



# I491xQ Series

## Hardware Design

**LTE Standard Module Series**

Version: 1.0.0

Date: 2025-03-20

Status: Preliminary



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# About the Document

## Revision History

Version	Date	Description
-	2025-03-20	Creation of the document
1.0.0	2025-03-20	Preliminary

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# 1 Introduction

This document describes the I491xQ series features, performance, and air interfaces and hardware interfaces connected to your applications. The document provides a quick insight into interface specifications, RF performance, electrical and mechanical specifications, and other module information, as well.

This document is applicable to the following modules:

- I4915Q series: I4915Q-NA, I4915Q-AF
- I4916Q-GL

## 1.1. Special Marks

**Table 1: Special Marks**

Mark	Definition
*	Unless otherwise specified, an asterisk (*) after a function, feature, interface, pin name, command, argument, and so on indicates that it is under development and currently not supported; and the asterisk (*) after a model indicates that the model sample is currently unavailable.

## 2 Product Overview

I491xQ series are SMD modules with compact packaging, which also support GNSS to meet your specific application demands.

**Table 2: Basic Information**

Item	I4915Q Series	I4916Q-GL
Packaging type	LGA	LGA
Pin counts	126	126
Dimensions	(23.6 $\pm$ 0.2) mm $\times$ (19.9 $\pm$ 0.2) mm $\times$ (2.4 $\pm$ 0.2) mm	(26.5 $\pm$ 0.2) mm $\times$ (22.5 $\pm$ 0.2) mm $\times$ (2.4 $\pm$ 0.2) mm
Weight	Approx. 2.3 g	Approx. 2.9 g

### 2.1. Frequency Bands and Functions

**Table 3: Frequency Bands and Functions**

Technology	I4915Q-NA	I4915Q-AF	I4916Q-GL
LTE-FDD	B2/B4/B5/B12/ B13/B66	B2/B4/B5/B12/B13/ B14/B66/B71	B1/B2/B3/B4/B5/B7/B8/B12 /B13/B18/ B19/B20/B25/B26/ B28/B66
LTE-TDD	-	-	B34/B38/B39/B40/ B41
GNSS (Optional)	GPS, GLONASS, BDS, Galileo, QZSS	GPS, GLONASS, BDS, Galileo, QZSS	GPS, GLONASS, BDS, Galileo, QZSS
Wi-Fi Scan	802.11b/g/n with 2.4G DSSS beacon	802.11b/g/n with 2.4G DSSS beacon	802.11b/g/n with 2.4G DSSS beacon

**NOTE**

Wi-Fi Scan function shares the same antenna interface with the main antenna. These two antennas should use TDM (Time Division Multiplexing) and cannot be used simultaneously. Wi-Fi Scan only supports receiving and does not support transmitting.

## 2.2. Key Features

**Table 4: Key Features**

Categories	Descriptions
Supply Voltage	<ul style="list-style-type: none"> <li>● 3.3–4.3 V</li> <li>● Typ.: 3.8 V</li> </ul>
SMS	<ul style="list-style-type: none"> <li>● Text and PDU mode</li> <li>● Point-to-point MO and MT</li> <li>● SMS cell broadcast</li> <li>● SMS storage: ME by default</li> </ul>
USIM Interfaces	<ul style="list-style-type: none"> <li>● Support 2 USIM interfaces: USIM1 interface and USIM2 interface</li> <li>● Only support Dual SIM Single Standby</li> <li>● USIM1: 1.8/3.0 V</li> <li>● USIM2: 1.8 V</li> <li>● When USIM1 and USIM2 are used at the same time, the power domain of USIM interfaces should be 1.8 V. Otherwise, USIM2 interface will be damaged.</li> <li>● USIM2 interface and Camera SPI* cannot be used at the same time.</li> </ul>
PCM Interface*	<ul style="list-style-type: none"> <li>● Supports one digital audio interface: PCM interface</li> <li>● Used for audio function with external Codec</li> </ul>
I2C Interface*	<ul style="list-style-type: none"> <li>● One I2C interface</li> <li>● Complies with I2C-bus specification</li> </ul>
Camera SPI *	<ul style="list-style-type: none"> <li>● Supports one camera SPI</li> <li>● Supports the SPI dual-wire data transmission</li> <li>● USIM2 and Camera SPI cannot be used at the same time.</li> </ul>
USB Interface	<ul style="list-style-type: none"> <li>● Compliant with USB 2.0 specifications (only supports slave mode)</li> <li>● Data transmission rate up to 480 Mbps</li> <li>● Used for AT command communication, data transmission, GNSS NMEA sentence output (<b>All-in-one</b> solution only), software debugging, firmware upgrade and the output of partial logs</li> <li>● The USB interface can be used to upgrade firmware only after the module entering download mode (Pulling up USB_BOOT to VDD_EXT before turning on the module, and then the module will enter download mode).</li> <li>● USB serial drivers: Windows 8.1/10/11, Linux 2.6–6.7, Android 4.x–13.x systems</li> </ul>

	<b>Main UART:</b>
	<ul style="list-style-type: none"> <li>Used for AT command communication and data transmission</li> <li>Baud rate: 115200 bps by default</li> <li>RTS and CTS hardware flow control</li> </ul>
UART Interfaces	<b>Debug UART:</b>
	<ul style="list-style-type: none"> <li>Used for the output of partial logs</li> <li>Baud rate: 115200 bps, 3 Mbps (by default)</li> </ul>
	<b>GNSS UART:</b>
	<ul style="list-style-type: none"> <li>Used for outputting GNSS data or GNSS NMEA sentence output</li> <li>Baud rate: 921600 bps</li> </ul>
	<b>GNSS debug UART:</b>
	<ul style="list-style-type: none"> <li>Used for outputting GNSS system logs</li> <li>Baud rate: 3 Mbps</li> </ul>
Network Indication	<b>NET_STATUS:</b>
	<ul style="list-style-type: none"> <li>Used for indicating network connectivity status</li> </ul>
AT Commands	<ul style="list-style-type: none"> <li>Complies with the AT commands defined in <i>3GPP TS 27.007</i> and <i>3GPP TS 27.005</i></li> </ul>
Antenna Interface	<ul style="list-style-type: none"> <li>Main antenna/Wi-Fi Scan antenna interface (ANT_MAIN)</li> <li>GNSS antenna interface (ANT_GNSS)</li> <li>50 Ω characteristic impedance</li> </ul>
Transmitting Power	<ul style="list-style-type: none"> <li>LTE bands: Class 3 (23 dBm ±2 dB)</li> </ul>
LTE Features	<ul style="list-style-type: none"> <li>Complies with 3GPP Rel-14 FDD</li> <li>Max. LTE category: Cat 1 bis</li> <li>1.4/3/5/10/15/20 MHz RF bandwidth</li> <li>DL modulations: QPSK, 16QAM and 64QAM</li> <li>UL modulations: QPSK, 16QAM</li> <li>LTE-FDD Max. data rates: 10 Mbps (DL)/5 Mbps (UL)</li> <li>LTE-TDD Max. data rates: 8.96 Mbps (DL)/3.1 Mbps (UL)</li> </ul>
Internet Protocol Features	<ul style="list-style-type: none"> <li>Complies with TCP/UDP/NTP/NITZ/FTP/HTTP/PING/HTTPS/FTPS/SSL/MQTT/CMUX/PPP/FILE/SMTP/SMTPS/MMS* protocols</li> <li>Complies with PPP protocol's PAP and CHAP authentication</li> </ul>
Temperature Ranges	<ul style="list-style-type: none"> <li>Normal operating temperature <sup>1</sup>: -35 °C to +75 °C</li> <li>Extended operating temperature <sup>2</sup>: -40 °C to +85 °C</li> <li>Storage temperature: -40 °C to +90 °C</li> </ul>
Firmware Upgrade	Via USB 2.0 interface or DFOTA
RoHS	All hardware components fully comply with EU RoHS directive

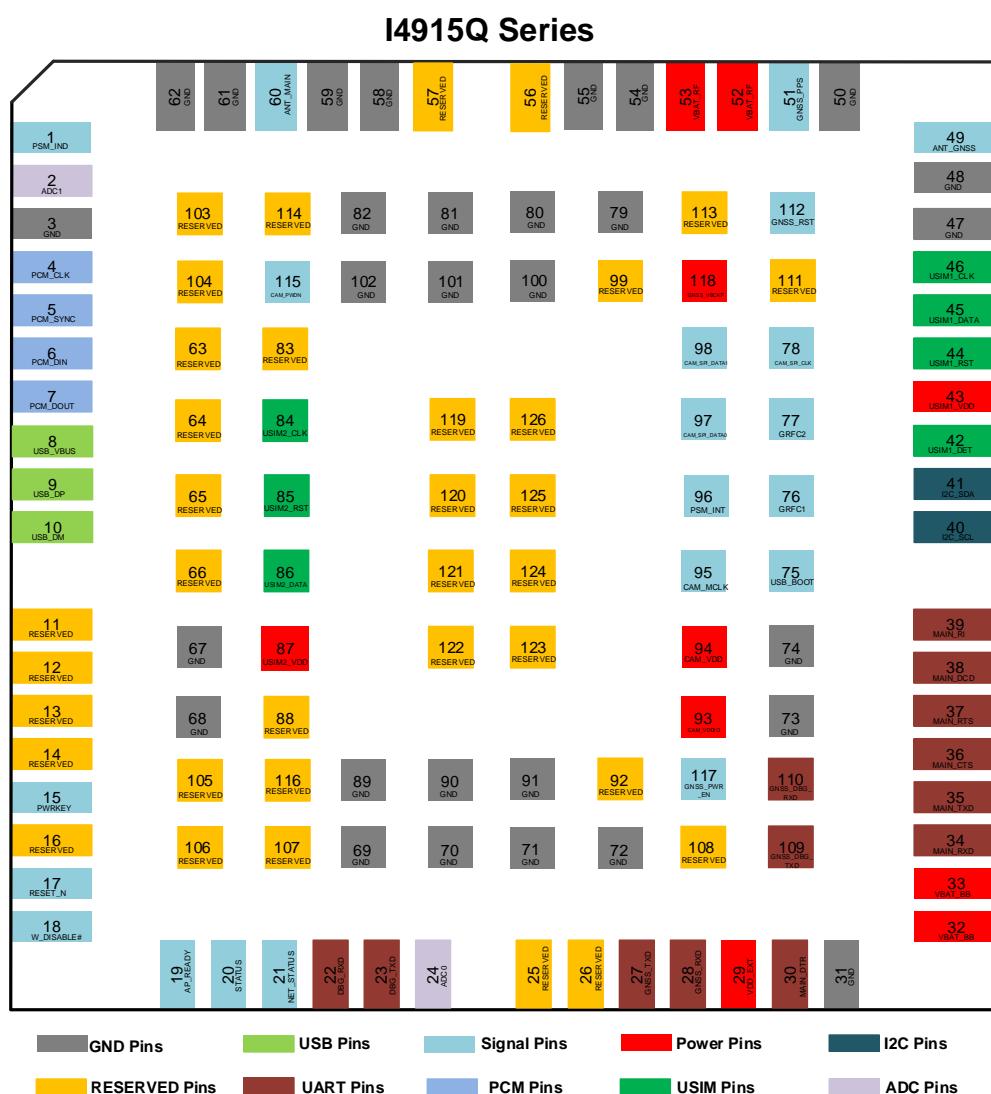
<sup>1</sup> Within this range, the module's indicators comply with 3GPP specification requirements.

<sup>2</sup> Within this range, the module retains the ability to establish and maintain functions such as SMS and data transmission, without any unrecoverable malfunction. Radio spectrum and radio network remain uninfluenced, whereas the value of one or more parameters, such as  $P_{out}$ , may decrease and fall below the range of the 3GPP specified tolerances. When the temperature returns to the normal operating temperature range, the module's indicators will comply with 3GPP specification requirements again.

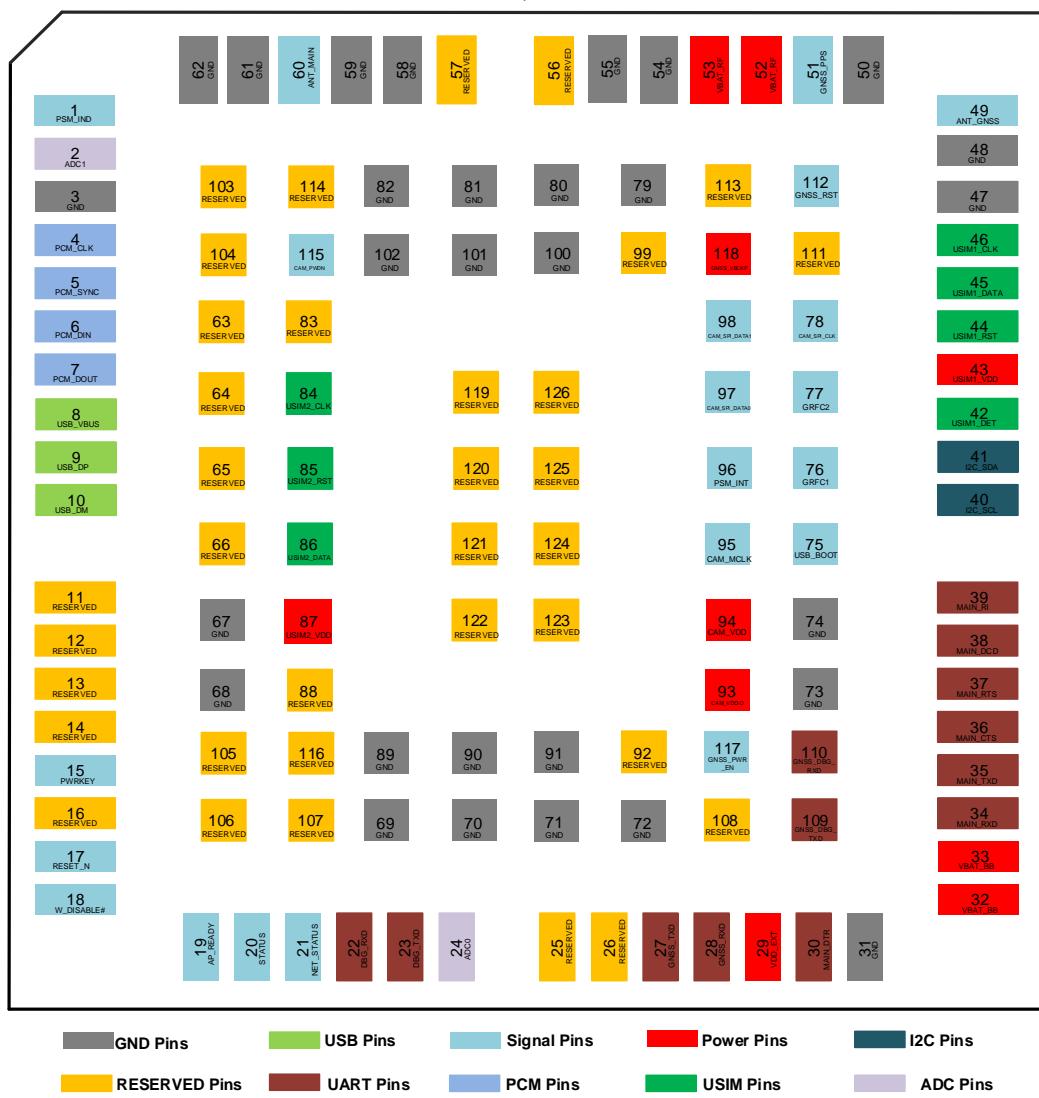
**NOTE**

I491xQ series support SPI. If you need this function, please contact Eagle Technical Support.

## 2.3. Pin Assignment



**Figure 1: I4915Q Series Pin Assignment (Top View)**

**I4916Q-GL**

**Figure 2: I4916Q-GL Pin Assignment (Top View)**
**NOTE**

1. If the module does not need to enter download mode, USB\_BOOT (pin 75) should not be pulled up to VDD\_EXT before the module successfully starts up.
2. In sleep mode, pins 34–37 of the main UART interface, pins 22 and 23 of debug UART interface, USB\_BOOT (pin 75), pins 4–7 of PCM interface\*, pins 40 and 41 of I2C interface\*, and pins 78, 93, 95, 97, 98 and 115 of Camera SPI\* are powered down. The driving capacity will be lost and the functions of status indication and data transmission are disabled. Pay attention to it when designing circuits.
3. When USIM1 and USIM2 are used at the same time, the power domain of USIM interfaces should be 1.8 V. Otherwise, USIM2 interface will be damaged.
4. The module supports SPI. If you need this function, please contact Eagle Technical Support.
5. GNSS interface (pins 27, 28, 49, 51, 109, 110, 112, 117, 118) is optional. If you need this function, please

- contact Eagle Technical Support.
6. USIM2 interface and Camera SPI\* cannot be used at the same time.
  7. Keep all RESERVED pins and unused pins unconnected.

## 2.4. Pin Description

**Table 5: Parameter Definition**

Parameter	Description
AI	Analog Input
AIO	Analog Input/Output
DI	Digital Input
DO	Digital Output
DIO	Digital Input/Output
PI	Power Input
PO	Power Output
OD	Open Drain

DC characteristics include power domain and rated current.

**Table 6: Pin Description**

Power Supply					
Pin Name	Pin No.	I/O	Description	DC Characteristic	Comment
VBAT_BB	32, 33	PI	Power supply for the module's BB part	Vmax = 4.3 V Vmin = 3.3 V Vnom = 3.8 V	External power supply is recommended to provide with current of 0.3 A at least. A test point is recommended to be reserved.
VBAT_RF	52, 53	PI	Power supply for the		External power supply

				module's RF part		
VDD_EXT	29	PO	Provide 1.8 V for external circuit	V <sub>nom</sub> = 1.8 V I <sub>max</sub> = 50 mA	is recommended to provide with current of 1.2 A at least. A test point is recommended to be reserved.	
GNSS_3	118	PI	Power supply for GNSS RTC	V <sub>max</sub> = 3.6 V V <sub>min</sub> = 1.9 V V <sub>nom</sub> = 3.3 V	Power supply for external GPIO's pull-up circuits. A test point is recommended to be reserved.	
GND			3, 31, 47, 48, 50, 54, 55, 58, 59, 61, 62, 67–74, 79–82, 89–91, 100–102			

#### Turn On/Off

Pin Name	Pin No.	I/O	Description	DC Characteristic	Comment
PWRKEY	15	DI	Turn on/off the module	V <sub>ILmax</sub> = 0.5 V	Active low. A test point is recommended to be reserved.
RESET_N	17	DI	Reset the module		Active low. A test point is recommended to be reserved if unused.

#### Indication Signals

Pin Name	Pin No.	I/O	Description	DC Characteristic	Comment
STATUS	20	DO	Indicate the module's operation status		
NET_STATUS	21	DO	Indicate the module's network activity status	VDD_EXT	If unused, keep them open.

#### USB Interface

Pin Name	Pin No.	I/O	Description	DC Characteristic	Comment
USB_VBUS	8	AI	USB connection detect	V <sub>max</sub> = 5.25 V V <sub>min</sub> = 3.0 V V <sub>nom</sub> = 5.0 V	A test point must be reserved.

<sup>3</sup> This pin is optional. If you need this function, please contact Eagle Technical Support.

USB_DP	9	AIO	USB differential data (+)	USB 2.0 compliant. Requires differential impedance of $90\ \Omega$ . Test points must be reserved.	
USB_DM	10	AIO	USB differential data (-)		
<b>USIM Interfaces <sup>4</sup></b>					
Pin Name	Pin No.	I/O	Description	DC Characteristic	Comment
				$I_{O\max} = 50\ \text{mA}$	
USIM1_VDD	43	PO	USIM1 card power supply	<b>Low-voltage:</b> $V_{max} = 1.85\ \text{V}$ $V_{min} = 1.75\ \text{V}$  <b>High-voltage:</b> $V_{max} = 3.05\ \text{V}$ $V_{min} = 2.95\ \text{V}$	Either 1.8 V or 3.0 V USIM1 card is supported and can be identified automatically by the module.
USIM1_DATA	45	DIO	USIM1 card data		
USIM1_CLK	46	DO	USIM1 card clock	USIM1_VDD	
USIM1_RST	44	DO	USIM1 card reset		
USIM1_DET	42	DI	USIM1 card hot-plug detect	VDD_EXT	If unused, keep it open.
USIM2_VDD <sup>5</sup>	87	PO	USIM2 card power supply	USIM1_VDD <b>(Low-voltage)</b>	Connected with USIM1_VDD inside the module.  1.8 V power domain is required for USIM2. Otherwise, this interface will be damaged.
USIM2_DATA <sup>5</sup>	86	DIO	USIM2 card data	VDD_EXT	Connected with pin 97 (CAM_SPI_DATA0) internally.  1.8 V power domain is required for USIM2. Otherwise, this interface will be damaged.

<sup>4</sup> When USIM1 and USIM2 are used at the same time, the power domain of USIM interfaces should be 1.8 V. Otherwise, USIM2 interface will be damaged.

<sup>5</sup> USIM2 and Camera SPI\* cannot be used at the same time.

USIM2_RST <sup>5</sup>	85	DO	USIM2 card reset	Connected with pin 78 (CAM_SPI_CLK) internally. 1.8 V power domain is required for USIM2. Otherwise, this interface will be damaged.
USIM2_CLK <sup>5</sup>	84	DO	USIM2 card clock	Connected with pin 115 (CAM_PWDN) internally. 1.8 V power domain is required for USIM2. Otherwise, this interface will be damaged.

### Main UART

Pin Name	Pin No.	I/O	Description	DC Characteristic	Comment
MAIN_CTS	36	DO	Clear to send signal from the module		Connect to MCU's CTS. If unused, keep it open.
MAIN_RTS	37	DI	Request to send signal to the module		Connect to MCU's RTS. If unused, keep it open.
MAIN_RXD	34	DI	Main UART receive	VDD_EXT	
MAIN_DCD	38	DO	Main UART data carrier detect		
MAIN_TXD	35	DO	Main UART transmit		If unused, keep them open.
MAIN_RI	39	DO	Main UART ring indication		
MAIN_DTR	30	DI	Main UART data terminal ready		

### Debug UART

Pin Name	Pin No.	I/O	Description	DC Characteristic	Comment
DBG_RXD	22	DI	Debug UART receive		Test points must be reserved.
DBG_TXD	23	DO	Debug UART transmit	VDD_EXT	

### GNSS UART

Pin Name	Pin No.	I/O	Description	DC Characteristic	Comment
GNSS_TXD <sup>3</sup>	27	DO	GNSS UART transmit	VDD_EXT	Test points are recommended to be reserved.
GNSS_RXD <sup>3</sup>	28	DI	GNSS UART receive		

**GNSS debug UART**

Pin Name	Pin No.	I/O	Description	DC Characteristic	Comment
GNSS_DBG_TXD <sup>3</sup>	109	DO	GNSS debug UART transmit	VDD_EXT	Test points must be reserved.
GNSS_DBG_RXD <sup>3</sup>	110	DI	GNSS debug UART receive		

**I2C Interface\***

Pin Name	Pin No.	I/O	Description	DC Characteristic	Comment
I2C_SCL	40	OD	I2C serial clock	VDD_EXT	External pull-up resistor is required. If unused, keep them open.
I2C_SDA	41	OD	I2C serial data		

**PCM Interface\***

Pin Name	Pin No.	I/O	Description	DC Characteristic	Comment
PCM_SYNC	5	DO	PCM data frame sync	VDD_EXT	If unused, keep them open.
PCM_CLK	4	DO	PCM clock		
PCM_DIN	6	DI	PCM data input		
PCM_DOUT	7	DO	PCM data output		

**RF Antenna Interface**

Pin Name	Pin No.	I/O	Description	DC Characteristic	Comment
ANT_MAIN <sup>6</sup>	60	AI0	Main antenna/Wi-Fi Scan antenna interface		50 Ω impedance.
ANT_GNSS <sup>3</sup>	49	AI	GNSS antenna interface		50 Ω impedance.

**GRFC Interfaces**

Pin Name	Pin No.	I/O	Description	DC Characteristic	Comment

<sup>6</sup> ANT\_MAIN only supports passive antennas.

GRFC1	76	DO	Generic RF controller	VDD_EXT	If unused, keep them open.
GRFC2	77	DO	Generic RF controller		

**Camera SPI\*<sup>5</sup>**

Pin Name	Pin No.	I/O	Description	DC Characteristic	Comment
CAM_MCLK	95	DO	Master clock of the camera		If unused, keep it open.
CAM_SPI_CLK	78	DI	Camera SPI clock		Connected with pin 85 (USIM2_RST) internally.
CAM_SPI_DATA0	97	DI	Camera SPI data bit 0	VDD_EXT	If unused, keep it open.
CAM_SPI_DATA1	98	DI	Camera SPI data bit 1		Connected with pin 86 (USIM2_DATA) internally.
CAM_PWDN	115	DO	Power down of the camera		If unused, keep it open.
CAM_VDD	94	PO	Camera analog power supply	V <sub>nom</sub> = 2.8 V	If unused, keep them open.
CAM_VDDIO	93	PO	Camera digital power supply	VDD_EXT	

**ADC Interfaces**

Pin Name	Pin No.	I/O	Description	DC Characteristic	Comment
ADC0	24	AI	General-purpose ADC interface		Voltage range: 0–1.2 V
ADC1	2	AI	General-purpose ADC interface		If unused, keep them open.

**Other Interfaces**

Pin Name	Pin No.	I/O	Description	DC Characteristic	Comment
USB_BOOT	75	DI	Make the module enter download mode	VDD_EXT	Active high before power-up. A test point must be reserved.
W_DISABLE#*	18	DI	Airplane mode control		If unused, keep them

PSM_IND*	1	DO	Indicate the module's power saving mode	open.
PSM_INT*	96	DI	External interrupt; wake up the module from power saving mode	
AP_READY*	19	DI	Application processor ready	
GNSS_PPS <sup>3</sup>	51	DO	GNSS pulse per second output	
GNSS_RST <sup>3</sup>	112	DI	Reset the GNSS chip	A test point is recommended to be reserved.
GNSS_PWR_EN <sup>3</sup>	117	DI	GNSS power enabled	If unused, keep it open.
<b>RESERVED Pins</b>				
Pin Name	Pin No.			Comment
RESERVED	11–14, 16, 25, 26, 56, 57, 63–66, 83, 88, 92, 99, 103–108, 111, 113, 114, 116, 119–126			Keep these pins open.

## 2.5. EVB Kit

Eagle supplies an evaluation board (UMTS&LTE EVB) with accessories to develop or test the module. For more details, see **document [1]**.

# 3 Operating Characteristics

## 3.1. Operating Modes

The module integrates both LTE and GNSS <sup>7</sup> engines which can work as a whole (**All-in-one** solution) unit or work independently (**Stand-alone** solution) according to your demands.

### 3.1.1. Operating Modes of LTE Part

**Table 7: Operating Modes Overview of LTE Part**

Modes	Descriptions				
Full Functionality Mode	<table border="1"> <tr> <td>Idle</td> <td>Software is active. The module is registered on the network but has no data interaction with the network.</td> </tr> <tr> <td>Data</td> <td>Network connection is ongoing. Power consumption is decided by network setting and data rate.</td> </tr> </table>	Idle	Software is active. The module is registered on the network but has no data interaction with the network.	Data	Network connection is ongoing. Power consumption is decided by network setting and data rate.
Idle	Software is active. The module is registered on the network but has no data interaction with the network.				
Data	Network connection is ongoing. Power consumption is decided by network setting and data rate.				
Minimum Functionality Mode	<ul style="list-style-type: none"> <li>● <b>AT+CFUN=0</b> can set the module to the minimum functionality mode when the power is on.</li> <li>● Both RF function and USIM card will be invalid.</li> </ul>				
Airplane Mode	<ul style="list-style-type: none"> <li>● <b>AT+CFUN=4</b> or driving W_DISABLE#* low can set the module to airplane mode.</li> <li>● RF function will be invalid.</li> </ul>				
Sleep Mode	Power consumption of the module will be reduced to an ultra-low level. The module can still receive paging, SMS and TCP/UDP data from the network.				
Power Down Mode	The VBAT_BB and VBAT_RF pins are constantly turned on and the software stops working.				

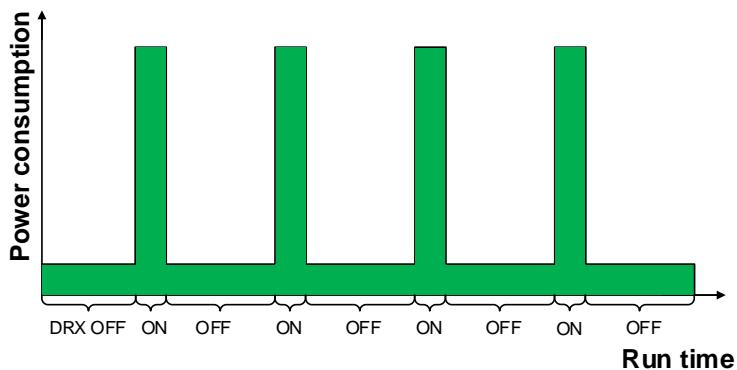
**NOTE**

For more details about **AT+CFUN**, see *document [2]*.

<sup>7</sup> GNSS function is optional. If you need the function, please contact Eagle Technical Support.

### 3.1.1.1. Sleep Mode

With DRX technology, power consumption of the module will be reduced to an ultra-low level.



**Figure 3: Power Consumption During Sleep Mode**

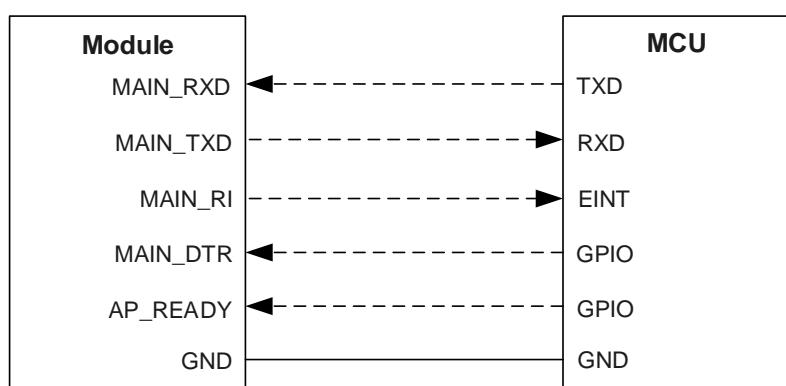
**NOTE**

The DRX cycle values are transmitted sent over the wireless network.

### 3.1.1.2. UART Application Scenario

If the module communicates with the MCU via main UART, both the following preconditions should be met to set the module to sleep mode:

- Execute **AT+QSCLK=1**. For more details, see [document \[2\]](#).
- Ensure **MAIN\_DTR** is held high or is kept unconnected.



**Figure 4: Sleep Mode Application via UART**

- Driving MAIN\_DTR low with the MCU will wake up the module.
- When the module has a URC to report, MAIN\_RI signal will wake up the MCU. See *Chapter 4.10.3* for details about MAIN\_RI.

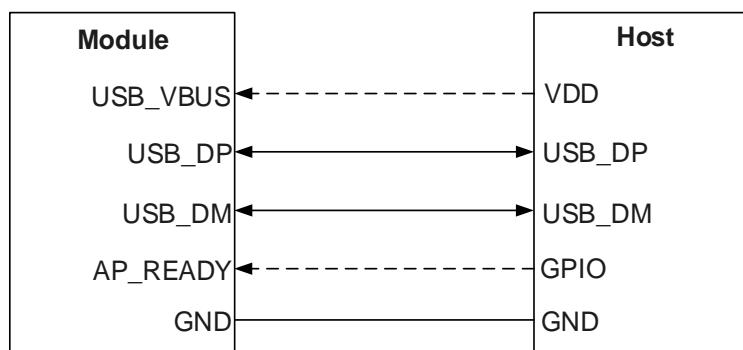
**NOTE**

Pay attention to the level match shown in the dotted line between the module and the MCU.

### 3.1.1.3. USB Application with USB Remote Wakeup Function

If the host supports USB Suspend/Resume and remote wakeup functions, the following three preconditions must be met to set the module to sleep mode.

- Execute AT+QSCLK=1.
- Ensure MAIN\_DTR is held high or is kept unconnected.
- Ensure the host's USB bus, which is connected to the module's USB interface, enters Suspend state.



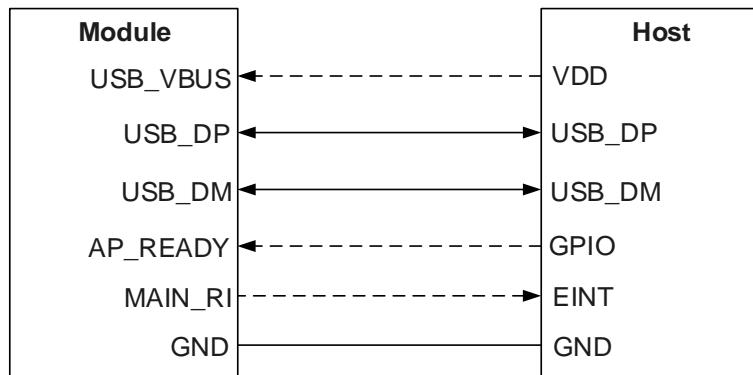
**Figure 5:Sleep Mode Application with USB Suspend/Resume and Remote Wakeup**

- Sending data to the module through USB will wake up the module.
- When the module has a URC to report, the module will send remote wake-up signals through USB bus to wake up the host.

### 3.1.1.4. USB Application with USB Suspend/Resume and MAIN\_RI Function

If the host supports USB Suspend/Resume, but does not support remote wakeup function, the MAIN\_RI signal is needed to wake up the host. The following three preconditions must be met to set the module to sleep mode.

- Execute AT+QSCLK=1.
- Ensure MAIN\_DTR is held high or is kept unconnected.
- Ensure the host's USB bus, which is connected to the module's USB interface, enters Suspend state.



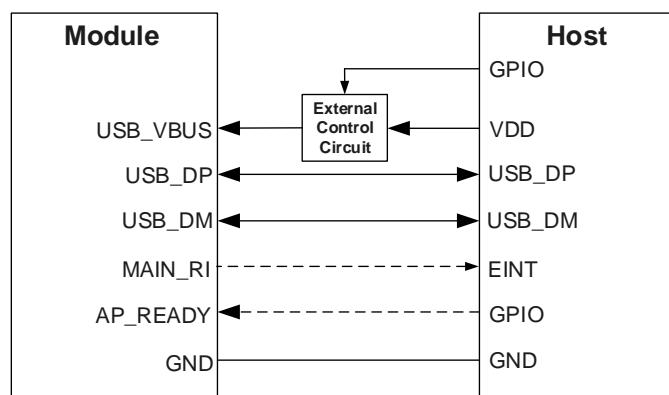
**Figure 6: Sleep Mode Application with USB Suspend/Resume and MAIN\_RI**

- Sending data to the module through USB will wake up the module.
- When the module has a URC to report, the module will wake up the host through MAIN\_RI signal. See *Chapter 4.10.3* for details about MAIN\_RI behavior.

### 3.1.1.5. USB Application without USB Suspend Function

If the host does not support USB Suspend function, the following three preconditions must be met to set the module to sleep mode:

- Execute AT+QSCLK=1.
- Ensure MAIN\_DTR is held high or is kept unconnected.
- Ensure USB\_VBUS is disconnected via the external control circuit.



**Figure 7: Sleep Mode Application without USB Suspend**

Restore the power supply of USB\_VBUS will wake up the module.

**NOTE**

Pay attention to the level match shown in the dotted line between the module and the host.

### 3.1.1.6. Airplane Mode

When the module enters airplane mode, the RF function will be disabled, and all AT commands correlative with RF function will be inaccessible. This mode can be set via the following methods.

**Hardware:**

W\_DISABLE#\* is pulled up by default. Driving it low makes the module enter airplane mode.

**Software:**

AT+CFUN=<fun> provides choice of the functionality level via setting <fun> to 0, 1 or 4. For more details, see *document [2]*.

- **AT+CFUN=0:** Minimum functionality mode (Both USIM and RF functions are disabled).
- **AT+CFUN=1:** Full functionality mode (By default).
- **AT+CFUN=4:** Airplane mode (RF function is disabled).

### 3.1.2. Operating Modes of GNSS Part

**Table 8: Operating Modes Overview of GNSS Part**

Modes	Descriptions
Continuous Mode	<ul style="list-style-type: none"> <li>● GNSS starts to work. It can automatically locate, track, and continuously output positioning information.</li> <li>● GNSS RF reception function is enabled.</li> <li>● Entry conditions: GNSS_PWR_EN is at high-level and GNSS_VBCKP is powered on, the module will automatically enter the Continuous mode.</li> <li>● Continuous mode includes acquisition mode and tracking mode. <ul style="list-style-type: none"> <li>– <b>Acquisition mode:</b> 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.</li> <li>– <b>Tracking mode:</b> The module tracks satellites and demodulates the navigation data from specific satellites.</li> </ul> </li> </ul>

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Backup Mode*	<ul style="list-style-type: none"> <li>Most system components will be shut down to save power consumption.</li> <li>Navigation data will be stored in the backup area for quick positioning next time.</li> </ul>
Power Down Mode	<ul style="list-style-type: none"> <li>The power supply inside and outside the GNSS is cut off.</li> <li>The software stops working.</li> </ul>

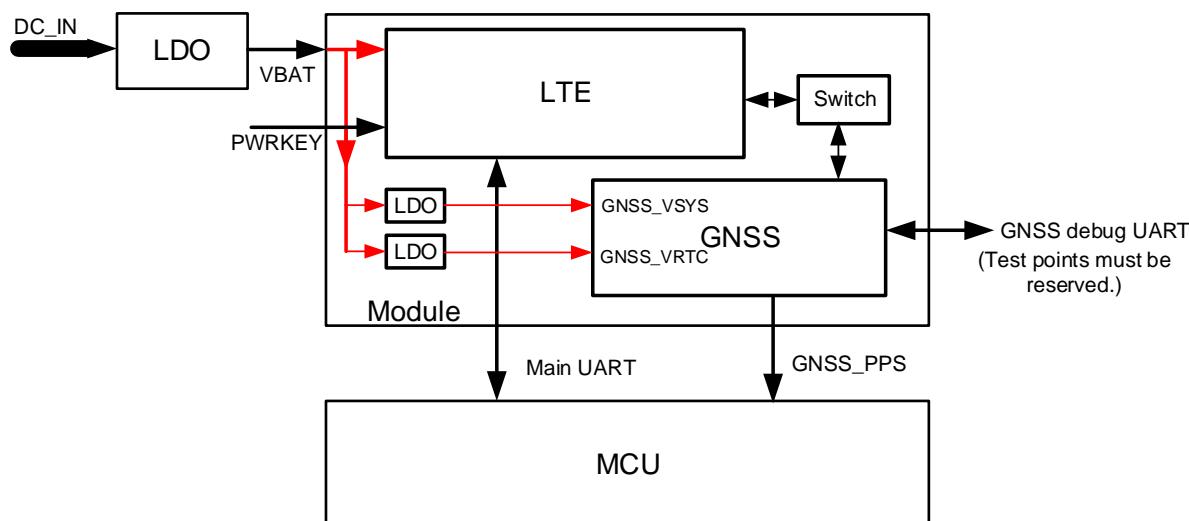
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### 3.1.3. Summary of LTE and GNSS Parts' State in All-in-one Solution

In **All-in-one** solution, LTE part and GNSS part can be worked as a whole unit. The GNSS part can be regarded as a peripheral of the LTE part. Without an external power supply, the LTE part can internally control the LDO to supply power to the GNSS. If the LTE part is disabled, the GNSS will not work. This allows for convenient communication between LTE and GNSS parts, such as AT command sending for GNSS control, and AGPS data injection.

It should be noted that the UART of the GNSS part is switched by an analog switch inside the module. In **All-in-one** mode, the GNSS UART interface (pins 27 and 28) of the module is not connected inside.

The schematic diagram of **All-in-one** solution is shown below.

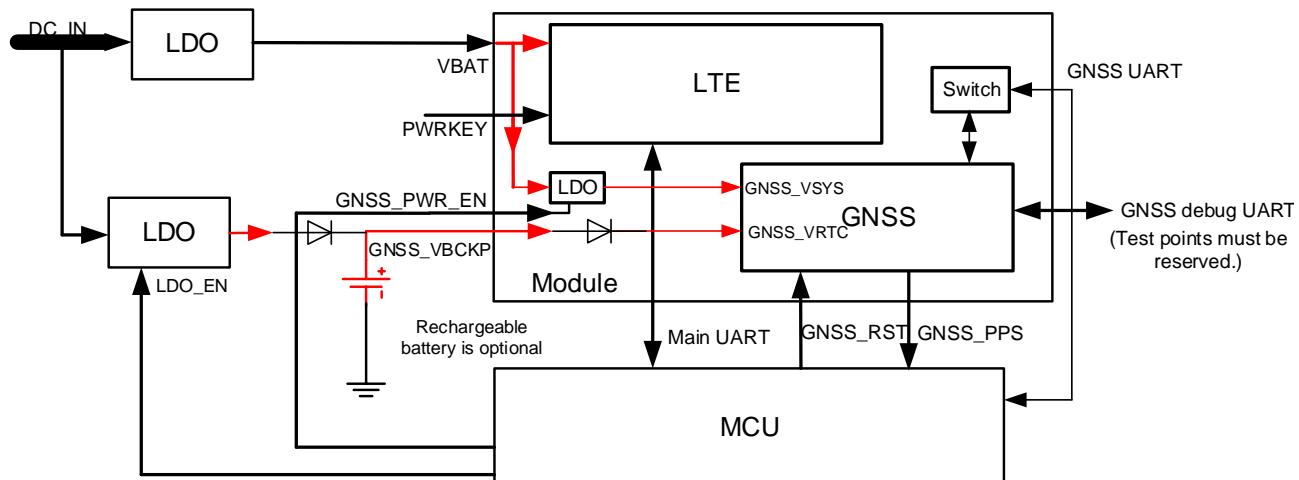


**Figure 8: All-in-one Solution Schematic Diagram**

### 3.1.4. Summary of LTE and GNSS Parts' State in Stand-alone Solution

In **Stand-alone** solution, LTE and GNSS parts work separately. Thus, they should be controlled separately by MCU. A lithium battery can be added externally to power GNSS\_VBCKP independently. You can use MCU to control GNSS\_VSYS to power on GNSS chip. At this time, the LTE part does not need to be enabled, and the GNSS part can still work.

The schematic diagram of **Stand-alone** solution is shown below.



**Figure 9: Stand-alone Solution Schematic Diagram**

**NOTE**

1. In the **Stand-alone** or **All-in-one** solution, if the GNSS chip is powered externally, the GNSS firmware cannot be upgraded through the LTE network because LTE cannot reset the GNSS chip. If you want to upgrade the GNSS firmware through the LTE network, you need to disconnect GNSS\_PWR\_EN (pin 117) and GNSS\_VBCKP (pin 118) from the outside or set both pins to low.
2. Whether in **Stand-alone** or **All-in-one** solution, to facilitate GNSS firmware upgrade, it is recommended to reserve test points for GNSS UART (pins 27 and 28) and GNSS\_RST (pin 112).

## 3.2. Power Supply

### 3.2.1. Power Supply Pins

The module provides four VBAT pins dedicated to connecting with the external power supply:

**Table 9: Pin Description of Power Supply Interface**

Pin Name	Pin No.	I/O	Description	Min.	Typ.	Max.	Units
VBAT_BB	32, 33	PI	Power supply for the module's BB part	3.3	3.8	4.3	V
VBAT_RF	52, 53	PI	Power supply for the module's RF part	3.3	3.8	4.3	V
GNSS_VBCKP <sup>8</sup>	118	PI	Power supply for GNSS RTC	1.9	3.3	3.6	V

<sup>8</sup> This pin is optional. If you need this function, please contact Eagle Technical Support.

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GND	3, 31, 47, 48, 50, 54, 55, 58, 59, 61, 62, 67–74, 79–82, 89–91, 100–102
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### 3.2.2. Reference Design for Power Supply

Power design for the module is essential.

For LTE part, it is recommended to use a power supply that can provide the module with at least 1.5 A current. If the voltage difference between input voltage and the supply voltage is small, it is suggested to use an LDO; if the voltage difference is big, a buck converter is recommended.

The following figure shows a reference design for +5 V input power supply.

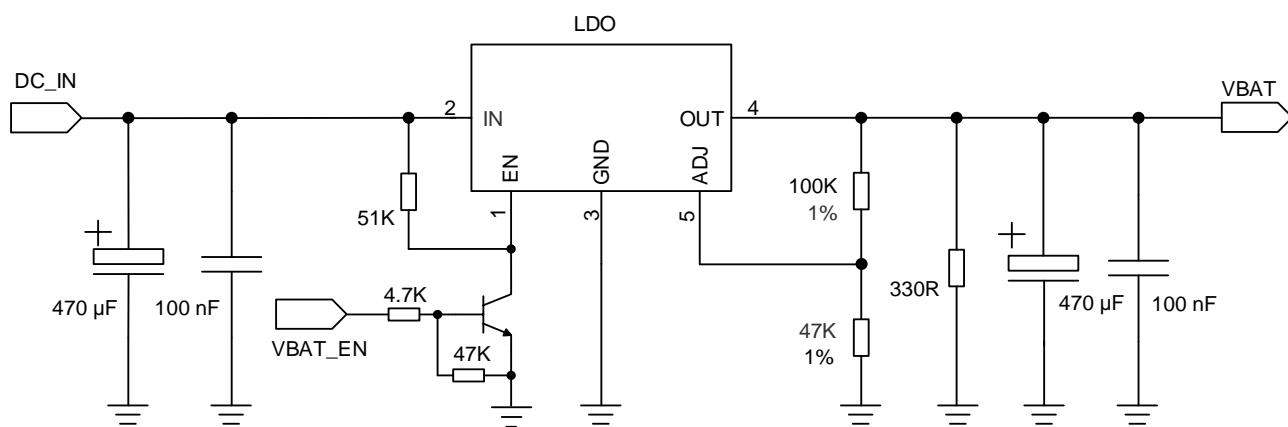


Figure 10: Reference Design of Power Input

**NOTE**

To avoid corrupting the data in the internal flash, do not switch off the power supply when the module works normally. Only after turning off the module with PWRKEY or AT command can you cut off the power supply.

For the power supply of GNSS part:

- In **All-in-one** solution, the power supply of GNSS part is controlled by the LTE part internally.
- In **Stand-alone** solution, the power supply of GNSS part is controlled independently by MCU.

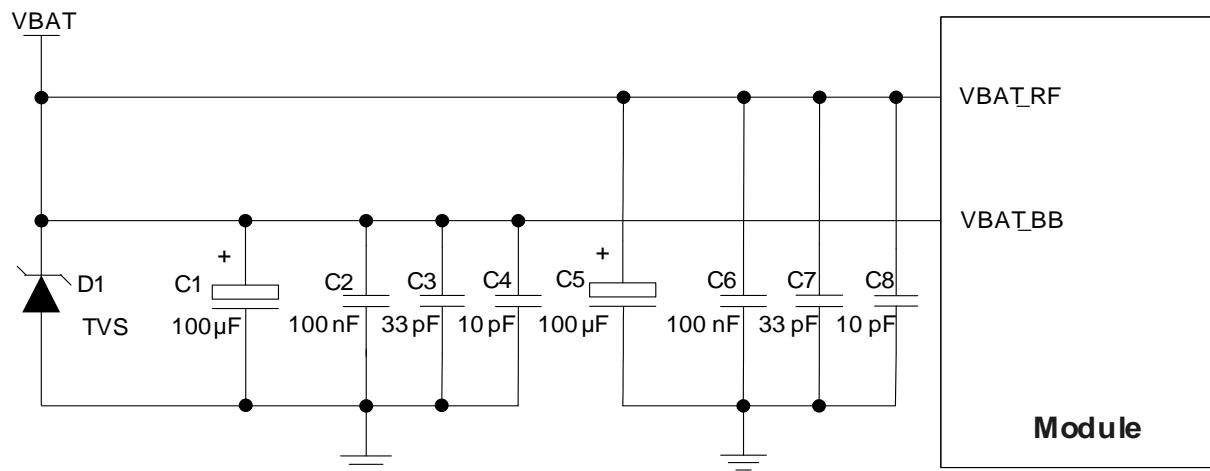
For more information about **All-in-one** solution and **Stand-alone** solution, see **Chapter 3.1.3 & 3.1.4**

### 3.2.3. Voltage Stability Requirements

The power supply range of the module is 3.3–4.3 V. Ensure the input voltage never drops below 3.3 V.

To decrease the voltage drop, use a bypass capacitor of about 100  $\mu$ F with low ESR for VBAT\_BB and VBAT\_RF respectively and reserve a multi-layer ceramic chip (MLCC) capacitor array with ultra-low ESR. Use three ceramic capacitors (100 nF, 33 pF and 10 pF) for composing the MLCC array, and place these capacitors close to the VBAT pins. The main power supply from an external application should be a single voltage source and can be expanded to two sub paths with the star configuration. The width of VBAT\_BB trace and VBAT\_RF trace should be at least 1 mm and 2 mm respectively. In principle, the longer the VBAT trace is, the wider it should be.

To avoid the ripple and surge and to ensure the stability of the power supply to the module, it is recommended to add a TVS with  $V_{RWM} = 4.7$  V, low clamping voltage and high reverse peak pulse current  $I_{pp}$  at the front end of the power supply.



**Figure 11: Reference Design of Power Supply**

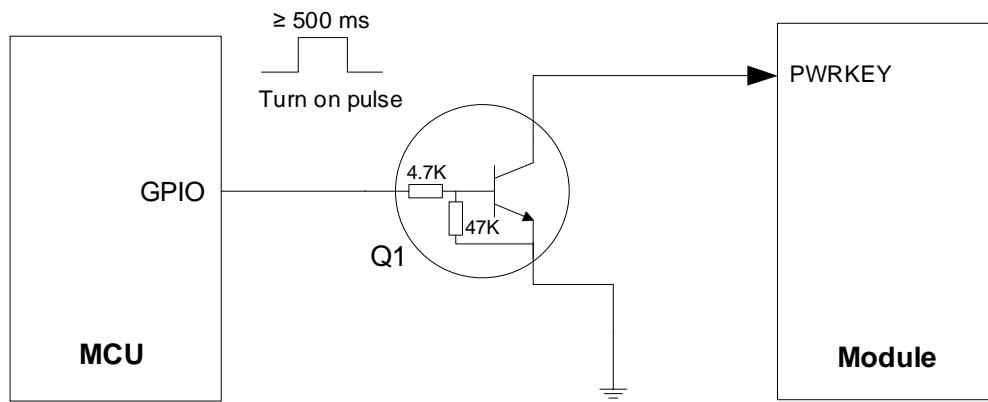
### 3.3. Turn On

#### 3.3.1. Turn On with PWRKEY

**Table 10: Pin Description of PWRKEY**

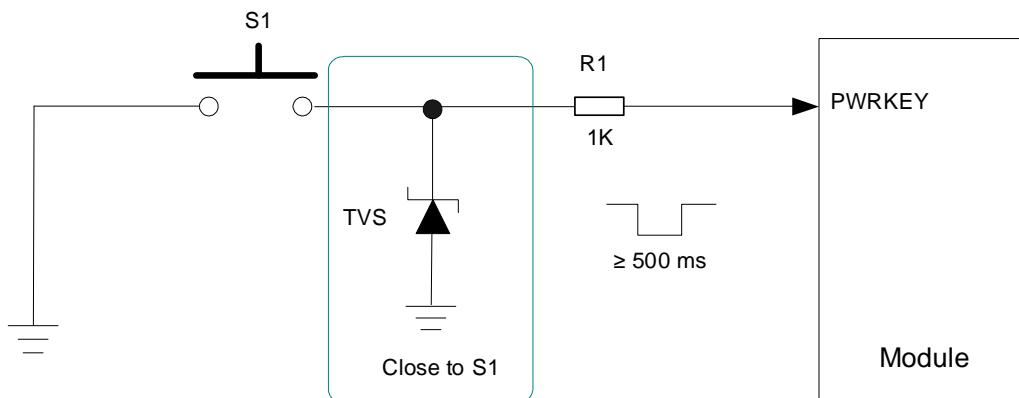
Pin Name	Pin No.	I/O	Description	Comment
PWRKEY	15	DI	Turn on/off the module	Active low. A test point is recommended to be reserved.

When the module is in power-down mode, it can be turned on by driving the PWRKEY low for at least 500 ms. It is recommended to use an open drain/collector driver to control the PWRKEY.



**Figure 12: Reference Design of Turn On with Driving Circuit**

Another way to control the PWRKEY is using a keystroke directly. When pressing the keystroke, an electrostatic strike may be generated from finger. Therefore, you should place a TVS component near the keystroke for ESD protection.



**Figure 13: Reference Design of Turn On with Keystroke**

The power-up timing is illustrated in the following figure.

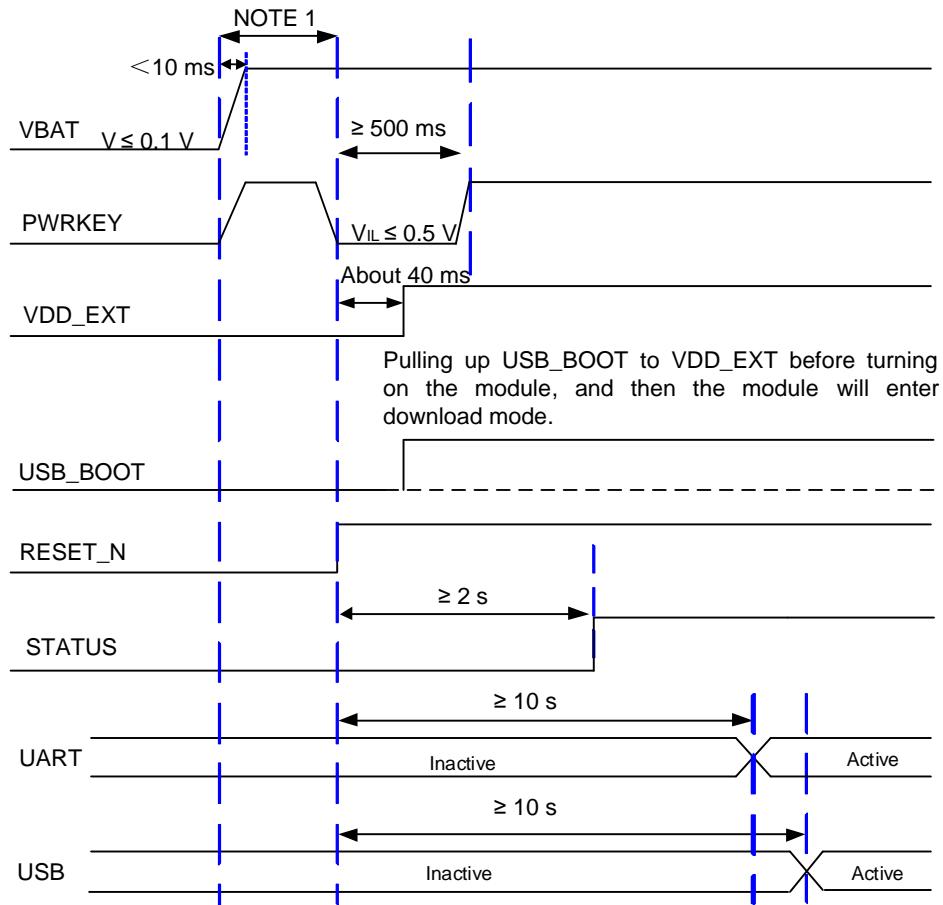


Figure 14: Power-up Timing with PWRKEY

**NOTE**

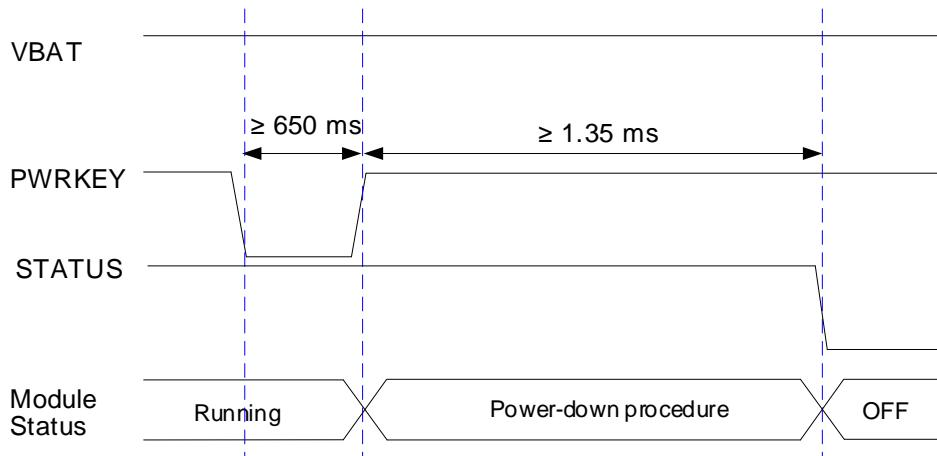
1. Ensure the voltage of VBAT is stable for at least 30 ms before driving the PWRKEY low.
2. If the module needs to turn on automatically but does not need the turn-off function, PWRKEY can be driven low directly to ground with a recommended  $4.7 \text{ k}\Omega$  resistor.

### 3.4. Turn Off

The following procedures can be used to turn off the module normally.

#### 3.4.1. Turn Off with PWRKEY

Drive the PWRKEY low for at least 650 ms and then release it. Then, the module will execute the turn-off procedure.



**Figure 15: Power-down Timing with PWRKEY**

### 3.4.2. Turn Off with AT Command

For proper shutdown procedure, execute **AT+QPOWD**, which is similar to turning off the module via the PWRKEY pin. See *document [2]* for details about **AT+QPOWD**.

**NOTE**

1. To avoid corrupting the data in the internal flash, do not switch off the power supply when the module works normally. Only after turning off the module with PWRKEY or AT command can you cut off the power supply.
2. If the module is turned on by connecting the PWRKEY to ground for a long time, **AT+QPOWD** cannot be used to turn off the module.
3. When turning off the module with the AT command, keep PWRKEY at high level after the execution of the command. Otherwise, the module cannot be turned off successfully.

## 3.5. Reset

The reset function requires the PWRKEY and RESET\_N pins to work together to complete. Pulling down PWRKEY when RESET\_N is at low level can reset the module. The RESET\_N signal is sensitive to interference, so it is recommended to route the trace as short as possible and surround it with ground.

Table 11: Pin Description of RESET\_N

Pin Name	Pin No.	I/O	Description	Comment
RESET_N	17	DI	Reset the module	Active low. A test point is recommended to be reserved if unused.

The recommended circuit for reset function is similar to the PWRKEY control circuit. You can use an open drain/collector driver or a button to control RESET\_N and PWRKEY pins.

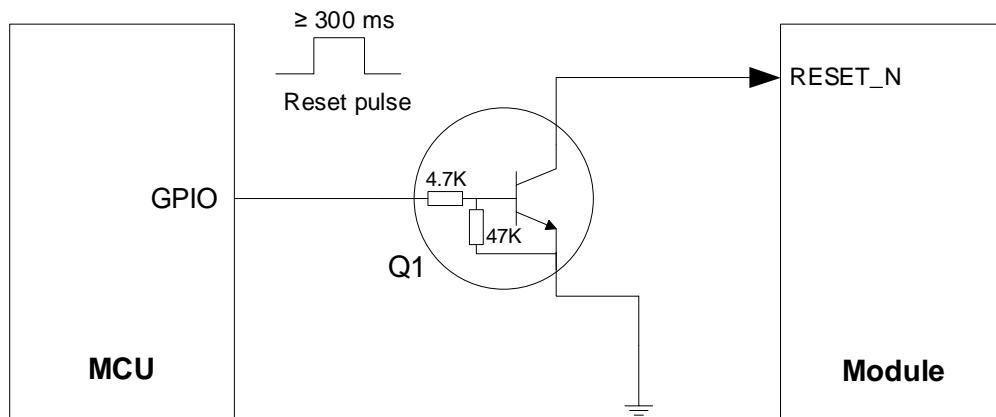


Figure 16: Reference Design of Reset with Driving Circuit

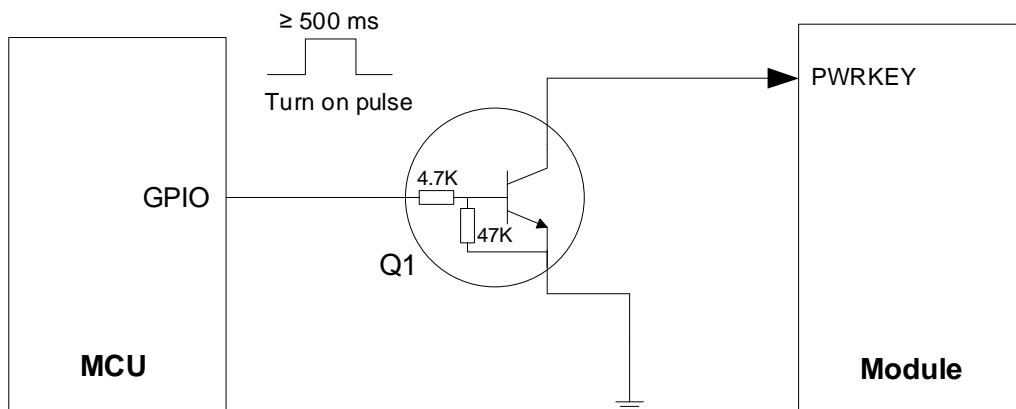
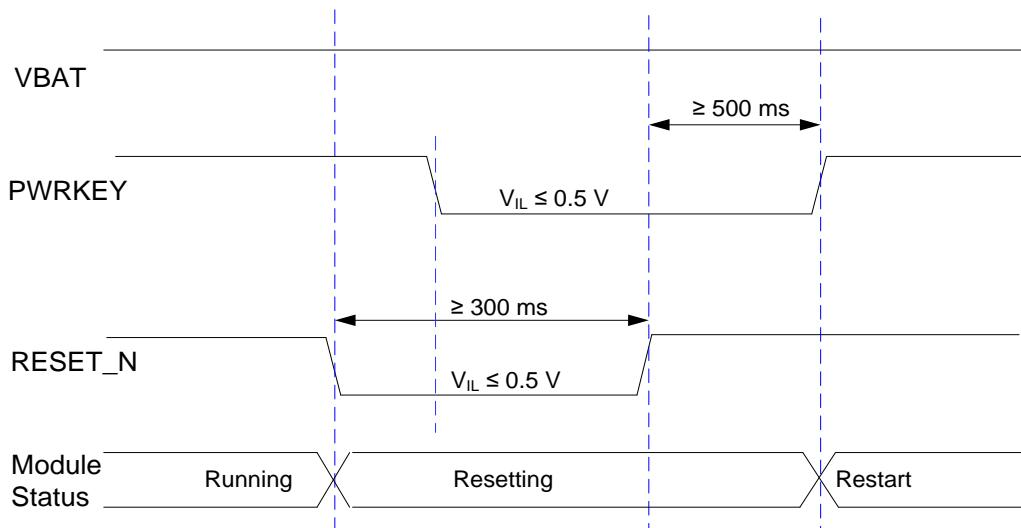


Figure 17: Reference Design of PWRKEY with Driving Circuit



**Figure 18: Reset Timing**

**NOTE**

1. In reset timing, pull down PWRKEY when RESET\_N is at low level.
2. Ensure the capacitance on PWRKEY and RESET\_N does not exceed 10 nF.

# 4 Application Interfaces

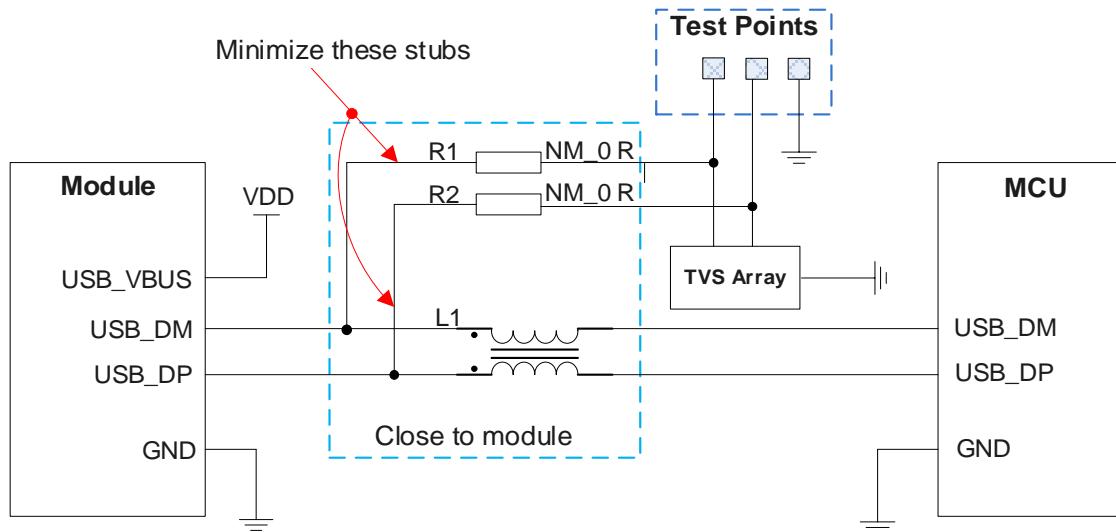
## 4.1. USB Interface

The module provides one integrated Universal Serial Bus (USB) interface which complies with the USB 2.0 specifications and supports high-speed (480 Mbps) and full-speed (12 Mbps) for USB 2.0. The module only supports USB slave mode. The USB interface can be used for AT command communication, data transmission, GNSS NMEA sentence output (**All-in-one** mode only), software debugging, firmware upgrade and the output of partial logs.

**Table 12: Pin Description of USB Interface**

Pin Name	Pin No.	I/O	Description	Comment
USB_VBUS	8	AI	USB connection detect	A test point must be reserved.
USB_DP	9	AIO	USB differential data (+)	USB 2.0 compliant. Requires differential impedance of 90 $\Omega$ .
USB_DM	10	AIO	USB differential data (-)	Test points must be reserved.

Test points of USB 2.0 interface must be reserved, which can be used for firmware upgrading. Only in download mode, the module supports firmware upgrade over USB 2.0 interface.



**Figure 19: Reference Design of USB 2.0 Interface**

It is recommended to add a common-mode choke L1 in series between MCU and the module to suppress EMI. Meanwhile, it is also suggested to add R1 and R2 in series between the module and test points for debugging. These resistors are not mounted by default. To ensure the signal integrity of USB 2.0 data transmission, you should place L1, R1 and R2 close to the module, and keep these resistors close to each other. Moreover, keep extra stubs of trace as short as possible.

To ensure performance, you should follow the following principles when designing USB interface:

- Route USB signal traces as differential pairs with surrounded ground. The impedance of USB 2.0 differential trace is  $90 \Omega$ .
- Route USB differential traces at the inner-layer of the PCB, and surround the traces with ground on that layer and with ground planes above and below. For signal traces, provide clearance from power supply traces, crystal-oscillators, magnetic devices, sensitive signals like RF signals, analog signals, noise signals generated by clock and DC-DC.
- Pay attention to the impact caused by stray capacitance of the ESD protection component on USB data lines. Typically, the stray capacitance should be less than 2 pF for USB 2.0.
- Keep the ESD protection components as close to the USB port as possible.

For more details about the USB specifications, visit <http://www.usb.org/home>.

## 4.2. USB\_BOOT

The module provides a **USB\_BOOT** pin for download. Pulling up **USB\_BOOT** to **VDD\_EXT** before turning on the module, and then the module will enter download mode. Only in this mode, the module supports firmware upgrade over USB 2.0 interface.

Table 13: Pin Description of USB\_BOOT

Pin Name	Pin No.	I/O	Description	Comment
USB_BOOT	75	DI	Make the module into download mode	Active high before power-up. A test point must be reserved.

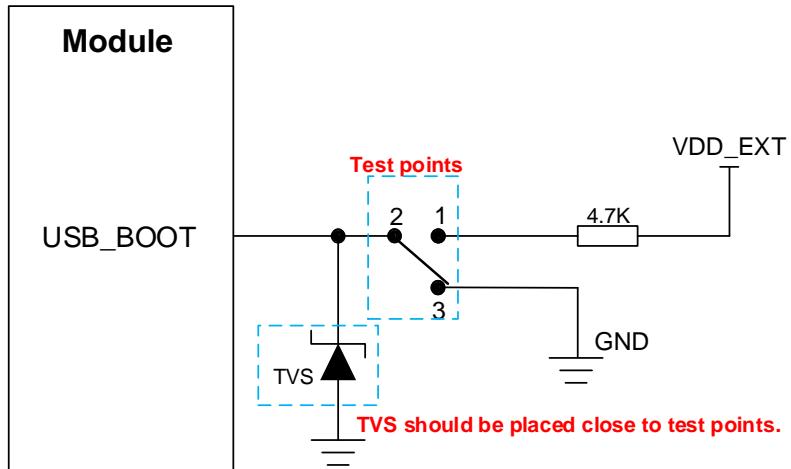


Figure 20: Reference Design of USB\_BOOT

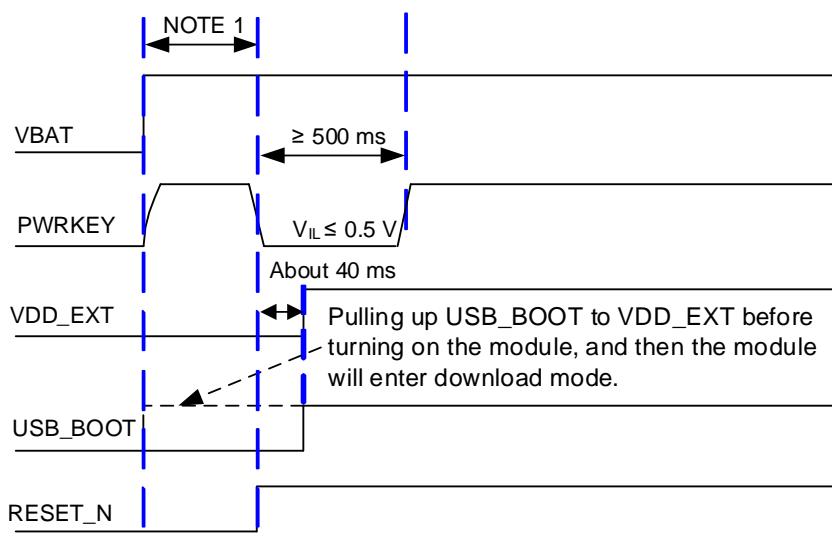


Figure 21: Timing of Entering Download Mode

**NOTE**

1. Ensure VBAT is stable before driving PWRKEY low.
2. Follow the above timing when using MCU control the module to enter the forced download mode.
3. If you need to manually force the module to enter download mode, directly connect the test points shown in **Figure 20**.
4. The firmware upgrade function of USB interface can only be used in download mode. It is strongly recommended to lead out USB\_BOOT and VDD\_EXT together with the USB interface.

### 4.3. USIM Interfaces

The USIM interfaces meets ETSI and IMT-2000 requirements.

- USIM1 interface supports 1.8 V or 3.0 V power domain.
- USIM2 interface only supports 1.8 V power domain.
- When USIM1 and USIM2 are used at the same time, the power domain of USIM interfaces should be 1.8 V. Otherwise, USIM2 interface will be damaged.
- USIM interfaces support Dual SIM Single Standby.
- USIM2 and Camera SPI\* cannot be used at the same time.

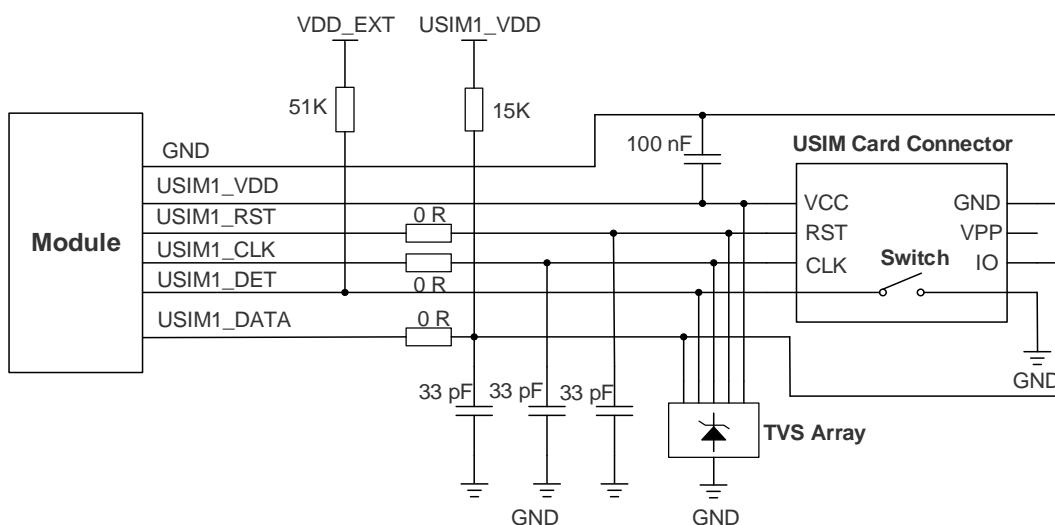
**Table 14: Pin Description of USIM Interfaces**

Pin Name	Pin No.	I/O	Description	Comment
USIM1_VDD	43	PO	USIM1 card power supply	Either 1.8 V or 3.0 V USIM1 card is supported and can be identified automatically by the module.
USIM1_DATA	45	DIO	USIM1 card data	
USIM1_CLK	46	DO	USIM1 card clock	
USIM1_RST	44	DO	USIM1 card reset	
USIM1_DET	42	DI	USIM1 card hot-plug detect	If unused, keep it open.
USIM2_VDD	87	PO	USIM2 card power supply	Connected with USIM1_VDD inside the module. 1.8 V power domain is required for USIM2. Otherwise, this interface will be damaged.
USIM2_DATA	86	DIO	USIM2 card data	Connected with pin 97 (CAM_SPI_DATA0) internally. 1.8 V power domain is required for USIM2. Otherwise, this interface will be damaged.

USIM2_RST	85	DO	USIM2 card reset	Connected with pin 78 (CAM_SPI_CLK) internally. 1.8 V power domain is required for USIM2. Otherwise, this interface will be damaged.
USIM2_CLK	84	DO	USIM2 card clock	Connected with pin 115 (CAM_PWDN) internally. 1.8 V power domain is required for USIM2. Otherwise, this interface will be damaged.

The module supports USIM1 card hot-plug via the USIM1\_DET, and both high-level and low-level detections are supported. Hot-plug function is disabled by default and you can use **AT+QSIMDET** to configure this function. See **document [2]** for more details. Only USIM1 supports hot-plug detection.

The following figure illustrates a reference design for USIM1 card interface with an 8-pin USIM card connector.



**Figure 22: Reference Design of USIM1 Interface with an 8-pin USIM Card Connector**

If the function of USIM1 card hot-plug is not needed, keep USIM1\_DET disconnected. A reference design for USIM interfaces with a 6-pin USIM card connector is illustrated in the following figure.

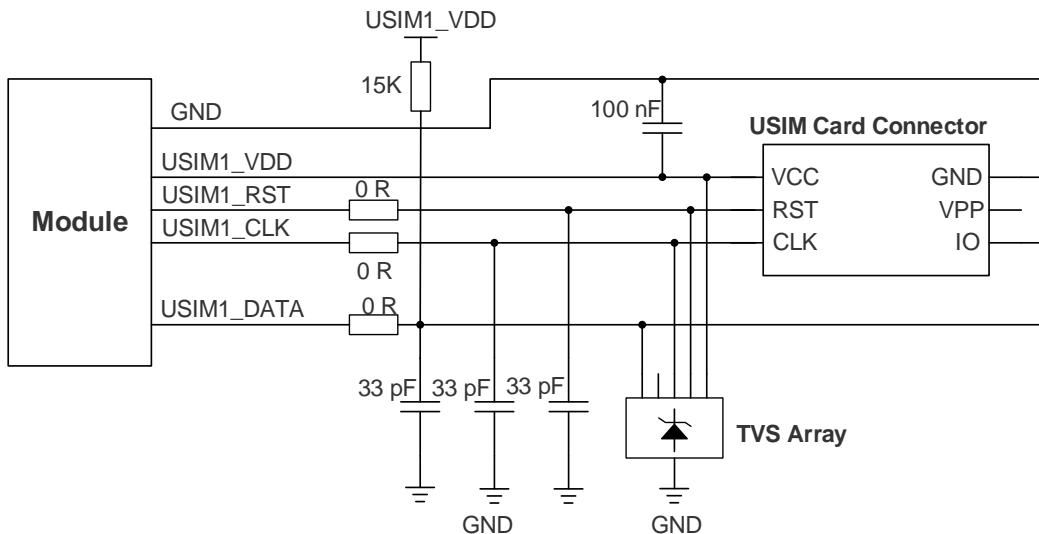


Figure 23: Reference Design of USIM1 Interface with a 6-pin USIM Card Connector

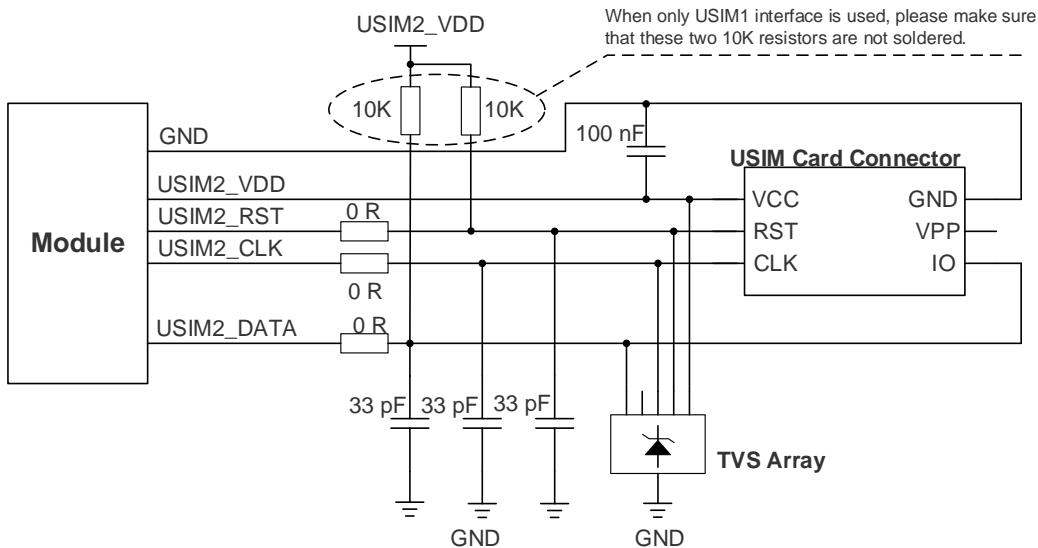


Figure 24: Reference Design of USIM2 Interface with a 6-pin USIM Card Connector

To enhance the reliability and availability of the USIM cards in applications, follow the principles below in the USIM circuit design:

- Place the USIM card connector close to the module. Keep the trace length as short as possible and at most 200 mm.
- Route USIM card traces at the inner-layer of the PCB, and surround the traces with ground on that layer and with ground planes above and below. For signal traces, provide spacing from power supply traces, crystal-oscillators, magnetic devices, sensitive signals such as RF signals, analog signals, and noise signals generated by clock, DC-DC.
- Ensure the tracing between the USIM card connector and the module is short and wide. Keep the trace width of ground and USIM\_VDD at least 0.5 mm to maintain the same electric potential.

- To avoid cross-talk between USIM\_DATA and USIM\_CLK, keep the traces away from each other and shield them with surrounded ground.
- To offer good ESD protection, it is recommended to add a TVS array of which parasitic capacitance should be less than 15 pF. Add 0 Ω resistors in series between the module and the USIM card connector to facilitate debugging. The 33 pF capacitors are used for filtering out RF interference. Additionally, keep the USIM peripheral circuit close to the USIM card connector.
- The pull-up resistor on USIM1\_DATA trace, USIM2\_DATA and USIM2\_RST can improve anti-jamming capability when long layout trace and sensitive occasions are applied, and should be placed close to the USIM card connector.

## 4.4. UART

The module provides four UARTs.

**Table 15: UART Information (Unit: bps)**

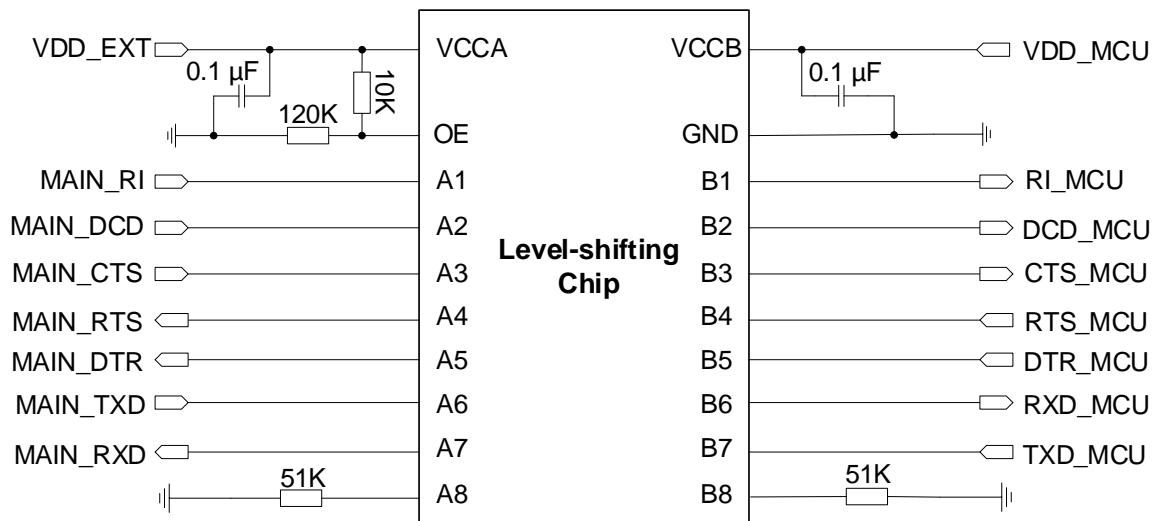
UART Types	Supported Baud Rates	Default Baud Rates	Functions
Main UART	4800, 9600, 19200, 38400, 57600, 115200, 230400, 460800, 921600	115200	<ul style="list-style-type: none"> <li>● AT command communication</li> <li>● data transmission</li> <li>● RTS and CTS hardware flow control</li> </ul>
Debug UART	115200, 3000000	3000000	<ul style="list-style-type: none"> <li>● Partial logs output</li> </ul>
GNSS UART	921600	921600	<ul style="list-style-type: none"> <li>● GNSS data output</li> <li>● GNSS NMEA sentence output</li> </ul>
GNSS debug UART	3000000	3000000	<ul style="list-style-type: none"> <li>● GNSS system logs output</li> </ul>

**Table 16: Pin Description of UART**

Pin Name	Pin No.	I/O	Description	Comment
MAIN_CTS	36	DO	Clear to send signal from the module	Connect to MCU's CTS. If unused, keep it open.
MAIN_RTS	37	DI	Request to send signal to the module	Connect to MCU's RTS. If unused, keep it open.
MAIN_RXD	34	DI	Main UART receive	
MAIN_DCD	38	DO	Main UART data carrier detect	If unused, keep them open.
MAIN_TXD	35	DO	Main UART transmit	

MAIN_RI	39	DO	Main UART ring indication	
MAIN_DTR	30	DI	Main UART data terminal ready	
DBG_RXD	22	DI	Debug UART receive	
DBG_TXD	23	DO	Debug UART transmit	Test points must be reserved.
GNSS_TXD <sup>9</sup>	27	DO	GNSS UART transmit	
GNSS_RXD <sup>9</sup>	28	DI	GNSS UART receive	Test points are recommended to be reserved.
GNSS_DBG_TXD <sup>9</sup>	109	DO	GNSS debug UART transmit	
GNSS_DBG_RXD <sup>9</sup>	110	DI	GNSS debug UART receive	Test points must be reserved.

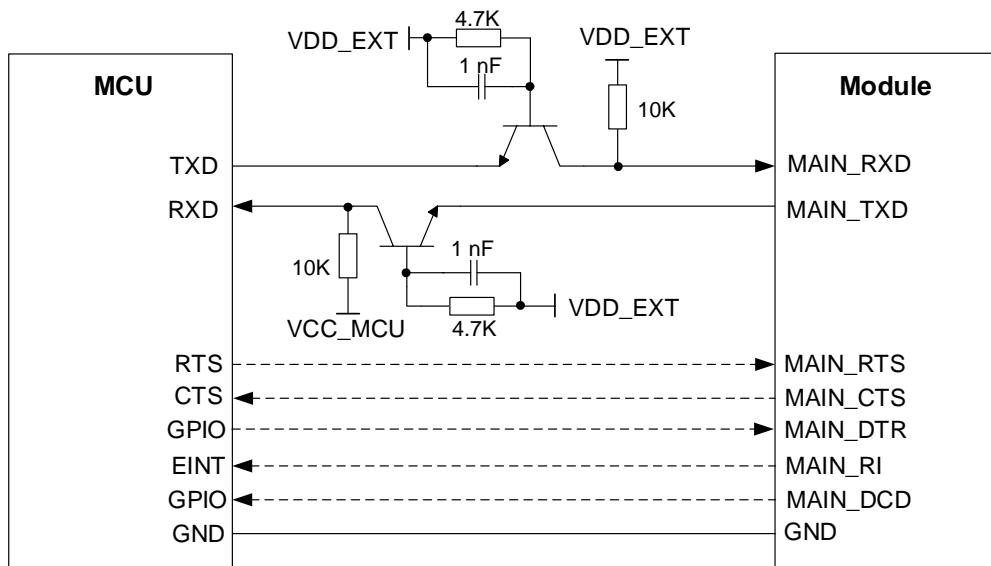
The module provides 1.8 V UART interfaces. You can use a level-shifting chip between the module and MCU's UART if the MCU is equipped with a 3.3 V UART.



**Figure 25: Reference Design of UART with Level-shifting Chip (Main UART)**

Another example of level-shifting circuit is shown as below. For the design of circuits in dotted lines, see that shown in solid lines, but pay attention to the direction of the connection.

<sup>9</sup> This pin is optional. If you need this function, please contact Eagle Technical Support.



**Figure 26: Reference Design of UART with Transistor Level-shifting Circuit (Main UART)**

**NOTE**

1. Transistor circuit solution above is not suitable for applications with baud rates exceeding 460 kbps.
2. Please note that the module's CTS is connected to MCU's CTS, and the module's RTS is connected to MCU's RTS.
3. The level-shifting circuits (**Figure 25** and **Figure 26**) take the main UART as an example. The circuits of debug UART, GNSS UART and GNSS debug UART are connected in the same way as the main UART.
4. To increase the stability of UART communication, it is recommended to add UART hardware flow control design.

## 4.5. PCM and I2C Interfaces\*

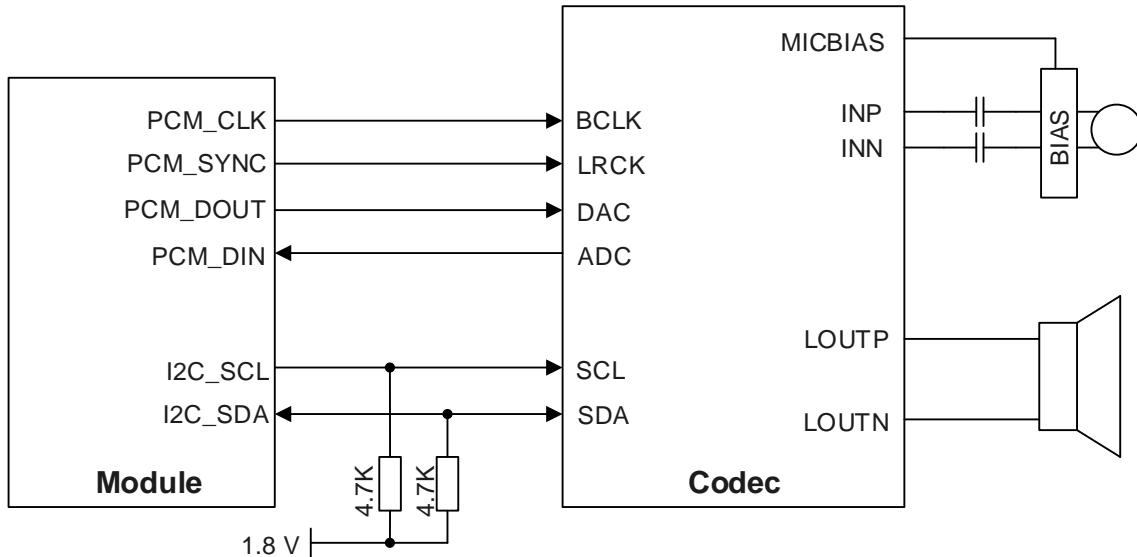
The module provides one Pulse Code Modulation (PCM) digital interface and one I2C interface.

**Table 17: Pin Description of PCM and I2C Interfaces**

Pin Name	Pin No.	I/O	Description	Comment
PCM_SYNC	5	DO	PCM data frame sync	
PCM_CLK	4	DO	PCM clock	If unused, keep them open.
PCM_DIN	6	DI	PCM data input	

PCM_DOUT	7	DO	PCM data output	
I2C_SCL	40	OD	I2C serial clock	External pull-up resistor is required.
I2C_SDA	41	OD	I2C serial data	If unused, keep them open.

The reference design is illustrated as follows.



**Figure 27: Reference Design of PCM and I2C Interfaces**

**NOTE**

1. It is recommended to reserve RC circuits ( $R = 22 \Omega$ ,  $C = 22 \text{ pF}$ ) on the PCM signal traces, especially on the PCM\_CLK pin.
2. The module can only be used as a master device in applications related to both the PCM interface and the I2C interface.

## 4.6. ADC Interfaces

The module provides two Analog-to-Digital Converter (ADC) interfaces. To improve the accuracy of ADC, surround the trace of ADC with ground.

**Table 18: Pin Description of ADC Interfaces**

Pin Name	Pin No.	I/O	Description	Comment
ADC0	24	AI	General-purpose ADC interface	If unused, keep them open.
ADC1	2	AI	General-purpose ADC interface	

With **AT+QADC=<port>**, you can:

- **AT+QADC=0**: read the voltage value on ADC0
- **AT+QADC=1**: read the voltage value on ADC1

For more details about the AT command, see *document [2]*.

**Table 19: Characteristics of ADC Interfaces**

Parameters	Min.	Typ.	Max.	Units
ADC0 input voltage range	0	-	1.2	V
ADC input resistance	0.26	-	0.75	MΩ
ADC resolution	-	12	-	bits

**NOTE**

1. The input voltage of every ADC interface should not exceed 1.2 V.
2. It is prohibited to directly supply any voltage to ADC Interfaces when the module is not powered by the VBAT.
3. It is recommended to use resistor divider circuit for ADC interface application. Resistance of the external resistor divider should not exceed 100 kΩ, and the divider resistor accuracy should not be higher than 1 %, otherwise the measurement accuracy of ADC would be significantly reduced. It is recommended to reserve a 100 nF capacitor for the design.

## 4.7. Camera SPI\*

The module provides one camera SPI supporting SPI dual-wire data transmission. USIM2 and Camera SPI cannot be used at the same time.

**Table 20: Pin Description of Camera SPI**

Pin Name	Pin No.	I/O	Description	Comment
CAM_MCLK	95	DO	Master clock of the camera	If unused, keep it open.
CAM_SPI_CLK	78	DI	Camera SPI clock	Connected with pin 85 (USIM2_RST) internally. If unused, keep it open.
CAM_SPI_DATA0	97	DI	Camera SPI data bit 0	Connected with pin 86 (USIM2_DATA) internally. If unused, keep it open.
CAM_SPI_DATA1	98	DI	Camera SPI data bit 1	If unused, keep it open.
CAM_PWDN	115	DO	Power down of the camera	Connected with pin 84 (USIM2_CLK) internally. If unused, keep it open.
CAM_VDD	94	PO	Camera analog power supply	If unused, keep them open.
CAM_VDDIO	93	PO	Camera digital power supply	

## 4.8. GRFC Interfaces

The module provides two GRFC (generic RF control) interfaces for the control of external antenna tuners.

**Table 21: Pin Description of GRFC Interfaces**

Pin Name	Pin No.	I/O	Description	Comment
GRFC1	76	DO	Generic RF controller	If unused, keep them open.
GRFC2	77	DO	Generic RF controller	

## 4.9. Control Signals

Table 22: Pin Description of Control Signals

Pin Name	Pin No.	I/O	Description	Comment
W_DISABLE#*	18	DI	Airplane mode control	
PSM_IND*	1	DO	Indicate the module's power saving mode	
PSM_INT*	96	DI	External interrupt; wake up the module from power saving mode	If unused, keep them open.
AP_READY*	19	DI	Application processor ready	

### 4.9.1. W\_DISABLE#\*

The module provides W\_DISABLE# to enable or disable RF function. When the voltage level of W\_DISABLE# is high, you can send **AT+CFUN=<fun>** to set the module's operating mode. For the details of this command, see *document [2]*. Driving W\_DISABLE# low will set the module to airplane mode.

Table 23: W\_DISABLE# AT Command Configuration Information

Level Status	AT Command	RF Function	Operating Mode
High level	<b>AT+CFUN=1</b>	Enabled	Full functionality mode
	<b>AT+CFUN=0</b>	Disabled	Minimum functionality mode
	<b>AT+CFUN=4</b>	Disabled	Airplane mode
Low level	<b>AT+CFUN=0</b>		
	<b>AT+CFUN=1</b>	Disabled	Airplane mode
	<b>AT+CFUN=4</b>		

## 4.10. Indication Signals

**Table 24: Pin Description of Indication Signals**

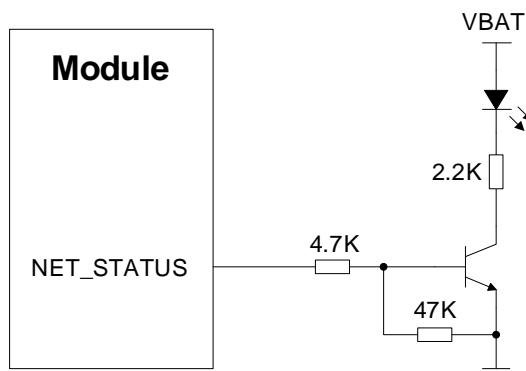
Pin Name	Pin No.	I/O	Description	Comment
STATUS	20	DO	Indicate the module's operation status	
NET_STATUS	21	DO	Indicate the module's network activity status	If unused, keep them open.
GNSS_PPS <sup>10</sup>	51	DO	GNSS pulse per second output	

#### 4.10.1. Network Status Indication

The module provides one network status indication pin: the NET\_STATUS for the module's network operation status indication, which can drive corresponding LEDs.

**Table 25: Network Status Indication Pin Level and Module Network Status**

Pin Name	NET_STATUS Level Status	Module Network Status
	Blink slowly (200 ms High/1800 ms Low)	Network searching
NET_STATUS	Blink slowly (1800 ms High/200 ms Low)	Idle
	Blink quickly (125 ms High/125 ms Low)	Data transmission is ongoing


**Figure 28: Reference Design of NET\_STATUS Indication**

#### 4.10.2. STATUS

The STATUS is used for indicating the module's operation status. It will output high level when the module is turned on.

<sup>10</sup> This pin is optional. If you need this function, please contact Eagle Technical Support.

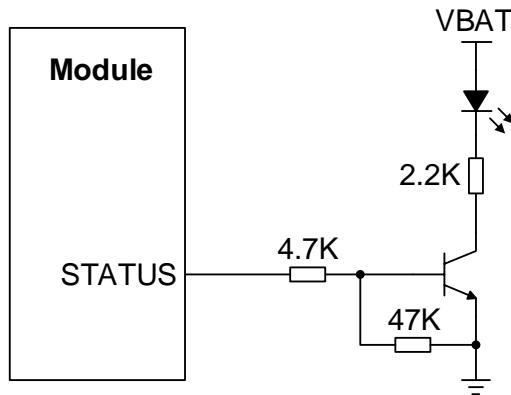


Figure 29: Reference Design of STATUS

#### 4.10.3. MAIN\_RI

AT+QCFG=“risignaltype”, “physical” can be used to configure MAIN\_RI behavior. No matter on which port a URC information is presented, the URC information will trigger the behavior of the MAIN\_RI. For the details of AT+QCFG, see *document [2]*.

**NOTE**

The AT+QURCCFG allows you to set the main UART, USB AT port or USB modem port as the URC information output port. The USB AT port is the URC output port by default. For more details about AT+QURCCFG, see *document [2]*.

You can configure MAIN\_RI behaviors flexibly. The default behaviors of the MAIN\_RI are shown as below.

Table 26: MAIN\_RI Level and Module Status

Module Status	MAIN_RI Level Status
Idle	High level
When a new URC information returns	MAIN_RI will output a low level for at least 120 ms. After this pin changes to a high level, the module starts to output data.

Indication behavior for MAIN\_RI can be configured via AT+QCFG="urc/ri/ring".

# 5 RF Specifications

Appropriate antenna type and design should be used with matched antenna parameters according to specific application. It is required to perform a comprehensive functional test for the RF design before mass production of terminal products. The entire content of this chapter is provided for illustration only. Analysis, evaluation and determination are still necessary when designing target products.

## 5.1. LTE/Wi-Fi Scan Antenna Interface

### 5.1.1. Antenna Interface & Frequency Bands

**Table 27: Pin Description of LTE/Wi-Fi Scan Antenna Interface**

Pin Name	Pin No.	I/O	Description	Comment
ANT_MAIN <sup>11</sup>	60	AIO	Main antenna/Wi-Fi Scan antenna interface	50 Ω impedance.

**NOTE**

Wi-Fi Scan function shares the same antenna interface with the main antenna. These two antennas should use TDM (Time Division Multiplexing) and cannot be used simultaneously. Wi-Fi Scan only supports receiving and does not support transmitting.

**Table 28: Operating Frequency of I4915Q-NA (Unit: MHz)**

Operating Frequency	Transmit	Receive
LTE-FDD B2	1850–1910	1930–1990
LTE-FDD B4	1710–1755	2110–2155
LTE-FDD B5	824–849	869–894
LTE-FDD B12	699–716	729–746

<sup>11</sup> ANT\_MAIN only supports passive antennas.

LTE-FDD B13	777–787	746–756
LTE-FDD B66	1710–1780	2110–2180

**Table 29: Operating Frequency of I4915Q-AF (Unit: MHz)**

Operating Frequency	Transmit	Receive
LTE-FDD B2	1850–1910	1930–1990
LTE-FDD B4	1710–1755	2110–2155
LTE-FDD B5	824–849	869–894
LTE-FDD B12	699–716	729–746
LTE-FDD B13	777–787	746–756
LTE-FDD B14	788–798	758–768
LTE-FDD B66	1710–1780	2110–2180
LTE-FDD B71	663–698	617–652

**Table 30: Operating Frequency of I4916Q-GL (Unit: MHz)**

Operating Frequency	Transmit	Receive
LTE-FDD B1	1920–1980	2110–2170
LTE-FDD B2	1850–1910	1930–1990
LTE-FDD B3	1710–1785	1805–1880
LTE-FDD B4	1710–1755	2110–2155
LTE-FDD B5	824–849	869–894
LTE-FDD B7	2500–2570	2620–2690
LTE-FDD B8	880–915	925–960
LTE-FDD B12	699–716	729–746
LTE-FDD B13	777–787	746–756
LTE-FDD B18	815–830	860–875

LTE-FDD B19	830–845	875–890
LTE-FDD B20	832–862	791–821
LTE-FDD B25	1850–1915	1930–1995
LTE-FDD B26	814–849	859–894
LTE-FDD B28	703–748	758–803
LTE-TDD B34	2010–2025	2010–2025
LTE-TDD B38	2570–2620	2570–2620
LTE-TDD B39	1880–1920	1880–1920
LTE-TDD B40	2300–2400	2300–2400
LTE-TDD B41	2496–2690	2496–2690
LTE-FDD B66	1710–1780	2110–2180

### 5.1.2. Tx Power

Table 31: RF Transmitting Power

Frequency Bands	Max.	Min.
LTE bands	23 dBm $\pm 2$ dB	< -39 dBm

### 5.1.3. Rx Sensitivity

Table 32: Conducted RF Receiver Sensitivity of I4915Q-NA (Unit: dBm)

Frequency Bands	Receiver Sensitivity (Typ.)	
	Primary	3GPP (SIMO)
LTE-FDD B2 (10 MHz)	-98 dBm	-94.3 dBm
LTE-FDD B4 (10 MHz)	-98.5 dBm	-96.3 dBm
LTE-FDD B5 (10 MHz)	-99 dBm	-94.3 dBm
LTE-FDD B12 (10 MHz)	-98.5 dBm	-93.3 dBm

LTE-FDD B13 (10 MHz)	-98.5 dBm	-93.3 dBm
LTE-FDD B66 (10 MHz)	-98.5 dBm	-95.8 dBm

**Table 33: Conducted RF Receiver Sensitivity of I4915Q-AF (Unit: dBm)**

Frequency Bands	Receiver Sensitivity (Typ.)	
	Primary	3GPP (SIMO)
LTE-FDD B2 (10 MHz)	-98 dBm	-94.3 dBm
LTE-FDD B4 (10 MHz)	-98.5 dBm	-96.3 dBm
LTE-FDD B5 (10 MHz)	-99 dBm	-94.3 dBm
LTE-FDD B12 (10 MHz)	-98.5 dBm	-93.3 dBm
LTE-FDD B13 (10 MHz)	-98.5 dBm	-93.3 dBm
LTE-FDD B14 (10 MHz)	-98.5 dBm	-93.3 dBm
LTE-FDD B66 (10 MHz)	-98.5 dBm	-95.8 dBm
LTE-FDD B71 (10 MHz)	-98 dBm	-93.5 dBm

**Table 34: Conducted RF Receiver Sensitivity of I4916Q-GL (Unit: dBm)**

Frequency Bands	Receiver Sensitivity (Typ.)	
	Primary	3GPP (SIMO)
LTE-FDD B1 (10 MHz)	-98.6 dBm	-96.3 dBm
LTE-FDD B2 (10 MHz)	-99.4 dBm	-94.3 dBm
LTE-FDD B3 (10 MHz)	-98.9 dBm	-93.3 dBm
LTE-FDD B4 (10 MHz)	-98.6 dBm	-96.3 dBm
LTE-FDD B5 (10 MHz)	-99.1 dBm	-94.3 dBm
LTE-FDD B7 (10 MHz)	-97.4 dBm	-94.3 dBm
LTE-FDD B8 (10 MHz)	-99.3 dBm	-93.3 dBm
LTE-FDD B12 (10 MHz)	-99.5 dBm	-93.3 dBm

LTE-FDD B13 (10 MHz)	-98.3 dBm	-93.3 dBm
LTE-FDD B18 (10 MHz)	-99.3 dBm	-96.3 dBm
LTE-FDD B19 (10 MHz)	-99.1 dBm	-96.3 dBm
LTE-FDD B20 (10 MHz)	-99.8 dBm	-93.3 dBm
LTE-FDD B25 (10 MHz)	-99.4 dBm	-92.8 dBm
LTE-FDD B26 (10 MHz)	-98.9 dBm	-93.8 dBm
LTE-FDD B28 (10 MHz)	-98.6 dBm	-94.8 dBm
LTE-TDD B34 (10 MHz)	-99.2 dBm	-96.3 dBm
LTE-TDD B38 (10 MHz)	-97.6 dBm	-96.3 dBm
LTE-TDD B39 (10 MHz)	-99.8 dBm	-96.3 dBm
LTE-TDD B40 (10 MHz)	-98 dBm	-96.3 dBm
LTE-TDD B41 (10 MHz)	-97.7 dBm	-94.3 dBm
LTE-FDD B66 (10 MHz)	-98.6 dBm	-95.8 dBm

#### 5.1.4. Reference Design

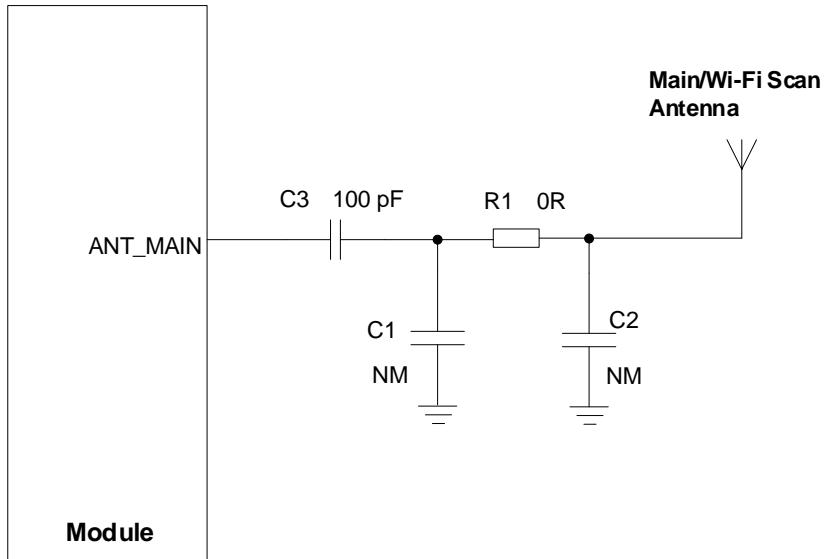


Figure 30: Reference Design of Main/Wi-Fi Scan Antenna

**NOTE**

1. Use a dual L-type matching circuit for the antenna interface for better cellular performance and for the ease of debugging.
2. Capacitors C1 and C2 are not mounted by default.
3. Place the dual L-type matching components (R1 & C1 & C2 & C3) to the antenna as close as possible.
4. Notes on C3:
  - 1) If there is DC power at the antenna ports, place capacitor on C3 to prevent short circuit to ground. The capacitance value is recommended to be 100 pF, which can be adjusted according to the debugging results.
  - 2) If there is no DC power in the peripheral design:
    - a) Do not reserve C3.
    - b) If C3 has already been reserved, it should be mounted with components, and it is recommended to use  $0\ \Omega$  resistors. You can also match the component according to the debugging results.

## 5.2. GNSS (Optional)

### 5.2.1. Antenna Interface & Frequency Bands

The GNSS part of the module supports GPS, GLONASS, BDS, Galileo, and QZSS systems.

**Table 35: Pin Description of GNSS Antenna Interface**

Pin Name	Pin No.	I/O	Description	Comment
ANT_GNSS	49	AI	GNSS antenna interface	$50\ \Omega$ impedance.

**Table 36: GNSS Frequency (Unit: MHz)**

GNSS Constellation Type	Frequency
GPS	$1575.42 \pm 1.023$ (L1)
GLONASS	1597.5–1605.8 (L1)
BDS	$1561.098 \pm 2.046$ (B1I)
Galileo	$1575.42 \pm 2.046$ (E1)

QZSS

1575.42 ±1.023 (L1)

### 5.2.2. GNSS Performance

**Table 37: GNSS Performance of I4915Q Series**

Parameter	Description	Conditions	Typ.	Unit
Sensitivity	Acquisition		-145	
	Reacquisition	Autonomous	-157	dBm
	Tracking		-160	
TTFF	Cold start @ open sky	Autonomous	27.43	
		AGPS enabled	5.6	s
	Warm start @ open sky	Autonomous	27.37	
Accuracy	Hot start @ open sky	Autonomous	2.56	
	CEP-50	Autonomous @ open sky	2.5	m

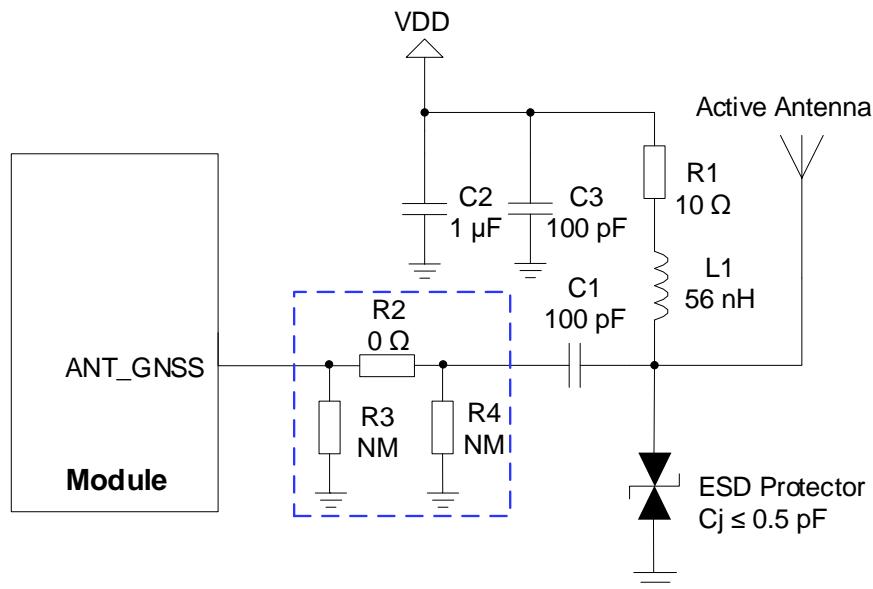
**Table 38: GNSS Performance of I4916Q-GL**

NOTE	Description	Conditions	Typ.	Unit
Sensitivity	Acquisition		-148	
	Reacquisition	Autonomous	-160	dBm
	Tracking		-166	
TTFF	Cold start @ open sky	Autonomous	24.96	
		AGPS enabled	11.3	s
	Warm start @ open sky	Autonomous	24.36	
Accuracy	Hot start @ open sky	Autonomous	2.22	
	CEP-50	Autonomous @ open sky	2.5	m

1. Tracking sensitivity: the minimum GNSS signal power at which the module can maintain lock (keep positioning for at least 3 minutes continuously).
2. Reacquisition sensitivity: the minimum GNSS signal power required for the module to maintain lock within 3 minutes after loss of lock.
3. Acquisition sensitivity: the minimum GNSS signal power at which the module can fix position successfully within 3 minutes after executing cold start command.

### 5.2.3. Reference Design

In any case, it is recommended to use a passive antenna. However, if an active antenna is needed in your application, it is recommended to reserve a  $\pi$ -type attenuation circuit and use a high-performance LDO in the power system design.



**Figure 31: Reference Design of GNSS Antenna**

#### NOTE

1. An external LDO can be selected to supply power according to the active antenna requirement.
2. If the module is designed with a passive antenna, then the VDD circuit is not needed.
3. Notes on C1:
  - 1) If there is DC power at the antenna ports, place capacitor on C1 to prevent short circuit to ground. The capacitance value is recommended to be 100 pF, which can be adjusted according to the debugging results.
  - 2) If there is no DC power in the peripheral design:
    - a) Do not reserve C1.
    - b) If C1 has already been reserved, it should be mounted with components, and it is recommended to

use  $0\ \Omega$  resistors. You can also match the component according to the debugging results.

### 5.3. RF Routing Guidelines

For user's PCB, the characteristic impedance of all RF traces should be controlled to  $50\ \Omega$ . The impedance of the RF traces is usually determined by the trace width (W), the materials' dielectric constant, the height from the reference ground to the signal layer (H), and the spacing between RF traces and grounds (S). Microstrip or coplanar waveguide is typically used in RF layout to control characteristic impedance. The following are reference designs of microstrip or coplanar waveguide with different PCB structures.

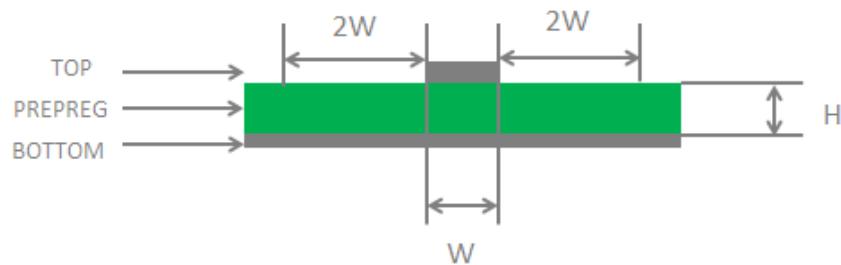


Figure 32: Microstrip Design on a 2-layer PCB

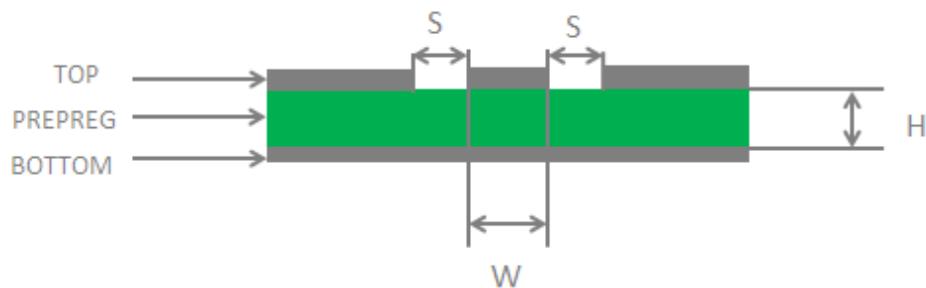
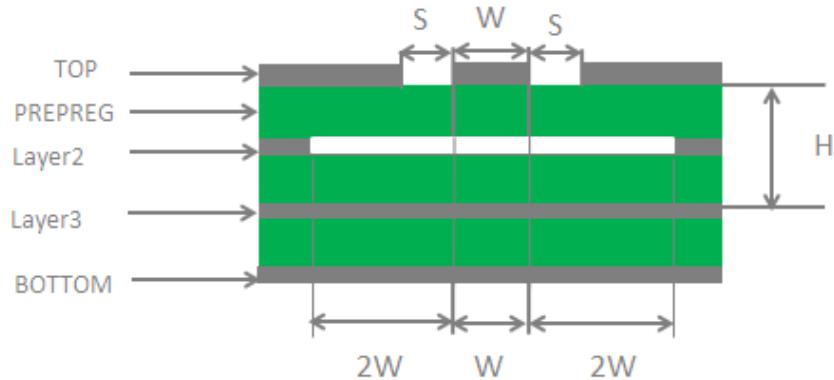
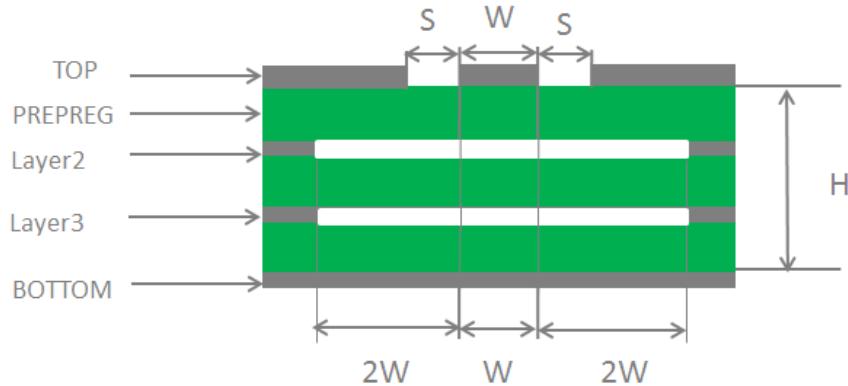


Figure 33: Coplanar Waveguide Design on a 2-layer PCB



**Figure 34: Coplanar Waveguide Design on a 4-layer PCB (Layer 3 as Reference Ground)**



**Figure 35: Coplanar Waveguide Design on a 4-layer PCB (Layer 4 as Reference Ground)**

To ensure RF performance and reliability, follow the principles below in RF layout design:

- Use an impedance simulation tool to accurately control the characteristic impedance of RF traces to  $50\ \Omega$ .
  - The GND pins adjacent to RF pins should not be designed as thermal relief pads, and should be fully connected to ground.
  - The distance between the RF pins and the RF connector should be as short as possible and all the right-angle traces should be changed to curved ones. The recommended trace angle is  $135^\circ$ .
  - There should be clearance under the signal pin of the antenna connector or solder joint.
  - The reference ground of RF traces should be complete. Meanwhile, adding some ground vias around RF traces and the reference ground could help to improve RF performance. The distance between the ground vias and RF traces should be at least twice the width of RF signal traces ( $2 \times W$ ).
- Keep RF traces away from interference sources, and avoid intersection and paralleling between traces on adjacent layers.

For more details about RF layout, see *document [3]*.

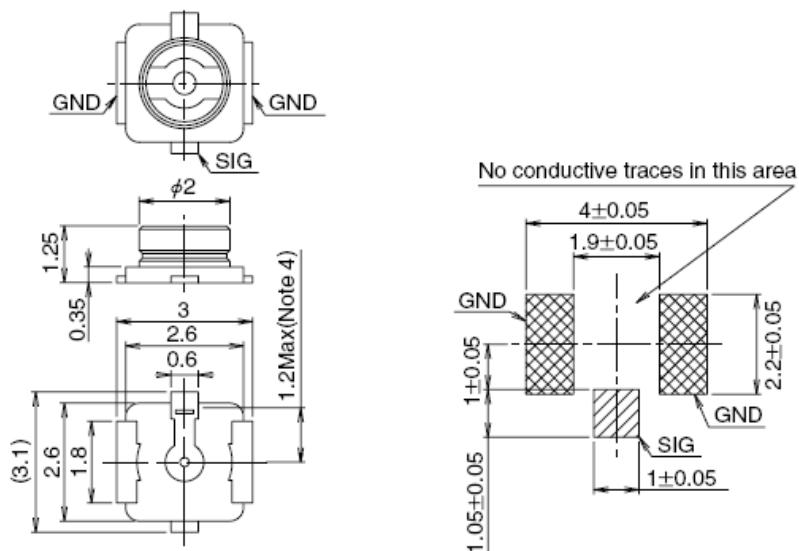
## 5.4. Antenna Design Requirements

**Table 39: Requirements for Antenna Design**

Antenna Types	Requirements
GNSS (Optional)	<ul style="list-style-type: none"> <li>● Frequency range: 1559–1609 MHz</li> <li>● Polarization: RHCP or linear</li> <li>● VSWR: <math>\leq 2</math> (Typ.)</li> </ul> <p><b>For passive antenna usage:</b></p> <ul style="list-style-type: none"> <li>● Passive antenna gain: <math>&gt; 0</math> dBi</li> </ul> <p><b>For active antenna usage:</b></p> <ul style="list-style-type: none"> <li>● Active antenna noise figure: <math>&lt; 1.5</math> dB</li> <li>● Active antenna embedded LNA gain: <math>&lt; 17</math> dB</li> <li>● VSWR: <math>\leq 2</math></li> <li>● Efficiency: <math>&gt; 30</math> %</li> <li>● Gain: 1 dBi</li> <li>● Max. input power: 50 W</li> <li>● Input impedance: <math>50 \Omega</math></li> <li>● Vertical polarization</li> <li>● Cable insertion loss:           <ul style="list-style-type: none"> <li>&lt; 1 dB: LB (<math>&lt; 1</math> GHz)</li> <li>&lt; 1.5 dB: MB (1–2.3 GHz)</li> <li>&lt; 2 dB: HB (<math>&gt; 2.3</math> GHz)</li> </ul> </li> </ul>
Cellular/Wi-Fi Scan	<p><b>NOTE</b></p> <p>It is recommended to use a passive GNSS antenna when LTE B13 or B14 is supported, as the use of active antenna may generate harmonics which will affect the GNSS performance.</p>

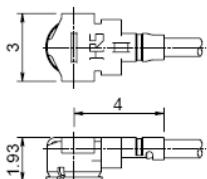
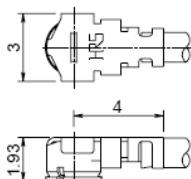
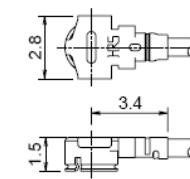
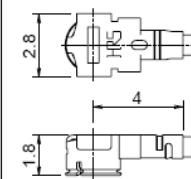
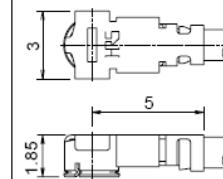
## 5.5. RF Connector Recommendation

If RF connector is used for antenna connection, it is recommended to use the U.FL-R-SMT connector provided by Hirose.



**Figure 36: Dimensions of the Receptacle (Unit: mm)**

U.FL-LP series mated plugs listed in the following figure can be used to match the U.FL-R-SMT connector.

Part No.	U.FL-LP-040	U.FL-LP-066	U.FL-LP(V)-040	U.FL-LP-062	U.FL-LP-088
					
Mated Height	2.5mm Max. (2.4mm Nom.)	2.5mm Max. (2.4mm Nom.)	2.0mm Max. (1.9mm Nom.)	2.4mm Max. (2.3mm Nom.)	2.4mm Max. (2.3mm Nom.)
Applicable cable	Dia. 0.81mm Coaxial cable	Dia. 1.13mm and Dia. 1.32mm Coaxial cable	Dia. 0.81mm Coaxial cable	Dia. 1mm Coaxial cable	Dia. 1.37mm Coaxial cable
Weight (mg)	53.7	59.1	34.8	45.5	71.7
RoHS			YES		

**Figure 37: Specifications of Mated Plugs**

The following figure describes the space factor of mated connectors.

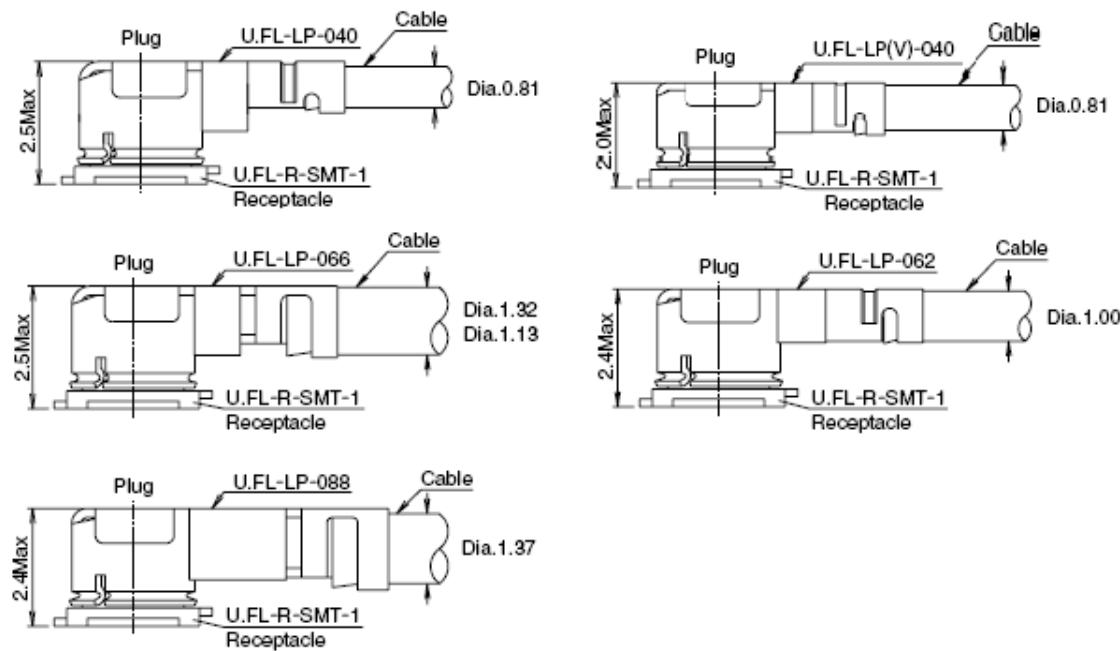


Figure 38: Space Factor of Mated Connectors (Unit: mm)

For more details, please visit <http://www.hirose.com>.

# 6 Electrical Characteristics and Reliability

## 6.1. Absolute Maximum Ratings

Table 40: Absolute Maximum Ratings

Parameters	Min.	Max.	Unit
Voltage at VBAT_RF & VBAT_BB	-0.3	5	V
Voltage at USB_VBUS	-0.3	5.25	V
Voltage at GNSS_VBCKP	-0.3	3.63	V
Voltage at digital pins	-0.3	2.3	V

## 6.2. Power Supply Ratings

Table 41: Power Supply Ratings

Parameters	Descriptions	Conditions	Min.	Typ.	Max.	Units
VBAT	VBAT_BB & VBAT_RF	The actual input voltages must be kept between the minimum and maximum values.	3.3	3.8	4.3	V
GNSS_VBCKP	Power supply for GNSS RTC		1.9	3.3	3.6	V
I <sub>VBAT</sub>	Peak power consumption	At maximum power control level	-	-	1.0	A
USB_VBUS	USB connection detection	-	3.0	5.0	5.25	V

### 6.3. Power Consumption

Table 42: Power Consumption of I4915Q-NA LTE Part (GNSS Part Off)

Description	Conditions	Typ.	Units
OFF state	Power down	0.4	µA
	AT+CFUN=0 (USB disconnected)	54	µA
	AT+CFUN=4 (USB disconnected)	130	µA
	LTE-FDD @ PF = 32 (USB disconnected)	1.24	mA
Sleep state	LTE-FDD @ PF = 64 (USB disconnected)	0.68	mA
	LTE-FDD @ PF = 128 (USB disconnected)	0.41	mA
	LTE-FDD @ PF = 256 (USB disconnected)	0.3	mA
Idle state	LTE-FDD @ PF = 64 (USB disconnected)	4.55	mA
	LTE-FDD @ PF = 64 (USB connected)	25.31	mA
	LTE-FDD B2	629	mA
	LTE-FDD B4	570	mA
	LTE-FDD B5	544	mA
LTE data transmission	LTE-FDD B12	571	mA
	LTE-FDD B13	657	mA
	LTE-FDD B66	543	mA

Table 43: Power Consumption of I4915Q-AF LTE Part (GNSS Part Off)

Description	Conditions	Typ.	Units
OFF state	Power down	0.5	µA
Sleep state	AT+CFUN=0 (USB disconnected)	61	µA
	AT+CFUN=4 (USB disconnected)	139	µA

Idle state	LTE-FDD @ PF = 32 (USB disconnected)	1.12	mA
	LTE-FDD @ PF = 64 (USB disconnected)	0.61	mA
	LTE-FDD @ PF = 128 (USB disconnected)	0.35	mA
	LTE-FDD @ PF = 256 (USB disconnected)	0.24	mA
	LTE-FDD @ PF = 64 (USB disconnected)	4.31	mA
	LTE-FDD @ PF = 64 (USB connected)	24.75	mA
	LTE-FDD B2	629	mA
	LTE-FDD B4	570	mA
	LTE-FDD B5	544	mA
	LTE-FDD B12	571	mA
LTE data transmission	LTE-FDD B13	606	mA
	LTE-FDD B14	548	mA
	LTE-FDD B66	543	mA
	LTE-FDD B71	584	mA

**Table 44: Power Consumption of I4916Q-GL LTE Part (GNSS Part Off)**

Description	Conditions	Typ.	Units
OFF state	Power down	0.5	µA
	AT+CFUN=0 (USB disconnected)	54	µA
	AT+CFUN=4 (USB disconnected)	135	µA
	LTE-FDD @ PF = 32 (USB disconnected)	1.23	mA
	LTE-FDD @ PF = 64 (USB disconnected)	0.68	mA
	LTE-FDD @ PF = 128 (USB disconnected)	0.41	mA
	LTE-FDD @ PF = 256 (USB disconnected)	0.31	mA
	LTE-TDD @ PF = 32 (USB disconnected)	1.27	mA

Idle state	LTE-TDD @ PF = 64 (USB disconnected)	0.70	mA
	LTE-TDD @ PF = 128 (USB disconnected)	0.42	mA
	LTE-TDD @ PF = 256 (USB disconnected)	0.32	mA
	LTE-FDD @ PF = 64 (USB disconnected)	4.56	mA
	LTE-FDD @ PF = 64 (USB connected)	25.80	mA
	LTE-TDD @ PF = 64 (USB disconnected)	4.58	mA
	LTE-TDD @ PF = 64 (USB connected)	25.51	mA
	LTE-FDD B1	616.3	mA
	LTE-FDD B2	529.6	mA
	LTE-FDD B3	630.0	mA
	LTE-FDD B4	572.3	mA
	LTE-FDD B5	506.0	mA
	LTE-FDD B7	722.3	mA
	LTE-FDD B8	581.2	mA
	LTE-FDD B12	520.1	mA
	LTE-FDD B13	559.8	mA
	LTE-FDD B18	480.0	mA
	LTE-FDD B19	474.9	mA
	LTE-FDD B20	550.9	mA
	LTE-FDD B25	546.5	mA
	LTE-FDD B26	493.8	mA
	LTE-FDD B28	580.5	mA
	LTE-TDD B34	246.8	mA
	LTE-TDD B38	258.6	mA
	LTE-TDD B39	249.8	mA

LTE-TDD B40	216.3	mA
LTE-TDD B41	259.46	mA
LTE-FDD B66	574.4	mA

## 6.4. Digital I/O Characteristics

**Table 45: VDD\_EXT I/O Characteristics (Unit: V)**

Parameters	Descriptions	Min.	Max.
$V_{IH}$	High-level input voltage	1.2	2
$V_{IL}$	Low-level input voltage	-0.3	0.6
$V_{OH}$	High-level output voltage	1.35	-
$V_{OL}$	Low-level output voltage	-	0.45

**Table 46: USIM Low-voltage I/O Characteristics (Unit: V)**

Parameters	Descriptions	Min.	Max.
$V_{IH}$	High-level input voltage	1.2	-
$V_{IL}$	Low-level input voltage	-	0.6
$V_{OH}$	High-level output voltage	1.35	-
$V_{OL}$	Low-level output voltage	-	0.45

**Table 47: USIM High-voltage I/O Characteristics (Unit: V)**

Parameters	Descriptions	Min.	Max.
$V_{IH}$	High-level input voltage	1.95	-
$V_{IL}$	Low-level input voltage	-	1.0

V <sub>OH</sub>	High-level output voltage	2.55	-
V <sub>OL</sub>	Low-level output voltage	-	0.45

## 6.5. ESD Protection

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

**Table 48: ESD Characteristics (Temperature: 25–30 °C, Humidity: 40 ±5 %; Unit: kV)**

Test Points	Contact Discharge	Air Discharge
VBAT & GND	±8	±12
Antenna interface	±5	±10
Other interfaces	±0.5	±1

## 6.6. Operating and Storage Temperatures

**Table 49: Operating and Storage Temperatures (Unit: °C)**

Parameters	Min.	Typ.	Max.
Normal Operating Temperature <sup>12</sup>	-35	+25	+75
Extended Operating Temperature <sup>13</sup>	-40	-	+85
Storage Temperature	-40	-	+90

<sup>12</sup> Within this range, the module's indicators comply with 3GPP specification requirements.

<sup>13</sup> Within this range, the module retains the ability to establish and maintain functions such as SMS and data transmission, without any unrecoverable malfunction. Radio spectrum and radio network remain uninfluenced, whereas the value of one or more parameters, such as P<sub>out</sub>, may decrease and fall below the range of the 3GPP specified tolerances. When the temperature returns to the normal operating temperature range, the module's indicators will comply with 3GPP specification requirements again.

# 7 Mechanical Information

This chapter describes the mechanical dimensions of the module. All dimensions are measured in millimeter (mm), and the dimensional tolerances are  $\pm 0.2$  mm unless otherwise specified.

## 7.1. Mechanical Dimensions

### 7.1.1. Mechanical Dimensions of I4915Q Series

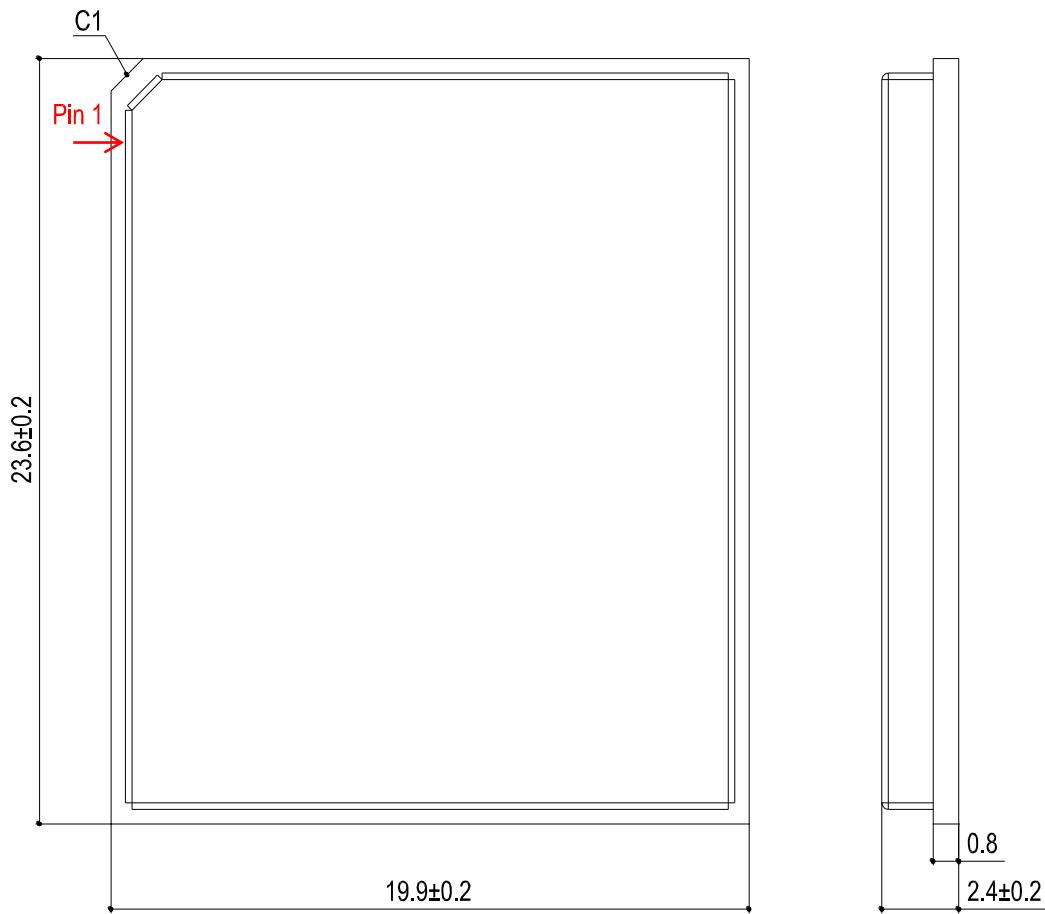


Figure 39: I4915Q Series Top and Side Dimensions (Unit: mm)

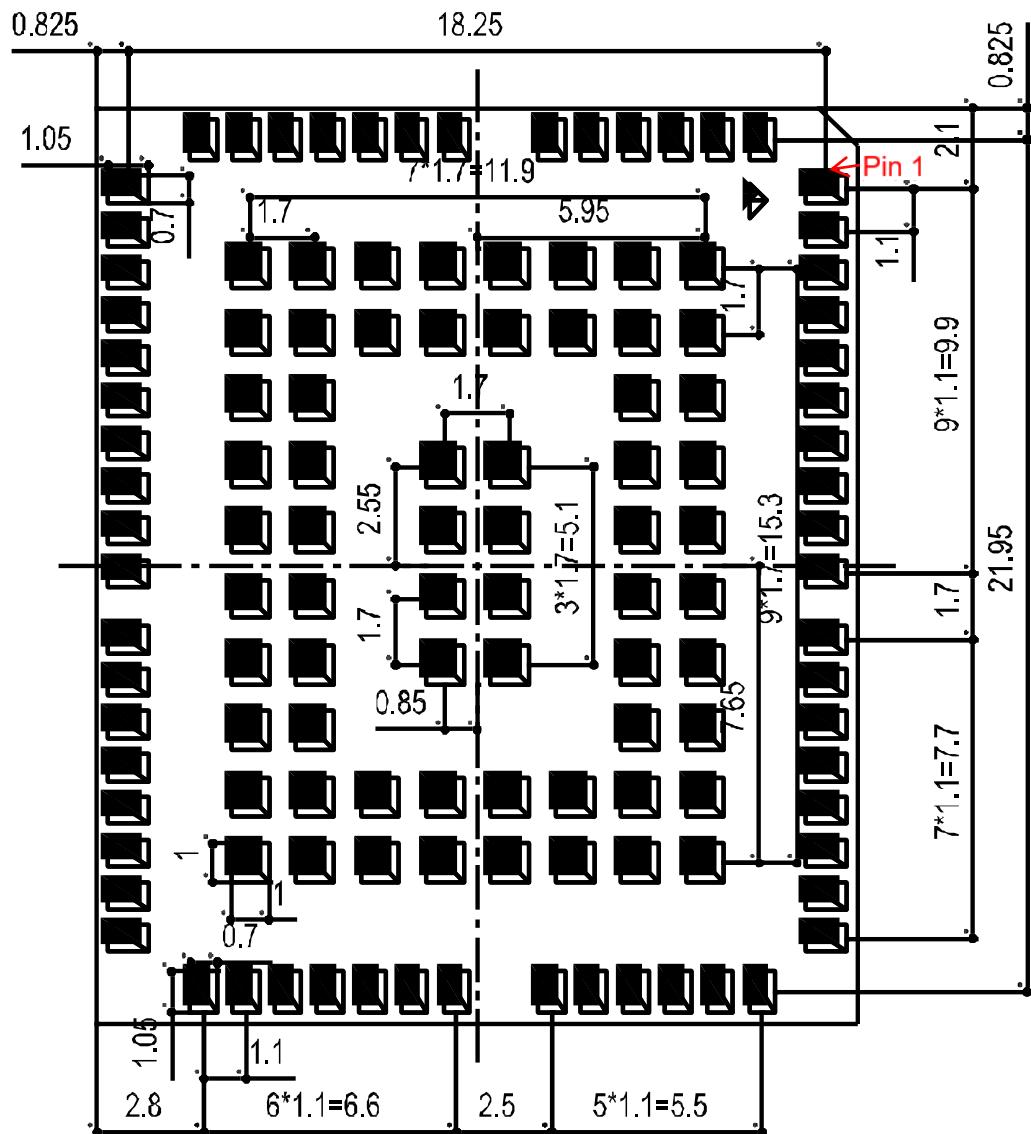


Figure 40: I4915Q Series Bottom Dimension (Bottom View, Unit: mm)

## NOTE

The module's coplanarity standard:  $\leq 0.13$  mm.

### 7.1.2. Mechanical Dimensions of I4916Q-GL

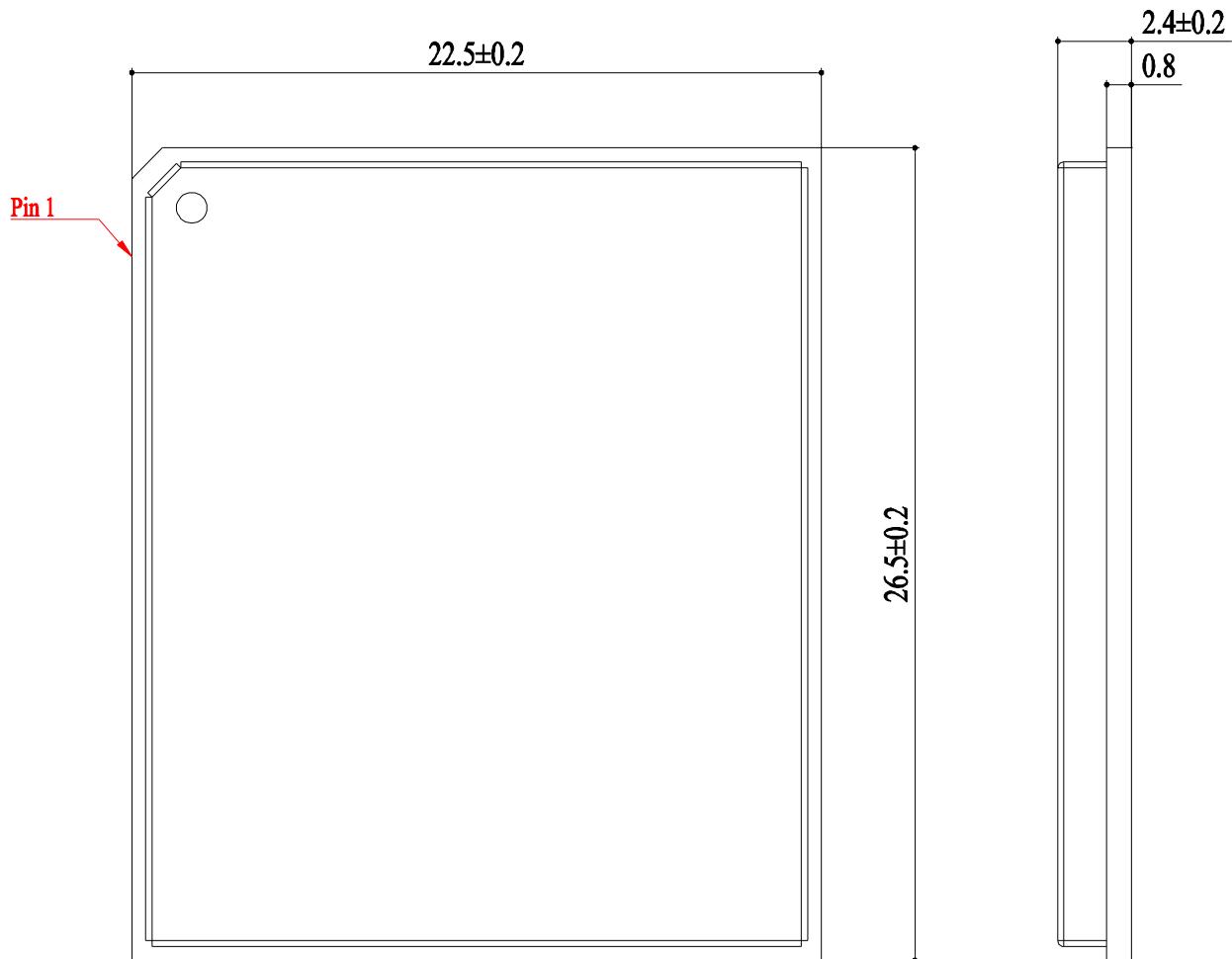


Figure 41: I4916Q-GL Top and Side Dimensions (Unit: mm)

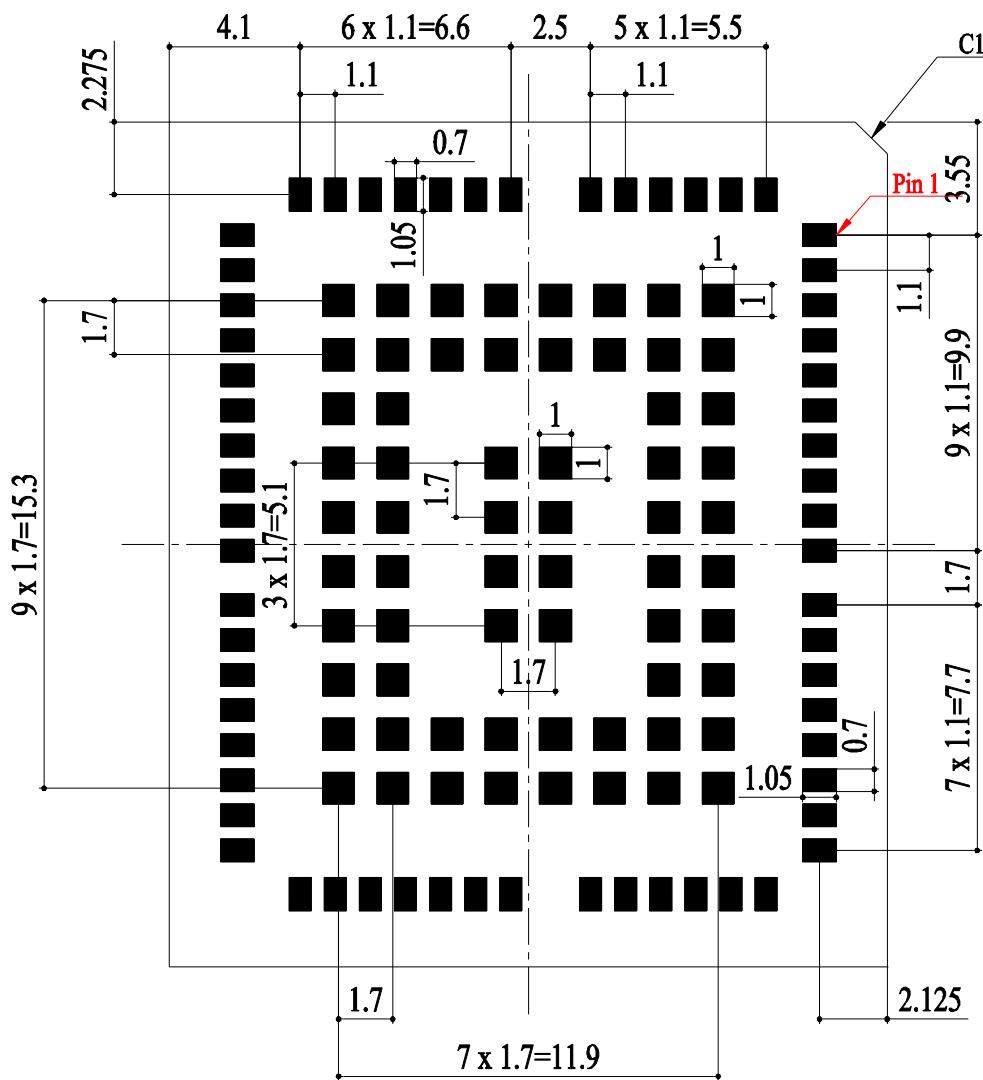


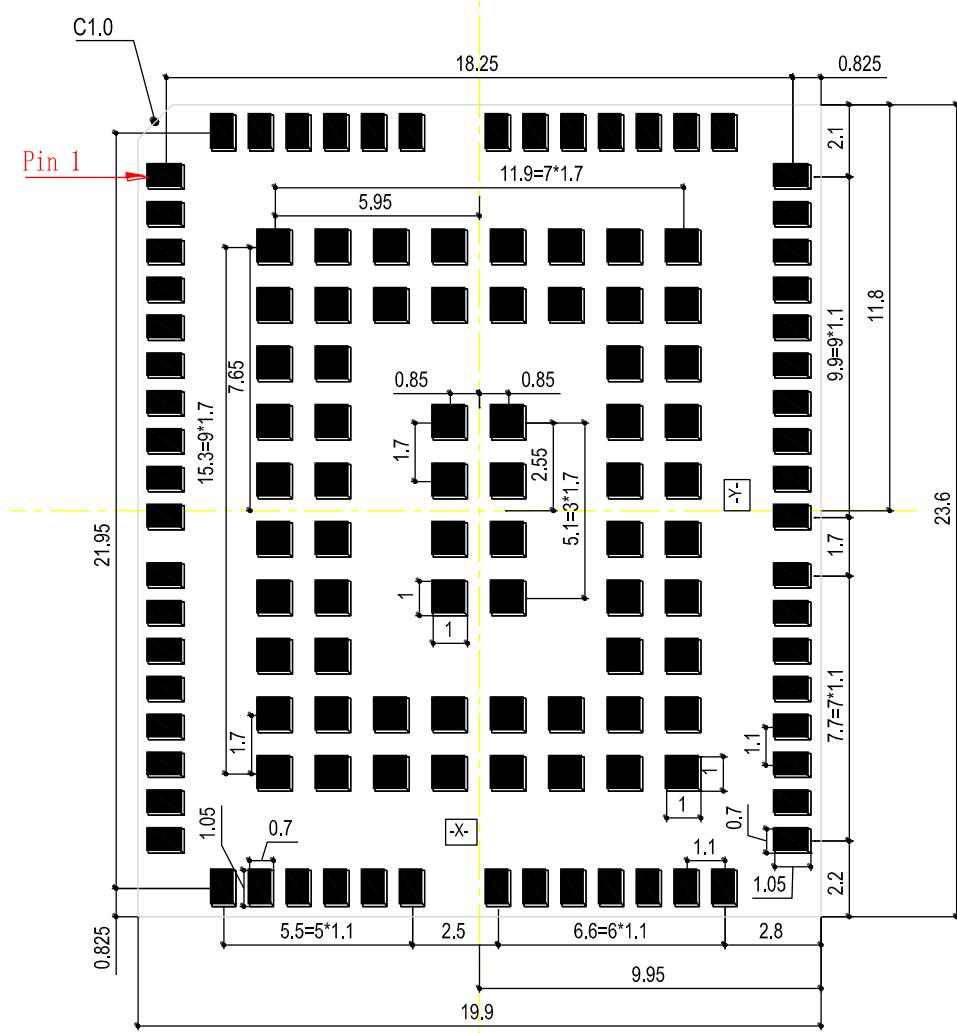
Figure 42: I4916Q-GL Bottom Dimension (Bottom View, Unit: mm)

## NOTE

The module's coplanarity standard:  $\leq 0.13$  mm.

## 7.2. Recommended Footprint

### 7.2.1. Recommended Footprint of I4915Q Series



**Figure 43: I4915Q Series Recommended Footprint (Unit: mm)**

## NOTE

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

### 7.2.2. Recommended Footprint of I4916Q-GL

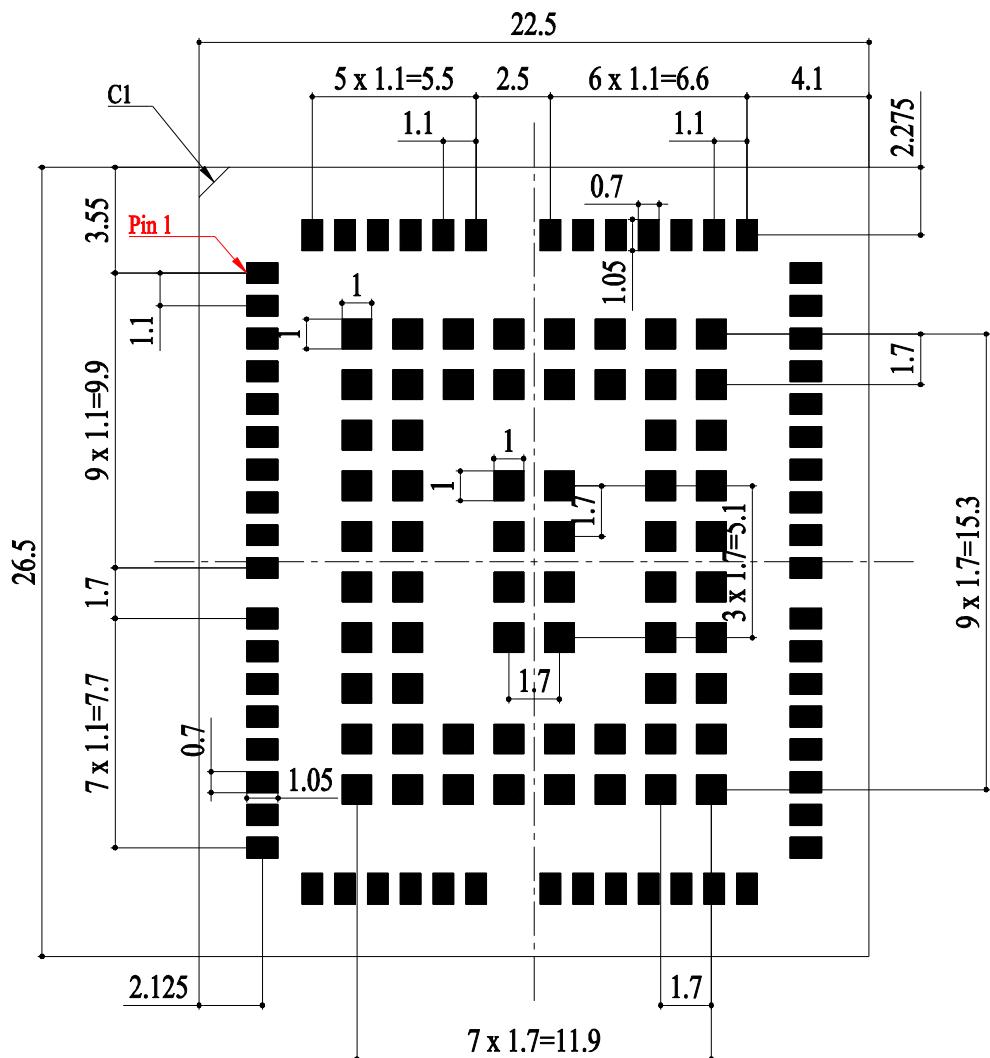


Figure 44: I4916Q-GL Recommended Footprint (Unit: mm)

**NOTE**

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

## 7.3. Top and Bottom Views

### 7.3.1. Top and Bottom Views of I4915Q Series

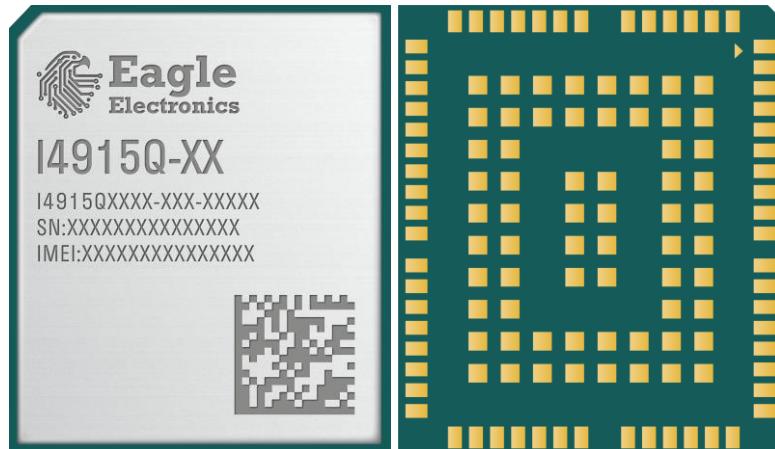


Figure 45: I4915Q Series Top and Bottom Views

### 7.3.2. Top and Bottom Views of I4916Q-GL

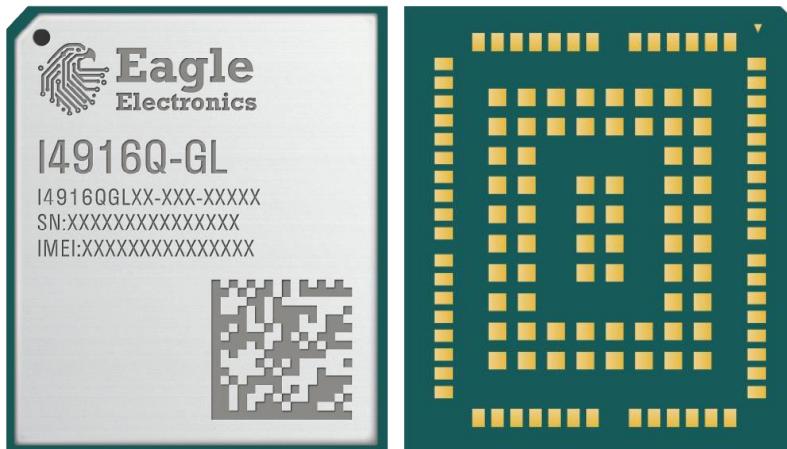


Figure 46: I4916Q-GL Top and Bottom Views

**NOTE**

Images above are for illustration purpose only and may differ from the actual module. For authentic appearance and label, please refer to the module received from Eagle.

# 8 Storage, Manufacturing & Packaging

## 8.1. Storage Conditions

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

1. Recommended Storage Condition: the temperature should be  $23 \pm 5$  °C and the relative humidity should be 35–60 %.
2. Shelf life (in a vacuum-sealed packaging): 12 months in Recommended Storage Condition.
3. Floor life: 168 hours <sup>14</sup> in a factory where the temperature is  $23 \pm 5$  °C and relative humidity is below 60 %. After the vacuum-sealed packaging is removed, the module must be processed in reflow soldering or other high-temperature operations within 168 hours. Otherwise, the module should be stored in an environment where the relative humidity is less than 10 % (e.g., a dry cabinet).
4. The module should be pre-baked to avoid blistering, cracks and inner-layer separation in PCB under the following circumstances:
  - The module is not stored in Recommended Storage Condition;
  - Violation of the third requirement mentioned above;
  - Vacuum-sealed packaging is broken, or the packaging has been removed for over 24 hours;
  - Before module repairing.
5. If needed, the pre-baking should follow the requirements below:
  - The module should be baked for 24 hours at  $120 \pm 5$  °C;
  - The module must be soldered to PCB within 24 hours after the baking, otherwise it should be put in a dry environment such as in a dry cabinet.

---

<sup>14</sup> This floor life is only applicable when the environment conforms to *IPC/JEDEC J-STD-033*. It is recommended to start the solder reflow process within 24 hours after the package is removed if the temperature and moisture do not conform to, or are not sure to conform to *IPC/JEDEC J-STD-033*. And do not unpack the modules in large quantities until they are ready for soldering.

**NOTE**

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

## 8.2. 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. Apply proper force on the squeegee to produce a clean stencil surface on a single pass. To guarantee module soldering quality, the thickness of stencil for the module is recommended to be 0.13–0.15 mm. For more details, see *document [4]*.

The recommended peak reflow temperature should be 235–246 °C, with 246 °C as the absolute maximum reflow temperature. To avoid damage to the module caused by repeated heating, it is recommended that the module should be mounted only 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.

**Temp. (°C)**

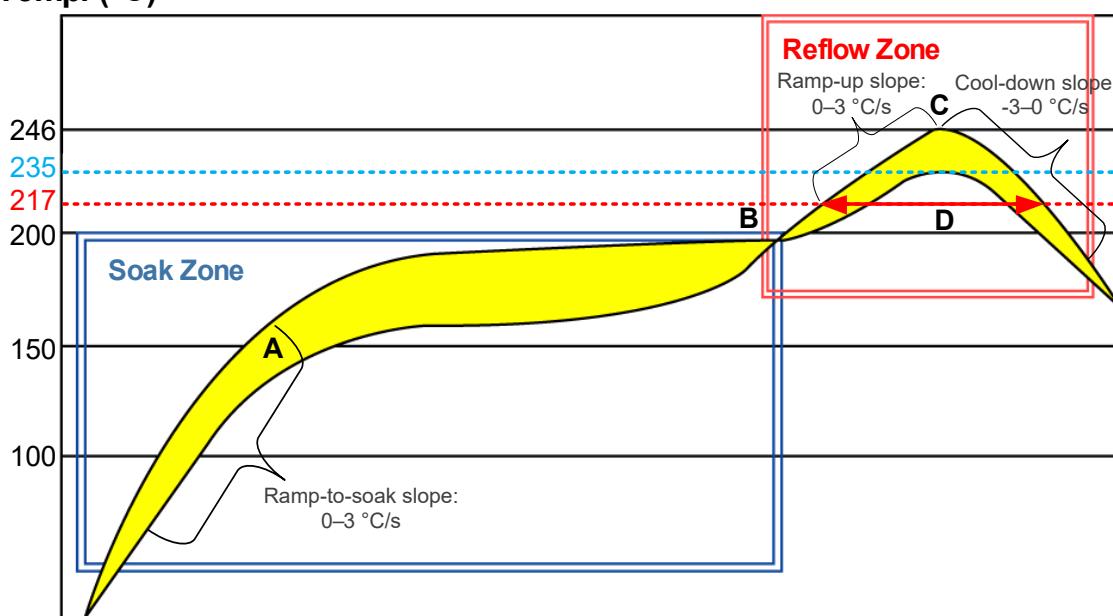


Figure 47: Recommended Reflow Soldering Thermal Profile

**Table 50: Recommended Thermal Profile Parameters**

Factor	Recommended Value
<b>Soak Zone</b>	
Ramp-to-soak slope	0–3 °C/s
Soak time (between A and B: 150 °C and 200 °C)	70–120 s
<b>Reflow Zone</b>	
Ramp-up slope	0–3 °C/s
Reflow time (D: over 217°C)	40–70 s
Max temperature	235–246 °C
Cool-down slope	-3–0 °C/s
<b>Reflow Cycle</b>	
Max reflow cycle	1

**NOTE**

1. The above profile parameter requirements are for the measured temperature of the solder joints. Both the hottest and coldest spots of solder joints on the PCB should meet the above requirements.
2. During manufacturing and soldering, or any other processes that may contact the module directly, never wipe the module's shielding can with organic solvents, such as acetone, ethyl alcohol, isopropyl alcohol and trichloroethylene. Otherwise, the shielding can may become rusted.
3. The shielding can for the module is made of Cupro-Nickel base material. It is tested that after 12 hours' Neutral Salt Spray test, the laser engraved label information on the shielding can is still clearly identifiable and the QR code is still readable, although white rust may be found.
4. If a conformal coating is necessary for the module, do not use any coating material that may chemically react with the PCB or shielding cover, and prevent the coating material from flowing into the module.
5. Avoid using ultrasonic technology for module cleaning since it can damage crystals inside the module.
6. Avoid using materials that contain mercury (Hg), such as adhesives, for module processing, even if the materials are RoHS compliant and their mercury content is below 1000 ppm (0.1 %).
7. Corrosive gases may corrode the electronic components inside the module, affecting their reliability and performance, and potentially leading to a shortened service life that fails to meet the designed lifespan. Therefore, do not store or use unprotected modules in environments containing corrosive gases such as hydrogen sulfide, sulfur dioxide, chlorine, and ammonia.
8. Due to the complexity of the SMT process, contact Eagle Technical Supports in advance for any situation that you are not sure about, or any process (e.g. selective wave soldering, ultrasonic soldering) that is not mentioned in **document [5]**.

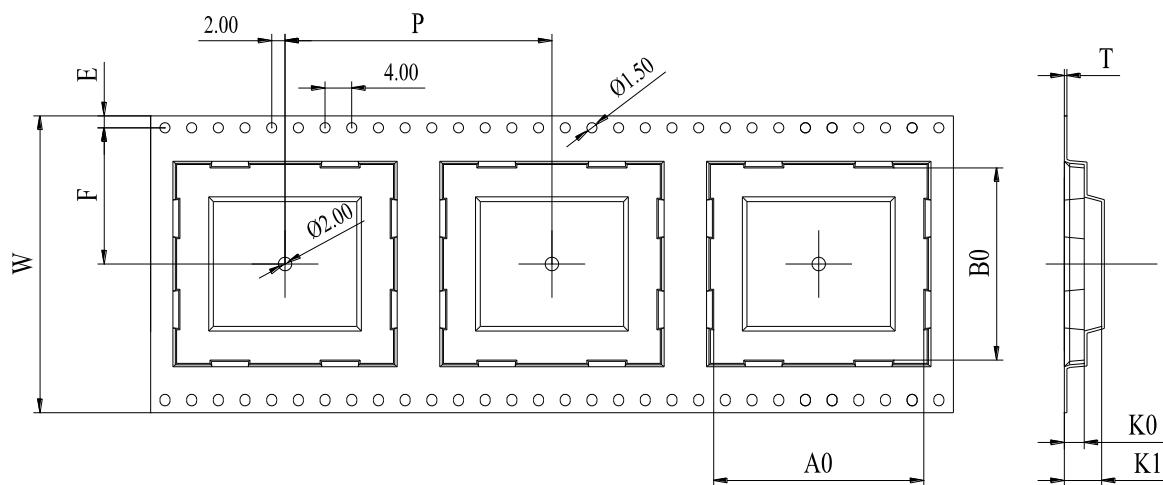
## 8.3. Packaging Specification

This chapter outlines the key packaging parameters and processes. All figures below are for reference purposes only, as the actual appearance and structure of packaging materials may vary in delivery.

The modules are packed in a tape and reel packaging as specified in the sub-chapters below.

### 8.3.1. Carrier Tape

Carrier tape dimensions are illustrated in the following figure and table:



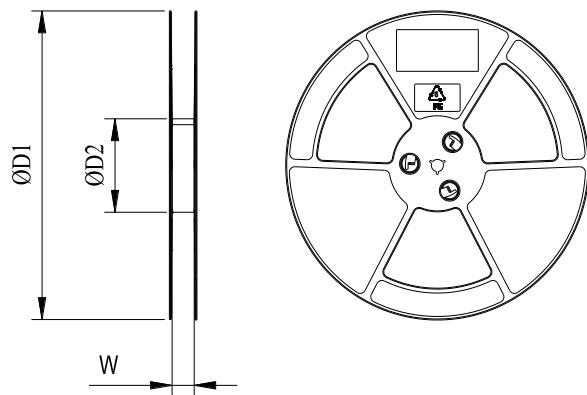
**Figure 48: Carrier Tape Dimension Drawing (Unit: mm)**

**Table 51: Carrier Tape Dimension Table (Unit: mm)**

Module Name	W	P	T	A0	B0	K0	K1	F	E
I4915Q Series	44	32	0.35	20.2	24	3.15	6.65	20.2	1.75
I4916Q-GL	44	32	0.35	22.8	26.8	3.1	6.9	20.2	1.75

### 8.3.2. Plastic Reel

Plastic reel dimensions are illustrated in the following figure and table:

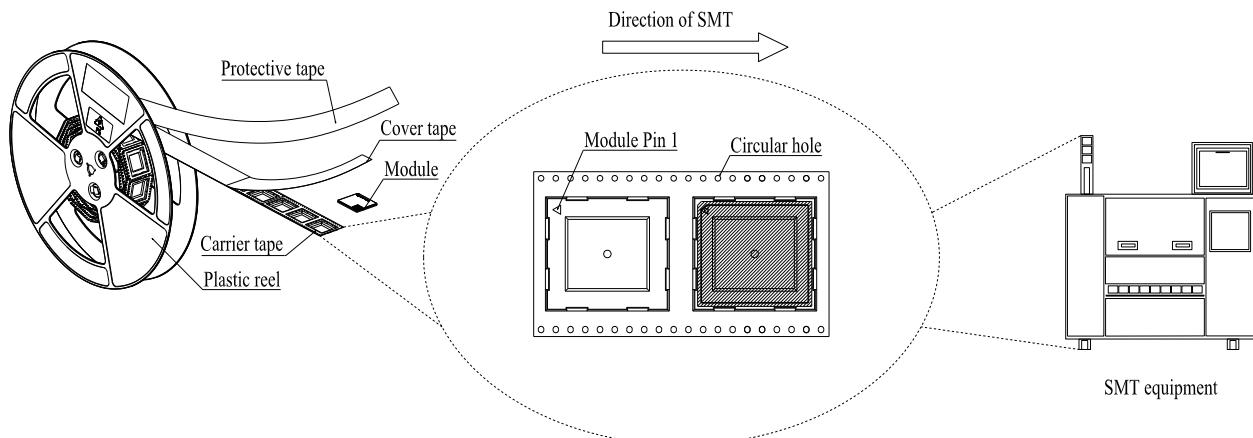


**Figure 49: Plastic Reel Dimension Drawing**

**Table 52: Plastic Reel Dimension Table (Unit: mm)**

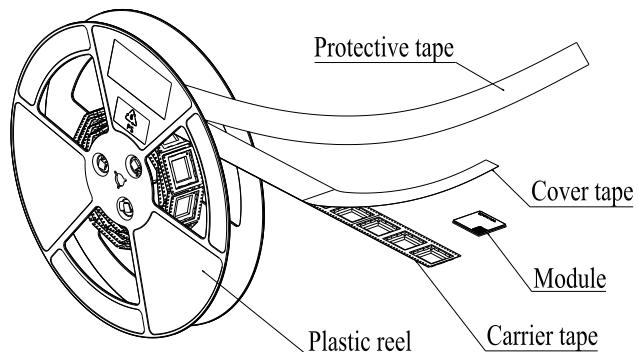
$\phi D1$	$\phi D2$	W
330	100	44.5

### 8.3.3. Mounting Direction



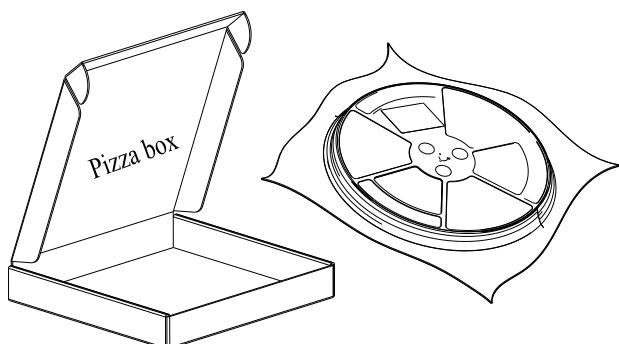
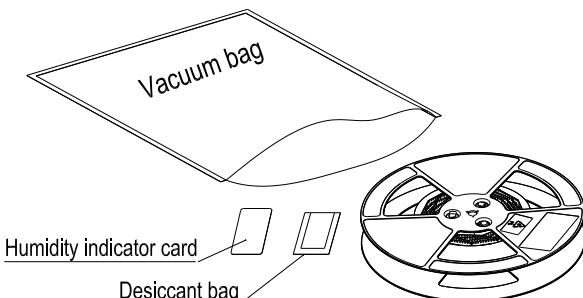
**Figure 50: Mounting Direction**

#### 8.3.4. Packaging Process



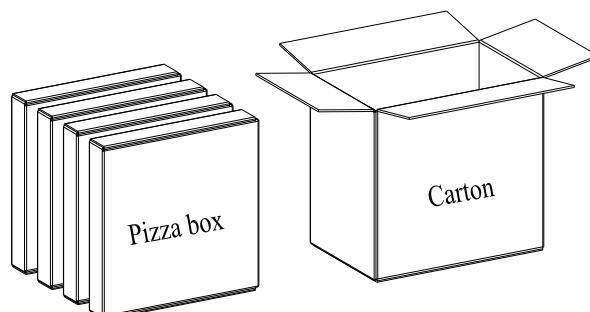
Place the modules onto the carrier tape cavity and cover them securely with cover tape. Wind the heat-sealed carrier tape onto a plastic reel and apply a protective tape for additional protection. 1 plastic reel can pack 250 modules.

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



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

Place the 4 packaged pizza boxes into 1 carton and seal it. 1 carton can pack 1000 modules.



**Figure 51: Packaging Process**

# 9 Appendix References

**Table 53: Related Documents**

Document Name
[1] Eagle_UMTS&LTE_EVB_User_Guide
[2] Eagle_I491xQ_Series_AT_Commands_Manual
[3] Eagle_RF_Layout_Application_Note
[4] Eagle_Module_Stencil_Design_Requirements
[5] Eagle_Module_SMT_Application_Note

**Table 54: Terms and Abbreviations**

Abbreviation	Description
3GPP	3rd Generation Partnership Project
ADC	Analog-to-Digital Converter
bps	Bits Per Second
CHAP	Challenge Handshake Authentication Protocol
CMUX	Connection MUX
CTS	Clear To Send
DFOTA	Delta Firmware Upgrade Over the Air
DL	Downlink
DRX	Discontinuous Reception
DSSS	direct-sequence spread spectrum
DTR	Data Terminal Ready

ESD	Electrostatic Discharge
FDD	Frequency Division Duplex
FILE	File Protocol
FTP	File Transfer Protocol
FTPS	FTP over SSL
GRFC	General RF Control
HB	High Band
HTTP	Hypertext Transfer Protocol
HTTPS	Hypertext Transfer Protocol Secure
I2C	Inter-Integrated Circuit
I/O	Input/Output
IMT-2000	International Mobile Telecommunications 2000
LB	Low Band
LED	Light Emitting Diode
LGA	Land Grid Array
LTE	Long Term Evolution
MB	Middle Band
MCU	Microcontroller Unit
MO	Mobile Originated
MQTT	Message Queuing Telemetry Transport
MT	Mobile Terminated
NITZ	Network Identity and Time Zone
NTP	Network Time Protocol
PAP	Password Authentication Protocol
PCB	Printed Circuit Board

PCM	Pulse Code Modulation
PDU	Protocol Data Unit
PING	Packet Internet Groper
PPP	Point-to-Point Protocol
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
RI	Ring Indicator
RF	Radio Frequency
RoHS	Restriction of Hazardous Substances
RTS	Request To Send
Rx	Receive
SMD	Surface Mount Device
SMS	Short Message Service
SMTP	Simple Mail Transfer Protocol
SMTPS	Simple Mail Transfer Protocol Secure
SPI	Serial Peripheral Interface
SSL	Secure Sockets Layer
TCP	Transmission Control Protocol
TVS	Transient Voltage Suppressor
Tx	Transmit
UART	Universal Asynchronous Receiver/Transmitter
UDP	User Datagram Protocol
UL	Uplink
UMTS	Universal Mobile Telecommunications System
URC	Unsolicited Result Code

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USB	Universal Serial Bus
USIM	Universal Subscriber Identity Module
VBAT	Voltage at Battery (Pin)
V <sub>IH</sub>	High-level input voltage
V <sub>IL</sub>	Low-level input voltage
V <sub>OH</sub>	High-level output voltage
V <sub>OL</sub>	Low-level output voltage
V <sub>max</sub>	Maximum Voltage
V <sub>nom</sub>	Nominal Voltage
V <sub>min</sub>	Minimum Voltage
V <sub>IL,max</sub>	Maximum Low-level Input Voltage
V <sub>RWM</sub>	Working Peak Reverse Voltage
VSWR	Voltage Standing Wave Ratio

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**FCC ID: 2BNX7I4916QGLA**

## **OEM/Integrators Installation Manual**

### **Important Notice to OEM integrators**

1. This module is limited to OEM installation ONLY.
2. This module is limited to installation in mobile or fixed applications, according to Part 2.1091(b).
3. The separate approval is required for all other operating configurations, including portable configurations with respect to Part 2.1093 and different antenna configurations
4. For FCC Part 15.31 (h) and (k): The host manufacturer is responsible for additional testing to verify compliance as a composite system. When testing the host device for compliance with Part 15 Subpart B, the host manufacturer is required to show compliance with Part 15 Subpart B while the transmitter module(s) are installed and operating. The modules should be transmitting and the evaluation should confirm that the module's intentional emissions are compliant (i.e. fundamental and out of band emissions). The host manufacturer must verify that there are no additional unintentional emissions other than what is permitted in Part 15 Subpart B or emissions are compliant with the transmitter(s) rule(s).

The Grantee will provide guidance to the host manufacturer for Part 15 B requirements if needed.

### **Important Note**

notice that any deviation(s) from the defined parameters of the antenna trace, as described by the instructions, require that the host product manufacturer must notify to Eagle that they wish to change the antenna trace design. In this case, a Class II permissive change application is required to be filed by the USI, or the host manufacturer can take responsibility through the change in FCC ID (new application) procedure followed by a Class II permissive change application.

### **End Product Labeling**

When the module is installed in the host device, the FCC/IC ID label must be visible through a window on the final device or it must be visible when an access panel, door or cover is easily re-moved. If not, a second label must be placed on the outside of the final device that contains the following text:

“Contains FCC ID: 2BNX7I4916QGLA”

“Contains IC: 33571-I4916QGLA”

The FCC ID/IC ID can be used only when all FCC/IC compliance requirements are met.

### **Antenna Installation**

- (1) The antenna must be installed such that 20 cm is maintained between the antenna and users,
- (2) The transmitter module may not be co-located with any other transmitter or antenna.

In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the FCC/IC authorization is no longer considered valid and the FCC ID/IC ID cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC/IC authorization.

Antenna Type	Max Gain	
External Antenna	LTE Band 2:1.59dBi	LTE Band 25: 1.59dBi
	LTE Band 4: 2.00dBi	LTE Band 26(814-824MHz):2.53dBi
	LTE Band 5: 2.13dBi	LTE Band 26(824-849MHz):2.13dBi
	LTE Band 7: 3.00dBi	LTE Band 38:2.06dBi
	LTE Band 12: 3.26dBi	LTE Band 41:3.00dBi
	LTE Band 13: 4.45dBi	LTE Band 66:2.00dBi

## Manual Information to the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module. The end user manual shall include all required regulatory information/warning as show in this manual.

## Federal Communication Commission Interference Statement

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

## List of applicable FCC rules

This module has been tested and found to comply with part 15, part 22, part 24, part 27 and part 90 requirements for Modular Approval.

The modular transmitter is only FCC authorized for the specific rule parts (i.e., FCC transmitter rules) listed on the grant, and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. If the grantee markets their product as being Part 15 Subpart B compliant (when it also contains unintentional-radiator digital circuitry), then the grantee shall provide a notice stating that the final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.

**This device is intended only for OEM integrators under the following conditions:**

## (For module device use)

- 1) The antenna must be installed such that 20 cm is maintained between the antenna and users, and
- 2) The transmitter module may not be co-located with any other transmitter or antenna.

As long as 2 conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

## Radiation Exposure Statement

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20 cm between the radiator & your body.

**IC: 33571-I4916QGLA**

## Industry Canada Statement

This device complies with Industry Canada's licence-exempt RSSs. Operation is subject to the following two conditions:

- (1) This device may not cause interference; and
- (2) This device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence.

L'exploitation est autorisée aux deux conditions suivantes:

- (1) l'appareil ne doit pas produire de brouillage, et
- (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement."

## Radiation Exposure Statement

This equipment complies with IC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

## Déclaration d'exposition aux radiations:

Cet équipement est conforme aux limites d'exposition aux rayonnements ISED établies pour un environnement non contrôlé. Cet équipement doit être installé et utilisé avec un minimum de 20cm de distance entre la source de rayonnement et votre corps.

## This device is intended only for OEM integrators under the following conditions:

### (For module device use)

- 1) The antenna must be installed such that 20cm is maintained between the antenna and users, and
- 2) The transmitter module may not be co-located with any other transmitter or antenna.

As long as 2 conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

### Cet appareil est conçu uniquement pour les intégrateurs OEM dans les conditions suivantes: (Pour utilisation de dispositif module)

- 1) L'antenne doit être installée de telle sorte qu'une distance de 20cm est respectée entre l'antenne et les utilisateurs, et
- 2) Le module émetteur peut ne pas être coimplanté avec un autre émetteur ou antenne.

Tant que les 2 conditions ci-dessus sont remplies, des essais supplémentaires sur l'émetteur ne seront pas nécessaires. Toutefois, l'intégrateur OEM est toujours responsable des essais sur son

produit final pour toutes exigences de conformité supplémentaires requis pour ce module installé.

## **IMPORTANT NOTE:**

In the event that these conditions cannot be met (for example certain laptop configurations or colocation with another transmitter), then the Canada authorization is no longer considered valid and the IC ID cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate Canada authorization.

## **NOTE IMPORTANTE:**

Dans le cas où ces conditions ne peuvent être satisfaites (par exemple pour certaines configurations d'ordinateur portable ou de certaines co-localisation avec un autre émetteur), l'autorisation du Canada n'est plus considéré comme valide et l'ID IC ne peut pas être utilisé sur le produit final. Dans ces circonstances, l'intégrateur OEM sera chargé de réévaluer le produit final (y compris l'émetteur) et l'obtention d'une autorisation distincte au Canada.

## **End Product Labeling**

This transmitter module is authorized only for use in device where the antenna may be installed such that 20cm may be maintained between the antenna and users. The final end product must be labeled in a visible area with the following: "Contains IC: 33571-I4916QGLA".

## **Plaque signalétique du produit final**

Ce module émetteur est autorisé uniquement pour une utilisation dans un dispositif où l'antenne peut être installée de telle sorte qu'une distance de 20cm peut être maintenue entre l'antenne et les utilisateurs. Le produit final doit être étiqueté dans un endroit visible avec l'inscription suivante: "Contient des IC: 33571-I4916QGLA".

## **Manual Information To the End User**

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as show in this manual.

## **Manuel d'information à l'utilisateur final**

L'intégrateur OEM doit être conscient de ne pas fournir des informations à l'utilisateur final quant à la façon d'installer ou de supprimer ce module RF dans le manuel de l'utilisateur du produit final qui intègre ce module.

Le manuel de l'utilisateur final doit inclure toutes les informations réglementaires requises et avertissements comme indiqué dans ce manuel.