L26 Hardware Design

GNSS Module Series

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The following safety precautions must be observed during all phases of operation, such as use, 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	**L26 Hardware Design**
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Revision History

Version	Date	Description
1.0	2013-05-08	Initial
1.1	2014-05-10	1. Modified the input power at RF_IN. 2. Changed the tracking sensitivity to -167 dBm.
1.2	2014-06-11	Updated packaging information.
1.3	2014-12-23	Updated series resistance between VCC_RF and V_ANT in Figure 14 & 16.
1.4	2022-03-11	1. Completely reorganized the structure of the document, including but not limited to the adding of Chapters 1.5, 1.6, 1.10, 3.4, 3.5, 4.1.2, 5.1.2, 5.2, 6.3, 8.2 and 9. 2. Selected pin names have been updated to agree with a common naming convention across Quectel GNSS modules. The pins have the same physical hardware but with updated names. Pin 1: from FORCE_ON to WAKEUP Pin 8: from RESET TO RESET_N Pin 9: from VCC_RF to VDD_RF Pin 14: from ANTON to ANT_ON Pin 20: from TXD1 to TXD Pin 21: from RXD1 to RXD 3. Updated the product features and performance (Tables 1 and 2).

	4. Optimized the reset sequence (Figure 15). 5. Added two notes for the UART interface (Chapter 4.1.1.1). 6. Updated the frequency range of passive antenna and active antenna (Table 6). 7. Optimized the active antenna reference design with short-circuit protection (Figure 16). 8. Changed the maximum supply voltage of VCC and V_BCKP from 5 V to 4.3 V and the minimum and maximum storage temperature (Table 8). 9. Updated the recommended operating conditions (Table 9). 10. Added the measures that ensure ESD protection (Chapter 6.4). 11. Detailed the top, side and bottom view dimensions (Figure 24). 12. Optimized the module packaging (Chapter 8.1). 13. Updated the recommended reflow soldering thermal profile (Figure 29).

Contents

Table Index

Figure Index

1 Product Description

1.1. Overview

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

Key features:

- The L26 module is a single-band, multi-constellation GNSS module and features a high-performance, high reliability positioning engine. This module facilitates fast and precise GNSS positioning.
- The module supports serial communication interface UART.
- The module features EASY™ technology, a kind of AGNSS, which allows it to collect and process all internal ancillary information like GPS time, ephemeris and rough position, and achieve a very short TTFF (Time to First Fix) in either hot or warm start.
- The embedded flash memory provides the capacity for storing user-specific configurations and future firmware updates.

The L26 module is an SMD type module with a compact form factor of 12.2 mm × 16.0 mm × 2.4 mm. It can be embedded in your applications through the 24 LCC pins.

The module is fully compliant with the EU RoHS Directive.

1.2. Features

Table 1: Product Features

Features		L26
Grade	Industrial	●
	Automotive	-
Category	Standard Precision GNSS	●

	High Precision GNSS		-
	DR		-
	RTK		-
	Timing		-
Supply Voltage	2.8–4.3 V, typical: 3.3 V		●
IO Voltage	Typical: 2.8 V		●
Communication Interfaces	UART		●
	SPI		-
	I2C		-
	CAN		-
Integrated Features	Additional LNA		●
	Additional SAW		●
	RTC Crystal		●
	TCXO Oscillator		●
	6-axis IMU		-
Constellations	GPS	L1 C/A	●
		L5	-
	GLONASS	L1	●
	Galileo	E1	●
		E5a	-
	BDS	B1I	●
		B2a	-
	QZSS	L1 C/A	●
		L5	-
	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 × (2.4 ±0.20) mm Weight: Approx. 1.0 g

NOTE

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

1.3. Performance

Table 2: Product Performance

Parameter	Specification	L26
Power Consumption [1] (GPS + GLONASS)	Acquisition	29 mA
	Tracking	21 mA
	AlwaysLocate™ Mode [2]	2.7 mA
	Standby Mode	350 μA
	Backup Mode	7 μA
Sensitivity (GPS + GLONASS)	Acquisition	-148 dBm
	Reacquisition	-160 dBm
	Tracking	-167 dBm
TTFF [1] (without AGNSS)	Cold Start	35 s
	Warm Start	30 s
	Hot Start	1 s
TTFF [3] (with AGNSS)	Cold Start	15 s
	Warm Start	5 s

[1] Room temperature, all satellites at -130 dBm.
[2] Measured in GPS+GLONASS system in outdoor static mode.
[3] Open-sky, active high-precision GNSS antenna.

	Hot Start	1 s
Horizontal Position Accuracy [4]		2.5 m
Update Rate	1 Hz (max. 10 Hz)	
Accuracy of 1PPS Signal	Typical Accuracy: 100 ns	
Velocity Accuracy [1]	Without Aid: 0.1 m/s	
Acceleration Accuracy [1]	Without Aid: 0.1 m/s²	
Dynamic Performance [1]	Maximum Altitude: 18000 m Maximum Velocity: 515 m/s Acceleration: 4 g	

1.4. Block Diagram

The following figure shows the block diagram of L26 module, which includes a single chip GNSS IC, an LNA, a SAW, a TCXO, an XTAL and a short-circuit detection and protection circuit for active antenna.

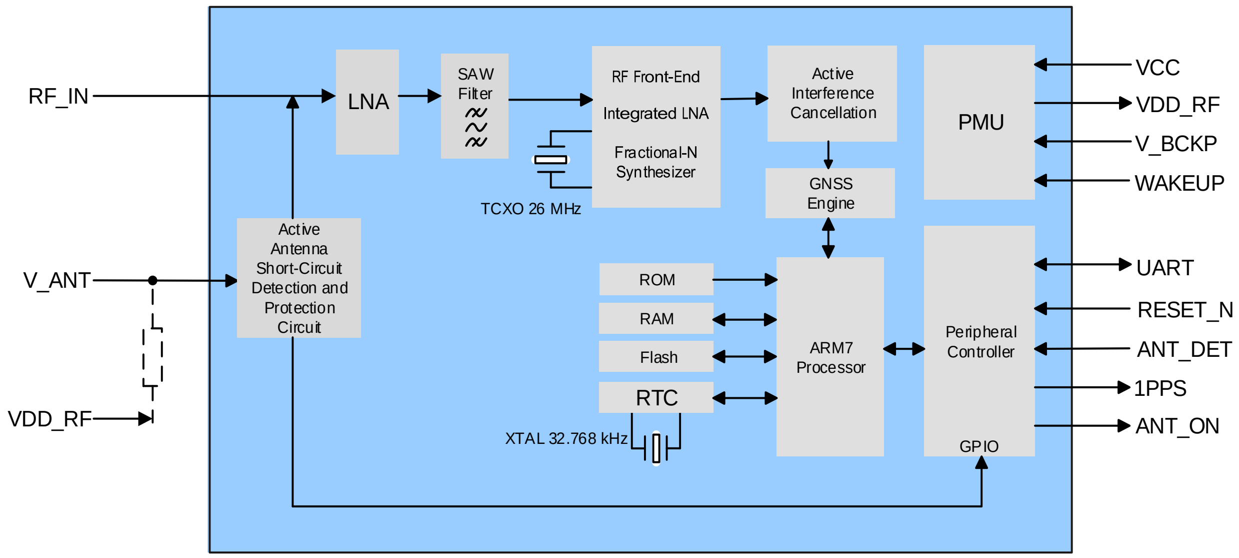


Figure 1: Block Diagram

4 CEP, 50 %, 24 hours static, -130 dBm, more than 6 SVs.

1.5. GNSS Constellations

Quectel L26 module is a single-band GNSS receiver that can receive and track GNSS signals.

1.5.1. GPS

The module is designed to receive and track GPS L1 C/A signal centered at 1575.42 MHz.

1.5.2. GLONASS

The module is designed to receive and track GLONASS L1 signal in the frequency range from 1598.0625 MHz to 1605.375 MHz.

1.5.3. Galileo

The module is designed to receive and track Galileo E1 signal centered at 1575.42 MHz.

1.5.4. BDS

The module is designed to receive and track BDS B1I signal provided by the BDS Navigation Satellite System centered at 1561.098 MHz. The ability to receive and track BDS signals in conjunction with GPS results in higher coverage, improved reliability, and better accuracy.

1.5.5. QZSS

The Quasi-Zenith Satellite System (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 L26 module can detect and track QZSS L1 C/A signal concurrently with GPS signals, leading to better availability especially under challenging conditions, e.g., in urban canyons.

1.6. Augmentation System

1.6.1. SBAS

L26 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 signals can also be used as additional signals for ranging or distance measurement, thus further improving availability. Supported SBAS systems: WAAS, EGNOS, MSAS and

GAGAN.

1.7. AGNSS

L26 module supports AGNSS feature that significantly reduces the module’s TTFF, especially under lower signal conditions. To implement the AGNSS feature, the module should get the ancillary data including the current time and rough position.

1.7.1. EASY™

The module supports the EASY™ technology to improve TTFF and acquisition sensitivity of GNSS modules. To achieve that goal, the EASY™ technology provides ancillary information, such as the ephemeris, almanac, rough position, time, and a satellite status.

The EASY™ technology works as an embedded software to accelerate TTFF by predicting satellite navigation messages from the received ephemeris. After receiving the broadcast ephemeris for the first time, the GNSS engine automatically calculates and predicts orbit information up to subsequent 3 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 reduces TTFF to 5 s in warm start. In this case, the backup domain should still be valid. To obtain enough broadcast ephemeris information from GNSS satellites after fixing the position, the GNSS module should keep tracking the information for at least 5 minutes in strong-signal environments.

The EASY™ function is enabled by default, and disabled by sending commands. For more information about commands, see ***document [1]***.

1.8. LOCUS™

L26 module supports the embedded logger function called LOCUS. When this function is enabled, it logs position information to the internal flash memory. In addition, with this function, the host can reduce power consumption. As a result, the host won’t track the NMEA information all the time. The module provides more than 16 hours of log capacity (64 KB). A command can be used to query the current state of LOCUS. For more information about the command, see ***document [1]***.

1.9. Multi-tone AIC

L26 module features a function called multi-tone active interference cancellation (AIC) to decrease harmonic distortion of RF signals from Wi-Fi, Bluetooth, and 2G, 3G, 4G, and 5G network.

Up to 12 AIC tones embedded in the module achieve effective narrow-band interference and jamming elimination. Thus, the GNSS signal can be demodulated from the jammed signal, which can ensure better navigation quality.

AIC anti-jamming performance is presented in the figure below:

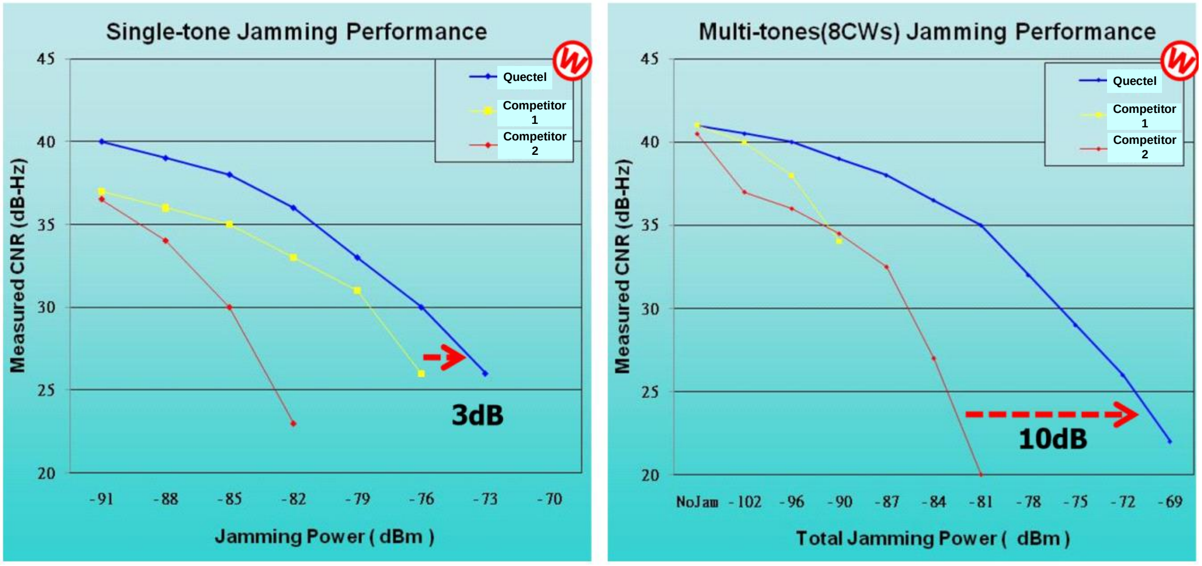


Figure 2: AIC Anti-Jamming Performance

The AIC function is enabled by default, and it can be disabled with software commands. For more information about the commands, see ***document [1]***.

1.10. Firmware Upgrade

L26 module is delivered with preprogrammed firmware. Quectel may release firmware versions that contain bug fixes or performance optimizations. It’s highly important that you 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 [2]***.

2 Pin Assignment

Quectel L26 module is equipped with 24 LCC pins by which the module can be mounted on your PCB.

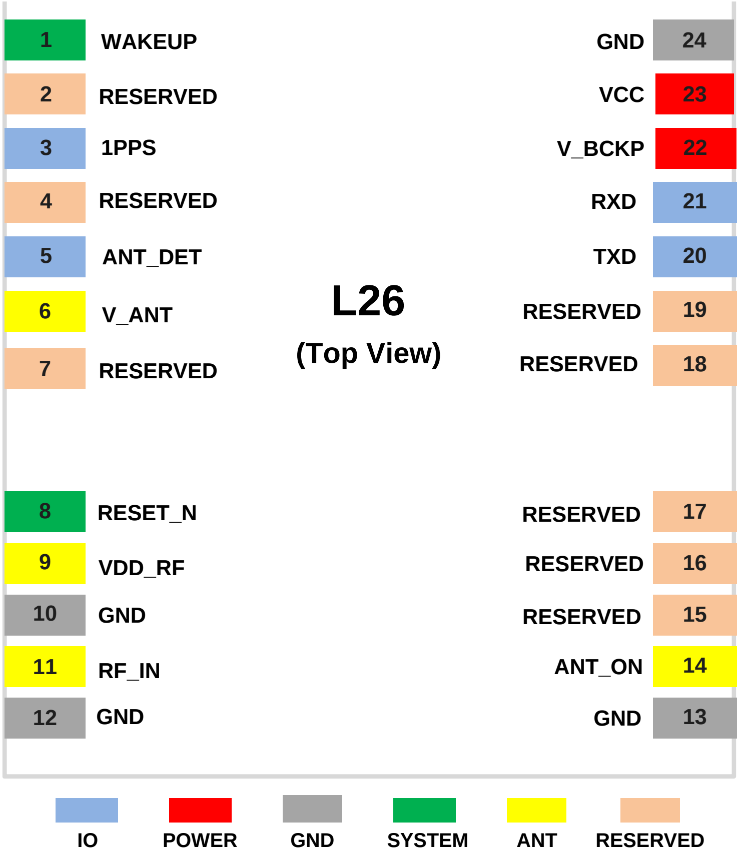


Figure 3: Pin Assignment

Table 3: I/O Parameter Definition

Type	Description
AI	Analog Input
DI	Digital Input
DO	Digital Output

PI	Power Input
PO	Power Output

Table 4: Pin Description

Function	Name	No.	I/O	Description	Remarks
Power	VCC	23	PI	Main power supply	Provides clean and steady voltage.
	V_BCKP	22	PI	Backup power supply for backup domain	V_BCKP must be connected to power supply for startup. It should always be powered if hot (warm) start is needed.
IO	TXD	20	DO	Transmits data	UART interface is used for standard NMEA message output, PMTK/PQ command input and output, and firmware upgrade.
	RXD	21	DI	Receives data	
	1PPS	3	DO	One pulse per second	Synchronized on rising edge. If unused, leave the pin N/C (not connected).
	ANT_DET	5	DI	Active antenna detection	Logic High: active antenna is unconnected; Logic Low: active antenna is connected well. If unused, leave the pin N/C.
ANT	V_ANT	6	PI	Active antenna bias voltage	Connect to GND (or leave N/C if passive antenna is used. If an active antenna is used, a 22 Ω resistor should be connected in series between the V_ANT and the VDD_RF.
	RF_IN	11	AI	GNSS antenna interface	50 Ω characteristic impedance.
	ANT_ON	14	DO	Controls power for active antenna	If unused, leave the pin N/C.
	VDD_RF	9	PO	Supplies power for external RF components	VDD_RF = VCC, the output current capacity depends on VCC. Typically used to supply power for an external active antenna or LNA. If unused, leave the pin N/C.
System	WAKEUP	1	DI	Wakes up the module from Backup mode	Leave the pin N/C or pull it low before entering Backup mode. It belongs to backup domain. If unused, leave the pin N/C.

	RESET_N	8	DI	Resets the module	Active low.
GND	GND	10, 12, 13, 24	-	Ground	Assures a good GND connection to all module GND pins, preferably with a large ground plane.
RESERVED	RESERVED	2, 4, 7, 15–19	-	Reserved	These pins must be left floating and cannot be connected to power or GND.

NOTE

Leave RESERVED and unused pins N/C.

3 Power Management

Quectel L26 module has 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 five operating modes: Standby mode, Periodic mode, AlwaysLocate^{TM} 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. 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 power for the backup domain. To achieve quick startup and improve TTFF, the backup domain power supply should be valid during the interval the VCC level is invalid. Low power RAM memory also belongs to the backup domain. If the VCC level is invalid, the V_BCKP supplies power for low power RAM memory that contains all the necessary GNSS data and some of the user configuration variables.

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

The module’s internal power supply is shown below:

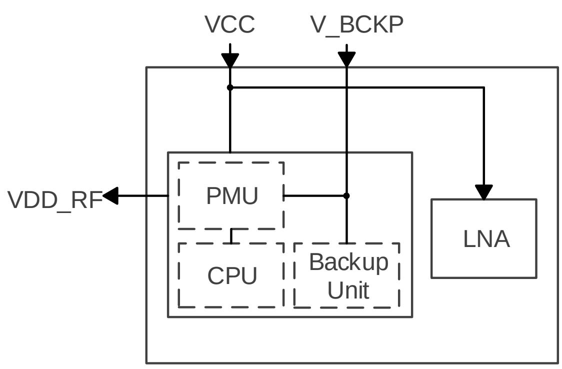


Figure 4: Internal Power Supply

3.2. Power Supply

3.2.1. VCC

The VCC is the supply voltage pin. The VCC pin supplies power for BB and RF.

Module power consumption may vary by several orders of magnitude, especially when power saving mode is enabled. Therefore, it is important that the power supply can sustain 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 Continuous mode or starts up, 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 modes, it is important that the LDO at the power supply or module input can provide the current. An LDO with a high PSRR should be chosen for good performance. In addition, a TVS, and a combination of a 10 μF, a 100 nF and a 33 pF decoupling capacitor network should be added near the VCC pin. The lowest value capacitor should be the closest to module pins.

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

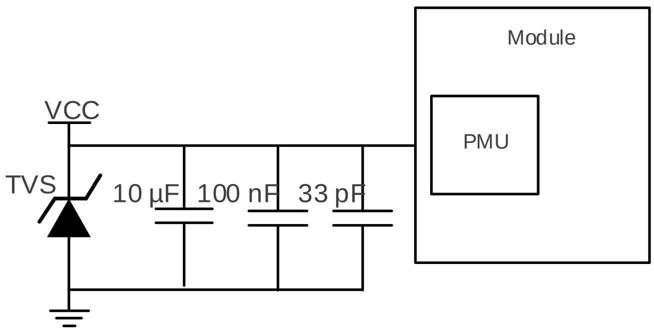


Figure 5: VCC Input Reference Circuit

3.2.2. V_BCKP

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

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

V_BCKP can be directly powered by an external battery (rechargeable or non-rechargeable). It is recommended to place a battery with a TVS and a combination of a 4.7 μF, a 100 nF and a 33 pF capacitor near the V_BCKP pin. The figure below illustrates the reference design for powering the backup domain with a non-rechargeable battery.

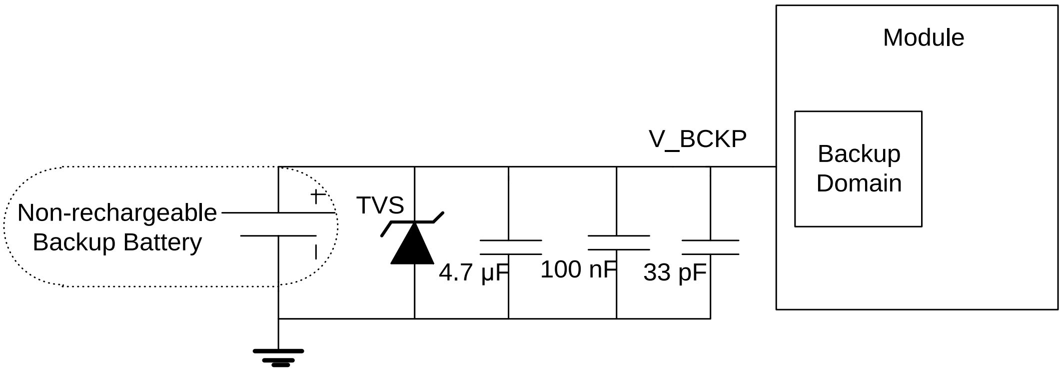


Figure 6: Backup Domain Powered by Non-Rechargeable Backup Battery

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

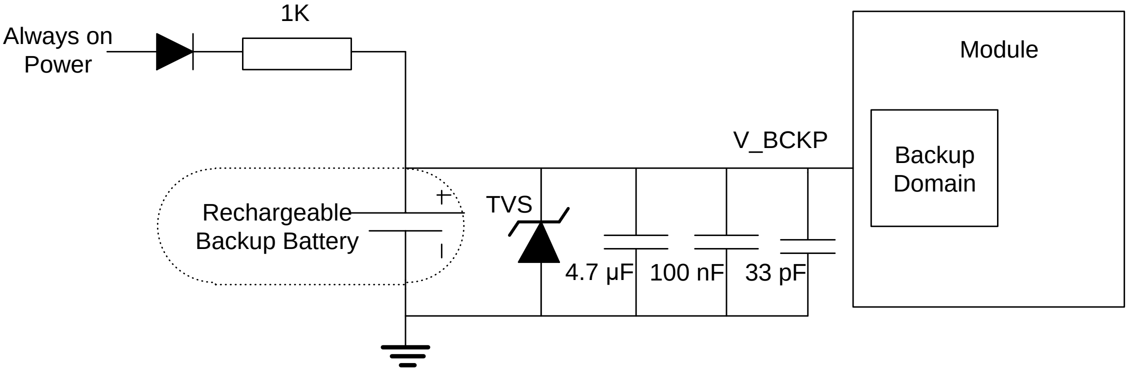


Figure 7: Reference Charging Circuit for Rechargeable Backup Battery

NOTE

1. V_BCKP cannot be below the spec value, otherwise the module cannot work normally.
2. A suitable resistor should be chosen according to the charging current of the battery.

3.3. Power Mode

3.3.1. Feature Comparison

The table below illustrates the supported features/functions of the module in different modes.

Table 5: Feature Comparison in Different Power Modes

Features	Continuous	Standby	Backup	Periodic	AlwaysLocate™
NMEA from UART	●	(Enter Continuous mode after receiving any command)	-	**O**	-
1PPS	●	-	-	**O**	-
RF	●	-	-	**O**	-
Acquisition & Tracking	●	-	-	**O**	-
Power Consumption	High	Low	Low	Medium	Low
Position Accuracy	High	-	-	Low	-

NOTE

O = supported in the Periodic Continuous mode

3.3.2. Continuous Mode

If VCC is 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. Standby Mode

The Standby mode is a power saving mode. In Standby mode, the internal core and the IO power domain are still active, but the RF is powered off, so the module stops satellite searching and navigation. The UART interface still receives commands or any other data in Standby mode, but NMEA messages can't be output via the interface.

You can send the software command (see ***document [1]*** for more information about the command) to make the module enter the Standby mode. Sending any data via the UART interface can make the module exit the Standby mode. When the module exits the Standby mode, it will use all internal ancillary information such as GPS time, ephemeris, and rough position to ensure the fastest possible TTFF during hot or warm start.

3.3.4. Backup Mode

For power-sensitive applications, the module has Backup mode to reduce power consumption. Only backup domain is active in Backup mode, and it keeps track of time. There are two approaches to enter/exit Backup mode.

The first approach:

- Enter Backup mode: set the module into Backup mode with a command. For more information on the command, see ***document [1]***.
- Exit Backup mode: wake up the module by pulling WAKEUP high for at least 10 ms.

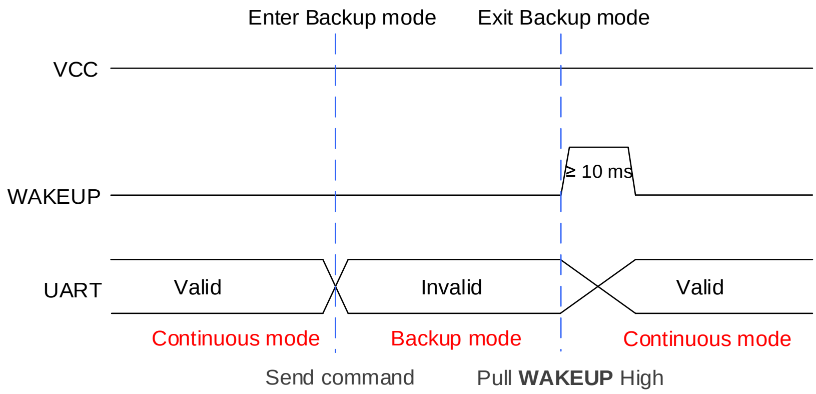


Figure 8: Enter/Exit Backup Mode Sequence 1

The second approach:

- Enter Backup mode: cut off the power supply of VCC for at least 1 s and keep V_BCKP powered.
- Exit Backup mode: restore the VCC power supply.

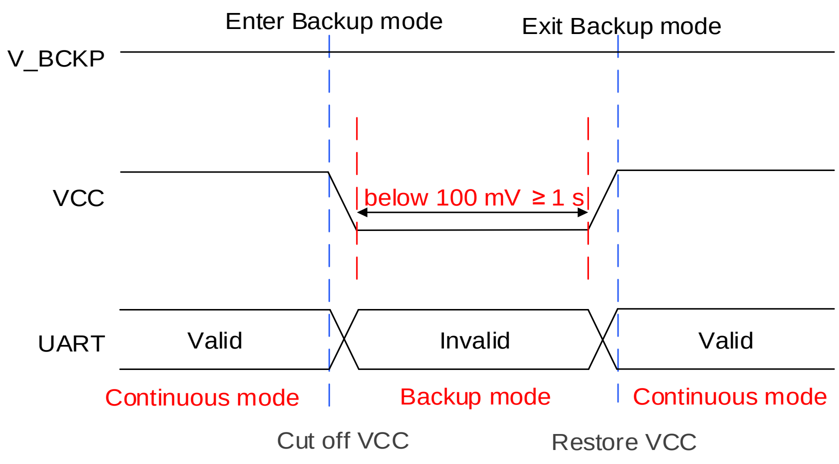


Figure 9: Enter/Exit Backup Mode Sequence 2

3.3.5. Periodic Mode

The Periodic mode achieves a balance between the positioning accuracy and power consumption, but the performance is lower compared to the Continuous mode. In the Periodic mode, the module should always be powered. In this mode, the module switches between the Continuous mode and the Standby/Backup mode periodically to reduce power consumption.

Through software commands, the module enters/exits the Periodic mode. For more information about the commands, see ***document [1]***.

The following figure illustrates the operation of the Periodic mode. After sending the command for entering the Periodic mode, the module first goes into the Continuous mode and remains in it for several minutes. Afterwards, the module enters the Periodic mode and operates according to the parameters set in the command. If the module fails to fix the position in **Run Time**, it switches to the **Second Run Time** and **Second Sleep Time** automatically. As long as it manages to fix the position again, the module will return to **Run Time** and **Sleep Time**.

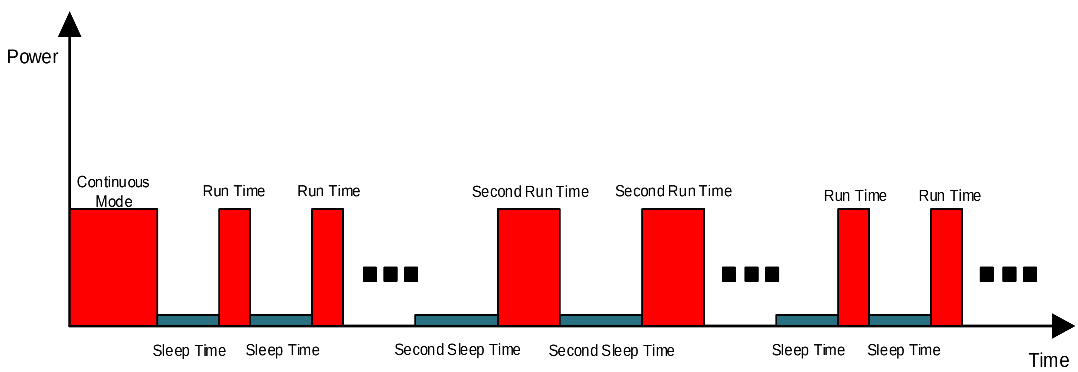


Figure 10: Periodic Mode

The average current value can be calculated with the following formula:

$I_{periodic} = (I_{tracking} \times T1 + I_{standby/backup} \times T2) / (T1+T2)$

T1 = Run Time, T2 = Sleep Time.

NOTE

Before entering the Periodic mode, make sure the module is in the Tracking mode; otherwise, there is a risk of satellite-tracking failure. If the module operates in weak signal environments, it is recommended to set a longer **Second Run Time** to ensure successful reacquisition.

3.3.6. AlwaysLocate^{TM} Mode

AlwaysLocate^{TM} is an intelligent power saving mode. It is comprised of AlwaysLocate^{TM} Backup mode and AlwaysLocate^{TM} Standby mode.

AlwaysLocate^{TM} Standby mode allows the module to switch automatically between Continuous mode and Standby mode. According to the environmental and motion conditions, the module can adjust the Continuous time and Standby time to achieve a balance between positioning accuracy and power consumption. Sending software command and the module returning a corresponding command means the module accesses AlwaysLocate^{TM} Standby mode successfully. It will benefit power saving in this mode. Sending software command in any time will make the module back to Continuous mode.

AlwaysLocate^{TM} Backup mode is similar to AlwaysLocate^{TM} Standby mode. The difference is that AlwaysLocate^{TM} Backup mode switches automatically between Continuous mode and Backup mode. Sending a software command makes the module enter AlwaysLocate^{TM} Backup mode. Pulling WAKEUP high and immediately sending the software command will make the module enter Continuous mode.

For more information about above-mentioned commands, see ***document [1]***.

The position accuracy in AlwaysLocate^{TM} mode will be degraded, especially in highly dynamic scenarios. The following picture shows the rough power consumption of L26 module in different daily scenes when AlwaysLocate^{TM} mode is enabled.

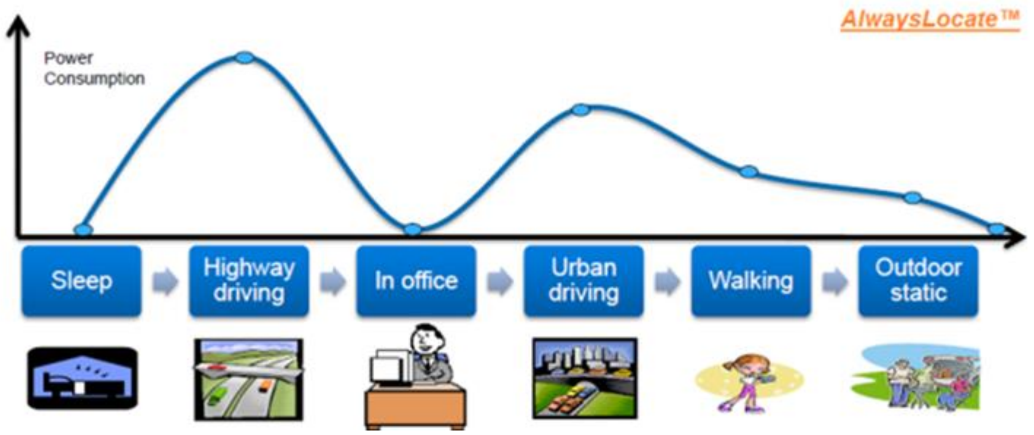


Figure 11: AlwaysLocate™ Mode

Example:
Typical average consumption is about 2.8 mA in AlwaysLocate™ Standby mode and 2.7 mA in AlwaysLocate™ Backup mode.

NOTE

1. Power consumption is measured in GPS & GLONASS system in outdoor static mode with active antenna.
2. The sleep time in Periodic Backup mode and AlwaysLocate™ Backup mode is equal to the time in Backup mode.
3. Leave WAKEUP pin open or low before entering AlwaysLocate™ Backup mode, otherwise, the AlwaysLocate™ Backup mode will be unavailable.

3.4. Power-Up Sequence

Once the VCC is 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 or before the VCC.

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

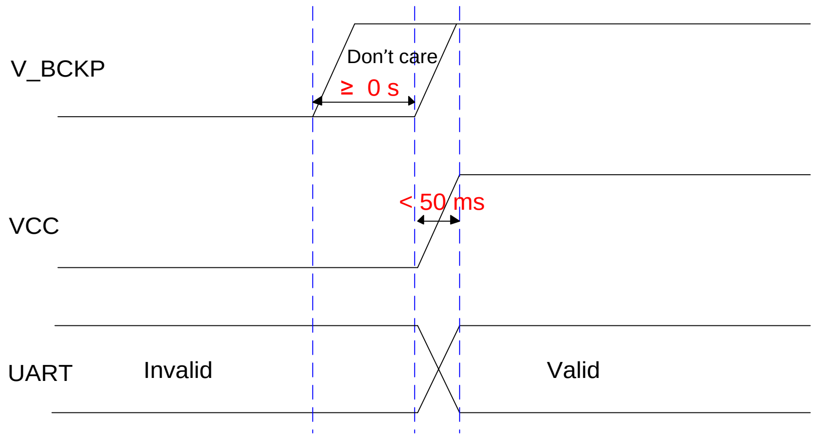


Figure 12: Power-Up Sequence

3.5. Power-Down Sequence

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

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

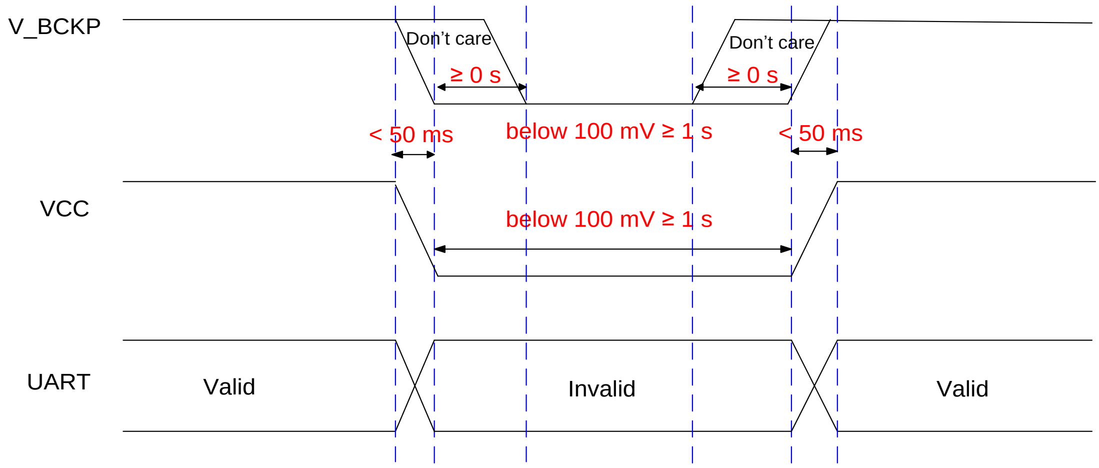


Figure 13: Power-Down and Power-On Restart Sequence

4 Application Interfaces

4.1. IO Pins

4.1.1. Communication Interface

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

4.1.1.1. UART Interface

The module has one UART interface with the following features:

- Supports standard NMEA message output, PMTK/PQ command input and output, and firmware upgrade.
- Supports the following baud rates: 4800, 9600, 14400, 19200, 38400, 57600, 115200 bps.
- Hardware flow control and synchronous operation are not supported.

A reference design is shown in the figure below. For more information, see ***document [3]***.

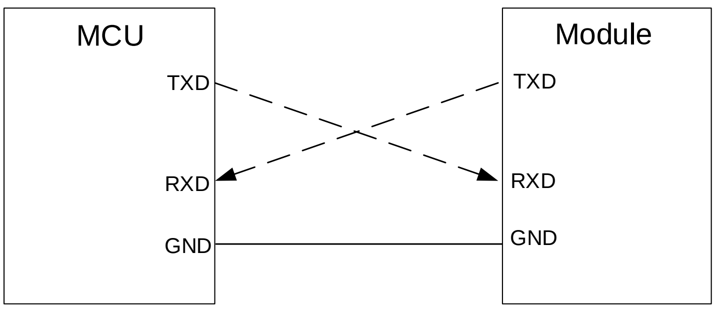


Figure 14: UART Interface Reference Design

NOTE

1. UART interface default settings vary depending on software version. See specific software versions for details.
2. If the IO voltage of MCU is not matched with the module, a level shifter must be selected.

4.1.2. 1PPS

The 1PPS output pin generates one pulse per second periodic signal synchronized with a GNSS time grid with intervals. The accuracy is < 100 ns. Thus, it may be used as a low frequency time synchronization pulse or as a high frequency reference signal. To maintain the high accuracy of 1PPS, it is required to have visible satellites in an open sky environment and keep the VCC powered.

4.1.3. ANT_DET

The ANT_DET pin can be used to indicate the state of an external active antenna.

- When the ANT_DET pin keeps a high level, active antenna is unconnected;
- When the ANT_ENT pin keeps a low level, active antenna is connected well.

If unused, leave the pin N/C.

4.2. System 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.

RESET_N is internally pulled up to 2.8 V with a 75 kΩ resistor by default, so no external pull-up circuit is allowed for this pin.

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

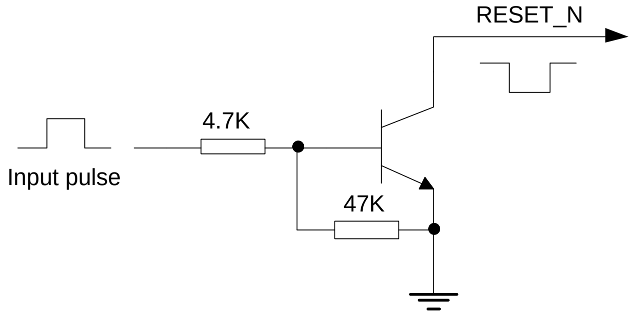


Figure 15: Reference OC Circuit for Module Reset

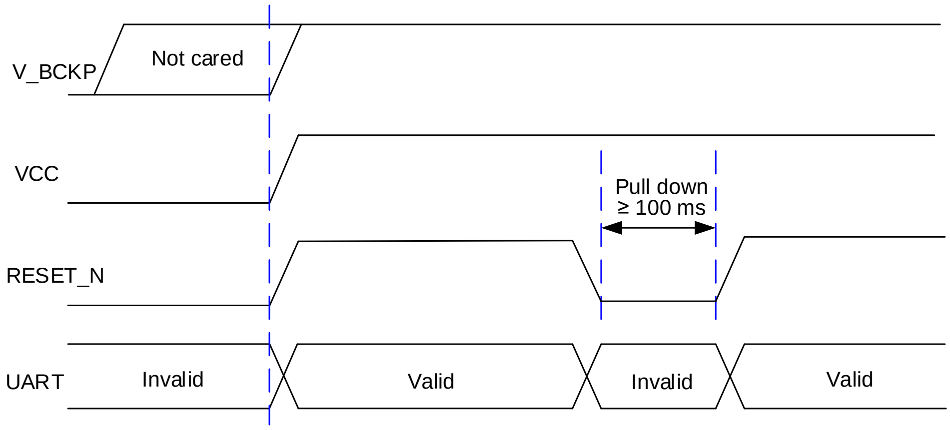


Figure 16: Reset Sequence

NOTE

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

4.2.2. WAKEUP

The WAKEUP pin has been pulled down internally by default. Keep the pin low when the module is in the Continuous mode and the Backup mode. To exit the Backup mode, drive the pin high for at least 10 ms. If unused, leave the pin N/C.

5 Design

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

5.1. Antenna Reference Design

5.1.1. Antenna Specifications

L26 module can be connected to a dedicated passive or active single-band GNSS antenna to receive GNSS satellite signals. The recommended antenna specifications are given in the table below.

Table 6: Recommended Antenna Specifications

Antenna Type	Specification
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

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

5.1.2. Antenna Selection Guide

Both active and passive single-band GNSS antennas can be used for L26 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 information about RF layout, see ***document [4]***.

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 surface is about -130 dBm. “Thermal Noise” is -174 dBm/Hz at 290 K. To improve C/N_0 of GNSS signal, an LNA could be added to reduce “System NF”.
“System NF”, formula:

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

“F” is the noise factor of receiver system:

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

“F1” is the first stage noise factor; “G1” is the first stage gain, etc. This formula indicates that 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.

5.1.3. Active Antenna Reference Design

Short-circuit protection and antenna detection for active antenna are supported by L26 module. Short-circuit protection circuit is embedded in the module, while an external circuit is needed to implement the antenna detection function.

L26 module provides the NMEA message about active antenna status, which allows for timely status acquisition by the host. See ***document [1]*** for detailed information about this message.

5.1.3.1. Active Antenna with Short-Circuit Protection

Active antenna has an integrated LNA which could be directly connected to RF_IN. If an active antenna is connected to RF_IN, the correct voltage needs to be supplied to the integrated LNA of the antenna through V_ANT pin. Usually, the supply voltage is fed to the antenna through the coaxial RF cable. VDD_RF or an external LDO can be used to power V_ANT. If RF_IN is accidentally short-circuited, the route from V_ANT to RF_IN will be cut off by the internal short-circuit protection circuit to protect the module and the active antenna. The principle of short-circuit protection function is illustrated in the figure below. If VDD_RF voltage is not suitable for your active antenna, it could be replaced with an external LDO.

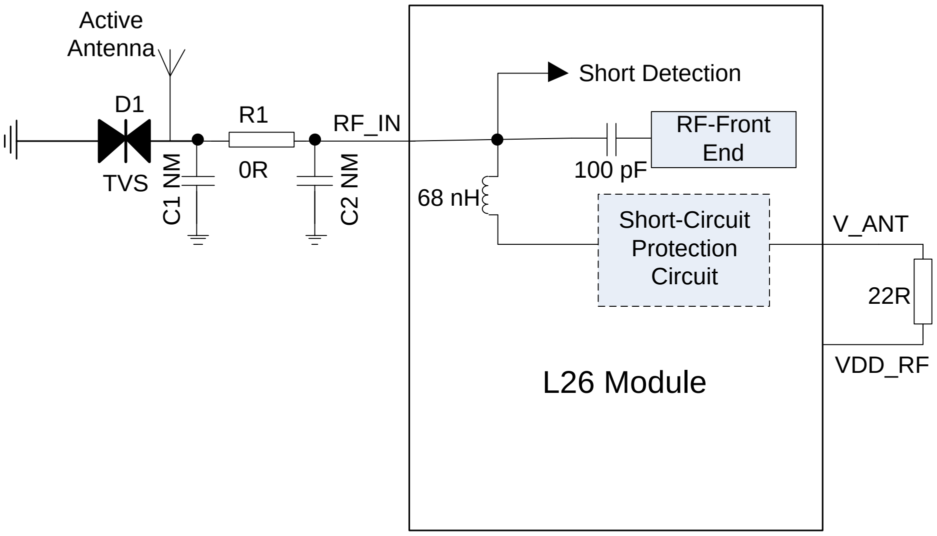


Figure 17: Active Antenna Reference Design with Short-Circuit Protection

C1, R1, C2 are reserved components comprising the matching circuit for antenna impedance modification. By default, C1 and C2 are not mounted, R1 is 0 Ω.

5.1.3.2. Active Antenna with Antenna Status Detection

The following figure is a typical reference design of an active antenna with status detection function.

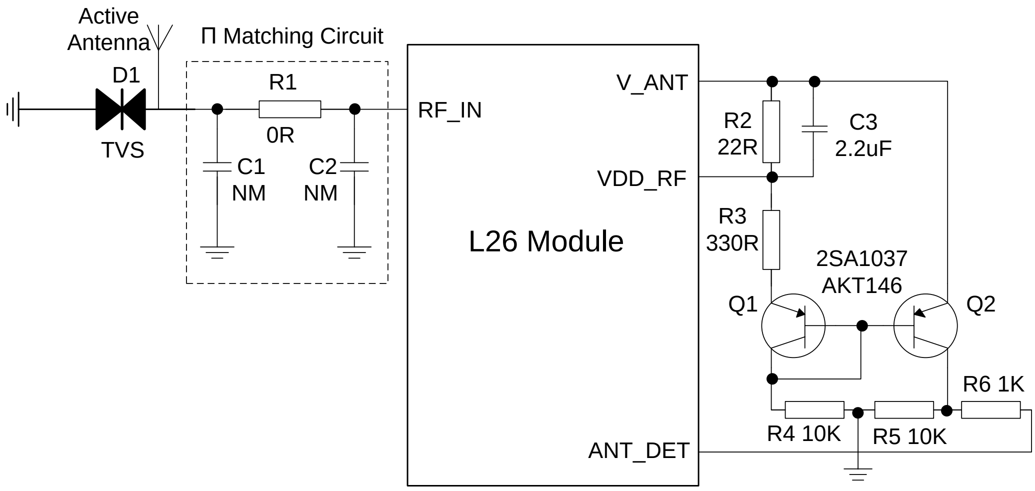


Figure 18: Active Antenna Reference Design with Antenna Status Detection

When active antenna is not connected to RF_IN or they are in poor contact, ANT_DET will be at a high level to indicate the absence of the active antenna. ANT_DET will change to a low level when active antenna is connected well.

C1, R1, C2 are reserved components comprising the matching circuit for antenna impedance modification. By default, C1 and C2 are not mounted, R1 is 0 Ω.

5.1.3.3. Active Antenna with ANT_ON Circuit

In order to cut off the power supply of active antenna to reduce power consumption in power saving mode, the ANT_ON pin can be used to control the power supply of active antenna.

The reference circuit for active antenna with "ANT_ON" function is given below. In addition, VDD_RF can be replaced with an external LDO if it does not meet your requirements.

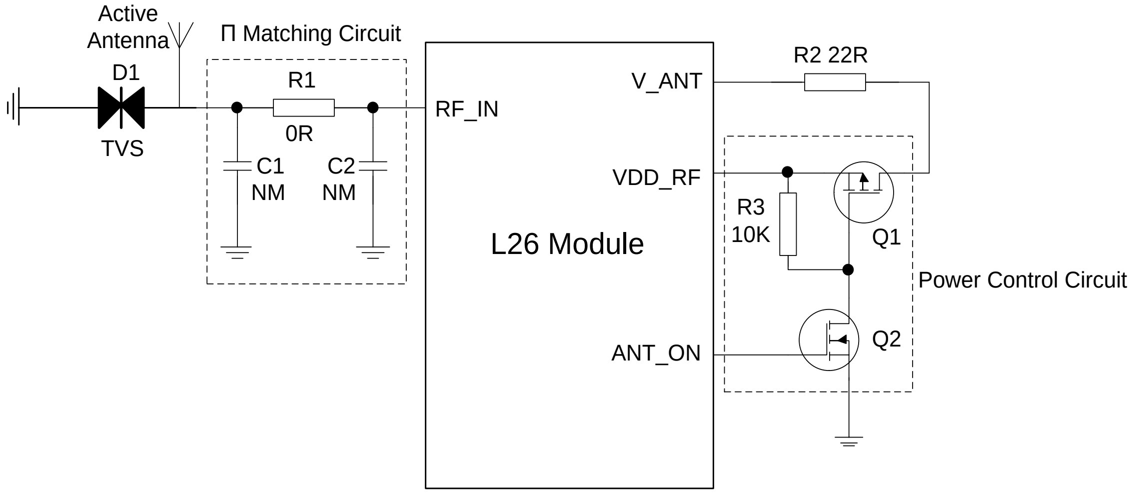


Figure 19: Reference Design for Active Antenna with ANT_ON

ANT_ON is an optional pin which can be used to control the power supply of an active antenna. When the ANT_ON pin is pulled down, MOSFET Q1 and Q2 are in high impedance state and the power supply for antenna is cut off. If ANT_ON is pulled high, Q1 and Q2 will enter the on-state, VDD_RF provides power supply for the active antenna. The level of ANT_ON pin is determined by the power mode of the module. If the module is in normal operating mode, ANT_ON pin will be at high level and if the module is in power saving mode, the pin will be at low level. If unused, please leave ANT_ON pin open.

C1, R1, C2 are reserved components comprising the matching circuit for antenna impedance modification. By default, C1 and C2 are not mounted, R1 is 0 Ω.

5.1.4. Passive Antenna Reference Design

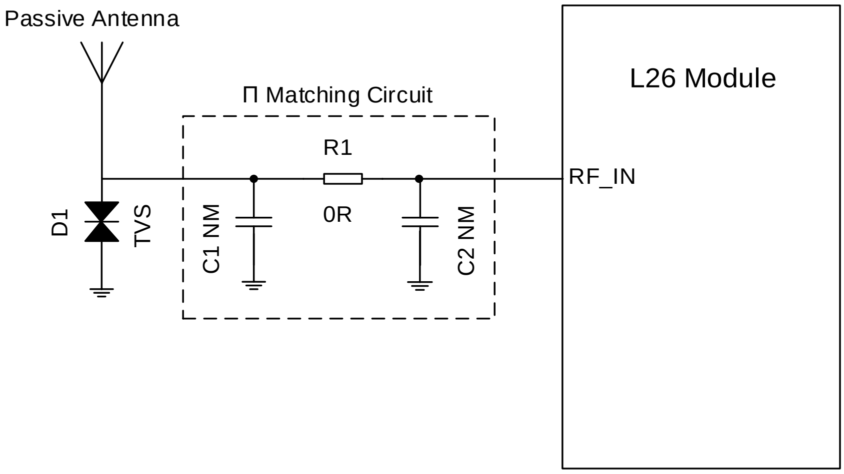


Figure 20: Passive Antenna Reference Design

C1, R1 and C2 are reserved components comprising the matching circuit for antenna impedance modification. By default, R1 is 0 Ω, while C1 and C2 are not mounted. D1 is an electrostatic discharge (ESD) protection device to protect RF route from the damage caused by ESD. The junction capacitance of D1 cannot be more than 0.6 pF and WE05DUCF-BF transient voltage suppressor is recommended. RF trace impedance should be controlled to 50 Ω and trace length should be kept as short as possible.

5.2. 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. Therefore, coexistence with cellular systems must be optimized to avoid significant deterioration of 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.

This chapter also provides suggestions for decreasing the impact of interference signals that will ensure interference immunity of a GNSS receiver.

5.2.1. 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.

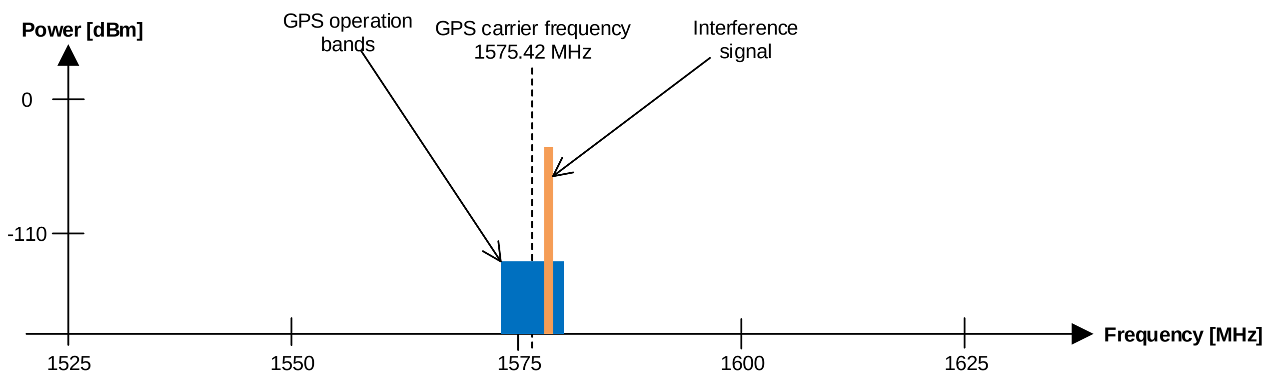


Figure 21: In-Band Interference on GPS L1

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 Band 13.

Table 7: 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
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

5.2.2. Out-of-Band Interference

Strong signals transmitted by other communication systems can cause GNSS receiver saturation, thus greatly deteriorating its performance, as illustrated in the following figure.

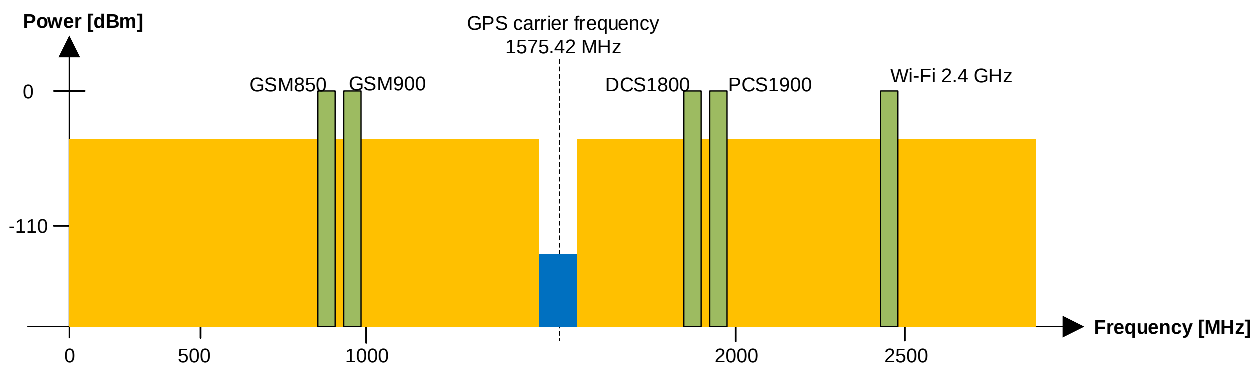


Figure 22: Out-of-Band Interference on GPS L1

5.2.3. 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, 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.

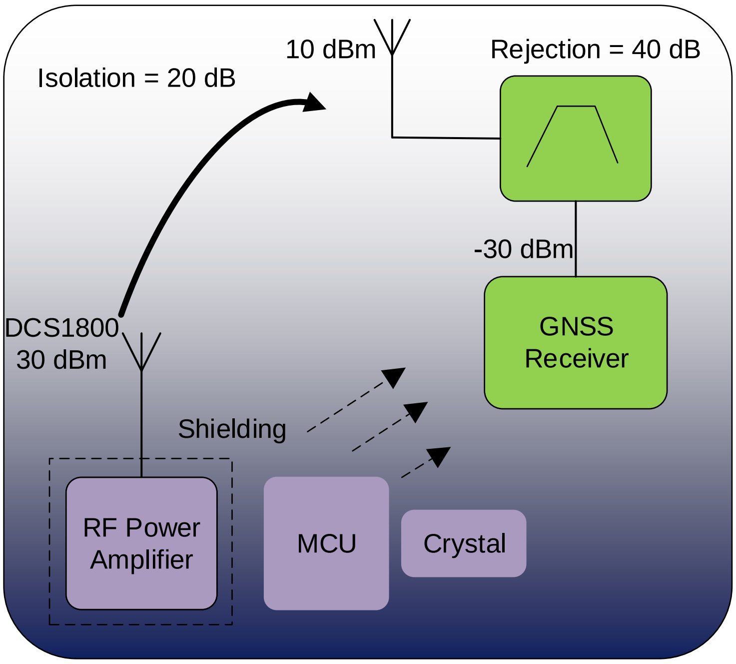


Figure 23: Interference Source and Its Path

5.3. Recommended Footprint

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

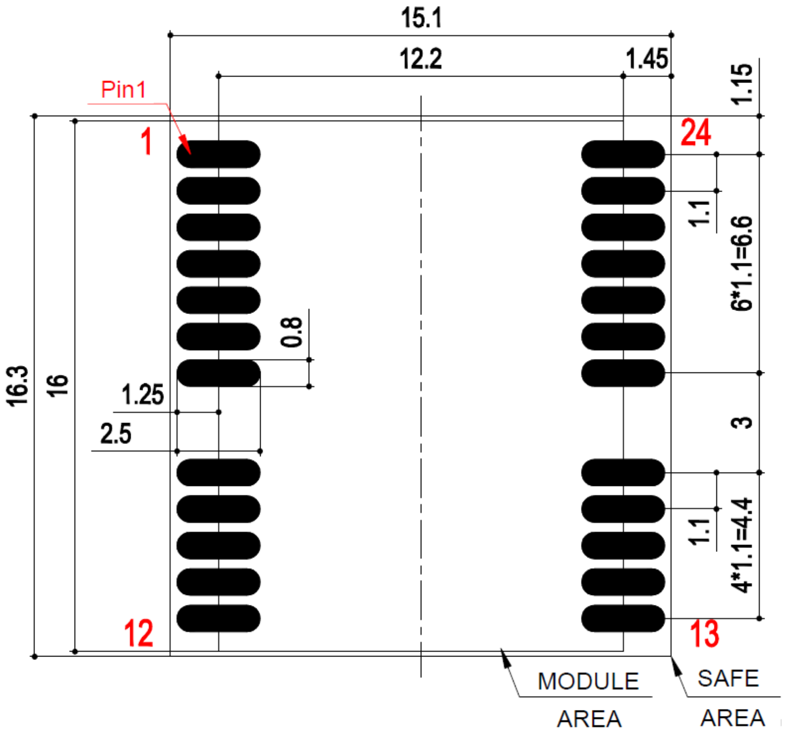


Figure 24: Recommended Footprint

NOTE

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

6 Electrical Specification

6.1. Absolute Maximum Ratings

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

Table 8: Absolute Maximum Ratings

Parameter	Description	Min.	Max.	Unit
VCC	Main Power Supply Voltage	-0.3	4.3	V
V_BCKP	Backup Supply Voltage	-0.3	4.3	V
V_{IN}_IO	Input Voltage at IO Pins	-0.3	3.6	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 9: Recommended Operating Conditions

Parameter	Description	Min.	Typ.	Max.	Unit
VCC	Power Supply Voltage	2.8	3.3	4.3	V
V_BCKP	Backup Supply Voltage	2.5	3.3	4.3	V
IO_Domain	Digital IO Pin Domain Voltage		2.8		V
V_{IL}	Digital IO Pin Low-Level Input Voltage	-0.3	-	0.7	V
V_{IH}	Digital IO Pin High-Level Input Voltage	2.1	-	3.1	V
V_{OL}	Digital IO Pin Low-Level Output Voltage	-	-	0.42	V
V_{OH}	Digital IO Pin High-Level Output Voltage	2.4	-	-	V
RESET_N	Low-Level Input Voltage	-0.3	-	0.7	V
VDD_RF	VDD_RF Voltage	-	VCC	-	V
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. IO_Domain specifically refers to the IO pins in GPIO in ***Chapter 2***.

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 10: Supply Current

Parameter	Description	Condition	$I_{Typ.}$ [5]	I_{PEAK} [5]
I_{VCC} [6]	Current at VCC	Acquisition mode	29 mA	76 mA
		Tracking mode	21 mA	76 mA
		Standby mode	338 μA	352 μA
I_{V_BCKP} [7]	Current at V_BCKP	Continuous mode	31 μA	73 μA
		Standby mode	12 μA	46 μA
		Backup mode	7 μA	41 μA

6.4. ESD Protection

If the static electricity generated in various ways discharges to the module, the module may be damaged to a certain extent. Thus, please take proper ESD countermeasures and handling methods. For example, wearing anti-static gloves during the development, production, assembly and testing of the module; adding ESD protective components to the ESD sensitive interfaces and points in the product design.

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 and soldering iron).
- When soldering the RF_IN pin, make sure to use an ESD safe soldering iron (tip).

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

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

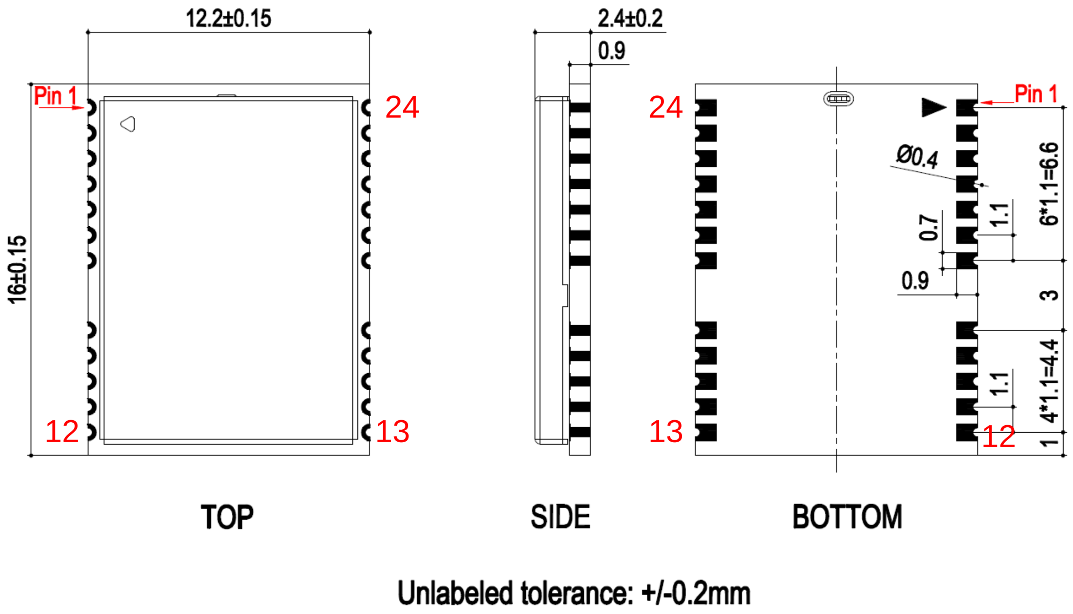


Figure 25: Top, Side and Bottom View Dimensions

NOTE

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

7.2. Top and Bottom Views

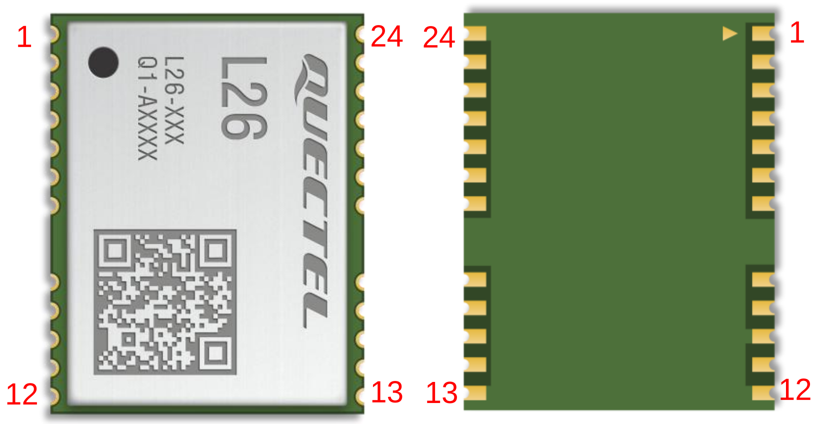


Figure 26: Top and Bottom Module Views

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

Quectel L26 module is delivered in a tape carrier package, 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. Carrier Tape

Dimension details are as follow:

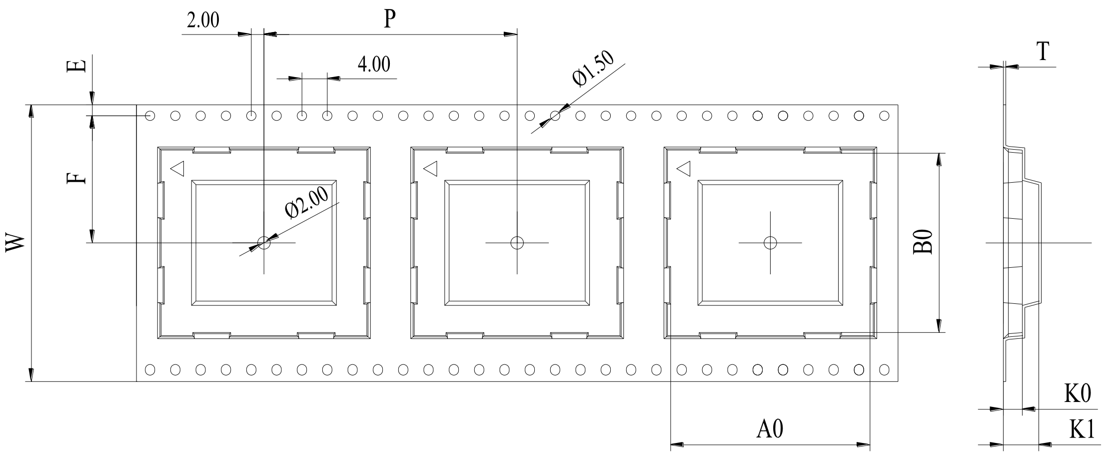


Figure 27: Carrier Tape Dimension Drawing

Table 11: Carrier Tape Dimension Table (Unit: mm)

W	P	T	A0	B0	K0	K1	F	E
32	24	0.4	12.7	16.4	2.9	7.4	14.2	1.75

8.1.2. Plastic Reel

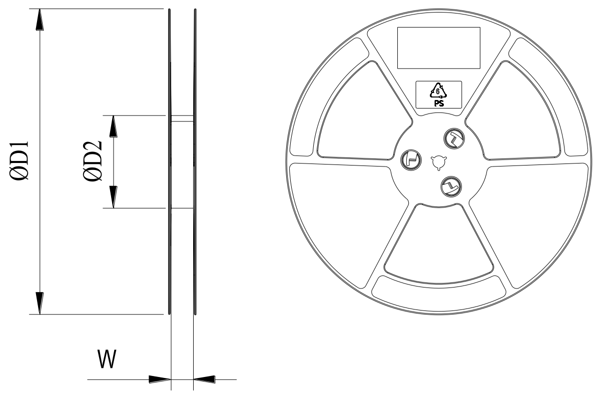
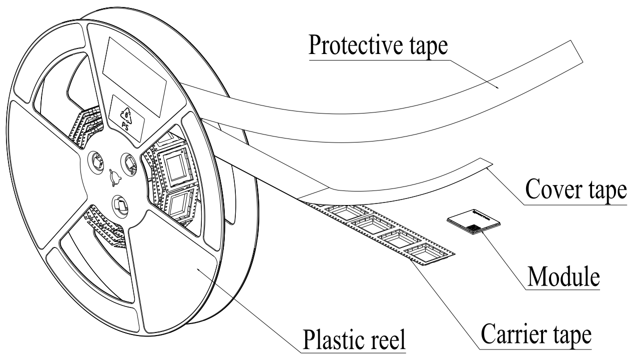


Figure 28: Plastic Reel Dimension Drawing

Table 12: Plastic Reel Dimension Table (Unit: mm)

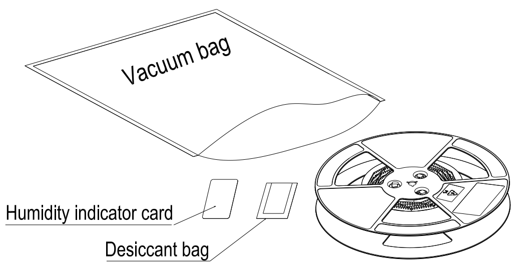
øD1	øD2	W
330	100	32.5

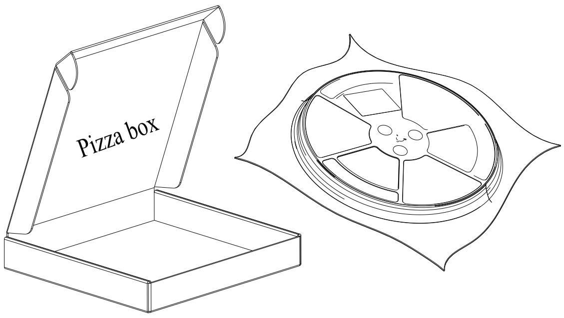
8.1.3. Packaging Process



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

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





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

Place 4 pizza boxes inside 1 carton and seal it. One cartoon box can pack 1000 modules.

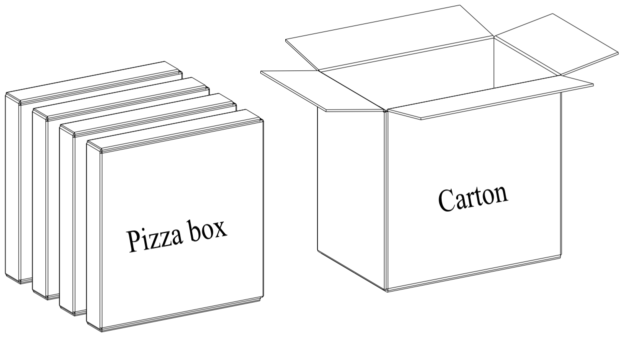


Figure 29: Packaging Process

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. The storage life (in vacuum-sealed packaging) is 12 months in recommended storage conditions.

3. The shelf life of the module is 168 hours [8] 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 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 drying cabinet).

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

[8] The 168 h shelf life rule is only valid when the environment conforms to *IPC/JEDEC J-STD-033*. It is recommended to start the solder reflow process within 24 hours of removing the package if the temperature and moisture do not conform to, or it is not certain that they conform to *IPC/JEDEC J-STD-033*. Do not remove the packaging if the module is not ready for soldering.

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

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

- The module should be baked for 8 hours at 120 ±5 °C;
- The module must be soldered to the PCB within 24 hours of baking, otherwise it 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 the module out of the packaging and put it on high-temperature-resistant fixtures before baking. The module must be soldered to PCB within 24 hours of the baking, otherwise put it 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 module.

8.3. Manufacturing and Soldering

Push the squeegee to apply solder paste on 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 for the module, see ***document [5]***.

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.

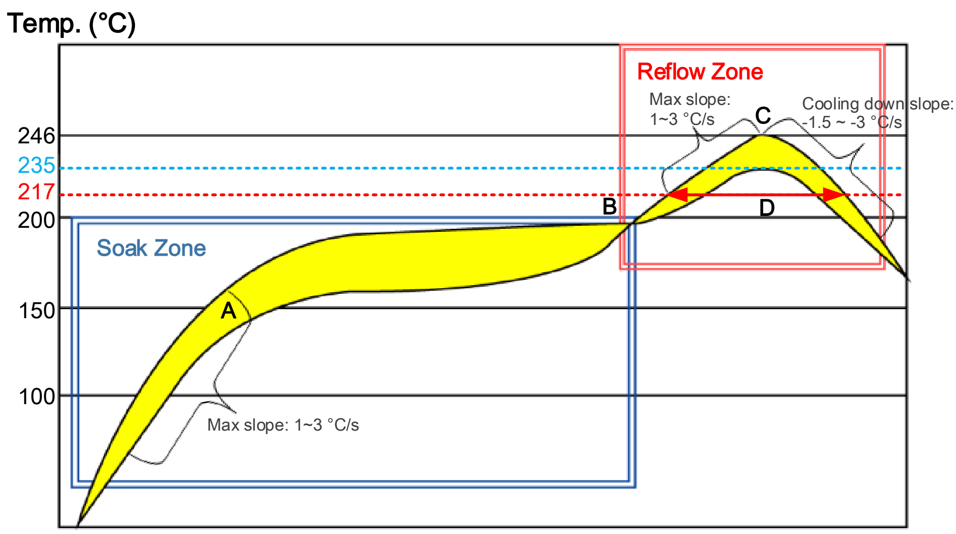


Figure 30: Recommended Reflow Soldering Thermal Profile

Table 13: 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	1–3 °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 shielding can with organic solvents, such as acetone, ethyl alcohol, isopropyl alcohol and trichloroethylene. 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 entering the module shield.
4. Avoid using ultrasonic technology for module cleaning since it can damage crystals inside the module.
5. Due to SMT process complexity, please contact Quectel Technical Support in advance regarding any situation that you are not sure about, or any process (e.g. selective soldering, ultrasonic soldering) that is not mentioned in ***document [5]***.

9 Labelling Information

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

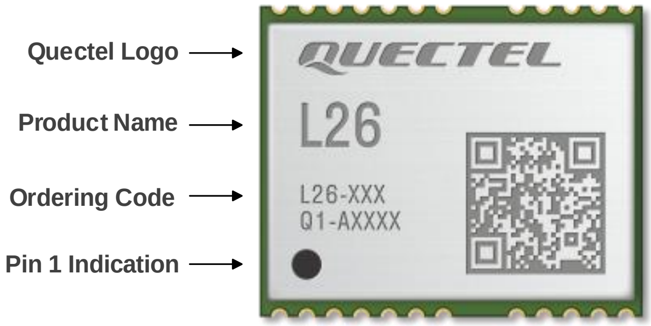


Figure 31: Labelling Information

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 14: Related Documents

Document Name
[1] Quectel_Lx0&Lx6&LC86L&LG77L_GNSS_Protocol_Specification
[2] Quectel_Lx6&LC86L&LG77L_Firmware_Upgrade_Guide
[3] Quectel_L26_Reference_Design
[4] Quectel_RF_Layout_Application_Note
[5] Quectel_Module_Secondary_SMT_Application_Note

Table 15: Terms and Abbreviations

Abbreviation	Description
AGNSS	Assisted Global Positioning System
AGPS	Assisted GPS (Global Positioning System)
AIC	Active Interference Cancellation
ARM	Advanced RISC Machine
BDS	BeiDou Navigation Satellite System
CEP	Circular Error Probable
C/N_0	Carrier-to-noise Ratio
CPU	Central Processing Unit
DCS1800	Digital Cellular System at 1800MHz
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 (Russian)
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GSM	Global System for Mobile Communications
I/O	Input/Output
I2C	Inter-Integrated Circuit
IC	Integrated Circuit
IMU	Inertial Measurement Unit
I_{PEAK}	Peak Current
IRNSS/NavIC	Indian Regional Navigation Satellite System
kbps	kilobits per second
LCC	Leadless Chip Carrier (package)
LDO	Low-dropout Regulator
LNA	Low-Noise Amplifier
LTE	Long Term Evolution
Mbps	Megabits per second
MCU	Microcontroller Unit/Microprogrammed Control Unit
MSAS	Multi-functional Satellite Augmentation System (Japan)
MSL	Moisture Sensitivity Levels
NMEA	National Marine Electronics Association
OC	Open Connector
PC	Personal Computer

PCB	Printed Circuit Board
PI	Power Input
PMU	Power Management Unit
1PPS	One Pulse Per Second
PQ	Quectel Proprietary Protocol
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
RMC	Recommended Minimum Specific GNSS Data
RMS	Root Mean Square
RoHS	Restriction of Hazardous Substances
RTC	Real-Time Clock
RXD	Receive Data
3GPP	3rd Generation Partnership Project
SAW	Surface Acoustic Wave
SBAS	Satellite-Based Augmentation System
SMD	Surface Mount Device
SMT	Surface Mount Technology
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
UTC	Coordinated Universal Time
VSWR	Voltage Standing Wave Ratio
WAAS	Wide Area Augmentation System
WCDMA	Wideband Code Division Multiple Access
XTAL	External Crystal Oscillator