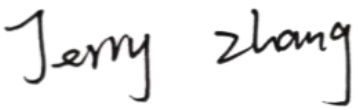
RF Test Report

Applicant:	Quectel Wireless Solutions Co., Ltd.
Address:	Building 5, Shanghai Business Park Phase III (Area B), No.1016 Tianlin Road, Minhang District, Shanghai,China,200233
Product:	5G Sub-6 GHz LGA Module
Model No.:	RG500U-LA
Brand Name:	QUECTEL
FCC ID:	XMR2023RG500ULA
Standards:	47 CFR Part 22 47 CFR Part 24 47 CFR Part 27
Report No.:	PD20230197RF02
Issue Date:	2024/03/02
Test Result:	PASS *

* **The above equipment has been tested and compliance with the requirement of the relative standards by Hefei Panwin Technology Co., Ltd.**



Reviewed By: Jerry Zhang **Approved By:** Alec Yang

Hefei Panwin Technology Co., Ltd.

Floor 1, Zone E, Plant 2#, Mingzhu Industrial Park, No.106 Chuangxin Avenue, High-tech Zone, Hefei City, Anhui Province,China

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Revision History

Report No.	Version	Description	Issue Date	Note
PD20230197RF02	1	Initial Report	2024/03/02	Valid

CONTENTS

Test Summary

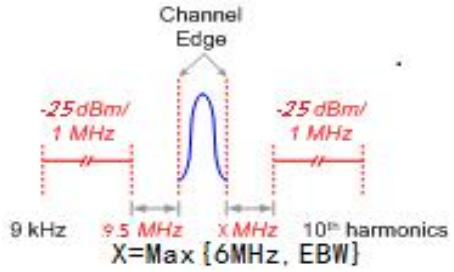
NR Band n2

No.	Test Case	FCC Rules	Limit	Verdict
1	RF Output Power & Effective Radiated Power	§2.1046, §24.232(c)	EIRP ≤2 Watt	PASS
2	Peak-to-Average Ratio	§24.232(d)	≤13 dB	PASS
3	Occupied Bandwidth	§2.1049	No limit.	Report Only
4	Conducted Band Edge Measurement	§2.1051, §24.238(a)	≤ -13 dBm/1%*EBW, in 1 MHz bands immediately outside and adjacent to the frequency block.	PASS
5	Spurious Emissions at Antenna Terminals	§2.1051, §24.238(a)	≤ -13 dBm/1 MHz, from 9 kHz to 10th harmonics but outside authorized operating frequency ranges.	PASS
6	Radiated Spurious Emission	§2.1053, §24.238(a)	≤ -13 dBm/1 MHz.	PASS
7	Frequency Stability	§2.1055 §24.235	Within authorized bands of operation/frequency block.	PASS

NR Band n5

No.	Test Case	FCC Rules	Limit	Verdict
1	RF Output Power & Effective Radiated Power	§2.1046 §22.913 (a)(5)	ERP ≤ 7 Watt	PASS
2	Peak-to-Average Ratio	§22.913 (d)	≤13 dB	PASS
3	Occupied Bandwidth	§2.1049	No limit.	Report Only
4	Conducted Band Edge Measurement	§2.1051 §22.917 (a)	≤ -13 dBm/1%*EBW, in 1 MHz bands immediately outside and adjacent to the frequency block.	PASS
5	Spurious Emissions at Antenna Terminals	§2.1051 §22.917(a)	FCC: ≤ -13 dBm/100 kHz, from 9 kHz to 10th harmonics but outside authorized operating frequency ranges.	PASS
6	Radiated Spurious Emission	§2.1053 §22.917(a)	FCC: ≤ -13 dBm/100 kHz.	PASS
7	Frequency Stability	§2.1055 §22.355	< ±2.5 ppm	PASS

NR Band n7 / n38

No.	Test Case	FCC Rules	Limit	Verdict
1	RF Output Power & Effective Radiated Power	§2.1046, §27.50(h)(2)	EIRP ≤ 2 Watt	PASS
2	Peak-to-Average Ratio	--	≤13 dB	PASS
3	Occupied Bandwidth	§2.1049	No limit.	Report Only
4	Conducted Band Edge Measurement	§2.1051, §27.53(m4)	For mobile digital stations, the attenuation factor shall be not less than 40 + 10 log (P) dB on all frequencies between the channel edge and 5 megahertz from the channel edge, 43 + 10 log (P) dB on all frequencies between 5 megahertz and X megahertz from the channel edge, and 55 + 10 log (P) dB on all frequencies more than X megahertz from the channel edge, where X is the greater of 6 megahertz or the actual emission bandwidth as defined in paragraph (m)(6) of this section. In addition, the attenuation factor shall not be less that 43 + 10 log (P) dB on all frequencies between 2490.5 MHz and 2496 MHz and 55 + 10 log (P) dB at or below 2490.5 MHz.	PASS
5	Spurious Emissions at Antenna Terminals	§2.1051, §27.53(m)		PASS
6	Radiated Spurious Emission	§2.1053, §27.53(m)		PASS
7	Frequency Stability	§2.1055 §27.54	Within authorized bands of operation/frequency block.	PASS

NR Band n66

No.	Test Case	FCC Rules	Limit	Verdict
1	RF Output Power & Effective Radiated Power	§2.1046, §27.50(d)(4)	EIRP ≤ 1 Watt	PASS
2	Peak-to-Average Ratio	§27.50(d)(5)	≤13 dB	PASS
3	Occupied Bandwidth	§2.1049	No limit.	Report Only
4	Conducted Band Edge Measurement	§2.1051, §27.53(h)	≤ -13 dBm/1%*EBW, in 1 MHz bands immediately outside and adjacent to the frequency block.	PASS
5	Spurious Emissions at Antenna Terminals	§2.1051, §27.53(h)	≤ -13 dBm/1 MHz, from 9 kHz to 10th harmonics but outside authorized operating frequency ranges.	PASS
6	Radiated Spurious Emission	§2.1053, §27.53(h)	≤ -13 dBm/1 MHz.	PASS
7	Frequency Stability	§2.1055 §27.54	Within authorized bands of operation/frequency block.	PASS

NR Band n71

No.	Test Case	FCC Rules	Limit	Verdict
1	RF Output Power & Effective Radiated Power	§2.1046, §27.50(c)(10)	ERP ≤ 3 Watt	PASS
2	Peak-to-Average Ratio	--	≤13 dB	PASS
3	Occupied Bandwidth	§2.1049	No limit.	Report Only
4	Conducted Band Edge Measurement	§2.1051, §27.53(g)	≤ -13 dBm/1%*EBW, in 1 MHz bands immediately outside and adjacent to the frequency block.	PASS
5	Spurious Emissions at Antenna Terminals	§2.1051, §27.53(g)	FCC: ≤ -13 dBm/1 MHz, from 9 kHz to 10th harmonics but outside authorized operating frequency ranges.	PASS
6	Radiated Spurious Emission	§2.1053, §27.53(g)	≤ -13 dBm/1 MHz.	PASS
7	Frequency Stability	§2.1055 §27.54	within the authorized bands of operation.	PASS

NR Band n78(3450 to 3550MHz)

No.	Test Case	FCC Rules	Limit	Verdict
1	RF Output Power & Effective Radiated Power	§2.1046, §27.50(k)(3)	EIRP ≤ 30dBm	PASS
2	Peak-to-Average Ratio	§27.50(k)(4)	≤13 dB	PASS
3	Occupied Bandwidth	§2.1049	No limit.	Report Only
4	Conducted Band Edge Measurement	§2.1051, §27.50(n)(2)	For mobile operations in the 3450-3550 MHz band, the conducted power of any emission outside the licensee's authorized bandwidth shall not exceed −13 dBm/MHz.	PASS
5	Spurious Emissions at Antenna Terminals			PASS
6	Radiated Spurious Emission	§2.1053, §27.50(n)(2)		PASS
7	Frequency Stability	§2.1055 §27.54	Within authorized bands of operation/frequency block.	PASS

Conducted detection date: 2023/11/10 to 2024/03/01
Radiated detection date: 2023/11/21 to 2024/01/26
Date of Sample Received: 2023/11/10

• We, Hefei Panwin Technology Co., Ltd., would like to declare that the tested sample has been evaluated in accordance with the procedures given in applied standard(s) in **Section 2.5** of this report and shown compliance with the applicable technical standards.

• All indications of PASS/FAIL in this report are based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only.

1 Test Laboratory

1.1 Notes of the Test Report

This report is invalid without signature of auditor and approver or with any alterations. The report shall not be partially reproduced without written approval of the testing company. Entrusted test results are only responsible for incoming samples. If there is any objection to the testing report, it shall be raised to the testing company within 15 days from the date of receiving the report. In the test results, "NA" means "not applicable", and the test items marked with "Δ" are subcontracted projects.

1.2 Test Facility

FCC (Designation Number: CN1361, Test Firm Registration Number: 473156)

Hefei Panwin Technology Co., Ltd. has been listed on the US Federal Communications Commission list of test facilities recognized to perform measurements.

A2LA (Certificate Number: 6849.01)

Hefei Panwin Technology Co., Ltd. has been listed by American Association for Laboratory Accreditation to perform measurement.

1.3 Testing Laboratory

Company Name	Hefei Panwin Technology Co., Ltd.
Address	Floor 1, Zone E, Plant 2#, Mingzhu Industrial Park, No.106 Chuangxin Avenue, High-tech Zone, Hefei City, Anhui Province,China
Telephone	+86-0551-63811775
Post Code	230031

2 General Description of Equipment under Test

2.1 Details of Application

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

2.2 Details of EUT

Product	5G Sub-6 GHz LGA Module						
Model	RG500U-LA						
Hardware Version	R1.0						
Software Version	RG500ULAAAR03A03M4G						
SN	Conducted: D1Y23J94F000075 Radiated: D1Y23J94F000093						
Single Band	FDD Band: n2, n5, n7, n66, n71 TDD Band: n38, n78						
NSA Band	DC_2A_n5A, DC_2A_n7A, DC_2A_n66A, DC_2A_n78A, DC_4A_n2A, DC_4A_n7A, DC_4A_n78A, DC_5A_n2A, DC_5A_n7A, DC_5A_n66A, DC_5A_n78A, DC_7A_n2A, DC_7A_n5A, DC_7A_n66A, DC_7A_n78A, DC_26A_n78A, DC_40A_n78A, DC_66A_n2A, DC_66A_n5A, DC_66A_n7A, DC_66A_n78A						
Feature	UL 2*2 MIMO: n38, n78						
HPUE Power Class	Class 2: n78						
Type of Modulation	UL: Up to 256QAM DL: Up to 256QAM						
Antenna Type	☑ External ☐ Integrated						
Support	☑SA ☑NSA						
Antenna Gain	n2: 1.37dBi (Ant7) n5: 1.18dBi (Ant1) n7: 1.48dBi (Ant7) n38: 0.81dBi (Ant1); 0.81dBi (Ant7)				n66: 1.37dBi (Ant7) n71: -1.00dBi (Ant7) n78: 2.00dBi (Ant1); 2.00dBi (Ant7)		
Frequency Band(s)	**SISO Band**	**Supported Channel Bandwidth (MHz)**				**Tx (MHz)**	**Rx (MHz)**
	NR Band n2	5	10	15	20	1850 to 1910	1930 to 1990
	NR Band n5	5	10	15	20	824 to 849	869 to 894
	NR Band n7	5	10	15	20	2500 to 2570	2620 to 2690
	NR Band n38	10	15	20	40	2570 to 2620	2570 to 2620
	NR Band n66	5	10	15	20	1710 to 1780	2110 to 2200
		40	--	--	--		
	NR Band n71	5	10	15	20	663 to 698	617 to 652
	NR Band n78	10	15	20	40	3450 to 3550	3450 to 3550
		50	60	80	90		
		100	--	--	--		
Note 1: The declared of product specification for EUT and/or Antenna presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.							

Note 2: The frequency band subcarrier interval of TDD is 30kHz, and the frequency band subcarrier interval of FDD is 15kHz.
Note 3: Tested the power and RSE of ENDC, report only show worst mode.
Note 4: All the supported ENDC combinations are verified conducted power, only the ENDC combination with highest power are shown in the report.
Note 5: 5G NR support SA mode and NSA mode. According to the maximum power between SA and NSA mode, SA covers NSA mode.
Note 6: The maximum ERP/EIRP is calculated from max output power and max antenna gain.
Note 7: All modulations have been tested, only the worst test results of PSK & QAM are shown in the report.
Note 8: UL MIMO mode only support CP-OFDM, so RF Output Power, Conducted Band Edge and Spurious Emissions at Antenna Terminals were tested.

2.3 Maximum Conducted power and Emission Designator

NR Band	BW (MHz)	DFT -s-Pi/2-BPSK / QPSK		16QAM / 64QAM / 256QAM	
		Max Power (W)	Designator	Max Power (W)	Designator
NR Band n2	5	0.1742	4M55G7D	0.1706	4M53W7D
	10	0.1914	9M30G7D	0.1858	9M34W7D
	15	0.1871	14M1G7D	0.1824	14M2W7D
	20	0.1986	18M9G7D	0.1936	18M9W7D
NR Band n5	5	0.1706	4M67G7D	0.1211	4M66W7D
	10	0.1592	9M01G7D	0.1213	8M98W7D
	15	0.1592	13M4G7D	0.1208	13M4W7D
	20	0.1641	17M9G7D	0.1236	17M9W7D
NR Band n7	5	0.2056	4M56G7D	0.1600	4M51W7D
	10	0.2213	8M99G7D	0.1698	9M39W7D
	15	0.2138	13M4G7D	0.1633	14M2W7D
	20	0.2042	17M9G7D	0.1581	19M0W7D
NR Band n38	10	0.2009	8M85G7D	0.1910	9M15W7D
	15	0.2168	13M7G7D	0.2104	13M7W7D
	20	0.2104	18M3G7D	0.2046	18M3W7D
	40	0.2163	37M8G7D	0.2168	37M9W7D
NR Band n66	5	0.2438	4M55G7D	0.2188	4M56W7D
	10	0.2495	9M41G7D	0.2234	9M50W7D
	15	0.2223	14M1G7D	0.1977	14M2W7D
	20	0.2183	18M9G7D	0.1945	19M2W7D
	40	0.2328	38M5G7D	0.2070	38M5W7D
NR Band n71	5	0.2128	4M70G7D	0.1959	4M57W7D
	10	0.2296	9M05G7D	0.2094	8M99W7D
	15	0.2198	13M4G7D	0.1932	13M4W7D
	20	0.2203	17M9G7D	0.1945	17M9W7D
NR Band n78 (3450 to 3550)	10	0.4955	8M73G7D	0.3981	9M31W7D
	15	0.5105	13M7G7D	0.4121	13M7W7D
	20	0.5212	18M3G7D	0.4207	18M4W7D
	40	0.5741	37M9G7D	0.4571	37M9W7D
	50	0.5164	47M5G7D	0.4102	47M6W7D

	60	0.5297	57M7G7D	0.4159	57M8W7D
	80	0.5346	77M3G7D	0.4093	77M5W7D
	90	0.4898	88M1G7D	0.3999	88M0W7D
	100	0.4721	97M3G7D	0.3864	97M2W7D

2.4 Frequency List of Low/Middle/High Channels

NR Band n2 Channel and Frequency List				
BW [MHz]	Channel/Frequency(MHz)	Lowest	Middle	Highest
5	Channel	370500	376000	381500
	Frequency	1852.5	1880	1907.5
10	Channel	371000	376000	381000
	Frequency	1855	1880	1905
15	Channel	371500	376000	380500
	Frequency	1857.5	1880	1902.5
20	Channel	372000	376000	380000
	Frequency	1860	1880	1900

NR Band n5 Channel and Frequency List				
BW [MHz]	Channel/Frequency(MHz)	Lowest	Middle	Highest
5	Channel	165300	167300	169300
	Frequency	826.5	836.5	846.5
10	Channel	165800	167300	168800
	Frequency	829	836.5	844
15	Channel	166300	167300	168300
	Frequency	831.5	836.5	841.5
20	Channel	166800	167300	167800
	Frequency	834	836.5	839

NR Band n7 Channel and Frequency List				
BW [MHz]	Channel/Frequency(MHz)	Lowest	Middle	Highest
5	Channel	500500	507000	513500
	Frequency	2502.5	2535	2567.5
10	Channel	501000	507000	513000
	Frequency	2505	2535	2565
15	Channel	501500	507000	512500
	Frequency	2507.5	2535	2562.5
20	Channel	502000	507000	512000
	Frequency	2510	2535	2560

NR Band n38 Channel and Frequency List				
BW [MHz]	Channel/Frequency(MHz)	Lowest	Middle	Highest
10	Channel	515000	519000	523000
	Frequency	2575	2595	2615
15	Channel	515500	519000	522500
	Frequency	2577.5	2595	2612.5

20	Channel	516000	519000	522000
	Frequency	2580	2595	2610
40	Channel	518000	519000	520000
	Frequency	2590	2595	2600

NR Band n66 Channel and Frequency List				
BW [MHz]	**Channel/Frequency(MHz)**	**Lowest**	**Middle**	**Highest**
5	Channel	342500	349000	355500
	Frequency	1712.5	1745	1777.5
10	Channel	343000	349000	355000
	Frequency	1715	1745	1775
15	Channel	343500	349000	354500
	Frequency	1717.5	1745	1772.5
20	Channel	344000	349000	354000
	Frequency	1720	1745	1770
40	Channel	346000	349000	352000
	Frequency	1730	1745	1760

NR Band n71 Channel and Frequency List				
BW [MHz]	**Channel/Frequency(MHz)**	**Lowest**	**Middle**	**Highest**
5	Channel	133100	136100	139100
	Frequency	665.5	680.5	695.5
10	Channel	133600	136100	138600
	Frequency	668	680.5	693
15	Channel	134100	136100	138100
	Frequency	670.5	680.5	690.5
20	Channel	134600	136100	137600
	Frequency	673	680.5	688

NR Band n78 (3450 to 3550MHz) Channel and Frequency List				
BW [MHz]	**Channel/Frequency(MHz)**	**Lowest**	**Middle**	**Highest**
10	Channel	630334	633334	636334
	Frequency	3455.01	3500.01	3545.01
15	Channel	630500	633334	636166
	Frequency	3457.5	3500.01	3542.49
20	Channel	630666	633334	636000
	Frequency	3459.99	3500.01	3540
40	Channel	631334	633334	635334
	Frequency	3470.01	3500.01	3530.01
50	Channel	631666	633334	635000
	Frequency	3474.99	3500.01	3525
60	Channel	632000	633334	634666
	Frequency	3480	3500.01	3519.99
80	Channel	632666	633334	634000
	Frequency	3489.99	3500.01	3510
90	Channel	633000	633334	633666
	Frequency	3495	3500.01	3504.99
100	Channel	/	633334	/
	Frequency	/	3500.01	/

2.5 Applied Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

47 CFR Part 2
47 CFR Part 22
47 CFR Part 24
47 CFR Part 27
ANSI C63.26-2015
FCC KDB 971168 D01 Power Meas License Digital Systems v03r01
FCC KDB 412172 D01 Determining ERP and EIRP v01r01

Remark: All test items were verified and recorded according to the standards and without any deviation during the test.

3 Test Condition

3.1 Test Environmental Conditions

During testing, environmental conditions are described below.

Normal Configuration		Extreme Configuration		
Voltage	3.8V	Voltage	High: 4.3V	Low: 3.3V

3.2 Test Configuration

Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture). The worst cases were recorded in this report.

Radiated measurements are performed by rotating the EUT in three different orthogonal test planes (Z, X, Y axis), receiver antenna polarization (horizontal and vertical), the worst emission was found in ‘ Z ‘ position and the worst case was recorded.

Test Case	BW	modulation					RB		CH		
		BPSK	QPSK	16QAM	64QAM	256QAM	1	full	L	M	H
RF Output Power & Effective (Isotropic) Radiated Power	all	v	v	v	v	v	v	v	v	v	v
Occupied Bandwidth	all	v	v	v	v	v	--	v	v	v	v
Conducted Band Edge Measurement	all	v	v	v	v	v	v	v	v	--	v
Spurious Emissions at Antenna Terminals	max	v	v	v	v	v	v	v	v	v	v
Peak-to-Average Ratio	max	v	v	--	--	--	--	v	v	v	v
Frequency Stability	max	--	v	--	--	--		v	--	v	--
Radiated Spurious Emission	worst case										

Note:

1.The mark " V " means that this configuration is chosen for testing.

2.The mark " -- " means that this bandwidth is not supported.

3.The device is investigated from 30Hz to 10 times of fundamental signal for radiated spurious emission test under different RB size/offset and modulations in exploratory test. Subsequently, only the worst case emissions are reported.

4.Frequency Stability : Normal Voltage = 3.8V ; Low Voltage =3.3V. ; High Voltage =4.3V

3.3 Equipment List

Name of Equipment	Manufacturer	Model	Asset No.	Cal. Interval	Cal. Due Date
Base Station Simulator	KEYSIGHT	E7515E	PWC0042	1 Year	2024/10/10
Spectrum Analyzer	KEYSIGHT	N9020B	PWC0049	1 Year	2024/10/10
Matrix Control Unit	Tonscend	JS0806-1	PWC0056	1 Year	2024/11/08
DC Power	KEYSIGHT	E3640A	PWC0045	1 Year	2024/10/11
Shielded Chamber	Mao Rui	MR534	PWC0041	3 Years	2026/08/26
Base Station Simulator	Anritsu	MT8000A_020/021	PWC0032	1 Year	2024/10/11
Spectrum Analyzer	R&S	FSV3044	PWC0036	1 Year	2024/10/11
Matrix Control Unit	Tonscend	JS0806-1	PWC0034	1 Year	2024/10/12
DC Power	KEYSIGHT	E3640A	PWB0080	1 Year	2024/10/11
Climate Chamber	Boyi	B-T-48C	PWC0035	1 Year	2024/10/10
Shielded Chamber	Kaituo	KT-SR423	PWC0031	3 Years	2024/08/08
Test Software	Tonscend	JS1120 V2.4.1	/	/	/
Receiver	R&S	ESR7	PWB0023	1 Year	2024/10/11
Spectrum Analyzer	R&S	FSV3044	PWB0024	1 Year	2024/10/11
TRILOG Broadband Antenna	Schwarzbeck	VULB9162	PWB0029	1 Year	2024/10/14
Double-Ridged Guide Antenna	ETS-Lindgren	3117	PWB0031	1 Year	2024/10/12
Loop Antenna	R&S	HFH2-Z2E	PWB0026	1 Year	2024/10/21
k Type Horn Antenna	Steatite Antennas	QMS-00880	PWB0035	1 Year	2024/10/17
Horn Antenna	Steatite Antennas	QMS-00208	PWB0033	1 Year	2024/10/21
Pre-Amplifier	R&S	SCU08F1	PWB0030	1 Year	2024/10/11
Pre-Amplifier	R&S	SCU40F1	PWB0036	1 Year	2024/10/11
Pre-Amplifier	R&S	OSP220	PWB0042	1 Year	2024/10/13
Pre-Amplifier	R&S	SCU18F	PWB0034	1 Year	2024/10/11
Pre-Amplifier	COM-MW	DLNA8	PWB0094	1 Year	2024/11/08
Anechoic Chamber	ETS.LINDGREN	Fact 3-2m	PWB0003	3 Years	2026/06/05
Test Software	R&S	ELEKTRA 4.20.2	/	/	/

3.4 Test Uncertainty

No.	Parameter	Uncertainty
1	Maximum transmit power	400MHz≤f < 3GHz 0.684dB 3GHz≤f < 6GHz 1.210dB
2	Frequency error	37.074Hz
3	Bandwidth occupied	5.9kHz
4	Emission spurious, Band edge and PAPR	10Hz-3.5GHz: 0.982dB 3.5GHz-18GHz: 1dB 18GHz-26.5GHz: 0.777dB 26.5GHz-40GHz: 1.066dB
5	Radiated Spurious Emission	30MHz-18GHz: ±4.46 dB 18GHz-40GHz: ±4.46 dB
6	Temperature	±3℃
7	Humidity	±1.3 %
8	Supply voltages	±0.006 V

4 Test Items Description

Ambient condition

Shielded Chamber

Temperature [°C]	21.5 to 25.5
Humidity [%RH]	35 to 48
Pressure [kPa]	100.5 to 102.5

Anechoic Chamber

Temperature [°C]	20.1 to 24.7
Humidity [%RH]	40 to 43
Pressure [kPa]	100.9 to 102.3

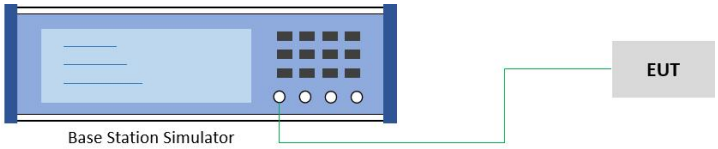
4.1 RF Output Power & Effective (Isotropic) Radiated Power

Methods of Measurement

Base Station Simulator was used to establish communication with the EUT. Its parameters were set to force the EUT transmitting at maximum output power. The measured power in the radio frequency on the transmitter output terminals shall be reported.

According to KDB 412172 D01 Power Approach,
EIRP = PT + GT - LC, ERP = EIRP - 2.15, where
PT = transmitter output power in dBm
GT = gain of the transmitting antenna in dBi
LC = signal attenuation in the connecting cable between the transmitter and antenna in dB

Test Setup



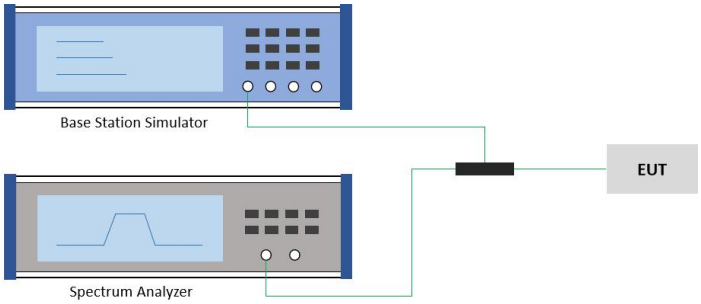
1.The testing follows ANSI C63.26 Section 5.2.
2.The transmitter output port was connected to the base station simulator.
3.Set EUT at maximum power through the base station simulator
4.Select lowest, middle, and highest channels for each band and different modulation.
5.Measure and record the power level from the system simulator.

4.2 EIRP Power Density

Methods of Measurement

Measurement Procedure: C63.26 -2015 section 5.2.4

Test Setup



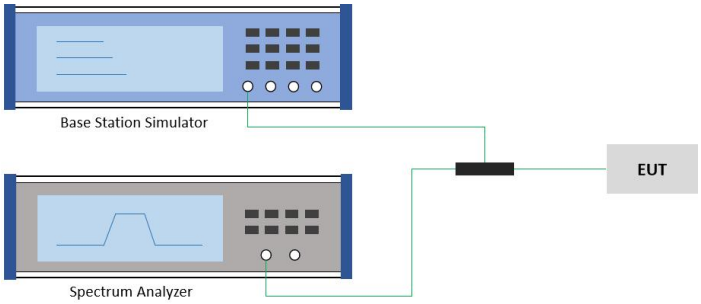
1.Set instrument center frequency to OBW center frequency.
2.Set span to at least 1.5 times the OBW.
3.Set the RBW to the specified reference bandwidth (often 1 MHz).
4.Set VBW ≥ 3 × RBW.
5.Detector = RMS (power averaging).
6.Ensure that the number of measurement points in the sweep ≥ 2 × span/RBW.
7.Sweep time = auto couple.
8.Employ trace averaging (RMS) mode over a minimum of 100 traces.
9.Use the peak marker function to determine the maximum amplitude level within the reference bandwidth (PSD).

4.3 Peak-to-Average Ratio

Methods of Measurement

Power Complementary Cumulative Distribution Function (CCDF) curves provide a means for characterizing the power peaks of a digitally modulated signal on a statistical basis. A CCDF curve depicts the probability of the peak signal amplitude exceeding the average power level. Most contemporary measurement instrumentation include the capability to produce CCDF curves for an input signal provided that the instrument's resolution bandwidth can be set wide enough to accommodate the entire input signal bandwidth.

Test Setup



1.The testing follows ANSI C63.26 Section 5.2.3.4 (CCDF).

2.The EUT was connected to spectrum and system simulator via a power divider.

3.Set the CCDF (Complementary Cumulative Distribution Function) option in spectrum analyzer.

4.The highest RF powers were measured and recorded the maximum PAPR level associated with a probability of 0.1 %.

5.Record the deviation as Peak to Average Ratio.

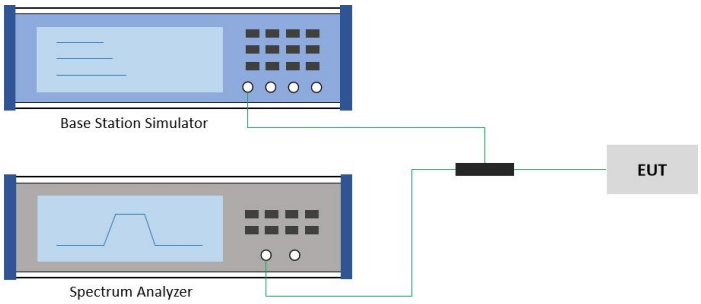
4.4 Occupied Bandwidth

Methods of Measurement

The occupied bandwidth is the width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to a specified percentage 0.5% of the total mean transmitted power.

The 26 dB emission bandwidth is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated 26 dB below the maximum in-band spectral density of the modulated signal. Spectral density (power per unit bandwidth) is to be measured with a detector of resolution bandwidth equal to approximately 1.0% of the emission bandwidth.

Test Setup



The testing follows ANSI C63.26 Section 5.4.
The EUT was connected to spectrum analyzer and system simulator via a power divider.
The spectrum analyzer center frequency is set to the nominal EUT channel center frequency. The span range for the spectrum analyzer shall be between two and five times the anticipated OBW.
The nominal resolution bandwidth (RBW) shall be in the range of 1 to 5 % of the anticipated OBW, and the VBW shall be at least 3 times the RBW.
Set the detection mode to peak, and the trace mode to max hold.
Determine the reference value: Set the EUT to transmit a modulated signal. Allow the trace to stabilize. Set the spectrum analyzer marker to the highest level of the displayed trace.
(this is the reference value).
Determine the '-26 dB down amplitude' as equal to (Reference Value – X).
Place two markers, one at the lowest and the other at the highest frequency of the envelope of the spectral display such that each marker is at or slightly below the '–X dB down amplitude' determined in step 6. If a marker is below this '-X dB down amplitude' value it shall be placed as close as possible to this value. The OBW is the positive frequency difference between the two markers.
Use the 99 % power bandwidth function of the spectrum analyzer and report the measured bandwidth.

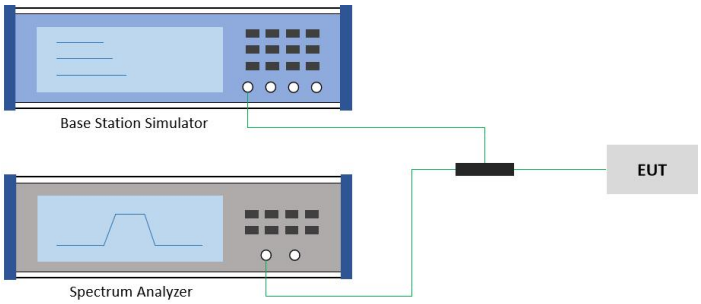
4.5 Conducted Band Edge Measurement

Methods of Measurement

Measurement Procedure: FCC KDB 971168 D01 V03r01 Section 6.0

The transmitter output was connected to a calibrated coaxial cable, attenuator and Spectrum analyser, the other end of which was connected to a Base Station Simulator. The Base Station Simulator was set to force the EUT to its maximum power setting. The tests were performed at two frequencies (low channel and high channel). In the 1MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of 100kHz or 1% of the emission bandwidth of the fundamental emission of the transmitter may be employed. The EUT emission bandwidth is measured as the width of the signal between two points, outside of which all emission are attenuated at least 26dB below the transmitter power. The video bandwidth of the spectrum analyzer was set at thrice the resolution bandwidth. Detector Mode was set to RMS.

Test Setup



1.The testing follows ANSI C63.26 section 5.7

2.The EUT was connected to spectrum analyzer and system simulator via a power divider.

3.The band edges of low and high channels for the highest RF powers were measured.

4.Set RBW >= 1% EBW in the 1MHz band immediately outside and adjacent to the band edge.

5.Beyond the 1 MHz band from the band edge, RBW=1MHz was used or a narrower RBW was used and the measured power was integrated over the full required measurement bandwidth of 1 MHz.

6.Set spectrum analyzer with RMS detector.

7.The RF fundamental frequency should be excluded against the limit line in the operating frequency band.

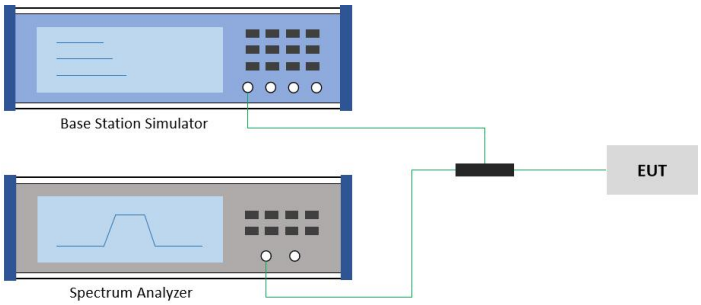
4.6 Spurious Emissions at Antenna Terminals

Methods of Measurement

Measurement Procedure: FCC KDB 971168 D01 V03r01 Section 6.0

The transmitter output was connected to a calibrated coaxial cable, attenuator and Spectrum analyzer, the other end of which was connected to a Base Station Simulator. The Base Station Simulator was set to force the EUT to its maximum power setting. The level of the carrier and the various conducted spurious and harmonic frequencies is measured by means of a calibrated spectrum analyzer. The spectrum is scanned from the lowest frequency generated in the equipment up to a frequency including its 10th harmonic. On any frequency outside a licensee's frequency block, the power of any emission shall be attenuated below the transmitter power (P) by at least 43 + 10 log(P) dB. Compliance with these provisions is based on the use of measurement instrumentation employing a resolution bandwidth of 1 MHz or greater. However, in the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emission are attenuated at least 26 dB below the transmitter power.

Test Setup



1.The testing follows ANSI C63.26 section 5.7

2.The EUT was connected to spectrum analyzer and system simulator via a power divider.

3.The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.

4.The middle channel for the highest RF power within the transmitting frequency was measured.

5.The conducted spurious emission for the whole frequency range was taken.

6.Make the measurement with the spectrum analyzer's RBW = 1MHz, VBW = 3MHz.

7.Set spectrum analyzer with RMS detector.

8.Taking the record of maximum spurious emission.

9.The RF fundamental frequency should be excluded against the limit line in the operating frequency band.

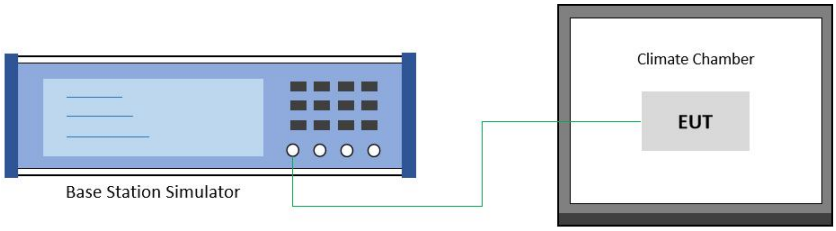
Note: As described in Section C63.26 4.2.3: Generally, the measurement must be corrected by adding 10 log [(reference bandwidth) / (resolution or measurement bandwidth)] to the measured value (such bandwidth scaling is limited to cases where the measurement bandwidth used to perform the measurement is less than the reference bandwidth). Therefore, the converted limit value is the standard limit value minus the conversion factor.

4.7 Frequency Stability

Methods of Measurement

The frequency stability shall be measured by variation of ambient temperature and variation of primary supply voltage to ensure that the fundamental emission stays within the authorized frequency block. The frequency stability of the transmitter shall be maintained within ±0.00025% (±2.5ppm) of the center frequency.

Test Setup



Test Procedures for Temperature Variation

1.The testing follows ANSI C63.26 section 5.6.4

2.The EUT was set up in the thermal chamber and connected with the system simulator.

3.With power OFF, the temperature was decreased to -30°C and the EUT was stabilized before testing. Power was applied and the maximum change in frequency was recorded within one minute.

4.With power OFF, the temperature was raised in 10°C step up to 50°C. The EUT was stabilized at each step for at least half an hour. Power was applied and the maximum frequency change was recorded within one minute.

Test Procedures for Voltage Variation

1.The testing follows ANSI C63.26 section 5.6.5

2.The EUT was placed in a temperature chamber at 20±5°C and connected with the system simulator.

3.The power supply voltage to the EUT was varied from 85% to 115% of the nominal value for other than hand carried battery equipment.

4.For hand carried, battery powered equipment, reduce the primary ac or dc supply voltage to the battery operating end point, which shall be specified by the manufacturer.

5.The variation in frequency was measured for the worst case.

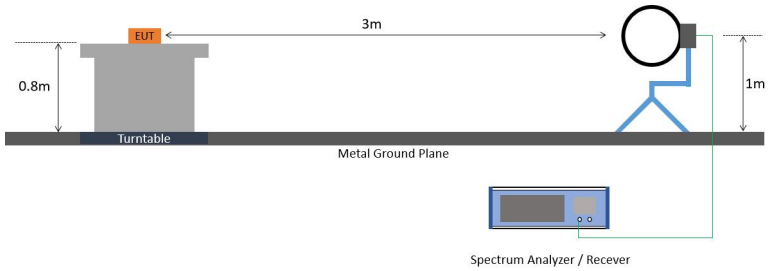
4.8 Radiated Spurious Emission

Methods of Measurement

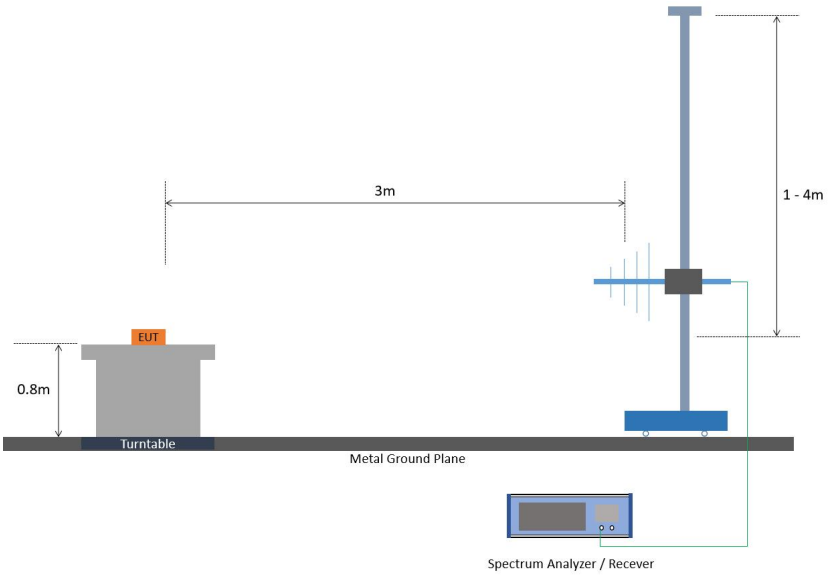
The radiated spurious emission was measured by substitution method according to ANSI C63.26. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitter power (P) by a factor of at least 43 + 10 log (P) dB.

The spectrum is scanned from 30 MHz up to a frequency including its 10th harmonic.

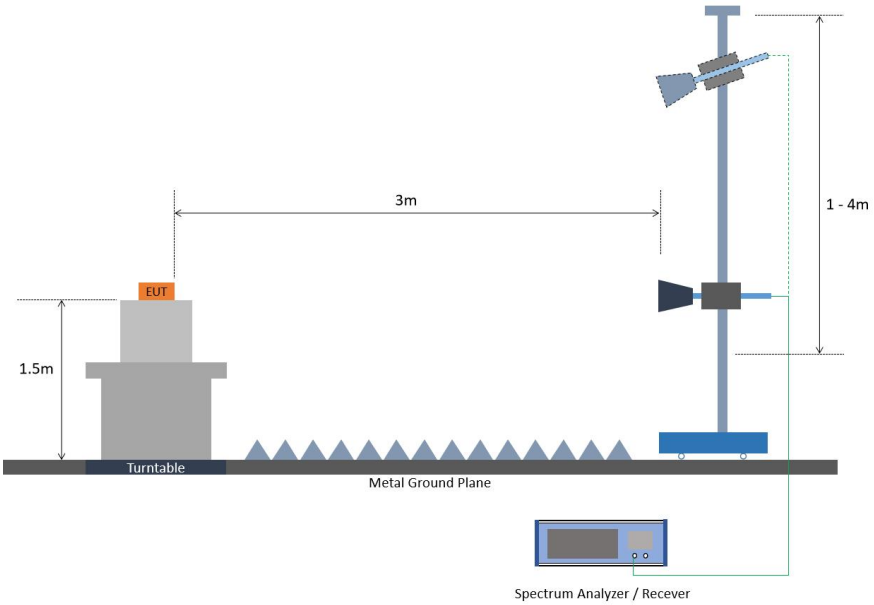
Test Setup



For radiated test below 30MHz



For radiated test from 30MHz to 1GHz



For radiated test above 1GHz

1.The testing follows ANSI C63.26 Section 5.5
2.The EUT was placed on a turntable with 0.8 meter height for frequency below 1GHz and 1.5 meter height for frequency above 1GHz respectively above ground.
3.The EUT was set 3 meters from the receiving antenna mounted on the antenna tower.
4.The table was rotated 360 degrees to determine the position of the highest spurious emission.
5.The height of the receiving antenna is varied between 1m to 4m to search the maximum spurious emission for both horizontal and vertical polarizations.
6.During the measurement, the system simulator parameters were set to force the EUT transmitting at maximum output power.
7.Make the measurement with the spectrum analyzer's RBW = 1MHz, VBW = 3MHz, taking the record of maximum spurious emission.
8.A horn antenna was substituted in place of the EUT and was driven by a signal generator.
9.Tune the output power of signal generator to the same emission level with EUT maximum spurious emission.
10.EIRP (dBm) = S.G. Power – Tx Cable Loss + Tx Antenna Gain
11.ERP (dBm) = EIRP - 2.15
12.The RF fundamental frequency should be excluded against the limit line in the operating frequency band.

Remark: The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line was not reported.

Appendixes

Appendix A.1	PD20230197_EUT External Photograph
Appendix A.2	PD20230197_EUT Internal Photograph
Appendix A.3	PD20230197RF_Setup Photograph

Test Results of Conducted Test

Appendix B.19	NR Band n2	Appendix B.24	NR Band n71
Appendix B.20	NR Band n5	Appendix B.25	NR Band n78 (3450 to 3550)
Appendix B.21	NR Band n7	Appendix B.27	NR ULMIMO Band n38
Appendix B.22	NR Band n38	Appendix B.28	NR ULMIMO Band n78 (3450 to 3550)
Appendix B.23	NR Band n66		

Test Results of Radiated Test

Appendix C.4	All NR SA Bands
Appendix C.5	All NR NSA Bands
Appendix C.6	All NR UL MIMO Bands

****** End of the Report ******