PERFECT WIRELESS EXPERIENCE

FM101R-GL

Hardware Guide

V1.0

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Do not operate wireless communication products in areas where the use of radio is not recommended without proper equipment certification. These areas include environments that may generate radio interference, such as flammable and explosive environments, medical devices, aircraft or any other equipment that may be subject to any form of radio interference.

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Applicable Model

No.	Applicable Model	Description
1	FM101R-GL	Qualcomm SDX12 platform. 4G communication module with M.2 interface for Global. USB only for data transmission.

Change History

1 Foreword

1.1 Introduction

The document describes the electrical characteristics, RF performance, dimensions and application environment, etc. of FM101R-GL (hereinafter referred to as FM101). With the assistance of the document and other instructions, the developers can quickly understand the hardware functions of FM101 modules and develop products.

1.2 Reference Standard

The design of the product complies with the following standards:

- 3GPP TS 34.121-1 V9.7.0: User Equipment (UE) conformance specification; Radio transmission and reception (FDD); Part 1: Conformance specification
- 3GPP TS 34.122 V11.13.0: Technical Specification Group Radio Access Network; Radio transmission and reception (TDD)
- 3GPP TS 36.521-1 V12.8.0 User Equipment (UE) conformance specification; Radio transmission and reception; Part 1: Conformance testing
- 3GPP TS 21.111 V10.0.0: USIM and IC card requirements
- 3GPP TS 51.011 V4.15.0: Specification of the Subscriber Identity Module -Mobile Equipment (SIM-ME) interface
- 3GPP TS 31.102 V10.11.0: Characteristics of the Universal Subscriber Identity Module (USIM) application
- 3GPP TS 31.11 V10.16.0: Universal Subscriber Identity Module (USIM) Application Toolkit (USAT)
- 3GPP TS 36.124 V10.3.0: Electro Magnetic Compatibility (EMC) requirements for mobile terminals and ancillary equipment
- 3GPP TS 27.007 V10.0.8: AT command set for User Equipment (UE)

- 3GPP TS 27.005 V10.0.1: Use of Data Terminal Equipment - Data Circuit terminating Equipment (DTE-DCE) interface for Short Message Service (SMS) and Cell Broadcast Service (CBS)
- PCI Express M.2 Specification Rev4.0

1.3 Related Documents

- FIBOCOM_RF Antenna Design Application Note
- Fibocom_EVB-M2_User Guide
- Fibocom_FM101_AT Commands User Manual
- Fibocom_FM101_SAR Design User Guide

2 Overview

2.1 Introduction

FM101R-GL is a highly integrated 4G WWAN module which uses M.2 form factor interface. It supports LTE FDD/LTE TDD/WCDMA systems and can be applied to most cellular networks of mobile carrier in the world.

2.2 Specification

2.2.1 RF Characteristic

FM101 RF characteristic is shown in Table 1:

Table 1. RF characteristic

Operating Band	
FDD-LTE	B1/2/3/4/5/7/8/12/13/14/17/18/19/20/25/26/28/29/30/32/66/71
TDD-LTE	B38/39/40[1)]/41/42[1)]/43[1)]/48[2)]
UMTS/HSPA+[3)]	B1/2/4/5/6/8/19
GNSS	GPS/GLONASS/Galileo/BDS
Data Throughput	
LTE Peak	DL 600Mbps (CAT12)/UL 150Mbps (CAT13)
UMTS/HSPA+ Peak	DL UMTS: 384 kbps/UL 384 kbps
	DL DC-HSPA+: 42 Mbps (CAT24)/UL 5.76 Mbps (CAT6)
Modulation Characteristic	
LTE Modulation	3GPP Release 12 DL 256 QAM

	UL 64 QAM
UMTS	3GPP Release 9
RF Characteristic	
MIMO	2x2 MIMO
Carrier Aggregation	
LTE	DL 2CA/3CA UL 2CA

1) B40/42/43 is not supported in FCC/IC.

2) B48 is not supported in IC.

3) FM101R-GL not supported UMTS/ HSPA+ in Japan.

2.3 Key Features

Table 2. Key features

Specification	
CPU	Qualcomm SDX12, 14nm process, ARM Cortex-A7, up to 1.28 GHz
Memory	1Gb LPDDR2+1Gb NAND Flash
Supported OS	Windows 11/Chrome /Linux
Power Supply	DC 3.135V to 4.4V, typical 3.3V
Temperature	Normal operating temperature: –10°C to +55°C
	Extended operating temperature: –30°C to +75°C[1)]
	Storage temperature: –40°C to +85°C
Physical	Interface: M.2 Key-B

Characteristics	Dimension: 30 mm x 42 mm x 2.3 mm
	Weight: 5.8g
Interface	
Antenna Connector	WWAN Antenna x 2
	Support 2x2 MIMO
Function Interface	Dual SIM (one embedded eSIM), 1.8V/3V
	USB 2.0
	USB 3.0
	W_Disable#
	Bodysar
	LED
	Tunable antenna
	I2C (Reserved)
Software	
Protocol Stack	IPV4/IPV6
AT Commands	3GPP TS 27.007 and 27.005
Firmware Update	USB2.0
Other Feature	Multiple carrier
	Windows/Chrome MBIM support
	Windows/Chrome update
	AGNSS

1) When temperature goes beyond normal operating temperature range of -10°C to +55°C, RF performance of module may be slightly off 3GPP specifications.

2.4 Application Block

The peripheral applications for FM101R-GL module are shown in Figure 1:

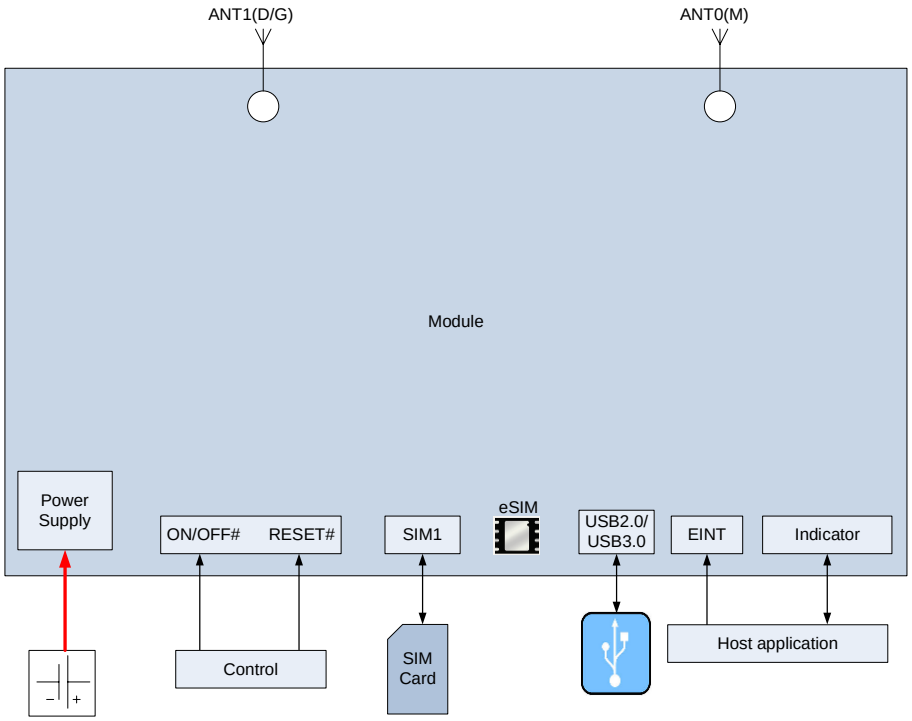

Figure 1. Application block

2.5 Hardware Block Diagram

The hardware block diagram in Figure 2 shows the main hardware functions of FM101R-GL module, including base band and RF functions.

Baseband contains:

- UMTS/LTE TDD/LTE FDD controller

- PMU
- MCP (NAND+ LPDDR2)
- Application interface

RF contains:

- RF Transceiver
- RF DCDC/PA
- RF Duplexer
- Antenna Connector

2.6 Antenna Configuration

FM101R-GL module supports two antennas and the configuration is as below Table:

Table 3. Antenna configuration

Antenna Connector	Function Description	Band Configuration (TX)	Band Configuration (RX)	Frequency Range (MHz)
ANT0 (M)	Main antenna port for TRX	WCDMA B1/2/4/5/6/8/19 LTE Band B1/2/3/4/5/7/8/12/13/14/17/18/19/20/25/26/28/30/66/71/38/39/40/41/42/43/48	WCDMA B1/2/4/5/6/8/19 LTE Band B1/2/3/4/5/7/8/12/13/14/17/18/19/20/25/26/28/29/30/32/66/71/38/39/40/41/42/43/48	617–3800
ANT1 (D/G)	Antenna port for RX	-	WCDMA B1/2/4/5/6/8/19 LTE Band B1/2/3/4/5/7/8/12/13/14/17/18/19/20/25/26/28/29/30/32/66/71/38/39/40/41/42/43/48 GNSS	617–3800

3 Application Interface

3.1 M.2 Interface

The FM101R-GL module applies standard M.2 Key-B interface, with a total of 75 pins.

3.1.1 Pin Map

74	+3.3V	CONFIG_2	75
72	+3.3V	GND	73
70	+3.3V	GND	71
68	NC	CONFIG_1	69
66	SIM_DETECT(1.8V)	RESET#(1.8V)	67
64	COEX_TXD(1.8V)	ANTCTL3(1.8V)	65
62	COEX_RXD(1.8V)	ANTCTL2(1.8V)	63
60	COEX3(1.8V)	ANTCTL1(1.8V)	61
58	RFFE_SDATA(1.8V)	ANTCTL0(1.8V)	59
56	RFFE_SCLK(1.8V)	GND	57
54	NC	NC	55
52	NC	NC	53
50	NC	GND	51
48	NC	NC	49
46	NC	NC	47
44	I2C_IRQ#(EINT)	GND	45
42	I2C_SDA(I2C Master)	NC	43
40	I2C_SCL(I2C Master)	NC	41
38	NC	GND	39
36	UIM_PWR	USB3.0_RX+	37
34	UIM_DATA	USB3.0_RX-	35
32	UIM_CLK	GND	33
30	UIM_RESET	USB3.0_TX+	31
28	GPIO	USB3.0_TX-	29
26	W_DISABLE2#(3.3/1.8V)	GND	27
24	VIO_1.8V	DPR(3.3/1.8V)	25
22	ANT_TUNER_CFG	WOWWAN#(1.8V)	23
20	GPIO	CONFIG_0	21
	Notch	Notch	
	Notch	Notch	
	Notch	Notch	
	Notch	Notch	
10	LED1#(3.3V OD)	GND	11
8	W_DISABLE1#(3.3/1.8V)	USB D-	9
6	FULL_CARD_POWER_OFF#(3.3/1.8V)	USB D+	7
4	+3.3V	GND	5
2	+3.3V	GND	3
		CONFIG_3	1

Figure 3. Pin map

Pin “Notch” represents the gap of the gold fingers.

3.1.2 Pin Definition

IO Parameter definition is as below Table.

Table 4. IO parameter definition

Type	Description
PI	Power Input
PO	Power Output
DI	Digital Input
DO	Digital Output
DIO	Digital Input /Output
AI	Analog Input
AO	Analog Output
AIO	Analog Input /Output
OD	Open Drain
T	Tristate
PU	Pull Up
PD	Pull Down
Hi-Z	High impedance
NC	Not connected

The pin definition is as follows:

Table 5. Pin definition

Pin	Pin Name	I/O	Default State[1)]	Pin Description	Type
1	CONFIG_3	O	GND	GND, FM101 M.2 module is configured as the WWAN – SSIC, USB 3.0 interface type	-
2	+3.3V	PI	-	Power input	Power Supply
3	GND	-	-	GND	Power Supply
4	+3.3V	PI	-	Power input	Power Supply
5	GND	-	-	GND	Power Supply
6	FULL_CARD_ POWER_OFF#	I	PU	Power enable, module power on input, internal pull up	3.3/1.8V
7	USB D+	I/O	-	USB data plus	0.3-3V
8	W_DISABLE1#	I	PU	WWAN disable, default high, active low	3.3/1.8V
9	USB D-	I/O	-	USB data minus	0.3-3V
10	LED1#	OD	T	System status LED, drain output	3.3V
11	GND	-	-	GND	Power Supply
12	Notch			Notch	
13	Notch			Notch	

Pin	Pin Name	I/O	Default State[1)]	Pin Description	Type
14	Notch			Notch	
15	Notch			Notch	
16	Notch			Notch	
17	Notch			Notch	
18	Notch			Notch	
19	Notch			Notch	
20	GPIO	I	PD	GPIO(I), default low, reserved	1.8V
21	CONFIG_0	-	NC	NC, FM101 M.2 module is configured as the WWAN – SSIC, USB 3.0 interface type	-
22	ANT_TUNER_CFG	I	PD	External interrupt for SAR and antenna environment detection, reserved	1.8V
23	WOWWAN#	O	PD	Wake up host, Reserved	1.8V
24	ANT_TUNER_1V8	PO	PU	1.8V output for ANT Tuner, reserved.	Power Supply /1.8V
25	DPR	I	PU	Dynamic power reduction detect, default high, active low	3.3/1.8V
26	W_DISABLE2#	I	PU	GNSS disable, default high, active low, reserved	3.3/1.8V
27	GND	-	-	GND	Power Supply

Pin	Pin Name	I/O	Default State[1)]	Pin Description	Type
28	GPIO	I/O	PD	GPIO, default low, reserved	1.8V
29	USB 3.0_TX-	O	-	USB 3.0 transmit data minus	-
30	UIM1_RESET	O	-	SIM reset signal	1.8V/3V
31	USB 3.0_TX+	O	-	USB 3.0 transmit data plus	-
32	UIM1_CLK	O	-	SIM clock signal	1.8V/3V
33	GND	-	-	GND	Power Supply
34	UIM1_DATA	I/O	-	SIM data input/output	1.8V/3V
35	USB 3.0_RX-	I	-	USB 3.0 receive data minus	-
36	UIM1_PWR	O	-	SIM power supply, 1.8V/3V	1.8V/3V
37	USB 3.0_RX+	I	-	USB 3.0 receive data plus	-
38	NC	-	-	NC	-
39	GND	-	-	GND	Power Supply
40	I2C_SCL	O	PU	I2C clock, master mode，default high, reserved	1.8V
41	NC	-	-	NC	-
42	I2C_SDA	I/O	PU	I2C data, master mode, default high, reserved	1.8V
43	NC	-	-	NC	-
44	I2C_IRQ#	I	PD	I2C interrupt, used for wake up	1.8V

Pin	Pin Name	I/O	Default State[1)]	Pin Description	Type
				I2C host, default low, reserved	
45	GND	-	-	GND	Power Supply
46	NC	-	-	NC	-
47	NC	-	-	NC	-
48	NC	-	-	NC	-
49	NC	-	-	NC	-
50	NC	-	-	NC	-
51	GND	-	-	GND	Power Supply
52	NC	-	-	NC	-
53	NC	-	-	NC	-
54	NC	-	-	NC	-
55	NC	-	-	NC	-
56	RFFE_SCLK	O	PD	MIPI interface tunable ANT, RFFE clock	1.8V
57	GND	-	-	GND	Power Supply
58	RFFE_SDATA	I/O	PD	MIPI interface tunable ANT, RFFE data	1.8V
59	ANTCTL0	O	PD	Tunable ANT CTRL0, default low	1.8V

Pin	Pin Name	I/O	Default State[1)]	Pin Description	Type
60	COEX3	I/O	PD	Wireless coexistence between WWAN and WIFI/BT modules, based on BT-SIG coexistence protocol. COEX_EXT_FTA, Reserved	1.8V
61	ANTCTL1	O	PD	Tunable ANT CTRL1, default low	1.8V
62	COEX_RXD	I	PU	Wireless coexistence between WWAN and WIFI/BT modules, based on BT-SIG coexistence protocol. UART receive signal (WWAN module side), Reserved	1.8V
63	ANTCTL2	O	PD	Tunable ANT CTRL2, default low	1.8V
64	COEX_TXD	O	PU	Wireless coexistence between WWAN and WIFI/BT modules, based on BT-SIG coexistence protocol. UART transmit signal (WWAN module side), Reserved	1.8V
65	ANTCTL3	O	PD	Tunable ANT CTRL3, default low	1.8V
66	SIM1_DETECT	I	PD	SIM1 detect, internal pull up (390KΩ), active high	1.8V
67	RESET#	I	PU	WWAN reset input, active low, internal pull up (47KΩ) by PMU	1.8V
68	NC	-	-	NC	-
69	CONFIG_1	O	GND	GND, FM101 M.2 module is configured as the WWAN – SSIC,	-

Pin	Pin Name	I/O	Default State[1)]	Pin Description	Type
				USB 3.0 interface type	
70	+3.3V	PI	-	Power input	Power Supply
71	GND	-	-	GND	Power Supply
72	+3.3V	PI	-	Power input	Power Supply
73	GND[2)]	-	-	GND	Power Supply
74	+3.3V	PI	-	Power input	Power Supply
75	CONFIG_2	O	GND	GND, FM101 M.2 module is configured as the WWAN – SSIC, USB 3.0 interface type	-

1) Default state refers to the state when the pin-name function is enabled.
2) FM101 Pin73 is internally connected to GND. If the customer requires to be compatible with the WWAN of the PCIe interface and needs the sideband voltage indication detection function, the Pin73 can be NC in host side.

3.2 Power Supply

The power interface of FM101R-GL module as shown in the following Table:

Table 6. Power interface

Pin	Pin Name	I/O	Pin Description	DC Parameter (V)		
				Minimum Value	Typical Value	Maximum Value
2, 4, 70, 72, 74	+3.3V	PI	Power supply input	3.135	3.3	4.4
24	ANT_TUNER_1V8	PO	1.8V power output for antenna tuner	1.71	1.8	1.89
36	UIM1_PWR	PO	USIM power supply	-	1.8V/3V	-

The Power rating is shown in the following Table:

Table 7. Power rating

Pin	Pin Name	I/O	Pin Description	Peak Current (mA)
2, 4, 70, 72, 74	+3.3V	PI	Power supply input	2500
24	ANT_TUNER_1V8	PO	1.8V power output for antenna tuner	200
36	UIM1_PWR	PO	USIM power supply	150

3.2.1 Power Supply

The FM101R-GL module should be powered through the +3.3V pins, and the power supply design is shown in Figure:

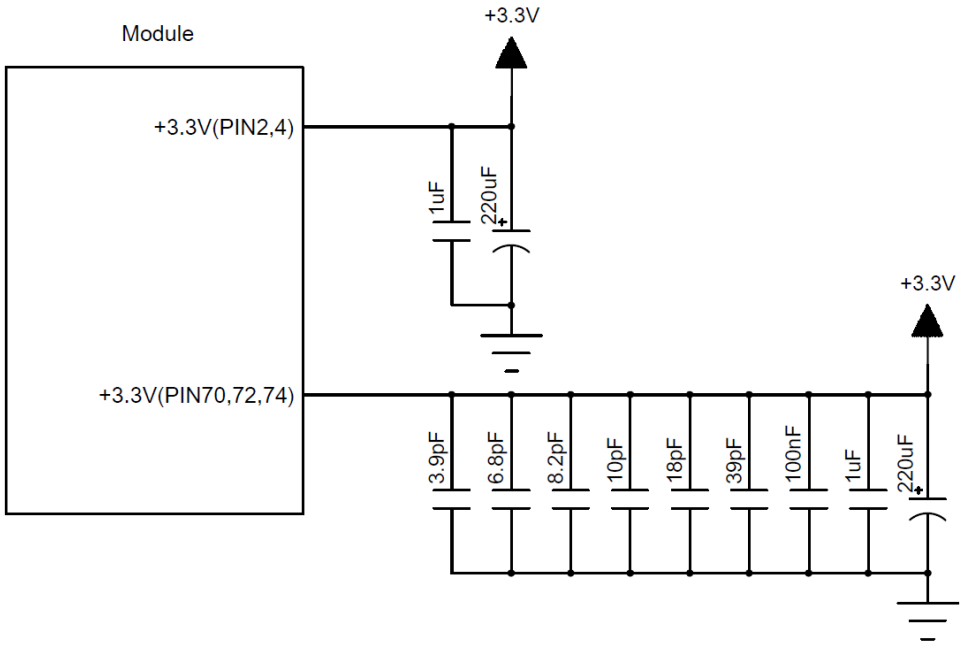

Figure 4. Power supply design

The filter capacitor design for power supply as shown in the following Table:

Table 8. The filter capacitor design for power supply

Recommended capacitance	Application	Description
220uF x 2	Voltage-stabilizing capacitors	Reduce power fluctuations of the module in operation, requiring capacitors with low ESR. LDO or DC/DC power supply requires the capacitor with no less than 440uF in the power supply voltage range.
1uF, 100nF	Digital signal noise	Filter out the interference generated from the clock and digital signals
39pF, 33pF	700/800, 850/900 MHz frequency band	Filter out low frequency band RF interference
18pF, 10pF,	1500/1800, 2100/2300,	Filter out medium/high frequency band

Recommended capacitance	Application	Description
8.2pF, 6.8pF, 3.9pF	2600MHz, 3500/3600/3700MHz, 5GHz	RF interference

The stable power supply can ensure the normal operation of FM101R-GL module; and the ripple of the power supply should be less than 100mV in design. When the module operates with the maximum emission power, the maximum operating current can reach 2.5A, so the power source should be not lower than 3.135V, or the module may shut down or reboot. The power supply description and requirement are shown in Table 9 and Figure 5:

Table 9. Power supply description

Description	Conditions	Min	Typ	Max	Unit
Power supply	Directly measured at module. Voltage must stay within the min/max values, including voltage drop, ripple, spikes	3.135	3.3	4.4	V

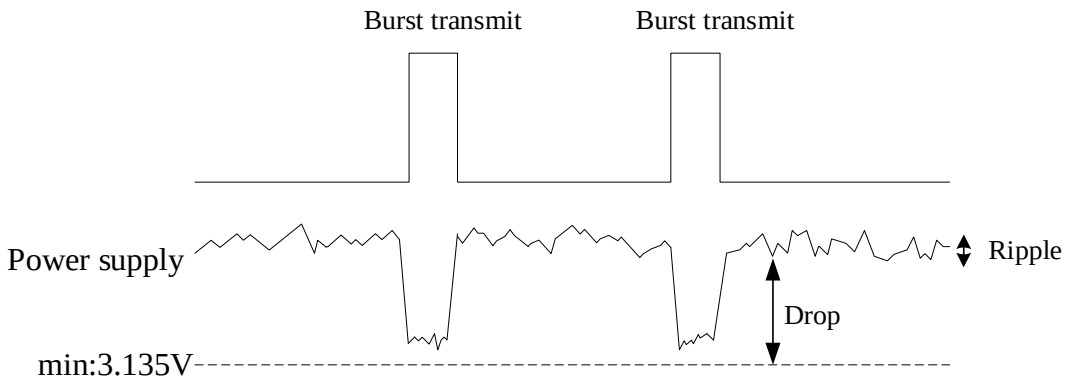

Figure 5. Power supply requirement

3.2.2 Logic Level

The FM101R-GL module 1.8V logic level definition is shown in the following Table:

Table 10. Module 1.8V logic level definition

Parameter	Minimum	Typical	Maximum	Unit
V_{OH}[1)]	1.71	1.8	1.89	V
V_{OL}[2)]	-0.3	0	0.3	V
V_{IH}[3)]	1.3	1.8	1.89	V
V_{IL}[4)]@1mA	-0.3	0	0.3	V

The FM101R-GL module 3.3V logic level definition is shown in the following Table:

Table 11. Module 3.3V logic level definition

Parameter	Minimum	Typical	Maximum	Unit
V_{IH}[2)]	2.3	3.3	3.465	V
V_{IL}[3)]@1mA	-0.3	0	0.3	V

3) V_{OH}: Output high level effective voltage.
4) V_{OL}: Output low level effective voltage.
5) V_{IH}: Input high level effective voltage.
6) V_{IL}: Input low level effective voltage.

3.2.3 Power Consumption

In the condition of 3.3V power supply, the FM101R-GL power consumption is shown in the following Table:

Table 12. Power consumption

Parameter	Mode	Condition	Typical Current (mA)	Note
I_{off}	Power off	Power supply enable, module power off	TBD	--
I_{Sleep}	WCDMA	DRX=8	TBD	-
	LTE FDD	Paging cycle #128 frames (1.28s DRx cycle)	TBD	-
	LTE TDD	Paging cycle #128 frames (1.28s DRx cycle)	TBD	-
	Radio Off	AT+CFUN=4, flight mode	TBD	-
$I_{WCDMA-RMS}$	WCDMA	Band 1	TBD	-
		Band 2	TBD	-
		Band 4	TBD	-
		Band 5	TBD	-
		Band 6	TBD	-
		Band 8	TBD	-
		Band 19	TBD	-
$I_{LTE-RMS}$	LTE FDD	Band 1	TBD	10MHz BW, 12RB
		Band 2	TBD	10MHz BW, 12RB
		Band 3	TBD	10MHz BW, 12RB
		Band 4	TBD	10MHz BW, 12RB
		Band 5	TBD	10MHz BW, 12RB

Parameter	Mode	Condition	Typical Current (mA)	Note
		Band 7	TBD	10MHz BW, 12RB
		Band 8	TBD	10MHz BW, 12RB
		Band 12	TBD	10MHz BW, 12RB
		Band 13	TBD	10MHz BW, 12RB
		Band 14	TBD	10MHz BW, 12RB
		Band 17	TBD	10MHz BW, 12RB
		Band 18	TBD	10MHz BW, 12RB
		Band 19	TBD	10MHz BW, 12RB
		Band 20	TBD	10MHz BW, 12RB
		Band 25	TBD	10MHz BW, 12RB
		Band 26	TBD	10MHz BW, 12RB
		Band 28	TBD	10MHz BW, 12RB
		Band 30	TBD	10MHz BW, 12RB
		Band 66	TBD	10MHz BW, 12RB
		Band 71	TBD	10MHz BW, 12RB
	LTE TDD	Band 38	TBD	10MHz BW, 12RB
		Band 39	TBD	10MHz BW, 12RB
		Band 40	TBD	10MHz BW, 12RB
		Band 41	TBD	10MHz BW, 12RB
		Band 42	TBD	10MHz BW, 12RB

Parameter	Mode	Condition	Typical Current (mA)	Note
		Band 43	TBD	10MHz BW, 12RB
		Band 48	TBD	10MHz BW, 12RB

1) LTE TDD band current is tested with slot configuration DL: UL:S=4: 4: 2
2) The above data is the average value obtained by testing the sample for high/medium/low channels in room temperature (ambient temperature 25°C)

3.3 Control Signal

The FM101R-GL module provides two control signals for power on/off and reset operations. The pin is defined in the following Table:

Table 13. Control signal

Pin	Pin Name	I/O	Default State	Function	Level
6	FULL_CARD_POWER_OFF#	I	PU	Module power on/off input, internal pull up (47KΩ) by PMU. Power on: High/Floating Power off: Low	3.3/1.8V
67	RESET#	I	PU	WWAN reset input, active low, internal pull up (47KΩ) by PMU.	1.8V

RESET# needs to be controlled by independent GPIO, and not shared with other devices on the host. It's a sensitive signal. So it should keep away from RF interference and protected by ground. It should be neither near PCB edge nor route on surface layer to avoid being reset abnormally caused by ESD.

3.3.1 Module Start-Up

3.3.1.1 Start-up Circuit

The FCPO# (FULL_CARD_POWER_OFF #) pin needs an external 3.3V or 1.8V pull up for booting up. AP (Application Processor) controls the module start-up. The recommended design is using a default PD port to control FCPO#. It also should reserve a 10KΩ(NC) pull down resistor on AP side. The circuit design is shown in Figure:

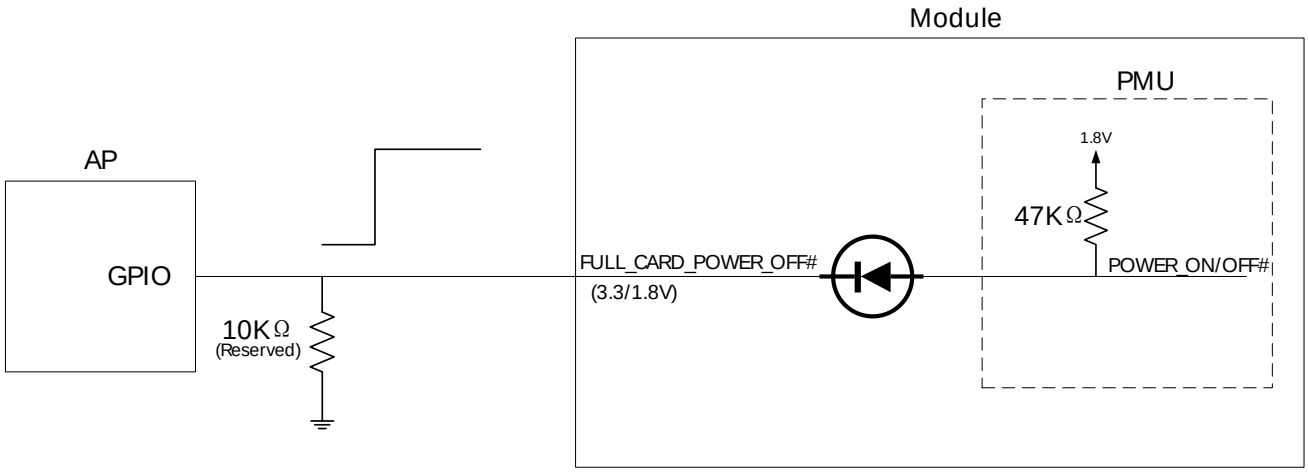

Figure 6. Circuit for module start-up controlled by AP

3.3.1.2 Start-up Timing Sequence

When power supply is ready, the PMU of module will power on and start initialization process by pulling high FCPO# signal. After about 15s, module will complete initialization process. The start-up timing is shown in Figure:

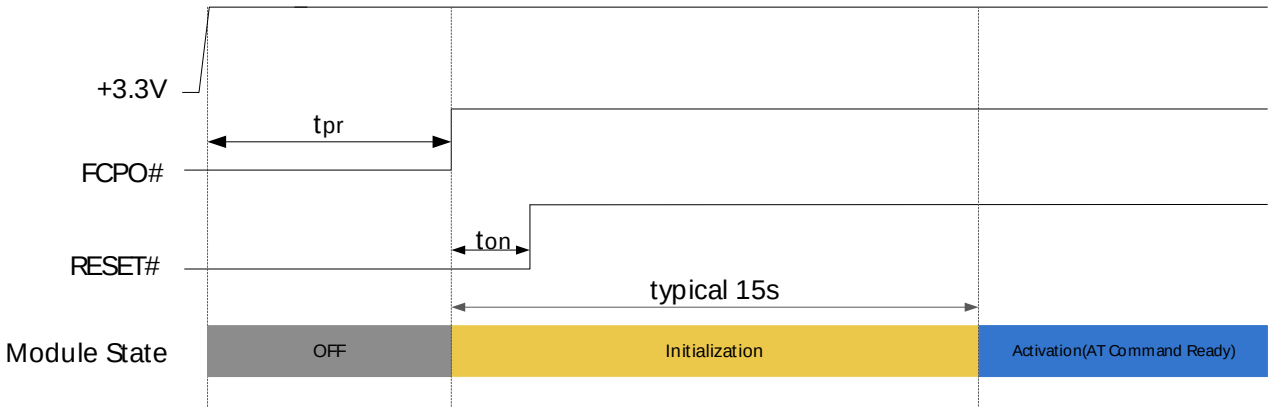

Figure 7. Timing control for start-up

Index	Min.	Recommended	Max.	Comment
t_{pr}	0ms	-	-	The delay time of power supply rising from 0V up to 3.135 V stably. If power supply always ready, it can be ignored.
t_{on}	0ms	20ms	-	The time from FCPO# high to RESET# high.

3.3.2 Module Shutdown

The module can be shut down by pull down RESET# and FCPO# pin. The control timing is shown in Figure 8:

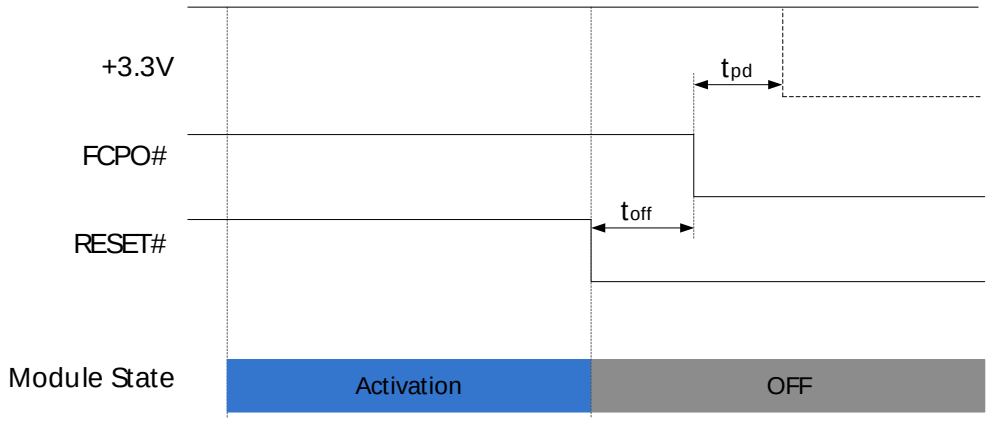

Figure 1. Recommend control power off timing

Index	Min.	Recommended	Max.	Comment
t_{pd}	10ms	100ms	-	The time for +3.3V delay time of shutdown. If +3.3V keeps constant supply, the delay time can be ignored.
t_{off}	0ms	10ms	-	The time difference between the RESET # signal and the FULL_CARD_POWER_OFF # signal.

3.3.3 Module Reset

The FM101R-GL module can reset to its initial status by pulling down the RESET# signal for more than 20ms, and module will restart after RESET# signal is released. When customer executes RESET# function, the PMU power will be turned off. The recommended circuit design is shown in the Figure 9:

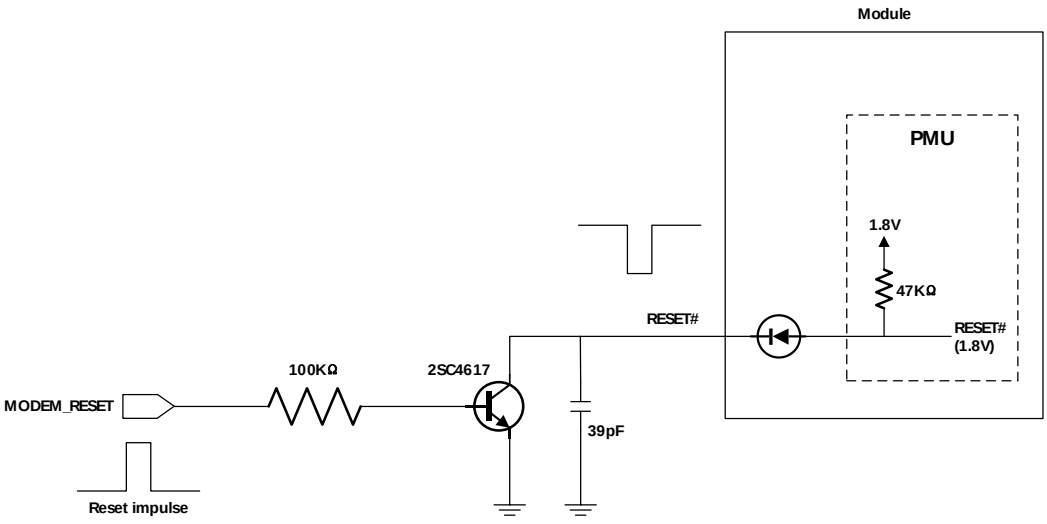

Figure 9. Recommended design for reset circuit

There are two reset control timings as below:

- Reset timing 1st in Figure 10, PMU of module internal will be off in reset sequence, recommend using in module recovery;
- Reset timing 2nd in Figure 11, PMU of module internal will be off in reset sequence, recommend using in system warm boot.

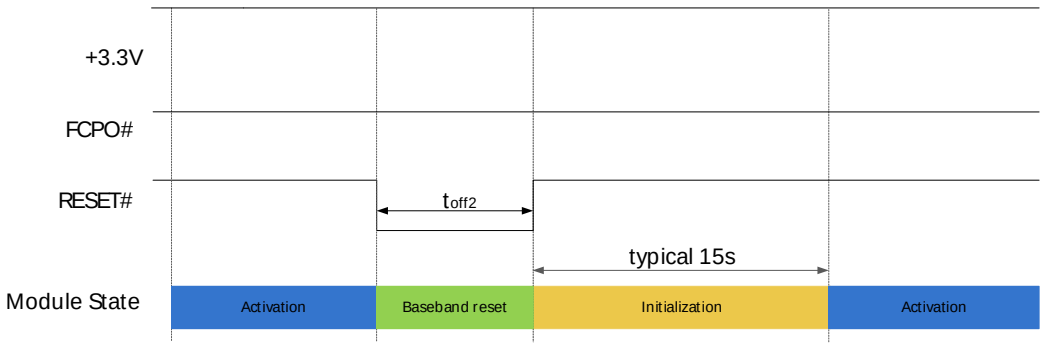

Figure 10. Reset timing 1st

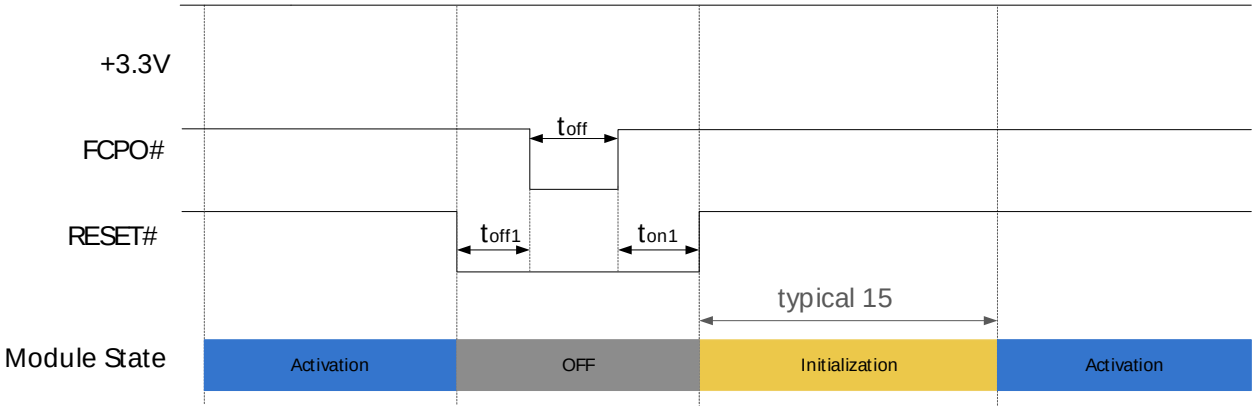

Figure 11. Reset timing 2nd

Index	Min.	Recommended	Max.	Comment
t_{off2}	2ms	10ms	-	RESET# asserted time
t_{off1}	0ms	10ms	-	FCPO# should be asserted after RESET#, refer section 3.3.2
t_{off}	500ms	500ms	-	Time to allow the WWAN module to fully discharge any residual voltages before the pin could be de-asserted again. This is required for both Pre-OS as well as Runtime flow
t_{on1}	0ms	20ms	-	RESET# should be de-asserted after FCPO# assert to high, refer section 3.3.1.2

RESET# is a sensitive signal, it's recommended to add a filter capacitor close to the module. In case of PCB layout, the RESET# signal lines should keep away from the RF interference and protected by GND. Also, the RESET# signal lines shall neither near the PCB edge nor route on the surface planes to avoid module from reset caused by ESD problems.

3.4 USIM Interface

The FM101R-GL module has Dual SIM (one embedded eSIM and USIM interface). USIM interface supports 1.8V/3V SIM card.

3.4.1 USIM Pins

The USIM pins description is shown in the following Table:

Pin	Pin Name	I/O	Default State	Description	Type
36	UIM1_PWR	PO	-	USIM power supply	1.8V/3V
30	UIM1_RESET	O	-	USIM reset	1.8V/3V
32	UIM1_CLK	O	-	USIM clock	1.8V/3V
34	UIM1_DATA	I/O	-	USIM data, internal pull up (4.7KΩ)	1.8V/3V
66	SIM1_DETECT	I	PD	USIM card detect, internal 390 KΩ pull-up. Active high, and high level indicates SIM card is inserted; and low level indicates SIM card is detached.	1.8V

3.4.2 USIM Interface Circuit

3.4.2.1 N.C. SIM Card Slot

The reference circuit design for N.C. (Normally Closed) SIM card slot is shown in Figure 12:

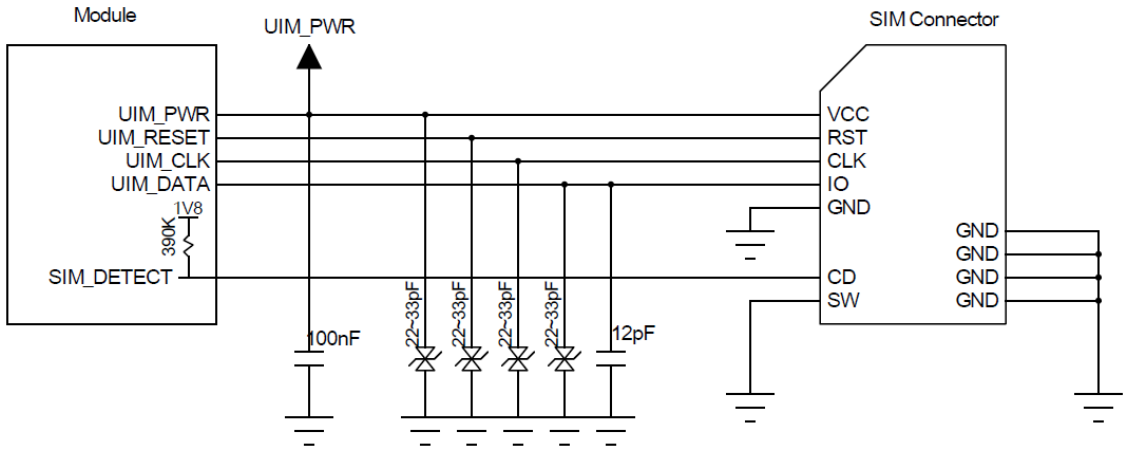

Figure 12. Reference circuit for N.C. SIM card slot

The principles of the N.C.SIM card slot are described as follows:

- When the SIM card is detached, it connects the short circuit between CD and SW pins, and drives the SIM1_DETECT pin low.
- When the SIM card is inserted, it connects an open circuit between CD and SW pins, and drives the SIM1_DETECT pin high.

3.4.2.2 N.O. SIM Card Slot

The reference circuit design for N.O. (Normally Open) SIM card slot is shown in Figure 13:

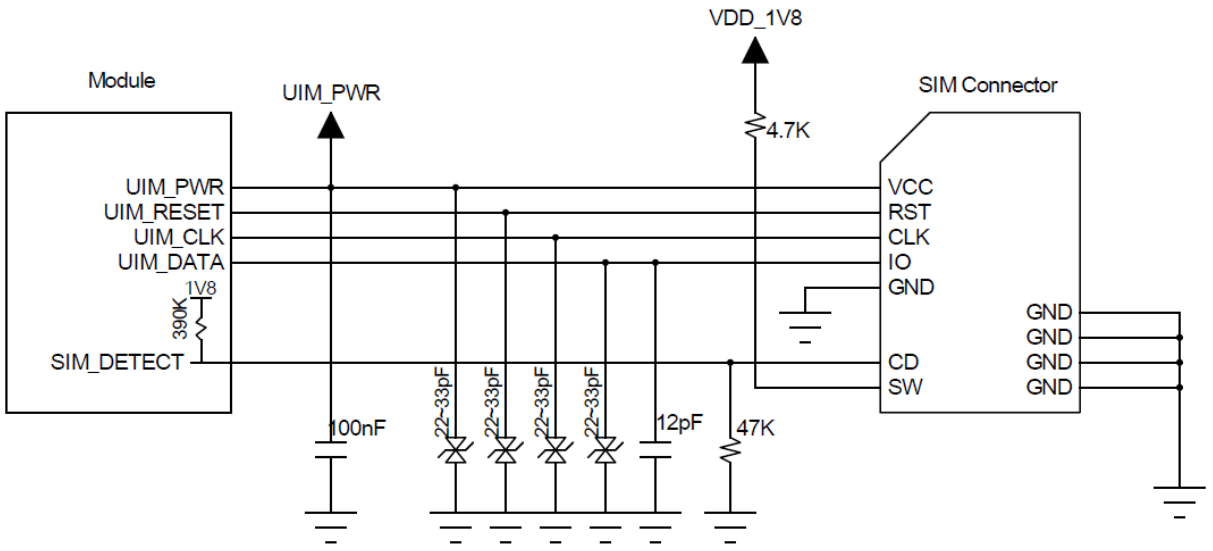

Figure 13. Reference circuit for N.O. SIM card slot

The principles of the N.O.SIM card slot are described as follows:

- When the SIM card is detached, it connects an open circuit between CD and SW pins, and drives the SIM_DETECT pin low.
- When the SIM card is inserted, it connects the short circuit between CD and SW pins, and drives the SIM_DETECT pin high.

3.4.3 USIM Hot-Plug

The FM101R-GL module supports the SIM card hot-plug function, which determines whether the SIM card is inserted or detached by detecting the SIM_DETECT pin state of the SIM card slot.

The SIM card hot-plugging function can be configured by AT+MSMPD command, and the description for AT command is shown in the following Table:

AT Command	Hot-plug Detection	Function Description
AT+MSMPD=1	Enable	Default value, the SIM card hot-plug detection function is enabled. The module can detect whether the SIM card is inserted or not through the SIM_DETECT pin state.

AT Command	Hot-plug Detection	Function Description
AT+MSMPD=0	Disable	The SIM card hot-plug detect function is disabled. The module reads the SIM card when starting up, and the SIM_DETECT status will not be detected.

After the SIM card hot-plugging detection function is enabled, the module detects that the SIM card is inserted when the SIM_DETECT pin is high, then executes the initialization program and finish the network registration after reading the SIM card information. When the SIM_DETECT pin is low, the module determines that the SIM card is detached and does not read the SIM card.

SIM_DETECT is active high. It can be swapped to active low by AT CMD.

3.4.4 USIM Design

The SIM card circuit design should meet the EMC standards and ESD requirements with the improved capability to resist interference, to ensure that the SIM card can work stably. The following guidelines should be noted in design:

- The SIM card slot should be placed as close as possible to the module, and away from the RF antenna, DC/DC power supply, clock signal lines, and other strong interference sources.
- The SIM card slot with a metal shielding housing can improve the anti-interference ability.
- The trace length between the SIM card slot and the module should not exceed 100mm, or it could reduce the signal quality.
- The UIM_CLK and UIM_DATA signal lines should be isolated by GND to avoid crosstalk interference. If it is difficult for the layout, the whole SIM signal lines should be wrapped with GND as a group at least.
- The filter capacitors and ESD devices for SIM card signals should be placed near to the SIM card slot, and the ESD devices with 22~33pF capacitance should be used.

3.5 USB Interface

The FM101R-GL module supports USB2.0 which is compatible with USB High-Speed (480 Mbit/s) and USB Full-Speed (12 Mbit/s). At the same time, FM101 also supports USB 3.0 5Gbit/s to achieve ultra-high-speed data transmission, which is used to meet the high-speed transmission requirements of LTE mobile networks. For the USB timing and electrical specification of FM101 module, please refer to Universal Serial Bus Specification 2.0" and "Universal Serial Bus Specification 3.0".

FM101 FW update only can base on USB2.0 interface. So it should still confirm USB2.0's connected. If only use USB3.0 does data communication. Please refer to the following Table for the connection combination of USB2.0 and USB3.0.

Connection Combination	USB2.0	USB3.0	Support or not	Remark
1	Not connect	Connect	Not support	USB2.0 must be used for firmware update
2	Connect	Not connect	Not support	USB2.0 bandwidth does not meet the maximum data transmission rate of FM101R-GL
3	Connect	Connect	Support	USB2.0 for firmware update and USB3.0 for data communication

Module has to be initialized by pulling M.2 control signals according spec, USB enumeration will be done automatically by module itself. No need to reset USB bus to enumerate USB port seperately because of module SoC design limitation (download function will be lost if re-enumerate USB port when chip already in

download mode or core dump mode)

3.5.1 USB Interface Definition

Pin	Pin Name	I/O	Default State	Pin Description	Level
7	USB D+	I/O	-	USB data plus	0.3-3V
9	USB D-	I/O	-	USB data minus	0.3-3V
29	USB 3.0_TX-	O	-	USB 3.0 transmit data minus	-
31	USB 3.0_TX+	O	-	USB 3.0 transmit data plus	-
35	USB 3.0_RX-	I	-	USB 3.0 receive data minus	-
37	USB 3.0_RX+	I	-	USB 3.0 receive data plus	-

3.5.2 USB2.0 Interface Application

The reference circuit is shown in Figure 14:

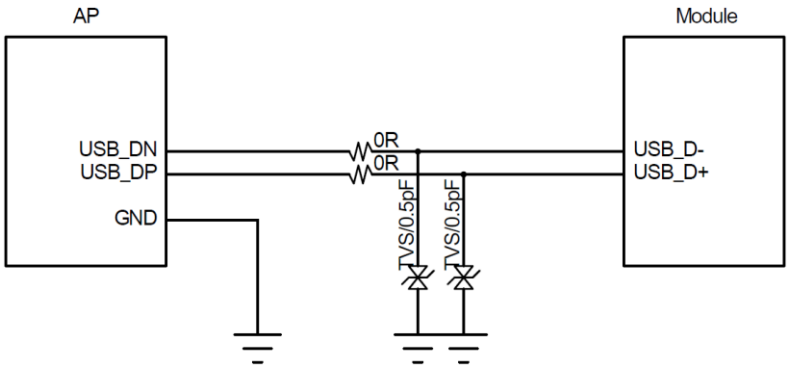

Figure 14 Reference circuit for USB 2.0 interface

Since the module supports USB 2.0 High-Speed, it is required to use TVS diodes with

equivalent capacitance of 1pF or smaller ones on the USB_D-/D+ differential signal lines, it is recommended to use 0.5pF TVS diodes.

USB_D- and USB_D+ are high speed differential signal lines with the maximum transfer rate of 480 Mbit/s, so the following rules shall be followed carefully in the case of PCB layout:

- USB_D- and USB_D+ signal lines should have the differential impedance of 90±10 ohms.
- USB_D- and USB_D+ signal cables must be less than 2mm in length and parallel, the right angle routing should be avoided.
- USB_D- and USB_D+ signal lines should be routed on the layer that is adjacent to the ground layer, and wrapped with GND vertically and horizontally.

3.5.3 USB3.0 Interface Application

The reference circuit is shown in Figure 15:

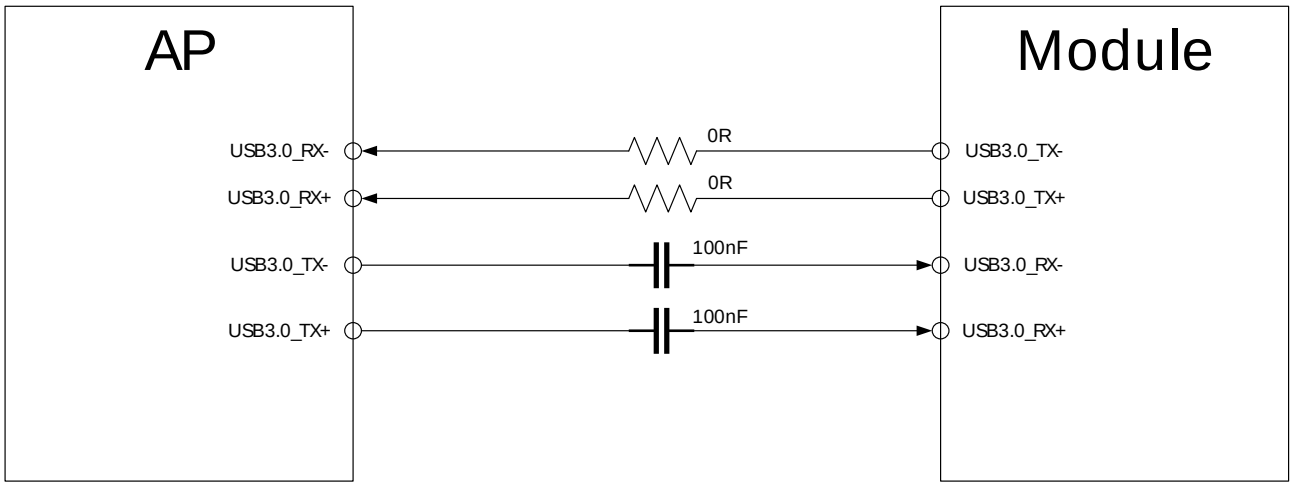

Figure 15. Reference circuit for USB 3.0 interface

USB 3.0 signals are super speed differential signal lines with the maximum transfer rate of 5Gbps. So the following rules should be followed carefully in the case of PCB layout:

- USB 3.0_TX-/USB 3.0_TX+ and USB 3.0_RX-/ USB 3.0_RX+ are two pairs differential signal lines. The differential impedance should be controlled as 90±10 ohms.
- The two pairs differential signal lines should be parallel and have the equal length. The right angle routing should be avoided.
- The two pairs differential signal lines should be routed on the layer that is adjacent to the ground layer, and wrapped with GND vertically and horizontally.

3.6 Status Indicator

The FM101R-GL module provides two signals to indicate the operating status of the module, and the status indicator pins is shown in the following Table:

Pin	Pin Name	I/O	Default State	Pin Description	Level
10	LED1#	OD	T	System status LED, drain output.	3.3V
23	WOWWAN#	DO	PD	Wake up host, Reserved	1.8V

3.6.1 LED1# Signal

The LED1# signal is used to indicate the operating status of the module, and the detailed description is shown in the following Table:

Module Status	LED1# Signal
RF function ON	Low level (LED on)
RF function OFF	High level (LED off)

The LED driving circuit is shown in Figure 16:

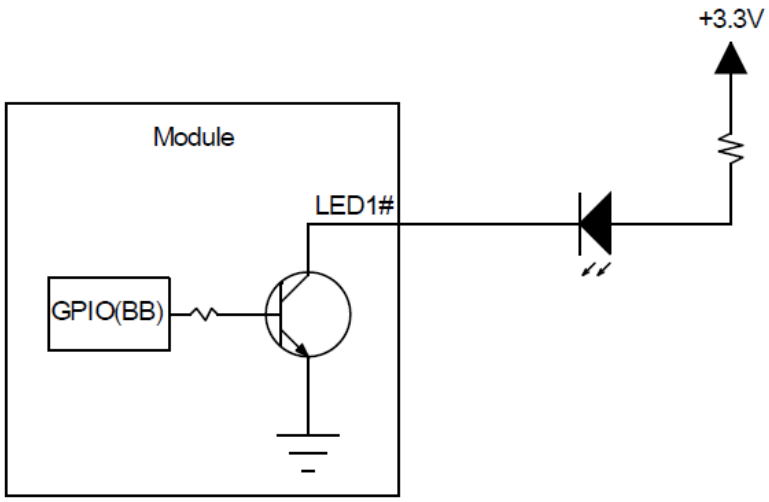

Figure 16. LED driving circuit

The resistance of LED current-limiting resistor is selected according to the driving voltage and the driving current.

3.7 Interrupt Control

The FM101R-GL module provides two interrupt signals, and the pin definitions are as follows:

Pin	Pin Name	I/O	Default State	Pin Description	Type
8	W_DISABLE1#	I	PU	WWAN disable, default high, active low	3.3/1.8V
22	ANT_TUNER_CFG	I	PD	External interrupt for SAR and antenna environment detection, reserved	1.8V
25	DPR	I	PU	Dynamic power reduction detect, default high, active low	3.3/1.8V

3.7.1 W_DISABLE1#

The module provides a hardware pin to enable/disable WWAN RF function, need AT+GTFMODE=1 to enable this function and the function can also be controlled by the AT command. The module enters into flight mode after the RF function is disabled. The definition of W_DISABLE1# signal is as follows:

W_DISABLE1# signal	Function

High/Floating	WWAN function is enabled, the module exits the flight mode.
Low	WWAN function is disabled, the module enters into flight mode.

The function of W_DISABLE1# is disabled in default. It can be enabled by customer’s request.

3.7.2 SAR and Antenna Environment Detection

The related position of devices with FM101R-GL installed in different placement states and the end user's body has effect on parameter configurations of Radio-Frequency-related functions such as SAR and tunable antenna.

ANT_TUNER_CFG on Pin 22 is the detection signal for the related position mentioned above referred as SAR and antenna environment. It will assist in the implementation of SAR and tunable antenna. FM101 will assign different parameters for SAR and tunable antenna functions based on the logic Low/High states of ANT_TUNER_CFG.

3.7.3 DPR

The FM101 module supports BodySAR function by detecting the DPR pin. The voltage level of DPR is high by default, and when the SAR sensor detects the closing human body, the DPR signal will be pulled down. As the result, the module then lowers down its emission power to its default threshold value, thus reducing the RF radiation on the human body. The threshold of emission power can be set by the AT Commands. The definition of DPR signal is shown in the following Table:

DPR Signal	Function
High/Floating	The module keeps the default emission power
Low	Lower the maximum emission power to the threshold value of the module.

3.8 ANT Tunable Interface

The module supports ANT Tunable interfaces with two different control modes, i.e. MIPI interface and 4bit GPO interface. Through cooperating with external antenna adapter switch via ANT tunable, it can flexibly configure the bands of WCDMA and LTE antenna to improve the antenna's working efficiency and save space for the antenna. Module also support 1.8V output for antenna tuner. The pin definition is as below Table:

Pin	Pin Name	I/O	Default State	Pin Description	Level
24	ANT_TUNER_1V8	PO	PU	1.8V power output for antenna tuner, reserved	1.8V
56	RFFE_SCLK	O	PD	Tunable ANT control, MIPI Interface, RFFE clock	1.8V
58	RFFE_SDATA	I/O	PD	Tunable ANT control, MIPI Interface, RFFE data	1.8V
59	ANTCTL0	O	PD	Tunable ANT CTRL0, default low	1.8V
61	ANTCTL1	O	PD	Tunable ANT CTRL1, default low	1.8V
63	ANTCTL2	O	PD	Tunable ANT CTRL2, default low	1.8V
65	ANTCTL3	O	PD	Tunable ANT CTRL3, default low	1.8V

3.9 Configuration Interface

The FM101R-GL module provides 4 configuration pins, they are output pins, used to read the level of H/L for the host system, so the host system can know the module type insert in the M.2 slot. If the host system is not need to know the module type, that is no need to connect these 4 pins, let they are floating is OK.

This module is configured as the WWAN-SSIC-0 type M.2 module:

Pin	Pin Name	I/O	Default State	Pin Description	Type
1	CONFIG_3	O	GND	GND, FM101 M.2 module is configured as the WWAN – SSIC, USB 3.0 interface type	-
21	CONFIG_0	-	NC	NC, FM101 M.2 module is configured as the WWAN – SSIC, USB 3.0 interface type	-
69	CONFIG_1	O	GND	GND, FM101 M.2 module is configured as the WWAN – SSIC, USB 3.0 interface type	-
75	CONFIG_2	O	GND	GND, FM101 M.2 module is configured as the WWAN – SSIC, USB 3.0 interface type	-

The M.2 module configuration is shown in the following Table:

Config_0 (pin21)	Config_1 (pin69)	Config_2 (pin75)	Config_3 (pin1)	Module Type and Main Host Interface	Port Configuration
NC	GND	GND	GND	WWAN–SSIC	0

Please refer to “PCI Express M.2 Specification Rev4.0” for more details.

4 Radio Frequency

4.1 RF Interface

4.1.1 RF Interface Functionality

The FM101R-GL module supports two RF connectors used for external antenna connection. As the Figure 17 shows, “M” is for Main antenna, which is used to receive and transmit RF signal; “D/G” is for Diversity antenna, which is used to receive the diversity RF signal and GNSS signal.

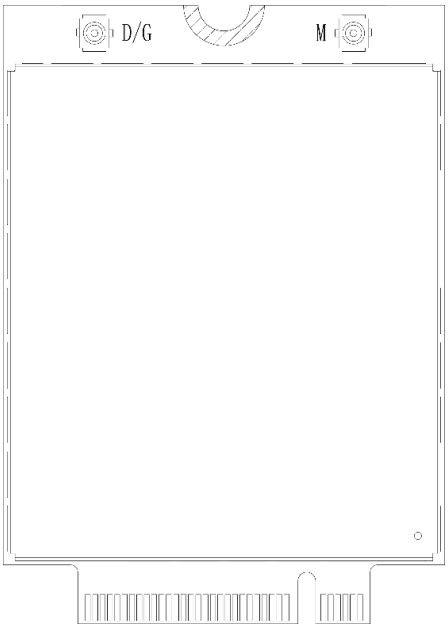

Figure 17. RF connectors

4.1.2 RF Connector Characteristic

Rated Condition		Environment Condition
Frequency Range	DC-6GHz	Temperature Range: –40°C to +85°C
Characteristic Impedance	50Ω	

4.1.3 RF Connector Dimensions

FM101R-GL module uses standard M.2 RF connectors. The RF connector part number is 818004607 manufactured by ECT cooperation, and the size is 2×2×0.6mm. The connector dimension is shown as following picture:

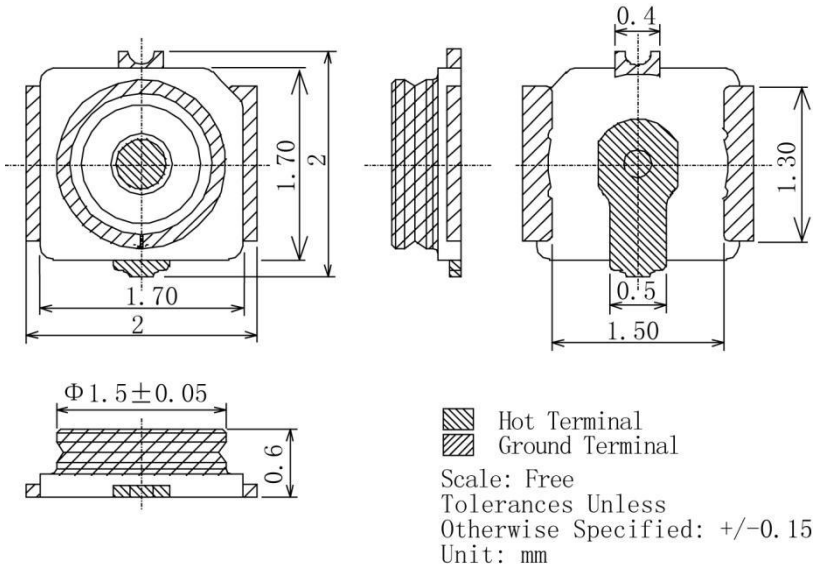

Figure 18. RF connector dimensions

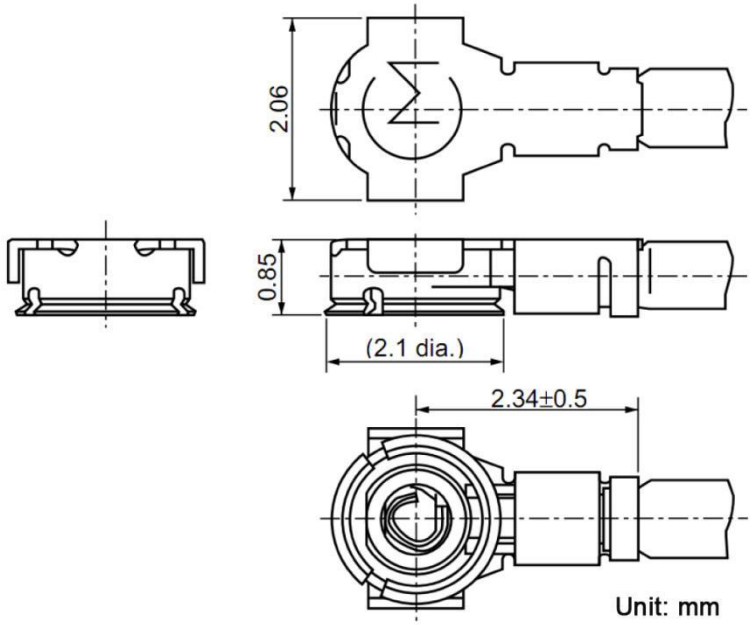

Figure 19. 0.81mm coaxial antenna dimensions

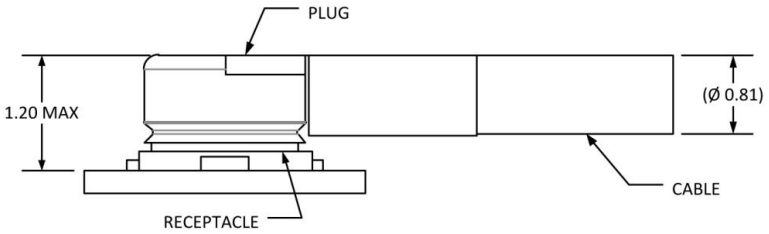

Figure 20. Schematic diagram of 0.81mm coaxial antenna connected to the RF connector

4.1.4 RF Connector Assembly

Mate RF connector parallel refer Figure 21, do not slant mate with strong force.

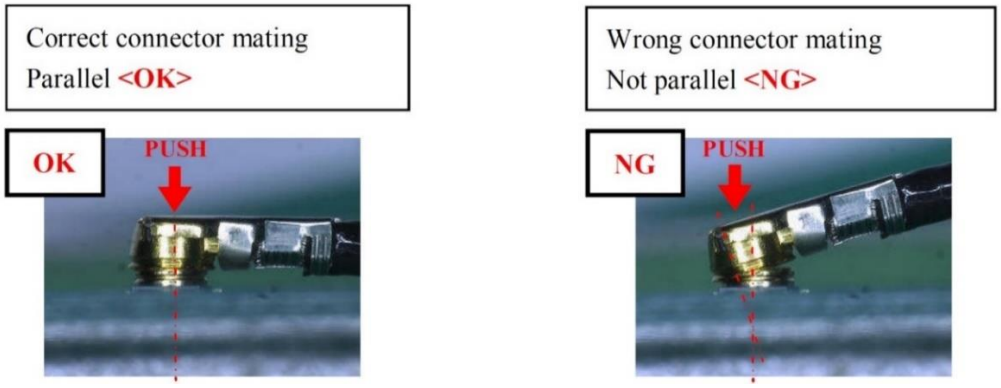

Figure 21. Mate RF connector

To avoid damage in RF connector mating, it is recommended using pulling JIG as Figure 22, and the pulling JIG must be lifted up vertically to PCB surface (see Figure 23 and 24). Pulling JIG must be lifted up vertically to PCB surface (see Figure 23 and 24).

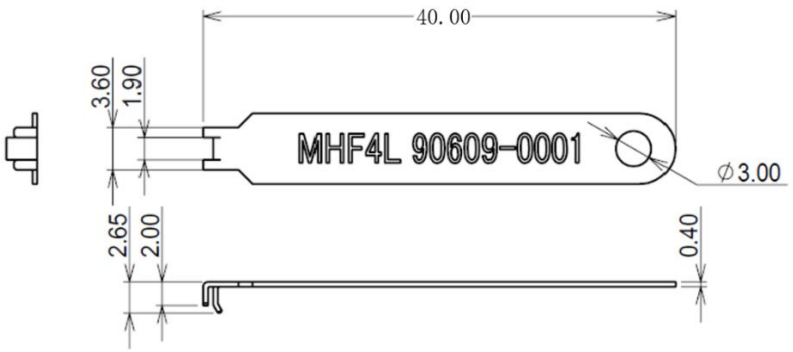

Figure 22. Pulling JIG

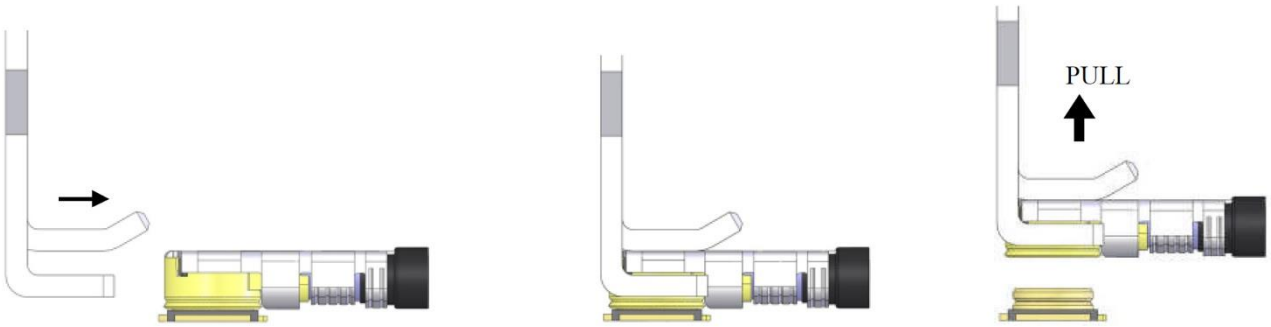

Figure 23. Lift up pulling JIG

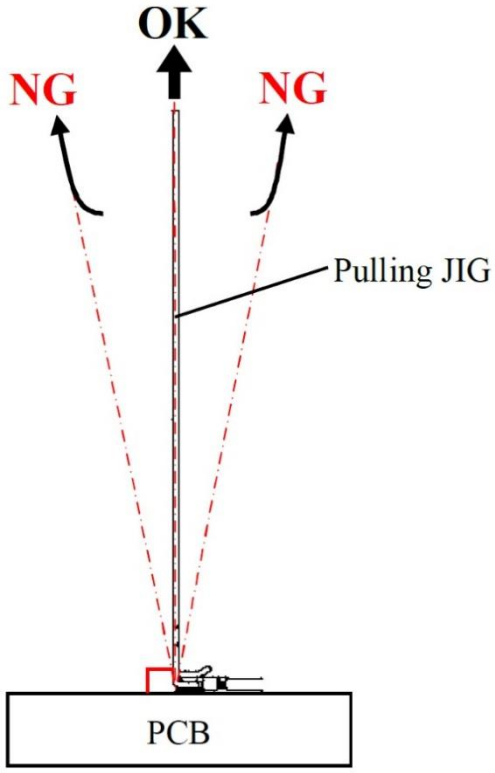

Figure 24. Pulling direction

4.2 Operating Band

The operating bands of FM101R-GL module are shown in the following Table:

Operating Band	Description	Mode	Tx (MHz)	Rx (MHz)
Band 1	2100MHz	LTE FDD/WCDMA	1920-1980	2110-2170
Band 2	1900MHz	LTE FDD/WCDMA	1850-1910	1930-1990
Band 3	1800MHz	LTE FDD	1710-1785	1805-1880

Operating Band	Description	Mode	Tx (MHz)	Rx (MHz)
Band 4	1700MHz	LTE FDD/WCDMA	1710-1755	2110-2155
Band 5	850MHz	LTE FDD/WCDMA	824-849	869-894
Band 6	850MHz	WCDMA	830-840	875-885
Band 7	2600Mhz	LTE FDD	2500-2570	2620-2690
Band 8	900MHz	LTE FDD/WCDMA	880-915	925-960
Band 12	700MHz	LTE FDD	699-716	729-746
Band 13	700MHz	LTE FDD	777-787	746-756
Band 14	700MHz	LTE FDD	788-798	758-768
Band 17	700MHz	LTE FDD	704-716	734-746
Band 18	800MHz	LTE FDD	815-830	860-875
Band 19	800MHz	LTE FDD/WCDMA	830-845	875-890
Band 20	800MHz	LTE FDD	832-862	791-821
Band 25	1900MHz	LTE FDD	1850-1915	1930-1995
Band 26	850MHz	LTE FDD	814-849	859-894
Band 28	700MHz	LTE FDD	703-748	758-803
Band 29	700MHz	LTE FDD	-	716-728
Band 30	2300MHz	LTE FDD	2305-2315	2350-2360
Band 32	1400MHz	LTE FDD	-	1452-1496
Band 66	1700MHz	LTE FDD	1710-1780	2110-2200
Band 71	680MHz	LTE FDD	663-698	617-652
Band 38	2600MHz	LTE TDD	2570-2620	
Band 39	1900MHZ	LTE TDD	1880-1920	

Operating Band	Description	Mode	Tx (MHz)	Rx (MHz)
Band 40	2300MHz	LTE TDD	2300-2400	
Band 41	2500MHZ	LTE TDD	2496-2690	
Band 42	3500MHZ	LTE TDD	3400-3600	
Band 43	3700MHZ	LTE TDD	3600-3800	
Band 48	3600MHZ	LTE TDD	3550-3700	
GPS L1	-	-	-	1575.42±1.023
GLONASS L1	-	-	-	1602.5625±4
BDS	-	-	-	1561.098±2.046
Galileo	-	-	-	1575.42±1.023

4.3 Transmitting Power

The transmitting power for each band of FM101R-GL module is shown in the following Table:

Mode	Band	3GPP Requirement (dBm)	Tx Power (dBm)	Note
WCDMA	Band 1	24+1.7/-3.7	TBD	-
	Band 2	24+1.7/-3.7	TBD	-
	Band 4	24+1.7/-3.7	TBD	-
	Band 5	24+1.7/-3.7	TBD	-
	Band 6	24+1.7/-3.7	TBD	-
	Band 8	24+1.7/-3.7	TBD	-
	Band 19	24+1.7/-3.7	TBD	-
LTE FDD	Band 1	23±2.7	TBD	10MHz Bandwidth, 1

Mode	Band	3GPP Requirement (dBm)	Tx Power (dBm)	Note
				RB
	Band 2	23±2.7	TBD	10MHz Bandwidth, 1 RB
	Band 3	23±2.7	TBD	10MHz Bandwidth, 1 RB
	Band 4	23±2.7	TBD	10MHz Bandwidth, 1 RB
	Band 5	23±2.7	TBD	10MHz Bandwidth, 1 RB
	Band 7	23±2.7	TBD	10MHz Bandwidth, 1 RB
	Band 8	23±2.7	TBD	10MHz Bandwidth, 1 RB
	Band 12	23±2.7	TBD	10MHz Bandwidth, 1 RB
	Band 13	23±2.7	TBD	10MHz Bandwidth, 1 RB
	Band 14	23±2.7	TBD	10MHz Bandwidth, 1 RB
	Band 17	23±2.7	TBD	10MHz Bandwidth, 1 RB
	Band 18	23±2.7	TBD	10MHz Bandwidth, 1 RB
	Band 19	23±2.7	TBD	10MHz Bandwidth, 1

Mode	Band	3GPP Requirement (dBm)	Tx Power (dBm)	Note
				RB
	Band 20	23±2.7	TBD	10MHz Bandwidth, 1 RB
	Band 25	23±2.7	TBD	10MHz Bandwidth, 1 RB
	Band 26	23±2.7	TBD	10MHz Bandwidth, 1 RB
	Band 28	23+2.7/-3.2	TBD	10MHz Bandwidth, 1 RB
	Band 30	23±2.7	TBD	10MHz Bandwidth, 1 RB
	Band 66	23±2.7	TBD	10MHz Bandwidth, 1 RB
	Band 71	23+2.7/-3.2	TBD	10MHz Bandwidth, 1 RB
LTE TDD	Band 38	23±2.7	TBD	10MHz Bandwidth, 1 RB
	Band 39	23±2.7	TBD	10MHz Bandwidth, 1 RB
	Band 40	23±2.7	TBD	10MHz Bandwidth, 1 RB
	Band 41	23±2.7	TBD	10MHz Bandwidth, 1 RB
	Band 42	23+3/-4	TBD	10MHz Bandwidth, 1

Mode	Band	3GPP Requirement (dBm)	Tx Power (dBm)	Note
				RB
	Band 43	23+3/-4	TBD	10MHz Bandwidth, 1 RB
	Band 48	23+3/-4	TBD	10MHz Bandwidth, 1 RB

4.4 Receiver Sensitivity

4.4.1 Dual Antennas Receiver Sensitivity

All bands support dual antennas, the receiver sensitivity for each band of FM101R-GL module is shown in below Table:

Mode	Band	3GPP Requirement (dBm)	Rx Sensitivity Typical(dBm)	Note
WCDMA	Band 1	-106.7	TBD	BER < 0.1%
	Band 2	-104.7	TBD	BER < 0.1%
	Band 4	-106.7	TBD	BER < 0.1%
	Band 5	-104.7	TBD	BER < 0.1%
	Band 6	-106.7	TBD	BER < 0.1%
	Band 8	-103.7	TBD	BER < 0.1%
	Band 19	-106.7	TBD	BER < 0.1%
LTE FDD	Band 1	-96.3	TBD	10MHz Bandwidth

Mode	Band	3GPP Requirement (dBm)	Rx Sensitivity Typical(dBm)	Note
	Band 2	-94.3	TBD	10MHz Bandwidth
	Band 3	-93.3	TBD	10MHz Bandwidth
	Band 4	-96.3	TBD	10MHz Bandwidth
	Band 5	-94.3	TBD	10MHz Bandwidth
	Band 7	-94.3	TBD	10MHz Bandwidth
	Band 8	-93.3	TBD	10MHz Bandwidth
	Band 12	-93.3	TBD	10MHz Bandwidth
	Band 13	-93.3	TBD	10MHz Bandwidth
	Band 14	-93.3	TBD	10MHz Bandwidth
	Band 17	-93.3	TBD	10MHz Bandwidth
	Band 18	-96.3	TBD	10MHz Bandwidth
	Band 19	-96.3	TBD	10MHz Bandwidth

Mode	Band	3GPP Requirement (dBm)	Rx Sensitivity Typical(dBm)	Note
	Band 20	-93.3	TBD	10MHz Bandwidth
	Band 25	-92.8	TBD	10MHz Bandwidth
	Band 26	-93.8	TBD	10MHz Bandwidth
	Band 28	-94.8	TBD	10MHz Bandwidth
	Band 29	-93.3	TBD	10MHz Bandwidth
	Band 30	-95.3	TBD	10MHz Bandwidth
	Band 32	-96.3	TBD	10MHz Bandwidth
	Band 66	-95.8	TBD	10MHz Bandwidth
	Band 71	-93.5	TBD	10MHz Bandwidth
LTE TDD	Band 38	-96.3	TBD	10MHz Bandwidth
	Band 39	-96.3	TBD	10MHz Bandwidth
	Band 40	-96.3	TBD	10MHz Bandwidth

Mode	Band	3GPP Requirement (dBm)	Rx Sensitivity Typical(dBm)	Note
	Band 41	-94.3	TBD	10MHz Bandwidth
	Band 42	-95	TBD	10MHz Bandwidth
	Band 43	-95	TBD	10MHz Bandwidth
	Band 48	-95	TBD	10MHz Bandwidth

The above values are measured in dual antennas condition (Main+Diversity). For single main antenna (without Diversity), the sensitivity will drop about 3dBm for each band of LTE.

4.5 GNSS

FM101R-GL module supports GPS/GLONASS/BDS/GALILEO and adopts RF diversity and GNSS integrated antenna.

Description	Positioning system	Condition	Test Result
			Typical
Current	GPS	Fixing	TBD
		Tracking	TBD
		Sleep	TBD
	GPS+ BDS+ GLONASS+ Galileo	Fixing	TBD
		Tracking	TBD
		Sleep	TBD

Description	Positioning system	Condition	Test Result
			Typical
TTFF	GPS	Cold start	TBD
		Warm start	TBD
		Hot Start	TBD
	GPS+ BDS+ GLONASS+ Galileo	Cold start	TBD
		Warm start	TBD
		Hot Start	TBD
Sensitivity	GPS	Tracking	TBD
		Acquisition	TBD
	GPS+ BDS+ GLONASS+ Galileo	Tracking	TBD
		Acquisition	TBD

GNSS current is tested with RF disabled at 25°C temperature.

4.6 Antenna Design

The FM101R-GL module provides two antenna interfaces, and the antenna design requirements are shown in the following Table:

FM101R-GL Module Main Antenna Requirement	
Frequency range	The most proper antenna to adapt the frequencies should be used.
Bandwidth (WCDMA)	WCDMA band 1 (2100): 250 MHz WCDMA band 2 (1900): 140 MHz WCDMA band 4 (1700): 445 MHz

FM101R-GL Module Main Antenna Requirement	
	WCDMA band 5 (850): 70 MHz
	WCDMA band 6 (850): 55 MHz
	WCDMA band 8 (900): 80 MHz
	WCDMA band 19 (850): 60 MHz
Bandwidth (LTE)	LTE band 1 (2100): 250 MHz
	LTE band 2 (1900): 140MHz
	LTE Band 3 (1800): 170 MHz
	LTE band 4 (1700): 445MHz
	LTE band 5 (850): 70 MHz
	LTE band 7 (2600): 190 MHz
	LTE Band 8 (900): 80 MHz
	LTE Band 12 (700): 47 MHz
	LTE Band 13 (700): 41 MHz
	LTE Band 14 (700): 40 MHz
	LTE Band 17 (700): 42 MHz
	LTE Band 18 (800): 80 MHz
	LTE Band 19 (800): 80 MHz
	LTE band 20 (800): 71 MHz
	LTE band 25 (1900):145 MHz
	LTE band 26 (850): 80 MHz
	LTE band 28 (700): 100 MHz
	LTE band 29 (700): 12 MHz
	LTE band 30 (2300): 55 MHz
	LTE band 32 (1400): 44MHz

FM101R-GL Module Main Antenna Requirement	
	LTE band 66 (1700): 490MHz LTE band 71 (680): 35MHz LTE band 38 (2600): 50 MHz LTE Band 39 (1900): 40 MHz LTE band 40 (2300): 100 MHz LTE band 41 (2500): 194 MHz LTE band 42 (3500): 200 MHz LTE band 43 (3700):200MHz LTE band 48 (3600):150MHz
Bandwidth (GNSS)	GPS: 2 MHz GLONASS: 8 MHz BDS: 4 MHz Galileo: 2 MHz
Impedance	50Ω
Input power	> 28 dBm average power WCDMA & LTE
Recommended standing-wave ratio (SWR)	≤ 2:1

ANT on B30 suggestion: Peak gain < 1dBi, for FCC EIRP requirement, Efficient > 50% for carrier TRP requirement. If integrator doesn't follow the instruction, may cause FCC EIRP or carrier TRP certification fail.

5 ESD Characteristics

The module is generally not protected against Electrostatic Discharge (ESD). ESD handling precautions that apply to ESD sensitive components should be strictly followed. Proper ESD handling procedures must be applied throughout the processing, handling, assembly and operation of any application with module. The ESD characteristics are shown in the following Table (Temperature: 25°C, Relative Humidity: 40%).

Interface	Contact Discharge	Air Discharge
GND	±8 kV	±15 kV
Antenna Interface	±8 kV	NA
Golden Finger	±1KV	NA

ESD performance is based on EVB-M2 development board.

6 Structure Specification

6.1 Product Appearance

The product appearance for FM101R-GL module is shown in Figure 25:

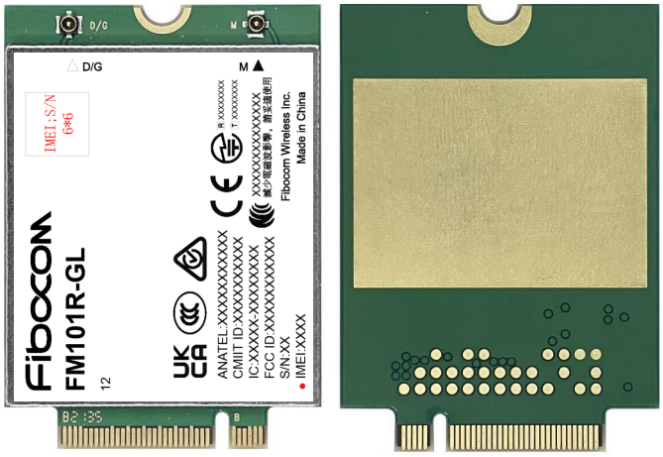

Figure 25. Module appearance

The label of each module is subject to the good shipped.

6.2 Dimension of Structure

The structural dimension of the FM101R-GL module is shown in Figure 26:

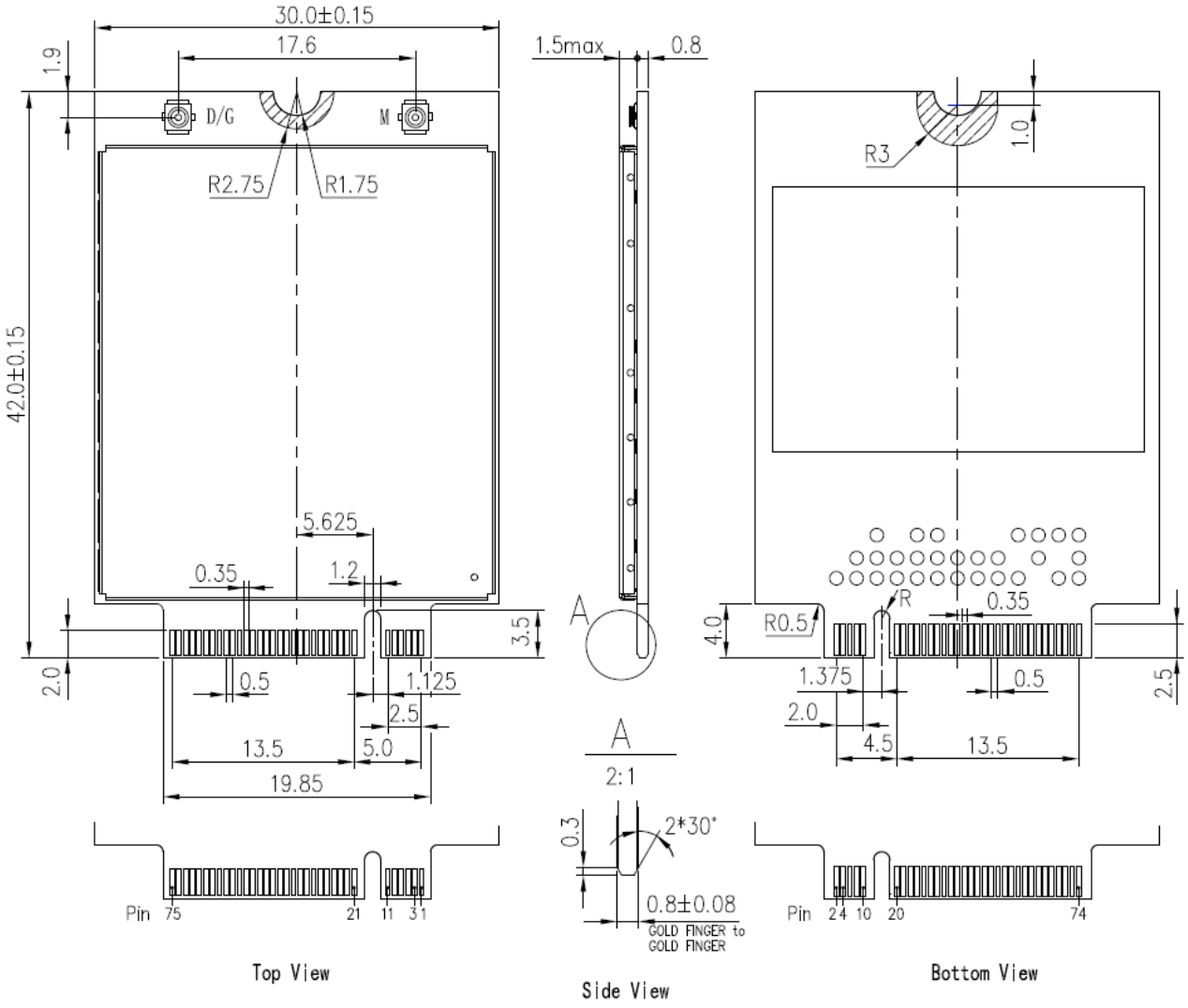

Figure 26. Dimension of structure

6.3 M.2 Interface Model

The FM101R-GL M.2 module adopts 75-pin gold finger as external interface, where 67 pins are signal pins and 8 pins are notch pins as shown in Figure 3. For module dimension, please refer to Figure 27 Dimension of Structure. Based on the M.2 interface definition, FM101 module adopts Type 3042-S3-B interface (30 x 42 mm, the component maximum height on t top layer is 1.5 mm, PCB thickness is 0.8 mm, and KEY ID is B).

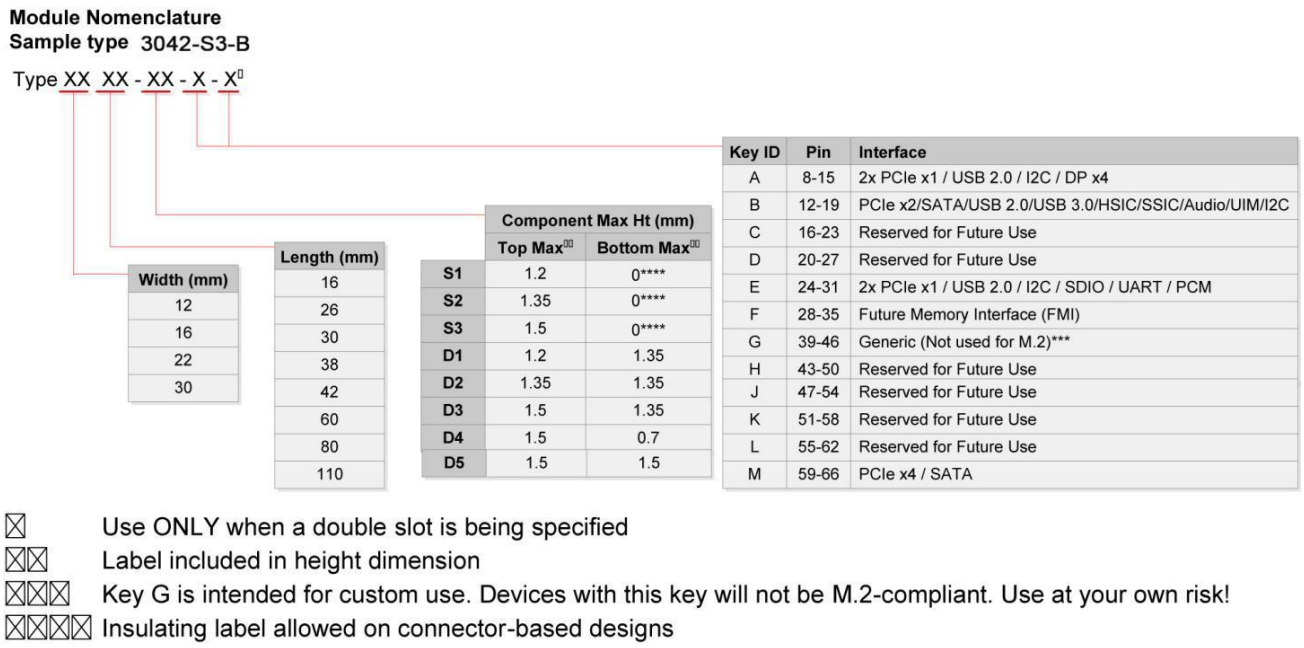

Figure 27. M.2 interface model

6.4 M.2 Connector

FM101R-GL module connects with host by M.2 connector which is built in host. The recommended part number is APCI0026-P001A manufactured by LOTES Corporation, and the dimensions are shown in Figure 28. For stack-up top-mount single-sided module, the recommended part number is APCI0144-P001A, manufactured by LOTES Corporation, and the dimension is shown in Figure 29. The package of connector, please refer to the specification.

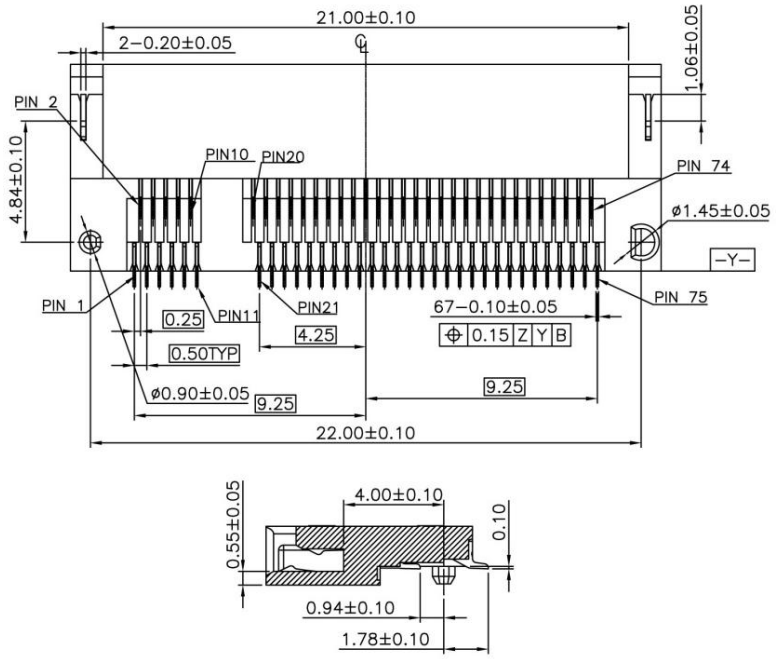

Figure 28. M.2 Dimensions of structure for stack-up mid-mount single-sided module

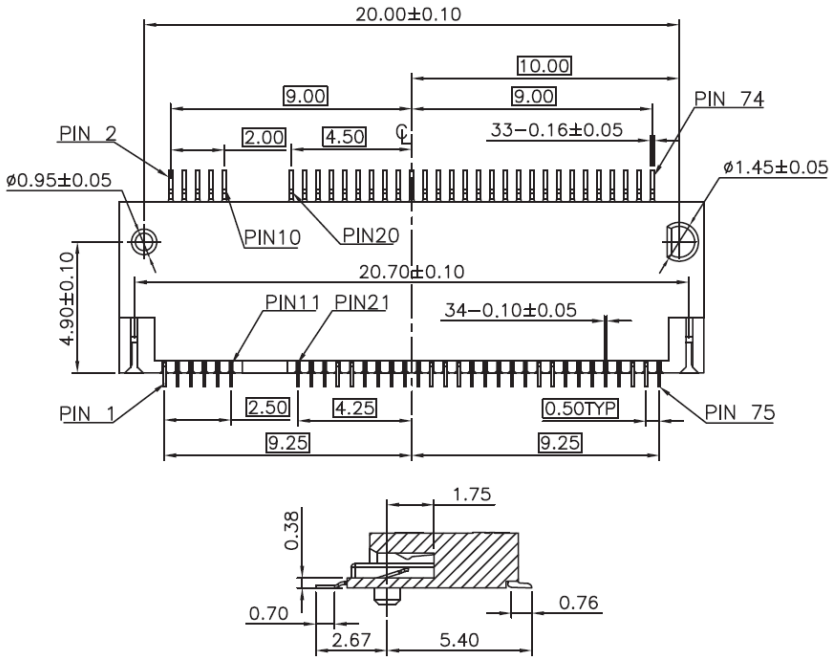

Figure 29. M.2 dimensions of structure for stack-up top-mount single-sided module

6.5 M.2 Card Assembly

6.5.1 Card Insertion

Angled insertion is allowable and preferred; intent is to minimize the insertion and extraction force. The minimum angle of insertion is 5˚. For APCI0144-P001A, the maximum angle of insertion is 5°. For APCI0026-P001A, the maximum angle of insertion is 20°. Refer to Figure 30 and Figure 30 to insert and extract the module.

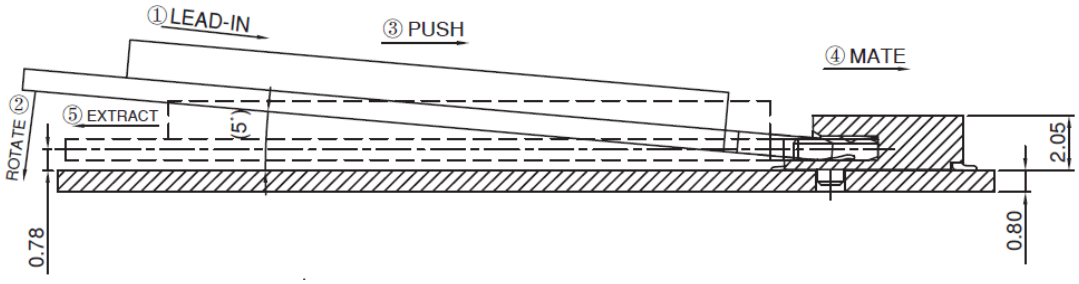

Figure 30. Angle of insertion for APCI0144-P001A

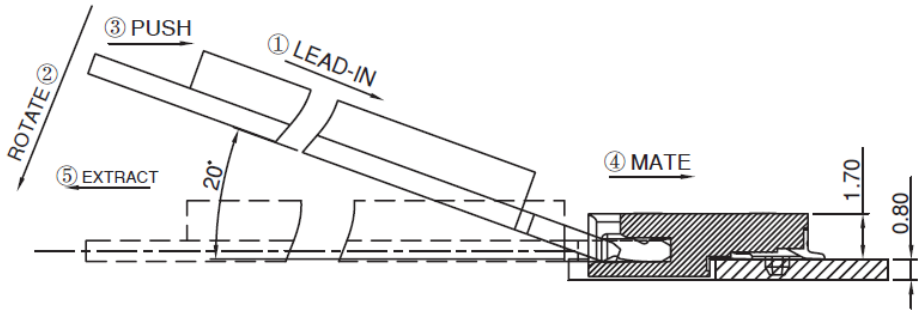

Figure 31. Angle of insertion for APCI0026-P001A

6.5.2 Mid-mount Connection with Single-Sided Module

Stack-up Mid-mount (In-line) single-sided module is shown in Figure 32. The maximum height of components is 1.5 mm.

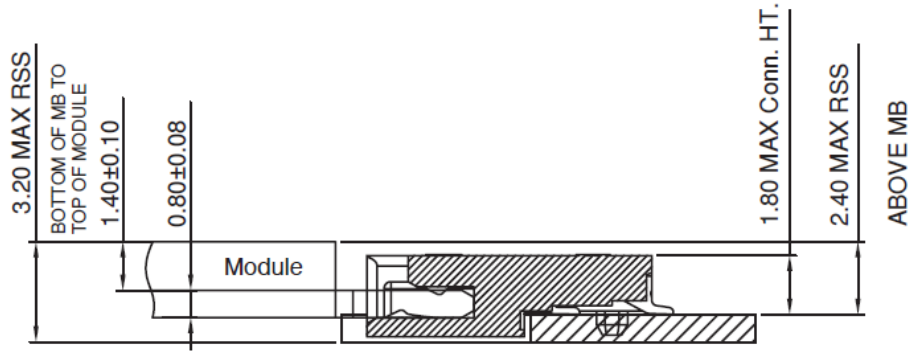

Figure 32. Stack-up mid-mount single-sided module

2.4 mm maximum above mother board

Suggest to cut the area of mother board under M.2 module

6.5.1 Top-mount Connection with Single-Sided Module

Stack-up top-mount single-sided module is shown in Figure 33. The maximum height of components is 1.5 mm.

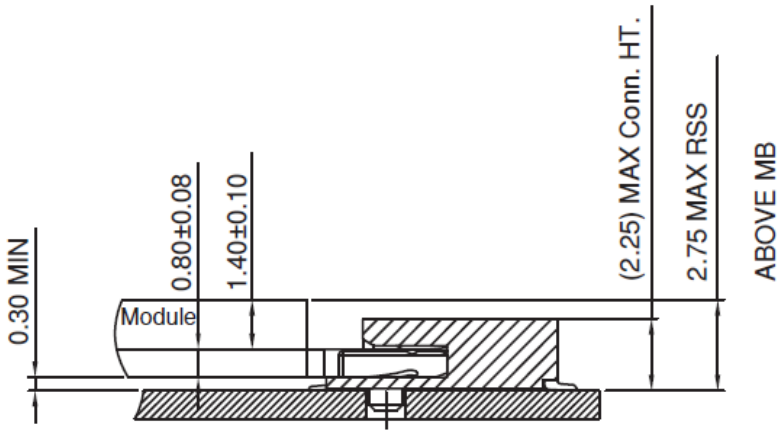

Figure 33. Stack-up top-mount single-sided module

2.75 mm maximum above mother board. Full keep out area 30 mm × 42 mm below module, which means don't place any components and routings below M.2 module. Add thermal pad between M.2 module and mother board for thermal

dissipation.

It's a MUST to use appropriate screw or nut combination to secure the M.2 module horizontally without tilting or wobbling, to ensure grounding and thermal dissipation.

7 Storage

7.1 Storage Life

Storage Conditions (recommended): Temperature is 23 ±5℃, relative humidity is less than RH 60%.

Storage period: Under the recommended storage conditions, the storage life is 12 months.

7.2 Packaging

The FM101R-GL module uses the tray sealed packing, combined with the outer packing method using the hard cartoon box, so that the storage, transportation and the usage of modules can be protected to the greatest extent.

The module is a precision electronic product, and may suffer permanent damage if no correct electrostatic protection measures are taken.

7.2.1 Tray Package

The FM101R-GL module uses tray package, 20 pcs are packed in each tray, with 5 trays including one empty tray on top in each box and 5 boxes in each case. Tray packaging process is shown in Figure 34:

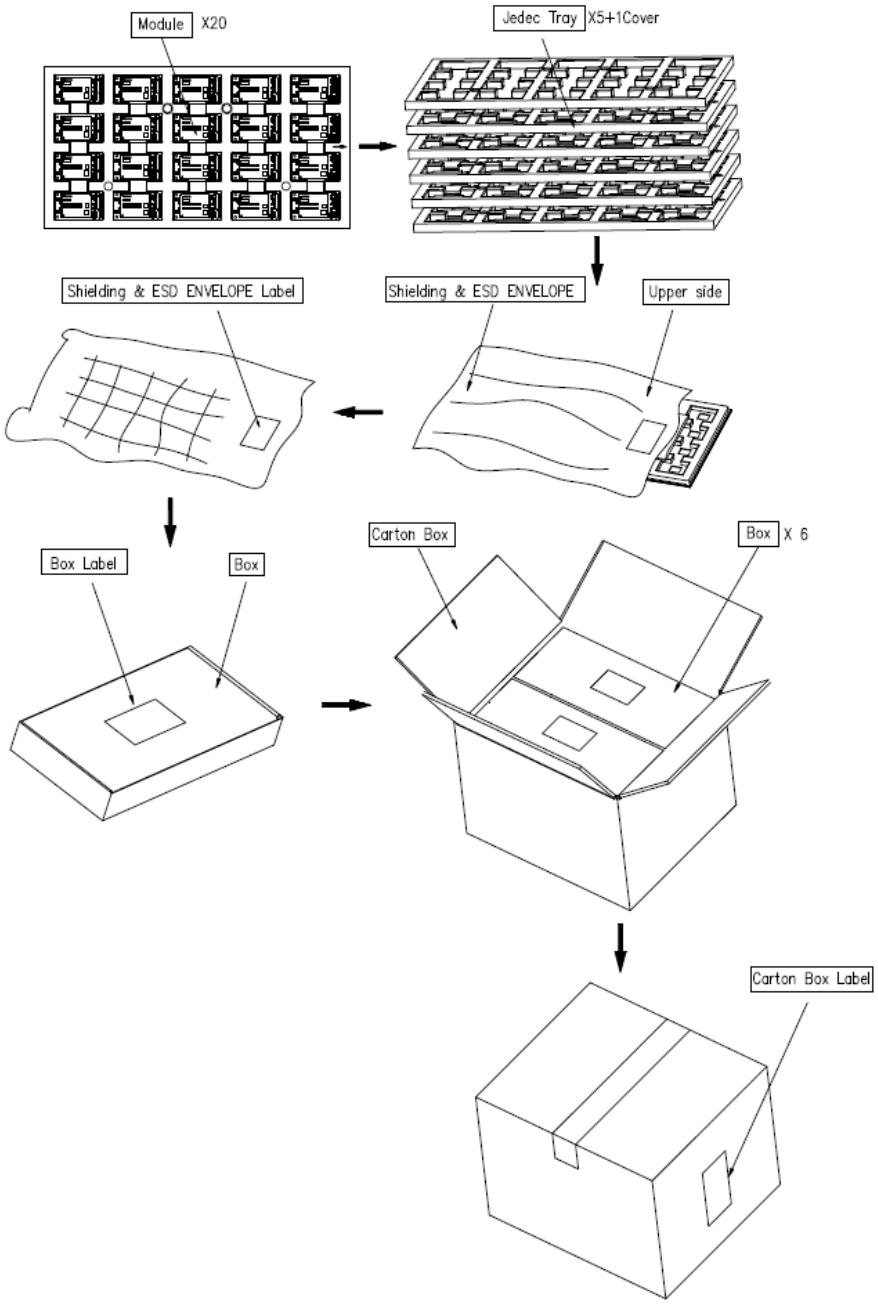

Figure 34. Tray packaging process

7.2.2 Tray Size

The pallet size is 315 mm × 170 mm × 6.5 mm, and is shown in Figure 35:

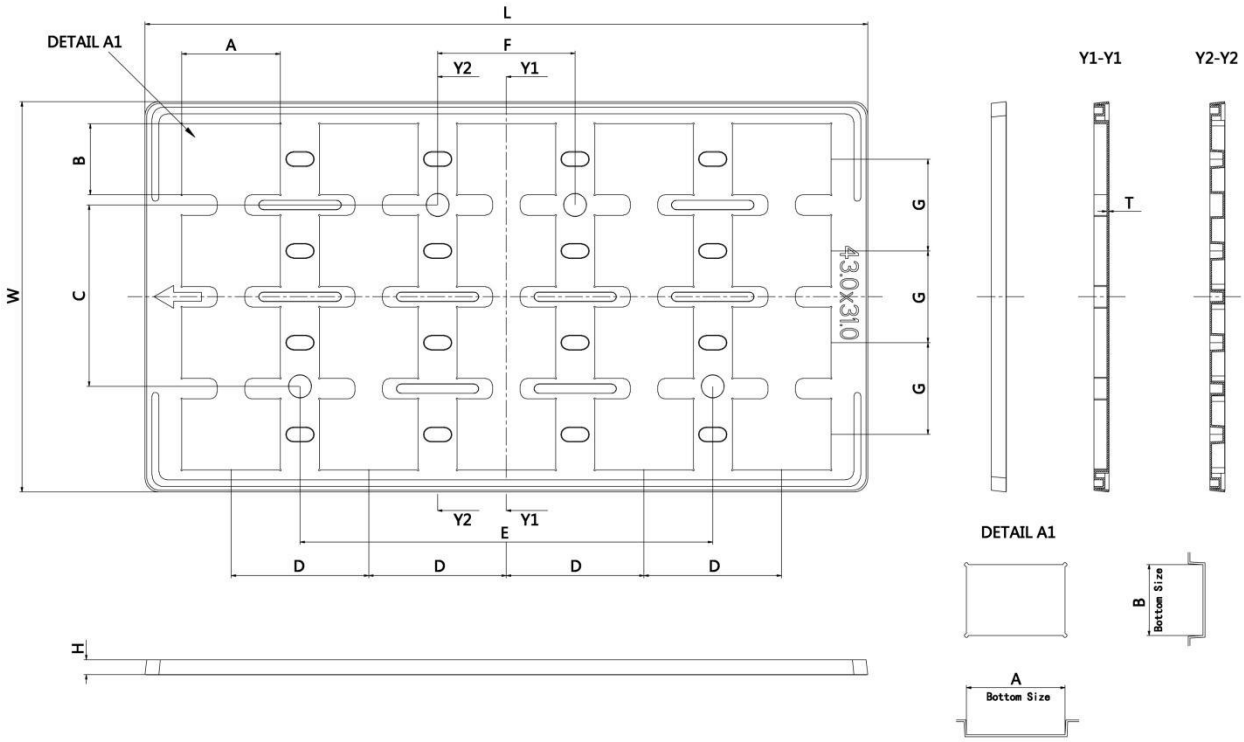

Figure 35. Tray size (unit: mm)

ITEM	DIM (Unit: mm)
L	315.0±2.0
W	170.0±2.0
H	6.5±0.3
T	0.8±0.1
A	43.0±0.3
B	31.0±0.3
C	79.0±0.2
D	60.0±0.2

ITEM	DIM (Unit: mm)
E	180.0±0.2
F	60.0±0.2
G	40.0±0.2

8 Certification Statement

8.1 FCC Certification Requirements.

According to the definition of mobile and fixed device is described in Part 2.1091(b), this device is a mobile device.
And the following conditions must be met:

1. This Modular Approval is limited to OEM installation for mobile and fixed applications only. The antenna installation and operating configurations of this transmitter, including any applicable source-based time averaging duty factor, antenna gain, and cable loss must satisfy MPE categorical Exclusion Requirements of 2.1091.
2. The EUT is a mobile device; maintain at least a 20 cm separation between the EUT and the user's body and must not transmit simultaneously with any other antenna or transmitter.
3. A label with the following statements must be attached to the host end product: This device contains FCC ID: ZMOFM101RGL
4. To comply with FCC regulations limiting both maximum RF output power and human exposure to RF radiation, maximum antenna gain (including cable loss) must not exceed:

Antenna Type	Band	FCC Max Antenna Gain（dBi）
PIFA	WCDMA B2	4
	WCDMA B4	3
	WCDMA B5	3
	LTE B2	4
	LTE B4	3
	LTE B5	3
	LTE B7	4
	LTE B12	3
	LTE B13	3
	LTE B14	3
	LTE B17	3
	LTE B25	4
	LTE B26	3
	LTE B30	1
	LTE B38	4
	LTE B41	4
	LTE B48	1
	LTE B66	3
	LTE B71	3

5. This module must not transmit simultaneously with any other antenna or transmitter
6. The host end product must include a user manual that clearly defines operating requirements and conditions that must be observed to ensure compliance with current FCC RF exposure guidelines.
For this device, in addition to the conditions 3 through 6 described above, a separate approval is required to satisfy the SAR requirements of FCC Part 2.1093
If the device is used for other equipment that separate approval is required for all other operating configurations, including portable configurations with respect to 2.1093 and different antenna configurations.
For this device, OEM integrators must be provided with labeling instructions of finished products.
Please refer to KDB784748 D01 v07, section 8. Page 6/7 last two paragraphs:
A certified modular has the option to use a permanently affixed label, or an electronic label. For a permanently affixed label, the module must be labeled with an FCC ID - Section 2.926 (see 2.2 Certification (labeling requirements) above). The OEM manual must provide clear instructions explaining to the OEM the labeling requirements, options and OEM user manual instructions that are required (see next paragraph).
For a host using a certified modular with a standard fixed label, if (1) the module's FCC ID is not visible when installed in the host, or (2) if the host is marketed so that end users do not have straightforward commonly used methods for access to remove the module so that the FCC ID of the module is visible; then an additional permanent label referring to the enclosed module: "Contains Transmitter Module FCC ID: ZMOFM101RGL" or "Contains FCC ID: ZMOFM101RGL" must be used.
The host OEM user manual must also contain clear instructions on how end users can find and/or access the module and the FCC ID.
The final host / module combination may also need to be evaluated against the FCC Part 15B criteria for unintentional radiators in order to be properly authorized for operation as a Part 15 digital device.
The user's manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes, or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. In cases where the manual is provided only in a form other than paper, such as on a computer disk or over the Internet, the information required by this section may be included in the manual in that alternative form, provided the user can reasonably be expected to have the capability to access information in that form.
This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:
(1) This device may not cause harmful interference, and
(2) this device must accept any interference received, including interference that may cause undesired operation.
Changes or modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment.
To ensure compliance with all non-transmitter functions the host manufacturer is responsible for ensuring compliance with the module(s) installed and fully operational. For example, if a host was previously authorized as an unintentional radiator under the Supplier's Declaration of Conformity procedure without a transmitter certified module and a module is added, the host manufacturer is responsible for ensuring that the after the module is installed and operational the host continues to be compliant with the Part 15B unintentional radiator requirements.

Manual Information to the End User
The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module. The end user manual shall include all required regulatory information/warning as show in this manual.

8.2 IC Statement

IRSS-GEN

"This device complies with Industry Canada's licence-exempt RSSs. Operation is subject to the following two conditions: (1) This device may not cause interference; and (2) This device must accept any interference, including interference that may cause undesired operation of the device." or "Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : 1) l'appareil ne doit pas produire de brouillage; 2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement."
Déclaration sur l'exposition aux rayonnements RF L'autre utilisé pour l'émetteur doit être installé pour fournir une distance de séparation d'au moins 20 cm de toutes les personnes et ne doit pas être colocalisé ou fonctionner conjointement avec une autre antenne ou un autre émetteur.
The host product shall be properly labeled to identify the modules within the host product.
The Innovation, Science and Economic Development Canada certification label of a module shall be clearly visible at all times when installed in the host product; otherwise, the host product must be labeled to display the Innovation, Science and Economic Development Canada certification number for the module, preceded by the word "Contains" or similar wording expressing the same meaning, as follows: "Contains IC: 21374-FM101RGL" or "where: 21374- FM101RGL is the module's certification number".
Le produit hôte doit être correctement étiqueté pour identifier les modules dans le produit hôte.
L'étiquette de certification d'Innovation, Sciences et Développement économique Canada d'un module doit être clairement visible en tout temps lorsqu'il est installédans le produit hôte; sinon, le produit hôte doit porter une étiquette indiquant le numéro de certification d'Innovation, Sciences et Développement économique Canada pour le module, précédé du mot «Contient» ou d'un libellé semblable exprimant la même signification, comme suit:
"Contient IC: 21374- FM101RGL " ou "où: 21374- FM101RGL est le numéro de certification du module".
i. the device for operation in the band 5150–5250 MHz is only for indoor use to reduce the potential for harmful interference to co-channel mobile satellite systems;
ii. for devices with detachable antenna(s), the maximum antenna gain permitted for devices in the bands 5250-5350 MHz and 5470-5725 MHz shall be such that the equipment still complies with the e.i.r.p. limit;
iii. for devices with detachable antenna(s), the maximum antenna gain permitted for devices in the band 5725-5850 MHz shall be such that the equipment still complies with the e.i.r.p. limits as appropriate;
iv. Omnidirectional antenna is recommended

8.3 CE Certification Requirements.

Exposure

The device could beused with aseparation distance of 20 cm to the human body.

Declaration of conformity

Hereby,[Fibocom Wireless Inc.] declares that the radio equipment type[FM101R-GL]is in compliance with Directive 2014/53/EU.

The full text of the EU declaration of conformity is available at the following internet address: https://www.fibocom.com/en/downloadcenter