L70-R Series

Hardware Design

GPS Module Series

Rev. L70-R_Series_Hardware_Design_V3.0

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About the Document

History

Revision	Date	Author	Description
1.0	2014-05-07	King HAO	Initial
1.1	2014-06-11	King HAO	Updated packaging information.
1.2	2014-12-19	King HAO	Optimized the description of RESET in Chapter 3.5 and description of LOCUS in Chapter 3.9.
2.0	2015-07-09	King HAO	1. Updated Chapter 2.1 2. Updated Table 1 and Table 4 3. Deleted description of periodic mode and AlwayLocate™ mode in Chapter 3.4.4 and 3.4.5 4. Deleted the description of LOCUS 5. Added the description of EASY technology
2.1	2015-11-09	Neil WU	Added the description of PPS VS. NMEA.
3.0	2015-05-31	Storm BAO	1. Incorporated related information of L70-RL. 2. Changed the document name from L70-R_Hardware_Design to L70-R_Series_Hardware Design

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1 Introduction

This document defines and specifies L70-R series GPS module. It describes the hardware interfaces, external application reference circuits, mechanical size and the air interface of L70-R series module.

This document can help you quickly understand the interface specifications, as well as electrical and mechanical details of L70-R series module. Other documents such as protocol specification and user guide are also provided for your reference. These documents provide the guidance for you to design and set up applications relating to L70-R series module.

L70-R series module contains two variants: L70-R and L70-RL. You can choose a dedicated type base on your requirement.

Table 1: L70-R Series Products

Module	GPS	GLONASS	BeiDou	Embedded LNA
L70-R	√			
L70-RL	√			√

2 Product Concept

2.1. General Description

The L70-R series ROM-based GPS module brings the high performance of MTK positioning engine to 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 lead-free package. With 66 search channels and 22 simultaneous tracking channels, it can acquire and track satellites in the shortest time even at indoor signal level.

L70-R series module integrates many advanced features including AIC, EASY and EPO into the compact form factor. These features are beneficial to reduce TTFF and improve sensitivity for GPS system.

L70-R series module is an SMD type module with the compact form factor of 10.1mm × 9.7mm × 2.5mm, which can be embedded in your applications through the 18-pin pads. It provides necessary hardware interfaces between the module and the main board.

The module is fully ROHS compliant to EU regulation.

2.2. Key Features

Table 2: Module Key Features

Feature	Implementation
Receiver Type	● GPS L1 1575.42MHz C/A Code ● 66 search channels, 22 simultaneous tracking channels
Power Supply	● Supply voltage: 2.8V ~ 4.3V ● Typical supply voltage: 3.3V
Power Consumption	● Refer to Table 10
Sensitivity	● Acquisition: -148dBm@L70-R ● Re-acquisition: -160dBm@L70-R ● Tracking: -165dBm@L70-R

	● Acquisition: -149dBm@L70-RL ● Re-acquisition: -161dBm@L70-RL ● Tracking: -167dBm@L70-RL
TTFF (EASY Disabled)	● Cold start (Autonomous): 35s typ.@-130dBm ● Warm start (Autonomous): 30s typ.@-130dBm ● Hot start (Autonomous): 1s typ.@-130dBm
TTFF (EASY Enabled)	● Cold start: 15s typ. @-130dBm ● Warm start: 5s typ. @-130dBm ● Hot start: 1s typ. @-130dBm
Horizontal Position Accuracy (Autonomous)	● < 2.5m CEP @-130dBm
Max Update Rate	● Up to 5Hz, 1Hz by default
Accuracy of 1PPS Signal	● Typical accuracy: ±10ns ● Time pulse width 100ms
Velocity Accuracy	● Without aid: 0.1m/s
Acceleration Accuracy	● Without aid: 0.1m/s²
Dynamic Performance	● Maximum altitude: 18,000m ● Maximum velocity: 515m/s Maximum ● Acceleration: 4G
UART Port	● UART Port: TXD1 and RXD1 ● Supports baud rate from 4800bps to 115200bps, 9600bps by default ● UART port is used for NMEA output and MTK proprietary commands input
Temperature Range	● Normal operation: -40°C ~ +85°C ● Storage temperature: -45°C ~ +125°C
Physical Characteristics	● Size: 10.1±0.15 × 9.7±0.15 × 2.5±0.15mm ● Weight: Approx. 0.6g

NOTES

1. The power consumption is measured under conditions that GPS signal generator, AIC and EASY are all enabled.
2. The sensitivity is measured with passive antenna but without external LNA.

2.3. Block Diagram

The following figure shows a block diagram of L70-R series module. It consists of a single chip GPS IC which includes the RF part and baseband part, a SAW filter, a TCXO and a crystal oscillator.

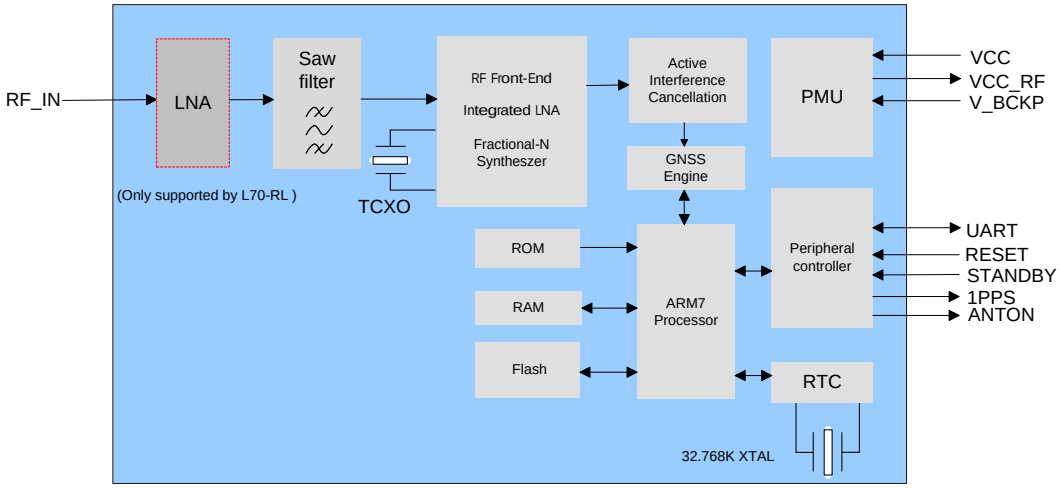

Figure 1: Block Diagram

2.4. Evaluation Board

In order to help you use L70-R series module on your applications, Quectel supplies an Evaluation Board (EVB) with micro USB serial cable, active antenna and other peripherals to test the module.

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

2.5. Protocols Supported by the Module

Table 3: Protocols Supported by the Module

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

NOTE

Please refer to ***document [2]*** about NMEA standard protocol and MTK proprietary protocol.

3 Application

The L70-R series module is equipped with an 18-pin 1.1mm pitch SMT pad that connects to your application platform. Sub-interfaces included in these pads are described in details in the following chapters.

3.1. Pin Assignment

Figure 2: Pin Assignment

3.2. Pin Definition

Table 4: Pin Description

Power Supply					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
VCC	8	I	Main power supply	Vmax=4.3V Vmin=2.8V	Supply current no less than 100mA.

				Vnom=3.3V	
V_BCKP	6	I	Backup power supply	Vmax=4.5V Vmin=1.5V Vnom=3.3V	Supply power for RTC domain when VCC is powered off.
VCC_RF	14	O	Power supply for external RF components	Vmax=4.3V Vmin=2.8V Vnom=3.3V	Usually supply power for external active antenna or LNA. If unused, keep this pin open. VCC_RF=VCC.
Reset					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RESET	9	I	System reset	VILmin=-0.3V VILmax=0.8V VIHmin=2.0V VIHmax=3.6V	Active low. If unused, keep this pin open or connect it to VCC.
UART Port					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RXD1	3	I	Receive data	VILmin=-0.3V VILmax=0.8V VIHmin=2.0V VIHmax=3.6V	UART Port is used for NMEA output, PMTK commands input and firmware upgrade.
TXD1	2	O	Transmit data	VOLmin=-0.3V VOLmax=0.4V VOHmin=2.4V VOHmax=3.1V	
RF Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RF_IN	11	I	RF signal input	Characteristic impedance of 50Ω	Refer to ***Chapter 4***
Other Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
ANTON	13	O	External LNA control pin or active antenna power control pin in power saving mode.	The typical value is 2.8V in full on mode and will be pulled down in power saving mode.	If unused, keep this pin open.
STANDBY	5	I	Used to enter into or	VILmin=-0.3V	Pulled up internally.

			exit from standby mode.	VILmax=0.8V VIHmin=2.0V VIHmax=3.6V	It is edge-triggered. If unused, keep this pin open.
1PPS	4	O	One pulse per second	VOLmin=-0.3V VOLmax=0.4V VOHmin=2.4V VOHmax=3.1V	Synchronized at rising edge; the pulse width is100ms. If unused, keep this pin open.
RESERVED	16,17				Keep these pins open.
RESERVED	18				Reserve an external 0R resistor to ground.

3.3. Power Supply

VCC pin supplies power for BB, RF, I/O and RTC domain. The load current of VCC varies according to the VCC level, processor load, the number of satellite track and the rate of satellite re-acquisition. Typical VCC peak current may reach 30mA during GPS acquisition after being powered up. So it is important to supply sufficient current and keep the power clean and stable. The ripple voltage supplied by VCC 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. A cell battery with the combination of 4.7uF and 100nF capacitor is recommended to keep close to V_BCKP pin. The voltage of RTC domain ranges from 1.5V to 4.5V. In order to achieve better TTFF, RTC domain should be valid all the time. It can supply power for RAM 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 not only supplies power for PMU but also for VCC_RF and RTC domain. V_BCKP supplies power for RTC domain only. The two diodes form an “OR” gate to supply power for RTC domain.

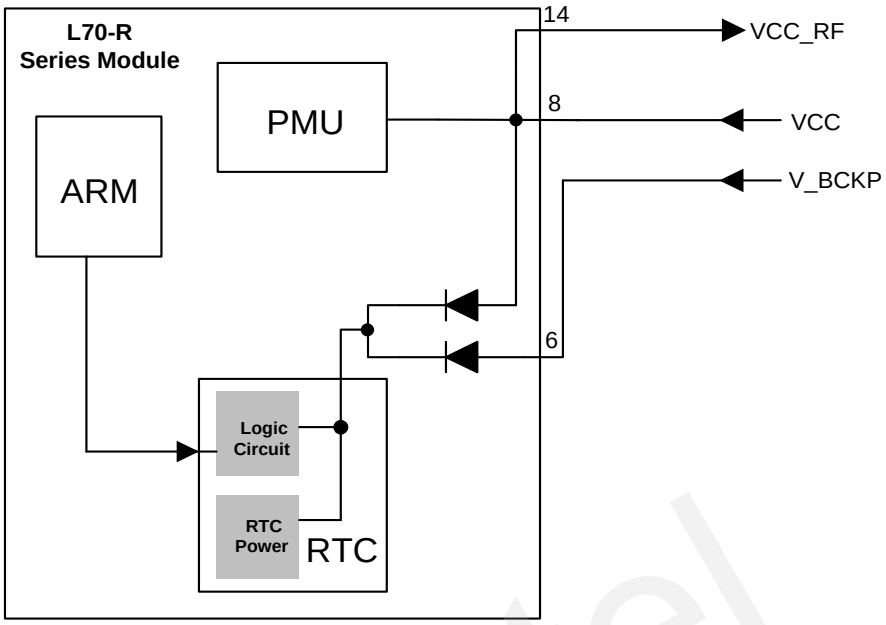

Figure 3: Internal Power Construction

The following picture shows the corresponding average power and current consumption at varied VCC voltage levels. These were measured with GPS signal generator in tracking mode.

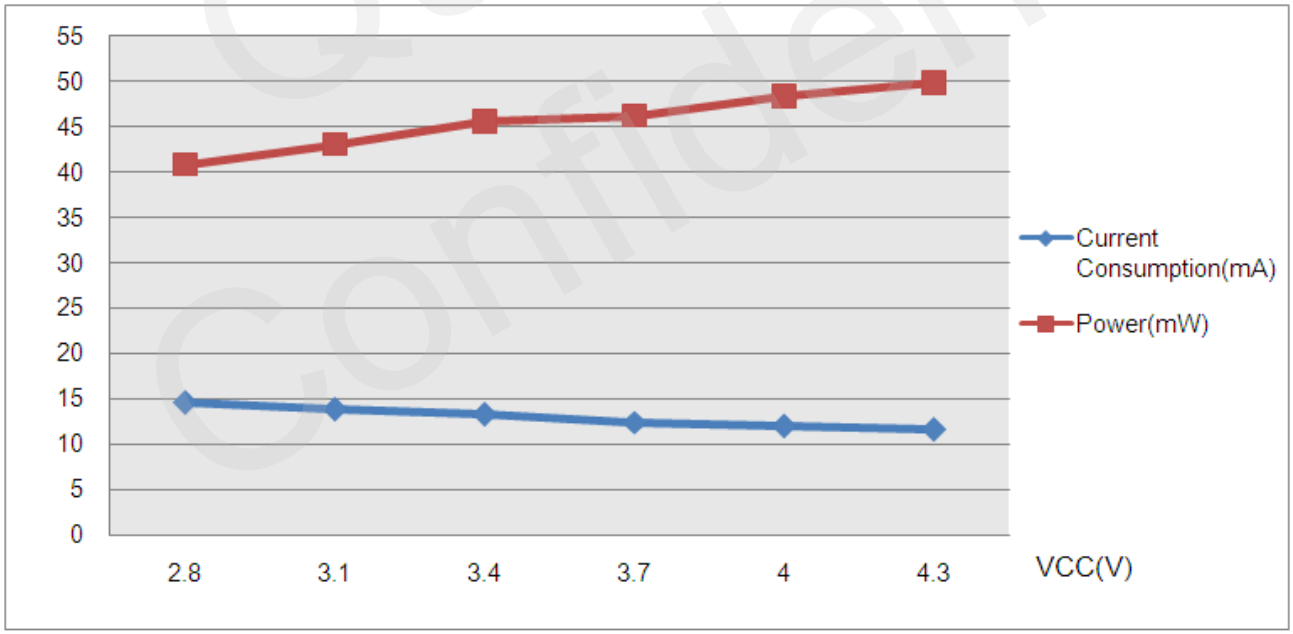

Figure 4: Power and Current Consumption @ Varied VCC Voltage Levels

3.4. Operating Modes

The table below briefly illustrates the relationship among different operating modes of L70-R series module.

Table 5: Module States Switch

Current Mode	Next Mode		
	Backup	Standby	Full on
Backup	N/A	N/A	Restore the main power supply VCC.
Standby	N/A	N/A	Pull up STANDBY pin or send any data via UART1.
Full on	Remain V_BCKP and cut off VCC.	Pull down STANDBY pin or 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 that the module starts to search satellites, and to determine visible satellites, coarse carrier frequency & code phase of satellite signals. When the acquisition is completed, it switches to tracking mode automatically. Tracking mode is defined as that the module keeps tracking satellites and demodulates the navigation data from the specific satellites.

Whether the VCC and V_BCKP are both valid or only VCC 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 to know more about internal power construction. You can also use PMTK commands to change the configurations to satisfy your requirements.

Table 6: Default Configurations

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

3.4.2. Standby Mode

Standby mode is a low-power mode. In standby mode, the internal core and I/O power domain are still active, but RF and TCXO are powered off; the module stops satellites search and navigation. UART1 is still accessible via PMTK commands or any other data, but there is no NMEA messages output.

There are two ways to enter into or exit from standby mode:

- **Using PMTK command**: Sending PMTK command "$PMTK161,0*28" will make L70-R series module enter into standby mode. Sending any data via UART1 can wake up the module. When the module exits from standby mode, it will use all internal aiding information like GPS time, ephemeris, last position etc., thus leading to a fastest possible TTFF in either Hot or Warm start. The typical current consumption in standby mode is about 500uA @VCC=3.3V.

- **Using STANDBY pin**: Pulling STANDBY pin low also can make L70-R series module enter into standby mode, and releasing STANDBY which has been pulled high internally will make the module back to full on mode. Note that pulling down STANDBY pin to ground will cause extra current consumption which will make the typical standby mode current consumption reach to about 550uA @VCC=3.3V.

NOTE

It is recommended to set the host's GPIO which controls STANDBY pin as input before turning on the module. As the module is edge-triggered, it may enter into standby mode unexpectedly when turning on it. After that, you can reset the GPIO as output to control the STANDBY pin. If unused, keep this pin open.

3.4.3. Backup Mode

Backup mode requires lower power consumption than standby mode. In this mode, only the backup power supply V_BCKP is powered on while the main power supply VCC is cut off.

In backup mode, L70-R series module stops acquiring and tracking satellites. UART1 is not accessible. But all the necessary GPS information for quick start-up, a small amount of user configuration variables and some user navigation data contained in the backed-up memory of RTC domain are alive. Due to the backed-up memory, EASY technology is available. The typical current consumption in backup mode can be as low as 8uA.

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

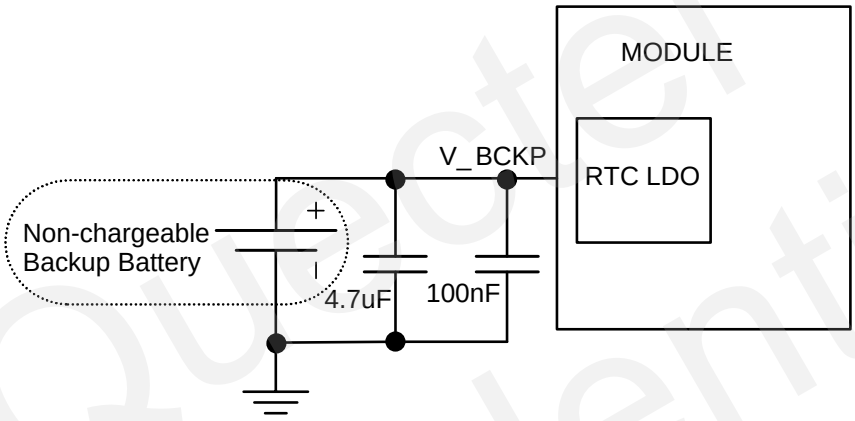

Figure 5: RTC Supply from Non-chargeable Battery

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

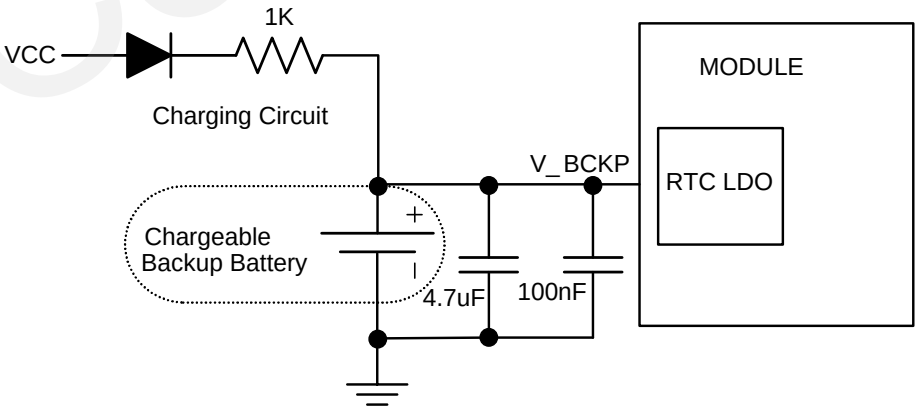

Figure 6: Reference Charging Circuit for Chargeable Battery

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.

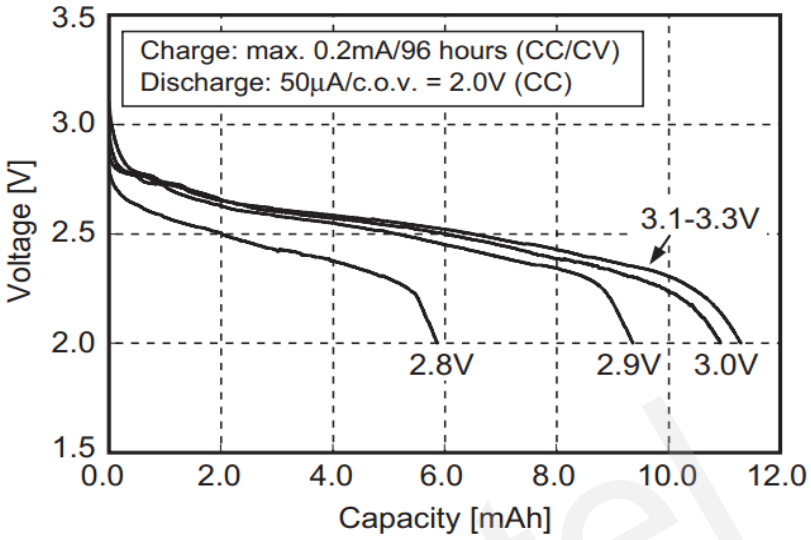

Figure 7: Seiko MS920SE Charge and Discharge Characteristics

3.5. Reset

L70-R series 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.

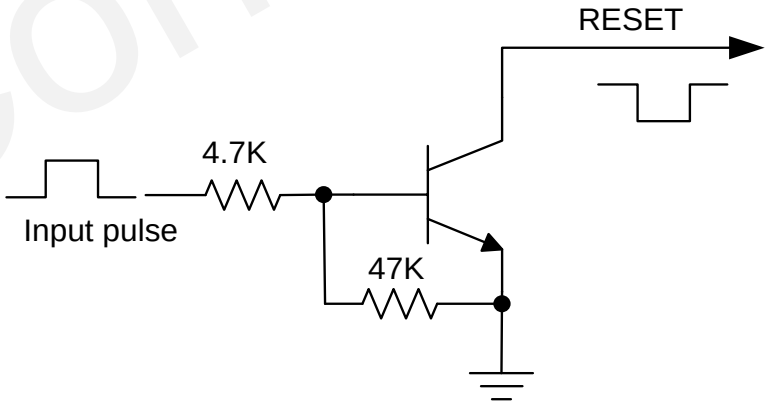

Figure 8: Reference Reset Circuit Using OC Circuit

The restart timing of L70-R series is illustrated as bellow.

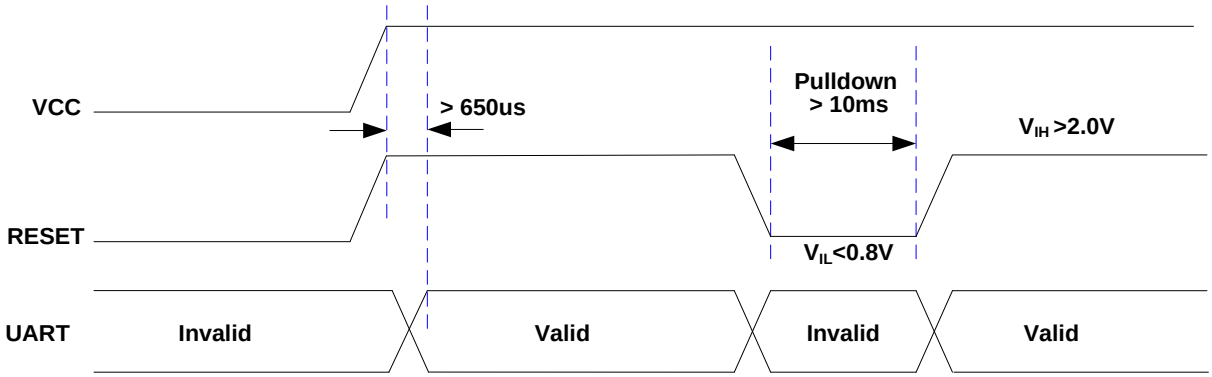

Figure 9: Restart Timing

3.6. UART Interface

The module provides one universal asynchronous receiver & transmitter (UART) serial port. The module is designed as DCE (Data Communication Equipment), and complies with the traditional DCE-DTE (Data Terminal Equipment) connection. The module and the client (DTE) are connected through the following signals shown in Figure 10. 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

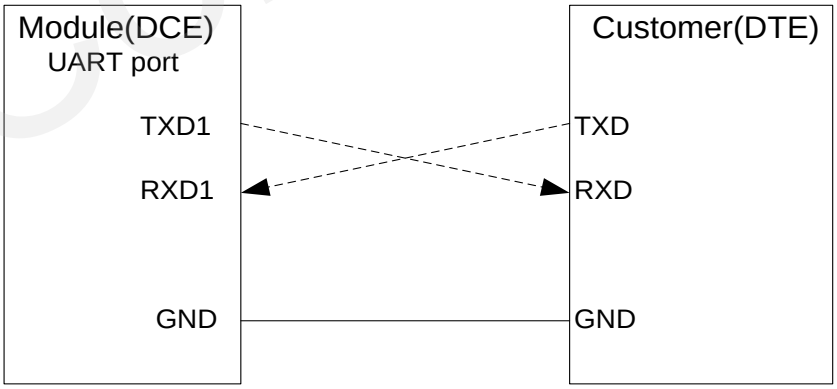

Figure 10: Connection of Serial Interfaces

The UART port has the following features:

- The 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.
- The 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.

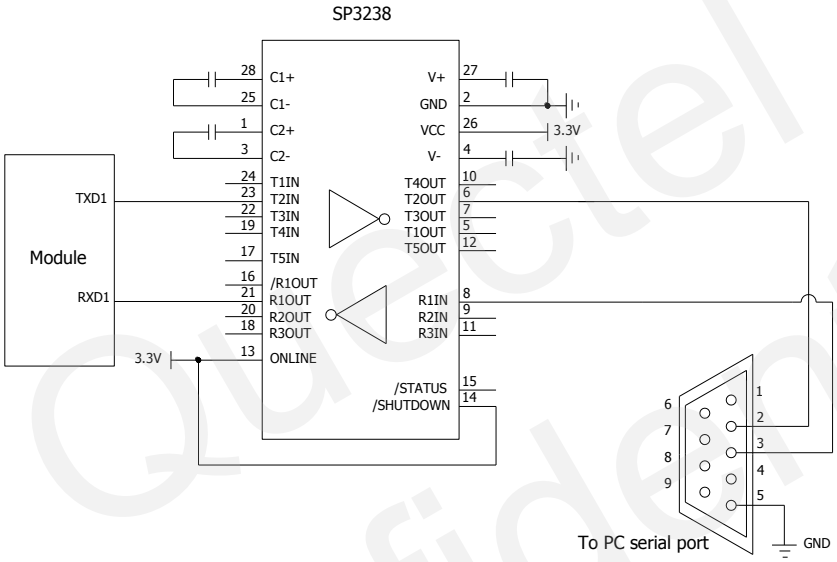

Figure 11: RS-232 Level Shift Circuit

3.7. Multi-tone AIC

L70-R series 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. ANTON

L70-R series module provides a pin called ANTON which is related to module states. Its voltage level will be changed in different module states. When the module works in full on mode, this pin is in high level; while in standby mode or backup mode, this pin is in a low level. Based on this characteristic, ANTON pin can be used to control the power supply of active antenna or the enable pin of an external LNA to save power consumption. There is an example of this pin's application described in Chapter 4.2.

3.9. EPO Offline AGPS Technology

L70-R series module features a function called EPO (Extended Prediction Orbit) which is a world leading technology that supports 30-day orbit predictions to customers. Occasional download from the EPO server is needed. For more details, please refer to the ***document [4].***

3.10. EASY Automomous AGPS 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 will be 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 a good signal condition after fixing the position.

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

3.11. PPS VS. NMEA

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

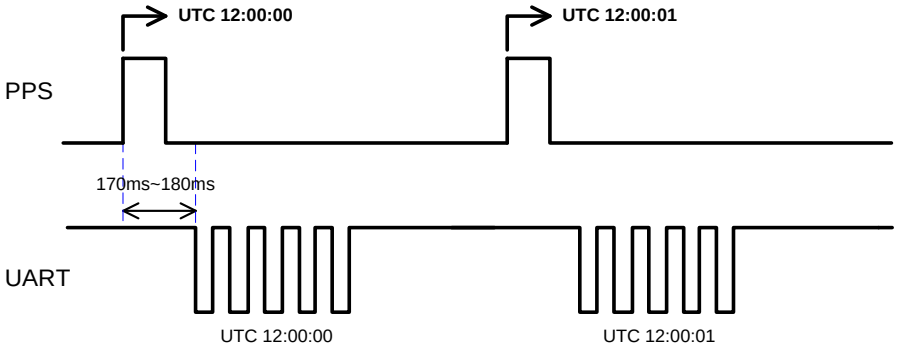

Figure 12: PPS VS. NMEA Timing

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 rates, 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 Interface

L70-R series module receives L1 band signal from GPS satellites at a nominal frequency of 1575.42MHz. The RF signal is obtained from the RF_IN pin. 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.

4.1. Antenna Specification

Table 7: Recommended Antenna Specification

Antenna Type	Specification
Passive Antenna	Center frequency: 1575.42MHz Band width : > 5MHz VSWR: < 2 (Typ.) Polarization: RHCP or Linear Gain: > 0dBi
Active Antenna	Center frequency: 1575.42MHz Band width: > 5MHz VSWR: < 2 (Typ.) Polarization: RHCP or Linear Noise figure: < 1.5dB Gain (antenna): > -2dBi Gain (embedded LNA): 20dB (Typ.) Total Gain: > 18dBi (Typ.)

4.2. Recommended Circuit for Antenna

Both active and passive antennas can be used for L70-R series module.

4.2.1. Active Antenna

4.2.1.1. Active Antenna without ANTON

The following figure is a typical reference design for active antenna without ANTON. In this mode, the antenna directly gets power from the VCC_RF.

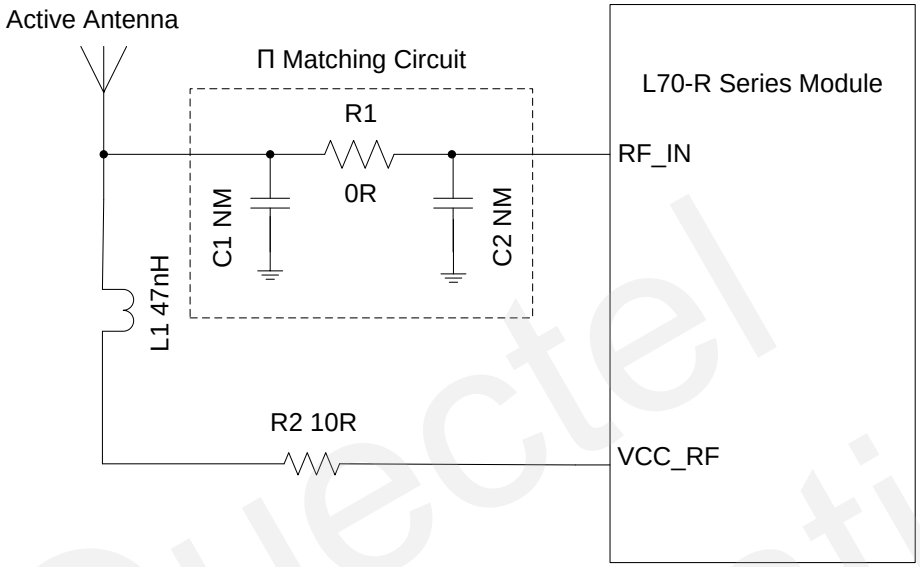

Figure 13: Reference Design for Active Antenna without ANTON

C1, R1 and C2 are reserved matching circuit for antenna impedance modification. By default, C1 and C2 are not mounted; R1 is 0 ohm.

L70-R series module provides power supply for external active antenna by VCC_RF. The voltage ranges from 2.8V to 4.3V, and the typical value is 3.3V. If the VCC_RF voltage does not meet the requirement for powering the active antenna, an external LDO should be used.

The inductor L1 is used to prevent the RF signal from leaking into the VCC_RF and route the bias supply to the active antenna; and the recommended value of L1 is no less than 47nH. R2 can protect the whole circuit in case the active antenna is shorted to ground.

4.2.1.2. Active Antenna with ANTON

L70-R series module can also save power consumption by controlling the power supply of active antenna through the pin “ANTON”.

A reference circuit for active antenna with “ANTON” function is given as below.

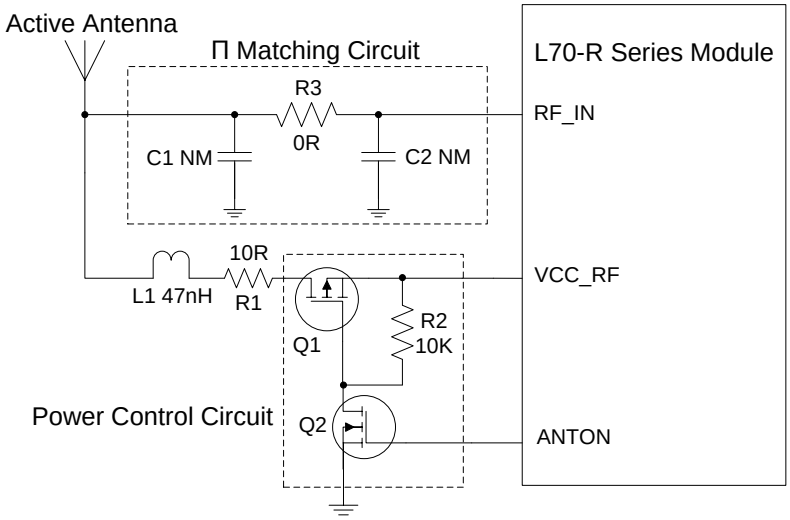

Figure 14: Reference Design for Active Antenna with ANTON

ANTON is an optional pin which can be used to control the power supply of the active antenna. When the ANTON pin is pulled down, MOSFET Q1 and Q2 are in high impedance state and the power supply for antenna is cut off. When ANTON is pulled high, it will make Q1 and Q2 in the on-state; VCC_RF will provide power supply for the active antenna. The level of ANTON signal is determined by the module's states. Please refer to Chapter 3.8 for more details. If unused, please keep this pin open.

For minimizing the current consumption, the value of resistor R2 should not be too small, and the recommended value is not less than 10k ohm.

4.2.2. Passive Antenna

4.2.2.1. Passive Antenna without External LNA

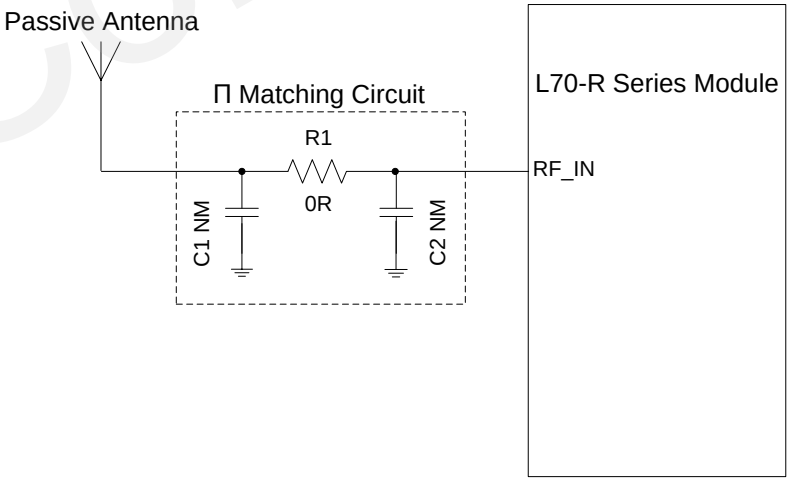

Figure 15: Reference Design for Passive Antenna without LNA

The above figure is a typical reference design for passive antenna without LNA.

C1, R1 and C2 are reserved matching circuit for antenna impedance modification. By default, C1 and C2 are not mounted; R1 is 0 ohm. Impedance of RF trace should be controlled as 50 ohm and the trace length should be kept as short as possible.

4.2.2.2. Passive Antenna with External LNA

In order to improve the GPS receiver sensitivity and reduce the TTFF, an external LNA between the passive antenna and the L70-R series module is recommended. A reference design is shown as below.

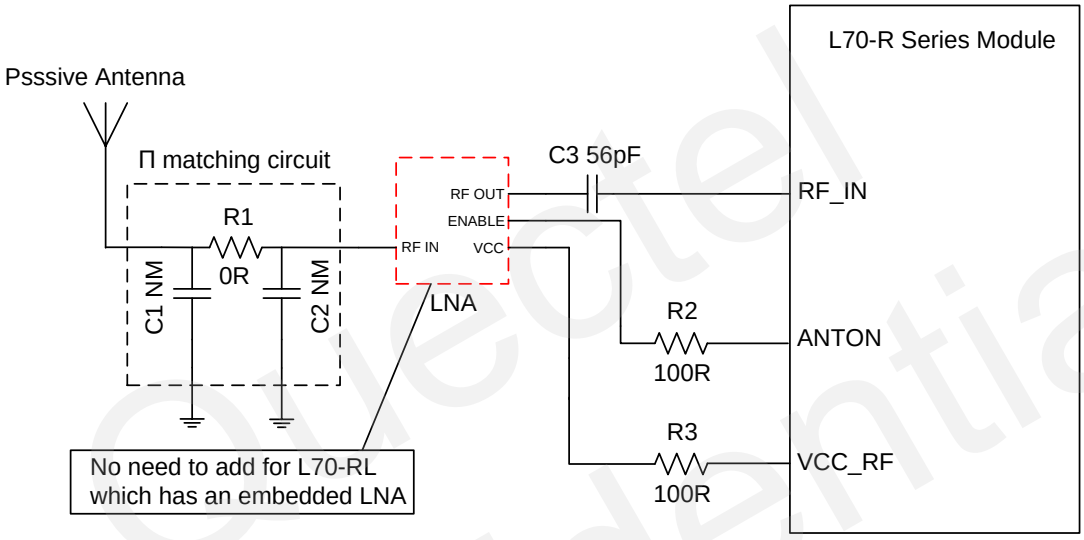

Figure 16: Reference Design for Passive Antenna with LNA

Here, C1, R1 and C2 form a reserved matching circuit for passive antenna and LNA. By default, C1 and C2 are not mounted; R1 is 0 ohm. C3 is reserved for impedance matching between LNA and L70-R series module and the default value of C3 capacitor is 56pF which can be optimized according to the actual conditions. ANTON is an optional pin which can be used to control the enable pin of the external LNA.

NOTES

1. There is no need to use an external LNA for L70-RL module, because an embedded LNA is already used inside the module.
1. In order to ensure compatibility with Quectel's GNSS module, it is recommended that the part number of the LNA component is MAX2659 or SKY65602. Both of them can support GPS and GLONASS system. For the details about the GNSS module, please contact Quectel technical support.
2. The power consumption of the device will be reduced by controlling "LNA ENABLE" through the pin "ANTON" of L70-R/L70-RL. If "ANTON" function is not used, please connect the pin "LNA ENABLE" to VCC to keep LNA always on.

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 8: 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
Input Power at RF_IN (P_{RF_IN})		15	dBm
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 the table above, it must be limited to values within the specified boundaries by using appropriate protection diodes.

5.2. Operating Conditions

Table 9: Power Supply Ratings

Parameter	Description	Operating 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		1.5	3.3	4.5	V
VCC_RF	Output voltage RF section			VCC		V
T_{OPR}	Normal operation 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 device reliability.

5.3. Current Consumption

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

Table 10: Current Consumption

Module	Conditions	Acquisition @3.3V	Tracking @3.3V	Standby @3.3V	Backup @V_BCKP=3.3V
L70-R	@-130dBm GPS	16mA	13mA	0.5mA	8uA
L70-RL	@-130dBm GPS	21mA	18mA	0.5mA	8uA

NOTES

1. The embedded LNA in L70-RL is powered by an internal LDO which will be cut off in standby mode.
2. The VCC_RF current is not reckoned in above consumption.
3. The tracking current is tested in the following conditions:
   - For Cold Start, 10 minutes after First Fix.
   - For Hot Start, 15 seconds after First Fix.

5.4. Reliability Test

Table 11: Reliability Test

Test Item	Condition	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

6 Mechanical Dimensions

This chapter describes the mechanical dimensions of L70-R series module.

6.1. Mechanical Dimensions of the Module

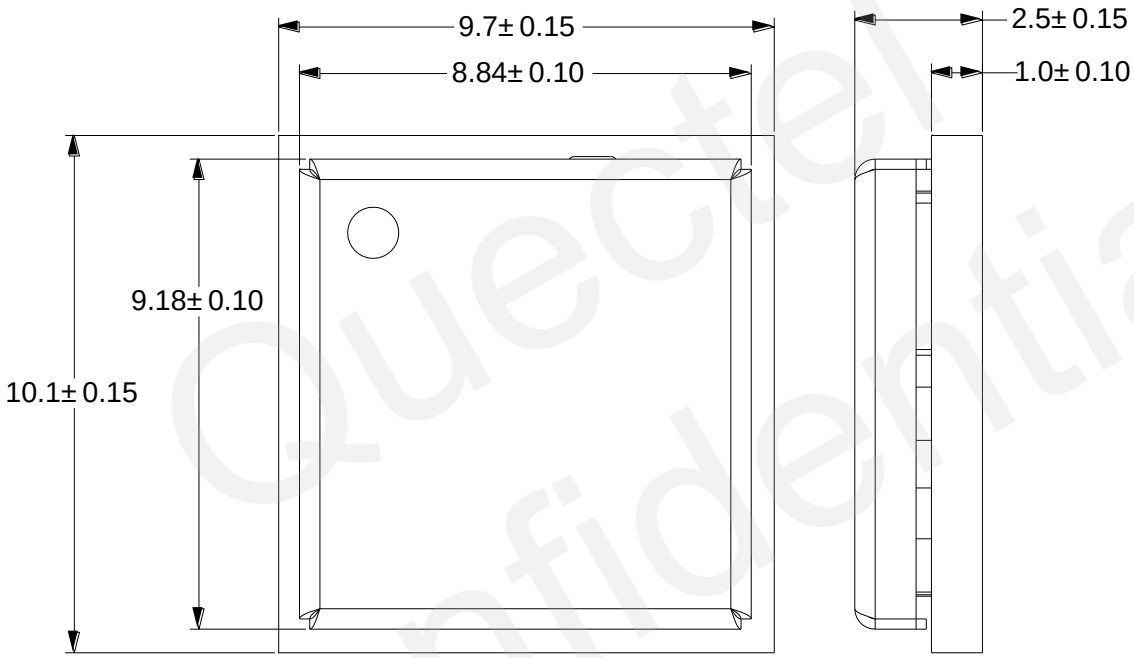

Figure 17: Top and Side Dimensions (Unit: mm)

6.2. Bottom Dimensions and Recommended Footprint

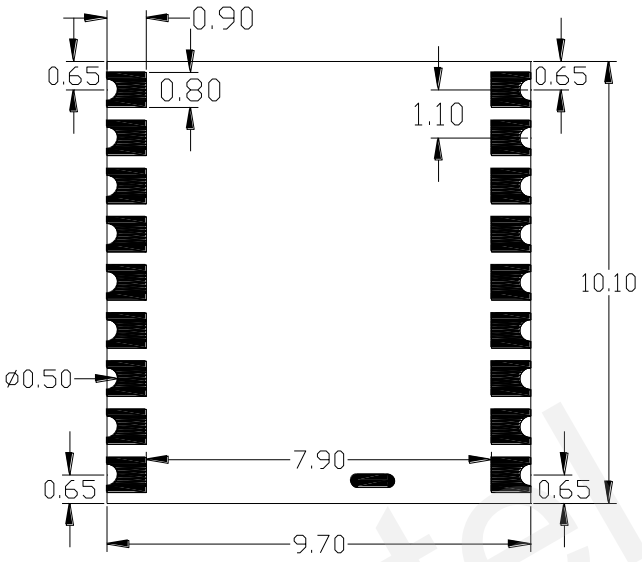

Figure 18: Bottom Dimensions (Unit: mm)

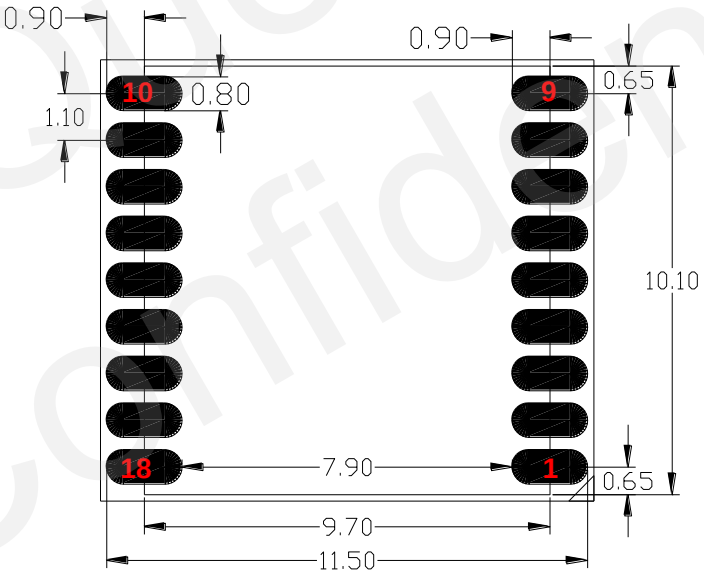

Figure 19: Recommended Footprint (Unit: mm)

NOTE

For easy maintenance of L70-R series module and easy access to these pads, please keep a distance of no less than 3mm between the module and other components in host board.

6.3. Top and Bottom View of the Module

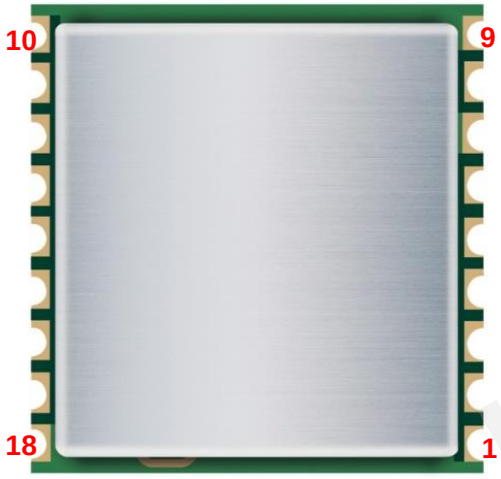

Figure 20: Top View of the Module

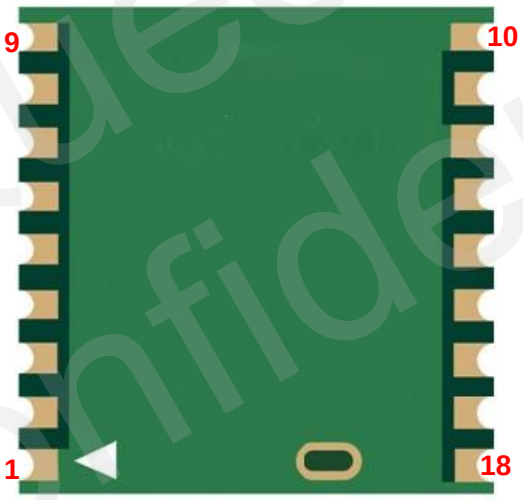

Figure 21: Bottom View of the Module

NOTE

These are design effect drawings of L70-R series 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

L70-R series 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 130um 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 from 235 to 245ºC (for SnAg3.0Cu0.5 alloy). The absolute maximum reflow temperature is 260ºC. To avoid damage caused by repeated heating, it is recommended that the module should be mounted after reflow soldering for the bottom side of the PCB has been finished. Recommended reflow soldering thermal profile is shown below.

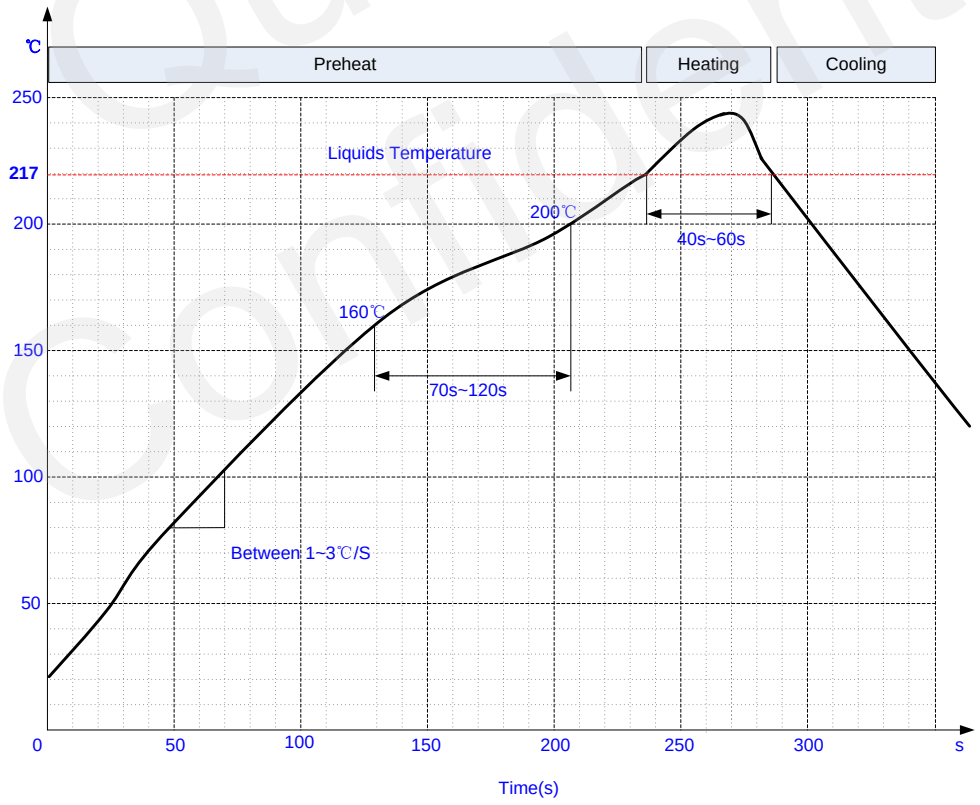

Figure 22: Recommended Reflow Soldering Thermal Profile

7.2. Moisture Sensitivity

L70-R series module is sensitive to moisture. To prevent L70-R series GPS module from permanent damage during reflow soldering, baking before reflow soldering is required in the 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.

L70-R series module 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. L70-R series module should be taken out from the plastic package before preheating; otherwise, the tape maybe damaged by high-temperature heating.

7.3. ESD Protection

L70-R series module is an ESD sensitive device. ESD protection precautions should be emphasized. Proper ESD handling and packaging procedures must be applied throughout the processing, handling and operation of any application. Please note the following measures are good for ESD protection during the module handling.

- Unless there is a galvanic coupling between the local GND and the PCB GND, the first point of contact shall always be between the local GND and PCB GND when handling the PCB.
- Before mounting the RF_IN pad, please make sure the GND of the module has been connected.
- Do not contact any charged capacitors and materials which can easily develop or store charges (such as patch antenna, coax cable, soldering iron) when handling with the RF_IN pad.
- To prevent electrostatic discharge from the RF input, please do not touch any exposed area of the mounted patch antenna.
- Make sure to use an ESD safe soldering iron (tip) when soldering the RF_IN pin.

7.4. Tape and Reel Packaging

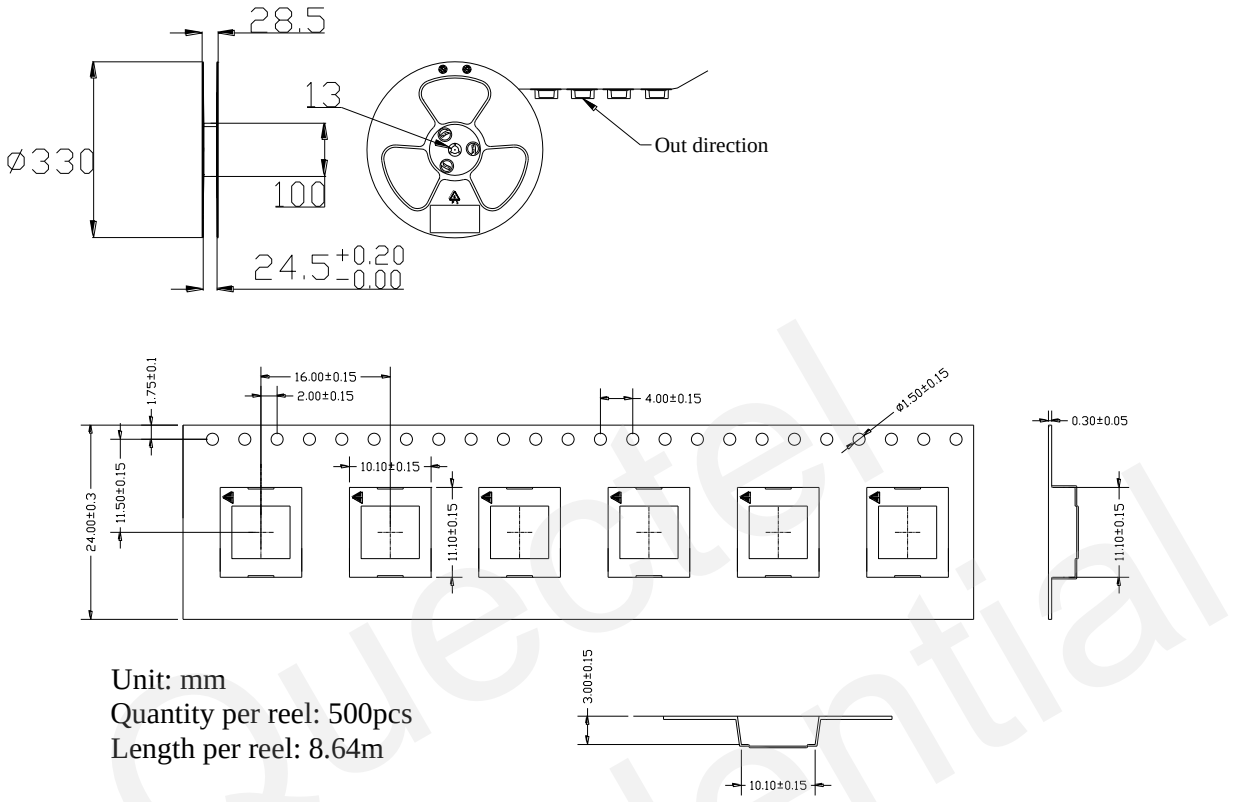

Figure 23: Tape and Reel Specifications

Table 12: Reel Packaging

Model Name	MOQ for MP	Minimum Package: 500pcs	Minimum Package × 4 =2000pcs
L70-R/L70-RL	500pcs	Size: 370mm × 350mm × 56mm N.W: 0.25kg G.W: 1.00kg	Size: 380mm × 250mm × 365mm N.W: 1.1kg G.W: 4.4kg

7.5. Ordering Information

Table 13: Ordering Information

Model Name	Ordering Code
L70-R	L70RE-M37
L70-RL	L70REL-M37

8 Appendix References

Table 14: Related Documents

SN	Document Name	Remark
[1]	Quectel_L70-R_Series_EVB_User Guide	L70-R Series EVB User Guide
[2]	Quectel_L70-R_Series_GPS_Protocol_Specification	L70-R Series GPS Protocol Specification
[3]	Quectel_L70-R_Series_Reference_Design	L70-R Series Reference Design
[4]	Quectel_GNSS_EPO_Application_Note	GNSS EPO Application Note

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