Wireless Module Expert

L76 Hardware Design

GNSS Module Series

Rev. L76_Hardware_Design_V1.2

Date: 2014-05-10

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About the Document

History

Revision	Date	Author	Description
V1.0	2013-02-08	Ray XU	Initial
V1.1	2013-03-21	Ray XU	1. Delete PMTK 291 command. 2. Change R3 to 100R in figure 17. 3. Updated chapter 2.4. 4. Changed typical voltage of V_BCKP to 3.3V.
V1.2	2014-05-10	Tony GAO	1. Modified the input power at RF_IN. 2. Change the tracking sensitivity to -165dBm.

Contents

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1 Introduction

This document defines and specifies L76 GNSS module. It describes L76 GNSS module hardware interface and its external application reference circuits, mechanical size and air interface.

This document can help you quickly understand the interface specifications, electrical and mechanical details of L76 GNSS module. We also offer you other documents such as L76 software application notes and user guider. These documents can ensure you use L76 module to design and set up mobile applications quickly.

2 Product Concept

2.1. General Description

L76 is a single receiver module integrated with GLONASS and GPS system. 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. The embedded flash memory provides capacity for storing user-specific configurations and allows for future updates.

The L76 GNSS module supports multiple positions and navigation system including autonomous GPS, GLONASS, SBAS (including WAAS, EGNOS, MSAS and GAGAN), QZSS, and AGPS.

Embedded with many advanced power saving modes including period, AlwaysLocate™, standby and backup, L76 GNSS module has excellent low-power consumption in different scenes.

Easy technology as the key feature of L76 is one kind of AGPS. Collecting and processing all internal aiding information like GPS time, Ephemeris, Last Position etc, the GNSS module will have a fast TTFF in either Hot or Warm start.

L76 GNSS module is an SMD type module with the compact 10.1mm × 9.7mm × 2.5mm form factor, which can be embedded in your applications through the 18-pin pads. It provides necessary hardware interfaces between the module and your board.

The module is fully ROHS compliant to EU regulation.

2.2. Key Features

Table 1: Feature

Feature	Implementation
GNSS	GPS&GLONASS
Power Supply	Supply voltage: 2.8V - 4.3V typical: 3.3V
Power Consumption	Acquisition: 21mA @-130dBm(GPS) Tracking: 15mA @-130dBm(GPS) Acquisition: 25mA @-130dBm(GPS+GLONASS) Tracking: 18mA @-130dBm(GPS+GLONASS)
Receiver Type	GPS L1 1575.42MHz C/A Code GLONASS L1 1598.0625~1605.375 C/A Code
Sensitivity(NOTE)	Acquisition: -148dBm Reacquisition: -160dBm Tracking: -165dBm
Time-To-First-Fix (EASY Enabled)	Cold Start: <15s average @-130dBm Warm Start: <5s average @-130dBm Hot Start: 1s @-130dBm
Time-To-First-Fix (EASY Disabled)	Cold Start (Autonomous): <35s average @-130dBm Warm Start (Autonomous): <30s average @-130dBm Hot Start (Autonomous): 1s @-130dBm
Horizontal Position Accuracy(Autonomous)	<2.5 m CEP @-130dBm
Update Rate	Up to 10Hz, 1Hz by default
Accuracy of 1PPS Signal	Typical accuracy <15ns (Not support timeservice) 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 messages input and firmware upgrade
Temperature Range	Normal operation: -45°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

NOTE

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 L76 GNSS module. It consists of a single chip GNSS IC which includes RF part and Baseband part, a SAW filter, a TCXO and a crystal oscillator.

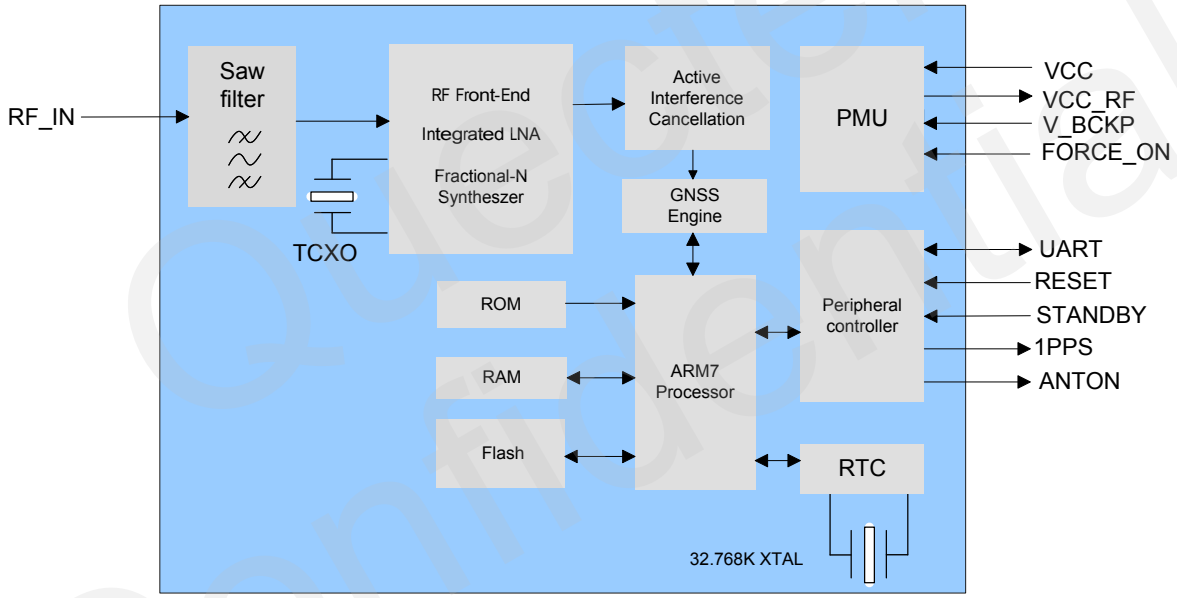

Figure 1: Block Diagram

2.4. Evaluation Board

In order to help you use L76 GNSS module on your applications, Quectel supplies an Evaluation Board (EVB) with Micro-USB cable, active antenna and other peripherals to test the module.

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

2.5. The Module Supports Protocols

Table 2: The Protocol Supported by the Module

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

NOTE

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

3 Application

The 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	Assure load current no less than 150mA.
V_BCKP	6	I	Backup power supply	Vmax=4.5V Vmin=1.5V	Supply power for RTC domain when VCC is

				Vnom=3.3V I_{V_BCKP}=7uA @Backup mode	powered off.
VCC_RF	14	O	Supply Power for external RF component	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=0.7V VIHmin=2.1V VIHmax= 3.1V	It is low level active. If unused, keep this pin open or connect it to VCC.
UART Port					
Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
RXD1	3	I	Receive data	VILmin=-0.3V VILmax=0.7V VIHmin=2.1V VIHmax= 3.1V	
TXD1	2	O	Transmit data	VOLmax=0.42V VOHmin=2.4V VOHnom=2.8V	
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 Interface					
Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
ANTON	13	O	External LNA control pin and active antenna power control pin in power save mode	VOLmax=0.42V VOHmin=2.4V VOHnom=2.8V	If unused, keep this pin open.
STANDBY	5	I	Used to enter into or exit from standby mode	VILmin=-0.3V VILmax=0.7V VIHmin=2.1V VIHmax=3.1V	It is pulled up internally. It is edge-triggered. If unused, keep this pin open.

1PPS	4	O	One pulse per second	VOLmax=0.42V VOHmin=2.4V VOHnom=2.8V	Synchronized at rising edge, the pulse width is100ms. If unused, keep this pin open.
FORCE_ON	18	I	Logic high will force module to be waked up from backup mode	VILmin=-0.3V VILmax=0.7V VIHmin=2.1V VIHmax=3.1V	Keep this pin open or pulled low before entering into backup mode. It belongs to RTC domain. If unused, keep this pin open.
RESERV-ED	16,17				Keep these pins open.

3.3. Power Supply

VCC pin supplies power for BB, RF, I/O and RTC domain. The load current of VCC pin varies according to the VCC level, processor load and satellite acquisition. Typical VCC peak current is 40mA (typ.) during GPS acquisition after power up. So it is important to supply sufficient current and make the power clean and stable. VCC supply ripple voltage should meet the requirement: 54 mV (RMS) max @f=0…3MHz and 15mV (RMS) max @f>3MHz. You should choose the LDO without built-in output high-speed discharge function to keep long output voltage drop-down period. The decouple combination of 10uF and 100nF capacitor is recommended nearby 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 nearby V_BCKP pin. The voltage of RTC domain ranges from 1.5V to 4.5V. In order to achieve a better Time To First Fix (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 pin not only supplies power for PMU but also for VCC_RF and RTC domain. V_BCKP supplies power for RTC domain only. The two diode in following figure construct an OR gate supply power for RTC domain. FORCE_ON pin belongs to RTC domain. The signal which has been shown as red line in the following diagram can open and close the switch. The following action will close and open the switch:

- The switch will be closed by default when VCC is supplied power (VCC off ⟶ on).
- Based on above step, FORCE_ON open or low and sending PMTK command can open the switch (full on ⟶ backup).
- Based on above step, FORCE_ON logic high can close the switch (backup ⟶ full on).

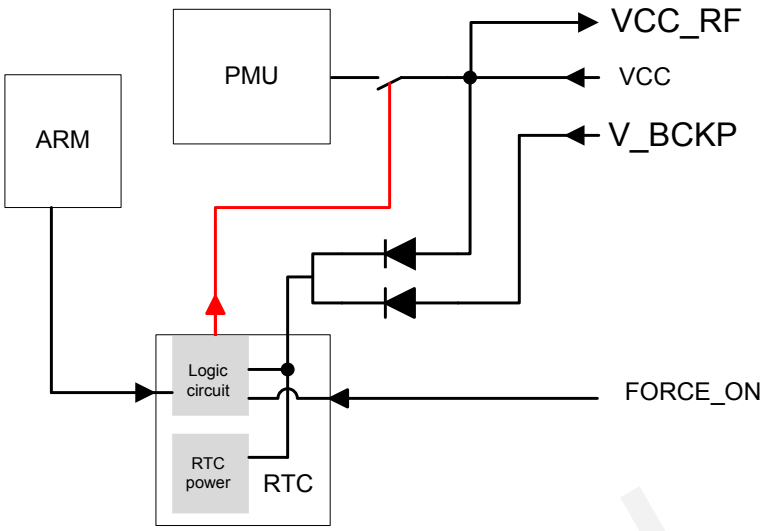

Figure 3: Internal Power Construction

The following picture shows average current and power consumption versus VCC supply voltage. It was tested in the open sky and tracking mode based on GPS&GLONASS.

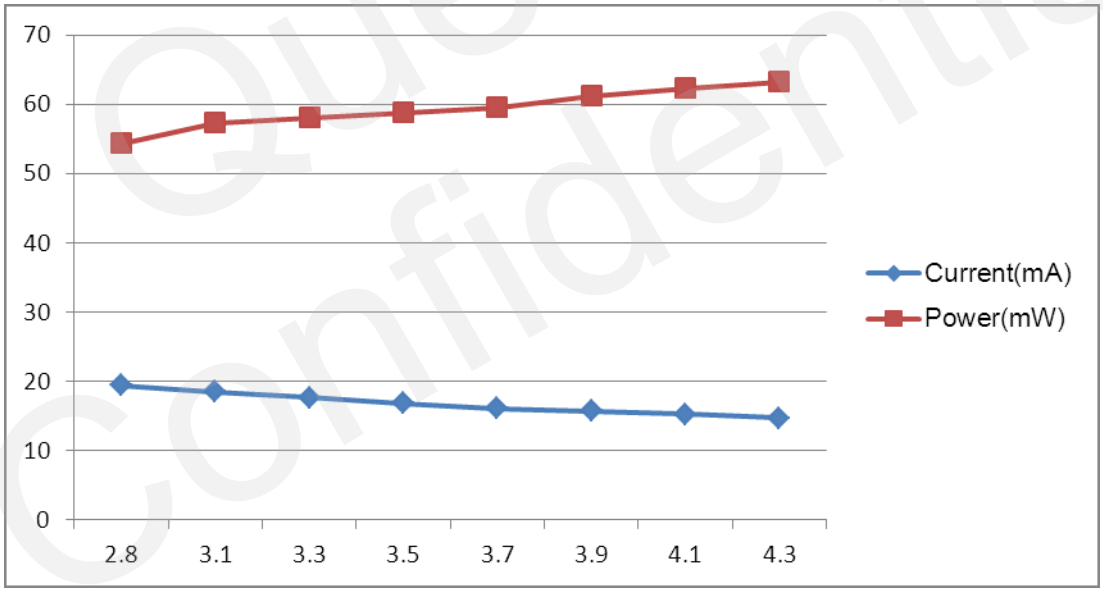

Figure 4: Current and Consumption Versus VCC

NOTE

The sleep time in period backup mode and AlwaysLocate™ backup mode equals to the time in backup mode.

3.4. Operate Mode

The table below briefly illustrates the relationship among different operating modes of L76 GNSS module.

Table 4: Module State Switch

Current Mode	Next Mode				
	Backup	Standby	Full on	Period	Always Locate
Backup	N/A	N/A	Refer to ***chapter 3.4.3***	N/A	N/A
Standby	N/A	N/A	Pull STANDBY high Send any data via UART1	N/A	N/A
Full on	Refer to ***chapter 3.4.3***	Pull STANDBY low PMTK161	N/A	PMTK 225	PMTK225
Period	N/A	N/A	Refer to ***chapter 3.4.4***	N/A	N/A
Always locate	N/A	N/A	Refer to ***chapter 3.4.5***	N/A	N/A

NOTE

Please refer to ***document [2]*** about MTK proprietary protocol for more details.

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 tracks satellites and demodulates the navigation data from the specific satellites.

Whether the combination of VCC and V_BCKP pins is valid or VCC is valid, the module will enter into full on mode automatically and follow the default configuration as below. You can refer to ***chapter 3.3*** about internal power construction to have a good comprehension. You also can use PMTK commands to change the configuration to satisfy the requirement.

Table 5: Default Configuration

Item	Configuration	Comment
Baud Rate	9600bps	
Protocol	NMEA	RMC, VTG, GGA, GSA, GSV and GLL
Update Rate	1Hz	
SBAS	Enable	
AIC	Enable	
LOCUS	Disable	
Easy Technology	Enable	
GNSS	GPS+GLONASS	

In full on mode, the consumption will comply with the following regulation:

When the module is powered on, the average current will rush to 40mA and it will last a few seconds, then the consumption will be decreased to acquisition current marked in ***table 1*** and we defined this state as acquisition state, also it will last several minutes until it switches to tracking state automatically. The consumption in tracking state is less than acquisition. The value is also listed in ***table 1.***

Using PMTK commands can switch among multiple position system:

- $PMTK353,0,1*36: search GLONASS satellites only
- $PMTK353,1,0*36: search GPS satellites only
- $PMTK353,1,1*37: search GLONASS and GPS satellites

3.4.2. Standby Mode

Standby mode is a low-power consumption mode. In standby mode, the internal core and I/O power domain are still active, but RF and TCXO are powered off, 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 standby mode and exit from standby mode.

- **Using STANDBY pin**: Pulling STANDBY low will make the GNSS module to 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 makes the typical standby current reach to about 600uA @ VCC=3.3V.

- **Using PMTK command**: Sending PMTK command “$PMTK161,0*28” will enter into standby mode. Sending any data via UART1 will make the module exiting from standby mode as UART1 is still accessible in standby mode. When the module exit from standby mode, it will use all internal aiding information like GPS time, Ephemeris, Last Position etc, resulting to a fastest possible TTFF in either Hot or Warm start. The typical current consumption in this way is about 500uA @VCC=3.3V in standby mode.

NOTE

Setting the customer’s GPIO which control STANDBY pin as input is recommended before turning on the module to avoid entering into standby mode unexpectedly during starting the module due to its edge-triggered characteristics, after that, customer can reset the GPIO as output to control the STANDBY pin. If it is unused, keep it open.

3.4.3. Backup Mode

Back up mode is a lower power consumption mode than standby mode. In this mode, the module stops to acquire and track satellites. UART1 is not accessible. But the backed-up memory in RTC domain which contains all the necessary GPS information for quick start-up and a small amount of user configuration variables is alive. Due to the backed-up memory, easy technology is available. The type consumption in this mode is about 7uA.

There are two ways to enter into backup mode and back to full on mode.

- Send command: “$PMTK225,4*2F” (the red line open the switch in Figure 3) to enter into backup mode forever. The only way to wake up the module is pulling the FORCE_ON high (the red line closes the switch in Figure 3).
- Cutting off VCC and V_BCKP present will make the module to enter into backup mode from full on mode. As long as the VCC pin is supplied power, the module will enter into full on mode immediately. But this method is not recommended.

NOTE

Keep FORCE_ON pin open or low before entering into backup mode or it is not available.

To have a good comprehension, please refer to ***chapter 3.3*** about internal power construction. The V_BCKP pin can be directly provided by an external capacitor or battery (rechargeable or non-chargeable). Please refer to the following figure for RTC backup reference design.

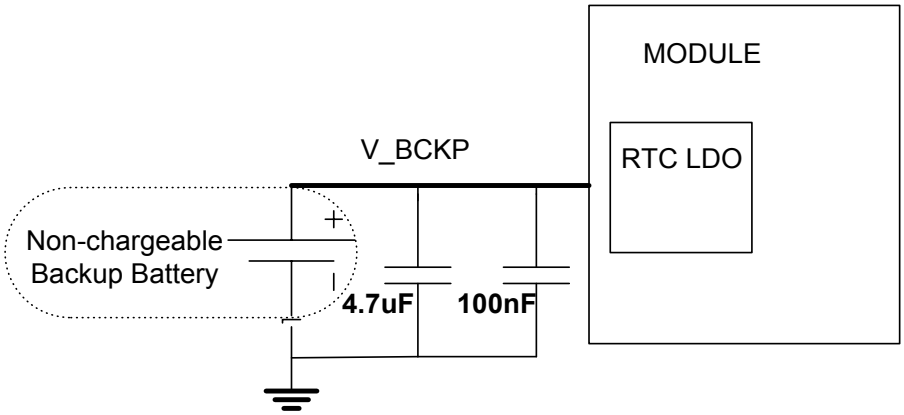

Figure 5: RTC Supply from Non-chargeable Battery

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

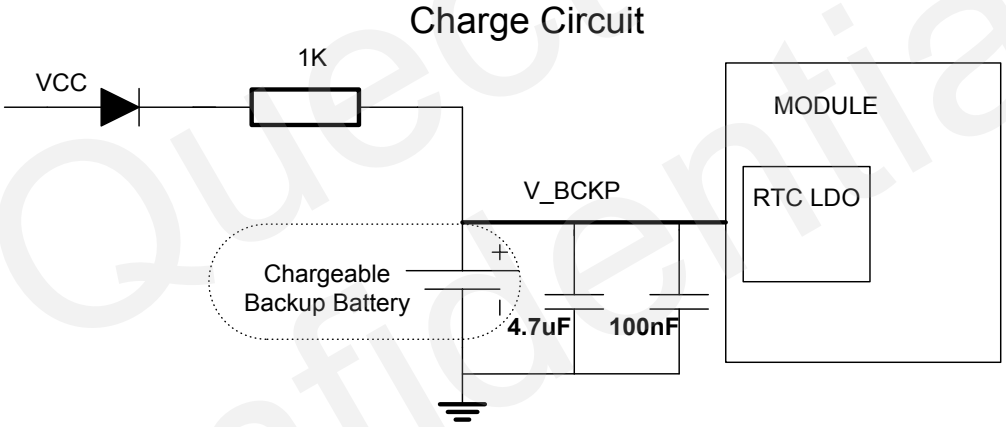

Figure 6: Reference Charging Circuit for Chargeable Battery

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.

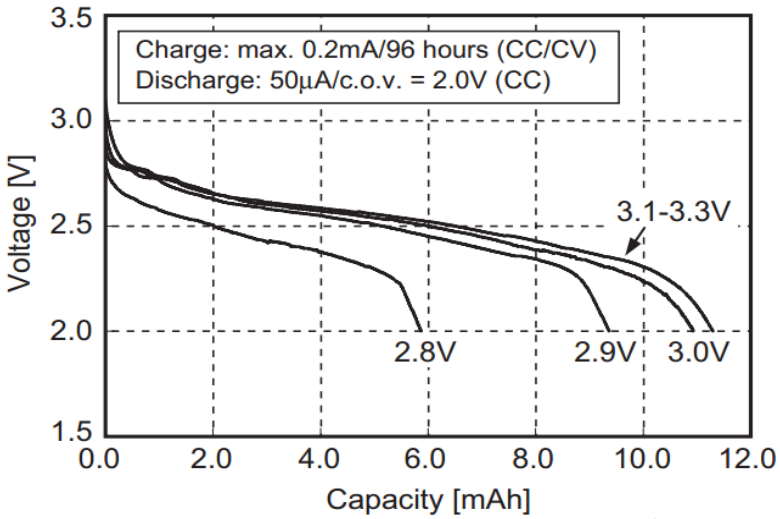

Figure 7: Seiko MS920SE Charge and Discharge Characteristics

3.4.4. Period Mode

Period mode is a mode that can control the full on mode and standby/backup mode periodically to reduce power consumption. It contains Period standby mode and Period backup mode.

The format of the command which enters into period mode is as following:

Table 6: PMTK Command Format

Format: $PMTK225,<Type>,<Run_time>,<Sleep_time>,<2nd_run_time>,<2nd_sleep_time>*<checksum><CR><LF>		
Parameter	**Format**	**Description**
Type	Decimal	**Type=1** for Period Backup Mode **Type=2** for Period Standby Mode
Run_time	Decimal	**Run_time**=Full on period (ms)
Sleep_time	Decimal	**Sleep_time**=Standby/Backup period (ms)
2nd_run_time	Decimal	**2nd_run_time**=Full on period (ms) for extended acquisition in case module's acquisition fails during the **Run_time**
2nd_sleep_time	Decimal	**2nd_sleep_time**=Standby/Backup period (ms) for extended sleep in case module's acquisition fails during the **Run_time**
Checksum	Hexadecimal	Hexadecimal checksum

Example:
$PMTK225,2,3000,12000,18000,72000*15<CR><LF>
$PMTK225,1,3000,12000,18000,72000*16<CR><LF>

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

Pulling the FORCE_ON high and sending "$PMTK225,0*2B" immediately will make the module to full on mode from Period backup mode.

Sending "$PMTK225,0*2B" in **Run_time** or **2nd_run_time** will also make the module to full on mode from Period backup mode, but it is hard to operate and not recommended.

NOTES

1. Setting the customer's GPIO which control STANDBY pin as input is recommended before turning on the module to avoid entering into standby mode unexpectedly during starting the module due to its edge-triggered characteristics, after that, customer can reset the GPIO as output to control the STANDBY pin. If it is unused, keep it open.
2. Keep FORCE_ON pin open or low before entering into period backup mode or it is not available.

The following figure has shown the operation of period mode. When you send PMTK command, the module will be in the full on mode firstly. After several minute, the module will enter into the period mode and follow the parameters set by you. When the module fails to fix the position in **run time**, the module will switch to second run and sleep time automatically. As long as the module fixs the position again, the module will return to first run and sleep time.

Note that before entering into period mode, assure the module is in the tracking mode; otherwise the module will have a risk of failure to track the satellite. If GNSS module is located in weak signal environment, it is better to set the longer second run time to ensure the success of reacquisition.

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

$I_{period} = (I_{tracking} * T1 + I_{standby/backup} * T2) / (T1+T2)$ T1: Run time, T2: Sleep time

Example:
PMTK225,2,3000,12000,18000,72000*15 for period mode with 3s in tracking mode and 12s in standby mode based on GPS&GLONASS. The average current consumption is calculated below:
I period=(I tracking*T1+Istandby*T2)/(T1+T2)=(18mA*3s + 0.5mA*12s)/(3s+12s)≈4.0(mA)

PMTK225,1,3000,12000,18000,72000*16 for period mode with 3s in tracking mode and 12s in backup mode based on GPS&GLONASS. The average current consumption is calculated below:
I period=(I tracking*T1+Ibackup*T2)/(T1+T2)=(18mA*3s + 0.007mA*12s)/(3s+12s)≈3.6(mA)

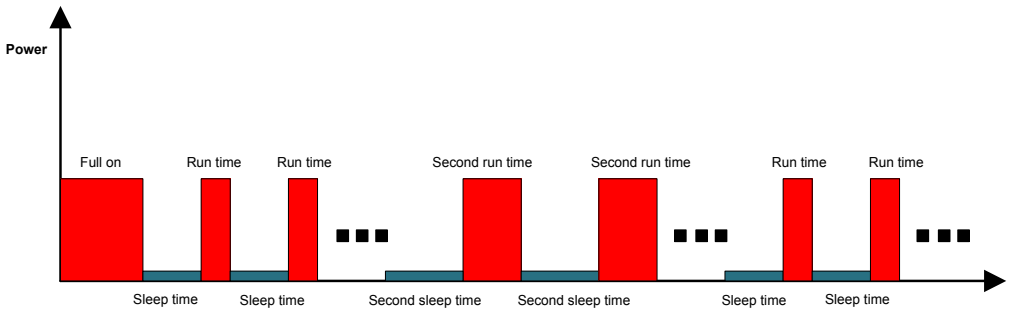

Figure 8: Period Timing

3.4.5. AlwaysLocate™ Mode

AlwaysLocate™ is an intelligent power saving mode. It contains alwaysLocate™ backup mode and alwaysLocate™ standby mode.

AlwaysLocate™ 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 the balance between positioning accuracy and power consumption. Sending "$PMTK225,8*23" and the module returning: "$PMTK001,225,3*35" means the module accesses alwaysLocate™ standby mode successfully. It will benefit power saving in this mode. Sending "$PMTK225,0*2B" in any time will make the module back to full on mode.

AlwaysLocate™ backup mode is the similar with alwaysLocate™ standby mode. The difference is that AlwaysLocate™ backup mode switches automatically between full on mode and backup mode. The PMTK command to enter into alwaysLocate™ backup mode is "$PMTK225,9*22". Pulling FORCE_ON high and sending "$PMTK225,0*2B" immediately will make the module enter into full on mode.

The position accuracy in AlwaysLocate™ mode will be degraded, especially in high speed. The following picture shows the rough consumption in different scenes.

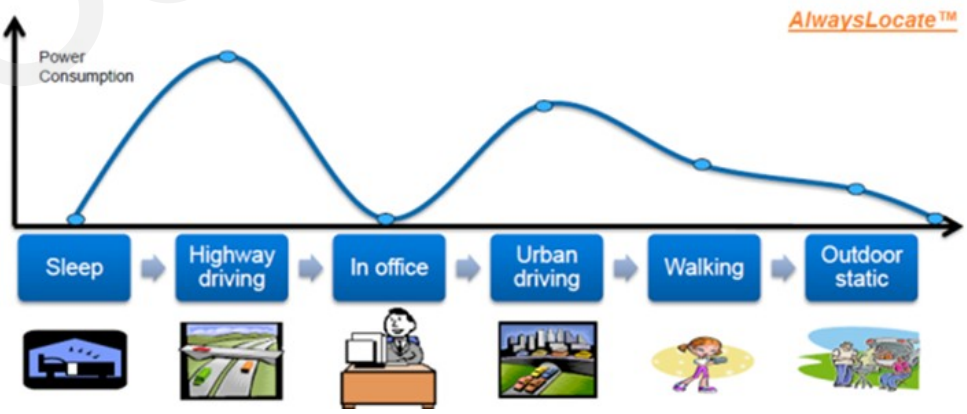

Figure 9: AlwaysLocate™ Mode

Example:
The average consumption of the module which is located in outdoor in static and equipped active antenna after tracking satellites is about 2.7mA in AlwaysLocate™ standby mode based on GPS&GLONASS.

The average consumption of the module which is located in outdoor in static and equipped active antenna after tracking satellites is about 2.6mA in AlwaysLocate™ backup mode based on GPS&GLONASS.

NOTES

1. Setting the customer's GPIO which controls STANDBY pin as input is recommended before turning on the module to avoid entering into standby mode unexpectedly during starting the module due to its edge-triggered characteristics, after that, customer can reset the GPIO as output to control the STANDBY pin. If it is unused, keep it open.
2. Keep FORCE_ON pin open or low before entering into AlwaysLocate™ backup mode or it is not available.

3.5. Reset

L76 GNSS module can be restarted by driving the RESET to a low level voltage for a certain time and then releasing it. This action will force volatile RAM data loss. Note that Non-Volatile Backup RAM content is not cleared and thus fast TTFF is possible. An OC driver circuit shown as below is recommended to control the RESET.

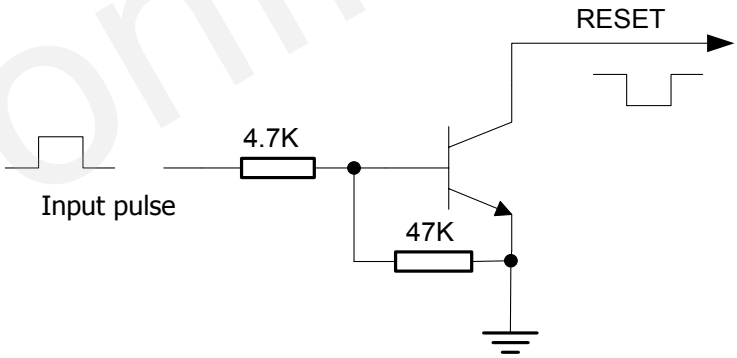

Figure 10: Reference Reset Circuit using OC Circuit

The following picture is shown the timing of L76 module.

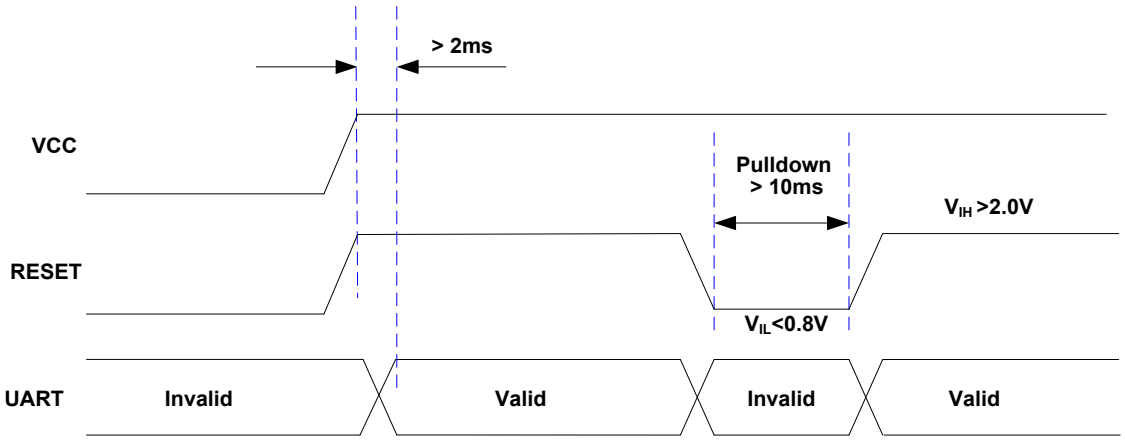

Figure 11: Module Timing

3.6. UART Interface

The module provides one universal asynchronous receiver & transmitter serial port. The module is designed as a DCE (Data Communication Equipment), following the traditional DCE-DTE (Data Terminal Equipment) connection. The module and the client (DTE) are connected through the following signal shown as following figure. It supports data baud-rate from 4800bps to 115200bps.

UART port:

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

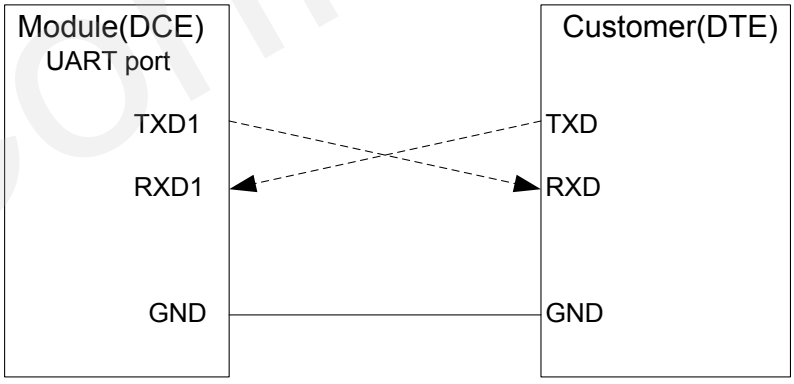

Figure 12: Connection of serial interfaces

This UART port has the following features:

- UART port can be used for firmware upgrade, NMEA output and PMTK proprietary messages input.
- The default output NMEA type setting is **RMC, VTG, GGA, GSA, GSV and GLL**.
- 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.

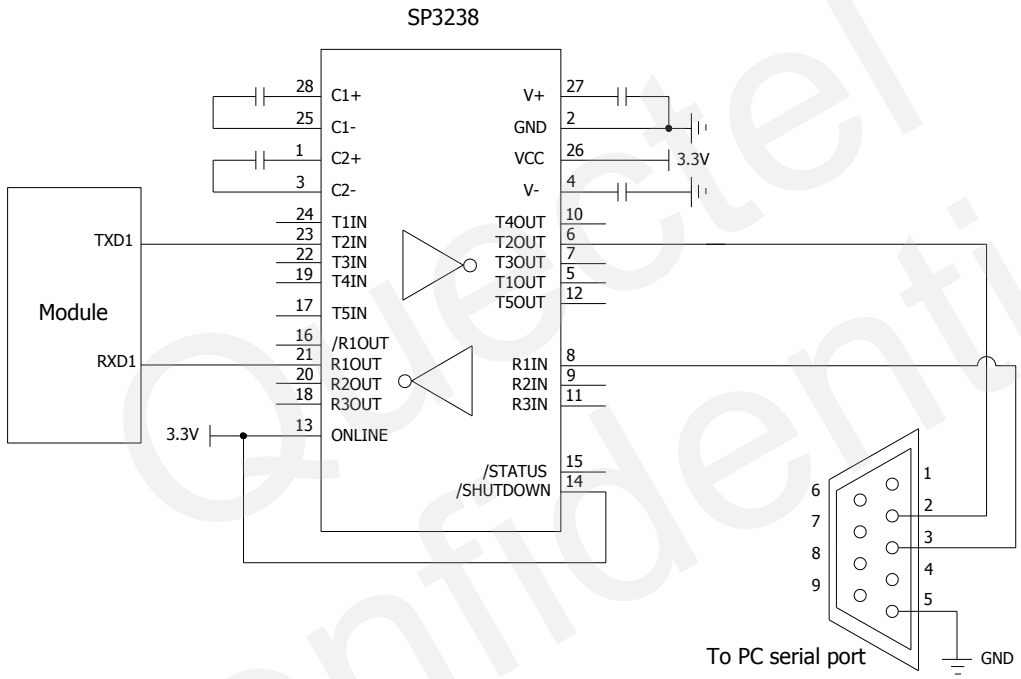

Figure 13: RS-232 Level Shift Circuit

NOTE

As GNSS module outputs more data than single GPS system. The default output NMEA types running in 4800 baud rate and 1Hz update rate will lose some data. The solution to avoid losing data in 4800 baud rate and 1Hz update rate is to decrease the output NMEA types. 9600 baud rate is enough to transmit GNSS NMEA in default settings and it is recommended.

3.7. EASY Technology

Supplying aided information like ephemeris, almanac, rough last position, time, and satellite status，can help improving GNSS module TTFF and the acquisition sensitivity. We call this easy technology and The L76 GNSS module supports it.

EASY technology works as embedded software which can accelerate TTFF by predicting satellite navigation messages from received ephemeris. The GNSS engine will calculate and predict orbit information automatically up to 3 days after first receiving the broadcast ephemeris, and saving the predicted information into the internal memory. GNSS engine will use this information for positioning if no enough information from satellites, so the function will be helpful for positioning and TTFF improvement.

The EASY function can reduce TTFF to 5s for warm start. In this case, RTC domain should be valid. In order to gain enough broadcast ephemeris information from GNSS satellites, the GNSS module should receive the information for at least 5 minutes in the good signal condition after it fix the position.

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

3.8. Multi-tone AIC

L76 GNSS module has a function called multi-tone AIC (Active Interference Cancellation) to decease harmonic of RF noise from Wi-Fi, Bluetooth, GSM and 3G.

Up to 12 multi-tone AIC embedded in the module can provide effective narrow-band interference and jamming elimination. The GNSS signal could be demodulated from the jammed signal, which can ensure better navigation quality. AIC function is enabled by default. Opening AIC function will increase about 1mA @VCC=3.3V consumption. This function is enabled by default. The following commands can be used to set AIC function.

Enable AIC function: “$PMTK 286,1*23”.
Disable AIC function: “$PMTK 286,0*22”.

3.9. ANTON

L76 GNSS module provides a pin called ANTON which is related to module state. Its voltage level will change in different module state. When the module works in full on mode, this pin is high level, while works in standby mode, backup mode as well as sleep time in period mode and alwaysLocate™ mode, this pin is low level. Based on this characteristic, this ANTON pin can be used to control the power supply

of active antenna or the enable pin of the external LNA to reduce power consumption. Please refer to ***chapter 3.2*** for more electrical characteristics about this pin. There is an example of this pin's application described in ***chapter 4.2***.

3.10. LOCUS

The L76 GNSS module supports the embedded logger function called LOCUS. It can log position information to internal flash memory automatically when this function is enabled by sending PMTK command "$PMTK185, 0*22". Due to this function, the host can go to sleep to save power consumption and do not need to receive the NMEA information all the time. The module can provide a log capacity of more than 16 hours.

The detail procedures of this function are as following:

- The module has fixed the position (only 3D_fixed is available),
- Sending PMTK command "$PMTK184,1*22" to erase internal flash.
- Sending PMTK command "$PMTK185,0*22" to start log.
- Module logs the basic information (UTC time, latitude, longitude and height) every 15 seconds to internal flash memory.
- Stop logging the information by sending "$PMTK185,1*23".
- MCU can get the data via UART1 by sending "$PMTK622,1*29" to the module.

The raw data which MCU gets has to be parsed via locus parser code provided by Quectel. For more detail, please contact Quectel FAE department.

4 Antenna Interface

L76 GNSS module supports both GPS and GLONASS systems. The RF signal is obtained from the RF_IN pin. The impedance of RF trace should be controlled by 50 Ohm, and the length should be kept as short as possible.

4.1. Antenna Specification

The L76 GNSS module can be connected to a dedicated GPS/GLONASS passive or active antenna in order to receive both GPS and GLONASS satellite signals. The recommended antenna specification is given in following table.

Table 7: Recommended Antenna Specification

Antenna Type	Specification
Passive Antenna	GPS frequency: 1575.42±2MHz GLONASS frequency: 1602±4MHz VSWR: <2 (Typ.) Polarization: RHCP or Linear Gain: >0dBi
Active Antenna	GPS frequency: 1575.42±2MHz GLONASS frequency:1602±4MHz 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 L76 GNSS module.

4.2.1. Active Antenna

4.2.1.1. Active Antenna without ANTON

The following figure is a typical reference design with active antenna. In this mode, the antenna's power is from the VCC_RF.

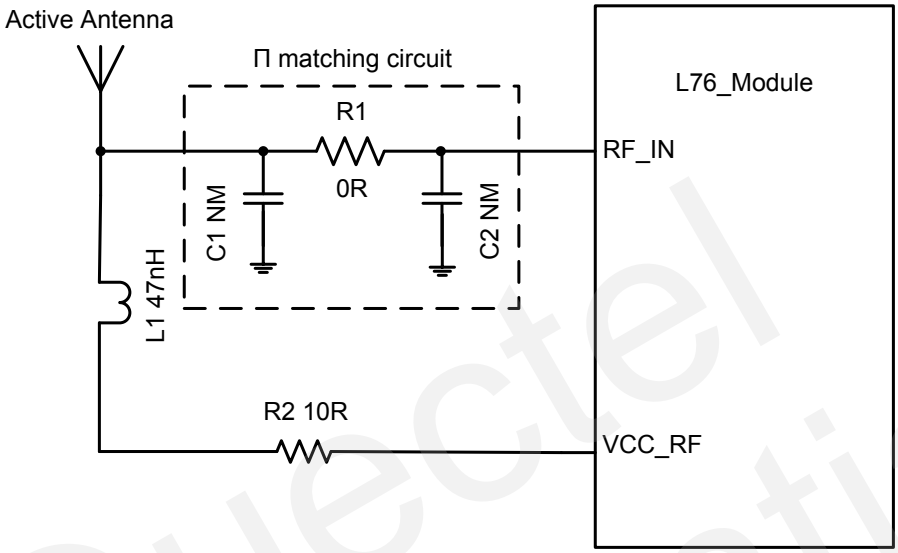

Figure 14: Reference Design with Active Antenna

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

L76 GNSS 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 requirements 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 pin 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

L76 GNSS module can also reduce 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.

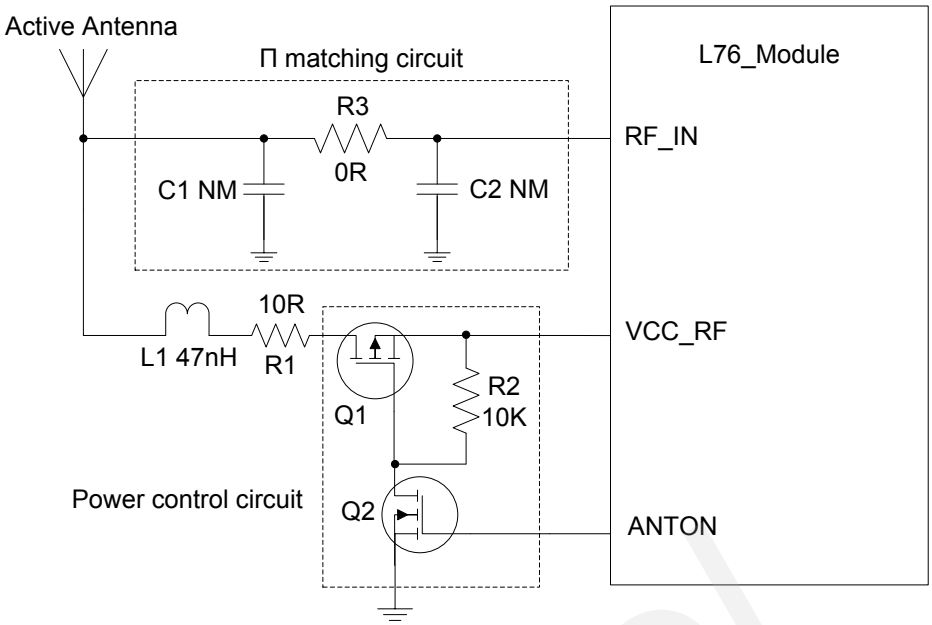

Figure 15: Reference Design for Active Antenna with ANTON

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 pin is determined by the module's state. Please refer to ***chapter 3.9*** for more detail. If unused, please keep ANTON pin open.

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

4.2.2. Passive Antenna

4.2.2.1. Passive Antenna without External LNA

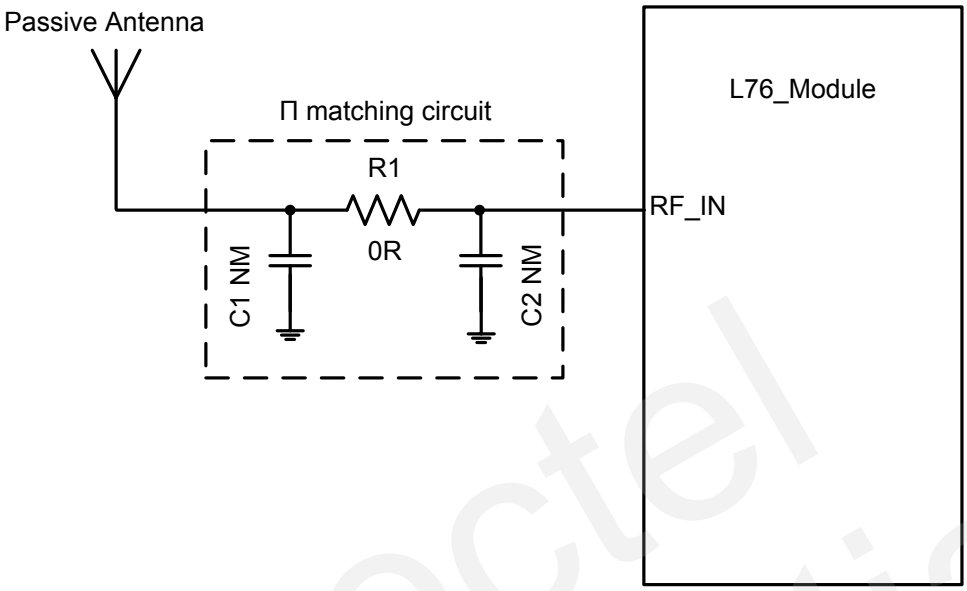

Figure 16: Reference Design with Passive Antenna

The above figure is a typical reference design with passive antenna.

C1, R1, C2 are reserved matching circuit for antenna impedance modification. C1 and C2 are not mounted by default, 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 L76 GNSS 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 receiver sensitivity and reduce the TTFF, an external LNA between the passive antenna and the L76 GNSS module is recommended. The reference design is shown as below.

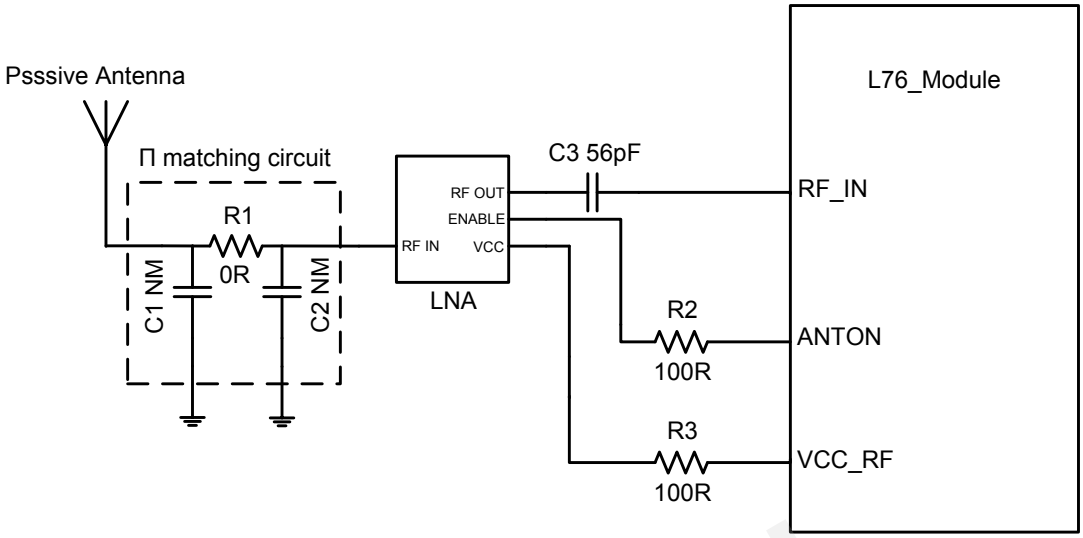

Figure 17: Reference Design for Passive Antenna with LNA

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 L76 GNSS module and the default value of C3 capacitor is 56pF which you might optimize according to the real conditions. ANTON is an optional pin which can be used to control the enable pin of an external LNA.

NOTES

1. The selected LNA should support both GPS and GLONASS system. The recommended parts numbers are MAX2659, BGU7007 and SKY65602. Here, MAX2659 and BGU7007 are pin to pin compatible. For more details, please contact Quectel FAE department.
2. The power consumption of the device will be reduced by controlling “LNA ENABLE” through the pin “ANTON” of L76 GNSS module. If “ANTON” function is not used, please connect the pin “LNA ENABLE” to VCC and keep LNA always on.

5 Electrical, Reliability and Radio Characteristics

5.1. Absolute Maximum Ratings

Absolute maximum rating for power supply and voltage on digital pins of the module are listed in following table.

Table 8: Absolute Maximum Ratings

Parameter	Min.	Max.	Unit
Power Supply Voltage （VCC）	-0.3	5	V
Backup Battery Voltage (V_BCKP)	-0.3	5	V
Input Voltage at Digital Pins	-0.3	3.6	V
Input Power at RF_IN (PRF_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 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 9: The Module Power Supply Ratings

Parameter	Description	Conditions	Min.	Type.	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			150	mA
V_BCKP	Backup voltage supply		1.5	3.3	4.5	V
VCC_RF	Output voltage RF section				VCC	V
TOPR	Full on Operating temperature		-45	25	85	℃

NOTES

1. This figure 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 following table.

Table 10: The Module Current Consumption

Parameter	Conditions	Min.	Type.	Unit
I_{VCC} @Acquisition	@-130dBm(GPS)		21	mA
I_{VCC} @Tracking	@-130dBm (GPS)		15	mA
I_{VCC} @Acquisition	@-130dBm(GPS+GLONASS)		25	mA
I_{VCC} @Tracking	@-130dBm (GPS+GLONASS)		18	mA

I_{VCC} @Standby	@VCC=3.3V	0.5	mA
I_{BCKP} @backup	@V_BCKP=3.3V	7	uA

NOTES

1. The VCC_RF current is not reckoned in above consumption.
2. The tracking current is tested in following condition:
   - For Cold Start, 10 minutes after First Fix.
   - For Hot Start, 15 seconds after First Fix.

5.4. Electro-static Discharge

L76 GNSS module is an ESD sensitive device. 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 following table. Note that you should add ESD components to module pins in the particular application.

Table 11: The ESD Endurance Table (Temperature: 25℃, Humidity: 45%)

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

5.5. Reliability Test

Table 12: Reliability Test

Test item	Conditions	Standard
Thermal Shock	-30°C...+80°C, 144 cycles	GB/T 2423.22-2002 Test Na IEC 68-2-14 Na
Damp Heat, Cyclic	+55°C; >90% Rh 6 cycles for 144 hours	IEC 68-2-30 Db Test
Vibration Shock	5~20Hz, 0.96m2/s3; 20~500Hz, 0.96m2/s3-3dB/oct, 1hour/axis; no function	2423.13-1997 Test Fdb IEC 68-2-36 Fdb Test
Heat Test	85°C, 2 hours, operational	GB/T 2423.1-2001 Ab IEC 68-2-1 Test
Cold Test	-40°C, 2 hours, operational	GB/T 2423.1-2001 Ab IEC 68-2-1 Test
Heat Soak	90°C, 72 hours, non-operational	GB/T 2423.2-2001 Bb IEC 68-2-2 Test B
Cold Soak	-45°C, 72 hours, non-operational	GB/T 2423.1-2001 A IEC 68-2-1 Test

6 Mechanics

This chapter describes the mechanical dimensions of the module.

6.1. Mechanical View Of the Module

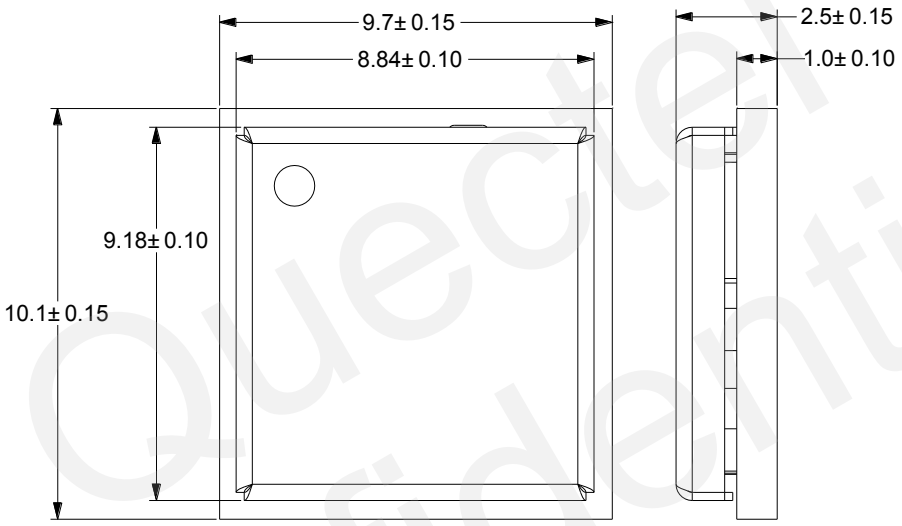

Figure 18: Top View and Side View (Unit: mm)

6.2. Bottom Dimension and Recommended Footprint

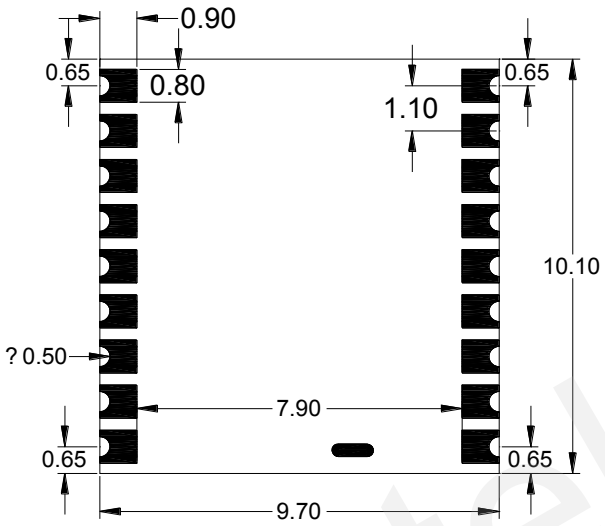

Figure 19: Bottom Dimension (Unit: mm)

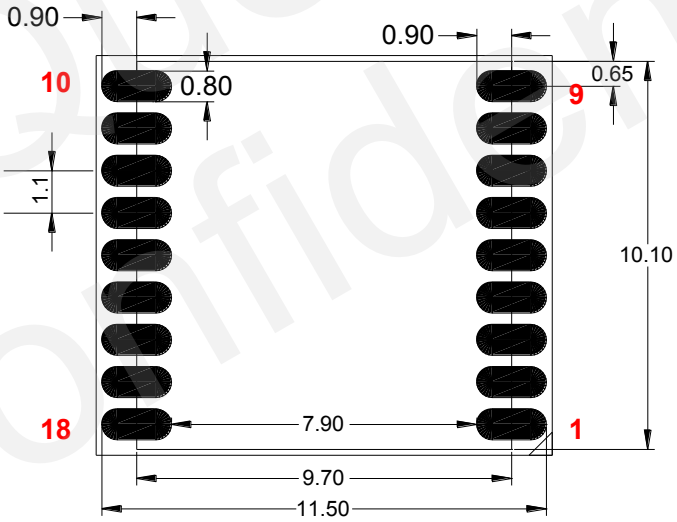

Figure 20: Footprint of Recommendation (Unit: mm)

NOTE

For easy maintenance of this module and accessing 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

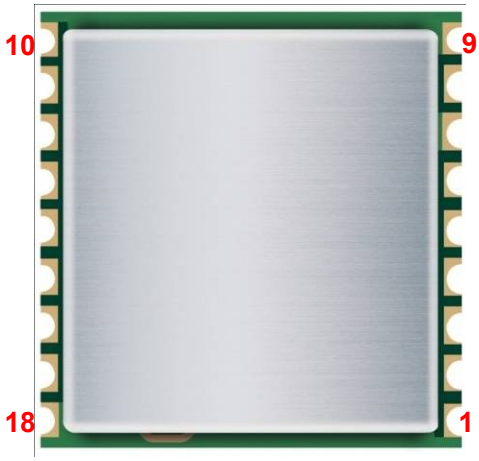

Figure 21: Top View of the Module

6.4. Bottom View of the Module

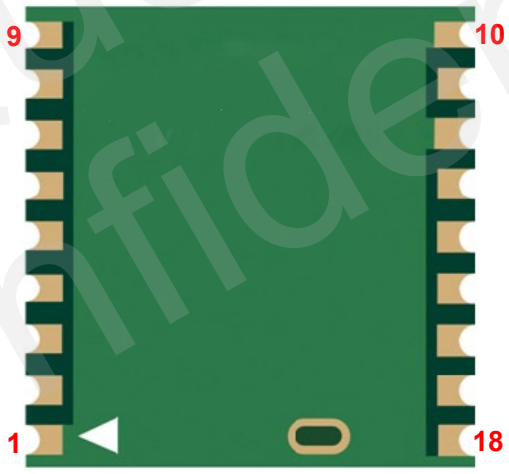

Figure 22: Bottom View of the Module

7 Manufacturing

7.1. Assembly and Soldering

L76 GNSS module is intended for SMT assembly and soldering in a Pb-free reflow process on the top side of the PCB. It is suggested that the minimum height of solder paste stencil is 130um to ensure sufficient solder volume. Pad openings of paste mask can be increased to ensure proper soldering and solder wetting over pads. It is suggested that peak reflow temperature is 235~245ºC (for SnAg3.0Cu0.5 alloy). Absolute max reflow temperature is 260ºC. 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.

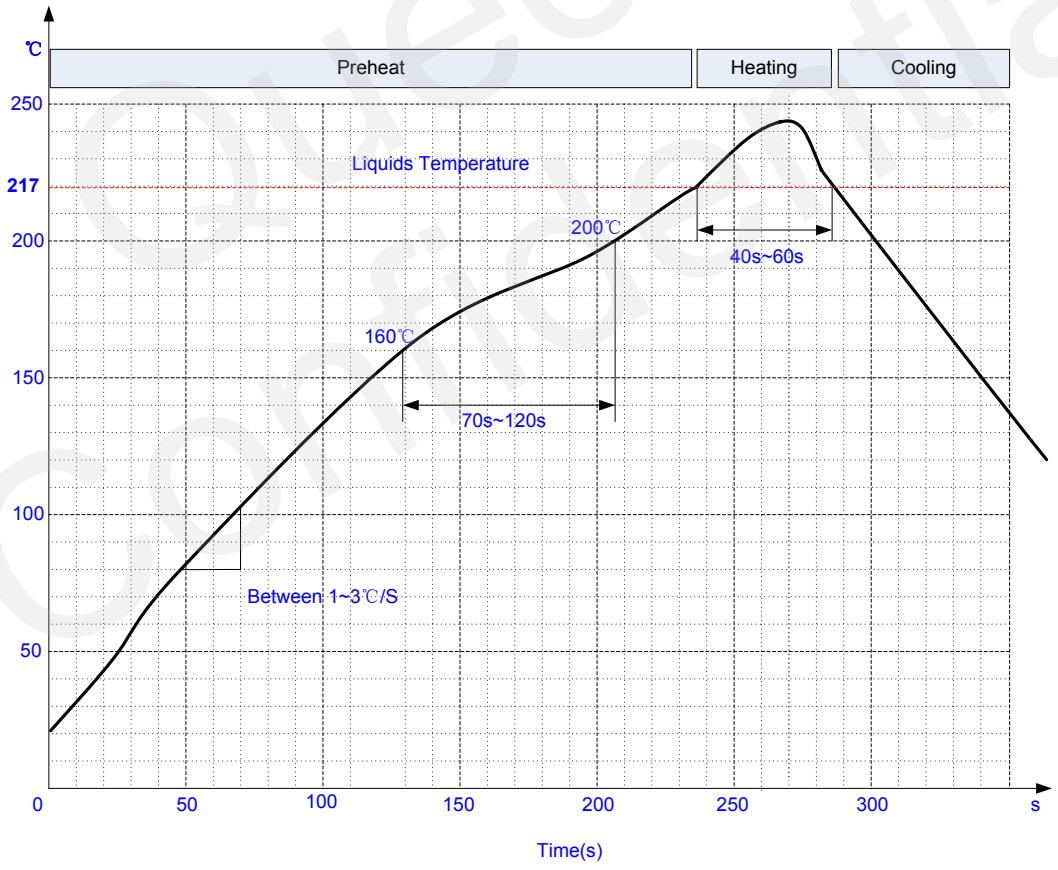

Figure 23: Ramp-soak-spike-reflow of Furnace Temperature

7.2. Moisture Sensitivity

L76 GNSS module is sensitivity to moisture absorption. To prevent L76 GNSS module 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.

L76 GNSS module 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. L76 GNSS module should be taken out before preheating, otherwise, the tray maybe damaged by high-temperature heating.

7.3. ESD Protection

L76 module is sensitive to ESD and requires special precautions when handling. Particular care must be exercised when handing patch antenna, duo to the risk of electrostatic charges.

7.4. Tape and Reel

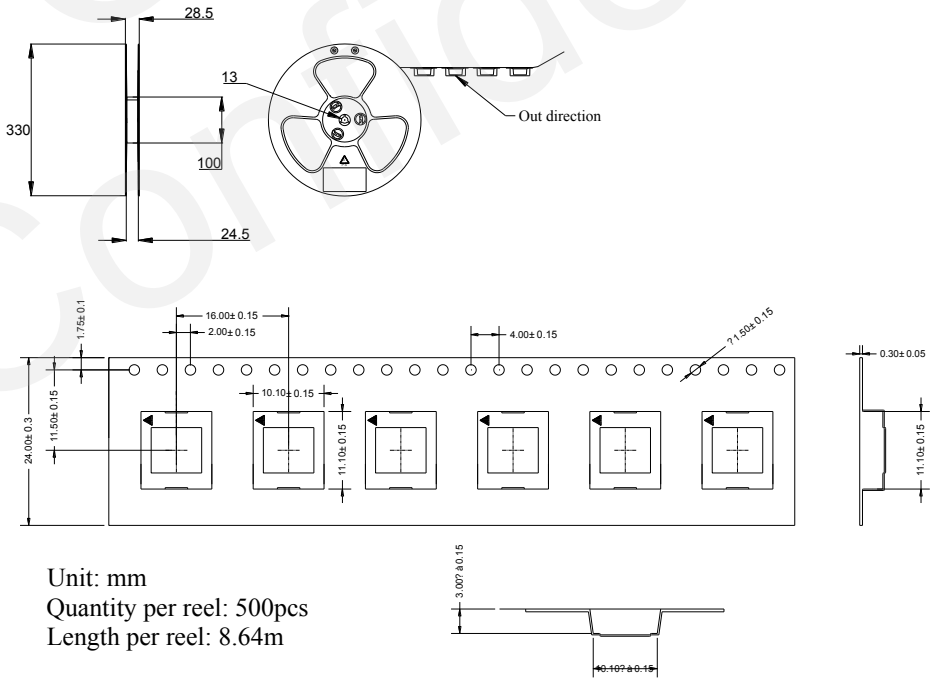

Figure 24: Tape and Reel Specification

Table 13: Tray Packing

Model Name	MOQ for MP	Minimum Package: 500pcs	Minimum Package x4=2000pcs
L76	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 14: Ordering Information

Model Name	Product Number	Ordering Code
L76	S2-W1087	L76-M33

8 Appendix Reference

Table 15: Related Documents

SN	Document Name	Remark
[1]	Quectel_L76_EVB _User Guide	L76 EVB User Guide
[2]	Quectel_L76_GNSS_Protocol_Specification	L76 GNSS Protocol Specification
[3]	Quectel_L76_Reference_Design	L76 Reference Design

Table 16: Terms and Abbreviations

Abbreviation	Description
AGPS	Assisted GPS
AIC	Active Interference Cancellation
CEP	Circular Error Probable
DGPS	Differential GPS
EASY	Embedded Assist System
EGNOS	European Geostationary Navigation Overlay Service
EMC	Electromagnetic Compatibility
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 SYSTE
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
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
RTCM	Radio Technical Commission for Maritime Services
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