LC76G Series
Hardware Design

GNSS Module Series

Version: 1.2

Date: 2023-05-30

Status: Released

At Quectel, our aim is to provide timely and comprehensive services to our customers. If you require any assistance, please contact our headquarters:

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

Or our local offices. For more information, please visit:
http://www.quectel.com/support/sales.htm.

For technical support, or to report documentation errors, please visit:
http://www.quectel.com/support/technical.htm.
Or email us at: support@quectel.com.

Legal Notices

Use and Disclosure Restrictions

License Agreements

Copyright

Trademarks

Except as otherwise set forth herein, nothing in this document shall be construed as conferring any rights to use any trademark, trade name or name, abbreviation, or counterfeit product thereof owned by Quectel or any third party in advertising, publicity, or other aspects.

Third-Party Rights

This document may refer to hardware, software and/or documentation owned by one or more third parties (“third-party materials”). Use of such third-party materials shall be governed by all restrictions and obligations applicable thereto.

We make no warranty or representation, either express or implied, regarding the third-party materials, including but not limited to any implied or statutory, warranties of merchantability or fitness for a particular purpose, quiet enjoyment, system integration, information accuracy, and non-infringement of any third-party intellectual property rights with regard to the licensed technology or use thereof. Nothing herein constitutes a representation or warranty by us to either develop, enhance, modify, distribute, market, sell, offer for sale, or otherwise maintain production of any our products or any other hardware, software, device, tool, information, or product. We moreover disclaim any and all warranties arising from the course of dealing or usage of trade.

Privacy Policy

To implement module functionality, certain device data are uploaded to Quectel’s or third-party’s servers, including carriers, chipset suppliers or customer-designated servers. Quectel, strictly abiding by the relevant laws and regulations, shall retain, use, disclose or otherwise process relevant data for the purpose of performing the service only or as permitted by applicable laws. Before data interaction with third parties, please be informed of their privacy and data security policy.

Disclaimer

a) We acknowledge no liability for any injury or damage arising from the reliance upon the information.
b) We shall bear no liability resulting from any inaccuracies or omissions, or from the use of the information contained herein.
c) While we have made every effort to ensure that the functions and features under development are free from errors, it is possible that they could contain errors, inaccuracies, and omissions. Unless otherwise provided by valid agreement, we make no warranties of any kind, either implied or express, and exclude all liability for any loss or damage suffered in connection with the use of features and functions under development, to the maximum extent permitted by law, regardless of whether such loss or damage may have been foreseeable.
d) We are not responsible for the accessibility, safety, accuracy, availability, legality, or completeness of information, advertising, commercial offers, products, services, and materials on third-party websites and third-party resources.

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 precautions by incorporating them 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	**LC76G Series Hardware Design**
Subtitle	GNSS Module Series
Document Type	Hardware Design
Document Status	Released

Revision History

Version	Date	Description
-	2022-05-11	Creation of the document
1.0	2022-07-14	First official release
1.1	2023-02-09	1. Added the applicable variant LC76G (PB). 2. Added I2C function for LC76G (PA). 3. Added the ALP mode (*Chapters 1.1, 1.3* and *3.3*). 4. Added the number of concurrent GNSS (*Table 2*). 5. Updated the power consumption under acquisition and tracking modes, TTFF, 1PPS accuracy signal of LC76G (AB) and LC76G (PA), and the power consumption under Backup mode, horizontal position accuracy and update rate of LC76G (PA), and added the power data (*Table 3*). 6. Added the DC characteristics of all pins (*Table 6*). 7. Reserved the AP_REQ pin (*Figure 1*, *Chapters 2* and *4.1*). 8. Added the supported messages for UART, SPI and I2C interfaces (*Table 6* and *Chapter 4.1*) 9. Added the 3.7 V lithium battery reference circuit (*Figure 7*). 10. Updated or added the description of Backup mode, including: The way to exit Backup mode; Notes of the way to exit Backup mode for LC76G (AB), the way to enter Backup mode for LC76G (PA), and modules' approximate power

Version	Date	Description
		consumption when they are forced into Backup mode without sending a software command (*Chapter 3.3.4*). 11. Updated the supported baud rates of UART interface (*Chapter 4.1.1.2*). 12. Updated the resistance of the pull-up resistors in I2C interface reference design (*Figure*). 13. Added the optional notch circuit and band-pass filter circuit to active and passive antenna reference designs, as well as the corresponding description (*Chapter 5.2*). 14. Updated the maximum input power at RF_IN for LC76G (AB) and LC76G (PA) (*Table 10*). 15. Updated the typical high-level input voltage of RESET_N and added the maximum output current of VDD_RF for LC76G (AB) and LC76G (PA) (*Table 12*). 16. Update the supply current for LC76G (PA) (*Table 15*). 17. Added the module mounting direction (*Chapter 8.1.3*). 18. Added the sizes of pizza box and carton (*Chapter 8.1.4*). 19. Updated the recommended ramp-to-soak, ramp-up and cool-down slopes (*Figure* and *Table 19*).
1.2	2023-05-30	1. Added the power consumption in ALP mode for LC76G (AB) (*Table 3* and *Table 14*). 2. Added the requirement for GEOFENCE and 3D_FIX pins when the module is powered on (*Chapters 2*, *4.1.2* and *4.1.4*). 3. Deleted the notch circuit in antenna reference designs and corresponding description (*Chapter 5.2*).

Contents

Table Index

Figure Index

1 Product Description

1.1. Overview

Quectel LC76G series module supports multiple global positioning constellations, such as GPS, GLONASS, Galileo, BDS and QZSS. The modules also support SBAS (including WAAS, EGNOS, MSAS and GAGAN) and AGNSS functions. The LC76G series comprises three variants: LC76G (AB), LC76G (PA) and LC76G (PB).

Key features:

- The single-band, multi-constellation GNSS module series features a high-performance, high reliability positioning engine facilitating fast and precise GNSS positioning.
- The LC76G (AB) is designed to meet standard application requirements while operating at 3.3 V, while the LC76G (PA) and the LC76G (PB) are super low power consumption variants operating at 3.3 V and 1.8 V respectively.
- Supported serial communication interfaces: UART, SPI* and I2C.
- Supported advanced power saving modes: Backup mode and ALP mode.
- The embedded low-power algorithms make the LC76G series module suitable for different application scenarios.
- EASY technology facilitates achieving a faster Time to First Fix (TTFF) in either hot or warm start.
- The integrated flash memory provides the capacity for storing user-specific configurations and future firmware upgrades.

The LC76G is a series of SMD type modules with a compact form factor of 10.1 mm × 9.7 mm × 2.4 mm. They can be embedded in your applications through 18 LCC pins and 10 LGA pins.

The LC76G series is fully compliant with the EU RoHS Directive.

NOTE

Where applicable, this document will use the words module/modules when referring to common attributes and LC76G (AB), LC76G (PA) and LC76G (PB) 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, an asterisk (*) after a function, feature, interface, pin name, or argument, 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 model sample is currently unavailable.
●	The symbol indicates that a function or technology is supported by the module(s).

1.2. Features

Table 2: Product Features

Features		LC76G (AB)	LC76G (PA)	LC76G (PB)
Grade	Industrial	●	●	●
	Automotive	-	-	-
Category	Standard Precision GNSS	●	●	●
	High Precision GNSS	-	-	-
	DR	-	-	-
	RTK	-	-	-
	Timing	-	-	-
VCC Voltage	2.55–3.6 V, Typ. 3.3 V	●	●	-
	1.75–1.98 V, Typ. 1.8 V	-	-	●
V_BCKP Voltage	1.65–3.6 V, Typ. 3.3 V	●	●	-
	1.65–3.6 V, Typ. 1.8 V	-	-	●
I/O Voltage	Following VCC	●	●	●
Communication Interfaces	UART	●	●	●
	SPI*	●	●	●

Features			LC76G (AB)	LC76G (PA)	LC76G (PB)
	I2C		●	●	●
	CAN		-	-	-
	USB		-	-	-
Integrated Features	Additional LNA		●	●	●
	Additional Filter		●	●	●
	RTC Crystal		●	●	●
	TCXO Oscillator		●	●	●
	6-axis IMU		-	-	-
Constellations and Frequency Bands	Number of Concurrent GNSS		4 + QZSS	4 + QZSS	4 + QZSS
	GPS	L1 C/A	●	●	●
		L5	-	-	-
		L2C	-	-	-
	GLONASS	L1	●	●	●
		L2	-	-	-
	Galileo	E1	●	●	●
		E5a	-	-	-
		E5b	-	-	-
	BDS	B1I	●	●	●
		B1C	●	●	●
		B2a	-	-	-
		B2I	-	-	-
	QZSS	L1 C/A	●	●	●
		L5	-	-	-
		L2C	-	-	-
	NavIC	L5	-	-	-
	SBAS	L1	●	●	●

Features		LC76G (AB)	LC76G (PA)	LC76G (PB)
Temperature Range	Operating temperature range: -40 °C to +85 °C Storage temperature range: -40 °C to +90 °C			
Physical Characteristics	Size: (10.1 ±0.15) mm × (9.7 ±0.15) mm × (2.4 ±0.20) mm Weight: Approx. 0.5 g			

NOTE

For more information about GNSS constellation configuration, see *document [1] protocol specification*.

1.3. Performance

Table 3: Product Performance

Parameter	Specification	LC76G (AB)	LC76G (PA)	LC76G (PB)
Power Consumption [1] (GPS + GLONASS + Galileo + BDS + QZSS)	Acquisition	36 mA (118.8 mW)	10 mA (33 mW)	15 mA (27 mW)
	Tracking	36 mA (118.8 mW)	10 mA (33 mW)	15 mA (27 mW)
	ALP mode	13 mA (42.9 mW)	5.5 mA (18.15 mW)	7.5 mA (13.5 mW)
	Backup Mode	13 µA (42.9 µW)	13 µA (42.9 µW)	13 µA (23.4 µW)
Sensitivity (GPS + GLONASS + Galileo + BDS + QZSS)	Acquisition	-147 dBm	-147 dBm	-147 dBm
	Reacquisition	-159 dBm	-159 dBm	-159 dBm
	Tracking	-166 dBm	-166 dBm	-166 dBm
TTFF [1] (without AGNSS)	Cold Start	28 s	28 s	28 s
	Warm Start	25 s	25 s	25 s
	Hot Start	1 s	1 s	1 s
TTFF [2] (with EASY)	Cold Start	15 s	15 s	15 s
	Warm Start	2 s	2 s	2 s

[1] Room temperature, all satellites at -130 dBm.
[2] Open-sky, active high precision GNSS antenna.

Parameter	Specification	LC76G (AB)	LC76G (PA)	LC76G (PB)
	Hot Start	1 s	1 s	1 s
TTFF [2] (with EPO)	Cold Start	5 s	5 s	5 s
Horizontal Position Accuracy [3]		1.5 m	1.5 m	1.5 m
Update Rate		1 Hz (Default); Max. 10 Hz	1 Hz	1 Hz
Accuracy of 1PPS Signal [1]	RMS	30 ns	30 ns	30 ns
	3σ	70 ns	70 ns	70 ns
Velocity Accuracy [1]	Without Aid: 0.1 m/s			
Acceleration Accuracy [1]	Without Aid: 0.1 m/s²			
Dynamic Performance [1]	Maximum Altitude: 10000 m Maximum Velocity: 500 m/s Maximum Acceleration: 4g			

1.4. Block Diagram

A block diagram of the module is presented below. It includes a front-end section with an additional LNA and SAW filter. Other parts of the module include a TCXO, an XTAL and a GNSS IC with a PMU.

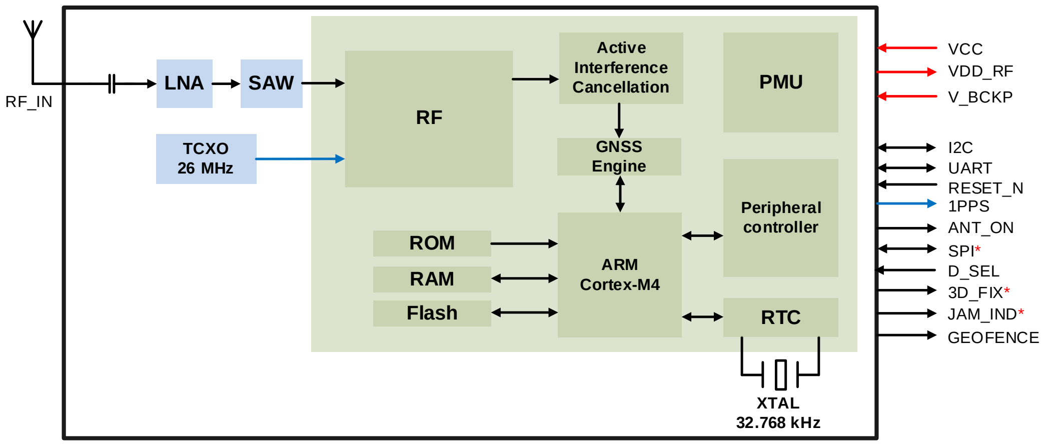


Figure 1: Block Diagram

[3] CEP, 50 %, 24 hours static, -130 dBm, more than 6 SVs.

1.5. GNSS Constellations

The module is a single-band GNSS receiver that can concurrently track signals from up to 4 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 an intense low power consumption is the application’s main a key factor, then the module can be configured for a subset of these 4 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 dense urban canyons.

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 B1C: 1575.42 MHz
QZSS	L1 C/A: 1575.42 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 are WAAS, EGNOS, MSAS and GAGAN.

1.7. AGNSS

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

1.7.1. EASY

The module supports the EASY technology to improve TTFF by providing ancillary information, such as ephemeris and almanac.

The EASY technology works as an embedded software to reduce the TTFF duration 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 for 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 can improve the 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 using the **$PAIR490** command. For more information about the command, see *document [1] protocol specification*.

1.7.2. EPO

The module features a leading AGNSS technology called EPO, which assists the receiver to reduce the TTFF, and it's valid for up to 14 days. For more information about EPO, see *document [2] AGNSS application note*.

1.8. Multi-Tone AIC

The module includes a function called multi-tone Active Interference Cancellation (AIC), which is used to reduce the 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 a better navigation quality.

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

1.9. 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 its current location is within a defined GEOFNECE region or not and signals its status via the GEOFENCE pin. The geofencing feature can be configured using the **$PAIR890** command. The feature is activated once one or more geofences has been configured.

For more information about geofencing configuration, see *document [1] protocol specification*.

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 [3] firmware upgrade guide*.

2 Pin Assignment

The module is equipped with 28 pins (18 LCC pins and 10 LGA pins) by which it can be mounted on your PCB.

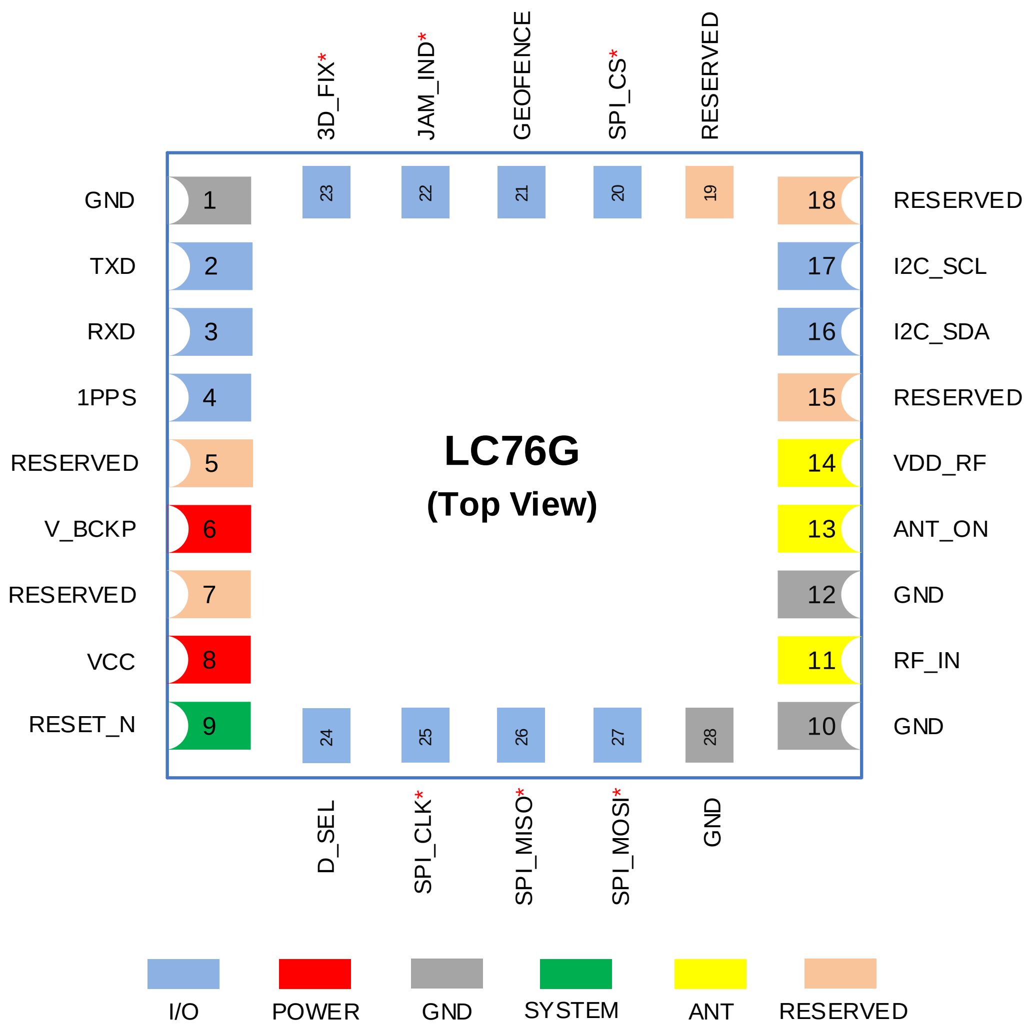


Figure 2: Pin Assignment

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	DC Characteristics	Remarks
Power	VCC	8	PI	Main power supply	For LC76G (AB, PA): $V_I$min = 2.55 V $V_I$nom = 3.3 V $V_I$max = 3.6 V For LC76G (PB): $V_I$min = 1.75 V $V_I$nom = 1.8 V $V_I$max = 1.98 V	Provides clean and steady voltage.
	V_BCKP	6	PI	Backup power supply for backup domain	For LC76G (AB, PA): $V_I$min = 1.65 V $V_I$nom = 3.3 V $V_I$max = 3.6 V For LC76G (PB): $V_I$min = 1.65 V $V_I$nom = 1.8 V $V_I$max = 3.6 V	V_BCKP must be connected to power supply for startup, and it should always be powered if hot (warm) start is needed.
I/O	TXD	2	DO	Transmits data	For LC76G (AB, PA): V_{OL}max = 0.4 V V_{OH}min = 2.4 V For LC76G (PB): V_{OL}max = 0.27 V V_{OH}min = 1.53 V	UART interface supports RTCM message, standard NMEA message, PAIR/PQTM message, binary data and firmware upgrade.

Function	Name	No.	I/O	Description	DC Characteristics	Remarks
	RXD	3	DI	Receives data	For LC76G (AB, PA): V_{IL}min = -0.3 V V_{IL}max = 0.8 V V_{IH}min = 2 V V_{IH}max = VCC + 0.3 V For LC76G (PB): V_{IL}min = -0.3 V V_{IL}max = 0.45 V V_{IH}min = 1.35 V V_{IH}max = VCC + 0.3 V	
	D_SEL	24	DI	Selects the interface to download		D_SEL is internally pulled down by default. High level: select SPI to download; Low level: select UART to download.
	SPI_CLK*	25	DI	SPI clock		SPI supports RTCM message, standard NMEA message, PAIR/PQTM message and firmware upgrade. In this case, the module requires a four-wire SPI (SPI_MOSI, SPI_MISO, SPI_CLK and SPI_CS).
	SPI_CS*	20	DI	SPI chip-select		
	SPI_MOSI*	27	DI	SPI master out; slave in		
	SPI_MISO*	26	DO	SPI master in; slave out	For LC76G (AB, PA): V_{OL}max = 0.4 V V_{OH}min = 2.4 V For LC76G (PB): V_{OL}max = 0.27 V V_{OH}min = 1.53 V	
	I2C_SCL	17	DI	I2C serial clock	For LC76G (AB, PA): V_{IL}min = -0.3 V V_{IL}max = 0.8 V V_{IH}min = 2 V V_{IH}max = VCC + 0.3 V V_{OL}max = 0.4 V V_{OH}min = 2.4 V For LC76G (PB): V_{IL}min = -0.3 V V_{IL}max = 0.45 V V_{IH}min = 1.35 V V_{IH}max = VCC + 0.3 V V_{OL}max = 0.27 V V_{OH}min = 1.53 V	I2C interface supports RTCM message, standard NMEA message and PAIR/PQTM message.
	I2C_SDA	16	DIO	I2C serial data		
	GEOFENCE	21	DO	Indicates geofence status	For LC76G (AB, PA): V_{OL}max = 0.4 V V_{OH}min = 2.4 V For LC76G (PB): V_{OL}max = 0.27 V V_{OH}min = 1.53 V	Once the pin is activated, the receiver continuously compares its current position to the preset geofence area. If unused, leave the pin N/C (not connected).

Function	Name	No.	I/O	Description	DC Characteristics	Remarks
	JAM_IND*	22	DO	Jamming indication	For LC76G (AB, PA): V_{OL}max = 0.4 V V_{OH}min = 2.4 V For LC76G (PB): V_{OL}max = 0.27 V V_{OH}min = 1.53 V	If unused, leave the pin N/C.
	1PPS	4	DO	One pulse per second		Synchronized on the rising edge. If unused, leave the pin N/C.
	3D_FIX*	23	DO	3D position fix indication		If unused, leave the pin N/C.
ANT	RF_IN	11	AI	GNSS antenna interface	-	50 Ω characteristic impedance.
	ANT_ON	13	DO	Power control for external LNA or active antenna in power saving mode	For LC76G (AB, PA): V_{OL}max = 0.4 V V_{OH}min = 2.4 V For LC76G (PB): V_{OL}max = 0.27 V V_{OH}min = 1.53 V	The pin outputs high-level signal in Continuous and ALP modes, and low-level signal in Backup mode. If unused, leave the pin N/C.
	VDD_RF	14	PO	Supplies power for external RF components	$V_O$nom = VCC	VDD_RF = VCC. The output current capacity depends on VCC. Typically used for powering an external active antenna or LNA. If unused, leave the pin N/C.
System	RESET_N	9	DI	Resets the module	For LC76G (AB, PA): V_{IL}min = -0.3 V V_{IL}max = 0.45 V V_{IH}min = 1.8 V V_{IH}max = 3.6 V For LC76G (PB): V_{IL}min = -0.3 V V_{IL}max = 0.45 V V_{IH}min = 1.35 V V_{IH}max = 2.1 V	Active low. The pin belongs to the backup domain.
GND	GND	1, 10, 12, 28	-	Ground	-	Ensure a good GND connection to all module GND pins, preferably with a large ground plane.
RESERVED	RESERVED	5, 7, 15, 18, 19	-	Reserved	-	These pins must be left floating and cannot be connected to power or GND.

NOTE

1. To ensure that the module enters the normal operating mode, it is necessary that GEOFENCE and 3D_FIX* pins cannot be pulled up within 50 ms after the module is reset or powered on.
2. Leave RESERVED and unused pins N/C.

3 Power Management

The module features a power optimized architecture with a built-in autonomous energy saving capabilities. To minimize power consumption at any given time, the receiver can operate at one of the three operating modes: ALP mode and Backup mode for optimum power consumption, and Continuous mode for optimum performance.

3.1. Power Unit

VCC is the supply voltage pin of the module. It supplies 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 RAM. To achieve quick startup and improve TTFF duration, the backup domain power supply should be valid. If the VCC is not valid, the V_BCKP is powering the RAM section 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 Continuous mode, VDD_RF supplies for the external active antenna or the LNA. Only if VCC is cut off, VDD_RF is turned off.

The module’s internal power supply is shown below:

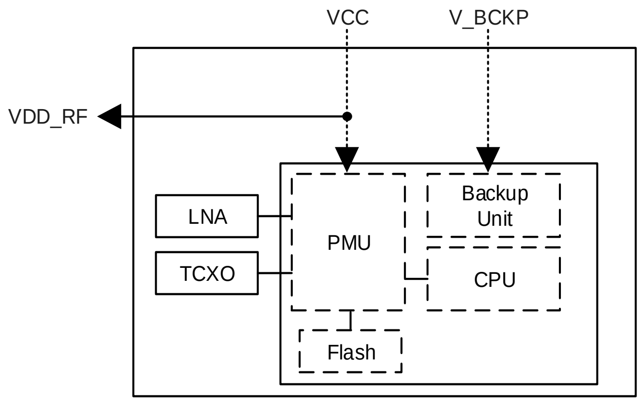


Figure 3: Internal Power Supply

3.2. Power Supply

3.2.1. VCC

The VCC is the supply voltage pin that provides power to the BB and RF sections.

Module power consumption may vary by several orders of magnitude, especially when a power saving mode is enabled. Therefore, it is important that the power supply is 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 that the LDO at the power supply or module input can provide the sufficient current. 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 lowest value capacitor should be the closest to module pins.

It is not recommended to use a switching DC-DC converter.

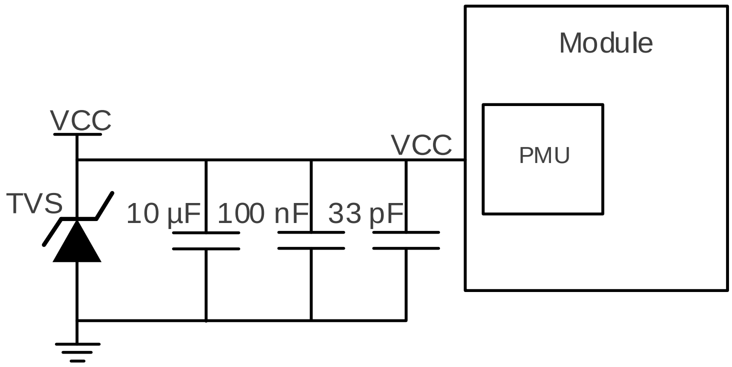


Figure 4: VCC Input Reference Circuit

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 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.

For LC76G (AB) and LC76G (PA), it is recommended to use an external rechargeable battery for V_BCKP and place the 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 reference charging circuit is illustrated below.

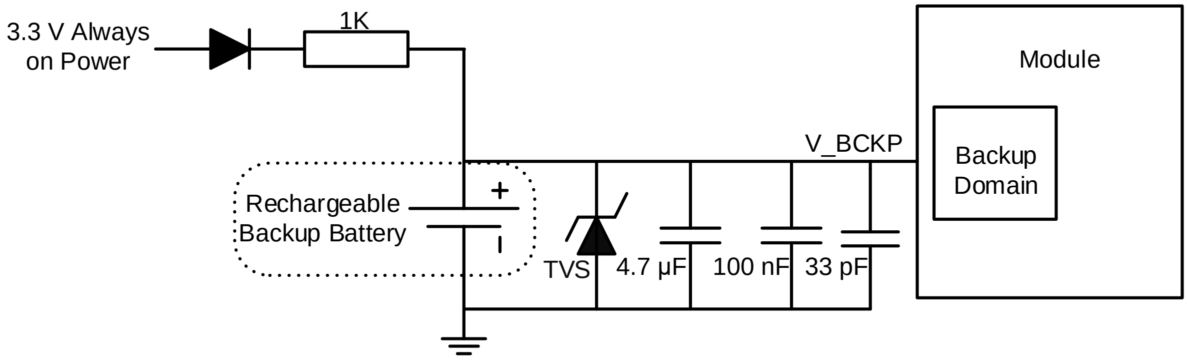


Figure 5: LC76G (AB, PA) Reference Charging Circuit with Rechargeable Backup Battery

For LC76G (PB), it is recommended to use a power supply of 1.8 V for V_BCKP and place a TVS and a combination of a 4.7 μF, a 100 nF and a 33 pF capacitor near the V_BCKP pin. The reference circuit is illustrated below.

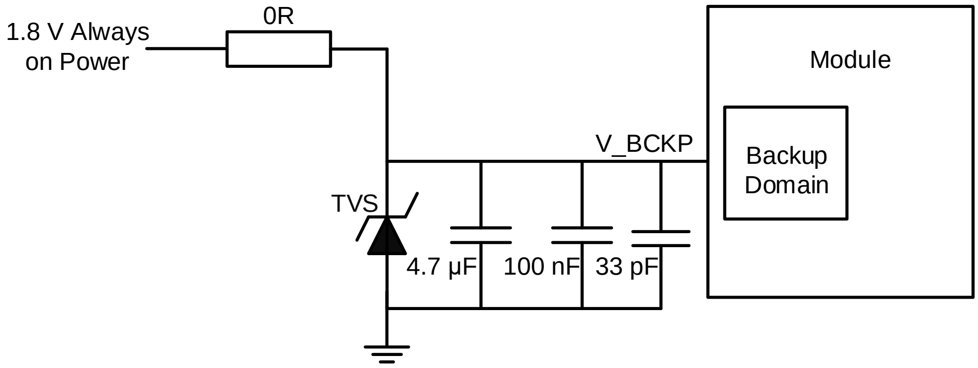


Figure 6: LC76G (PB) Reference Power Supply Circuit

V_BCKP on LC76G (AB), LC76G (PA) and LC76G (PB) can also be powered by a 3.7 V lithium battery, as shown below.

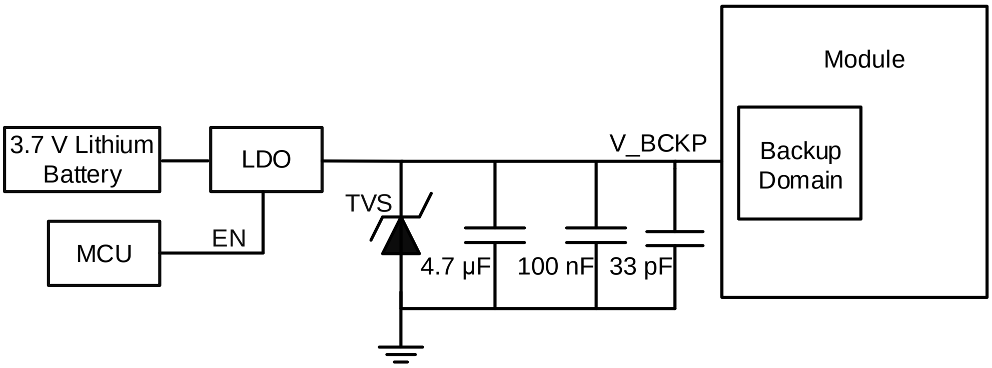


Figure 7: LC76G (AB, PA, PB) Reference Power Supply Circuit with 3.7 V Lithium Battery

NOTE

1. Connect the V_BCKP pin to VCC when backup supply voltage is unavailable.
2. In the Continuous mode, the maximum current consumption of V_BCKP exceeds 100 µA, which will deplete the battery. Therefore, it is not recommended to use a non-rechargeable battery.
3. If V_BCKP is below the minimum recommended operating voltage, the module cannot work normally.
4. To limit the charging current and maintain the performance of the rechargeable battery, it is necessary to select 1 kΩ current-limiting resistor. The required specific resistance depends on the battery chosen for your application.
5. It is recommended to control the module V_BCKP 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	ALP
NMEA/RTCM from UART	●	-	●
1PPS	●	-	●
RF	●	-	●
Acquisition & Tracking	●	-	●
Power Consumption	High	Low	Low
Position Accuracy	High	-	Medium

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. When the acquisition is completed, the module automatically switches to tracking mode. In tracking mode, the module tracks satellites and demodulates the navigation data from specific satellites.

3.3.3. ALP Mode

The ALP mode refers to Adaptive Low Power mode. It is currently only available under the normal operating mode. Moreover, some of the features, such as SBAS, will be automatically disabled.

- To enter ALP mode: Send the **$PAIR732,1*21** command.
- To exit ALP mode: Send the **$PAIR732,0*20** command.

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

3.3.4. Backup Mode

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

- To enter Backup mode:
  1. Send the **$PAIR650,0*25** command to shut down internal main power supply in sequence.
  2. Cut off the power supply of the VCC pin and keep the V_BCKP powered.

- To exit Backup mode:
  1. Restore VCC power supply.
  2. Drive the RESET_N low for at least 100 ms.

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

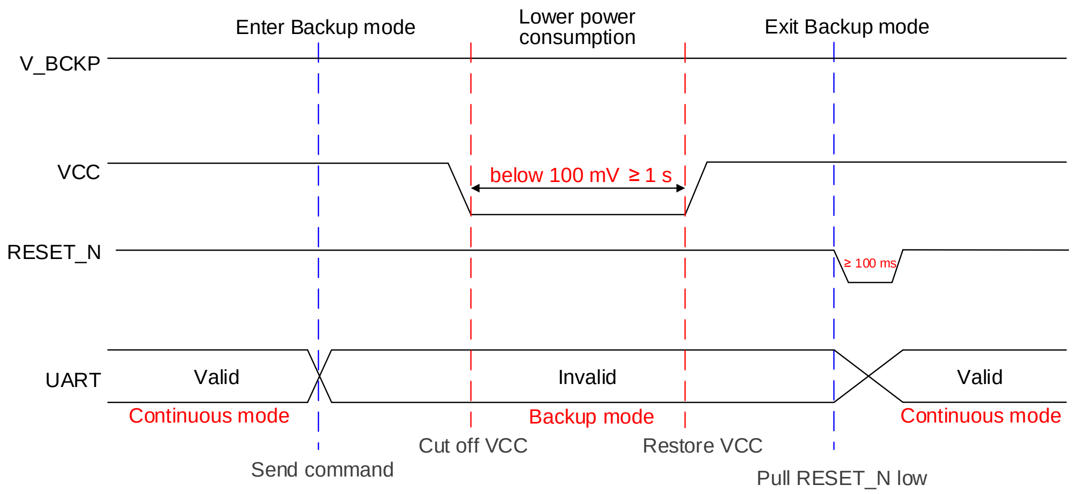


Figure 8: Enter/Exit Backup Mode Sequence

NOTE

1. The **$PAIR650,0*25** command must be sent; to ensure hot (warm) start of the module at the next startup, V_BCKP must be kept powered.
2. Ensure a stable V_BCKP voltage without rush or drop when the VCC is switched on or off.
3. For LC76G (AB), if you only send the **$PAIR650,0*25** command without cutting off VCC, exit Backup mode by pulling RESET_N low for at least 100 ms.
4. For LC76G (PA) and LC76G (PB), the VCC must be cut off to enter Backup mode; otherwise, the power consumption will be at mA level.
5. If you cut off module power supply directly without sending the **$PAIR650,0*25** command first, then the module will not enter the Backup mode normally. In this case, the module will be in an undefined state and the power consumption is going to be higher, about 30 μA.

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.

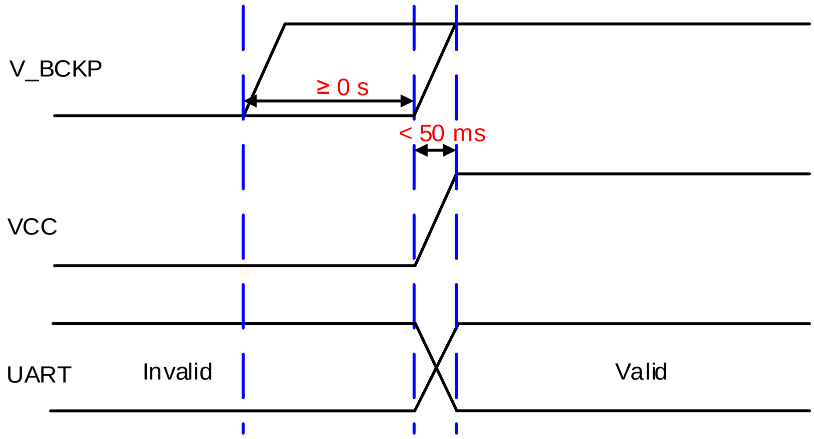


Figure 10: Power-up Sequence

3.5. Power-down Sequence

Once the VCC and V_BCKP are shut down, the module turns off automatically and voltage should drop quickly in less than 50 ms.

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

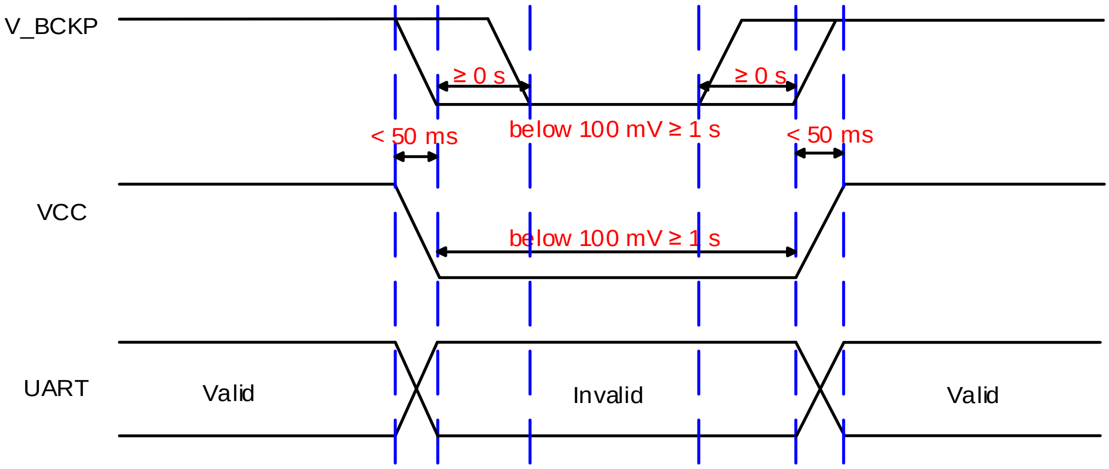


Figure 1: Power-down and Power-on Restart Sequence

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_SEL)

The D_SEL pin is internally pulled down by default and the UART is selected to download. If SPI is selected to download, pull the D_SEL pin up externally with a 10 kΩ resistor.

4.1.1.2. UART Interface

The module has one UART interface with the following features:

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

For more information, see *document [1] protocol specification*.

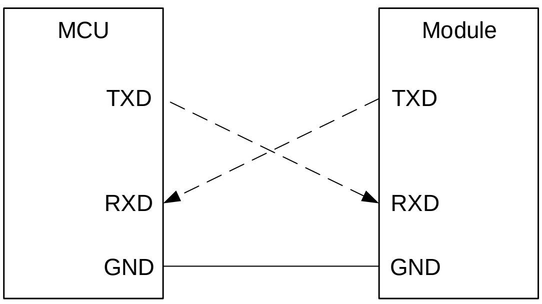


Figure 2: UART Interface Reference Design

A reference design is shown in the figure above. For more information, see *document [4] reference design*.

NOTE

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

4.1.1.3. SPI*

The module has one SPI with the following features:

- Supports RTCM message, standard NMEA message, PAIR/PQTM message and firmware upgrade.
- Operates in slave mode.
- Fixed data frame size of 8 bits.

For more information, see *document [1] protocol specification*.

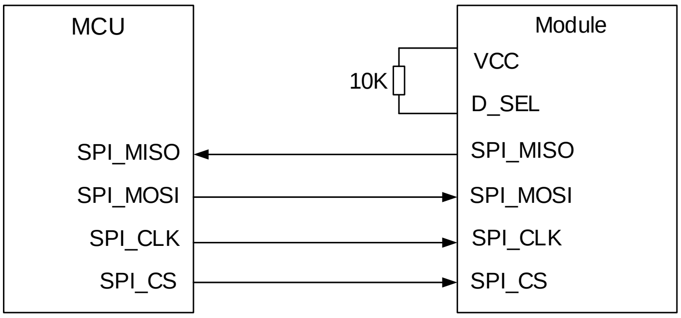


Figure 3: SPI Reference Design

A reference design is shown in the figure above. For more information, see *document [4] reference design*.

NOTE

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

4.1.1.4. I2C Interface

The module has one I2C interface with the following features:

- Supports RTCM message, standard NMEA message and PAIR/PQTM message.
- Supports standard mode (100 kbps) and fast mode (400 kbps).
- Operates in slave mode.
- Support 7-bit address.
- Open-drain output.

For more information, see *document [1] protocol specification*.

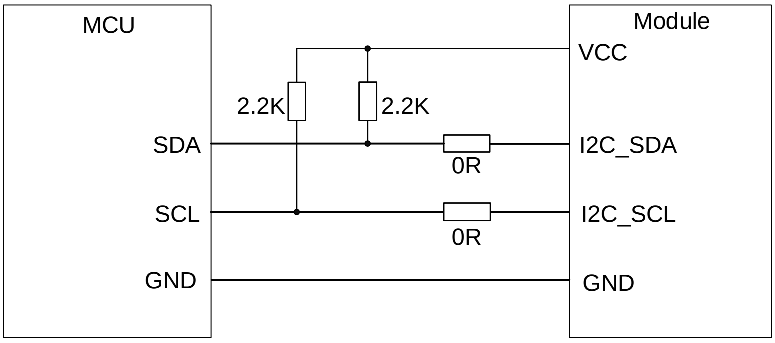


Figure 4: I2C Interface Reference Design

A reference design is shown in the figure above. For more information, see *document [4] reference design*.

NOTE

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

4.1.2. GEOFENCE

The GEOFENCE pin indicates the current geofence status. Geofence configurations including geofence area(s) can be set using the **$PAIR890** command. The receiver continuously compares its current position to the preset geofence area(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 the receiver is inside the geofence area(s). For more information, see *document [1] protocol specification*.

NOTE

Once the module is powered on, the level of the pin affects the internal configuration due to the internal mechanism of the module. To ensure that the module enters the normal operation mode, it is necessary that the pin cannot be pulled up within 50 ms of the module being reset or powered on.

4.1.3. 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.

4.1.4. 3D_FIX*

The 3D_FIX pin is at a 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.

NOTE

When the module is powered on, the level of the pin will affect the internal configuration due to the internal mechanism of the module. To ensure that the module enters the normal operation mode, it is necessary that the pin cannot be pulled up within 50 ms of the module being reset or powered on.

4.1.5. 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 about pulse accuracy.

4.2. System Pin

4.2.1. RESET_N

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

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

The reference circuit shown below is recommended to control the RESET_N pin.

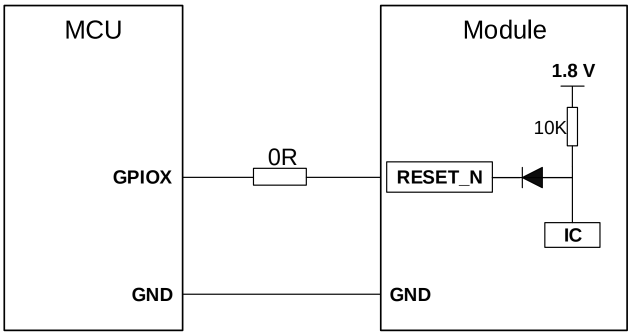


Figure 5: Reference Circuit for Module Reset

The following figure shows the reset sequence of the module.

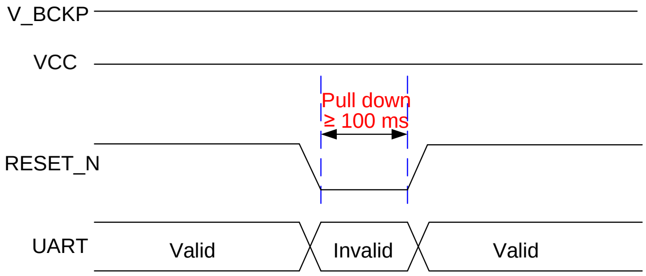


Figure 6: Reset Sequence

NOTE

The module's RESET_N pin must be connected to the MCU so that it can be used to reset the module if it enters an abnormal state.

5 Design

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

5.1. Antenna Selection

5.1.1. Antenna Specifications

The module can be connected to a dedicated passive or an active single-band GNSS antenna to receive GNSS satellite signals. The recommended antenna specifications are listed in the table below.

Table 8: Recommended Antenna Specifications

Antenna Type	Specifications
Passive Antenna	Frequency Range: 1559–1606 MHz Polarization: RHCP VSWR: < 2 (Typ.) Passive Antenna Gain: > 0 dBi
Active Antenna	Frequency Range: 1559–1606 MHz Polarization: RHCP VSWR: < 2 (Typ.) Passive Antenna Gain: > 0 dBi Active Antenna Noise Figure: < 1.5 dB Active Antenna Total Gain: < 17 dB

NOTE

1. For recommended antenna and design, see *document [5] GNSS antenna selection guidance* or contact Quectel Technical Support (support@Quectel.com).
2. The total antenna gain equals the internal LNA gain minus the total insertion loss of cables and components inside the antenna.

5.1.2. Antenna Selection Guide

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

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

"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 the 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, a SAW filter circuit must be added to the antenna design to further reduce the impact of out-of-band signals on the GNSS module. The SAW filter circuit has a stable suppression effect on all out-of-band signals. In the actual layout, the circuit should be placed close to RF_IN pin. The recommended SAW in the SAW filter circuit is SAFFB1G56AC0F7F from Murata or B39162B2618P810 from RF360. SAW filter circuit can be selected according to the use case.

5.2.1. Active Antenna Reference Design

A typical reference design of an active antenna is illustrated in the following figure. In this case, the antenna is powered by VDD_RF. To mitigate the impact of out-of-band signals on GNSS module performance in a complex electromagnetic environment around the module, you must choose the active antenna whose SAW filter is placed in front of the LNA in the internal framework

If VDD_RF pin supplies the active antenna, it is important to consider the 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. The minimum operating voltage of the selected active antenna must meet the circuit design characteristics.

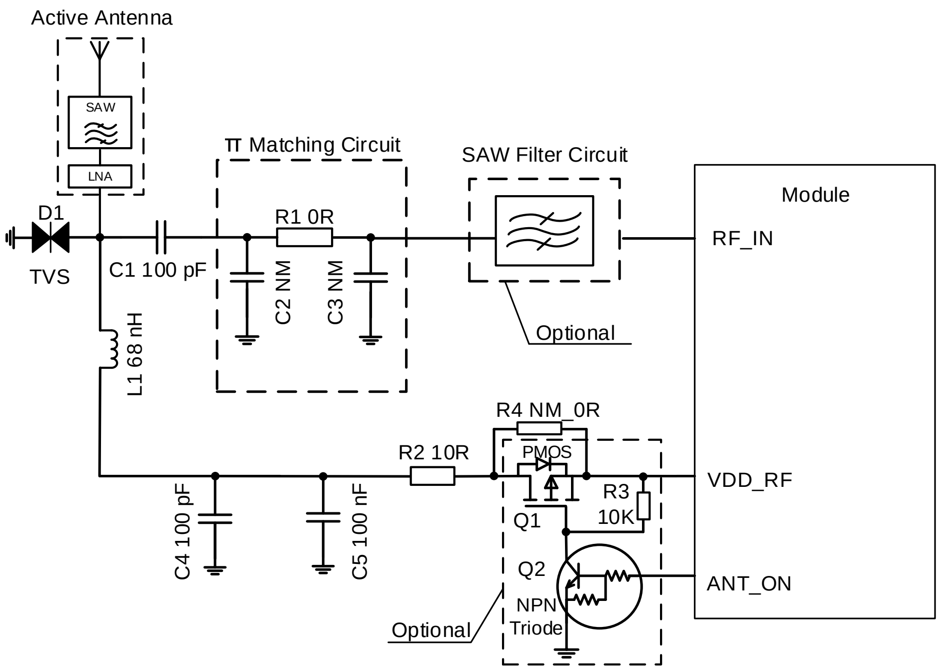


Figure 7: Active Antenna Reference Design

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.

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

The antenna is always powered when R4 is mounted. When it is not mounted, while Q1, Q2 and R3 are mounted, the antenna power supply can be controlled through 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.

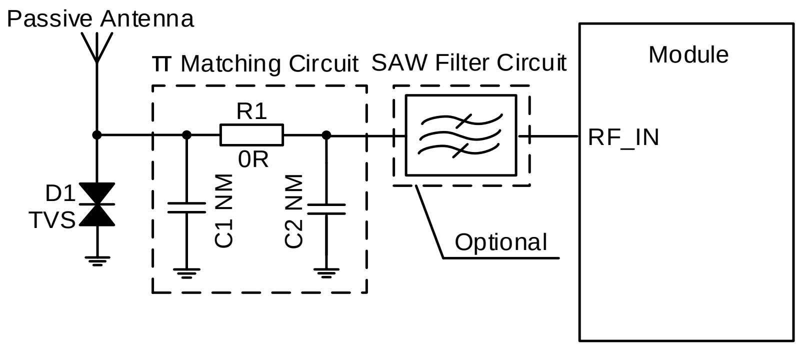


Figure 8: Passive Antenna Reference Design

C1, R1, and C2 are reserved for matching antenna impedance. By default, R1 is 0 Ω, and C1 and C2 are not mounted. D1 is an electrostatic discharge (ESD) protection device to protect the RF signal input from the potential damage caused by ESD. The junction capacitance of D1 cannot be more than 0.6 pF and a transient voltage suppressor is recommended. RF trace impedance 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 the environmental interference. According to 3GPP specifications, a cellular terminal should transmit a signal of up to 33 dBm at GSM bands, or of about 24 dBm at WCDMA and LTE bands, or of about at 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. For example, GPS L1 is centered at 1575.42 MHz with a bandwidth of 2.046 MHz. As shown in the figure below, the frequency of the interfering signal is within the GPS operation band, and the power of the interfering signal is higher than the power of the received GPS signal.

See the following figure for more details.

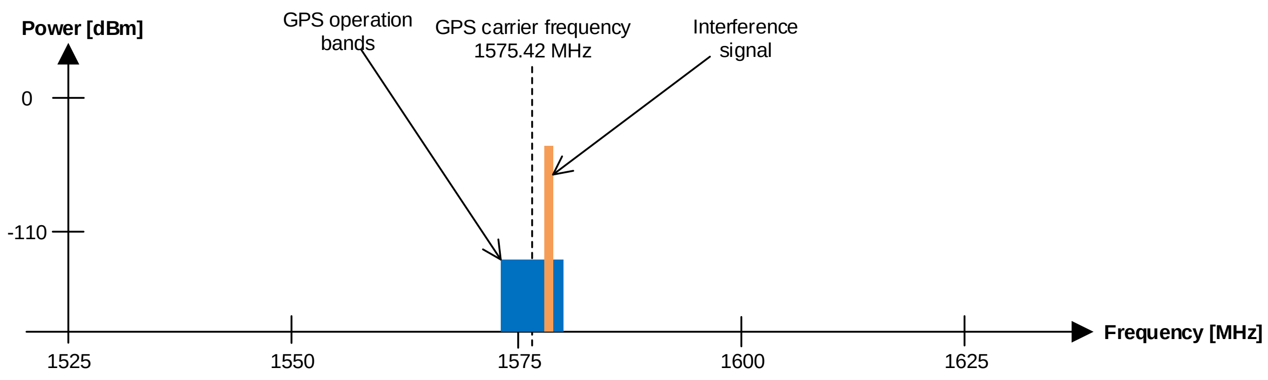


Figure 9: In-band Interference on GPS L1

The most common in-band interferences usually come from:

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

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

Table 9: Intermodulation Distortion (IMD) Products

Source F1	Source F2	IM Calculation	IMD Products
GSM850/Band 5	Wi-Fi 2.4 GHz	F2 (2412 MHz) - F1 (837 MHz)	IMD2 = 1575 MHz
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	N/A	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.

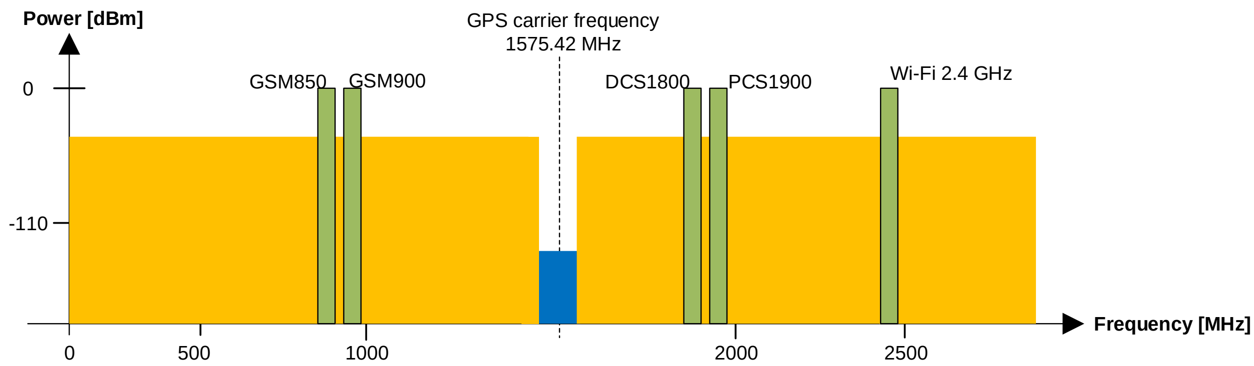


Figure 20: Out-of-band Interference on GPS L1

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 its possible 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.

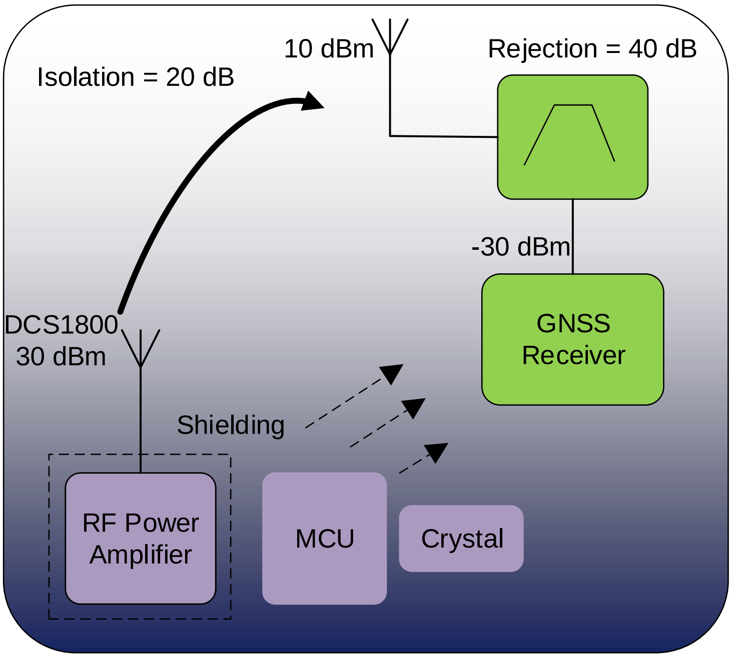


Figure 1: Interference Source and Its Path

5.4. Recommended Footprint

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

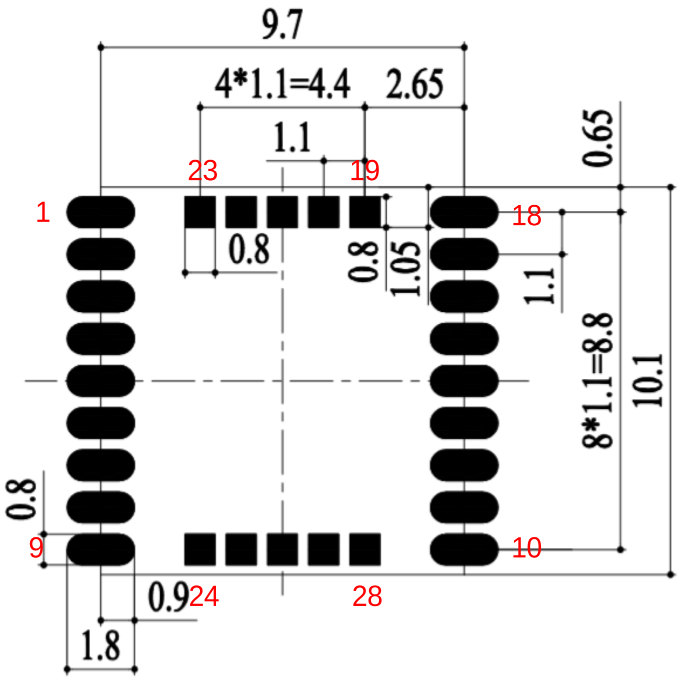


Figure 2: Recommended Footprint

NOTE

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

6 Electrical Specification

6.1. Absolute Maximum Ratings

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

Table 10: Absolute Maximum Ratings for LC76G (AB) and LC76G (PA)

Parameter	Description	Min.	Max.	Unit
VCC	Main Power Supply Voltage	-0.3	3.63	V
V_BCKP	Backup Supply Voltage	0	3.63	V
V_{IN}_IO	Input Voltage at I/O Pins	-0.3	3.63	V
P_{RF_IN}	Input Power at RF_IN	-	0	dBm
T_storage	Storage Temperature	-40	90	°C

Table 11: Absolute Maximum Ratings for LC76G (PB)

Parameter	Description	Min.	Max.	Unit
VCC	Main Power Supply Voltage	-0.3	1.98	V
V_BCKP	Backup Supply Voltage	0	3.63	V
V_{IN}_IO	Input Voltage at I/O Pins	-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 Conditions for LC76G (AB) and LC76G (PA)

Parameter	Description	Min.	Typ.	Max.	Unit
VCC	Main Power Supply Voltage	2.55	3.3	3.6	V
V_BCKP	Backup Supply Voltage	1.65	3.3	3.6	V
IO_Domain	Digital I/O Pin Voltage Domain	-	VCC	-	V
V_{IL}	Digital I/O Pin Low-level Input Voltage	-0.3	-	0.8	V
V_{IH}	Digital I/O Pin High-level Input Voltage	2	-	VCC + 0.3	V
V_{OL}	Digital I/O Pin Low-level Output Voltage	-	-	0.4	V
V_{OH}	Digital I/O Pin High-level Output Voltage	2.4	-	-	V
RESET_N	Low-level Input Voltage	-0.3	-	0.45	V
	High-level Input Voltage	1.8	-	3.6	V
VDD_RF	VDD_RF Output Voltage	-	VCC	-	V
I_{VDD_RF}	VDD_RF Output Current	-	-	100	mA
T_operating	Operating Temperature	-40	25	+85	°C

Table 13: Recommended Operating Conditions for LC76G (PB)

Parameter	Description	Min.	Typ.	Max.	Unit
VCC	Main Power Supply Voltage	1.75	1.8	1.98	V
V_BCKP	Backup Supply Voltage	1.65	1.8	3.6	V
IO_Domain	Digital I/O Pin Voltage Domain	-	VCC	-	V
V_{IL}	Digital I/O Pin Low-level Input Voltage	-0.3	-	0.45	V
V_{IH}	Digital I/O Pin High-level Input Voltage	1.35	-	VCC + 0.3	V
V_{OL}	Digital I/O Pin Low-level Output Voltage	-	-	0.27	V
V_{OH}	Digital I/O Pin High-level Output Voltage	1.53	-	-	V
RESET_N	Low-level Input Voltage	-0.3	-	0.45	V
	High-level Input Voltage	1.35	-	2.1	V
VDD_RF	VDD_RF Output Voltage	-	VCC	-	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. Digital I/O Pin refers to all digital pins specified in *Table 6: Pin Description* except RESET_N.

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 14: Supply Current for LC76G (AB) Module

Parameter	Description	Condition	$I_{Typ.}$ [4]	I_{PEAK} [4]
I_{VCC} [5]	Current at VCC	Acquisition	36 mA	62 mA
		Tracking	36 mA	62 mA
		ALP mode	13 mA	43 mA
I_{V_BCKP} [6]	Current at V_BCKP	Continuous mode	130 µA	167 µA
		ALP mode	125 µA	191 µA
		Backup mode	13 µA	53 µA

Table 15: Supply Current for LC76G (PA) Module

Parameter	Description	Condition	$I_{Typ.}$ [4]	I_{PEAK} [4]
I_{VCC} [5]	Current at VCC	Acquisition	10 mA	19 mA
		Tracking	10 mA	19 mA
		ALP mode	5.5 mA	18 mA
I_{V_BCKP} [6]	Current at V_BCKP	Continuous mode	127 µA	190 µA
		ALP mode	122 µA	182 µA
		Backup mode	13 µA	46 µA

Table 16: Supply Current for LC76G (PB) Module

Parameter	Description	Condition	$I_{Typ.}$ [4]	I_{PEAK} [4]
I_{VCC} [5]	Current at VCC	Acquisition	15 mA	28 mA
		Tracking	15 mA	28 mA
		ALP mode	7.5 mA	25 mA
I_{V_BCKP} [6]	Current at V_BCKP	Continuous mode	122 µA	182 µA
		ALP mode	117 µA	175 µA
		Backup mode	13 µA	44 µA

[4] Room temperature, measurements are taken with typical voltage.
[5] Used to determine maximum current capability of power supply.
[6] Used to determine required battery current capability.

6.4. ESD Protection

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

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

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

7 Mechanical Dimensions

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

7.1. Top, Side and Bottom View Dimensions

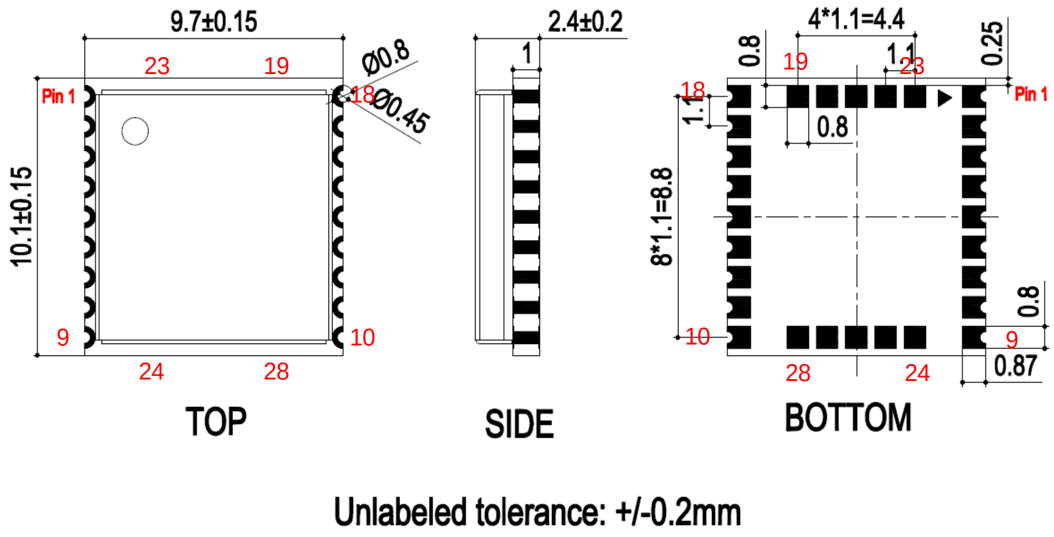


Figure 3: Top, Side and Bottom View Dimensions

NOTE

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

7.2. Top and Bottom Views

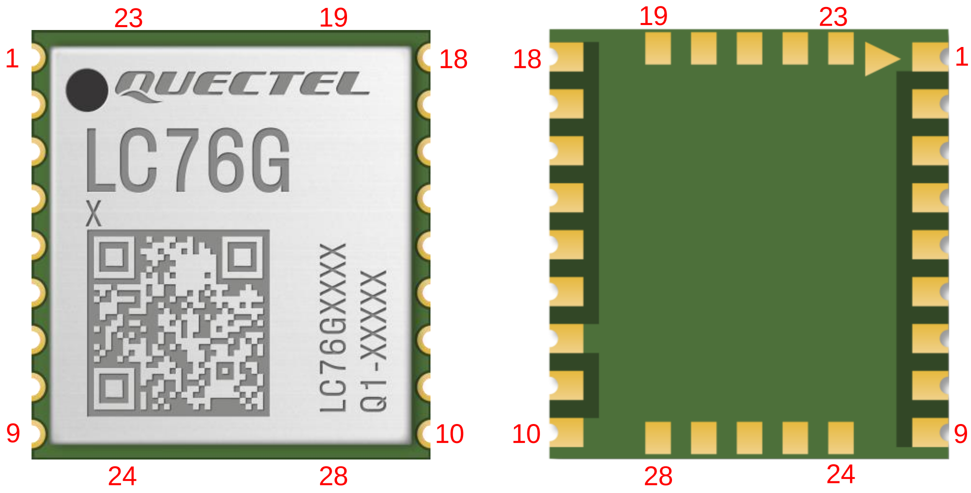


Figure 4: Top and Bottom Module Views

NOTE

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

8 Product Handling

8.1. Packaging

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

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

8.1.1. Carrier Tape

Carrier tape dimensions are detailed below:

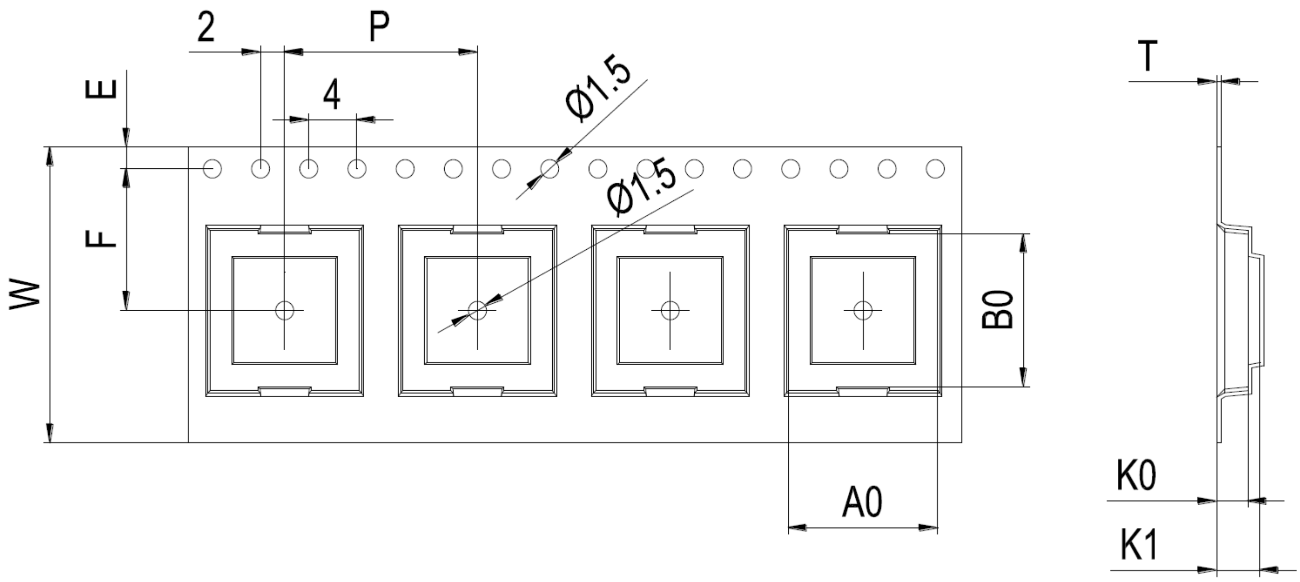


Figure 5: Carrier Tape Dimension Drawing

Table 17: Carrier Tape Dimension Table (Unit: mm)

W	P	T	A0	B0	K0	K1	F	E
24	16	0.3	10.1	10.5	2.8	3.3	11.5	1.75

8.1.2. Plastic Reel

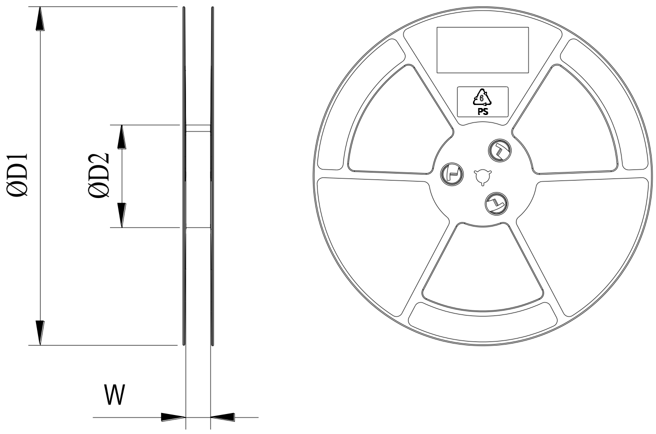


Figure 6: Plastic Reel Dimension Drawing

Table 18: Plastic Reel Dimension Table (Unit: mm)

øD1	øD2	W
330	100	24.5

8.1.3. Mounting Direction

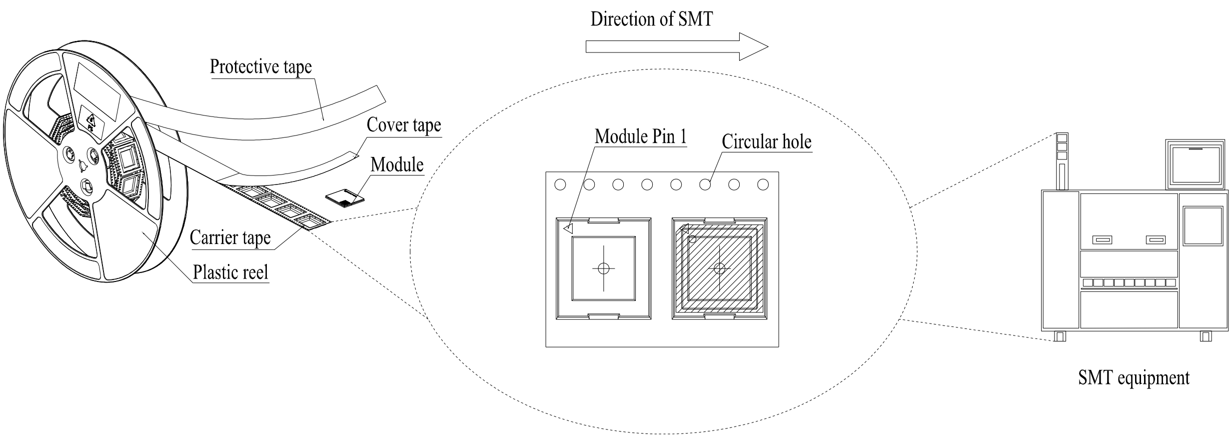
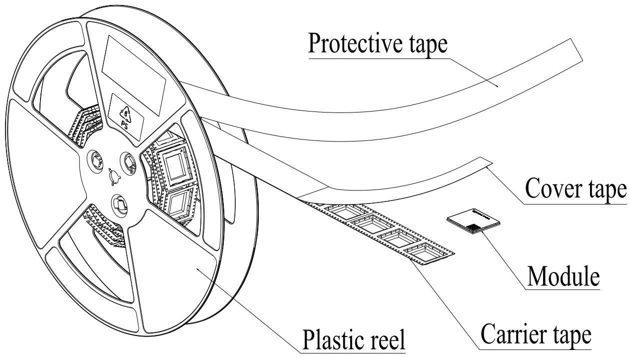


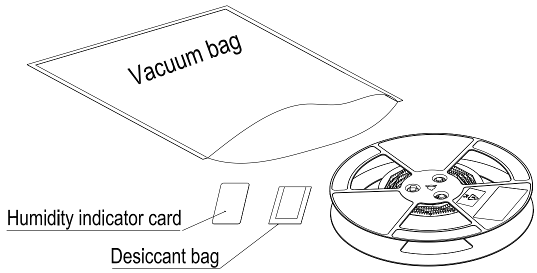
Figure 7: Mounting Direction

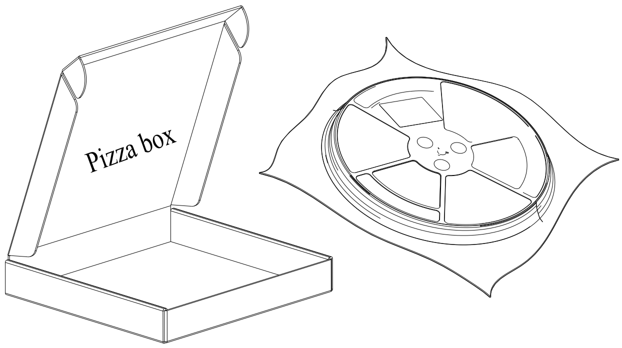
8.1.4. Packaging Process



Place the module onto the carrier tape and use the cover tape to cover it; then wind the heat-sealed carrier tape on the plastic reel and use the protective tape for protection. 1 plastic reel can load 500 modules.

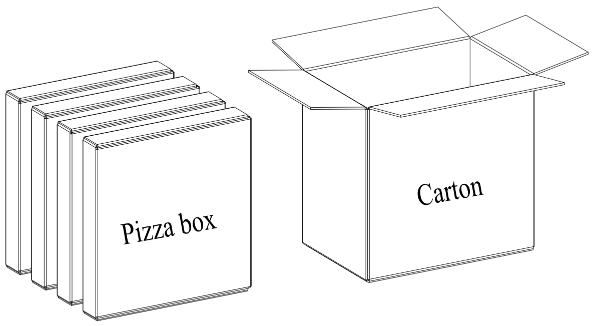
Place the packaged plastic reel, 1 humidity indicator card and 1 desiccant bag inside a vacuum bag, then vacuumize it.





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

Place 4 packaged pizza boxes inside 1 carton and seal it. 1 carton packs 2000 modules.



Pizza box size (mm): 363 × 343 × 41
Carton size (mm): 380 × 190 × 365

Figure 8: Packaging Process

8.2. 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 [7] 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 out the module from the package and put it on high-temperature-resistant fixtures before baking. If shorter baking time is desired, see *IPC/JEDEC J-STD-033* for the baking procedure.
3. Pay attention to ESD protection, such as wearing anti-static gloves, when touching the module.

[7] 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*. Do not unpack the modules in large quantities until they are ready for soldering.

8.3. Manufacturing and Soldering

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

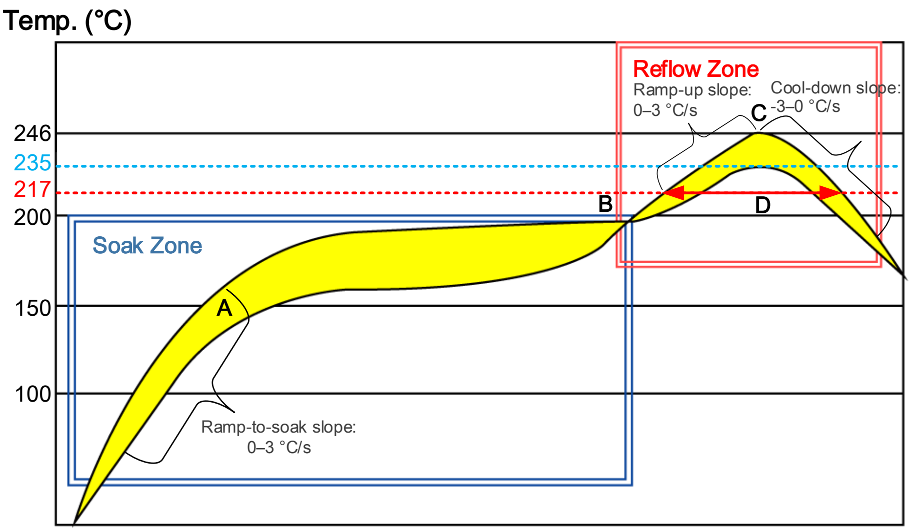


Figure 9: Recommended Reflow Soldering Thermal Profile

Table 19: Recommended Thermal Profile Parameters

Factor	Recommendation
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
Cooling 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 module, **NEVER** wipe the module shielding can with organic solvents, such as acetone, ethyl alcohol, isopropyl alcohol, and trichloroethylene. Otherwise, the shielding can may become rusty.
3. The module shielding can is made of cupronickel base material. The Neutral Salt Spray Test has shown that after 12 hours the laser-engraved label information on the shielding can is still clearly identifiable and the QR code is still readable, although white rust may be found.
4. If a conformal coating is necessary for the module, **DO NOT** use any coating material that may react with the PCB or shielding cover. Prevent the coating material from penetrating the module shield.
5. Avoid using ultrasonic technology for module cleaning since it can damage crystals inside the module.
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 [7] 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 the figure below.

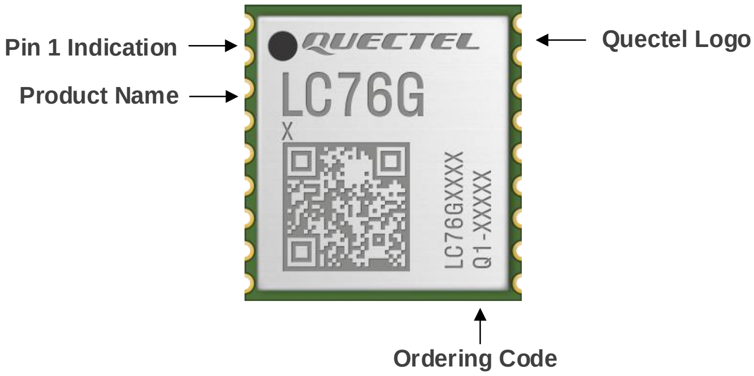


Figure30: Labelling Information

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

10 Appendix References

Table 20: Related Documents

Document Name	
[1]	Quectel_LC26G(AB)&LC76G&LC86G_Series_GNSS_Protocol_Specification
[2]	Quectel_LC26G&LC76G&LC86G_Series_AGNSS_Application_Note
[3]	Quectel_LC26G(AB)&LC76G&LC86G_Series_Firmware_Upgrade_Guide
[4]	Quectel_LC76G_Series_Reference_Design
[5]	Quectel_GNSS_Antenna_Selection_Guidance
[6]	Quectel_RF_Layout_Application_Note
[7]	Quectel_Module_SMT_Application_Note

Table 21: Terms and Abbreviations

Abbreviation	Description
AGNSS	Assisted GNSS (Global Navigation Satellite System)
AIC	Active Interference Cancellation
ALP	Adaptive Low Power
ARM	Advanced RISC Machine
BDS	BeiDou Satellite Navigation System
bps	bit(s) per second
CEP	Circular Error Probable
C/N_0	Carrier-to-noise Ratio
DCS1800	Digital Cellular System at 1800 MHz

Abbreviation	Description
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
NavIC	Indian Regional Navigation Satellite System
kbps	kilobits per second
LCC	Leadless Chip Carrier (package)
LDO	Low-dropout Regulator
LGA	Land Grid Array
LNA	Low-Noise Amplifier
LTE	Long-Term Evolution
Mbps	Megabits per second
MCU	Microcontroller Unit/Microprogrammed Control Unit
MISO	Master In Slave Out

Abbreviation	Description
MOSI	Master Out Slave In
MSAS	Multi-functional Satellite Augmentation System (Japan)
MSL	Moisture Sensitivity Levels
NF	Noise Figure
NMEA	NMEA (National Marine Electronics Association) 0183 Interface Standard
OC	Open Connector
PCB	Printed Circuit Board
PI	Power Input
PMU	Power Management Unit
1PPS	One Pulse Per Second
PSRR	Power Supply Rejection Ratio
QR (Code)	Quick Response (Code)
QZSS	Quasi-Zenith Satellite System
RAM	Random Access Memory
RF	Radio Frequency
RHCP	Right Hand Circular Polarization
RoHS	Restriction of Hazardous Substances
RTC	Real-Time Clock
RTK	Real-Time Kinematic
RXD	Receive Data (Pin)
3GPP	3rd Generation Partnership Project
SAW	Surface Acoustic Wave
SBAS	Satellite-Based Augmentation System
CLK	SPI Serial Clock
SMD	Surface Mount Device
SMT	Surface Mount Technology

Abbreviation	Description
SPI	Serial Peripheral Interface
TCXO	Temperature Compensated Crystal Oscillator
T_operating	Operating Temperature
TTFF	Time to First Fix
TVS	Transient Voltage Suppressor
TXD	Transmit Data (Pin)
UART	Universal Asynchronous Receiver/Transmitter
USB	Universal Serial Bus
VCC	Supply Voltage
$V_I$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
WCDMA	Wideband Code Division Multiple Access
XTAL	External Crystal Oscillator