General Description

The RB-1612-UB7X is a complete GPS engine module that features super sensitivity, ultra low power and small form factor. The GPS signal is applied to the antenna input of module, and a complete serial data message with position, velocity and time information is presented at the serial interface with NMEA protocol or custom protocol.

Its –165dBm tracking sensitivity extends positioning coverage into place like urban canyons and dense foliage environment where the GPS was not possible before. The small form factor and low power consumption make the module easy to integrate into portable device like PNDs, mobile phones, cameras and vehicle navigation systems.

Figure: RB-1612-UB7X Top View

Applications
- LBS (Location Based Service)
- PND (Portable Navigation Device)
- Vehicle navigation system
- Mobile phone

Features
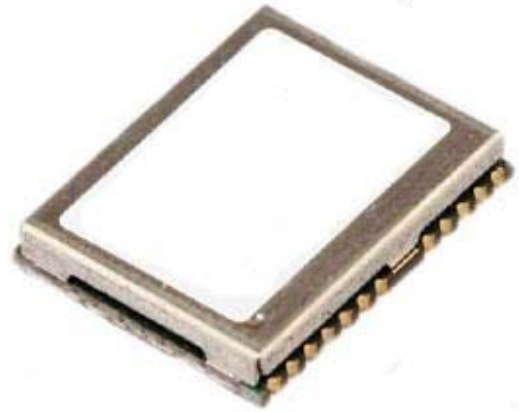- Build on high performance, low-power ublox G7x chip set
- Ultra high Track sensitivity: -165dBm
- Built in high gain LNA
- Perfect compatibility ublox NEO-7Q/M
- Extremely fast TTFF at low signal level
- Low power consumption: Max 35mA@3.3V
- NMEA-0183 compliant protocol or custom protocol
- Operating voltage: 2.8V to 3.6V
- Operating temperature range:-40to85℃
- SMD type with stamp holes
- Small form factor: 16x12.2x2.6mm
- RoHS compliant (Lead-free)

1 Functional description

1.1 Overview

The RB-1612-UB7X series of standalone concurrent GPS modules is built on the exceptional performance of the u-blox 7 GPS (GPS, GLONASS, QZSS and SBAS) engine in the industry proven form factor.

The RB-1612-UB7X series provides high sensitivity and minimal acquisition times while maintaining low system power. The RB-1612-UB7X is optimized for cost sensitive applications, while RB-1612-UB7X provides best performance and easier RF integration. The form factor allows easy migration from previous generations. Sophisticated RF-architecture and interference suppression ensure maximum performance even in GPS-hostile environments.

RB-1612-UB7X modules use ublox 7 GPS chips qualified according to AEC-Q100, are manufactured in ISO/TS 16949 certified sites, and fully tested on a system level. Qualification tests are performed as stipulated in the ISO16750 standard: "Road vehicles – Environmental conditions and testing for electrical and electronic equipment".

RB-1612-UB7X modules support the u-blox Assist Now Online and Assist Now Offline A-GPS and are OMA SUPL compliant. u-blox′ AssistNow Assistance supply aiding information, such as ephemeris, almanac, rough last position and time, reduce the time to first fix significantly and improve the acquisition sensitivity. AssistNow data are with u-blox 7 supporting both GPS   constellation for faster acquisition than a GPS-only assistance. The extended validity of AssistNow Offline data (up to 35 days) and AssistNow Autonomous data (up to 6 days) provide faster acquisition after long off time.

Made of lead-free technology, conforms to the RoHS standard, Single patch, two times more rapid application of SMT scheme.

1.2. Key Features

Table 1: Key Features

Parameter	Specification
Power Supply	• Supply voltage: 2.8V~3.6V Typical: 3.3V
Power Consumption	• Acquisition: 35mA @VCC=V_BCKP=3.3V • Tracking: 30mA @VCC=V_BCKP=3.3V • Backup: 15uA @V_BCKP=3.3V
Receiver Type	• Code 56 search channels ,22 synchronous tracking channels • GPS&QZSS L1 1575.42MHz C/A ,GLONASS L1OF 1602MHz, SBAS: WAAS, EGNOS, MSAS, GAGAN
Sensitivity	• Tracking: -165dBm • Re-acquisition: -156dBm • Acquisition: -146dBm
TTFF (Autonomous)	• Cold start: 35s typ @-130dBm • Warm start: 30s typ @-130dBm • Hot start: 1s typ @-130dBm
Horizontal Position Accuracy (Autonomous)	• <2.5m CEP @-130 dBm
Max Update Rate	• Up to 10Hz,1Hz by fault
Accuracy of 1PPS Signal	• Typical accuracy: ±10ns • Time pulse width : 100ms
Acceleration Accuracy	• Without aid: 0.1m/s²
Dynamic Performance	• Maximum altitude: 18,000m • Maximum velocity: 515m/s • Acceleration: 4G
UART Port	• UART Port: TXD and RXD • Supports baud rate from 4800bps to 115200bps, 9600bps by default • UART port for NMEA and UBX output, binary or ublox proper Agreement input
Temperature Range	• Normal operation: -40°C ~ +85°C • Storage temperature: -45°C ~ +125°C
Physical Characteristics	• Size: 16±0.15 × 12.2±0.15 × 2.6±0.1mm • Weight: Approx. 0.92g

1.2. Block Diagram

  The following figure shows a block diagram of RB-1612-UB7X module. It consists of a single chip GPS IC which includes the RF part and Baseband part, a LNA, a SAW filter, a TCXO, a crystal oscillator.
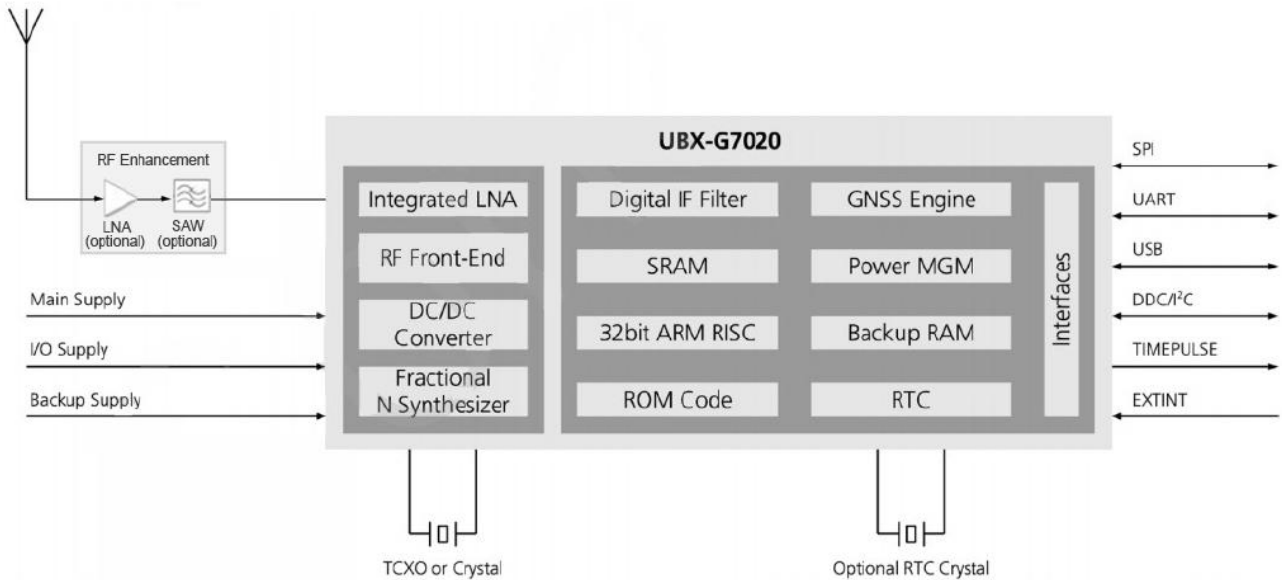

Figure 1:   Block Diagram

2 Application

  The module is equipped with a 24-pin SMT pad that connects to your application platform. Sub-interfaces included in the pad are described in details in the following chapters.

2.1. Pin Assignment

Figure 2: Pin Assignment

2.2. Pin Definition

Pin No.	Pin name	I/O	Description	Pin No.	Pin name	I/O	Description
1	SAFEBOOT	I	Leave Open if not used	13	GND	G	Ground
2	NC	I	Leave Open if not used	14	ANT_OK	I/O	Antenna status of antenna supervisor
3	TIMEPULSE	O	Time pulse (1PPS)	15	ANT_OFF	I/O	Antenna power control of antenna supervisor
4	EXTINT0	I	External Interrupt Pin	16	RESET_N	I/O	Leave Open if not used
5	USB_DM	I/O	USB Data	17	EXTINT1	I	External Interrupt Pin
6	USB_DP	I/O	USB Data	18	SDA	I/O	DDC Data
7	VDD_USB	I	USB Supply	19	SCL	I/O	DDC Clock
8	NC	I	Leave Open if not used	20	TXD	O	UART Serial Data Output
9	VCC_RF	O	Output Voltage RF section	21	RXD	I	UART Serial Data Input
10	GND	G	Ground	22	V_BAT	P	Backup battery supply voltage
11	RF_IN	I	GPS&GPS Signal Input	23	VCC	P	DC suppiy voltage
12	GND	G	Ground	24	GND	G	Ground

2.3. Power Supply

VCC pin supplies power for BB, RF, I/O, Antenna. The load current of VCC varies according to the VCC level, processor load, the number of tracked satellites and the rate of satellite re-acquisition. Using external active antenna will consume additional 11mA from our module. So it is important to supply sufficient current and make the power clean and stable. VCC supply ripple voltage should meet the requirement: 54mV (RMS) max @f=0···3MHz and 15mV (RMS) max@f >3MHz. You should choose the LDO without built-in output high-speed discharge function to keep long output voltage drop-down period. The decouple combination of 10uF and 100nF capacitor is recommended nearby VCC pin.

The VBAT pin supplies power for RTC domain. It should be valid when power on the module. The voltage of RTC domain ranges from 1.8V to 3.6V. In order to achieve a better TTFF, RTC domain should be valid all the time. It can supply power for SRAM memory in RTC domain which contains all the necessary GPS information for quick start-up and a small amount of user configuration variables.

✦ The module's internal power construction is shown as below.

VCC supplies power for PMU, and VBAT supplies power for RTC domain. TIMER signal highlighted in red in the following figure belongs to RTC domain and can be used to control the power switch on/off.
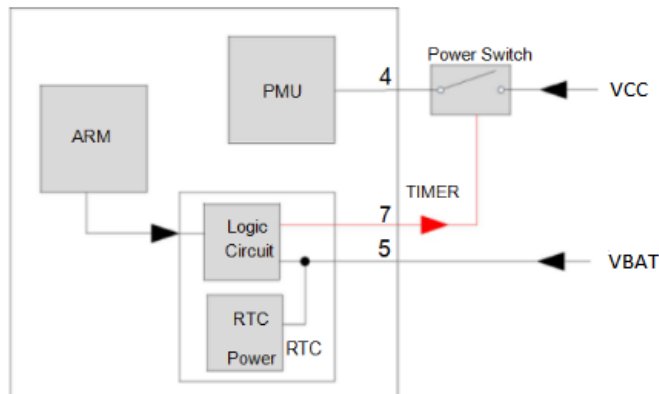
Figure 3: Internal Power Construction

✦ Power supply solutions for RB-1612-UB7X module are listed as the following.

The simplest power circuit for RB-1612-UB7X module is 3.3V power source connected to VCC pin and VBAT pin of the module directly. In this case, once you powered on the module, the full cold start will be implemented.
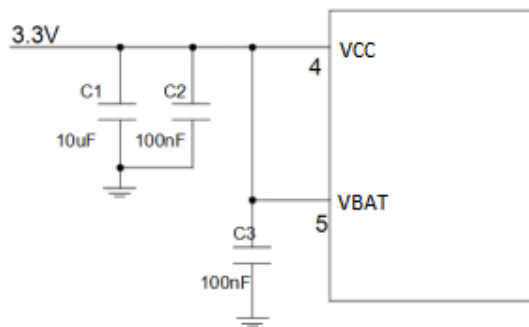
Figure 4: Reference Circuit for Power Supply

✦ If your power supply circuit adopts the design mentioned above , RB-1612-UB7X module does not support backup mode.

The other way is feeding VBAT through a backup battery directly. The module will enter into backup mode when power source (3.3V) is cut off. Furthermore,it is necessary to add an external charging circuit.for rechargeable battery. The detailed schematic (mount R2 with 0R to replace Power switch) is shown as there is no charge source when power source (3.3V) is cut off. MS621FE FL11E from Seiko is recommended. The consumption of VBAT is as low as 7uA in backup mode.

The schematic with power supply circuit is shown as below. As power source (3.3V) is always valid and the battery is charged continuously, the capacity of the battery can be small. The detailed schematic for power switch circuit is shown in *Figure 5.*
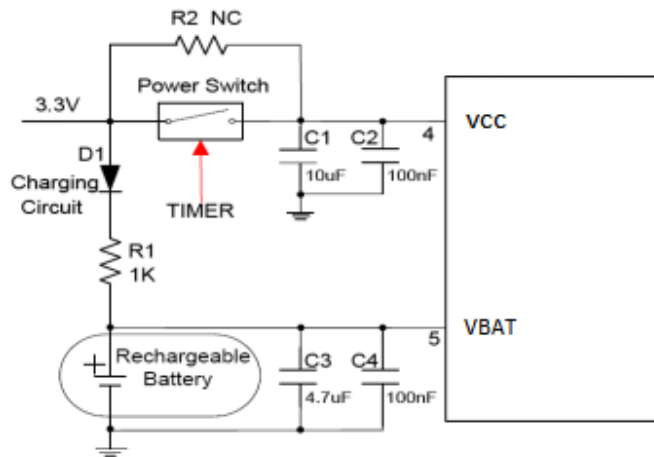
Figure 5: Reference Charging Circuit for Chargeable Battery

VCC does not supply power for RTC domain in RB-1612-UB7X module, so the VBAT pin must be powered externally. Furthermore, it is strongly recommended to supply power to VBAT through a backup battery, which can ensure RB-1612-UB7X module improves TTFF after next restart. For details about TTFF.

2.4. UART Interface

The module provides one universal asynchronous receiver& transmitter serial port. The module is designed as DCE (Data Communication Equipment), following the traditional DCE-DTE (Data Terminal Equipment) connection. The module and the client (DTE) are connected through the signals shown in the following figure. It supports data baud-rate from 4800bps to 115200bps.

UART port:
TXD: Send data to the RXD1 signal line of DTE.
RXD: Receive data from the TXD1 signal line of DTE.
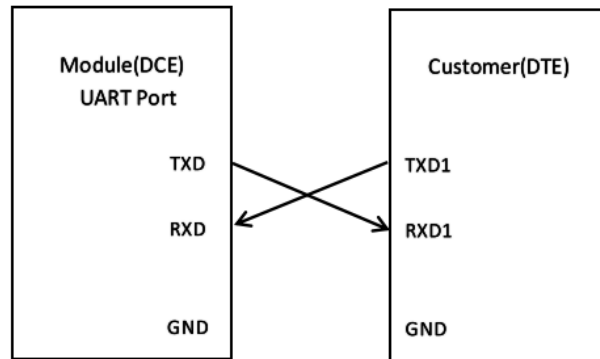
Figure 6: Connection of Serial Interfaces

This UART port has the following features:

● UART port can be used for NMEA or UBX Protocol output and proprietary commands input.
● The default output NMEA type setting is RMC, GGA, GSA, GSV, VTG, GLL.
● UART port supports the following data rates:
   4800, 9600, 14400, 19200, 38400, 57600, 115200bps.
   The default setting is 9600bps, 8 bits, no parity bit, 1 stop bit.
● Hardware flow control and synchronous operation are not supported.

   The UART port does not support the RS-232 level but only CMOS level. If the module's UART port is connected to the UART port of a computer, it is necessary to add a level shift circuit between the module and the computer. Please refer to the following figure.
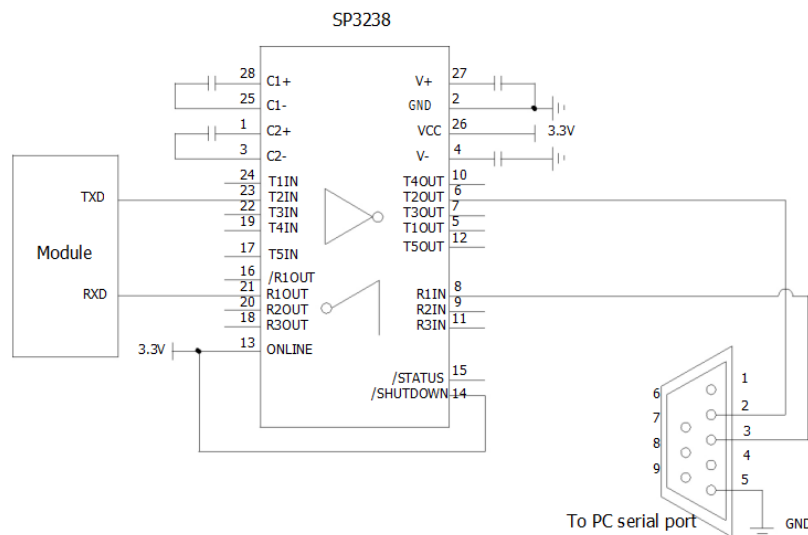
Figure 7: RS-232 Level Shift Circuit

2.5. USB Interface

RB-1612-UB7X modules provide a USB version 2.0 FS (Full Speed, 12Mbit/s) interface as an alternative to the UART. u-blox provides a Microsoft®certified USB driver for Windows XP and Windows Vista operating systems. Windows 7 /8/10 will also be supported following certification.

The module provides a USB general purpose port, Interface contains Module USB circuit power supply VDD_USB, data transmission USB_DM,USB_DP. Supply voltage is 2.8V~3.6V, the maximum can not exceed 3.6V, otherwise it will damage the main chip. Recommended voltage 3.0V.　Design circuits such as *Figure 8*.
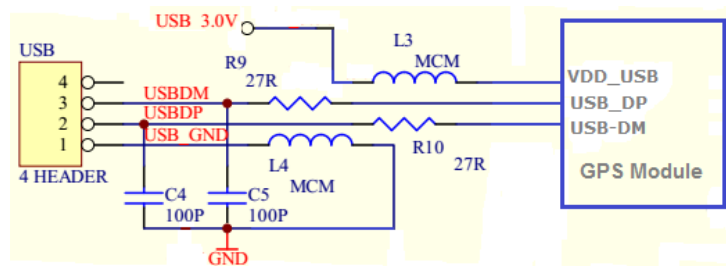
Figure 8: USB circuit design reference

3 Antenna Interfaces

3.1. PCB Design Guide

The RB-1612-UB7X GPS receiver is designed for supporting the active antenna or passive antenna connected with pin RF_IN. The gain of active antenna should be no less than 15dB. The maximum noise figure should be no more than 2.5dB and output impedance is at 50 Ohm.
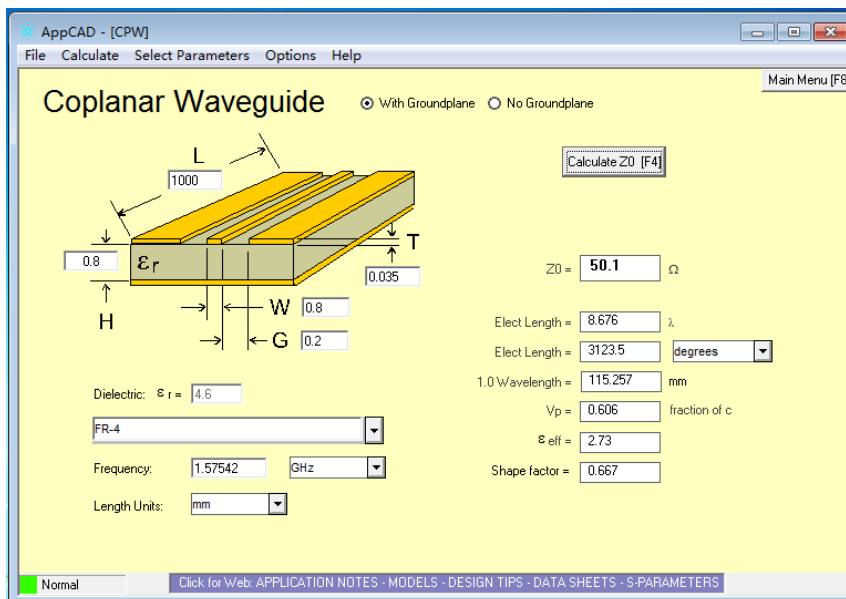
Figure 9:　Antenna design requirements

3.2. External Active Antenna

The following figure is a typical reference design with active antenna. In this mode, DC on the VCC_RF pin is powered by VCC and supplies power to the external active antenna.
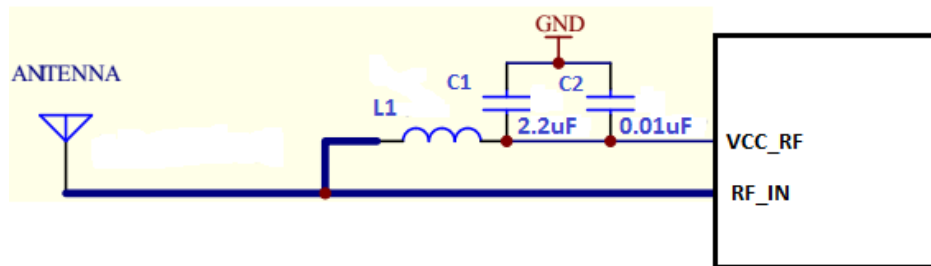
Figure 10: Reference Design for Active Antenna

C1, C2, L1 is used for power supply and filtering effect to the external active antenna, RF_IN antenna to a circuit part (BOLD line) for high frequency microstrip line, PCB in the design of this part of the line to calculate the characteristic impedance of the high-frequency line according to the principle of high frequency wiring.

The impedance of RF trace line in main PCB should be controlled as 50 Ohm, and the trace length should be kept as short as possible.

Table 2: The modules Antenna Specifications

Parameter	Specification	
Antenna Type	Passive and active antenna	
ActiveAntenna Recommendations	Minimum gain	15 dB (to compensate signal loss in RF cable)
	Maximum gain	50^9 dB / 30^{10} dB
	Maximum noise figure	1.5 dB

4. Configuration instruction Explain

The module supports the commonly used commands in configuration, The following table describes some of the parameters of the UART port configuration command,baud rate setting: NMEA data refresh rate is set, the NMEA statement output set, positioning mode setting etc.

The Module power up initialization requires 300ms,Please send the sixteen system from CPU via serial port.

Table 3: Baud rate configuration command

Common commands	Instructions
Cold star	B5 62 06 04 04 00 FF FF 02 00 0E 61
Hot start	B5 62 06 04 04 00 00 00 02 00 10 68
Reset	B5 62 06 04 04 00 FF 87 01 00 95 F7
Restore factory settings	B5 62 06 09 0D 00 FF FF 00 00 00 00 00 00 FF FF 00 00 07 1F 9E
Save configuration	B5 62 06 09 0D 00 00 00 00 00 00 FF FF 00 00 00 00 00 00 17 31 BF
Baud rate is 4800bps	b5 62 06 00 14 00 01 00 00 00 d0 08 00 00 c0 12 00 00 07 00 07 00 00 00 00 00 d3 fc b5 62 06 00 01 00 01 08 22
Baud rate is 9600bps	b5 62 06 00 14 00 01 00 00 00 d0 08 00 00 80 25 00 00 07 00 07 00 00 00 00 00 a6 cd b5 62 06 00 01 00 01 08 22
Baud rate is 38400bps	b5 62 06 00 14 00 01 00 00 00 d0 08 00 00 00 96 00 00 07 00 07 00 00 00 00 00 97 a8 b5 62 06 00 01 00 01 08 22
Baud rate is 115200bps	b5 62 06 00 14 00 01 00 00 00 d0 08 00 00 00 c2 01 00 07 00 07 00 00 00 00 00 c4 96 b5 62 06 00 01 00 01 08 22
NMEA data refresh rate is 1Hz	B5 62 06 08 06 00 E8 03 01 00 01 00 01 39
NMEA data refresh rate is 2Hz	B5 62 06 08 06 00 F4 01 01 00 01 00 0B 77
NMEA data refresh rate is 4Hz	B5 62 06 08 06 00 FA 00 01 00 01 00 10 96
NMEA data refresh rate is 5Hz	B5 62 06 08 06 00 C8 00 01 00 01 00 DE 6A B5 62 06 08 00 00 0E 30
NMEA data refresh rate is 10Hz	B5 62 06 08 06 00 64 00 01 00 01 00 7A 12 B5 62 06 08 00 00 0E 30

Table4: NMEA statement content output configuration

Statement conten	Instructions
Close GGA OutPut	24 45 49 47 50 51 2c 47 47 41 2a 32 37 0d 0a b5 62 06 01 03 00 f0 00 00 fa 0f
Close GLL OutPut	24 45 49 47 50 51 2c 47 4c 4c 2a 32 31 0d 0a b5 62 06 01 03 00 f0 01 00 fb 11
Close GSA OutPut	24 45 49 47 50 51 2c 47 53 41 2a 33 33 0d 0a b5 62 06 01 03 00 f0 02 00 fc 13
Close GSV OutPut	24 45 49 47 50 51 2c 47 53 56 2a 32 34 0d 0a b5 62 06 01 03 00 f0 03 00 fd 15
Close RMC OutPut	24 45 49 47 50 51 2c 52 4d 43 2a 33 41 0d 0a b5 62 06 01 03 00 f0 04 00 fe 17
Close VTG OutPut	24 45 49 47 50 51 2c 56 54 47 2a 32 33 0d 0a b5 62 06 01 03 00 f0 05 00 ff 19
Open GGA OutPut	24 45 49 47 50 51 2c 47 47 41 2a 32 37 0d 0a b5 62 06 01 03 00 f0 00 01 fb 10
Open GLL OutPut	24 45 49 47 50 51 2c 47 4c 4c 2a 32 31 0d 0a b5 62 06 01 03 00 f0 01 01 fc 12
Open GSA OutPut	24 45 49 47 50 51 2c 47 53 41 2a 33 33 0d 0a b5 62 06 01 03 00 f0 02 00 fc 13
Open GSV OutPut	24 45 49 47 50 51 2c 47 53 56 2a 32 34 0d 0a b5 62 06 01 03 00 f0 03 00 fd 15
Open RMC OutPut	24 45 49 47 50 51 2c 52 4d 43 2a 33 41 0d 0a b5 62 06 01 03 00 f0 04 00 fe 17
Open VTG OutPut	24 45 49 47 50 51 2c 56 54 47 2a 32 33 0d 0a b5 62 06 01 03 00 f0 05 00 ff 19
GSV 5S Output once	B5 62 06 01 08 00 F0 03 00 05 00 00 00 00 07 51
Output only RMC	B56206010300F00100FB11B56206010300F00200FC13B56206010300F00300FD15B56206010300F00500FF19B56206010300F00000FA0F

5 Electrical, Reliability and Radio Characteristics

5.1. Absolute Maximum Ratings

Absolute maximum ratings for power supply and vol age on digital pins of the module are listed in the following table.

Table 5: Absolute Maximum Ratings

values within the specified boundaries by using appropriate protection diodes.

Parameter	Min.	Max.	Unit
Power Supply Voltage (VCC)	-0.3	3.6	V
Backup Battery Voltage (VBAT)	-0.3	3.6	V
Input Voltage at Digital Pins	-0.3	3.6	V
Input Power at RF_IN		15	dBm
Storage Temperature	-45	125	°C

✧ Stressing the device beyond the "Absolute Maximum Ratings" may cause permanent damage. These are stress ratings only. The product is not protected against over voltage or reversed voltage. If necessary, voltage spikes exceeding the power supply voltage specification, given in table above, must be limited to values within the specified boundaries by using appropriate protection diodes.

5.2. Operating Conditions

Table 6: Power Supply Ratings

Parameter	Description	Conditions	Min.	Typ.	Max.	Unit
VCC	Supply voltage	Voltage must stay within the min/max values, including voltage drop, ripple, and spikes.	2.8	3.3	3.6	V
IVCCP	Peak supply current	VCC=3.3V			100	mA
VBAT	Backup voltage supply		1.8	3.3	3.6	V
TOPR	Normal operating temperature		-40	25	80	°C

✧ The figure IVCCP can be used to determine the maximum current capability of power supply.
✧ Operation beyond the "Operating Conditions" is not recommended and extended exposure beyond the "Operating Conditions" may affect the device's reliability.

5.3. Current Consumption

The values for current consumption are shown in the following table.

Table 7: Current Consumption

Parameter	Conditions	Min.	Typ.	Max.	Unit
I_{VCC} @Acquisition	VCC=VBAT=3.3V		25		mA
I_{VCC} @Tracking	VCC=VBAT=3.3V		20		mA
I_{VCC} @Standby	VCC=VBAT=3.3V		2.0		mA
I_{BCKP} @Backup	VBAT=3.3V		15		uA

The tracking current is tested in the following conditions:

✧ In Cold Start, 10 minutes after First Fix.

✧ In Hot Start, 15 seconds after First Fix.

5.4. ESD handling precautions

RB-1612-UB7X series modules are Electrostatic Sensitive Devices (ESD). Observe precautions for handling! Failure to observe these precautions can result in severe damage to the GPS receiver!

GPS receivers are Electrostatic Sensitive Devices (ESD) and require special precautions when handling. Particular care must be exercised when handling patch antennas, due to the risk of electrostatic charges. In addition to standard ESD safety practices, the following measures should be taken into account whenever handling the receiver:

✧ Unless there is a galvanic coupling between the local GND (i.e. the work table) and the PCB GND, then the first point of contact when handling the PCB must always be between the local GND and PCB GND.

✧ Before mounting antenna patch,connect ground of the device When handling the RF pin, do not come into contact with any charged capacitors and be careful when contacting materials that can develop charges (e.g. patch antenna ~10pF, coax cable ~50-80pF/m, soldering iron, …)

✧ To prevent electrostatic discharge through the RF input, do not touch any exposed antenna area. If there is any risk that such exposed antenna area is touched in non ESD protected work area, implement proper ESD protection measures in the design.

✧ When soldering RF connectors and patch antennas to the receiver's RF pin, make sure to use an ESD safe soldering iron (tip).
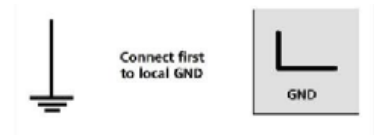
Table 8: ESD Endurance Table (Temperature : 25°C, Humidity: 45%)

Pin	Contact Discharge	Air Discharge
RF_IN	±5KV	±10KV
VCC	±5KV	±10KV
UART	±3KV	±6KV
Others	±2KV	±4KV

6 Mechanical Dimensions

This chapter describes the mechanical dimensions of the module.
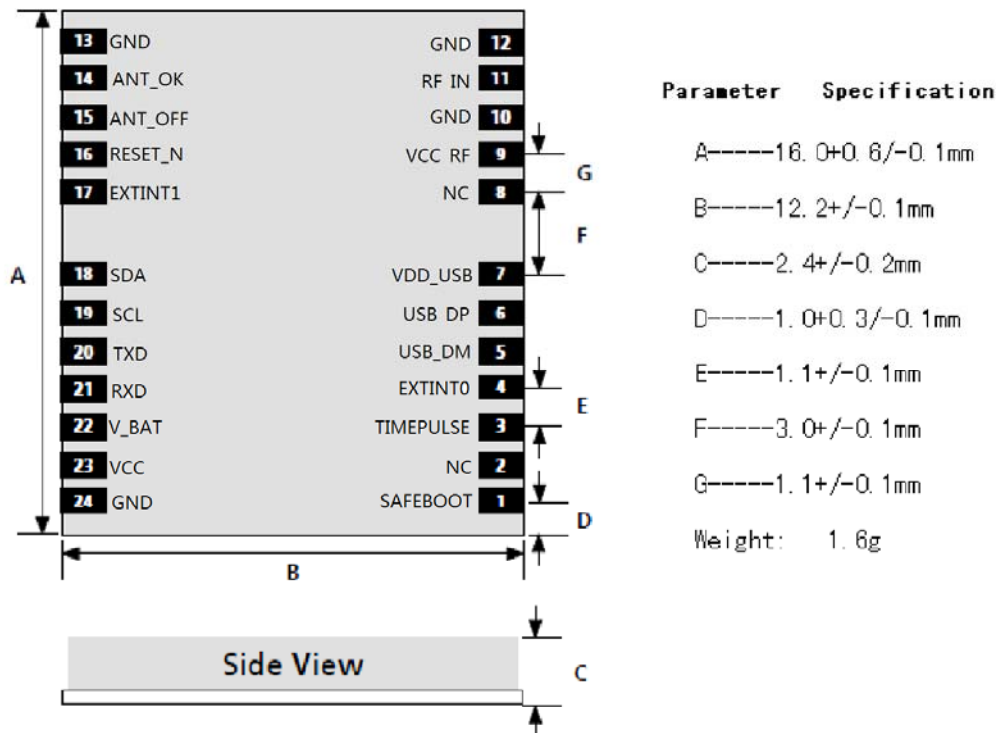

Figure 11: Bottom View Dimensions

7 Manufacturing, Packaging and Ordering Information

7.1. Assembly and Soldering

RB-1612-UB7X module is intended for SMT assembly and soldering in a Pb-free reflow process on the top side of the PCB. It is suggested that the minimum height of solder paste stencil is 100um to ensure sufficient solder volume. Pad openings of paste mask can be increased to ensure proper soldering and solder wetting over pads. It is suggested that the peak reflow temperature is 235~245°C (for SnAg3.0Cu0.5 alloy). The absolute maximum reflow temperature is 260°C. To avoid damage to the module when it is repeatedly heated, it is suggested that the module should be mounted after reflow soldering for the other side of PCB has been completed. Recommended reflow soldering thermal profile is shown below:
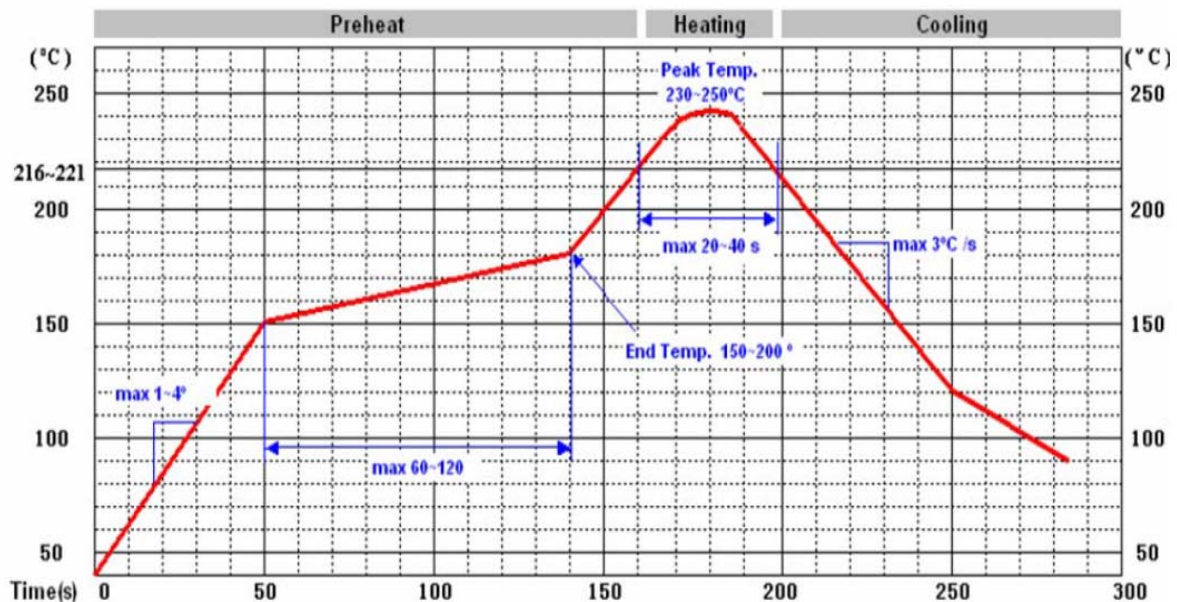
Figure 12: Recommended Reflow Soldering Thermal Profile

7.2. Moisture Sensitivity

RB-1612-UB7X module is sensitive to moisture. To prevent RB-1612-UB7X from permanent damage during reflow soldering, baking before reflow soldering is required in following cases:

✧ Humidity indicator card: One or more indicating spots are no longer blue.
✧ The seal is opened and the module is exposed to excessive humidity.

RB-1612-UB7X should be baked for 192 hours at temperature 40°C+5°C/-0°C and <5% RH in low-temperature containers, or 24 hours at temperature 125°C±5°C in high-temperature containers. Care should be taken that the plastic tape is not heat resistant. RB-1612-UB7X should be taken out from the tape before preheating; otherwise, the tape maybe damaged by high-temperature heating.

7.3. Tape and Reel Packaging
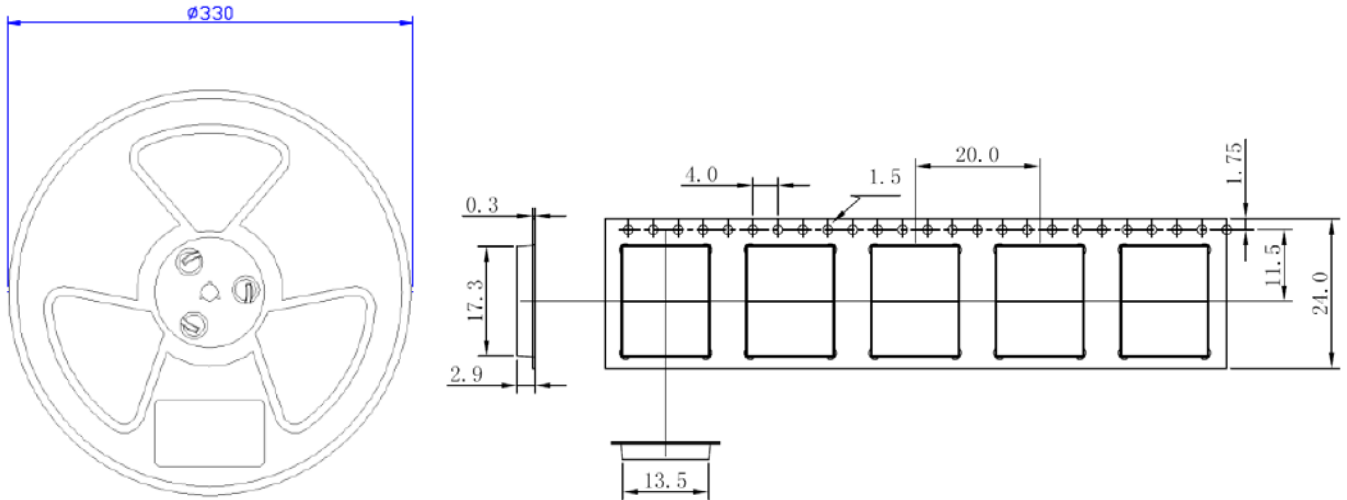
Unit: mm

Quantity per reel:1000pcs

Lengh per reel: 20m

Figure 13: Tape and Reel Specifications

Table 9: Reel Packaging

Model Name	MOQ for MP	Minimum Package: 1000pcs
RB-1612-UB7X	1000pcs	Size: 365mm × 350mm × 53mm N.W: 1.42kg G.W: 1.6kg

8 Appendix References

Table 10: Terms and Abbreviations

Abbreviation	Description
AGPS	Assisted Global navigation satellite system
DGPS	Differential GPS
ESD	Electrostatic Discharge
GPS	Global Positioning System
GPS	Global Navigation Satellite System
GGA	GPS Fix Data
GLL	Geographic Position – Latitude/Longitude
GLONASS	Global Navigation Satellite System
GSA	GPS DOP and Active Satellites
GSV	GPS Satellites in View
HDOP	Horizontal Dilution of Precision
I/O	Input/Output
Kbps	Kilo Bits Per Second
LNA	Low Noise Amplifier
MSAS	Multi-Functional Satellite Augmentation System
MOQ	Minimum Order Quantity
NMEA	National Marine Electronics Association
PDOP	Position Dilution of Precision
PPS	Pulse Per Second
PRN	Pseudo Random Noise Code
QZSS	Quasi-Zenith Satellite System
RHCP	Right Hand Circular Polarization
RMC	Recommended Minimum Specific GPS Data
SBAS	Satellite-based Augmentation System
SAW	Surface Acoustic Wave
SPDT	Single-Pole Double-Throw
TTFF	Time To First Fix

UART	Universal Asynchronous Receiver & Transmitter
VDOP	Vertical Dilution of Precision
VTG	Course over Ground and Ground Speed, Horizontal Course and Horizontal Velocity
WAAS	Wide Area Augmentation System
Inom	Nominal Current
Imax	Maximum Load Current
Vmax	Maximum Voltage Value
Vnom	Nominal Voltage Value
Vmin	Minimum Voltage Value
VIHmax	Maximum Input High Level Voltage Value
VIHmin	Minimum Input High Level Voltage Value
VILmax	Maximum Input Low Level Voltage Value
VILmin	Minimum Input Low Level Voltage Value
VImax	Absolute Maximum Input Vol age Value
VImin	Absolute Minimum Input Vol age Value
VOHmax	Maximum Output High Level Vol age Value
VOHmin	Minimum Output High Level Voltage Value
VOLmax	Maximum Output Low Level Voltage Value
VOLmin	Minimum Output Low Level Voltage Value

9 NMEA 0183 Protocol

The NMEA protocol is an ASCII-based protocol, Records start with a $ and with carriage return/line feed. GPS specific messages all start with $GPxxx is a three-letter identifier of the message data that follows. NMEA messages have a check sum, which allows detection of corrupted data transfers.

✧   The RB-1612-UB7X supports the following NMEA-0183 messages: $GPGGA, $GPGLL, $GPGSA, $GPGSV, $GPRMC and $GPVTG.

Table 11: NMEA-0183 Output Messages

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

9.1 GGA-Global Positioning System Fixed Data

$GPGGA, 161229.487,3723.24751,N, 12158.34160,W, 1,07,1.0,9.0,M.0000*18

Table 12: GGA Data Format

Name	Example	Units	Description
Message ID	$GPGGA		GGA protocol header
UTC Position	161229.487		hhmmss.sss
Latitude	3723.24571		ddmm.mmmmm
N/S indicator	N		N=north or S=south
Longitude	12158.34160		dddmm.mmmmm
E/W Indicator	W		E=east or W=west
Position Fix Indicator	1		See Table 12-1
Satellites Used	07		Range 0 to 12
HDOP	1.0		Horizontal Dilution of Precision
MSL Altitude	9.0	meters	
Units	M	meters	
Geoids Separation		meters	
Units	M	meters	
Age of Diff.Corr.		second	Null fields when DGPS is not Used
Diff.Ref.Station ID	0000		
Check sum	*18		
<CR> <LF>			End of message termination

Table 12-1: Position Fix Indicators

Value	Description
0	Fix not available or invalid
1	GPS SPS Mode, fix valid
2	Differential GPS, SPS Mode, fix valid
3	GPS PPS Mode, fix valid

9.2 GLL-Geographic Position – Latitude/Longitude

$GPGLL , 3723.24755, N,12158.34161, W,161229.487, A*2C.

Table 13: GLL Data Format

Name	Example	Units	Description
Message ID	$GPGLL		GLL protocol header
Latitude	3723.24755		ddmm.mmmmm
N/S Indicator	N		N=north or S=south
Longitude	12158.34161		dddmm.mmmmm
E/W Indicator	W		E=east or W=west
UTC Position	161229.487		hhmmss.sss
Status	A		A=data valid or V=data not valid
Check sum	*2C		
<CR> <LF>			End of message termination

9.3 GSA-GNSS DOP and Active Satellites

$GPGSA , A, 3, 07, 02, 26,27, 09, 04,15, , , , , , 1.8,1.0,1.5*33.

Table 14: GSA Data Format

Name	Example	Units	Description
Message	$GPGSA		GSA protocol header
Mode 1	A		See Table 14-2
Mode 2	3		See Table 14-1
Satellite Used	07		Sv on Channel 1
Satellite Used	02		Sv on Channel 2
…	…		…
Satellite Used			Sv on Channel 12
PDOP	1.8		Position Dilution of Precision
HDOP	1.0		Horizontal Dilution of Precision
VDOP	1.5		Vertical Dilution of Precision
Check sum	*33		
<CR> <LF>			End of message termination

Table 14-1: Mode 1

Value	Description
1	Fix not available
2	2D
3	3D

Table 14-2: Mode 2

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

9.4 GSV-GPS Satellites in View

$GPGSV , 2, 1, 07, 07, 79,048, 42, 02, 51,062, 43, 26, 36,256, 42, 27, 27, 138,42*71

$GPGSV, 2, 2, 07, 09, 23,313, 42, 04, 19, 159, 41, 15,12,041, 42*41.

Table 15: GGA Data Format

Name	Example	Units	Description
Message ID	$GPGSV		GSV protocol header
Number of Message	2		Range 1 to 3
Message Number	1		Range 1 to 3
Satellites in View	07		
Satellite ID	07		Channel 1(Range 1 to 32)
Elevation	79	degrees	Channel 1(Maximum 90)
Azinmuth	048	degrees	Channel 1(True, Range 0 to 359)
SNR(C/NO)	42	dB/Hz	Range 0 to 99,null when not tracking
…			…
Satellite ID	27		Channel 4(Range 1 to 32)
Elevation	27	degrees	Channel 4(Maximum 90)
Azimuth	138	degrees	Channel 4(True, Range 0 to 359)
SNR(C/NO)	42	dB/Hz	Range 0 to 99, null when not tracking
Check sum	*71		
<CR> <LF>			End of message termination

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

9.5 RMC-Recommended Minimum Specific GNSS Data

$GPRMC, 161229.487, A, 3723.24751, N, 12158.34161, W, 0.13,309.62, 120598,, *10

Table 16: RMC Data Format

Name	Example	Units	Description
Message ID	$GPRMC		RMC protocol header
UTC Position	161229.487		hhmmss.sss
Status	A		A=data valid or V=data not valid
Latitude	3723.24751		ddmm.mmmmm

N/S Indicator	N		N=north or S=south
Longitude	12158.34161		dddmm.mmmmm
E/W Indicator	W		E=east or W=west
Speed Over Ground	0.13	Knots	
Course Over Ground	309.62	Degrees	True
Date	120598		dummy
Magnetic variation		Degrees	E=east or W=west
Check sum	*10		
<CR> <LF>			End of message termination

9.6 VTG-Course Over Ground and Ground Speed

$GPVTG, 309.62, T, M, 0.13, N, 0.2, K*6E

Table 17: VTG Data Format

Name	Example	Units	Description
Message ID	$GPVTG		VTG protocol header
Course	309.62	Degrees	Measured heading
Reference	T		True
Course		Degrees	Measured heading
Reference	M		Magnetic
Speed	0.13	Knots	Measured horizontal speed
Units	N		Knots
Speed	0.2	Km/hr	Measured horizontal speed
Units	K		Kilometer per hour
Check sum	*6E		
<CR> <LF>			End of message termination