L89 R2.0
Hardware Design

GNSS Module Series

Version: 1.4

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Status: Released

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Safety Information

The following safety precautions must be observed during all phases of operation, such as usage, service, or repair of any terminal or mobile incorporating the module. Manufacturers of the terminal should notify users and operating personnel of the following safety information by incorporating these guidelines into all product manuals. Otherwise, Quectel assumes no liability for customers' failure to comply with these precautions.

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

About the Document

Document Information	
Title	**L89 R2.0 Hardware Design**
Subtitle	GNSS Module Series
Document Type	Hardware Design
Document Status	Released

Revision History

Version	Date	Description
-	2020-04-29	Creation of the document
1.0	2021-01-04	First official release
1.1	2022-01-14	1. Numerous changes were made to this document; it should be read in its entirety. 2. Added chapters of Features, GNSS Constellations, Augmentation System, AGNSS, Firmware Upgrade, Feature Comparison, Power-Up Sequence, Power-Down Sequence, and WAKEUP. 3. Deleted chapters of Supported Protocols, Evaluation Board, and PQTMANTENNASTATUS Sentence. 4. Updated pin 7 and pin 14 to WAKEUP and GEOFENCE, as well as their descriptions; changed the name of pin 11 from ANT_GNSS to EX_ANT; updated descriptions of pin 4 (VCC), pin 8 (AADET_N), pin 15 (I2C_SCL), and pin 16 (I2C_SDA). 5. Updated product performance data and relevant notes; updated chapters of LOCUS™, Geofencing, and Multi-tone AIC (Chapter 1.3, 1.8, 1.9 & 1.10). 6. Updated chapters of power unit and power supply; replaced the chapter of Full-on Mode with Continuous Mode; updated the chapter of Backup Mode (Chapter 3). 7. Updated descriptions of UART interface, I2C interface*, 3D_FIX,

Version	Date	Description
		GEOFENCE, and 1PPS; updated the chapter of RESET_N (Chapter 4). 8. Updated note to the recommendation footprint; updated the chapter of External Active Antenna Reference Design; added details of coexistence with cellular systems (Chapter 5.1, 5.3.3 & 5.4). 9. Updated absolute maximum ratings, recommended operating conditions, and ESD protection information (Chapter 6). 10. Updated dimensional tolerances to ±0.20 mm; updated the top and bottom views of the module (Chapter 7). 11. Updated information of packaging, storage, and manufacturing and soldering (Chapter 8). 12. Added labelling information (Chapter 9). 13. Updated the appendix and added corresponding hyperlinks to documents [1], [2], and [3] (Chapter 10).
1.2	2022-09-09	1. Incorporated the information of L89 (HB) into this document. 2. Added TTFF (with flash EPO) (Table 2). 3. Added software commands for EASY, EPO, multi-tone AIC and entering the Backup mode (Chapter 1.7, 1.9 & 3.3.3). 4. Added supply current requirement (Chapter 7.3). 5. Updated the max slope of reflow zone and added a note on module shielding can (Chapter 9.3).
1.3	2023-05-12	1. Deleted the information related to LOCUS. 2. Added the number of concurrent GNSS (*Table 2*). 3. Added the power data of power consumption and updated the accuracy of 1PPS signal (*Table 3*). 4. Added a software command to output the geofence status (*Chapter 1.8*). *5.* Added the DC characteristics of pins (6. *Table 6*). 7. Added the reference design of 3.7 V lithium battery (*Figure 8*). 8. Updated the undervoltage protection threshold and the voltage range of V_BCKP when the module powers off automatically for undervoltage protection (*Chapter 4.2*). 9. Updated the recommended footprint (*Figure 32*). 10. Updated the maximum input power for EX_ANT (*Table 11*). 11. Updated the recommended operating conditions (*Table 12*). 12. Added the module mounting direction (*Chapter 9.1.3*). 13. Updated the recommended ramp-to-soak, ramp-up and cool-down slopes (*Figure 42* and *Table 17*).
1.4	2024-11-08	1. Added the applicable module L89 (HD). 2. Deleted L89 (HB) according to Quectel's product marketing strategies. 3. Updated the module height of L89 (HA) (*Chapter 1.1*, *Table 2* and *Figure 34*). 4. Updated the dimensional tolerances of L89 (HA) (*Table 2* and *Figure 34*).

Version	Date	Description
		5. Updated the test condition for module power consumption when using an external antenna, sensitivity, accuracy of 1PPS, velocity accuracy, acceleration accuracy and dynamic performance, and added the module power consumption when using internal antennas (*Chapters 1.3* and *7.3*). 6. Deleted the 3σ accuracy of 1PPS signal (*Table 3*). 7. Deleted the information on EASY and added the information on EPOC (*Chapter 1.7.1*). 8. Deleted the rechargeable battery circuit of V_BCKP pin for L89 (HA) (*Chapter 3.2.2*). 9. Updated supported UART baud rates (*Chapter 5.1.1.1*). 10. Added the out-of-band rejection for active antenna (*Table 10*). 11. Moved Coexistence with Cellular Systems to Quectel_GNSS_Antenna_Application_Note. 12. Added the note on the measured supply current values (*Chapter 7.3*). 13. Updated the module coplanarity requirement (*Chapter 8.1*). 14. Updated manufacturing and soldering related information (*Chapter 9.3*): ● Updated the reference document for recommended module stencil thickness; ● Added the note specifying that mercury-containing materials should be avoided for module processing; ● Added the note prohibiting storage or use of unprotected modules in environments containing corrosive gases.

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1 Product Description

1.1. Overview

Quectel L89 R2.0 module supports multiple global positioning and navigation systems: GPS, GLONASS, Galileo, BDS, QZSS and NavIC. The module also supports SBAS (including WAAS, EGNOS, MSAS and GAGAN) and AGNSS functions. The L89 R2.0 module comprises two variants: L89 (HA) and L89 (HD).

Key features:

- L89 R2.0 is a dual-band, multi-constellation GNSS module that features a high-performance, high-reliability positioning engine. It facilitates fast and precise GNSS positioning.
- Supports serial communication interfaces: UART and I2C.
- Compared to L89 (HA) module, L89 (HD) module has an extra protection system with a programmable watchdog timer, which provides power-on delay, undervoltage protection and automatic reset features. In addition, L89 (HD) also supports a 6-axis IMU.
- The integrated flash memory provides the capacity for storing user-specific configurations and future firmware upgrades.

The L89 R2.0 is an SMD type module with a compact form factor of 26.4 mm × 18.4 mm × 7.4 mm. L89 (HA) has 45 pins (16 LCC pins and 29 LGA pins), while L89 (HD) has 49 pins (20 LCC pins and 29 LGA pins).

The module is fully compliant with the EU RoHS Directive.

1.1.1. Special Mark

Table 1: Special Mark

Mark	Definition
●	A function or technology is supported by the module(s).

NOTE

For conciseness purpose, L89 (HA) and L89 (HD) variants will hereinafter be referred to collectively as "L89 R2.0/the module/modules" in parts hereof applicable to both modules, and individually as "L89 (HA) and "L89 (HD)" in parts hereof referring to the differences between them.

1.2. Features

Table 2: Product Features

Features		L89 (HA)	L89 (HD)
Grade	Industrial	●	●
	Automotive	-	-
Category	Standard Precision GNSS	●	●
	High Precision GNSS	-	-
	DR	-	●
	RTK	-	-
	Timing	-	-
VCC Voltage	3.1–4.3 V, typ. 3.3 V	●	●
V_BCKP Voltage	2.2–4.3 V, typ. 3.3 V	●	●
I/O Voltage	Typ. 3.0 V	●	●
Communication Interfaces	UART	●	●
	SPI	-	-
	I2C	●	●
Integrated Features	Additional LNA	●	●
	Additional Filter	●	●
	RTC Crystal	●	●
	TCXO Oscillator	●	●

Features			L89 (HA)	L89 (HD)
	6-axis IMU		-	●
Constellations and Frequency Bands	Number of Concurrent GNSS		3 + QZSS	3 + QZSS
	GPS	L1 C/A	●	●
		L5	-	-
	GLONASS	L1	●	●
	Galileo	E1	●	●
		E5a	-	-
	BDS	B1I	●	●
		B2a	-	-
	QZSS	L1 C/A	●	●
		L5	-	-
	NavIC	L5	●	●
	SBAS	L1	●	●
Temperature Range	Operating temperature range: -40 °C to +85 °C Storage temperature range: -40 °C to +90 °C			
Physical Characteristics	Size: (26.4 ±0.25) mm × (18.4 ±0.2) mm × (7.4 ±0.4) mm Weight: Approx. 8.2 g			

NOTE

For more information about GNSS constellation configurations, see *documents [1]* and *[2] protocol specifications*.

1.3. Performance

Table 3: Product Performance [1]

Parameter	Specification		L89 (HA)	L89 (HD)
Power Consumption [2] (Using External Antenna)	GPS + Galileo + QZSS + NavIC	Acquisition	32 mA (105.6 mW)	36 mA (118.8 mW)
		Tracking	32 mA (105.6 mW)	36 mA (118.8 mW)
		Backup mode	51 μA (168.3 μW)	51 μA (168.3 μW)
	NavIC	Acquisition	25 mA (82.5 mW)	28 mA (92.4 mW)
		Tracking	25 mA (82.5 mW)	28 mA (92.4 mW)
		Backup mode	51 μA (168.3 μW)	51 μA (168.3 μW)
Power Consumption [3] (Using Internal Antennas)	GPS + Galileo + QZSS + NavIC	Acquisition	44 mA (145.2 mW)	48 mA (158.4 mW)
		Tracking	44 mA (145.2 mW)	48 mA (158.4 mW)
		Backup mode	51 μA (168.3 μW)	51 μA (168.3 μW)
	NavIC	Acquisition	40 mA (132 mW)	44 mA (145.2 mW)
		Tracking	40 mA (132 mW)	44 mA (145.2 mW)
		Backup mode	51 μA (168.3 μW)	51 μA (168.3 μW)
Sensitivity [2]	GPS + Galileo + GLONASS + BDS + QZSS + NavIC	Acquisition	-148 dBm	
		Reacquisition	-157 dBm	
		Tracking	-165 dBm	
	NavIC	Acquisition	-144 dBm	

[1] If not mentioned otherwise, measurements are taken with VCC = 3.3 V.
[2] Tested at room temperature, with typical operating voltage, and satellite signal of -130 dBm configured by the instrument. In this case, the power consumption refers exclusively to that of the module, excluding the external antenna.
[3] Tested at room temperature, with typical operating voltage and the internal antennas. When internal antennas are used, the additional LNA within the module starts to function. The number of satellites may vary by regions, and the data provided is for reference only.

Parameter	Specification	L89 (HA)	L89 (HD)
	Reacquisition	-152 dBm	
	Tracking	-161 dBm	
TTFF [4] (Without AGNSS)	Cold Start	28 s	
	Warm Start	23 s	
	Hot Start	1 s	
TTFF [4] (with EPOC [5])	Cold Start	15 s	
	Warm Start	5 s	
	Hot Start	1 s	
TTFF [4] (with Flash EPO)	Cold Start	3 s	
Horizontal Position Accuracy [6]		1.8 m	
Update Rate		1 Hz (Default); Max. 10 Hz	
Accuracy of 1PPS Signal [2]	RMS	7 ns	
Velocity Accuracy [2]	Without Aid	0.1 m/s	
Acceleration Accuracy [2]	Without Aid	0.1 m/s²	
Dynamic Performance [2]	Maximum Altitude	10000 m	
	Maximum Velocity	500 m/s	
	Maximum Acceleration	4g	

1.4. Block Diagram

Block diagrams of the L89 R2.0 module are presented below. Both diagrams include a GNSS IC, two additional LNAs, two additional SAW filters, a diplexer, two SPDT switches, a TCXO and an XTAL. In addition, L89 (HD) includes a notch circuit, a UVLO and a WDT for VCC, a UVLO for V_BCKP and a 6-axis IMU. The diplexer integrates two band-pass filters, which can improve the out-of-band rejection.

[4] Open-sky, active high-precision GNSS antenna.
[5] The EPOC feature is under development for L89 (HA).
[6] CEP, 50 %, 24 hours static, -130 dBm, more than 6 SVs.

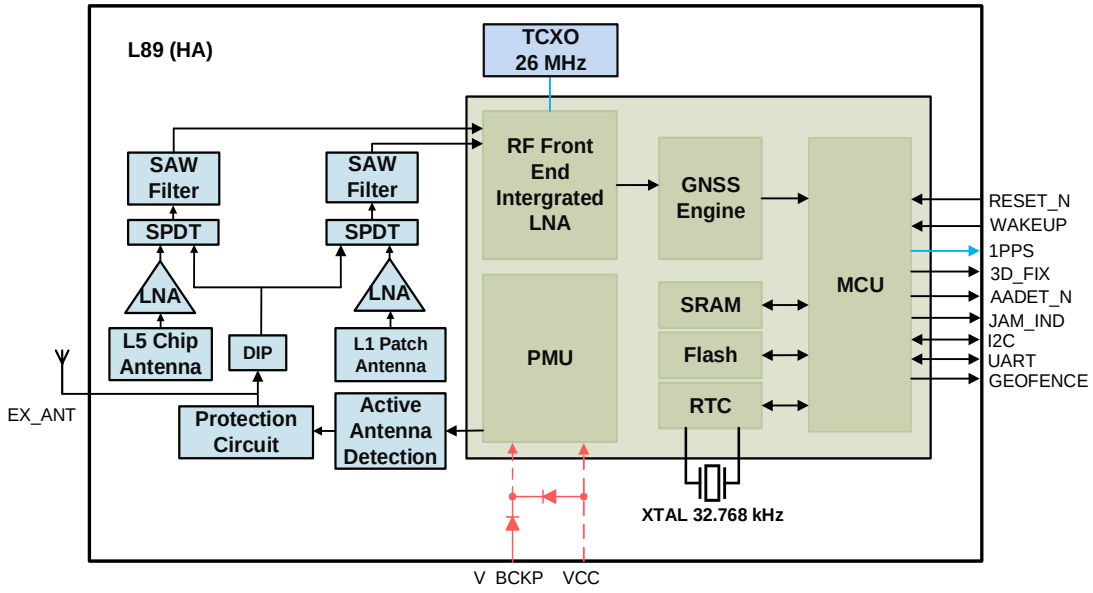


Figure 1: L89 (HA) Block Diagram

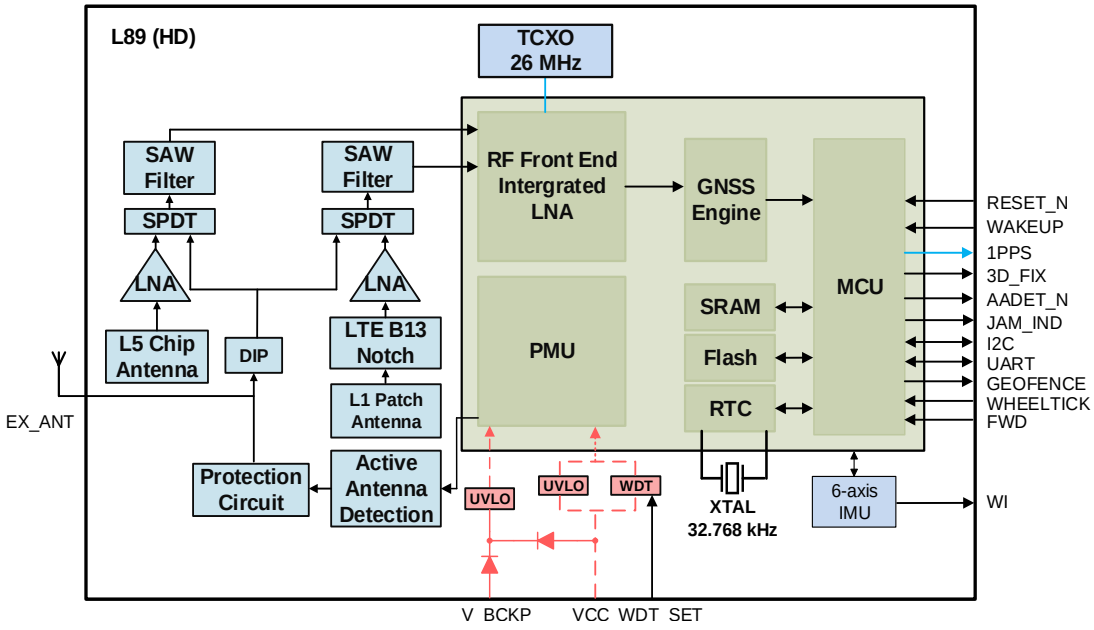


Figure 2: L89 (HD) Block Diagram

1.5. GNSS Constellations

The module is a dual-band concurrent GNSS receiver that can receive and track multiple GNSS systems. Due to the RF front-end architecture, it can track the following GNSS constellations: GPS, GLONASS,

Galileo, BDS, QZSS and NavIC, plus SBAS satellites. If low power consumption is a key factor, then the module 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 module can detect and track QZSS L1 C/A signal concurrently with GPS signals, leading to better availability especially under challenging conditions, e.g., in urban canyons.

NavIC is a regional satellite navigation system that transmits additional L5 signal for complying with the requirements of an independent accurate positioning system for users in India.

Table 4: GNSS Constellations and Frequency Bands

System	Signal
GPS	L1 C/A: 1575.42 MHz
GLONASS	L1: 1602 MHz + K × 562.5 kHz, K = (-7 to +6, integer)
Galileo	E1: 1575.42 MHz
BDS	B1I: 1561.098 MHz
QZSS	L1 C/A: 1575.42 MHz
NavIC	L5: 1176.45 MHz

1.6. Augmentation System

1.6.1. SBAS

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

1.7. AGNSS

The module supports AGNSS feature that significantly reduces the module's TTFF, especially under lower signal conditions. To implement the AGNSS feature, the module should get the assistance data

including the current time and rough position. For more information, see *document [3] AGNSS application note*.

1.7.1. EPOC

The module supports the EPOC [7] technology. EPOC is an internal module application designed to improve the TTFF performance by predicting GNSS constellation orbits using the received broadcast 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 [3] AGNSS application note*.

1.7.2. EPO

The module features 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. Geofencing

The module supports geofence areas, defined on the Earth's surface using a 2D model. Geofencing is active when at least one geofence area is defined. The current status can be found by polling the receiver. The receiver evaluates whether the current location of each area is within that area or not and signals its status via the GEOFENCE pin or **PQTMGEOFENCESTATUS**.

The evaluation is activated whenever one or more geofences are configured. For more information about geofencing configuration, see *document [2] protocol specification*.

1.9. Multi-tone AIC

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

[7] The EPOC feature is under development for L89 (HA).

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.

1.10. 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 [4] firmware upgrade guide*.

2 Pin Assignment

L89 (HA) module is equipped with 16 LCC pins and 29 LGA pins and L89 (HD) has four additional LCC pins by which the modules can be mounted on your PCB.

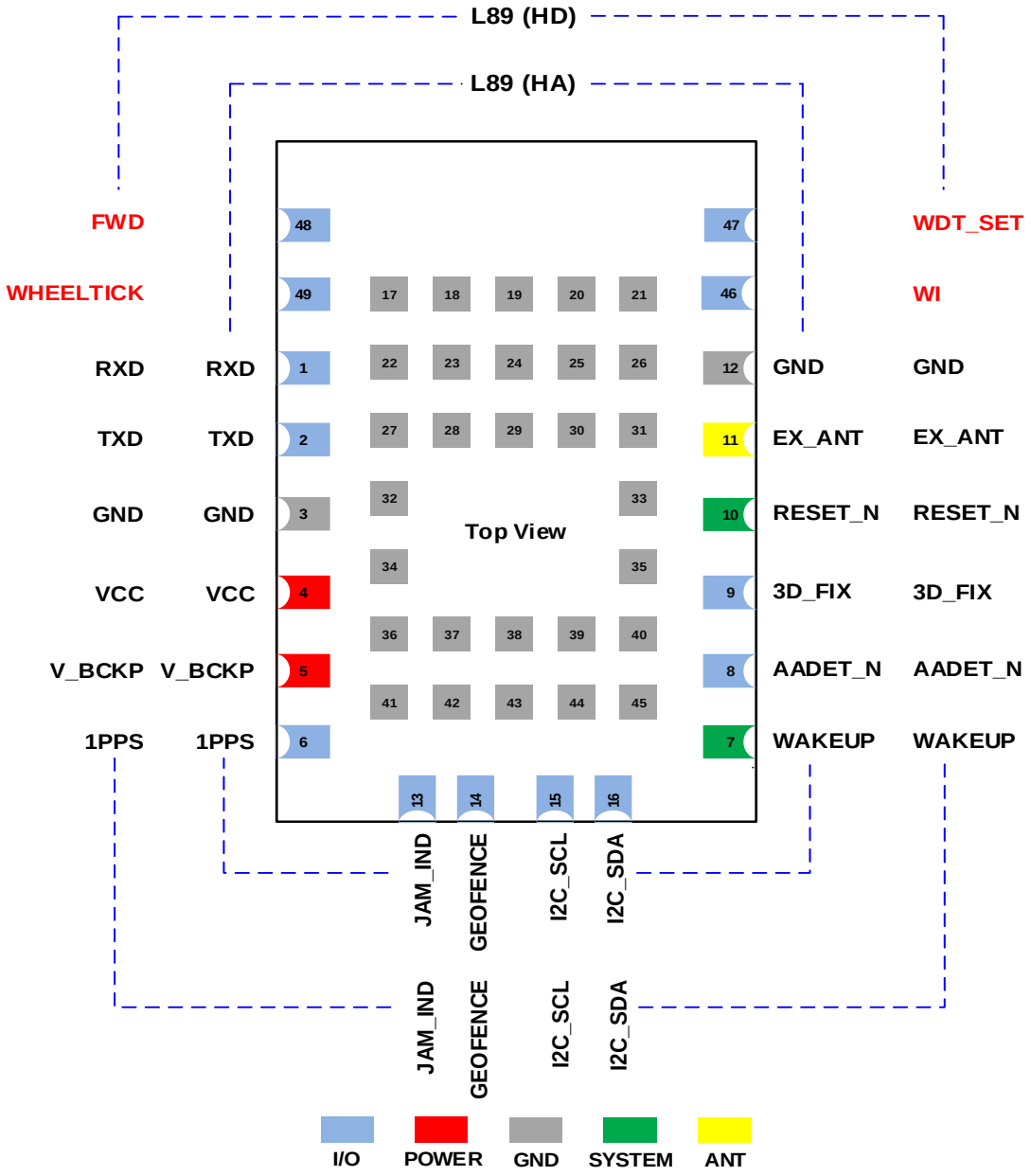


Figure 3: Pin Assignment

Table 5: Parameter Definition

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

Table 6: Pin Description

Function	Name	No.	I/O	Description	DC Characteristics	Remarks
Power	VCC	4	PI	Main power supply	$V_I$min = 3.1 V $V_I$nom = 3.3 V $V_I$max = 4.3 V	Requires clean and steady voltage. Ensure the current capability of the power supply is at least 100 mA.
	V_BCKP	5	PI	Backup power supply for backup domain	$V_I$min = 2.2 V $V_I$nom = 3.3 V $V_I$max = 4.3 V	V_BCKP must be connected to power supply for startup, and it should be always powered if hot (warm) start is needed.
I/O	TXD	2	DO	Transmits data	V_{OL}max = 0.375 V V_{OH}min = 2.25 V	The UART interface supports standard NMEA message, PAIR/PQTM messages, and binary data, as well as firmware upgrade.
	RXD	1	DI	Receives data	V_{IL}min = -0.3 V V_{IL}max = 0.75 V V_{IH}min = 1.875 V V_{IH}max = 3.08 V	
	I2C_SDA	16	DIO	I2C serial data	V_{IL}min = -0.3 V V_{IL}max = 0.75V V_{IH}min = 1.875 V V_{IH}max = 3.08 V V_{OL}max = 0.375 V V_{OH}min = 2.25 V	The I2C interface supports standard NMEA message, PAIR/PQTM messages, and binary data.
	I2C_SCL	15	DI	I2C serial clock	V_{IL}min = -0.3 V V_{IL}max = 0.75 V V_{IH}min = 1.875 V V_{IH}max = 3.08 V	

Function	Name	No.	I/O	Description	DC Characteristics	Remarks
	3D_FIX	9	DO	3D position fix indication		If unused, leave the pin N/C (not connected).
	AADET_N	8	DO	Active antenna open circuit status indication		If unused, leave the pin N/C.
	GEOFENCE	14	DO	Indicates geofence status	V_{OL}max = 0.375 V V_{OH}min = 2.25 V	Once the pin is enabled, the receiver continuously compares its current position to the preset geofence area(s). If unused, leave the pin N/C.
	JAM_IND	13	DO	Jamming indication		If unused, leave the pin N/C.
	1PPS	6	DO	One pulse per second		Synchronized on the rising edge. If unused, leave the pin N/C.
	WI	46	DO	Warning indicator		This pin is only supported by L89 (HD). VCC must be valid to ensure the output of interrupt signal.
	WDT_SET	47	DI	Disables watchdog	V_{IL}min = -0.3 V V_{IL}max = 0.75 V V_{IH}min = 1.875 V V_{IH}max = 3.08 V	This pin is only supported by L89 (HD). Pulling it down disables the watchdog, thereby turning off the automatic reset function. If unused, leave the pin N/C.
	FWD	48	DI	Forward/Backward status signal input		These pins are only supported by L89 (HD). If unused, leave the pin N/C.
	WHEELTICK	49	DI	Odometer/Wheel-tick pulse input		
ANT	EX_ANT	11	AI	External active antenna interface	$V_O$max = 3.0 V	50 Ω characteristic impedance. It supplies power for external active antenna.
System	RESET_N	10	DI	Resets the module	V_{IL}min = -0.3 V V_{IL}max = 0.1 V V_{IH}min = 1.8 V V_{IH}nom = 3.3 V V_{IH}max = 4.3 V	Active low.
	WAKEUP	7	DI	Wakes up the module from	V_{IL}min = -0.3 V V_{IL}max = 0.75 V	Pulled down internally. Keep the pin low when the

Function	Name	No.	I/O	Description	DC Characteristics	Remarks
				Backup mode	V_{IH}min = 3.0 V V_{IH}nom = 3.3 V V_{IH}max = 4.3 V	module is in the Continuous mode and the Backup mode. To exit the Backup mode, drive the pin high for at least 10 ms. If unused, leave the pin N/C.
GND	GND	3, 12, 17–45	-	Ground	-	Ensure a good GND connection to all module GND pins, preferably with a large ground plane.

3 Power Management

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

3.1. Power Unit

VCC is the supply voltage pin of the module. 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, which includes RTC and SRAM. 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 SRAM that contains all the necessary GNSS data and some of the user configuration variables.

The module's internal power supply is shown below.

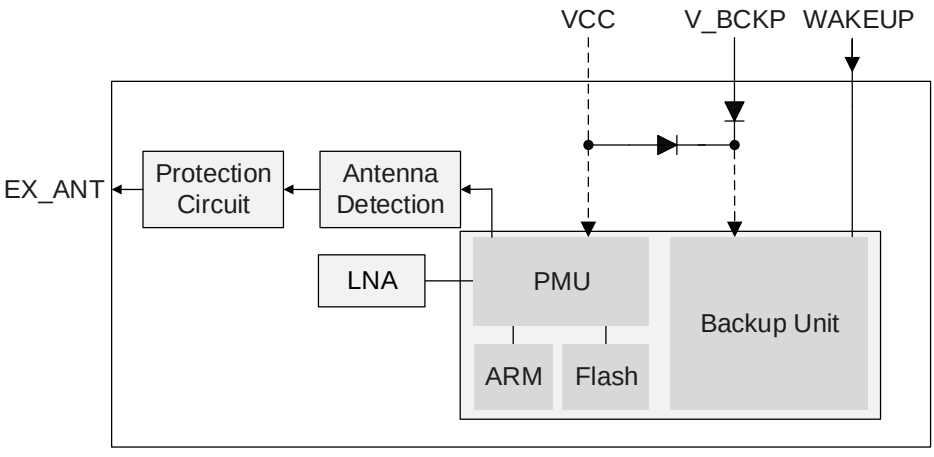


Figure 4: L89 (HA) Internal Power Supply

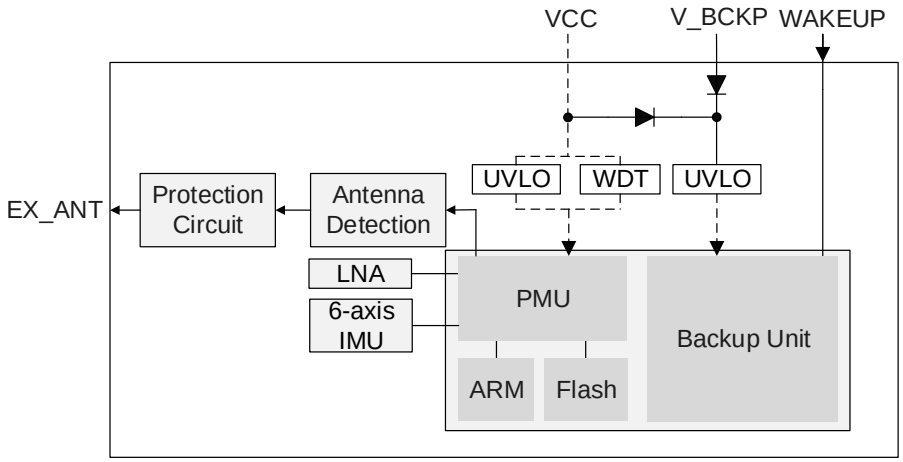


Figure 5: L89 (HD) Internal Power Supply

3.2. Power Supply

3.2.1. VCC

The VCC is the supply voltage pin that supplies BB, RF and 6-axis IMU (only supported by L89 (HD)).

Module power consumption may vary by several orders of magnitude, especially when power saving mode is enabled. Therefore, it is important for the power supply to be able to sustain peak power for a short time, ensuring that the load current does not exceed the rated value. When the module starts 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, it is important for the LDO at the power supply or module input to be able to provide the sufficient current when the module is switched from Backup mode to Continuous mode. An LDO with a high PSRR should be chosen for optimum performance. In addition, a TVS, and a combination of a 10 µF, a 100 nF, and a 33 pF decoupling capacitor should be added near the VCC pin. The minimum value capacitor should be the closest to the VCC pin.

Instead of a switching DC-DC converter, it is recommended to use a low-noise LDO and place it close to the GNSS module.

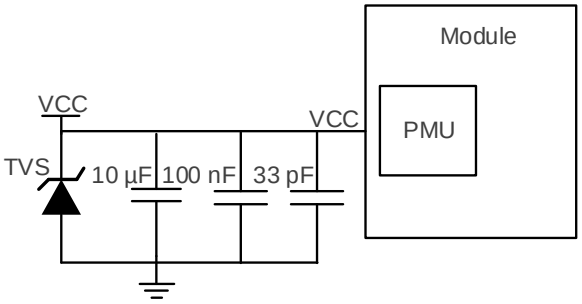


Figure 6: VCC Input Reference Design

NOTE

Ensure the module VCC is controlled by MCU to save power, or restart the module when it enters an abnormal state.

3.2.2. V_BCKP

The V_BCKP pin supplies power for the backup domain. Use of valid time and GNSS orbit data at startup allows GNSS hot (warm) start. V_BCKP must be connected to power supply for startup, and it should be always 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.

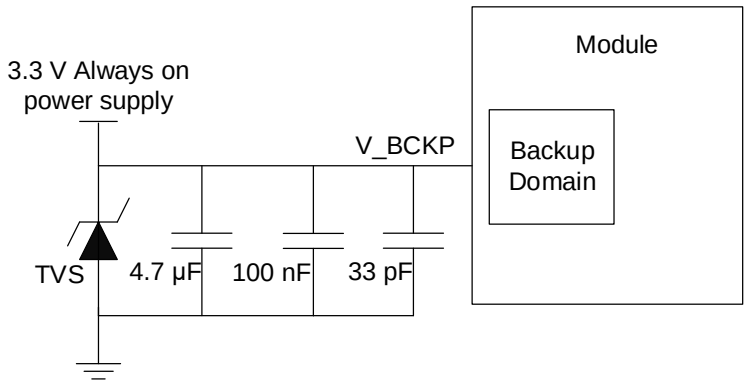


Figure 7: Backup Domain Input Reference Circuit

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

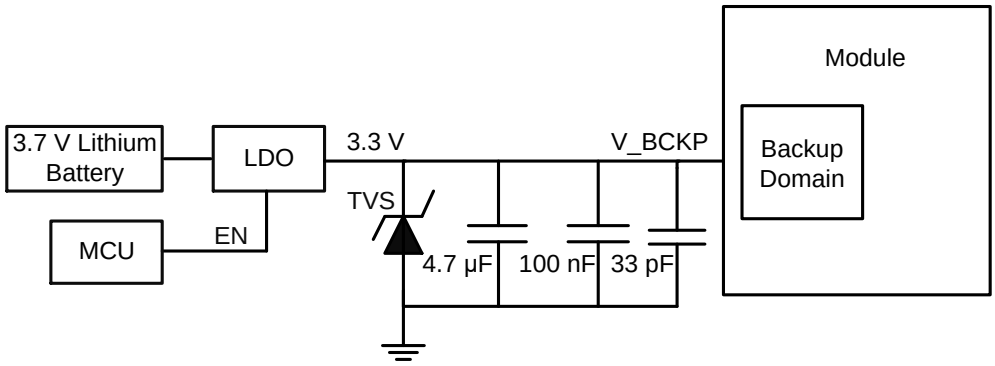


Figure 8: Reference Power Supply Circuit with 3.7 V Lithium Battery

NOTE

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

3.3. Power Modes

3.3.1. Feature Comparison

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

Table 7: Feature Comparison in Different Power Modes

Features	Continuous	Backup
NMEA from UART	●	-
1PPS	●	-
RF	●	-
Antenna Detection	●	-
Acquisition & Tracking	●	-
Power Consumption	High	Low
Position Accuracy	High	-

3.3.2. Continuous Mode

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

3.3.3. Backup Mode

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

- Enter the Backup mode:
  1. Send **PAIR650** command 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 WAKEUP high for at least 10 ms after the VCC power supply is restored.

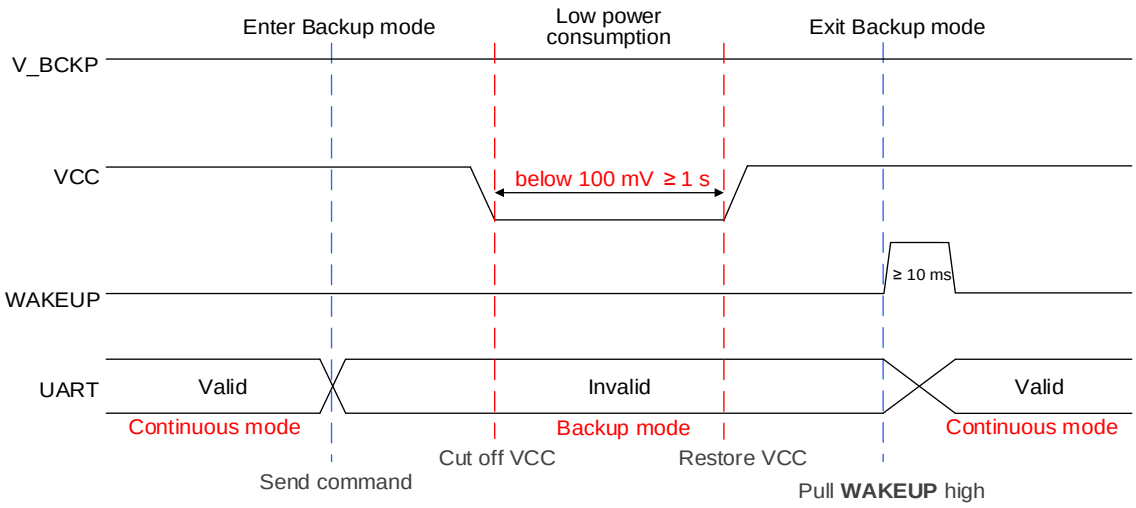


Figure 9: Sequence of Entering/Exiting Backup Mode

For details of the relevant software command, see *document [1] protocol specification*.

NOTE

1. The **PAIR650** command must be sent; to ensure hot (warm) start at the module's next startup, the V_BCKP must be kept powered.

2. If the **PAIR650** command is not sent, or the VCC is not cut off, the module will not enter the Backup mode entirely, thus causing a higher current consumption than the specified value.
3. After restoring VCC, the WAKEUP pin must be pulled up for at least 10 ms to exit the Backup mode.
4. Ensure a stable V_BCKP voltage without rush or drop when the VCC is switched on or off.

3.4. Power-up Sequence

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

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

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

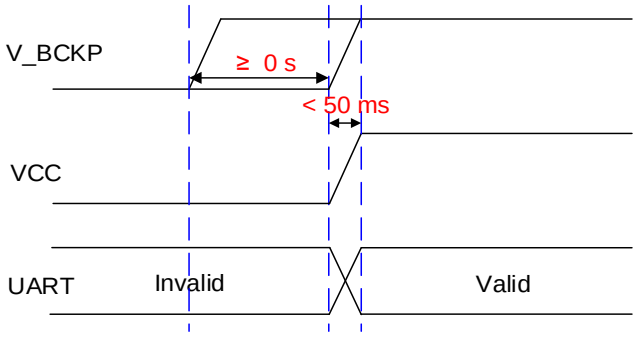


Figure 10: L89 (HA) Power-up Sequence

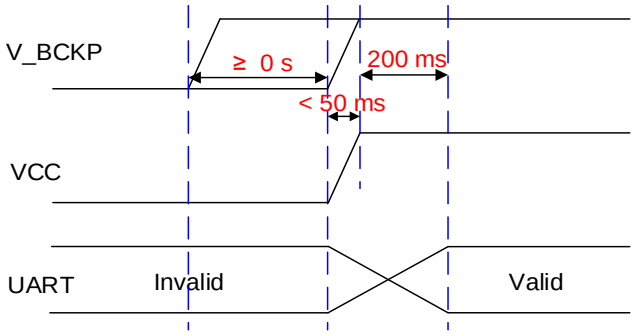


Figure 11: L89 (HD) Power-up Sequence

3.5. Power-down Sequence

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

To avoid abnormal voltage conditions, if VCC and V_BCKP falls 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.

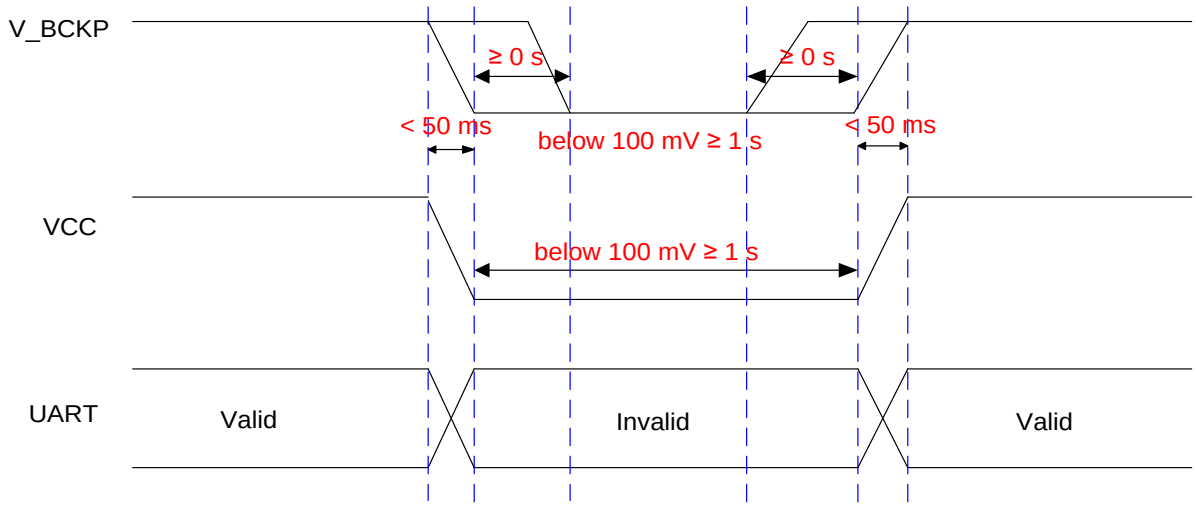


Figure 12: L89 (HA) Power-down and Power-on Restart Sequence

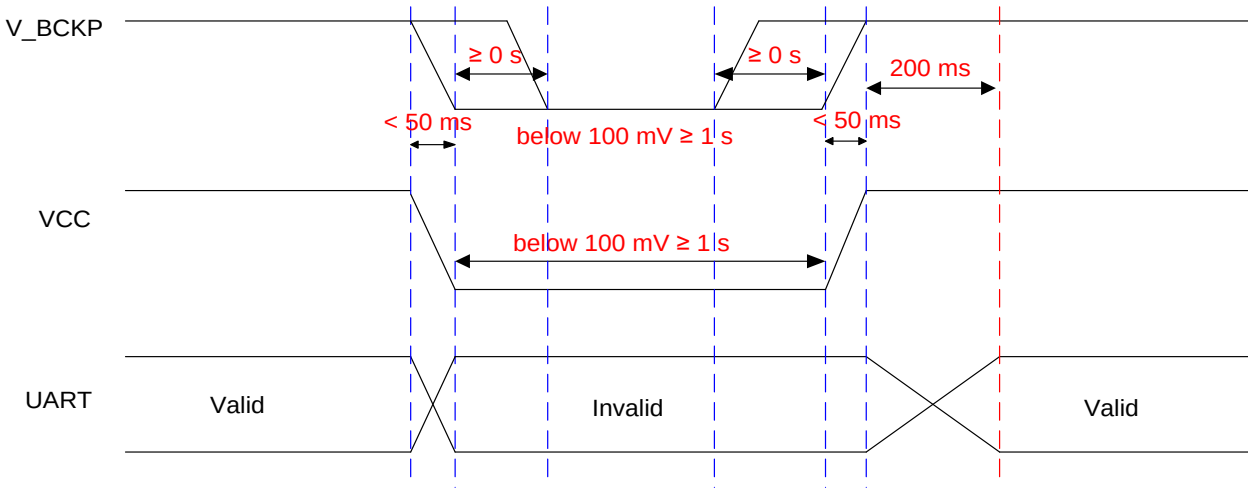


Figure 13: L89 (HD) Power-down and Power-on Restart Sequence

4 Module Protection

The L89 (HD) module has an extra precision voltage monitor with a programmable watchdog timer, which provides features of power-on delay, undervoltage protection and automatic reset under abnormal conditions. The L89 (HA) does not support these features.

4.1. Power-on Delay

After the VCC is powered up for 200 ms, the internal LDO supplies power to the GNSS IC and the L89 (HD) module works normally, avoiding the impact of voltage jitter during power-up.

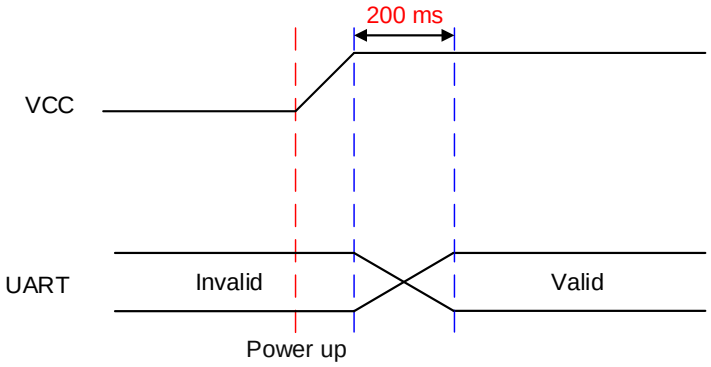


Figure 14: Power-on Delay Sequence

4.2. Undervoltage Protection

Undervoltage protection is activated if the VCC power supply of the module drops below the threshold (2.3 V), which is detected by the internal watchdog timer as undervoltage state. In this state, the internal LDO does not supply power to the GNSS IC, which in turn stops the operation of internal GNSS IC. The module enters Backup mode when the V_BCKP voltage is in the normal operating range; it is powered off automatically if the V_BCKP voltage drops to 1.4–2.2 V.

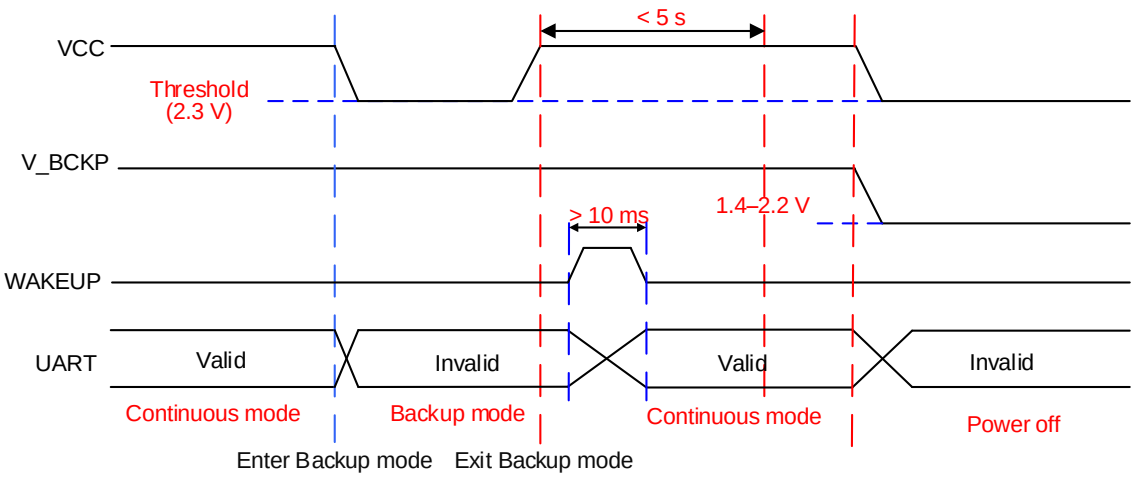


Figure 15: Undervoltage Protection Sequence

4.3. Automatic Reset

If the L89 (HD) module enters an abnormal state in which UART interface does not output data, after a 5-second delay, the watchdog timer automatically resets the module by driving the RESET_N pin low with an internal control circuit.

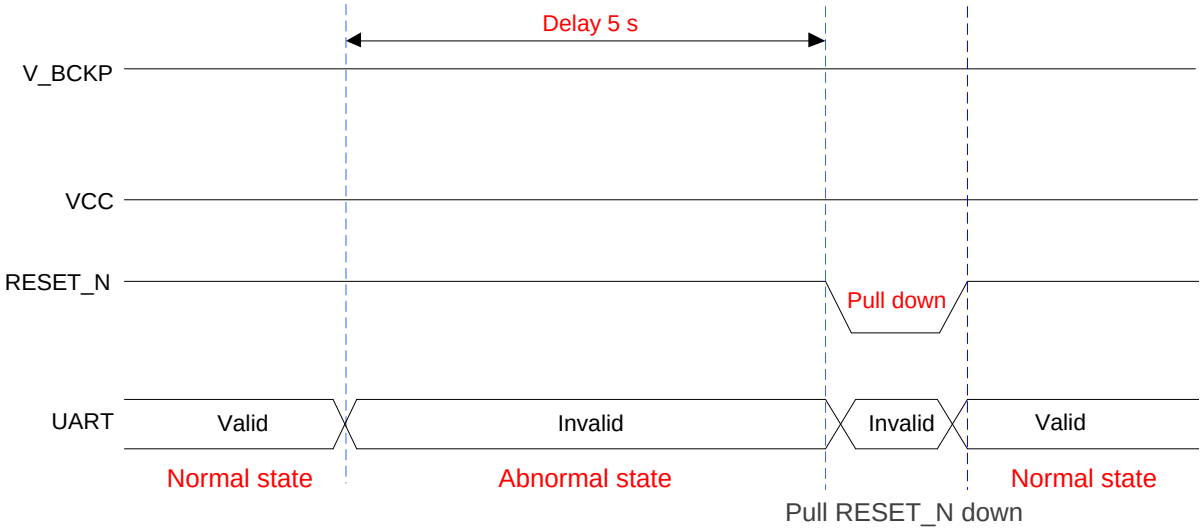


Figure 16: Automatic Reset Sequence

5 Application Interfaces

5.1. I/O Pins

5.1.1. Communication Interfaces

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

5.1.1.1. UART Interface

The module provides one UART interface with the following features:

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

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

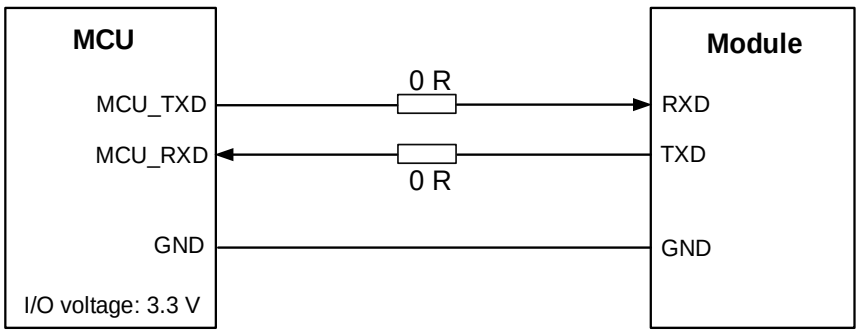


Figure 17: UART Interface Reference Design

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

NOTE

1. UART interface default settings may vary depending on software versions. See the relevant software versions for details.
2. Since the RXD pin of the module has been isolated internally using a transistor isolation circuit, it can withstand 3.3 V voltage. The typical output voltage of the module's TXD pin is 3.0 V, so if the I/O port level of your MCU is 3.3 V, the above design can be your reference. Note that this reference design is only applicable when the I/O voltage difference between the MCU and module is within 0.3 V. For example, when the I/O voltage of the MCU is 1.8 V, a level-shifting circuit must be selected.

5.1.1.2. I2C Interface

The module provides one I2C interface with the following features:

- Supports standard NMEA message, PAIR/PQTM message and binary data.
- Supports standard mode (100 kbps) and fast mode (400 kbps).
- Operates in slave mode.
- Supports 7-bit address.

For more information, see *document [6] I2C application note*.

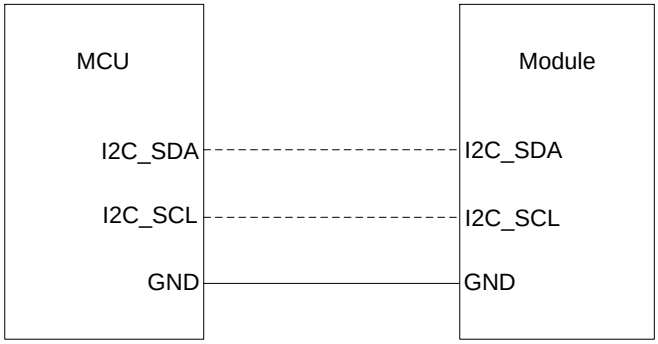


Figure 18: I2C Interface Reference Design

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

NOTE

The power domain of the I2C interface is 3.0 V. I2C_SCL and I2C_SDA have been pulled up to 3.0 V internally with 4.7 kΩ resistors. If the I/O voltage of MCU is not matched with the module, a level-shifting circuit must be selected.

5.1.2. 3D_FIX

The 3D_FIX pin is at low level by default and assigned as a fix flag output. It outputs a high logic level voltage to indicate a successful 3D position fix.

5.1.3. GEOFENCE

The GEOFENCE pin indicates the current geofence status. Geofence configurations including geofence area(s) can be set using the related command. The receiver continuously compares its current position to the preset geofence areas(s) and the pin reflects whether the receiver is inside the active area(s) or not. It outputs a high logic level voltage to indicate that the receiver is inside the geofence area(s). For more information, see *documents [1]* and *[2] protocol specifications*.

5.1.4. JAM_IND

In case of jamming that may interfere with the desired signal(s), the JAM_IND pin outputs a low-level signal; otherwise, it outputs a high-level signal.

5.1.5. AADET_N

The AADET_N pin can be used to indicate the open circuit status of an external active antenna.

When the external active antenna is not connected to the EX_ANT pin or has poor contact with the antenna feeding point, the AADET_N pin keeps outputting high-level signal to indicate the absence of the active antenna. When a good connection to the active antenna is restored, the pin changes to low level. For more information, see *document [5] reference design*.

5.1.6. 1PPS

The 1PPS output pin can be used for time pulse signals, it generates one pulse per second periodic signal synchronized with a 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.

5.1.7. FWD

The FWD pin only supported by L89 (HD) 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 L89 (HD) when ADR function is used.

5.1.8. WHEELTICK

The WHEELTICK pin supported by L89 (HD) 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 [5] reference design*.

NOTE

The WHEELTICK pin must be connected on L89 (HD) when ADR function is used.

5.1.9. WI

WI supported by L89 (HD) is an interrupt output pin to wake up the host. The pin is pulled up internally to 3.0 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.

5.1.10. WDT_SET

WDT_SET supported by L89 (HD) is internally pulled up with a 47 kΩ resistor by default. If the automatic reset function is not required, the internal watchdog chip can be disabled by pulling the WDT_SET pin down.

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

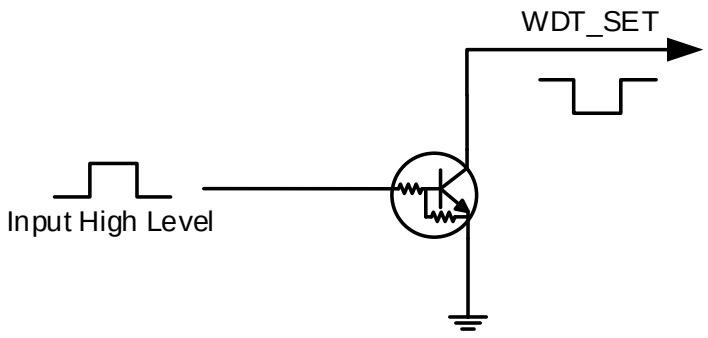


Figure 19: Reference OC Circuit to Turn Off the Automatic Reset Function

5.2. System Pins

5.2.1. WAKEUP

The WAKEUP pin has been pulled down internally by default. Keep the pin low when the module is in the Continuous mode and the Backup mode. To exit the Backup mode, drive the pin high for at least 10 ms. If unused, leave the pin N/C (not connected).

5.2.2. RESET_N

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

- For L89 (HA), it is internally pulled up to 1.8 V with a 10 kΩ resistor by default.
- For L89 (HD), it is internally pulled up to V_BCKP with a 10 kΩ resistor by default.

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.

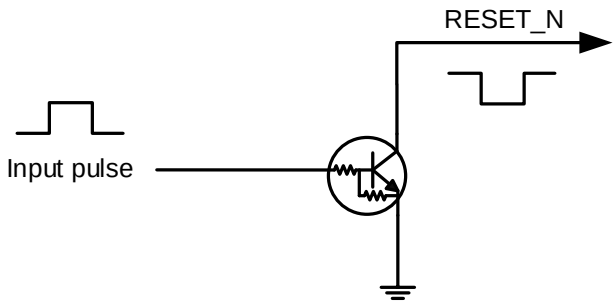


Figure 20: Reference OC Circuit for Module Reset

The following figure shows the reset sequence of the module.

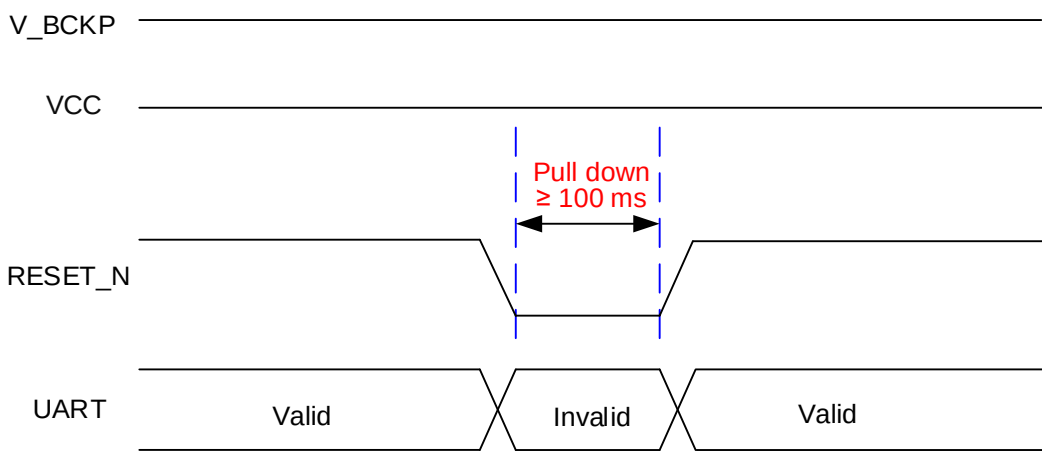


Figure 21: Reset Sequence

NOTE

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

6 Design

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

6.1. Integrated Antennas

The module has two integrated passive antennas: a patch antenna and a chip antenna. The patch antenna is dedicated to receiving GNSS signals in band L1 while the chip antenna signals in band L5.

6.1.1. Patch Antenna

The module has an 18.4 mm × 18.4 mm × 4.0 mm high-performance patch antenna that supports GPS + Galileo + GLONASS constellations by default. The specifications of this antenna are given in the following table.

Table 8: Patch Antenna Specifications (with 100 mm × 60 mm Ground Plane)

Parameter	Specification	Notes
Size	18.4 mm × 18.4 mm × 4.0 mm	-
Frequency Range for Receiver	GPS L1 C/A Galileo E1 GLONASS L1	-
Impendence	50 Ω	-
Bandwidth	Min. 10 MHz	Return Loss ≤ -10 dB
Polarization	RHCP	-
Gain at Zenith	Typ. 4 dBi	Center Frequency
VSWR	Max. 1.5	

The test result of the patch antenna is illustrated with the following figures, showing that this integrated GNSS antenna provides good radiation efficiency, right hand circular polarization, and optimized radiation pattern. It is insensitive to surroundings and has a high tolerance for frequency shifts.

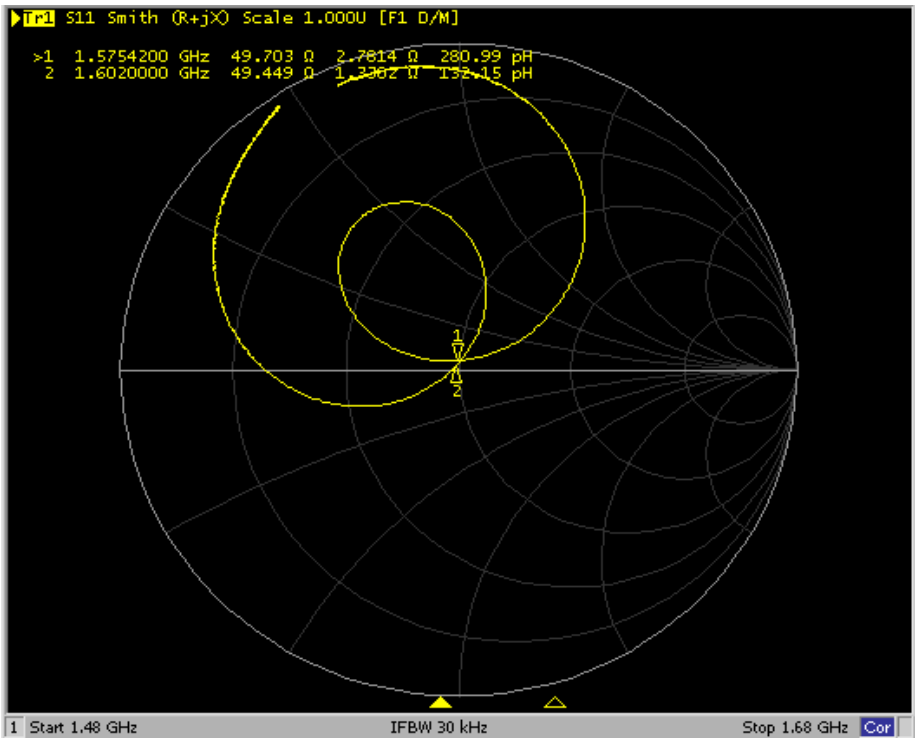


Figure 22: Smith Chart of Patch Antenna

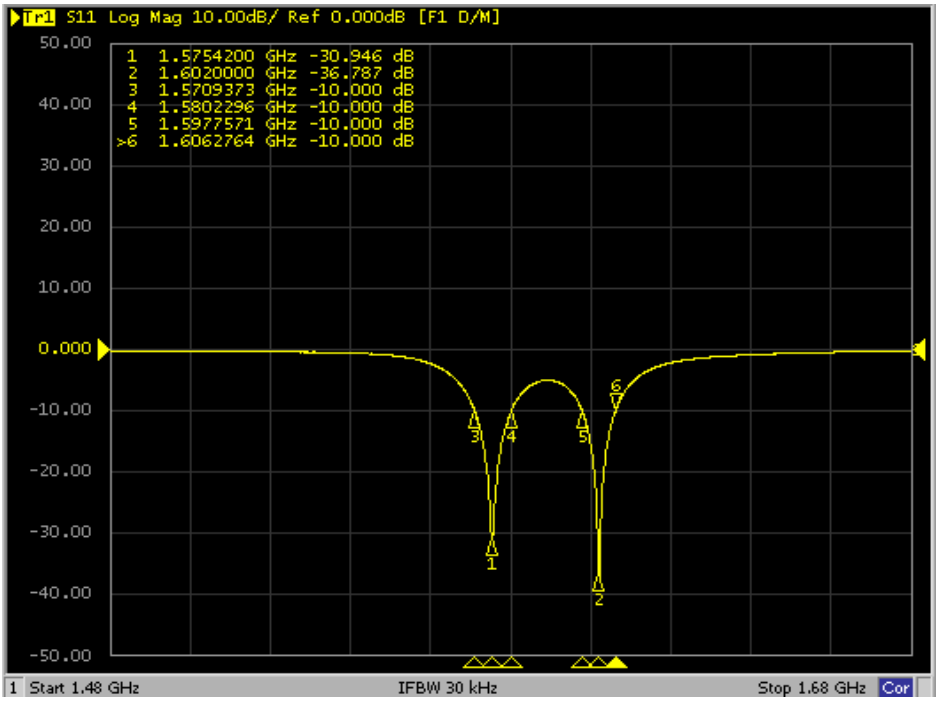


Figure 23: S11 of Patch Antenna

6.1.2. Chip Antenna

The module has an integrated chip antenna for NavIC L5 signal. The 10.0 mm × 3.2 mm × 4.0 mm high-performance chip antenna helps reduce product size. It features high stability and sensitivity in receiving signals. Its specifications are described in the following table.

Table 9: Chip Antenna Specifications

Parameter	Specification	Notes
Size	10.0 mm × 3.2 mm × 4.0 mm	-
Range of Receiving Frequency	NavIC L5	-
Impendence	50 Ω	-
Bandwidth	Min. 25 MHz	Return Loss ≤ -10 dB
Polarization	LP	-
Gain at Zenith	Typ. 1 dBi	Center Frequency
VSWR	Max. 1.5	

6.1.3. PCB Design Guide

The radiation characteristics of an antenna depend on various factors, such as the size and shape of the PCB and the dielectric constant of components nearby. It is recommended to follow the design rules listed below.

6.1.3.1. Module and Components Placement

Keep the module at least 20 mm away from the left and right edge of the motherboard, ideally at the center of the motherboard. Make sure the antenna points to the sky.

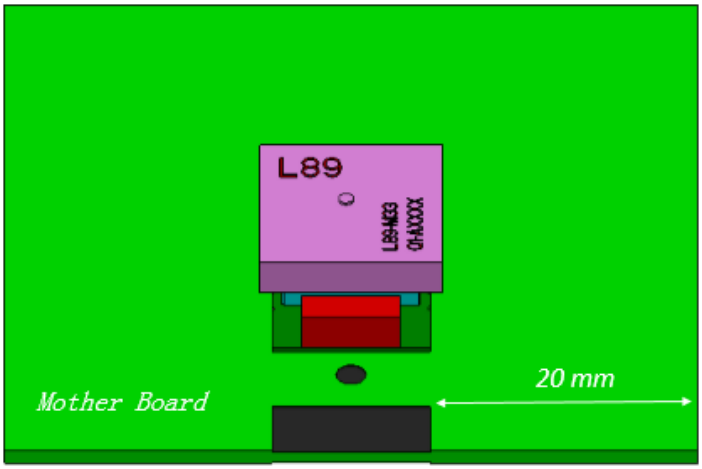


Figure 24: Recommended Distance Between the Module and Motherboard Edges

Keep both the patch antenna and chip antenna at least 10 mm away from tall metal components higher than 6 mm. Otherwise, the antenna performance will be affected.

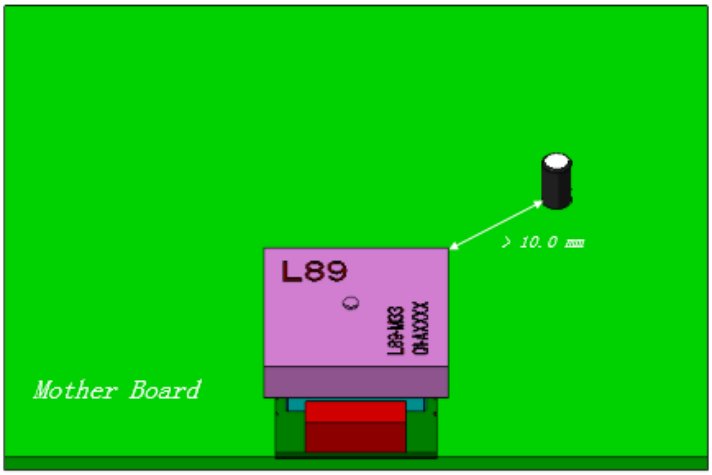
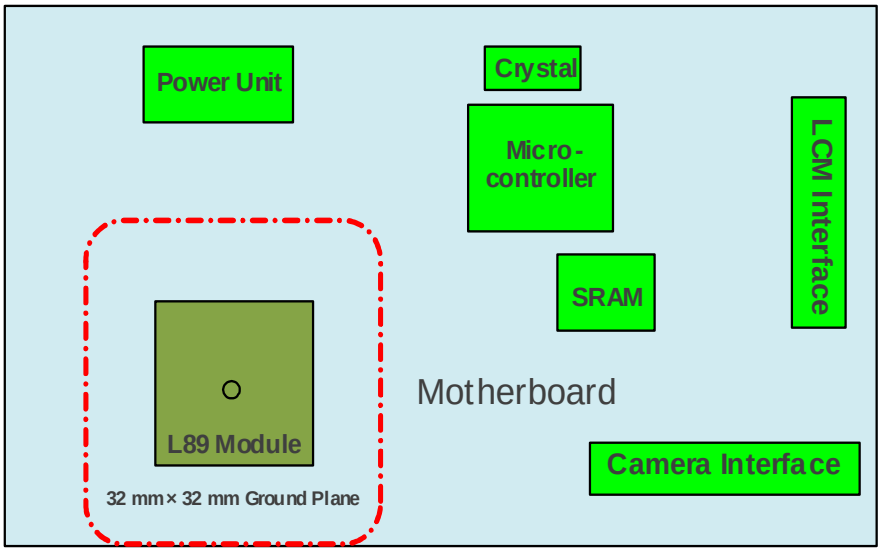


Figure 25: Recommended Distance Between the Module and Tall Metal Components

Make sure the microcontroller, crystal, LCM, camera and other high-speed components and interfaces are placed on the opposite side of the module, and keep them as far away from the module as possible, for example, in the diagonal position to the module.



Brown Background: Top; Green Background: Bottom

Figure 26: Recommended Placement of the Module and Other Components

- Make sure interfering signals (USB, LCM, camera, crystal, etc.) are on inner layer shielded by ground plane, and keep them and their vias far away from the module.
- Make sure the RF systems such as Wi-Fi, Bluetooth, 2G, 3G, 4G and 5G are placed on the mother board opposite to the module, and keep them away from the module as far as possible, preferably by placing the RF systems in the diagonal position relative to the module.
- Keep the DC-DC converter far away from the module.
- Device enclosure should be made of non-metal materials, especially for those which are around the antenna area. The minimum distance between antenna and enclosure is 3 mm.
- The RF part of the module is sensitive to temperature. Please keep it away from the heat-emitting circuit.
- It is recommended to reserve an integrated ground layer to isolate the GNSS module from other modules.

6.1.3.2. Keepout Design

On each layer of the PCB (except the bottom layer), the areas corresponding to the feed point of the patch antenna should be kept out, and the diameter of the keepout area should be no less than 4 mm. Likewise, on each layer, the areas (each measuring 16.00 mm × 6.25 mm) right under the chip antenna should be kept out.

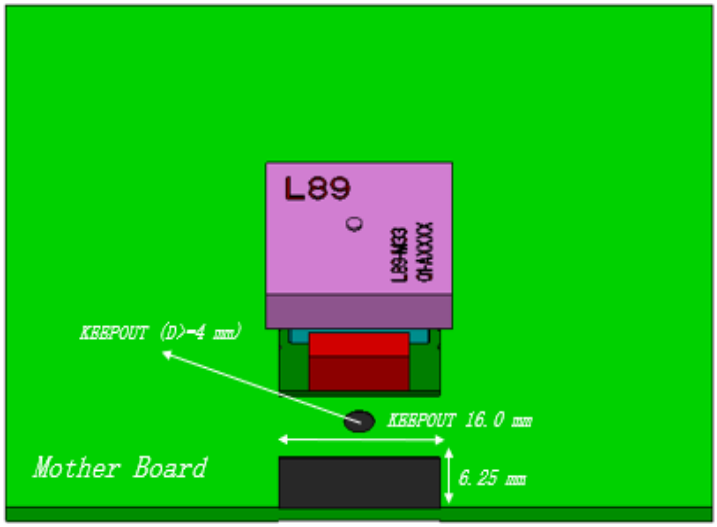


Figure 27: Recommended Keepout Design for Patch Antenna

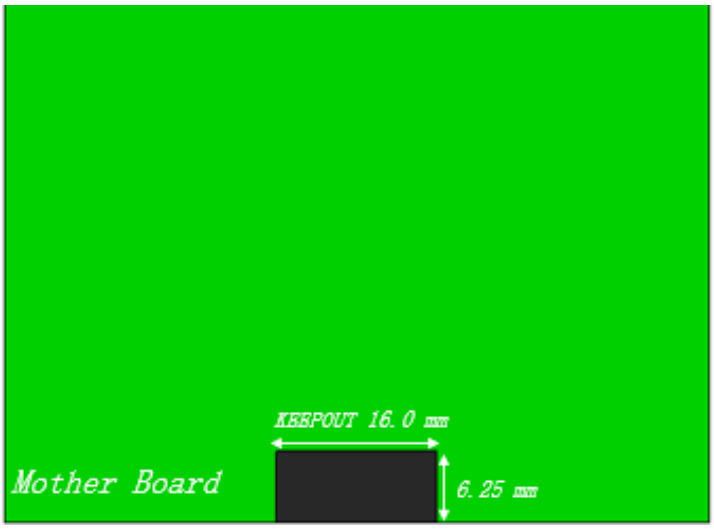


Figure 28: Recommended Keepout Design for Chip Antenna

6.1.3.3. Ground Plane Design

The performance of the integrated patch antenna depends on the actual size of the ground plane around the module. It is recommended to reserve a ground plane of 32.00 mm × 32.00 mm, as shown below. In addition, avoid placing any components, especially tall metal components, or arranging any interfering vias on the ground plane.

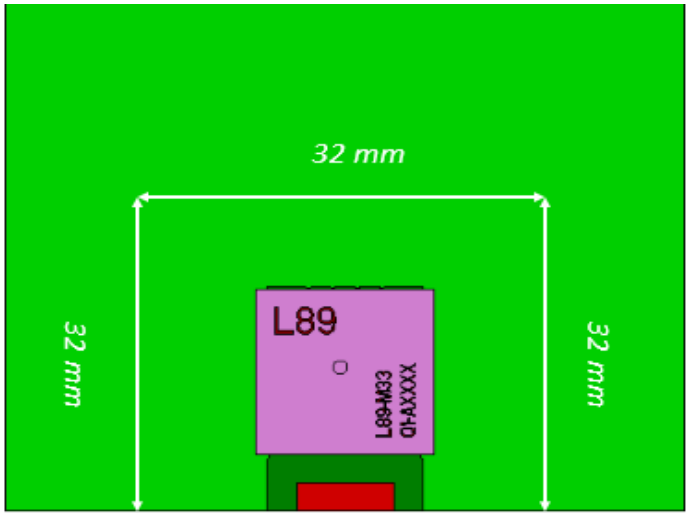


Figure 29: Recommended Ground Plane Design

6.2. External Active Antenna

6.2.1. Antenna Specifications

The module can be connected via the EX_ANT pin to an external dual-band (L1 + L5) active antenna to receive GPS, Galileo, QZSS and NavIC satellite signals. When connected to an external active antenna, the module automatically switches integrated antenna signals to external active antenna signals through its SPDT switches after detecting the external active antenna.

The recommended external active antenna specifications are given in the table below.

Table 10: Recommended External Active Antenna Specifications

Antenna Type	Specifications
Active antenna	Frequency Range: 1164–1189 MHz and 1559–1606 MHz Polarization: RHCP VSWR: < 2 (Typ.) Passive Antenna Gain: > 0 dBi Active Antenna Noise Figure: < 1.5 dB Active Antenna Total Gain: < 35 dB [8] Out-of-band Rejection: > 30 dB

[8] The total antenna gain equals the internal LNA gain minus the total insertion loss of cables and components inside the antenna.

Select an active antenna whose current consumption falls within the range of 5 mA to 40 mA and take account of the relationship between the voltage of EX_ANT pin and the antenna current consumption, as is illustrated in the following figure while making the selection.

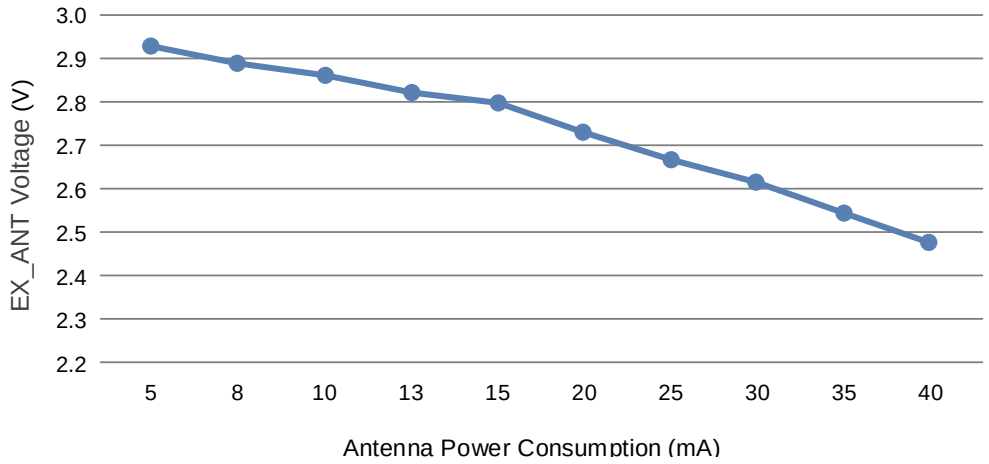


Figure 30: Relationship Between EX_ANT Voltage and Antenna Current Consumption

NOTE

For recommended antenna and design, see *document [7] GNSS antenna application note* or contact Quectel Technical Support (support@quectel.com).

6.2.2. Antenna Reference Design

The following figure is a typical reference design of an active antenna. Inside the module, the EX_ANT pin is powered by VCC and supplies power to the external active antenna. To further mitigate the impact of out-of-band signals on the GNSS module in a complex electromagnetic environment, 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.

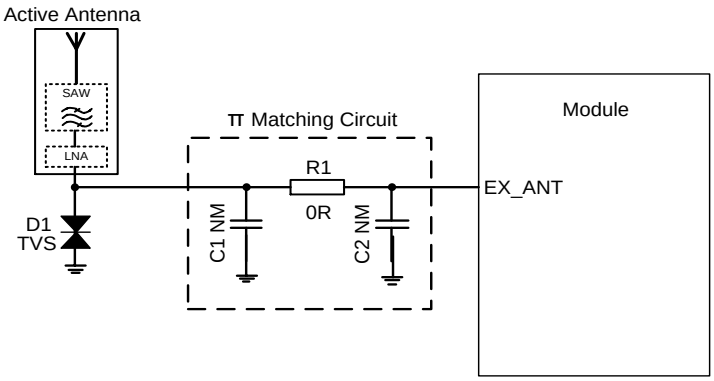


Figure 31: Active Antenna Reference Design

The C1, R1, and C2 components are reserved for matching antenna impedance. By default, R1 is 0 Ω, and C1 and C2 are not mounted. D1 is an 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. The impedance of the RF trace line on the main PCB should be controlled to 50 Ω, and the trace length should be kept as short as possible. For more information about RF layout, see *document [8] RF layout application note*.

If the external antenna is short-circuited, the module will cut off the power supply for it and switch to the integrated antennas automatically to avoid damage. When the short-circuit problem is solved, power supply will be automatically restored to the external antenna.

6.3. Recommended Footprint

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

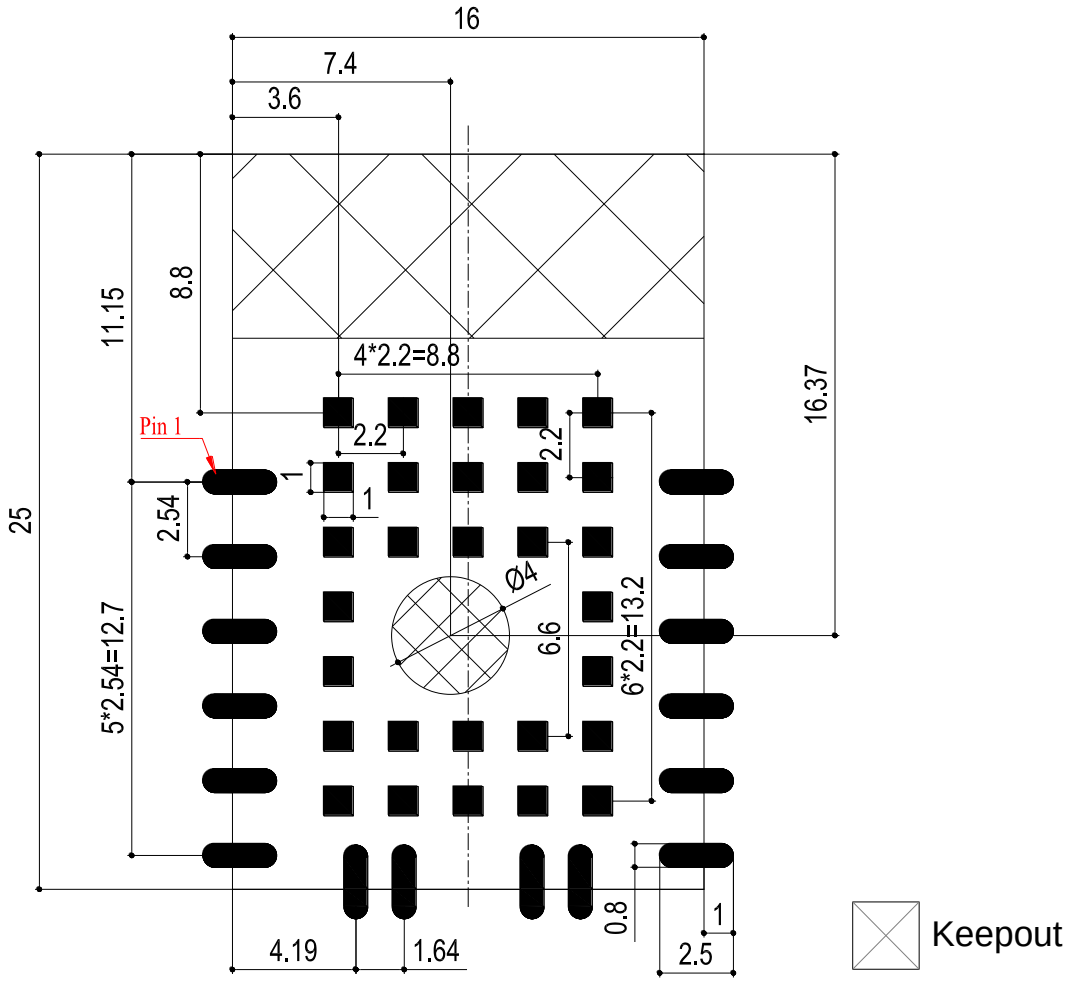


Figure 32: L89 (HA) Recommended Footprint

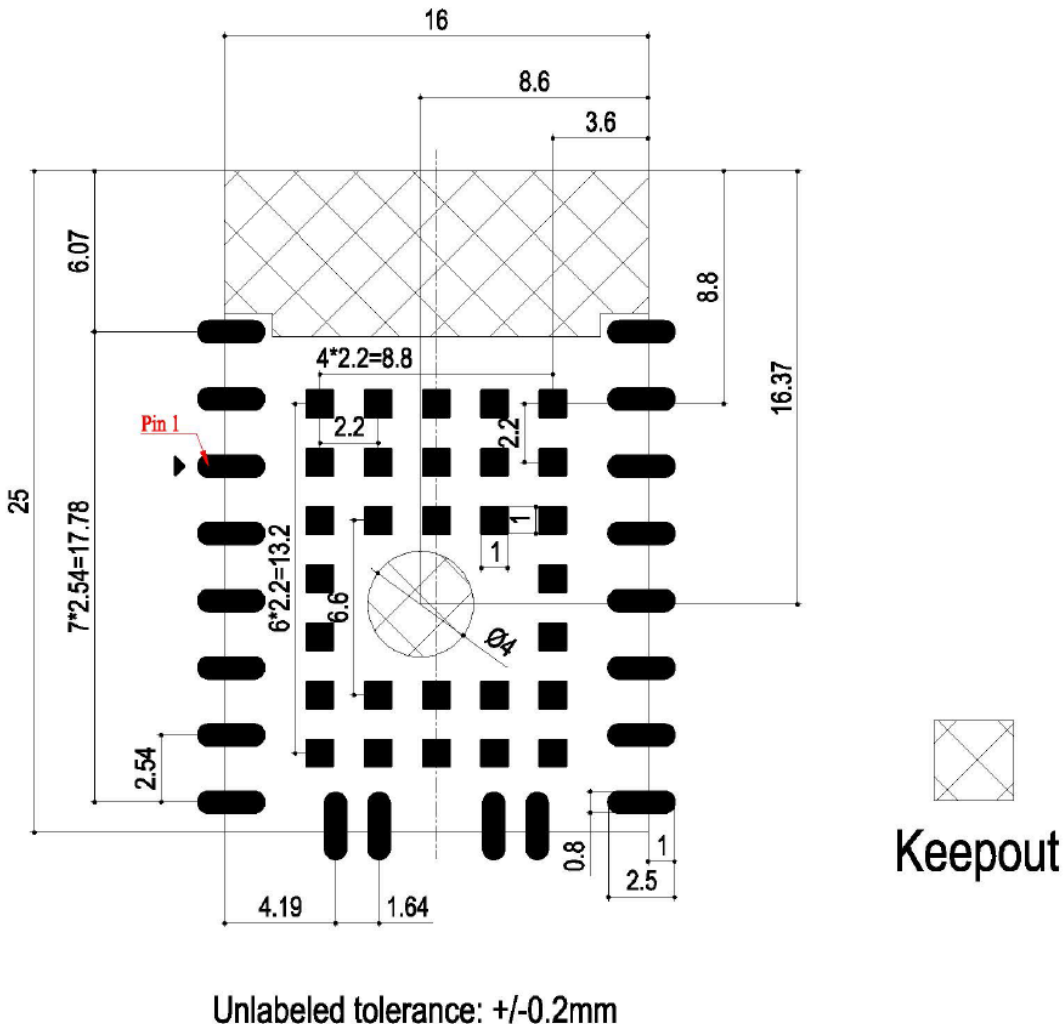


Figure 33: L89 (HD) Recommended Footprint

NOTE

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

7 Electrical Specification

7.1. 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	Main 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	-0.3	3.08	V
P_{EX_ANT}	Input Power at EX_ANT	-	0	dBm
T_storage	Storage Temperature	-40	90	°C

NOTE

1. 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.
2. Since the RXD pin of the module is isolated internally using a transistor isolation circuit, it can withstand 3.3 V voltage.

7.2. 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 Conditions

Parameter	Description	Min.	Typ.	Max.	Unit
VCC	Main Power Supply Voltage	3.1	3.3	4.3	V
V_BCKP	Backup Supply Voltage	2.2	3.3	4.3	V
IO_Domain	Digital I/O Pin Voltage Domain	-	3.0	-	V
V_{IL}	Digital I/O Pin Low-level Input Voltage	-0.3	-	0.75	V
V_{IH}	Digital I/O Pin High-level Input Voltage	1.875	-	3.08	V
V_{OL}	Digital I/O Pin Low-level Output Voltage	-	-	0.375	V
V_{OH}	Digital I/O Pin High-level Output Voltage	2.25	-	-	V
RESET_N	Low-level Input Voltage	-0.3	-	0.1	V
	High-level Input Voltage	1.8	3.3	4.3	V
WAKEUP	Low-level Input Voltage	-0.3	-	0.75	V
	High-level Input Voltage	3.0	3.3	4.3	V
EX_ANT	EX_ANT Output Voltage	-	-	3.0	V
I_{EX_ANT}	EX_ANT Output Current	-	-	40	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. Digital I/O Pin refers to all digital pins specified in *Table 6: Pin Description* except RESET_N and WAKEUP.

7.3. 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.

Table 13: L89 (HA) Supply Current

Parameter	Description	Condition	$I_{Typ.}$ [9]	I_{PEAK} [9]
I_{VCC} [10]	Current at VCC	Acquisition	32 mA [11]/44mA [12]	48 mA [11]/75 mA [12]
		Tracking	32 mA [11]/44 mA [12]	50 mA [11]/75 mA [12]
I_{V_BCKP} [13]	Current at V_BCKP	Continuous mode	10 μA	50 μA
		Backup mode	51 μA	108 μA

Table 14: L89 (HD) Supply Current

Parameter	Description	Condition	$I_{Typ.}$ [9]	I_{PEAK} [9]
I_{VCC} [10]	Current at VCC	Acquisition	36 mA [11]/48 mA [12]	57 mA [11]/80 mA [12]
		Tracking	36 mA [11]/48 mA [12]	57 mA [11]/80 mA [12]
I_{V_BCKP} [11]	Current at V_BCKP	Continuous mode	10 μA	51 μA
		Backup mode	51 μA	108 μA

NOTE

The above power consumption values are measured within the respective modes, excluding transient pulse currents that occur during power-up and mode transition.

[9] Room temperature, measurements are taken with typical voltage.
[10] Used to determine the maximum current capability of power supply.
[11] Tested using instruments with an external antenna.
[12] Tested with internal antennas.
[13] Used to determine the required battery current capacity.

7.4. ESD Protection

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

- When mounting the module onto a motherboard, make sure to connect the GND first, and then the EX_ANT pin.
- When handling the EX_ANT 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 EX_ANT pin, make sure to use an ESD safe soldering iron (tip).

8 Mechanical Dimensions

This chapter describes the mechanical dimensions of the module. All dimensions are in millimeters (mm). The dimensional tolerances are ±0.20 mm, unless otherwise specified.

8.1. Top, Side and Bottom View Dimensions

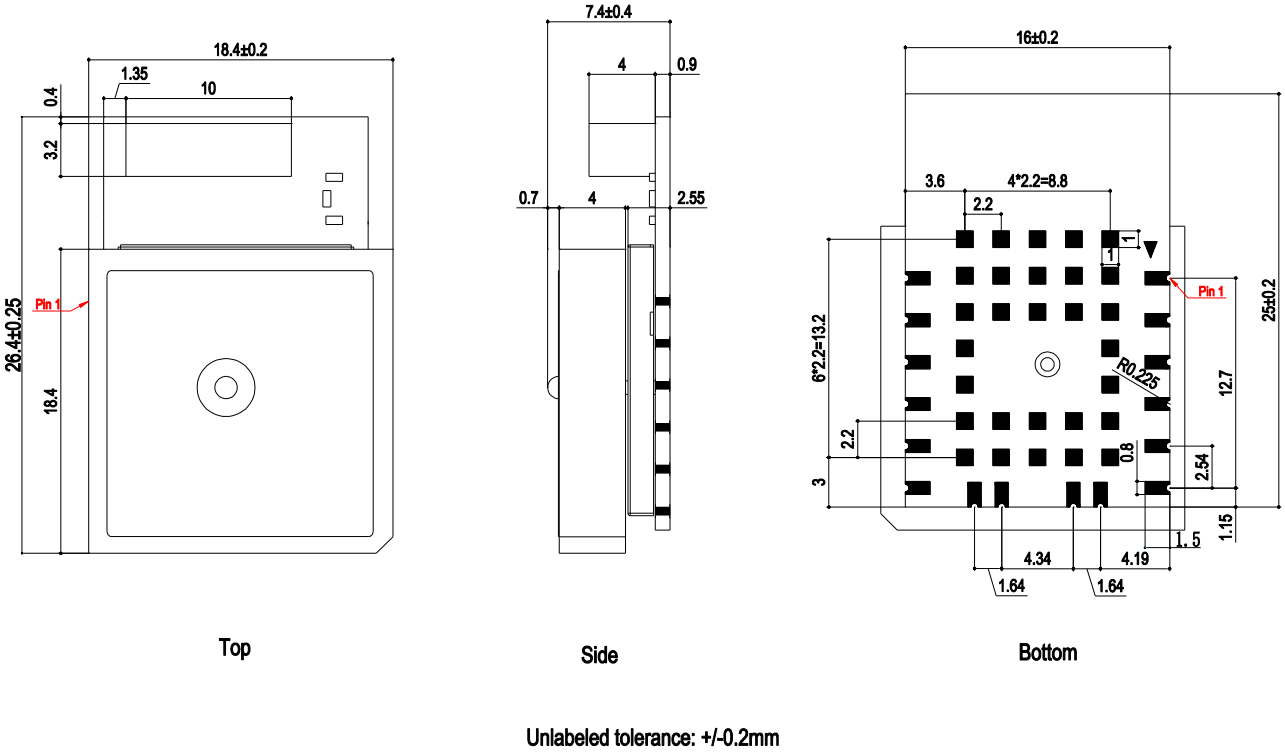


Figure 34: L89 (HA) Top, Side and Bottom View Dimensions

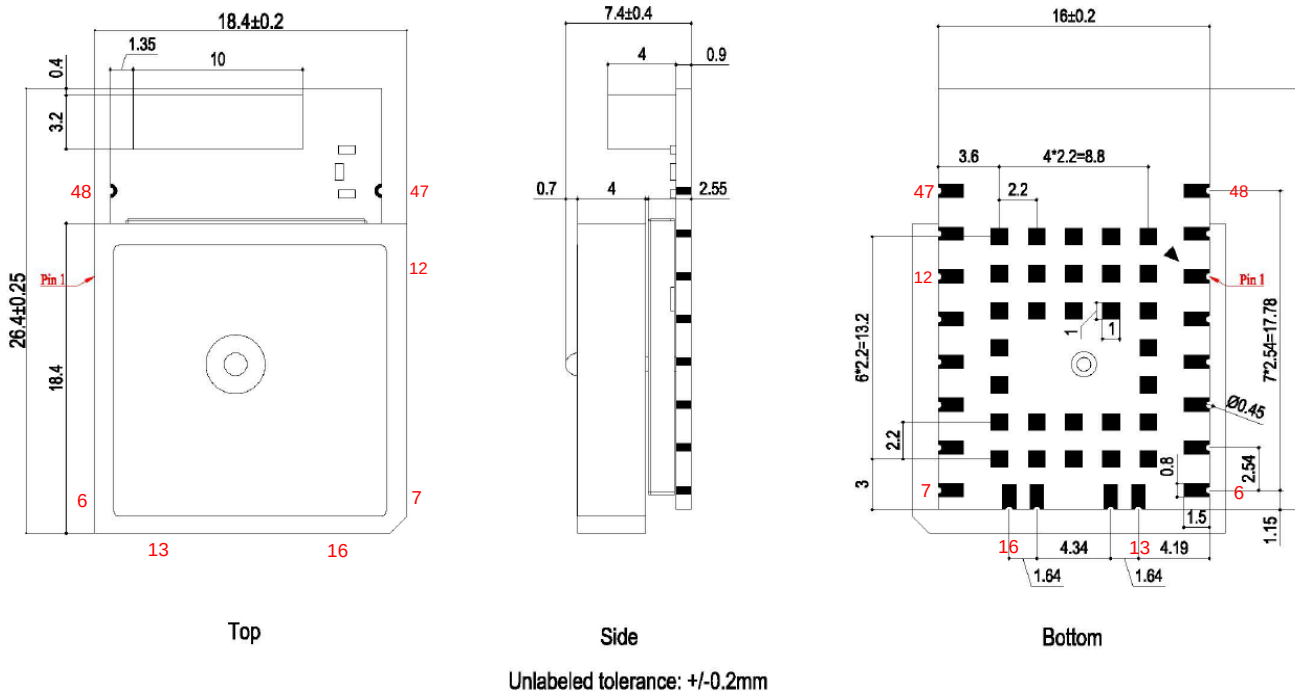


Figure 35: L89 (HD) Top, Side and Bottom View Dimensions

NOTE

The module's coplanarity standard: ≤ 0.13 mm.

8.2. Top and Bottom Views

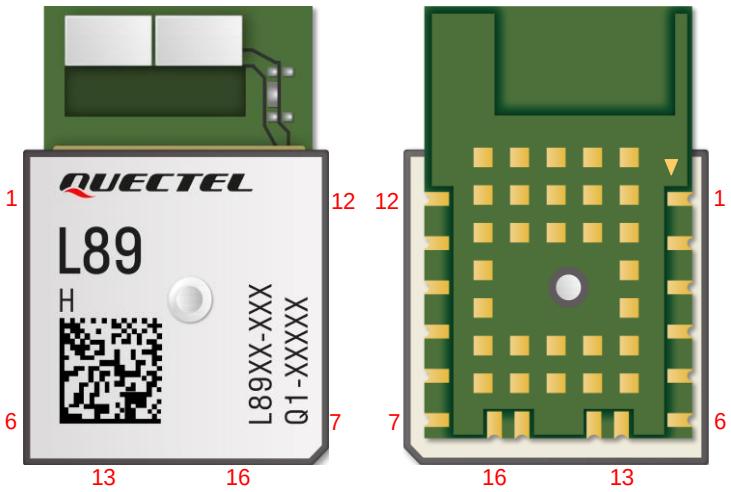


Figure 36: L89 (HA) Top and Bottom Views

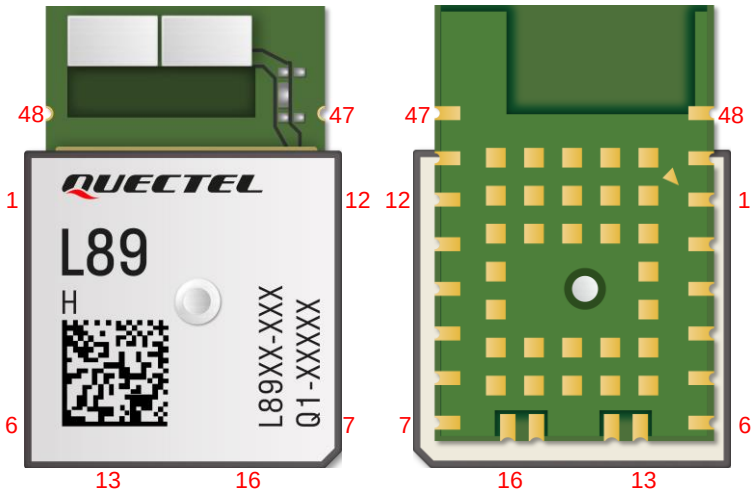


Figure 37: L89 (HD) Top and Bottom Views

NOTE

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

9 Product Handling

9.1. Packaging Specification

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

The module adopts carrier tape packaging and details are as follow:

9.1.1. Carrier Tape

Dimension details are as follow:

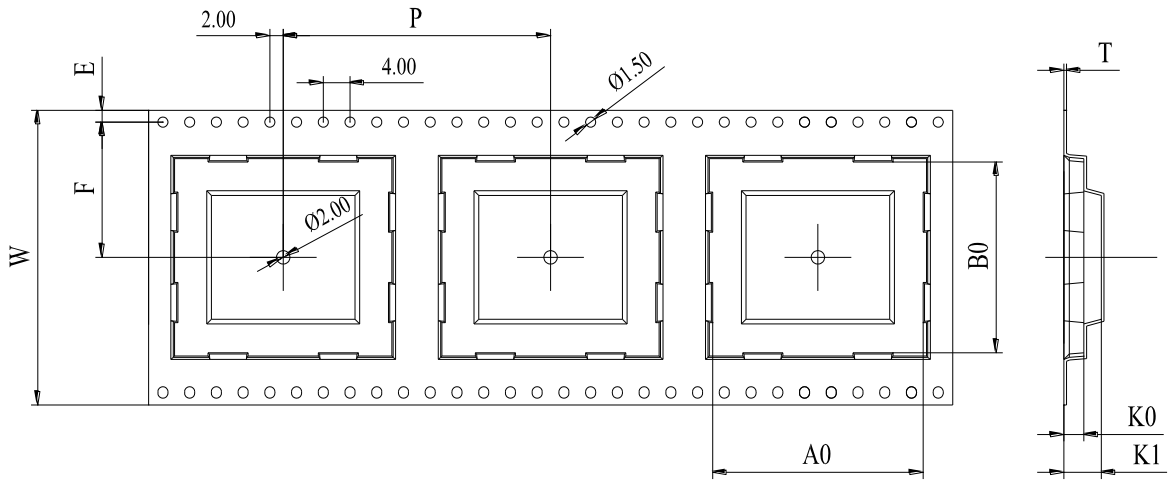


Figure 38: Carrier Tape Dimensions Drawing

Table 15: Carrier Tape Dimensions (Unit: mm)

W	P	T	A0	B0	K0	K1	F	E
44	32	0.4	16.5	25.5	5.15	7.25	20.2	1.75

9.1.2. Plastic Reel

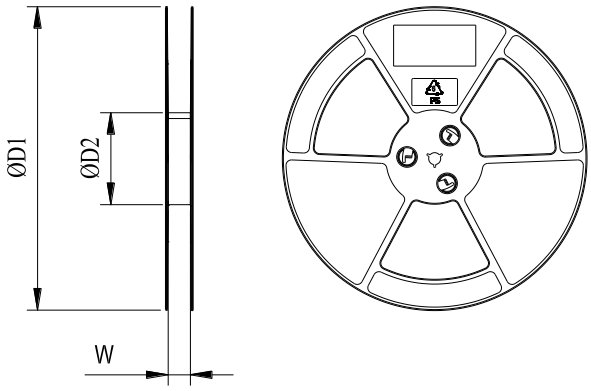


Figure 39: Plastic Reel Dimensions Drawing

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

øD1	øD2	W
330	100	44.5

9.1.3. Mounting Direction

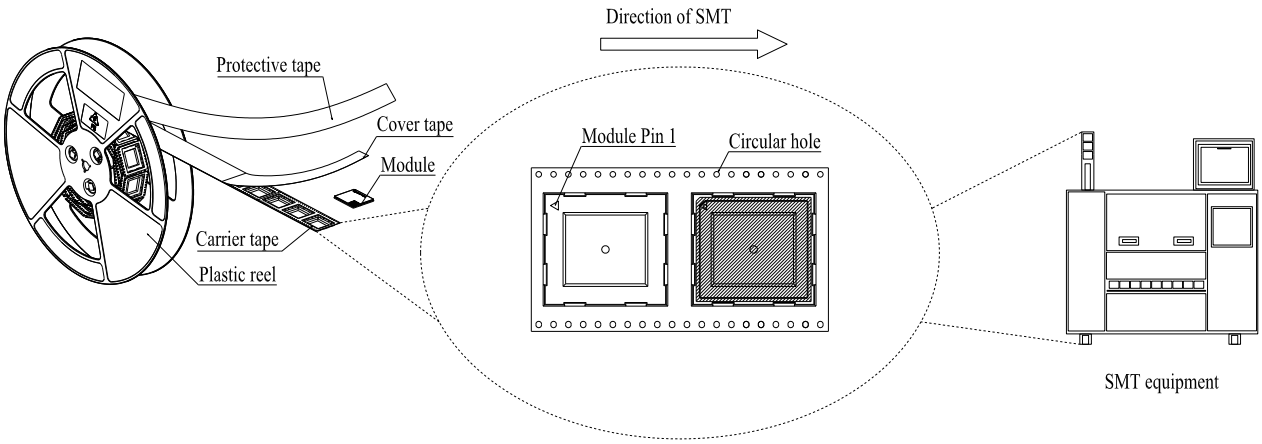
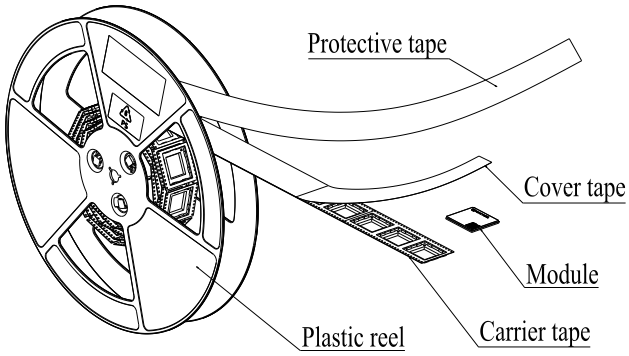


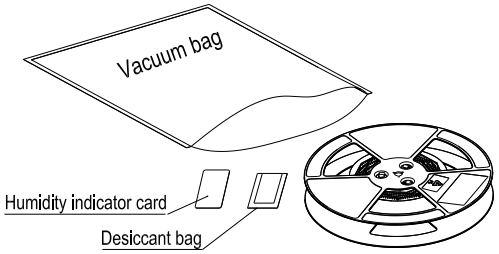
Figure 40: Mounting Direction

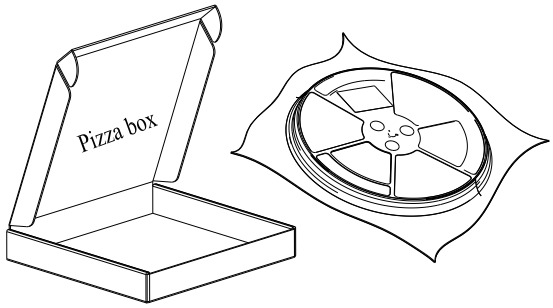
9.1.4. Packaging Process



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

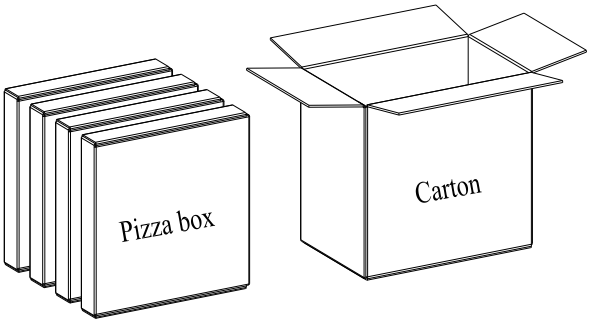
Place the packaged plastic reel, 1 humidity indicator card and 1 desiccant bag into a vacuum bag, vacuumize it.





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

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



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

Figure 41: Packaging Process

9.2. Storage

The module is provided in a vacuum-sealed packaging. MSL of the module is rated at 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 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 module must be processed in reflow soldering or other high-temperature operations within 168 hours. Otherwise, the module should be stored in an environment where the relative humidity is less than 10 % (e.g., a dry cabinet).

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

   - The module is not stored in Recommended Storage Condition;
   - Violation of the third requirement above;
   - 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 meet the requirements below:

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

NOTE

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

[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 conform to *IPC/JEDEC J-STD-033*. And do not unpack the modules in large quantities until they are ready for soldering.

9.3. 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 module, see *document [9] module stencil design requirements*.

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 module 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.

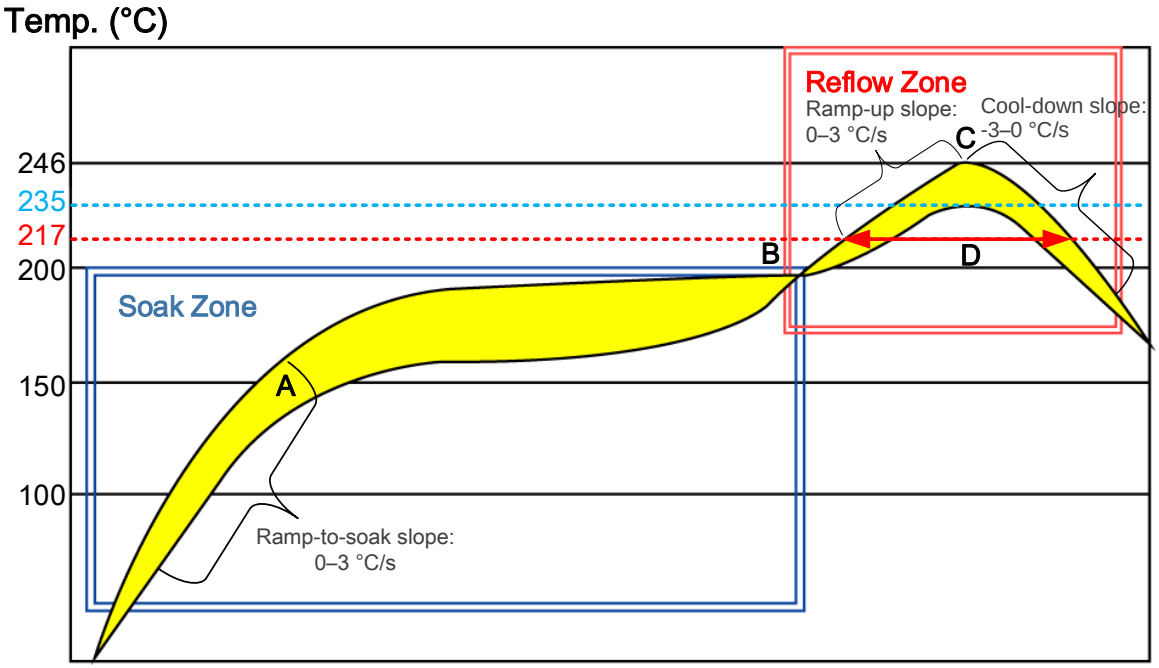


Figure 42: Recommended Reflow Soldering Thermal Profile

Table 17: Recommended Thermal Profile Parameters

Factor	Recommendation 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 contact the module directly, NEVER wipe the module label with organic solvents, such as acetone, ethyl alcohol, isopropyl alcohol, trichloroethylene. Otherwise, the label information may become unclear.
3. If a conformal coating is necessary for the module, DO NOT use any coating material that may chemically react with the PCB or shielding cover and prevent the coating material from flowing into the module.
4. Avoid using ultrasonic technology for module cleaning since it can damage crystals inside the module.
5. 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 %).
6. 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.
7. 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 [10] module SMT application note*.

10 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.

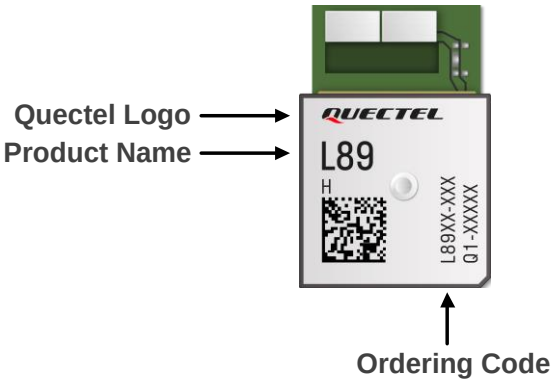


Figure 43: L89 (HA) Labelling Information

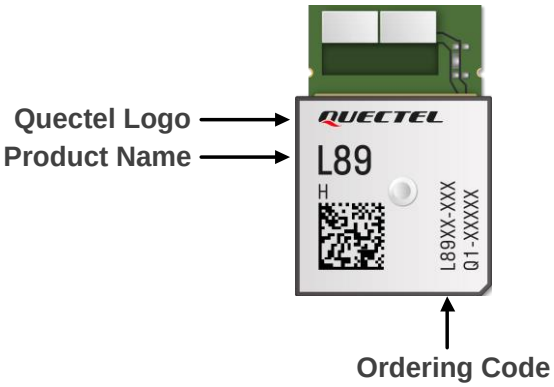


Figure 44: L89 (HD) Labelling Information

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

11 Appendix References

Table 18: Related Documents

Document Name	
[1]	Quectel_L89_R2.0_GNSS_Protocol_Specification
[2]	Quectel_L89(HD)&LC29H(AI)_GNSS_Protocol_Specification
[3]	Quectel_L89_R2.0&LC02H&LC29H&LC79H&QLM29H_Series_AGNSS_Application_Note
[4]	Quectel_L89_R2.0&LC29H&LC79H&QLM29H_Series_Firmware_Upgrade_Guide
[5]	Quectel_L89_R2.0_Reference_Design
[6]	Quectel_L89_R2.0&LC29H_Series&LC79H(AL)_I2C_Application_Note
[7]	Quectel_GNSS_Anetnna_Application_Note
[8]	Quectel_RF_Layout_Application_Note
[9]	Quectel_Module_Stencil_Design_Requirements
[10]	Quectel_Module_SMT_Application_Note

Table 19: Terms and Abbreviations

Abbreviation	Description
1PPS	1 Pulse Per Second
AGNSS	Assisted GNSS (Global Navigation Satellite System)
AIC	Active Interference Cancellation
BDS	BeiDou Navigation Satellite System
CEP	Circular Error Probable
DR	Dead Reckoning

Abbreviation	Description
EGNOS	European Geostationary Navigation Overlay Service
EPO	Extended Prediction Orbit
EPOC	Extended 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
kbps	kilobits per second
LCC	Leadless Chip Carrier (package)
LCM	Liquid Crystal Monitor
LDO	Low-dropout Regulator
LGA	Land Grid Array
LNA	Low-Noise Amplifier
MCU	Microcontroller Unit/Microprogrammed Control Unit
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
OC	Open Collector
PAIR	Proprietary Protocol of Airoha

Abbreviation	Description
PCB	Printed Circuit Board
PMU	Power Management Unit
PQTM	Proprietary Protocol of Quectel
PSRR	Power Supply Rejection Ratio
QZSS	Quasi-Zenith Satellite System
RF	Radio Frequency
RHCP	Right Hand Circular Polarization
RMS	Root Mean Square
RoHS	Restriction of Hazardous Substances
RTC	Real-Time Clock
RTK	Real-time Kinematic
RXD	Receive Data (Pin)
SAW	Surface Acoustic Wave
SBAS	Satellite-Based Augmentation System
SCL	Serial Clock
SDA	Serial Data
SMD	Surface Mount Device
SMT	Surface Mount Technology
SPDT	Single-Pole Double-Throw
SPI	Serial Peripheral Interface
SRAM	Static Random Access Memory
SV	Satellite Vehicle
TCXO	Temperature Compensated Crystal Oscillator
TTFF	Time to First Fix
TVS	Transient Voltage Suppressor

Abbreviation	Description
UART	Universal Asynchronous Receiver/Transmitter
USB	Universal Serial Bus
UTC	Coordinated Universal Time
UVLO	Undervoltage Protection
$V_I$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
WDT	Watchdog Timer
XTAL	External Crystal Oscillation