LC29H Series

Hardware Design

GNSS Module Series

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

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	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	**LC29H Series Hardware Design**
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Revision History

Version	Date	Description
-	2021-05-31	Creation of the document
1.0	2022-06-10	First official release
1.1	2022-09-02	1. Reserved pins 2 and 4 for LC29H (DA) and LC29H (EA). 2. Updated (or added) product performance parameters, including: Power consumption of LC29H (DA); Sensitivity of LC29H (BA), LC29H (CA) and LC29H (DA); TTFF (without AGNSS) of LC29H (AA), LC29H (BA), LC29H (CA) and LC29H (DA); TTFF (with EPO) of LC29H (AA), LC29H (BA), LC29H (CA) and LC29H (DA); Horizontal position accuracy and convergence time of LC29H (BA) and LC29H (DA); Update rate of LC29H (AA), LC29H (BA), LC29H (CA) and LC29H (DA); Accuracy of 1PPS signal of LC29H (AA), LC29H (BA), LC29H (CA), LC29H (DA) and LC29H (EA) (*Table 3*). 3. Updated supply current of LC29H (DA) (*Table 13*).
1.2	2023-01-17	1. Added the applicable variant: LC29H (BS). 2. Added SPI* and UART2 interfaces. 3. Updated pins 5, 6, 15 and 16 from RESERVED to D_SEL1,

Version	Date	Description
		D_SEL2, TXD2 and RXD2, respectively. 4. Added Typ. 1.8V for I/O voltage (Table 2). 5. Added the notch circuit in the block diagram (Figure 1). 6. Updated the pin 17 of LC29H (BA) and LC29H (CA) from RESERVED to WI* (Chapters 2 and 4.1.5). 7. Updated powered consumption, sensitivity, TTFF (without AGNSS), TTFF (with EPO), horizontal position accuracy, convergence time and update rate for LC29H (EA) (Table 3). 8. Updated the velocity accuracy (Table 3). 9. Added the 3.7 V lithium battery reference circuit (Figure 8). 10. Updated the parameters of the recommended antenna specification (Table 9). 11. Added the band-pass filter circuit and corresponding description (Chapter 5.2). 12. Added the absolute maximum ratings of the 1.8V input voltage for V_{IN}_IO and updated the absolute maximum rating (maximum value) of the input power at RF_IN (Table 10). 13. Added recommended operating conditions, including: 1.8 V digital I/O pin voltage domain; high-level input voltage of RESET_N; VDD_RF output current (Table 11). 14. Updated supply current of LC29H (EA) (Table 13). 15. Added the mounting direction for the modules (Chapter 8.1.3). 16. Updated the recommended ramp-to-soak, ramp-up and cool-down slopes (Figure 26 and Table 17).
1.3	2024-07-30	1. Added the applicable module LC29H (AI). 2. Updated the following pins for LC29H (EA): ● Pin 5 from D_SEL1 to RESERVED; ● Pin 6 from D_SEL2 to RESERVED; ● Pin 15 from TXD2 to RESERVED; ● Pin 16 from RXD2 to RESERVED; ● Pin 18 from I2C_SDA/SPI_CS to RESERVED; ● Pin 19 from I2C_SCL/SPI_CLK to RESERVED; ● Pin 20 from TXD1/SPI_MISO to TXD1; ● Pin 21 from RXD1/SPI_MOSI to RXD1. 3. Updated the SBAS feature to be supported on LC29H (BA, BS, CA, DA, EA) (Chapters 1.1 and 1.6.1, and Table 2). 4. Added the number of concurrent GNSS (Table 2). 5. Updated product performance data (Table 3): ● Added the power data; ● Updated the power consumption in acquisition and tracking modes for LC29H (BA, CA, DA, EA);

Version	Date	Description
		● Deleted the TTFF (with EASY) and TTFF (with EPO) data, added the full cold start data of TTFF (with AGNSS); ● Added the DR position error in ADR and UDR modes for LC29H (BA, CA); ● Updated the PVT update rate for LC29H (BS); ● Updated the GNSS raw data update rate for LC29H (EA). 6. Deleted the information on EASY and added the information on EPOC for LC29H (AA, BS) (*Chapter 1.7.1*). 7. Added pin DC characteristics (*Table 6*). 8. Deleted the rechargeable battery circuit for the V_BCKP pin (*Chapter 3.2.2*). 9. Added 4800 bps and deleted 14400 bps for UART1 and UART2 (*Chapters 4.1.1.2* and *4.1.1.3*). 10. Added the note on connection requirement of FWD and WHEELTICK pins for LC29H (BA, CA) (*Chapters 4.1.2* and *4.1.3*). 11. Moved the C/N$_0$ information in Antenna Selection Guide and Coexistence with Cellular Systems to Quectel_GNSS_Antenna_Application_Note. 12. Added the phase center offset, phase center variation, axial ratio and -3 dB beam width of passive antenna, and out-of-band rejection of active antenna (*Table 9*). 13. Updated the recommended SAW filters for antenna reference design (*Chapter 5.2*). 14. Updated the typical current values of LC29H (BA, CA, DA, EA) and peak current values of LC29H (BA, CA) at VCC in acquisition and tracking modes (*Chapter 6.3*). 15. Updated the pizza box size (*Figure 25*). 16. Added the note specifying that mercury-containing materials and should be avoided for module processing and the note prohibiting storage or use of unprotected modules in environments containing corrosive gases (*Chapter 8.3*).

Contents

Table Index

Figure Index

1 Product Description

1.1. Overview

The Quectel LC29H series module includes seven variants: LC29H (AA), LC29H (AI), LC29H (BA), LC29H (BS), LC29H (CA), LC29H (DA), and LC29H (EA).

The LC29H series module supports multiple global positioning constellations, such as GPS, GLONASS, Galileo, BDS, QZSS, and NavIC (only supported by LC29H (AI)). The modules support AGNSS and SBAS [1] including WAAS, EGNOS, MSAS and GAGAN.

Key features:

- Dual-band and multi-constellation GNSS module and featuring a high-performance, high reliability positioning engine, which facilitates fast and precise GNSS positioning capability.
- Serial communication interfaces: UART, I2C and SPI [2] (I2C and SPI are not supported by LC29H (EA)).
- LC29H (BA, CA) variants include an integrated 6-axis IMU and support sophisticated dead-reckoning algorithms, fusing the IMU data with the GNSS data to provide continuous tracking solution in GNSS impaired environments.
- LC29H (BA, DA, EA) integrates an RTK position engine in order to provide cm-level positioning.
- The LC29H (BS) module is used as a base station to generate RTK differential correction data that can be transmitted over radio or over cellular connectivity to become a part of a NTRIP network.
- Embedded flash memory provides the capacity for storing not only user-specific configurations, but also future firmware updates.

The LC29H is an SMD module type 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 modules are fully compliant with the EU RoHS Directive.

NOTE

Where applicable, this document will use the words modules when referring to common attributes and "LC29H (AA)", "LC29H (AI)", "LC29H (BA)", "LC29H (BS)", "LC29H (CA)", "LC29H (DA)" or "LC29H (EA)"

[1] The SBAS feature is under development for LC29H (EA).
[2] The SPI is under development for LC29H (BS).

when referring to attributes associated with a particular subset of module.

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, argument, and so on, it indicates that the function, feature, interface, pin, argument, and so on, is under development and currently not supported; and the asterisk (*) after a model indicates that the model sample is currently unavailable.
●	The symbol indicates that a function or technology is supported by the module(s).

1.2. Features

Table 2: Product Features

Features		LC29H (AA)	LC29H (AI)	LC29H (BA)	LC29H (BS)	LC29H (CA)	LC29H (DA)	LC29H (EA)
Grade	Industrial	●	●	●	●	●	●	●
	Automotive	-	-	-	-	-	-	-
Category	Standard Precision GNSS	●	●	-	●	●	-	-
	High Precision GNSS	-	-	●	-	-	●	●
	DR	-	-	●	-	●	-	-
	RTK [3]	-	-	●	-	-	●	●
	Timing	-	-	-	-	-	-	-
VCC Voltage	3.1–3.6 V, typ. 3.3 V	●	●	●	●	●	●	●
V_BCKP Voltage	2.2–3.6 V, typ. 3.3 V	●	●	●	●	●	●	●
I/O Voltage [4]	Typ. 2.8 V	●	●	●	●	●	●	●
Communication	UART	●	●	●	●	●	●	●
	SPI	●	●	●	●	●	●	-

[3] For LC29H (AA, AI, BS, CA), RTK function can be implemented using an external position engine running on external host, while these modules will provide the raw data only.
[4] For D_SEL1, D_SEL2 and UART2, the voltage domain is 1.8 V.

Features			LC29H (AA)	LC29H (AI)	LC29H (BA)	LC29H (BS)	LC29H (CA)	LC29H (DA)	LC29H (EA)
Interfaces [5]	I2C		●	●	●	●	●	●	-
Integrated Features	Additional LNA		●	●	●	●	●	●	●
	Additional Filter		●	●	●	●	●	●	●
	RTC Crystal		●	●	●	●	●	●	●
	TCXO Oscillator		●	●	●	●	●	●	●
	6-axis IMU		-	-	●	-	●	-	-
Constellations and Frequency Bands	Number of Concurrent GNSS		4 + QZSS	5 + QZSS	4 + QZSS	4 + QZSS	4 + QZSS	4 + QZSS	4 + QZSS
	GPS	L1 C/A	●	●	●	●	●	●	●
		L5	●	-	●	●	●	●	●
		L2C	-	-	-	-	-	-	-
	GLONASS	L1	●	●	●	●	●	●	●
		L2	-	-	-	-	-	-	-
	Galileo	E1	●	●	●	●	●	●	●
		E5a	●	-	●	●	●	●	●
		E5b	-	-	-	-	-	-	-
	BDS	B1I	●	●	●	●	●	●	●

5 LC29H (EA) only supports UART1 and does not support UART2, I2C, and SPI. The SPI is under development for LC29H (BS).

Features			LC29H (AA)	LC29H (AI)	LC29H (BA)	LC29H (BS)	LC29H (CA)	LC29H (DA)	LC29H (EA)
		B2a	●	-	●	●	●	●	●
		B2I	-	-	-	-	-	-	-
	QZSS	L1 C/A	●	●	●	●	●	●	●
		L5	●	-	●	●	●	●	●
		L2C	-	-	-	-	-	-	-
	NavIC	L5	-	●	-	-	-	-	-
SBAS [6]		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

1. The L5 band support on LC29H (AI) is specifically for NavIC's L5 frequency.
2. For more information about GNSS constellation configuration, see *documents [1]*, *[2]* and *[3] protocol specifications*.

[6] The SBAS feature is under development for LC29H (EA).

1.3. Performance

Table 3: Product Performance

Parameter	Specification	LC29H (AA)	LC29H (AI)	LC29H (BA)	LC29H (BS)	LC29H (CA)	LC29H (DA)	LC29H (EA)
Power Consumption [7]		GPS + GLONASS + Galileo + BDS + QZSS	GPS + GLONASS + Galileo + BDS + QZSS + NavIC	GPS + GLONASS + Galileo + BDS + QZSS	GPS + GLONASS + Galileo + BDS + QZSS	GPS + GLONASS + Galileo + BDS + QZSS	GPS + GLONASS + Galileo + BDS + QZSS	GPS + GLONASS + Galileo + BDS + QZSS
	Acquisition	24 mA (79.2 mW)	16 mA (52.8 mW)	32 mA (105.6 mW)	24 mA (79.2 mW)	30 mA (99 mW)	30 mA (99 mW)	30 mA (99 mW)
	Tracking	24 mA (79.2 mW)	16 mA (52.8 mW)	32 mA (105.6 mW)	24 mA (79.2 mW)	30 mA (99 mW)	30 mA (99 mW)	30 mA (99 mW)
	Backup Mode	25 µA (82.5 µW)	51 µA (168.3 µW)	25 µA (82.5 µW)	25 µA (82.5 µW)	25 µA (82.5 µW)	25 µA (82.5 µW)	25 µA (82.5 µW)
Sensitivity		GPS + GLONASS + Galileo + BDS + QZSS	GPS + GLONASS + Galileo + BDS + QZSS + NavIC	GPS + GLONASS+ Galileo + BDS + QZSS	GPS + GLONASS + Galileo + BDS + QZSS	GPS + GLONASS + Galileo + BDS + QZSS	GPS + GLONASS + Galileo + BDS + QZSS	GPS + GLONASS + Galileo + BDS + QZSS
	Acquisition	-147 dBm	-150 dBm [8]	-145 dBm	-147 dBm	-145 dBm	-145 dBm	-145 dBm
	Reacquisition	-159 dBm	-160 dBm [8]	-157 dBm	-159 dBm	-157 dBm	-157 dBm	-157 dBm
	Tracking	-165 dBm	-165 dBm [8]	-165 dBm	-165 dBm	-165 dBm	-165 dBm	-165 dBm
TTFF (Without	Full Cold Start	26 s	29 s	26 s	-	26 s	26 s	26 s

[7] Room temperature, all satellites at -130 dBm.
[8] Tested with an external LNA with 17 dB gain and 0.55 dB noise figure for LC29H (AI).

Parameter	Specification	LC29H (AA)	LC29H (AI)	LC29H (BA)	LC29H (BS)	LC29H (CA)	LC29H (DA)	LC29H (EA)
AGNSS) [7]	Warm Start	16 s	24 s	16 s	-	16 s	16 s	16 s
	Hot Start	1 s	1 s	1 s	-	1 s	1 s	1 s
TTFF (with AGNSS) [9]	Full Cold Start	5 s	5 s	5 s	-	5 s	5 s	5 s
DR Position Error (ADR)	4-wheeler (Without GNSS)	-	-	< 2 % of distance traveled	-	< 2 % of distance traveled	-	-
	2-wheeler (Without GNSS)	-	-	< 4 % of distance traveled	-	< 4 % of distance traveled	-	-
DR Position Error (UDR)	4-wheeler (Without GNSS)	-	-	< 3 % of distance traveled	-	< 3 % of distance traveled	-	-
	2-wheeler (Without GNSS)	-	-	< 6 % of distance traveled	-	< 6 % of distance traveled	-	-
Horizontal Position Accuracy	Autonomous [10]	1 m	1.8 m	1 m	-	1 m	1 m	1 m
	RTK [11]	-	-	< 0.1 m + 1 ppm	-	-	1 cm + 1 ppm	1 cm + 1 ppm
Convergence Time	RTK [11]	-	-	< 10 s	-	-	< 10 s	< 10 s
Update Rate	PVT	1–10 Hz	1–10 Hz	1 Hz/10 Hz	1–10 Hz	1 Hz/10 Hz	1 Hz (RTK)	1–10 Hz (RTK)
	GNSS Raw Data	1 Hz	1 Hz	1 Hz	1 Hz	1 Hz	1 Hz	1 Hz
	IMU Raw Data	-	-	100 Hz (Max.)	-	100 Hz (Max.)	-	-
Velocity Accuracy [7]		0.03 m/s	0.1 m/s	0.03 m/s	-	0.03 m/s	0.03 m/s	0.03 m/s

[9] Open-sky, active high-precision GNSS antenna.
[10] CEP, 50 %, 24 hours static, -130 dBm, more than 6 SVs.
[11] CEP, 50 %, with active high-precision antennas in an open-sky environment and within 1 km from the base stations.

Parameter	Specification	LC29H (AA)	LC29H (AI)	LC29H (BA)	LC29H (BS)	LC29H (CA)	LC29H (DA)	LC29H (EA)
Accuracy of 1PPS Signal [7]	RMS	20 ns	80 ns	20 ns	20 ns	20 ns	20 ns	20 ns
Dynamic Performance [7]		Maximum Altitude: 10000 m Maximum Velocity [12]: 500 m/s Maximum Acceleration [12]: 4g						

[12] ITAR limits.

1.4. Block Diagram

A block diagram of the LC29H (AA, BA, BS, CA, DA, EA) modules is presented below. It includes a front-end section with an additional LNA, a DIP, a notch circuit, a TCXO, an XTAL, a 6-axis IMU (only supported by LC29H (BA, CA)), and a GNSS IC with a PMU. The diplexer integrates two band-pass filters, which can improve the out-of-band rejection.

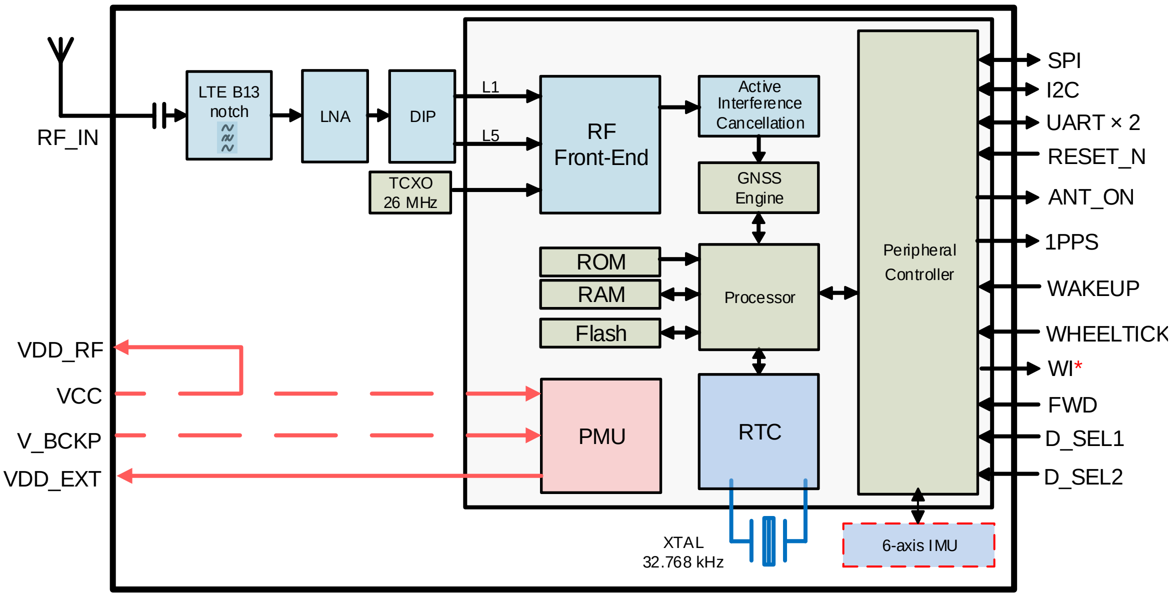


Figure 1: LC29H (AA, BA, BS, CA, DA, EA) Block Diagram

A block diagram of the LC29H (AI) module is presented below. It includes a front-end section with two additional LNAs and SAWs, a DIP, a notch circuit, a TCXO, an XTAL, and a GNSS IC with a PMU. The diplexer integrates two band-pass filters, which can improve the out-of-band rejection.

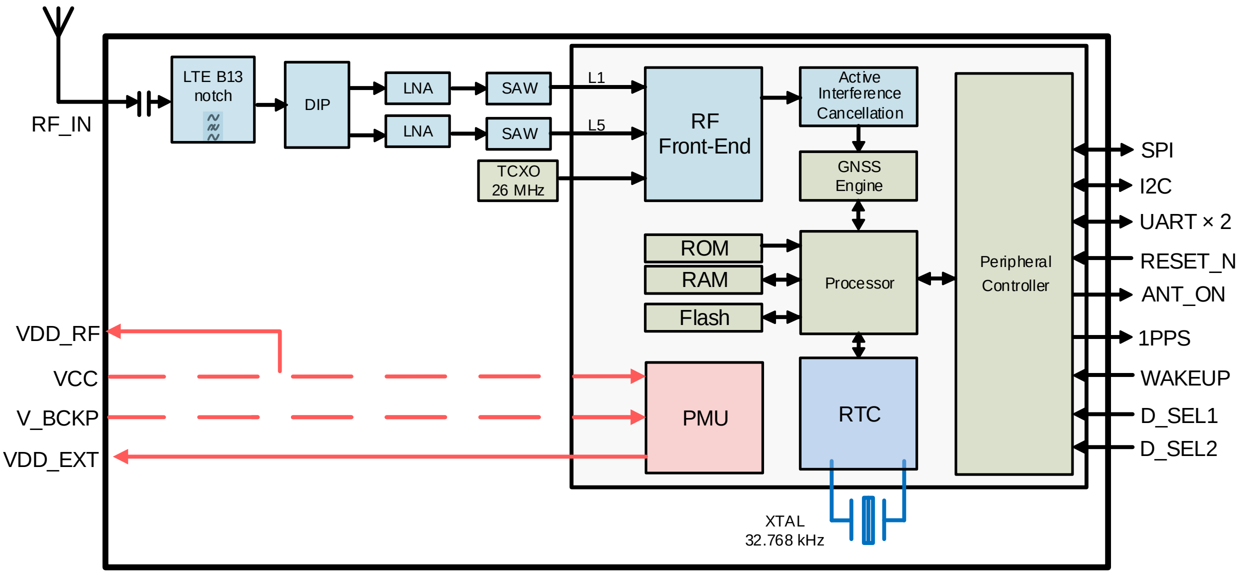


Figure 2: LC29H (AI) Block Diagram

NOTE

1. FWD, WHEELTICK, and WI* are supported by LC29H (BA, CA); D_SEL1, D_SEL2, I2C, SPI, and UART2 are not supported by LC29H (EA).
2. For LC29H (AA, BA, BS, CA, DA), SPI is only used for communication; whereas for LC29H (AI), it is used for communication and firmware upgrade. The pins of SPI are multiplexed with I2C and UART1 pins, and thus cannot be used simultaneously with I2C and UART1. The SPI is under development for LC29H (BS).

1.5. GNSS Constellations

The modules can receive and track multiple GNSS system. Owing to their RF front-end architecture, they can concurrently track the following GNSS constellations: GPS, GLONASS, Galileo, BDS, QZSS, and NavIC (only supported by LC29H (AI)) plus SBAS satellites. If low power consumption is a key factor, then the modules can be configured for a subset of GNSS constellations.

QZSS is a regional navigation satellite system that transmits signals compatible with the GPS L1 C/A, L1C, L2C and L5 signals for the Pacific region covering Japan and Australia. The modules can detect and track QZSS L1 C/A and L5 (not supported by LC29H (AI)) signals concurrently with GPS signals, leading to better availability especially under challenging conditions, e.g., in urban canyons.

Table 4: GNSS Constellations and Frequency Bands

System	Signal	
	LC29H (AA, BA, BS, CA, DA, EA)	**LC29H (AI)**
GPS	L1 C/A: 1575.42 MHz L5: 1176.45 MHz	L1 C/A: 1575.42 MHz
GLONASS	L1: 1602 MHz + K × 562.5 kHz K = (-7 to +6, integer)	L1: 1602 MHz + K × 562.5 kHz K = (-7 to +6, integer)
Galileo	E1: 1575.42 MHz E5a: 1176.45 MHz	E1: 1575.42 MHz
BDS	B1I: 1561.098 MHz B2a: 1176.45 MHz	B1I: 1561.098 MHz
QZSS	L1 C/A: 1575.42 MHz L5: 1176.45 MHz	L1 C/A: 1575.42 MHz
NavIC	-	L5: 1176.45 MHz

1.6. Augmentation System

1.6.1. SBAS

The modules support the reception of SBAS [13] signals. 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 modules support AGNSS feature that significantly reduces the modules' TTFF, especially under lower signal conditions. To implement the AGNSS feature, the modules should get the assistance data including the current time, rough position. For more information, see *document [4] AGNSS application note*.

1.7.1. EPOC

The LC29H (AA, BS) support the EPOC technology. EPOC is an internal module application designed to improve the TTFF performance by predicting GNSS constellation orbits using the received broadcast

[13] The SBAS feature is under development for LC29H (EA).

ephemeris data. EPOC aiding data serves as an alternative AGNSS method aimed at speeding up TTFF when the loss of EPO aiding data is caused by unavailability of external network connectivity.

The operational mechanism of EPOC: On day 1, TTFF is approximately 30 s without EPOC aiding data. Once the broadcast ephemerides are received, EPOC automatically activates the 3-day satellite orbit prediction process. Over the subsequent 72 hours, EPOC accelerates TTFF and ensures precise positioning. After completing the orbit prediction process for all available broadcast ephemerides, EPOC transitions to standby state until new broadcast ephemeris data becomes available.

For more information about EPOC, see *document [5] EASY&EPOC difference introduction*.

1.7.2. EPO

The modules feature a leading AGNSS technology called EPO, which assists the receiver to reduce the TTFF for up to 14 days. For more information about EPO, see *document [4] AGNSS application note*.

1.8. Multi-Tone AIC

The modules feature 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.

1.9. RTK

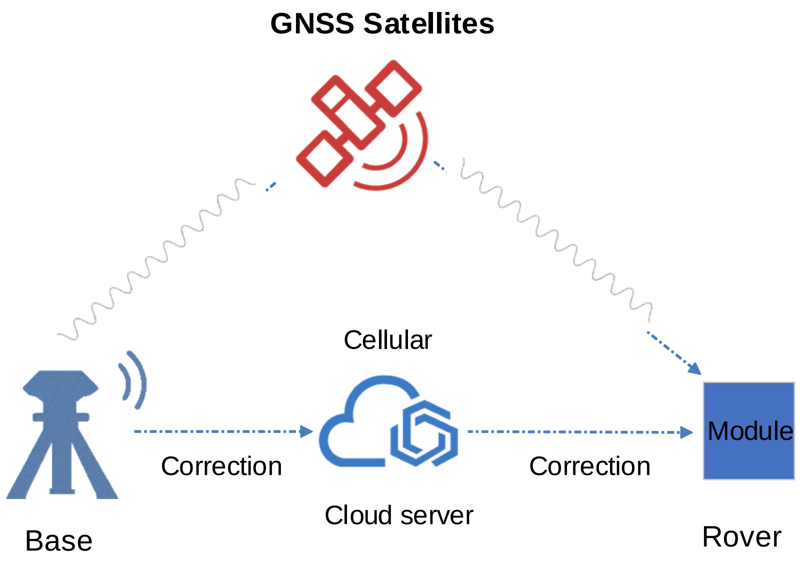


Figure 3: RTK Operation Process

1.9.1. RTK Rover

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

Before implementing the RTK navigation technique, the module needs to receive the RTK differential data via its UART port. RTK differential data 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 the differential correction data is validated to be used by the position engine, the module will enter differential mode or RTK float mode. Once the module internal position engine decodes the carrier phase ambiguities, it will achieve the RTK fixed mode. In RTK fixed mode, the positioning accuracy can reach sub-meter or centimeter level.

The convergence time refers to the interval as the module internal position engine switching from RTK float mode to RTK fixed mode. It typically takes less than 60 s to fix the carrier phase ambiguities. For more information, see *document [6] DR&RTK application note*.

1.9.2. RTK Base Station

The LC29H (BS) module supports RTCM data output as a base station.

The LC29H (BS) module supports static mode, and the receiver mode can be set as “Fixed mode” through corresponding command. For more information about the command, see *document [2] protocol* specification. The LC29H (BS) module can be set to use a previously surveyed coordinate set of the base station antenna position. Provided that the surveyed position has been professionally captured during a geodic survey, this method can be the best option in terms of accuracy.

The LC29H (BS) module can also set as “Survey-in-mode” by the corresponding command, which means the module can self-survey its position (coordinates) without using pre-surveyed position data. When this survey-in mode is adopted, the user provides the defined observation time and 3D error threshold for the survey. The receiver will self-survey its position during this period and accumulate the data less than the 3D error threshold, and then calculate its average position. Once the observation time has elapsed, the module will start running in static mode and output the configured RTCM reference station messages.

1.10. Dead Reckoning Function

The LC29H (BA, 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. For more information, see *document [6] DR&RTK application note*.

1.11. Firmware Upgrade

The module is delivered with preprogrammed firmware. Quectel may release firmware versions that contain bug fixes or performance optimizations. It is highly important to implement a firmware upgrade mechanism in your system. A firmware upgrade is the process of transferring a binary file image to the receiver and storing it in non-volatile flash. For more information, see *document [7] firmware upgrade guide*.

2 Pin Assignment

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

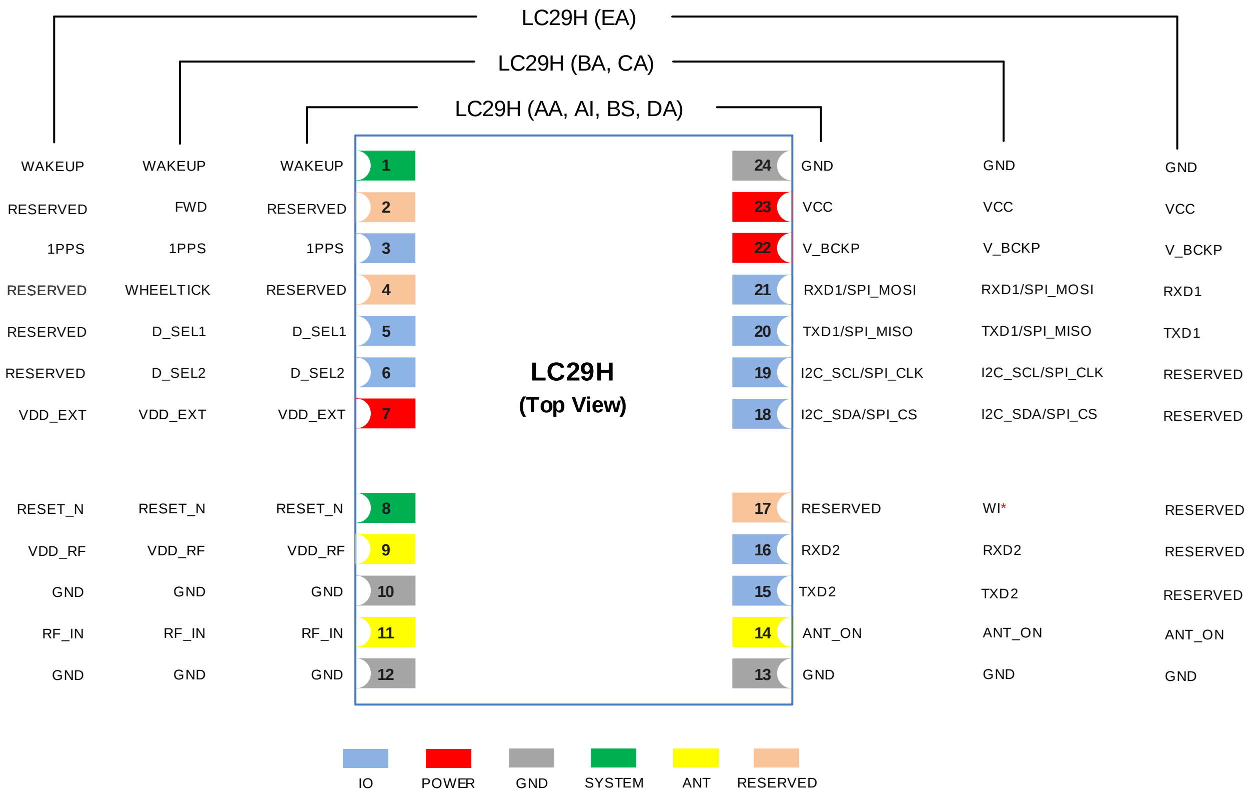


Figure 4: Pin Assignment

Table 5: Parameter Definition

Parameter	Description
AI	Analog Input
DI	Digital Input
DO	Digital Output
DIO	Digital Input/Output

Parameter	Description
PI	Power Input
PO	Power Output

Table 6: Pin Description

Function	Name	No.	I/O	Description	DC Characteristics	Remarks
Power	VCC	23	PI	Main power supply	V_{I}min = 3.1 V V_{I}nom = 3.3 V V_{I}max = 3.6 V	Requires clean and steady voltage.
	V_BCKP	22	PI	Backup power supply for backup domain	V_{I}min = 2.2 V V_{I}nom = 3.3 V V_{I}max = 3.6 V	V_BCKP must be connected to power supply for startup, and it should always be powered if hot (warm) start is needed.
	VDD_EXT	7	PO	Provides 2.8 V for external circuit	V_{O} = 2.8 V	Maximum output current is 100 mA.
I/O	D_SEL1	5	DI	Selects UART1/ SPI/I2C	V_{IL}min = -0.3 V V_{IL}max = 0.63 V V_{IH}min = 1.17 V V_{IH}max = 2.1 V	D_SEL1 and D_SEL2 can be used for selecting the interface for communication and firmware upgrade. The I/O voltage domain of D_SEL1 and D_SEL2 is 1.8 V. See *Chapter 4.1.1.1 Interface Selection (D_SEL1 & D_SEL2)* for details. UART1/I2C supports standard NMEA message, RTCM message [14], binary data, PAIR/PQTM message and firmware upgrade. SPI [15] supports standard NMEA message, RTCM message [14], binary data, PAIR/PQTM message and
	D_SEL2	6	DI			
	TXD1/ SPI_MISO	20	DO	UART1 Transmits data/ SPI master in, slave out	V_{OL}max = 0.35 V V_{OH}min = 2.1 V	
	RXD1/ SPI_MOSI	21	DI	UART1 Receives data/ SPI master out, slave in	V_{IL}min = -0.3 V V_{IL}max = 0.7 V V_{IH}min = 1.75 V V_{IH}max = 3.08 V	
	I2C_SDA/ SPI_CS	18	DIO	I2C serial data/ SPI chip-select	V_{IL}min = -0.3 V V_{IL}max = 0.7 V V_{IH}min = 1.75 V V_{IH}max = 3.08 V V_{OL}max = 0.35 V V_{OH}min = 2.1 V	
	I2C_SCL/ SPI_CLK	19	DI	I2C serial clock/ SPI clock	V_{IL}min = -0.3 V V_{IL}max = 0.7 V	

[14] RTCM message input is only supported by LC29H (BA, DA, EA).
[15] The SPI is under development for LC29H (BS).

Function	Name	No.	I/O	Description	DC Characteristics	Remarks
					V_{IH}min = 1.75 V V_{IH}max = 3.08 V	firmware upgrade [16]. LC29H (EA) only supports UART1 interface and does not support D_SEL1, D_SEL2, I2C, and SPI.
	TXD2	15	DO	UART2 Transmits data	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	UART2 interface supports system debugging data. Its I/O voltage domain is 1.8 V. If unused, leave the pin N/C (not connected). The pins are reserved on LC29H (EA).
	RXD2	16	DI	UART2 Receives data	VILmin = -0.3 V VILmax = 0.63 V VIHmin = 1.17 V VIHmax = 2.1 V	
	FWD	2	DI	Forward/Backward status signal input	V_{IL}min = -0.3 V V_{IL}max = 0.7 V V_{IH}min = 1.75 V V_{IH}max = 3.08 V	The pins are reserved on LC29H (AA, AI, BS, DA, EA). If unused, leave the pin N/C.
	WHEELTICK	4	DI	Odometer/ Wheel-tick pulse input		
	1PPS	3	DO	One pulse per second	V_{OL}max = 0.35 V V_{OH}min = 2.1 V	Synchronized on rising edge. If unused, leave the pin N/C.
	WI*	17	DO	Warning Indicator	V_{OL}max = 0.35 V V_{OH}min = 2.1 V	VCC must be valid to ensure the output of interrupt signal. The pin is reserved on LC29H (AA, AI, BS, DA, EA).
ANT	VDD_RF	9	PO	Supplies power for external RF components	V_{I}min = 3.1 V V_{I}nom = 3.3 V V_{I}max = 3.6 V	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	Controls external LNA and active antenna power	V_{OL}max = 0.35 V V_{OH}min = 2.1 V	The pin outputs high-level signal in the Continuous mode and low-level signal in the Backup mode.

[16] Only LC29H (AI) supports firmware upgrade via the SPI.

Function	Name	No.	I/O	Description	DC Characteristics	Remarks
						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	V_{IL}min = -0.3 V V_{IL}max = 0.1 V V_{IH}min = 1.8 V V_{IH}max = 3.6 V	Active low.
	WAKEUP	1	DI	Wakes up the module from the Backup mode	V_{IL}min = -0.3 V V_{IL}max = 0.7 V V_{IH}min = 3.0 V V_{IH}max = 3.6 V	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	2, 4–6, 15–19	-	Reserved	-	For LC29H (BA, CA), pins 2, 4 and 17 are FWD, WHEELTICK and WI* respectively. For LC29H (AA, AI, BA, BS, CA, DA), pins 5, 6, 15, 16, 18 and 19 are D_SEL1, D_SEL2, TXD2, RXD2, I2C_SDA/SPI_CS, and I2C_SCL/SPI_CLK respectively. For other variants, these pins are RESERVED. They must be left N/C and cannot be connected to power or GND.

NOTE

1. The I/O voltage domain of D_SEL1, D_SEL2 and UART2 interfaces is 1.8 V.
2. Leave RESERVED and unused pins N/C.

3 Power Management

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

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

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

The modules' internal power supply is shown below:

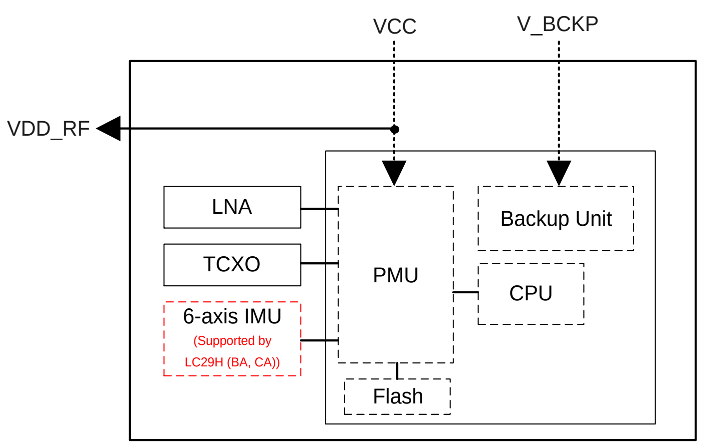


Figure 5: Internal Power Supply

3.2. Power Supply

3.2.1. VCC

The VCC is the supply voltage pin that supplies BB, RF and 6-axis IMU (supported only by LC29H (BA, CA)).

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

For low-power applications using power saving mode, it is important for the LDO at the power supply or module input to be able to provide sufficient current when the module is switched from Backup mode to Continuous mode. 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 minimum value capacitor should be the closest to module pins.

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

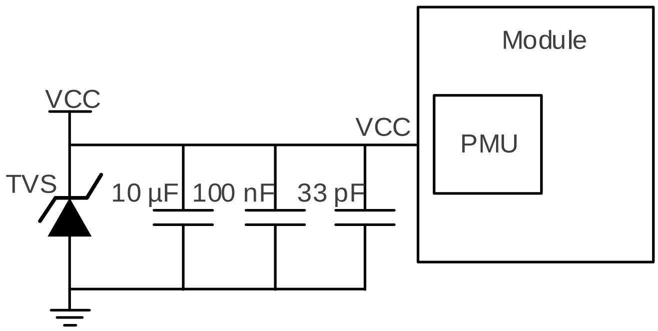


Figure 6: VCC Input Reference Circuit

NOTE

Ensure the module VCC is controlled by application MCU in order to save power or restart the module should it enter 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.

It is recommended to place a TVS and a combination of a 4.7 μF, a 100 nF and a 33 pF decoupling capacitor near the V_BCKP pin. The figure below illustrates the reference design for powering the backup domain.

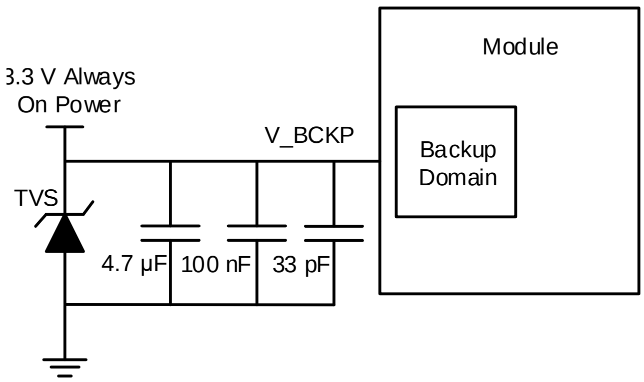


Figure 7: Backup Domain Input Reference Circuit

V_BCKP can also be powered by a 3.7 V lithium battery. It is recommended to control the enable pin of LDO via MCU, as shown in the figure below.

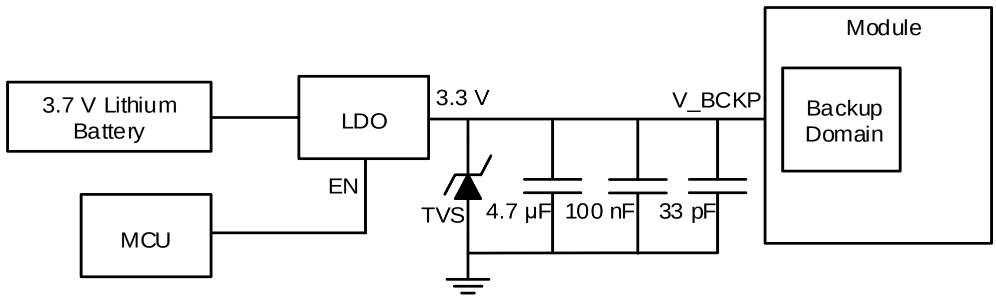


Figure 8: Reference Power Supply Circuit with 3.7 V Lithium Battery

NOTE

1. If V_BCKP is below the minimum value of the recommended operating voltage, the modules cannot work normally.
2. It is recommended to control the V_BCKP of the modules via MCU to restart the modules if the modules enter an abnormal state.

3.3. Power Modes

3.3.1. Feature Comparison

The modules feature supported in different modes are listed in the table below.

Table 7: Feature Comparison in Different Power Modes

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

3.3.2. Continuous Mode

If VCC and V_BCKP are powered on, the modules automatically enter the Continuous mode that comprises acquisition mode and tracking mode. In acquisition mode, the modules initiate a satellites search to determine visible satellites, coarse frequency, as well as the code phase of satellite signals. Once the acquisition is completed, the modules automatically switch to tracking mode. In tracking mode, the modules track satellites and demodulate the navigation data from specific satellites.

3.3.3. Backup Mode

For power-sensitive applications, the modules support 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 **$PAIR650** to shut down internal main power supply in sequence.
  2. Cut off the power supply of VCC and keep the V_BCKP powered.

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

For more information about the relevant software command, see *document [1] protocol specification*.

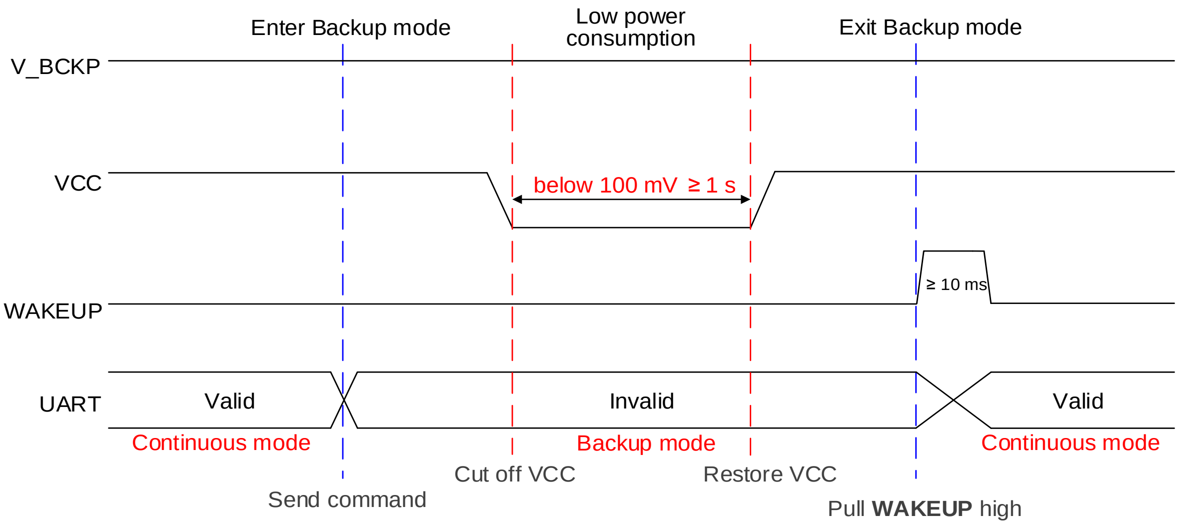


Figure 9: Enter/Exit Backup Mode Sequence

NOTE

1. **$PAIR650** must be sent; to ensure hot (warm) start of the modules at the next startup, V_BCKP must be kept powered.
2. After VCC is restored, the WAKEUP pin must be pulled up for at least 10 ms for the modules to exit the Backup mode. Otherwise, the UART will not output data.
3. Ensure a stable V_BCKP without a rush or drop when the VCC is switched on or off.
4. If you cut off module's power supply directly (without sending **$PAIR650**), the modules cannot enter the Backup mode normally. In this case, the modules 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 modules start 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. Hence, the V_BCKP must be powered simultaneously with the VCC or before it.

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

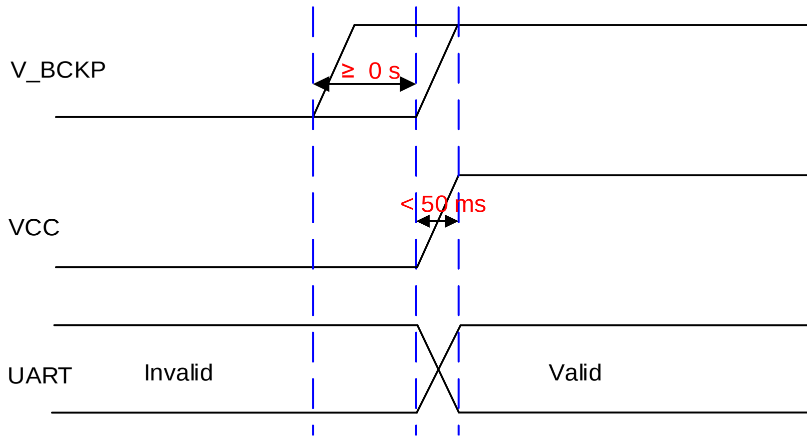


Figure 10: Power-up Sequence

3.5. Power-down Sequence

Once the VCC and V_BCKP are shut down, the module turns off automatically and the voltage should drop quickly within less than 50 ms. It is recommended to use a voltage regulator that supports fast discharging.

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

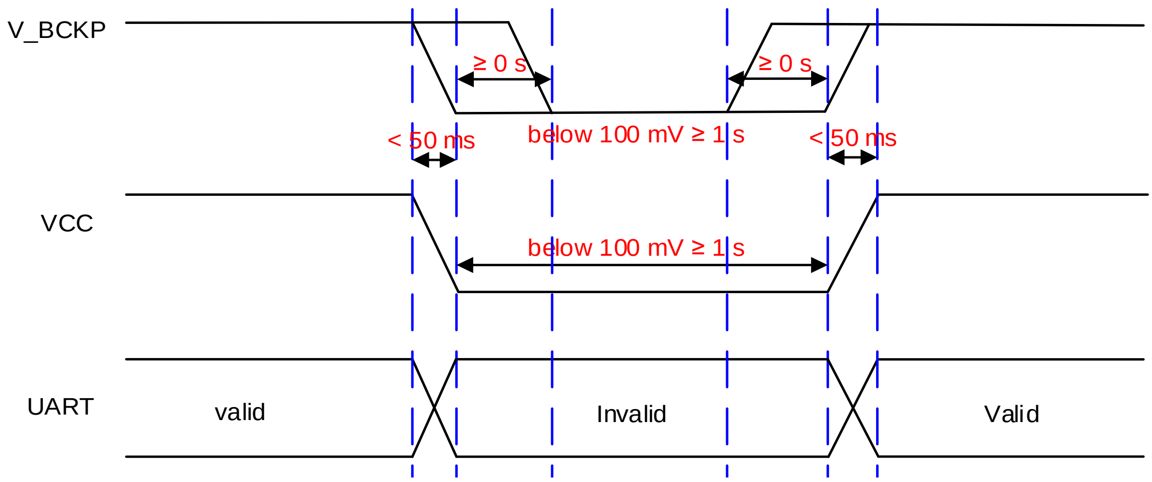


Figure 11: Power-down and Power-on Restart Sequence

4 Application Interfaces

4.1. I/O Pins

4.1.1. Communication Interfaces

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

4.1.1.1. Interface Selection (D_SEL1 & D_SEL2)

By default, D_SEL1 and D_SEL2 are pulled down internally to GND with a 75 kΩ resistors. Pull one or both of them up externally to high logical level to switch the interface for communication and firmware upgrade. See *document [8] reference design* for the reference circuit of interface selection and *document [7] firmware upgrade guide* for details on the firmware upgrade in Download and Upgrade modes.

Table 8: Interface Selection by D_SEL1 & D_SEL2

Interface Selection	UART1	SPI [17]	I2C
D_SEL1 = 0 & D_SEL2 = 0 (Default)	Can be used for communication and firmware upgrade in Download mode	-	Can only be used for communication and firmware upgrade in Upgrade mode [18]
D_SEL1 = 0 & D_SEL2 = 1	-	-	-
D_SEL1 = 1 & D_SEL2 = 0	-	Can be used for communication and firmware upgrade in Upgrade mode [18]	-
D_SEL1 = 1 & D_SEL2 = 1	Can only be used for communication	-	Can be used for communication and firmware upgrade in Download mode

[17] The SPI is under development for LC29H (BS).
[18] Only LC29H (AI) supports firmware upgrade in Upgrade mode via the I2C/SPI.

NOTE

1. D_SEL1 and D_SEL2 are not supported by LC29H (EA).
2. The I/O voltage domain of D_SEL1 and D_SEL2 is 1.8 V.

4.1.1.2. UART1 Interface

The modules provide one UART1 interface with the following features:

- Supports standard NMEA message, RTCM message [19], binary data, PAIR/PQTM message and firmware upgrade.
- Supported baud rates: 4800 bps, 9600 bps, 19200 bps, 38400 bps, 57600 bps, 115200 bps, 230400 bps, 460800 bps, 921600 bps and 3000000 bps.
- Hardware flow control and synchronous operation are not supported.

For more information, see *documents [1]*, *[2]* and *[3] protocol specifications*.

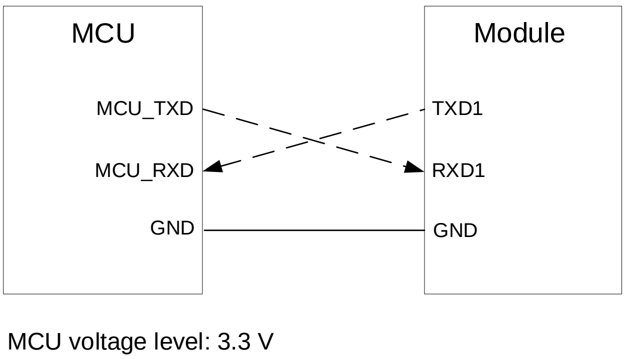


Figure 12: UART1 Interface Reference Design

A reference design is shown in the figure above. For more information, see *document [8] reference design*.

NOTE

1. The 4800 bps and 3000000 bps baud rates are not supported by LC29H (AI).
2. UART1 interface default settings may vary depending on software version. See the relevant software versions for details.
3. If the I/O voltage of MCU is not matched with module, a level-shifting circuit must be selected.

[19] RTCM message input is only supported by LC29H (BA, DA, EA).

4.1.1.3. UART2 Interface

The modules provide one UART2 interface with the following features:

- Supports system debugging data.
- Supported baud rates: 4800 bps, 9600 bps, 19200 bps, 38400 bps, 57600 bps, 115200 bps, 230400 bps, 460800 bps, 921600 bps and 3000000 bps.
- Hardware flow control and synchronous operation are not supported.

NOTE

1. The default baud rate of the UART2 interface is 3000000 bps. The UART2 interface is not supported by LC29H (EA).
2. The I/O typical voltage of UART2 interface is 1.8 V. If the I/O voltage of MCU is not matched with the modules, a level-shifting circuit must be selected.

4.1.1.4. I2C Interface

The modules provide one I2C interface with the following features:

- Supports standard NMEA message, RTCM message [20], binary data, PAIR/PQTM message and firmware upgrade.
- Operates in slave mode.
- Supports 7-bit address.
- Supports the standard mode (100 kbps) and fast mode (400 kbps).

For more information, see *document [9] I2C application note*.

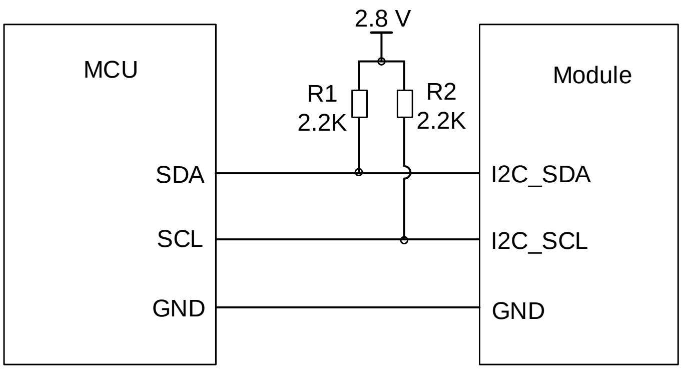


Figure 13: I2C Interface Reference Design

[20] RTCM message input is only supported by LC29H (BA, DA).

A reference design is shown in the figure above. For more information, see *document [8] reference design*.

NOTE

1. The I2C interface is not supported by LC29H (EA).
2. If the I/O voltage of MCU is not matched with that of the modules, a level-shifting circuit must be selected.

4.1.1.5. SPI

The modules provide one SPI with the following features:

- Supports standard NMEA message, RTCM message [20], binary data, PAIR/PQTM message and firmware upgrade [21].
- Operates in slave mode.
- Supports full duplex SPI.
- Maximum clock frequency: 48 MHz.

For more information, see *document [10] SPI application note*.

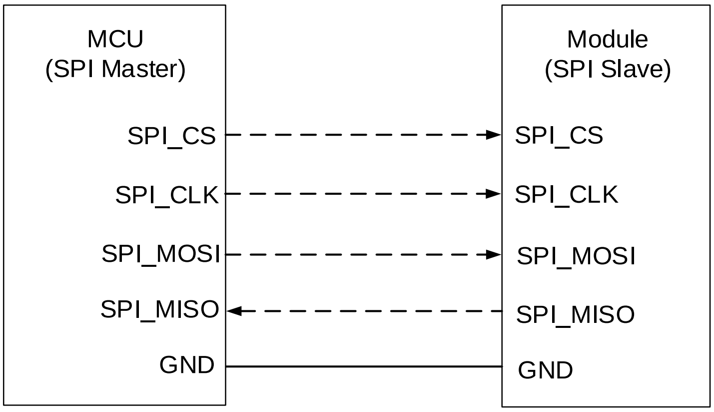


Figure 14: SPI Reference Design

A reference design is shown in the figure above. For more information, see *document [8] reference design*.

NOTE

1. The SPI is not supported by LC29H (EA) and is under development for LC29H (BS).
2. The pins of the SPI are multiplexed with I2C and UART1 pins, and thus cannot be used with I2C or UART1 at the same time.

[21] Only LC29H (AI) supports firmware upgrade via the SPI.

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

4.1.2. FWD

The FWD pin (only supported by LC29H (BA, CA)) can be used to input the status signals indicating the vehicle's forward/backward movement. When the vehicle is moving forward, it is at a low voltage level; when the vehicle is moving backward, it is at a high level.

NOTE

The FWD pin must be connected on LC29H (BA, CA) when ADR function is used.

4.1.3. WHEELTICK

The WHEELTICK pin (only supported by LC29H (BA, CA)) can be 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, see *document [8] reference design*.

NOTE

The WHEELTICK pin must be connected on LC29H (BA, CA) when ADR function is used.

4.1.4. 1PPS

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

4.1.5. WI*

WI (only supported by LC29H (BA, CA)) signal is an interrupt output to wake up the host. The pin is pulled up internally to 2.8 V and outputs low level when the value of the 6-axis IMU is higher than the threshold value. The module cannot determine what causes the vehicle tilting. It needs the host to judge whether the vehicle is towed or is running normally on an uphill road.

4.2. System Pins

4.2.1. WAKEUP

Pull the WAKUP pin high for at least 10 ms to wake up the modules 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 modules 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 V_BCKP, 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.

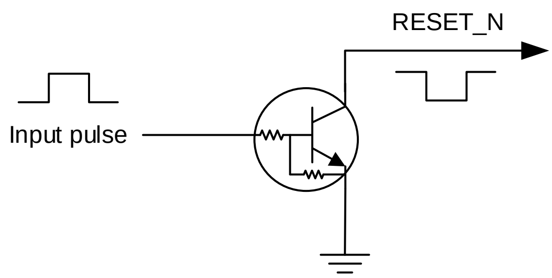


Figure 15: Reference OC Circuit for Module Reset

The following figure shows the reset sequence of the modules.

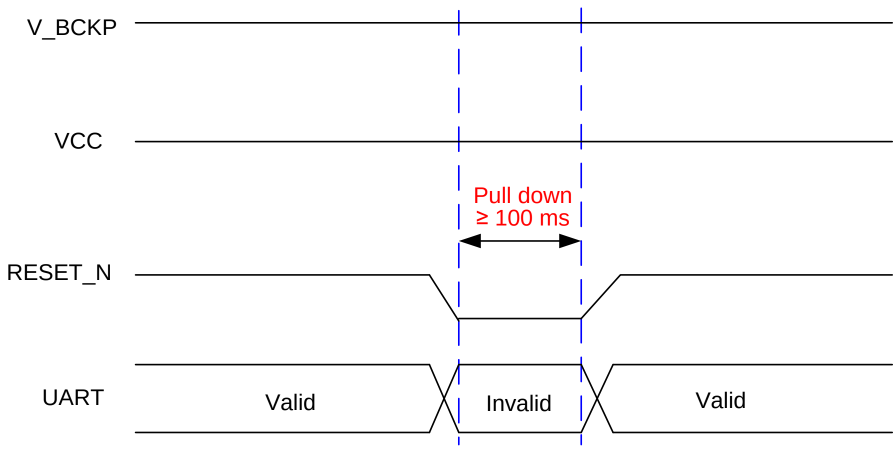


Figure 16: Reset Sequence

NOTE

RESET_N must be connected so that it can be used to reset the modules if they enter an abnormal state.

5 Design

This chapter explains the reference design of RF section and recommended footprint of the modules. GNSS receivers could be vulnerable to environmental interference. To learn the details about interference and ensuring interference immunity, see *document [11] GNSS antenna application note*.

5.1. Antenna Selection

5.1.1. Antenna Specifications

The modules can be connected to a dedicated passive or an active GNSS antenna to receive GNSS satellite signals. The recommended antenna specifications are given in the table below.

Table 9: 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 Phase Center Offset: < 20 mm [22] Phase Center Variation: < 20 mm [23] Axial Ratio: < 3 dB [23] -3 dB Beam Width: > 90° [23]
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 Out-of-band Rejection: > 30 dB Phase Center Offset: < 20 mm [23] Phase Center Variation: < 20 mm [23] Axial Ratio: < 3 dB [23]

[22] When RTK function is used to achieve high-precision positioning, the antenna should meet the specifications recommended above.

Antenna Type	Specifications
	-3 dB Beam Width: > 90° [23]

NOTE

1. For recommended antenna and design, see *document [11] GNSS antenna application note* or contact Quectel Technical Support (support@quectel.com).
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 GNSS antennas can be used for the modules. A passive antenna is recommended if the antenna can be placed close to the modules, for instance, when the distance between the modules and the antenna is less than 1 m. It is recommended to switch from a passive antenna to an active antenna once the loss is > 1 dB, since the insertion loss of RF cable can decrease the C/N_0 of GNSS signal. For more information about antenna selection, see *document [11] GNSS antenna application note*.

5.2. Antenna Reference Design

To mitigate the impact of out-of-band signals on the GNSS module in a complex electromagnetic environment, a SAW filter circuit must be added to the antenna design. The SAW filter circuit has a stable suppression effect on all out-of-band signals. The recommended SAW filter is B39162B2651P810 (automotive grade) or B39162B8389P810 (industrial grade) from RF360 for L1 + L5 bands. The encapsulations of the B39162B2651P810 and B39162B8389P810 are inconsistent. In the actual layout, the circuit should be placed close to the RF_IN pin. The SAW filter circuit should be selected according to the use case.

5.2.1. Active Antenna Reference Design

When using VDD_RF pin to supply the active antenna, it is important to pay attention to operating voltage range of the antenna and the voltage drop on the power supply circuit. The voltage drop is caused by the resistor (R2) and the inductor (L1) in the external power supply circuit. To further mitigate the impact of out-of-band signals on GNSS modules, you must choose the active antenna whose SAW filter is placed in front of the LNA in the internal framework. DO NOT place the LNA in the front. The minimum operating voltage of selected active antenna needs to meet the circuit design characteristics.

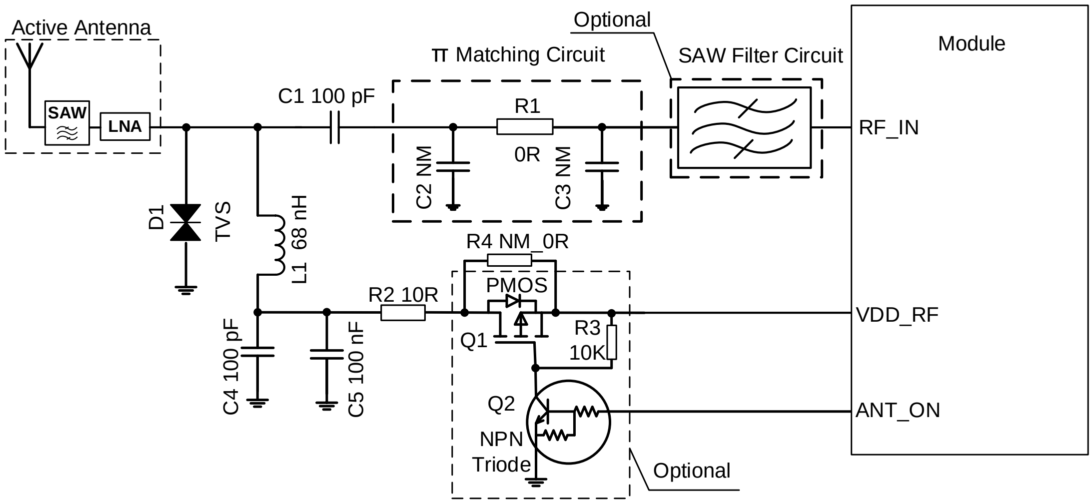


Figure 17: Active Antenna Reference Design

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, C1 is 100 pF; R1 is 0 Ω, while C2 and C3 are not mounted. They should be placed near the antenna in the actual layout. D1 is an electrostatic discharge (ESD) protection device to protect RF components inside the modules from the damage caused by ESD through the antenna interface. The junction capacitance of D1 cannot be more than 0.6 pF and a transient voltage suppressor is recommended.

L1 is used to 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. Place L1, C4 and C5 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 should be mounted to protect the modules in case the active antenna is short-circuited to the ground plane. RF trace impedance should be controlled to 50 Ω and trace length should be kept as short as possible. For more information, see *document [12] RF layout application note*.

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.

5.2.2. Passive Antenna Reference Design

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

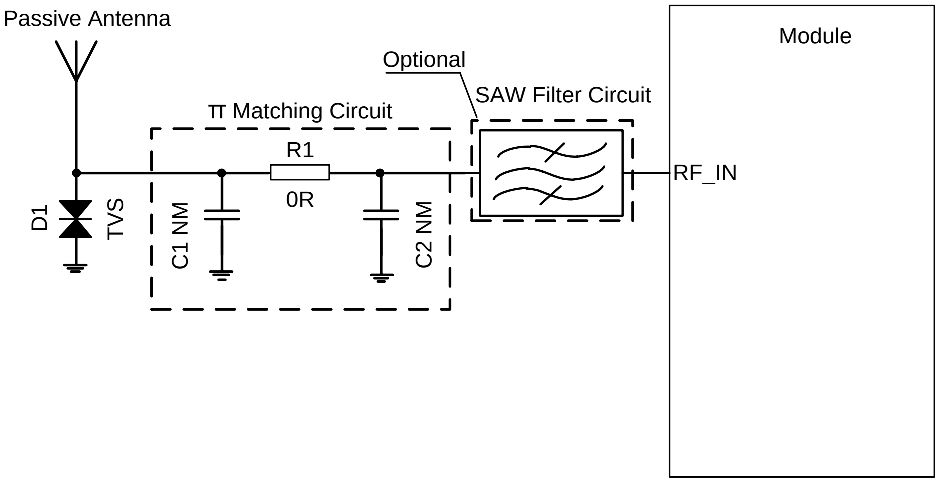
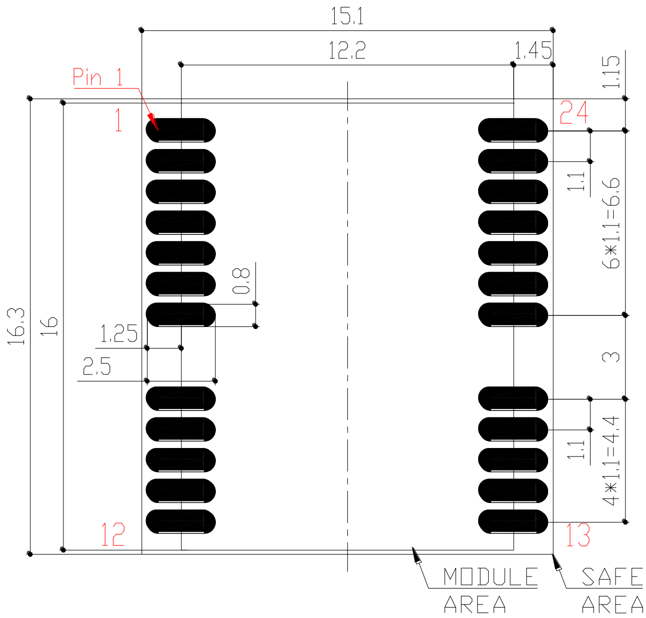


Figure 18: Passive Antenna Reference Design

C1, R1 and C2 are reserved for matching antenna impedance. By default, R1 is 0 Ω, while C1 and C2 are not mounted. They should be placed near the antenna in the actual layout. D1 is an electrostatic discharge (ESD) protection device to protect RF components inside the modules from the damage caused by ESD through the antenna interface. 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.

5.3. Recommended Footprint

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



Unlabeled tolerance: +/-0.2mm

Figure 19: Recommended Footprint

NOTE

Maintain at least 3 mm keepout between the modules 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 module are listed in table below.

Table 10: 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 I/O Pins	$V_{I/O}$ = 2.8 V	-0.3	3.08	V
		$V_{I/O}$ = 1.8 V	-0.3	1.98	V
P_{RF_IN}	Input Power at RF_IN		-	0	dBm
T_storage	Storage Temperature		-40	90	°C

NOTE

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

6.2. Recommended Operating Conditions

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

Table 11: Recommended Operating 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 I/O Pin Voltage Domain		2.1	2.8	3.08	V
			1.62	1.8	1.98	V
V_{IL}	Digital I/O Pin Low-level Input Voltage	$V_{I/O}$ = 2.8 V	-0.3	0	0.7	V
		$V_{I/O}$ = 1.8 V	-0.3	0	0.63	V
V_{IH}	Digital I/O Pin High-level Input Voltage	$V_{I/O}$ = 2.8 V	1.75	-	3.08	V
		$V_{I/O}$ = 1.8 V	1.17	-	2.1	V
V_{OL}	Digital I/O Pin Low-level Output Voltage	$V_{I/O}$ = 2.8 V	-	-	0.35	V
		$V_{I/O}$ = 1.8 V	-	-	0.45	V
V_{OH}	Digital I/O Pin High-level Output Voltage	$V_{I/O}$ = 2.8 V	2.1	-	-	V
		$V_{I/O}$ = 1.8 V	1.35	-	-	V
RESET_N	Low-level Input Voltage		-0.3	-	0.1	V
	High-level Input Voltage		1.8	3.3	3.6	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 Output Voltage		3.1	3.3	3.6	V
I_{VDD_RF}	VDD_RF Output Current		-	-	100	mA
T_operating	Operating Temperature		-40	25	+85	°C

NOTE

1. Operation beyond the “Operating Conditions” is not recommended and extended exposure beyond the “Operating Conditions” may affect device reliability.
2. The 2.8 V digital I/O pins mentioned in the table above refer to all digital pins in *Table 6: Pin Description* except RESET_N, WAKEUP, TXD2, RXD2, D_SEL1 and D_SEL2 pins.
3. The 1.8 V digital I/O pins mentioned in the table above refer to TXD2, RXD2, D_SEL1 and D_SEL2 pins in *Table 6: Pin Description*.

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, and test duration and conditions.

Table 12: Supply Current for LC29H (AA, BA, BS)

Parameter	Description	Condition	LC29H (AA)		LC29H (BA)		LC29H (BS)	
			$I_{Typ.}$ [23]	I_{PEAK} [23]	$I_{Typ.}$ [23]	I_{PEAK} [23]	$I_{Typ.}$ [23]	I_{PEAK} [23]
I_{VCC} [24]	Current at VCC	Acquisition	24 mA	61 mA	32 mA	64 mA	24 mA	38 mA
		Tracking	24 mA	65 mA	32 mA	64 mA	24 mA	39 mA
I_{V_BCKP} [25]	Current at V_BCKP	Continuous mode	93 µA	134 µA	74 µA	113 µA	75 µA	138 µA
		Backup mode	25 µA	61 µA	25 µA	60 µA	25 µA	55 µA

Table 13: Supply Current for LC29H (CA, DA, EA)

Parameter	Description	Condition	LC29H (CA)		LC29H (DA)		LC29H (EA)	
			$I_{Typ.}$ [23]	I_{PEAK} [23]	$I_{Typ.}$ [23]	I_{PEAK} [23]	$I_{Typ.}$ [23]	I_{PEAK} [23]
I_{VCC} [24]	Current at VCC	Acquisition	30 mA	64 mA	30 mA	68 mA	30 mA	68 mA
		Tracking	30 mA	64 mA	30 mA	68 mA	30 mA	68 mA
I_{V_BCKP} [25]	Current at V_BCKP	Continuous mode	74 µA	113 µA	74 µA	113 µA	74 µA	113 µA
		Backup mode	25 µA	60 µA	25 µA	51 µA	25 µA	51 µA

[23] Room temperature, measurements are taken with typical voltage.
[24] Used to determine maximum current capability of power supply.
[25] Used to determine required battery current capability.

Table 14: Supply Current for LC29H (AI)

Parameter	Description	Condition	LC29H (AI)	
			$I_{Typ.}$ [23]	I_{PEAK} [23]
I_{VCC} [24]	Current at VCC	Acquisition	16 mA	61 mA
		Tracking	16 mA	65 mA
I_{V_BCKP} [25]	Current at V_BCKP	Continuous mode	123 μA	202 μA
		Backup mode	51 μA	68 μA

6.4. ESD Protection

Static electricity occurs naturally and it may damage the modules. 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 modules; 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 modules:

- When mounting the modules 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 modules. All dimensions are in millimeters (mm). The dimensional tolerances are ±0.20 mm, unless otherwise specified.

7.1. Top, Side and Bottom View Dimensions

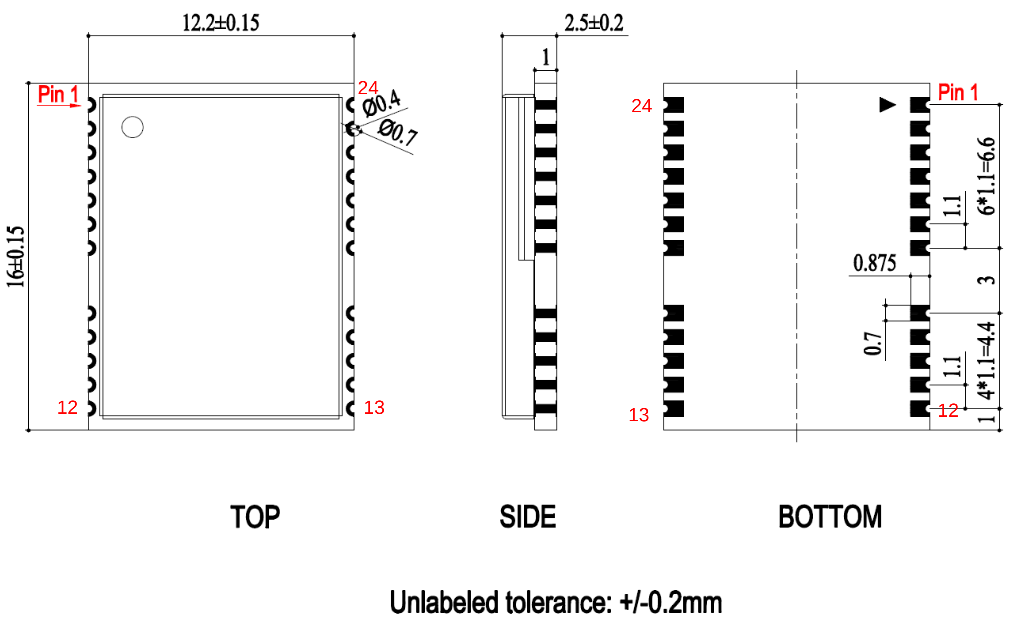


Figure 20: Top, Side and Bottom View Dimensions

NOTE

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

7.2. Top and Bottom Views

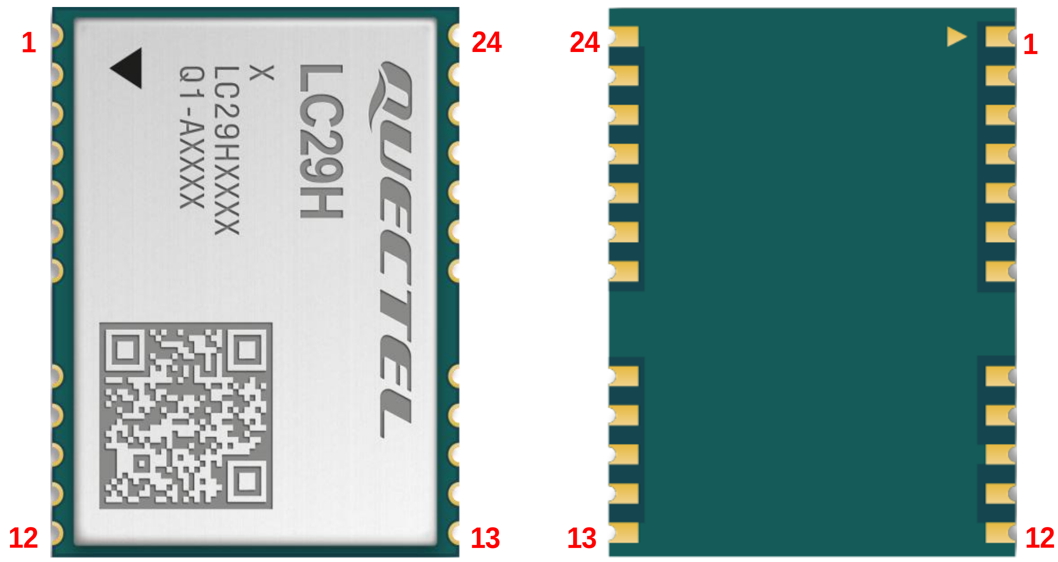


Figure 21: Top and Bottom Module Views

NOTE

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

8 Product Handling

8.1. Packaging Specification

This chapter outlines the key packaging parameters and processes. All figures below are for reference purposes only, as the actual appearance and structure of packaging materials may vary in delivery.

The modules are packed in a tape and reel packaging as specified in the sub-chapters below.

8.1.1. Carrier Tape

Carrier tape dimensions are illustrated in the following figure and table:

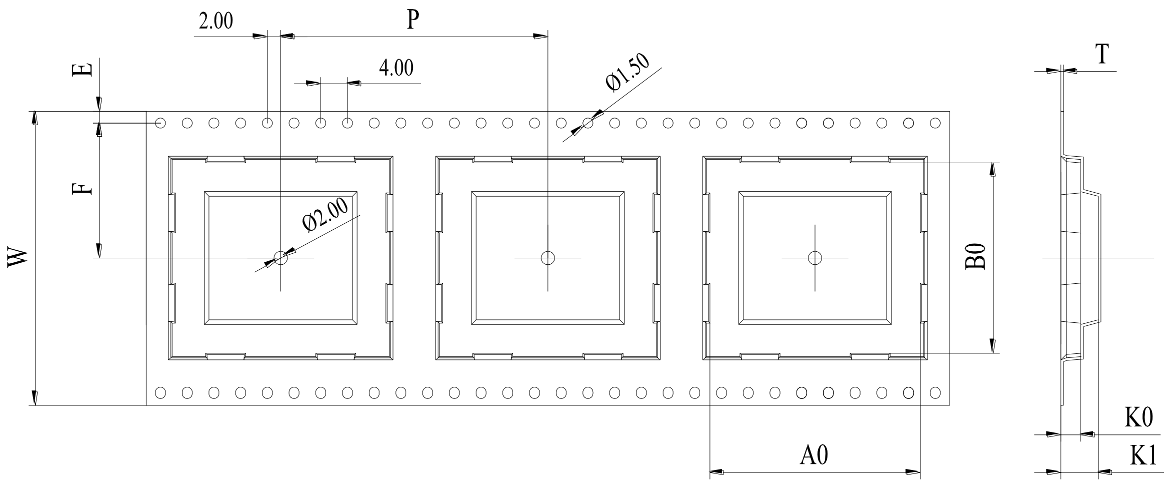


Figure 22: Carrier Tape Dimension Drawing (Unit: mm)

Table 15: 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

Plastic reel dimensions are illustrated in the following figure and table:

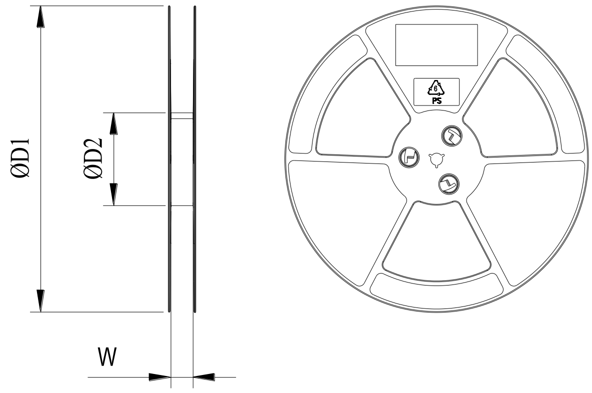


Figure 23: Plastic Reel Dimension Drawing

Table 16: Plastic Reel Dimension Table (Unit: mm)

øD1	øD2	W
330	100	32.5

8.1.3. Mounting Direction

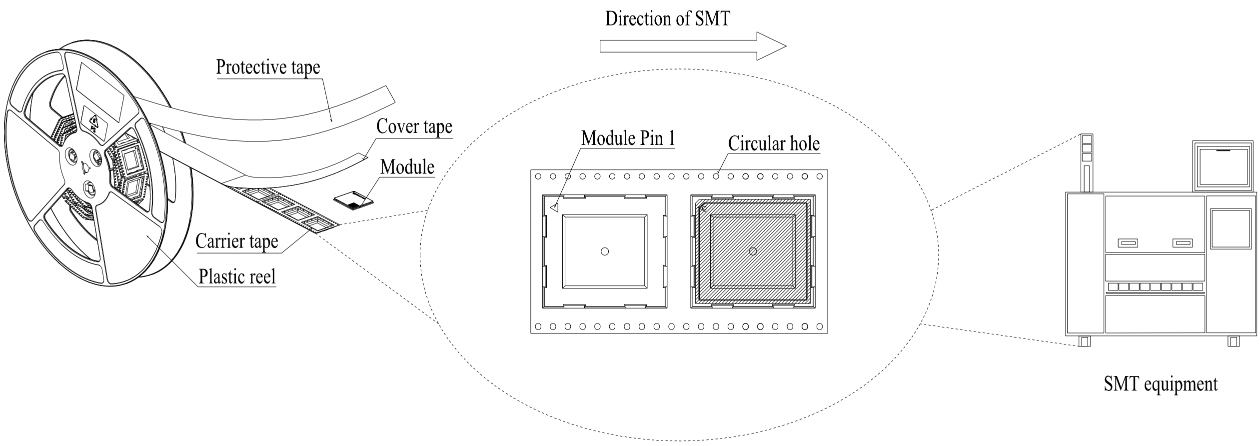
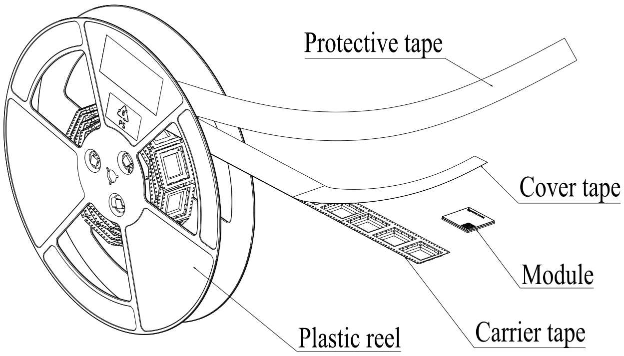


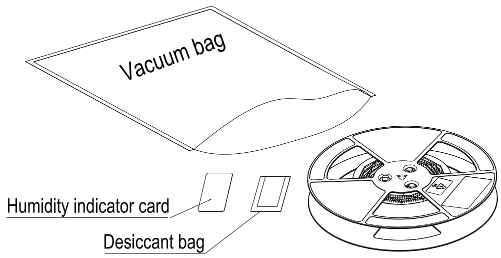
Figure 24: Mounting Direction

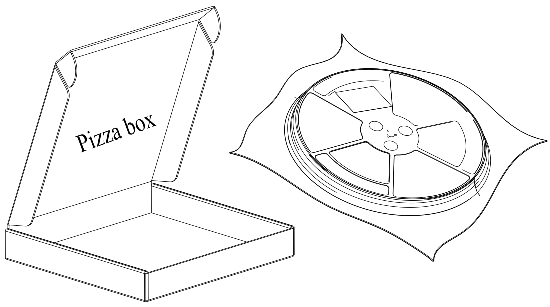
8.1.4. Packaging Process



Place the modules onto the carrier tape cavity and cover them securely with cover tape. Wind the heat-sealed carrier tape onto a plastic reel and apply a protective tape for additional protection. 1 plastic reel can pack 250 modules.

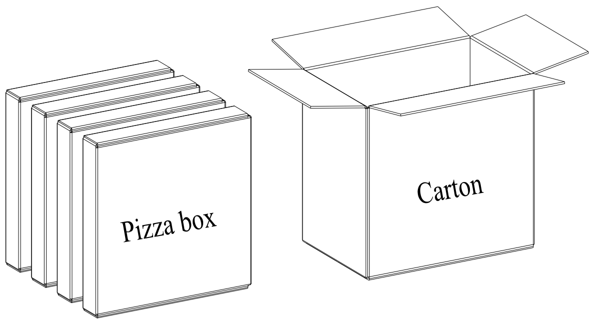
Place the packed plastic reel, humidity indicator card and desiccant bag into a vacuum bag, and vacuumize it.





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

Place the 4 packaged pizza boxes into 1 carton and seal it. 1 carton can pack 1000 modules.



Pizza box size (mm): 365 × 345 × 56
Carton size (mm): 380 × 250 × 365

Figure 25: Packaging Process

8.2. Storage

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

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

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

3. Floor life: 168 hours [26] in a factory where the temperature is 23 ±5 °C and relative humidity is below 60 %. After the vacuum-sealed packaging is removed, the modules must be processed in reflow soldering or other high-temperature operations within 168 hours. Otherwise, the module should be stored in an environment where the relative humidity is less than 10 % (e.g., a dry cabinet).

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

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

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

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

NOTE

1. To avoid blistering, layer separation and other soldering issues, extended exposure of the modules to the air is forbidden.
2. Take out the modules from the package 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 modules.

[26] 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 confirm to *IPC/JEDEC J-STD-033*. Do not unpack the modules in large quantities until they are ready for soldering.

8.3. Manufacturing and Soldering

Push the squeegee to apply solder paste on the 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 the stencil thickness of the modules, see *document [13] module SMT application note*.

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

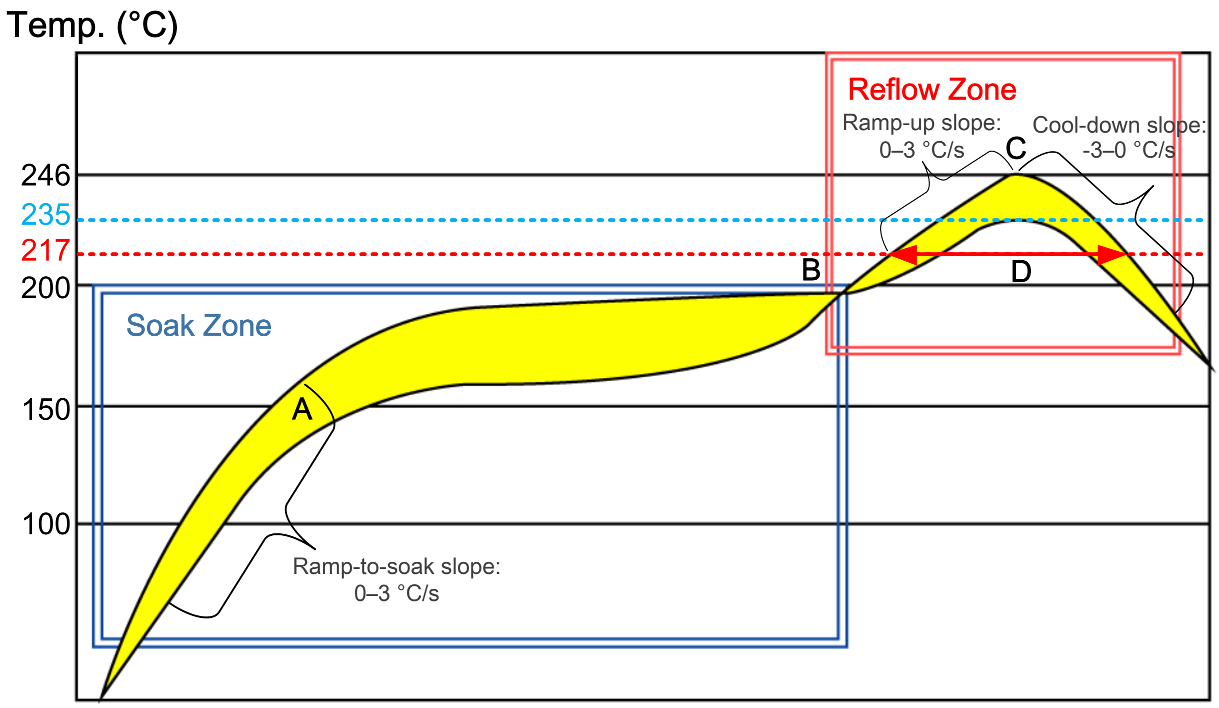


Figure 26: Recommended Reflow Soldering Thermal Profile

Table 17: Recommended Thermal Profile Parameters

Factor	Recommended Value
Soak Zone	
Ramp-to-soak slope	0–3 °C/s
Soak Time (between A and B: 150 °C and 200 °C)	70–120 s

Factor	Recommended Value
Reflow Zone	
Ramp-up Slope	0–3 °C/s
Reflow Time (D: over 217°C)	40–70 s
Max. Temperature	235–246 °C
Cool Down Slope	-3–0 °C/s
Reflow Cycle	
Max. Reflow Cycle	1

NOTE

1. The above profile parameter requirements are for the measured temperature of the solder joints. Both the hottest and coldest spots of solder joints on the PCB should meet the above requirements.
2. During manufacturing and soldering, or any other processes that may require direct contact with the modules, **NEVER** wipe the modules shielding can with organic solvents, such as acetone, ethyl alcohol, isopropyl alcohol, and trichloroethylene. Otherwise, the shielding can may become rusty.
3. The module shielding can is made of cupronickel base material. The Neutral Salt Spray Test has shown that after 12 hours the laser-engraved label information on the shielding can is still clearly identifiable and the QR code is still readable, although white rust may be found.
4. If a conformal coating is necessary for the modules, **DO NOT** use any coating material that may react with the PCB or shielding cover. Prevent the coating material from penetrating the modules shield.
5. Avoid using ultrasonic technology for module cleaning since it can damage crystals inside the modules.
6. Avoid using materials that contain mercury (Hg), as adhesives, for module processing, even if the materials are RoHS compliant and their mercury content is below 1000 ppm (0.1 %).
7. Corrosive gases may corrode the electronic components inside the module, affecting their reliability and performance, and potentially leading to a shortened service life that fails to meet the designed lifespan. Therefore, do not store or use unprotected modules in environments containing corrosive gases such as hydrogen sulfide, sulfur dioxide, chlorine, and ammonia.
8. 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 [13] module SMT application note*.

9 Labelling Information

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

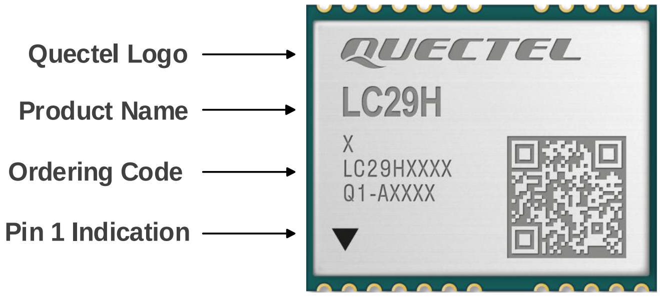


Figure 27: Labelling Information

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

10 Appendix References

Table 18: Related Documents

Document Name	
[1]	Quectel_LC29H&LC79H&QLM29H_Series_GNSS_Protocol_Specification
[2]	Quectel_LC29H(BS)_GNSS_Protocol_Specification
[3]	Quectel_L89(HD)&LC29H(AI)_GNSS_Protocol_Specification
[4]	Quectel_L89_R2.0&LC02H&LC29H&LC79H&QLM29H_Series_AGNSS_Application_Note
[5]	Quectel_L89_R2.0&LC29H(AA,BS)&LC79H(AL)_EASY&EPOC_Difference_Introduction
[6]	Quectel_LC29H(BA,CA,DA,EA)&QLM29H_Series_DR&RTK_Application_Note
[7]	Quectel_L89_R2.0&LC29H&LC79H&QLM29H_Series_Firmware_Upgrade_Guide
[8]	Quectel_LC29H_Series_Reference_Design
[9]	Quectel_L89_R2.0&LC29H_Series&LC79H(AL)_I2C_Application_Note
[10]	Quectel_LC29H_Series_SPI_Application_Note
[11]	Quectel_GNSS_Antenna_Application_Note
[12]	Quectel_RF_Layout_Application_Note
[13]	Quectel_Module_SMT_Application_Note

Table 19: Terms and Abbreviations

Abbreviation	Description
1PPS	1 Pulse Per Second
3GPP	3rd Generation Partnership Project
AIC	Active Interference Cancellation

Abbreviation	Description
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
DR	Dead Reckoning
EGNOS	European Geostationary Navigation Overlay Service
EPO	Extended Prediction Orbit
EPOC	Enhanced Prediction Orbit on Chip
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
I/O	Input/Output
I2C	Inter-Integrated Circuit
IC	Integrated Circuit
IMU	Inertial Measurement Unit
I_{PEAK}	Peak Current
kbps	kilobits per second
LCC	Leadless Chip Carrier (package)
LDO	Low-dropout Regulator
LNA	Low-noise Amplifier
MCU	Microcontroller Unit/Microprogrammed Control Unit

Abbreviation	Description
MSAS	Multi-functional Satellite Augmentation System (Japan)
MSL	Moisture Sensitivity Levels
NavIC	Indian Regional Navigation Satellite System
NMEA	NMEA (National Marine Electronics Association) 0183 Interface Standard
NRTIP	Networked Transport of RTCM via Internet Protocol
OC	Open Connector
PAIR	Proprietary Protocol of Airoha
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

Abbreviation	Description
SPI	Serial Peripheral Interface
TCXO	Temperature Compensated Crystal Oscillator
T_operating	Operating Temperature
TTFF	Time to First Fix
TVS	Transient Voltage Suppressor
TXD	Transmit Data (Pin)
UART	Universal Asynchronous Receiver/Transmitter
USB	Universal Serial Bus
VCC	Supply Voltage (Pin)
$V_I$max	Maximum Input Voltage
$V_I$min	Minimum Input Voltage
$V_I$nom	Normal Input Voltage
V_{IH}max	High-level Maximum Input Voltage
V_{IH}min	High-level Minimum Input Voltage
V_{IH}nom	High-level Normal Input Voltage
V_{IL}max	Low-level Maximum Input Voltage
V_{IL}min	Low-level Minimum Input Voltage
$V_O$nom	Normal Output Voltage
V_{OL}max	Low-level Maximum Output Voltage
V_{OH}min	High-level Minimum Output Voltage
VSWR	Voltage Standing Wave Ratio
WAAS	Wide Area Augmentation System
XTAL	External Crystal Oscillator