TEST REPORT

Applicant:	Queclink Wireless Solutions Co., Ltd.
Address:	No.30, Lane 500, Xinlong Road, Minhang District, Shanghai, China 201101
Equipment Type:	LTE Cat M1 & Cat NB2 & EGPRS Module
Model Name:	QLM100
Brand Name:	Queclink
FCC ID:	YQD-QLM100
Test Standard:	47 CFR Part 2 (Others refer to chapter 3.1)
Sample Arrival Date:	Jul. 14, 2023
Test Date:	Jul. 14, 2023 - Jul. 25, 2023
Date of Issue:	Jul. 27, 2023

ISSUED BY:

Shenzhen BALUN Technology Co., Ltd.

Tested by: Lu Jiamin **Checked by:** Wu Huihui **Approved by:** Tolan Tu

(Testing Director)

Revision History

Version	Issue Date	Revisions Content
Rev. 01	Jul. 27, 2023	Initial Issue

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1 GENERAL INFORMATION

1.1 Test Laboratory

Name	Shenzhen BALUN Technology Co., Ltd.
Address	Block B, 1/F, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China
Phone Number	+86 755 6685 0100

1.2 Test Location

Name	Shenzhen BALUN Technology Co., Ltd.
Location	☑ Block B, 1/F, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China
	☐ 1/F, Building B, Ganghongji High-tech Intelligent Industrial Park, No. 1008, Songbai Road, Yangguang Community, Xili Sub-district, Nanshan District, Shenzhen, Guangdong Province, P. R. China
Accreditation Certificate	The laboratory is a testing organization accredited by FCC as a accredited testing laboratory. The designation number is CN1196.

2 PRODUCT INFORMATION

2.1 Applicant Information

Applicant	Queclink Wireless Solutions Co., Ltd.
Address	No.30, Lane 500, Xinlong Road, Minhang District, Shanghai, China 201101

2.2 Manufacturer Information

Manufacturer	Queclink Wireless Solutions Co., Ltd.
Address	No.30, Lane 500, Xinlong Road, Minhang District, Shanghai, China 201101

2.3 Factory Information

Factory	N/A
Address	N/A

2.4 General Description for Equipment under Test (EUT)

EUT Name	LTE Cat M1 & Cat NB2 & EGPRS Module
Model Name Under Test	QLM100
Series Model Name	N/A
Description of Model name differentiation	N/A
Hardware Version	V1.03
Software Version	QLM100R00A03M512
Dimensions (Approx.)	26.5 mm(L) × 22.5 mm(W) × 2.25 mm(H)
Weight (Approx.)	3 g

2.5 Technical Information

All Network and Wireless connectivity for EUT	2G Network GPRS/EDGE 850/900/1800/1900 MHz 4G Network FDD LTE-M1 Band 1/ 2/ 3/ 4/ 5/ 8/ 12/ 13/ 18/ 19/ 20/ 25/ 27/ 28/ 66/ 85; FDD NB-IoT Band 1/ 2/ 3/ 4/ 5/ 8/ 12/ 13/ 18/ 19/ 20/ 25/ 28/ 66/ 71/ 85; GPS, GLONASS, Beidou, Galileo, QZSS
About the Product	The equipment is LTE Cat M1 & Cat NB2 & EGPRS Module, intended for used with information technology equipment.

The following is the technical information of the EUT tested frequency bands in this report.

Operating Bands	GPRS/EGPRS 850/ 1900 MHz FDD LTE-M1 Band 2/ 4/ 5/ 12/ 13/ 25/ 66/ 85; FDD NB-IoT Band 2/ 4/ 5/ 12/ 13/ 25/ 66/ 71/ 85;	
Modulation Type	GPRS	GMSK
	EGPRS	8PSK
	LTE-M1	QPSK
		16QAM
	NB-IoT	BPSK
		QPSK
Multislot Class	GPRS/EGPRS: 33	
Antenna Type	Omni Antenna	
Antenna Gain	GPRS/EGPRS 850: -0.76 dBi GPRS/EGPRS 1900: -1.20 dBi FDD LTE-M1 Band 2: -1.20 dBi FDD LTE-M1 Band 4: -0.90 dBi FDD LTE-M1 Band 5: -0.76 dBi FDD LTE-M1 Band 12: -3.00 dBi FDD LTE-M1 Band 13: -0.81 dBi FDD LTE-M1 Band 25: -1.20 dBi FDD LTE-M1 Band 66: -0.90 dBi FDD LTE-M1 Band 85: -2.40 dBi FDD NB-IoT Band 2: -1.20 dBi FDD NB-IoT Band 4: -0.90 dBi FDD NB-IoT Band 5: -0.76 dBi FDD NB-IoT Band 12: -3.00 dBi FDD NB-IoT Band 13: -0.81 dBi FDD NB-IoT Band 25: -1.20 dBi FDD NB-IoT Band 66: -0.90 dBi FDD NB-IoT Band 71: -4.10 dBi FDD NB-IoT Band 85: -2.40 dBi	
The Max RF Output Power (EIRP/ERP)	GPRS/EGPRS 850: 30.39 dBm GPRS/EGPRS 1900: 29.69 dBm FDD LTE-M1 Band 2: 21.78 dBm	

			FDD LTE-M1 Band 4: 21.89 dBm FDD LTE-M1 Band 5: 19.89 dBm FDD LTE-M1 Band 12: 17.65 dBm FDD LTE-M1 Band 13: 19.70 dBm FDD LTE-M1 Band 25: 21.30 dBm FDD LTE-M1 Band 66: 21.58 dBm FDD LTE-M1 Band 85: 17.94 dBm FDD NB-IoT Band 2: 21.20 dBm FDD NB-IoT Band 4: 21.49 dBm FDD NB-IoT Band 5: 19.49 dBm FDD NB-IoT Band 12: 17.19 dBm FDD NB-IoT Band 13: 19.41 dBm FDD NB-IoT Band 25: 21.10 dBm FDD NB-IoT Band 66: 21.41 dBm FDD NB-IoT Band 71: 15.63 dBm FDD NB-IoT Band 85: 17.74 dBm	
Band	Power Class		Tx Frequency Range	Rx Frequency Range
	GMSK	GMSK		
GSM850	4	E2	824 MHz ~ 849 MHz	869 MHz ~ 894 MHz
GSM1900	1	E2	1850 MHz ~ 1910 MHz	1930 MHz ~ 1990 MHz
LTE-M1 B2	3		1850 MHz ~ 1910 MHz	1930 MHz ~ 1990 MHz
LTE-M1 B4	3		1710 MHz ~ 1755 MHz	2110 MHz ~ 2155 MHz
LTE-M1 B5	3		824 MHz ~ 849 MHz	869 MHz ~ 894 MHz
LTE-M1 B12	3		699 MHz ~ 716 MHz	729 MHz ~ 746 MHz
LTE-M1 B13	3		777 MHz ~ 787 MHz	746 MHz ~ 756 MHz
LTE-M1 B25	3		1850 MHz ~ 1915 MHz	1930 MHz ~ 1995 MHz
LTE-M1 B66	3		1710 MHz ~ 1780 MHz	2135 MHz ~ 2155 MHz
LTE-M1 B85	3		698 MHz ~ 716 MHz	728 MHz ~ 746 MHz
LTE NB-IoT B2	3		1850 MHz ~ 1910 MHz	1930 MHz ~ 1990 MHz
LTE NB-IoT B4	3		1710 MHz ~ 1755 MHz	2110 MHz ~ 2155 MHz
LTE NB-IoT B5	3		824 MHz ~ 849 MHz	869 MHz ~ 894 MHz
LTE NB-IoT B12	3		699 MHz ~ 716 MHz	729 MHz ~ 746 MHz
LTE NB-IoT B13	3		777 MHz ~ 787 MHz	746 MHz ~ 756 MHz
LTE NB-IoT B25	3		1850 MHz ~ 1915 MHz	1930 MHz ~ 1995 MHz
LTE NB-IoT B66	3		1710 MHz ~ 1780 MHz	2135 MHz ~ 2155 MHz
LTE NB-IoT B71	3		663 MHz ~ 698 MHz	617 MHz ~ 652 MHz
LTE NB-IoT B85	3		698 MHz ~ 716 MHz	728 MHz ~ 746 MHz

Note1: The EUT information provided by the applicant, except for The Max RF Output Power (EIRP/ERP). For more detailed band specifications and features description, please refer to the manufacturer's specifications or user's manual.

3 SUMMARY OF TEST RESULTS

3.1 Test Standards

No.	Identity	Document Title
1	47 CFR Part 2	Frequency Allocations and Radio Treaty Matters; General Rules and Regulations
2	47 CFR Part 22 Subpart H	Cellular Radiotelephone Service
3	47 CFR Part 24 Subpart E	Broadband PCS
4	47 CFR Part 27	Miscellaneous Wireless Communications Services
5	ANSI C63.26-2015	American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services
6	KDB 971168 D01 v03	Measurement Guidance for Certification of Licensed Digital Transmitters

3.2 Test Verdict

No.	Test Description	FCC Part No.	Test Result	Test Verdict
1	Conducted RF Output Power	2.1046	Reporting only (ANNEX A.1)	Pass
2	Effective (Isotropic) Radiated Power	2.1046 22.913 24.232 27.50	ANNEX A.1	Pass
3	Peak to Average Radio	2.1046 24.232(d) 27.50(d)	ANNEX A.2	Pass
4	Occupied Bandwidth	2.1049 22.917 24.238 27.53	ANNEX A.3	Pass
5	Frequency Stability	2.1055 22.355 24.235 27.54	ANNEX A.4	Pass
6	Spurious Emission at Antenna Terminals	2.1051 22.917 24.238 27.53	ANNEX A.5	Pass
7	Band Edge	2.1051 22.917 24.238 27.53	ANNEX A.6	Pass
8	Field Strength of Spurious Radiation	2.1053 22.917 24.238 27.53	ANNEX A.7	Pass
Note: The differences between the EUT (test samples in this report) and testing sample of report No.BL-EC2140498-501(G1), which was issued by Shenzhen BALUN Technology Co., Ltd. on Jul. 26, 2021 are that upgraded software from QLM100R00A01M512 to QLM100R00A03M512 and replaced the shield frame of the module from the semi-enclosed type to whole-covering type. Therefore, just Field Strength of Spurious Radiation was retested in this report. Other test items please refer to the No. BL-EC2140498-501(G1) on Jul. 26, 2021.				

4 GENERAL TEST CONFIGURATIONS

4.1 Test Environments

During the measurement, the environmental conditions were within the listed ranges:

Relative Humidity		20% to 75%
Atmospheric Pressure		98 kPa to 102 kPa
Test Voltage of the EUT	NV (Normal Voltage)	3.8 V_{DC}
	LV (Low Voltage)	3.3 V_{DC}
	HV (High Voltage)	4.4 V_{DC}
Test Temperature of the EUT	NT (Normal Temperature)	15 °C to 35 °C
	LT (Low Temperature)	-40 °C
	HT (High Temperature)	+85 °C

4.2 Test Equipment List

Description	Manufacturer	Model	Serial No.	Version	Cal. Date	Cal. Due
2/3/4/5G RF Test System						
BL410 Test Software	BALUN	BL410R	N/A	2.1.1.496	N/A	N/A
Analog Signal Generator	R&S	SMB100A	182396	3.20.390.24	2022.09.06	2023.09.05
Temperature Chamber	AHK	SP20	1412	N/A	2022.09.20	2023.09.19
Vibration Table	GAOXIN	G-600-ZD	1901064	N/A	2022.11.11	2023.11.10
Wideband Radio Communication Tester	R&S	CMW 500	167190	V4.0.60	2023.05.11	2024.05.10
Wideband Radio Communication Tester	R&S	CMW 500	102318	V3.2.71	2023.05.16	2024.05.15
Spectrum Analyzer	keysight	N9020A	MY50531628	A.16.09	2023.05.12	2024.05.11
DC Power Supply	ITECH	IT6863A	800014020757120005	N/A	2022.09.09	2023.09.08
Radiated Test System						
Radiated Test System Test Software	BALUN	BL410-E	N/A	V19.918	N/A	N/A
Wideband Radio Communication Tester	R&S	CMW 500	102318	V3.2.71	2023.05.16	2024.05.15
Test Antenna-Bi-Log(30 MHz-3 GHz)	Schwarzbeck	VULB 9163	9163-624	N/A	2021.08.20	2024.08.19
Test Antenna-Horn(1-18 GHz)	Schwarzbeck	BBHA 9120D	9120D-1917	N/A	2022.06.09	2025.06.08
Anechoic Chamber	YIHENG	9m*6m*6m	#3	N/A	2022.02.09	2024.09.03
EMI Receiver	Keysight	N9038A	MY53220118	A.14.16	2022.09.08	2023.09.07

4.3 Test Configurations

Test Items	Test Mode	Test Channel		
		LCH	MCH	HCH
Effective (Isotropic) Radiated Power	GPRS 850	v	v	v
	GPRS 1900	v	v	v
	EGPRS 850	v	v	v
	EGPRS 1900	v	v	v
Occupied Bandwidth	GPRS 850	v	v	v
	GPRS 1900	v	v	v
	EGPRS 850	v	v	v
	EGPRS 1900	v	v	v
Frequency Stability	GPRS 850	v	v	v
	GPRS 1900	v	v	v
	EGPRS 850	v	v	v
	EGPRS 1900	v	v	v
Spurious Emission at Antenna Terminals	GPRS 850	v	v	v
	GPRS 1900	v	v	v
	EGPRS 850	v	v	v
	EGPRS 1900	v	v	v
Band Edge	GPRS 850	v	--	v
	GPRS 1900	v	--	v
	EGPRS 850	v	--	v
	EGPRS 1900	v	--	v
Field Strength of Spurious Radiation	GPRS 850	v	v	v
	GPRS 1900	v	v	v
	EGPRS 850	v	v	v
	EGPRS 1900	v	v	v
Note 1: The mark “v” means that this configuration is chosen for testing.				

Test Mode	UL Channel	UL Channel No.	UL Frequency (MHz)
GPRS/EGPRS 850	Low Channel	128	824.2
	Middle Channel	190	836.6
	High Channel	251	848.8
GPRS/EGPRS 1900	Low Channel	512	1850.2
	Middle Channel	661	1880.0
	High Channel	810	1909.8

LTE-M1	Bandwidth (MHz)						Modulation Type		RB#			Test Channel		
Band	1.4	3	5	10	15	20	QPSK	16-QAM	1	Half	Full	LCH	MCH	HCH
Effective (Isotropic) Radiated Power														
2	v	v	v	v	v	v	v	v	v	--	v	v	v	v
4	v	v	v	v	v	v	v	v	v	--	v	v	v	v
5	v	v	v	v	n	n	v	v	v	--	v	v	v	v
12	v	v	v	v	n	n	v	v	v	--	v	v	v	v
13	n	n	v	v	n	n	v	v	v	--	v	v	v	v
25	v	v	v	v	v	v	v	v	v	--	v	v	v	v
66	v	v	v	v	v	v	v	v	v	--	v	v	v	v
85	n	n	v	v	n	n	v	v	v	--	v	v	v	v
Peak to Average Ratio														
2	--	--	--	--	--	v	v	v	--	--	v	v	v	v
4	--	--	--	--	--	v	v	v	--	--	v	v	v	v
5	--	--	--	v	n	n	v	v	--	--	v	v	v	v
12	--	--	--	v	n	n	v	v	--	--	v	v	v	v
13	n	n	--	v	n	n	v	v	--	--	v	v	v	v
25	--	--	--	--	--	v	v	v	--	--	v	v	v	v
66	--	--	--	--	--	v	v	v	--	--	v	v	v	v
85	n	n	--	v	n	n	v	v	--	--	v	v	v	v
Occupied Bandwidth														
2	v	v	v	v	v	v	v	v	--	--	v	v	v	v
4	v	v	v	v	v	v	v	v	--	--	v	v	v	v
5	v	v	v	v	n	n	v	v	--	--	v	v	v	v
12	v	v	v	v	n	n	v	v	--	--	v	v	v	v
13	n	n	v	v	n	n	v	v	--	--	v	v	v	v
25	v	v	v	v	v	v	v	v	--	--	v	v	v	v
66	v	v	v	v	v	v	v	v	--	--	v	v	v	v
85	n	n	v	v	n	n	v	v	--	--	v	v	v	v
Frequency Stability														
2	--	--	--	--	--	v	v	v	--	--	v	--	v	--
4	--	--	--	--	--	v	v	v	--	--	v	--	v	--
5	--	--	--	v	n	n	v	v	--	--	v	--	v	--
12	--	--	--	v	n	n	v	v	--	--	v	--	v	--
13	n	n	--	v	n	n	v	v	--	--	v	--	v	--
25	--	--	--	--	--	v	v	v	--	--	v	--	v	--
66	--	--	--	--	--	v	v	v	--	--	v	--	v	--
85	n	n	--	v	n	n	v	v	--	--	v	--	v	--
Spurious Emission at Antenna Terminals														
2	v	v	v	v	v	v	v	v	v	--	--	v	v	v
4	v	v	v	v	v	v	v	v	v	--	--	v	v	v
5	v	v	v	v	n	n	v	v	v	--	--	v	v	v

LTE-M1 Band	Bandwidth (MHz)						Modulation Type		RB#			Test Channel		
	1.4	3	5	10	15	20	QPSK	16-QAM	1	Half	Full	LCH	MCH	HCH
12	v	v	v	v	n	n	v	v	v	--	--	v	v	v
13	n	n	v	v	n	n	v	v	v	--	--	v	v	v
25	v	v	v	v	v	v	v	v	v	--	--	v	v	v
66	v	v	v	v	v	v	v	v	v	--	--	v	v	v
85	n	n	v	v	n	n	v	v	v	--	--	v	v	v
Band Edge														
2	v	v	v	v	v	v	v	v	v	--	v	v	--	v
4	v	v	v	v	v	v	v	v	v	--	v	v	--	v
5	v	v	v	v	n	n	v	v	v	--	v	v	--	v
12	v	v	v	v	n	n	v	v	v	--	v	v	--	v
13	n	n	v	v	n	n	v	v	v	--	v	v	--	v
25	v	v	v	v	v	v	v	v	v	--	v	v	--	v
66	v	v	v	v	v	v	v	v	v	--	v	v	--	v
85	n	n	v	v	n	n	v	v	v	--	v	v	--	v
Field Strength of Spurious Radiation														
2	v	v	v	v	v	v	v	--	v	--	--	--	v	--
4	v	v	v	v	v	v	v	--	v	--	--	--	v	--
5	v	v	v	v	n	n	v	--	v	--	--	--	v	--
12	v	v	v	v	n	n	v	--	v	--	--	--	v	--
13	n	n	v	v	n	n	v	--	v	--	--	--	v	--
25	v	v	v	v	v	v	v	--	v	--	--	--	v	--
66	v	v	v	v	v	v	v	--	v	--	--	--	v	--
85	n	n	v	v	n	n	v	--	v	--	--	--	v	--

Note 1: The mark “v” means that this configuration is chosen for testing.

Note 2: The mark “n” means that this bandwidth is not supported.

NB-IoT Band	Sub-carrier spacing (kHz)		Modulation Type		Test Channel		
	3.75	15	BPSK	QPSK	LCH	MCH	HCH
Effective (Isotropic) Radiated Power							
2	v	v	v	v	v	v	v
4	v	v	v	v	v	v	v
5	v	v	v	v	v	v	v
12	v	v	v	v	v	v	v
13	v	v	v	v	v	v	v
25	v	v	v	v	v	v	v
66	v	v	v	v	v	v	v
71	v	v	v	v	v	v	v
85	v	v	v	v	v	v	v
Peak to Average Ratio							
2	v	v	v	v	v	v	v

NB-IoT Band	Sub-carrier spacing (kHz)		Modulation Type		Test Channel		
	3.75	15	BPSK	QPSK	LCH	MCH	HCH
4	v	v	v	v	v	v	v
5	v	v	v	v	v	v	v
12	v	v	v	v	v	v	v
13	v	v	v	v	v	v	v
25	v	v	v	v	v	v	v
66	v	v	v	v	v	v	v
71	v	v	v	v	v	v	v
85	v	v	v	v	v	v	v
Occupied Bandwidth							
2	v	v	v	v	v	v	v
4	v	v	v	v	v	v	v
5	v	v	v	v	v	v	v
12	v	v	v	v	v	v	v
13	v	v	v	v	v	v	v
25	v	v	v	v	v	v	v
66	v	v	v	v	v	v	v
71	v	v	v	v	v	v	v
85	v	v	v	v	v	v	v
Frequency Stability							
2	v	v	v	v	--	v	--
4	v	v	v	v	--	v	--
5	v	v	v	v	--	v	--
12	v	v	v	v	--	v	--
13	v	v	v	v	--	v	--
25	v	v	v	v	--	v	--
66	v	v	v	v	--	v	--
71	v	v	v	v	--	v	--
85	v	v	v	v	--	v	--
Spurious Emission at Antenna Terminals							
2	v	v	v	v	v	v	v
4	v	v	v	v	v	v	v
5	v	v	v	v	v	v	v
12	v	v	v	v	v	v	v
13	v	v	v	v	v	v	v
25	v	v	v	v	v	v	v
66	v	v	v	v	v	v	v
71	v	v	v	v	v	v	v
85	v	v	v	v	v	v	v
Band Edge							
2	v	v	v	v	v	--	v

NB-IoT Band	Sub-carrier spacing (kHz)		Modulation Type		Test Channel		
	3.75	15	BPSK	QPSK	LCH	MCH	HCH
4	v	v	v	v	v	--	v
5	v	v	v	v	v	--	v
12	v	v	v	v	v	--	v
13	v	v	v	v	v	--	v
25	v	v	v	v	v	--	v
66	v	v	v	v	v	--	v
71	v	v	v	v	v	--	v
85	v	v	v	v	v	--	v
Field Strength of Spurious Radiation							
2	v	v	v	v	--	v	--
4	v	v	v	v	--	v	--
5	v	v	v	v	--	v	--
12	v	v	v	v	--	v	--
13	v	v	v	v	--	v	--
25	v	v	v	v	--	v	--
66	v	v	v	v	--	v	--
71	v	v	v	v	--	v	--
85	v	v	v	v	--	v	--
Note 1: The mark “v” means that this configuration is chosen for testing. Note 2: The mark “n” means that this bandwidth is not supported.							

Test Mode	UL Channel	Channel Bandwidth (MHz)	UL Channel No.	UL Frequency (MHz)
LTE-M1 Band 2	Low Range	1.4	18607	1850.7
		3	18615	1851.5
		5	18625	1852.5
		10	18650	1855
		15	18675	1857.5
		20	18700	1860
	Middle Range	1.4/3/5/10/15/20	18900	1880
	High Range	1.4	19193	1909.3
		3	19185	1908.5
		5	19175	1907.5
		10	19150	1905
		15	19125	1902.5
		20	19100	1900
LTE-M1 Band 4	Low Range	1.4	19957	1710.7
		3	19965	1711.5
		5	19975	1712.5
		10	20000	1715

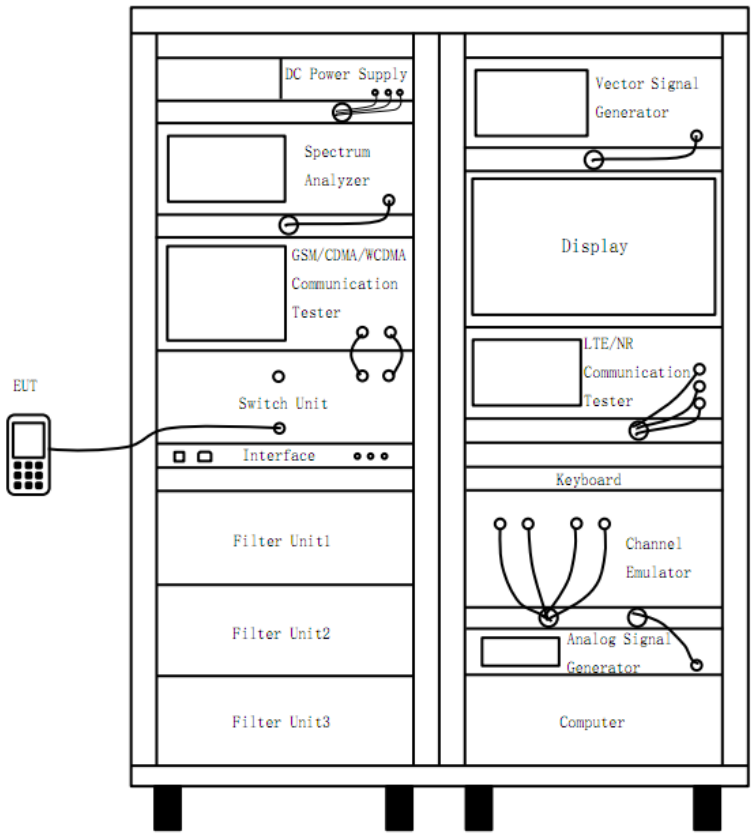
Test Mode	UL Channel	Channel Bandwidth (MHz)	UL Channel No.	UL Frequency (MHz)
		15	20025	1717.5
		20	20050	1720
	Middle Range	1.4/3/5/10/15/20	20175	1732.5
	High Range	1.4	20393	1754.3
		3	20385	1753.5
		5	20375	1752.5
		10	20350	1750
		15	20325	1747.5
		20	20300	1745
LTE-M1 Band 5	Low Range	1.4	20407	824.7
		3	20415	825.5
		5	20425	826.5
		10	20450	829
	Middle Range	1.4/3/5/10	20525	836.5
	High Range	1.4	20643	848.3
		3	20635	847.5
		5	20625	846.5
		10	20600	844
LTE-M1 Band 12	Low Range	1.4	23017	699.7
		3	23025	700.5
		5	23035	701.5
		10	23060	704
	Middle Range	1.4/3/5/10	23095	707.5
	High Range	1.4	23173	715.3
		3	23165	714.5
		5	23155	713.5
		10	23130	711
LTE-M1 Band 13	Low Range	5	23205	779.5
		10	--	--
	Middle Range	5/10	23230	782
	High Range	5	23225	784.5
		10	--	--
LTE-M1 Band 25	Low Range	1.4	26047	1850.7
		3	26055	1851.5
		5	26065	1852.5
		10	26090	1855
		15	26115	1857.5
		20	26140	1860
	Middle Range	1.4/3/5/10/15/20	26363	1882.5
	High Range	1.4	26683	1914.3
		3	26675	1913.5

Test Mode	UL Channel	Channel Bandwidth (MHz)	UL Channel No.	UL Frequency (MHz)
		5	26665	1912.5
		10	26640	1910
		15	26615	1907.5
		20	26590	1905
LTE-M1 Band 66	Low Range	1.4	131979	1710.7
		3	131987	1711.5
		5	131997	1712.5
		10	132022	1715
		15	132047	1717.5
		20	132072	1720
	Middle Range	1.4/3/5/10/15/20	132322	1745
	High Range	1.4	132665	1779.3
		3	132657	1778.5
		5	132647	1777.5
		10	132622	1775
		15	132597	1772.5
		20	132572	1770
LTE-M1 Band 85	Low Range	5	134027	700.5
		10	134052	703
	Middle Range	5/10	134092	707
	High Range	5	134147	712.5
		10	134132	711
NB-IoT Band 2	Low Range	---	18601	1850.1
	Middle Range	---	18900	1880.0
	High Range	---	19199	1909.9
NB-IoT Band 4	Low Range	---	19951	1710.1
	Middle Range	---	20175	1732.5
	High Range	---	20399	1754.9
NB-IoT Band 5	Low Range	---	20401	824.1
	Middle Range	---	20525	836.5
	High Range	---	20649	848.9
NB-IoT Band 12	Low Range	---	23011	699.1
	Middle Range	---	23095	707.5
	High Range	---	23179	715.9
NB-IoT Band 13	Low Range	---	23181	777.1
	Middle Range	---	23230	782.0
	High Range	---	23279	786.9
NB-IoT Band 25	Low Range	---	26041	1850.1
	Middle Range	---	26365	1882.5
	High Range	---	26689	1914.9
NB-IoT	Low Range	---	131973	1710.1

Test Mode	UL Channel	Channel Bandwidth (MHz)	UL Channel No.	UL Frequency (MHz)
Band 66	Middle Range	---	132322	1745
	High Range	---	132671	1779.9
NB-IoT Band 71	Low Range	---	133123	663.1
	Middle Range	---	133297	680.5
	High Range	---	133471	697.9
NB-IoT Band 85	Low Range	---	134003	698.1
	Middle Range	---	134092	707
	High Range	---	134181	715.9

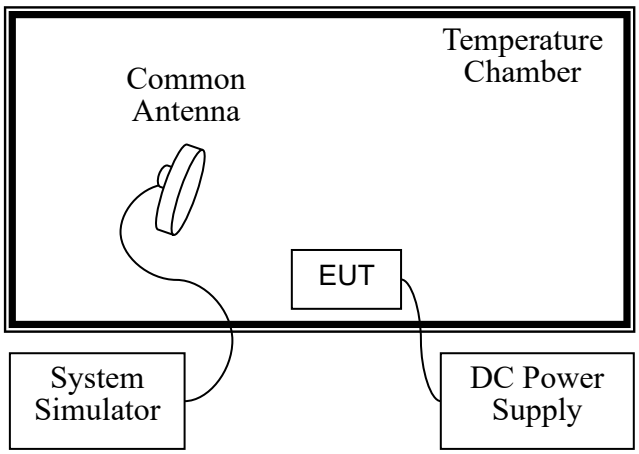
4.4 Test Setup

4.4.1 For Antenna Port Test



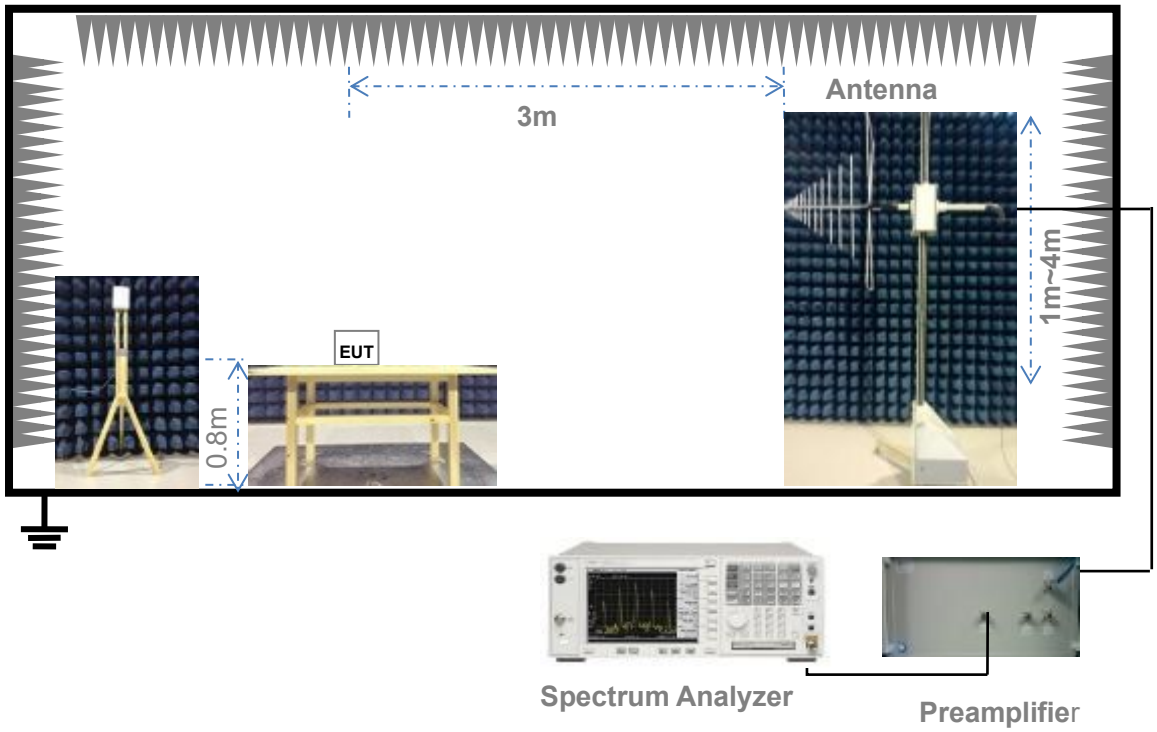
(Diagram 1)

4.4.2 For Frequency Stability Test



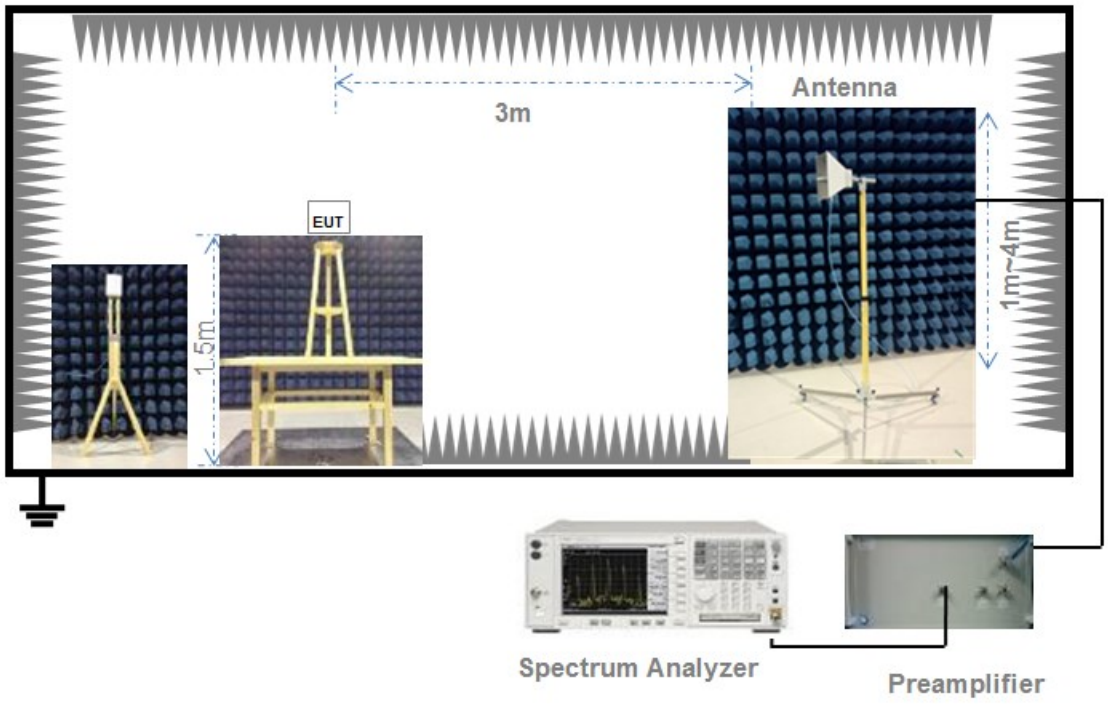
(Diagram 2)

4.4.3 For Radiated Test (30 MHz ~ 1 GHz)



(Diagram 3)

4.4.4 For Radiated Test (Above 1 GHz)



(Diagram 4)

5 TEST ITEMS

5.1 Transmitter Radiated Power (EIRP/ERP)

5.1.1 Limit

FCC § 2.1046 & 22.913(a) & 24.232(c) & 27.50(a) & 27.50(b) & 27.50(c) & 27.50(d) & 27.50(h)

According to FCC section 22.913(a) (5), the Effective Radiated Power (ERP) of mobile transmitters and auxiliary test transmitters must not exceed 7 watts.

According to FCC section 24.232(c), mobile and portable stations are limited to 2 watts EIRP and the equipment must employ a means for limiting power to the minimum necessary for successful communications.

According to FCC section 27.50(a) (3), for mobile and portable stations transmitting in the 2305-2315MHz band or the 2350-2360MHz band, the average EIRP must not exceed 50 milliwatts within any 1 megahertz of authorized bandwidth, except that for mobile and portable stations compliant with 3GPP LTE standards. For mobile and portable stations using time division duplexing (TDD) technology, the duty cycle must not exceed 38 percent in the 2305-2315 MHz and 2350-2360 MHz bands.

FCC section 27.50(b) (10), portable stations (hand-held devices) transmitting in the 746-757MHz, 776-788MHz, and 805-806MHz bands are limited to 3 watts ERP.

FCC section 27.50(c) (10), portable stations (hand-held devices) in the 600MHz uplink band and the 698-746MHz band, and fixed and mobile stations in the 600MHz uplink band are limited to 3 watts ERP.

FCC section 27.50(d) (4), fixed, mobile, and portable (hand-held) stations operating in the 1710-1755 MHz band and mobile and portable stations operating in the 1695-1710 MHz and 1755-1780 MHz bands are limited to 1 watt EIRP. Fixed stations operating in the 1710-1755 MHz band are limited to a maximum antenna height of 10 meters above ground. Mobile and portable stations operating in these bands must employ a means for limiting power to the minimum necessary for successful communications.

(7) Fixed, mobile, and portable (hand-held) stations operating in the 2000-2020 MHz band are limited to 2 watts EIRP.

And FCC section 27.50(h) (2), for mobile and other user stations, mobile stations are limited to 2.0 watts EIRP. All user stations are limited to 2.0 watts transmitter output power.

5.1.2 Test Setup

The section 4.4.1 (Diagram 1) test setup description is used for conducted test, and the section 4.4.3 and 4.4.4 (Diagram 3, 4) test setup description is used for radiated test. The photo of test setup please refer to ANNEX B.

5.1.3 Test Procedure

Description of the Conducted Output Power Measurement

The EUT is coupled to the SS with attenuator through power splitter; the RF load attached to EUT antenna terminal is 50Ohm; the path loss as the factor is calibrated to correct the reading. A system simulator is used to establish communication with the EUT, and its parameters are 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.

The relevant equation for determining the conducted measured value is:

Conducted Output Power Value (dBm) = Measured Value (dBm) + Path Loss (dB)

where:
Conducted Output Power Value = final conducted measured value in the conducted power test, in dBm;
Measured Value = measured conducted power received by spectrum analyzer or power meter, in dBm;
Path Loss = signal attenuation in the connecting cable between the transmitter and spectrum analyzer or power meter, including external cable loss, in dB;

During the test, the data of Path Loss (dB) is added in the spectrum analyzer or power meter, so Measured Value (dBm) is the final values which contains the data of Path Loss (dB).

For example:

In the conducted output power test, when measured value for GSM850 is 24.7 dBm, and path loss is 8.5 dB, then final conducted output power value is:

Conducted Output Power Value (dBm) = 24.7 dBm + 8.5 dB = 33.2 dBm

Description of the Transmitter Radiated Power Measurement

In many cases, the RF output power limits for licensed digital transmission devices is specified in terms of effective radiated power (ERP) or equivalent isotropic radiated power (EIRP). Typically, ERP is specified when the operating frequency is less than or equal to 1 GHz and EIRP is specified when the operating frequency is greater than 1 GHz. Both are determined by adding the transmit antenna gain to the conducted RF output power with the primary difference between the two being that when determining the ERP, the transmit antenna gain is referenced to a dipole antenna (i.e., dBd) whereas when determining the EIRP, the transmit antenna gain is referenced to an isotropic antenna (dBi).

Final measurement calculation as below:

The relevant equation for determining the ERP or EIRP from the conducted RF output power measured using the guidance provided above is:

$ERP/EIRP = P_{Meas} + GT - LC$

where:
ERP/EIRP = effective or equivalent radiated power, respectively (expressed in the same units as P_{Meas}, typically dBW or dBm);
P_{Meas} = measured transmitter output power or PSD, in dBm or dBW;
GT = gain of the transmitting antenna, in dBd (ERP) or dBi (EIRP);
dBd (ERP)=dBi (EIRP) -2.15 dB
LC = signal attenuation in the connecting cable between the transmitter and antenna, in dB.

For devices utilizing multiple antennas, KDB 662911 provides guidance for determining the effective array transmit antenna gain term to be used in the above equation.

For example:
In the EIRP test, when P_{Meas} value for GSM1900 is 30.2 dBm, LC is 0.6 dB, and GT is -3.4 dB, then final EIRP value is:
EIRP for GSM1900 = 30.2 dBm - 3.4 dBi - 0.6 dB = 26.2 dBm

The relevant equation for determining the ERP/EIRP from the radiated RF output power is:
ERP/EIRP (dBm) = SA Read Value (dBm) + Correction Factor (dB)

where:
ERP/EIRP = effective or equivalent radiated power, in dBm;
SA Read Value = measured transmitter power received by EMI receiver or spectrum analyzer, in dBm;
Correction Factor = total correction factor including cable loss, in dB;

During the test, the data of Correction Factor (dB) is added in the EMI receiver or spectrum analyzer, so SA Read Value (dBm) is the final values which contains the data of Correction Factor (dB).

For example:

In the ERP test, when SA read value for GSM850 is 21dBm, and correction factor is 8dB, then final ERP value for GSM850 is:

ERP (dBm) = 21dBm + 8dB = 29dBm

5.1.4 Test Result

Please refer to ANNEX A.1.

5.2 Peak to Average Ratio

5.2.1 Limit

FCC § 2.1046 & 24.232(d) & 27.50(d)

In addition, when the transmitter power is measured in terms of average value, the peak-to-average power ratio (PAPR) of the transmitter shall not exceed 13 dB for more than 0.1% of the time using a signal corresponding to the highest PAPR during periods of continuous transmission.

According to FCC section 24.232(d), power measurements for transmissions by stations authorized under this section may be made either in accordance with a Commission-approved average power technique or in compliance with 24.232 (e) of this section. In both instances, equipment employed must be authorized in accordance with the provisions of § 24.51. In measuring transmissions in this band using an average power technique, the peak-to-average ratio (PAR) of the transmission may not exceed 13 dB.

FCC section 24.232(e), peak transmit power must be measured over any interval of continuous transmission using instrumentation calibrated in terms of an rms equivalent voltage. The measurement results shall be properly adjusted for any instrument limitations, such as detector response times, limited resolution bandwidth capability when compared to the emission bandwidth, sensitivity, etc., so as to obtain a true peak measurement for the emission in question over the full bandwidth of the channel.

According to FCC section 27.50(d) (5), in measuring transmissions in this band using an average power technique, the peak-to-average ratio (PAR) of the transmission may not exceed 13dB.

5.2.2 Test Setup

The section 4.4.1 (Diagram 1) test setup description is used for this test. The photo of test setup please refer to ANNEX B.

5.2.3 Test Procedure

Here the lowest, middle and highest channels are selected to perform testing to verify the peak-to-average ratio.

According to KDB 971168 D01, there is CCDF procedure for PAPR:

a) Refer to instrument’s analyzer instruction manual for details on how to use the power statistics/CCDF function;

b) Set resolution/measurement bandwidth ≥ signal’s occupied bandwidth;

c) Set the number of counts to a value that stabilizes the measured CCDF curve;

d) Set the measurement interval as follows:

1) for continuous transmissions, set to 1 ms,

2) for burst transmissions, employ an external trigger that is synchronized with the EUT burst timing

sequence, or use the internal burst trigger with a trigger level that allows the burst to stabilize and set the measurement interval to a time that is less than or equal to the burst duration.

e) Record the maximum PAPR level associated with a probability of 0.1%.

Alternate procedure for PAPR:

Use one of the procedures presented in 4.1 to measure the total peak power and record as P_{Pk}. Use one of the applicable procedures presented 4.2 to measure the total average power and record as P_{Avg}. Both the peak and average power levels must be expressed in the same logarithmic units (e.g., dBm). Determine the PAPR from:

PAPR (dB) = P_{Pk} (dBm) - P_{Avg} (dBm).

5.2.4 Test Result

Please refer to ANNEX A.2.

5.3 Occupied Bandwidth

5.3.1 Limit

FCC § 2.1049

The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission.

Many of the individual rule parts specify a relative OBW in lieu of the 99% OBW. In such cases, the OBW is defined as the width of the signal between two points, one below the carrier center frequency and on above the carrier center frequency, outside of which all emissions are attenuated by at least X dB below the transmitter power, where the value of X is typically specified as 26.

5.3.2 Test Setup

The section 4.4.1 (Diagram 1) test setup description is used for this test. The photo of test setup please refer to ANNEX B.

5.3.3 Test Procedure

The following procedure shall be used for measuring power bandwidth.

a) The spectrum analyzer center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be set wide enough to capture all modulation products including the emission skirts (i.e., two to five times the anticipated OBW).

b) The nominal IF filter bandwidth (3 dB 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.

c) Set the reference level of the instrument as required to keep the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope must be at least 10log (OBW / RBW) below the reference level.

d) NOTE—Steps a) through c) may require iteration to adjust within the specified tolerances.

e) For -26 dB OBW, the dynamic range of the spectrum analyzer at the selected RBW shall be at least 10dB below the target “-X dB down” requirement, e.g. -26 dB OBW, the spectrum analyzer noise floor at the selected RBW shall be 36dB below the reference value.

f) Set the detection mode to peak, and the trace mode to max hold.

g) For 99% OBW, use the 99 % power bandwidth function of the spectrum analyzer (if available) and report the measured bandwidth.

If the instrument does not have a 99 % power bandwidth function, the trace data points are to be recovered and directly summed in linear power terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5 % of the total is reached; that frequency is

recorded as the lower frequency. The process is repeated until 99.5 % of the total is reached; that frequency is recorded as the upper frequency. The 99 % power bandwidth is the difference between these two frequencies.

h) For -26 dB OBW, 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 “-X dB down amplitude” as equal to (reference value -X). Alternatively, this calculation can be performed by the analyzer by using the marker-delta function.

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 “-X dB down amplitude” determined in step g). 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.

i) The OBW shall be reported by providing plot(s) of the measuring instrument display. The frequency and amplitude axes and scale shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

j) Change variable modulations, coding, or channel bandwidth settings, then repeat above test procedures.

5.3.4 Test Result

Please refer to ANNEX A.3.

5.4 Frequency Stability

5.4.1 Limit

FCC § 2.1055 & 22.355 & 24.235 & 27.54

FCC § 2.1055

The frequency stability shall be measured with variation of ambient temperature as follows:

(1) The temperature is varied from -30°C to +50°C.

(2) Frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than 10°C through the range.

The frequency stability shall be measured with variation of primary supply voltage as follows:

(1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than carried battery equipment.

(2) For hand carried, battery powered equipment, reduce primary supply voltage to the battery operating and point which shall be specified by the manufacture.

(3) The supply voltage shall be measured at the input to the cable normally provided with the equipment, or at the power supply terminals if cables are not normally provided.

FCC § 22.355

Except as otherwise provided in this part, the carrier frequency of each transmitter in the Public Mobile Services must be maintained within the tolerances given in Table C-1 of this section.

Table C-1—Frequency Tolerance for Transmitters in the Public Mobile Services

Frequency range (MHz)	Base, fixed (ppm)	Mobile > 3 watts (ppm)	Mobile ≤ 3 watts (ppm)
25 to 50	20.0	20.0	50.0
50 to 450	5.0	5.0	50.0
450 to 512	2.5	5.0	5.0
821 to 896	1.5	2.5	2.5
928 to 929	5.0	n/a	n/a
929 to 960	1.5	n/a	n/a
2110 to 2220	10.0	n/a	n/a

FCC § 24.235

The frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block.

FCC § 27.54

The frequency stability shall be sufficient to ensure that the fundamental emissions stay within the authorized bands of operation.

5.4.2 Test Setup

The section 4.4.2 (Diagram 2) test setup description is used for this test. The photo of test setup please refer to ANNEX B.

5.4.3 Test Procedure

1. The EUT is placed in a temperature chamber.

2. The temperature is set to 25°C and allowed to stabilize. After sufficient soak time, the transmitting frequency error is measured.

3. The temperature is increased by not more than 10 degrees, allowed to stabilize and soak, and then repeat the frequency error measurement.

4. Repeat procedure 3 until +50°C and -30°C is reached.

5. Change supply voltage, and repeat measurement until extreme voltage is reached.

5.4.4 Test Result

Please refer to ANNEX A.4.

5.5 Spurious Emission at Antenna Terminals

5.5.1 Limit

FCC § 2.1051 & 22.917(a) & 24.238(a) & 27.53(a) & 27.53(c) & 27.53(f) & 27.53(g) & 27.53(h) & 27.53(m)

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 emissions are attenuated at least 26 dB below the transmitter power.

FCC § 22.917(a) & 24.238(a)

The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43+10*log(P) dB. This is calculated to be -13 dBm.

FCC § 27.53(a) (4)

For mobile and portable stations operating in the 2305-2315MHz and 2350-2360MHz bands:

(1)By a factor of not less than: 43 + 10 log (P) dB on all frequencies between 2305 and 2320MHz and on all frequencies between 2345 and 2360MHz that are outside the licensed band(s) of operation, not less than 55 + 10 log (P) dB on all frequencies between 2320 and 2324MHz and on all frequencies between 2341 and 2345MHz, not less than 61 + 10 log (P) dB on all frequencies between 2324 and 2328MHz and on all frequencies between 2337 and 2341MHz, and not less than 67 + 10 log (P) dB on all frequencies between 2328 and 2337MHz.

(2)By a factor of not less than 43 + 10 log (P) dB on all frequencies between 2300 and 2305MHz, 55 + 10 log (P) dB on all frequencies between 2296 and 2300MHz, 61 + 10 log (P) dB on all frequencies between 2292 and 2296MHz, 67 + 10 log (P) dB on all frequencies between 2288 and 2292MHz, and 70 + 10 log (P) dB below 2288MHz.

(3)By a factor of not less than 43 + 10 log (P) dB on all frequencies between 2360 and 2365MHz, and not less than 70 + 10 log (P) dB above 2365MHz.

FCC § 27.53(c)

For operations in the 746–758 MHz band and the 776–788 MHz band, the power of any emission outside the licensee’s frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, in accordance with the following:

(1) On any frequency outside the 746–758 MHz band, the power of any emission shall be attenuated outside the

band below the transmitter power (P) by at least 43 + 10 log (P) dB;

(2) On any frequency outside the 776–788 MHz band, the power of any emission shall be attenuated outside the

band below the transmitter power (P) by at least 43 + 10 log (P) dB;

(3) On all frequencies between 763–775 MHz and 793–805 MHz, by a factor not less than 76 + 10 log (P) dB in a 6.25 kHz band segment, for base and fixed stations;

(4) On all frequencies between 763–775 MHz and 793–805 MHz, by a factor not less than 65 + 10 log (P) dB in a 6.25 kHz band segment, for mobile and portable stations;

(5) Compliance with the provisions of paragraphs (c)(1) and (c)(2) of this section is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater.

However, in the 100 kHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth

of at least 30 kHz may be employed;

(6) Compliance with the provisions of paragraphs (c)(3) and (c)(4) of this section is based on the use of measurement instrumentation such that the reading taken with any resolution bandwidth setting should be adjusted to indicate spectral energy in a 6.25 kHz segment.

FCC § 27.53(f)

For operations in the 746–758 MHz, 775–788 MHz, and 805–806 MHz bands, emissions in the band 1559–1610 MHz shall be limited to - 70 dBW/MHz equivalent isotropically radiated power (EIRP) for wideband signals, and -80 dBW EIRP for discrete emissions of less than 700 Hz bandwidth. For the purpose of equipment authorization, a transmitter shall be tested with an antenna that is representative of the type that will be used with the equipment in normal operation.

FCC § 27.53(g)

For operations in the 600MHz band and the 698-746MHz band, the power of any emission outside a licensee’s frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least 43+10*log(P) dB. Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz bands immediately outside and adjacent to a licensee’s frequency block, a resolution bandwidth of at least 30 kHz may be employed.

FCC § 27.53(h) (1)

Except as otherwise specified below, for operations in the 1695-1710 MHz, 1710-1755 MHz, 1755-1780 MHz, 1915-1920 MHz, 1995-2000 MHz, 2000-2020 MHz, 2110-2155 MHz, 2155-2180 MHz, and 2180-2200 bands, the power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) in watts by at least $43 + 10 \log_{10}(P)$ dB.

FCC § 27.53(m) (4)

For mobile digital stations (BRS and EBS stations), the attenuation factor shall be not less than:

• 40+10logP dB (−10 dBm, 100 nW) on all frequencies between the channel edge and 5 MHz from the

channel edge.

• 43+10logP dB (−13 dBm, 50 nW) on all frequencies between 5 MHz and X MHz from the channel edge,

• 55+10logP dB (−25 dBm, 3 nW) on all frequencies more than X MHz from the channel edge, where X is the greater of 6 MHz or the actual emission bandwidth (26 dB).

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. Mobile Satellite Service licensees operating on frequencies below 2495 MHz may also submit a documented interference complaint against BRS licensees operating on channel BRS Channel 1 on the same terms and conditions as adjacent channel BRS or EBS licensees.

5.5.2 Test Setup

The section 4.4.1 (Diagram 1) test setup description was used for this test. The photo of test setup please refer to ANNEX B.

5.5.3 Test Procedure

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 blocks 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 emissions are attenuated at least 26 dB below the transmitter power.

1. The EUT is coupled to the system simulator and spectrum analyzer; the RF load attached to EUT antenna terminal is 50Ohm; the path loss as the factor is calibrated to correct the reading.

2. Base Station is used to establish communication with the EUT, and its parameters are set to force the EUT transmitting at maximum output power.

3. The RF output of the transmitter is connected to the input of the spectrum analyzer through sufficient attenuation.

4. Spurious emissions are tested with 0.001MHz RBW for frequency less than 150kHz, 0.01MHz RBW for frequency less than 30MHz, 0.1MHz RBW for frequency less than 1GHz, and 1MHz RBW for frequency above 1GHz. And sweep point number are at least 401, referring to following formula.

Sweep point number = Span/RBW

VBW=3*RBW

Detector Mode=mean or average power

5. Record the frequencies and levels of spurious emissions.

5.5.4 Test Result

Please refer to ANNEX A.5.

5.6 Band Edge

5.6.1 Limit

FCC § 2.1051 & 22.917(a) & 24.238(a) & 27.53(a) & 27.53(c) & 27.53(g) & 27.53(h) & 27.53(m)

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 emissions are attenuated at least 26 dB below the transmitter power.

FCC § 22.917(a) & 24.238(a)

The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43+10*log(P) dB. This is calculated to be -13 dBm.

FCC § 27.53(a) (4)

For mobile and portable stations operating in the 2305-2315MHz and 2350-2360MHz bands:

(1)By a factor of not less than: 43 + 10 log (P) dB on all frequencies between 2305 and 2320MHz and on all frequencies between 2345 and 2360MHz that are outside the licensed band(s) of operation, not less than 55 + 10 log (P) dB on all frequencies between 2320 and 2324MHz and on all frequencies between 2341 and 2345MHz, not less than 61 + 10 log (P) dB on all frequencies between 2324 and 2328MHz and on all frequencies between 2337 and 2341MHz, and not less than 67 + 10 log (P) dB on all frequencies between 2328 and 2337MHz.

(2)By a factor of not less than 43 + 10 log (P) dB on all frequencies between 2300 and 2305MHz, 55 + 10 log (P) dB on all frequencies between 2296 and 2300MHz, 61 + 10 log (P) dB on all frequencies between 2292 and 2296MHz, 67 + 10 log (P) dB on all frequencies between 2288 and 2292MHz, and 70 + 10 log (P) dB below 2288MHz.

(3)By a factor of not less than 43 + 10 log (P) dB on all frequencies between 2360 and 2365MHz, and not less than 70 + 10 log (P) dB above 2365MHz.

FCC § 27.53(c)

For operations in the 746–758 MHz band and the 776–788 MHz band, the power of any emission outside the licensee’s frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, in accordance with the following:

(1) On any frequency outside the 746–758 MHz band, the power of any emission shall be attenuated outside the

band below the transmitter power (P) by at least 43 + 10 log (P) dB;

(2) On any frequency outside the 776–788 MHz band, the power of any emission shall be attenuated outside the

band below the transmitter power (P) by at least 43 + 10 log (P) dB;

(3) On all frequencies between 763–775 MHz and 793–805 MHz, by a factor not less than 76 + 10 log (P) dB in a 6.25 kHz band segment, for base and fixed stations;

(4) On all frequencies between 763–775 MHz and 793–805 MHz, by a factor not less than 65 + 10 log (P) dB in a 6.25 kHz band segment, for mobile and portable stations;

(5) Compliance with the provisions of paragraphs (c)(1) and (c)(2) of this section is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater.

However, in the 100 kHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth

of at least 30 kHz may be employed;

(6) Compliance with the provisions of paragraphs (c)(3) and (c)(4) of this section is based on the use of measurement instrumentation such that the reading taken with any resolution bandwidth setting should be adjusted to indicate spectral energy in a 6.25 kHz segment.

FCC § 27.53(g)

For operations in the 600MHz band and the 698-746MHz band, the power of any emission outside a licensee’s frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least 43+10*log(P) dB. Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz bands immediately outside and adjacent to a licensee’s frequency block, a resolution bandwidth of at least 30 kHz may be employed.

FCC § 27.53(h) (1)

Except as otherwise specified below, for operations in the 1695-1710 MHz, 1710-1755 MHz, 1755-1780 MHz, 1915-1920 MHz, 1995-2000 MHz, 2000-2020 MHz, 2110-2155 MHz, 2155-2180 MHz, and 2180-2200 bands, the power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) in watts by at least 43 + 10 $\log_{10}$ (P) dB.

FCC § 27.53(m) (4)

For mobile digital stations (BRS and EBS stations), the attenuation factor shall be not less than:

• 40+10logP dB (−10 dBm, 100 nW) on all frequencies between the channel edge and 5 MHz from the channel edge.

• 43+10logP dB (−13 dBm, 50 nW) on all frequencies between 5 MHz and X MHz from the channel edge,

• 55+10logP dB (−25 dBm, 3 nW) on all frequencies more than X MHz from the channel edge, where X is the greater of 6 MHz or the actual emission bandwidth (26 dB).

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. Mobile Satellite Service

licensees operating on frequencies below 2495 MHz may also submit a documented interference complaint against BRS licensees operating on channel BRS Channel 1 on the same terms and conditions as adjacent channel BRS or EBS licensees.

5.6.2 Test Setup

The section 4.4.1 (Diagram 1) test setup description was used for this test. The photo of test setup please refer to ANNEX B.

5.6.3 Test Procedure

The EUT, which is powered by the Battery, is coupled to the Spectrum Analyzer (SA) and the System Simulator (SS) with attenuators through the Power Splitter; the RF load attached to the EUT antenna terminal is 50 Ohm; the path loss as the factor is calibrated to correct the reading.

1.The EUT is coupled to the system simulator and spectrum analyzer; the RF load attached to EUT antenna terminal is 50Ohm; the path loss as the factor is calibrated to correct the reading.

2. Base Station is used to establish communication with the EUT, and its parameters are set to force the EUT transmitting at maximum output power.

3. The RF output of the transmitter is connected to the input of the spectrum analyzer through sufficient attenuation.

4. The center of the spectrum analyzer was set to block edge frequency.

5. Band edge are tested with 1%*cBW (RBW), and sweep point number referred to following formula.

Sweep point number = 2*Span/RBW

VBW=3RBW

6. Record the frequencies and levels of spurious emissions.

For mobile and portable stations, on all frequencies between 763–775 MHz and 793–805 MHz, by a factor not less than 65 + 10 log (P) dB in a 6.25 kHz band segment. Since it was not possible to set the resolution bandwidth to 6.25 kHz with the available equipment, a bandwidth of 10 kHz was used instead to show compliance. By using a 10 kHz bandwidth on the spectrum analyzer.

10*log(10 kHz / 6.25 kHz) = 2.04 dB
Limit Line = -35 dBm + 2.04 dB = -32.96dBm

5.6.4 Test Result

Please refer to ANNEX A.6.

5.7 Field Strength of Spurious Radiation

5.7.1 Limit

FCC § 2.1053 & 22.917(a) & 24.238(a) & 27.53(a) & 27.53(c) & 27.53(f) & 27.53(g) & 27.53(h) & 27.53(m)

FCC § 22.917(a) & 24.238(a)

The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43+10*log(P) dB. This is calculated to be -13 dBm.

FCC § 27.53(a) (4)

For mobile and portable stations operating in the 2305-2315MHz and 2350-2360MHz bands:

(1)By a factor of not less than: 43 + 10 log (P) dB on all frequencies between 2305 and 2320MHz and on all frequencies between 2345 and 2360MHz that are outside the licensed band(s) of operation, not less than 55 + 10 log (P) dB on all frequencies between 2320 and 2324MHz and on all frequencies between 2341 and 2345MHz, not less than 61 + 10 log (P) dB on all frequencies between 2324 and 2328MHz and on all frequencies between 2337 and 2341MHz, and not less than 67 + 10 log (P) dB on all frequencies between 2328 and 2337MHz.

(2)By a factor of not less than 43 + 10 log (P) dB on all frequencies between 2300 and 2305MHz, 55 + 10 log (P) dB on all frequencies between 2296 and 2300MHz, 61 + 10 log (P) dB on all frequencies between 2292 and 2296MHz, 67 + 10 log (P) dB on all frequencies between 2288 and 2292MHz, and 70 + 10 log (P) dB below 2288MHz.

(3)By a factor of not less than 43 + 10 log (P) dB on all frequencies between 2360 and 2365MHz, and not less than 70 + 10 log (P) dB above 2365MHz.

FCC § 27.53(c)

For operations in the 746–758 MHz band and the 776–788 MHz band, the power of any emission outside the licensee’s frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, in accordance with the following:

(1) On any frequency outside the 746–758 MHz band, the power of any emission shall be attenuated outside the

band below the transmitter power (P) by at least 43 + 10 log (P) dB;

(2) On any frequency outside the 776–788 MHz band, the power of any emission shall be attenuated outside the

band below the transmitter power (P) by at least 43 + 10 log (P) dB;

(3) On all frequencies between 763–775 MHz and 793–805 MHz, by a factor not less than 76 + 10 log (P) dB in a 6.25 kHz band segment, for base and fixed stations;

(4) On all frequencies between 763–775 MHz and 793–805 MHz, by a factor not less than 65 + 10 log (P) dB in a 6.25 kHz band segment, for mobile and portable stations;

(5) Compliance with the provisions of paragraphs (c)(1) and (c)(2) of this section is based on the use of

measurement instrumentation employing a resolution bandwidth of 100 kHz or greater.

However, in the 100 kHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth

of at least 30 kHz may be employed;

(6) Compliance with the provisions of paragraphs (c)(3) and (c)(4) of this section is based on the use of measurement instrumentation such that the reading taken with any resolution bandwidth setting should be adjusted to indicate spectral energy in a 6.25 kHz segment.

FCC § 27.53(f)

For operations in the 746–758 MHz, 775–788 MHz, and 805–806 MHz bands, emissions in the band 1559–1610 MHz shall be limited to - 70 dBW/MHz equivalent isotropically radiated power (EIRP) for wideband signals, and -80 dBW EIRP for discrete emissions of less than 700 Hz bandwidth. For the purpose of equipment authorization, a transmitter shall be tested with an antenna that is representative of the type that will be used with the equipment in normal operation.

FCC § 27.53(g)

For operations in the 600MHz band and the 698-746MHz band, the power of any emission outside a licensee’s frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least 43+10*log(P) dB. Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz bands immediately outside and adjacent to a licensee’s frequency block, a resolution bandwidth of at least 30 kHz may be employed.

FCC § 27.53(h) (1)

Except as otherwise specified below, for operations in the 1695-1710 MHz, 1710-1755 MHz, 1755-1780 MHz, 1915-1920 MHz, 1995-2000 MHz, 2000-2020 MHz, 2110-2155 MHz, 2155-2180 MHz, and 2180-2200 bands, the power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) in watts by at least $43 + 10 \log_{10}(P)$ dB.

FCC § 27.53(m) (4)

For mobile digital stations (BRS and EBS stations), the attenuation factor shall be not less than:

• 40+10logP dB (−10 dBm, 100 nW) on all frequencies between the channel edge and 5 MHz from the channel edge.

• 43+10logP dB (−13 dBm, 50 nW) on all frequencies between 5 MHz and X MHz from the channel edge,

• 55+10logP dB (−25 dBm, 3 nW) on all frequencies more than X MHz from the channel edge, where X is the greater of 6 MHz or the actual emission bandwidth (26 dB).

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. Mobile Satellite Service licensees operating on frequencies below 2495 MHz may also submit a documented interference complaint against BRS licensees operating on channel BRS Channel 1 on the same terms and conditions as adjacent channel BRS or EBS licensees.

5.7.2 Test Setup

The section 4.4.3 and 4.4.4 (Diagram 3, 4) test setup description was used for this test. The photo of test setup please refer to ANNEX B.

5.7.3 Test Procedure

1. On a test site, the EUT shall be placed at 80cm height on a turn table, and in the position close to normal use as declared by the applicant.

2. The test antenna shall be oriented initially for vertical polarization located 3 m from EUT to correspond to the fundamental frequency of the transmitter.

3. The output of the test antenna shall be connected to the measuring receiver and the peak detector is used for the measurement.

4. During the measurement of the EUT, the resolution bandwidth was to 1 MHz and the average bandwidth

was set to 1 MHz.

5. The transmitter shall be switched on; the measuring receiver shall be tuned to the frequency of the

transmitter under test.

6. The test antenna shall be raised and lowered through the specified range of height until the maximum

signal level is detected by the measuring receiver.

7. The transmitter shall be rotated through 360° in the horizontal plane, until the maximum signal level is

detected by the measuring receiver.

8. The test antenna shall be raised and lowered again through the specified range of height until the

maximum signal level is detected by the measuring receiver.

9. The maximum signal level detected by the measuring receiver shall be noted.

10. The EUT was replaced by half-wave dipole (824 ~ 849 MHz) or horn antenna (1 850 ~ 1 910 MHz) connected to a signal generator.

11. In necessary, the input attenuator setting on the measuring receiver shall be adjusted in order to increase

the sensitivity of the measuring receiver.

12. The test antenna shall be raised and lowered through the specified range of height to ensure that the

maximum signal is received.

13. The input signal to the substitution antenna shall be adjusted to the level that produces a level

detected by the measuring received, which is equal to the level noted while the transmitter radiated

power was measured, corrected for the change of input attenuator setting of the measuring receiver.

14. The input level to the substitution antenna shall be recorded as power level in dBm, corrected for any change of input attenuator setting of the measuring receiver.

15. The measurement shall be repeated with the test antenna and the substitution antenna orientated for horizontal polarization.

Final measurement calculation as below:

The relevant equation for determining the ERP/EIRP from the radiated RF output power is:

ERP/EIRP (dBm) = SA Read Value (dBm) + Correction Factor (dB)

where:
ERP/EIRP = effective or equivalent radiated power, in dBm;
SA Read Value = measured transmitter power received by EMI receiver or spectrum analyzer, in dBm;
Correction Factor = total correction factor including cable loss, in dB;

During the test, the data of Correction Factor (dB) is added in the EMI receiver or spectrum analyzer, so SA Read Value (dBm) is the final values which contains the data of Correction Factor (dB).

For example:

In the ERP test, when SA read value for GSM850 is 21dBm, and correction factor is 8dB, then final ERP value for GSM850 is:

ERP (dBm) = 21dBm + 8dB = 29dBm

5.7.4 Test Result

Please refer to ANNEX A.7.

ANNEX A TEST RESULTS

A.1 Transmitter Radiated Power (EIRP/ERP)

Note: The Transmitter Radiated Power (EIRP/ERP) please refer to the Report No. BL-EC2140498-501(G1), which issued by Shenzhen BALUN Technology Co., Ltd. on Jul. 26, 2021, Section A.1 Transmitter Radiated Power (EIRP/ERP).

A.2 Peak to Average Ratio

Note: The Peak to Average Ratio please refer to the Report No. BL-EC2140498-501(G1), which issued by Shenzhen BALUN Technology Co., Ltd. on Jul. 26, 2021, Section A.2 Peak to Average Ratio.

A.3 Occupied Bandwidth

Note: The Occupied Bandwidth please refer to the Report No. BL-EC2140498-501(G1), which issued by Shenzhen BALUN Technology Co., Ltd. on Jul. 26, 2021, Section A.3 Occupied Bandwidth.

A.4 Frequency Stability

Note: The Frequency Stability please refer to the Report No. BL-EC2140498-501(G1), which issued by Shenzhen BALUN Technology Co., Ltd. on Jul. 26, 2021, Section A.4 Frequency Stability.

A.5 Spurious Emission at Antenna Terminals

Note: The Spurious Emission at Antenna Terminals please refer to the Report No. BL-EC2140498-501(G1), which issued by Shenzhen BALUN Technology Co., Ltd. on Jul. 26, 2021, Section A.5 Spurious Emission at Antenna Terminals.

A.6 Band Edge

Note: The Band Edge please refer to the Report No. BL-EC2140498-501(G1), which issued by Shenzhen BALUN Technology Co., Ltd. on Jul. 26, 2021, Section A.6 Band Edge.

A.7 Field Strength of Spurious Radiation

Note 1: All modes have been tested, and only the worst case data are shown here.

Note 2: The frequencies of verdict which are marked by "N/A" should be ignored because they are UE carrier frequency.

Note 3: Test plots please refer to the document “Annex No.: BL-EC2350572-501 Data Part 1.pdf”.

GSM Mode Test Verdict

Test Band	Test Channel	Refer to Plot[Note3]	Verdict
GPRS 850	LCH	1.1	Pass
	MCH	1.2	Pass
	HCH	1.3	Pass
GPRS 1900	LCH	2.1	Pass
	MCH	2.2	Pass
	HCH	2.3	Pass
EGPRS 850	LCH	3.1	Pass
	MCH	3.2	Pass
	HCH	3.3	Pass
EGPRS 1900	LCH	4.1	Pass
	MCH	4.2	Pass
	HCH	4.3	Pass

LTE-M1 Mode Test Data

Test Band	Test Bandwidth	Test Channel	Test Mode	Test RB (Size#Offset)	Refer to Plot[Note3]	Verdict
LTE-M1 Band 2	1.4 MHz	MCH	QPSK	RB1#0	5.1	Pass
	3 MHz	MCH	QPSK	RB1#0	5.2	Pass
	5 MHz	MCH	QPSK	RB1#0	5.3	Pass
	10 MHz	MCH	QPSK	RB1#0	5.4	Pass
	15 MHz	MCH	QPSK	RB1#0	5.5	Pass
	20 MHz	MCH	QPSK	RB1#0	5.6	Pass
LTE-M1 Band 4	1.4 MHz	MCH	QPSK	RB1#0	6.1	Pass
	3 MHz	MCH	QPSK	RB1#0	6.2	Pass
	5 MHz	MCH	QPSK	RB1#0	6.3	Pass
	10 MHz	MCH	QPSK	RB1#0	6.4	Pass
	15 MHz	MCH	QPSK	RB1#0	6.5	Pass
	20 MHz	MCH	QPSK	RB1#0	6.6	Pass
LTE-M1 Band 5	1.4 MHz	MCH	QPSK	RB1#0	7.1	Pass
	3 MHz	MCH	QPSK	RB1#0	7.2	Pass
	5 MHz	MCH	QPSK	RB1#0	7.3	Pass
	10 MHz	MCH	QPSK	RB1#0	7.4	Pass
LTE-M1 Band 12	1.4 MHz	MCH	QPSK	RB1#0	8.1	Pass
	3 MHz	MCH	QPSK	RB1#0	8.2	Pass
	5 MHz	MCH	QPSK	RB1#0	8.3	Pass
	10 MHz	MCH	QPSK	RB1#0	8.4	Pass
LTE-M1 Band 13	5 MHz	MCH	QPSK	RB1#0	9.1	Pass
	10 MHz	MCH	QPSK	RB1#0	9.2	Pass
LTE-M1 Band 25	1.4 MHz	MCH	QPSK	RB1#0	10.1	Pass
	3 MHz	MCH	QPSK	RB1#0	10.2	Pass
	5 MHz	MCH	QPSK	RB1#0	10.3	Pass
	10 MHz	MCH	QPSK	RB1#0	10.4	Pass
	15 MHz	MCH	QPSK	RB1#0	10.5	Pass
	20 MHz	MCH	QPSK	RB1#0	10.6	Pass
LTE-M1 Band 66	1.4 MHz	MCH	QPSK	RB1#0	11.1	Pass
	3 MHz	MCH	QPSK	RB1#0	11.2	Pass
	5 MHz	MCH	QPSK	RB1#0	11.3	Pass
	10 MHz	MCH	QPSK	RB1#0	11.4	Pass
	15 MHz	MCH	QPSK	RB1#0	11.5	Pass
	20 MHz	MCH	QPSK	RB1#0	11.6	Pass
LTE-M1 Band 85	5 MHz	MCH	QPSK	RB1#0	12.1	Pass
	10 MHz	MCH	QPSK	RB1#0	12.2	Pass

NB-IoT Mode Test Data

Test Band	Test Sub-carrier spacing	Test Channel	Test Mode	Test RB (Size#Offset)	Refer to Plot[Note3]	Verdict
NB-IoT Band 2	3.75kHz	MCH	QPSK	RB1#0	13.1	Pass
			BPSK	RB1#0	13.2	Pass
	15kHz	MCH	QPSK	RB1#0	13.3	Pass
			BPSK	RB1#0	13.4	Pass
NB-IoT Band 4	3.75kHz	MCH	QPSK	RB1#0	14.1	Pass
			BPSK	RB1#0	14.2	Pass
	15kHz	MCH	QPSK	RB1#0	14.3	Pass
			BPSK	RB1#0	14.4	Pass
NB-IoT Band 5	3.75kHz	MCH	QPSK	RB1#0	15.1	Pass
			BPSK	RB1#0	15.2	Pass
	15kHz		QPSK	RB1#0	15.3	Pass
			BPSK	RB1#0	15.4	Pass
NB-IoT Band 12	3.75kHz	MCH	QPSK	RB1#0	16.1	Pass
			BPSK	RB1#0	16.2	Pass
	15kHz		QPSK	RB1#0	16.3	Pass
			BPSK	RB1#0	16.4	Pass
NB-IoT Band 13	3.75kHz	MCH	QPSK	RB1#0	17.1	Pass
			BPSK	RB1#0	17.2	Pass
	15kHz		QPSK	RB1#0	17.3	Pass
			BPSK	RB1#0	17.4	Pass
NB-IoT Band 25	3.75kHz	MCH	QPSK	RB1#0	18.1	Pass
			BPSK	RB1#0	18.2	Pass
	15kHz		QPSK	RB1#0	18.3	Pass
			BPSK	RB1#0	18.4	Pass
NB-IoT Band 66	3.75kHz	MCH	QPSK	RB1#0	19.1	Pass
			BPSK	RB1#0	19.2	Pass
	15kHz		QPSK	RB1#0	19.3	Pass
			BPSK	RB1#0	19.4	Pass
NB-IoT Band 71	3.75kHz	MCH	QPSK	RB1#0	20.1	Pass
			BPSK	RB1#0	20.2	Pass
	15kHz		QPSK	RB1#0	20.3	Pass
			BPSK	RB1#0	20.4	Pass
NB-IoT Band 85	3.75kHz	MCH	QPSK	RB1#0	21.1	Pass
			BPSK	RB1#0	21.2	Pass
	15kHz		QPSK	RB1#0	21.3	Pass
			BPSK	RB1#0	21.4	Pass

ANNEX B TEST SETUP PHOTOS

Please refer to the document “BL-EC2370572-AR.PDF”.

ANNEX C EUT EXTERNAL PHOTOS

Please refer to the document “BL-EC2370572-AW.PDF”.

ANNEX D EUT INTERNAL PHOTOS

Please refer to the document “BL-EC2370572-AI.PDF”.

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