L80-R Hardware Design

GNSS Module Series

Rev. L80-R_Hardware_Design_V1.3

Date: 2020-04-29

Status: Released

Our aim is to provide customers with timely and comprehensive service. For any assistance, please contact our company headquarters:

Quectel Wireless Solutions Co., Ltd.
Building 5, Shanghai Business Park Phase III (Area B), No.1016 Tianlin Road, Minhang District, Shanghai, China 200233
Tel: +86 21 5108 6236
Email: info@quectel.com

Or our local office. For more information, please visit:
http://www.quectel.com/support/sales.htm

For technical support, or to report documentation errors, please visit:
http://www.quectel.com/support/technical.htm
Or email to: support@quectel.com

GENERAL NOTES

COPYRIGHT

About the Document

Revision History

Version	Date	Author	Description
1.0	2015-08-10	Neil WU	Initial
1.1	2015-11-09	Neil WU	1. Added the description of PPS VS. NMEA. 2. Added not for the position of pin 1. 3. Modified the PCB design guide.
1.2	2016-04-22	Neil WU	Modified the PCB design guide.
1.3	2020-04-29	Andy ZHAO	1. Updated the description about the backup mode in Chapter 3.4.3. 2. Added the description about the power-on sequence of the module in Chapter 3.5. 3. Modified the module thickness in Chapter 6.1, VCC and V_BCKP voltage ranges in Chapter 3.2.

Contents

Table Index

Figure Index

1 Introduction

This document defines and specifies L80-R GPS module. Hardware interfaces, external application reference circuits, mechanical size and air interface of L80-R module are described in this document.

This document helps customers quickly understand the interface specifications, as well as electrical and mechanical details of L80-R module. Other documents such as *Quectel L80-R_GPS_Protocol_Specification* and *Quectel L80-R_EVB_User_Guide* are also provided for reference. These documents provide the guidance for customers to design and set up applications related to L80-R module.

1.1. Safety Information

The following safety precautions must be observed during all phases of operation, such as usage, service or repair of any terminal incorporating Quectel L80-R module. Manufacturers of the terminal should notify users and operating personnel of the following safety information by incorporating these guidelines into all manuals supplied with the product. If not so, Quectel assumes no liability for customers' failure to comply with these precautions.

	Ensure the use of the product conforms to the local safety and environment regulations, and is allowed in the country and the environment required.
	Keep away from explosive and flammable materials. The use of electronic products in extreme power supply conditions and locations with potentially explosive atmospheres may cause fire and explosion accidents.
	The product must be powered by a stable voltage source, and the wiring shall conform to security precautions and fire prevention regulations.
	Proper ESD handling procedures must be followed throughout the mounting, handling and operation of any application that incorporates the module to avoid ESD damages.

2 Description

2.1. General Description

L80-R GPS module equipped with an embedded patch antenna (15 mm × 15 mm × 4 mm) and LNA brings high performance of MTK positioning engine to the industrial applications. With a small-footprint leadless package, the L80-R GPS module makes it possible to implement the top level of sensitivity, accuracy and TTFF in the industry with the minimum power consumption. By using 66 search channels and 22 simultaneous tracking channels, L80-R GPS module can track and find satellites within the shortest time even when the signal is in a signal-challenging environment.

The L80-R module is integrated with advanced features such as AIC and EASY with respect to the compact form factor. These features can help shorten TTFF and improve sensitivity in GPS system. By using the L80-R module equipped with the embedded patch antenna and LNA, the design of the device can be simplified and the costs of the device can be reduced.

The L80-R module is an SMD type module with a compact 16 mm × 16 mm × 6.95 mm form factor. The module can be built in applications by using the 12 pins at 2.54 mm pitch spacing. The L80-R module provides necessary hardware interfaces for connection to the main PCB.

The module is fully compliant to EU RoHS regulations.

2.2. Key Features

Table 1: Key Features

Feature	Implementation
Power Supply	● Supply voltage: 2.8–4.3 V, typ. 3.3 V
Power Consumption	● Acquisition: 25 mA @ VCC = V_BCKP = 3.3 V ● Tracking: 20 mA @ VCC = V_BCKP = 3.3 V ● Standby: 1.0 mA @ VCC = V_BCKP = 3.3 V ● Backup: 7 µA @ V_BCKP = 3.3 V

Receiver Type	● GPS L1 1575.42 MHz C/A Code ● 66 search channels, 22 simultaneous tracking channels
Sensitivity	● Acquisition: –148 dBm ● Re-acquisition: –160 dBm ● Tracking: –165 dBm
TTFF (EASY enabled)	● Cold start: typ. 15 s @ –130 dBm ● Warm start: typ. 5 s @ –130 dBm ● Hot start: typ. 1 s @ –130 dBm
TTFF (EASY disabled)	● Cold start (Autonomous): typ. 35 s @ –130 dBm ● Warm start (Autonomous): typ. 30 s @ –130 dBm ● Hot start (Autonomous): typ. 1 s @ –130 dBm
Horizontal Position Accuracy (Autonomous)	● < 2.5 m CEP @ –130 dBm
Max Update Rate	● Up to 5 Hz, 1 Hz by default
Accuracy of 1PPS Signal	● Typical accuracy: ±10 ns ● Time pulse width 100 ms
Velocity Accuracy	● Without aid: 0.1 m/s
Acceleration Accuracy	● Without aid: 0.1 m/s²
Dynamic Performance	● Maximum altitude: 18,000 m ● Maximum velocity: 515 m/s ● Acceleration: 4 G
UART Port	● UART Port: TXD1 and RXD1 ● Supports baud rate from 4800 bps to 115200 bps, where the default setting is 9600 bps. ● UART port is used for NMEA output and MTK proprietary commands input.
Temperature Range	● Normal operation: –40 °C to +85 °C ● Storage temperature: –45 °C to +125 °C
Physical Characteristics	● Size: 16 ±0.15 mm × 16 ±0.15 mm × 6.95 ±0.1 mm ● Weight: Approx. 6.0 g

NOTE

The power consumption is measured in open air with internal patch antenna. Meanwhile, EASY and AIC are enabled.

2.3. Block Diagram

The following figure shows a block diagram of L80-R module. It consists of a single chip GPS IC which includes the RF part and Baseband part, a patch antenna, a LNA, a SAW filter, a TCXO, a crystal oscillator.

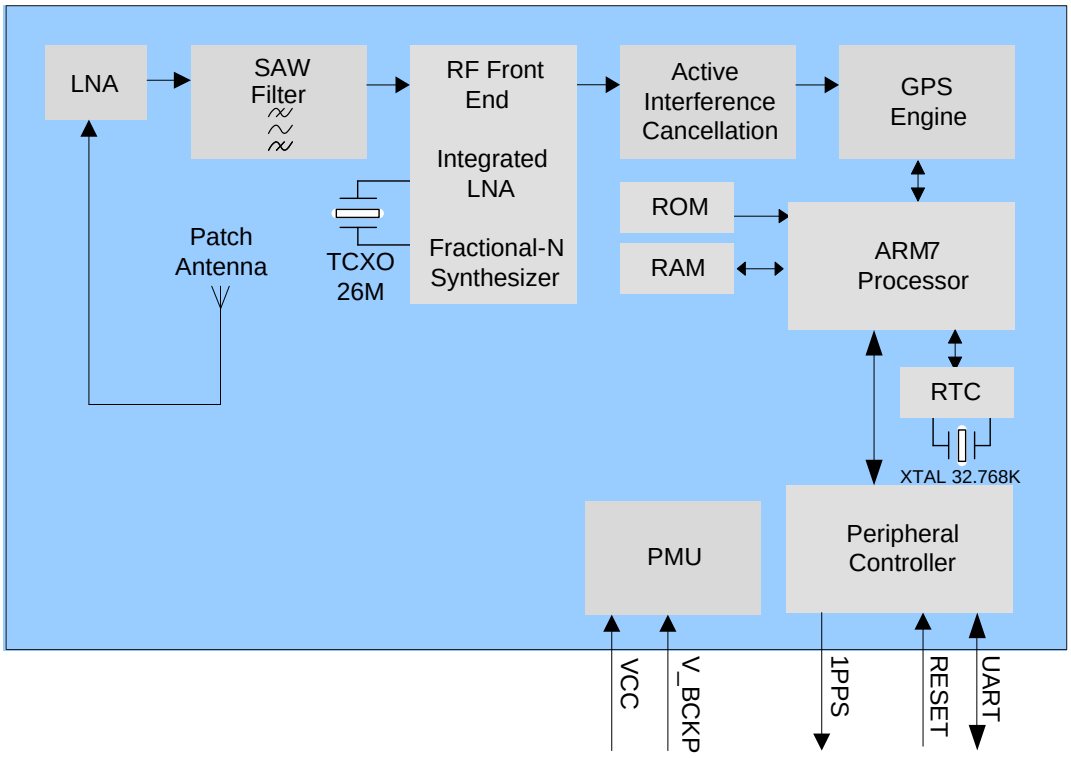

Figure 1: Block Diagram

2.4. Evaluation Board

To help customers apply the L80-R module to applications of the customers, Quectel provides an Evaluation Board (EVB) with a micro USB serial cable and other peripherals to test the module.

For more details, please refer to the ***document [1]***.

2.5. Protocols Supported by the Module

Table 2: Protocols Supported by the Module

Protocol	Type
NMEA	Output, ASCII, 0183, 3.01
PMTK	Input, MTK proprietary protocol

NOTE

For details of NMEA standard protocol and MTK proprietary protocol, please refer to ***document [2]***.

3 Application

The module is equipped with 12 LCC pins with 2.54 mm pitch that are connected to customer applications. Interfaces of the pin are described in details in the following chapters.

3.1. Pin Assignment

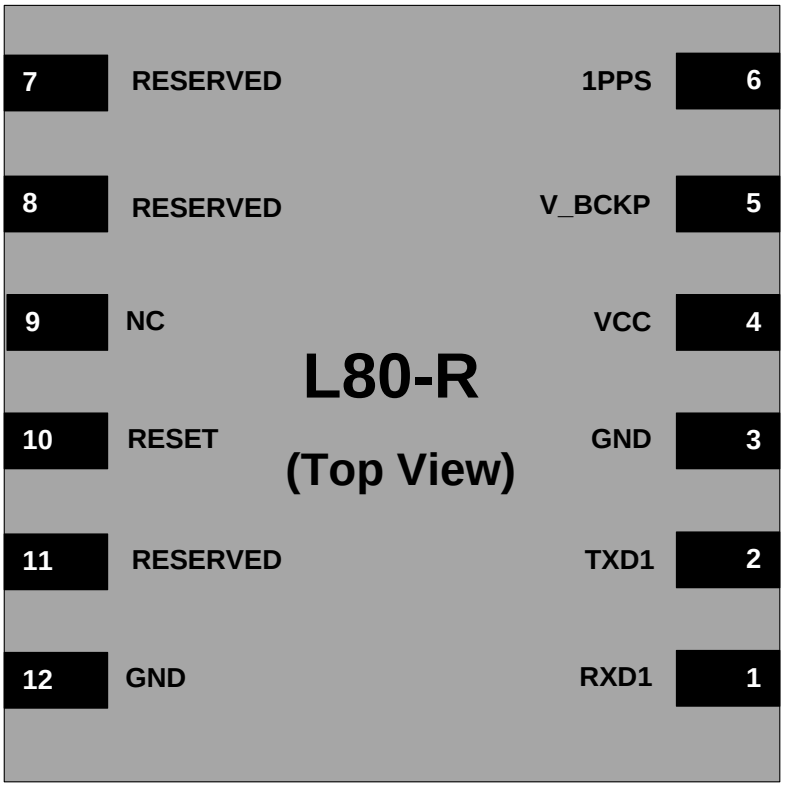

Figure 2: Pin Assignment

3.2. Pin Definition

Table 3: Pin Description

Power Supply					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
VCC	4	I	Main power supply	Vmax = 4.3 V Vmin = 2.8 V Vnom = 3.3 V	Supply current no less than 100 mA.
V_BCKP	5	I	Backup power supply	Vmax = 4.3 V Vmin = 2 V Vnom = 3.3 V	Supply power for RTC domain. The V_BCKP pin can be directly powered by battery or connected to VCC.
Reset					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RESET	10	I	System reset	V_{IL}min = –0.3 V V_{IL}max = 0.8 V V_{IH}min = 2.0 V V_{IH}max = 3.6 V	Low level active. If unused, keep this pin open or connect it to VCC.
UART Port					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RXD1	1	I	Receive data	V_{IL}min = –0.3 V V_{IL}max = 0.8 V V_{IH}min = 2.0 V V_{IH}max = 3.6 V	
TXD1	2	O	Transmit data	V_{OL}min = –0.3 V V_{OL}max = 0.4 V V_{OH}min = 2.4 V V_{OH}max = 3.1 V	
Other Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
1PPS	6	O	One pulse per second	V_{OL}min = –0.3 V V_{OL}max = 0.4 V V_{OH}min = 2.4 V V_{OH}max = 3.1 V	Synchronized at rising edge, the pulse width is 100 ms. If unused, keep this pin open.

RESERVED					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RESERVED	7, 8, 11				Keep this pin open

3.3. Power Supply

VCC pin supplies power for BB, RF, I/O, and LNA. 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. Therefore, it is important to supply sufficient current and make the power clean and stable. VCC supply ripple voltage should meet the requirement: max. 54 mV (RMS) @ f = 0 to 3 MHz and max. 15 mV (RMS) @ f >3 MHz. Customers should choose the LDO without built-in output high-speed discharge function to keep long output voltage drop-down period. The decouple combination of 10 μF and 100 nF capacitor is recommended to keep close to VCC pin.

The V_BCKP pin supplies power for RTC domain. It should be valid when powering on the module. The voltage of RTC domain ranges from 2 V to 4.3 V. 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 below.

VCC supplies power for PMU and V_BCKP supplies power for RTC domain.

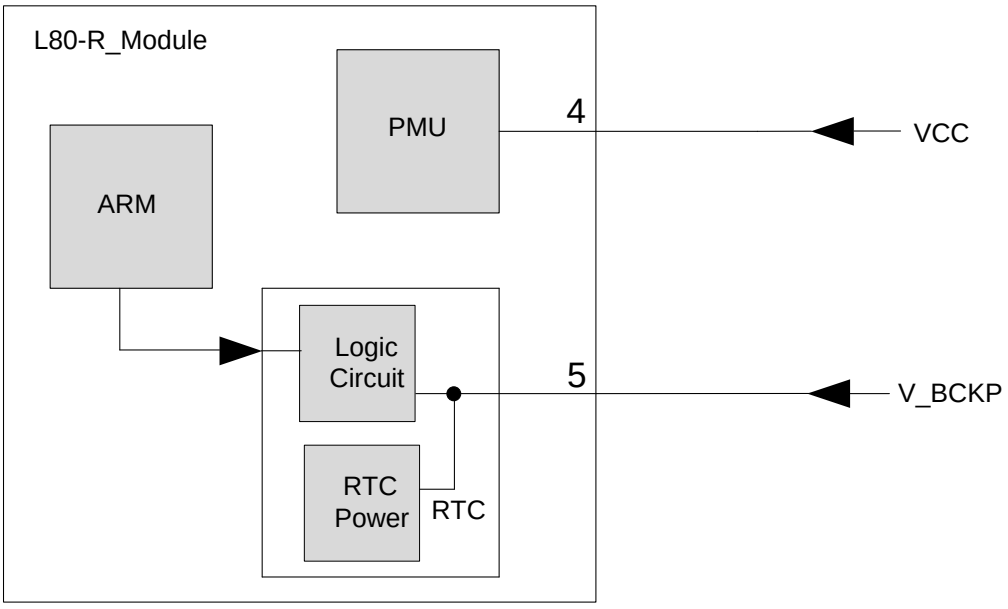

Figure 3: Internal Power Construction

Power supply solution for L80-R module is as follows:

A simple power circuit for L80-R module is 3.3 V power source connected to VCC pin and V_BCKP pin of the module directly. In this case, once the module is powered on, the full cold start begins.

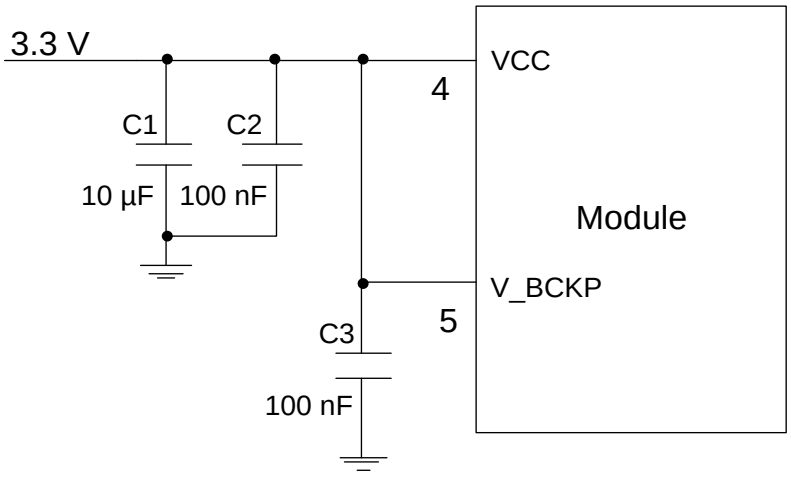

Figure 4: Reference Circuit for Power Supply

NOTES

1. If the design mentioned above is applied to power supply circuits of customers, L80-R module does not support backup mode or other modes related to it.
2. VCC does not supply power for RTC domain in L80-R module, and therefore, the V_BCKP pin must be powered externally. Furthermore, it is strongly recommended to supply power to V_BCKP through a backup battery, which can ensure L80-R module improves TTFF after next restart.

3.4. Operating Modes

The table below briefly illustrates the relationship among different operating modes of L80-R module.

Table 4: Module State Switching

Current Mode	Next Mode		
	Backup	Standby	Full on
Backup	N/A	N/A	Restore the main supply VCC
Standby	N/A	N/A	Send any data via UART1

Full on	Maintain V_BCKP and disconnect VCC	Send PMTK161 command	N/A

NOTE

For more details about MTK proprietary protocol, please refer to ***document [2]***.

3.4.1. Full on Mode

Full on mode includes tracking mode and acquisition mode. Acquisition mode is defined as the mode in which the module starts searching satellites and determining the visible satellites, coarse carrier frequency and code phase of satellite signals. When the acquisition is completed, it switches to tracking mode automatically. Tracking mode is defined as the mode in which the module keeps tracking satellites and demodulates the navigation data from the specific satellites.

When the combination of VCC and V_BCKP is valid, the module will enter full on mode automatically and follow the default configurations as below. For more details, refer to ***Chapter 3.3*** about internal power construction. PMTK commands can be also used to change the configurations to satisfy particular requirements.

Table 5: Default Configurations

Item	Configuration	Comment
Baud Rate	9600 bps	
Protocol	NMEA	GGA, GSV, GSA, VTG and RMC
Update Rate	1 Hz	
EASY	Enable	EASY will be disabled automatically when update rate exceeds 1 Hz
AIC	Enable	

3.4.2. Standby Mode

Standby mode is a low-power-consumption mode. In standby mode, the internal core and I/O power domain are still active, but RF and TCXO are powered off, and the module stops satellite search and navigation. UART is still accessible through PMTK commands or any other data, but there is no NMEA messages output.

Sending PMTK command “$PMTK161,0*28” will make L80-R module enter standby mode. Sending any

data via UART can wake the module up. When the module exits from standby mode, it will use all internal aiding information like GPS time, Ephemeris, Last Position, etc, resulting to the fastest possible TTFF in either Hot or Warm start. The typical standby current consumption in this way is about 1 mA @ VCC = 3.3 V.

3.4.3. Backup Mode

Less power is consumed in the backup mode compared with that consumed in the standby mode. In this mode, only the backup supply V_BCKP is powered on while the main supply VCC is disconnected. The specific operation steps of backup mode are as follows:

- Supply power to the VCC pin later than the V_BCKP pin, where the module is working normally.
- Cut off the power supply for the VCC pin, so that the module enters backup mode, where the current measured at V_BCKP pin is the current in backup mode.

The typical current value in the backup mode is 7 μA. If customers directly supply power to the V_BCKP pin in the shutdown state without performing the foregoing steps, the module will enter an unstable state and the current will exceed the nominal value.

The following timing diagram indicates that the module enters backup mode after being powered on.

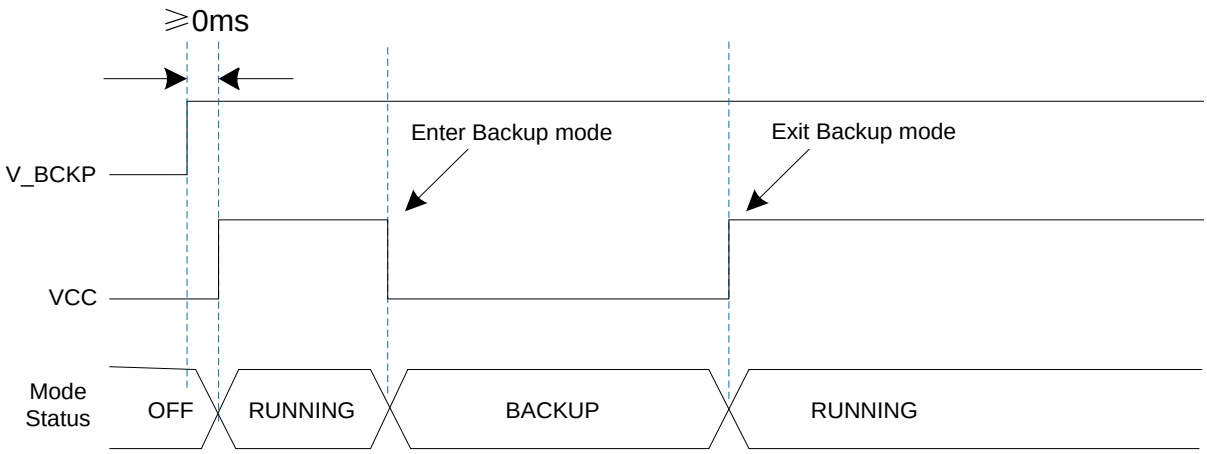

Figure 5: Backup Mode Sequence Diagram

In backup mode, L80-R module stops acquiring and tracking satellites. UART is not accessible. But the backed-up memory in RTC domain which contains all the necessary GPS information for quick start-up and a small amount of user configuration variables is alive.

The V_BCKP pin can be directly supplied by an external capacitor or battery (rechargeable or non-chargeable). Please refer to the following reference design for RTC backup.

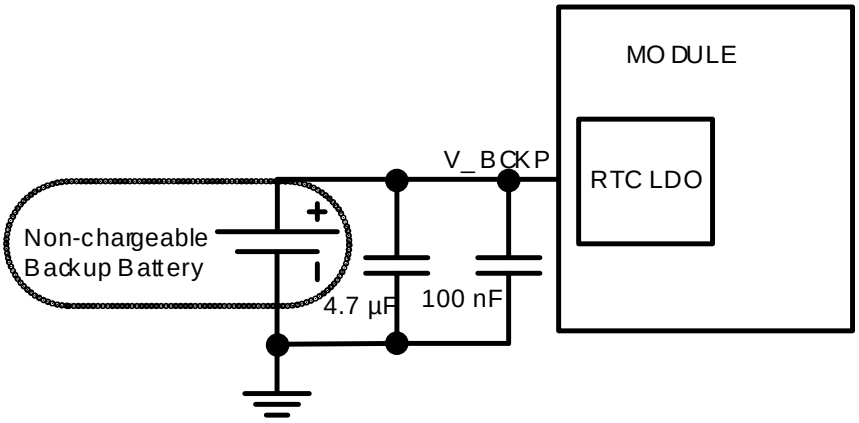

Figure 6: RTC Supply from Non-chargeable Battery

The V_BCKP pin does not support charging function for rechargeable battery. It is necessary to add an external charging circuit for rechargeable batteries.

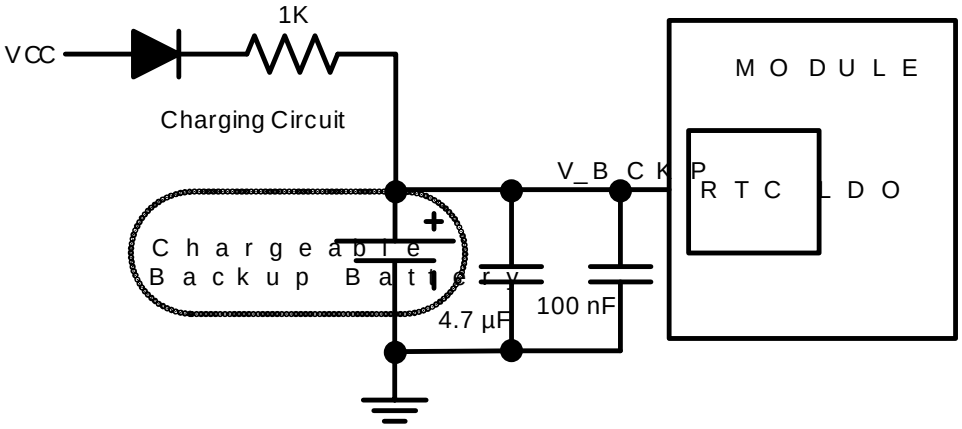

Figure 7: Reference Charging Circuit for Chargeable Battery

Coin-type rechargeable capacitor such as MS920SE from Seiko can be used and Schottky diode such as RB520S30T1G from ON Semiconductor is recommended to be used here for its low voltage drop.

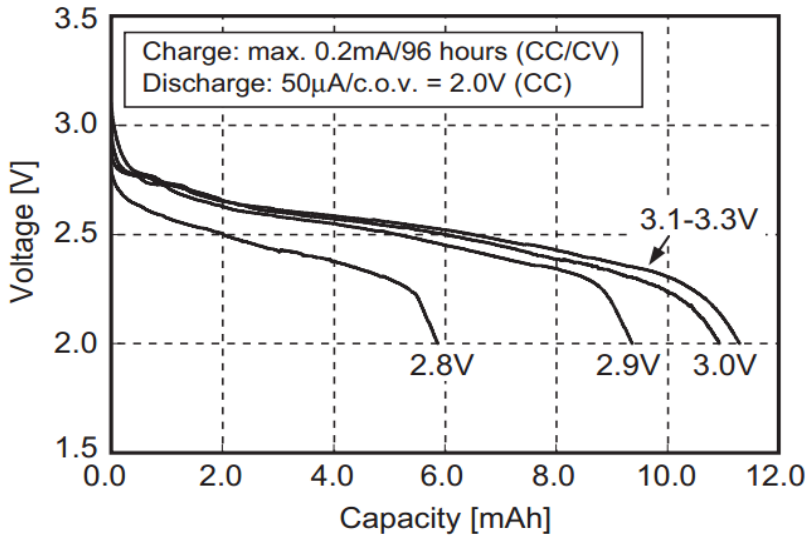

Figure 8: Seiko MS920SE Charge and Discharge Characteristics

3.5. Power on

Power is supplied to the V_BCKP pin and the VCC pin in sequence to power on the L80 module. After being powered on, the module outputs the NMEA message through the serial port. The power-on sequence diagram is shown below.

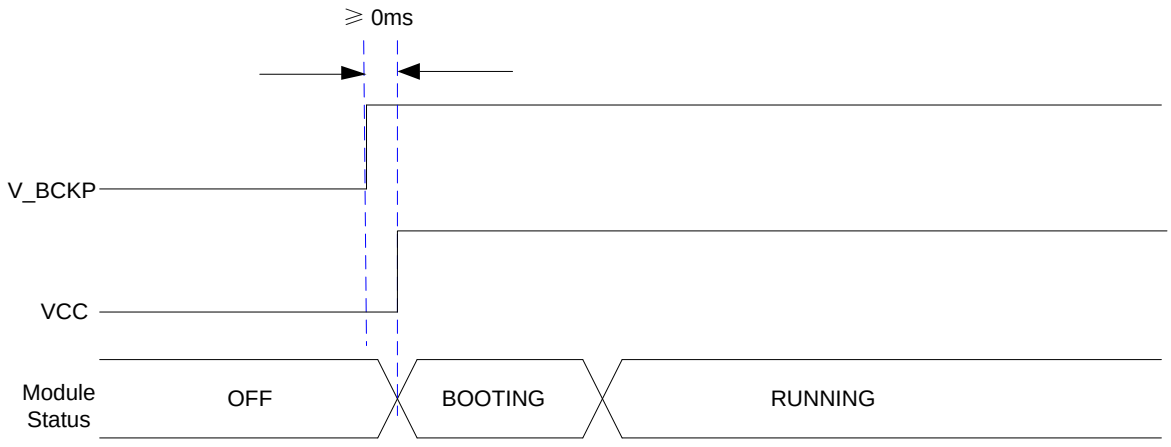

Figure 9: Power-on Timing

3.6. Reset

L80-R module can be restarted by driving RESET pin to a low level voltage for a certain time and then releasing it. This operation will reset the digital part of the GPS receiver. It should be noted that the content in the RAM is not cleared after resetting and therefore a short TTFF is possible. An OC driver circuit shown below is recommended to control the RESET pin.

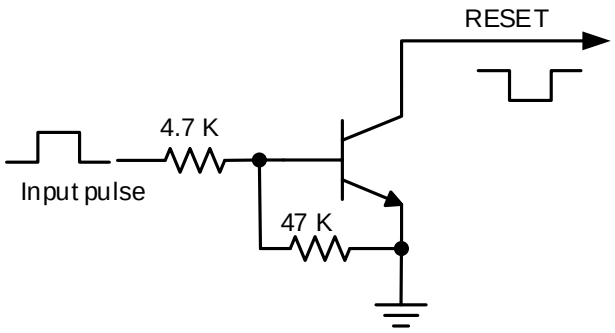

Figure 10: Reference Reset Circuit Using OC Circuit

The restart timing of L80-R is illustrated bellow.

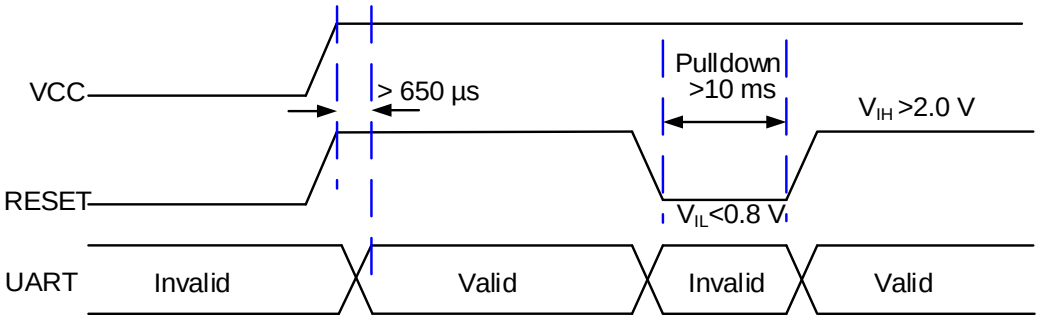

Figure 11: Restart Timing

3.7. 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 following figure. It supports data baud rate from 4800 bps to 115200 bps.

UART port:

- TXD1: Send data to the RXD signal line of DTE.
- RXD1: Receive data from the TXD signal line of DTE.

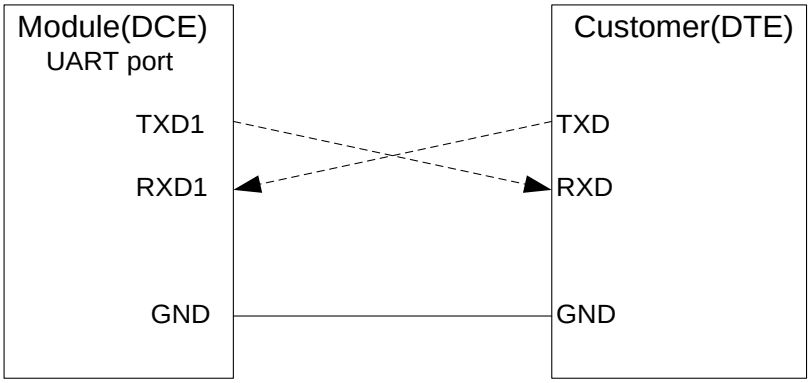

Figure 12: Connection of Serial Interfaces

This UART port has the following features:

- UART port can be used for NMEA output and PMTK proprietary commands input.
- The default output NMEA type setting is GGA, GSV, GSA, VTG and RMC.
- UART port supports the following baud rates:
  4800 bps, 9600 bps, 14400 bps, 19200 bps, 38400 bps, 57600 bps, 115200 bps.
  The default setting is 9600 bps, 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.

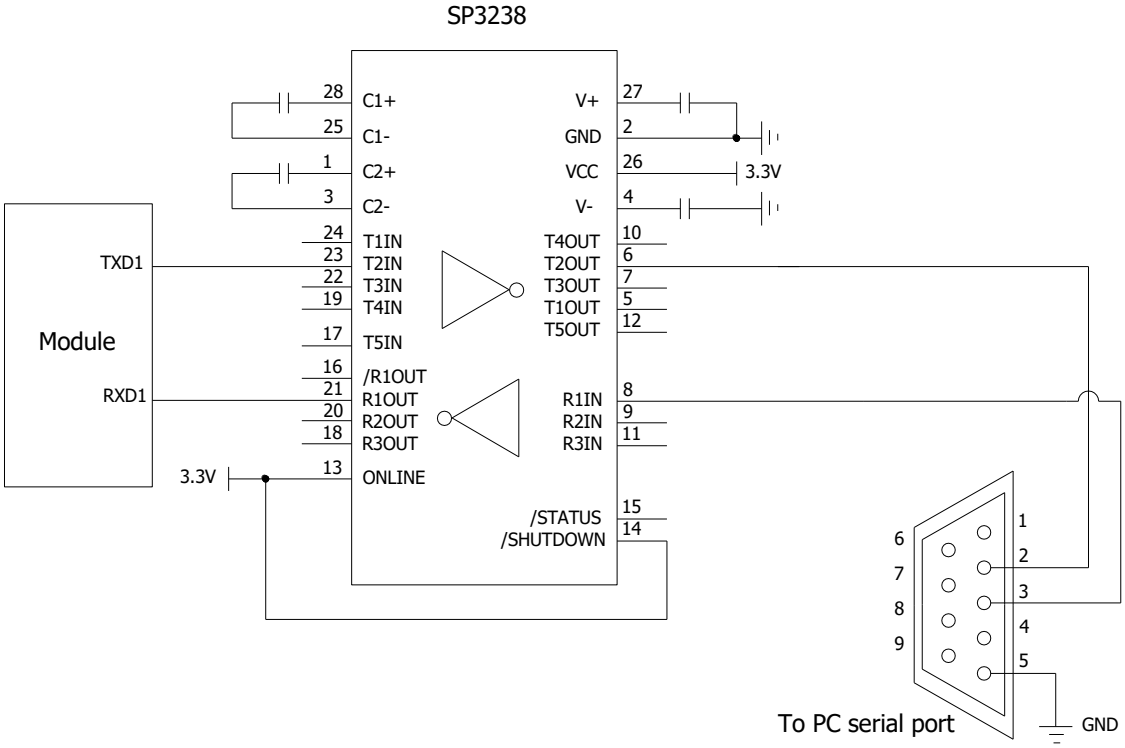

Figure 13: RS-232 Level Shift Circuit

3.8. Multi-tone AIC

L80-R module provides an advanced technology referred to as multi-tone AIC (Active Interference Cancellation) to reject RF interference caused by other active components on the main board.

Up to 12 multi-tone AIC embedded in the module can provide effective narrow-band interference and jam elimination. The GPS signal could be recovered from the jammed signal, which can ensure better navigation quality. AIC is enabled by default, closing it will save about 1 mA @ VCC = 3.3 V consumption. The following commands can be used to set AIC.

- Enable AIC function: “$PMTK 286,1*23”.
- Disable AIC function: “$PMTK 286,0*22”.

3.9. EASY Technology

EASY technology works as embedded software which can accelerate TTFF by predicting satellite navigation messages from received ephemeris. The GPS engine will calculate and predict orbit

information automatically up to 3 days after first receiving the broadcast ephemeris, and then save the predicted information into the internal memory. GPS engine will use the information for positioning if no enough information from satellites, so the function is helpful for positioning and TTFF improvement.

The EASY function can reduce TTFF to 5 seconds in warm start. In this case, RTC domain should be valid. In order to gain enough broadcast ephemeris information from GPS satellites, the GPS module should receive the information for at least 5 minutes in good signal conditions after fixing the position.

EASY function is enabled by default. Command “$PMTK869,1,0*34” can be used to disable EASY. For more details, please refer to the ***document [2]***.

3.10. PPS VS. NMEA

Pulse per Second (PPS) VS. NMEA can be used in time service. The latency range of the beginning of UART Tx is between 170 ms and 180 ms, and behind the rising edge of PPS.

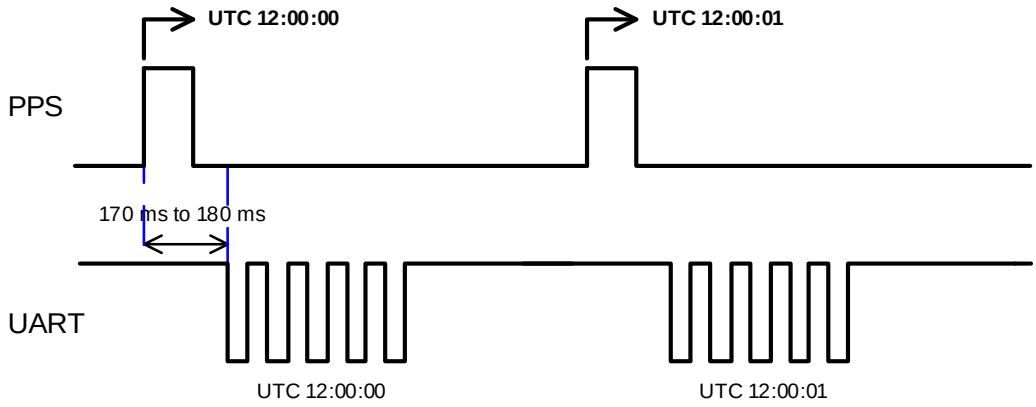

Figure 14: PPS VS. NMEA Timing

This feature only supports 1 Hz NMEA output and baud rate at 14400–115200 bps. At baud rates of 9600 bps and 4800 bps, it only supports RMC NMEA sentence. Because at low baud rate, per second transmission may exceed one second if there are many NMEA sentences output. This function can be enabled by sending “$PMTK255,1*2D”, and the function can be disabled by sending “$PMTK255,0*2C”.

4 Antenna Interfaces

L80-R module receives L1 band signal from GPS satellites at a nominal frequency of 1575.42 MHz. The LNA is embedded for better performance. It is an ultra-compact module with embedded 15.0 mm × 15.0 mm × 4.0 mm patch antenna.

4.1. Internal Patch Antenna

4.1.1. 15×15×4 Patch Antenna

The quality of the embedded GPS antenna is crucial to the overall sensitivity of the GPS system. L80-R offers an on-module patch antenna. A 15.0 mm × 15.0mm × 4.0 mm high-performance patch antenna is chosen for reducing product size. This antenna is specially designed for satellite reception applications, and it has excellent stability and sensitivity to consistently provide high signal reception efficiency. The specification of the antenna used by L80-R is described in following table.

Table 6: Antenna Specification for the Module with Ground Plane 100 mm × 60 mm

Antenna Type	Parameter	Specification	Notes
Patch Antenna	Size	15.0 mm × 15.0 mm × 4.0 mm	
	Range of Receiving Frequency	1575.42 ±1.023 MHz	
	Impendence	50 Ω	
	Bandwidth	Min. 10 MHz	Return Loss ≤ –10 dB
	Frequency Temperature Coefficient (TF)	0 ±20 ppm/°C	–40 °C to +85 °C
	Polarization	RHCP	Right Hand Circular Polarization
	Gain at Zenith	Typ. 3.4 dBi	Center frequency
	VSWR	Max. 1.5	
	Axial ratio	Max. 3 dB	

The test result of the antenna is shown in the following figure. This embedded GPS antenna provides good radiation efficiency, right hand circular polarization and optimized radiation pattern. The antenna is insensitive to surroundings and has high tolerance against frequency shifts.

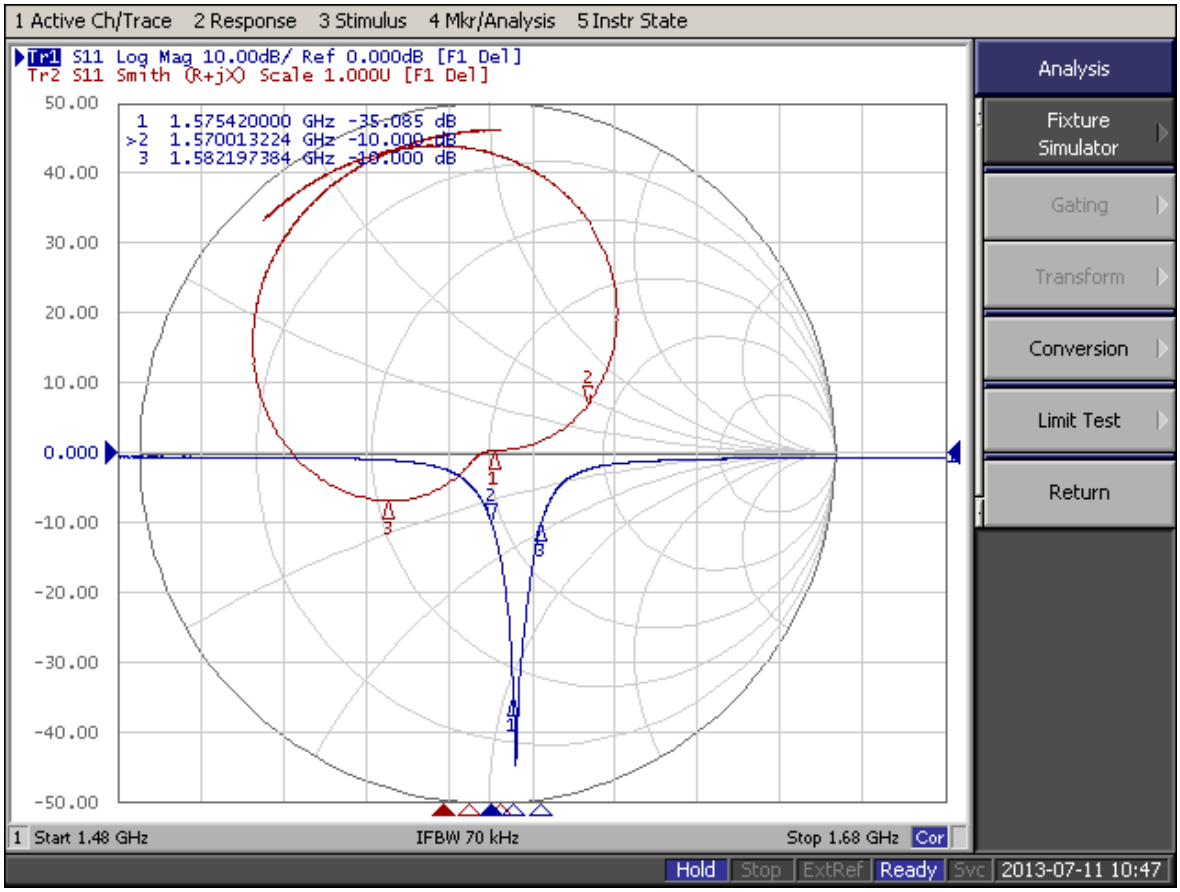

Figure 15: Patch Antenna Test Result with Ground Plane 100 mm × 60 mm

4.1.2. PCB Design Guide

The radiation characteristic of antenna depends on various factors, such as the size, shape of the PCB and the dielectric constant of components nearby. It is recommended to follow the rules listed below.

- Keep the module at least 5 mm away from the nearest edge of the motherboard, that is, it is better to be placed in the center of the motherboard.

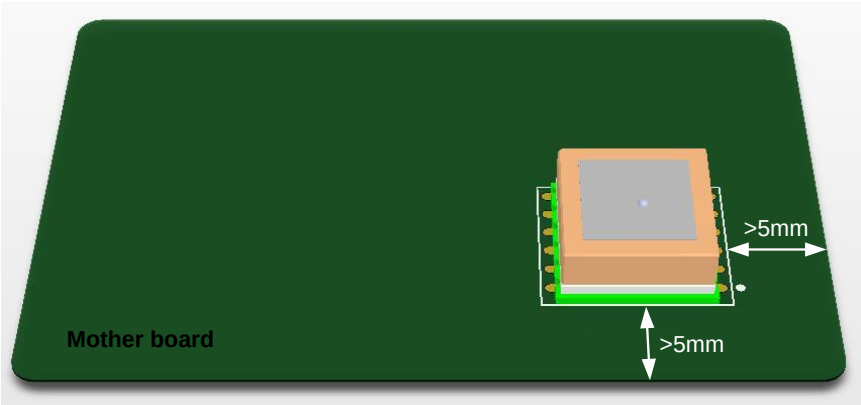

Figure 16: Recommended Distance between Module and Motherboard Edges

- The position on the motherboard corresponding to the feed point of the patch antenna should be kept out on each layer, and the diameter of the keepout area should not be less than 2.5 mm.

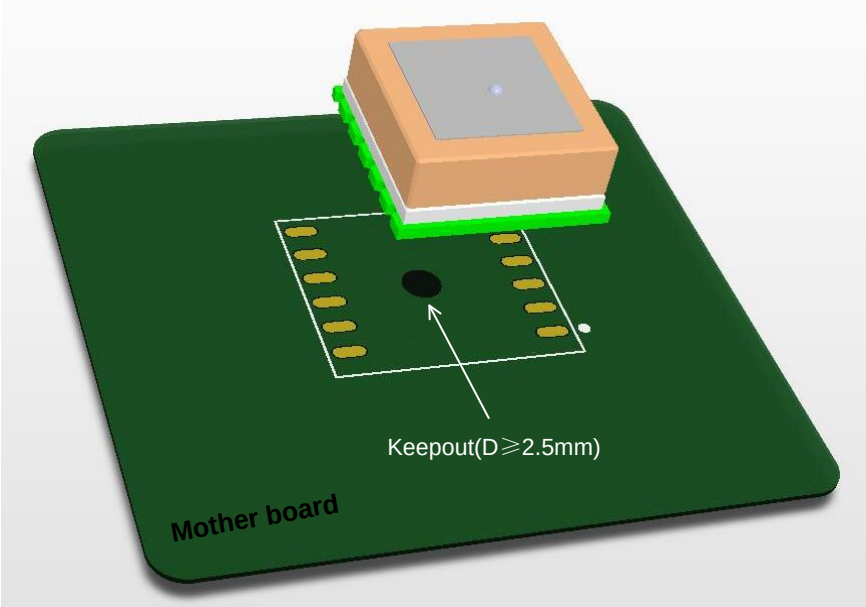

Figure 17: Recommended Treatment for the Feed Point of the Patch Antenna

- Make sure the antenna points to the sky.
- The performance of embedded patch antenna depends on the actual size of the ground plane around the module. It is recommended to design a 30 mm × 30 mm ground plane shown below. In addition, components, especially thick ones, cannot be placed in the areas in any case (interfering vias are not allowed either).

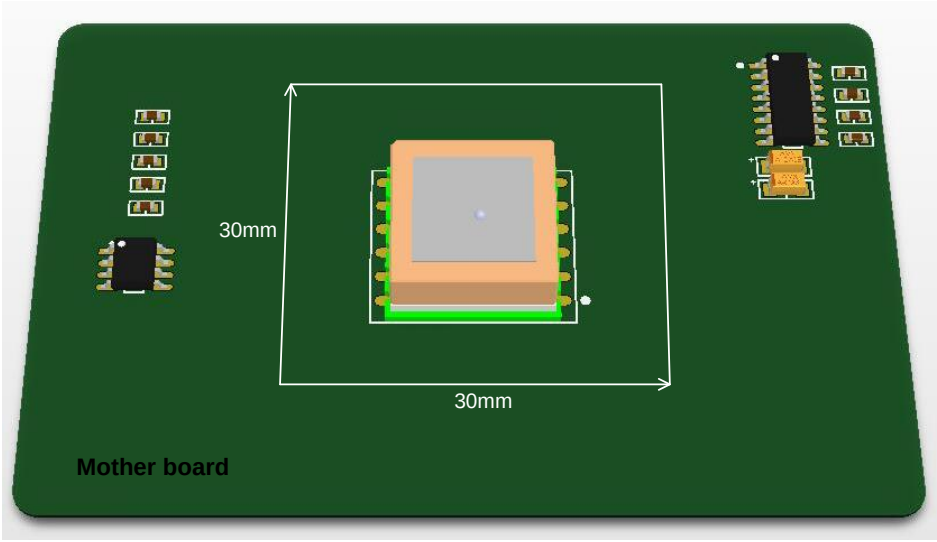

Figure 18: Recommended Ground Plane

- Keep the patch antenna at least 10 mm away from other tall metal components. Otherwise, the antenna performance will be affected.

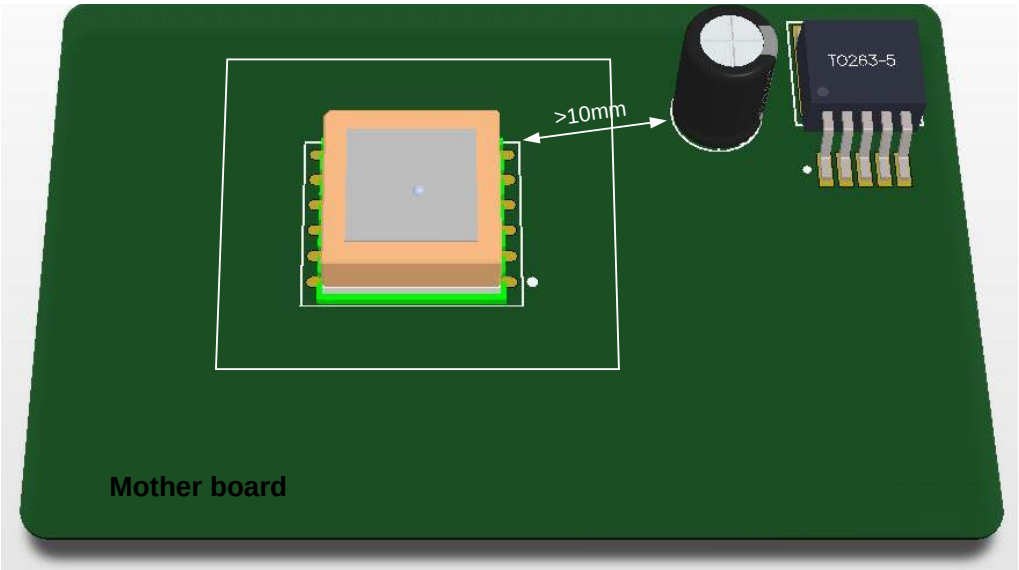

Figure 19: Recommended Distance between Module and Tall Metal Components

- Make sure the microcontroller, crystal, LCD, camera and other high-speed components and interfaces are placed on the opposite side of the module, and keep them away from the module as far as possible, such as in diagonal position of the motherboard.

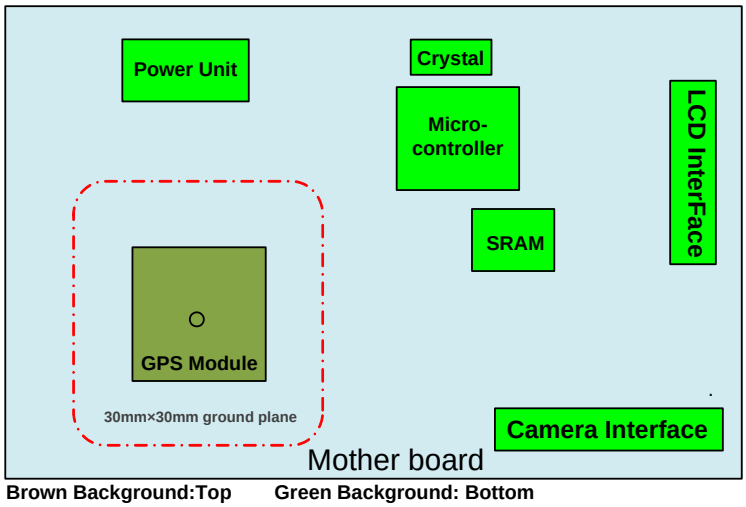

Figure 20: Recommended Placement of GNSS Module

- Make sure interfering signals (USB, LCD, Camera, Crystal, etc.) are on inner layer and shielded by ground plane, and keep them and their vias far away from the module.
- Make sure RF system such as BT/WIFI/GSM is on the opposite side of the module, and keep them away from the module as far as possible, such as in diagonal position of the board.

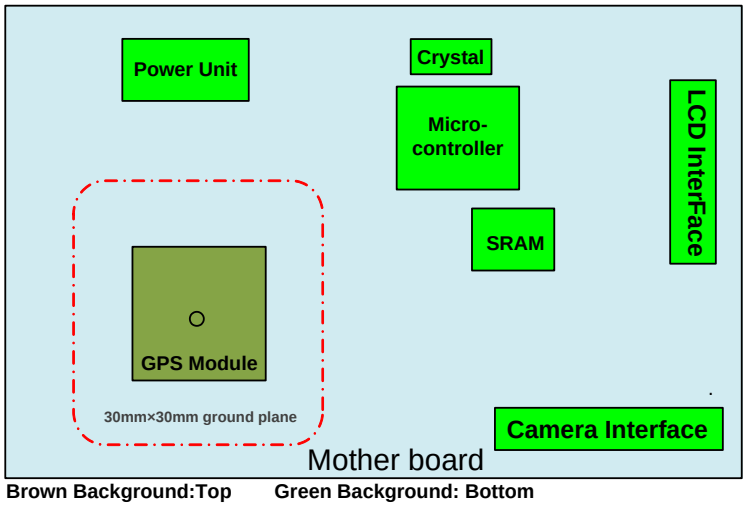

Figure 21: Recommended Placement of GNSS Module with the RF System

- Keep DCDC far away from the module.
- Device enclosure should be made of non-metal materials especially for those which are around antenna area. The minimum distance between antenna and enclosure is 3 mm.
- The RF part of GPS module is sensitive to temperature. Please keep them away from heat-emitting circuit.
- It is recommended to reserve an integrate ground layer to isolate GPS module from others.

5 Electrical, Reliability and Radio Characteristics

5.1. Absolute Maximum Ratings

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

Table 7: Absolute Maximum Ratings

Parameter	Min.	Max.	Unit
Power Supply Voltage (VCC)	–0.3	5.0	V
Backup Battery Voltage (V_BCKP)	–0.3	5.0	V
Input Voltage at Digital Pins	–0.3	3.6	V
Storage Temperature	–45	125	°C

NOTE

When in a condition with parameters exceeding the “absolute maximum ratings”, the device may be permanently damaged. The product is not protected against overvoltage or reversed voltage. Thus, it is necessary to utilize appropriate protection diodes to keep voltage spikes within the parameters given in the table above.

5.2. Operating Conditions

Table 8: 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	4.3	V
I_{VCCP}	Peak supply current	VCC = 3.3V			100	mA
V_BCKP	Backup voltage supply		2	3.3	4.3	V
TOPR	Normal operating temperature		–40	25	85	°C

NOTES

1. The figure I_{VCCP} can be used to determine the maximum current capability of power supply.
2. 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 9: Current Consumption

Parameter	Conditions	Min.	Typ.	Max.	Unit
I_{VCC} @ Acquisition	VCC = V_BCKP = 3.3V		25		mA
I_{VCC} @ Tracking	VCC = V_BCKP = 3.3V		20		mA
I_{VCC} @ Standby	VCC = V_BCKP = 3.3V		1.0		mA
I_{BCKP} @ Backup	V_BCKP = 3.3V		7		μA

NOTES

1. The tracking current is tested in the following conditions:
   - At Cold Start, 10 minutes after First Fix.
   - At Hot Start, 15 seconds after First Fix.
2. For current consumption test for the backup mode, please refer to ***Chapter 3.4.3***.

5.4. Electrostatic Discharge

L80-R module is an ESD sensitive device. ESD protection precautions should still be emphasized. Proper ESD handling and packaging procedures must be followed throughout the processing, handling and operation of any application.

The ESD bearing capability of the module is listed in the following table. Note that customers should add ESD components to module pins in particular applications.

Table 10: ESD Endurance Table (Temperature: 25 °C, Relative Humidity: 45%)

Pin	Contact Discharge	Air Discharge
Patch Antenna	±5 kV	±10 kV
VCC	±5 kV	±10 kV
UART	±3 kV	±6 kV
Others	±2 kV	±4 kV

5.5. Reliability Test

Table 11: Reliability Test

Test Item	Conditions	Standard
Thermal Shock	–30 °C to +80 °C, 144 cycles	GB/T 2423.22-2002 Test Na IEC 68-2-14 Na
Damp Heat, Cyclic	+55 °C; > 90% RH 6 cycles for 144 hours	IEC 68-2-30 Db Test

Vibration Shock	5–20 Hz, 0.96 m2/s3; 20–500 Hz, 0.96 m2/s3-3 dB/oct, 1 hour/axis; no function	2423.13-1997 Test Fdb IEC 68-2-36 Fdb Test
Heat Test	85 °C, 2 hours, operational	GB/T 2423.1-2001 Ab IEC 68-2-1 Test
Cold Test	–40 °C, 2 hours, operational	GB/T 2423.1-2001 Ab IEC 68-2-1 Test
Heat Soak	90 °C, 72 hours, non-operational	GB/T 2423.2-2001 Bb IEC 68-2-2 Test B
Cold Soak	–45 °C, 72 hours, non-operational	GB/T 2423.1-2001 A IEC 68-2-1 Test

6 Mechanical Dimensions

This chapter describes the mechanical dimensions of the module.

6.1. Mechanical Dimensions of the Module

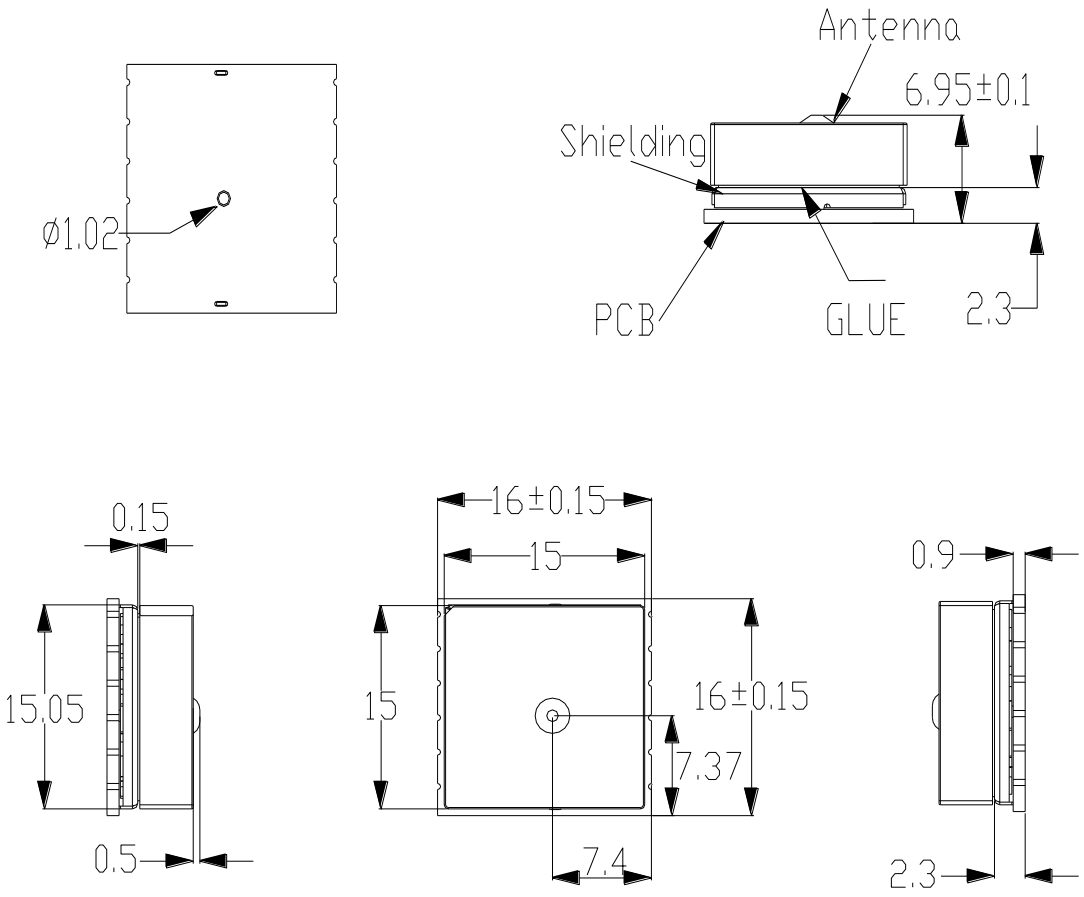

Figure 22: Mechanical Dimensions (Unit: mm)

6.2. Bottom View Dimensions and Recommended Footprint

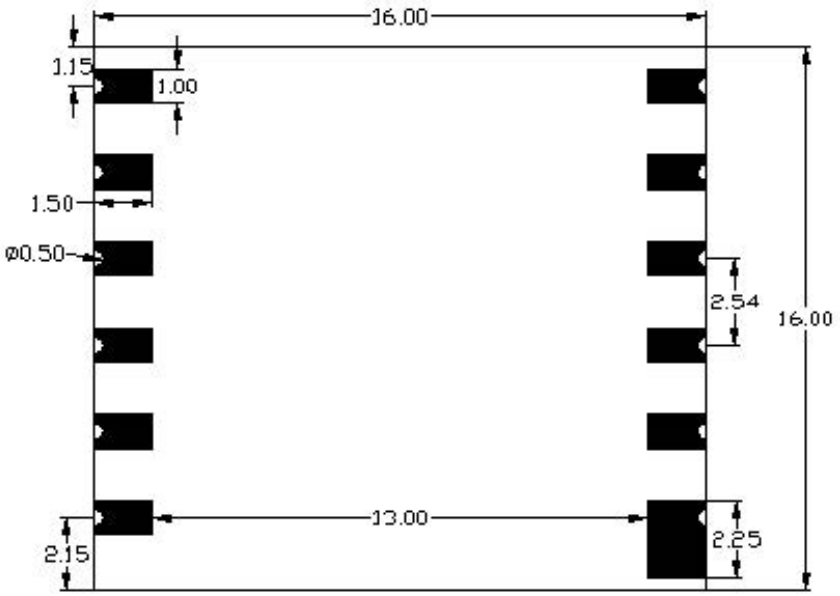

Figure 23: Bottom View Dimensions (Unit: mm)

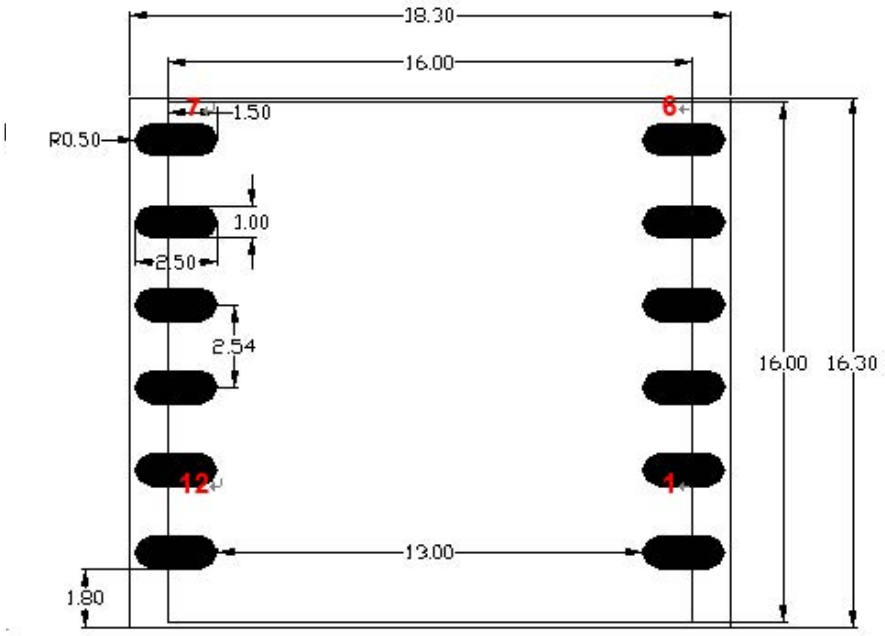

Figure 24: Recommended Footprint (Unit: mm)

NOTE

For easy maintenance, please keep a distance of no less than 3mm between the module and other components on the motherboard.

6.3. Top and Bottom Views of the Module

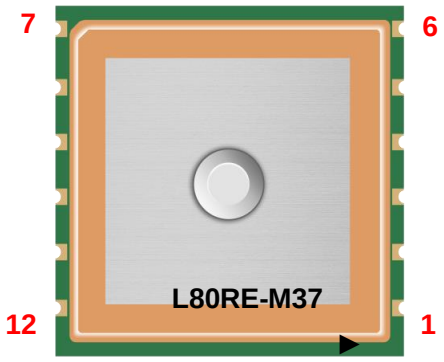

Figure 25: Top View of the Module

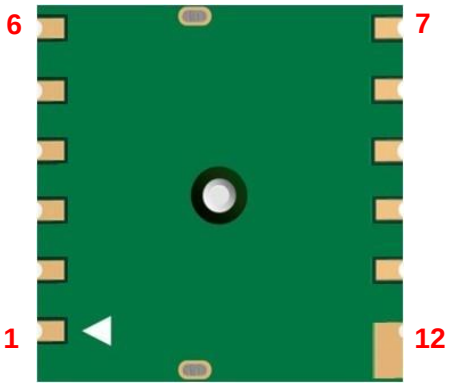

Figure 26: Bottom View of the Module

NOTES

1. The chamfer of the patch antenna does not indicate the position of pin 1.
2. These are design rendering drawings of L80-R module. For authentic appearance, please refer to the module from Quectel.

7 Manufacturing, Packaging and Ordering Information

7.1. Storage

L80-R module is provided with vacuum-sealed packaging. MSL of the module is rated as 3. The storage requirements are shown below.

1. Recommended Storage Condition: The temperature should be 23 ±5 °C and the relative humidity should be 35%–60%.

2. The storage life (in vacuum-sealed packaging) is 12 months in Recommended Storage Condition.

3. The floor life of the module is 24 hours in a plant where the temperature is 23 ±5 °C and relative humidity is below 60%. After the vacuum-sealed packaging is removed, the module must be processed in reflow soldering or other high-temperature operations within 24 hours. Otherwise, the module should be stored in an environment where the relative humidity is less than 10% (e.g. a drying cabinet).

4. The module should be pre-baked to avoid blistering, cracks and inner-layer separation in PCB under the following circumstances:

   - The module is not stored in Recommended Storage condition;
   - Violation of the third requirement above occurs;
   - Vacuum-sealed packaging is broken, or the packaging has been removed for over 24 hours;
   - Before module repairing.

5. If needed, the pre-baking should follow the requirements below:

   - The module should be baked for 8 hours at 120 ±5 °C;
   - All modules must be soldered to PCB within 24 hours after the baking, otherwise they should be put in a dry environment such as in a drying oven.

NOTE

Please take the module out of the packaging and put it on high-temperature resistant fixtures before the baking. If shorter baking time is desired, please refer to *IPC/JEDEC J-STD-033* for baking procedure.

7.2. Manufacturing and Soldering

Push the squeegee to apply the solder paste on the surface of stencil, so that the paste fills the stencil openings and then penetrate to the PCB. The force on the squeegee should be adjusted properly so as to produce a clean stencil surface on a single pass. To ensure the module soldering quality, the thickness of stencil for the module is recommended to range from 0.15–0.18 mm. For more details, please refer to ***document [3]***.

It is suggested that the peak reflow temperature ranges from 238–246 ºC, and the absolute maximum reflow temperature is 246 ºC. To avoid damage to the module caused by repeated heating, it is strongly recommended that the module should be mounted after reflow soldering for the other side of PCB has been completed. The recommended reflow soldering thermal profile (lead-free reflow soldering) and related parameters are shown below.

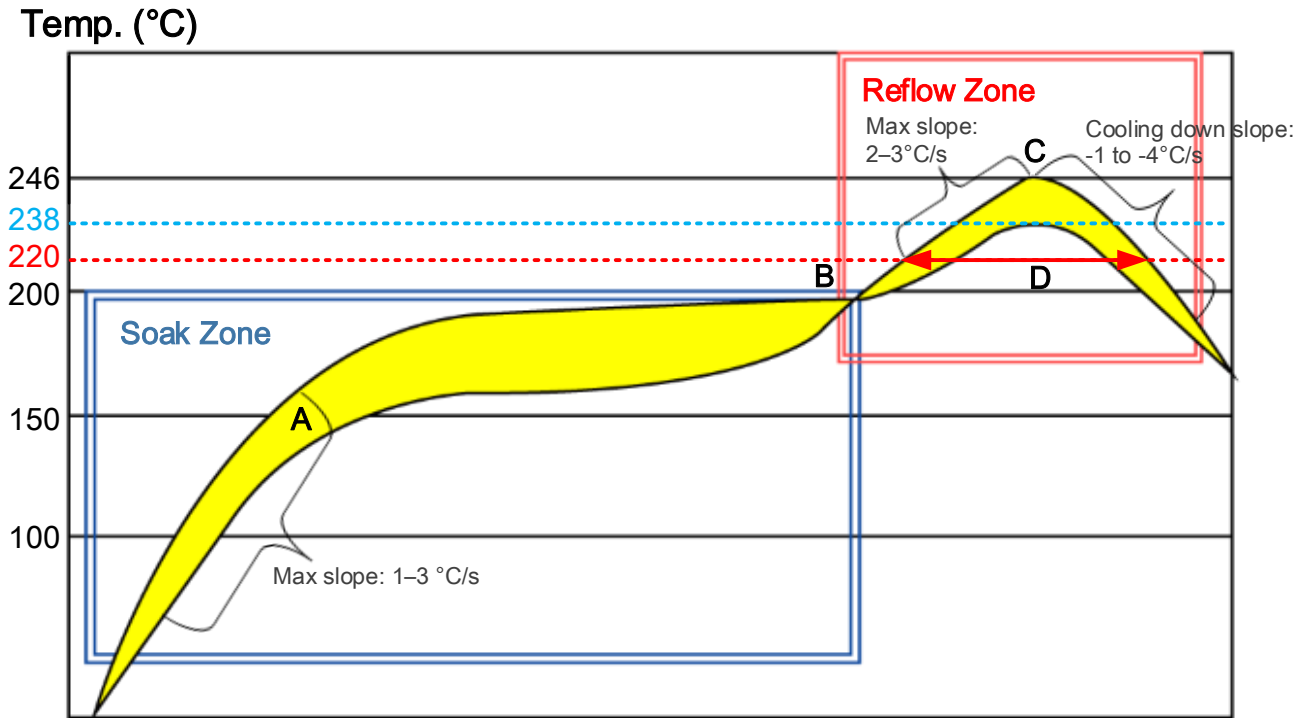

Figure 27: Recommended Reflow Soldering Thermal Profile

Table 12: Recommended Thermal Profile Parameters

Factor	Recommendation
Soak Zone	
Max slope	1–3 °C/s
Soak time (between A and B: 150°C and 200°C)	70–120 s
Reflow Zone	
Max slope	2–3 °C/s
Reflow time (D: over 220°C)	45–70 s
Max temperature	238–246 °C
Cooling down slope	-1 to -4 °C/s
Reflow Cycle	
Max reflow cycle	1

NOTES

1. During manufacturing and soldering, or any other processes that may contact the module directly, NEVER wipe the module's shielding can with organic solvents, such as acetone, ethyl alcohol, isopropyl alcohol, trichloroethylene, etc. Otherwise, the shielding can may become rusted.
2. The shielding can for the module is made of Cupro-Nickel base material. It is tested that after 12 hours' Neutral Salt Spray test, the laser engraved label information on the shielding can is still clearly identifiable and the QR code is still readable, although white rust may be found.

7.3. Packaging

The modules are stored inside a vacuum-sealed bag under ESD protection. It should not be opened until the devices are ready to be soldered onto the application.

7.3.1. Tape and Reel Packaging

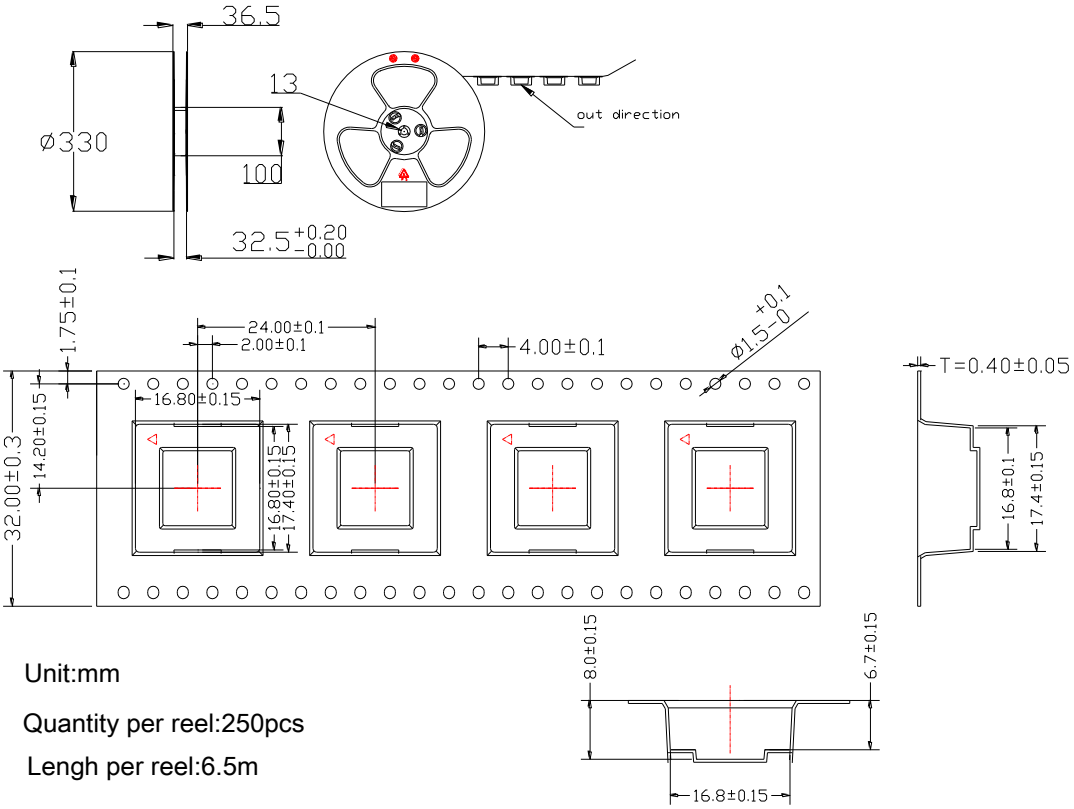

Figure 28: Tape and Reel Specifications (Unit: mm)

Table 13: Reel Packaging

Model Name	MOQ for MP	Minimum Package: 250pcs	Minimum Package x4 = 1000pcs
L80-R	250pcs	Size: 370 mm × 350 mm × 56 mm N.W: 1.5 kg G.W: 2.25 kg	Size: 380 mm × 250 mm × 365 mm N.W: 6.1 kg G.W: 9.4 kg

7.4. Ordering Information

Table 14: Ordering Information

Model Name	Ordering Code
L80-R	L80RE-M37

8 Appendix A References

Table 15: Related Documents

SN	Document Name	Remark
[1]	Quectel_L80-R_EVB_User Guide	L80-R EVB user guide
[2]	Quectel_L80-R_GPS_Protocol_Specification	L80-R GPS protocol specification
[3]	Quectel_Module_Secondary_SMT_Application_Note	Secondary SMT user guide for Quectel modules

Table 16: Terms and Abbreviations

Abbreviation	Description
AGPS	Assisted GPS
AIC	Active Interference Cancellation
CEP	Circular Error Probable
DGPS	Differential GPS
EGNOS	European Geostationary Navigation Overlay Service
EPO	Extended Prediction Orbit
ESD	Electrostatic Discharge
GPS	Global Positioning System
GNSS	Global Navigation Satellite System
GGA	GPS Fix Data
GLL	Geographic Position—Latitude/Longitude
GLONASS	Global Navigation Satellite System
GSA	GNSS DOP and Active Satellites

GSV	GNSS Satellites in View
HDOP	Horizontal Dilution of Precision
I/O	Input/Output
Inom	Nominal Current
Imax	Maximum Load Current
Kbps	Kilo Bits Per Second
LNA	Low Noise Amplifier
MSAS	Multi-Functional Satellite Augmentation System
MSL	Moisture Sensitive Level
MOQ	Minimum Order Quantity
NMEA	National Marine Electronics Association
PDOP	Position Dilution of Precision
PMTK	MTK Proprietary Protocol
PPS	Pulse Per Second
PRN	Pseudo Random Noise Code
QZSS	Quasi-Zenith Satellite System
RHCP	Right Hand Circular Polarization
RMC	Recommended Minimum Specific GNSS Data
SBAS	Satellite-based Augmentation System
SAW	Surface Acoustic Wave
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
Vmax	Maximum Voltage Value
Vnom	Nominal Voltage Value

Vmin	Minimum Voltage Value
V_{IH}max	Maximum Input High Level Voltage Value
V_{IH}min	Minimum Input High Level Voltage Value
V_{IL}max	Maximum Input Low Level Voltage Value
V_{IL}min	Minimum Input Low Level Voltage Value
V_{I}max	Absolute Maximum Input Voltage Value
V_{I}min	Absolute Minimum Input Voltage Value
V_{OH}max	Maximum Output High Level Voltage Value
V_{OH}min	Minimum Output High Level Voltage Value
V_{OL}max	Maximum Output Low Level Voltage Value
V_{OL}min	Minimum Output Low Level Voltage Value
WAAS	Wide Area Augmentation System