L76K Hardware Design

GNSS Module Series

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Quectel Wireless Solutions Co., Ltd.
Building 5, Shanghai Business Park Phase III (Area B), No.1016 Tianlin Road, Minhang District, Shanghai 200233, China
Tel: +86 21 5108 6236
Email: info@quectel.com

Or our local offices. For more information, please visit:
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The following safety precautions must be observed during all phases of operation, such as usage, service, or repair of any terminal or mobile incorporating the module. Manufacturers of the terminal should notify users and operating personnel of the following safety information by incorporating these guidelines into all product manuals. Otherwise, Quectel assumes no liability for customers' failure to comply with these precautions.

	Ensure that the product may be used in the country and the required environment, as well as that it conforms to the local safety and environmental regulations.
	Keep away from explosive and flammable materials. The use of electronic products in extreme power supply conditions and locations with potentially explosive atmospheres may cause fire and explosion accidents.
	The product must be powered by a stable voltage source, and the wiring shall conform to security precautions and fire prevention regulations.
	Proper ESD handling procedures must be followed throughout the mounting, handling and operation of any devices and equipment that incorporate the module to avoid ESD damages.

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Contents

Safety Information 3
About the Document 4
Contents 5
Table Index 7
Figure Index 8

1 Product Description 9
1.1. Overview 9
1.2. Features 9
1.3. Performance 11
1.4. Block Diagram 12
1.5. GNSS Constellations 12
1.5.1. GPS 13
1.5.2. GLONASS 13
1.5.3. BeiDou 13
1.5.4. QZSS 13
1.6. AGNSS 13

2 Pin Assignment 14

3 Power Management 17
3.1. Power Unit 17
3.2. Power Supply 18
3.2.1. VCC 18
3.2.2. V_BCKP 18
3.3. Power Mode 19
3.3.1. Feature Comparison 19
3.3.2. Continuous Mode 20
3.3.3. Standby Mode 20
3.3.4. Backup Mode 20
3.4. Power-Up Sequence 21
3.5. Power-Down Sequence 22

4 Application Interfaces 23
4.1. IO 23
4.1.1. Communication Interfaces 23
4.1.1.1. UART Interface 23
4.1.2. SET 24
4.1.3. 1PPS 24
4.2. System Pins 24
4.2.1. RESET_N 24
4.2.2. WAKEUP 25

5 Design 26

5.1. Recommended Footprint 26
5.2. Antenna Reference Design 27
5.2.1. Antenna Specifications 27
5.2.2. Antenna Selection Guide 27
5.2.3. Active Antenna Reference Design 28
5.2.3.1. Active Antenna Reference Design with Antenna Detection 28
5.2.3.2. Active Antenna Reference Design without Antenna Detection 29
5.2.4. Passive Antenna Reference Design 30
5.3. Coexistence with Cellular Systems 30
5.3.1. In-Band Interference 31
5.3.2. Out-of-Band Interference 32
5.3.3. Ensuring Interference Immunity 32

6 Electrical Specification 34
6.1. Absolute Maximum Ratings 34
6.2. Recommended Operating Conditions 35
6.3. ESD Protection 36

7 Mechanical Dimensions 37
7.1. Top, Side and Bottom View Dimensions 37
7.2. Top and Bottom Views 38

8 Product Handling 39
8.1. Packaging 39
8.1.1. Carrier Tape 39
8.1.2. Plastic Reel 40
8.1.3. Packaging Process 40
8.2. Storage 41
8.3. Manufacturing and Soldering 42

9 Labelling Information 45

10 Appendix References 46

Table Index

Table 1: Product Features........ 9
Table 2: Product Performance........ 11
Table 3: I/O Parameter Definition........ 14
Table 4: Pinout........ 15
Table 5: Feature Comparison in Different Power Modes........ 20
Table 6: Recommended Antenna Specifications........ 27
Table 7: Intermodulation Distortion (IMD) Products........ 31
Table 8: Absolute Maximum Ratings........ 34
Table 9: Recommended Operating Conditions........ 35
Table 10: Carrier Tape Dimension Table (Unit: mm)........ 39
Table 11: Plastic Reel Dimension Table (Unit: mm)........ 40
Table 12: Recommended Thermal Profile Parameters........ 43
Table 13: Related Documents........ 46
Table 14: Terms and Abbreviations........ 46

Figure Index

Figure 1: Block Diagram 12
Figure 2: Pin Assignment 14
Figure 3: Internal Power Supply 17
Figure 4: VCC Input Reference Circuit 18
Figure 5: RTC Powered by Non-Rechargeable Battery 19
Figure 6: Reference Charging Circuit for Rechargeable Battery 19
Figure 7: Enter/Exit from Backup Mode Sequence 21
Figure 8: Power-Up Sequence 21
Figure 9: Power-Down Sequence 22
Figure 10: UART Interface Reference Design 23
Figure 11: Reference OC Circuit for Module Reset 24
Figure 12: Reset Sequence 25
Figure 13: Recommended Footprint 26
Figure 14: Active Antenna Reference Design with Antenna Detection 28
Figure 15: Active Antenna Reference Design without Antenna Detection 29
Figure 16: Passive Antenna Reference Design 30
Figure 17: In-Band Interference on GPS L1 31
Figure 18: Out-of-Band Interference on GPS L1 32
Figure 19: Interference Source and Its Path 33
Figure 20: Top, Side and Bottom View Dimensions 37
Figure 21: Top and Bottom Module Views 38
Figure 22: Carrier Tape Dimension Drawing 39
Figure 23: Plastic Reel Dimension Drawing 40
Figure 24: Packaging Process 41
Figure 25: Recommended Reflow Soldering Thermal Profile 43
Figure 26: Labelling Information 45

1 Product Description

1.1. Overview

The Quectel L76K module supports multiple global positioning and navigation systems: GPS, GLONASS, BeiDou, and QZSS. The module also supports AGNSS function. The default constellations is GPS and BeiDou.

Key features:

- The L76K module is a ROM based single band, multi-constellation GNSS module and features a high-performance, high reliability positioning engine. This module facilitates fast and precise GNSS positioning.
- The module supports serial communication interface UART.
- The module supports active antenna detection and short-circuit protection. Antenna status can be output and displayed through NMEA sentences, so that the host can query the status in a timely and convenient manner.

The Quectel L76K module is an SMD type module with a compact form factor of 10.1 mm × 9.7 mm × 2.0 mm. It can be embedded in your applications through the 18 LCC pins.

The module is fully compliant with the EU RoHS Directive.

1.2. Features

Table 1: Product Features

Features		L76K
Grade	Industrial	●
	Automotive	-
Category	Standard Precision GNSS	●

	High Precision GNSS		-
	DR		-
	RTK		-
	Timing		-
Supply Voltage	2.7-3.4 V, Typical: 3.3 V		●
I/O Voltage	Typical: VCC		●
Communication Interfaces	UART		●
	SPI		-
	I2C		-
Integrated Features	Additional LNA		●
	Additional SAW		●
	RTC Crystal		●
	TCXO Oscillator		●
	6-axis IMU		-
Constellations	GPS/QZSS	L1 C/A	●
		L5	-
	GLONASS	L1	●
	Galileo	E1	-
		E5a	-
	BeiDou	B1I	●
		B2a	-
	IRNSS	L5	-
	SBAS	L1	-
Temperature Range	Operating temperature range: -40 °C to +85 °C Storage temperature range: -40 °C to +90 °C		
Physical Characteristics	Size: (10.1 ±0.15) mm × (9.7 ±0.15) mm × (2.0 ±0.20) mm Weight: Approx. 0.4 g		

NOTE

For more information about GNSS constellation configuration, see ***document [1]***.

1.3. Performance

Table 2: Product Performance

Parameter		Specification	L76K
Power Consumption [1]	GPS + BeiDou	Acquisition	29 mA
		Tracking	29 mA
		Standby Mode	20 μA
		Backup Mode	8 μA
	GPS + GLONASS	Acquisition	29 mA
		Tracking	29 mA
		Standby Mode	20 μA
		Backup Mode	8 μA
Sensitivity		Acquisition	-148 dBm
		Reacquisition	-160 dBm
		Tracking	-162 dBm
TTFF [1] (without AGNSS)		Cold Start	30 s
		Hot Start	2 s
TTFF [2] (with AGNSS)		Cold Start	5.5 s
		Hot Start	2 s
Horizontal Position Accuracy [3]		2.0 m	
Update Rate		1 Hz (max. 5 Hz)	
Accuracy of 1PPS Signal		Typical accuracy: < 30 ns @ 1σ	

[1] Room temperature, all satellites at -130 dBm.
[2] Open-sky, active high precision GNSS antenna, less than 1 km baseline length.
[3] CEP, 50%, 24 hours static, -130 dBm, more than 6 SVs.

	Time pulse width: 100 ms
Velocity Accuracy	Without aid: 0.1 m/s
Acceleration Accuracy	Without aid: 0.1 m/s²
Dynamic Performance	Maximum Altitude: 18000 m Maximum Velocity: 515 m/s Acceleration: 4g

1.4. Block Diagram

The following figure shows a block diagram of the module. The module includes a GNSS IC, an additional LNA, an additional SAW , a TCXO and a XTAL. The LNA will have less chance to produce in-band interference in challenging environments (e.g., with a cellular module transmitting B13 at the same time), which ensures enhanced performance in a jamming environment.

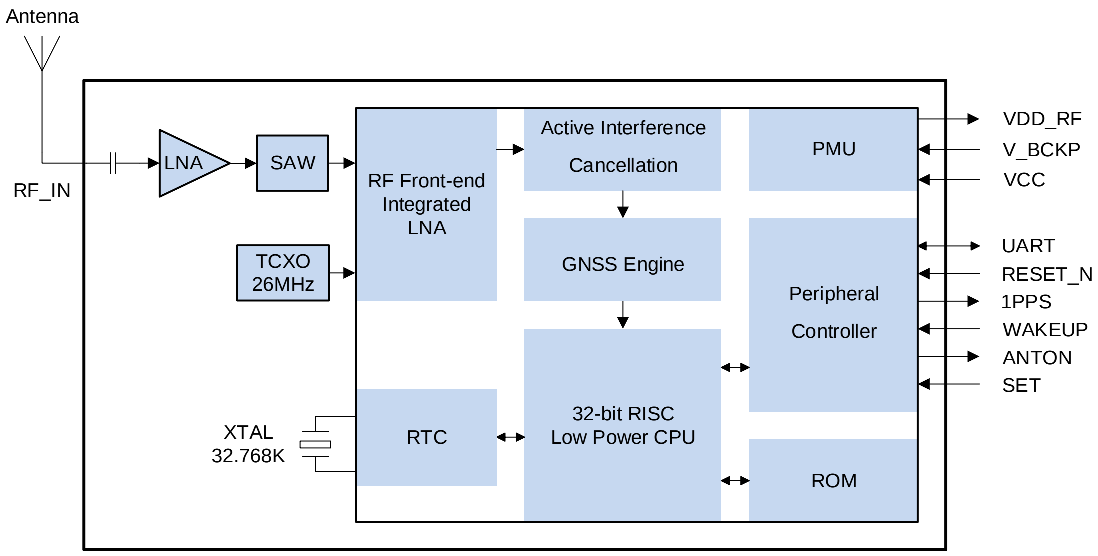


Figure 1: Block Diagram

1.5. GNSS Constellations

The Quectel L76K module is a single-band GNSS receiver that can receive and track GNSS signals. It can track GPS, Beidou, GLONASS, QZSS satellite signals and realize multi-system joint positioning.

1.5.1. GPS

The module is designed to receive and track GPS L1 C/A (1574.397–1576.443 MHz) signals provided by GPS.

1.5.2. GLONASS

The module is designed to receive and track GLONASS L1 (1597.781–1605.656 MHz) signals provided by GLONASS.

1.5.3. BeiDou

The module is designed to receive and track BeiDou B1I (1559.052–1563.144 MHz) signals provided by the BeiDou Navigation Satellite System. The ability to receive and track BeiDou signals in conjunction with GPS results in higher coverage, improved reliability, and better accuracy.

1.5.4. QZSS

The Quasi-Zenith Satellite System (QZSS) is a regional navigation satellite system that transmits additional GPS L1 C/A signals for the Pacific region covering Japan and Australia. The Quectel L76K module can detect and track these signals concurrently with GPS signals, resulting in better availability especially under challenging conditions, e.g., in urban canyons.

1.6. AGNSS

The module supports AGNSS feature that significantly reduces the module's TTFF, especially under lower signal conditions. To implement AGNSS feature, the module should get the assistance data including the current time, and rough position.

2 Pin Assignment

The Quectel L76K module is equipped with 18 LCC pins by which the module can be mounted on your PCB.

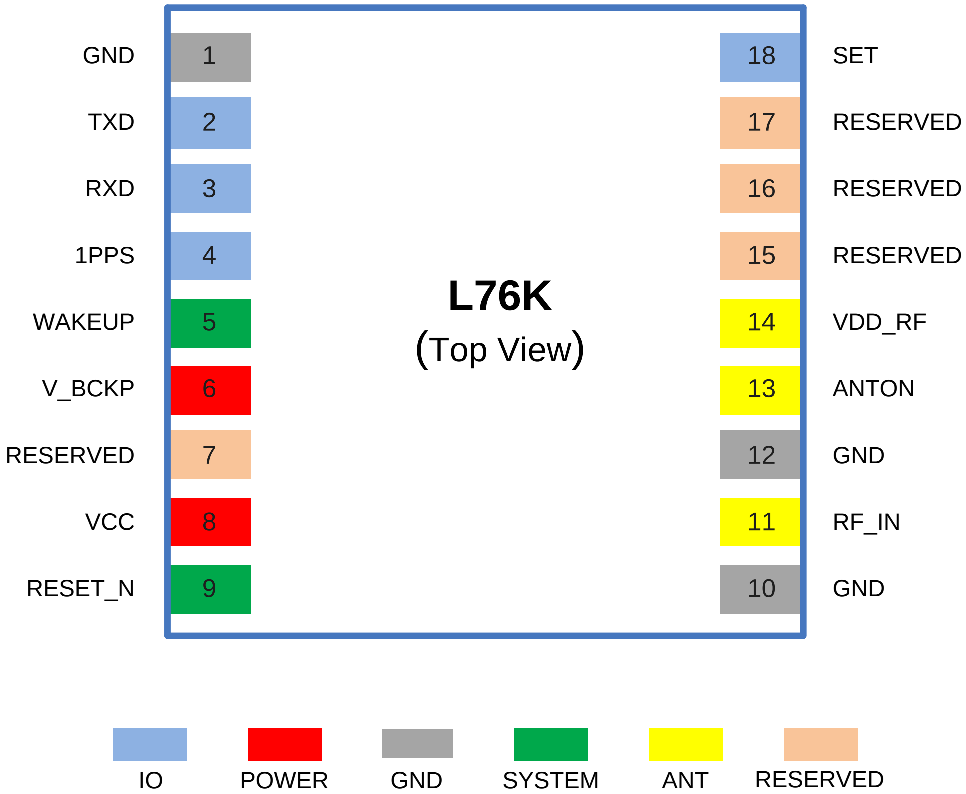


Figure 2: Pin Assignment

Table 3: I/O Parameter Definition

Type	Description
AI	Analog Input
DI	Digital Input
DO	Digital Output

PI	Power Input
PO	Power Output

Table 4: Pinout

Function	Name	No.	I/O	Description	Remarks
Power	VCC	8	PI	Main power supply	Provides clean and steady voltage. Make sure that the load capacity of the power supply is not less than 100 mA.
	V_BCKP	6	PI	Backup power supply for RTC domain	Supplies power to the RTC domain when VCC power supply is disconnected.
IO	TXD	2	DO	Transmits data	For NMEA data output and command input.
	RXD	3	DI	Receives data	
	SET	18	DI	Sets constellation	Floating: GPS + BeiDou Low level: GPS + GLONASS
	1PPS	4	DO	One pulse per second	Synchronized on rising edge, and the pulse width is 100 ms. If unused, leave the pin N/C (not connected).
Antenna	VDD_RF	14	PO	Power supply for external RF components	VDD_RF = VCC Typically used to supply power for an external active antenna or LNA. If unused, leave the pin N/C (not connected).
	RF_IN	11	AI	GNSS antenna interface	50 Ω characteristic impedance.
	ANTON	13	DO	Used for external LNA control and active antenna power control in power Saving modes	The ANTON pin outputs high level in Continuous mode, and outputs a low level in Standby mode and Backup mode. If unused, leave the pin N/C (not connected).
System	RESET_N	9	DI	Resets the module	Active low.
	WAKEUP	5	DI	Enters or exits Standby mode	Active low, pull-up internally. If unused, leave the pin N/C (not connected).

GND	GND	1, 10, 12	-	Ground	Assures a good GND connection to all module GND pins, preferably with a large ground plane.
RESERVED	RESERVED	7, 15-17	-	Reserved	These pins must be left floating and cannot be connected to power or GND.

NOTE

Leave RESERVED and unused pins N/C (not connected).

3 Power Management

The Quectel L76K module provides a power optimized architecture with built-in autonomous energy saving capabilities to minimize power consumption at any given time. The receiver can be used in three operating modes: Standby mode, Backup mode for best power consumption, and Continuous mode for best performance.

3.1. Power Unit

VCC is the voltage supply pin of the module. It supplies power for the PMU which in turn supplies the entire system and RTC domains. The load current of the VCC pin varies according to VCC voltage level, processor load, and satellite acquisition. It is important to supply sufficient current and make sure the power supply is clean and stable.

The V_BCKP pin supplies power for the RTC domain. If the VCC voltage drops under the acceptable level, the V_BCKP keeps the RTC domain powered. To achieve quick startup and improve Time to First Fix (TTFF), the RTC domain power supply should be valid during the interval the VCC does not have a valid level. SRAM memory also belongs to the RTC domain. If the VCC is not valid, the V_BCKP supplies power for SRAM memory that contains all the necessary GNSS data and some of the user configuration variables.

VDD_RF is an output pin, equal in voltage to the VCC input. In Continuous mode, VDD_RF supplies power for the external active antenna or the LNA. In Standby mode, VDD_RF is turned off.

The module's internal power supply is shown below:

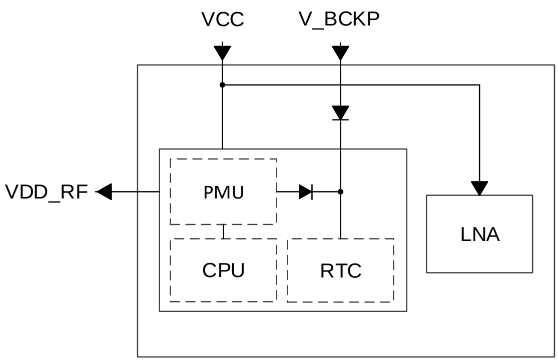


Figure 3: Internal Power Supply

3.2. Power Supply

3.2.1. VCC

The VCC is the voltage supply pin. The VCC pin supplies power for BB, RF, and RTC domain. VCC pin load current varies according to VCC voltage level, processor load and satellite acquisition state.

Module power consumption may vary by several orders of magnitude, especially when low power mode is enabled. Therefore, it is important that the power supply can sustain peak power for a short time, ensuring that the load current does not exceed the rated value. When the module switches from Backup mode to Continuous mode or startup, it must charge the internal capacitors in the core domain. In some cases, this can lead to a significant current drain.

For low-power applications using power saving modes, it is important that the LDO at the power supply or module input can provide the current/drain. An LDO with a high PSRR should be chosen for good performance. In addition, a TVS diode, and a combination of a 10 μF, 100 nF and a 33 pF decoupling capacitor network should be added near the VCC pin. The lowest value capacitor should be the closest to module pins.

An LDO voltage regulator with a fast discharge is recommended as the power supply. This can ensure a quick voltage drop when the VCC power is cut.

It is not recommended to use a switching DC-DC power supply.

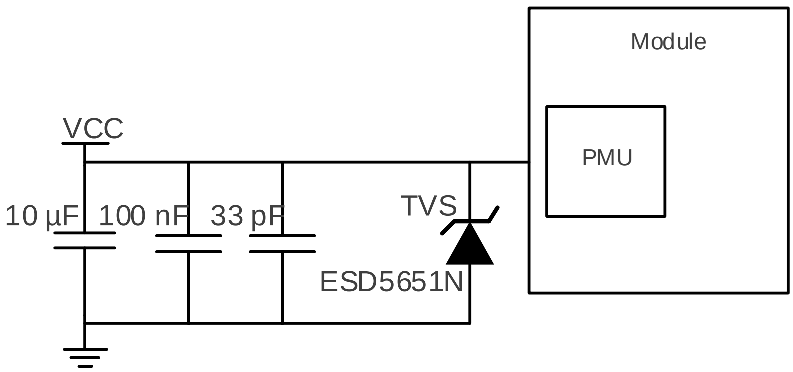


Figure 4: VCC Input Reference Circuit

3.2.2. V_BCKP

The V_BCKP pin supplies power for the RTC domain. If the module power supply fails, the V_BCKP pin supplies the real-time clock (RTC) and RAM. Use of valid time and GNSS orbit data at startup, allows GNSS hot (warm) start. If no backup power is connected, the module performs a cold start at power up.

If there is a constant power supply in your system, it can be used to provide a suitable voltage to supply V_BCKP.

V_BCKP can be directly powered by an external battery (rechargeable or non-rechargeable). It is recommended to place a battery with the combination of a 4.7 μF, a 100 nF and a 33 pF capacitor near the V_BCKP pin. The figure below illustrates the reference design for supplying the RTC domain with a non-rechargeable battery.

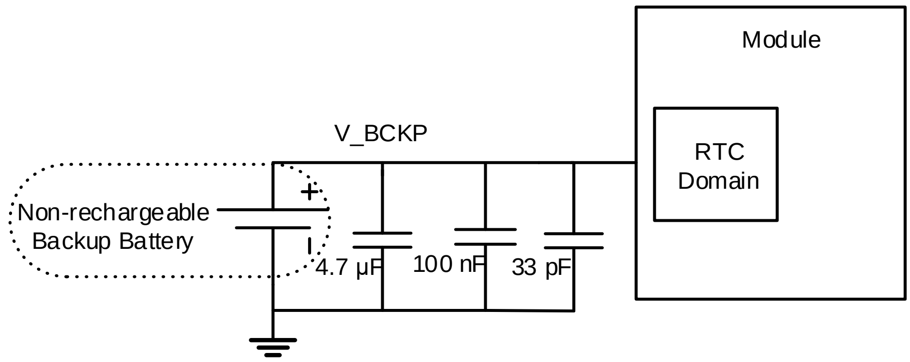


Figure 5: RTC Powered by Non-Rechargeable Battery

If V_BCKP is powered by a rechargeable battery, it is necessary to implement an external charging circuit for the battery. A reference charging circuit is illustrated below.

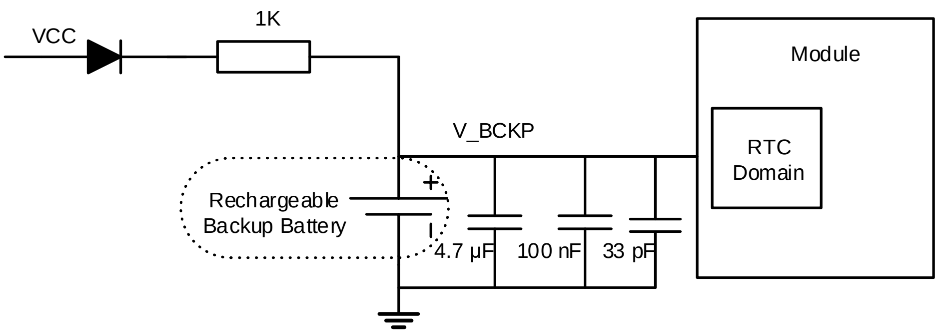


Figure 6: Reference Charging Circuit for Rechargeable Battery

3.3. Power Mode

3.3.1. Feature Comparison

The table below illustrates the supported features/functions of the module in different modes.

Table 5: Feature Comparison in Different Power Modes

Features	Continuous	Standby	Backup
NMEA from UART	●	-	-
1PPS	●	-	-
RF	●	-	-
Acquisition & Tracking	●	-	-
Power Consumption	High	Low	Low
Position Accuracy	High	-	-

3.3.2. Continuous Mode

If VCC is powered on, it automatically enters Continuous mode. Continuous mode comprises acquisition mode and tracking mode. In acquisition mode, the module starts to search satellites, and to determine visible satellites, coarse frequency, as well as the code phase of satellite signals. When the acquisition is completed, the module automatically switches to tracking mode. In tracking mode, the module tracks satellites and demodulates the navigation data from specific satellites.

3.3.3. Standby Mode

The Standby mode is a low-power Consumption mode. In Standby mode, the internal core and the I/O power domain are still active, but the RF is powered off, so the module stops satellite searching and navigation.

Pulling down the WAKEUP pin will make the module enter Standby mode; after releasing the WAKEUP pin, the module will return to Continuous mode.

3.3.4. Backup Mode

For power-sensitive applications, the module receiver provides a Backup mode to reduce power consumption. The current consumption in Backup mode is lower than that in Standby mode.

If VCC is cut off and V_BCKP is powering the RTC domain, the module switches from Continuous mode to Backup mode. Only RTC domain is active in Backup mode and it keeps track of time. As soon as the VCC pin is powered, the module immediately switches to Continuous mode.

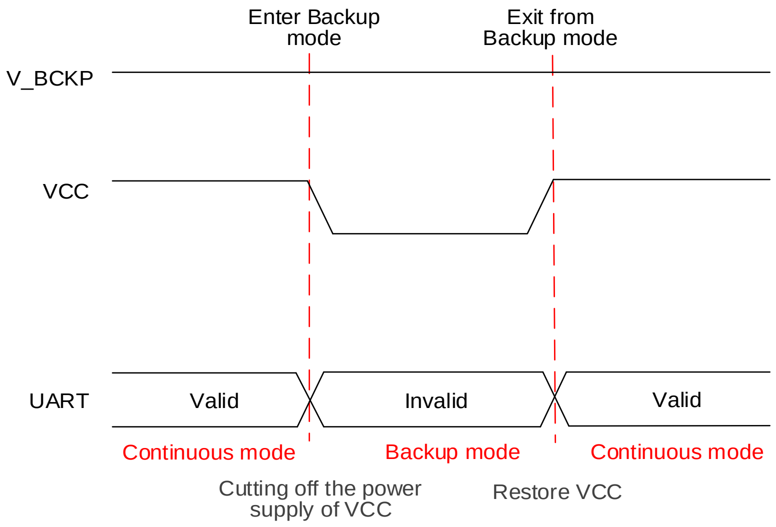


Figure 7: Enter/Exit from Backup Mode Sequence

3.4. Power-Up Sequence

When VCC is powered up, the module starts up automatically and the voltage should rise rapidly in less than 40 ms.

To ensure the correct power-up sequence, the RTC logic should start up before the PMU. Therefore, the V_BCKP must be supplied at the same time or before the VCC.

Ensure that the VCC has no rush or drop during rising time, and then keep the voltage stable. The recommended ripple is < 100 mV.

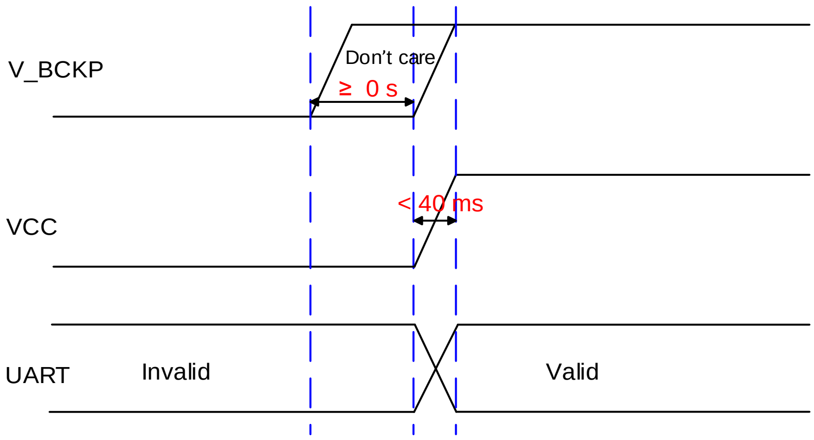


Figure 8: Power-Up Sequence

3.5. Power-Down Sequence

When the VCC is shut down, voltage should drop quickly with a drop time of less than 50 ms. It is recommended to use a voltage regulator that supports fast discharge.

To avoid abnormal voltage condition, if VCC falls below minimum specified value, the system must initiate a power-on reset by lowering VCC to less than 100 mV for at least 100 ms.

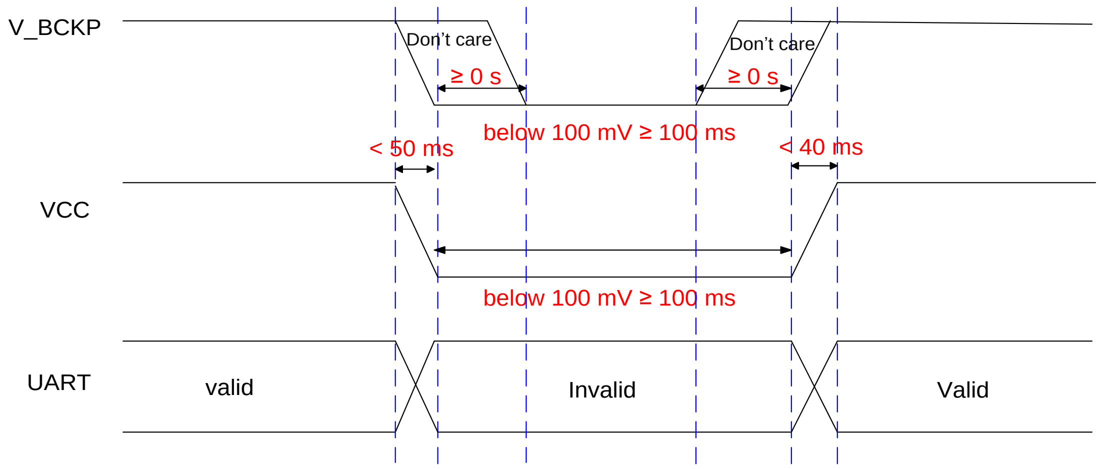


Figure 9: Power-Down Sequence

4 Application Interfaces

4.1. IO

4.1.1. Communication Interfaces

The following interfaces can be used for NMEA data output and command input.

4.1.1.1. UART Interface

The module provides one UART interface. UART port features:

- Support for NMEA data output and command input.
- Supported baud rates: 9600, 19200, 38400, 57600 and 115200 bps.
- The hardware flow control is not supported.

A reference design is shown in the figure below. For more information, see ***document [2]***.

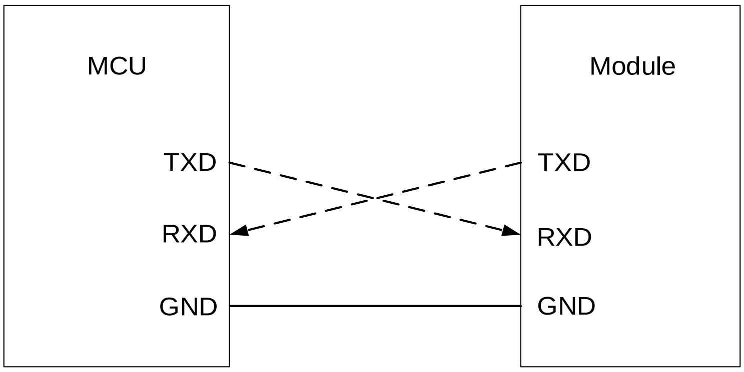


Figure 10: UART Interface Reference Design

NOTE

1. If the IO voltage of MCU is not matched with the module, a level shifter must be selected.
2. The default settings of the UART interface vary with software versions. Please refer to specific

software version for details.

4.1.2. SET

The SET pin is used to configure constellations. When the pin is floating, the constellation combination is GPS and BeiDou. When the pin is at the low level, the constellation combination is GPS and GLONASS.

4.1.3. 1PPS

The 1PPS output generates one pulse per second periodic signal synchronized with a GNSS time grid with intervals configurable over a wide range of frequencies. The accuracy is < 30 ns. Thus, it may be used as a low frequency time synchronization pulse or as a high frequency reference signal.

4.2. System Pins

4.2.1. RESET_N

RESET_N is an input pin. The module can be reset by driving RESET_N low for at least 100 ms and then releasing it.

RESET_N is internally pulled up to 3.3 V by default, so no external pull-up circuit is allowed for this pin.

An OC driver circuit as shown below is recommended to control the RESET_N pin.

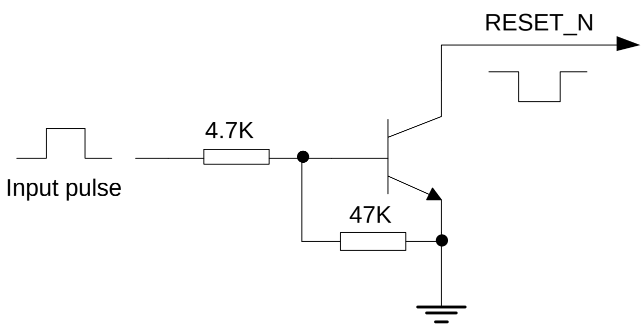


Figure 11: Reference OC Circuit for Module Reset

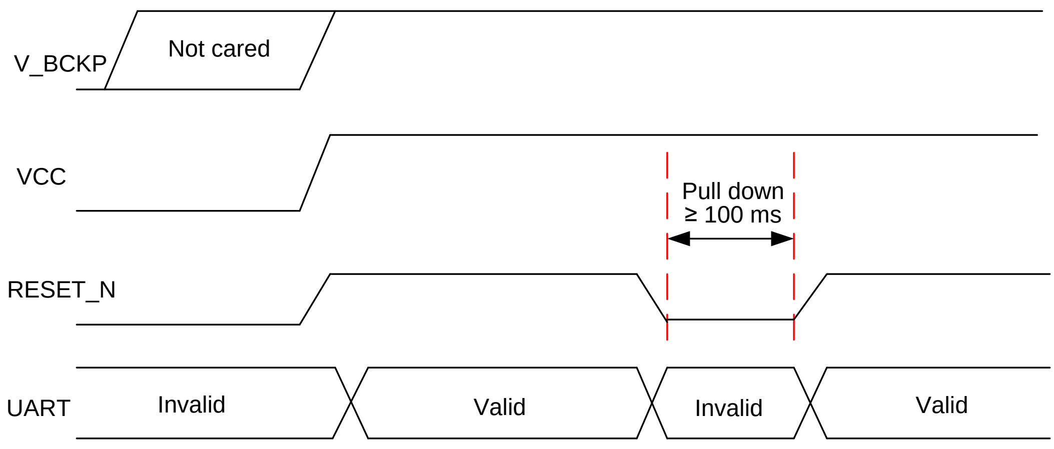


Figure 12: Reset Sequence

NOTE

Ensure RESET_N is connected so that it can be used to reset the module if the module enters an abnormal state.

4.2.2. WAKEUP

The WAKEUP pin is pulled-up internally. The pin is used to enter or exit Standby mode. Pulling down the WAKEUP pin will make the module enter the Standby mode; after releasing the WAKEUP pin, the module will return to the Continuous mode.

5 Design

This chapter explains the recommended footprint and the reference design of RF part of the module.

5.1. Recommended Footprint

The figure below describes the module footprint. These are recommendations, not specifications.

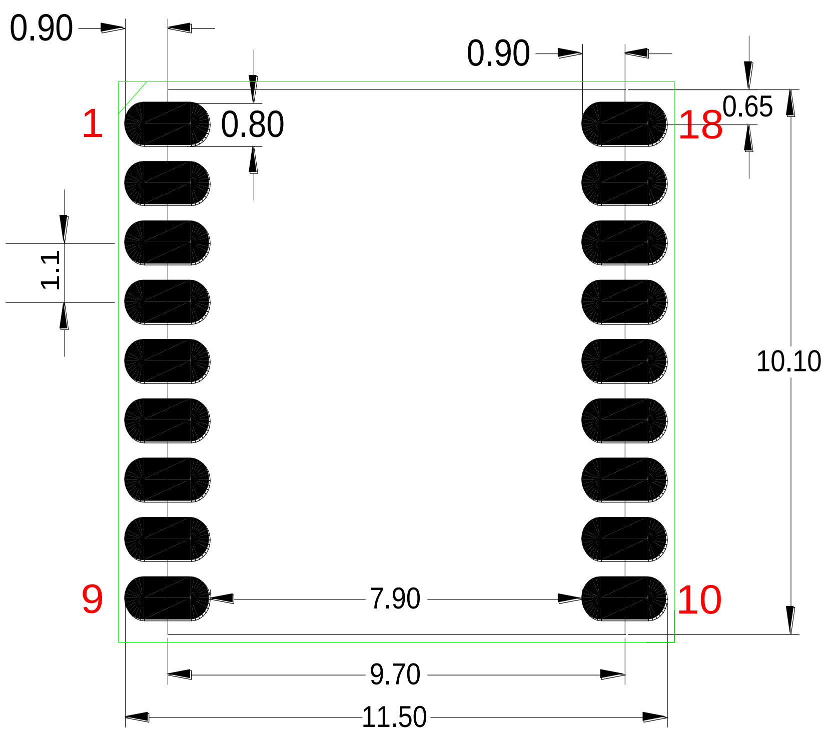


Figure 13: Recommended Footprint

NOTE

For easy maintenance, keep a distance of at least 3 mm between the module and other components on the motherboard.

5.2. Antenna Reference Design

5.2.1. Antenna Specifications

The Quectel L76K module can be connected to a dedicated passive or active single-band GNSS antenna to receive GNSS satellite signals. The recommended antenna specifications are given in the table below.

Table 6: Recommended Antenna Specifications

Antenna Type	Specifications
Passive Antenna	Frequency Range: 1559–1609 MHz Polarization: RHCP VSWR: < 2 (Typ.) Passive Antenna Gain: > 0 dBi
Active Antenna	Frequency Range: 1559–1609 MHz Polarization: RHCP VSWR: < 2 (Typ.) Passive Antenna Gain: > 0 dBi Active Antenna Noise Figure: < 1.5 dB Active Antenna Total Gain: < 17 dB

NOTE

The total antenna gain is equal to the internal LNA gain minus total insertion loss of cables and components inside the antenna.

5.2.2. Antenna Selection Guide

Both active and passive single-band GNSS antennas can be used for the Quectel L76K module. A passive antenna is recommended if the antenna can be placed close to the module, for instance, when the distance between the module and the antenna is less than 1 m. Otherwise, use an active antenna, since the insertion loss of RF cable can decrease the CNR of GNSS signal.

CNR is an important factor for GNSS receivers, and it is defined as the ratio of the received modulated carrier signal power to the received noise power in one Hz bandwidth. CNR formula:

$$\text{CNR} = \text{Power of GNSS signal} - \text{Thermal Noise} - \text{System NF(dB-Hz)}$$

The “Power of GNSS signal” is GNSS signal level. In practical environment, the signal level at the earth surface is about -130 dBm. “Thermal Noise” is -174 dBm/Hz at 290 K. To improve CNR of GNSS signal, an LNA could be added to reduce “System NF”.

"System NF", formula:

$$\mathrm{NF} = 10\log \mathrm{F}\,(\mathrm{dB})$$

"F" is the noise factor of receiver system:

$$\mathrm{F} = \mathrm{F1} + (\mathrm{F2} - 1)/\mathrm{G1} + (\mathrm{F3} - 1)/(\mathrm{G1} \cdot \mathrm{G2}) + \cdots$$

"F1" is the first stage noise factor, "G1" is the first stage gain, etc. This formula indicates that the LNA with enough gain can compensate for the noise factor behind the LNA. In this case, "System NF" depends mainly on the noise figure of components and traces before first stage LNA plus noise figure of the LNA itself. This explains the need for using an active antenna if the antenna connection cable is too long.

5.2.3. Active Antenna Reference Design

5.2.3.1. Active Antenna Reference Design with Antenna Detection

The following figure is a typical reference design of an active antenna. In this case, the antenna is powered by the VDD_RF. When selecting the active antenna, it is necessary to pay attention to operating voltage range.

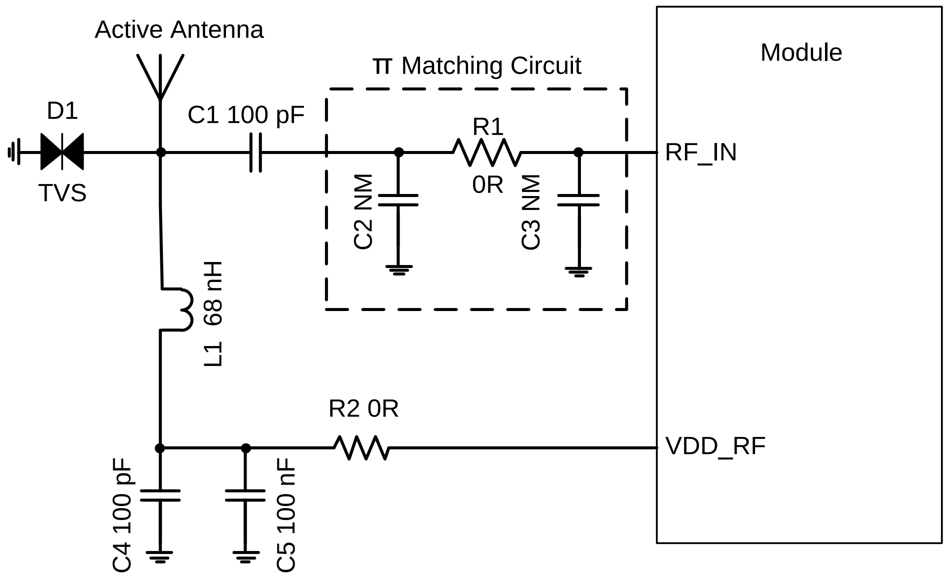


Figure 14: Active Antenna Reference Design with Antenna Detection

The components C2, R1 and C3 are reserved for matching antenna impedance. By default, R1 is 0 Ω, while C2 and C3 are not mounted. C1 is 100 pF, D1 is an electrostatic discharge (ESD) protection device to protect the RF signal input from the potential damage caused by ESD.

An active antenna can use the power supply from the VDD_RF pin. In that case, the inductor L1 is used to prevent the RF signal from leaking into the VDD_RF and to prevent noise propagation from the VDD_RF to the antenna. The L1 inductor routes the bias voltage to the active antenna without losses. The recommended value of L1 is no less than 68 nH. The resistor R2 is used to protect the module in case the active antenna is short-circuited to the ground plane.

The VDD_RF output voltage value is equal to the module VCC. When selecting an active antenna, pay attention to its operating voltage range.

When the VDD_RF output current is less than 2.5 mA, the antenna is judged to be an open circuit; when the output current is between 2.5 and 50 mA, the antenna is considered to be normal; VDD_RF can output a maximum of 50 mA current. If the antenna current consumption is greater than 50 mA, the antenna is considered to be in a short circuit state. Therefore, when choosing an active antenna, pay attention to its current consumption parameter. The antenna status can be output through NMEA sentences.

5.2.3.2. Active Antenna Reference Design without Antenna Detection

The following figure is a typical reference design of an active antenna without antenna detection.

The ANTON outputs high level in Continuous mode, and outputs a low level in Standby mode and Backup mode.

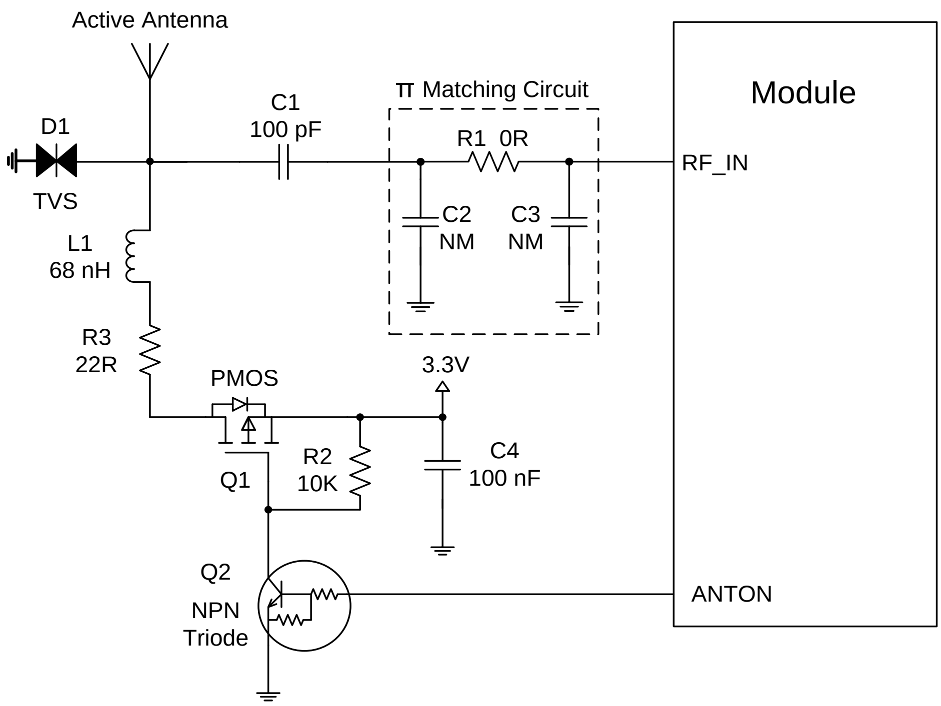


Figure 15: Active Antenna Reference Design without Antenna Detection

5.2.4. Passive Antenna Reference Design

The following figure is a typical reference design of a passive antenna.

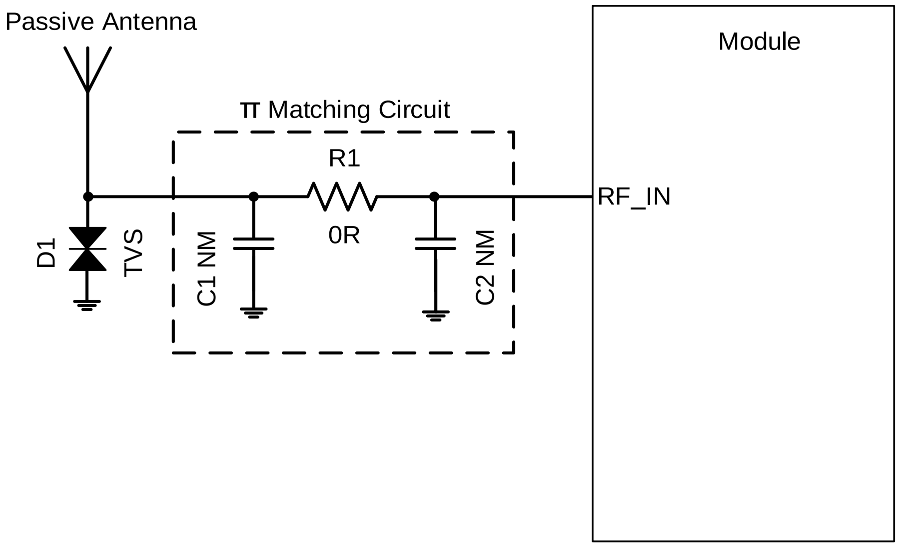


Figure 16: Passive Antenna Reference Design

The components C1, R1 and C2 are reserved for matching antenna impedance. By default, R1 is 0 Ω, while C1 and C2 are not mounted. D1 is an electrostatic discharge (ESD) protection device to protect one signal line from the damage caused by ESD. The impedance of RF trace should be controlled to 50 Ω and the trace length should be kept as short as possible.

5.3. Coexistence with Cellular Systems

Since GNSS signals are usually very weak, a GNSS receiver could be vulnerable to the interference of the surrounding environment. According to 3GPP specifications, a cellular terminal should transmit a signal of up to 33 dBm at GSM bands, or of about 24 dBm at WCDMA and LTE bands. As a result, coexistence with cellular systems must be optimized to avoid significant deterioration of the GNSS performance.

In a complex communication environment, interference signals can come from in-band and out-of-band signals. Therefore, interference can be divided into two types: in-band interference and out-of-band interference, which are both described in this chapter.

In this chapter, you can also find suggestions for decreasing the impact of interference signals that will ensure the interference immunity of a GNSS receiver.

5.3.1. In-Band Interference

In-band interference refers to the signal whose frequency is within or near the operating frequency range of a GNSS signal.

See the following figure for more details.

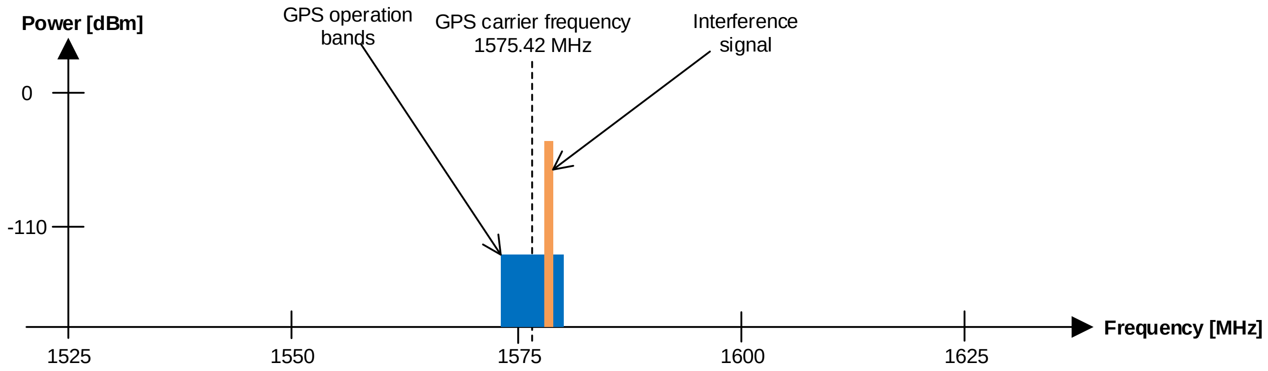


Figure 17: In-Band Interference on GPS L1

The most common in-band interferences usually come from:

- Harmonics, caused by crystals, high-speed signal lines, MCUs, switch-mode power supply etc., or
- Intermodulation from different communication systems.

Common frequency combinations are presented in the table below. The table lists some probable in-band interferences generated by two kinds of out-of-band signal intermodulation, or the second harmonic of LTE B13.

Table 7: Intermodulation Distortion (IMD) Products

Source F1	Source F2	IM Calculation	IMD Products
GSM850/B5	Wi-Fi 2.4 GHz	F2 (2412 MHz) - F1 (837 MHz)	IMD2 = 1575 MHz
DCS1800/B3	PCS1900/B2	2 × F1 (1712.6 MHz) - F2 (1850.2 MHz)	IMD3 = 1575 MHz
PCS1900/B2	Wi-Fi 5 GHz	F2 (5280 MHz) - 2 × F1 (1852 MHz)	IMD3 = 1576 MHz
LTE B13	N/A	2 × F1 (786.9 MHz)	IMD2 = 1573.8 MHz

5.3.2. Out-of-Band Interference

Strong signals transmitted by other communication systems can cause a GNSS receiver to become saturated, so that its performance is greatly deteriorated, as illustrated in the following figure.

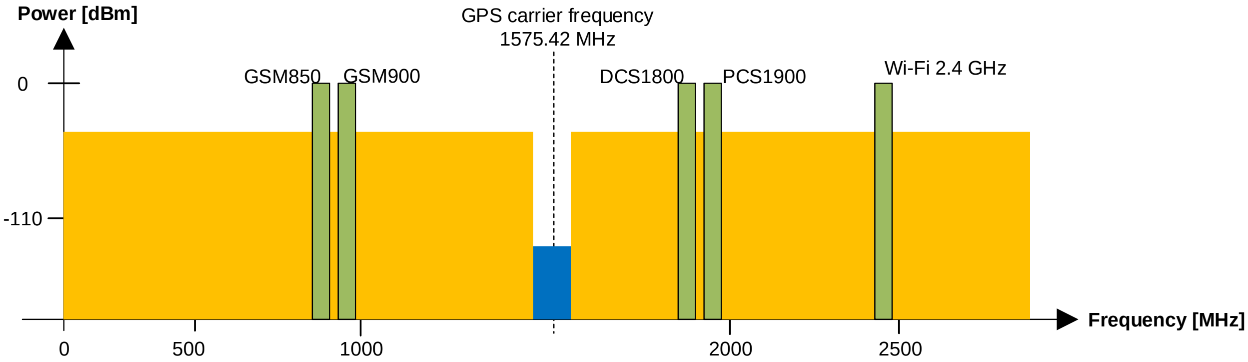


Figure 18: Out-of-Band Interference on GPS L1

5.3.3. Ensuring Interference Immunity

There are several things you can do to decrease the impact of interference signals and thus ensure the interference immunity of a GNSS receiver:

- Keep the GNSS antenna away from interference sources;
- Add a band-pass filter in front of the GNSS module;
- Use shielding, multi-layer PCB and ensure adequate grounding;
- Optimize layout and component placement of the PCB and the whole device.

The following figure illustrates the interference source and its possible interference path. In a complex communication system, there are usually RF power amplifiers, MCUs, crystals, etc. These devices should be far away from a GNSS receiver, or a GNSS module. In particular, shielding should be used to prevent strong signal interference for power amplifiers. The cellular antenna should be placed away from a GNSS receiving antenna to ensure enough isolation. Usually, a good design should provide at least a 20 dB isolation between two antennas. Take DCS1800, for example, the maximum transmitted power of DCS1800 is around 30 dBm. After a 20 dB attenuation, the signal received by the GNSS antenna will be around 10 dBm, which is still too high for a GNSS module. With a GNSS band-pass filter with around 40 dB rejection in front of the GNSS module, the out-of-band signal will be attenuated to -30 dBm.

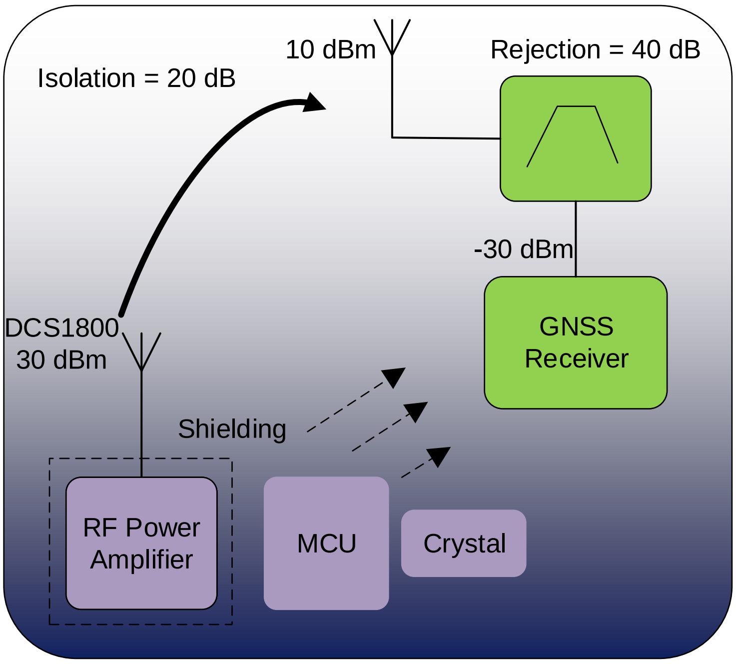


Figure 19: Interference Source and Its Path

6 Electrical Specification

6.1. Absolute Maximum Ratings

Absolute maximum ratings for power supply and voltage on digital pins of the Quectel L76K module are listed in table below.

Table 8: Absolute Maximum Ratings

Parameter	Description	Min.	Max.	Unit
VCC	Power Supply Voltage	-0.3	3.6	V
V_BCKP	Backup Supply Voltage	-0.3	3.6	V
V_{IN}_IO	Input Voltage at I/O Pins	-0.2	VCC + 0.3	V
P_{RF_IN}	Input Power at RF_IN	-	15	dBm
T_storage	Storage Temperature	-40	90	°C

NOTE

Stressing the device beyond the "Absolute Maximum Ratings" may cause permanent damage. The product is not protected against over-voltage or reversed voltage. Therefore, it is necessary to use appropriate protection diodes to keep voltage spikes within the parameters given in the table above.

6.2. Recommended Operating Conditions

All specifications are at an ambient temperature of 25 °C. Extreme operating temperatures can significantly impact the specified values. Applications operating near the temperature limits should be tested to ensure the validity of the specification.

Table 9: Recommended Operating Conditions

Parameter	Description	Min.	Typ.	Max.	Unit
VCC	Power Supply Voltage	2.7	3.3	3.4	V
V_BCKP	Backup Supply Voltage	1.4	3.3	3.6	V
IO_Domain	Domain Voltage at Digital I/O Pins	-	VCC	-	V
V_{IL}	Digital I/O Pin Low-Level Input Voltage	-0.3	-	0.2 × VCC	V
V_{IH}	Digital I/O Pin High-Level Input Voltage	0.8 × VCC	VCC	VCC + 0.3	V
V_{OL}	Digital I/O Pin Low-Level Output Voltage	-	-	0.4	V
V_{OH}	Digital I/O Pin High-Level Output Voltage	VCC - 0.4	VCC	-	V
RESET_N	Low-Level Input Voltage	-0.3	-	0.2 × VCC	V
WAKEUP	Low-Level Input Voltage	-0.3	-	0.2 × VCC	V
	High-Level Input Voltage	0.8 × VCC	VCC	VCC + 0.3	V
VDD_RF	VDD_RF Voltage	-	VCC	-	V
T_operating	Operating Temperature	-40	25	+85	°C

NOTE

1. Operation beyond the "Operating Conditions" is not recommended and extended exposure beyond the "Operating Conditions" may affect device reliability.
2. IO_Domain specifically refers to the IO pins in GPIO in ***Chapter 2***.

6.3. ESD Protection

If the static electricity generated by various ways discharges to the module, the module maybe damaged to a certain extent. Thus, please take proper ESD countermeasures and handling methods. For example, wearing anti-static gloves during the development, production, assembly and testing of the module; adding ESD protective components to the ESD sensitive interfaces and points in the product design.

The following measures ensure ESD protection when the module is handled:

- When mounting the module onto a motherboard, make sure to connect the GND first, and then the RF_IN pad.
- When handling the RF_IN pad, do not come into contact with any charged capacitors or materials that may easily generate or store charges (such as patch antenna, coaxial cable, soldering iron, etc.).
- When soldering the RF_IN pin, make sure to use an ESD safe soldering iron (tip).

7 Mechanical Dimensions

This chapter describes the mechanical dimensions of the module. All dimensions are in millimeters (mm). The dimensional tolerances are ±0.20 mm, unless otherwise specified.

7.1. Top, Side and Bottom View Dimensions

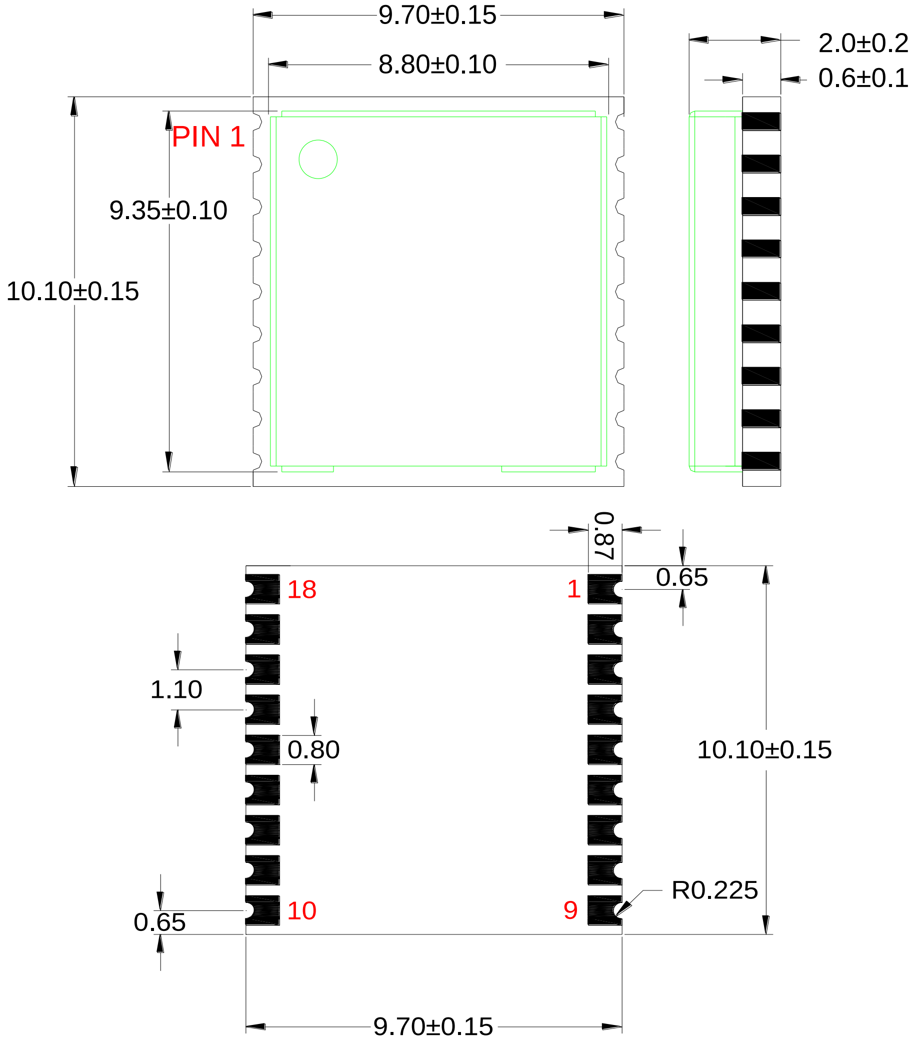


Figure 20: Top, Side and Bottom View Dimensions

NOTE

The package warpage level of the module conforms to the *JEITA ED-7306* standard.

7.2. Top and Bottom Views

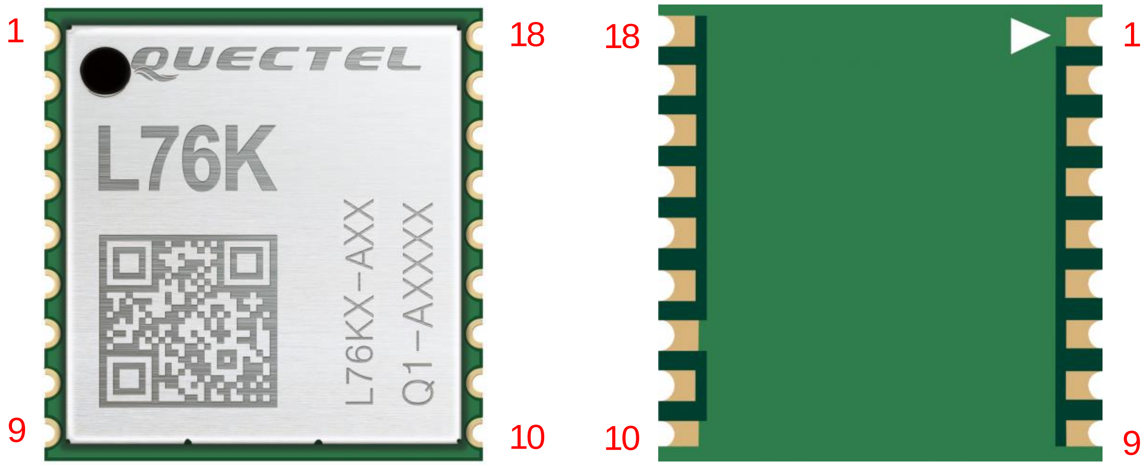


Figure 21: Top and Bottom Module Views

NOTE

The images above are for illustrative purposes only and may differ from the actual module. For authentic appearance and label, see the module received from Quectel.

8 Product Handling

8.1. Packaging

The Quectel L76K module is delivered as a reeled tape, which enables efficient production, set-up and dismantling of production batches. It is shipped in a vacuum-sealed packaging to prevent moisture intake and electrostatic discharge.

8.1.1. Carrier Tape

Dimension details are as follow:

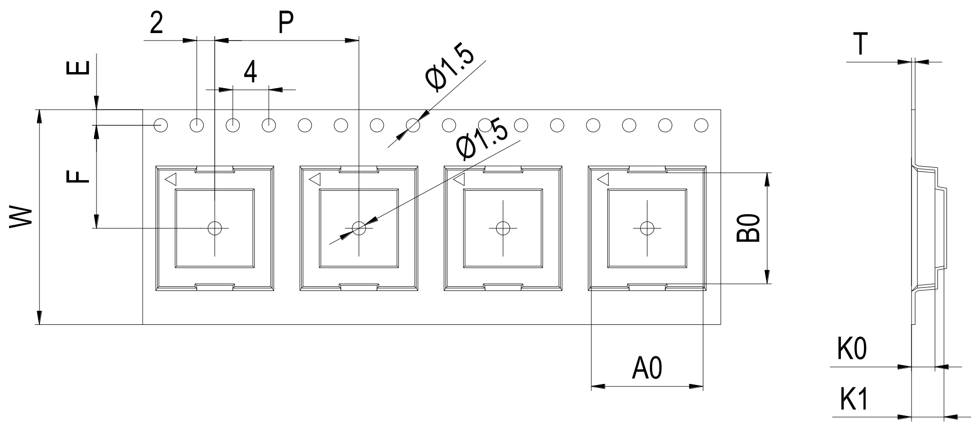


Figure 22: Carrier Tape Dimension Drawing

Table 10: Carrier Tape Dimension Table (Unit: mm)

W	P	T	A0	B0	K0	K1	F	E
24	16	0.3	10.1	10.5	2.8	3.3	11.5	1.75

8.1.2. Plastic Reel

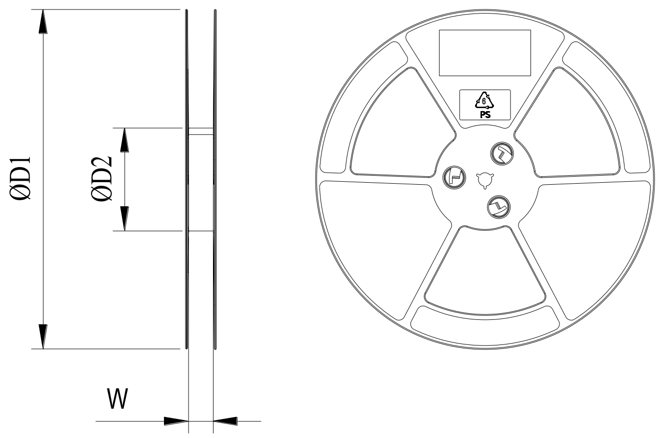
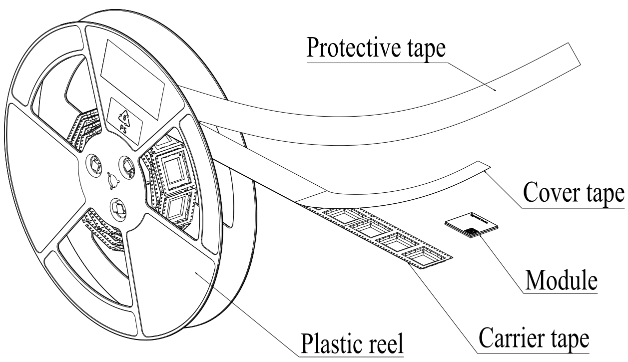


Figure 23: Plastic Reel Dimension Drawing

Table 11: Plastic Reel Dimension Table (Unit: mm)

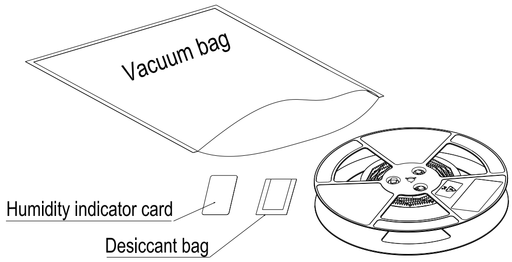
øD1	øD2	W
330	100	24.5

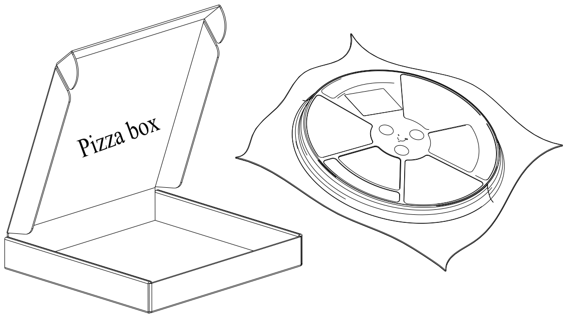
8.1.3. Packaging Process



Place the module into the carrier tape and use the cover tape to cover them; then wind the heat-sealed carrier tape to the plastic reel and use the protective tape for protection. One plastic reel can load 500 modules.

Place the packaged plastic reel, humidity indicator card and desiccant bag into a vacuum bag, then vacuumize it.





Place the vacuum-packed plastic reel into a pizza box.

Put 4 pizza boxes into 1 carton and seal it. One carton can pack 2000 modules.

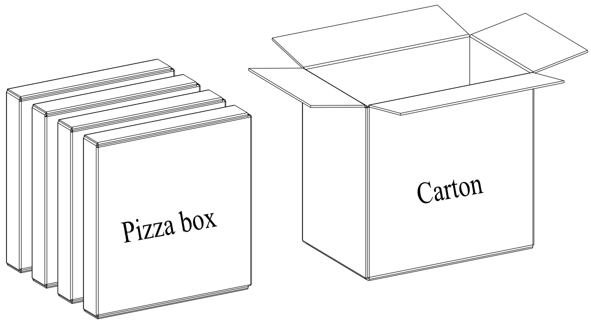


Figure 24: Packaging Process

8.2. Storage

The module is provided in the vacuum-sealed packaging. MSL of the module is rated as 3. The storage requirements are listed below.

1. Recommended storage conditions: The temperature should be 23 ±5 °C and the relative humidity should be 35–60 %.

2. The storage life (in vacuum-sealed packaging) is 12 months in recommended storage conditions.

3. The shelf life of the module is 168 hours [4] in a plant where the temperature is 23 ±5 °C and relative humidity is below 60 %. After the vacuum-sealed packaging is removed, the module must be

[4] The 168 h shelf life rule is only valid when the environment conforms to *IPC/JEDEC J-STD-033*. It is recommended to start the solder reflow process within 24 hours of removing the package if the temperature and moisture do not conform to, or if it is not certain that they conform to *IPC/JEDEC J-STD-033*. Do not remove the packaging if the module is not ready for soldering.

processed in reflow soldering or other high-temperature operations within 168 hours. Otherwise, the module should be stored in an environment where the relative humidity is less than 10 % (e.g., a drying cabinet).

4. The module should be pre-baked to avoid blistering, cracks and inner-layer separation in PCB under the following circumstances:

   - The module is not stored under Recommended Storage Condition;
   - Violation of the third requirement above occurs;
   - Vacuum-sealed packaging is broken, or the packaging has been removed for over 24 hours;
   - Before module repairing.

5. If needed, the pre-baking should follow the requirements below:

   - The module should be baked for 8 hours at 120 ±5 °C;
   - All modules must be soldered to the PCB within 24 hours of baking, otherwise they should be put in a dry environment such as a drying oven.

NOTE

1. To avoid blistering, layer separation and other soldering issues, extended exposure of the module to the air is forbidden.
2. Take out the module out of the packaging and put it on high-temperature-resistant fixtures before baking. All modules must be soldered to PCB within 24 hours of the baking, otherwise put them in the drying oven. If shorter baking time is desired, see *IPC/JEDEC J-STD-033* for the baking procedure.
3. Pay attention to ESD protection, such as wearing anti-static gloves, when touching the modules.

8.3. Manufacturing and Soldering

Push the squeegee to apply solder paste on the surface of stencil, thus making the paste fill the stencil openings and then penetrate the PCB. Apply proper force on the squeegee to produce a clean stencil surface on a single pass. For more information about the stencil thickness for the module, see ***document [3]***.

The peak reflow temperature should be 235–246 ºC, with 246 ºC as the absolute maximum reflow temperature. To avoid module damage caused by repeated heating, it is strongly recommended that the module should be mounted to the PCB only after reflow soldering of the other side of PCB has been completed. The recommended reflow soldering thermal profile (lead-free reflow soldering) and related parameters are shown in the figure and table below.

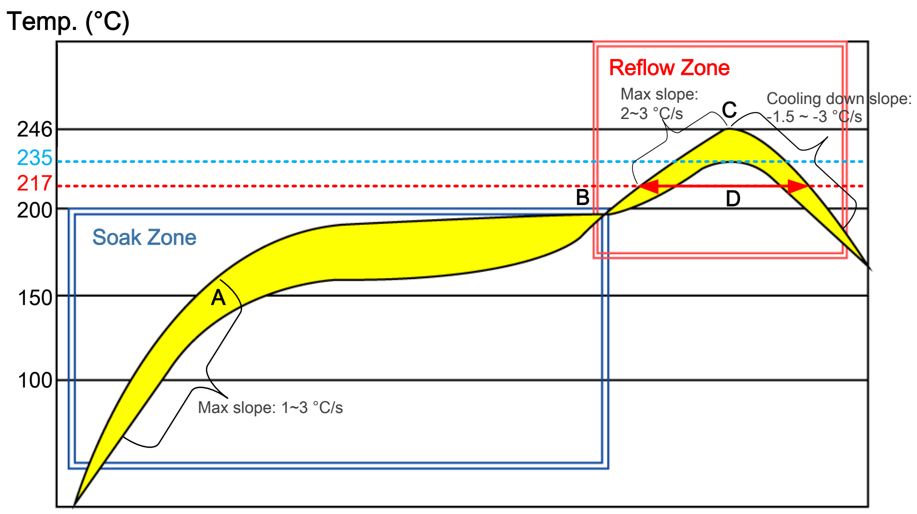


Figure 25: Recommended Reflow Soldering Thermal Profile

Table 12: Recommended Thermal Profile Parameters

Factor	Recommendation
Soak Zone	
Max. Slope	1–3 °C/s
Soak Time (between A and B: 150 °C and 200 °C)	70–120 s
Reflow Zone	
Max. Slope	2–3 °C/s
Reflow Time (D: over 217 °C)	40–70 s
Max. Temperature	235 °C to 246 °C
Cooling Down Slope	-1.5 to -3 °C/s
Reflow Cycle	
Max. Reflow Cycle	1

NOTE

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.
3. If a conformal coating is necessary for the module, do NOT use any coating material that may chemically react with the PCB or shielding cover, and prevent the coating material from flowing into the module.
4. Avoid using ultrasonic technology for module cleaning since it can damage crystals inside the module.
5. Due to the complexity of the SMT process, please contact Quectel Technical Supports in advance for any situation that you are not sure about, or any process (e.g. selective soldering, ultrasonic soldering) that is not mentioned in ***document [3]***.

9 Labelling Information

The label of the Quectel GNSS modules contains important product information. The location of the product type number is shown in the figure below.

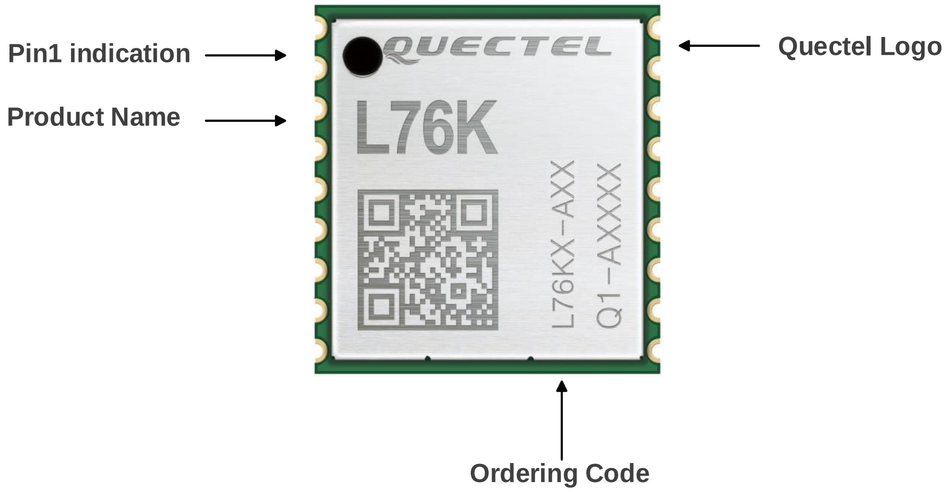


Figure 26: Labelling Information

The image above is for illustrative purposes only and may differ from the actual module. For authentic appearance and label, see the module received from Quectel.

10 Appendix References

Table 13: Related Documents

Document Name	
[1]	Quectel_L76K_GNSS_Protocol_Specification
[2]	Quectel_L76K_Reference_Design
[3]	Quectel_Module_Secondary_SMT_Application_Note

Table 14: Terms and Abbreviations

Abbreviation	Description
AGNSS	Assisted Global Positioning System
CEP	Circular Error Probable
CNR or C/N	Carrier-to-noise Ratio
DCS1800	Digital Cellular System at 1800 MHz
DR	Dead Reckoning
ESD	Electrostatic Discharge
Galileo	Galileo Satellite Navigation System (EU)
GLONASS	Global Navigation Satellite System (Russian)
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GSM	Global System for Mobile Communications
I/O	Input /Output
I2C	Inter-Integrated Circuit

IC	Integrated Circuit
IRNSS/NavIC	Indian Regional Navigation Satellite System
LCC	Leadless Chip Carrier (package)
LDO	Low-dropout Regulator
LNA	Low-Noise Amplifier
LTE	Long Term Evolution
MCU	Microcontroller Unit/Microprogrammed Control Unit
MSL	Moisture Sensitivity Levels
NMEA	National Marine Electronics Association
OC	Open Connector
PCB	Printed Circuit Board
PMU	Power Management Unit
1PPS	One Pulse Per Second
PSRR	Power Supply Rejection Ratio
QR (code)	Quick Response (Code)
QZSS	Quasi-Zenith Satellite System
RF	Radio Frequency
RHCP	Right Hand Circular Polarization
RoHS	Restriction of Hazardous Substances
RTC	Real-Time Clock
RTK	Real-Time Kinematic
RXD	Receive Data
3GPP	3rd Generation Partnership Project
SAW	Surface Acoustic Wave
SBAS	Satellite-Based Augmentation System
SMD	Surface-Mount Device

SMT	Surface-Mount Technology
SPI	Serial Peripheral Interface
SRAM	Static Random Access Memory
TCXO	Temperature Compensated Crystal Oscillator
T_{OPR}	Continuous mode operating temperature
TTFF	Time to First Fix
TVS	Transient Voltage Suppressor
TXD	Transmit Data (Pin)
UART	Universal Asynchronous Receiver/Transmitter
VSWR	Voltage Standing Wave Ratio
WCDMA	Wideband Code Division Multiple Access
XTAL	External Crystal Oscillator