LOCOSYS Technology Inc.
20F.-13, No.79, Sec. 1, Xintai 5th Rd.,
Xizhi Dist., New Taipei City 221, Taiwan
☎ 886-2-8698-3698
886-2-8698-3699
www.locosystech.com/

Product name	Description	Version
MZ-1612i-UDB	GNSS UDR module with 3D sensors	0.1

1 Introduction

LOCOSYS MZ-1612-UDB dead reckoning (DR) module is the perfect solution for automotive application. MZ-1612-UDB not only supports GPS and BEIDOU, but also has inertial sensors (3-axis accelerometers and 3-axis gyros) to provide dead reckoning. Besides, no need of odometer connection and auto calibration function make it easy to use. With these features, MZ-1612-UDB can reduce position errors in multipath environment and continue to work where GNSS signals are poor or not available, such as tunnels and indoor parking lots, as well as deliver seamless car navigation.

2 Features

- High sensitivity GNSS chip
- Support GPS and BEIDOU
- Fast TTFF at low signal level
- Built-in active antenna detection
- Built-in MEMS sensor (3-axis gyroscope and 3-axis accelerometer)
- Fast calibration
- No requirement for installation orientation
- AEC-Q100 qualified GNSS chip
- IATF 16949 quality control
- Small form factor 16.9 x 12.2 x 2.4 mm
- SMD type, RoHS compliant

3 Application

- Automotive navigation
- Fleet management
- Vehicle data logger

LOCOSYS Technology Inc.
20F.-13, No.79, Sec. 1, Xintai 5th Rd.,
Xizhi Dist., New Taipei City 221, Taiwan
☎ 886-2-8698-3698
886-2-8698-3699
www.locosystech.com/

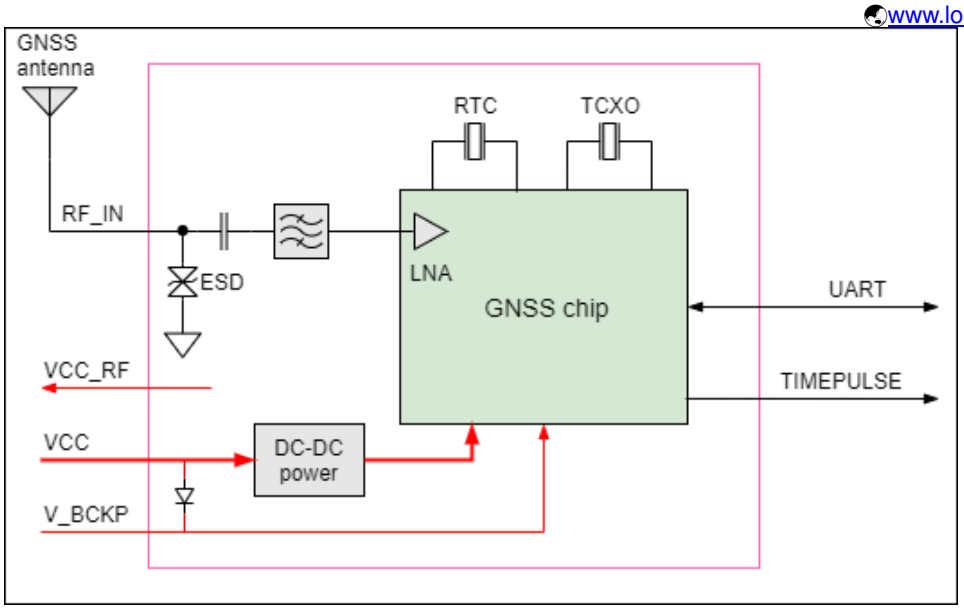


Fig 3-1 System block diagram.

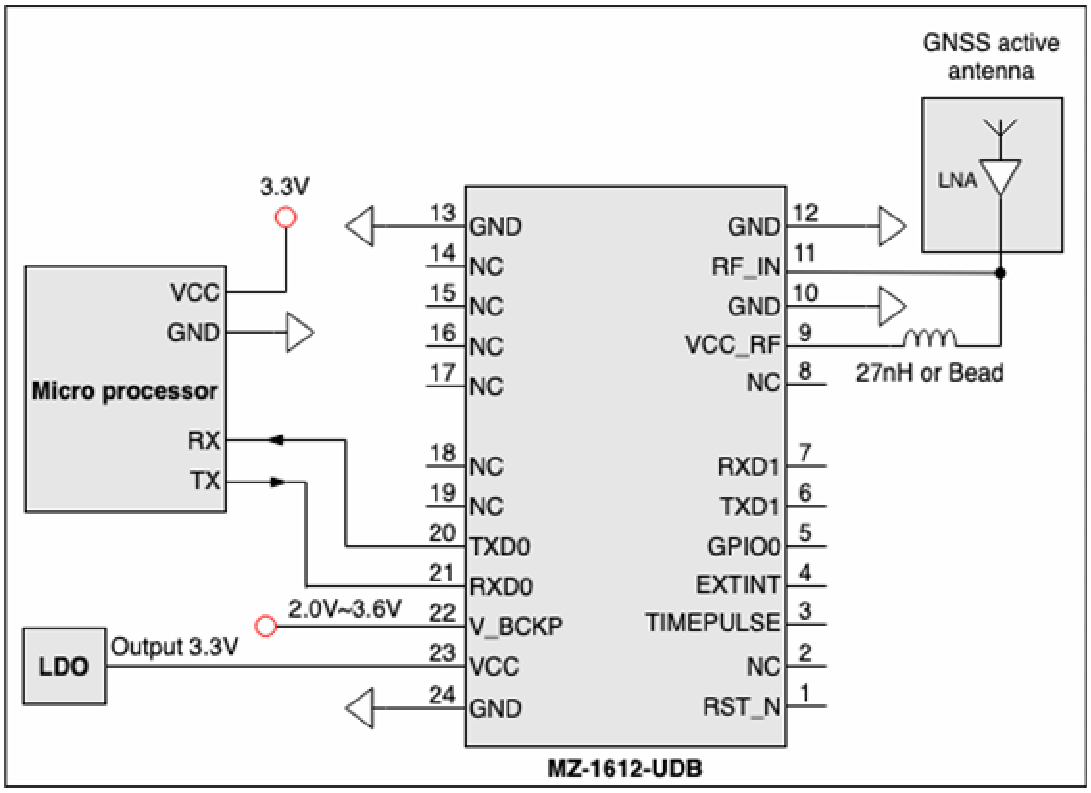


Fig 3-2 Typical application circuit that uses an active antenna.

LOCOSYS

LOCOSYS Technology Inc.
20F.-13, No.79, Sec. 1, Xintai 5th Rd.,
Xizhi Dist., New Taipei City 221, Taiwan
☎ 886-2-8698-3698
886-2-8698-3699
www.locosystech.com/

4 GNSS receiver

Frequency	GPS: L1C/A (1575.42MHz) BEIDOU: B1 (1561.098MHz)	
Channels	Support 64 channels	
Update rate	1Hz default	
Sensitivity	Tracking	up to -162dBm (with external LNA)
	Cold start	up to -147dBm (with external LNA)
Acquisition Time	Cold Start (Open Sky)	32s (typical)
	Hot Start (Open Sky)	≤ 1s (typical)
Position Accuracy	Autonomous	2.5m CEP
	UDR mode	CEP ≤ 10% of distance travelled (1)
Max. Altitude	< 18,000 m	
Max. Velocity	< 515 m/s	
Protocol Support	NMEA 0183 ver. 3.01	9600 bps (2), 8 data bits, no parity, 1 stop bits (default) 1Hz: GGA, GSA, GSV, RMC, VTG, TXT 1Hz: $INSSTAT, $GNATT

Note 1: Test condition: after calibration, drive at 30 m/s for 60 seconds without GNSS signals.

Note 2: Both baud rate and output message rate are configurable to be factory default.

LOCOSYS Technology Inc.
20F.-13, No.79, Sec. 1, Xintai 5th Rd.,
Xizhi Dist., New Taipei City 221, Taiwan
☏ 886-2-8698-3698
886-2-8698-3699
www.locosystech.com/

5 Software interface

5.1 NMEA output message

Table 5.1-1 NMEA output message

NMEA record	Description
GGA	Global positioning system fixed data
GSA	GNSS DOP and active satellites
GSV	GNSS satellites in view
RMC	Recommended minimum specific GNSS data
VTG	Course over ground and ground speed
TXT	Text Transmission

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

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

*$GNGGA,081340.000,2503.71262,N,12138.74527,E,1,21,0.64,137.113,M,0,M,,*5B*

Table5.1- 2 GGA Data Format

Name	Example	Units	Description
Message ID	$GNGGA		GGA protocol header GN for GPS+BEIDOU ; GP for GPS only
UTC Time	081340.000		hhmmss.sss
Latitude	2503.71262		ddmm.mmmmm
N/S indicator	N		N=north or S=south
Longitude	12138.74527		dddmm.mmmmm
E/W Indicator	E		E=east or W=west
Position Fix Indicator	1		See Table 5.1-3
Satellites Used	21		Range 0 to 33
HDOP	0.64		Horizontal Dilution of Precision
MSL Altitude	137.113	meters	
Units	M	meters	
Geoid Separation	0	meters	
Units	M	meters	
DGPS Age			Not supported
DGPS Reference			
Checksum	*5B		
<CR> <LF>			End of message termination

Table 5.1-3 Position Fix Indicators

Value	Description
0	Fix not available or invalid
1	GNSS fix valid
2	Differential GNSS fix valid
3-5	Not supported
6	Estimated (Dead Reckoning) Mode

Note: It can bet DGPS (RTCM) or SBAS

● GSA---GNSS DOP and Active Satellites

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

*$GPGSA,A,3,01,04,07,08,09,11,16,23,26,27,31,,1.24,0.64,1.07*07*

*$BDGSA,A,3,01,02,03,04,06,07,08,09,10,13,,,1.24,0.64,1.07*17*

Table 5.1-4 GSA Data Format

Name	**Example**	**Units**	**Description**
Message ID	$GPGSA		GSA protocol header GP for GPS ; BD for BEIDOU
Mode 1	A		See Table 5.1-5
Mode 2	3		See Table 5.1-6
ID of satellite used	01		Sv on Channel 1
ID of satellite used	04		Sv on Channel 2
….			….
ID of satellite used			Sv on Channel 12
PDOP	1.24		Position Dilution of Precision
HDOP	0.64		Horizontal Dilution of Precision
VDOP	1.07		Vertical Dilution of Precision
Checksum	*07		
<CR> <LF>			End of message termination

Table 5.1-5 Mode 1

Value	Description
M	Manual- forced to operate in 2D or 3D mode
A	Automatic-allowed to automatically switch 2D/3D

Table 5.1-6 Mode 2

Value	Description

LOCOSYS Technology Inc.
20F.-13, No.79, Sec. 1, Xintai 5th Rd.,
Xizhi Dist., New Taipei City 221, Taiwan
☏ 886-2-8698-3698
886-2-8698-3699
www.locosystech.com/

1	Fix not available
2	2D
3	3D

● GSV---GNSS Satellites in View

Table 5.1-7 contains the values for the following example:

*$GPGSV,3,1,12,01,07,188,35,04,42,237,43,07,14,319,37,08,71,263,44*7E*
*$GPGSV,3,2,12,09,33,279,36,11,43,191,42,16,38,042,38,18,,,36*4E*
*$GPGSV,3,3,12,23,39,245,43,26,24,068,35,27,65,018,45,31,15,131,32*75*
*$BDGSV,3,1,10,01,55,141,40,02,38,239,36,03,57,205,40,04,39,118,36*6F*
*$BDGSV,3,2,10,06,37,200,36,07,58,351,40,08,29,167,34,09,49,229,40*69*
*$BDGSV,3,3,10,10,47,315,37,13,13,187,31*64*

Table 5.1-7 GSV Data Format

Name	**Example**	**Units**	**Description**
Message ID	$GPGSV		GSV protocol header, GP includes GPS Satellites in view; BD means BEIDOU
Total number of messages[1]	3		Range 1 to 4
Message number[1]	1		Range 1 to 4
Satellites in view	12		
Satellite ID	01		Channel 1 (Range 01 to 196) GPS Satellites ID : 01~32, SBAS Satellites ID : 33~64, & QZSS Satellites ID : 193~196
Elevation	07	degrees	Channel 1 (Range 00 to 90)
Azimuth	188	degrees	Channel 1 (Range 000 to 359)
SNR (C/No)	35	dB-Hz	Channel 1 (Range 00 to 99, null when not tracking)
….			….
Satellite ID	08		Channel 4 (Range 01 to 196)
Elevation	71	degrees	Channel 4 (Range 00 to 90)
Azimuth	263	degrees	Channel 4 (Range 000 to 359)
SNR (C/No)	44	dB-Hz	Channel 4 (Range 00 to 99, null when not tracking)
Checksum	*7E		
<CR> <LF>			End of message termination

Note: Depending on the number of satellites tracked multiple messages of GSV data may be required.

LOCOSYS Technology Inc.
20F.-13, No.79, Sec. 1, Xintai 5th Rd.,
Xizhi Dist., New Taipei City 221, Taiwan
☏ 886-2-8698-3698
886-2-8698-3699
www.locosystech.com/

● RMC---Recommended Minimum Specific GNSS Data

Table 5.1-8 contains the values for the following example:

*$GNRMC,081340.000,A,2503.71262,N,12138.74527,E,0.068,87.03,180220,,,A*7B*

Table 5.1-8 RMC Data Format

Name	Example	Units	Description
Message ID	$GNRMC		RMC protocol header GN for GPS+BEIDOU ; GP for GPS only
UTC Time	081340.000		hhmmss.sss
Status	A		A=data valid or V=data not valid
Latitude	2503.71262		ddmm.mmmmm
N/S Indicator	N		N=north or S=south
Longitude	12138.74527		dddmm.mmmmm
E/W Indicator	E		E=east or W=west
Speed over ground	0.068	knots	True
Course over ground	87.03	degrees	
Date	180220		ddmmyy
Magnetic variation		degrees	(Not shown)
Variation sense			E=east or W=west (Not shown)
Mode	A		A=autonomous, D=DGPS, E=DR, N=Data not valid, R=Coarse Position, S=Simulator
Checksum	*7B		
<CR> <LF>			End of message termination

● VTG---Course Over Ground and Ground Speed

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

*$GNVTG,87.03,T,,M,0.068,N,0.127,K,A*15*

Table 5.1-9 VTG Data Format

Name	Example	Units	Description
Message ID	$GPVTG		VTG protocol header GN for GPS+BEIDOU ; GP for GPS only
Course over ground	87.03	degrees	Measured heading
Reference	T		True

LOCOSYS Technology Inc.
20F.-13, No.79, Sec. 1, Xintai 5th Rd.,
Xizhi Dist., New Taipei City 221, Taiwan
☏ 886-2-8698-3698
886-2-8698-3699
www.locosystech.com/

Course over ground		degrees	Measured heading (Not shown)
Reference	M		Magnetic (Not shown)
Speed over ground	0.068	knots	Measured speed
Units	N		Knots
Speed over ground	0.127	km/hr	Measured speed
Units	K		Kilometer per hour
Mode	A		A=autonomous, D=DGPS, E=DR, N=Data not valid, R=Coarse Position, S=Simulator
Checksum	*15		
<CR> <LF>			End of message termination

● TXT---Antenna Status

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

*$GNTXT,01,01,02,ANTSTATUS=OK*25*

Table 5.1-10 TXT Data Format

Name	**Example**	**Units**	**Description**
Message ID	$GNTXT		GNTXT protocol header
numMsg	01		Total number of messages. Fixed value: 01
msgNum	01		Message number. Fixed value: 01
msgType	02		Message type 00: error 01: warning 02: notice
txt	ANTSTATUS=OK		ANTSTATUS=OK: active antenna is well connected. ANTSTATUS=SHORT: Active antenna is short. ANTSTATUS=OPEN: Active antenna is open, i.e. not connected.
Checksum	*25		
<CR> <LF>			End of message termination

LOCOSYS Technology Inc.
20F.-13, No.79, Sec. 1, Xintai 5th Rd.,
Xizhi Dist., New Taipei City 221, Taiwan
☏ 886-2-8698-3698
886-2-8698-3699
www.locosystech.com/

5.2 Proprietary NMEA output message

Table 5.2-1 Proprietary NMEA output message

NMEA record	Description
INSSTAT	Dead reckoning status
GNATT	Altitude status

● INSSTAT --- Dead reckoning status

Table 5.2-2 contains the values for the following example:

*$INSSTAT,1,3,1,0,00*69*

Table 5.2-2 INSSTAT Data Format

Name	Example	Units	Description
Message ID	$INSSTAT		$INSSTAT protocol header
insInitStatus	1		Inertial sensor (INS) status 0: not initialized 1: initialized
fusionMode	3		Fusion mode 0: not initialized 1: reserved 2: reference mode (fused solution is based on position and time before power off) 3: Fused navigation of GNSS and dead reckoning.
mntAlgStatus	1		Installation status 0: not calibrated 1: calibration done
wtInitStatus	0		Wheel tick initial status. Fixed value: 0 for UDR. 0: not initialized 1: initialized
error	00		Error message Bit0: 1 means wheel tick mode Bit1: 1 means abnormal IMU Bit2: 1 means abnormal wheel tick Bit3: reserved Bit4: 1 means INS is disabled
Checksum	*69		
<CR> <LF>			End of message termination

LOCOSYS Technology Inc.
20F.-13, No.79, Sec. 1, Xintai 5th Rd.,
Xizhi Dist., New Taipei City 221, Taiwan
☎ 886-2-8698-3698
886-2-8698-3699
www.locosystech.com/

- **GNATT --- Altitude status**

Table 5.2-3 contains the values for the following example:

*$GNATT,0.874,0.588,-93.648*59*

Table 5.2-3 GNATT Data Format

Name	Example	Units	Description
Message ID	$GNATT		$GNATTT protocol header
Roll	0.874	degrees	
Pitch	0.588	degrees	
Yaw	-93.648	degrees	
Checksum	*59		
<CR> <LF>			End of message termination

6 Pin assignment and descriptions

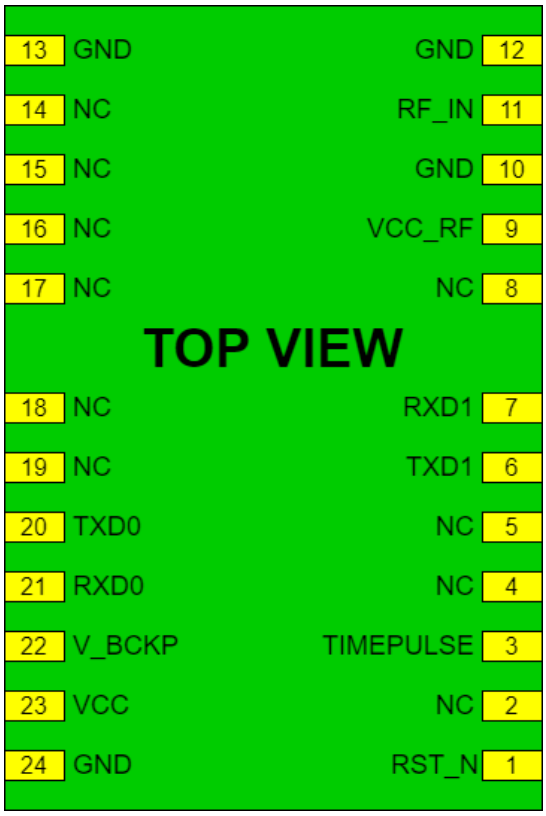


Table 6-1 Pin descriptions

Pin #	Name	Type	Description	Note
1	RST_N	I	External reset, low active. Leave unconnected if not used.	
2	NC		Not connected	
3	TIMEPULSE	O	Time pulse (1PPS, pulse/sec)	
4	NC		Not connected	
5	NC		Not connected	

LOCOSYS Technology Inc.
20F.-13, No.79, Sec. 1, Xintai 5th Rd.,
Xizhi Dist., New Taipei City 221, Taiwan
☏ 886-2-8698-3698
886-2-8698-3699
www.locosystech.com/

6	TXD1	O	Serial_1 output. Leave unconnected if not used.	
7	RXD1	I	Serial_1 input. Leave unconnected if not used.	
8	NC		Not connected	
9	VCC_RF	O	Output voltage for active antenna.	
10	GND	P	Ground	
11	RF_IN	I	GNSS RF signal input	1
12	GND	P	Ground	
13	GND	P	Ground	
14	NC		Not connected	
15	NC		Not connected	
16	NC		Not connected	
17	NC		Not connected	
18	NC		Not connected	
19	NC		Not connected	
20	TXD0	O	Serial_0 output (Default NMEA)	
21	RXD0	I	Serial_1 input (Default NMEA)	
22	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. If no backup power is available, connect V_BCKP to the main power supply (VCC).	
23	VCC	I	DC supply input	
24	GND	P	Ground	

Note 1: An active antenna with a gain of 15 to 30 dB is recommended.

LOCOSYS Technology Inc.
20F.-13, No.79, Sec. 1, Xintai 5th Rd.,
Xizhi Dist., New Taipei City 221, Taiwan
☎ 886-2-8698-3698
886-2-8698-3699
www.locosystech.com/

7 DC & Temperature characteristics

7.1 Absolute maximum ratings

Parameter	Symbol	Ratings	Units
DC Supply Input Voltage	VCCabs.	3.6	V
Backup Battery Input Voltage	V_BCKPabs.	3.6	V
Operating Temperature Range	Topr_abs.	-40 ~ 85	℃
Storage Temperature Range	Tstg_abs.	-40 ~ 85	℃

7.2 DC Electrical characteristics

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
DC Supply Input Voltage	VCC		3.0	3.3	3.6	V
Backup Battery Input Voltage	V_BCKP		2.0		3.6	V
VCC_RF Output Voltage	VCC_RF			VCC		V
Supply Current	Iss	VCC = 3.3V, w/o active antenna, Peak Tracking		 45 (1)	100	 mA mA
Backup Battery Current	Ibat	VCC = 0V		37		uA
VCC_RF Output Current	Iout	VIN = 3.3V			25	mA
High Level Input Voltage	V_{IH}		0.7*VCC		3.6	V
Low Level Input Voltage	V_{IL}				0.2*VCC	V
High Level Output Voltage	V_{OH}		VCC-0.4			V
Low Level Output Voltage	V_{OL}				0.4	V

Note 1. Measured for 12 hours when position fix (1Hz) is available and input voltage is 3.3V.

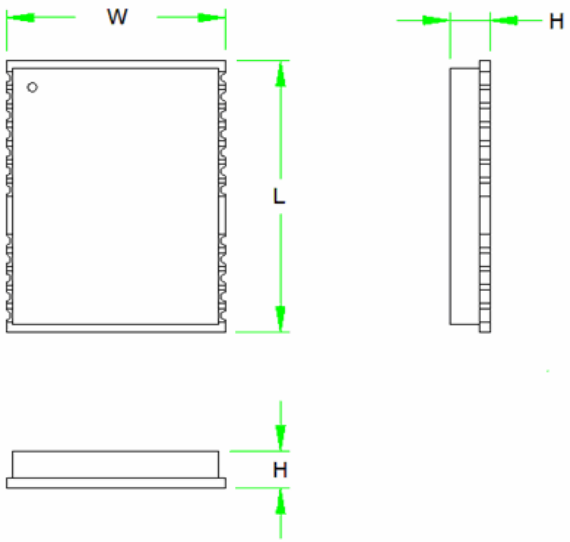
7.3 Temperature characteristics

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

LOCOSYS Technology Inc.
20F.-13, No.79, Sec. 1, Xintai 5th Rd.,
Xizhi Dist., New Taipei City 221, Taiwan
☏ 886-2-8698-3698
886-2-8698-3699
www.locosystech.com/

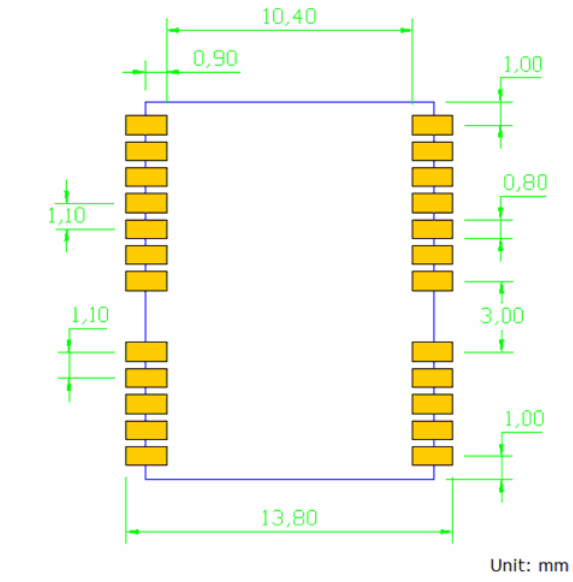
8 Mechanical specification

8.1 Outline dimensions



Symbol	Min. (mm)	Typ. (mm)	Max. (mm)
W	12.1	12.2	12.3
L	16.5	16.9	17.3
H	2.2	2.4	2.6

8.2 Recommended land pattern dimensions



Note: The recommended land pattern dimensions are for reference only as actual layout may vary depending on applications.

LOCOSYS Technology Inc.
20F.-13, No.79, Sec. 1, Xintai 5th Rd.,
Xizhi Dist., New Taipei City 221, Taiwan
☏ 886-2-8698-3698
886-2-8698-3699
www.locosystech.com/

8.3 Installation

The module must be rigidly fixed on the vehicle before power-on. No requirement for installation orientation. Do not move the module after power-on. The module is only suitable for vehicle navigation with acceleration less than 2g.

In order to get the better fused navigation, the initialization and calibration steps are suggested in the following.

1. Power on the module and wait GNSS position fix in the open sky environment.
2. Stay still for more than 5 seconds.
3. Accelerate and decelerate linearly more than 5 times in the open sky environment.
4. Drive at the speed above 40km/h for more than 1 minutes in the open sky environment.
5. Complete 2 or more 90-degree turns in the open sky environment.

If the module is moved after rigidly fixing on the vehicle, it can automatically start initialization and calibration.

LOCOSYS Technology Inc.
20F.-13, No.79, Sec. 1, Xintai 5th Rd.,
Xizhi Dist., New Taipei City 221, Taiwan
☏ 886-2-8698-3698
886-2-8698-3699
www.locosystech.com/

9 Product handling

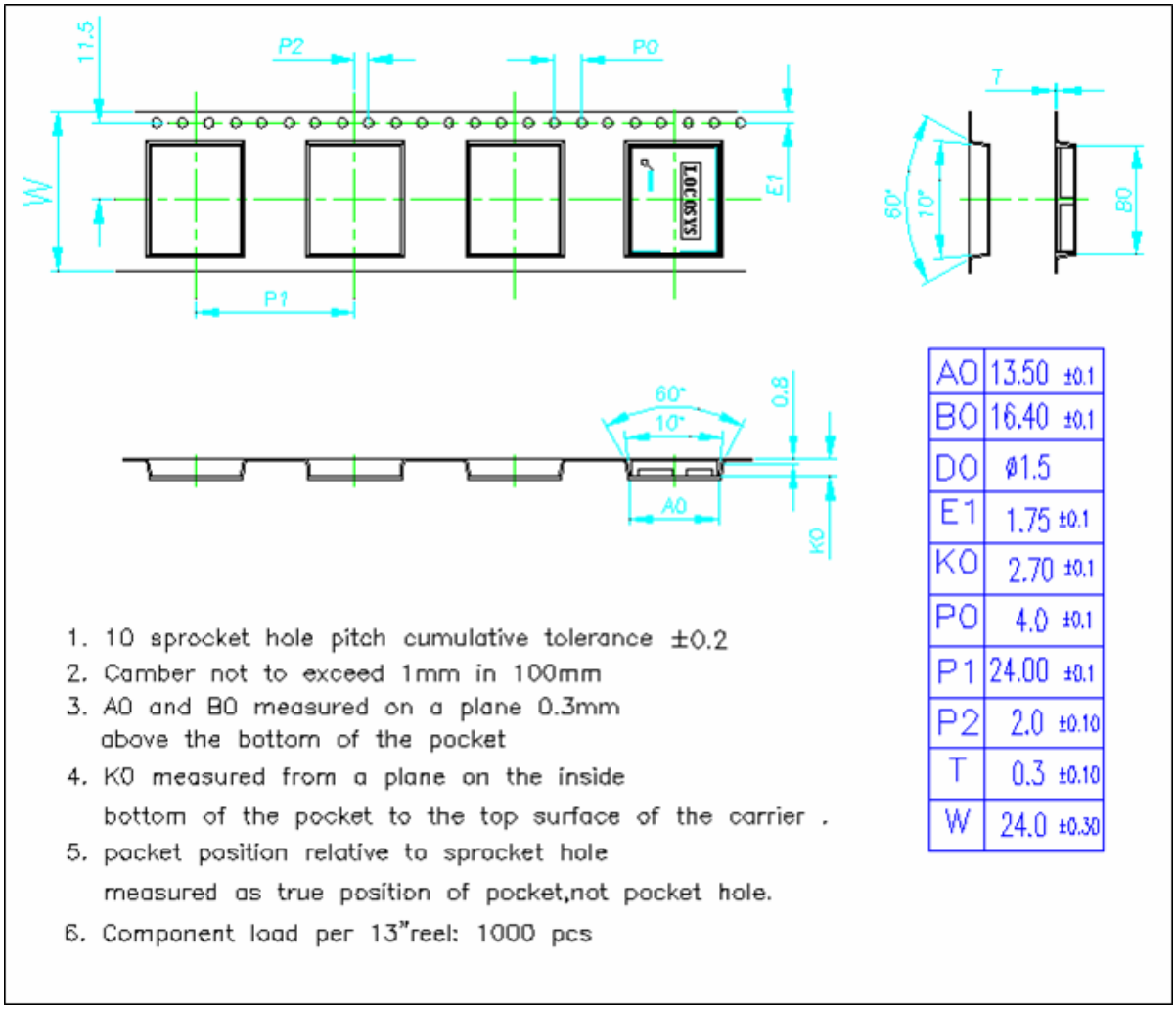
9.1 ESD precaution

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 Tape and reel packaging

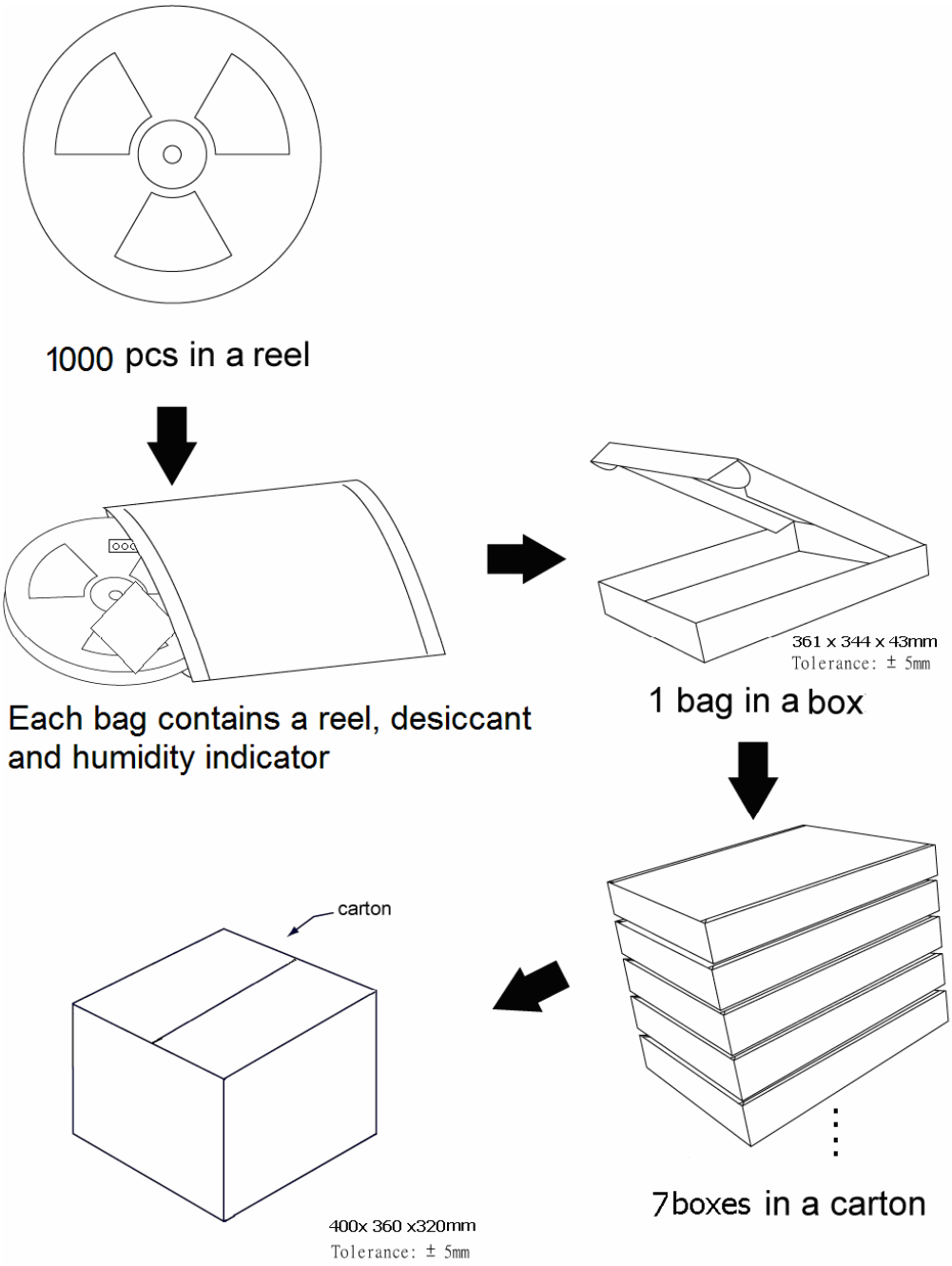


A0	13.50 ±0.1
B0	16.40 ±0.1
D0	ø1.5
E1	1.75 ±0.1
K0	2.70 ±0.1
P0	4.0 ±0.1
P1	24.00 ±0.1
P2	2.0 ±0.10
T	0.3 ±0.10
W	24.0 ±0.30

1. 10 sprocket hole pitch cumulative tolerance ±0.2
2. Camber not to exceed 1mm in 100mm
3. A0 and B0 measured on a plane 0.3mm above the bottom of the pocket
4. K0 measured from a plane on the inside bottom of the pocket to the top surface of the carrier .
5. pocket position relative to sprocket hole measured as true position of pocket,not pocket hole.
6. Component load per 13"reel: 1000 pcs

LOCOSYS Technology Inc.
20F.-13, No.79, Sec. 1, Xintai 5th Rd.,
Xizhi Dist., New Taipei City 221, Taiwan
☎ 886-2-8698-3698
886-2-8698-3699
www.locosystech.com/

9.2.2 Box packaging



9.3 Moisture sensitivity level

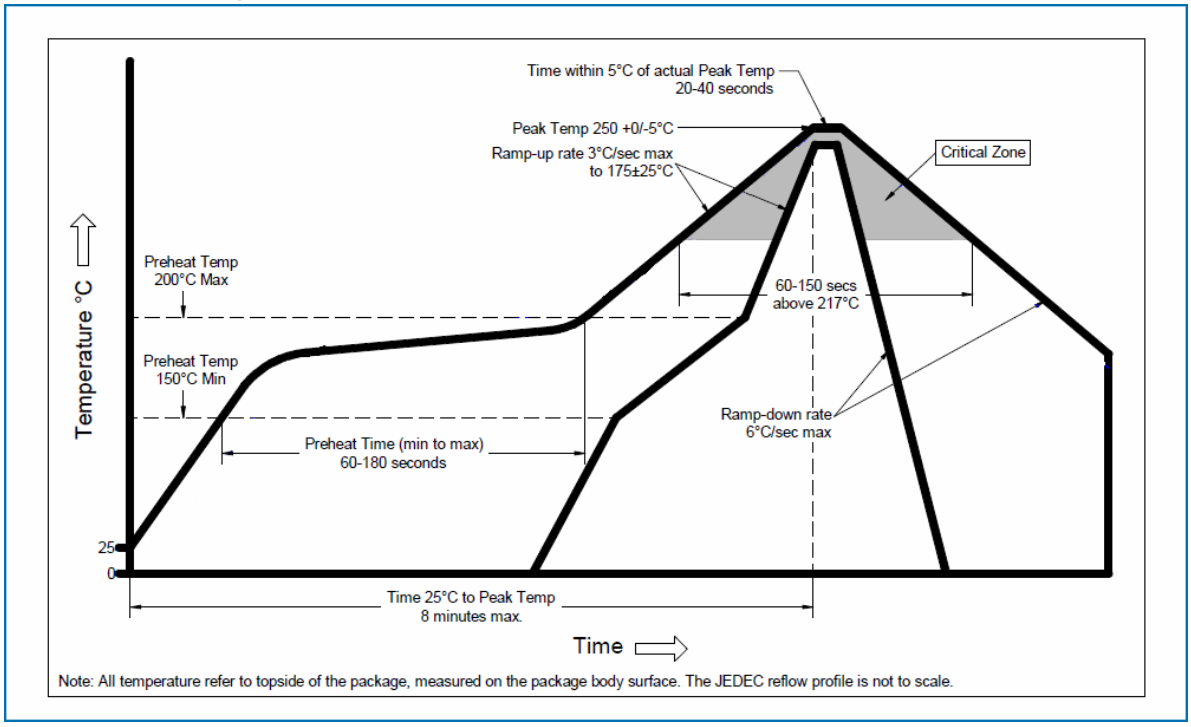
The moisture sensitivity level of the module is 3. After the sealed bag is opened, modules should be mounted within 168 hours at factory conditions of ≦ 30℃ and 60% RH or stored at ≦ 20% RH.

The modules require baking before mounting if above conditions are not met. If baking is required, the modules may be baked for:

a. 192 hours at 40℃ + 5℃ / -0℃ and < 5% RH
b. 24 hours at 125℃ + 5℃ / -0℃

LOCOSYS Technology Inc.
20F.-13, No.79, Sec. 1, Xintai 5th Rd.,
Xizhi Dist., New Taipei City 221, Taiwan
☏ 886-2-8698-3698
886-2-8698-3699
www.locosystech.com/

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
MZ-1612-UDB	GNSS UDR module with 3D sensors	GPS, BEIDOU

LOCOSYS

LOCOSYS Technology Inc.
20F.-13, No.79, Sec. 1, Xintai 5th Rd.,
Xizhi Dist., New Taipei City 221, Taiwan
☎ 886-2-8698-3698
886-2-8698-3699
www.locosystech.com/

Document change list

Revision 0.1

- Draft release on February 21, 2020