LC26G (AB)
Hardware Design

GNSS Module Series

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Safety Information

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 precautions by incorporating them 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.

About the Document

Document Information	
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-	2022-07-09	Creation of the document
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Contents

Table Index

Figure Index

1 Product Description

1.1. Overview

Quectel LC26G (AB) module supports multiple global positioning systems: GPS, GLONASS, Galileo, BDS and QZSS. The module also supports SBAS (including WAAS, EGNOS, MSAS and GAGAN) and AGNSS functions.

Key features:

- Single-band, multi-constellation GNSS module features high-performance, high reliability positioning engine, which facilitates fast and precise GNSS positioning.
- Supported serial communication interfaces: UART and I2C.
- Supported advanced power saving mode: Backup mode.
- EASY technology facilitates achieving a faster Time to First Fix (TTFF) in either hot or warm start.
- Embedded flash memory provides the capacity for storing user-specific configurations and future firmware updates.

The LC26G (AB) module is an SMD module type with a compact form factor of 12.2 mm × 16.0 mm × 2.4 mm. It can be embedded in your applications through 24 LCC pins.

The module is fully compliant with the EU RoHS Directive.

1.1.1. Special Marks

Table 1: Special Marks

Mark	Definition
*	Unless otherwise specified, when an asterisk (*) is used after a function, feature, interface, pin name, or argument, it indicates that the function, feature, interface, pin, or argument is under development and currently not supported; and the asterisk (*) after a model indicates that the sample of the model is currently unavailable.
●	The symbol indicates that a function or technology is supported by the module.

1.2. Features

Table 2: Product Features

Features			LC26G (AB)
Grade	Industrial		●
	Automotive		-
Category	Standard Precision GNSS		●
	High Precision GNSS		-
	DR		-
	RTK		-
	Timing		-
VCC Voltage	2.55–3.6 V, Typ. 3.3 V		●
V_BCKP Voltage	1.65–3.6 V, Typ. 3.3 V		●
I/O Voltage	Same as VCC		●
Communication Interfaces	UART		●
	SPI		-
	I2C		●
	CAN		-
	USB		-
Integrated Features	Additional LNA		●
	Additional Filter		●
	RTC Crystal		●
	TCXO Oscillator		●
	6-axis IMU		-
Constellations and Frequency Bands	Number of Concurrent GNSS		4 + QZSS
	GPS	L1 C/A	●

Features			LC26G (AB)
		L5	-
		L2C	-
	GLONASS	L1	●
		L2	-
	Galileo	E1	●
		E5a	-
		E5b	-
	BDS	B1I	●
		B1C*	●
		B2a	-
		B2I	-
	QZSS	L1 C/A	●
		L5	-
		L2C	-
	NavIC	L5	-
	SBAS	L1	●
Temperature Range	Operating temperature range: -40 °C to +85 °C Storage temperature range: -40 °C to +90 °C		
Physical Characteristics	Size: (12.2 ±0.2) mm × (16.0 ±0.2) mm × (2.4 ±0.2) mm Weight: Approx. 0.85 g		

NOTE

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

1.3. Performance

Table 3: Product Performance

Parameter	Specification	LC26G (AB)
Power Consumption [1] (GPS + GLONASS + Galileo + BDS + QZSS)	Acquisition	36 mA (118.8 mW)
	Tracking	36 mA (118.8 mW)
	Backup Mode	13 µA (42.9 µW)
Sensitivity (GPS + GLONASS + Galileo + BDS + QZSS)	Acquisition	-147 dBm
	Reacquisition	-159 dBm
	Tracking	-166 dBm
TTFF [1] (without AGNSS)	Cold Start	28 s
	Warm Start	25 s
	Hot Start	1 s
TTFF [2] (with EASY)	Cold Start	15 s
	Warm Start	2 s
	Hot Start	1 s
TTFF [2] (with EPO)	Cold Start	5 s
Horizontal Position Accuracy [3]	1.5 m	
Update Rate	1 Hz (Default), Max. 10 Hz	
Accuracy of 1PPS Signal [1]	RMS	20 ns
	3σ	60 ns
Velocity Accuracy [1]	Without Aid: 0.1 m/s	
Acceleration Accuracy [1]	Without Aid: 0.1 m/s²	
Dynamic Performance [1]	Maximum Altitude: 10000 m	
	Maximum Velocity: 490 m/s	
	Maximum Acceleration: 4g	

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

1.4. Block Diagram

A block diagram of the module is presented below. It includes a front-end section consisting of an additional LNA, a SAW filter, a notch circuit, a TCXO and an XTAL, and a GNSS IC consisting of an internal PMU.

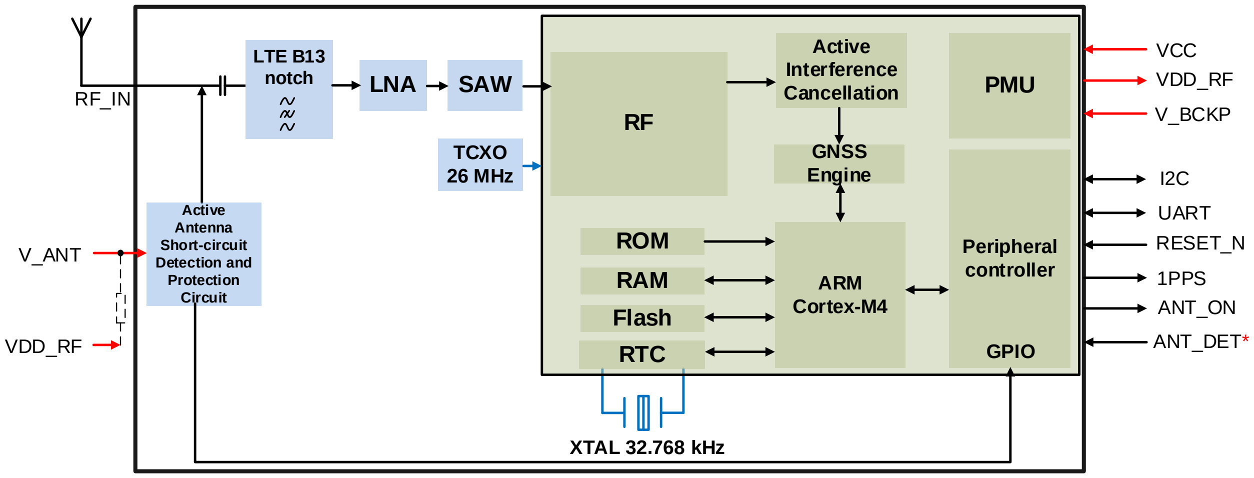


Figure 1: Block Diagram

1.5. GNSS Constellations

The module is a single-band GNSS receiver that can track multiple GNSS systems concurrently. Due to the RF front-end architecture, it can concurrently track the following GNSS constellations: GPS, GLONASS, Galileo, BDS and QZSS, plus SBAS satellites. If low power consumption is a key factor, the module can be configured for a subset of GNSS constellations.

QZSS is a regional navigation satellite system that transmits signals compatible with the GPS L1 C/A, L1C, L2C and L5 signals for the Pacific region covering Japan and Australia. The module can detect and track QZSS L1 C/A signal concurrently with GPS signals, leading to better availability especially under challenging conditions, e.g. in dense urban areas.

Table 4: GNSS Constellations and Frequency Bands

System	Signals
GPS	L1 C/A: 1575.42 MHz
GLONASS	L1: 1602 MHz + K × 562.5 kHz, K= (-7 to +6, integer)

System	Signals
Galileo	E1: 1575.42 MHz
BDS	B1I: 1561.098 MHz B1C*: 1575.42 MHz
QZSS	L1 C/A: 1575.42 MHz

1.6. Augmentation System

1.6.1. SBAS

The module supports SBAS signal reception. By augmenting primary GNSS constellations with additional satellite-broadcast messages, the system improves the accuracy and reliability of GNSS information by correcting signal measurement errors and providing information about signal accuracy, integrity, continuity and availability. SBAS transmits signals for ranging or distance measurement, thus further improving availability. Supported SBAS systems: WAAS, EGNOS, MSAS and GAGAN.

1.7. AGNSS

The module supports AGNSS feature that significantly reduces the module's TTFF, especially under lower signal conditions. To implement the AGNSS feature, the module should get the assistance data including the current time and rough position. For more information, see *document [2] AGNSS application note*.

1.7.1. EASY

The module supports the EASY technology to that can improve TTFF. To achieve that goal, the EASY technology provides ancillary information, such as ephemeris and almanac.

The EASY technology works as an embedded software to accelerate TTFF by predicting satellite navigation messages from the received ephemeris. After receiving the broadcast ephemeris for the first time, the GNSS engine automatically calculates and predicts the orbit information up to subsequent 3 days, and saves the predicted information in the internal memory. The GNSS engine will use the information for positioning if there is not enough information from satellites, resulting in improved TTFF.
The EASY function can improve the TTFF to 2 s in a warm start. In this case, the backup domain should still be valid. To obtain enough broadcast ephemeris information from GNSS satellites after fixing the position, the GNSS module should keep tracking the information for at least 5 minutes in strong-signal environments.

The EASY function is enabled by default, and it is disabled by **$PAIR490**. For more information, see *document [1] protocol specification*.

1.7.2. EPO

The module features a leading AGNSS technology called EPO, which can assist the receiver to reduce the TTFF for up to 14 days. For more information about EPO, see *document [2] AGNSS application note*.

1.8. Multi-tone AIC

The module features a function called multi-tone active interference cancellation (AIC) to decrease harmonic distortion of RF signals from Wi-Fi, Bluetooth, and cellular networks.

Up to 12 AIC tones embedded in the module provide effective narrow-band interference and jamming elimination. Thus, the GNSS signal could be demodulated from the jammed signal, which can ensure better navigation quality.

The AIC function is enabled by default, and it can be disabled with **$PAIR074**. For more information, see *document [1] protocol specification*.

1.9. Firmware Upgrade

The module is delivered with preprogrammed firmware. Quectel may release firmware versions that contain bug fixes or performance optimizations. It is highly important to implement a firmware upgrade mechanism in your system. A firmware upgrade is the process of transferring a binary file image to the receiver and storing it in non-volatile flash. For more information, see *document [3] firmware upgrade guide*.

2 Pin Assignment

Quectel LC26G (AB) features 24 pins, which can be used to mount the module on a PCB.

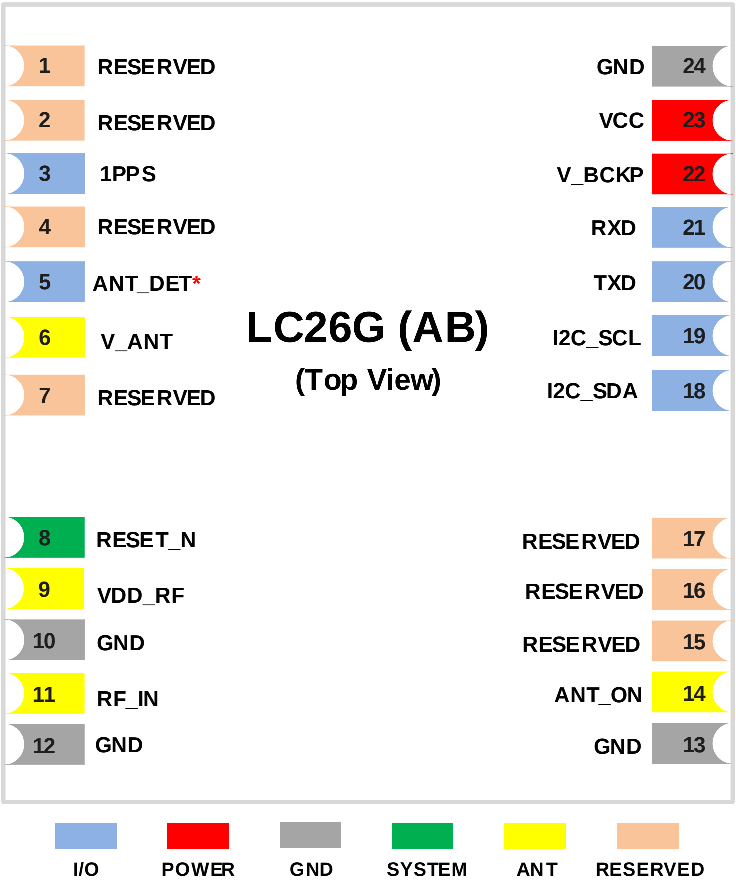


Figure 2: Pin Assignment

Table 5: I/O Parameter Definition

Type	Description
AI	Analog Input
DI	Digital Input
DO	Digital Output

Type	Description
DIO	Digital Input/Output
PI	Power Input
PO	Power Output

Table 6: Pin Description

Function	Name	No.	I/O	Description	DC Characteristics	Remarks
Power	VCC	23	PI	Main power supply	V_{I}min = 2.55 V V_{I}nom = 3.3 V V_{I}max = 3.6 V	Provides clean and steady voltage.
	V_BCKP	22	PI	Backup power supply for backup domain	V_{I}min = 1.65 V V_{I}nom = 3.3 V V_{I}max = 3.6 V	V_BCKP must be connected to power supply for startup, and it should always be powered if hot (warm) start is needed.
I/O	TXD	20	DO	Transmits data	V_{OL}max = 0.4 V V_{OH}min = 2.4 V	UART interface is used for RTCM and standard NMEA message output, PQTM/PAIR message and binary data input/output, and firmware upgrade.
	RXD	21	DI	Receives data	V_{IL}min = -0.3 V V_{IL}max = 0.8 V V_{IH}min = 2 V V_{IH}max = VCC + 0.3	
	I2C_SCL	19	DI	I2C serial clock	V_{IL}min = -0.3 V V_{IL}max = 0.8 V V_{IH}min = 2 V V_{IH}max = VCC + 0.3	I2C interface is used for standard NMEA message output and PQTM/PAIR message input/output.
	I2C_SDA	18	DIO	I2C serial data	V_{OL}max = 0.4 V V_{OH}min = 2.4 V	
	1PPS	3	DO	One pulse per second	V_{OL}max = 0.4 V V_{OH}min = 2.4 V	Synchronized on rising edge. If unused, leave the pin not connected (N/C).
	ANT_DET*	5	DI	Antenna detection	V_{IL}min = -0.3 V V_{IL}max = 0.8 V V_{IH}min = 2 V V_{IH}max = VCC + 0.3	Logic High: active antenna is unconnected or not connected well; Logic Low: active antenna is connected well. If unused, leave the pin N/C.
ANT	RF_IN	11	AI	GNSS antenna interface	-	50 Ω characteristic impedance.

Function	Name	No.	I/O	Description	DC Characteristics	Remarks
	V_ANT	6	PI	Active antenna bias voltage	$V_O$nom = VCC	If passive antenna is used, leave the pin N/C. If an active antenna is used, a 22 Ω resistor should be connected in series between V_ANT and VDD_RF.
	ANT_ON	14	DO	Power control for external LNA and active antenna.	V_{OL}max = 0.4 V V_{OH}min = 2.4 V	Outputs high level signal in Continuous mode and low level signal in the power saving mode. If unused, leave this pin N/C.
	VDD_RF	9	PO	Supplies power for external RF components	$V_O$nom = VCC	VDD_RF = VCC. Outputs current capacity depends on VCC. Typically used for powering an external active antenna or LNA. If unused, leave the pin N/C.
System	RESET_N	8	DI	Resets the module	V_{IL}min = -0.3 V V_{IL}max = 0.45 V V_{IH}min = 1.8 V V_{IH}max = 3.6 V	Active low. Belongs to backup domain.
GND	GND	10, 12 13, 24	-	Ground	-	Ensure a good GND connection to all module GND pins, preferably with a large ground plane.
RESERVED	RESERVED	1, 2, 4, 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 LC26G (AB) module features 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 two operating modes: Backup mode for optimum power consumption, and Continuous mode for optimum performance.

3.1. Power Unit

VCC is the supply voltage pin of the module. It supplies the PMU which in turn supplies the entire system. 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 the backup domain, which includes RTC and low power RAM. To achieve quick startup and improve TTFF, the backup domain power supply should be valid during the interval. If the VCC is not valid, the V_BCKP supplies low power RAM 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 for the external active antenna or the LNA. Only when VCC is cut off, will VDD_RF be turned off.

The module's internal power supply is shown below:

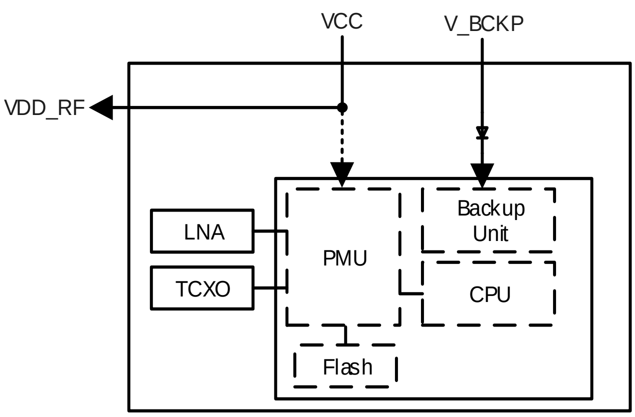


Figure 3: Internal Power Supply

3.2. Power Supply

3.2.1. VCC

The VCC is the supply voltage pin that supplies BB and RF.

Module power consumption may vary by several orders of magnitude, especially when a power saving mode is enabled. Therefore, it is important for 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 starts up or switches from the Backup mode to the Continuous mode, VCC 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 for the LDO at the power supply or module input to be able to provide the sufficient current. An LDO with a high PSRR should be chosen for optimum performance. In addition, a TVS, and a combination of a 10 µF, a 100 nF and a 33 pF decoupling capacitor should be added near the VCC pin. The lowest value capacitor should be the closest to module pins.

It is not recommended to use a switching DC-DC converter.

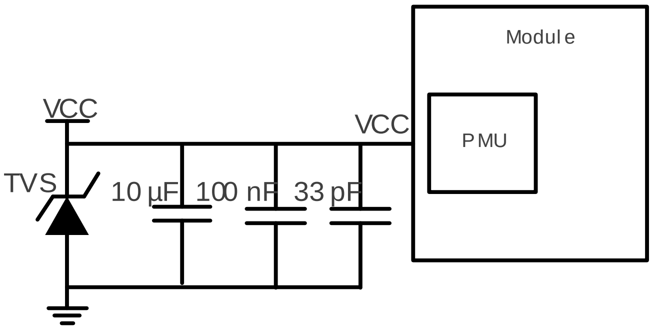


Figure 4: VCC Input Reference Circuit

NOTE

It is recommended to control the module VCC via MCU to save power, or restart the module if it enters an abnormal state.

3.2.2. V_BCKP

The V_BCKP pin supplies the backup domain. Use of valid time and GNSS orbit data at startup allows GNSS hot (warm) start. V_BCKP must be connected to power supply for startup, and it should always be powered if hot (warm) start is needed.

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

V_BCKP can be directly powered by an external rechargeable battery. It is recommended to place a battery with a TVS and a 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 powering the backup domain with a rechargeable battery.

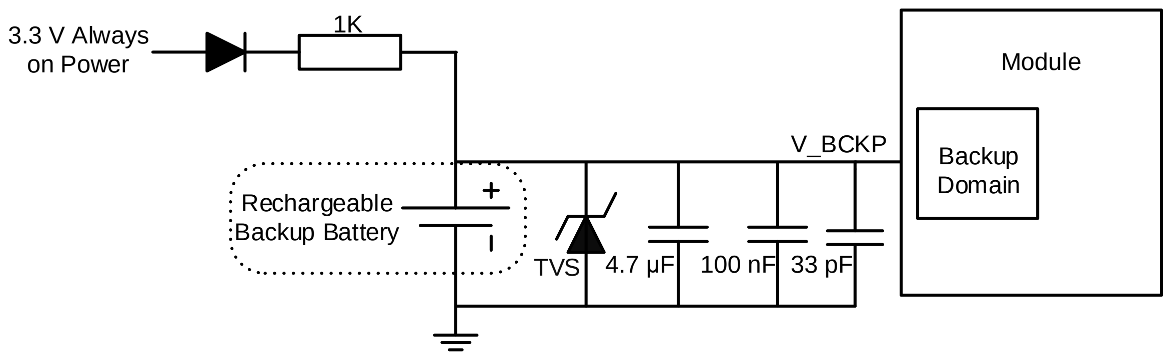


Figure 5: Reference Charging Circuit with Rechargeable Backup Battery

V_BCKP can also be powered by a 3.7 V lithium battery, as shown in the figure below.

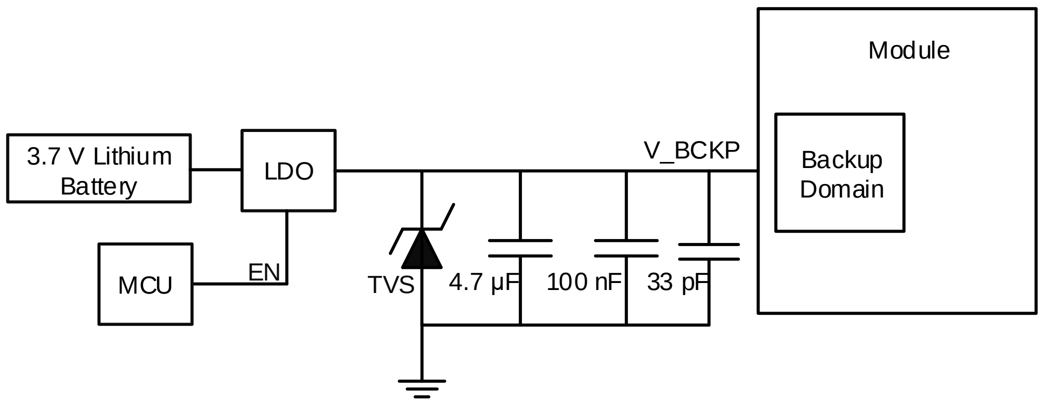


Figure 6: Reference Circuit for 3.7 V Lithium Battery

NOTE

1. In the Continuous mode, the maximum current consumption of V_BCKP exceeds 100 μA, which will deplete the battery. Therefore, it is not recommended to use a non-rechargeable battery.

2. If V_BCKP is below the minimum value of the recommended operating voltage, the module cannot work normally.
3. A 1 kΩ resistor should be used, the resistance value of the current-limiting resistor is related to the battery selected by your application. In order to maintain the performance of the rechargeable battery, it is necessary to select 1 kΩ resistor to limit the charging current.
4. It is recommended to control the module V_BCKP via MCU to restart the module if the module enters an abnormal state.

3.3. Power Mode

3.3.1. Feature Comparison

The module features supported in different modes are listed in the table below.

Table 7: Feature Comparison in Different Power Modes

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

3.3.2. Continuous Mode

If VCC and V_BCKP are powered on, the module automatically enters the Continuous mode that 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. Once 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. Backup Mode

For power-sensitive applications, the module receiver supports a Backup mode to reduce power consumption. Only backup domain is active in Backup mode and it keeps track of time.

- Enter Backup mode:
  1. Send **$PAIR650,0*25** to shut down internal main power supply in sequence.
  2. Cut off the power supply to the VCC pin and keep the V_BCKP pin powered.

- Exit Backup mode:
  1. Restore VCC power.
  2. Driving the RESET_N low for at least 100 ms.

For details of the relevant software command, see *document [1] protocol specification*.

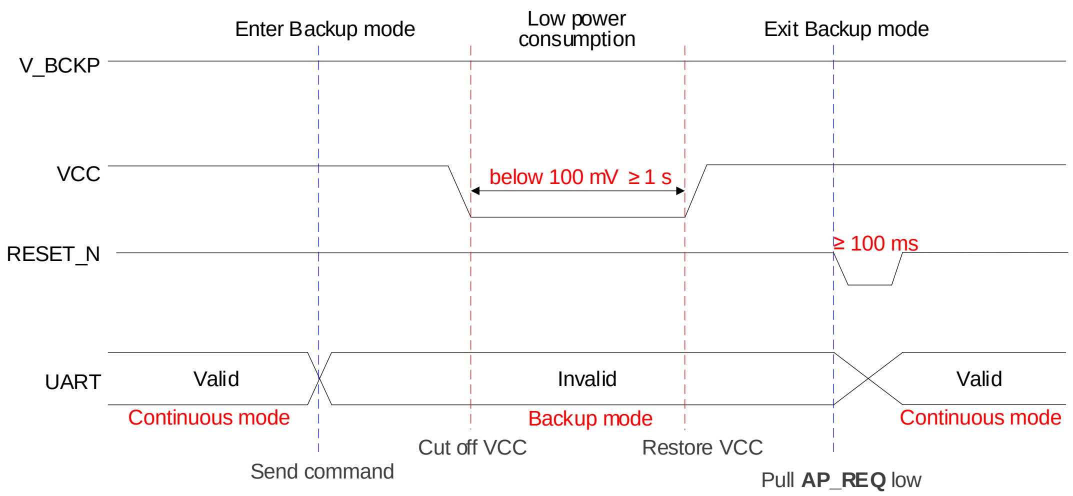


Figure 7: Enter/Exit Backup Mode Sequence

NOTE

1. The software command must be sent; to ensure hot (warm) start of the module at the next startup, the V_BCKP must be kept powered.
2. Ensure a stable V_BCKP voltage, without a rush or drop when the VCC is switched on or off.
3. If you cut off module's power supply directly (without sending a software command), the module cannot enter the Backup mode normally. In this case, the module will be in an undefined state and the power consumption will be higher.

3.4. Power-up Sequence

Once the VCC and V_BCKP are powered up, the module starts up automatically and the voltage should rise rapidly in less than 50 ms.

To ensure the correct power-up sequence, the backup unit should start up no later than the PMU. Therefore, the V_BCKP must be powered simultaneously with the VCC or before it.

Ensure that the VCC has no rush or drop during rising time, and then keep it stable. The recommended ripple is < 50 mV.

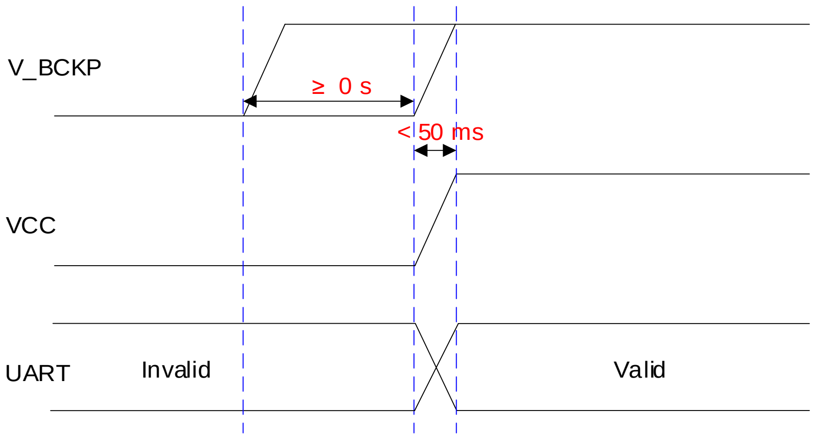


Figure 8: Power-up Sequence

3.5. Power-down Sequence

Once the VCC and V_BCKP are shut down, voltage should drop quickly within less than 50 ms.

To avoid abnormal voltage condition, if VCC falls below the minimum specified value, the system must initiate a power-on restart by lowering VCC to less than 100 mV for at least 1 s.

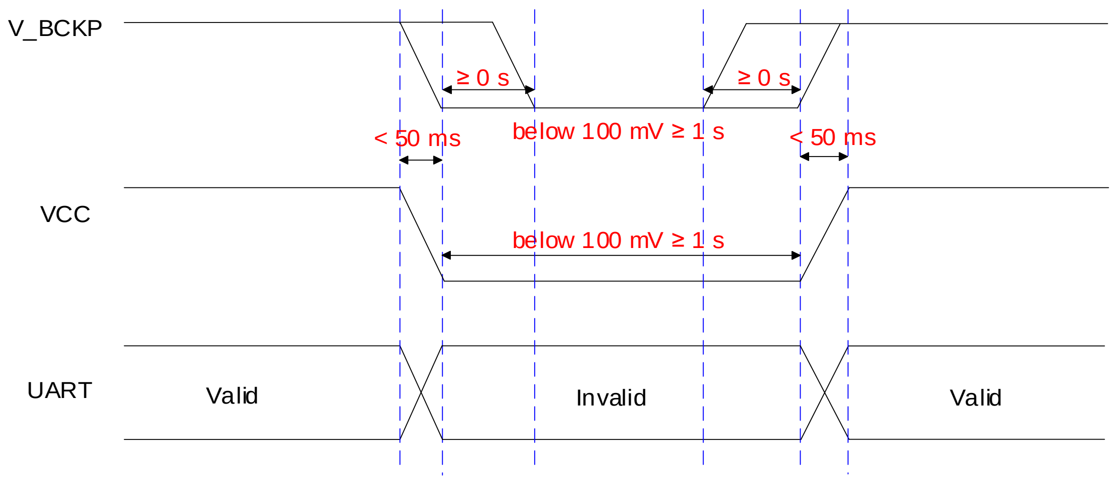


Figure 9: Power-down and Power-on Restart Sequence

4 Application Interfaces

4.1. I/O Pins

4.1.1. Communication Interfaces

The following interfaces can be used for data reception and transmission.

4.1.1.1. UART Interface

The module has one UART interface with the following features:

- Supports RTCM and standard NMEA message output, PQTM/PAIR message and binary data input/output and firmware upgrade.
- Supported baud rates: 9600, 19200, 38400, 57600, 115200, 230400, 460800 and 921600 bps.
- Hardware flow control and synchronous operation are not supported.

A reference design is shown in the figure below. For more information, see *document [4] reference design*.

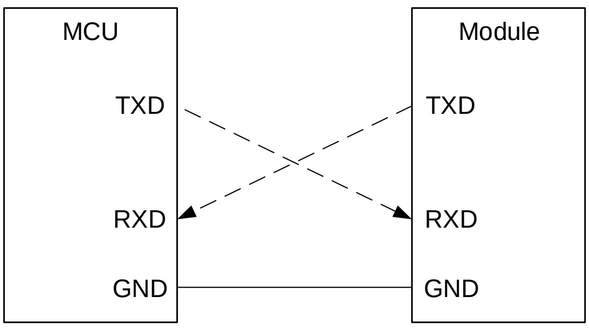


Figure 10: UART Interface Reference Design

NOTE

1. UART interface default settings vary depending on software version. See the relevant software versions for details.

2. If the I/O voltage of MCU is not matched with the module, a level-shifting circuit must be selected.

4.1.1.2. I2C Interface

The module has one I2C interface with the following features:

- Supports standard NMEA message output, and PQTM/PAIR message input/output.
- Supports standard mode (100 kbps) and fast mode (400 kbps).
- Supports 7-bit address.
- Operates in slave mode.
- Open-drain output.

A reference design is shown in the figure below. For more information, see *document [4] reference design*.

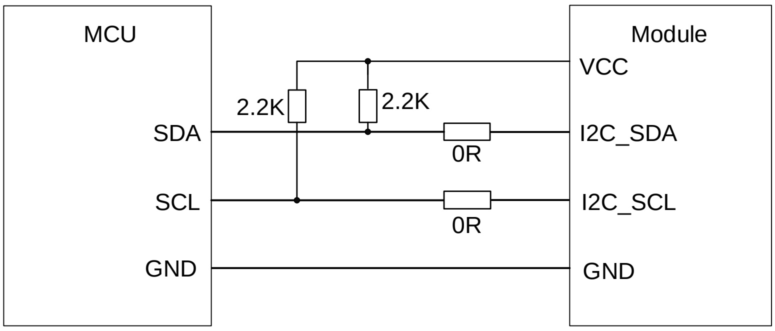


Figure 11: I2C Interface Reference Design

NOTE

If the I/O voltage of MCU is not matched with that of the module, a level-shifting circuit must be selected.

4.1.2. 1PPS

The 1PPS output pin generates one pulse per second periodic signal synchronized with a GNSS time grid with intervals. Maintaining high accuracy of 1PPS requires visible satellites in an open sky environment and powered VCC. See *Table 3: Product Performance* for details about pulse accuracy.

4.2. System Pins

4.2.1. RESET_N

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

By default, the RESET_N pin is pulled up internally to 1.8 V with a 10 kΩ resistor, thus no external pull-up circuit is allowed for this pin.

The reference circuit as shown below is recommended to control the RESET_N pin.

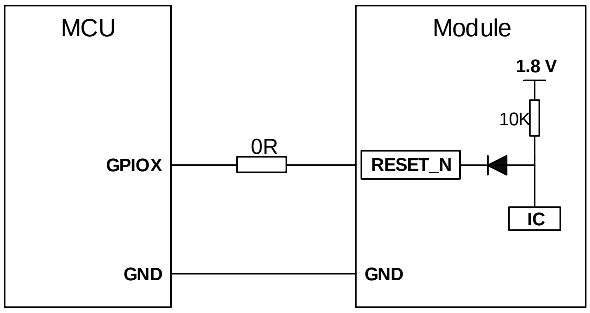


Figure 12: Reference Circuit for Module Reset

The following figure shows the reset sequence of the module.

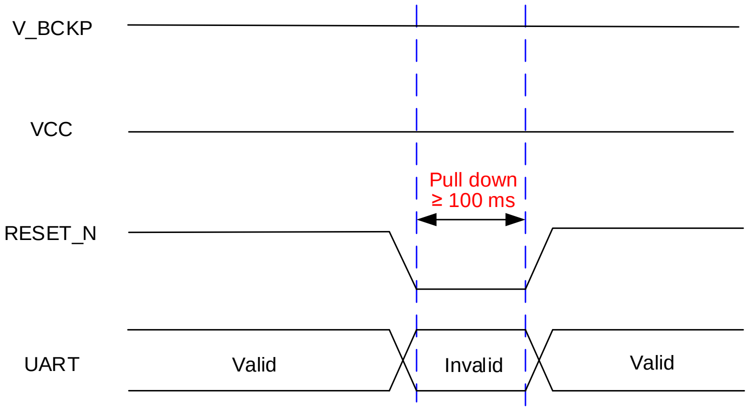


Figure 13: Reset Sequence

NOTE

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

5 Design

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

5.1. Antenna Reference Design

5.1.1. Antenna Specifications

The 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 8: Recommended Antenna Specifications

Antenna Type	Specifications
Passive Antenna	Frequency Range: 1559–1606 MHz Polarization: RHCP VSWR: < 2 (Typ.) Passive Antenna Gain: > 0 dBi
Active Antenna	Frequency Range: 1559–1606 MHz Polarization: RHCP VSWR: < 2 (Typ.) Passive Antenna Gain: > 0 dBi Out-of-Band Rejection: > 40 dB Active Antenna Noise Figure: < 1.5 dB Active Antenna Total Gain: < 17 dB

NOTE

1. For recommended antenna selection and design, see *document [5] GNSS antenna selection guidance* or contact Quectel Technical Support.
2. The total antenna gain equals the internal LNA gain minus the total insertion loss of cables and components inside the antenna.

5.1.2. Antenna Selection Guide

Both active and passive single-band GNSS antennas can be used for the 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. It is recommended to switch from a passive antenna to an active antenna once the loss is > 1 dB, since the insertion loss of RF cable can decrease the C/N_0 of GNSS signal. For more information about RF layout, see *document [6] RF layout application note*.

C/N_0 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. C/N_0 formula:

$$C/N_0 = \text{Power of GNSS signal} - \text{Thermal Noise} - \text{System NF(dB-Hz)}$$

The "Power of GNSS signal" is GNSS signal level. In practical environment, the signal level at the earth's surface is about -130 dBm. "Thermal Noise" is -174 dBm/Hz at 290 K. To improve C/N_0 of GNSS signal, an LNA could be added to reduce "System NF".
"System NF", formula:

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

"F" is the noise factor of receiver system:

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

"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.

5.1.3. Active Antenna Reference Design

Short-circuit protection and antenna status detection for active antenna are supported by LC26G (AB) module. Short-circuit protection circuit is embedded in the module, while an external circuit is needed to implement the antenna detection function. Antenna status detection and ANT_ON circuit of active antenna cannot be used simultaneously. When it is necessary to control the power supply of active antenna, ANT_ON circuit can be used. When the antenna status needs to be detected, the antenna status detection circuit can be used. If an active antenna is used, a 22 Ω resistor should be connected in series between V_ANT and VDD_RF.

Active antenna has an integrated LNA which could be directly connected to RF_IN. If an active antenna is connected to RF_IN, the correct voltage needs to be supplied to the integrated LNA of the antenna through V_ANT pin. Usually, the supply voltage is fed to the antenna through the coaxial RF cable. VDD_RF or an external LDO can be used to power V_ANT.

The active antenna with the SAW filter placed in front of the LNA in the internal framework must be used. This will minimize the impact of out-of-band signals on GNSS module performance in complex electromagnetic environments.

5.1.3.1. Active Antenna with Short-Circuit Protection

If RF_IN is accidentally short-circuited, to protect the module and the active antenna, the route from V_ANT to RF_IN will be cut off by the internal short-circuit protection circuit illustrated in the figure below. If VDD_RF voltage is not suitable for your active antenna, it could be replaced with an external LDO.

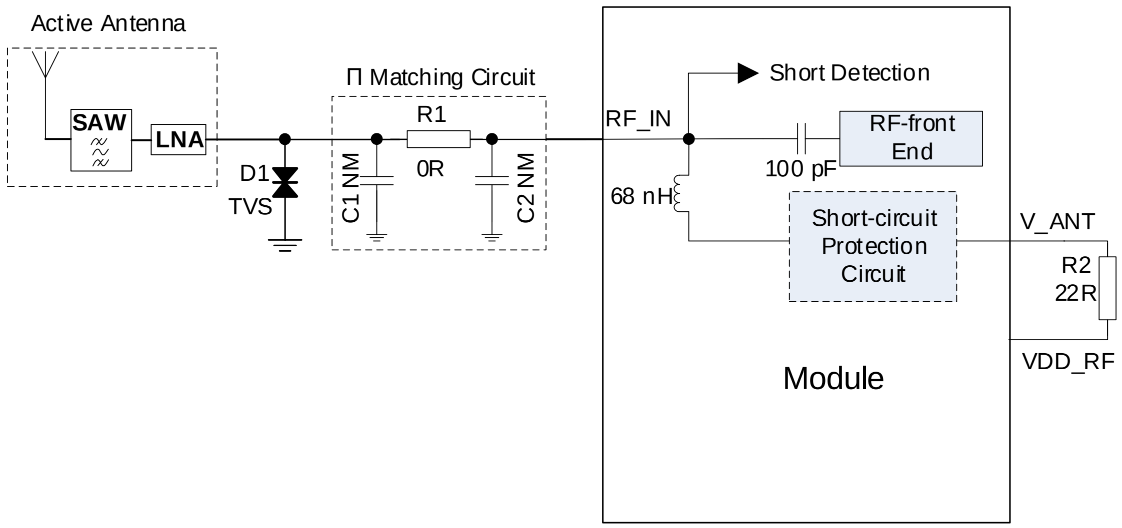


Figure 14: Active Antenna Reference Design with Short-circuit Protection

C1, R1 and C2 are reserved components comprising the matching circuit for antenna impedance modification. By default, C1 and C2 are not mounted, R1 is 0 Ω. D1 is an electrostatic discharge (ESD) protection device to protect RF route from the damage caused by ESD. The junction capacitance of D1 cannot be more than 0.6 pF and a transient voltage suppressor is recommended. The impedance of RF trace should be controlled to 50 Ω and trace length should be kept as short as possible.

5.1.3.2. Active Antenna with Antenna Status Detection

The following figure is a typical reference design of an active antenna with status detection function.

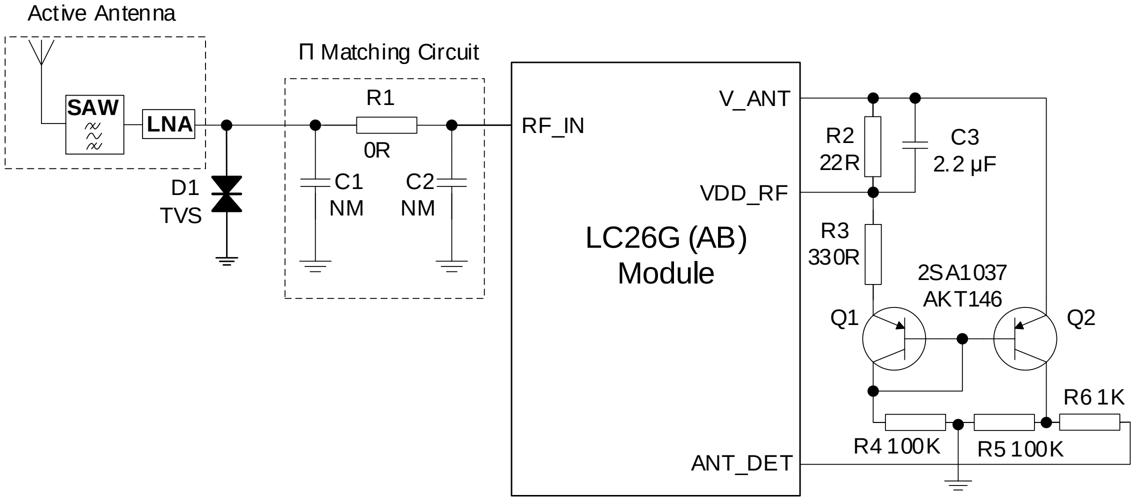


Figure 15: Active Antenna Reference Design with Antenna Status Detection

When active antenna is not connected to RF_IN or they are in poor contact, ANT_DET* will be at a high level to indicate the absence of the active antenna. ANT_DET* will change to a low level when active antenna is connected well.

C1, R1 and C2 are reserved components comprising the matching circuit for antenna impedance modification. By default, C1 and C2 are not mounted, R1 is 0 Ω. D1 is an electrostatic discharge (ESD) protection device to protect RF route from the damage caused by ESD. The junction capacitance of D1 cannot be more than 0.6 pF and a transient voltage suppressor is recommended. The impedance of RF trace should be controlled to 50 Ω and trace length should be kept as short as possible. C3, R3, R4, R5 and R6 are 2.2 μF, 330 Ω, 100 kΩ, 100 kΩ and 1 kΩ respectively. When C3, R3, R4, R5, R6, Q1 and Q2 are mounted, the antenna status can be detected by ANT_DET*.

5.1.3.3. Active Antenna with ANT_ON Circuit

In order to cut off the power supply of active antenna to reduce power consumption in power saving mode, the ANT_ON pin can be used to control the power supply of active antenna. R4 is not mounted by default. If the ANT_ON circuit is not used to control the active antenna power supply, R4 is mounted.

The reference circuit for active antenna with “ANT_ON” function is given below. In addition, VDD_RF can be replaced with an external LDO if it does not meet your requirements.

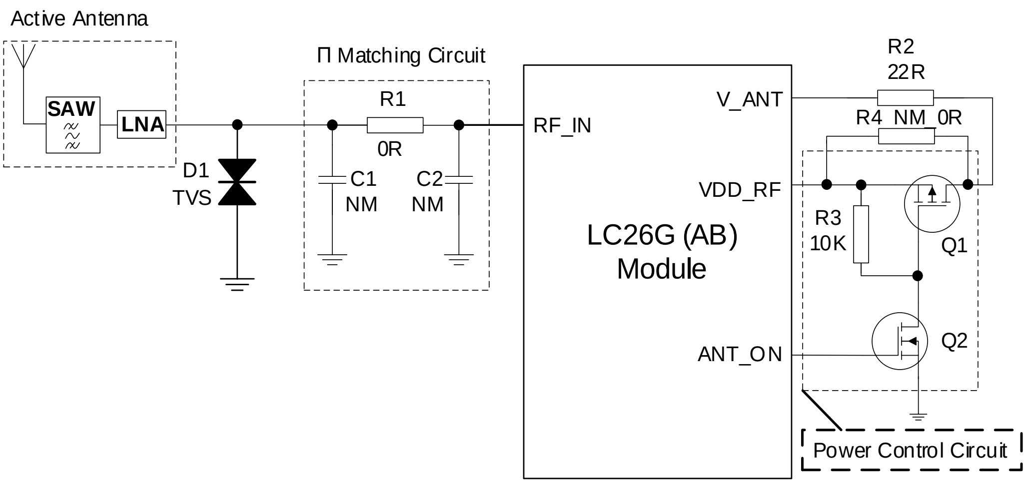


Figure 16: Active Antenna with ANT_ON Circuit

The active antenna is always powered when R4 is mounted. When it is not mounted, while Q1, Q2 and R3 are mounted, the antenna power supply can be controlled through ANT_ON pin. When the pin outputs high level, the antenna is powered; otherwise, the antenna is not powered.

C1, R1 and C2 are reserved components comprising the matching circuit for antenna impedance modification. By default, C1 and C2 are not mounted; R1 is 0 Ω. D1 is an electrostatic discharge (ESD) protection device to protect the RF signal input from the potential damage caused by ESD. The junction capacitance of D1 cannot be more than 0.6 pF and a transient voltage suppressor is recommended.

When using VDD_RF pin to supply power for the active antenna, it is important to consider the voltage drop on the power supply circuit which is caused by the resistor and inductor on the V_ANT internal circuit, and the resistor (R2) in the external power supply circuit.

5.1.4. Passive Antenna Reference Design

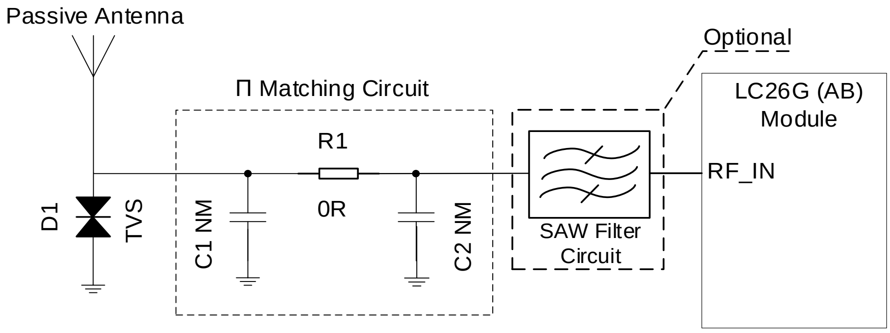


Figure 17: Passive Antenna Reference Design

C1, R1 and C2 are reserved components comprising the matching circuit for antenna impedance modification. By default, R1 is 0 Ω, while C1 and C2 are not mounted. D1 is an electrostatic discharge (ESD) protection device to protect RF route from the damage caused by ESD. The junction capacitance of D1 cannot be more than 0.6 pF and a transient voltage suppressor is recommended. RF trace impedance should be controlled to 50 Ω and trace length should be kept as short as possible.

In a complex electromagnetic environment, a SAW filter circuit must be added to the antenna design to further reduce the impact of out-of-band signals on the GNSS module. The recommended SAW filters are B39162B2618P810 from RF360 and SAFFB1G56AC0F7FR1X from Murata. In the actual layout, the circuit should be placed close to RF_IN pin.

5.2. Coexistence with Cellular Systems

Since GNSS signals are usually very weak, a GNSS receiver could be vulnerable to environmental interference. 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 or 26 dBm at 5G bands. Therefore, 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.

5.2.1. In-Band Interference

In-band interference refers to the signal whose frequency is within or near the operating frequency range of a GNSS signal. For example, GPS L1 has a center frequency of 1575.42 MHz and a bandwidth of 2.046 MHz. As shown in the figure below, the frequency of the interfering signal is within the GPS working bandwidth, and the power of the interfering signal is higher than the power value of the actual GPS signal received.

See the following figure for more details.

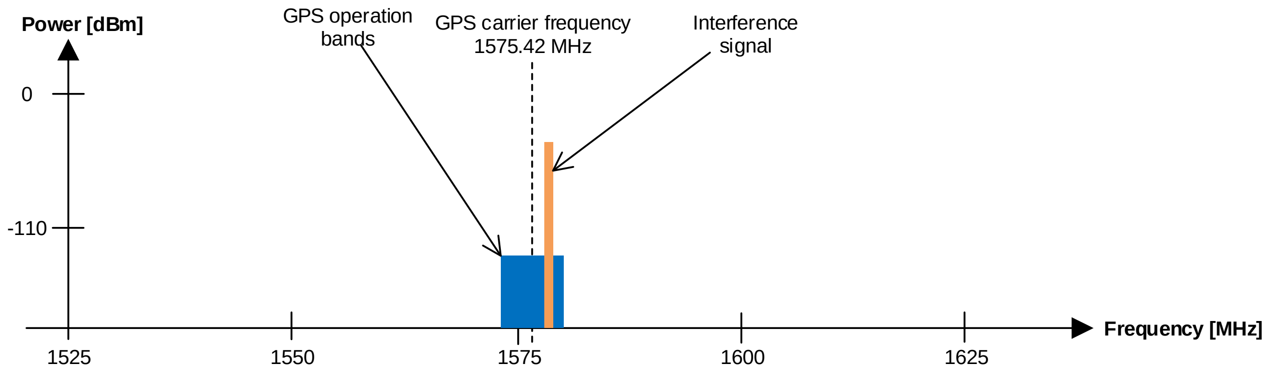


Figure 18: In-Band Interference on GPS L1

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 Band 13.

Table 9: Intermodulation Distortion (IMD) Products

Source F1	Source F2	IM Calculation	IMD Products
GSM850/Band 5	Wi-Fi 2.4 GHz	F2 (2412 MHz) - F1 (837 MHz)	IMD2 = 1575 MHz
Band 1	n78	F2 (3500 MHz) - F1 (1925 MHz)	IMD2 = 1575 MHz
DCS1800/Band 3	PCS1900/Band 2	2 × F1 (1712.6 MHz) - F2 (1850.2 MHz)	IMD3 = 1575 MHz
PCS1900/Band 2	Wi-Fi 5 GHz	F2 (5280 MHz) - 2 × F1 (1852 MHz)	IMD3 = 1576 MHz
LTE Band 13	N/A	2 × F1 (786.9 MHz)	IMD2 = 1573.8 MHz

Strong signals transmitted by other communication systems can cause a GNSS receiver saturation, thus greatly deteriorating its performance, as illustrated in the following figure. In practical applications common strong interference signals originate from wireless communication modules, such as GSM, 3G, LTE, 5G, Wi-Fi, Bluetooth.

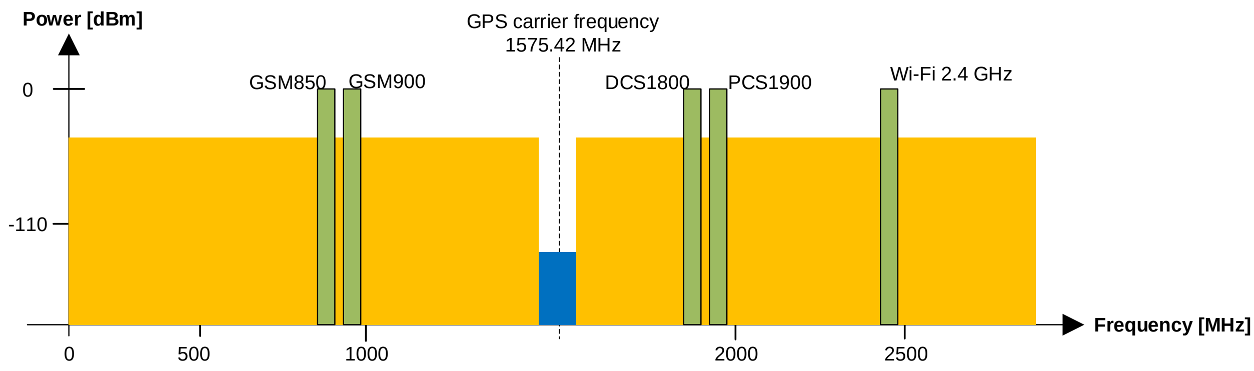


Figure 19: Out-of-Band Interference on GPS L1

5.2.2. 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 and 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. A complex communication system usually contains 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.

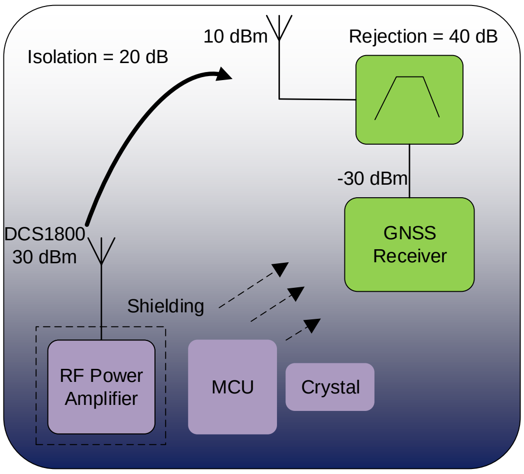


Figure 20: Interference Source and Its Path

5.3. Recommended Footprint

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

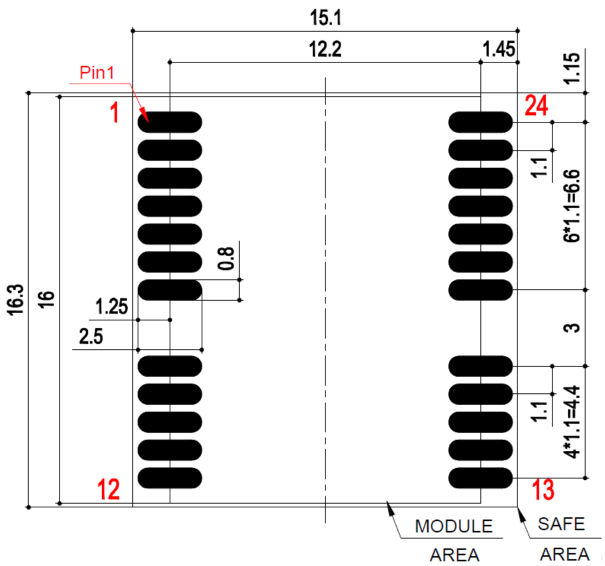


Figure 21: Recommended Footprint

NOTE

Maintain at least 3 mm keepout between the module and other components on the motherboard to improve soldering quality and maintenance convenience.

6 Electrical Specification

6.1. Absolute Maximum Ratings

Absolute maximum ratings for power supply and voltage on digital pins of the Quectel LC26G (AB) module are listed in table below.

Table 10: Absolute Maximum Ratings

Parameter	Description	Min.	Max.	Unit
VCC	Main Power Supply Voltage	-0.3	3.63	V
V_BCKP	Backup Supply Voltage	0	3.63	V
V_{IN}_IO	Input Voltage at I/O Pins	-0.3	3.63	V
P_{RF_IN}	Input Power at RF_IN	-	0	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 specification validity.

Table 11: Recommended Operating Conditions

Parameter	Description	Min.	Typ.	Max.	Unit
VCC	Main Power Supply Voltage	2.55	3.3	3.6	V
V_BCKP	Backup Supply Voltage	1.65	3.3	3.6	V
IO_Domain	Digital I/O Pin Voltage Domain	-	VCC	-	V
V_{IL}	Digital I/O Pin Low-level Input Voltage	-0.3	-	0.8	V
V_{IH}	Digital I/O Pin High-level Input Voltage	2	-	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	2.4	-	-	V
RESET_N	Low-level Input Voltage	-0.3	-	0.45	V
	High-level Input Voltage	1.8	-	3.6	V
VDD_RF	VDD_RF Voltage	-	VCC	-	V
I_{VDD_RF}	VDD_RF Output Current	-	-	100	mA
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. Digital I/O pin refers to all digital pins specified in *Table 6: Pin Description* except RESET_N.

6.3. Supply Current Requirement

The following table lists the supply current values of the total system that may be applied. Actual power requirements may vary depending on processor load, external circuits, firmware version, the number of tracked satellites, signal strength, startup type, test time and conditions.

Table 12: Supply Current

Parameter	Description	Condition	$I_{Typ.}$ [4]	I_{PEAK} [4]
I_{VCC} [5]	Current at VCC	Acquisition	36 mA	81 mA
		Tracking	36 mA	81 mA
I_{V_BCKP} [6]	Current at V_BCKP	Continuous mode	129 µA	202 µA
		Backup mode	13 µA	82 µA

6.4. ESD Protection

Static electricity occurs naturally and it may damage the module. Therefore, applying proper ESD countermeasures and handling methods is imperative. For example, wear anti-static gloves during the development, production, assembly and testing of the module; add ESD protection components to the ESD sensitive interfaces and points in the product design.

Measures to ensure protection against ESD damage when handling the module:

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

[4] Room temperature, measurements are taken with typical voltage.
[5] Used to determine maximum current capability of power supply.
[6] Used to determine required battery current capability.

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

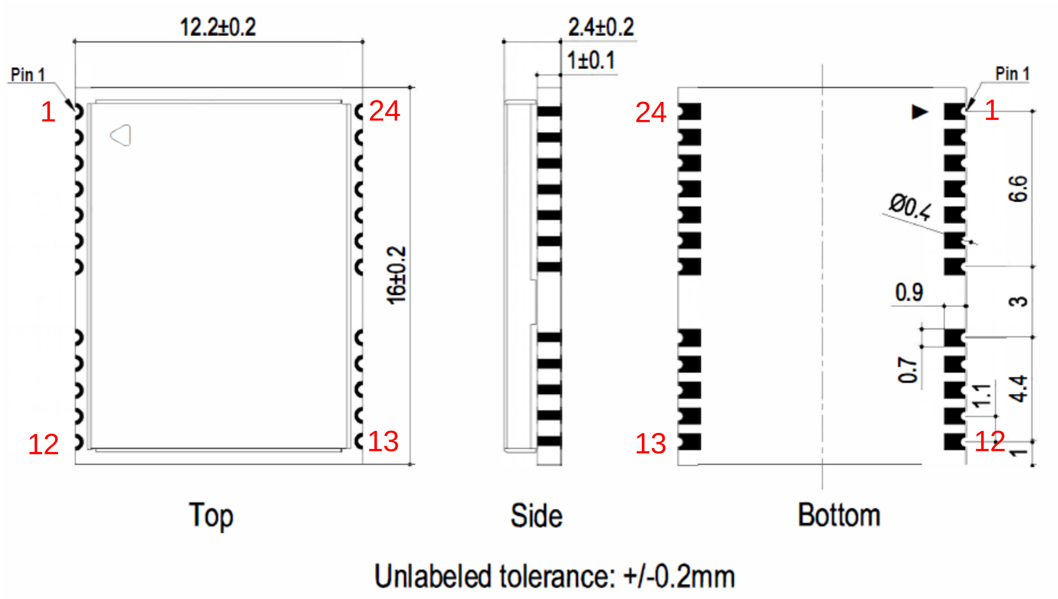


Figure 22: Top, Side and Bottom View Dimensions

NOTE

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

7.2. Top and Bottom Views

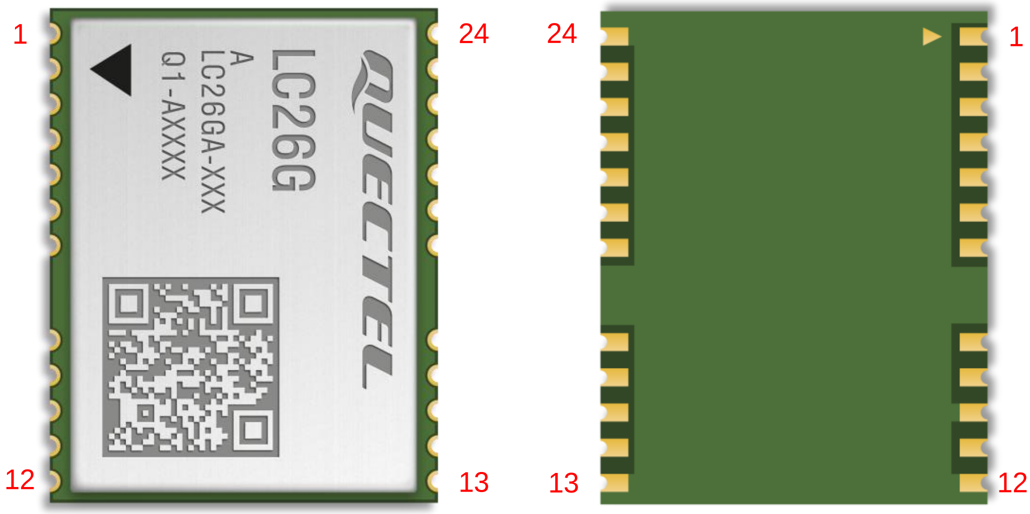


Figure 23: Top and Bottom Module Views

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

This chapter describes only the key parameters and process of packaging. All figures below are for reference only. The appearance and structure of packaging materials are subject to the actual delivery.

The module adopts carrier tape packaging and details are as follow.

8.1.1. Carrier Tape

Carrier tape dimensions are detailed below:

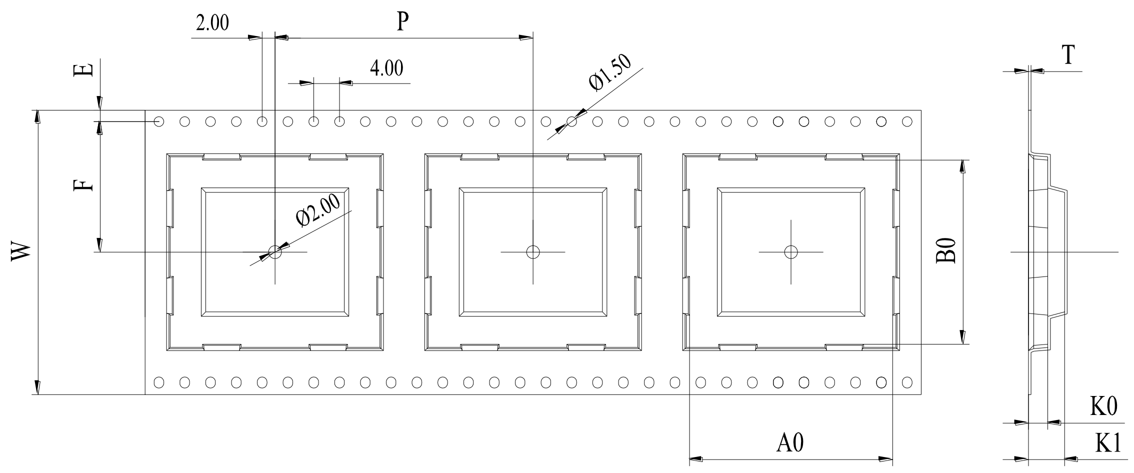


Figure 24: Carrier Tape Dimension Drawing

Table 13: Carrier Tape Dimension Table (Unit: mm)

W	P	T	A0	B0	K0	K1	F	E
32	24	0.4	12.7	16.4	2.9	7.4	14.2	1.75

8.1.2. Plastic Reel

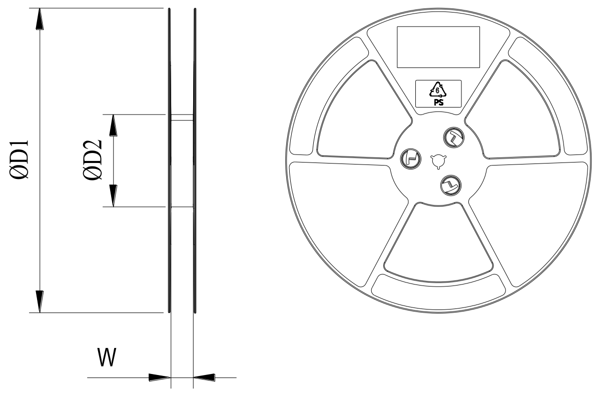


Figure 25: Plastic Reel Dimension Drawing

Table 14: Plastic Reel Dimension Table (Unit: mm)

øD1	øD2	W
330	100	32.5

8.1.3. Mounting Direction

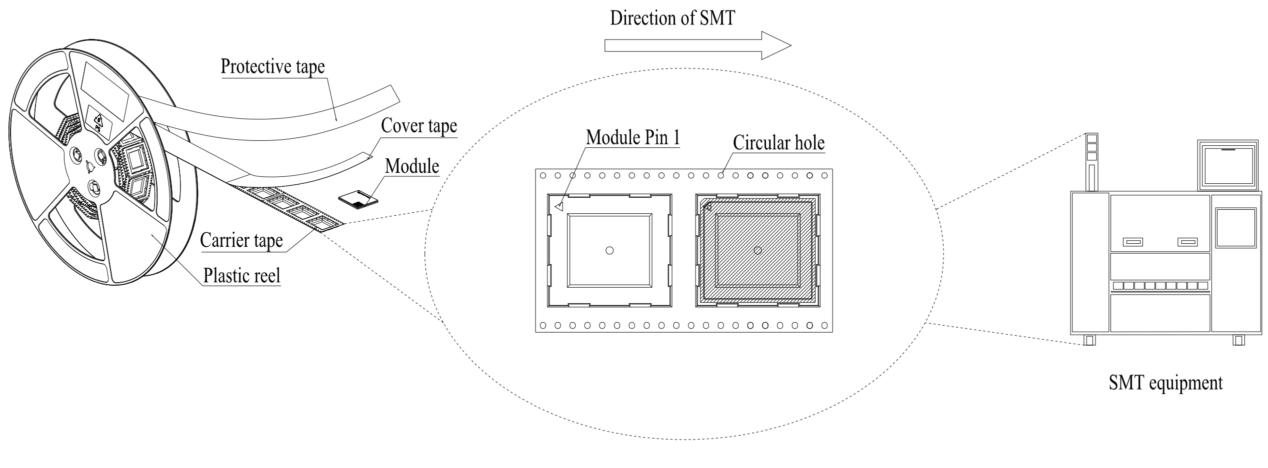
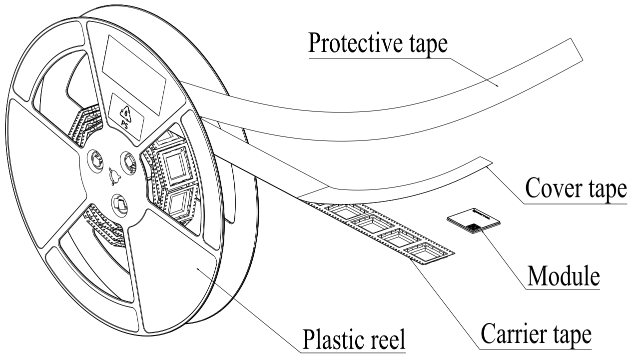


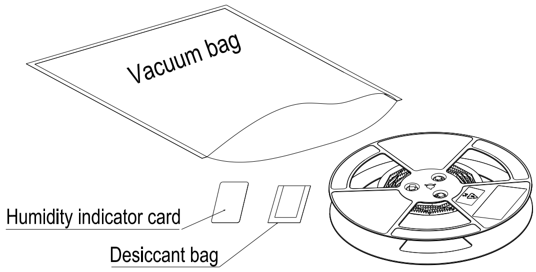
Figure 26: Mounting Direction

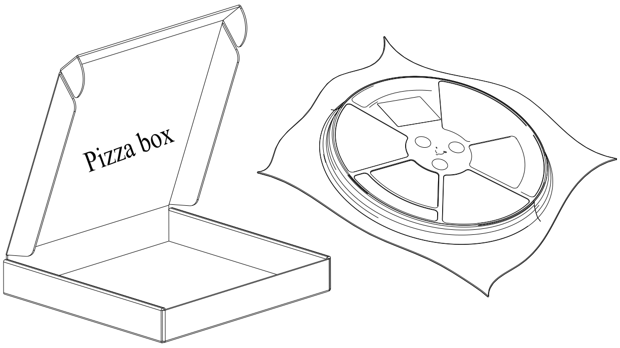
8.1.4. Packaging Process



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

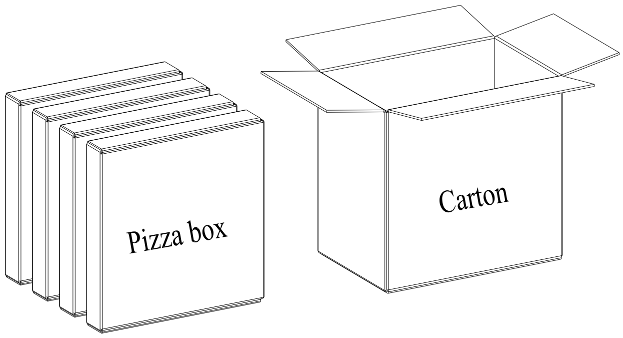
Place the packaged plastic reel, humidity indicator card and desiccant bag inside a vacuum bag, then vacuumize it.





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

Place 4 packaged pizza boxes inside 1 carton box and seal it. 1 carton box can pack 2000 modules.



Pizza box size (mm): 363 × 343 × 55
Carton size (mm): 380 × 250 × 365

Figure 27: Packaging Process

8.2. Storage

The module is provided in a vacuum-sealed packaging. MSL of the module is rated at 3. The storage requirements are shown below.

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

2. Shelf life (in a vacuum-sealed packaging): 12 months in Recommended Storage Condition.

3. Floor life: 168 hours [7] in a factory where the temperature is 23 ±5 °C and relative humidity is below 60 %. After the vacuum-sealed packaging is removed, the module must be 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 dry 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 in Recommended Storage Condition;
   - Violation of the third requirement above;
   - Vacuum-sealed packaging is broken, or the packaging has been removed for over 24 hours;
   - Before module repairing.

5. If pre-baking is needed, it should meet the requirements below:

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

NOTE

1. To avoid blistering, layer separation and other soldering issues, extended exposure of the module to the air is forbidden.
2. Take the module out of the packaging and put it on high-temperature-resistant fixtures before baking. 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 module.

[7] This floor life is only applicable when the environment conforms to *IPC/JEDEC J-STD-033*. It is recommended to start the solder reflow process within 24 hours after the package is removed if the temperature and moisture do not conform to, or are not sure to conform to *IPC/JEDEC J-STD-033*. Do not unpack the modules in large quantities until they are ready for soldering.

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 of the module, see *document [7] module SMT application note*.

The recommended 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 recommended to mount the module to the PCB only after reflow soldering of the other side of the PCB. The recommended reflow soldering thermal profile (lead-free reflow soldering) and related parameters are shown in the figure and table below.

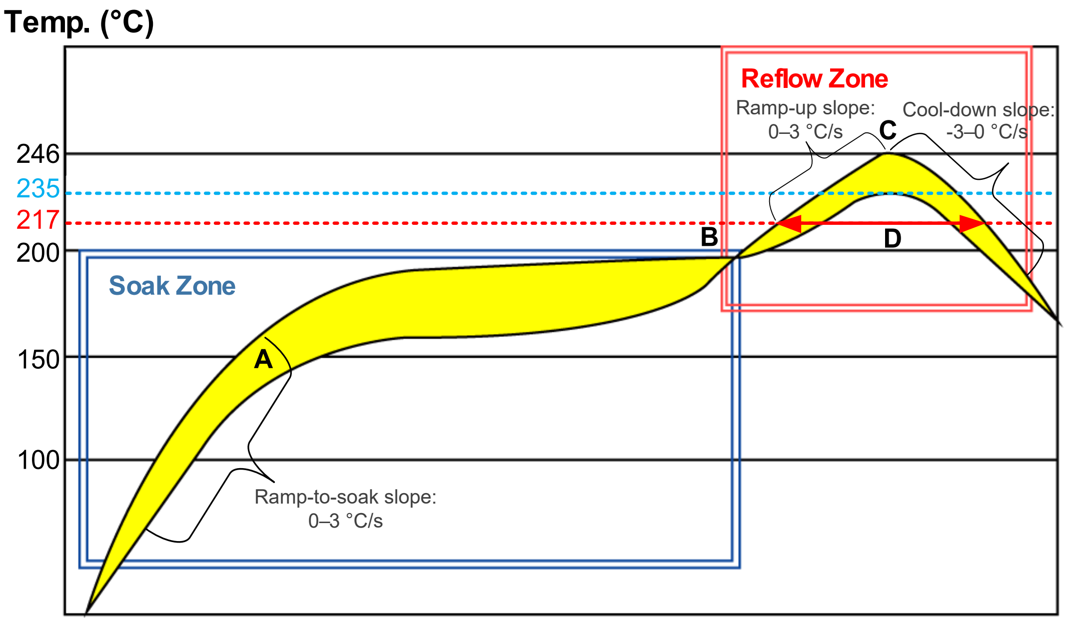


Figure 28: Recommended Reflow Soldering Thermal Profile

Table 15: Recommended Thermal Profile Parameters

Factor	Recommended Value
Soak Zone	
Ramp-to-soak slope	0–3 °C/s
Soak time (between A and B: 150 °C and 200 °C)	70–120 s
Reflow Zone	
Ramp-up slope	0–3 °C/s
Reflow time (D: over 217°C)	40–70 s
Max temperature	235–246 °C
Cool-down slope	-3–0 °C/s
Reflow Cycle	
Max reflow cycle	1

NOTE

1. The above profile parameter requirements are for the measured temperature of the solder joints. Both the hottest and coldest spots of solder joints on the PCB should meet the above requirements.
2. During manufacturing and soldering, or any other processes that may require direct contact with the module, **NEVER** wipe the module shielding can with organic solvents, such as acetone, ethyl alcohol, isopropyl alcohol, and trichloroethylene. Otherwise, the shielding can may become rusty.
3. The module shielding can is made of cupronickel base material. The Neutral Salt Spray Test has shown that after 12 hours 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.
4. If a conformal coating is necessary for the module, **DO NOT** use any coating material that may react with the PCB or shielding cover. Prevent the coating material from penetrating the module shield.
5. Avoid using ultrasonic technology for module cleaning since it can damage crystals inside the module.
6. Due to SMT process complexity, contact Quectel Technical Support in advance regarding any ambiguous situation, or any process (e.g. selective soldering, ultrasonic soldering) that is not addressed in *document [7] module SMT application note*.

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.

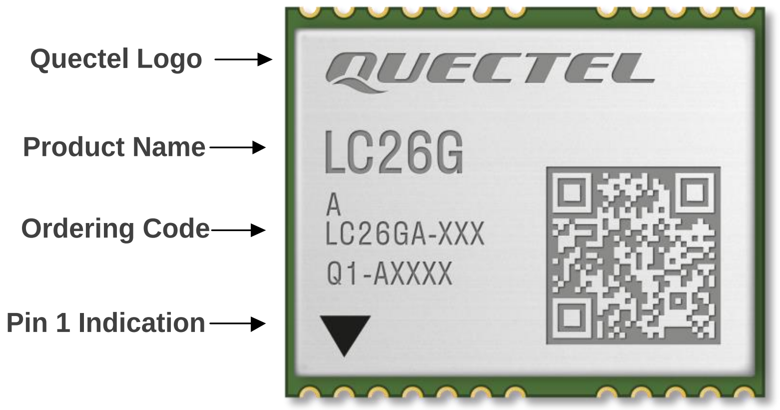


Figure 29: Labelling Information

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 16: Related Documents

Document Name
[1] Quectel_LC26G(AB)&LC76G&LC86G_Series_GNSS_Protocol_Specification
[2] Quectel_LC26G(AB)&LC76G&LC86G_Series_AGNSS_Application_Note
[3] Quectel_LC26G(AB)&LC76G&LC86G_Series_Firmware_Upgrade_Guide
[4] Quectel_LC26G(AB)_Reference_Design
[5] Quectel_GNSS_Antenna_Selection_Guidance
[6] Quectel_RF_Layout_Application_Note
[7] Quectel_Module_SMT_Application_Note

Table 17: Terms and Abbreviations

Abbreviation	Description
AGNSS	Assisted GNSS (Global Navigation Satellite System)
AIC	Active Interference Cancellation
ARM	Advanced RISC Machine
BDS	BeiDou Satellite Navigation System
bps	bit(s) per second
CEP	Circular Error Probable
C/N_0	Carrier-to-noise Ratio
DCS1800	Digital Cellular System at 1800 MHz
DR	Dead Reckoning

Abbreviation	Description
EASY	Embedded Assist System
EGNOS	European Geostationary Navigation Overlay Service
EPO	Extended Prediction Orbit
ESD	Electrostatic Discharge
GAGAN	GPS Aided Geo Augmented Navigation
Galileo	Galileo Satellite Navigation System (EU)
GLONASS	Global Navigation Satellite System (Russia)
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
IMU	Inertial Measurement Unit
I_{PEAK}	Peak Current
NavIC/IRNSS	Indian Regional Navigation Satellite System
kbps	kilobits per second
LCC	Leadless Chip Carrier (package)
LDO	Low-dropout Regulator
LGA	Land Grid Array
LNA	Low-Noise Amplifier
LTE	Long-Term Evolution
Mbps	Megabits per second
MCU	Microcontroller Unit/Microprogrammed Control Unit
MISO	Master In Slave Out

Abbreviation	Description
MOSI	Master Out Slave In
MSAS	Multi-functional Satellite Augmentation System (Japan)
MSL	Moisture Sensitivity Levels
NF	Noise Figure
NMEA	NMEA (National Marine Electronics Association) 0183 Interface Standard
OC	Open Connector
PCB	Printed Circuit Board
PI	Power Input
PMU	Power Management Unit
1PPS	One Pulse Per Second
PSRR	Power Supply Rejection Ratio
QZSS	Quasi-Zenith Satellite System
RAM	Random Access Memory
RF	Radio Frequency
RHCP	Right Hand Circular Polarization
RoHS	Restriction of Hazardous Substances
RTC	Real-Time Clock
RTK	Real-Time Kinematic
RXD	Receive Data (Pin)
3GPP	3rd Generation Partnership Project
SAW	Surface Acoustic Wave
SBAS	Satellite-Based Augmentation System
CLK	SPI Serial Clock
SMD	Surface Mount Device
SMT	Surface Mount Technology

Abbreviation	Description
SPI	Serial Peripheral Interface
TBD	To Be Determined
TCXO	Temperature Compensated Crystal Oscillator
T_operating	Operating Temperature
TTFF	Time to First Fix
TVS	Transient Voltage Suppressor
TXD	Transmit Data (Pin)
UART	Universal Asynchronous Receiver/Transmitter
USB	Universal Serial Bus
VCC	Supply Voltage
VSWR	Voltage Standing Wave Ratio
WAAS	Wide Area Augmentation System
WCDMA	Wideband Code Division Multiple Access
XTAL	External Crystal Oscillator