EG915U Series

Hardware Design

LTE Standard Module Series

Version: 1.0

Date: 2021-11-23

Status: Released

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Safety Information

The following safety precautions must be observed during all phases of operation, such as usage, service or repair of any cellular terminal or mobile incorporating the module. Manufacturers of the cellular terminal should notify users and operating personnel of the following safety information by incorporating these guidelines into all manuals of the product. Otherwise, Quectel assumes no liability for customers' failure to comply with these precautions.

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

About the Document

Revision History

Version	Date	Author	Description
-	2021-11-23	Len CHEN/Reuben WANG/ Frank WANG/Ailsa WANG	Creation of the document
1.0	2021-11-23	Len CHEN/Reuben WANG/ Frank WANG/Ailsa WANG	First official release

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1 Introduction

This document defines the EG915U series module and describes its air interfaces and hardware interfaces which are connected with relate to customers' applications.

It can help customers quickly understand interface specifications, electrical and mechanical details, as well as other related information of the module. Associated with application notes and user guides, customers can use this module to design and to set up mobile applications easily.

1.1. Special Mark

Table 1: Special Mark

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

2 Product Overview

EG915U series module is an LTE-FDD, LTE-TDD and GSM wireless communication module, which provides data connectivity on LTE-FDD, LTE-TDD and GPRS networks. It also provides voice functionality, Bluetooth and Wi-Fi Scan [1] to meet your specific application demands. Related information and details are listed in the table below:

Table 2: Brief Introduction of the Module

Categories	
Packaging and pins number	126-pin; LGA
Dimensions	(23.6 ±0.2) mm × (19.9 ±0.2) mm × (2.4±0.2)mm
Weight	2.5 ±0.2 g
Wireless network functions	LTE/GSM/Bluetooth/Wi-Fi Scan [1]
Variants	EG915U-CN [2]; EG915U-EU; EG915U-LA

2.1. Frequency Bands and Functions

Table 2: Wireless Network Type

Wireless Network Type	EG915U-CN	EG915U-EU	EG915U-LA
LTE-FDD	B1/B3/B5/B8	B1/B3/B5/B7/B8/B20/B28	B2/B3/B4/B5/B7/B8/B28 /B66
LTE-TDD	B34/B38/B39/B40/B41	-	-
GSM	900/1800 MHz	850/900/1800/1900 MHz	850/900/1800/1900 MHz
Bluetooth and Wi-Fi Scan [1]	2.4 GHz	2.4 GHz	2.4 GHz

[1] EG915U series support Bluetooth and Wi-Fi Scan functions. Due to the shared antenna interface, the two functions cannot be used simultaneously. Bluetooth and Wi-Fi Scan functions are optional (both supported or not), please contact Quectel Technical Support for details.
[2] Only EG915U-CN provides LTE-TDD, please consult Quectel Technical Support for details.

2.2. Key Features

The following table describes the detailed features of EG915U series module.

Table 4: Key Features of EG915U Series Module

Features	Description
Power Supply	● Supply voltage: 3.3–4.3 V ● Typical supply voltage: 3.8 V
Transmitting Power	**EG915U-CN:** ● EGSM900: Class 4 (33 dBm ±2 dB) ● DCS1800: Class 1 (30 dBm ±2 dB) ● LTE-FDD: Class 3 (23 dBm ±2 dB) ● LTE-TDD: Class 3 (23 dBm ±2 dB) **EG915U-EU:** ● GSM850/EGSM900: Class 4 (33 dBm ±2 dB) ● DCS1800/PCS1900: Class 1 (30 dBm ±2 dB) ● LTE-FDD: Class 3 (23 dBm ±2 dB) **EG915U-LA:** ● GSM850/EGSM900: Class 4 (33 dBm ±2 dB) ● DCS1800/PCS1900: Class 1 (30 dBm ±2 dB) ● LTE-FDD: Class 3 (23 dBm ±2 dB)
LTE Features	**EG915U-CN:** ● Supports up to Cat 1 FDD/TDD. ● Supports 1.4/3/5/10/15/20 MHz RF bandwidth. ● Supports uplink QPSK, 16QAM. ● Supports downlink QPSK, 16QAM and 64QAM. ● FDD: Max 10 Mbps (DL)/5 Mbps (UL). ● TDD: Max 8.96 Mbps (DL)/3.1 Mbps (UL). **EG915U-EU:** ● Supports up to Cat 1 FDD. ● Supports 1.4/3/5/10/15/20 MHz RF bandwidth. ● Supports uplink QPSK, 16QAM. ● Supports downlink QPSK, 16QAM and 64QAM. ● FDD: Max 10 Mbps (DL)/5 Mbps (UL). **EG915U-LA:** ● Supports up to Cat 1 FDD. ● Supports 1.4/3/5/10/15/20 MHz RF bandwidth. ● Supports uplink QPSK, 16QAM. ● Supports downlink QPSK, 16QAM and 64QAM.

	● FDD: Max 10 Mbps (DL)/5 Mbps (UL).
GSM Features	**GPRS:** ● Supports GPRS multi-slot class 12 ● Coding scheme: CS-1/CS-2/CS-3/CS-4 ● Max 85.6 Kbps (DL)/85.6 Kbps (UL)
Internet Protocol Features	● Supports TCP/UDP/PPP/NTP/NITZ/FTP/HTTP/PING/CMUX/HTTPS/ FTPS/SSL/FILE/MQTT/MMS protocols ● Support PAP (Password Authentication Protocol) and CHAP (Challenge Handshake Authentication Protocol) protocols which are usually used for PPP connection
SMS	● Text and PDU modes ● Point-to-point MO and MT ● SMS cell broadcast ● SMS storage: Stored in (U)SIM card and ME, stored in ME by default
(U)SIM Interface	● Supports USIM/SIM card: 1.8/3.0 V
UART Interfaces	**Main UART** ● Used for AT command communication and data transmission ● Baud rates reach up to 921600 bps; 115200 bps by default ● Supports RTS and CTS hardware flow control **Debug UART** ● Used for the output of partial logs ● Baud rate: 921600 bps ● Only used for debug UART, cannot be used for universal UART **Auxiliary UART**
SPI Interface	● Supports one SPI Interface (master mode only)
I2C Interface	● Supports one I2C Interface
PCM Interface	● Supports one PCM Interface
Audio Features	● Supports one analog audios input and one analog audios output ● GSM: HR/FR/EFR/AMR/AMR-WB ● Supports echo cancellation and noise suppression
ADC Interfaces	● Supports two ADC Interfaces
Network Indication	● NET_STATUS used to indicate the network connectivity status
AT Commands	● Compliant with *3G PP TS 27.007, 27.005* and Quectel enhanced AT commands
USB_BOOT Interface	● Supports one download control interface
Antenna Interfaces	● Main antenna interface (ANT_MAIN) ● Bluetooth and Wi-Fi Scan antenna interface (ANT_BT/WIFI_SCAN) ● 50 Ω impedance

Position Fixing	●	Support Wi-Fi Scan
Temperature Range	●	Operation temperature range: -35 to +75 ℃ [4] ● Extended temperature range: -40 to +85 ℃ [5] ● Storage temperature range: -40 to +90 ℃
Firmware Upgrade	●	USB interface and DFOTA
RoHS	●	All hardware components are fully compliant with EU RoHS directive

2.3. Functional Diagram

The following figure shows a block diagram of the module and illustrates the major functional parts.

- Power management
- Baseband
- Flash
- Radio frequency
- Peripheral interfaces

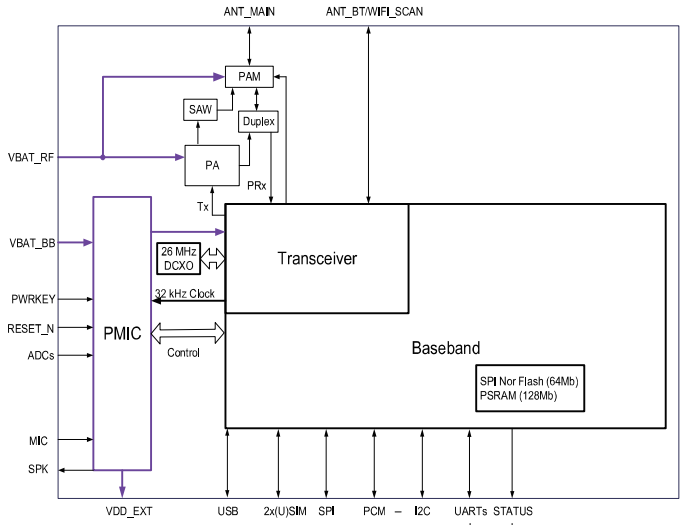

Figure 1: Functional Diagram

[4] Within operating temperature range, the module meets 3GPP specifications.
[5] Within extended temperature range, the module remains the ability to establish and maintain functions such as voice, SMS, data transmission, etc., without any unrecoverable malfunction. Radio spectrum and radio network are not influenced, while one or more specifications, such as P_{out}, may exceed the specified tolerances of 3GPP. When the temperature returns to the operating temperature range, the module meets 3GPP specifications again.

2.4. Pin Assignment

The following figure illustrates the pin assignment of the module.

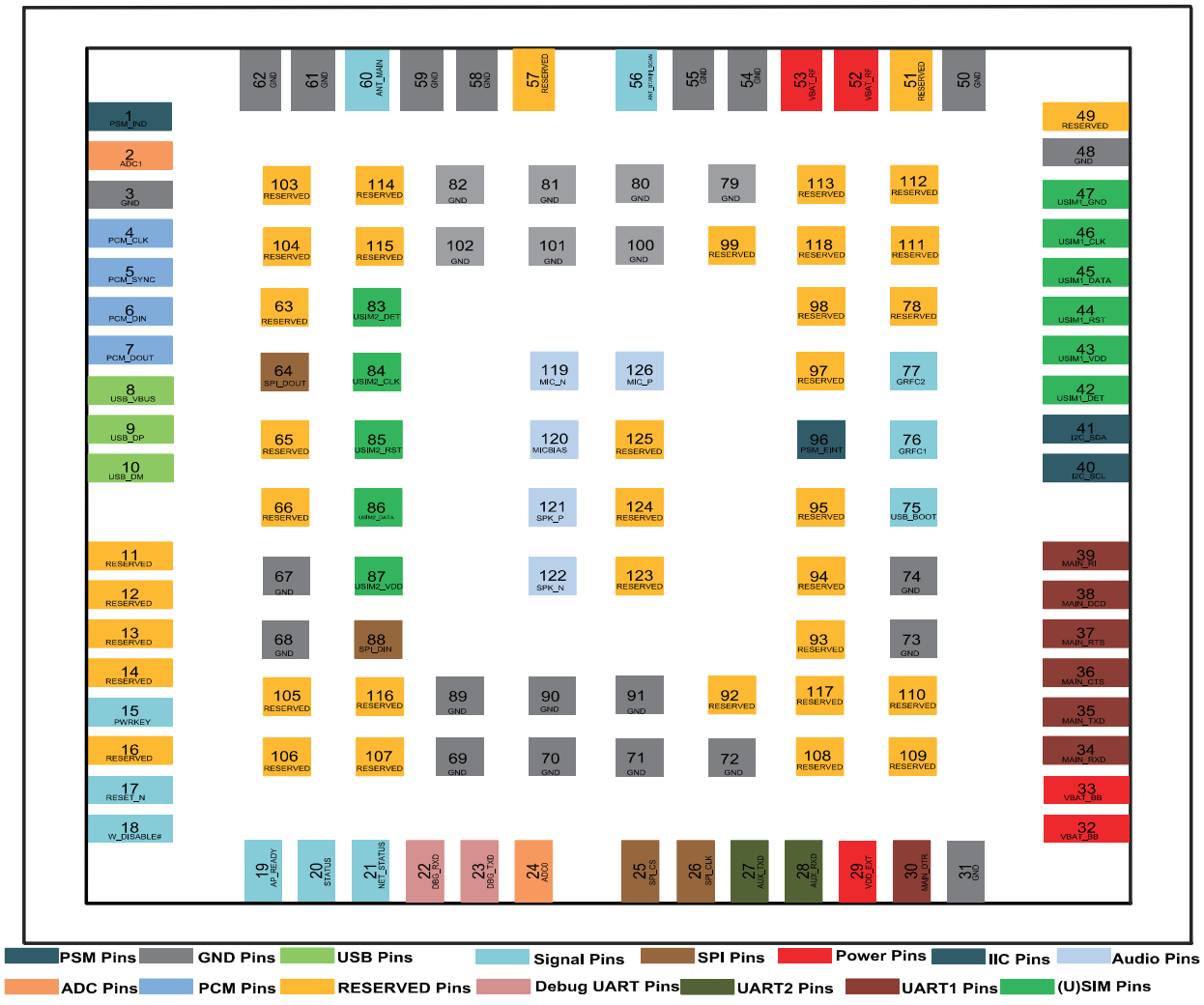

Figure 2: EG915U Series Module Pin Assignment (Top View)

NOTE

1. USB_BOOT cannot be pulled up before startup.
2. Keep NC and RESERVED pins unconnected, all GND pins shall be connected to the ground.
3. The function of PSM is under development and it is not recommended to use it right now.
4. The module supports dual-SIM single stand by. For details, please contact Quectel Technical Support.

2.5. Pin Description

The following tables show the pin definition of the module.

Table 3: I/O Parameters Definition

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

Table 4: Pin Description

Power Supply					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
VBAT_BB	32, 33	PI	Power supply for the module's baseband part	Vmax = 4.3 V Vmin = 3.3 V Vnom = 3.8 V	It must be provided with sufficient current up to 1 A
VBAT_RF	52, 53	PI	Power supply for the module's RF part		It must be provided with sufficient current up to 2.5 A
VDD_EXT	29	PO	Provide 1.8 V for external circuit	Vnom = 1.8 V $I_O$max = 50 mA	Power supply for external GPIO's pull-up circuits. Add 2.2 µF bypass capacitor when in use.

					If unused, keep it open.
Power On/Off					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
PWRKEY	15	DI	Turn on/off the module	V_{IL}max = 0.5 V	VBAT power domain.
RESET_N	17	DI	Reset the module		VBAT power domain. If unused, keep it open.
Indication Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
STATUS	20	DO	Indicate the module's operation status	V_{OH}min = 1.35 V V_{OL}max = 0.45 V	1.8 V power domain. If unused, keep it open
NET_STATUS	21	DO	Indicate the module's network activity status	V_{OH}min = 1.35 V V_{OL}max = 0.45 V	1.8 V power domain. If unused, keep it open.
USB Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
USB_VBUS	8	AI	USB connection detect	Vmax = 5.25 V Vmin = 3.5 V Vnom = 5.0 V	Typical: 5.0 V If unused, keep it open.
USB_DP	9	AIO	USB differential data (+)		USB 2.0 compliant. Require differential impedance of 90 Ω. If unused, keep it open.
USB_DM	10	AIO	USB differential data (-)		
(U)SIM Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
USIM1_VDD	43	PO	(U)SIM1 card power supply	$I_O$max = 50 mA **For 1.8 V (U)SIM:** Vmax = 1.9 V	Either 1.8 V or 3.0 V (U)SIM card is supported and

				Vmin = 1.7 V **For 3.0 V (U)SIM:** Vmax = 3.05 V Vmin = 2.7 V	can be identified automatically by the module.
USIM1_DATA	45	DIO	(U)SIM1 card data	**For 1.8 V (U)SIM:** V_{IL}max = 0.6 V V_{IH}min = 1.26 V V_{OL}max = 0.45 V V_{OH}min = 1.35 V **For 3.0 V (U)SIM:** V_{IL}max = 1.0 V V_{IH}min = 1.95 V V_{OL}max = 0.45 V V_{OH}min = 2.55 V	
USIM1_CLK	46	DO	(U)SIM1 card clock	**For 1.8 V (U)SIM:** V_{OL}max = 0.45 V V_{OH}min = 1.35 V **For 3.0 V (U)SIM:** V_{OL}max = 0.45 V V_{OH}min = 2.55 V	
USIM1_RST	44	DO	(U)SIM1 card reset	**For 1.8 V (U)SIM:** V_{OL}max = 0.45 V V_{OH}min = 1.35 V **For 3.0 V (U)SIM:** V_{OL}max = 0.45 V V_{OH}min = 2.55 V	
USIM1_DET	42	DI	(U)SIM1 card hot-plug detect	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.26 V V_{IH}max = 2.0 V	1.8 V power domain. If unused, keep this pin open
USIM1_GND	47	-	Ground	-	Specified ground for (U)SIM1 card
USIM2_VDD	87	PO	(U)SIM2 card power supply	Iomax = 50 mA **1.8 V (U)SIM:** Vmax = 1.9 V Vmin = 1.7 V **3.0 V (U)SIM:** Vmax = 3.05 V Vmin = 2.7 V	Either 1.8 V or 3.0 V (U)SIM card is supported and can be identified automatically by the module.

USIM2_DATA	86	DIO	(U)SIM2 card data	**1.8 V (U)SIM:** V_{IL}max = 0.6 V V_{IH}min = 1.26 V V_{OL}max = 0.45 V V_{OH}min = 1.35 V **3.0 V (U)SIM:** V_{IL}max = 1.0 V V_{IH}min = 1.95 V V_{OL}max = 0.45 V V_{OH}min = 2.55 V	
USIM2_CLK	84	DO	(U)SIM2 card clock	**1.8 V (U)SIM:** V_{OL}max = 0.45 V V_{OH}min = 1.35 V **3.0 V (U)SIM:** V_{OL}max = 0.45 V V_{OH}min = 2.55 V	
USIM2_RST	85	DO	(U)SIM2 card reset	**1.8 V (U)SIM:** V_{OL}max = 0.45 V V_{OH}min = 1.35 V **3.0 V (U)SIM:** V_{OL}max = 0.45 V V_{OH}min = 2.55 V	
USIM2_DET	83	DI	(U)SIM2 card hot-plug detect	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.26 V V_{IH}max = 2.0 V	1.8 V power domain. If unused, keep it open
Main UART Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
MAIN_CTS	36	DO	DTE clear to send signal to DCE (connect to DTE's CTS)	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	1.8 V power domain. If unused, keep it open. MAIN_DTR& MAIN_DCD& MAIN_RI will have a period of time when the module is powered on.
MAIN_RTS	37	DI	DTE request to send signal to DCE (connect to DTE's RTS)	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.26 V V_{IH}max = 2.0 V	
MAIN_RXD	34	DI	Main UART receive	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.26 V V_{IH}max = 2.0 V	

MAIN_DCD	38	DO	Main UART data carrier detect	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	
MAIN_TXD	35	DO	Main UART transmit	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	
MAIN_RI	39	DO	Main UART ring indication	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	
MAIN_DTR	30	DI	Main UART data terminal ready	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.26 V V_{IH}max = 2.0 V	
Auxiliary UART Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**comment**
AUX_TXD	27	DO	Auxiliary UART transmit	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	1.8 V power domain. If unused, keep it open.
AUX_RXD	28	DI	Auxiliary UART receive	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.26 V V_{IH}max = 2.0 V	1.8 V power domain. If unused, keep it open.
Debug UART Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
DBG_RXD	22	DI	Debug UART receive	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.26 V V_{IH}max = 2.0 V	1.8 V power domain. If unused, keep it open.
DBG_TXD	23	DO	Debug UART transmit	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	
I2C Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
I2C _SCL	40	OD	I2C serial clock		External pull-up resistor is required. 1.8 V only. If unused, keep it open.
I2C _SDA	41	OD	I2C serial data		The I2 C interface supports simultaneous

					connection of multiple peripherals except for codec IC
PCM Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
PCM_SYNC	5	DI	PCM data frame sync	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.26 V V_{IH}max = 2.0 V	1.8 V power domain. If unused, keep it open. Support slave mode only.
PCM_CLK	4	DI	PCM clock	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.26 V V_{IH}max = 2.0 V	
PCM_DIN	6	DI	PCM data input	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.26 V V_{IH}max = 2.0 V	
PCM_DOUT	**7**	DO	PCM data output	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	
RF Antenna Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
ANT_MAIN	60	AIO	Main antenna interface		50 Ω impedance
ANT_BT/ WIFI_SCAN	56	AIO	The shared interface for Bluetooth and Wi-Fi Scan		50 Ω impedance. If unused, keep it open
GRFC Antenna Tuner Control Interface*					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
GRFC1	76	DO	Generic RF Controller		If unused, keep it open.
GRFC2	77	DO			
SPI Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
SPI_CLK	26	DO	SPI clock	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	Master mode only.
SPI_CS	25	DO	SPI chip select	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	

SPI_DIN	88	DI	SPI master mode input	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.26 V V_{IH}max = 2.0 V	
SPI_DOUT	64	DO	SPI master mode output	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	
ADC Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
ADC0	24	AI	General-purpose ADC interface	Voltage range: 0.1 V to VBAT	If unused, keep it open.
ADC1	2	AI			
Analog Audio Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
MIC_N	119	AI	Microphone analog input (-)		
MICBIAS	120	PO	Bias voltage output for microphone	Vo = 2.2–3.0 V Vnom = 2.2 V	
SPK_P	121	AO	Analog audio differential output (+)		
SPK_N	122	AO	Analog audio differential output (-)		
MIC_P	126	AI	Microphone analog input (+)		
USB_BOOT					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
USB_BOOT	75	DI	Control pin for module to enter download mode	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.26 V V_{IH}max = 2.0 V	1.8 V power domain. Active high. A circuit that enables the module to enter the download mode must be reserved.
PSM Interface*					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**

PSM_IND	1	DO	Indicate the module's power saving mode		
PSM_EINT	96	DI	External interrupt pin; wake up the module from PSM		
Other Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
W_DISABLE#	18	DI	Airplane mode control	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.26 V V_{IH}max = 2.0 V	1.8 V power domain. Pulled up by default. When it is in low voltage level, the module can enter airplane mode. If unused, keep it open. When the pin is powered on, there will be a period of time when the level status is uncertain.
AP_READY	19	DI	Application processor ready	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.26 V V_{IH}max = 2.0 V	1.8 V power domain. If unused, keep it open. When the PIN pin is powered on, there will be a period of time when the level status is uncertain.
GND					
Pin Name	**Pin No.**				
GND	3, 31, 48, 50, 54, 55, 58, 59, 61, 62, 67, 68, 69, 70, 71, 72, 73, 74, 79, 80, 81, 82, 89, 90, 91, 100, 101, 102				
RESERVED					
Pin Name	**Pin No.**				

NOTE	11, 12, 13, 14, 16, 49, 51, 57, 65, 66, 78, 92, 93, 94, 95, 97, 98, 99, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 123, 124, 125

1. The functions of PSM and GRFC are under development and it is not recommended to use them right now, please consult Quectel Technical Support for details.

5. PIN18(MAIN_W_DISABLE)&PIN19(AP_READY)&PIN30(MAIN_DTR) &PIN38(MAIN_DCD)&PIN39(MAIN_RI) When the module is powered on, there will be a period of time when the power level is indeterminate. First, high level 3V lasts for 2 seconds, then low power Ping lasts for 1.2 seconds, and then it is configured as 1.8V input/output. According to specific usage scenarios and circuit design, please evaluate whether the output stage that is indeterminate when the power is just turned on meets the customer's application design requirements.

2.6. EVB

In order to help customers develop applications with EG915U series moduel. Quectel provides an evaluation board (UMTS&LTE EVB), USB to RS-232 converter cable, earphone, antennas and other peripherals to control or test the module. For more details, please refer to ***document [1]***.

3 Operating Characteristics

EG915U series module have a total of 126 pins, The subsequent chapters will provide detailed descriptions of the following interfaces.

- Power supply
- (U)SIM interface
- USB interface
- UART interfaces
- SPI interface
- PCM and I2C interfaces
- Analog audio interfaces
- ADC interfaces
- PSM interface*
- Status indication
- USB_BOOT interface

3.1. Operating Modes

The following table briefly outlines the operating modes to be mentioned in the following chapters.

Table 5: Overview of Operating Modes

Mode	Details	
Normal Operation	Idle	Software is active. The module is registered on the network and ready to send and receive data.
	Talk/Data	Network connection is ongoing. In this mode, the power consumption is decided by network setting and data transfer rate.
Minimum Functionality Mode	**AT+CFUN=0** command can set the module to a minimum functionality mode without removing the power supply. In this case, both RF function and (U)SIM card will be invalid.	
Airplane Mode	**AT+CFUN=4** command or W_DISABLE# pin can set the module to airplane mode. In this case, RF function will be invalid.	
Sleep Mode	In this mode, current consumption of the module will be reduced to the minimal	

	level. In this mode, the module can still receive paging, SMS, voice call and TCP/UDP data from network normally.
Power Down Mode	In this mode, the VBAT power supply is constantly turned on and the software stops working.

3.2. Sleep Mode

The module is able to reduce its current consumption to an ultra-low value in the sleep mode. The following section describes power saving procedures of EG915U series module.

3.2.1 UART Application Scenario

If the host communicates with module via UART interface, the following preconditions should be met to let the module enter sleep mode.

- Execute **AT+QSCLK=1** to enable sleep mode.
- Drive MAIN_DTR to high level.

The following figure shows the connection between the module and the host.

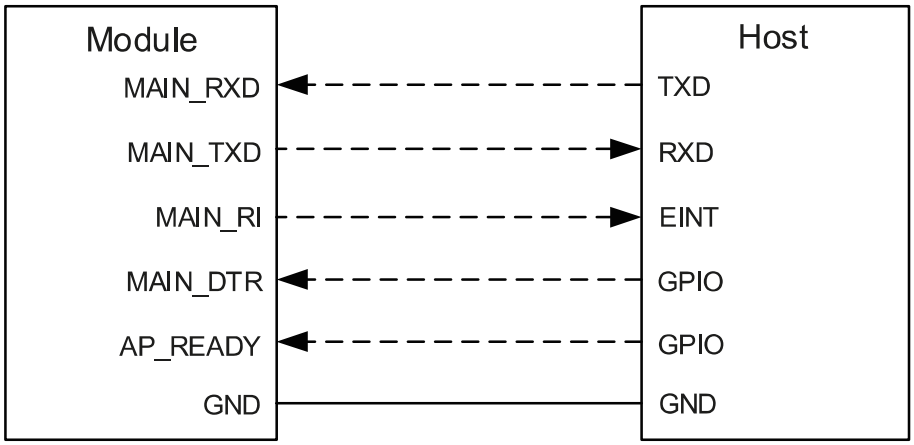

Figure 3: Sleep Mode Application via UART

- Driving MAIN_DTR low will wake up the module.
- When EG915U series has a URC to report, the URC will trigger the behavior of MAIN_RI pin. See ***Chapter 4.10.3*** for details about MAIN_RI behavior.

3.2.2. USB Application Scenario

If the host supports USB suspend/resume and remote wakeup functions, the following three preconditions can make the module enter the sleep mode.

- Execute **AT+QSCLK=1** to enable the sleep mode.
- Ensure the MAIN_DTR is kept at high level or kept open.
- Ensure the host's USB Bus, which is connected with the module's USB interface, enters suspend state.

The following figure shows the connection between the module and the host.

3.2.2.1.USB Application with USB Remote Wakeup Function

The host supports USB Suspend/Resume and remote wakeup function.
The following figure illustrates the connection between the module and the host.

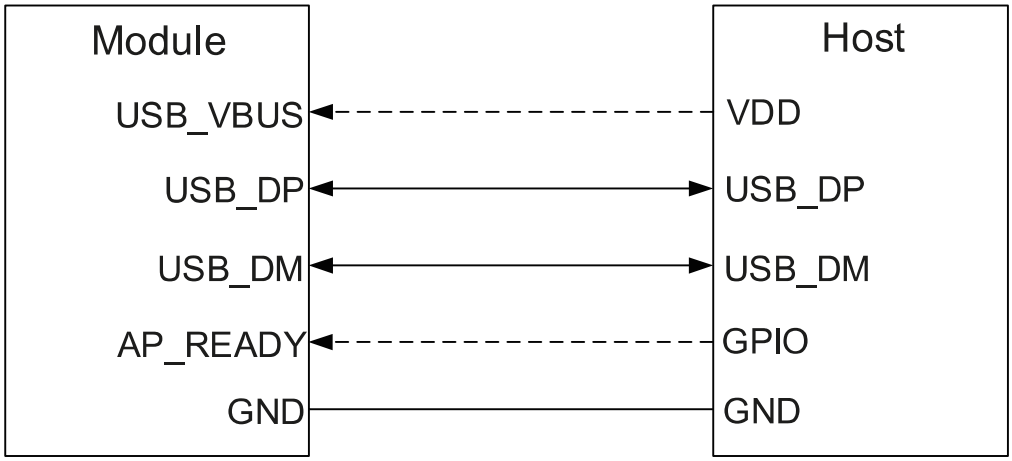

Figure 4: Sleep Mode Application with USB Remote Wakeup

- You can wake up the module by sending data to it through USB.
- When the module has a URC to report, the module will send remote wakeup signals via USB bus so as to wake up the host.

NOTE

1. Under Linux OS, USB support Suspend, under Windows OS nonsupport Suspend.
2. Pay attention to the level match shown in dotted line between the module and the host.

3.2.2.2.USB Application with USB Suspend/Resume and MAIN_RI Wakeup 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 figure shows the connection between the module and the host.

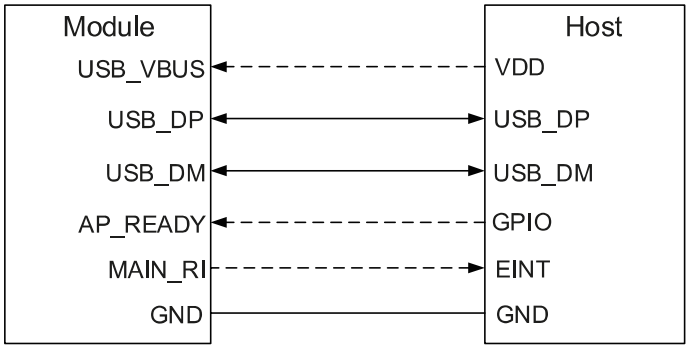

Figure 5: Sleep Mode Application with MAIN_RI

- Sending data to the module through USB will wake up the module.
- When the module has a URC to report, the URC will trigger the behavior of MAIN_RI pin.

3.3. Airplane Mode

When the module enters into airplane mode, the RF function will be disabled, and all AT commands related to it will be inaccessible. This mode can be set via the following ways.

3.3.1. Hardware

The W_DISABLE# pin is pulled up by default. Its control function for airplane mode is disabled by default and **AT+QCFG="airplanecontrol",1** can be used to enable the function. Driving it low will set the module enter airplane mode.

3.3.2. Software

AT+CFUN=<fun> provides choices of the functionality level through setting <fun> into 0, 1 or 4.

- **AT+CFUN=0**: Minimum functionality (disable RF function and (U)SIM function).
- **AT+CFUN=1**: Full functionality (default).
- **AT+CFUN=4**: Airplane mode (disable RF function).

3.4. Power Supply

3.4.1. Power Supply Pins

The module provides 4 VBAT pins for connection with an external power supply.

- Two VBAT_RF pins for RF part.
- Two VBAT_BB pins for BB part.

Table 6: Pin Definition of Power Supply

Pin Name	Pin No.	I/O	Description	Min.	Typ.	Max.	Unit
VBAT_BB	32, 33	PI	Power supply for the module's baseband 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
GND	3, 31, 48, 50, 54, 55, 58, 59, 61, 62, 67, 68, 69, 70, 71, 72, 73, 74, 79, 80, 81, 82, 89, 90,						

	91, 100, 101, 102

3.4.2. Reference Design for Power Supply

The power design for the module is very important, as the performance of the module largely depends on the power source. The power supply of the module should be able to provide sufficient current of 3.0 A at least. If the voltage drops between input and output is not too high, it is suggested that an LDO should be used to supply power to the module. If there is a big voltage difference between the input source and the desired output (VBAT), a buck converter is recommended.

The following figure illustrates a reference design for +5 V input power source. The typical output of the power supply is about 3.8 V and the maximum load current is 3.0 A.

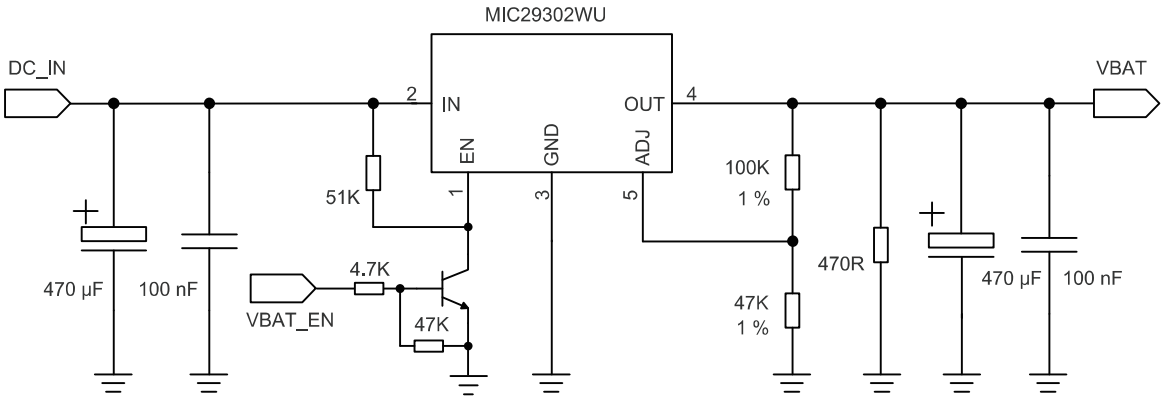

Figure 6: Reference Design of Power Supply

3.4.3. Requirements for Voltage Stability

The power supply range of the module is from 3.3 V to 4.3 V. Please make sure the input voltage will never drop below 3.3 V.

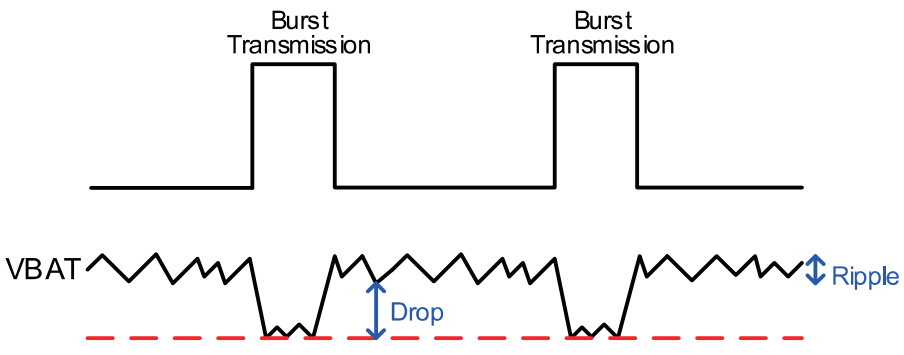

Figure 7: Power Supply Limits during Burst Transmission

To decrease the voltage drop, use bypass capacitors of about 100 μF with low ESR (ESR = 0.7 Ω) and reserve a multi-layer ceramic chip (MLCC) capacitor array due to their ultra-low ESR. It is recommended to use three ceramic capacitors (100 nF, 33 pF, 10 pF) for composing the MLCC array, and place these capacitors close to the VBAT_SENSE and VBAT_RF pins. When the external power supply is connected to the module, VBAT_SENSE and VBAT_RF need to be routed in star structure. The width of the VBAT_RF trace should not be less than 2.5 mm. When used as a power supply pin (that is, without charging function), the width of the VBAT_SENSE trace should not be less than 1 mm. In principle, the longer the VBAT trace is, the wider it will be.

In addition, to avoid the surge, use a TVS diode of which reverse working voltage is 4.7 V and peak pulse power is up to 2550 W. The reference circuit is shown as below:

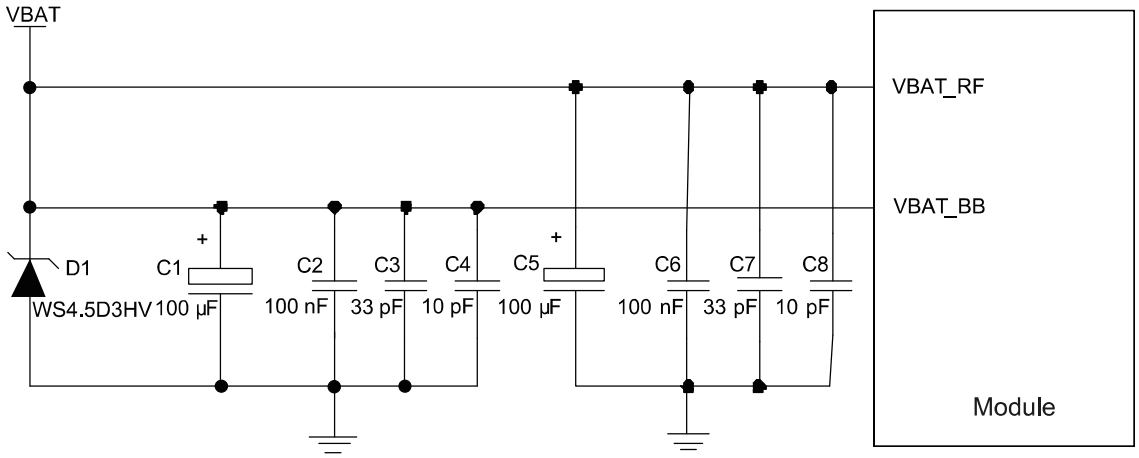

Figure 8: Power Supply

3.5. Turn on

3.5.1. Turn on with PWPKEY

Table 7: Pin Definition of PWRKEY

Pin Name	Pin No.	I/O	Description	Comment
PWRKEY	15	DI	Turn on/off the module	VBAT power domain.

When the module is in power down mode, you can turn it on to normal mode by driving the PWRKEY pin low for at least 2 s. It is recommended to use an open drain/collector driver to control the PWRKEY. A

simple reference circuit is illustrated in the following figure.

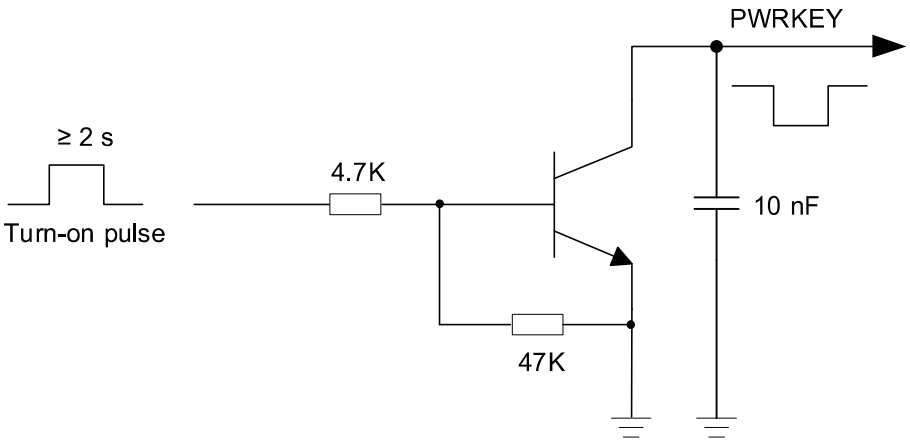

Figure 9: Turing on the Module Using Driving Circuit

Another way to control the PWRKEY is using a button directly. When you are pressing the key, electrostatic strike may be generated from finger. Therefore, you must place a TVS component nearby the button for ESD protection. A reference circuit is shown in the following figure.

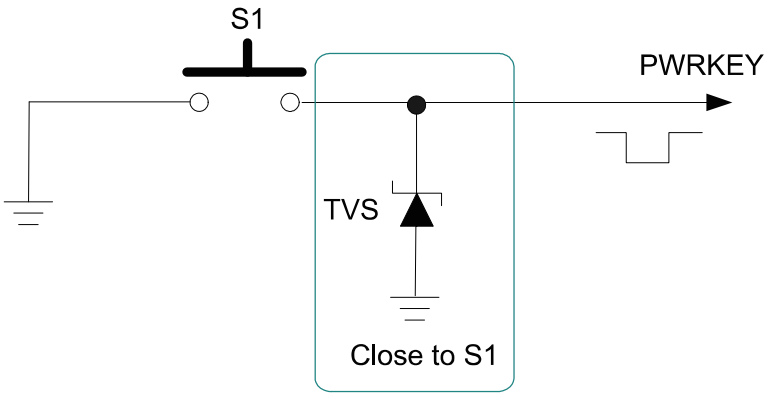

Figure 10: Turing on the Module Using Button

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

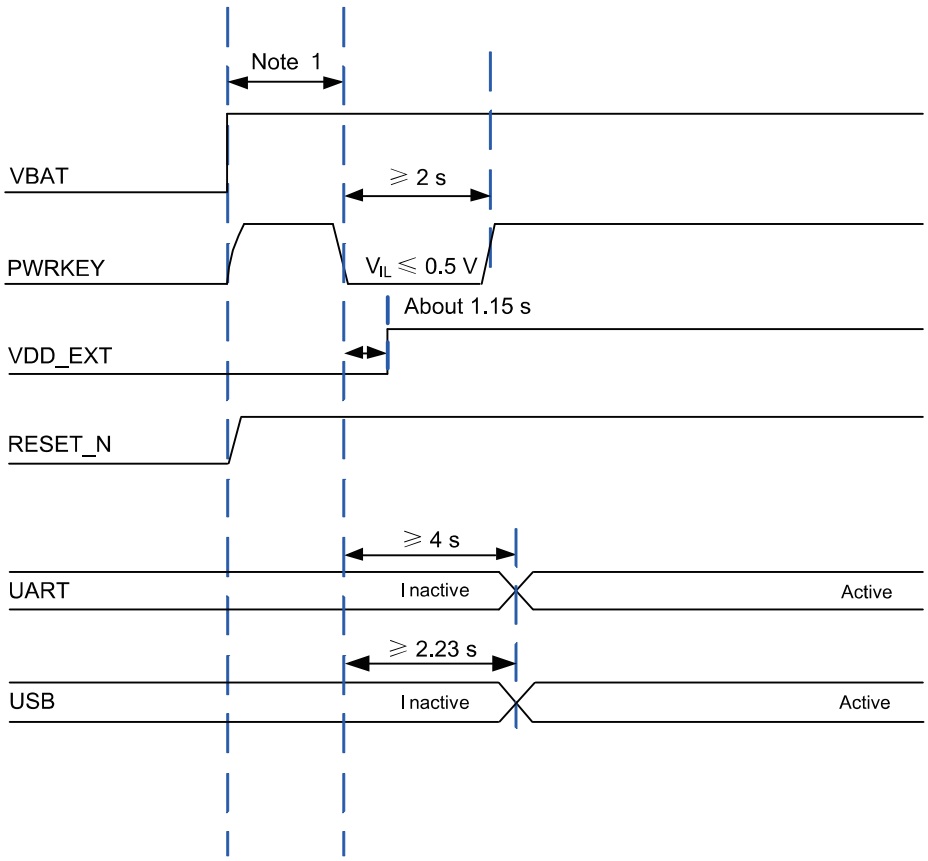

Figure 11: Power-up Timing

NOTE

1. Make sure that the VBAT is stable before pulling down PWRKEY pin. It is recommended that the time difference between powering up VBAT and pulling down PWRKEY pin is no less than 30 ms.
2. PWRKEY can be pulled down directly to GND with a recommended 1 kΩ resistor if the module needs to be powered on automatically and shutdown is not needed.

3.6. Turn off

The following procedures can be used to turn off the module:

- Using the PWRKEY pin.
- Using **AT+QPOWD**.

3.6.1. Turn off with PWPKEY

Drive the PWRKEY pin low for at least 3 s and then release PWRKEY. After this, the module executes power-down procedure. The power-down scenario is illustrated in the following figure.

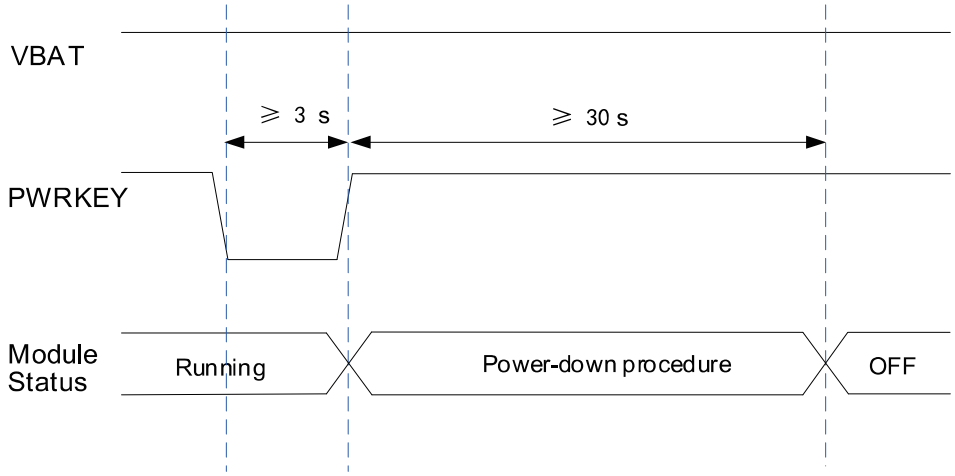

Figure 12: Timing of Turning off Module

3.6.2. Turn off with AT Command

It is also a safe way to use **AT+QPOWD** to turn off the module, which is similar to turning off the module via the PWRKEY pin.

Please refer to ***document [2]*** for details about **AT+QPOWD** command.

NOTE

1. To avoid damaging internal flash, do not switch off the power supply when the module works normally. Only after shutting down the module with PWRKEY or AT command can you cut off the power supply.
2. When keeping the PWRKEY to the ground and the AT command cannot be used to turn off, the module can only be forced to turn off by cutting off the VBAT power supply. Therefore, we recommend that you can turn on or turn off the module by pulling up and pulling down the PWEKEY instead of keeping the PWRKEY to the ground.
3. The time for the module to log out of the network is related to the current network status, so the specific shutdown time is related to the network status, please pay attention to the shutdown time in the design.

3.7. Reset

The RESET_N pin can be used to reset the module. The module can be reset by pulling the RESET_N pin low for at least 100 ms and then releasing it. 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 8: Pin Description of RESET_N

Pin Name	Pin No.	I/O	Description	Comment
RESET_N	17	DI	Reset the module	VBAT power domain. If unused, keep it open.

The recommended circuit is similar to the PWRKEY control circuit. An open drain/collector driver or button can be used to control the RESET_N.

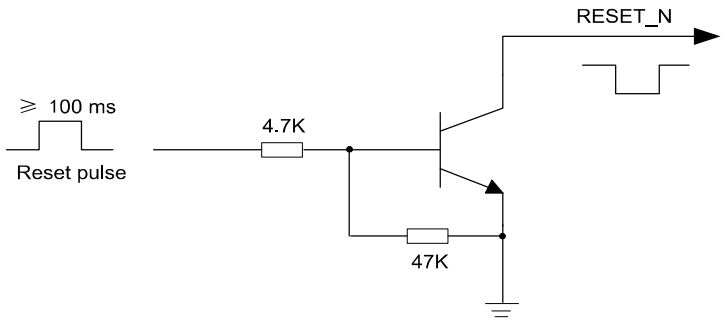

Figure 13: Reference Circuit of RESET_N by Using Driving Circuit

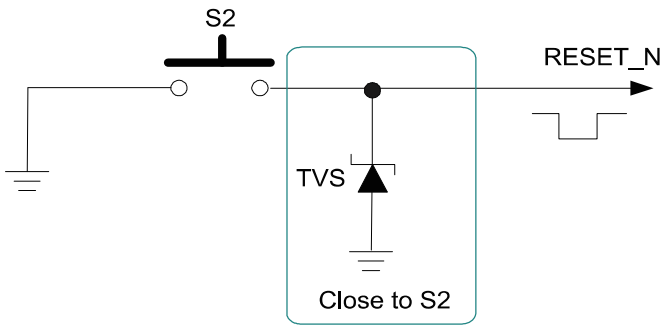

Figure 14: Reference Circuit of RESET_N by Using Button

The reset scenario is illustrated in the following figure.

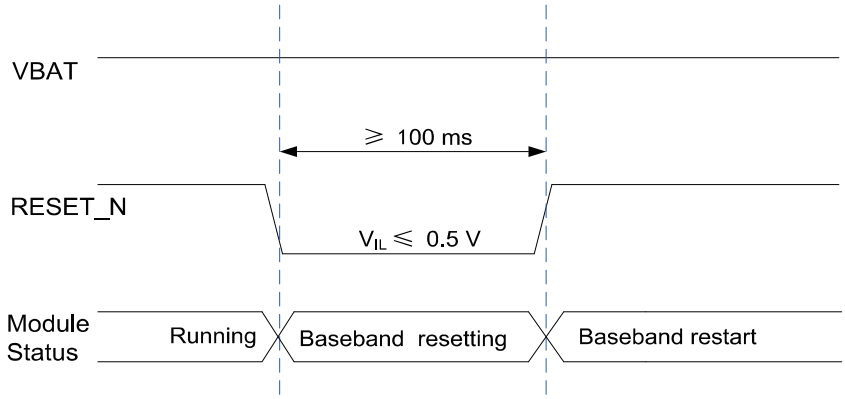

Figure 15: Timing of Resetting the Module

NOTE

1. Ensure that there is no large capacitance exceeding 10 nF on PWRKEY and RESET_N pins.
2. It is recommended to use RESET_N only when you fail to turn off the module with the **AT+QPOWD** or PWRKEY pin.

4 Application Interfaces

4.1. Analog Audio Interfaces

The module provides one analog audio input channel and one analog audio output channel. The pin definitions are shown in the following table.

Table 9: Pin Definition of Analog Audio Interfaces

Pin Name	Pin No.	I/O	Description
MIC_N	119	AI	Microphone analog input (-)
MICBIAS	120	PO	Bias voltage output for microphone
SPK_P	121	AO	Analog audio differential output (+)
SPK_N	122	AO	Analog audio differential output (-)
MIC_P	126	AI	Microphone analog input (+)

- AI channels are differential input channels, which can be applied for input of microphone (usually an electret microphone is used).
- AO channels are differential output channels, which can be applied for output receiver.
- The module's internal audio amplifier is configured as a class AB amplifier by default.

4.1.1. Audio Interfaces Design Considerations

It is recommended to use the electret microphone with dual built-in capacitors (e.g., 10 pF and 33 pF) for filtering out RF interference, thus reducing TDD noise. The 33 pF capacitor is applied for filtering out RF interference when the module is transmitting at EGSM900. Without placing this capacitor, TDD noise could be heard. The 10 pF capacitor here is used for filtering out RF interference at DCS1800. Note that the resonant frequency point of a capacitor largely depends on the material and production technique. Therefore, you would have to discuss with your capacitor vendors to choose the most suitable capacitor for filtering out high-frequency noises.

The filter capacitors on the PCB board should be placed as close to the audio devices or audio interfaces

as possible, and the traces should be as short as possible. They should go through the filter capacitors before arriving at other connection points.

To reduce radio or other signal interference, RF antennas should be placed away from audio interfaces and audio traces. Power traces should not be parallel with and also should be far away from the audio traces.

The differential audio traces must be routed according to the differential signal layout rule.

4.1.2. Microphone Interface Design

The microphone channel reference circuit is shown in the following figure.

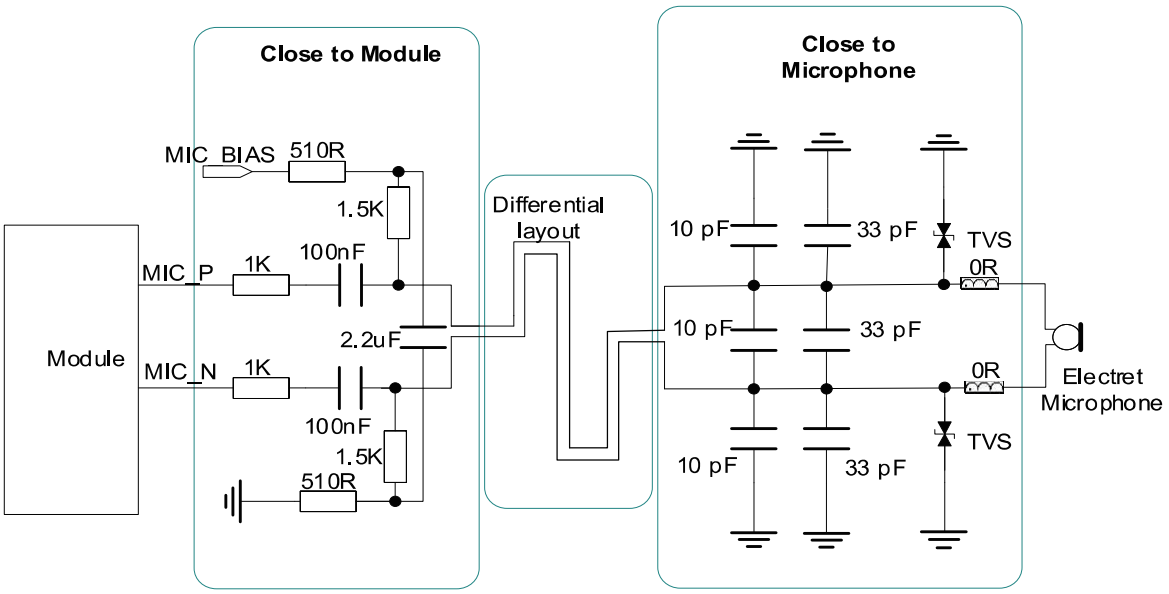

Figure 16: Reference Design for Microphone Interface

NOTE

MIC channel is sensitive to ESD, so it is not recommended to remove the ESD components used for protecting the MIC.

4.1.3. Receiver Interface Design

The receiver channel reference circuit is shown in the following figure:

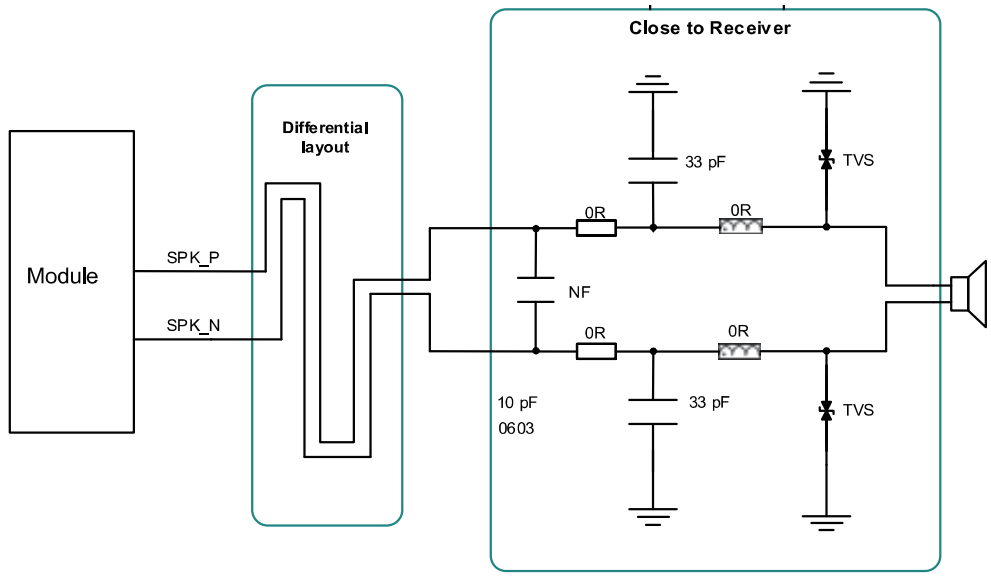

Figure 17: Reference Design for Receiver Interface

4.2. USB Interface

EG915U series module provides one integrated Universal Serial Bus (USB) interface which complies with the USB 2.0 specification and supports full-speed (12 Mbps) and high-speed (480 Mbps) modes. The USB interface can only serve as a slave device and is used for AT command communication, data transmission, software debugging and firmware upgrade.

Table 10: Functions of the USB Interface

Functions	
Data communication with external AP	Y
AT command communication	Y
Data transmission	Y
GNSS NMEA output	N
Software debugging	Y
Firmware upgrade	Y
Voice over USB	N

Table 11: Pin Definition of USB Interface

Pin Name	Pin No.	I/O	Description	Comment
USB_VBUS	8	AI	USB connection detect	Typical 5.0 V Minimum 3.5 V
USB_DP	9	AIO	USB differential data (+)	USB 2.0 compliant. Require differential impedance of 90 Ω. If unused, keep it open.
USB_DM	10	AIO	USB differential data (-)	

For more details about the USB 2.0 specifications, visit http://www.usb.org/home.

It is recommended to reserve test points for debugging and firmware upgrade in your design. The following figure shows a reference circuit of USB interface.

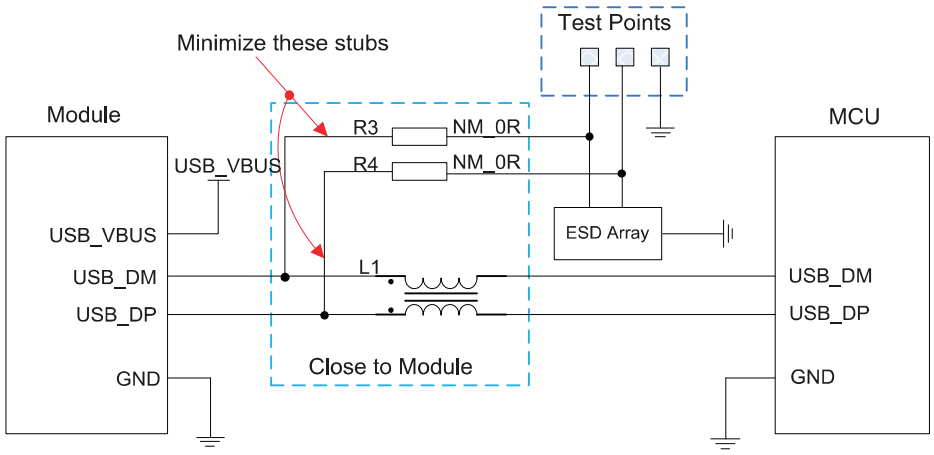

Figure 18: Reference Circuit of USB Application

A common mode choke L1 is recommended to be added in series between the module and your MCU to suppress EMI spurious transmission. Meanwhile, the 0 Ω resistors (R3 and R4) should be added in series between the module and the test points so as to facilitate debugging, and the resistors are not mounted by default. To ensure the signal integrity of USB data lines, L1, R3 and R4 must be placed close to the module, and resistors R3 and R4 should be placed close to each other. The extra stubs of trace must be as short as possible.

When designing the USB interface, you should follow the following principles to meet USB 2.0 specification.

- Route the USB signal traces as differential pairs with ground surrounded. The impedance of USB differential trace is 90 Ω.
- Do not route signal traces under crystals, oscillators, magnetic devices and RF signal traces. Route the USB differential traces in inner-layer of the PCB, and surround the traces with ground on that

layer and ground planes above and below.

- Pay attention to the selection of the ESD component on the USB data line. Its stray capacitance should not exceed 2 pF and should be placed as close as possible to the USB connector.

4.3. USB_BOOT Interface

The module provides a USB_BOOT pin. You can pull up USB_BOOT to VDD_EXT before power-up and the module will enter download mode when it is turned on. In this mode, the module supports firmware upgrade over USB interface.

Table 12: Pin Definition of USB_BOOT Interface

Pin Name	Pin No.	I/O	Description	Comment
USB_BOOT	75	DI	Control pin for module to enter download mode	1.8 V power domain. Active high. A circuit that enables the module to enter the download mode must be reserved.

The following figure shows a reference circuit of USB_BOOT interface.

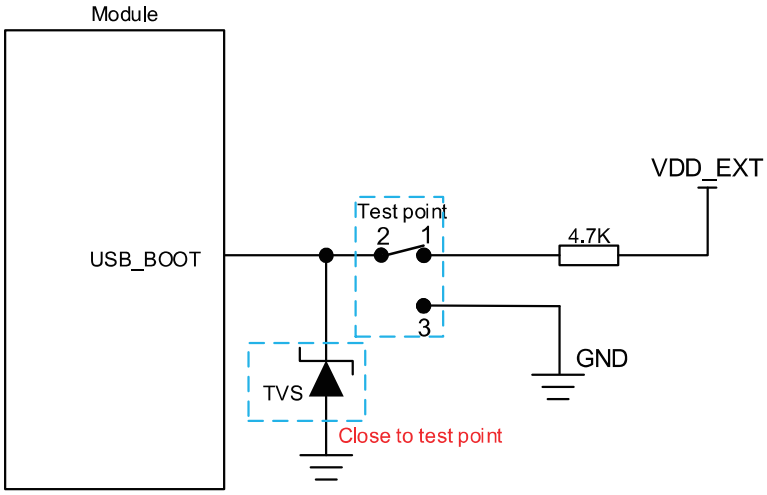

Figure 19: Reference Circuit of USB_BOOT Interface

4.4. (U)SIM Interface

The module provides 2 (U)SIM interfaces, dual SIM single stand by. The (U)SIM interfaces circuitry meets ETSI requirement. Both 1.8 V and 3.0 V (U)SIM cards are supported.

Table 15: Pin Definition of (U)SIM Interfaces

Pin Name	Pin No.	I/O	Description	Comment
USIM1_VDD	43	PO	(U)SIM1 card power supply	Either 1.8 V or 3.0 V (U)SIM card is supported and can be identified automatically by the module.
USIM1_DATA	45	DIO	(U)SIM1 card data	
USIM1_CLK	46	DO	(U)SIM1 card clock	
USIM1_RST	44	DO	(U)SIM1 card reset	
USIM1_DET	42	DI	(U)SIM1 card hot-plug detect	1.8 V power domain. If unused, keep this pin open
USIM1_GND	47			Specified ground for (U)SIM1 card
USIM2_VDD	87	PO	(U)SIM2 card power supply	Either 1.8 V or 3.0 V (U)SIM card is supported and can be identified automatically by the module.
USIM2_DATA	86	IO	(U)SIM2 card data	
USIM2_CLK	84	DO	(U)SIM2 card clock	
USIM2_RST	85	DO	(U)SIM2 card reset	
USIM2_DET	83	DI	(U)SIM2 card hot-plug detect	1.8 V power domain. If unused, keep it open

EG915U series module supports (U)SIM card hot-plug via the USIM_DET pin and both high and low level detections are supported. By default, the function is disabled, please see **AT+QSIMDET** in ***document [2]*** for more details.

The following figure shows a reference design for (U)SIM interface with an 8-pin (U)SIM card connector.

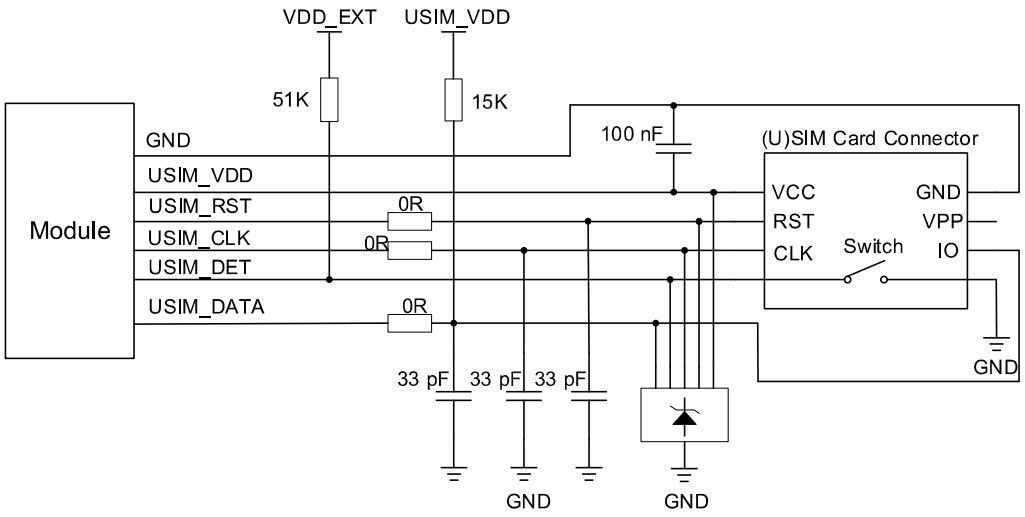

Figure 20: Reference Circuit of (U)SIM Interface with an 8-Pin (U)SIM Card Connector

If (U)SIM card detection function is not needed, please keep USIM_DET unconnected. A reference circuit for (U)SIM interface with a 6-pin (U)SIM card connector is illustrated in the following figure.

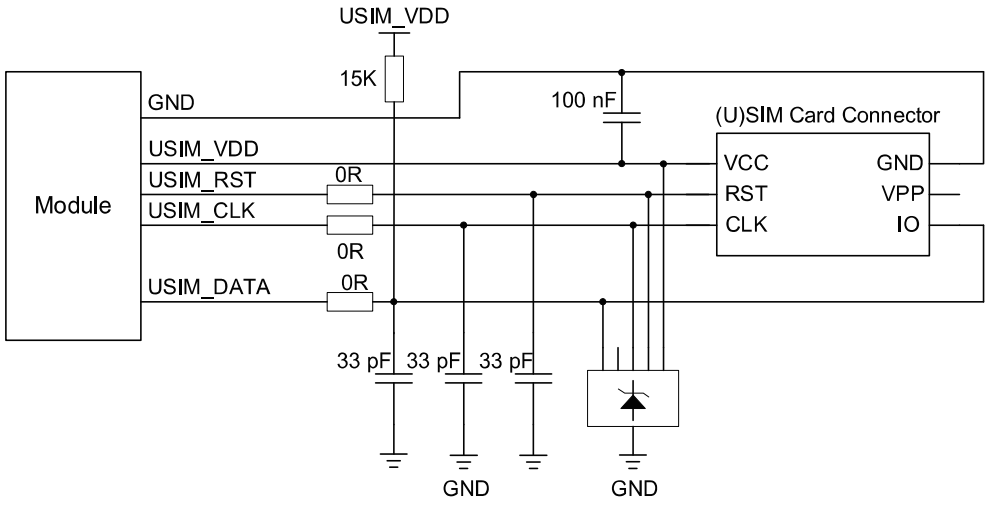

Figure 21: Reference Circuit of (U)SIM Interface with a 6-Pin (U)SIM Card Connector

To enhance the reliability and availability of the (U)SIM card in applications, follow the criteria below in (U)SIM circuit design:

- Place (U)SIM card connector as close to the module as possible. Keep the trace length less than 200 mm as far as possible.
- Keep (U)SIM card signals away from RF and VBAT traces.
- Ensure the USIM_VDD has a bypass capacitor less than 1 μF, and the capacitor should be close to the (U)SIM card connector.

- To avoid cross-talk between USIM_DATA and USIM_CLK, keep them away from each other and shield them with surrounded ground.
- To offer good ESD protection, it is recommended to add a TVS diode array of which the parasitic capacitance should be less than 15 pF. Add 0 Ω resistors in series between the module and the (U)SIM card to facilitate debugging. The 33 pF capacitors are used for filtering interference of EGSM900. Additionally, keep the (U)SIM peripheral circuit close to the (U)SIM card connector.
- The pull-up resistor on USIM_DATA can improve anti-jamming capability of the (U)SIM card. If the (U)SIM card traces are too long, or the interference source is relatively close, it is recommended to add a pull-up resistor near the (U)SIM card connector.

4.5. I2C and PCM Interfaces

The module provides one I2C interface and one pulse code modulation (PCM) interface. The PCM interface of the module only supports slave mode; therefore, the clock signal of the codec IC needs to be provided externally.

Table 13: Pin Definition of I2C and PCM Interfaces

Pin Name	Pin No.	I/O	Description	Comment
I2C _SCL	40	OD	I2C serial clock	External pull-up resistor is required. 1.8 V only. If unused, keep it open. If the I2C interface is used to connect to external codec, it cannot connect to other external devices.
I2C _SDA	41	OD	I2C serial data	
PCM_DIN	6	DI	PCM data input	1.8 V power domain. If unused, keep it open. Support slave mode only.
PCM_DOUT	7	DO	PCM data output	
PCM_SYNC	5	DI	PCM data frame sync	
PCM_CLK	4	DI	PCM clock	

The following figure shows a reference design of PCM interface with external codec IC.

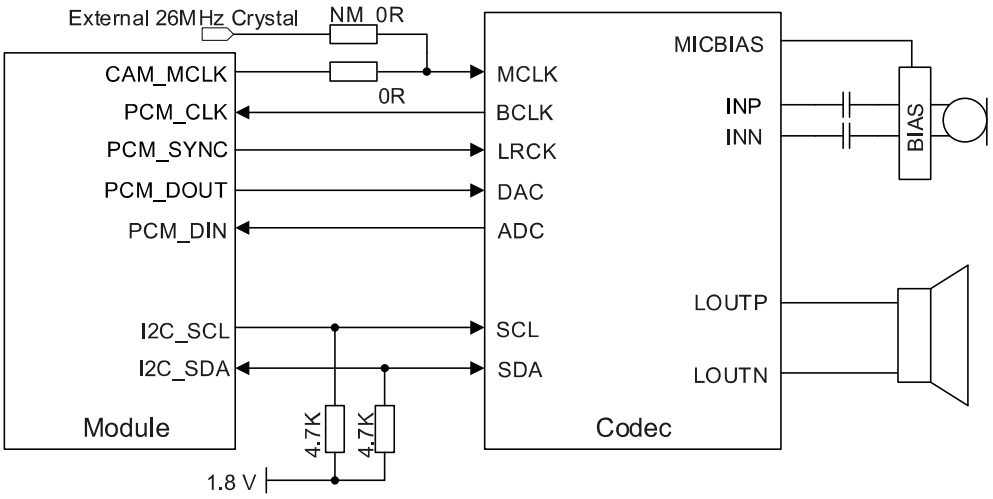

Figure 22: Reference Circuit of I2 C and PCM Application with Audio Codec

NOTE

1. It is recommended to reserve an RC (R = 22 Ω, C = 22 pF) circuit on the PCM traces, especially for PCM_CLK.
2. The I2 C interface supports simultaneous connection of multiple peripherals except for codec IC. In other words, if a codec IC has been mounted on the I2 C bus, no other peripherals can be mounted; if there is no codec IC on the bus, multiple peripherals can be mounted.

4.6. UART Interfaces

The module provides three UART interfaces: the main UART interface and the debug UART interface and auxiliary UART. Their features are described as follows.

- Main UART interface supports 4800 bps, 9600 bps, 19200 bps, 38400 bps, 57600 bps, 115200 bps, 230400 bps, 460800 bps and 921600 bps baud rates, and the default is 115200 bps. This interface is used for data transmission and AT command communication.
- Debug UART interface supports 921600 bps baud rate. It is used for the output of partial logs.
- Auxiliary UART.

Table 14: Pin Definition of Main UART Interface

Pin Name	Pin No.	I/O	Description	Comment
MAIN_CTS	36	DO	DTE clear to send signal to DCE (connect to DTE's CTS)	1.8 V power domain. If unused, keep it

MAIN_RTS	37	DI	DTE request to send signal to DCE (connect to DTE's RTS)	open.
MAIN_RXD	34	DI	Main UART receive	
MAIN_DCD	38	DO	Main UART data carrier detect	
MAIN_TXD	35	DO	Main UART transmit	
MAIN_RI	39	DO	Main UART ring indication	
MAIN_DTR	30	DI	Main UART data terminal ready	

Table 15: Pin Definition of Debug UART Interface

Pin Name	Pin No.	I/O	Description	Comment
DBG_RXD	22	DI	Debug UART receive	1.8 V power domain. If unused, keep it open.
DBG_TXD	23	DO	Debug UART transmit	

Table 16: Auxiliary UART

Pin Name	Pin No.	I/O	Description	Comment
AUX_TXD	27	DO	Auxiliary UART transmit	1.8 V power domain. If unused, keep it open.
AUX_RXD	28	DI	Auxiliary UART receive	

The module provides 1.8 V UART interfaces. Use a level shifter if the application is equipped with a 3.3 V UART interface. A level shifter TXS0108EPWR provided by Texas Instruments is recommended. The following figure shows a reference design.