

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 : 47 CFR Part 2, 22(H), 24(E), 27(L)

Equipment: Fibocom L860-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
FG9O1139-02A	01	Initial issue of report	Dec. 30, 2019
FG9O1139-02A	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	Pass	-
	§22.913 (a)(2)	Effective Radiated Power (WCDMA Band V)		
	§24.232 (c)	Equivalent Isotropic Radiated Power (WCDMA Band II)		
	§27.50 (d)(4)	Equivalent Isotropic Radiated Power (WCDMA Band IV)		
-	§24.232 (d)	Peak-to-Average Ratio	Not Required	
-	§2.1049 §22.917 (b) §24.238 (b) §27.53 (g)	Occupied Bandwidth (WCDMA Band V) (WCDMA Band II) (WCDMA Band IV)	Not Required	-
-	§2.1051 §22.917 (a) §24.238 (a) §27.53 (g)	Band Edge Measurement (WCDMA Band V) (WCDMA Band II) (WCDMA Band IV)	Not Required	-
-	§2.1051 §22.917 (a) §24.238 (a) §27.53 (g)	Conducted Emission (WCDMA Band V) (WCDMA Band II) (WCDMA Band IV)	Not Required	-
-	§2.1055 §22.355 §24.235 §27.54	Frequency Stability Temperature & Voltage	Not Required	-
4.4	§2.1053 §22.917 (a) §24.238 (a) §27.53 (h)	Field Strength of Spurious Radiation (WCDMA Band V) (WCDMA Band II) (WCDMA Band IV)	Pass	Under limit 34.57 dB at 7011.000 MHz

Remark:

- Not required means after assessing, test items are not necessary to carry out.
- 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: Lucy Wu

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 L860-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 subjective to this standard

Standards-related Product Specification	
Tx Frequency	WCDMA: Band V: 826.4 MHz ~ 846.6 MHz Band II: 1852.4 MHz ~ 1907.6 MHz Band IV: 1712.4 MHz ~ 1752.6 MHz
Rx Frequency	WCDMA: Band V: 871.4 MHz ~ 891.6 MHz Band II: 1932.4 MHz ~ 1987.6 MHz Band IV: 2112.4 MHz ~ 2152.6 MHz
Maximum Output Power to Antenna	WCDMA: Band V: 23.63 dBm Band II: 23.34 dBm Band IV: 23.46 dBm
Type of Modulation	WCDMA: BPSK (Uplink) HSDPA: 64QAM (Downlink) HSUPA: QPSK (Uplink)

1.3 Modification of EUT

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

1.4 Testing Location

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, Huaya 1st Rd., Guishan Dist., Taoyuan City, Taiwan
Test Site No.	Sporton Site No.
	03CH13HY
Test Engineer	JC Liang and 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 Applicable Standards

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

- ♦ ANSI C63.26-2015
- ♦ ANSI / TIA-603-E
- ♦ 47 CFR Part 2, 22(H), 24(E), 27(L)
- ♦ FCC KDB 971168 D01 Power Meas. License Digital Systems v03r01
- ♦ FCC KDB 412172 D01 Determining ERP and EIRP v01r01

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

2 Test Configuration of Equipment Under Test

2.1 Test Mode

Antenna port conducted and radiated test items were 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. The worst cases (Y Plane for AWS Band) were recorded in this report.

Radiated emissions were investigated as following frequency range:

1. 30 MHz to 9000 MHz for WCDMA Band V
2. 30 MHz to 18000 MHz for WCDMA Band IV
3. 30 MHz to 19100 MHz for WCDMA Band II

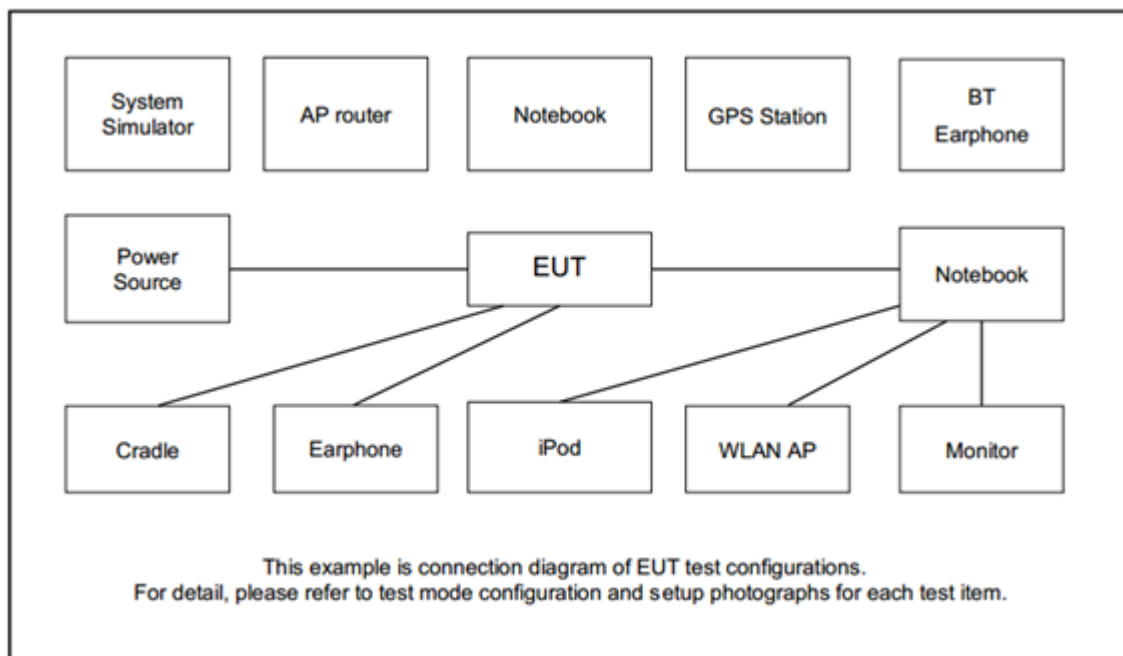
All modes and data rates and positions were investigated.

Test modes are chosen to be reported as the worst case configuration below:

Test Modes	
Band	Radiated TCs
WCDMA Band IV	■ RMC 12.2Kbps Link

Remark: All the radiated test cases were performed with Adapter 4 and Sample 1.

2.2 Connection Diagram of Test System



2.3 Support Unit used in test configuration

Item	Equipment	Trade Name	Model No.	FCC ID	Data Cable	Power Cord
1.	System Simulator	R&S	CMU 200	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

Frequency List				
Band	Channel/Frequency(MHz)	Lowest	Middle	Highest
WCDMA Band V	Channel	4132	4182	4233
	Frequency	826.4	836.4	846.6
WCDMA Band II	Channel	9262	9400	9538
	Frequency	1852.4	1880.0	1907.6
WCDMA Band IV	Channel	1312	1413	1513
	Frequency	1712.4	1732.6	1752.6

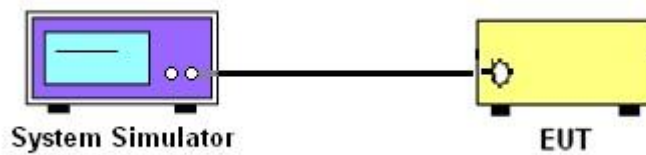
3 Conducted Test Result

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 and ERP/EIRP

3.2.1 Description of the Conducted Output Power and ERP/EIRP

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

The ERP of mobile transmitters must not exceed 7 Watts for WCDMA Band V

The EIRP of mobile transmitters must not exceed 2 Watts for WCDMA Band II

The EIRP of mobile transmitters must not exceed 1 Watts for WCDMA Band IV

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 the system simulator.
2. Set EUT at maximum power through system simulator.
3. Select lowest, middle, and highest channels for each band and different modulation.
4. Measure the maximum burst average power for GSM and maximum average power for other modulation signal.

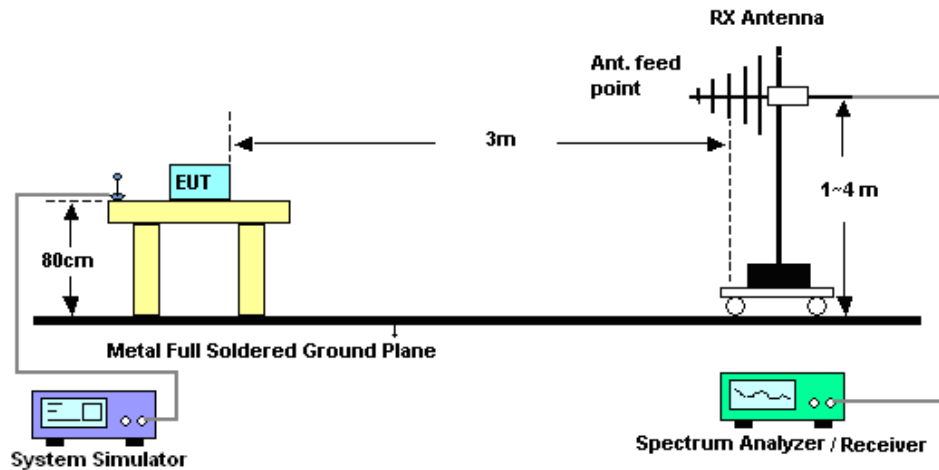
4 Radiated Test Items

4.1 Measuring Instruments

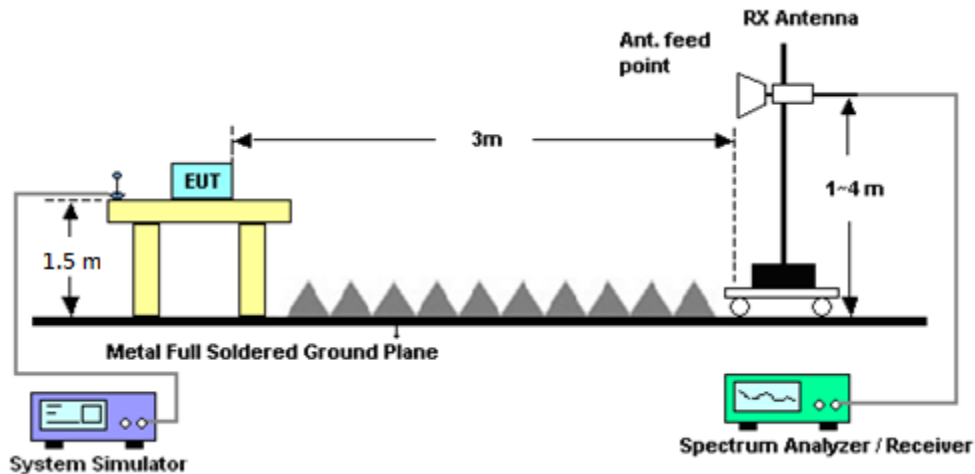
See list of measuring instruments of this test report.

4.2 Test Setup

For radiated test from 30MHz to 1GHz



For radiated test above 1GHz



4.3 Test Result of Radiated Test

Please refer to Appendix B.

4.4 Field Strength of Spurious Radiation Measurement

4.4.1 Description of Field Strength of Spurious Radiated Measurement

The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitter power (P) by a factor of at least $43 + 10 \log (P)$ dB. The spectrum is scanned from 30 MHz up to a frequency including its 10th harmonic.

4.4.2 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 rotatable wooden table 0.8 meters for frequency below 1GHz and 1.5 meter for frequency above 1GHz above the 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 for the maximum spurious emission for both horizontal and vertical polarizations.
5. Make the measurement with the spectrum analyzer's RBW = 1MHz, VBW = 3MHz, taking 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. $EIRP \text{ (dBm)} = S.G. \text{ Power} - Tx \text{ Cable Loss} + Tx \text{ Antenna Gain}$
11. $ERP \text{ (dBm)} = EIRP - 2.15$
12. The RF fundamental frequency should be excluded against the limit line in the operating frequency band.
13. The limit line is derived from $43 + 10\log(P)$ dB below the transmitter power P(Watts)



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-0010 1800-30-10P	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*11SK 252	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	WHKX12-2700 -3000-18000-6 0SS	SN2	3GHz High Pass Filter	Jul. 14, 2019	Nov. 03, 2019~Nov. 19, 2019	Jul. 13, 2020	Radiation (03CH13-HY)
Filter	Wainwright	WHKX12-1080 -1200-15000-6 0SS	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)

Conducted Power (*Unit: dBm)						
Band	WCDMA Band V			WCDMA Band II		
Channel	4132	4182	4233	9262	9400	9538
Frequency	826.4	836.4	846.6	1852.4	1880	1907.6
RMC 12.2K	23.28	23.63	23.02	23.20	23.34	22.99
HSDPA Subtest-1	22.46	22.71	21.96	23.17	23.33	22.95
HSDPA Subtest-2	22.41	22.72	21.97	22.21	22.31	21.94
HSDPA Subtest-3	21.94	22.44	21.42	21.73	21.82	21.39
HSDPA Subtest-4	21.70	22.49	21.15	21.51	21.49	21.16
HSUPA Subtest-1	21.85	22.14	21.49	21.69	21.87	21.47
HSUPA Subtest-2	20.17	20.94	19.67	19.95	20.11	19.63
HSUPA Subtest-3	20.91	21.69	20.45	20.66	20.82	20.35
HSUPA Subtest-4	20.42	20.95	19.95	20.13	20.29	19.85
HSUPA Subtest-5	22.40	22.10	21.50	22.20	22.30	21.90

Conducted Power (*Unit: dBm)			
Band	WCDMA Band IV		
Channel	1312	1413	1513
Frequency	1712.4	1732.6	1752.6
RMC 12.2K	23.21	23.46	23.45
HSDPA Subtest-1	22.25	22.46	22.41
HSDPA Subtest-2	22.30	22.49	22.42
HSDPA Subtest-3	21.81	21.91	21.16
HSDPA Subtest-4	21.57	21.71	21.65
HSUPA Subtest-1	21.66	21.90	21.99
HSUPA Subtest-2	19.96	20.23	20.26
HSUPA Subtest-3	20.66	20.92	20.95
HSUPA Subtest-4	20.19	20.41	20.33
HSUPA Subtest-5	22.30	22.50	22.31



Appendix B. Test Results of ERP/EIRP and Radiated Test

ERP/EIRP

Channel	Mode	Conducted		ERP	
		Power (dBm)	Power (Watts)	ERP(dBm)	ERP(W)
Lowest	WCDMA Band V	23.28	0.2128	22.30	0.1698
Middle	RMC 12.2Kbps	23.63	0.2307	22.65	0.1841
Highest	(GT - LC = 1.17 dB)	23.02	0.2004	22.04	0.1600
Limit	ERP < 7W	Result		PASS	

Channel	Mode	Conducted		EIRP	
		Power (dBm)	Power (Watts)	EIRP(dBm)	EIRP(W)
Lowest	WCDMA Band II	23.20	0.2089	24.64	0.2911
Middle	RMC 12.2Kbps	23.34	0.2158	24.78	0.3006
Highest	(GT - LC = 1.44 dB)	22.99	0.1991	24.43	0.2773
Limit	EIRP < 2W	Result		PASS	

Channel	Mode	Conducted		EIRP	
		Power (dBm)	Power (Watts)	EIRP(dBm)	EIRP(W)
Lowest	WCDMA Band IV	23.21	0.2094	24.31	0.2698
Middle	RMC 12.2Kbps	23.46	0.2218	24.56	0.2858
Highest	(GT - LC = 1.1 dB)	23.45	0.2213	24.55	0.2851
Limit	EIRP < 1W	Result		PASS	

**Radiated Spurious Emission****WCDMA 1700**

WCDMA 1700									
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	3427	-55.79	-13	-42.79	-74.89	-66.16	1.81	12.18	H
	5135	-51.63	-13	-38.63	-75.04	-61.45	2.30	12.13	H
	6850	-49.17	-13	-36.17	-75.37	-57.85	2.37	11.05	H
									H
									H
									H
	3427	-53.33	-13	-40.33	-73.05	-63.70	1.81	12.18	V
	5135	-51.03	-13	-38.03	-75.01	-60.85	2.30	12.13	V
	6850	-49.10	-13	-36.10	-75.86	-57.78	2.37	11.05	V
									V
									V
									V
Middle	3462	-56.45	-13	-43.45	-75.88	-66.90	1.84	12.29	H
	5193	-53.33	-13	-40.33	-76.78	-63.19	2.28	12.14	H
	6927	-50.27	-13	-37.27	-76.71	-58.85	2.40	10.97	H
									H
									H
									H
	3462	-55.24	-13	-42.24	-75.2	-65.69	1.84	12.29	V
	5193	-52.92	-13	-39.92	-76.93	-62.78	2.28	12.14	V
	6927	-49.77	-13	-36.77	-76.81	-58.35	2.40	10.97	V
									V
									V
									V
Highest	3504	-55.08	-13	-42.08	-74.88	-65.61	1.87	12.40	H
	5256	-52.34	-13	-39.34	-75.85	-62.24	2.26	12.15	H
	7011	-48.74	-13	-35.74	-75.47	-57.21	2.41	10.88	H
									H
									H
									H
	3504	-54.91	-13	-41.91	-75.16	-65.44	1.87	12.40	V
	5256	-52.75	-13	-39.75	-76.79	-62.65	2.26	12.15	V
	7011	-47.57	-13	-34.57	-74.95	-56.04	2.41	10.88	V
									V
									V
									V

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