

EG25-G Mini PCIe

Hardware Design

LTE Standard Module Series

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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	2019-11-21	Lorry XU/ Ethan SHAN	Initial
1.1	2019-07-05	Lorry XU/ Ethan SHAN	<ol style="list-style-type: none"> Deleted notes of EG25-G Mini PCIe's Telematics and Data-only versions because Telematics version is default. Updated supported protocols and USB serial driver (Table 2). Updated functional diagram with integrated (U)SIM card connector, which is optional (Figure 1). Updated pin assignment (Figure 2). Updated the pin name and comment of pins 3 and 5 (Table 4). Updated the power domain of USIM_PRESENCE (Table 6). Updated reference circuit of (U)SIM interface with an 8-pin (U)SIM card connector (Figure 4). Updated reference circuit of USB interface (Figure 6). Updated the description of W_DISABLE# signal (Chapter 3.8.3). Updated conducted RF receiving sensitivity (Table 19). Updated current consumption (Table 23). Updated GNSS current consumption (Table 24). Updated mechanical dimensions of EG25-G Mini PCIe (Figure 18).
1.2	2020-04-29	Ward WANG/ Ethan SHAN	<ol style="list-style-type: none"> Reserved COEX UART Interface. Updated supported protocols (Table 2). Added operating modes of the module (Chapter 3.1).

1 Introduction

This document defines EG25-G Mini PCIe module, and describes its air interfaces and hardware interfaces which are connected with your applications.

With this document, you can quickly understand module interface specifications, electrical and mechanical details, as well as other related information of the module. The document, coupled with application notes and user guides, makes it easy to design and set up wireless applications with the module.

2 Product Overview

2.1. General Description

EG25-G Mini PCIe module provides data connectivity on LTE-FDD, LTE-TDD, DC-HSDPA, HSPA+, HSDPA, HSUPA, WCDMA, EDGE and GPRS networks with PCI Express Mini Card 1.2 standard interface. It supports embedded operating systems, such as Linux and Android, and provides audio, high-speed data transmission, and GNSS functionalities to meet your specific application demands.

EG25-G Mini PCIe module can be applied in the following fields:

- PDA and laptop computer
- Remote monitor system
- Wireless POS system
- Intelligent meter reading system
- Wireless router and switch
- Other wireless terminal devices

2.2. Module Description

The following table shows the supported frequency bands, GNSS, and digital audio functions of EG25-G Mini PCIe module.

Table 1: Description of EG25-G Mini PCIe

Frequency Bands/GNSS/ Digital Audio	EG25-G Mini PCIe
LTE-FDD	B1/B2/B3/B4/B5/B7/B8/B12/B13/B18/B19/B20/B25/B26/B28
LTE-TDD	B38/B39/B40/B41
WCDMA	B1/B2/B4/B5/B6/B8/B19
GSM	850/900/1800/1900

GNSS (Optional)	GPS, GLONASS, BeiDou (COMPASS), Galileo, QZSS
Digital Audio (PCM)	Supported

2.3. Key Features

The following table describes the detailed features of EG25-G Mini PCIe module.

Table 2: Key Features

Features	Description
Function Interface	PCI Express Mini Card 1.2 Standard Interface
Power Supply	<ul style="list-style-type: none"> Supply voltage: 3.0–3.6 V Typical supply voltage: 3.3 V
Transmitting Power	<ul style="list-style-type: none"> Class 4 (33 dBm \pm2 dB) for GSM850 Class 4 (33 dBm \pm2 dB) for EGSM900 Class 1 (30 dBm \pm2 dB) for DCS1800 Class 1 (30 dBm \pm2 dB) for PCS1900 Class E2 (27 dBm \pm3 dB) for GSM850 8-PSK Class E2 (27 dBm \pm3 dB) for EGSM900 8-PSK Class E2 (26 dBm \pm3 dB) for DCS1800 8-PSK Class E2 (26 dBm \pm3 dB) for PCS1900 8-PSK Class 3 (24 dBm \pm1/-3 dB) for WCDMA bands Class 3 (23 dBm \pm2 dB) for LTE-FDD bands Class 3 (23 dBm \pm2 dB) for LTE-TDD bands
LTE Features	<ul style="list-style-type: none"> Supports up to non-CA Cat 4 FDD and TDD Supports 1.4/3/5/10/15/20 MHz RF bandwidth Supports MIMO in DL direction Max. transmission data rates: LTE-FDD: 150 Mbps (DL), 50 Mbps (UL) LTE-TDD: 130 Mbps (DL), 30 Mbps (UL)
UMTS Features	<ul style="list-style-type: none"> Supports 3GPP Rel-8 DC-HSDPA, HSPA+, HSDPA, HSUPA and WCDMA Supports QPSK, 16QAM and 64QAM modulation Max. transmission data rates: DC-HSDPA: 42 Mbps (DL) HSUPA: 5.76 Mbps (UL) WCDMA: 384 kbps (DL), 384 kbps (UL)

GSM Features	GPRS: <ul style="list-style-type: none"> • Supports GPRS multi-slot class 33 (33 by default) • Coding scheme: CS-1, CS-2, CS-3 and CS-4 • Max. 107 kbps (DL), Max. 85.6 kbps (UL)
	EDGE: <ul style="list-style-type: none"> • Supports EDGE multi-slot class 33 (33 by default) • Supports GMSK and 8-PSK for different MCS (Modulation and Coding Scheme) • Downlink coding schemes: MCS 1-9 • Uplink coding schemes: MCS 1-9 • Max. 296 kbps (DL), Max. 236.8 kbps (UL)
Internet Protocol Features	<ul style="list-style-type: none"> • Supports TCP/UDP/PPP/FTP/FTPS/HTTP/HTTPS/NTP/PING/QMI/NITZ/SMTP/SSL/MQTT/CMUX/SMTPS/FILE/MMS protocols • Supports PAP and CHAP for PPP connections
SMS	<ul style="list-style-type: none"> • Text and PDU modes • Point-to-point MO and MT • SMS cell broadcast • SMS storage: ME by default
(U)SIM Interface	Supports USIM/SIM card: 1.8 V, 3.0 V
UART Interface	Main UART: <ul style="list-style-type: none"> • Supports RTS and CTS hardware flow control • Baud rate can reach up to 230400 bps, 115200 bps by default • Used for AT command communication and data transmission
Audio Features	<ul style="list-style-type: none"> • Supports one digital audio interface: PCM interface • GSM: HR/FR/EFR/AMR/AMR-WB • WCDMA: AMR/AMR-WB • LTE: AMR/AMR-WB • Supports echo cancellation and noise suppression
PCM Interface	<ul style="list-style-type: none"> • Supports 16-bit linear data format • Supports long frame synchronization and short frame synchronization • Supports master and slave modes, but must be the master for long frame synchronization
USB Interface	<ul style="list-style-type: none"> • Compliant with USB 2.0 specification (slave only); the data transfer rate can reach up to 480 Mbps • Used for AT command communication, data transmission, firmware upgrade, software debugging and GNSS NMEA output • Supports USB serial drivers for: Windows 7/8/8.1/10, Linux 2.6–5.12, Android 4.x–11.x, etc.
Antenna Connectors	Includes main antenna, diversity antenna and GNSS antenna receptacle connectors
Rx-diversity (Optional)	Supports LTE/WCDMA Rx-diversity

GNSS Features	<ul style="list-style-type: none"> ● Protocol: <i>NMEA 0183</i> ● Data update rate: 1 Hz by default
AT Commands	<ul style="list-style-type: none"> ● Compliant with <i>3GPP TS 27.007</i>, <i>3GPP TS 27.005</i> ● Quectel enhanced AT commands
Physical Characteristics	<ul style="list-style-type: none"> ● Size: 51.0 mm × 30.0 mm × 4.9 mm ● Weight: approx. 9.8 g
Temperature Range	<ul style="list-style-type: none"> ● Operating temperature range: -35 to +75 °C ¹ ● Extended temperature range: -40 to +80 °C ² ● Storage temperature range: -40 to +90 °C
Firmware Upgrade	USB 2.0 interface or DFOTA
RoHS	All hardware components are fully compliant with EU RoHS directive

2.4. Functional Diagram

The following figure shows the block diagram of EG25-G Mini PCIe.

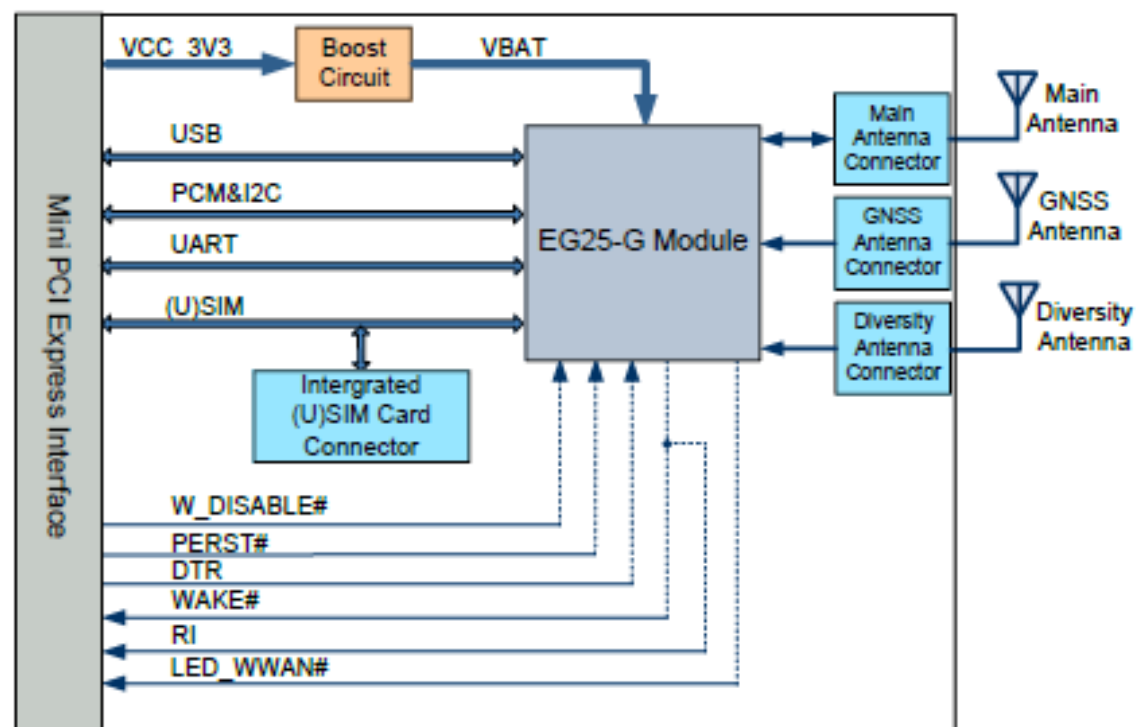


Figure 1: Functional Diagram

¹ Within the operating temperature range, the module meets 3GPP specifications.

² Within the extended temperature range, the module remains the ability to establish and maintain functions such as voice, SMS, and data transmission, without any unrecoverable malfunction. Radio spectrum and radio network are not influenced, while one or more specifications, such as P_{out} , may exceed the specified tolerances of 3GPP. When the temperature returns to the operating temperature range, the module meets 3GPP specifications again.

NOTE

There are two types of EG25-G Mini PCIe, i.e., modules with or without an integrated (U)SIM card connector. Sharing the same (U)SIM bus with the external one that connects to the Mini PCI Express (U)SIM interface, the integrated (U)SIM card connector does not support (U)SIM card hot-plug detect. The two (U)SIM card connectors cannot be used simultaneously. The external one functions normally when the integrated (U)SIM card connector is not in use.

3 Application Interfaces

The physical connections and signal levels of EG25-G Mini PCIe comply with *PCI Express Mini Card Electromechanical Specification*. This chapter mainly describes the definition and application of the following interfaces/pins of EG25-G Mini PCIe:

- Power supply
- (U)SIM interface
- USB interface
- UART interface
- PCM and I2C interfaces
- Control and indication interfaces

3.1. Pin Assignment

The following figure shows the pin assignment of the module. The top side contains EG25-G module and antenna connectors.

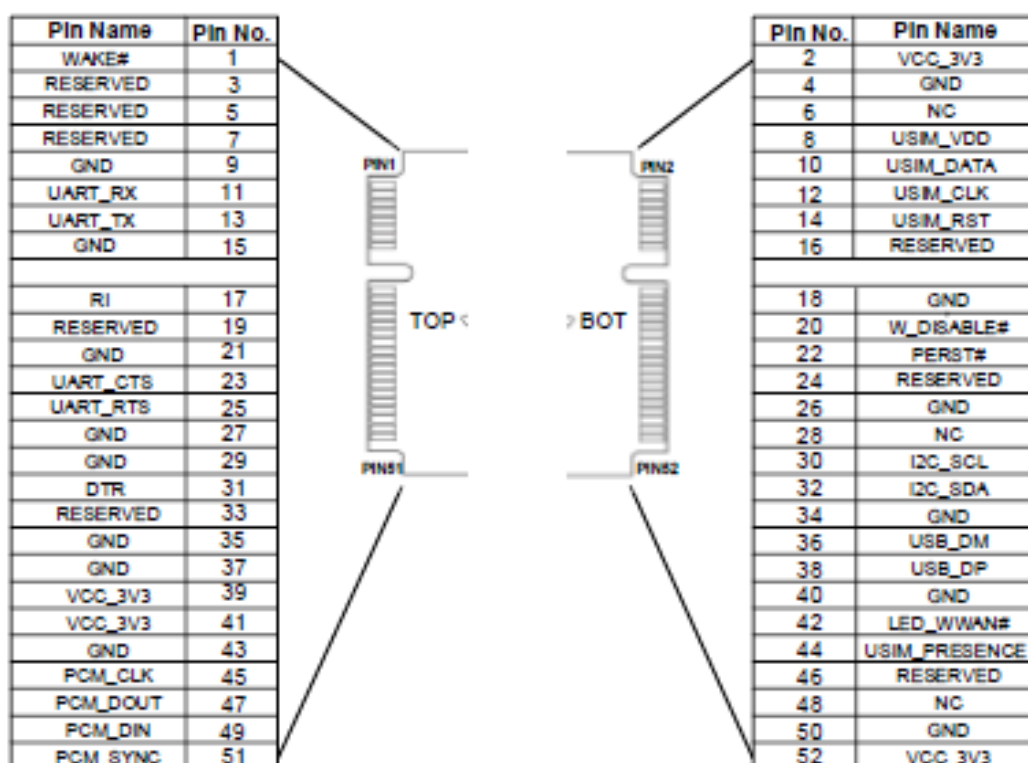


Figure 2: Pin Assignment

3.2. Pin Description

The following tables show the definition and description of the 52 pins on EG25-G Mini PCIe.

Table 3: I/O Parameters Definition

Type	Description
AIO	Analog Input/Output
DI	Digital Input
DO	Digital Output
DIO	Digital Input/Output
OC	Open Collector
PI	Power Input
PO	Power Output

Table 4: Pin Description

Pin No.	Mini PCI Express Standard Name	EG25-G Mini PCIe Pin Name	I/O	Description	Comment
1	WAKE#	WAKE#	OC	Wake up the host	
2	3.3Vaux	VCC_3V3	PI	3.0–3.6 V, typ. 3.3 V DC supply	
3	COEX1	RESERVED		Reserved	It is prohibited to be pulled up to high level before startup.
4	GND	GND		Mini card ground	
5	COEX2	RESERVED		Reserved	It is prohibited to be pulled up to high level before startup.
6	1.5V	NC		Not connected	
7	CLKREQ#	RESERVED		Reserved	
8	UIM_PWR	USIM_VDD	PO	(U)SIM card power supply	
9	GND	GND		Mini card ground	
10	UIM_DATA	USIM_DATA	DIO	(U)SIM card data	
11	REFCLK-	UART_RX	DI	UART receive	Connect to DTE's Tx.
12	UIM_CLK	USIM_CLK	DO	(U)SIM card clock	
13	REFCLK+	UART_TX	DO	UART transmit	Connect to DTE's Rx.
14	UIM_RESET	USIM_RST	DO	(U)SIM card reset	
15	GND	GND		Mini card ground	
16	UIM_VPP	RESERVED		Reserved	
17	RESERVED	RI	DO	Ring indication	
18	GND	GND		Mini card ground	
19	RESERVED	RESERVED		Reserved	

20	W_DISABLE#	W_DISABLE#	DI	Airplane mode control	Pulled up by default. Active LOW.
21	GND	GND		Mini card ground	
22	PERST#	PERST#	DI	Fundamental reset	Pulled up by default. Active LOW.
23	PERn0	UART_CTS	DI	DCE clear to send signal from DTE	Connects to DTE's RTS.
24	3.3Vaux	RESERVED		Reserved	
25	PERp0	UART_RTS	DO	DCE request to send signal from DTE	Connects to DTE's CTS.
26	GND	GND		Mini card ground	
27	GND	GND		Mini card ground	
28	1.5V	NC		Not connected	
29	GND	GND		Mini card ground	
30	SMB_CLK	I2C_SCL	DO	I2C serial clock (for external Codec)	Requires external pull-up to 1.8 V.
31	PETn0	DTR	DI	Sleep mode control	
32	SMB_DATA	I2C_SDA	DIO	I2C serial data (for external Codec)	Requires external pull-up to 1.8 V.
33	PETp0	RESERVED		Reserved	
34	GND	GND		Mini card ground	
35	GND	GND		Mini card ground	
36	USB_D-	USB_DM	AIO	USB differential data (-)	Requires differential impedance of 90 Ω .
37	GND	GND		Mini card ground	
38	USB_D+	USB_DP	AIO	USB differential data (+)	Requires differential impedance of 90 Ω .

39	3.3Vaux	VCC_3V3	PI	3.0–3.6 V, typ. 3.3 V DC supply
40	GND	GND		Mini card ground
41	3.3Vaux	VCC_3V3	PI	3.0–3.6 V, typ. 3.3 V DC supply
42	LED_WWAN#	LED_WWAN#	OC	LED signal for indicating the network status of the module Active LOW.
43	GND	GND		Mini card ground
44	LED_WLAN#	USIM_ PRESENCE	DI	(U)SIM card hot-plug detect
45	RESERVED	PCM_CLK	DIO	PCM clock
46	LED_WPAN#	RESERVED		Reserved
47	RESERVED	PCM_DOUT	DO	PCM data output
48	1.5V	NC		Not connected
49	RESERVED	PCM_DIN	DI	PCM data input
50	GND	GND		Mini card ground
51	RESERVED	PCM_SYNC	DIO	PCM frame sync
52	3.3Vaux	VCC_3V3	PI	3.0–3.6 V, typ. 3.3 V DC supply

NOTE

Keep all NC, RESERVED and unused pins unconnected.

3.3. Operating Modes

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

Table 5: Overview of Operating Modes

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

3.4. Power Saving

3.4.1. Sleep Mode

EG25-G Mini PCIe is able to reduce its current consumption to a minimum value in sleep mode. There are three preconditions must be met to make the module enter sleep mode.

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

3.4.2. Airplane Mode

When the module enters airplane mode, the RF function will be disabled, and all AT commands related to it will be inaccessible. For more details, refer to *Chapter 3.10.2*.

3.5. Power Supply

The following table shows the definition of VCC_3V3 pins and ground pins.

Table 6: Definition of VCC_3V3 and GND Pins

Pin Name	Pin No.	I/O	Power Domain	Description
VCC_3V3	2, 39, 41, 52	PI	3.0–3.6 V	Typ. 3.3 V DC supply
GND	4, 9, 15, 18, 21, 26, 27, 29, 34, 35, 37, 40, 43, 50			

The typical supply voltage of EG25-G Mini PCIe is 3.3 V. In the 2G network, the input peak current may reach 3.5 A during the transmitting time. Therefore, the power supply must be able to provide a rated output current of 3.5 A at least, and a bypass capacitor of no less than 470 μF with low ESR should be used to prevent the voltage from dropping. If a switching power supply is used to power the module, the power device (e.g., MIC29502WU in the figure below) and the routing traces of the switching power supply should avoid the antennas as much as possible to prevent EMI interference.

The following figure shows a reference design of power supply where R2 and R3 are 1% tolerance resistors and C3 is a low ESR capacitor.

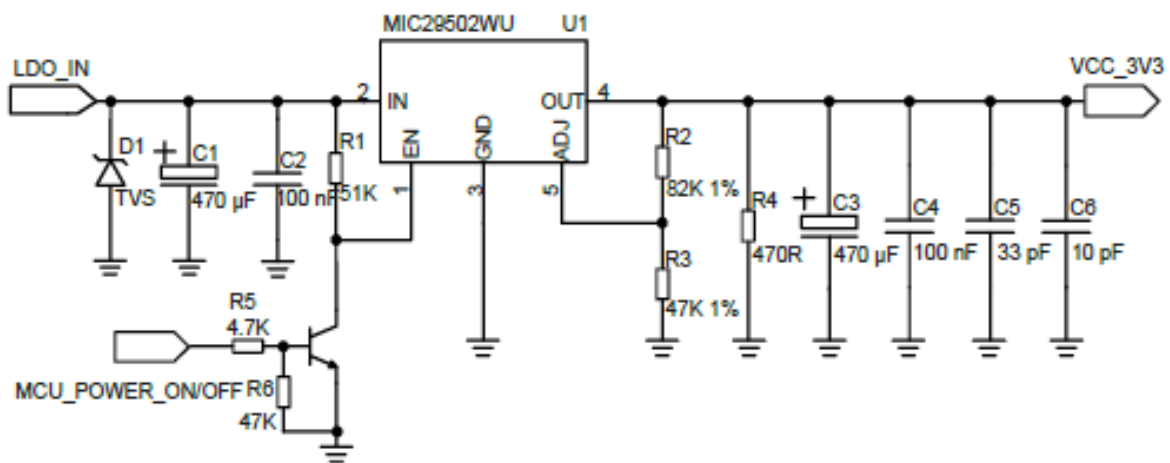


Figure 3: Reference Circuit of Power Supply

3.6. (U)SIM Interface

The (U)SIM interface circuitry meets ETSI and IMT-2000 requirements. Either 1.8 V or 3.0 V (U)SIM card is supported. The following table shows the pin definition of (U)SIM interface.

Table 7: Pin Definition of (U)SIM Interface

Pin Name	Pin No.	I/O	Power Domain	Description
USIM_VDD	8	PO	1.8/3.0 V	(U)SIM card power supply
USIM_DATA	10	DIO	1.8/3.0 V	(U)SIM card data
USIM_CLK	12	DO	1.8/3.0 V	(U)SIM card clock
USIM_RST	14	DO	1.8/3.0 V	(U)SIM card reset
USIM_PRESENCE	44	DI	1.8 V	(U)SIM card hot-plug detect

EG25-G Mini PCIe supports (U)SIM card hot-plug via the USIM_PRESENCE pin. The function supports low-level and high-level detections. Disabled by default, it can be configured via **AT+QSIMDET**. See *document [1]* for details about the command.

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

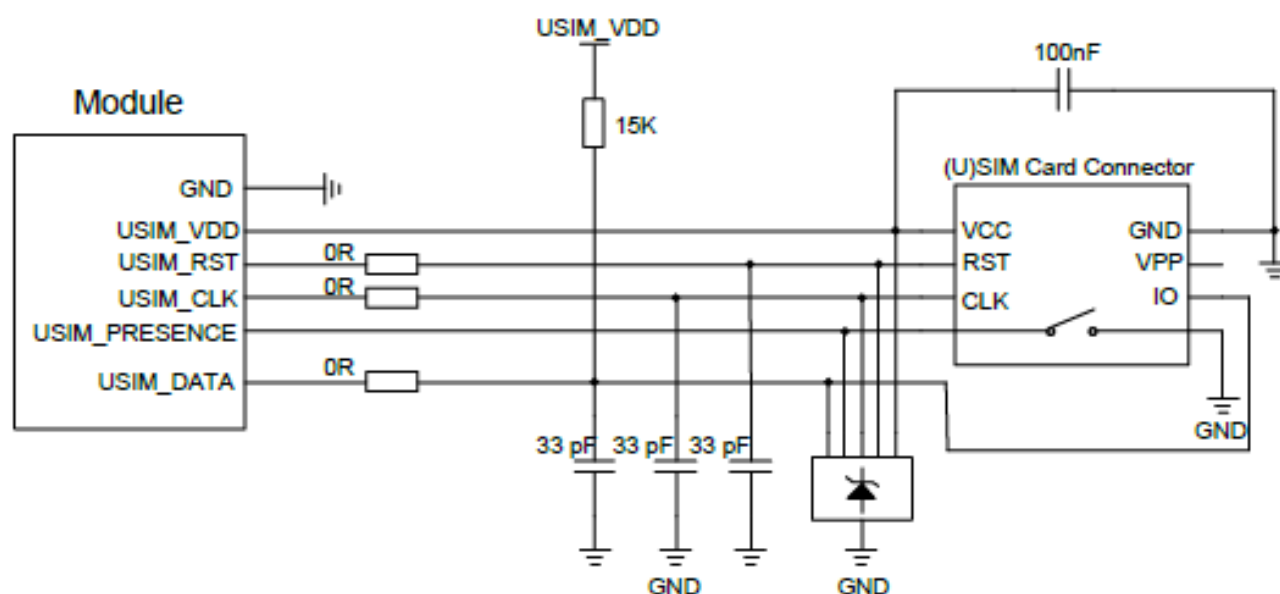


Figure 4: Reference Circuit of (U)SIM Interface with an 8-pin (U)SIM Card Connector

If (U)SIM card hot-plug detect 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.

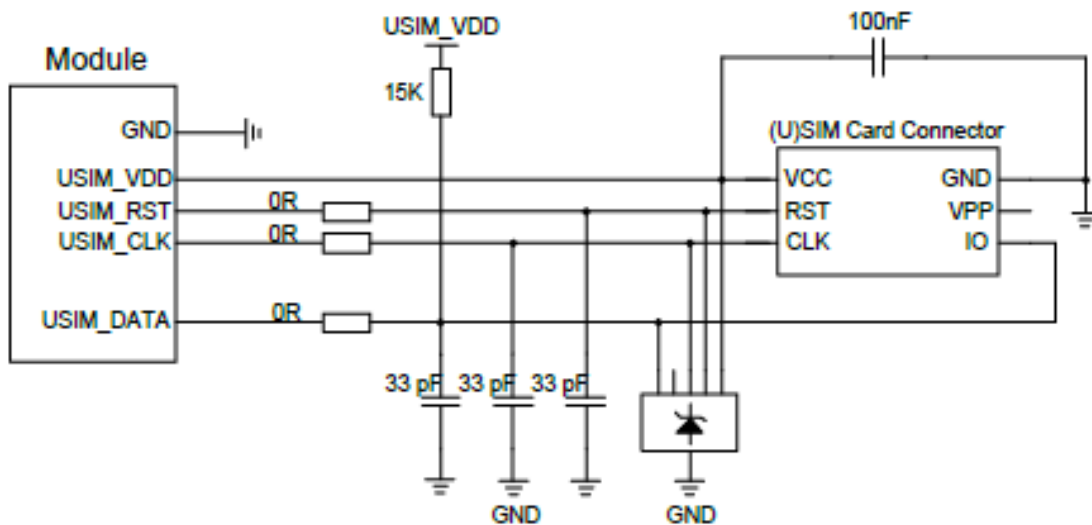


Figure 5: Reference Circuit of (U)SIM Interface with a 6-pin (U)SIM Card Connector

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

- Place the (U)SIM card connector as close to the module as possible. Keep the trace length as less than 200 mm as possible.
- Keep (U)SIM card signals away from RF and power supply traces.
- 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 with parasitic capacitance not exceeding 15 pF.
- The 0 Ω resistors should be added in series between the module and the (U)SIM card connector 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 it should be placed close to the (U)SIM card connector.

NOTE

There are two types of EG25-G Mini PCIe, i.e., modules with or without an integrated (U)SIM card connector. Sharing the same (U)SIM bus with the external one that connects to the Mini PCI Express (U)SIM interface, the integrated (U)SIM card connector does not support (U)SIM card hot-plug detect. The two (U)SIM card connectors cannot be used simultaneously. The external one functions normally when the integrated (U)SIM card connector is not in use.

3.7. USB Interface

EG25-G Mini PCIe provides one integrated Universal Serial Bus (USB) interface which complies with USB 2.0 specification. It can only be used as a slave device. Meanwhile, it supports high-speed (480 Mbps) mode and full-speed (12 Mbps) mode.

The USB interface is used for AT command communication, data transmission, GNSS NMEA output, software debugging and firmware upgrade.

The following table shows the pin definition of USB interface.

Table 8: Pin Definition of USB Interface

Pin Name	Pin No.	I/O	Description	Comment
USB_DM	36	AIO	USB differential data (-)	Requires differential impedance of 90 Ω .
USB_DP	38	AIO	USB differential data (+)	Requires differential impedance of 90 Ω .

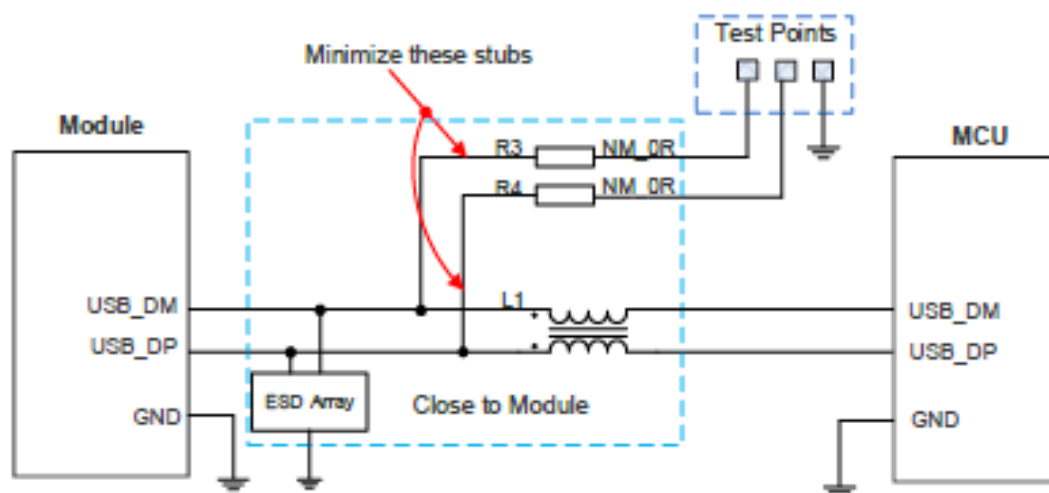


Figure 6: Reference Circuit of USB Interface

A common mode choke L1 is recommended to be added in series between the module and customer's MCU to suppress EMI spurious transmission. Meanwhile, the 0 Ω resistors (R3 and R4) should be added in series between the module and the test points to facilitate debugging, and the resistors are not mounted by default. In order to ensure the integrity of USB data line signal, L1, R3, and R4 components must be placed close to the module, and also 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.

- Route the USB signal traces as differential pairs with ground surrounded. The impedance of USB differential trace is 90 Ω .
- Do not route signal traces under crystals, oscillators, magnetic devices and RF signal traces. Route the USB differential traces in inner-layer of the PCB, and surround the traces with ground on that layer and with ground planes above and below.
- Junction capacitance of the ESD protection device might cause influences on USB data traces, so you should pay attention to the selection of the device. Typically, the capacitance value should be less than 2 pF.
- Keep the ESD protection devices as close to the USB connector as possible.

3.8. UART Interface

EG25-G Mini PCIe provides one main UART interface that supports 9600 bps, 19200 bps, 38400 bps, 57600 bps, 115200 bps and 230400 bps baud rates, and the default is 115200 bps. It supports RTS and CTS hardware flow control, and can be used for AT command communication and data transmission.

The following table shows the pin definition of the interface.

Table 9: Pin Definition of Main UART Interface

Pin Name	Pin No.	I/O	Description	Power Domain
UART_RX	11	DI	UART receive	3.3 V
UART_TX	13	DO	UART transmit	3.3 V
UART_CTS	23	DI	DCE clear to send signal from DTE	3.3 V
UART_RTS	25	DO	DCE request to send signal from DTE	3.3 V

The signal level of main UART interface is 3.3 V. When connecting to the peripheral MCU/RAM, you need to pay attention to the signal direction. The reference circuit is shown as below:

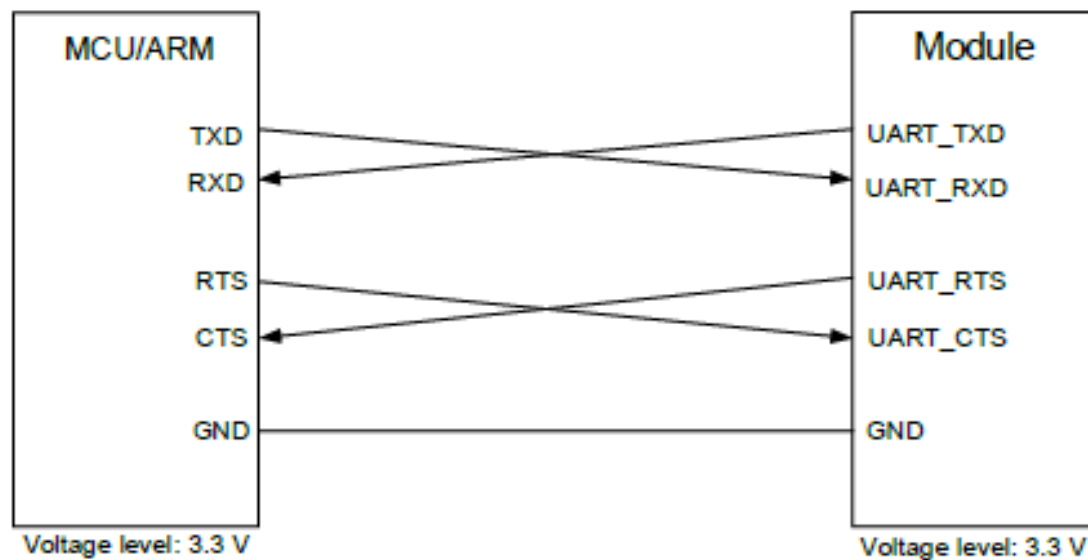


Figure 7: Reference Circuit of Power Supply

NOTE

AT+IPR can be used to set the baud rate of the main UART, and AT+IFC can be used to set the hardware flow control (hardware flow control is disabled by default). See *document [1]* for details.

3.9. PCM and I2C Interfaces

EG25-G Mini PCIe provides one Pulse Code Modulation (PCM) digital interface and one I2C interface.

The following table shows the pin definition of PCM and I2C interfaces that can be applied in audio Codec design.

Table 10: Pin Definition of PCM and I2C Interfaces

Pin Name	Pin No.	I/O	Description	Comment
PCM_CLK	45	DIO	PCM clock	1.8 V
PCM_DOUT	47	DO	PCM data output	1.8 V
PCM_DIN	49	DI	PCM data input	1.8 V
PCM_SYNC	51	DIO	PCM frame sync	1.8 V

I2C_SCL	30	DO	I2C serial clock (for external Codec)	Requires external pull-up to 1.8 V.
I2C_SDA	32	DIO	I2C serial data (for external Codec)	Requires external pull-up to 1.8 V.

EG25-G Mini PCIe provides one PCM digital interface, which supports 16-bit linear data format and the following modes:

- Primary mode (short frame synchronization, works as either master or 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.

The following figure shows the timing relationship in primary mode with 8 kHz PCM_SYNC and 2048 kHz PCM_CLK.

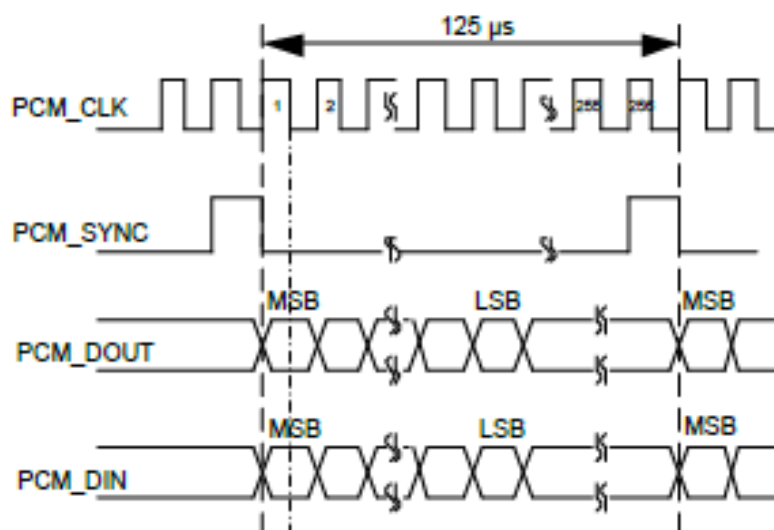


Figure 8: Timing in Primary Mode

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. The following figure shows the timing relationship in auxiliary mode with 8 kHz PCM_SYNC and 256 kHz PCM_CLK.

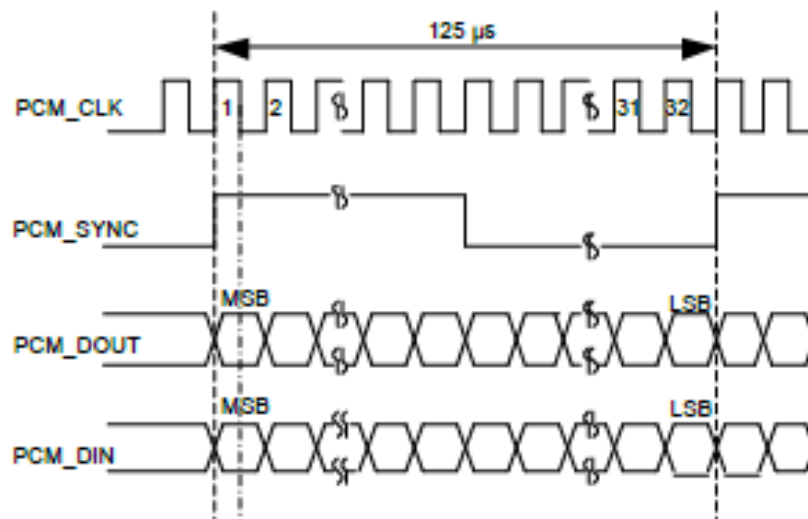


Figure 9: Timing in Auxiliary Mode

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. In addition, EG25-G Mini PCIe's firmware has integrated the configuration on some PCM Codec's application with I2C interface. See *document [1]* for details about AT+QDAI.

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

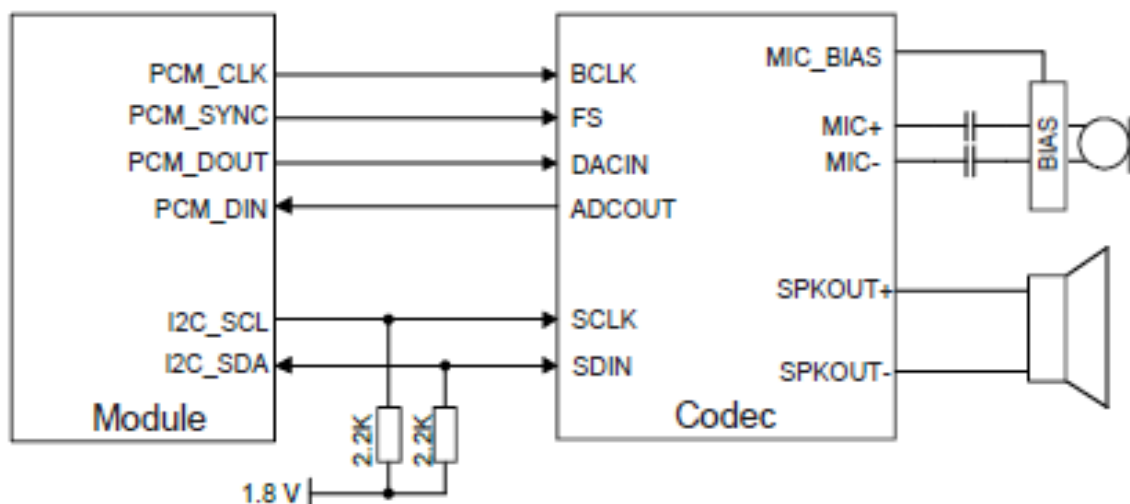


Figure 10: Reference Circuit of PCM and I2C Application with Audio Codec

3.10. Control and Indication Interfaces

The following table shows the pin definition of control and indication signals.

Table 11: Pin Definition of Control and Indication Interfaces

Pin Name	Pin No.	I/O	Description	Comment
RI	17	DO	Ring indication	3.3 V power domain.
DTR	31	DI	Sleep mode control	3.3 V power domain.
W_DISABLE#	20	DI	Airplane mode control	3.3 V power domain. Pulled up by default; Active LOW.
PERST#	22	DI	Fundamental reset	3.3 V power domain. Pulled up by default; Active LOW.
LED_WWAN#	42	OC	LED signal for indicating the network status of the module	Active LOW.
WAKE#	1	OC	Wake up the host	

3.10.1. RI

The RI signal can be used to wake up the host. When a URC returns, there will be the following behaviors on the RI pin after executing `AT+QCFG="risignalttype","physical"`.

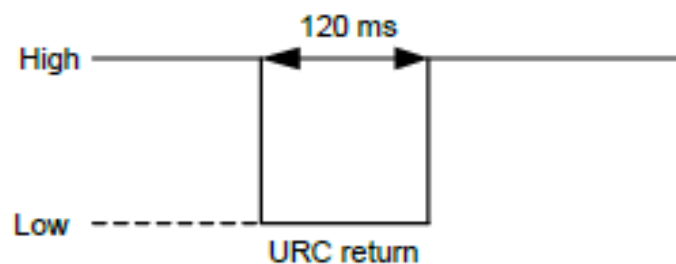


Figure 11: RI Behaviors

3.10.2. W_DISABLE#

The module provides a W_DISABLE# signal to disable or enable the RF function (excluding GNSS). The W_DISABLE# pin is pulled up by default. Disabled in firmware by default, the W_DISABLE# control

function for airplane mode can be enabled by `AT+QCFG="airplanecontrol",1`. Driving it low can make the module enter airplane mode.

Table 12: Airplane Mode Controlled by Hardware Method

W_DISABLE#	RF Function Status	Module Operating Mode
High level	RF enabled	Normal operation
Low level	RF disabled	Airplane mode

The RF function can also be enabled or disabled through `AT+CFUN`, and the details are as follows.

Table 13: Airplane Mode Controlled by Software Method

AT+CFUN=?	RF Function Status	Module Operating Mode
0	RF and (U)SIM disabled	Minimum functionality mode
1	RF enabled	Normal operation
4	RF disabled	Airplane mode

3.10.3. DTR

The DTR signal is used for sleep mode control. It is pulled up by default. When the module is in sleep mode, driving DTR low can wake up the module. For more details about the preconditions for the module to enter sleep mode, refer to *Chapter 3.4.1*.

3.10.4. PERST#

The PERST# signal can be used to force a hardware reset. The module can be reset by driving the PERST# signal low for 150–460 ms and then releasing it. The PERST# signal is sensitive to interference. The traces should be as short as possible and be surrounded with ground.

The reset scenario is illustrated in the following figure.

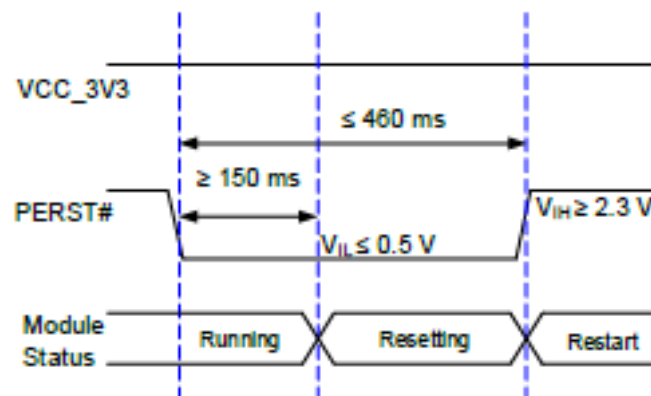


Figure 12: Reset Timing

3.10.5. LED_WWAN#

LED_WWAN# is an open collector output signal, it is used to indicate the network status of the module, and its maximum input current can be up to 40 mA. According to the following circuit, to reduce the current of the LED, a resistor must be placed in series with the LED. The LED emits light when the LED_WWAN# output signal is active LOW.



Figure 13: LED_WWAN# Signal Reference Circuit Diagram

There are two indication modes for LED_WWAN# signal to indicate network status, which can be switched through following AT commands:

- AT+QCFG="ledmode",0 (default setting)
- AT+QCFG="ledmode",2

The following tables show the detailed network status indications of the LED_WWAN# signal.

Table 14: Indications of Network Status (AT+QCFG="ledmode",0, Default Setting)

Pin Status	Description
Flicker slowly (200 ms Low/1800 ms High)	Network searching
Flicker slowly (1800 ms Low/200 ms High)	Idle
Flicker quickly (125 ms Low/125 ms High)	Data transfer is ongoing

Always Low

Voice calling

Table 15: Indications of Network Status (AT+QCFG="ledmode",2)

Pin Status	Description
Low Level (Light ON)	Registered on network successfully
High-Impedance (Light OFF)	<ul style="list-style-type: none"> No network coverage or not registered W_DISABLE# signal is at low level. (RF Disabled.) AT+CFUN=0, AT+CFUN=4 input

3.10.6. WAKE#

The WAKE# signal is an open collector signal, which is similar to RI signal, but a pull-up resistor and AT+QCFG="risignalttype","physical" are required to wake up the host. When a URC returns, a 120 ms low level pulse will be outputted. The state of WAKE# signal is shown as below.

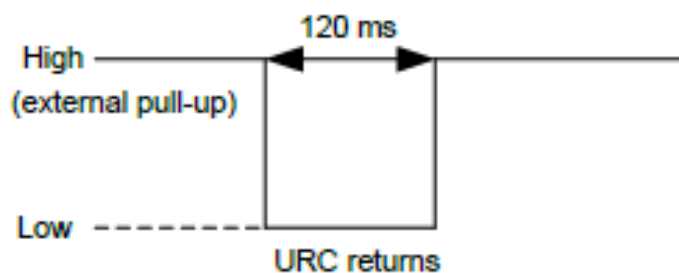


Figure 14: WAKE# Behaviors

Accuracy (GNSS)	CEP-50	Autonomous @ open sky	< 2.5	m
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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.

4.3. GNSS Frequency

The following table shows the GNSS frequency of EG25-G Mini PCIe.

Table 17: 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
BeiDou (COMPASS)	1561.098 \pm 2.046	MHz
QZSS	1575.42	MHz

5 Antenna Connection

5.1. Antenna Connectors

EG25-G Mini PCIe is mounted with three antenna connectors for external antenna connection: a main antenna connector, an Rx-diversity antenna connector, and a GNSS antenna connector. And Rx-diversity function is enabled by default. The impedance of the antenna connectors is 50 Ω .

5.1.1. Operating Frequency

The following table shows the operating frequencies of EG25-G Mini PCIe.

Table 18: 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 B18	815–830	860–875	MHz
LTE-FDD B19	830–845	875–890	MHz
LTE-FDD B20	832–862	791–821	MHz
LTE-FDD B25	1850–1915	1930–1995	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 B39	1880–1920	1880–1920	MHz
LTE-TDD B40	2300–2400	2300–2400	MHz
LTE-TDD B41	2496–2690	2496–2690	MHz

5.2. Antenna Design Requirements

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

Table 19: Antenna Requirements

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

NOTE

1. It is recommended to use a passive GNSS antenna when LTE B13 or B14 is supported, as the use of active antenna may generate harmonics which will affect the GNSS performance.
2. Since the GNSS port has a 2.85 V voltage output, a passive antenna that causes short to GND, such as PIFA antenna, is not recommended.

5.3. Recommended Mating Plugs for Antenna Connection

EG25-G Mini PCIe is mounted with RF connectors (receptacles) for convenient antenna connection. The dimensions of the antenna connectors are shown as below.

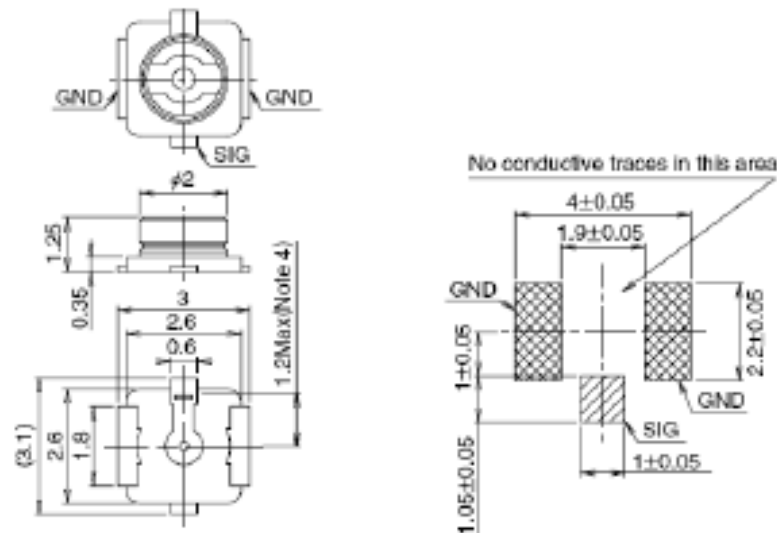


Figure 15: Dimensions of the Receptacle RF Connectors (Unit: mm)

U.FL-LP mating plugs listed in the following figure can be used to match the receptacles.

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 16: Mechanicals of U.FL-LP Mating Plugs

The following figure describes the space factor of mating plugs.

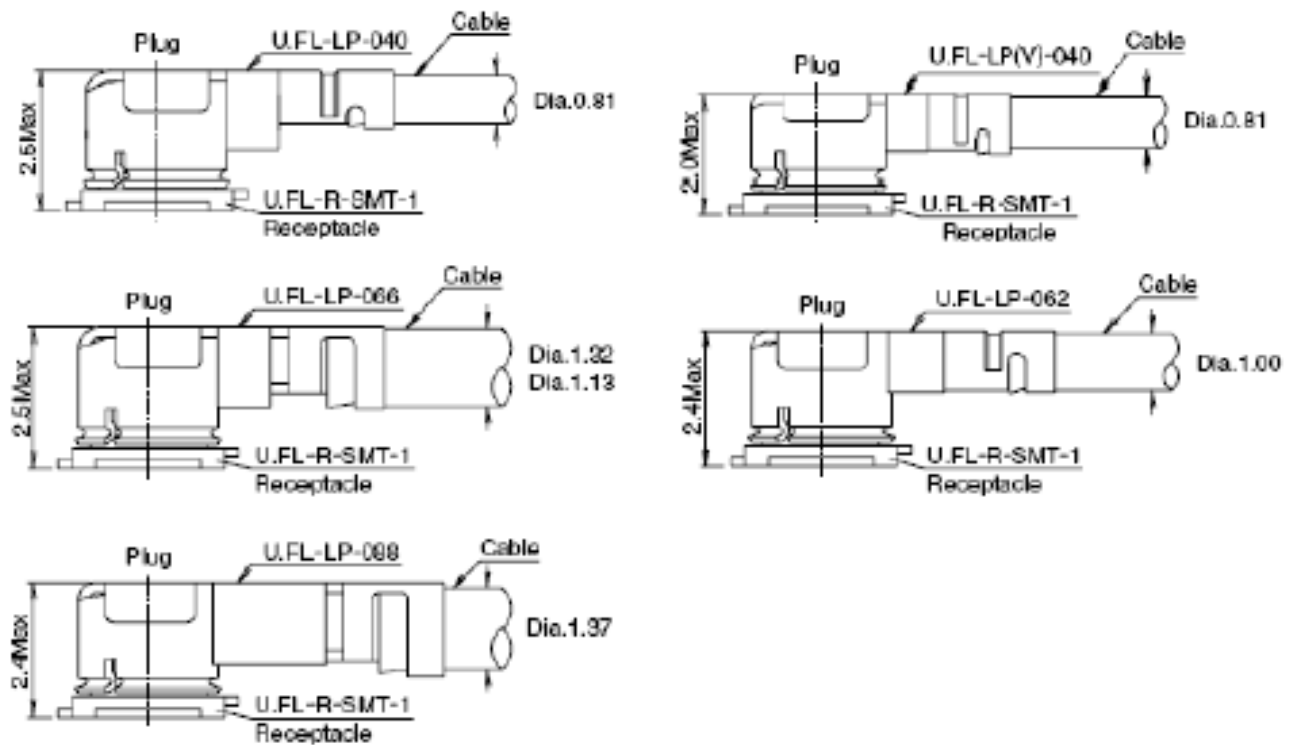


Figure 17: Space Factor of Mating Plugs (Unit: mm)

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

6 Reliability, Radio and Electrical Characteristics

6.1. General Description

This chapter mainly describes the following electrical and radio characteristics of EG25-G Mini PCIe:

- Power supply requirements
- Digital I/O characteristic
- Tx power
- Rx sensitivity
- ESD
- Power consumption
- Thermal dissipation

6.2. Power Supply Requirements

The input voltage of EG25-G Mini PCIe is 3.0–3.6 V, as specified by *PCI Express Mini Card Electromechanical Specification Revision 1.2*. The following table shows the power supply requirements of EG25-G Mini PCIe.

Table 20: Power Supply Requirements

Parameter	Description	Min.	Typ.	Max.	Unit
VCC_3V3	Power supply	3.0	3.3	3.6	V

6.3. Digital I/O Characteristic

The following table shows the I/O requirements of EG25-G Mini PCIe.

Table 21: I/O Requirements

Parameter	Description	Min.	Max.	Unit
V_{IH}	Input high voltage	$0.7 \times VCC_3V3$	$VCC_3V3 + 0.3$	V
V_{IL}	Input low voltage	-0.3	$0.3 \times VCC_3V3$	V
V_{OH}	Output high voltage	$VCC_3V3 - 0.5$	VCC_3V3	V
V_{OL}	Output low voltage	0	0.4	V

NOTE

1. The PCM and I2C interfaces are 1.8 V power domain and other I/O interfaces are VCC_3V3 power domain.
2. The maximum voltage value of V_{IL} for PERST# and W_DISABLE# is 0.5 V.

6.4. Tx Power

The following tables show the conducted RF output power of EG25-G Mini PCIe module.

Table 22: Conducted RF Output Power

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

NOTE

1. In GPRS 4 slots TX mode, the maximum output power is reduced by 4.0 dB. The design conforms to the GSM specification as described in *Chapter 13.16* of 3GPP TS 51.010-1.
2. EG25-G Mini PCIe supports LTE B25, but Qorvo Phase 6 PAMiD QM77031 in the module does not actually support LTE B25. Qorvo has confirmed that the SAW integrated in the PA can support LTE B2, with which B25 can work at the same frequency. B25 is 5 MHz wider than B2. Therefore, the sensitivity of the Rx channels 8630–8689 is poor, and there is a big gap with the 3GPP standard. At a high temperature of 75 °C, the maximum power of channels 26640–26689 will be reduced by about 2.5 dB.

6.5. Rx Sensitivity

Table 23: EG25-G Mini PCIe Conducted RF Receiving Sensitivity

Frequency Bands	Primary	Diversity	SIMO ³	3GPP (SIMO)
GSM850	-108 dBm	-	-	-102 dBm
EGSM900	-108 dBm	-	-	-102 dBm
DCS1800	-107.5 dBm	-	-	-102 dBm
PCS1900	-107.5 dBm	-	-	-102 dBm
WCDMA B1	-108.2 dBm	-108.5 dBm	-109.2 dBm	-106.7 dBm
WCDMA B2	-109.5 dBm	-109 dBm	-110 dBm	-104.7 dBm
WCDMA B4	-109.5 dBm	-	-	-103.7 dBm
WCDMA B5	-109 dBm	-109.5 dBm	-110 dBm	-104.7 dBm
WCDMA B6	-109 dBm	-109.5 dBm	-110.5 dBm	-106.7 dBm
WCDMA B8	-109.2 dBm	-	-	-103.7 dBm
WCDMA B19	-109 dBm	-109.5 dBm	-110.5 dBm	-106.7 dBm

³ 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.

LTE-FDD B1 (10 MHz)	-97.3 dBm	-98.3 dBm	-99.5 dBm	-96.3 dBm
LTE-FDD B2 (10 MHz)	-98 dBm	-99 dBm	-99.9 dBm	-94.3 dBm
LTE-FDD B3 (10 MHz)	-97.4 dBm	-98.1 dBm	-99.8 dBm	-93.3 dBm
LTE-FDD B4 (10 MHz)	-97.7 dBm	-98.2 dBm	-99.7 dBm	-96.3 dBm
LTE-TDD B5 (10 MHz)	-98 dBm	-98.5 dBm	-99.9 dBm	-94.3 dBm
LTE-TDD B7 (10 MHz)	-97.3 dBm	-97.3 dBm	-99.1 dBm	-94.3 dBm
LTE-TDD B8 (10 MHz)	-98 dBm	-98.1 dBm	-99.8 dBm	-93.3 dBm
LTE-TDD B12 (10 MHz)	-98 dBm	-98.1 dBm	-99.9 dBm	-93.3 dBm
LTE-TDD B13 (10 MHz)	-98 dBm	-98.1 dBm	-100.1 dBm	-93.3 dBm
LTE-TDD B18 (10 MHz)	-98 dBm	-99.5 dBm	-100 dBm	-96.3 dBm
LTE-TDD B19 (10 MHz)	-98 dBm	-99 dBm	-99.8 dBm	-96.3 dBm
LTE-TDD B20 (10 MHz)	-98 dBm	-98.8 dBm	-99.7 dBm	-93.3 dBm
LTE-TDD B25 (10 MHz)	-98 dBm	-98 dBm	-100.2 dBm	-92.8 dBm
LTE-TDD B26 (10 MHz)	-98 dBm	-98.8 dBm	-100 dBm	-93.8 dBm
LTE-TDD B28 (10 MHz)	-98.1 dBm	-98.9 dBm	-99.8 dBm	-94.8 dBm
LTE-TDD B38 (10 MHz)	-96.8 dBm	-96.9 dBm	-98.3 dBm	-96.3 dBm
LTE-TDD B39 (10 MHz)	-98 dBm	-98.2 dBm	-99.8 dBm	-96.3 dBm
LTE-TDD B40 (10 MHz)	-97.7 dBm	-97.5 dBm	-99.7 dBm	-96.3 dBm
LTE-TDD B41 (10 MHz)	-96.8 dBm	-96.0 dBm	-98 dBm	-94.3 dBm

6.6. ESD

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 ESD characteristics of EG25-G Mini PCIe.

Table 24: ESD Characteristics

Tested Interfaces	Contact Discharge	Air Discharge	Unit
Power Supply and GND	±5	±10	kV
Antenna Interfaces	±4	±8	kV
USB Interface	±4	±8	kV
(U)SIM Interface	±4	±8	kV
Others	±0.5	±1	kV

6.7. Power Consumption

Table 25: Power Consumption

Description	Conditions	Typ.	Unit
Sleep state	AT+CFUN=0 (USB Disconnected)	2.1	mA
	EGSM900 @ DRX = 2 (USB Disconnected)	4.2	mA
	EGSM900 @ DRX = 5 (USB Disconnected)	3.6	mA
	EGSM900 @ DRX = 5 (USB Suspend)	3.9	mA
	EGSM900 @ DRX = 9 (USB Disconnected)	3.4	mA
	DCS1800 @ DRX = 2 (USB Disconnected)	3.6	mA
	DCS1800 @ DRX = 5 (USB Disconnected)	3.0	mA
	DCS1800 @ DRX = 5 (USB Suspend)	3.2	mA
	DCS1800 @ DRX = 9 (USB Disconnected)	2.8	mA
	WCDMA @ PF = 64 (USB Suspend)	3.9	mA
	WCDMA @ PF = 128 (USB Disconnected)	3.2	mA
	WCDMA @ PF = 256 (USB Disconnected)	2.9	mA
	WCDMA @ PF = 512 (USB Disconnected)	2.7	mA

	LTE-FDD @ PF = 32 (USB Disconnected)	5.4	mA
	LTE-FDD @ PF = 64 (USB Disconnected)	3.9	mA
	LTE-FDD @ PF = 64 (USB Suspend)	4.1	mA
	LTE-FDD @ PF = 128 (USB Disconnected)	3.2	mA
	LTE-FDD @ PF = 256 (USB Disconnected)	2.8	mA
	LTE-TDD @ PF = 32 (USB Disconnected)	5.4	mA
	LTE-TDD @ PF = 64 (USB Disconnected)	3.8	mA
	LTE-TDD @ PF = 64 (USB Suspend)	4.1	mA
	LTE-TDD @ PF = 128 (USB Disconnected)	3.2	mA
	LTE-TDD @ PF = 256 (USB Disconnected)	2.8	mA
Idle state	EGSM900 DRX = 5 (USB Disconnected)	22.1	mA
	EGSM900 DRX = 5 (USB Connected)	35.1	mA
	WCDMA @ PF = 64 (USB Disconnected)	22.3	mA
	WCDMA @ PF = 64 (USB Connected)	35.3	mA
	LTE-FDD @ PF = 64 (USB Disconnected)	22.2	mA
	LTE-FDD @ PF = 64 (USB Connected)	35.2	mA
	LTE-TDD @ PF = 64 (USB Disconnected)	22.4	mA
	LTE-TDD @ PF = 64 (USB Connected)	35.5	mA
GPRS data transfer (GNSS OFF)	GSM850 1UL/4DL @ 32.1 dBm	376.8	mA
	GSM850 2UL/3DL @ 30.0 dBm	547	mA
	GSM850 3UL/2DL @ 28.9 dBm	701	mA
	GSM850 4UL/1DL @ 27.6 dBm	794	mA
	EGSM900 1UL/4DL @ 32.2 dBm	344.4	mA
	EGSM900 2UL/3DL @ 31.2 dBm	560.4	mA
	EGSM900 3UL/2DL @ 29.2 dBm	649.4	mA

EDGE data transfer (GNSS OFF)	EGSM900 4UL/1DL @ 27.9 dBm	741.2	mA
	DCS1800 1UL/4DL @ 29.2 dBm	205.2	mA
	DCS1800 2UL/3DL @ 28.5 dBm	333.7	mA
	DCS1800 3UL/2DL @ 26.5 dBm	400.2	mA
	DCS1800 4UL/1DL @ 25.7 dBm	480	mA
	PCS1900 1UL/4DL @ 29.2 dBm	227.7	mA
	PCS1900 2UL/3DL @ 28.1 dBm	363.8	mA
	PCS1900 3UL/2DL @ 26.3 dBm	440	mA
	PCS1900 4UL/1DL @ 24.9 dBm	507.2	mA
	GSM850 1UL/4DL @ 26.3 dBm	212	mA
	GSM850 2UL/3DL @ 25.1 dBm	337	mA
	GSM850 3UL/2DL @ 23.3 dBm	415	mA
	GSM850 4UL/1DL @ 22.2 dBm	487	mA
	EGSM900 1UL/4DL @ 26.6 dBm	195	mA
	EGSM900 2UL/3DL @ 25.3 dBm	312	mA
	EGSM900 3UL/2DL @ 23.7 dBm	392.7	mA
	EGSM900 4UL/1DL @ 22.5 dBm	463.5	mA
	DCS1800 1UL/4DL @ 25.5 dBm	156.8	mA
	DCS1800 2UL/3DL @ 25.0 dBm	260	mA
	DCS1800 3UL/2DL @ 23.8 dBm	334	mA
	DCS1800 4UL/1DL @ 22.6 dBm	405	mA
	PCS1900 1UL/4DL @ 25.4 dBm	169	mA
	PCS1900 2UL/3DL @ 24.6 dBm	272	mA
	PCS1900 3UL/2DL @ 23.3 dBm	350	mA
	PCS1900 4UL/1DL @ 22.0 dBm	418	mA

WCDMA data transfer (GNSS OFF)	WCDMA B1 HSDPA @ 22.5 dBm	735.9	mA
	WCDMA B2 HSDPA @ 22.6 dBm	740.6	mA
	WCDMA B4 HSDPA @ 22.6 dBm	776.8	mA
	WCDMA B5 HSDPA @ 22.3 dBm	670.8	mA
	WCDMA B6 HSDPA @ 22.4 dBm	675.3	mA
	WCDMA B8 HSDPA @ 22.5 dBm	748.3	mA
	WCDMA B19 HSDPA @ 22.4 dBm	676.8	mA
	WCDMA B1 HSUPA @ 22.3 dBm	730.8	mA
	WCDMA B2 HSUPA @ 22.3 dBm	730.5	mA
	WCDMA B4 HSUPA @ 22.0 dBm	742.6	mA
	WCDMA B5 HSUPA @ 22.3 dBm	713.9	mA
	WCDMA B6 HSUPA @ 22.4 dBm	717.9	mA
	WCDMA B8 HSUPA @ 22.0 dBm	712	mA
	WCDMA B19 HSUPA @ 22.3 dBm	710.9	mA
LTE data transfer (GNSS OFF)	LTE-FDD B1 @ 22.8 dBm	966.8	mA
	LTE-FDD B2 @ 22.7 dBm	1021.8	mA
	LTE-FDD B3 @ 23.0 dBm	1017.7	mA
	LTE-FDD B4 @ 23.4 dBm	1052.3	mA
	LTE-FDD B5 @ 23.5 dBm	886.3	mA
	LTE-FDD B7 @ 23.6 dBm	1114	mA
	LTE-FDD B8 @ 23.6 dBm	988.7	mA
	LTE-FDD B12 @ 23.1 dBm	811.4	mA
	LTE-FDD B13 @ 23.7 dBm	910.7	mA
	LTE-FDD B18 @ 23.5 dBm	1038.5	mA
	LTE-FDD B19 @ 23.5 dBm	938.8	mA

	LTE-FDD B20 @ 23.3 dBm	1014	mA
	LTE-FDD B25 @ 22.7 dBm	1001.3	mA
	LTE-FDD B26 @ 23.4 dBm	999.4	mA
	LTE-FDD B28 @ 23.6 dBm	1004.7	mA
	LTE-TDD B38 @ 23.3 dBm	573.8	mA
	LTE-TDD B39 @ 23.2 dBm	482.8	mA
	LTE-TDD B40 @ 22.7 dBm	508.2	mA
	LTE-TDD B41 @ 23.3 dBm	561.9	mA
GSM voice call	GSM850 PCL = 5 @ 31.8 dBm	375.6	mA
	EGSM900 PCL = 5 @ 32.2 dBm	366	mA
	DCS1800 PCL = 0 @ 29.2 dBm	221	mA
	PCS1900 PCL = 0 @ 29.0 dBm	236.6	mA
WCDMA voice call	WCDMA B1 @ 23.0 dBm	780.3	mA
	WCDMA B2 @ 23.1 dBm	796.3	mA
	WCDMA B4 @ 23.2 dBm	846.2	mA
	WCDMA B5 @ 23.2 dBm	731	mA
	WCDMA B6 @ 23.2 dBm	739.4	mA
	WCDMA B8 @ 23.1 dBm	822.6	mA
	WCDMA B19 @ 23.0 dBm	720.9	mA

Table 26: GNSS Current Consumption

Description	Conditions	Typ.	Unit
Searching (AT+CFUN=0)	Cold start @ Passive antenna	67	mA
	Lost state @ Passive antenna	66	mA
Tracking (AT+CFUN=0)	Instrument environment	46	mA

6.8. 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 PCI Express Mini Card away from heating sources.
- Do not place components on the PCB area where the module is mounted, in order to facilitate adding of heatsink.
- Do not apply solder mask on 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.
- Add a heatsink on the top of the module and 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.
- Add a thermal pad with appropriate thickness at the bottom of the module to conduct the heat to PCB.

The following figure shows the reference heatsink design.

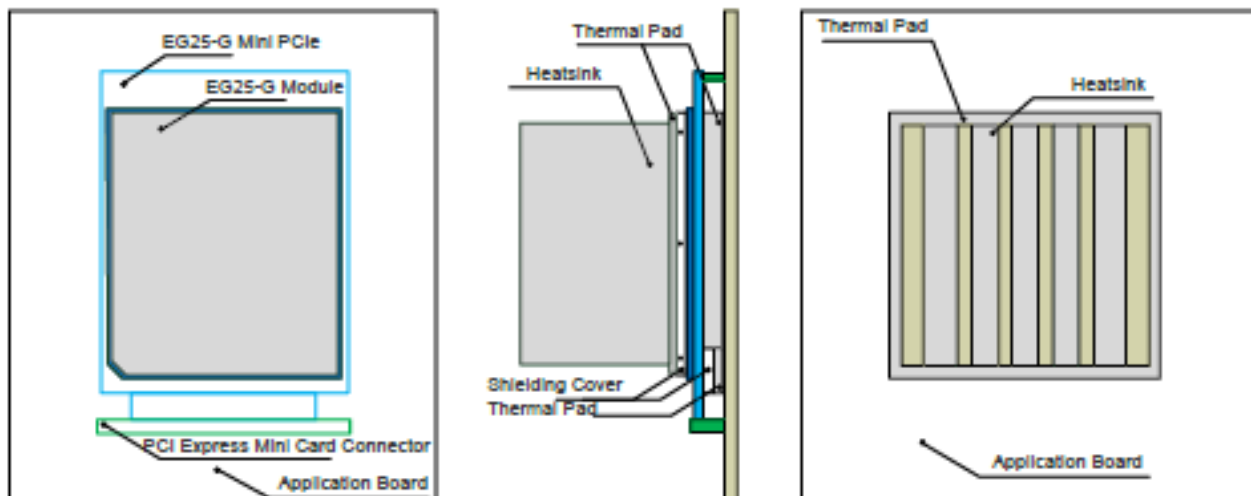


Figure 18: Reference Heatsink Design

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 more details of the command, see *document [3]*.

2. For more detailed guidelines on thermal design, see *document [4]*.

6.9. Notification

Please follow the principles below in the module application.

6.9.1. 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.

6.9.2. Cleaning

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

This chapter mainly describes mechanical dimensions as well as packaging specification of EG25-G Mini PCIe module. All dimensions are measured in millimeter (mm), and the dimensional tolerances are ± 0.15 mm unless otherwise specified.

[illegible]

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NOTE

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

7.3. Standard Dimensions of Mini PCI Express

EG25-G Mini PCIe adopts a standard Mini PCI Express connector which complies with the directives and standards listed in the *PCI Express Mini Card Electromechanical Specification Revision 1.2*. The following figure takes the Molex 679105700 as an example.

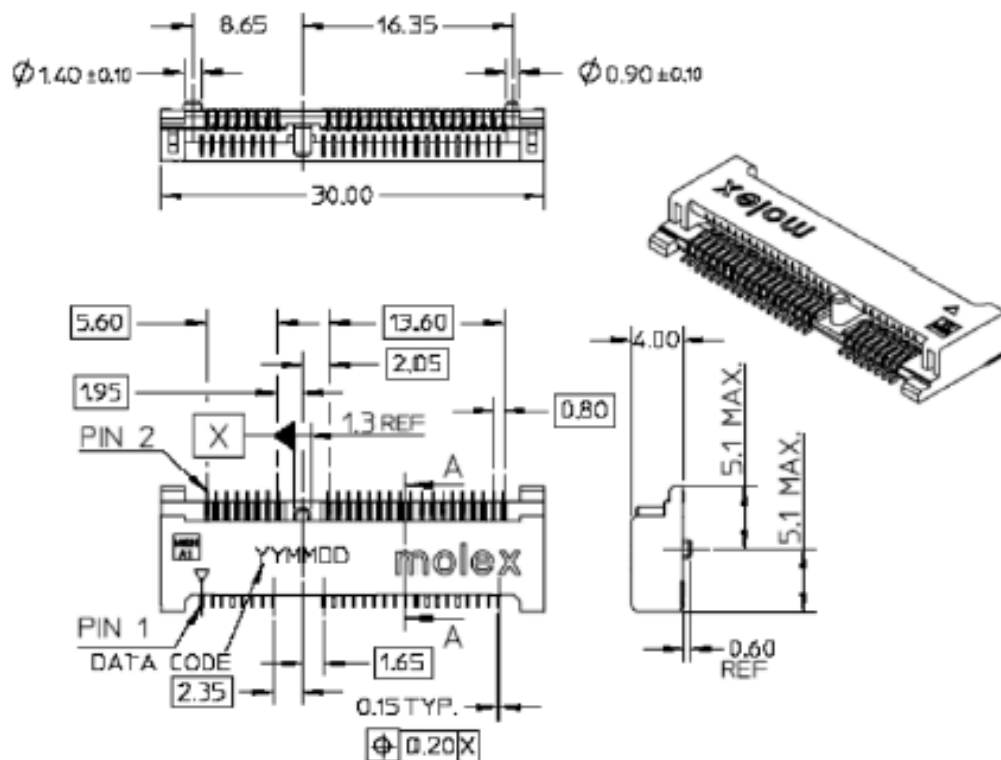


Figure 20: Standard Dimensions of Mini PCI Express Connector (Molex 679105700)

7.4. Packaging Specifications

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

7.4.1. Blister Tray

Dimension details are as follow:

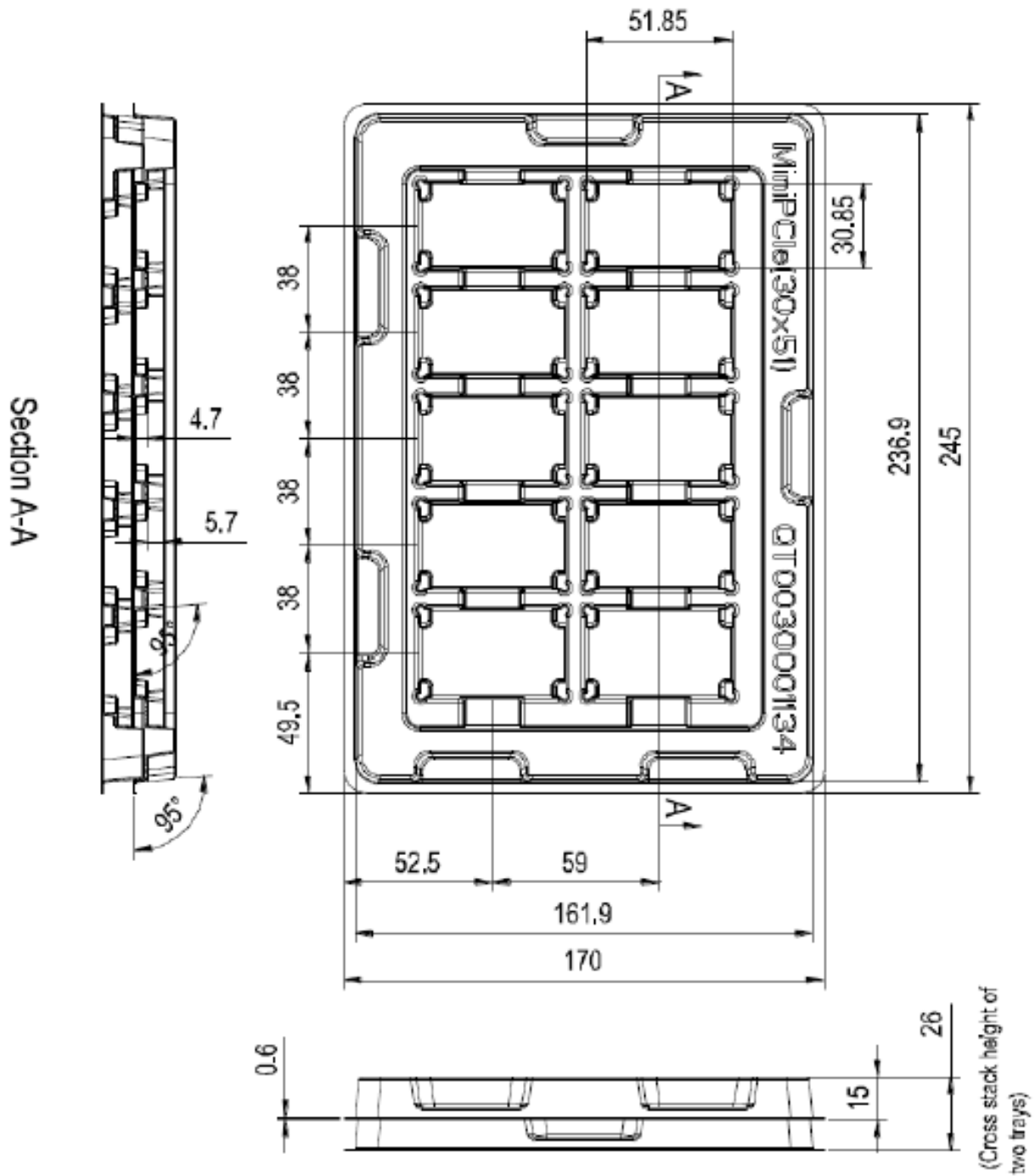
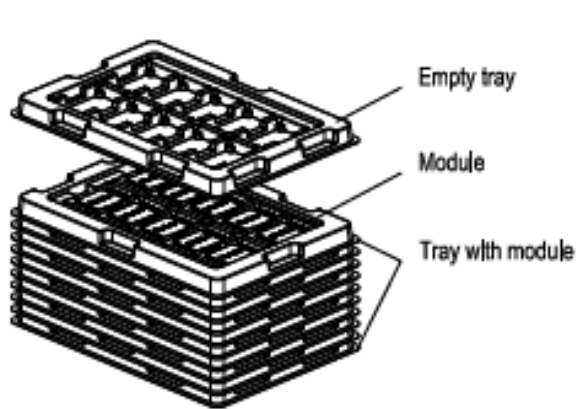
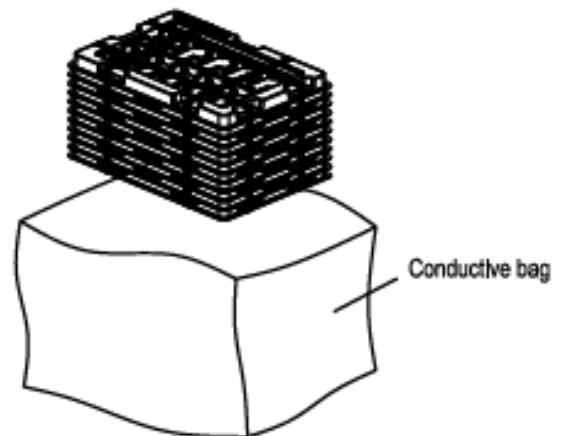


Figure 21: Blister Tray Dimension Drawing

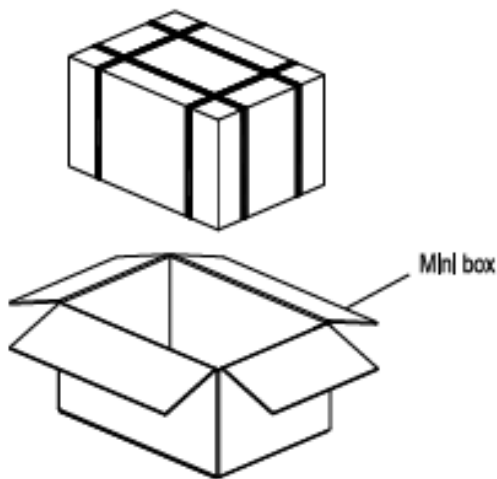
7.4.2. Packaging Process



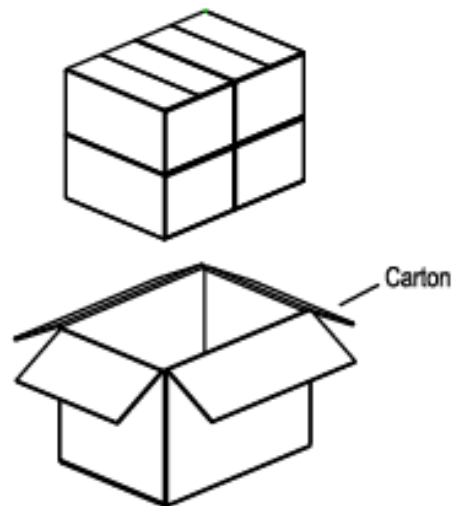
Each blister tray packs 10 modules. Stack 10 blister trays with modules together, and put 1 empty blister tray on the top.



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



Put seal-packed blister trays into a mini box. One mini box can pack 100 modules.



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

Figure 22: Packaging Process

8 Appendix References

Table 27: Related Documents

Document Name
[1] Quectel_EC2x&EG9x&EG2x-G&EM05_Series_AT_Commands_Manual
[2] Quectel_EC2x&EG9x&EG2x-G&EM05_Series_GNSS_Application_Note
[3] Quectel_EC2x&EG9x&EG2x-G&EM05_Series_Thermal_Mitigation_User_Guide
[4] Quectel_LTE_Module_Thermal_Design_Guide

Table 28: Terms and Abbreviations

Abbreviation	Description
AMR	Adaptive Multi-rate
bps	Bits Per Second
CHAP	Challenge Handshake Authentication Protocol
CMUX	Connection Multiplexing
CS	Coding Scheme
CTS	Clear to Send
DCE	Data Communications Equipment
DC-HSPA+	Dual-carrier High Speed Packet Access
DCS	Digital Communication System
DFOTA	Delta Firmware Upgrade Over-The-Air
DL	Downlink

DTE	Data Terminal Equipment
DTR	Data Terminal Ready
EDGE	Enhanced Data Rates for GSM Evolution
EFR	Enhanced Full Rate
EGSM	Enhanced GSM
EMI	Electro Magnetic Interference
ESD	Electrostatic Discharge
ESR	Equivalent Series Resistance
FDD	Frequency Division Duplexing
FR	Full Rate
FTPS	FTP over SSL
GLONASS	Russian Global Navigation Satellite System
GMSK	Gaussian Minimum Shift Keying
GNSS	Global Navigation Satellite System
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
kbps	Kilo Bits Per Second
LED	Light Emitting Diode
LTE	Long-Term Evolution

Mbps	Million Bits Per Second
MCS	Modulation and Coding Scheme
MCU	Micro Control Unit
ME	Mobile Equipment
MIMO	Multiple-Input Multiple-Output
MMS	Multimedia Messaging Service
MO	Mobile Originated
MQTT	Message Queuing Telemetry Transport
MT	Mobile Terminated
NMEA	National Marine Electronics Association
PA	Power amplifier
PCM	Pulse Code Modulation
PDA	Personal Digital Assistant
PDU	Protocol Data Unit
PIFA	Planar Inverted F Antenna
PING	Packet Internet Groper
POS	Point of Sale
PPP	Point-to-Point 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
RTS	Ready To Send

Rx	Receive
SAW	Surface Acoustic Wave
SIMO	Single Input Multiple Output
SMS	Short Message Service
SMTP	Simple Mail Transfer Protocol
SMTPS	Simple Mail Transfer Protocol Secure
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
TVS	Transient Voltage Suppressor
UART	Universal Asynchronous Receiver & Transmitter
UL	Uplink
URC	Unsolicited Result Code
USB	Universal Serial Bus
(U)SIM	(Universal) Subscriber Identification Module
VSWR	Voltage Standing Wave Ratio
WCDMA	Wideband Code Division Multiple Access
WLAN	Wireless Local Area Network

FCC Statement:

To satisfy FCC exterior labeling requirements, the following text must be placed on the exterior of the end product Contains Transmitter module FCC ID: 2BKRZ-WL432EG25G.

This device complies with part 15 of the FCC Rules. 47 CFR Part 2, 47 CFR Part 22 subpart H, 47 CFR Part 24 subpart E, 47 CFR Part 27 subpart C, 47 CFR Part 90 subpart S

This equipment should be installed and operated with minimum distance of 20 cm between the radiator and your body.

MODIFICATION: Any changes or modifications not expressly approved by the grantee of this device could void the user's authority to operate the device.

This radio module must not be installed to co-locate and operate simultaneously with other radios in the host system except by following FCC multi-transmitter product procedures. Additional testing and device authorization may be required to operate simultaneously with other radios.

The availability of some specific channels and/or operational frequency bands are country dependent and are firmware programmed at the factory to match the intended destination. The firmware setting is not accessible to the end-user.

The host product manufacturer is responsible for compliance with any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. The final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed. The separate approval is required for all other operating configurations including portable configurations with respect to Part 2.1093 and different antenna configuration.

The end-user manual shall include all required regulatory information/warnings as shown in this manual, including "This product must be installed and operated with a minimum distance of 20 cm between the radiator and user body". The OEM integrator is responsible for ensuring that the end-user has no manual instructions to remove or install module.

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

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

As long as the 2 conditions above are met, further transmitter tests will not be required.

However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.