LC29D Hardware Design

GNSS Module Series

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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.

About the Document

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1 Product Description

1.1. Overview

The Quectel LC29D module supports multiple global positioning and navigation systems: BeiDou, GPS, Galileo, GLONASS, QZSS, IRNSS. The module also supports SBAS (including WAAS, EGNOS, MSAS and GAGAN) and AGNSS functions.

Key features:

- The LC29D module is a dual-band, multi-constellation GNSS module and features a high-performance, high reliability positioning engine. This module facilitates a fast and precise GNSS positioning capability.
- The module supports serial communication interfaces UART and SPI.
- The module integrates a 6-axis MEMS sensor and supports sophisticated RTK and dead-reckoning algorithms to fuse the sensor data, GNSS raw data and speed data, etc. to provide sub-meter level positioning accuracy in an open-sky environment.
- The embedded flash memory provides the capacity for storing user-specific configurations and future firmware updates.

The Quectel LC29D module is an SMD type module with a compact form factor of 12.2 mm × 16.0 mm × 2.4 mm. It can be embedded in your applications through the 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, AT command, or argument, it indicates that the function, feature, interface, pin, AT command, or argument is under development and currently not supported; and the asterisk (*) after a model indicates that the sample of such model is currently unavailable.

1.2. Features

Table 2: Product Features

Features			LC29D (A)	LC29D (B)*	LC29D (C)
Grade	Industrial		●	●	●
	Automotive		-	-	-
Category	Standard Precision GNSS		-	-	-
	High Precision GNSS		●	●	●
	DR		●	●	●
	RTK		-	●	-
	Timing		-	-	-
Supply	2.7–3.6 V, Typical: 3.3 V		●	●	●
Interfaces	UART		●	●	●
	SPI		●	●	●
	I2C		-	-	-
	1PPS		●	●	●
Features	LNA		●	●	●
	SAW		●	●	●
	RTC crystal		●	●	●
	TCXO oscillator		●	●	●
	6-axis MEMS sensor		●	●	●
Constellations	GPS/QZSS	L1 C/A	●	●	●
		L5	●	●	●
	Galileo	E1	●	●	●
		E5a	●	●	●
	BeiDou	B1I	●	●	●

		B2a	-	●	-
	GLONASS	L1	●	●	●
	NavIC (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: (12.2 ±0.15) mm × (16.0 ±0.15) mm × (2.4 ±0.20) mm Weight: Approx. 0.9 g				

NOTE

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

1.3. Performance

Table 3: Product Performance

Parameter	Specification	LC29D (A)	LC29D (B)*	LC29D (C)
Power Consumption [1]	Acquisition	53 mA	51 mA	53 mA
	Tracking	39 mA	37 mA	39 mA
Sensitivity	Acquisition	-148 dBm	-148 dBm	-148 dBm
	Reacquisition	-158 dBm	-157 dBm	-157 dBm
	Tracking	-163 dBm	-162 dBm	-163 dBm
TTFF [1] (without AGNSS)	Cold Start	34 s	34 s	34 s
	Warm Start	30 s	30 s	30 s
	Hot Start	2 s	2 s	2 s
TTFF [1] (with AGNSS)	Cold Start	5 s	5 s	5 s

[1] All satellites at -130 dBm, except Galileo at -122 dBm.

Horizontal Position Accuracy [2]	1.2 m	Autonomous:1.0 m RTK: 0.2 m [3]	1.2 m
Update Rate	1 Hz	1 Hz (max. 10 Hz)	1 Hz
Accuracy of 1PPS Signal	Typical accuracy: 100 ns Time pulse width: 5 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		

[2] CEP, 50%, 24 hours static, -130 dBm, more than 6 SVs.

[3] CEP, 50%, 24 hours static, open sky, more than 6 SVs.

1.4. Block Diagram

The following figure shows a block diagram of the module. The module includes a GNSS IC, a 6-axis MEMS sensor chip, two external LNAs, two SAW filters, a diplexer, flash memory, a TCXO and a crystal oscillator. The diplexer integrates two band-pass filters, which can improve the out-of-band rejection. Consequently, the LNAs 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.

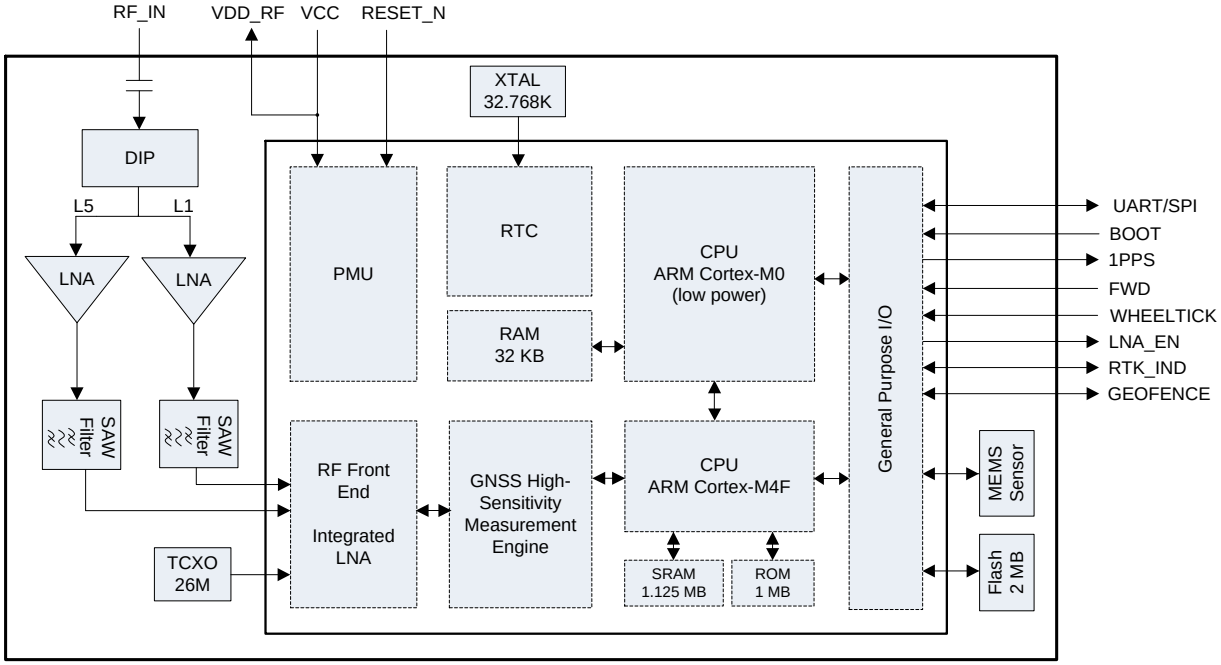

Figure 1: Block Diagram

1.5. GNSS Constellations

The Quectel LC29D module is a dual-band GNSS receiver that can receive and track GPS, BeiDou, GLONASS, Galileo, QZSS, IRNSS signals.

1.5.1. GPS

The module is designed to receive and track GPS L1 C/A signals (1574.397–1576.443 MHz) and L5 signals (1166.22–1186.68 MHz) provided by GPS.

1.5.2. BeiDou

The module is designed to receive and track BeiDou B1I (1559.052–1563.144 MHz) and B2a (1155.99–1196.91 MHz). The ability to receive and track BeiDou signals in conjunction with GPS results in higher coverage, improved reliability, and better accuracy.

NOTE

Only LC29D (B) can receive and track B2a signals provided by BeiDou satellite.

1.5.3. GLONASS

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

1.5.4. Galileo

The module is designed to receive and track Galileo E1 (1573.374–1577.466 MHz) and E5a (1166.22–1186.68 MHz) signals provided by Galileo.

1.5.5. IRNSS

The Indian Regional Navigation Satellite System (IRNSS) or NavIC is a regional navigation satellite system that transmits additional L5 signals for complying with the requirements of an independent accurate positioning system for users in India. The Quectel LC29D module is designed to receive and track IRNSS L5 signals (1175.427–1177.473 MHz) from IRNSS satellites.

1.5.6. 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 LC29D 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. Augmentation System

1.6.1. SBAS

The Quectel LC29D module supports SBAS (Satellite-Based Augmentation System) broadcast signal reception, and GPS data are complemented by additional regional or wide area GPS enhancement data. The system enhances the data through satellite broadcasting, and this information can be used in GNSS receivers to improve the accuracy of the results. SBAS satellites can also be used as additional signals for ranging or distance measurement, 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 AGNSS feature, the module should get the assistance data including the current time, rough position, and LTO data. For more information, see ***document [2]***.

1.8. RTK

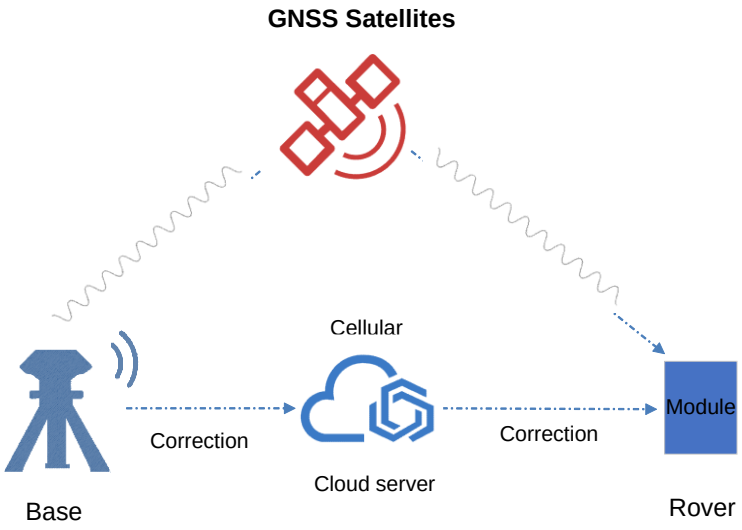

Figure 2: RTK Operation Process

1.8.1. RTK Module Mode

The Quectel LC29D (A) and LC29D (B)* modules support RTK functionality as rovers.

Before supporting the RTK navigation technique, the module needs to receive the RTK correction messages via its UART port. RTK correction messages can be delivered either using a cellular module or other terrestrial network technology. In default configuration, the module will attempt to achieve the best positioning accuracy based on the correction data that it receives. When the module receives an input stream of RTCM messages, it enters RTK float mode. Once it fixes carrier phase ambiguities, the module enters the RTK fixed mode.

The module may be expected to achieve sub-meter level accuracy only when it is in RTK fixed mode.

If the module loses the carrier phase lock, at the minimum semaphore required to maintain the RTK fixed mode, it returns to the RTK float mode. The module will also continue to try to resolve carrier phase ambiguity and return to RTK fixed mode after restoring the minimum semaphore.

The current mode of operation is set by the associated NMEA messages.

For more information, see ***document [3]***.

1.9. ODO

The FWD hardware input is used to input vehicle forward/backward status signals. When it is at low voltage level, the vehicle is moving forward, and when it is at high level, it is moving backward.

The WHEELTICK hardware input is used to input odometer signals from a vehicle. It can be sampled from the wheel revolution sensors or the transmission of the vehicle. For more information about the reference circuit design, see ***document [4]***.

NOTE

Only cars need to be connected to the FWD signal, electric bicycles do not.

1.10. Geofencing

The Quectel LC29D module supports geofence areas, defined on the Earth's surface using a 2D model. Geofencing is active when at least one geofence area is defined. The current status can be found by polling the receiver. The receiver evaluates whether the current location of each region is within that region or not and signals its status via GEOFENCE pin (pin 16). Geofencing feature can be configured using Quectel geofence messages. The evaluation is activated whenever one or more geofences are configured.

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

1.11. Dead Reckoning Function

Dead Reckoning is the process of estimating the module’s current position based on the last position obtained from GNSS, speed, heading sensor data, etc. With this combined sensor inputs, the system plots the navigation trace when the satellite signals are partially or completely blocked while satellite signals provide updates and correction for sensor drift. With this technology, the system obtains continuous and high-accuracy positioning in environments such as tunnels and urban canyons.

In addition, the module supports output of sensor raw data through UART to support your applications such as driving behavior analysis. For more information about raw data output configuration, see ***document [1]***.

2 Pin Assignment

The Quectel LC29D module is equipped with 24 LCC pins by which the module can be mounted on the your PCB.

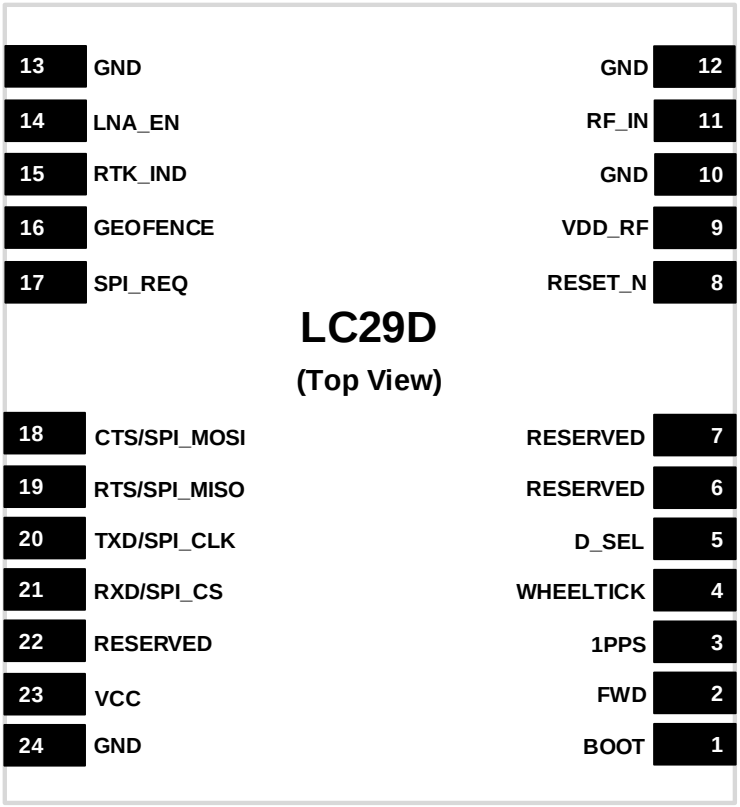

Figure 3: Pin Assignment

Table 4: I/O Parameter Definition

Type	Description
AI	Analog Input
DI	Digital Input
DO	Digital Output

DIO	Digital Input/Output
PI	Power Input
PO	Power Output

Table 5: Pinout

Function	Name	No.	I/O	Description	Remarks
Power	VCC	23	PI	Main power supply	Provides clean and steady voltage.
UART/SPI	TXD/ SPI_CLK	20	DIO	Transmits data/ SPI clock	**When using UART Interface: D_SEL=1** (**Pulled up internally by default**) For NMEA data transmission and firmware upgrade in normal operating mode, the module requires a two-wire UART (TXD and RXD) only. However, for bootloader upgrade in host mode, the module requires a four-wire UART (TXD, RXD, CTS and RTS). **When using SPI Interface: D_SEL=0** (**Pulled down externally with a 1 kΩ resistor**) For NMEA data transmission and firmware upgrade, the module requires a five-wire SPI (SPI_MOSI, SPI_MISO, SPI_CLK, SPI_CS and SPI_REQ).
	RXD/ SPI_CS	21	DI	Receives data/ SPI chip-select	
	CTS/ SPI_MOSI	18	DI	Clear to send/ SPI master out slave in	
	RTS/ SPI_MISO	19	DO	Request to send/ SPI master in slave out	
	SPI_REQ	17	DO	Indicates SPI data validity	
	D_SEL	5	DI	Selects UART/SPI interface	
Antenna	VDD_RF	9	PO	Power supply for external RF components	VDD_RF = VCC, the output current capacity depends on 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.
	LNA_EN	14	DO	Power control for active antenna	If unused, leave the pin N/C (not connected).
ODO	FWD	2	DI	Forward/Backward direction	Pulled up internally by default.
	WHEELTICK	4	DI	Odometer wheel-tick input	

System	BOOT	1	DI	Controls module startup mode	Pulled down internally by default. While the pin is kept floating during startup, the module will enter normal operating mode. While the pin is kept at high level for about 100 ms during startup, the module will enter host mode.
	RTK_IND	15	DIO	Indicates RTK status	This pin is set high at startup. If unused, leave the pin N/C (not connected).
	GEOFENCE	16	DIO	Indicates geofence status	Once the pin is activated, the receiver continuously compares its current position to the preset geofence area. If unused, leave the pin N/C (not connected).
	1PPS	3	DO	One pulse per second	Synchronized on rising edge, and the pulse width is 5 ms. If unused, leave the pin N/C (not connected).
	RESET_N	8	DI	Resets the module	Active low. If unused, leave the pin N/C (not connected).
	GND	10, 12, 13, 24	-	Ground	Ensure a good GND connection to all GND pins of the module, preferably with a large ground plane.
	RESERVED	6, 7, 22	-	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 LC29D 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 one operating mode: continuous mode for best performance.

3.1. Power Supply

3.1.1. VCC

The VCC is the supply voltage pin. The VCC pin supplies power for BB, RF, MEMS sensor 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.

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's VCC pin.

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.

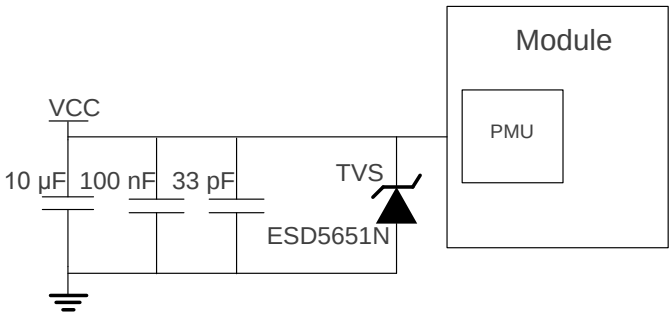

Figure 4: VCC Input Reference Circuit

3.2. Power Mode

3.2.1. 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. Power-Up Sequence

When VCC is powered up, the module starts up automatically.

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

3.4. 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 (2.7 V), the system must initiate a power-on reset by lowering VCC to less than 100 mV for at least 100 ms.

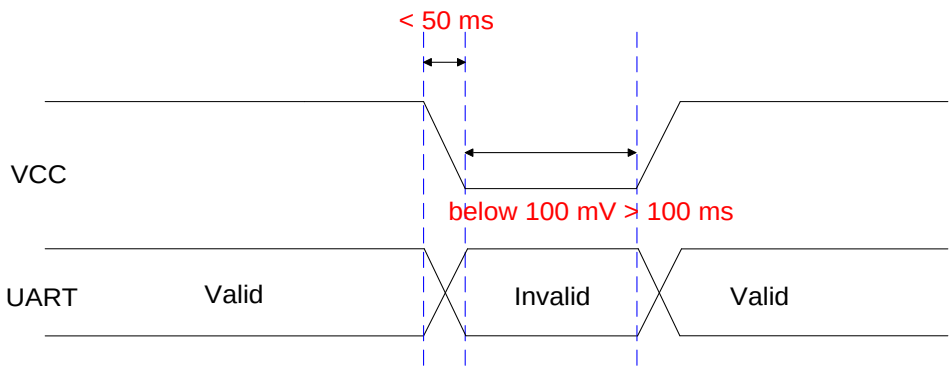

Figure 5: Power-Down Sequence

4 Application Interfaces

4.1. Communication Interfaces

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

4.1.1. Interface Selection (D_SEL)

The D_SEL pin is pulled up internally by default. At this time, the UART interface is selected. If the SPI interface is needed, pull the D_SEL pin down externally with a 1 kΩ resistor.

Table 6: Data Interface Selection by Using D_SEL

PIN#	D_SEL=1 (Pulled up internally by default)	D_SEL=0 (Pulled down externally with a 1 kΩ resistor)	
20	TXD	SPI_CLK	
21	RXD	SPI_CS	
18	CTS	SPI_MOSI	
19	RTS	SPI_MISO	
17	SPI_REQ	SPI_REQ	SPI_REQ will not be changed by D_SEL. The pin is needed when using SPI interface.

4.1.2. UART Interface

The module provides one UART interface. The UART port has the following features:

- Supports NMEA data transmission and firmware upgrade.
- Supported baud rates: 115200 bps, 230400 bps, 460800 bps, and 921600 bps.
- Default settings: 115200 bps, 8 bits, no parity bit, 1 stop bit.

The reference design is shown the figure below.

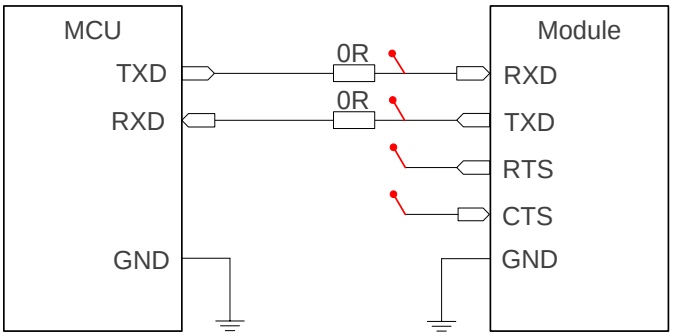

Figure 6: UART Interface Reference Design

NOTE

1. For NMEA data transmission and firmware upgrade in normal operating mode, the module requires a two-wire UART (TXD and RXD) only. However, for bootloader upgrade in host mode, the module requires a four-wire UART (TXD, RXD, CTS and RTS).
2. "\" represents test points of UART interface. Place the test points close to the module.
3. If the IO voltage of MCU is not matched with module, a level shifter that supports open-drain and push-pull outputs must be selected.
4. The UART interface cannot have any pull-down resistors.

4.1.3. SPI Interface

The module provides one SPI interface that supports the features listed below:

- Supports NMEA data transmission and firmware upgrade;
- Operates as a slave;
- Fixed data frame size of 8 bits;
- Supported baud rates: 1 Mbps to 3 Mbps.

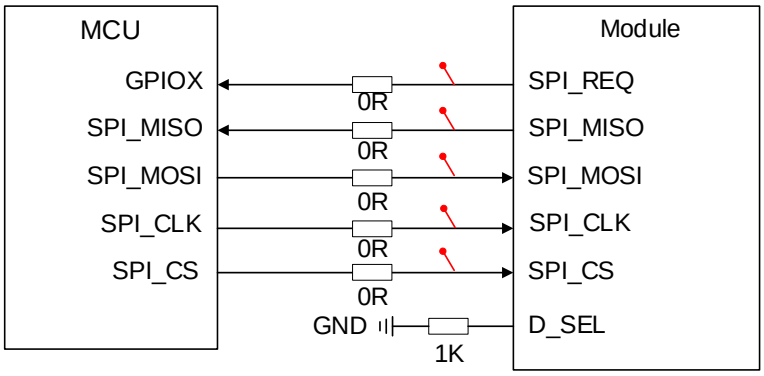

Figure 7: SPI Interface Reference Design

NOTE

1. The recommended minimum speed for SPI is 1 MHz and the maximum speed depends on firmware.
2. For SPI selection, D_SEL pin must be pulled down externally with a 1 kΩ resistor.
3. "↘" represents test points of SPI interface. Place the test points close to the module.
4. If the IO voltage of MCU is not matched with module, a level shifter that supports open-drain or push-pull outputs must be selected.
5. SPI interface cannot have any pull-down resistors.

4.2. I/O Pins

4.2.1. RESET_N

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

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

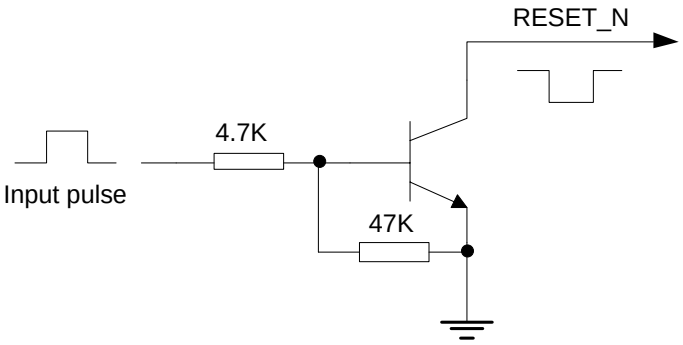

Figure 8: Reference OC Circuit for Module Reset

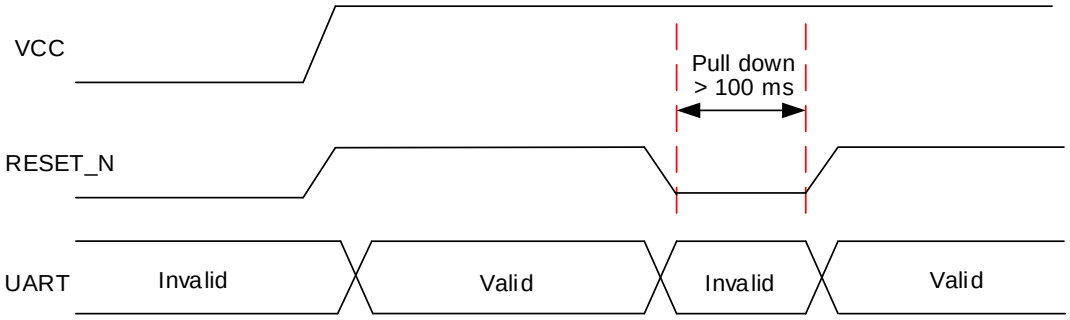

Figure 9: Reset Sequence

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. BOOT

BOOT pin is used to put the module into bootloader download mode. It is pulled down internally by default. While the pin is kept floating during startup, the module enters normal operating mode receiving signals from satellites. While the pin is kept at high level for about 100 ms during startup, the module enters host mode. For more information about the reference circuit design, see ***document [4]***.

The BOOT pin voltage level is checked to identify its operating mode when the module is powered on.

Table 7: Operating Modes

Voltage Level	Operating Mode	Comment
Low	Normal	While the pin is kept floating during startup, the module enters normal operating mode after receiving signals from satellites.
High	Host	While the pin is kept at high level for about 100 ms during startup, the module enters host mode.

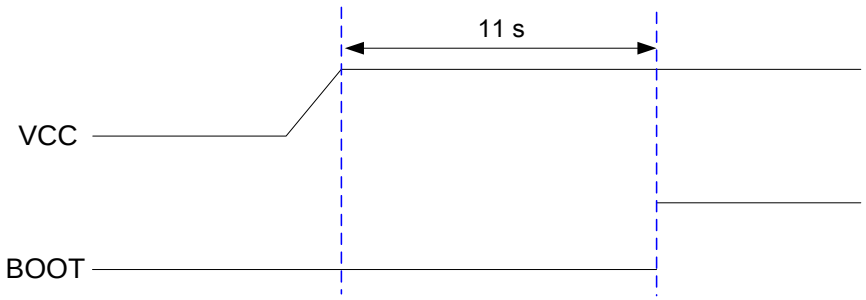

Figure 10: BOOT Pin State (Normal Operating Mode)

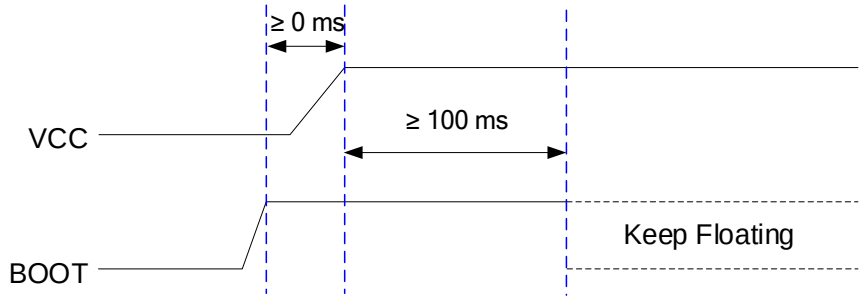

Figure 11: BOOT Pin Control Sequence (Host Mode)

4.2.3. GEOFENCE

The GEOFENCE pin indicates the current geofence status. Pin active polarity and geofence locations are preset using a command. Once the pin is configured, the receiver continuously compares its current position to the preset geofence area. The pin state reflects the current geofence status, e.g., whether the receiver is inside the active region or not.

4.2.4. RTK_IND

RTK_IND is an indicator pin for RTK positioning status. This pin is set high at startup. When a valid RTCM 3 messages flow is received, the pin switches from high to low level. The default rate is 1 Hz. The RTK_IND pin is set to a continuous low output when the receiver is operating in RTK fixed mode.

4.2.5. LNA_EN

LNA_EN is at high level after power on and can enable external LNA or external active antenna.

4.2.6. 1PPS

The 1PPS output generates one pulse per second trains synchronized with a GPS or UTC time grid with intervals configurable over a wide range of frequencies. The accuracy is less than 100 ns. Thus, it may be used as a low frequency time synchronization pulse or as a high frequency reference signal.

5 Design

5.1. Recommended Footprint

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

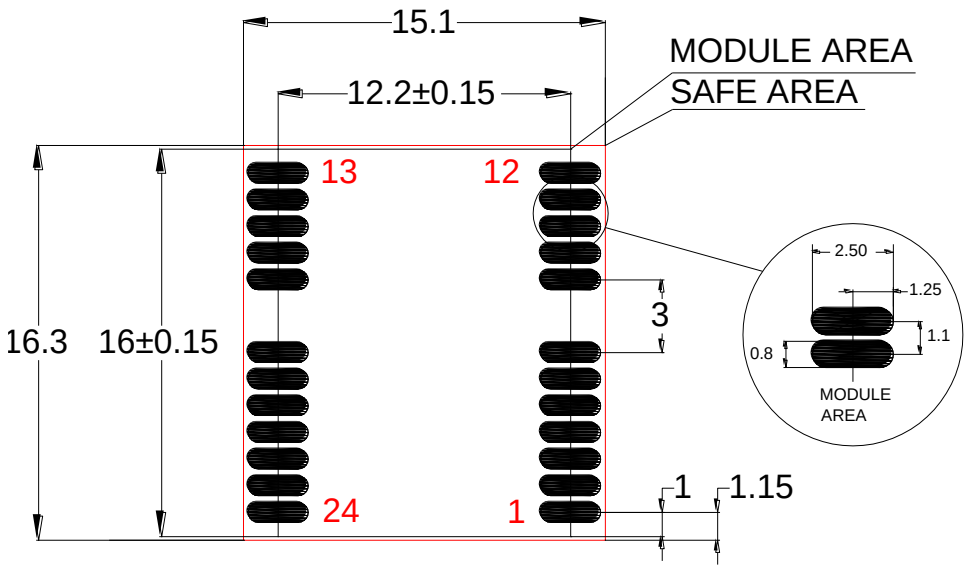

Figure 12: Recommended Footprint

NOTE

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

5.2. Antenna Design

5.2.1. Antenna Specification

The Quectel LC29D module can be connected to a dedicated passive or active dual-band (L1 + L5) GNSS antenna to receive GPS, Galileo, GLONASS, BeiDou, QZSS, IRNSS satellite signals. The recommended antenna specifications are given in the table below.

Table 8: Recommended Antenna Specifications

Antenna Type	Specifications
Passive Antenna	Frequency Range: 1164–1189 MHz & 1559–1609 MHz Polarization: RHCP VSWR: < 2 (Typ.) Passive Antenna Gain: > 0 dBi
Active Antenna	Frequency Range: 1164–1189 MHz & 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 gain of the whole antenna is 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 dual-band (L1 + L5) GNSS antennas can be used for the Quectel LC29D 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 is as below:

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

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, a LNA could be added to reduce “System NF”.

"System NF", formula:

$$NF = 10 \log F\,(dB)$$

"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 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 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

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.

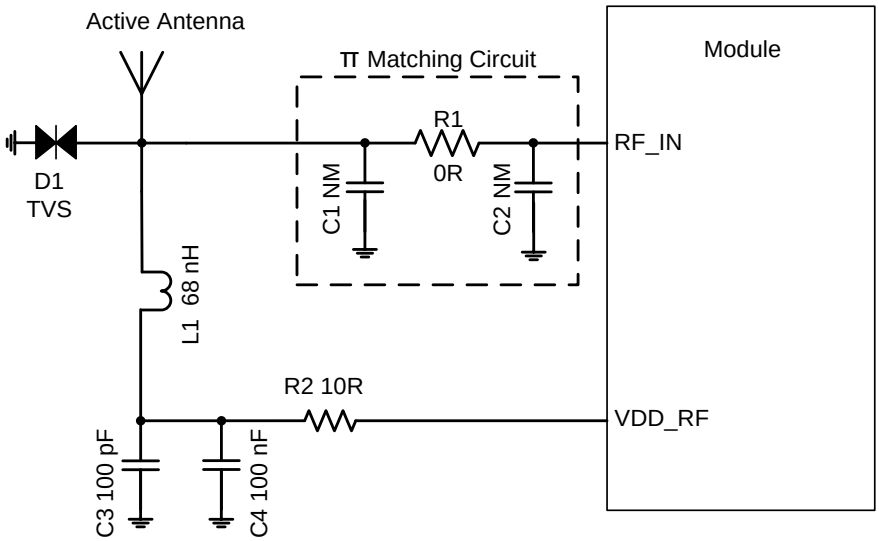

Figure 13: Active Antenna Reference Design

The components C1, R1 and C2 are reserved for matching antenna impedance. By default, R1 is 0 Ω, C1 and C2 are not mounted. 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 existing footprints in the matching circuit can be used to mount other type of components than the ones presented in the figure above. In that case, you must pay attention to the DC power supply. For example, if an inductor is mounted on the C1 footprint, then the circuit needs a DC-blocking capacitor between L1 and C1 to prevent short-circuiting of the DC power supply through the inductor to the ground. The same can apply to the C2 footprint.

5.2.4. Passive Antenna Reference Design

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

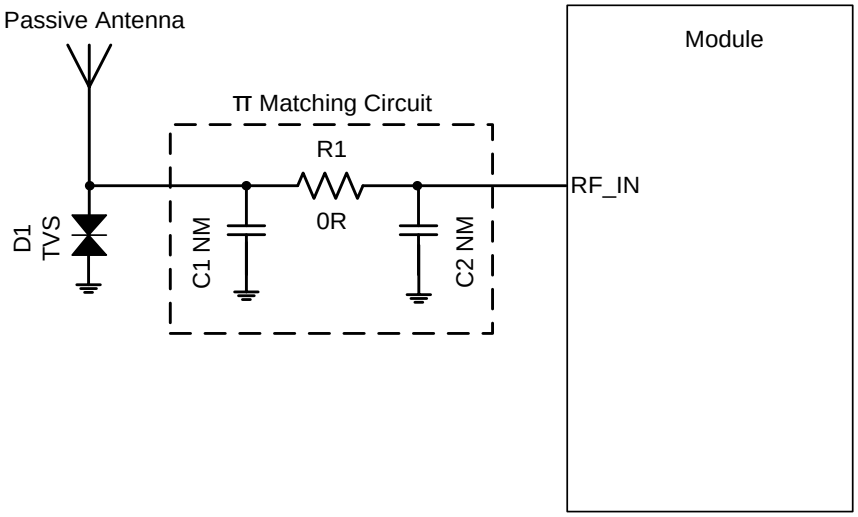

Figure 14: Passive Antenna Reference Design

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.

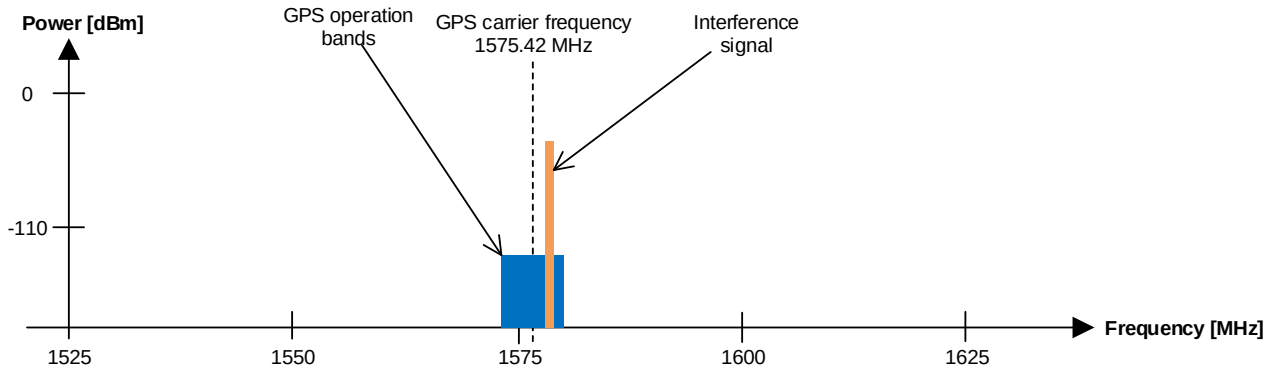

Figure 15: In-Band Interference on GPS L1

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 9: 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.

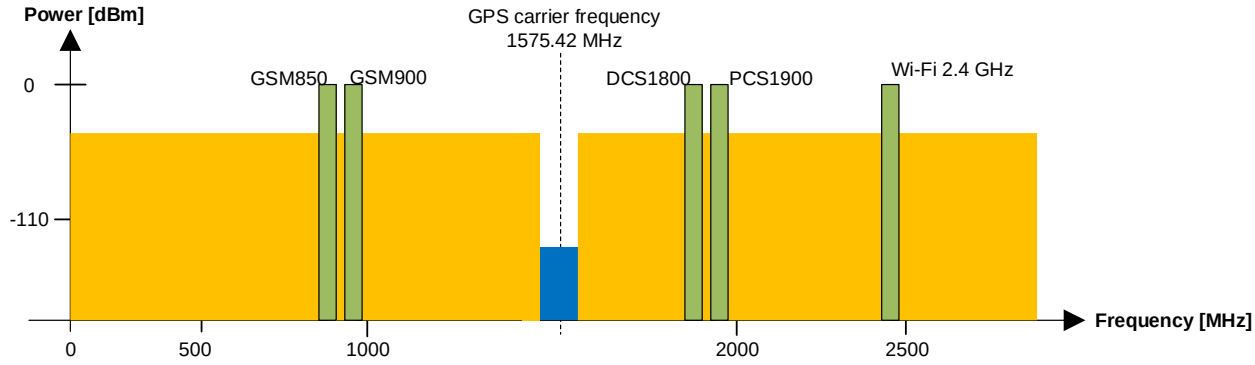

Figure 16: Out-of-Band Interference on GPS L1

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 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. In a complex communication system, there are usually RF power amplifier, MCU, crystal, 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.

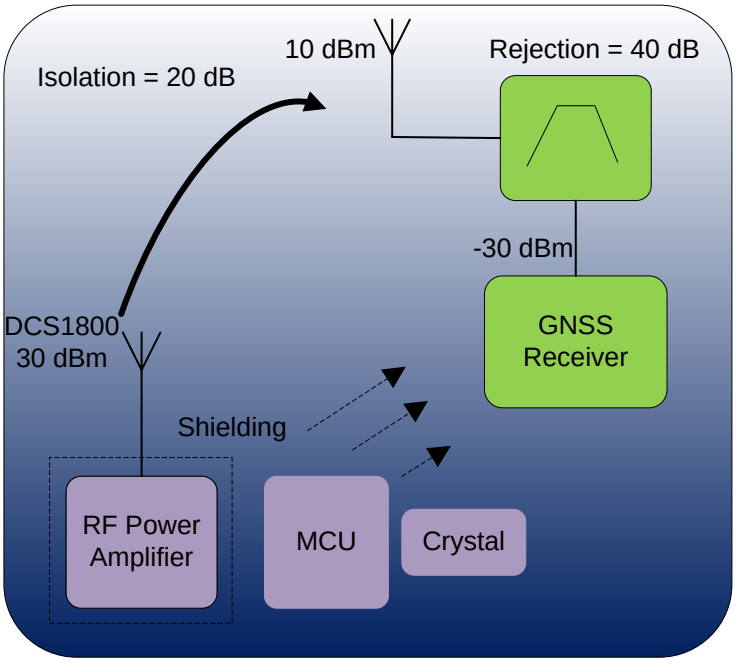

Figure 17: Interference Source and Its Path

6 Electrical Specification

6.1. Absolute Maximum Ratings

Absolute maximum ratings for power supply and voltage on digital pins of the Quectel LC29D module are listed in table below.

Table 10: Absolute Maximum Ratings

Parameter	Description	Min.	Max.	Unit
VCC	Main Power Supply Voltage	-0.3	3.6	V
Vin_IO	Input Voltage at I/O Pins	-0.3	3.6	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. 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 11: Power Supply Ratings

Parameter	Description	Min.	Typ.	Max.	Unit
VCC	Main Power Supply Voltage	2.7	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	-	0.35 × VCC	V
V_{IH}	Digital I/O Pin High-Level Input Voltage	0.65 × 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	-	-	V
RESET_N	Low-level Input voltage	-0.3	-	0.35	V
	High-level Input voltage	0.65 × VCC	-	VCC + 0.3	V
VDD_RF	VDD_RF Voltage	-	VCC	-	V
LNA_EN	Low-level Output Voltage	-	-	0.4	V
	High-level Output Voltage	1.7	1.8	1.9	V
T_operating	Operating Temperature	-40	25	+85	°C

NOTE

Operation beyond the "Operating Conditions" is not recommended and extended exposure beyond the "Operating Conditions" may affect device reliability.

6.3. ESD Protection

The Quectel LC29D module is an ESD sensitive device. Therefore, proper ESD handling and packaging procedures must be applied throughout the processing, handling and operation of any application that incorporates the module.

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 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, 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

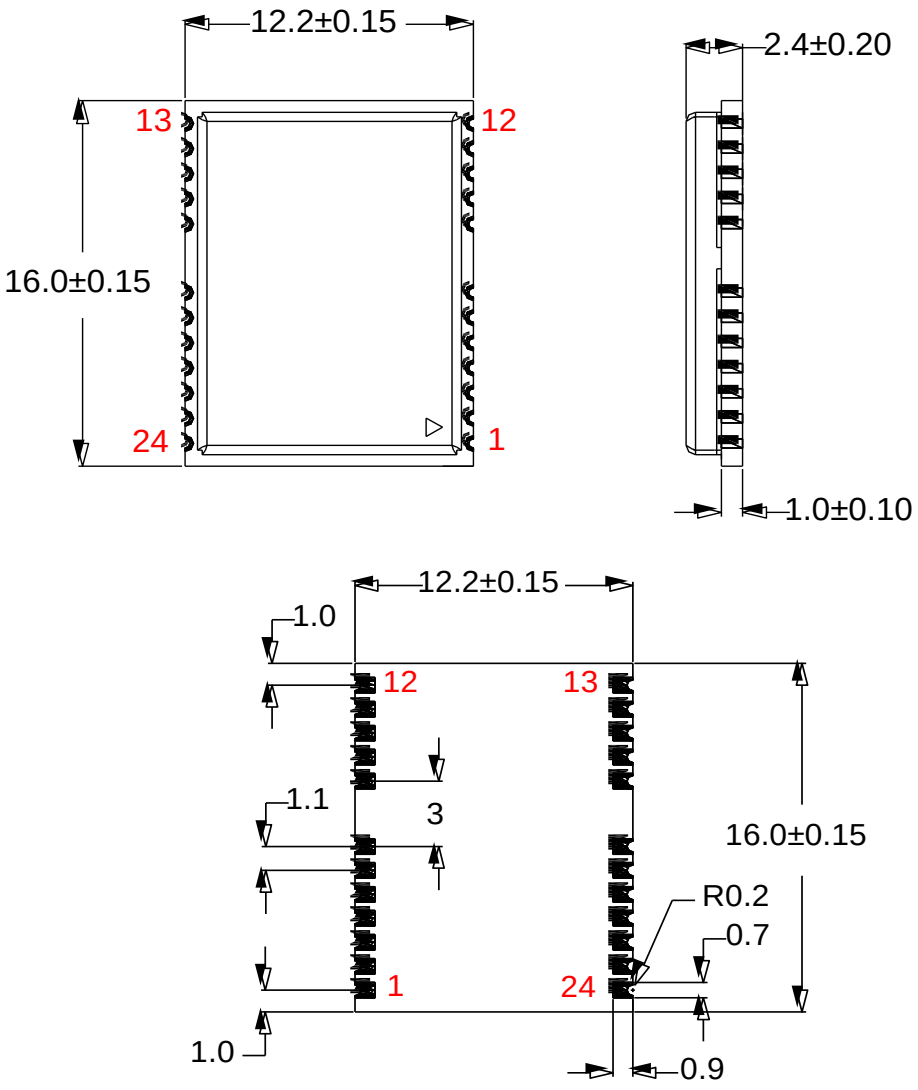

Figure 18: Top, Side and Bottom View Dimensions

NOTE

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

7.2. Top and Bottom Views

Figure 19: Top and Bottom Views of the Module

NOTE

Images above are for illustrative purpose 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 LC29D 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. Tapes

The following figure shows the position of the Quectel LC29D module when delivered in tape and the dimensions of the tape.

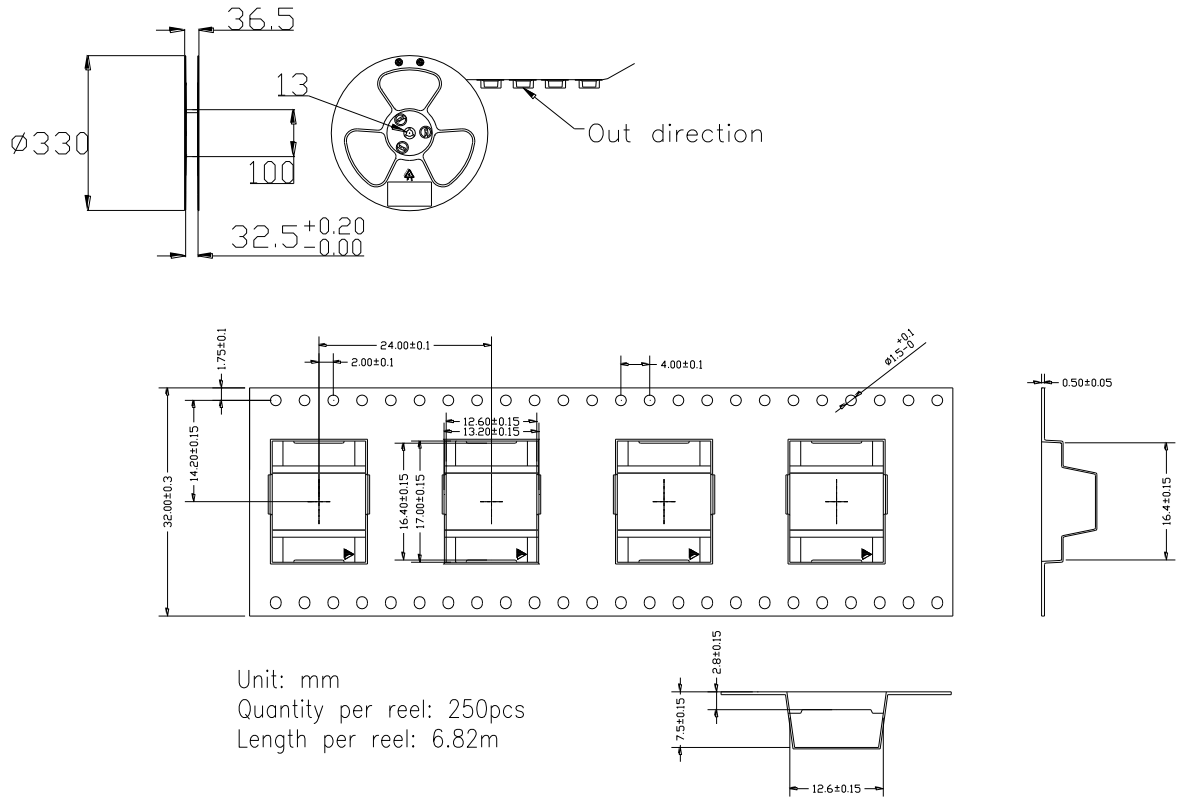

Figure 20: Tape and Reel Specifications

8.1.2. Reels

Each reel contains 250 modules. See the figure above.

Table 12: Reel Packaging

Model Name	MOQ	Minimum Package (MP): 250 pcs	Minimum Package × 4 = 1000 pcs
LC29D	250 pcs	Size: 370 mm × 350 mm × 56 mm N.W: 0.2105 kg G.W: 0.846 kg	Size: 380 mm × 250 mm × 365 mm N.W: 0.842 kg G.W: 3.942 ±0.1 kg

8.2. Storage

The module is provided with vacuum-sealed packaging. MSL of the module is rated as 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. The storage life (in vacuum-sealed packaging) is 12 months in Recommended Storage Condition.

3. The floor 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 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 in 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.

[4] 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*. And do not remove the packages of tremendous modules if they are not ready for soldering.

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 PCB within 24 hours after the baking, otherwise they should be put in a dry environment such as in 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 from the package and put it on high-temperature-resistant fixtures before baking. All modules must be soldered to PCB within 24 hours after 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 the solder paste on the surface of stencil, thus making the paste fill the stencil openings and then penetrate to the PCB. Apply proper force on the squeegee to produce a clean stencil surface on a single pass. To ensure module soldering quality, see ***document [5]***.

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

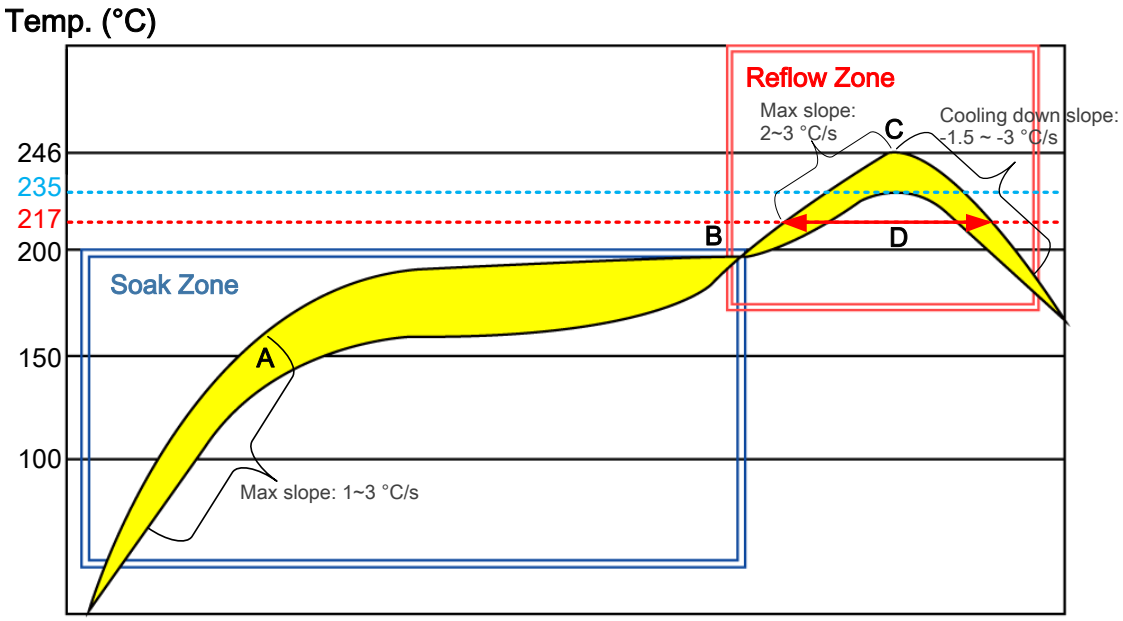

Figure 21: Recommended Reflow Soldering Thermal Profile

Table 13: 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 cycles	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.

9 Labelling Information

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

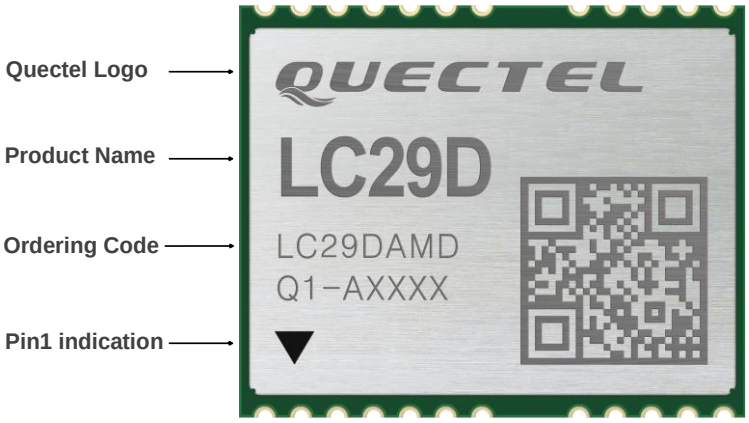

Figure 22: Labelling Information

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

10 Appendix A References

Table 14: Related Documents

Document Name	
[1]	Quectel_LC29D_GNSS_Protocol_Specification
[2]	Quectel_LC29D_AGNSS_Application_Note
[3]	Quectel_LC29D_DR&RTK(0)_Application_Note
[4]	Quectel_LC29D_Reference_Design
[5]	Quectel_Module_Secondary_SMT_Application_Note

Table 15: Terms and Abbreviations

Abbreviation	Description
AGNSS	Assisted Global Positioning System
CEP	Circular Error Probable
CNR	Carrier-to-Noise Ratio
CTS	Clear to Send
DCS1800	Digital Cellular System at 1800MHz
DR	Dead Reckoning
EGNOS	European Geostationary Navigation Overlay Service
ESD	Electrostatic Discharge
GAGAN	GPS Aided Geo Augmented Navigation
Galileo	Galileo Satellite Navigation System (EU)

GLONASS	Global Navigation Satellite System (the Russian GNSS)
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GSM	Global System for Mobile Communications
G.W	Gross Weight
IC	Integrated Circuit
IMD	Intermodulation Distortion
I/O	Input /Output
IRNSS/NavIC	Indian Regional Navigation Satellite System
LCC	Leadless Chip Carrier (package)
LDO	Low-dropout Regulator
LED	Light Emitting Diode
LNA	Low Noise Amplifier
LTE	Long Term Evolution
LTO	Long-term Orbit
Mbps	Megabits per second
MCU	Microcontroller Unit/Microprogrammed Control Unit
MEMS	Micro-Electro-Mechanical System
MISO	Master In Slave Out
MOQ	Minimum Order Quantity
MOSI	Master Out Slave In
MP	Mass Production
MSL	Moisture Sensitivity Levels
N.W	Net Weight
NMEA	National Marine Electronics Association
OC	Open Connector

ODO	Odometer
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
RAM	Random Access Memory
RF	Radio Frequency
RMC	Recommended Minimum Specific GNSS Data
RHCP	Right Hand Circular Polarization
ROM	Read Only Memory
RoHS	Restriction of Hazardous Substances
RTC	Real Time Clock
RTK	Real-Time KiNMEAtic
3GPP	3rd Generation Partnership Project
SAW	Surface Acoustic Wave
SBAS	Satellite-based Augmentation System
SMD	Surface Mount Device
SPI	Serial Peripheral Interface
SRAM	Static Random Access Memory
TCXO	Temperature Compensated Crystal Oscillator
TTFF	Time to First Fix
TVS	Transient Voltage Suppressor
UART	Universal Asynchronous Receiver/Transmitter
UTC	Coordinated Universal Time

VSWR	Voltage Standing Wave Ratio
WAAS	Wide Area Augmentation System
WCDMA	Wideband Code Division Multiple Access