L89 Hardware Design

GNSS Module Series

Rev. L89_Hardware_Design_V1.1

Date: 2019-07-26

Status: Released

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About the Document

History

Revision	Date	Author	Description
1.0	2019-04-09	Gobber HU/ Gene LI	Initial
1.1	2019-07-26	Gobber HU/ Gene LI	1. Added the power consumption of GPS+Galileo+IRNSS in Table 1 and 13. 2. Updated the default GNSS configuration into GPS+Galileo+IRNSS in Table 5. 3. Updated the dimensions of L89 in Chapter 2.1, 2.2 and 6.1. 4. Updated Figure 1, 2, 3 and 4. 5. Updated the keepout area design in Chapter 4.1.3.2.

Contents

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1 Introduction

This document defines and specifies L89 GNSS module. It describes the hardware interfaces, external application reference circuits, mechanical size and air interface of L89 module.

This document helps customers quickly understand module interface specifications, as well as electrical and mechanical details of L89 module. Other documents such as L89 software application notes and user guides are also provided. These documents ensure customers can use L89 module to design and set up mobile applications quickly.

1.1 Safety Information

The following safety precautions must be observed during all phases of operation, such as usage, service or repair of any cellular terminal or mobile incorporating L89 module. Manufacturers of the cellular terminal should send the following safety information to users and operating personnel, and incorporate these guidelines into all manuals supplied with the product. If not so, Quectel assumes no liability for customers' failure to comply with these precautions.

	Full attention must be given to driving at all times in order to reduce the risk of an accident. Using a mobile while driving (even with a handsfree kit) causes distraction and can lead to an accident. Please comply with laws and regulations restricting the use of wireless devices while driving.
	Switch off the cellular terminal or mobile before boarding an aircraft. The operation of wireless appliances in an aircraft is forbidden to prevent interference with communication systems. If the device offers an Airplane Mode, then it should be enabled prior to boarding an aircraft. Please consult the airline staff for more restrictions on the use of wireless devices on boarding the aircraft.
	Wireless devices may cause interference on sensitive medical equipment, so please be aware of the restrictions on the use of wireless devices when in hospitals, clinics or other healthcare facilities.
	Cellular terminals or mobiles operating over radio signals and cellular network cannot be guaranteed to connect in all possible conditions (for example, with unpaid bills or with an invalid (U)SIM card). When emergent help is needed in such conditions, please remember using emergency call. In order to make or receive a call, the cellular terminal or mobile must be switched on in a service area with adequate cellular signal strength.
	The cellular terminal or mobile contains a transmitter and receiver. When it is ON, it receives and transmits radio frequency signals. RF interference can occur if it is used close to TV set, radio, computer or other electric equipment.
	In locations with potentially explosive atmospheres, obey all posted signs to turn off wireless devices such as your phone or other cellular terminals. Areas with potentially explosive atmospheres include fuelling areas, below decks on boats, fuel or chemical transfer or storage facilities, areas where the air contains chemicals or particles such as grain, dust or metal powders, etc.

2 Product Concept

2.1. General Description

L89 is a GNSS module with two GNSS receivers. It is able to achieve a high industrial level of sensitivity, accuracy and TTFF with a low power consumption in a small footprint. The embedded flash memory provides a capacity for storing user-specific configurations and allows for future updates.

The module supports multiple positioning and navigation systems including autonomous GPS, BeiDou, GLONASS, Galileo, IRNSS, SBAS (including WAAS, EGNOS, MSAS and GAGAN), QZSS, DGPS, and AGPS.

L89 module is an SMD type module with a compact 26.4mm × 18.4mm × 6.8mm form factor. It can be embedded in customers' applications through the 16 pads. It provides necessary hardware interfaces for connection with the main PCB.

The module is fully compliant with EU RoHS directive.

2.2. Key Features

Table 1: Key Features

Features	
Receiver Type [1)]	● GPS L1 C/A (1574.397MHz-1576.443MHz) ● BeiDou B1 C/A (1559.052MHz-1563.144MHz) ● GLONASS L1 C/A (1597.5MHz-1605.8MHz) ● Galileo E1 C/A (1573.374MHz-1577.466MHz) ● IRNSS L5 C/A (1164MHz-1189MHz)
Power Supply	● VCC: 3.1V~4.3V ● Typical: 3.3V
Power Consumption (GPS+IRNSS)	● Tracking: 100mA @-130dBm, VCC=3.3V ● Acquisition: 102mA @-130dBm, VCC=3.3V ● Backup: 7uA, VCC=3.3V

Power Consumption (only GPS)	● Tracking: 78mA @-130dBm, VCC=3.3V ● Acquisition: 91mA @-130dBm, VCC=3.3V ● Backup: 7uA, VCC=3.3V
Power Consumption (only IRNSS)	● Tracking: 88mA @-130dBm, VCC=3.3V ● Acquisition: 100mA @-130dBm, VCC=3.3V ● Backup: 7uA, VCC=3.3V
Power Consumption (GPS+Galileo+IRNSS)	● Tracking: 95mA @-130dBm, VCC=3.3V ● Acquisition: 99mA @-130dBm, VCC=3.3V ● Backup: 7uA, VCC=3.3V
Sensitivity (only GPS)	● Acquisition: -147dBm ● Reacquisition: -156dBm ● Tracking: -163dBm
Sensitivity (only IRNSS)	● Acquisition: -144dBm ● Reacquisition: -154dBm ● Tracking: -161dBm
TTFF@-130dBm (without AGPS)	● Cold Start <32s ● Warm Start <25s ● Hot Start <2s
TTFF@-130dBm (with AGPS)	● Cold Start: <13s ● Warm Start: <5s ● Hot Start: <2s
Horizontal Position Accuracy (Autonomous)	● <1.8m CEP @-130dBm
Update Rate	● 1Hz by default, max 10Hz
Accuracy of 1PPS Signal	● Typical accuracy: 3.9ns ● Time pulse width: 500ms
Velocity Accuracy	● Without aid: 0.1m/s
Acceleration Accuracy	● Without aid: 0.1m/s²
Dynamic Performance	● Maximum Altitude: 18000m ● Maximum Velocity: 515m/s ● Acceleration: 4G
UART Interface	● UART port: TXD and RXD ● Support baud rate from 4800bps to 921600bps; 9600bps by default ● UART port is used for NMEA output and firmware upgrade
I2C Interface	● Support fast mode, with bit rate up to 400Kbps ● Support 7-bit address
Temperature Range	● Normal operation temperature range: -40°C ~ +85°C ● Storage temperature range: -40°C ~ +90°C
Physical Characteristics	● Size: (26.4±0.20) mm × (18.4±0.20) mm × (6.8±0.20) mm ● Weight: Approx. 8.2g

NOTE

1) The default GNSS configuration of L89 is GPS+Galileo+IRNSS. For more details about the GNSS configuration, please refer to ***document [1]***.

2.3. Block Diagram

The following figure shows the block diagram of L89 module. It consists of two GNSS ICs including RF/Baseband parts, two LNAs, two SAW filters, a TCXO and a crystal oscillator.

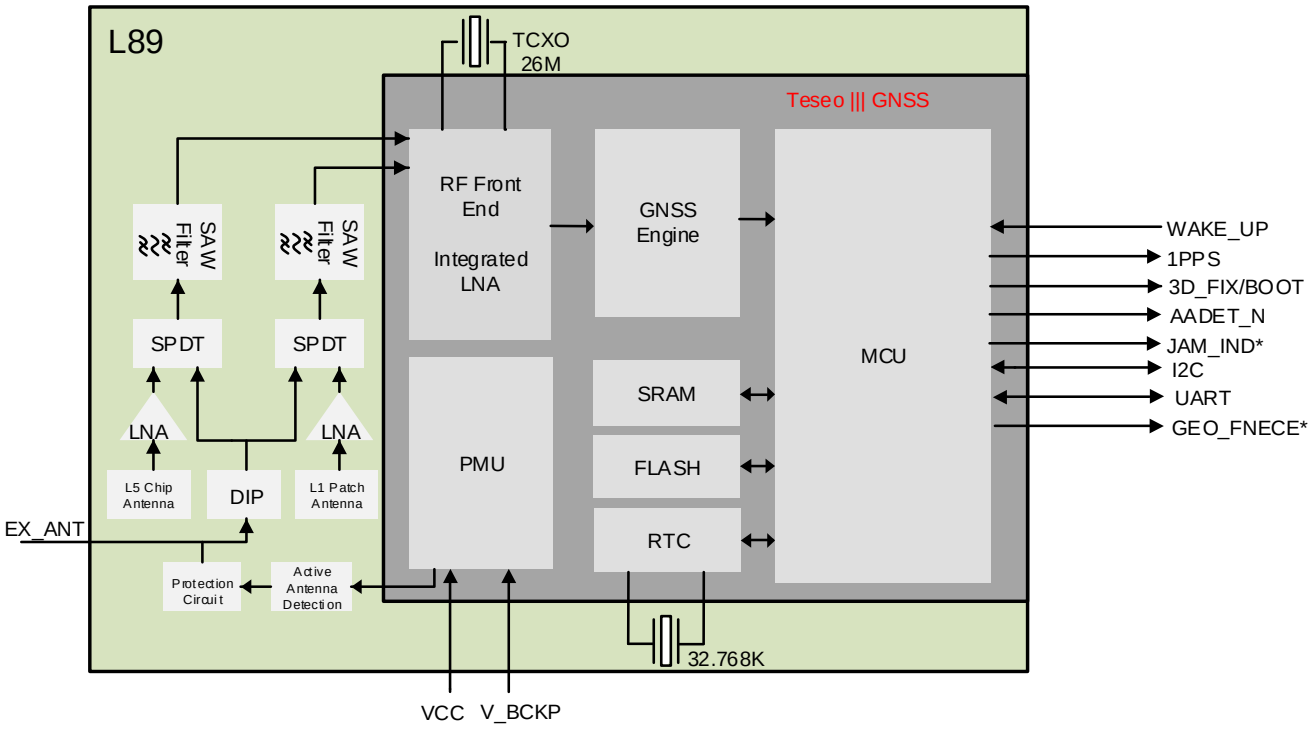


Figure 1: Block Diagram

NOTE

"*" means under development.

2.4. Evaluation Board

In order to assist customers to use L89 module on their applications, Quectel offers the evaluation board (EVB), Micro-USB cable, active antenna and other peripherals to test the module. For more details, please refer to ***document [2]***.

2.5. Protocols Supported by the Module

Table 2: Supported Protocols

Protocol	Type
NMEA	ASCII, 0183, 3.01(default)/4.10
PSTM	ST proprietary protocols

NOTE

Please refer to ***document [1]*** for more details about supported protocols.

3 Application Interfaces

The module is equipped with 16 LCC pins that can be connected to customers' application platforms. Sub-interfaces included in the pad are described in details in the following chapters.

3.1. Pin Assignment

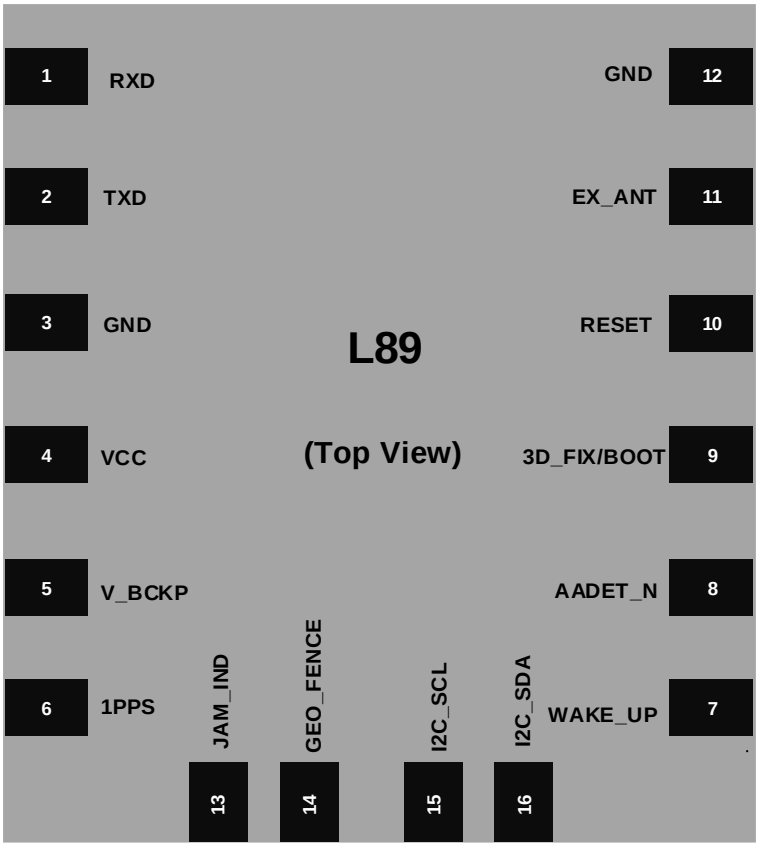


Figure 2: Pin Assignment

3.2. Pin Description

Table 3: I/O Parameters Definition

Type	Description
AI	Analog Input
AO	Analog Output
DI	Digital Input
DO	Digital Output
IO	Bidirectional
PI	Power Input
PO	Power Output

Table 4: Pin Description

Power Supply					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
V_BCKP	5	PI	Backup power supply	Vmax=4.3V Vmin=1.9V Vnom=3.3V	Supply power for RTC domain when VCC is powered off.
VCC	4	PI	Main power supply	Vmax=4.3V Vmin=3.1V Vnom=3.3V	Assure load current not less than 150mA.
Reset					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RESET	10	DI	Reset the module	V_{IL}min=-0.3V V_{IL}max=0.35V V_{IH}min=0.65V V_{IH}max=1.3V	Active low. If unused, keep this pin open.

UART Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
TXD	2	DO	Transmit data	V_{OL}max=0.4V V_{OH}min=2.6V V_{OH}nom=3.0V	UART port is used for NMEA output, and firmware upgrade.
RXD	1	DI	Receive data	V_{IL}min=-0.2V V_{IL}max=0.4V V_{IH}min=2.1V V_{IH}max=3.3V	
RF Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
EX_ANT	11	AI	RF signal input		50Ω characteristic impedance.
I2C Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
I2C_SDA	16	IO	I2C serial data	V_{IL}max=0.4V V_{IH}min=2.1V V_{OL}max=0.4V V_{OH}min=2.6V V_{OH}nom=3.0V	If unused, keep these pins open.
I2C_SCL	15	IO	I2C serial clock		
Other Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
1PPS	6	DO	One pulse per second	V_{OL}max=0.4V V_{OH}min=2.6V V_{OH}nom=3.0V	Synchronized at rising edge, and the pulse width is 500ms. This pin must be low at startup for normal operation. It has been pulled down internally with a 47KΩ resistor. If unused, keep this pin open.
WAKE_UP	7	DI	Wakeup from backup mode	V_{IL}min=-0.2V V_{IL}max=0.4V V_{IH}min=2.6V V_{IH}nom=3.3V	Keep the pin at low voltage level in full on mode. It has been pulled down internally with a 51KΩ resistor.

					Drive the pin to a high voltage level to make the module exit from backup mode. If unused, keep this pin open or connected to GND.
AADET_N	8	DO	Active antenna indicator	V_{OL}max=0.4V V_{OH}min=2.6V V_{OH}nom=3.0V	If unused, keep this pin open.
3D_FIX/BOOT	9	IO	3D fix indicator/ boot pin	V_{OL}max=0.4V V_{OH}min=2.6V V_{OH}nom=3.0V	Please refer to ***Chapter 3.8*** for more details.
JAM_IND	13	DO	Jamming detection indicator	V_{OL}max=0.4V V_{OH}min=2.6V V_{OH}nom=3.0V	If unused, keep this pin open.
GEO_FENCE	14	DO	Geo-fence boundary indicator	V_{OL}max=0.4V V_{OH}min=2.6V V_{OH}nom=3.0V	If unused, keep this pin open.
GND	3, 12		GND		

3.3. Power Supply

VCC supplies power for BB, RF and RTC domains. The load current of VCC varies according to the VCC voltage level, processor load and satellite acquisition. It is important to supply sufficient current and make the power clean and stable. It is recommended for customers to choose an LDO with minimum output current of 150mA as the power supply, and add a decoupling capacitor combination (10uF and 100nF) as well as a TVS near the VCC pin.

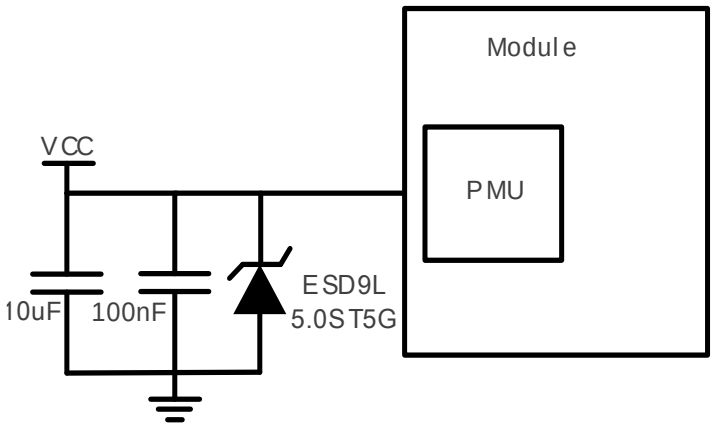


Figure 3: VCC Input Reference Circuit

The V_BCKP pin supplies power for RTC domain. A cell battery and a capacitor combination (4.7uF and 100nF) are recommended to be placed nearby V_BCKP pin. The voltage of RTC domain ranges from 1.9V to 4.3V. In order to achieve better Time to First Fix (TTFF), RTC domain should be valid all the time so as to supply power for SRAM memory which contains all the necessary GNSS information for quick start-up and a small amount of user configuration variables.

The module's internal power construction is illustrated as below.

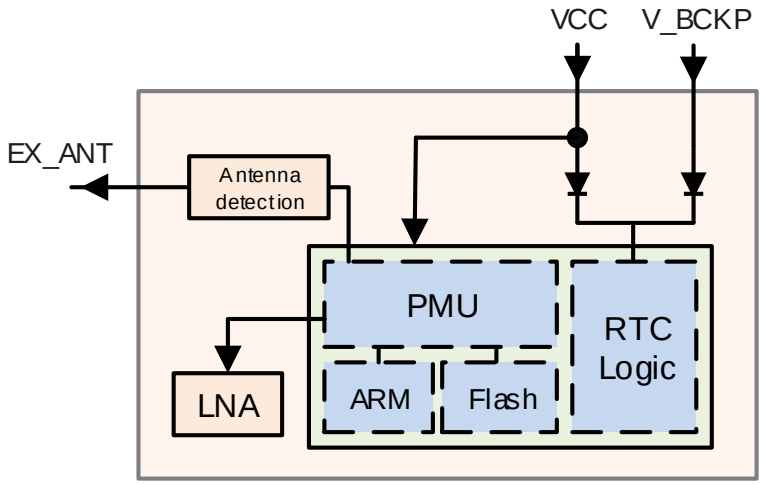


Figure 4: Internal Power Construction

VCC not only supplies power for PMU but also for RTC domain, while V_BCKP supplies power for RTC domain only. When the power supply voltage of VCC is within the normal range, please use VCC; otherwise, please use V_BCKP.

3.4. Operation Modes

3.4.1. Full on Mode

Full on mode comprises tracking mode and acquisition mode. Acquisition mode is defined as the mode in which the module starts to search satellites, and to determine the visible satellites, coarse carrier frequency as well as code phase of satellite signals. When the acquisition is completed, it will automatically switch to tracking mode. Tracking mode is defined as the module tracking satellites and demodulating the navigation data from specific satellites.

When both VCC and V_BCKP pins are valid or only VCC is valid, the module will enter into full on mode automatically and follow the default configuration as below. Please refer to ***Chapter 3.3*** about internal power construction for better comprehension.

Table 5: Default Configuration

Item	Configuration	Comment
Baud Rate	9600bps	
Protocol	NMEA	RMC, VTG, GGA, GSA, GSV and GLL
Update Rate	1Hz	
SBAS	Enable	
GNSS	GPS+Galileo+IRNSS	

NOTE

RMC, VTG, GGA, GSA, GSV and GLL are the output NMEA message types, which stand for functions as: RMC (Recommended Minimum Specific GNSS Data), VTG (Course over Ground and Ground Speed, Horizontal Course and Horizontal Velocity), GGA (GPS Fix Data), GSA (GNSS DOP and Active Satellites), GSV (GNSS Satellites in View), GLL (Geographic Position – Latitude/Longitude).

3.4.2. Backup Mode

In backup mode, the module stops acquiring and tracking satellites. UART is also not accessible. But the backup memory in RTC domain which contains all the necessary GNSS information for quick start-up and a small amount of user configuration variables is kept.

There is one way to enter backup mode and two ways to exit backup mode.

- Send “$PSTMFORCESTANDBY,<duration>” Command to enter into backup mode.
- Two ways to exit backup mode: Driving the WAKE_UP pin to high voltage level to trigger interrupt wakeup or waiting for the command duration to end.

Table 6: Command Duration

Parameter	Format	Description
<duration>	Decimal, 5 digits	Duration of the backup time in seconds

For a better understanding, please refer to ***Chapter 3.3*** to see details about the internal power construction. V_BCKP can be directly powered by an external capacitor or battery (rechargeable or non-chargeable). The following figure illustrates the reference design for RTC backup supply.

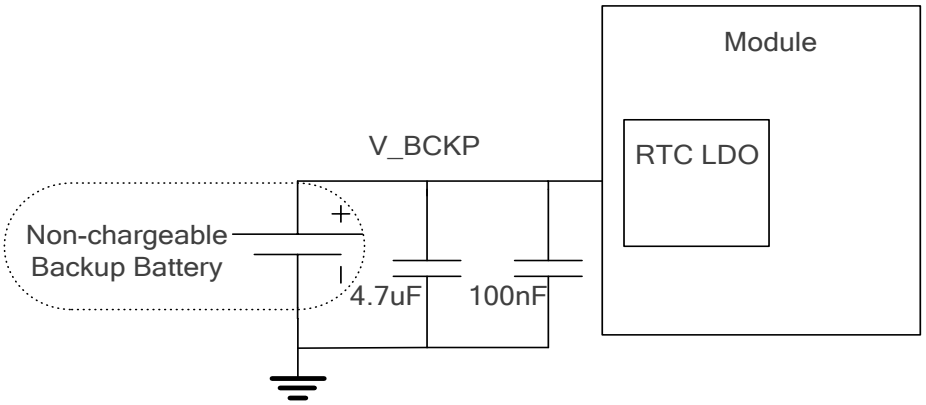


Figure 5: RTC Supply from Non-chargeable Battery

With a charging circuit, V_BCKP will support battery charging function. Please see the reference charging circuit in the figure below.

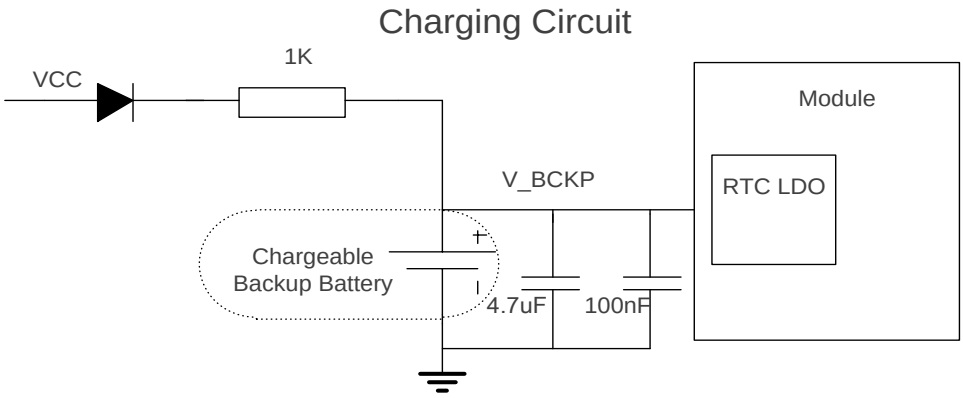


Figure 6: Reference Charging Circuit for Rechargeable Batteries

The coin-type rechargeable capacitor from Seiko (http://www.sii.co.jp/en) can be used as an alternative to the chargeable backup battery. And Schottky diode from ON Semiconductor (http://www.onsemi.com) is recommended to be the choice of diode for its low voltage drop.

3.5. Reset

As RESET is 1V voltage domain, please do not reserve any pull-up circuit for this pin.

L89 module can be reset by driving RESET to a low-level voltage for at least 10ms and then releasing it. To control RESET, an OC driver circuit shown as below is recommended.

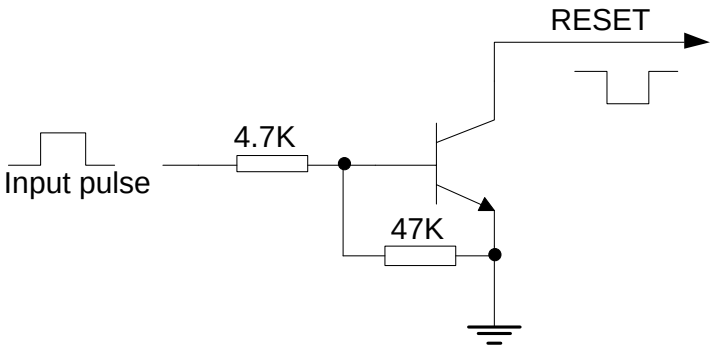


Figure 7: Reference Reset Circuit

The following figure shows the reset timing of L89 module.

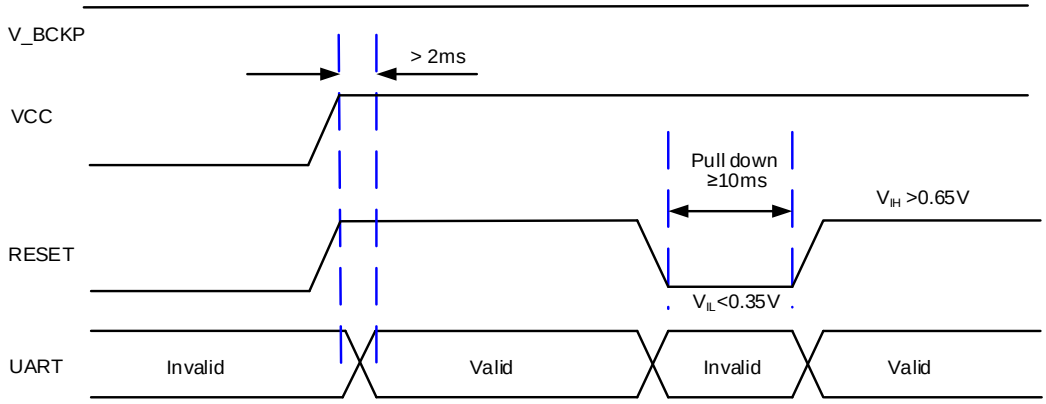


Figure 8: Reset Timing

NOTE

The module resetting will possibly 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.

3.6. UART Interface

The module provides one universal asynchronous receiver & transmitter serial port. It is designed as DCE (Data Communication Equipment) following the traditional DCE-DTE (Data Terminal Equipment) connection. The module and the DTE (Data Terminal Equipment) are connected through the signals shown in the following figure. It supports data baud-rate from 4800bps to 921600bps, 9600bps by default.

UART port:

- TXD: Send data to the RXD signal line of DTE
- RXD: Receive data from the TXD signal line of DTE

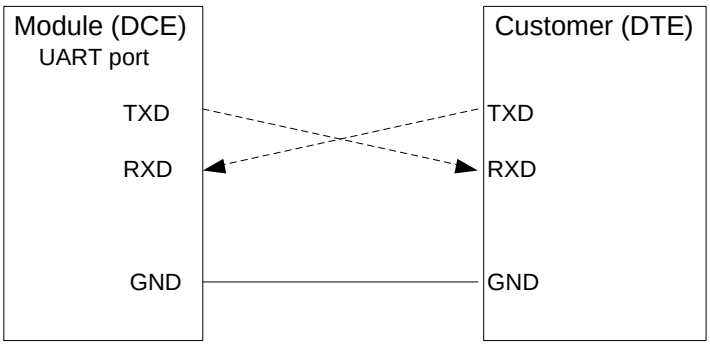


Figure 9: Reference Design for UART Port

This UART port has the following features:

- UART port is used for NMEA output and firmware upgrade.
- The default NMEA output type setting is RMC, VTG, GGA, GSA, GSV and GLL.
- UART port supports data rates: 4800bps, 9600bps, 14400bps, 19200bps, 38400bps, 57600bps, 115200bps, 230400bps, 460800bps, 921600bps. The default is 9600bps, 8 bits, no parity bit, 1 stop bit.
- Hardware flow control and synchronous operation are not supported.

The UART port does not support the RS-232 level but only CMOS level. Thus, if the module's UART port is connected to the serial port of a computer, it is necessary to add a level shifter circuit in between. Please refer to the following figure.

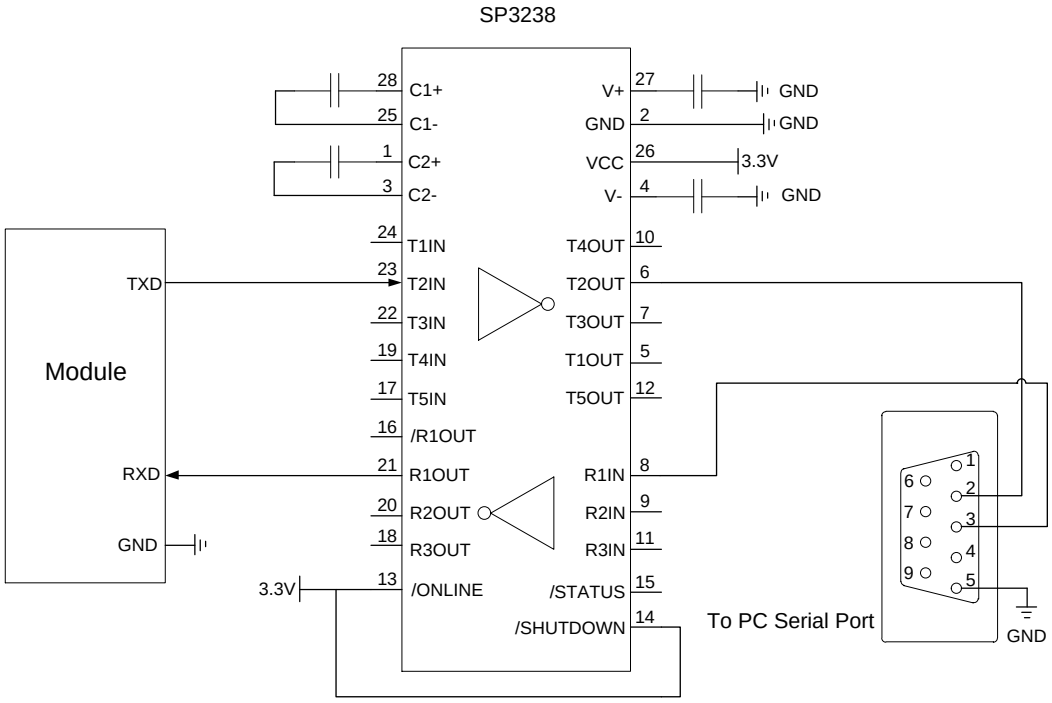


Figure 10: RS-232 Level Shift Circuit

NOTE

GNSS modules output more data than single GPS systems. The default baud rate (9600bps) of L89 is enough to transmit GNSS NMEA. If the baud rate has to be set to 4800bps, then it is recommended to decrease NMEA output types so as to avoid possible data loss.

3.7. I2C Interface

L89 module provides one I2C interface. The NMEA data output can be read via I2C.

The I2C interface has the following features:

- Support fast mode, with bit rate up to 400kbps.
- Support 7-bit address.
- Work on slave mode.
- Default I2C 7-bit address value: 0x3A.

For more details, please refer to ***document [1]***.

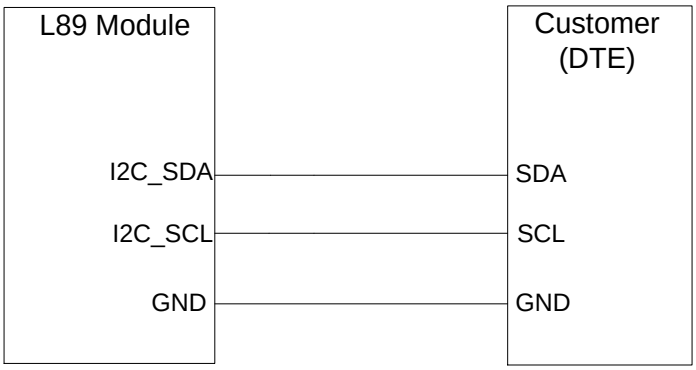


Figure 11: Reference Design for I2C Interface

NOTE

I2C_SCL and I2C_SDA have been pulled up to 3.0V internally with 4.7KΩ resistors.

3.8. 3D_FIX/BOOT Interface

When the module is powered on, the voltage level of the 3D_FIX/BOOT pin will be checked to identify its working mode.

Table 7: Working Modes of 3D_FIX/BOOT Pin

Voltage Levels	Working Modes	Comment
Low	Normal	The pin is at low level by default, as it has been internally pulled down with a 47KΩ resistor. When it is at low level during startup, it will serve as a fix flag output, and it will output a high voltage level to indicate successful positioning after the module is turned on.
High	Boot Download	When the pin is at high level during startup, it will be used for firmware download. For details about reference design of the interface, please refer to ***document [4]***.

NOTE

3D_FIX/BOOT must be low at startup for normal operation, and it is at low level by default.

3.9. JAM_IND Interface*

L89 module provides a jamming detection indicator to detect whether there are any jammers that may have impact on the device. If there is any jammer, JAM_IND pin will output a low level; otherwise it outputs a high voltage level.

3.10. GEO_FENCE Interface*

The GEO_FENCE signal is used for geo-fence boundary indication.

3.11. AADET_N Interface

The module provides AADET_N to indicate the active antenna status. When active antenna is not connected to EX_ANT or has poor contact with antenna feeding point, AADET_N will keep a high level to indicate the absence of the active antenna. The signal will change to a low level when active antenna is connected well.

4 Built-in Antennas and External Antenna Interfaces

L89 module is designed to support IRNSS L5, GPS L1 and Galileo E1 signals simultaneously by default. Two LNAs are embedded for better performance on receiving these signals.

The ultra-compact module is embedded with a patch antenna and a chip antenna. It also supports external active antenna, and the RF signal is obtained from the EX_ANT pin. Internal antenna signals and external active antenna signals are intelligently switched through an SPDT switch.

4.1. Internal Antennas

4.1.1. 18.4mm × 18.4mm × 4.0mm Patch Antenna

L89 module is designed with an 18.4mm × 18.4mm × 4.0mm high-performance patch antenna. Its specification is described in the following table.

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

Parameter	Specification	Comment
Size	18.4mm × 18.4mm × 4.0mm	
Range of Receiving Frequency	GPS: 1575.42±1.023MHz GLONASS: 1597.5~1605.8MHz	
Impendence	50 Ohm	
Bandwidth	10MHz min.	Return Loss ≤ -10dB
Frequency Temperature Coefficient (TF)	0±20ppm/°C	-40°C~+85°C
Polarization	RHCP	Right Hand Circular Polarization
Gain at Zenith	4dBi typ.	Centre Frequency
VSWR	1.5 max.	

The test result of the antenna is shown as the following figure. This embedded GNSS antenna provides good radiation efficiency, right hand circular polarization and optimized radiation pattern. The antenna is insensitive to surroundings and has high tolerance against frequency shifts.

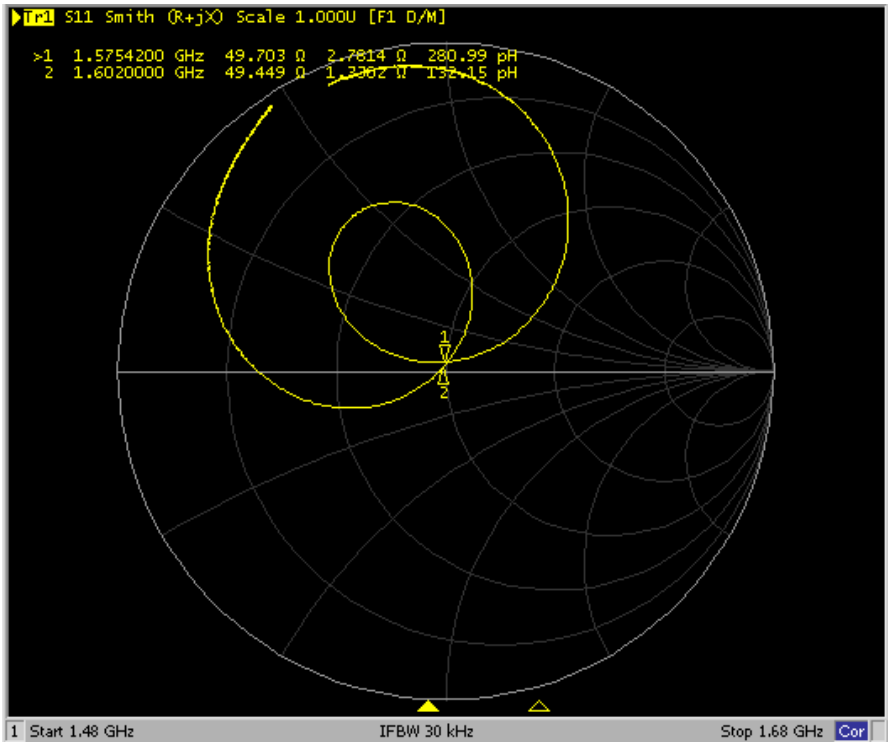


Figure 12: Matching Map of Patch Antenna

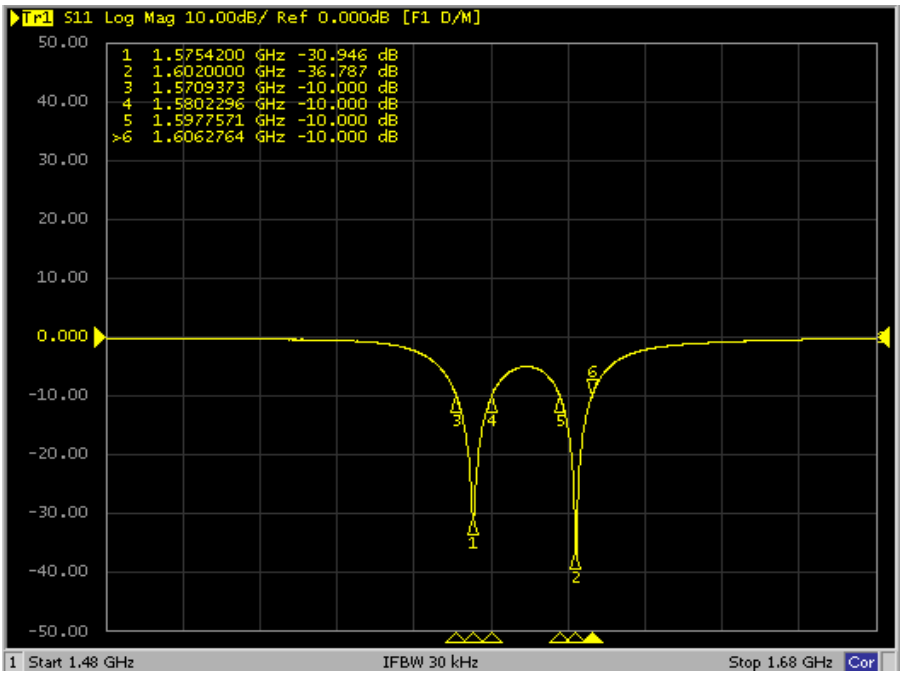


Figure 13: S11 Parameters of Patch Antenna

4.1.2. 10.0mm × 3.2mm × 4.0mm Chip Antenna

L89 module has an embedded chip antenna for IRNSS L5. A 10.0mm × 3.2mm × 4.0mm high-performance chip antenna is chosen for reducing product size. It features excellent stability and sensitivity to consistently provide high signal reception efficiency. Its specification is described in the following table.

Table 9: Chip Antenna Specification

Parameter	Specification	Comment
Size	10.0mm × 3.2mm × 4.0mm	
Range of Receiving Frequency	IRNSS: 1176.45±12.5MHz	
Impendence	50 Ohm	
Bandwidth	25MHz min.	Return Loss ≤ -10dB
Frequency Temperature Coefficient (TF)	0±20ppm/°C	-40°C~+85°C
Polarization	LP	Linear Polarization
Gain at Zenith	1dBi typ.	Centre Frequency
VSWR	1.5 max.	

4.1.3. PCB Design Guide

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

4.1.3.1. Recommended Module and Component Placement

- Please keep the module at least 20mm away from the nearest edge of the motherboard and it is recommended to be placed in the center of the motherboard. And please make sure the antenna points to the sky.

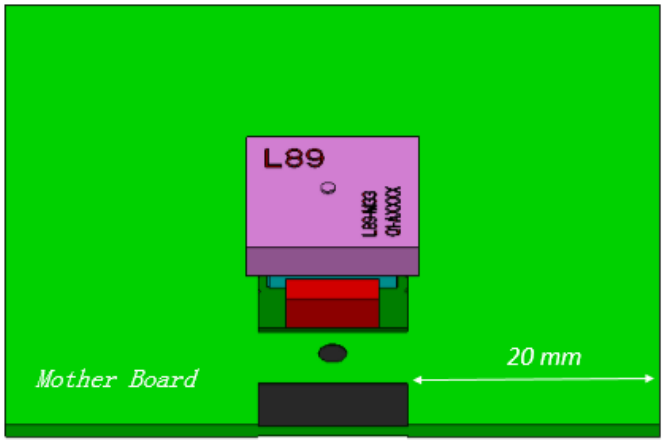


Figure 14: Recommended Distance between L89 and Motherboard Edge

- Please keep patch antenna and chip antenna at least 10mm away from other tall metal components. Otherwise, the antenna performance will be affected.

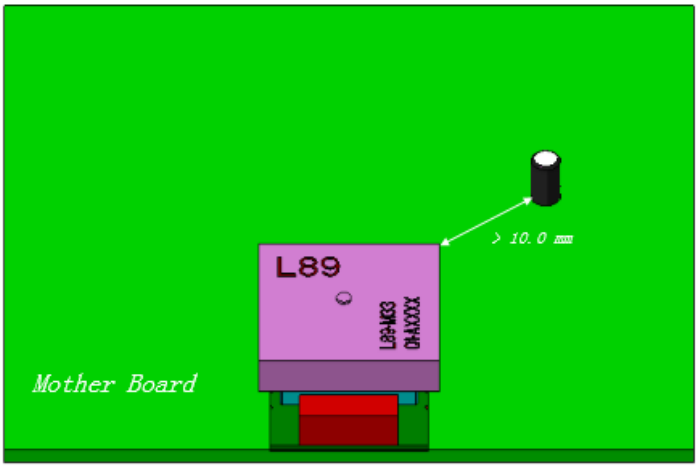


Figure 15: Recommended Distance between L89 and Tall Metal Components

- Make sure the microcontroller, crystal, LCD, camera and other high speed components and interfaces are placed on the opposite side of the motherboard where L89 is mounted, and keep them away from the module as far as possible, such as in diagonal position of the motherboard.

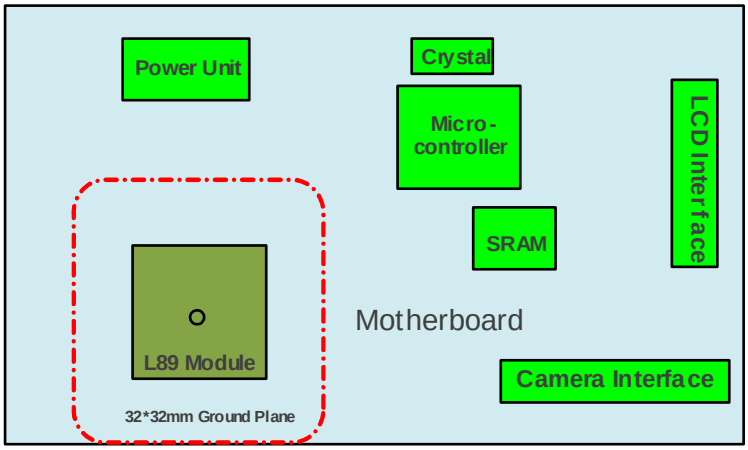


Figure 16: Recommended Placement of L89 and Other Components

- Please make sure interfering signals (USB, LCD, Camera, Crystal, etc.) are in inner layers and shielded by ground plane, and keep them and their vias far away from the module.
- Please make sure RF system such as BT/Wi-Fi/GSM is on the opposite side of the motherboard where L89 is mounted, and keep them away from the module as far as possible, such as in diagonal position of the board.
- Please keep DC-DC far away from the module.
- Device enclosure should be made of non-metal materials especially for those around the antenna area. The minimum distance between antenna and enclosure is 3mm.
- The RF part of L89 module is sensitive to temperature. Please keep them away from heat-emitting circuit.
- It is recommended to reserve an integrate ground layer to isolate the GNSS module from others.

4.1.3.2. Recommended Keepout Design

The position corresponding to the feed point of the patch antenna on each layer of the motherboard (except bottom layer) should be kept out, and the diameter of the keepout area should be not less than 4mm, and the area (16mm x 6.25mm) under the L5 Chip antenna should be kept out on each layer.

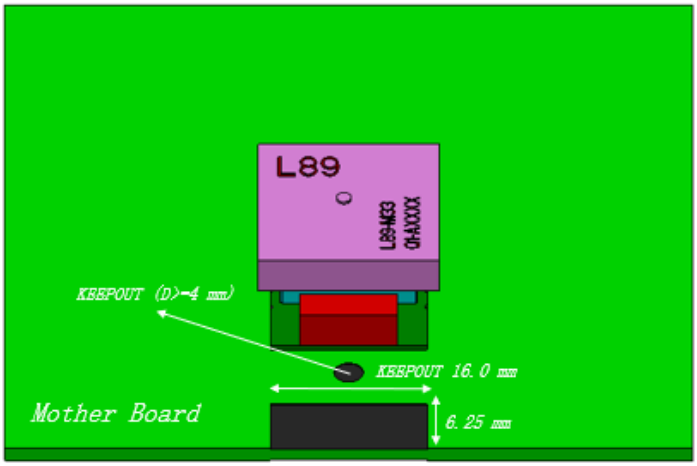


Figure 17: Recommended Keepout Design for the Patch Antenna

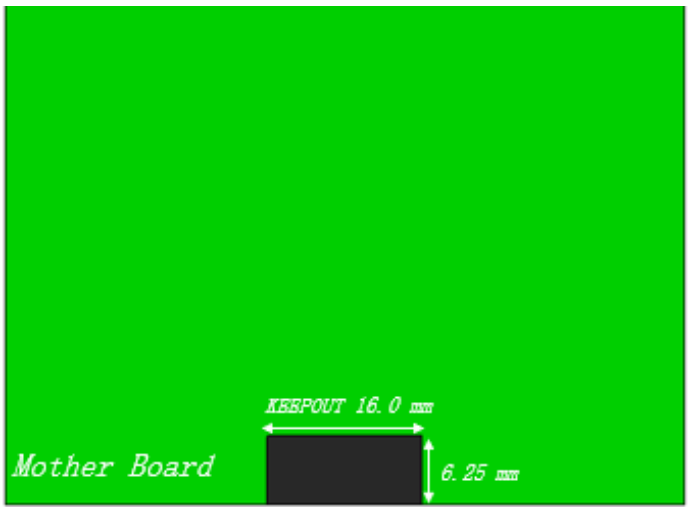


Figure 18: Recommended Keepout Design for the Chip Antenna

4.1.3.3. Recommended Ground Plane Design

The performance of embedded patch antenna depends on the actual size of the ground plane around the module. It is recommended to design a 32mm × 32mm ground plane as shown below. Meanwhile, do not put any components especially tall components in the areas whenever possible. (Interfering vias are not allowed either).

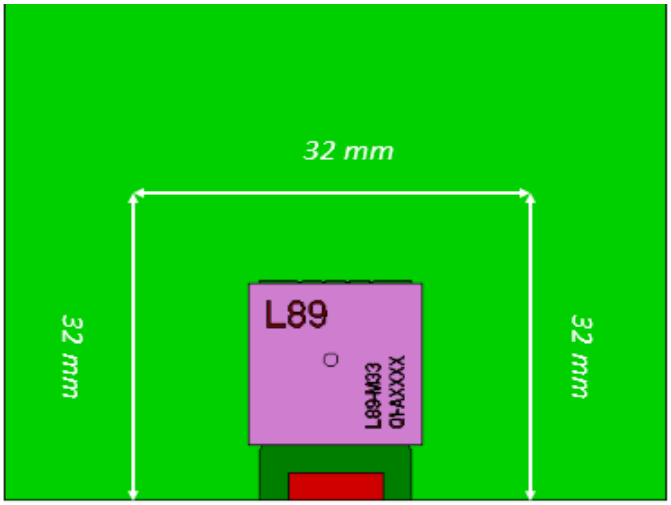


Figure 19: Recommended Ground Plane Design

4.2. External Active Antenna Interface

4.2.1. Reference Design for Active Antenna

The following figure is a typical reference design for active antenna. DC on the EX_ANT pin is powered by VCC and it supplies power for the external active antenna.

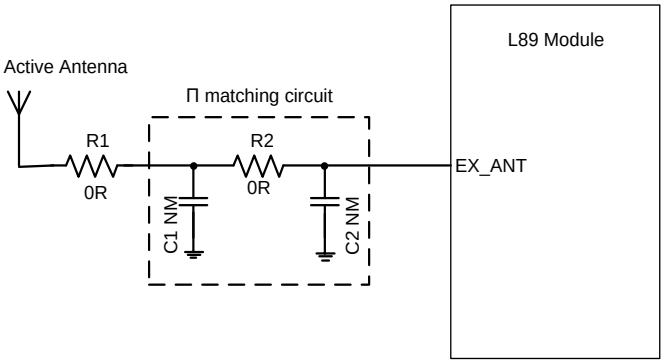


Figure 20: Reference Design for Active Antenna

C1, C2, R1 and R2 are reserved matching circuits for antenna impedance modification. By default, R1, R2 is 0Ω, while C1 and C2 are not mounted.

4.2.2. Recommended Specifications

Table 10: Recommended Antenna Specifications

Antenna Type	Specification
GNSS L1	Frequency Range: 1559MHz~1609MHz Polarization: RHCP or linear VSWR: <2 (Typ.) Passive Antenna Gain: >0dBi Active Antenna Noise Figure: <1.5dB Active Antenna Gain: >0dBi Active Antenna Embedded LNA Gain: <17dB
IRNSS L5	Frequency Range: 1164MHz~1189MHz Polarization: RHCP or linear VSWR: <2 (Typ.) Passive Antenna Gain: >0dBi Active Antenna Noise Figure: <1.5dB Active Antenna Gain: >0dBi Active Antenna Embedded LNA Gain: <17dB

4.2.3. The Selection of Active Antenna

The relationship between the voltage of EX_ANT pin and the antenna current consumption is illustrated in the following figure. Please make sure the antenna current consumption falls within the range of 7mA-40mA, otherwise the active antenna may not work. When the external active antenna works, the built-in antennas will stop working.

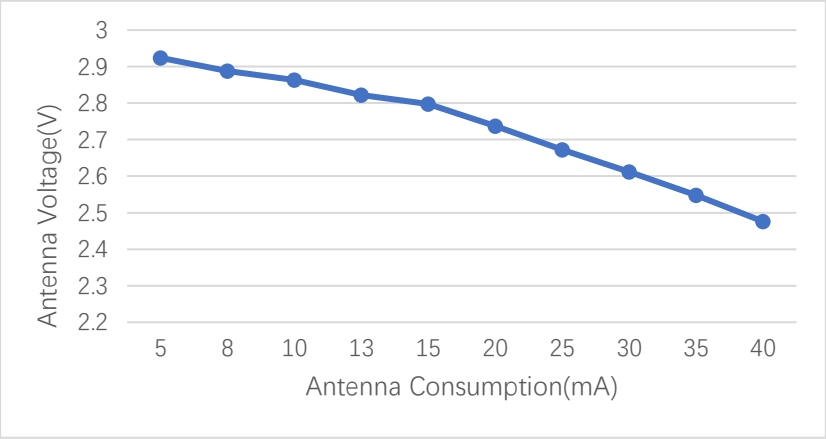


Figure 21: The Relationship between EX_ANT Voltage and Antenna Current Consumption

When an external active antenna is used, the antenna status (open/normal/short) can be queried by $PSTMANTENNASTATUS command. If the external antenna is in a short-circuit state, L89 module will turn off the power supply for the antenna. When the antenna is not short-circuited, the power supply will be automatically restored.

5 Electrical, Reliability and Radio Characteristics

5.1. Absolute Maximum Ratings

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

Table 11: Absolute Maximum Ratings

Parameter	Min.	Max.	Unit
Power Supply Voltage (VCC)	-0.2	4.3	V
Backup Battery Voltage (V_BCKP)	-0.2	4.3	V
Input Voltage at Digital Pins	-0.2	3.3	V
Input Power at EX_ANT (P_{EX_ANT})		15	dBm

NOTE

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

5.2. Operating Conditions

Table 12: Power Supply Ratings

Parameter	Description	Conditions	Min.	Typ.	Max.	Unit
VCC	Supply voltage	The actual input voltages must stay between the minimum and maximum values.	3.1	3.3	4.3	V
I_{VCCP}	Peak supply current	VCC=3.3V			150	mA
V_BCKP	Backup voltage supply		1.9	3.3	4.3	V
T_{OPR}	Full on mode operating temperature		-40	25	85	°C

NOTES

1. The values in the table above can be used to determine the maximum current capability of power supply.
2. Operation beyond the "Operating Conditions" is not recommended and extended exposure beyond the "Operating Conditions" may affect the device reliability.

5.3. Current Consumption

The values of current consumption are shown in the following table.

Table 13: Current Consumption

Module	Conditions	Acquisition @VCC=3.3V	Tracking @VCC=3.3V	Backup @VCC=3.3V V_BCKP=3.3V
L89	@-130dBm GPS	91mA	78mA	7uA
	@-130dBm IRNSS	100mA	88mA	
	@-130dBm GPS+IRNSS	102mA	100mA	
	@-130dBm GPS+Galileo+IRNSS	99mA	95mA	

5.4. Reliability Test

Table 14: Reliability Tests

Test Item	Conditions	Standard
Thermal Shock	-30°C+80°C, 144 cycles	GB/T 2423.22-2002 Test Na IEC 68-2-14 Na
Damp Heat, Cyclic	+55°C; >90% Rh 6 cycles for 144 hours	IEC 68-2-30 Db Test
Vibration Shock	5Hz~20Hz, 0.96m^2/s^3; 20Hz~500Hz, 0.96m^2/s^3-3dB/oct, 1 hour/axis; no function	2423.13-1997 Test Fdb IEC 68-2-36 Fdb Test
Heat Test	+85°C, 2 hours, operational	GB/T 2423.1-2001 Ab IEC 68-2-1 Test
Cold Test	-40°C, 2 hours, operational	GB/T 2423.1-2001 Ab IEC 68-2-1 Test
Heat Soak	+90°C, 72 hours, non-operational	GB/T 2423.2-2001 Bb IEC 68-2-2 Test B
Cold Soak	-45°C, 72 hours, non-operational	GB/T 2423.1-2001 A IEC 68-2-1 Test

5.5. ESD Protection

L89 GNSS module is an ESD sensitive device. ESD protection precautions should be emphasized. Proper ESD handling and packaging procedures must be applied throughout processing, handling and operation of any application that incorporates the module.

Please note that the following measures are helpful for ESD protection when L89 module is handled.

- The first contact point shall always be between the local GND and PCB GND when handling the PCB, unless there is a galvanic coupling between the local GND and the PCB GND.
- When mounting the module onto a motherboard, please make sure the GND is connected before the EX_ANT pad.
- Do not contact any charged capacitors or materials which may easily generate or store charges (such as patch antenna, coaxial cable, soldering iron, etc.) when handling the EX_ANT pad.
- Make sure to use an ESD safe soldering iron (tip) when soldering the EX_ANT pin.

6 Mechanical Dimensions

This chapter describes the mechanical dimensions of the module. All dimensions are measured in millimeter (mm). The tolerances for dimensions without tolerance values are ±0.05mm.

6.1. Mechanical Dimensions of the Module

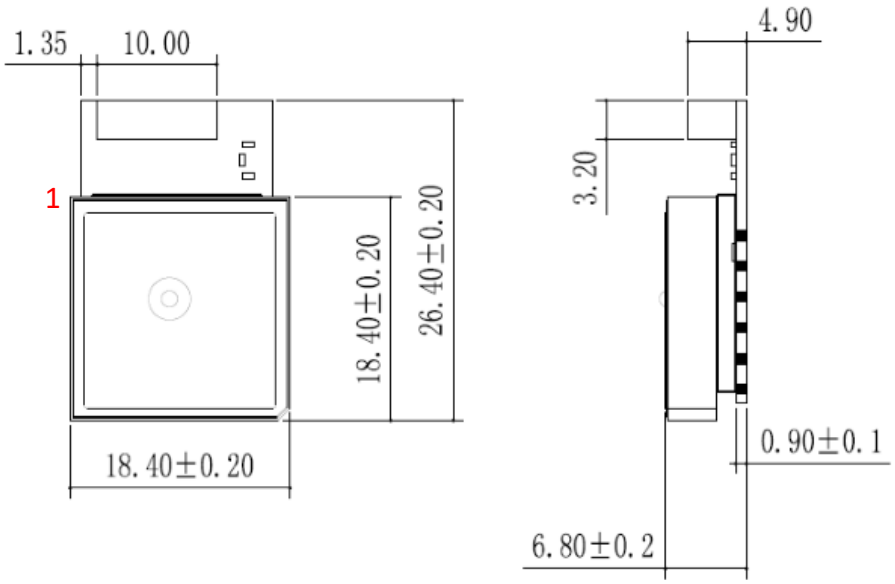


Figure 22: Top and Side Dimensions

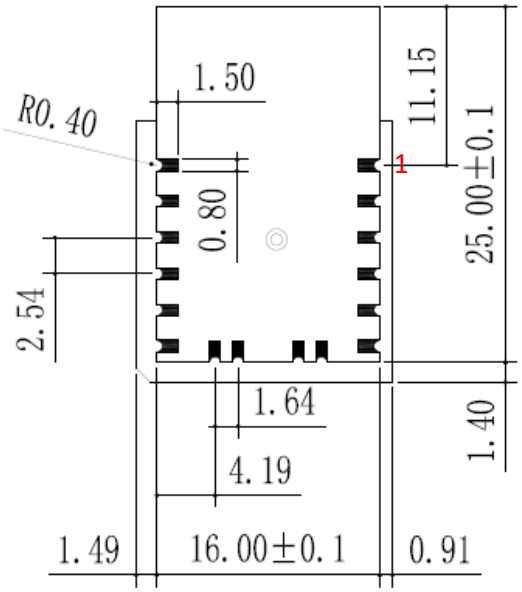


Figure 23: Bottom Dimensions

6.2. Recommended Footprint

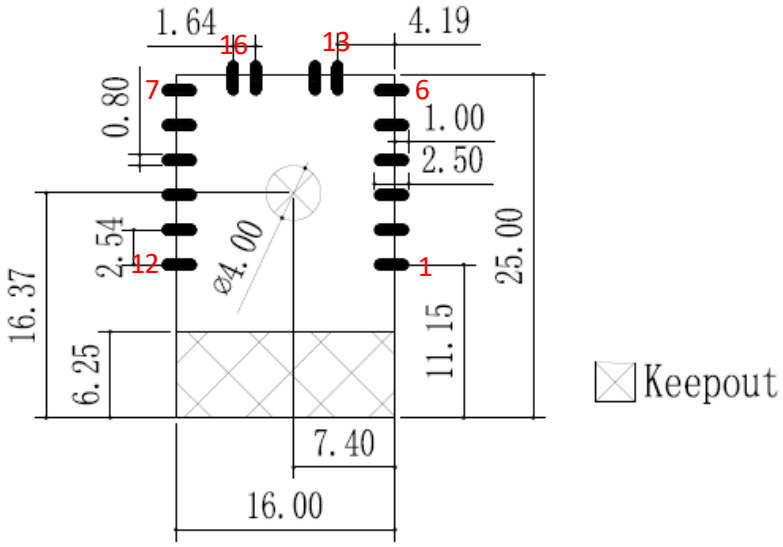


Figure 24: Recommended Footprint

NOTES

1. For more details about the keepout area design, please refer to ***Chapter 4.1.3.2***.
2. For easy maintenance of this module and accessing to these pads, please keep a distance of no less than 3mm between the module and other components on a motherboard.

6.3. Design Effect Drawings of the Module

Figure 25: Top View of the Module

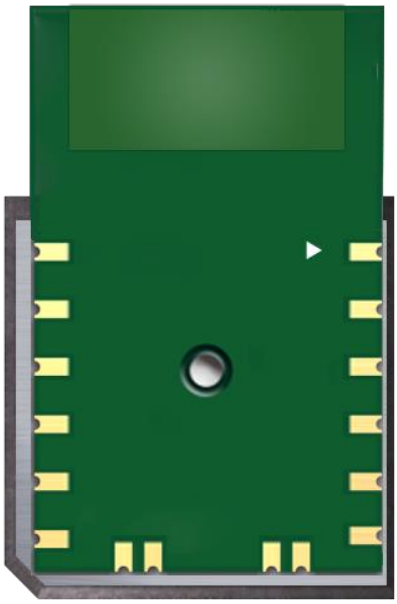


Figure 26: Bottom View of the Module

NOTE

These are renderings of L89 module. For authentic appearance, please refer to the module that you receive from Quectel.

7 Storage, Manufacturing, and Packaging

7.1. Storage

L89 is stored in a vacuum-sealed bag. It is rated at MSL 3, and its storage restrictions are shown as below.

1. Shelf life in the vacuum-sealed bag: 12 months at <40ºC/90%RH.
2. After the vacuum-sealed bag is opened, devices that will be subjected to reflow soldering or other high temperature processes must be:
   - Mounted within 168 hours at the factory environment of ≤30ºC/60%RH.
   - Stored at <10%RH.
3. Devices require baking before mounting, if any circumstance below occurs.
   - When the ambient temperature is 23ºC±5ºC and the humidity indication card shows the humidity is >10% before opening the vacuum-sealed bag.
   - Device mounting cannot be finished within 168 hours at factory conditions of ≤30ºC/60%.
4. If baking is required, devices may be baked for 8 hours at 120ºC±5ºC.

NOTE

As the plastic package cannot be subjected to high temperature, it should be removed from devices before high temperature (120ºC) baking. If shorter baking time is desired, please refer to *IPC/JEDECJ-STD-033* for baking procedure.

7.2. Manufacturing and Soldering

Push the squeegee to apply the solder paste on the surface of stencil, thus making the paste fill the stencil openings and then penetrate to the PCB. The force on the squeegee should be adjusted properly so as to produce a clean stencil surface on a single pass. To ensure the module soldering quality, the thickness of stencil for the module is recommended to be 0.18mm~0.20mm. For more details, please refer to ***document [3]***.

It is suggested that the peak reflow temperature is 238~245ºC, and the absolute maximum reflow temperature is 245ºC. To avoid damage to the module caused by repeated heating, it is strongly recommended that the module should be mounted after reflow soldering for the other side of PCB has been completed. The recommended reflow soldering thermal profile (lead-free reflow soldering) and related parameters are shown below.

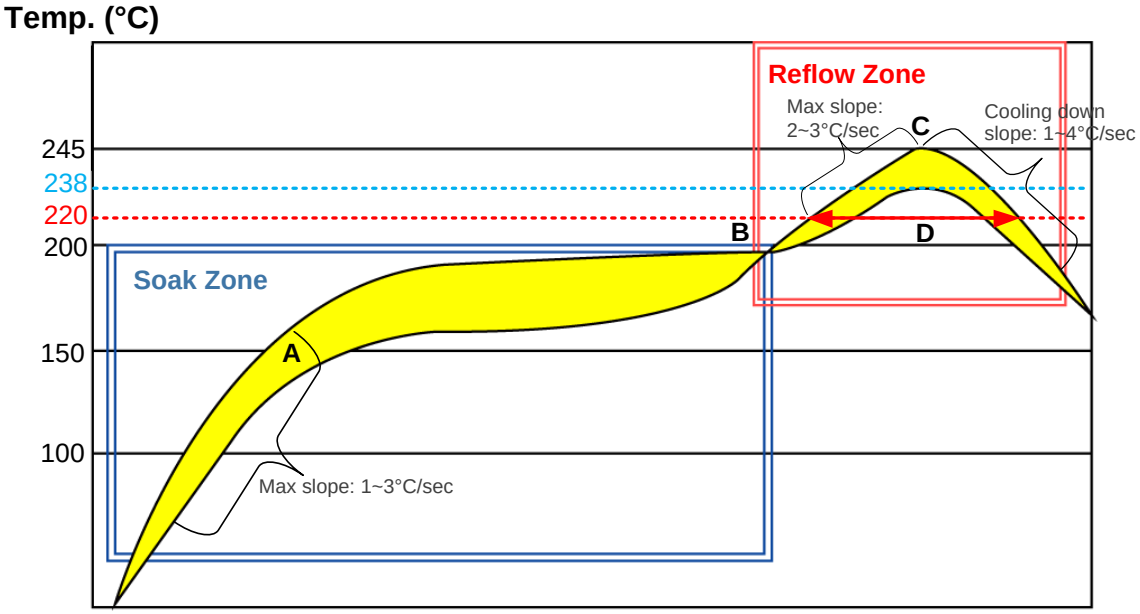


Figure 27: Recommended Reflow Soldering Thermal Profile

Table 15: Recommended Thermal Profile Parameters

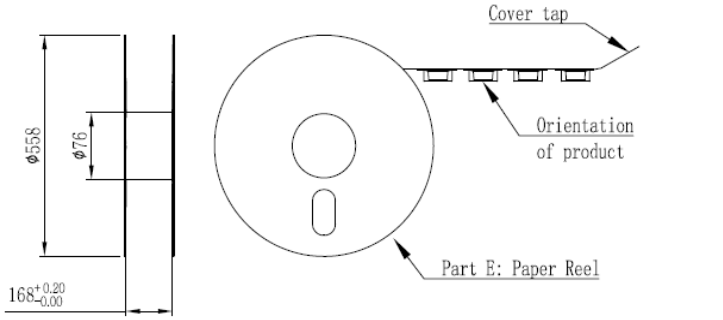
Factor	Recommendation
Soak Zone	
Max slope	1 to 3°C/sec
Soak time (between A and B: 150°C and 200°C)	60 to 120 sec

Reflow Zone	
Max slope	2 to 3°C/sec
Reflow time (D: over 220°C)	40 to 60 sec
Max temperature	238°C ~ 245°C
Cooling down slope	1 to 4°C/sec
Reflow Cycle	
Max reflow cycle	1

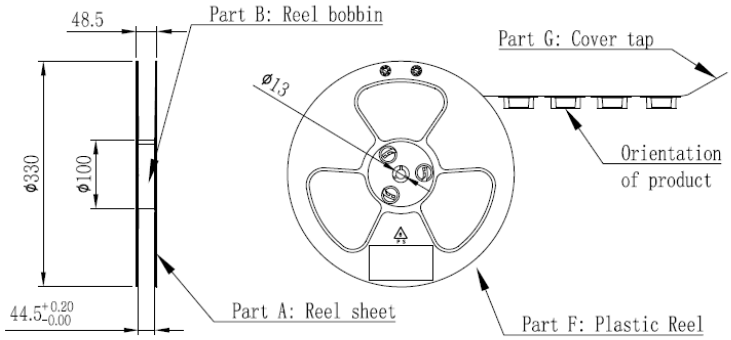
NOTE

During manufacturing and soldering, or any other processes that may contact the module directly, NEVER wipe the module label with organic solvents, such as acetone, ethyl alcohol, isopropyl alcohol, trichloroethylene, etc. Otherwise, the label information may become unclear.

7.3. Tape and Reel Packaging



★All part C packed in 1pcs part E can be disassemble and packing in 11pcs part F
★Part E Spec.: 22″*3″*6.6″
★Part E package : Module: M2=250*11=2750pcs
Cave: C2=270*11+50=3020pcs
Length: L2=32*3020=96640mm=96.64m



★1pcs part B and 2pcs part A assemble to 1pcs Part F
★Part F Spec.: 13″*4″*44mm
★Part F package: Module: M1=250pcs
Cave: C1=270pcs
Length: L1=32*270m=8640mm=8.64m

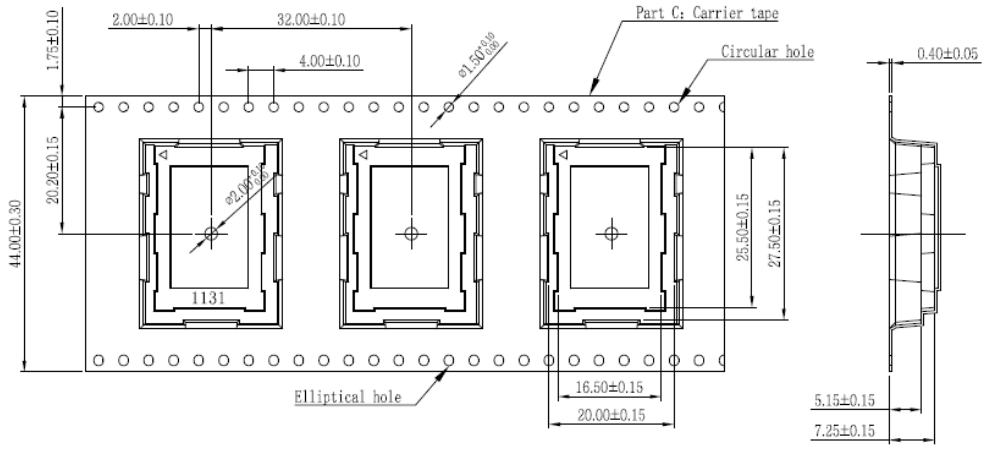


Figure 28: Tape and Reel Specifications

Table 16: Reel Packaging

Model Name	MOQ for MP	Minimum Package: 250pcs	Minimum Package x 4 = 1000pcs
L89	500pcs	Size: 370mm × 350mm × 56mm N.W: 2.05kg G.W: 2.75kg	Size: 380mm × 250mm × 365mm N.W: 8.3kg G.W: 10.5kg

8 Appendix A References

Table 17: Related Documents

SN	Document Name	Remark
[1]	Quectel_L89_GNSS_Protocol_Specification	L89 GNSS Protocol Specification
[2]	Quectel_L89_EVB_User_Guide	L89 EVB User Guide
[3]	Quectel_Module_Secondary_SMT_User_Guide	Module Secondary SMT User Guide
[4]	Quectel_L89_Reference_Design	L89 Reference Design

Table 18: Terms and Abbreviations

Abbreviation	Description
AGPS	Assisted Global Positioning System
CEP	Circular Error Probable
DGPS	Differential Global Positioning System
EGNOS	European Geostationary Navigation Overlay Service
ESD	Electrostatic Discharge
GLONASS	Global Navigation Satellite System (the Russian GNSS)
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
IC	Integrated Circuit
Inom	Nominal Current
Imax	Maximum Load Current
I/O	Input /Output
IRNSS	India Regional Navigation Satellite System

Kbps	Kilo Bits Per Second
LNA	Low Noise Amplifier
MOQ	Minimum Order Quantity
MSAS	Multi-Functional Satellite Augmentation System
NMEA	National Marine Electronics Association
NVM	Non-Volatile Memory
PPS	Pulse Per Second
PQ	Quectel Proprietary Protocol
QZSS	Quasi-Zenith Satellite System
RAM	Random-Access Memory
RHCP	Right Hand Circular Polarization
RTCM	Radio Technical Commission for Maritime Services
SBAS	Satellite-based Augmentation System
SAW	Surface Acoustic Wave
SMD	Surface Mounted Device
SPDT	Single Pole Double Throw
T_{OPR}	Operating Temperature
TTFF	Time to First Fix
UART	Universal Asynchronous Receiver & Transmitter
Vmax	Maximum Voltage Value
Vnom	Nominal Voltage Value
Vmin	Minimum Voltage Value
V_{IH}max	Maximum Input High Level Voltage Value
V_{IH}min	Minimum Input High Level Voltage Value
V_{IL}max	Maximum Input Low Level Voltage Value
V_{IL}min	Minimum Input Low Level Voltage Value
$V_I$max	Absolute Maximum Input Voltage Value

$V_I$min	Absolute Minimum Input Voltage Value
V_{OH}max	Maximum Output High Level Voltage Value
V_{OH}min	Minimum Output High Level Voltage Value
V_{OL}max	Maximum Output Low Level Voltage Value
V_{OL}min	Minimum Output Low Level Voltage Value
WAAS	Wide Area Augmentation System