




# RF EXPOSURE REPORT



Report No.: 16050028-FCC-H-V1

Applicant	Quectel Wireless Solutions Co., Ltd.	
Product Name	Wifi& BT Module	
Model No.	FC20	
Serial No.	N/A	
Test Standard	FCC 2.1091: 2016	
Test Date	March 08, 2017	
Issue Date	May10, 2017	
Test Result	<input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail	
Equipment complied with the specification <input checked="" type="checkbox"/>		
Equipment did not comply with the specification <input type="checkbox"/>		
		
Leen Yang Test Engineer	David Huang Checked By	
This test report may be reproduced in full only Test result presented in this test report is applicable to the tested sample only		

Issued by:

**SIEMIC (SHENZHEN-CHINA) LABORATORIES**

Zone A, Floor 1, Building 2 Wan Ye Long Technology Park

South Side of Zhoushi Road, Bao' an District, Shenzhen, Guangdong China 518108

Phone: +86 0755 2601 4629801 Email: [China@siemic.com.cn](mailto:China@siemic.com.cn)

## Laboratories Introduction

SIEMIC, headquartered in the heart of Silicon Valley, with superior facilities in US and Asia, is one of the leading independent testing and certification facilities providing customers with one-stop shop services for Compliance Testing and Global Certifications.



In addition to testing and certification, SIEMIC provides initial design reviews and compliance management throughout a project. Our extensive experience with China, Asia Pacific, North America, European, and International compliance requirements, assures the fastest, most cost effective way to attain regulatory compliance for the global markets.

### Accreditations for Conformity Assessment

Country/Region	Scope
USA	EMC, RF/Wireless, SAR, Telecom
Canada	EMC, RF/Wireless, SAR, Telecom
Taiwan	EMC, RF, Telecom, SAR, Safety
Hong Kong	RF/Wireless, SAR, Telecom
Australia	EMC, RF, Telecom, SAR, Safety
Korea	EMI, EMS, RF, SAR, Telecom, Safety
Japan	EMI, RF/Wireless, SAR, Telecom
Singapore	EMC, RF, SAR, Telecom
Europe	EMC, RF, SAR, Telecom, Safety

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## 1. Report Revision History

Report No.	Report Version	Description	Issue Date
16050028-FCC-H	NONE	Original	March 09, 2017
16050028-FCC-H-V1	V1	Adding collocated MPE Calculation	May 10, 2017

## 2. Customer information

Applicant Name	Quectel Wireless Solutions Co., Ltd.
Applicant Add	RM501,Building 13,No.99 TianZhou Road,Xuhui District,Shanghai,China
Manufacturer	Quectel Wireless Solutions Co., Ltd.
Manufacturer Add	RM501,Building 13,No.99 TianZhou Road,Xuhui District,Shanghai,China

## 3. Test site information

Lab performing tests	SIEMIC (Shenzhen-China) LABORATORIES
Lab Address	Zone A, Floor 1, Building 2 Wan Ye Long Technology Park South Side of Zhoushi Road, Bao' an District, Shenzhen, Guangdong China 518108
FCC Test Site No.	718246
IC Test Site No.	4842E-1
Test Software	Labview of SIEMIC version 2.0

## 4. Equipment under Test (EUT) Information

Description of EUT:	Wifi& BT Module
Main Model:	FC20
Serial Model:	N/A
Equipment Category :	DTS
Antenna Gain:	Bluetooth/BLE: 3dBi WIFI(2.4G): 3 dBi WIFI(5150-5250MHz): 3 dBi WIFI(5250-5350MHz): 3 dBi WIFI(5470-5725MHz): 3 dBi WIFI(5725-5850MHz): 3 dBi <b>( Note: The radio module will be sold without antenna, this antenna only used limited to ERP/EIRP or radiated spurious emission test. )</b>
Antenna type :	Fixed External antenna
Input Power:	Main supply voltage: 3.3V, 500mA IO supply voltage: 1.8V
Trade Name :	Quectel
FCC ID:	XMR201703FC20
Type of Modulation:	Bluetooth: GFSK, $\pi$ /4DQPSK, 8DPSK BLE: GFSK 802.11b: DSSS 802.11g/n20/n40/ac20/ac40/ac80: OFDM

RF Operating Frequency (ies):

WIFI: 802.11b/g/n(20M): 2412-2462 MHz(TX/RX)  
WIFI: 802.11n(40M): 2422-2452 MHz(TX/RX)  
802.11ac 20: 5180-5240 MHz; 5260-5320 MHz; 5500-5700 MHz;  
5745-5825 MHz; (TX/RX)  
802.11ac 40: 5190-5230 MHz; 5270-5310 MHz; 5510-5710 MHz;  
5755-5795 MHz; (TX/RX)  
802.11ac 80: 5210 MHz; 5290 MHz; 5530-5690 MHz; 5775 MHz;  
(TX/RX)  
Bluetooth& BLE: 2402-2480 MHz

Number of Channels:

WIFI :802.11b/g/n(20M): 11CH  
WIFI :802.11n(40M): 7CH  
WIFI :802.11ac20: 24CH  
WIFI :802.11ac40: 12CH  
WIFI :802.11ac80: 6CH  
Bluetooth: 79CH  
BLE: 40CH

## 5. FCC §2.1091 - Maximum Permissible exposure (MPE)

### 5.1 Applicable Standard

According to §1.1307(b)(1), systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission' s guidelines.

According to §1.1310 and §2.1091 RF exposure is calculated.

Limits for General Population/Uncontrolled Exposure

Table 1

Limits for General Population/Uncontrolled Exposure				
Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm <sup>2</sup> )	Averaging Time (minutes)
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/f <sup>2</sup> )	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	f/1500	30
1500-100,000	/	/	1.0	30

f = frequency in MHz

\* = Plane-wave equivalent power density



## 5.2 Test Result

### 2.4G WIFI Mode:

Table 2

Type	Test mode	CH	Freq (MHz)	Conducted Power (dBm)	Tune Up Power (dBm)
Output power	802.11b	Low	2412	<b>15.83</b>	15±1
		Mid	2437	15.73	15±1
		High	2462	15.60	15±1
	802.11g	Low	2412	13.85	14±1
		Mid	2437	<b>13.91</b>	14±1
		High	2462	13.62	14±1
	802.11n (20M)	Low	2412	13.95	14±1
		Mid	2437	<b>13.96</b>	14±1
		High	2462	13.79	14±1
	802.11n (40M)	Low	2422	12.79	12±1
		Mid	2437	12.81	12±1
		High	2452	<b>12.82</b>	12±1

## 5G WIFI Mode:

Table 3

Test mode	Freq Band (MHz)	CH	Frequency (MHz)	Conducted Power (dBm)	Duty factor (dB)	Conducted Power with D.F(dBm)	Tune Up Power (dBm)
802.11ac (20M)	5150-5250	Low	5180	11.98	0.18	12.16	11.5±1
		Middle	5200	11.74	0.18	11.92	11.5±1
		High	5240	11.69	0.18	11.87	11.5±1
	5250-5350	Low	5260	11.95	0.18	12.13	11.5±1
		Middle	5300	12.03	0.18	12.21	11.5±1
		High	5320	11.79	0.18	11.97	11.5±1
	5470-5725	Low	5500	10.92	0.18	11.10	11±1
		Mid	5600	10.86	0.18	11.04	11±1
		High	5700	10.92	0.18	11.10	11±1
	5725-5850	Low	5745	11.07	0.18	11.25	11±1
		Mid	5785	11.00	0.18	11.18	11±1
		High	5825	11.05	0.18	11.23	11±1
802.1ac (40M)	5150-5250	Low	5190	10.90	0.36	11.26	11±1
		High	5230	11.14	0.36	11.50	11±1
	5250-5350	Low	5270	11.06	0.36	11.42	11±1
		High	5310	10.89	0.36	11.25	11±1
	5470-5725	Low	5510	10.70	0.36	11.06	11±1
		Mid	5590	10.45	0.36	10.81	11±1
		High	5670	10.54	0.36	10.90	11±1
		Straggle	5710	10.54	0.36	10.90	11±1
	5725-5850	Low	5755	9.49	0.36	9.85	10±1
		High	5795	9.57	0.36	9.93	10±1
802.11ac (80M)	5150-5250	One	5210	9.97	0.71	10.68	10±1
	5250-5350	One	5290	10.06	0.71	10.77	10±1
	5470-5725	Low	5530	10.15	0.71	10.86	10±1
		High	5610	9.89	0.71	10.60	10±1
		Straddle	5690	9.69	0.71	10.40	10±1
	5725-5850	One	5775	9.03	0.71	9.74	10±1

### Bluetooth Mode:

Table 4

Type	Test mode	CH	Freq (MHz)	Conducted Power (dBm)	Tune Up Power (dBm)
Output power	GFSK	Low	2402	4.943	5.8±1
		Mid	2441	<b>6.736</b>	5.8±1
		High	2480	6.476	5.8±1
	$\pi$ /4 DQPSK	Low	2402	3.879	3.5±1
		Mid	2441	5.820	5.5±1
		High	2480	5.554	5.5±1
	8DPSK	Low	2402	4.317	4±1
		Mid	2441	6.161	6±1
		High	2480	5.938	6±1

### BLE Mode:

Table 5

Type	CH	Frequency (MHz)	Conducted Power (dBm)	Tune Up Power (dBm)
Output power	Low	2402	0.239	1±1
	Mid	2440	1.109	1±1
	High	2480	1.358	1±1

**MPE:**

Table 6

Frequency bands	Max. Turn-up Conducted power (dBm)	Max. allow antenna gain (dBi)	Max. ERP/EIRP	Exemption Limit of RF Exposure Evaluation	Result(if Exemption or not)
5150-5250MHz WIFI	12.5	2	15.5	34.77	Yes
5250-5350 WIFI	12.5	2	15.5	34.77	Yes
5470-5725 WIFI	12	2	15	34.77	Yes
5725-5850 WIFI	12	2	15	34.77	Yes

**Note:**

**FCC Part 2.1091 Radiofrequency radiation exposure evaluation: mobile devices.**

(c) (2) Unlicensed personal communications service devices, unlicensed millimeter wave devices and unlicensed NII devices authorized under §§15.253(f), 15.255(g), 15.257(g), 15.319(i), and 15.407(f) of this chapter are also subject to routine environmental evaluation for RF exposure prior to equipment authorization or use if their ERP is 3 watts or more or if they meet the definition of a portable device as specified in §2.1093(b) requiring evaluation under the provisions of that section.

## 2.4G WIFI:

Predication of MPE limit at a given distance

$$S = \frac{PG}{4\pi R^2}$$

Where: S = power density (in appropriate units, e.g. mW/cm<sup>2</sup>)

P = power input to the antenna (in appropriate units, e.g., mW).

G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain.

R = distance to the center of radiation of the antenna (appropriate units, e.g., cm)

For the antenna manufacturer provide only used limited to ERP/EIRP or radiated spurious emission test. The MPE evaluation as below:

Max Turn-up Conducted Source Based time Average Power  
(dBm) at antenna input terminal: 16 ( dBm)

Maximum output power at antenna input terminal: 39.81 ( mW)

Prediction distance: >20 (cm)

Predication frequency: 2412 (MHz) Low frequency

Antenna Gain (typical): 2 (dBi)

The worst case is power density at predication frequency at 20 cm: 0.013(mW/cm<sup>2</sup>)

MPE limit for general population exposure at prediction frequency: 1.0 (mW/cm<sup>2</sup>)

0.013(mW/cm<sup>2</sup>) < 1.0 (mW/cm<sup>2</sup>)

**Result: Pass**

**BT:**

Predication of MPE limit at a given distance

$$S = \frac{PG}{4\pi R^2}$$

Where: S = power density (in appropriate units, e.g. mW/cm<sup>2</sup>)

P = power input to the antenna (in appropriate units, e.g., mW).

G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain.

R = distance to the center of radiation of the antenna (appropriate units, e.g., cm)

For the antenna manufacturer provide only used limited to ERP/EIRP or radiated spurious emission test. The MPE evaluation as below:

Maximum output power at antenna input terminal: 6.8 ( dBm)

Maximum output power at antenna input terminal: 4.786 (mW)

Prediction distance: >20 (cm)

Predication frequency: 2441(MHz) Mid frequency

Antenna Gain (typical): 2 (dBi)

The worst case is power density at predication frequency at 20 cm: 0.0015 (mW/cm<sup>2</sup>)

MPE limit for general population exposure at prediction frequency: 1.0 (mW/cm<sup>2</sup>)

0.0015(mW/cm<sup>2</sup>) < 1.0 (mW/cm<sup>2</sup>)

**Result: Pass**

## BLE:

Predication of MPE limit at a given distance

$$S = \frac{PG}{4\pi R^2}$$

Where: S = power density (in appropriate units, e.g. mW/cm<sup>2</sup>)

P = power input to the antenna (in appropriate units, e.g., mW).

G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain.

R = distance to the center of radiation of the antenna (appropriate units, e.g., cm)

For the antenna manufacturer provide only used limited to ERP/EIRP or radiated spurious emission test. The MPE evaluation as below:

Maximum output power at antenna input terminal: 2 ( dBm)

Maximum output power at antenna input terminal: 1.585 (mW)

Prediction distance: >20 (cm)

Predication frequency: 2480 (MHz) High frequency

Antenna Gain (typical): 2 (dBi)

The worst case is power density at predication frequency at 20 cm: 0.00005 (mW/cm<sup>2</sup>)

MPE limit for general population exposure at prediction frequency: 1.0 (mW/cm<sup>2</sup>)

0.00005(mW/cm<sup>2</sup>) < 1.0 (mW/cm<sup>2</sup>)

**Result: Pass**

## 6 . Introduction

Quectel Wireless Solutions Co., Ltd. seeks modular approval for the FC20 Wifi& BT Module for use in mobile configuration. This Maximum Permissive Exposure (“ MPE” ) report demonstrates compliance for FC20 Wifi& BT Module with FCC CFR 47 §1.1310 and 2.1091 for standalone and collocated simultaneous transmission in mobile exposure conditions. The MPE analysis is valid for transmitters operating within the parameters defined in Table 8 used for analysis.

Any collocated transmitter must have a valid FCC ID documenting equivalent or degraded RF characteristics with the collocated parameters defined in this MPE analysis.

The mobile classification applies when 20 cm or more separation distance is maintained between the end user and both WLAN, BT and WWAN transmission antennas.

Portable user conditions or additional collocated modules not allowed based on this RF exposure analysis require a Class II permissive change and updated MPE or SAR report.



## 7. Product Transmitter Parameters Summary:

Table 7 summarizes transmitter parameters Summary

**Table 7 WWAN Transmitter**

Technology	Max Transmitter Duty Cycle	Transmitter Range (MHz)	Maximum Conducted Power		Max Antenna Gain (dBi)
			(dBm)	(W)	
2.4G WIFI	100%	2412 ~ 2462	16.0	0.03981	3
5.0&5.8G WIFI	100%	5150 ~ 5850	12.5	0.01778	3
2.4G BT	77.52%	2402 ~ 2480	7.0	0.00501	3
2.4G BLE	100%	2402 ~ 2480	2.0	0.00158	3

## 8. Collocated Transmitters

This MPE analysis is applicable to any collocated transmitters with transmit power less than or equal to **29.0** dBm for WWAN. Specific FCC IDs for those devices are not necessary or identified in this analysis providing they are classified as mobile transmitters. A 100% duty cycle is used for calculations to present a worst-case analysis.

## 9 Transmitter Summary

Table 8 summarizes transmitter parameters.

The 2.4G WIFI, 5& 5.8G WIFI, 2.4G BT and 2.4G BLE modes of operation reflect the FC20 Wifi& BT Module parameters associated with this FCC ID: XMR201703FC20.

The WWAN transmit power and antenna gain parameters represent a maximum transmit power for a given frequency band.

Integration of a WWAN module that exceeds the parameters requires a new FCC authorization or permissive change application.

**Table 8 WLAN and WWAN Declared Transmitter Parameters**

Module Model	Technology	Frequency (MHz)	Maximum Conducted Power (dBm)	Conducted Power (W)	Maximum Antenna Gain (dBi)	Duty Cycle
FC20	2.4G WIFI	2412 ~ 2462	16.0	0.03981	3	100%
	5.0&5.8G WIFI	5150 ~ 5850	12.5	0.01778	3	100%
	2.4G BT	2402 ~ 2480	7.0	0.00501	3	77.52%
	2.4G BLE	2402 ~ 2480	2.0	0.00158	3	100%
EC25-A	UMTS Band II	1850 – 1910	24	0.25119	12	100%
	UMTS Band IV	1710 – 1755	24	0.25119	12	100%
	UMTS Band V	824 – 849	24	0.25119	10	100%
	LTE Band II	1850 – 1910	24	0.25119	12	100%
	LTE Band IV	1710 – 1755	24	0.25119	12	100%
	LTE Band XII	2500 – 2570	24	0.25119	12	100%
EC21-A	UMTS Band II	1850 – 1910	24	0.25119	12	100%
	UMTS Band IV	1710 – 1755	24	0.25119	12	100%
	UMTS Band V	824 – 849	24	0.25119	10	100%

	LTE Band II	1850 – 1910	24	0.25119	12	100%
	LTE Band IV	1710 – 1755	24	0.25119	12	100%
	LTE Band XII	2500 – 2570	24	0.25119	12	100%
EC25-V	LTE Band IV	1850 – 1910	24	0.25119	12	100%
	LTE Band XIII	777 – 787	24	0.25119	10	100%
EC21-V	LTE Band IV	1850 – 1910	24	0.25119	12	100%
	LTE Band XIII	777 – 787	24	0.25119	10	100%

## 10 MPE Calculations

### 10.1 Stand Alone Transmitter Calculations

The power density calculations for standalone transmitters at an exposure separation distance of 20 cm are shown in Table 9 per the transmit power and antenna gain values declared in Table 8.

For frequency dependent limits, the lowest transmitter frequency was used to represent the lowest MPE limit (e.g. 826.6MHz = 0.551 mW/cm<sup>2</sup>).

The WWAN power levels listed represent the worst-case values for the corresponding frequency ranges given.

**Table 9 WWAN and WLAN Standalone MPE Calculations**

Module Model	Techno-logy	Frequency (MHz)	Maximum Conducted Power (dBm)	Conducted Power (W)	Maximum Antenna Gain (dBi)	Duty Cycle	Average EIRP (dBm)	Average EIRP (W)	Power Density @ 20cm (mW/cm <sup>2</sup> )	FCC MPE Limit (mW/cm <sup>2</sup> )
FC20	2.4G WIFI	2412 ~ 2462	16.0	0.03981	3	100%	19.0	0.07943	0.016	1
	5.0&5.8G WIFI	5150 ~ 5850	12.5	0.01778	3	100%	15.5	0.03548	0.007	1
	2.4G BT	2402 ~ 2480	7.0	0.00501	3	77.52%	8.9	0.00776	0.002	1
	2.4G BLE	2402 ~ 2480	2.0	0.00158	3	100%	5.0	0.00316	0.001	1
EC25-A	UMTS Band II	1850 – 1910	24.0	0.25119	12.0	100%	36.0	3.98107	0.792	1
	UMTS Band IV	1710 – 1755	24.0	0.25119	12.0	100%	36.0	3.98107	0.792	1
	UMTS Band V	824 – 849	24.0	0.25119	10.0	100%	34.0	2.51189	0.500	0.549
	LTE Band II	1850 – 1910	24.0	0.25119	12.0	100%	36.0	3.98107	0.792	1
	LTE Band IV	1710 – 1755	24.0	0.25119	12.0	100%	36.0	3.98107	0.792	1

	LTE Band XII	2500 – 2570	24.0	0.25119	12.0	100%	36.0	3.98107	0.792	1
EC21- A	UMTS Band II	1850 – 1910	24.0	0.25119	12.0	100%	36.0	3.98107	0.792	1
	UMTS Band IV	1710 – 1755	24.0	0.25119	12.0	100%	36.0	3.98107	0.792	1
	UMTS Band V	824 – 849	24.0	0.25119	10.0	100%	34.0	2.51189	0.500	0.549
	LTE Band II	1850 – 1910	24.0	0.25119	12.0	100%	36.0	3.98107	0.792	1
	LTE Band IV	1710 – 1755	24.0	0.25119	12.0	100%	36.0	3.98107	0.792	1
	LTE Band XII	2500 – 2570	24.0	0.25119	12.0	100%	36.0	3.98107	0.792	1
EC25- V	LTE Band IV	1850 – 1910	24.0	0.25119	12.0	100%	36.0	3.98107	0.792	1
	LTE Band X III	777 – 787	24.0	0.25119	10.0	100%	34.0	2.51189	0.500	0.518
EC21- V	LTE Band IV	1850 – 1910	24.0	0.25119	12.0	100%	36.0	3.98107	0.792	1
	LTE Band X III	777 – 787	24.0	0.25119	10.0	100%	34.0	2.51189	0.500	0.518

## 10.2 Collocated MPE Calculations

Per OET 65, when RF sources have difference frequencies, the fraction of the FCC power density limit shall be determined and the sum of all fractional components shall be less than 1.

**Table 10 Collocation Power Density**

Module Model	Technology	Frequency Band	WLAN Pd (mW/cm <sup>2</sup> )	FCC MPE Limit (mW/cm <sup>2</sup> )	(WLAN Pd) / (MPE Limit)	850 MHz WWAN Pd (mW/cm <sup>2</sup> )	FCC MPE Limit (mW/cm <sup>2</sup> )	(WWAN 850 MHz) / MPE Limit	(850 MHz WWAN fraction) + (WLAN fraction)	Limit	Pass/Fail
EC25-A	UMTS Band II	1850 – 1910	0.026	1	0.026	0.792	1	0.792	0.818	1	Pass
	UMTS Band IV	1710 – 1755	0.026	1	0.026	0.792	1	0.792	0.818	1	Pass
	UMTS Band V	824 – 849	0.026	1	0.026	0.500	0.549	0.911	0.937	1	Pass
	LTE Band II	1850 – 1910	0.026	1	0.026	0.792	1	0.792	0.818	1	Pass
	LTE Band IV	1710 – 1755	0.026	1	0.026	0.792	1	0.792	0.818	1	Pass
	LTE Band XII	2500 – 2570	0.026	1	0.026	0.792	1	0.792	0.818	1	Pass
EC21-A	UMTS Band II	1850 – 1910	0.026	1	0.026	0.792	1	0.792	0.818	1	Pass
	UMTS Band IV	1710 – 1755	0.026	1	0.026	0.792	1	0.792	0.818	1	Pass
	UMTS Band V	824 – 849	0.026	1	0.026	0.500	0.549	0.911	0.937	1	Pass
	LTE Band II	1850 – 1910	0.026	1	0.026	0.792	1	0.792	0.818	1	Pass
	LTE Band IV	1710 – 1755	0.026	1	0.026	0.792	1	0.792	0.818	1	Pass
	LTE Band XII	2500 – 2570	0.026	1	0.026	0.792	1	0.792	0.818	1	Pass
EC25-V	LTE Band IV	1850 – 1910	0.026	1	0.026	0.792	1	0.792	0.818	1	Pass
	LTE Band XIII	777 – 787	0.026	1	0.026	0.500	0.518	0.965	0.991	1	Pass
EC21-V	LTE Band IV	1850 – 1910	0.026	1	0.026	0.792	1	0.792	0.818	1	Pass
	LTE Band XIII	777 – 787	0.026	1	0.026	0.500	0.518	0.965	0.991	1	Pass