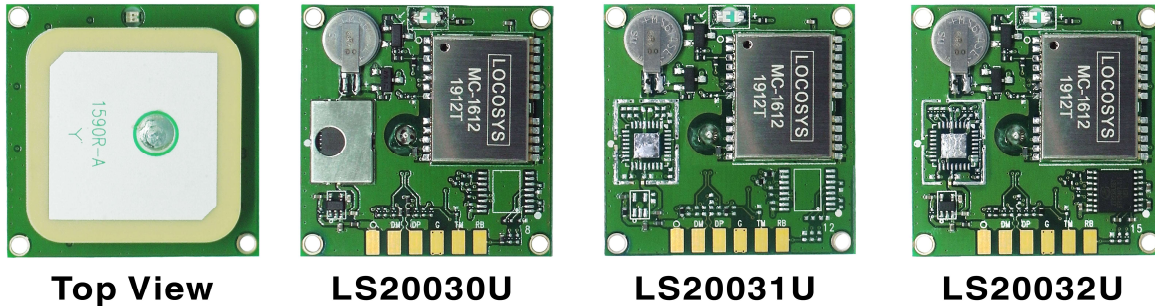


| Product name | Description | Version |
|--------------|--|---------|
| LS20030U | GPS smart antenna module/USB,9600BPS,30x30mm | 1.0 |
| LS20031U | GPS smart antenna module/TTL,9600BPS,30x30mm | |
| LS20032U | GPS smart antenna module/RS232,9600BPS,30x30mm | |

Datasheet of GPS smart antenna module, LS2003xU series



1 Introduction

LS2003xU series products are complete GPS smart antenna receivers, including an embedded antenna and GPS receiver circuits, designed for a broad spectrum of OEM system applications. The product is based on the proven technology found in LOCOSYS 66 channel GPS SMD type receiver MC-1612 that uses MediaTek chip solution. The GPS smart antenna will acquire up to 66 satellites at a time while providing fast time-to-first-fix, one-second navigation update and low power consumption. 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.

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 Japan QZSS
- Indoor and outdoor multi-path detection and compensation
- Support ± 11 ns high accuracy time pulse (PPS)
- Build-in micro battery to reserve system data for rapid satellite acquisition
- LED indicator for GPS fix or not fix

3 Application

- Personal positioning and navigation
- Automotive navigation
- Marine navigation

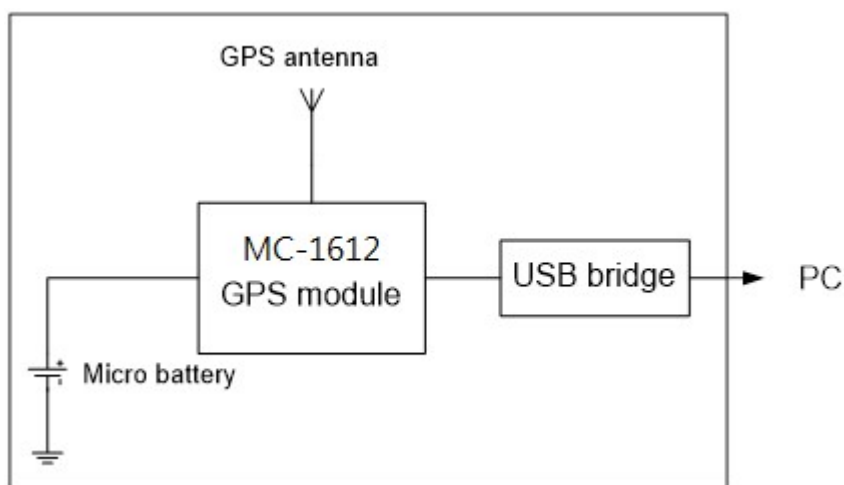


Fig 3-1 System block diagram of LS20030U

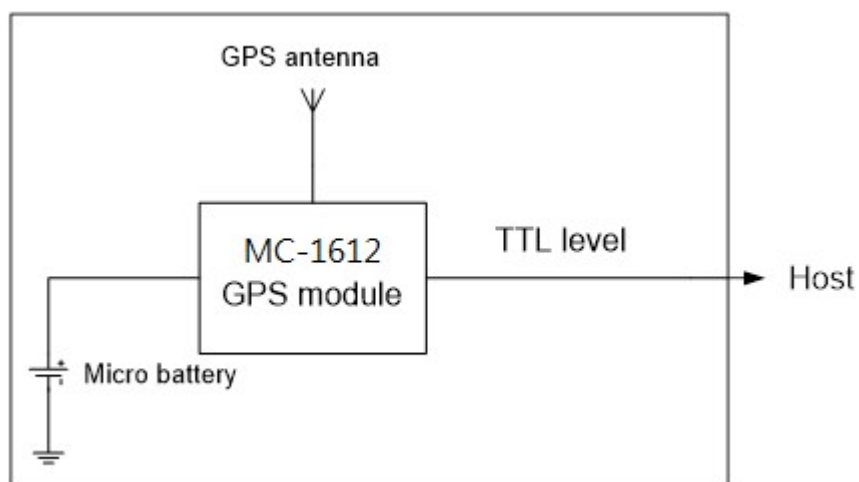


Fig 3-2 System block diagram of LS20031U

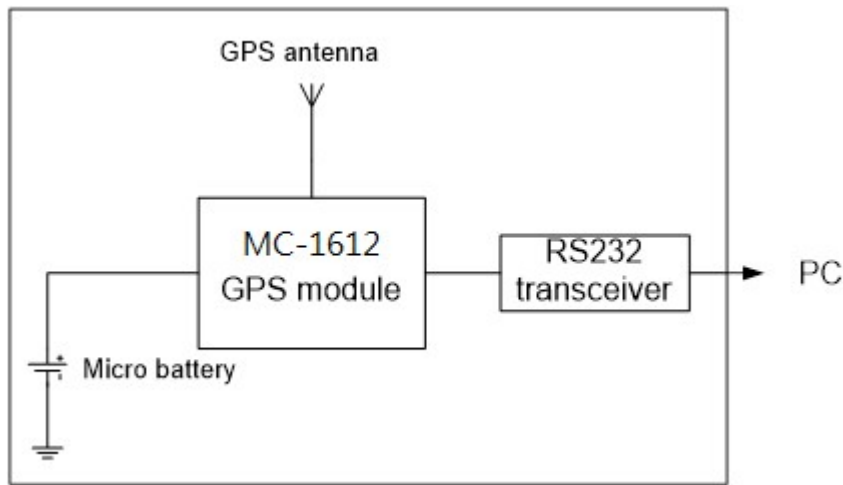


Fig 3-3 System block diagram of LS20032U

4 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 | |
| Acquisition Time | Hot start (Open Sky) | < 1s (typical) |
| | 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) |
| Datum | WGS-84 (default) | |
| 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, N=Data not valid, 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

| Name | Example | Units | Description |
|------|---------|-------|-------------|
|------|---------|-------|-------------|

| | | | |
|---------------------------------------|---------|---------|--|
| Message ID | \$GPGSV | | GSV protocol header |
| Total number of messages ¹ | 3 | | Range 1 to 4 |
| Message number ¹ | 1 | | Range 1 to 4 |
| 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 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, N=Data not valid, R=Coarse Position, S=Simulator |
| 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, S=Simulator |
| Checksum | *38 | | |
| <CR> <LF> | | | End of message termination |

5.2 Proprietary NMEA input message

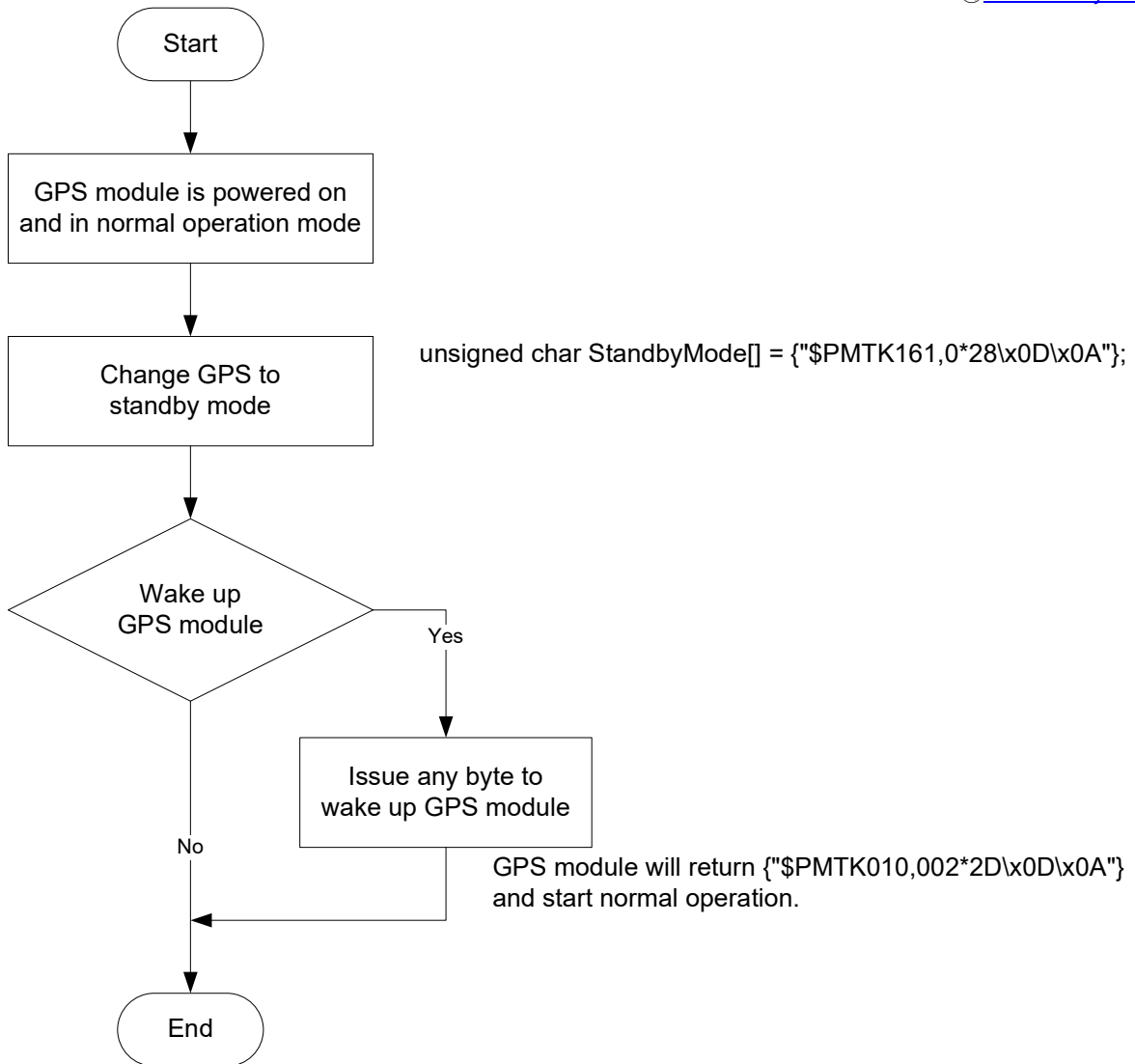
Please refer to MTK proprietary message.

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.

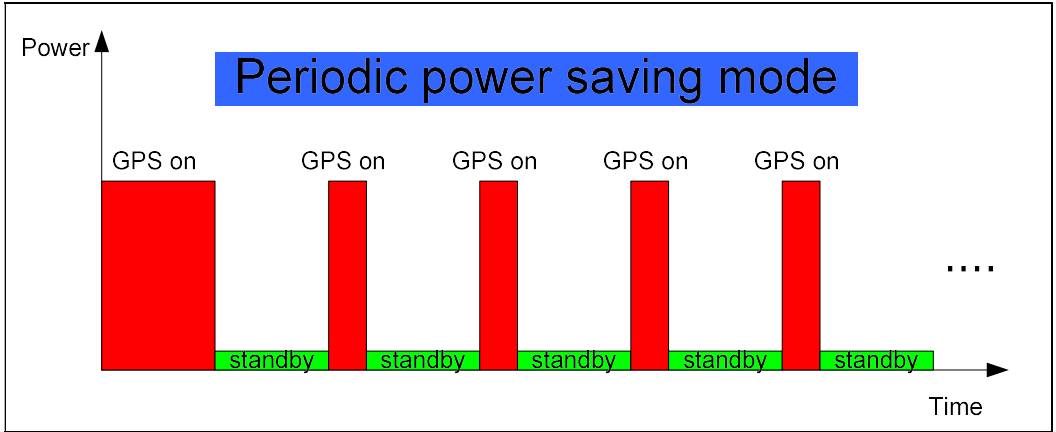
5.3.1 Standby mode

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.



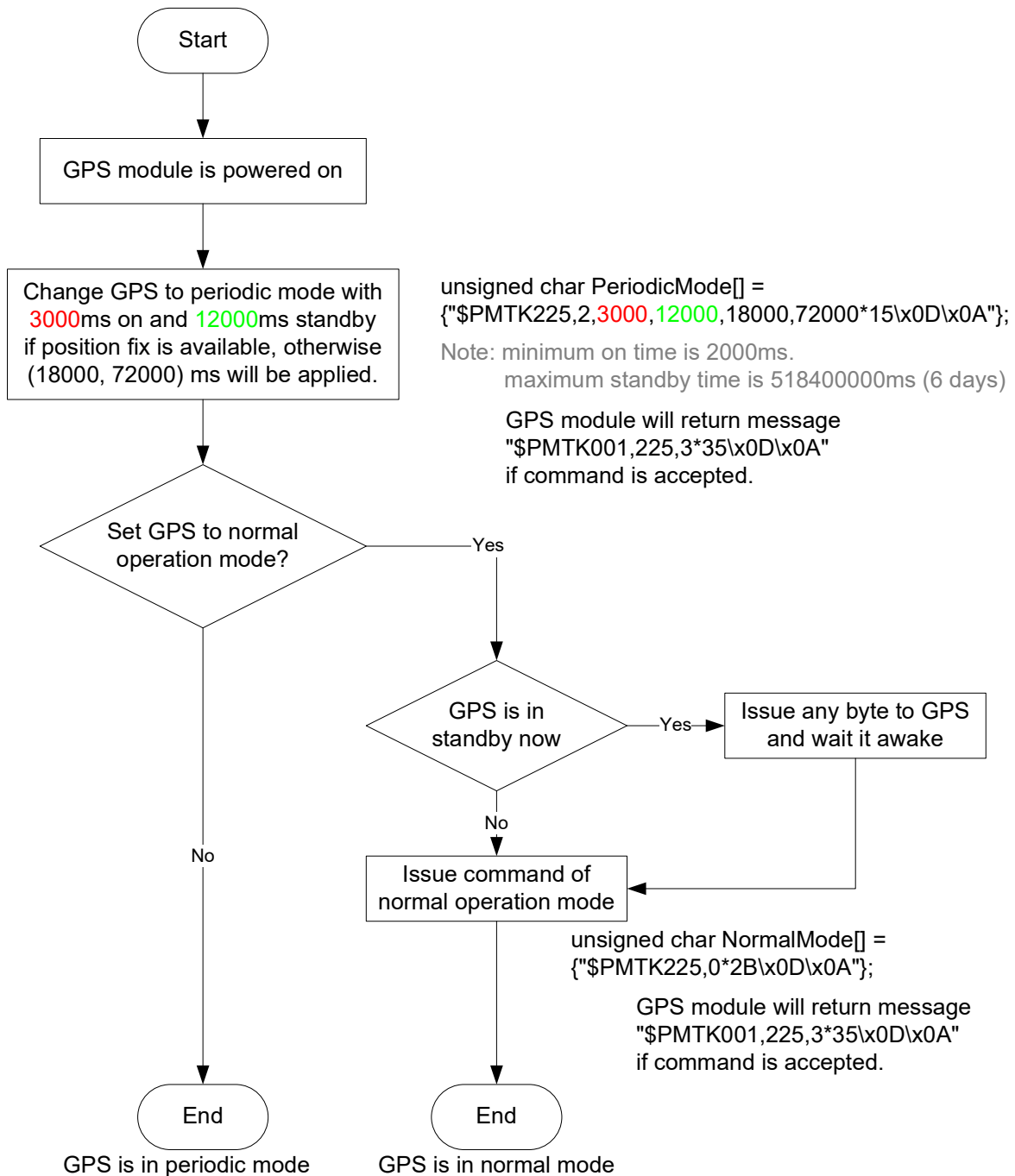
5.3.2 Periodic mode

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

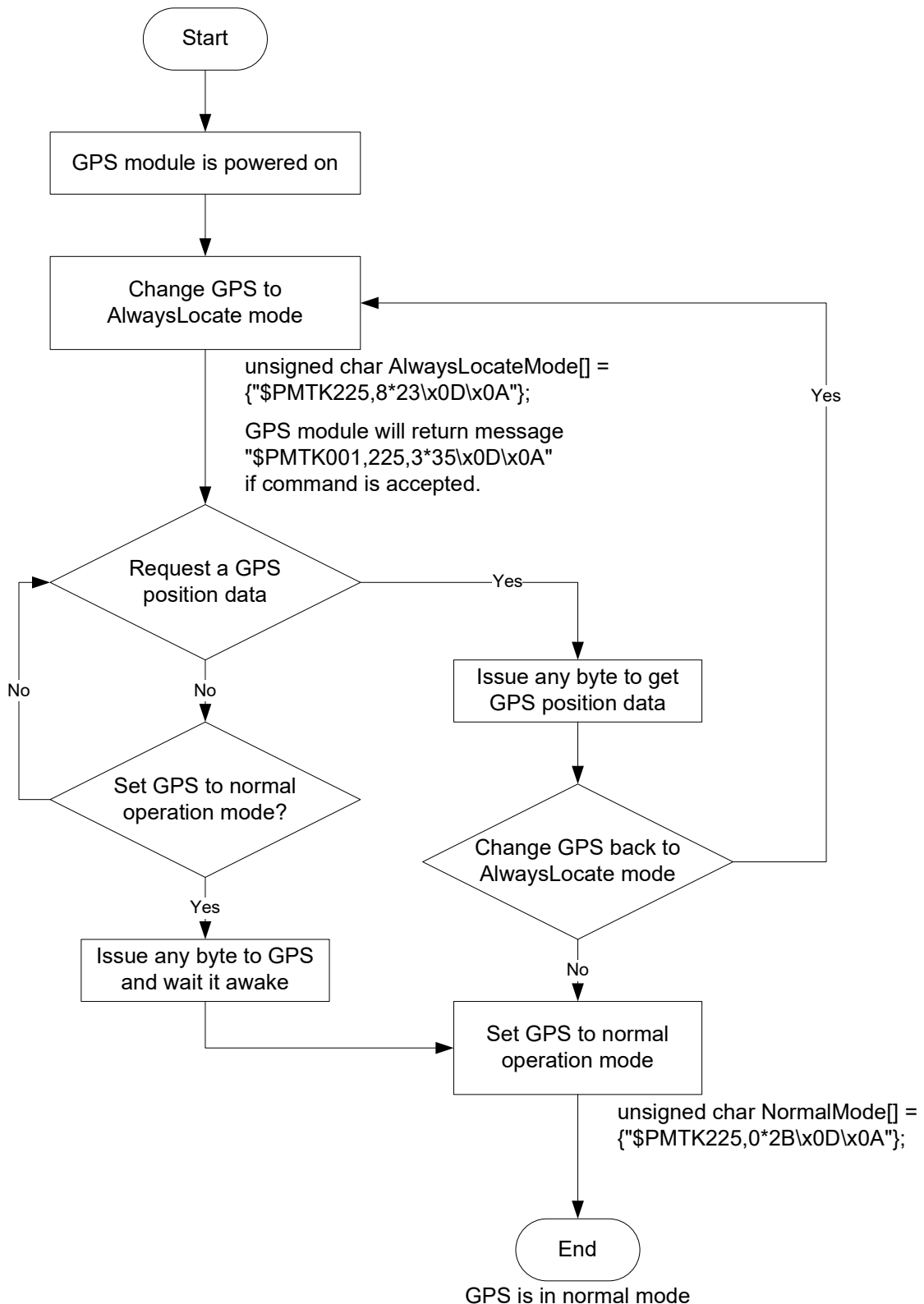
and then back to normal operation mode.



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.

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

6 LED indicator

The red LED is an indicator of GPS 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.

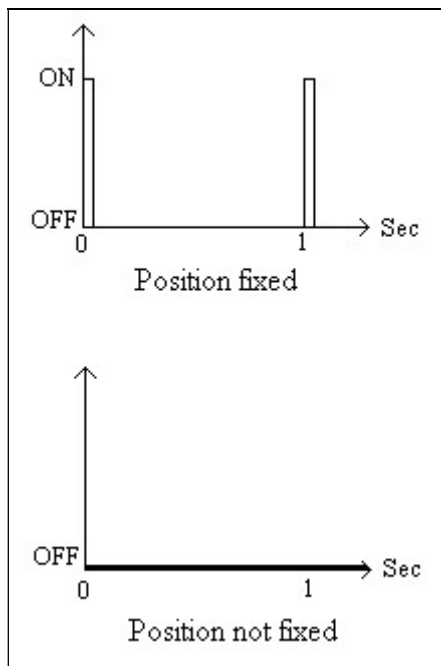
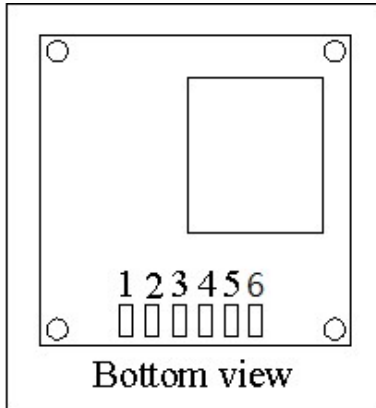


Fig 6.1 LED indicator of GPS positioning status

7 Pin assignment and descriptions



- **LS20030U**

| Pin # | Name | Type | Description |
|-------|-----------|------|--|
| 1 | VBUS | P | USB power input |
| 2 | D- | | D- line |
| 3 | D+ | | D+ line |
| 4 | GND | P | Ground |
| 5 | TIMEPULSE | O | PPS, default 100ms pulse/sec when 3D fix is available. |
| 6 | NC | | Not connect |

- **LS20031U**

| 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 | TIMEPULSE | O | PPS, default 100ms pulse/sec when 3D fix is available. |
| 6 | NC | | Not connect |

- **LS20032U**

| 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 | TIMEPULSE | O | PPS, default 100ms pulse/sec when 3D fix is available. |
| 6 | NC | | Not connect |

8 DC & Temperature characteristics

8.1 DC Electrical characteristics

| Parameter | Symbol | Product | Min. | Typ. | Max. | Units |
|---------------------------|-----------------|----------|------|-------------------|------|-------|
| Input voltage | VCC | LS20030U | 4.75 | 5 | 5.25 | V |
| | | LS20031U | 3 | 3.3 | 3.6 | |
| | | LS20032U | 4.5 | 5 | 5.5 | |
| Input current | Icc | LS20030U | | 43 ⁽¹⁾ | | mA |
| | | LS20031U | | 26 ⁽¹⁾ | | |
| | | LS20032U | | 31 ⁽¹⁾ | | |
| High Level Input Voltage | V _{IH} | LS20031U | 2.0 | | 3.6 | V |
| Low Level Input Voltage | V _{IL} | | 0 | | 0.8 | V |
| High Level Output Voltage | V _{OH} | | 2.4 | | 3.3 | 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 |

1. Measured when position fix (1Hz) is available and the function of self-generated ephemeris prediction is inactive.

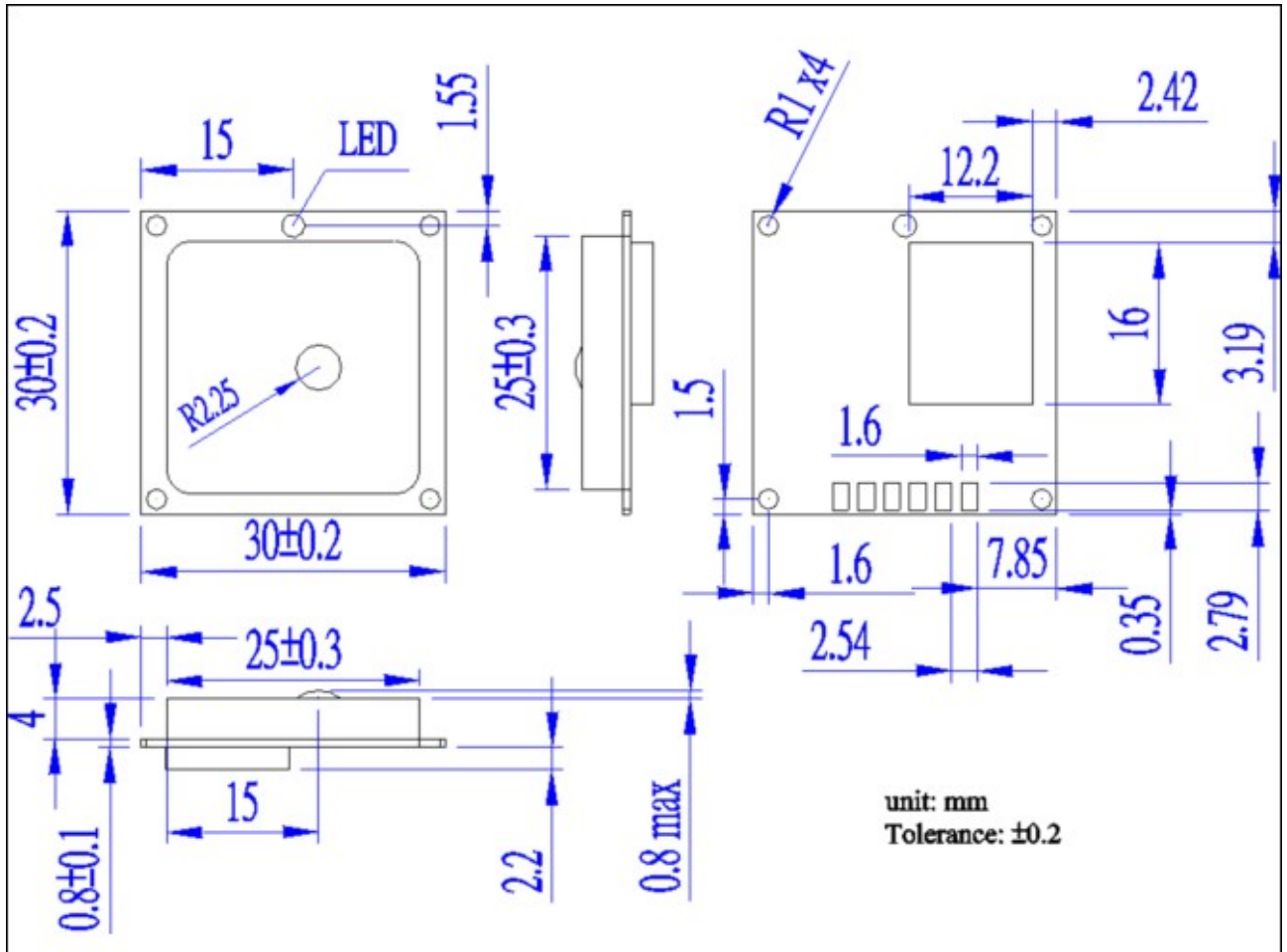
8.2 Temperature characteristics

| Parameter | Symbol | Min. | Typ. | Max. | Units |
|-----------------------|---------------------------------|------|------|------|-------|
| Operating Temperature | T _{opr} ⁽¹⁾ | -40 | - | 85 | °C |
| Storage Temperature | T _{stg} ⁽²⁾ | -40 | 25 | 85 | °C |

Note

1. battery: -20 ~ 60°C
2. battery: -40 ~ 60°C

9 Mechanical specification

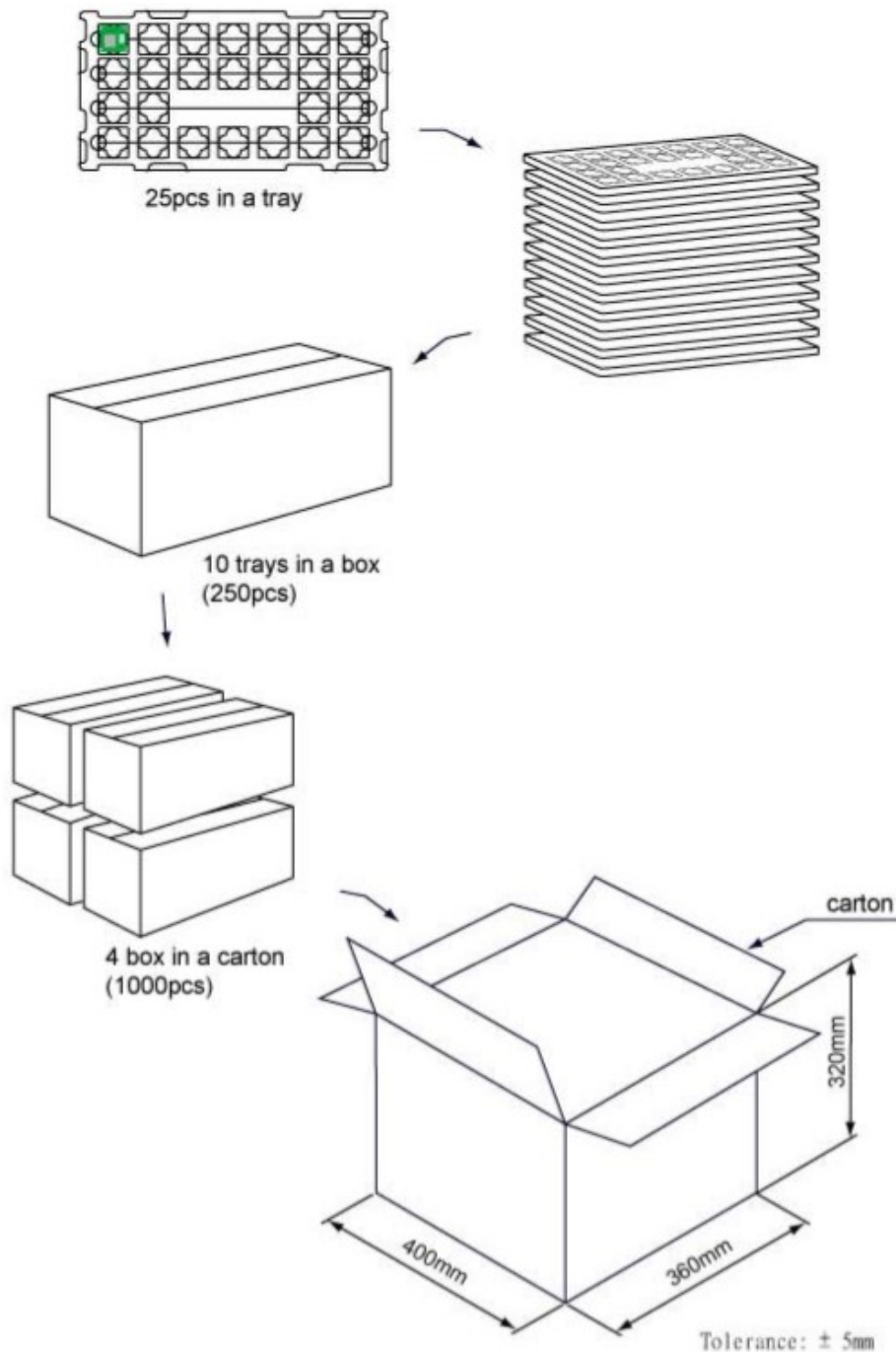


10 Product handling

10.1 ESD precaution

GNSS modules are electrostatic sensitive devices. Handling the modules without proper ESD protection may result in severe damage to them. ESD protection must be implemented throughout the processing, handling and even when the modules are being returned for repair.

10.2 Packaging



10.3 Storage

We recommend storing the smart antenna module in a dry place, such as moisture-proof cabinet. The shelf life of the module package is about 6 months from the packaging date when it is stored in a non-condensing storage environment (<30°C/60% RH).

11 Ordering information

| Product name | Description | Remark |
|--------------|--------------------------|------------------|
| LS20030U | GPS smart antenna, USB | GPS/QZSS: L1 C/A |
| LS20031U | GPS smart antenna, TTL | |
| LS20032U | GPS smart antenna, RS232 | |

Document change list

Revision 1.0

- First release on May 6, 2022.