L70-R Hardware Design

GPS Module Series

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About the Document

History

Revision	Date	Author	Description
1.0	2014-05-07	King HAO	Initial

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1 Introduction

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

This document can help you quickly understand the interface specifications, electrical and mechanical details of L70-R module. Other documents such as *Quectel_L70-R_GPS_Protocol_Specification* and *Quectel_L70-R_EVB_User_Guider* are also provided for your reference. These documents provide the guidance for you to design and set up applications by L70-R module.

2 Product Concept

2.1. General Description

The L70-R ROM-based GPS module brings the 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 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 module integrates many advanced features including AIC, LOCUS and AlwaysLocate^{TM} into the compact form factor. These features are beneficial to save consumption, improve sensitivity for GPS system. The module supports various location, navigation and industrial applications, including autonomous GPS, SBAS (including WAAS, EGNOS, MSAS, and GAGAN) and QZSS.

L70-R 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 1: Module Key Features

Feature	Implementation
Power Supply	● Supply voltage: 2.8V ~ 4.3V ● Typical supply voltage: 3.3V
Power Consumption	● Acquisition: 16mA @VCC=3.3V ● Tracking: 13mA @VCC=3.3V ● Standby: 500uA @VCC=3.3V ● Backup: 8uA @V_BCKP=3.3V
Receiver Type	● GPS L1 1575.42MHz C/A Code ● 66 search channels, 22 simultaneous tracking channels

Sensitivity	• Acquisition: -148dBm
	• Re-acquisition: -160dBm
	• Tracking: -165dBm
TTFF	• Cold start (Autonomous): 35s typ.@-130dBm
	• Warm start (Autonomous): 30s typ.@-130dBm
	• Hot start (Autonomous): 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 < 15ns (Time service is not supported)
	• 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, 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 GPS signal generator, AIC and SBAS are enabled.
2. The sensitivity is measured with passive antenna but without external LNA. It might be higher by about 2dB with external LNA or only with active antenna.

2.3. Block Diagram

The following figure shows a block diagram of L70-R module. It consists of a single chip GPS IC which includes RF part and baseband part, a SAW filter, a TCXO and a crystal oscillator.
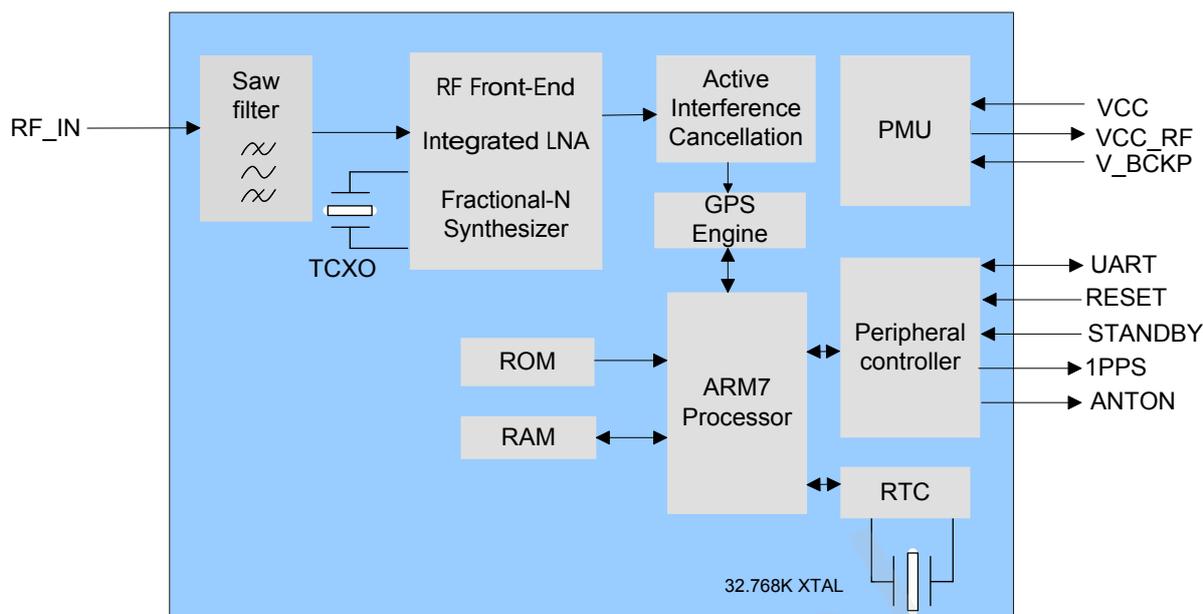
Figure 1: Block Diagram

2.4. Evaluation Board

In order to help you to use L70-R 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. The Protocols Module Supports

Table 2: The Protocols Supported by the Module

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

NOTE

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

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3 Application

The L70-R 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 3: 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 Vnom=3.3V	Supply current for no less than 100mA.

| 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	
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 exit from standby mode.	VILmin=-0.3V VILmax=0.8V VIHmin=2.0V	Pulled up internally. It is edge-triggered. If unused, keep this pin

				VIHmax=3.6V	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 satellites track and the rate of satellite re-acquisition. Typical VCC peak current may reach to 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: 54 mV (RMS) max @ f = 0… 3MHz and 15 mV (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 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 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 supply power for RTC domain.
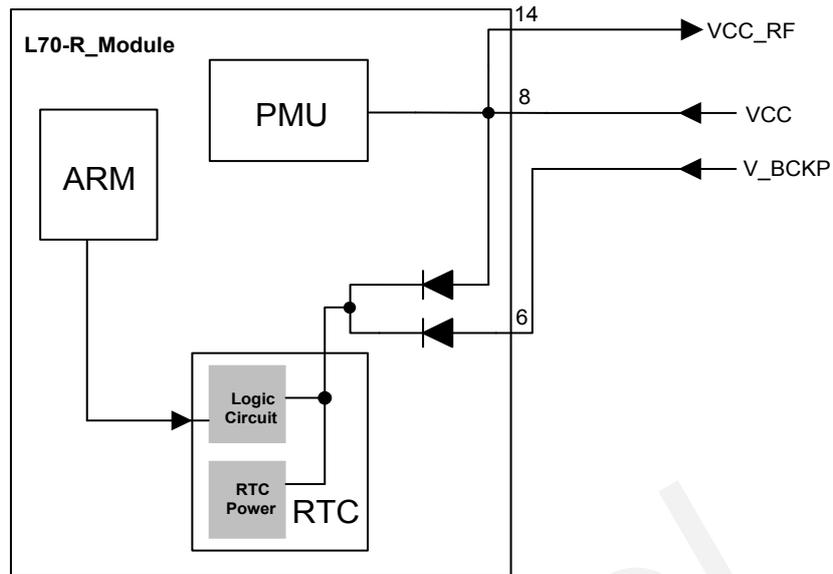
Figure 3: Internal Power Construction

The following picture shows the average power and current consumption versus VCC supply voltage. It was measured with GPS signal generator in tracking mode.
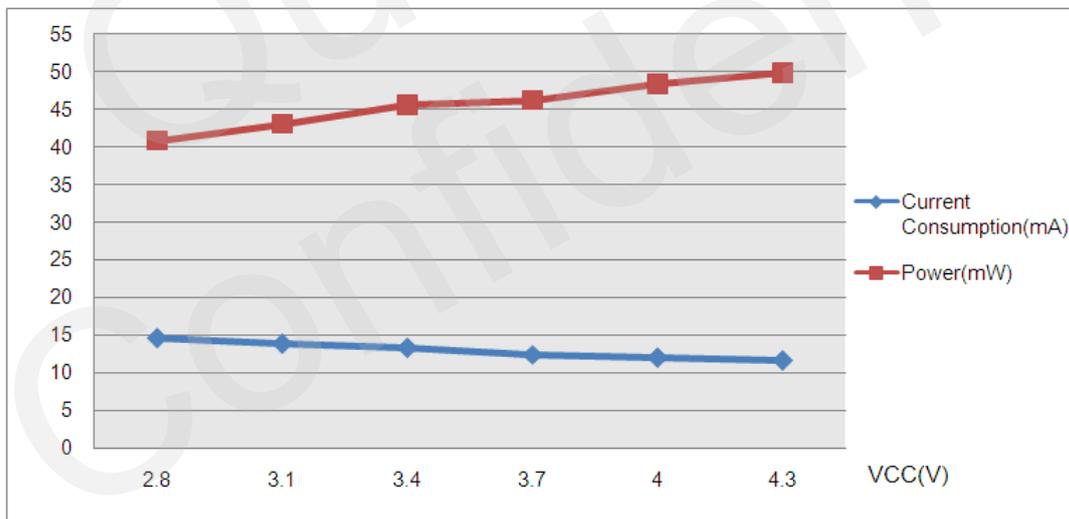
Figure 4: Power and Current Consumption versus VCC

3.4. Operating Modes

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

Table 4: Module States Switch

Current Mode	Next Mode				
	Backup	Standby	Full on	Periodic	AlwaysLocate
Backup	N/A	N/A	Restore the main supply VCC.	N/A	N/A
Standby	N/A	N/A	Pull up STANDBY pin or send any data via UART1.	N/A	N/A
Full on	Remain V_BCKP and cut off VCC.	Pull down STANDBY pin or send PMTK161 command.	N/A	Send PMTK225 command.	Send PMTK225 command.
Periodic	N/A	N/A	Send PMTK225 command.	N/A	N/A
AlwaysLocate	N/A	N/A	Send PMTK225 command.	N/A	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, determine visible satellites and 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 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 5: Default Configurations

Item	Configuration	Comment
Baud Rate	9600bps	
Protocol	NMEA	GGA, GSV, GSA and RMC
Update Rate	1Hz	
SBAS	Enable	
AIC	Enable	
LOCUS	Disable	

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 like PMTK commands or any other data, but there is no NMEA messages output.

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

● **Using PMTK command**: Sending PMTK command "$PMTK161,0*28" will make L70 module enter into standby mode. Sending any data via UART1 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., thus leading to a fastest possible TTFF in either Hot or Warm start. The typical standby current consumption in this way is about 500uA @VCC=3.3V.

● **Using STANDBY pin**: Pulling STANDBY pin low also can make L70 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 the extra current consumption which will make the typical standby current 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. For 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 is a lower power mode 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, L70-R 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. The typical consumption in backup mode can be as low as 8uA.

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.
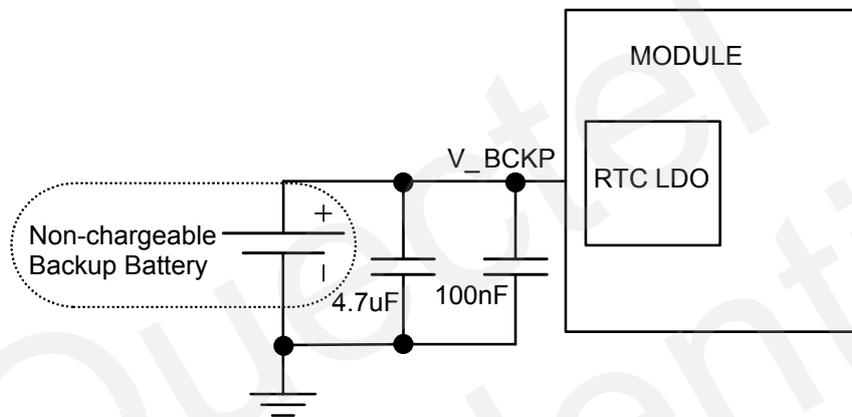

Figure 5: RTC Supply from Non-chargeable Battery

The V_BCKP pin does not support charging function for rechargeable battery. It is necessary to add an external charging circuit for rechargeable battery.
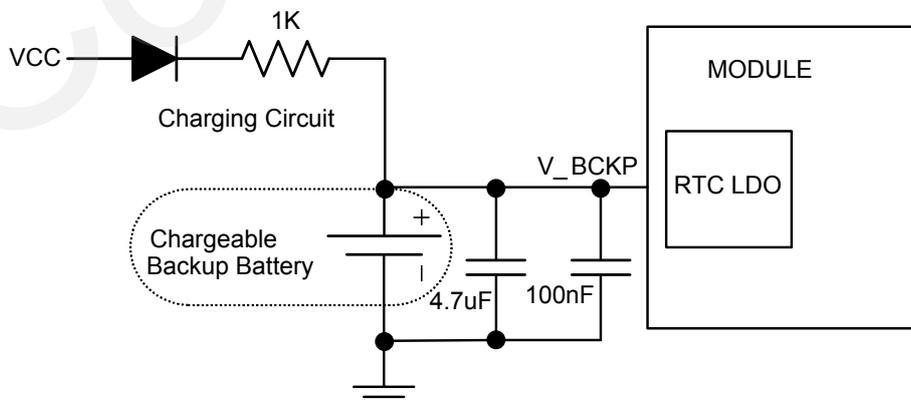
Figure 6: Reference Charging Circuit for Chargeable Battery

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.
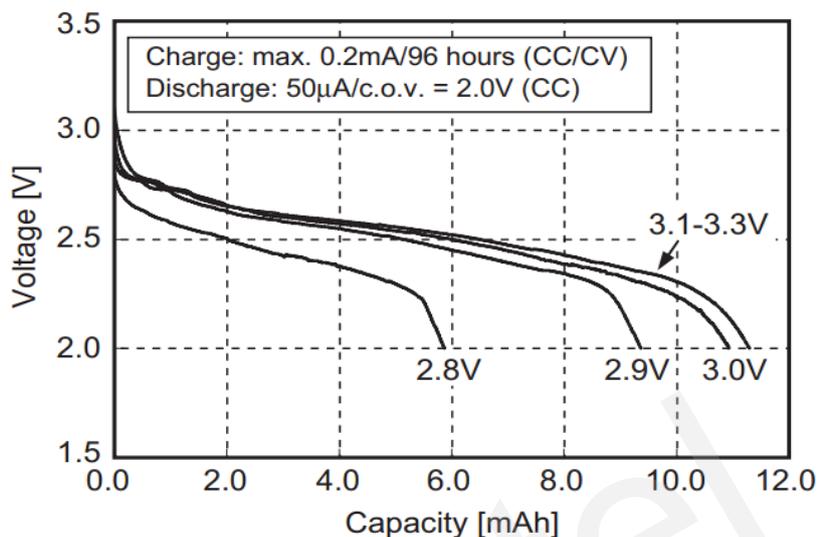
Figure 7: Seiko MS920SE Charge and Discharge Characteristics

3.4.4. Periodic Mode

Periodic mode is a power saving mode of L70-R that can switch the full on mode and standby mode periodically to reduce power consumption.

The format of the command which is used to let the module enter into periodic mode is as follows:

Table 6: PMTK Command Format

Format: $PMTK225,2,<Run_time>,<Sleep_time>,<2nd_run_time>,<2nd_sleep_time>*<checksum><CR><LF>		
Parameter	**Format**	**Description**
Run_time	Decimal	Full on period (ms)
Sleep_time	Decimal	Standby period (ms)
2nd_run_time	Decimal	Full on period (ms) for extended acquisition in case GPS module acquisition fails during the **Run_time**
2nd_sleep_time	Decimal	Standby period (ms) for extended sleep in case GPS module acquisition fails during the **Run_time**
Checksum	Hexadecimal	Hexadecimal checksum

Example:

$PMTK225,2,3000,12000,18000,72000*15<CR><LF>

Sending "$PMTK225,0*2B" in any time will make the module return to full on mode from periodic standby mode.

Figure 8 has shown the operation of periodic mode. When you send PMTK command, the module will be in the full on mode firstly. After several minutes, the module will enter into the periodic mode and follow the parameters set by you. When the module fails to fix the position in run time, the module will switch to 2nd_run_time and 2nd_sleep_time automatically. As long as the module fixes the position again, the module will return to Run_time and Sleep_time.

Please ensure the module is in the tracking state before entering into periodic mode. Otherwise the module may fail to track the satellites. If GPS module is located in weak signal environment, it is better to set a longer 2nd_run_time to ensure the success of re-acquisition.

The average current value can be calculated by the following formula:

I periodic= (I tracking*T1+Istandby*T2)/ (T1+T2)   T1: Run_time, T2: Sleep_time

Example:

PMTK225,2,3000,12000,18000,72000*15 for periodic mode with 3s in tracking mode and 12s in standby mode. The average current consumption is calculated below:
I periodic=(I tracking*T1+I standby*T2)/(T1+T2)=(13mA*3s + 0.5mA*12s)/(3s+12s)=3(mA)
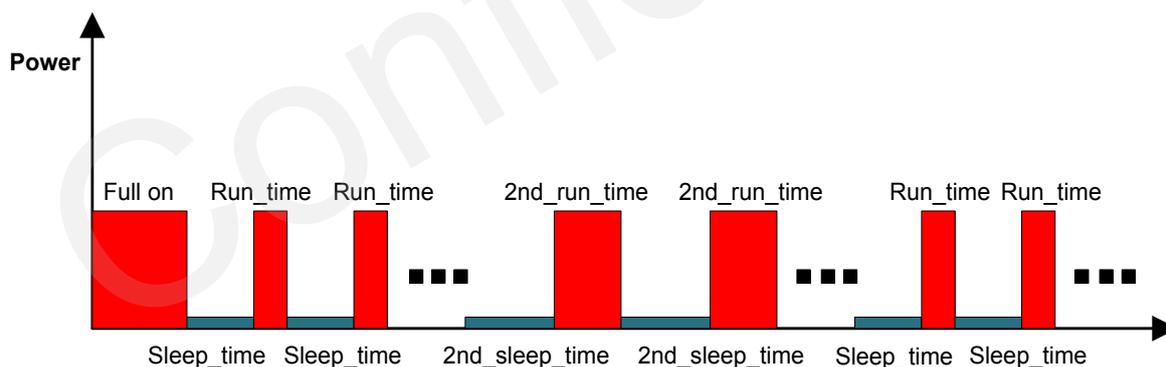
Figure 8: Periodic Mode

3.4.5. AlwaysLocate^{TM} Mode

AlwaysLocate^{TM} is an intelligent power saving mode. AlwaysLocate^{TM} standby mode supports the module to switch automatically between full on mode and standby mode. According to the environmental and motion conditions, the module can adaptively adjust the full on time and standby time to achieve a balance between positioning accuracy and power consumption. Sending "$PMTK225,8*23" and the module returns: "$PMTK001,225,3*35" means the module accesses AlwaysLocate^{TM} standby mode successfully. It will benefit power saving in this mode. Sending "$PMTK225,0*2B" in any time will bring the module back to full on mode.

The positioning accuracy in AlwaysLocate^{TM} mode will be somewhat degraded, especially in high speed. The following picture shows the rough power consumption of L70-R module in different daily scenes when AlwaysLocate^{TM} mode is enabled.
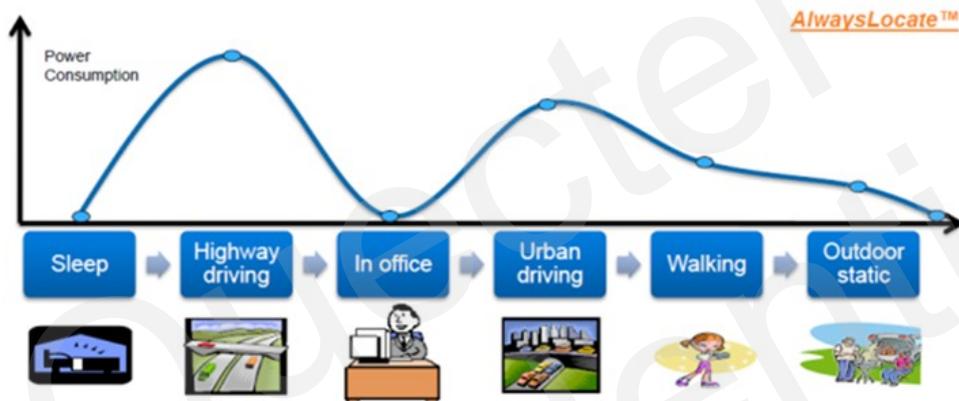
Figure 9: AlwaysLocate^{TM} Mode

The typical average consumption is about 1.6mA in AlwaysLocate^{TM} standby mode when the GPS module is located in outdoor static mode with active antenna.

3.5. Reset

L70-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 non-volatile backup RAM is not cleared, thus a fast TTFF is possible. An OC driver circuit shown as below is recommended to control the RESET.
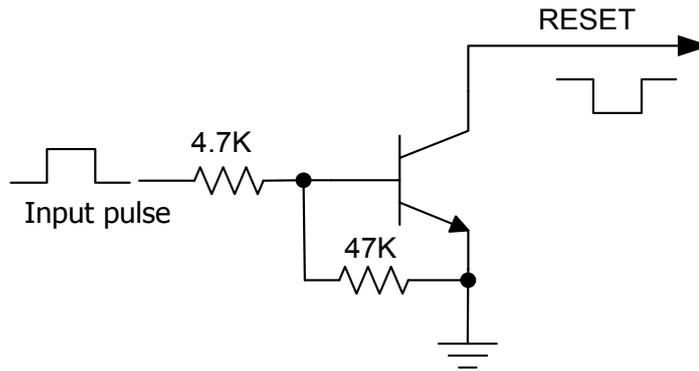
Figure 10: Reference Reset Circuit Using OC Circuit

The restart timing of L70-R has been illustrated as bellow.
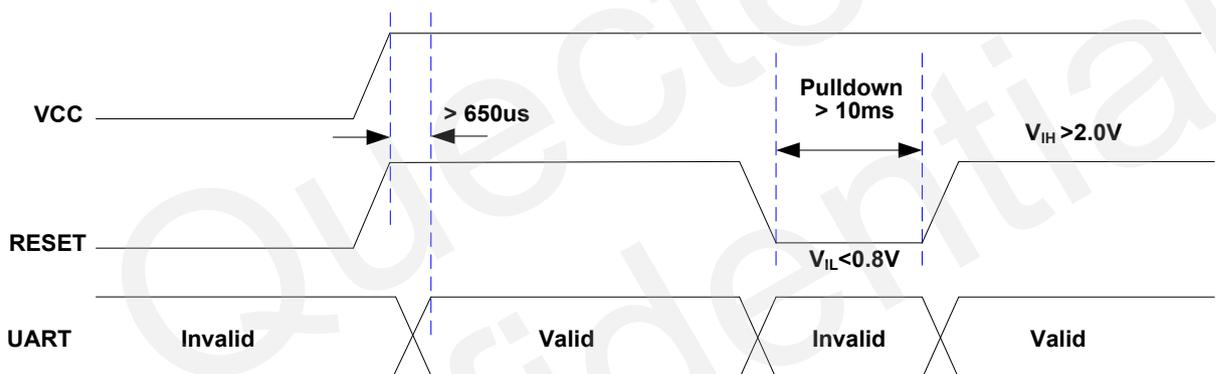
Figure 11: Restart Timing

3.6. UART Interface

The module provides one universal asynchronous receiver & transmitter serial port. The module is designed as a 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 as Figure 12. 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
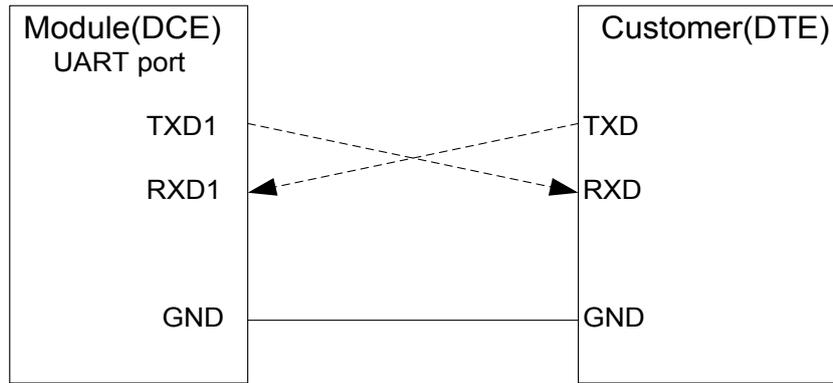
Figure 12: Connection of Serial Interfaces

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 and RMC.
- UART port supports the following data rates:
  4800, 9600, 14400, 19200, 38400, 57600, 115200.
  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.
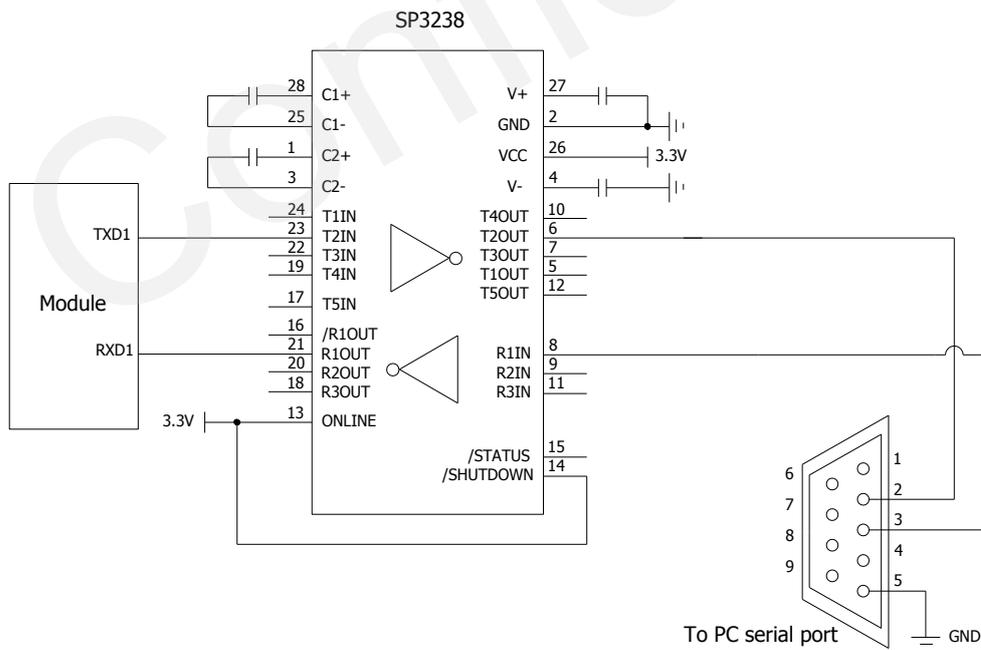
Figure 13: RS-232 Level Shift Circuit

3.7. Multi-tone AIC

L70-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. ANTON

L70-R 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 works in standby mode, backup mode, sleep time in periodic mode or AlwaysLocate^{TM} 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. LOCUS

L70-R module supports the embedded logger function called LOCUS. It can log position information to the internal NVRAM automatically when this function is enabled by sending PMTK command "$PMTK185, 0*22". Due to this function, the host can enter to sleep to save power consumption and do not need to receive the NMEA information all the time.

The detail procedures of this function are illustrated as below:

● The module has fixed the position (only 3D_fixed is available);
● Sending PMTK command "$PMTK184,1*22" to erase internal NVRAM;
● Sending PMTK command "$PMTK185,0*22" to start log;
● Module logs the basic information (UTC time, latitude, longitude and height) every 50 meters to internal NVRAM;
● Stop logging the information by sending "$PMTK185,1*23";
● Host can get the data from the module via UART1 by sending "$PMTK622,1*29".

The raw data which host gets has to be parsed via LOCUS parser code provided by Quectel. For more details, please contact Quectel technical support.

NOTE

With internal 8KB NVRAM, L70-R can log around 500 events of logging data, please note that the NVRAM data will be lost when RTC power is removed.

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4 Antenna Interface

L70-R 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 by 50 Ohm, and the 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 antenna can be used for L70-R 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.
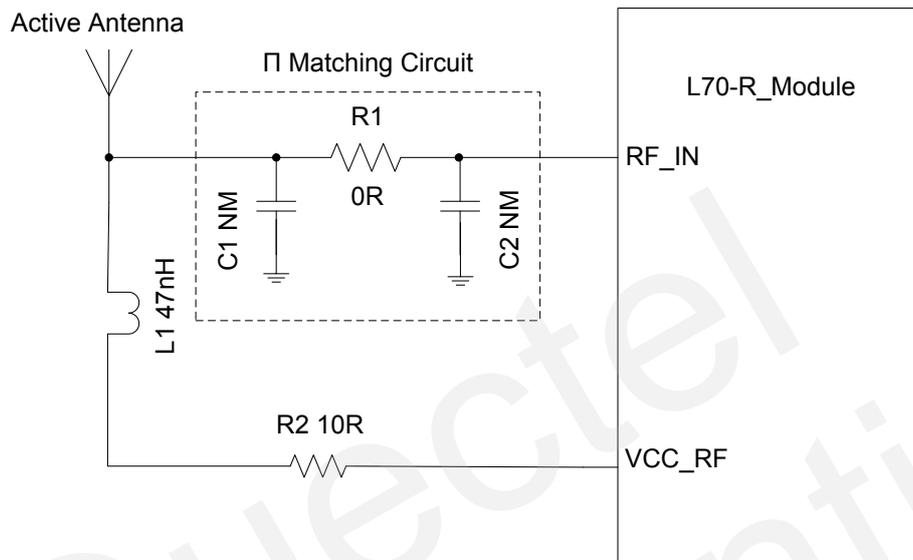
Figure 14: Reference Design for Active Antenna without ANTON

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

L70-R module provides power supply for external active antenna by VCC_RF. The voltage ranges from 2.8V to 4.3V, 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 module can also save power consumption by controlling the power supply of active antenna through the pin "ANTON".

The reference circuit for active antenna with "ANTON" function is given as below.
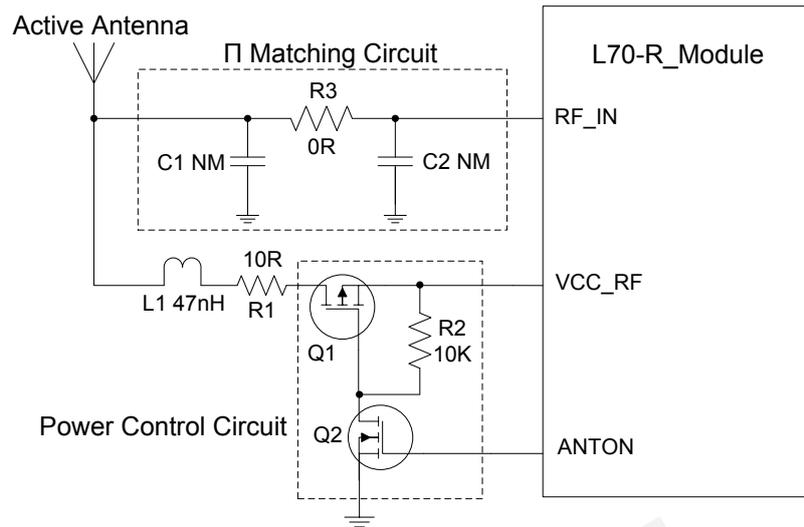
Figure 15: Reference Design for Active Antenna with ANTON

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 high and low 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 than10k ohm.

4.2.2. Passive Antenna

4.2.2.1. Passive Antenna without External LNA
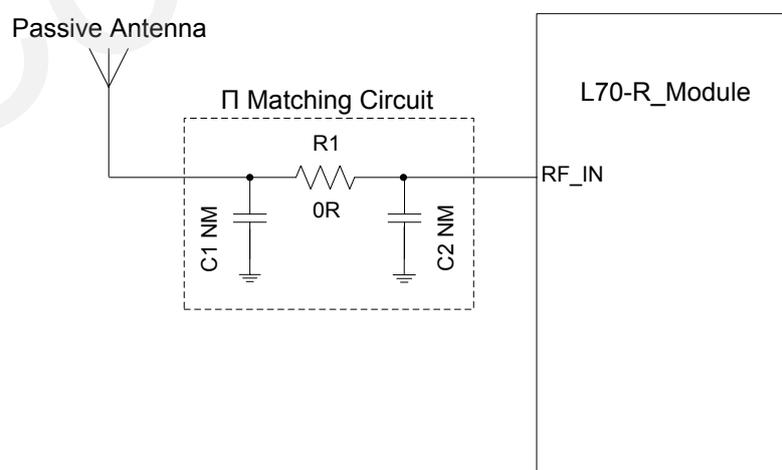
Figure 16: Reference Design for Passive Antenna without LNA

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

C1, R1, 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 by 50 ohm and the length should be kept as short as possible.

If an external LNA is added between passive antenna and L70-R module, the total sensitivity will be improved about 2dB, and the TTFF will be shorter in weak signal, which might be helpful for better performance.

4.2.2.2. Passive Antenna with External LNA

In order to improve the GPS receiver sensitivity and TTFF, an external LNA between the passive antenna and the L70-R module is recommended. The reference design is shown as below.
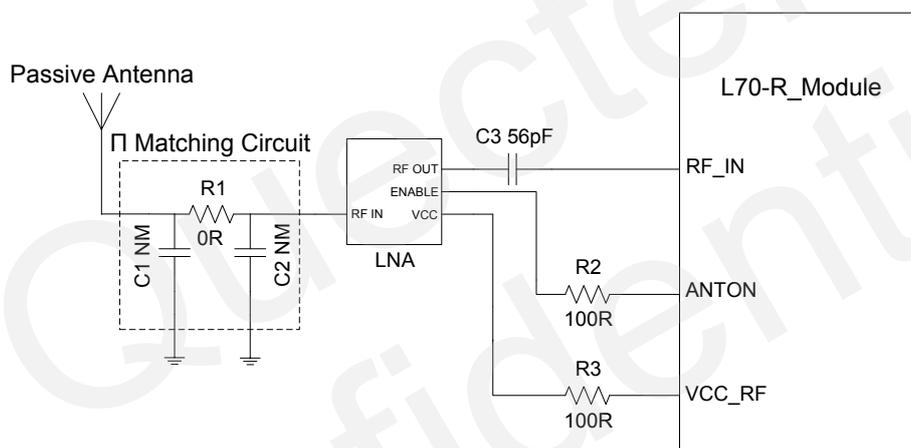
Figure 17: Reference Design for Passive Antenna with LNA

Here, C1, R1, 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 module and the default value of C3 capacitor is 56pF which can be optimized according to the real conditions. ANTON is an optional pin which can be used to control the enable pin of the LNA.

NOTES

1. In order to be compatible 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. If "ANTON" function is unused, 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 table above, it must be limited to values within the specified boundaries by using appropriate protection diodes.

5.2. Operating Conditions

Table 9: The Module 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	℃

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: The Module Current Consumption

Parameter	Conditions	Min.	Typ.	Max.	Unit
I_{VCC}@Acquisition	@VCC=3.3V		16		mA
I_{VCC}@Tracking	@VCC=3.3V		13		mA
I_{VCC}@Standby	@VCC=3.3V		500		uA
I_{BCKP}@Backup	@V_BCKP=3.3V		8		uA

NOTES

1. The VCC_RF current is not reckoned in above consumption.
2. 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 Mechanics

This chapter describes the mechanical dimensions of the module.

6.1. Mechanical View of the Module
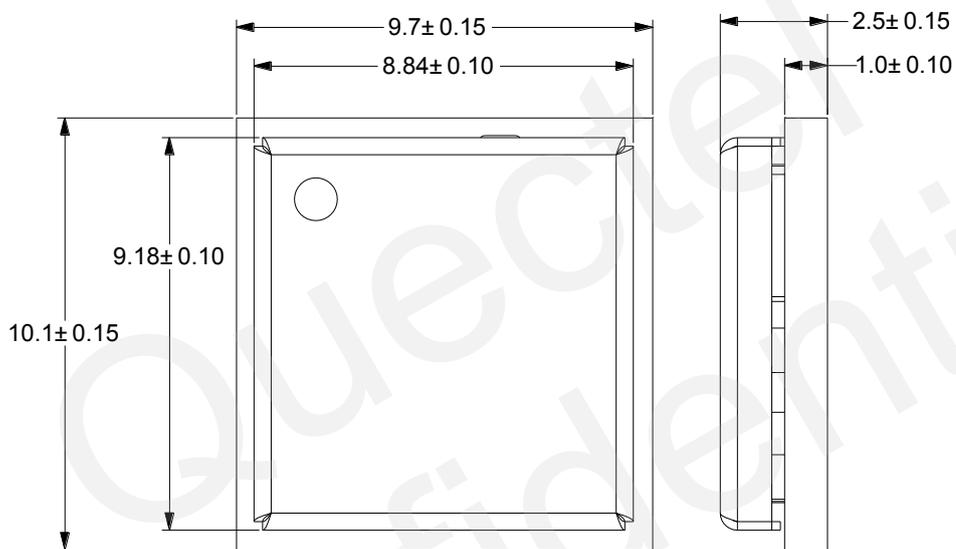
**Figure 18: Top View and Side View（Unit: mm）**

6.2. Bottom Dimension and Recommended Footprint
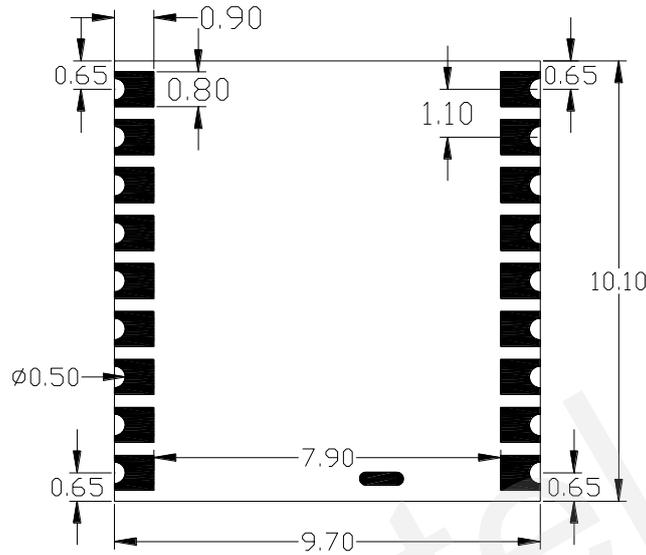
Figure 19: Bottom Dimension（Unit: mm）
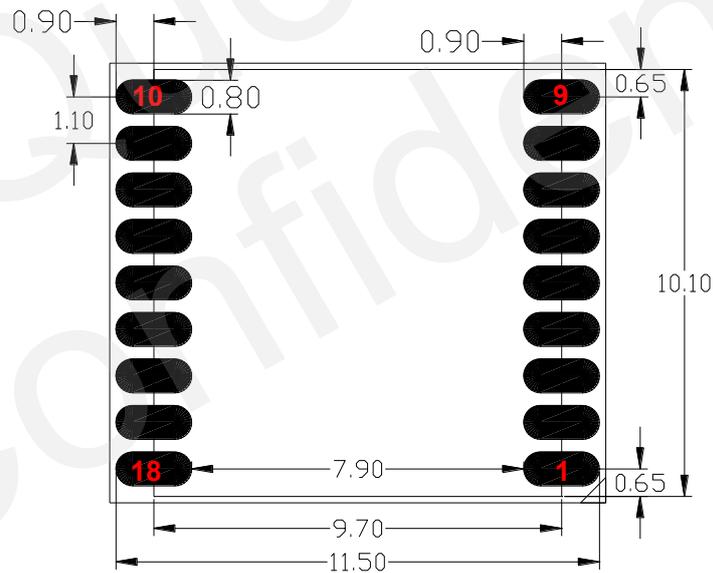
Figure 20: Footprint of Recommendation（Unit: mm）

> **NOTE**
>
> For easy maintenance of this module and 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 View of the Module
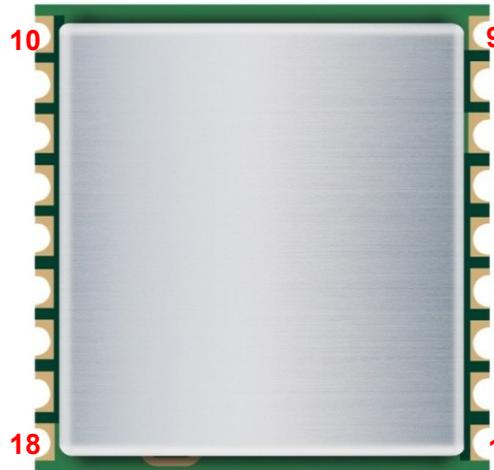
Figure 21: Top View of the Module

6.4. Bottom View of the Module
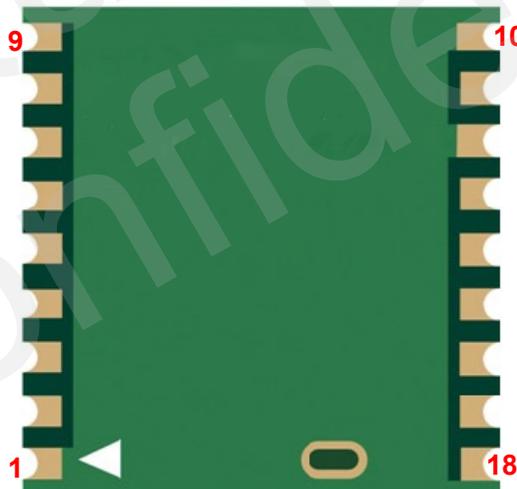
Figure 22: Bottom View of the Module

7 Manufacturing

7.1. Assembly and Soldering

L70-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 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 proposed that peak reflow temperature is 235~245ºC (for SnAg3.0Cu0.5 alloy). Absolute max reflow temperature is 260ºC. To avoid the damage caused by repeatedly heating the module, it is recommended that the module should be mounted after the first panel has been reflowed. The following picture is the actual diagram.
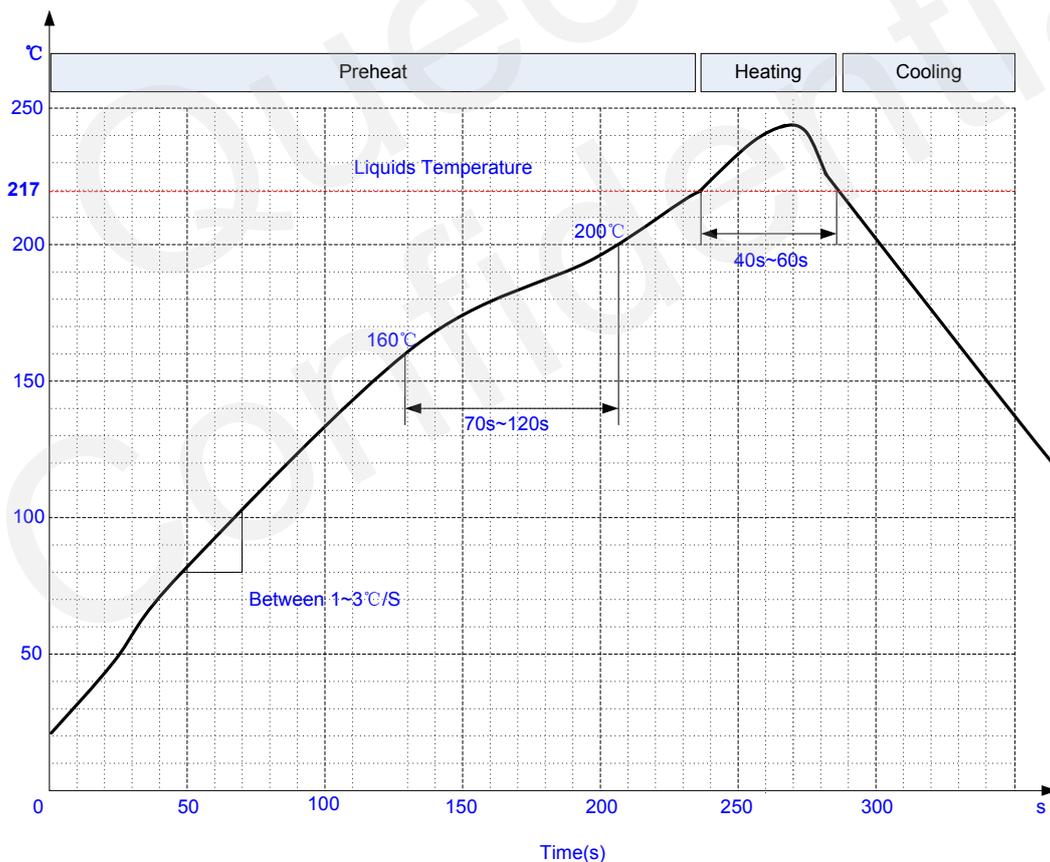
Figure 23: Ramp-soak-spike-reflow of Furnace Temperature

## 7.2. Moisture Sensitivity

L70-R module is sensitive to moisture absorption. To prevent L70-R from permanent damage during reflow soldering, baking before reflow is required in following cases:

● Humidity indicator card: At least one circular indicator is no longer blue
● The seal is opened and the module is exposed to excessive humidity

L70-R should be baked for 192 hours at temperature 40℃+5℃/-0℃ and < 5% RH in low-temperature containers, or 24 hours at temperature 125℃±5℃ in high-temperature containers. Care should be taken that plastic tray is not heat resistant. L70-R should be taken out before preheating, otherwise, the tray maybe damaged by high-temperature heating.

7.3. ESD Protection

L70-R module is an ESD sensitive device. ESD protection precautions should be emphasized. Proper ESD handing 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 when L70-R module is handled.

● Unless there is a galvanic coupling between the local GND and the PCB GND, then the first point of contact shall always be between the local GND and PCB GND when handling the PCB.
● Before mounting with 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

Unit: mm
Quantity per reel: 500pcs
Length per reel: 8.64m
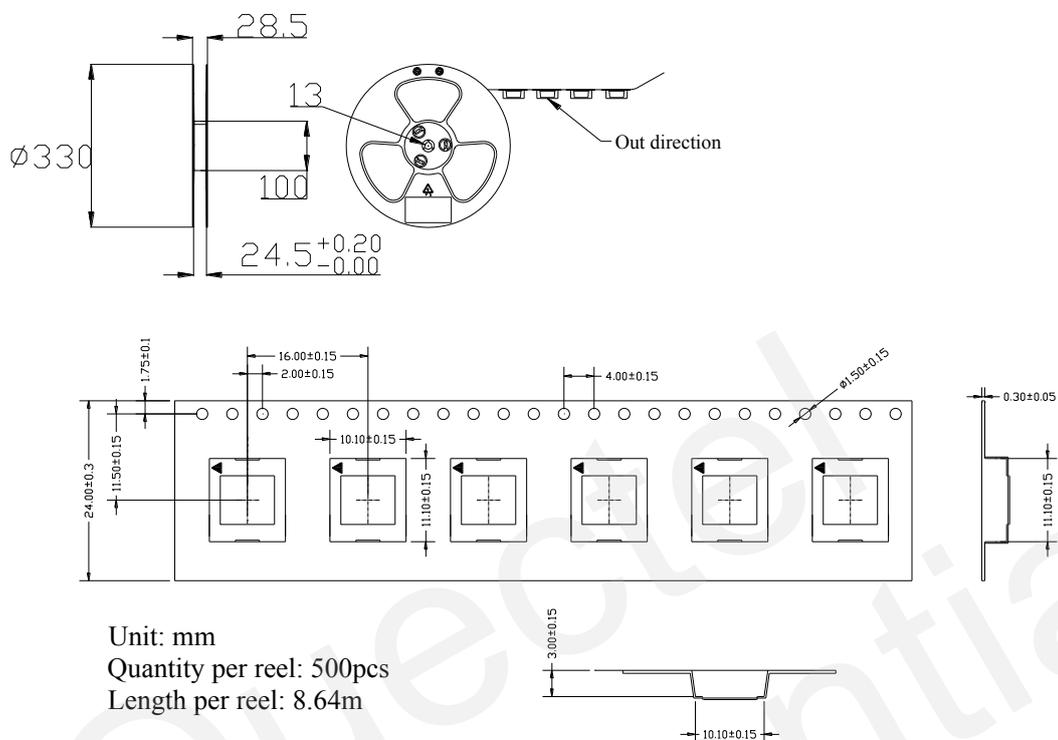
Figure 24: Tape and Reel Specification

Table 12: Tray Packing

Model Name	MOQ for MP	Minimum Package: 500pcs	Minimum Package x4=2000pcs
L70-R	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	Product Number	Ordering Code
L70-R	S2-W1789	L70R-M37

8 Appendix Reference

Table 14: Related Documents

SN	Document Name	Remark
[1]	Quectel_L70-R_EVB _User Guide	L70-R EVB User Guide
[2]	Quectel_L70-R_GPS_Protocol_Specification	L70-R GPS Protocol Specification
[3]	Quectel_L70-R_Reference_Design	L70-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