L10

Quectel GPS Engine

Hardware Design

L10_HD_V1.02

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0 Revision history

Revision	Date	Author	Description of change
1.00	2009-07-05	Yong AN/Samuel HONG	Initial
1.01	2009-11-16	Yong AN/Samuel HONG	1. Add NMEA message type of module output in default. 2. Add descriptions about relation between USB interface and standby mode.
1.02	2011-3-12	Crystal HE	1. Add description of UART port2 2. Revise Figure12~Figure15. 3. Modify UART port to UART port1

1 Introduction

This document defines and specifies the L10 GPS module. It describes L10 hardware interface and its external application reference circuits, mechanical size and air interface.

This document can help you quickly understand module interface specifications, electrical and mechanical details. With the help of this document and other application notes, you can use L10 module to design and set up your applications quickly.

1.1 Related documents

Table 1: Related documents

SN	Document name	Remark
[1]	L10_HD_AN	L10 Hardware Design Application Notes
[2]	L10_EVB _UGD	L10 EVB User Guide
[3]	L10_GPS_Protocol	L10 GPS Protocol Specification

1.2 Terms and abbreviations

Table 2: Terms and abbreviations

Abbreviation	Description
BEE	Broadcast Ephemeris Extension
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge
EPO	Extended Prediction Orbit
EGNOS,	European Geostationary Navigation Overlay Service
GPS	Global Positioning System
GNSS	Global Navigation Satellite System
GGA	GPS Fix Data
GLL	Geographic Position – Latitude/Longitude
GSA	GNSS DOP and Active Satellites
GSV	GNSS Satellites in View
HDOP	Horizontal Dilution of Precision
IC	Integrated Circuit
I/O	Input/Output
Kbps	Kilo Bits Per Second

LNA	Low Noise Amplifier
MSAS	Multi-Functional Satellite Augmentation System
NMEA	National Marine Electronics Association
OMA	Open Mobile Alliance
PDOP	Position Dilution of Precision
PMTK	MTK Private Protocol
RMC	Recommended Minimum Specific GNSS Data
RTCM	Radio Technical Commission for Maritime Services
SBAS	Satellite-based Augmentation System
SUPL	Secure User Plane Location
SAW	Surface Acoustic Wave
USB	Universal Serial Bus
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
ZDA	Time & Date
Inorm	Normal Current
Imax	Maximum Load Current
Vmax	Maximum Voltage Value
Vnorm	Normal 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

2 Product concept

The L10 GPS module brings the high performance of the MTK positioning engine to the industrial standard. The module supports 210 PRN channels. With 66 search channels and 22 simultaneous tracking channels, it acquires and tracks satellites in the shortest time even at indoor signal level. This versatile, stand-alone receiver combines an extensive array of features with flexible connectivity options. The embedded FLASH memory provides capacity for storing user-specific configuration settings and allows for future updates. L10 advanced jamming suppression mechanism and innovative RF architecture provides a high level of immunity for jamming, ensuring maximum GPS performance. The module supports location, navigation and industrial applications including autonomous GPS C/A, SBAS (including WAAS, EGNOS, and MSAS), DGPS (RTCM), and AGPS.

The L10 is an SMD type module with the compact 22.4mm x 17.0mm x 3.0 mm form factor, which can be embedded in customer applications through the 28-pin pads. It provides all hardware interfaces between the module and customer's board.

- The UART port can help to develop customer's application easily.
- The USB port is available for faster data transmission and more flexibility
- The antenna interface supports passive and active antenna.

The module is fully RoHS compliant to EU regulation.

2.1 Key features

Table 3: Module key features

Feature	Implementation
Power supply	Single supply voltage: 3.0V – 4.3V typical : 3.3V
Power consumption (passive antenna)	● Acquisition 43mA ● Tracking 38mA ● Standby 2mA
Receiver Type	● GPS L1 1575.42MHz C/A Code ● 66 search channels, 22 simultaneous tracking channels
Sensitivity	● Cold Start (Autonomous) -147 dBm ● Reacquisition -160 dBm ● Hot start -160 dBm ● Tracking -165 dBm
Time-To-First-Fix	● Cold Start (Autonomous) 35s average ● Warm Start (Autonomous) 35s average ● Hot Start (Autonomous) <1.2 s ● SUPL 5 ~10s
Position Accuracy	● Without Aid 3.0 m 2D-RMS

	● DGPS 2.5 m
Max Update Rate	● 5Hz
Accuracy of 1PPS Signal	● Typical accuracy 61 ns ● Time pulse adjustable from 1ms to 999ms, default 100ms
Velocity Accuracy	● Without Aid 0.1 m/s ● DGPS 0.05 m/s
Acceleration Accuracy	● Without Aid 0.1 m/s² ● DGPS 0.05 m/s²
Dynamic Performance	● Maximum Altitude 18,000 m ● Maximum Velocity 515 m/s Maximum ● Acceleration 4 G
UART Port	UART Port1: ● Two lines TXD1 and RXD1 ● UART Port 1 supports baud rate from 4800bps to 115200bps. ● UART Port1 is used for NMEA output or input , PMTK private messages input and firmware upgrade UART Port2: ● Two lines TXD2 and RXD2 ● UART Port2 is used for the input of RTCM files. ● UART Port 2 supports baud rate from 4800bps to 115200bps.
USB Port	● Support USB 2.0 full-speed compatible ● USB Port is used for NMEA outputting or inputting , PMTK private messages inputting and firmware upgrade
Temperature range	● Normal operation: -40°C ~ +85°C ● Storage temperature: -45°C ~ +125°C
Physical Characteristics	Size: 22.4±0.15 x 17±0.15 x 3.0±0.1mm Weight: about 2.2g
Firmware Upgrade	Firmware upgrade over UART port or USB port

2.2 Functional diagram

The following figure shows a block diagram of the L10 module. It consists of single chip GPS IC which includes RF part and Baseband part, LNA and SAW filter as well as antenna supervision.

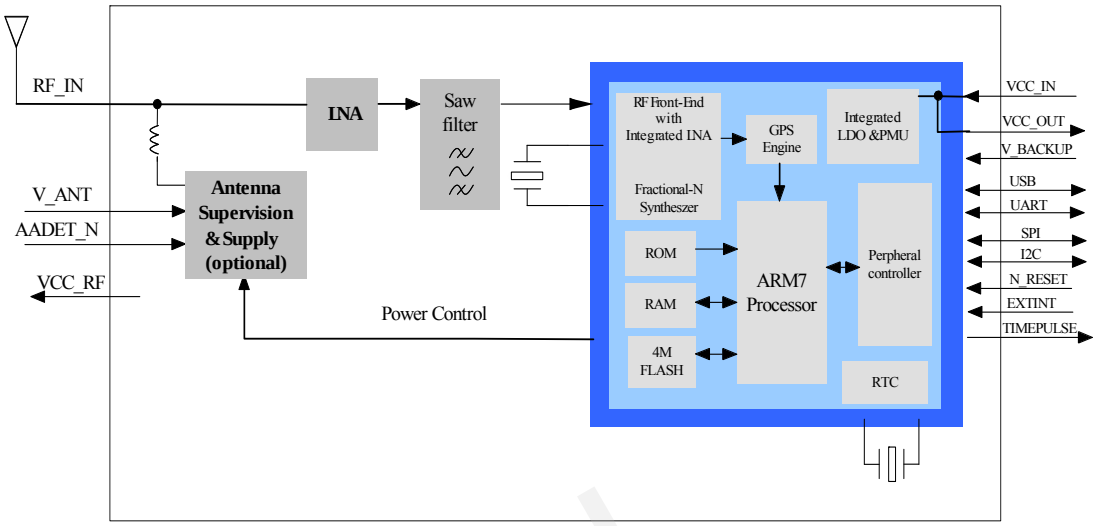


Figure 1: Module functional diagram

2.3 Evaluation board

In order to help customer on the application of L10 module, Quectel supplies an Evaluation Board (EVB) with appropriate power supply, RS-232 serial cable, USB cable, antenna and the module.
For more details, please refer to the document [2].

2.4 Assisted GPS

Supplying aiding information, like ephemeris, almanac, rough last position, time, and satellite status, can improve the acquisition sensitivity. The L10 module supports OMA SUPL compliant, but for being lack of some testing condition, it is still not be verified by Quectel.

2.5 Protocol

The module supports standard NMEA-0183 protocol and MTK private protocol (PMTK messages) that can be used to provide extended capabilities for many applications. The module is capable of supporting the following NMEA formats: ***GGA, GSA, GLL, GSV, RMC, ZDA, and VTG.***

Table 4: The module supports protocol

Protocol	Type
NMEA	Input/output, ASCII, 0183, 3.01
PMTK	Input/output, MTK private protocol

Note: Please refer to document [3] about NMEA standard protocol and MTK private protocol.

3 Application interface

The module is equipped with a 28-pin 1.1mm pitch SMT pad that connects to the user application platform. Sub-interfaces included in these pads are described in details in the following chapters:

- Power supply *(refer to Chapter 3.3)*
- UART interfaces *(refer to Chapter 3.7)*
- USB interfaces *(refer to Chapter 3.8)*

Electrical and mechanical characteristics of the SMT pad are specified in *Chapter 5&Chapter 6.*

3.1 Pin description

Table 5: Pin description

Power Supply				
PIN NAME	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
VCC	I	Supply voltage	Vmax= 4.3V Vmin=3.0V Vnorm=3.3V	Supply current for no less than 150mA.
V_BCKP	I	Backup voltage supply	Vmax=4.3V Vmin=2.0V Vnorm=3.3V Iin=4uA	Power supply for RTC when VCC is not applied for the system.
VCC_OUT	O	Output voltage	Vmax= 4.3V Vmin=3.0V Vnorm=3.3V Imax=20mA	If unused, keep this pin open. This pin is internally connected to VCC.
VCC_RF	O	Output voltage RF section	Vmax=4.3V Vmin=3.0V Vnorm=3.3V Imax=50mA	If unused, keep this pin open. Usually supply for external active antenna. VCC_RF≈ VCC-0.1V
V_ANT	I	Antenna bias voltage	Vmax=5.5V Vmin=2.7V	If unused, keep this pin open. Using VCC_RF or external voltage source.
Reset				
PIN NAME	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
RESET_N	I	System reset, low level active.	VILmin=-0.3V VILmax=0.5V	If unused, keep this pin open. Internally pulled up

			VIHmin=2.1V VIHmax=2.8V	
General purpose input/output				
PIN NAME	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
SDA2	I/O	I2C interface	VILmin=-0.3V VILmax=0.8V VIHmin=2.0V VIHmax= 3.6V VOLmin=-0.3V VOLmax=0.4V VOHmin=2.4V VOHmax=2.9 V	If unused keep these pins open. Internally pulled up.
SCL2	I/O			
EXTINT0	I	External interrupt input		If unused keep this pin open. Internally pulled up.
AADET_N	I	Active antenna detect	VILmin=-0.3V VILmax=0.5V VIHmin=2.0V VIHmax=5.5V	If unused keep this pin open.
AOK	O	Antenna abnormal report	VOLmin=-0.3V VOLmax=0.4V VOHmin=2.4V VOHmax=2.9V	If unused keep this pin open. Internally pulled down.
TIMEPULSE	O	Time pulse	VOLmin=-0.3V VOLmax=0.4V VOHmin=2.4V VOHmax=2.9V	1 pulse per second (1PPS). Synchronized at rising edge, pulse length 100ms. If unused keep this pin open.
UART port				
PIN NAME	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
RXD1	I	Receive data	VILmin=-0.3V VILmax=0.8V VIHmin=2.0V VIHmax= 3.6V VOLmin=-0.3V VOLmax=0.4V VOHmin=2.4V VOHmax=2.9V	Be used to output NMEA and input PMTK private messages
TXD1	O	Transmit data		
RXD2	I	Receive data		Be used for the input of RTCM files If unused keep these pins open.
TXD2	O	Transmit data		
USB Port				
PIN NAME	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
VDDUSB	I	Voltage supply for USB port	Vmax= 3.6V Vmin=3.0V Vnorm=3.3V	If unused, connect to GND.
USB_DM	I/O	USB data negative	Compliant with USB2.0	If unused, keep this pin

USB_DP		USB data positive	specification	open. Compatible with USB with 27 Ohms series resistance.
RF interface				
PIN NAME	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
RF_IN	I/O	GPS signal input	Impedance of 50Ω	Refer to chapter 4

3.2 Operating modes

The table below briefly summarizes the various operating modes referred to in the following chapters.

Table 6: Overview of operating modes

Mode	Function
Acquisition mode	The module starts to search satellite, determine visible satellites and coarse carrier frequency and code phase of satellite signals. When the acquisition is performed, it switches to tracking mode automatically.
Tracking mode	The module refines acquisition's message, as well as keeps tracking and demodulating the navigation data from the specific satellites.
Standby mode	EXTINT0 pin can be used to make the module enter into standby mode. In this case, the UART port and USB port are not accessible, and the current consumption of the module is also minimal. The module could be woken up by EXTINT0 pin.

3.3 Power supply

The main power supply is fed through the VCC pin. It is important that the system power supply circuitry is able to support the peak power. So the power supply must be able to provide sufficient current up to 150mA.

The circuit design of the power supply depends strongly on the power source where this power is drained. An LDO (Low Dropout Regulator) device, such as Torex (http://www.torex.co.jp/English) XC6219B332MR is recommended. For more details of this power supply application, please refer to document [1].

3.4 Turn on and Turn off

3.4.1 Turn on

The module can be turned on by various ways which are described in the following chapters:

- Power on reset *(please refer to chapter 3.4.1.1)*;
- Via RESET_N pin: restarts module *(please refer to chapter 3.4.1.2)*

3.4.1.1 Power on

A built-in reset controller automatically turns on the module when VCC is supplied.

3.4.1.2 Restart module using the RESET_N pin

L10 module can be restarted by driving the RESET_N to low level voltage for a certain time and then releasing it. An open drain driver circuit is suggested in application to control the RESET_N. A simple reference circuit illustrates in Figure 2.

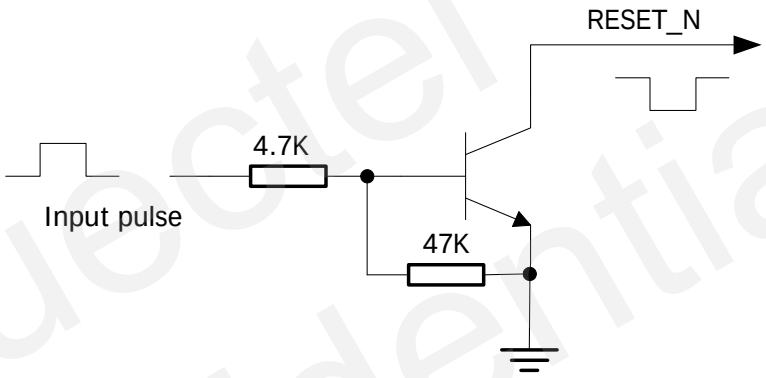


Figure 2: Reference reset circuit using OC circuit

The other way to control the RESET_N is using a button directly. A TVS component needs to be placed nearby the button for ESD protection. While pressing the key, ESD strike may generate from finger. A reference circuit illustrates in Figure 3.

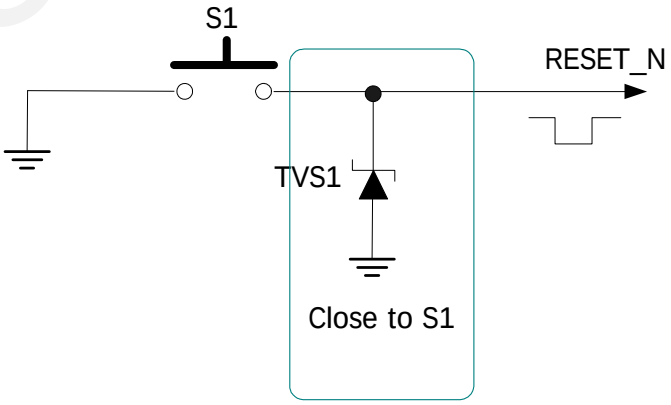


Figure 3: Reference reset circuit using button

The restart timing illustrates in Figure 4.

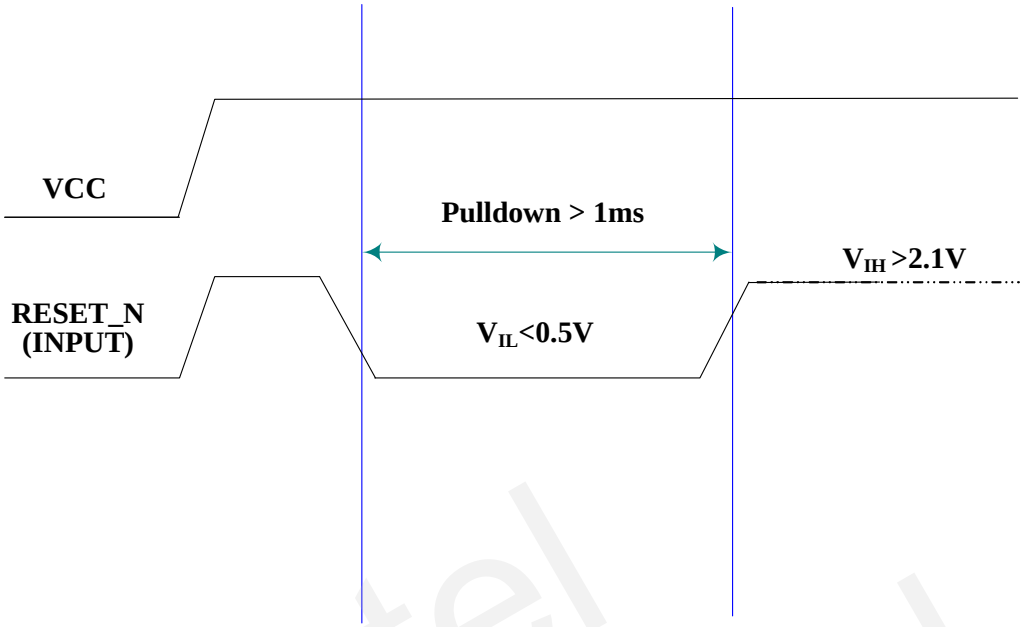


Figure 4: Timing of restart system

3.4.2 Turn off

Shutting down the module's power supply is the only way to turn off the system. For more details of this part application, please refer to document [1].

3.5 Power saving

3.5.1 Enter standby mode

The EXTINT0 pin can be used to drive the module into standby mode. When the EXTINT0 pin is changed from high to low, the module will enter the standby mode. In this case, the UART port and the USB port are not accessible, and the current consumption of the module is also minimal.

Note: When USB interface of the module is being used, the module could not enter standby mode.

3.5.2 Exit from standby mode

When the EXTINT0 pin is changed from low to high, the module will exit from the standby mode.

3.6 RTC backup

The RTC (Real Time Clock) power supply of module can be directly provided by an external capacitor or battery (rechargeable or non-chargeable) through the V_BCKP pin. It can supply power for

backed-up memory which contains all the necessary GPS information for quick start-up and a small amount of user configuration variables.

Table 7: Pin definition of the V_BCKP pin

Name	Pin	Function
V_BCKP	11	Backup voltage supply

Note: The VRTC couldn't keep open. The VRTC pin should be connected to a battery or a capacitor for GPS module hot start and AGPS..

Please refer to the following figure for RTC backup:

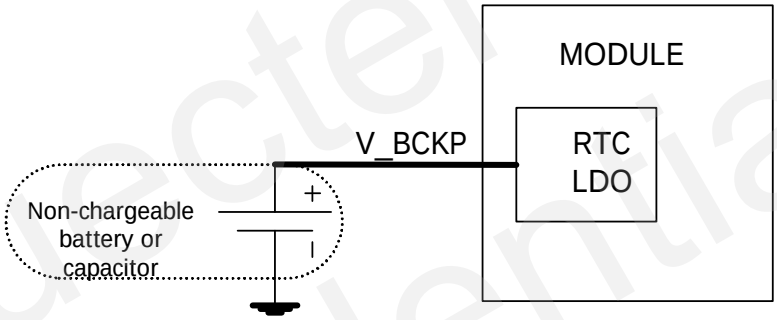


Figure 5: RTC supply from non-chargeable battery or capacitor

The V_BCKP pin does not implement charging for rechargeable battery. It is necessary to add a charging circuit for rechargeable battery, shown as the following figure:

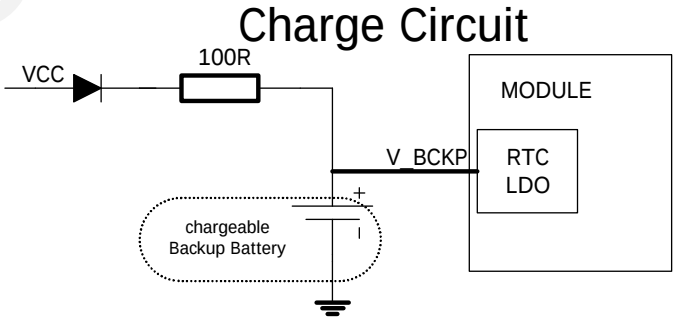


Figure 6: Reference charging circuit for chargeable battery

- **Coin-type Capacitor backup**

Coin-type Rechargeable Capacitor such as XH414H-IV01E form Seiko can be used.

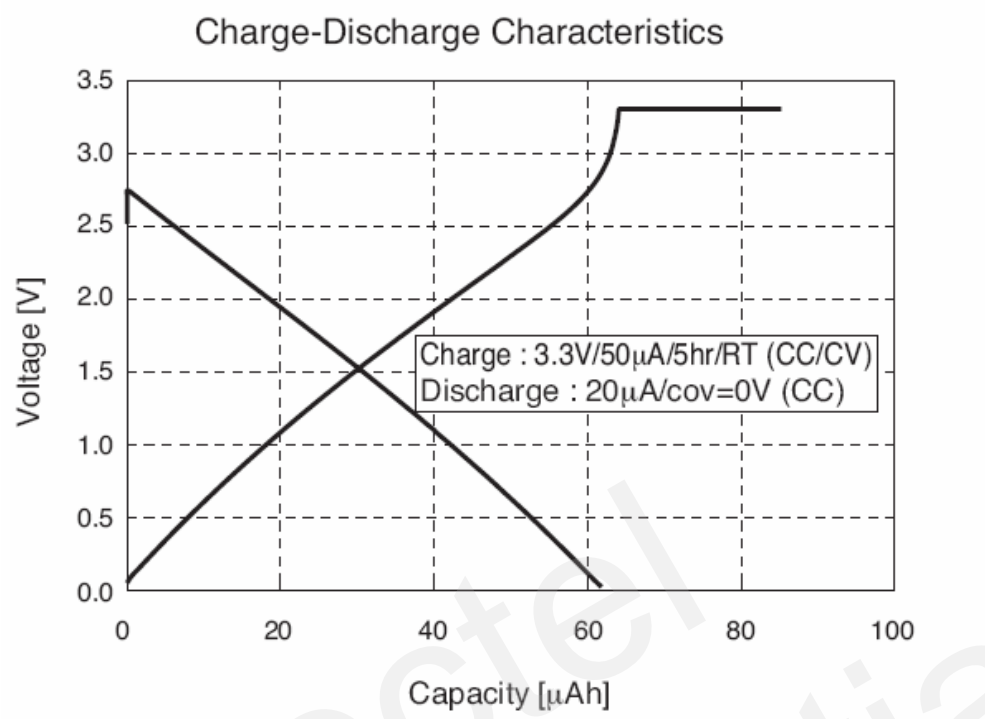


Figure 7: Seiko XH414H-IV01E charge characteristic

3.7 UART interface

The module provides two universal asynchronous receiver & transmitter serial ports. UART port1 is used for the NMEA&PMTK input/output and UART port2 is used for receiving RTCM files.

Table 8: Pin definition of the UART interfaces

Interface	Name	Pin	Function
UART Port1	TXD1	3	Transmitting data
	RXD1	4	Receiving data
UART Port2	TXD2	22	Transmitting data of RTCM files.
	RXD2	23	Receiving data of RTCM files.

UART port1:

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

The module is designed as a DCE (Data Communication Equipment), following the traditional DCE-DTE (Data Terminal Equipment) connection. The module and the client (DTE) are connected through the following signal (shown as Figure 8). It supports data baud-rate from 4800bps to 115200bps.

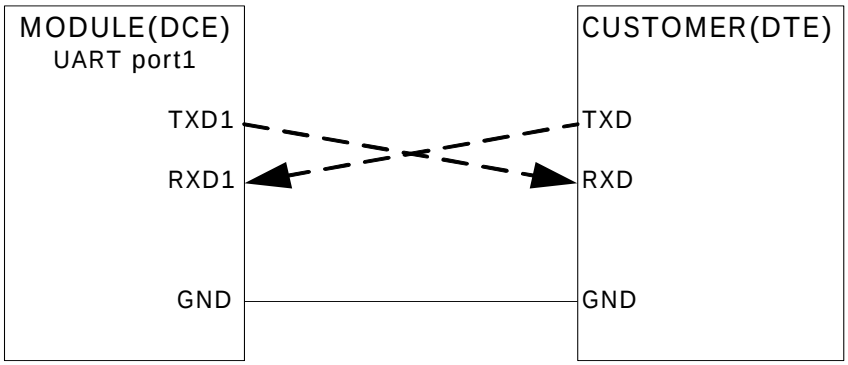


Figure 8: Connection of UART port1

This UART port1 has the following features:

- UART port1 can be used for firmware upgrade, inputting or outputting NMEA or PMTK private messages.
  The default output NMEA type setting is **RMC, VTG, GGA, GSA, GSV, and GLL.**
- UART port1 supports the following data rates:
  4800, 9600, 14400, 19200, 28800, 38400, 57600, 115200.
  The default setting is 9600bps, 8 bits, no parity bit, 1 stop bit, no hardware flow control.
- Hardware flow control and synchronous operation are not supported.

Note: It is strongly recommended that the UART port1 is used to output NMEA message to serial port of host in design.

UART port2:

- TXD2: Send data of RTCM files.
- RXD2: Receive data of RTCM files.

- UART port2 can be used for receiving RTCM files from the device where the RTCM files are saved.
- UART port2 supports the following data rates:
  4800, 9600, 14400, 19200, 28800, 38400, 57600, 115200.

The default setting is 9600bps, 8 bits, no parity bit, 1 stop bit, no hardware flow control

L10 module currently supports these RTCM message types: type 1, 2, 3, and 9. these four message types were all defined in RTCM SC-104 v2.0 spec, and also the same in v2.1, v2.2, v2.3 and v3.0

If customer needs to use DGPS, The following steps should be adopted:

- Enable RTCM. Please use command PMTK301, 1 to enable RTCM.
- RTCM simulator should be connected to the UART2 of L10 module.

- Look up GGA NMEA:" Fix quality, DGPS age and DGPS station ID number" to monitor the DGPS status.

The UART port1 and UART port2 do not support the RS-232 level but only support the LVTTL level. If the module's UART port is connected to the UART port of a computer, it is necessary to insert a level shift circuit between the module and the computer. Please refer to the following figure.

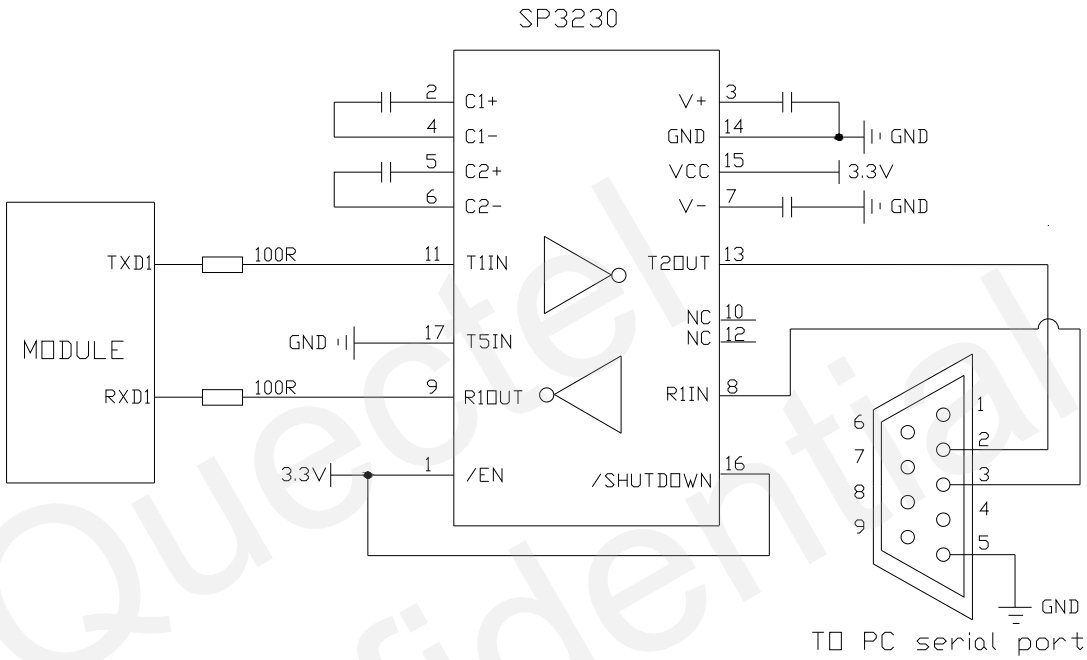


Figure 9: RS-232 level shift circuit

3.8 USB interface

The USB (Universal Serial Bus) port makes the GPS receiver capable of significantly improving data transmission and receiving rate. It is USB 2.0 Full-Speed compatible. This interface is automatically converted to COM port to HOST operating systems and its driver could operate on Windows 98, 2000, XP, and Vista operation system. Customer can update firmware through this port.

The USB port can be used for firmware update, inputting or outputting NMEA or PMTK private messages. It is the same function as serial port.

Plug-and-Play feature provides easier way for customer's data communication with most navigation software. Moreover, flexibility of applications for different USB classes is available.

Table 9: Pin definition of USB interface

Interface	Name	Pin	Function

USB Port	VDDUSB	24	USB power supply
	USB_DM	25	USB data-
	USB_DP	26	USB data+

In order to comply with USB specifications, VDDUSB must be connected to an LDO as shown in Figure 10 when the USB port is used. For more details please refer to document [1].

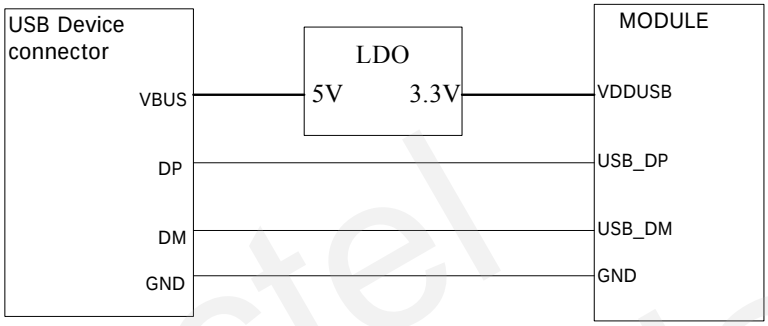


Figure 10: USB interface circuit

Note: The USB interface is not recommended to output NMEA message to USB port of the host, such as ARM processor because the driver of USB may be not reliable. If don't use the USB port, please connect VDDUSB to GND.

3.9 Software upgrade

The UART port and USB port can be used for firmware upgrade, and one of them should be selected.

3.10 EXTINT0

The EXTINT0 pin is an external interrupt input pin. It is an edge trigger interrupt and can be used to wake up the module from the standby mode. When the EXTINT0 pin is changed from high to low, the module will enter the standby mode. When the EXTINT0 pin is changed from low to high, the module will exit from standby mode.

Table 10: Pin definition of the EXTINT0

Name	Pin	Function
EXTINT0	27	External interrupt input

3.11 AOK

AOK can output antenna status message. It outputs a low level when the active GPS antenna is assembled and operating normally. When the GPS antenna is not assembled or short-circuited, it outputs a high level to indicate to the host controller.

Table 11: Pin definition of the AOK

Name	Pin	Function
AOK	12	Active GPS antenna status indication

3.12 I2C interface

The module has a standard I2C interface, but its driver is not embedded in the default firmware.

Table 12: Pin definition of the I2C interface

Name	Pin	Function
SDA2	1	I2C data
SCL2	2	I2C clock

Note: This interface function is not supported in the default firmware.

4 Antenna interface and supervisor

The L10 module receives L1 band signal from GPS satellites at a nominal frequency of 1575.42MHz. The RF signal is connected to the RF_IN pin. Customer should use a controlled impedance transmission line of 50 Ohm to connect to RF_IN.

4.1 Antenna

The L10 module can be connected to passive or active antenna. In the default operation mode the antenna supervisor is activated and enables the receiver to detect short-circuit at the antenna port by checking the bias voltage level and can shut down the voltage bias immediately when short-circuit happens. NMEA messages are provided to report the condition of the antenna supply. Open-circuit detection can also be supported with an additional external circuit. The reference design of the external circuit is shown in Figure 11.

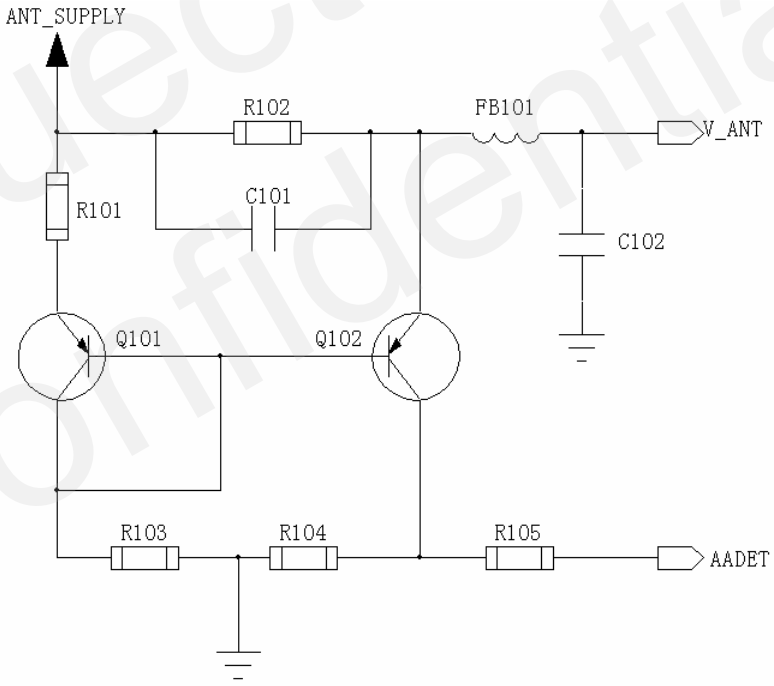


Figure 11: External detect circuit for open-circuit of active antenna

Table 13: Pin definition of the AADET_N

Name	Pin	Function
AADET_N	20	Active antenna detect input

Table 14: AADET_N and active antenna

Active antenna state	AADET_N	Description

Open-circuit	High	Active antenna disconnected
OK	Low	Active antenna connected

The specification of active antenna is listed as Table 15.

Table 15: Antenna specification for L10 module

Antenna type	Specification
Passive antenna	Center frequency: 1575.42 MHz Band Width: >20 MHz Gain: >0 dBi Polarization: RHCP or Linear
Active antenna	Center frequency: 1575.42 MHz Band Width: >5 MHz Minimum gain: 15-20dB(compensate signal loss in RF cable) Maximum noise figure: 1.5dB Maximum gain: 50dB Polarization: RHCP or Linear

4.2 Antenna supply

4.2.1 Passive antenna

Passive antenna doesn't require a DC bias voltage and can be connected to RF_IN pin directly. V_ANT can be connected to GND. It is always beneficial to reserve a passive matching network between the antenna and the RF_IN port of the module. Figure 12 is the reference design.

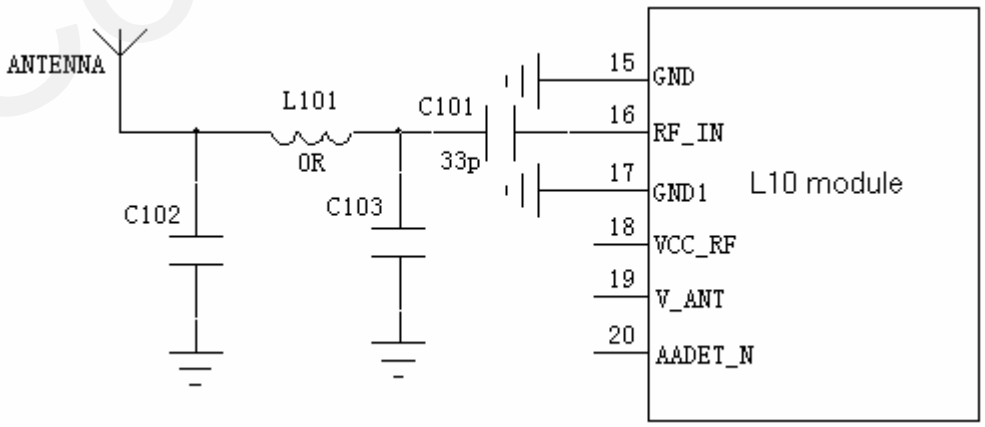


Figure 12: Reference design for passive antenna

4.2.2 Active antenna

Active antenna has an integrated low-noise amplifier which could be connected to RF_IN directly. If an active antenna is connected to RF_IN, the integrated low-noise amplifier of the antenna needs to be supplied with the correct voltage through pin V_ANT. Usually, the supply voltage is fed to the antenna through the coaxial RF cable. An active antenna consumes current at 5~20mA. The inductor inside the module can separate the RF signal from the V_ANT pin and routes the bias supply to the active antenna. The block diagram of the supply part for active antenna is shown in Figure 13.

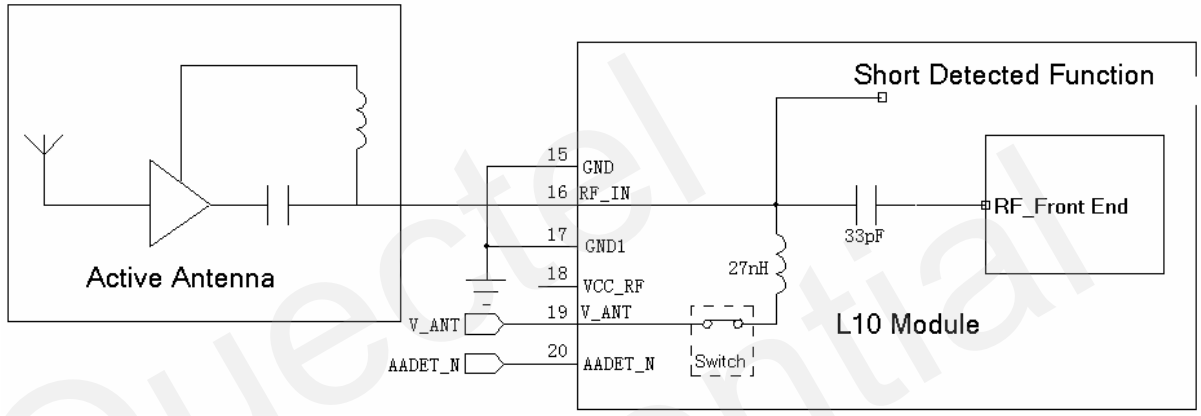


Figure 13: Active antenna biasing

If the active antenna is short-circuited, the module would turn off the power supply to the antenna immediately. Afterwards, the antenna status will be detected every 60 seconds. When the short-circuit problem is removed, it will recover the power supply to the active antenna.

If the VCC_RF voltage is suitable for powering the active antenna, pin VCC_RF could be directly connected to pin V_ANT. A reference circuit is shown in Figure 14.

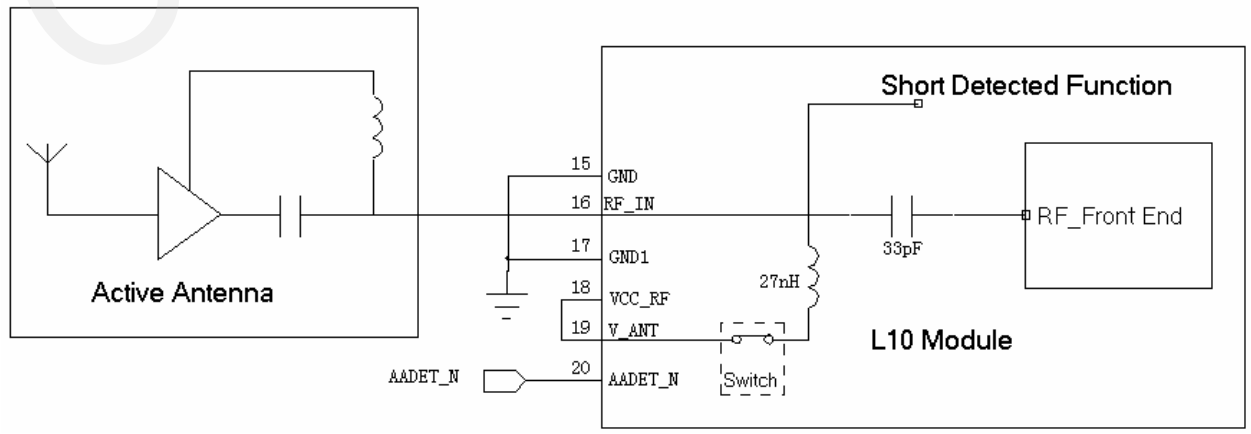


Figure 14: Active antenna with VCC_RF

If the VCC_RF voltage doesn't meet the requirement for powering the active antenna, an external LDO could be used. The output of the external LDO can be connected to pin V_ANT. A reference circuit is

shown in Figure 15.

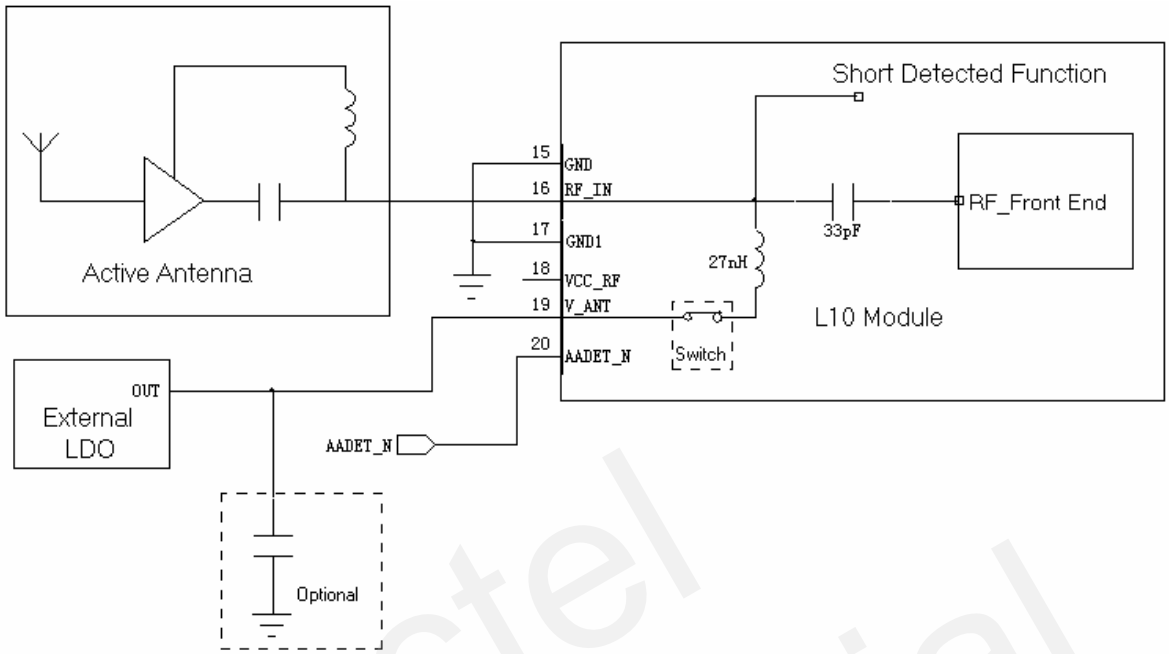


Figure 15: Active antenna with external LDO

If an external power supply and an external inductor are used to power the active antenna, the short-circuit detection function could still work, but it couldn't cut off the external power supply. So customer is not recommended to do in this way.

5 Electrical, reliability and radio characteristics

5.1 PIN assignment of the module

Table 16: L10 pin assignment

PIN NO.	PIN NAME	I/O		PIN NO.	PIN NAME	I/O
1	SDA2	I/O		15	GND	
2	SCL2	O		16	RF_IN	I
3	TXD1	O		17	GND	
4	RXD1	I		18	VCC_RF	O
5	RESERVED			19	V_ANT	I
6	VCC	I		20	AADET_N	I
7	GND			21	RESERVED	
8	VCC_OUT	O		22	TXD2	O
9	RESERVED			23	RXD2	I
10	RESET_N	I		24	VDDUSB	I
11	V_BCKP	I		25	USB_DM	I/O
12	AOK	O		26	USB_DP	I/O
13	GND			27	EXTINT0	I
14	GND			28	TIMEPULSE	O

Note: Please keep all reserved pins open.

5.2 Absolute maximum ratings

Absolute maximum rating for power supply and voltage on digital pins of module are listed in Table 17.

Table 17: Absolute maximum ratings

Parameter	Min	Max	Unit
Power supply voltage （VCC）	-0.3	4.3	V
Backup battery voltage (V_BCKP)	-0.3	4.3	V
USB supply voltage (VDDUSB)	-0.3	3.6	V
Input voltage at digital pins	-0.5	3.6	V
	-0.5	3.6	V
VCC_RF output current (Ivccrf)		50	mA
Input power at RF_IN (Prfin)		0	dBm
Antenna bias voltage(V_ANT)	0	6	V
Antenna bias current(Iant)		100	mA
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 necessary, voltage spikes exceeding the power supply voltage specification, given in table above, must be limited to values within the specified boundaries by using appropriate protection diodes.

5.3 Operating conditions

Table 18: The module 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			150	mA
V_BCKP	Backup voltage supply		2.0	3.3	4.3	V
I_{BCKP}	Backup battery current	V_BCKP=3.3V		4		uA
V_ANT	Antenna bias voltage		2.7		5.5	V
V_{ANT_DROP}	Antenna bias				0.1	V

	voltage drop					
I_{ANT}	V_ANT supply current	V_ANT=3.3V			100	mA
VDDUSB	USB supply voltage		3.0	3.3	3.6	V
VCC_RF	Output voltage RF section				VCC -0.1	V
I_{VCC_RF}	VCC_RF output current				50	mA
T_{OPR}	Normal Operating temperature		-40	25	85	℃

**** Use this figure to determine the maximum current capability of power supply.***
Note: Operation beyond the "Operating Conditions" is not recommended and extended exposure beyond the "Operating Conditions" may affect device reliability.

5.4 Current consumption

The values for current consumption are shown in Table 19.

Table 19: The module current consumption (passive antenna)

Parameter	Condition	Min	Typ	Max	Unit
Icc Acquisition	Passive antenna@-130dBm		43		mA
Icc Tracking	For Cold Start, 10 minutes after First Fix. For Hot Start, 15 seconds after First Fix with passive antenna.		38		mA
Icc Standby	EXTINT0 pin is changed from high to low with passive antenna.		2		mA

Note: In the standby mode, the power supply to active antenna through V_ANT is cut off. It will be re-activated when the module exits from the standby mode.

5.5 Electro-static discharge

Although the module is fully protected against ESD strike, ESD protection precautions should still be emphasized. Proper ESD handing and packaging procedures must be applied throughout the processing, handing and operation of any application.

The ESD bearing capability of the module is listed in Table 20.

Table 20: The ESD endurance table (Temperature: 25℃, Humidity: 45 %)

Pin	Contact discharge	Air discharge
Antenna port	±5KV	±10KV
VCC,GND	±4KV	±8KV
Others	±4KV	±8KV

5.6 Reliability test

Table 21: Reliability test

Test term	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,0.96m^2/s^3;20~500Hz,0.96m^2/s^3-3dB/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 dimensions of the module

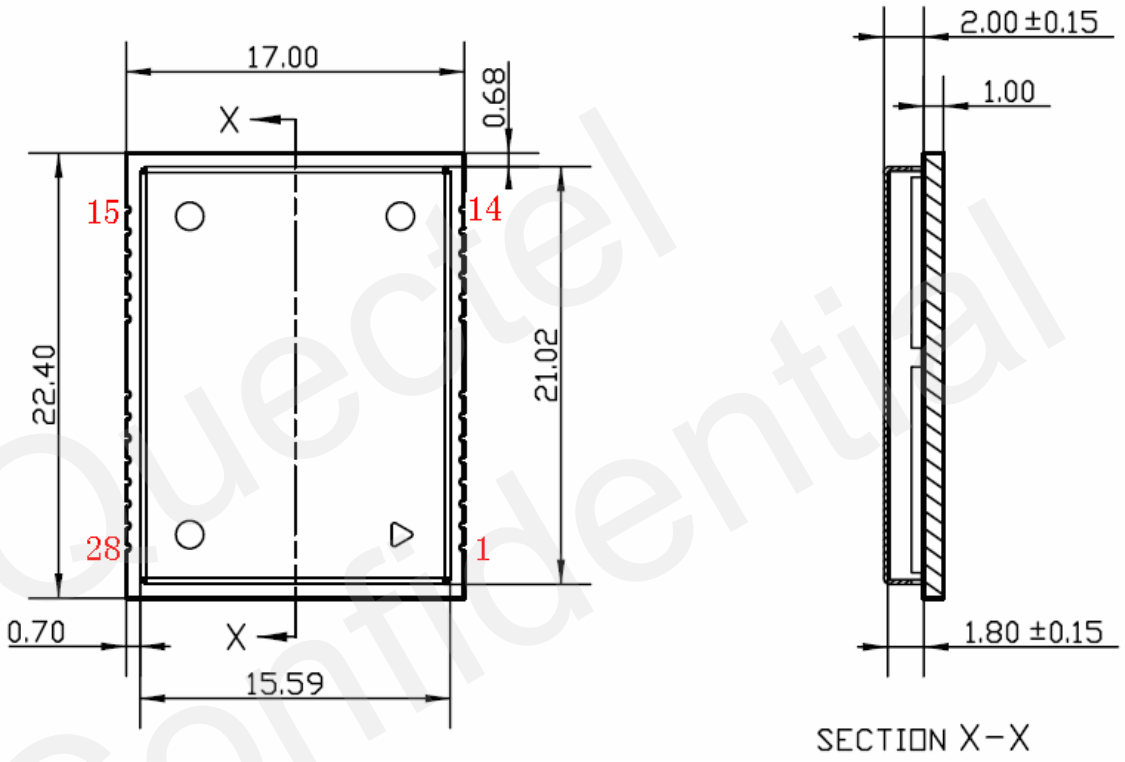


Figure 16: L10 Top view and Side dimensions（Unit:mm）

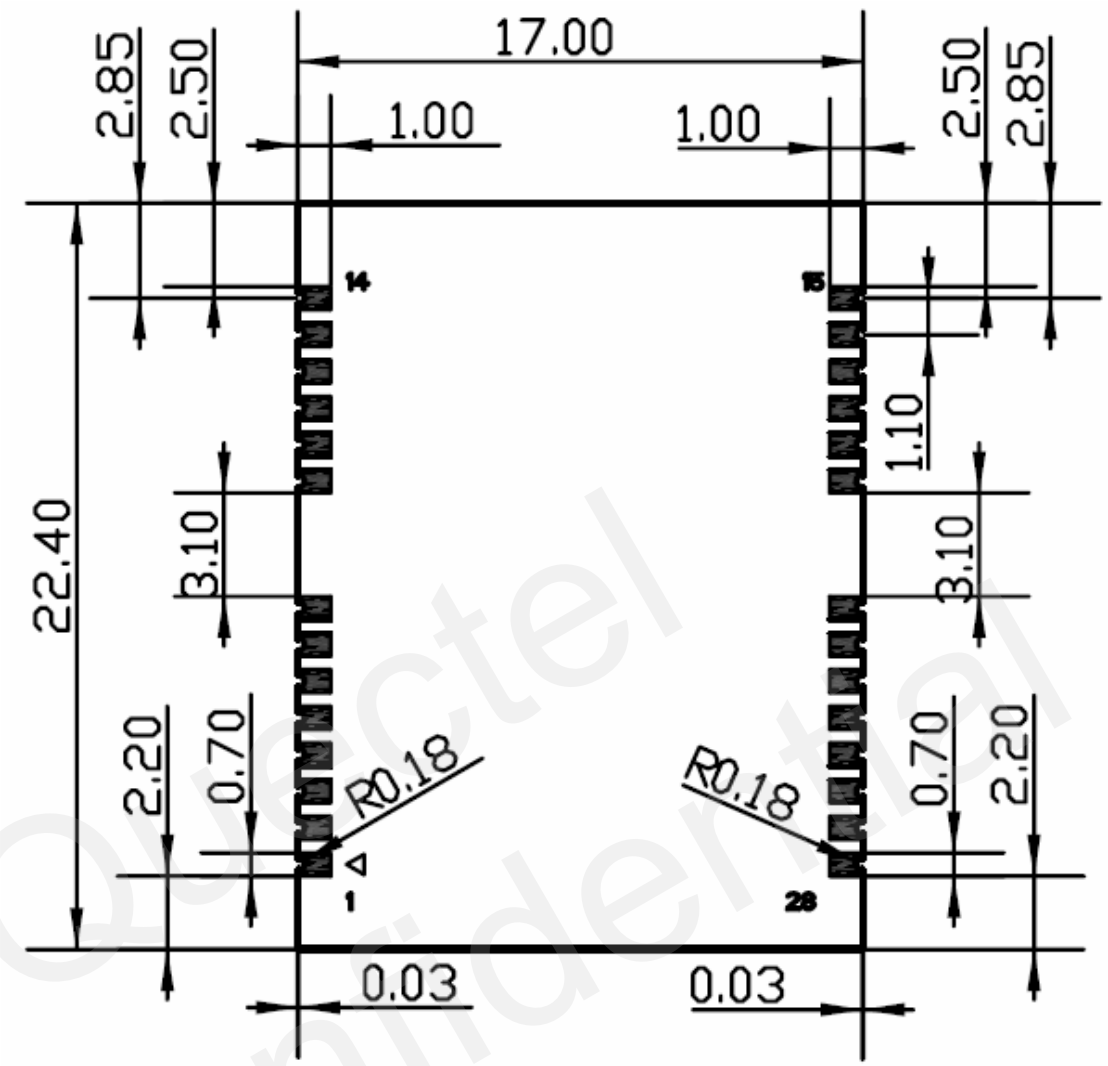


Figure 17: L10 Bottom dimensions（Unit:mm）

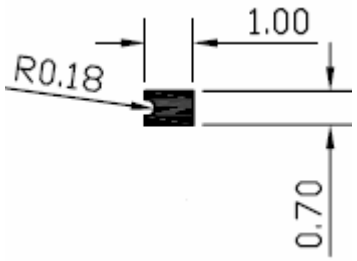
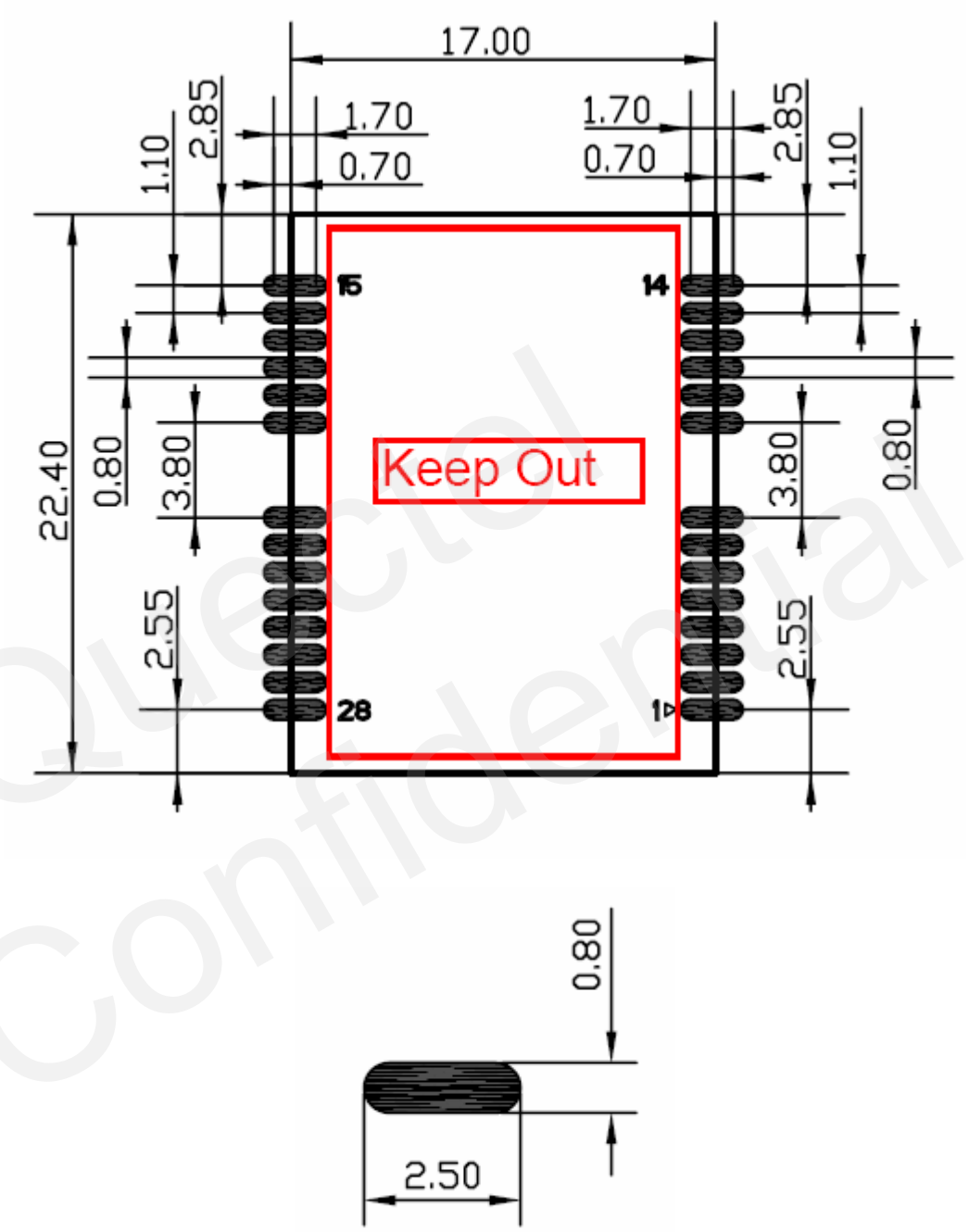


Figure 18: PAD Bottom dimensions（Unit:mm）

6.2 Footprint of recommendation



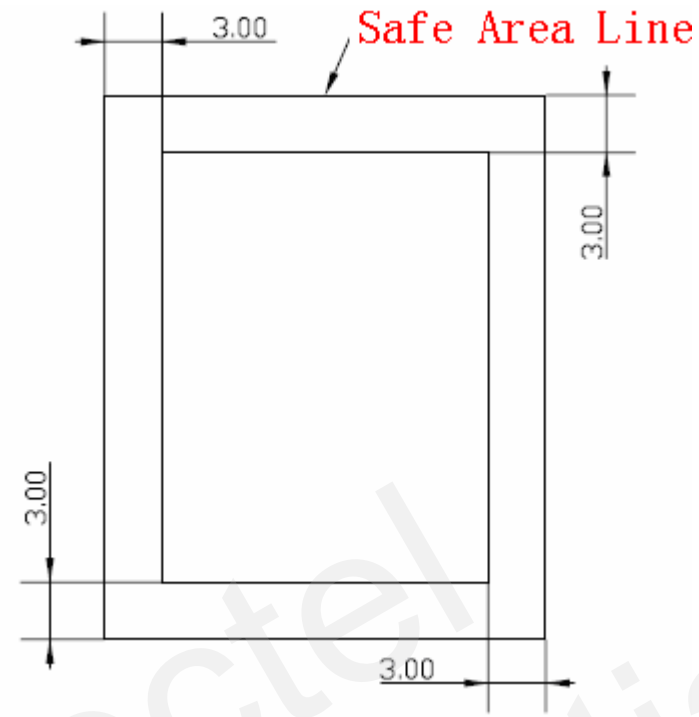


Figure 19: Footprint of recommendation（Unit: mm）

Note1：Keep out on the host board below the module and the keep-out area should be covered by solder mask and top silk layer for isolation between the top layer of host board and the bottom layer of the module.

Note2：For easy maintenance of this module and accessing to these pads, please keep a distance no less than 3mm between the module and other components in host board.

6.3 Top view of the module

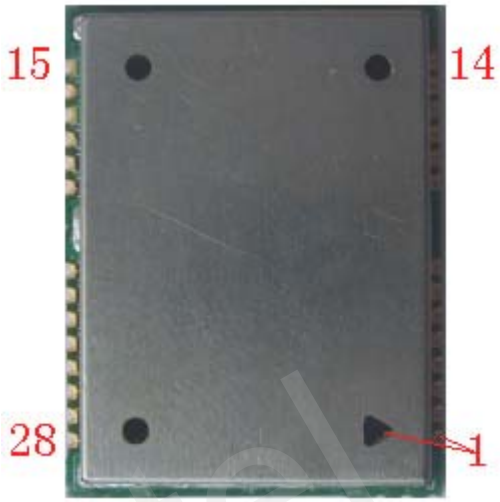


Figure 20: Top view of the module

6.4 Bottom view of the module

Figure 21: Bottom view of the module

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