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Product name	Description	Version
RTK-1612AD-DR	High-precision untethered dead reckoning module	0.3

1 Introduction

LOCOSYS RTK-1612AD-DR uses an Airoha AG3335AD chip, dual-frequency multi-constellation solution GNSS, providing RTK high precision and sensor fusion solution in one. It not only supports GPS, GLONASS, GALILEO, BEIDOU, and QZSS but also has inertial sensors (3-axis accelerometers and 3-axis gyros) to provide an untethered dead reckoning function.

In addition to DR, an inertial sensor can detect the vehicular dynamics when it is attached firmly on the vehicle. Consequently, abnormal driving behaviors and the vehicle status can be detected and the alarm status will be enabled to remind the users. No requirement of installation orientation and automatic calibration function make it easy to use. With these features, RTK-1612AD-DR 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 navigation.

2 Features

- Build on high performance, low-power Airoha AG3335AD chip
- Dual-frequency multi-constellation GNSS RTK positioning and dead reckoning.
- Support GPS, GLONASS, GALILEO, BEIDOU and QZSS
- Capable of SBAS (WAAS, EGNOS, MSAS, GAGAN)
- Support 135-channel GNSS
- Built-in TDK-42670-P 6-axis MEMS (3-axis gyroscope and 3-axis accelerometer)
- UDR Mode CEP $\leq$ 3% of distance travelled without GNSS
- Alarm statuses detected by VMDS
- No requirement for installation orientation
- Small form factor 16 x 12.2 x 2.4 mm
- SMD type with stamp holes; RoHS compliant

3 Application

- Automotive navigation
- LBS (location Base Service)
- Vehicle Remote Monitoring
- ITS (Intelligent Traffic System)

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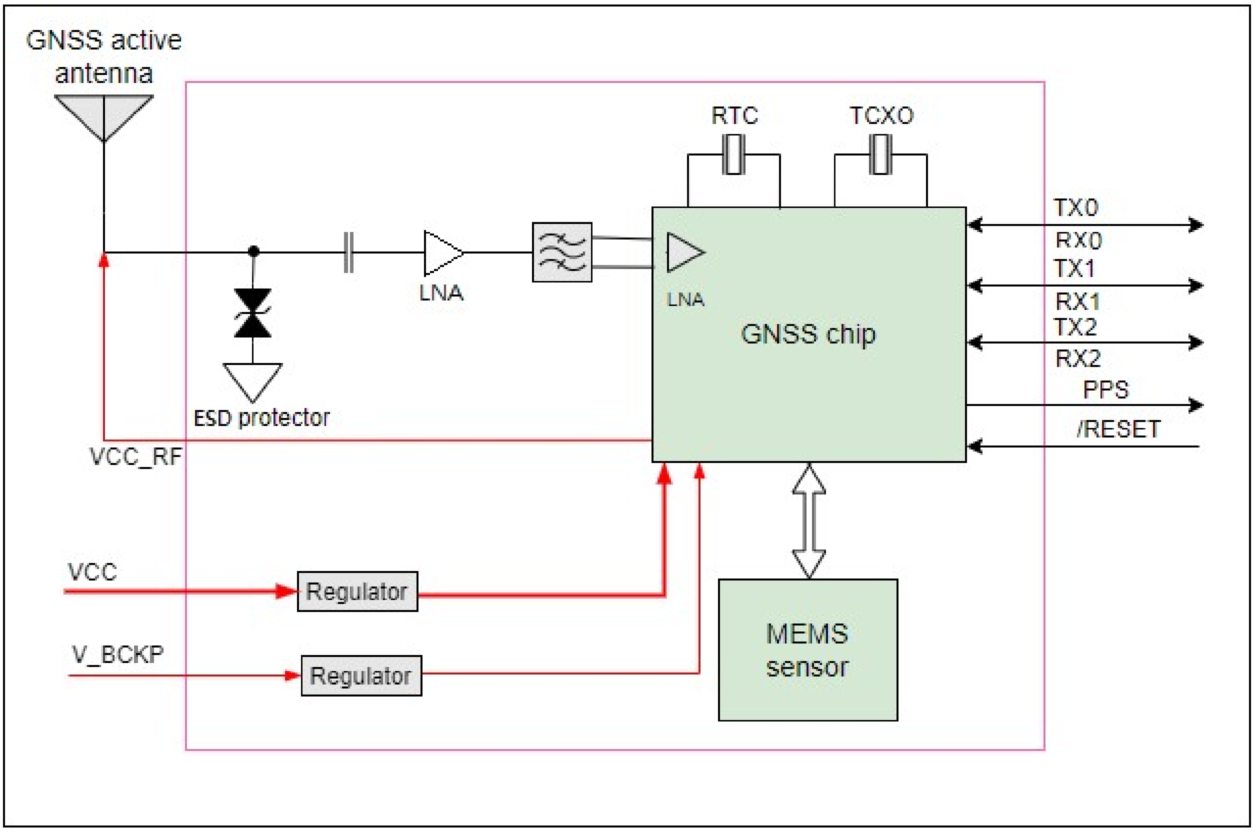

Fig 3-1 System block diagram.

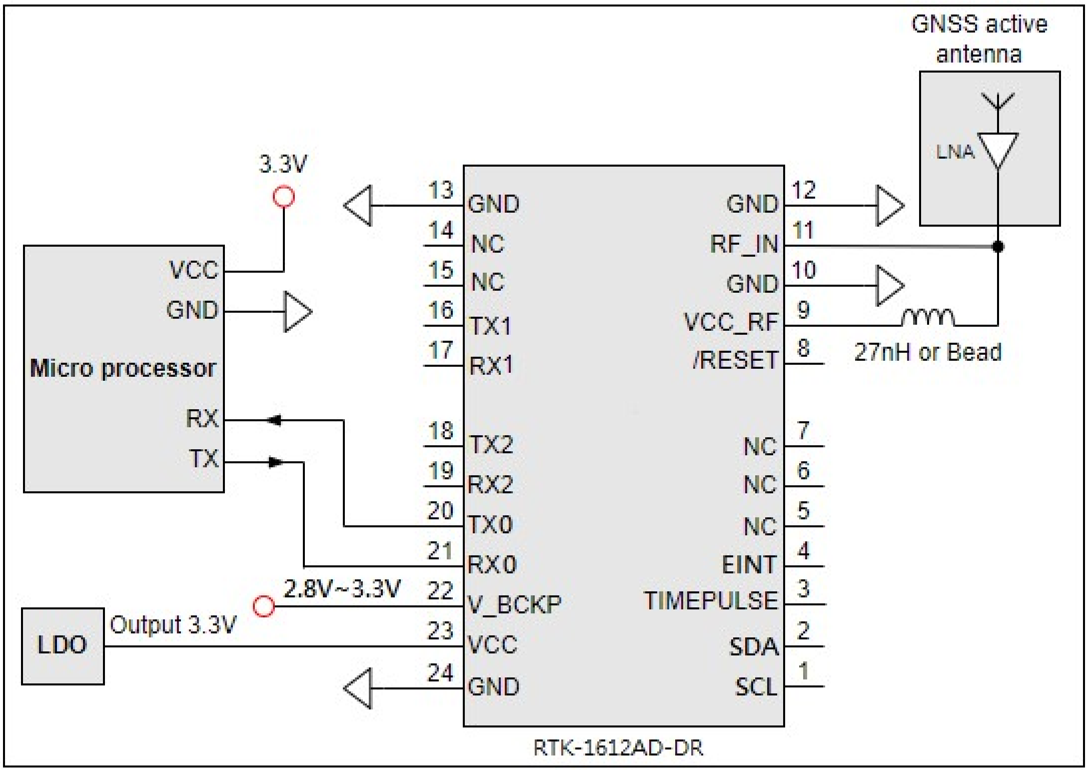

Fig 3-2 Typical application circuit

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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	
Sensitivity	Cold start	-148dBm
	Hot start	-155dBm
	Reacquisition	-158dBm
	Tracking	-165dBm
Acquisition Time	Hot start (Open Sky)	1s (typical)
	Cold Start (Open Sky)	24s (typical)
Position Accuracy	Autonomous	1.5m CEP (1)
	RTK	1cm + 1ppm (horizontal) CEP(1) 1.5cm + 1ppm (vertical) CEP(1)
	UDR mode	CEP ≤ 3% of distance travelled without GNSS
Max. Altitude	< 18,000 m	
Max. Velocity	< 500 m/s	
Protocol Support	115200 bps(2), 8 data bits, no parity, 1 stop bits (default)	
	NMEA 0183 ver. 4.1	1Hz: GGA,GLL, RMC 0.2 Hz: GSA, and GSV
	Proprietary message	1Hz: PLSATTIT
	RTCM V3.3	Message type 1005, 1074, 1084, 1094, 1114, 1124

<Note>

1. 24hr, static, open sky, demonstrated with good dual-frequency active antennas.
2. Both baud rate and output message rate are configurable to be factory default.

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5 Software interface

5.1 NMEA output message

Table 5.1-1 NMEA output message

NMEA record	Description
GGA	Global positioning system fixed data
GLL	Geographic position - latitude/longitude
GSA	GNSS DOP and active satellites
GSV	GNSS satellites in view
RMC	Recommended minimum specific GNSS data
VTG	Course over ground and ground speed

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

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

$GNGGA,061730.000,2503.7135400,N,12138.7466600,E,1,46,0.49,131.36,M,15.32,M,,*71

Table 5.1- 2 GGA Data Format

Name	Example	Units	Description
Message ID	$GNGGA		GGA protocol header
UTC Time	061730.000		hhmmss.sss
Latitude	2503.7135400		ddmm.mmmmmmm
N/S indicator	N		N=north or S=south
Longitude	12138.7466600		dddmm.mmmmmmm
E/W Indicator	E		E=east or W=west
Position Fix Indicator	1		See Table 5.1-3
Satellites Used	46		Number of satellite in use
HDOP	0.49		Horizontal Dilution of Precision
MSL Altitude	131.36	meters	Antenna Altitude above/below mean-sea-level (geoid), (in meters)
Units	M	meters	Units of antenna altitude, meters
Geoidal Separation	15.32	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	*71		Checksum
<CR> <LF>			End of message termination

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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 Mode

- **GLL--- Geographic Position – Latitude/Longitude**

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

$GNGLL,2503.7135400,N,12138.7466600,E,061730.000,A,A*48

Table 5.1-4 GLL Data Format

Name	**Example**	**Units**	**Description**
Message ID	$GNGLL		GLL protocol header
Latitude	2503.7135400		ddmm.mmmmmmm
N/S indicator	N		N=north or S=south
Longitude	12138.7466600		dddmm.mmmmmmm
E/W indicator	E		E=east or W=west
UTC Time	061730.000		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	*48		
<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

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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	1		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	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

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$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=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:

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$GNRMC,061730.000,A,2503.7135400,N,12138.7466600,E,0.01,0.00,230522,,,A,V*00

Table 5.1-10 RMC Data Format

Name	Example	Units	Description
Message ID	$GNRMC		RMC protocol header
UTC Time	061730.000		hhmmss.sss
Status	A		A=data valid or V=data not valid
Latitude	2503.7135400		ddmm.mmmmmmm
N/S Indicator	N		N=north or S=south
Longitude	12138.7466600		dddmm.mmmmmmm
E/W Indicator	E		E=east or W=west
Speed over ground	0.01	knots	True
Course over ground	0.00	degrees	
Date	230522		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	*00		
<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	GNVTG		VTG protocol header
Course over ground	0.00	degrees	Measured heading
Reference	T		True
Course over ground		degrees	Measured heading

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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

5.2 Proprietary output message

- **PLSATTIT**

Table 5.2-1 contains the values for the following example:

$PLSATTIT,061030.000,120723,3,2,0,155.54,0.70,-0.41,25.0619348,121.6561793,30.39,-27.99,11.84,0.06,37.00,21. 66,0.0,0.0*2D

Table 5.2- 1 PLSATTIT Data Format

Name	Example	Units	Description
Message ID	$PLSATTIT		PLSATTIT protocol header
UTC Time	061030.000		hhmmss.sss
Date	120723		ddmmyy
DR_Stage	3		DR algorithm stage, 0: unknown, 1: initializing, 2: coarse, 3: stable.
Static_Status	2		User static status, 0: unknown, 1: static, 2: dynamic
Motion_Alarm	0		User motion detection alarm, 0: unknown 1: HARSH_ACCELERATION 2: HARSH_DECELERATION 4: HARSH_TURN 8: HARSH_LANE_CHANGE 16: HORIZONTAL_COLLISION 32: ROLLOVER 64: STABILITY_WARNING 128: EULER_ANOMALY

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Vehicle_Heading	155.54	degree	0~360
Vehicle_Pitch	0.70	degree	-180~180
Vehicle_Roll	-0.41	degree	~180~180
Latitude	25.0619348	degree	dd.ddddddd, latitude in WGS84
Longitude	121.6561793	degree	dd.ddddddd, longitude in WGS84
Ground_Speed	30.39	km/hr	Speed over ground (2D)
Velocity_North	-27.99	km/hr	Velocity in north direction
Velocity_East	11.84	km/hr	Velocity in east direction
Velocity_Down	0.06	km/hr	Velocity in down direction
Height_WGS84_Ellipsoid	37.00	meter	Altitude above WGS84 ellipsoid
Height_Mean_Sea_Level	21.66	meter	Altitude above mean sea level
Reserved1	0.0		
Reserved2	0.0		
Checksum	*2D		
<CR><LF>			

5.3 Proprietary input command

Table 5.3-1 Proprietary input message

NMEA like record	Description
$PAIR004	Perform GNSS hot start
$PAIR005	Perform GNSS warm start
$PAIR006	Perform GNSS cold start
$PLSC,SETBASEXYZ	Set the base location (reference position)
$PLSC,GETBASEXYZ	Get the base location setting
$PLSC,MCBASE	Set up module as a reference station or as a rover

- **$PAIR004 --- Perform GNSS hot start**

Table 5.3-2 contains the values for the following example:

$PAIR004*3E

Table 5.3-2 PAIR004 Data Format

Name	Example	Units	Description
Message ID	$PAIR004		$PAIR004 protocol header
Checksum	*3E		
<CR> <LF>			End of message termination

Response:

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

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- **$PAIR005 --- Perform GNSS warm start**

Table 5.3-3 contains the values for the following example:

$PAIR005*3F

Table 5.3-3 PAIR005 Data Format

Name	Example	Units	Description
Message ID	$PAIR005		$PAIR005 protocol header
Checksum	*3F		
<CR> <LF>			End of message termination

Response:

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

- **$PAIR006 --- Perform GNSS cold start**

Table 5.3-4 contains the values for the following example:

$PAIR006*3C

Table 5.3-4 PAIR006 Data Format

Name	Example	Units	Description
Message ID	$PAIR006		$PAIR006 protocol header
Checksum	*3C		
<CR> <LF>			End of message termination

Response:

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

- **$PLSC,SETBASEXYZ --- Set the base location (reference position)**

Table 5.3-5 contains the values for the following example:

$PLSC,SETBASEXYZ,-3028442.081,4923062.884,2687870.875*03

Table 5.3-5 PLSC,SETBASEXYZ Data Format

Name	Example	Units	Description
Message ID	$PLSC,SETBASEXYZ		$PLSC,SETBASEXYZ protocol header
X	-3028442.081	Meters	WGS-84 ECEF X-axis coordinate in Meter
Y	4923062.884	Meters	WGS-84 ECEF Y-axis coordinate in Meter
Z	2687870.875	Meters	WGS-84 ECEF Z-axis coordinate in Meter
Checksum	*03		
<CR> <LF>			End of message termination

Response:

$PLSR,BASEXYZ,-3028442.081,4923062.884,2687870.875*50\r\n ==> Success

- **$PLSC,GETBASEXYZ --- Get the base location setting**

Table 5.3-6 contains the values for the following example:

$PLSC,GETBASEXYZ*38

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Table 5.3-6 PLSC,GETBASEXYZ Data Format

Name	**Example**	**Units**	**Description**
Message ID	$PLSC,GETBASEXYZ		$PLSC,GETBASEXYZ protocol header
Checksum	*38		
<CR> <LF>			End of message termination

Response:

$PLSR,BASEXYZ,-3028442.081,4923062.884,2687870.875*50\r\n ==> Success

- **$PLSC,MCBASE --- Set up module as a reference station or as a rover**

Table 5.3-7 contains the values for the following example:

$PLSC,MCBASE,1*26

Table 5.3-7 PLSC,MCBASE Data Format

Name	**Example**	**Units**	**Description**
Message ID	$PLSC,MCBASE		$PLSC,MCBASE protocol header
Mode	1		0: set up the board as a rover (default) 1: set up the board as a reference station (Output RTCM3.3 1005, 1074, 1084, 1094, 1124 messages)
Checksum	*26		
<CR> <LF>			End of message termination

Response:

$PAIR001,604,0*39\r\n ==> Success

$PLSR,MCBASE,-1*1A\r\n ==> Fail. (The base location does not set yet)

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6 Pin assignment and descriptions

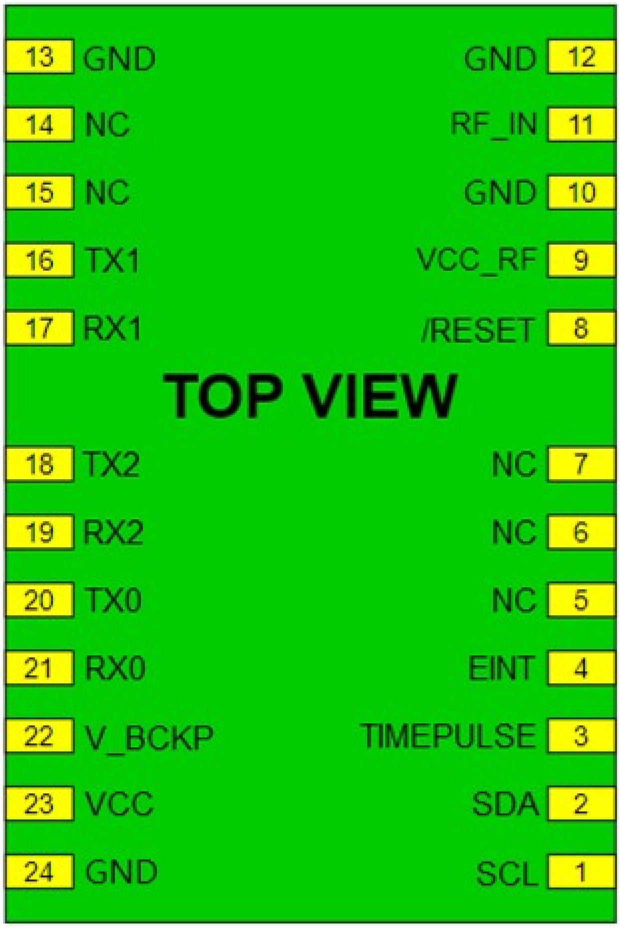

Table 6-1 Pin descriptions

Pin #	Name	Type	Description	Note
1	SCL	I/O	Slave I2C clock	
2	SDA	I/O	Slave I2C data	
3	TIMEPULSE	O	Time pulse (PPS, default 100ms pulse/sec when GNSS fix is available.)	
4	EINT	I	Interrupt pin, low level, suspended it when module enters dormant state. Leave unconnected if not used.	
5	NC		Not connected	
6	NC		Not connected	
7	NC		Not connected	
8	/RESET	I	Reset input. Low active. Leave unconnected if not used.	
9	VCC_RF	O	Output voltage for active antenna	
10	GND	P	Ground	
11	RF_IN	I	GNSS RF signal input.	
12	GND	P	Ground	

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13	GND	P	Ground	
14	NC		Not connected	
15	NC		Not connected	
16	TX1	O	Reserved Debugging port (Idle)	
17	RX1	I	Reserved Debugging port (Idle)	
18	TX2	O	Standby serial port output	
19	RX2	I	Standby serial port input	
20	TX0	O	Serial output	1
21	RX0	I	Serial input	1
22	V_BCKP	P	Backup battery input. Leave it vacant when not in use. If no backup power is available, connect V_BCKP to the main power supply (VCC).	
23	VCC	P	DC supply input. Must be clean and stable.	
24	GND	P	Ground	

<Note>

1. Main interface for NMEA and PAIRMSG messages.

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7 DC & Temperature characteristics

7.1 Absolute maximum ratings

Parameter	Symbol	Ratings	Units
DC Supply Input Voltage	VCCabs	3.6	V
Input Backup Battery Voltage	V_BCKPabs	3.3	V
Input Power at RF_IN	RF_IN_{MAX}	+20	dBm
Operating Temperature Range	Topr_abs	-40 ~ 85	℃
Storage Temperature Range	Tstg_abs	-55 ~ 100	℃

7.2 DC Electrical characteristics

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
DC Supply Input Voltage	VCC		3.0	3.3	3.6	V
Input Backup Battery Voltage	V_BCKP		2.8		3.3	V
VCC_RF Output Voltage	VCC_RF			VCC		V
Supply Current [1,2]	Iss	VCC = 3.3V, w/o active antenna, Acquisition Tracking		45 56		mA mA
Backup Battery Current	Ibat	VIN = 0V		64 (TBR)		uA
VCC_RF Output Current	Iout	VIN = 3.3V			30	mA
High Level Input Voltage	VI H		2.1		3.6	V
Low Level Input Voltage	VI L		0.3		0.7	V
High Level Output Voltage	VOH		2.4		VCC	V
Low Level Output Voltage	VOL				0.4	V

<Note>

1. Measured when position fix (1Hz) is available and input voltage is 3.3V.
2. The inrush current that occurs at the first power-on or “full cold start” command can be as high as 600mA for 20μs.

7.3 Temperature characteristics

Parameter	Symbol	Min.	Typ.	Max.	Units
Operating Temperature	Topr	-40	-	85	℃
Storage Temperature	Tstg	-55	25	100	℃

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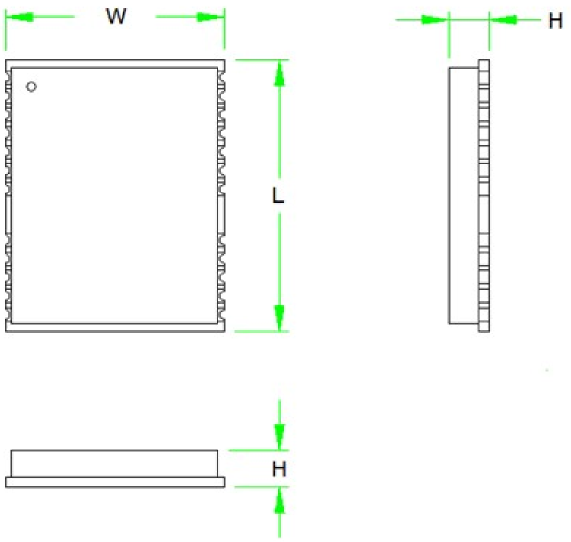
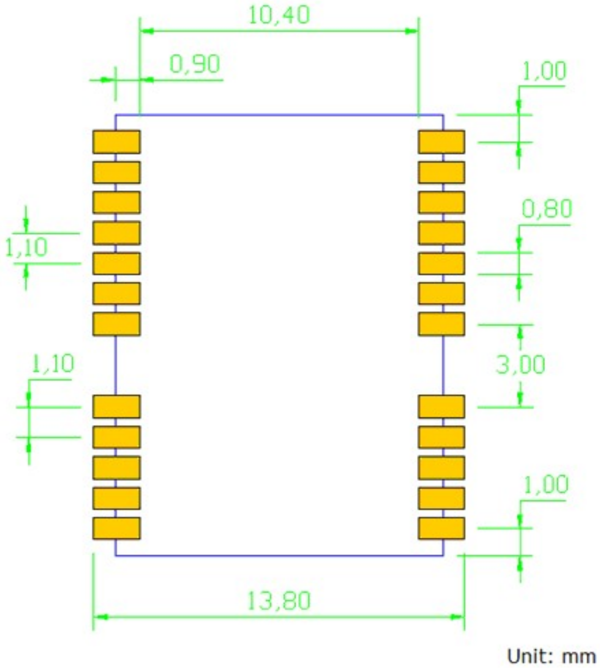
8 Mechanical specification

8.1 Outline dimensions



Symbol	Min. (mm)	Typ. (mm)	Max. (mm)
W	12.0	12.2	12.4
L	15.4	16.0	16.6
H	2.2	2.4	2.6

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 Installation & Calibration

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 4g.

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

A. Power on the module and wait GNSS position fix in the open sky environment.
B. Stay still for about 180 second or more.
C. Drive straight for 500 meters with the speed > 10 km/h and < 50 km/h in the open sky environment.
D. Drive around the block with the speed > 10 km/h and < 50 km/h in the open sky environment.
E. The system ready flag in the message "$PAIRMSG" shows if the fused PVT is ready.

The EVK must be rigidly fixed on the vehicle before it power-on. It does not have the requirement for installation orientation. Do not move the EVK after power-on. The EVK is only suitable for vehicle navigation with an acceleration of less than 4G.

Phase	Procedure	Indicator of success
Empty Calibrated data (if needed)	Power on the EVK module Waiting 500msec Input command: $PAIR782*37 to delete the fusion content saved in NVRAM	
IMU initialization	Stay stationary under good GNSS signal reception conditions for at least 180 seconds.	$PAIRMSG,90,hhmmss.sss,1*CS
IMU-mount alignment calibration	Drive on a straight road at speed above 10 km/h and < 50 km/h for at least 5 minutes in the open sky environment. Accelerate and decelerate more than 5 times linearly during the drive.	$PAIRMSG,90,hhmmss.sss,2*CS
INS initialization with attitude	With speed above 10 km/h and < 50 km/h complete 2 or more 90-degree left and right turns in the open sky environment.	$PAIRMSG,90,hhmmss.sss,3*CS

INS initialization maintain	Before powering off, make static Input command: $PAIR781*34 to save current fusion content to NVRAM and complete the INS initialization conserve and the latest position save.

10 Antenna Consideration

The RTK-1612AD-DR is designed to use with an active antenna, or a passive antenna with higher antenna gain. Passive ceramic patch antenna is low-cost and provides good sensitivity. With a 50-ohm impedance and larger size ceramic patch antenna also with higher antenna gain design as Figure 10.1 can be connected directly to the RF input of the module. Usually, the ceramic patch antenna mounted on the reverse side of the RTK-1612AD-DR PCB is to reduce the possibility of picking up digital noise. To improve signal reception performance, use a larger ground plane under the patch antenna if possible; the more significant the ground plane, the larger the overall antenna gain. The center frequency of the ceramic patch antenna changes with ground plane size. For optimal L1+L5 operation, the frequency bandwidth of the antenna needs to cover 1174MHz ~ 1179MHz and 1561MHz ~ 1606MHz respectively, when it is mounted on the PCB. Therefore, ask the ceramic patch antenna supplier to select or tune a patch antenna that best matches the customer's PCB.

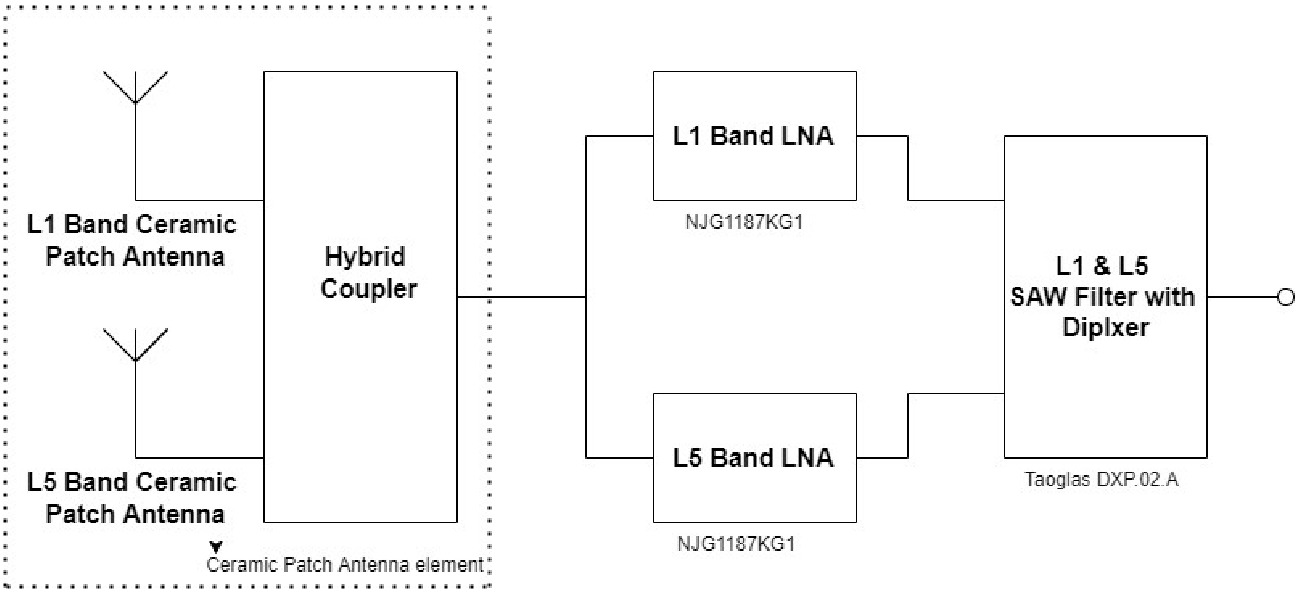

Fig10-1 A reference design for ceramic patch antenna working with LNA & SAW filter

An active antenna is a standalone device that integrates with a passive patch antenna, built-in LNA, saw filter, and cable to the module with high gain and good performance. Customers do not need to consider designing a complex dual-band antenna themselves, which may include dual-band patch antennas, L1 and L5 band LNAs, L1 and L5 band saw filters, hybrid couplers and matching circuits. An active antenna usually costs more than a passive patch antenna, but the performance in low signal environments is generally better than a passive one. It is also easier to implement than the customer's own design antenna.

Antenna Type	**Passive**	**Active**
GPS & QZSS Frequency (MHz)	1575.42 +/- 2 (L1) 1176.45 +/- 6 (L5)	1575.42 +/- 2 (L1) 1176.45 +/- 6 (L5)

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BDS Frequency (MHz)	1561 .098+/- 2 (B1) 1176.45+/- 2 (B2)	1561 .098+/- 2 (B1) 1176.45+/- 2 (B2)
GLONASS Frequency (MHz)	1602 +/- 4 (L1)	1602 +/- 4 (L1)
GALILEO Frequency (MHz)	1575.42 +/- 2 (E1) 1176.45 +/- 6 (E5)	1575.42 +/- 2 (E1) 1176.45 +/- 6 (E5)
VSWR	< 2 (typical)	< 2 (typical)
Polarization	RHCP	RHCP
Antenna Gain	> 0dBi	> -2dBi
LNA Gain		20dB (typical)
Noise Figure		< 1.5dB
Total Gain		> 18dBi

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11 Reel Packing information

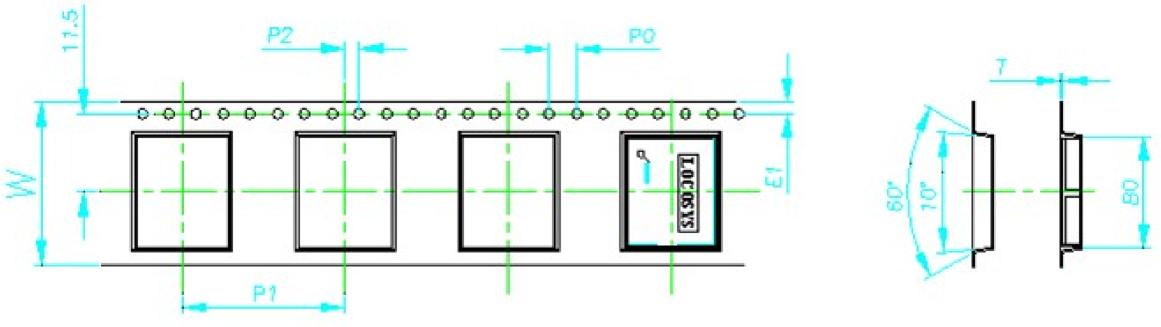
11.1 ESD precaution

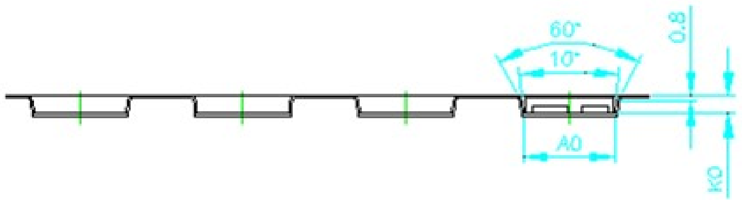
GNSS modules are electrostatic sensitive devices. Handling the modules without proper ESD protection may result in severe damage to them. ESD protection must be implemented throughout the processing, handling and even when the modules are being returned for repair.

11.2 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.

11.2.1 Packaging





A0	13.50 ±0.1
B0	16.40 ±0.1
D0	Φ1.5
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

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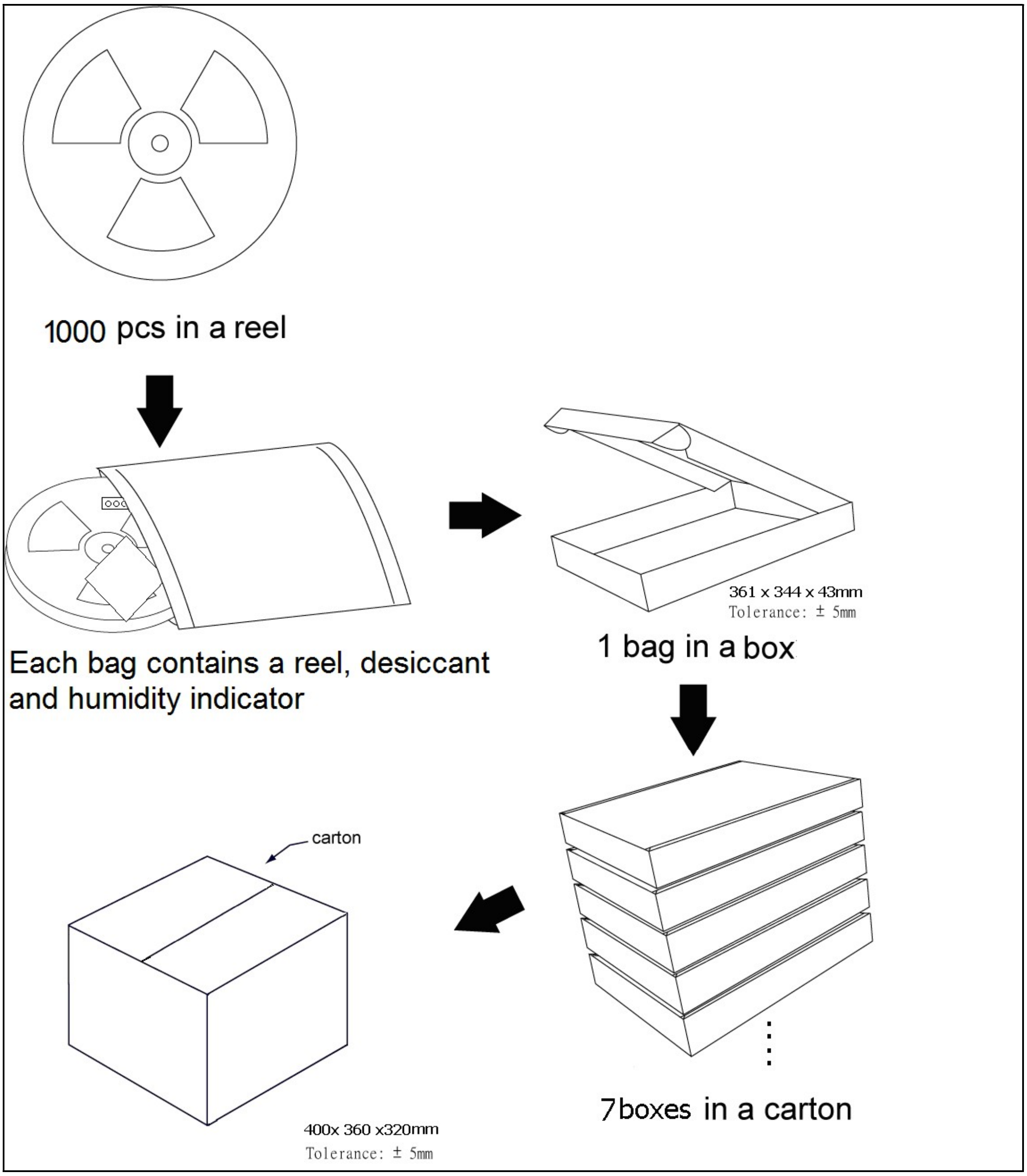
11.2.2 Box packaging



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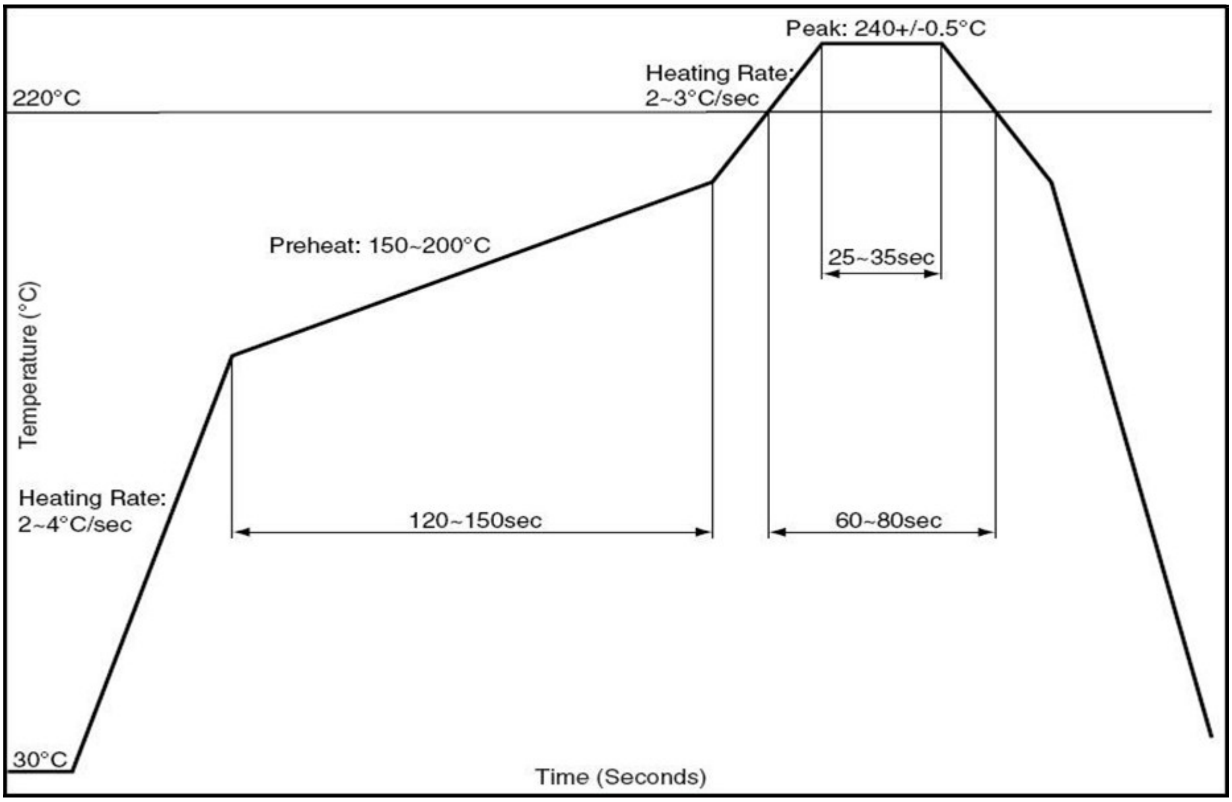
11.3 Moisture sensitivity level

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

11.4 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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Document change list

Revision 0.1

- Draft release on Nov. 22, 2022.

Revision 0.2 (August 10, 2023)

- Add the GLL and PLSATTIT output in the section 4.
- Removed the PAIRMSG in the section 4.
- Removed the $PAIRMSG、$PINVMSLOPE、$PINVMATTIT、$PINVMIMU in section 5.2.
- Add the PLSATTIT in section 5.2.
- Removed the $PAIR780、$PAIR781、$PLSC,MEMS、$PLSC,VER、$PAIR007 in section 5.3.

Revision 0.3 (March 07, 2024)

- Revised NMEA GGA, GLL and RMC message in section 5.1.