1 Pin descriptions

| Pin # | Name | Type | Description | Note |
|-------|-----------|------|--|------|
| 1 | NC | | Not connected | |
| 2 | NC | | Not connected | |
| 3 | TIMEPULSE | O | Time pulse (1PPS, default 100 ms pulse/sec when 3D fix is available) | |
| 4 | NC | | Not connected | |
| 5 | NC | | Not connected | |
| 6 | NC | | Not connected | |
| 7 | NC | | Not connected | |
| 8 | NC | | Not connected | |
| 9 | VCC_RF | O | Output voltage for active antenna | 1 |
| 10 | GND | P | Ground | |
| 11 | RF_IN | I | GPS RF signal input | |
| 12 | GND | P | Ground | |
| 13 | GND | P | Ground | |
| 14 | NC | | Not connected | |

| | | | | |
|----|--------|---|--|---|
| 15 | NC | | Not connected | |
| 16 | NC | | Not connected | |
| 17 | NC | | Not connected | |
| 18 | NC | | Not connected | |
| 19 | NC | | Not connected | |
| 20 | TX | O | Serial output (Default NMEA) | |
| 21 | RX | I | Serial input (Default NMEA) | |
| 22 | V_BCKP | P | Backup battery supply voltage This pin must be powered to enable the module. | 2 |
| 23 | VCC | P | DC supply voltage | |
| 24 | GND | P | Ground | |

<Note>

1. VCC_RF does not have short circuit protection.
2. In order to get the advantage of hybrid ephemeris prediction, this pin must be always powered during the period of effective ephemeris prediction.

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 | °C |
| Storage Temperature Range | Tstg | -40 ~ 85 | °C |

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 |
| VCC_RF Output Voltage | VCC_RF | | | VCC | | V |
| Supply Current | Iss | VCC = 3.3V, w/o active antenna, Peak Acquisition Tracking Standby | | | 87 ⁽¹⁾ | mA |
| | | | | 26 | | mA |
| | | | | 18 ⁽²⁾ | | mA |
| | | | | 170 | | 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-1612.

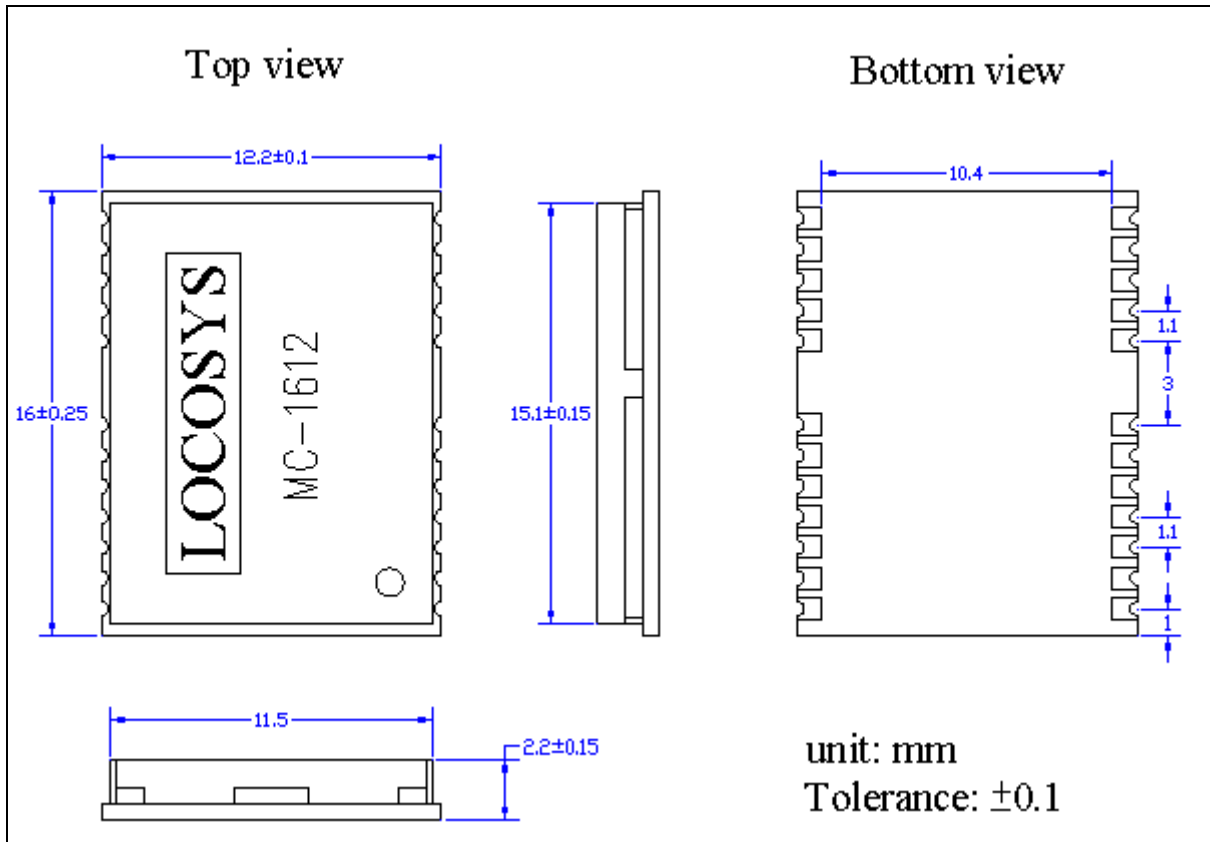
Note 2. Measured when position fix (1Hz) is available, input voltage is 3.3V and the function of self-generated ephemeris prediction is inactive.

7.3 Temperature characteristics

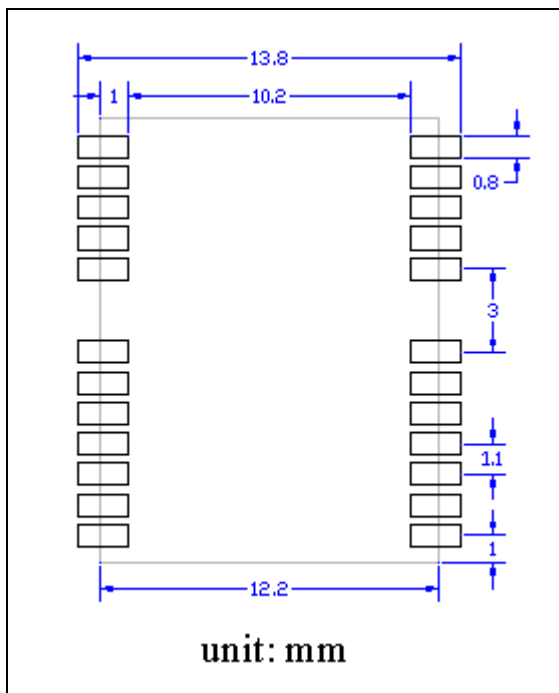
| Parameter | Symbol | Min. | Typ. | Max. | Units |
|-----------------------|--------|------|------|------|-------|
| Operating Temperature | Topr | -40 | - | 85 | °C |
| Storage Temperature | Tstg | -40 | 25 | 85 | °C |

8 Mechanical specification

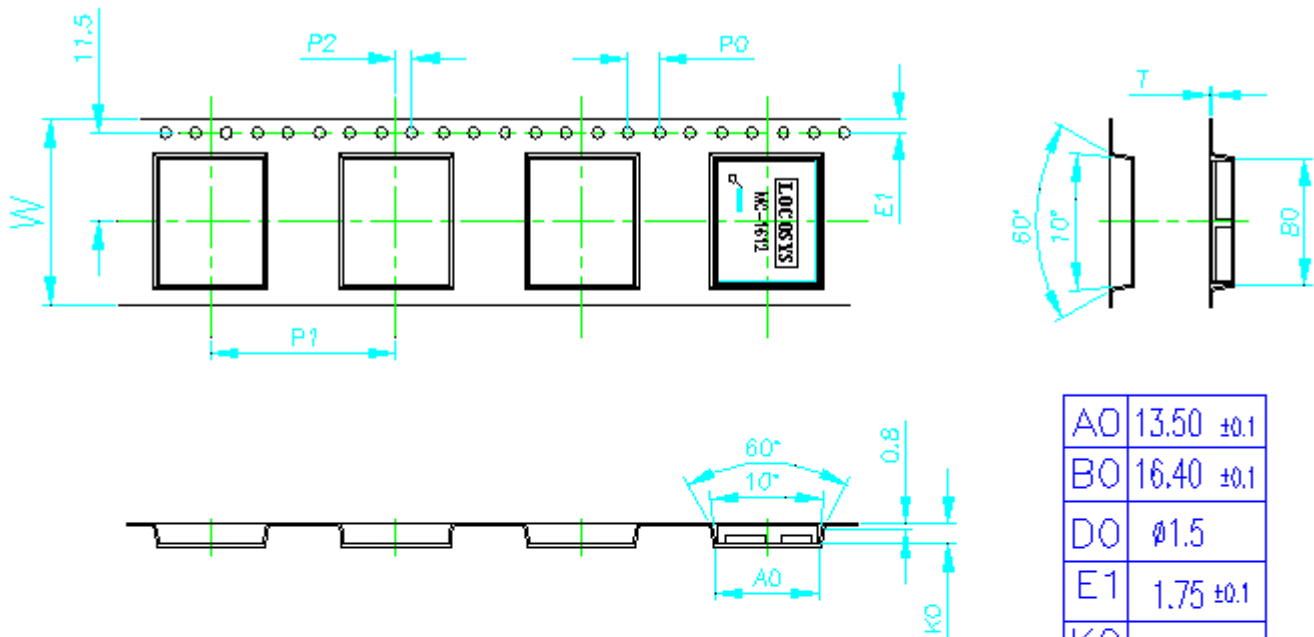
8.1 Outline dimensions



8.2 Recommended land pattern dimensions



9 Reel Packing information



| | |
|----|------------|
| A0 | 13.50 ±0.1 |
| B0 | 16.40 ±0.1 |
| D0 | ∅1.5 |
| 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. Packing length per 22" reel: 75 M

Document change list

Revision 1.0

- First release on Sep. 23, 2010.

Revision 1.0 to revision 1.1 (November 2, 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 has 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, Fig 3-2 and Fig 3-3
- Added Fig 3-4
- Changed tracking sensitivity from -164dBm to -162dBm on page 5.
- Changed cold start sensitivity from -147dBm to -143.5dBm on page 5.
- Changed hot start time from < 2s to < 1s on page 5.
- Changed cold start time from 35s to 32s on page 5.
- Changed Max. Altitude from 18,000m to 50,000m on page 5.
- Added section 5.3 and 5.4
- Changed the definition of pin 5~7 to NC in the Table 6-1.
- 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 47mA to 26mA in the section 7.2.
- Changed the tracking current from 41mA to 18mA in the section 7.2.
- Added standby current, 170uA in the section 7.2.
- Changed the minimum operation temperature from -30°C to -40°C in the section 7.3