FCC RADIO TEST REPORT

FCC ID	:	**2AJN7-TP00146ALQ**
Equipment	:	**Notebook Computer**
Brand Name	:	**Lenovo**
Compliance ID	:	**TP00146A**
Applicant	:	**LC Future Center Limited Taiwan Branch** **7F., No.780, Beian Rd., Zhongshan Dist., Taipei 104, Taiwan**
Manufacturer	:	**LCFC (HeFei) Electronics Technology Co., Ltd.** **No. 3188-1, Yungu Road (Hefei Export Processing Zone), Hefei Economics & Technology Development Area, Anhui, CHINA**
Standard	:	**FCC 47 CFR Part 2, 90(R)**

Equipment: Quectel EM05-G tested inside of Lenovo Notebook Computer.

The product was received on Nov. 14, 2022 and testing was performed from Dec. 26, 2022 to Jan. 05, 2023. We, Sporton International Inc. EMC & Wireless Communications Laboratory, would like to declare that the tested sample has been evaluated in accordance with the test procedures given in ANSI / TIA-603-E and has been in compliance with the applicable technical standards.

The test results in this partial report apply exclusively to the tested model / sample. Without written approval from Sporton International Inc. EMC & Wireless Communications Laboratory, the test report shall not be reproduced except in full.

Louis Wu

Approved by: Louis Wu

Sporton International Inc. EMC & Wireless Communications Laboratory

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History of this test report

Report No.	Version	Description	Issue Date
FG2N1408-01C	01	Initial issue of report	Jan. 09, 2023
FG2N1408-01C	02	Revise cover page and Product Feature	Feb. 21, 2023
FG2N1408-01C	03	Revise Product Feature	Feb. 24, 2023

Summary of Test Result

Report Clause	Ref Std. Clause	Test Items	Result (PASS/FAIL)	Remark
3.2	§2.1046	Conducted Output Power	Reporting only	-
	§90.542 (a)(7)	Effective Radiated Power	Pass	-
-	-	Peak-to-Average Ratio	-	See Note
-	§2.1049	Occupied Bandwidth	-	See Note
-	§2.1053 §90.543 (e)(2)	Conducted Band Edge Measurement	-	See Note
-	§2.1051 §90.210 (n)	Emission Mask	-	See Note
-	§2.1053 §90.543 (e)(3)	Conducted Spurious Emission	-	See Note
-	§2.1055 §90.539 (e)	Frequency Stability Temperature & Voltage	-	See Note
4.2	§2.1053 §90.543 (e)(3) §90.543 (f)	Radiated Spurious Emission	Pass	10.38 dB under the limit at 1584.000 MHz

Note:
1. For host device, Radiated Spurious Emission and Equivalent Radiated Power are verified and complies with the limit in this test report.
2. For host device, the Conducted Output Power is no difference after compared to module (Model: EM05-G)

Declaration of Conformity:
1. The test results (PASS/FAIL) with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers. It's means measurement values may risk exceeding the limit of regulation standards, if measurement uncertainty is include in test results. 2. The measurement uncertainty please refer to report "Uncertainty of Evaluation".
Comments and Explanations:
The product specifications of the EUT presented in the report are declared by the manufacturer who shall take full responsibility for the authenticity.

Reviewed by: Sheng Kuo

Report Producer: Lucy Wu

1 General Description

1.1 Product Feature of Equipment Under Test

Product Feature	
Equipment	Notebook Computer
Brand Name	Lenovo
Compliance ID	TP00146A
FCC ID	2AJN7-TP00146ALQ
Integrated WLAN Module	Brand Name: Intel Model Name: AX211D2W FCC ID: PD9AX211D2
Integrated NFC Module	Brand Name: Foxconn Model Name: T77H747
Sample 1	EUT with Luxshare-ICT Antenna
Sample 2	EUT with Speed Taiwan Corporation Antenna
EUT supports Radios application	WCDMA/HSPA/LTE/GNSS/NFC WLAN 11a/b/g/n HT20/HT40 WLAN 11ac VHT20/VHT40/VHT80/VHT160 WLAN 11ax HE20/HE40/HE80/HE160 Bluetooth BR/EDR/LE
EUT Stage	Production Unit

Remark:

1. The above EUT's information was declared by manufacturer.

2. Equipment: Quectel EM05-G tested inside of Lenovo Notebook Computer.

WWAN Antenna Information				
Main Antenna	**Manufacturer**	Luxshare-ICT	**Peak gain (dBi)**	LTE Band 14 :0.32
	Part number	DC33001YV10	**Type**	PIFA
	Manufacturer	Speed Taiwan Corporation	**Peak gain (dBi)**	LTE Band 14 :0.32
	Part number	DC33001YU10	**Type**	PIFA

Remark: The above EUT's information was declared by manufacturer. Please refer to Comments and Explanations in report summary.

1.2 Product Specification of Equipment Under Test

Product Specification is subject to this standard	
Tx Frequency	LTE Band 14 :790.5 MHz ~ 795.5 MHz
Rx Frequency	LTE Band 14 :760.5 MHz ~ 765.5 MHz
Bandwidth	5MHz / 10MHz
Maximum Output Power to Antenna	24.13 dBm
Type of Modulation	QPSK / 16QAM

1.3 Modification of EUT

No modifications made to the EUT during the testing.

1.4 Testing Site

Test Site	Sporton International Inc. EMC & Wireless Communications Laboratory	
Test Site Location	No.52, Huaya 1st Rd., Guishan Dist.,Taoyuan City 333	
Test Site No.	Sporton Site No.	
	TH03-HY	03CH07-HY
Test Engineer	Cotty Hsu	Jesse Wang, Stan Hsieh and Ken Wu
Temperature (℃)	22.2~23.1	18.2~23.5
Relative Humidity (%)	51~56	56.3~68.3

Note: The test site complies with ANSI C63.4 2014 requirement.

FCC Designation No.: TW1190

1.5 Applied Standards

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

- ANSI C63.26-2015
- FCC 47 CFR Part 2, Part 90(R)
- ANSI / TIA-603-E
- FCC KDB 971168 D01 Power Meas. License Digital Systems v03r01
- FCC KDB 412172 D01 Determining ERP and EIRP v01r01
- FCC KDB 414788 D01 Radiated Test Site v01r01

Remark:

1. All the test items were validated and recorded in accordance with the standards without any modification during the testing.
2. The TAF code is not including all the FCC KDB listed without accreditation.

2 Test Configuration of Equipment Under Test

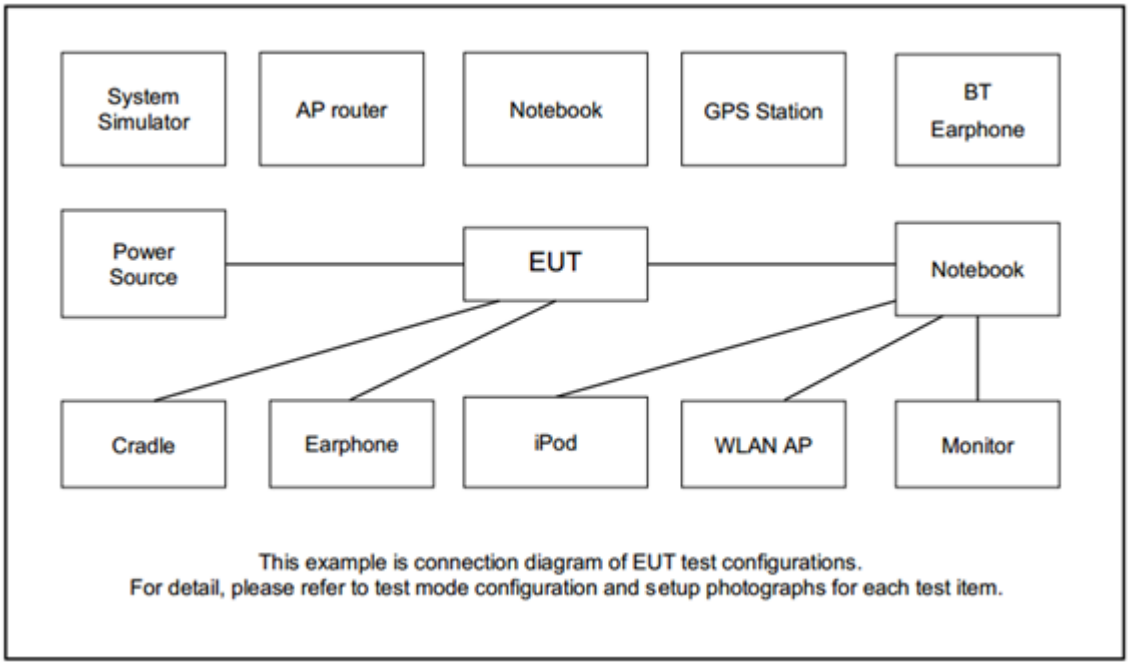
2.1 Test Mode

Antenna port conducted and radiated test items listed below are performed according to KDB 971168 D01 Power Meas. License Digital Systems v03r01 with maximum output power.

For radiated measurement, the measured emission level of the EUT was maximized by rotating the EUT on a turntable, adjusting the orientation of the EUT and EUT antenna in Tablet Type (three orthogonal panels, X, Y, Z) and Notebook Type, and adjusting the measurement antenna orientation, following C63.26 exploratory test procedures and only the worst case emissions were reported in this report.

Conducted Test Cases	Band	Bandwidth (MHz)						Modulation		RB #			Test Channel		
		1.4	3	5	10	15	20	QPSK	16QAM	1	Half	Full	L	M	H
Max. Output Power	14	-	-	v	v	-	-	v	v	v	v	v	v	v	v
E.R.P	14	-	-	v	v	-	-	v	v	Max. Power					
Radiated Spurious Emission	14	-	-	v	v	-	-	v		v			v	v	v
Remark	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 30MHz 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.** All the radiated test cases were performed with Sample 1														

2.2 Connection Diagram of Test System



This example is connection diagram of EUT test configurations.
For detail, please refer to test mode configuration and setup photographs for each test item.

2.3 Support Unit used in test configuration and system

Item	Equipment	Brand Name	Model No.	FCC ID	Data Cable	Power Cord
1.	System Simulator	Anritsu	MT8821C	N/A	N/A	Unshielded, 1.8 m
2.	iPod Earphone	Apple	N/A	Verification	Unshielded, 1.0 m	N/A

2.4 Frequency List of Low/Middle/High Channels

LTE Band 14 Channel and Frequency List				
BW [MHz]	Channel/Frequency(MHz)	Lowest	Middle	Highest
10	Channel	-	23330	-
	Frequency	-	793	-
5	Channel	23305	23330	23355
	Frequency	790.5	793	795.5

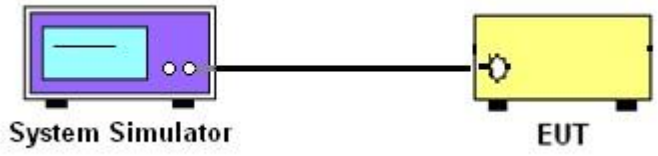
3 Conducted Test Items

3.1 Measuring Instruments

See list of measuring instruments of this test report.

3.1.1 Test Setup

3.1.2 Conducted Output Power



3.1.3 Test Result of Conducted Test

Please refer to Appendix A.

3.2 Conducted Output Power Measurement and ERP

3.2.1 Description of the Conducted Output Power Measurement and ERP Measurement

A base station simulator was used to establish communication with the EUT. Its parameters were set to transmit the maximum power on the EUT. The measured power in the radio frequency on the transmitter output terminals shall be reported.

The ERP of mobile transmitters must not exceed 3 Watts for LTE Band 14.

According to KDB 412172 D01 Power Approach,

EIRP = $P_T + G_T - L_C$, ERP = EIRP -2.15, where

P_T = transmitter output power in dBm

G_T = gain of the transmitting antenna in dBi

L_C = signal attenuation in the connecting cable between the transmitter and antenna in dB

3.2.2 Test Procedures

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

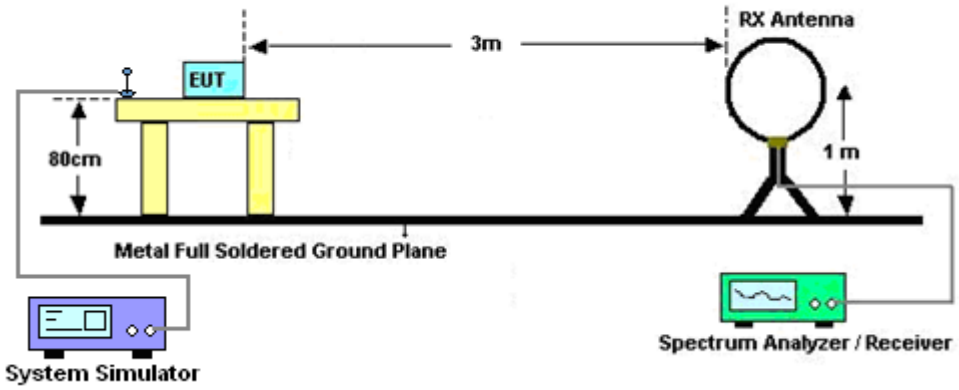
4 Radiated Test Items

4.1 Measuring Instruments

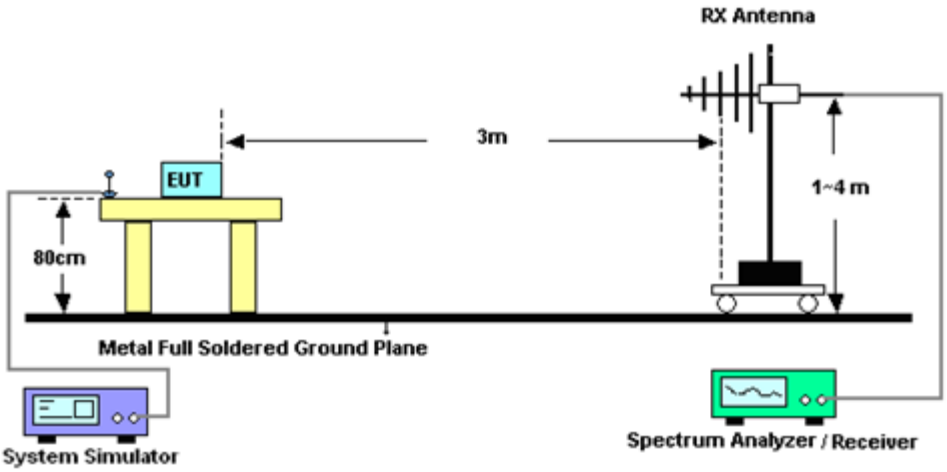
See list of measuring instruments of this test report.

4.1.1 Test Setup

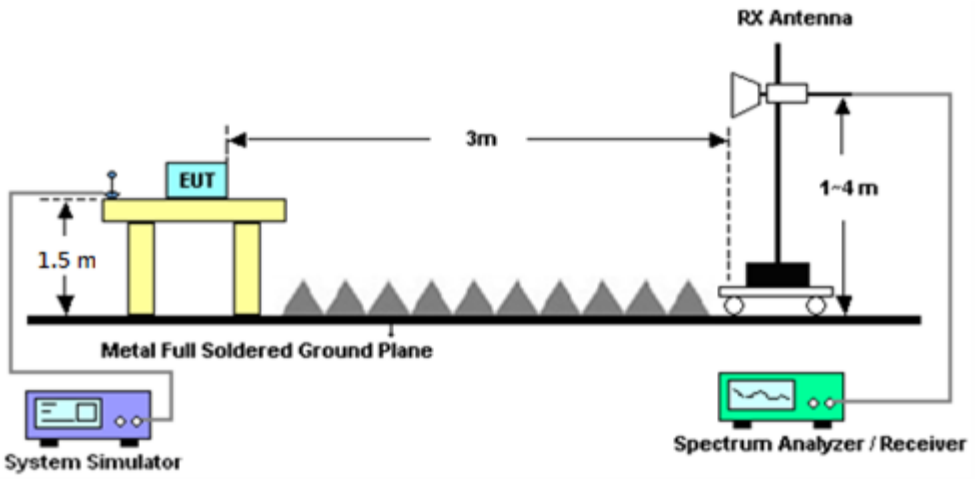
For radiated test below 30MHz



For radiated test from 30MHz to 1GHz



For radiated test above 1GHz



4.1.2 Test Result of Radiated Test

Please refer to Appendix B.

Note:

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.

There is adequate comparison measurement of both open-field test site and alternative test site - semi-Anechoic chamber according to 414788 D01 Radiated Test Site v01r01, and the result came out very similar.

4.2 Radiated Spurious Emission

4.2.1 Description of Radiated Spurious Emission

The radiated spurious emission was measured by substitution method according to ANSI / TIA-603-E. 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.

For operations in the 758-775 MHz and 788-805 MHz bands, all emissions including harmonics 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.

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

4.2.2 Test Procedures

The testing follows FCC KDB 971168 D01 v03r01 Section 7 and ANSI / TIA-603-E Section 2.2.12.

1. The EUT was placed on a turntable with 0.8 meter for frequency below 1GHz and 1.5 meter for frequency above 1GHz respectively above ground.
2. The EUT was set 3 meters from the receiving antenna, which was mounted on the antenna tower.
3. The table was rotated 360 degrees to determine the position of the highest spurious emission.
4. The height of the receiving antenna is varied between one meter and four meters to search the maximum spurious emission for both horizontal and vertical polarizations.
5. Make the measurement with the spectrum analyzer's RBW = 1MHz, VBW = 3MHz, Sweep = 500ms, Taking the record of maximum spurious emission.
6. A horn antenna was substituted in place of the EUT and was driven by a signal generator.
7. Tune the output power of signal generator to the same emission level with EUT maximum spurious emission.
8. Taking the record of output power at antenna port.
9. Repeat step 7 to step 8 for another polarization.
10. The RF fundamental frequency should be excluded against the limit line in the operating frequency band.
11. The limit line is derived from 43 + 10log(P)dB below the transmitter power P(Watts)

5 List of Measuring Equipment

Instrument	Brand Name	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
Bilog Antenna	TESEQ	CBL 6111D & 00800N1D01 N-06	35419 & 03	30MHz~1GHz	Apr. 24, 2022	Dec. 28, 2022~ Jan. 05, 2023	Apr. 23, 2023	Radiation (03CH07-HY)
Double Ridge Horn Antenna	ESCO	3117	00075962	1GHz ~ 18GHz	Dec. 01, 2022	Dec. 28, 2022~ Jan. 05, 2023	Nov. 30, 2023	Radiation (03CH07-HY)
Preamplifier	MITEQ	AMF-7D-0010 1800-30-10P	1590075	1GHz~18GHz	Apr. 21, 2022	Dec. 28, 2022~ Jan. 05, 2023	Apr. 20, 2023	Radiation (03CH07-HY)
Preamplifier	COM-POWER	PA-103A	161241	10MHz~1GHz	Oct. 03, 2022	Dec. 28, 2022~ Jan. 05, 2023	Oct. 02, 2023	Radiation (03CH07-HY)
Preamplifier	Agilent	8449B	3008A02362	1GHz~26.5GHz	Oct. 03, 2022	Dec. 28, 2022~ Jan. 05, 2023	Oct. 02, 2023	Radiation (03CH07-HY)
Spectrum Analyzer	Agilent	N9030A	MY52350276	3Hz~44GHz	Jul. 22, 2022	Dec. 28, 2022~ Jan. 05, 2023	Jul. 21, 2023	Radiation (03CH07-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	MY15682/4	30MHz to 18GHz	Feb. 23, 2022	Dec. 28, 2022~ Jan. 05, 2023	Feb. 22, 2023	Radiation (03CH07-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	MY24971/4	9kHz to 18GHz	Feb. 23, 2022	Dec. 28, 2022~ Jan. 05, 2023	Feb. 22, 2023	Radiation (03CH07-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	MY28655/4	9kHz to 18GHz	Feb. 23, 2022	Dec. 28, 2022~ Jan. 05, 2023	Feb. 22, 2023	Radiation (03CH07-HY)
Controller	EMEC	EM1000	N/A	Control Ant Mast	N/A	Dec. 28, 2022~ Jan. 05, 2023	N/A	Radiation (03CH07-HY)
Controller	MF	MF-7802	N/A	Control Turn table	N/A	Dec. 28, 2022~ Jan. 05, 2023	N/A	Radiation (03CH07-HY)
Antenna Mast	EMEC	AM-BS-4500E	N/A	Boresight mast 1M~4M	N/A	Dec. 28, 2022~ Jan. 05, 2023	N/A	Radiation (03CH07-HY)
Turn Table	ChainTek	Chaintek 3000	N/A	0~360 Degree	N/A	Dec. 28, 2022~ Jan. 05, 2023	N/A	Radiation (03CH07-HY)
Software	Audix	E3	N/A	N/A	N/A	Dec. 28, 2022~ Jan. 05, 2023	N/A	Radiation (03CH07-HY)
USB Data Logger	TECPEL	TR-32	HE17XB2495	N/A	Mar. 07, 2022	Dec. 28, 2022~ Jan. 05, 2023	Mar. 06, 2023	Radiation (03CH07-HY)
Loop Antenna	Rohde & Schwarz	HFH2-Z2	100488	9 kHz~30 MHz	Sep. 20, 2022	Dec. 28, 2022~ Jan. 05, 2023	Sep. 19, 2023	Radiation (03CH07-HY)
Horn Antenna	ETS-Lindgren	3117	00143261	1GHz~18GHz	Feb. 11, 2022	Dec. 28, 2022~ Jan. 05, 2023	Feb. 10, 2023	Radiation (03CH07-HY)
Signal Generator	Anritsu	MG3710A	6261943042	2G / 3G / LTE / 5G FR1	May 23, 2022	Dec. 28, 2022~ Jan. 05, 2023	May 22, 2023	Radiation (03CH07-HY)
Radio Communication Analyzer	Anritsu	MT8821C	6262025353	LTE FDD/TDD LTE-2CC DLCA/ULCA	Oct. 13, 2022	Dec. 26, 2022	Oct. 12, 2023	Conducted (TH03-HY)
Coupler	Warison	20dB 25W SMA Directional Coupler	#B	1-18GHz	Jan. 07, 2022	Dec. 26, 2022	Jan. 06, 2023	Conducted (TH03-HY)

6 Uncertainty of Evaluation

Uncertainty of Radiated Emission Measurement (30 MHz ~ 1000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**3.25 dB**

Uncertainty of Radiated Emission Measurement (1 GHz ~ 18 GHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**3.50 dB**

Appendix A. Test Results of Conducted Test

Conducted Output Power(Average power & ERP)

LTE Band 14 Maximum Average Power [dBm] (GT - LC = 0.32 dB)								
BW [MHz]	RB Size	RB Offset	Mod	Lowest	Middle	Highest	ERP (dBm)	ERP (W)
10	1	0	QPSK	-	24.13	-	22.30	0.1698
10	1	25			24.12			
10	1	49			24.07			
10	25	0			23.22			
10	25	12			23.13			
10	25	25			23.21			
10	50	0			23.19			
10	1	0	16-QAM		22.86		21.24	0.1330
10	1	25			23.07			
10	1	49			23.01			
10	25	0			22.21			
10	25	12			22.25			
10	25	25			22.41			
10	50	0			22.13			
Limit	ERP < 3W			Result			Pass	

LTE Band 14 Maximum Average Power [dBm] (GT - LC = 0.32 dB)								
BW [MHz]	RB Size	RB Offset	Mod	Lowest	Middle	Highest	ERP (dBm)	ERP (W)
5	1	0	QPSK	24.08	24.10	24.06	22.29	0.1694
5	1	12		24.12	24.11	24.11		
5	1	24		24.09	24.07	24.05		
5	12	0		23.35	23.35	23.21		
5	12	7		23.45	23.37	23.34		
5	12	13		23.41	23.33	23.31		
5	25	0		23.38	23.36	23.33		
5	1	0	16-QAM	23.04	23.18	22.90	21.71	0.1483
5	1	12		23.16	23.01	23.04		
5	1	24		23.54	23.46	23.21		
5	12	0		22.20	22.30	22.16		
5	12	7		22.44	22.37	22.26		
5	12	13		22.40	22.25	22.26		
5	25	0		22.46	22.38	22.31		
Limit	ERP < 3W			Result			Pass	

Appendix B. Test Results of Radiated Test

LTE Band 14

LTE Band 14 / 5MHz / QPSK									
Channel	Frequency (MHz)	ERP (dBm)	Limit (dBm)	Over Limit (dB)	SPA Reading (dBm)	S.G. Power (dBm)	TX Cable loss (dB)	TX Antenna Gain (dBi)	Polarization (H/V)
Lowest	1576	-54.91	-42.15	-12.76	-65.99	-56.9	0.95	5.09	H
	2368	-48.00	-13	-35.00	-64.54	-49.6	1.25	5.00	H
	3152	-57.98	-13	-44.98	-76.58	-60.8	1.50	6.47	H
									H
									H
									H
	1576	-55.21	-42.15	-13.06	-66.81	-57.2	0.95	5.09	V
	2368	-43.50	-13	-30.50	-60.4	-45.1	1.25	5.00	V
	3152	-55.98	-13	-42.98	-74.6	-58.8	1.50	6.47	V
									V
									V
									V
Middle	1584	-53.93	-42.15	-11.78	-65.04	-55.9	0.95	5.06	H
	2376	-50.47	-13	-37.47	-66.86	-52.1	1.25	5.03	H
	3160	-58.44	-13	-45.44	-77.04	-61.3	1.50	6.50	H
									H
									H
									H
	1584	-56.23	-42.15	-14.08	-67.79	-58.2	0.95	5.06	V
	2376	-44.97	-13	-31.97	-61.89	-46.6	1.25	5.03	V
	3160	-56.34	-13	-43.34	-75.66	-59.2	1.50	6.50	V
									V
									V
									V

Highest	1584	-52.53	-42.15	-10.38	-63.43	-54.5	0.95	5.06	H
	2384	-50.85	-13	-37.85	-67.64	-52.5	1.25	5.05	H
	3176	-55.78	-13	-42.78	-74.4	-58.7	1.50	6.57	H
									H
									H
									H
	1584	-52.83	-42.15	-10.68	-64.18	-54.8	0.95	5.06	V
	2384	-45.15	-13	-32.15	-62.46	-46.8	1.25	5.05	V
	3176	-52.68	-13	-39.68	-71.99	-55.6	1.50	6.57	V
									V
									V
									V

Remark: Spurious emissions within 30-1000MHz were found more than 20dB below limit line.

LTE Band 14 / 10MHz / QPSK									
Channel	Frequency (MHz)	ERP (dBm)	Limit (dBm)	Over Limit (dB)	SPA Reading (dBm)	S.G. Power (dBm)	TX Cable loss (dB)	TX Antenna Gain (dBi)	Polarization (H/V)
Middle	1576	-55.81	-42.15	-13.66	-66.83	-57.8	0.95	5.09	H
	2368	-51.10	-13	-38.10	-67.53	-52.7	1.25	5.00	H
	3152	-57.38	-13	-44.38	-75.86	-60.2	1.50	6.47	H
									H
									H
									H
	1576	-55.41	-42.15	-13.26	-66.75	-57.4	0.95	5.09	V
	2368	-45.50	-13	-32.50	-62.61	-47.1	1.25	5.00	V
	3152	-56.48	-13	-43.48	-75.64	-59.3	1.50	6.47	V
									V
									V
									V

Remark: Spurious emissions within 30-1000MHz were found more than 20dB below limit line.