

L80-R Hardware Design

GPS Module Series

Rev. L80-R_Hardware_Design_V1.2

Date: 2016-04-22



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

Quectel Wireless Solutions Co., Ltd.

Office 501, Building 13, No.99, Tianzhou Road, 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/salesupport.aspx>

For technical support, or to report documentation errors, please visit:

<http://www.quectel.com/support/techsupport.aspx>

Or email to: Support@quectel.com

GENERAL NOTES

QUECTEL OFFERS THE INFORMATION AS A SERVICE TO ITS CUSTOMERS. THE INFORMATION PROVIDED IS BASED UPON CUSTOMERS' REQUIREMENTS. QUECTEL MAKES EVERY EFFORT TO ENSURE THE QUALITY OF THE INFORMATION IT MAKES AVAILABLE. QUECTEL DOES NOT MAKE ANY WARRANTY AS TO THE INFORMATION CONTAINED HEREIN, AND DOES NOT ACCEPT ANY LIABILITY FOR ANY INJURY, LOSS OR DAMAGE OF ANY KIND INCURRED BY USE OF OR RELIANCE UPON THE INFORMATION. ALL INFORMATION SUPPLIED HEREIN IS SUBJECT TO CHANGE WITHOUT PRIOR NOTICE.

COPYRIGHT

THE INFORMATION CONTAINED HERE IS PROPRIETARY TECHNICAL INFORMATION OF QUECTEL CO., LTD. TRANSMITTING, REPRODUCTION, DISSEMINATION AND EDITING OF THIS DOCUMENT AS WELL AS UTILIZATION OF THE CONTENT ARE FORBIDDEN WITHOUT PERMISSION. OFFENDERS WILL BE HELD LIABLE FOR PAYMENT OF DAMAGES. ALL RIGHTS ARE RESERVED IN THE EVENT OF A PATENT GRANT OR REGISTRATION OF A UTILITY MODEL OR DESIGN.

Copyright © Quectel Wireless Solutions Co., Ltd. 2016. All rights reserved.

About the Document

History

Revision	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.

Contents

About the Document	2
Contents	3
Table Index	5
Figure Index	6
1 Introduction	7
2 Description	8
2.1. General Description	8
2.2. Key Features	8
2.3. Block Diagram	9
2.4. Evaluation Board	10
2.5. Protocols Supported by the Module	10
3 Application	11
3.1. Pin Assignment	11
3.2. Pin Definition	11
3.3. Power Supply	13
3.4. Operating Modes	14
3.4.1. Full on Mode	15
3.4.2. Standby Mode	15
3.4.3. Backup Mode	15
3.5. Reset	17
3.6. UART Interface	18
3.7. Multi-tone AIC	19
3.8. EASY Technology	20
3.9. PPS VS. NMEA	20
4 Antenna Interfaces	21
4.1. Internal Patch Antenna	21
4.1.1. 15x15x4 Patch Antenna	21
4.1.2. PCB Design Guide	22
5 Electrical, Reliability and Radio Characteristics	26
5.1. Absolute Maximum Ratings	26
5.2. Operating Conditions	27
5.3. Current Consumption	27
5.4. Electrostatic Discharge	28
5.5. Reliability Test	28
6 Mechanical Dimensions	30
6.1. Mechanical Dimensions of the Module	30
6.2. Bottom View Dimensions and Recommended Footprint	31
6.3. Top and Bottom View of the Module	32

7	Manufacturing, Packaging and Ordering Information	33
7.1.	Assembly and Soldering	33
7.2.	Moisture Sensitivity	34
7.3.	ESD Protection.....	34
7.4.	Tape and Reel Packaging.....	35
7.5.	Ordering Information	35
8	Appendix References	36

Quectel
Confidential

Table Index

TABLE 1: KEY FEATURES	8
TABLE 2: PROTOCOLS SUPPORTED BY THE MODULE	10
TABLE 3: PIN DESCRIPTION	11
TABLE 4: MODULE STATES SWITCH.....	14
TABLE 5: DEFAULT CONFIGURATIONS.....	15
TABLE 6: ANTENNA SPECIFICATION FOR THE MODULE WITH GROUND PLANE 100MMx60MM ..	21
TABLE 7: ABSOLUTE MAXIMUM RATINGS.....	26
TABLE 8: POWER SUPPLY RATINGS.....	27
TABLE 9: CURRENT CONSUMPTION	27
TABLE 10: ESD ENDURANCE TABLE (TEMPERATURE: 25°C, HUMIDITY: 45%).....	28
TABLE 11: RELIABILITY TEST	28
TABLE 12: REEL PACKAGING.....	35
TABLE 13: ORDERING INFORMATION	35
TABLE 14: RELATED DOCUMENTS	36
TABLE 15: TERMS AND ABBREVIATIONS	36

Figure Index

FIGURE 1: BLOCK DIAGRAM.....	10
FIGURE 2: PIN ASSIGNMENT	11
FIGURE 3: INTERNAL POWER CONSTRUCTION	13
FIGURE 4: REFERENCE CIRCUIT FOR POWER SUPPLY	14
FIGURE 5: RTC SUPPLY FROM NON-CHARGEABLE BATTERY	16
FIGURE 6: REFERENCE CHARGING CIRCUIT FOR CHARGEABLE BATTERY	16
FIGURE 7: SEIKO MS920SE CHARGE AND DISCHARGE CHARACTERISTICS	17
FIGURE 8: REFERENCE RESET CIRCUIT USING OC CIRCUIT	17
FIGURE 9: RESTART TIMING.....	18
FIGURE 10: CONNECTION OF SERIAL INTERFACES.....	18
FIGURE 11: RS-232 LEVEL SHIFT CIRCUIT	19
FIGURE 12: PPS VS. NMEA TIMING.....	20
FIGURE 13: PATCH ANTENNA TEST RESULT WITH GROUND PLANE 100MM × 60MM.....	22
FIGURE 14: RECOMMENDED DISTANCE BETWEEN MODULE AND MOTHER BOARD EDGES.....	23
FIGURE 15: RECOMMENDED TREATMENT FOR THE FEED POINT OF THE PATCH ANTENNA	23
FIGURE 16: RECOMMENDED GROUND PLANE	24
FIGURE 17: RECOMMENDED DISTANCE BETWEEN MODULE AND TALL METAL COMPONENTS	24
FIGURE 18: RECOMMENDED PLACEMENT OF GNSS MODULE	25
FIGURE 19: RECOMMENDED PLACEMENT OF GNSS MODULE WITH THE RF SYSTEM.....	25
FIGURE 20: MECHANICAL DIMENSIONS (UNIT: MM)	30
FIGURE 21: BOTTOM VIEW DIMENSIONS (UNIT: MM)	31
FIGURE 22: RECOMMENDED FOOTPRINT (UNIT: MM).....	31
FIGURE 23: TOP VIEW OF THE MODULE	32
FIGURE 24: BOTTOM VIEW OF THE MODULE	32
FIGURE 25: RECOMMENDED REFLOW SOLDERING THERMAL PROFILE.....	33
FIGURE 26: TAPE AND REEL SPECIFICATIONS.....	35

1 Introduction

This document defines and specifies L80-R GPS module. It describes hardware interfaces, external application reference circuits, mechanical size and air interface of L80-R module.

This document can help you 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 your reference. These documents provide the guidance for you to design and set up applications relating to L80-R module.

Quectel
Confidential

2 Description

2.1. General Description

L80-R GPS module with an embedded patch antenna (15mm × 15mm × 4mm) and LNA brings high performance of MTK positioning engine to the industrial applications. It is able to achieve the industry's highest level of sensitivity, accuracy and TTFF with the lowest power consumption in a small-footprint leadless package. With 66 search channels and 22 simultaneous tracking channels, it acquires and tracks satellites in the shortest time even at indoor signal level.

L80-R module integrates many advanced features including AIC, EASY into the compact form factor. These features are beneficial to reduce TTFF and improve sensitivity for GPS system. L80-R simplifies the device's design and cost because of embedded Patch Antenna and LNA.

L80-R module is a SMD type module with the compact 16mm × 16mm × 6.45mm form factor. It can be embedded in your applications through the 12-pin pads with 2.54mm pitch. It provides necessary hardware interfaces for connection with the main PCB.

The module is fully RoHS compliant to EU regulation.

2.2. Key Features

Table 1: Key Features

Feature	Implementation
Power Supply	<ul style="list-style-type: none"> Supply voltage: 3.0V~4.3V typical: 3.3V
Power Consumption	<ul style="list-style-type: none"> Acquisition: 25mA @VCC=V_BCKP=3.3V Tracking: 20mA @VCC=V_BCKP=3.3V Standby: 1.0mA @VCC=V_BCKP=3.3V Backup: 7uA @V_BCKP=3.3V
Receiver Type	<ul style="list-style-type: none"> GPS L1 1575.42MHz C/A Code 66 search channels, 22 simultaneous tracking channels Acquisition: -148dBm

Sensitivity	<ul style="list-style-type: none"> ● Re-acquisition: -160dBm ● Tracking: -165dBm
TTFF (EASY enabled)	<ul style="list-style-type: none"> ● Cold start: 15s typ. @-130dBm ● Warm start: 5s typ. @-130dBm ● Hot start: 1s typ. @-130dBm
TTFF (EASY disabled)	<ul style="list-style-type: none"> ● Cold start (Autonomous): 35s typ. @-130dBm ● Warm start (Autonomous): 30s typ. @-130dBm ● Hot start (Autonomous): 1s typ. @-130dBm
Horizontal Position Accuracy (Autonomous)	<ul style="list-style-type: none"> ● <2.5m CEP @-130dBm
Max Update Rate	<ul style="list-style-type: none"> ● Up to 5Hz, 1Hz by default
Accuracy of 1PPS Signal	<ul style="list-style-type: none"> ● Typical accuracy: ± 10ns ● Time pulse width 100ms
Velocity Accuracy	<ul style="list-style-type: none"> ● Without aid: 0.1m/s
Acceleration Accuracy	<ul style="list-style-type: none"> ● Without aid: 0.1m/s²
Dynamic Performance	<ul style="list-style-type: none"> ● Maximum altitude: 18,000m ● Maximum velocity: 515m/s ● Acceleration: 4G
UART Port	<ul style="list-style-type: none"> ● UART Port: TXD1 and RXD1 ● Supports baud rate from 4800bps to 115200bps, 9600bps by default ● UART port is used for NMEA output, MTK proprietary commands input
Temperature Range	<ul style="list-style-type: none"> ● Normal operation: -40°C ~ +85°C ● Storage temperature: -45°C ~ +125°C
Physical Characteristics	<ul style="list-style-type: none"> ● Size: 16\pm0.15 × 16\pm0.15 × 6.45\pm0.1mm ● Weight: Approx. 6.0g

NOTE

The power consumption is measured in the open sky 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.

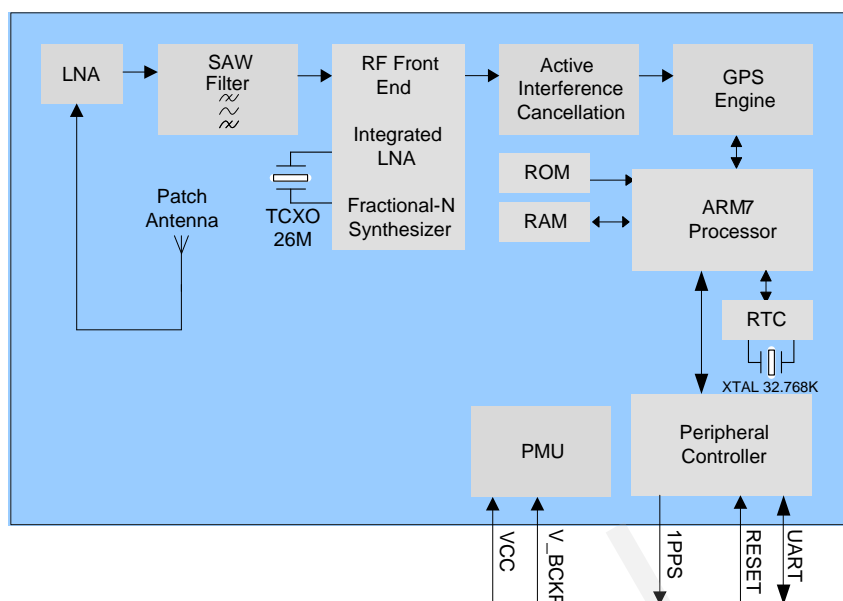


Figure 1: Block Diagram

2.4. Evaluation Board

In order to help you use L80-R module on your applications, Quectel supplies an Evaluation Board (EVB) with 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

Please refer to **document [2]** for details of NMEA standard protocol and MTK proprietary protocol.

3 Application

The module is equipped with a 12-pin 2.54mm pitch SMT pad that connects to your application platform. Sub-interfaces included in the pad are described in details in the following chapters.

3.1. Pin Assignment

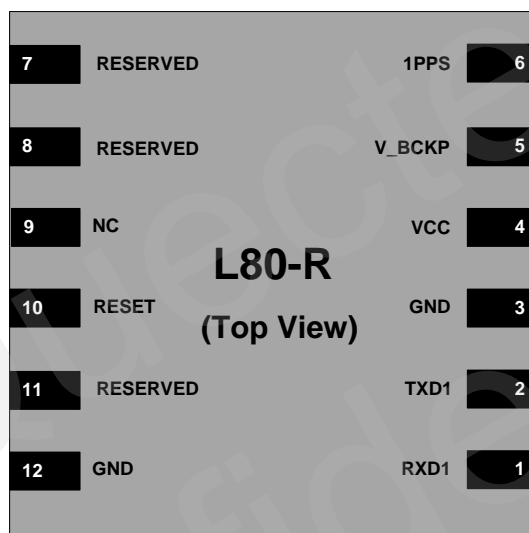


Figure 2: Pin Assignment

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=4.3V Vmin=3.0V Vnom=3.3V	Supply current not less than 100mA.
V_BCKP	5	I	Backup power	Vmax=4.3V	Supply power for RTC

supply

V_{min}=1.5V
V_{nom}=3.3V

domain. The V_BCKP pin can be directly supplied power by battery or connect it to VCC.

Reset

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
RESET	10	I	System reset	V _{ILmin} =-0.3V V _{ILmax} =0.8V V _{IHmin} =2.0V V _{IHmax} =3.6V	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 _{ILmin} =-0.3V V _{ILmax} =0.8V V _{IHmin} =2.0V V _{IHmax} =3.6V	
TXD1	2	O	Transmit data	V _{OLmin} =-0.3V V _{OLmax} =0.4V V _{OHmin} =2.4V V _{OHmax} =3.1V	

Other Interfaces

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
1PPS	6	O	One pulse per second	V _{OLmin} =-0.3V V _{OLmax} =0.4V V _{OHmin} =2.4V V _{OHmax} =3.1V	Synchronized at rising edge, the pulse width is 100ms. If unused, keep this pin open.
RESERVED	7				Keep this pin open
RESERVED	8				Keep this pin open
RESERVED	11				Keep this pin open

NOTE

The incision of the patch antenna does not indicate the position of pin 1.

3.3. Power Supply

VCC pin supplies power for BB, RF, I/O, 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. 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 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 1.5V to 4.3V. 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 V_BCKP supplies power for RTC domain.

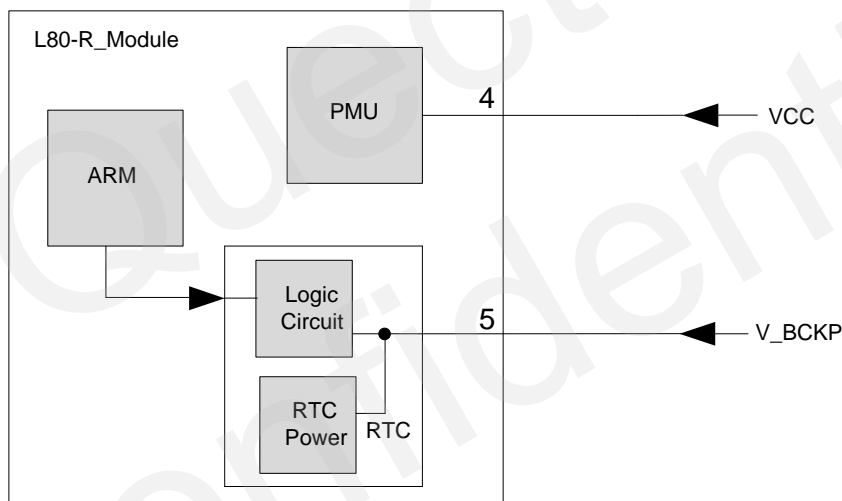


Figure 3: Internal Power Construction

Power supply solutions for L80-R module are listed as below.

The simplest power circuit for L80-R module is 3.3V power source connected to VCC pin and V_BCKP pin of the module directly. In this case, once you powering on the module, the full cold start will be implemented.

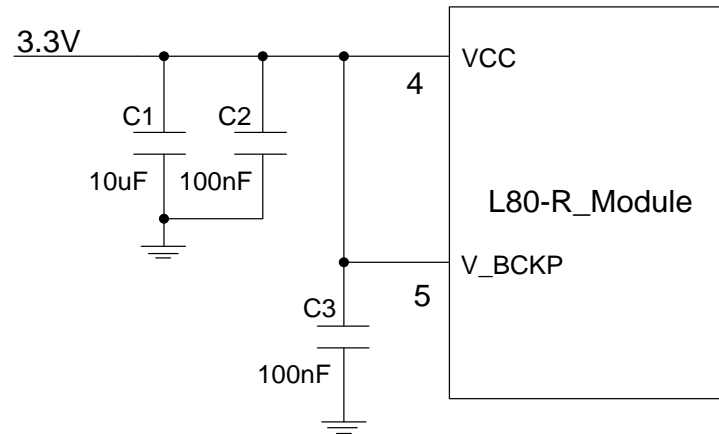


Figure 4: Reference Circuit for Power Supply

NOTES

1. If your power supply circuit adopts the design mentioned above, L80-R module does not support backup mode as well as other modes related to it.
2. VCC does not supply power for RTC domain in L80-R module, so 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 States Switch

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	Remain V_BCKP and cut off VCC	Send PMTK161 command	N/A

NOTE

For more details on 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 module starts to search satellites, determines visible satellites and coarse carrier frequency as well as code phase of satellite signals. When the acquisition is completed, it switches to tracking mode automatically. Tracking mode is defined as 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 into full on mode automatically and follow the default configurations as below. You can refer to Chapter 3.3 about internal power construction to have a better comprehension. You can also use PMTK commands to change the configurations to meet your requirements.

Table 5: Default Configurations

Item	Configuration	Comment
Baud Rate	9600bps	
Protocol	NMEA	GGA, GSV, GSA, VTG and RMC
Update Rate	1Hz	
EASY	Enable	EASY will be disabled automatically when update rate exceeds 1Hz
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 satellites 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 into 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 1mA @VCC=3.3V.

3.4.3. Backup Mode

Backup mode consumes lower power than standby mode. In this mode, only the backup supply V_BCKP

is powered on while the main supply VCC is cut off.

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 typical consumption in backup mode can be as low as 7uA.

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.

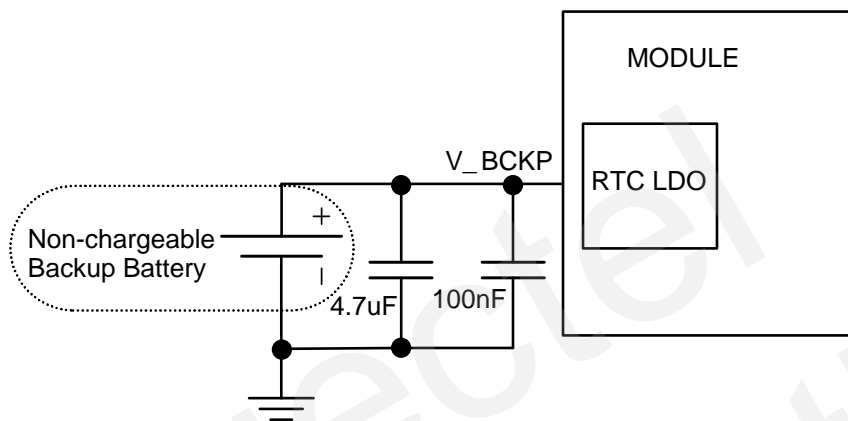


Figure 5: RTC Supply from Non-chargeable Battery

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

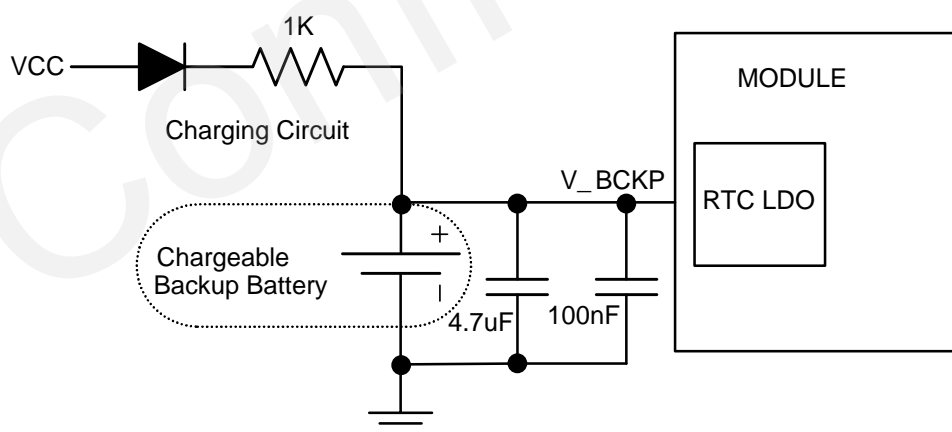


Figure 6: Reference Charging Circuit for Chargeable Battery

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.

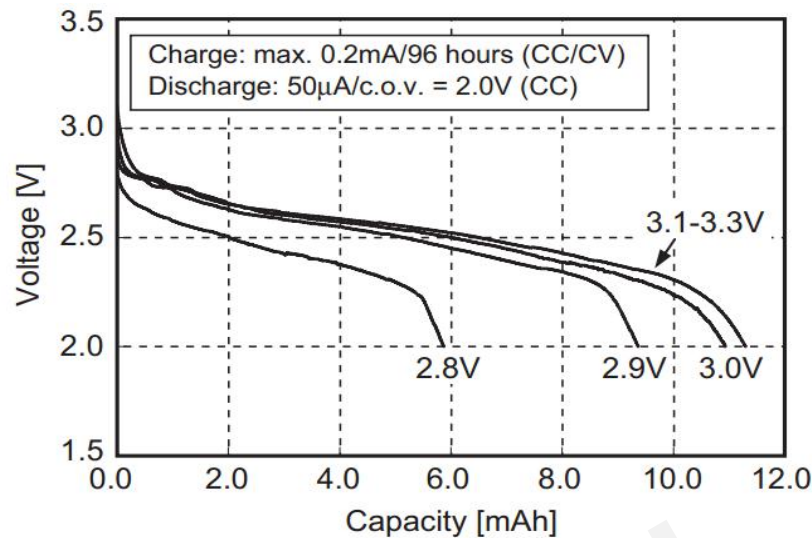


Figure 7: Seiko MS920SE Charge and Discharge Characteristics

3.5. Reset

L80-R module can be restarted by driving the RESET to a low level voltage for a certain time and then releasing it. This operation will reset the digital part of the GPS receiver. Note that the content in the RAM is not cleared, thus a fast TTFF is possible. An OC driver circuit shown as below is recommended to control the RESET.

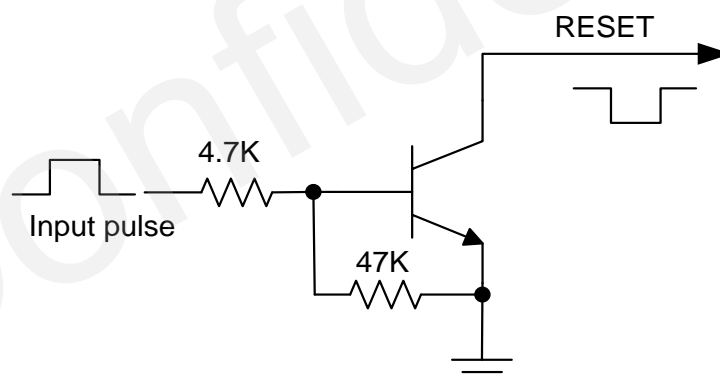


Figure 8: Reference Reset Circuit Using OC Circuit

The restart timing of L80-R has been illustrated bellow.

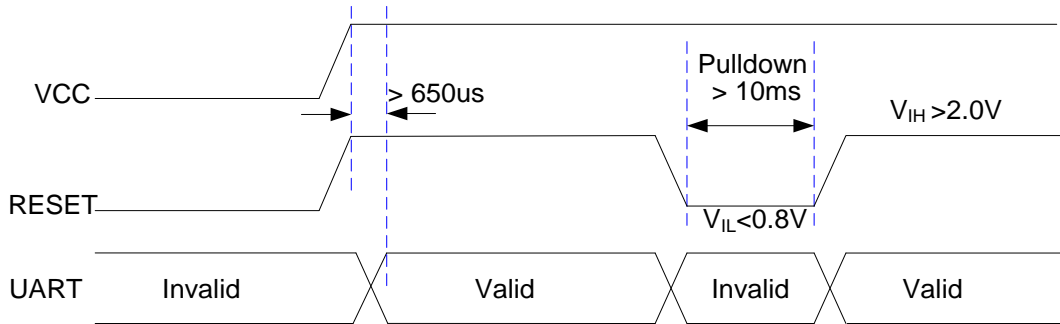


Figure 9: Restart Timing

3.6. 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 4800bps to 115200bps.

UART port:

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

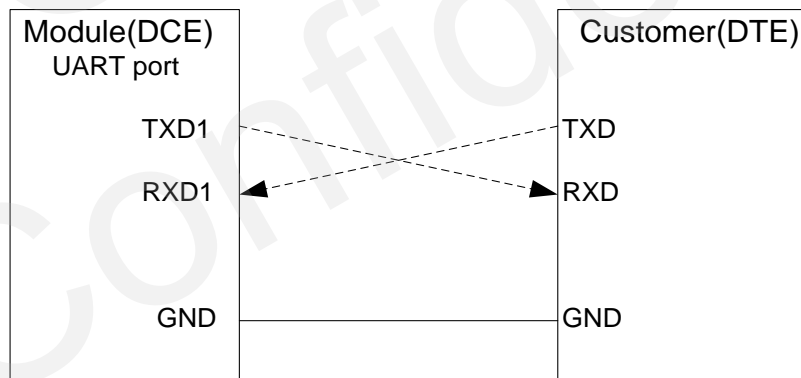


Figure 10: Connection of Serial Interfaces

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 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.

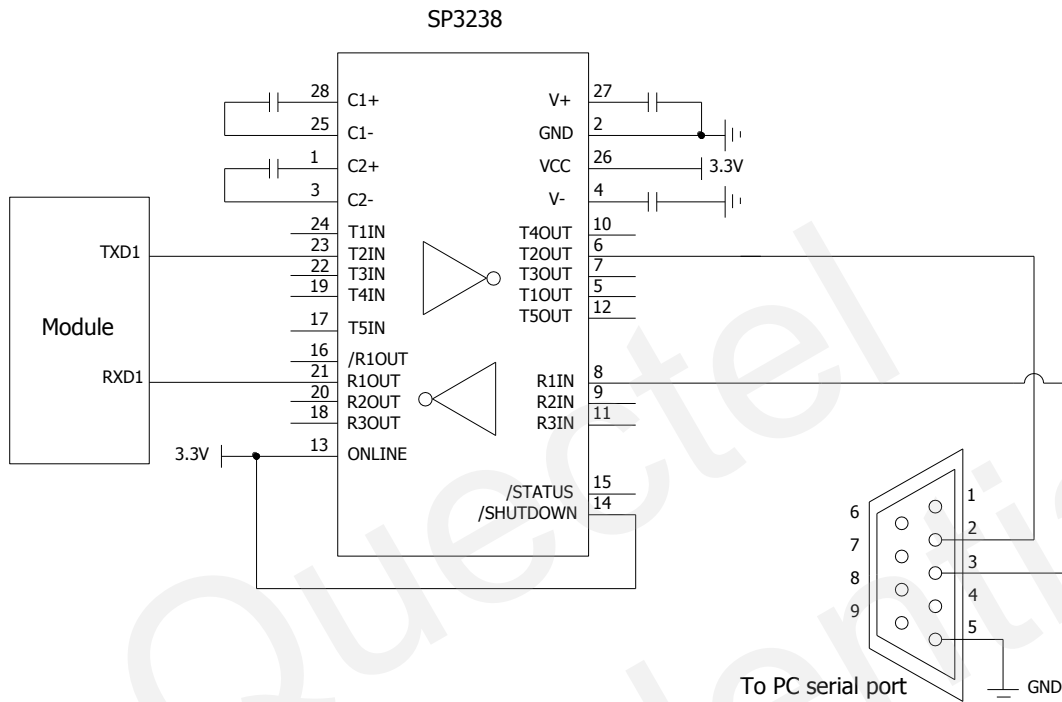


Figure 11: RS-232 Level Shift Circuit

3.7. Multi-tone AIC

L80-R module provides an advanced technology called multi-tone AIC (Active Interference Cancellation) to reject RF interference which comes from other active components on the main board.

Up to 12 multi-tone AIC embedded in the module can provide effective narrow-band interference and jamming 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 1mA @VCC=3.3V consumption. The following commands can be used to set AIC.

Enable AIC function: "\$PMTK 286,1*23".

Disable AIC function: "\$PMTK 286,0*22".

3.8. 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 5s 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 \[2\]](#).

3.9. 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 170ms and 180ms, and behind the rising edge of PPS.

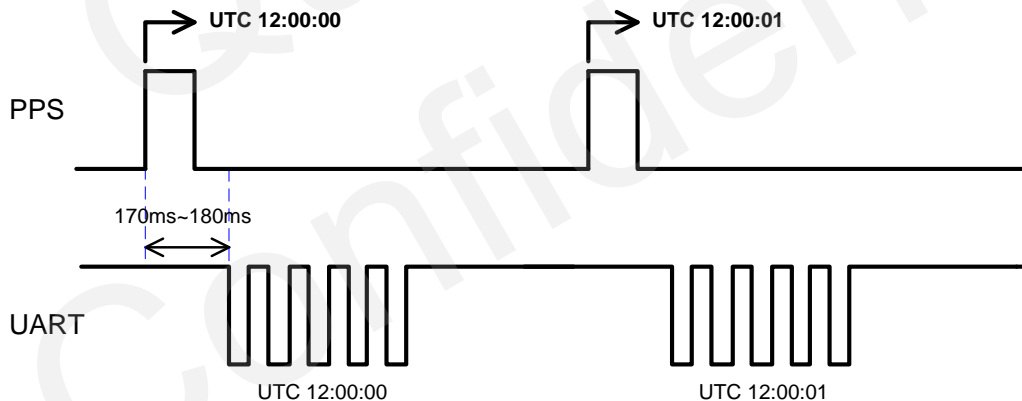


Figure 12: PPS VS. NMEA Timing

This feature only supports 1Hz NMEA output and baud rate at 14400~115200bps. At baud rate of 9600 and 4800bps, 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. You can enable this function by sending “\$PMTK255,1*2D”, and disable the function by sending “\$PMTK255,0*2C”.

4 Antenna Interfaces

L80-R module receives L1 band signal from GPS satellites at a nominal frequency of 1575.42MHz. The LNA is embedded for better performance. It is an ultra-compact module with embedded 15.0 × 15.0 × 4.0mm 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 × 15.0 × 4.0mm 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 100mm×60mm

Antenna Type	Parameter	Specification	Notes
Patch Antenna	Size	15.0 × 15.0 × 4.0mm	
	Range of receiving Frequency	1575.42MHz±1.023MHz	
	Impedence	50 Ohm	
	Band Width	10MHz minimum	Return Loss ≤ -10dB
	Frequency Temperature Coefficient (TF)	0±20ppm/°C	-40°C ~ +85°C
	Polarization	RHCP	Right Hand Circular Polarization
	Gain at Zenith	3.4dBi typ.	
	VSWR	1.5 max	Centre frequency
	Axial ratio	3 dB max	

The test result of the antenna is shown as 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.

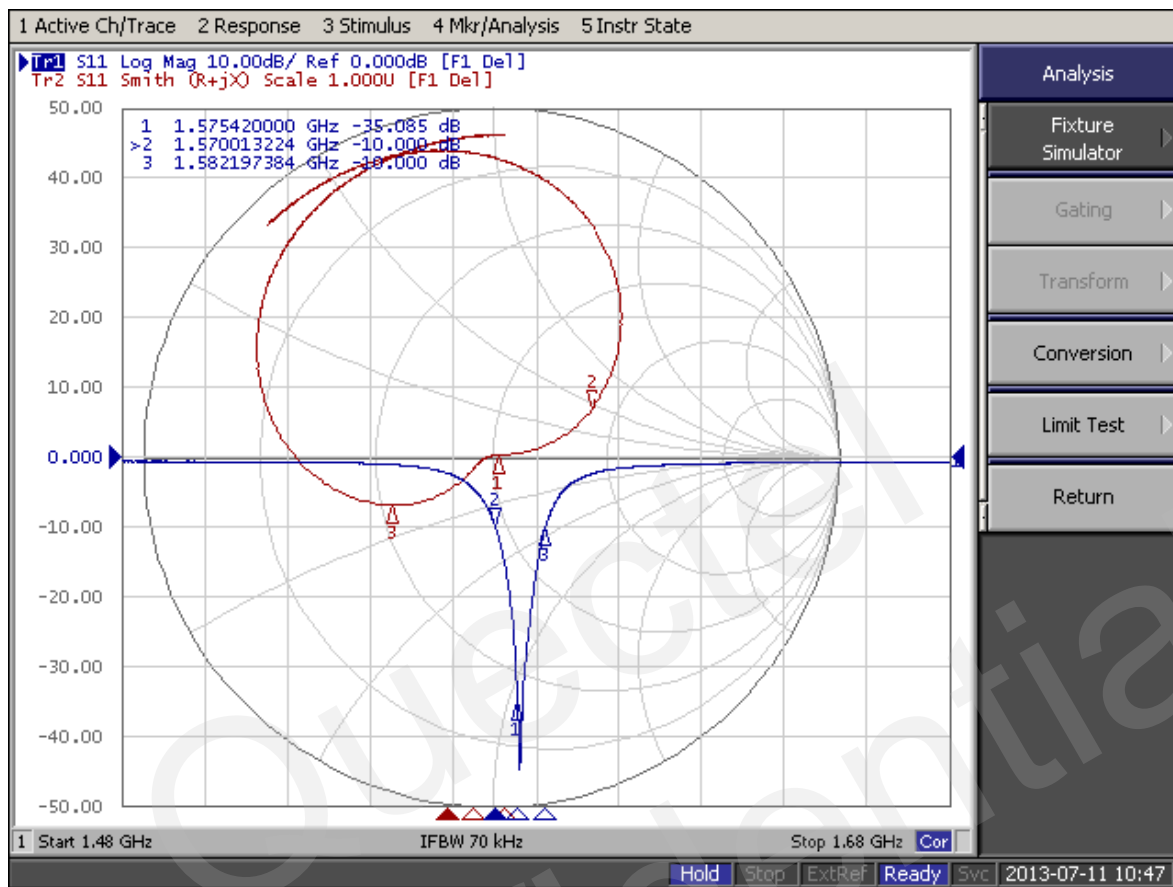


Figure 13: Patch Antenna Test Result with Ground Plane 100mm × 60mm

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 5mm away from the nearest edge of the mother board, that is, it is better to be placed in the center of the mother board.

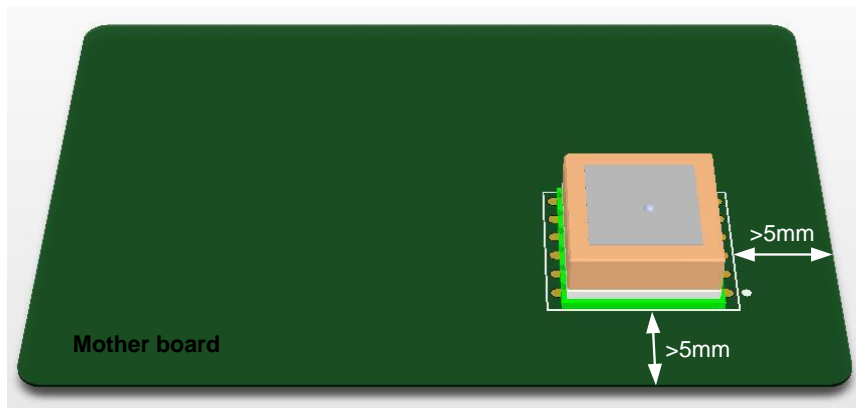


Figure 14: Recommended Distance between Module and Mother Board Edges

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

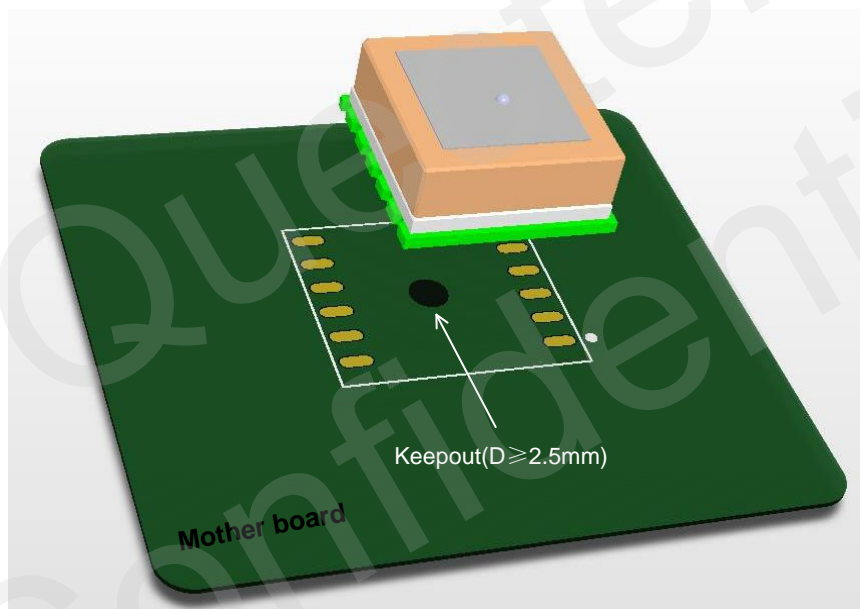


Figure 15: Recommended Treatment for the Feed Point of the Patch Antenna

- 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 30mm×30mm ground plane as shown below. Meanwhile, do not put any components especially tall components in the areas whenever possible. (Interfering vias is not allowed either).

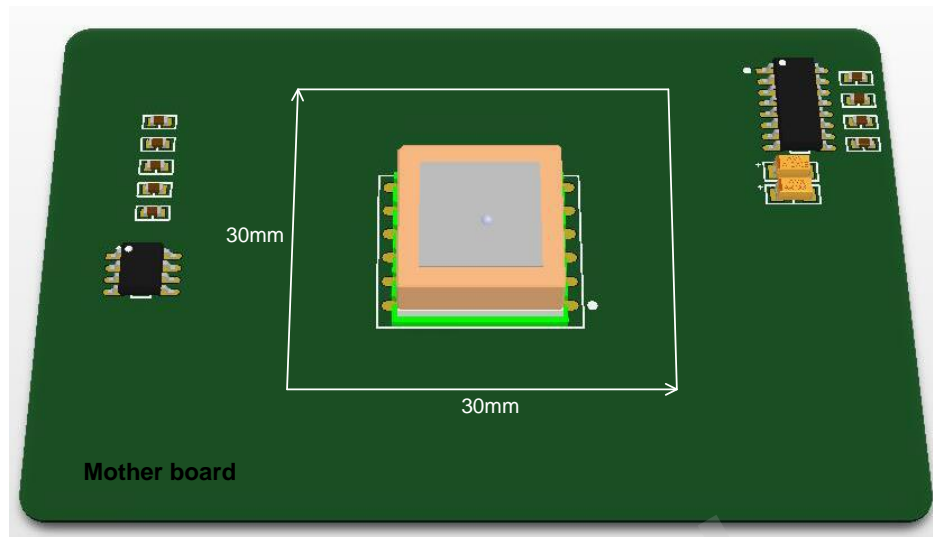


Figure 16: Recommended Ground Plane

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

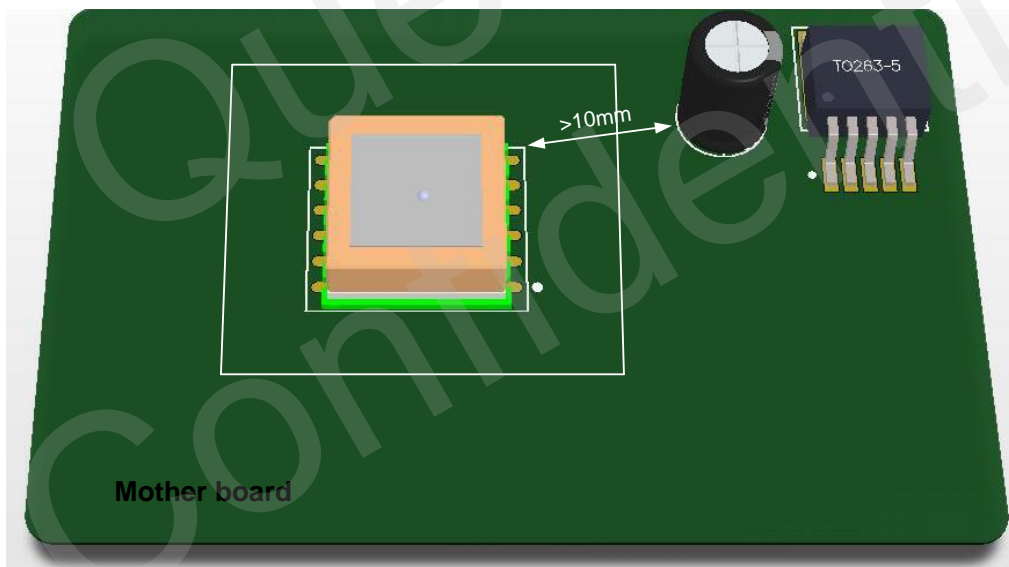


Figure 17: Recommended Distance between Module and Tall Metal Components

- 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 mother board.

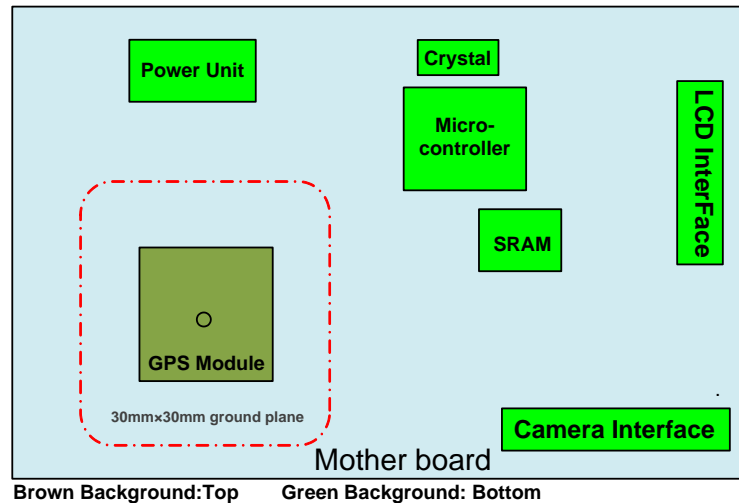


Figure 18: Recommended Placement of GNSS Module

- Make sure interfering signals (USB, LCD, Camera, Crystal, etc.) are in 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.

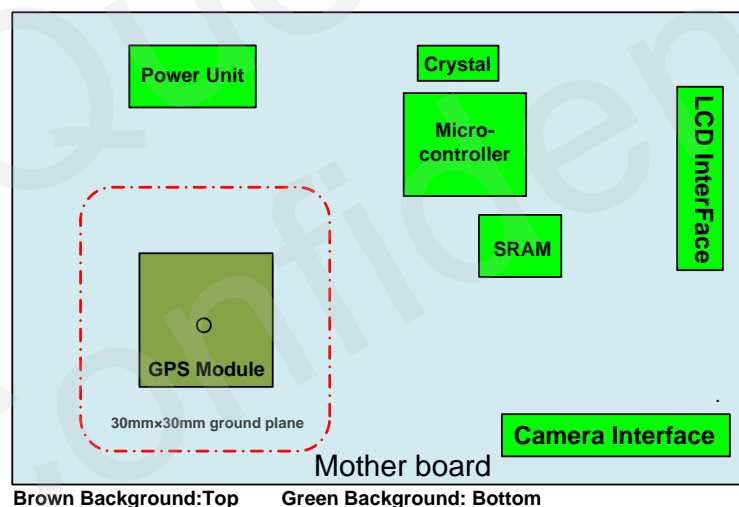


Figure 19: Recommended Placement of GNSS Module with the RF System

- 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 3mm.
- 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

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 voltage spikes exceed the power supply voltage specification given in table above, it must be limited to values within the specified boundaries by using appropriate protection diodes.

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.	3.0	3.3	4.3	V
I _{VCCP}	Peak supply current	VCC=3.3V			100	mA
V_BCKP	Backup voltage supply		1.5	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		uA

NOTES

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. 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 applied throughout the processing, handling and operation of any application.

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

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

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

5.5. Reliability Test

Table 11: Reliability Test

Test Item	Conditions	Standard
Thermal Shock	-30°C ~ +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	5~20Hz, 0.96m2/s3; 20~500Hz, 0.96m2/s3-3dB/oct, 1hour/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

Quectel
Confidential

6 Mechanical Dimensions

This chapter describes the mechanical dimensions of the module.

6.1. Mechanical Dimensions of the Module

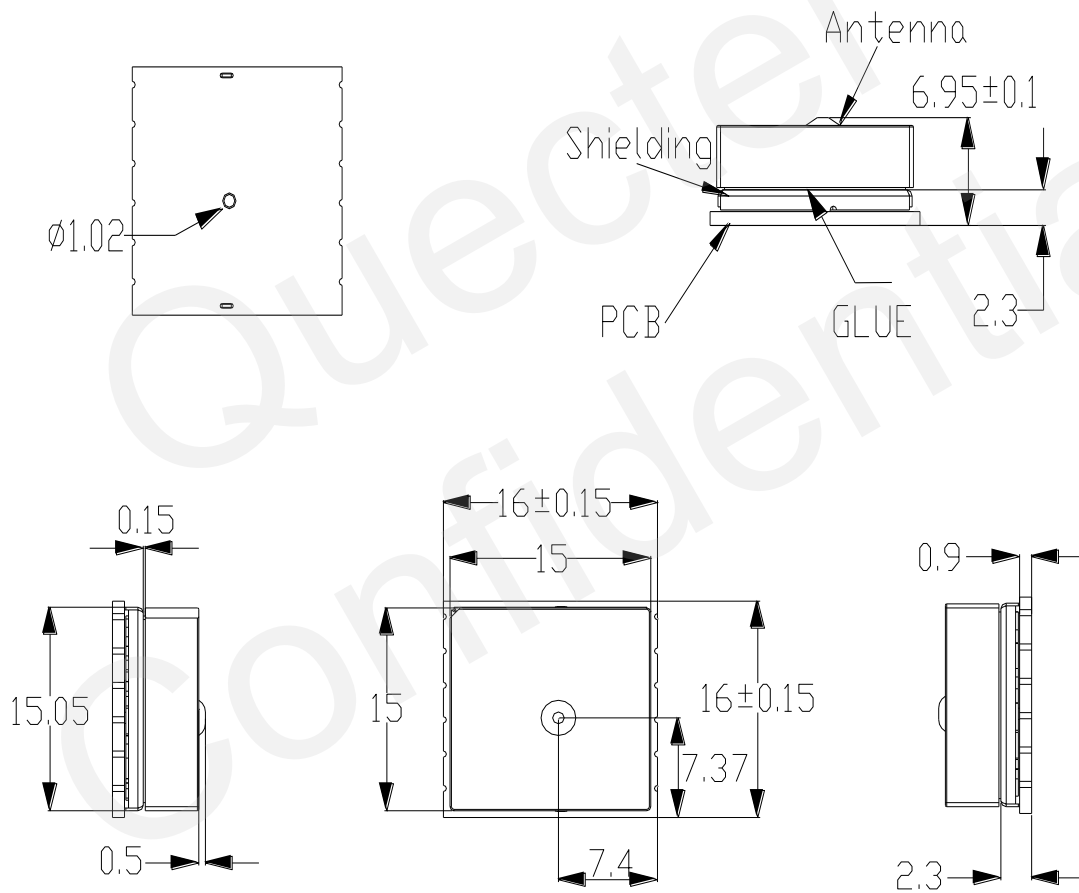


Figure 20: Mechanical Dimensions (Unit: mm)

6.2. Bottom View Dimensions and Recommended Footprint

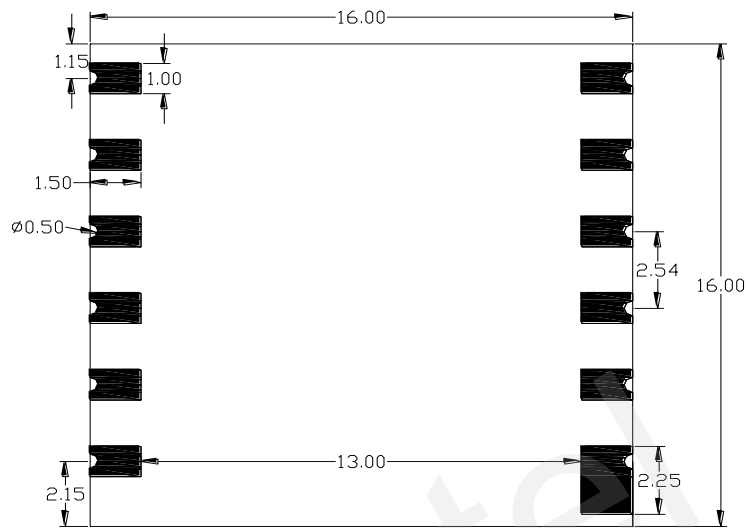


Figure 21: Bottom View Dimensions (Unit: mm)

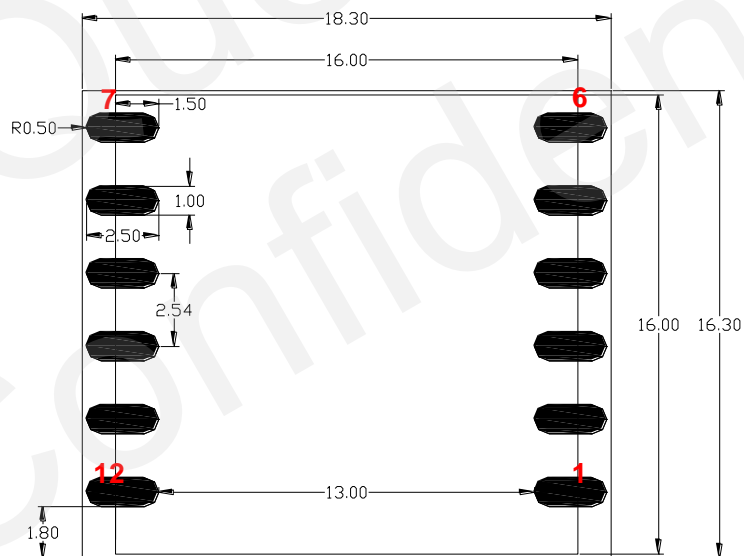


Figure 22: Recommended Footprint (Unit: mm)

NOTE

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

6.3. Top and Bottom View of the Module

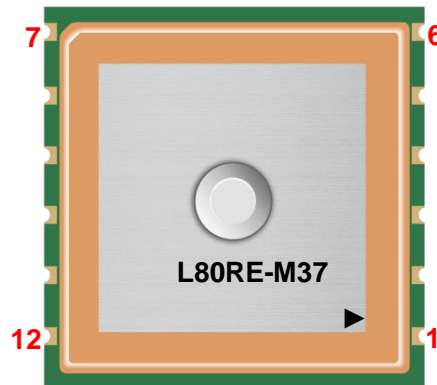


Figure 23: Top View of the Module

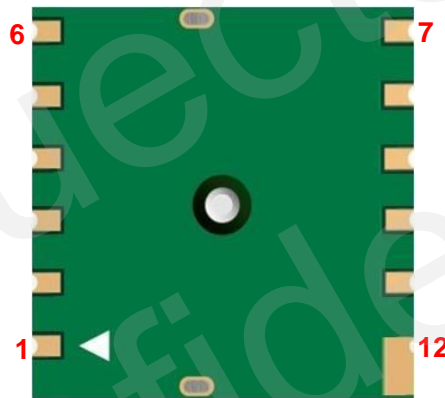


Figure 24: Bottom View of the Module

NOTES

1. The incision of the patch antenna does not indicate the position of pin 1.
2. These are design effect drawings of L80-R module. For more accurate pictures, please refer to the module that you get from Quectel.

7 Manufacturing, Packaging and Ordering Information

7.1. Assembly and Soldering

L80-R 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 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:

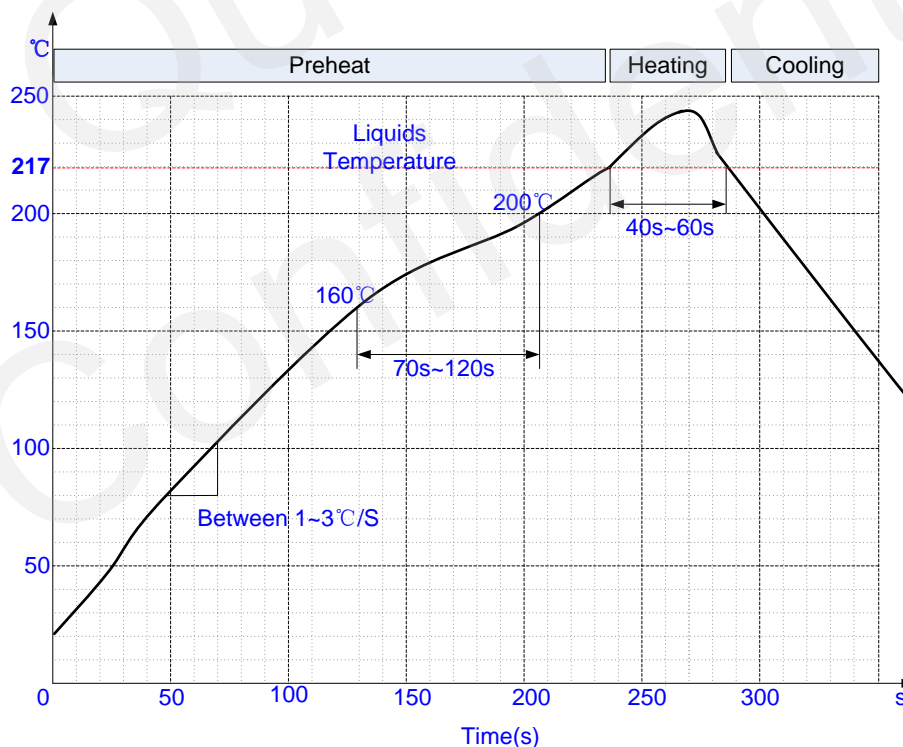


Figure 25: Recommended Reflow Soldering Thermal Profile

7.2. Moisture Sensitivity

L80-R module is sensitive to moisture. To prevent L80-R 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.

L80-R should be baked for 192 hours at temperature $40^{\circ}\text{C}+5^{\circ}\text{C}/-0^{\circ}\text{C}$ and $<5\%$ RH in low-temperature containers, or 24 hours at temperature $125^{\circ}\text{C}\pm 5^{\circ}\text{C}$ in high-temperature containers. Care should be taken that plastic tape is not heat resistant. L80-R should be taken out from the tape before preheating; otherwise, the tape maybe damaged by high-temperature heating.

7.3. ESD Protection

L80-R module is sensitive to ESD and requires special precautions when handling. Particular care must be exercised when handling patch antenna, duo to the risk of electrostatic charges.

Figure 26: Tape and Reel Specifications

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

Model Name	Ordering Code
L80-R	L80RE-M37

8 Appendix References

Table 14: 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_L80-R_Reference_Design	L80-R Reference Design

Table 15: 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
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
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
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 Voltage Value
VImin	Absolute Minimum Input Voltage Value
VOHmax	Maximum Output High Level Voltage Value
VOHmin	Minimum Output High Level Voltage Value
VOLmax	Maximum Output Low Level Voltage Value
VOLmin	Minimum Output Low Level Voltage Value