



FCC RADIO TEST REPORT

FCC ID : 2AJN7-TP00145ALQ
Equipment : Notebook Computer
Brand Name : Lenovo
Compliance ID : TP00145A; TP00145B
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. 13, 2022 to Dec. 26, 2022. We, Sporton International Inc. Wensan 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. Wensan Laboratory, the test report shall not be reproduced except in full.

Approved by: Louis Wu

Sporton International Inc. Wensan Laboratory



Table of Contents

History of this test report.....	3
Summary of Test Result.....	4
1 General Description	5
1.1 Product Feature of Equipment Under Test.....	5
1.2 Product Specification of Equipment Under Test.....	6
1.3 Modification of EUT	6
1.4 Testing Site	6
1.5 Applied Standards	7
2 Test Configuration of Equipment Under Test	8
2.1 Test Mode	8
2.2 Connection Diagram of Test System.....	8
2.3 Support Unit used in test configuration and system	9
2.4 Frequency List of Low/Middle/High Channels	9
3 Conducted Test Items	10
3.1 Measuring Instruments	10
3.2 Conducted Output Power Measurement and ERP	11
4 Radiated Test Items	12
4.1 Measuring Instruments	12
4.2 Radiated Spurious Emission	14
5 List of Measuring Equipment.....	15
6 Uncertainty of Evaluation	16
Appendix A. Test Results of Conducted Test	
Appendix B. Test Results of Radiated Test	
Appendix C. Test Setup Photographs	



History of this test report

Report No.	Version	Description	Issue Date
FG2N1456-01C	01	Initial issue of report	Dec. 28, 2022
FG2N1456-01C	02	Revise Product Feature	Feb. 20, 2023
FG2N1456-01C	03	Revise cover page and Product Feature	Feb. 23, 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	10.39 dB under the limit at 1576.000 MHz

Note:

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

Declaration of Conformity:

- 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.
- 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.
- The purpose of different Compliance ID is for CPU (Intel/AMD).

Reviewed by: Sheng Kuo

Report Producer: Cindy Liu

1 General Description

1.1 Product Feature of Equipment Under Test

Product Feature	
Equipment	Notebook Computer
Brand Name	Lenovo
Compliance ID	TP00145A; TP00145B
FCC ID	2AJN7-TP00145ALQ
Sample 1	EUT with Amphenol Taiwan Corporation Antenna
Sample 2	EUT with Speed Antenna
Integrated WLAN Module	Brand Name: Intel Model Name: AX211D2W FCC ID: PD9AX211D2
Integrated WLAN Module	Brand Name: Qualcomm Model Name: QCNFA725 FCC ID: A5M-QCNFA725
Integrated NFC Module	Brand Name: Foxconn Model Name: T77H747
EUT supports Radios application	WCDMA/HSPA/LTE/GNSS/NFC WLAN 11a/b/g/n HT20/HT40 WLAN 11ac 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	Brand Name	Amphenol Taiwan Corporation	Peak gain(dBi)	LTE Band 14: -2.1
	Part number	DC33001YS50	Type	PIFA
	Brand Name	Speed	Peak gain(dBi)	LTE Band 14: -2.1
	Part number	DC33001YT50	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	23.93 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 (TAF Code: 1190)
Test Engineer	Cotty Hsu
Temperature (°C)	22.2~23.1
Relative Humidity (%)	51~56
Remark	The Conducted test item subcontracted to Sporton International Inc. EMC & Wireless Communications Laboratory

Test Site	Sporton International Inc. Wensan Laboratory
Test Site Location	No.58, Aly. 75, Ln. 564, Wenhua 3rd, Rd., Guishan Dist., Taoyuan City 333010
Test Site No.	Sporton Site No.
	03CH20-HY
Test Engineer	JC Liang, John Chuang and Steven Wu
Temperature (°C)	18~21
Relative Humidity (%)	68~70

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

FCC Designation No.: TW1190 and TW3786



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.

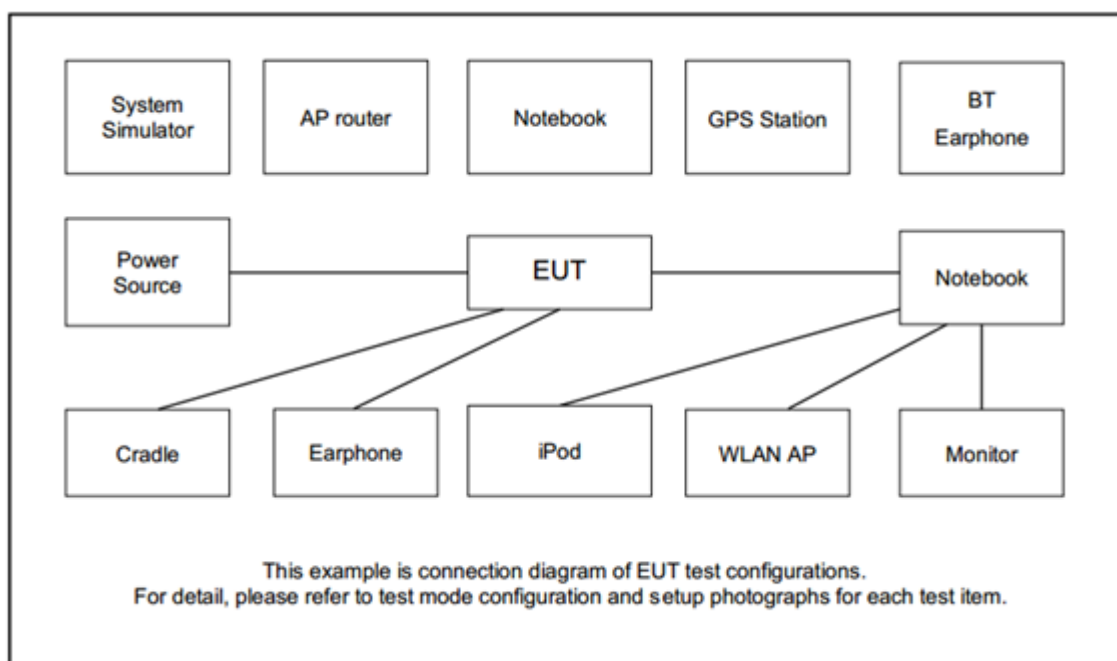
2 Test Configuration of Equipment Under Test

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.

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	<ol style="list-style-type: none"> The mark "v " means that this configuration is chosen for testing The mark "- " means that this bandwidth is not supported. 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. All the radiated test cases were performed with Sample 1. 														

2.2 Connection Diagram of Test System



2.3 Support Unit used in test configuration and system

Item	Equipment	Brand Name	Model No.	FCC ID	Data Cable	Power Cord
1.	iPod Earphone	Apple	N/A	Verification	Unshielded, 1.0 m	N/A
2.	System Simulator	Anritsu	MT8821C	N/A	N/A	Unshielded, 1.8 m
3.	System Simulator	Anritsu	MT8820C	N/A	N/A	Unshielded, 1.8 m

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

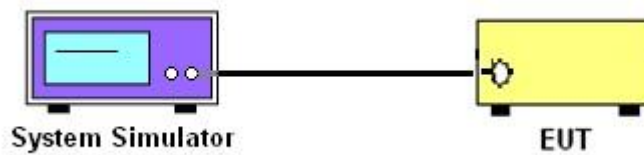
3 Conducted Test Items

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.

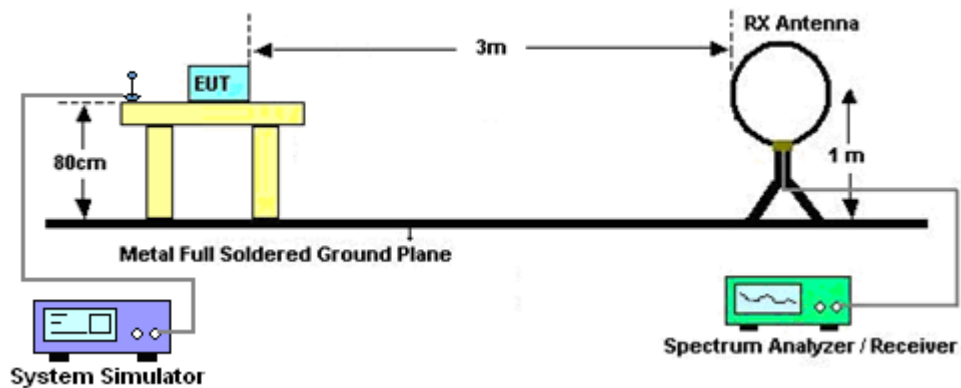
4 Radiated Test Items

4.1 Measuring Instruments

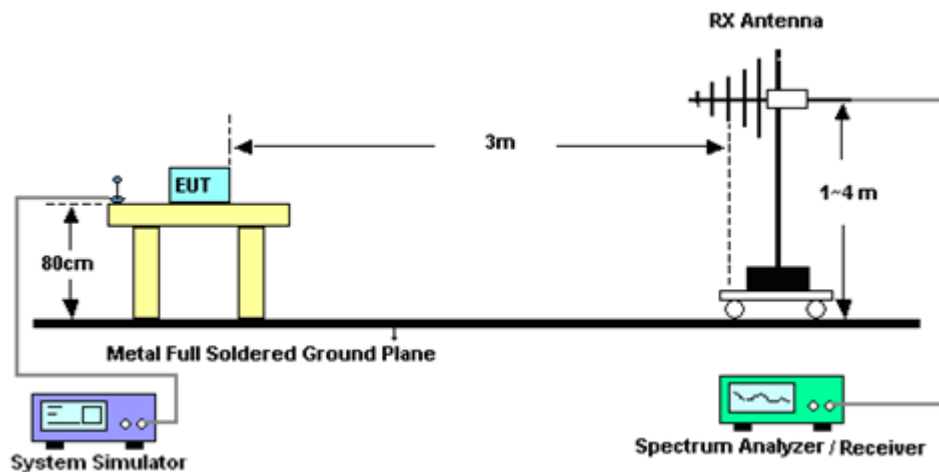
See list of measuring instruments of this test report.

4.1.1 Test Setup

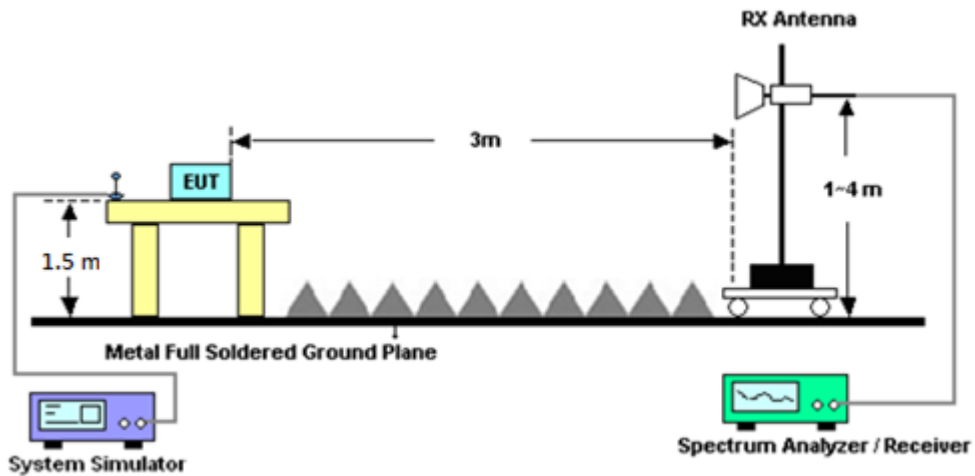
For radiated test below 30MHz



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 $43 + 10\log(P)$ 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
Signal Analyzer	Keysight	N9010B	MY60240520	N/A	Dec. 23, 2021	Dec. 13, 2022~ Dec. 21, 2022	Dec. 22, 2022	Radiation (03CH20-HY)
Signal Generator	Anritsu	MG3694C	163401	0.1Hz~40GHz	Feb. 13, 2022	Dec. 13, 2022~ Dec. 21, 2022	Feb. 12, 2023	Radiation (03CH20-HY)
Preamplifier	COM-POWER	PAM-103	18020201	1MHz-1000MHz	Jan. 03, 2022	Dec. 13, 2022~ Dec. 21, 2022	Jan. 02, 2023	Radiation (03CH20-HY)
Amplifier	EMCI	EMC118A45SE	980792	N/A	Nov. 14, 2022	Dec. 13, 2022~ Dec. 21, 2022	Nov. 13, 2023	Radiation (03CH20-HY)
Loop Antenna	Rohde & Schwarz	HFH2-Z2	100315	9 kHz~30 MHz	Jan. 07, 2022	Dec. 13, 2022~ Dec. 21, 2022	Jan. 06, 2023	Radiation (03CH20-HY)
Loop Antenna	Rohde & Schwarz	HFH2-Z2	100488	9 kHz~30 MHz	Sep. 20, 2022	Dec. 13, 2022~ Dec. 21, 2022	Sep. 19, 2023	Radiation (03CH20-HY)
Bilog Antenna	TESEQ	CBL 6111D&00802N1D 01N-06	54682 & AT-N0603	30MHz~1GHz	Sep. 18, 2022	Dec. 13, 2022~ Dec. 21, 2022	Sep. 17, 2023	Radiation (03CH20-HY)
Bilog Antenna	TESEQ	CBL 6111D&00802N1D 01N-06	55606 & 08	30MHz~1GHz	Oct. 22, 2022	Dec. 13, 2022~ Dec. 21, 2022	Oct. 21, 2023	Radiation (03CH20-HY)
Horn Antenna	SCHWARZBE CK	BBHA 9120 D	9120D-02038	1GHz~18GHz	Aug. 09, 2022	Dec. 13, 2022~ Dec. 21, 2022	Aug. 08, 2023	Radiation (03CH20-HY)
Horn Antenna	SCHWARZBE CK	BBHA 9120 D	9120D-1212	1GHz~18GHz	Mar. 10, 2022	Dec. 13, 2022~ Dec. 21, 2022	Mar. 09, 2023	Radiation (03CH20-HY)
Hygrometer	TECEPIL	DTM-303B	TP200879	N/A	Sep. 28, 2022	Dec. 13, 2022~ Dec. 21, 2022	Sep. 27, 2023	Radiation (03CH20-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	519229/2,8040 15/2,804027/2	N/A	Jan. 19, 2022	Dec. 13, 2022~ Dec. 21, 2022	Jan. 18, 2023	Radiation (03CH20-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	MY2857/2	N/A	Sep. 28, 2022	Dec. 13, 2022~ Dec. 21, 2022	Sep. 27, 2023	Radiation (03CH20-HY)
Software	Audix	E3 6.2009-8-24	RK-002156	N/A	N/A	Dec. 13, 2022~ Dec. 21, 2022	N/A	Radiation (03CH20-HY)
Antenna Mast	EMEC	AM-BS-4500-B	N/A	1m~4m	N/A	Dec. 13, 2022~ Dec. 21, 2022	N/A	Radiation (03CH20-HY)
Turn Table	EMEC	TT2000	N/A	0~360 Degree	N/A	Dec. 13, 2022~ Dec. 21, 2022	N/A	Radiation (03CH20-HY)
Controller	EMEC	EM1000	N/A	Control Turn table & Ant Mast	N/A	Dec. 13, 2022~ Dec. 21, 2022	N/A	Radiation (03CH20-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% ($U = 2U_c(y)$)	3.33 dB
---	---------

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

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2U_c(y)$)	3.40 dB
---	---------



Appendix A. Test Results of Conducted Test

Conducted Output Power(Average power & ERP)

LTE Band 14 Maximum Average Power [dBm] (GT - LC = -2.1 dB)								
BW [MHz]	RB Size	RB Offset	Mod	Lowest	Middle	Highest	ERP (dBm)	ERP (W)
10	1	0	QPSK	-	23.93	-	19.68	0.0929
10	1	25			23.90			
10	1	49			23.90			
10	25	0			23.07			
10	25	12			23.03			
10	25	25			22.94			
10	50	0			23.01			
10	1	0	16-QAM	-	22.82	-	18.75	0.0750
10	1	25			23.00			
10	1	49			22.80			
10	25	0			22.16			
10	25	12			22.05			
10	25	25			22.09			
10	50	0			21.94			
Limit	ERP < 3W			Result			Pass	

LTE Band 14 Maximum Average Power [dBm] (GT - LC = -2.1 dB)								
BW [MHz]	RB Size	RB Offset	Mod	Lowest	Middle	Highest	ERP (dBm)	ERP (W)
5	1	0	QPSK	23.85	23.90	23.83	19.65	0.0923
5	1	12		23.90	23.80	23.90		
5	1	24		23.83	23.88	23.86		
5	12	0		23.03	22.98	23.07		
5	12	7		22.93	22.98	23.01		
5	12	13		22.92	22.91	22.87		
5	25	0		22.96	22.94	22.94		
5	1	0	16-QAM	22.79	22.79	22.81	18.70	0.0741
5	1	12		22.92	22.95	22.91		
5	1	24		22.76	22.72	22.79		
5	12	0		22.07	22.10	22.08		
5	12	7		22.04	22.02	22.01		
5	12	13		22.09	22.05	22.03		
5	25	0		21.84	21.89	21.85		
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)	Margin (dB)	SPA Reading (dBm)	S.G. Power (dBm)	TX Cable loss (dB)	TX Antenna Gain (dBi)	Polarization (H/V)
Lowest	1576	-53.22	-42.15	-11.07	-63.13	-55.16	4.82	8.91	H
	2368	-38.23	-13	-25.23	-51.09	-40.65	5.93	10.50	H
	3152	-57.72	-13	-44.72	-74.40	-59.30	6.87	10.61	H
	3944	-52.54	-13	-39.54	-71.85	-53.89	7.79	11.29	H
									H
									H
									H
	1576	-53.07	-42.15	-10.92	-62.80	-55.01	4.82	8.91	V
	2368	-42.89	-13	-29.89	-55.79	-45.31	5.93	10.50	V
	3152	-55.70	-13	-42.70	-72.10	-57.28	6.87	10.61	V
	3944	-54.71	-13	-41.71	-73.80	-56.06	7.79	11.29	V
									V
									V
									V
Middle	1584	-53.54	-42.15	-11.39	-63.46	-55.53	4.83	8.97	H
	2376	-38.07	-13	-25.07	-50.95	-40.48	5.94	10.50	H
	3160	-54.65	-13	-41.65	-71.37	-56.26	6.88	10.64	H
	3952	-52.76	-13	-39.76	-72.12	-54.12	7.80	11.31	H
									H
									H
	1584	-53.14	-42.15	-10.99	-62.86	-55.13	4.83	8.97	V
	2376	-45.40	-13	-32.40	-58.32	-47.81	5.94	10.50	V
	3160	-53.19	-13	-40.19	-69.63	-54.80	6.88	10.64	V
	3952	-58.16	-13	-45.16	-77.31	-59.52	7.80	11.31	V
									V
									V



Highest	1584	-53.90	-42.15	-11.75	-63.82	-55.89	4.83	8.97	H
	2384	-38.76	-13	-25.76	-51.64	-41.16	5.95	10.50	H
	3176	-57.99	-13	-44.99	-74.76	-59.64	6.90	10.70	H
	3968	-56.99	-13	-43.99	-76.43	-58.43	7.82	11.41	H
									H
									H
									H
	1584	-54.67	-42.15	-12.52	-64.39	-56.66	4.83	8.97	V
	2384	-42.14	-13	-29.14	-55.07	-44.54	5.95	10.50	V
	3176	-55.87	-13	-42.87	-72.38	-57.52	6.90	10.70	V
	3968	-57.78	-13	-44.78	-77.01	-59.22	7.82	11.41	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)	Margin (dB)	SPA Reading (dBm)	S.G. Power (dBm)	TX Cable loss (dB)	TX Antenna Gain (dBi)	Polarization (H/V)
Middle	1576	-52.54	-42.15	-10.39	-62.45	-54.48	4.82	8.91	H
	2368	-37.74	-13	-24.74	-50.6	-40.16	5.93	10.50	H
	3152	-54.79	-13	-41.79	-71.47	-56.37	6.87	10.61	H
	3944	-52.36	-13	-39.36	-71.67	-53.71	7.79	11.29	H
									H
									H
									H
	1576	-54.40	-42.15	-12.25	-64.13	-56.34	4.82	8.91	V
	2368	-44.54	-13	-31.54	-57.44	-46.96	5.93	10.50	V
	3152	-54.20	-13	-41.20	-70.6	-55.78	6.87	10.61	V
	3944	-55.23	-13	-42.23	-74.32	-56.58	7.79	11.29	V
									V
									V
									V
									V
									V

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