

# 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/<br>Frank WANG    | <ol style="list-style-type: none"> <li>Updated EC25 series frequency bands in Table 1.</li> <li>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.</li> <li>Updated timing of turning on module in Figure 12.</li> <li>Updated timing of turning off module in Figure 13.</li> <li>Updated timing of resetting module in Figure 16.</li> <li>Updated supported baud rates of main UART in Chapter 3.11.</li> <li>Added notes for ADC interface in Chapter 3.13.</li> <li>Updated GNSS performance in Table 21.</li> <li>Updated operating frequencies of module in Table 23.</li> <li>Added current consumption in Chapter 6.4.</li> <li>Updated RF output power in Chapter 6.5.</li> <li>Added RF receiving sensitivity in Chapter 6.6.</li> </ol> |
| 1.2     | 2016-11-04 | Lyndon LIU/<br>Michael ZHANG | <ol style="list-style-type: none"> <li>Added SGMII and WLAN interfaces in Table 2.</li> <li>Updated function diagram in Figure 1.</li> <li>Updated pin assignment (Top View) in Figure 2.</li> <li>Added description of SGMII and WLAN interfaces in Table 4.</li> <li>Added SGMII interface in Chapter 3.17.</li> <li>Added WLAN interface in Chapter 3.18.</li> <li>Added USB_BOOT interface in Chapter 3.19.</li> <li>Added reference design of RF layout in Chapter 5.1.4.</li> <li>Added note about SIMO in Chapter 6.6.</li> </ol>                                                                                                                                                                                                                                                                                                                                  |

|     |            |                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
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| 1.3 | 2017-01-24 | Lyndon LIU/<br>Frank WANG                 | <ol style="list-style-type: none"> <li>Updated function diagram in Figure 1.</li> <li>Updated pin assignment (top view) in Figure 2.</li> <li>Added BT interface in Chapter 3.18.2.</li> <li>Updated GNSS performance in Table 24.</li> <li>Updated reference circuit of wireless connectivity interfaces with FC20 module in Figure 29.</li> <li>Updated current consumption of EC25-E module in Table 33.</li> <li>Updated EC25-A conducted RF receiving sensitivity in Table 38.</li> <li>Added EC25-J conducted RF receiving sensitivity in Table 40.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 1.4 | 2018-03-05 | AnniceZHANG/<br>Lyndon LIU/<br>Frank WANG | <ol style="list-style-type: none"> <li>Updated functional diagram in Figure 1.</li> <li>Updated LTE, UMTS and GSM features in Table 2.</li> <li>Updated description of pin 40/136/137/138.</li> <li>Updated PWRKEY pulled down time to 500 ms in Chapter 3.7.1 and reference circuit in Figure 10.</li> <li>Updated reference circuit of (U)SIM interface in Figure 17 &amp; 18.</li> <li>Updated reference circuit of USB interface in Figure 19.</li> <li>Updated PCM mode in Chapter 3.12.</li> <li>Added SD card interface in Chapter 3.13.</li> <li>Updated USB_BOOT reference circuit in Chapter 3.20.</li> <li>Updated module operating frequencies in Table 26.</li> <li>Updated antenna requirements in Table 30.</li> <li>Updated EC25 series module current consumption in Chapter 6.4.</li> <li>Updated EC25 series module conducted RF receiving sensitivity in Chapter 6.6.</li> <li>Added thermal consideration description in Chapter 6.8.</li> <li>Added dimension tolerance information in Chapter 7.</li> <li>Added storage temperature range in Table 2 and Chapter 6.3.</li> <li>Updated RF output power in Table 41.</li> <li>Updated GPRS multi-slot classes in Table 53.</li> <li>Updated storage information in Chapter 8.1.</li> </ol> |
| 1.5 | 2018-04-20 | Kinsey ZHANG                              | <ol style="list-style-type: none"> <li>Added information of EC25-AF in Table 1.</li> <li>Updated module operating frequencies in Table 27.</li> <li>Added current consumption of EC25-AF module in Table 40.</li> <li>Changed GNSS current consumption of EC25 series</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

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|-----|------------|--------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|     |            |                                                        | module into Table 41.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|     |            |                                                        | 5. Added EC25-AF conducted RF receiving sensitivity in Table 50.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 2.0 | 2019-04-30 | Nathan LIU/<br>Frank WANG/<br>Ward WANG/<br>Ethan SHAN | <ol style="list-style-type: none"> <li>Added new variants EC25-EU/-EC/-EUX/-MX and related information.</li> <li>Updated functional diagram in Figure 1.</li> <li>Updated star structure of the power supply in Figure 8.</li> <li>Updated power-on scenario of module in Figure 12.</li> <li>Updated reference circuit with translator chip in Figure 20.</li> <li>Added timing sequence for entering into emergency download mode of USB_BOOT interface in Figure 32.</li> <li>Updated general description in Table 1.</li> <li>Updated module operating frequencies in Table 27.</li> <li>Updated GNSS frequency in Table 29.</li> <li>Updated antenna requirements in Table 30.</li> <li>Updated EC25-V current consumption in Table 36.</li> <li>Added EC25-EU current consumption in Table 41</li> <li>Added EC25 EC current consumption in Table 42.</li> <li>Added EC25-EUX current consumption in Table 43.</li> <li>Added EC25-MX current consumption in Table 44.</li> <li>Updated EC25-E conducted RF receiving sensitivity in Table 47.</li> <li>Updated EC25-A conducted RF receiving sensitivity in Table 48.</li> <li>Updated EC25-V conducted RF receiving sensitivity in Table 49.</li> <li>Updated EC25-AUT conducted RF receiving sensitivity in Table 52.</li> <li>Updated EC25-AUTL conducted RF receiving sensitivity in Table 53.</li> <li>Added EC25-EU conducted RF receiving sensitivity in Table 55.</li> <li>Added EC25 EC conducted RF receiving sensitivity in Table 56.</li> <li>Added EC25-EUX conducted RF receiving sensitivity in Table 57.</li> <li>Added EC25-MX conducted RF receiving sensitivity in Table 58.</li> <li>Updated recommended stencil thickness as 0.18–0.20 mm and reflow soldering thermal profile in Chapter 8.2.</li> </ol> |

|     |            |                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
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| 2.1 | 2019-07-05 | Fanny CHEN/<br>Ethan SHAN             | <ol style="list-style-type: none"> <li>Added new variants EC25-AFX/-AUX and related information.</li> <li>Added notes for interfaces not supported by ThreadX modules.</li> <li>Updated supported protocols and USB serial drivers in Table 2.</li> <li>Updated reference circuit of wireless connectivity interfaces with FC20 module in Figure 26.</li> <li>Added EC25-AFX current consumption in Table 41.</li> <li>Added EC25-AFX conducted RF receiving sensitivity in Table 56.</li> <li>Updated mechanical dimensions of the module in Figure 45.</li> <li>Added tape and reel directions in Figure 51.</li> </ol> |
| 2.2 | 2019-08-19 | Ward WANG/<br>Owen WEI/<br>Frank WANG | <ol style="list-style-type: none"> <li>Updated EC25-J current consumption in Table 37.</li> <li>Deleted the LTE-TDD bands information of EC25-AUT current consumption in Table 39.</li> <li>Updated EC25-EC current consumption in Table 43.</li> <li>Updated EC25-EUX current consumption in Table 44.</li> <li>Added EC25-AUX current consumption in Table 46.</li> <li>Updated EC25-AU conducted RF receiving sensitivity in Table 53.</li> <li>Updated EC25-EU conducted RF receiving sensitivity in Table 58.</li> <li>Added EC25-AUX conducted RF receiving sensitivity in Table 62.</li> </ol>                     |
| 2.3 | 2019-11-26 | Fanny CHEN                            | <ol style="list-style-type: none"> <li>Removed related information of ThreadX OS because the baseline has been updated.</li> <li>Updated the supported protocols and USB serial drivers in Table 2.</li> <li>AT command AT+QCFG="airplanecontrol" has been fully developed in Chapter 3.5.</li> <li>Updated the notes for GNSS performance in Chapter 4.2.</li> <li>Updated the AT command be used to disable the receive diversity in Chapter 5.1.3.</li> <li>Updated EC25-J current consumption in Table 37.</li> </ol>                                                                                                 |
| 2.4 | 2022-01-24 | Barret XIONG                          | <ol style="list-style-type: none"> <li>Deleted the related information of EC25-EC, EC25-AUT and EC25-AUTL.</li> <li>Added the related information of EC25-AFXD.</li> <li>Deleted the description of emergency call (Chapter 2.2&amp;5.3).</li> <li>Updated the supported protocols and USB serial drivers (Table 3).</li> </ol>                                                                                                                                                                                                                                                                                           |

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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 bottom views (Chapter 6).
  8. Updated the information of storage, manufacturing and packaging (Chapter 7).
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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 such a model is currently unavailable. |
| [...] | Brackets ([...]) used after a pin enclosing a range of numbers indicate all pins of the same type. For example, SDC1_DATA[0:3] refers to all four SDC1_DATA pins: SDC1_DATA0, SDC1_DATA1, SDC1_DATA2, and SDC1_DATA3.                                                                                                                                                       |

## 2 Product Overview

### 2.1. Frequency Bands and Functions

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

EC25 series contains 12 variants: EC25-E, EC25-A, EC25-V, EC25-J, EC25-AU, EC25-AUX, EC25-AF, EC25-AFX, EC25-AFXD, EC25-EU, EC25-EUX and EC25-MX. 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 <sup>1</sup>                            |
|-----------------|-------------------------------------------------------------|--------------------|--------------------------------------------|--------------|----------------------------------------------|
| <b>EC25-E</b>   | FDD: B1/B3/B5/B7/B8/B20<br>TDD: B38/B40/B41                 | B1/B5/B8           | EGSM900/<br>DCS1800                        | ●            | GPS,<br>GLONASS,<br>BDS,<br>Galileo,<br>QZSS |
| <b>EC25-A</b>   | FDD: B2/B4/B12                                              | B2/B4/B5           | -                                          | ●            |                                              |
| <b>EC25-V</b>   | FDD: B4/B13                                                 | -                  | -                                          | ●            |                                              |
| <b>EC25-J</b>   | FDD: B1/B3/B8/B18/B19/<br>B26<br>TDD: B41                   | B1/B6/B8/<br>B19   | -                                          | ●            |                                              |
| <b>EC25-AU</b>  | FDD: B1/B2 <sup>3</sup> /B3/B4/B5/<br>B7/B8/B28<br>TDD: B40 | B1/B2/B5/B8        | GSM850/<br>EGSM900/<br>DCS1800/<br>PCS1900 | ●            |                                              |
| <b>EC25-AUX</b> | FDD: B1/B2 <sup>3</sup> /B3/B4/B5/<br>B7/B8/B28<br>TDD: B40 | B1/B2/B4/B5/<br>B8 | GSM850/<br>EGSM900/<br>DCS1800/            | ●            |                                              |

<sup>1</sup> GNSS function is optional.

<sup>2</sup> EC25 series module contains **Data + Voice** version and **Data-only** version.

<sup>3</sup> EC25-AU and EC25-AUX modules do not support Rx diversity in B2.

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

With a compact profile of 29.0 mm × 32.0 mm × 2.4 mm, EC25 series can meet almost all requirements for M2M applications such as automotive, 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       | <ul style="list-style-type: none"> <li>● Supply voltage: 3.3–4.3 V</li> <li>● Typical supply voltage: 3.8 V</li> </ul>                                                                                                                                                                                                                                                                        |
| Transmitting Power | <ul style="list-style-type: none"> <li>● Class 4 (33 dBm ±2 dB) for GSM850</li> <li>● Class 4 (33 dBm ±2 dB) for EGSM900</li> <li>● Class 1 (30 dBm ±2 dB) for DCS1800</li> <li>● Class 1 (30 dBm ±2 dB) for PCS1900</li> <li>● Class E2 (27 dBm ±3 dB) for GSM850 8-PSK</li> <li>● Class E2 (27 dBm ±3 dB) for EGSM900 8-PSK</li> <li>● Class E2 (26 dBm ±3 dB) for DCS1800 8-PSK</li> </ul> |

|                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                            | <ul style="list-style-type: none"> <li>● Class E2 (26 dBm <math>\pm</math>3 dB) for PCS1900 8-PSK</li> <li>● Class 3 (24 dBm + 1/-3 dB) for WCDMA bands</li> <li>● Class 3 (23 dBm <math>\pm</math>2 dB) for LTE-FDD bands</li> <li>● Class 3 (23 dBm <math>\pm</math>2 dB) for LTE-TDD bands</li> </ul>                                                                                                                                                                                                                                                                          |
| LTE Features               | <ul style="list-style-type: none"> <li>● Support up to non-CA Cat 4 FDD and TDD</li> <li>● Support 1.4/3/5/10/15/20 MHz RF bandwidth</li> <li>● Support MIMO in DL direction</li> <li>● LTE-FDD: Max. 150 Mbps (DL)/Max. 50 Mbps (UL)</li> <li>● LTE-TDD: Max. 130 Mbps (DL)/Max. 30 Mbps (UL)</li> </ul>                                                                                                                                                                                                                                                                         |
| UMTS Features              | <ul style="list-style-type: none"> <li>● Support 3GPP Rel-8 DC-HSDPA, HSPA+, HSDPA, HSUPA and WCDMA</li> <li>● Support QPSK, 16QAM and 64QAM modulations</li> <li>● DC-HSDPA: Max 42 Mbps (DL)</li> <li>● HSUPA: Max. 5.76 Mbps (UL)</li> <li>● WCDMA: Max. 384 kbps (DL)/Max. 384 kbps (UL)</li> </ul>                                                                                                                                                                                                                                                                           |
| GSM Features               | <p><b>GPRS:</b></p> <ul style="list-style-type: none"> <li>● Support GPRS multi-slot class 33 (33 by default)</li> <li>● Coding scheme: CS-1, CS-2, CS-3 and CS-4</li> <li>● Max. 107 kbps (DL)/Max. 85.6 kbps (UL)</li> </ul> <p><b>EDGE:</b></p> <ul style="list-style-type: none"> <li>● Support EDGE multi-slot class 33 (33 by default)</li> <li>● Support GMSK and 8-PSK for different MCS (Modulation and Coding Scheme)</li> <li>● Downlink coding schemes: MCS 1–9</li> <li>● Uplink coding schemes: MCS 1–9</li> <li>● Max 296 kbps (DL)/Max 236.8 kbps (UL)</li> </ul> |
| Internet Protocol Features | <ul style="list-style-type: none"> <li>● Support TCP/UDP/PPP/FTP/FTPS/HTTP/HTTPS/NTP/PING/QMI/NITZ/SMTP/SSL/MQTT/FILE/CMUX/SMTPS/MMS/FILE protocols</li> <li>● Support PAP and CHAP protocols for PPP connections</li> </ul>                                                                                                                                                                                                                                                                                                                                                      |
| SMS                        | <ul style="list-style-type: none"> <li>● Text and PDU mode</li> <li>● Point-to-point MO and MT</li> <li>● SMS cell broadcast</li> <li>● SMS storage: ME by default</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                     |
| (U)SIM Interface           | Support USIM/SIM card: 1.8 V, 3.0 V                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Audio Features             | <ul style="list-style-type: none"> <li>● Support one digital audio interface: PCM interface</li> <li>● GSM: HR/FR/EFR/AMR/AMR-WB</li> <li>● WCDMA: AMR/AMR-WB</li> <li>● LTE: AMR/AMR-WB</li> <li>● Support echo cancellation and noise suppression</li> </ul>                                                                                                                                                                                                                                                                                                                    |
| PCM Interface              | <ul style="list-style-type: none"> <li>● Used for audio function with external codec</li> <li>● Support 16-bit linear data format</li> <li>● Support long frame synchronization and short frame synchronization</li> <li>● Support master and slave modes, but must be the master in long frame</li> </ul>                                                                                                                                                                                                                                                                        |

|                                            |                                                                                                                                                                                                                                                                                                                                                                                                             |
|--------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                            | synchronization                                                                                                                                                                                                                                                                                                                                                                                             |
| USB Interface                              | <ul style="list-style-type: none"> <li>Compliant with USB 2.0 specification (slave only); the data transfer rate can reach up to 480 Mbps</li> <li>Used for AT command communication, data transmission, GNSS NMEA sentences output, software debugging, firmware upgrade and voice over USB</li> <li>Support USB serial drivers for: Windows 7/8/8.1/10, Linux 2.6–5.14, Android 4.x–11.x, etc.</li> </ul> |
| UART Interfaces                            | <b>Main UART:</b> <ul style="list-style-type: none"> <li>Used for AT command communication and data transmission</li> <li>Baud rates reach up to 921600 bps, 115200 bps by default</li> <li>Support RTS and CTS hardware flow control</li> </ul> <b>Debug UART:</b> <ul style="list-style-type: none"> <li>Used for Linux console and log output</li> <li>115200 bps baud rate</li> </ul>                   |
| SD Card Interface                          | Support SD 3.0 protocol                                                                                                                                                                                                                                                                                                                                                                                     |
| SGMII Interface                            | <ul style="list-style-type: none"> <li>Support 10 Mbps/100 Mbps/1000 Mbps Ethernet work mode</li> <li>Support Max. 150 Mbps (DL)/50 Mbps (UL) for 4G network</li> </ul>                                                                                                                                                                                                                                     |
| WLAN and Bluetooth Applications Interfaces | <ul style="list-style-type: none"> <li>Support SDIO 3.0 interface for WLAN</li> <li>Support UART &amp; PCM interfaces for Bluetooth</li> </ul>                                                                                                                                                                                                                                                              |
| Rx-diversity                               | Support LTE/WCDMA Rx-diversity                                                                                                                                                                                                                                                                                                                                                                              |
| GNSS Features                              | Protocol: <i>NMEA-0183</i><br>Data update rate: 1 Hz by default                                                                                                                                                                                                                                                                                                                                             |
| AT Commands                                | <ul style="list-style-type: none"> <li>Compliant with <i>3GPP TS 27.007</i>, <i>3GPP TS 27.005</i></li> <li>Quectel enhanced AT commands</li> </ul>                                                                                                                                                                                                                                                         |
| Network Indication                         | Two pins including NET_MODE and NET_STATUS to indicate network connectivity status                                                                                                                                                                                                                                                                                                                          |
| Antenna Interfaces                         | <ul style="list-style-type: none"> <li>Main antenna interface (ANT_MAIN)</li> <li>Rx-diversity antenna interface (ANT_DIV)</li> <li>GNSS antenna interface (ANT_GNSS)</li> </ul>                                                                                                                                                                                                                            |
| Physical Characteristics                   | <ul style="list-style-type: none"> <li>Size: (29.0 ±0.15) mm × (32.0 ±0.15) mm × (2.4 ±0.2) mm</li> <li>Weight: approx. 4.9 g</li> </ul>                                                                                                                                                                                                                                                                    |
| Temperature Range                          | <ul style="list-style-type: none"> <li>Operating temperature range: -35 to +75 °C <sup>4</sup></li> <li>Extended temperature range: -40 to +85 °C <sup>5</sup></li> <li>Storage temperature range: -40 to +90 °C</li> </ul>                                                                                                                                                                                 |
| Firmware Upgrade                           | USB 2.0 interface or DFOTA                                                                                                                                                                                                                                                                                                                                                                                  |

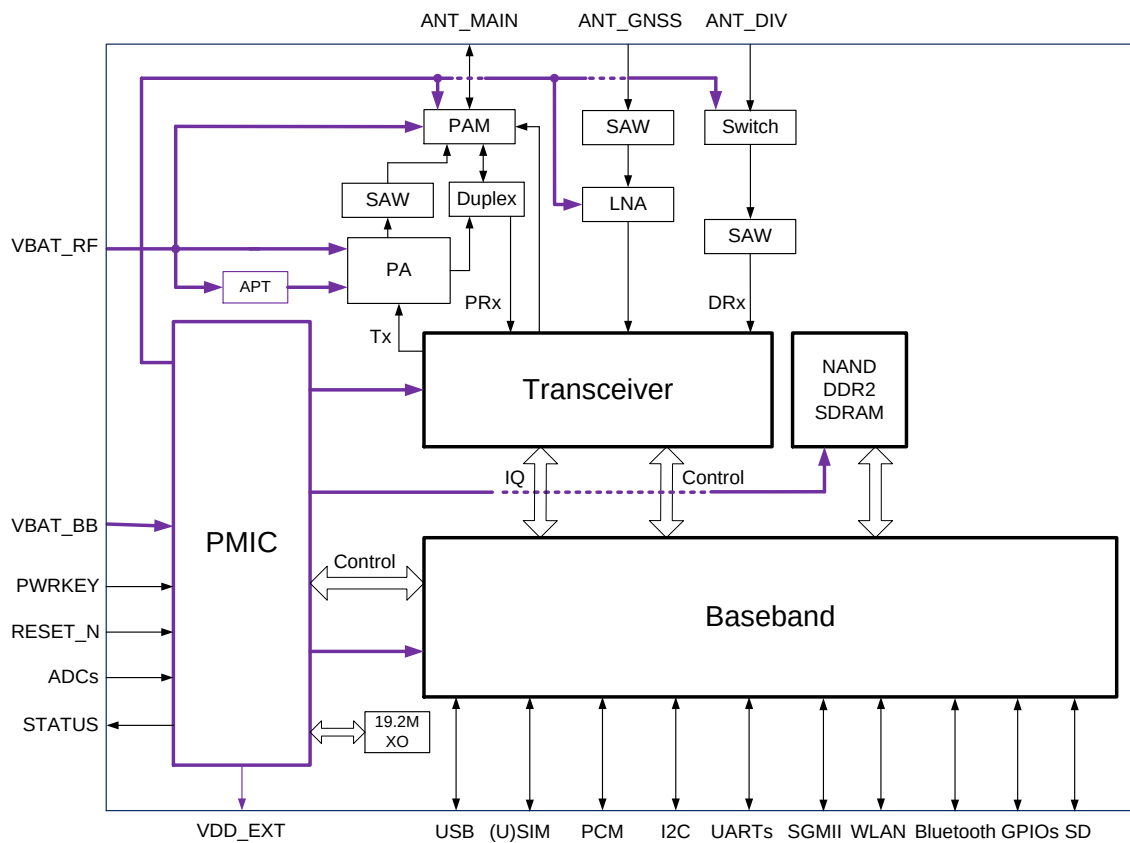
<sup>4</sup> Within the operating temperature range, the module meets 3GPP specifications.

<sup>5</sup> 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<sub>out</sub>, may exceed the specified tolerances of 3GPP. When the temperature returns to the operating temperature range, the module meets 3GPP specifications again.

## 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



**Figure 1: Functional Diagram**

## 2.4. EVB

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

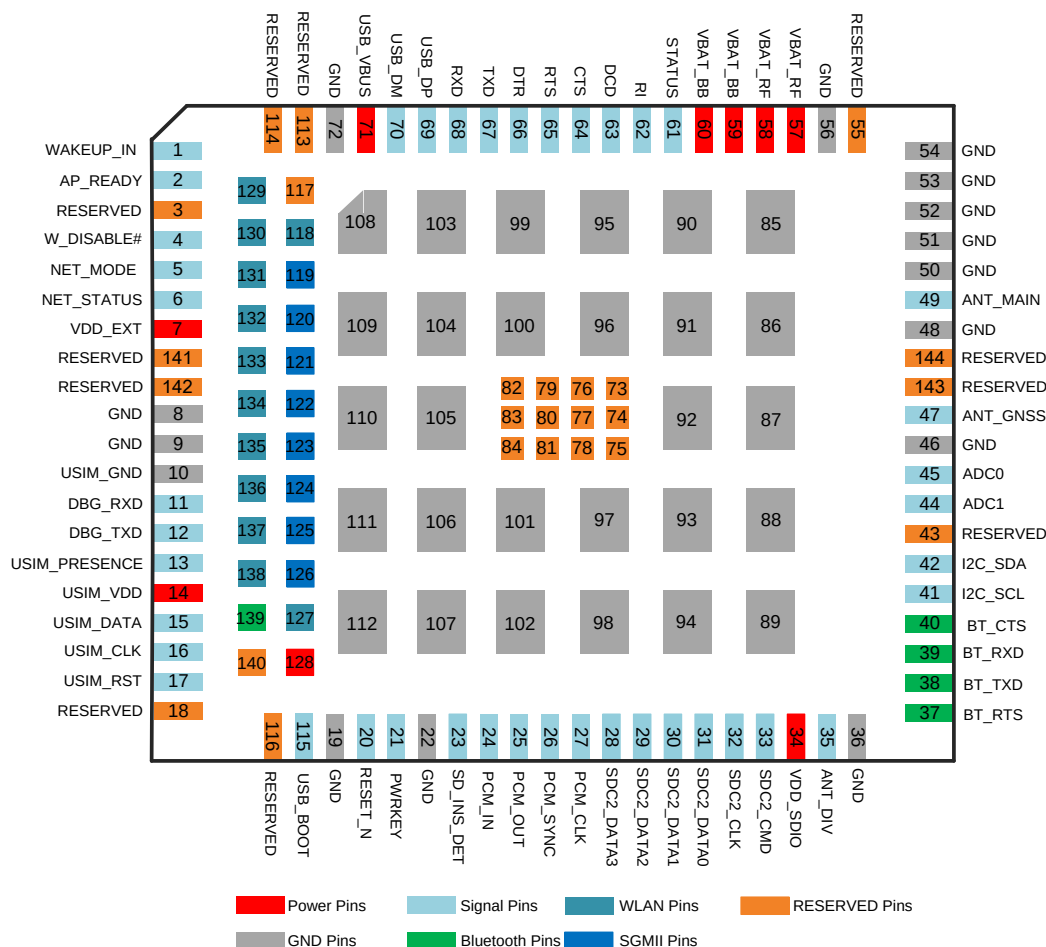
## 3.1. General Description

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 applications 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<br>Vmin = 3.3 V<br>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<br>Vmin = 3.3 V<br>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<br>I <sub>o</sub> max = 50 mA   | Power supply for external GPIO's pull-up circuits.<br>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 <sub>IH</sub> max = 2.1 V<br>V <sub>IH</sub> min = 1.3 V<br>V <sub>IL</sub> 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.<br>An external pull-up resistor is required.<br>If unused, keep it open. |
| NET_MODE   | 5       | DO  | Indicate the module's network registration mode | V <sub>OH</sub> min = 1.35 V<br>V <sub>OL</sub> max = 0.45 V | 1.8 V power domain.<br>It cannot be pulled up before startup.<br>If unused, keep it open.                                |
| NET_STATUS | 6       | DO  | Indicate the module's network activity status   | V <sub>OH</sub> min = 1.35 V<br>V <sub>OL</sub> max = 0.45 V | 1.8 V power domain.<br>If unused, keep it open.                                                                          |

#### USB Interface

| Pin Name | Pin No. | I/O | Description               | DC Characteristics                                                                | Comment                                                                                     |
|----------|---------|-----|---------------------------|-----------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| USB_VBUS | 71      | PI  | USB connection detection  | V <sub>max</sub> = 5.25 V<br>V <sub>min</sub> = 3.0 V<br>V <sub>nom</sub> = 5.0 V | Typ. 5.0 V.<br>If unused, keep it open.                                                     |
| USB_DP   | 69      | AIO | USB differential data (+) |                                                                                   | USB 2.0 Compliant.<br>Require differential impedance of 90 Ω.<br>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 | $V_{ILmin} = -0.3\text{ V}$<br>$V_{ILmax} = 0.6\text{ V}$<br>$V_{IHmin} = 1.2\text{ V}$<br>$V_{IHmax} = 2.0\text{ V}$<br>$I_{Omax} = 50\text{ mA}$                                                                                                                                                        | 1.8 V power domain.<br>If unused, keep it open.                 |
| USIM_VDD        | 14 | PO  | (U)SIM card power supply    | <b>For 1.8 V (U)SIM:</b><br>$V_{max} = 1.9\text{ V}$<br>$V_{min} = 1.7\text{ V}$<br><b>For 3.0 V (U)SIM:</b><br>$V_{max} = 3.05\text{ V}$<br>$V_{min} = 2.7\text{ V}$                                                                                                                                     | Either 1.8 V or 3.0 V is supported by the module automatically. |
| USIM_DATA       | 15 | DIO | (U)SIM card data            | <b>For 1.8 V (U)SIM:</b><br>$V_{ILmax} = 0.6\text{ V}$<br>$V_{IHmin} = 1.2\text{ V}$<br>$V_{OLmax} = 0.45\text{ V}$<br>$V_{OHmin} = 1.35\text{ V}$<br><b>For 3.0 V (U)SIM:</b><br>$V_{ILmax} = 1.0\text{ V}$<br>$V_{IHmin} = 1.95\text{ V}$<br>$V_{OLmax} = 0.45\text{ V}$<br>$V_{OHmin} = 2.55\text{ V}$ |                                                                 |
| USIM_CLK        | 16 | DO  | (U)SIM card clock           | <b>For 1.8 V (U)SIM:</b><br>$V_{OLmax} = 0.45\text{ V}$<br>$V_{OHmin} = 1.35\text{ V}$<br><b>For 3.0 V (U)SIM:</b><br>$V_{OLmax} = 0.45\text{ V}$<br>$V_{OHmin} = 2.55\text{ V}$                                                                                                                          |                                                                 |
| USIM_RST        | 17 | DO  | (U)SIM card reset           | <b>For 1.8 V (U)SIM:</b><br>$V_{OLmax} = 0.45\text{ V}$<br>$V_{OHmin} = 1.35\text{ V}$<br><b>For 3.0 V (U)SIM:</b><br>$V_{OLmax} = 0.45\text{ V}$<br>$V_{OHmin} = 2.55\text{ V}$                                                                                                                          |                                                                 |

#### Main UART Interface

| Pin Name | Pin No. | I/O | Description | DC Characteristics | Comment |
|----------|---------|-----|-------------|--------------------|---------|
|----------|---------|-----|-------------|--------------------|---------|

|     |    |    |                                                   |                                                                                                                           |                                                                                                                                    |
|-----|----|----|---------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|
| RI  | 62 | DO | Main UART ring indicator                          | V <sub>OL</sub> max = 0.45 V<br>V <sub>OH</sub> min = 1.35 V                                                              | 1.8 V power domain.<br>If unused, keep them open.                                                                                  |
| DCD | 63 | DO | Main UART data carrier detection                  |                                                                                                                           |                                                                                                                                    |
| CTS | 64 | DO | DTE clear to send signal from DCE                 |                                                                                                                           |                                                                                                                                    |
| RTS | 65 | DI | DTE request to send signal from DCE               | V <sub>IL</sub> min = -0.3 V<br>V <sub>IL</sub> max = 0.6 V<br>V <sub>IH</sub> min = 1.2 V<br>V <sub>IH</sub> max = 2.0 V | 1.8 V power domain.<br>If unused, keep it open.<br>Connect to DTE's RTS.                                                           |
| DTR | 66 | DI | Main UART Data terminal ready, sleep mode control | V <sub>IL</sub> min = -0.3 V<br>V <sub>IL</sub> max = 0.6 V<br>V <sub>IH</sub> min = 1.2 V<br>V <sub>IH</sub> max = 2.0 V | 1.8 V power domain.<br>Pulled up by default. DTR can wake up the module when DTR remains at low level.<br>If unused, keep it open. |
| TXD | 67 | DO | Main UART transmit                                | V <sub>OL</sub> max = 0.45 V<br>V <sub>OH</sub> min = 1.35 V                                                              | 1.8 V power domain.<br>If unused, keep it open.                                                                                    |
| RXD | 68 | DI | Main UART receive                                 | V <sub>IL</sub> min = -0.3 V<br>V <sub>IL</sub> max = 0.6 V<br>V <sub>IH</sub> min = 1.2 V<br>V <sub>IH</sub> max = 2.0 V | 1.8 V power domain.<br>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 <sub>OL</sub> max = 0.45 V<br>V <sub>OH</sub> min = 1.35 V                                                              | 1.8 V power domain.<br>If unused, keep it open. |
| DBG_RXD  | 11      | DI  | Debug UART receive  | V <sub>IL</sub> min = -0.3 V<br>V <sub>IL</sub> max = 0.6 V<br>V <sub>IH</sub> min = 1.2 V<br>V <sub>IH</sub> max = 2.0 V | 1.8 V power domain.<br>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:<br>0.3 V to VBAT_BB | If unused, keep them open. |
| ADC1     | 44      | AI  | General-purpose ADC interface |                                    |                            |

| PCM Interface <sup>6</sup> |         |     |                                           |                                                                                                                                                                                           |                                                                                                                                                           |
|----------------------------|---------|-----|-------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Pin Name                   | Pin No. | I/O | Description                               | DC Characteristics                                                                                                                                                                        | Comment                                                                                                                                                   |
| PCM_IN                     | 24      | DI  | PCM data input                            | V <sub>IL</sub> min = -0.3 V<br>V <sub>IL</sub> max = 0.6 V<br>V <sub>IH</sub> min = 1.2 V<br>V <sub>IH</sub> max = 2.0 V                                                                 | 1.8 V power domain.<br>If unused, keep it open.                                                                                                           |
| PCM_OUT                    | 25      | DO  | PCM data output                           | V <sub>OL</sub> max = 0.45 V<br>V <sub>OH</sub> min = 1.35 V                                                                                                                              |                                                                                                                                                           |
| PCM_SYNC                   | 26      | DIO | PCM frame sync                            | V <sub>OL</sub> max = 0.45 V<br>V <sub>OH</sub> min = 1.35 V<br>V <sub>IL</sub> min = -0.3 V<br>V <sub>IL</sub> max = 0.6 V<br>V <sub>IH</sub> min = 1.2 V<br>V <sub>IH</sub> max = 2.0 V | 1.8 V power domain.<br>Serve as output signal in master mode.                                                                                             |
| PCM_CLK                    | 27      | DIO | PCM clock                                 | V <sub>OL</sub> max = 0.45 V<br>V <sub>OH</sub> min = 1.35 V<br>V <sub>IL</sub> min = -0.3 V<br>V <sub>IL</sub> max = 0.6 V<br>V <sub>IH</sub> min = 1.2 V<br>V <sub>IH</sub> max = 2.0 V | Serve as input signal in slave mode.<br>If unused, keep them open.                                                                                        |
| I2C Interface              |         |     |                                           |                                                                                                                                                                                           |                                                                                                                                                           |
| Pin Name                   | Pin No. | I/O | Description                               | DC Characteristics                                                                                                                                                                        | Comment                                                                                                                                                   |
| I2C_SCL                    | 41      | OD  | I2C serial clock.<br>(for external codec) |                                                                                                                                                                                           | An external 1.8 V pull-up resistor is required.<br>If unused, keep them open.                                                                             |
| I2C_SDA                    | 42      | OD  | I2C serial data.<br>(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                   | <b>1.8 V signaling:</b><br>V <sub>OL</sub> max = 0.45 V<br>V <sub>OH</sub> min = 1.4 V<br>V <sub>IL</sub> min = -0.3 V<br>V <sub>IL</sub> max = 0.58 V<br>V <sub>IH</sub> min = 1.27 V    | SDIO signal level can be selected according to the signal level supported by SD card; see SD 3.0 protocol for more details.<br>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                   |                                                                                                                                                                                           |                                                                                                                                                           |

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

|                        |                |            |                            |                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                  |
|------------------------|----------------|------------|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
|                        |                |            |                            | $V_{IHmax} = 2.0\text{ V}$                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                  |
| SDC2_DATA0             | 31             | DIO        | SD card SDIO data bit 0    | <b>3.0 V signaling:</b><br>$V_{OLmax} = 0.38\text{ V}$<br>$V_{OHmin} = 2.01\text{ V}$<br>$V_{ILmin} = -0.3\text{ V}$<br>$V_{ILmax} = 0.76\text{ V}$<br>$V_{IHmin} = 1.72\text{ V}$<br>$V_{IHmax} = 3.34\text{ V}$                                                                                                                                                                                                                    |                                                                                                  |
| SDC2_CLK               | 32             | DO         | SDIO clock                 | <b>1.8 V signaling:</b><br>$V_{OLmax} = 0.45\text{ V}$<br>$V_{OHmin} = 1.4\text{ V}$<br><b>3.0 V signaling:</b><br>$V_{OLmax} = 0.38\text{ V}$<br>$V_{OHmin} = 2.01\text{ V}$                                                                                                                                                                                                                                                        |                                                                                                  |
| SDC2_CMD               | 33             | DIO        | SD card SDIO command       | <b>1.8 V signaling:</b><br>$V_{OLmax} = 0.45\text{ V}$<br>$V_{OHmin} = 1.4\text{ V}$<br>$V_{ILmin} = -0.3\text{ V}$<br>$V_{ILmax} = 0.58\text{ V}$<br>$V_{IHmin} = 1.27\text{ V}$<br>$V_{IHmax} = 2.0\text{ V}$<br><b>3.0 V signaling:</b><br>$V_{OLmax} = 0.38\text{ V}$<br>$V_{OHmin} = 2.01\text{ V}$<br>$V_{ILmin} = -0.3\text{ V}$<br>$V_{ILmax} = 0.76\text{ V}$<br>$V_{IHmin} = 1.72\text{ V}$<br>$V_{IHmax} = 3.34\text{ V}$ |                                                                                                  |
| SD_INS_DET             | 23             | DI         | SD card insertion detect   | $V_{ILmin} = -0.3\text{ V}$<br>$V_{ILmax} = 0.6\text{ V}$<br>$V_{IHmin} = 1.2\text{ V}$<br>$V_{IHmax} = 2.0\text{ V}$                                                                                                                                                                                                                                                                                                                | 1.8 V power domain.<br>If SD card function is unused, keep this pin open.                        |
| VDD_SDIO               | 34             | PO         | SD card SDIO pull-up power | $I_{Omax} = 50\text{ mA}$                                                                                                                                                                                                                                                                                                                                                                                                            | 1.8/2.85 V configurable.<br>Cannot be used for SD card power supply.<br>If unused, keep it open. |
| <b>SGMII Interface</b> |                |            |                            |                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                  |
| <b>Pin Name</b>        | <b>Pin No.</b> | <b>I/O</b> | <b>Description</b>         | <b>DC Characteristics</b>                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Comment</b>                                                                                   |

|             |     |     |                                  |                                                                                                                                                                                                                                                                                                            |                                                                                                                  |
|-------------|-----|-----|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|
| EPHY_RST_N  | 119 | DO  | Ethernet PHY reset               | <b>For 1.8 V:</b><br>V <sub>OL</sub> max = 0.45 V<br>V <sub>OH</sub> min = 1.4 V<br><br><b>For 2.85 V:</b><br>V <sub>OL</sub> max = 0.35 V<br>V <sub>OH</sub> min = 2.14 V                                                                                                                                 | 1.8/2.85 V power domain.<br>If unused, keep it open.                                                             |
| EPHY_INT_N  | 120 | DI  | Ethernet PHY interrupt           | V <sub>IL</sub> min = -0.3 V<br>V <sub>IL</sub> max = 0.6 V<br>V <sub>IH</sub> min = 1.2 V<br>V <sub>IH</sub> max = 2.0 V                                                                                                                                                                                  | 1.8 V power domain.<br>If unused, keep it open.                                                                  |
| SGMII_MDATA | 121 | DIO | SGMII MDIO data                  | <b>For 1.8 V:</b><br>V <sub>OL</sub> max = 0.45 V<br>V <sub>OH</sub> min = 1.4 V<br>V <sub>IL</sub> max = 0.58 V<br>V <sub>IH</sub> min = 1.27 V<br><br><b>For 2.85 V:</b><br>V <sub>OL</sub> max = 0.35 V<br>V <sub>OH</sub> min = 2.14 V<br>V <sub>IL</sub> max = 0.71 V<br>V <sub>IH</sub> min = 1.78 V | 1.8/2.85 V power domain.<br>If unused, keep it open.                                                             |
| SGMII_MCLK  | 122 | DO  | SGMII MDIO clock                 | <b>For 1.8 V:</b><br>V <sub>OL</sub> max = 0.45 V<br>V <sub>OH</sub> min = 1.4 V<br><br><b>For 2.85 V:</b><br>V <sub>OL</sub> max = 0.35 V<br>V <sub>OH</sub> min = 2.14 V                                                                                                                                 | 1.8/2.85 V power domain.<br>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.<br>If unused, keep them open. |
| SGMII_TX_P  | 124 | AO  | SGMII transmit (+)               |                                                                                                                                                                                                                                                                                                            |                                                                                                                  |
| SGMII_RX_P  | 125 | AI  | SGMII receive (+)                |                                                                                                                                                                                                                                                                                                            |                                                                                                                  |
| SGMII_RX_M  | 126 | AI  | SGMII receive (-)                |                                                                                                                                                                                                                                                                                                            |                                                                                                                  |
| USIM2_VDD   | 128 | PO  | SGMII_MDATA pull-up power supply |                                                                                                                                                                                                                                                                                                            | Configurable power supply.<br>1.8/2.85 V power domain.<br>If unused, keep it open.                               |

#### Interfaces for WLAN and Bluetooth Applications

| Pin Name         | Pin No. | I/O | Description                               | DC Characteristics                                                                                                                                                                  | Comment                                                                                                |
|------------------|---------|-----|-------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|
| SDC1_DATA3       | 129     | DIO | WLAN SDIO data bit 3                      | $V_{OLmax} = 0.45\text{ V}$<br>$V_{OHmin} = 1.35\text{ V}$<br>$V_{ILmin} = -0.3\text{ V}$<br>$V_{ILmax} = 0.6\text{ V}$<br>$V_{IHmin} = 1.2\text{ V}$<br>$V_{IHmax} = 2.0\text{ V}$ | 1.8 V power domain.<br>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                         | $V_{OLmax} = 0.45\text{ V}$<br>$V_{OHmin} = 1.35\text{ V}$                                                                                                                          | 1.8 V power domain.<br>If unused, keep them open.                                                      |
| PM_ENABLE        | 127     | DO  | WLAN power control                        |                                                                                                                                                                                     |                                                                                                        |
| WAKE_ON_WIRELESS | 135     | DI  | WLAN wake up the module                   | $V_{ILmin} = -0.3\text{ V}$<br>$V_{ILmax} = 0.6\text{ V}$<br>$V_{IHmin} = 1.2\text{ V}$<br>$V_{IHmax} = 2.0\text{ V}$                                                               | 1.8 V power domain.<br>Active low.<br>If unused, keep it open.                                         |
| WLAN_EN          | 136     | DO  | WLAN function enable                      | $V_{OLmax} = 0.45\text{ V}$<br>$V_{OHmin} = 1.35\text{ V}$                                                                                                                          | 1.8 V power domain.<br>Active high.<br>Cannot be pulled up before startup.<br>If unused, keep it open. |
| COEX_UART_RX     | 137     | DI  | LTE/WLAN & Bluetooth coexistence receive  | $V_{ILmin} = -0.3\text{ V}$<br>$V_{ILmax} = 0.6\text{ V}$<br>$V_{IHmin} = 1.2\text{ V}$<br>$V_{IHmax} = 2.0\text{ V}$                                                               | 1.8 V power domain.<br>Cannot be pulled up before startup.<br>If unused, keep it open.                 |
| COEX_UART_TX     | 138     | DO  | LTE/WLAN & Bluetooth coexistence transmit | $V_{OLmax} = 0.45\text{ V}$<br>$V_{OHmin} = 1.35\text{ V}$                                                                                                                          | 1.8 V power domain.<br>Cannot be pulled up before startup.<br>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       | $V_{ILmin} = -0.3\text{ V}$<br>$V_{ILmax} = 0.6\text{ V}$<br>$V_{IHmin} = 1.2\text{ V}$<br>$V_{IHmax} = 2.0\text{ V}$                                                               | 1.8 V power domain.<br>If unused, keep it open.<br>Connect to DTE's RTS.                               |
| BT_TXD           | 38      | DO  | Bluetooth UART transmit                   | $V_{OLmax} = 0.45\text{ V}$<br>$V_{OHmin} = 1.35\text{ V}$                                                                                                                          | 1.8 V power domain.<br>If unused, keep it open.                                                        |
| BT_RXD           | 39      | DI  | Bluetooth UART receive                    | $V_{ILmin} = -0.3\text{ V}$<br>$V_{ILmax} = 0.6\text{ V}$                                                                                                                           | 1.8 V power domain.<br>If unused, keep it open.                                                        |

|                             |         |     |                                             | $V_{IHmin} = 1.2\text{ V}$<br>$V_{IHmax} = 2.0\text{ V}$                                                              |                                                                                                                             |
|-----------------------------|---------|-----|---------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| BT_CTS                      | 40      | DO  | DTE clear to send signal from DCE           | $V_{OLmax} = 0.45\text{ V}$<br>$V_{OHmin} = 1.35\text{ V}$                                                            | 1.8 V power domain.<br>Cannot be pulled up before startup.<br>If unused, keep it open.<br>Connect to DTE's RTS.             |
| BT_EN                       | 139     | DO  | Bluetooth function enable                   | $V_{OLmax} = 0.45\text{ V}$<br>$V_{OHmin} = 1.35\text{ V}$                                                            | 1.8 V power domain.<br>If unused, keep it open.                                                                             |
| <b>RF Interfaces</b>        |         |     |                                             |                                                                                                                       |                                                                                                                             |
| Pin Name                    | Pin No. | I/O | Description                                 | DC Characteristics                                                                                                    | Comment                                                                                                                     |
| ANT_DIV                     | 35      | AI  | Diversity antenna interface                 |                                                                                                                       | 50 $\Omega$ impedance.<br>If unused, keep it open.                                                                          |
| ANT_MAIN                    | 49      | AIO | Main antenna interface                      |                                                                                                                       | 50 $\Omega$ impedance.                                                                                                      |
| ANT_GNSS                    | 47      | AI  | GNSS antenna interface                      |                                                                                                                       | 50 $\Omega$ impedance.<br>If unused, keep it open.                                                                          |
| <b>Other Interface Pins</b> |         |     |                                             |                                                                                                                       |                                                                                                                             |
| Pin Name                    | Pin No. | I/O | Description                                 | DC Characteristics                                                                                                    | Comment                                                                                                                     |
| WAKEUP_IN                   | 1       | DI  | Sleep mode control                          | $V_{ILmin} = -0.3\text{ V}$<br>$V_{ILmax} = 0.6\text{ V}$<br>$V_{IHmin} = 1.2\text{ V}$<br>$V_{IHmax} = 2.0\text{ V}$ | 1.8 V power domain.<br>Cannot be pulled up before startup.<br>Low level can wake up the module.<br>If unused, keep it open. |
| W_DISABLE#                  | 4       | DI  | Airplane mode control                       | $V_{ILmin} = -0.3\text{ V}$<br>$V_{ILmax} = 0.6\text{ V}$<br>$V_{IHmin} = 1.2\text{ V}$<br>$V_{IHmax} = 2.0\text{ V}$ | 1.8 V power domain.<br>Pull-up by default.<br>At low level, the module can enter airplane mode.<br>If unused, keep it open. |
| AP_READY                    | 2       | DI  | Application processor sleep state detection | $V_{ILmin} = -0.3\text{ V}$<br>$V_{ILmax} = 0.6\text{ V}$<br>$V_{IHmin} = 1.2\text{ V}$<br>$V_{IHmax} = 2.0\text{ V}$ | 1.8 V power domain.<br>If unused, keep it open.                                                                             |
| <b>USB_BOOT Interface</b>   |         |     |                                             |                                                                                                                       |                                                                                                                             |
| Pin Name                    | Pin No. | I/O | Description                                 | DC Characteristics                                                                                                    | Comment                                                                                                                     |
| USB_BOOT                    | 115     | DI  | Force the module to enter                   | $V_{ILmin} = -0.3\text{ V}$<br>$V_{ILmax} = 0.6\text{ V}$                                                             | 1.8 V power domain.<br>Cannot be pulled up before                                                                           |

|               |                                                   |     |                            |                                                            |                                                         |
|---------------|---------------------------------------------------|-----|----------------------------|------------------------------------------------------------|---------------------------------------------------------|
|               |                                                   |     | emergency<br>download mode | V <sub>IH</sub> min = 1.2 V<br>V <sub>IH</sub> max = 2.0 V | startup.<br>It is recommended to<br>reserve test point. |
| RESERVED Pins |                                                   |     |                            |                                                            |                                                         |
| Pin Name      | Pin<br>No.                                        | I/O | Description                | DC<br>Characteristics                                      | Comment                                                 |
| RESERVED      | 3, 18, 43, 55, 73–84, 113, 114, 116, 117, 140-144 |     |                            |                                                            | Keep these pins<br>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**

| Mode                       | Details                                                                                                                                                                                                                            |
|----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Normal Operation           | Idle<br>The module remains registered on the network, and is ready to send and receive data. In this mode, the software is active.                                                                                                 |
|                            | Talk/<br>Data<br>The module is connected to network. Its current consumption varies with the network setting and data transfer rate.                                                                                               |
| Airplane Mode              | <b>AT+CFUN=4</b> or W_DISABLE# pin can set the module to airplane mode where the RF function is invalid.                                                                                                                           |
| Minimum Functionality Mode | <b>AT+CFUN=0</b> 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. Power Saving

### 3.5.1. Sleep Mode

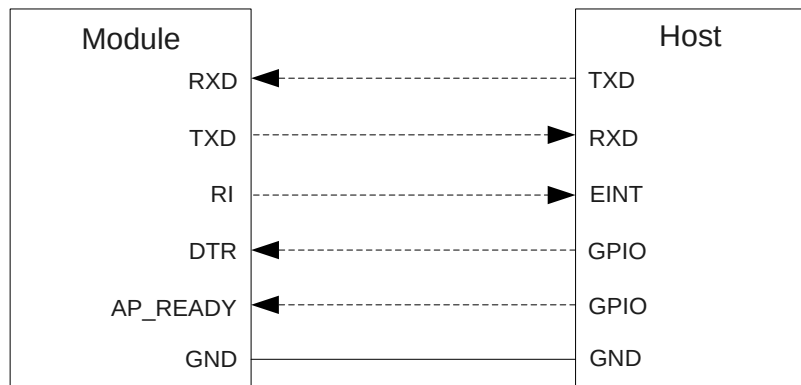
EC25 series can reduce its current consumption to a minimum value during the sleep mode. The following section describes power saving procedures of EC25 series module.

#### 3.5.1.1. 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**

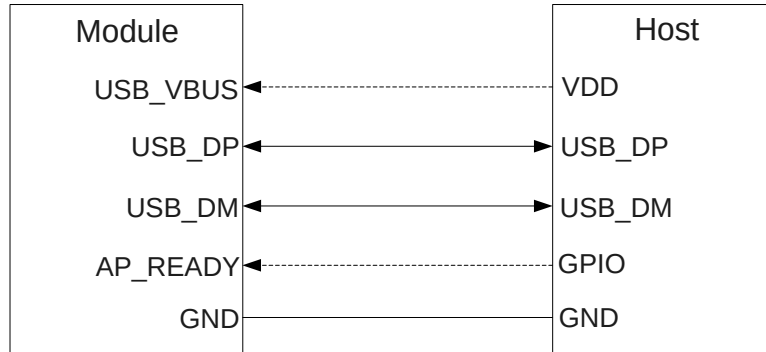
- Driving the module's DTR to low level will wake up the module.
- When EC25 series has a URC to report, RI signal will wake up the host. See **Chapter 3.17.3** for details about RI behaviors.
- AP\_READY will detect the sleep state of the host (can be configured to high level or low level detection). See *document [3]* for details about **AT+QCFG="apready"**.

#### 3.5.1.2. 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.

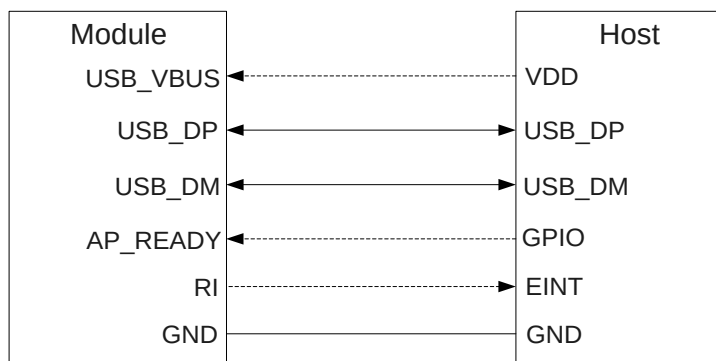
### 3.5.1.3. USB Application with USB Suspend/Resume and RI Function

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**

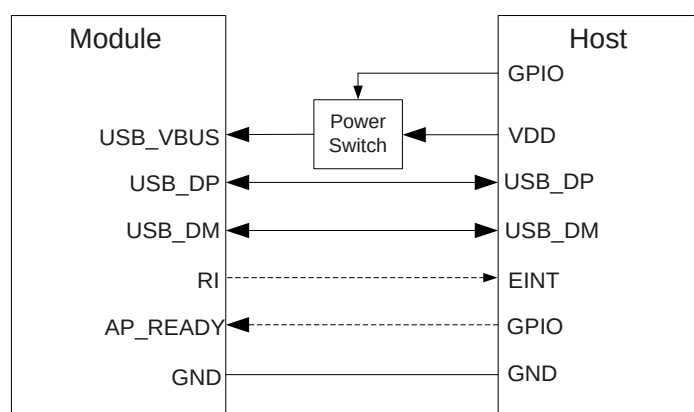
- Sending data to EC25 series via USB will wake up the module.
- When EC25 series module has a URC to report, RI signal will wake up the host.

#### 3.5.1.4. 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+QSCCLK=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]**.

### 3.5.2. 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.

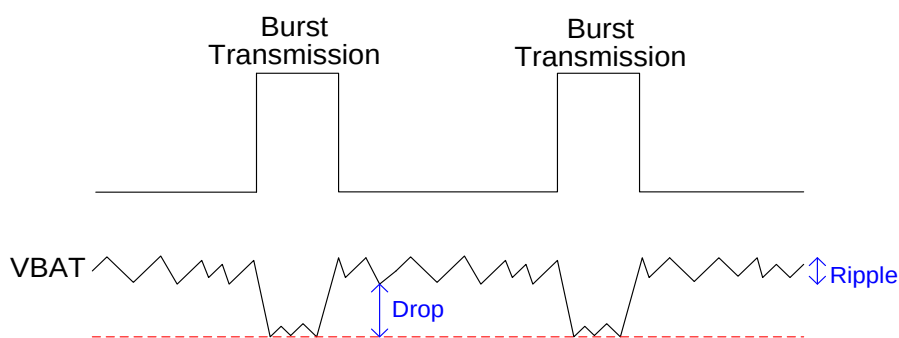


Figure 7: Power Supply Limits During Burst Transmission

To decrease the voltage drop, a bypass capacitor of about 100  $\mu\text{F}$  with low ESR ( $\text{ESR} = 0.7 \Omega$ ) 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  $V_{\text{RWM}}$  4.5 V, low clamping voltage  $V_{\text{C}}$  and high reverse peak pulse current  $I_{\text{PP}}$  should be used. The following figure shows the star structure of the power supply.

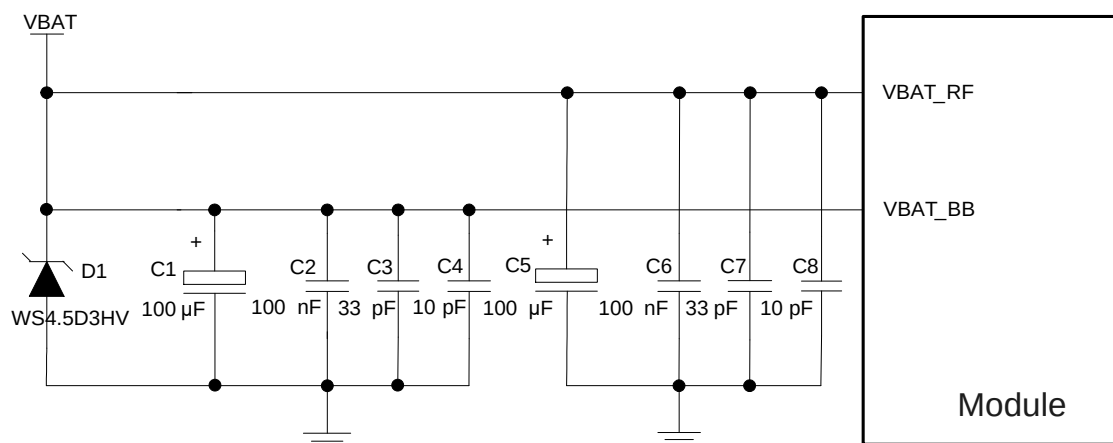


Figure 8: Star Structure of the Power Supply

### 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.

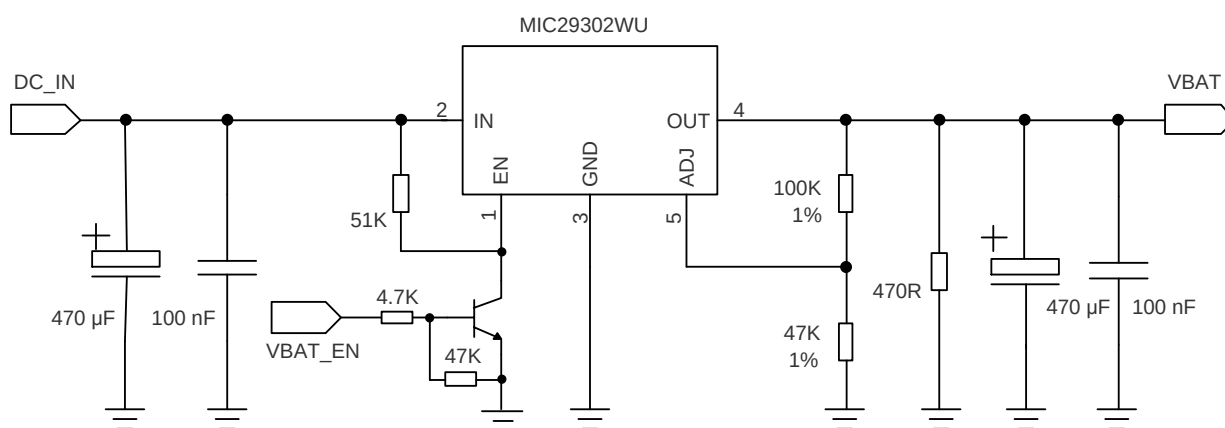


Figure 9: Reference Circuit of Power Supply

#### NOTE

To avoid damaging internal flash, 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. Power-on/off Scenarios

### 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.

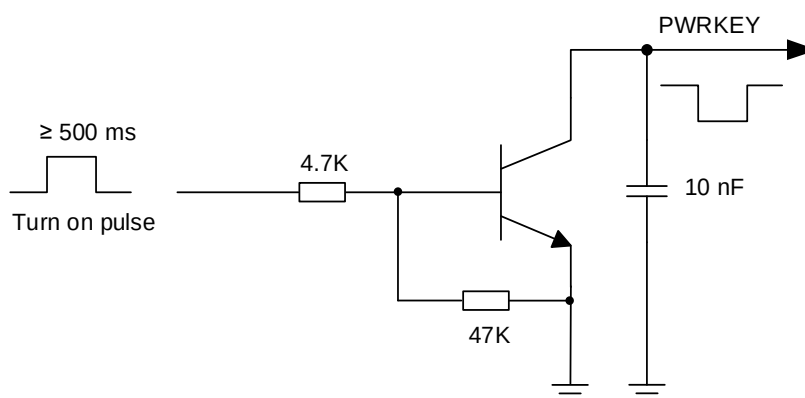
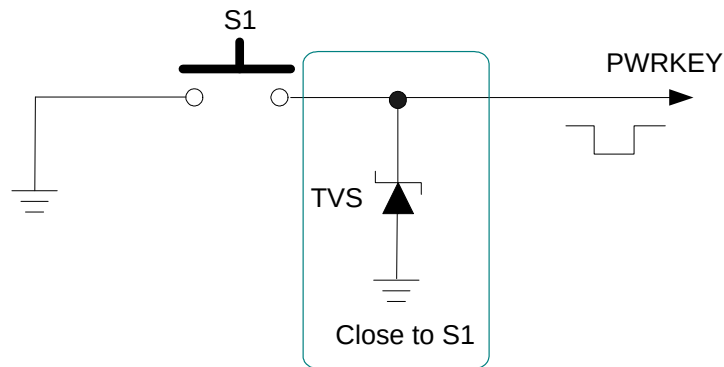


Figure 10: Turn on the Module by Using Driving Circuit

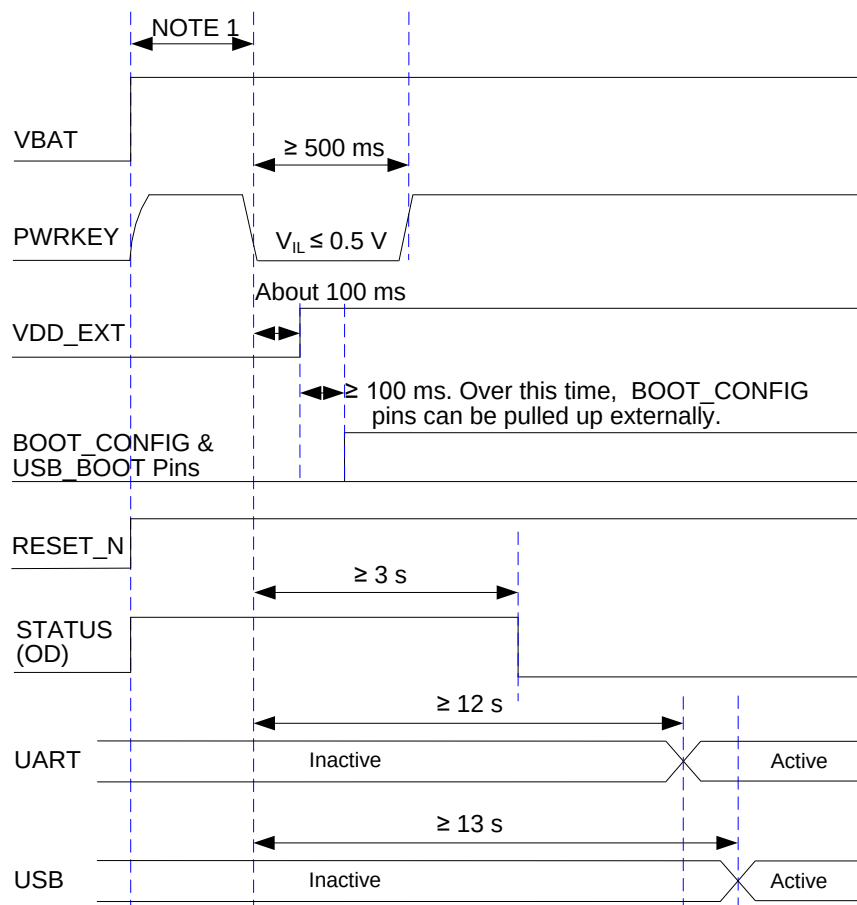
The other way to control the PWRKEY is using a button directly. When pressing the button, electrostatic strike may generate from finger. Therefore, a TVS component is indispensable to be placed nearby the

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.

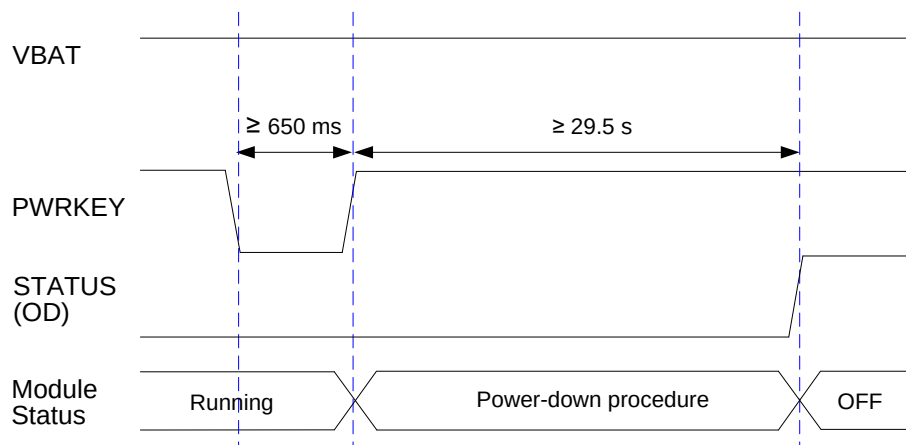
### 3.7.2. Turn off

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]**.

#### 3.7.2.1. 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**

### 3.7.2.2. 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 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.

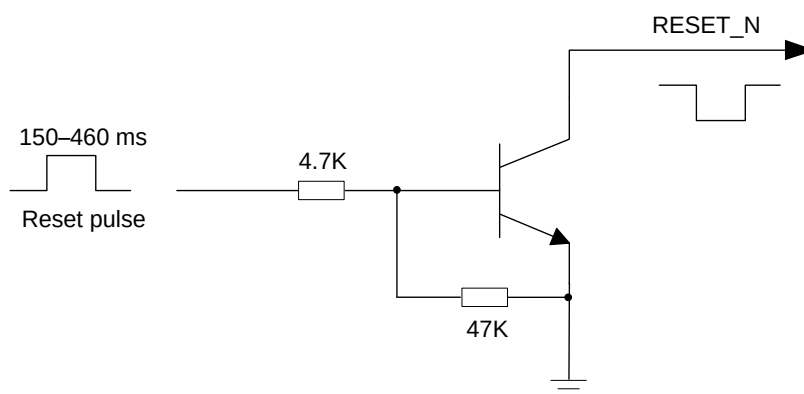
## 3.8. Reset Module

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.

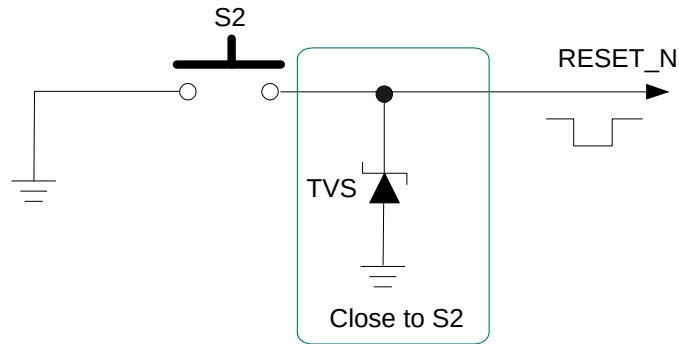
**Table 9: Pin Definition of RESET\_N**

| 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.

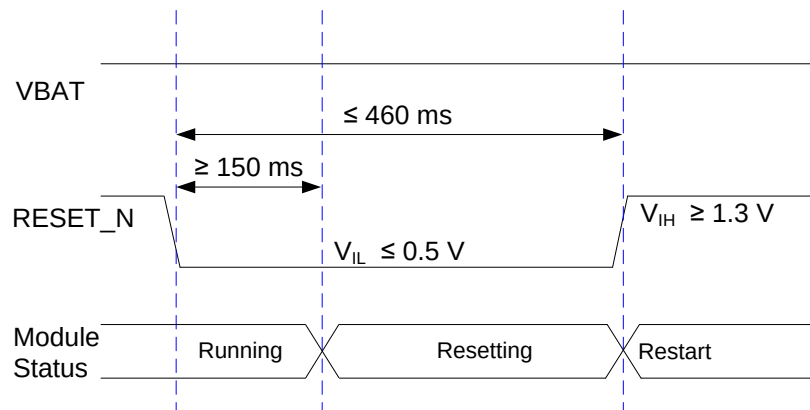


**Figure 14: Reference Circuit of RESET\_N by Using Driving Circuit**



**Figure 15: Reference Circuit of RESET\_N by Using a Button**

The reset scenario 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.

### 3.9. (U)SIM Interface

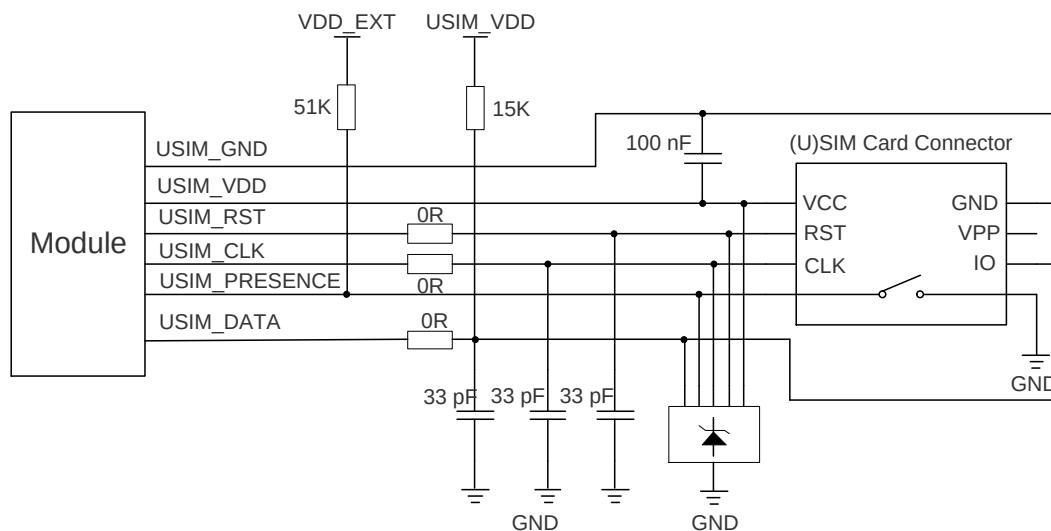
The (U)SIM interface circuitry meets ETSI and IMT-2000 requirements. Both 1.8 V and 3.0 V (U)SIM cards are supported.

**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.<br>If unused, keep it open.                 |
| USIM_GND      | 10      |     | Specified ground for (U)SIM card |                                                                 |

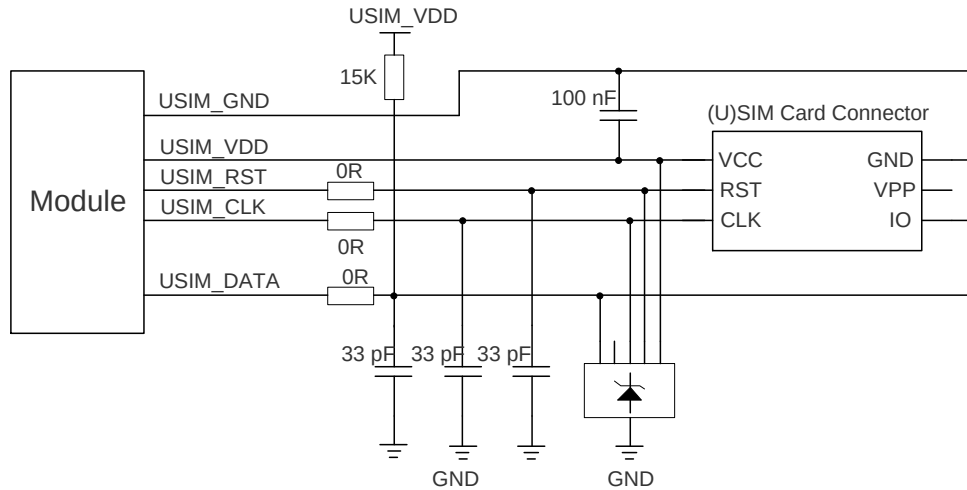
EC25 series supports (U)SIM card hot-plug via the USIM\_PRESENCE pin. The function supports low level and high level detections. By default, it is disabled, and can be configured via **AT+QSIMDET**. See **document [2]** for more details about the command.

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 VBAT traces.
- Make sure the bypass capacitor between USIM\_VDD and USIM\_GND less than 1  $\mu$ F, 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  $\Omega$  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.

### 3.10. 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.

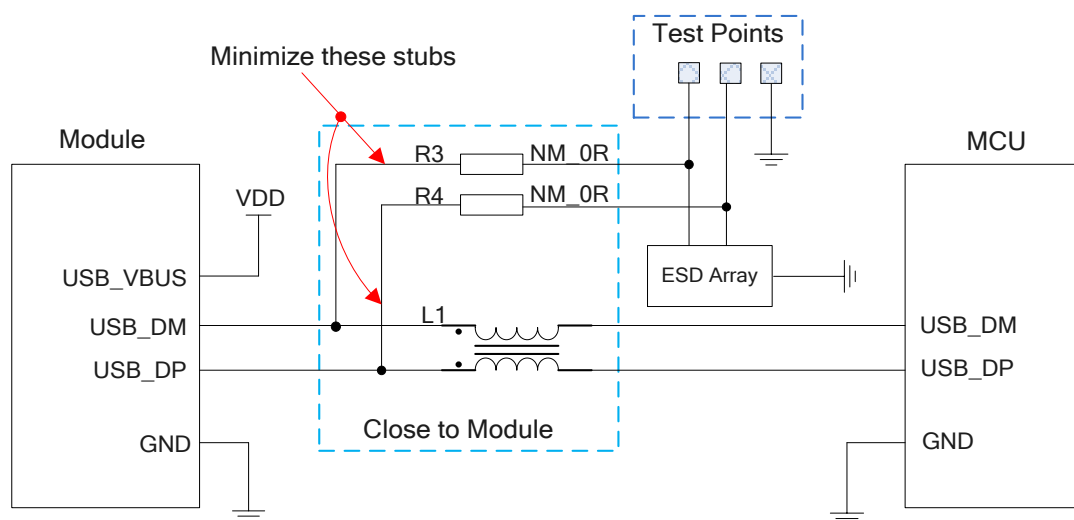
The following table shows the pin definition of USB interface.

**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.<br>Require differential impedance of 90 $\Omega$ . |
| USB_DM   | 70      | AIO | USB differential data (-) | If unused, keep them open.                                            |
| 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  $\Omega$  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  $\Omega$ .
- 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.

### 3.11. 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.

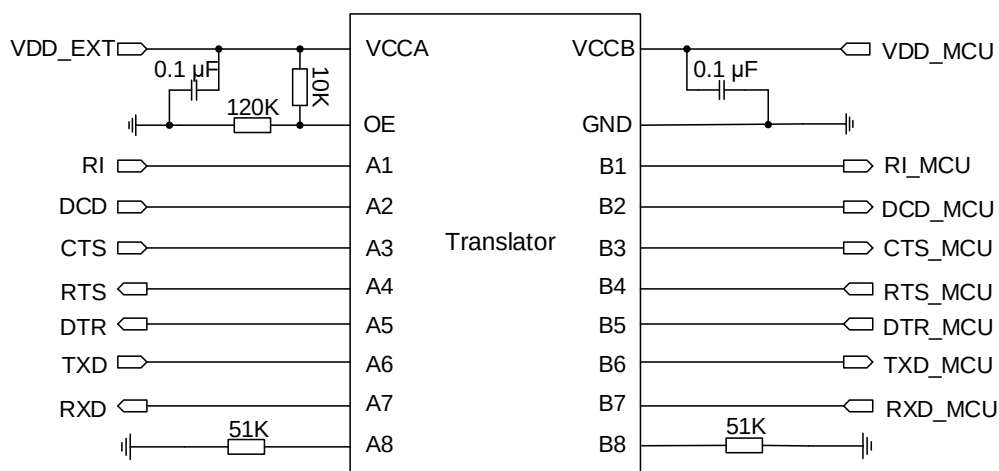
**Table 12: Pin Definition of Main UART Interface**

| 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<br>Connect to DTE's RTS. |
| RTS      | 65      | DI  | DTE request to send signal from DCE               | 1.8 V power domain<br>Connect to DTE's CTS. |
| DTR      | 66      | DI  | Main UART data terminal ready, sleep mode control | 1.8 V power domain                          |
| TXD      | 67      | DO  | Main UART transmit                                |                                             |
| 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<br>If unused, keep them open. |
| DBG_RXD  | 11      | DI  | Debug UART receive  |                                                  |

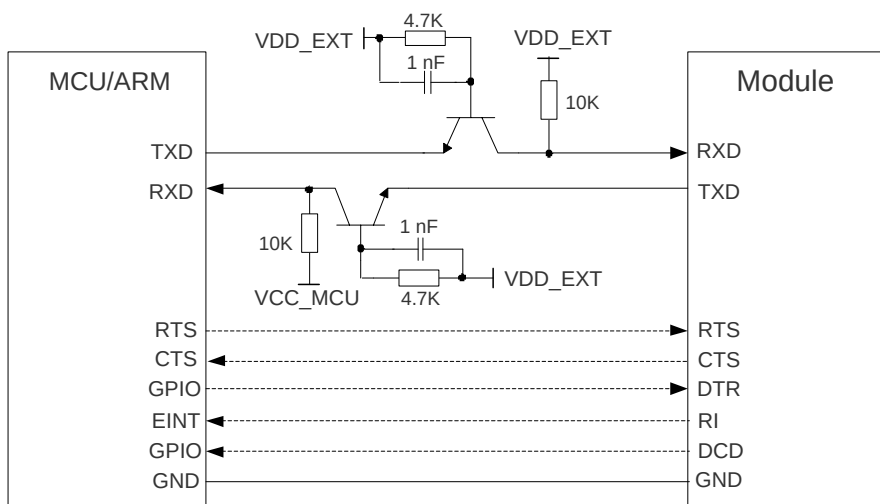
The module provides 1.8 V UART interface. A voltage-level translator should be used if your application is equipped with a 3.3 V UART interface. A voltage-level translator TXS0108EPWR provided by *Texas Instruments* is recommended. The following figure shows a reference design.



**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.

### 3.12. 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:

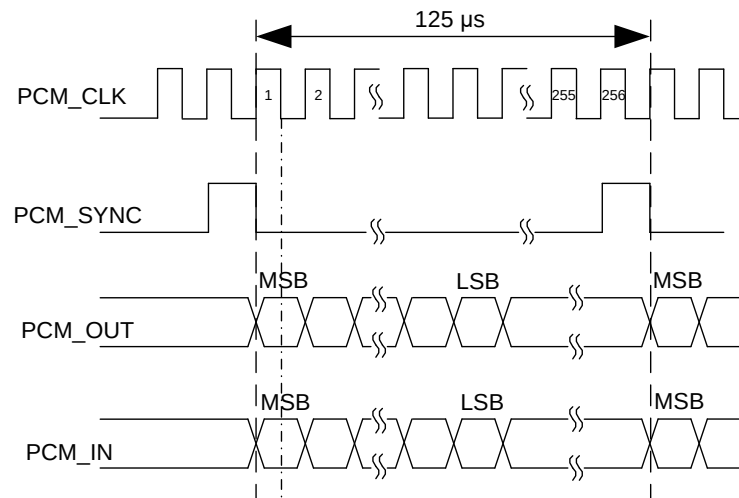
- Primary mode (short frame synchronization, works as both master and slave)
- Auxiliary mode (long frame synchronization, works as master only)

In primary 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.

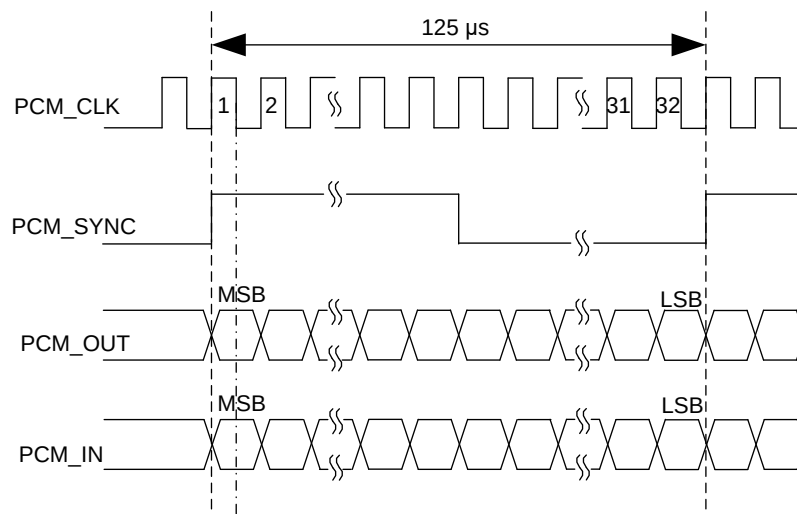
In auxiliary mode, the data is sampled on the falling edge of the PCM\_CLK and transmitted on the rising edge. The PCM\_SYNC rising edge represents the MSB. In this mode, the PCM interface operates with a 256 kHz, 512 kHz, 1024 kHz or 2048 kHz PCM\_CLK and an 8 kHz, 50% duty cycle PCM\_SYNC.

EC25 series supports 16-bit linear data format. The following figures show the primary mode's timing relationship with 8 kHz PCM\_SYNC and 2048 kHz PCM\_CLK, as well as the auxiliary mode's timing

relationship with 8 kHz PCM\_SYNC and 256 kHz PCM\_CLK.



**Figure 22: Primary Mode Timing**



**Figure 23: Auxiliary Mode Timing**

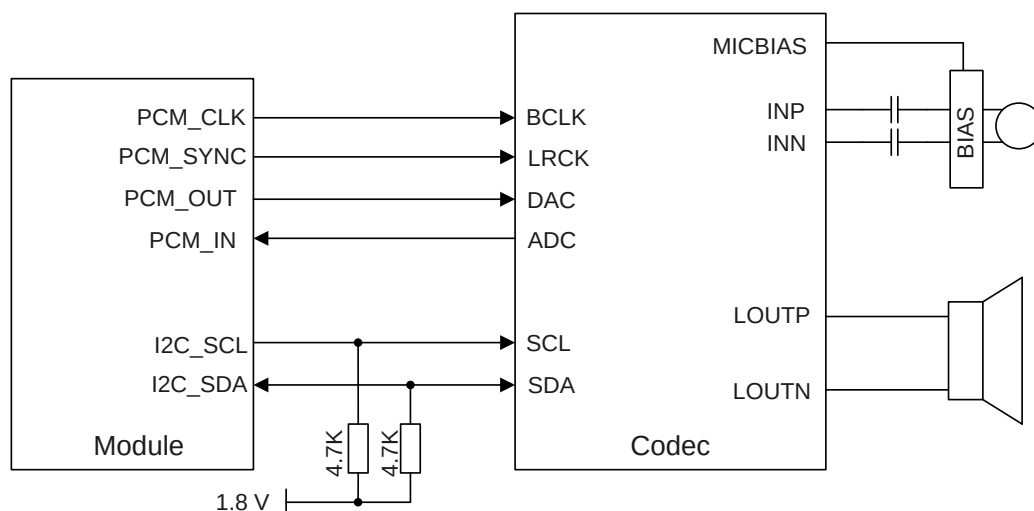
Clock and mode can be configured by AT command, and the default configuration is master mode using short frame synchronization format with 2048 kHz PCM\_CLK and 8 kHz PCM\_SYNC. See **document [2]** for more details about **AT+QDAI**.

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<br>If unused, keep them open.                                                                            |
| PCM_OUT  | 25      | DO  | PCM data output                          |                                                                                                                             |
| PCM_SYNC | 26      | DIO | PCM frame sync                           | 1.8 V power domain<br>Serve as output signal in master mode or<br>input signal in slave mode.<br>If unused, keep them open. |
| PCM_CLK  | 27      | DIO | PCM clock                                |                                                                                                                             |
| I2C_SCL  | 41      | OD  | I2C serial clock<br>(for external codec) | Require external pull-up to 1.8 V.<br>If unused, keep them open.                                                            |
| I2C_SDA  | 42      | OD  | I2C serial data<br>(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 ( $R = 22\ \Omega$ ,  $C = 22\ \text{pF}$ ) 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.

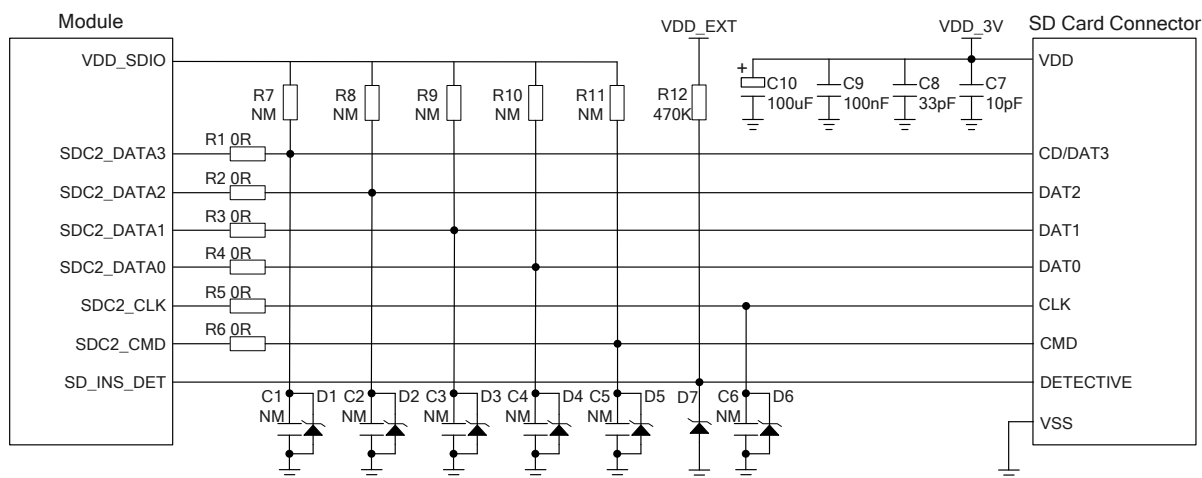
### 3.13. SD Card Interface

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     |                                                                                                                                               |
| SDC2_DATA2 | 29      | DIO | SD card SDIO data bit 2     | 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. |
| 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        | If unused, keep them open.                                                                                                                    |
| 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 k $\Omega$  and the recommended value is 100 k $\Omega$ . VDD\_SDIO should be used as the pull-up power.
- In order to adjust signal quality, it is recommended to add 0  $\Omega$  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  $\Omega$  ( $\pm 10\%$ ).
- 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.

### 3.14. WLAN and Bluetooth Applications 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 applications interfaces.

**Table 16: Pin Definition of WLAN and Bluetooth Applications**

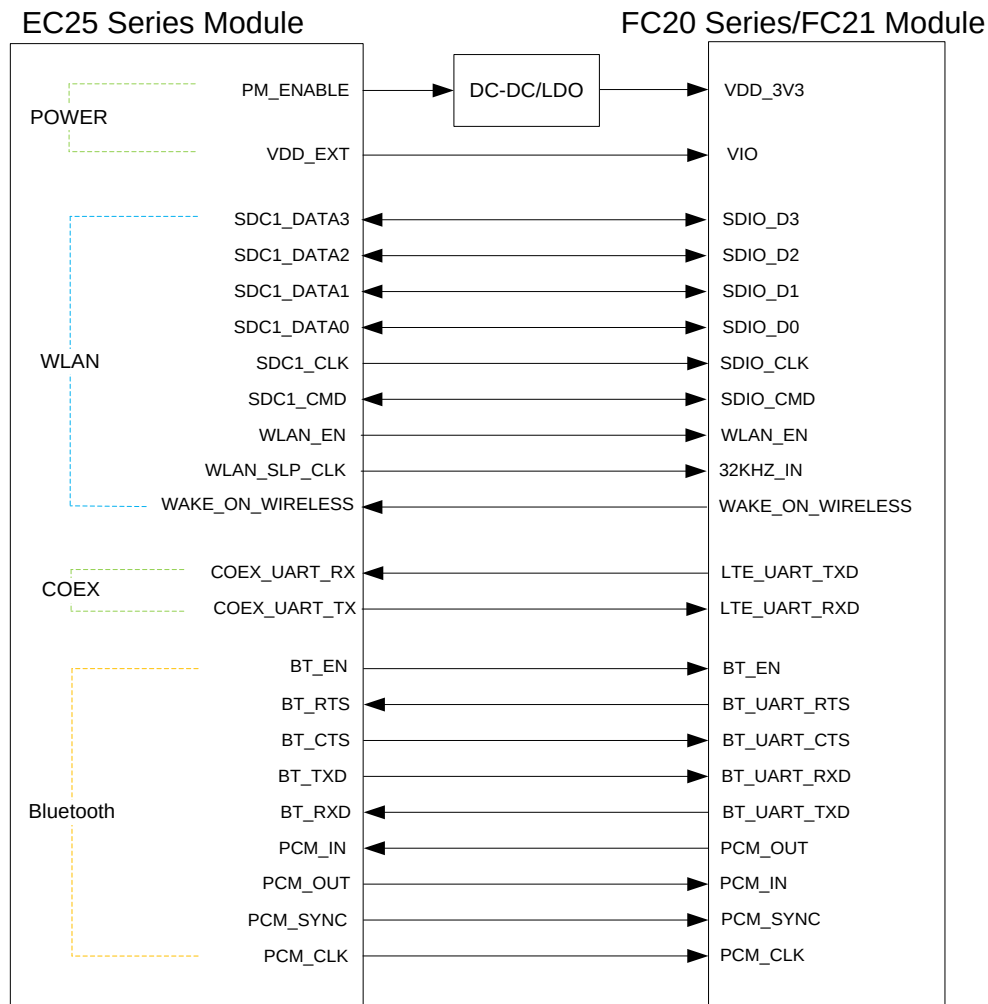
| Pin Name                          | Pin No. | I/O | Description          | Comment                                           |
|-----------------------------------|---------|-----|----------------------|---------------------------------------------------|
| <b>WLAN Application Interface</b> |         |     |                      |                                                   |
| SDC1_DATA3                        | 129     | DIO | WLAN SDIO data bit 3 | 1.8 V power domain.<br>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.<br>Active high.<br>Cannot be pulled up before startup.<br>If unused, keep it open.          |
| <b>Coexistence and Control Interface</b> |     |     |                                           |                                                                                                                 |
| PM_ENABLE                                | 127 | DO  | WLAN power control                        | 1.8 V power domain<br>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.<br>Cannot be pulled up before startup.<br>If unused, keep it open.                          |
| COEX_UART_TX                             | 138 | DO  | LTE/WLAN & Bluetooth coexistence transmit | 1.8 V power domain.<br>Cannot be pulled up before startup.<br>If unused, keep it open.                          |
| WLAN_SLP_CLK                             | 118 | DO  | WLAN sleep clock                          |                                                                                                                 |
| <b>Bluetooth Application Interface</b>   |     |     |                                           |                                                                                                                 |
| BT_RTS                                   | 37  | DI  | DTE request to send signal from DCE       | 1.8 V power domain.<br>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.<br>Cannot be pulled up before startup.<br>Connect to DTE's CTS.<br>If unused, keep it open. |
| PCM_IN <sup>7</sup>                      | 24  | DI  | PCM data input                            | 1.8 V power domain.                                                                                             |
| PCM_OUT <sup>7</sup>                     | 25  | DO  | PCM data output                           | 1.8 V power domain.                                                                                             |
| PCM_SYNC <sup>7</sup>                    | 26  | DIO | PCM frame sync                            | 1.8 V power domain.                                                                                             |
| PCM_CLK <sup>7</sup>                     | 27  | DIO | PCM clock                                 | 1.8 V power domain                                                                                              |

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

|       |     |    |                           |                                     |
|-------|-----|----|---------------------------|-------------------------------------|
| BT_EN | 139 | DO | Bluetooth function enable | 1.8 V power domain.<br>Active high. |
|-------|-----|----|---------------------------|-------------------------------------|

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 Applications 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]**.

### 3.14.1. 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  $50\ \Omega \pm 10\%$ .
- 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  $\Omega$  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.

### 3.14.2. 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 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.

### 3.15. 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.

### 3.16. 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:

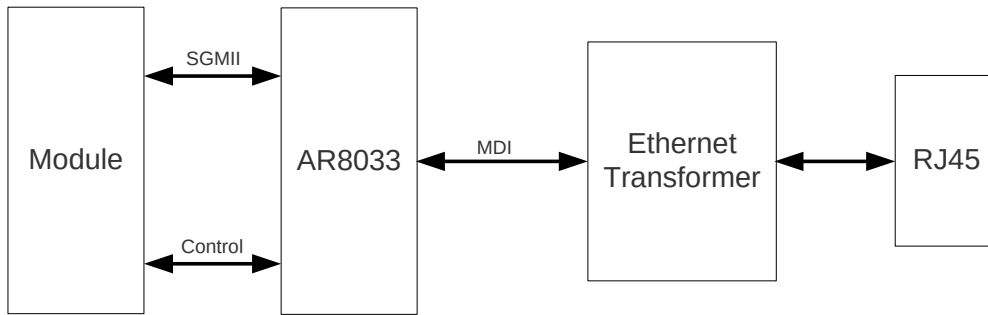
- IEEE802.3 compliant
- Support 10 Mbps/100 Mbps/1000 Mbps Ethernet work mode
- Support maximum 150 Mbps (DL)/50 Mbps (UL) for 4G network
- Support VLAN tagging
- Support IEEE1588 and Precision Time Protocol (PTP)
- Can be used to connect to external Ethernet PHY like AR8033, or to an external switch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

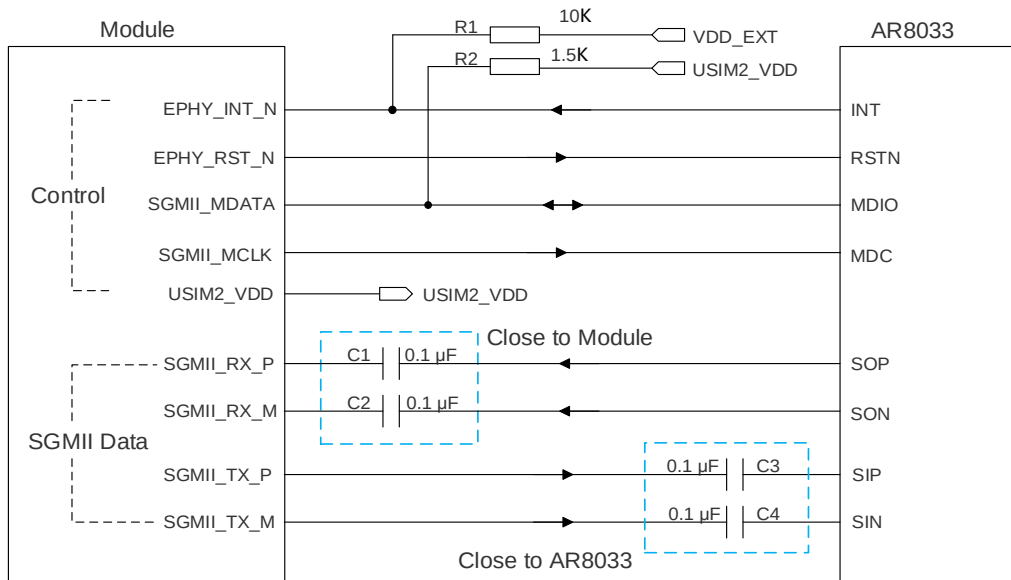
| Pin Name              | Pin No. | I/O | Description                      | Comment                                                                                                               |
|-----------------------|---------|-----|----------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| <b>Control Signal</b> |         |     |                                  |                                                                                                                       |
| 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 MDIO data                  | 1.8/2.85 V power domain.                                                                                              |
| SGMII_MCLK            | 122     | DO  | SGMII MDIO clock                 | 1.8/2.85 V power domain.                                                                                              |
| USIM2_VDD             | 128     | PO  | SGMII_MDATA pull-up power supply | Configurable power supply.<br>1.8/2.85 V power domain.                                                                |
| <b>SGMII Signal</b>   |         |     |                                  |                                                                                                                       |
| SGMII_TX_M            | 123     | AO  | SGMII transmit (-)               | Connect this pin with a 0.1 $\mu$ F capacitor, and the capacitor close to the PHY side.<br>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 $\mu$ F capacitor, and the capacitor close to the module.<br>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  $100\ \Omega \pm 10\%$ , 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.

## 3.17. Indication Signals

### 3.17.1. 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.

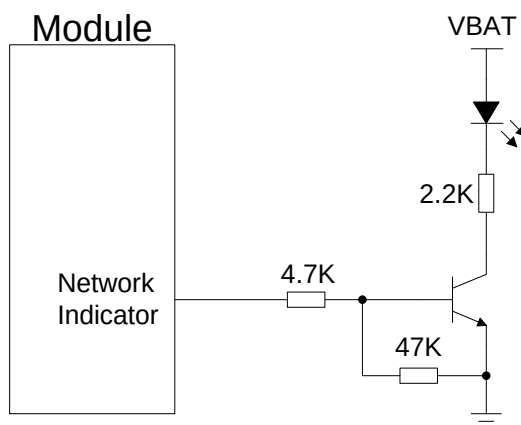
**Table 20: Pin Definition of Network Connection Status/Activity Indicator**

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

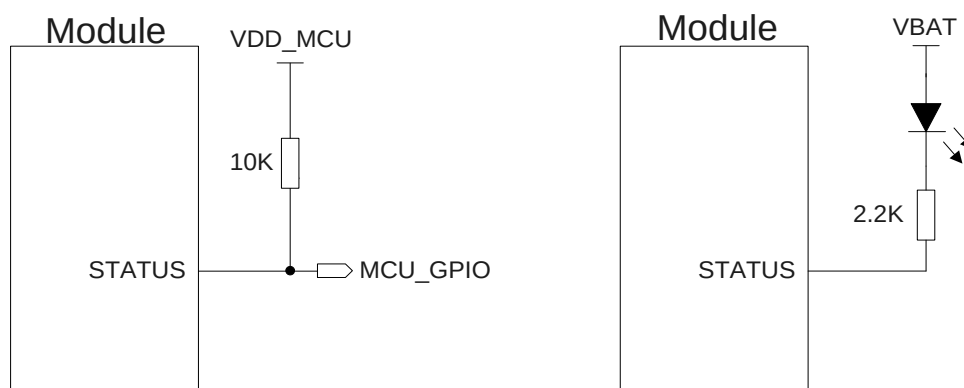
### 3.17.2. STATUS

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.

### 3.17.3. RI

**AT+QCFG="risignalttype","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 [2]* 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.

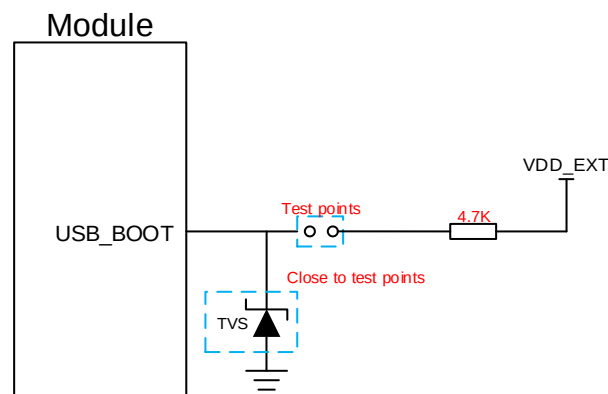
## 3.18. USB\_BOOT Interface

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.

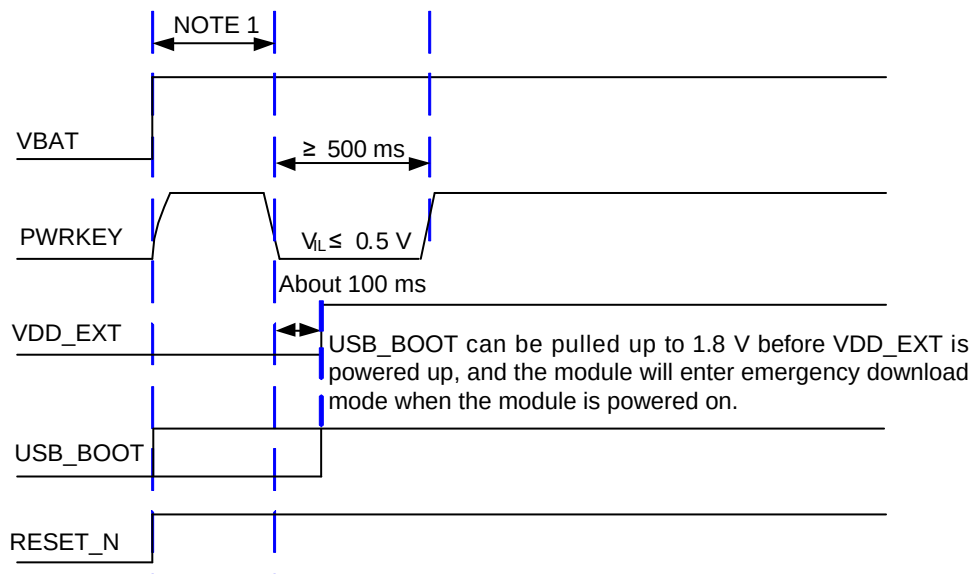
**Table 24: Pin Definition of USB\_BOOT Interface**

| 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.<br>Active high.<br>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  $\Omega$ .

### 4.1. Cellular 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 $\Omega$ impedance                              |
| ANT_DIV  | 35      | AI  | Diversity antenna interface | 50 $\Omega$ impedance.<br>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 $\pm$ 2 dB | 5 dBm $\pm$ 5 dB |
| DCS1800/PCS1900         | 30 dBm $\pm$ 2 dB | 0 dBm $\pm$ 5 dB |
| GSM850/EGSM900 (8-PSK)  | 27 dBm $\pm$ 3 dB | 5 dBm $\pm$ 5 dB |
| DCS1800/PCS1900 (8-PSK) | 26 dBm $\pm$ 3 dB | 0 dBm $\pm$ 5 dB |
| WCDMA bands             | 24 dBm + 1/-3 dB  | < -49 dBm        |
| LTE-FDD bands           | 23 dBm $\pm$ 2 dB | < -39 dBm        |
| LTE-TDD bands           | 23 dBm $\pm$ 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.

**Table 28: EC25-E Conducted Rx Sensitivity**

| Frequency Bands | Primary    | Diversity | SIMO <sup>8</sup> | 3GPP (SIMO) |
|-----------------|------------|-----------|-------------------|-------------|
| EGSM900         | -109.0 dBm | -         | -                 | -102.0 dBm  |

<sup>8</sup> 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.

|                      |            |           |            |            |
|----------------------|------------|-----------|------------|------------|
| 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  |

**Table 29: EC25-A Conducted Rx Sensitivity**

| Frequency Bands      | Primary    | Diversity | SIMO <sup>8</sup> | 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   |

Table 30: EC25-V Conducted Rx Sensitivity

| Frequency Bands      | Primary   | Diversity | SIMO <sup>8</sup> | 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   |

Table 31: EC25-J Conducted Rx Sensitivity

| Frequency Bands      | Primary    | Diversity  | SIMO <sup>8</sup> | 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   |

Table 32: EC25-AU Conducted Rx Sensitivity

| Frequency Bands | Primary    | Diversity | SIMO <sup>8</sup> | 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  |

**Table 33: EC25-AUX Conducted Rx Sensitivity**

| Frequency Bands | Primary    | Diversity  | SIMO <sup>8</sup> | 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 |

**Table 34: EC25-AF Conducted Rx Sensitivity**

| Frequency Bands      | Primary    | Diversity | SIMO <sup>8</sup> | 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   |

Table 35: EC25-AFX Conducted Rx Sensitivity

| Frequency Bands      | Primary    | Diversity | SIMO <sup>8</sup> | 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   |

Table 36: EC25-AFXD Conducted Rx Sensitivity

| Frequency Bands      | Primary    | Diversity | SIMO <sup>8</sup> | 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 |

**Table 37: EC25-EU Conducted Rx Sensitivity**

| Frequency Bands       | Primary    | Diversity  | SIMO <sup>8</sup> | 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   |

**Table 38: EC25-EUX Conducted Rx Sensitivity**

| Frequency Bands | Primary    | Diversity  | SIMO <sup>8</sup> | 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  |

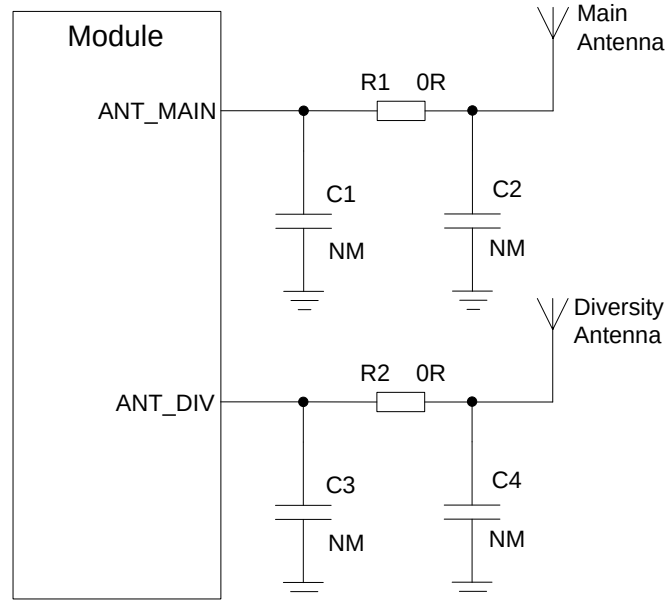
|                       |           |           |            |           |
|-----------------------|-----------|-----------|------------|-----------|
| LTE-FDD B1 (10 MHz)   | -98.0 dBm | -98.0 dBm | -101 dBm   | -96.3 dBm |
| LTE-FDD B3 (10 MHz)   | -96.5 dBm | -98.5 dBm | -99.5 dBm  | -93.3 dBm |
| LTE-FDD B7 (10 MHz)   | -97.0 dBm | -94.5 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 |

**Table 39: EC25-MX Conducted Rx Sensitivity**

| Frequency Bands      | Primary    | Diversity  | SIMO <sup>8</sup> | 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   |

### 4.1.5. Reference Design

A reference design of ANT\_MAIN and ANT\_DIV antenna pins is shown as below. A  $\pi$ -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  $\pi$ -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) includes a fully integrated global navigation satellite system solution that supports GPS, GLONASS, BeiDou, 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 $\Omega$ impedance.<br>If unused, keep it open. |

**Table 41: GNSS Frequency**

| Type    | Frequency            | Unit |
|---------|----------------------|------|
| GPS     | 1575.42 $\pm$ 1.023  | MHz  |
| GLONASS | 1597.5–1605.8        | MHz  |
| Galileo | 1575.42 $\pm$ 2.046  | MHz  |
| BDs     | 1561.098 $\pm$ 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) | Cold start            | Autonomous   | -146 | dBm  |
|                    | Reacquisition         | Autonomous   | -157 | dBm  |
|                    | Tracking              | Autonomous   | -157 | dBm  |
| TTFF(GNSS)         | Cold start @ open sky | Autonomous   | 35   | s    |
|                    |                       | XTRA enabled | 18   | s    |

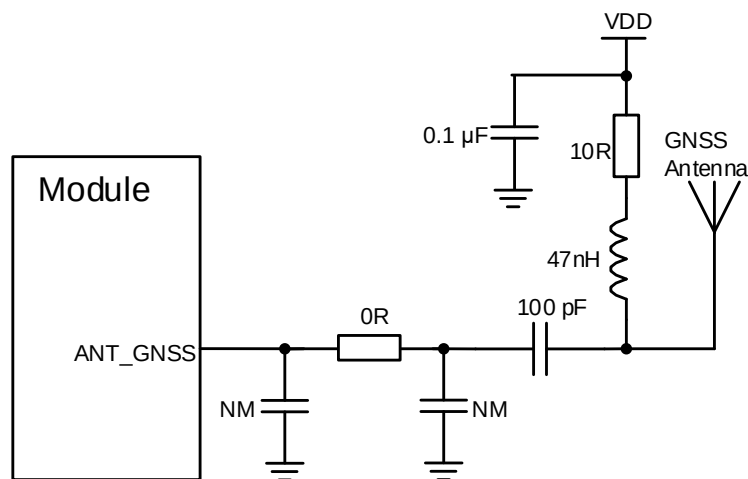
|                 |                       |                       |     |   |
|-----------------|-----------------------|-----------------------|-----|---|
|                 | Warm start @ open sky | Autonomous            | 26  | s |
|                 |                       | XTRA enabled          | 2.2 | s |
|                 |                       | 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. Cold start 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  $\Omega$  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  $\Omega$ . The impedance of the RF traces is usually determined by the trace width (W), the materials' dielectric constant, the height from the reference ground to the signal layer (H), and the spacing between RF traces and grounds (S). Microstrip or coplanar waveguide is typically used in RF layout to control characteristic impedance. The following are reference designs of microstrip or coplanar waveguide with different PCB structures.

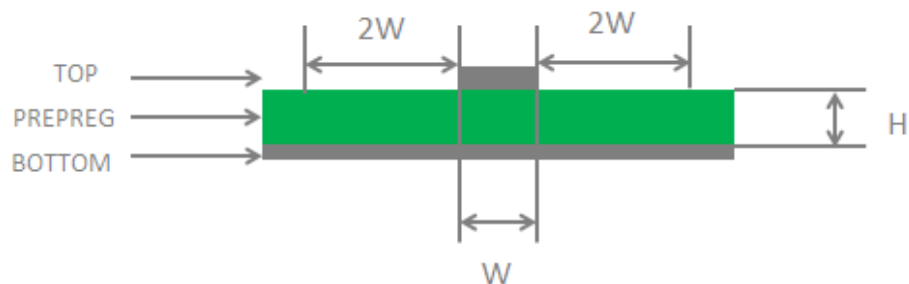


Figure 35: Microstrip Design on a 2-layer PCB

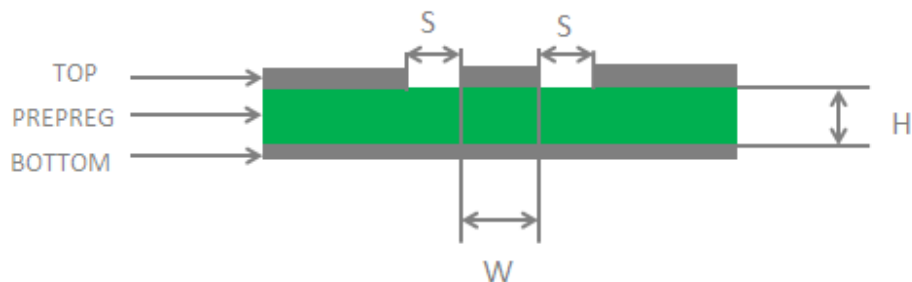
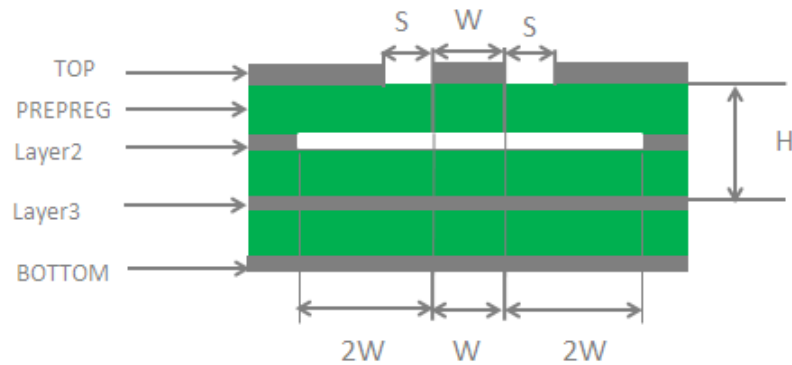
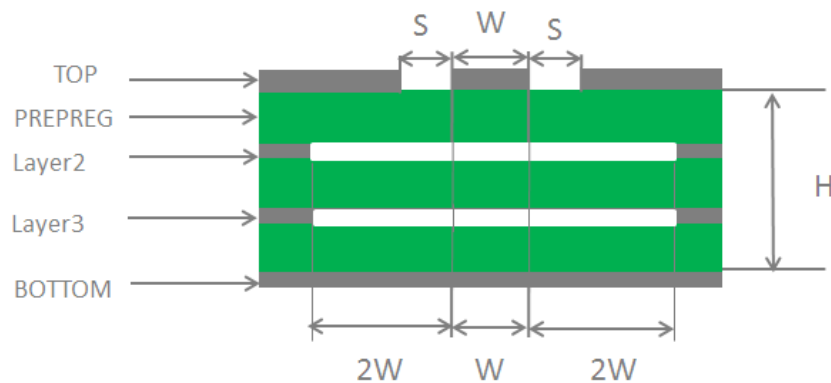


Figure 36: Coplanar Waveguide Design on a 2-layer PCB



**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  $\Omega$ .
- The GND pins adjacent to RF pins should not be designed as thermal relief pads, and should be fully connected to ground.
- The distance between the RF pins and the RF connector should be as short as possible and all the right-angle traces should be changed to curved ones. The recommended trace angle is 135°.
- 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 ( $2 \times W$ ).
- Keep RF traces away from interference sources, and avoid intersection and paralleling between traces on adjacent layers.

For more details about RF layout, see **document [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**

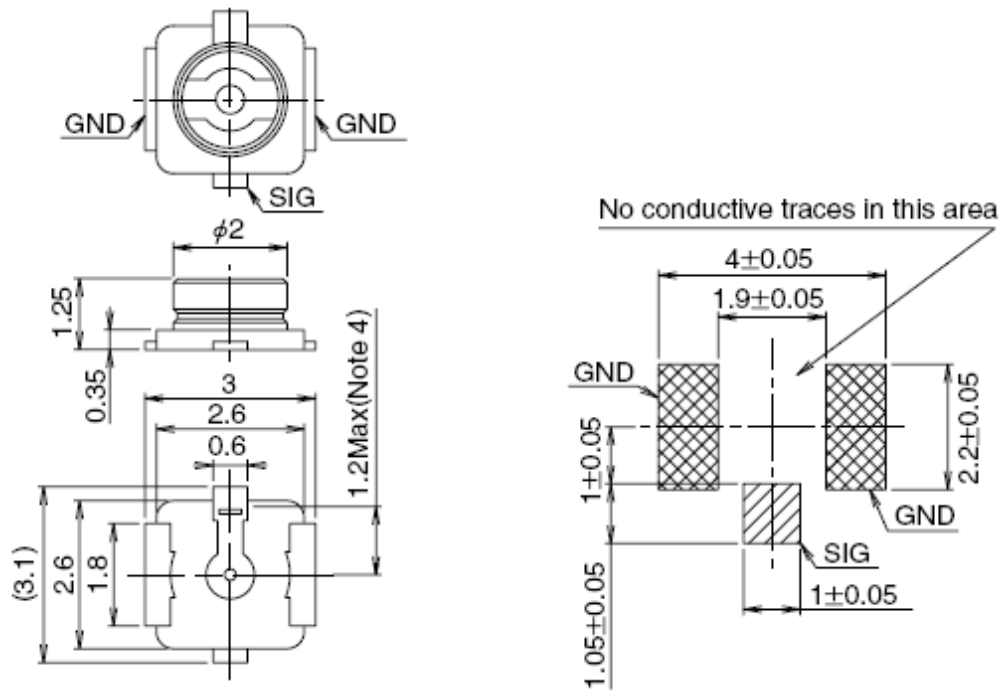
| Type          | Requirements                                                                                                                                                                                                                              |
|---------------|---------------------------------------------------------------------------------------------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

U.FL-LP serial 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.<br>(2.4mm Nom.)   | 2.5mm Max.<br>(2.4mm Nom.)                      | 2.0mm Max.<br>(1.9mm Nom.)   | 2.4mm Max.<br>(2.3mm Nom.) | 2.4mm Max.<br>(2.3mm Nom.)   |
| Applicable cable | Dia. 0.81mm<br>Coaxial cable | Dia. 1.13mm and<br>Dia. 1.32mm<br>Coaxial cable | Dia. 0.81mm<br>Coaxial cable | Dia. 1mm<br>Coaxial cable  | Dia. 1.37mm<br>Coaxial cable |
| Weight (mg)      | 53.7                         | 59.1                                            | 34.8                         | 45.5                       | 71.7                         |
| RoHS             | YES                          |                                                 |                              |                            |                              |

**Figure 40: Mechanicals of U.FL-LP Connectors**

The following figure describes the space factor of mated connector.

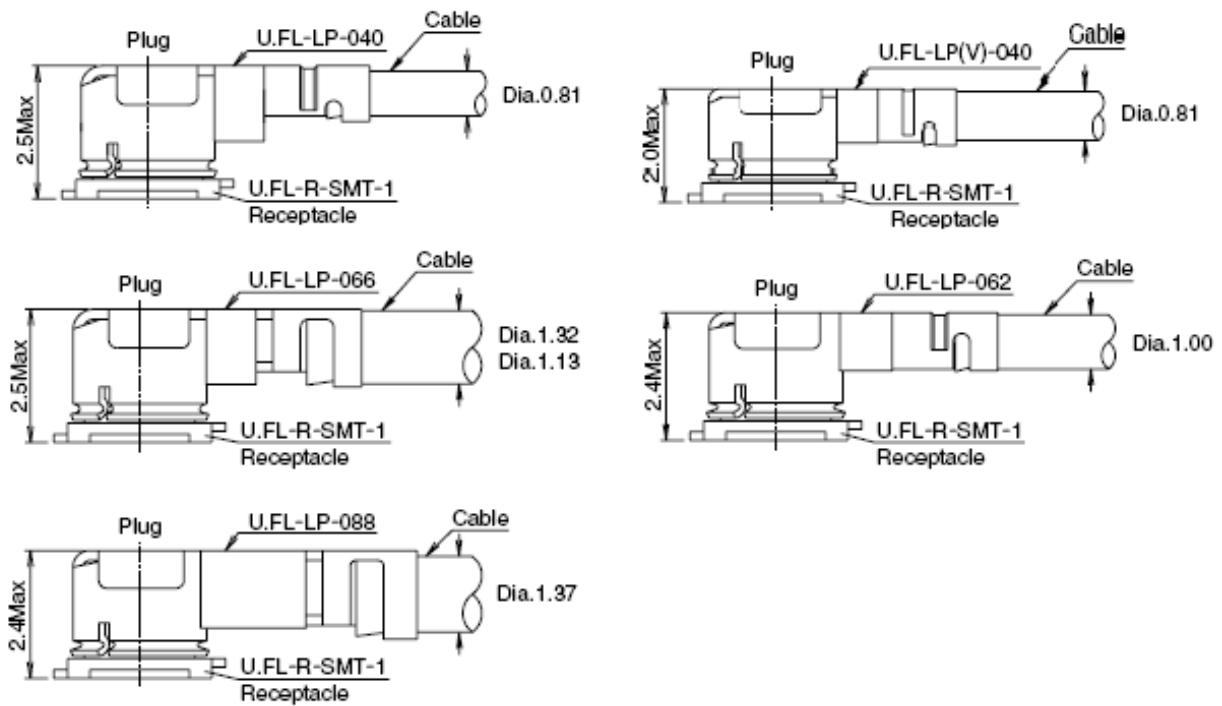


Figure 41: Space Factor of Mated Connector (Unit: mm)

For more details, please 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 <sub>VBAT</sub> | 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 <sup>9</sup> | -35  | +25  | +75  | °C   |
| Extended Temperature Range <sup>10</sup> | -40  | -    | +85  | °C   |
| Storage Temperature Range                | -40  | -    | +90  | °C   |

<sup>9</sup> Within the operating temperature range, the module meets 3GPP specifications.

<sup>10</sup> 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<sub>out</sub>, 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.

**Table 47: EC25-E Power Consumption**

| Description | Conditions                          | Typ.  | Unit |
|-------------|-------------------------------------|-------|------|
| OFF state   | Power down                          | 11    | μA   |
| Sleep state | <b>AT+CFUN=0</b> (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   |
|             | 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   |
| Idle state  | LTE-TDD PF = 64 (USB disconnected)  | 20.8  | mA   |
|             | LTE-TDD PF = 64 (USB connected)     | 32.0  | mA   |
|             | GPRS data transfer (GNSS OFF)       | 271.0 | mA   |
|             | EGSM900 4DL/1UL @ 33.22 dBm         | 271.0 | mA   |
|             | 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<br>(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<br>(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<br>(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 |

Table 48: EC25-A Power Consumption

| Description                       | Conditions                          | Typ.  | Unit |
|-----------------------------------|-------------------------------------|-------|------|
| OFF state                         | Power down                          | 10    | μA   |
| Sleep state                       | <b>AT+CFUN=0</b> (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   |
|                                   | WCDMA PF = 64 (USB connected)       | 31.0  | mA   |
| Idle state                        | 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 B2 HSDPA @ 21.9 dBm           | 591.0 | mA   |
| WCDMA data transfer<br>(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<br>(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 |

Table 49: EC25-V Power Consumption

| Description                     | Conditions                          | Typ.  | Unit |
|---------------------------------|-------------------------------------|-------|------|
| OFF state                       | Power down                          | 10    | μA   |
| Sleep state                     | <b>AT+CFUN=0</b> (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<br>(GNSS OFF) | LTE-FDD B4 @ 23.14 dBm              | 770.0 | mA   |
|                                 | LTE-FDD B13 @ 23.48 dBm             | 531.0 | mA   |

Table 50: EC25-J Power Consumption

| Description | Conditions                          | Typ. | Unit |
|-------------|-------------------------------------|------|------|
| OFF state   | Power down                          | 10   | μA   |
| Sleep state | <b>AT+CFUN=0</b> (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<br>(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<br>(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 |

|                  |                         |       |    |
|------------------|-------------------------|-------|----|
| WCDMA voice call | LTE-FDD B26 @ 22.87 dBm | 689.0 | mA |
|                  | LTE-TDD B41 @ 22.52 dBm | 438.0 | mA |
|                  | WCDMA B1 @ 23.33 dBm    | 604.0 | mA |
|                  | WCDMA B6 @ 23.28 dBm    | 548.0 | mA |
|                  | WCDMA B19 @ 23.2 dBm    | 570.0 | mA |
|                  | WCDMA B19 @ 23.28 dBm   | 548.0 | mA |
|                  |                         |       |    |
|                  |                         |       |    |

Table 51: EC25-AU Power Consumption

| Description | Conditions                          | Typ. | Unit |
|-------------|-------------------------------------|------|------|
| OFF state   | Power down                          | 11   | μA   |
| Sleep state | <b>AT+CFUN=0</b>                    | 1.3  | mA   |
|             | <b>AT+CFUN=0</b> (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<br>(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<br>(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<br>(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<br>(GNSS OFF)   | LTE-FDD B1 @ 23.28 dBm      | 817.0 | mA |
|                                   | 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 |

Table 52: EC25-AUX Power Consumption

| Description | Conditions                          | Typ. | Unit |
|-------------|-------------------------------------|------|------|
| OFF state   | Power down                          | 9    | μA   |
| Sleep state | <b>AT+CFUN=0</b> (USB disconnected) | 0.9  | mA   |
|             | GSM 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<br>(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<br>(GNSS OFF) | GSM850 4DL/1UL @ 26.94 dBm      | 177.5 | mA |
|                                  | 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<br>(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 |
| LTE data transfer<br>(GNSS OFF)   | WCDMA B8 HSDPA @ 22.46 dBm  | 545.5 | mA |
|                                   | WCDMA B8 HSUPA @ 21.89 dBm  | 541.1 | mA |
|                                   | 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 |

Table 53: EC25-AF Power Consumption

| Description         | Conditions                          | Typ.  | Unit |
|---------------------|-------------------------------------|-------|------|
| OFF state           | Power down                          | 10    | μA   |
| Sleep state         | <b>AT+CFUN=0</b> (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 | WCDMA B2 HSDPA @ 22.63 dBm          | 560.0 | mA   |

|                                 |                            |       |    |
|---------------------------------|----------------------------|-------|----|
| (GNSS OFF)                      | 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<br>(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 |
| WCDMA voice call                | LTE-FDD B71 @ 23.39 dBm    | 689.0 | mA |
|                                 | WCDMA B2 @ 23.59 dBm       | 585.0 | mA |
|                                 | WCDMA B4 @ 23.47 dBm       | 610.0 | mA |
|                                 | WCDMA B5 @ 23.46 dBm       | 605.0 | mA |

**Table 54: EC25-AFX Power Consumption**

| Description | Conditions                          | Typ. | Unit |
|-------------|-------------------------------------|------|------|
| OFF state   | Power down                          | 8    | μA   |
| Sleep state | <b>AT+CFUN=0</b> (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<br>(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<br>(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 |

Table 55: EC25-AFXD Power Consumption

| Description                       | Conditions                          | Typ.  | Unit |
|-----------------------------------|-------------------------------------|-------|------|
| OFF state                         | Power down                          | 8     | μA   |
| Sleep state                       | <b>AT+CFUN=0</b> (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   |
|                                   | WCDMA PF = 64 (USB disconnected)    | 14.9  | mA   |
| Idle state                        | 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 B2 HSDPA @ 22.1 dBm           | 548.0 | mA   |
| WCDMA data transfer<br>(GNSS OFF) | 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-FDD B2 @ 23.36 dBm              | 621.0 | mA   |
| LTE data transfer<br>(GNSS OFF)   | 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 |

Table 56: EC25-EU Power Consumption

| Description | Conditions                          | Typ. | Unit |
|-------------|-------------------------------------|------|------|
| OFF state   | Power down                          | 11   | μA   |
| Sleep state | <b>AT+CFUN=0</b> (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   |
|             | 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<br>(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<br>(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 |
| WCDMA data transfer<br>(GNSS OFF) | DCS1800 1DL/4UL PCL = 2 @ 21.24 dBm | 379.0 | mA |
|                                   | 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<br>(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 |

Table 57: EC25-EUX Power Consumption

| Description | Conditions                          | Typ. | Unit |
|-------------|-------------------------------------|------|------|
| OFF state   | Power down                          | 9    | μA   |
| Sleep state | <b>AT+CFUN=0</b> (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   |
|             | EGSM900 DRX = 5 (USB disconnected)  | 14.5 | mA   |
| Idle state  | 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<br>(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 |
| EDGE data transfer<br>(GNSS OFF)  | DCS1800 1DL/4UL @ 26.44 dBm         | 377.7 | mA |
|                                   | 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 |
| WCDMA data transfer<br>(GNSS OFF) | DCS1800 2DL/3UL PCL = 2 @ 23.14 dBm | 301.2 | mA |
|                                   | DCS1800 1DL/4UL PCL = 2 @ 22.60 dBm | 391.8 | mA |
|                                   | 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<br>(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 |

Table 58: EC25-MX Power Consumption

| Description | Conditions                          | Typ. | Unit |
|-------------|-------------------------------------|------|------|
| OFF state   | Power down                          | 19   | μA   |
| Sleep state | <b>AT+CFUN=0</b> (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   |
|             | WCDMA PF = 64 (USB disconnected)    | 12.9 | mA   |
| Idle state  | 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<br>(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<br>(GNSS OFF)   | LTE-FDD B2 @ 23.2 dBm           | 685.0 | mA |
|                                   | 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 |

Table 59: GNSS Power Consumption of EC25 Series Module

| Description              | Conditions                   | Typ. | Unit |
|--------------------------|------------------------------|------|------|
| Searching<br>(AT+CFUN=0) | Cold start @ Passive Antenna | 54.0 | mA   |
|                          | Lost state @ Passive Antenna | 53.9 | mA   |
| Tracking<br>(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

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

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

**Table 60: Electrostatics Discharge Characteristics (Temperature: 25 °C, Humidity: 45 %)**

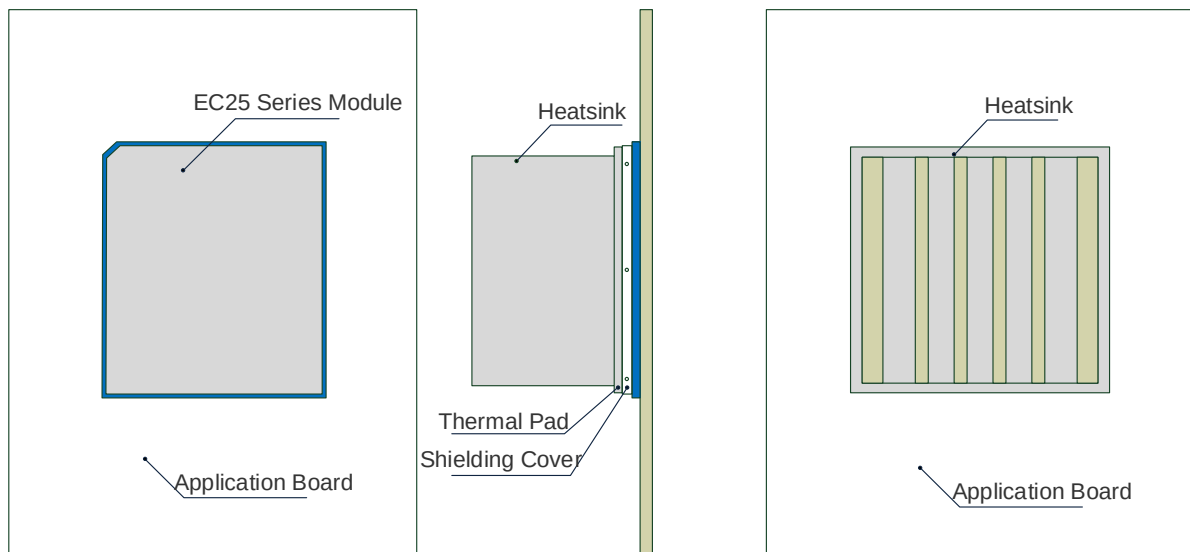
| Tested Interfaces      | Contact Discharge | Air Discharge | Unit |
|------------------------|-------------------|---------------|------|
| VBAT, GND              | ±5                | ±10           | kV   |
| All Antenna Interfaces | ±4                | ±8            | kV   |
| Other Interfaces  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

## 5.6. Thermal Dissipation

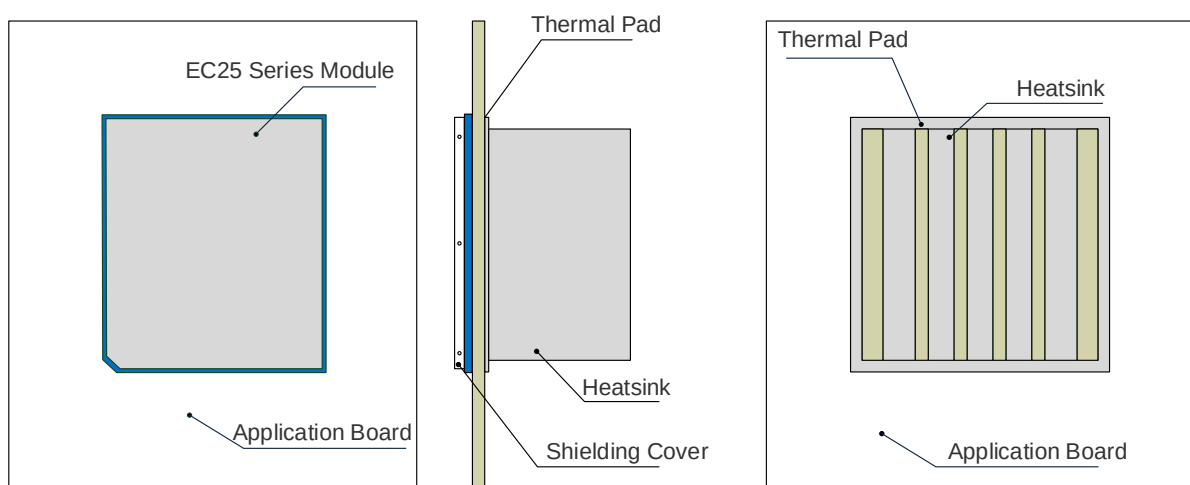
In order to achieve better performance of the module, it is recommended to comply with the following principles for thermal consideration:

- 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  $\pm 0.2$  mm unless otherwise specified.

## 6.1. Mechanical Dimensions

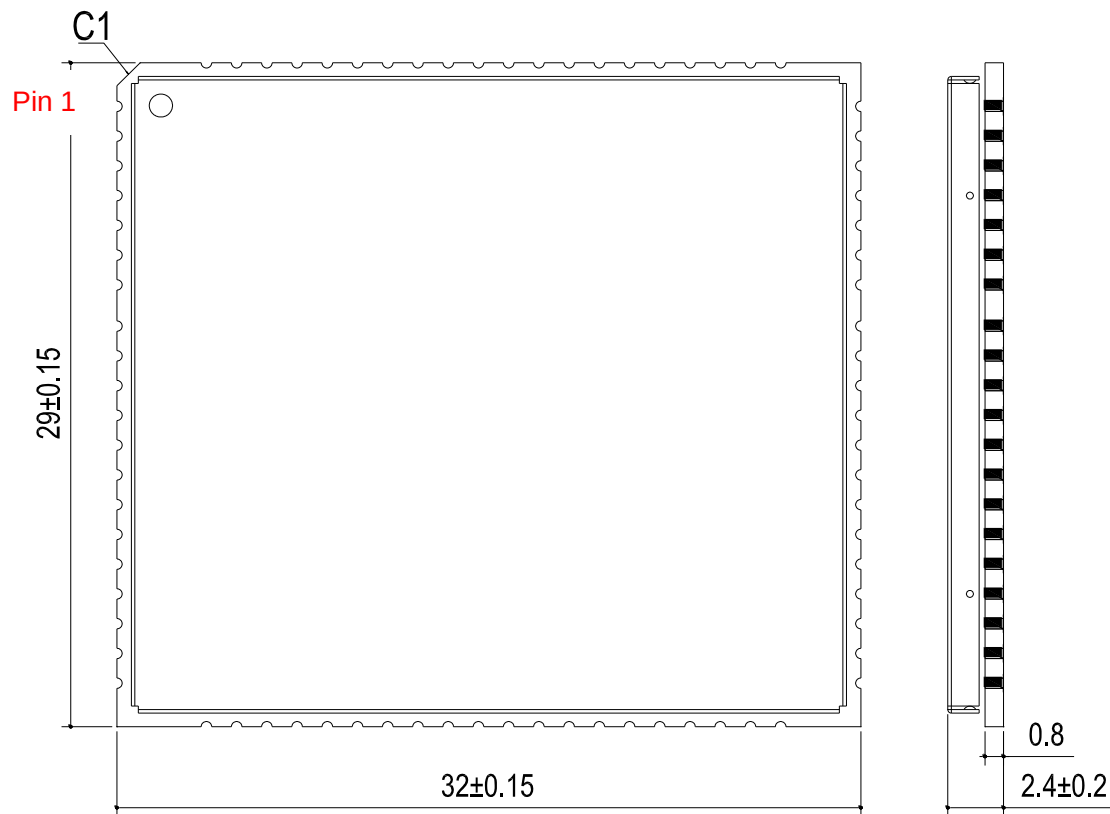
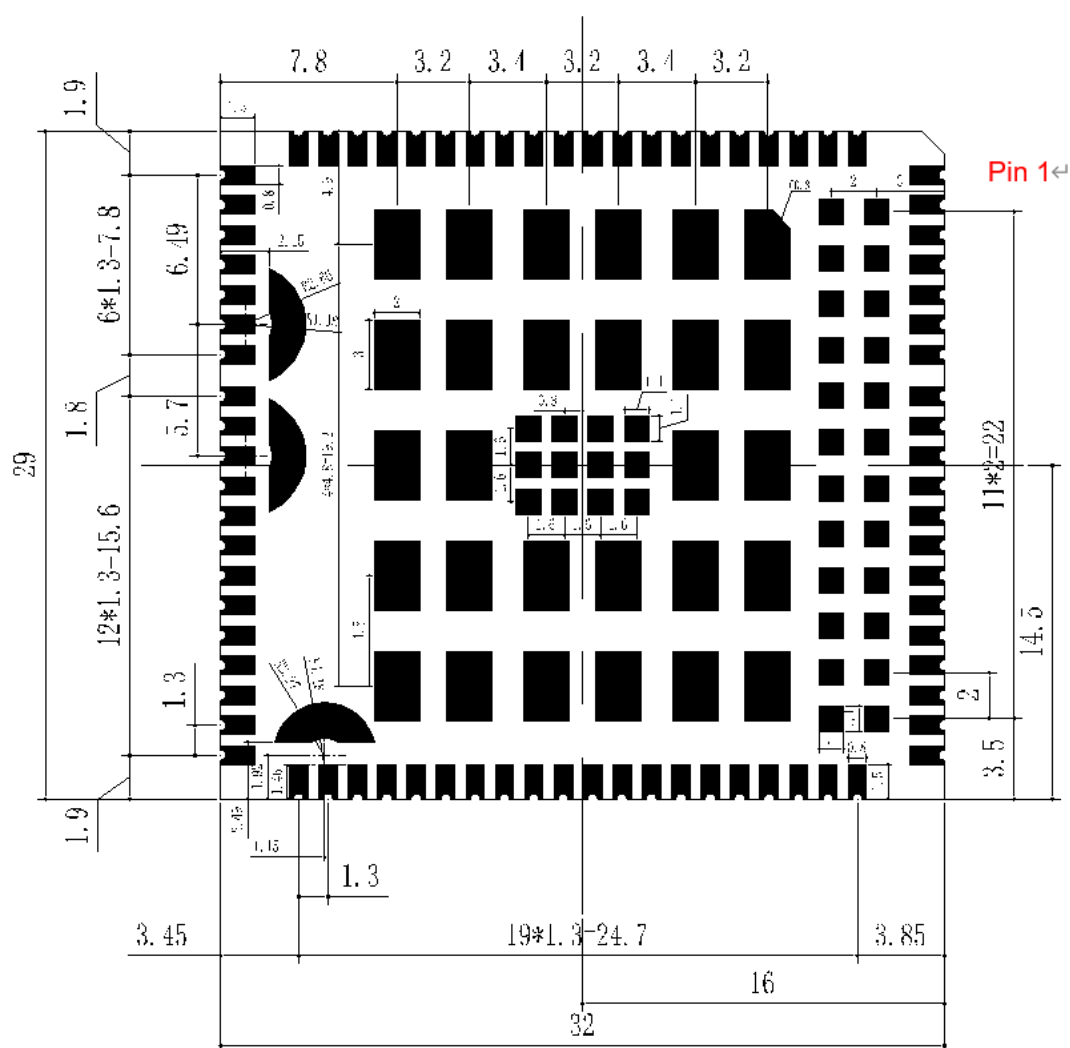


Figure 44: Module Top and Side Dimensions

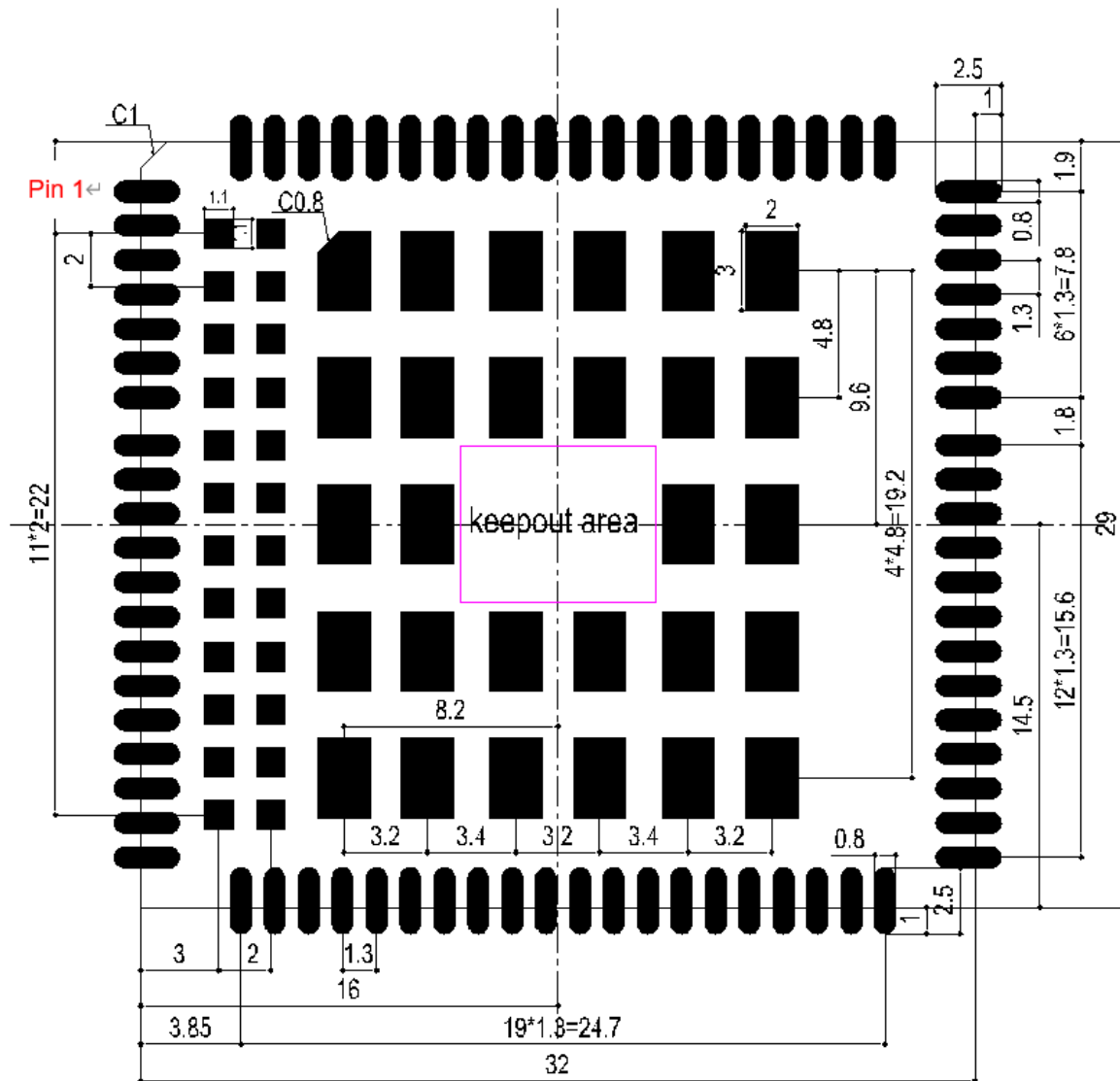


**Figure 45: Bottom Dimensions (Bottom View)**

## NOTE

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

## 6.2. Recommended Footprint

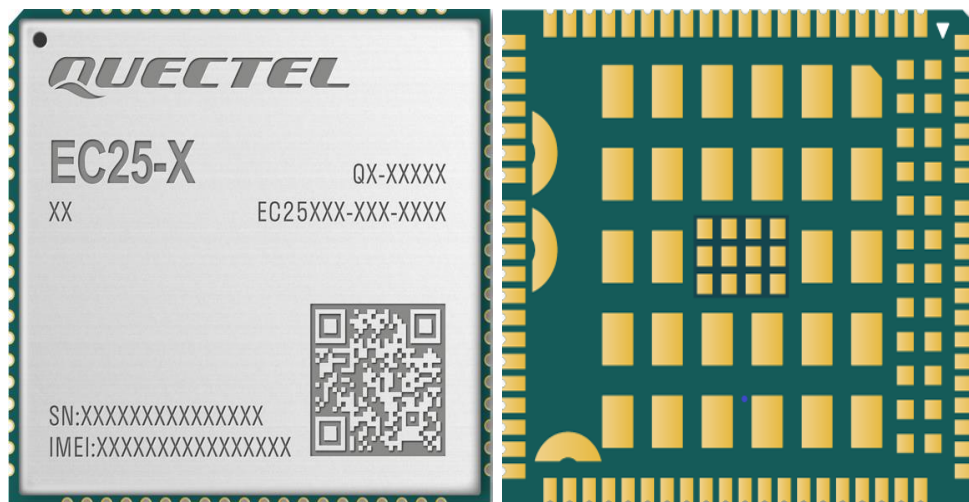


### Figure 46: Recommended Footprint (Top View)

## 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  $23 \pm 5$  °C and the relative humidity should be 35–60 %.
2. The storage life (in vacuum-sealed packaging) is 12 months in Recommended Storage Condition.
3. The floor life of the module is 168 hours <sup>11</sup> in a plant where the temperature is  $23 \pm 5$  °C and relative humidity is below 60 %. After the vacuum-sealed packaging is removed, the module must be processed in reflow soldering or other high-temperature operations within 168 hours. Otherwise, the module should be stored in an environment where the relative humidity is less than 10 % (e.g., a drying 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 above occurs;
  - Vacuum-sealed packaging is broken, or the packaging has been removed for over 24 hours;
  - Before module repairing.
5. If needed, the pre-baking should follow the requirements below:
  - The module should be baked for 8 hours at  $120 \pm 5$  °C;
  - All modules must be soldered to PCB within 24 hours after the baking, otherwise they should be put in a dry environment such as in a drying oven.

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

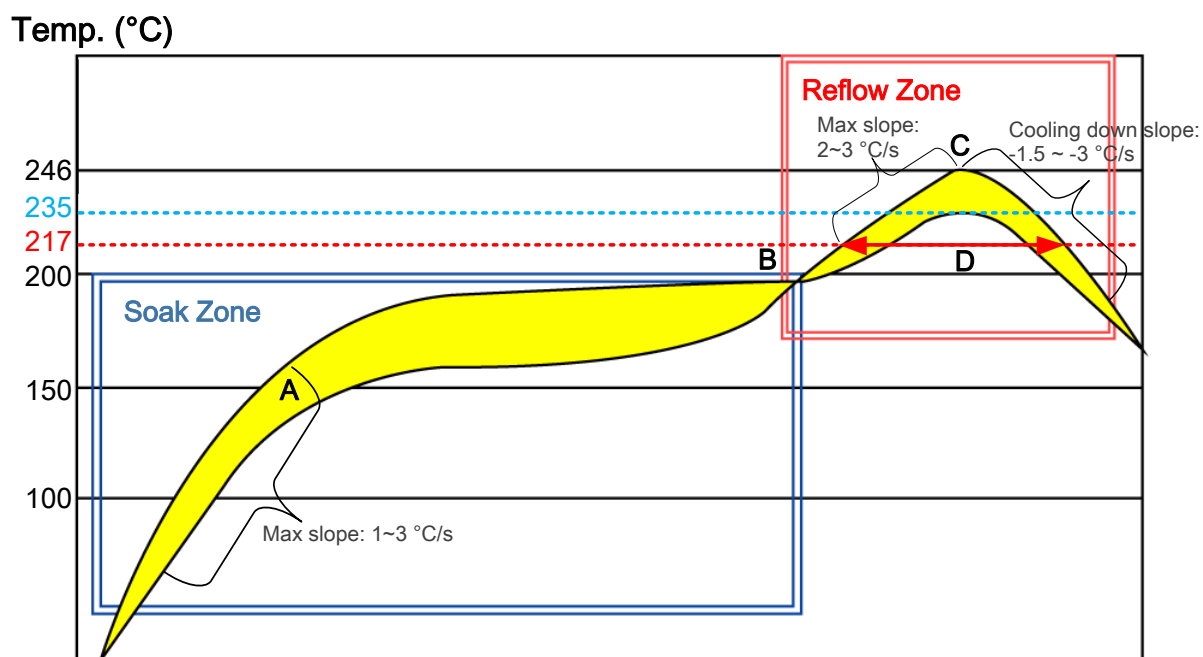
**NOTE**

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 °C, with 246 °C 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   |
|------------------------------------------------|------------------|
| <b>Soak Zone</b>                               |                  |
| Max slope                                      | 1–3 °C/s         |
| Soak time (between A and B: 150 °C and 200 °C) | 70–120 s         |
| <b>Reflow Zone</b>                             |                  |
| Max slope                                      | 2–3 °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  |
| <b>Reflow Cycle</b>                            |                  |
| Max reflow cycle                               | 1                |

**NOTE**

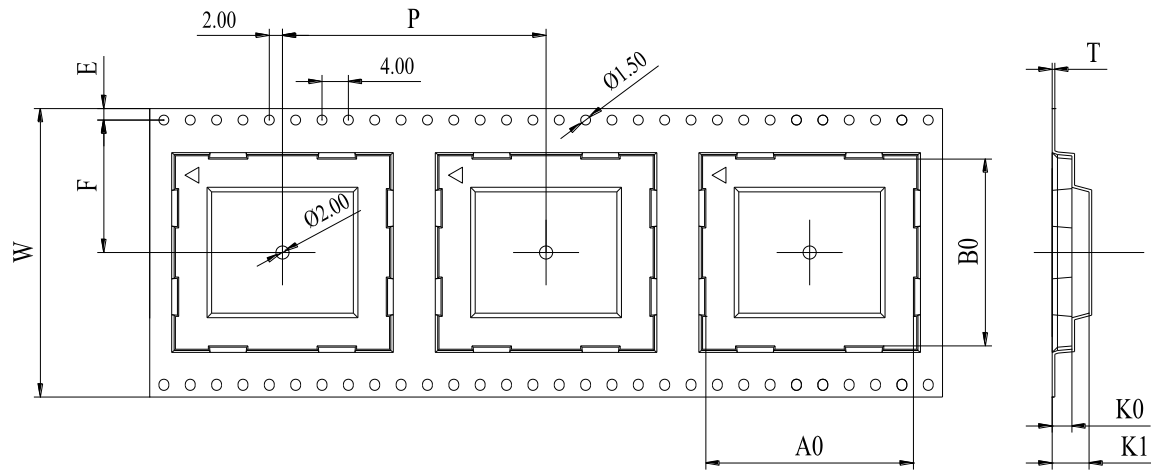
1. If a conformal coating is necessary for the module, do NOT use any coating material that may chemically react with the PCB or shielding cover, and prevent the coating material from flowing into the module.
2. Avoid using ultrasonic technology for module cleaning since it can damage crystals inside 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:

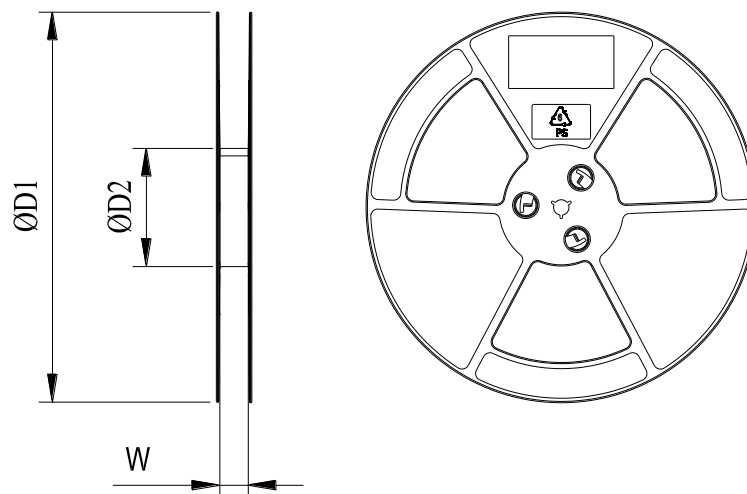


**Figure 49: Carrier Tape Dimension Drawing**

**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

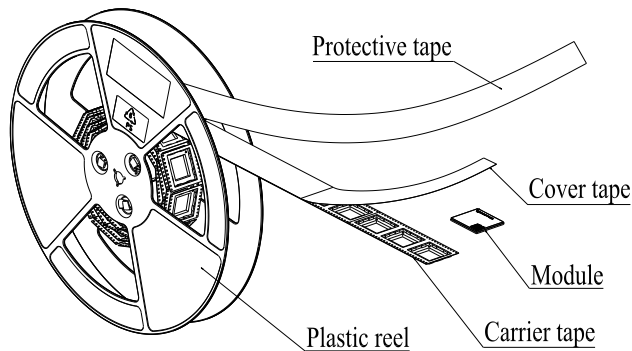


**Figure 50: Plastic Reel Dimension Drawing**

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

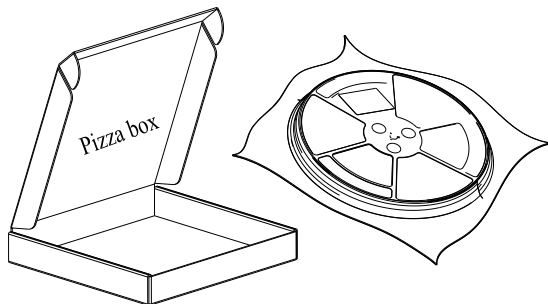
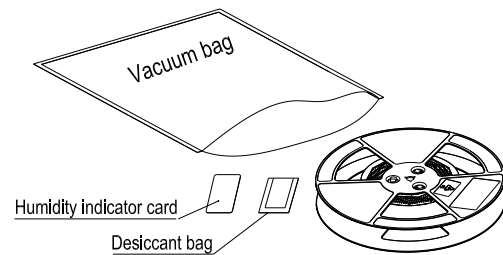
| øD1 | øD2 | W    |
|-----|-----|------|
| 330 | 100 | 44.5 |

### 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.

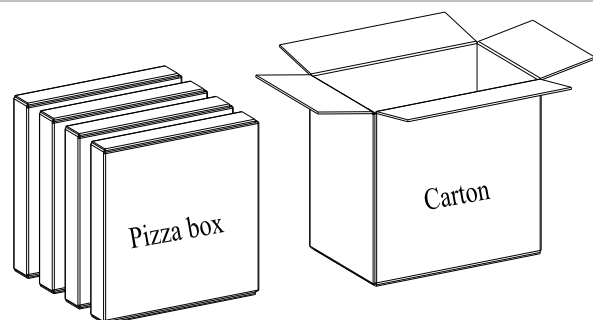


Figure 51: Packaging Process

# 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                    |

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|          |                                             |
|----------|---------------------------------------------|
| CHAP     | Challenge Handshake Authentication Protocol |
| CMUX     | Connection Multiplexing                     |
| CS       | Coding Scheme                               |
| CSD      | Circuit Switched Data                       |
| 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                |

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|       |                                         |
|-------|-----------------------------------------|
| 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                     |
| LSB   | Least Significant Bit                   |
| 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                  |
| V <sub>max</sub>   | Maximum Voltage                                         |
| V <sub>nom</sub>   | Nominal Voltage                                         |
| V <sub>min</sub>   | Minimum Voltage                                         |
| V <sub>IHmax</sub> | Maximum High-level Input Voltage                        |
| V <sub>IHmin</sub> | Minimum High-level Input Voltage                        |
| V <sub>ILmax</sub> | Maximum Low-level Input Voltage                         |

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|             |                                        |
|-------------|----------------------------------------|
| $V_{ILmin}$ | Minimum Low-level Input Voltage        |
| $V_{OHmin}$ | Minimum High-level Output Voltage      |
| $V_{OLmax}$ | 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            |

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