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Product name	Description	Version
RTK-1612-DR	High precision dead reckoning module	0.2

1 Introduction

LOCOSYS RTK-1612-DR is a dual-frequency multi-constellation GNSS module providing RTK high precision and sensor fusion solution. It not only supports GPS, GLONASS, GALILEO, BEIDOU and QZSS, but also has inertial sensors (3-axis accelerometers and 3-axis gyros) to provide dead reckoning. It will detect if there is an odometer connection or vehicle speed input, and then automatically operate in ADR or UDR mode.

Raw data of the inertial sensors and vehicle's altitude including pitch, roll and heading angles can be output for the driver behavior analysis. For example, the internet connected vehicles can automatically send emergency calls (e.g., E-Call) for help based on the vehicle's altitude. No requirement of installation orientation and automatic calibration function make it easy to use. With these features, RTK-1612-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

- Dual-frequency and multi-constellation RTK and dead reckoning.
- Support GPS, GLONASS, GALILEO, BEIDOU and QZSS
- Capable of SBAS (WAAS, EGNOS, MSAS, GAGAN)
- Support 135-channel GNSS
- Up to 10 Hz update rate
- Built-in MEMS sensor (3-axis gyroscope and 3-axis accelerometer)
- No requirement for installation orientation
- Auto detect and operate in ADR or UDR mode
- Support odometer (wheel-tick pulse) and forward/reverse signal input
- Support vehicle speed input from UART port
- Small form factor 16 x 12.2 x 2.4 mm
- SMD type with stamp holes; RoHS compliant

3 Application

- Automotive navigation

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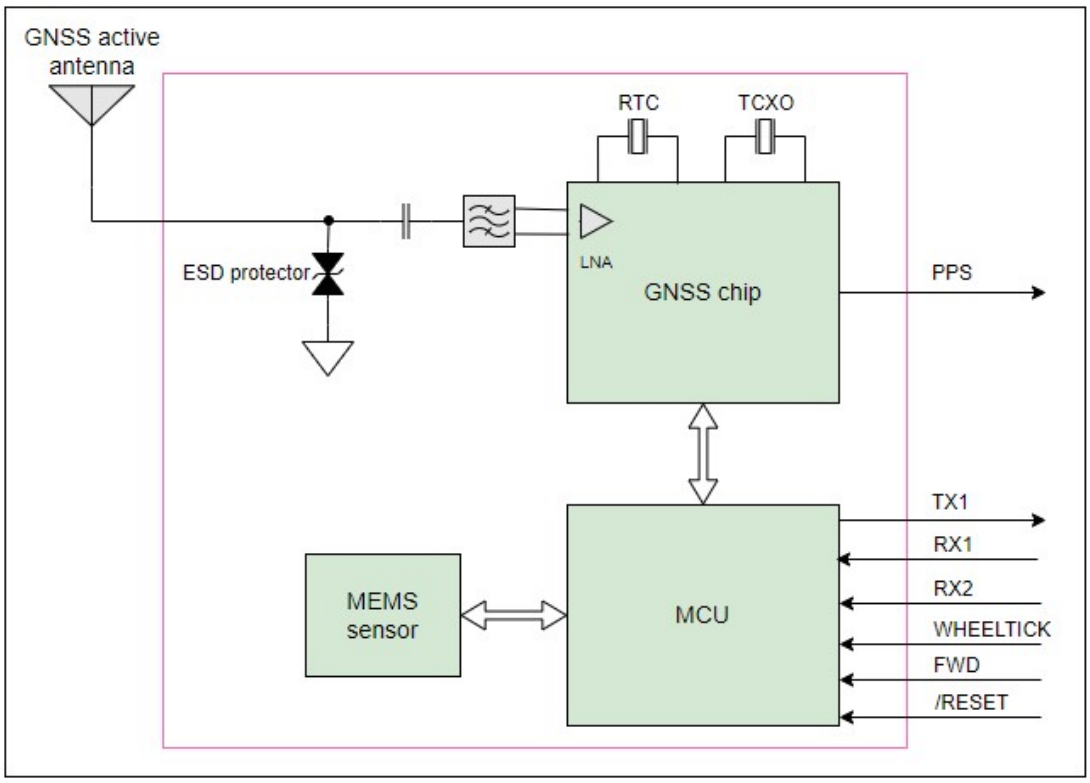

Fig 3-1 System block diagram.

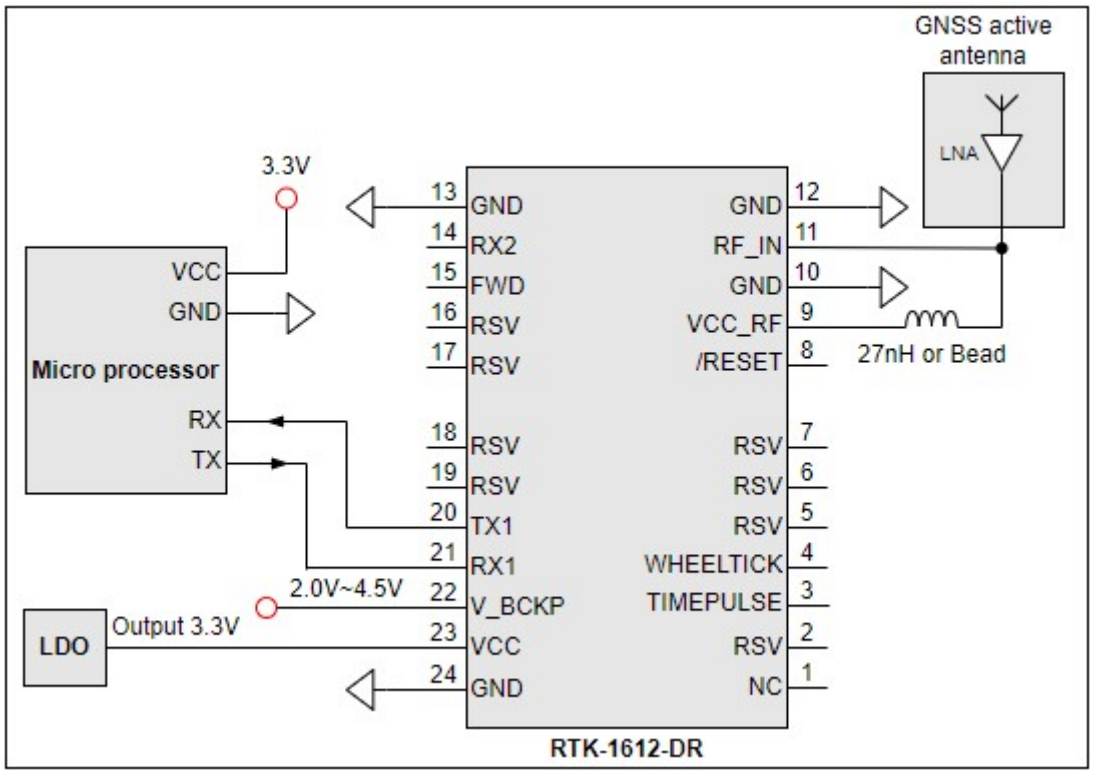

Fig 3-2 Typical application circuit

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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, 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)
Position Accuracy	Autonomous	1.5m CEP [1]
	RTK	1cm + 1ppm (horizontal) CEP [1] 1.5cm + 1ppm (vertical) CEP [1]
	ADR mode	CEP ≤ 2% of distance travelled without GNSS [2]
	UDR mode	CEP ≤ 10% of distance travelled without GNSS [2]
Max. Altitude	< 18,000 m	
Max. Velocity	< 500 m/s	
Protocol Support	115200 bps [3], 8 data bits, no parity, 1 stop bits (default)	
	NMEA 0183 ver. 4.1	1Hz: GSA, GSV, GGA, RMC, GST, PLSVD, PINVMINR, PINVMSLOPE, PINVMATTIT
	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. Test condition: after calibration, drive at 30 km/h for 60 seconds without GNSS signals.
3. 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
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

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 view
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

● 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	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

$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:

$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	GNVTG		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

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5.2 Proprietary output message

Table 5.2-1 Proprietary output message

NMEA like record	Description
$PLSVD	Velocity estimate
$PINVMINR	Calibration status
$PINVMSLOPE	Slope information
$PINVMATTIT	Attitude information
$PINVMIMU	MEMS raw data
$PINVMVGS	Vehicle ground speed

● PLSVD--- Velocity Estimate

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

$PLSVD,0,0,0,4,3,3*59

Table5.2- 2 PLSVD Data Format

Name	Example	Units	Description
Message ID	$PLSVD		PLSVD protocol header
VE	0	cm/s	Velocity in east (-51500~51500)
VN	0	cm/s	Velocity in north (-51500~51500)
VD	0	cm/s	Velocity in down (-10000~10000)
stdVE	4	cm/s	Standard deviation of velocity error in east
stdVN	3	cm/s	Standard deviation of velocity error in north
stdVD	3	cm/s	Standard deviation of velocity error in down
Checksum	*59		
<CR> <LF>			End of message termination

<Note> The data is derived from GNSS.

● $PINVMINR --- Calibration status

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

$PINVMINR,1*04

Table 5.2-3 PINVMINR Data Format

Name	Example	Units	Description
Message ID	$PINVMINR		$PINVMINR protocol header
Status	1		0: wait for calibration 1: calibration is in progress 2: calibration is in progress 3: calibration is done

Checksum	*04		
<CR> <LF>			End of message termination

● $PINVMSLOPE --- Slope information

Table 5.2-4 contains the values for the following example:

$PINVMSLOPE,-3.13,-0.05,0.93,54.42,2.60,1.86*3B

Table 5.2-4 PINVMSLOPE Data Format

Name	Example	Units	Description
Message ID	$PINVMSLOPE		$PINVMSLOPE protocol header
Slope	-3.13	degree	slope + : up ; - : down
Alt_Diff	-0.05	meters	altitude difference, + : up ; - : down
Move_Dist	0.93	meters	move distance
Slope_Accu	54.42	degree	slope accuracy
Alt_Diff_Accu	2.60	meters	altitude difference accuracy
Move_Dist_Accu	1.86	meters	move distance accuracy
Checksum	*3B		
<CR> <LF>			End of message termination

<Note> The data is valid only when the calibration is done.

● PINVMATTIT --- Attitude information

Table 5.2-5 contains the values for the following example:

$PINVMATTIT,-20.652,32.265,0.000*3C

Table 5.2-5 $PINVMATTIT Data Format

Name	Example	Units	Description
Message ID	$PINVMATTIT		$PINVMATTIT protocol header
Roll	-20.652	degree	Vehicle roll.
Pitch	32.265	degree	Vehicle pitch.
Heading	0.000	degree	Vehicle heading.
Checksum	*3C		
<CR> <LF>			End of message termination

<Note> The data is valid only when the calibration is done.

● $PINVMIMU --- IMU raw data

Table 5.2-6 contains the values for the following example:

$PINVMIMU,1114.106,-0.36990,1.51074,9.81383,0.67139,0.61035,-0.30518*22

Table 5.2-6 PINVMIMU Data Format

Name	Example	Units	Description
Message ID	$PINVMIMU		$PINVMIMU protocol header
Time_Second	1114.106	sec	Time stamp
Accel_X	-0.36990	m/s^2	Accel_X output data of MEMS sensor
Accel_Y	1.51074	m/s^2	Accel_Y output data of MEMS sensor
Accel_Z	9.81383	m/s^2	Accel_Z output data of MEMS sensor
Gyro_X	0.67139	degree /s	Gyro_X output data of MEMS sensor
Gyro_Y	0.61035	degree /s	Gyro_Y output data of MEMS sensor
Gyro_Z	-0.30518	degree /s	Gyro_Z output data of MEMS sensor
Checksum	*22		
<CR> <LF>			End of message termination

<Note> The raw data is 100Hz.

● $PINVMVGS --- Vehicle ground speed

Table 5.2-7 contains the values for the following example:

$PINVMVGS,4269.200,43.60,F*5E

Table 5.2-7 PINVMVGS Data Format

Name	Example	Units	Description
Message ID	$PINVMVGS		$PINVMVGS protocol header
Time stamp	4269.200	sec	MCU time stamp
Speed	43.60	km/h	Speed over ground
Direction	F		Vehicle's travel direction F: forward R: reverse U: unknown
Checksum	*5E		
<CR> <LF>			End of message termination

<Note>

This message will be automatically output when the speed is derived from the odometer or serial input from the host.

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5.3 Proprietary input command

Table 5.3-1 Proprietary input message

NMEA like record	Description
$PINVCRES	Clear DR NVM data
$PINVCSTR	Restart DR calibration
$PLSC,MEMS	Enable/disable output MEMS raw data
$PAIR004	Perform GNSS hot start
$PAIR005	Perform GNSS warm start
$PAIR006	Perform GNSS cold start
$PAIR007	Perform GNSS full cold start
$PLSC,VER	Query firmware version
$PINVCVGS	Input vehicle ground speed of ADR mode
$PLSC,SPDSRC	Set vehicle speed source of ADR mode
$PLSC,FORWARD	Set active level of forward/reverse signal.

- **$PINVCRES ---Clear DR NVM data**

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

$PINVCRES,0*1A

Table 5.3-2 PINVCRES Data Format

Name	Example	Units	Description
Message ID	$PINVCRES		$PINVCRES protocol header
Value	0		Clear DR NVM data
Checksum	*1A		
<CR> <LF>			End of message termination

Response:

$PINVMSTR,0*05\r\n

- **$PINVCSTR --- Restart DR calibration**

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

$PINVCSTR,14*3E

Table 5.3-3 PINVCSTR Data Format

Name	Example	Units	Description
Message ID	$PINVCSTR		$PINVCSTR protocol header
Type	14		Restart DR calibration
Checksum	*3E		
<CR> <LF>			End of message termination

Response:

$PINVMSTR,2*07\r\n

- **$PLSC,MEMS --- Enable/disable output MEMS raw data**

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

$PLSC,MEMS,1*2B

Table 5.3-4 PLSC,MEMS Data Format

Name	Example	Units	Description
Message ID	$PLSC,MEMS		$PLSC,MEMS protocol header
Enable	1		1: enable. 0: disable.
Checksum	*2B		
<CR> <LF>			End of message termination

Response:

$PLSR,MEMS,1,OK\r\n

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

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

$PAIR004*3E

Table 5.3-5 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

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

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

$PAIR005*3F

Table 5.3-6 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 5.3-7 contains the values for the following example:

$PAIR006*3C

Table 5.3-7 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

- **$PAIR007 --- Perform GNSS full cold start**

Table 5.3-8 contains the values for the following example:

$PAIR007*3D

Table 5.3-8 PAIR007 Data Format

Name	Example	Units	Description
Message ID	$PAIR007		$PAIR007 protocol header
Checksum	*3D		
<CR> <LF>			End of message termination

Response:

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

- **$PLSC,VER --- Query firmware version**

Table 5.3-9 contains the values for the following example:

$PLSC,VER*61

Table 5.3-9 PLSC,VER Data Format

Name	Example	Units	Description
Message ID	$PLSC,VER		$PLSC,VER protocol header
Checksum	*61		
<CR> <LF>			End of message termination

Response:

$PINVMVER,R20200306,RTK35X_V1.0L0331AD_Lib20220322,AUDR,May 16 2022_10:21:51*35\r\n

- **$PINVCVGS --- Input vehicle ground speed of ADR mode**

Table 5.3-10 contains the values for the following example:

$PINVCVGS,16.80,F*67

Table 5.3-10 PINVCVGS Data Format

Name	Example	Units	Description
Message ID	$PINVCVGS		$PINVCVGS protocol header
Speed	16.80	km/h	Speed over ground
Direction	F		Vehicle's travel direction F: forward R: reverse
Checksum	*67		
<CR> <LF>			End of message termination

Response:

$PINVMVGS,703.581,16.80,F*63\r\n

<Note>

This message can be input from both serial ports, i.e., RX1 and RX2 of the module. The input message rate has to be equal to or higher than 5Hz.

- **$PLSC,SPDSRC --- Set vehicle speed source of ADR mode**

Table 5.3-11 contains the values for the following example:

$PLSC,SPDSRC,ODO*4D

Table 5.3-11 PLSC,SPDSRC Data Format

Name	Example	Units	Description
Message ID	$PLSC,SPDSRC		$PLSC,SPDSRC protocol header
Source	ODO		ODO: vehicle speed from odometer UART: vehicle speed from serial port. This is default.
Checksum	*4D		
<CR> <LF>			End of message termination

Response:

$PLSR,SPDSRC,ODO,OK*74\r\n

- **$PLSC,FORWARD --- Set active level of forward/reverse signal**

Table 5.3-12 contains the values for the following example:

$PLSC,FORWARD,0*67

Table 5.3-12 PLSC,FORWARD Data Format

Name	Example	Units	Description
Message ID	$PLSC,FORWARD		$PLSC,FORWARD protocol header
Type	0		0: low and high level represents forward and reverse, respectively. This is default. 1: low and high level represents reverse and forward,

			respectively.
Checksum	*67		
<CR> <LF>			End of message termination

Response:

$PLSR,FORWARD,0,OK*5E\r\n

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6 Pin assignment and descriptions

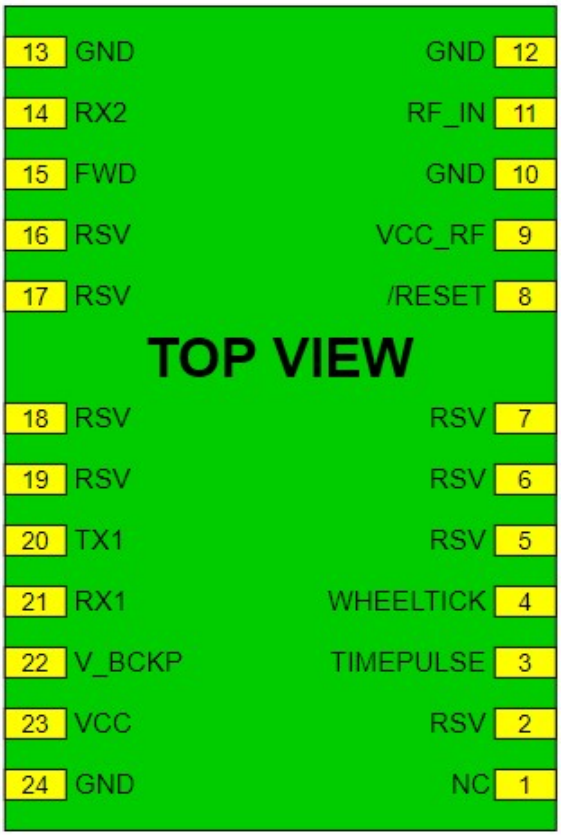

Table 6-1 Pin descriptions

Pin #	Name	Type	Description	Note
1	NC		Not connect	
2	RSV		Reserved pin. Leave unconnected.	
3	TIMEPULSE	O	Time pulse (PPS, default 100ms pulse/sec when GNSS fix is available.)	
4	WHEELTICK	I	Wheel tick input. Please refer to the software command “$PLSC,SPDSRC” to enable the function. Leave unconnected if not used.	
5	RSV		Reserved pin. Leave unconnected.	
6	RSV		Reserved pin. Leave unconnected.	
7	RSV		Reserved pin. Leave unconnected.	
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. The total gain of the active antenna must be between 15dB ~ 27dB.	

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12	GND	P	Ground	
13	GND	P	Ground	
14	RX2	I	Serial input used for the host to send vehicle speed to RTK-1612-DR. Leave unconnected if not used.	1
15	FWD	I	Forward/reverse input for speed pulse. Leave unconnected if not used.	
16	RSV		Reserved pin. Leave unconnected.	
17	RSV		Reserved pin. Leave unconnected.	
18	RSV		Reserved pin. Leave unconnected.	
19	RSV		Reserved pin. Leave unconnected.	
20	TX1	O	Serial output	2
21	RX1	I	Serial input	2
22	V_BCKP	P	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).	
23	VCC	P	DC supply input. Must be clean and stable.	
24	GND	P	Ground	

<Note>

1. The host can send vehicle speed to the module from RX1 or RX2.
2. Main interface for NMEA and RTCM3 messages.

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7 DC & Temperature characteristics

7.1 Absolute maximum ratings

Parameter	Symbol	Ratings	Units
DC Supply Input Voltage	VCCabs	4	V
Input Backup Battery Voltage	V_BCKPabs	5.5	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
Input Backup Battery Voltage	V_BCKP		2.0		4.5	V
VCC_RF Output Voltage	VCC_RF			VCC		V
Supply Current [1,2]	Iss	VCC = 3.3V, w/o active antenna, Tracking		93		mA
Backup Battery Current	Ibat	VIN = 0V		64		uA
VCC_RF Output Current	Iout	VIN = 3.3V			30	mA
High Level Input Voltage	VI H		0.7*VCC		VCC	V
Low Level Input Voltage	VI L		0		0.3*VCC	V
High Level Output Voltage	VOH		0.7*VCC		VCC	V
Low Level Output Voltage	VOL				0.45	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	-40	25	85	℃

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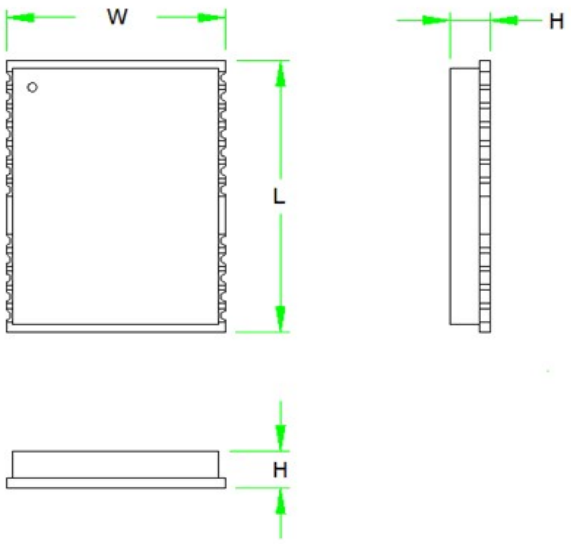
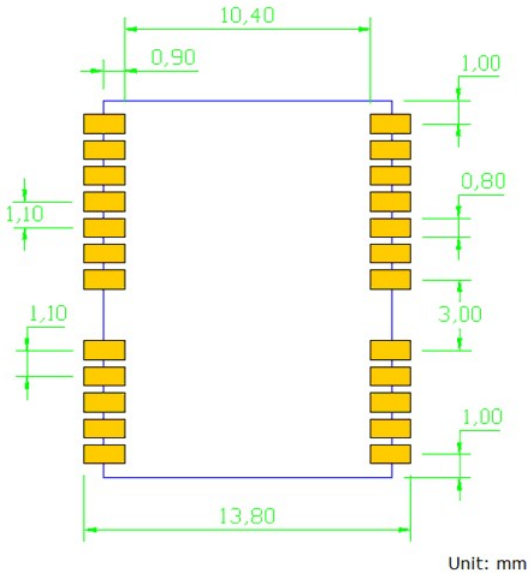
8 Mechanical specification

8.1 Outline dimensions



Symbol	Min. (mm)	Typ. (mm)	Max. (mm)
W	12.1	12.2	12.3
L	15.7	16.0	16.4
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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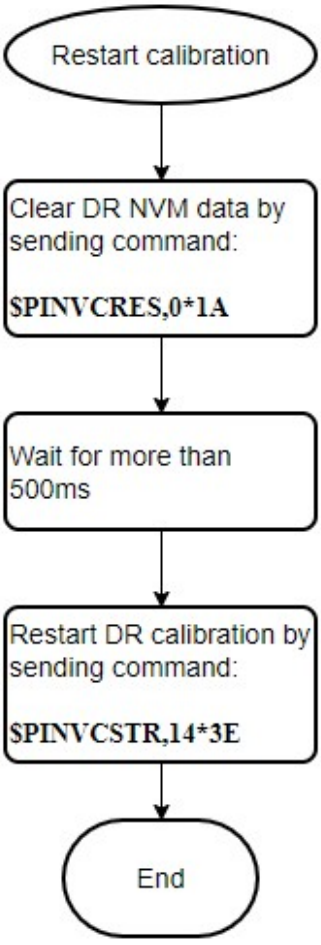
8.3 Installation and calibration

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.

1. Power on the module and wait GNSS position fix in the open sky environment.
2. Stay still for about 1 minute or more.
3. Drive in the straight road at the speed above 30km/h for more than 5 minutes in the open sky environment.
4. Accelerate and decelerate linearly more than 5 times in the open sky environment.
5. Complete 2 or more 90-degree turns in the open sky environment.
6. The calibration status in the message "**$PINVMINR**" shows if the calibration is done.

If the module is moved after rigidly fixing on the vehicle, it can automatically start initialization and calibration. If the user wants to force the module to do calibration again, please issue the software commands as below flowchart. Then the module will restart the initialization and calibration.



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9 Reel Packing information

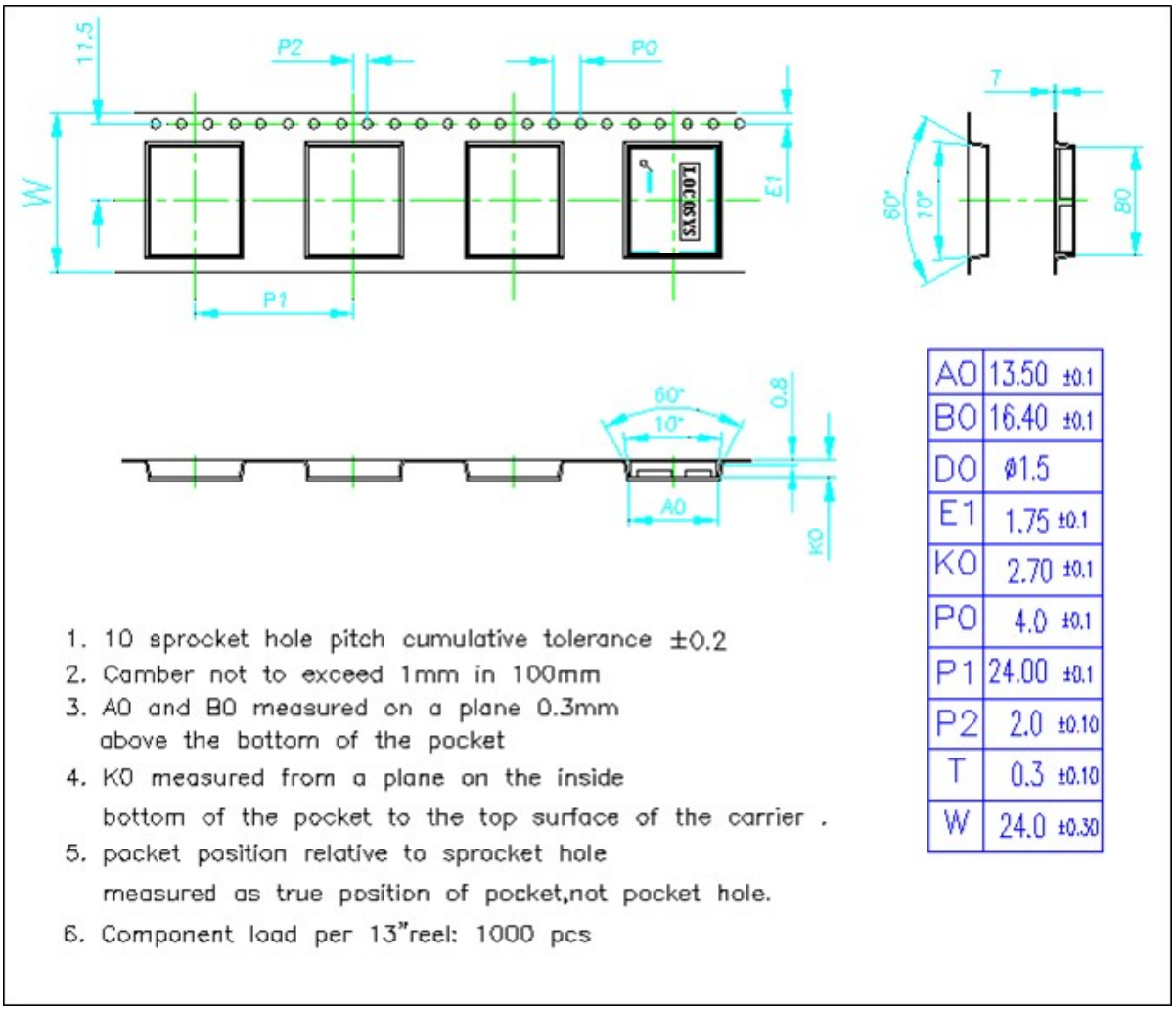
9.1 ESD precaution

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



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

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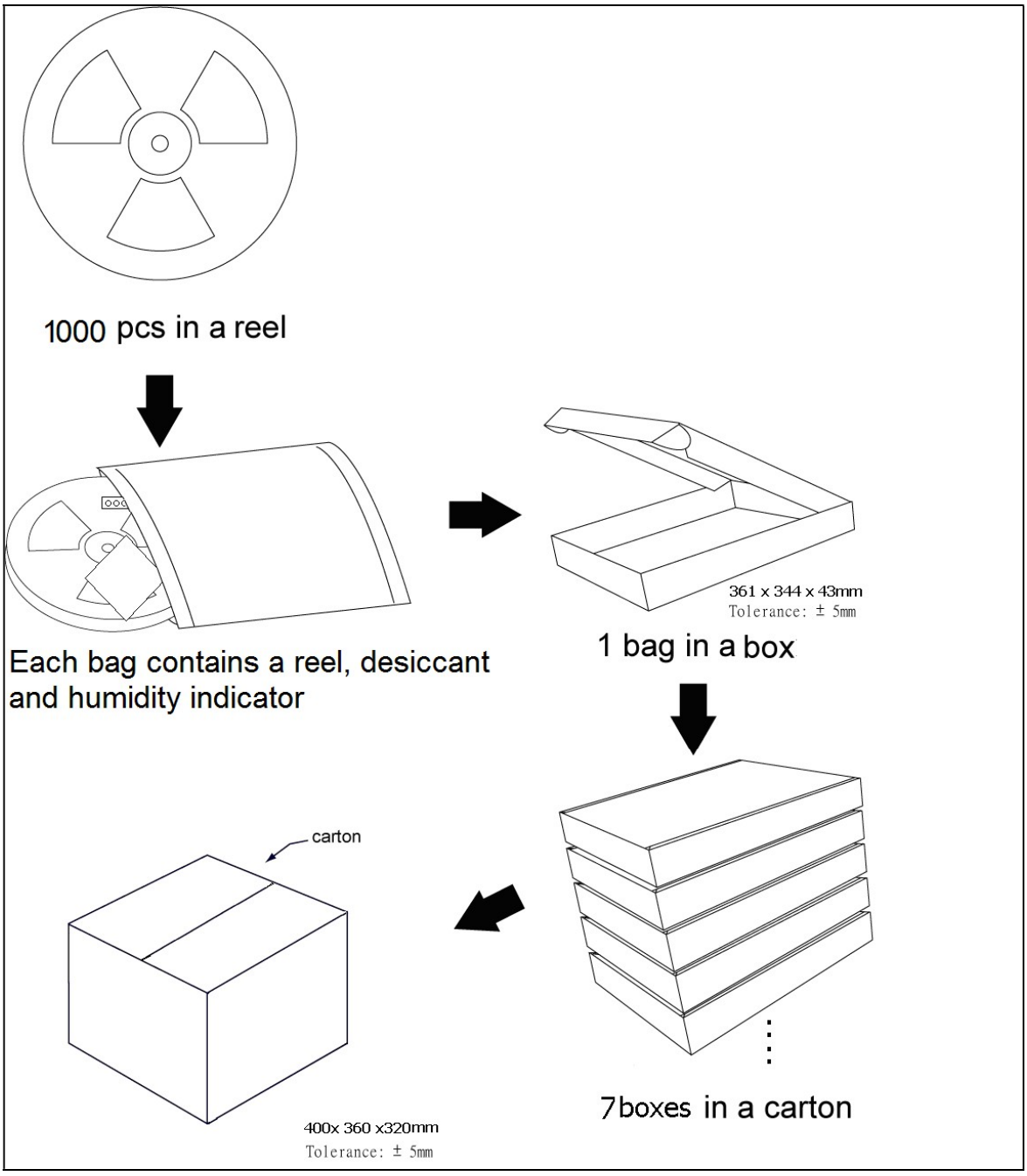
9.2.2 Box packaging



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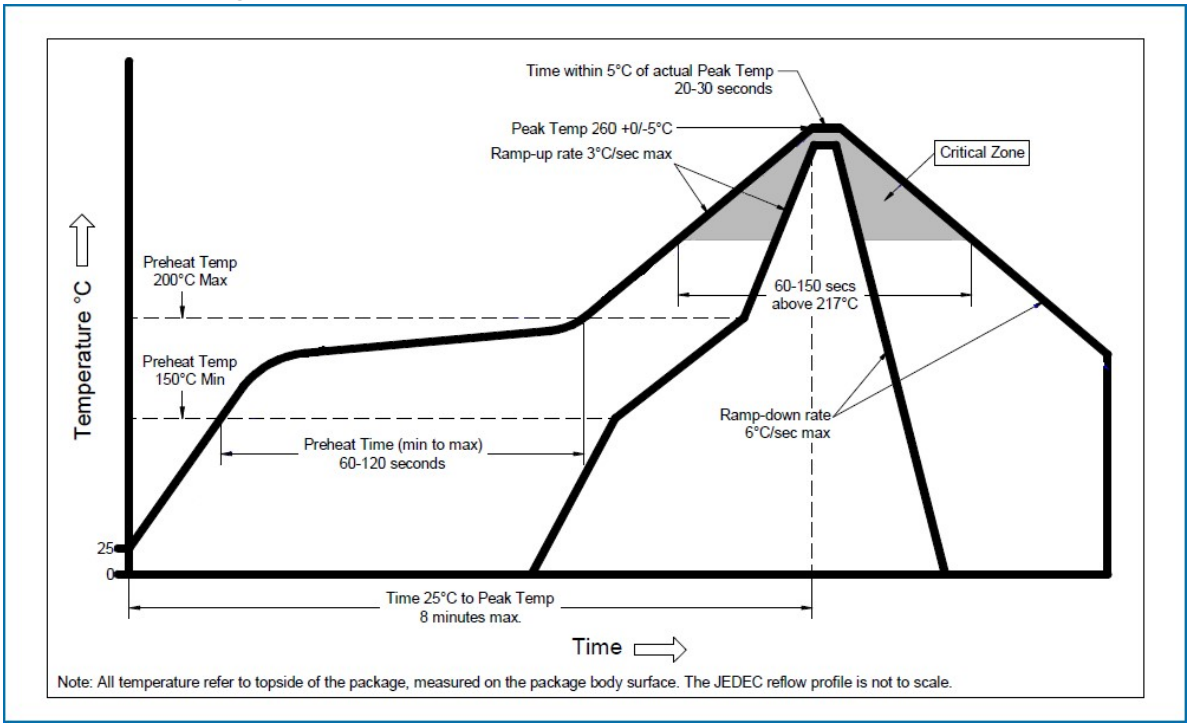
9.3 Moisture sensitivity level

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
RTK-1612-DR	High precision dead reckoning module	GPS/QZSS: L1 C/A, L5C GLONASS: L1OF GALILEO: E1, E5a BEIDOU: B1I, B2a

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Document change list

Revision 0.1

- Draft release on May 20, 2022.

Revision 0.2 (October 7, 2022)

- Changed the position accuracy of RTK in section 4