L26-DR Hardware Design

GNSS Module Series

Version: 1.3

Date: 2021-06-28

Status: Released

Our aim is to provide customers with timely and comprehensive service. For any assistance, contact our company 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 office. For more information, visit:
http://www.quectel.com/support/sales.htm.

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

General Notes

Quectel offers the information as a service to its customers. The information provided is based upon customers' requirements. Quectel makes every effort to ensure the quality of the information it makes available. Quectel does not make any warranty as to the information contained herein, and does not accept any liability for any injury, loss or damage of any kind incurred by the use of or reliance upon the information. All information supplied herein is subject to change without prior notice.

Disclaimer

While Quectel has made efforts to ensure that the functions and features under development are free from errors, it is possible that these functions and features could contain errors, inaccuracies, and omissions. Unless otherwise provided by valid agreement, Quectel makes no warranties of any kind, implied or express, with respect to the use of features and functions under development. To the maximum extent permitted by law, Quectel excludes all liability for any loss or damage suffered in connection with the use of the functions and features under development, regardless of whether such loss or damage may have been foreseeable.

Duty of Confidentiality

The Receiving Party shall keep confidential all documentation and information provided by Quectel, except when the specific permission has been granted by Quectel. The Receiving Party shall not access or use Quectel's documentation and information for any purpose except as expressly provided herein. Furthermore, the Receiving Party shall not disclose any of the Quectel's documentation and information to any third party without prior written consent by Quectel. Quectel reserves the right to take legal action for any noncompliance to the above requirements, unauthorized use, or other illegal or malicious use of the documentation and information.

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	**L26-DR Hardware Design**
Subtitle	GNSS Module Series
Document Type	Hardware Design
Document Status	Released

Revision History

Version	Date	Description
-	2019-04-28	Creation of the document
1.0	2019-04-28	First official release
1.1	2019-10-19	1. Updated RF path in Figure 1; 2. Updated Chapter 2.1; 3. Updated power consumption in Table 1; 4. Updated the comment of CAN, FWD, WHEELTICK interfaces in Table 4; 5. Added TVS diode model in Figure 3; 6. Updated the update rate in Table 5; 7. Updated Chapter 3.5; 8. Added reference document for RF layout guide in Chapter 4; 9. Modified the description for recommended antenna specifications; 10. Deleted the reference design for external LNA and relevant description; 11. Updated Figure 4, 14, 15 and 16; 12. Updated Table 13; 13. Modified the description for module mounting and added content about the installation of L26-DR (UDR) Chapter 6.4.

1.2	2021-06-02	1. Changed the name of PIN1 from WAKE_UP to WAKEUP; 2. Changed the name of PIN3 from TIMEPULSE to 1PPS; 3. Changed the name of PIN9 from VCC_RF to VDD_RF; 4. Changed the names of PIN16 and PIN17 from ANT2 to ANT_DET2, ANT1 to ANT_DET1; 5. Changed the names of PIN18 and PIN19 from CANTX to CAN_TX, CANRX to CAN_RX; 6. Changed the names of PIN20 and PIN21 from UART_TX to TXD, UART_RX to RXD; 7. Chapter 1.2: Updated the Table 2; 8. Chapter 1.5: Added the description of GNSS constellations; 9. Chapter 3.3.2: Updated the description of standby mode; 10. Chapter 3.3.3, 3.4 and 3.5: Added these sections; 11. Chapter 4.1.1: Updated the description of UART; 12. Chapter 4.2.2: Updated the description of BOOT; 13. Chapter 5.2.3.1: Update the description of active antenna reference design; 14. Chapter 5.3: Added this section; 15. Chapter 6.2: Updated the description of operating conditions; 16. Chapter 8.2: Updated the notes about module storage; 17. Chapter 8.3: Updated the recommended peak reflow temperature and the reflow time in reflow zone; 18. Chapter 9: Added this chapter.
1.3	2021-06-28	1. Changed the grade of L26-DR(ADR) from industrial to automotive; 2. Deleted the L26-DR(ADRA), and added the L26-DR(ADRC); 3. Modified the 6-axis MEMS sensor to 6-axis IMU; 4. Updated the Table 2; 5. Updated the Table 3; 6. Modified the titles (Chapter 6.2); 7. Added sequence figures of entering/exiting the standby mode and backup mode (Figure 7 and Figure 8); 8. Added the power supply rating of RESET_N pin (Table 10); 9. Updated the description of RESET_N pin (Chapter 4.2.1).

Contents

Table Index

Figure Index

1 Product Description

1.1. Overview

The Quectel L26-DR module supports multiple global positioning and navigation systems: BeiDou, GPS, Galileo, GLONASS, QZSS. The module also supports SBAS (including WAAS, EGNOS, MSAS and GAGAN), and AGNSS functions.

L26-DR comprises three models: L26-DR (ADR), L26-DR (UDR), and L26-DR (ADRC).

Key features:

- The L26-DR module is a single-band, multi-constellation GNSS module and features a high-performance, high reliability positioning engine. This module facilitates a fast and precise GNSS positioning capability.
- The module supports a serial communication interface UART.
- The automotive-grade modules L26-DR (ADR) and L26-DR (ADRC) both support Automotive Dead Reckoning (ADR) technology. They combine information from GNSS, 6-axis IMU and speed information from the vehicle to provide continuous and accurate positioning for vehicles.
- The industrial-grade module L26-DR (UDR) supports Untethered Dead Reckoning (UDR) technology and, without requiring speed information from the vehicle, only combines information from GNSS and 6-axis IMU to provide continuous and accurate positioning for vehicles.
- The embedded flash memory provides the capacity for storing user-specific configurations and future firmware updates.

The Quectel L26-DR module is an SMD type module with a compact form factor of 12.2 mm × 16.0 mm × 2.3 mm. It can be embedded in your applications through its 24 LCC pins.

The module is fully compliant with the EU RoHS Directive.

1.1.1. Special Mark

Table 1: Special Mark

Mark	Definition
◆	Unless otherwise specified, when the mark ◆ is used after a piece of data, it indicates that the data is preliminary.

1.2. Features

Table 2: Product Features

Features		L26-DR (ADR)	L26-DR (UDR)	L26-DR (ADRC)
Grade	Industrial	-	●	-
	Automotive	●	-	●
Category	Standard Precision GNSS	-	-	-
	High Precision GNSS	●	●	●
	DR	●	●	●
	RTK	-	-	-
	Timing	-	-	-
Supply	3.0–3.6 V, Typical: 3.3 V	●	●	●
Interfaces	UART	●	●	●
	SPI	-	-	-
	I2C	-	-	-
	1PPS	●	●	●
Features	Additional LNA	●	●	●
	SAW	●	●	●
	RTC crystal	●	●	●
	TCXO oscillator	●	●	●

	6-axis IMU		●	●	●
Constellations	GPS/QZSS	L1 C/A	●	●	●
		L5	-		-
	Galileo	E1	●	●	●
		E5a	-		-
	BeiDou	B1I	●	●	●
		B2a	-		-
	GLONASS	L1	●	●	●
	IRNSS	L5	-		-
	SBAS	L1	●	●	●
Temperature Range	Operating temperature range: -40 °C to +85 °C Storage temperature range: -40 °C to +90 °C				
Physical Characteristics	Size: (12.2 ±0.15) mm × (16.0 ±0.15) mm × (2.3 ±0.20) mm Weight: Approx. 0.9 g				

NOTE

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

1.3. Performance

Table 3: Product Performance

Parameter	Specification	L26-DR (ADR)	L26-DR (UDR)	L26-DR (ADRC)
Power Consumption [1] (GPS+GLONASS+Galileo)	Acquisition	79 mA	84 mA	79 mA◆
	Tracking	74 mA	81 mA	74 mA◆
	Standby mode [2]	17 µA	13 µA	13 µA◆
	Backup mode [3]	75 µA	75 µA	75 µA◆
Sensitivity (GPS+GLONASS)	Acquisition	-145 dBm	-145 dBm	-145 dBm◆
	Reacquisition	-152 dBm	-152 dBm	-152 dBm◆
	Tracking	-162 dBm	-162 dBm	-162 dBm◆
TTFF [1] (without AGNSS)	Cold Start	32 s	32 s	32 s◆
	Warm Start	25 s	25 s	25 s◆
	Hot Start	2 s	2 s	2 s◆
TTFF [1] (with AGNSS)	Cold Start	13 s	13 s	13 s◆
Horizontal Position Accuracy [4]		1.5 m	1.5 m	1.5 m◆
Update Rate		1 Hz	1 Hz (Max. 10 Hz)	1 Hz (Max. 10 Hz)
Accuracy of 1PPS Signal	Typical accuracy	100 ns	100 ns	100 ns◆
	Time pulse width	500 ms	500 ms	500 ms◆
Velocity Accuracy (Without aid)		0.1 m/s	0.1 m/s	0.1 m/s◆

[1] All satellites at -130 dBm, except Galileo at -122 dBm.
[2] Total power consumption of the module in standby mode.
[3] Power consumption on V_BCKP pin, the power consumption in backup mode is higher than the power consumption in standby mode - because standby mode is controlled by the command, and all parts of the chip except for the IMU and the RTC domain are shut-down, while in backup mode the VCC is cut off which causes that the parts of the chip, except the RTC, are unpowered and there is some current leakage from the powered to the unpowered parts of the chip.
[4] CEP, 50 %, 24 hours static, -130 dBm, more than 6 SVs.

Acceleration Accuracy (Without aid)		0.1 m/s^2	0.1 m/s^2	0.1 m/s^2◆
Dynamic Performance	Max. Altitude	18000 m	18000 m	18000 m◆
	Max. Velocity	515 m/s	515 m/s	515 m/s◆
	Acceleration	4g	4g	4g◆

1.4. Block Diagram

The following figure shows a block diagram of the module. The module includes a single GNSS IC, a 6-axis IMU chip, an additional LNA, two additional SAW filters, a TCXO and a crystal oscillator. The first stage SAW improves out-band rejection. Consequently, the LNA will have less chance to produce in-band interference in challenging environments (e.g., with a cellular module transmitting B13 at the same time), which ensures reliable performance in a jamming environment.

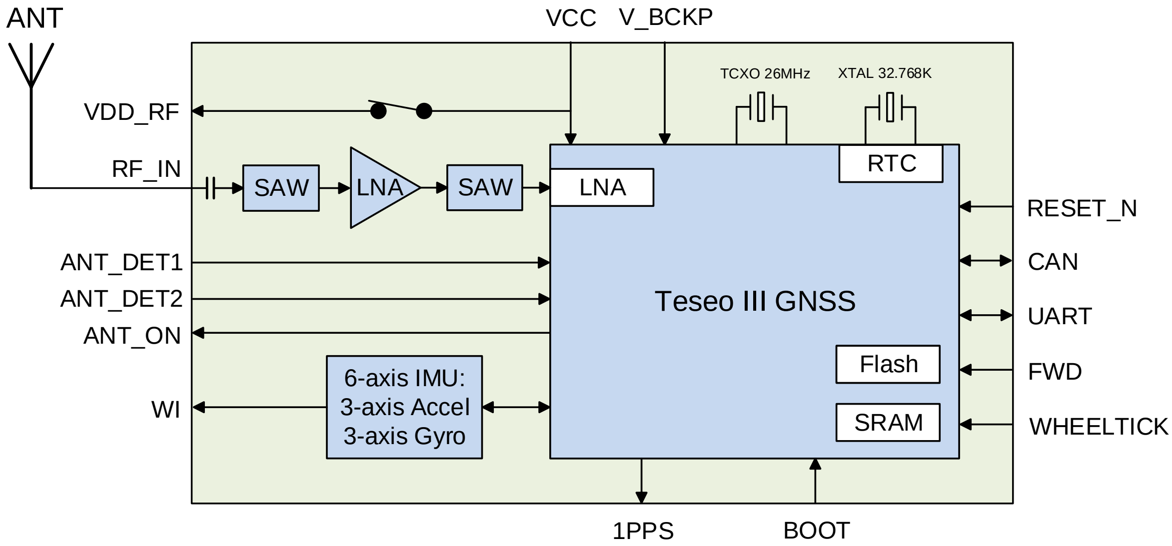

Figure 1: Block Diagram

1.5. GNSS Constellations

The Quectel L26-DR module is a single-band GNSS receiver that can receive and track GPS, BeiDou, GLONASS, Galileo and QZSS signals.

1.5.1. GPS

The module is designed to receive and track GPS L1 C/A signals (1574.397–1576.443 MHz) provided by GPS.

1.5.2. BeiDou

The module is designed to receive and track BeiDou B1I signals (1559.052–1563.144 MHz) provided by the BeiDou Navigation Satellite System. The ability to receive and track BeiDou signals in conjunction with GPS signals results in wider coverage, higher reliability, and enhanced accuracy.

1.5.3. GLONASS

The module is designed to receive and track GLONASS L1 signals (1597.781–1605.656 MHz) provided by GLONASS.

1.5.4. Galileo

The module is designed to receive and track Galileo E1 signals (1573.374–1577.466 MHz) provided by Galileo.

1.5.5. QZSS

The Quasi-Zenith Satellite System (QZSS) is a regional navigation satellite system that transmits additional GPS L1 C/A signals for the Pacific region covering Japan and Australia. The module can detect and track these signals concurrently with GPS signals, resulting in better availability especially under challenging conditions, e.g., in urban canyons.

1.6. Augmentation System

1.6.1. SBAS

The Quectel L26-DR module supports SBAS (Satellite-Based Augmentation System) broadcast signal reception, and GPS data is complemented by additional regional or wide area GPS enhancement data. The system enhances the data through satellite broadcasting, and this information can be used in GNSS receivers to improve the accuracy of the results. SBAS satellites can also be used as additional signals for ranging or distance measurement, 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 AGNSS feature, the module should get the assistance data including the current time, rough position, and LTO data. For more information, see ***document [2]***.

1.8. Dead Reckoning Function

Dead Reckoning is the process of estimating the module's current position based on the last position obtained from GNSS, speed, heading IMU data, etc. With this combined IMU inputs, the system plots the navigation trace when the satellite signals are partially or completely blocked while satellite signals provide updates and correction for IMU drift. With this technology, the system obtains continuous and high-accuracy positioning in environments such as tunnels and urban canyons.

To provide optimal solution, the 6-axis IMU parameters should be calibrated. For more information about the calibration of 6-axis IMU, see ***document [3]***.

In addition, the module supports output of 6-axis IMU raw data through UART to support your applications such as driving behavior analysis. For more information about raw data output configuration, see ***document [1]***.

2 Pin Assignment

The Quectel L26-DR module is equipped with 24 LCC pins by which the module can be mounted on the customer's PCB.

Figure 2: Pin Assignment

NOTE

L26-DR (UDR) does not support WHEELTICK, FWD, CAN features, please keep these pins open when designing.

Table 4: I/O Parameter Definition

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

Table 5: Pinout

Function	Name	No.	I/O	Description	Remarks
Power	VCC	23	PI	Main power supply	Provides clean and steady voltage.
	V_BCKP	22	PI	Backup power supply for RTC domain	Supplies power to the RTC domain when VCC power supply is disconnected. If VCC is powered continuously, V_BCKP can be left open.
UART	TXD	20	DO	Transmits data	Used for NMEA/PSTM sentences transmission, firmware upgrade and speed information obtaining.
	RXD	21	DI	Receives data	
Antenna	VDD_RF	9	PO	Power supply for external RF components	VDD_RF = VCC Typically used to supply power for an external active antenna or the additional LNA. In standby mode, VDD_RF is turned off. If unused, leave the pin N/C (not connected).
	RF_IN	11	AI	GNSS antenna interface	50 Ω characteristic impedance.
	ANT_DET2	16	AI	Antenna detection 2	If unused, leave the pin N/C (not connected).
	ANT_DET1	17	AI	Antenna detection 1	
	ANT_ON	14	DO	Power control for active antenna detection	

CAN	CAN_TX	18	DO	CAN bus transmits data	Used for requesting speed information of the vehicle. L26-DR (UDR) does not support this feature. If unused, leave the pin N/C (not connected).
	CAN_RX	19	DI	CAN bus receives data	
ODO	FWD	15	DI	Forward/Backward direction	Pulled up internally by default. L26-DR (UDR) does not support this feature. If unused, leave the pin N/C (not connected).
	WHEELTICK	4	DI	Odometer wheel-tick input	
System	BOOT	6	DI	Controls module startup mode	Pulled down internally by default. While the pin is kept floating during startup, the module will enter normal working mode. While the pin is kept at high level for about 100 ms during startup, the module will enter boot download mode. Pull up the pin to VCC with a 10 KΩ resistor during startup, and the module will enter boot download.
	WAKEUP	1	DI	Wake up the module from the standby mode	Keep this pin at low voltage level in continuous mode. It has been pulled down internally with a 47 KΩ resistor. Drive the pin to a high level to make the module exit standby mode. If unused, leave the pin N/C (not connected).
	1PPS	3	DO	One pulse per second	Synchronized on a rising edge, and the pulse width is 500 ms. This pin must be kept at low level at startup for normal operation. It has been internally pulled down with a 47 KΩ resistor. If unused, leave the pin N/C (not connected).

WI	2	DO	Warning indicator	VCC must be valid to ensure the interrupt signal output.
RESET_N	8	DI	Resets the module	Active low. Do not reserve any pull-up circuit for this pin. If unused, leave the pin N/C (not connected).
GND	10, 12, 13, 24	-	Ground	Ensure a good GND connection to all GND pins of the module, preferably with a large ground plane.
RESERVED	7	-	Reserved	These pins must be left floating and cannot be connected to power or GND.
NC	5	-	Not connected	-

NOTE

Leave NC, RESERVED and unused pins N/C (not connected).

3 Power Management

The Quectel L26-DR module provides 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 three operating modes: standby mode, backup mode for best power consumption and continuous mode for best performance.

3.1. Power Unit

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

The V_BCKP pin supplies power for the RTC domain. If the VCC voltage drops below the acceptable level, the V_BCKP keeps the RTC domain powered. To achieve quick startup and improve Time to First Fix (TTFF), the RTC domain power supply should be valid during the interval when the VCC does not have a valid level. The backup RAM also belongs to the RTC domain. If the VCC is not valid, the V_BCKP supplies power for the backup RAM, which contains all the necessary GNSS data and some of the user configuration variables.

If VCC is always valid, the V_BCKP does not need to be connected.

VDD_RF is an output pin, equal in voltage to the VCC input. In normal operating mode, VDD_RF supplies power for the external active antenna or the additional LNA. In standby mode, VDD_RF is turned off.

The module’s internal power supply is shown below:

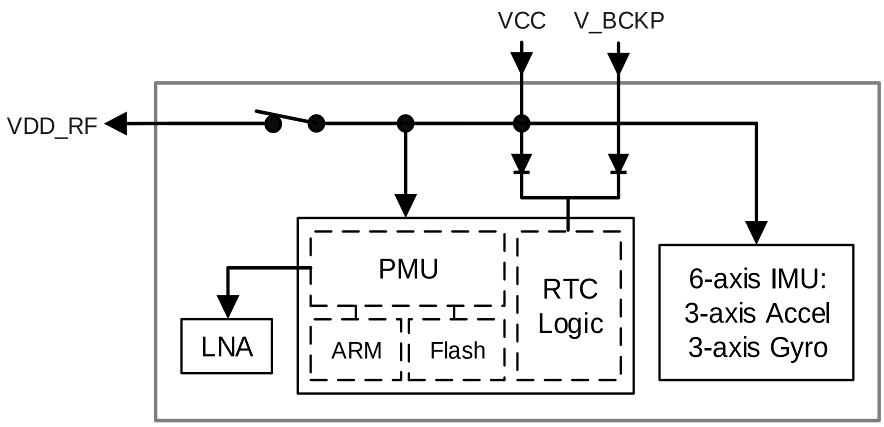

Figure 3: Internal Power Supply

3.2. Power Supply

3.2.1. VCC

The VCC is the supply voltage pin. It supplies power for the BB, RF, 6-axis IMU and RTC domain. The pin's load current varies according to its voltage level, the processor's load current and the satellite acquisition state.

The module's power consumption may vary by several orders of magnitude, especially when low power mode is enabled. Therefore, it is important that the power supply can sustain the peak power for a short time, ensuring that the load current does not exceed the rated value. When the module switches from backup mode to normal operation or startup, it must charge the internal capacitors in the core domain. In some cases, this can lead to a significant current drain.

For low-power applications using power saving and backup modes, it is important that the LDO at the power supply or module input can provide the current/drain. An LDO with a high PSRR should be chosen for good performance. In addition, a TVS diode, and a decoupling capacitor network of three decoupling capacitors of 10 µF, 100 nF and 33 pF respectively should be added near the VCC pin. The lowest-value capacitor should be the closest to module pins.

An LDO voltage regulator with a fast discharge is recommended as the power supply. This can ensure a quick voltage drop when the VCC power is cut.

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

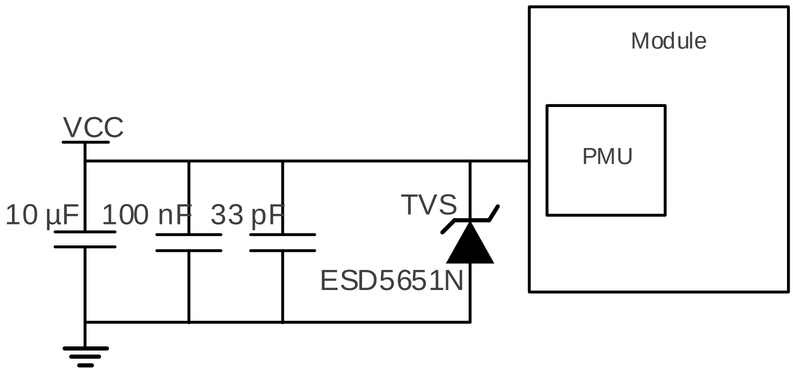

Figure 4: VCC Input Reference Circuit

3.2.2. V_BCKP

The V_BCKP pin supplies power for the RTC domain. If the VCC power supply fails, the V_BCKP pin supplies power for the real-time clock (RTC) and Backup RAM. The use of valid time and GNSS orbit data at startup allows GNSS hot (warm) start. If no backup power is connected, the module performs a cold start at power up.

If VCC is always valid, the V_BCKP pin can be left open.

If there is a constant power supply in your system, it can be used to provide a suitable voltage to supply V_BCKP.

V_BCKP can be directly powered by an external battery, rechargeable or non-rechargeable. It is recommended to place a battery along with a combination of 4.7 µF, 100 nF and 33 pF capacitors near the V_BCKP pin. The figure below illustrates the reference design for supplying power to the RTC domain with a non-rechargeable battery.

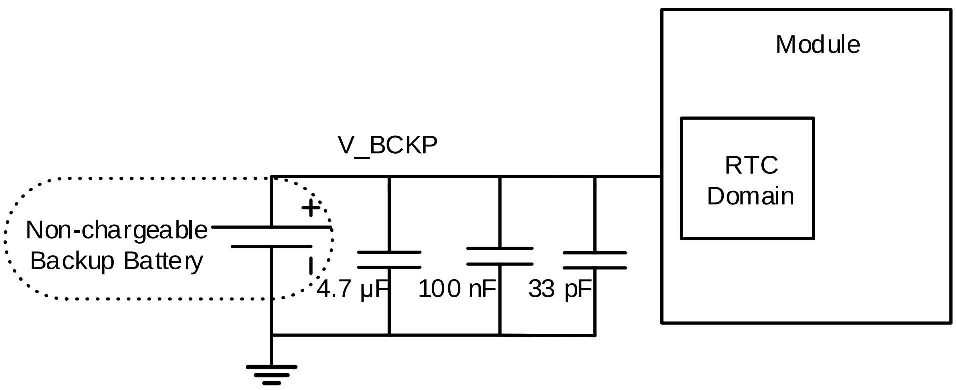

Figure 5: RTC Powered by Non-Rechargeable Battery

If V_BCKP is powered by a rechargeable battery, it is necessary to apply an external charging circuit for the battery. A reference charging circuit is illustrated below.

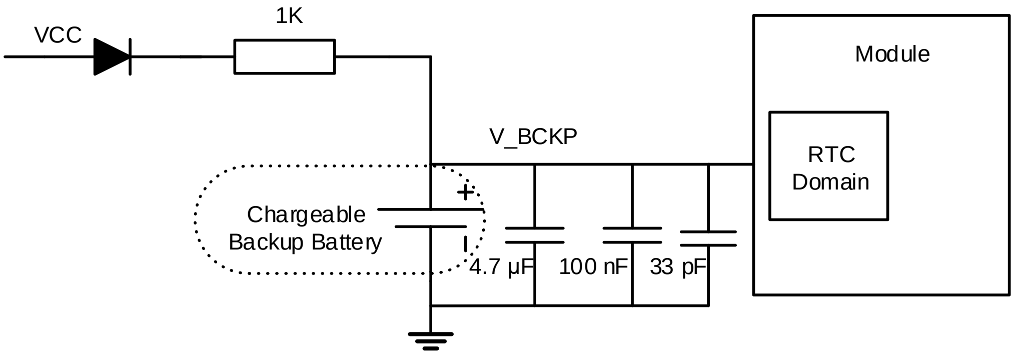

Figure 6: Reference Charging Circuit for a Rechargeable Battery

3.3. Power Mode

3.3.1. Continuous Mode

If VCC is powered on, the module automatically enters continuous mode. Continuous mode 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.

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

3.3.2. Standby Mode

Standby mode is a low-power-consuming mode. In this mode, the internal core and I/O power domain, RF and TCXO are powered off. The UART is not accessible and the module stops acquiring and tracking satellites. Only the 6-axis IMU and the RTC domain are active.

There is one approach to entering standby mode and two approaches to exiting standby mode.

- Sending command to enter standby mode. For more information about the command duration, see ***document [1]***.
- Two approaches to exiting standby mode: driving WAKEUP pin to high voltage level to trigger interrupt wakeup or waiting for the command duration to end. For more information about the command duration, see ***document [1]***.

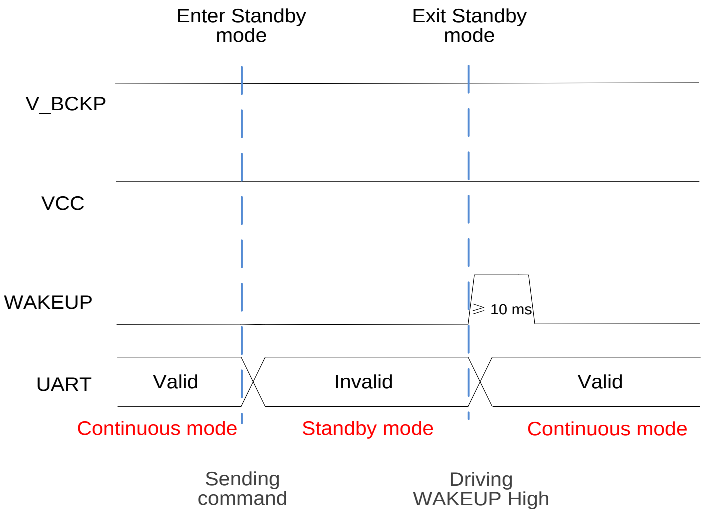

Figure 7: Sequence of Entering/Exiting Standby Mode

NOTE

Before running the command, please ensure the WAKEUP pin is not pulled up, otherwise the module will enter an indeterminate state.

3.3.3. Backup Mode

For power-sensitive applications, the module receiver provides a backup mode to reduce power consumption.

If VCC is cut off and V_BCKP is powering the RTC domain, the module switches from continuous mode to backup mode. Only RTC domain is active in backup mode and it keeps track of time. As soon as the VCC pin is powered, the module immediately switches to continuous mode.

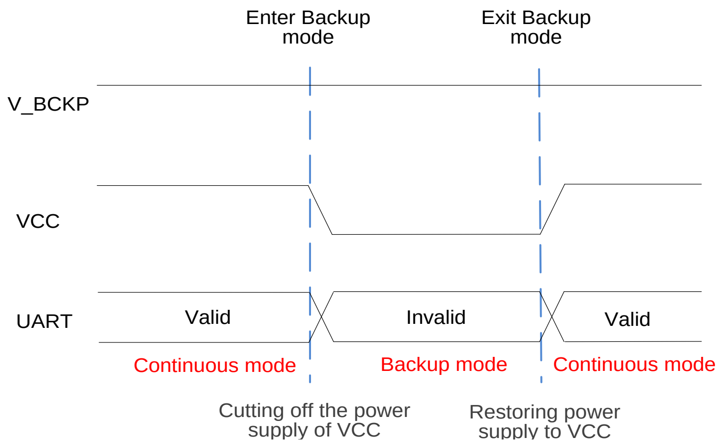

Figure 8: Sequence of Entering/Exiting Backup Mode

3.4. Power-Up Sequence

When VCC is powered up, the module starts up automatically.

To ensure correct power-up sequence, the RTC logic should start up before the PMU. So, V_BCKP must be powered up before the VCC is powered.

Ensure that the VCC has no rush or drop during the rising time, and keep the voltage stable. The recommended ripple is lower than 100 mV.

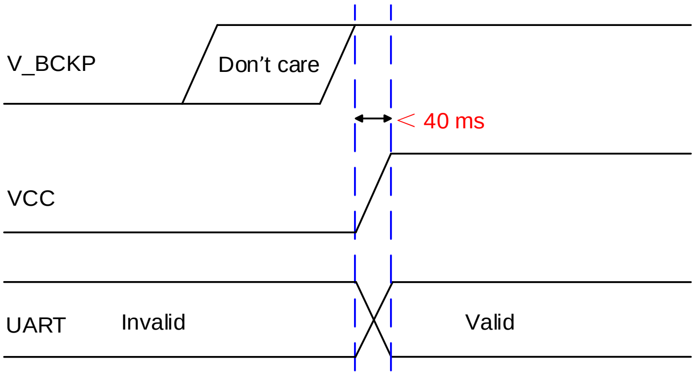

Figure 9: Power-Up Sequence

3.5. Power-Down Sequence

When VCC powers down, its voltage drops quickly in 70 ms. Therefore, it is recommended to use a voltage regulator that supports fast discharge.

If VCC falls below the specified minimum value 3.0 V, it is necessary to initiate a power-on reset of the system by driving the pin below 100 mV for at least 100 ms to avoid abnormal voltage condition.

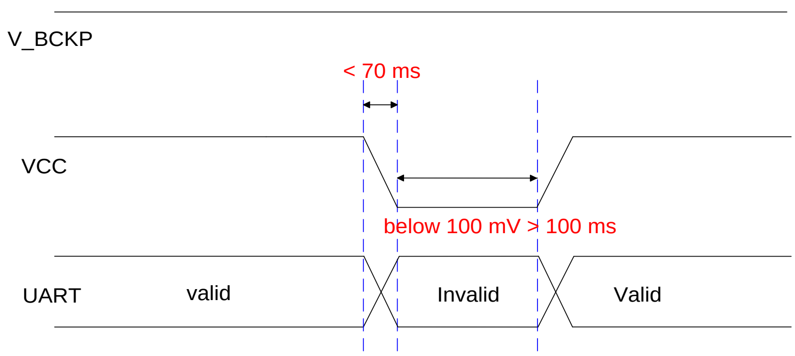

Figure 10: Power-Down Sequence

4 Application Interfaces

4.1. Communication Interfaces

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

4.1.1. UART Interface

The Quectel L26-DR module provides one universal asynchronous receiver & transmitter (UART) serial port.

The UART port has the following features:

- Supports NMEA/PSTM data transmission, firmware upgrading and speed information obtaining.
- The default output NMEA type setting is RMC, VTG, GGA, GSA, GSV, GLL.
- Supported baud rates: 115200, 230400, 460800, 921600 bps.
- Default settings: 115200 bps, 8 bits, no parity bit, 1 stop bit.
- Hardware flow control and synchronous operation are not supported.

The module is designed as data communication equipment (DCE), whereas the client is operating as data terminal equipment (DTE), thus establishing the traditional DCE-DTE connection.

A reference design is shown in the figure below.

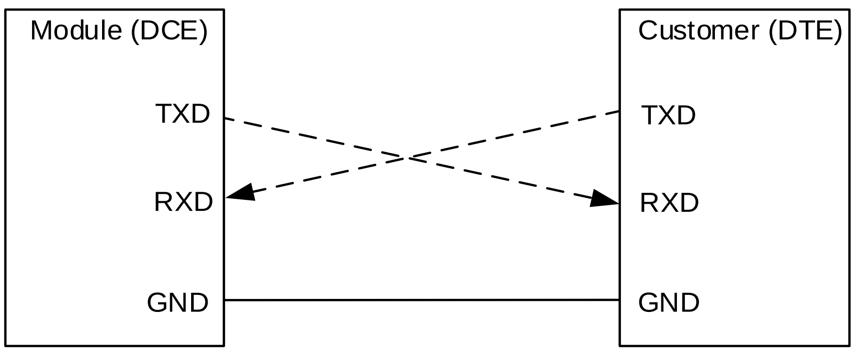

Figure 11: UART Interface Reference Design

The UART port does not support the RS-232 level. Therefore, if the module's UART port is connected to the UART port of a computer, it is necessary to add a level shift circuit in between, as illustrated below.

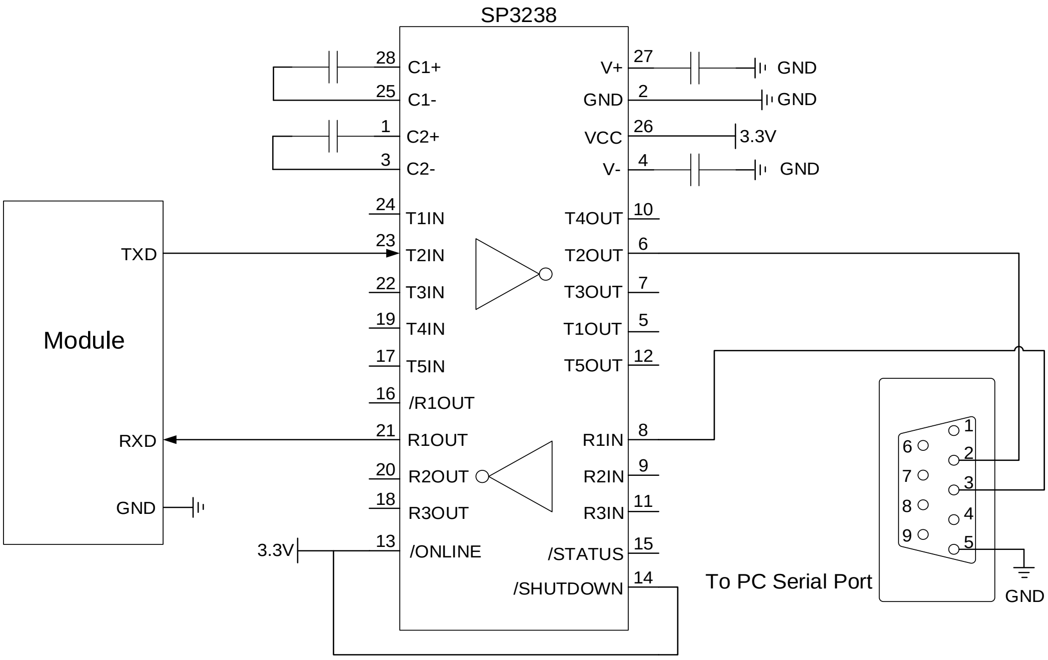

Figure 12: RS-232 Level Shift Circuit

4.2. I/O Pins

4.2.1. RESET_N

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

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

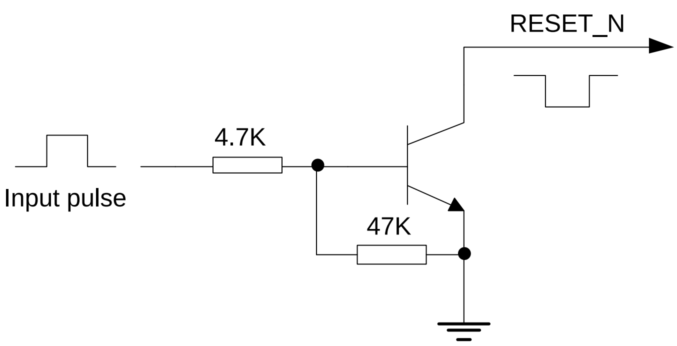

Figure 13: Reference OC Circuit for Module Reset

The following figure shows the reset timing of the module.

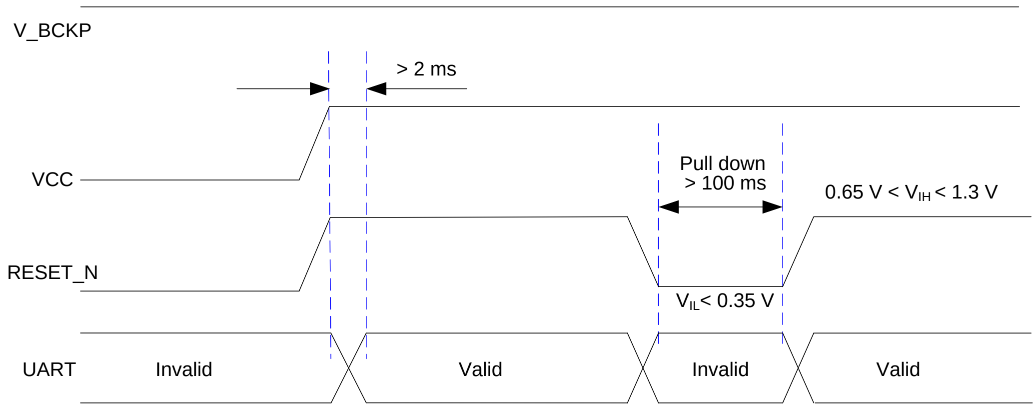

Figure 14: Reset Sequence

NOTE

1. The module resetting can force the loss of volatile RAM data. But the NVM data will not be cleared after resetting, so that fast TTFF is still possible and command settings that have been saved into NVM will not be cleared.
2. Ensure RESET_N is connected so that it can be used to reset the module if the module enters an abnormal state. As RESET_N is in the 1.0 V voltage domain, please do not reserve any pull-up circuit for this pin.
3. RESET_N pin can be used to reset the module to resolve crashes.

4.2.2. BOOT

The BOOT pin is used to put the module into boot download mode. It is pulled down internally by default. Keep the pin floating during startup, and the module enters normal operating mode. Keep the pin at high level for about 100 ms during startup, and the module enters boot download mode. For more information about the reference design, see ***document [4]***.

Check the voltage level of this pin and you can tell which operating mode the module is in after powering up.

Table 6: Operating Modes

Voltage Level	Operating Mode	Comment
Low	Normal	If BOOT is kept floating during module startup, the module enters normal operating mode.
High	Boot download	If BOOT is kept at high level for about 100 ms during module startup, the module enters boot download mode.

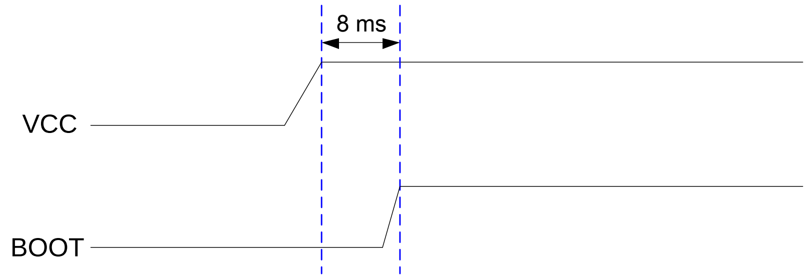

Figure 15: BOOT Pin State (Normal Operating Mode)

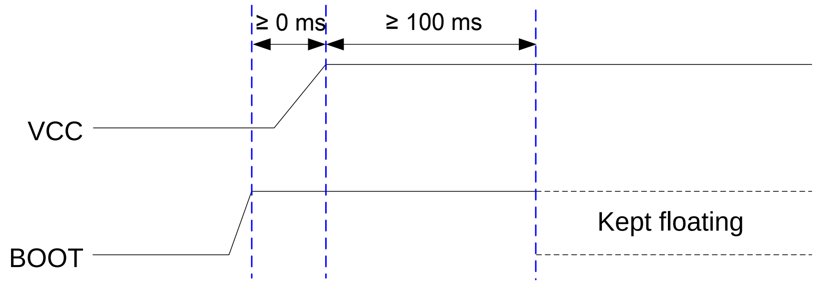

Figure 16: BOOT Pin Control Sequence (Boot Download Mode)

4.2.3. CAN

The module provides a CAN bus interface supporting 50 kbps, 100 kbps, 125 kbps, 250 kbps, 500 kbps (default) and 1 Mbps baud rates. The main function of this interface is to get speed information of a vehicle. A CAN transceiver is needed between the module and the CAN bus of the vehicle.

4.2.4. ODO

The FWD hardware input is used to get vehicle forward/backward status signals. When it is at low voltage level, the vehicle is moving forward, and when it is at high level, the vehicle is moving backward.

The WHEELTICK hardware input is used to get odometer signals from a vehicle. It can be sampled from the wheel revolution sensors or the transmission of the vehicle. For more information about the reference design of this interface, see ***document [4]***.

NOTE

Only cars need to be connected to the FWD pin, while electric bicycles do not.

4.2.5. WI

WI signal is an interrupt output to wake up the host when the IMU's value is bigger than the threshold value. The Quectel L26-DR module cannot determine what causes the vehicle to have an inclination angle. It needs the MCU to judge whether the vehicle is towed by a trailer or is running normally on an uphill road.

NOTE

To ensure the interrupt signal output, the VCC of the module cannot be powered off.

4.2.6. 1PPS

The 1PPS output generates one pulse per second trains synchronized with a GPS or UTC time grid with intervals configurable over a wide range of frequencies. The accuracy is < 100 ns. Thus, it may be used as a low frequency time synchronization pulse or as a high frequency reference signal.

5 Design

5.1. Recommended Footprint

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

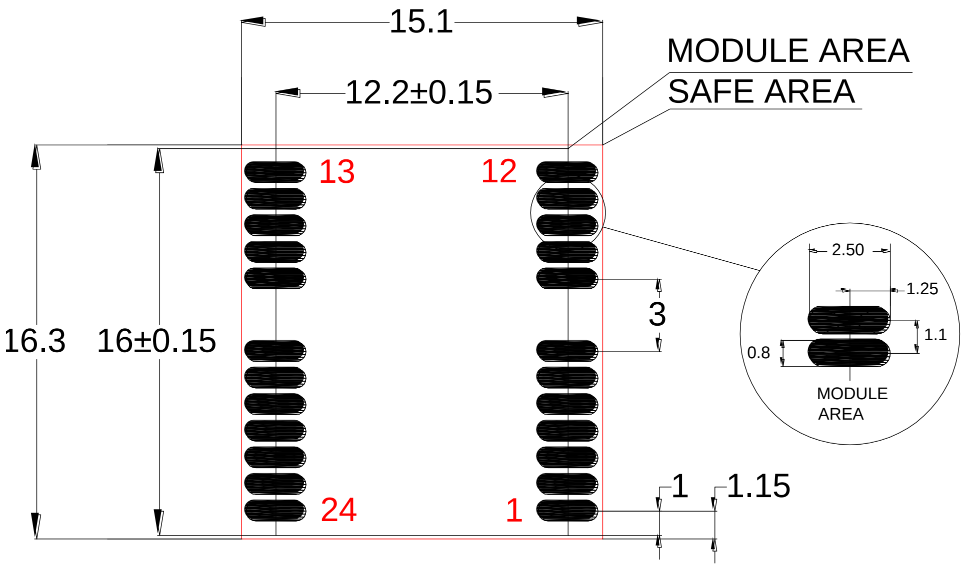

Figure 17: Recommended Footprint

NOTE

For easy maintenance, keep a distance of at least 3 mm between the module and other components on the motherboard.

5.2. Antenna Design

5.2.1. Antenna Specification

The Quectel L26-DR module can be connected to a dedicated passive or active single-band GNSS antenna to receive GPS, Galileo, GLONASS, BeiDou, QZSS satellite signals. The recommended antenna specifications are given in the table below.

For more information about RF trace layout, see ***document [5]***.

Table 7: Recommended Antenna Specifications

Antenna Type	Specifications
Passive Antenna	Frequency range: 1559–1609 MHz Polarization: RHCP VSWR: < 2 (Typ.) Passive antenna gain: > 0 dBi
Active Antenna	Frequency Range: 1559–1609 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

The total gain of the whole antenna is the internal LNA gain minus the total insertion loss of cables and components inside the antenna.

5.2.2. Antenna Selection Guide

Both active and passive single-band GNSS antennas can be used for the Quectel L26-DR 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. Otherwise, use an active antenna, since the insertion loss of RF cable can decrease the CNR of GNSS signal.

CNR 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 1 Hz bandwidth. CNR formula is as below:

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

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

"System NF", formula:

$$NF = 10\log F\,(dB)$$

"F" is the noise factor of receiver system:

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

"F1" is the first stage noise factor, "G1" is the first stage gain, etc. This formula indicates that LNA with enough gain can compensate for the noise factor behind the LNA. In this case, "System NF" depends mainly on the noise figure of components and traces before first stage LNA plus noise figure of the LNA itself. This explains the need for using an active antenna, if the antenna connection cable is too long.

5.2.3. Active Antenna Reference Design

5.2.3.1. Active Antenna Reference Design without Antenna Detection Function

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

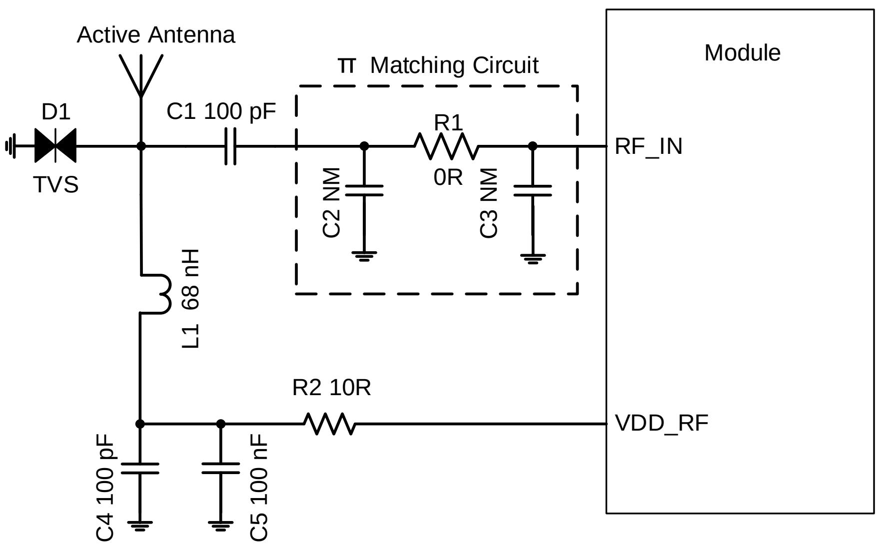

Figure 18: Active Antenna Reference Design without Antenna Detection Function

The components C2, R1 and C3 are reserved for matching antenna impedance. By default, R1 is 0 Ω, C1 is 100 pF, C2 and C3 are not mounted. D1 is an electrostatic discharge (ESD) protection device to protect the RF signal input from the potential damage caused by ESD.

An active antenna can use the power supply from the VDD_RF pin. In that case, the inductor L1 is used to prevent the RF signal from leaking into the VDD_RF and to prevent noise propagation from the VDD_RF to the antenna. The L1 inductor routes the bias voltage to the active antenna without losses. The recommended value of L1 is no less than 68 nH. The resistor R2 is used to protect the module in case the active antenna is short-circuited to the ground plane.

The existing footprints in the matching circuit can be used to mount other type of components than the ones presented in the figure above. In that case, you must pay attention to the DC power supply. For example, if an inductor is mounted on the C1 footprint, then the circuit needs a DC-blocking capacitor between L1 and C1 to prevent short-circuiting of the DC power supply through the inductor to the ground. The same can apply to the C2 footprint.

5.2.3.2. Active Antenna Reference Design with Antenna Detection Function

The following figure is a typical reference design for active antenna with antenna detection function.

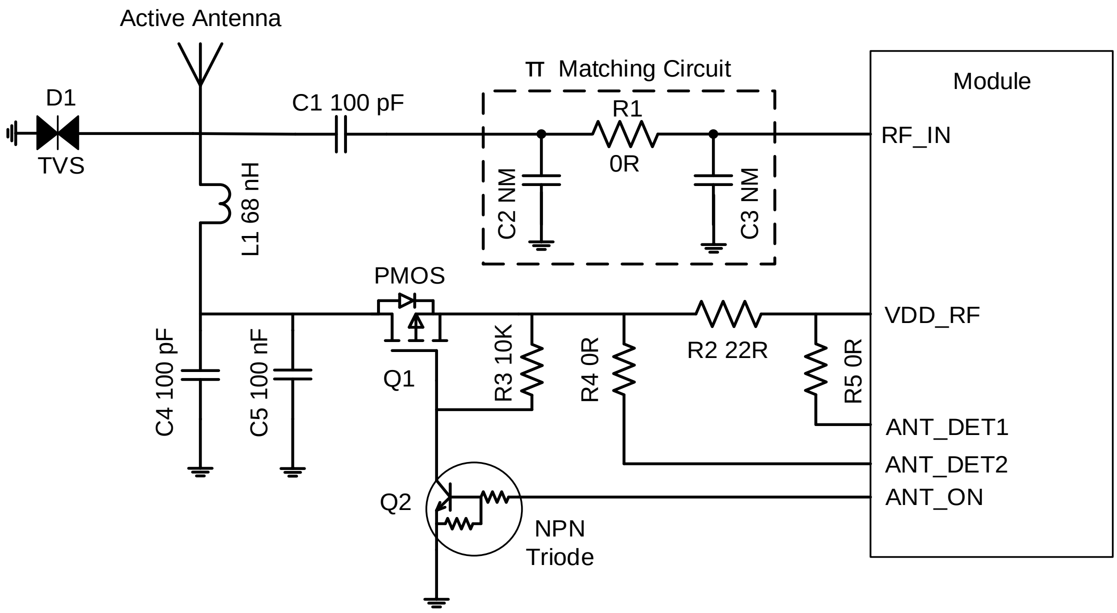

Figure 19: Active Antenna Reference Design with Antenna Detection Function

The Quectel L26-DR module reads the voltage at the R2 resistor ends (22 Ω recommended) through two analog inputs, ANT_DET1 and ANT_DET2. Through the antenna detection circuit, the state of antenna (normal/open/short) can be judged by comparing the voltages at both ends of the R2 resistor. The ANT_ON pin controls the power supply to the antenna.

When ANT_ON is high, both transistors Q1 and Q2 will be switched ON and the external antenna will be powered by VDD_RF. When ANT_ON is at low level, both Q1 and Q2 will be switched OFF, so the external antenna is disabled. In standby mode, VDD_RF will be automatically powered off.

Please ensure that the current consumption of the antenna falls within the range of 7–30 mA, otherwise the active antenna may not be able to work. The status of the antenna supervisor will be reported on startup and with each change in the form of an NMEA message.

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

5.2.4. Passive Antenna Reference Design

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

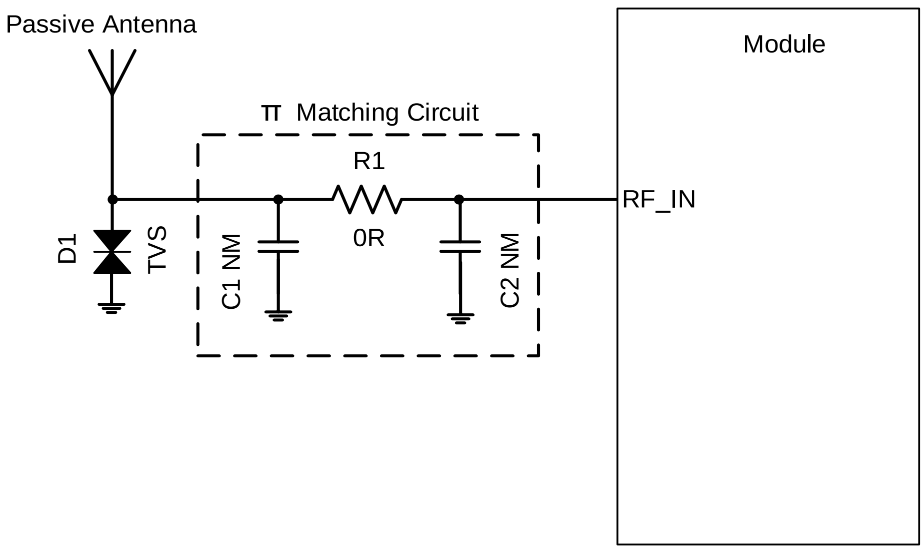

Figure 20: Passive Antenna Reference Design

The components C1, R1 and C2 are reserved for matching antenna impedance. By default, R1 is 0 Ω, while C1 and C2 are not mounted. D1 is an electrostatic discharge (ESD) protection device to protect one signal line from the damage caused by ESD. The impedance of RF trace should be controlled to 50 Ω and the 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 can be vulnerable to the interference of the surrounding environment. 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. As a result, a GNSS receiver's 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 to ensure the interference immunity of a GNSS receiver.

5.3.1. In-Band Interference

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

See the following figure for more details.

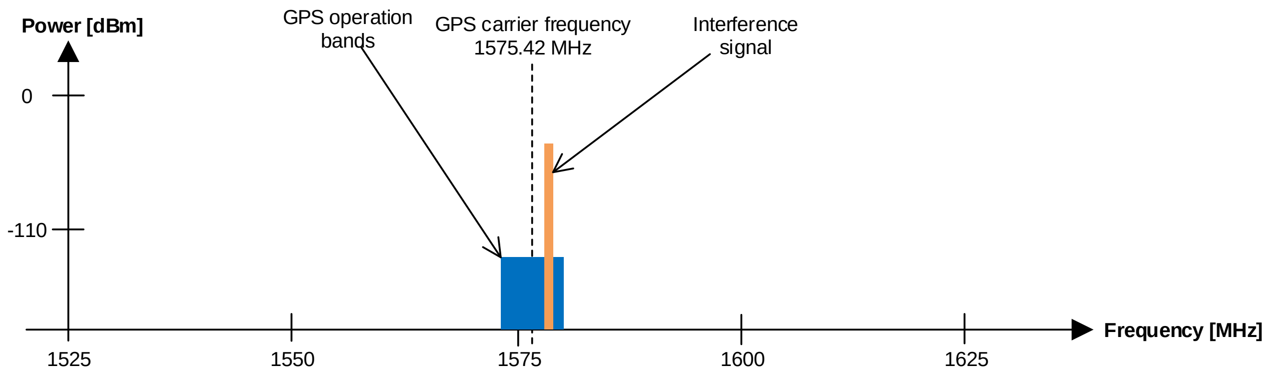

Figure 21: In-Band Interference on GPS L1

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 B13.

Table 8: Intermodulation Distortion (IMD) Products

Source F1	Source F2	IM Calculation	IMD Products
GSM850/B5	Wi-Fi 2.4 GHz	F2 (2412 MHz) - F1 (837 MHz)	IMD2 = 1575 MHz
DCS1800/B3	PCS1900/B2	2 × F1 (1712.6 MHz) - F2 (1850.2 MHz)	IMD3 = 1575 MHz

PCS1900/B2	Wi-Fi 5 GHz	F2 (5280 MHz) - 2 × F1 (1852 MHz)	IMD3 = 1576 MHz
LTE B13	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 to become saturated, so that its performance is greatly deteriorated, as illustrated in the following figure.

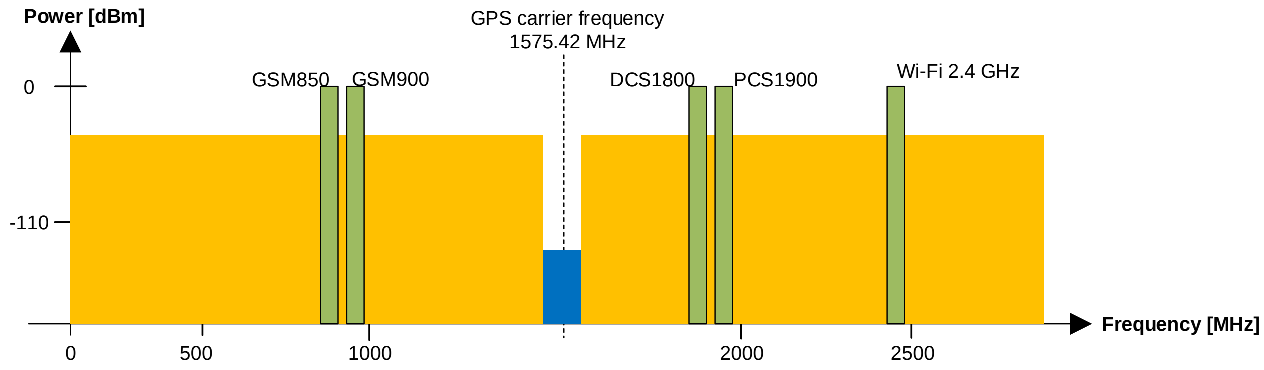

Figure 22: Out-of-Band Interference on GPS L1

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. In a complex communication system, there are usually 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.

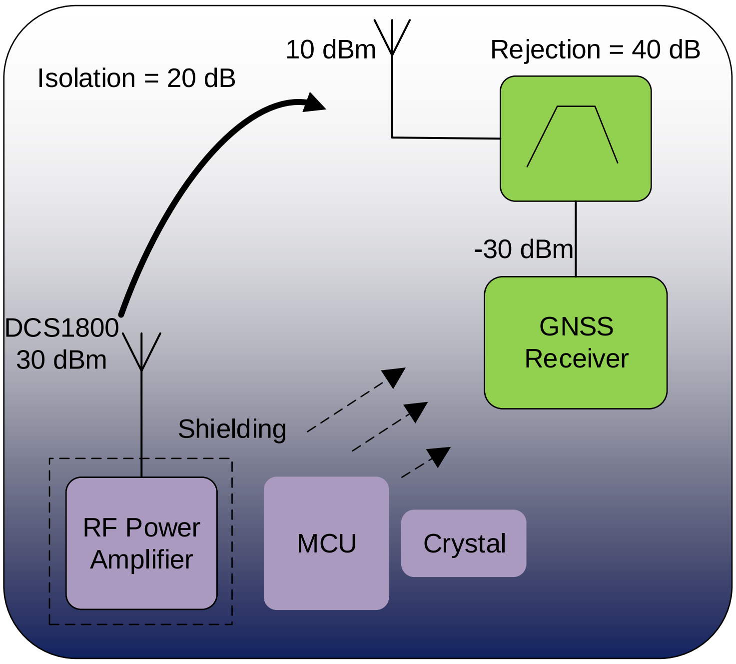

Figure 23: Interference Source and Its Path

6 Electrical Specification

6.1. Absolute Maximum Ratings

Absolute maximum ratings for power supply and voltage on digital pins of the Quectel L26-DR module are listed in table below.

Table 9: Absolute Maximum Ratings

Parameter	Description	Min.	Max.	Unit
VCC	Main Power Supply Voltage	-0.3	4.8	V
V_BCKP	Backup Supply Voltage	-0.3	4.8	V
V_{IN}_IO	Input Voltage at I/O Pins	-0.2	VCC + 0.3	V
P_{RF_IN}	Input Power at RF_IN	-	15	dBm
T_storage	Storage Temperature	-40	90	°C

NOTE

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

6.2. Recommended Operating Conditions

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

Table 10: Recommended Operating Conditions

Parameter	Description	Min.	Typ.	Max.	Unit
VCC	Main Power Supply Voltage	3.0	3.3	3.6	V
V_BCKP	Backup Supply Voltage	2.0	3.3	3.6	V
IO_domain	Domain Voltage at Digital I/O Pins	-	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	2.0		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	VCC - 0.4	-	-	V
RESET_N	Low-level Input Voltage	-0.3	-	0.35	V
	High-level Input Voltage	0.65	-	1.3	V
VDD_RF	VDD_RF Voltage	3.0	3.3	3.6	V
T_operating	Operating Temperature	-40	25	+85	°C

NOTE

Operation beyond the "Operating Conditions" is not recommended and extended exposure beyond the "Operating Conditions" may affect device reliability.

6.3. ESD Protection

The Quectel L26-DR module is an ESD sensitive device. Therefore, proper ESD handling and packaging procedures must be applied throughout the processing, handling and operation of any application that incorporates the module.

The following measures ensure ESD protection when the module is handled:

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

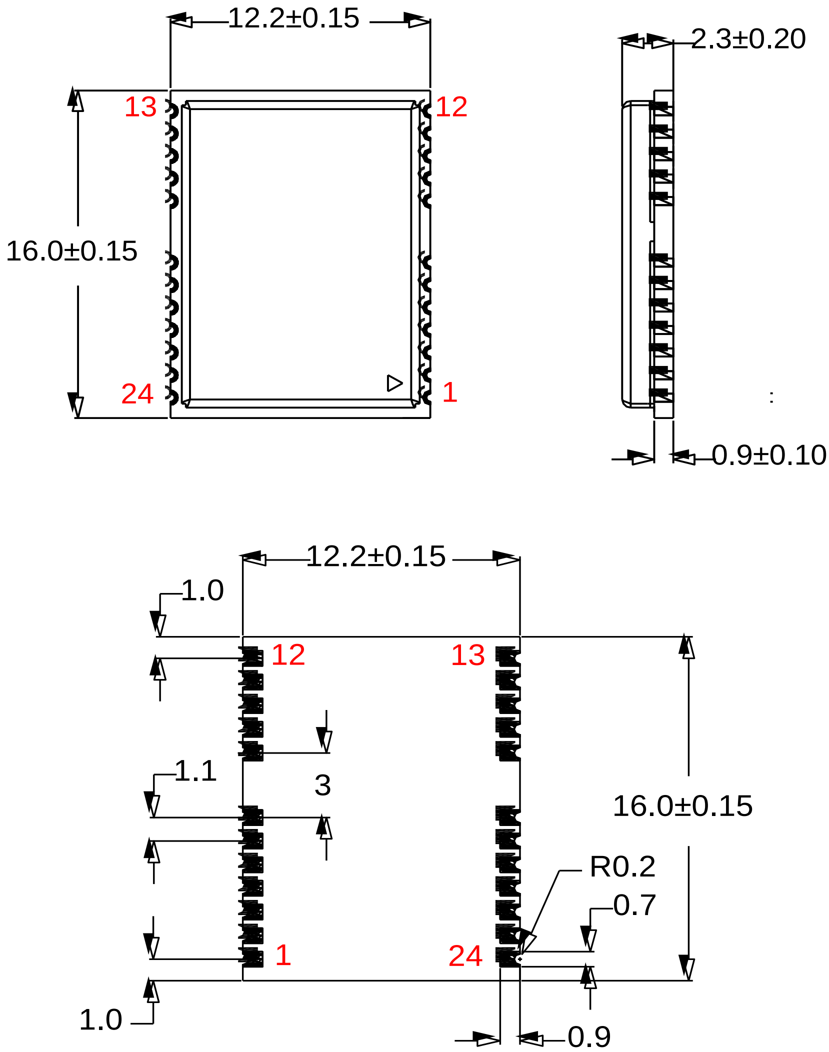

Figure 24: Top, Side and Bottom View Dimensions

NOTE

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

7.2. Top and Bottom Views

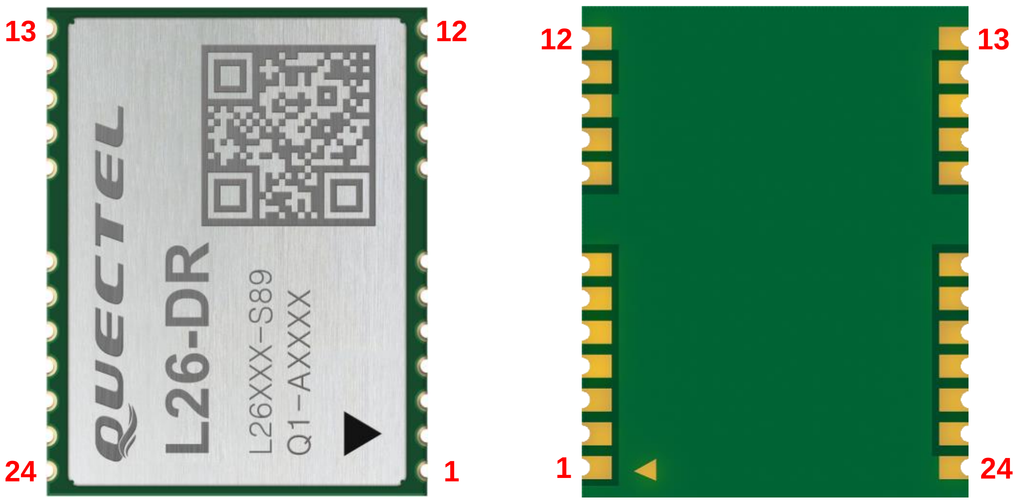

Figure 25: Top and Bottom Views of the Module

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.

7.3. Recommended Mounting

L26-DR (ADR) and L26-DR (ADRC) allow for flexible installation without constraint on angle and direction. The modules will automatically recognize the mounting angle deviation and compensates the deviation by algorithmic calculations.

The installation of L26-DR (UDR) is relatively more demanding; one of the x, y and z axes, shown in the following figure, should be perpendicular to the horizontal plane, and the deviation should be less than 20°. In this case, there is no limit to the placement direction on the plane formed by the other two axes. In other words, if axis z is perpendicular to the horizontal plane, there is no limit to the mounting direction of the module on the module plane (i.e. the plane formed by x and y axes).

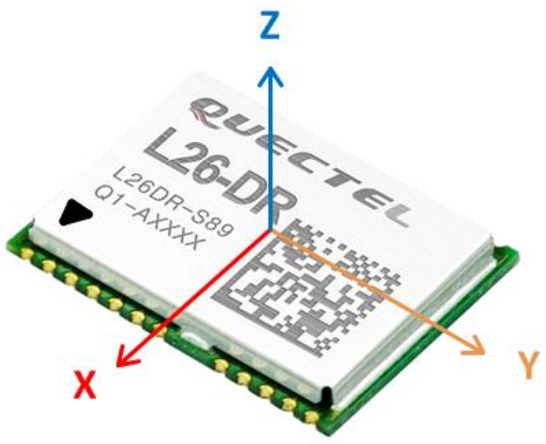

Figure 26: Axes of L26-DR Module

To ensure the performance, L26-DR module must be fixed tightly on the vehicle without movement or shaking during positioning.

8 Product Handling

8.1. Packaging

The Quectel L26-DR module is delivered as a reeled tape, which enables efficient production, set-up and dismantling of production batches. It is shipped in a vacuum-sealed packaging to prevent moisture intake and electrostatic discharge.

8.1.1. Tapes

The following figure shows the position of the Quectel L26-DR module when delivered in tape and the dimensions of the tape.

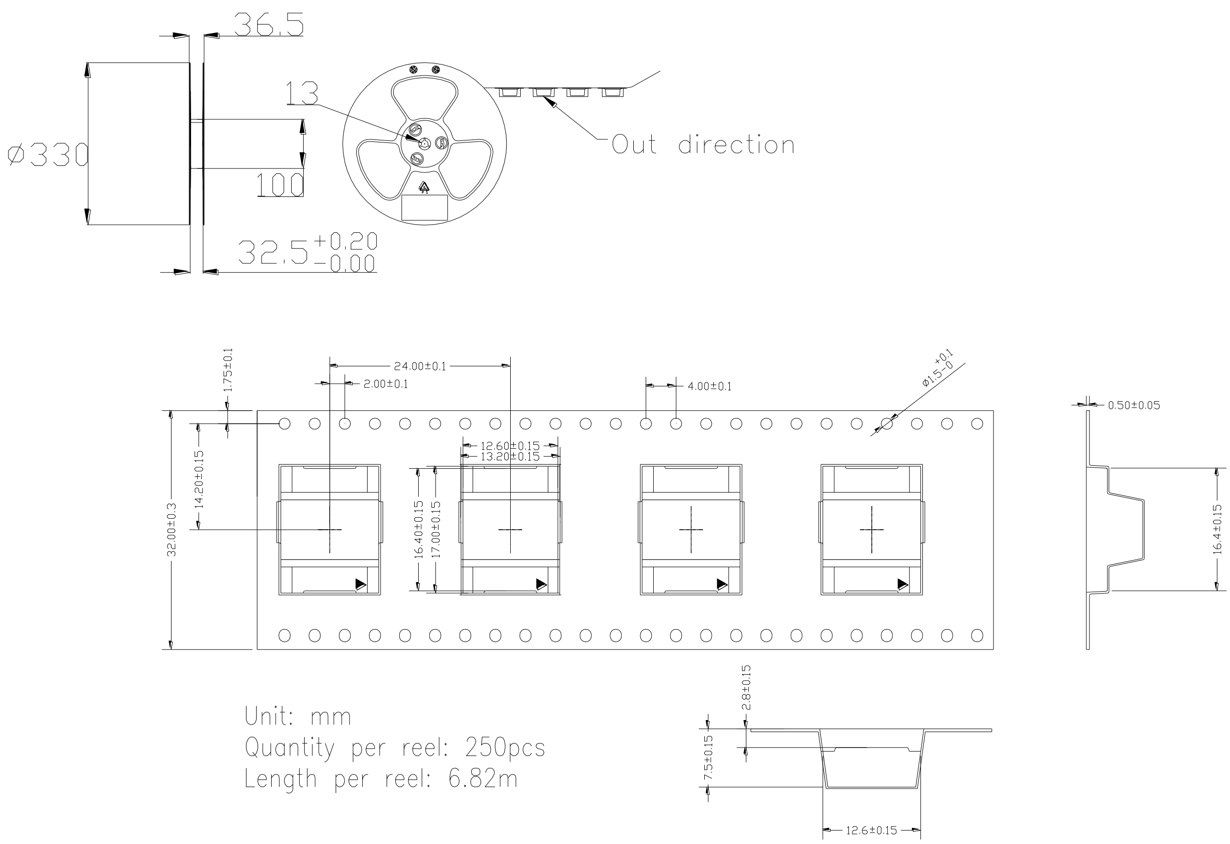

Figure 27: Tape and Reel Specifications

8.1.2. Reels

Each reel contains 250 Quectel GNSS modules. See the figure above.

Table 11: Reel Packaging

Model Name	MOQ	Minimum Package (MP): 250 pcs	Minimum Package x 4 = 1000 pcs
L26-DR	250 pcs	Size: 370 mm × 350 mm × 56 mm N.W: 0.225 kg G.W: 1.0 kg	Size: 380 mm × 250 mm × 365 mm N.W: 0.9 kg G.W: 4.3 ±0.1 kg

8.2. Storage

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

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

2. Storage life (in the vacuum-sealed packaging) is 12 months in recommended storage conditions.

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

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

   - The module is not stored under recommended storage conditions;
   - Violation of the third requirement above occurs;
   - Vacuum-sealed packaging is broken, or the packaging has been removed for more than 24 hours;
   - Before repairing the module.

[5] 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 remove the packages of tremendous modules if they are not ready for soldering.

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

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

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. All modules must be soldered to PCB within 24 hours after the baking, otherwise put them in the drying oven. If shorter baking time is desired, see *IPC/JEDEC J-STD-033* for the baking procedure.
3. Pay attention to ESD protection, such as wearing anti-static gloves, when touching the modules.

8.3. Manufacturing and Soldering

Push the squeegee to apply solder paste on the surface of stencil, thus making the paste fill the stencil openings and then penetrate the PCB. Apply proper force on the squeegee to produce a clean stencil surface on a single pass. For more information about the thickness of stencil for the module, see ***document [6]***.

The peak reflow temperature should be 235–246 ºC, with 246 ºC as the absolute maximum reflow temperature. To avoid module damage caused by repeated heating, it is strongly recommended that the module should be mounted to the PCB only after reflow soldering of the other side of PCB has been completed. The recommended reflow soldering thermal profile (lead-free reflow soldering) and related parameters are shown in the figure and table below.

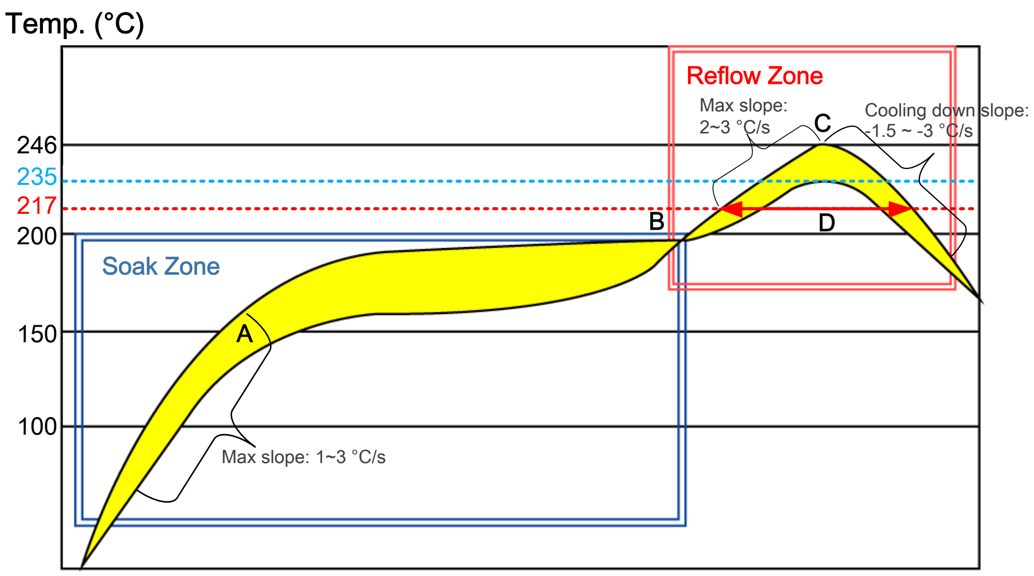

Figure 28: Recommended Reflow Soldering Thermal Profile

Table 12: Recommended Thermal Profile Parameters

Factor	Recommendation
Soak Zone	
Max slope	1–3 °C/s
Soak time (between A and B: 150 °C and 200 °C)	70–120 s
Reflow Zone	
Max slope	2–3 °C/s
Reflow time (D: over 217 °C)	40–70 s
Max temperature	235 °C to 246 °C
Cooling down slope	-1.5 to -3 °C/s
Reflow Cycle	
Max reflow cycle	1

NOTE

1. During manufacturing and soldering, or any other processes that may require direct contact with the

module, NEVER wipe the module's shielding can with organic solvents, such as acetone, ethyl alcohol, isopropyl alcohol, trichloroethylene, etc. Otherwise, the shielding can may become rusty.

2. The module shielding can be made of cupronickel base material. The Neutral Salt Spray Test has shown that after 12 hours the laser-engraved label information on the shielding can is still clearly identifiable and the QR code is still readable, although white rust may be found.
3. If a conformal coating is necessary for the module, **DO NOT** use any coating material that may chemically react with the PCB or shielding cover, and prevent the coating material from flowing into the module.

9 Labelling Information

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

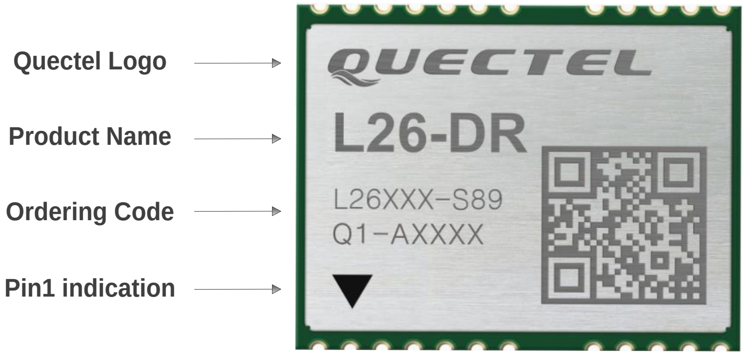

Figure 29: Labelling Information

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

10 Appendix References

Table 13: Related Documents

SN	Document Name
[1]	Quectel_L26-DR_GNSS_Protocol_Specification
[2]	Quectel_L89&L26-DR&L26-P&L26-T_AGNSS_Application_Note
[3]	Quectel_L26-DR_Application_Note
[4]	Quectel_L26-DR_Reference_Design
[5]	Quectel_L26-DR_RF_Layout_Guide
[6]	Quectel_Module_Secondary_SMT_Application_Note

Table 14: Terms and Abbreviations

Abbreviation	Description
AGNSS	Assisted GNSS
CAN	Controller Area Network
CEP	Circular Error Probable
CNR or C/N	Carrier-to-noise Ratio
DCE	Data Communications Equipment
DCS1800	Digital Cellular System at 1800 MHz
DR	Dead Reckoning
DTE	Data Terminal Equipment
EGNOS	European Geostationary Navigation Overlay Service

ESD	Electrostatic Discharge
GAGAN	GPS Aided Geo Augmented Navigation
Galileo	Galileo Satellite Navigation System (EU)
GGA	Global Positioning System Fix Data
GLL	Geographic Position-Latitude and Longitude
GLONASS	Global Navigation Satellite System (Russian)
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GSA	GPS DOP and Active Satellites
GSM	Global System for Mobile Communications
GSV	GNSS Satellites in View
G.W	Gross Weight
I/O	Input/Output
IC	Integrated Circuit
IMU	Inertial Measurement Unit
kbps	kilobits per second
LCC	Leadless Chip Carrier (package)
LDO	Low-dropout Regulator
LNA	Low-Noise Amplifier
LTE	Long Term Evolution
LTO	Long-term Orbit
Mbps	Megabits per second
MCU	Microcontroller Unit/Microprogrammed Control Unit
MEMS	Micro-Electro-Mechanical System
MOQ	Minimum Order Quantity
MP	Mass Production

MSAS	Multi-functional Satellite Augmentation System (Japan)
MSL	Moisture Sensitivity Levels
N.W	Net Weight
N/A	Not Applicable
NMEA	National Marine Electronics Association
OC	Open Connector
ODO	Odometer
PCB	Printed Circuit Board
PMU	Power Management Unit
1PPS	One Pulse Per Second
PSRR	Power Supply Rejection Ratio
QR (code)	Quick Response (Code)
QZSS	Quasi-Zenith Satellite System
RF	Radio Frequency
RHCP	Right Hand Circular Polarization
RMC	Recommended Minimum Specific GNSS Data
RoHS	Restriction of Hazardous Substances
ROM	Read Only Memory
RTC	Real-Time Clock
RTCM	Radio Technical Commission for Maritime Services
RTK	Real-Time Kinematic
RXD	Receive Data
3GPP	3rd Generation Partnership Project
SAW	Surface Acoustic Wave
SBAS	Satellite-Based Augmentation System
SMD	Surface Mount Device

SN	Serial Number
SPI	Serial Peripheral Interface
SRAM	Static Random Access Memory
SV	Visible Satellite
TCXO	Temperature Compensated Crystal Oscillator
TTFF	Time to First Fix
TVS	Transient Voltage Suppressor
UART	Universal Asynchronous Receiver/Transmitter
UTC	Coordinated Universal Time
VSWR	Voltage Standing Wave Ratio
VTG	Course Over Ground & Ground Speed
WAAS	Wide Area Augmentation System
WI	Warning Indicator