



FCC RADIO TEST REPORT

FCC ID : 2AJN7-TP00110B
Equipment : Notebook Computer
Brand Name : Lenovo
Model Name : TP00110B
Marketing Name : ThinkPad X1 Yoga Gen 5
Applicant : LC Future Center
7F., No.780, Bei'an Rd., Zhongshan Dist., Taipei City 104, Taiwan
Manufacturer : LC Future Center Limited Taiwan Branch
7F., No.780, Bei'an Rd., Zhongshan Dist., Taipei City 104, Taiwan
Standard : FCC 47 CFR Part 2, Part 27(D)

Equipment: Fibocom L850-GL and Intel AX201D2W tested inside of Lenovo Notebook Computer.

The product was received on Oct. 11, 2019 and testing was started from Nov. 03, 2019 and completed on Nov. 19, 2019. 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 report must not be used by the client to claim product certification, approval, or endorsement by TAF or any agency of government.

The test results in this variant report apply exclusively to the tested model / sample. Without written approval of 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
No. 52, Huaya 1st Rd., Guishan Dist., Taoyuan City, Taiwan



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History of this test report

Report No.	Version	Description	Issued Date
FG9O1139-02C	01	Initial issue of report	Dec. 30, 2019
FG9O1139-02C	02	Revise applicant information	Feb. 25, 2020



Summary of Test Result

Report Clause	Ref Std. Clause	Test Items	Result (PASS/FAIL)	Remark
3.2	§2.1046	Conducted Output Power and Effective Isotropic Radiated Power	Reporting only	-
-	-	Peak-to-Average Ratio	Not Required	-
-	§27.50 (a)(3)	EIRP Power Density	Not Required	-
-	§2.1049	Occupied Bandwidth	Not Required	-
-	§2.1051 §27.53 (a)(4)	Conducted Band Edge Measurement	Not Required	-
-	§2.1051 §27.53 (a)(4)	Conducted Spurious Emission	Not Required	-
-	§2.1055 §27.54	Frequency Stability Temperature & Voltage	Not Required	-
4.2	§2.1053 §27.53 (a)(4)	Radiated Spurious Emission	Pass	Under limit 0.30 dB at 11520.000 MHz

Remark:

1. Not required means after assessing, test items are not necessary to carry out.
2. This is a variant report which can be referred Product Equality Declaration. All the test cases were performed on original report (FCC ID: 2AJN7-TP00110A). Based on the original report, the test cases were verified.

Declaration of Conformity:

The test results with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers.

Comments and Explanations:

The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.

Reviewed by: Wii Chang

Report Producer: Vivian Hsu

1 General Description

1.1 Product Feature of Equipment Under Test

Product Feature	
Equipment	Notebook Computer
Brand Name	Lenovo
Model Name	TP00110B
Marketing Name	ThinkPad X1 Yoga Gen 5
FCC ID	2AJN7-TP00110B
Sample 1	EUT with Amphenol Antenna
Sample 2	EUT with SPEEDWIRE Antenna
EUT supports Radios application	WCDMA/HSPA/LTE/GNSS
EUT Stage	Production Unit

Remark:

1. The above EUT's information was declared by manufacturer.
2. Equipment: Fibocom L850-GL and Intel AX201D2W tested inside of Lenovo Notebook Computer.

Antenna Information				
WWAN				3G<E (dBi)
Antenna 1	Manufacturer	Amphenol	Peak gain	2.30
	Part number	LX9865-16-000-C	Type	PIFA
Antenna 2	Manufacturer	SPEEDWIRE	Peak gain	2.07
	Part number	F.0G.ZV-0008-001-00	Type	PIFA

1.2 Product Specification of Equipment Under Test

Product Feature	
Tx Frequency	LTE Band 30 : 2307.5 MHz ~2312.5 MHz
Rx Frequency	LTE Band 30 : 2352.5 MHz ~ 2357.5 MHz
Bandwidth	5MHz / 10MHz
Maximum Output Power to Antenna	LTE Band 30 : 22.88 dBm
Type of Modulation	QPSK / 16QAM

1.3 Modification of EUT

No modifications are made to the EUT during all test items.



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, Taiwan
Test Site No.	Sporton Site No.
	TH05-HY
Test Engineer	Jacky Wang
Temperature	23~25°C
Relative Humidity	52~55%

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

Test Site	SPORTON INTERNATIONAL INC. EMC & Wireless Communications Laboratory
Test Site Location	No.58 , Aly. 75, Ln. 564, Wenhua 3rd, Rd., Guishan Dist., Taoyuan City, Taiwan
Test Site No.	Sporton Site No.
	03CH13-HY
Test Engineer	JC Liang 、 Wilson Wu
Temperature	21.5~23.5°C
Relative Humidity	46.9~49.5%

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

FCC Designation No. TW1190 and TW0007

1.5 Applied Standards

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

- ◆ ANSI C63.26-2015
- ◆ 47 CFR Part 2, Part 27(D)
- ◆ ANSI / TIA-603-E
- ◆ FCC KDB 971168 Power Meas License Digital Systems D01 v03r01
- ◆ FCC KDB 412172 D01 Determining ERP and EIRP v01r01

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

2 Test Configuration of Equipment Under Test

2.1 Test Mode

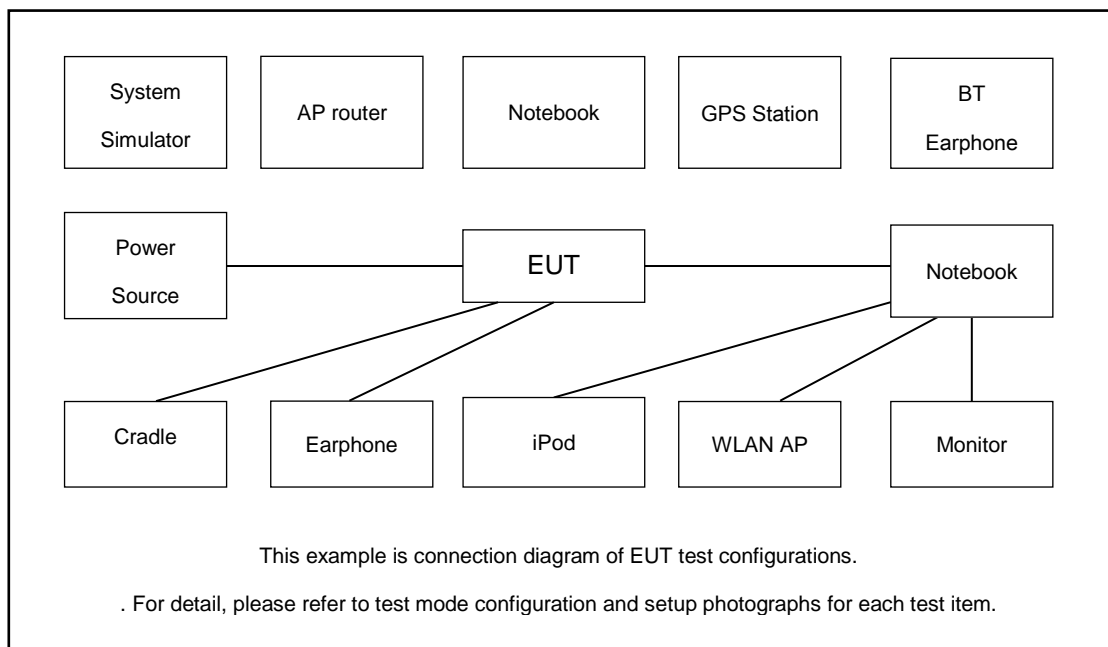
Antenna port conducted and radiated test items listed below are performed according to KDB 971168 D01 Power Meas. License Digital Systems v03r01 with maximum output power.

For radiated measurement, pre-scanned in three orthogonal panels, X, Y, Z, and Notebook Mode.

The worst cases (Notebook Mode) were recorded in this report.

Test Items	Band	Bandwidth (MHz)						Modulation			RB #			Test Channel		
		1.4	3	5	10	15	20	QPSK	16QAM	64QAM	1	Half	Full	L	M	H
Max. Output Power	30	-	-	v	v	-	-	v	v	v	v	v	v	v	v	v
Radiated Spurious Emission	30	Worst Case											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 Adapter 4 and Sample1. 															

2.2 Connection Diagram of Test System





2.3 Support Unit used in test configuration and system

Item	Equipment	Trade Name	Model No.	FCC ID	Data Cable	Power Cord
1.	System Simulator	Anritsu	MT8820C	N/A	N/A	Unshielded, 1.8 m
2.	Earphone	zyia	NA	N/A	Unshielded, 1.2m	N/A

2.4 Frequency List of Low/Middle/High Channels

LTE Band 30 Channel and Frequency List				
BW [MHz]	Channel/Frequency(MHz)	Lowest	Middle	Highest
10	Channel	-	27710	-
	Frequency	-	2310	-
5	Channel	27685	27710	27735
	Frequency	2307.5	2310	2312.5

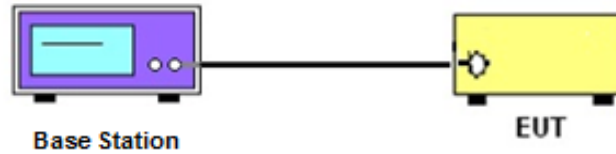
3 Conducted Test Items

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 EIRP Measurement

3.2.1 Description of the Conducted Output Power Measurement and EIRP 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 EIRP of mobile transmitters must not exceed 0.25 Watts for LTE Band 30.

According to KDB 412172 D01 Power Approach,

$EIRP = P_T + G_T - L_C$, 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 the system simulator.
2. Set EUT at maximum power through the system simulator.
3. Select lowest, middle, and highest channels for each band and different modulation.
4. Measure and record the power level from the system simulator.

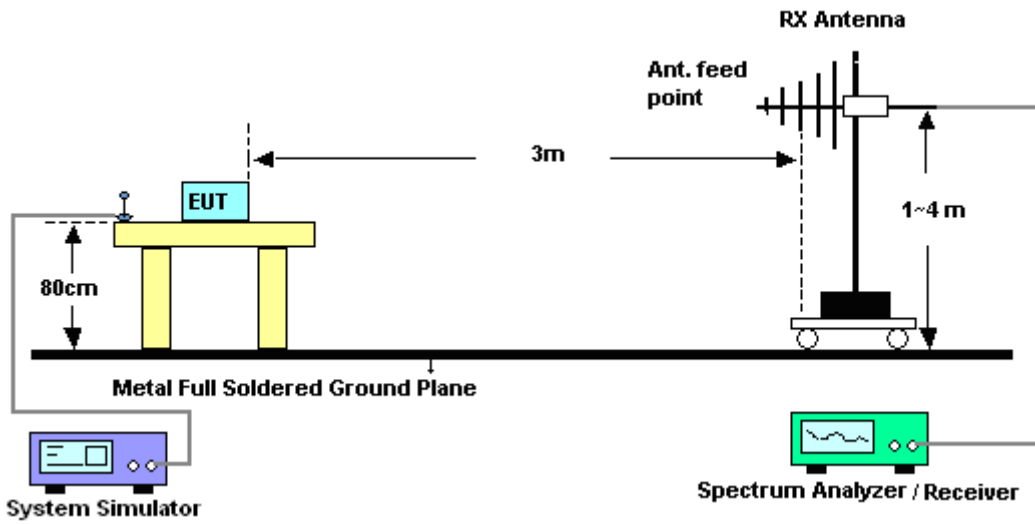
4 Radiated Test Items

4.1 Measuring Instruments

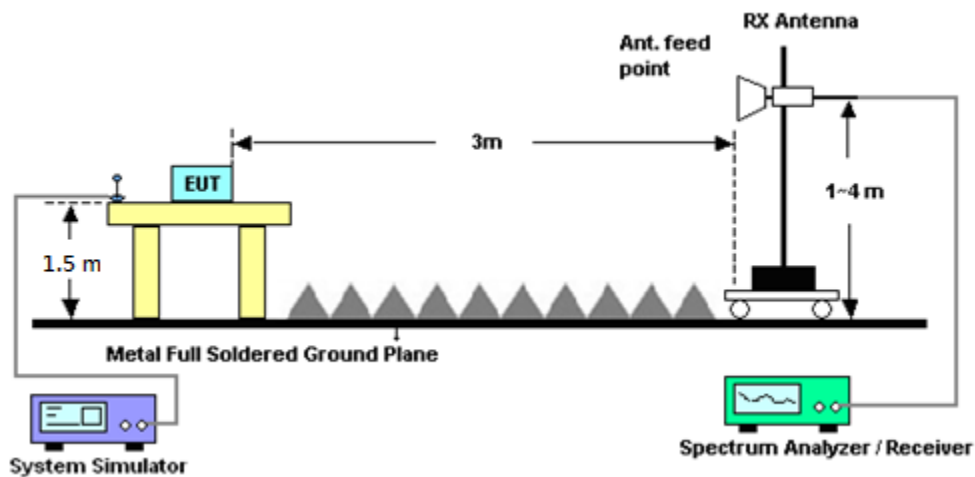
See list of measuring instruments of this test report.

4.1.1 Test Setup

For radiated test from 30MHz to 1GHz



For radiated test above 1GHz



4.1.2 Test Result of Radiated Test

Please refer to Appendix B.



4.2 Radiated Spurious Emission Measurement

4.2.1 Description of Radiated Spurious Emission Measurement

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 $70 + 10 \log (P)$ dB. 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 height for frequency below 1GHz and 1.5 meter height for frequency above 1GHz respectively above ground.
2. The EUT was set 3 meters from the receiving antenna 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 1m to 4m to search the maximum spurious emission for both horizontal and vertical polarizations.
5. During the measurement, the system simulator parameters were set to force the EUT transmitting at maximum output power.
6. Make the measurement with the spectrum analyzer's RBW = 1MHz, VBW = 3MHz, taking the record of maximum spurious emission.
7. A horn antenna was substituted in place of the EUT and was driven by a signal generator.
8. Tune the output power of signal generator to the same emission level with EUT maximum spurious emission.

$$\text{EIRP (dBm)} = \text{S.G. Power} - \text{Tx Cable Loss} + \text{Tx Antenna Gain}$$

$$\text{ERP (dBm)} = \text{EIRP} - 2.15$$

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

The limit line is derived from $70 + 10\log(P)$ dB below the transmitter power P(Watts)

$$= P(\text{W}) - [70 + 10\log(P)] (\text{dB})$$

$$= [30 + 10\log(P)] (\text{dBm}) - [70 + 10\log(P)] (\text{dB})$$

$$= -40\text{dBm}.$$



5 List of Measuring Equipment

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
LTE Base Station	Anritsu	MT8820C	6201107509	-	Jul. 03, 2019	Nov. 04, 2019	Jul. 02, 2020	Conducted (TH05-HY)
Bilog Antenna	TESEQ	CBL 6111D & 00800N1D01N-06	40103 & 07	30MHz~1GHz	Apr. 30, 2019	Nov. 03, 2019~Nov. 19, 2019	Apr. 29, 2020	Radiation (03CH13-HY)
Bilog Antenna	TESEQ	CBL 6111D&00802N1D01N-06	54682 & AT-N0603	30MHz~1GHz	Sep. 26, 2019	Nov. 03, 2019~Nov. 19, 2019	Sep. 25, 2020	Radiation (03CH13-HY)
Horn Antenna	SCHWARZBECK	BBHA 9120 D	9120D-1241	1GHz~18GHz	Jul. 02, 2019	Nov. 03, 2019~Nov. 19, 2019	Jul. 01, 2020	Radiation (03CH13-HY)
Horn Antenna	SCHWARZBECK	BBHA 9120 D	9120D-1212	1GHz~18GHz	May 14, 2019	Nov. 03, 2019~Nov. 19, 2019	May 13, 2020	Radiation (03CH13-HY)
SHF-EHF Horn Antenna	SCHWARZBECK	BBHA 9170	BBHA9170576	18GHz~40GHz	May 14, 2019	Nov. 03, 2019~Nov. 19, 2019	May 13, 2020	Radiation (03CH13-HY)
SHF-EHF Horn Antenna	SCHWARZBECK	BBHA 9170	BBHA9170584	18GHz~40GHz	Dec. 05, 2018	Nov. 03, 2019~Nov. 19, 2019	Dec. 04, 2019	Radiation (03CH13-HY)
Amplifier	SONOMA	310N	187282	9kHz~1GHz	Dec. 18, 2018	Nov. 03, 2019~Nov. 19, 2019	Dec. 17, 2019	Radiation (03CH13-HY)
Preamplifier	MITEQ	AMF-7D-00101800-30-10P	1590074	1GHz~18GHz	May 20, 2019	Nov. 03, 2019~Nov. 19, 2019	May 19, 2020	Radiation (03CH13-HY)
Preamplifier	EMEC	EM18G40G	060715	18GHz~40GHz	Dec. 06, 2018	Nov. 03, 2019~Nov. 19, 2019	Dec. 05, 2019	Radiation (03CH13-HY)
Preamplifier	Agilent	8449B	3008A02375	1GHz~26.5GHz	May 27, 2019	Nov. 03, 2019~Nov. 19, 2019	May 26, 2020	Radiation (03CH13-HY)
Spectrum Analyzer	Keysight	N9010A	MY55370526	10Hz~44GHz	Mar. 19, 2019	Nov. 03, 2019~Nov. 19, 2019	Mar. 18, 2020	Radiation (03CH13-HY)
Controller	EMEC	EM1000	N/A	Control Turn table & Ant Mast	N/A	Nov. 03, 2019~Nov. 19, 2019	N/A	Radiation (03CH13-HY)
Antenna Mast	EMEC	AM-BS-4500-B	N/A	1m~4m	N/A	Nov. 03, 2019~Nov. 19, 2019	N/A	Radiation (03CH13-HY)
Turn Table	EMEC	TT2000	N/A	0~360 Degree	N/A	Nov. 03, 2019~Nov. 19, 2019	N/A	Radiation (03CH13-HY)
Software	Audix	E3 6.2009-8-24	RK-000992	N/A	N/A	Nov. 03, 2019~Nov. 19, 2019	N/A	Radiation (03CH13-HY)
Hygrometer	TECPEL	DTM-303B	TP157151	N/A	Jun. 17, 2019	Nov. 03, 2019~Nov. 19, 2019	Jun. 16, 2020	Radiation (03CH13-HY)
Signal Generator	Rohde & Schwarz	SMF100A	101107	100kHz~40GHz	Aug. 27, 2019	Nov. 03, 2019~Nov. 19, 2019	Aug. 26, 2020	Radiation (03CH13-HY)
RF Cable	HUBER + SUHNER	SF102/2*11S K252	MY4278/2	9kHz~40GHz	May 16, 2019	Nov. 03, 2019~Nov. 19, 2019	May 15, 2020	Radiation (03CH13-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	MY24961/4	30M-18G	Feb. 13, 2019	Nov. 03, 2019~Nov. 19, 2019	Feb. 12, 2020	Radiation (03CH13-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	MY2859/2	30M~40GHz	Mar. 13, 2019	Nov. 03, 2019~Nov. 19, 2019	Mar. 12, 2020	Radiation (03CH13-HY)
Filter	Wainwright	WHKX12-270 0-3000-18000-60SS	SN2	3GHz High Pass Filter	Jul. 14, 2019	Nov. 03, 2019~Nov. 19, 2019	Jul. 13, 2020	Radiation (03CH13-HY)
Filter	Wainwright	WHKX12-108 0-1200-15000-60SS	SN3	1.2GHz High Pass Filter	Jul. 03, 2019	Nov. 03, 2019~Nov. 19, 2019	Jul. 02, 2020	Radiation (03CH13-HY)



6 Uncertainty of Evaluation

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

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	3.21
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Uncertainty of Radiated Emission Measurement (1 GHz ~ 18 GHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	3.24
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Uncertainty of Radiated Emission Measurement (18 GHz ~ 40 GHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	3.99
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Appendix A. Test Results of Conducted Test

Conducted Output Power(Average power)

LTE Band 30 Maximum Average Power [dBm]						
BW [MHz]	RB Size	RB Offset	Mod	Lowest	Middle	Highest
10	1	0	QPSK		22.88	
10	1	25			22.85	
10	1	49			22.86	
10	25	0			21.95	
10	25	12			21.85	
10	25	25			21.79	
10	50	0			21.79	
10	1	0	16-QAM		22.12	
10	1	25			22.09	
10	1	49			21.99	
10	25	0			20.82	
10	25	12			20.87	
10	25	25			20.90	
10	50	0			20.88	
5	1	0	QPSK	22.75	22.85	22.82
5	1	12		22.64	22.84	22.78
5	1	24		22.65	22.83	22.86
5	12	0		21.65	21.66	21.60
5	12	7		21.77	21.82	21.76
5	12	13		21.86	21.87	21.71
5	25	0		21.87	21.88	21.72
5	1	0	16-QAM	22.05	22.15	22.11
5	1	12		22.03	22.15	22.12
5	1	24		22.09	22.08	22.07
5	12	0		20.86	20.86	20.90
5	12	7		20.97	20.88	20.85
5	12	13		20.80	20.89	20.96
5	25	0		20.94	20.81	20.88



Appendix B. Test Results of EIRP and Radiated Test

EIRP

<Reporting Only>

LTE Band 30 / 5MHz (Average) (GT - LC = 0.93 dB)							
Channel	Mode	RB		Conducted		EIRP	
		Size	Offset	Power (dBm)	Power (Watts)	EIRP(dBm)	EIRP(W)
Lowest	QPSK	1	24	22.65	0.1841	23.58	0.2280
Middle		1	24	22.83	0.1919	23.76	0.2377
Highest		1	24	22.86	0.1932	23.79	0.2393
Lowest	16QAM	1	0	22.05	0.1603	22.98	0.1986
Middle		1	0	22.15	0.1641	23.08	0.2032
Highest		1	0	22.11	0.1626	23.04	0.2014
Limit	EIRP < 0.25W			Result		PASS	

LTE Band 30 / 10MHz (Average) (GT - LC = 0.93 dB)							
Channel	Mode	RB		Conducted		EIRP	
		Size	Offset	Power (dBm)	Power (Watts)	EIRP(dBm)	EIRP(W)
Lowest	QPSK	-	-	-	-	-	-
Middle		1	0	22.88	0.1941	23.81	0.2404
Highest		-	-	-	-	-	-
Lowest	16QAM	-	-	-	-	-	-
Middle		1	0	22.12	0.1629	23.05	0.2018
Highest		-	-	-	-	-	-
Limit	EIRP < 0.25W			Result		PASS	



Radiated Spurious Emission

LTE Band 30

LTE Band 30 / 5MHz / QPSK									
Channel	Frequency (MHz)	EIRP (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	4620	-47.43	-40	-7.43	-38.39	-57.47	2.06	12.10	H
	6930	-56.38	-40	-16.38	-53.66	-64.95	2.40	10.97	H
	9234	-54.81	-40	-14.81	-56.88	-64.71	2.22	12.12	H
	11556	-45.15	-40	-5.15	-49.51	-53.99	2.30	11.13	H
	4620	-51.51	-40	-11.51	-43.18	-61.55	2.06	12.10	V
	6930	-51.35	-40	-11.35	-49.25	-59.92	2.40	10.97	V
	9234	-55.36	-40	-15.36	-56.84	-65.26	2.22	12.12	V
	11556	-45.35	-40	-5.35	-49.55	-54.19	2.30	11.13	V
Middle	4626	-47.45	-40	-7.45	-38.44	-57.48	2.07	12.10	H
	6936	-56.02	-40	-16.02	-53.31	-64.59	2.40	10.96	H
	9252	-56.97	-40	-16.97	-59.05	-66.85	2.22	12.10	H
	11556	-50.58	-40	-10.58	-54.94	-59.42	2.30	11.13	H
	4626	-49.87	-40	-9.87	-41.56	-59.90	2.07	12.10	V
	6936	-51.62	-40	-11.62	-49.53	-60.19	2.40	10.96	V
	9252	-56.92	-40	-16.92	-58.36	-66.80	2.22	12.10	V
	11556	-49.28	-40	-9.28	-53.48	-58.12	2.30	11.13	V
Highest	4632	-47.68	-40	-7.68	-38.7	-57.71	2.07	12.10	H
	6942	-53.36	-40	-13.36	-50.66	-61.92	2.40	10.96	H
	9252	-56.44	-40	-16.44	-58.52	-66.32	2.22	12.10	H
	11574	-43.93	-40	-3.93	-48.31	-52.81	2.30	11.18	H
	4632	-49.68	-40	-9.68	-41.4	-59.71	2.07	12.10	V
	6942	-47.25	-40	-7.25	-45.18	-55.81	2.40	10.96	V
	9252	-56.67	-40	-16.67	-58.11	-66.55	2.22	12.10	V
	11574	-42.17	-40	-2.17	-46.37	-51.05	2.30	11.18	V

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



LTE Band 30 / 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	4614	-50.38	-40	-10.38	-41.31	-60.42	2.06	12.10	H
	6918	-51.25	-40	-11.25	-48.51	-59.84	2.39	10.98	H
	9216	-54.74	-40	-14.74	-56.81	-64.65	2.23	12.14	H
	11520	-40.71	-40	-0.71	-45.04	-49.47	2.29	11.05	H
	4614	-49.69	-40	-9.69	-41.33	-59.73	2.06	12.10	V
	6918	-44.55	-40	-4.55	-42.42	-53.14	2.39	10.98	V
	9216	-54.15	-40	-14.15	-55.67	-64.06	2.23	12.14	V
	11520	-40.30	-40	-0.30	-44.49	-49.06	2.29	11.05	V

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