EC25 Series

Hardware Design

LTE Standard Module Series

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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
1.0	2016-04-01	Woody WU	Initial
1.1	2016-09-22	Lyndon LIU/ Frank WANG	1. Updated EC25 series frequency bands in Table 1. 2. Updated transmitting power, supported maximum baud rate of main UART/internal protocols/USB drivers of USB interface, firmware upgrade and temperature range in Table 2. 3. Updated timing of turning on module in Figure 12. 4. Updated timing of turning off module in Figure 13. 5. Updated timing of resetting module in Figure 16. 6. Updated supported baud rates of main UART in Chapter 3.11. 7. Added notes for ADC interface in Chapter 3.13. 8. Updated GNSS performance in Table 21. 9. Updated operating frequencies of module in Table 23. 10. Added current consumption in Chapter 6.4. 11. Updated RF output power in Chapter 6.5. 12. Added RF receiving sensitivity in Chapter 6.6.
1.2	2016-11-04	Lyndon LIU/ Michael ZHANG	1. Added SGMII and WLAN interfaces in Table 2. 2. Updated function diagram in Figure 1. 3. Updated pin assignment (Top View) in Figure 2. 4. Added description of SGMII and WLAN interfaces in Table 4. 5. Added SGMII interface in Chapter 3.17. 6. Added WLAN interface in Chapter 3.18. 7. Added USB_BOOT interface in Chapter 3.19. 8. Added reference design of RF layout in Chapter 5.1.4. 9. Added note about SIMO in Chapter 6.6.

1.3	2017-01-24	Lyndon LIU/ Frank WANG	1. Updated function diagram in Figure 1. 2. Updated pin assignment (top view) in Figure 2. 3. Added BT interface in Chapter 3.18.2. 4. Updated GNSS performance in Table 24. 5. Updated reference circuit of wireless connectivity interfaces with FC20 module in Figure 29. 6. Updated current consumption of EC25-E module in Table 33. 7. Updated EC25-A conducted RF receiving sensitivity in Table 38. 8. Added EC25-J conducted RF receiving sensitivity in Table 40.
1.4	2018-03-05	AnniceZHANG/ Lyndon LIU/ Frank WANG	1. Updated functional diagram in Figure 1. 2. Updated LTE, UMTS and GSM features in Table 2. 3. Updated description of pin 40/136/137/138. 4. Updated PWRKEY pulled down time to 500 ms in Chapter 3.7.1 and reference circuit in Figure 10. 5. Updated reference circuit of (U)SIM interface in Figure 17 & 18. 6. Updated reference circuit of USB interface in Figure 19. 7. Updated PCM mode in Chapter 3.12. 8. Added SD card interface in Chapter 3.13. 9. Updated USB_BOOT reference circuit in Chapter 3.20. 10. Updated module operating frequencies in Table 26. 11. Updated antenna requirements in Table 30. 12. Updated EC25 series module current consumption in Chapter 6.4. 13. Updated EC25 series module conducted RF receiving sensitivity in Chapter 6.6. 14. Added thermal consideration description in Chapter 6.8. 15. Added dimension tolerance information in Chapter 7. 16. Added storage temperature range in Table 2 and Chapter 6.3. 17. Updated RF output power in Table 41. 18. Updated GPRS multi-slot classes in Table 53. 19. Updated storage information in Chapter 8.1.
1.5	2018-04-20	Kinsey ZHANG	1. Added information of EC25-AF in Table 1. 2. Updated module operating frequencies in Table 27. 3. Added current consumption of EC25-AF module in Table 40. 4. Changed GNSS current consumption of EC25 series

			module into Table 41. 5. Added EC25-AF conducted RF receiving sensitivity in Table 50.
2.0	2019-04-30	Nathan LIU/ Frank WANG/ Ward WANG/ Ethan SHAN	1. Added new variants EC25-EU/-EC/-EUX/-MX and related information. 2. Updated functional diagram in Figure 1. 3. Updated star structure of the power supply in Figure 8. 4. Updated power-on scenario of module in Figure 12. 5. Updated reference circuit with translator chip in Figure 20. 6. Added timing sequence for entering into emergency download mode of USB_BOOT interface in Figure 32. 7. Updated general description in Table 1. 8. Updated module operating frequencies in Table 27. 9. Updated GNSS frequency in Table 29. 10. Updated antenna requirements in Table 30. 11. Updated EC25-V current consumption in Table 36. 12. Added EC25-EU current consumption in Table 41 13. Added EC25 EC current consumption in Table 42. 14. Added EC25-EUX current consumption in Table 43. 15. Added EC25-MX current consumption in Table 44. 16. Updated EC25-E conducted RF receiving sensitivity in Table 47. 17. Updated EC25-A conducted RF receiving sensitivity in Table 48. 18. Updated EC25-V conducted RF receiving sensitivity in Table 49. 19. Updated EC25-AUT conducted RF receiving sensitivity in Table 52. 20. Updated EC25-AUTL conducted RF receiving sensitivity in Table 53. 21. Added EC25-EU conducted RF receiving sensitivity in Table 55. 22. Added EC25 EC conducted RF receiving sensitivity in Table 56. 23. Added EC25-EUX conducted RF receiving sensitivity in Table 57. 24. Added EC25-MX conducted RF receiving sensitivity in Table 58. 25. Updated recommended stencil thickness as 0.18–0.20 mm and reflow soldering thermal profile in Chapter 8.2.

2.1	2019-07-05	Fanny CHEN/ Ethan SHAN	1. Added new variants EC25-AFX/-AUX and related information. 2. Added notes for interfaces not supported by ThreadX modules. 3. Updated supported protocols and USB serial drivers in Table 2. 4. Updated reference circuit of wireless connectivity interfaces with FC20 module in Figure 26. 5. Added EC25-AFX current consumption in Table 41. 6. Added EC25-AFX conducted RF receiving sensitivity in Table 56. 7. Updated mechanical dimensions of the module in Figure 45. 8. Added tape and reel directions in Figure 51.
2.2	2019-08-19	Ward WANG/ Owen WEI/ Frank WANG	1. Updated EC25-J current consumption in Table 37. 2. Deleted the LTE-TDD bands information of EC25-AUT current consumption in Table 39. 3. Updated EC25-EC current consumption in Table 43. 4. Updated EC25-EUX current consumption in Table 44. 5. Added EC25-AUX current consumption in Table 46. 6. Updated EC25-AU conducted RF receiving sensitivity in Table 53. 7. Updated EC25-EU conducted RF receiving sensitivity in Table 58. 8. Added EC25-AUX conducted RF receiving sensitivity in Tbale 62.
2.3	2019-11-26	Fanny CHEN	1. Removed related information of ThreadX OS because the baseline has been updated. 2. Updated the supported protocols and USB serial drivers in Table 2. 3. AT command AT+QCFG="airplanecontrol" has been fully developed in Chapter 3.5. 4. Updated the notes for GNSS performance in Chapter 4.2. 5. Updated the AT command be used to disable the receive diversity in Chapter 5.1.3. 6. Updated EC25-J current consumption in Table 37.
2.4	2022-01-24	Barret XIONG	1. Deleted the related information of EC25-EC, EC25-AUT and EC25-AUTL. 2. Added the related information of EC25-AFXD. 3. Deleted the description of emergency call (Chapter 2.2&5.3). 4. Updated the supported protocols and USB serial drivers (Table 3).

			5. Added the description of Bluetooth application interface (Chapter 3.14.2). 6. Updated the power consumption of EC25-J and EC25-EU (Chapter 5.4). 7. Updated the mechanical dimensions, recommended footprint, top and buttom views (Chapter 6). Updated the information of storage, manufacturing and packaging (Chapter 7).
2.5	2022-04-14	Joe MA Cody ZHOU	1. Added variant EC25-EM. 2. Updated the supported USB serial drivers (Table 3). 3. Updated the conducted Rx-diversity of B7 on EC25-EUX (Table 38). 4. Updated the data of max slope in reflow soldering thermal profile (Figure 48 & Table 61).

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Table Index

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1 Introduction

This document defines EC25 series module and describes its air interface and hardware interfaces which are connected with your applications.

This document can help you quickly understand module interface specifications, electrical and mechanical details, as well as other related information of EC25 series module. To facilitate its application in different fields, relevant reference design is also provided for your reference. Associated with application note and user guide, you can use EC25 series module to design and set up mobile applications easily.

1.1. Special Marks

Table 1: Special Marks

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 the model is currently unavailable.
[…]	Brackets ([…]) used after a pin enclosing a range of numbers indicate all pins of the same type. For example, SDC2_DATA[0:3] refers to all four SDC2_DATA pins: SDC2_DATA0, SDC2_DATA1, SDC2_DATA2, and SDC2_DATA3.

2 Product Overview

2.1. Frequency Bands and Functions

EC25 series module is a series of LTE/WCDMA/GSM wireless communication module with Rx-diversity. It provides data connectivity on LTE-FDD, LTE-TDD, DC-HSDPA, HSPA+, HSDPA, HSUPA, WCDMA, EDGE and GPRS networks. It also provides GNSS [1] and voice functionality [2] for your specific applications.

EC25 series contains 13 variants: EC25-E, EC25-A, EC25-V, EC25-J, EC25-AU, EC25-AUX, EC25-AF, EC25-AFX, EC25-AFXD, EC25-EU, EC25-EUX , EC25-MX and EC25-EM. You can choose a dedicated type based on the region or operator. The following table shows the frequency bands of EC25 series module.

Table 2: Supported Frequency Bands and GNSS Function of EC25 Series Module

Modules	LTE Bands	WCDMA Bands	GSM Bands	Rx-diversity	GNSS [1]
EC25-E	FDD: B1/B3/B5/B7/B8/B20 TDD: B38/B40/B41	B1/B5/B8	EGSM900/ DCS1800	●	GPS, GLONASS, BDS, Galileo, QZSS
EC25-A	FDD: B2/B4/B12	B2/B4/B5	-	●	
EC25-V	FDD: B4/B13	-	-	●	
EC25-J	FDD: B1/B3/B8/B18/B19/ B26 TDD: B41	B1/B6/B8/ B19	-	●	
EC25-AU	FDD: B1/B2 [3]/B3/B4/B5/ B7/B8/B28 TDD: B40	B1/B2/B5/B8	GSM850/ EGSM900/ DCS1800/ PCS1900	●	
EC25-AUX	FDD: B1/B2 [3]/B3/B4/B5/ B7/B8/B28	B1/B2/B4/B5/ B8	GSM850/ EGSM900/	●	

[1] GNSS function is optional.
[2] EC25 series module contains **Data + Voice** version and **Data-only** version.
[3] EC25-AU and EC25-AUX modules do not support Rx-diversity in B2.

	TDD: B40		DCS1800/ PCS1900		
EC25-AF	FDD: B2/B4/B5/B12/B13/ B14/B66/B71	B2/B4/B5	-	●	
EC25-AFX	FDD: B2/B4/B5/B12/B13/ B14/B66/B71	B2/B4/B5	-	●	
EC25-AFXD	FDD: B2/B4/B5/B12/B13/ B14/B66/B71	B2/B4/B5	-	-	
EC25-EU	FDD: B1/B3/B7/B8/B20/ B28A TDD: B38/B40/B41	B1/B8	EGSM900/ DCS1800	●	
EC25-EUX	FDD: B1/B3/B7/B8/B20/ B28A TDD: B38/B40/B41	B1/B8	EGSM900/ DCS1800	●	
EC25-MX	FDD: B2/B4/B5/B7/B28/ B66	B2/B4/B5	-	●	-
EC25-EM	FDD: B1/B3/B5/B7/B8 B20/B28 TDD: B38/B40/B41	B1/B5/B8	EGSM900/ DCS1800	●	-

With a compact profile of 29.0 mm × 32.0 mm × 2.4 mm, EC25 series meets almost all requirements for M2M applications such as automation, metering, tracking system, security, router, wireless POS, mobile computing device, PDA phone, and tablet PC.

EC25 series is an SMD type module which can be embedded into applications through its 144 pins, including 80 LCC pins and 64 LGA pins.

2.2. Key Features

The following table describes the detailed features of EC25 series module.

Table 3: Key Features

Features	Description
Power Supply	● Supply voltage: 3.3–4.3 V ● Typical supply voltage: 3.8 V
Transmitting Power	● Class 4 (33 dBm ±2 dB) for GSM850 ● Class 4 (33 dBm ±2 dB) for EGSM900 ● Class 1 (30 dBm ±2 dB) for DCS1800 ● Class 1 (30 dBm ±2 dB) for PCS1900 ● Class E2 (27 dBm ±3 dB) for GSM850 8-PSK ● Class E2 (27 dBm ±3 dB) for EGSM900 8-PSK ● Class E2 (26 dBm ±3 dB) for DCS1800 8-PSK ● Class E2 (26 dBm ±3 dB) for PCS1900 8-PSK ● Class 3 (24 dBm + 1/-3 dB) for WCDMA bands ● Class 3 (23 dBm ±2 dB) for LTE-FDD bands ● Class 3 (23 dBm ±2 dB) for LTE-TDD bands
LTE Features	● Support up to non-CA Cat 4 FDD and TDD ● Support 1.4/3/5/10/15/20 MHz RF bandwidth ● Support MIMO in DL direction ● LTE-FDD: Max. 150 Mbps (DL)/Max. 50 Mbps (UL) LTE-TDD: Max. 130 Mbps (DL)/Max. 30 Mbps (UL)
UMTS Features	● Support 3GPP Rel-8 DC-HSDPA, HSPA+, HSDPA, HSUPA and WCDMA ● Support QPSK, 16QAM and 64QAM modulations ● DC-HSDPA: Max 42 Mbps (DL) HSUPA: Max. 5.76 Mbps (UL) WCDMA: Max. 384 kbps (DL)/Max. 384 kbps (UL)
GSM Features	**GPRS:** ● Support GPRS multi-slot class 33 (33 by default) ● Coding scheme: CS-1, CS-2, CS-3 and CS-4 ● Max. 107 kbps (DL)/Max. 85.6 kbps (UL) **EDGE:** ● Support EDGE multi-slot class 33 (33 by default) ● Support GMSK and 8-PSK for different MCS (Modulation and Coding Scheme) ● Downlink coding schemes: MCS 1–9 ● Uplink coding schemes: MCS 1–9

	● Max 296 kbps (DL)/Max 236.8 kbps (UL)
Internet Protocol Features	● Support TCP/UDP/PPP/FTP/FTPS/HTTP/HTTPS/NTP/PING/QMI/NITZ/SMTP/SSL/MQTT/FILE/CMUX/SMTPS/MMS protocols ● Support PAP and CHAP protocols for PPP connections
SMS	● Text and PDU mode ● Point-to-point MO and MT ● SMS cell broadcast ● SMS storage: ME by default
(U)SIM Interface	Support USIM/SIM card: 1.8 V, 3.0 V
Audio Features	● Support one digital audio interface: PCM interface ● GSM: HR/FR/EFR/AMR/AMR-WB ● WCDMA: AMR/AMR-WB ● LTE: AMR/AMR-WB ● Support echo cancellation and noise suppression
PCM Interface	● Used for audio function with external codec ● Support 16-bit linear data format ● Support long frame synchronization and short frame synchronization ● Support master and slave modes, but must be the master in long frame synchronization
USB Interface	● Compliant with USB 2.0 specification (slave only); the data transfer rate can reach up to 480 Mbps ● Used for AT command communication, data transmission, GNSS NMEA sentences output, software debugging, firmware upgrade and voice over USB ● Support USB serial drivers for: Windows 7/8/8.1/10, Linux 2.6–5.15, Android 4.x–12.x, etc.
UART Interfaces	**Main UART:** ● Used for AT command communication and data transmission ● Baud rate: reach up to 921600 bps, 115200 bps by default ● Support RTS and CTS hardware flow control **Debug UART:** ● Used for Linux console and log output ● 115200 bps baud rate
SD Card Interface	Support SD 3.0 protocol
SGMII Interface	● Support 10 Mbps/100 Mbps/1000 Mbps Ethernet work mode ● Support Max. 150 Mbps (DL)/50 Mbps (UL) for 4G network
WLAN and Bluetooth Application Interfaces	● Support SDIO 3.0 interface for WLAN ● Support UART & PCM interfaces for Bluetooth
Rx-diversity	Support LTE/WCDMA Rx-diversity
GNSS Features	● Protocol: NMEA 0183 ● Data update rate: 1 Hz by default

AT Commands	● Compliant with *3GPP TS 27.007*, *3GPP TS 27.005* ● Quectel enhanced AT commands
Network Indication	Two pins including NET_MODE and NET_STATUS to indicate network connectivity status
Antenna Interfaces	● Main antenna interface (ANT_MAIN) ● Rx-diversity antenna interface (ANT_DIV) ● GNSS antenna interface (ANT_GNSS)
Physical Characteristics	● Size: (29.0 ±0.15) mm × (32.0 ±0.15) mm × (2.4 ±0.2) mm ● Weight: approx. 4.9 g
Temperature Range	● Operating temperature range: -35 to +75 °C [4] ● Extended temperature range: -40 to +85 °C [5] ● Storage temperature range: -40 to +90 °C
Firmware Upgrade	USB 2.0 interface or DFOTA
RoHS	All hardware components are fully compliant with EU RoHS directive

2.3. Functional Diagram

The following figure shows a block diagram of EC25 series and illustrates the major functional parts.

- Power management
- Baseband
- DDR + NAND flash
- Radio frequency
- Peripheral interfaces

[4] Within the operating temperature range, the module meets 3GPP specifications.
[5] Within the 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.

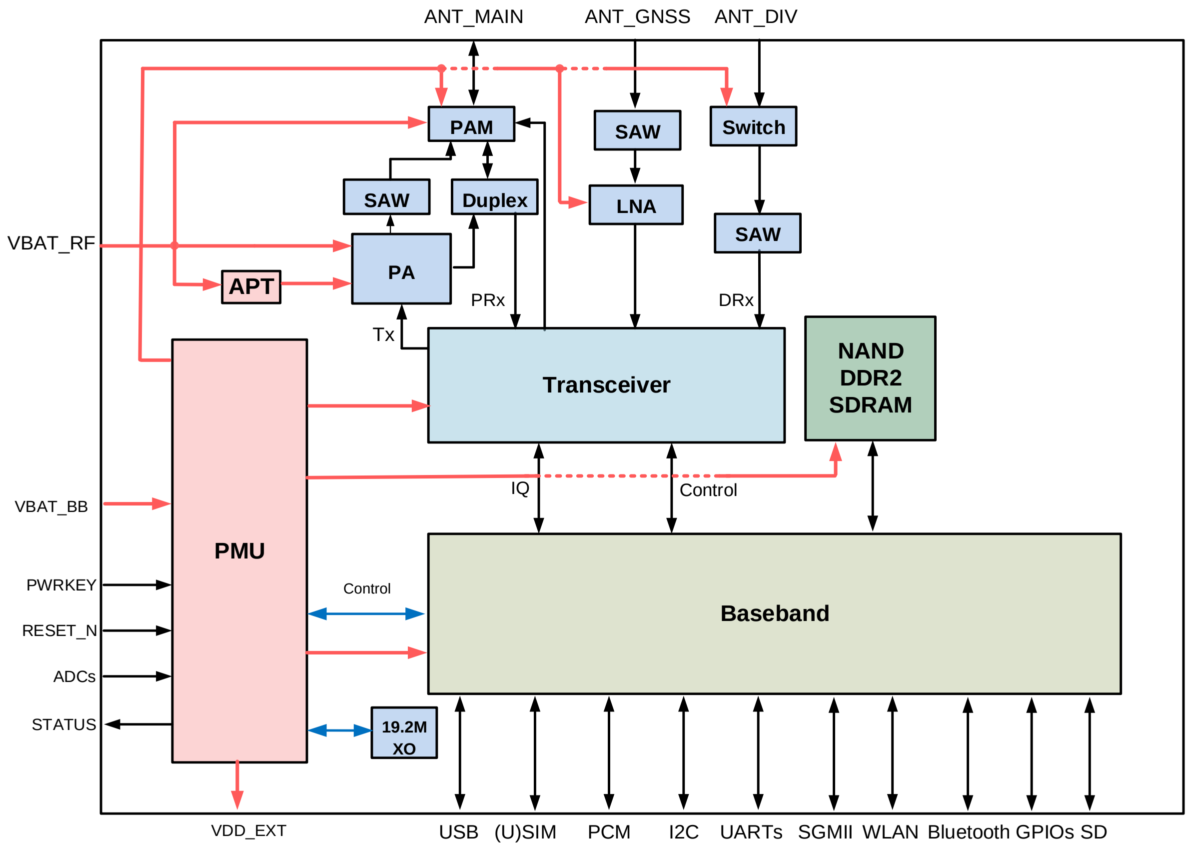


Figure 1: Functional Diagram

2.4. EVB Kit

To facilitate application design with the module, Quectel supplies an evaluation board (UMTS&LTE EVB), USB to RS-232 converter cable, earphone, antenna and other peripherals to control or test the module. For more details, see ***document [1]***.

.

3 Application Interfaces

3.1. General Description

EC25 series module is equipped with 80 LCC pins and 64 LGA pins that can be connected to cellular application platform. The subsequent chapters will provide detailed descriptions of the following interfaces/functions.

- Power supply
- (U)SIM interface
- USB interface
- UART interfaces
- PCM and I2C interfaces
- SD card interface
- WLAN & Bluetooth application interfaces
- ADC interfaces
- SGMII interface
- Indication signals
- USB_BOOT interface

3.2. Pin Assignment

The following figure shows the pin assignment of EC25 series module.

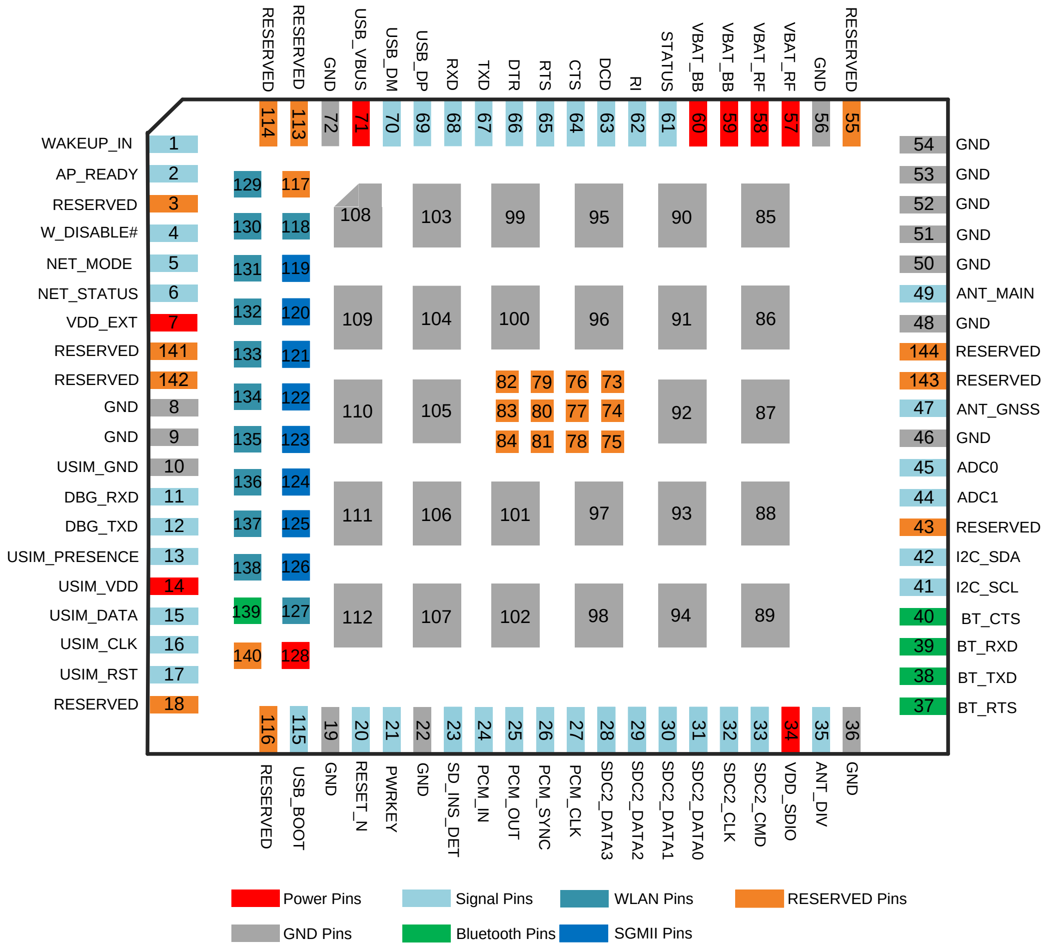


Figure 2: Pin Assignment (Top View)

NOTE

1. WAKEUP_IN, NET_MODE, WLAN_EN, COEX_UART_RX, COEX_UART_TX, USB_BOOT and BT_CTS pins cannot be pulled up before startup.
2. PWRKEY output voltage is 0.8 V because of the diode drop in the baseband chipset.
3. Digital audio (PCM) interface is only supported on **Data + Voice** version.
4. Pins 37–40, 118, 127 and 129–139 are used for WLAN & Bluetooth application interfaces, among which pins 118, 127 and 129–138 are WLAN function pins, and the rest are Bluetooth function pins.
5. Pins 119–126 and pin 128 are used for SGMII interface.
6. Pins 24–27 for PCM function are used for audio design on EC25 series module and Bluetooth function on FC20 series/FC21 module.
7. Keep all RESERVED pins and unused pins unconnected.
8. GND pins 85–112 should be connected to ground in the design. Pins 73–84 (RESERVED) should not be designed in schematic and PCB decal, and these pins should be served as a keepout area.

3.3. Pin Description

The following tables show the pin definition of EC25 series module.

Table 4: 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 5: Pin Description

Power Supply					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
VBAT_BB	59, 60	PI	Power supply for 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 0.8 A.
VBAT_RF	57, 58	PI	Power supply for module's RF part	Vmax = 4.3 V Vmin = 3.3 V Vnom = 3.8 V	It must be provided with sufficient current up to 1.8 A in a burst transmission.
VDD_EXT	7	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. If unused, keep it open.

GND	8, 9, 19, 22, 36, 46, 48, 50–54, 56, 72, 85–112				
Power-on/off					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
PWRKEY	21	DI	Turn on/off the module		The output voltage is 0.8 V because of the diode drop in the baseband chipset.
RESET_N	20	DI	Reset the module	V_{IH}max = 2.1 V V_{IH}min = 1.3 V V_{IL}max = 0.5 V	If unused, keep it open.
Status Indication Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
STATUS	61	OD	Indicate the module's operation status		The driving current should be less than 0.9 mA. An external pull-up resistor is required. If unused, keep it open.
NET_MODE	5	DO	Indicate the module's network registration mode	V_{OH}min = 1.35 V V_{OL}max = 0.45 V	1.8 V power domain. It cannot be pulled up before startup. If unused, keep it open.
NET_STATUS	6	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	71	PI	USB connection detection	Vmax = 5.25 V Vmin = 3.0 V Vnom = 5.0 V	Typ. 5.0 V. If unused, keep it open.
USB_DP	69	AIO	USB differential data (+)		USB 2.0 Compliant. Require differential impedance of 90 Ω. If unused, keep them open.
USB_DM	70	AIO	USB differential data (-)		
(U)SIM Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
USIM_GND	10		Specified ground		

			for (U)SIM card		
USIM_ PRESENCE	13	DI	(U)SIM card hot plug detect	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.2 V V_{IH}max = 2.0 V	1.8 V power domain. If unused, keep it open.
USIM_VDD	14	PO	(U)SIM card power supply	$I_O$max = 50 mA **For 1.8 V (U)SIM:** Vmax = 1.9 V Vmin = 1.7 V **For 3.0 V (U)SIM:** Vmax = 3.05 V Vmin = 2.7 V	Either 1.8 V or 3.0 V is supported by the module automatically.
USIM_DATA	15	DIO	(U)SIM card data	**For 1.8 V (U)SIM:** V_{IL}max = 0.6 V V_{IH}min = 1.2 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	
USIM_CLK	16	DO	(U)SIM 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	
USIM_RST	17	DO	(U)SIM card reset		
Main UART Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RI	62	DO	Main UART ring indicator	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	1.8 V power domain. If unused, keep them open.
DCD	63	DO	Main UART data carrier detection		
CTS	64	DO	DTE clear to send signal from DCE		1.8 V power domain. If unused, keep it open. Connect to DTE's RTS.

RTS	65	DI	DTE request to send signal from DCE	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.2 V V_{IH}max = 2.0 V	1.8 V power domain. If unused, keep it open. Connect to DTE's CTS.
DTR	66	DI	Main UART data terminal ready, sleep mode control	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.2 V V_{IH}max = 2.0 V	1.8 V power domain. Pulled up by default. DTR can wake up the module when DTR remains at low level. If unused, keep it open.
TXD	67	DO	Main UART transmit	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	1.8 V power domain. If unused, keep it open.
RXD	68	DI	Main UART receive	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.2 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_TXD	12	DO	Debug UART transmit	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	1.8 V power domain. If unused, keep it open.
DBG_RXD	11	DI	Debug UART receive	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.2 V V_{IH}max = 2.0 V	1.8 V power domain. If unused, keep it open.
ADC Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
ADC0	45	AI	General-purpose ADC interface	Voltage range: 0.3 V to VBAT_BB	If unused, keep them open.
ADC1	44	AI	General-purpose ADC interface		
PCM Interface [6]					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
PCM_IN	24	DI	PCM data input	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.2 V V_{IH}max = 2.0 V	1.8 V power domain. If unused, keep it open.

[6] The pins of PCM interface are used for audio design on EC25 series module and Bluetooth function on FC20 series/FC21 module.

PCM_OUT	25	DO	PCM data output	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	
PCM_SYNC	26	DIO	PCM frame sync	V_{OL}max = 0.45 V V_{OH}min = 1.35 V V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.2 V V_{IH}max = 2.0 V	1.8 V power domain. Serve as output signal in master mode. Serve as input signal in slave mode. If unused, keep them open.
PCM_CLK	27	DIO	PCM clock	V_{OL}max = 0.45 V V_{OH}min = 1.35 V V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.2 V V_{IH}max = 2.0 V	
I2C Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
I2C_SCL	41	OD	I2C serial clock. (for external codec)		An external 1.8 V pull-up resistor is required. If unused, keep them open.
I2C_SDA	42	OD	I2C serial data. (for external codec)		
SD Card Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
SDC2_DATA3	28	DIO	SD card SDIO data bit 3	**1.8 V signaling:** V_{OL}max = 0.45 V V_{OH}min = 1.4 V V_{IL}min = -0.3 V V_{IL}max = 0.58 V V_{IH}min = 1.27 V V_{IH}max = 2.0 V **3.0 V signaling:** V_{OL}max = 0.38 V V_{OH}min = 2.01 V V_{IL}min = -0.3 V V_{IL}max = 0.76 V V_{IH}min = 1.72 V V_{IH}max = 3.34 V	SDIO signal level can be selected according to the signal level supported by SD card; see SD 3.0 protocol for more details. If unused, keep them open.
SDC2_DATA2	29	DIO	SD card SDIO data bit 2		
SDC2_DATA1	30	DIO	SD card SDIO data bit 1		
SDC2_DATA0	31	DIO	SD card SDIO data bit 0		

SDC2_CLK	32	DO	SDIO clock	**1.8 V signaling:** V_{OL}max = 0.45 V V_{OH}min = 1.4 V **3.0 V signaling:** V_{OL}max = 0.38 V V_{OH}min = 2.01 V	
SDC2_CMD	33	DIO	SD card SDIO command	**1.8 V signaling:** V_{OL}max = 0.45 V V_{OH}min = 1.4 V V_{IL}min = -0.3 V V_{IL}max = 0.58 V V_{IH}min = 1.27 V V_{IH}max = 2.0 V **3.0 V signaling:** V_{OL}max = 0.38 V V_{OH}min = 2.01 V V_{IL}min = -0.3 V V_{IL}max = 0.76 V V_{IH}min = 1.72 V V_{IH}max = 3.34 V	
SD_INS_DET	23	DI	SD card insertion detect	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.2 V V_{IH}max = 2.0 V	1.8 V power domain. If SD card function is unused, keep this pin open.
VDD_SDIO	34	PO	SD card SDIO pull-up power	$I_O$max = 50 mA	1.8/2.85 V configurable. Cannot be used for SD card power supply. If unused, keep it open.
SGMII Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
EPHY_RST_N	119	DO	Ethernet PHY reset	**For 1.8 V:** V_{OL}max = 0.45 V V_{OH}min = 1.4 V **For 2.85 V:** V_{OL}max = 0.35 V V_{OH}min = 2.14 V	1.8/2.85 V power domain. If unused, keep it open.
EPHY_INT_N	120	DI	Ethernet PHY interrupt	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.2 V	1.8 V power domain. If unused, keep it open.

				V_{IH}max = 2.0 V	
SGMII_MDATA	121	DIO	SGMII management data	**For 1.8 V:** V_{OL}max = 0.45 V V_{OH}min = 1.4 V V_{IL}max = 0.58 V V_{IH}min = 1.27 V **For 2.85 V:** V_{OL}max = 0.35 V V_{OH}min = 2.14 V V_{IL}max = 0.71 V V_{IH}min = 1.78 V	1.8/2.85 V power domain. If unused, keep it open.
SGMII_MCLK	122	DO	SGMII management data clock	**For 1.8 V:** V_{OL}max = 0.45 V V_{OH}min = 1.4 V **For 2.85 V:** V_{OL}max = 0.35 V V_{OH}min = 2.14 V	1.8/2.85 V power domain. If unused, keep it open.
SGMII_TX_M	123	AO	SGMII transmit (-)		Connect this pin with a 0.1 μF capacitor, and the capacitor close to the PHY side. If unused, keep them open.
SGMII_TX_P	124	AO	SGMII transmit (+)		
SGMII_RX_P	125	AI	SGMII receive (+)		Connect this pin with a 0.1 μF capacitor, and the capacitor close to the module. If unused, keep them open.
SGMII_RX_M	126	AI	SGMII receive (-)		
USIM2_VDD	128	PO	SGMII_MDATA pull-up power supply		Configurable power supply. 1.8/2.85 V power domain. If unused, keep it open.

WLAN and Bluetooth Application Interfaces

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
SDC1_DATA3	129	DIO	WLAN SDIO data bit 3	V_{OL}max = 0.45 V V_{OH}min = 1.35 V V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.2 V V_{IH}max = 2.0 V	1.8 V power domain. If unused, keep them open.
SDC1_DATA2	130	DIO	WLAN SDIO data bit 2		
SDC1_DATA1	131	DIO	WLAN SDIO data bit 1		

SDC1_DATA0	132	DIO	WLAN SDIO data bit 0		
SDC1_CLK	133	DO	WLAN SDIO clock	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	1.8 V power domain. If unused, keep them open.
SDC1_CMD	134	DIO	WLAN SDIO command		
PM_ENABLE	127	DO	WLAN power supply enable		
WAKE_ON_ WIRELESS	135	DI	WLAN wake up the module	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.2 V V_{IH}max = 2.0 V	1.8 V power domain. Active low. If unused, keep it open.
WLAN_EN	136	DO	WLAN function enable	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	1.8 V power domain. Active high. Cannot be pulled up before startup. If unused, keep it open.
COEX_UART_ RX	137	DI	LTE/WLAN & Bluetooth coexistence receive	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.2 V V_{IH}max = 2.0 V	1.8 V power domain. Cannot be pulled up before startup. If unused, keep it open.
COEX_UART_ TX	138	DO	LTE/WLAN & Bluetooth coexistence transmit	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	1.8 V power domain. Cannot be pulled up before startup. If unused, keep it open.
WLAN_SLP_ CLK	118	DO	WLAN sleep clock		If unused, keep it open.
BT_RTS	37	DI	DTE request to send signal from DCE	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.2 V V_{IH}max = 2.0 V	1.8 V power domain. If unused, keep it open. Connect to DTE's RTS.
BT_TXD	38	DO	Bluetooth UART transmit	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	1.8 V power domain. If unused, keep it open.
BT_RXD	39	DI	Bluetooth UART receive	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.2 V V_{IH}max = 2.0 V	1.8 V power domain. If unused, keep it open.
BT_CTS	40	DO	DTE clear to send signal from DCE	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	1.8 V power domain. Cannot be pulled up before startup. If unused, keep it open. Connect to DTE's RTS.
BT_EN	139	DO	Bluetooth function	V_{OL}max = 0.45 V	1.8 V power domain.

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
			enable	V_{OH}min = 1.35 V	If unused, keep it open.
RF Antenna Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
ANT_DIV	35	AI	Diversity antenna interface		50 Ω impedance. If unused, keep it open.
ANT_MAIN	49	AIO	Main antenna interface		50 Ω impedance.
ANT_GNSS	47	AI	GNSS antenna interface		50 Ω impedance. If unused, keep it open.
Other Interface Pins					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
WAKEUP_IN	1	DI	Sleep mode control	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.2 V V_{IH}max = 2.0 V	1.8 V power domain. Cannot be pulled up before startup. Low level can wake up the module. If unused, keep it open.
W_DISABLE#	4	DI	Airplane mode control	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.2 V V_{IH}max = 2.0 V	1.8 V power domain. Pull-up by default. At low level, the module can enter airplane mode. If unused, keep it open.
AP_READY	2	DI	Application processor sleep state detection	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.2 V V_{IH}max = 2.0 V	1.8 V power domain. If unused, keep it open.
USB_BOOT Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
USB_BOOT	115	DI	Force the module to enter emergency download mode	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.2 V V_{IH}max = 2.0 V	1.8 V power domain. Cannot be pulled up before startup. It is recommended to reserve test point.
RESERVED Pins					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**

RESERVED	3, 18, 43, 55, 73–84, 113, 114, 116, 117, 140–144	Keep these pins unconnected.

3.4. Operating Modes

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

Table 6: Overview of Operating Modes

Modes	Details	
Normal Operation	Idle	The module remains registered on the network, and is ready to send and receive data. In this mode, the software is active.
	Talk/ Data	The module is connected to network. Its current consumption varies with the network setting and data transfer rate.
Airplane Mode	**AT+CFUN=4** or W_DISABLE# pin can set the module to airplane mode where the RF function is invalid.	
Minimum Functionality Mode	**AT+CFUN=0** can set the module into a minimum functionality mode without removing the power supply. In this mode, both RF function and (U)SIM card are invalid.	
Sleep Mode	The module remains the ability to receive paging message, SMS, voice call and TCP/UDP data from the network normally. In this mode, the current consumption of the module is reduced to a very low level.	
Power Down Mode	The module’s power supply is cut off by its power management unit. In this mode, the software is inactive, the serial interfaces are inaccessible, while the operating voltage (connected to VBAT_RF and VBAT_BB) remains applied.	

For details of the commands, see ***document [2]***.

3.5. Sleep Mode

EC25 series can reduce its current consumption to a minimum value during the sleep mode. The following section describes the power saving procedures of EC25 series module.

3.5.1. UART Application Scenario

If the host communicates with the module via UART interface, the following preconditions can let the module enter sleep mode.

- Execute **AT+QSCLK=1** to enable sleep mode. For details of the command, see ***document [2]***.
- Drive DTR to high level.

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

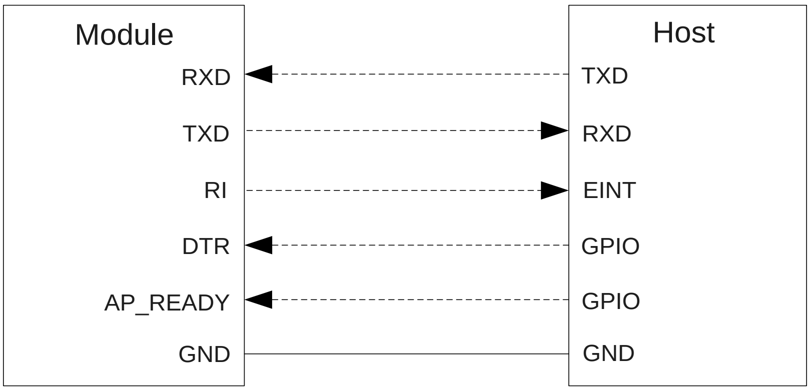


Figure 3: Sleep Mode Application via UART

- Driving the module's DTR to low level will wake up the module.
- When EC25 series has a URC to report, RI signal will wake up the host. See ***Chapter 3.18.3*** for details about RI behaviors.
- AP_READY will detect the sleep state of the host (can be configured to high level or low level detection). See ***document [3]*** for details about **AT+QCFG="apready"**.

3.5.2. USB Application Scenario

3.5.2.1. 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 let the module enter sleep mode.

- Execute **AT+QSCLK=1** to enable sleep mode.
- Ensure DTR is held at high level or keep it open.
- 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.

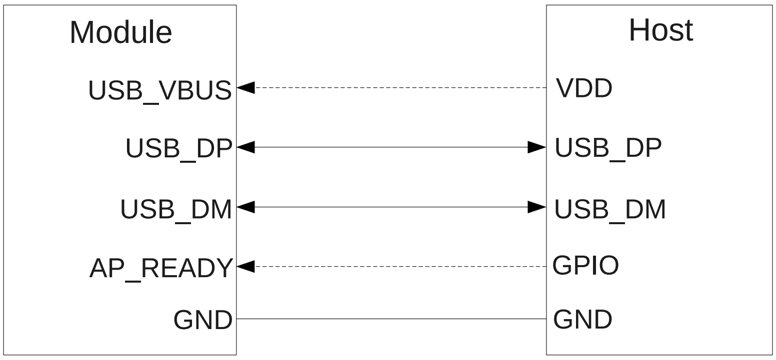


Figure 4: Sleep Mode Application with USB Remote Wakeup

- Sending data to EC25 series via USB will wake up the module.
- When EC25 series has a URC to report, the module will send remote wake-up signals via USB bus to wake up the host.

3.5.2.2. USB Application with USB Suspend/Resume and RI Function

If the host supports USB suspend and resume, but does not support remote wake-up function, the RI signal is needed to wake up the host.

There are three preconditions to let the module enter sleep mode.

- Execute **AT+QSCLK=1** to enable sleep mode.
- Ensure the DTR is held at high level or keep it open.
- 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.

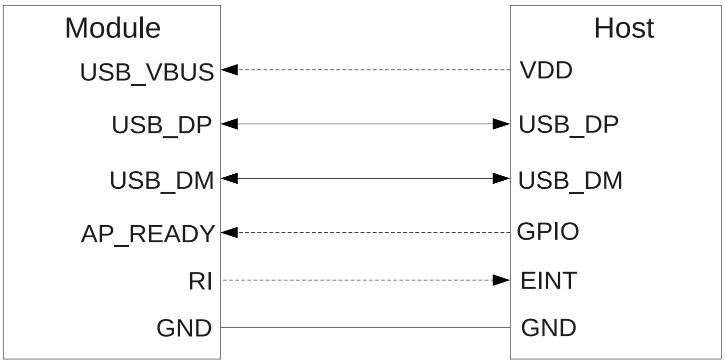


Figure 5: Sleep Mode Application with RI

- Sending data to EC25 series via USB will wake up the module.
- When EC25 series module has a URC to report, RI signal will wake up the host.

3.5.2.3. USB Application without USB Suspend Function

If the host does not support USB suspend function, USB_VBUS should be disconnected via an additional control circuit to let the module enter sleep mode.

- Execute **AT+QSCLK=1** to enable sleep mode.
- Ensure the DTR is held at high level or keep it open.
- Disconnect USB_VBUS.

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

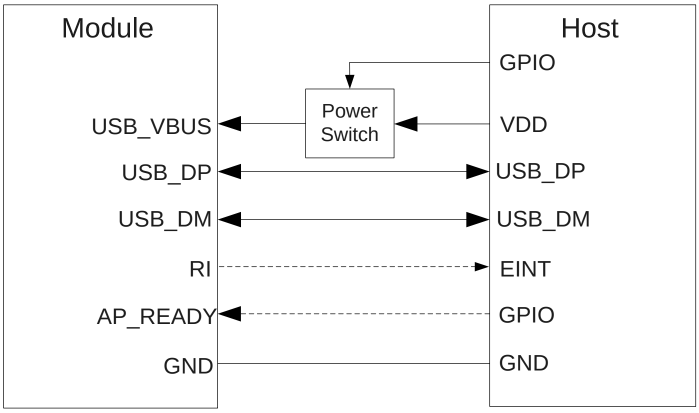


Figure 6: Sleep Mode Application without Suspend Function

Switching on the power switch to supply power to USB_VBUS will wake up the module.

NOTE

Pay attention to the voltage-level matching of the circuit in dotted line between the module and the host. For more details about EC25 series power management application, see ***document [4]***.

3.5.3. Airplane Mode

When the module enters 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.

Hardware:

The W_DISABLE# pin is pulled up by default. Driving it to low level will let the module enter airplane mode.

Software:

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

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

NOTE

1. The W_DISABLE# control function is disabled in firmware by default. It can be enabled by **AT+QCFG="airplanecontrol"**.
2. The execution of **AT+CFUN** will not affect GNSS function.

3.6. Power Supply

3.6.1. Power Supply Pins

EC25 series provides four VBAT pins for connection with the external power supply. There are two separate voltage domains for VBAT.

- Two VBAT_RF pins for module's RF part
- Two VBAT_BB pins for module's baseband part

The following table shows the details of VBAT pins and ground pins.

Table 7: VBAT and GND Pins

Pin Name	Pin No.	Description	Min.	Typ.	Max.	Unit
VBAT_RF	57, 58	Power supply for module's RF part	3.3	3.8	4.3	V
VBAT_BB	59, 60	Power supply for module's baseband part	3.3	3.8	4.3	V
GND	8, 9, 19, 22, 36, 46, 48, 50–54, 56, 72, 85–112		-	0	-	V

3.6.2. Decrease Voltage Drop

The power supply range of EC25 series is from 3.3–4.3 V. Please make sure that the input voltage will never drop below 3.3 V. The following figure shows the voltage drop during burst transmission in 2G network. The voltage drop will be less in 3G and 4G networks.

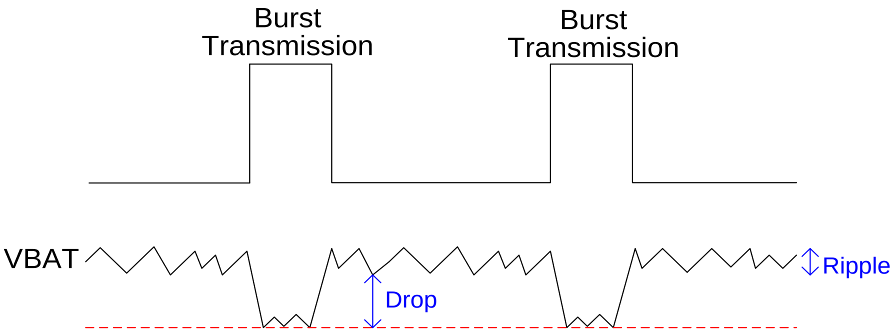


Figure 7: Power Supply Limits During Burst Transmission

To decrease the voltage drop, a bypass capacitor of about 100 µF with low ESR (ESR = 0.7 Ω) should be used, and a multi-layer ceramic chip (MLCC) capacitor array should also be reserved due to its 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 VBAT_BB/VBAT_RF pins. The main power supply from an external application has to be a single voltage source and can be expanded to two sub paths with star structure. The width of VBAT_BB trace should be no less than 1 mm; and the width of VBAT_RF trace should be no less than 2 mm. In principle, the longer the VBAT trace is, the wider it will be.

In addition, in order to avoid the damage caused by electric surge and ESD, it is suggested that a TVS component with suggested low reverse stand-off voltage V_{RWM} 4.5 V, low clamping voltage V_C and high reverse peak pulse current I_{PP} should be used. The following figure shows the star structure of the power supply.

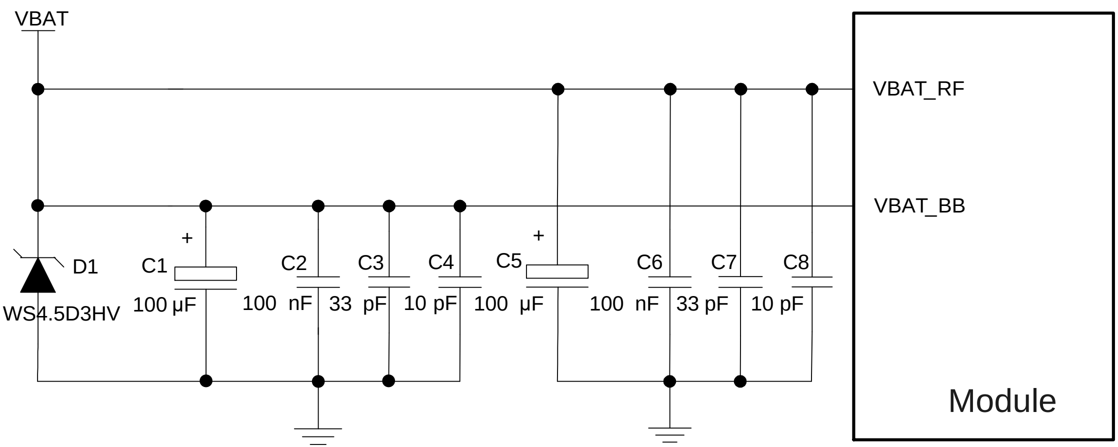


Figure 8: Star Structure of the Power Supply

3.6.3. Reference Design for Power Supply

The performance of the module largely depends on the power source. The power supply should be able to provide sufficient current up to 2.0 A at least. If the voltage drop between the input and output is not too high, it is suggested that an LDO should be used to supply power for the module. If there is a big voltage difference between the input source and the desired output (VBAT), a buck converter is preferred to be used as the power supply.

The following figure shows a reference design for +5.0 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.

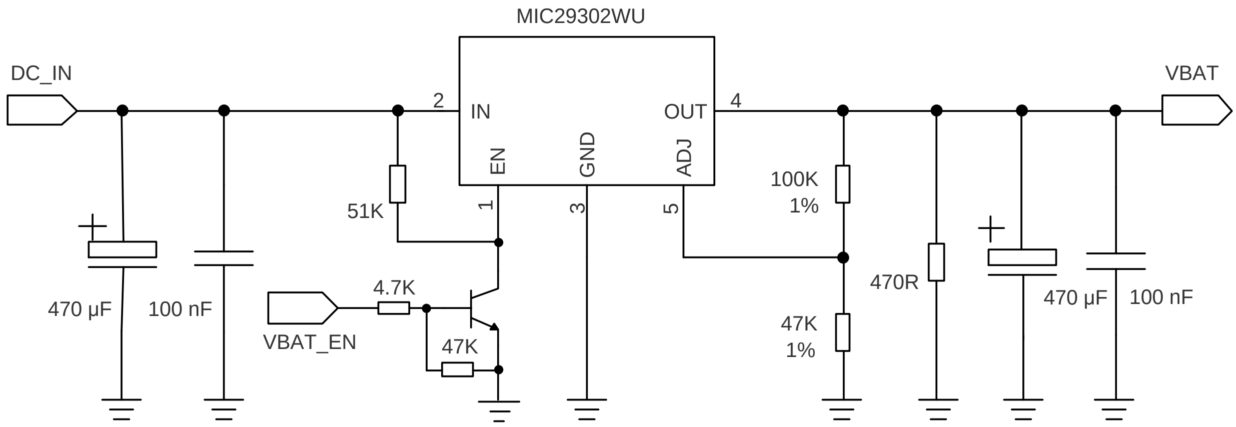


Figure 9: Reference Circuit of Power Supply

NOTE

To avoid damaging internal flash data, do not switch off the power supply when the module works normally. Only after the module is shut down by PWRKEY or AT command, then the power supply can be cut off.

3.6.4. Power Supply Voltage Monitoring

AT+CBC can be used to monitor the VBAT_BB voltage value. For more details, see ***document [2]***.

3.7. Turn On

3.7.1. Turn On with PWRKEY

The following table shows the pin definition of PWRKEY.

Table 8: Pin Definition of PWRKEY

Pin Name	Pin No.	I/O	Description	Comment
PWRKEY	21	DI	Turn on/off the module	The output voltage is 0.8 V because of the diode drop in the chipset.

When the module is in power down mode, it can be turned on by driving PWRKEY low for at least 500 ms. It is recommended to use an open drain/collector driver to control the PWRKEY. After STATUS pin (require external pull-up resistor) outputs a low level, PWRKEY pin can be released.

A simple reference circuit is illustrated in the following figure.

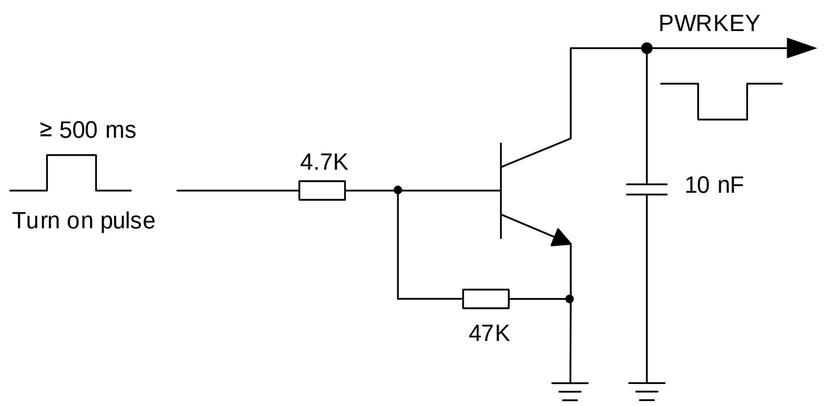


Figure 10: Turn On the Module by Using Driving Circuit

The other way to control the PWRKEY is using a button directly. When pressing the button, electrostatic strike may generate from fingers. Therefore, a TVS component is indispensable to be placed nearby the button for ESD protection. A reference circuit is shown in the following figure.

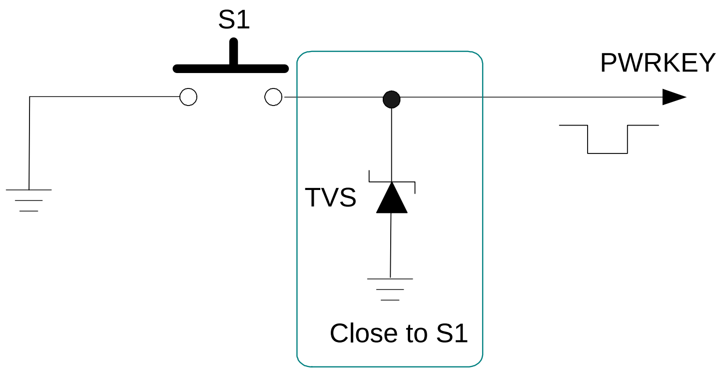


Figure 11: Turn On the Module by Using a Button

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

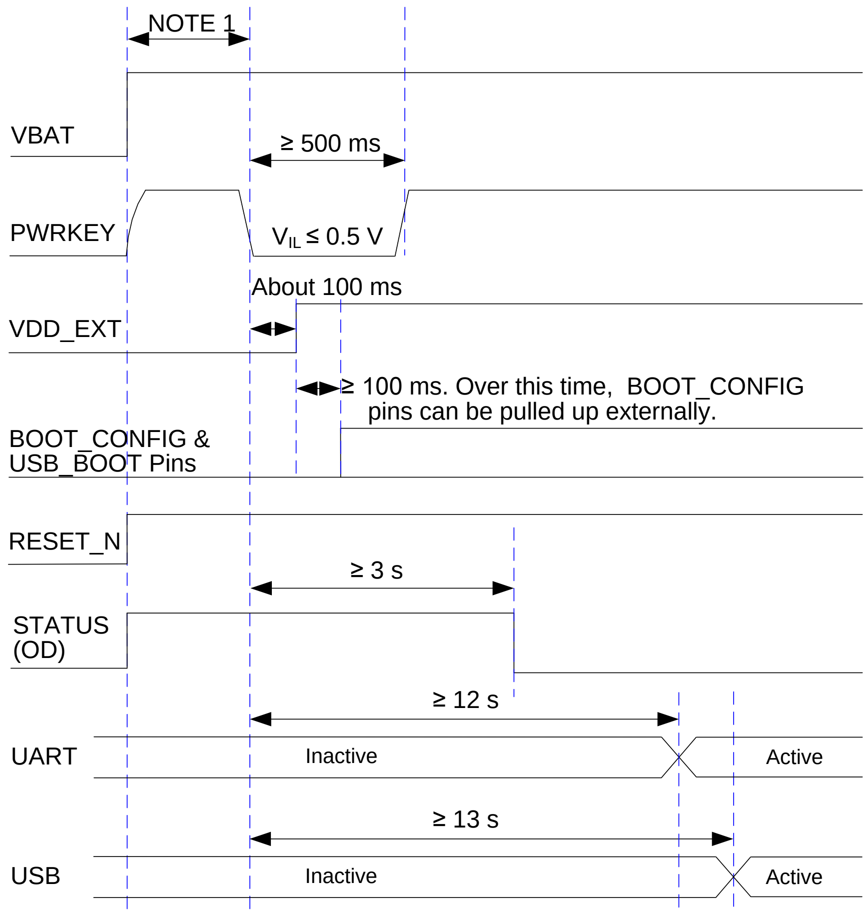


Figure 12: Power-up Timing

NOTE

1. Make sure that VBAT is stable before pulling down PWRKEY pin. It is recommended that the time 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 10 kΩ resistor if module needs to be powered on automatically and shutdown is not needed.
3. The output voltage of PWRKEY is 0.8 V because of the diode drop in the baseband chipset.
4. BOOT_CONFIG pins (WAKEUP_IN, NET_MODE, WLAN_EN, COEX_UART_RX, COEX_UART_TX, USB_BOOT and BT_CTS) cannot be pulled up before statup.

3.8. Turn Off

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

- Turn off the module using the PWRKEY pin.
- Turn off the module using **AT+QPOWD**. For details of the command, see ***document [2]***.

3.8.1. Turn Off with PWRKEY

Driving the PWRKEY pin to low for at least 650 ms, the module will execute power-off procedure after the PWRKEY is released. The power-down scenario is illustrated in the following figure.

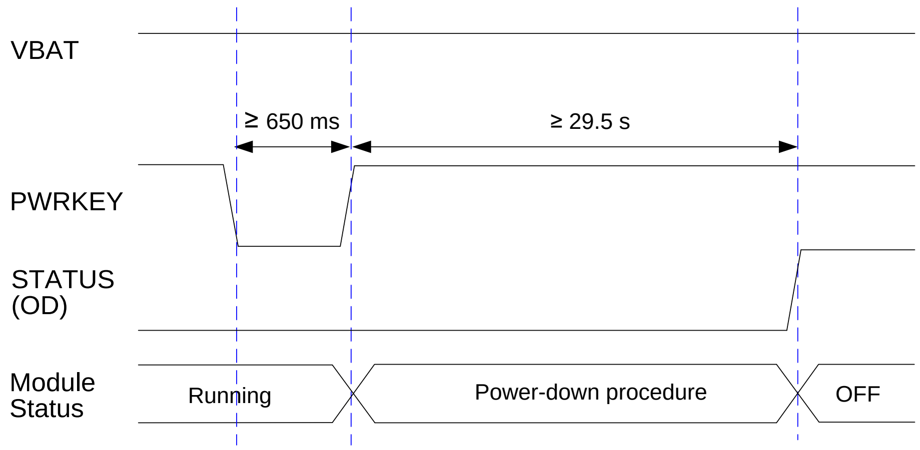


Figure 13: Power-down Timing

3.8.2. 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 PWRKEY pin. See ***document [2]*** for details about **AT+QPOWD**.

NOTE

1. To avoid damaging the data of internal flash, do not switch off the power supply when the module works normally. Only after the module is shut down by PWRKEY or AT command, then the power supply can be cut off.
2. When turning off module with the AT command, keep PWRKEY at high level after the execution of the command. Otherwise, the module will be turned on again after a successful turn-off.

3.9. Reset

The RESET_N pin can be used to reset the module. The module can be reset by driving RESET_N low for 150–460 ms.

Table 9: Pin Definition of RESET_N

Pin Name	Pin No.	I/O	Description	Comment
RESET_N	20	DI	Reset the module	1.8 V power domain

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.

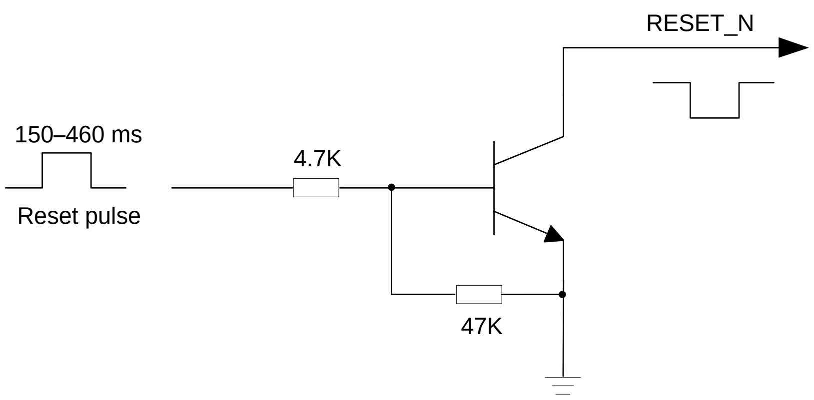


Figure 14: Reference Circuit of RESET_N by Using Driving Circuit

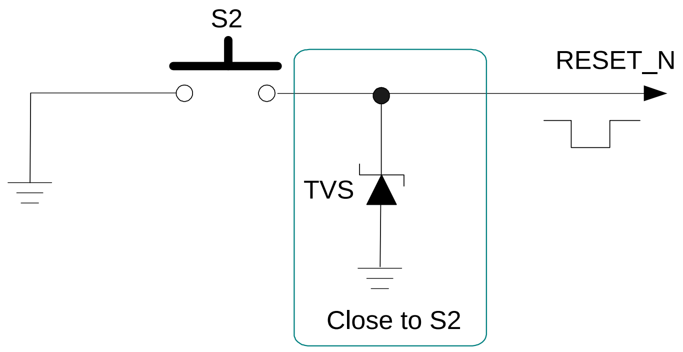


Figure 15: Reference Circuit of RESET_N by Using a Button

The reset timing is illustrated in the following figure.

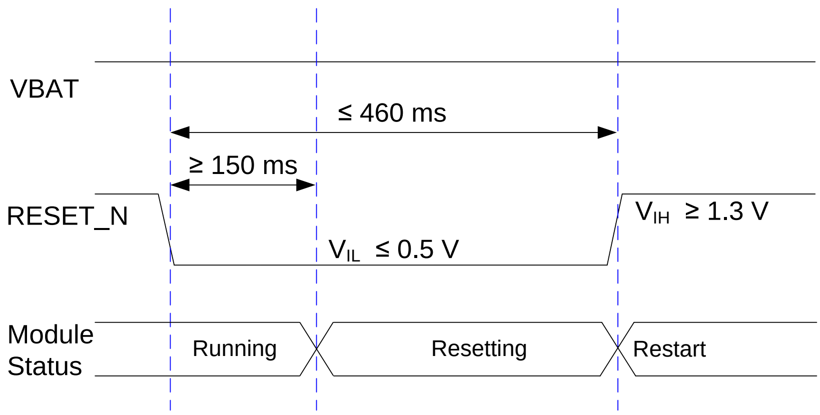


Figure 16: Reset Timing

NOTE

1. Use RESET_N only when failed to turn off the module by **AT+QPOWD** and PWRKEY pin.
2. Ensure that there is no large capacitance on PWRKEY and RESET_N pins.

3.10. (U)SIM Interface

The (U)SIM interface circuitry meets ETSI and IMT-2000 requirements. Both 1.8 V and 3.0 V (U)SIM cards are supported.

Table 10: Pin Definition of (U)SIM Interface

Pin Name	Pin No.	I/O	Description	Comment
USIM_VDD	14	PO	(U)SIM card power supply	Either 1.8 V or 3.0 V is supported by the module automatically.
USIM_DATA	15	DIO	(U)SIM card data	
USIM_CLK	16	DO	(U)SIM card clock	
USIM_RST	17	DO	(U)SIM card reset	
USIM_ PRESENCE	13	DI	(U)SIM card hot plug detection	1.8 V power domain. If unused, keep it open.
USIM_GND	10		Specified ground for (U)SIM card	

EC25 series supports (U)SIM card hot-plug via the USIM_PRESENCE pin. The function supports low level and high level detections. By default, it is disabled, and can be configured via **AT+QSIMDET**. See ***document [2]*** for more details about the command.

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

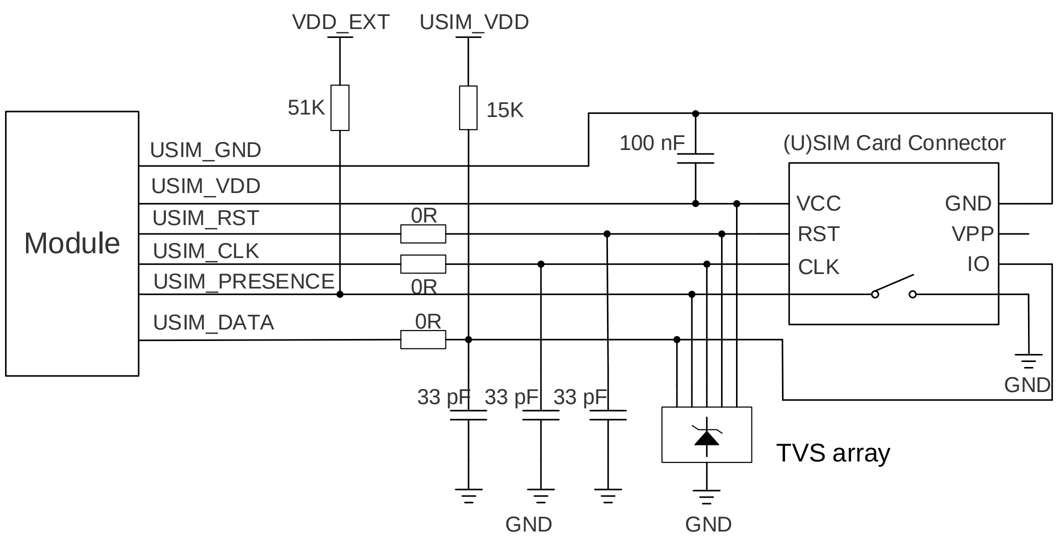


Figure 17: Reference Circuit of (U)SIM Interface with an 8-pin (U)SIM Card Connector

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

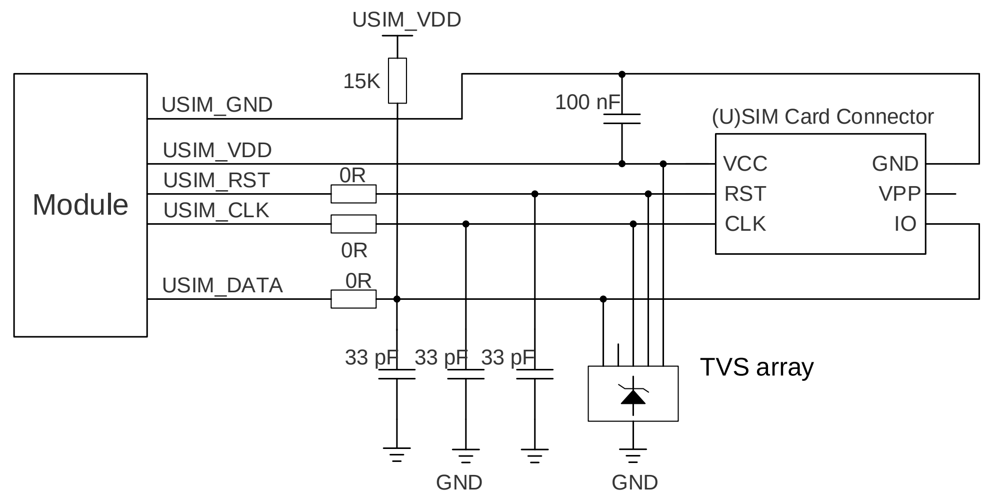


Figure 18: Reference Circuit of (U)SIM Interface with a 6-pin (U)SIM Card Connector

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

- Keep placement of (U)SIM card connector to the module as close as possible. Keep the trace length as less than 200 mm as possible.
- Keep (U)SIM card signals away from RF and power supply traces.
- Make sure the bypass capacitor between USIM_VDD and USIM_GND less than 1 μF, and place it as close to (U)SIM card connector as possible. If the ground is complete on customers' PCB, USIM_GND can be connected to PCB ground directly.
- To avoid cross-talk between USIM_DATA and USIM_CLK, keep them away from each other and shield them with surrounded ground.
- For better ESD protection, it is recommended to add a TVS diode array whose parasitic capacitance should not be more than 15 pF. The 0 Ω resistors should be added in series between the module and the (U)SIM card to facilitate debugging. The 33 pF capacitors are used for filtering interference of EGSM900. Please note that the (U)SIM peripheral circuit should be close to the (U)SIM card connector.
- The pull-up resistor on USIM_DATA trace can improve anti-jamming capability when long layout trace and sensitive occasion are applied, and should be placed close to the (U)SIM card connector.

3.11. USB Interface

EC25 series module contains one integrated Universal Serial Bus (USB) interface which complies with the USB 2.0 specification and supports high-speed (480 Mbps) and full-speed (12 Mbps) modes. The USB interface can only serve as a slave device.

The interface can be used for AT command communication, data transmission, GNSS NMEA sentences output, software debugging, firmware upgrade and voice over USB.

The following table shows the pin definition of USB interface.

Table 11: Pin Description of USB Interface

Pin Name	Pin No.	I/O	Description	Comment
USB_DP	69	AIO	USB differential data (+)	USB 2.0 Compliant. Require differential impedance of 90 Ω. If unused, keep them open.
USB_DM	70	AIO	USB differential data (-)	
USB_VBUS	71	PI	USB connection detection	Typ. 5.0 V
GND	72		Ground	

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

The USB interface is recommended to be reserved for firmware upgrade in your designs. The following figure shows a reference circuit of USB interface.

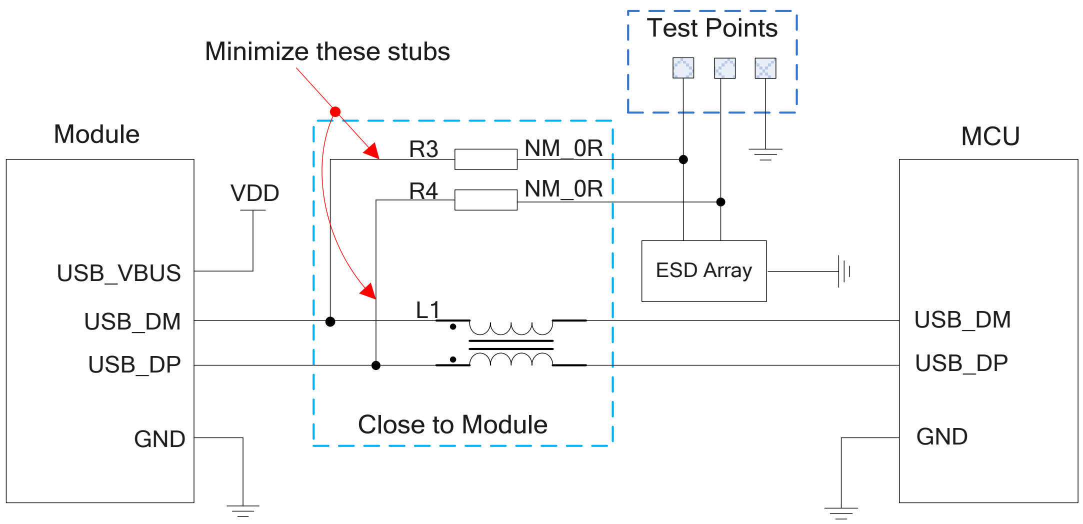


Figure 19: Reference Circuit of USB Application

A common mode choke L1 is recommended to be added in series between the module and 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 to facilitate debugging, and the resistors are not mounted by default. In order to ensure the integrity of USB data trace signal, L1 & R3 & R4 components must be placed close to the module, and these resistors should be placed close to each other. The extra stubs of trace must be as short as possible.

To meet USB 2.0 specification, the following principles should be complied with when design the USB interface.

- It is important to 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. It is important to route the USB differential traces in inner-layer of the PCB, and surround the traces with ground on that layer and with ground planes above and below.
- Junction capacitance of the ESD protection components might cause influences on USB data traces, so pay attention to the selection of the component. Typically, the stray capacitance should be less than 2 pF.
- Keep the ESD protection components to the USB connector as close as possible.

3.12. UART Interfaces

The module provides two UART interfaces: main UART and debug UART. The following shows their features.

- The main UART interface supports 4800, 9600, 19200, 38400, 57600, 115200, 230400, 460800 and 921600 bps baud rates, and the default is 115200 bps. It also supports RTS and CTS hardware flow control, and can be used for data transmission and AT command communication.
- The debug UART interface supports 115200 bps baud rate. It is used for Linux console and log output.

The following tables show the pin definition of the UART interfaces.

Table 12: Pin Definition of Main UART Interface

Pin Name	Pin No.	I/O	Description	Comment
RI	62	DO	Main UART ring indication	1.8 V power domain
DCD	63	DO	Main UART data carrier detect	
CTS	64	DO	DTE clear to send signal from DCE	1.8 V power domain Connect to DTE's RTS.
RTS	65	DI	DTE request to send signal from DCE	1.8 V power domain Connect to DTE's CTS.
DTR	66	DI	Main UART data terminal ready, sleep mode control	1.8 V power domain Pulled up by default. DTR can wake up the module when DTR remains at low level.
TXD	67	DO	Main UART transmit	1.8 V power domain
RXD	68	DI	Main UART receive	

Table 13: Pin Definition of Debug UART Interface

Pin Name	Pin No.	I/O	Description	Comment
DBG_TXD	12	DO	Debug UART transmit	1.8 V power domain If unused, keep them open.
DBG_RXD	11	DI	Debug UART receive	

The module provides 1.8 V UART interface. A voltage-level translator should be used if your application is equipped with a 3.3 V UART interface. A voltage-level translator TXS0108EPWR provided by Texas Instruments is recommended. The following figure shows a reference design.

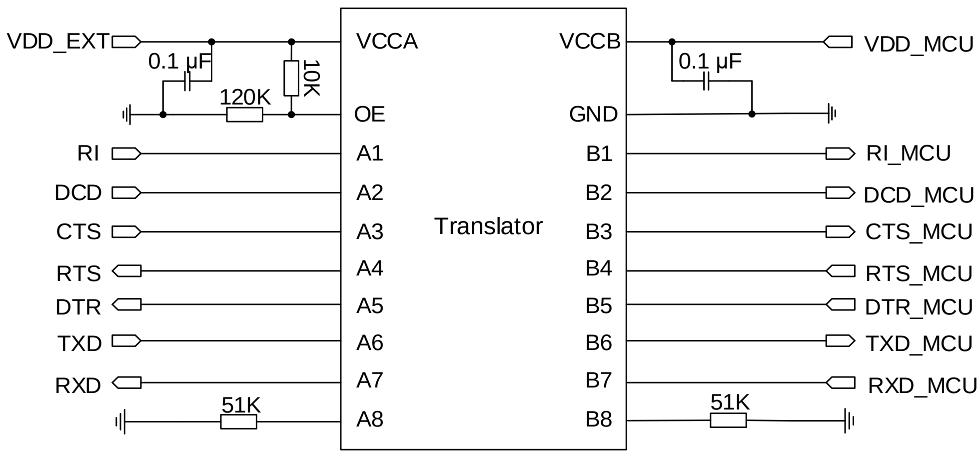


Figure 20: Reference Circuit with Translator Chip

Visit http://www.ti.com for more information.

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

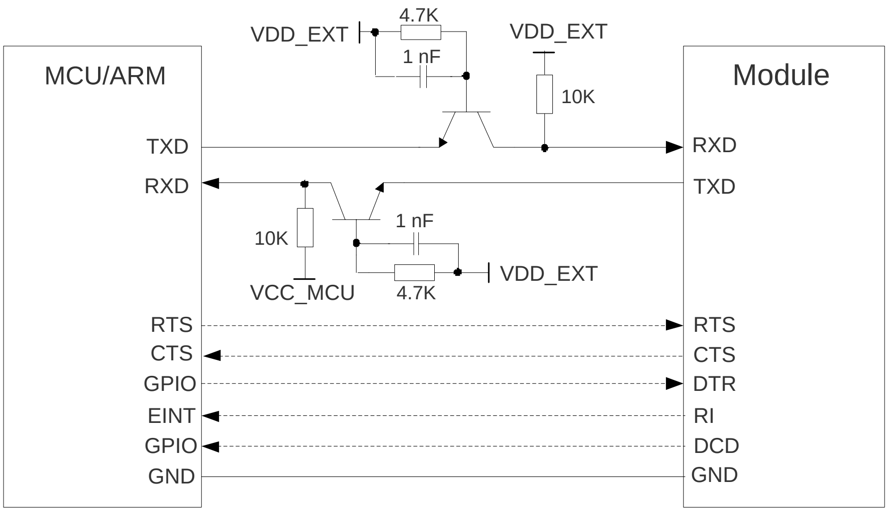


Figure 21: Reference Circuit with Transistor Circuit

NOTE

1. Transistor circuit solution is not suitable for applications with high baud rates exceeding 460 kbps.
2. Please note that the module's CTS is connected to the host's CTS, and the module's RTS is connected to the host's RTS.

3.13. PCM and I2C Interfaces

EC25 series provides one I2C interface and one Pulse Code Modulation (PCM) digital interface for audio design, which supports the following modes:

- Short frame synchronization, works as both master and slave)
- Long frame synchronization, works as master only)

In short frame sync mode, the data is sampled on the falling edge of the PCM_CLK and transmitted on the rising edge. The PCM_SYNC falling edge represents the MSB. In this mode, the PCM interface supports 256 kHz, 512 kHz, 1024 kHz or 2048 kHz PCM_CLK at 8 kHz PCM_SYNC, and also supports 4096 kHz PCM_CLK at 16 kHz PCM_SYNC.

In long frame sync mode, the data is sampled on the falling edge of the PCM_CLK and transmitted on the rising edge. The PCM_SYNC rising edge represents the MSB. In this mode, the PCM interface operates with a 256 kHz, 512 kHz, 1024 kHz or 2048 kHz PCM_CLK and an 8 kHz, 50% duty cycle PCM_SYNC.

EC25 series supports 16-bit linear data format. The following figures show the short frame sync mode's timing relationship with 8 kHz PCM_SYNC and 2048 kHz PCM_CLK, as well as the long frame sync mode's timing relationship with 8 kHz PCM_SYNC and 256 kHz PCM_CLK.

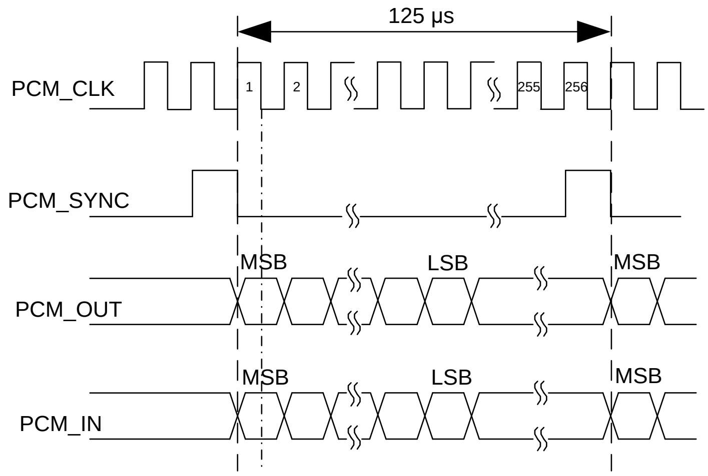


Figure 22: Short Frame Sync Mode Timing

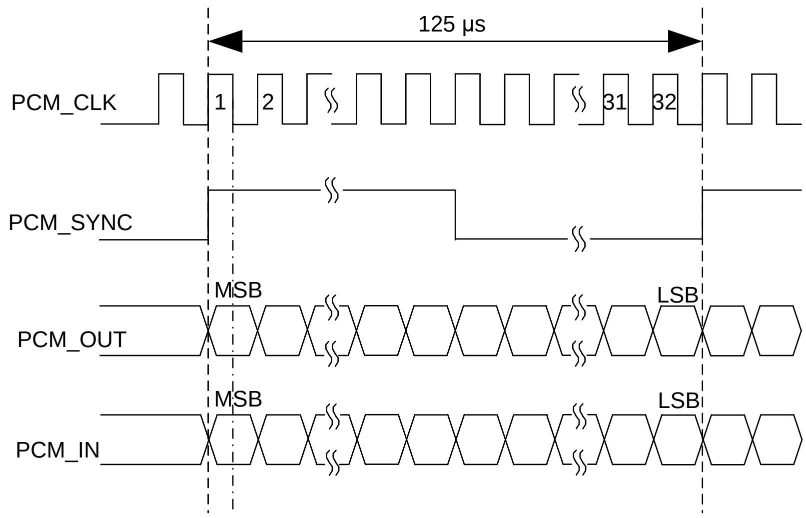


Figure 23: Long Frame Sync Mode Timing

Clock and mode can be configured by AT command, and the default configuration is master mode using short frame synchronization format with 2048 kHz PCM_CLK and 8 kHz PCM_SYNC. See ***document [2]*** for more details about **AT+QDAI**.

The following table shows the pin definition of PCM and I2C interfaces which can be applied on audio codec design.

Table 14: Pin Definition of PCM and I2C Interfaces

Pin Name	Pin No.	I/O	Description	Comment
PCM_IN	24	DI	PCM data input	1.8 V power domain If unused, keep them open.
PCM_OUT	25	DO	PCM data output	
PCM_SYNC	26	DIO	PCM frame sync	1.8 V power domain Serve as output signal in master mode or input signal in slave mode. If unused, keep them open.
PCM_CLK	27	DIO	PCM clock	
I2C_SCL	41	OD	I2C serial clock (for external codec)	Require external pull-up to 1.8 V. If unused, keep them open.
I2C_SDA	42	OD	I2C serial data (for external codec)	

The following figure shows a reference design of PCM and I2C interfaces with an external codec IC.

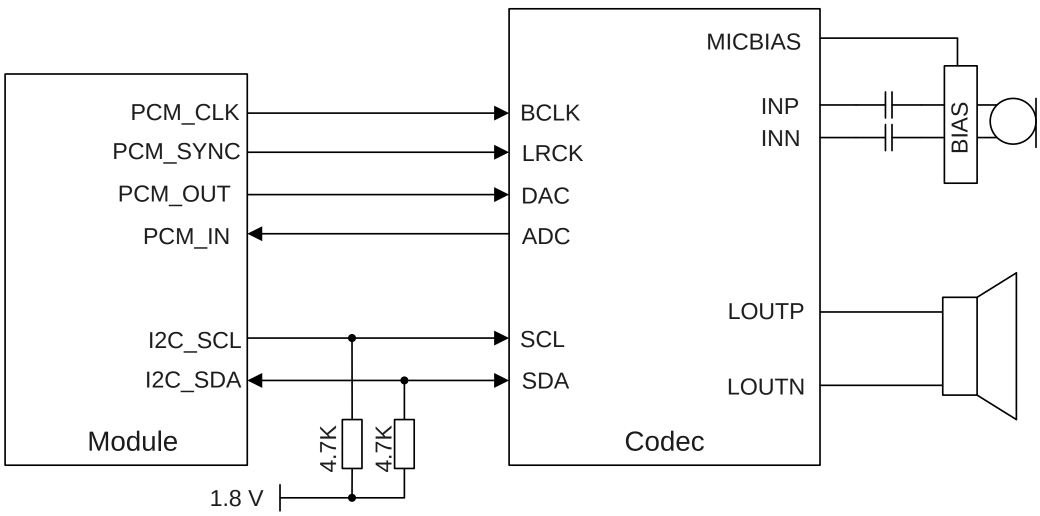


Figure 24: Reference Circuit of PCM and I2C Application with Audio Codec

NOTE

1. It is recommended to reserve an RC (R = 22 Ω, C = 22 pF) circuits on the PCM traces, and close to codec, especially for PCM_CLK.
2. EC25 series only works as a master device pertaining to I2C interface.

3.14. SD Card Interface

EC25 series supports SDIO 3.0 interface for SD card. The following table shows the pin definition of SD card interface.

Table 15: Pin Definition of SD Card Interface

Pin Name	Pin No.	I/O	Description	Comment
SDC2_DATA3	28	DIO	SD card SDIO data bit 3	SDIO signal output voltage can be selected according to the signal output voltage supported by SD card; see SD 3.0 protocol for more details. If unused, keep them open.
SDC2_DATA2	29	DIO	SD card SDIO data bit 2	
SDC2_DATA1	30	DIO	SD card SDIO data bit 1	
SDC2_DATA0	31	DIO	SD card SDIO data bit 0	
SDC2_CLK	32	DO	SD card SDIO clock	
SDC2_CMD	33	DIO	SD card SDIO command	
VDD_SDIO	34	PO	SD card SDIO pull-up power	1.8/2.85 V configurable. Cannot be used for SD card power. If unused, keep it open.
SD_INS_DET	23	DI	SD card insertion detection	1.8 V power domain. If SD card function is unused, keep this pin open.

The following figure shows a reference design of SD card.

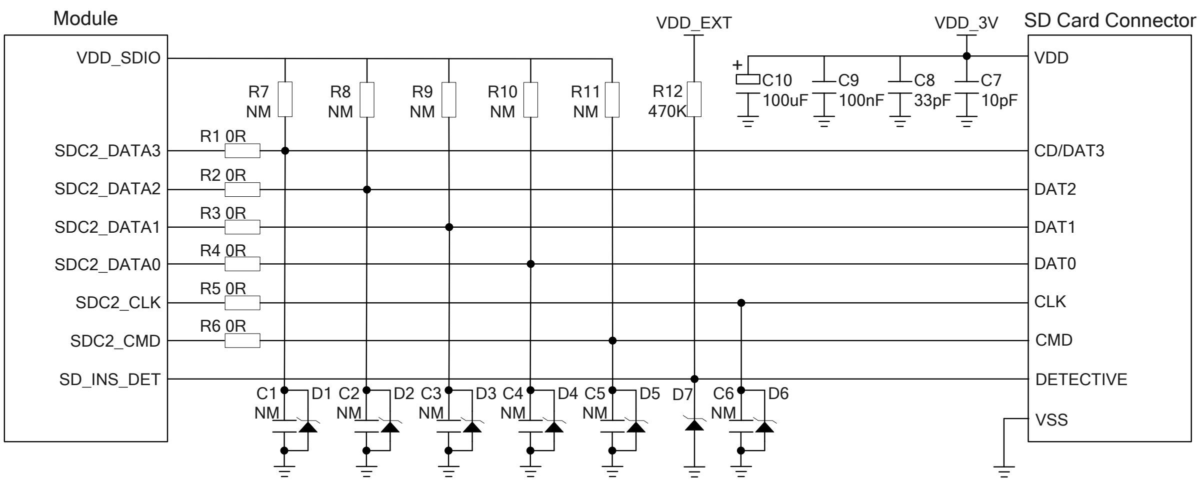


Figure 25: Reference Circuit of SD Card Interface

In SD card interface design, in order to ensure good communication performance with SD card, the following design principles should be complied with:

- SD_INS_DET must be connected when used for SD card.
- The voltage range of SD card power supply VDD_3V is 2.7–3.6 V and a sufficient current up to 0.8 A should be provided. As the maximum output current of VDD_SDIO is 50 mA which can only be used for SDIO pull-up resistors, an externally power supply is needed for SD card.
- To avoid jitter of bus, resistors R7–R11 are needed to pull up the SDIO to VDD_SDIO. Value of these resistors is among 10–100 kΩ and the recommended value is 100 kΩ. VDD_SDIO should be used as the pull-up power.
- In order to adjust signal quality, it is recommended to add 0 Ω resistors R1–R6 in series between the module and the SD card. The bypass capacitors C1–C6 are reserved and not mounted by default. All resistors and bypass capacitors should be placed close to the module.
- For better ESD protection, it is recommended to add a TVS array on SD card pins near the SD card connector with junction capacitance less than 15 pF.
- Keep SDIO signals far away from other sensitive circuits/signals such as RF circuits, analog signals, etc., as well as noisy signals such as clock signals, DC-DC signals, etc.
- It is important to route the SDIO signal traces with total grounding. The impedance of SDIO data trace is 50 Ω (±10%).
- Make sure the adjacent trace spacing is two times of the trace width and the load capacitance of SDIO bus should be less than 15 pF.
- It is recommended to keep the trace length difference between SDC2_CLK and SDC2_DATA[0:3]/SDC2_CMD less than 1 mm and the total routing length less than 50 mm. The total trace length inside the module is 27 mm, so the exterior total trace length should be less than 23 mm.

3.15. WLAN and Bluetooth Application Interfaces

EC25 series supports a SDIO 3.0 interface for WLAN and UART/PCM interfaces for Bluetooth function.

The following table shows the pin definition of WLAN and Bluetooth application interfaces.

Table 16: Pin Definition of WLAN and Bluetooth Applications

Pin Name	Pin No.	I/O	Description	Comment
WLAN Application Interface				
SDC1_DATA3	129	DIO	WLAN SDIO data bit 3	1.8 V power domain. If unused, keep them open.
SDC1_DATA2	130	DIO	WLAN SDIO data bit 2	
SDC1_DATA1	131	DIO	WLAN SDIO data bit 1	

SDC1_DATA0	132	DIO	WLAN SDIO data bit 0	
SDC1_CLK	133	DO	WLAN SDIO clock	
SDC1_CMD	134	DIO	WLAN SDIO command	
WLAN_EN	136	DO	WLAN function enable	1.8 V power domain. Active high. Cannot be pulled up before startup. If unused, keep it open.
Coexistence and Control Interface				
PM_ENABLE	127	DO	WLAN power control	1.8 V power domain Active high.
WAKE_ON_ WIRELESS	135	DI	WLAN wake up the module	1.8 V power domain
COEX_UART_RX	137	DI	LTE/WLAN & Bluetooth coexistence receive	1.8 V power domain. Cannot be pulled up before startup. If unused, keep them open.
COEX_UART_TX	138	DO	LTE/WLAN & Bluetooth coexistence transmit	
WLAN_SLP_CLK	118	DO	WLAN sleep clock	
Bluetooth Application Interface				
BT_RTS	37	DI	DTE request to send signal from DCE	1.8 V power domain. Connect to DTE's CTS.
BT_TXD	38	DO	Bluetooth UART transmit	1.8 V power domain.
BT_RXD	39	DI	Bluetooth UART receive	1.8 V power domain.
BT_CTS	40	DO	DTE clear to send signal from DCE	1.8 V power domain. Cannot be pulled up before startup. Connect to DTE's CTS. If unused, keep it open.
BT_EN	139	DO	Bluetooth function enable	1.8 V power domain. Active high.
PCM_IN [7]	24	DI	PCM data input	1.8 V power domain.
PCM_OUT [7]	25	DO	PCM data output	
PCM_SYNC [7]	26	DIO	PCM frame sync	1.8 V power domain. Serve as output signal in master mode or input signal in slave mode.
PCM_CLK [7]	27	DIO	PCM clock	

[7] Pins 24–27 for PCM function are used for audio design on EC25 series module and Bluetooth function on FC20 series/FC21 module.

The following figure shows a reference design of WLAN and Bluetooth interfaces with Quectel FC20 series/FC21 module.

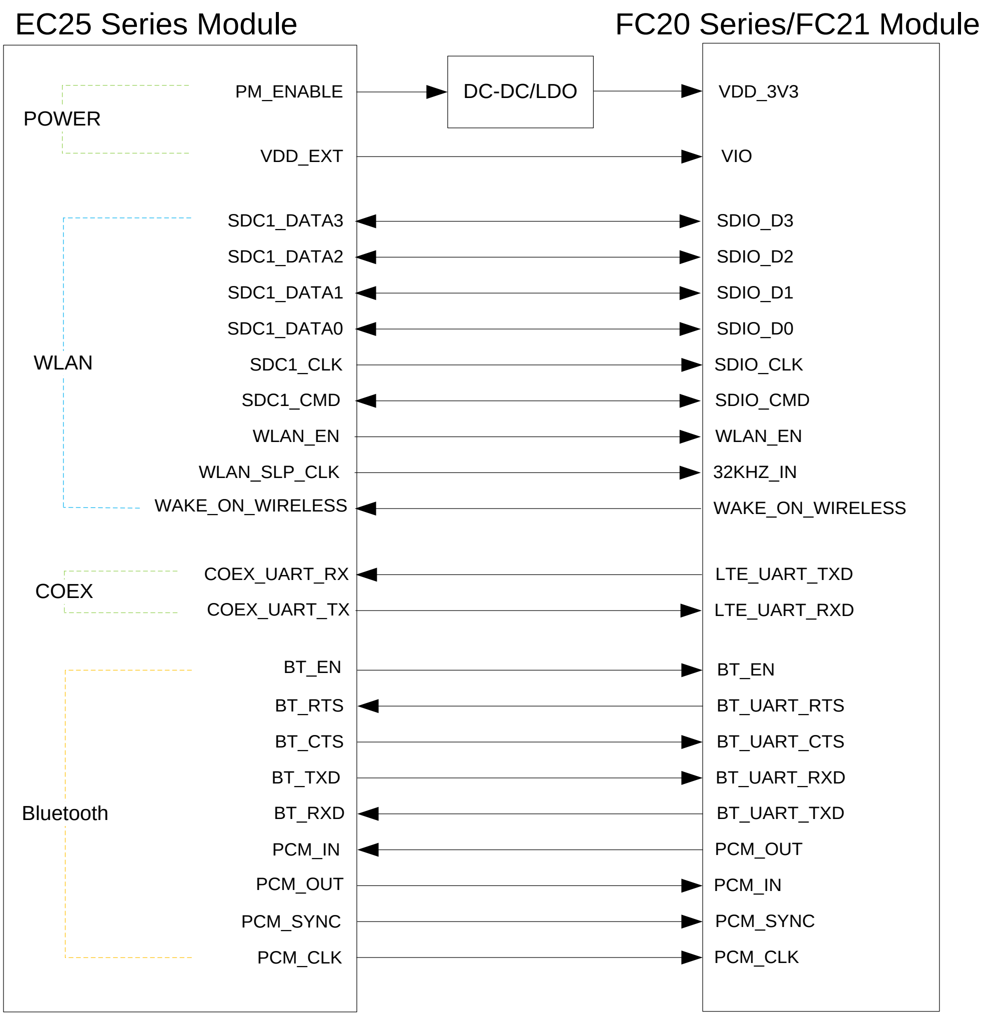


Figure 26: Reference Circuit of WLAN & Bluetooth Application Interfaces with FC20 Series/FC21

NOTE

1. FC20 series/FC21 module can only be used as a slave device.
2. When Bluetooth function is enabled on EC25 series module, PCM_SYNC and PCM_CLK pins are only used to output signals.
3. For more information about interfaces for WLAN and Bluetooth applications, see ***document [6]***.

3.15.1. WLAN Application Interface

EC25 series provides a SDIO 3.0 interface and a control interface for WLAN design. SDIO interface supports the SDR mode, and the maximum frequency is up to 50 MHz.

As SDIO signals are high-speed, in order to ensure the SDIO interface design corresponds with the SDIO 3.0 specification, please comply with the following principles:

- It is important to route the SDIO signal traces with total grounding. The impedance of SDIO signal trace is 50 Ω ±10 %.
- Keep SDIO signals far away from other sensitive circuits/signals such as RF circuits, analog signals, etc., as well as noisy signals such as clock signals, DC-DC signals, etc.
- It is recommended to keep matching length between SDC1_CLK and SDC1_DATA[0:3]/SDC1_CMD less than 1 mm and total routing length less than 50 mm.
- Keep termination resistors within 15–24 Ω on SDC1_CLK signal traces near the module and keep the routing distance from module's SDC1_CLK pin to termination resistors less than 5 mm.
- Make sure the adjacent trace spacing is 2 times of the trace width and bus capacitance is less than 15 pF.

3.15.2. Bluetooth Application Interface

EC25 series module supports a dedicated UART interface and a PCM interface for Bluetooth application. Bluetooth UART interface supports high-speed mode up to 3 Mbps. It also supports RTS and CTS hardware flow control.

As Bluetooth UART interface signals are high-speed, in order to ensure the Bluetooth UART interface works normally, please comply with the following principles:

- The module provides 1.8 V Bluetooth UART interface. A voltage-level translator should be used if your application is equipped with a 3.3 V UART interface. Make sure the voltage-level translator supports data transmission with high rate.
- Make sure the communication cable supports data transmission with high rate.

NOTE

Whether the module supports Bluetooth function depends on the hardware interface and software version.

3.16. ADC Interfaces

The module provides two analog-to-digital converter (ADC) interfaces.

AT+QADC=0 can be used to read the voltage value on ADC0 pin.
AT+QADC=1 can be used to read the voltage value on ADC1 pin.

For more details about these AT commands, see ***document [2]***.

To improve the accuracy of ADC, the trace of ADC should be surrounded by ground.

Table 17: Pin Definition of ADC Interfaces

Pin Name	Pin No.	Description
ADC0	45	General-purpose ADC interface
ADC1	44	General-purpose ADC interface

The following table describes the characteristic of ADC function.

Table 18: Characteristic of ADC

Parameter	Min.	Typ.	Max.	Unit
ADC0 Voltage Range	0.3	-	VBAT_BB	V
ADC1 Voltage Range	0.3	-	VBAT_BB	V
ADC Resolution	-	15	-	bits

NOTE

1. ADC input voltage must not exceed that of VBAT_BB.
2. It is prohibited to supply any voltage to ADC pins when VBAT power supply is removed.
3. It is recommended to use a resistor divider circuit for ADC application.

3.17. SGMII Interface

EC25 series module includes an integrated Ethernet MAC with an SGMII interface and two management interfaces. The key features of the SGMII interface are shown below:

- *IEEE802.3* compliant
- Support 10 Mbps/100 Mbps/1000 Mbps Ethernet work mode
- Support maximum 150 Mbps (DL)/50 Mbps (UL) for 4G network
- Support VLAN tagging
- Support IEEE1588 and Precision Time Protocol (PTP)
- Can be used to connect to external Ethernet PHY like AR8033, or to an external switch
- Management interfaces support dual voltage 1.8/2.85 V

The following table shows the pin definition of SGMII interface.

Table 19: Pin Definition of SGMII Interface

Pin Name	Pin No.	I/O	Description	Comment
SGMII Control Signal				
EPHY_RST_N	119	DO	Ethernet PHY reset	1.8/2.85 V power domain.
EPHY_INT_N	120	DI	Ethernet PHY interrupt	1.8 V power domain.
SGMII_MDATA	121	DIO	SGMII management data	1.8/2.85 V power domain.
SGMII_MCLK	122	DO	SGMII management data clock	1.8/2.85 V power domain.
USIM2_VDD	128	PO	SGMII_MDATA pull-up power supply	Configurable power supply. 1.8/2.85 V power domain.
SGMII Data Signal				
SGMII_TX_M	123	AO	SGMII transmit (-)	Connect this pin with a 0.1 μF capacitor, and the capacitor close to the PHY side. If unused, keep them open.
SGMII_TX_P	124	AO	SGMII transmit (+)	
SGMII_RX_P	125	AI	SGMII receive (+)	Connect this pin with a 0.1 μF capacitor, and the capacitor close to the module. If unused, keep them open.
SGMII_RX_M	126	AI	SGMII receive (-)	

The following figure shows the simplified block diagram for Ethernet application.

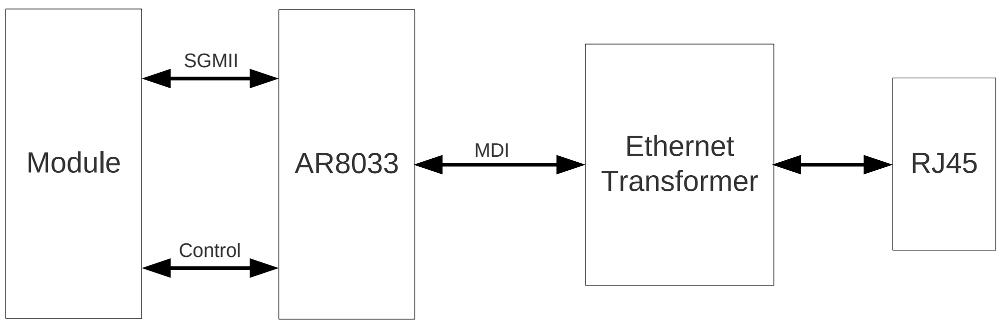


Figure 27: Simplified Block Diagram for Ethernet Application

The following figure shows a reference design of SGMII interface with PHY AR8033 application.

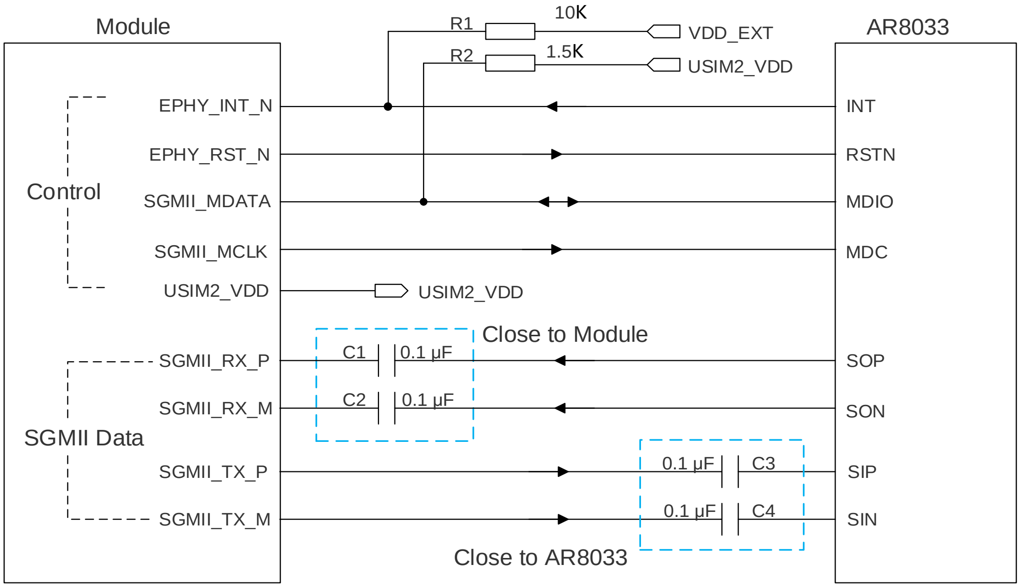


Figure 28: Reference Circuit of SGMII Interface with PHY AR8033 Application

To enhance the reliability and availability in your applications, please follow the criteria below in the Ethernet PHY circuit design:

- Keep SGMII data and control signals away from other sensitive circuits/signals such as RF circuits, analog signals, etc., as well as noisy signals such as clock signals and DC-DC signals.
- Keep the maximum trace length less than 10 inches and keep skew on the differential pairs less than 20 mil.
- The differential impedance of SGMII data trace is 100 Ω ±10 %, and the reference ground of the area should be complete.
- Make sure the trace spacing between SGMII_TX_P/M and SGMII_RX_P/M is at least 3 times of the trace width, and the same to the adjacent signal traces.

3.18. Indication Signals

3.18.1. Network Status Indication

The network indication pins can be used to drive network status indication LEDs. The module provides two pins which are NET_MODE and NET_STATUS. The following tables describe the pin definition and logic level changes in different network status.

Table 20: Pin Definition of Network Connection Status/Activity Indicator

Pin Name	Pin No.	I/O	Description	Comment
NET_MODE	5	DO	Indicate the module's network registration mode	1.8 V power domain Cannot be pulled up before startup. If unused, keep it open.
NET_STATUS	6	DO	Indicate the module's network activity status	1.8 V power domain If unused, keep it open.

Table 21: Working State of Network Connection Status/Activity Indicator

Pin Name	Logic Level Changes	Network Status
NET_MODE	Always High	Registered on LTE network
	Always Low	Others
NET_STATUS	Flicker slowly (200 ms High/1800 ms Low)	Network searching
	Flicker slowly (1800 ms High/200 ms Low)	Idle
	Flicker quickly (125 ms High/125 ms Low)	Data transfer is ongoing
	Always High	Voice calling

A reference circuit is shown in the following figure.

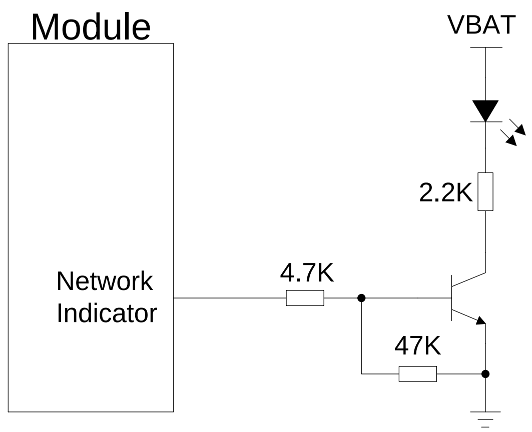


Figure 29: Reference Circuit of the Network Indicator

3.18.2. STATUS

The STATUS pin is an open drain output for indicating the module's operation status. It can be connected to a GPIO of DTE with a pull-up resistor, or as LED indication circuit as below. When the module is turned on normally, the STATUS will present the low state. Otherwise, the STATUS will present high-impedance state.

Table 22: Pin Definition of STATUS

Pin Name	Pin No.	I/O	Description	Comment
STATUS	61	OD	Indicate the module's operation status	An external pull-up resistor is required. If unused, keep it open.

The following figure shows different circuit designs of STATUS, and you can choose either one according to your application demands.

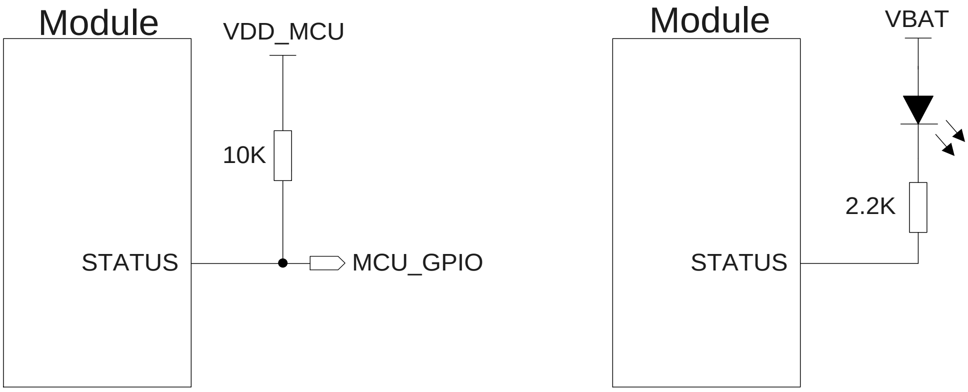


Figure 30: Reference Circuits of STATUS

NOTE

The STATUS pin cannot be used as the indication of the module shutdown status when VBAT power supply is removed.

3.18.3. RI

AT+QCFG="risignaltype","physical" can be used to configure RI behavior. No matter on which port a URC is presented, the URC will trigger the behaviors of RI pin.

In addition, RI behavior can be configured flexibly. The default behaviors of the RI are shown as below.

Table 23: Behaviors of RI

State	Response
Idle	RI keeps at high level
URC	RI outputs 120 ms low pulse when a new URC returns

The RI behavior can be changed by **AT+QCFG="urc/ri/ring"**. See ***document [3]*** for details.

NOTE

A URC can be outputted from UART port, USB AT port and USB modem port through configuration via **AT+QURCCFG**. The default port is USB AT port. See ***document [2]*** for details.

3.19. USB_BOOT Interface

EC25 series module provides a USB_BOOT pin. You can pull up USB_BOOT to 1.8 V before VDD_EXT is powered up, and the module will enter emergency download mode when it is powered on. In this mode, the module supports firmware upgrade over USB interface.

Table 24: Pin Definition of USB_BOOT Interface

Pin Name	Pin No.	I/O	Description	Comment
USB_BOOT	115	DI	Force the module to enter emergency download mode	1.8 V power domain. Active high. It is recommended to reserve test points.

The following figure shows a reference circuit of USB_BOOT interface.

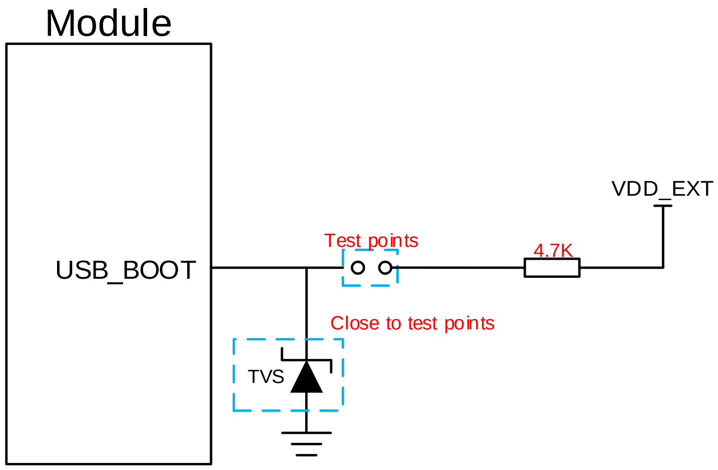


Figure 31: Reference Circuit of USB_BOOT Interface

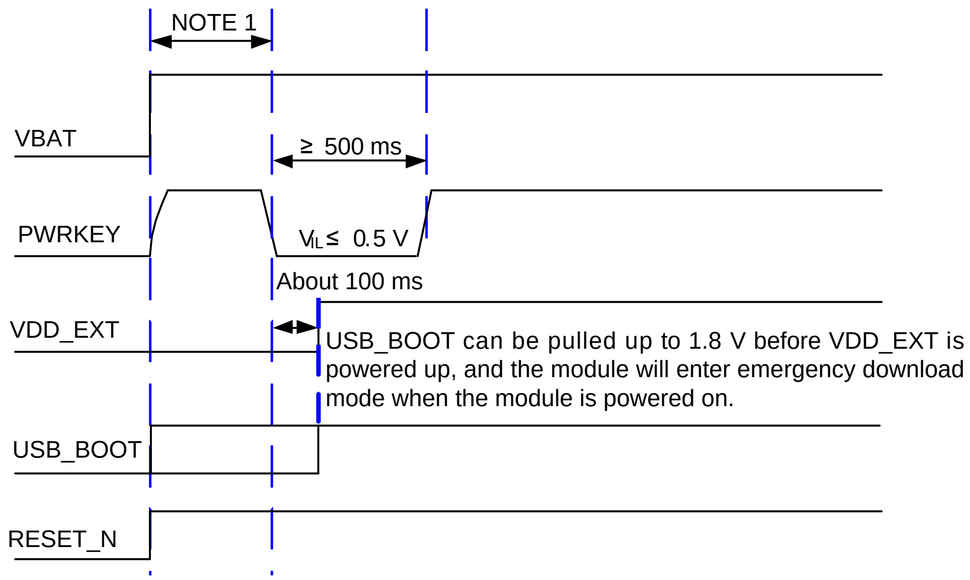


Figure 32: Timing Sequence for Entering Emergency Download Mode

NOTE

1. Make sure that VBAT is stable before pulling down PWRKEY pin. It is recommended that the time between powering up VBAT and pulling down PWRKEY pin is no less than 30 ms.
2. The output voltage of PWRKEY is 0.8 V because of the diode drop in the baseband chipset.
3. When using MCU to control module to enter the emergency download mode, please follow the above timing sequence. It is not recommended to pull up USB_BOOT to 1.8 V before powering up VBAT. Connect the test points as shown in ***Figure 31*** can manually force the module to enter download mode.

4 RF Specifications

EC25 series antenna interfaces include a main antenna interface, an Rx-diversity antenna interface which is used to resist the fall of signals caused by high speed movement and multipath effect, and a GNSS antenna interface. The impedance of antenna ports is 50 Ω.

4.1. Celluar Network

4.1.1. Antenna Interfaces & Frequency Bands

The pin definition of main antenna and Rx-diversity antenna interfaces is shown below.

Table 25: Pin Definition of RF Antennas

Pin Name	Pin No.	I/O	Description	Comment
ANT_MAIN	49	AIO	Main antenna interface	50 Ω impedance
ANT_DIV	35	AI	Diversity antenna interface	50 Ω impedance. If unused, keep it open.

4.1.2. Operating Frequency

Table 26: Module Operating Frequencies

3GPP Band	Transmit	Receive	Unit
GSM850	824–849	869–894	MHz
EGSM900	880–915	925–960	MHz
DCS1800	1710–1785	1805–1880	MHz
PCS1900	1850–1910	1930–1990	MHz
WCDMA B1	1920–1980	2110–2170	MHz

WCDMA B2	1850–1910	1930–1990	MHz
WCDMA B4	1710–1755	2110–2155	MHz
WCDMA B5	824–849	869–894	MHz
WCDMA B6	830–840	875–885	MHz
WCDMA B8	880–915	925–960	MHz
WCDMA B19	830–845	875–890	MHz
LTE-FDD B1	1920–1980	2110–2170	MHz
LTE-FDD B2	1850–1910	1930–1990	MHz
LTE-FDD B3	1710–1785	1805–1880	MHz
LTE-FDD B4	1710–1755	2110–2155	MHz
LTE-FDD B5	824–849	869–894	MHz
LTE-FDD B7	2500–2570	2620–2690	MHz
LTE-FDD B8	880–915	925–960	MHz
LTE-FDD B12	699–716	729–746	MHz
LTE-FDD B13	777–787	746–756	MHz
LTE-FDD B14	788–798	758–768	MHZ
LTE-FDD B18	815–830	860–875	MHz
LTE-FDD B19	830–845	875–890	MHz
LTE-FDD B20	832–862	791–821	MHz
LTE-FDD B26	814–849	859–894	MHz
LTE-FDD B28	703–748	758–803	MHz
LTE-TDD B38	2570–2620	2570–2620	MHz
LTE-TDD B40	2300–2400	2300–2400	MHz
LTE-TDD B41	2555–2655	2555–2655	MHz
LTE-FDD B66	1710–1780	2110–2180	MHz

LTE-FDD B71	663–698	617–652	MHz

4.1.3. Tx Power

The following table shows the Tx power of EC25 series module.

Table 27: Tx Power

Frequency	Max. Tx Power	Min. Tx Power
GSM850/EGSM900	33 dBm ±2 dB	5 dBm ±5 dB
DCS1800/PCS1900	30 dBm ±2 dB	0 dBm ±5 dB
GSM850/EGSM900 (8-PSK)	27 dBm ±3 dB	5 dBm ±5 dB
DCS1800/PCS1900 (8-PSK)	26 dBm ±3 dB	0 dBm ±5 dB
WCDMA bands	24 dBm + 1/-3 dB	< -49 dBm
LTE-FDD bands	23 dBm ±2 dB	< -39 dBm
LTE-TDD bands	23 dBm ±2 dB	< -39 dBm

NOTE

In GPRS 4 slots TX mode, the maximum output power is reduced by 3.0 dB. The design conforms to the GSM specification as described in ***Chapter 13.16*** of *3GPP TS 51.010-1*.

4.1.4. Rx Sensitivity

The following tables show the conducted Rx sensitivity of EC25 series module.

4.1.4.1. EC25-E Conducted Rx Sensitivity

Table 28: EC25-E Conducted Rx Sensitivity

Frequency Bands	Primary	Diversity	SIMO [8]	3GPP (SIMO)
EGSM900	-109.0 dBm	-	-	-102.0 dBm
DCS1800	-109.0 dBm	-	-	-102.0dbm
WCDMA B1	-110.5 dBm	-	-	-106.7 dBm
WCDMA B5	-110.5 dBm	-	-	-104.7 dBm
WCDMA B8	-110.5 dBm	-	-	-103.7 dBm
LTE-FDD B1 (10 MHz)	-98.0 dBm	-98.0 dBm	-101.5 dBm	-96.3 dBm
LTE-FDD B3 (10 MHz)	-96.5 dBm	-98.5 dBm	-101.5 dBm	-93.3 dBm
LTE-FDD B5 (10 MHz)	-98.0 dBm	-98.5 dBm	-101.0 dBm	-94.3 dBm
LTE-FDD B7 (10 MHz)	-97.0 dBm	-97.0 dBm	-99.5 dBm	-94.3 dBm
LTE-FDD B8 (10 MHz)	-97.0 dBm	-97.0 dBm	-101.0 dBm	-93.3 dBm
LTE-FDD B20 (10 MHz)	-97.5 dBm	-99.0 dBm	-102.5 dBm	-93.3 dBm
LTE-TDD B38 (10 MHz)	-95 dBm	-97.0 dBm	-98.9 dBm	-96.3 dBm
LTE-TDD B40 (10 MHz)	-96.3 dBm	-98.0 dBm	-101.0 dBm	-96.3 dBm
LTE-TDD B41 (10 MHz)	-94.5 dBm	-97.0 dBm	-98.5 dBm	-94.3 dBm

[8] SIMO is a smart antenna technology that uses a single antenna at the transmitter side and two antennas at the receiver side, which can improve Rx performance.

4.1.4.2. EC25-A Conducted Rx Sensitivity

Table 29: EC25-A Conducted Rx Sensitivity

Frequency Bands	Primary	Diversity	SIMO [8]	3GPP (SIMO)
WCDMA B2	-110.0 dBm	-	-	-104.7 dBm
WCDMA B4	-110.0 dBm	-	-	-106.7 dBm
WCDMA B5	-110.5 dBm	-	-	-104.7 dBm
LTE-FDD B2 (10 MHz)	-98.0 dBm	-98.0 dBm	-101.0 dBm	-94.3 dBm
LTE-FDD B4 (10 MHz)	-97.5 dBm	-99.0 dBm	-101.0 dBm	-96.3 dBm
LTE-FDD B12 (10 MHz)	-97.2 dBm	-98.0 dBm	-101.0 dBm	-93.3 dBm

4.1.4.3. EC25-V Conducted Rx Sensitivity

Table 30: EC25-V Conducted Rx Sensitivity

Frequency Bands	Primary	Diversity	SIMO [8]	3GPP (SIMO)
LTE-FDD B4 (10 MHz)	-97.5 dBm	-99.0 dBm	-101.0 dBm	-96.3 dBm
LTE-FDD B13 (10 MHz)	-97.7 dBm	-97.0 dBm	-100.0 dBm	-93.3 dBm

4.1.4.4. EC25-J Conducted Rx Sensitivity

Table 31: EC25-J Conducted Rx Sensitivity

Frequency Bands	Primary	Diversity	SIMO [8]	3GPP (SIMO)
WCDMA B1	-110.0 dBm	-110.5 dBm	-111.0 dBm	-106.7 dBm
WCDMA B6	-110.5 dBm	-110.5 dBm	-111.0 dBm	-106.7 dBm
WCDMA B8	-110.5 dBm	-111.0 dBm	-111.0 dBm	-103.7 dBm
WCDMA B19	-110.5 dBm	-110.5 dBm	-111.0 dBm	-106.7 dBm
LTE-FDD B1 (10 MHz)	-97.5 dBm	-98.7 dBm	-100.2 dBm	-96.3 dBm

LTE-FDD B3 (10 MHz)	-96.5 dBm	-97.1 dBm	-100.5 dBm	-93.3 dBm
LTE-FDD B8 (10 MHz)	-98.4 dBm	-99.0 dBm	-101.2 dBm	-93.3 dBm
LTE-FDD B18 (10 MHz)	-99.5 dBm	-99.0 dBm	-101.7 dBm	-96.3 dBm
LTE-FDD B19 (10 MHz)	-99.2 dBm	-99.0 dBm	-101.4 dBm	-96.3 dBm
LTE-FDD B26 (10 MHz)	-99.5 dBm	-99.0 dBm	-101.5 dBm	-93.8 dBm
LTE-TDD B41 (10 MHz)	-95.0 dBm	-95.7 dBm	-99.0 dBm	-94.3 dBm

4.1.4.5. EC25-AU Conducted Rx Sensitivity

Table 32: EC25-AU Conducted Rx Sensitivity

Frequency Bands	Primary	Diversity	SIMO [8]	3GPP (SIMO)
GSM850	-109.0 dBm	-	-	-102.0 dBm
EGSM900	-109.0 dBm	-	-	-102.0 dBm
DCS1800	-109.0 dBm	-	-	-102.0 dBm
PCS1900	-109.0 dBm	-	-	-102.0 dBm
WCDMA B1	-110.0 dBm	-109 dBm	-112 dBm	-106.7 dBm
WCDMA B2	-110.0 dBm	-	-	-104.7 dBm
WCDMA B5	-111.0 dBm	-112 dBm	-113 dBm	-104.7 dBm
WCDMA B8	-111.0 dBm	-111 dBm	-113 dBm	-103.7 dBm
LTE-FDD B1 (10 MHz)	-97.2 dBm	-97.5 dBm	-100.2 dBm	-96.3 dBm
LTE-FDD B2 (10 MHz)	-98.2 dBm	-	-	-94.3 dBm
LTE-FDD B3 (10 MHz)	-98.7 dBm	-98.6 dBm	-102.2 dBm	-93.3 dBm
LTE-FDD B4 (10 MHz)	-97.7 dBm	-97.4 dBm	-100.2 dBm	-96.3 dBm
LTE-FDD B5 (10 MHz)	-98.0 dBm	-98.2 dBm	-101.0 dBm	-94.3 dBm
LTE-FDD B7 (10 MHz)	-97.7 dBm	-97.7 dBm	-101.2 dBm	-94.3 dBm
LTE-FDD B8 (10 MHz)	-99.2 dBm	-98.2 dBm	-102.2 dBm	-93.3 dBm

LTE-FDD B28 (10 MHz)	-98.6 dBm	-98.7 dBm	-102.0 dBm	-94.8 dBm
LTE-TDD B40 (10 MHz)	-97.2 dBm	-98.4 dBm	-101.2 dBm	-96.3 dBm

4.1.4.6. EC25-AUX Conducted Rx Sensitivity

Table 33: EC25-AUX Conducted Rx Sensitivity

Frequency Bands	Primary	Diversity	SIMO [8]	3GPP (SIMO)
GSM850	-109.0 dBm	-	-	-102.0 dBm
EGSM900	-109.0 dBm	-	-	-102.0 dBm
DCS1800	-109.0 dBm	-	-	-102.0 dBm
PCS1900	-109.0 dBm	-	-	-102.0 dBm
WCDMA B1	-110.0 dBm	-109.5 dBm	-112 dBm	-106.7 dBm
WCDMA B2	-110.5 dBm	-	-	-104.7 dBm
WCDMA B4	-110.0 dBm	-110 dBm	-112 dBm	-104.7 dBm
WCDMA B5	-111.0 dBm	-112 dBm	-113 dBm	-104.7 dBm
WCDMA B8	-111.0 dBm	-112 dBm	-113 dBm	-103.7 dBm
LTE-FDD B1 (10 MHz)	-98.0 dBm	-97.7 dBm	-101.2 dBm	-96.3 dBm
LTE-FDD B2 (10 MHz)	-98.5 dBm	-	-	-94.3 dBm
LTE-FDD B3 (10 MHz)	-99.0 dBm	-98.8 dBm	-102.2 dBm	-93.3 dBm
LTE-FDD B4 (10 MHz)	-97.7 dBm	-97.6 dBm	-100.2 dBm	-96.3 dBm
LTE-FDD B5 (10 MHz)	-98.5 dBm	-98.2 dBm	-101.0 dBm	-94.3 dBm
LTE-FDD B7 (10 MHz)	-97.7 dBm	-97.7 dBm	-101.2 dBm	-94.3 dBm
LTE-FDD B8 (10 MHz)	-99.0 dBm	-98.5 dBm	-102.2 dBm	-93.3 dBm
LTE-FDD B28 (10 MHz)	-98.0 dBm	-98.7 dBm	-101.5 dBm	-94.8 dBm
LTE-TDD B40 (10 MHz)	-97.5 dBm	-98.2 dBm	-101.2 dBm	-96.3 dBm

4.1.4.7. EC25-AF Conducted Rx Sensitivity

Table 34: EC25-AF Conducted Rx Sensitivity

Frequency Bands	Primary	Diversity	SIMO [8]	3GPP (SIMO)
WCDMA B2	-109.5 dBm	-110 dBm	-110.4 dBm	-104.7 dBm
WCDMA B4	-109.6 dBm	-110 dBm	-110.6 dBm	-106.7 dBm
WCDMA B5	-110 dBm	-110 dBm	-110.7 dBm	-104.7 dBm
LTE-FDD B2 (10 MHz)	-98.0 dBm	-98.5 dBm	-100.5 dBm	-94.3 dBm
LTE-FDD B4 (10 MHz)	-97.5 dBm	-98.2 dBm	-99.5 dBm	-96.3 dBm
LTE-FDD B5 (10 MHz)	-98.0 dBm	-98.5 dBm	-100.5 dBm	-94.3 dBm
LTE-FDD B12 (10 MHz)	-99.0 dBm	-99.5 dBm	-100.5 dBm	-93.3 dBm
LTE-FDD B13 (10 MHz)	-98.5 dBm	-99.5 dBm	-100.7 dBm	-93.3 dBm
LTE-FDD B14 (10 MHz)	-99.4 dBm	-99.5 dBm	-100.9 dBm	-93.3 dBm
LTE-FDD B66 (10 MHz)	-97.5 dBm	-98.5 dBm	-99.6 dBm	-95.8 dBm
LTE-FDD B71 (10 MHz)	-98.6 dBm	-99.5 dBm	-100 dBm	-93.5 dBm

4.1.4.8. EC25-AFX Conducted Rx Sensitivity

Table 35: EC25-AFX Conducted Rx Sensitivity

Frequency Bands	Primary	Diversity	SIMO [8]	3GPP (SIMO)
WCDMA B2	-109.5 dBm	-110 dBm	-110.4 dBm	-104.7 dBm
WCDMA B4	-109.6 dBm	-110 dBm	-110.6 dBm	-106.7 dBm
WCDMA B5	-110 dBm	-110 dBm	-110.7 dBm	-104.7 dBm
LTE-FDD B2 (10 MHz)	-98.0 dBm	-98.5 dBm	-100.5 dBm	-94.3 dBm
LTE-FDD B4 (10 MHz)	-97.5 dBm	-98.2 dBm	-99.5 dBm	-96.3 dBm
LTE-FDD B5 (10 MHz)	-98.0 dBm	-98.5 dBm	-100.5 dBm	-94.3 dBm

LTE-FDD B12 (10 MHz)	-99.0 dBm	-99.5 dBm	-100.5 dBm	-93.3 dBm
LTE-FDD B13 (10 MHz)	-98.5 dBm	-99.5 dBm	-100.7 dBm	-93.3 dBm
LTE-FDD B14 (10 MHz)	-99.4 dBm	-99.5 dBm	-100.9 dBm	-93.3 dBm
LTE-FDD B66 (10 MHz)	-97.5 dBm	-98.5 dBm	-99.6 dBm	-95.8 dBm
LTE-FDD B71 (10 MHz)	-98.6 dBm	-99.5 dBm	-100 dBm	-93.5 dBm

4.1.4.9. EC25-AFXD Conducted Rx Sensitivity

Table 36: EC25-AFXD Conducted Rx Sensitivity

Frequency Bands	Primary	Diversity	SIMO [8]	3GPP (SIMO)
WCDMA B2	-109.5 dBm	-110 dBm	-110.4 dBm	-104.7 dBm
WCDMA B4	-109.6 dBm	-110 dBm	-110.6 dBm	-106.7 dBm
WCDMA B5	-110 dBm	-110 dBm	-110.7 dBm	-104.7 dBm
LTE-FDD B2 (10 MHz)	-98.0 dBm	-98.5 dBm	-100.5 dBm	-94.3 dBm
LTE-FDD B4 (10 MHz)	-97.5 dBm	-98.2 dBm	-99.5 dBm	-96.3 dBm
LTE-FDD B5 (10 MHz)	-98.0 dBm	-98.5 dBm	-100.5 dBm	-94.3 dBm
LTE-FDD B12 (10 MHz)	-99.0 dBm	-99.5 dBm	-100.5 dBm	-93.3 dBm
LTE-FDD B13 (10 MHz)	-98.5 dBm	-99.5 dBm	-100.7 dBm	-93.3 dBm
LTE-FDD B14 (10 MHz)	-99.4 dBm	-99.5 dBm	-100.9 dBm	-93.3 dBm
LTE-FDD B66 (10 MHz)	-97.5 dBm	-98.5 dBm	-99.6 dBm	-95.8 dBm
LTE-FDD B71 (10 MHz)	-98.6 dBm	-99.5 dBm	-100 dBm	-93.5 dBm

4.1.4.10. EC25-EU Conducted Rx Sensitivity

Table 37: EC25-EU Conducted Rx Sensitivity

Frequency Bands	Primary	Diversity	SIMO [8]	3GPP (SIMO)
EGSM900	-108.5 dBm	-	-	-102.0 dBm
DCS1800	-108.5 dBm	-	-	-102.0 dBm
WCDMA B1	-109.5 dBm	-109.5 dBm	-	-106.7 dBm
WCDMA B8	-110.0 dBm	-111.5 dBm	-	-103.7 dBm
LTE-FDD B1 (10 MHz)	-98.5 dBm	-99.0 dBm	-101.7 dBm	-96.3 dBm
LTE-FDD B3 (10 MHz)	-98.2 dBm	-99.8 dBm	-102 dBm	-93.3 dBm
LTE-FDD B7 (10 MHz)	-96.7 dBm	-98.5 dBm	-100.7 dBm	-94.3 dBm
LTE-FDD B8 (10 MHz)	-98.5 dBm	-100.4 dBm	-102.4 dBm	-93.3 dBm
LTE-FDD B20 (10 MHz)	-98.7 dBm	-100.2 dBm	-102.7 dBm	-93.3 dBm
LTE-FDD B28A (10 MHz)	-98.7 dBm	-100.5 dBm	-102.5 dBm	-94.8 dBm
LTE-TDD B38 (10 MHz)	-95.2 dBm	-97.0 dBm	-100.2 dBm	-96.3 dBm
LTE-TDD B40 (10 MHz)	-95.7 dBm	-98.2 dBm	-101.2 dBm	-96.3 dBm
LTE-TDD B41 (10 MHz)	-95.0 dBm	-97.1 dBm	-100.2 dBm	-94.3 dBm

4.1.4.11. EC25-EUX Conducted Rx Sensitivity

Table 38: EC25-EUX Conducted Rx Sensitivity

Frequency Bands	Primary	Diversity	SIMO [8]	3GPP (SIMO)
EGSM900	-109.0 dBm	-	-	-102.0 dBm
DCS1800	-109.0 dBm	-	-	-102.0 dBm
WCDMA B1	-110.5 dBm	-110.5 dBm	-111.0 dBm	-106.7 dBm
WCDMA B8	-110.5 dBm	-110.5 dBm	-111.0 dBm	-103.7 dBm

LTE-FDD B1 (10 MHz)	-98.0 dBm	-98.0 dBm	-101 dBm	-96.3 dBm
LTE-FDD B3 (10 MHz)	-96.5 dBm	-98.5 dBm	-99.5 dBm	-93.3 dBm
LTE-FDD B7 (10 MHz)	-97.0 dBm	-96.5 dBm	-99.5 dBm	-94.3 dBm
LTE-FDD B8 (10 MHz)	-97.0 dBm	-97.0 dBm	-100.0 dBm	-93.3 dBm
LTE-FDD B20 (10 MHz)	-97.5 dBm	-99.0 dBm	-101.5 dBm	-93.3 dBm
LTE-FDD B28A (10 MHz)	-98.6 dBm	-98.7 dBm	-101.0 dBm	-94.8 dBm
LTE-TDD B38 (10 MHz)	-96.3 dBm	-97 dBm	-98.5 dBm	-96.3 dBm
LTE-TDD B40 (10 MHz)	-96.9 dBm	-98.0 dBm	-99.1 dBm	-96.3 dBm
LTE-TDD B41 (10 MHz)	-95.3 dBm	-97.5 dBm	-98.0 dBm	-94.3 dBm

4.1.4.12. EC25-MX Conducted Rx Sensitivity

Table 39: EC25-MX Conducted Rx Sensitivity

Frequency Bands	Primary	Diversity	SIMO [8]	3GPP (SIMO)
WCDMA B2	-109 dBm	-110.5 dBm	-	-104.7 dBm
WCDMA B4	-109.5 dBm	-110 dBm	-	-106.7 dBm
WCDMA B5	-110 dBm	-111 dBm	-	-104.7 dBm
LTE-FDD B2 (10 MHz)	-98 dBm	-99.1 dBm	-101.5 dBm	-94.3 dBm
LTE-FDD B4 (10 MHz)	-98.5 dBm	-98.2 dBm	-101.5 dBm	-96.3 dBm
LTE-FDD B5 (10 MHz)	-99 dBm	-99.2 dBm	-102.5 dBm	-94.3 dBm
LTE-FDD B7 (10 MHz)	-97 dBm	-98.5 dBm	-101.5 dBm	-94.3 dBm
LTE-FDD B28 (10 MHz)	-98 dBm	-99.3 dBm	-102 dBm	-94.8 dBm
LTE-FDD B66 (10 MHz)	-98 dBm	-98.4 dBm	-101.5 dBm	-95.8 dBm

4.1.4.13. EC25-EM Conducted Rx Sensitivity

Table 40: EC25-EM Conducted Rx Sensitivity

Frequency Bands	Primary	Diversity	SIMO [8]	3GPP (SIMO)
EGSM900	- 109 dBm	-	-	-102.0 dBm
DCS1800	- 109 dBm	-	-	-102.0 dBm
WCDMA B1	- 110 dBm	- 110 dBm	-	- 106.7 dBm
WCDMA B5	- 110 dBm	- 110 dBm	-	- 104.7 dBm
WCDMA B8	- 110 dBm	- 110 dBm	-	- 103.7 dBm
LTE-FDD B1 (10 MHz)	- 97.5 dBm	- 98.5 dBm	-101 dBm	- 96.3 dBm
LTE-FDD B3 (10 MHz)	- 98.3 dBm	- 99 dBm	-101.5 dBm	- 93.3 dBm
LTE-FDD B5 (10 MHz)	- 99 dBm	- 99.5 dBm	- 102.5 dBm	- 94.3 dBm
LTE-FDD B7 (10 MHz)	- 96 dBm	- 97 dBm	- 99.3 dBm	- 94.3 dBm
LTE-FDD B8 (10 MHz)	- 99 dBm	- 99 dBm	- 102.5 dBm	- 93.3 dBm
LTE-FDD B20 (10 MHz)	- 98.5 dBm	- 100 dBm	- 102.5 dBm	- 93.3 dBm
LTE-FDD B28 (10 MHz)	- 99 dBm	- 99.5 dBm	- 103dBm	- 94.8 dBm
LTE-TDD B38 (10 MHz)	- 98 dBm	-97.5 dBm	- 101 dBm	- 96.3 dBm
LTE-TDD B40 (10 MHz)	- 98 dBm	- 97.5 dBm	- 101 dBm	- 96.3 dBm
LTE-TDD B41 (10 MHz)	- 98 dBm	- 97 dBm	- 100 dBm	- 94.3 dBm

4.1.5. Reference Design

A reference design of ANT_MAIN and ANT_DIV antenna pins is shown as below. A π-type matching circuit should be reserved for better RF performance. The capacitors are not mounted by default.

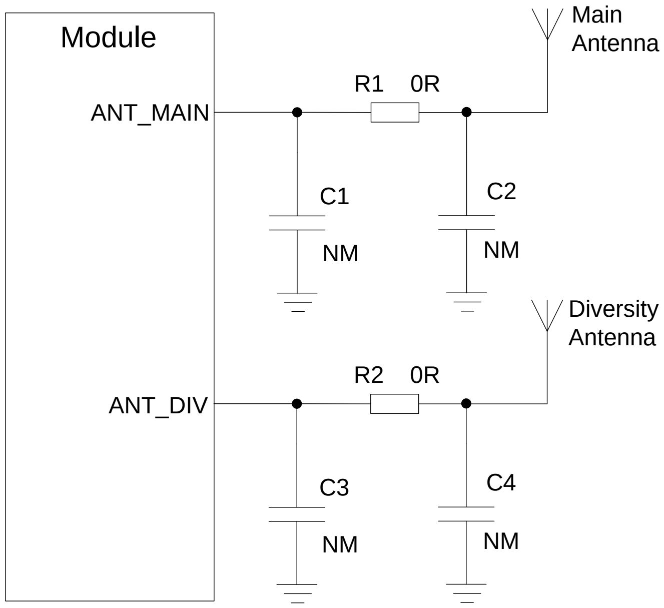


Figure 33: Reference Circuit of RF Antenna Interface

NOTE

1. Keep a proper distance between the main antenna and the Rx-diversity antenna to improve the receiving sensitivity.
2. ANT_DIV function is enabled by default. **AT+QCFG="divctl",0** can be used to disable receive diversity. See ***document [3]*** for details.
3. Place the π-type matching components (R1 & C1 & C2, R2 & C3 & C4) as close to the antenna as possible.

4.2. GNSS

4.2.1. Antenna Interfaces & Frequency Bands

EC25 series (except for EC25-MX and EC25-EM) includes a fully integrated global navigation satellite system solution that supports GPS, GLONASS, BDS, Galileo, and QZSS.

EC25 series supports standard NMEA 0183 protocol, and outputs NMEA sentences at 1 Hz data update rate via USB interface by default.

By default, EC25 series GNSS engine is switched off. It has to be switched on via AT command. For more details about GNSS engine technology and configurations, see ***document [5]***.

The following tables show the pin definition and frequency specification of GNSS antenna interface.

Table 40: Pin Definition of GNSS Antenna Interface

Pin Name	Pin No.	I/O	Description	Comment
ANT_GNSS	47	AI	GNSS antenna	50 Ω impedance. If unused, keep it open.

Table 41: GNSS Frequency

Type	Frequency	Unit
GPS	1575.42 ±1.023	MHz
GLONASS	1597.5–1605.8	MHz
Galileo	1575.42 ±2.046	MHz
BDs	1561.098 ±2.046	MHz
QZSS	1575.42	MHz

4.2.2. GNSS Performance

The following table shows the GNSS performance of the module.

Table 42: GNSS Performance

Parameter	Description	Conditions	Typ.	Unit
Sensitivity (GNSS)	Acquisition	Autonomous	-146	dBm
	Reacquisition	Autonomous	-157	dBm
	Tracking	Autonomous	-157	dBm
TTFF(GNSS)	Cold start @ open sky	Autonomous	35	s
		XTRA enabled	18	s
	Warm start @ open sky	Autonomous	26	s
		XTRA enabled	2.2	s
	Hot start @ open sky	Autonomous	2.5	s

		XTRA enabled	1.8	s
Accuracy (GNSS)	CEP-50	Autonomous @ open sky	2.5	m

NOTE

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.

4.2.3. Reference Design

A reference design of GNSS antenna is shown as below.

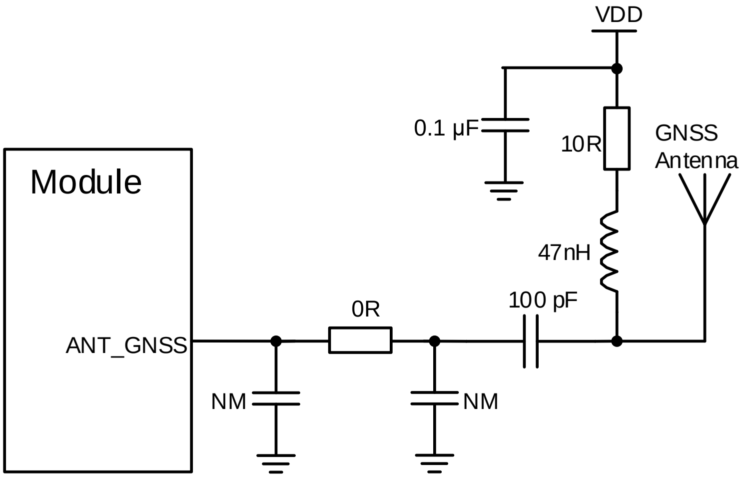


Figure 34: Reference Circuit of GNSS Antenna

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 power supply (VDD) circuit is not needed.

4.2.4. Layout Guidelines

The following layout guidelines should be taken into account in your designs.

- Maximize the distance among GNSS antenna, main antenna, and Rx-diversity antenna.
- Digital circuits such as (U)SIM card, USB interface, camera module and display connector should be kept away from the antennas.
- Use ground vias around the GNSS trace and sensitive analog signal traces to provide coplanar isolation and protection.
- Keep 50 Ω characteristic impedance for the ANT_GNSS trace.

4.3. RF Routing Guidelines

For user's PCB, the characteristic impedance of all RF traces should be controlled to 50 Ω. 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.

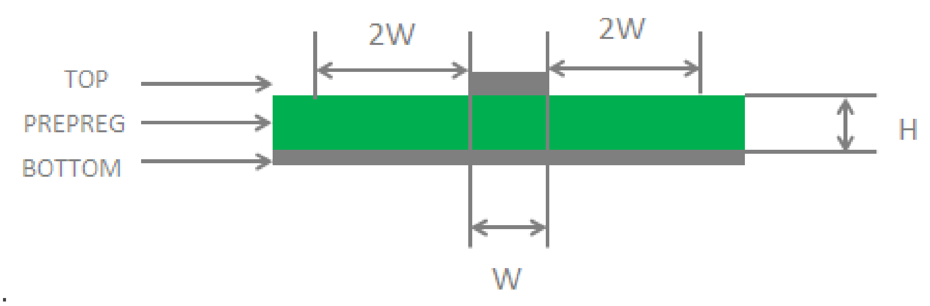


Figure 35: Microstrip Design on a 2-layer PCB

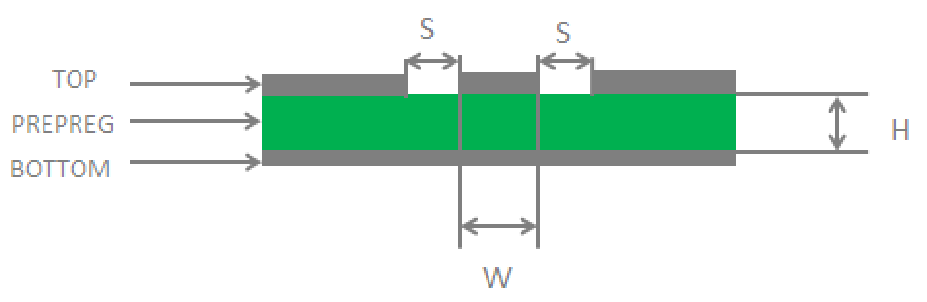


Figure 36: Coplanar Waveguide Design on a 2-layer PCB

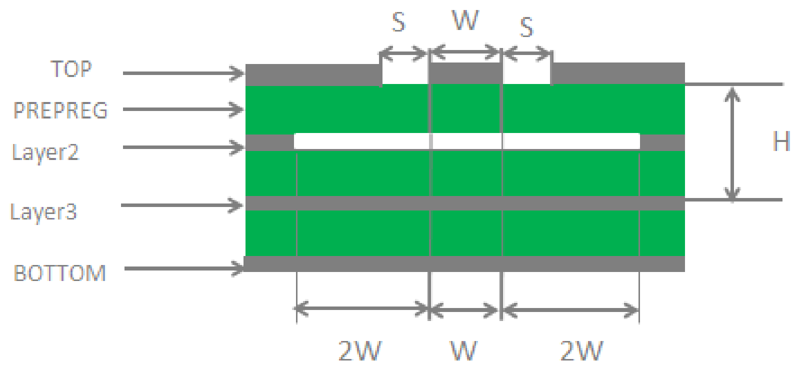


Figure 37: Coplanar Waveguide Design on a 4-layer PCB (Layer 3 as Reference Ground)

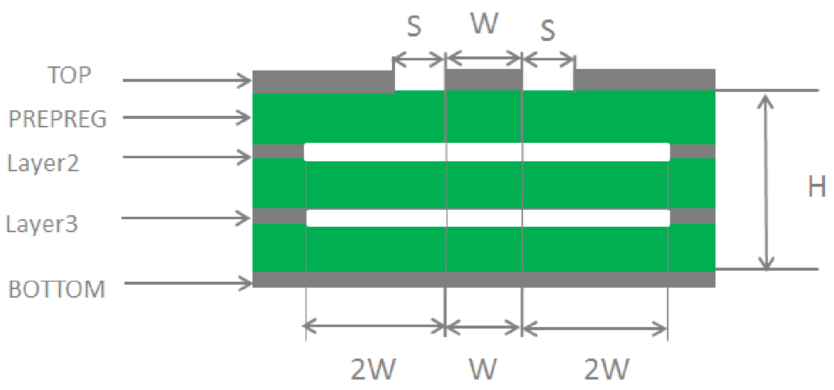


Figure 38: Coplanar Waveguide Design on a 4-layer PCB (Layer 4 as Reference Ground)

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 Ω.
- 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°.
- 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 no less than two times the width of RF signal traces (2 × 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 [7]***.

4.4. Antenna Design Requirements

The following table shows the requirements on main antenna, Rx-diversity antenna and GNSS antenna.

Table 43: Antenna Design Requirements

Type	Requirements
GNSS	Frequency range: 1559–1609 MHz Polarization: RHCP or linear VSWR: < 2 (Typ.) Passive antenna gain: > 0 dBi Active antenna noise figure: < 1.5 dB Active antenna gain: > 0 dBi Active antenna embedded LNA gain: < 17 dB
GSM/WCDMA/LTE	VSWR: ≤ 2 Efficiency: > 30 % Max input power: 50 W Input impedance: 50 Ω Cable insertion loss: **< 1 dB:** LB (<1 GHz) **< 1.5 dB:** MB (1–2.3 GHz) **< 2 dB:** HB (> 2.3 GHz)

NOTE

When the module supports LTE B13 or B14, it is recommended to use passive GNSS antennas, since active antennas may cause harmonics that affect GNSS performance.

4.5. RF Connector Recommendation

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

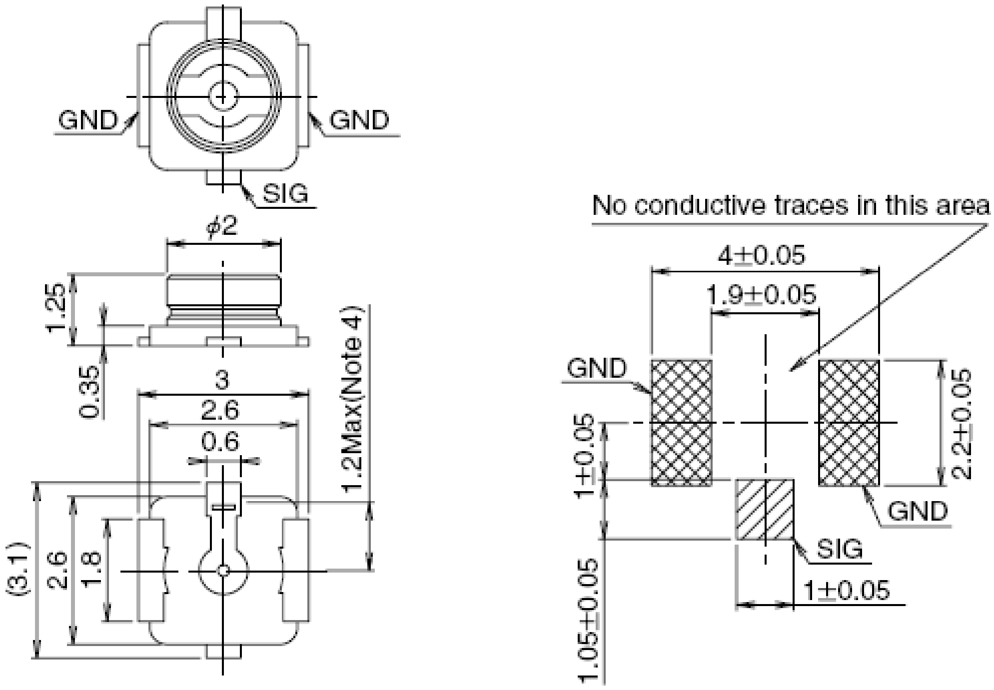


Figure 39: Dimensions of the Receptacle (Unit: mm)

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

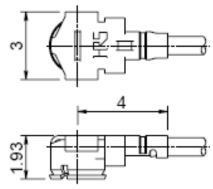
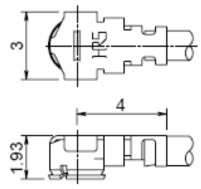
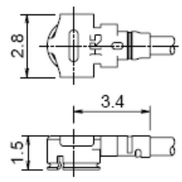
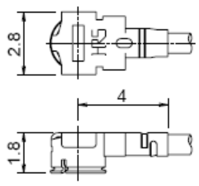
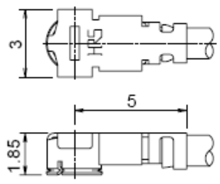
Part No.	U.FL-LP-040	U.FL-LP-066	U.FL-LP(V)-040	U.FL-LP-062	U.FL-LP-088
					
Mated Height	2.5mm Max. (2.4mm Nom.)	2.5mm Max. (2.4mm Nom.)	2.0mm Max. (1.9mm Nom.)	2.4mm Max. (2.3mm Nom.)	2.4mm Max. (2.3mm Nom.)
Applicable cable	Dia. 0.81mm Coaxial cable	Dia. 1.13mm and Dia. 1.32mm Coaxial cable	Dia. 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 40: Specifications of Mated Plugs

The following figure describes the space factor of mated connectors.

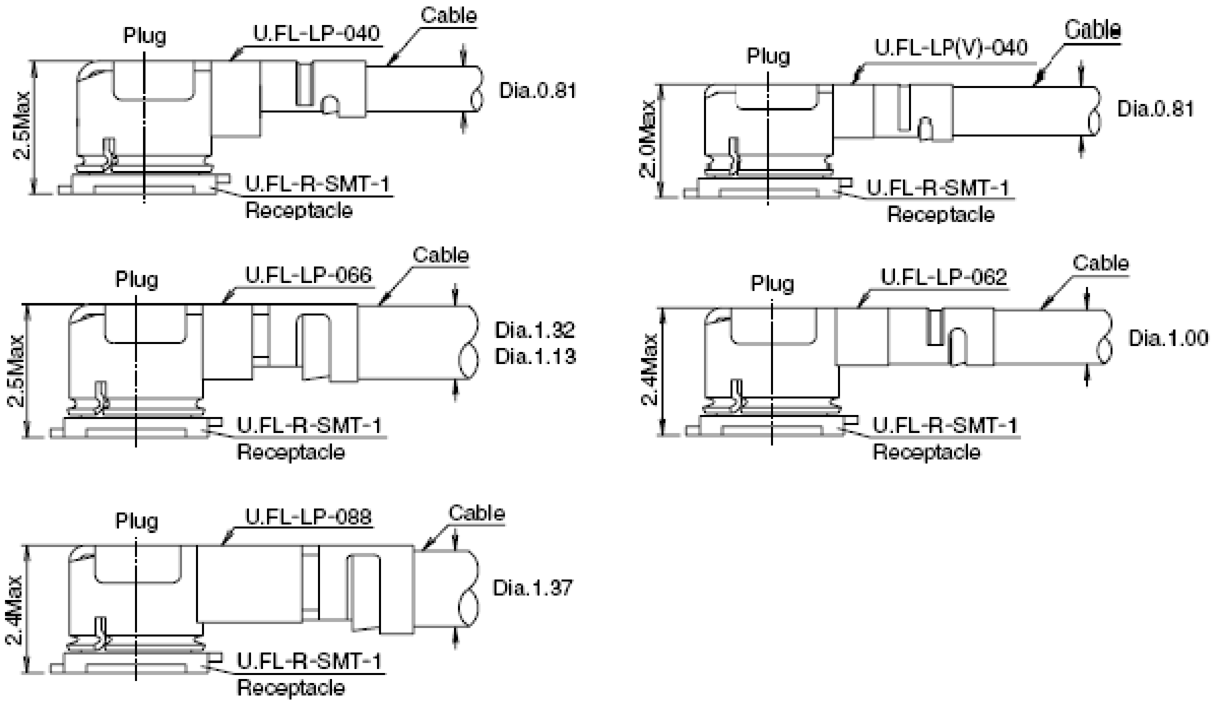


Figure 41: Space Factor of Mated Connectors (Unit: mm)

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

5 Electrical Characteristics and Reliability

5.1. Absolute Maximum Ratings

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

Table 44: Absolute Maximum Ratings

Parameter	Min.	Max.	Unit
VBAT_RF/VBAT_BB	-0.3	4.7	V
USB_VBUS	-0.3	5.5	V
Peak Current of VBAT_BB	-	0.8	A
Peak Current of VBAT_RF	-	1.8	A
Voltage at Digital Pins	-0.3	2.3	V
Voltage at ADC0	0	VBAT_BB	V
Voltage at ADC1	0	VBAT_BB	V

5.2. Power Supply Ratings

Table 45: Power Supply Ratings

Parameter	Description	Conditions	Min.	Typ.	Max.	Unit
VBAT	VBAT_BB and VBAT_RF	The actual input voltages must be kept between the minimum and maximum values.	3.3	3.8	4.3	V
	Voltage drop during burst transmission	Maximum power control level on EGSM900	-	-	400	mV
I_{VBAT}	Peak supply current (during transmission slot)	Maximum power control level on EGSM900	-	1.8	2.0	A
USB_VBUS	USB connection detection	-	3.0	5.0	5.25	V

5.3. Operating and Storage Temperatures

The operating and storage temperatures are listed in the following table.

Table 46: Operating and Storage Temperatures

Parameter	Min.	Typ.	Max.	Unit
Operating Temperature Range [9]	-35	+25	+75	ºC
Extended Temperature Range [10]	-40	-	+85	ºC
Storage Temperature Range	-40	-	+90	ºC

[9] Within the operating temperature range, the module meets 3GPP specifications.
[10] Within the 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.

5.4. Power Consumption

The values of power consumption are shown below.

5.4.1. EC25-E Power Consumption

Table 47: EC25-E Power Consumption

Description	Conditions	Typ.	Unit
OFF state	Power down	11	μA
Sleep state	**AT+CFUN=0** (USB disconnected)	1.16	mA
	EGSM900 DRX = 2 (USB disconnected)	2.74	mA
	EGSM900 DRX = 9 (USB disconnected)	2.00	mA
	WCDMA PF = 64 (USB disconnected)	2.15	mA
	WCDMA PF = 128 (USB disconnected)	1.67	mA
	LTE-FDD PF = 64 (USB disconnected)	2.60	mA
	LTE-FDD PF = 128 (USB disconnected)	1.90	mA
	LTE-TDD PF = 64 (USB disconnected)	2.79	mA
	LTE-TDD PF = 128 (USB disconnected)	2.00	mA
Idle state	EGSM900 DRX = 5 (USB disconnected)	19.5	mA
	EGSM900 DRX = 5 (USB connected)	29.5	mA
	WCDMA PF = 64 (USB disconnected)	21.0	mA
	WCDMA PF = 64 (USB connected)	31.0	mA
	LTE-FDD PF = 64 (USB disconnected)	20.7	mA
	LTE-FDD PF = 64 (USB connected)	30.8	mA
	LTE-TDD PF = 64 (USB disconnected)	20.8	mA
	LTE-TDD PF = 64 (USB connected)	32.0	mA
GPRS data transfer	EGSM900 4DL/1UL @ 33.22 dBm	271.0	mA

(GNSS OFF)	EGSM900 3DL/2UL @ 33.0 dBm	464.0	mA
	EGSM900 2DL/3UL @ 30.86 dBm	524.0	mA
	EGSM900 1DL/4UL @ 29.58 dBm	600.0	mA
	DCS1800 4DL/1UL @ 29.92 dBm	192.0	mA
	DCS1800 3DL/2UL @ 29.84 dBm	311.0	mA
	DCS1800 2DL/3UL @ 29.67 dBm	424.0	mA
	DCS1800 1DL/4UL @ 29.48 dBm	539.0	mA
EDGE data transfer (GNSS OFF)	EGSM900 4DL/1UL PCL = 8 @ 27.40 dBm	174.0	mA
	EGSM900 3DL/2UL PCL = 8 @ 27.24 dBm	281.0	mA
	EGSM900 2DL/3UL PCL = 8 @ 27.11 dBm	379.0	mA
	EGSM900 1DL/4UL PCL = 8 @ 26.99 dBm	480.0	mA
	DCS1800 4DL/1UL PCL = 2 @ 25.82 dBm	159.0	mA
	DCS1800 3DL/2UL PCL = 2 @ 25.85 dBm	251.0	mA
	DCS1800 2DL/3UL PCL = 2 @ 25.68 dBm	340.0	mA
	DCS1800 1DL/4UL PCL = 2 @ 25.57 dBm	433.0	mA
WCDMA data transfer (GNSS OFF)	WCDMA B1 HSDPA @ 22.47 dBm	613.0	mA
	WCDMA B1 HSUPA @ 22.44 dBm	609.0	mA
	WCDMA B5 HSDPA @ 23.07 dBm	671.0	mA
	WCDMA B5 HSUPA @ 23.07 dBm	669.0	mA
	WCDMA B8 HSDPA @ 22.67 dBm	561.0	mA
	WCDMA B8 HSUPA @ 22.39 dBm	557.0	mA
LTE data transfer (GNSS OFF)	LTE-FDD B1 @ 23.27 dBm	754.0	mA
	LTE-FDD B3 @ 23.54 dBm	774.0	mA
	LTE-FDD B5 @ 22.83 dBm	762.0	mA
	LTE-FDD B7 @ 23.37 dBm	842.0	mA

	LTE-FDD B8 @ 23.48 dBm	720.0	mA
	LTE-FDD B20 @ 22.75 dBm	714.0	mA
	LTE-TDD B38 @ 23.05 dBm	481.0	mA
	LTE-TDD B40 @ 23.17 dBm	431.8	mA
	LTE-TDD B41 @ 23.02 dBm	480.0	mA
GSM voice call	EGSM900 PCL = 5 @ 33.08 dBm	264.0	mA
	DCS1800 PCL = 0 @ 29.75 dBm	190.0	mA
WCDMA voice call	WCDMA B1 @ 23.22 dBm	680.0	mA
	WCDMA B5 @ 23.18 dBm	677.0	mA
	WCDMA B8 @ 23.54 dBm	618.0	mA

5.4.2. EC25-A Power Consumption

Table 48: EC25-A Power Consumption

Description	Conditions	Typ.	Unit
OFF state	Power down	10	μA
Sleep state	**AT+CFUN=0** (USB disconnected)	1.1	mA
	WCDMA PF = 64 (USB disconnected)	1.8	mA
	WCDMA PF = 128 (USB disconnected)	1.5	mA
	LTE-FDD PF = 64 (USB disconnected)	2.2	mA
	LTE-FDD PF = 128 (USB disconnected)	1.6	mA
Idle state	WCDMA PF = 64 (USB disconnected)	21.0	mA
	WCDMA PF = 64 (USB connected)	31.0	mA
	LTE-FDD PF = 64 (USB disconnected)	21.0	mA
	LTE-FDD PF = 64 (USB connected)	31.0	mA
WCDMA data transfer	WCDMA B2 HSDPA @ 21.9 dBm	591.0	mA

(GNSS OFF)	WCDMA B2 HSUPA @ 21.62 dBm	606.0	mA
	WCDMA B4 HSDPA @ 22.02 dBm	524.0	mA
	WCDMA B4 HSUPA @ 21.67 dBm	540.0	mA
	WCDMA B5 HSDPA @ 22.71 dBm	490.0	mA
	WCDMA B5 HSUPA @ 22.58 dBm	520.0	mA
LTE data transfer (GNSS OFF)	LTE-FDD B2 @ 22.93 dBm	715.0	mA
	LTE-FDD B4 @ 22.96 dBm	738.0	mA
	LTE-FDD B12 @ 23.35 dBm	663.0	mA
WCDMA voice call	WCDMA B2 @ 22.93 dBm	646.0	mA
	WCDMA B4 @ 23 dBm	572.0	mA
	WCDMA B5 @ 23.78 dBm	549.0	mA

5.4.3. EC25-V Power Consumption

Table 49: EC25-V Power Consumption

Description	Conditions	Typ.	Unit
OFF state	Power down	10	μA
Sleep state	**AT+CFUN=0** (USB disconnected)	0.85	mA
	LTE-FDD PF = 64 (USB disconnected)	2.0	mA
	LTE-FDD PF = 128 (USB disconnected)	1.5	mA
Idle state	LTE-FDD PF = 64 (USB disconnected)	20.0	mA
	LTE-FDD PF = 64 (USB connected)	31.0	mA
LTE data transfer (GNSS OFF)	LTE-FDD B4 @ 23.14 dBm	770.0	mA
	LTE-FDD B13 @ 23.48 dBm	531.0	mA

5.4.4. EC25-J Power Consumption

Table 50: EC25-J Power Consumption

Description	Conditions	Typ.	Unit
OFF state	Power down	10	μA
Sleep state	**AT+CFUN=0** (USB disconnected)	1.1	mA
	WCDMA PF = 64 (USB disconnected)	1.9	mA
	WCDMA PF = 128 (USB disconnected)	1.5	mA
	LTE-FDD PF = 64 (USB disconnected)	2.5	mA
	LTE-FDD PF = 128 (USB disconnected)	1.8	mA
	LTE-TDD PF = 64 (USB disconnected)	2.6	mA
	LTE-TDD PF = 128 (USB disconnected)	1.9	mA
Idle state	WCDMA PF = 64 (USB disconnected)	21.0	mA
	WCDMA PF = 64 (USB connected)	31.0	mA
	LTE-FDD PF = 64 (USB disconnected)	21.0	mA
	LTE-FDD PF = 64 (USB connected)	32.0	mA
	LTE-TDD PF = 64 (USB disconnected)	21.0	mA
	LTE-TDD PF = 64 (USB connected)	32.0	mA
WCDMA data transfer (GNSS OFF)	WCDMA B1 HSDPA @ 22.32 dBm	549.0	mA
	WCDMA B1 HSUPA @ 21.79 dBm	533.0	mA
	WCDMA B6 HSDPA @ 22.64 dBm	515.0	mA
	WCDMA B6 HSUPA @ 22.33 dBm	520.0	mA
	WCDMA B8 HSDPA @ 22.3 dBm	560.0	mA
	WCDMA B8 HSUPA @ 22.65 dBm	556.0	mA
	WCDMA B19 HSDPA @ 22.67 dBm	516.0	mA
	WCDMA B19 HSUPA @ 22.33 dBm	521.0	mA

LTE data transfer (GNSS OFF)	LTE-FDD B1 @ 23.16 dBm	685.0	mA
	LTE-FDD B3 @ 23.22 dBm	765.0	mA
	LTE-FDD B8 @ 23.22 dBm	640.0	mA
	LTE-FDD B18 @ 23.35 dBm	660.0	mA
	LTE-FDD B19 @ 23.16 dBm	676.0	mA
	LTE-FDD B26 @ 22.87 dBm	689.0	mA
	LTE-TDD B41 @ 22.52 dBm	438.0	mA
WCDMA voice call	WCDMA B1 @ 23.33 dBm	604.0	mA
	WCDMA B6 @ 23.28 dBm	548.0	mA
	WCDMA B8 @ 23.2 dBm	570.0	mA
	WCDMA B19 @ 23.28 dBm	548.0	mA

5.4.5. EC25-AU Power Consumption

Table 51: EC25-AU Power Consumption

Description	Conditions	Typ.	Unit
OFF state	Power down	11	μA
Sleep state	**AT+CFUN=0**	1.3	mA
	AT+CFUN=0 (USB disconnected)	1.46	mA
	GSM850 DRX = 5 (USB disconnected)	1.8	mA
	EGSM900 DRX = 5 (USB disconnected)	2.0	mA
	DCS1800 DRX = 5 (USB disconnected)	1.9	mA
	PCS1900 DRX = 5 (USB disconnected)	1.9	mA
	WCDMA PF = 64 (USB disconnected)	2.0	mA
	WCDMA PF = 128 (USB disconnected)	1.6	mA
	LTE-FDD PF = 64 (USB disconnected)	2.2	mA

	LTE-FDD PF = 128 (USB disconnected)	1.6	mA
	LTE-TDD PF = 64 (USB disconnected)	2.3	mA
	LTE-TDD PF = 128 (USB disconnected)	1.6	mA
Idle state	EGSM900 DRX = 5 (USB disconnected)	22.0	mA
	EGSM900 DRX = 5 (USB connected)	34.0	mA
	WCDMA PF = 64 (USB disconnected)	22.0	mA
	WCDMA PF = 64 (USB connected)	33.0	mA
	LTE-FDD PF = 64 (USB disconnected)	24.0	mA
	LTE-FDD PF = 64 (USB connected)	35.0	mA
GPRS data transfer (GNSS OFF)	GSM850 1UL/4DL @ 32.53 dBm	232.0	mA
	GSM850 2UL/3DL @ 32.34 dBm	384.0	mA
	GSM850 3UL/2DL @ 30.28 dBm	441.0	mA
	GSM850 4UL/1DL @ 29.09 dBm	511.0	mA
	EGSM900 1UL/4DL @ 32.34 dBm	241.0	mA
	EGSM900 2UL/3DL @ 32.19 dBm	397.0	mA
	EGSM900 3UL/2DL @ 30.17 dBm	459.0	mA
	EGSM900 4UL/1DL @ 28.96 dBm	533.0	mA
	DCS1800 1UL/4DL @ 29.71 dBm	183.0	mA
	DCS1800 2UL/3DL @ 29.62 dBm	289.0	mA
	DCS1800 3UL/2DL @ 29.49 dBm	392.0	mA
	DCS1800 4UL/1DL @ 29.32 dBm	495.0	mA
	PCS1900 1UL/4DL @ 29.61 dBm	174.0	mA
	PCS1900 2UL/3DL @ 29.48 dBm	273.0	mA
	PCS1900 3UL/2DL @ 29.32 dBm	367.0	mA
	PCS1900 4UL/1DL @ 29.19 dBm	465.0	mA

EDGE data transfer (GNSS OFF)	GSM850 1UL/4DL @ 27.09 dBm	154.0	mA
	GSM850 2UL/3DL @ 26.94 dBm	245.0	mA
	GSM850 3UL/2DL @ 26.64 dBm	328.0	mA
	GSM850 4UL/1DL @ 26.53 dBm	416.0	mA
	EGSM900 1UL/4DL @ 26.64 dBm	157.0	mA
	EGSM900 2UL/3DL @ 26.95 dBm	251.0	mA
	EGSM900 3UL/2DL @ 26.57 dBm	340.0	mA
	EGSM900 4UL/1DL @ 26.39 dBm	431.0	mA
	DCS1800 1UL/4DL @ 26.03 dBm	152.0	mA
	DCS1800 2UL/3DL @ 25.62 dBm	240.0	mA
	DCS1800 3UL/2DL @ 25.42 dBm	325.0	mA
	DCS1800 4UL/1DL @ 25.21 dBm	415.0	mA
	PCS1900 1UL/4DL @ 25.65 dBm	148.0	mA
	PCS1900 2UL/3DL @ 25.63 dBm	232.0	mA
	PCS1900 3UL/2DL @ 25.54 dBm	313.0	mA
	PCS1900 4UL/1DL @ 25.26 dBm	401.0	mA
WCDMA data transfer (GNSS OFF)	WCDMA B1 HSDPA @ 22.34 dBm	625.0	mA
	WCDMA B1 HSUPA @ 21.75 dBm	617.0	mA
	WCDMA B2 HSDPA @ 22.51 dBm	610.0	mA
	WCDMA B2 HSUPA @ 22. 14 dBm	594.0	mA
	WCDMA B5 HSDPA @ 22.98 dBm	576.0	mA
	WCDMA B5 HSUPA @ 22.89 dBm	589.0	mA
	WCDMA B8 HSDPA @ 22.31 dBm	556.0	mA
	WCDMA B8 HSUPA @ 22.11 dBm	572.0	mA
LTE data transfer	LTE-FDD B1 @ 23.28 dBm	817.0	mA

(GNSS OFF)	LTE-FDD B2 @ 23.34 dBm	803.0	mA
	LTE-FDD B3 @ 23.2 dBm	785.0	mA
	LTE-FDD B4 @ 22.9 dBm	774.0	mA
	LTE-FDD B5 @ 23.45 dBm	687.0	mA
	LTE-FDD B7 @ 22.84 dBm	843.0	mA
	LTE-FDD B8 @ 22.92 dBm	689.0	mA
	LTE-FDD B28 @ 23.23 dBm	804.0	mA
	LTE-TDD B40 @ 23.3 dBm	429.0	mA
GSM voice call	GSM850 PCL5 @ 32.66 dBm	228.0	mA
	EGSM900 PCL5 @ 32.59 dBm	235.0	mA
	DCS1800 PCL0 @ 29.72 dBm	178.0	mA
	PCS1900 PCL0 @ 29.82 dBm	170.0	mA
WCDMA voice call	WCDMA B1 @ 23.27 dBm	687.0	mA
	WCDMA B2 @ 23.38 dBm	668.0	mA
	WCDMA B5 @ 23.38 dBm	592.0	mA
	WCDMA B8 @ 23.32 dBm	595.0	mA

5.4.6. EC25-AUX Power Consumption

Table 52: EC25-AUX Power Consumption

Description	Conditions	Typ.	Unit
OFF state	Power down	9	μA
Sleep state	**AT+CFUN=0** (USB disconnected)	0.9	mA
	GSM850 DRX = 2 (USB disconnected)	2.4	mA
	LTE-FDD PF = 128 (USB disconnected)	2.5	mA
	LTE-TDD PF = 64 (USB disconnected)	3.4	mA

Idle state	GSM850 DRX = 5 (USB disconnected)	16.9	mA
	GSM850 DRX = 5 (USB connected)	34.5	mA
	WCDMA PF = 64 (USB disconnected)	17.9	mA
	WCDMA PF = 64 (USB connected)	35.2	mA
	LTE-FDD PF = 64 (USB disconnected)	18.3	mA
	LTE-FDD PF = 64 (USB connected)	35.1	mA
	LTE-TDD PF = 64 (USB disconnected)	18.4	mA
	LTE-TDD PF = 64 (USB connected)	35.1	mA
GPRS data transfer (GNSS OFF)	GSM850 4DL/1UL @ 32.48 dBm	240.1	mA
	GSM850 3DL/2UL @ 31.59 dBm	384.8	mA
	GSM850 2DL/3UL @ 29.51 dBm	452.1	mA
	GSM850 1DL/4UL @ 28.41 dBm	542.1	mA
	EGSM900 4DL/1UL @ 33.27 dBm	272.7	mA
	EGSM900 3DL/2UL @ 31.99 dBm	406.9	mA
	EGSM900 2DL/3UL @ 29.67 dBm	470.2	mA
	EGSM900 1DL/4UL @ 28.44 dBm	547.1	mA
	DCS1800 4DL/1UL @ 29.44 dBm	164.5	mA
	DCS1800 3DL/2UL @ 28.47 dBm	235.7	mA
	DCS1800 2DL/3UL @ 26.29 dBm	292.2	mA
	DCS1800 1DL/4UL @ 25.26 dBm	363.8	mA
	PCS1900 4DL/1UL @ 29.44 dBm	162.9	mA
	PCS1900 3DL/2UL @ 28.59 dBm	246.8	mA
	PCS1900 2DL/3UL @ 26.51 dBm	300.6	mA
	PCS1900 1DL/4UL @ 25.34 dBm	370.5	mA
EDGE data transfer	GSM850 4DL/1UL @ 26.94 dBm	177.5	mA

(GNSS OFF)	GSM850 3DL/2UL @ 25.90 dBm	290.8	mA
	GSM850 2DL/3UL @ 23.70 dBm	394.0	mA
	GSM850 1DL/4UL @ 22.47 dBm	504.5	mA
	EGSM900 4DL/1UL @ 27.18 dBm	176.6	mA
	EGSM900 3DL/2UL @ 26.03 dBm	289.6	mA
	EGSM900 2DL/3UL @ 23.97 dBm	390.7	mA
	EGSM900 1DL/4UL @ 22.68 dBm	502.1	mA
	DCS1800 4DL/1UL @ 26.01 dBm	141.0	mA
	DCS1800 3DL/2UL @ 25.02 dBm	227.5	mA
	DCS1800 2DL/3UL @ 23.04 dBm	316.3	mA
	DCS1800 1DL/4UL @ 22.11 dBm	411.0	mA
	PCS1900 4DL/1UL @ 26.24 dBm	143.3	mA
	PCS1900 3DL/2UL @ 25.46 dBm	231.4	mA
	PCS1900 2DL/3UL @ 23.45 dBm	316.1	mA
	PCS1900 1DL/4UL @ 22.38 dBm	411.0	mA
WCDMA data transfer (GNSS OFF)	WCDMA B1 HSDPA @ 22.60 dBm	534.6	mA
	WCDMA B1 HSUPA @ 22.48 dBm	541.3	mA
	WCDMA B2 HSDPA @ 21.60 dBm	572.9	mA
	WCDMA B2 HSUPA @ 22.06 dBm	560.0	mA
	WCDMA B4 HSDPA @ 22.97 dBm	495.8	mA
	WCDMA B4 HSUPA @ 23.20 dBm	512.4	mA
	WCDMA B5 HSDPA @ 22.63 dBm	493.1	mA
	WCDMA B5 HSUPA @ 22.98 dBm	504.7	mA
	WCDMA B8 HSDPA @ 22.46 dBm	545.5	mA
	WCDMA B8 HSUPA @ 21.89 dBm	541.1	mA

LTE data transfer (GNSS OFF)	LTE-FDD B1 @ 22.91 dBm	713.5	mA
	LTE-FDD B2 @ 22.85 dBm	713.4	mA
	LTE-FDD B3 @ 23.12 dBm	675.7	mA
	LTE-FDD B4 @ 22.52 dBm	607.8	mA
	LTE-FDD B5 @ 23.12 dBm	563.1	mA
	LTE-FDD B7 @ 22.95 dBm	702.9	mA
	LTE-FDD B8 @ 23.55 dBm	728.8	mA
	LTE-FDD B28 @ 23.23 dBm	769.3	mA
	LTE-TDD B40 @ 23.54 dBm	335.5	mA
GSM voice call	GSM850 PCL5 @ 32.36 dBm	240.3	mA
	EGSM900 PCL5 @ 33.15 dBm	260.9	mA
	DCS1800 PCL0 @ 29.38 dBm	153.0	mA
	PCS1900 PCL0 @ 29.47 dBm	160.3	mA
WCDMA voice call	WCDMA B1 @ 23.13 dBm	568.9	mA
	WCDMA B2 @ 22.99 dBm	628.4	mA
	WCDMA B4 @ 22.90 dBm	506.3	mA
	WCDMA B5 @ 23.10 dBm	507.5	mA
	WCDMA B8 @ 22.90 dBm	581.5	mA

5.4.7. EC25-AF Power Consumption

Table 53: EC25-AF Power Consumption

Description	Conditions	Typ.	Unit
OFF state	Power down	10	μA
Sleep state	**AT+CFUN=0** (USB disconnected)	1.0	mA
	WCDMA PF = 64 (USB disconnected)	1.8	mA

	WCDMA PF = 128 (USB disconnected)	1.4	mA
	LTE-FDD PF = 64 (USB disconnected)	2.2	mA
	LTE-FDD PF = 128 (USB disconnected)	1.8	mA
Idle state	WCDMA PF = 64 (USB disconnected)	23.3	mA
	WCDMA PF = 64 (USB connected)	33.4	mA
	LTE-FDD PF = 64 (USB disconnected)	17.6	mA
	LTE-FDD PF = 64 (USB connected)	29.4	mA
WCDMA data transfer (GNSS OFF)	WCDMA B2 HSDPA @ 22.63 dBm	560.0	mA
	WCDMA B2 HSUPA @ 22.49 dBm	564.0	mA
	WCDMA B4 HSDPA @ 22.45 dBm	601.0	mA
	WCDMA B4 HSUPA @ 22.57 dBm	610.0	mA
	WCDMA B5 HSDPA @ 22.49 dBm	603.0	mA
	WCDMA B5 HSUPA @ 22.43 dBm	617.0	mA
LTE data transfer (GNSS OFF)	LTE-FDD B2 @ 22.92 dBm	698.0	mA
	LTE-FDD B4 @ 23.12 dBm	710.0	mA
	LTE-FDD B5 @ 22.98 dBm	650.0	mA
	LTE-FDD B12 @ 23.42 dBm	648.0	mA
	LTE-FDD B13 @ 22.92 dBm	690.0	mA
	LTE-FDD B14 @ 23.42 dBm	685.0	mA
	LTE-FDD B66 @ 23.35 dBm	715.0	mA
	LTE-FDD B71 @ 23.39 dBm	689.0	mA
WCDMA voice call	WCDMA B2 @ 23.59 dBm	585.0	mA
	WCDMA B4 @ 23.47 dBm	610.0	mA
	WCDMA B5 @ 23.46 dBm	605.0	mA

5.4.8. EC25-AFX Power Consumption

Table 54: EC25-AFX Power Consumption

Description	Conditions	Typ.	Unit
OFF state	Power down	8	μA
Sleep state	**AT+CFUN=0** (USB disconnected)	0.83	mA
	WCDMA PF = 64 (USB disconnected)	1.55	mA
	WCDMA PF = 128 (USB disconnected)	1.24	mA
	WCDMA PF = 256 (USB disconnected)	1.07	mA
	WCDMA PF = 512 (USB disconnected)	1.00	mA
	LTE-FDD PF = 32 (USB disconnected)	2.97	mA
	LTE-FDD PF = 64 (USB disconnected)	1.93	mA
	LTE-FDD PF = 128 (USB disconnected)	1.43	mA
	LTE-FDD PF = 256 (USB disconnected)	1.17	mA
Idle state	WCDMA PF = 64 (USB disconnected)	14.9	mA
	WCDMA PF = 64 (USB connected)	34.2	mA
	LTE-FDD PF = 64 (USB disconnected)	15.2	mA
	LTE-FDD PF = 64 (USB connected)	34.8	mA
WCDMA data transfer (GNSS OFF)	WCDMA B2 HSDPA @ 22.1 dBm	548.0	mA
	WCDMA B2 HSUPA @ 22.28 dBm	545.0	mA
	WCDMA B4 HSDPA @ 22.2 dBm	580.0	mA
	WCDMA B4 HSUPA @ 22.2 dBm	596.0	mA
	WCDMA B5 HSDPA @ 22.1 dBm	498.0	mA
	WCDMA B5 HSUPA @ 22.0 dBm	500.0	mA
LTE data transfer (GNSS OFF)	LTE-FDD B2 @ 23.36 dBm	621.0	mA
	LTE-FDD B4 @ 22.7 dBm	702.0	mA

	LTE-FDD B5 @ 22.7 dBm	564.0	mA
	LTE-FDD B12 @ 22.66 dBm	648.0	mA
	LTE-FDD B13 @ 22.79 dBm	617.0	mA
	LTE-FDD B14 @ 22.72 dBm	622.0	mA
	LTE-FDD B66 @ 22.86 dBm	698.0	mA
	LTE-FDD B71 @ 22.73 dBm	628.0	mA
WCDMA voice call	WCDMA B2 @ 22.63 dBm	578.0	mA
	WCDMA B4 @ 22.74 dBm	581.0	mA
	WCDMA B5 @ 22.6 dBm	561.0	mA

5.4.9. EC25-AFXD Power Consumption

Table 55: EC25-AFXD Power Consumption

Description	Conditions	Typ.	Unit
OFF state	Power down	8	μA
Sleep state	**AT+CFUN=0** (USB disconnected)	0.83	mA
	WCDMA PF = 64 (USB disconnected)	1.55	mA
	WCDMA PF = 128 (USB disconnected)	1.24	mA
	WCDMA PF = 256 (USB disconnected)	1.07	mA
	WCDMA PF = 512 (USB disconnected)	1.00	mA
	LTE-FDD PF = 32 (USB disconnected)	2.97	mA
	LTE-FDD PF = 64 (USB disconnected)	1.93	mA
	LTE-FDD PF = 128 (USB disconnected)	1.43	mA
	LTE-FDD PF = 256 (USB disconnected)	1.17	mA
Idle state	WCDMA PF = 64 (USB disconnected)	14.9	mA
	WCDMA PF = 64 (USB connected)	34.2	mA

	LTE-FDD PF = 64 (USB disconnected)	15.2	mA
	LTE-FDD PF = 64 (USB connected)	34.8	mA
WCDMA data transfer (GNSS OFF)	WCDMA B2 HSDPA @ 22.1 dBm	548.0	mA
	WCDMA B2 HSUPA @ 22.28 dBm	545.0	mA
	WCDMA B4 HSDPA @ 22.2 dBm	580.0	mA
	WCDMA B4 HSUPA @ 22.2 dBm	596.0	mA
	WCDMA B5 HSDPA @ 22.1 dBm	498.0	mA
	WCDMA B5 HSUPA @ 22.0 dBm	500.0	mA
LTE data transfer (GNSS OFF)	LTE-FDD B2 @ 23.36 dBm	621.0	mA
	LTE-FDD B4 @ 22.7 dBm	702.0	mA
	LTE-FDD B5 @ 22.7 dBm	564.0	mA
	LTE-FDD B12 @ 22.66 dBm	648.0	mA
	LTE-FDD B13 @ 22.79 dBm	617.0	mA
	LTE-FDD B14 @ 22.72 dBm	622.0	mA
	LTE-FDD B66 @ 22.86 dBm	698.0	mA
	LTE-FDD B71 @ 22.73 dBm	628.0	mA

5.4.10. EC25-EU Power Consumption

Table 56: EC25-EU Power Consumption

Description	Conditions	Typ.	Unit
OFF state	Power down	11	μA
Sleep state	**AT+CFUN=0** (USB disconnected)	1.82	mA
	EGSM900 DRX = 2 (USB disconnected)	2.74	mA
	EGSM900 DRX = 9 (USB disconnected)	2.0	mA
	WCDMA PF = 64 (USB disconnected)	2.15	mA

	WCDMA PF = 128 (USB disconnected)	1.67	mA
	LTE-FDD PF = 64 (USB disconnected)	2.60	mA
	LTE-FDD PF = 128 (USB disconnected)	1.90	mA
	LTE-TDD PF = 64 (USB disconnected)	2.79	mA
	LTE-TDD PF = 128 (USB disconnected)	2.00	mA
Idle state	EGSM900 DRX = 5 (USB disconnected)	19.5	mA
	EGSM900 DRX = 5 (USB connected)	29.5	mA
	WCDMA PF = 64 (USB disconnected)	21.0	mA
	WCDMA PF = 64 (USB connected)	31.0	mA
	LTE-FDD PF = 64 (USB disconnected)	20.7	mA
	LTE-FDD PF = 64 (USB connected)	30.8	mA
	LTE-TDD PF = 64 (USB disconnected)	20.8	mA
	LTE-TDD PF = 64 (USB connected)	32.0	mA
GPRS data transfer (GNSS OFF)	EGSM900 4DL/1UL @ 33.23 dBm	243.0	mA
	EGSM900 3DL/2UL @ 31.96 dBm	388.0	mA
	EGSM900 2DL/3UL @ 29.73 dBm	453.0	mA
	EGSM900 1DL/4UL @ 28.5 dBm	522	mA
	DCS1800 4DL/1UL @ 30.49 dBm	172.0	mA
	DCS1800 3DL/2UL @ 29.24 dBm	274.0	mA
	DCS1800 2DL/3UL @ 27.15 dBm	337.0	mA
	DCS1800 1DL/4UL @ 25.88 dBm	406.0	mA
EDGE data transfer (GNSS OFF)	EGSM900 4DL/1UL PCL = 8 @ 26.60 dBm	142.0	mA
	EGSM900 3DL/2UL PCL = 8 @ 25.43 dBm	229.0	mA
	EGSM900 2DL/3UL PCL = 8 @ 23.4 dBm	286.0	mA
	EGSM900 1DL/4UL PCL = 8 @ 22.36 dBm	348.0	mA

	DCS1800 4DL/1UL PCL = 2 @ 25.59 dBm	136.0	mA
	DCS1800 3DL/2UL PCL = 2 @ 24.54 dBm	225.0	mA
	DCS1800 2DL/3UL PCL = 2 @ 22.38 dBm	300.0	mA
	DCS1800 1DL/4UL PCL = 2 @ 21.24 dBm	379.0	mA
WCDMA data transfer (GNSS OFF)	WCDMA B1 HSDPA @ 22.93 dBm	504.0	mA
	WCDMA B1 HSUPA @ 22.62 dBm	512.0	mA
	WCDMA B8 HSDPA @ 22.88 dBm	562.0	mA
	WCDMA B8 HSUPA @ 22.14 dBm	535.0	mA
LTE data transfer (GNSS OFF)	LTE-FDD B1 @ 23.6 dBm	664.0	mA
	LTE-FDD B3 @ 23.67 dBm	728.0	mA
	LTE-FDD B7 @ 23.83 dBm	821.0	mA
	LTE-FDD B8 @ 23.82 dBm	695.0	mA
	LTE-FDD B20 @ 23.88 dBm	649.0	mA
	LTE-FDD B28A @ 23.43 dBm	689.0	mA
	LTE-TDD B38 @ 22.82 dBm	438.0	mA
	LTE-TDD B40 @ 23.43 dBm	355.0	mA
	LTE-TDD B41 @ 23.46 dBm	451.0	mA
GSM voice call	EGSM900 PCL = 5 @ 33.25 dBm	258.0	mA
	DCS1800 PCL = 0 @ 30.23 dBm	178.0	mA
WCDMA voice call	WCDMA B1 @ 23.88 dBm	548.0	mA
	WCDMA B8 @ 23.8 dBm	615.0	mA

5.4.11. EC25-EUX Power Consumption

Table 57: EC25-EUX Power Consumption

Description	Conditions	Typ.	Unit
OFF state	Power down	9	μA
Sleep state	**AT+CFUN=0** (USB disconnected)	0.9	mA
	EGSM900 DRX = 2 (USB disconnected)	1.8	mA
	EGSM900 DRX = 9 (USB disconnected)	1.3	mA
	WCDMA PF = 64 (USB disconnected)	1.6	mA
	WCDMA PF = 128 (USB disconnected)	1.3	mA
	LTE-FDD PF = 64 (USB disconnected)	2.2	mA
	LTE-FDD PF = 128 (USB disconnected)	1.6	mA
	LTE-TDD PF = 64 (USB disconnected)	2.2	mA
	LTE-TDD PF = 128 (USB disconnected)	1.6	mA
Idle state	EGSM900 DRX = 5 (USB disconnected)	14.5	mA
	EGSM900 DRX = 5 (USB connected)	34.3	mA
	WCDMA PF = 64 (USB disconnected)	14.7	mA
	WCDMA PF = 64 (USB connected)	35.3	mA
	LTE-FDD PF = 64 (USB disconnected)	15.0	mA
	LTE-FDD PF = 64 (USB connected)	36.5	mA
	LTE-TDD PF = 64 (USB disconnected)	15.0	mA
	LTE-TDD PF = 64 (USB connected)	36.5	mA
GPRS data transfer (GNSS OFF)	EGSM900 4DL/1UL @ 33.02 dBm	270.7	mA
	EGSM900 3DL/2UL @ 32.24 dBm	444.3	mA
	EGSM900 2DL/3UL @ 30.08 dBm	509.8	mA
	EGSM900 1DL/4UL @ 29.50 dBm	629.3	mA

	DCS1800 4DL/1UL @ 29.63 dBm	157.4	mA
	DCS1800 3DL/2UL @ 28.96 dBm	246.3	mA
	DCS1800 2DL/3UL @ 27.49 dBm	310.6	mA
	DCS1800 1DL/4UL @ 26.44 dBm	377.7	mA
EDGE data transfer (GNSS OFF)	EGSM900 4DL/1UL PCL = 8 @ 27.27 dBm	175.4	mA
	EGSM900 3DL/2UL PCL = 8 @ 26.13 dBm	292.1	mA
	EGSM900 2DL/3UL PCL = 8 @ 24.03 dBm	386.8	mA
	EGSM900 1DL/4UL PCL = 8 @ 23.35 dBm	494.7	mA
	DCS1800 4DL/1UL PCL = 2 @ 25.92 dBm	134.5	mA
	DCS1800 3DL/2UL PCL = 2 @ 25.63 dBm	222.9	mA
	DCS1800 2DL/3UL PCL = 2 @ 23.14 dBm	301.2	mA
	DCS1800 1DL/4UL PCL = 2 @ 22.60 dBm	391.8	mA
WCDMA data transfer (GNSS OFF)	WCDMA B1 HSDPA @ 22.01 dBm	534.8	mA
	WCDMA B1 HSUPA @ 21.38 dBm	526.7	mA
	WCDMA B8 HSDPA @ 22.21 dBm	459.8	mA
	WCDMA B8 HSUPA @ 21.85 dBm	471.6	mA
LTE data transfer (GNSS OFF)	LTE-FDD B1 @ 23.38 dBm	743.4	mA
	LTE-FDD B3 @ 22.87 dBm	674.6	mA
	LTE-FDD B7 @ 22.08 dBm	658.8	mA
	LTE-FDD B8 @ 23.49 dBm	607.3	mA
	LTE-FDD B20 @ 23.01 dBm	711.0	mA
	LTE-FDD B28A @ 23.18 dBm	788.2	mA
	LTE-TDD B38 @ 23.38 dBm	446.6	mA
	LTE-TDD B40 @ 23.56 dBm	344.4	mA
	LTE-TDD B41 @ 23.17 dBm	483.2	mA

GSM voice call	EGSM900 PCL = 5 @ 32.81 dBm	262.2	mA
	DCS1800 PCL = 0 @ 29.62 dBm	151.2	mA
WCDMA voice call	WCDMA B1 @ 23.09 dBm	594.2	mA
	WCDMA B8 @ 23.18 dBm	504.3	mA

5.4.12. EC25-MX Power Consumption

Table 58: EC25-MX Power Consumption

Description	Conditions	Typ.	Unit
OFF state	Power down	19	μA
Sleep state	**AT+CFUN=0** (USB disconnected)	1.0	mA
	WCDMA PF = 64 (USB disconnected)	2.3	mA
	WCDMA PF = 128 (USB disconnected)	1.7	mA
	LTE-FDD PF = 64 (USB disconnected)	2.5	mA
	LTE-FDD PF = 128 (USB disconnected)	2.2	mA
Idle state	WCDMA PF = 64 (USB disconnected)	12.9	mA
	WCDMA PF = 64 (USB connected)	32.0	mA
	LTE-FDD PF = 64 (USB disconnected)	13.7	mA
	LTE-FDD PF = 64 (USB connected)	32.6	mA
WCDMA data transfer (GNSS OFF)	WCDMA B2 HSDPA @ 22.27 dBm	581.9	mA
	WCDMA B2 HSUPA @ 22.15 dBm	603.0	mA
	WCDMA B4 HSDPA @ 22.5 dBm	578.0	mA
	WCDMA B4 HSUPA @ 22.5 dBm	571.0	mA
	WCDMA B5 HSDPA @ 22.4 dBm	499.0	mA
	WCDMA B5 HSUPA @ 22.17 dBm	515.0	mA
LTE data transfer	LTE-FDD B2 @ 23.2 dBm	685.0	mA

(GNSS OFF)	LTE-FDD B4 @ 23.4 dBm	744.0	mA
	LTE-FDD B5 @ 23.2 dBm	578.0	mA
	LTE-FDD B7 @ 24.3 dBm	868.0	mA
	LTE-FDD B28 @ 23.45 dBm	631.0	mA
	LTE-FDD B66 @ 22.68 dBm	781.0	mA
WCDMA voice call	WCDMA B2 @ 23.47 dBm	643.0	mA
	WCDMA B4 @ 23.5 dBm	633.0	mA
	WCDMA B5 @ 23.5 dBm	551.0	mA

5.4.13. EC25-EM Power Consumption

Table 59: EC25-EM Power Consumption

Description	Conditions	Typ.	Unit
OFF state	Power down	7	μA
Sleep state	**AT+CFUN=0** (USB disconnected)	0.76	mA
	EGSM900 DRX = 2 (USB disconnected)	1.72	mA
	EGSM900 DRX = 9 (USB disconnected)	1.02	mA
	WCDMA PF = 64 (USB disconnected)	1.6	mA
	WCDMA PF = 128 (USB disconnected)	1.21	mA
	WCDMA PF = 256 (USB disconnected)	0.98	mA
	WCDMA PF = 512 (USB disconnected)	0.87	mA
	LTE-FDD PF = 32 (USB disconnected)	3.31	mA
	LTE-FDD PF = 64 (USB disconnected)	2.07	mA
	LTE-FDD PF = 128 (USB disconnected)	1.44	mA
	LTE-TDD PF = 32 (USB disconnected)	3.59	mA
	LTE-TDD PF = 64 (USB disconnected)	2.19	mA

	LTE-TDD PF = 128 (USB disconnected)	1.5	mA
	LTE-TDD PF = 256(USB disconnected)	1.16	mA
Idle state	EGSM900 DRX = 5 (USB disconnected)	20.45	mA
	EGSM900 DRX = 5 (USB connected)	30	mA
	WCDMA PF = 64 (USB disconnected)	21.15	mA
	WCDMA PF = 64 (USB connected)	30.72	mA
	LTE-FDD PF = 64 (USB disconnected)	21.2	mA
	LTE-FDD PF = 64 (USB connected)	30.78	mA
	LTE-TDD PF = 64 (USB disconnected)	21.33	mA
	LTE-TDD PF = 64 (USB connected)	30.89	mA
GPRS data transfer (GNSS OFF)	EGSM900 4DL/1UL @ 32.41dBm	241	mA
	EGSM900 3DL/2UL @ 31.06dBm	392	mA
	EGSM900 2DL/3UL @ 28.63dBm	476	mA
	EGSM900 1DL/4UL @28.18dBm	593	mA
	DCS1800 4DL/1UL @ 29dBm	159	mA
	DCS1800 3DL/2UL @ 27.36dBm	237	mA
	DCS1800 2DL/3UL @ 25.3dBm	277	mA
	DCS1800 1DL/4UL @24.19dBm	323	mA
EDGE data transfer (GNSS OFF)	EGSM900 4DL/1UL PCL = 8 @ 26.58 dBm	147	mA
	EGSM900 3DL/2UL PCL = 8 @ 25.45 dBm	238	mA
	EGSM900 2DL/3UL PCL = 8 @ 24.36dBm	310	mA
	EGSM900 1DL/4UL PCL = 8 @ 23.24dBm	376	mA
	DCS1800 4DL/1UL PCL = 2 @ 25.32dBm	124	mA
	DCS1800 3DL/2UL PCL = 2 @ 24.79dBm	199	mA
	DCS1800 2DL/3UL PCL = 2 @ 23.19dBm	252	mA

	DCS1800 1DL/4UL PCL = 2 @ 22.05dBm	299	mA
WCDMA data transfer (GNSS OFF)	WCDMA B1 HSDPA @ 22.66dBm	541	mA
	WCDMA B1 HSUPA @ 22.32dBm	517	mA
	WCDMA B5 HSDPA @ 23.38dBm	548	mA
	WCDMA B5 HSUPA @ 23.13dBm	539	mA
	WCDMA B8 HSDPA @ 22.7dBm	509	mA
	WCDMA B8 HSUPA @ 21.76dBm	505	mA
LTE data transfer (GNSS OFF)	LTE-FDD B1 @ 23.3dBm	691	mA
	LTE-FDD B3 @ 23.23dBm	764	mA
	LTE-FDD B5 @ 23.2 dBm	632	mA
	LTE-FDD B7 @ 23.56dBm	899	mA
	LTE-FDD B8 @ 23.14dBm	598	mA
	LTE-FDD B20 @ 23.19dBm	712	mA
	LTE-FDD B28 @ 23.05dBm	757	mA
	LTE-TDD B38 @ 23.42dBm	382	mA
	LTE-TDD B40 @ 23.08dBm	436	mA
	LTE-TDD B41 @ 23.41dBm	415	mA
GSM voice call	EGSM900 PCL = 5 @ 32.48dBm	260	mA
	DCS1800 PCL = 0 @ 29.16dBm	174	mA
WCDMA voice call	WCDMA B1 @ 23.58dBm	554	mA
	WCDMA B5 @ 23.55dBm	547	mA
	WCDMA B8 @ 23.68dBm	535	mA

5.4.14. GNSS Power Consumption

Table 59: GNSS Power Consumption of EC25 Series Module

Description	Conditions	Typ.	Unit
Searching (**AT+CFUN=0**)	Cold start @ Passive Antenna	54.0	mA
	Lost state @ Passive Antenna	53.9	mA
Tracking (**AT+CFUN=0**)	Instrument Environment	30.5	mA
	Open Sky @ Passive Antenna	33.2	mA
	Open Sky @ Active Antenna	40.8	mA

5.5. 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.

The following table shows the module's electrostatics discharge characteristics.

Table 60: Electrostatics Discharge Characteristics (Temperature: 25 ºC, Humidity: 45 %)

Tested Interfaces	Contact Discharge	Air Discharge	Unit
VBAT, GND	±5	±10	kV
All Antenna Interfaces	±4	±8	kV
Other Interfaces	±0.5	±1	kV

5.6. Thermal Dissipation

In order to achieve better performance of the module, it is recommended to comply with the following principles for thermal consideration:

- On customers' PCB design, please keep placement of the module away from heating sources, especially high power components such as ARM processor, audio power amplifier, power supply, etc.
- Do not place components on the opposite side of the PCB area where the module is mounted, in order to facilitate adding of heatsink when necessary.
- Do not apply solder mask on the opposite side of the PCB area where the module is mounted, so as to ensure better heat dissipation performance.
- The reference ground of the area where the module is mounted should be complete, and add ground vias as many as possible for better heat dissipation.
- Make sure the ground pads of the module and PCB are fully connected.
- According to customers' application demands, the heatsink can be mounted on the top of the module, or the opposite side of the PCB area where the module is mounted, or both of them.
- The heatsink should be designed with as many fins as possible to increase heat dissipation area. Meanwhile, a thermal pad with high thermal conductivity should be used between the heatsink and module/PCB.

The following shows two kinds of heatsink designs for reference and customers can choose one or both of them according to their application structure.

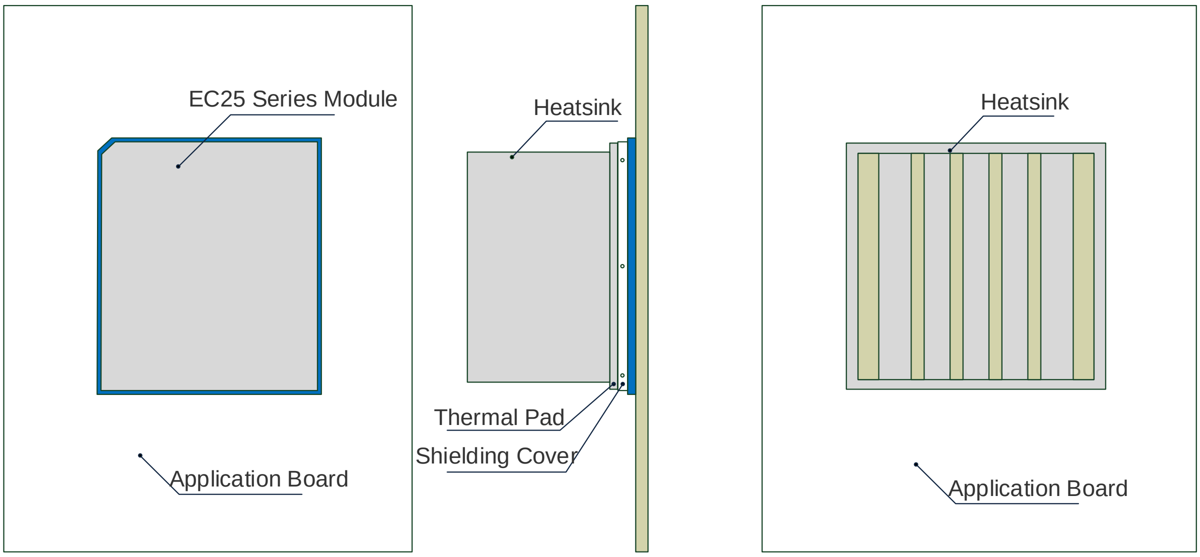


Figure 42: Referenced Heatsink Design (Heatsink at the Top of the Module)

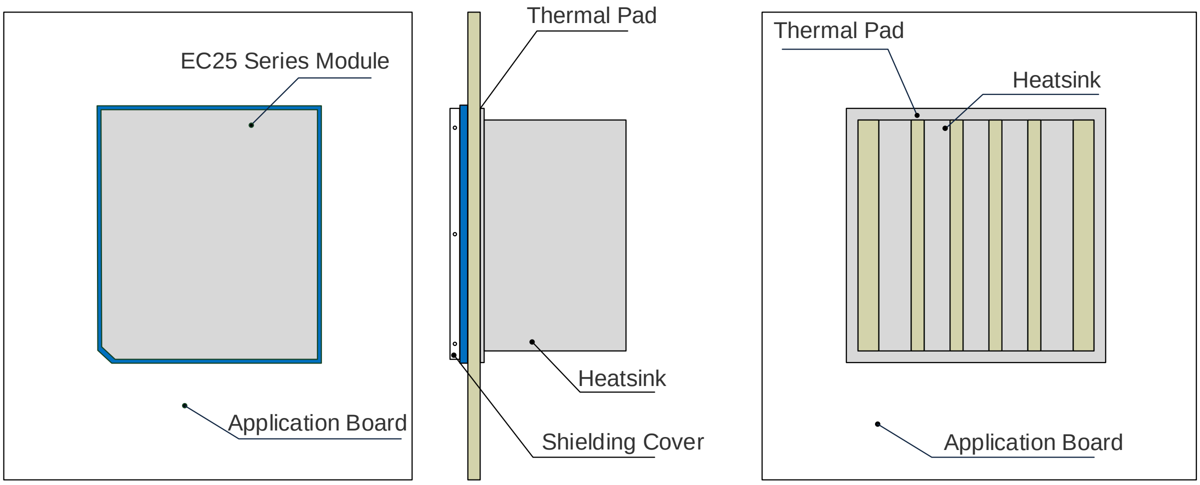


Figure 43: Referenced Heatsink Design (Heatsink at the Backside of Customers' PCB)

NOTE

1. The module offers the best performance when the internal BB chip stays below 105 °C. When the maximum temperature of the BB chip reaches or exceeds 105 °C, the module works normal but provides reduced performance (such as RF output power, data rate, etc.). When the maximum BB chip temperature reaches or exceeds 115 °C, the module will disconnect from the network, and it will recover to network connected state after the maximum temperature falls below 115 °C. Therefore, the thermal design should be maximally optimized to make sure the maximum BB chip temperature always maintains below 105 °C. Customers can execute **AT+QTEMP** and get the maximum BB chip temperature from the first returned value. For details of the command, see ***document [8]***.
2. For more detailed guidelines on thermal design, see ***document [9]***.

6 Mechanical Information

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

6.1. Mechanical Dimensions

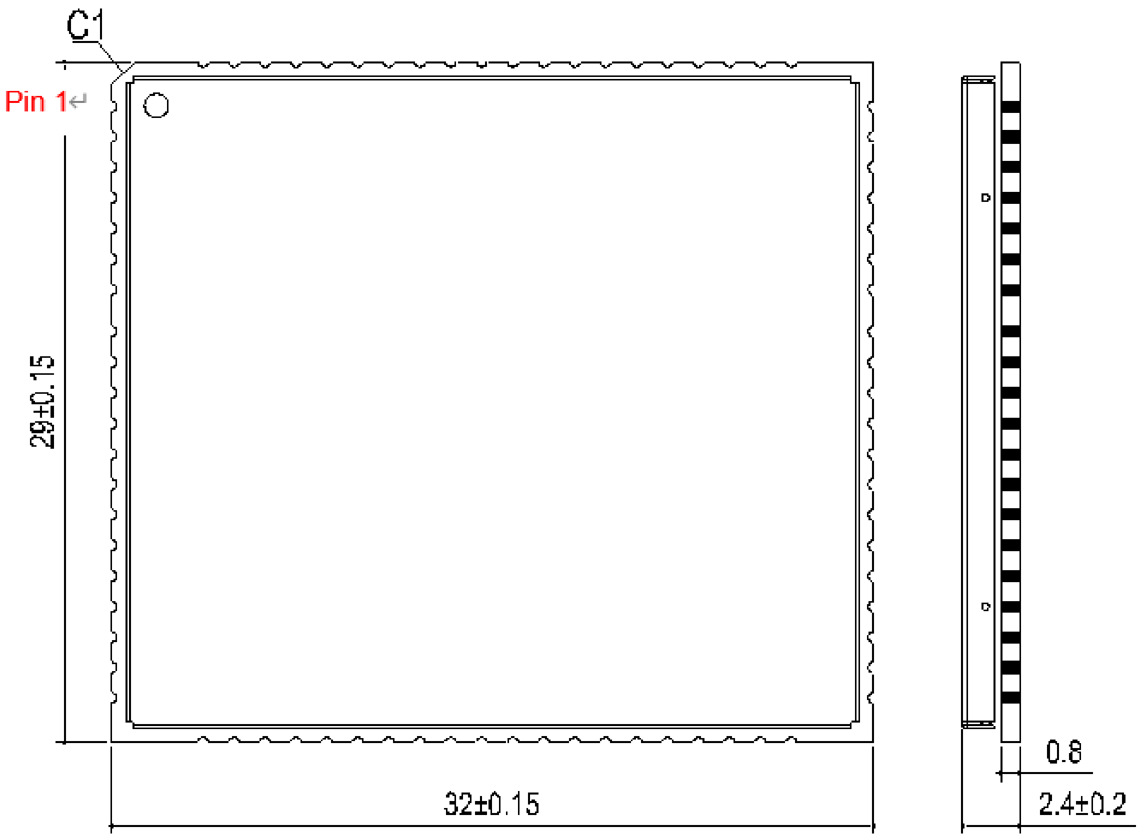


Figure 44: Module Top and Side Dimensions

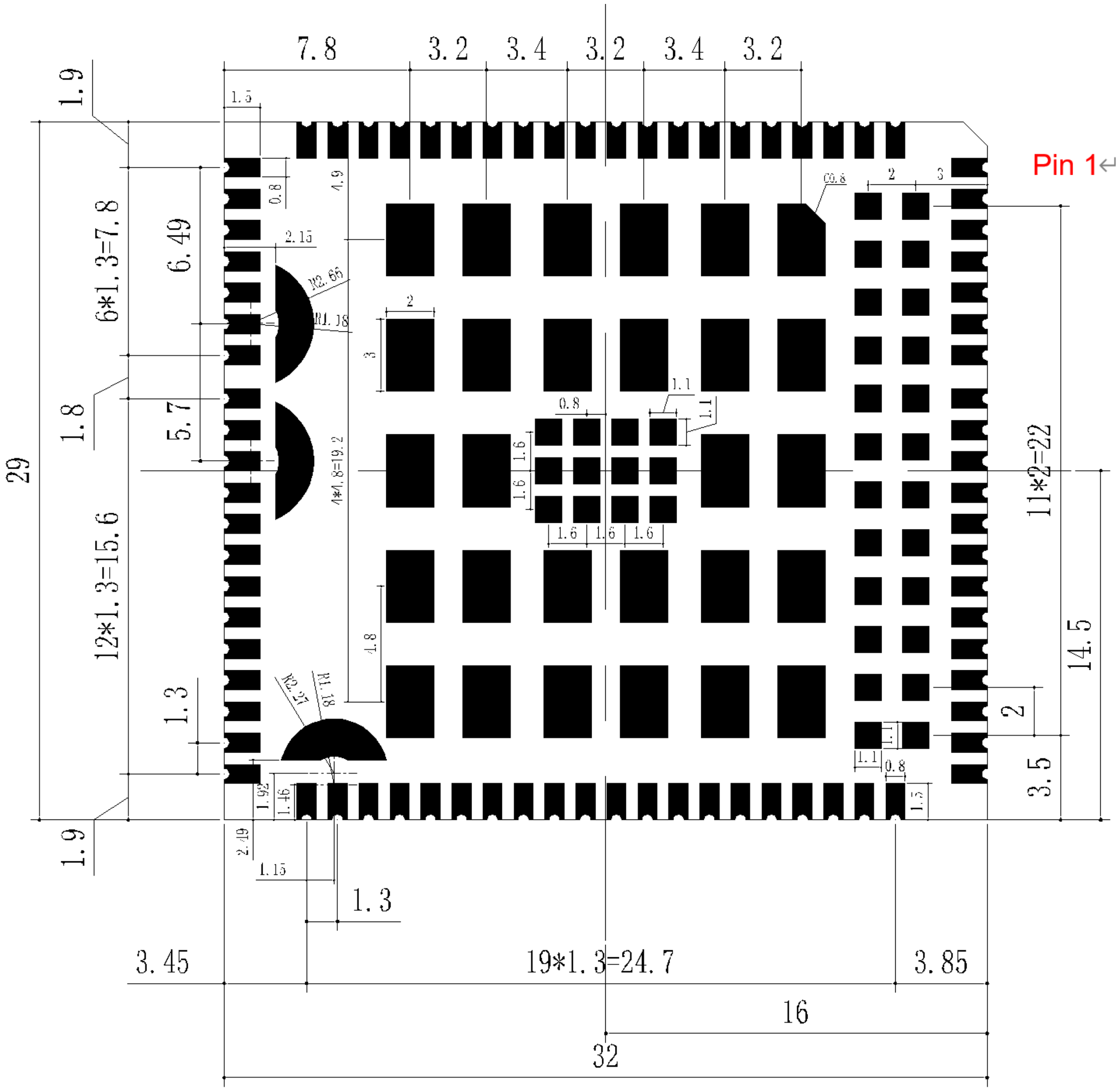


Figure 45: Bottom Dimensions (Bottom View)

NOTE

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

6.2. Recommended Footprint

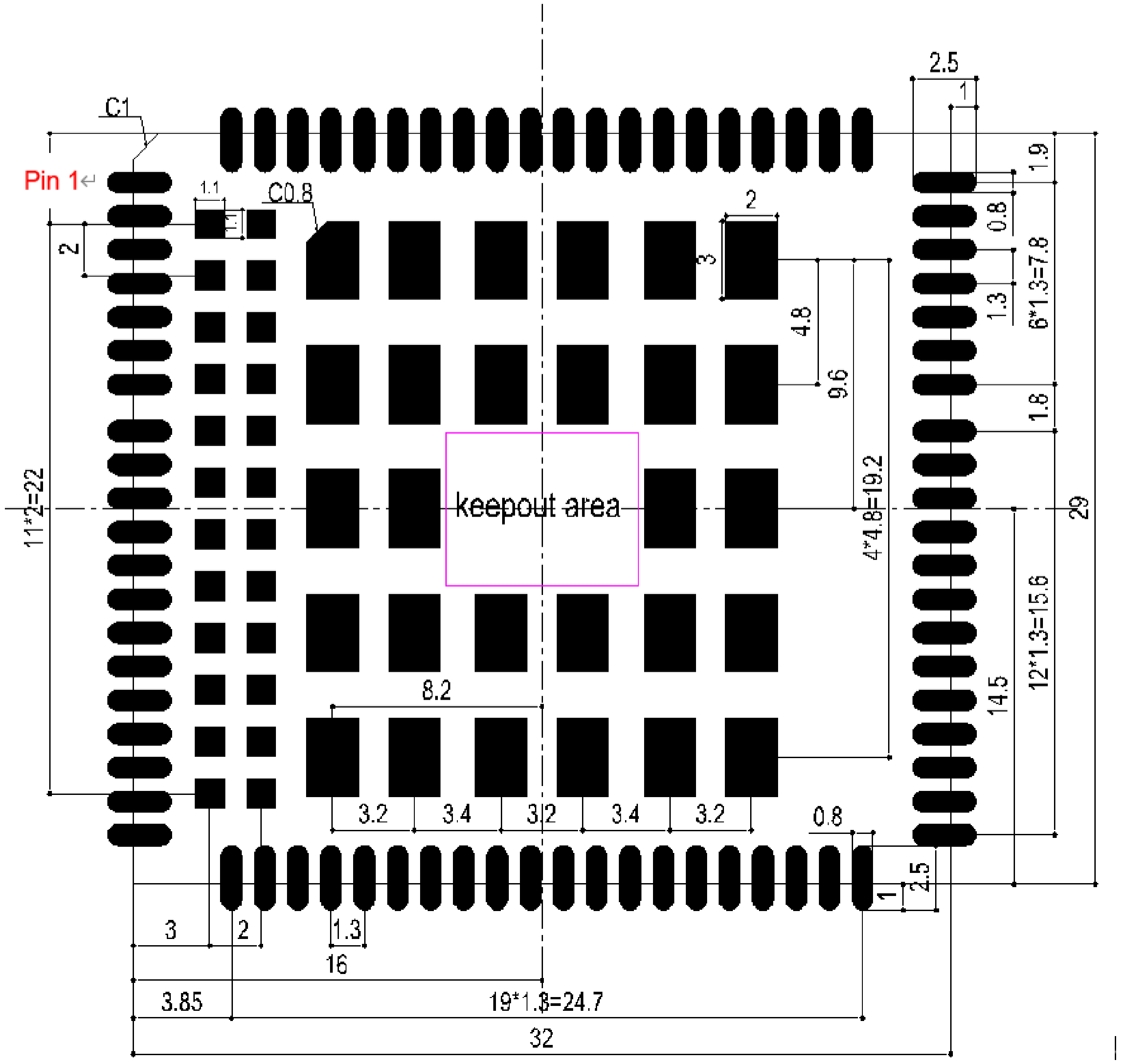


Figure 46: Recommended Footprint (Top View)

NOTE

1. The keepout area (pin 73–84) should not be designed.
2. Keep at least 3 mm between the module and other components on the motherboard to improve soldering quality and maintenance convenience.

6.3. Top and Bottom Views

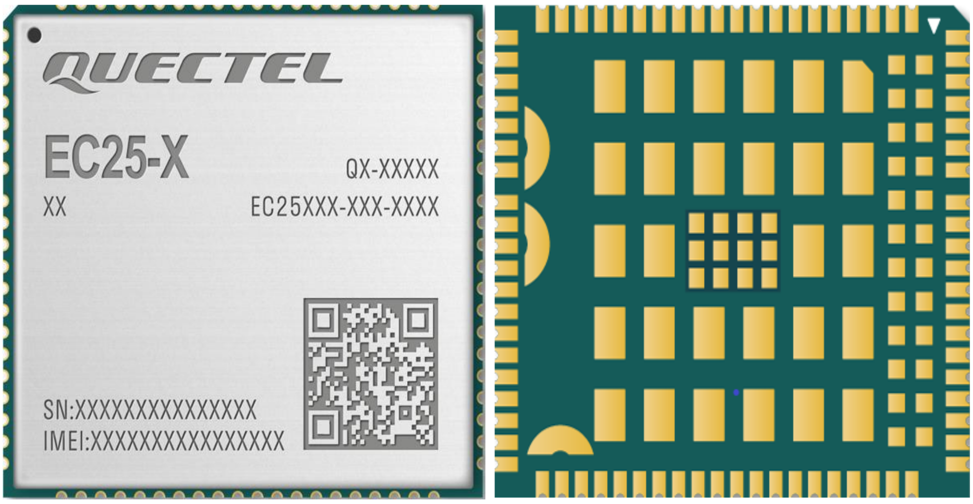


Figure 47: Top and Bottom Views of the Module

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 Quectel.

7 Storage, Manufacturing and Packaging

7.1. 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 ±5 °C and the relative humidity should be 35–60 %.

2. Shelf life (in vacuum-sealed packaging): 12 months in Recommended Storage Condition.

3. Floor life: 168 hours [11] in a factory where the temperature is 23 ±5 °C and relative humidity is below 60 %. After the vacuum-sealed packaging is removed, the module must be processed in reflow soldering or other high-temperature operations within 168 hours. Otherwise, the module should be stored in an environment where the relative humidity is less than 10 % (e.g. a 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 8 hours at 120 ±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.

[11] This floor life is only applicable when the environment conforms to *IPC/JEDEC J-STD-033*. It is recommended to start the solder reflow process within 24 hours after the package is removed if the temperature and moisture do not conform to, or are not sure to conform to *IPC/JEDEC J-STD-033*. And do not remove the packages of tremendous modules if they are not ready for soldering.

NOTE

1. To avoid blistering, layer separation and other soldering issues, extended exposure of the module to the air is forbidden.
2. Take out the module from the package and put it on high-temperature-resistant fixtures before baking. All modules must be soldered to PCB within 24 hours after the baking, otherwise put them in the drying oven. If shorter baking time is desired, see *IPC/JEDEC J-STD-033* for the baking procedure.
3. Pay attention to ESD protection, such as wearing anti-static gloves, when touching the modules.

7.2. Manufacturing and Soldering

Push the squeegee to apply the solder paste on the surface of stencil, thus making the paste fill the stencil openings and then penetrate to the PCB. 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 0.18–0.20 mm. For more details, see ***document [10]***.

The peak reflow temperature should be 235–246 ºC, with 246 ºC as the absolute maximum reflow temperature. To avoid damage to the module caused by repeated heating, it is strongly 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.

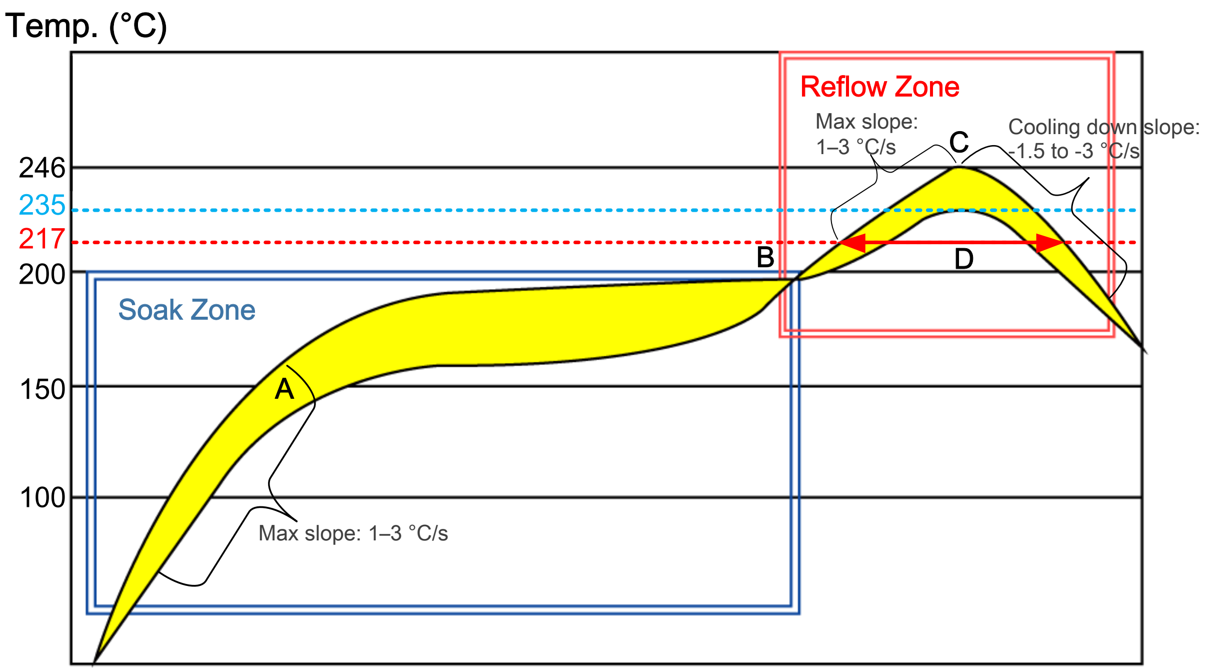


Figure 48: Reflow Soldering Thermal Profile

Table 61: Recommended Thermal Profile Parameters

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

NOTE

1. 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.
2. Avoid using ultrasonic technology for module cleaning since it can damage crystals inside the module.
3. Due to the complexity of the SMT process, please contact Quectel Technical Supports in advance for any situation that you are not sure about, or any process (e.g., selective soldering, ultrasonic soldering) that is not mentioned in ***document [10]***.

7.3. Packaging Specification

The module adopts carrier tape packaging and details are as follow:

7.3.1. Carrier Tape

Dimension details are as follow:

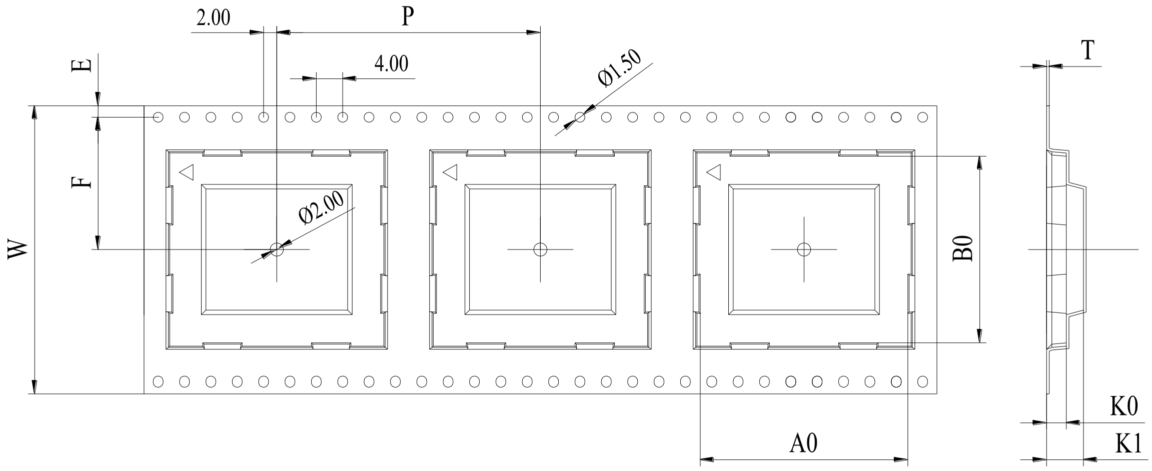


Figure 49: Carrier Tape Dimension Drawing

Table 62: Carrier Tape Dimension Table (Unit: mm)

W	P	T	A0	B0	K0	K1	F	E
44	44	0.35	32.5	29.5	3.0	3.8	20.2	1.75

7.3.2. Plastic Reel

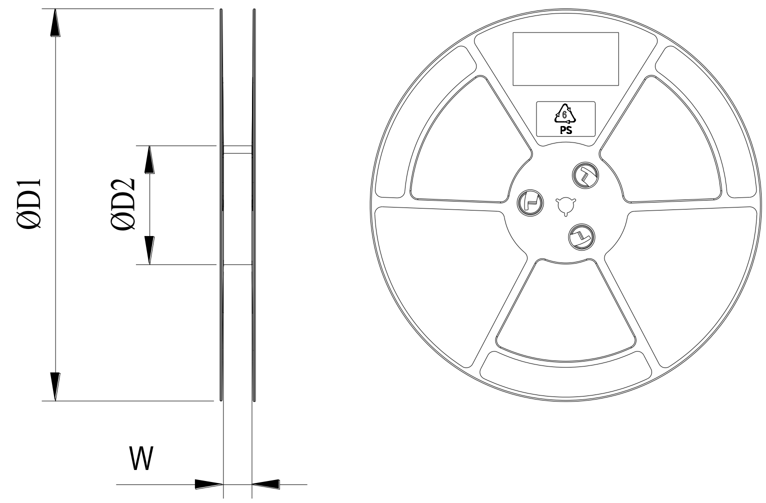
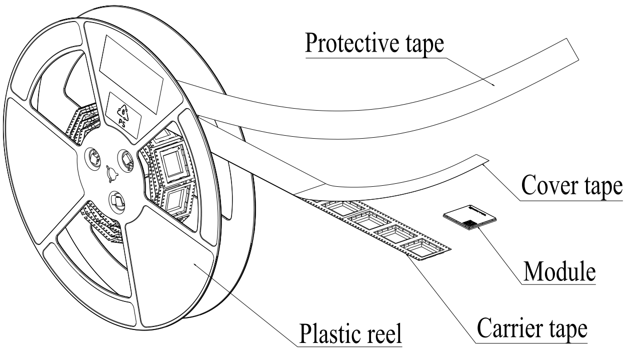


Figure 50: Plastic Reel Dimension Drawing

Table 63: Plastic Reel Dimension Table (Unit: mm)

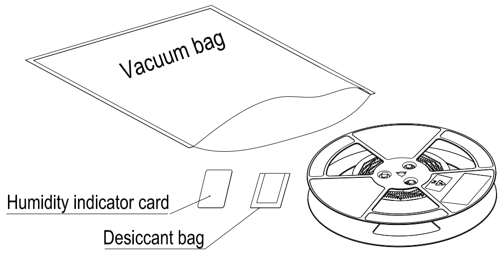
øD1	øD2	W
330	100	44.5

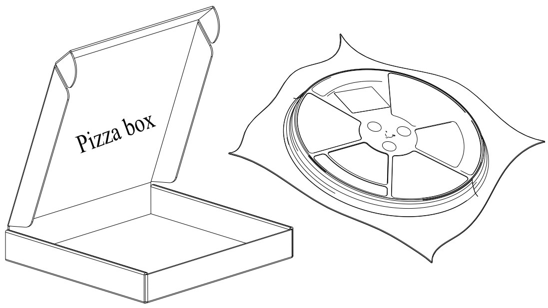
7.3.3. Packaging Process



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

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





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

Put 4 pizza boxes into 1 carton and seal it. One carton can pack 1000 modules.

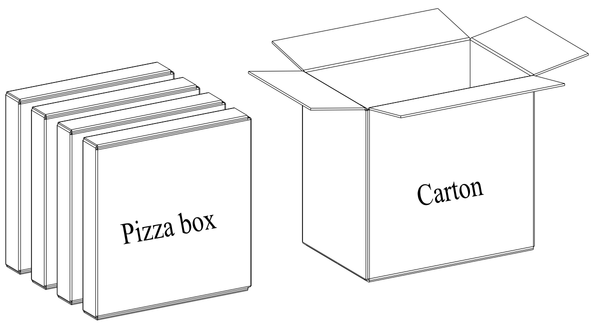


Figure 51: Packaging Process

8 Appendix References

Table 64: Related Documents

Document Name
[1] Quectel_UMTS&LTE_EVB_User_Guide
[2] Quectel_EC2x&EG9x&EG2x-G&EM05_Series_AT_Commands_Manual
[3] Quectel_EC2x&EG9x&EG2x-G&EM05_Series_QCFG_AT_Commands_Manual
[4] Quectel_EC2x&EGxx_Power_Management_Application_Note
[5] Quectel_EC2x&EG9x&EG2x-G&EM05_Series_GNSS_Application_Note
[6] Quectel_EC25_Reference_Design
[7] Quectel_RF_Layout_Application_Note
[8] Quectel_EC2x&EG9x&EG2x-G&EM05_Series_Thermal_Mitigation_User_Guide
[9] Quectel_Module_Thermal_Design_Guide
[10] Quectel_Module_Secondary_SMT_Application_Guide

Table 65: Terms and Abbreviations

Abbreviation	Description
3GPP	3rd Generation Partnership Project
ADC	Analog-to-Digital Converter
AMR	Adaptive Multi-rate
APT	Average Power Tracking
bps	Bits Per Second

CHAP	Challenge Handshake Authentication Protocol
CMUX	Connection Multiplexing
CS	Coding Scheme
CTS	Clear to Send
DCE	Data Communications Equipment
DC-HSPA+	Dual-carrier High Speed Packet Access
DCS	Digital Communication System
DFOTA	Delta Firmware Upgrade Over-The-Air
DL	Downlink
DTE	Data Terminal Equipment
DTR	Data Terminal Ready
DTX	Discontinuous Transmission
EDGE	Enhanced Data Rates for GSM Evolution
EFR	Enhanced Full Rate
EGSM	Enhanced GSM
ESD	Electrostatic Discharge
ESR	Equivalent Series Resistance
FDD	Frequency Division Duplex
FR	Full Rate
FTPS	FTP over SSL
GLONASS	Russian Global Navigation Satellite System
GMSK	Gaussian Minimum Shift Keying
GNSS	Global Navigation Satellite System
GPRS	General Packet Radio Service
GPS	Global Positioning System

GSM	Global System for Mobile Communications
HR	Half Rate
HSPA	High Speed Packet Access
HSDPA	High Speed Downlink Packet Access
HSUPA	High Speed Uplink Packet Access
HTTP	Hypertext Transfer Protocol
HTTPS	Hypertext Transfer Protocol Secure
I/O	Input/Output
LCC	Leadless Chip Carrier (package)
LDO	Low-dropout Regulator
LED	Light Emitting Diode
LNA	Low Noise Amplifier
LTE	Long Term Evolution
M2M	Machine to Machine
MCS	Modulation and Coding Scheme
MDIO	Management Data Input/Output
MIMO	Multiple Input Multiple Output
MLCC	Multi-layer Ceramic Chip
MMS	Multimedia Messaging Service
MO	Mobile Originated
MQTT	Message Queuing Telemetry Transport
MSB	Most Significant Bit
MT	Mobile Terminated
NITZ	Network Identity and Time Zone / Network Informed Time Zone
NMEA	NMEA (National Marine Electronics Association) 0183 Interface Standard

NTP	Network Time Protocol
PA	Power Amplifier
PAM	Power Amplifier Module
PAP	Password Authentication Protocol
PCB	Printed Circuit Board
PCM	Pulse Code Modulation
PCS	Personal Communication System
PDA	Personal Digital Assistant
PDU	Protocol Data Unit
PING	Packet Internet Groper
PMIC	Power Management IC
POS	Point of Sale
PPP	Point-to-Point Protocol
PTP	Precision Time Protocol
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
QZSS	Quasi-Zenith Satellite System
RF	Radio Frequency
RHCP	Right Hand Circularly Polarized
RoHS	Restriction of Hazardous Substances
Rx	Receive
SAW	Surface Acoustic Wave
SDR	Software-Defined Radio
SGMII	Serial Gigabit Media Independent Interface
SIM	Subscriber Identification Module

SIMO	Single Input Multiple Output
SMS	Short Message Service
SMTP	Simple Mail Transfer Protocol
SMTPS	Simple Mail Transfer Protocol Secure
SSL	Secure Sockets Layer
TCP	Transmission Control Protocol
TDD	Time Division Duplexing
TDMA	Time Division Multiple Access
TD-SCDMA	Time Division-Synchronous Code Division Multiple Access
TX	Transmitting Direction
UART	Universal Asynchronous Receiver/Transmitter
UDP	User Datagram Protocol
UL	Uplink
UMTS	Universal Mobile Telecommunications System
URC	Unsolicited Result Code
USB	Universal Serial Bus
(U)SIM	(Universal) Subscriber Identity Module
Vmax	Maximum Voltage
Vnom	Nominal Voltage
Vmin	Minimum Voltage
V_{IH}max	Maximum High-level Input Voltage
V_{IH}min	Minimum High-level Input Voltage
V_{IL}max	Maximum Low-level Input Voltage
V_{IL}min	Minimum Low-level Input Voltage
V_{OH}min	Minimum High-level Output Voltage

$V_{OL}max$	Maximum Low-level Output Voltage
VLAN	Virtual Local Area Network
VSWR	Voltage Standing Wave Ratio
WCDMA	Wideband Code Division Multiple Access
WLAN	Wireless Local Area Network