

Product name	Description	Version
U7-1612-2R	Datasheet of U7-1612-2R multiple GNSS module	1.1



1 Introduction

LOCOSYS U7-1612-2R module can simultaneously acquire and track multiple satellite constellations that include GPS, GLONASS, QZSS and SBAS. It features high sensitivity, low power and ultra small form factor. This multiple GNSS module is powered by u-blox 7, it can provide user with superior sensitivity and performance even in urban canyon and dense foliage environment.

2 Features

- u-blox 7 high sensitivity solution
- Support GPS, GLONASS, QZSS
- Capable of SBAS (WAAS, EGNOS, MSAS)
- Support 56-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 x 12.2 x 2.2 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

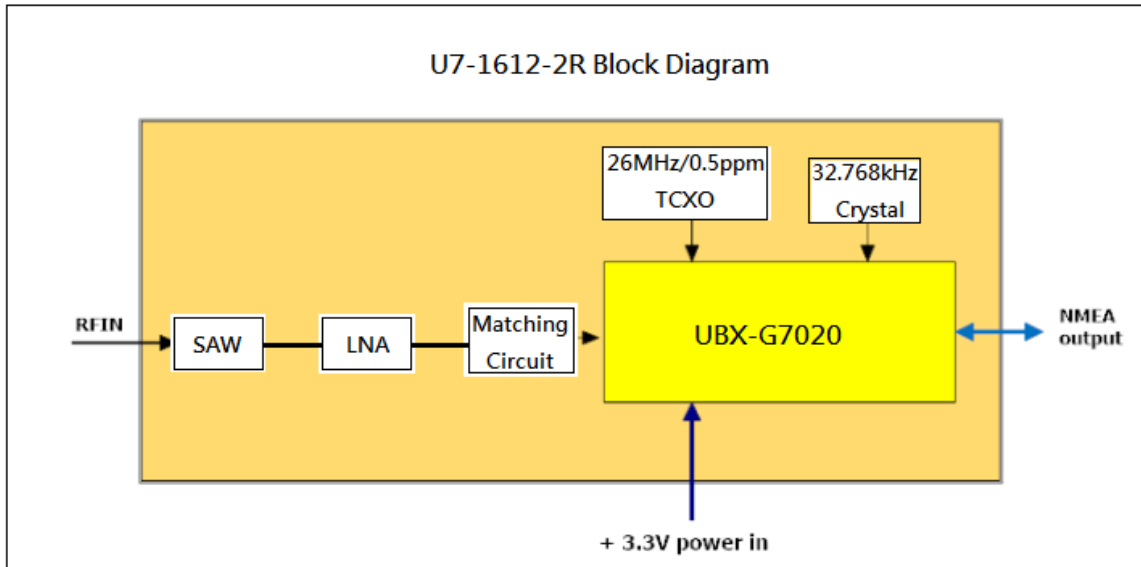


Fig 4-1 System block diagram.

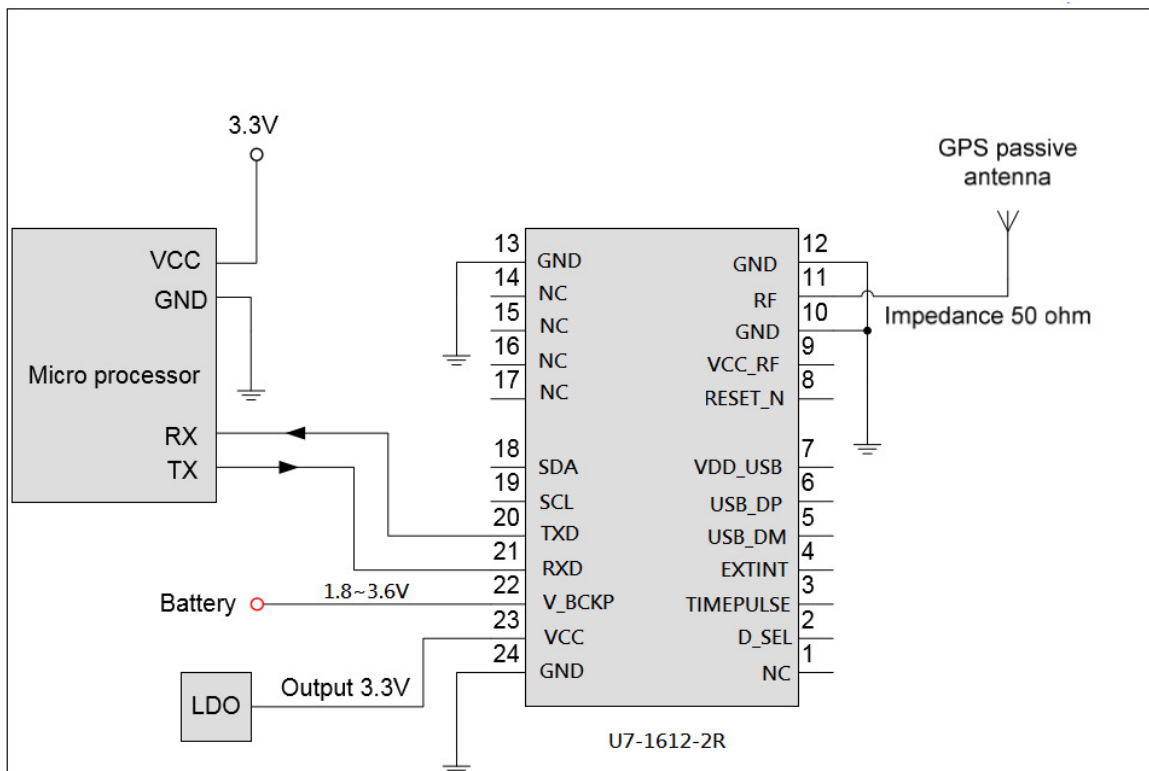


Fig 4-2 Typical application circuit that uses a passive antenna.

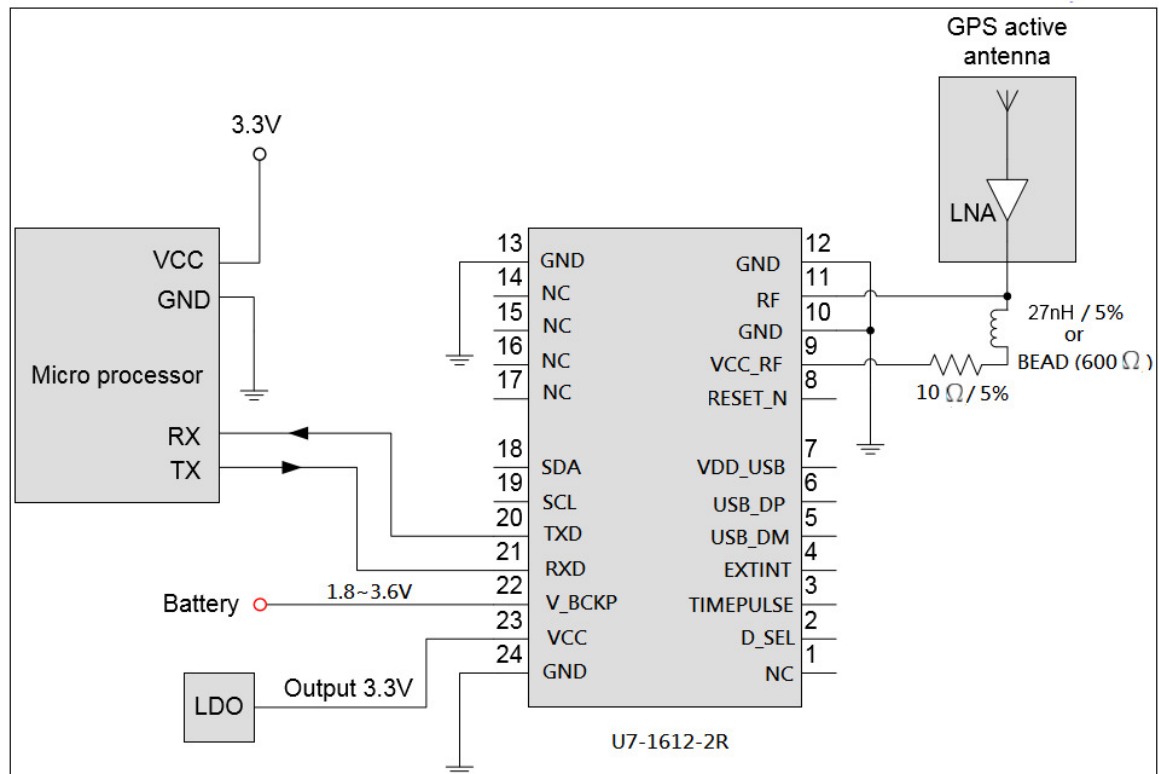


Fig 4-3 Typical application circuit that uses an active antenna.

4.2 GNSS Performance

Chip	UBX-G7020	
Frequency	GPS, QZSS: L1 1575.42MHz, C/A code GLONASS: L1 1598.0625MHz ~ 1605.375MHz, C/A code	
Channels	Support 56 channels	
Update rate	1Hz default, up to 10Hz	
Sensitivity	Tracking	GPS : -162dBm (with external LNA) GLONASS : -158dBm (with external LNA)
	Cold start	GPS : -148dBm (with external LNA) GLONASS : -140dBm (with external LNA)
Acquisition Time	Hot start (Open Sky)	GPS : < 1s (typical) GLONASS : < 1s (typical)
	Cold Start (Open Sky)	GPS : 29s (typical) GLONASS : 30s (typical)
Position Accuracy	Autonomous	GPS : 2.5m CEP GLONASS : 4.0m CEP
Max. Altitude	< 50,000 m	
Max. Velocity	< 500 m/s	
Protocol Support	NMEA 0183 ver 3.0	9600bps ⁽¹⁾ , 8 data bits, no parity, 1 stop bits (default) 1Hz: GGA, GLL, GSA, GSV, RMC, VTG and TXT
	UBX Protocol	9600 bps (configurable), 8 data bits, no parity, 1 stop bits

4.3 Pin assignment and descriptions (Top view)

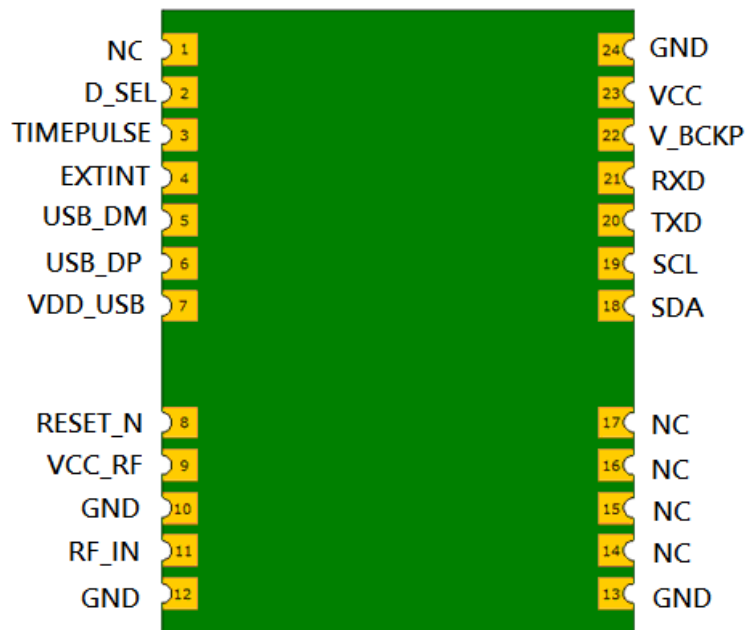


Table 4.3-1 Pin descriptions

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	
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	

5 DC & Temperature characteristics

5.1 Absolute maximum ratings

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

5.2 DC Electrical characteristics

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Input Voltage	VCC		3.0	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	I _{ss}	VCC = 3.3V, w/o active antenna, Peak Acquisition Tracking		30 23	67	mA mA mA
Backup Battery Current	I _{bat}	VCC = 0V		15		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

5.3 Temperature characteristics

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

7 Software interface

7.1 NMEA output message

Table 7.1-1 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 7.1-2 contains the values for the following example:

\$GPGGA,092725.00,4717.11399,N,00833.91590,E,1,08,1.01,499.6,M,48.0,M,,*5B

Table 7.1-2 GGA Data Format

Name	Example	Units	Description
Message ID	\$GPGGA		GGA Message ID (GP = current Talker ID)
UTC Time	092725.00		hhmmss.ss
Latitude	4717.113999		ddmm.mmmmm
N/S indicator	N		N=north or S=south
Longitude	00833.91590		dddmm.mmmmm
E/W Indicator	E		E=east or W=west
Position Fix Indicator	1		See Table 7.1-3
Satellites Used	08		Number of satellites in view, 00-24
HDOP	1.01		Horizontal Dilution of Precision (meters)
MSL Altitude	499.6	meters	Antenna Altitude above/below mean-sea-level (geoid) (in meters)
Units	M	meters	Units of antenna altitude, meters
Geoidal Separation	48.0	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	*5B		Checksum
<CR> <LF>			End of message termination

Table 7.1-3 Position Fix Indicators

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

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

Table 7.1-4 contains the values for the following example:

\$GPGLL,2503.71286,N,12138.74702,E,034518.00,A,A*63

Table 7.1-4 GLL Data Format

Name	Example	Units	Description
Message ID	\$GPGLL		GLL protocol header
Latitude	2503.71286		ddmm.mmmmm
N/S indicator	N		N=north or S=south
Longitude	12138.74702		dddmm.mmmmm
E/W indicator	E		E=east or W=west
UTC Time	034518.00		hhmmss.ss
Status	A		A=data valid or V=data not valid
Mode	A		V = Invalid, A= Autonomous and D =Differential
Checksum	*63		
<CR> <LF>			End of message termination

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

Table 7.1-5 contains the values for the following example:

\$GPGSA,A,3,08,23,09,16,27,,,,,,,,,6.61,3.36,5.69*0D

Table 7.1-5 GSA Data Format

Name	Example	Units	Description
Message ID	\$GPGSA		GSA protocol header
Mode 1	A		See Table 7.1-6
Mode 2	3		See Table 7.1-7
ID of satellite used	08		Sv on Channel 1
ID of satellite used	23		Sv on Channel 2
....			
ID of satellite used			Sv on Channel 12
PDOP	6.61		Position Dilution of Precision
HDOP	3.36		Horizontal Dilution of Precision
VDOP	5.69		Vertical Dilution of Precision
Checksum	*0D		
<CR> <LF>			End of message termination

Table 7.1-6 Mode 1

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

Table 7.1-7 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 7.1-8 contains the values for the following example:

\$GPGSV,4,1,16,04,47,095,36,07,,,35,08,53,223,39,09,25,305,34*4C

\$GPGSV,4,2,16,10,,,22,11,,,32,12,,,16,16,47,016,36*4A

\$GPGSV,4,3,16,19,,,22,20,,,21,21,,,29,23,46,273,36*48

\$GPGSV,4,4,16,26,32,049,33,27,87,000,39,28,,,22,31,,,36*7B

Table 7.1-8 GSV Data Format

Name	Example	Units	Description
Message ID	\$GPGSV		GSV protocol header
Total number of messages ¹	4		Range 1 to 6
Message number ¹	1		Range 1 to 6
Satellites in view	16		
Satellite ID ²	04		Channel 1
Elevation	47	degrees	Channel 1 (Range 00 to 90)
Azimuth	095	degrees	Channel 1 (Range 000 to 359)
SNR (C/No)	36	dB-Hz	Channel 1 (Range 00 to 99, null when not tracking)
....			
Satellite ID	09		Channel 4 (Range 01 to 196)
Elevation	25	degrees	Channel 4 (Range 00 to 90)
Azimuth	305	degrees	Channel 4 (Range 000 to 359)
SNR (C/No)	34	dB-Hz	Channel 4 (Range 00 to 99, null when not tracking)
Checksum	*4C		
<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 7.1-9 contains the values for the following example:

\$GPRMC,034519.00,A,2503.71293,N,12138.74692,E,0.123,,260517,,,A*70

Table 7.1-9 RMC Data Format

Name	Example	Units	Description
Message ID	\$GPRMC		RMC protocol header
UTC Time	034519.00		hhmmss.ss
Status	A		A=data valid or V=data not valid
Latitude	2503.71293		ddmm.mmmmm
N/S Indicator	N		N=north or S=south
Longitude	12138.74692		dddmm.mmmmm

E/W Indicator	E		E=east or W=west
Speed over ground	0.123	knots	True
Course over ground		degrees	
Date	260517		ddmmyy
Magnetic variation		degrees	
Variation sense			E=east or W=west
Mode	A		V=Invalid A=autonomous, D=Differential.
Checksum	*70		
<CR> <LF>			End of message termination

● VTG---Course Over Ground and Ground Speed

Table 7.1-10 contains the values for the following example:

\$GPVTG,,T,,M,0.023,N,0.043,K,A*25

Table 7.1-10 VTG Data Format

Name	Example	Units	Description
Message ID	\$GPVTG		VTG protocol header
Course over ground		degrees	Measured heading
Reference	T		True
Course over ground		degrees	Measured heading
Reference	M		Magnetic
Speed over ground	0.023	knots	Measured speed
Units	N		Knots
Speed over ground	0.043	km/hr	Measured speed
Units	K		Kilometer per hour
Mode	A		V=Invalid A=autonomous, D=Differential.
Checksum	*25		
<CR> <LF>			End of message termination

● TXT--- Text Transmission

Table 7.1-11 contains the values for the following example:

\$GPTXT,01,01,02,ANTSTATUS=INIT*25

\$GPTXT,01,01,02,ANTSTATUS=OK*3B

Table 7.1-11 TXT Data Format

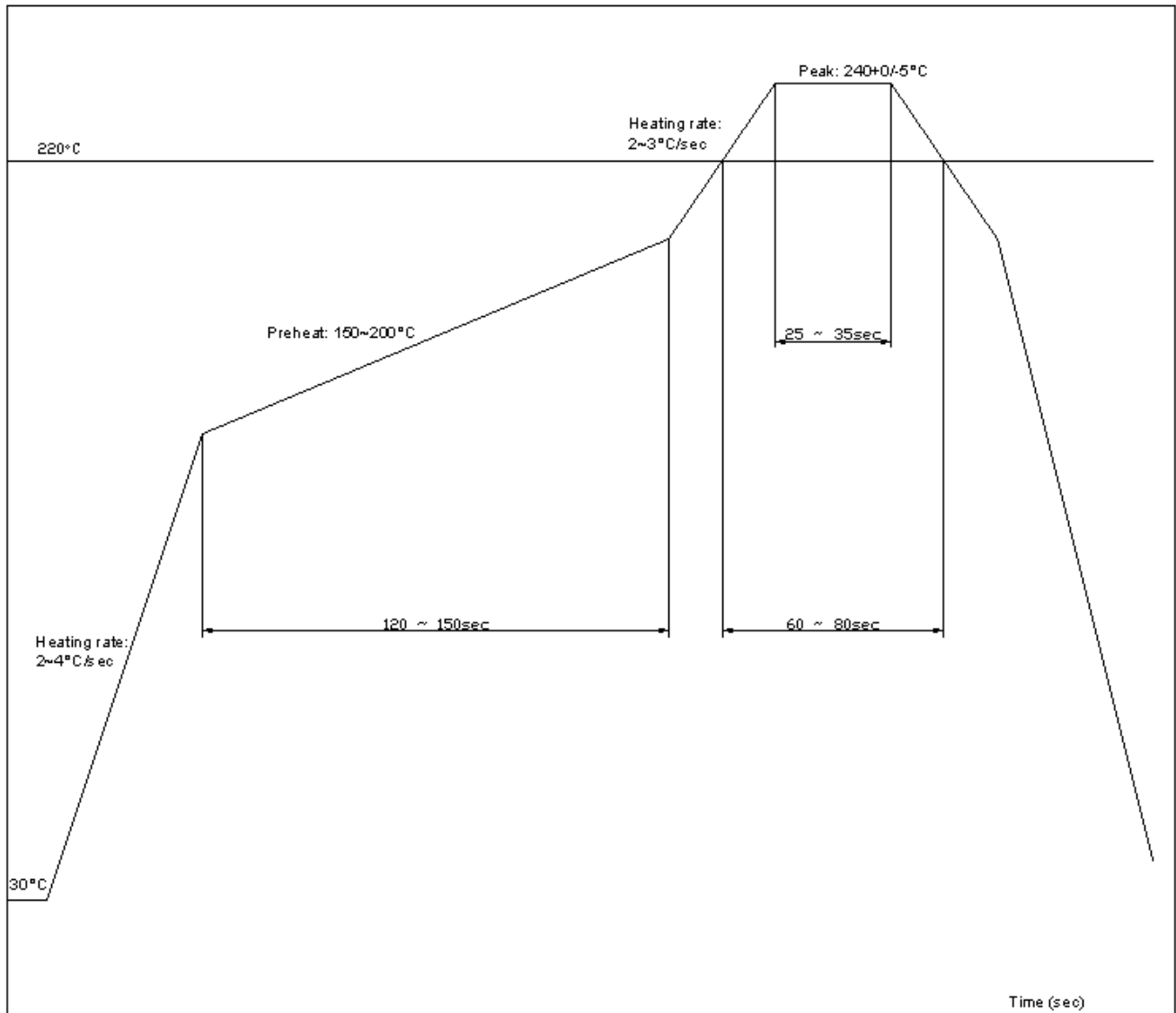
Name	Example	Units	Description
Message ID	\$GPTXT		TXT protocol header
numMsg	01		Total number of messages in this transmission, 01.. 99
msgNum	01		Message number in this transmission, range 01..xx
msgType	02		Text identifier, u-blox GPS receivers specify the type of the message with this number. 00: Error 01: Warning 02: Notice 07: User

text	ANTSTATUS=INT		Any ASCII text
Checksum	*25		
<CR> <LF>			End of message termination

8 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



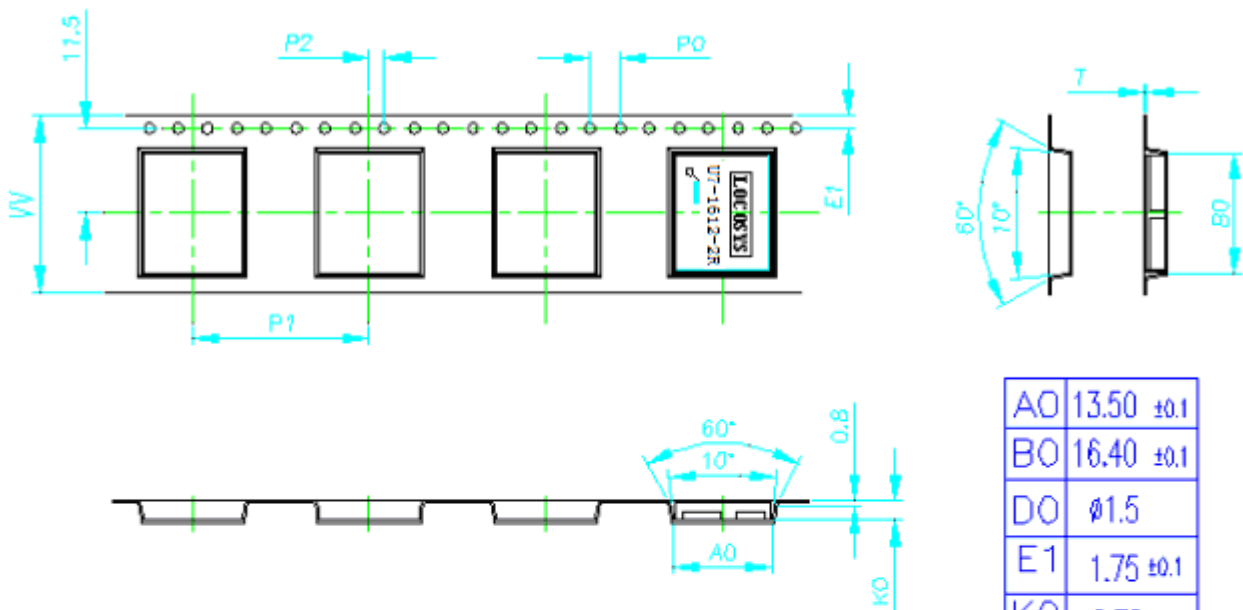
Lead -Free Solder Paste (Sn 96.5-Ag 3.0-Cu 0.5)

Cycle Interval: 300 sec

Note:

The U7-1612-2R module should be soldered on the topside in the soldering process to prevent from falling down.

9 Reel Packing information



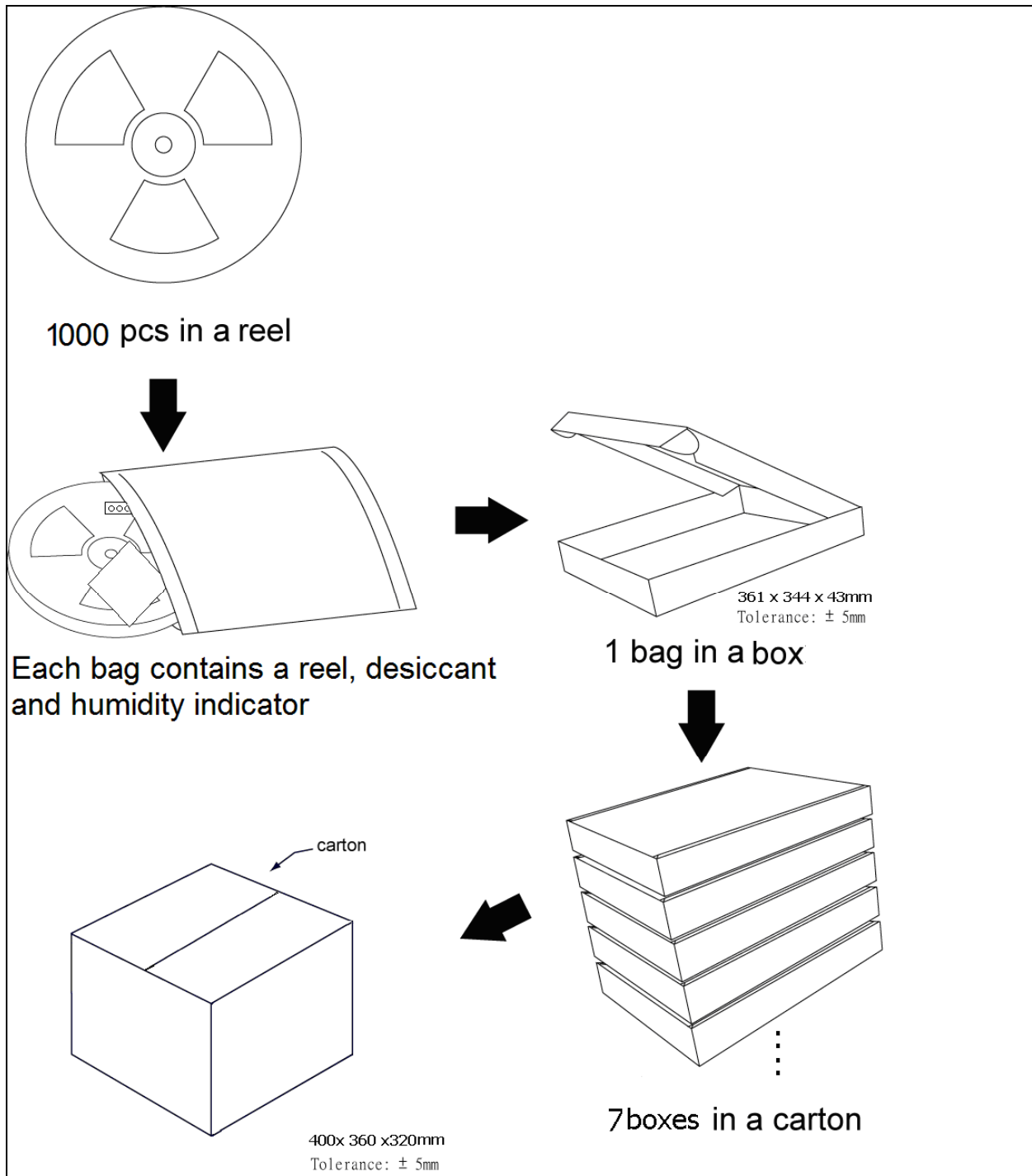
A0	13.50 ±0.1
B0	16.40 ±0.1
D0	Ø1.5
E1	1.75 ±0.1
K0	2.70 ±0.1
P0	4.0 ±0.1
P1	24.00 ±0.1
P2	2.0 ±0.10
T	0.3 ±0.10
W	24.0 ±0.30

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
7. Packing length per 22" reel: 75 M

10 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.

10.1 Packing



10.2 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)

10.3 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 Jan 5, 2018

Revision 1.1 (Feb.01, 2018)

- Revise PCB dimensions on page 7.