LC29H Series
Hardware Design

GNSS Module Series

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Safety Information

The following safety precautions must be observed during all phases of operation, such as usage, service, or repair of any terminal or mobile incorporating the module. Manufacturers of the terminal should notify users and operating personnel of the following safety 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

Document Information	
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1 Product Description

1.1. Overview

The Quectel LC29H series module includes five variants: LC29H (AA), LC29H (BA)*, LC29H (CA)*, LC29H (DA)* and LC29H (EA)*.

The LC29H series module supports multiple global positioning and navigation systems: GPS, GLONASS, Galileo, BDS and QZSS. The module also supports SBAS (including WAAS, EGNOS, MSAS and GAGAN) and AGNSS functions.

Key features:

- The 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 I2C.
- The module integrates a 6-axis IMU (beside the LC29H (AA)) and supports sophisticated RTK and dead-reckoning algorithms to fuse the 6-axis IMU data, GNSS raw data and speed data, etc. to provide cm-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 LC29H is an SMD type module with a compact form factor of 12.2 mm × 16.0 mm × 2.5 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 Mark

Table 1: Special Mark

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

1.2. Features

Table 2: Product Features

Features		LC29H (AA)	LC29H (BA)*	LC29H (CA)*	LC29H (DA)*	LC29H (EA)*
Grade	Industrial	●	●	●	●	●
	Automotive	-	-	-	-	-
Category	Standard Precision GNSS	●	-	●	-	-
	High Precision GNSS	-	●	-	●	●
	DR	-	●	●	-	-
	RTK	-	●	-	●	●
	Timing	-	-	-	-	-
Supply Voltage	3.1–3.6 V, Typ. 3.3 V	●	●	●	●	●
V_BCKP Voltage	2.2–3.6 V, Typ. 3.3 V	●	●	●	●	●
IO Voltage	Typ. 2.8 V	●	●	●	●	●
Communication Interfaces	UART	●	●	●	●	●
	SPI	-	-	-	-	-
	I2C	●	●	●	●	●

Integrated Features	Additional LNA		●	●	●	●	●
	Additional Filter		●	●	●	●	●
	RTC Crystal		●	●	●	●	●
	TCXO Oscillator		●	●	●	●	●
	6-axis IMU		-	●	●	-	-
Constellations	GPS	L1 C/A	●	●	●	●	●
		L5	●	●	●	●	●
		L2C	-	-	-	-	-
	GLONASS	L1	●	●	●	●	●
		L2	-	-	-	-	-
	Galileo	E1	●	●	●	●	●
		E5a	●	●	●	●	●
		E5b	-	-	-	-	-
	BDS	B1I	●	●	●	●	●
		B2a	●	●	●	●	●
		B2I	-	-	-	-	-
	QZSS	L1 C/A	●	●	●	●	●
		L5	●	●	●	●	●

		L2C	-	-	-	-	-
	IRNSS	L5	-	-	-	-	-
	SBAS	L1	●	●	●	●	●
	L-band	L-band	-	-	-	-	-
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 × (2.5 ±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	LC29H (AA)	LC29H (BA)*	LC29H (CA)*	LC29H (DA)*	LC29H (EA)*
Power Consumption [1] (GPS + GLONASS + Galileo + BDS + QZSS)	Acquisition	24 mA	30 mA	28 mA	TBD	TBD
	Tracking	24 mA	30 mA	28 mA	TBD	TBD
	Backup Mode	25 µA	25 µA	25 µA	TBD	TBD
Sensitivity (GPS + GLONASS + Galileo + BDS + QZSS)	Acquisition	-147 dBm	-147 dBm	-147 dBm	TBD	TBD
	Reacquisition	-159 dBm	-159 dBm	-159 dBm	TBD	TBD
	Tracking	-165 dBm	-165 dBm	-165 dBm	TBD	TBD
TTFF [1] (without AGNSS [2])	(Full) Cold Start [3]	31 s	TBD	TBD	TBD	TBD
	Warm Start	24 s	TBD	TBD	TBD	TBD
	Hot Start	1 s	TBD	TBD	TBD	TBD
TTFF [4]	(Full) Cold Start [3]	16 s	TBD	TBD	TBD	TBD

[1] Room temperature, all satellites at -130 dBm.
[2] AGNSS refers to EASY™ Technology in this document.
[3] Full Cold Start is only supported by LC29H (BA)* and LC29H (CA)*.
[4] Open-sky, active high-precision GNSS antenna; less than 1 km baseline length is also required for LC29H (BA)*, LC29H (DA)* and LC29H (EA)*.

(with AGNSS [2])	Warm Start	2 s	TBD	TBD	TBD	TBD
	Hot Start	1 s	TBD	TBD	TBD	TBD
Horizontal Position Accuracy		Autonomous [5]: 1 m	Autonomous [5]: 1 m RTK [6]: TBD	Autonomous [5]: 1 m	Autonomous [5]: 1 m RTK [6]: TBD	Autonomous [5]: 1 m RTK [6]: TBD
Convergence Time		-	RTK [6]: 10 s	-	RTK [6]: TBD	RTK [6]: TBD
Update Rate		1 Hz (Default); Max. 10 Hz	GNSS Raw Data: 1 Hz IMU Raw Data: 1 Hz (Default); Max. 10 Hz	IMU Raw Data: 1 Hz (Default); Max. 10 Hz	GNSS Raw Data: 1 Hz	GNSS Raw Data: 10 Hz
Accuracy of 1PPS Signal [1]		Typ. 100 ns				
Velocity Accuracy [1]		Without Aid TBD				
Acceleration Accuracy [1]		Without Aid: TBD				
Dynamic Performance [1]		Maximum Altitude [7]: 10000 m Maximum Velocity [7]: 500 m/s Maximum Acceleration: 4g				

[5] CEP, 50 %, 24 hours static, -130 dBm, more than 6 SVs.
[6] CEP, 50 %, with active high-precision antennas in an open-sky environment and within 1 km from the base station.
[7] ITAR limits.

1.4. Block Diagram

A block diagram of the module which includes a GNSS IC, a 6-axis IMU (supported only by LC29H (BA)* and LC29H (CA)*), an additional LNA, a diplexer, a TCXO and an XTAL is presented below. The diplexer integrates two band-pass filters, which can improve the out-of-band rejection.

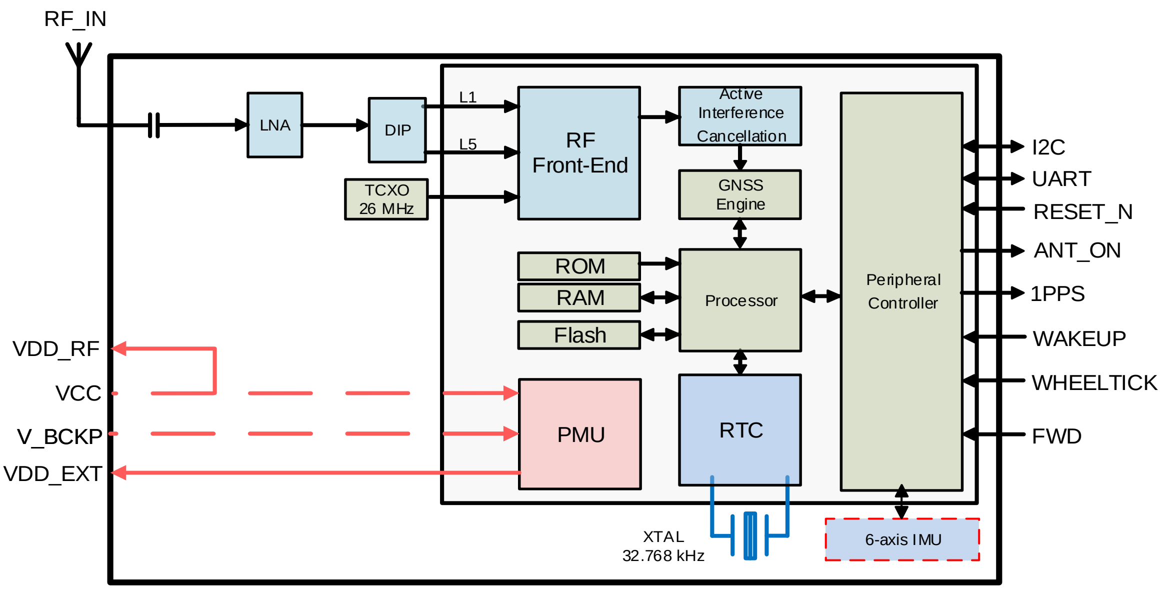


Figure 1: Block Diagram

NOTE

FWD* and WHEELTICK* are supported by LC29H (BA)*, LC29H (CA)*, LC29H (DA)* and LC29H (EA)*.

1.5. GNSS Constellations

The Quectel LC29H series module is a dual-band GNSS receiver that can receive and track GNSS signals. The module supports the concurrent tracking of five constellations.

1.5.1. GPS

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

1.5.2. GLONASS

The module is designed to receive and track GLONASS L1 signals in the 1598.0625–1605.375 MHz frequency range.

1.5.3. Galileo

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

1.5.4. BDS

The module is designed to receive and track BDS B1I and B2a signals centered on 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 signals compatible with the GPS L1 C/A, L1C, L2C and L5 signals for the Pacific region covering Japan and Australia. The module can detect and track QZSS L1 C/A and L5 signals concurrently with GPS signals, leading to better availability especially under challenging conditions, e.g., in urban canyons.

1.6. Augmentation System

1.6.1. SBAS

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

1.7. AGNSS

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

1.7.1. EASY™

The module supports the EASY™ technology to improve TTFF and acquisition sensitivity of GNSS modules. To achieve that goal, the EASY™ technology provides ancillary information, such as the ephemeris, almanac, last rough position, time and satellite status.

The EASY™ technology works as an embedded software to accelerate TTFF by predicting satellite navigation messages from the received ephemeris. After receiving the broadcast ephemeris for the first time, the GNSS engine automatically calculates and predicts the orbit information up to the subsequent 3 days, and saves the predicted information in the internal memory. The GNSS engine will use the information for positioning if there is not enough information from satellites, resulting in improved positioning and TTFF.

The EASY™ function reduces TTFF to 2 s in warm start. In this case, the backup domain should still be valid. To obtain enough broadcast ephemeris information from GNSS satellites after fixing the position, the GNSS module should keep tracking the information for at least 5 minutes in strong-signal environments.

The EASY™ function is enabled by default, and it is disabled by sending commands. For more information about commands, see ***document [1]***.

1.7.2. EPO™

The module features a leading AGNSS technology called EPO™, which improves the sensitivity of the module and therefore shortens its TTFF. EPO™ can assist the receiver to reduce the TTFF for up to 14 days. For more information about EPO™, see ***document [2]***.

1.8. LOCUS

The module supports the embedded logger function called LOCUS. When this function is enabled, it automatically logs position information to the internal flash memory. As a result, the module can reduce power consumption and the host does not need to track the NMEA messages all the time. A command can be used to query the current state of LOCUS.

1.9. Multi-Tone AIC

The module features the function called multi-tone active interference cancellation (multi-tone AIC), which decreases harmonic distortion of RF signals from Wi-Fi, Bluetooth, 2G, 3G, 4G and 5G networks.

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

The anti-jamming performance of the AIC is illustrated in the following figure:

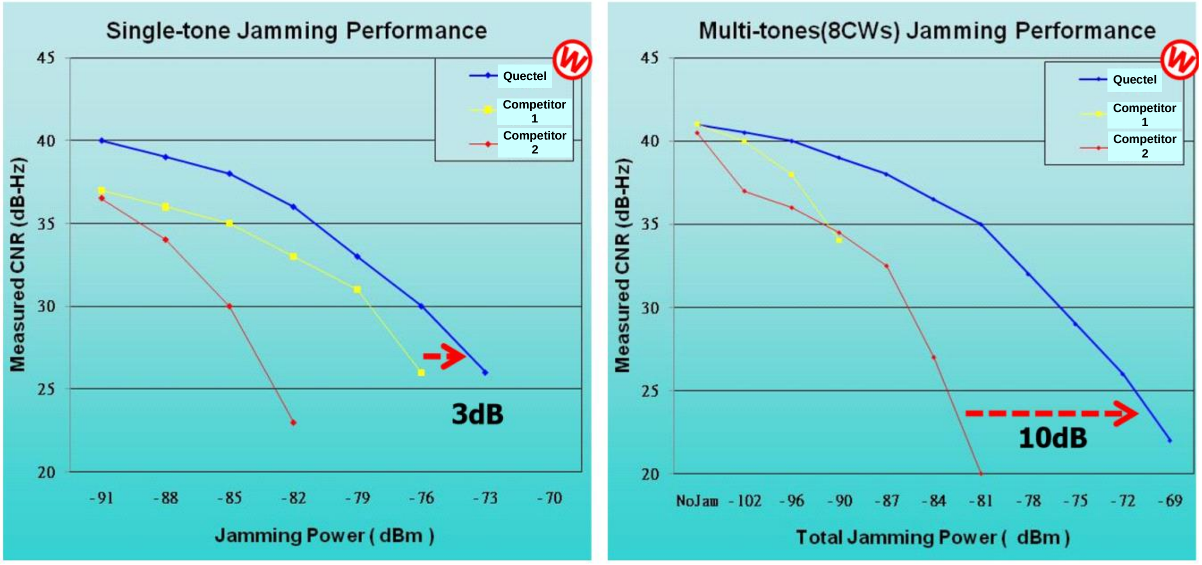


Figure 2: Anti-Jamming Performance of AIC

The AIC function is enabled by default, and it can be disabled with software commands. For more information about the commands, see ***document [1]***.

1.10. RTK*

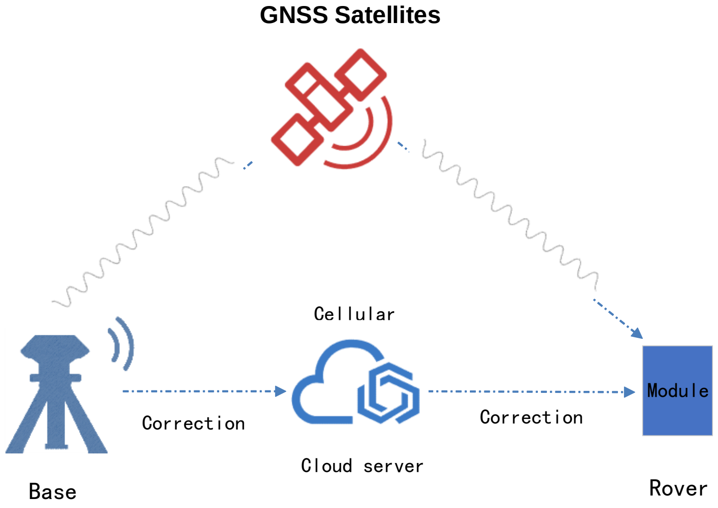


Figure 3: RTK Operation Process

1.10.1. RTK Module Mode

The LC29H (BA)*, LC29H (DA)* and LC29H (EA)* support RTK functionality as rovers.

Before implementing 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 technologies. When set to the default configuration, the module will attempt to achieve the best positioning accuracy based on the received correction data. Once it receives RTCM correction data, it enters RTK float mode. Once the module internal position engine decodes the carrier phase ambiguities, it will achieve the RTK fixed mode. The expected accuracy at RTK fixed mode is < 20 cm.

It typically takes less than 60 s before the module internal position engine fixes the carrier phase ambiguities and switches from RTK float mode to RTK fixed mode. This interval is referred to as the convergence time. For more information, see ***document [3]***.

1.11. Dead Reckoning Function

The LC29H (BA)* and LC29H (CA)* support the Dead Reckoning technology. By combining satellite navigation data with wheel speed, gyroscope and accelerometer data, the module obtains continuous and high accuracy positioning in weak signal environments such as tunnels and urban canyons when the vehicle state (e.g., speed, forward direction or vertical displacement) changes, or even when the satellite signal is partially or completely blocked.

1.12. Firmware Upgrade

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

2 Pin Assignment

The Quectel LC29H series module is equipped with 24 LCC pins by which the module can be mounted on your PCB.

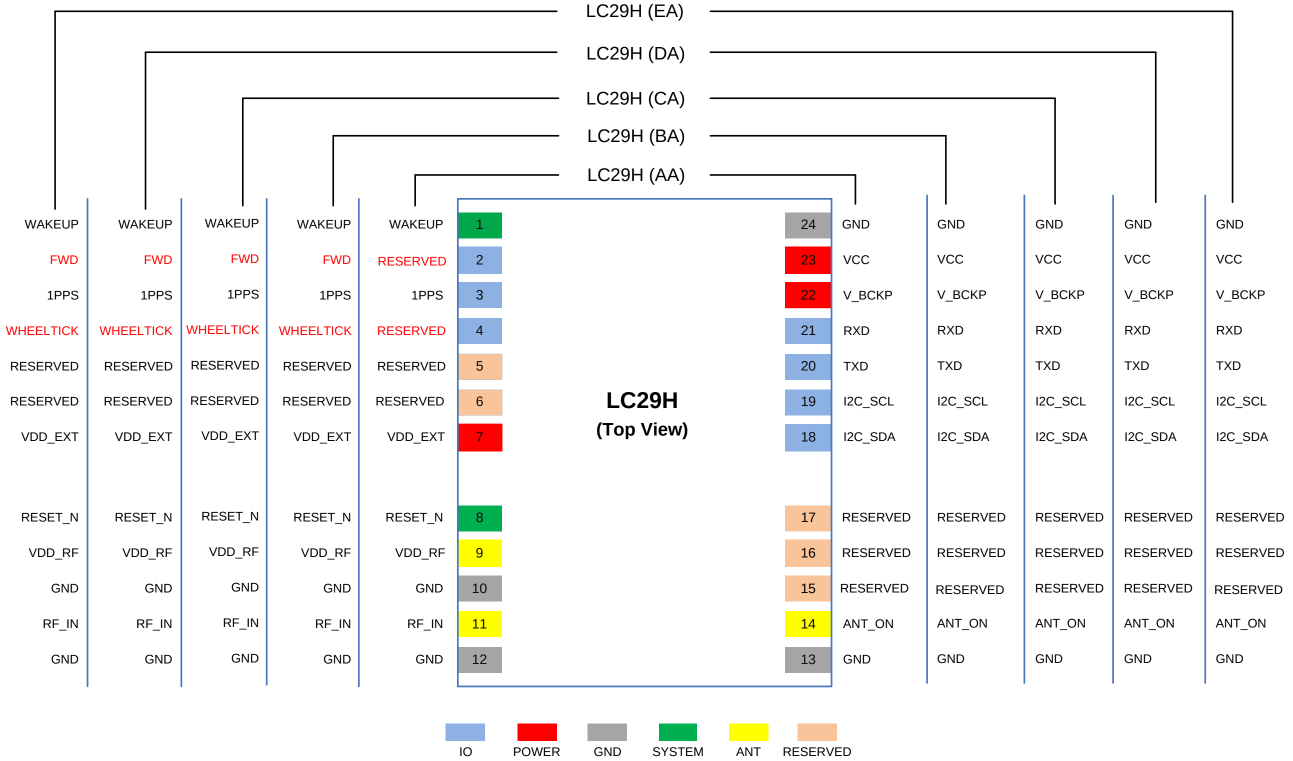


Figure 4: Pin Assignment

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.
	V_BCKP	22	PI	Backup power supply for backup domain	V_BCKP must be connected to power supply for startup, and it should always be powered if hot (warm) start is needed.
	VDD_EXT	7	PO	Provides 2.8 V for external circuit	Maximum output current is 100 mA.
IO	TXD	20	DO	Transmits data	UART interface is used for standard NMEA message output, binary data input/output, PAIR/PQTM command input/output and firmware upgrade.
	RXD	21	DI	Receives data	
	I2C_SDA	18	DIO	I2C serial data	I2C interface is used for standard NMEA message output, binary data input/output, and PAIR/PQTM command input/output.
	I2C_SCL	19	DI	I2C serial clock	
	FWD*	2	DI	Forward/Backward status signal input	The pins are reserved on LC29H (AA). If unused, leave the pin N/C (not connected).
	WHEELTICK*	4	DI	Odometer/Wheel-tick pulse input	

	1PPS	3	DO	One pulse per second	Synchronized on rising edge. If unused, leave the pin N/C.
ANT	VDD_RF	9	PO	Supplies power for external RF components	VDD_RF = VCC. The output current capacity depends on VCC. Typically used to supply power for an external active antenna. If unused, leave the pin N/C.
	ANT_ON	14	DO	Active antenna power control in power saving mode	The pin outputs high level signal in the Continuous mode and low level signal in the Backup mode. If unused, leave the pin N/C.
	RF_IN	11	AI	GNSS antenna interface	50 Ω characteristic impedance.
System	RESET_N	8	DI	Resets the module	Active low. The pin belongs to the backup domain.
	WAKEUP	1	DI	Wakes up the module from the Backup mode	Pull the pin high for at least 10 ms to wake up the module from the Backup mode. Keep the pin open or pulled low before entering the Backup mode. The pin belongs to the backup domain. If unused, leave the pin N/C.
GND	GND	10, 12, 13, 24	-	Ground	Ensure a good GND connection to all module GND pins, preferably with a large ground plane.
RESERVED	RESERVED	5, 6, 15, 16, 17	-	Reserved	These pins must be left floating and cannot be connected to power or GND.

NOTE

Leave RESERVED and unused pins N/C.

3 Power Management

The Quectel LC29H series module features a power optimized architecture with built-in autonomous energy saving capabilities to minimize power consumption at any given time. The receiver can be used in two operating modes: Backup mode for optimum power consumption, and Continuous mode for optimum performance.

3.1. Power Unit

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

The V_BCKP pin supplies the backup domain that includes RTC and low power RAM memory. To achieve quick startup and improve TTFF, the backup domain power supply should be valid during the interval. If the VCC is not valid, the V_BCKP supplies low power RAM memory that contains all the necessary GNSS data and some of the user configuration variables.

VDD_RF is an output pin equal in voltage to the VCC input. In the Continuous mode, VDD_RF supplies the external active antenna. Only if the VCC is cut off, VDD_RF is turned off.

The module's internal power supply is shown below:

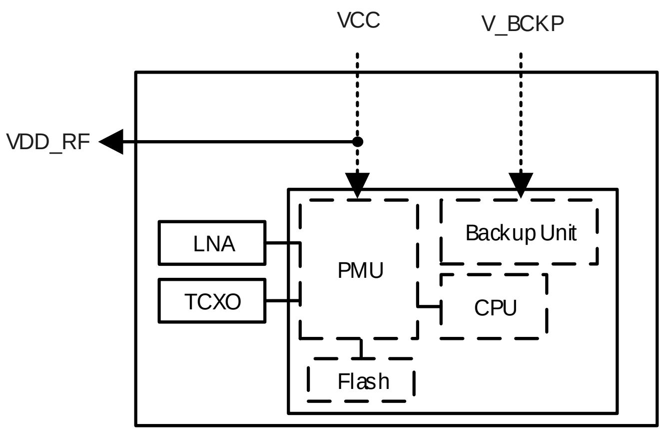


Figure 5: Internal Power Supply

3.2. Power Supply

In the process of using, module power consumption may vary by several orders of magnitude, especially when power saving mode is enabled. Therefore, it is important for the power supply to be able to sustain peak power for a short time, ensuring that the load current does not exceed the rated value.

3.2.1. VCC

The VCC is the supply voltage pin that supplies BB, RF and 6-axis IMU (supported only by LC29H (BA)* and LC29H (CA)*). When the module starts up or switches from the Backup mode to the Continuous mode, it must charge the internal capacitors in the core domain. In some cases, this can lead to a significant current drain.

For low-power applications using power saving mode, the LDO at the power supply or module input needs to be able to provide sufficient current. 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 module pins.

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

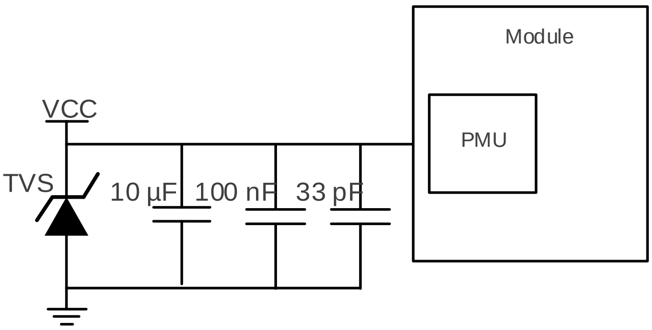


Figure 6: VCC Input Reference Circuit

NOTE

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

3.2.2. V_BCKP

The V_BCKP pin supplies power for the backup domain. Use of valid time and GNSS orbit data at startup, allows GNSS hot (warm) start. V_BCKP must be connected to power supply for startup, and it should always be powered if hot (warm) start is needed. If there is a constant power supply in your system, it can be used to provide a suitable voltage to power V_BCKP.

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

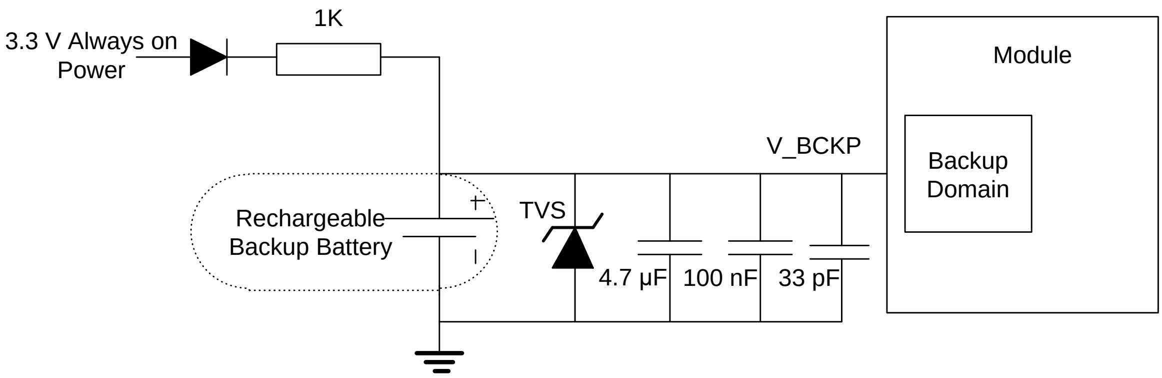


Figure 7: Reference Charging Circuit with Rechargeable Backup Battery

NOTE

1. If V_BCKP is below the spec value, the module cannot work normally.
2. In the Continuous mode, V_BCKP has a maximum current consumption of 100 µA, which will deplete the battery. Therefore, it is not recommended to use a non-rechargeable battery.
3. A suitable resistor should be chosen according to the charging current value of the battery.
4. It is recommended to control the V_BCKP of the module via MCU to restart the module when the module enters an abnormal state.

3.3. Power Modes

3.3.1. Feature Comparison

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

Table 6: Feature Comparison in Different Power Modes

Features	Continuous	Backup
NMEA from UART	●	-
1PPS	●	-
RF	●	-
Acquisition & Tracking	●	-
Power Consumption	High	Low
Positioning Accura	High	-

3.3.2. Continuous Mode

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

3.3.3. Backup Mode

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

- Enter the Backup mode:
  1. Send the relevant software command to shut down internal main power supply in sequence. For more information about the command, see ***document [1]***.
  2. Cut off the power supply to the VCC pin and keep the V_BCKP pin powered.

- Exit the Backup mode:
  1. Restore VCC.
  2. Pull the WAKEUP pin high for at least 10 ms.

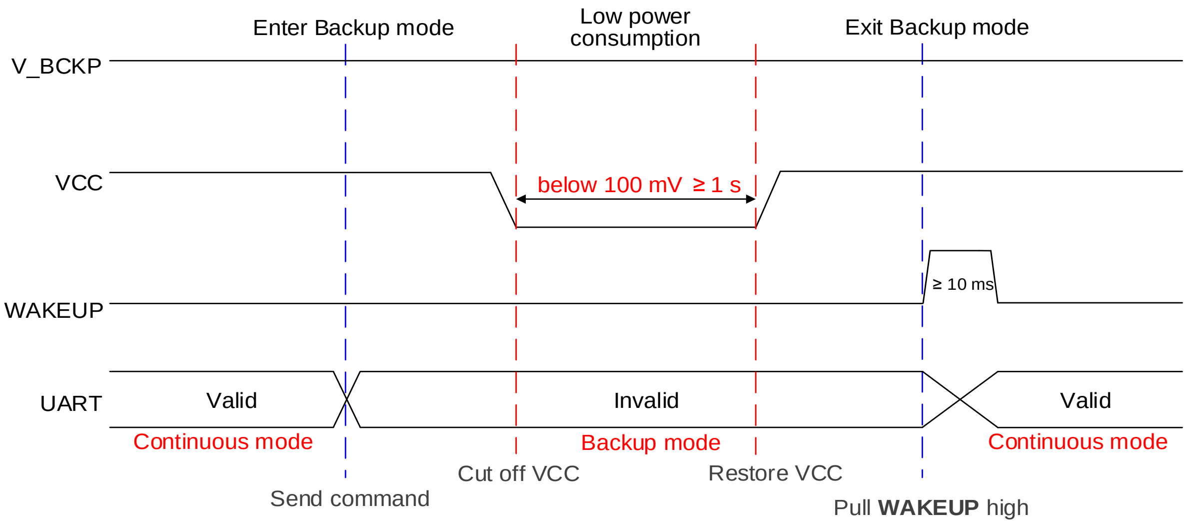


Figure 8: Enter/Exit Backup Mode Sequence

NOTE

1. The software command must be sent, and the V_BCKP must be kept powered to ensure hot (warm) start of the module at the next startup.
2. After restoring VCC, the WAKEUP pin must be pulled up for at least 10 ms for the module to exit the Backup mode. Otherwise, the UART will not output data.
3. Ensure a stable V_BCKP, without rush and drop when VCC is switched on/off.
4. If you cut off module's power supply directly (without sending a software command), the module cannot enter the Backup mode normally. In this case, the module will be in an undefined state and the power consumption is going to be higher.

3.4. Power-up Sequence

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

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

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

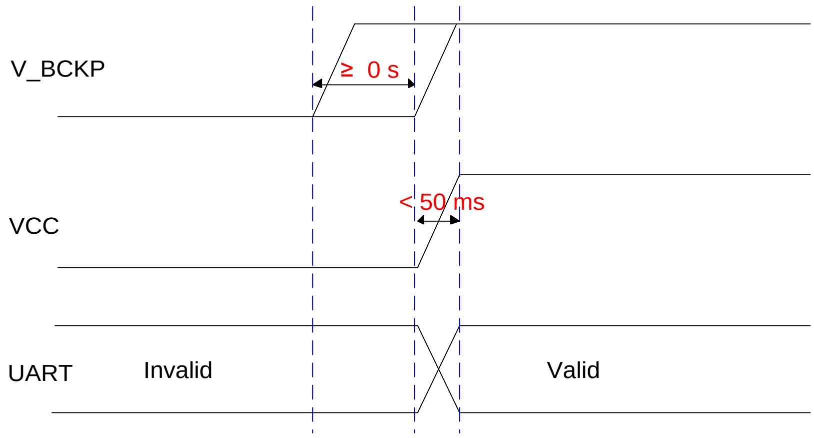


Figure 9: Power-up Sequence

3.5. Power-down Sequence

Once the VCC is shut down, voltage should drop quickly in less than 50 ms.

To avoid abnormal voltage conditions, 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.

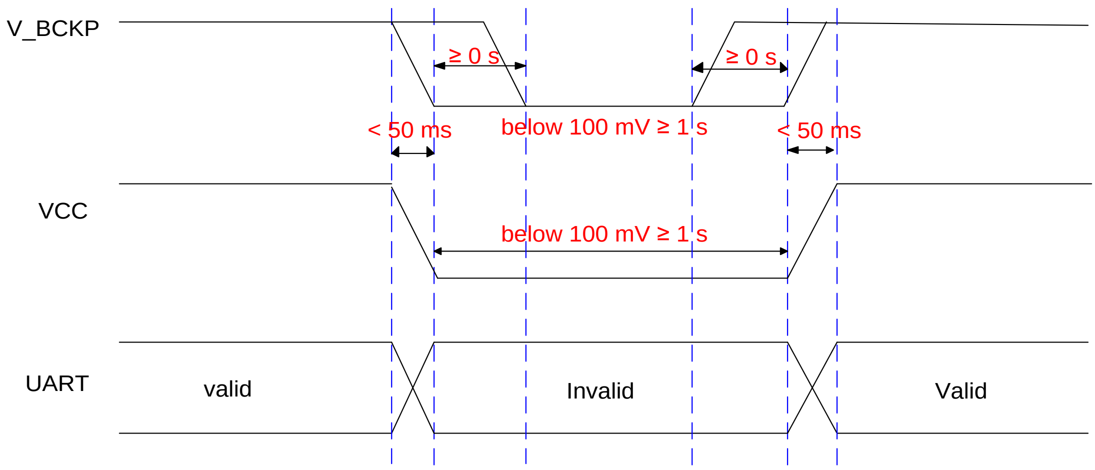


Figure 10: Power-down and Power-on Restart Sequence

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. UART Interface

The module has one UART interface with the following features:

- Supports standard NMEA message output, binary data input/output, PAIR/PQTM command input/output, and firmware upgrade.
- Supported baud rates: 9600, 14400, 19200, 38400, 57600, 115200, 230400, 460800 and 921600 bps.
- Hardware flow control and synchronous operation are not supported.

A reference design is shown in the figure below. For more information about the reference design, see ***document [5]***.

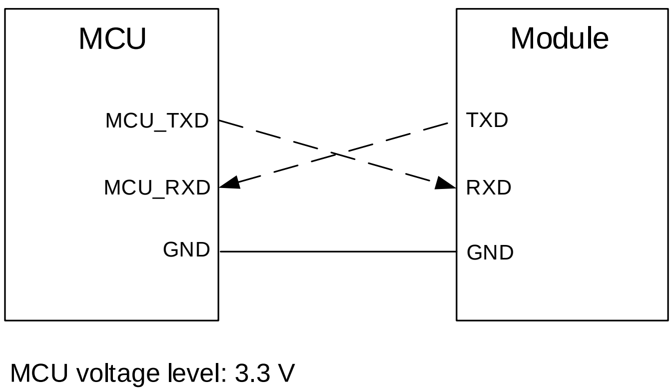


Figure 11: UART Interface Reference Design

NOTE

1. UART interface default settings vary depending on software version. See the relevant software versions for details.
2. If the IO voltage of MCU is not matched with module, a level-shifting circuit must be selected.

4.1.1.2. I2C Interface

The module has one I2C interface with the following features:

- Operates in slave mode.
- Supports 7- or 10-bit address.
- Supports the standard mode (100 kbps) and fast mode (400 kbps).

A reference design is shown in the figure below. For more information, see ***document [5]***.

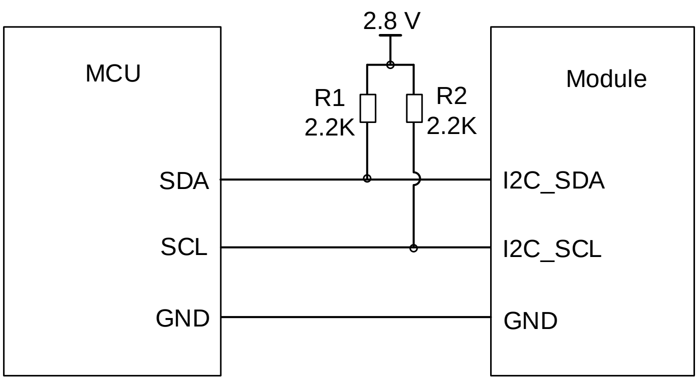


Figure 12: I2C Interface Reference Design

NOTE

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

4.1.2. FWD*

The FWD pin can be used to input the status signals indicating the vehicle's forward/backward 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 two-wheelers.

4.1.3. WHEELTICK*

The WHEELTICK pin is used to input wheel tick pulse signals from a vehicle, which are obtained from the wheel revolution sensors or vehicle transmission. For more information about the reference circuit diagram, see ***document [5]***.

4.1.4. 1PPS

The 1PPS output pin generates one pulse per second periodic signal synchronized with a GNSS time grid with intervals. Pulse 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. Maintaining high accuracy of 1PPS requires visible satellites in an open sky environment and powered VCC.

4.2. System Pins

4.2.1. WAKEUP

Pull the WAKUP pin high for at least 10 ms to wake up the module from the Backup mode. Keep this pin open or pulled low before entering the Backup mode. The WAKEUP pin is pulled down internally and it belongs to backup domain. If unused, leave the pin N/C.

4.2.2. RESET_N

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

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

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

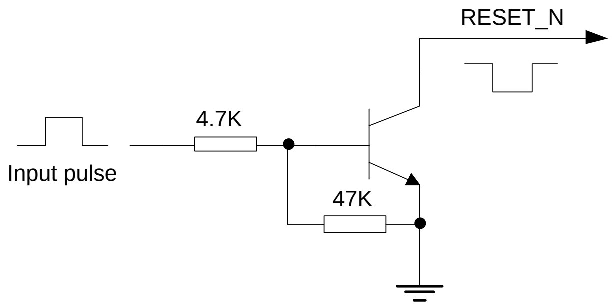


Figure 13: Reference OC Circuit for Module Reset

The following figure shows the reset sequence of the module.

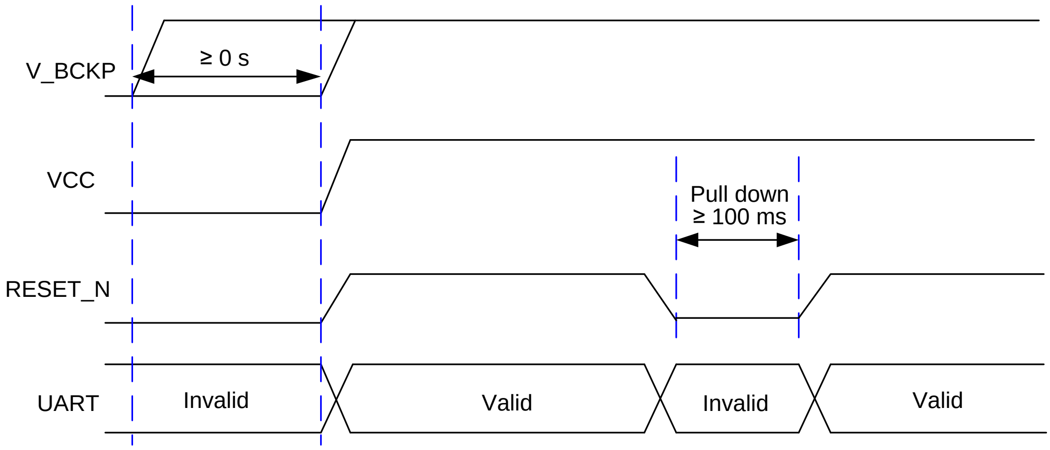


Figure 14: Reset Sequence

NOTE

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

5 Design

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

5.1. Antenna Reference Design

5.1.1. Antenna Specifications

The Quectel LC29H series 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 7: 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

NOTE

1. Contact Quectel Technical Support for recommended antenna model(s).
2. The total antenna gain equals the internal LNA gain minus the total insertion loss of cables and components inside the antenna.

5.1.2. Antenna Selection Guide

Both active and passive dual-band (L1 + L5) GNSS antennas can be used for the module. A passive antenna is recommended if the antenna can be placed close to the module, for instance, when the distance between the module and the antenna is less than 1 m. It is recommended to switch from a passive antenna to an active antenna once the loss is > 1 dB, since the insertion loss of RF cable can decrease the C/N_0 of GNSS signal. For more information, see ***document [6]***.

C/N_0 is an important factor for GNSS receivers, and it is defined as the ratio of the received modulated carrier signal power to the received noise power in one Hz bandwidth. C/N_0 formula:

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

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

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

"F" is the noise factor of receiver system:

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

"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 the LNA itself. This explains the need for using an active antenna, if the antenna connection cable is too long.

5.1.3. Active Antenna Reference Design

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

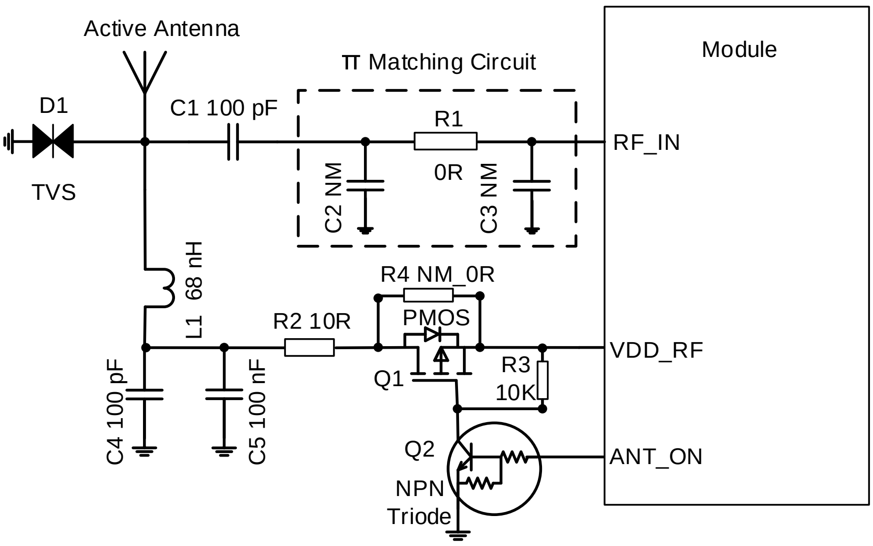


Figure 15: Active Antenna Reference Design

C1 is a DC-blocking capacitor used for blocking the DC current from VDD_RF. The C2, R1 and C3 components are reserved for matching antenna impedance. By default, R1 is 0 Ω, C1 is 100 pF, C2 and C3 are not mounted. D1 is an electrostatic discharge (ESD) protection device to protect the RF signal input from the potential damage caused by ESD. The junction capacitance of D1 cannot be more than 0.6 pF and a transient voltage suppressor is recommended.

An active antenna can be powered by the VDD_RF pin. In that case, the inductor L1 is used for preventing the RF signal from leaking into VDD_RF and preventing noise propagation from the VDD_RF to the antenna. The L1 inductor routes the bias voltage to the active antenna without losses. Place L1, C4 and C5 components close to the antenna interface and route the proximal end of L1 pad on the RF trace. The recommended value of L1 should be at least 68 nH. The R2 resistor is used to protect the module in case the active antenna is short-circuited to the ground plane.

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

5.1.4. Passive Antenna Reference Design

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

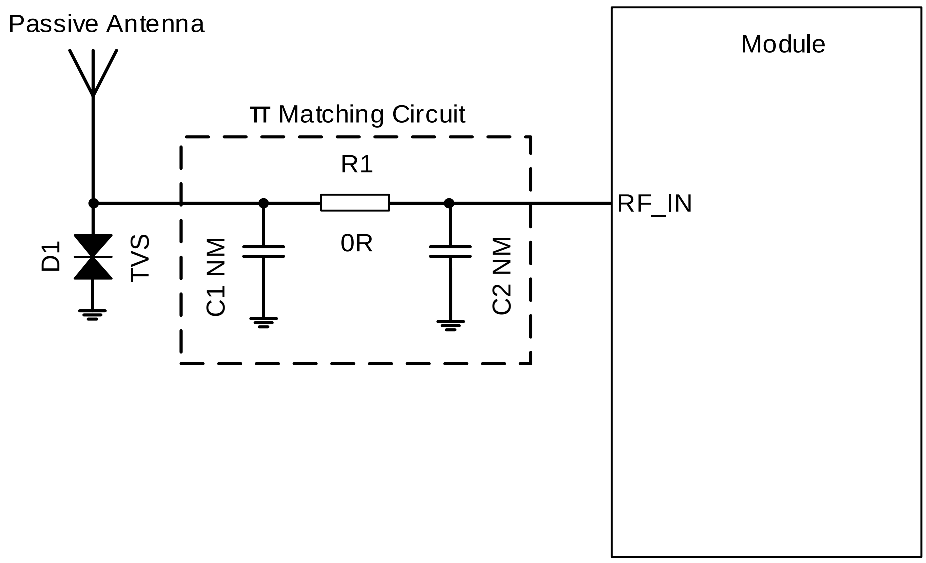


Figure 16: Passive Antenna Reference Design

The C1, R1 and C2 components 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 RF route from the damage caused by ESD. The junction capacitance of D1 cannot be more than 0.6 pF and a transient voltage suppressor is recommended. The impedance of RF trace should be controlled to 50 Ω and trace length should be kept as short as possible.

5.2. Coexistence with Cellular Systems

Since GNSS signals are usually very weak, a GNSS receiver could be vulnerable to environmental interference. According to 3GPP specifications, a cellular terminal should transmit a signal of up to 33 dBm at GSM bands, or of about 24 dBm at WCDMA and LTE bands. 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.

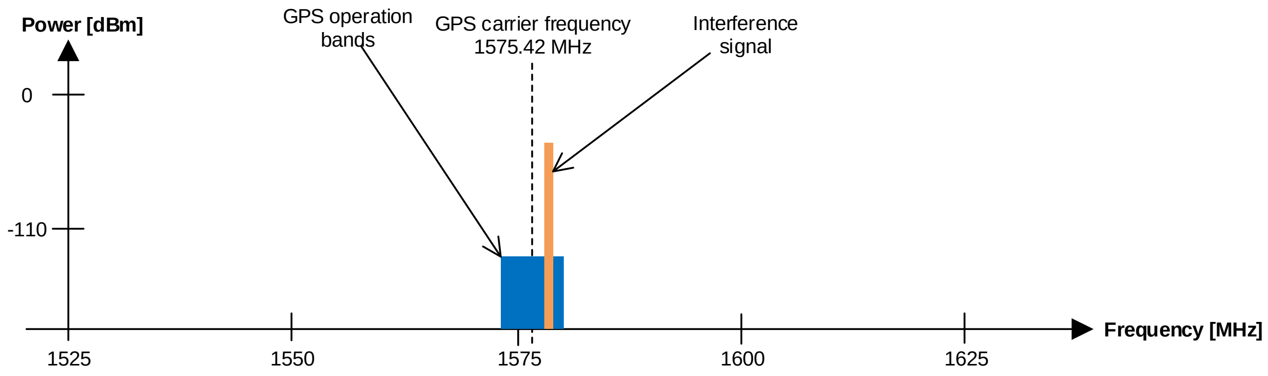


Figure 17: In-Band Interference on GPS L1

The most common in-band interferences usually come from:

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

Common frequency combinations are presented in the table below. The table lists some probable in-band interferences generated by two kinds of out-of-band signal intermodulation, or the second harmonic of LTE Band 13.

Table 8: 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 saturation, thus greatly deteriorating its performance, as illustrated in the following figure.

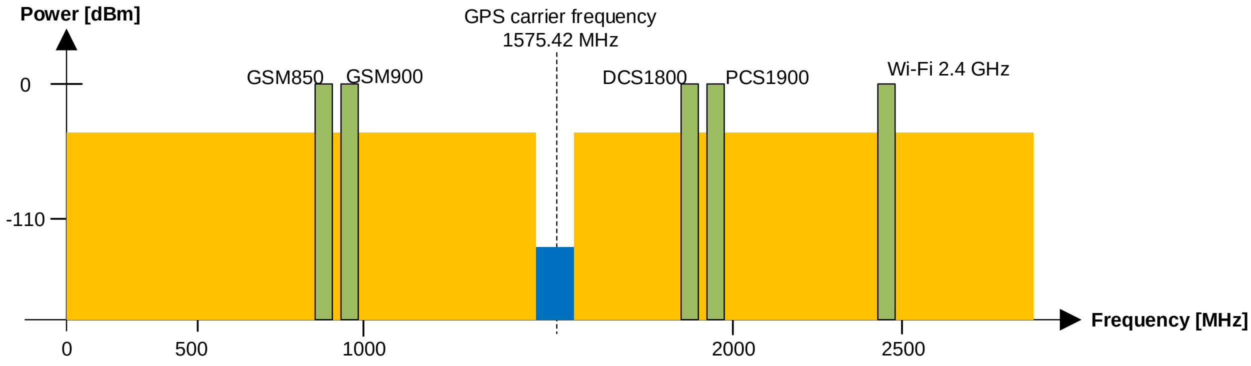


Figure 18: Out-of-Band Interference on GPS L1

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

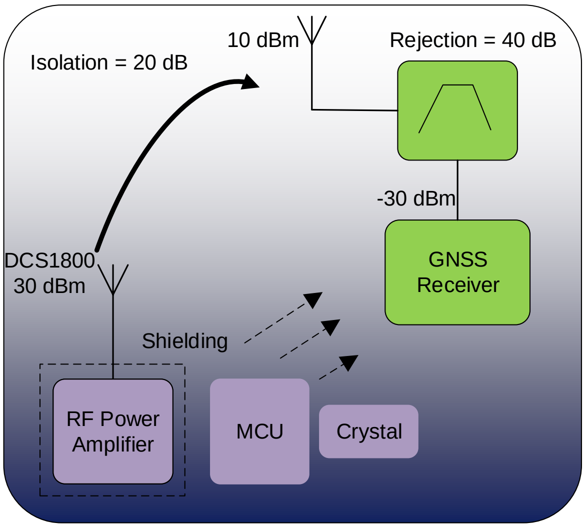


Figure 19: Interference Source and Its Path

5.3. Recommended Footprint

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

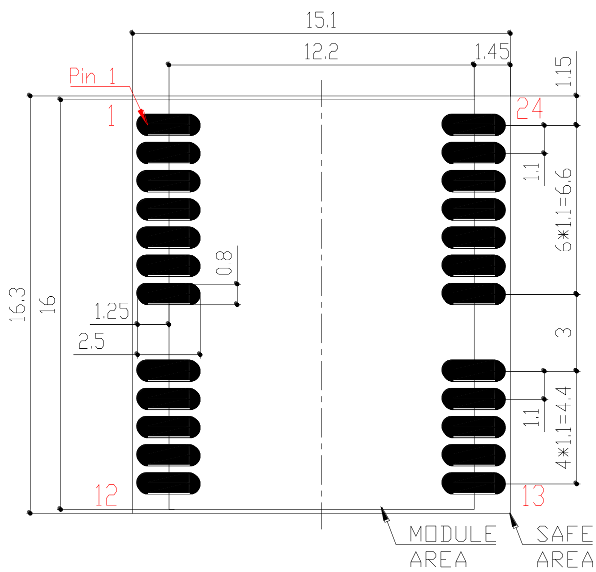


Figure 20: Recommended Footprint

NOTE

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

6 Electrical Specification

6.1. Absolute Maximum Ratings

Absolute maximum ratings for power supply and voltage on digital pins of the Quectel LC29H series module are listed in table below.

Table 9: Absolute Maximum Ratings

Parameter	Description	Min.	Max.	Unit
VCC	Power Supply Voltage	-0.3	4.3	V
V_BCKP	Backup Supply Voltage	-0.3	4.3	V
V_{IN}_IO	Input Voltage at IO Pins	-0.3	3.08	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 specification validity.

Table 10: Recommended Operating Condition

Parameter	Description	Min.	Typ.	Max.	Unit
VCC	Power Supply Voltage	3.1	3.3	3.6	V
V_BCKP	Backup Supply Voltage	2.2	3.3	3.6	V
VDD_EXT	Power Output Voltage	-	2.8	-	V
IO_Domain	Digital IO Pin Domain Voltage	-	2.8	-	V
V_{IL}	Digital IO Pin Low-Level Input Voltage	-0.3	0	0.7	V
V_{IH}	Digital IO Pin High-Level Input Voltage	1.75	-	3.08	V
V_{OL}	Digital IO Pin Low-Level Output Voltage	-	-	0.35	V
V_{OH}	Digital IO Pin High-Level Output Voltage	2.1	-	-	V
RESET_N	Low-Level Input Voltage	-0.3	-	0.1	V
WAKEUP	Low-Level Input Voltage	-0.3	0	0.7	V
	High-Level Input Voltage	3.0	3.3	3.6	V
VDD_RF	VDD_RF Voltage	3.1	3.3	3.6	V
T_operating	Operating Temperature	-40	25	+85	°C

NOTE

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

6.3. 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 11: Supply Current

Parameter	Description	Condition	LC29H (AA)		LC29H (BA)*		LC29H (CA)*		LC29H (DA)*		LC29H (EA)*	
			$I_{Typ.}$ [8]	I_{PEAK} [8]	$I_{Typ.}$ [8]	I_{PEAK} [8]	$I_{Typ.}$ [8]	I_{PEAK} [8]	$I_{Typ.}$ [8]	I_{PEAK} [8]	$I_{Typ.}$ [8]	I_{PEAK} [8]
I_{VCC} [9]	Current at VCC	Acquisition	24 mA	61 mA	30 mA	54 mA	28 mA	54 mA	TBD	TBD	TBD	TBD
		Tracking	24 mA	65 mA	30 mA	54 mA	28 mA	54 mA	TBD	TBD	TBD	TBD
I_{V_BCKP} [10]	Current at V_BCKP	Continuous mode	93 µA	134 µA	74 µA	113 µA	74 µA	113 µA	TBD	TBD	TBD	TBD
		Backup mode	25 µA	61 µA	25 µA	60 µA	25 µA	60 µA	TBD	TBD	TBD	TBD

[8] Room temperature, measurements are taken with typical voltage.
[9] Used to determine maximum current capability of power supply.
[10] Used to determine required battery current capability.

6.4. ESD Protection

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

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

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

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

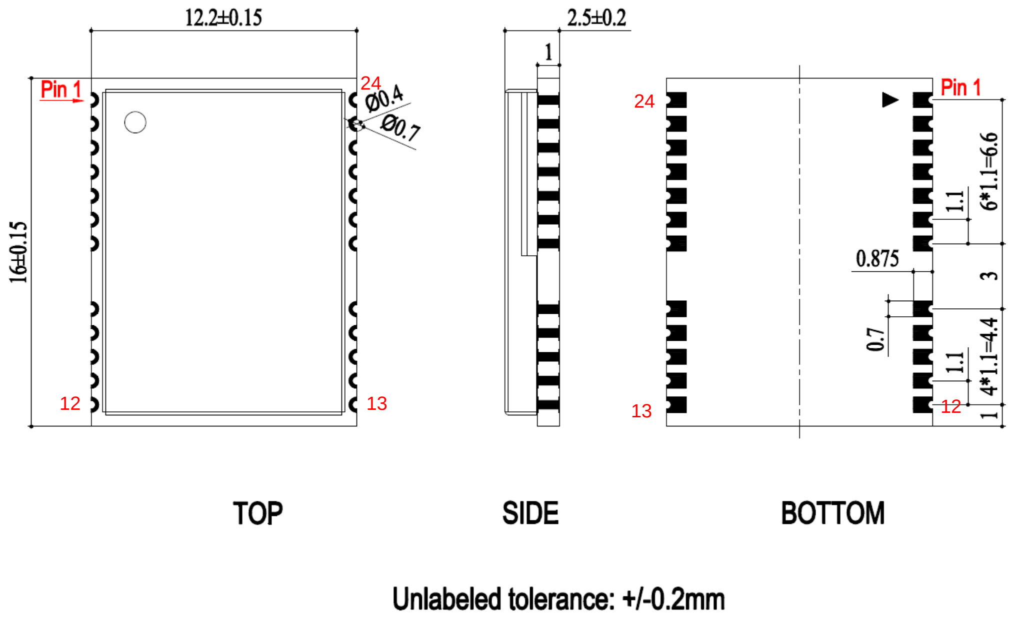


Figure 21: Top, Side and Bottom View Dimensions

NOTE

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

7.2. Top and Bottom Views

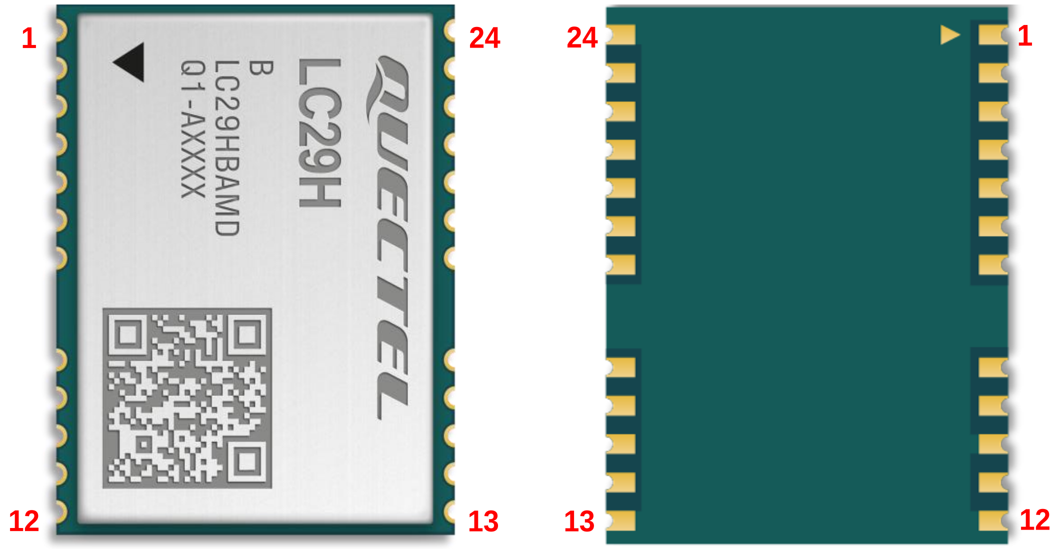


Figure 22: Top and Bottom Module Views

NOTE

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

8 Product Handling

8.1. Packaging

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

The LC29H series module adopts carrier tape packaging and details are as follows.

8.1.1. Carrier Tape

Carrier tape dimensions are detailed below:

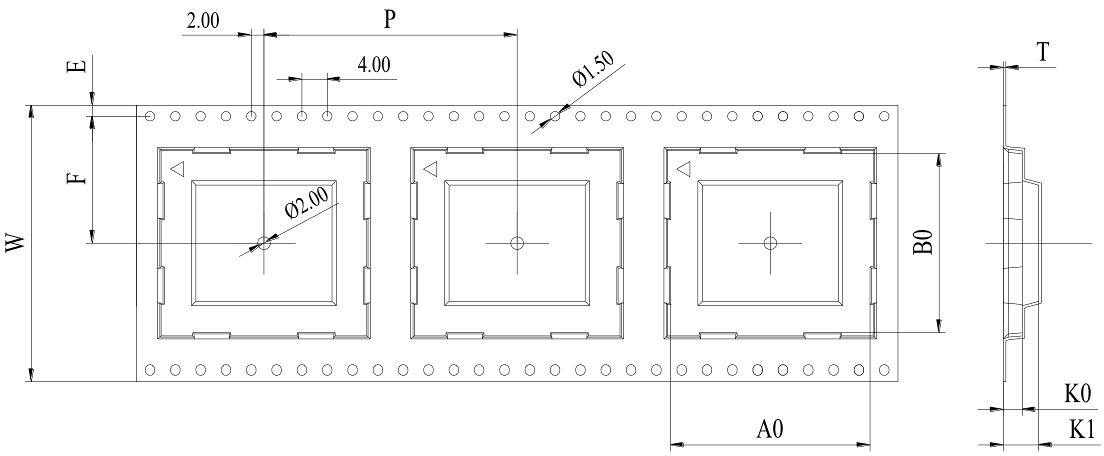


Figure 23: Carrier Tape Dimension Drawing

Table 12: 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

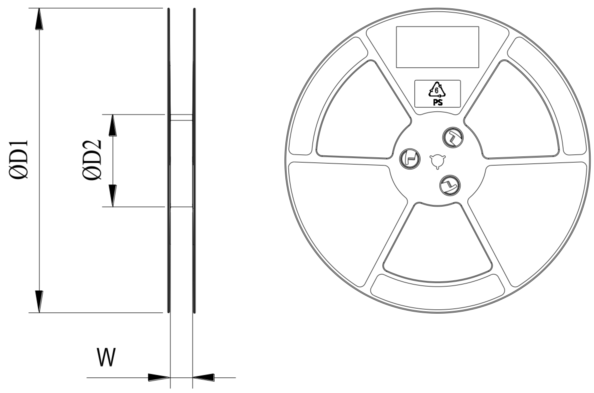
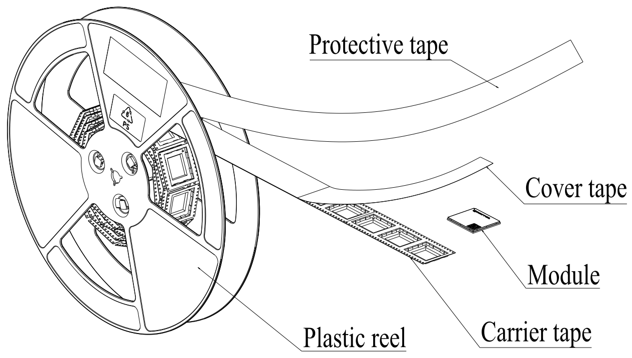


Figure 24: Plastic Reel Dimension Drawing

Table 13: Plastic Reel Dimension Table (Unit: mm)

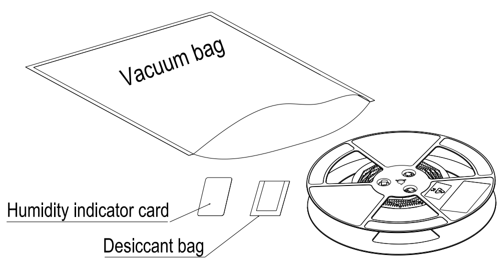
øD1	øD2	W
330	100	32.5

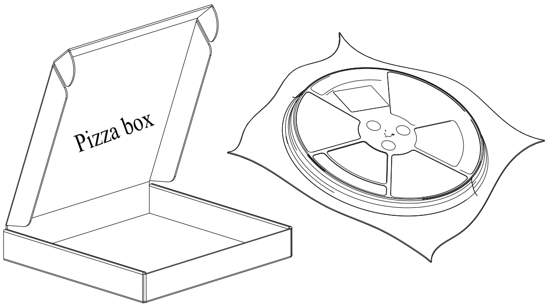
8.1.3. Packaging Process



Place the module onto the carrier tape and use the cover tape to cover them; then wind the heat-sealed carrier tape on the plastic reel and use the protective tape for protection. 1 plastic reel can load 250 modules.

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





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

Place 4 pizza boxes inside 1 carton and seal it. One carton can pack 1000 modules.

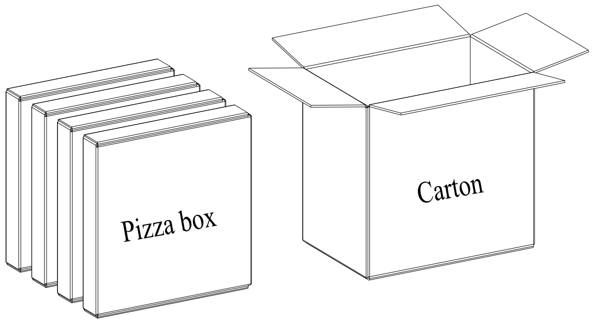


Figure 25: Packaging Process

8.2. Storage

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

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

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

3. Floor life: 168 hours [11] in a factory where the temperature is 23 ±5 °C and relative humidity is below 60%. After the vacuum-sealed packaging is removed, the module must be processed in reflow soldering or other high-temperature operations within 168 hours. Otherwise, the module should be stored in an environment where the relative humidity is less than 10 % (e.g., a drying cabinet).

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

    - The module is not stored under Recommended Storage Condition;

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

- Violation of the third requirement above;
- Vacuum-sealed packaging is broken, or the packaging has been removed for over 24 hours;
- Before module repairing.

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

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

NOTE

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

8.3. Manufacturing and Soldering

Push the squeegee to apply solder paste on the surface of stencil, thus making the paste fill the stencil openings and then penetrate the PCB. Apply proper force on the squeegee to produce a clean stencil surface on a single pass. For more information about the stencil thickness of the module, see ***document [7]***.

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.

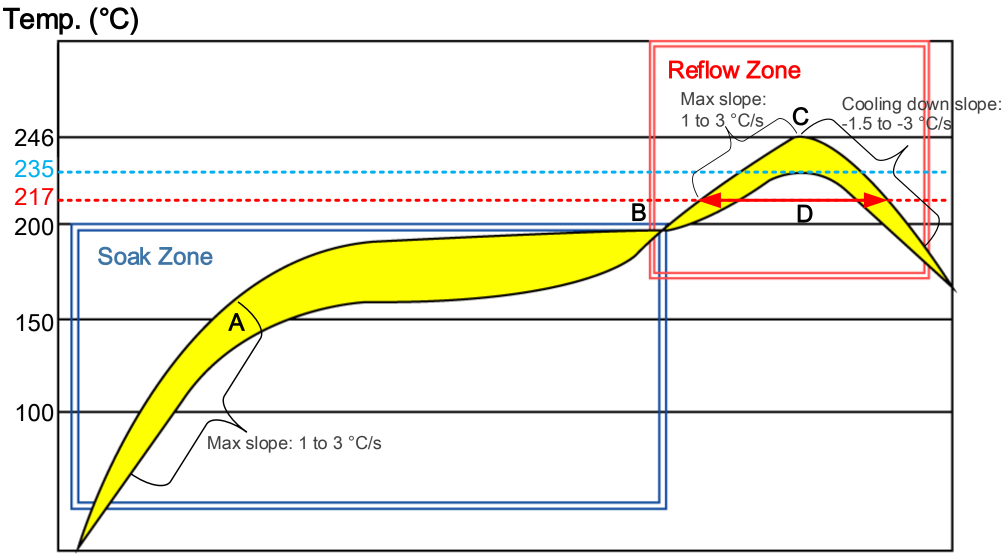


Figure 26: Recommended Reflow Soldering Thermal Profile

Table 14: 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 Cycle	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, and trichloroethylene. 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 a conformal coating is necessary for the module, **DO NOT** use any coating material that may chemically react with the PCB or shielding cover. Prevent the coating material from penetrating the module shield.
4. Avoid using ultrasonic technology for module cleaning since it can damage crystals inside the module.
5. Due to SMT process complexity, contact Quectel Technical Support in advance regarding any ambiguous situation, or any process (e.g. selective soldering, ultrasonic soldering) that is not addressed in ***document [7]***.

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.

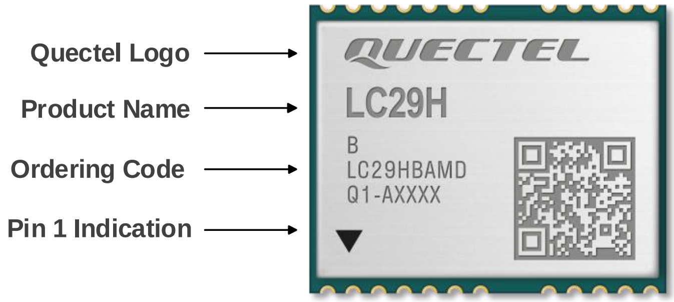


Figure 27: Labelling Information

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

10 Appendix References

Table 15: Related Documents

Document Name	
[1]	Quectel_LC29H&LC79H_GNSS_Protocol_Specification
[2]	Quectel_L89_R2.0&LC29H&LC79H_AGNSS_Application_Note
[3]	Quectel_LC29H(BA,CA,DA)_DR&RTK_Application_Note
[4]	Quectel_L89_R2.0&LC29H&LC79H_Firmware_Upgrade_Guide
[5]	Quectel_LC29H_Reference_Design
[6]	Quectel_RF_Layout_Application_Note
[7]	Quectel_Module_Secondary_SMT_Application_Note

Table 16: Terms and Abbreviations

Abbreviation	Description
3GPP	3rd Generation Partnership Project
1PPS	1 Pulse Per Second
AIC	Active Interference Cancellation
AGNSS	Assisted GNSS (Global Navigation Satellite System)
BDS	BeiDou Navigation Satellite System
bps	bit(s) per second
CEP	Circular Error Probable
C/N_0	Carrier-to-noise Ratio
DCS1800	Digital Cellular System at 1800 MHz

DR	Dead Reckoning
EASY	Embedded Assist System
EGNOS	European Geostationary Navigation Overlay Service
EPO	Extended Prediction Orbit
ESD	Electrostatic Discharge
GAGAN	GPS Aided Geo Augmented Navigation
Galileo	Galileo Satellite Navigation System (EU)
GLONASS	Global Navigation Satellite System (Russia)
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GSM	Global System for Mobile Communications
I/O	Input/Output
I2C	Inter-Integrated Circuit
IC	Integrated Circuit
IMU	Inertial Measurement Unit
I_{PEAK}	Peak Current
IRNSS/NavIC	Indian Regional Navigation Satellite System
kbps	kilobits per second
LCC	Leadless Chip Carrier (package)
LDO	Low-dropout Regulator
LNA	Low-Noise Amplifier
LTE	Long-Term Evolution
MCU	Microcontroller Unit/Microprogrammed Control Unit
MSAS	Multi-functional Satellite Augmentation System (Japan)
MSL	Moisture Sensitivity Levels
NF	Noise Figure

NMEA	NMEA (National Marine Electronics Association) 0183 Interface Standard
OC	Open Connector
PCB	Printed Circuit Board
PI	Power Input
PMU	Power Management Unit
PSRR	Power Supply Rejection Ratio
QR (code)	Quick Response (Code)
QZSS	Quasi-Zenith Satellite System
RAM	Random Access Memory
RF	Radio Frequency
RHCP	Right Hand Circular Polarization
RoHS	Restriction of Hazardous Substances
ROM	Read Only Memory
RTC	Real-Time Clock
RTCM	Radio Technical Commission for Maritime Services
RTK	Real-Time Kinematic
RXD	Receive Data (Pin)
SBAS	Satellite-Based Augmentation System
SMD	Surface Mount Device
SMT	Surface Mount Technology
SPI	Serial Peripheral Interface
TBD	To Be Determined
TCXO	Temperature Compensated Crystal Oscillator
TTFF	Time to First Fix
TVS	Transient Voltage Suppressor
UART	Universal Asynchronous Receiver/Transmitter

VSWR	Voltage Standing Wave Ratio
WAAS	Wide Area Augmentation System
XTAL	External Crystal Oscillator