

RF Exposure Evaluation Report

APPLICANT : Quectel Wireless Solutions Co., Ltd.
EQUIPMENT : 5G Sub-6 GHz LGA Module
BRAND NAME : Quectel
MODEL NAME : RG500L-NA
FCC ID : XMR2023RG500LNA
STANDARD : 47 CFR Part 2.1091

The product evaluation date was started from May 12, 2023 and completed on May 12, 2023. We, Sporton International Inc. (Kunshan), would like to declare that the device has been evaluated in accordance with 47 CFR Part 2.1091 and FCC KDB 447498 D01 v06, and pass the limit. Without written approval of Sporton International Inc. (Kunshan), the test report shall not be reproduced except in full.



Approved by: Si Zhang

Sporton International Inc. (Kunshan)

***No. 1098, Pengxi North Road, Kunshan Economic Development Zone Jiangsu Province 215300
People's Republic of China***



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Revision History

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FA2D0201	Rev. 01	Initial issue of report.	Jun. 02, 2023



1. Administration Data

1.1. Testing Laboratory

Sporton International Inc. (Kunshan) is accredited to ISO/IEC 17025:2017 by American Association for Laboratory Accreditation with Certificate Number 5145.02.

Testing Laboratory			
Test Firm	Sporton International Inc. (Kunshan)		
Test Site Location	No. 1098, Pengxi North Road, Kunshan Economic Development Zone Jiangsu Province 215300 People's Republic of China TEL : +86-512-57900158 FAX : +86-512-57900958		
Test Site No.	Sporton Site No.	FCC Designation No.	FCC Test Firm Registration No.
	SAR01-KS	CN1257	314309

Applicant	
Company Name	Quectel Wireless Solutions Co., Ltd.
Address	Building 5, Shanghai Business Park Phase III (Area B), No.1016 Tianlin Road, Minhang District, Shanghai 200233, China

Manufacturer	
Company Name	Quectel Wireless Solutions Co., Ltd.
Address	Building 5, Shanghai Business Park Phase III (Area B), No.1016 Tianlin Road, Minhang District, Shanghai 200233, China

2. Description of Equipment Under Test (EUT)

Product Feature & Specification	
EUT Type	5G Sub-6 GHz LGA Module
Brand Name	Quectel
Model Name	RG500L-NA
FCC ID	XMR2023RG500LNA
Wireless Technology and Frequency Range	LTE Band 2 : 1850 MHz ~ 1910 MHz LTE Band 4 : 1710 MHz ~ 1755 MHz LTE Band 5 : 824 MHz ~ 849 MHz LTE Band 7: 2500 MHz ~ 2570 MHz LTE Band 12 : 699 MHz ~ 716 MHz LTE Band 13 : 777 MHz ~ 787 MHz LTE Band 14: 788 MHz ~ 798 MHz LTE Band 17: 704 MHz ~ 716 MHz LTE Band 25 : 1850 MHz ~ 1915 MHz LTE Band 26 : 814 MHz ~ 849 MHz LTE Band 30: 2305 MHz ~ 2315 MHz LTE Band 38: 2570 MHz ~ 2620 MHz LTE Band 41: 2496 MHz ~ 2690 MHz LTE Band 42: 3450 MHz ~ 3550 MHz LTE Band 43: 3600 MHz ~ 3700MHz LTE Band 48: 3550 MHz ~ 3700 MHz LTE Band 66 : 1710 MHz ~ 1780 MHz LTE Band 71: 663 MHz ~ 698 MHz 5G NR n2 : 1850 MHz ~ 1910 MHz 5G NR n5 : 824 MHz ~ 849 MHz 5G NR n7 : 2500 MHz ~ 2570 MHz 5G NR n12 : 699 MHz ~ 716 MHz 5G NR n25 : 1850 MHz ~1915 MHz 5G NR n66 : 1710 MHz ~ 1780 MHz 5G NR n71 : 663 MHz ~ 698 MHz 5G NR n38 : 2570 MHz ~ 2620 MHz 5G NR n41 : 2496 MHz ~ 2690 MHz 5G NR n48 : 3550 MHz ~ 3700 MHz 5G NR n77: 3450 MHz ~ 3980 MHz 5G NR n78: 3450 MHz ~ 3800 MHz
Mode	LTE: QPSK, 16QAM, 64QAM, 256QAM 5G NR : CP-OFDM / DFT-s-OFDM, PI/2 BPSK, QPSK, 16QAM, 64QAM, 256QAM
Antenna Type	Dipole Antenna
HW Version	R1.0
SW Version	RG500LNAAAR04A02E32_OCPU
EUT Stage	Identical Prototype

Remark:

- The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.
- WWAN 5G NR n41/n77/n78/n48 support SISO/MIMO mode, so only chose MIMO tune up power to perform MPE calculation conservatively for MIMO power is higher.
- This device supports HPUE for 5G NR n41/n77/n78 with class 2 power level, so HPUE has been performed MPE calculation.
- The intra-band ULCA and EN-DC mode combination could be referred to the product spec.
- This device supports intra-band ULCA, due to intra-band ULCA and non-CA power is same, so non-CA MPE analysis can represent ULCA MPE analysis.

Comments and Explanations:

- The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.
- The maximum RF output tune up power, antenna gain also the safe distance used for evaluate RF exposure were declared by manufacturer.

Antenna Gain table:

Band	Antenna Gain (dBi)			
	Ant0	Ant1	Ant6	Ant7
LTE Band2	/	0.73	/	0.75
LTE Band4	/	/	/	0.33
LTE Band5	/	0.49	/	/
LTE Band7	/	1.42	/	1.26
LTE Band12	/	/	/	-8.65
LTE Band13	/	-0.92	/	-10.95
LTE Band14	/	/	/	-10.95
LTE Band17	/	/	/	-8.65
LTE Band25	/	/	/	0.75
LTE Band26	/	0.49	/	/
LTE Band30	/	/	/	-3.06
LTE Band38	/	/	/	1.69
LTE Band41	/	/	/	2.61
LTE Band42	-4.29	/	/	/
LTE Band43	-4.11	/	/	/
LTE Band48	-4.29	/	-4.29	/
LTE Band66	/	-0.2	/	0.33
LTE Band71	/	/	/	-9.34
5G NR n2	/	0.73	/	0.75
5G NR n5	/	0.49	/	/
5G NR n7	/	1.42	/	1.26
5G NR n12	/	/	/	-8.65
5G NR n25	/	0.73	/	0.75
5G NR n38	/	0.77	/	1.69
5G NR n41	/	1.42	/	2.61
5G NR n48	-4.29	/	/	/
5G NR n66	/	-0.2	/	0.33
5G NR n71	/	-6.05	/	-9.34
5G NR n77	-3.48	/	-3.48	/
5G NR n78	-4.11	/	-4.11	/

**3. Maximum RF average output tune up power among production units****<WWAN>**

Band	Maximum Average Power (dBm)			
	Ant0	Ant1	Ant6	Ant7
LTE Band2	/	25.00	/	25.00
LTE Band4	/	/	/	25.00
LTE Band5	/	25.00	/	/
LTE Band7	/	25.00	/	25.00
LTE Band12	/	/	/	25.00
LTE Band13	/	25.00	/	25.00
LTE Band14	/	/	/	25.00
LTE Band17	/	/	/	25.00
LTE Band25	/	/	/	25.00
LTE Band26	/	25.00	/	/
LTE Band30	/	/	/	25.00
LTE Band38	/	/	/	25.00
LTE Band41	/	/	/	25.00
LTE Band42	25.00	/	/	/
LTE Band43	25.00	/	/	/
LTE Band48	25.00	/	25.00	/
LTE Band66	/	25.00	/	25.00
LTE Band71	/	/	/	25.00
5G NR n2	/	25.00	/	25.00
5G NR n5	/	25.00	/	/
5G NR n7	/	25.00	/	25.00
5G NR n12	/	/	/	25.00
5G NR n25	/	25.00	/	25.00
5G NR n66	/	25.00	/	25.00
5G NR n71	/	25.00	/	25.00
5G NR n38	/	25.00	/	25.00
5G NR n41 PC3	/	25.00	/	25.00
5G NR n41 PC2	/	28.00	/	28.00
5G NR n48	25.00	/	/	/
5G NR n77 PC3	25.00	/	/	/
5G NR n77 PC2	28.00	/	/	/
5G NR n78 PC3	25.00	/	/	/
5G NR n78 PC2	28.00	/	/	/

<MIMO>

Mode		Maximum Average power(dBm)
PC3	n41 Ant1+7	25.00
	n48 Ant0+6	25.00
	n77 Ant0+6	25.00
	n78 Ant0+6	25.00
PC2	n41 Ant1+7	28.00
	n77 Ant0+6	28.00
	n78 Ant0+6	28.00



4. RF Exposure Limit Introduction

According to ANSI/IEEE C95.1-1992, the criteria listed in Table 1 shall be used to evaluate the environmental impact of human exposure to radio frequency (RF) radiation as specified in §1.1310.

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3-3.0	614	1.63	*(100)	6
3.0-30	1842/f	4.89/f	*(900/f ²)	6
30-300	61.4	0.163	1.0	6
300-1500			f/300	6
1500-100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/f ²)	30
30-300	27.5	0.073	0.2	30
300-1500			f/1500	30
1500-100,000			1.0	30

The MPE was calculated at 20 cm to show compliance with the power density limit.

The following formula was used to calculate the Power Density:

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

Where:

S = Power Density

P = Output Power at Antenna Terminals

G = Gain of Transmit Antenna (linear gain)

R = Distance from Transmitting Antenna



5. Radio Frequency Radiation Exposure Evaluation

5.1. Standalone Power Density Calculation

Band	Frequency (MHz)	Antenna Gain (dBi)	Maximum Power (dBm)	Maximum EIRP (dBm)	Average EIRP (mW)	Power Density at 20cm (mW/cm ²)	Limit (mW/cm ²)	Power Density / Limit
LTE Band 2	1850.0	0.75	25.00	25.750	375.837	0.075	1.000	0.075
LTE Band 4	1710.0	0.33	25.00	25.330	341.193	0.068	1.000	0.068
LTE Band 5	824.0	0.49	25.00	25.490	353.997	0.070	0.549	0.128
LTE Band 7	2500.0	1.42	25.00	26.420	438.531	0.087	1.000	0.087
LTE Band 12	699.0	-8.65	25.00	16.350	43.152	0.009	0.466	0.018
LTE Band 13	777.0	-0.92	25.00	24.080	255.859	0.051	0.518	0.098
LTE Band 14	788.0	-10.95	25.00	14.050	25.410	0.005	0.525	0.010
LTE Band 17	704.0	-8.65	25.00	16.350	43.152	0.009	0.469	0.018
LTE Band 25	1850.0	0.75	25.00	25.750	375.837	0.075	1.000	0.075
LTE Band 26	814.0	0.49	25.00	25.490	353.997	0.070	0.543	0.130
LTE Band 30	2305.0	-3.06	25.00	21.940	156.315	0.031	1.000	0.031
LTE Band 38	2570	1.69	25.00	26.690	466.659	0.093	1.000	0.093
LTE Band 41	2496.0	2.61	25.00	27.610	576.766	0.115	1.000	0.115
LTE Band 42	3450.0	-4.29	25.00	20.710	117.761	0.023	1.000	0.023
LTE Band 43	3600.0	-4.11	25.00	20.890	122.744	0.024	1.000	0.024
LTE Band 48	3550.0	-4.29	25.00	20.710	117.761	0.023	1.000	0.023
LTE Band 66	1710.0	0.33	25.00	25.330	341.193	0.068	1.000	0.068
LTE Band 71	663.0	-9.34	25.00	15.660	36.813	0.007	0.442	0.017
5G NR n2	1850.0	0.75	25.00	25.750	375.837	0.075	1.000	0.075
5G NR n5	824.0	0.49	25.00	25.490	353.997	0.070	0.549	0.128
5G NR n7	2500.0	1.42	25.00	26.420	438.531	0.087	1.000	0.087
5G NR n12	699.0	-8.65	25.00	16.350	43.152	0.009	0.466	0.018
5G NR n25	1850.0	0.75	25.00	25.750	375.837	0.075	1.000	0.075
5G NR n38	2570.0	1.69	25.00	26.690	466.659	0.093	1.000	0.093
5G NR n41	2496.0	2.61	28.00	30.610	1150.800	0.229	1.000	0.229
5G NR n48	3550.0	-4.29	25.00	20.710	117.761	0.023	1.000	0.023
5G NR n66	1710.0	0.33	25.00	25.330	341.193	0.068	1.000	0.068
5G NR n71	663.0	-6.05	25.00	18.950	78.524	0.016	0.442	0.035
5G NR n77	3450.0	-3.48	28.00	24.520	283.139	0.056	1.000	0.056
5G NR n78	3450.0	-4.11	28.00	23.890	244.906	0.049	1.000	0.049

Note:

1. For conservativeness, the lowest frequency of each band is used to determine the MPE limit of that band.
2. Chose the maximum power to do MPE analysis.
3. Chose the maximum RF output tune up power of all antennas among same frequency WWAN bands and the maximum antenna gain to perform MPE calculation conservatively.
4. The MIMO mode is completely uncorrelated, so selected the higher SISO gain among all antennas as MIMO gain to perform MPE calculation.

**5.2. Collocated Power Density Calculation**

WWAN LTE Power Density / Limit	WWAN 5G NR Power Density / Limit	$\Sigma(\text{Power Density / Limit})$ of WWAN LTE + WWAN 5G NR
0.130	0.229	0.359

Note:

1. For collocation analysis, LTE band 26 is chosen for summation due to the highest (power density/limit) among all LTE modes.
2. For collocation analysis, 5G NR n41 is chosen for summation due to the highest (power density/limit) among all 5G NR modes.
3. $\Sigma(\text{Power Density / Limit})$: This is a summation of [(power density for each transmitter/antenna included in the simultaneous transmission)/ (corresponding MPE limit)], for WWAN LTE+ WWAN 5G NR.
4. Considering the WWAN LTE module collocation with the WWAN 5G NR transmitter of the EIRP performance listed in the table above, the aggregated (power density /limit) is smaller than 1, and MPE of 2 collocated transmitters is compliant.

Conclusion:

According to 47 CFR §2.1091, the RF exposure analysis concludes that the RF Exposure is FCC compliant.

-----THE END-----