LC29H Series
Hardware Design

GNSS Module Series

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	Ensure that the product may be used in the country and the required environment, as well as that it conforms to the local safety and environmental regulations.
	Keep away from explosive and flammable materials. The use of electronic products in extreme power supply conditions and locations with potentially explosive atmospheres may cause fire and explosion accidents.
	The product must be powered by a stable voltage source, and the wiring shall conform to security precautions and fire prevention regulations.
	Proper ESD handling procedures must be followed throughout the mounting, handling and operation of any devices and equipment that incorporate the module to avoid ESD damages.

About the Document

Document Information	
Title	**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 14*).
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, D_SEL2,

Version	Date	Description
		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 7*). 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 11*). 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 12*). 14. Updated supply current of LC29H (EA)* (*Table 14*). 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 28* and *Table 17*).

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1 Product Description

1.1. Overview

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

The LC29H series module supports multiple global positioning constellations, such as GPS, GLONASS, Galileo, BDS and QZSS. Only the LC29H (AA) supports SBAS (including WAAS, EGNOS, MSAS and GAGAN). The entire LC29H series supports AGNSS.

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*.
- LC29H (BA) and LC29H (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), LC29H (DA) and LC29H (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 (BA)", "LC29H (CA)", "LC29H (DA)", "LC29H (EA)*" or "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, or argument, it indicates that the function, feature, interface, pin, or argument is under development and currently not supported; and the asterisk (*) after a model indicates that the sample of the model is currently unavailable.
●	The symbol indicates that a function or technology is supported by the module(s).

1.2. Features

Table 2: Product Features

Features		LC29H (AA)	LC29H (BA)	LC29H (CA)	LC29H (DA)	LC29H (EA)*	LC29H (BS)
Grade	Industrial	●	●	●	●	●	●
	Automotive	-	-	-	-	-	-
Category	Standard Precision GNSS	●	-	●	-	-	●
	High Precision GNSS	-	●	-	●	●	-
	DR	-	●	●	-	-	-
	RTK [1]	-	●	-	●	●	-
	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 [2]	Typ. 2.8 V	●	●	●	●	●	●
Communication	UART	●	●	●	●	●	●

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

Features			LC29H (AA)	LC29H (BA)	LC29H (CA)	LC29H (DA)	LC29H (EA)*	LC29H (BS)
Interfaces	SPI*		●	●	●	●	●	●
	I2C		●	●	●	●	●	●
Integrated Features	Additional LNA		●	●	●	●	●	●
	Additional Filter		●	●	●	●	●	●
	RTC Crystal		●	●	●	●	●	●
	TCXO Oscillator		●	●	●	●	●	●
	6-axis IMU		-	●	●	-	-	-
Constellations and Frequency Band	GPS	L1 C/A	●	●	●	●	●	●
		L5	●	●	●	●	●	●
		L2C	-	-	-	-	-	-
	GLONASS	L1	●	●	●	●	●	●
		L2	-	-	-	-	-	-
	Galileo	E1	●	●	●	●	●	●
		E5a	●	●	●	●	●	●
		E5b	-	-	-	-	-	-
	BDS	B1I	●	●	●	●	●	●
		B2a	●	●	●	●	●	●

Features			LC29H (AA)	LC29H (BA)	LC29H (CA)	LC29H (DA)	LC29H (EA)*	LC29H (BS)
		B2I	-	-	-	-	-	-
	QZSS	L1 C/A	●	●	●	●	●	●
		L5	●	●	●	●	●	●
		L2C	-	-	-	-	-	-
	NavIC	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 *documents [1] and [2] protocol specifications*.

1.3. Performance

Table 3: Product Performance

Parameter	Specification	LC29H (AA)	LC29H (BA)	LC29H (CA)	LC29H (DA)	LC29H (EA)*	LC29H (BS)
Power Consumption [3] (GPS + GLONASS + Galileo + BDS + QZSS)	Acquisition	24 mA	30 mA	28 mA	25 mA	25 mA	24 mA
	Tracking	24 mA	30 mA	28 mA	25 mA	25 mA	24 mA
	Backup Mode	25 µA	25 µA	25 µA	20 µA	20 µA	25 µA
Sensitivity (GPS + GLONASS + Galileo + BDS + QZSS)	Acquisition	-147 dBm	-145 dBm	-145 dBm	-145 dBm	-145 dBm	-147 dBm
	Reacquisition	-159 dBm	-157 dBm	-157 dBm	-157 dBm	-157 dBm	-159 dBm
	Tracking	-165 dBm	-165 dBm	-165 dBm	-165 dBm	-165 dBm	-165 dBm
TTFF (without AGNSS) [3]	Full Cold Start	26 s	26 s	26 s	26 s	26 s	-
	Warm Start	16 s	16 s	16 s	16 s	16 s	-
	Hot Start	1 s	1 s	1 s	1 s	1 s	-
TTFF (with EASY) [4]	Full Cold Start	16 s	-	-	-	-	-
	Warm Start	2 s	-	-	-	-	-
	Hot Start	1 s	-	-	-	-	-

[3] Room temperature, all satellites at -130 dBm.
[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)*.

Parameter	Specification	LC29H (AA)	LC29H (BA)	LC29H (CA)	LC29H (DA)	LC29H (EA)*	LC29H (BS)
TTFF (with EPO) [4]	Full Cold Start	5 s	5 s	5 s	5 s	5 s	-
	Warm Start	3 s	3 s	3 s	3 s	3 s	-
	Hot Start	1 s	1 s	1 s	1 s	1 s	-
Horizontal Position Accuracy		Autonomous [5]: 1 m	Autonomous [5]: 1 m RTK [6]: < 0.1 m + 1 ppm	Autonomous [5]: 1 m	Autonomous [5]: 1 m RTK [6]: 1 cm + 1 ppm	Autonomous [5]: 1 m RTK [6]: 1 cm + 1 ppm	-
Convergence Time		-	RTK [6]: < 10 s	-	RTK [6]: < 10 s	RTK [6]: < 10 s	-
Update Rate		PVT: 1–10 Hz GNSS Raw Data: 1 Hz	PVT: 1 Hz/10 Hz GNSS Raw Data: 1 Hz IMU Raw Data: 100 Hz (Max.)*	PVT: 1 Hz/10 Hz GNSS Raw Data: 1 Hz IMU Raw Data: 100 Hz (Max.)*	PVT: 1 Hz (RTK) GNSS Raw Data: 1 Hz	PVT: 1–10 Hz (RTK) GNSS Raw Data: 10 Hz	PVT: 1 Hz GNSS Raw Data: 1Hz
Velocity Accuracy [3]		0.03 m/s	0.03 m/s	0.03 m/s	0.03 m/s	0.03 m/s	-
Accuracy of 1PPS Signal [3]		Typ. 20 ns					
Dynamic Performance [3]		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 modules is presented below. It includes a front-end section with an additional LNA, DIP and notch circuit, a TCXO and an XTAL, a 6-axis IMU (supported only by LC29H (BA) and LC29H (CA)), a GNSS IC with a PMU. The diplexer integrates two band-pass filters, which can improve the out-of-band rejection.

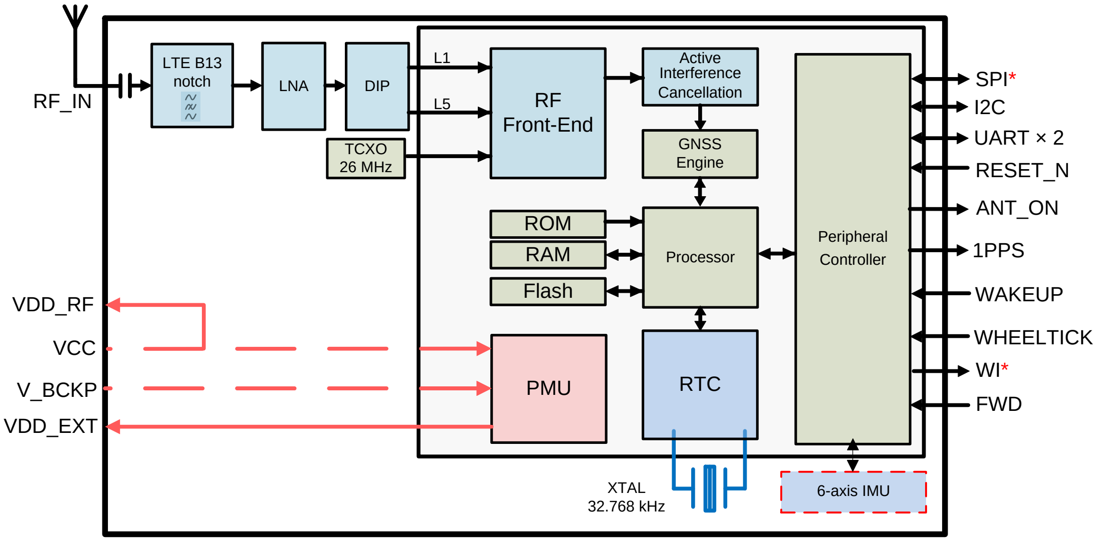


Figure 1: Block Diagram

NOTE

1. FWD, WHEELTICK and WI* are supported by LC29H (BA) and LC29H (CA).
2. SPI* is only used for communication. The pins of SPI are multiplexed with I2C and UART1 pins, and thus cannot be used simultaneously with I2C and UART1.

1.5. GNSS Constellations

The modules are a dual-band GNSS receiver that can receive and track concurrently multiple GNSS constellations. Owing to its RF front-end architecture, it can concurrently track the following GNSS constellations: GPS, GLONASS, Galileo, BDS and QZSS plus SBAS satellites. If low power consumption is a key factor, 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 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	Signals
GPS	L1 C/A: 1575.42 MHz L5: 1176.45 MHz
GLONASS	L1: 1602 MHz + K × 562.5 kHz K = (-7 to +6, integer)
Galileo	E1: 1575.42 MHz E5a: 1176.45 MHz
BDS	B1I: 1561.098 MHz B2a: 1176.45 MHz
QZSS	L1 C/A: 1575.42 MHz L5: 1176.45 MHz

1.6. Augmentation System

1.6.1. SBAS

The LC29H (AA) 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 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 and rough position. For more information, see *document [3] AGNSS application note*.

1.7.1. EASY

The LC29H (AA) and LC29H (BS) support the EASY technology to improve TTFF by providing ancillary information, such as the ephemeris and almanac.

The EASY technology works as an embedded software to accelerate TTFF by predicting satellite navigation messages from the received ephemeris. After receiving the broadcast ephemeris for the first time, the GNSS engine automatically calculates and predicts the orbit information up to 3 subsequent 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 of LC29H (AA) 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, in strong-signal environments the GNSS module should keep tracking the information for at least 5 minutes after fixing the position.

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

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 [3] 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.

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

1.9. RTK

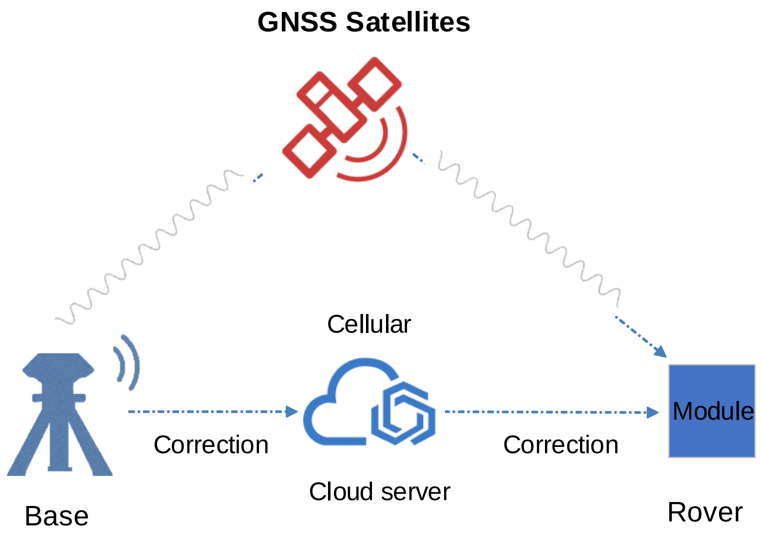


Figure 2: RTK Operation Process

1.9.1. RTK Rover

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 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. The expected accuracy at RTK fixed mode is lower than 20 cm.

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 [4] 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) 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. For more information, see *document [4] 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 [5] firmware upgrade guide*.

2 Pin Assignment

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

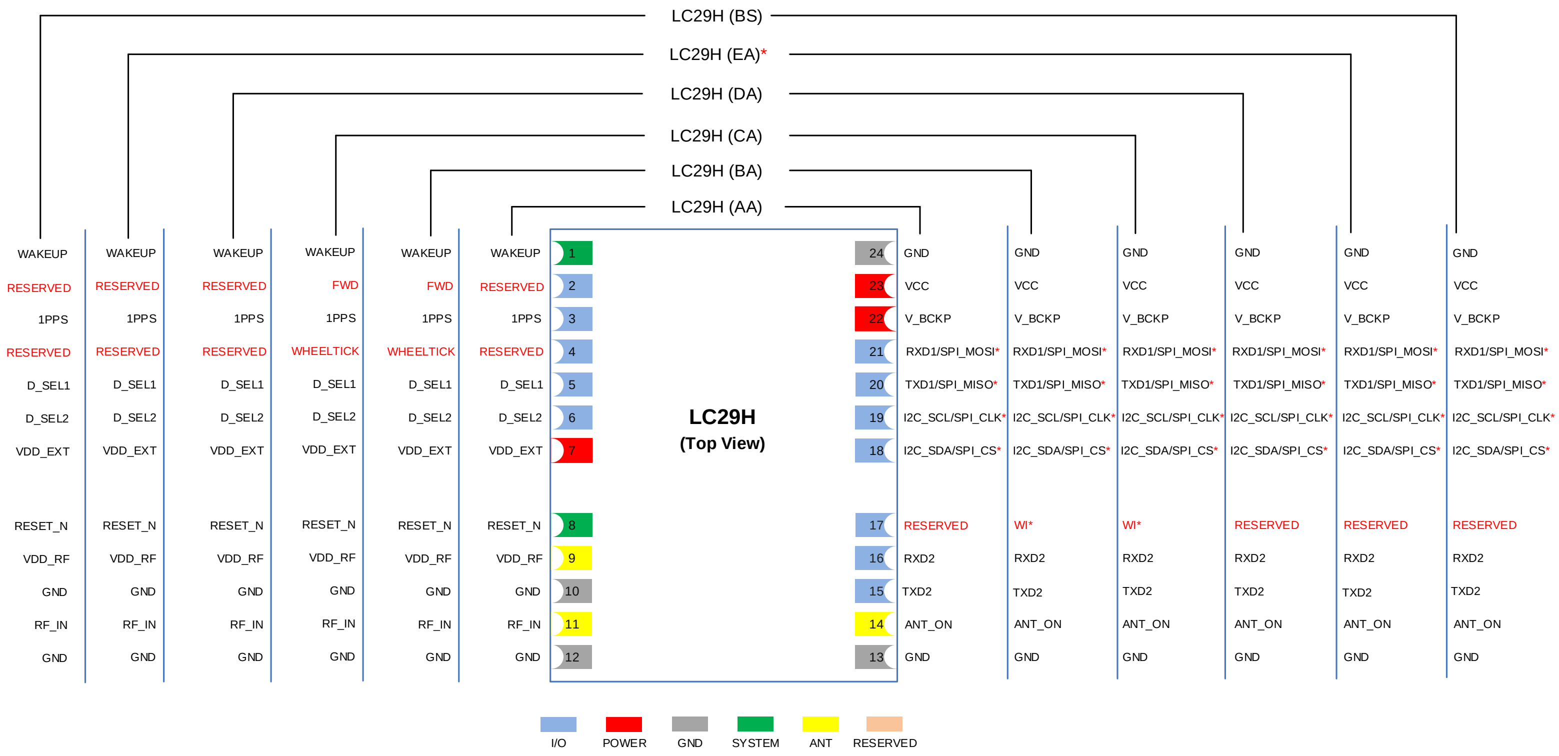


Figure 3: Pin Assignment

Table 5: 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 6: Pin Description

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.
I/O	D_SEL1	5	DI	Selects UART1/SPI*/I2C	D_SEL1 and D_SEL2 can be used for selecting the interface for communication and downloading. 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 interfaces are used for standard NMEA message output, RTCM message input [8]/output, binary data input/output, PAIR/PQTM message
	D_SEL2	6	DI		
	TXD1/SPI_MISO*	20	DO	UART1 Transmits data/ SPI master in, slave out	
	RXD1/SPI_MOSI*	21	DI	UART1 Receives data/ SPI master out, slave in	
	I2C_SDA/SPI_CS*	18	DIO	I2C serial data/ SPI chip-select	
	I2C_SCL/SPI_CLK*	19	DI	I2C serial clock/ SPI clock	

[8] Only supported by LC29H (BA), LC29H (DA) and LC29H (EA)*.

Function	Name	No.	I/O	Description	Remarks
					input/output and firmware upgrade. SPI* is used for standard NMEA message output, RTCM message input [8]/output, binary data input/output and PAIR/PQTM message input/output.
	TXD2	15	DO	UART2 Transmits data	UART2 is used for outputting system debugging data. Its I/O voltage domain is 1.8 V.
	RXD2	16	DI	UART2 Receives data	
	FWD	2	DI	Forward/Backward status signal input	The pins are reserved on LC29H (AA), LC29H (DA), LC29H (EA)* and LC29H (BS). 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.
	WI*	17	DO	Warning Indicator	The pin is reserved on LC29H (AA), LC29H (DA), LC29H (EA)* and LC29H (BS). VCC must be valid to ensure the output of interrupt signal.
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.

Function	Name	No.	I/O	Description	Remarks
					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, 17	-	Reserved	For LC29H (BA) and LC29H (CA), these pins are FWD, WHEELTICK and WI* respectively. For other variants, these pins are RESERVED. They must be left floating 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 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 modules’ internal power supply is shown below:

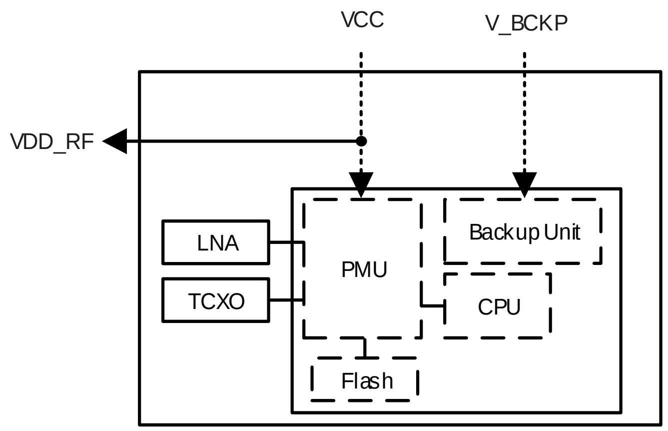


Figure 4: Internal Power Supply

3.2. Power Supply

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.

3.2.1. VCC

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

For low-power applications using power saving 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.

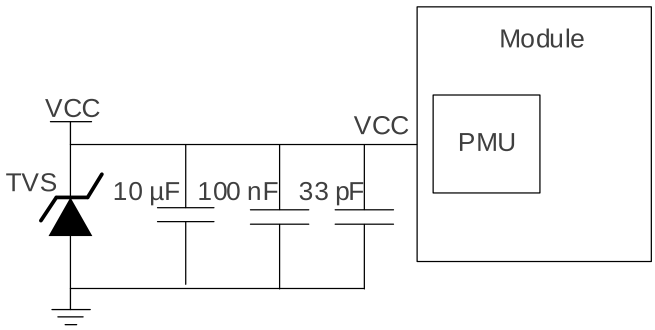


Figure 5: VCC Input Reference Circuit

NOTE

It is recommended to control the VCC of the modules via MCU to save power, or restart the modules if the modules 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.

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.

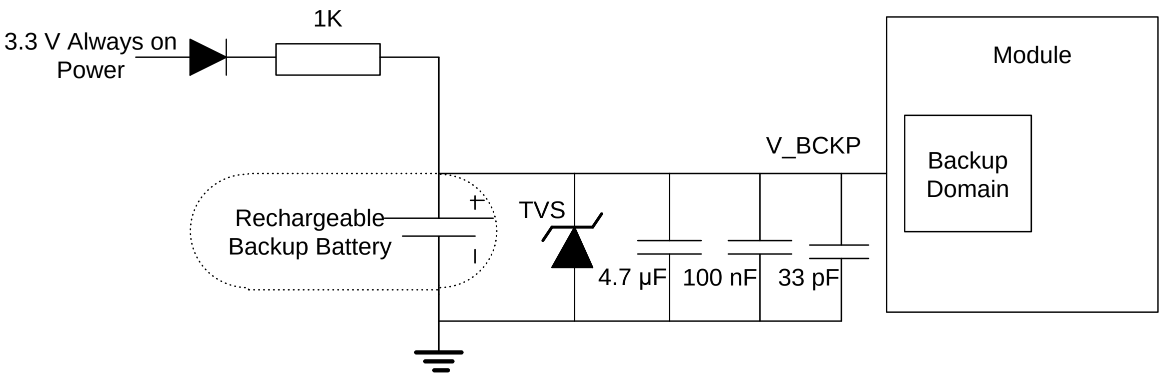


Figure 6: Reference Charging Circuit with Rechargeable Backup Battery

V_BCKP can also be powered by a 3.7 V lithium battery, as shown in the figure below. It is recommended to use MCU to control the enable pin of LDO. It is recommended to place a TVS and a combination of a 4.7 μF, a 100 nF and a 33 pF capacitor near the V_BCKP pin.

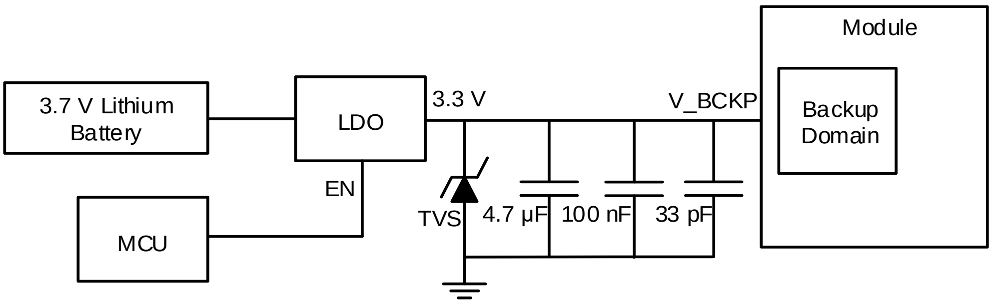


Figure 7: Reference Charging Circuit with 3.7 V Lithium Battery

NOTE

1. If V_BCKP is below the minimum value of the recommended operating voltage, the modules cannot work normally.
2. 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 rechargeable battery. And it is recommended to use a 1 kΩ resistor.
4. 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 V_BCKP and VCC are powered on, the modules automatically enters the Continuous mode that comprises acquisition mode and tracking mode. In acquisition mode, the modules start 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 modules automatically switches to tracking mode. In tracking mode, the modules track 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 **$PAIR650** to shut down internal main power supply in sequence.
  2. Cut off the power supply to the VCC pin and keep the V_BCKP pin powered.

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

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

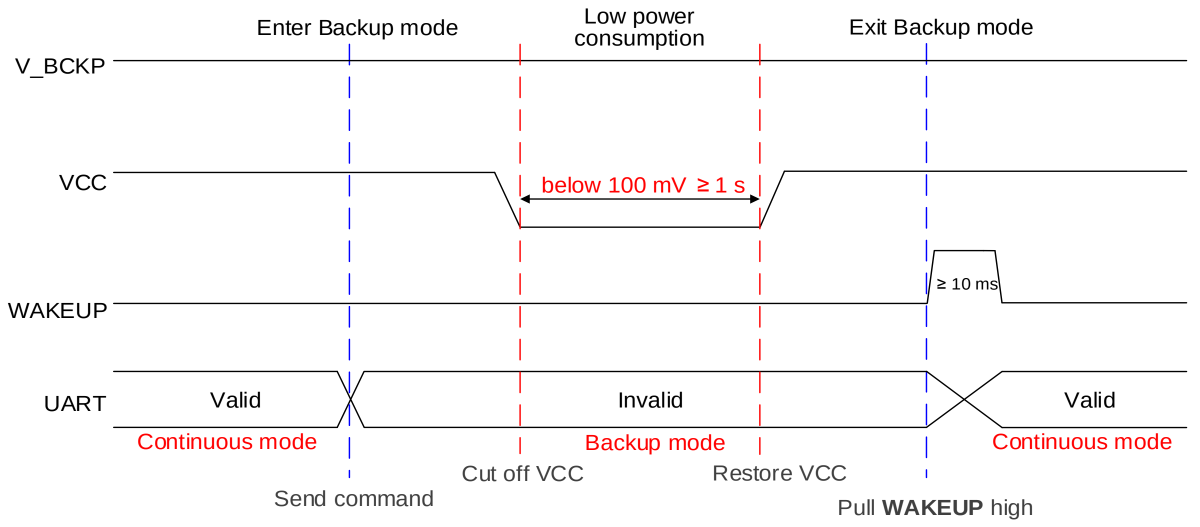


Figure 8: Enter/Exit Backup Mode Sequence

NOTE

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

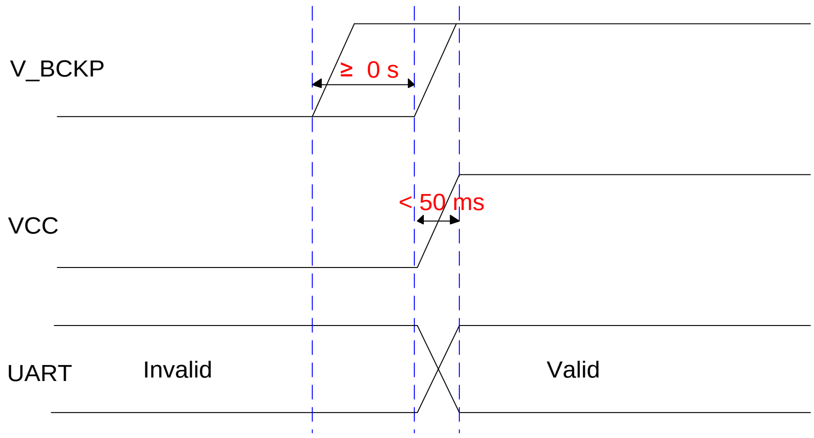


Figure 9: Power-up Sequence

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.

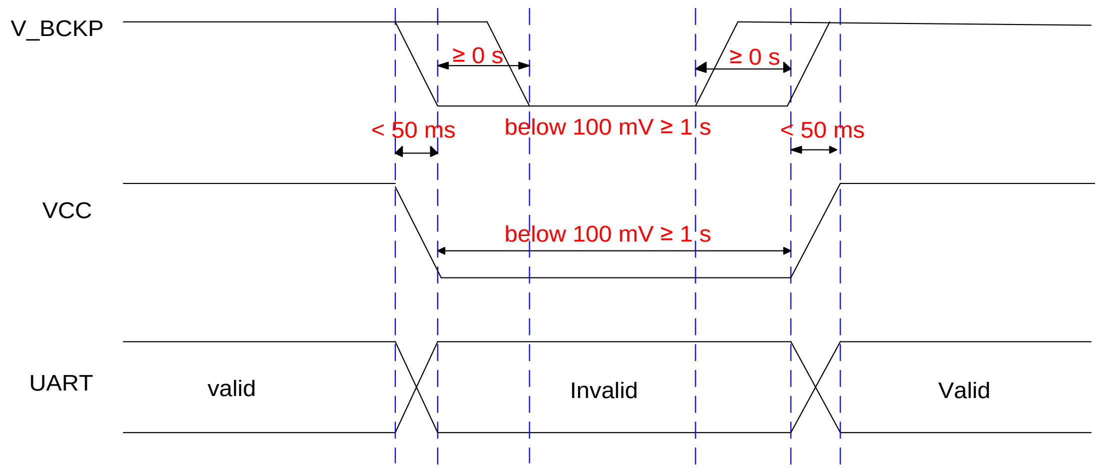


Figure 10: Power-down and Power-on Restart Sequence

4 Application Interfaces

4.1. 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 downloading. See *document [6] reference design* for the reference circuit of interface selection.

Table 8: Interface Selection by D_SEL1 & D_SEL2

Interface Selection	UART1	SPI*	I2C
D_SEL1 = 0 & D_SEL2 = 0 (Default)	Can be used for communication and downloading	-	Can only be used for communication
D_SEL1 = 0 & D_SEL2 = 1	-	-	-
D_SEL1 = 1 & D_SEL2 = 0	-	Can be used for communication	-
D_SEL1 = 1 & D_SEL2 = 1	Can only be used for communication	-	Can be used for communication and downloading

NOTE

D_SEL1 and D-SEL2 can be used for switching the interface for communication and downloading. The I/O voltage domain of D_SEL1 and D_SEL2 is 1.8 V.

4.1.1.2. UART1 Interface

The modules have one UART interface with the following features:

- Supports standard NMEA message output, RTCM message input [9]/output, binary data input/output, PAIR/PQTM command input/output, and firmware upgrade.
- Supported baud rates: 9600, 14400, 19200, 38400, 57600, 115200, 230400, 460800, 921600 and 3000000 bps.
- Hardware flow control and synchronous operation are not supported.

A reference design is shown in the figure below. For more information, see *document [6] reference design*.

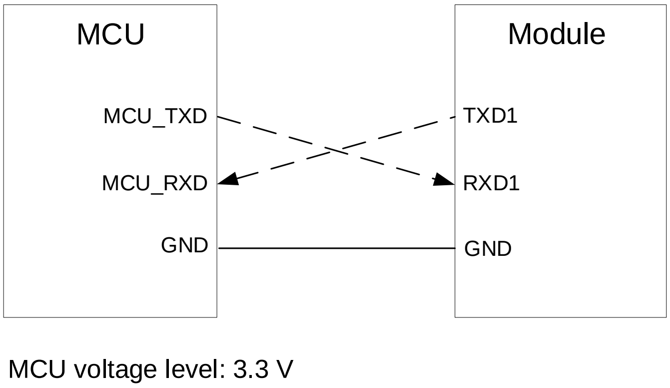


Figure 11: UART1 Interface Reference Design

NOTE

1. UART1 interface default settings vary depending on software version. See the relevant software versions for details.
2. If the I/O voltage of MCU is not matched with module, a level-shifting circuit must be selected.

4.1.1.3. UART2 Interface

The modules have one UART2 interface with the following features:

- Supports system debugging data output.
- Supported baud rates: 9600, 14400, 19200, 38400, 57600, 115200, 230400, 460800, 921600 and 3000000 bps.
- Hardware flow control and synchronous operation are not supported.

[9] Only supported by LC29H (BA), LC29H (DA) and LC29H (EA)*.

NOTE

1. The default baud rate of the UART2 interface is 3000000 bps.
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 have one I2C interface with the following features:

- Supports standard NMEA message output, RTCM message input [9]/output, binary data input/output and PAIR/PQTM message input/output.
- Operates in slave mode.
- Supports 7-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 [6] reference design*.

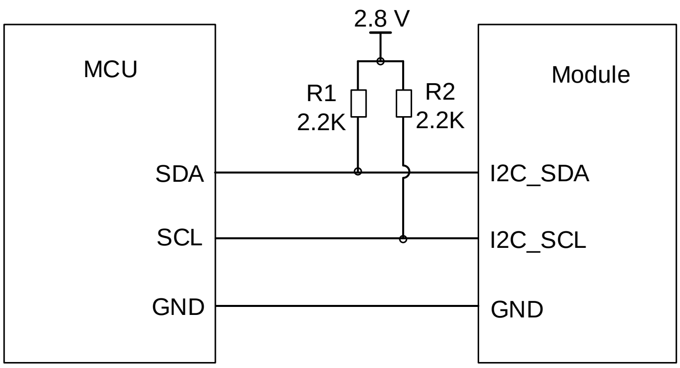


Figure 12: I2C Interface Reference Design

NOTE

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 have one SPI with the following features:

- Supports standard NMEA message output, RTCM message input [9]/output, binary data input/output, PAIR/PQTM message input/output.
- Operates in slave mode.
- Supports full duplex SPI (four-wire).
- Maximum clock frequency: 48 MHz.

A reference design is shown in the figure below. For more information, see *document [6] reference design*.

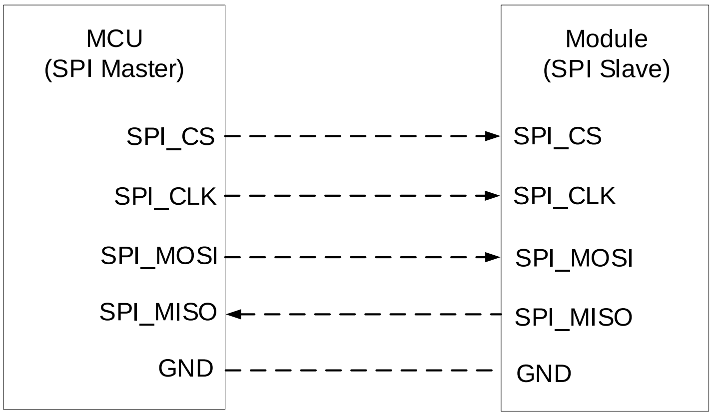


Figure 13: SPI Reference Design

NOTE

1. 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.
2. 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) and LC29H (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

Only 4-wheel vehicles need to be connected to the FWD pin, it is not required for 2-wheelers.

4.1.3. WHEELTICK

The WHEELTICK pin (only supported by LC29H (BA) and LC29H (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 diagram, see *document [6] reference design*.

4.1.4. 1PPS

The 1PPS can be used for time pulse signals, it generates a one pulse per second periodic signal, synchronized to GNSS time grid with intervals. Pulse accuracy is better than 20 ns. Maintaining high accuracy of 1PPS requires visible satellites in an open sky environment and keeping the VCC powered.

4.1.5. WI*

WI (only supported by LC29H (BA) and LC29H (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 MCU 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.

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

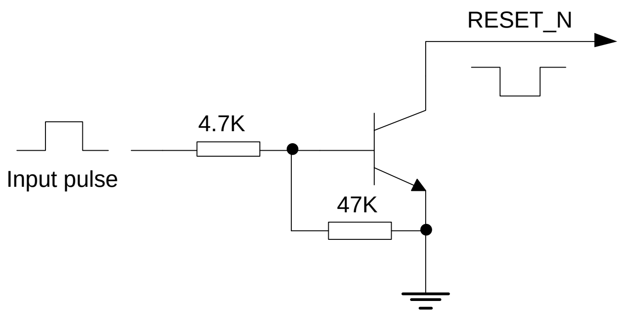


Figure 14: Reference OC Circuit for Module Reset

The following figure shows the reset sequence of the modules.

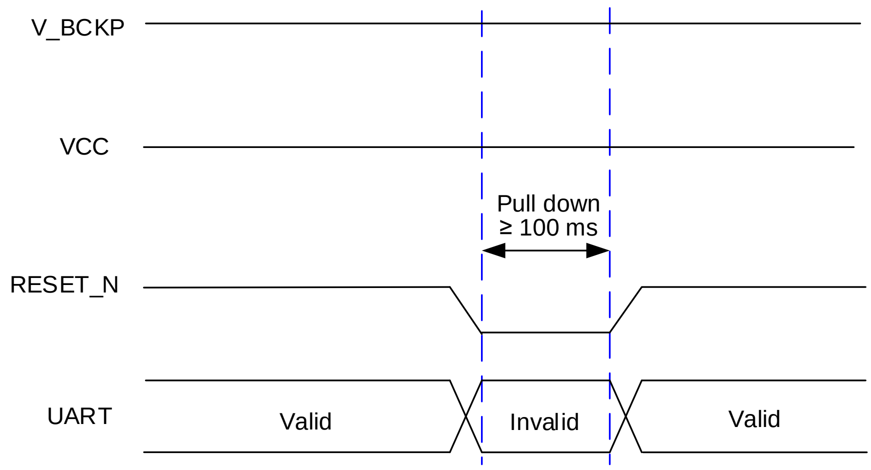


Figure 15: Reset Sequence

NOTE

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

5 Design

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

5.1. Antenna Selection

5.1.1. Antenna Specifications

The modules 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 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
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 Phase Center Offset: < 20 mm [10] Phase Center Variation: < 20 mm [10] Axial Ratio: < 3 dB [10] -3 dB Beam width: > 90° [10]

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

NOTE

1. For recommended antenna selection and design, see *document [7] GNSS antenna selection guidance* or contact Quectel Technical Support.
2. The total antenna gain equals the internal LNA gain minus the total insertion loss of cables and components inside the antenna.

5.1.2. Antenna Selection Guide

Both active and passive dual-band (L1 + L5) 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, see *document [8] RF layout application note*.

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

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

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

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

"F" is the noise factor of receiver system:

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

"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.

5.2. Antenna Reference Design

In a complex electromagnetic environment, it is recommended to add a band-pass filter circuit to the antenna design to further reduce the impact of out-of-band signals on the GNSS module, which has stable suppression effect on all out-of-band signals. The recommended SAW in the band-pass filter is B39162B2651P810 from RF360. In the actual layout, the circuit should be placed close to RF_IN pin. Band-pass filter circuit can 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. When selecting the active antenna, it is recommended to choose one of which the SAW filter is placed in front of the LNA in the internal framework. That can be used to further reduce the impact of out-of-band signals on the GNSS module when there is a complex electromagnetic environment around the modules. The minimum operating voltage of selected active antenna needs to meet the circuit design characteristics.

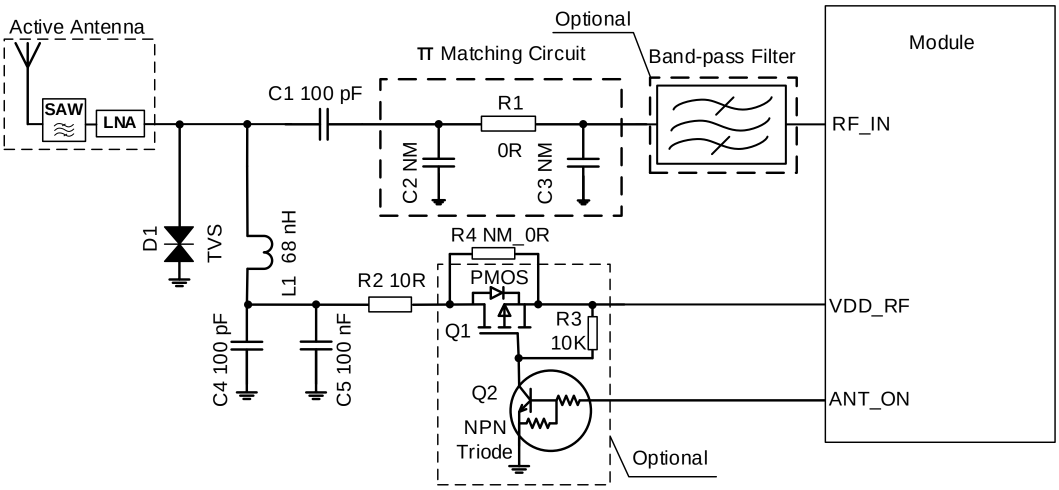


Figure 16: Active Antenna Reference Design

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, and 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 modules 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.

5.2.2. Passive Antenna Reference Design

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

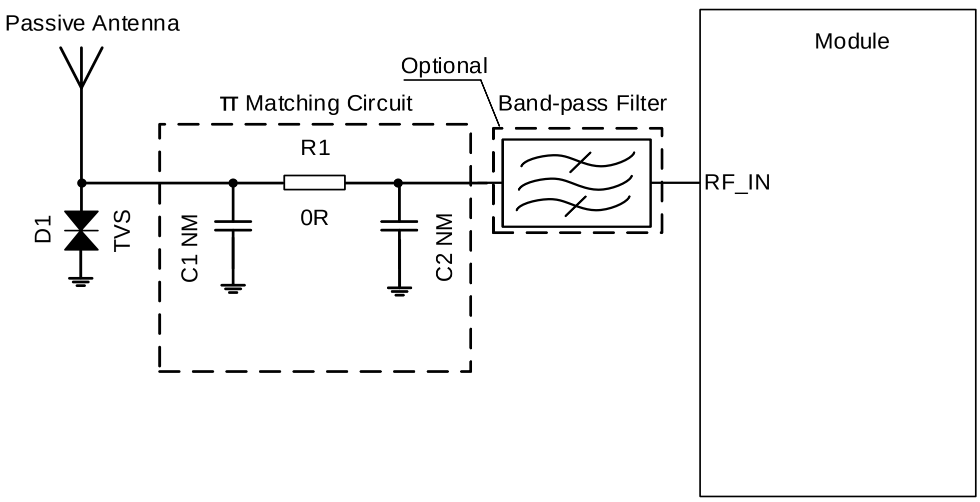


Figure 17: Passive Antenna Reference Design

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.

5.3. Coexistence with Cellular Systems

Since GNSS signals are usually very weak, a GNSS receiver could be vulnerable to environmental interference. According to 3GPP specifications, a cellular terminal should transmit a signal of up to 33 dBm at GSM bands, or of about 24 dBm at WCDMA and LTE bands or 26 dBm at 5G bands. Therefore, coexistence with cellular systems must be optimized to avoid significant deterioration of the GNSS performance.

In a complex communication environment, interference signals can come from in-band and out-of-band signals. Therefore, interference can be divided into two types: in-band interference and out-of-band interference, which are both described in this chapter.

In this chapter, you can also find suggestions for decreasing the impact of interference signals that will ensure the interference immunity of a GNSS receiver.

5.3.1. In-band Interference

In-band interference refers to the signal whose frequency is within or near the operating frequency range of a GNSS signal.

See the following figure for more details.

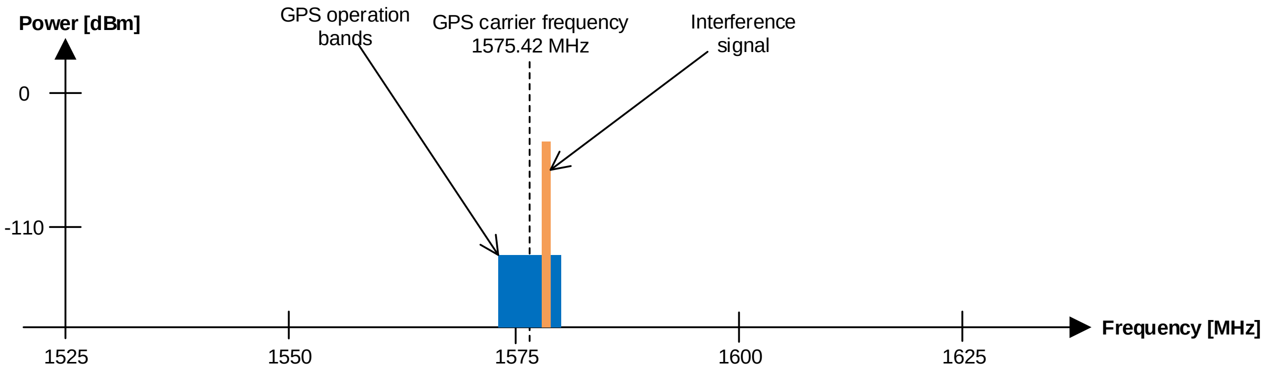


Figure 18: In-band Interference on GPS L1

The most common in-band interferences usually come from:

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

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

Table 10: Intermodulation Distortion (IMD) Products

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

5.3.2. Out-of-band Interference

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

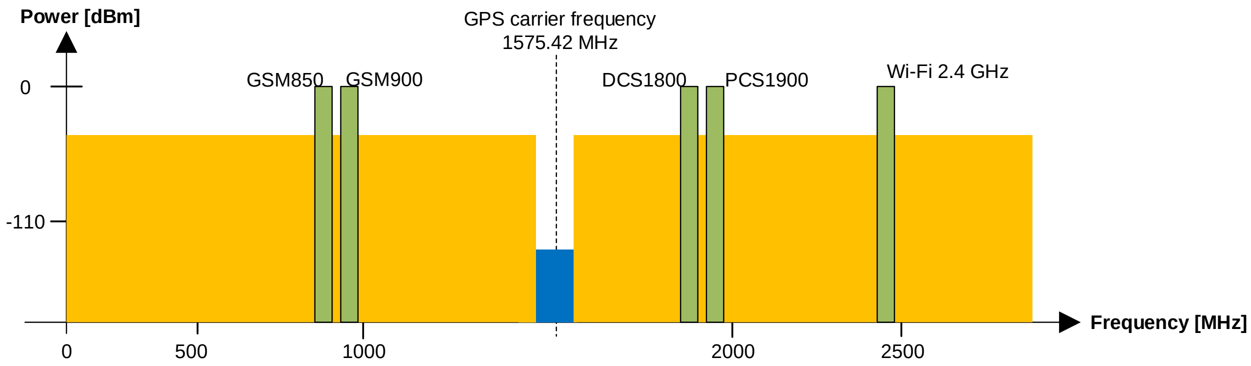


Figure 19: Out-of-band Interference on GPS L1

5.3.3. Ensuring Interference Immunity

There are several things you can do to decrease the impact of interference signals and thus ensure the interference immunity of a GNSS receiver:

- Keep the GNSS antenna away from interference sources;
- Add a band-pass filter in front of the GNSS module;
- Use shielding and multi-layer PCB and ensure adequate grounding;
- Optimize layout and component placement of the PCB and the whole device.

The following figure illustrates the interference source and 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.

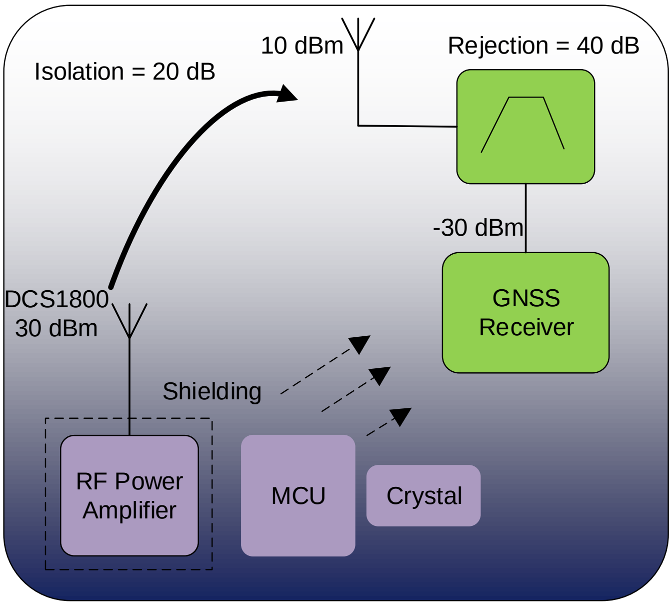


Figure 20: Interference Source and Its Path

5.4. Recommended Footprint

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

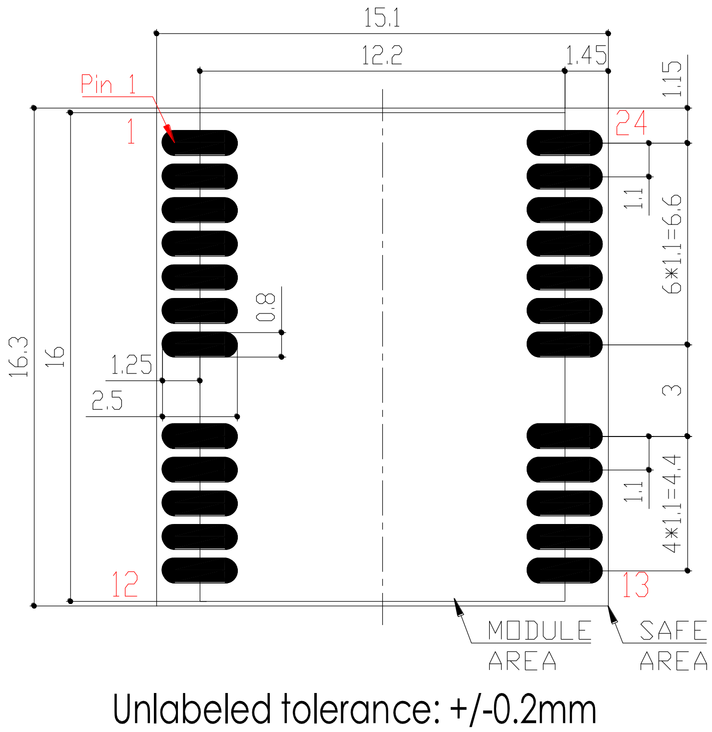


Figure 21: Recommended Footprint

NOTE

Maintain at least 3 mm keepout between the 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 11: 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 12: 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 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, test time and conditions.

Table 13: Supply Current for LC29H (AA), LC29H (BA) and LC29H (CA)

Parameter	Description	Condition	LC29H (AA)		LC29H (BA)		LC29H (CA)	
			$I_{Typ.}$ [11]	I_{PEAK} [11]	$I_{Typ.}$ [11]	I_{PEAK} [11]	$I_{Typ.}$ [11]	I_{PEAK} [11]
I_{VCC} [12]	Current at VCC	Acquisition	24 mA	61 mA	30 mA	54 mA	28 mA	54 mA
		Tracking	24 mA	65 mA	30 mA	54 mA	28 mA	54 mA
I_{V_BCKP} [13]	Current at V_BCKP	Continuous mode	93 μA	134 μA	74 μA	113 μA	74 μA	113 μA
		Backup mode	25 μA	61 μA	25 μA	60 μA	25 μA	60 μA

Table 14: Supply Current for LC29H (DA), LC29H (EA)* and LC29H (BS)

Parameter	Description	Condition	LC29H (DA)		LC29H (EA)*		LC29H (BS)	
			$I_{Typ.}$ [11]	I_{PEAK} [11]	$I_{Typ.}$ [11]	I_{PEAK} [11]	$I_{Typ.}$ [11]	I_{PEAK} [11]
I_{VCC} [12]	Current at VCC	Acquisition	25 mA	68 mA	25 mA	68 mA	24 mA	38 mA
		Tracking	25 mA	68 mA	25 mA	68 mA	24 mA	39 mA
I_{V_BCKP} [13]	Current at V_BCKP	Continuous mode	74 μA	113 μA	74 μA	113 μA	75 μA	138 μA
		Backup mode	25 μA	51 μA	25 μA	51 μA	25 μA	55 μA

[11] Room temperature, measurements are taken with typical voltage.
[12] Used to determine maximum current capability of power supply.
[13] Used to determine required battery current capability.

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

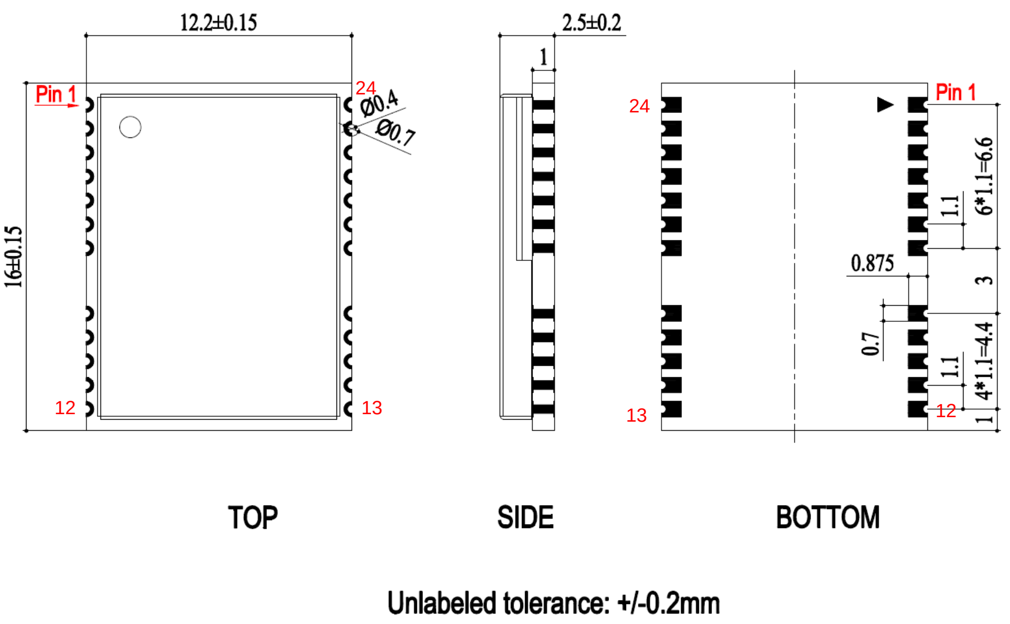


Figure 22: Top, Side and Bottom View Dimensions

NOTE

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

7.2. Top and Bottom Views

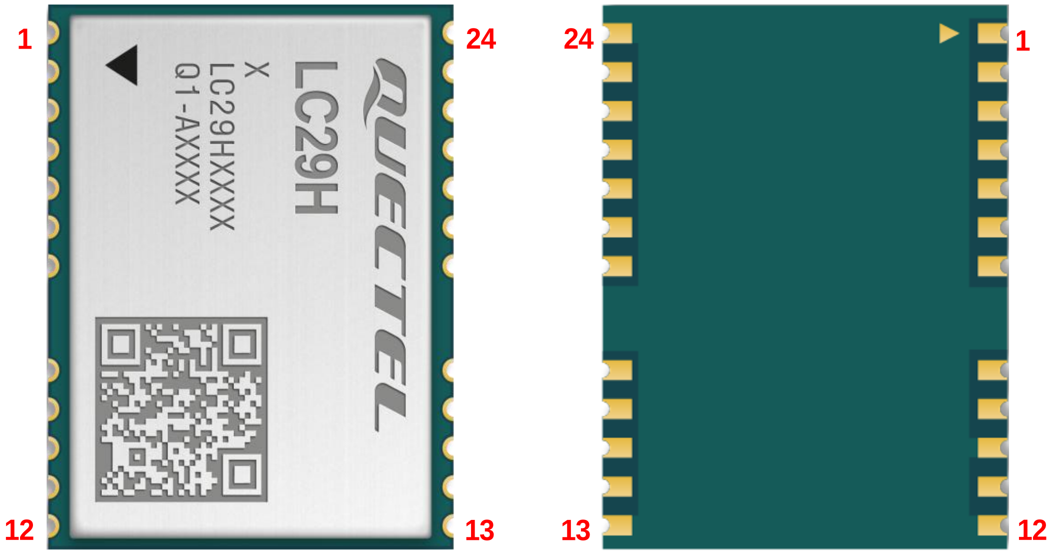


Figure 23: Top and Bottom Module Views

NOTE

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

8 Product Handling

8.1. Packaging

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

The modules are packed with carrier tape packaging and the details are as follows.

8.1.1. Carrier Tape

Carrier tape dimensions are detailed below:

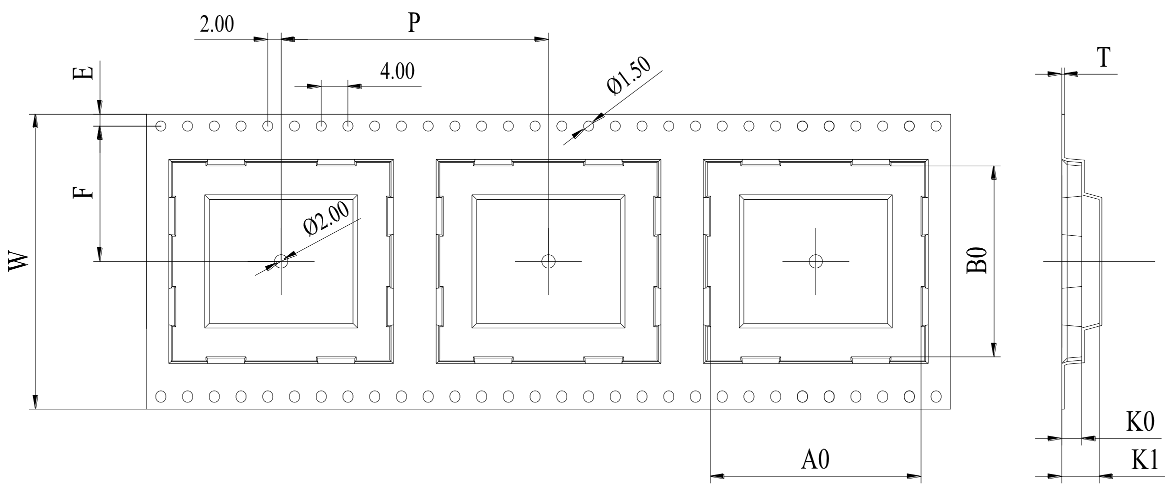


Figure 24: Carrier Tape Dimension Drawing

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

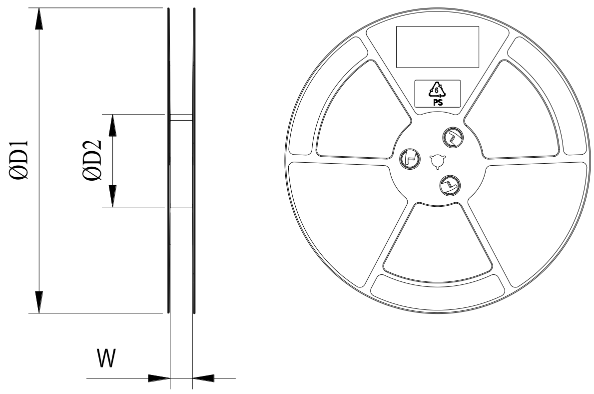


Figure 25: Plastic Reel Dimension Drawing

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

øD1	øD2	W
330	100	32.5

8.1.3. Mounting Direction

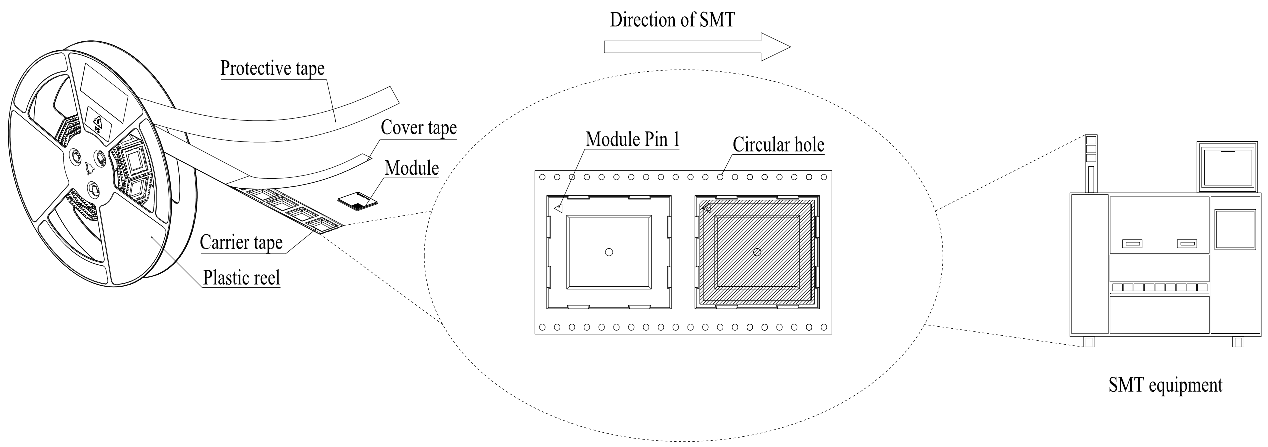
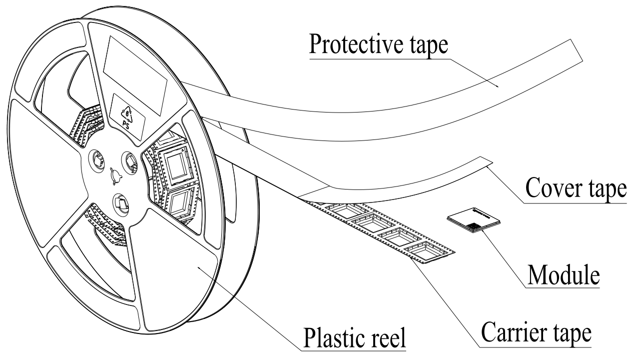


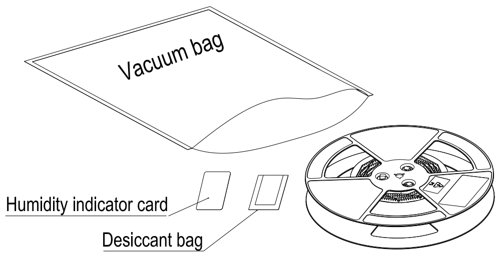
Figure 26: Plastic Reel Dimension Drawing

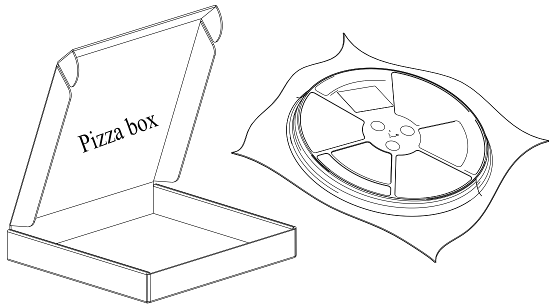
8.1.4. Packaging Process



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

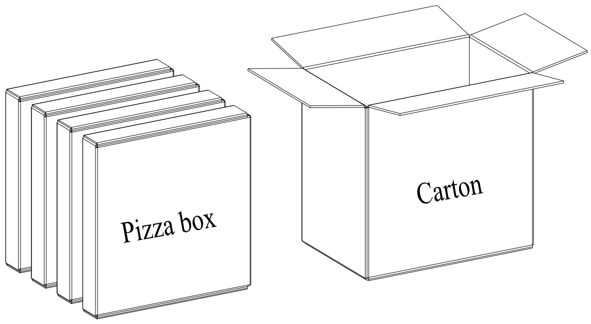
Place the packed plastic reel, humidity indicator card and desiccant bag inside a vacuum bag, then vacuumize it.





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.



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

Figure 27: 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 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 [14] 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 under Recommended Storage Condition;
   - Violation of the third requirement above;
   - Vacuum-sealed packaging is broken, or the packaging has been removed for over 24 hours;
   - Before module repairing.

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

   - The modules should be baked for 8 hours at 120 ±5 °C;
   - The modules must be soldered to the PCB within 24 hours of 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 the modules 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 modules.

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

8.3. Manufacturing and Soldering

Push the squeegee to apply solder paste on the surface of stencil, thus making the paste fill the stencil openings and then penetrate the PCB. Apply proper force on the squeegee to produce a clean stencil surface on a single pass. For more information about the stencil thickness of the modules, see *document [9] 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 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.

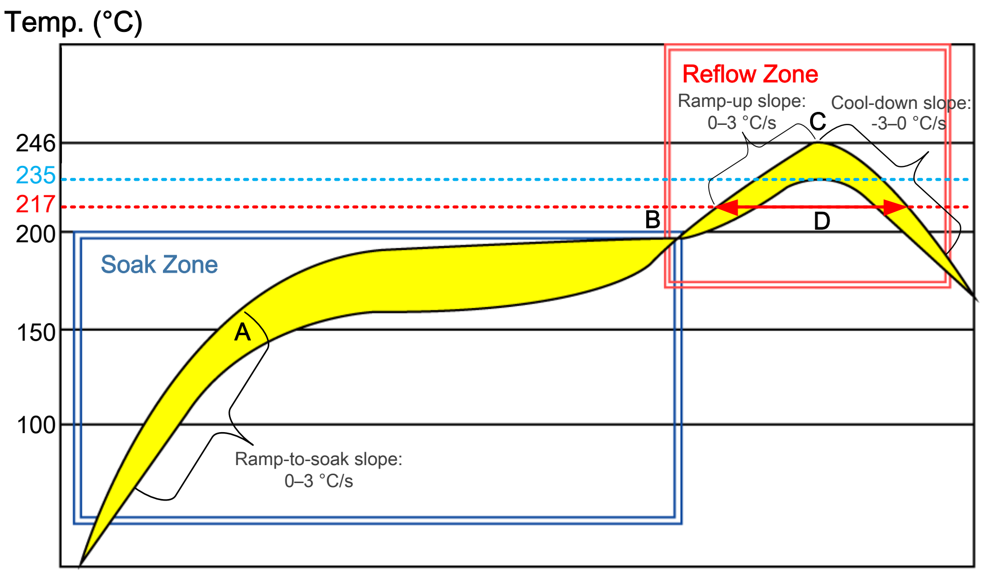


Figure 28: Recommended Reflow Soldering Thermal Profile

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
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 modules 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. 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 [9] 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.

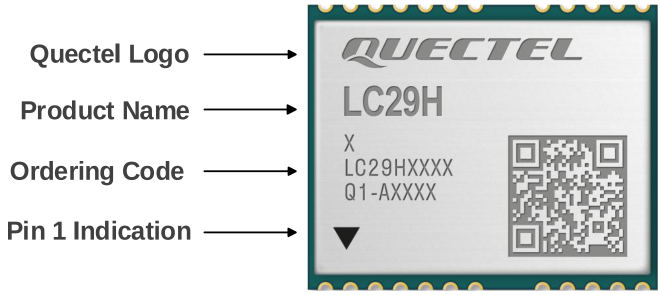


Figure 29: Labelling Information

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

10 Appendix References

Table 18: Related Documents

Document Name	
[1]	Quectel_LC29H&LC79H_Series_GNSS_Protocol_Specification
[2]	Quectel_LC29H(BS)_GNSS_Protocol_Specification
[3]	Quectel_L89_R2.0&LC29H&LC79H_AGNSS_Application_Note
[4]	Quectel_LC29H(BA,CA,DA)_DR&RTK_Application_Note
[5]	Quectel_L89_R2.0&LC29H&LC79H_Series_Firmware_Upgrade_Guide
[6]	Quectel_LC29H_Series_Reference_Design
[7]	Quectel_GNSS_Antenna_Selection_Guidance
[8]	Quectel_RF_Layout_Application_Note
[9]	Quectel_Module_SMT_Application_Note

Table 19: 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

Abbreviation	Description
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

Abbreviation	Description
MSAS	Multi-functional Satellite Augmentation System (Japan)
MSL	Moisture Sensitivity Levels
NF	Noise Figure
NMEA	NMEA (National Marine Electronics Association) 0183 Interface Standard
NTRIP	Networked Transport of RTCM via Internet Protocol
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

Abbreviation	Description
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
WI	Warning Indicator
XTAL	External Crystal Oscillator