Product name	Description	Version
MC-1010i-V2b	Dual-frequency multi-constellation GNSS positioning module	1.0

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 and QZSS
- 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
- ±10ns 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

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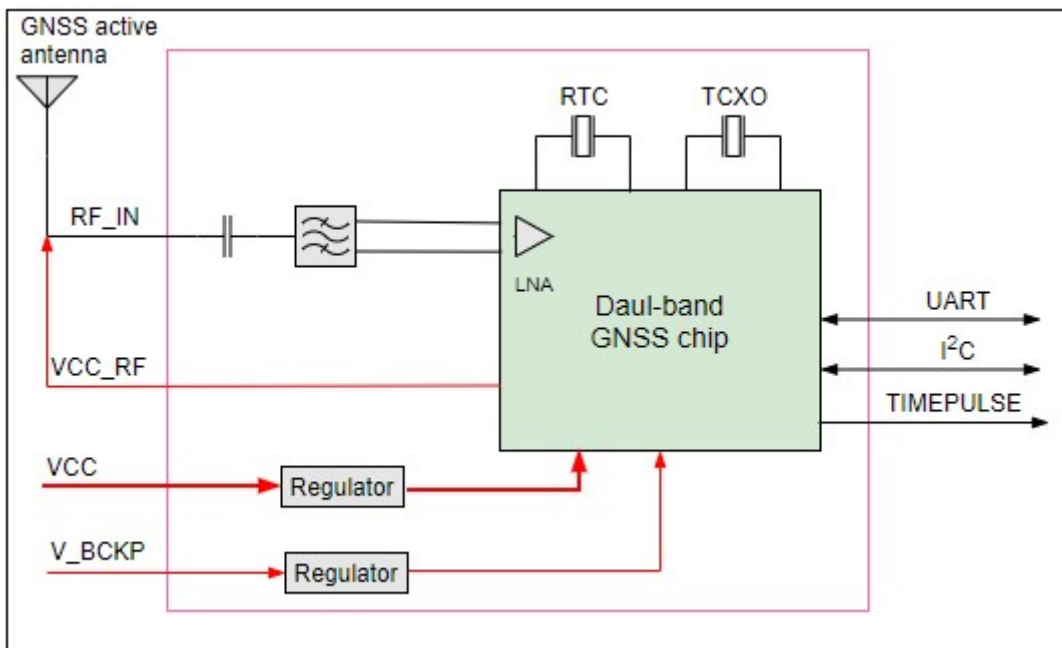20F.-13, No.79, Sec. 1, Xintai 5th Rd.,
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Fig. 3-1 System block diagram.
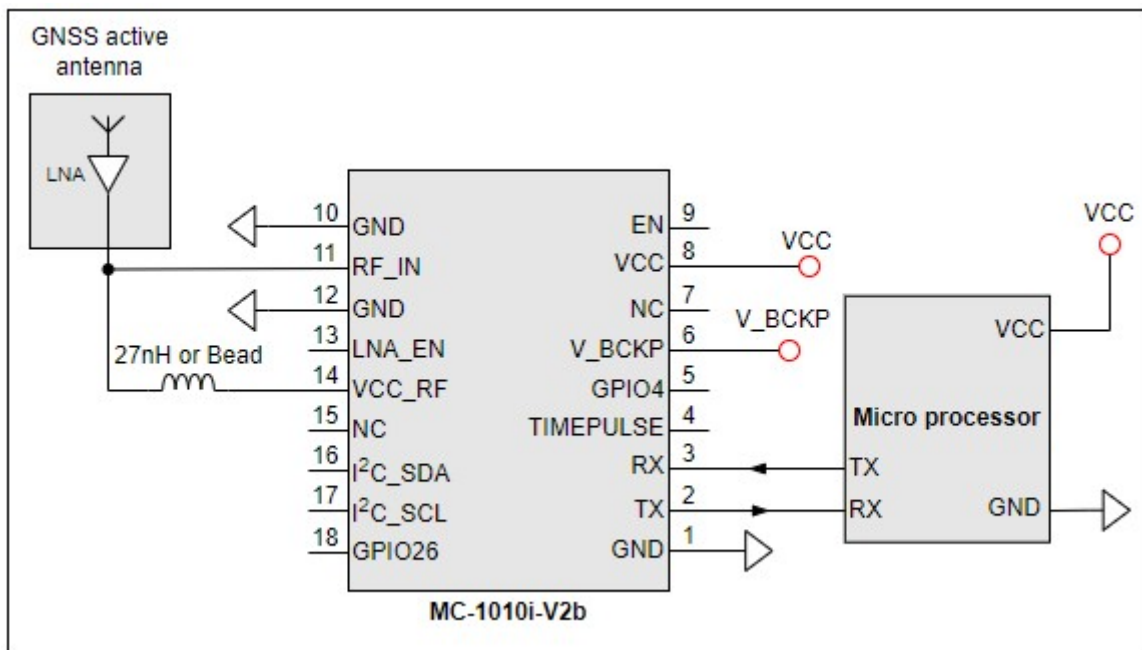
Fig. 3-2 Typical application circuit that uses UART interface.

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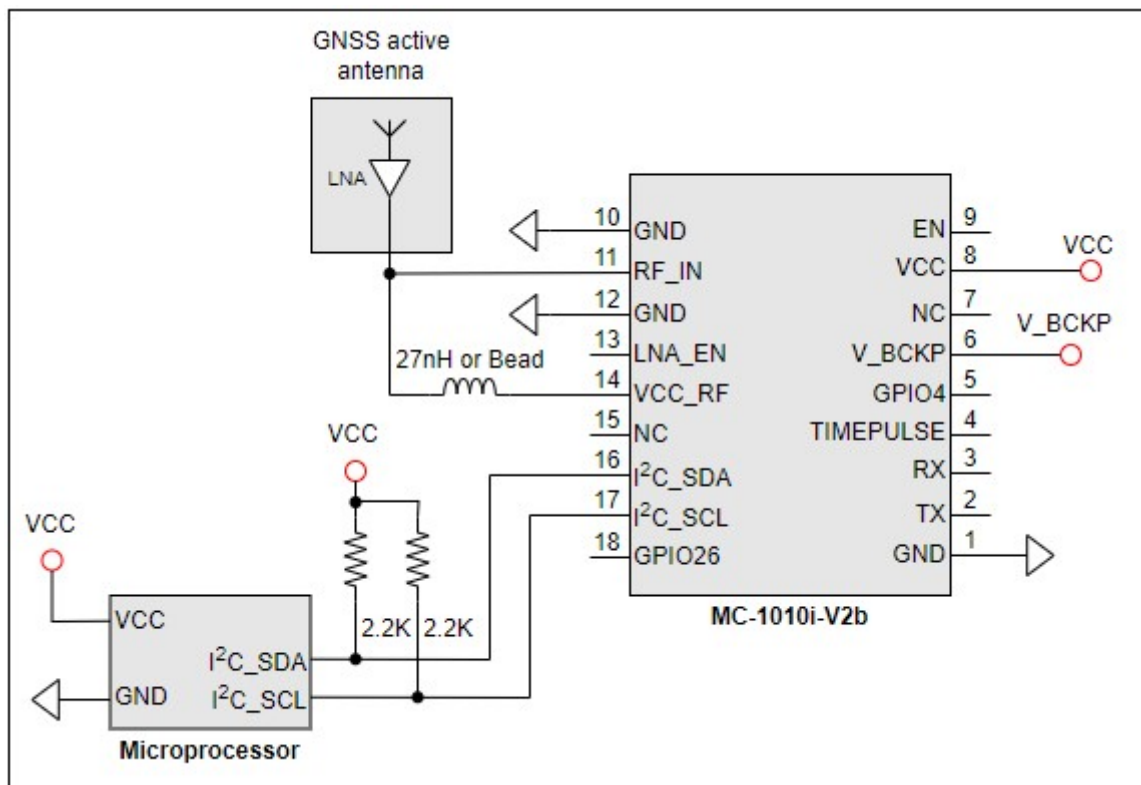
Fig. 3-3 Typical application circuit that uses I^{2}C interface.

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4 GNSS receiver

Frequency	GPS/QZSS: L1 C/A, L5C GLONASS: L1OF GALILEO: E1, E5a BEIDOU: B1I, B2a	
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

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Table5.1- 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

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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

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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	IRNSS

● **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

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Message ID	$GPGSV		GSV protocol header GP=GPS/QZSS, GL=GLONSS, GA=GALILEO, GB=BEIDOU, GI=IRNSS.
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 IRNSS: L6=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

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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

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			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.

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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.

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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:

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

5.2.7 ID: 007

[Description]

Full Cold Start.

In addition to Cold start, this command clears the system/user configurations at the start.

It resets the GNSS module to the factory default.

[Data Field]

$PAIR007*CS<CR><LF>

[Return]

PAIR_ACK for send result.

[Example]

Send:

$PAIR007*3D\r\n

Response:

$PAIR001,007,0*3C\r\n ==> Success

5.2.8 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.

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5.2.9 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

5.2.10 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

5.2.11 ID: 062

[Description]

Set the NMEA sentence output interval of corresponding NMEA type.

[Data Field]

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$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

5.2.12 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

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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

5.2.13 ID: 071

[Description]

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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.

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[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 purposes so 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 NMEA decimal precision will automatically change to lat/lon in 7 digits, alt in 3 digits)

'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.

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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

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$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

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[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.

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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%)

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'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:

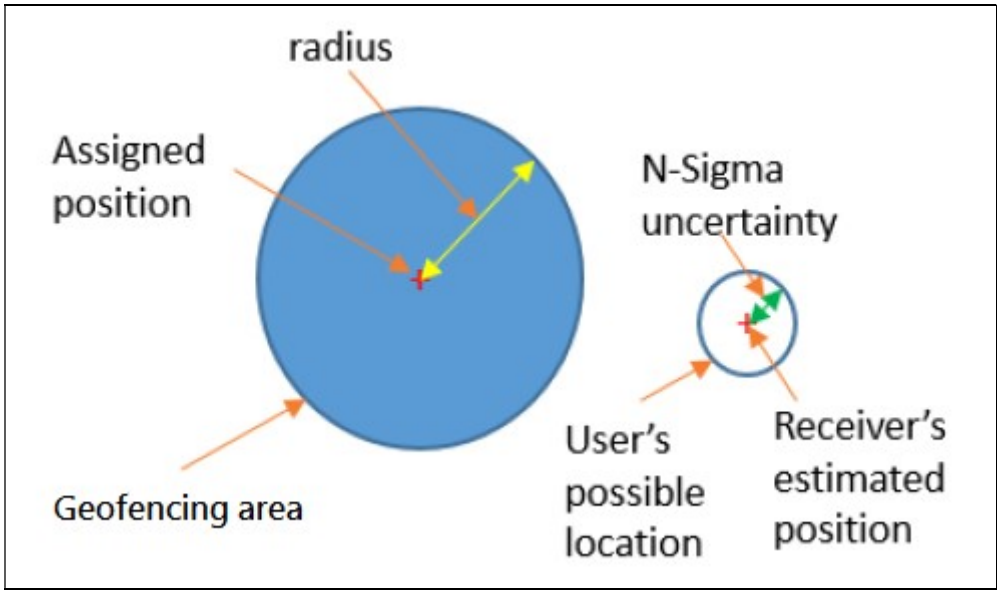$PAIR891*3A\r\n

Response:

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

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

5.3 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.
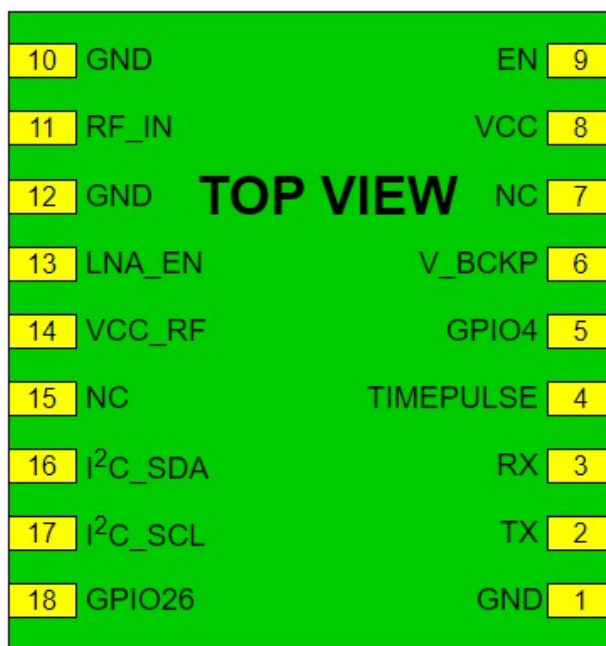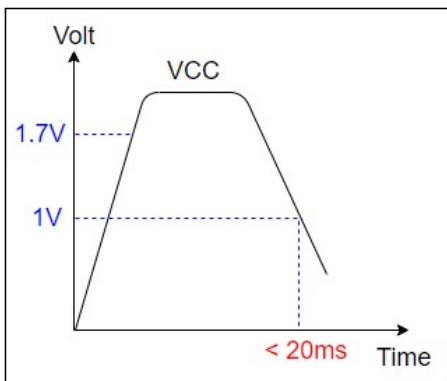- When the status is unknown or the geofencing function is not enabled, GPIO26 outputs high level.

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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	

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			The overall gain of the active antenna must be between 8dB ~ 25dB.	
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).

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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	℃
Storage Temperature Range	T_{STG_ABS}	-40 ~ 85	℃

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 56 [2]	110 [1]	mA mA 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^2C_SCL, I^2C_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.

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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

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8   Mechanical specification

8.1   Outline dimensions
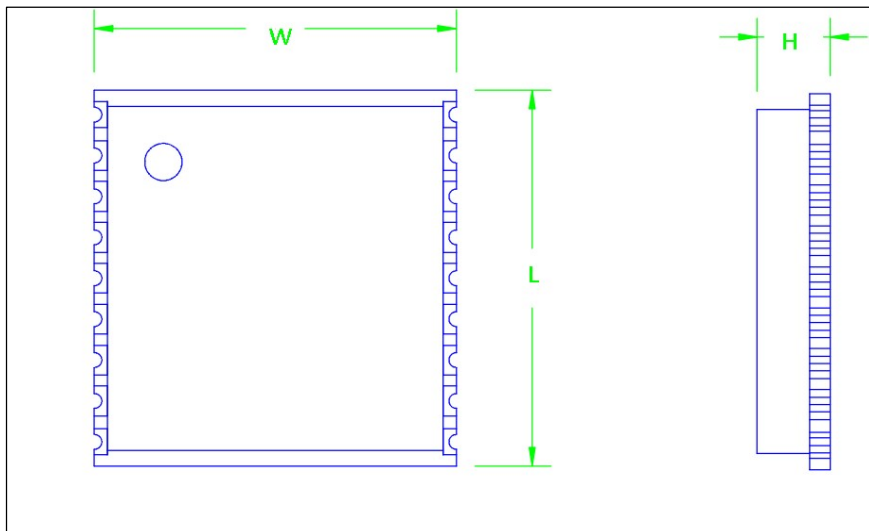
Symbol	Min. (mm)	Typ. (mm)	Max. (mm)
W	9.6	9.7	9.8
L	9.8	10.1	10.4
H	2.0	2.2	2.4

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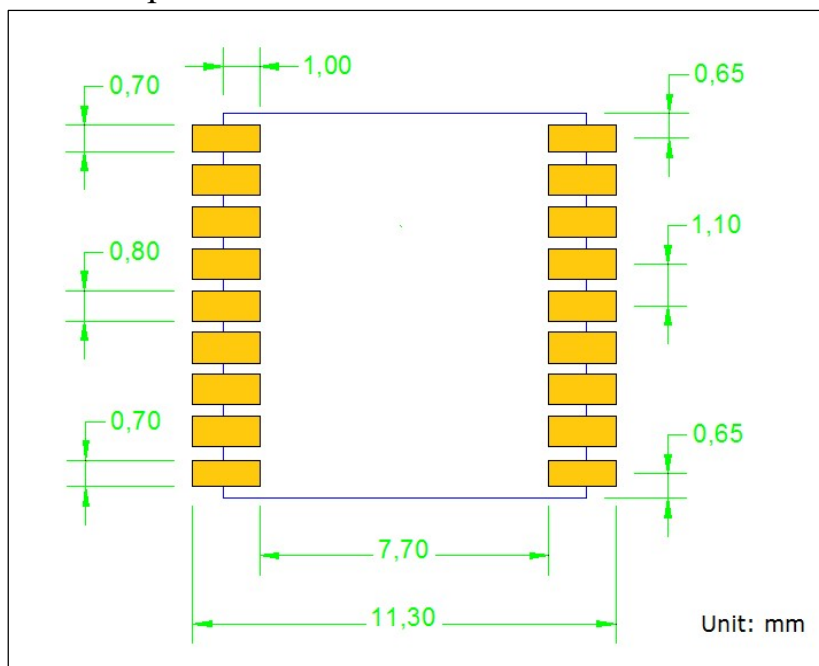
Note: The recommended land pattern dimensions are shown for reference only, as actual pad layouts may vary depending on application.

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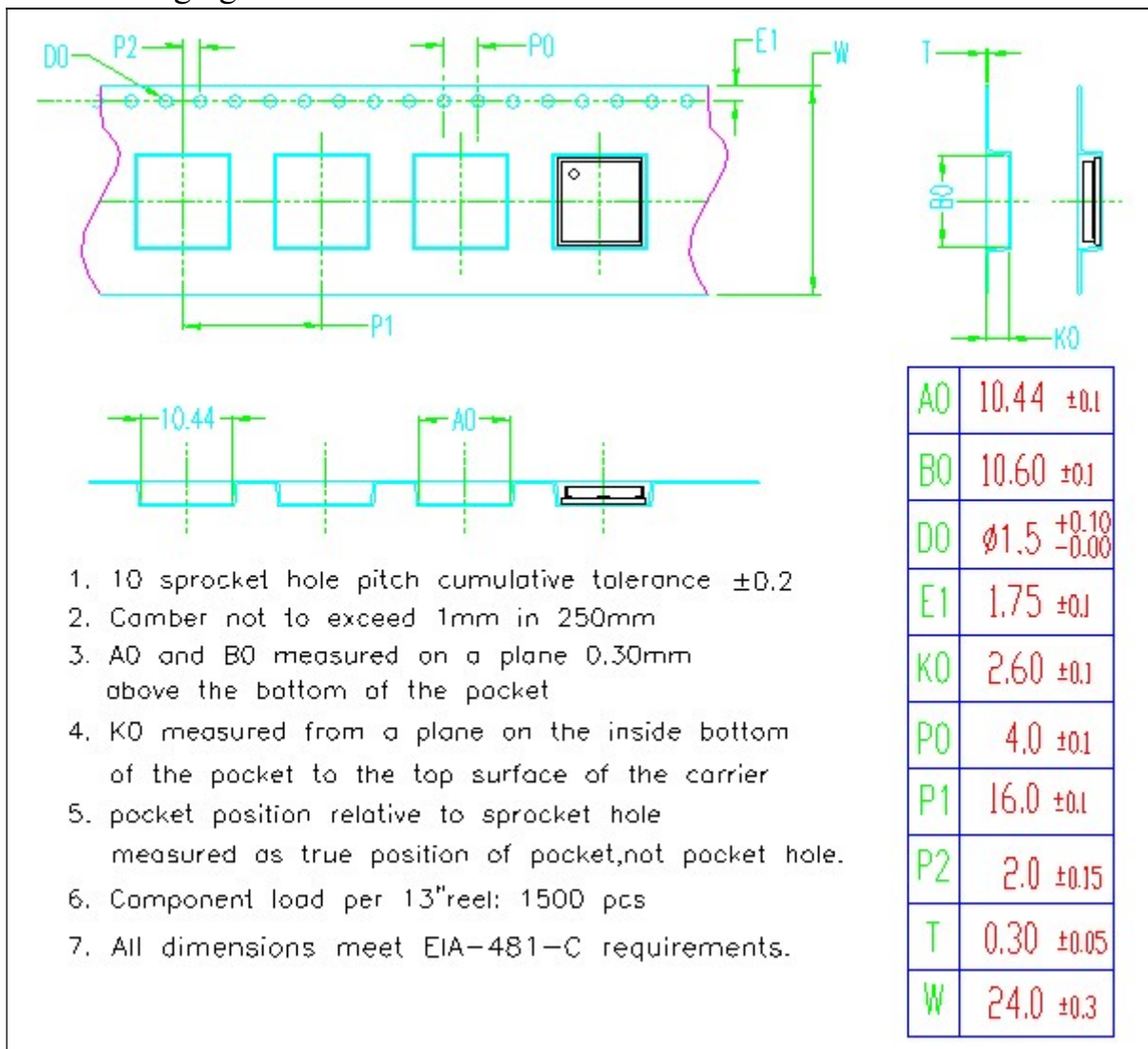# 9 Reel packing information

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.
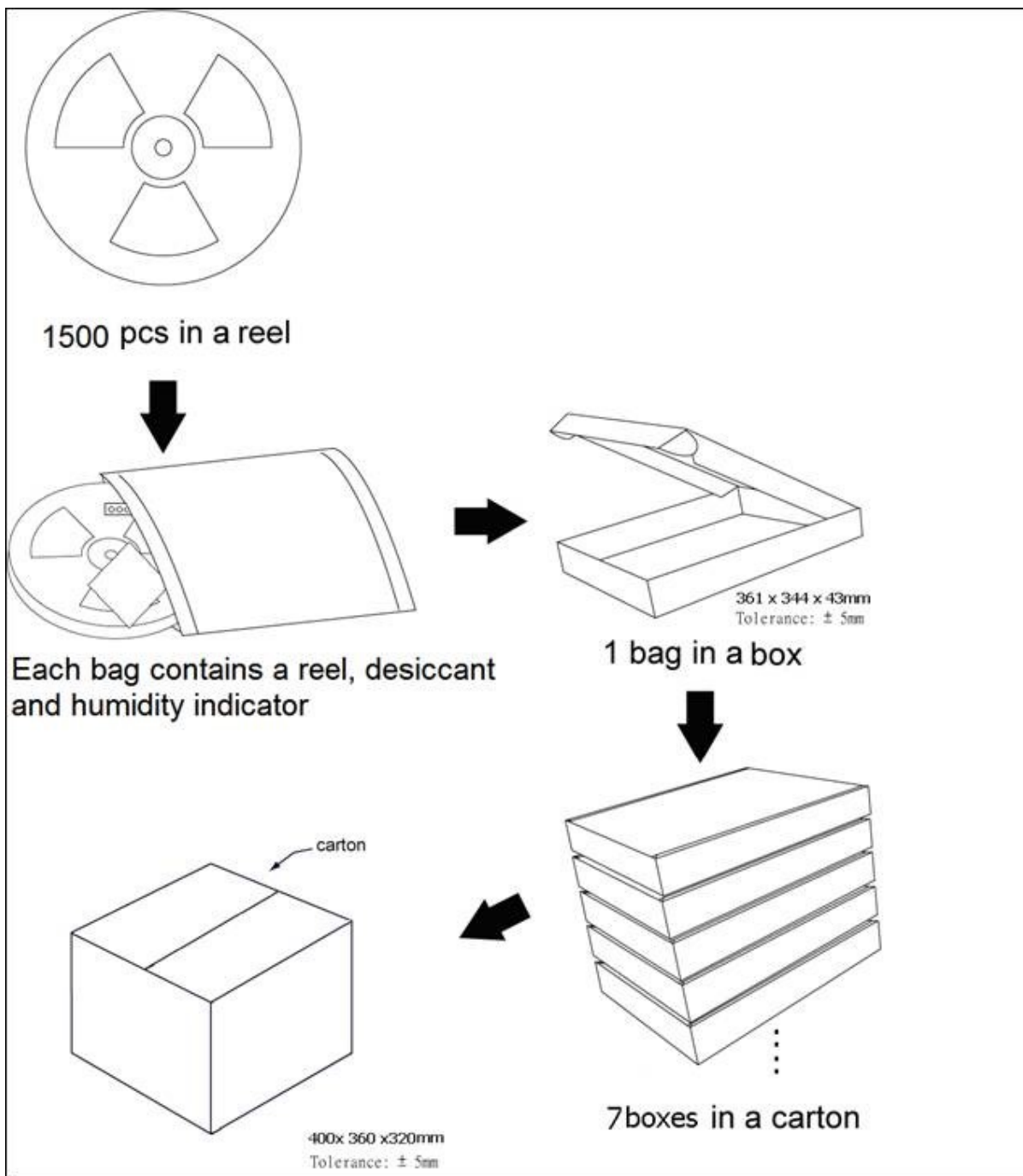
9.2 Packaging

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

1. 10 sprocket hole pitch cumulative tolerance ±0.2
2. Camber not to exceed 1mm in 250mm
3. A0 and B0 measured on a plane 0.30mm 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: 1500 pcs
7. All dimensions meet EIA-481-C requirements.

A0	10.44 ±0.1
B0	10.60 ±0.1
D0	∅1.5 +0.10 −0.00
E1	1.75 ±0.1
K0	2.60 ±0.1
P0	4.0 ±0.1
P1	16.0 ±0.1
P2	2.0 ±0.15
T	0.30 ±0.05
W	24.0 ±0.3

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9.2.2 Box packaging

1500 pcs in a reel

Each bag contains a reel, desiccant and humidity indicator

361 x 344 x 43mm
Tolerance: ± 5mm

1 bag in a box

carton

400x 360 x320mm
Tolerance: ± 5mm

7boxes in a carton

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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 ≤ 30°C and 60% RH or stored at ≤ 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°C + 5°C / -0°C and < 5% RH
b. 24 hours at 125°C + 5°C / -0°C

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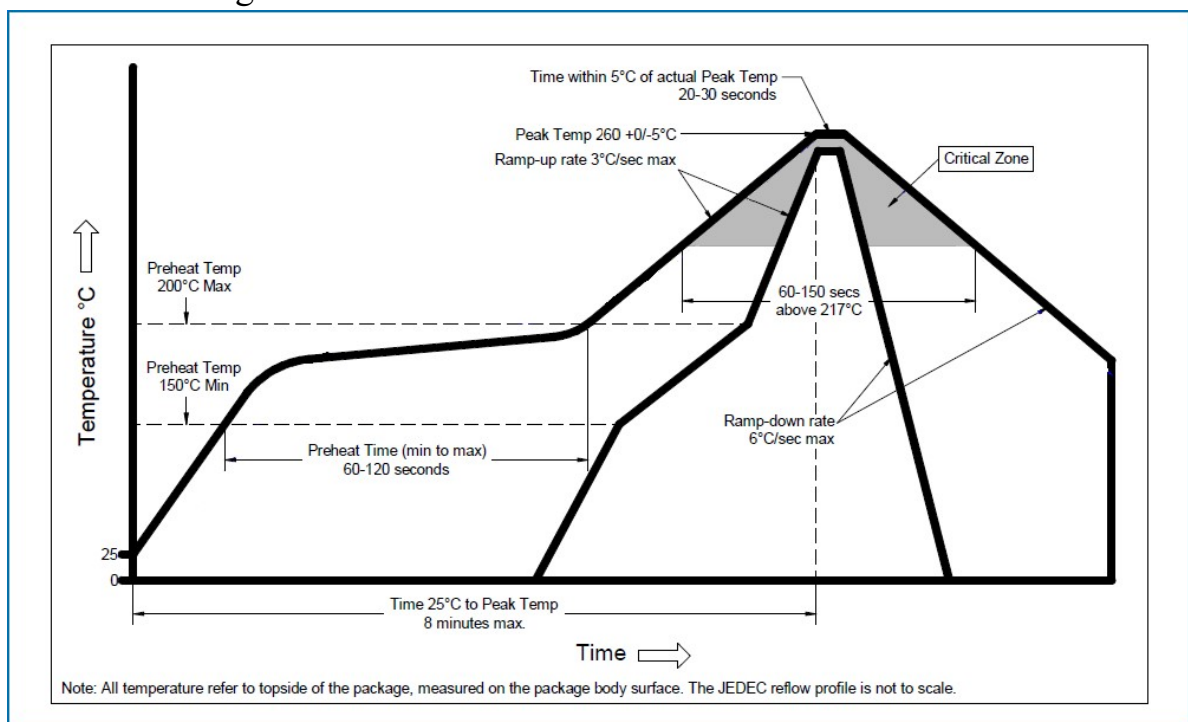
Note the module mounted to the top side (first reflow side) may fall off during reflow soldering of the bottom side.

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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

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Document change list

Revision 1.0

- Official release on July 25, 2023.