L76-LB Hardware Design

GNSS Module Series

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About the Document

History

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Contents

About the Document **2**
Contents **3**
Table Index **5**
Figure Index **6**

1 Introduction **7**

2 Product Concept **8**
2.1. General Description 8
2.2. Key Features 8
2.3. Block Diagram 10
2.4. Evaluation Board 10
2.5. Protocols Supported by the Module 11

3 Application Interfaces **12**
3.1. Pin Assignment 12
3.2. Pin Description 13
3.3. Power Supply 15
3.4. Operation Modes 16
3.4.1. Full on Mode 17
3.4.2. Standby Mode 18
3.4.3. Backup Mode 18
3.4.4. Periodic Mode 20
3.4.5. AlwaysLocate™ Mode 22
3.5. Reset 23
3.6. UART Interface 24
3.7. I2C Interface 26
3.8. EASY™ Autonomous AGPS Technology 27
3.9. EPO Offline AGPS Technology 27
3.10. Multi-tone AIC 27
3.11. ANTON 28
3.12. LOCUS 28
3.13. PPS VS. NMEA 29

4 Antenna Interfaces **30**
4.1. Antenna Specifications 30
4.2. Recommended Circuit for Antenna 31
4.2.1. Active Antenna 31
4.2.2. Passive Antenna 33

5 Electrical, Reliability and Radio Characteristics **35**
5.1. Absolute Maximum Ratings 35
5.2. Operating Conditions 36
5.3. Current Consumption 36

5.4. Reliability Test 37
5.5. ESD Protection 37

6 Mechanical Dimensions 39
6.1. Top and Side Dimensions of the Module 39
6.2. Bottom Dimensions and Recommended Footprint 40
6.3. Top and Bottom View of the Module 41

7 Storage, Manufacturing and Packaging 42
7.1. Storage 42
7.2. Manufacturing and Soldering 43
7.3. Tape and Reel Packaging 44

8 Appendix References 46

Table Index

TABLE 1: KEY FEATURES 8
TABLE 2: SUPPORTED PROTOCOLS 11
TABLE 3: PIN DESCRIPTION 13
TABLE 4: PIN DESCRIPTION 13
TABLE 5: MODULE MODE SWITCH 16
TABLE 6: DEFAULT CONFIGURATIONS 17
TABLE 7: PMTK COMMAND FORMAT 20
TABLE 8: UART INTERFACE 24
TABLE 9: RECOMMENDED ANTENNA SPECIFICATIONS 30
TABLE 10: ABSOLUTE MAXIMUM RATINGS 35
TABLE 11: POWER SUPPLY RATINGS 36
TABLE 12: CURRENT CONSUMPTION 36
TABLE 13: RELIABILITY TEST 37
TABLE 14: REEL PACKAGING 45
TABLE 15: RELATED DOCUMENTS 46
TABLE 16: TERMS AND ABBREVIATIONS 46

Figure Index

FIGURE 1: BLOCK DIAGRAM 10
FIGURE 2: PIN ASSIGNMENT 12
FIGURE 3: INTERNAL POWER CONSTRUCTION 16
FIGURE 4: RTC SUPPLY FROM NON-CHARGEABLE BATTERY 19
FIGURE 5: REFERENCE CHARGING CIRCUIT FOR RECHARGEABLE BATTERIES 20
FIGURE 6: PERIODIC MODE 21
FIGURE 7: ALWAYSLOCATE™ MODE POWER CONSUMPTION 23
FIGURE 8: REFERENCE RESET CIRCUIT USING OC CIRCUIT 24
FIGURE 9: RESET TIMING 24
FIGURE 10: CONNECTION OF SERIAL INTERFACES 25
FIGURE 11: RS-232 LEVEL SHIFT CIRCUIT 25
FIGURE 12: REFERENCE DESIGN FOR I2C INTERFACE 26
FIGURE 13: PPS VS. NMEA TIMING 29
FIGURE 14: REFERENCE DESIGN WITH ACTIVE ANTENNA 31
FIGURE 15: REFERENCE DESIGN FOR ACTIVE ANTENNA WITH ANTON 32
FIGURE 16: REFERENCE DESIGN WITH PASSIVE ANTENNA 33
FIGURE 17: REFERENCE DESIGN FOR PASSIVE ANTENNA WITH LNA 34
FIGURE 18: TOP AND SIDE DIMENSIONS (UNIT: MM) 39
FIGURE 19: BOTTOM DIMENSIONS (UNIT: MM) 40
FIGURE 20: RECOMMENDED FOOTPRINT (UNIT: MM) 40
FIGURE 21: TOP VIEW OF THE MODULE 41
FIGURE 22: BOTTOM VIEW OF THE MODULE 41
FIGURE 23: REFLOW SOLDERING THERMAL PROFILE 43
FIGURE 24: TAPE AND REEL SPECIFICATIONS 44

1 Introduction

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

This document helps customers quickly understand the interface specifications, as well as electrical and mechanical details of L76-LB module. Associated with documents such as L76-LB software application notes and user guides provided by Quectel, customers can make use of L76-LB module to design and set up mobile applications easily and quickly.

2 Product Concept

2.1. General Description

L76-LB module is a single receiver module integrated with GPS and BeiDou systems. It is able to achieve the industry's highest level of sensitivity, accuracy and TTFF with the lowest power consumption in a small lead-free package. The embedded flash memory provides capacity for storing user-specific configurations and allows for future updates.

The module supports multiple positioning and navigation systems including autonomous GPS, BeiDou, SBAS (including WAAS, EGNOS, MSAS and GAGAN), QZSS and AGPS.

Embedded with many advanced power saving modes including periodic, AlwaysLocate™, standby and backup, L76-LB module is of excellently low-power consumption in different scenes.

EASY technology as the key feature of L76-LB module is one kind of AGPS. Capable of collecting and processing all internal aiding information like GPS time, ephemeris, last position, etc., the GNSS module delivers a very short TTFF in either Hot or Warm start.

L76-LB module is an SMD type module with a compact 10.1mm × 9.7mm × 2.5mm form factor. It can be embedded in customers' applications through the 18-pin pad. It provides necessary hardware interfaces for connection with the main PCB.

The module is fully compliant with the RoHS directive of the European Union.

2.2. Key Features

Table 1: Key Features

Features	Implementation
Receiver Type	● GPS L1 C/A (1575.42±1.023MHz) ● BeiDou B1 C/A (1561.098±2.046MHz)
Power Supply	● Supply voltage: 2.8V~4.3V ● Typical: 3.3V

Power Consumption	**GPS:** ● Tracking: 24.1mA@-130dBm, VCC=3.3V ● Acquisition: 25.6mA@-130dBm, VCC=3.3V ● Standby: 0.6mA@-130dBm, VCC=3.3V ● Backup: 7uA@-130dBm, VCC=3.3V **GPS+BeiDou:** ● Tracking: 30.3mA@-130dBm, VCC=3.3V ● Acquisition: 31.6mA@-130dBm, VCC=3.3V ● Standby: 0.6mA@-130dBm, VCC=3.3V ● Backup: 7uA@-130dBm, VCC=3.3V
Sensitivity	● Acquisition: -148dBm ● Reacquisition: -163dBm ● 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)	● <2.5m CEP @-130dBm
Update Rate	● 1Hz by default, maximally up to 10Hz
Accuracy of 1PPS Signal	● Typical accuracy <10ns ● Time pulse width 100ms
Velocity Accuracy	● Without aid: 0.1m/s
Acceleration Accuracy	● Without aid: 0.1m/s²
Dynamic Performance	● Maximum Altitude: 18,000m ● Maximum Velocity: 515m/s ● Acceleration: 4G
UART Port	● UART port: TXD1 and RXD1 ● Supports baud rates from 4800bps to 115200bps; 9600bps by default ● Used for NMEA output, PMTK/PQ commands input and firmware upgrade
I2C	● Supports fast mode, with bit rate up to 400kbps ● Supports 7-bit address ● Outputs NMEA data by default when reading; it can also receive PMTK/PQ commands by I2C bus.
Temperature Range	● Normal operation: -40°C ~ +85°C ● Storage temperature: -40°C ~ +90°C

Physical Characteristics	● Size: (10.1±0.15)mm × (9.7±0.15)mm × (2.5±0.20)mm ● Weight: Approx. 0.5g

2.3. Block Diagram

The following figure shows the block diagram of L76-LB, including an LNA, a SAW filter, a TCXO, a crystal oscillator and a single-chip GNSS IC comprising RF and Baseband parts.

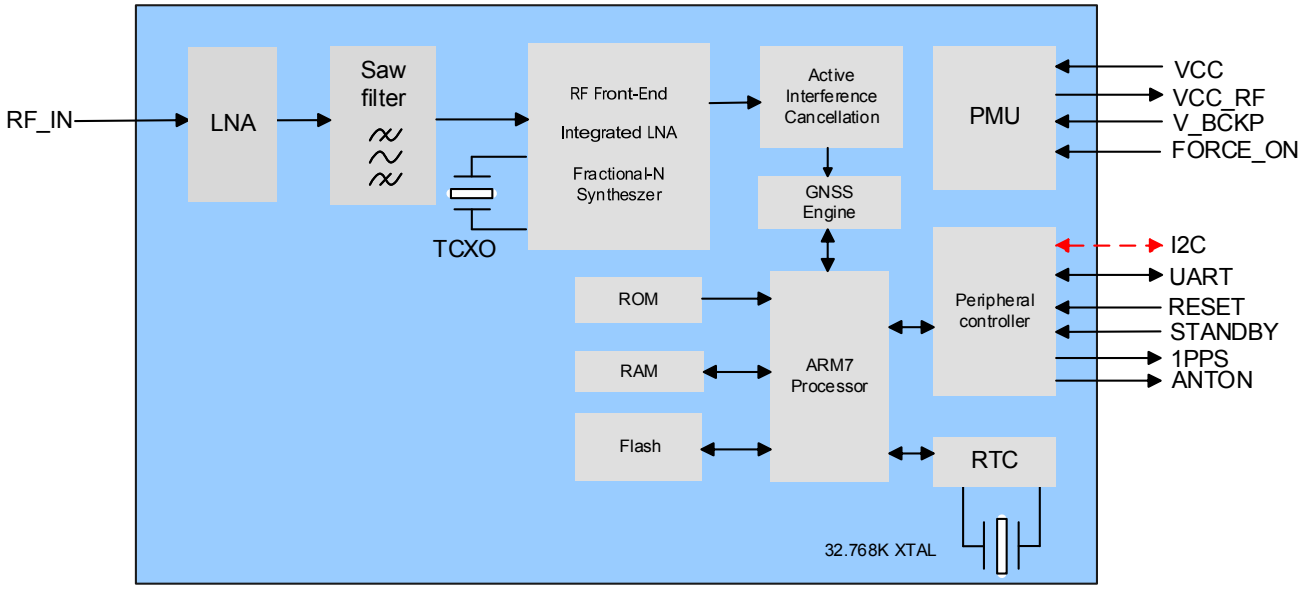

Figure 1: Block Diagram

2.4. Evaluation Board

In order to help with the application of L76-LB, Quectel supplies an Evaluation Board (EVB), a Micro-USB cable, an active antenna and other peripherals to test the module. For more details, please refer to ***document [1]***.

2.5. Protocols Supported by the Module

Table 2: Supported Protocols

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

NOTES

1. Please refer to ***document [2]*** for details of NMEA standard protocol and MTK proprietary protocol.
2. Please refer to ***document [6]*** for details of Quectel proprietary protocol.

3 Application Interfaces

L76-LB is equipped with 18 LCC pins that connect to customers' application platform. Sub-interfaces included in the pad are described in details in the following chapters.

3.1. Pin Assignment

Figure 2: Pin Assignment

3.2. Pin Description

Table 3: Pin Description

Type	Description
IO	Bidirectional
DI	Digital input
DO	Digital output
PI	Power input
PO	Power output
AI	Analog input
AO	Analog output

Table 4: Pin Description

Power Supply					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
VCC	8	PI	Main power supply	Vmax=4.3V Vmin=2.8V Vnorm=3.3V	Assure load current no less than 150mA
V_BCKP	6	PI	Backup power supply	Vmax=4.3V Vmin=2V Vnorm=4V I_{V_BCKP}=7uA@Backup mode	Supply power for RTC domain when VCC is powered off.
Reset					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RESET	9	DI	Reset the module	V_{IL}min=-0.3V V_{IL}max=0.7V V_{IH}min=2.1V V_{IH}max= 3.1V	Active low. If unused, keep this pin open

UART Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RXD1	3	DI	Receive data from the TXD signal line of DTE	V_{IL}min=-0.3V V_{IL}max=0.7V V_{IH}min=2.1V V_{IH}max= 3.1V	UART Port is used for NMEA output, PMTK/PQ commands input and firmware upgrade.
TXD1	2	DO	Transmit data to the RXD signal line of DTE	V_{OL}max=0.42V V_{OH}min=2.4V V_{OH}norm=2.8V	
RF Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
VCC_RF	14	PO	Supply power for external RF component	Vmax=4.3V Vmin=2.8V Vnorm=3.3V	Usually supply power for external active antenna or LNA. If unused, keep this pin open. VCC_RF≈ VCC
RF_IN	11	AI	RF signal input		Characteristic Impedance of 50Ω
Other Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
ANTON	13	AO	External LNA control pin and active antenna power control pin in power save mode	V_{OL}max=0.42V V_{OH}min=2.4V V_{OH}norm=2.8V	If unused, keep this pin open.
STANDBY	5	DI	Used to enter into or exit from standby mode	V_{IL}min=-0.3V V_{IL}max=0.7V V_{IH}min=2.1V V_{IH}max=3.1V	It is pulled up internally. It is edge-triggered. If unused, keep this pin open.
1PPS	4	DO	One pulse per second	V_{OL}max=0.42V V_{OH}min=2.4V V_{OH}norm=2.8V	Synchronized at rising edge, and the pulse width is 100ms. If unused, keep this pin open.
FORCE_ ON	18	DI	Logic high will force wake up the module from backup	V_{IL}min=-0.3V V_{IL}max=0.7V V_{IH}min=2.1V V_{IH}max=3.1V	Keep this pin open or pulled low before entering into backup mode. It belongs to RTC domain.

			mode		If unused, keep this pin open.
I2C_SDA	16	IO	Data signal of I2C interface	V_{IL}min=-0.3V V_{IL}max=0.7V V_{IH}min=2.1V V_{IH}max= 3.1V V_{OL}max=0.42V V_{OH}min=2.4V V_{OH}norm=2.8V	The module can receive PMTK/PQ commands by I2C bus.
I2C_SCL	17	IO	Clock signal of I2C interface		

3.3. Power Supply

VCC pin supplies power for BB, RF, I/O and RTC domains. The load current of VCC pin varies according to the VCC voltage level, processor load and satellite acquisition. Typical VCC peak current is 50mA during GPS acquisition after powered up. So it is important to supply sufficient current to make the power clean and stable. Meanwhile, an LDO without built-in output high-speed discharge function should be selected to keep long output-voltage drop-down period. It is recommended to place a combination of decoupling capacitors (a 10uF decoupling capacitor and a 100nF decoupling capacitor) and a TVS nearby VCC pin.

V_BCKP pin supplies power for RTC domain. A cell battery with the combination of 4.7uF and 100nF capacitors nearby V_BCKP pin is recommended. The voltage of RTC domain ranges from 2.0V to 4.3V. In order to achieve better Time to First Fix (TTFF), RTC domain should be valid all the time. V_BCKP supplies power for SRAM memory in RTC domain which contains all the necessary GNSS 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 supplies power for not only PMU but also VCC_RF and RTC domain, while V_BCKP supplies power for RTC domain only. The two diodes in the following figure construct an OR gate to supply power for RTC domain. FORCE_ON pin belongs to RTC domain. The signal line marked in red in the following diagram can open and close the switch. The following operation will close or open the switch:

- The switch will be closed by default when VCC is supplying power (VCC off → on).
- Based on the above step, the switch will be opened through keeping FORCE_ON open (not connected) or low and sending PMTK command (full on → backup).
- Based on the above step, keeping FORCE_ON logic high can close the switch (backup → full on).

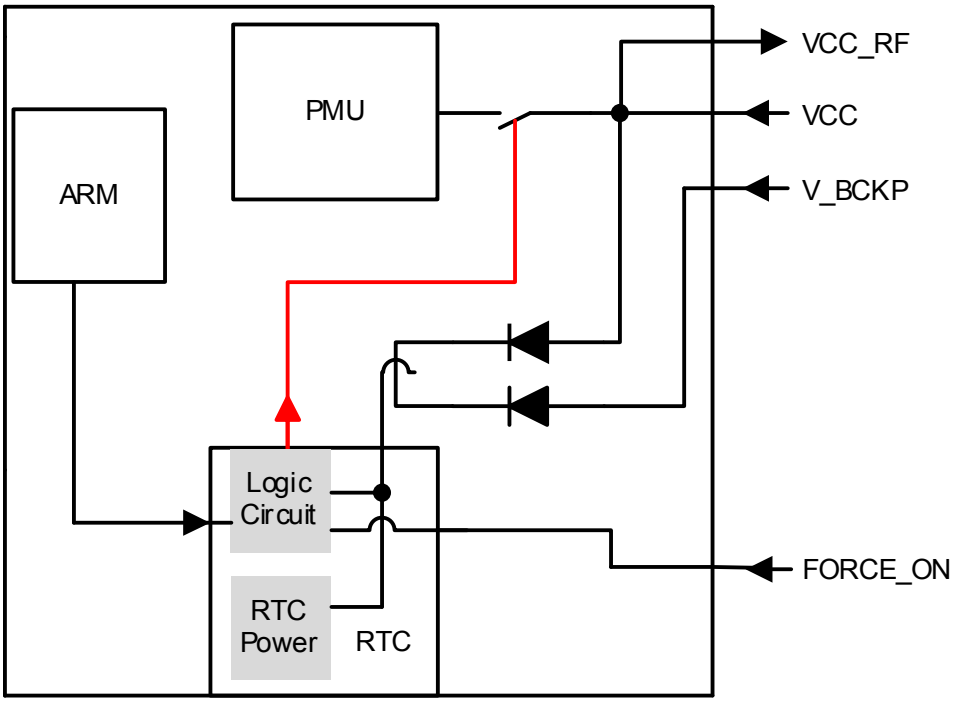

Figure 3: Internal Power Construction

3.4. Operation Modes

The table below briefly illustrates the relationship among different operation modes of L76-LB module.

Table 5: Module Mode Switch

Current Mode	Next Mode				
	Backup	**Standby**	**Full on**	**Periodic**	**AlwaysLocate**
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	PMTK225	PMTK225
Periodic	N/A	N/A	Refer to ***Chapter 3.4.4***	N/A	N/A

AlwaysLocate	N/A	N/A	Refer to ***Chapter 3.4.5***	N/A	N/A

NOTE

Please refer to ***document [2]*** for more details of MTK proprietary protocol (PMTK commands).

3.4.1. Full on Mode

Full on mode includes tracking mode and acquisition mode. Acquisition mode is defined as that in which the module starts to search satellites, determine visible satellites and coarse carrier frequency as well as code phase of satellite signals. When the acquisition is completed, it switches to tracking mode automatically. Tracking mode is defined as that in which the module tracks satellites and demodulates the navigation data from the specific satellites.

When the module is powered on (VCC is valid), the module will enter into full on mode automatically and follow the default configurations as below. Please refer to ***Chapter 3.3*** about internal power construction for better comprehension. PMTK commands can also be used to change the configuration to satisfy requirements.

Table 6: Default Configurations

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	EASY will be disabled automatically when update rate exceeds 1Hz.
GNSS	GPS+BeiDou	

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

When the module is powered on, the average current will rush to 50mA and last for a few seconds; then,

the current consumption will decrease to 25.6mA (GPS) or 31.6mA (GPS+BeiDou) and this state is defined as acquisition state which will last for several minutes until it switches to tracking state automatically. The consumption in tracking state is less than that in acquisition state and the value is 24.1mA (GPS) or 30.3mA (GPS+BeiDou).

The following PMTK commands can be used to switch among multiple positioning systems:

- $PMTK353,1,0,0,0,0*2A: search GPS satellites only
- $PMTK353,1,0,0,0,1*2B: search GPS and BeiDou 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, and the module stops satellites search and navigation. UART1 is still accessible through PMTK commands, 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 enter into standby mode and releasing STANDBY will make the module back to full on mode. Please note that pulling down STANDBY pin to ground will cause extra current consumption which will make the typical standby current reach up to about 600uA @VCC=3.3V.

- **Using PMTK command**: the module will enter into standby mode through PMTK command "$PMTK161,0*28". Sending any data via UART1 will make the module exit from standby mode as UART1 is still accessible in standby mode. When the module exits from standby mode, it will use all internal aiding information such as GNSS time, ephemeris, last position, resulting to the fastest possible TTFF in either Hot or Warm start. The typical current consumption is about 500uA @VCC=3.3V in standby mode.

NOTE

It is recommended to set the host GPIO which controls STANDBY pin as input before turning on the module to avoid entering into standby mode unexpectedly when starting the module due to its edge-triggered characteristic. After that, GPIO can be reset as output to control the STANDBY pin. If STANDBY is unused, keep it open.

3.4.3. Backup Mode

Power consumption in backup mode is lower than that in standby mode. In this mode, the module stops acquiring and tracking satellites. UART is not accessible. But the backup memory in RTC domain which contains all the necessary GNSS information for quick start-up and a small amount of user configuration variables is active. Due to the backup memory, EASY technology is available. The current consumption in

this mode is about 7uA.

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

- Send command “$PMTK225,4*2F” (the red signal line opens the switch in ***Figure 3***) to enter into backup mode constantly. The only way to wake up the module is by pulling FORCE_ON pin high (the red signal line closes the switch in ***Figure 3***).

- Cut off the power of VCC and keep V_BCKP powered to enter into backup mode from full on mode. As soon as the VCC pin is powered, the module will enter into full on mode immediately.

NOTE

Keep FORCE_ON pin open or low before entering into backup mode, otherwise, the backup mode will be unavailable.

For details about internal power construction, please refer to ***Chapter 3.3***. Power can be supplied through V_BCKP pin with an external capacitor or battery (rechargeable or non-chargeable). Please refer to the following figure for RTC backup reference design.

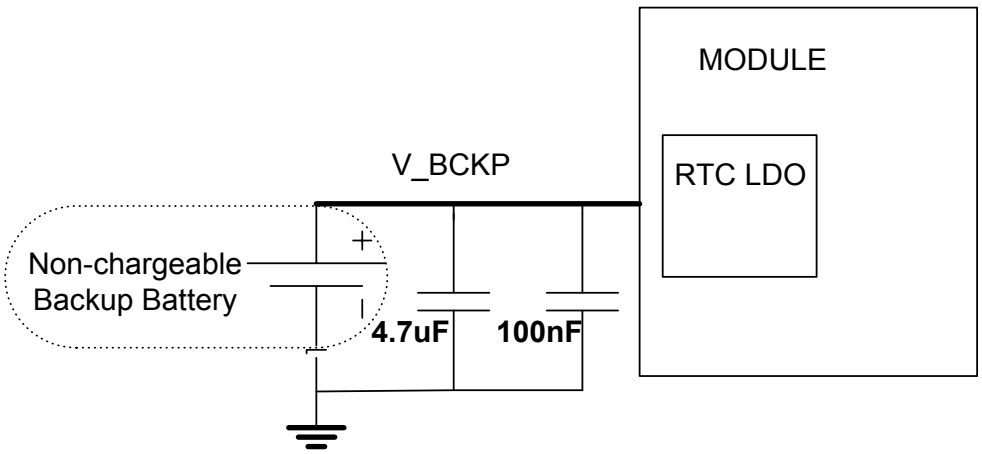

Figure 4: RTC Supply from Non-chargeable Battery

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

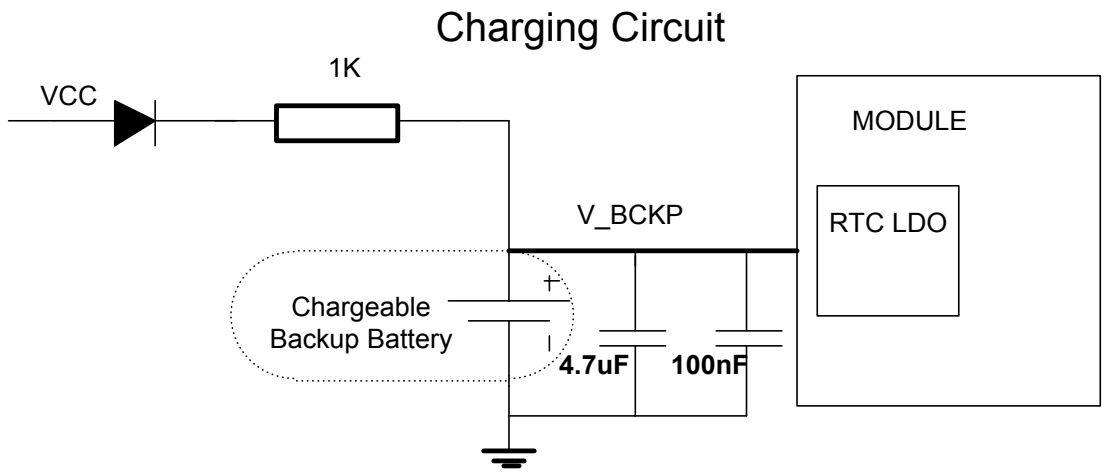

Figure 5: Reference Charging Circuit for Rechargeable Batteries

Coin-type Rechargeable Capacitor from Seiko (http://www.sii.co.jp/en/) can be used and Schottky diode from ON Semiconductor (http://www.onsemi.com/) is recommended to be used here for its low voltage drop.

3.4.4. Periodic Mode

Periodic mode is a mode that switches between full on mode and standby/backup mode periodically to reduce power consumption. It contains periodic standby mode and periodic backup mode.

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

Table 7: 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 periodic backup mode **Type=2** for periodic standby mode
Run_time	Decimal	**Run_time**=Full on mode period (ms)
Sleep_time	Decimal	**Sleep_time**=Standby/Backup mode period (ms)
2nd_run_time	Decimal	**2nd_run_time**=Full on mode period (ms) for extended acquisition in case module's acquisition fails during the **Run_time**
2nd_sleep_time	Decimal	**2nd_sleep_time**=Standby/Backup mode 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 enter into full on mode from Periodic standby mode.

Pulling the FORCE_ON high and sending “$PMTK225,0*2B” immediately will make the module enter into full on mode from Periodic backup mode.

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

NOTES

1. It is recommended to set the host GPIO which controls STANDBY pin as input before turning on the module to avoid entering into standby mode unexpectedly when starting the module due to its edge-triggered characteristic. After that, GPIO can be reset as output to control the STANDBY pin. If STANDBY pin is unused, keep it open.
2. Keep FORCE_ON pin open or low before entering into periodic backup mode, otherwise, the periodic backup mode will be unavailable.

The following figure illustrates the operation of periodic mode. When PMTK command is sent, the module is in the full on mode firstly. After several minutes, the module will enter into periodic mode and operate according to the parameters set in the PMTK command. When the module fails to fix the position in **run time**, the module will switch to the second run and sleep time automatically. As long as the module fixes the position again, the module will return to first run and sleep time.

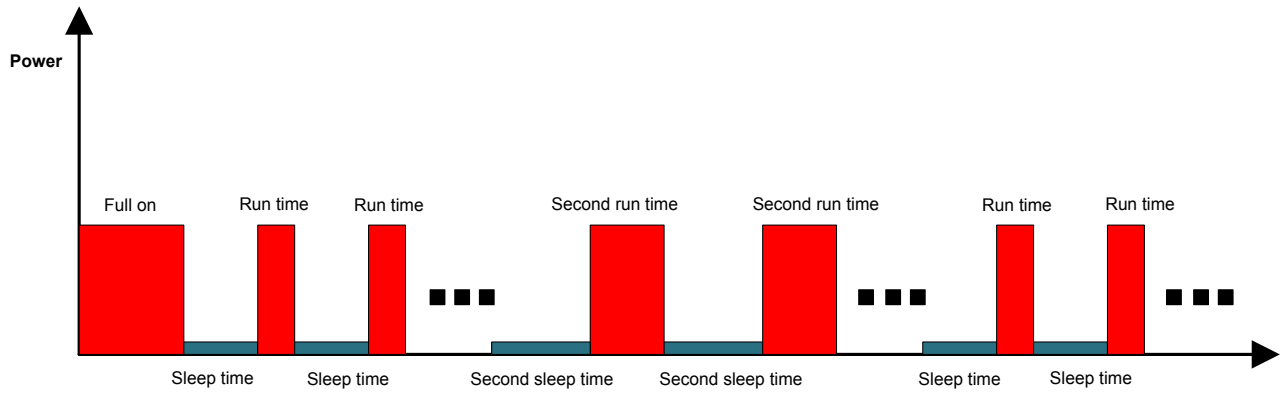

Figure 6: Periodic Mode

Before entering into periodic mode, please assure the module is in tracking mode, otherwise there will be a risk of satellite-tracking failure. If GNSS module is located in weak signal environment, it is recommended to set a longer second run time to ensure the success of reacquisition.

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

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

Example

PMTK225,2,3000,12000,18000,72000*15 for periodic mode with 3s in tracking mode and 12s in standby mode based on GPS. The average current consumption is calculated below:
I periodic=(I tracking*T1+Istandby*T2)/(T1+T2)=(22mA*3s + 0.5mA*12s)/(3s+12s)≈4.8(mA)

PMTK225,1,3000,12000,18000,72000*16 for periodic mode with 3s in tracking mode and 12s in backup mode based on GPS. The average current consumption is calculated below:
I periodic=(I tracking*T1+Ibackup*T2)/(T1+T2)=(22mA*3s + 0.007mA*12s)/(3s+12s)≈4.4(mA)

3.4.5. AlwaysLocate™ Mode

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

AlwaysLocate™ standby mode allows 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 “$PMTK225,8*23” with the module returning “$PMTK001,225,3*35” means the module accesses AlwaysLocate™ standby mode successfully. This mode will facilitate power saving. Sending “$PMTK225,0*2B” in any time will return the module back to full on mode.

AlwaysLocate™ backup mode is similar to 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 when the module is in high speed. The following picture shows the power consumption in different scenes.

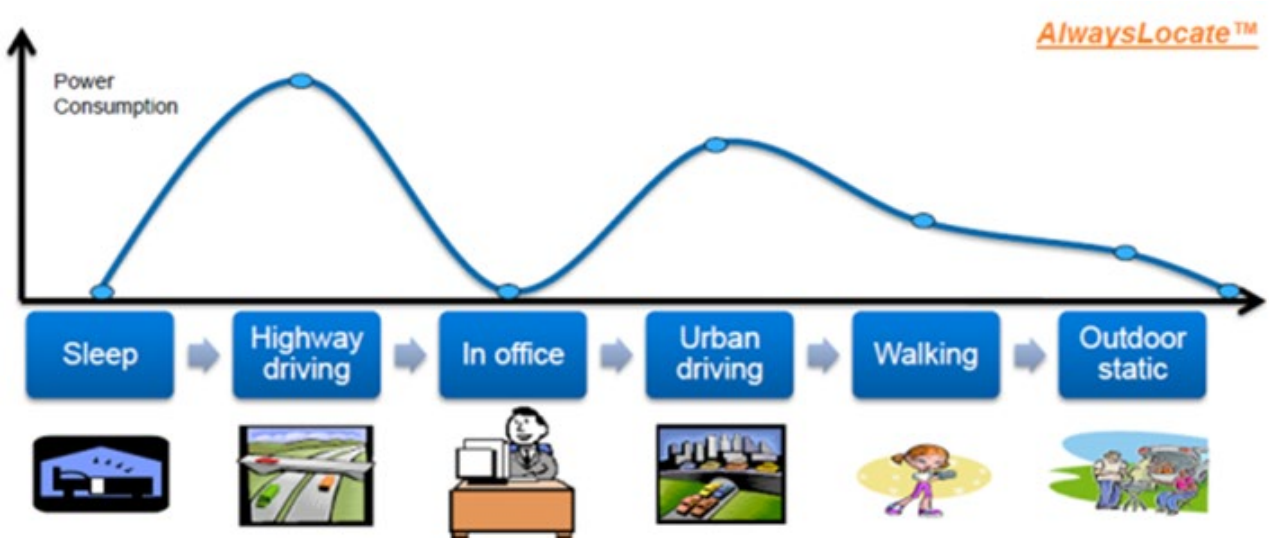

Figure 7: AlwaysLocate™ Mode Power Consumption

Example

The average consumption of the module when located outdoors and equipped with an active antenna in static is about 2.7mA after tracking satellites in AlwaysLocate™ standby mode based on GPS.

The average consumption of the module when located outdoors and equipped with an active antenna in static is about 2.6mA after tracking satellites in AlwaysLocate™ backup mode based on GPS.

NOTES

1. It is recommended to set the host GPIO which controls STANDBY pin as input before turning on the module to avoid entering into standby mode unexpectedly when starting the module due to its edge-triggered characteristic. After that, GPIO can be reset as output to control the STANDBY pin. If STANDBY pin is unused, keep it open.
2. Keep FORCE_ON pin open or low before entering into AlwaysLocate™ backup mode, otherwise, the AlwaysLocate™ backup mode will be unavailable.

3.5. Reset

L76-LB module can be reset by releasing RESET pin after driving it to a low level voltage. This action will force volatile RAM data loss. Please 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.

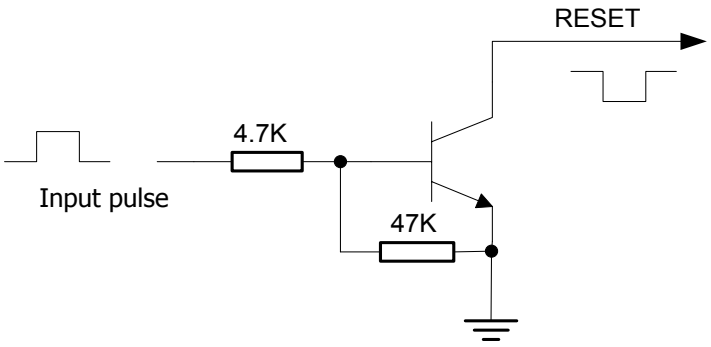

Figure 8: Reference Reset Circuit Using OC Circuit

The following picture shows the timing of L76-LB module.

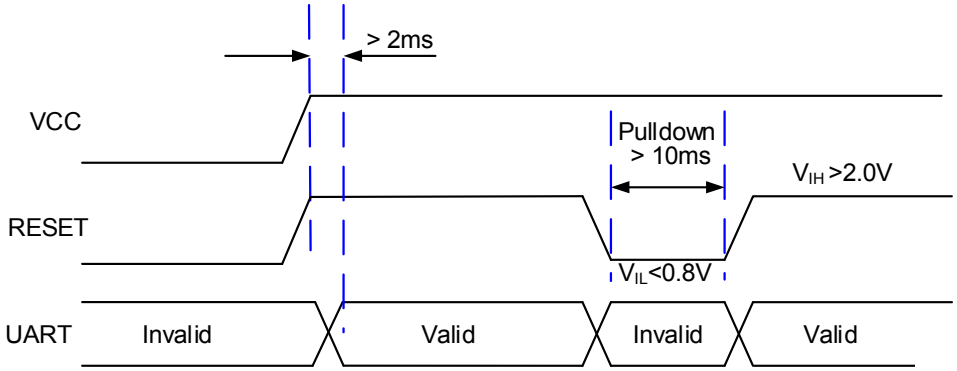

Figure 9: Reset Timing

3.6. UART Interface

The module provides one universal asynchronous receiver & transmitter serial port and is designed as DCE (Data Communication Equipment) following the traditional DCE-DTE (Data Terminal Equipment) connection. It supports baud rate from 4800bps to 115200bps.

Table 8: UART Interface

Pin Name	Pin No.	I/O	Description	Comment
TXD1	2	DO	Transmit data to the RXD signal line of DTE	UART port is used for NMEA output, PMTK/PQ commands input and firmware upgrade.
RXD1	3	DI	Receive data from the TXD signal line of DTE	

The following figure shows the connection between DCE and DTE.

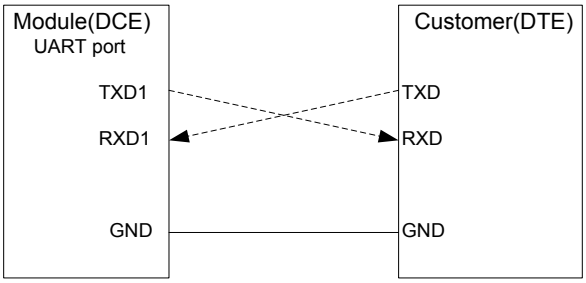

Figure 10: Connection of Serial Interfaces

Features of UART port are as follows:

- The UART port can be used for firmware upgrade, NMEA output and PMTK/PQ command input.
- The default output NMEA output type setting is RMC, VTG, GGA, GSA, GSV and GLL.
- UART port supports the following data rates: 4800bps, 9600bps, 14400bps, 19200bps, 38400bps, 57600bps, 115200bps.
  The default baud rate 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 in between. Please refer to the following figure.

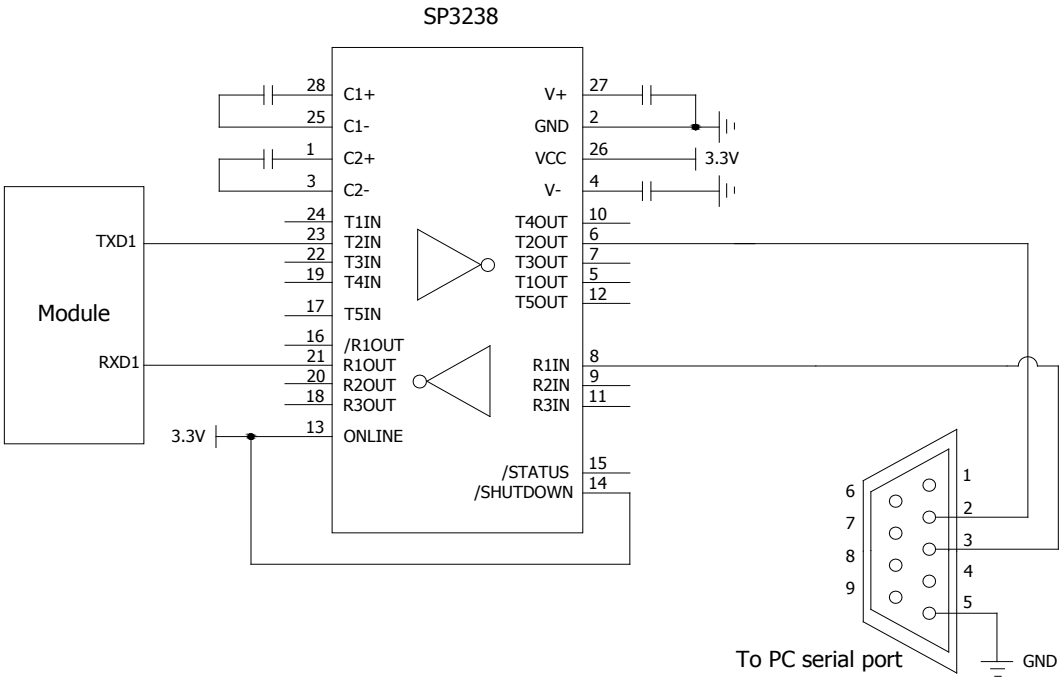

Figure 11: RS-232 Level Shift Circuit

NOTE

GNSS modules output more data than single GPS systems. The default baud rate (9600bps) of the module is enough to transmit GNSS NMEA. If the baud rate has to be set to 4800bps, then it is recommended to decrease the NMEA output types so as to avoid possible data loss.

3.7. I2C Interface

L76-LB provides an I2C interface and it receives PMTK/PQ commands by I2C bus.

Features of the I2C interface are as follows:

- Support fast mode, with bit rate up to 400kbps.
- Support 7-bit address.
- Work on slave mode.
- Default I2C address values are Write: 0x20, Read: 0x21.

For more details, please refer to the ***document [5]***.

The following circuit is an example of connection.

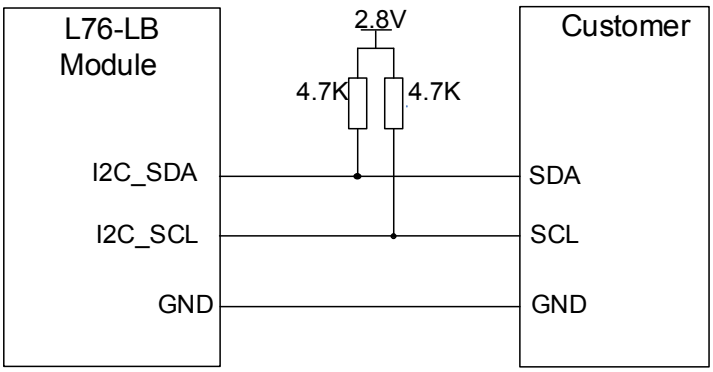

Figure 12: Reference Design for I2C Interface

NOTES

1. The voltage threshold of I2C is 2.8V. If the system voltage does not conform to it, a level shifter circuit must be used.
2. I2C interface is supported only in firmware of versions ended with “SC” and NEMA data should be outputted via I2C interface rather than UART interface, otherwise there may be NEMA data loss. For firmware in which I2C interface is not supported, I2C_SDA and I2C_SCL pins are used for RTCM data output.

3.8. EASY™ Autonomous AGPS Technology

L76-LB supports EASY technology that supplies assistant information such as ephemeris, almanac, rough last position, time, and satellite status that helps to improve TTFF and acquisition sensitivity of GNSS modules.

EASY technology works as embedded software which accelerates TTFF by predicting satellite navigation messages from received ephemeris. The GNSS engine will calculate and predict orbit information automatically up to following 3 days after receiving the broadcast ephemeris for the first time and saving the predicted information into the internal memory. GNSS engine will use the information for positioning in the case of no enough information from satellites. Thus, the function improves positioning and TTFF.

The EASY function reduces TTFF to 5s in warm start. In this case, RTC domain should be valid. In order to obtain enough broadcast ephemeris information from GNSS satellites, the GNSS module should receive the information for at least 5 minutes in environment with strong signal after it fixes the position.

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

3.9. EPO Offline AGPS Technology

L76-LB module features a function called EPO (Extended Prediction Orbit) which is a world leading technology that supports 30-day orbit predictions to customers. Occasional download from the EPO server is needed. For more details, please refer to the ***document [4].***

3.10. Multi-tone AIC

L76-LB module features a function called multi-tone AIC (Active Interference Cancellation) to decease harmonic of RF noise from Wi-Fi, Bluetooth, 2G, 3G and 4G.

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. Enabling AIC function will increase about 1mA @VCC=3.3V consumption. The following commands can be used to set AIC function.

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

3.11. ANTON

L76-LB module provides a pin called ANTON which is related to module state. Its voltage level will change in different module states.

- When the module works in full on mode, this pin is at high level.
- While working in standby mode, backup mode, AlwaysLocate™ mode, and during the sleep time in periodic mode, this pin is at low level.

Based on this characteristic, the ANTON pin can be used to control the power supply of active antenna or the enable the 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***.

3.12. LOCUS

The L76-LB module supports the embedded logger function called LOCUS that is able to 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 switch to sleep mode to save power consumption and does not need to receive the NMEA information all the time. The module provides a log capacity of more than 16 hours.

The detail procedures of this function are illustrated below:

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

The raw data which MCU gets has to be parsed via LOCUS parsing code provided by Quectel. For more details, please contact Quectel technical supports.

3.13. PPS VS. NMEA

Pulse per Second (PPS) VS. NMEA can be used for time service. The latency range of the beginning of UART Tx is between 465ms and 485ms, and after the rising edge of PPS.

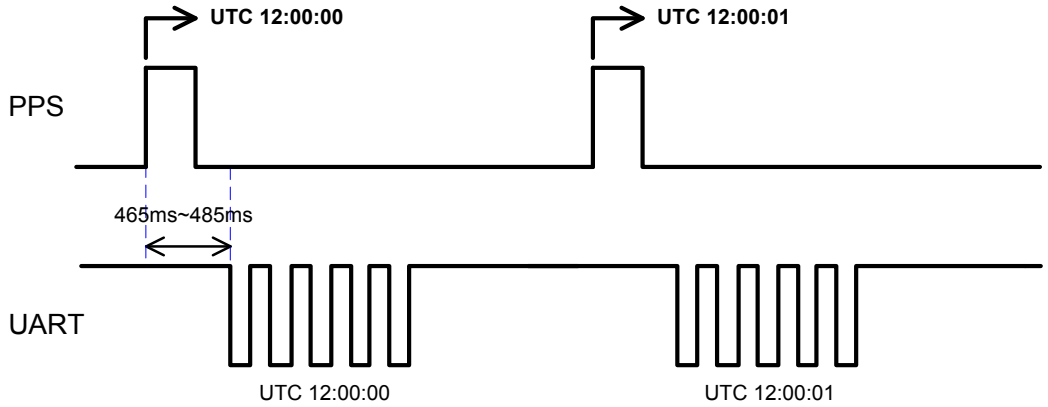

Figure 13: PPS VS. NMEA Timing

The feature only supports 1Hz NMEA output and baud rate from 14400bps to 115200bps. When the baud rate is 9600bps or 4800bps, only RMC NMEA sentence output is supported. This function is enabled by sending “$PMTK255,1*2D”, and disabled by sending “$PMTK255,0*2C”.

4 Antenna Interfaces

L76-LB module supports both GPS and BeiDou systems. The RF signal is obtained from the RF_IN pin. The impedance of RF trace should be controlled to 50Ω, and the trace length should be kept as short as possible.

4.1. Antenna Specifications

The L76-LB module can be connected to a dedicated GPS/BeiDou passive or active antenna to receive GPS/BeiDou satellite signals. The recommended antenna specifications are given in the following table.

Table 9: Recommended Antenna Specifications

Antenna Type	Specification
Passive Antenna	Frequency Range: 1559MHz-1609 MHz VSWR: <2 (Typ.) Polarization: RHCP or Linear Gain: >0dBi
Active Antenna	Frequency Range: 1559MHz-1609 MHz VSWR: <2 (Typ.) Polarization: RHCP or Linear Noise figure: <1.5dB Gain (antenna): >0 dBi Gain (embedded LNA): <17dB (Typ.)

4.2. Recommended Circuit for Antenna

Both active and passive antennas can be used for L76-LB 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.

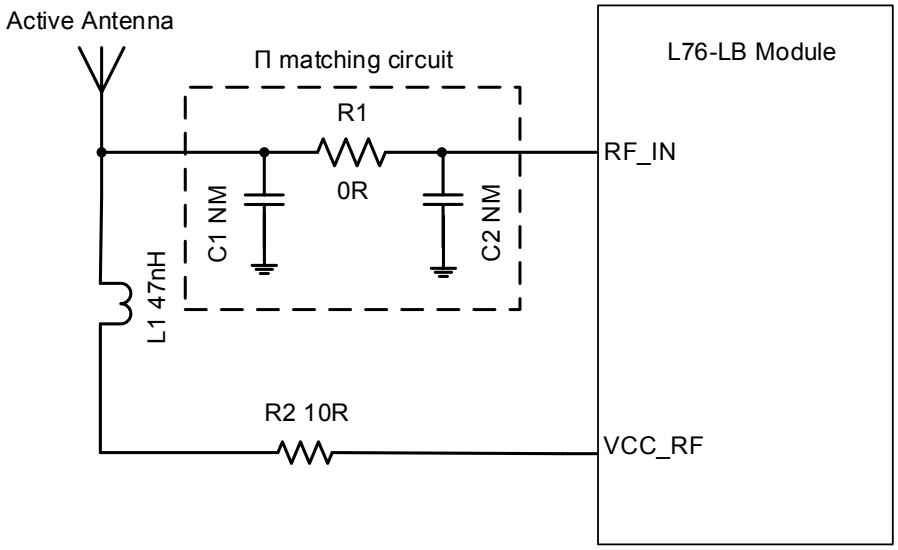

Figure 14: Reference Design with Active Antenna

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

L76-LB module provides power supply for external active antenna by VCC_RF. The voltage ranges from 2.8V to 4.3V, and the typical value is 3.3V. If the VCC_RF voltage does not meet the 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-LB module can also reduce power consumption by controlling the power supply of active antenna through the ANTON pin.

The reference circuit for active antenna with ANTON function is given as below.

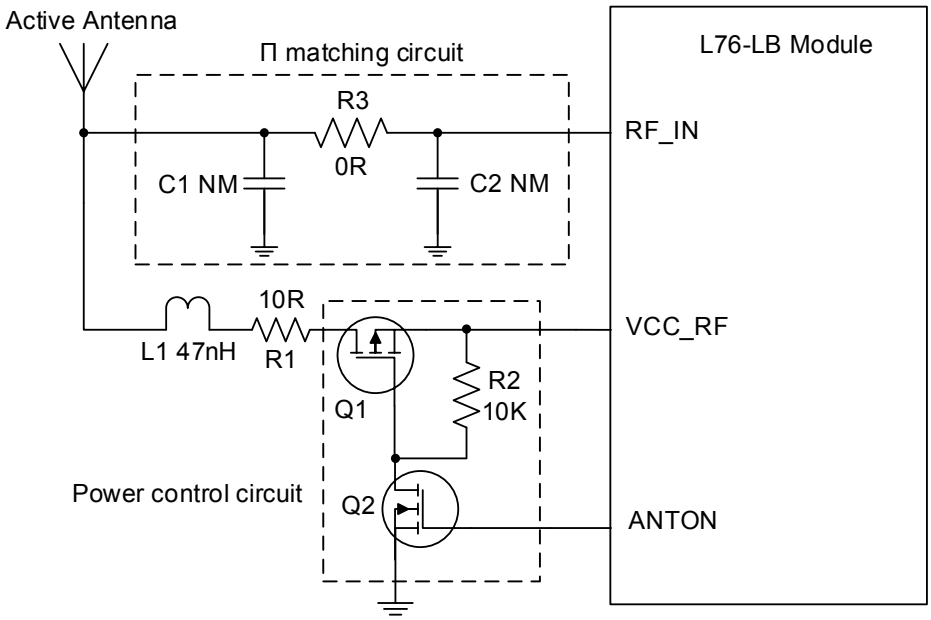

Figure 15: Reference Design for Active Antenna with ANTON

ANTON is an optional pin which can be used to control the power supply of the active antenna. When 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 turn Q1 and Q2 to the on-state and VCC_RF will supply power for the active antenna. The high and low level of ANTON pin is determined by the module's state. Please refer to ***Chapter 3.11*** for more details. If unused, please keep ANTON pin open.

For minimizing the current consumption, the value of resistor R2 should not be too low, and the recommended value is 10kΩ.

4.2.2. Passive Antenna

4.2.2.1. Passive Antenna without External LNA

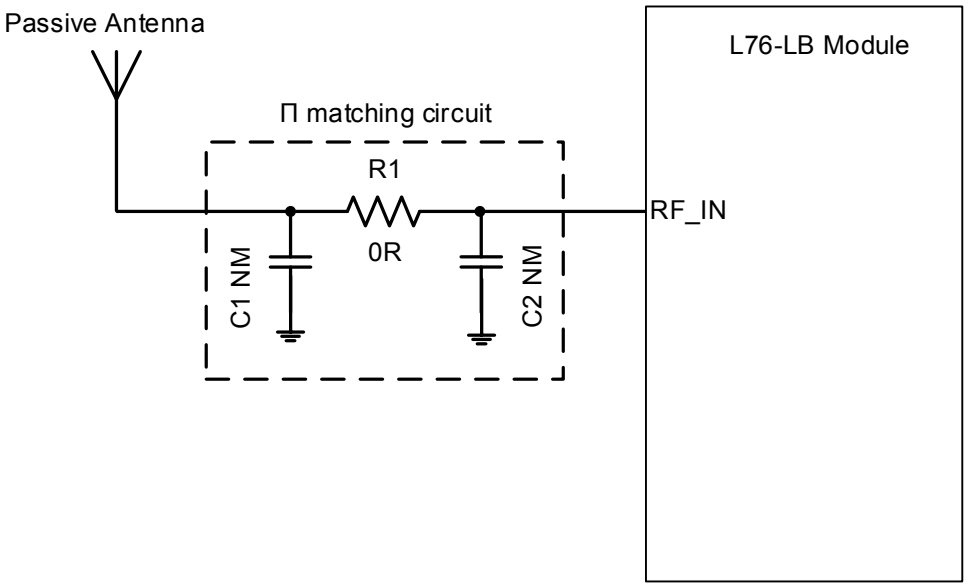

Figure 16: Reference Design with Passive Antenna

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

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

4.2.2.2. Passive Antenna with External LNA

In order to improve the receiver sensitivity and reduce the TTFF, an external LNA between the passive antenna and the L76-LB module is recommended. The reference design is shown as below.

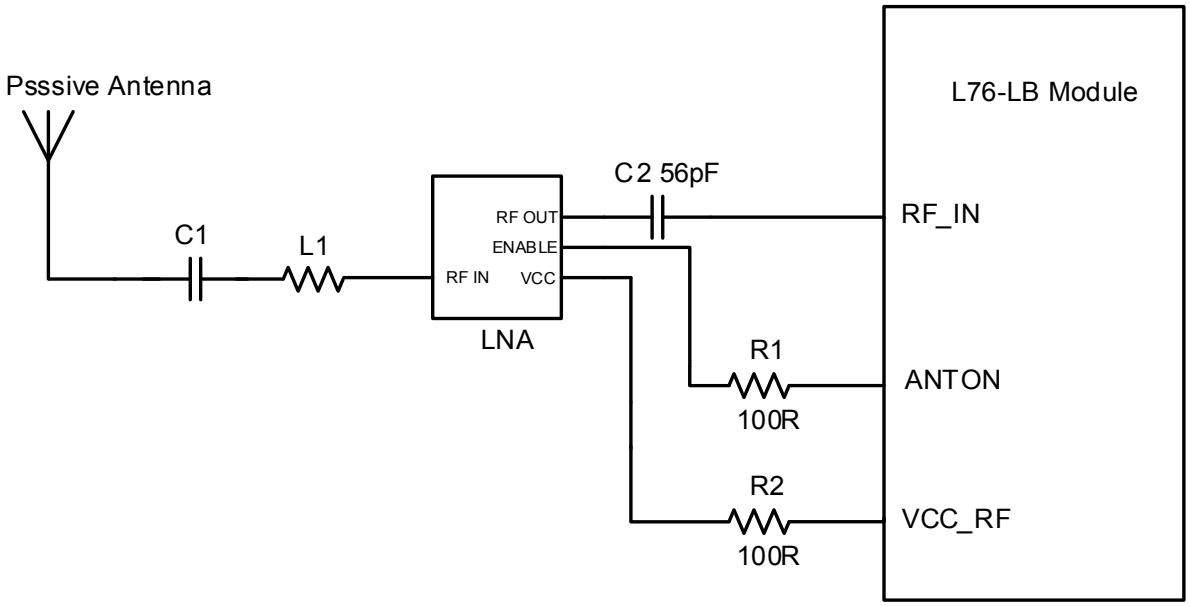

Figure 17: Reference Design for Passive Antenna with LNA

C1 and L1 are reserved for LNA impendence match, which you might optimize according to the LNA datasheet, the default value of C2 capacitor is 56pF. 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 GNSS system. LNA from Maxim (http://para.maximintegrated.com) or from Infineon (http://www.infineon.com) is recommended to be used in this case. For more details, please contact Quectel technical supports.
2. The power consumption will be reduced by controlling ENABLE pin of LNA through the ANTON pin of L76-LB module. If ANTON function is not used, please connect the ENABLE pin of LNA 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 10: 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
Input Voltage at Digital Pins	-0.3	3.6	V
Input Power at RF_IN (P_{RF_IN})		15	dBm
Storage Temperature	-40	90	°C

NOTE

Stressing the module beyond the absolute maximum ratings above may cause permanent damage. The product is not protected against over voltage or reversed voltage. Thus, it is necessary to utilize appropriate protection diodes to keep voltage spikes within the parameters given in the table above.

5.2. Operating Conditions

Table 11: Power Supply Ratings

Parameter	Description	Conditions	Min.	Typ.	Max.	Unit
VCC	Supply voltage	The actual input voltages must stay between the minimum and maximum values.	2.8	3.3	4.3	V
I_{VCCP}	Peak supply current	VCC=3.3V			150	mA
V_BCKP	Backup voltage supply		2	4	4.3	V
VCC_RF	Output voltage of RF section				VCC	V
T_{OPR}	Full on mode operating temperature		-40	+25	+85	°C

NOTES

1. All power-related values in the table above can be used to determine the maximum current capability of power supply.
2. Operation beyond the conditions above is not recommended and extended exposure beyond the operating conditions may affect module reliability.

5.3. Current Consumption

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

Table 12: Current Consumption

Module	Conditions	Acquisition @3.3V	Tracking @3.3V	Standby @3.3V	Backup @V_BCKP=3.3V
L76-LB	@-130dBm GPS	25.6mA	24.1mA	0.6mA	7uA
	@-130dBm GPS+BeiDou	31.6mA	30.3mA	0.6mA	7uA

NOTES

1. The power of the embedded LNA inside L76-LB will be cut off automatically once the module enters into standby mode or backup mode.
2. The VCC_RF current is not reckoned in above consumption.
3. The tracking current is tested in the following conditions:
   - In Cold Start, 15 minutes after First Fix.
   - In Hot Start, 15 seconds after First Fix.

5.4. Reliability Test

Table 13: 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

5.5. ESD Protection

L76-LB GNSS module is sensitive to ESD, so that ESD protection precautions should be emphasized. Proper ESD handling and packaging procedures must be applied throughout processing, handling and operation of any application that incorporates the module.

Please note that the following measures are good for ESD protection during module handling.

- The first contact point shall always be between the local GND and PCB GND when handling the PCB,

unless there is a galvanic coupling between the local GND and the PCB GND.

- Before mounting the RF_IN pad, please make sure the GND of the module has been connected.
- Do not contact any charged capacitors or materials which can easily generate or store charges (such as patch antenna, coax cable, soldering iron, etc.) when handling the RF_IN pad.
- To prevent electrostatic discharge from the RF input, please do not touch any exposed area of the mounted patch antenna.
- Make sure to use an ESD safe soldering iron (tip) when soldering the RF_IN pin.

6 Mechanical Dimensions

This chapter describes the mechanical dimensions of L76-LB module. All dimensions are measured in millimeter (mm). The tolerances for dimensions without tolerance values are ±0.05mm.

6.1. Top and Side Dimensions of the Module

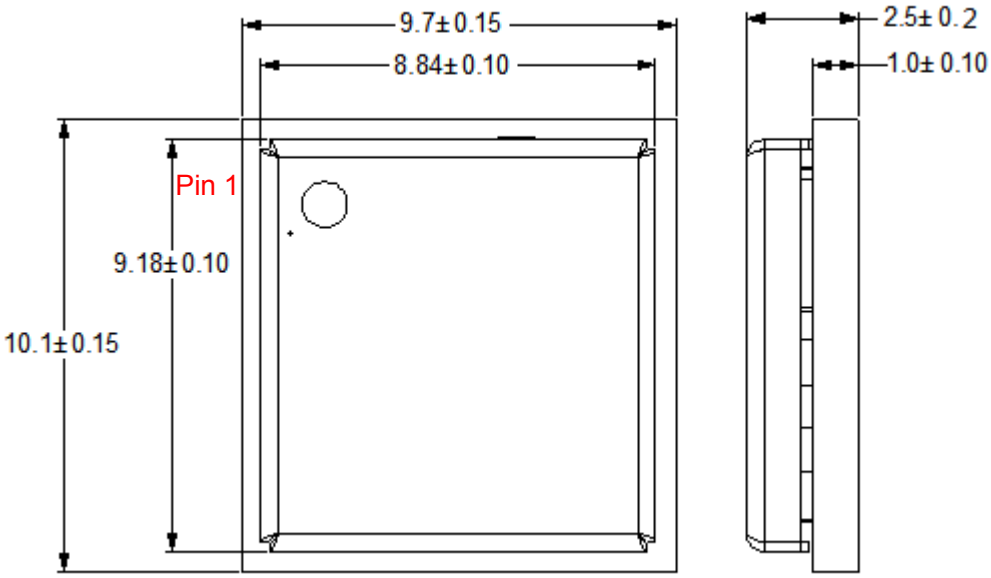

Figure 18: Top and Side Dimensions (Unit: mm)

6.2. Bottom Dimensions and Recommended Footprint

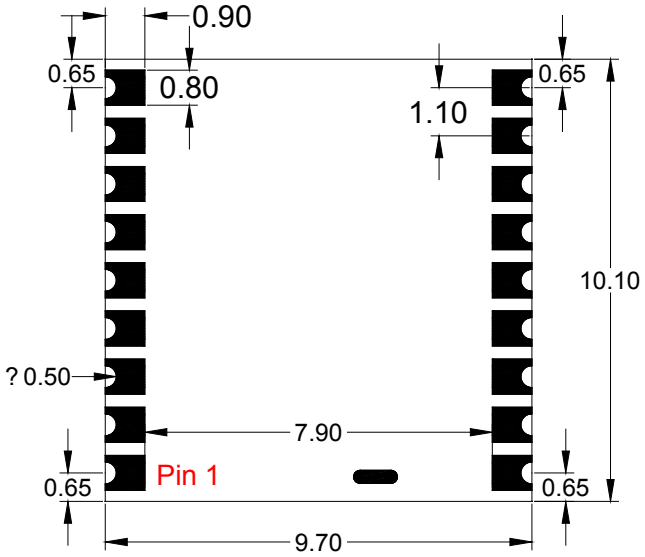

Figure 19: Bottom Dimensions (Unit: mm)

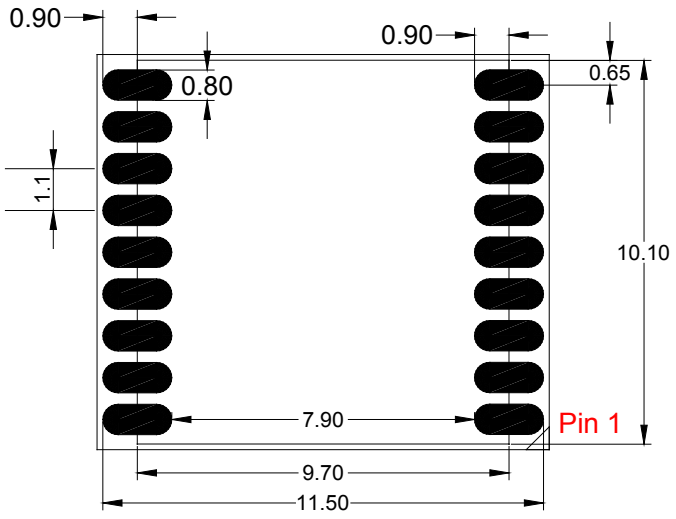

Figure 20: Recommended Footprint (Unit: mm)

NOTE

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

6.3. Top and Bottom View of the Module

Figure 21: Top View of the Module

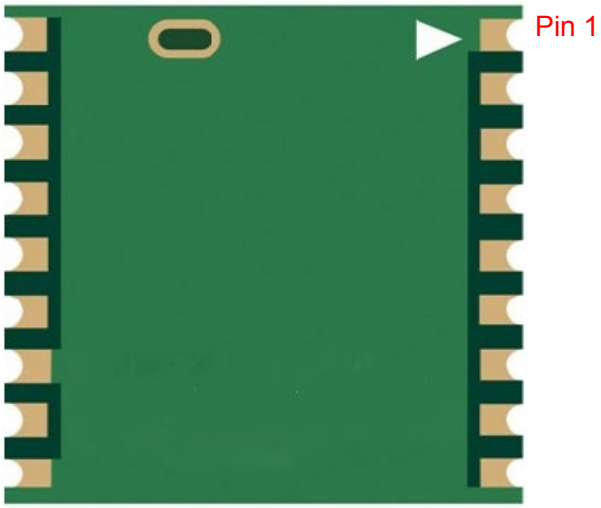

Figure 22: Bottom View of the Module

NOTES

1. These are renderings of L76-LB module. For authentic appearance, please refer to the module that you receive from Quectel.
2. The via on the bottom is for reference of the module's pin placement.

7 Storage, Manufacturing and Packaging

7.1. Storage

L76-LB is stored in a vacuum-sealed bag. It is rated at MSL 3, and its storage restrictions are shown as below.

1. Shelf life in the vacuum-sealed bag: 12 months at <40ºC/90%RH.

2. After the vacuum-sealed bag is opened, modules that will be subjected to reflow soldering or other high temperature processes must be:

   - Mounted within 168 hours at the factory environment of ≤30ºC/60%RH.
   - Stored at <10%RH.

3. Modules will need baking before mounting if any circumstance below occurs.

   - When the ambient temperature is 23ºC±5ºC and the humidity indication card shows the humidity is >10% before opening the vacuum-sealed bag.
   - Module mounting cannot be finished within 168 hours at factory conditions of ≤30ºC/60%RH.

4. If baking is required, modules may be baked for 8 hours at 120ºC±5ºC.

NOTE

As the plastic package cannot be subjected to high temperature, it should be removed from modules before high temperature (120ºC) baking. If shorter baking time is desired, please refer to *IPC/JEDECJ-STD-033* for baking procedure.

7.2. Manufacturing and Soldering

Push the squeegee to apply the solder paste on the surface of stencil, thus making the paste fill the stencil openings and then penetrate to the PCB. The force on the squeegee should be adjusted properly so as to produce a clean stencil surface on a single pass. To ensure the module soldering quality, the thickness of stencil for the module is recommended to be 0.13mm~0.15mm. For more details, please refer to ***document [7]***.

It is suggested that the peak reflow temperature is 238~245ºC, and the absolute maximum reflow temperature is 245ºC. To avoid damage to the module caused by repeated heating, it is strongly recommended that the module should be mounted after reflow soldering for the other side of PCB has been completed. The recommended reflow soldering thermal profile (lead-free reflow soldering) and related parameters are shown below.

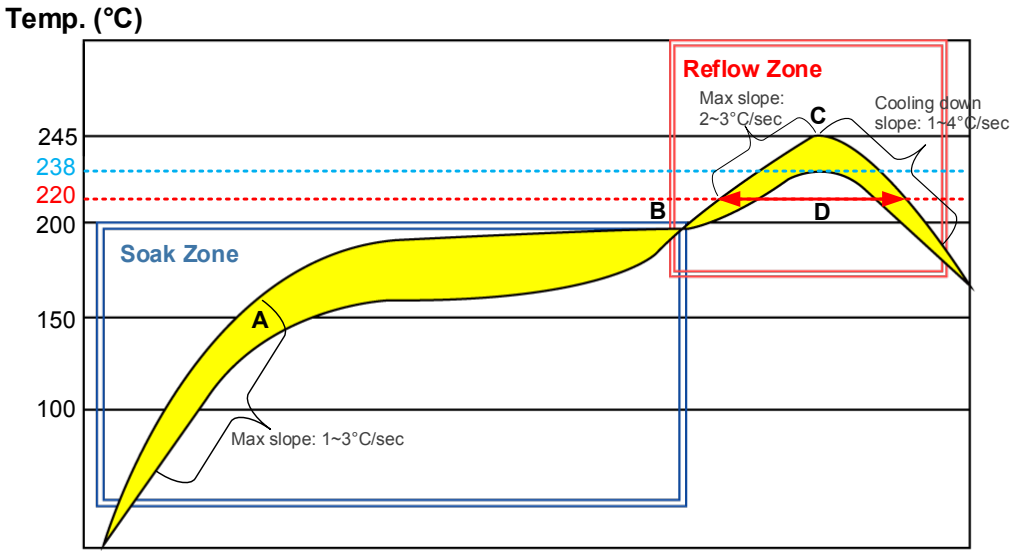

Figure 23: Reflow Soldering Thermal Profile

Table 1: Recommended Thermal Profile Parameters

Factor	Recommendation
Soak Zone	
Max slope	1 to 3°C/sec
Soak time (between A and B: 150°C and 200°C)	60 to 120 sec
Reflow Zone	
Max slope	2 to 3°C/sec

Reflow time (D: over 220°C)	40 to 60 sec
Max temperature	238°C ~ 245°C
Cooling down slope	1 to 4°C/sec
Reflow Cycle	
Max reflow cycle	1

NOTES

1. During manufacturing and soldering, or any other processes that may contact the module directly, NEVER wipe the module's shielding can with organic solvents, such as acetone, ethyl alcohol, isopropyl alcohol, trichloroethylene, etc. Otherwise, the shielding can may become rusted.
2. The shielding can for the module is made of Cupro-Nickel base material. It is tested that after 12 hours' Neutral Salt Spray test, the laser engraved label information on the shielding can is still clearly identifiable and the QR code is still readable, although white rust may be found.

7.3. Tape and Reel Packaging

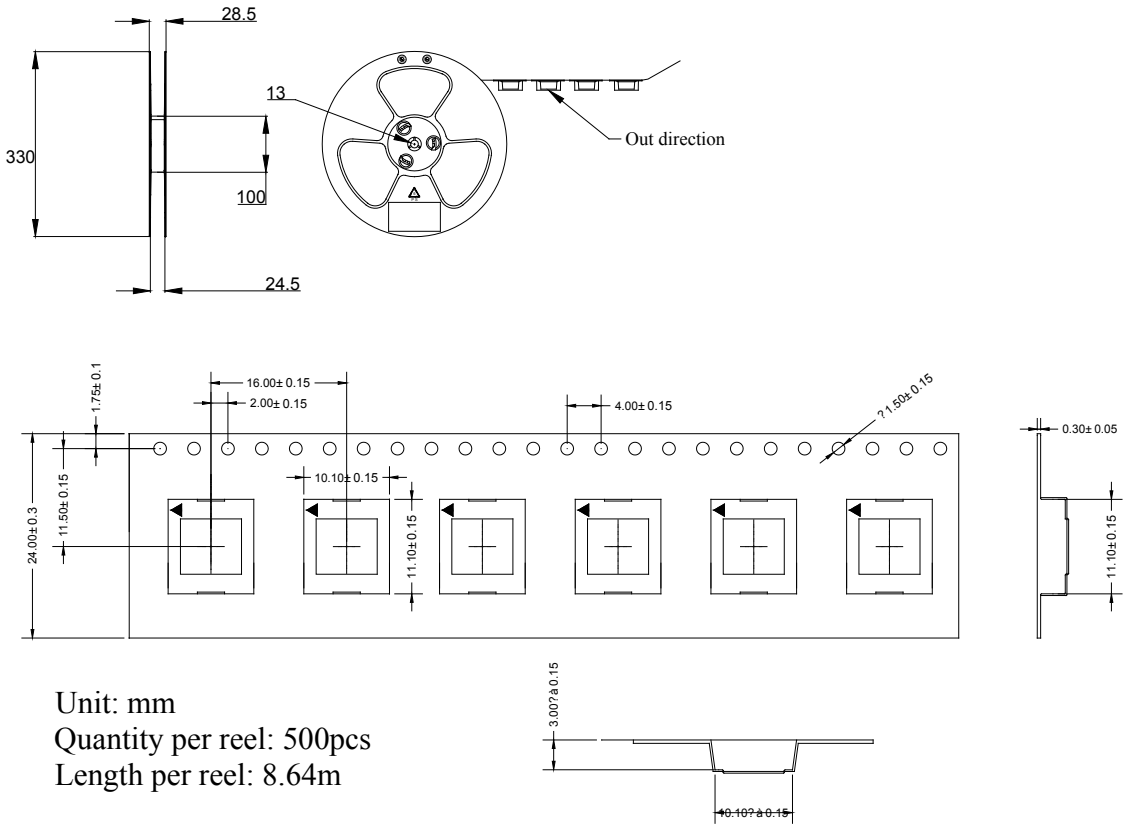

Figure 24: Tape and Reel Specifications

Table 14: Reel Packaging

Model Name	MOQ for MP	Minimum Package: 500pcs	Minimum Packagex4 = 2000pcs
L76-LB	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

8 Appendix References

Table 15: Related Documents

SN	Document Name	Remark
[1]	Quectel_L76-LB_EVB_User_Guide	L76-LB EVB User Guide
[2]	Quectel_L76-LB_GNSS_Protocol_Specification	L76-LB GNSS Protocol Specification
[3]	Quectel_L76-LB_Reference_Design	L76-LB Reference Design
[4]	Quectel_GNSS_EPO_Application_Note	GNSS EPO Application Note
[5]	Quectel_GNSS_I2C_Application_Note	I2C Application Note
[6]	Quectel_GNSS_SDK_Commands_Manual	GNSS SDK Commands Manual
[7]	Quectel_Module_Secondary_SMT_User_Guide	Module Secondary SMT User Guide

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
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
PQ	Quectel Proprietary Protocol
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
Imax	Maximum Load Current
Vmax	Maximum Voltage Value
Vnorm	Normal Voltage Value
Vmin	Minimum Voltage Value
V_{IH}max	Maximum Input High Level Voltage Value
V_{IH}min	Minimum Input High Level Voltage Value
V_{IL}max	Maximum Input Low Level Voltage Value
V_{IL}min	Minimum Input Low Level Voltage Value
$V_I$max	Absolute Maximum Input Voltage Value
$V_I$min	Absolute Minimum Input Voltage Value
V_{OH}max	Maximum Output High Level Voltage Value
V_{OH}min	Minimum Output High Level Voltage Value
V_{OL}max	Maximum Output Low Level Voltage Value
V_{OL}min	Minimum Output Low Level Voltage Value