# CD-PA1010D GNSS patch antenna module

# Data Sheet V.02
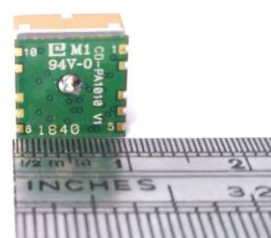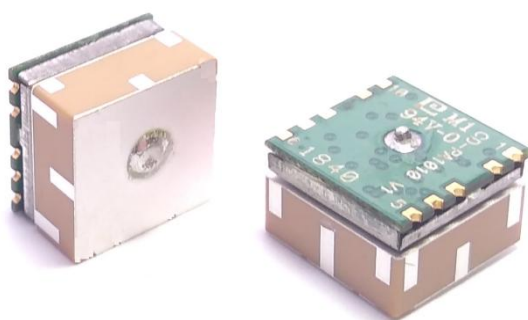
# Table of Contents

# 1. Functional Description

## 1.1 Product description

The CDTop CD-PA1010D module utilizes the MediaTek new generation GNSS Chipset MT3333 that support various location and navigation applications, including autonomous GPS, GLONASS, GALILEO, QZSS, SBAS(note) ranging (WAAS, EGNOS, GAGAN, MSAS), QZSS, DGPS and AGPS. It support up to 210 PRN channels with 99 search channels and 33 simultaneous tracking channels.

It is the industry's highest level of sensitivity (-165dBm) and instant Time-to-First Fix (TTFF). Precise GNSS signal processing give the ultra-precise positioning under low receptive, high velocity conditions. Up to 12 multi-tone active interference canceller (ISSCC2011 award), customer can have more flexibility in system design.

World's smallest multi-constellation antenna module enabling high-performance in a variety of application

Power management design makes CD-PA1010D easily integrated into your system without extra voltage regulator. The PA1010D support operational modes that allow them to provide positioning information at reduced overall current consumption. Availability of GNSS signals in the operating environment will also be a factor in choice of power management modes. The designer can choose a mode that provides the best trade-off of performance versus power consumption.

The power management modes are described below, and can be enabled via command:
- Full Power Continuous - for best GNSS performance
- Power saving mode to optimize power consumption:
  - ✓ Standby mode
  - ✓ Periodic mode
  - ✓ AlwaysLocate™ mode
- Backup mode

The excellent low power consumption of CD-PA1010D make it easier to applied to power sensitive devices, especially portable applications, need not worry about operating time anymore and user can get more fun.

It also combined with many advanced features including EASY™, EPO™, and logger function.

Application:
  - ✓ Wearable Device
  - ✓ Asset management
  - ✓ Handheld Device
  - ✓ M2M application
  - ✓ Security industry
  - ✓ Surveillance
  - ✓ Tablet PC/PLB/MID

## 1.2 Features

- Built-in 10x10x4.0mm ceramic patch antenna on the top of module

- Ultra-High Sensitivity: -165dBm (w/o patch antenna), up to 45dB C/N of SVs in open sky reception.

- AlwaysLocate: Intelligent Algorithm (Advance Power Periodic Mode) for power saving

- EASY: Self-Generated Orbit Prediction for instant positioning fix

- GPS Consumption current(@3.3V):

  - Acquisition: 36mA Typical

  - Tracking: 28mA Typical

- High accuracy 1-PPS timing support for Timing Applications (±20ns jitter)

- High Update Rate: up to 10Hz[note1]

- Logger function Embedded[note2]

- Supports QZSS, SBAS(WAAS, EGNOS, GAGAN, MSAS) ranging

- Ultra-High Sensitivity: -165dBm

- Automatic antenna switching function

Note 1:  SBAS can only be enabled when update rate is less than or equal to 5Hz.
Note2:  Some features need special firmware or command programmed by customer.
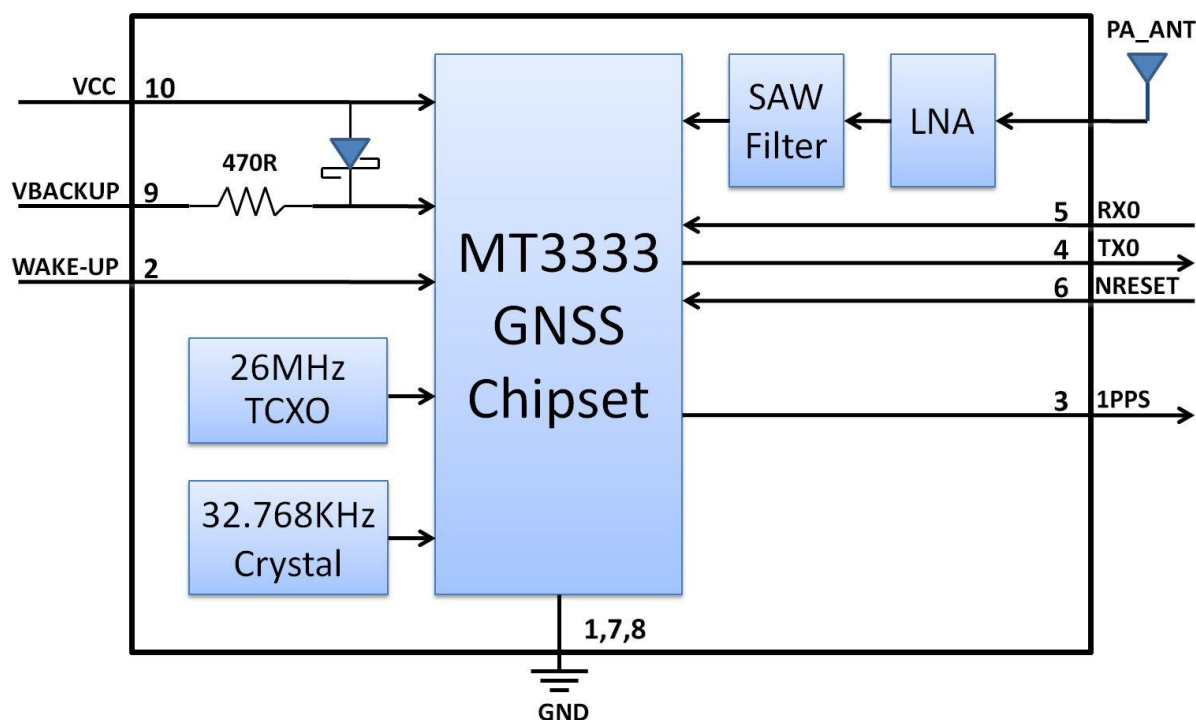
## 1.3 System Block Diagram



*Figure 1-1: System Block Diagram.*

## 1.4 Multi-tone active interference canceller

  Because different application (Wi-Fi, GSM/GPRS, 3G/4G, Bluetooth) are integrated into navigation system, the harmonic of RF signal will influence the GPS reception, the multi-tone active interference canceller (abbr: MTAIC) can reject external RF interference which come from other active components on the main board, to improve the capacity of GPS reception without any needed HW change in the design. CD-PA1010D can cancel up to 12 independent channel interference continuous wave (CW).

## 1.5 1PPS

  A pulse per second (1 PPS) is an electrical signal which precisely indicates the start of a second with the accuracy of ±20ns RMS (Root Mean Square). The PPS signal is provided through a designated output pin for many external applications. The pulse is not only limited to being active every second but is also allowed to set up the required duration, frequency, and active high/low through a programmable user-defined setting.

1PPS (Pulse Per Second) signal output available on configuration:
  → At 2D Fix only.
  → At 3D Fix only.
  → After the first Fix
  → Always- default configuration.

## 1.6 AGPS Support for Fast TTFF (EPO™)

Assisted GPS (or Aided GPS) is a method by which TTFF is reduced using information from a source other than broadcast GPS signals. The necessary ephemeris data is calculated either by the receiver itself (locally-generated ephemeris) or a server (server-generated ephemeris) and stored in the module.

The AGPS (EPO™) supply the predicated Extended Prediction Orbit data to speed TTFF, users can download the EPO data to GPS engine from the FTP server  by internet or wireless network, the GPS engine will use the EPO data to assist position calculation when the navigation information of satellites are not enough or weak signal zone .

PA1010D has EASY, EPO to allow for Hot Starts even in weak signal conditions and moving start-ups. EPO (Extended Prediction Orbit) is one of MediaTek's innovative proprietary off-line server based AGPS solution. Host could use an application to store and load the EPO files into device. With multi-constellation EPO, the user experience will be enhanced by the improved Time To First Fix (TTFF) and better first fix accuracy.

## 1.7 EASY™

The EASY™ is embedded assist system for quick positioning, the GPS engine will calculate and predict automatically the single ephemeris (Max. up to 3 days)when power on, and save the predict information into the memory, GPS engine will use these information for positioning if no enough information from satellites, so the function will be helpful for positioning and TTFF improvement under indoor or urban condition, the Backup power (VBACKUP) is necessary.

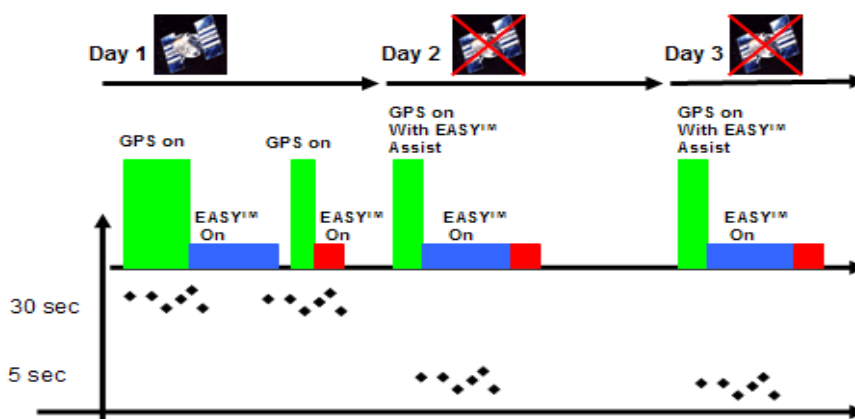Up to 3 days extension for single received ephemeris:



*Figure 1-2 EASY System operation*

Please refer to the Fig 1-2, When GPS device great the satellite information from GPS satellites, the GPS chip automatically pre-calculate the predict orbit information for 3 days.

The GPS device still can quickly do the positioning with EASY™ function under weak GPS signal.

## 1.8 Embedded Logger function(LOCUS)

The  Embedded Logger function(LOCUS)  don't need host CPU (MCU ) and external flash  to handle the operation, GPS Engine will use internal flash (embedded in GPS chipset ) to log the GPS data (Data format : UTC, Latitude, longitude, Valid, Checksum), the maximum log duration is up to two days under AlwaysLocate™.

## 1.9 Power Management Mode

The PA1010D support operational modes that allow them to provide positioning information at reduced overall current consumption. Availability of GNSS signals in the operating environment will also be a factor in choice of power management modes. The designer can choose a mode that provides the best trade-off of performance versus power consumption.

The power management modes are described below, and can be enabled via command:
• Full Power Continuous for best GNSS performance
• Power saving mode to optimize power consumption:
→ Standby mode
→ Periodic mode
→ AlwaysLocate™ mode
• Backup mode

### 1.9.1 Full Power Continuous Mode

The modules start up in full power continuous mode. This mode uses the acquisition engine at full performance resulting in the shortest possible TTFF and the highest sensitivity. It searches for all possible satellites. The receiver then switches to the tracking engine to lower the power consumption when:
   •    A valid GPS/GNSS position is obtained
   •    The ephemeris for each satellite in view is valid
To return to Full Power mode (from a low power mode), send the following command:
**$PMTK225,0*2B** (the module will wakes up from its previous sleep cycle).

### 1.9.2 Power Saving Mode

#### 1.9.2.1 Standby Mode

In this mode, the receiver stops navigation, the internal processor enters standby state, and the current drain at main supply (Vcc) is reduced. Standby mode is entered by sending the following command: **$PMTK161,0*28**

The host can then wake up the module from Standby mode to Full Power mode by sending any byte to the serial port.

#### 1.9.2.2 Periodic Mode

This mode allows autonomous power on/off with reduced fix rate to reduce average power consumption. In periodic mode, the main power supply Vcc is still powered, but power distribution to internal circuits is controlled by the receiver.
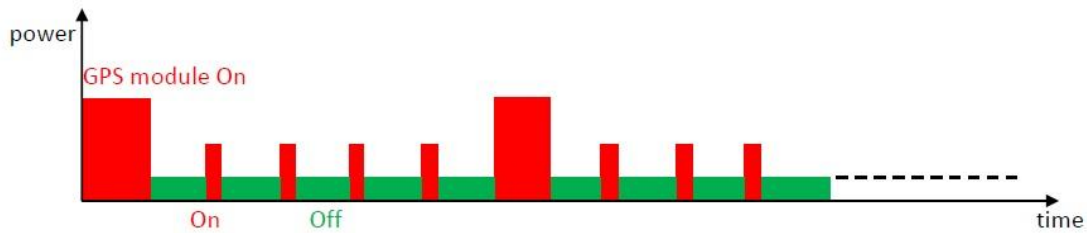
*Figure 1-3 Periodic Mode operation*

Enter periodic mode by sending the following command:
**$PMTK225,Type, Run_time, Sleep_time,2$^{nd}$_Run_time,2$^{nd}$_Sleep_time*checksum**
Where:
➔ Type = 1: Periodic backup mode, Type = 2 : Periodic standby mode
➔ Run time: Full Power period (ms)
➔ Sleep time: Standby period (ms)
  2$^{nd}$ Run time: Full Power period (ms) for extended acquisition if GNSS acquisition fails during Run time.

➔ 2$^{nd}$ Sleep time: Standby period (ms) for extended sleep if GNSS acquisition fails during Run time.

Example:
  **$PMTK225,2,4000,15000,24000,90000*16:** periodic mode with 4 second navigation and 15 second sleep.

  The acknowledgement response for this command is: **$PMTK001,225,3*35**

  Periodic mode is exited back to Full Power Continuous Mode by sending the command:
  **$PMTK225,0*2B** (the module wakes up from a previous sleep cycle).

### 1.9.2.3 AlwaysLocate Mode(Advance Power Periodic Mode)
  AlwaysLocate™ is an intelligent controller of the Periodic mode; the main power supply Vcc is still powered up, but power distribution is internally controlled. Depending on the environment and motion conditions, the module can autonomously and adaptively adjust the parameters of the Periodic mode, the average current can vary based on conditions.
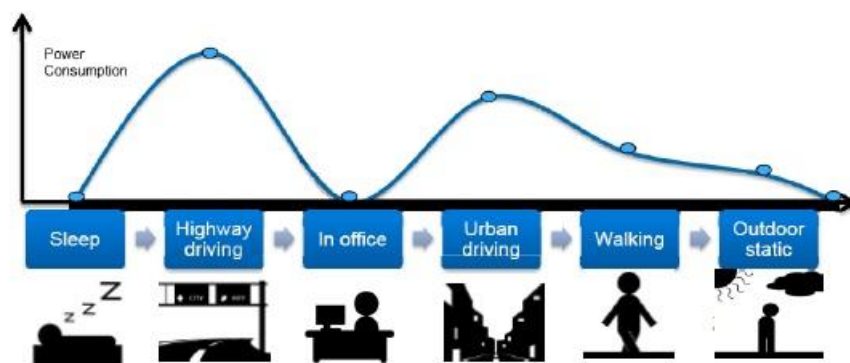


*Figure 1-4: Always Locate*

Enter AlwaysLocate™ mode by sending the following NMEA command: $**PMTK225,Type*CheckSum**
➔ **Type=8: AlwaysLocate$^{TM}$ backup mode, Type=9: AlwaysLocate$^{TM}$ backup mode**

The acknowledgement response for the command is:  **$PMTK001,225,3*35**
The user can exit low power modes to Full Power by sending NMEA command:
**$PMTK225,0*2B**( the module wakes up from its previous sleep cycle).

### 1.9.3 Backup Mode

Backup Mode means a low quiescent power state where receiver operation is stopped.

The Vcc is powered on but the current consumption is minimal. After waking up, the receiver uses all internal aiding, including GNSS time, Ephemeris, and Last Position, resulting in the fastest possible TTFF in either hot or warm start modes. During Backup State, the I/O block is powered off.

Entering to backup mode is done by a NMEA software command – $**PMTK225,4*2F**

Important: Before sending the command the WAKE-UP pin(pin 2) must be tied to ground. While in Backup mode, the module will consume 15uA from Vcc. It is not possible to wake up the module from backup mode by software command.

Example: **$PMTK225,4*2F**  Enter backup mode
NMEA Return feedback: **$PMTK001,225,3*35**

**Note:** In Periodic backup mode and AlwaysLocate™ backup mode. The user only could let module back to Full Power Continuous Mode by sending the command: **$PMTK225,0*2B** during the Run time stage. And Periodic standby mode do not have this limitation.

# 2. Specification

## 2.1 Mechanical Dimension
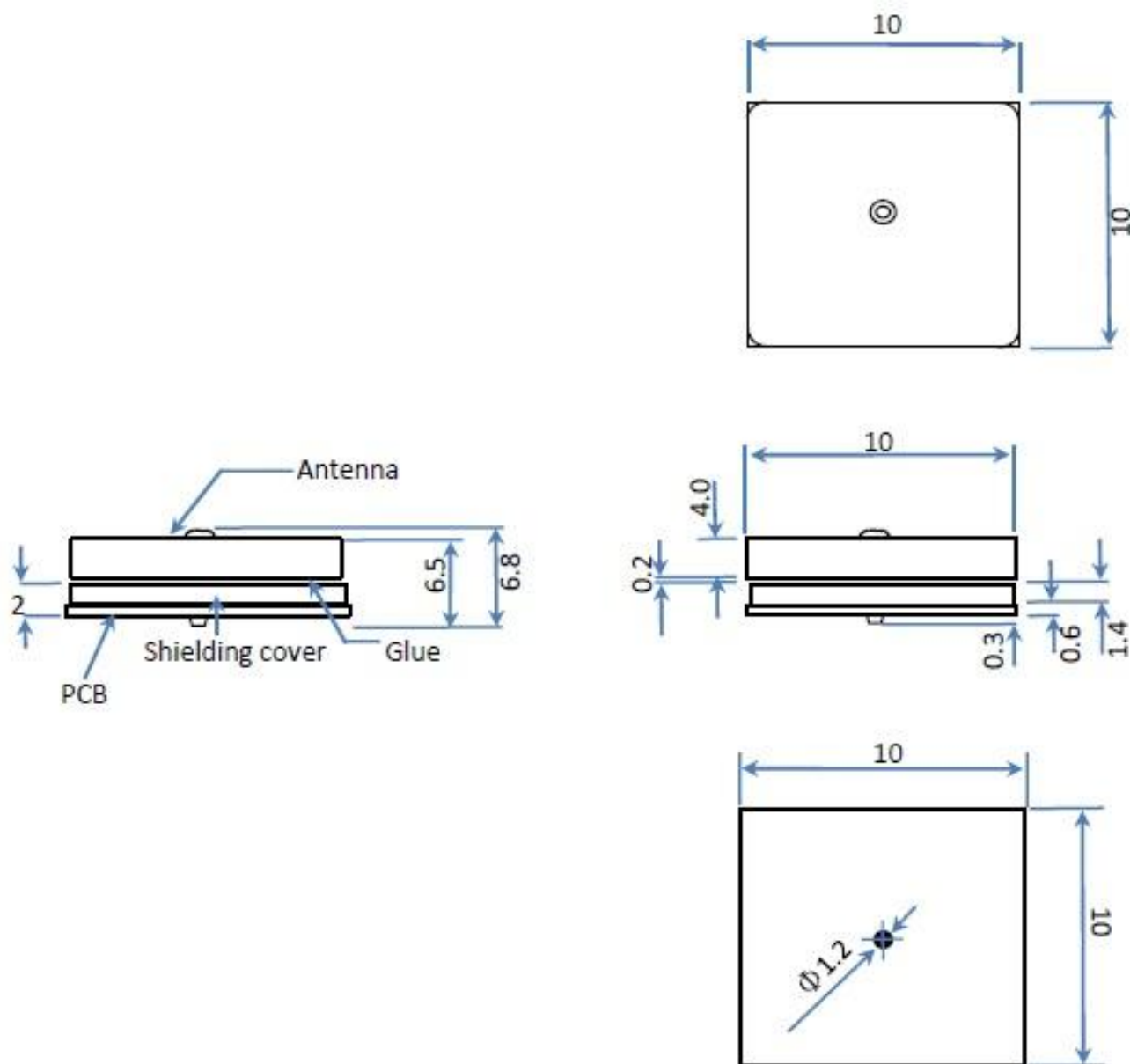


Dimension: (Unit: mm, Tolerance: +/- 0.2mm)

## 2.2 Recommended PCB pad Layout
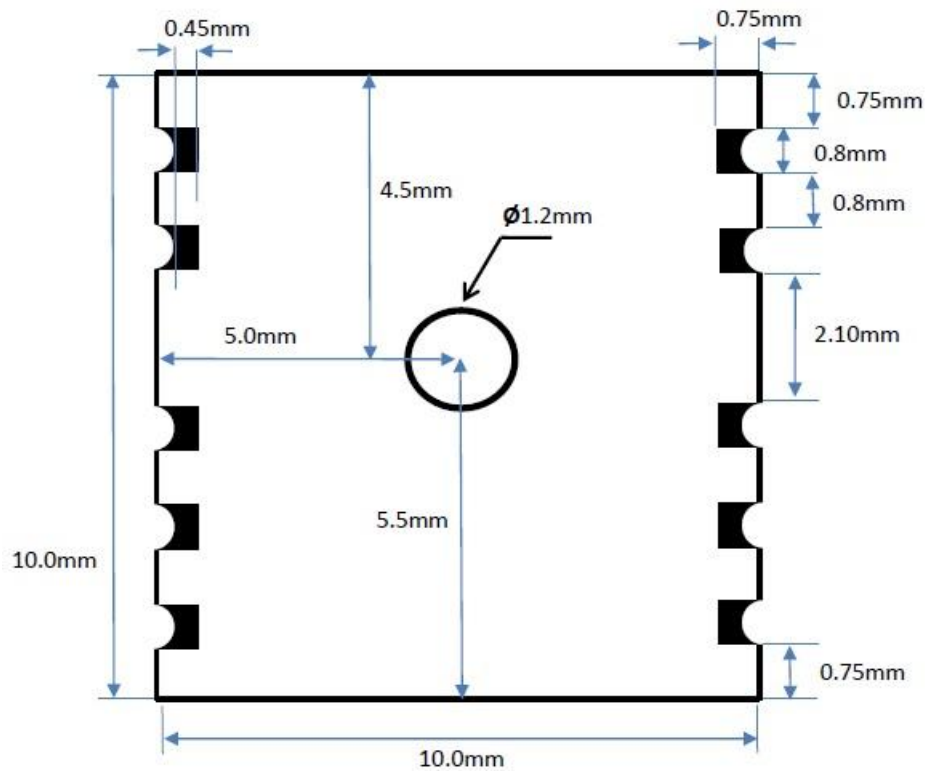


**(Unit: mm, Tolerance: ±0.1mm)**



**Note:**
Place one hole(diameter=3.0mm) under this module for antenna pad, avoid trace or VIAs pass this area

## 2.3 Pin Configuration

```
(1)GND    ●              VCC(10)
WAKE-UP                  VBACKUP

1PPS          ◎         GND

TX                       GND

(5)RX      (Top view)   NRESET(6)
```
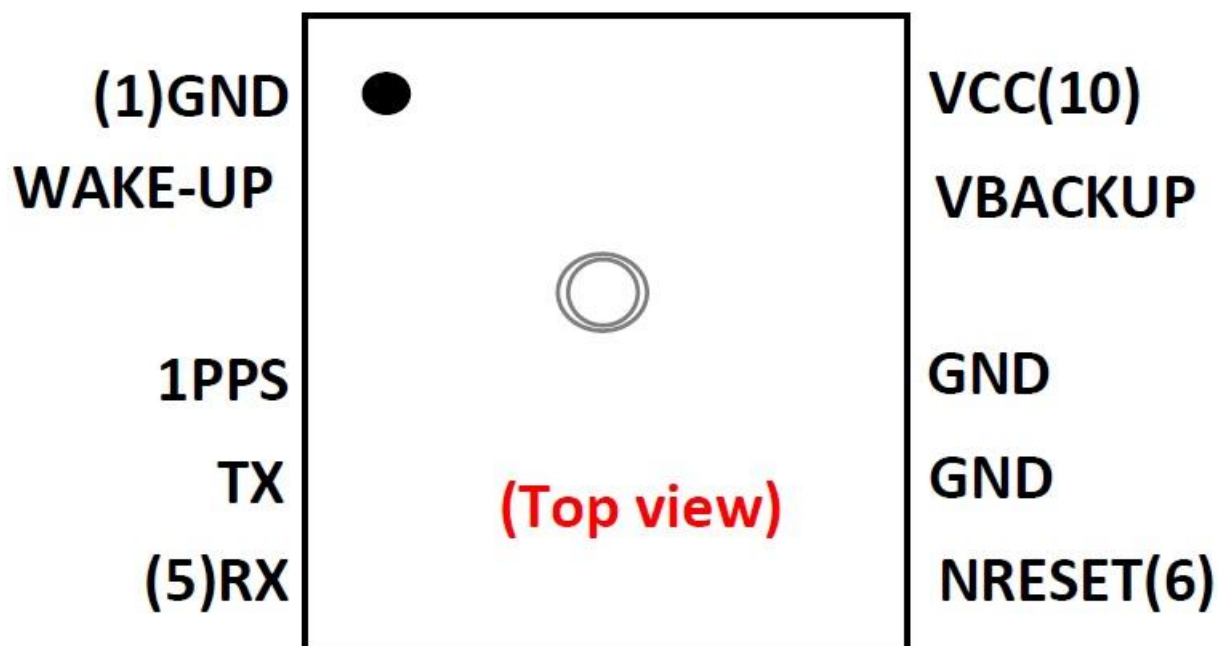
## 2.4 Pin Assignment

| Pin | Name | I/O | Description & Note |
|-----|------|-----|--------------------|
| 1 | GND | P | Ground |
| 2 | WAKE-UP | I | Wake up from **Backup Mode**(power saving), High Active |
| 3 | 1PPS | O | 1PPS Time Mark Output 2.8V CMOS Level |
| 4 | TX | O | Serial Data Output for NMEA Output  (UART TTL) |
| 5 | RX | I | Serial Data Input  for Firmware Update (UART TTL) |
| 6 | NRESET | I | Reset Input, Low Active |
| 7 | GND | P | Ground |
| 8 | GND | P | Ground |
| 9 | VBACKUP | PI | Backup Power Input for RTC & Navigation Data Retention |
| 10 | VCC | PI | Main DC power input |

## 2.5 Description of I/O Pin

### *Pin1,* **7, 8(GND**)
Ground

### *Pin2,* **(WAKE-UP)**
  Entering into BACKUP mode by sending SW command and tied to ground the WAKE-UP pin with 10K Ohm. Module will stay in BACKUP mode while WAKE-UP is 10K tied to ground for input pull down. To exit from BACKUP mode, Active High level will wake up the module. Keep floating if not used.

### *Pin3* **(1PPS**)
  This pin provides one pulse-per-second output from the module and synchronizes to GPS time. Keep floating if not used.

### *Pin4,* **(TX)**
This is the UART transmitter of the module.

### *Pin5***, (RX)**
This is the UART receiver of the module.

### *Pin6* **(NRESET)**
With a low level, it causes the module to reset. If not used, keep floating.

### *Pin9* **(VBACKUP)**
  This connects to the backup power of the GPS module. Power source (such as battery) connected to this pin will help the GPS chipset in keeping its internal RTC running when the main power source is removed. The voltage should be kept between 2.0V~4.3V, Typical 3.0V.

  **If VBACKUP power was not reserved, the GPS module will perform a lengthy cold start every time it is powered-on because previous satellite information is not retained and needs to be re- transmitted.**

  If not used, keep floating.

### *Pin10,* **(VCC)**
  The main DC power supply of the module, the voltage should be kept between from 3.0V to 4.3V. The Vcc ripple must be controlled under 50mVpp (Typical: 3.3V)

## 2.6 Specification List

| Item | Description |
|---|---|
| GNSS Solution | MTK MT3333 |
| Frequency | GPS L1, 1575.42MHz<br>GLONASS L1, 1598.0625~1605.375MHz<br>Galileo E1, 1575.42MHz |
| Sensitivity(GPS portion) | Acquisition: -148dBm,<br>cold start Reacquisition: -163dBm<br>Hot start Tracking: -165dBm |
| SV Number | #1~32 for GPS<br>#65~96 for GLONASS<br>#1~36 for Galileo<br>#193~195 for QZSS<br>#33~51 for SBAS |
| TTFF<br>(No. of SVs>4, C/N>40dB, PDop<1.5) | Hot start: 1 second typical<br>Warm start: 33 seconds typical<br>Cold start: 35 seconds typical, 60 seconds Max |
| Update Rate | 1Hz (default), maximum 10Hz |
| Baud Rate | 9600 bps (default) |
| Position Accuracy | Without aid:3.0m (50% CEP)<br>DGPS(SBAS(WAAS,EGNOS,MSAS)):2.5m (50% CEP) |
| Velocity Accuracy | Without aid : 0.1m/s<br>DGPS(SBAS(WAAS,EGNOS,MSAS,GAGAN)):0.05m/s |
| Timing Accuracy(1PPS Output) | ±20 ns RMS within 100ms in one pulse |
| Altitude | Maximum 18,000m (60,000 feet) |
| Velocity | Maximum 515m/s (1000 knots) |
| Acceleration | Maximum 4G |
| DGPS | SBAS(defult) [WAAS, EGNOS, MSAS,GAGAN] |
| Power Supply | VCC：3.0V to 4.3V；VBACKUP：2.0V to 4.3V |
| Current Consumption<br>@ 3.3V,1Hz Update Rate | Acquisition: 36mA, Tracking: 28mA |
| Working Temperature | -40 °C to +85 °C |
| Dimension | 10 x 10 x 6.8 mm, LCC |
| Weight | 2.75 g |

**Note:**
> The number range 65~96 of GLONASS satellite is shown in GLGSV sentence
> The number range 1~36 of Galileo satellite is shown in GAGSV sentence
> The number range 33~51 of SBAS and 193~195 of QZSS satellite is shown in GPGSV sentence

## 2.7 Absolute Maximum Ratings

The voltage applied for VCC should not exceed 4.3VDC.

| | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| **Power Supply Voltage** | VCC | 3.0 | 3.3 | 4.3 | V |
| **Backup battery Voltage** | VBACKUP | 2.0 | 3.0 | 4.3 | V |

## 2.8 Operating Condition

| | Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| **Operation supply Ripple Voltage** | — | — | — | 50 | **mVpp** |
| **RX0 TTL H Level** | Vcc=3.0~4.3V | 2.0 | — | Vcc | **V** |
| **RX0 TTL L Level** | Vcc=3.0~4.3V | 0 | — | 0.8 | **V** |
| **TX0 TTL H Level** | Vcc=3.0~4.3V | 2.4 | — | 2.8 | **V** |
| **TX0 TTL L Level** | Vcc=3.0~4.3V | 0 | — | 0.4 | **V** |
| **Current consumption @3.3V, 1Hz update rate** | Acquisition | — | 36 | — | **mA** |
| | Tracking | — | 28 | — | **mA** |
| **Backup power consumption @ 3V** | $25^0$C | — | 18 | — | **uA** |

# 3. Protocols

## 3.1 NMEA Output Sentences

**Table-1** lists each of the NMEA output sentences specifically developed and defined by MTK for use within MTK products

| Table-1: Each of the NMEA output sentences | |
|---|---|
| **Option** | **Description** |
| **GGA** | Time, position and fix type data. |
| **GSA** | GNSS receiver operating mode, active satellites used in the position solution and DOP values. |
| **GSV** | The number of GNSS satellites in view satellite ID numbers, elevation, azimuth, and SNR values. |
| **RMC** | Time, date, position, course and speed data. Recommended Minimum Navigation Information. |
| **VTG** | Course and speed information relative to the ground. |

| Table-2: NMEA Output Sentence for GPS and GNSS | | | | | |
|---|---|---|---|---|---|
| **System** | **GGA** | **GSA** | **GSV** | **RMC** | **VTG** |
| **GPS** | GPGGA | GPGSA | GPGSV | GPRMC | GPVTG |
| **GNSS (GPS+GLONASS)** | GNGGA | GPGSA GLGSA | GPGSV GLGSV | GNRMC | GNVTG |
| **GNSS (GPS+GLONASS+Galileo)** | GNGG | GPGSA GLGSA GAGSA | GPGSV GLGSV GAGSV | GNRMC | GNVTG |

**Note:** GP is a short term of "GPS"; GL is "GLONASS"; GA is "Galileo" and GN is "multi-system"
Default setting: GPS+GLONASS, GPS+GLONASS+Galileo need custom firmware and suggest work baud rate is 115,200bps.

## GGA—Global Positioning System Fixed Data. Time, Position and fix related data

**Table-3** contains the values for the following example :
*$GNGGA,165006.000,2241.9107,N,12017.2383,E,1,14,0.79,22.6,M,18.5,M,,*42*

| Table-3: GGA Data Format | | | |
|---|---|---|---|
| **Name** | **Example** | **Units** | **Description** |
| Message ID | $GNGGA | | GGA protocol header |
| UTC Time | 165006.000 | | hhmmss.sss |
| Latitude | 2241.9107 | | ddmm.mmmm |
| N/S Indicator | N | | N→North or S→South |
| Longitude | 12017.2383 | | dddmm.mmmm |
| E/W Indicator | E | | E→East or W→West |
| Position Fix Indicator | 1 | | See **Table-4** |
| Satellites Used | 14 | | Range 0 to 14 |
| HDOP | 0.79 | | Horizontal Dilution of Precision |
| MSL Altitude | 22.6 | meters | Antenna Altitude above/below mean-sea-level |
| Units | M | meters | Units of antenna altitude |
| Geoidal Separation | 18.5 | meters | |
| Units | M | meters | Units of geoids separation |
| Age of Diff. Corr. | | second | Null fields when DGPS is not used |
| Checksum | *42 | | |
| <CR> <LF> | | | End of message termination |

| Table-4: Position Fix Indicator | |
|---|---|
| **Value** | **Description** |
| 0 | Fix not available |
| 1 | GPS fix |
| 2 | Differential GPS fix |

**Note:**
When inputting the command $PMTK353,0,1,0,0,0*2A, $GNGGA will change to $GLGGA (For GLONASS).
When inputting the command $PMTK353,1,0,0,0,0*2A, $GNGGA will change to $GPGGA (For GPS)
User could refer to PMTK353 command for more detail

## GSA—GNSS DOP and Active Satellites

**Table-5** contains the values for the following example :
*$GPGSA,A,3,06,02,05,17,19,09,12,193,194,195,,,1.19,0.66,0.99*34*
*$GLGSA,A,3,65,66,88,87,81,67,,,,,,,1.19,0.66,0.99*13*
*$GAGSA,A,3,19,04,11,12,,,,,,,,,1.19,0.66,0.99*15*

| Table-5: GSA Data Format | | | |
|---|---|---|---|
| **Name** | **Example** | **Units** | **Description** |
| Message ID | $GPGSA or $GLGSA or $GAGSA | | GSA protocol header |
| Mode 1 | A | | See **Table-6** |
| Mode 2 | 3 | | See **Table-7** |
| Satellite Used | 06 | | SV on Channel 1 |
| Satellite Used | 02 | | SV on Channel 2 |
| .... | .... | .... | .... |
| Satellite Used | | | SV on Channel 12 |
| QZSS satellite | 193 | | Range 193 ~ 195 |
| PDOP | 1.19 | | Position Dilution of Precision |
| HDOP | 0.66 | | Horizontal Dilution of Precision |
| VDOP | 0.99 | | Vertical Dilution of Precision |
| Checksum | *34 | | |
| <CR> <LF> | | | End of message termination |

| Table-6: Mode 1 | |
|---|---|
| **Value** | **Description** |
| M | Manual—forced to operate in 2D or 3D mode |
| A | 2D Automatic—allowed to automatically switch 2D/3D |

| Table-7: Mode 2 | |
|---|---|
| **Value** | **Description** |
| 1 | Fix not available |
| 2 | 2D ($<$4 SVs used) |
| 3 | 3D ($\geqq$4 SVs used) |

**Note:**

It supports several header ID of GSA sentence for different satellite system like: GPxxx for GPS system, GLxxx for GLONASS system and GAxxx for Galileo system.

## GSV— Satellites in View, includes GPS(GPGSV),GLONASS(GLGSV) and Galileo(GAGSV )

**Table-8** contains the values for the following example :
*$GPGSV,4,1,15,195,59,162,39,05,53,288,45,42,51,129,36,02,49,348,41*4E*
*$GPGSV,4,2,15,19,49,149,42,06,42,065,43,13,29,187,37,12,24,254,33*75*
*$GPGSV,4,3,15,17,23,149,50,09,14,041,32,25,09,294,37,30,08,119,36*7E*
*$GPGSV,4,4,15,07,05,090,29,193,,,40,194,,,38*45*

| Table-8: GPGSV Data Format | | | |
|---|---|---|---|
| **Name** | **Example** | **Units** | **Description** |
| Message ID | $GPGSV | | GSV protocol header |
| Number of Messages | 4 | | Range 1 to 4 *(Depending on the number of satellites tracked, multiple messages of GSV data may be required.)* |
| Message Number1 | 1 | | Range 1 to 4 |
| Satellites in View | 15 | | |
| Satellite ID | 195 | | Channel 1 (Range 1 to 32) Note: 193~ 195 for QZSS |
| Elevation | 59 | degrees | Channel 1 (Maximum 90) |
| Azimuth | 162 | degrees | Channel 1 (True, Range 0 to 359) |
| SNR (C/No) | 39 | dBHz | Range 0 to 99,(null when not tracking) |
| .... | .... | .... | .... |
| Satellite ID | 07 | | Channel 4 (Range 1 to 32) |
| Elevation | 05 | degrees | Channel 4 (Maximum 90) |
| Azimuth | 090 | degrees | Channel 4 (True, Range 0 to 359) |
| SNR (C/No) | 29 | dBHz | Range 0 to 99, (null when not tracking) |
| Checksum | *4E | | |
| <CR> <LF> | | | End of message termination |

**Table-9** contains the values for the following example :
*$GLGSV,2,1,07,66,65,356,38,81,57,004,36,88,52,108,34,67,48,235,36*66*
*$GLGSV,2,2,07,82,13,332,,87,11,134,26,65,10,029,19*54*

| Table-9: GLGSV Data Format | | | |
|---|---|---|---|
| **Name** | **Example** | **Units** | **Description** |
| Message ID | $GLGSV | | GSV protocol header |
| Number of Messages | 2 | | Range 1 to 4 *(Depending on the number of satellites tracked, multiple messages of GSV data may be required.)* |
| Message Number1 | 1 | | Range 1 to 4 |
| Satellites in View | 07 | | |
| Satellite ID | 66 | | Channel 1 (Range 65 to 96) |
| Elevation | 65 | degrees | Channel 1 (Maximum 90) |
| Azimuth | 356 | degrees | Channel 1 (True, Range 0 to 359) |
| SNR (C/No) | 38 | dBHz | Range 0 to 99,(null when not tracking) |
| .... | .... | .... | .... |
| Satellite ID | 65 | | Channel 4 (Range 65 to 96) |
| Elevation | 10 | degrees | Channel 4 (Maximum 90) |
| Azimuth | 029 | degrees | Channel 4 (True, Range 0 to 359) |
| SNR (C/No) | 19 | dBHz | Range 0 to 99,(null when not tracking) |
| Checksum | *54 | | |
| <CR> <LF> | | | End of message termination |

*$GAGSV,2,1,06,04,79,161,42,12,59,058,38,11,38,332,35,19,36,042,32*6B*
*$GAGSV,2,2,06,24,10,226,,25,06,272,*69*

| Table-9: GAGSV Data Format | | | |
|---|---|---|---|
| **Name** | **Example** | **Units** | **Description** |
| Message ID | $GAGSV | | GSV protocol header |
| Number of Messages | 2 | | Range 1 to 4 *(Depending on the number of satellites tracked, multiple messages of GSV data may be required.)* |
| Message Number1 | 1 | | Range 1 to 4 |
| Satellites in View | 06 | | |
| Satellite ID | 04 | | Channel 1 (Range 1 to 36) |
| Elevation | 79 | degrees | Channel 1 (Maximum 90) |
| Azimuth | 161 | degrees | Channel 1 (True, Range 0 to 359) |
| SNR (C/No) | 42 | dBHz | Range 0 to 99,(null when not tracking) |
| .... | .... | .... | .... |
| Satellite ID | 25 | | Channel 4 (Range 1 to 36) |
| Elevation | 06 | degrees | Channel 4 (Maximum 90) |
| Azimuth | 272 | degrees | Channel 4 (True, Range 0 to 359) |
| SNR (C/No) | | dBHz | Range 0 to 99,(null when not tracking) |
| Checksum | *6D | | |
| <CR> <LF> | | | End of message termination |

## RMC—Recommended Minimum Navigation Information

**Table-10** contains the values for the following example：
*$GNRMC,064951.000,A,2307.1256,N,12016.4438,E,0.03,165.48,260406,3.05,W,A\*2C*
*$GNRMC,155503.000,A,5606.1725,N,01404.0622,E,0.04,0.00,110918,,,D\*75*

| Table-10: RMC Data Format | | | |
|---|---|---|---|
| **Name** | **Example** | **Units** | **Description** |
| Message ID | $GNRMC | | RMC protocol header |
| UTC Time | 155503.000 | | hhmmss.sss |
| Status | A | | A → data valid or V → data not valid |
| Latitude | 5606.1725 | | ddmm.mmmm |
| N/S Indicator | N | | N → North or S → South |
| Longitude | 01404.0622 | | dddmm.mmmm |
| E/W Indicator | E | | E → East or W → West |
| Speed over Ground | 0.04 | knots | |
| Course over Ground | 165.48 | degrees | True |
| Date | 260406 | | ddmmyy |
| Magnetic Variation | 3.05, W | degrees | E → East or W → West |
| Mode | A | | A → Autonomous mode<br>D → Differential mode<br>E → Estimated mode |
| Checksum | *2C | | |
| <CR> <LF> | | | End of message termination |

**Note:**
When inputting the commend $PMTK353,0,1,0,0,0*2A , $GNRMC will change to $GLRMC (for GLONASS).
When inputting the commend $PMTK353,1,0,0,0,0*2A : $GNRMC will change to $GPRMC (for GPS).
User could refer to PMTK353 command for more details

## VTG—Course and speed information relative to the ground

**Table-10** contains the values for the following example**:**
*$GNVTG,352.70,T,,M,0.07,N,0.13,K,A*25*

| Table-10: VTG Data Format | | | |
|---|---|---|---|
| **Name** | **Example** | **Units** | **Description** |
| Message ID | $GNVTG | | VTG protocol header |
| Course | 352.70 | degrees | Measured heading |
| Reference | T | | True |
| Course | | degrees | Measured heading |
| Reference | M | | Magnetic |
| Speed | 0.07 | knots | Measured horizontal speed |
| Units | N | | Knots |
| Speed | 0.13 | km/hr | Measured horizontal speed |
| Units | K | | Kilometers per hour |
| Mode | A | | A → Autonomous mode<br>D → Differential mode<br>E → Estimated mode |
| Checksum | *25 | | |
| <CR> <LF> | | | End of message termination |

**Note:**
When inputting the commend $PMTK353,0,1,0,0,0*2A , $GNVTG will change to $GLVTG(For GLONASS). When inputting the commend $PMTK353,1,0,0,0,0*2A : $GNVTG will change to $GPVTG (For GPS).

## 3.2 MTK NMEA Command Protocols

**Packet Type:**
103 PMTK_CMD_COLD_START

**Packet Meaning:**
Cold Start：Don't use Time, Position, Almanacs and Ephemeris data at re-start.
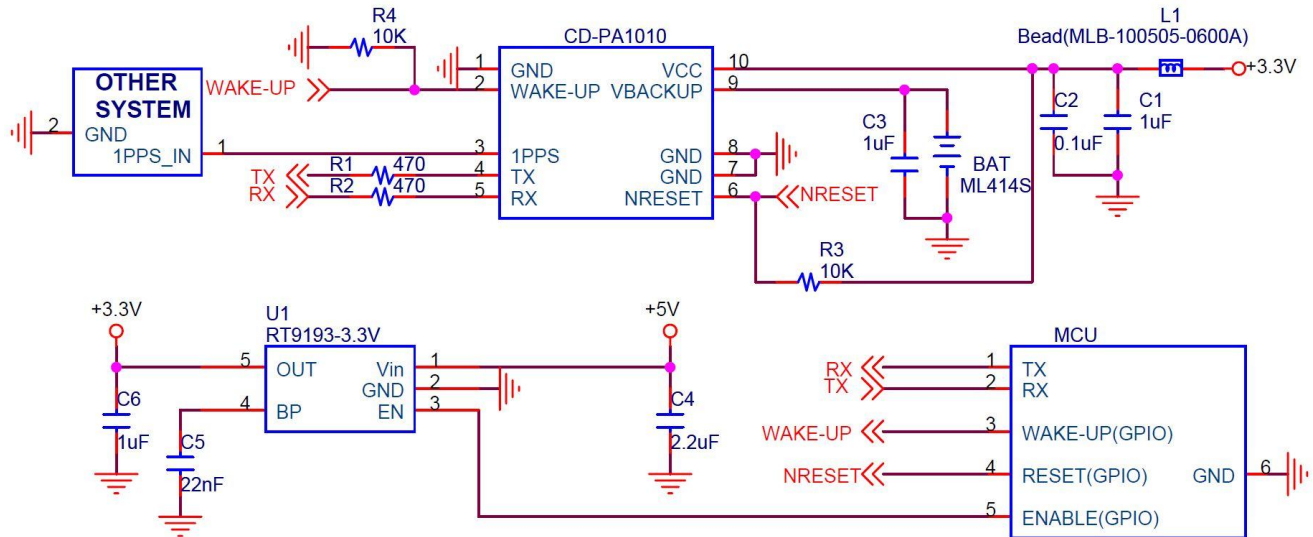
**Example:**
$PMTK103*30<CR><LF>

# 4. Reference Design

This chapter introduces the reference schematic design for the best performance. Additional tips and cautions on design are well documented on Application Note, which is available upon request.

## 4.1 Reference Design Circuit



**Note:**

1. Ferrite bead L1 is added for power noise reduction.
2. C1 and C2 bypass should be put near the module.
3. Damping resistors R1, R2 could be modified based on system application for EMI.
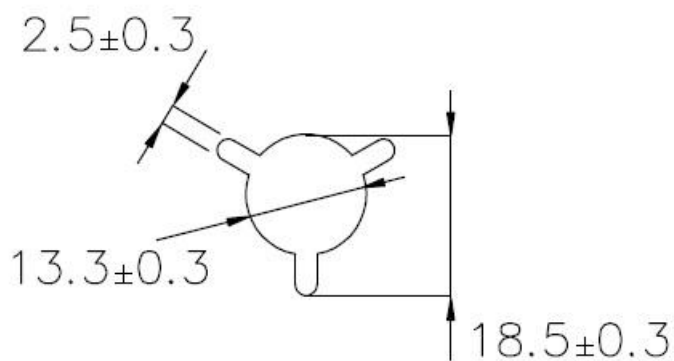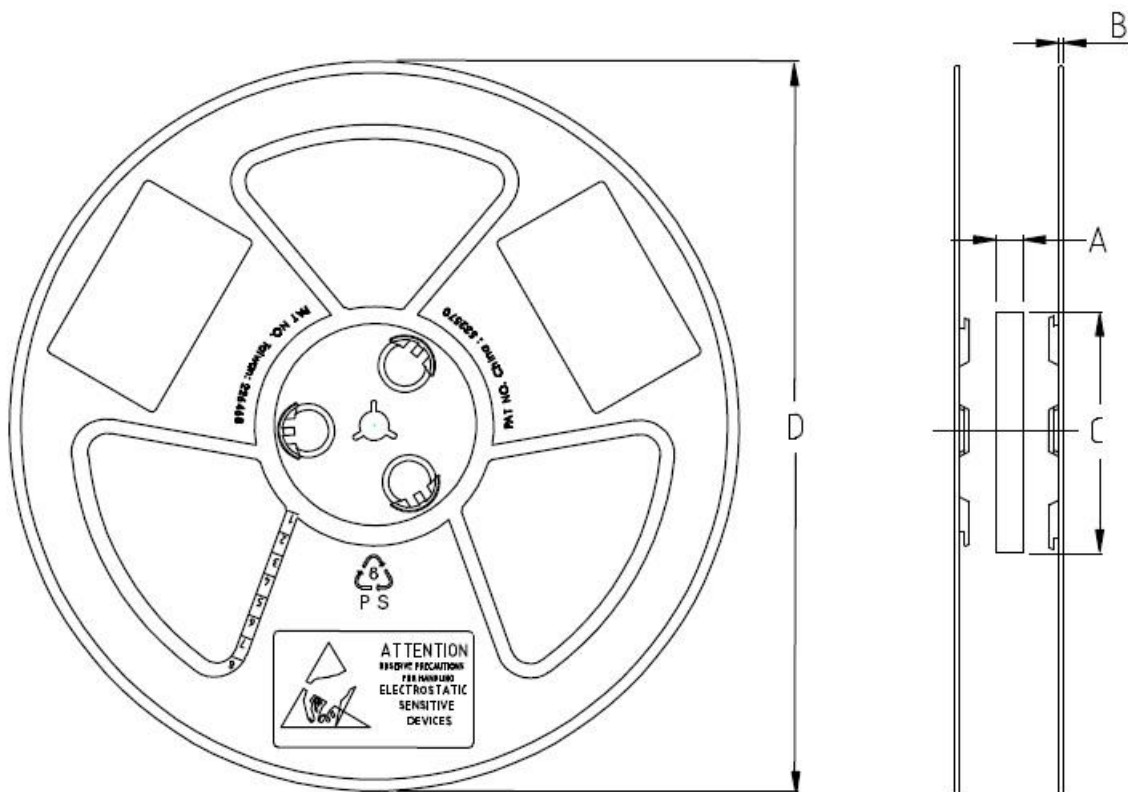
# 5. Reflow Soldering Note

**Cautionary Notes on Reflow-Soldering Process:**

1. Module must be pre-baked **before** going through SMT solder reflow process.
2. The usage of solder paste should follow "First-in-First out" principle. Opened solder paste needs to be monitored and recorded in a timely manner (refer to IPQC standards for related documentation and examples).
3. Temperature and humidity must be controlled within SMT production line and storage area. Temperature of 23°C, 60±5% RH humidity is recommended. (please refer to IPQC standards for related documentation and examples)
4. When performing solder paste printing, please notice if the amount of solder paste is in excess or insufficient, as both conditions may lead to defects such as electrical shortage, empty solder and etc.
5. Make sure the vacuum mouthpiece is able to bear the weight of the GNSS module to prevent positional shift during the loading process.
6. Before the PCBA is going through the reflow-soldering process, the operators should check with his/her own eyes to see if there are positional offset to the module.
7. The reflow temperature and its profile data must be measured before the SMT process and match the levels and guidelines set by IPQC.
8. If SMT protection line is running a double-sided process for PCBA, please process GNSS module during the second pass only to avoid repeated reflow exposures of the GNSS module. Please contact CDTop beforehand if you must process GNSS module during the $1^{st}$ pass of double-side process.
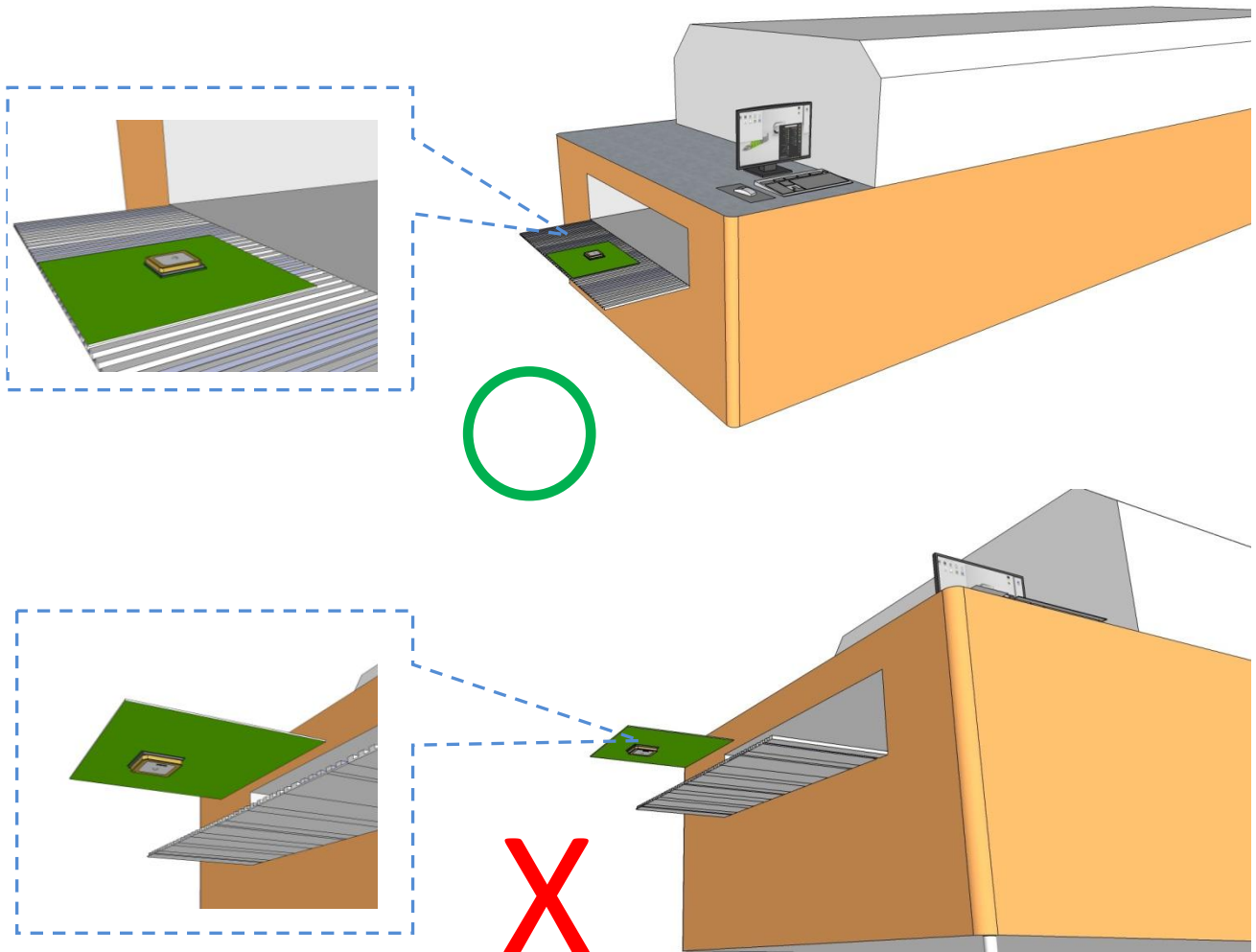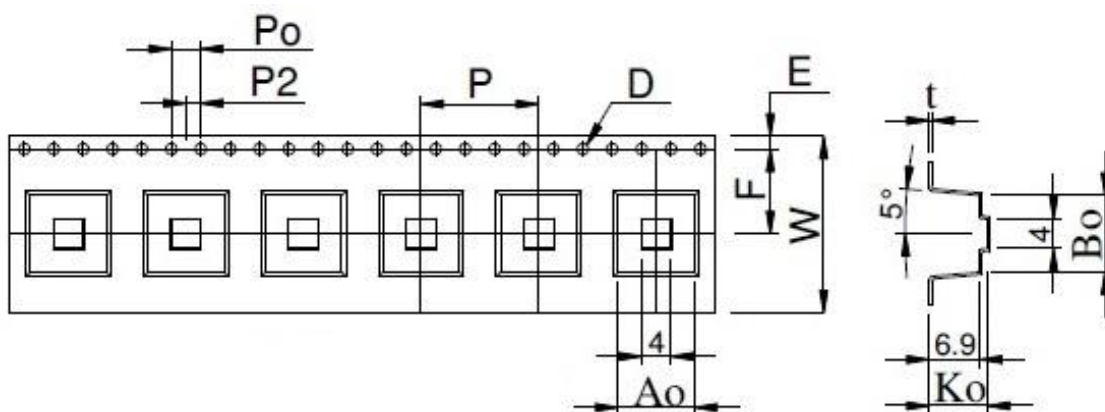
# 6. Tape Reel Packing Information

**One Reel : 500pcs**





2.5±0.3

13.3±0.3

18.5±0.3

| SPEC | 13" REEL W: 24 mm | | | | |
|------|------|------|------|------|------|
| | Material: HIPS | | | | |
| ITEM | A | B | C | D | Surface Resistivity |
| DIM | 24.5 ± $^{+1.0}_{-0.1}$ mm | 2.2 ± 0.2mm | 100 ± 1.0 mm | 330 ± 1.5mm | < 10$^{11}$ Ω/□ |
| ALTERNATE | | | | | |

Pin 1 position

Feed direction

| ITEM | SPEC |
|------|------|
| W | 24.0 $^{+0.30}_{-0.30}$ |
| Ao | 10.4 $^{+0.10}_{-0.10}$ |
| Bo | 10.4 $^{+0.10}_{-0.10}$ |
| Ko | 7.90 $^{+0.10}_{-0.10}$ |
| P | 16.0 $^{+0.10}_{-0.10}$ |
| F | 11.5 $^{+0.10}_{-0.10}$ |
| E | 1.75 $^{+0.10}_{-0.10}$ |
| D | 1.50 $^{+0.10}_{-0.00}$ |
| D1 | 0.00 $^{+0.10}_{-0.10}$ |
| Po | 4.00 $^{+0.10}_{-0.10}$ |
| P2 | 2.00 $^{+0.10}_{-0.10}$ |
| t | 0.35 $^{+0.05}_{-0.05}$ |