



L16

Quectel GNSS Engine

Hardware Design

L16_HD_V1.1



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0. Revision history

Revision	Date	Author	Description of change
1.0	2012-06-13	Mountain ZHOU	Initial
1.1	2012-06-21	Mountain ZHOU	<ol style="list-style-type: none">1. Modified Table 14.2. Added V_ANT in Table 11.3. The resistor R202 is modified to R205 in the note below Figure11.4. Added Figure 10 and UART2 port to upgrade firmware.5. Modified the RTC mode in Table 7.6. Modified Figure 8 and Figure 20.

1. Introduction

This document defines and specifies L16 GNSS module. It describes L16 hardware interface and its external application reference circuits, mechanical size and air interface.

This document can help customer quickly understand module interface specifications, electrical and mechanical characteristics. Associated with this document and other application notes, customer can use L16 module to design and set up application quickly.

1.1. Related documents

Table 1: Related documents

SN	Document name	Remark
[1]	L16_Reference_Design	L16 Reference Design
[2]	L16_EVB_UGD	L16 EVB User Guide
[3]	L16_GNSS_Protocol	L16 GNSS Protocol Specification

1.2. Terms and abbreviations

Table 2: Terms and abbreviations

Abbreviation	Description
bps	bits per second
CEP	Circular Error Probable
ESD	Electro-static Discharge
EVB	Evaluation Board
DTE	Date Terminal Equipment
GGA	NMEA: Global Positioning System Fix Data
GLL	NMEA: Geographic Position Latitude/Longitude
GLONASS	Global Navigation Satellite System (The Russian GNSS)
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GSA	NMEA: GNSS DOP and Active Satellites
GSV	NMEA: GNSS Satellites in View
I_{BCKP}	Backup Supply Current
I_{max}	Maximum Load Current
I_{VCC}	VCC Supply Current
I/O	Input / Output

LDO	Low Dropout Regulator
NMEA	National Marine Electronics Association
PPS	Pulse Per Second
PSTM	ST Proprietary Message
RMC	NMEA: Recommended Minimum Specific GPS/TRANSIT Data
RTC	Real Time Clock
UART	Universal Asynchronous Receiver & Transmitter
V _{Imax}	Absolute Maximum Input Voltage Value
V _{Imin}	Absolute Minimum Input Voltage Value
V _{IHmax}	Maximum Input High Level Voltage Value
V _{IHmin}	Minimum Input High Level Voltage Value
V _{ILmax}	Maximum Input Low Level Voltage Value
V _{ILmin}	Minimum Input Low Level Voltage Value
V _{max}	Maximum Voltage Value
V _{min}	Minimum Voltage Value
V _{norm}	Normal Voltage Value
V _{OHmax}	Maximum Output High Level Voltage Value
V _{OHmin}	Minimum Output High Level Voltage Value
V _{OLmax}	Maximum Output Low Level Voltage Value
V _{OLmin}	Minimum Output Low Level Voltage Value

2. Product concept

Based on the STMicroelectronics Teseo II positioning engine, L16 is a single receiver module integrated with GPS and GLONASS open service L1 reception. With 32 tracking channels and 2 fast acquisition channels, L16 can acquire and track any mix of GPS and GLONASS signals. Compared with using GPS only, enabling both GPS and GLONASS generally doubles the number of visible satellites, reduces the time to first fix and increases positioning accuracy, especially when driving in rough urban environments. Its super performance is perfectly suitable for automotive, consumer and other industrial applications.

The L16 is an SMD type module with the compact 22.4mm × 17.0mm × 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 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 ~ 3.6V typical : 3.3V
Power consumption (passive antenna) ^①	<ul style="list-style-type: none"> ● Acquisition 110mA ● Tracking 95mA ● RTC 75uA
Receiver Type	<ul style="list-style-type: none"> ● GPS L1 1575.42 MHz C/A Code ● GLONASS L1 1598.0625~1605.375 MHz C/A Code ● 32 tracking channels, 2 fast acquisition channels
Sensitivity	<ul style="list-style-type: none"> ● Cold Start -146dBm ● Reacquisition -148dBm ● Navigation -160dBm ● Tracking -162dBm
Time-To-First-Fix ^②	<ul style="list-style-type: none"> ● Cold Start (Autonomous) <35s average@-130dBm ● Warm Start (Autonomous) <24s average@-130dBm ● Hot Start (Autonomous) <2.5s average@-130dBm
Position Accuracy	<ul style="list-style-type: none"> ● CEP (Autonomous) <1.5m
Update Rate	<ul style="list-style-type: none"> ● Up to 5Hz, 1Hz by default
Accuracy of 1PPS Signal	<ul style="list-style-type: none"> ● Typical accuracy <15 ns ● Pulse width 500ms

	<ul style="list-style-type: none"> ● Output at 1Hz when L16 works normally
Dynamic Performance	<ul style="list-style-type: none"> ● Maximum Altitude 18,000 m ● Maximum Velocity 515 m/s Maximum ● Acceleration 4 G
UART Port	<p>UART Port1:</p> <ul style="list-style-type: none"> ● Two lines TXD1 and RXD1 ● UART Port 1 supports baud rate from 4800bps to 115200bps ● UART Port 1 is used for NMEA output, ST proprietary messages input/output and firmware upgrade <p>UART Port2:</p> <ul style="list-style-type: none"> ● Two lines TXD2 and RXD2 ● UART Port2 can be used for debug output and firmware upgrade
Temperature range	<ul style="list-style-type: none"> ● Normal operation: -40 °C ~ +85 °C ● Storage: -45 °C ~ +125 °C
Physical Characteristics	<p>Size: 22.4 (±0.15) × 17 (±0.15) × 3.0 (±0.15) mm</p> <p>Weight: approximately 2.2g</p>
Firmware Upgrade	Firmware upgrade over UART1 port or UART2 port

①②. Power consumption and TTF are both tested under the GPS+GLONASS system.

2.2. Block diagram

The following figure shows block diagram of L16 module.

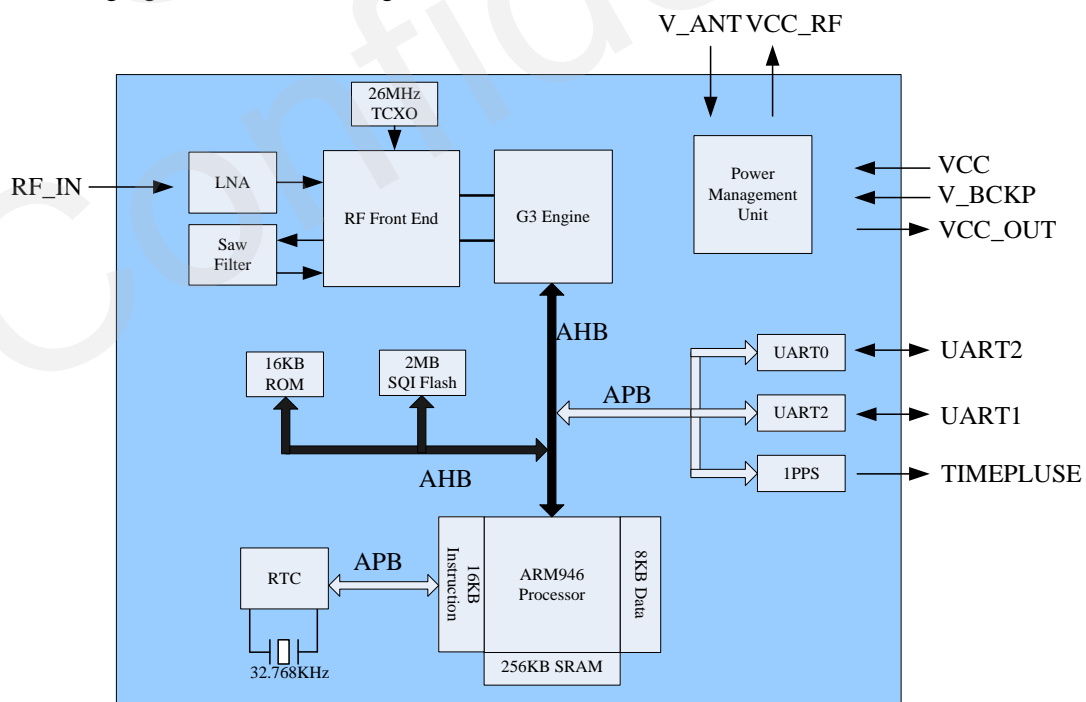


Figure 1: Module block diagram

2.3. Evaluation board

In order to help customer to develop applications with L16, Quectel provides an Evaluation Board (EVB) with appropriate power supply, USB to RS232 converter cable, Driver CD, antenna and the module.

Note: For more details, please refer to the document [2].

2.4. Protocol

L16 supports standard NMEA-0183 protocol and ST proprietary protocol (PSTM messages) that can be used to provide extended capabilities for many applications. The module is capable of supporting the following NMEA formats: *GGA, GSA, GSV, RMC, and GLL*.

Table 4: The protocol module supports

Protocol	Type
NMEA	output, ASCII, 0183, 3.01
ST	Input/output, ST proprietary protocol

Note: Please refer to the document [3] about NMEA standard protocol and ST proprietary protocol.

3. Application interface

L16 is equipped with a 28-pin 1.1mm pitch SMT pad that connects to customer application platform.

3.1. Pin description

15	GND	GND	14
16	RF_IN	GND	13
17	GND	NC	12
18	VCC_RF	V_BCKP	11
19	V_ANT	RESERVED	10
20	NC	NC	9
(Top view)			
21	NC	VCC_OUT	8
22	TXD2	GND	7
23	RXD2	VCC	6
24	NC	NC	5
25	RESERVED	RXD1	4
26	RESERVED	TXD1	3
27	NC	NC	2
28	TIMEPULSE	NC	1

Figure 2: Pin assignment

Table 5: Pin assignment

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

Note: Please keep all NC and RESERVED pins floating.

Table 6: Pin description

Power Supply					
PIN NAME	PIN NO.	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
VCC	6	I	Supply voltage for L16	$V_{max} = 3.6V$ $V_{min} = 3.0V$ $V_{norm} = 3.3V$	The maximum loading current should be more than 200mA.
V_BCKP	11	I	Supply voltage for Backup	$V_{max} = 3.6V$ $V_{min} = 2.0V$ $V_{norm} = 3.3V$ $I_{BCKP} = 75\mu A$	Power supply for RTC when VCC is not applied for the system.
VCC_OUT	8	O	Output voltage	$V_{max} = 3.6V$ $V_{min} = 3.0V$ $V_{norm} = 3.3V$ $I_{max} = 20mA$	This pin is internally connected to VCC. If unused, keep this pin floating.
VCC_RF	18	O	Optional output voltage for external active antenna	$V_{max} = 3.6V$ $V_{min} = 3.0V$ $V_{norm} = 3.3V$ $I_{max} = 30mA$	Supply power for external active antenna. If unused, keep this pin floating.
V_ANT	19	I	Supply voltage for external active antenna	$V_{max} = 5.5V$ $V_{min} = 2.7V$ $V_{norm} = 3.3V$	Using VCC_RF or external voltage source. If unused, keep this pin floating.
Specific purpose input/output					
PIN NAME	PIN NO.	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
TIME PULSE	28	O	Time pulse	$VOL_{max} = 0.4V$ $VOH_{min} = VCC - 0.4V$	1 pulse per second (1PPS). Synchronized at rising edge, pulse length 500ms. If unused, keep this pin floating.
UART port					
PIN NAME	PIN NO.	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
RXD1	4	I	Receive data	$VIL_{min} = -0.3V$	Used to output NMEA messages and upgrade firmware ^① .
TXD1	3	O	Transmit data	$VIL_{max} = 0.8V$ $VIH_{min} = 2.0V$	
RXD2	23	I	Receive data	$VIH_{max} = VCC + 0.3V$	Used to output debug messages and upgrade firmware. If unused, keep these pins floating.
TXD2	22	O	Transmit data	$VOL_{max} = 0.4V$ $VOH_{min} = VCC - 0.4V$	
RF interface					

PIN NAME	PIN NO.	I/O	DESCRIPTION	DC CHARACTERISTICS	COMMENT
RF_IN	16	I	GPS/GLONASS signal input	Impedance of 50Ω	Refer to chapter 4.

① *TXD1 net needs to be pulled down with 1K resistor in the upgrading mode, and remove this 1K resistor in the working mode.*

3.2. Operating modes

The table below briefly summarizes the various operating modes.

Table 7: 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.
RTC mode	When L16 is only powered through the V_BCKP pin, the system will be in the RTC mode. The RTC provides a high resolution clock which can be used for GPS. It keeps the time when the system is inactive. It has a clock trimming feature to compensate for the accuracy of the 32.768 kHz crystal and a secured time update.

3.3. Power supply

The main power supply is fed through the VCC pin. It is important that the system power supply circuit is able to support the peak power. So the power supply must be able to provide sufficient current up to 200mA.

3.3.1. Turn on and turn off

With one GPIO to control the enable function of transistor circuit, the module can be turned on and off by the following way.

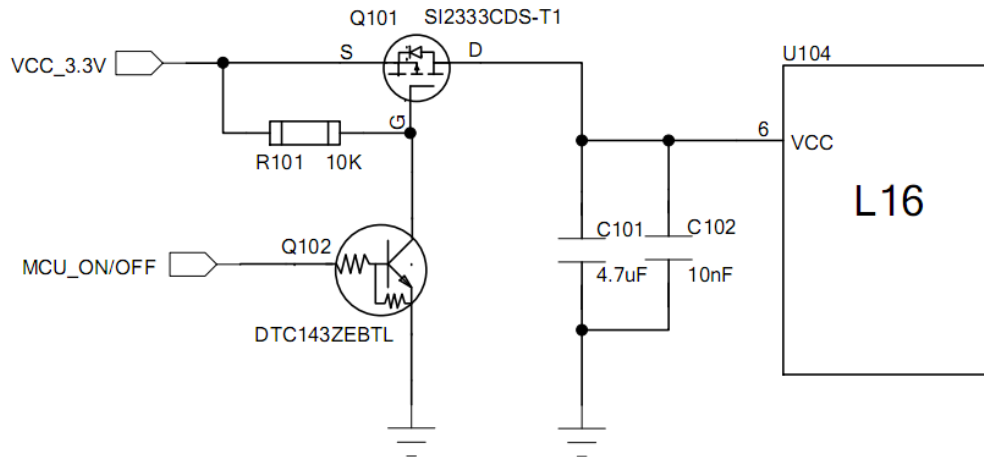


Figure 3: Reference turn on/off circuit

N-channel power MOSFET Q101 works as an analog switch. Use the MOSFET channel as a low-on-resistance switch to pass analog signals when on and as a high impedance when off.

To turn on L16, the base of the Q102 is driven to the high voltage level and the gate of the Q101 is driven to the low voltage level, so the MOSFET channel is on and the power is supplied to L16.

Similarly, to turn off L16, when the base of the Q102 is driven to the low voltage level, the gate of Q101 will be pulled up to high voltage level and MOSFET works in the high impedance state.

Note:

To ensure the stability, Q102 is recommended to apply digital transistor, and some parameters of N-channel power MOSFET Q101 are listed below:

The Gate-Source Threshold Voltage $V_{GS(th)}$ is in the range of -1V and -3V.

The Drain-Source On-State Resistance is less than 0.1Ω when $V_{GS}=2.5V$.

The absolute value of Continuous Drain Current is more than 200mA.

3.3.2. RTC backup

The RTC (backup system) provides a high resolution clock which can be used for GPS with 8Kbyte SRAM. It keeps the time when the system is inactive. It has a clock trimming feature to compensate for the accuracy of the 32.768 kHz crystal and a secured time update.

Table 8: Pin definition of the V_BCKP pin

Name	Pin No.	Function
V_BCKP	11	Supply voltage for backup

The V_BCKP pin powers for this backup system which contains all the necessary GNSS information for quick start-up. The internal circuit will supply power for it when the module is powered on, and the circuit can be directly provided by an external capacitor or battery (rechargeable or non-chargeable) through the V_BCKP pin when the module is powered off, thus the system will be in the RTC mode. Please refer to the following figure for RTC backup.

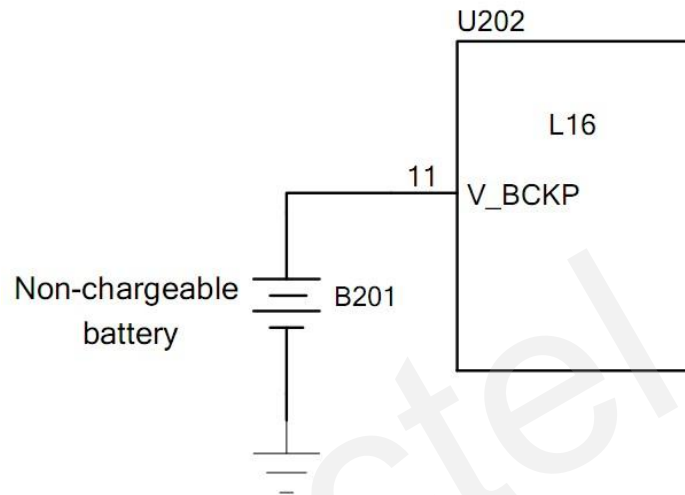


Figure 4: RTC supply from non-chargeable battery

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:

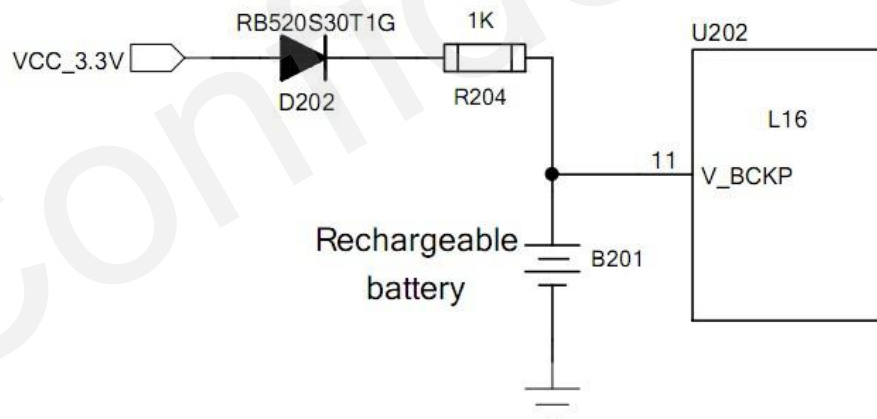


Figure 5: Reference charging circuit for rechargeable battery

Coin-type Rechargeable Capacitor such as XH414H-IV01E from Seiko can be used and Schottky diode such as RB520S30T1G from ON Semiconductor is recommended for its low voltage drop. The charging and discharging characteristic of XH414 is shown in the following figure.

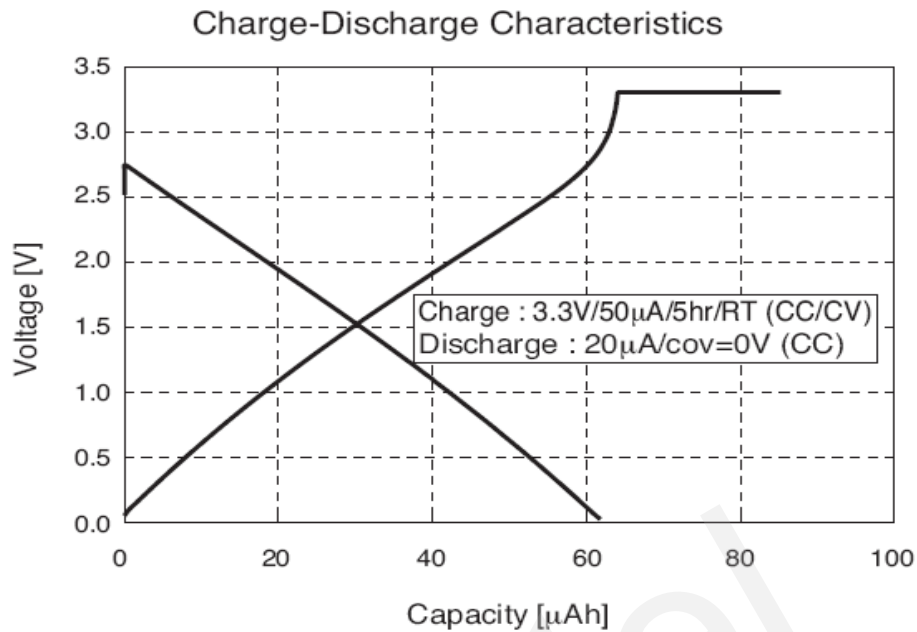


Figure 6: Seiko XH414 charging and discharging characteristics

3.4. UART interface

The module provides two universal asynchronous receiver & transmitter serial ports. The UART_x (x=1|2) performs serial-to-parallel conversion on data asynchronously received from a peripheral device on RXD_x pin, and parallel-to-serial conversion on data written by CPU for transmission on TXD_x pin. The transmit and receive paths are buffered with internal FIFO memories allowing up to 64 data byte for transmission, and 64 data byte with 4-bit status (break, frame, parity, and overrun) for receiving.

UART port1 is used for inputting and outputting NMEA&\$PSTM and UART port2 is used for outputting the debug messages as default setting.

The table below shows the pin definition of the UART interfaces.

Table 9: Pin definition of the UART interfaces

Interface	Name	Pin No.	Function
UART Port1	TXD1	3	Transmit data
	RXD1	4	Receive data
UART Port2	TXD2	22	Transmit data
	RXD2	23	Receive data

UART port1:

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

This UART port1 has the following features:

- UART port1 can be used for firmware upgrade, inputting or outputting NMEA or ST proprietary messages.

The default output NMEA type setting is **RMC, GGA, GSA, GSV, and GLL**.

- UART port1 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, no hardware flow control.

- Hardware flow control and synchronous operation are not supported.

The UART port does not support the RS-232 level but only support the CMOS level. If the module's UART port is connected to the UART port of PC, it is necessary to add a level shift circuit between the module and the computer.

In order to prevent the current leakage influence from the external device to module which maybe lead to the unsuccessful boot, the relevant solutions are suggested to adapted. The following figure is our recommended circuit, and the R103 and D102 circuit is just reserved, generally, choose 0R to replace D102 and keep R103 unmounted.

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

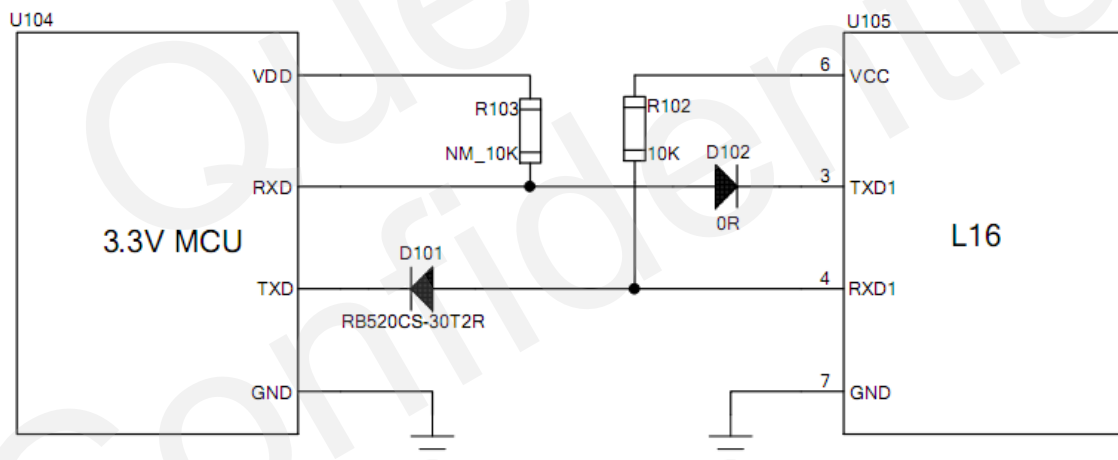


Figure 7: UART circuit of 3.3V MCU

And below circuit is recommended to realize the voltage level shifting and avoid the current leakage influence when the customer device belonged to 5V voltage domain.

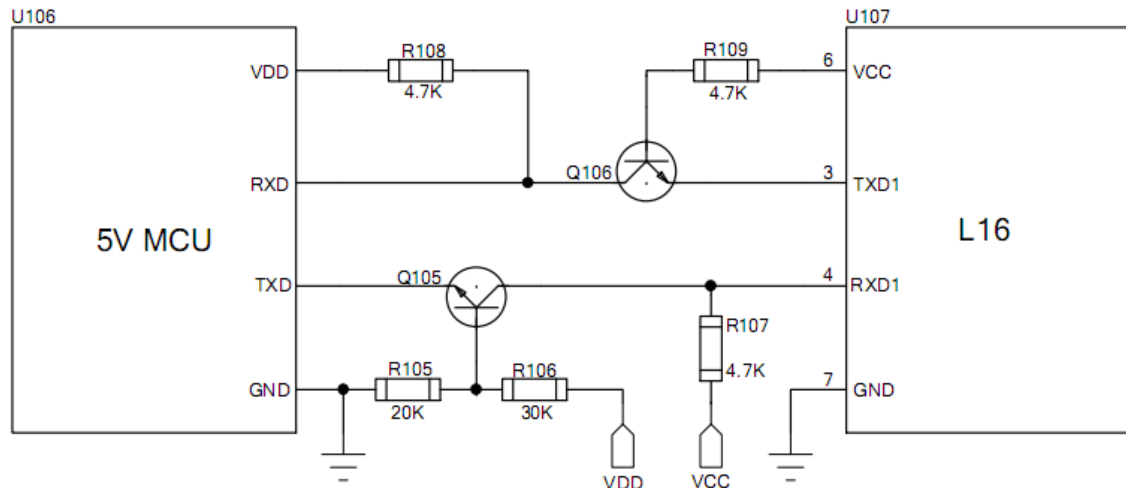


Figure 8: UART circuit of 5V MCU

3.5. Firmware upgrade

Quectel will provide X-Loader tool for customer to upgrade firmware shown as below.

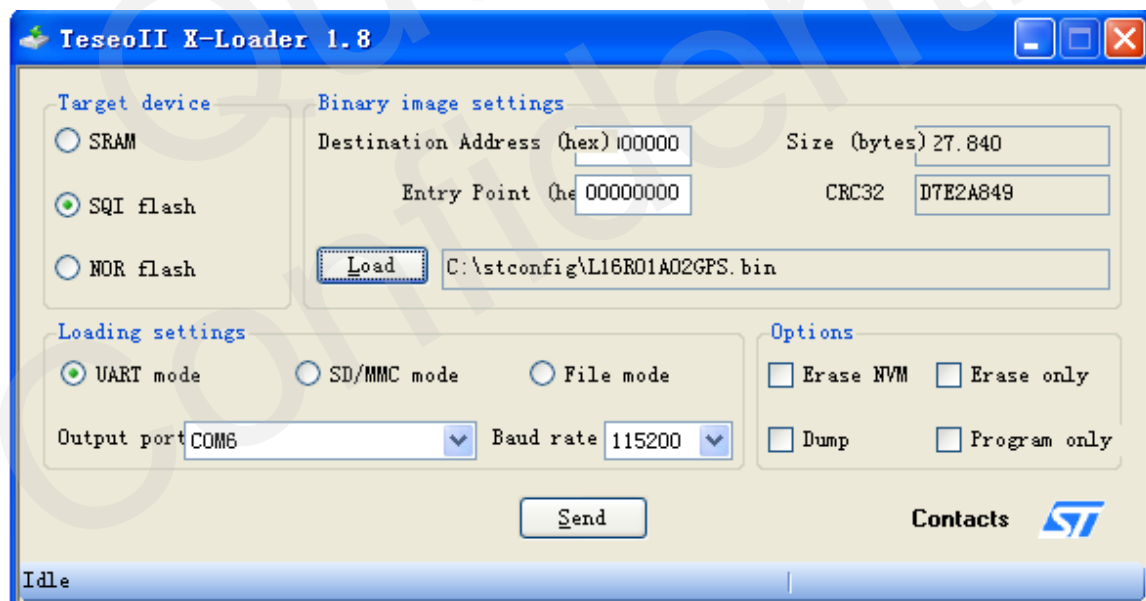
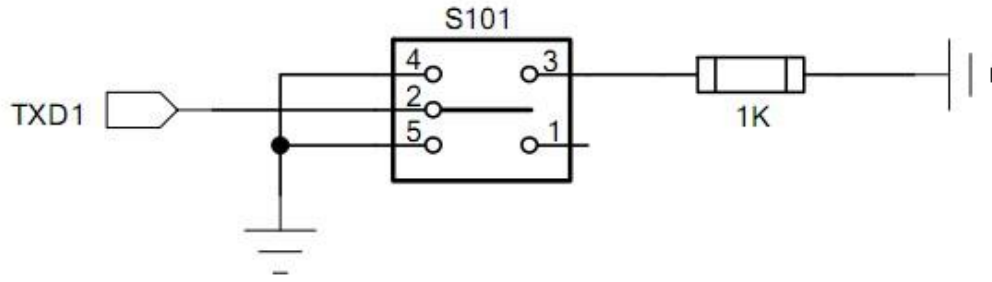


Figure 9: Upgrade tool

X-Loader is able to write firmware file via UART1 port or UART2 port. Before upgrading firmware, the TXD1 pin must be pulled down with 1K resistor, and then turn on the module to start the upgrade process. In the working mode, please keep this 1K resistor removed. To realize this transform, the switch button is recommended to be added between 1K resistor and the TXD1 pin shown as below.



Module is in the upgrading mode when switching S101 to Pin3 and in the working mode when switching S101 to Pin1.

Figure 10: Additional upgrade circuit

Note: For more details about firmware upgrade, please refer to the document [2].

4. Antenna interface

The L16 module is able to down-convert both the GPS signal from 1575.42MHz to 4.092MHz and GLONASS signal from 1601.718MHz to 8.57MHz. 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 specification

The L16 module can be connected to dedicated GPS/GLONASS passive or active antenna in order to receive both GPS and GLONASS satellite signals. L16 antenna specification is shown as below.

Table 10: Antenna specification

Antenna type	Specification
Passive antenna	Center frequency: 1593 MHz Band width: 43 MHz typ. Gain: >2.85 dBi Polarization: RHCP
Active antenna	Center frequency: 1593 MHz Band width: 43 MHz typ. Minimum gain: 10-15 dB(compensate signal loss in RF cable) Maximum noise figure: 1.5 dB Maximum gain: 50 dB Polarization: RHCP

4.2. Antenna reference design

4.2.1. Passive antenna

Passive antenna does not require a DC bias voltage and can be connected to RF_IN directly. It is always beneficial to reserve a passive matching network between the antenna and the RF_IN port of the module. Figure 11 is the reference design. And ESD protection device is still recommended to be added in the front-end of interface to improve the ESD performance.

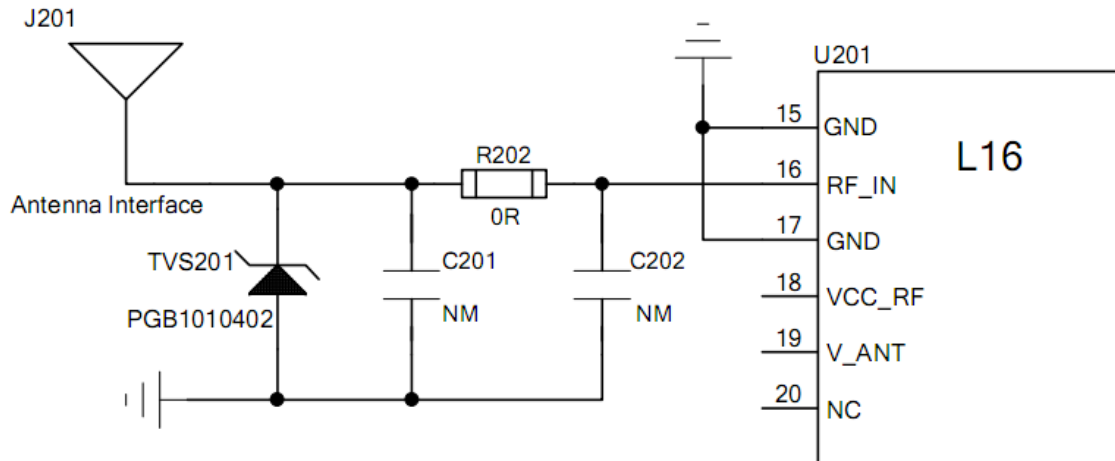


Figure 11: Reference design for passive antenna

4.2.2. Active antenna

Active antenna has 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 the V_ANT pin. Generally, 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.

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

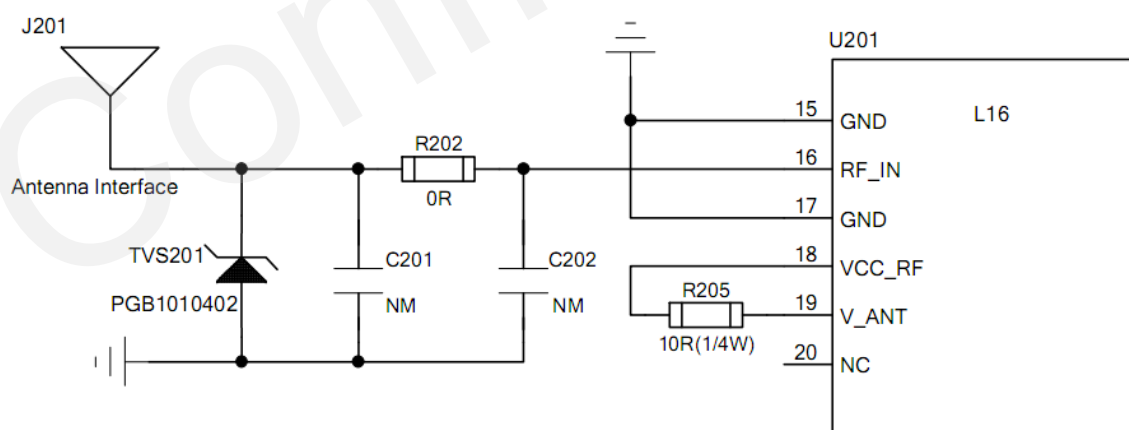


Figure 12: Active antenna with VCC_RF

Note: The resistor R205 here is to prevent antenna short-circuit from damaging the module.

If the VCC_RF voltage does not meet the requirement for powering the active antenna, an external voltage source could be used. The output of the external voltage source can be connected to the V_ANT pin. A reference circuit is shown below.

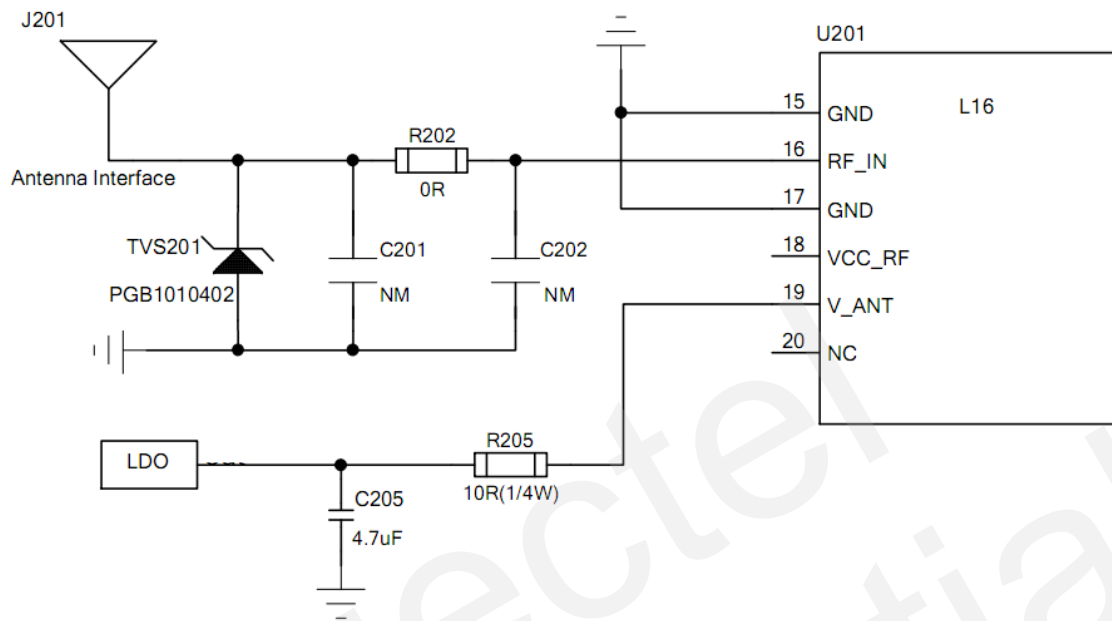


Figure 13: Active antenna with external LDO

5. Electrical and reliability characteristics

5.1. Absolute maximum ratings

Absolute maximum rating for power supply and voltage on digital pins of module are listed in Table 11.

Table 11: Absolute maximum ratings

Parameter	Min	Max	Unit
Power supply voltage (VCC)	- 0.3	+ 3.63	V
Backup battery voltage (V_BCKP)	- 0.3	+ 3.8	V
Antenna supply voltage (V_ANT)	0	+6	V
Input voltage at digital pins	- 0.3	+ 3.63	V
Storage temperature	- 45	+ 125	°C

Note: Stressing the device beyond the “Absolute Maximum Ratings” may cause permanent damage. These are stress ratings only. The product is not protected against over voltage or reversed voltage. If 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.

5.2. Operating conditions

Table 12: 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	3.6	V
V_BCKP	Backup voltage supply		2.0	3.3	3.6	V
I _{BCKP}	Backup battery current	V_BCKP = 3.3V		75		uA
V_ANT	Supply voltage		2.7		5.5	V
VCC_RF	Optional output voltage for external active antenna			VCC	VCC	V
T _{OPR}	Normal Operating temperature		-40	25	85	°C

Note: 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 Table 13.

Table 13: The module current consumption (passive antenna)

Parameter	Condition	Min	Typ	Max	Unit
I _{VCC} Acquisition	Passive antenna@-130dBm		110		mA
I _{VCC} Tracking	For Cold Start, 10 minutes after First Fix. For Hot Start, 15 seconds after First Fix with passive antenna.		95		mA
I _{BCKP} RTC	VCC is powered off and battery supplies power for V_BCKP		75		uA

5.4. Electro-static discharge

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

The ESD bearing capability of the module is listed in Table 14.

Table 14: The ESD endurance table (Temperature: 25°C, Humidity: 45 %)

Pin	Contact discharge	Air discharge
VCC,GND	±5KV	±10KV
VCC_OUT	±5KV	±10KV
V_BCKP	±5KV	±10KV
V_ANT	±5KV	±10KV
VCC_RF	±5KV	±10KV
TXD1	±4KV	±8KV
RXD1	±4KV	±8KV
TXD2	±4KV	±8KV
RXD2	±4KV	±8KV
RF_IN	±4KV	±8KV
1PPS	±3KV	±6KV

5.5. Reliability test

Table 15: Reliability test

Test term	Condition	Standard
Thermal shock	-30 °C for half an hour +80 °C for half an hour 144 cycles for 144 hours	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;	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

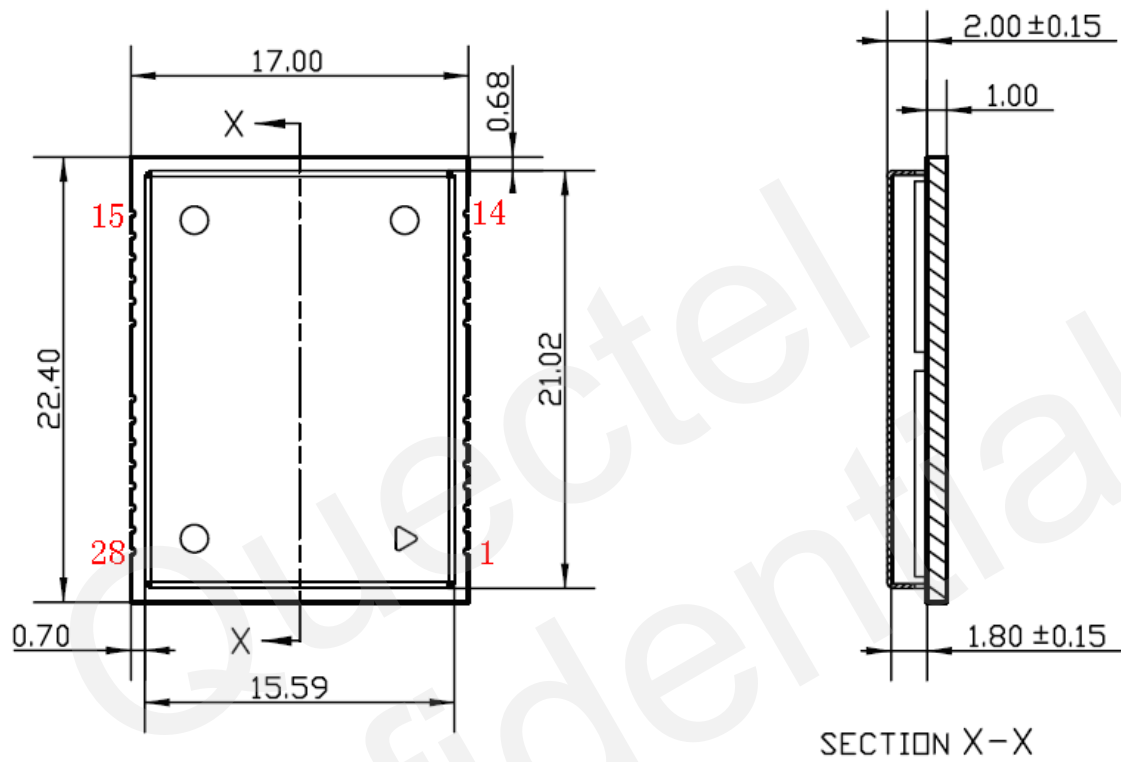


Figure 14: Top view and side dimensions (Unit: mm)

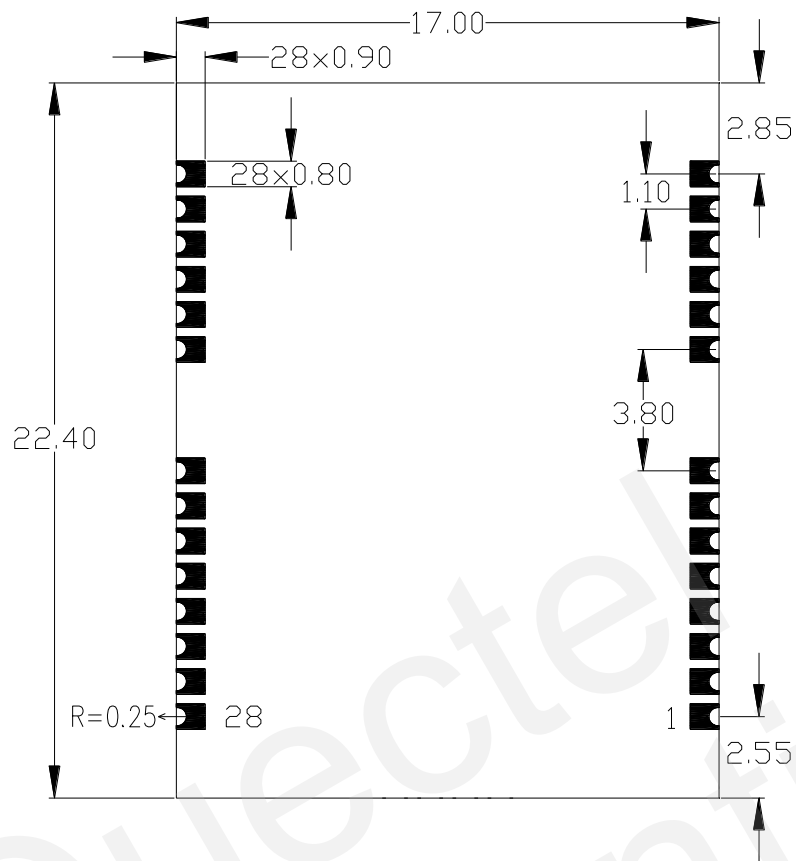


Figure 15: Bottom dimensions (Unit: mm)

6.2. Recommended pad layout

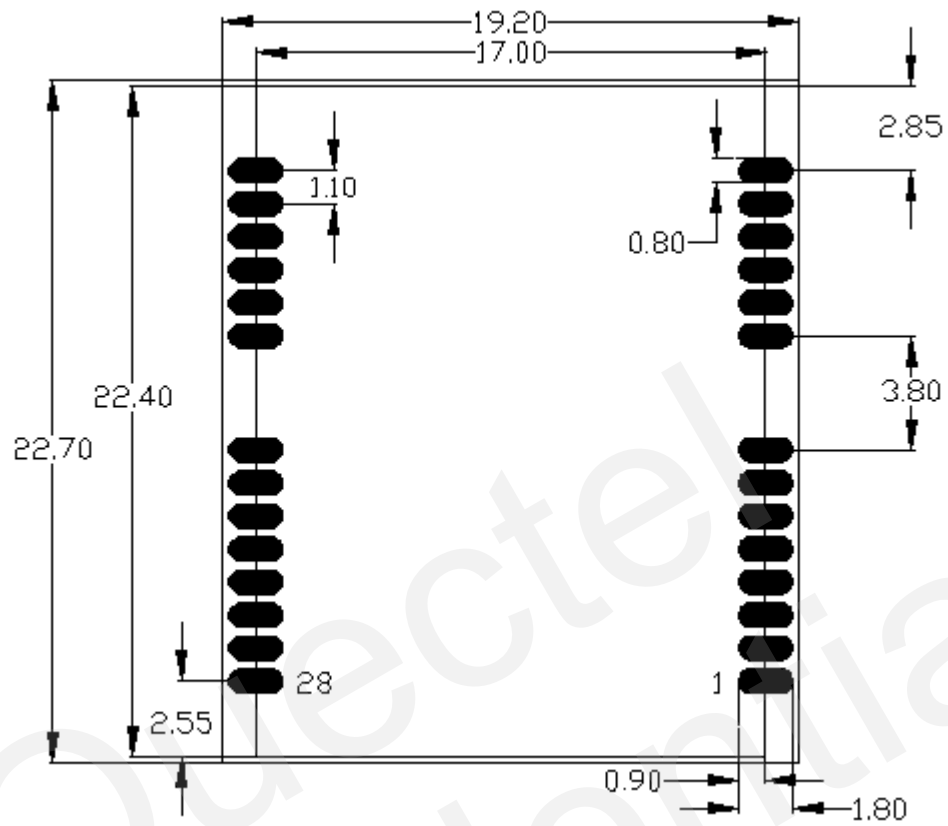


Figure 16: Recommended pad layout (Unit: mm)

6.3. Top view of the module

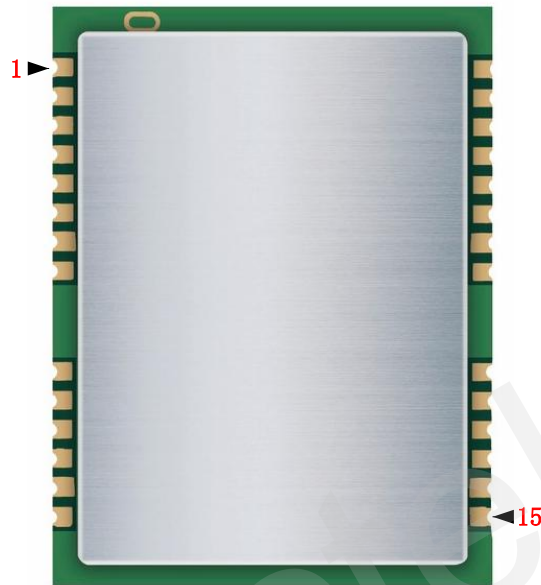


Figure 17: Top view of the module

6.4. Bottom view of the module

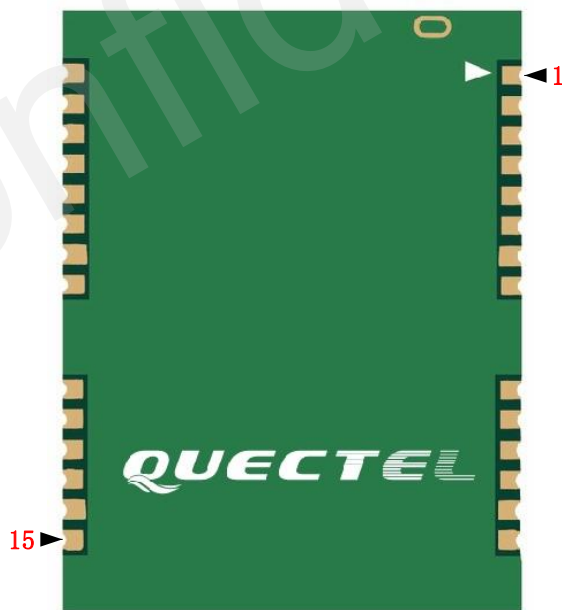


Figure 18: Bottom view of the module

7. Manufacturing

7.1. Assembly and soldering

L16 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 peak reflow temperature is 235~245 °C (for SnAg3.0Cu0.5 alloy). Absolute max reflow temperature is 260 °C. To avoid damage to the module when it is repeatedly heated, it is suggested that the module should be mounted after the first panel has been reflowed. The following picture is the actual diagram which we have operated.

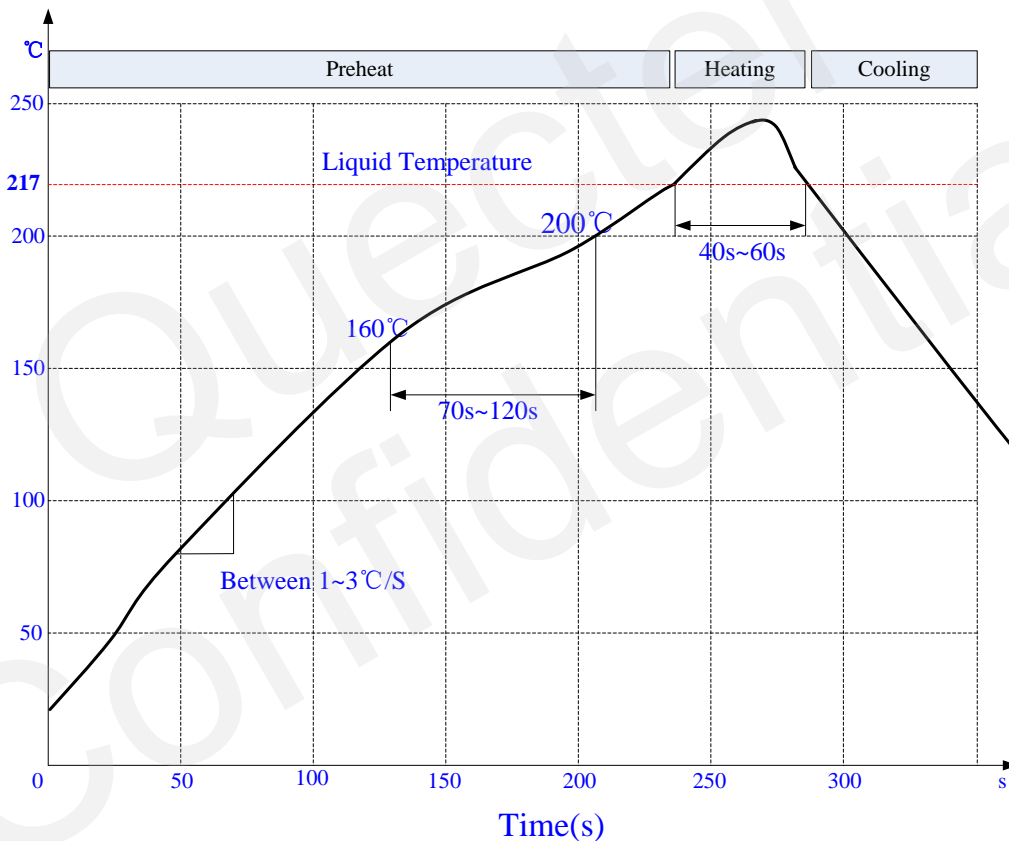


Figure 19: Ramp-soak-spike-reflow of furnace temperature

7.2. Tape and reel

One reel contains 250 modules.

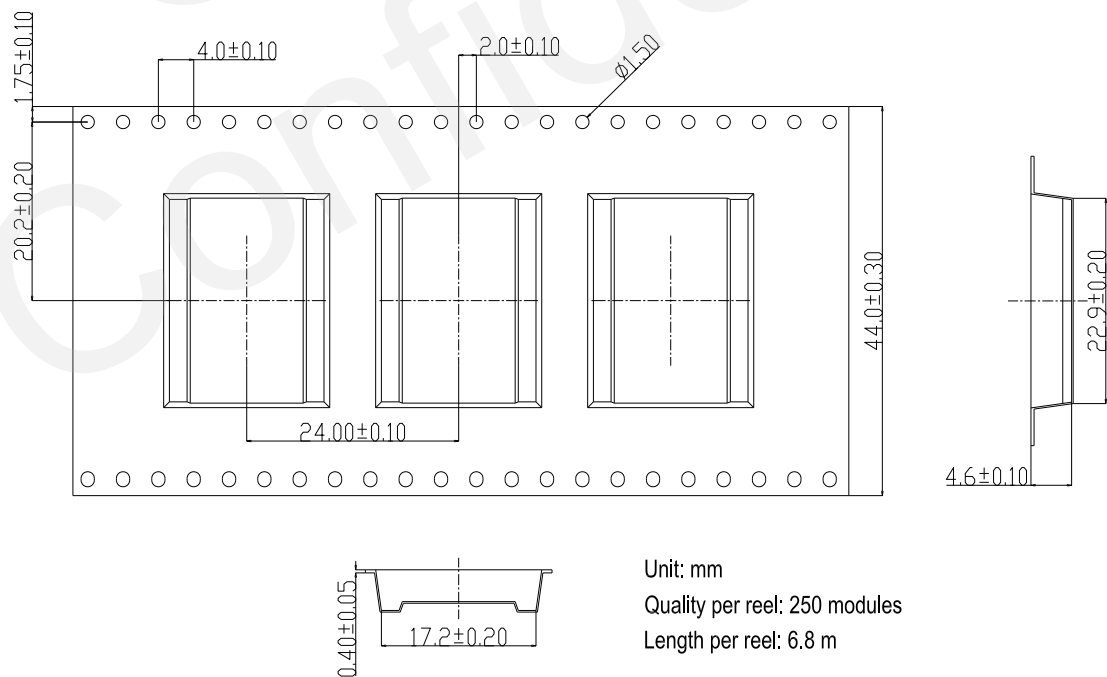
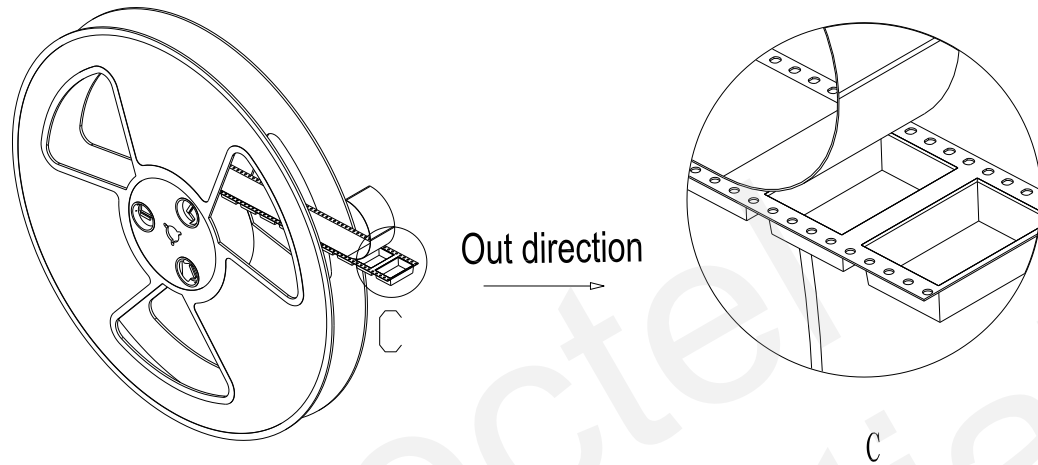


Figure 20: Tape and reel specification

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