



SIM8300G-M2 mmWave Antenna Module Application Notes

5G Module

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1 Introduction

This document describes the mmWave application notes for QTM525 and QTM527 module. Associated with other software application notes and user guides, customers can use mmWave easily by SIM8300G-M2 module.

1.1 Product Outline

SIM8300G-M2 is a wireless communication module focusing on 5G market. It supports multi-air access technology including 5G NR FR1 and FR2, LTE, and WCDMA, can meet the 3GPP R15 NR specification. The mmWave feature is implemented with Qualcomm's mmWave antenna module QTM525 or QTM527, QTM525 is for general application such as MiFi, and QTM527 is for high power application such as HP CPE.

The module's supported radio frequency bands are shown in the following table.

Table 1: SIM8300G-M2 mmWave frequency bands

Standard	Frequency Bands
5G FR2	QTM525-2: n257 and n258
	QTM525-5: n258, n260, and n261
	QTM527-1: n260 and n261
	QTM527-2: n257, n258 and n261

NOTE

Please confirm with SIMCom for the details information about the combination of ENDC.

1.2 MmWave Feature Overview

Table 2: Key features

Feature	Implementation
Transmit power	Power Class 1 for 5G mmWave (with QTM527) Power Class 3 for 5G mmWave (with QTM525)
Data transmission throughput	7 Gbps (DL)/ 3Gbps (UL) for 5G mmWave
Antenna	Eight IF interfaces ports for mmWave antenna module interconnection

1.3 MmWave antenna module support

Antenna module QTM525-2, QTM525-5, QTM527-1, QTM527-2 support mmWave feature, six cards below are for customers. QTM525 can be chosen for MIFI, QTM527 is mmWave high-power antenna module for customer premises equipment (CPE).

Table 3: mmWave cards

No.	Antenna Module Name	# modules	n257	n258	n260	n261
1	QTM525_5_V2	4		Y	Y	Y
2	QTM525_2_V2	4	Y	Y		
3	QTM527_1_V2	4			Y	Y
4	QTM527_1_V2	2			Y	Y
5	QTM527_2_V2	4	Y	Y		Y
6	QTM527_2_V2	2	Y	Y		Y

2 SIM8300G-M2 Antenna Interfaces

SIM8300G-M2 provides 14 antenna interfaces, and all of them should be 50Ω impedance controlled for RF signal.

2.1 SIM8300G-M2 Antenna Definitions

Antenna interfaces are shown in the following figure. 8 IF ANT ports for mmWave feature, ANT0~5 for 3G/4G/5G sub-6.

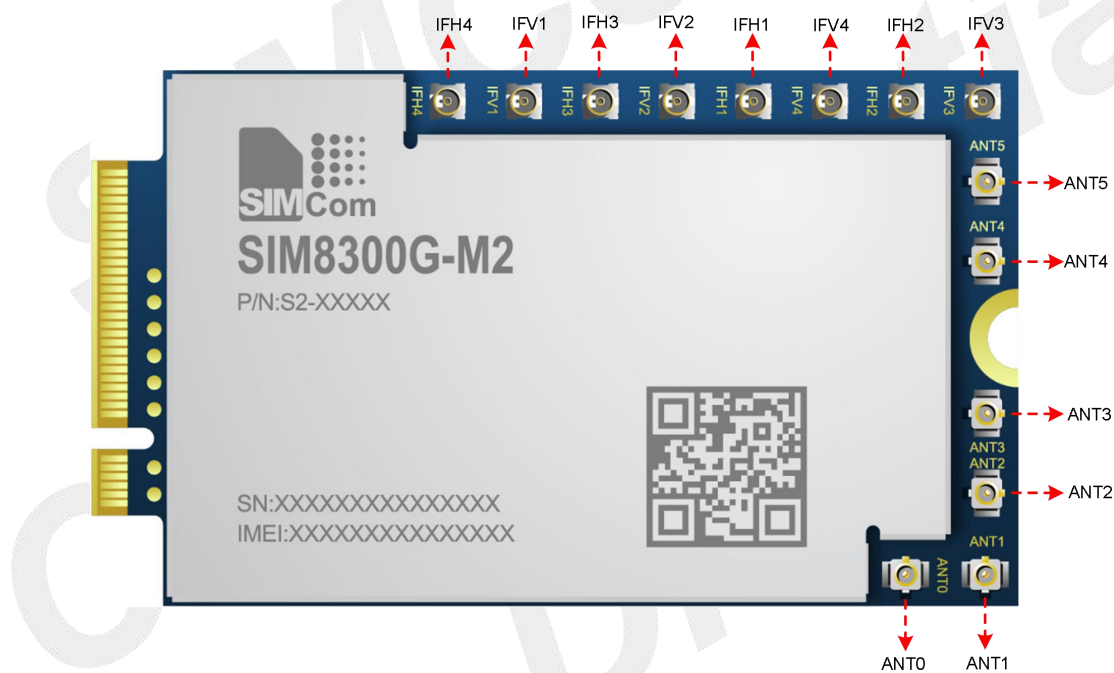


Figure 1: Antenna interfaces

2.2 5G mmWave Operating Frequency

Table 4: The module operating frequency

Frequency Bands	Uplink (UL)	Downlink (DL)	Duplex Mode
n257	26500~29500MHz	26500~29500MHz	TDD
n258	24250~27500MHz	24250~27500MHz	TDD
n260	37000~40000MHz	37000~40000MHz	TDD
n261	27500~28350MHz	27500~28350MHz	TDD

3 QTM525 mmWave Module

3.1 QTM525 Introduction

QTM525 is the second-generation mmWave modules that include an integrated RFIC, power management IC, and phased antenna array supporting 5G NR. The following figure shows QTM525 antenna module.

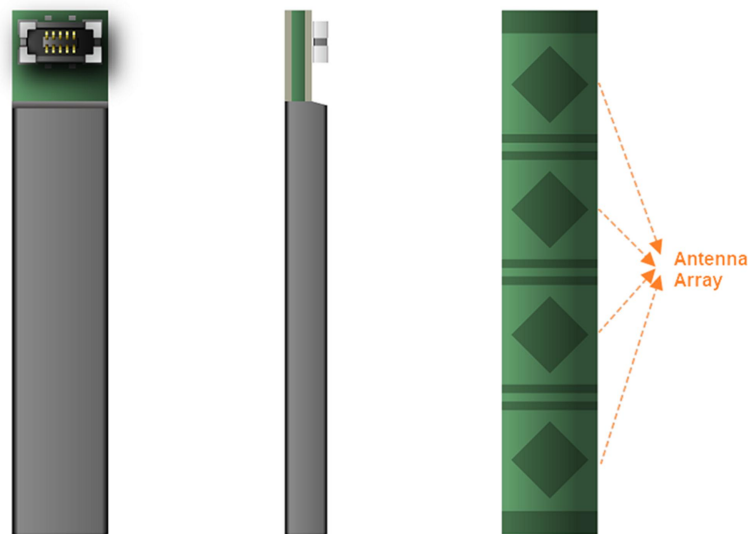


Figure 2: QTM525-2/QTM525-5

The follow figure is block diagram of SIM8300G-M2 and QTM525 connection.

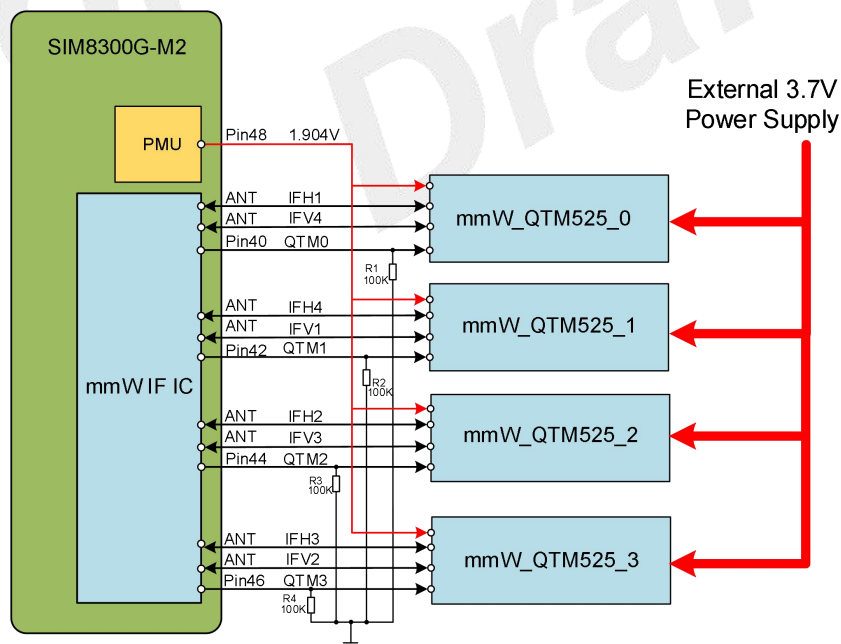


Figure 3: Block diagram of SIM8300G-M2 and QTM525 connection

NOTE

Pin40, Pin42, Pin44, Pin46, Pin48 is M2 pin number of SIM8300G-M2.

The table shows the main feature and capability of QTM525 module

Table 5: QTM525 overview

Feature	QTM525 capability
mmWave transceiver (common to Rx and Tx)	
RF operating bands	<ul style="list-style-type: none"> • QTM525-2 variants: n257 (26.5–29.5 GHz) and n258 (24.25–27.5 GHz) • QTM525-5 variants: n258 (24.25–27.5 GHz), n260 (37–40 GHz) and n261 (27.5–28.35 GHz),
MIMO support	Dual-polarization MIMO (horizontal and vertical)
Bandwidth support	Up to 800 MHz occupied bandwidth in any 1.4 GHz frequency range
Carrier aggregation (CA) support	<ul style="list-style-type: none"> • DL 2 × 2 MIMO: up to eight 100 MHz component carriers • UL 2 × 2 MIMO: up to four 100 MHz component carriers • UL 1 × 1 SISO: up to eight 100 MHz component carriers
Beamforming support	<ul style="list-style-type: none"> • Independent amplitude and phase control • Patch antenna elements enable broad spatial coverage
Duplex mode of operation	TDD only
MmWave receiver	
Receiver paths	<ul style="list-style-type: none"> • One horizontal polarization (IF1) and one vertical polarization (IF2) receiver signal path • Each receiver chain provides amplitude weighting, phase shifting, and I/Q quadrature mmWave-to-IF frequency translation

3.2 Top view of mmWave EVB and QTM525 connection

The following figure shows SIM8300G-M2 and QTM525 antenna ports definition.

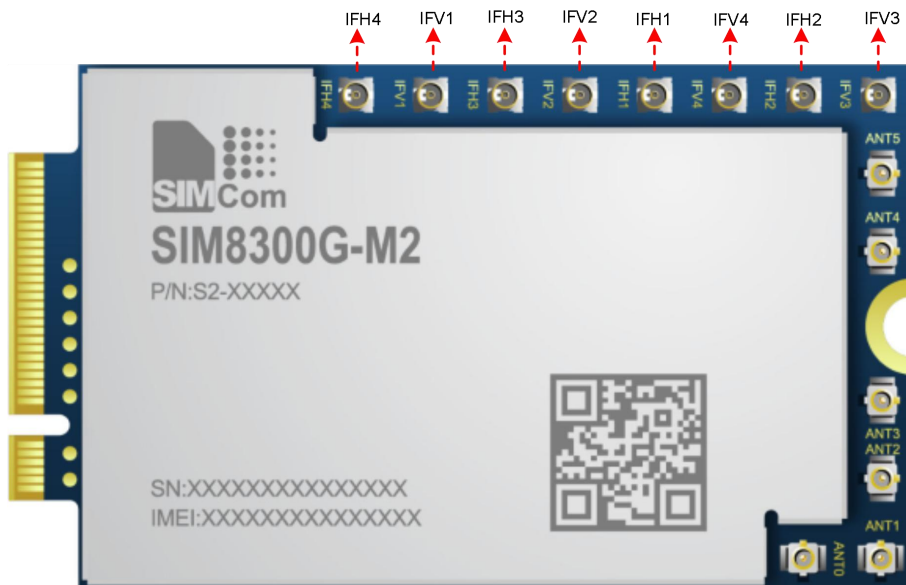


Figure 4: SIM8300G-M2 mmWave IF ports definition

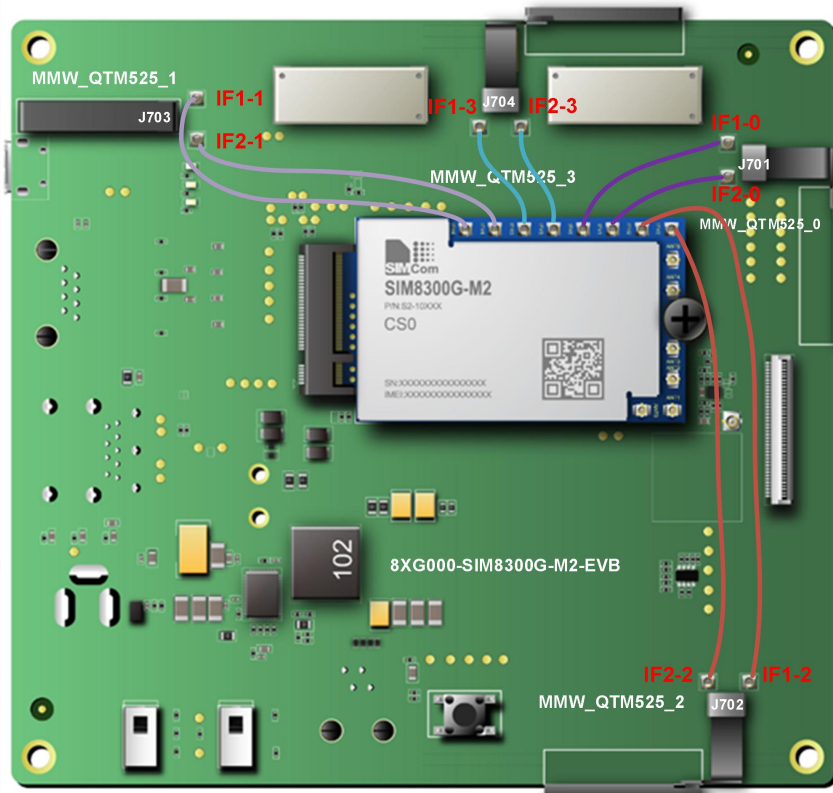


Figure 5: Four QTM525 modules IF ports definition

NOTE

The above is the design effect diagram of the module for reference. The actual appearance is subject to the actual product.

The connection of four QTM525 antenna modules and SIM8300G-M2, please refer to the following table.

Table 6: Four QTM525 modules and SIM8300G-M2 connection

mmWave antenna module	QTM525 IF ports	SIM8300G-M2
MMW_QTM525_0	IF1-0	IFH1
	IF2-0	IFV4
MMW_QTM525_1	IF1-1	IFH4
	IF2-1	IFV1
MMW_QTM525_2	IF1-2	IFH2
	IF2-2	IFV3
MMW_QTM525_3	IF1-1	IFH3
	IF2-2	IFV2

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4 QTM527 mmWave Module

4.1 QTM527 Introduction

The QTM527 is the first Qualcomm mmWave high-power LGA based antenna module for customer premises equipment (CPE), includes an integrated RFIC with power management IC and phased antenna array. The following figures are shown the view of QTM527-1 TE and QTM527-2 TE.

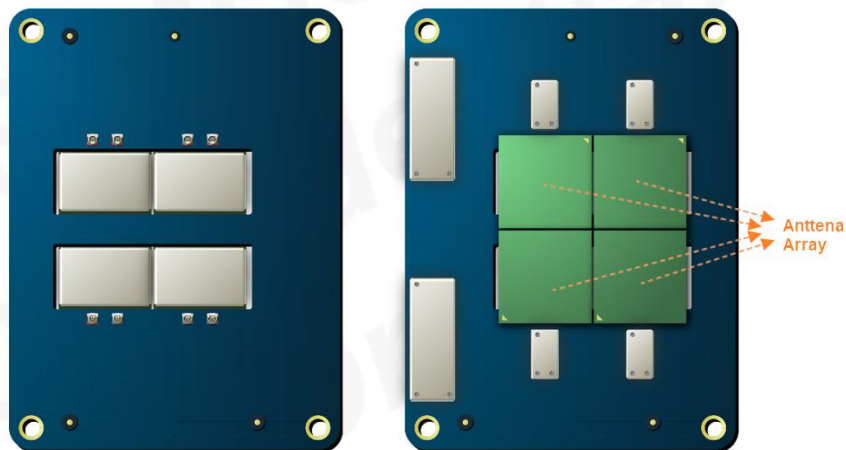


Figure 6: Top/Bottom view of QTM527-1 TE

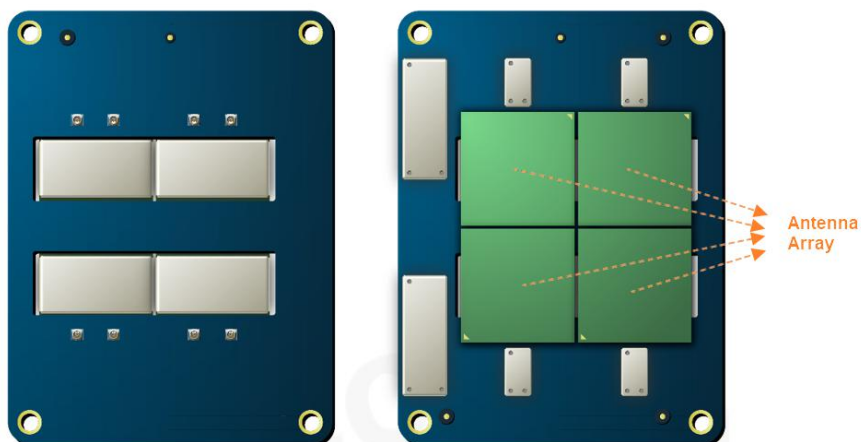


Figure 7: Top/Bottom view of QTM527-2 TE

The follow figure is block diagram of SIM8300G-M2 and QTM527-TE connection.

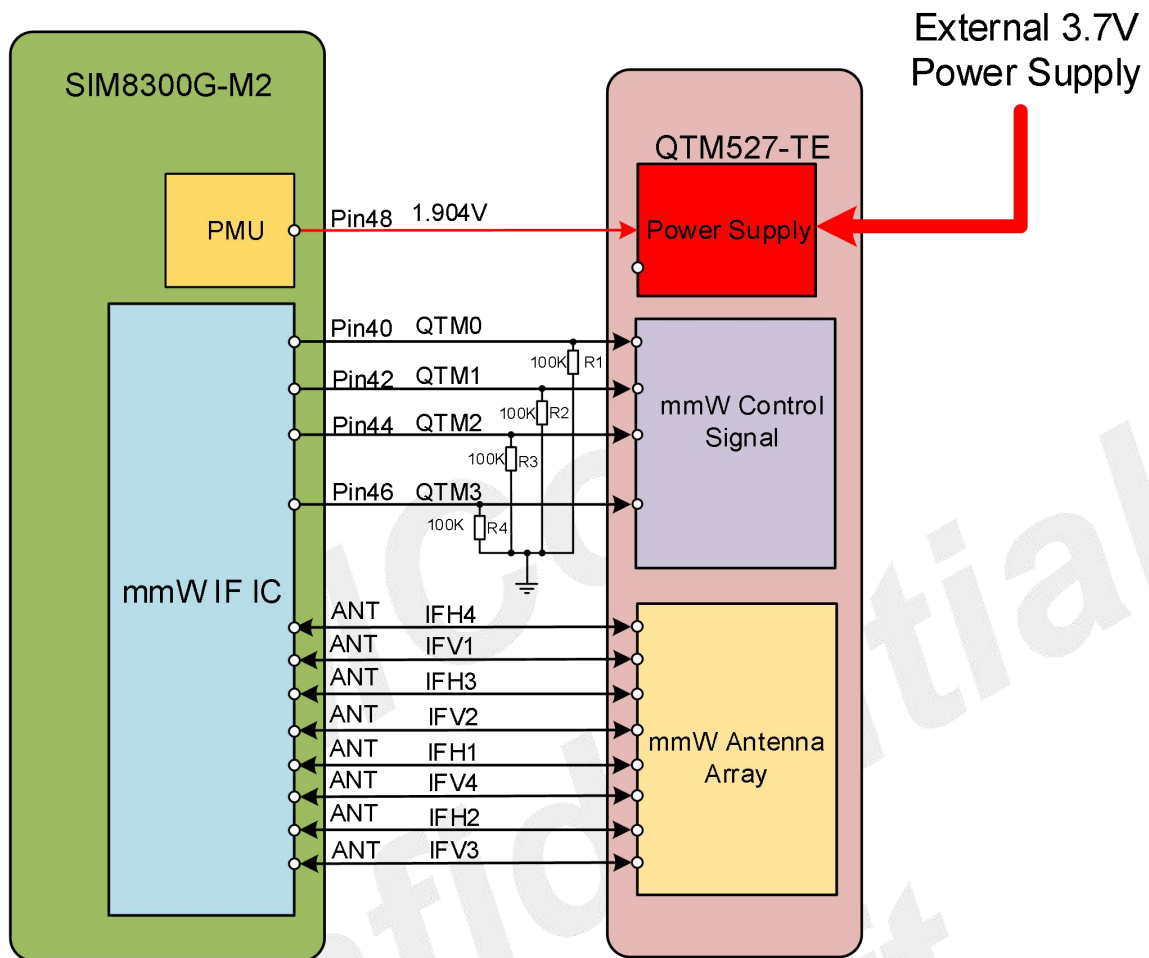


Figure 8: Block diagram of SIM8300G-M2 and QTM527-TE connection

NOTE

Pin40, Pin42, Pin44, Pin46, Pin48 is M2 pin number of SIM8300G-M2.

Table 7: QTM527 overview

Feature	QTM527 capability
mmWave transceiver (common to Rx and Tx)	
RF operating bands	<ul style="list-style-type: none"> • QTM527-1 variant: n260 (37–40GHz) and n261 (27.5–28.35GHz) • QTM527-2 variant: n257(26.5–29.5GHz) , n258 (24.25–27.5 GHz) and

	n261 (27.5–28.3 GHz)
MIMO support	Dual-polarization MIMO (horizontal and vertical)
Bandwidth support	Up to 800 MHz occupied bandwidth (DL) in any 1.2 GHz frequency range
Carrier aggregation (CA) support	<ul style="list-style-type: none"> • DL 2 × 2 MIMO: up to eight 100 MHz component carriers • UL 2 × 2 MIMO: up to four 100 MHz component carriers • UL 1 × 1 SISO: up to eight 100 MHz component carriers
Beamforming support	<ul style="list-style-type: none"> • Independent amplitude and phase control for up to sixteen antenna feeds per polarization (32 total) • Patch antenna elements enable broad spatial coverage
Duplex mode of operation	TDD only
Packaging Type	First QTI mmWave module using LGA packaging

mmWave receiver

Receiver paths	<ul style="list-style-type: none"> • One horizontal polarization and one vertical polarization (IF1/IF2 – per QTM527 module) receiver signal paths that are connected to IF receiver chip (SMR526) • Each receiver chain provides amplitude weighting, phase shifting, and I/Q quadrature mmWave-to-IF frequency translation
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mmWave transmitter

Transmitter paths	<ul style="list-style-type: none"> • horizontal polarizations (IF1) and two vertical polarization (IF2) transmitter signal paths • Each transmitter chain provides amplitude weighting, phase shifting, and I/Q quadrature IF-to-mmWave frequency translation
Transmit power detectors	<ul style="list-style-type: none"> • Power detector (PDET) to sense forward power for each transmit path • Used for maximum transmit power limiting (MTPL) and factory power calibration

Other key electrical features

Operating voltages	Two external supply voltages: VPH_PWR_MMW and 1.85 V nominal
Digital control interfaces	<ul style="list-style-type: none"> • SMR526 control signal provided by IF signal lines • Two PON input signals (R1/R2_V_P_ON combined) for RFIC to enable PMIC inside QTM527

4.2 Top/ Bottom view of mmWave EVB and QTM527-TE board connection

The following figure shows SIM8300G-M2 and QTM527 antenna ports definition.



Figure 9: SIM8300G-M2 mmWave IF ports definition

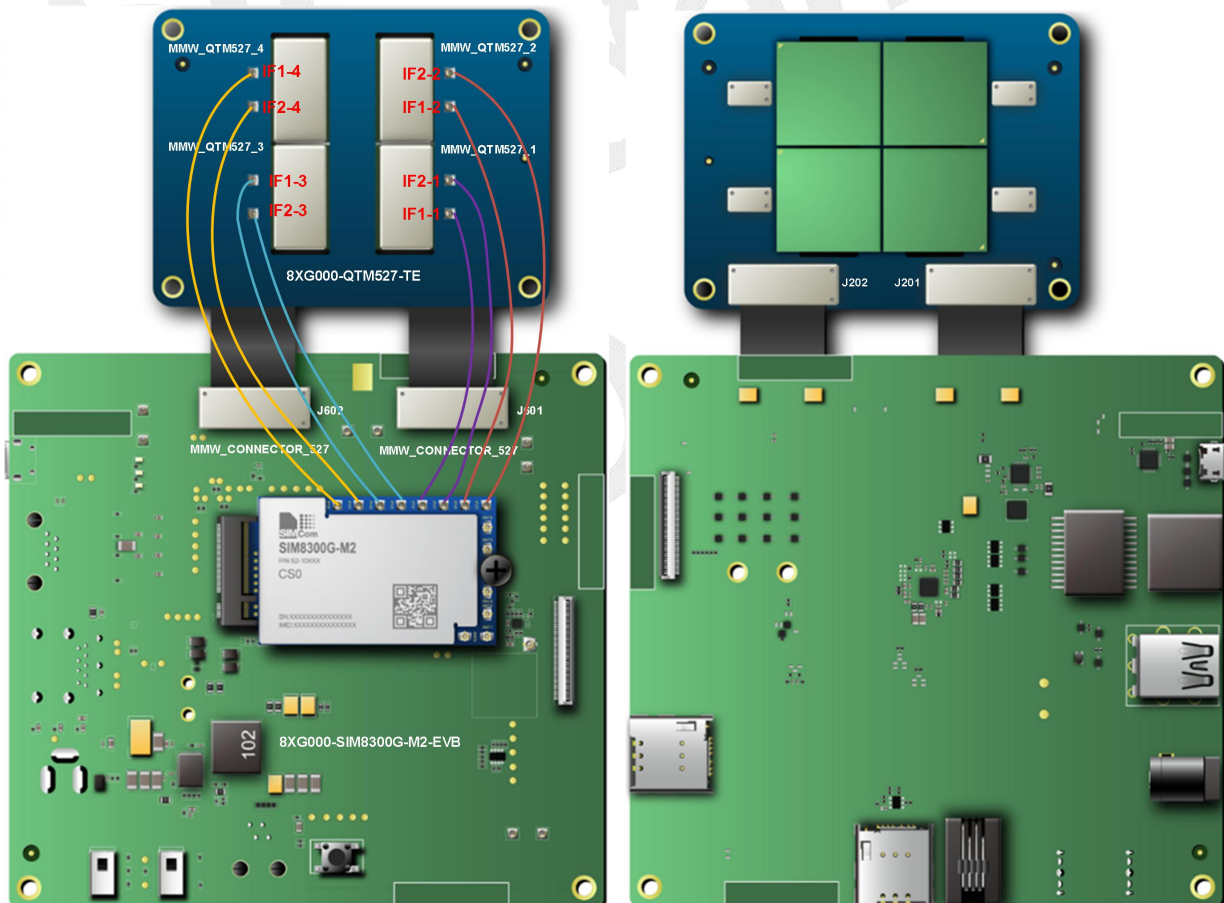


Figure 10: Top/Bottom view of mmWave EVB and QTM527-TE board connection

The connection of QTM527-TE board and SIM8300G-M2 module, please refer to the following table.

Table 8: QTM527-TE and SIM8300G-M2 module connection

mmWave antenna module	QTM527 IF ports	SIM8300G-M2
MMW_QTM527_1	IF1-1	IFH1
	IF2-1	IFV4
MMW_QTM527_2	IF1-2	IFH2
	IF2-2	IFV3
MMW_QTM527_3	IF1-3	IFH3
	IF2-3	IFV2
MMW_QTM527_4	IF1-4	IFH4
	IF2-4	IFV1

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5 Appendix

5.1 Related Documents

Table 9: Related documents

No.	Title	Description
[1]	SIM8200 Series_AT Command Manual	AT Command Manual
[2]	3GPP TS 51.010-1	Digital cellular telecommunications system (Release 5); Mobile Station (MS) conformance specification
[3]	3GPP TS 38.401	NG-RAN; Architecture description
[4]	3GPP TS 34.124	Electromagnetic Compatibility (EMC) for mobile terminals and ancillary equipment.
[5]	3GPP TS 34.121	Electromagnetic Compatibility (EMC) for mobile terminals and ancillary equipment.
[6]	3GPP TS 34.123-1	Technical Specification Group Radio Access Network; Terminal conformance specification; Radio transmission and reception (FDD)
[7]	3GPP TS 34.123-3	User Equipment (UE) conformance specification; Part 3: Abstract Test Suites.
[8]	EN 301 908-02 V2.2.1	Electromagnetic compatibility and Radio spectrum Matters (ERM); Base Stations (BS) and User Equipment (UE) for IMT-2000. Third Generation cellular networks; Part 2: Harmonized EN for IMT-2000, CDMA Direct Spread (UTRA FDD) (UE) covering essential requirements of article 3.2 of the R&TTE Directive
[9]	EN 301 489-24 V1.2.1	Electromagnetic compatibility and Radio Spectrum Matters (ERM); Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 24: Specific conditions for IMT-2000 CDMA Direct Spread (UTRA) for Mobile and portable (UE) radio and ancillary equipment
[10]	IEC/EN60950-1(2001)	Safety of information technology equipment (2000)
[11]	3GPP TS 51.010-1	Digital cellular telecommunications system (Release 5); Mobile Station (MS) conformance specification
[12]	GCF-CC V3.23.1	Global Certification Forum - Certification Criteria
[13]	2002/95/EC	Directive of the European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS)
[14]	3GPP TS 38.101	NR radio transmission and reception technical specification
[15]	SIM8300G_M2 Antenna Port Mapping and Design Guide	SIM8300G_M2 Antenna Port Mapping and Design Guide

5.2 Terms and Abbreviations







Table 10: Terms and abbreviations

Abbreviation	Description
ADC	Analog-To-Digital Converter
ARP	Antenna Reference Point
BER	Bit Error Rate
BTS	Base Transceiver Station
CPE	Customer Premise Equipment
CS	Coding Scheme
CSD	Circuit Switched Data
CTS	Clear To Send
DAC	Digital-To-Analog Converter
DRX	Discontinuous Reception
DSP	Digital Signal Processor
DTE	Data Terminal Equipment (typically computer, terminal, printer)
DTR	Data Terminal Ready
DTX	Discontinuous Transmission
DPR	Dynamic Power Reduction
DIV	The Diversity Receive signal
EFR	Enhanced Full Rate
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge
ETS	European Telecommunication Standard
EVDO	Evolution Data Only
FCC	Federal Communications Commission (U.S.)
FD	(U)SIM fix dialing phonebook
FDD	Frequency Division Dual
FDMA	Frequency Division Multiple Access
FR	Full Rate
GMSK	Gaussian Minimum Shift Keying
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HR	Half Rate
HSPA	High Speed Packet Access
HSIC	High-Speed Inter-Chip
I2C	Inter-Integrated Circuit
I2S	Inter-IC Sound

IF	Intermediate frequency
IMEI	International Mobile Equipment Identity
LTE	Long Term Evolution
LB	Low Frequency Band
LAA	Limited Access Authorization
MO	Mobile Originated
MSB	Most Significant Bit
MHB	Middle And High Frequency Band
MT	Mobile Terminated
MIMO	Multiple Input Multiple Output
NMEA	National Marine Electronics Association
PAP	Password Authentication Protocol
PBCCH	Packet Switched Broadcast Control Channel
PCB	Printed Circuit Board
PCIe	Peripheral Component Interface Express
RF	Radio Frequency
RMS	Root Mean Square (value)
RTC	Real Time Clock
SIM	Subscriber Identification Module
SMS	Short Message Service
SPI	Serial Peripheral Interface
SMPS	Switched-Mode Power Supply
TDD	Time Division Dual
TDMA	Time Division Multiple Access
TE	Terminal Equipment(also referred to as DTE)
TX	Transmit Direction
TRX	The Diversity Receive signal
VSWR	Voltage Standing Wave Ratio
SM	(U)SIM Phonebook
SGMII	Serial Gigabit Media Independent Interface
NC	Not connect
HSDPA	High Speed Downlink Packet Access
HSUPA	High Speed Uplink Packet Access
ZIF	Zero Intermediate Frequency
WCDMA	Wideband Code Division Multiple Access
VCTCXO	Voltage Control Temperature-Compensated Crystal Oscillator
(U)SIM	Universal Subscriber Identity Module
UHB	Ultra High Frequency Band
UMTS	Universal Mobile Telecommunications System
UART	Universal Asynchronous Receiver Transmitter

5.3 Safety Caution

Table 11: Safety caution

Marks	Requirements
	<p>When in a hospital or other health care facility, observe the restrictions about the use of mobiles. Switch the cellular terminal or mobile off, medical equipment may be sensitive and not operate normally due to RF energy interference.</p>
	<p>Switch off the cellular terminal or mobile before boarding an aircraft. Make sure it is switched off. The operation of wireless appliances in an aircraft is forbidden to prevent interference with communication systems. Forgetting to think much of these instructions may impact the flight safety, or offend local legal action, or both.</p>
	<p>Do not operate the cellular terminal or mobile in the presence of flammable gases or fumes. Switch off the cellular terminal when you are near petrol stations, fuel depots, chemical plants or where blasting operations are in progress. Operation of any electrical equipment in potentially explosive atmospheres can constitute a safety hazard.</p>
	<p>Your cellular terminal or mobile receives and transmits radio frequency energy while switched on. RF interference can occur if it is used close to TV sets, radios, computers or other electric equipment.</p>
	<p>Road safety comes first! Do not use a hand-held cellular terminal or mobile when driving a vehicle, unless it is securely mounted in a holder for hands free operation. Before making a call with a hand-held terminal or mobile, park the vehicle.</p>
	<p>Mobiles operate over radio frequency signals and cellular networks and cannot be guaranteed to connect in all conditions, especially with a mobile fee or an invalid (U)SIM card. While you are in this condition and need emergent help, please remember to use emergency calls. In order to make or receive calls, the cellular terminal or mobile must be switched on and in a service area with adequate cellular signal strength.</p> <p>Some networks do not allow for emergency call if certain network services or phone features are in use (e.g. lock functions, fixed dialing etc.). You may have to deactivate those features before you can make an emergency call.</p> <p>Also, some networks require that a valid (U)SIM card be properly inserted in the cellular terminal or mobile.</p>