LC29D (B,C,F)
Hardware Design

GNSS Module Series

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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	
Title	**LC29D (B,C,F) Hardware Design**
Subtitle	GNSS Module Series
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Revision History

Version	Date	Description
-	2021-04-26	Creation of the document
1.0	2021-06-18	First official release
1.1	2022-02-24	Numerous changes were made to this document; It should be read in its entirety. 1. Deleted the applicable OC: LC29D (A) and added the applicable OC: LC29D (F). 2. Reserved pin 15 (RTK_IND) and deleted the information related to RTK (Chapter 1, 2 and 4.1.5). 3. Added the combination of constellation for testing the data of power consumption and sensitivity, updated the power consumption data for LC29D (C) and the test conditions for TTFF (with AGNSS) and Horizontal Position Accuracy (Chapter 1.3). 4. Adjusted the order of sub-chapters within Chapter 1.5, 4 and 5. 5. Updated the content of QZSS, SBAS and DR (Chapter 1.5.6, 1.6.1 and 1.9). 6. Added the content of firmware update (Chapter 1.10). 7. Updated the figure of Pin Assignment and adjusted the

structure of Pinout (Chapter 2).

8. Updated the time for keeping the BOOT pin at high level during startup to enable the module to enter the Boot download mode (Chapter 2 and 4.2.2).
9. Specified the time limit for voltage rising during startup and updated the recommended ripple (Chapter 3.3).
10. Updated the figure of Power-Down and Power-on Restart Sequence (Chapter 3.4).
11. Deleted the chapter of LNA_EN.
12. Updated the figure of SPI Interface Reference Design (Chapter 4.1.1).
13. Updated the content of IPPS (Chapter 4.1.5).
14. Updated the figure of Reset Sequence (Chapter 4.2.1).
15. Updated the figure of Recommended Footprint. (Chapter 5.3).
16. Added the content of supply current requirement (Chapter 6.3).
17. Updated the figure of Top, Side and Bottom View Dimensions (Chapter 7.1).
18. Updated the figure of Top and Bottom views of the Module (Chapter 7.2).
19. Updated the packaging information about the module (Chapter 8.1).
20. Updated the content of the storage, manufacturing and soldering (Chapter 8.2 and 8.3).

Contents

Table Index

Figure Index

1 Product Description

1.1. Overview

The Quectel LC29D module includes three variants: LC29D (B)*, LC29D (C) and LC29D (F)*. Unless otherwise indicated, any information described in this document about LC29D applies to LC29D (B)*, LC29D (C) and LC29D (F)*.

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

Key features:

- The Quectel LC29D module is a dual-band, multi-constellation GNSS module and features a high-performance, high reliability positioning engine. The module facilitates a fast and precise GNSS positioning capability.
- The module supports serial communication interfaces UART and SPI.
- The module integrates a 6-axis IMU and supports sophisticated dead-reckoning algorithms to fuse the sensor data, GNSS raw data and speed data, etc.
- 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, 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 such model is currently unavailable.

1.2. Features

Table 2: Product Features

Features		LC29D (B)*	LC29D (C)	LC29D (F)*
Grade	Industrial	●	●	●
	Automotive	-	-	-
Category	Standard Precision GNSS	●	●	●
	High Precision GNSS	-	-	-
	DR	●	●	●
	RTK	-	-	-
	Timing	-	-	-
Supply Voltage	2.7–3.6 V, Typical: 3.3 V	●	●	●
IO Voltage	Typical: VCC	●	●	●
Communication Interfaces	UART	●	●	●
	SPI	●	●	●
	I2C	-	-	-
Integrated Features	Additional LNA	●	●	●
	Additional SAW	●	●	●
	RTC Crystal	●	●	●

	TCXO Oscillator		●	●	●
	6-axis IMU		●	●	●
Constellations	GPS	L1 C/A	●	●	●
		L5	●	●	●
	GLONASS	L1	●	●	●
	Galileo	E1	●	●	●
		E5a	●	●	●
	BDS	B1I	●	●	●
		B2a	●	-	●
	QZSS	L1 C/A	●	●	●
		L5	●	●	●
	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 (B)*	LC29D (C)	LC29D (F)*
Power Consumption [1] (GPS + GLONASS + Galileo + BDS + QZSS)	Acquisition	51 mA	38 mA	38 mA
	Tracking	37 mA	38 mA	39 mA
Sensitivity (GPS + GLONASS + Galileo + BDS + QZSS)	Acquisition	-148 dBm	-148 dBm	-148 dBm
	Reacquisition	-157 dBm	-157 dBm	-157 dBm
	Tracking	-162 dBm	-163 dBm	-162 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 [2] (with AGNSS)	Cold Start	5 s	5 s	5 s
Horizontal Position Accuracy [3]		1.0 m	1.2 m	1.0 m
Update Rate		1 Hz (Max. 10 Hz)	1 Hz	1 Hz (Max. 10 Hz)
Accuracy of 1PPS Signal	Typical accuracy: 100 ns			
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			

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[1] Room temperature, all satellites at -130 dBm, except Galileo at -122 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

The following figure shows a block diagram of the module. The module includes a GNSS IC, a 6-axis IMU, two additional LNAs, two additional SAWs, a diplexer, flash memory, a TCXO and an XTAL. 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, which ensures enhanced performance in a jamming environment.

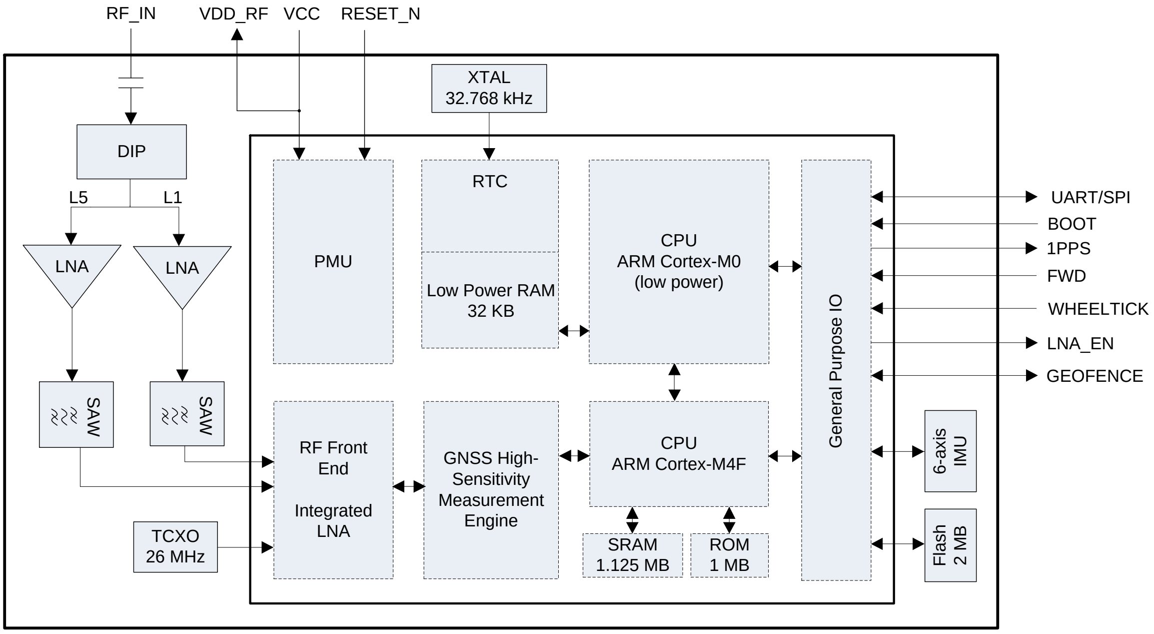

Figure 1: Block Diagram

1.5. GNSS Constellations

The Quectel LC29D module is a dual-band GNSS receiver that can receive and track GNSS signals.

1.5.1.GPS

The module is designed to receive and track GPS L1 C/A and L5 signals centered at 1575.42 MHz and 1176.45 MHz.

1.5.2.GLONASS

The module is designed to receive and track GLONASS L1 signal ranging from 1598.0625 to 1605.375 MHz.

1.5.3.Galileo

The module is designed to receive and track Galileo E1 and E5a signals centered at 1575.42 MHz and 1176.45 MHz.

1.5.4.BDS

The module is designed to receive and track BDS B1I and B2a signals provided by the BDS Navigation Satellite System centered at 1561.098 MHz and 1176.45 MHz. The ability to receive and track BDS signals in conjunction with GPS results in higher coverage, improved reliability, and better accuracy.

1.5.5.QZSS

The Quasi-Zenith Satellite System (QZSS) is a regional navigation satellite system that transmits additional GPS L1 C/A, L1C, L2C, and L5 signals for the Pacific region covering Japan and Australia. The Quectel LC29D module can detect and track QZSS L1 C/A and L5 signals concurrently with GPS signals, resulting in better availability especially under challenging conditions, i.e., in urban canyons.

1.5.6.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 from IRNSS satellites centered at 1176.45 MHz.

1.6. Augmentation System

1.6.1.SBAS

The Quectel LC29D module supports SBAS signals 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 signals can also be used as additional 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 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. 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]***.

1.9. Dead Reckoning Function

The Quectel LC29D module supports dead reckoning which is the process of estimating the module’s current position based on the last position obtained from GNSS, speed, heading sensor data, etc. With these 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 achieves continuous and high-accuracy positioning in environments such as tunnels and urban canyons. For more information, see ***document [3]***.

1.10. Firmware Upgrade

The Quectel GNSS module is delivered with preprogrammed firmware. Quectel may release firmware versions that contain bug fixes or performance optimizations. It’s highly important that customers implement a firmware upgrade mechanism in their system. A firmware upgrade is a process of transferring a binary file image to the receiver and storing it in non-volatile flash. For more information, see ***document [4]***.

2 Pin Assignment

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

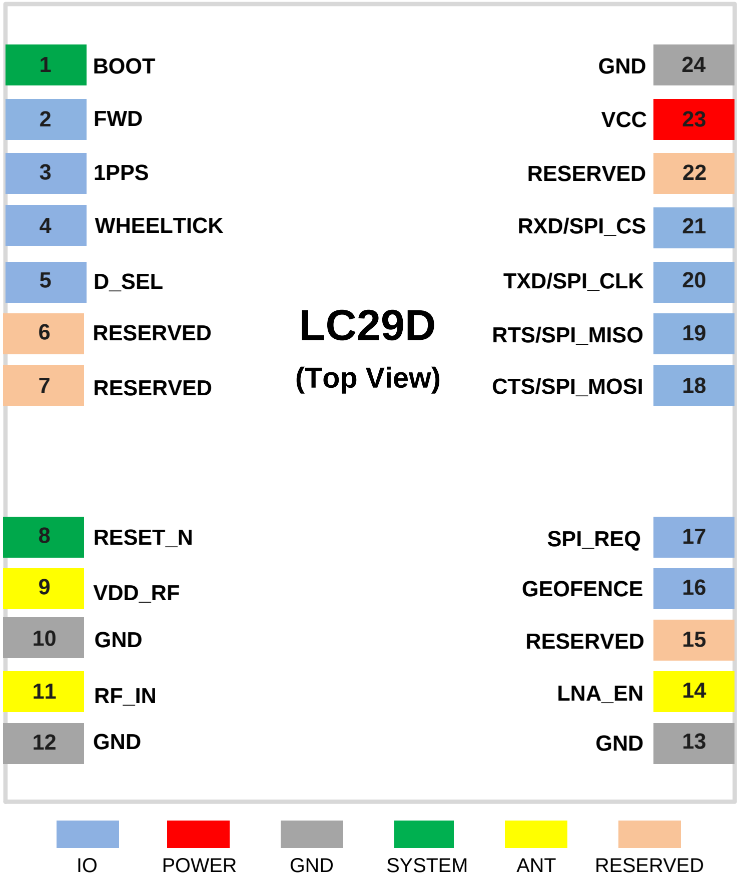

Figure 2: Pin Assignment

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: Pin Description

Function	Name	No.	I/O	Description	Remarks
Power	VCC	23	PI	Main power supply	Provides clean and steady voltage.
IO	TXD/ SPI_CLK	20	DIO	Transmits data/ SPI clock	**When using UART Interface: D_SEL=1** (**Pulled up internally by default**) In Normal operating mode, the UART interface can be used for standard NMEA message output, PGLOR/PQTM command input and output, Bream [4] message input and output, and firmware upgrade. In this mode, the module requires a two-wire UART (TXD and RXD) only. In Boot download mode, the UART interface can be used for bootloader upgrade. In this 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**) The SPI interface can be used for standard NMEA message output, PGLOR/PQTM command input and output, Bream [4] message input and output, and firmware upgrade. In this case, 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	
	FWD	2	DI	Forward/Backward direction	Pulled up internally by default.

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[4] Bream is the chipset supplier dedicated protocol.

	WHEELTICK	4	DI	Odometer wheel-tick input	
	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. If unused, leave the pin N/C (not connected).
ANT	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).
System	BOOT	1	DI	Controls module startup mode	Pulled down internally by default. If the pin is kept floating during startup, the module will enter Normal operating mode. If the pin is kept at high level for about 50 ms during startup, the module will enter Boot download mode.
	RESET_N	8	DI	Resets the module	Active low.
GND	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	RESERVED	6, 7, 15, 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 and 6-axis IMU.

Module power consumption may vary by several orders of magnitude, especially when power saving 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, and a combination of a 10 µF, a 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 the 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.

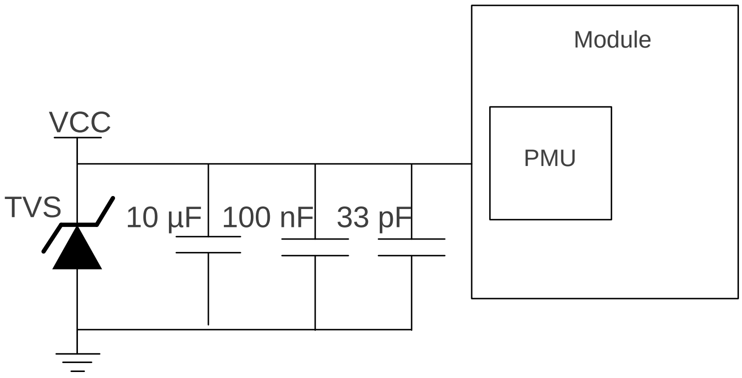

Figure 3: VCC Input Reference Circuit

3.2. Power Mode

3.2.1.Continuous Mode

If VCC is 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. 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

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

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

3.4. Power-Down Sequence

Once the VCC is shut down, voltage should drop quickly in 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 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.

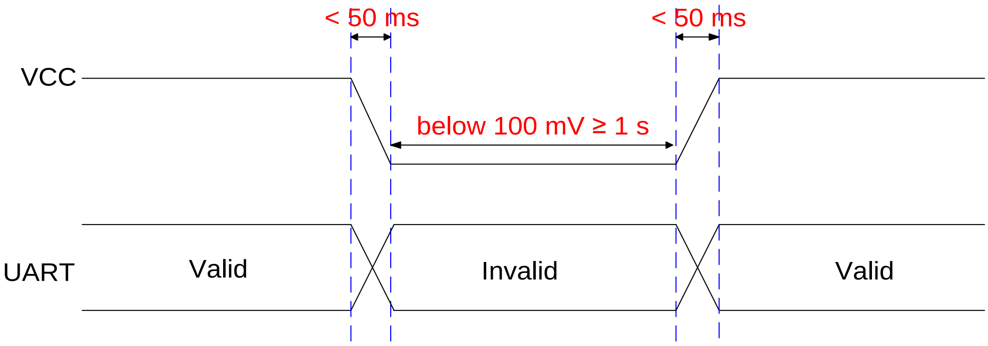

Figure 4: Power-Down and Power-on Restart Sequence

4 Application Interfaces

4.1. IO Pins

4.1.1.Communication Interfaces

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

4.1.1.1. 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.

4.1.1.2. UART Interface

The module provides one UART interface that has the following features:

- Supports standard NMEA message output, PGLOR/PQTM command input and output, Bream [5] message input and output, and firmware upgrade.
- Supports baud rates: 115200 bps, 230400 bps, 460800 bps and 921600 bps.

The reference design is shown the figure below.

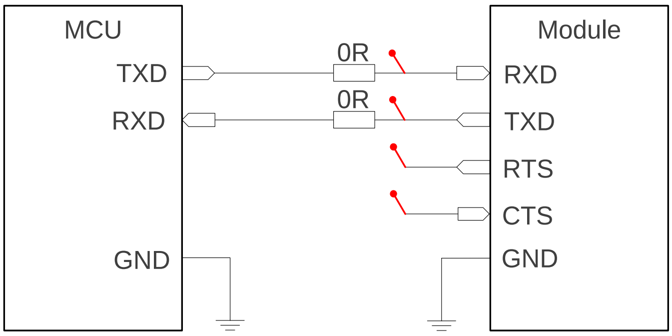

Figure 5: UART Interface Reference Design

NOTE

1. For data transmission and firmware upgrade in Normal operating mode, the module only requires a two-wire UART (TXD and RXD). However, a four-wire UART (TXD, RXD, CTS and RTS) is needed for firmware bootloader upgrade in Boot download mode. These additional pins should be made accessible in your design.
2. “⟍” represents UART interface test points. Place the test points close to the module.
3. UART interface default settings vary depending on software version. Please see specific software versions for details.
4. If the IO voltage of MCU is not matched with the module, a level shifter must be selected.

4.1.1.3. SPI Interface

The module provides one SPI interface that supports the following features:

- Supports standard NMEA message output, PGLOR/PQTM command input and output, Bream [5] message input and output, and firmware upgrade;
- Operates as a slave;

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[5] Bream is the chipset supplier dedicated protocol.

- Fixes data frame size of 8 bits;
- Supports baud rates: 1 Mbps to 3 Mbps.

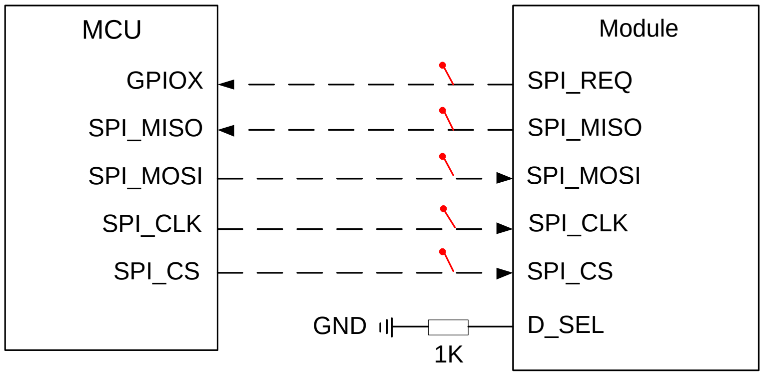

Figure 6: SPI Interface Reference Design

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 SPI interface test points. Place the test points close to the module.
4. If the IO voltage of MCU is not matched with that of the module, a level shifter must be selected.

4.1.2.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.

4.1.3.FWD

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

NOTE

Only cars need to be connected to the FWD pin, not 2-wheelers.

4.1.4.WHEELTICK

The WHEELTICK pin is used to input wheel tick pulse 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 [5]***.

4.1.5.1PPS

The 1PPS output pin generates one pulse per second periodic signal synchronized with a GNSS time grid with intervals. 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. To maintain the high accuracy of 1PPS, it is required to have visible satellites in an open sky environment and the VCC should be kept powered.

4.2. System Pins

4.2.1.RESET_N

RESET_N is an input pin that 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.

RESET_N is pulled up to 1.8 V internally with a 2.4 kΩ pull-up resistor, thus external pull-up circuit is not allowed for this pin.

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

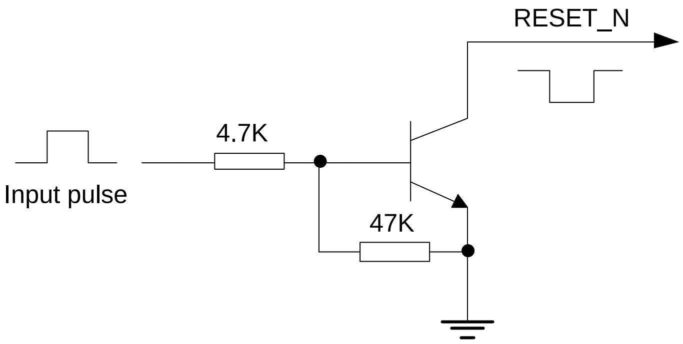

Figure 7: Reference OC Circuit for Module Reset

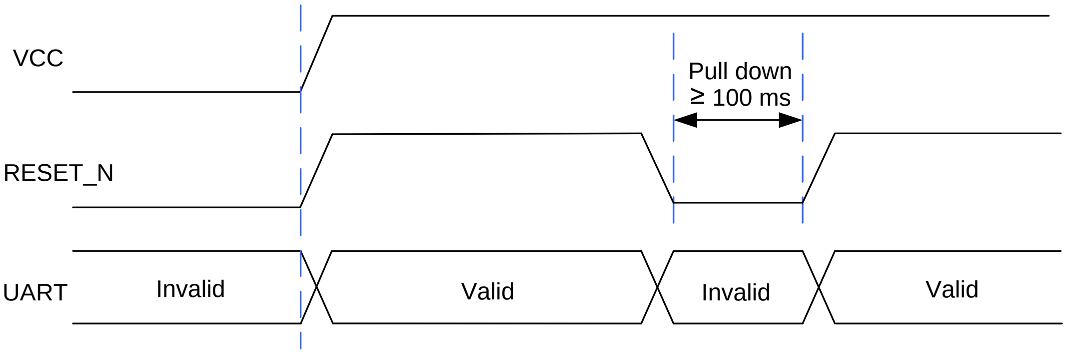

Figure 8: Reset Sequence

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 can be used to set the Quectel LC29D module into Boot download mode. It is pulled down internally by default. If the pin is kept floating during startup, the module enters Normal operating mode. If the pin is kept at high level for about 50 ms during startup, the module enters Boot download mode. For more information about the reference circuit design, see ***document [5]***.

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

Table 7: Operating Modes

Voltage Level	Operating Mode	Comment
Low	Normal	If the pin is kept floating during startup, the module enters Normal operating mode.
High	Boot download	If the pin is kept at high level for about 50 ms during startup, the module enters Boot download mode.

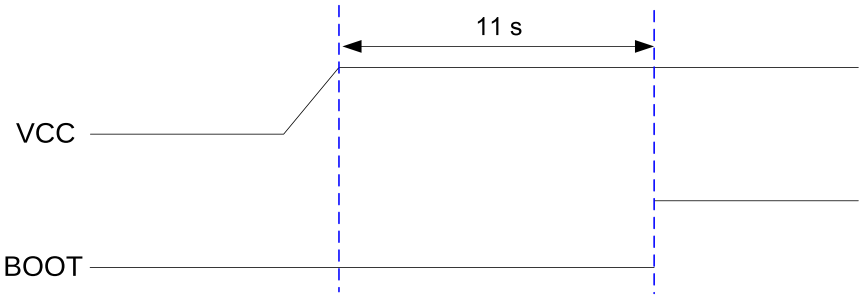

Figure 9: BOOT Pin State (Normal Operating Mode)

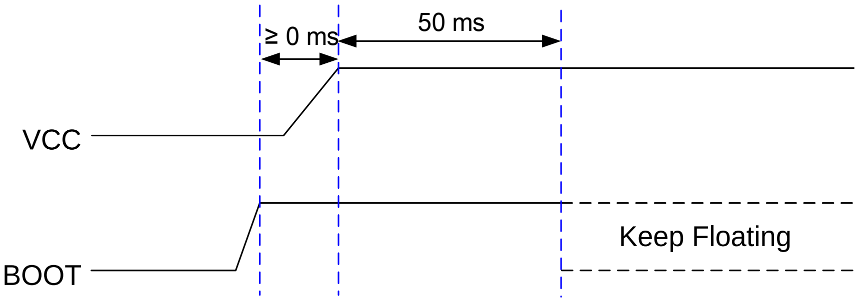

Figure 10: BOOT Pin Control Sequence (Boot Download Mode)

5 Design

5.1. Antenna Design

5.1.1. Antenna Specification

The Quectel LC29D module can be connected to a dedicated passive or active dual-band (L1 + L5) 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: 1164–1189 MHz & 1559–1606 MHz Polarization: RHCP VSWR: < 2 (Typ.) Passive Antenna Gain: > 0 dBi
Active Antenna	Frequency Range: 1164–1189 MHz & 1559–1606 MHz Polarization: RHCP VSWR: < 2 (Typ.) Passive Antenna Gain: > 0 dBi Active Antenna Noise Figure: < 1.5 dB Active Antenna Total Gain: < 17 dB Proposed by the Quectel Antenna Team: **YB0017AA**

NOTE

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

5.1.2. 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 C/N_0 of GNSS signal.

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 is as below:

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

The “Power of GNSS signal” is GNSS signal level. In practical environment, the signal level at the earth 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:

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

“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.

5.1.3.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.

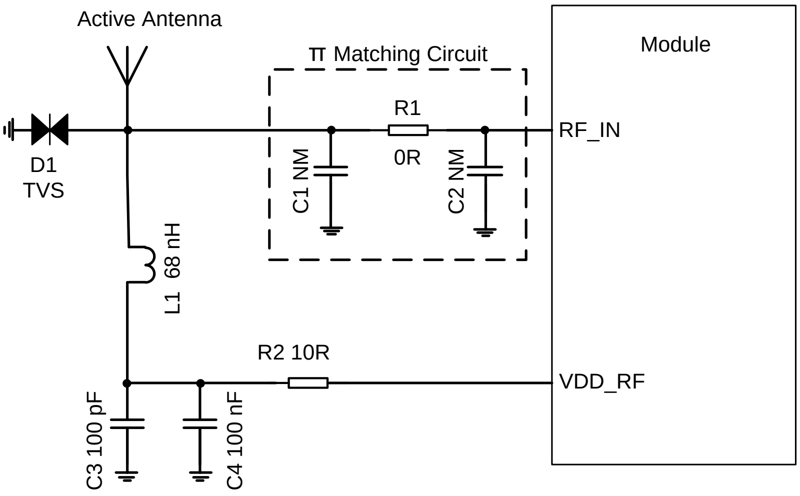

Figure 11: Active Antenna Reference Design

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 should be at least 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 applies to the C2 footprint.

5.1.4.Passive Antenna Reference Design

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

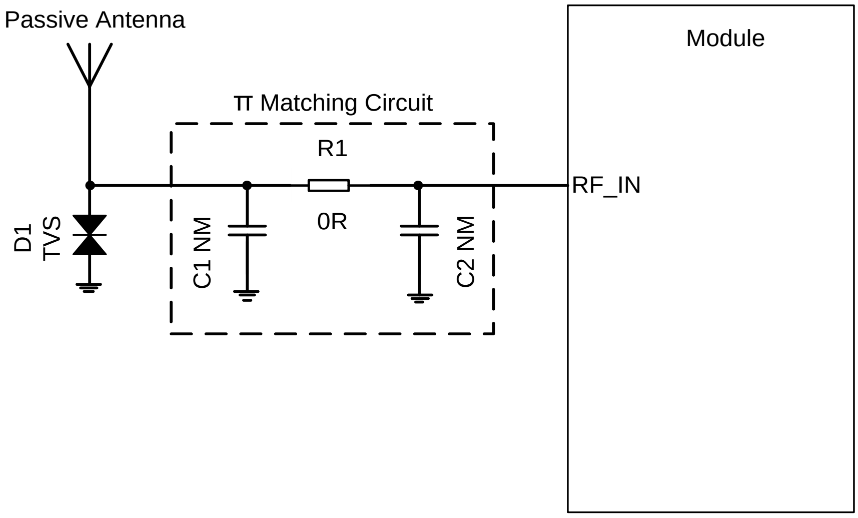

Figure 12: Passive Antenna Reference Design

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.

5.2. Coexistence with Cellular Systems

Since GNSS signals are usually very weak, a GNSS receiver could be vulnerable to the 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. 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.

See the following figure for more details.

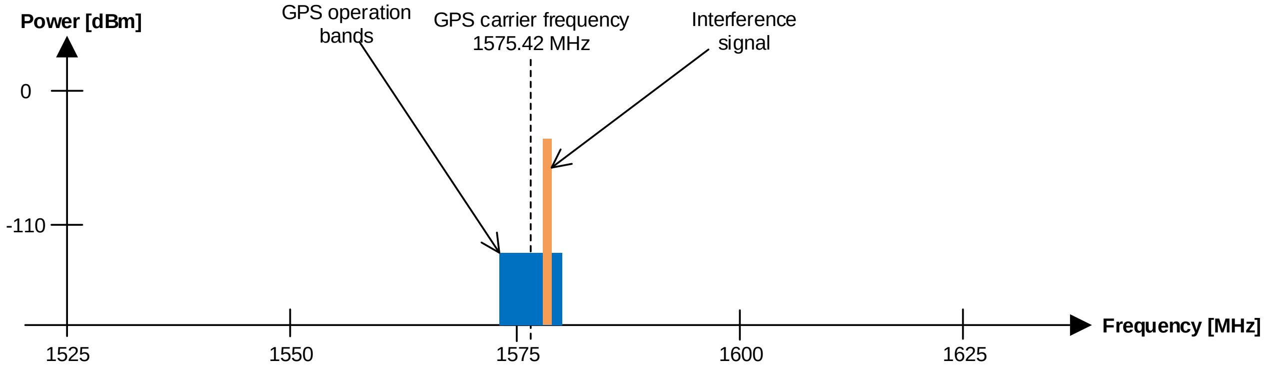

Figure 13: In-Band Interference on GPS L1

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
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

5.2.2.Out-of-Band Interference

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

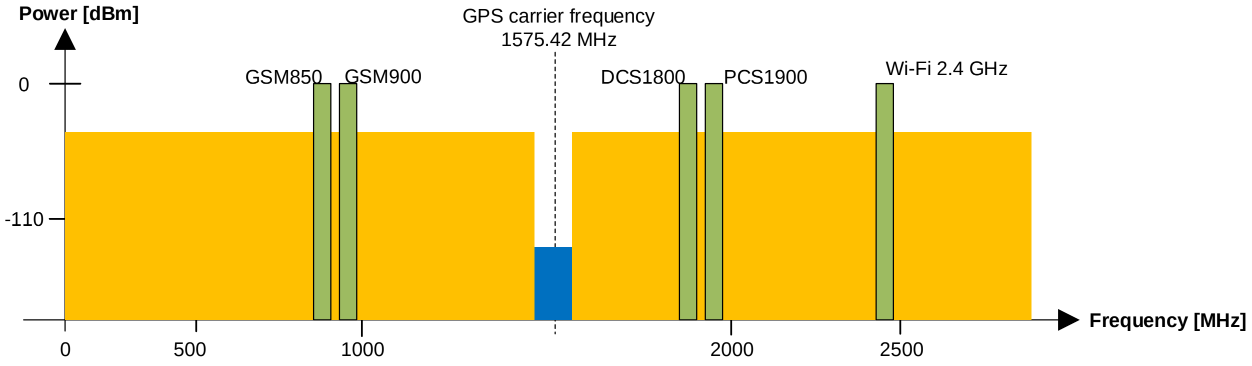

Figure 14: Out-of-Band Interference on GPS L1

5.2.3.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.

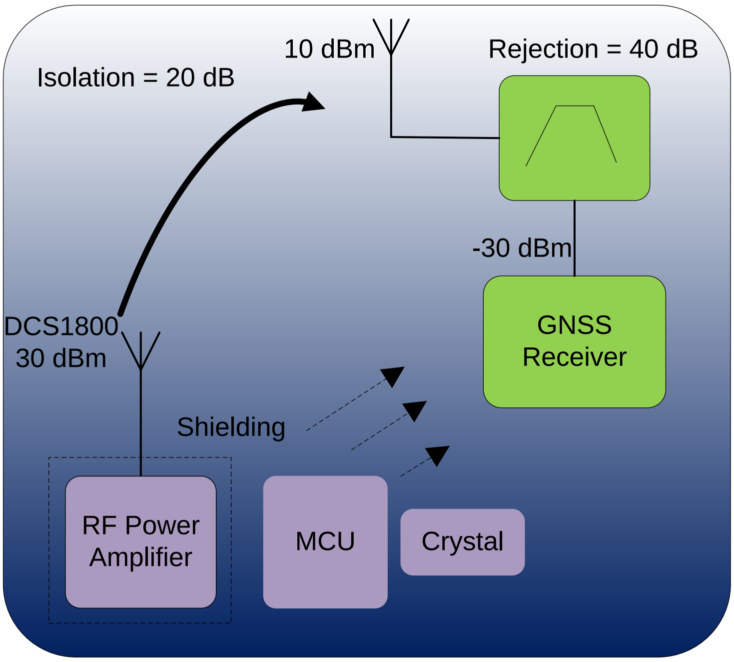

Figure 15: Interference Source and Its Path

5.3. Recommended Footprint

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

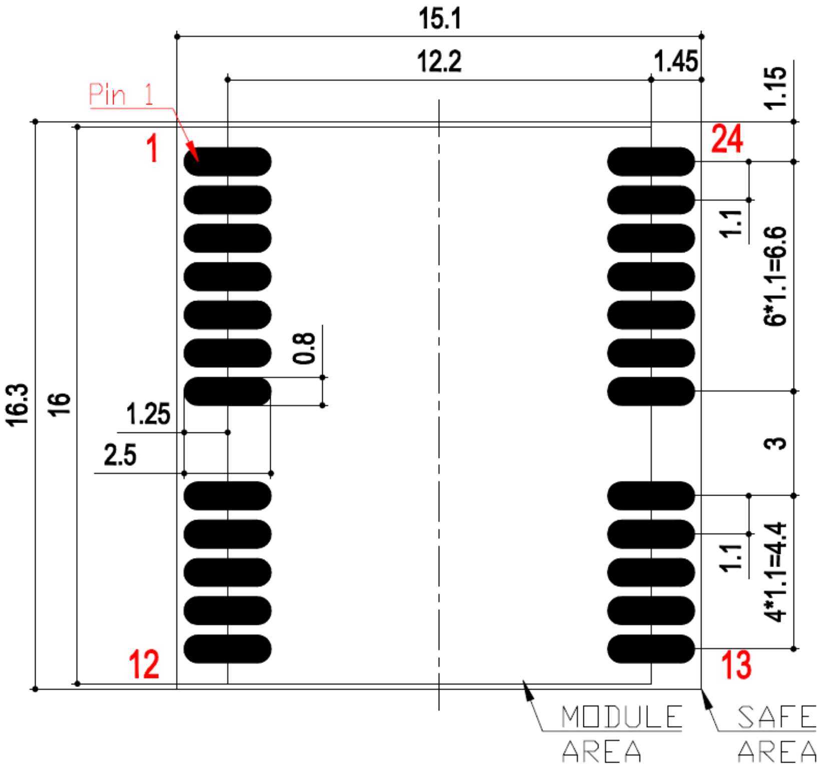

Figure 16: Recommended Footprint

NOTE

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

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
V_{IN}_IO	Input Voltage at IO 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. Recommended Operating Conditions

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

Table 11: Recommended Operating Conditions

Parameter	Description	Min.	Typ.	Max.	Unit
VCC	Power Supply Voltage	2.7	3.3	3.6	V
IO_Domain	Digital IO Pin Domain Voltage	-	VCC	-	V
V_{IL}	Digital IO Pin Low-Level Input Voltage	0	-	0.35 × VCC	V
V_{IH}	Digital IO Pin High-Level Input Voltage	0.65 × VCC		VCC + 0.3	V
V_{OL}	Digital IO Pin Low-Level Output Voltage	-	-	0.4	V
V_{OH}	Digital IO 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. 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	LC29D (B)*		LC29D (C)		LC29D (F)*	
			$I_{Typ.}$ [6]	I_{PEAK} [6]	$I_{Typ.}$ [6]	I_{PEAK} [6]	$I_{Typ.}$ [6]	I_{PEAK} [6]
I_{VCC} [7]	Current at VCC	Acquisition	51 mA	79 mA	38 mA	79 mA	38 mA	78 mA
		Tracking	37 mA	79 mA	38 mA	79 mA	39 mA	78 mA

6.4. ESD Protection

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

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

- When mounting the module onto a motherboard, make sure to connect the GND first, and then the RF_IN 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).

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[6] Room temperature, measurements are taken with typical voltage.

[7] Used to determine maximum current capability of power supply.

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

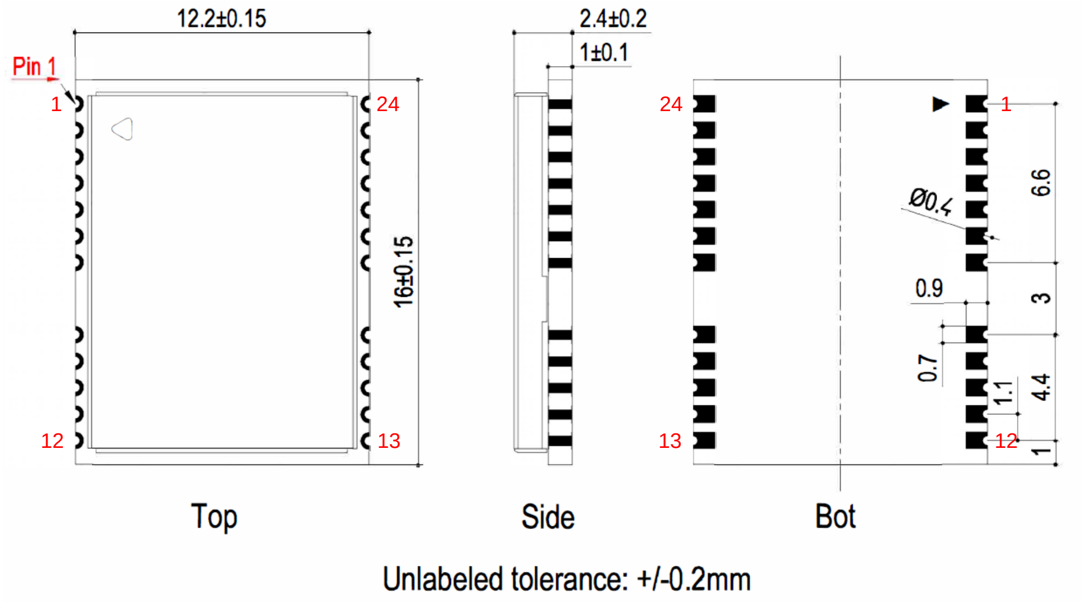


Figure 17: Top, Side and Bottom View Dimensions

NOTE

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

7.2. Top and Bottom Views

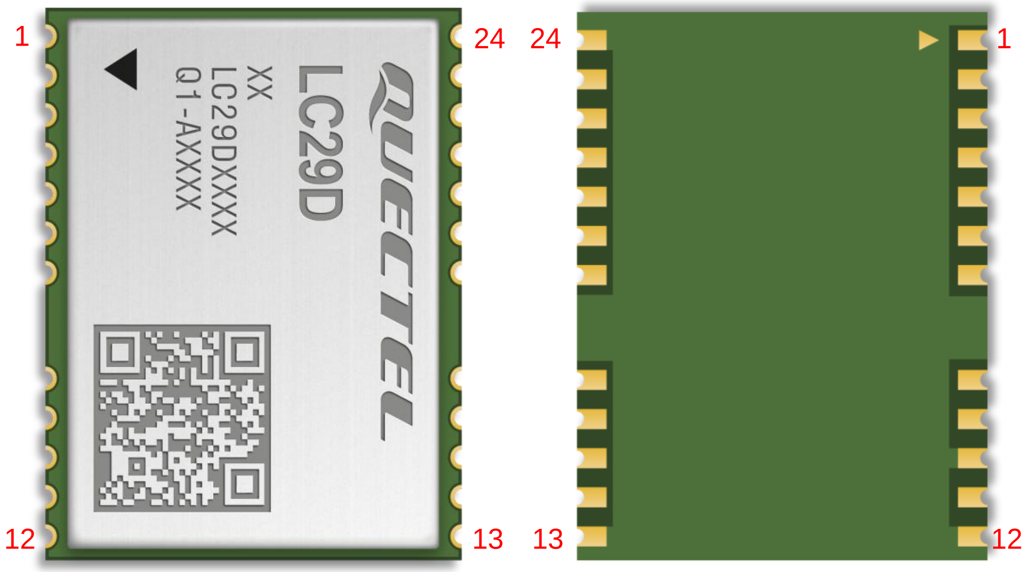


Figure 18: Top and Bottom Views

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 in a tape carrier package, which enables efficient production, set-up and dismantling of production batches. It is shipped in a vacuum-sealed packaging to prevent moisture intake and electrostatic discharge.

8.1.1.Carrier Tape

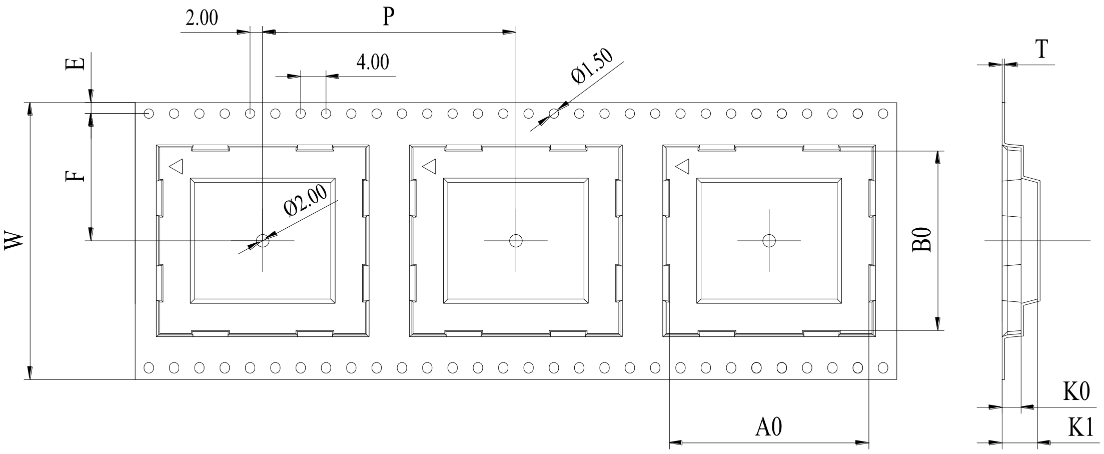


Figure 19: Carrier Tape Dimension Drawing

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

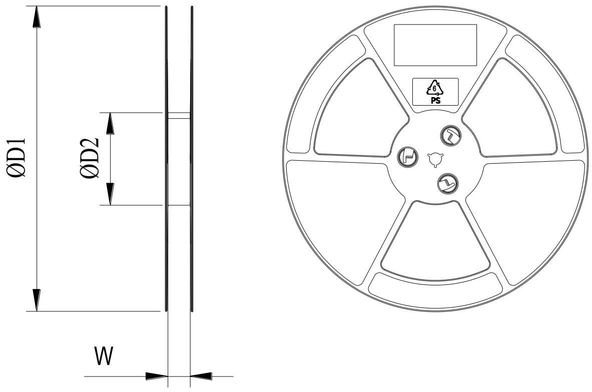
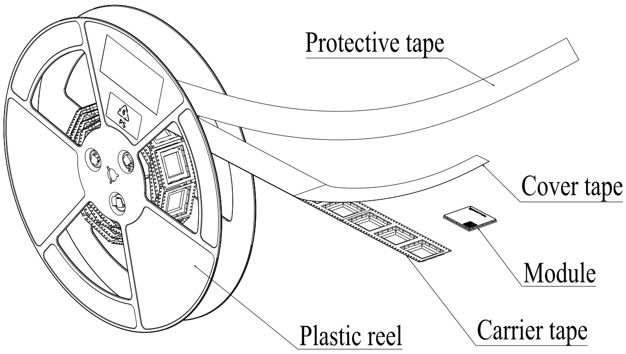


Figure 20: Plastic Reel Dimension Drawing

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

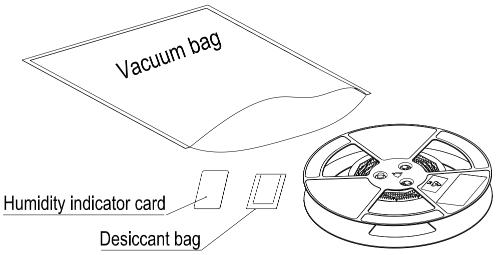
øD1	**øD2**	**W**
330	100	32.5

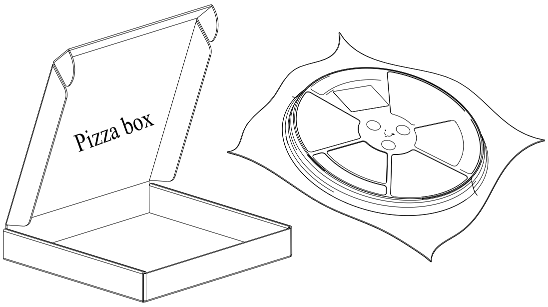
8.1.3.Packaging Process



Place the modules into the carrier tape and use the cover tape to cover them; then wind the heat-sealed carrier tape to the plastic reel and use the protective tape for protection. One plastic reel can load 250 modules.

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





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

Put 4 pizza boxes into 1 carton and seal it. One carton can pack 1000 modules.

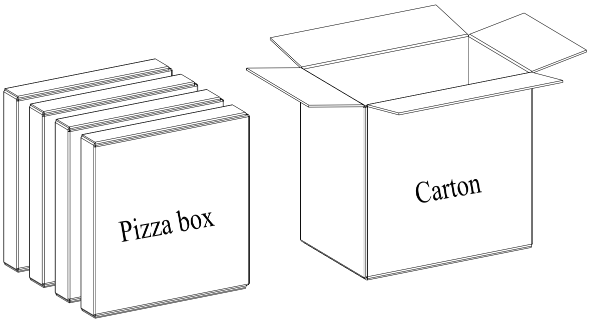


Figure 21: Plastic Reel Dimension Drawing

8.2. Storage

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

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

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

3. The shelf life of the module is 168 hours [8] 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 under recommended storage conditions;
   - Violation of the third requirement above occurs;
   - Vacuum-sealed packaging is broken, or the packaging has been removed for over 24 hours;
   - Before module repairing.

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

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

NOTE

1. To avoid blistering, layer separation and other soldering issues, extended exposure of the module to the air is forbidden.
2. Take the module out of the packaging and put it on high-temperature-resistant fixtures before baking. The module must be soldered to PCB within 24 hours of the baking, otherwise put it 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 module.

---

[8] 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.

8.3. Manufacturing and Soldering

Push the squeegee to apply solder paste on the stencil surface, 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 stencil thickness for the module, see ***document [6]***.

The peak reflow temperature should be 235–246 ºC, with 246 ºC as the absolute maximum reflow temperature. To avoid module damage caused by repeated heating, it is strongly recommended to mount the module to the PCB only after reflow soldering 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.

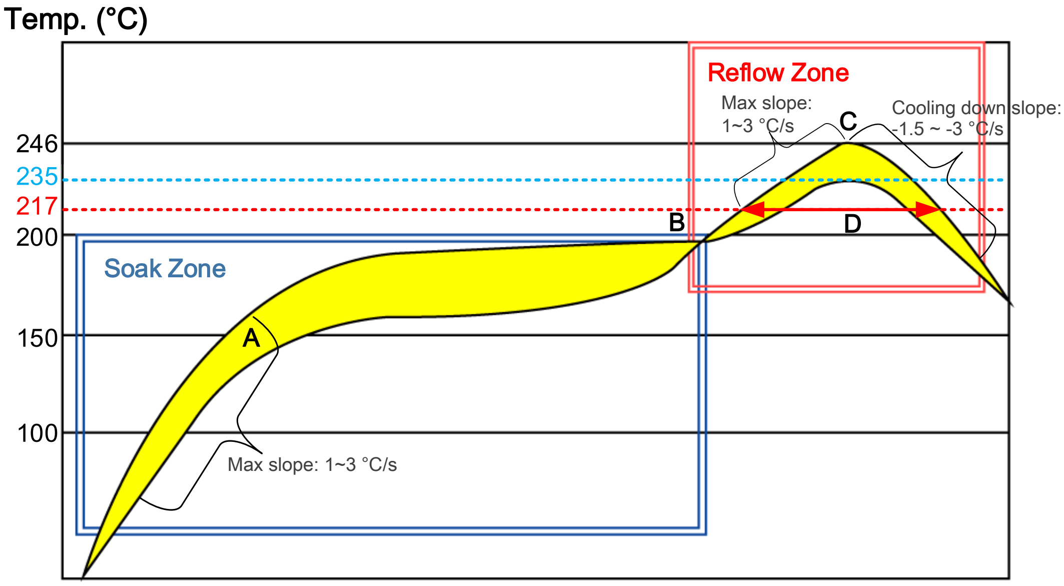


Figure 22: Recommended Reflow Soldering Thermal Profile

Table 15: 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	1–3 °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 require direct contact with the module, **NEVER** wipe the module shielding can with organic solvents, such as acetone, ethyl alcohol, isopropyl alcohol, trichloroethylene, etc. Otherwise, the shielding can may become rusty.
2. The module shielding can be 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.
3. If the module requires conformal coating, **DO NOT** use any coating material that may chemically react with the PCB or shielding cover, and prevent the coating material from entering the module shield.
4. Avoid cleaning the module with ultrasonic technology since it can damage crystals inside the module.
5. Due to SMT process complexity, please contact Quectel Technical Support before taking any action or implementing any process that you are not sure about (e.g. selective soldering, ultrasonic soldering) that is not mentioned in ***document [6]***.

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.

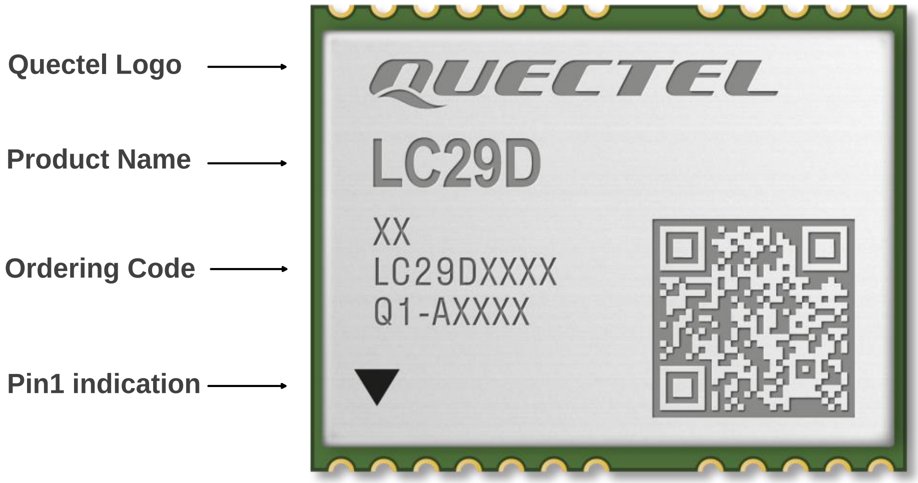


Figure 23: Labelling Information

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 References

Table 16: Related Documents

Document Name
[1] Quectel_LC29D(B,C,F)&LC79D(D)_GNSS_Protocol_Specification
[2] Quectel_LC29D(B,C,F)&LC79D(D)_AGNSS_Application_Note
[3] Quectel_LC29D(B,C,F)_DR_Application_Note
[4] Quectel_LC29D(B,C,F)&LC79D(D)_Firmware_Upgrade_Guide
[5] Quectel_LC29D(B,C,F)_Reference_Design
[6] Quectel_Module_Secondary_SMT_Application_Note

Table 17: Terms and Abbreviations

Abbreviation	Description
AGNSS	Assisted Global Positioning System
ARM	Advanced RISC Machine
CEP	Circular Error Probable
C/N_0	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
IC	Integrated Circuit
IMD	Intermodulation Distortion
I/O	Input /Output
$I_{Typ.}$	Typical Current
I_{PEAK}	Peak Current
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
MISO	Master In Slave Out
MOSI	Master Out Slave In
MSL	Moisture Sensitivity Levels
NMEA	National Marine Electronics Association
OC	Open Connector
PCB	Printed Circuit Board
PMU	Power Management Unit

1PPS	One Pulse Per Second
PSRR	Power Supply Rejection Ratio
QR (Code)	Quick Response (Code)
QZSS	Quasi-Zenith Satellite System
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 Kinematic
3GPP	3rd Generation Partnership Project
SAW	Surface Acoustic Wave
SBAS	Satellite-based Augmentation System
SMD	Surface Mount Device
SMT	Surface Mount Technology
SPI	Serial Peripheral Interface
SRAM	Static Random Access Memory
TCXO	Temperature Compensated Crystal Oscillator
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
XTAL	External Crystal Oscillator