EP06 Series

Hardware Design

LTE-A Module Series

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Quectel Wireless Solutions Co., Ltd.
Building 5, Shanghai Business Park Phase III (Area B), No.1016 Tianlin Road, Minhang District, Shanghai 200233, China
Tel: +86 21 5108 6236
Email: info@quectel.com

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	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 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.
	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 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 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 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	2018-06-25	Vae LIU/ Wison HE	Initial
1.1	2018-08-07	Vae LIU	Updated the extended temperature range in Table 2 and 27.
1.2	2019-01-31	Ewent LU/ Xavier XIA/ Reed WANG	1. Deleted EP06-APAC and all the related information and added EP06-CN and the related information. 2. Updated the supported bands and 2×CA combination of EP06-A in Table 1. 3. Updated the names of pins 8, 10, 12 and 14 of USIM1 interface. 4. Updated the Reference Circuit of USB 2.0 & 3.0 Interface in Figure 5. 5. Added Chapter 4 GNSS Receiver and updated the GNSS Performance in Table 14. 6. Updated the description of antenna connectors and antenna requirements in Chapter 5. 7. Updated EP06-E and EP06-A Conducted RF Receiving Sensitivity in Chapter 6.4. 8. Updated EP06-E and EP06-A Current Consumption in Chapter 6.7.
1.3	2020-08-08	Archibald JIANG	1. Deleted EP06-LA and EP06-CN. 2. Updated the weight and the dimensions in Table 2. 3. Updated the note for GNSS antenna requirements in Chapter 5.4. 4. Added the GNSS current consumption of EP06-E and EP06-A in Chapter 6.7. 5. Updated mechanical dimensions of the module in Chapter 7.1.

1.4	2021-07-29	Archibald JIANG	1. Changed pins 1 and 42 to NC pins and deleted their original information. 2. Updated the information of supported USB drivers (Table 4). 3. Deleted the information of Mini PCI Express Standard Name (Table 5).
1.5	2022-12-30	Frank GAO	1. Updated the supported USB serial drivers information (Table 3). 2. Added a note about shutdown methods (Chapter 3.4). 3. Added the chapter of notification (Chapter 6.7). 4. Changed the dimensional tolerances from ±0.2 mm to ±0.15 mm (Chapter 7). 5. Updated the packaging specification (Chapter 7.3).
1.6	2023-09-28	Henry YANG/ Iyukee SHEN/ Rocky LU	1. Updated the supported USB serial drivers information (Table 3). 2. Updated the description about GNSS antenna (Chapter 5.4). 3. Updated the top view of the module (Figure 12 & Figure 17).

Contents

Safety Information **3**
About the Document **4**
Contents **6**
Table Index **8**
Figure Index **9**

1 Introduction **10**
1.1. Special Marks 10

2 Product Concept **11**
2.1. General Description 11
2.2. Key Features 12
2.3. Functional Diagram 14
2.4. EVB Kit 14

3 Application Interfaces **15**
3.1. Pin Assignment 15
3.2. Pin Description 16
3.3. Operating Modes 19
3.3.1. Sleep mode 19
3.3.2. Airplane mode 20
3.4. Power Supply 21
3.5. (U)SIM Interfaces 22
3.6. USB Interface 23
3.7. PCM and I2C Interfaces 25
3.8. Control Signals 27
3.8.1. W_DISABLE_N* 27
3.8.2. RESET_N 28
3.9. Antenna Tuner Control Interfaces* 29

4 GNSS Receiver **30**
4.1. General Description 30
4.2. GNSS Performance 30

5 Antenna Connection **32**
5.1. Main/Rx-diversity Antenna Connectors 33
5.1.1. Description of Main/Rx-diversity Antenna Connectors 33
5.1.2. Operating Frequency 33
5.2. GNSS Antenna Connector 35
5.3. Antenna Connectors and Mated Plugs 36
5.4. Antenna Requirements 38
5.5. Layout Guidelines 39

6 Reliability, Radio and Electrical Characteristics **40**

6.1. Absolute Maximum Ratings 40
6.2. Power Supply Ratings 40
6.3. RF Characteristics 41
6.4. Operating and Storage Temperatures 43
6.5. Electrostatic Discharge 43
6.6. Power Consumption 44
6.7. Notification 49
6.7.1. Coating 49
6.7.2. Cleaning 49
6.7.3. Installing 49

7 Mechanical Dimensions 50
7.1. Mechanical Dimensions 50
7.2. Top and Bottom Views of the Module 51
7.3. Packaging Specification 52
7.3.1. Packaging Tray 52
7.3.2. Packaging Process 53

8 Appendix References 54

Table Index

Table 1: Special Marks 10
Table 2: Frequency Bands and GNSS Types of EP06 Series 11
Table 3: Key Features of EP06 Series 12
Table 4: Parameter Definition 16
Table 5: Pin Description 16
Table 6: Overview of Operating Modes 19
Table 7: Definition of VCC and GND Pins 21
Table 8: Pin Definition of (U)SIM Interfaces 22
Table 9: Pin Definition of USB Interface 23
Table 10: Pin Definition of PCM and I2C Interfaces 25
Table 11: Pin Definition of Control Signals 27
Table 12: RF Function Status 28
Table 13: Pin Definition of Tunable Antenna Control Interfaces 29
Table 14: GNSS Performance 30
Table 15: Description of Main/Rx-diversity Antenna Connectors 33
Table 16: EP06-E Operating Frequencies 33
Table 17: EP06-A Operating Frequencies 34
Table 18: Description of GNSS Antenna Connector 35
Table 19: GNSS Frequency 35
Table 20: Antenna Requirements 38
Table 21: Absolute Maximum Ratings 40
Table 22: Power Supply Ratings of EP06 Series 40
Table 23: RF Output Power 41
Table 24: EP06-E Conducted RF Receiving Sensitivity 41
Table 25: EP06-A Conducted RF Receiving Sensitivity 42
Table 26: Operating and Storage Temperatures 43
Table 27: Electrostatic Discharge Characteristics (Temperature: 25–30 °C, Humidity: 40 ±5 %) 43
Table 28: EP06-E Power Consumption 44
Table 29: EP06-A Power Consumption 46
Table 30: Related Documents 54
Table 31: Terms and Abbreviations 54

Figure Index

Figure 1: Functional Diagram 14
Figure 2: Pin Assignment 15
Figure 3: DRX Run Time and Power Consumption in Sleep Mode 19
Figure 4: Sleep Mode Application with USB Remote Wakeup 20
Figure 5: Reference Design of Power Supply 21
Figure 6: Reference Design of (U)SIM Interface with a 6-pin (U)SIM Card Connector 22
Figure 7: Reference Design of USB Interface 24
Figure 8: Primary Mode Timing Sequence 26
Figure 9: Auxiliary Mode Timing Sequence 26
Figure 10: Reference Design of PCM Interface with Audio Codec 27
Figure 11: Timing of Resetting Module 28
Figure 12: Antenna Connectors on the Module 32
Figure 13: Dimensions of the Receptacle (Unit: mm) 36
Figure 14: Specifications of Mated Plugs 36
Figure 15: Space Factor of Mated Connectors (Unit: mm) 37
Figure 16: Mechanical Dimensions of EP06 Series 50
Figure 17: Top and Bottom Views of the Module 51
Figure 18: Blister Tray Dimension Drawing 52
Figure 19: Packaging Process 53

1 Introduction

This document provides information on the functional features, interface specifications, as well as electrical and mechanical details of the EP06 series modules (EP06-E and EP06-A). Consult this document to learn about the air and hardware interfaces and external application reference designs among other related information of the series modules.

This document, coupled with application notes and user guides, makes it easy to design applications with the module.

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, argument, and so on, it indicates that the function, feature, interface, pin, AT command, argument, and so on, is under development and currently not supported; and the asterisk (*) after a model indicates that the sample of the model is currently unavailable.
[…]	Brackets ([…]) used after a pin enclosing a range of numbers indicate all pins of the same type. For example, SDIO_DATA[0:3] refers to all four SDIO pins: SDIO_DATA0, SDIO_DATA1, SDIO_DATA2, and SDIO_DATA3.

2 Product Concept

2.1. General Description

EP06 is a series of LTE-A/UMTS/HSPA+ wireless communication modules with receive diversity. It provides data connectivity on LTE-FDD, LTE-TDD, DC-HSDPA, HSPA+, HSDPA, HSUPA and WCDMA networks with *PCI Express Mini Card Electromechanical Specification Revision 2.1* standard interface.

EP06 series supports embedded operating systems such as Windows CE, Linux and Android, and also provides GNSS [1] and voice functionality [2] to meet your specific application demands. EP06 series contains two variants: EP06-E and EP06-A. You can select a dedicated type based on your application regions or target operators.

The following table shows the frequency bands and GNSS types of EP06 series.

Table 2: Frequency Bands and GNSS Types of EP06 Series

Mode	EP06-E	EP06-A
LTE-FDD (with Rx-diversity)	B1/B3/B5/B7/B8/B20/B28/B32 [3]	B2/B4/B5/B7/B12/B13/B25/B26/ B29 [3]/B30/B66
LTE-TDD (with Rx-diversity)	B38/B40/B41	-
2CA	B1 + B1/B5/B8/B20/B28; B3 + B3/B5/B7/B8/B20/B28; B7 + B5/B7/B8/B20/B28; B20 + B32 [3]; B38 + B38; B40 + B40; B41 + B41	B2 + B2/B5/B12/B13/B29 [3]; B4 + B4/B5/B12/B13/B29 [3]; B7 + B5/B7/B12/B26; B25 + B5/B12/B25/B26; B30 + B5/B12/B29 [3]; B66 + B5/B12/B13/B29 [3]/B66
WCDMA (with Rx-diversity)	B1/B3/B5/B8	B2/B4/B5
GNSS (Optional)	GPS, GLONASS, BDS, Galileo, QZSS	GPS, GLONASS, BDS, Galileo, QZSS

[1] GNSS function is optional.
[2] EP06 series contains **Telematics** version and **Data-only** version. **Telematics** version supports voice and data functions, while **Data-only** version only supports data function.
[3] LTE-FDD B29 and B32 support Rx only, and in 2CA they are only for secondary component carrier.

2.2. Key Features

The following table describes the detailed features of EP06 series.

Table 3: Key Features of EP06 Series

Feature	Details
Functional Interface	*PCI Express Mini Card Electromechanical Specification Revision 2.1* Standard Interface
Power Supply	● Supply voltage: 3.1–4.4 V ● Typical supply voltage: 3.3 V
Transmitting Power	● Class 3 (23 dBm ±2 dB) for LTE-FDD bands ● Class 3 (23 dBm ±2 dB) for LTE-TDD bands ● Class 3 (23 dBm ±2 dB) for WCDMA bands
LTE Features	● Support up to LTE Cat 6 ● Support Supports1.4/3/5/10/15/20 MHz RF bandwidths ● Support 2 × 2 MIMO in DL direction ● Max. transmission data rates [4]: - FDD: 300 Mbps (DL)/50 Mbps (UL) - TDD: 226 Mbps (DL)/28 Mbps (UL)
UMTS Features	● Support 3GPP Rel-8 DC-HSDPA, HSPA+, HSDPA, HSUPA and WCDMA ● Support QPSK, 16QAM and 64QAM modulations ● Max. transmission data rates [4]: - DC-HSDPA: 42 Mbps - HSUPA: 5.76 Mbps - WCDMA: 384 kbps (DL)/384 kbps (UL)
Internet Protocol Features	● Support PPP/QMI/TCP*/UDP*/FTP*/HTTP*/NTP*/PING*/HTTPS*/SMTP*/MMS*/FTPS*/SMTPS*/SSL* protocols ● Support PAP and CHAP for PPP connections
SMS	● Text and PDU modes ● Point-to-point MO and MT ● SMS cell broadcast ● SMS storage: ME by default
(U)SIM Interfaces	● Support (U)SIM card: 1.8 V, 3.0 V ● Include (U)SIM1 and (U)SIM2 interfaces ● Support Dual SIM Single Standby
Audio Feature	● Support two digital audio interfaces: PCM and I2C interfaces ● WCDMA: AMR/AMR-WB ● LTE: AMR/AMR-WB

[4] The maximum rates are theoretical and the actual values depend on the network configuration.

	● Support echo cancellation and noise suppression
PCM Interface	● Used for audio function with an external codec ● Supports 16-bit linear data formats ● Supports long frame synchronization and short frame synchronization ● Supports master and slave modes, but must be in master mode for long frame synchronization
USB Interface	● Compliant with USB 3.0 and 2.0 specifications, with maximum transmission rates up to 5 Gbps on USB 3.0 and 480 Mbps on USB 2.0 ● Used for AT command communication, data transmission, firmware upgrade, software debugging, GNSS NMEA sentence output and voice over USB ● Supports USB serial drivers: Windows 7/8/8.1/10/11, Linux 2.6–6.5, Android 4.x-13.x systems.
Antenna Connectors	Include main antenna, diversity antenna and GNSS antenna interfaces
Rx-diversity	Support LTE/WCDMA Rx-diversity
GNSS Features	Protocol: NMEA 0183
AT Commands	● Compliant with *3GPP TS 27.007* and *3GPP TS 27.005* ● Quectel enhanced AT commands
Physical Characteristics	● Dimensions: 30.0 mm × 50.95 mm × 3.95 mm ● Weight: approx. 10.1 g
Temperature Ranges	● Operating temperature range: -35 to +75 °C [5] ● Extended temperature range: -40 to +85 °C [6] ● Storage temperature range: -40 to +90 °C
Firmware Upgrade	USB interface and DFOTA
RoHS	All hardware components are fully compliant with EU RoHS directive

[5] Within operating temperature range, the module is 3GPP compliant.
[6] Within this range, proper mounting, heating sinks and active cooling may be required to make certain functions of the module such as voice, SMS, data transmission, emergency call to be realized. Only one or more parameters like P_{out} might reduce in their value and exceed the specified tolerances. When the temperature returns to normal operating temperature levels, the module will meet 3GPP specifications again.

2.3. Functional Diagram

The following figure shows the block diagram of EP06 series.

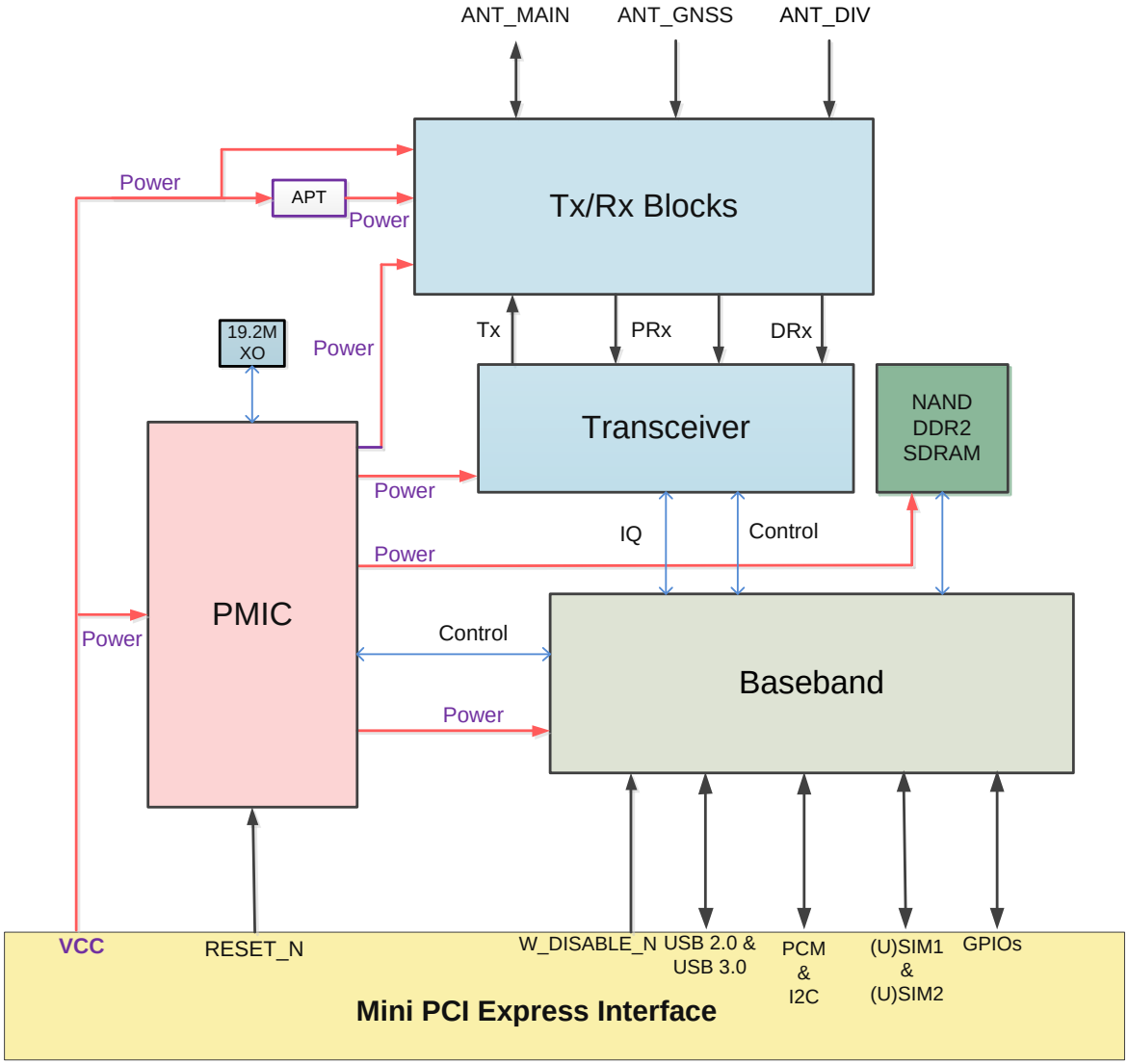


Figure 1: Functional Diagram

2.4. EVB Kit

To help you develop applications conveniently with the module, Quectel supplies an evaluation board (EPXX EVB) with accessories to develop and test the module. For more details, see ***document [1]***.

3 Application Interfaces

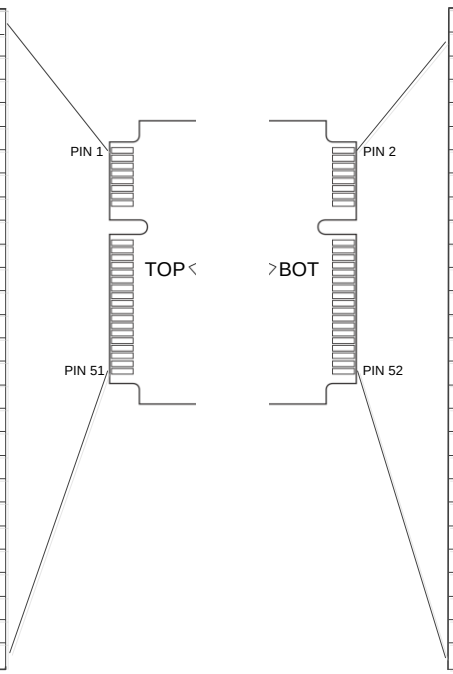
Physical connections and signal levels of the module comply with *PCI Express Mini Card Electromechanical Specification Revision 2.1*. This chapter mainly describes definition and application of the following module interfaces and signals:

- Power supply
- (U)SIM interfaces
- USB interface
- PCM and I2C interfaces
- Control signals
- Antenna tuner control interfaces*

3.1. Pin Assignment

The following figure shows the pin assignment of the module. The module and antenna connectors are disposed on the top side.

Pin Name	Pin No.
NC	1
ANTCTL0	3
ANTCTL1	5
USIM2_RST	7
GND	9
VREF_1.8V	11
USIM2_VDD	13
GND	15
USIM2_CLK	17
USIM2_DATA	19
GND	21
USB3.0_TX-	23
USB3.0_TX+	25
GND	27
GND	29
USB3.0_RX-	31
USB3.0_RX+	33
GND	35
GND	37
VCC	39
VCC	41
GND	43
PCM_CLK	45
PCM_DOUT	47
PCM_DIN	49
PCM_SYNC	51



Pin No.	Pin Name
2	VCC
4	GND
6	NC
8	USIM1_VDD
10	USIM1_DATA
12	USIM1_CLK
14	USIM1_RST
16	NC
18	GND
20	W_DISABLE_N
22	RESET_N
24	VCC
26	GND
28	NC
30	I2C_SCL
32	I2C_SDA
34	GND
36	USB_D-
38	USB_D+
40	GND
42	NC
44	ANTCTL2
46	ANTCTL3
48	NC
50	GND
52	VCC

Figure 2: Pin Assignment

3.2. Pin Description

The following tables show the pin definition and description of the module.

Table 4: Parameter Definition

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

Table 5: Pin Description

Pin No.	Pin Name	I/O	Description	Comment
1	NC		Not connected	
2	VCC	PI	Power supply for the module	Vmin = 3.1 V Vnom = 3.3 V Vmax = 4.4 V
3	ANTCTL0*	DO	Antenna tuner GPIO control	1.8 V power domain
4	GND		Ground	
5	ANTCTL1*	DO	Antenna tuner GPIO control	1.8 V power domain
6	NC		Not connected	
7	USIM2_RST	DO	(U)SIM2 card reset	1.8/3.0 V

8	USIM1_VDD	PO	(U)SIM1 card power supply	1.8/3.0 V
9	GND		Ground	
10	USIM1_DATA	DIO	(U)SIM1 card data	1.8/3.0 V
11	VREF_1.8V	PO	1.8 V reference voltage output	
12	USIM1_CLK	DO	(U)SIM1 card clock	1.8/3.0 V
13	USIM2_VDD	PO	(U)SIM2 card power supply	1.8/3.0 V
14	USIM1_RST	DO	(U)SIM1 card reset	1.8/3.0 V
15	GND		Ground	
16	NC		Not connected	
17	USIM2_CLK	DO	(U)SIM2 card clock	1.8/3.0 V
18	GND		Ground	
19	USIM2_DATA	DIO	(U)SIM2 card data	1.8/3.0 V
20	W_DISABLE_N*	DI	Airplane mode control	1.8 V power domain
21	GND		Ground	
22	RESET_N	DI	Reset the module	Active low A test point is recommended to be reserved if unused.
23	USB3.0_TX-	AO	USB 3.0 transmit data (-)	
24	VCC	PI	Power supply for the module	Vmin = 3.1 V Vnom = 3.3 V Vmax = 4.4 V
25	USB3.0_TX+	AO	USB 3.0 transmit data (+)	
26	GND		Ground	
27	GND		Ground	
28	NC		Not connected	
29	GND		Ground	
30	I2C_SCL	DO	I2C serial clock (for external codec)	Externally pulled up to 1.8 V
31	USB3.0_RX-	AI	USB 3.0 receive data (-)	
32	I2C_SDA	DIO	I2C serial data (for external codec)	Externally pulled up to 1.8 V

33	USB3.0_RX+	AI	USB 3.0 receive data (+)	
34	GND		Ground	
35	GND		Ground	
36	USB_D-	AIO	USB 2.0 differential data (-)	
37	GND		Ground	
38	USB_D+	AIO	USB 2.0 differential data (+)	
39	VCC	PI	Power supply for the module	Vmin = 3.1 V Vnom = 3.3 V Vmax = 4.4 V
40	GND		Ground	
41	VCC	PI	Power supply for the module	Vmin = 3.1 V Vnom = 3.3 V Vmax = 4.4 V
42	NC		Not connected	
43	GND		Ground	
44	ANTCTL2*	DO	Antenna tuner GPIO control	1.8 V power domain
45	PCM_CLK	DIO	PCM clock	
46	ANTCTL3*	DO	Antenna tuner GPIO control	1.8 V power domain
47	PCM_DOUT	DO	PCM data output	
48	NC		Not connected	
49	PCM_DIN	DI	PCM data input	
50	GND		Ground	
51	PCM_SYNC	DIO	PCM data frame sync	In master mode, it is an output signal. In slave mode, it is an input signal.
52	VCC	PI	Power supply for the module	Vmin = 3.1 V Vnom = 3.3 V Vmax = 4.4 V

NOTE

Keep all NC and unused pins unconnected.

3.3. Operating Modes

The table below briefly summarizes the various operating modes of EP06.

Table 6: Overview of Operating Modes

Mode	Details	
Full Functionality Mode	Idle	Software is active. The module has registered on the network, and it is ready to send and receive data.
	Voice/Data	Network connected. In this mode, the power consumption is decided by network setting and data transfer rate.
Minimum Functionality Mode	**AT+CFUN=0** sets the module to a minimum functionality mode without removing the power supply. In this mode, both RF function and (U)SIM card are invalid.	
Airplane Mode	**AT+CFUN=4** or driving W_DISABLE_N pin low will set the module to airplane mode. In this mode, the RF function is invalid.	
Sleep Mode	The module keeps receiving paging messages, SMS, voice calls and TCP/UDP data from the network with its power consumption reducing to an ultra-low level.	
Power Down Mode	In this mode, the power management unit shuts down the power supply. Software is inactive, all interfaces are inaccessible, and the operating voltage (connected to VCC) remains applied.	

3.3.1. Sleep mode

In sleep mode, DRX of the module is able to reduce the power consumption to an ultra-low level, and DRX cycle index values are broadcasted by the wireless network. The figure below shows the relationship between the DRX run time and the power consumption in sleep mode. The longer the DRX cycle is, the lower the power consumption will be.

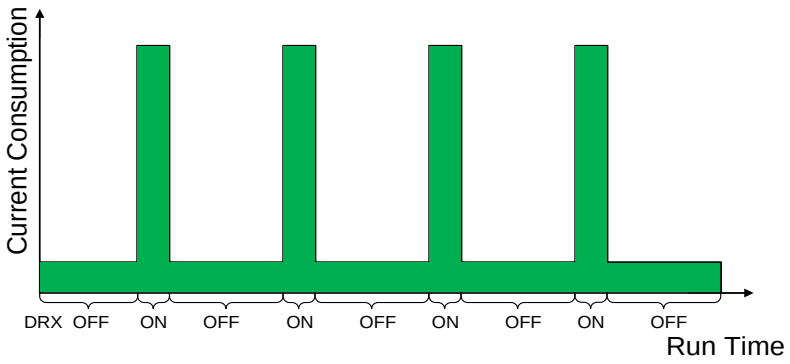


Figure 3: DRX Run Time and Power Consumption in Sleep Mode

NOTE

DRX cycle values are transmitted over the wireless network.

The following part of this section describes the power saving procedure and sleep mode entrance of the module.

If the host supports USB suspend/resume and remote wakeup function, the following two conditions must be met to make the module enter sleep mode.

- Execute **AT+QSCLK=1** to enable the sleep mode.
- The host's USB bus, which is connected to the module's USB interface, enters suspend state.

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

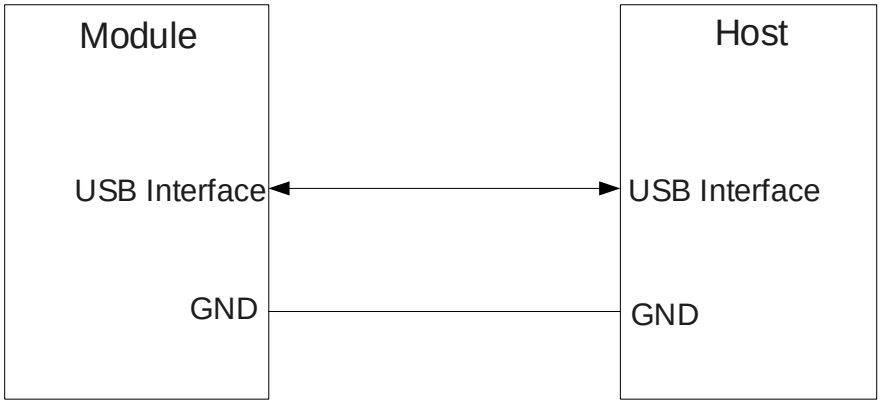


Figure 4: Sleep Mode Application with USB Remote Wakeup

The module and the host will wake up in the following conditions:

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

3.3.2. Airplane mode

The module provides a W_DISABLE_N pin to disable or enable airplane mode through hardware operation. See ***Chapter 3.8.1*** for more details.

3.4. Power Supply

The following table shows pin definition of VCC pins and ground pins.

Table 7: Definition of VCC and GND Pins

Pin No.	Pin Name	I/O	Power Domain	Description
2, 24, 39, 41, 52	VCC	PI	3.1–4.4 V	3.3 V typical DC power supply
4, 9, 15, 18, 21, 26, 27, 29, 34, 35, 37, 40, 43, 50	GND			Ground

The typical supply voltage of the module is 3.3 V. The power supply must be able to provide at least 2 A current, and a bypass capacitor of not less than 470 µF with low ESR should be used to prevent the voltage from dropping.

The following figure shows a reference design of power supply. The tolerance of resistors R2 and R3 is recommended to be 1 %, and the capacitor C3 needs a low ESR.

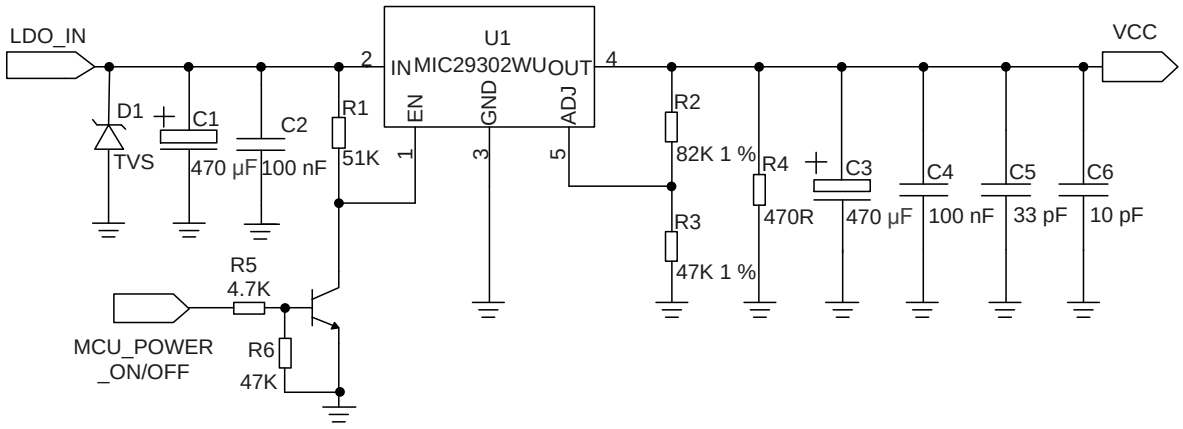


Figure 5: Reference Design of Power Supply

NOTE

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

3.5. (U)SIM Interfaces

The (U)SIM interfaces circuitry meet ETSI and IMT-2000 requirements. Both 1.8 V and 3.0 V (U)SIM cards are supported, and Dual SIM Single Standby function is supported.

The following table shows the pin definition of (U)SIM interfaces.

Table 8: Pin Definition of (U)SIM Interfaces

Pin No.	Pin Name	I/O	Power Domain	Description
8	USIM1_VDD	PO	1.8/3.0 V	(U)SIM1 card power supply
10	USIM1_DATA	DIO	1.8/3.0 V	(U)SIM1 card data
12	USIM1_CLK	DO	1.8/3.0 V	(U)SIM1 card clock
14	USIM1_RST	DO	1.8/3.0 V	(U)SIM1 card reset
13	USIM2_VDD	PO	1.8/3.0 V	(U)SIM2 card power supply
19	USIM2_DATA	DIO	1.8/3.0 V	(U)SIM2 card data
17	USIM2_CLK	DO	1.8/3.0 V	(U)SIM2 card clock
7	USIM2_RST	DO	1.8/3.0 V	(U)SIM2 card reset

The following figure shows a reference design for (U)SIM interface with a 6-pin (U)SIM card connector.

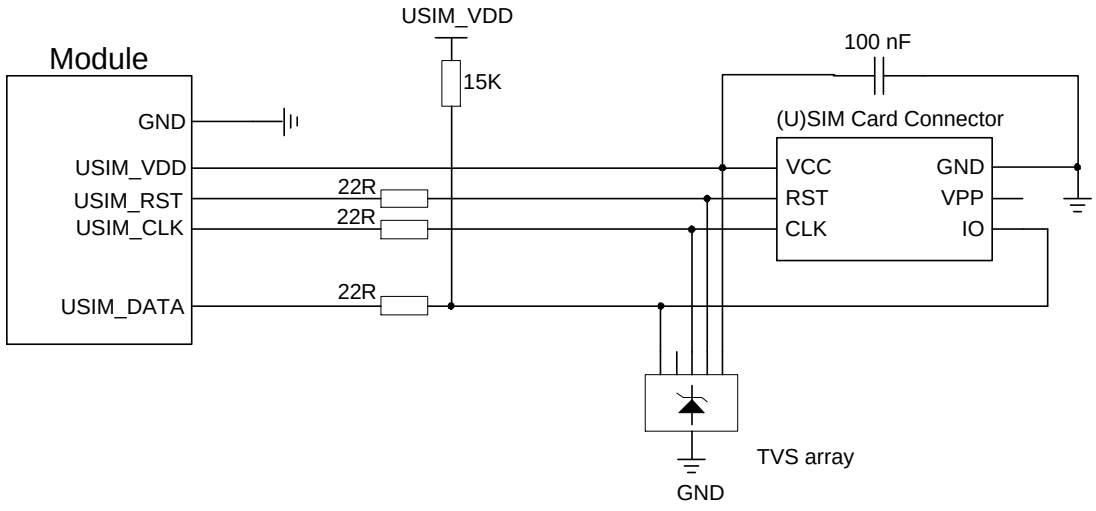


Figure 6: Reference Design of (U)SIM Interface with a 6-pin (U)SIM Card Connector

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

- Place the (U)SIM card connector as close to the module as possible. Keep the trace length as short as possible, at most 200 mm.
- Keep (U)SIM card signals away from RF and power supply traces.
- Keep the trace width of ground and USIM_VDD not less than 0.5 mm to maintain the same electric potential. The decoupling capacitor of USIM_VDD should be less than 1 μF and must be placed close to (U)SIM card connector.
- To avoid cross-talk between USIM_DATA and USIM_CLK, keep them away from each other and shield them with surrounded ground.
- To offer good ESD protection, it is recommended to add a TVS array with junction capacitance not exceeding 10 pF. The 22 Ω resistors should be added in series between the module and the (U)SIM card to suppress EMI and enhance ESD protection. Please note that the (U)SIM peripheral circuit should be close to the (U)SIM card connector.
- The pull-up resistor on USIM_DATA line can improve anti-jamming capability when long layout trace is applied and sensitive occasion occurs, and should be placed close to the (U)SIM card connector.

3.6. USB Interface

The module provides one integrated Universal Serial Bus (USB) interface which complies with the USB 3.0/2.0 specifications and supports SuperSpeed (5 Gbps) on USB 3.0, high-speed (480 Mbps) and full-speed (12 Mbps) modes on USB 2.0. The USB interface is used for AT command communication, data transmission, GNSS NMEA output, software debugging, firmware upgrade and voice over USB.

The following table shows the pin definition of USB interface.

Table 9: Pin Definition of USB Interface

Pin No.	Pin Name	I/O	Description	Comment
36	USB_D-	AIO	USB 2.0 differential data (-)	Compliant with USB 2.0 standard specification; Require differential impedance of 90 Ω.
38	USB_D+	AIO	USB 2.0 differential data (+)	
23	USB3.0_TX-	AO	USB 3.0 transmit data (-)	Compliant with USB 3.0 standard specification; Require differential impedance of 90 Ω.
25	USB3.0_TX+	AO	USB 3.0 transmit data (+)	
31	USB3.0_RX-	AI	USB 3.0 receive data (-)	
33	USB3.0_RX+	AI	USB 3.0 receive data (+)	

For more details about the USB 2.0 & 3.0 specifications, please visit http://www.usb.org/home.

The USB 2.0 interface must be reserved for firmware upgrade in your designs. The following figure shows a reference design of USB interface.

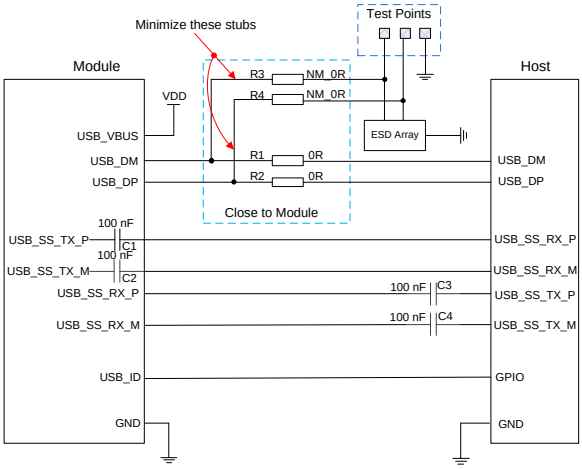


Figure 7: Reference Design of USB Interface

To ensure the signal integrity of USB data lines, C1 and C2 have been placed inside the module, C3 and C4 should be placed close to the MCU, and R1, R2, R3 and R4 should be placed close to the module and also close to each other. The extra stubs of trace must be as short as possible.

The following principles of USB interface design should be complied with, so as to meet USB 2.0 & USB 3.0 specifications.

- It is important to route the USB signal traces as differential pairs with ground surrounded. The impedance of USB differential trace is 90 Ω.
- For USB 2.0 signal traces, the trace length difference of the differential pair should be less than 2 mm.
- For USB 3.0 signal traces, the trace length difference of each differential pair (TX/RX) should be less than 0.7 mm.
- Do not route signal traces under crystals, oscillators, magnetic devices or RF signal traces. It is important to route the USB 2.0 and 3.0 differential traces in inner-layer of the PCB, and surround the traces with ground on that layer and with ground planes above and below.
- If a USB connector is used, keep the ESD protection components as close to the USB connector as possible. Junction capacitance of the ESD protection components might cause influences on USB 2.0 and 3.0 data traces, so pay attention to the selection of the components. Typically, the stray capacitance should be less than 2.0 pF for USB 2.0, and less than 0.4 pF for USB 3.0.
- If possible, reserve a 0 Ω resistor on USB_D+ and USB_D- traces respectively.

3.7. PCM and I2C Interfaces

The module supports audio communication via Pulse Code Modulation (PCM) digital and I2C interfaces.

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

Table 10: Pin Definition of PCM and I2C Interfaces

Pin No.	Pin Name	I/O	Power Domain	Description	Comment
45	PCM_CLK	DIO	1.8 V	PCM clock	
47	PCM_DOUT	DO	1.8 V	PCM data output	
49	PCM_DIN	DI	1.8 V	PCM data input	
51	PCM_SYNC	DIO	1.8 V	PCM data frame sync	In master mode, it is an output signal. In slave mode, it is an input signal.
30	I2C_SCL	DO	1.8 V	I2C serial clock	Externally pulled up to 1.8 V.
32	I2C_SDA	DIO	1.8 V	I2C serial data	Externally pulled up to 1.8 V.

The PCM interface supports the following modes:

- Primary mode (short frame synchronization, working as either master or slave)
- Auxiliary mode (long frame synchronization, working 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 when PCM_SYNC operates at 8 kHz, and also supports 4096 kHz PCM_CLK when PCM_SYNC operates at 16 kHz.

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, PCM interface operates with a 256 kHz PCM_CLK and an 8 kHz, 50 % duty cycle PCM_SYNC only.

The module supports 16-bit linear data format. The following figures show the timing sequence of 8 kHz PCM_SYNC and 2048 kHz PCM_CLK in the primary mode, as well as the timing sequence of 8 kHz PCM_SYNC and 256 kHz PCM_CLK in auxiliary mode.

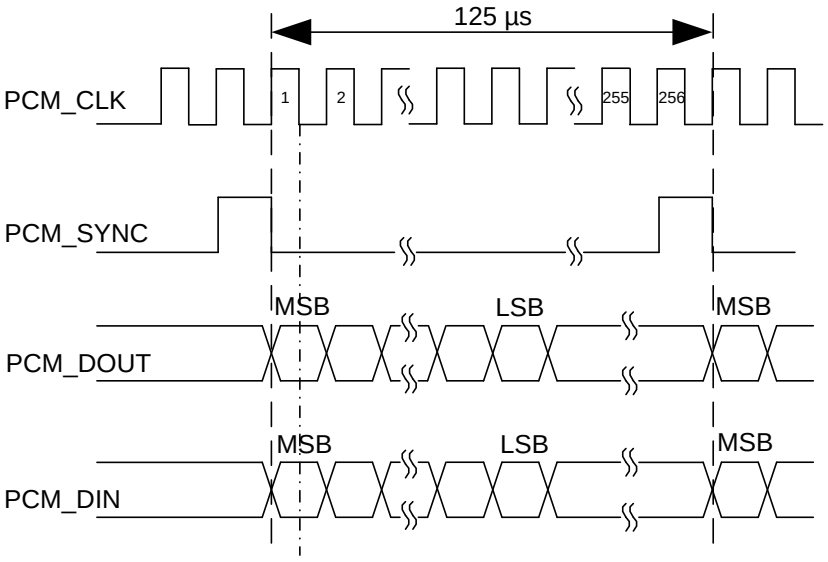


Figure 8: Primary Mode Timing Sequence

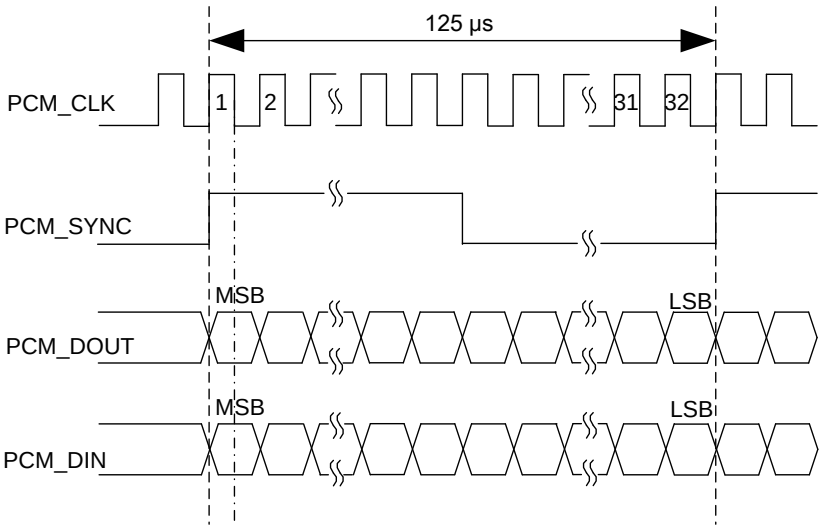


Figure 9: Auxiliary Mode Timing Sequence

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

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

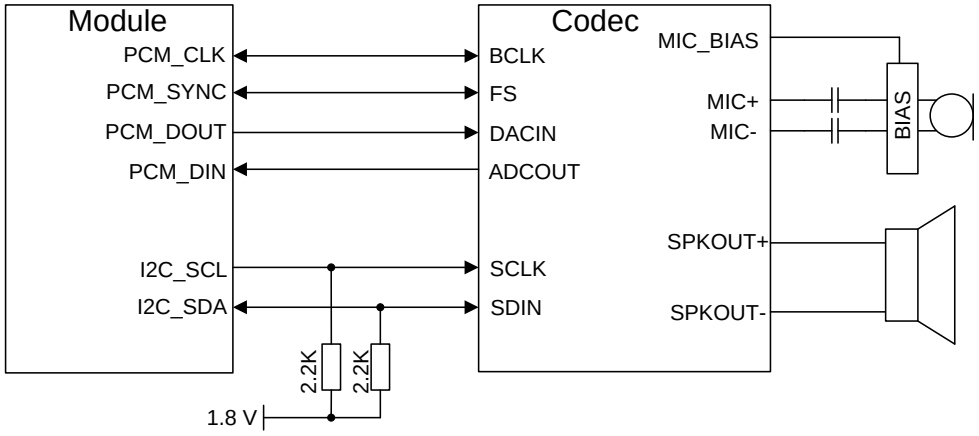


Figure 10: Reference Design of PCM Interface with Audio Codec

NOTE

1. It is recommended to reserve an RC (R = 22 Ω, C = 22 pF) circuit on the PCM traces, especially for PCM_CLK.
2. The module works as a master device pertaining to I2C interface.

3.8. Control Signals

The following table shows the pin definition of control signals.

Table 11: Pin Definition of Control Signals

Pin No.	Pin Name	I/O	Power Domain	Description	Comment
20	W_DISABLE_N*	DI	1.8 V	Airplane mode control	Active low.
22	RESET_N	DI	1.8 V	Reset the module	Active low.

3.8.1. W_DISABLE_N*

The module provides a W_DISABLE_N signal to disable or enable the RF function (excluding GNSS). W_DISABLE_N for RF function control is disabled by default, and **AT+QCFG="airplanecontrol",1** can be used to enable the function.

W_DISABLE_N is pulled up by default. Driving it low sets the module into airplane mode.

Table 12: RF Function Status

W_DISABLE_N Level	AT Command	RF Function Status	Operating Mode
High Level	**AT+CFUN=1**	Enable	Full functionality mode
	AT+CFUN=0	Disable	Minimum functionality mode
	AT+CFUN=4	Disable	Airplane mode
Low Level	**AT+CFUN=0** **AT+CFUN=1** **AT+CFUN=4**	Disable	Airplane mode

3.8.2. RESET_N

The RESET_N signal can be used to force a hardware reset of the module. Driving the pin low for 250–600 ms and then releasing it resets the module. The reset timing is illustrated in the following figure.

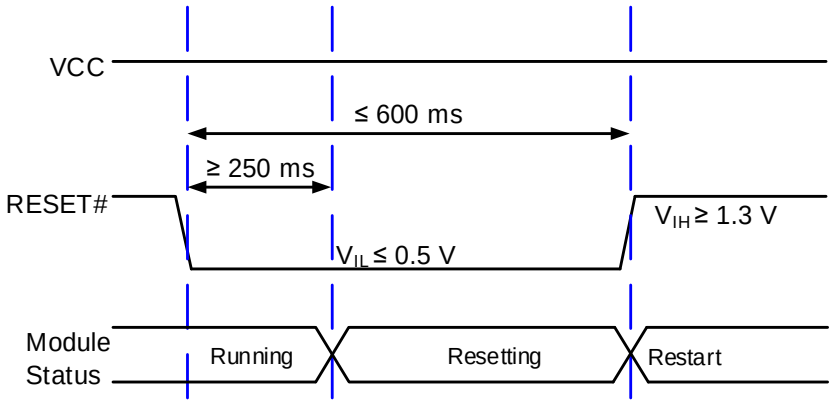


Figure 11: Timing of Resetting Module

3.9. Antenna Tuner Control Interfaces*

ANTCTL[0:3] signals are used for tunable antenna control and should be routed to an appropriate antenna control circuitry.

More details about the interface will be added in the future version of the document.

Table 13: Pin Definition of Tunable Antenna Control Interfaces

Pin Name	Pin No.	I/O	Description	Comment
ANTCTL0	3	DO	Antenna tuner GPIO control	1.8 V power domain
ANTCTL1	5	DO	Antenna tuner GPIO control	1.8 V power domain
ANTCTL2	44	DO	Antenna tuner GPIO control	1.8 V power domain
ANTCTL3	46	DO	Antenna tuner GPIO control	1.8 V power domain

4 GNSS Receiver

4.1. General Description

The module includes a fully integrated global navigation satellite system solution.

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

By default, GNSS engine of the module is switched off. It has to be switched on via AT command. For more details about GNSS engine technology and configurations, see ***document [3]***.

4.2. GNSS Performance

The following table shows GNSS performance of the module.

Table 14: GNSS Performance

Parameter	Description	Condition	Typ.	Unit
Sensitivity	Acquisition	Autonomous	-145	dBm
	Reacquisition	Autonomous	-157	dBm
	Tracking	Autonomous	-157	dBm
TTFF	Cold start @ open sky	Autonomous	34.56	s
		XTRA enabled	19.41	s
	Warm start @ open sky	Autonomous	25.77	s
		XTRA enabled	2.26	s
	Hot start	Autonomous	2.66	s

	@ open sky	XTRA enabled	2.03	s
Accuracy	CEP-50	Autonomous @ open sky	2.5	m

NOTE

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

5 Antenna Connection

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

The module is mounted with three 2 mm × 2 mm antenna connectors for external antenna connection: a main antenna connector, an Rx-diversity antenna connector, and a GNSS antenna connector. The impedance of the antenna connectors is 50 Ω.

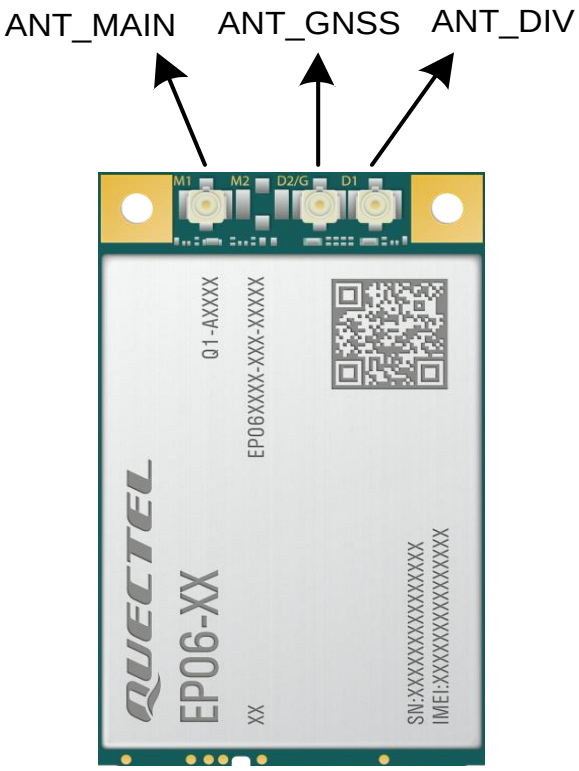


Figure 12: Antenna Connectors on the Module

5.1. Main/Rx-diversity Antenna Connectors

5.1.1. Description of Main/Rx-diversity Antenna Connectors

The details of main antenna and Rx-diversity antenna connectors are shown below.

Table 15: Description of Main/Rx-diversity Antenna Connectors

Connector	I/O	Description	Comment
M1	AIO	Main antenna connector	50 Ω impedance
D1	AI	Receive diversity antenna connector	50 Ω impedance

5.1.2. Operating Frequency

Table 16: EP06-E Operating Frequencies

3GPP Band	Transmit	Receive	Unit
WCDMA B1	1920–1980	2110–2170	MHz
WCDMA B3	1710–1785	1805–1880	MHz
WCDMA B5	824–849	869–894	MHz
WCDMA B8	880–915	925–960	MHz
LTE B1	1920–1980	2110–2170	MHz
LTE B3	1710–1785	1805–1880	MHz
LTE B5	824–849	869–894	MHz
LTE B7	2500–2570	2620–2690	MHz
LTE B8	880–915	925–960	MHz
LTE B20	832–862	791–821	MHz
LTE B28	703–748	758–803	MHz
LTE B32 [7]	-	1452–1496	MHz

[7] LTE-FDD B32 supports Rx only, and in 2CA it is only for secondary component carrier.

LTE B38	2570–2620	2570–2620	MHz
LTE B40	2300–2400	2300–2400	MHz
LTE B41	2545–2655	2545–2655	MHz

Table 17: EP06-A Operating Frequencies

3GPP Band	Transmit	Receive	Unit
WCDMA B2	1850–1910	1930–1990	MHz
WCDMA B4	1710–1755	2110–2155	MHz
WCDMA B5	824–849	869–894	MHz
LTE B2	1850–1910	1930–1990	MHz
LTE B4	1710–1755	2110–2155	MHz
LTE B5	824–849	869–894	MHz
LTE B7	2500–2570	2620–2690	MHz
LTE B12	699–716	729–746	MHz
LTE B13	777–787	746–756	MHz
LTE B25	1850–1915	1930–1995	MHz
LTE B26	814–849	859–894	MHz
LTE B29 [8]	-	717–728	MHz
LTE B30	2305–2315	2350–2360	MHz
LTE B66	1710–1780	2110–2200	MHz

[8] LTE-FDD B29 supports Rx only, and in 2CA it is only for secondary component carrier.

5.2. GNSS Antenna Connector

The following tables show details of GNSS antenna connector and the frequency specifications of GNSS antenna.

Table 18: Description of GNSS Antenna Connector

Connector	I/O	Description	Comment
D2/G	AI	GNSS antenna connector	50 Ω impedance

Table 19: GNSS Frequency

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

5.3. Antenna Connectors and Mated Plugs

The dimensions of the antenna connectors are shown as below.

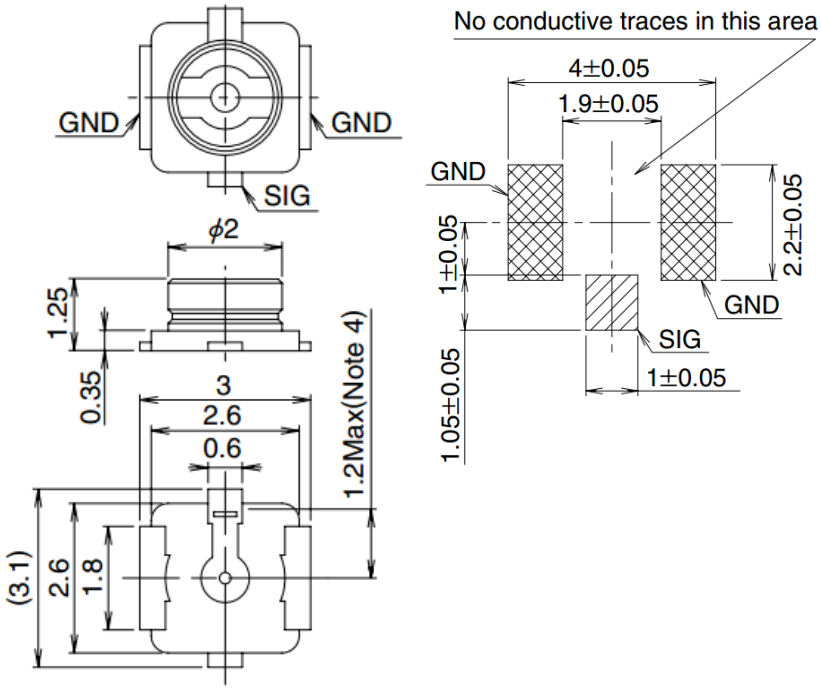


Figure 13: Dimensions of the Receptacle (Unit: mm)

It is recommended to use U.FL-LP mated plugs listed in the following figure to match the antenna connectors.

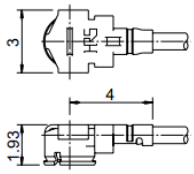
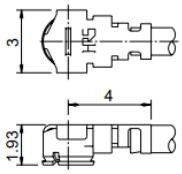
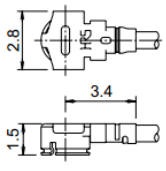
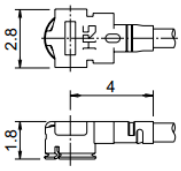
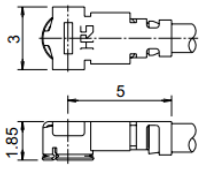
Part No.	U.FL-LP-040	U.FL-LP-066	U.FL-LP(V)-040	U.FL-LP-062	U.FL-LP-088
					
Mated Height	2.5mm Max. (2.4mm Nom.)	2.5mm Max. (2.4mm Nom.)	2.0mm Max. (1.9mm Nom.)	2.4mm Max. (2.3mm Nom.)	2.4mm Max. (2.3mm Nom.)
Applicable cable	Dia. 0.81mm Coaxial cable	Dia. 1.13mm and Dia. 1.32mm Coaxial cable	Dia.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

Figure 14: Specifications of Mated Plugs

The following figure describes the space factor of mated plugs.

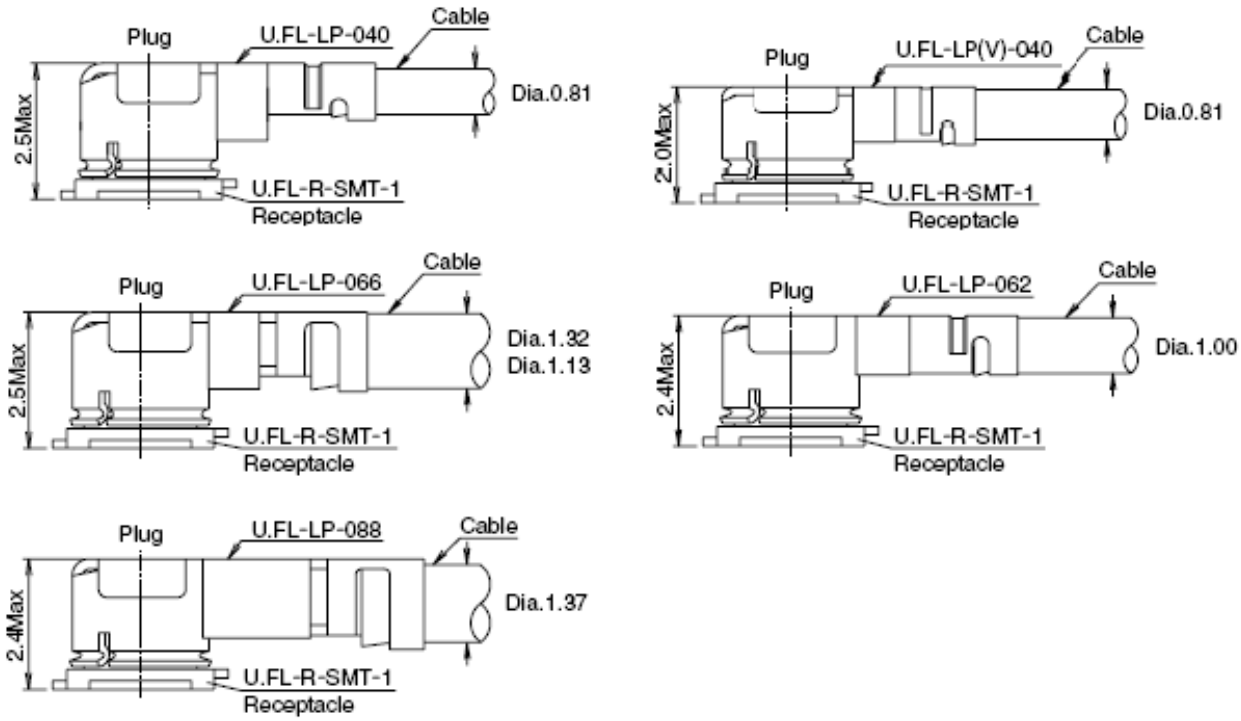


Figure 15: Space Factor of Mated Connectors (Unit: mm)

For more details of the recommended mated plugs, please visit http://www.hirose.com.

5.4. Antenna Requirements

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

Table 20: Antenna Requirements

Type	Requirements
GNSS [9]	● Frequency range: L1: 1559–1609 MHz ● Polarization: RHCP or linear ● VSWR: ≤ 2 (Typ.) ● Passive Antenna Gain: > 0 dBi
WCDMA/LTE	● VSWR: ≤ 2 ● Efficiency: > 30 % ● Max Input Power: 50 W ● Input Impedance: 50 Ω ● Cable Insertion Loss: - **< 1 dB:** LB (<1 GHz) - **< 1.5 dB:** MB (1–2.3 GHz) - **< 2 dB:** HB (> 2.3 GHz)

[9] EP06 series module supports passive and active GNSS antennas. The voltage of the GNSS antenna power supply is about 2.85 V in current design, so you could choose whether to use the internal power supply or to design an external power supply circuit for the GNSS antenna if you use the active antenna. However, when LTE B13 or B14 is supported, it is recommended to use a passive GNSS antenna as the use of active antenna may generate harmonics which will affect the GNSS performance.

5.5. Layout Guidelines

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

- Maximize the distance among GNSS antenna, main antenna and Rx-diversity antenna.
- Digital circuits such as (U)SIM card, USB interface, camera module, display connector and SD card 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.

6 Reliability, Radio and Electrical Characteristics

6.1. Absolute Maximum Ratings

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

Table 21: Absolute Maximum Ratings

Parameter	Min.	Max.	Unit
VCC	-0.3	4.7	V
Voltage at Digital Pins	-0.3	2.3	V

6.2. Power Supply Ratings

The typical input voltage of the module is 3.3 V, as specified by *PCI Express Mini Card Electromechanical Specification Revision 2.1*. And the power supply of the module should be able to provide sufficient current of 2 A at least. The following table shows the power supply ratings of the module.

Table 22: Power Supply Ratings of EP06 Series

Parameter	Description	Min.	Typ.	Max.	Unit
VCC	Power Supply	3.1	3.3	4.4	V

6.3. RF Characteristics

The following tables show the RF output power and receiving sensitivity of the module.

Table 23: RF Output Power

Frequency	Max.	Min.
WCDMA bands	23 dBm ±2 dB	< -50 dBm
LTE FDD bands	23 dBm ±2 dB	< -40 dBm
LTE TDD bands	23 dBm ±2 dB	< -40 dBm

Table 24: EP06-E Conducted RF Receiving Sensitivity

Frequency	Primary (Typ.)	Diversity (Typ.)	SIMO [10] (Typ.)	SIMO [11] (Worst Case)
WCDMA B1	-109.5 dBm	-107.5 dBm	TBD	-106.7 dBm
WCDMA B3	-108.5 dBm	-108.0 dBm	TBD	-103.7 dBm
WCDMA B5	-108.5 dBm	-109.0 dBm	TBD	-104.7 dBm
WCDMA B8	-109.5 dBm	-109.5 dBm	TBD	-103.7 dBm
LTE-FDD B1 (10 MHz)	-98.0 dBm	-96.0 dBm	-99.5 dBm	-96.3 dBm
LTE-FDD B3 (10 MHz)	-97.5 dBm	-97.5 dBm	-100.0 dBm	-93.3 dBm
LTE-FDD B5 (10 MHz)	-97.0 dBm	-98.5 dBm	-99.5 dBm	-94.3 dBm
LTE-FDD B7 (10 MHz)	-96.0 dBm	-96.0 dBm	-98.5 dBm	-94.3 dBm
LTE-FDD B8 (10 MHz)	-98.5 dBm	-98.0 dBm	-101.0 dBm	-93.3 dBm
LTE-FDD B20 (10 MHz)	-97.5 dBm	-99.0 dBm	-101.0 dBm	-93.3 dBm
LTE-FDD B28 (10 MHz)	-96.0 dBm	-98.0 dBm	-99.0 dBm	-94.8 dBm
LTE-TDD B38 (10 MHz)	-96.5 dBm	-96.0 dBm	-98.5 dBm	-96.3 dBm

[10] SIMO is a smart antenna technology that uses a single antenna at the transmitter side and two antennas at the receiver side to improve Rx performance.
[11] As per 3GPP specification.

LTE-TDD B40 (10 MHz)	-96.5 dBm	-97.0 dBm	-99.5 dBm	-96.3 dBm
LTE-TDD B41 (10 MHz)	-96.0 dBm	-96.0 dBm	-98.5 dBm	-94.3 dBm

Table 25: EP06-A Conducted RF Receiving Sensitivity

Frequency	Primary (Typ.)	Diversity (Typ.)	SIMO [10] (Typ.)	SIMO [11] (Worst Case)
WCDMA B2	-109.5 dBm	-108.5 dBm	TBD	-106.7 dBm
WCDMA B4	-109 dBm	-108.5 dBm	TBD	-103.7 dBm
WCDMA B5	-109.5 dBm	-110 dBm	TBD	-104.7 dBm
LTE-FDD B2 (10 MHz)	-98.2 dBm	-97.7 dBm	-100.7 dBm	-94.3 dBm
LTE-FDD B4 (10 MHz)	-97.7 dBm	-97.8 dBm	-100.2 dBm	-96.3 dBm
LTE-FDD B5 (10 MHz)	-98.0 dBm	-98.1 dBm	-100.9 dBm	-94.3 dBm
LTE-FDD B7 (10 MHz)	-96.2 dBm	-97 dBm	-98.2 dBm	-94.3 dBm
LTE-FDD B12 (10 MHz)	-97.2 dBm	-97.8 dBm	-101.7 dBm	-93.3 dBm
LTE-FDD B13 (10 MHz)	-97.7 dBm	-98.1 dBm	-100.7 dBm	-93.3 dBm
LTE-FDD B25 (10 MHz)	-98.8 dBm	-98.5 dBm	-100.5 dBm	-92.8 dBm
LTE-FDD B26 (10 MHz)	-98.5 dBm	-99.2 dBm	-101.8 dBm	-93.8 dBm
LTE-FDD B30 (10 MHz)	-96.9 dBm	-97.8 dBm	-99.2 dBm	-95.3 dBm
LTE-FDD B66 (10 MHz)	-98.1 dBm	-97.9 dBm	-100.6 dBm	-95.8 dBm

6.4. Operating and Storage Temperatures

Table 26: Operating and Storage Temperatures

Parameter	Min.	Typ.	Max.	Unit
Operating Temperature Range [12]	-35	+25	+75	ºC
Extended Temperature Range [13]	-40	-	+85	ºC
Storage Temperature Range	-40	-	+90	ºC

6.5. Electrostatic Discharge

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

Table 27: Electrostatic Discharge Characteristics (Temperature: 25–30 °C, Humidity: 40 ±5 %)

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

[12] Within operating temperature range, the module is 3GPP compliant.
[13] Within this range, proper mounting, heating sinks and active cooling may be required to make certain functions of the module such as voice, SMS, data transmission, emergency call to be realized. Only one or more parameters like P_{out} might reduce in their value and exceed the specified tolerances. When the temperature returns to normal operating temperature levels, the module will meet 3GPP specifications again.

6.6. Power Consumption

The following table shows the power consumption of EP06-E and EP06-A.

Table 28: EP06-E Power Consumption

Description	Condition	Typ.	Unit
Sleep state	**AT+CFUN=0** (USB disconnected)	1.69	mA
	WCDMA PF = 64 (USB disconnected)	2.65	mA
	WCDMA PF = 128 (USB disconnected)	2.69	mA
	WCDMA PF = 256 (USB disconnected)	2.41	mA
	WCDMA PF = 512 (USB disconnected)	2.66	mA
	LTE-FDD PF = 32 (USB disconnected)	3.06	mA
	LTE-FDD PF = 64 (USB disconnected)	3.26	mA
	LTE-FDD PF = 128 (USB disconnected)	2.58	mA
	LTE-FDD PF = 256 (USB disconnected)	2.26	mA
	LTE-TDD PF = 32 (USB disconnected)	3.1	mA
	LTE-TDD PF = 64 (USB disconnected)	3.3	mA
	LTE-TDD PF = 128 (USB disconnected)	2.63	mA
	LTE-TDD PF = 256 (USB disconnected)	2.29	mA
Idle state	WCDMA PF = 64 (USB disconnected)	24	mA
	WCDMA PF = 64 (USB connected)	32.12	mA
	LTE-FDD PF = 64 (USB disconnected)	19.2	mA
	LTE-FDD PF = 64 (USB connected)	28.5	mA
	LTE-TDD PF = 64 (USB disconnected)	21.3	mA
	LTE-TDD PF = 64 (USB connected)	28.6	mA
WCDMA data	WCDMA B1 HSDPA CH10700 @ 23.2 dBm	621.1	mA

transfer (GNSS OFF)	WCDMA B1 HSUPA CH10700 @ 23.0 dBm	637.8	mA
	WCDMA B3 HSDPA CH 1338 @ 23.4 dBm	859.6	mA
	WCDMA B3 HSUPA CH 1338 @ 22.9 dBm	875.5	mA
	WCDMA B5 HSDPA CH4408 @ 23.0 dBm	608.7	mA
	WCDMA B5 HSUPA CH4408 @ 22.8 dBm	614.8	mA
	WCDMA B8 HSDPA CH3012 @ 22.9 dBm	693.5	mA
	WCDMA B8 HSUPA CH3012 @ 22.7 dBm	709.9	mA
LTE data transfer (GNSS OFF)	LTE-FDD B1 CH300 @ 23.1 dBm	681.3	mA
	LTE-FDD B3 CH1575 @ 22.5 dBm	905.6	mA
	LTE-FDD B5 CH2525 @ 22.9 dBm	625.7	mA
	LTE-FDD B7 CH3100 @ 23.1 dBm	1042.1	mA
	LTE-FDD B8 CH3625 @ 22.9 dBm	763.3	mA
	LTE-FDD B20 CH6300 @ 22.5 dBm	778.9	mA
	LTE-FDD B28 CH9510 @ 23.1 dBm	788.2	mA
	LTE-TDD B38 CH38000 @ 23.1 dBm	452.1	mA
	LTE-TDD B40 CH39150 @ 23.4 dBm	443.5	mA
	LTE-TDD B41 CH40740 @ 23.1 dBm	453.3	mA
2CA data transfer	LTE-FDD B1 + B1 @ 23.5 dBm	770.5	mA
	LTE-FDD B1 + B5 @ 23.3 dBm	823.1	mA
	LTE-FDD B1 + B8 @ 22.5 dBm	820.3	mA
	LTE-FDD B1 + B20 @ 22.6 dBm	832.3	mA
	LTE-FDD B1 + B28 @ 23.2 dBm	920.3	mA
	LTE-FDD B3 + B3 @ 23.37 dBm	986.8	mA
	LTE-FDD B3 + B5 @ 23.1 dBm	1010.7	mA
	LTE-FDD B3 + B7 @ 22.9 dBm	1046.8	mA

	LTE-FDD B3 + B8 @ 22.8 dBm	1017.1	mA
	LTE-FDD B3 + B20 @ 22.7 dBm	1060.8	mA
	LTE-FDD B3 + B28 @ 22.6 dBm	1079.3	mA
	LTE-FDD B7 + B5 @ 23.3 dBm	991.3	mA
	LTE-FDD B7 + B7 @ 23.3 dBm	1022.2	mA
	LTE-FDD B7 + B8 @ 23.3 dBm	1030.9	mA
	LTE-FDD B7 + B20 @ 23.3 dBm	1095.8	mA
	LTE-FDD B7 + B28 @ 23.2 dBm	1111.2	mA
	LTE-FDD B20 + B32 @ 23.2 dBm	805.65	mA
	LTE-TDD B38 + B38 @ 23.1 dBm	530.68	mA
	LTE-TDD B40 + B40 @ 22.7 dBm	462.23	mA
	LTE-TDD B41 + B41 @ 23.4 dBm	506.37	mA
WCDMA voice call	WCDMA B1 CH10700 @ 23.2 dBm	622.18	mA
	WCDMA B3 CH1122 @ 23.2 dBm	862.14	mA
	WCDMA B5 CH4408 @ 22.9 dBm	611.89	mA
	WCDMA B8 CH3012 @ 22.9 dBm	699.91	mA

Table 29: EP06-A Power Consumption

Description	Condition	Typ.	Unit
Sleep state	**AT+CFUN=0** (USB disconnected)	1.88	mA
	WCDMA PF = 64 (USB disconnected)	2.4	mA
	WCDMA PF = 128 (USB disconnected)	2.29	mA
	WCDMA PF = 256 (USB disconnected)	2.29	mA
	WCDMA PF = 512 (USB disconnected)	2.28	mA
	LTE-FDD PF = 32 (USB disconnected)	3.5	mA

	LTE-FDD PF = 64 (USB disconnected)	3.47	mA
	LTE-FDD PF = 128 (USB disconnected)	3.5	mA
	LTE-FDD PF = 256 (USB disconnected)	3.49	mA
	LTE-TDD PF = 32 (USB disconnected)	3.67	mA
	LTE-TDD PF = 64 (USB disconnected)	3.6	mA
	LTE-TDD PF = 128 (USB disconnected)	3.2	mA
	LTE-TDD PF = 256 (USB disconnected)	3.54	mA
Idle state	WCDMA PF = 64 (USB disconnected)	21.2	mA
	WCDMA PF = 64 (USB connected)	31.3	mA
	LTE-FDD PF = 64 (USB disconnected)	22.7	mA
	LTE-FDD PF = 64 (USB connected)	31.1	mA
	LTE-TDD PF = 64 (USB disconnected)	23.9	mA
	LTE-TDD PF = 64 (USB connected)	31.2	mA
WCDMA data transfer (GNSS OFF)	WCDMA B2 HSDPA CH9400 @ 23.1 dBm	563.4	mA
	WCDMA B2 HSUPA CH9400 @ 23.1 dBm	552.5	mA
	WCDMA B4 HSDPA CH1412 @ 22.87 dBm	648.5	mA
	WCDMA B4 HSUPA CH1412 @ 22.7 dBm	647.4	mA
	WCDMA B5 HSDPA CH4407 @ 22.7 dBm	565.1	mA
	WCDMA B5 HSUPA CH4407 @ 22.7 dBm	588.2	mA
LTE data transfer (GNSS OFF)	LTE-FDD B2 CH900 @ 23.8 dBm	723.5	mA
	LTE-FDD B4 CH 2175 @ 23.8 dBm	837.5	mA
	LTE-FDD B5 CH2525 @ 23.5 dBm	654.5	mA
	LTE-FDD B7 CH3100 @ 23.4 dBm	1002	mA
	LTE-FDD B12 CH5095 @ 23.5 dBm	615	mA
	LTE-FDD B13 CH5230 @ 23.5 dBm	670.7	mA

	LTE-FDD B25 CH8365 @ 24.3 dBm	778.8	mA
	LTE-FDD B26 CH8865 @ 23.4 dBm	702.3	mA
	LTE-FDD B30 CH9820 @ 23.4 dBm	802.6	mA
	LTE-FDD B66 CH132322 @ 23.8 dBm	850.1	mA
2CA data transfer	LTE-FDD B2 + B2 @ 20.66 dBm	737.4	mA
	LTE-FDD B2 + B5 @ 20.98 dBm	699.6	mA
	LTE-FDD B2 + B12 @ 20.87 dBm	700.4	mA
	LTE-FDD B2 + B13 @ 21.06 dBm	698	mA
	LTE-FDD B2 + B29 @ 21.0 dBm	699.8	mA
	LTE-FDD B4 + B4 @ 21.55 dBm	772.4	mA
	LTE-FDD B4 + B5 @ 20.93 dBm	810.1	mA
	LTE-FDD B4 + B12 @ 20.75 dBm	809.2	mA
	LTE-FDD B4 + B13 @ 20.73 dBm	814.5	mA
	LTE-FDD B4 + B29 @ 20.77 dBm	808.7	mA
	LTE-FDD B7 + B5 @ 20.67 dBm	909.2	mA
	LTE-FDD B7 + B7 @ 20.63 dBm	903.5	mA
	LTE-FDD B7 + B12 @ 20.47 dBm	915.8	mA
	LTE-FDD B7 + B26 @ 20.55 dBm	938	mA
	LTE-FDD B25 + B5 @ 20.94 dBm	695.4	mA
	LTE-FDD B25 + B12 @ 20.55 dBm	697.5	mA
	LTE-FDD B25 + B25 @ 20.54 dBm	762.6	mA
	LTE-FDD B25 + B26 @ 21.06 dBm	721.4	mA
	LTE-FDD B30 + B5 @ 20.56 dBm	794.4	mA
	LTE-FDD B30 + B12 @ 20.43 dBm	799.4	mA
	LTE-FDD B30 + B29 @ 20.31 dBm	806.1	mA

	LTE-FDD B66 + B5 @ 20.06 dBm	732.9	mA
	LTE-FDD B66 + B12 @ 20.03 dBm	734	mA
	LTE-FDD B66 + B29 @ 20.05 dBm	736.1	mA
	LTE-FDD B66 + B66 @ 19.93 dBm	801.7	mA
	LTE-FDD B66 + B13 @ 20.03 dBm	739.7	mA
WCDMA voice call	WCDMA B2 CH9400 @ 24.2 dBm	608.1	mA
	WCDMA B4 CH1412 @ 23.8 dBm	720.8	mA
	WCDMA B5 CH4407 @ 23.5 dBm	619.6	mA

6.7. Notification

Please follow the principles below in the module application.

6.7.1. Coating

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.

6.7.2. Cleaning

Avoid using ultrasonic technology for module cleaning since it can damage crystals inside the module.

6.7.3. Installing

It is recommended to fix the module firmly when the module is inserted into a socket.

7 Mechanical Dimensions

This chapter describes the mechanical dimensions of the module. All dimensions are measured in millimeter (mm), and the dimensional tolerances are ±0.15 mm unless otherwise specified.

7.1. Mechanical Dimensions

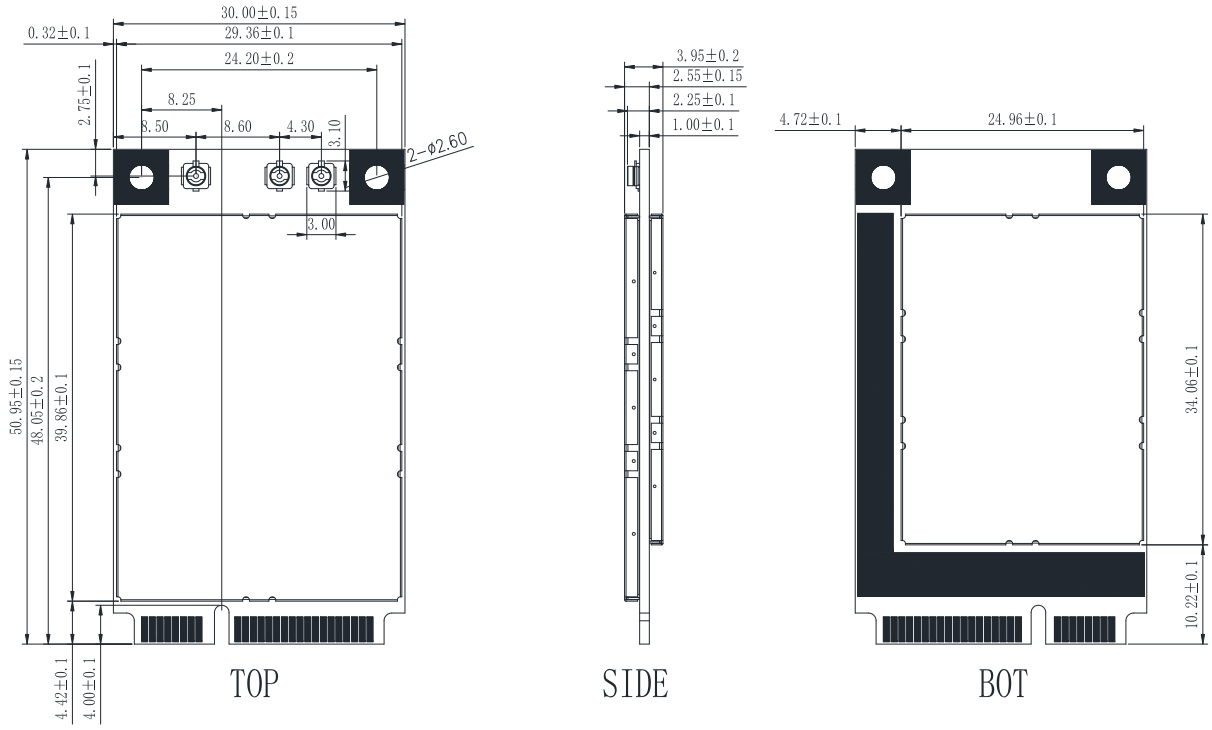


Figure 16: Mechanical Dimensions of EP06 Series

7.2. Top and Bottom Views of the Module

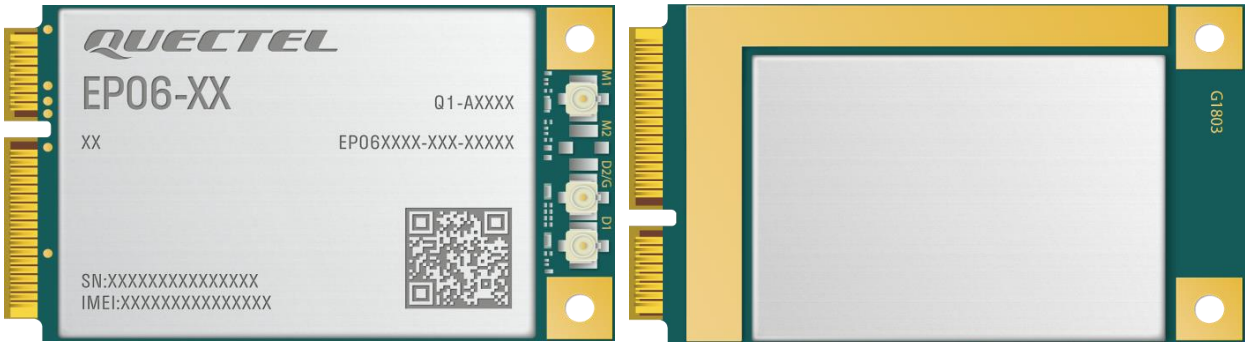


Figure 17: Top and Bottom Views of the Module

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.

7.3. Packaging Specification

This chapter describes only the key parameters and process of packaging. All figures below are for reference only. The appearance and structure of the packaging materials are subject to the actual delivery.

The module adopts blister tray packaging and details are as follow:

7.3.1. Packaging Tray

Dimension details are as follow:

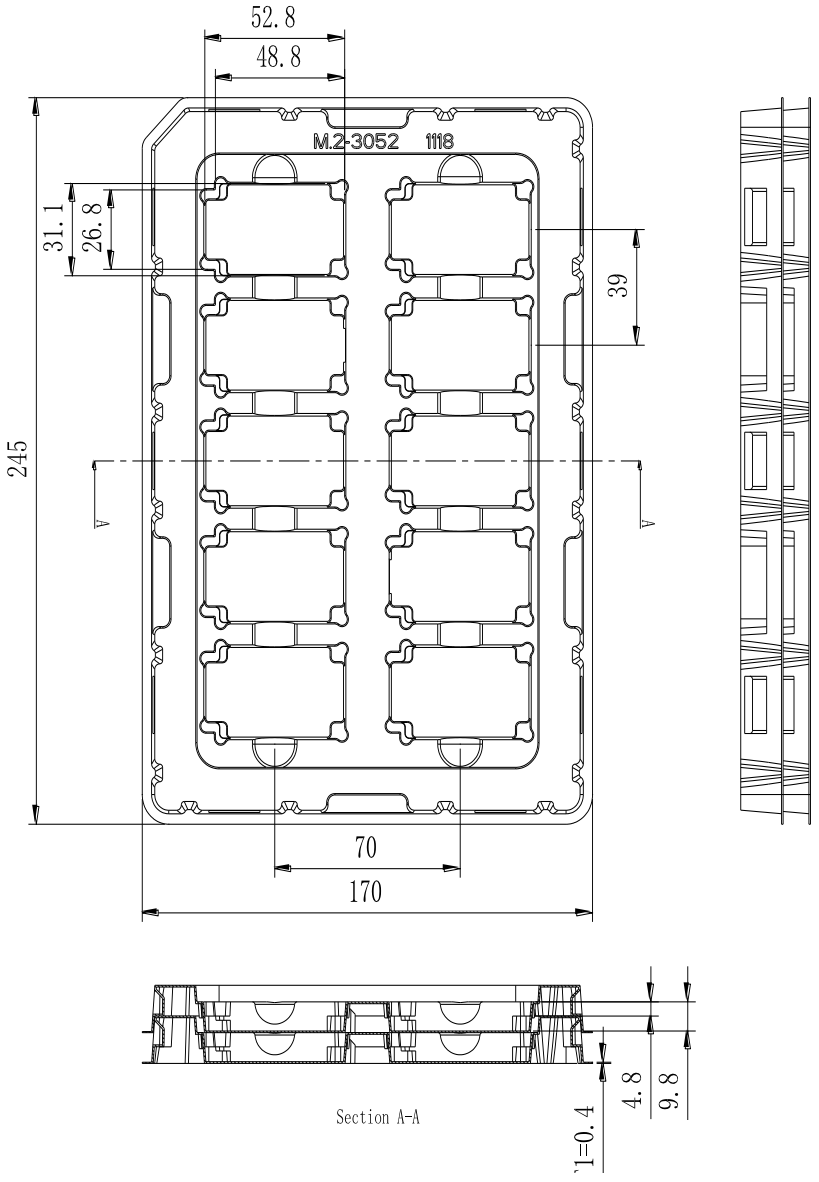
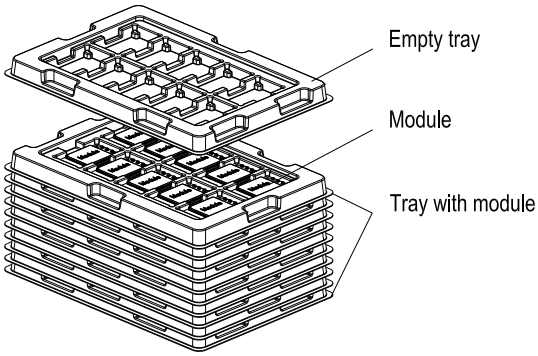
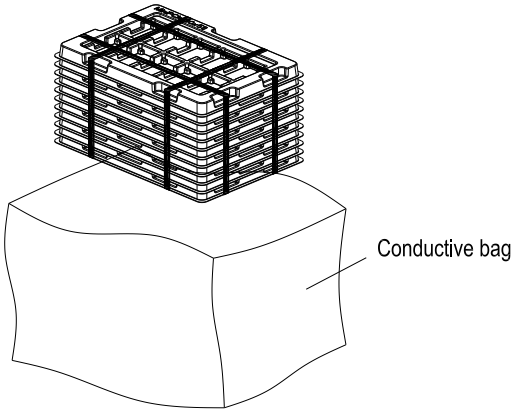


Figure 18: Blister Tray Dimension Drawing

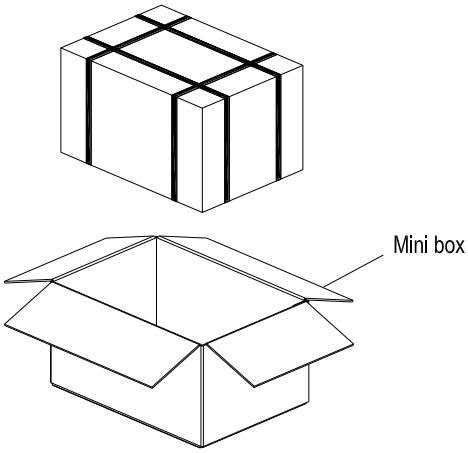
7.3.2. Packaging Process



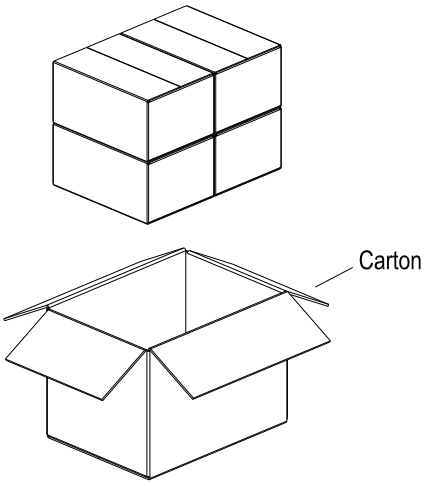
Each blister tray packs 10 modules. Stack 10 blister trays with modules together, and put 1 empty blister tray on the top.



Packing 11 blister trays together and then put blister trays into conductive bag, seal and pack the conductive bag.



Put the seal-packed blister trays into the mini box. 1 mini box can pack 100 modules.



Put 4 packaged mini boxes into 1 carton box and then seal it. 1 carton box can pack 400 modules.

Figure 19: Packaging Process

8 Appendix References

Table 30: Related Documents

Document Name
[1] Quectel_EPXX_EVB_User_Guide
[2] Quectel_EP06&EG06&EM06_AT_Commands_Manual
[3] Quectel_EP06&EG06&EM06_GNSS_AT_Commands_Manual

Table 31: Terms and Abbreviations

Abbreviation	Description
AMR	Adaptive Multi-rate
bps	Bits per Second
CHAP	Challenge Handshake Authentication Protocol
DFOTA	Delta Firmware Upgrade Over-the-Air
DL	Downlink
ESD	Electrostatic Discharge
FDD	Frequency Division Duplex
GLONASS	Global Navigation Satellite System (Russia)
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HSDPA	High Speed Downlink Packet Access
HSPA	High Speed Packet Access
HSUPA	High Speed Uplink Packet Access

kbps	Kilo Bits per Second
LTE-A	Long Term Evolution-Advanced
Mbps	Million Bits per Second
ME	Mobile Equipment (Module)
MIMO	Multiple-Input Multiple-Output
MMS	Multimedia Messaging Service
MO	Mobile Originated
MT	Mobile Terminated
PAP	Password Authentication Protocol
PCM	Pulse Code Modulation
PDU	Protocol Data Unit
PPP	Point-to-Point Protocol
RF	Radio Frequency
Rx	Receive
SIMO	Single Input Multiple Output
SMS	Short Message Service
UART	Universal Asynchronous Receiver/Transmitter
UL	Uplink
URC	Unsolicited Result Code
(U)SIM	(Universal) Subscriber Identification Module
Vmax	Maximum Voltage
Vmin	Minimum Voltage
Vnom	Nominal Voltage
WCDMA	Wideband Code Division Multiple Access