

TEST REPORT

of

FCC Part 2, 27

FCC ID : STESN-WiMAX-24C

Equipment Under Test : WiMAX In-door Repeater
Model Name : RSN-WiMAX-24C
Applicant : R-tron, Inc.
Manufacturer : R-tron, Inc.
Date of Test(s) : 2009-09-21 ~ 2009-09-28
Date of Issue : 2009-09-29

In the configuration tested, the EUT complied with the standards specified above.

Tested By:



Date

2009-09-29

Feel Jeong

Approved By



Date

2009-09-29

Charles Kim

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1. General Information

1-1. Testing Laboratory

SGS Testing Korea Co., Ltd.
- 705, Dongchun-Dong Sooji-Gu, Yongin-Shi, Kyungki-Do, South Korea.
www.electrolab.kr.sgs.com
Telephone : +82 +31 428 5700
FAX : +82 +31 427 2371

1-2. Details of Applicant

Applicant : R-tron, Inc.
Address : Jisan IT Venture Center 3F, 1004-9 Doksan-Dong, Gumcheon-Gu, Seoul, Korea 153-010
Contact Person : Yong-Hoon Kang
Phone No. : +82 +2 6343 1005
Fax No. : +82 +2 6343 1050

1-3. Description of EUT

Kind of Product	WiMAX In-door Repeater
Model Name	RSN-WiMAX-24C
Serial Number	N/A
Operating Frequency	Down link : 2502 ~ 2690 MHz
	Up link : 2502 ~ 2690 MHz
Frequency Band	* AB/BC/CD/EF/FH/HG
Power	Down Link: 24 dBm Up Link : 24 dBm
Power Rating	Input: 120 Vac, 60 Hz
Modulation Technique	OFDMA
Type of Emission	9M26W7D
Operating Conditions	-10 ~ 50
Tx antenna Gain	8 dBi(Patch Antenna)

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***Frequency points (channels)**

Band	Low Frequency (MHz)	Middle Frequency (MHz)	High Frequency (MHz)
AB	2508.5	2518.5	2528.5
BC	2525.0	2535.0	2545.0
CD	2541.5	2551.5	2561.5
EF	2630.5	2640.5	2650.5
FH	2647.0	2657.0	2667.0
HG	2663.5	2673.5	2683.5

1-4. EUT Cables

Routing		Shielded/ Unshielded	Description	Cable Length (m)
From	To			
EUT	AC power main	Unshielded	Power cable	1.5
IQ Signal Generator	EUT	Shielded(coaxial)	Coaxial cable	1.0
EUT	50 ohm load	Shielded(coaxial)	Coaxial cable	1.0

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1-5. Test Equipment List

EQUIPMENT	MANUFACTURER	MODEL	CAL DUE.
Signal Generator	Rohde & Schwarz	SMJ 100A	Sep. 25, 2010
Spectrum Analyzer	Rohde & Schwarz	FSV30	May 15, 2010
Attenuator	Agilent	8498A	Apr. 01, 2010
AC Power Supply	Dea kwang	Slidacs	Sep. 25, 2010
Bilog Antenna	SCHWARZBECK MESSELEKTRONIK	VULB9163	Jul. 22, 2010
Horn Antenna	Rohde & Schwarz	HF906	Jan. 10, 2010
Horn Antenna	Rohde & Schwarz	HF907	May 26, 2010
Dipole Antenna	VHAP/UHAP	975/958	Jan. 18, 2010
High-pass Filter	MICROWAVE-CIRCUITS	H03G12	Apr. 01, 2010
Preamplifier	Agilent	8449B	Apr. 01, 2010
Preamplifier	Agilent	8447F	Jun. 02, 2010
Anechoic Chamber	SY Corporation	L W H 9.6 m 6.4 m 6.6 m	Jan. 31, 2010

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1-6. Summary of Test Results

APPLIED STANDARD: FCC Part 2,27		
Section in FCC Part 2,27	Test Item	Result
§2.1046 §27.50(h)(1)	Maximum Channel Power	Complied
§27.53(l)(2)	Field Strength of Spurious Radiation	Complied
§2.1049	Occupied Bandwidth 26dB	Complied
§2.1051 §27.53(l)(6)	Spurious Emission at Antenna Terminal	Complied
§2.1055 §27.54	Frequency Stability	Complied
§27.53(l)(2)	Band Edge	Complied
§1.1307(b)(1)	Maximum Permissible Exposure (Exposure of Humans to RF Fields)	Complied

1-7 Test Report Revision

Revision	Report number
0	F690501/RF-RTL003363

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1.8 Worst-Case Configuration and Mode

Pre-test was performed on antenna terminal port to determine the worst-case mode

Down link mode

Test mode	Band	Frequency (MHz)	Measured channel Power	
			dBm	mW
QPSK 1/2	EF	2630.5	24.55	285.10
QPSK 3/4		2630.5	24.56	285.76
16QAM 1/2		2630.5	24.60	288.40
16QAM 3/4		2630.5	24.63	290.40
64QAM 1/2		2630.5	24.61	289.07
64QAM 2/3		2630.5	24.59	287.74
64QAM 3/4		2630.5	24.64	291.07

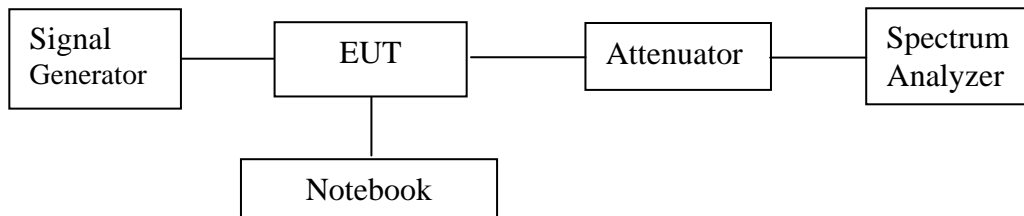
Up link mode

Test mode	Band	Frequency (MHz)	Measured channel Power	
			dBm	mW
QPSK 1/2	EF	2630.5	24.12	258.23
QPSK 3/4		2630.5	24.00	251.19
16QAM 1/2		2630.5	24.33	271.02
16QAM 3/4		2630.5	24.40	275.42

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2. Maximum Channel Power

2.1. Set up



2.2. Limit

According to 47 CFR Part 2 section § 2.1046 and Part 27 section § 27.50(h)(1), the maximum EIRP of a base station shall not exceed $33 \text{ dBW} + 10 \lg (X/Y) \text{ dBW}$, where X is the actual channel width in MHz and Y is either 6 MHz if prior to transition or the station is in the MBS following transition or 5.5 MHz if the station is in the LBS and UBS following transition.

As to the limit, the X is 10 MHz and Y is 5.5 MHz for the EUT, so the limit is calculated to be $33 \text{ dBW} + 10 \lg(10 \text{ MHz}/5.5 \text{ MHz}) = 65.60 \text{ dBm}$.

2.3. Test Procedure

1. The transmitter was tested while in a continuous transmit mode.
2. The EUT was tuned to a low, middle, and high channel in both the downlink (base to mobile) and uplink (mobile to base) directions.
3. RF power output was measured with an RF input level at the point just before the compression point of the amplifier.
4. This is the point of maximum RF output power. If the RF input level is increased beyond this point, the amplifier gain (and consequently output power) is automatically reduced.

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2.4. Test Results

Ambient temperature : 21 Relative humidity : 50 % R.H.

Down link mode

Test mode	Channel	Frequency (MHz)	Measured Channel Power	
			dBm	mW
64QAM 3/4	Low	2508.5	23.78	238.78
64QAM 3/4	Middle	2630.5	24.64	291.07
64QAM 3/4	High	2683.5	23.39	218.27

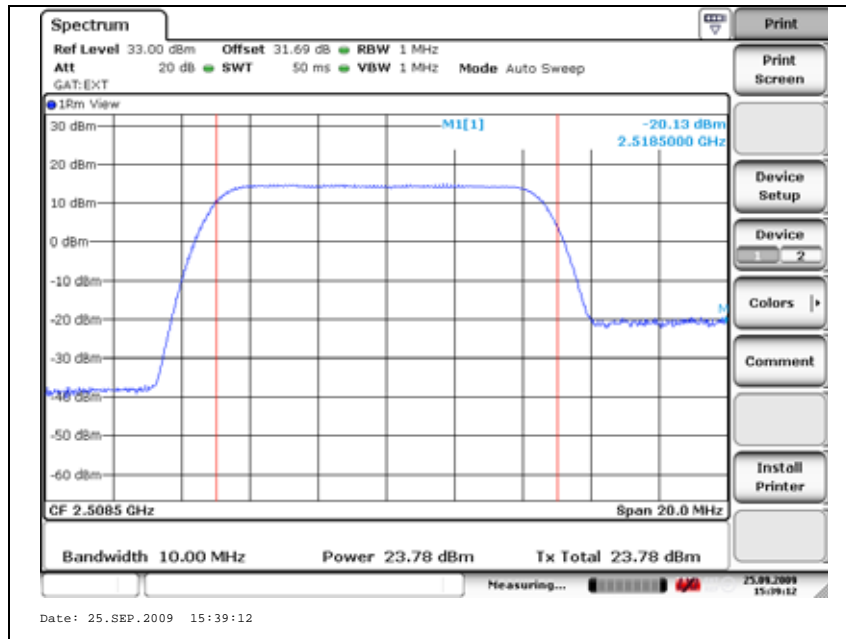
Up link mode

Test mode	Channel	Frequency (MHz)	Measured Channel Power	
			dBm	mW
16QAM 3/4	Low	2508.5	23.78	238.78
16QAM 3/4	Middle	2630.5	24.40	275.42
16QAM 3/4	High	2683.5	23.45	221.31

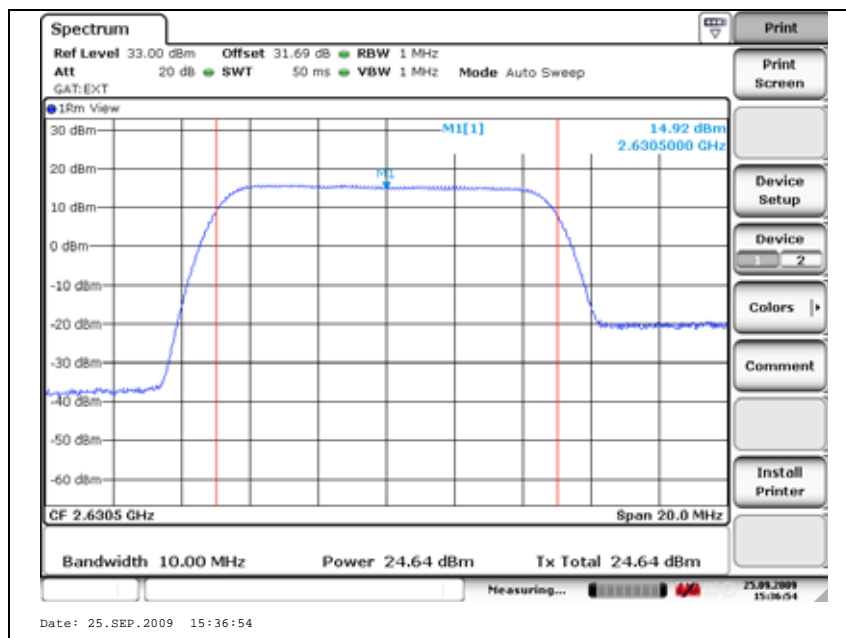
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Down link mode

Low Channel

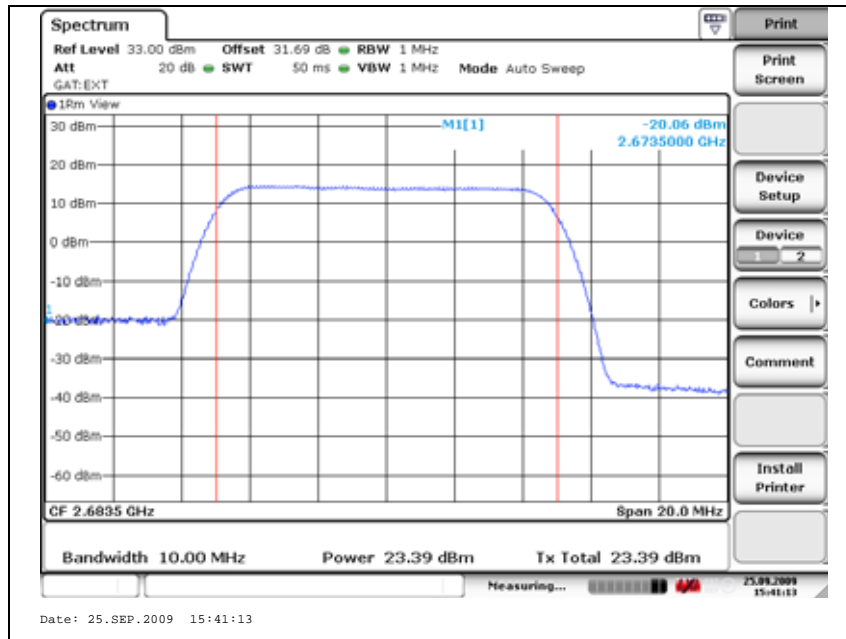


Middle Channel



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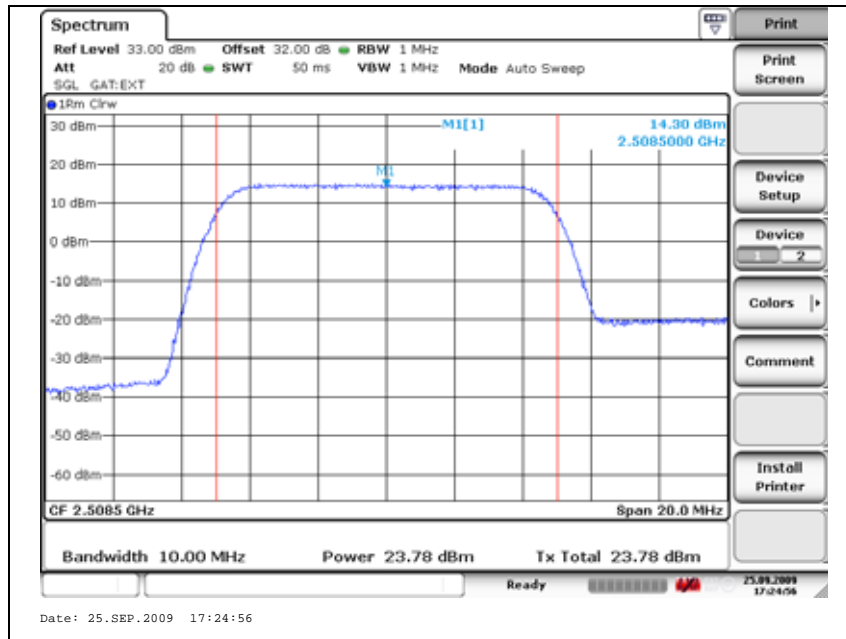
High Channel



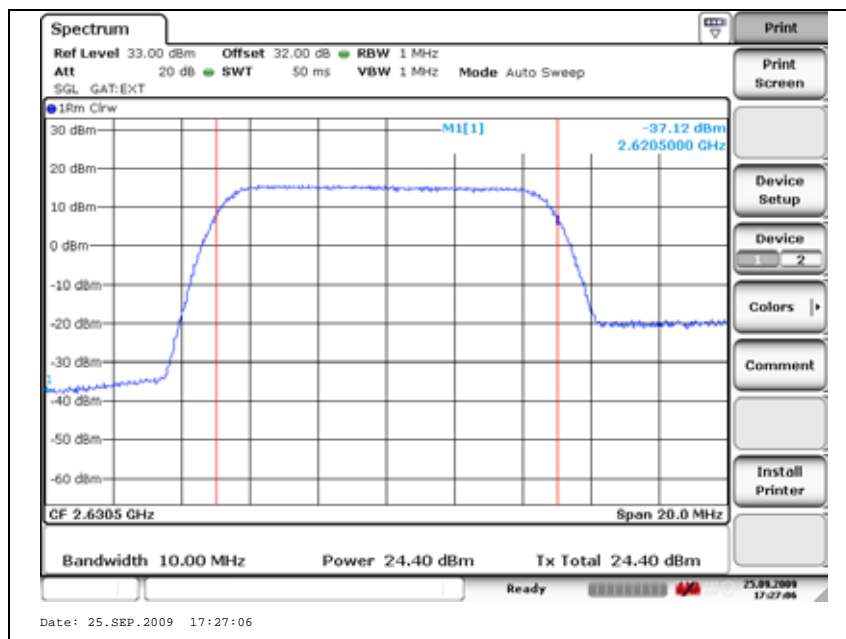
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Up link mode

Low Channel

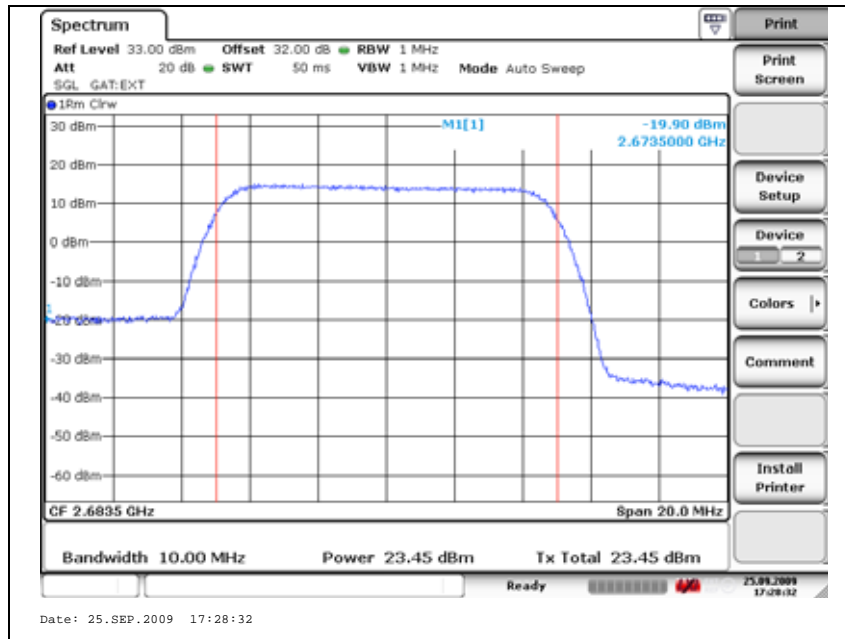


Middle Channel



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High Channel

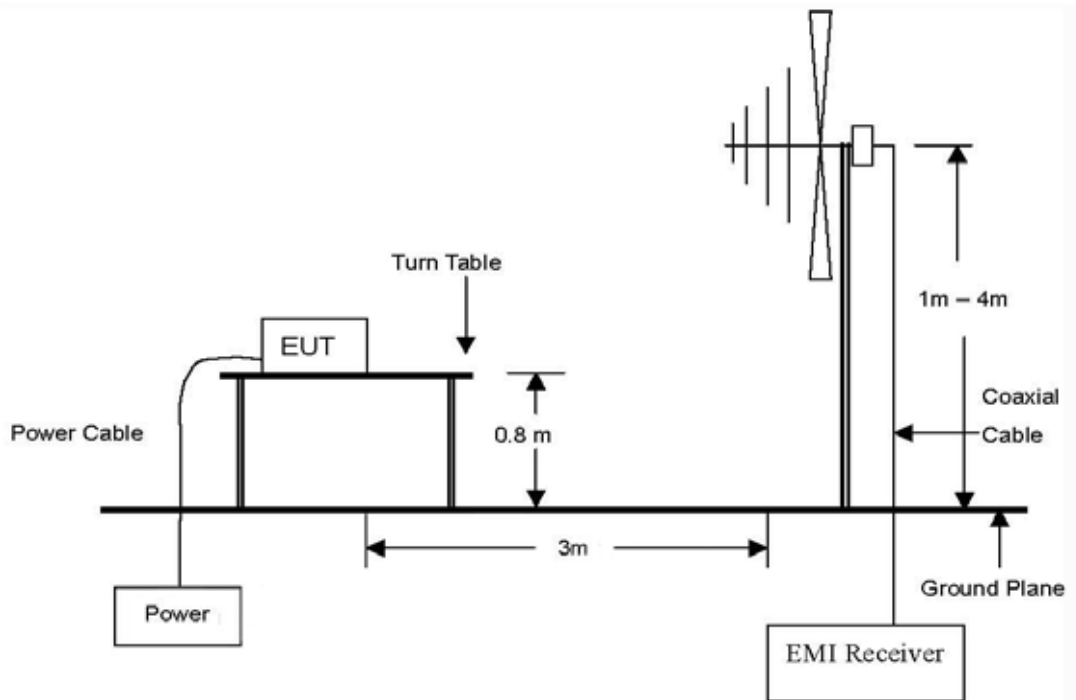


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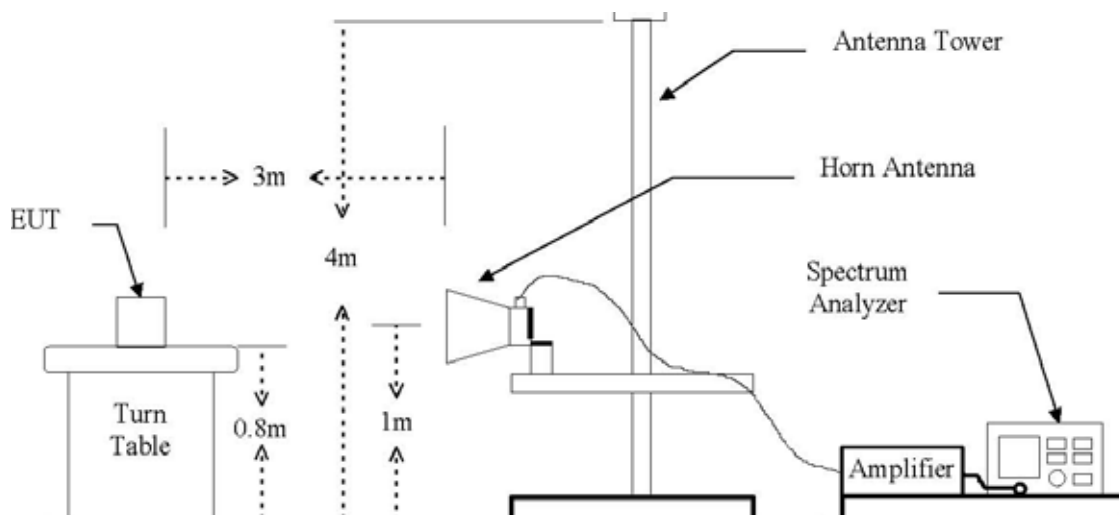
3. Field Strength of Spurious Radiation

3.1. Set up

The diagram below shows the test setup that is utilized to make the measurements for emission from 30 MHz to 1 GHz Emissions.



The diagram below shows the test setup that is utilized to make the measurements for emission from 1 GHz to 18 GHz Emissions.



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3.2. Limit

According to 47 CFR Part 2 section § 2.1053 and Part 27 section § 27.53(l)(2) and § 27.53(l)(6), the power of any emissions outside the licensee's frequency bands of operation must be attenuated below the transmitter power (P in watts) by at least $43 + 10 \log (P)$ dB. Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 1 MHz or greater.

The limit is calculated to be $P \text{ (W)} - \{43 \text{ dB} + 10 \log [P \text{ (W)}]\} = 10 \log [1000 P \text{ (W)}] \text{ (dBm)} - 43 \text{ dB} - 10 \log [P \text{ (W)}] = 30 \text{ dBm} - 43 \text{ dB} = -13 \text{ dBm}$.

3.3. Test Procedure

1. On a test site, the EUT shall be placed at 0.8cm height on a turn table, and in the position closest to normal use as declared by the applicant.
2. The test antenna shall be oriented initially for vertical polarization located 3m from EUT to correspond to the 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. The transmitter shall be switched on, the measuring receiver shall be tuned to the frequency of the transmitter under test.
5. The test antenna shall be raised and lowered through the specified range of height until a maximum signal level is detected by the measuring receiver.
6. The transmitter shall then be rotated through 360° in the horizontal plane, until the maximum signal level is detected by the measuring receiver.
7. The test antenna shall be raised and lowered again through the specified range of height until a maximum signal level is detected by the measuring receiver.
8. The maximum signal level detected by the measuring receiver shall be noted.
9. The transmitter shall be replaced by a horn (substitution antenna).
10. The substitution antenna shall be orientated for vertical polarization and the length of the substitution antenna shall be adjusted to correspond to the frequency of the transmitter.
11. The substitution antenna shall be connected to a calibrated signal generator.
12. In necessary, the input attenuator setting of the measuring receiver shall be adjusted in order to increase the sensitivity of the measuring receiver.
13. The test antenna shall be raised and lowered through the specified range of height to ensure that the maximum signal is received.
14. The input signal to the substitution antenna shall be adjusted to the level that produces a level detected by the measuring receiver, 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.
15. 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.
16. The measurement shall be repeated with the test antenna and the substitution antenna orientated for horizontal polarization.
17. The measure of the effective radiated power is the large of the two levels recorded, at the input to the substitution antenna, corrected for gain of the substitution antenna if necessary

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3.4. Test Result

Ambient temperature : 21 Relative humidity : 47 %R.H.

Down Link

Frequency (MHz)	Ant.Pol. (H/V)	S.G. reading (dBm)	CL (dB)	Gain (dBi)	Gain (dBd)	EIRP (dBm)	Limit (dBm)	Margin (dB)
Low Channel (2508.5 MHz)								
100.20	H	-48.41	0.13	-7.81	-9.96	-56.35	-13.00	43.35
202.40	H	-45.12	0.22	-7.47	-9.62	-52.81	-13.00	39.81
Middle Channel (2630.5 MHz)								
100.20	H	-47.84	0.13	-7.81	-9.96	-55.78	-13.00	42.78
202.40	H	-45.04	0.22	-7.47	-9.62	-52.73	-13.00	39.73
High Channel (2683.5 MHz)								
100.20	H	-48.68	0.13	-7.81	-9.96	-56.62	-13.00	43.62
202.40	H	-45.58	0.22	-7.47	-9.62	-53.27	-13.00	40.27

Up Link

Frequency (MHz)	Ant.Pol. (H/V)	S.G. reading (dBm)	CL (dB)	Gain (dBi)	Gain (dBd)	EIRP (dBm)	Limit (dBm)	Margin (dB)
Low Channel (2508.5 MHz)								
100.10	H	-48.54	0.13	-7.81	-9.96	-56.48	-13.00	43.48
202.30	H	-43.47	0.22	-7.47	-9.62	-51.16	-13.00	38.16
301.80	H	-42.50	0.40	-7.05	-9.20	-49.95	-13.00	36.95
Middle Channel (2630.5 MHz)								
100.10	H	-48.98	0.13	-7.81	-9.96	-56.92	-13.00	43.92
202.30	H	-43.41	0.22	-7.47	-9.62	-51.10	-13.00	38.10
301.80	H	-42.42	0.40	-7.05	-9.20	-49.87	-13.00	36.87
High Channel (2683.5 MHz)								
100.10	H	-48.05	0.13	-7.81	-9.96	-55.99	-13.00	42.99
202.30	H	-43.14	0.22	-7.47	-9.62	-50.83	-13.00	37.83
301.80	H	-42.66	0.40	-7.05	-9.20	-50.11	-13.00	37.11

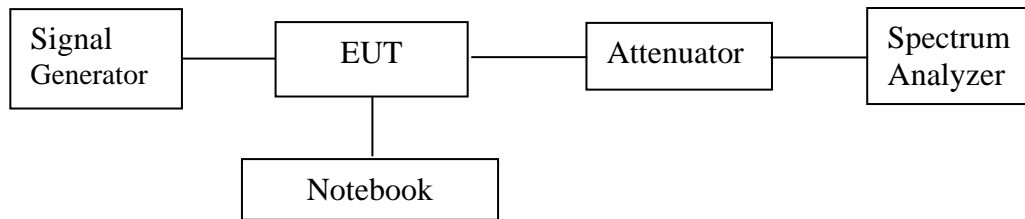
Remake: 1. No more spurious emissions above 310 MHz for all channel.

2. EIRP= SG Reading –Cable Loss +Gain

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4. Occupied Bandwidth 26 dB

4.1. Set up



4.2. Limit

According to 47 CFR Part 2 section § 2.1049 and Part 27, no specific modulation characteristics requirement limits is applicable.

The occupied bandwidth is defined in section § 2.1049: 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 shall be measured. The occupied bandwidth is normally called 99% bandwidth.

According to section § 27.53(l)(6), 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. The emission bandwidth is normally called 26 dB bandwidth.

4.3. Test Procedure

1. The transmitter was tested while in a continuous transmit mode.
2. The EUT was tuned to a low, middle, and high channel in both the downlink (base to mobile) and uplink (mobile to base) directions.
3. The resolution bandwidth of the spectrum analyzer was set at 100 kHz.

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4.4 Test Results

Ambient temperature : 21 Relative humidity : 50 %R.H.

Down link mode

Test mode	Channel	Frequency (MHz)	Measured Occupied Bandwidth	
			99%	26dB
64QAM 3/4	Low	2508.5	9.26	9.55
64QAM 3/4	Middle	2630.5	9.26	9.77
64QAM 3/4	High	2683.5	9.26	9.77

Up link mode

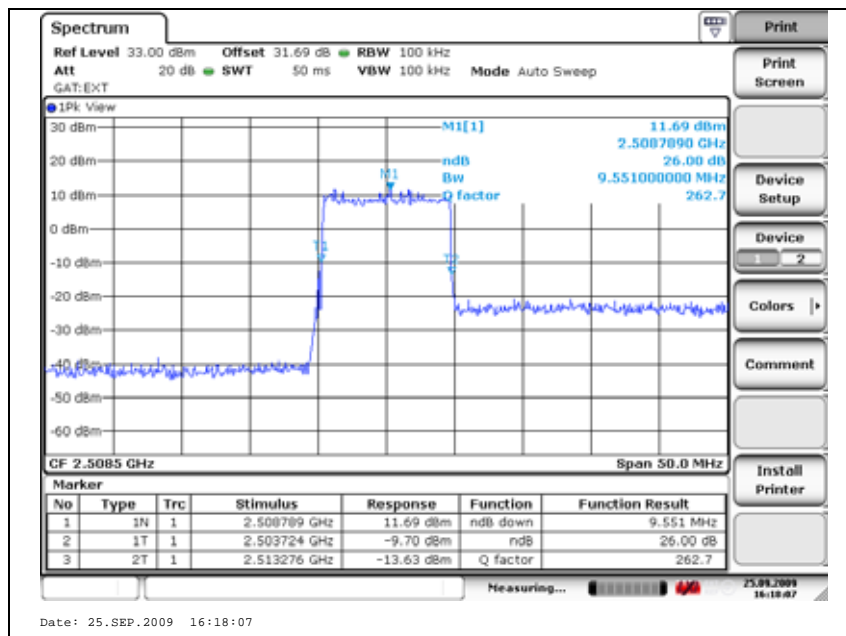
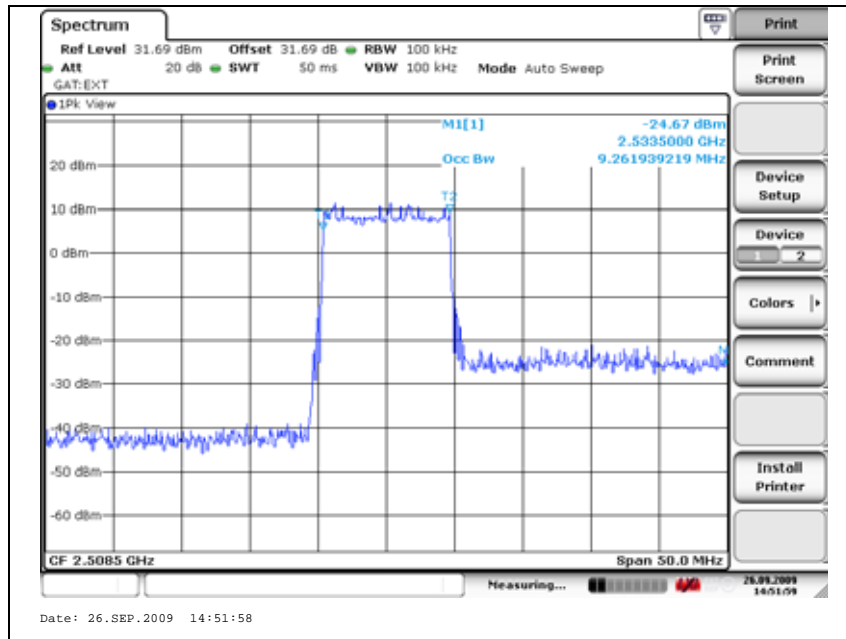
Test mode	Channel	Frequency (MHz)	Measured Occupied Bandwidth	
			99%	26dB
16QAM 3/4	Low	2508.5	9.19	10.06
16QAM 3/4	Middle	2630.5	9.19	10.06
16QAM 3/4	High	2683.5	9.19	10.42

Please refer to the following plots.

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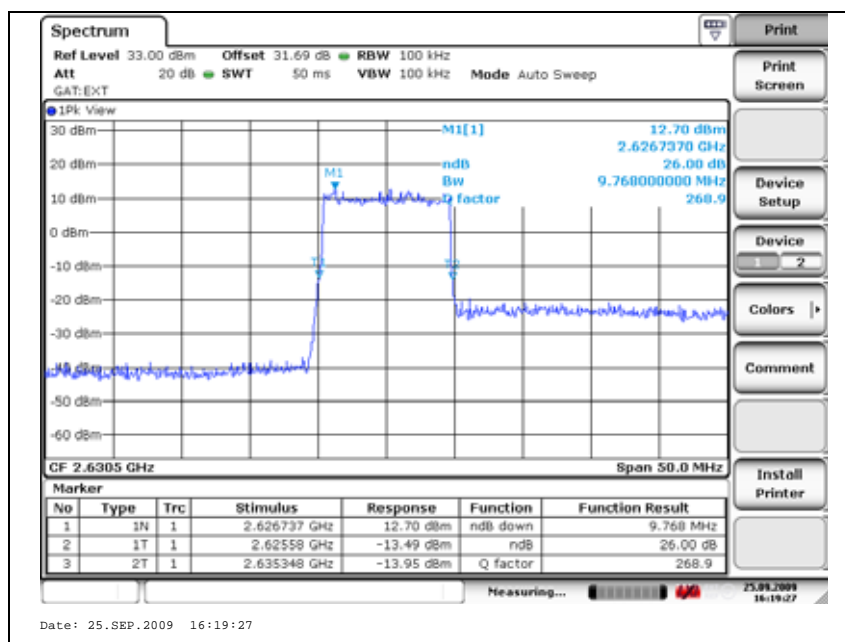
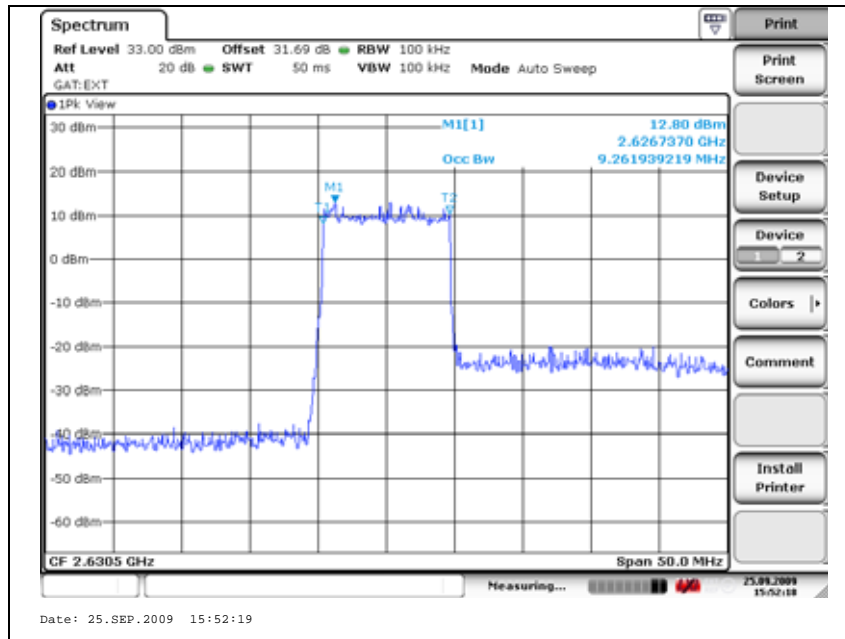
Down link mode

Low Channel



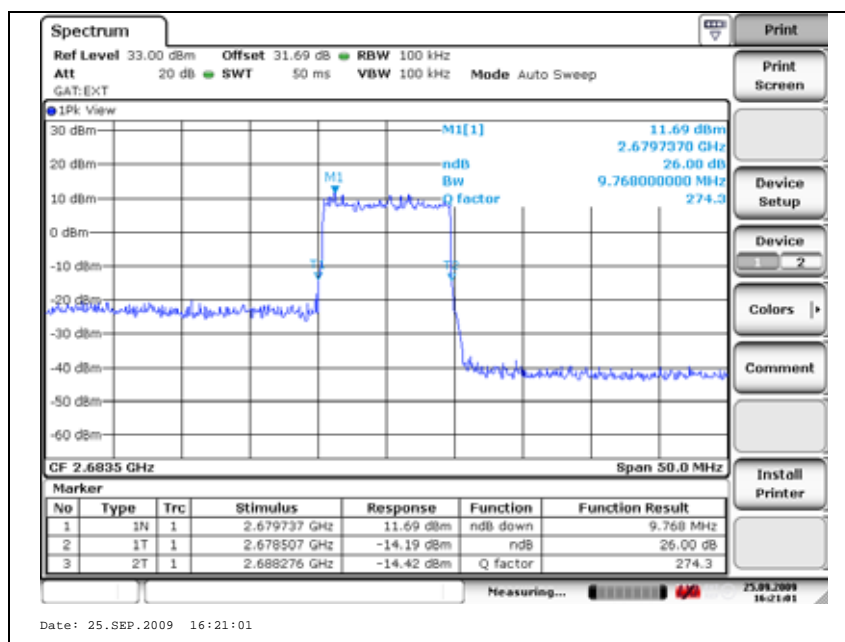
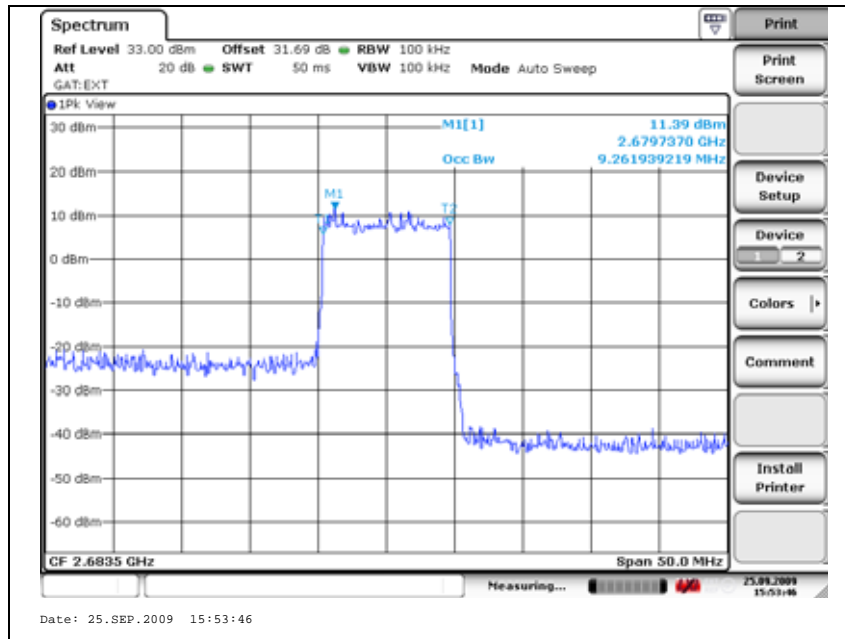
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Middle Channel



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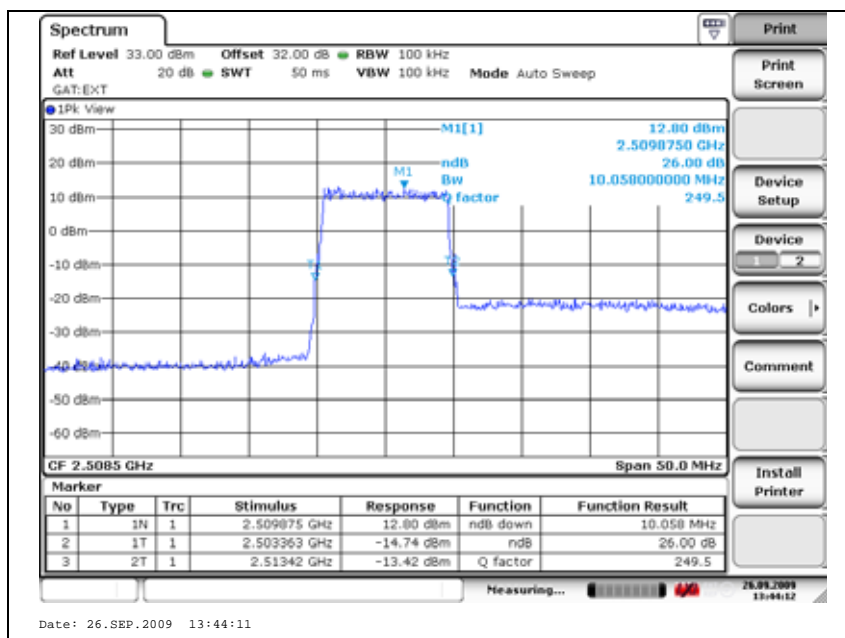
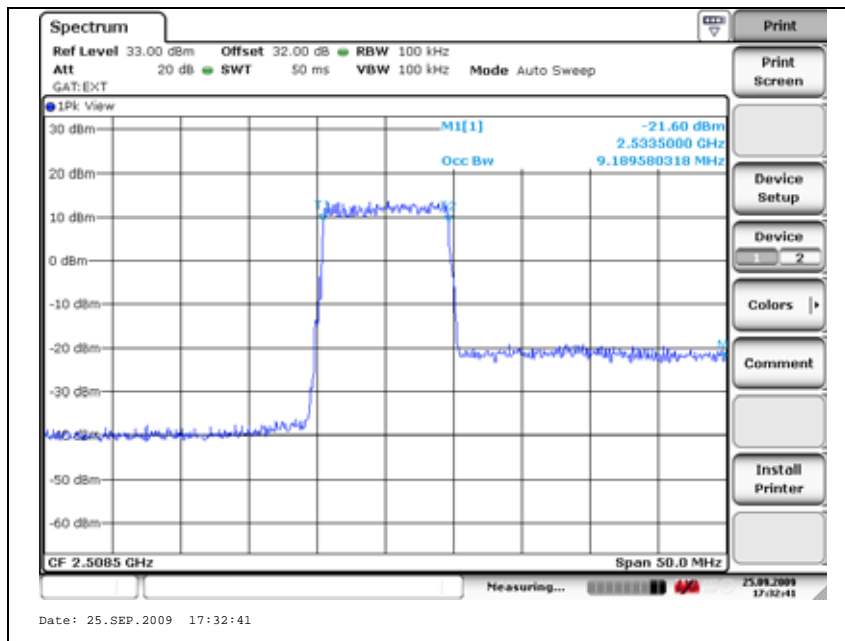
High Channel



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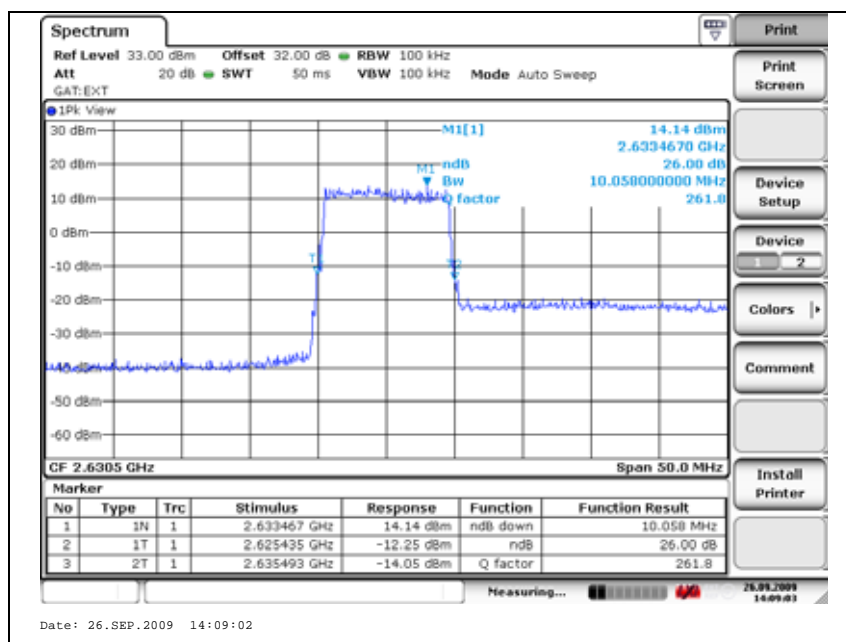
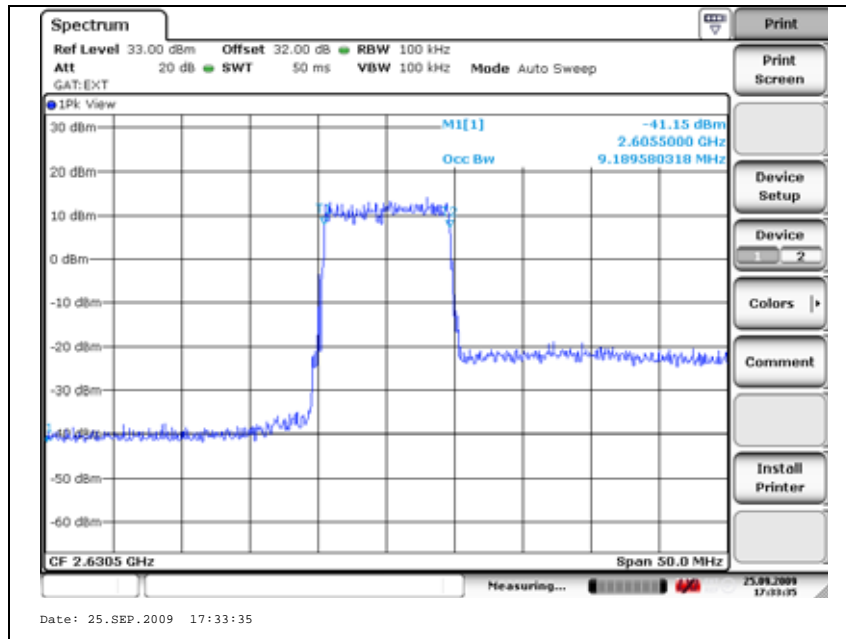
Up link mode

Low Channel



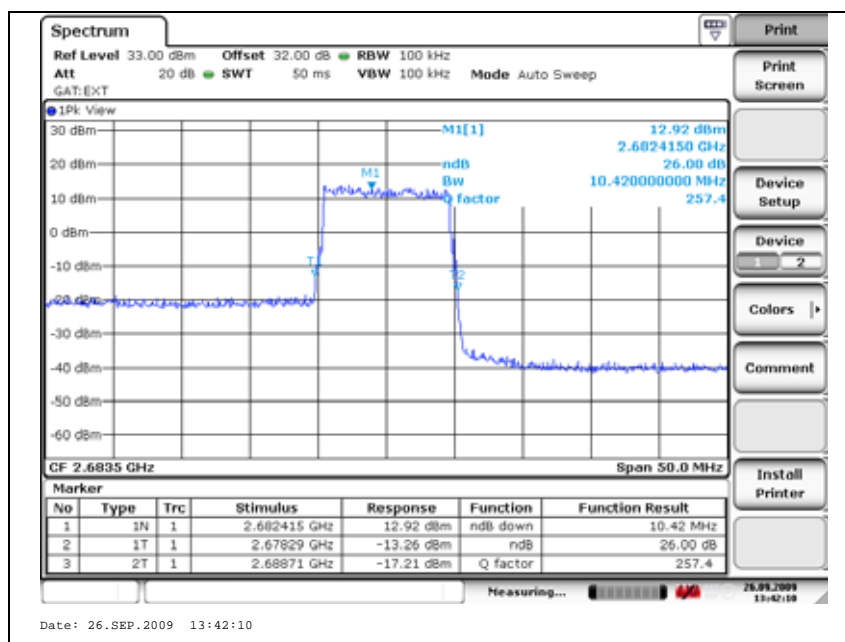
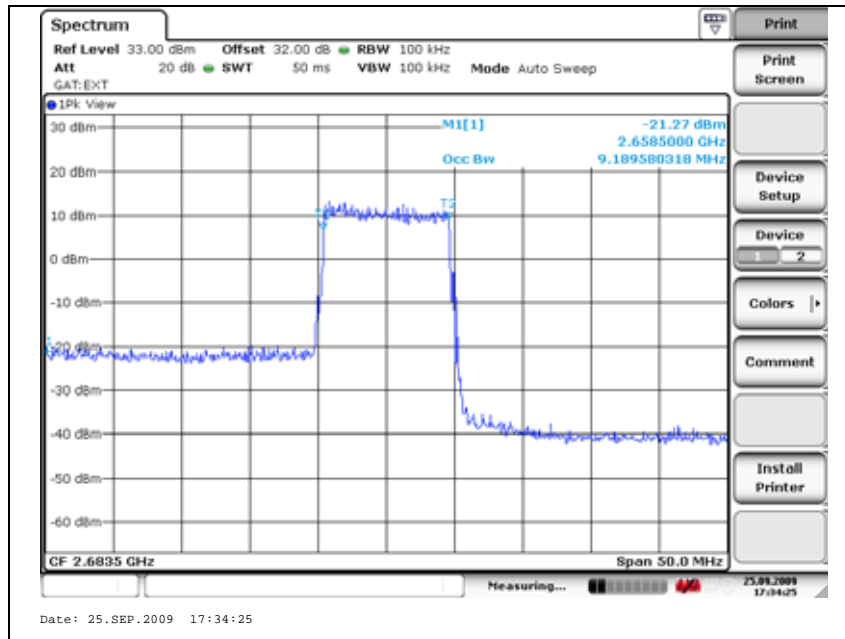
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Middle Channel



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High Channel

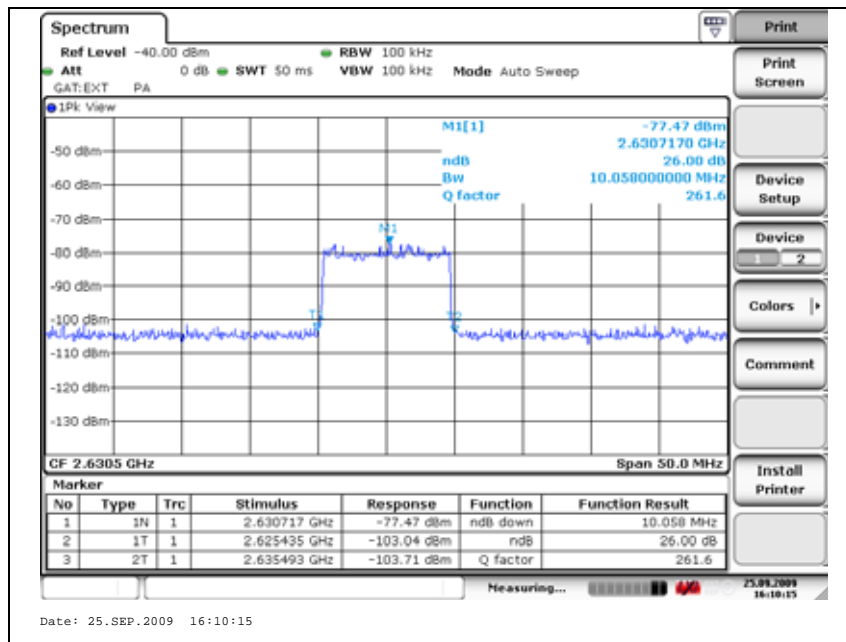


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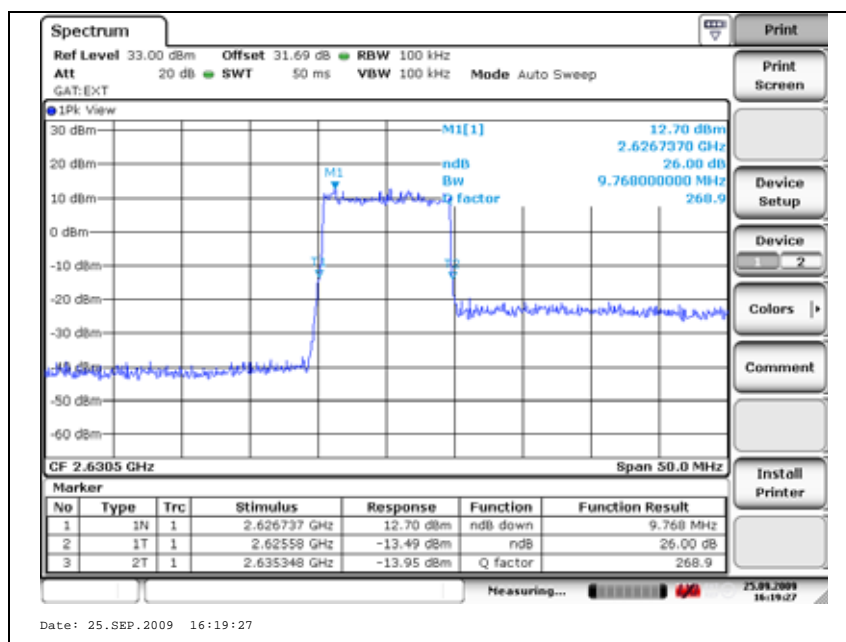
Input/Output comparison_26 dB Occupied Bandwidth

Down link mode

Middle Channel_64QAM 3/4



Input

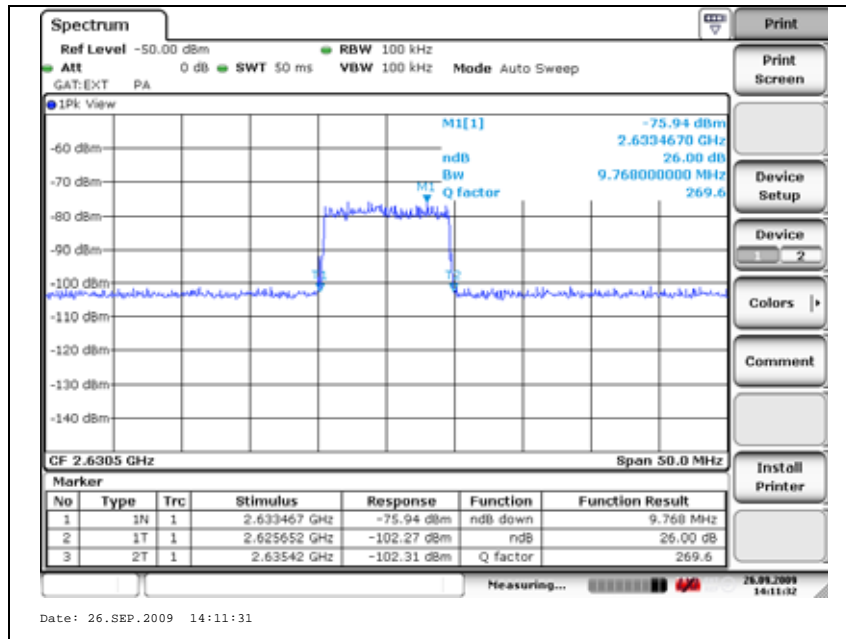


Output

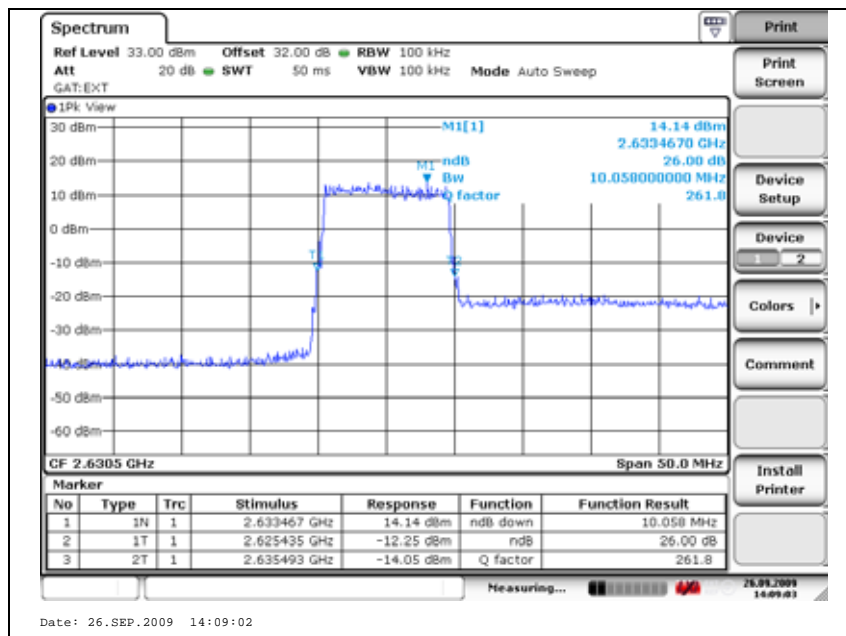
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Up link mode

Middle Channel_16QAM 3/4



Input

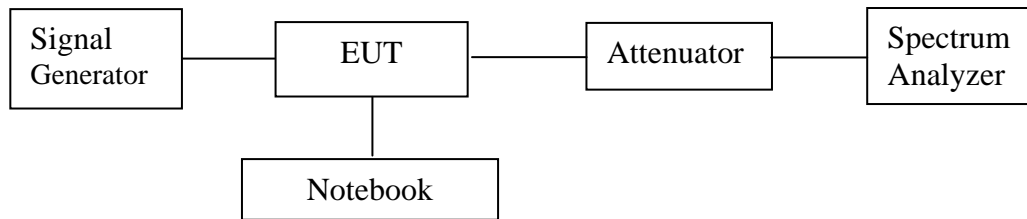


Output

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5. Spurious Emissions at Antenna Terminal

5.1. Set up



5.2. Limit

According to 47 CFR Part 2 section § 2.1053 and Part 27 section § 27.53(l)(2) and § 27.53(l)(6), the power of any emissions outside the licensee's frequency bands of operation must be attenuated below the transmitter power (P in watts) by at least $43 + 10 \log(P)$ dB. Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 1 MHz or greater.

The limit is calculated to be $P(W) - \{43 \text{ dB} + 10 \log[P(W)]\} = 10 \log[1000 P(W)] \text{ (dBm)} - 43 \text{ dB} - 10 \log[P(W)] = 30 \text{ dBm} - 43 \text{ dB} = -13 \text{ dBm}$.

5.3. Test Procedure

1. The transmitter was tested while in a continuous transmit mode.
2. The EUT was tuned to a low, middle, and high channel in both the downlink (base to mobile) and uplink (mobile to base) directions.
3. The resolution bandwidth of the spectrum analyzer was set at 1 MHz.

5.4. Test Results

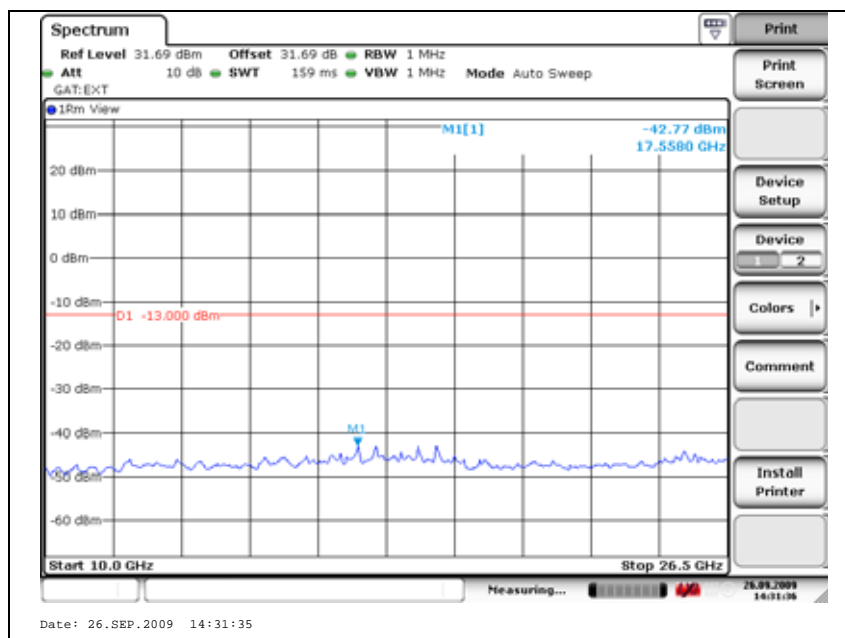
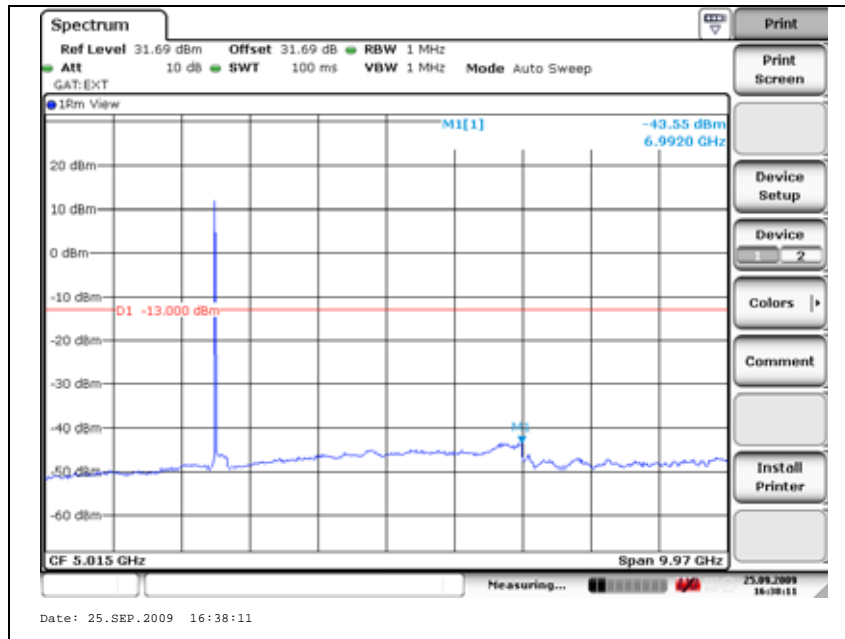
Ambient temperature : 21 Relative humidity : 50 %R.H.

Please refer to the following plots.

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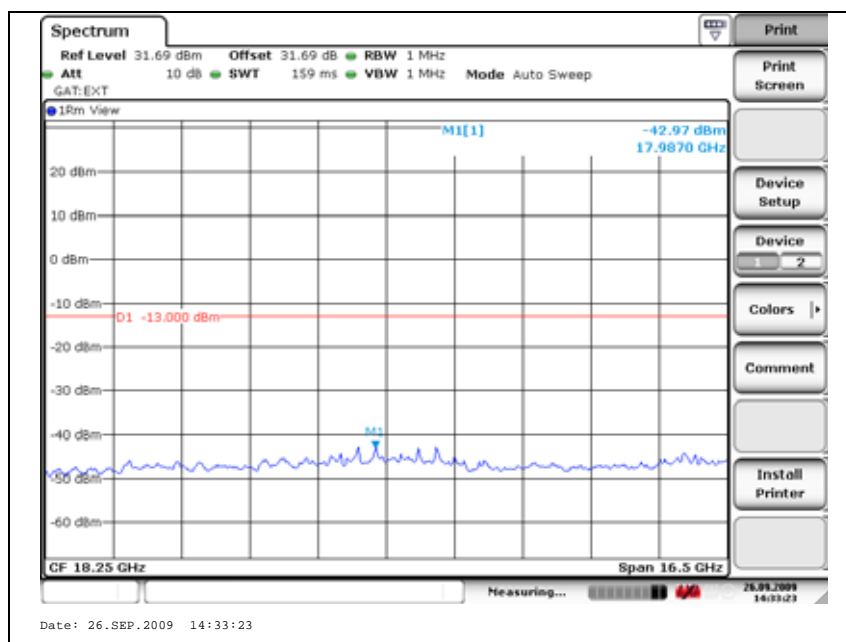
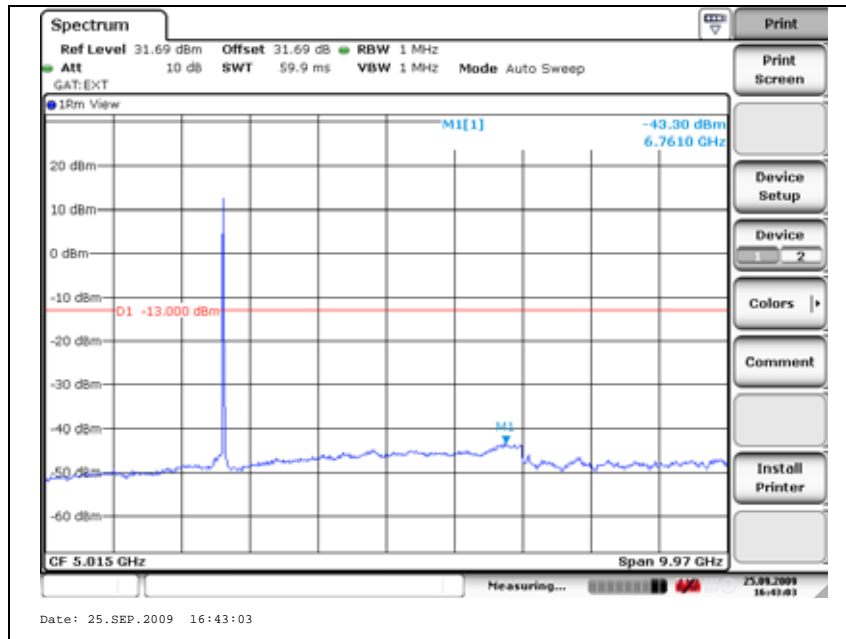
Down link mode

Low Channel



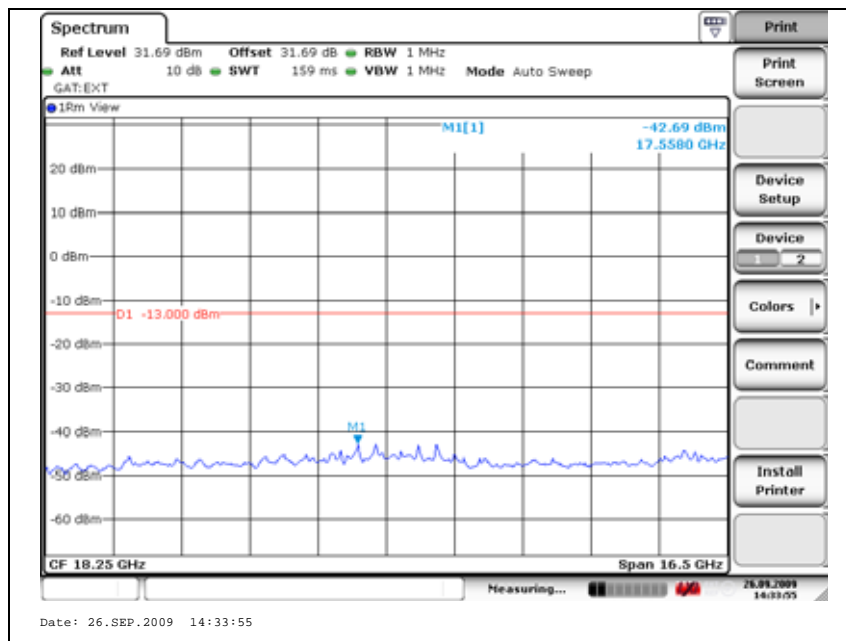
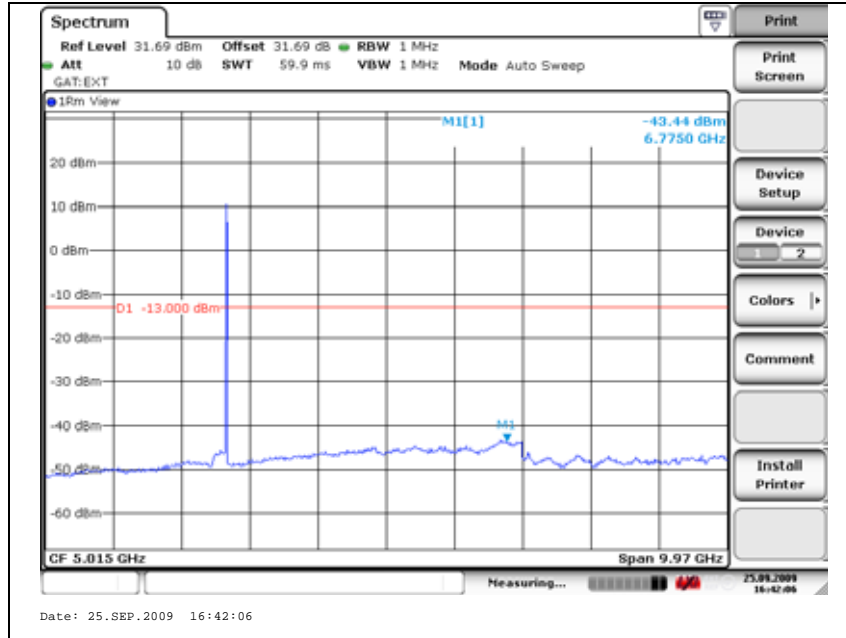
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Middle Channel



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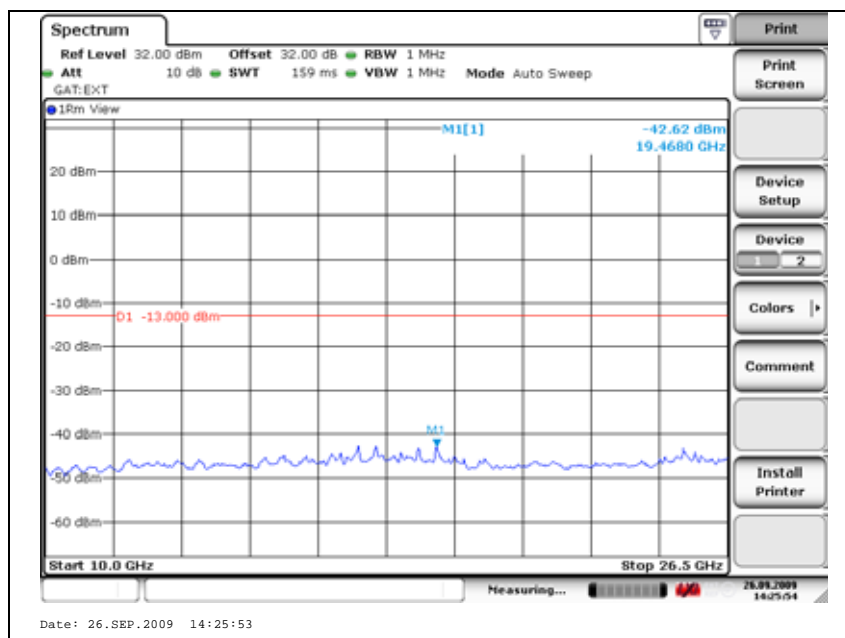
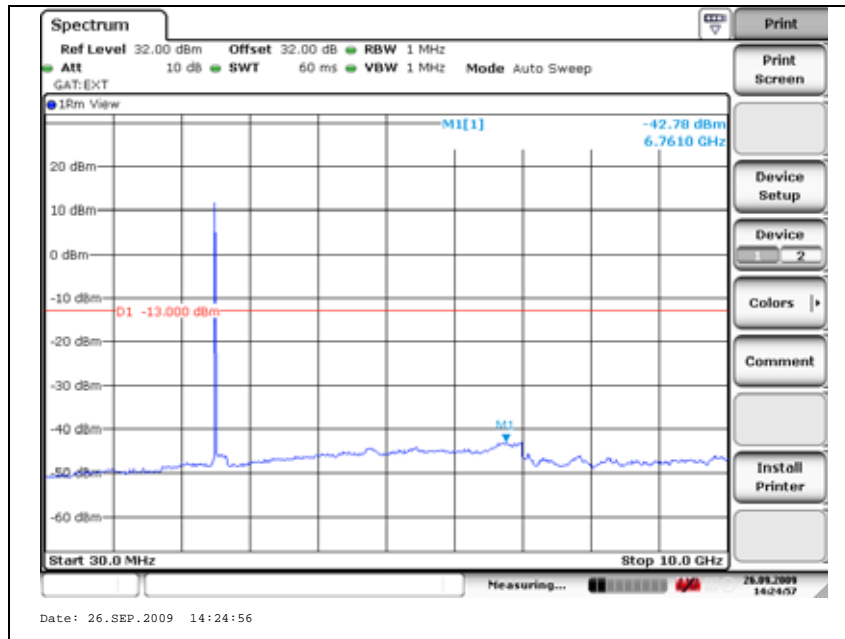
High Channel



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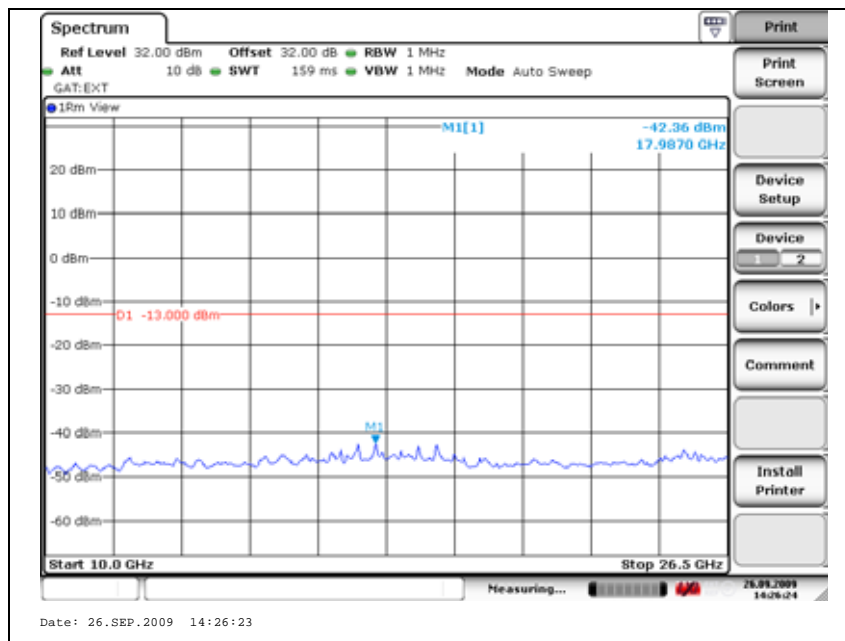
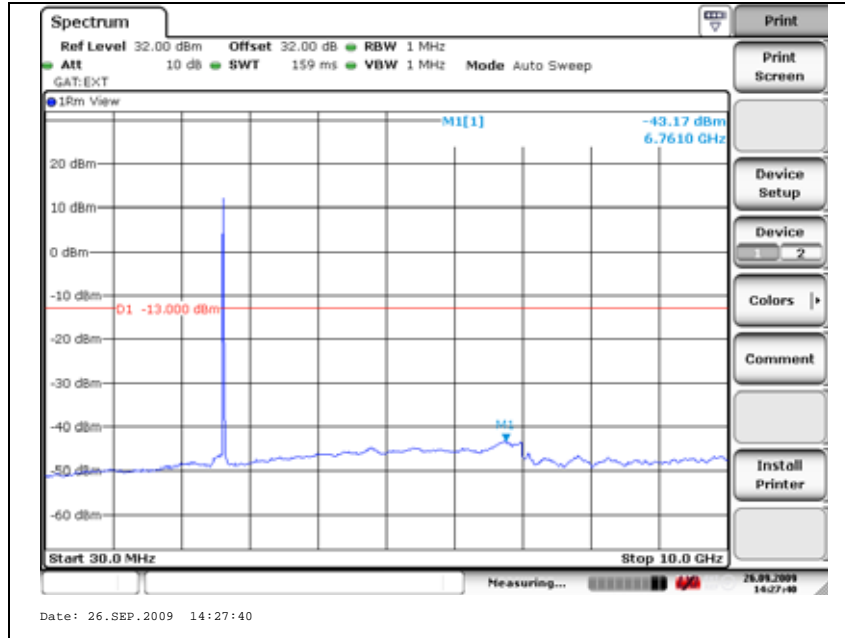
Up link mode

Low Channel



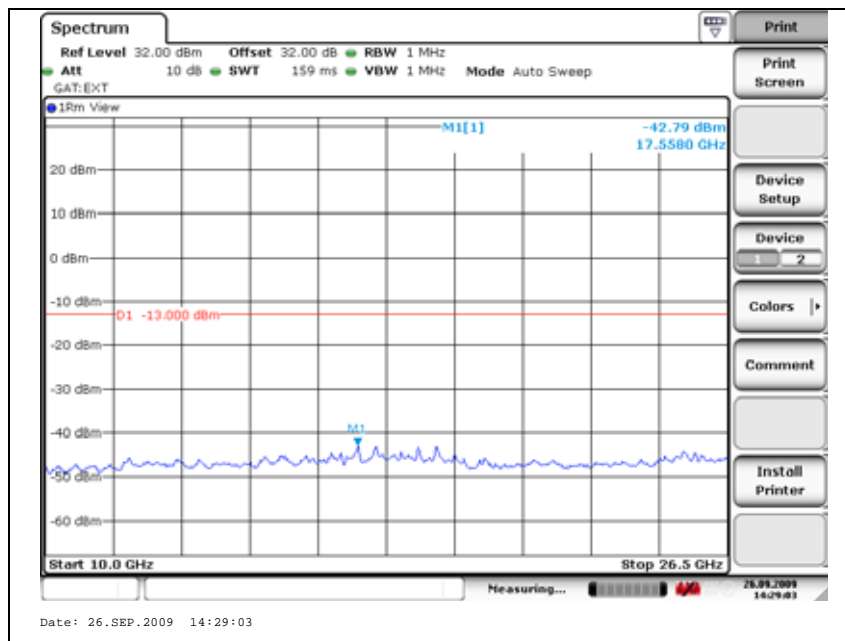
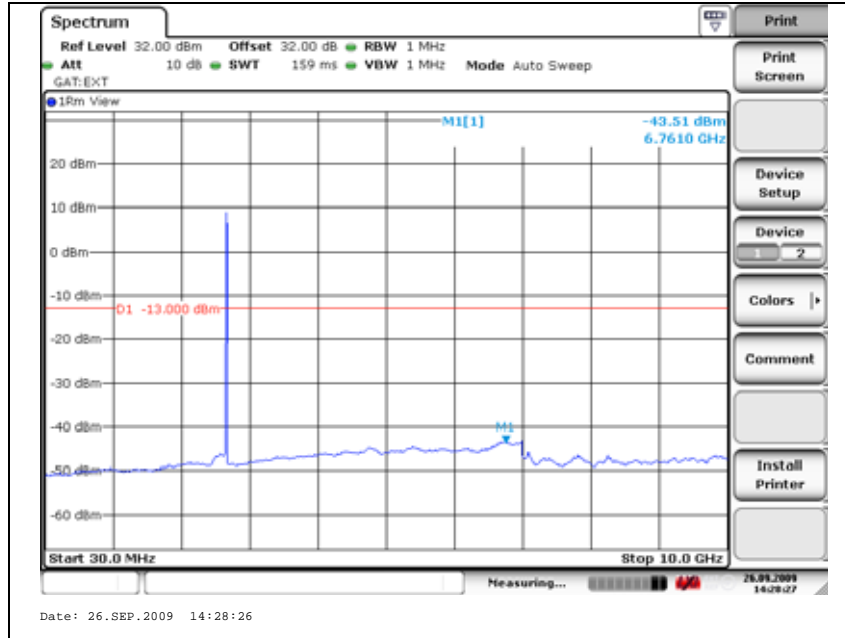
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Middle Channel



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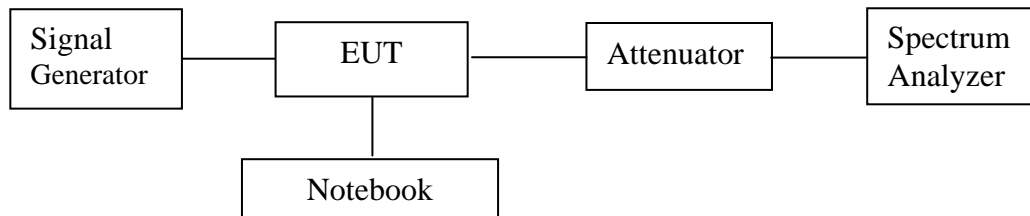
High Channel



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6. Band Edge

6.1. Set up



6.2. Limit

According to 47 CFR Part 2 section § 2.1053 and Part 27 section § 27.53(l)(2) and § 27.53(l)(6), the power of any emissions outside the licensee's frequency bands of operation must be attenuated below the transmitter power (P in watts) by at least $43 + 10 \log(P)$ dB. Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 1 MHz or greater.

The limit is calculated to be $P(W) - \{43 \text{ dB} + 10 \log[P(W)]\} = 10 \log[1000 P(W)] \text{ (dBm)} - 43 \text{ dB} - 10 \log[P(W)] = 30 \text{ dBm} - 43 \text{ dB} = -13 \text{ dBm}$.

6.3. Test Procedure

1. The transmitter was tested while in a continuous transmit mode.
2. The EUT was tuned to a low, middle, and high channel in both the downlink (base to mobile) and uplink (mobile to base) directions.
3. The resolution bandwidth of the spectrum analyzer was set at 100 kHz.

6.4. Test Results

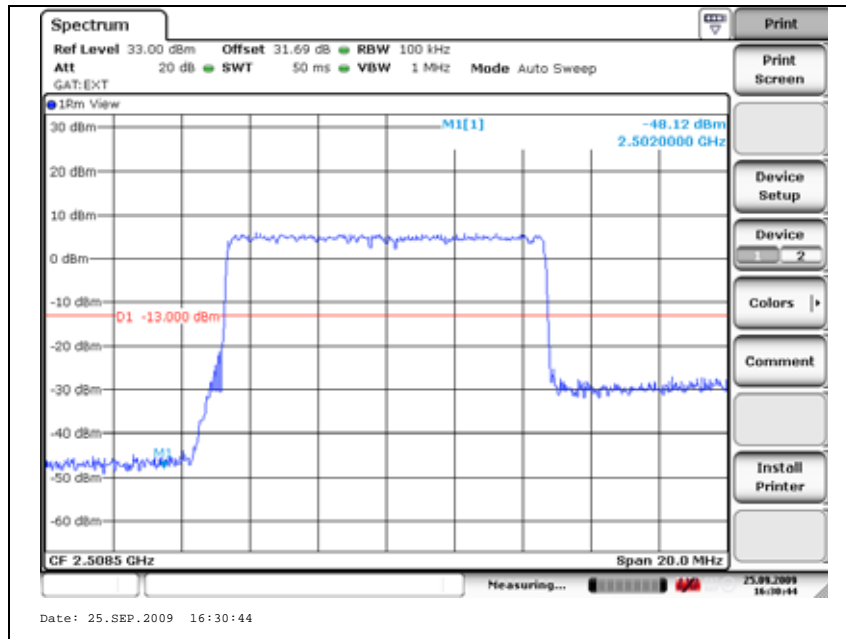
Ambient temperature : 21 Relative humidity : 50 %R.H.

Please refer to the following plots.

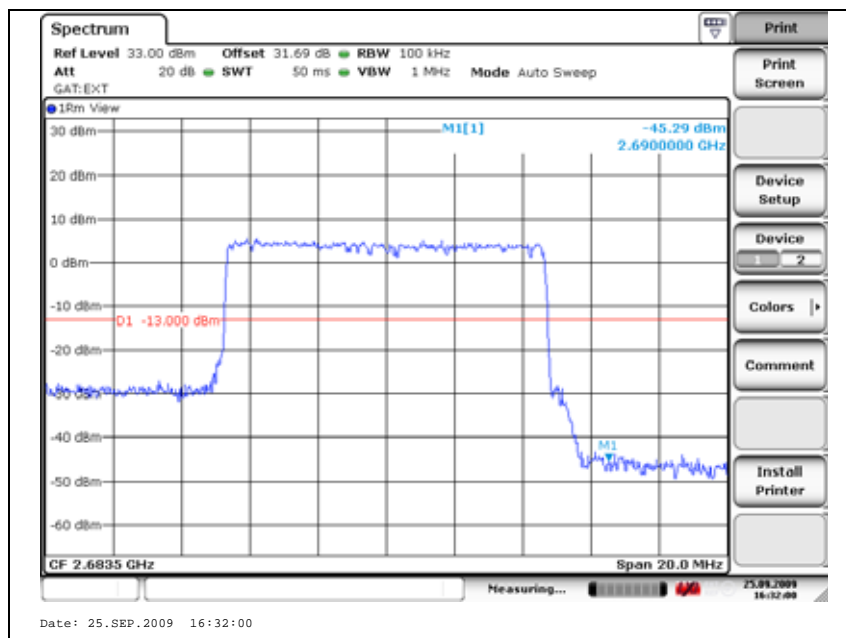
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Down link mode

Low Channel



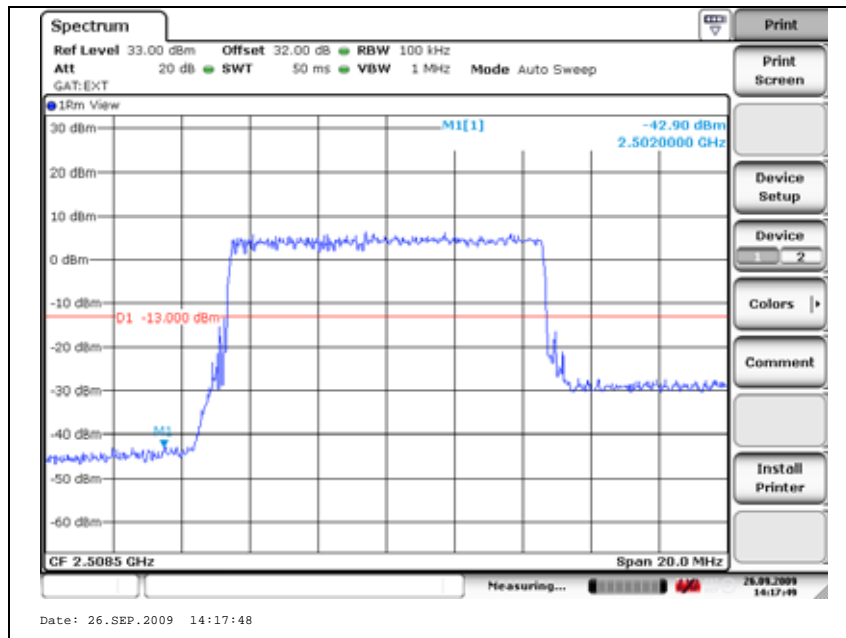
High Channel



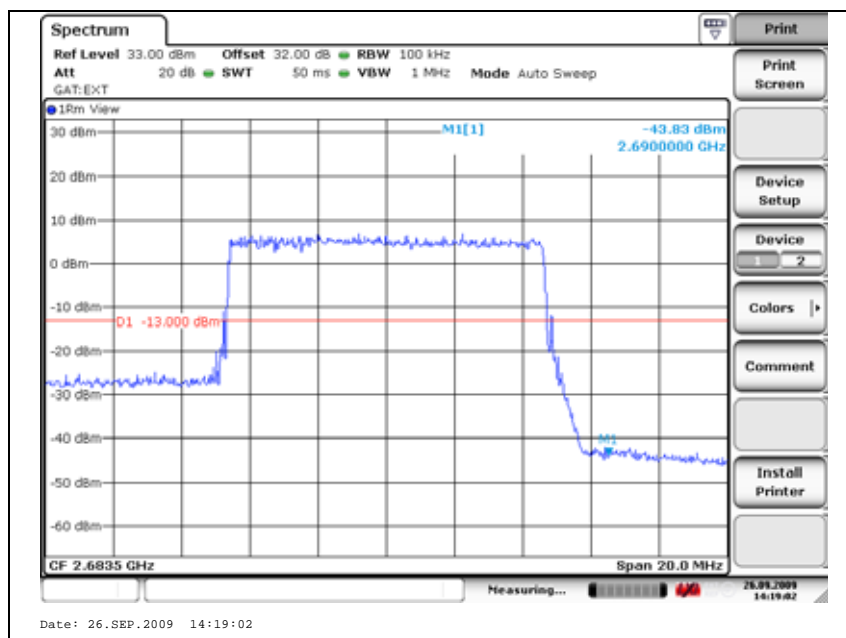
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Up link mode

Low Channel



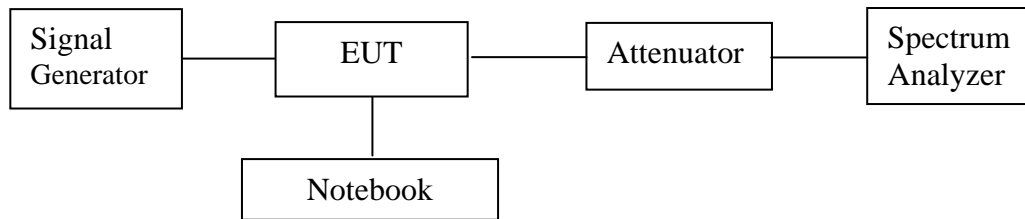
High Channel



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7. Frequency Stability

7.1. set up



7.2. Limit

According to 47 CFR Part 2 section § 2.1055 and Part 27 section § 27.54, the frequency stability shall be sufficient to ensure that the fundamental emissions stay within the authorized bands of operation.

According to WiMAX MRCT, the frequency tolerance is limited to ± 2 ppm.

7.3. Test Procedure

1. Frequency Stability vs. Temperature: The equipment under test was connected to an external AC power supply and the RF output was connected to a frequency counter via feed-through attenuators.
2. The EUT was placed inside the temperature chamber. The AC leads and RF output cable exited the chamber through an opening made for the purpose.
3. After the temperature stabilized for approximately 20 minutes, the frequency output was recorded from the counter.
4. Frequency Stability vs. Voltage: An external variable AC power supply was connected to the battery terminals of the equipment under test. The voltage was set to 115% of the nominal value and was then decreased until the transmitter light no longer illuminated; i.e., the AC end point. The output frequency was recorded for each AC.

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7.4. Test Results

Ambient temperature : 20 Relative humidity : 50 %R.H.

Frequency Stability versus Temperature

Down Link

Reference Frequency: 2630.5 MHz, Limit: ± 2 ppm			
Environment Temperature ()	Power Supplied (Vac)	Frequency Measure with Time Elapse	
		Frequency Error (Hz)	ppm
20(Ref.)	120	0	0.0000
50	120	-2	-0.0001
40	120	-5	-0.0002
30	120	-1	0.0000
10	120	3	0.0001
0	120	2	0.0001
-10	120	-4	-0.0002
-20	120	-2	-0.0001
-30	120	3	0.0001

Up Link

Reference Frequency: 2630.5 MHz, Limit: ± 2 ppm			
Environment Temperature ()	Power Supplied (Vac)	Frequency Measure with Time Elapse	
		Frequency Error (Hz)	ppm
20(Ref.)	120	0	0.0000
50	120	-4	-0.0002
40	120	-5	-0.0002
30	120	-3	-0.0001
10	120	-1	0.0000
0	120	2	0.0001
-10	120	2	0.0001
-20	120	4	0.0002
-30	120	3	0.0001

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Frequency Stability versus AC

Down Link

Reference Frequency: 2630.5 MHz, Limit: ± 2 ppm			
Power Supplied (Vac)	Environment Temperature ()	Frequency Error (Hz)	ppm
102	20	0	0.0000
138	20	0	0.0000

Up Link

Reference Frequency: 2630.5 MHz, Limit: ± 2 ppm			
Power Supplied (Vac)	Environment Temperature ()	Frequency Error (Hz)	ppm
102	20	0	0.0000
138	20	0	0.0000

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8. RF Exposure Evaluation

According to FCC 1.1310 : The criteria listed in the following table shall be used to evaluate the environment impact of human exposure to radio frequency (RF) radiation as specified in § 1.1307(b)

LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency Range (MHz)	Electric Field Strength(V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Average Time
(A) Limits for Occupational /Control Exposures				
300 – 1500	--	--	F/300	6
1500 - 100000	--	--	5	6
(B) Limits for General Population/Uncontrol Exposures				
300 – 1500	--	--	F/1500	6
<u>1500 - 100000</u>	--	--	<u>1</u>	<u>30</u>

8.1 Friis transmission formula : $P_d = (P_{out} * G) / (4 * \pi * R^2)$

Where

P_d = power density in mW/cm²

P_{out} = output power to antenna in mW

G = gain of antenna in linear scale

π = 3.1416

R = distance between observation point and center of the radiator in cm

P_d the limit of MPE, 1 mW/cm². If we know the maximum gain of the antenna and the total power input to the antenna, through the calculation, we will know the distance where the MPE limit is reached.

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8.2 Test Result of RF Exposure Evaluation

Test Item : RF Exposure Evaluation Data

Test Mode : Normal Operation

8.2.1 Output Power into Antenna & RF Exposure Evaluation Distance

Antenna: 8 dBi(Patch Antenna)

Test Mode: Down link_64QAM 3/4

Channel	Frequency (MHz)	Output Power to Antenna (dBm)	Antenna Gain (dBi)	R (cm)
Low	2508.5	23.78	8	10.9523
Middle	2630.5	24.64	8	12.0922
High	2683.5	23.39	8	10.4714

Test Mode Mode: Up link_16QAM 3/4

Channel	Frequency (MHz)	Output Power to Antenna (dBm)	Antenna Gain (dBi)	R (cm)
Low	2508.5	23.78	8	10.9523
Middle	2630.5	24.40	8	11.7627
High	2683.5	23.45	8	10.5440

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Test setup photos of EUT

A. Photo of Spurious Emission Test

