

| Product name | Description | Version |
|--------------|--|---------|
| MC-1010i-V2b | Dual-frequency multi-constellation GNSS positioning module | 1.1 |



1 Introduction

LOCOSYS MC-1010i-V2b is a high-performance dual-band GNSS positioning module that can track all global civil navigation systems. It adopts 12 nm process and integrates efficient power management architecture to perform low power and high sensitivity. Besides, concurrent reception of L1 and L5 band signals mitigates the multipath delay and achieves more accurate position.

The module supports hybrid ephemeris prediction to achieve faster cold start. One is self-generated ephemeris prediction (called EPOC) 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 GNSS module is powered on and satellites are available. The other is server-generated ephemeris prediction (called EPO) 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

- Support GPS, GLONASS, GALILEO, BEIDOU, QZSS and NavIC
- Capable of SBAS (WAAS, EGNOS, MSAS, GAGAN) and QZSS SLAS
- Support 135-channel GNSS
- Ultra low power consumption
- Fast TTFF at low signal level
- Free hybrid ephemeris prediction to achieve faster cold start
- Up to 10 Hz update rate
- ± 10 ns high accuracy time pulse (PPS)
- GNSS software package that can pass Android GMS certification
- Small form factor 10.1 x 9.7 x 2.2 mm
- SMD type with stamp holes; RoHS compliant

3 Application

- Personal positioning and navigation
- Automotive navigation
- Marine navigation

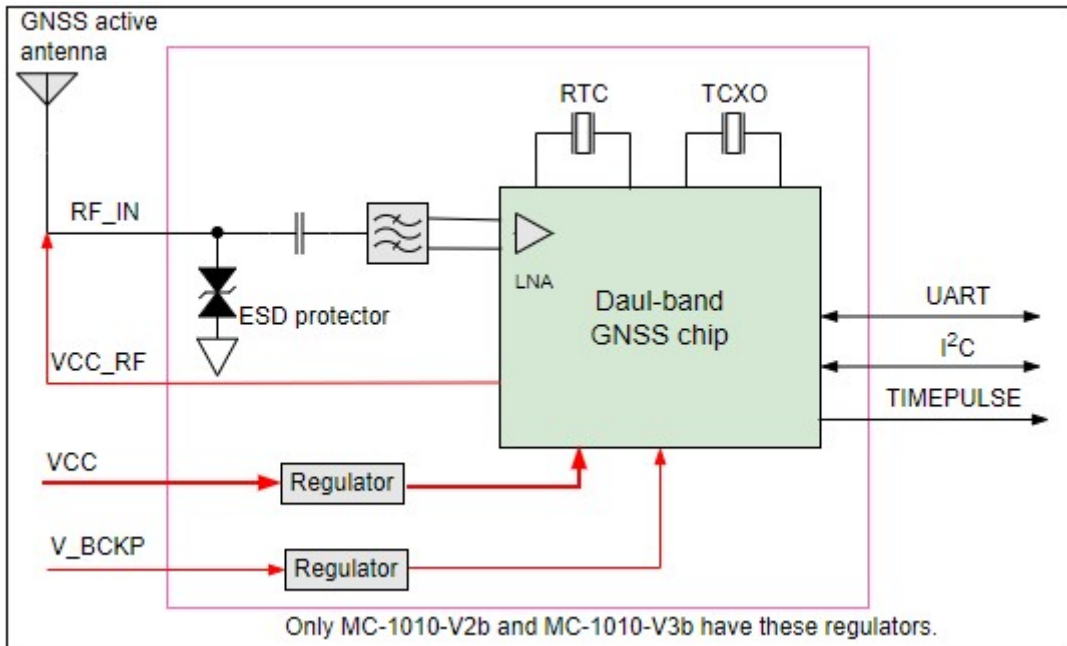


Fig. 3-1 System block diagram.

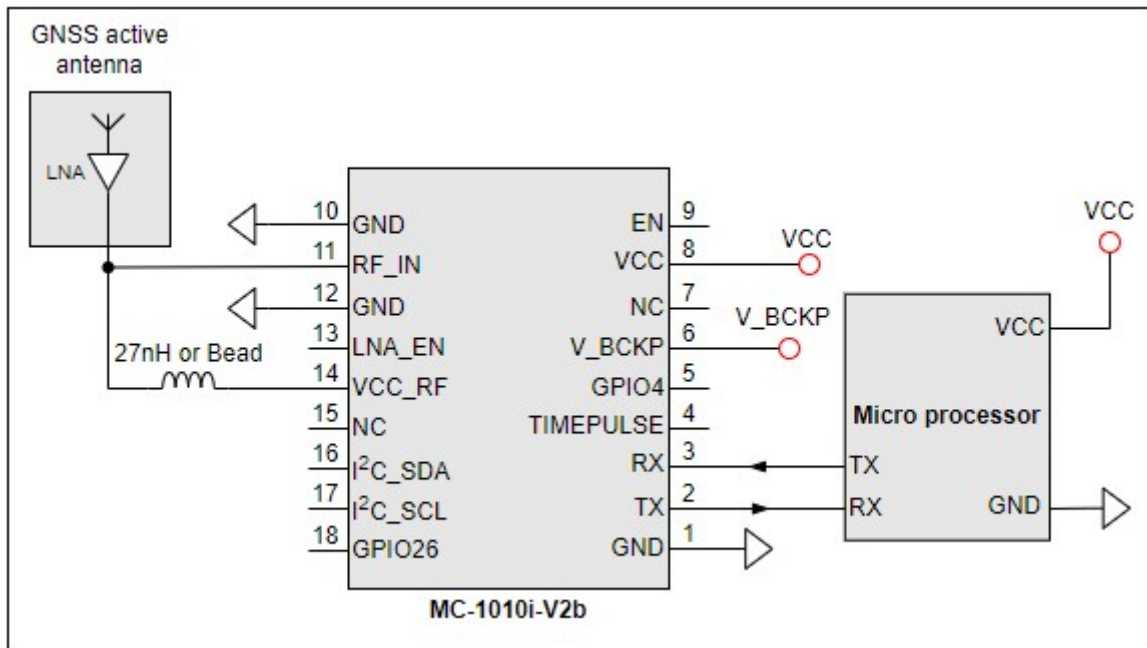


Fig. 3-2 Typical application circuit that uses UART interface.

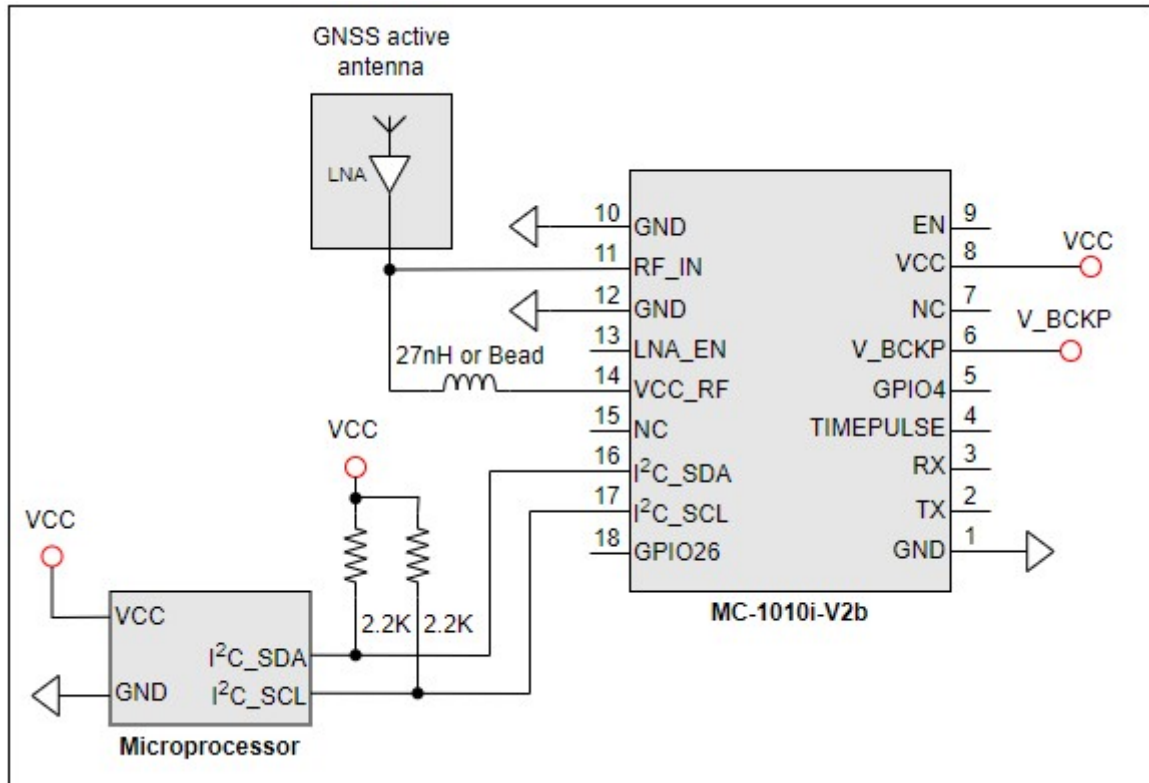


Fig. 3-3 Typical application circuit that uses I²C interface.

4 GNSS receiver

| | | |
|-------------------|---|---|
| Frequency | GPS/QZSS: L1 C/A, L5C GLONASS: L1OF GALILEO: E1, E5a BEIDOU: B1I, B2a NavIC: L5 | |
| Channels | Support 135 channels | |
| Update rate | 1Hz default, up to 10Hz | |
| Sensitivity | Tracking | -165dBm (with external LNA) |
| | Cold start | -148dBm (with external LNA) |
| Acquisition Time | Hot start (Open Sky) | 1s (typical) |
| | Cold Start (Open Sky) | 28s (typical) without AGPS |
| | | < 15s (typical) with AGPS (ephemeris prediction) |
| Position Accuracy | Autonomous: 1.5m (CEP) ⁽¹⁾ | |
| Max. Altitude | < 18,000 m | |
| Max. Velocity | < 500 m/s | |
| Protocol Support | NMEA 0183 ver. 4.1 | 115200 bps ⁽²⁾ , 8 data bits, no parity, 1 stop bits (default) 1Hz: GGA, GLL, GSA, GSV, RMC, VTG, GST |

Note 1. Open sky, dual band, demonstrated with a good external LNA.

Note 2. 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 |
| GST | Estimated error in position solution |

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

Table 5.1-2 contains the values for the following example:

```
$GNGGA,091250.000,2503.71250,N,12138.74514,E,1,32,0.55,119.0,M,17.2,M,,*7E
```

Table 5.1- 2 GGA Data Format

| Name | Example | Units | Description |
|------------------------|-------------|--------|---|
| Message ID | \$GNGGA | | GGA protocol header |
| UTC Time | 091250.000 | | hhmmss.sss |
| Latitude | 2503.71250 | | ddmm.mmmmm |
| N/S indicator | N | | N=north or S=south |
| Longitude | 12138.74514 | | dddmm.mmmmm |
| E/W Indicator | E | | E=east or W=west |
| Position Fix Indicator | 1 | | See Table 5.1-3 |
| Satellites Used | 32 | | Number of satellites in use |
| HDOP | 0.55 | | Horizontal Dilution of Precision (meters) |
| MSL Altitude | 119.0 | meters | Antenna Altitude above/below mean-sea-level (geoid) (in meters) |
| Units | M | meters | Units of antenna altitude, meters |
| Geoidal Separation | 17.2 | meters | |
| Units | M | meters | Units of geoidal separation, meters |
| Age of diff. GNSS data | | second | Null fields when DGPS is not used |
| Diff. Ref. Station ID | | | Differential reference station ID, 0000-1023 |
| Checksum | *7E | | Checksum |
| <CR> <LF> | | | End of message termination |

Table 5.1-3 Position Fix Indicators

| Value | Description |
|-------|------------------------------|
| 0 | No position fix |
| 1 | Autonomous GNSS fix |
| 2 | Differential GNSS fix |
| 4 | RTK fixed |
| 5 | RTK float |
| 6 | Estimated/Dead reckoning fix |

● GLL--- Geographic Position – Latitude/Longitude

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

\$GNGLL,2503.71193,N,12138.74582,E,094450.000,A,A*47

Table 5.1-4 GLL Data Format

| Name | Example | Units | Description |
|------------|---------|-------|---------------------|
| Message ID | \$GNGLL | | GLL protocol header |

| | | | |
|---------------|-------------|--|---|
| Latitude | 2503.71193 | | ddmm.mmmmm |
| N/S indicator | N | | N=north or S=south |
| Longitude | 12138.74582 | | dddmm.mmmmm |
| E/W indicator | E | | E=east or W=west |
| UTC Time | 094450.000 | | hhmmss.sss |
| Status | A | | A=data valid or V=data not valid |
| Mode | A | | N = No position fix A = Autonomous GNSS fix D = Differential GNSS fix R = RTK fixed F = RTK float E = Estimated/Dead reckoning fix |
| Checksum | *47 | | |
| <CR> <LF> | | | End of message termination |

● **GSA---GNSS DOP and Active Satellites**

Table 5.1-5 contains the values for the following example:

\$GNGSA,A,3,11,195,194,199,08,07,01,27,16,09,23,,1.19,0.64,1.00,1*3F

\$GNGSA,A,3,87,81,76,,,,,,,,,1.19,0.64,1.00,2*0F

\$GNGSA,A,3,,,,,,,,,1.19,0.64,1.00,3*09

\$GNGSA,A,3,34,24,12,07,11,10,08,38,25,09,13,16,1.19,0.64,1.00,4*02

Table 5.1-5 GSA Data Format

| Name | Example | Units | Description |
|----------------------|---------|-------|----------------------------------|
| Message ID | \$GNGSA | | GSA protocol header |
| Mode 1 | A | | See Table 5.1-6 |
| Mode 2 | 3 | | See Table 5.1-7 |
| ID of satellite used | 11 | | SV on Channel 1 |
| ID of satellite used | 195 | | SV on Channel 2 |
| | | | |
| ID of satellite used | | | SV on Channel 12 |
| PDOP | 1.19 | | Position Dilution of Precision |
| HDOP | 0.64 | | Horizontal Dilution of Precision |
| VDOP | 1.00 | | Vertical Dilution of Precision |
| GNSS system ID | 4 | | See Table 5.1-8 |
| Checksum | *3F | | |
| <CR> <LF> | | | End of message termination |

Table 5.1-6 Mode 1

| Value | Description |
|-------|---|
| M | Manually set to operate in 2D or 3D mode |
| A | Automatically switching between 2D or 3D mode |

Table 5.1-7 Mode 2

| Value | Description |
|-------|-----------------|
| 1 | No position fix |
| 2 | 2D fix |
| 3 | 3D fix |

Table 5.1-8 GNSS system ID

| Value | Description |
|-------|-------------|
| 1 | GPS |
| 2 | GLONASS |
| 3 | GALILEO |
| 4 | BEIDOU |
| 6 | NavIC |

● GSV---GNSS Satellites in View

Table 5.1-9 contains the values for the following example:

```
$GPGSV,3,1,09,8,71,268,47,27,63,18,49,11,44,191,46,4,41,237,46,1*54
$GPGSV,3,2,09,16,38,42,42,9,32,279,39,26,22,70,38,31,15,131,36,1*56
$GPGSV,3,3,09,7,15,320,40,1*6B
$GPGSV,1,1,04,8,71,268,50,27,63,18,49,9,32,279,43,26,22,70,42,8*6C
$GLGSV,2,1,05,82,63,47,47,83,56,182,36,80,47,9,42,79,33,85,45,1*71
$GLGSV,2,2,05,81,15,27,37,1*71
$GAGSV,1,1,04,08,48,300,43,03,47,025,45,13,36,309,42,05,06,061,34,7*79
$GAGSV,1,1,04,08,48,300,43,03,47,025,47,13,36,309,43,05,06,061,33,1*7B
$GBGSV,5,1,17,12,80,182,47,24,64,5,51,7,58,355,44,3,57,205,45,1*7C
$GBGSV,5,2,17,1,54,141,44,34,52,211,49,9,48,230,45,10,47,316,42,1*79
$GBGSV,5,3,17,26,44,100,47,16,39,207,43,4,38,117,41,2,37,240,41,1*77
$GBGSV,5,4,17,39,37,210,43,6,36,198,41,38,27,173,41,25,18,317,42,1*4E
$GBGSV,5,5,17,35,16,39,40,1*7F
$GBGSV,1,1,02,24,64,5,50,26,44,100,43,4*77
```

Table 5.1-9 GSV Data Format

| Name | Example | Units | Description |
|------------|---------|-------|--|
| Message ID | \$GPGSV | | GSV protocol header GP=GPS/QZSS, GL=GLONSS, GA=GALILEO, |

| | | | |
|--------------------------|-----|---------|--|
| | | | GB=BEIDOU, GI=NavIC. |
| Total number of messages | 3 | | Range 1 to 9 |
| Message number | 1 | | Range 1 to 9 |
| Satellites in view | 09 | | |
| Satellite ID | 8 | | Channel 1 |
| Elevation | 71 | degrees | Channel 1 (Range 00 to 90) |
| Azimuth | 268 | degrees | Channel 1 (Range 000 to 359) |
| SNR (C/No) | 47 | dB-Hz | Channel 1 (Range 00 to 99, null when not tracking) |
| | | | |
| Satellite ID | 4 | | Channel 4 (Range 01 to 196) |
| Elevation | 41 | degrees | Channel 4 (Range 00 to 90) |
| Azimuth | 237 | degrees | Channel 4 (Range 000 to 359) |
| SNR (C/No) | 46 | dB-Hz | Channel 4 (Range 00 to 99, null when not tracking) |
| Signal ID | 1 | | GPS/QZSS: L1 C/A=1, L5Q=8 GLONASS: L1 C/A=1 GALILEO: E1=7, E5a=1 BEIDOU: B1=1, B2a=4 NavIC: L5=1 |
| Checksum | *54 | | |
| <CR> <LF> | | | End of message termination |

● **RMC---Recommended Minimum Specific GNSS Data**

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

\$GNRMC,070143.000,A,2503.71317,N,12138.74533,E,0.002,70.50,130220,,,A,V*01

Table 5.1-10 RMC Data Format

| Name | Example | Units | Description |
|--------------------|-------------|---------|----------------------------------|
| Message ID | \$GNRMC | | RMC protocol header |
| UTC Time | 070143.000 | | hhmmss.sss |
| Status | A | | A=data valid or V=data not valid |
| Latitude | 2503.71317 | | ddmm.mmmmm |
| N/S Indicator | N | | N=north or S=south |
| Longitude | 12138.74533 | | dddmm.mmmmm |
| E/W Indicator | E | | E=east or W=west |
| Speed over ground | 0.002 | knots | True |
| Course over ground | 70.50 | degrees | |
| Date | 130220 | | ddmmyy |

| | | | |
|-------------------------------|-----|---------|---|
| Magnetic variation | | degrees | |
| Variation sense | | | E=east or W=west |
| Mode | A | | N = No position fix A = Autonomous GNSS fix D = Differential GNSS fix R = RTK fixed F = RTK float E = Estimated/Dead reckoning fix |
| Navigational status indicator | V | | S = Safe C = Caution U = Unsafe V = Void |
| Checksum | *01 | | |
| <CR> <LF> | | | End of message termination |

● VTG---Course Over Ground and Ground Speed

Table 5.1-11 contains the values for the following example:

\$GNVTG,0.00,T,,M,0.003,N,0.006,K,A*26

Table 5.1-11 VTG Data Format

| Name | Example | Units | Description |
|--------------------|---------|---------|---|
| Message ID | \$GPVTG | | VTG protocol header |
| Course over ground | 0.00 | degrees | Measured heading |
| Reference | T | | True |
| Course over ground | | degrees | Measured heading |
| Reference | M | | Magnetic |
| Speed over ground | 0.003 | knots | Measured speed |
| Units | N | | Knots |
| Speed over ground | 0.006 | km/hr | Measured speed |
| Units | K | | Kilometer per hour |
| Mode | A | | N = No position fix A = Autonomous GNSS fix D = Differential GNSS fix R = RTK fixed F = RTK float E = Estimated/Dead reckoning fix |
| Checksum | *26 | | |
| <CR> <LF> | | | End of message termination |

● **GST---Estimated error in position solution**

Table 5.1-12 contains the values for the following example:

\$GNGST,075707.000,2.9,1.8,1.5,113.3,1.6,1.8,5.9*7F

Table 5.1-12 GST Data Format

| Name | Example | Units | Description |
|------------|------------|---------|--|
| Message ID | \$GNGST | | GST protocol header |
| UTC Time | 075707.000 | | hhmmss.sss |
| RangeRMS | 2.9 | meters | RMS value of the standard deviation of the ranges |
| stdMajor | 1.8 | meters | Standard deviation of semi-major axis of error ellipse |
| stdMinor | 1.5 | meters | Standard deviation of semi-minor axis of error ellipse |
| Orient | 113.3 | degrees | Orientation of semi-major axis of error ellipse |
| stdLat | 1.6 | meters | Standard deviation of latitude error |
| stdLong | 1.8 | meters | Standard deviation of longitude error |
| stdAlt | 5.9 | meters | Standard deviation of altitude error |
| Checksum | *7F | | |
| <CR> <LF> | | | End of message termination |

5.2 Proprietary commands

The commonly used commands are in the following.

5.2.1 ID: 001

[Description]

PAIR_ACK. Acknowledge of the input command.

[Return]

\$PAIR001,Command_ID,Result*CS<CR><LF>

Command_ID: The command / packet type the acknowledge responds.

Result: The result of the command.

0: The command was successfully sent.

1: The command is processing. You must wait for the result.

2: Sending the command failed.

3: This command ID is not supported.

4: Command parameter error. Out of range / some parameters were lost / checksum error.

5: Service is busy. You can try again soon.

[Example]

Send:

\$PAIR002*38\r\n

Response:

\$PAIR001,002,0*39\r\n ==> Success

5.2.2 ID: 002

[Description]

Power on the GNSS system. Include DSP/RF/Clock and other GNSS sections.

[Data Field]

\$PAIR002*CS<CR><LF>

[Return]

PAIR_ACK for send result.

[Example]

Send:

\$PAIR002*38\r\n

Response:

\$PAIR001,002,1*38\r\n ==> The power on process is running. Please wait a moment.

\$PAIR001,002,0*39\r\n ==> Power on was successful.

5.2.3 ID: 003

[Description]

Power off GNSS system. Include DSP/RF/Clock and other GNSS sections. The location service is not available after this command is executed. The module can still receive configuration commands.

[Data Field]

\$PAIR003*CS<CR><LF>

[Return]

PAIR_ACK for send result.

[Example]

Send:

\$PAIR003*39\r\n

Response:

\$PAIR001,003,1*39\r\n ==> The power off process is running. Please wait a moment.

\$PAIR001,003,0*38\r\n ==> Power off was successful.

5.2.4 ID: 004

[Description]

Hot Start. Use the available data in the NVRAM.

[Data Field]

\$PAIR004*CS<CR><LF>

[Return]

PAIR_ACK for send result.

[Example]

Send:

\$PAIR004*3E\r\n

Response:

\$PAIR001,004,0*3F\r\n ==> Success

5.2.5 ID: 005

[Description]

Warm Start. Not using Ephemeris data at the start.

[Data Field]

\$PAIR005*CS<CR><LF>

[Return]

PAIR_ACK for send result.

[Example]

Send:

\$PAIR005*3F\r\n

Response:

\$PAIR001,005,0*3E\r\n ==> Success

5.2.6 ID: 006

[Description]

Cold Start. Not using the Position, Almanac and Ephemeris data at the start.

[Data Field]

\$PAIR006*CS<CR><LF>

[Return]

PAIR_ACK for send result.

[Example]

Send:

\$PAIR006*3C\r\n

Response:

\$PAIR001,006,0*3D\r\n ==> Success

5.2.7 ID: 864

[Description]

Set baud rate configuration.

[Data Field]

\$PAIR864,<Port_Type>,<Port_Index>,<Baudrate>*CS<CR><LF>

Port_Type: HW Port Type.

0: UART

Port_Index: HW Port Index

0: UART0

Baudrate: the baud rate needs config.

Support 115200, 230400, 460800, 921600, 3000000

[Return]

PAIR_ACK for send result.

[Example]

Send:

\$PAIR864,0,0,115200*1B\r\n

Response:

\$PAIR001,864,0*31\r\n ==> Success

[Note]

The change will take effect after reboot.

5.2.8 ID: 050

[Description]

Set Position Fix Interval.

If set less than 1000 ms, ASCII NMEA will automatically increase the update interval in order to decrease IO throughput.

[Data Field]

\$PAIR050,<Fix_Interval>*CS<CR><LF>

Fix_Interval: Position fix interval in milliseconds (ms). [Range: 100 ~ 1000]

[Return]

PAIR_ACK for send result.

[Example]

Send:

\$PAIR050,1000*12\r\n

Response:

\$PAIR001,050,0*3E\r\n ==> Success

5.2.9 ID: 051

[Description]

Get Position Fix Interval.

[Data Field]

\$PAIR051*CS<CR><LF>

[Return]

1. PAIR_ACK for send result.
2. \$PAIR050,<Fix_Interval>*CS<CR><LF>

Fix_Interval: Position fix interval in milliseconds (ms). [Range: 100 ~ 1000]

[Example]

Send:

\$PAIR051*3E\r\n

Response:

\$PAIR001,051,0*3F\r\n ==> Success

\$PAIR051,1000*13\r\n

5.2.10 ID: 062

[Description]

Set the NMEA sentence output interval of corresponding NMEA type.

[Data Field]

\$PAIR062,<Type>,<Output_Rate>*CS<CR><LF>

Type: NMEA Type

-1 Reset all sentence to default value.

- 0 NMEA_SEN_GGA, // GGA interval - GPS Fix Data
- 1 NMEA_SEN_GLL, // GLL interval - Geographic Position - Latitude longitude
- 2 NMEA_SEN_GSA, // GSA interval - GNSS DOPS and Active Satellites
- 3 NMEA_SEN_GSV, // GSV interval - GNSS Satellites in View
- 4 NMEA_SEN_RMC, // RMC interval - Recommended Minimum Specific GNSS Sentence
- 5 NMEA_SEN_VTG, // VTG interval - Course Over Ground and Ground Speed
- 6 NMEA_SEN_ZDA, // ZDA interval - Time & Date
- 7 NMEA_SEN_GRS, // GRS interval - GNSS Range Residuals
- 8 NMEA_SEN_GST, // GST Interval - GNSS Pseudorange Error Statistics

Output_Rate: Output interval setting (Valid range: 0~20)

- 0 - Disabled or not supported sentence
- 1 - Output once every one position fix
- 2 - Output once every two position fixes
- 3 - Output once every three position fixes
- 4 - Output once every four position fixes
- 5 - Output once every five position fixes

[Return]

PAIR_ACK for send result.

[Example]

Send:

```
$PAIR062,0,3*3D\r\n
```

Response:

```
$PAIR001,062,0*3F\r\n ==> Success
```

5.2.11 ID: 063

[Description]

Get the NMEA sentence output interval of corresponding NMEA type.

[Data Field]

```
$PAIR063,<Type>*CS<CR><LF>
```

Type: NMEA Type

-1 return all sentence configuration.

0 NMEA_SEN_GGA, // GGA interval - GPS Fix Data

1 NMEA_SEN_GLL, // GLL interval - Geographic Position - Latitude longitude

2 NMEA_SEN_GSA, // GSA interval - GNSS DOPS and Active Satellites

3 NMEA_SEN_GSV, // GSV interval - GNSS Satellites in View

4 NMEA_SEN_RMC, // RMC interval - Recommended Minimum Specific GNSS

Sentence

5 NMEA_SEN_VTG, // VTG interval - Course Over Ground and Ground Speed

6 NMEA_SEN_ZDA, // ZDA interval - Time & Date

7 NMEA_SEN_GRS, // GRS interval - GNSS Range Residuals

8 NMEA_SEN_GST, // GST Interval - GNSS Pseudorange Error Statistics

[Return]

1. PAIR_ACK for send result.

2. \$PAIR063,<Type>,<Output_Rate>*CS<CR><LF>

Type: NMEA Type

0 NMEA_SEN_GGA, // GGA interval - GPS Fix Data

1 NMEA_SEN_GLL, // GLL interval - Geographic Position - Latitude longitude

2 NMEA_SEN_GSA, // GSA interval - GNSS DOPS and Active Satellites

3 NMEA_SEN_GSV, // GSV interval - GNSS Satellites in View

4 NMEA_SEN_RMC, // RMC interval - Recommended Minimum Specific GNSS

Sentence

5 NMEA_SEN_VTG, // VTG interval - Course Over Ground and Ground Speed

6 NMEA_SEN_ZDA, // ZDA interval - Time & Date

7 NMEA_SEN_GRS, // GRS interval - GNSS Range Residuals
8 NMEA_SEN_GST, // GST Interval - GNSS Pseudorange Error Statistics
Output_Rate: Output interval setting (Valid range: 0~20, default value: 1)
0 - Disabled or not supported sentence
1 - Output once every one position fix
2 - Output once every two position fixes
3 - Output once every three position fixes
4 - Output once every four position fixes
5 - Output once every five position fixes

[Example]

Send:

```
$PAIR063,0*23\r\n
```

Response:

```
$PAIR001,063,0*3E\r\n ==> Success
```

```
$PAIR063,0,3*3C\r\n
```

5.2.12 ID: 070

[Description]

Set the static navigation speed threshold.

If the actual speed is less than the threshold, the output position remains the same and the output speed will be zero.

If the threshold value is set to 0, this function is disabled.

[Data Field]

```
$PAIR070,<Speed_thresholdd>*CS<CR><LF>
```

Speed_threshold. 0~20 dm/s. Default value is 0 dm/s.

The minimum is 1 dm/s, the maximum is 20 dm/s.

1 dm/s = 0.1m/s

[Return]

1. PAIR_ACK for send result.

[Example]

Send:

```
$PAIR070,4*25\r\n
```

Response:

```
$PAIR001,070,0*3C\r\n ==> Success
```

5.2.13 ID: 071

[Description]

Query the static navigation speed threshold.

[Data Field]

\$PAIR071*CS<CR><LF>

[Return]

1. PAIR_ACK for send result.
2. \$PAIR071,<Speed_threshold>*CS<CR><LF>
Speed_threshold: 0~2 m/s.
The maximum is 2.0 m/s.

[Example]

Send:

\$PAIR071*3C\r\n

Response:

\$PAIR001,071,0*3D\r\n ==> Success

\$PAIR071,0.4*3A\r\n

5.2.14 ID: 080

[Description]

Set navigation mode.

[Data Field]

\$PAIR080,<CmdType>*CS<CR><LF>

CmdType:

0. Normal mode: For general purpose
1. Fitness mode: For running and walking purpose so that the low-speed (< 5 m/s) movement will have more of an effect on the position calculation.
2. Reserved
3. Balloon mode: For high-altitude balloon purpose that the vertical movement will have more effect on the position calculation.
4. Stationary mode: For stationary applications with zero dynamics.
5. Drone mode: Used for drone applications with equivalent dynamics range and vertical acceleration on different flight phase. (Ex. hovering, cruising, etc.)
6. Reserved
7. Swimming mode: For swimming purpose so that it smooths the trajectory and improves the accuracy of distance calculation.
8. Reserved
9. Bike mode: For sharing bike application.

[Return]

PAIR_ACK for send result.

[Example]

Send:

\$PAIR080,1*2F\r\n ==> Enter fitness mode.

Response:

\$PAIR001,080,0*33\r\n ==> Success

5.2.15 ID: 081

[Description]

Get navigation mode.

[Data Field]

\$PAIR081*CS<CR><LF>

[Return]

1. PAIR_ACK for send result.
2. \$PAIR081,<CmdType>*CS<CR><LF>

CmdType:

0. [Default Value] Normal mode: For general purpose
 1. Fitness mode: For running and walking activities so that the low-speed (< 5 m/s) movement will have more of an effect on the position calculation.
 2. Reserved
 3. Balloon mode: For high-altitude balloon purpose that the vertical movement will have more effect on the position calculation.
 4. Stationary mode: For stationary applications where a zero dynamic assumed.
 5. Drone mode: Used for drone applications with equivalent dynamics range and vertical acceleration on different flight phase. (Ex. hovering, cruising, etc.) (Note: The precision of NMEA automatically changes to 7 decimal places for latitude/longitude, and 3 decimal places for altitude.)
 6. Reserved
 7. Swimming mode: For swimming purpose so that it smooths the trajectory and improves the accuracy of distance calculation.
 8. Reserved
 9. Bike mode: For sharing bike application.

[Example]

Send:

\$PAIR081*33\r\n

Response:

\$PAIR001,081,0*32\r\n ==> Success

\$PAIR081,1*2E\r\n ==> Current is fitness mode.

5.2.16 ID: 400

[Description]

Set DGPS correction data source mode.

[Data Field]

\$PAIR400,<Mode> *CS<CR><LF>

Mode: DGPS data source mode.

- '0': No DGPS source
- '1': RTCM
- '2': SBAS (Include WAAS/EGNOS/GAGAN/MSAS)
- '3': QZSS SLAS

[Return]

PAIR_ACK for send result.

[Example]

Send:

\$PAIR400,2*20\r\n ==> Set SBAS Mode

Response:

\$PAIR001,400,0*3F\r\n ==> Success

5.2.17 ID: 401

[Description]

Query the DGPS data source mode.

[Data Field]

\$PAIR401*CS<CR><LF>

[Return]

1. PAIR_ACK for send result.
2. \$PAIR401,<Mode>*CS<CR><LF>

Mode: DGPS data source mode.

- '0': No DGPS source
- '1': RTCM
- '2': SBAS (Include WAAS/EGNOS/GAGAN/MSAS)
- '3': QZSS SLAS

[Example]

Send:

\$PAIR401*3F\r\n

Response:

\$PAIR001,401,0*3E\r\n ==> Success

\$PAIR401,2*21\r\n ==> SBAS Mode

5.2.18 ID: 410

[Description]

Enable searching a SBAS satellite or not.

When navigation mode is Fitness or Swimming mode, SBAS is not supported.

[Data Field]

\$PAIR410,<Enabled>*CS<CR><LF>

Enabled: Enable or disable

'0' = Disable

'1' = Enable

[Return]

PAIR_ACK for send result.

[Example]

Send:

\$PAIR410,1*22\r\n ==> Enable SBAS

Response:

\$PAIR001,410,0*3E\r\n ==> Success

5.2.19 ID: 420

[Description]

Enable the QZSS SLAS (Sub-meter Level Augmentation Service) operation.

When navigation mode is Fitness or Swimming mode, QZSS SLAS is not supported.

[Data Field]

\$PAIR420,<Enabled>*CS<CR><LF>

Enabled: Enable or disable

'0' = Disable

'1' = Enable

[Return]

PAIR_ACK for send result.

[Example]

Send:

\$PAIR420,1*21\r\n ==> Enable QZSS SLAS

Response:

\$PAIR001,420,0*3D\r\n ==> Success

5.2.20 ID: 513

[Description]

Save the current configuration from RTC RAM to flash.

[Data Field]

\$PAIR513*CS<CR><LF>

[Return]

PAIR_ACK for send result.

[Example]

Send:

\$PAIR513*3D\r\n

Response:

\$PAIR001,513,0*3C\r\n

[Note]

The changes of the configuration are kept in the RTC RAM that is powered from V_BCKP pin. If the power from V_BCKP pin is not kept, the changes will be lost after system reboot. The user can use this command to save the changes into the non-volatile flash memory.

5.2.21 ID: 514**[Description]**

Clear the current configuration and restore the factory default settings. This function does not support run time restore when GNSS is power on. Please send \$PAIR003 command to power off GNSS before using this command.

[Data Field]

\$PAIR514*CS<CR><LF>

[Return]

PAIR_ACK for send result.

[Example]

Send:

\$PAIR514*3A\r\n

Response:

\$PAIR001,514,0*3B\r\n

5.2.22 ID: 890**[Description]**

This command is used to set geofencing configuration.

[Data Field]

\$PAIR890,<FenceNum>,<ConfLvl>,<Lat1>,<Lon1>,<Rad1>,...,<RadN>*CS<CR><LF>

FenceNum(N): Number of geofences, the value is limited to 4.

When the value is set to 0, the geofencing function is disabled.

ConfLvl: The confidence level for state evaluation.

- '0' No requirement
- '1' 1-Sigma (68%)
- '2' 2-Sigma (95%)
- '3' 3-Sigma (99.7%)
- '4' 4-Sigma (99.99%)
- '5' 5-Sigma (99.9999%)

Lat: Latitude of the geofence circle center (deg)

Lon: Longitude of the geofence circle center (deg)

Rad: Radius of the geofence circle (m)

[Return]

PAIR_ACK for send result.

[Example]

Enable the geofencing function:

Send:

```
$PAIR890,1,1,25.0567,121.5743,30*20\r\n
```

Response:

```
$PAIR001,890,0*3A\r\n ==> Success
```

Disable the geofencing function:

Send:

```
$PAIR890,0*27\r\n
```

Response:

```
$PAIR001,890,0*3A\r\n ==> Success
```

5.2.23 ID: 891

[Description]

This command is used to get geofencing configuration.

[Data Field]

```
$PAIR891*CS<CR><LF>
```

[Return]

PAIR_ACK for send result.

```
$PAIR891,<FenceNum>,<ConfLvl>,<Lat1>,<Lon1>,<Rad1>,...,<RadN>*CS<CR><LF>
```

FenceNum(N): Number of geofences, the value is limited to 4.

ConfLvl: The confidence level for state evaluation.

- '0' No requirement
- '1' 1-Sigma (68%)

- '2' 2-Sigma (95%)
- '3' 3-Sigma (99.7%)
- '4' 4-Sigma (99.99%)
- '5' 5-Sigma (99.9999%)

Lat: Latitude of the geofence circle center (deg)

Lon: Longitude of the geofence circle center (deg)

Rad: Radius of the geofence circle (m)

[Example]

Send:

```
$PAIR891*3A\r\n
```

Response:

```
$PAIR001,891,0*3B\r\n ==> Success
```

```
$PAIR891,1,1,25.0567,121.5743,30*21\r\n
```

5.2.24 ID: 066

[Description]

Configure the receiver to start searching for satellites. The setting is available when the NVRAM data is valid.

The device restarts when it receives this command.

Support constellation: BEIDOU, GPS+GALILEO+BEIDOU,
GPS+GALILEO+BEIDOU+NavIC, GPS+GLONASS+GALILEO+BEIDOU,
GPS+GLONASS+GALILEO+BEIDOU+NavIC.

QZSS is always switchable.

[Data Field]

```
$PAIR066,<GPS_Enabled>,<GLONASS_Enabled>,<Galileo_Enabled>,<BeiDou_Enabled>,<QZSS_Enabled>,<NavIC_Enabled>*CS<CR><LF>
```

GPS_Enabled:

"0", disable (DO NOT search GPS satellites).

"1", search GPS satellites.

GLONASS_Enabled:

"0", disable (DO NOT search GLONASS satellites).

"1", search GLONASS satellites.

Galileo_Enabled:

"0", disable (DO NOT search Galileo satellites).

"1", search Galileo satellites.

BeiDou_Enabled:

"0", disable (DO NOT search BeiDou satellites).

"1", search BeiDou satellites.

QZSS_Enabled:

"0", disable (DO NOT search QZSS satellites).

"1", search QZSS satellites.

NavIC_Enabled:

"0", disable (DO NOT search NavIC satellites).

"1", search NavIC satellites.

[Return]

PAIR_ACK for send result.

[Example]

Send:

```
$PAIR066,0,0,0,1,0,0*3B\r\n ==> Search BEIDOU satellites only.
```

Response:

```
$PAIR001,066,0*3B\r\n ==> Success
```

Send:

```
$PAIR066,1,0,1,1,1,0*3A\r\n ==> Search GPS, GALILEO, BEIDOU and QZSS satellites.
```

Response:

```
$PAIR001,066,0*3B\r\n ==> Success
```

[Note]

Supported constellation combinations will vary depending on the firmware version.

5.2.25 ID: 154

[Description]

Enable to output Return Link Message from navigation data.

[Data Field]

```
$PAIR154,<Enable>*CS<CR><LF>
```

Enable:

0: disable

1: enable

[Return]

PAIR_ACK for send result.

[Example]

Send:

```
$PAIR154,1*27\r\n
```

Response:

```
$PAIR001,154,0*3B\r\n ==> Success
```


5.2.26 ID: 155

[Description]

Query output Return Link Message status.

[Data Field]

\$PAIR155*CS<CR><LF>

Enable:

0: disable

1: enable

[Return]

1. PAIR_ACK for send result.

2. \$PAIR155,<Enable>*CS<CR><LF>

Enable:

0: Disable

1: Enable

[Example]

Send:

\$PAIR155*3B\r\n

Response:

\$PAIR001,155,0*3A\r\n ==> Success

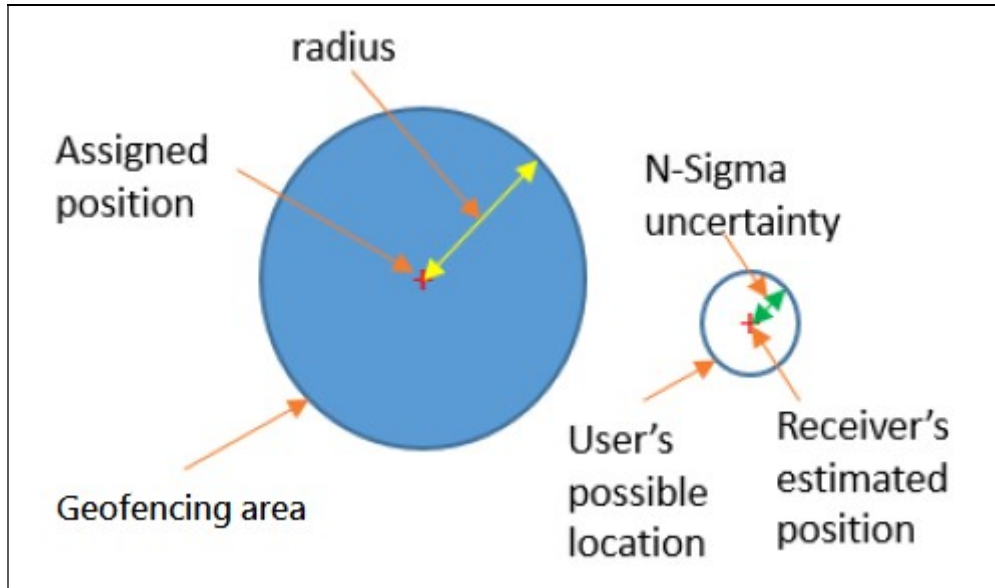
\$PAIR155,1*26\r\n

5.3 Geofence

This function enables the user to assign the desired areas for the geofencing application. It can be up to 4 desired areas at the same time.

Each area is composed of a circle. Enter the latitude and longitude as the center of the circle, and the maximum radius is 65535 meters.

- When the GNSS module is in one of the circular areas, GPIO26 outputs low level.
- When the GNSS module is outside all the circular areas or on the boundary, GPIO26 outputs high level.
- When the status is unknown or the geofencing function is not enabled, GPIO26 outputs high level.



6 Pin assignment and descriptions



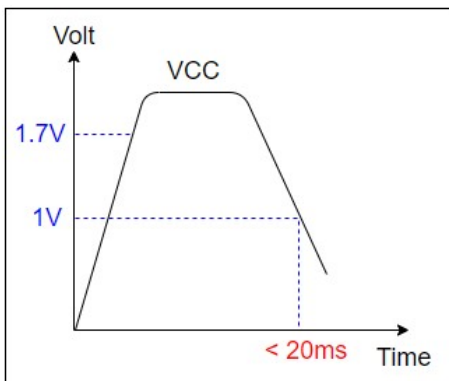
Table 6-1 Pin descriptions

| Pin # | Name | Type | Description | Note |
|-------|-----------|------|--|------|
| 1 | GND | P | Ground | |
| 2 | TX | O | Serial output | |
| 3 | RX | I | Serial input | |
| 4 | TIMEPULSE | O | Time pulse (PPS, default 100 ms pulse/sec when GNSS fix is available) | |
| 5 | GPIO4 | | General purpose IO | |
| 6 | V_BCKP | I | Backup battery input. It is recommended to connect a backup supply voltage to V_BCKP in order to enable warm and hot start features. Moreover, V_BCKP is a must of the system running. If no backup power is available, connect V_BCKP to the main power supply (VCC). | 1 |
| 7 | NC | | Not connect | |
| 8 | VCC | I | DC supply input. Must be clean and stable. | 2 |
| 9 | EN | I | Enable the module, high active. Internal 10K ohm pull-up resistor to 1.8V. Setting this pin to low will disable “hot start” function, i.e., boot from “cold start”. Leave unconnected if not used. | 3 |
| 10 | GND | P | Ground | |
| 11 | RF_IN | I | GNSS RF signal input | |

| | | | | |
|----|----------------------|-----|---|---|
| | | | The overall gain of the active antenna must be between 16dB ~ 35dB. | |
| 12 | GND | P | Ground | |
| 13 | LNA_EN | O | Output pin to control the external LNA. High active. | |
| 14 | VCC_RF | O | Output voltage for active antenna | 4 |
| 15 | NC | | Not connect. | |
| 16 | I ² C_SDA | I/O | I ² C serial data. Leave unconnected if not used. | |
| 17 | I ² C_SCL | I | I ² C serial clock input. Leave unconnected if not used. | |
| 18 | GPIO26 | O | Geofence output pin. | |

<Note>

1. In order to get the advantage of hybrid ephemeris prediction, this pin must be always powered during the period of effective ephemeris prediction.
2. If an abnormal input voltage as shown in the figure below is input, even if the correct voltage is input again later, the module may not work until V_BCKP pin is re-powered.



3. This pin's high level is 1.8V.
4. VCC_RF is controlled by EN pin (pin 9).

7 DC & Temperature characteristics

7.1 Absolute maximum ratings

| Parameter | Symbol | Ratings | Units |
|------------------------------|----------------------------------|----------|-------|
| DC Supply Input Voltage | VCC _{ABS} | 5.5 | V |
| Input Backup Battery Voltage | V _{BCKP} _{ABS} | 5.5 | V |
| Operating Temperature Range | T _{OPR} _{ABS} | -40 ~ 85 | °C |
| Storage Temperature Range | T _{STG} _{ABS} | -40 ~ 85 | °C |

7.2 DC Electrical characteristics

| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Units |
|------------------------------|-------------------|---|------|-------------------|--------------------|-------|
| DC Supply Input Voltage | VCC | | 3.1 | 3.3 | 4.5 | V |
| Input Backup Battery Voltage | V _{BCKP} | | 2.0 | | 4.5 | V |
| VCC_RF Output Voltage | VCC_RF | | 2.7 | 2.8 | 2.9 | V |
| Supply Current | I _{SS} | VCC = 3.3V, w/o active antenna, Peak Acquisition Tracking | | 37 | 110 ⁽¹⁾ | mA |
| | | | | 56 ⁽²⁾ | | mA |
| | I _{SHDN} | VCC=3.3V, EN=0V | | 22 | | μA |
| Backup Battery Current | I _{BAT} | VIN = 0V | | 44 | | μA |
| VCC_RF Output Current | I _{OUT} | VIN = 3.3V | | | 30 | mA |
| High Level Input Voltage | V _{IH} | For TX, RX, I ² C_SCL, I ² C_SDA, GPIO4 | 2.2 | | 3.6 | V |
| Low Level Input Voltage | V _{IL} | | -0.3 | | 0.8 | V |
| High Level Output Voltage | V _{OH} | | 2.18 | | 3.3 | V |
| Low Level Output Voltage | V _{OL} | | | | 0.4 | V |
| High Level Input Voltage | V _{IH} | For TIMEPULSE, EN, LNA_EN, GPIO26 | 1.21 | | 1.98 | V |
| Low Level Input Voltage | V _{IL} | | -0.3 | | 0.6 | V |
| High Level Output Voltage | V _{OH} | | 1.29 | | 1.98 | V |
| Low Level Output Voltage | V _{OL} | | | | 0.45 | V |

Note 1. This happens when downloading AGPS data to the module.

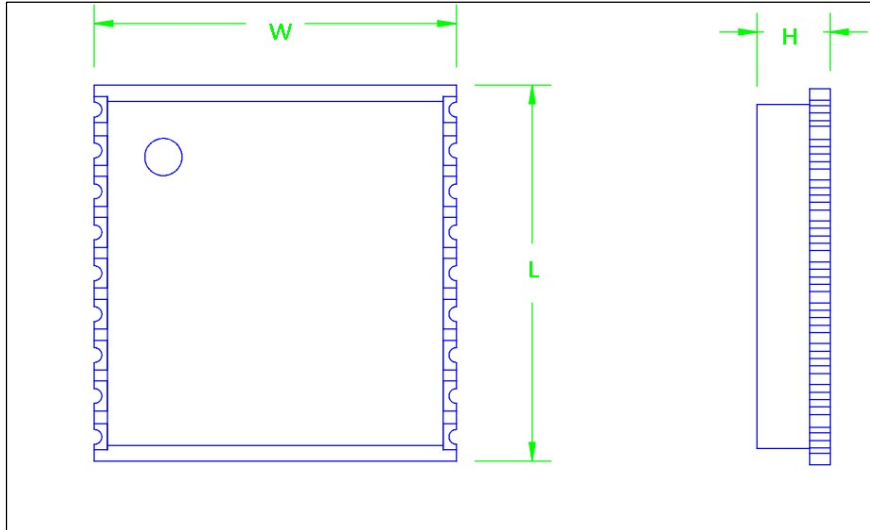
Note 2. Measured when position fix (1Hz) is available, input voltage is 3.3V and the function of self-generated ephemeris prediction is inactive.

7.3 Temperature characteristics

| Parameter | Symbol | Min. | Typ. | Max. | Units |
|-----------------------|------------------|------|------|------|-------|
| Operating Temperature | T _{OPR} | -40 | - | 85 | °C |
| Storage Temperature | T _{STG} | -40 | 25 | 85 | °C |

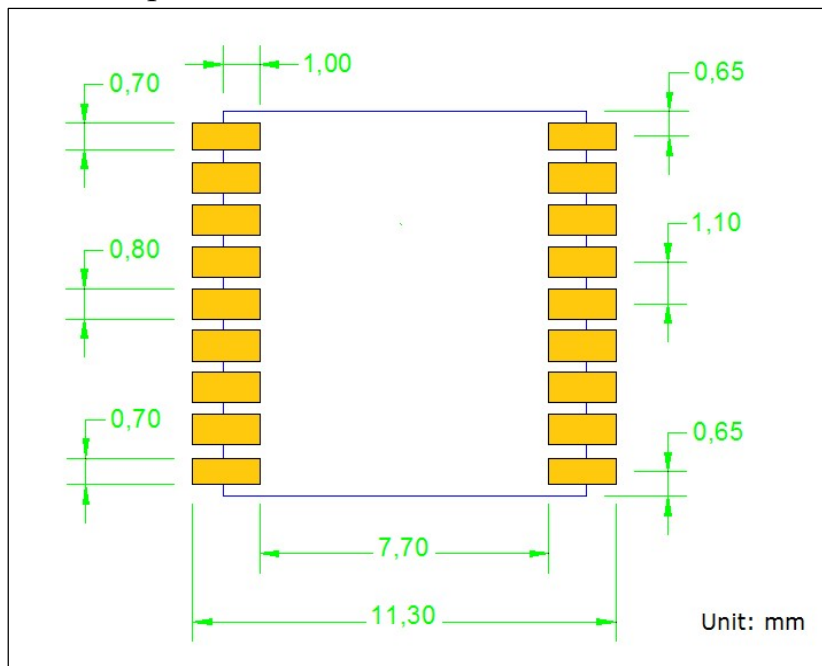
8 Mechanical specification

8.1 Outline dimensions



| Symbol | Min. (mm) | Typ. (mm) | Max. (mm) |
|--------|-----------|-----------|-----------|
| W | 9.6 | 9.7 | 9.8 |
| L | 9.8 | 10.1 | 10.4 |
| H | 2.0 | 2.2 | 2.4 |

8.2 Recommended land pattern dimensions



Note: The recommended land pattern dimensions are shown for reference only, as actual pad layouts may vary depending on application.

9 Reel packing information

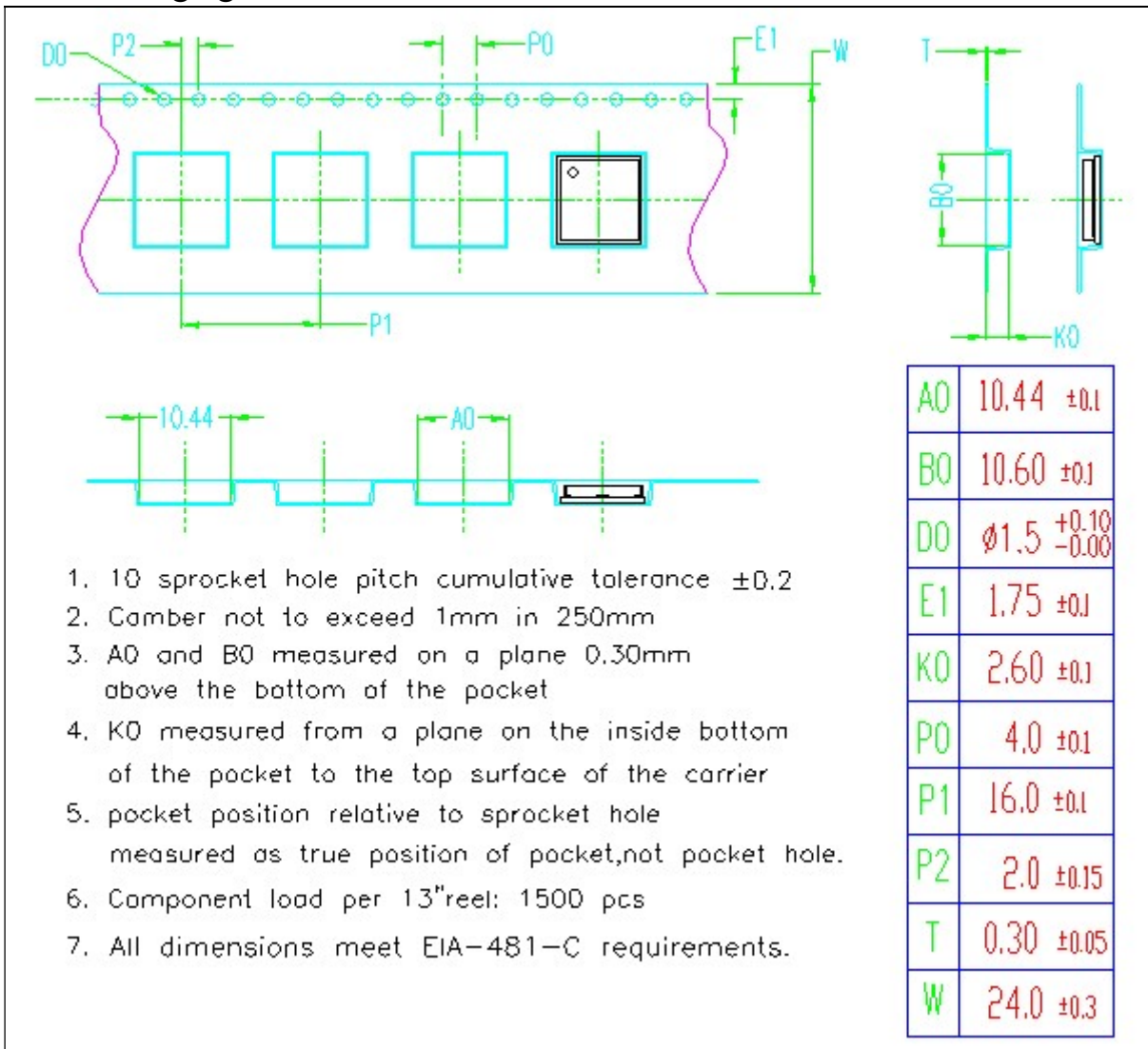
9.1 ESD precaution

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.

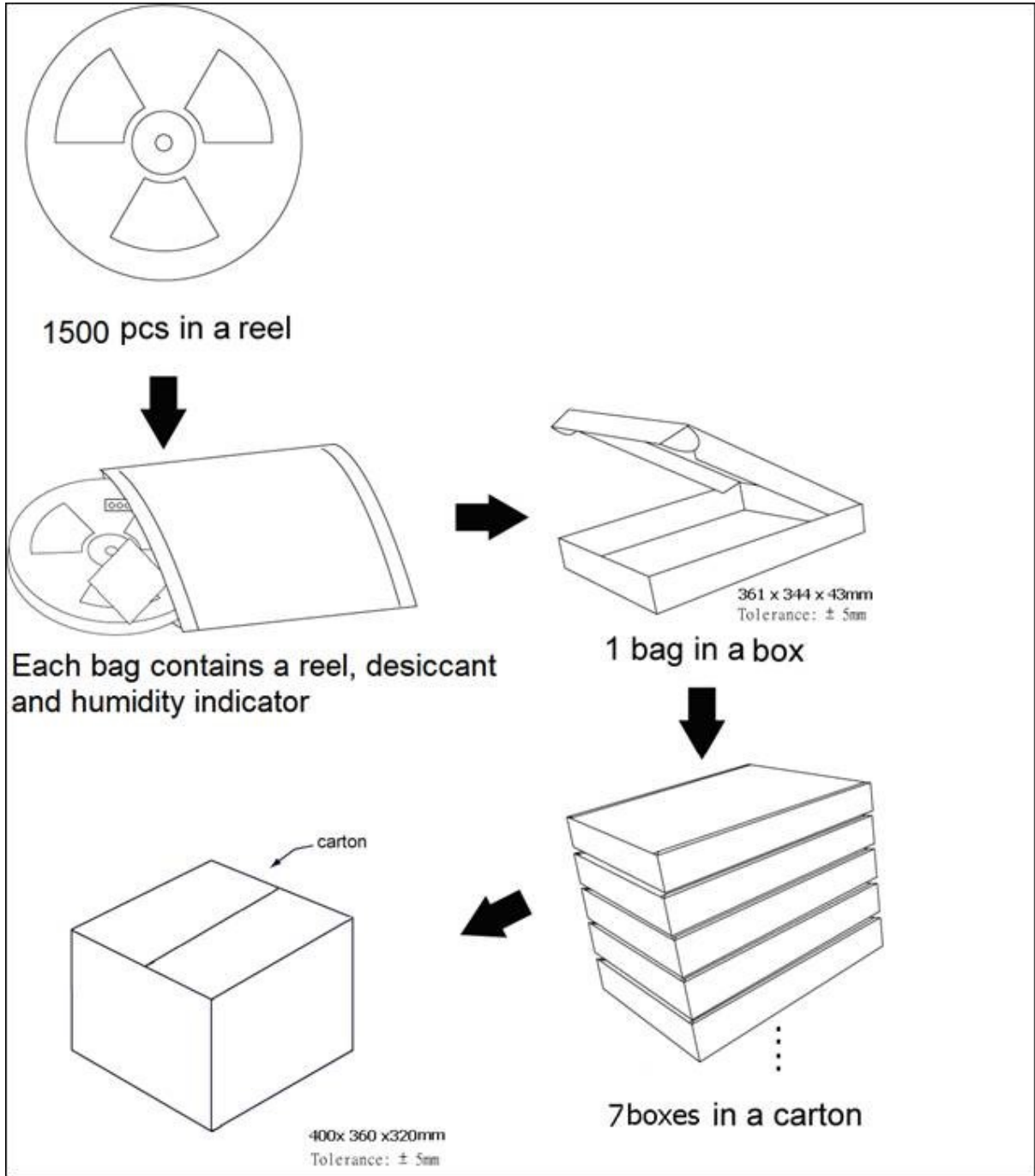
9.2 Packaging

The modules are sealed in a moisture barrier ESD bag with the appropriate units of desiccant and a humidity indicator card. It should not be opened until the modules are ready to be soldered onto the application.

9.2.1 Packaging



9.2.2 Box packaging



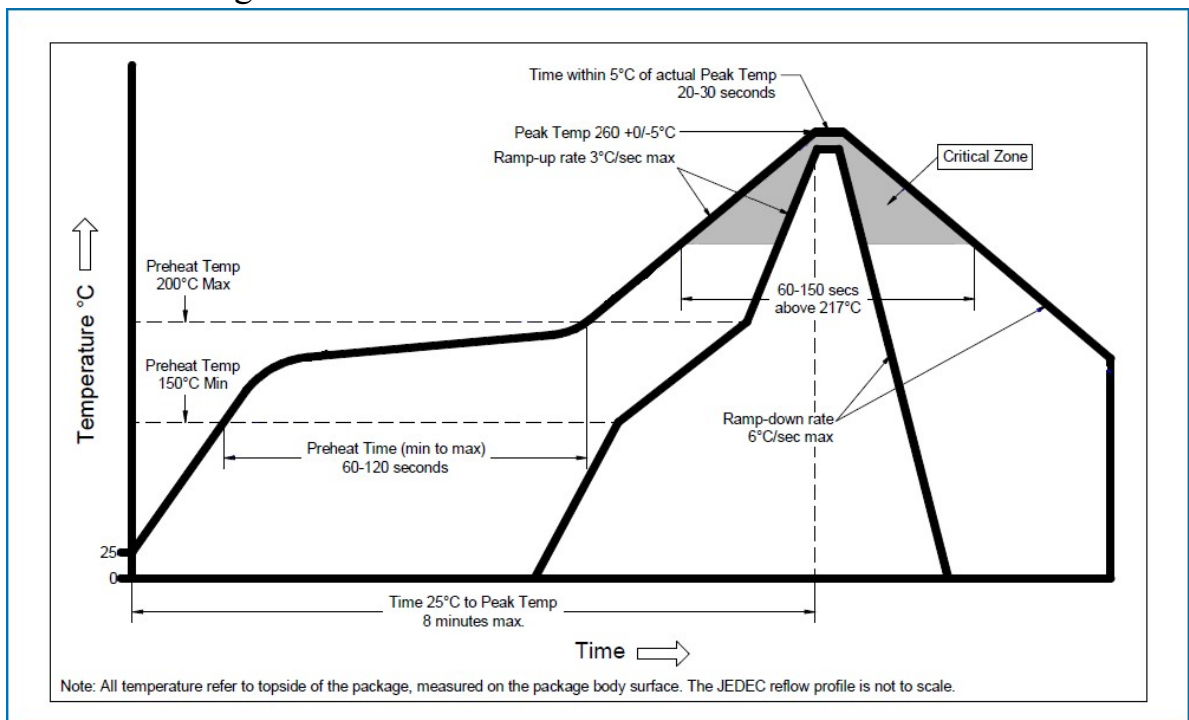
9.3 Moisture sensitivity level

The moisture sensitivity level of the module is 3. After the sealed bag is opened, modules should be mounted within 168 hours at factory conditions of $\leq 30^{\circ}\text{C}$ and 60% RH or stored at $\leq 20\%$ RH.

The modules require baking before mounting if above conditions are not met. If baking is required, the modules without the tape and reel may be baked for:

- a. 192 hours at $40^{\circ}\text{C} + 5^{\circ}\text{C} / -0^{\circ}\text{C}$ and $< 5\%$ RH
- b. 24 hours at $125^{\circ}\text{C} + 5^{\circ}\text{C} / -0^{\circ}\text{C}$

9.4 Reflow soldering



Note the module mounted to the top side (first reflow side) may fall off during reflow soldering of the bottom side.

10 Product marking and ordering information

10.1 Product marking

The marking of the module is engraved on the metal shielding that has product information, such as LOCOSYS logo, product name and manufacturing date.

10.2 Ordering information

| Product name | Description | Remark |
|--------------|--|---|
| MC-1010i-V2b | Dual-frequency multi-constellation GNSS positioning module | GPS/QZSS: L1 C/A, L5C GLONASS: L1OF GALILEO: E1, E5a BEIDOU: B1I, B2a NavIC: L5 |

Document change list

Revision 1.0

- Official release on July 25, 2023.

Revision 1.1 (July 3, 2024)

- Added support of NavIC.
- Added ESD protector to Fig. 3-1
- Removed the proprietary command ID 007 in section 5.2
- Added the proprietary command ID 070, 066, 154 and 155 in section 5.2
- Changed the overall gain of the active antenna from 8~25dB to 16~35dB in section 6.