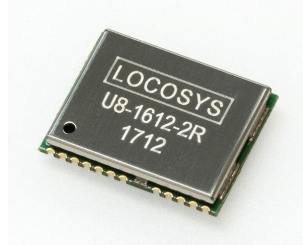


Product name	Description	Version
U8-1612-2X	Datasheet of U8-1612-2X multiple GNSS module	1.0



1 Introduction

LOCOSYS U8-1612-2X module can simultaneously acquire and track multiple satellite constellations that include GPS, GLONASS, BEIDOU, QZSS, GALILEO and SBAS. It features high sensitivity, low power and ultra small form factor. This multiple GNSS module is powered by u-blox 8, it can provide you with superior sensitivity and performance even in urban canyon and dense foliage environment.

2 Features

- u-blox 8 high sensitivity and low power solution
- Support GPS, GLONASS, BEIDOU, GALILEO and QZSS
- Capable of SBAS (WAAS, EGNOS, MSAS, GAGAN)
- Support 72-channels GNSS
- Fast TTFF at low signal level
- Support 1PPS synchronize with NMEA output
- Support interface of UART
- Support interface of USB
- Small form factor 16.0 x 12.2 x 2.4 mm
- SMD type with stamp holes; RoHS compliant
- ISO/IATF 16949 quality control

3 Application

- Personal positioning and navigation
- Automotive navigation
- Marine navigation

4 Overview

4.1 Block Diagram

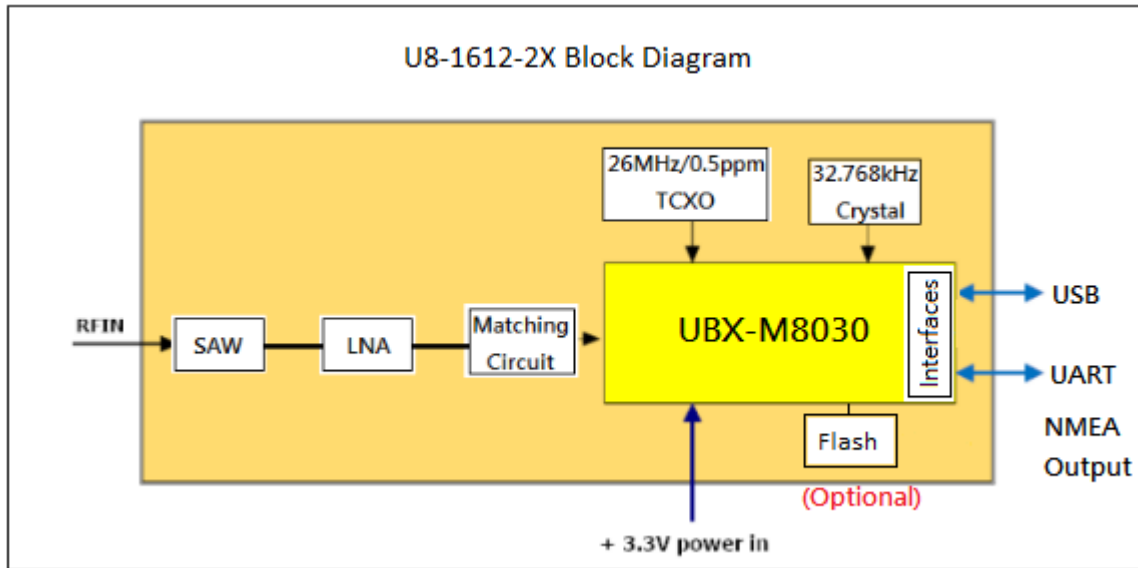


Fig 4-1 System block diagram

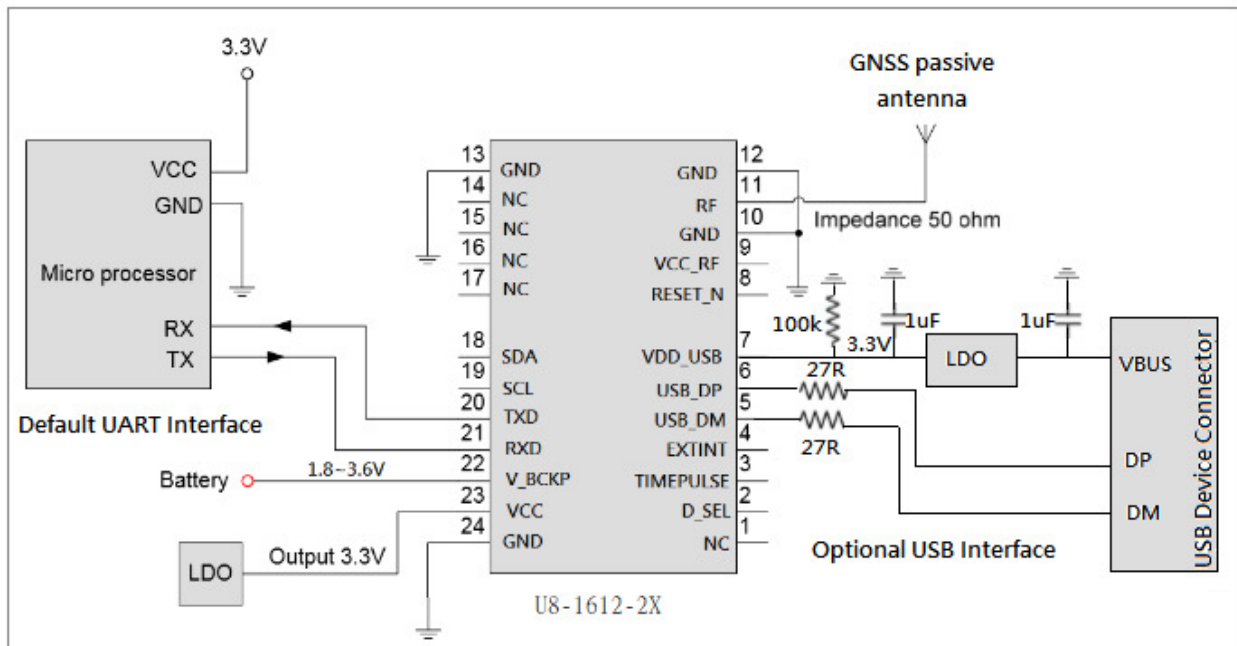


Fig 4-2 Typical application circuit that uses a passive antenna.

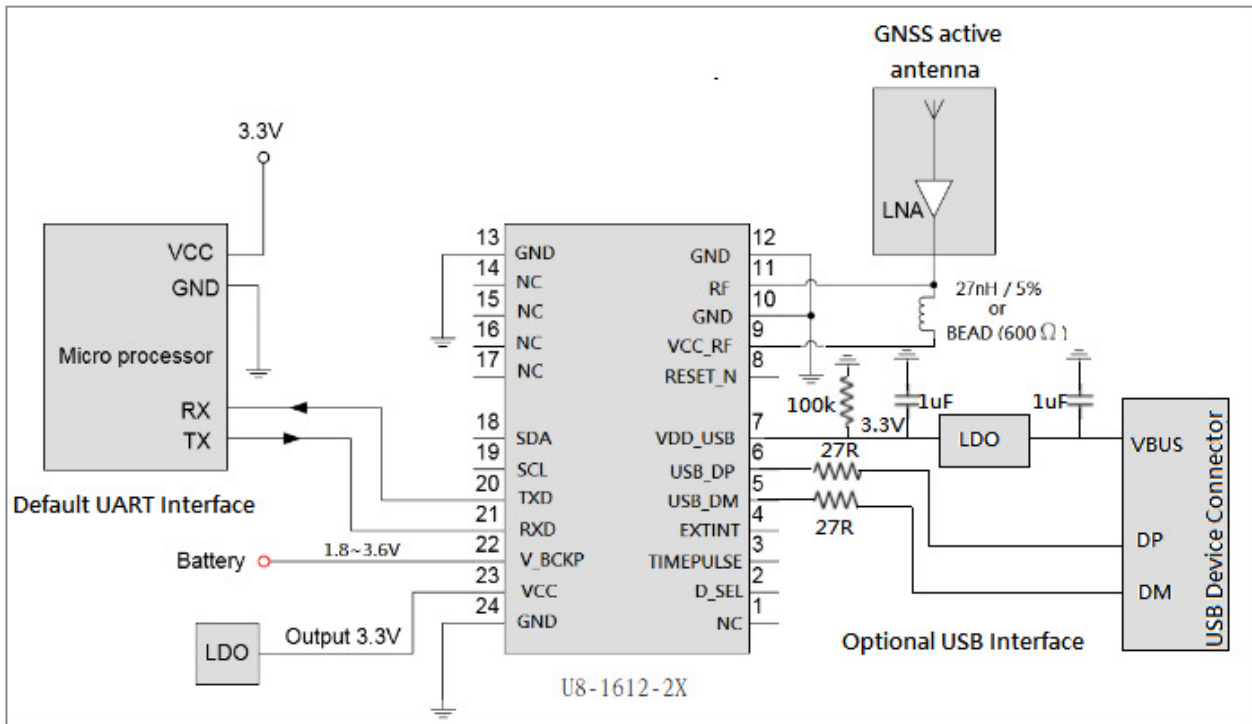


Fig 4-3 Typical application circuit that uses an active antenna.

4.2 GNSS Performance

Chip	UBX-M8030	
Frequency	GPS, QZSS: L1 1575.42MHz, C/A code GLONASS: L1 1598.0625MHz ~ 1605.375MHz, C/A code BEIDOU: B1 1561.098MHz, C/A code	
Channels	Support 72 channels	
Update rate	1Hz default, up to 10 Hz	
Sensitivity	Tracking	-167dBm (with external LNA)
	Cold start	-148dBm (with external LNA)
Acquisition Time	Hot start @ Open Sky ⁽¹⁾	1.5s (typical)
	Cold Start @ Open Sky ⁽¹⁾	30s (typical)
Position Accuracy	Autonomous	2.5m CEP
Velocity Accuracy ⁽²⁾	0.05 m/s	
Heading Accuracy ⁽²⁾	0.3 degrees	
Max. Altitude	50,000 m	
Max. Velocity	500 m/s	
Protocol Support	NMEA 0183 ver 4.0	9600bps ⁽³⁾ , 8 data bits, no parity, 1 stop bits (default) 1Hz: GGA, GLL, GSA, GSV, RMC, VTG and TXT
	UBX Protocol	9600 bps ⁽³⁾ , 8 data bits, no parity, 1 stop bits

Note 1: All satellites at outdoor field testing.

Note 2: 50% @30 m/s.

Note 3: U8-1612-2E baud rate and output message rate are configurable to be factory default.

4.3 Supported GNSS Constellations

The module can be configured to receive any single GNSS constellation or within the set of permissible combinations shown below.

GPS	Galileo	GLONASS	BeiDou
•	•	-	-
•	•	•	-
•	•	-	•
•	-	•	-
•	-	-	•
-	•	•	-
-	•	-	•
-	-	•	•

Note 1: Permissible GNSS combinations (• = enabled)

Note 2: Default GNSS combination is GPS+GLONASS constellation

5 Pin assignment and descriptions (Top view)

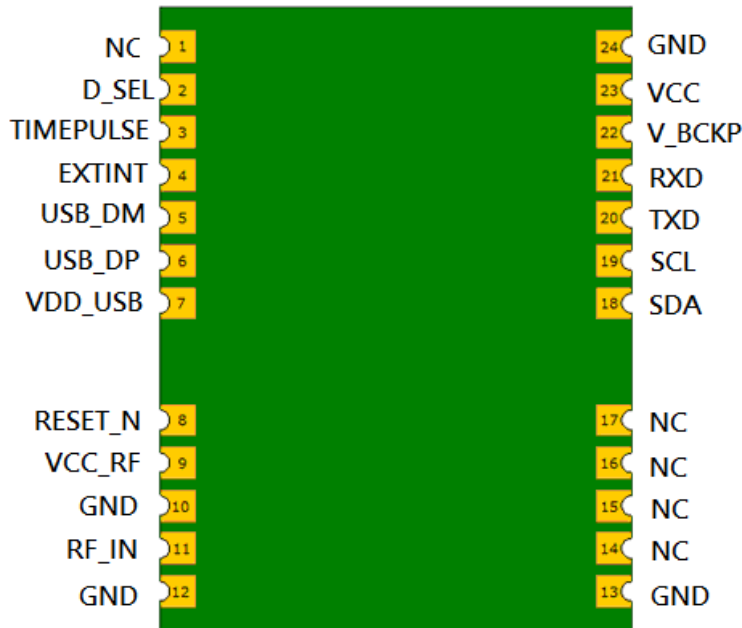


Table 5-1 Pin descriptions

Pin #	Name	Type	Description	Note
1	NC	I	Reserved, keep open.	
2	D_SEL	I	Interface select	
3	TIMEPULSE	O	Time pulse (1PPS, default 100 ms pulse/sec when 3D fix is available)	
4	EXTINT	I	External Interrupt Pin	
5	USB_DM	I/O	USB Data	
6	USB_DP	I/O	USB Data	
7	VDD_USB	O	USB Supply (Typical 3.3 V)	
8	RESET_N	I	RESET_N	
9	VCC_RF	O	Output voltage for active antenna (Typical 3.3 V)	
10	GND	P	Ground	
11	RF_IN	I	GNSS RF signal input,DC block inside.	
12	GND	P	Ground	
13	GND	P	Ground	
14	NC	-	Reserved, keep open.	
15	NC	-	Reserved, keep open.	
16	NC	-	Reserved, keep open.	
17	NC	-	Reserved, keep open.	

18	SDA	I/O	DDC Data	
19	SCL	I/O	DDC Clock	
20	TXD	O	UART, asynchronous output (Default NMEA)	
21	RXD	I	UART, asynchronous input	
22	V_BCKP	P	Backup battery supply voltage	
23	VCC	P	DC supply voltage	
24	GND	P	Ground	

6 DC & Temperature characteristics

6.1 Absolute maximum ratings

Parameter	Symbol	Ratings	Units
Input Voltage	VCC	-0.5 ~ 3.6	V
Input Backup Battery Voltage	V_BCKP	-0.5 ~ 3.6	V
Operating Temperature Range	Topr	-40 ~ 85	°C
Storage Temperature Range	Tstg	-40 ~ 85	°C

6.2 DC Electrical characteristics

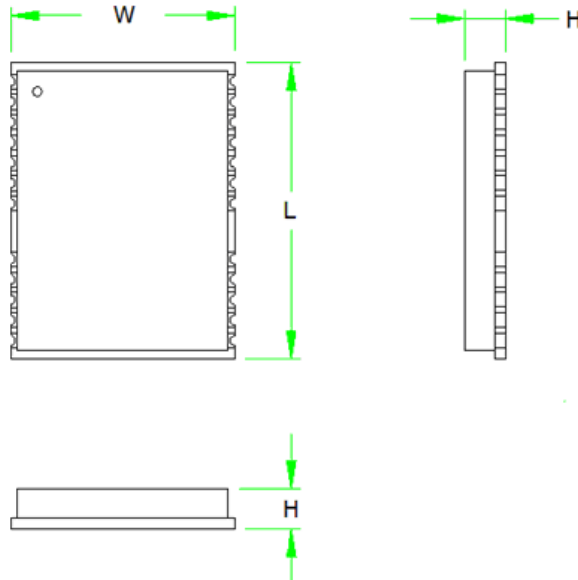
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Input Voltage	VCC		2.7	3.3	3.6	V
Input Backup Battery Voltage	V_BCKP		1.8		3.6	V
VCC_RF Output Voltage	VCC_RF			VCC		V
Supply Current	Iss	VCC = 3.3V, w/o active antenna, Peak Acquisition Tracking			98	mA
					27	mA
					24	mA
Backup Battery Current	Ibat	VCC = 0V		16		uA
VCC_RF Output Current	I _{out}	VIN = 3.3V			30	mA
High Level Input Voltage	V _{IH}		0.7*VCC		VCC	V
Low Level Input Voltage	V _{IL}		0		0.2*VCC	V
High Level Output Voltage	V _{OH}		VCC-0.4			V
Low Level Output Voltage	V _{OL}				0.4	V
High Level Output Current	I _{OH}			4		mA
High Level Output Current	I _{OL}			4		mA

6.3 Temperature characteristics

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

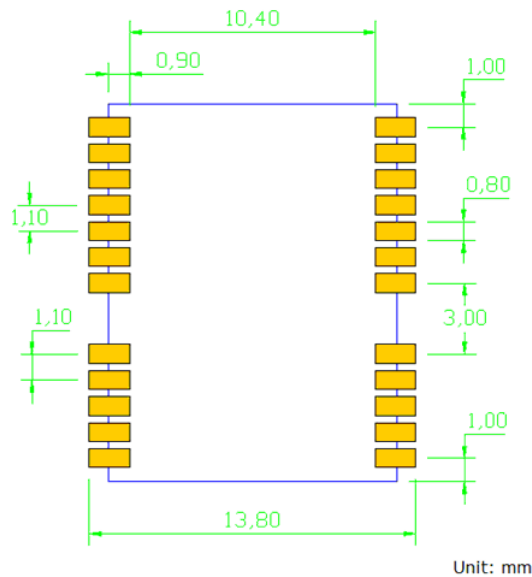
7 Mechanical specification

7.1 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

7.2 Recommended land pattern dimensions



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

8 Software interface

8.1 NMEA output message

Table 8.1-1 NMEA output message

NMEA	Description
GGA	Global positioning system fixed data
GLL	Geographic position - latitude/longitude
GSA	GNSS Overall satellite data
GSV	GNSS Detailed satellite data
RMC	Recommended minimal data for GNSS
VTG	Course over ground and ground speed
TXT	Text Transmission

- **GGA Global positioning system fixed data**

Table 8.1-2 contains the values for the following example:

\$GNGGA,052135.00,2503.71325,N,12138.74587,E,2,12,0.59,124.5,M,17.2,M,,0000*4E

Table 8.1-2 GGA Data Format

Name	Example	Units	Description
Message ID	\$GNGGA		GGA Message ID (GN = current Talker ID)
UTC Time	052132.00		hhmmss.ss
Latitude	2503.71325		ddmm.mmmmm
N/S indicator	N		N=north or S=south
Longitude	12138.74587		dddmm.mmmmm
E/W Indicator	E		E=east or W=west
Position Fix Indicator	2		See Table 8.1-3
Satellites Used	12		Number of satellites in view, 00-24
HDOP	0.59		Horizontal Dilution of Precision (meters)
MSL Altitude	124.5	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	0000		Differential reference station ID, 0000-1023
Checksum	*4E		Checksum
<CR> <LF>			End of message termination

Table 8.1-3 Position Fix Indicators

Value	Description
0	Fix not available
1	GNSS fix
2	Differential GNSS fix

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

Table 8.1-4 contains the values for the following example:

\$GNGLL,2503.71325,N,12138.74587,E,052135.00,A,D*74

Table 8.1-4 GLL Data Format

Name	Example	Units	Description
Message ID	\$GNGLL		GLL protocol header
Latitude	2503.71325		ddmm.mmmmm
N/S indicator	N		N=north or S=south
Longitude	12138.74587		dddmm.mmmmm
E/W indicator	E		E=east or W=west
UTC Time	052135		hhmmss.ss
Status	A		A=data valid or V=data not valid
Mode	D		V = Invalid, A= Autonomous and D =Differential
Checksum	*74		
<CR> <LF>			End of message termination

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

Table 8.1-5 contains the values for the following example:

\$GNGSA,A,3,01,03,11,17,19,22,28,30,06,07,41,,1.30,0.59,1.16*15

\$GNGSA,A,3,74,84,73,80,83,85,69,,,,,1.30,0.59,1.16*1E

Table 8.1-5 GSA Data Format

Name	Example	Units	Description
Message ID	\$GNGSA		GSA protocol header
Mode 1	A		See Table 8.1-6
Mode 2	3		See Table 8.1-7
ID of satellite used	01		Sv on Channel 1
ID of satellite used	03		Sv on Channel 2
....		
ID of satellite used	41		Sv on Channel 11
PDOP	1.30		Position Dilution of Precision
HDOP	0.59		Horizontal Dilution of Precision
VDOP	1.16		Vertical Dilution of Precision
Checksum	*15		
<CR> <LF>			End of message termination

Table 8.1-6 Mode 1

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

Table 8.1-7 Mode 2

Value	Description
-------	-------------

1	Fix not available
2	2D ⁽¹⁾
3	3D

Note 1: 2D fix hint that the receiver position error meets the 2D level. Maybe under this condition the used satellite number is little more than 4

● **GSV---GNSS Satellites in View**

Table 8.1-8 contains the values for the following example:

```
$GPGSV,4,1,15,01,40,032,45,03,52,108,42,06,22,241,37,07,16,190,40*7F
$GPGSV,4,2,15,08,10,087,,11,29,047,40,17,35,316,44,19,18,297,37*7C
$GPGSV,4,3,15,22,41,070,42,28,70,335,43,30,33,225,42,40,13,260,*73
$GPGSV,4,4,15,41,38,242,38,42,51,134,35,50,51,134,35*4F
$GLGSV,3,1,11,67,01,029,20,68,26,074,25,69,26,131,33,73,49,208,37*6F
$GLGSV,3,2,11,74,45,303,41,75,02,334,,80,09,174,35,83,26,033,31*6F
$GLGSV,3,3,11,84,39,326,34,85,12,277,29,,,43*63
```

Table 8.1-8 GSV Data Format

Name	Example	Units	Description
Message ID	\$GNGSV		GSV protocol header
Total number of messages ¹	4		Range 1 to 6
Message number ¹	1		Range 1 to 6
Satellites in view	15		
Satellite ID ²	01		Channel 1
Elevation	40	degrees	Channel 1 (Range 00 to 90)
Azimuth	032	degrees	Channel 1 (Range 000 to 359)
SNR (C/No)	45	dB-Hz	Channel 1 (Range 00 to 99, null when not tracking)
....		
Satellite ID	07		Channel 4 (Range 01 to 196)
Elevation	16	degrees	Channel 4 (Range 00 to 90)
Azimuth	190	degrees	Channel 4 (Range 000 to 359)
SNR (C/No)	40	dB-Hz	Channel 4 (Range 00 to 99, null when not tracking)
Checksum	*7F		
<CR> <LF>			End of message termination

Note 1: Depending on the number of satellites tracked multiple messages of GSV data may be required.

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

Table 8.1-9 contains the values for the following example:

```
$GNRMC,052136.00,A,2503.71326,N,12138.74586,E,0.003,,200717,,,D*6C
```

Table 8.1-9 RMC Data Format

Name	Example	Units	Description
Message ID	\$GNRMC		RMC protocol header
UTC Time	052136.00		hhmmss.ss

Status	A		A=data valid or V=data not valid
Latitude	2503.71326		ddmm.mmmmm
N/S Indicator	N		N=north or S=south
Longitude	12138.74586		dddmm.mmmmm
E/W Indicator	E		E=east or W=west
Speed over ground	0.003	knots	True
Course over ground		degrees	
Date	200717		ddmmyy
Magnetic variation		degrees	
Variation sense			E=east or W=west
Mode	D		V=Invalid A=autonomous, D=Differential.
Checksum	*6C		
<CR> <LF>			End of message termination

● **VTG---Course Over Ground and Ground Speed**

Table 8.1-10 contains the values for the following example:

\$GNVTG,,T,,M,0.003,N,0.006,K,D*3D

Table 8.1-10 VTG Data Format

Name	Example	Units	Description
Message ID	\$GNVTG		VTG protocol header
Course over ground		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	D		V=Invalid A=autonomous, D=Differential.
Checksum	*3D		
<CR> <LF>			End of message termination

● **TXT--- Text Transmission**

Table 8.1-11 contains the values for the following example:

\$GNTXT,01,01,02,ANTSTATUS=INIT*3B

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

Table 8.1-11 TXT Data Format

Name	Example	Units	Description
Message ID	\$GNTXT		TXT protocol header
numMsg	01		Total number of messages in this transmission, 01.. 99

msgNum	01		Message number in this transmission, range 01..xx
msgType	02		Text identifier, u-blox GPS receivers specify the type of the message with this number. 00: Error 01: Warning 02: Notice 07: User
text	ANTSTATUS=INT		Any ASCII text
Checksum	*3B		
<CR> <LF>			End of message termination

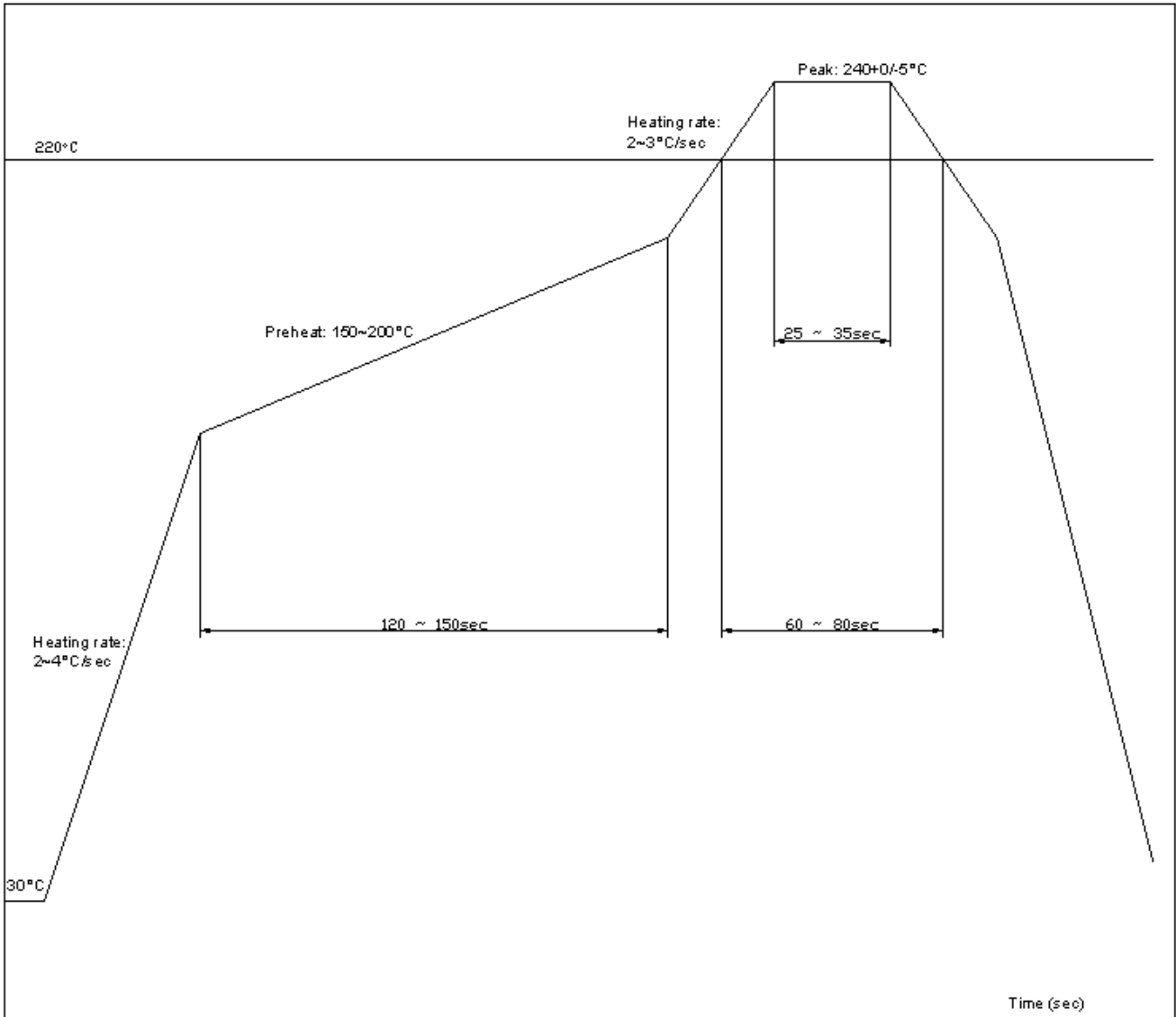
9 Ordering Information

Model	Note
U8-1612-2R	Without embedded Flash
U8-1612-2E	With embedded Flash

10 Recommended soldering reflow profile

The module belongs to RoHS device. The maximum of reflow temperature, real on top of PCB, is not over 240 Celsius.

Lead-free Processes



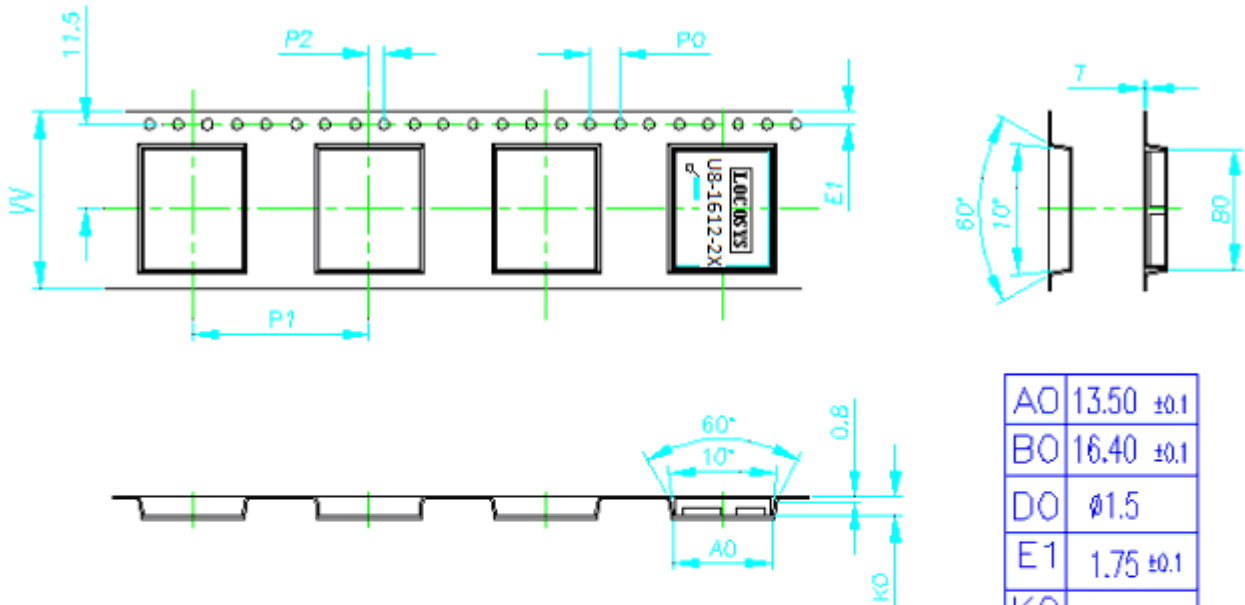
Lead-Free Solder Paste (Sn 96.5-Ag 3.0-Cu 0.5)

Cycle Interval: 300 sec

Note:

The U8-1612-2X module should be soldered on the topside in the soldering process to prevent from falling down.

11 Reel Packing information



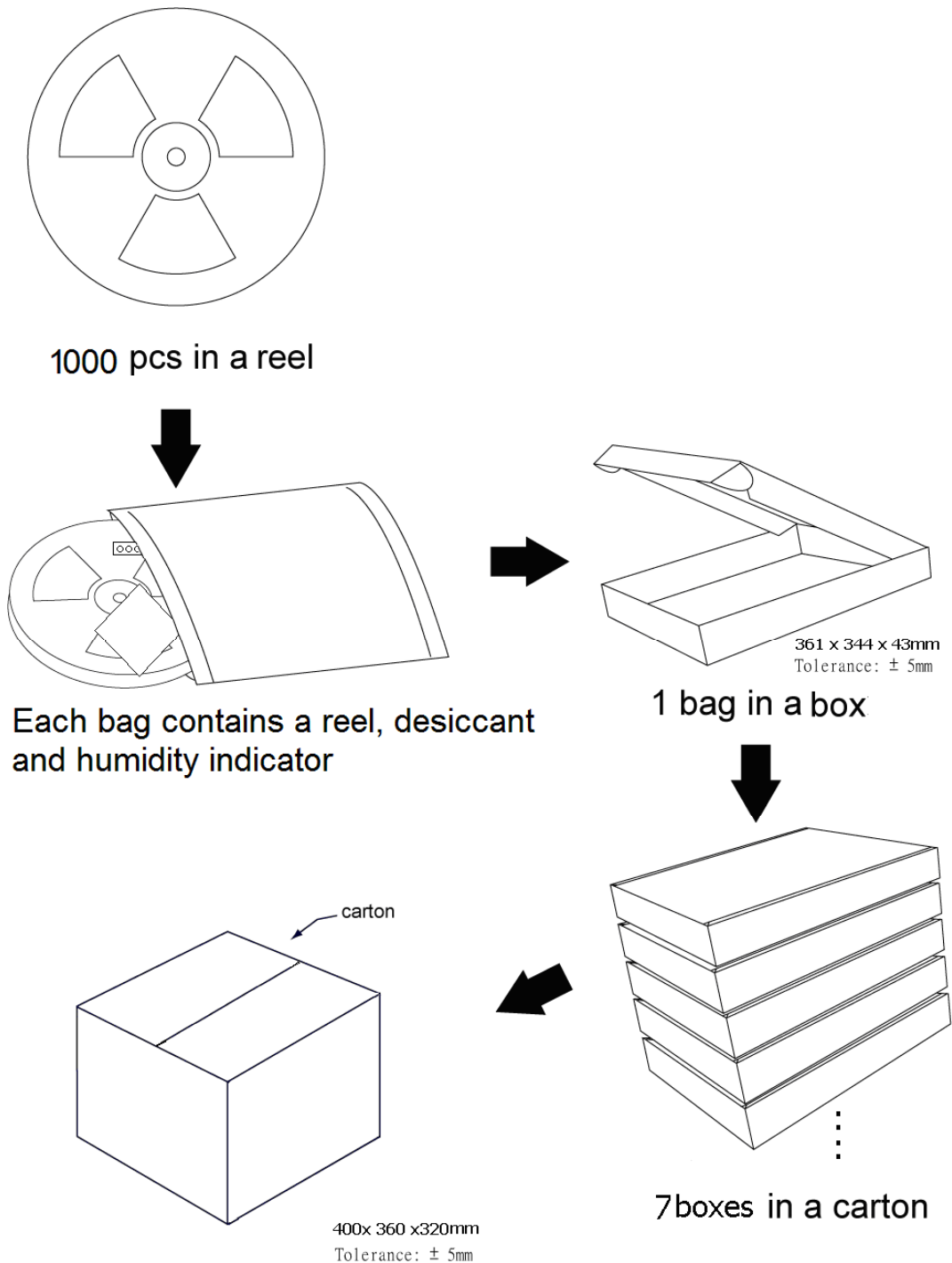
A0	13.50 ±0.1
B0	16.40 ±0.1
D0	∅1.5
E1	1.75 ±0.1
K0	2.70 ±0.1
P0	4.0 ±0.1
P1	24.00 ±0.1
P2	2.0 ±0.10
T	0.3 ±0.10
W	24.0 ±0.30

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
7. Packing length per 22" reel: 75 M

12 Packing and Handling

GNSS modules, like any other SMD devices, are sensitive to moisture, electrostatic discharge, and temperature. By following the description sketched in the document for LOCOSYS GNSS module storage and handling, it is possible to reduce the chances of them being damaged during production.

12.1 Packing



12.2 Moisture Sensitivity

The module belongs to moisture sensitive device (IPC/JEDEC J-STD-020C Level III). If it is not used by then, we strong recommended storing the GNSS modules in dry places such as dry cabinet. The approximate shelf life for LOCOSYS GNSS modules packages is 6 months from the bag seal date, when store in a non-condensing storage environment (<30°C/60% RH)

12.3 ESD Handling



Please carefully follow the following precautions to prevent severe damage to GNSS modules.

LOCOSYS GNSS modules are sensitive to electrostatic discharges, and thus are Electrostatic Sensitive Devices (ESD). Careful handling of the GNSS modules and in particular RFIN pin must follow the standard ESD safety protections:

- Unless there is a galvanic coupling between the local GND and the PCB GND, then the first point of contact when handling the PCB shall always be between the local GND and PCB GND.
- Before working with RFIN pin, please make sure the GND is connected.
- When working with RFIN pin, do not contact any charges capacitors or materials that can easily develop or store charges such as patch antenna, coax cable, soldering iron.
- When soldering RFIN pin, please make sure to use an ESD safe soldering iron (tip)

Document change list

Revision 1.0

- First release on Oct. 30, 2018.