EMC
TEST REPORT

Report No. : TS10110090-EME

Model No. : HES-309M, MAX308M

Issued Date : Jan. 05, 2011

Applicant:	**ZyXEL Communications Corporation** **6, Innovation Rd II, Science-Based Industrial Park,** **Hsin-Chu, Taiwan**
Test Method/ Standard:	**47 CFR FCC Part 2 and Part 27, Subpart C**
Test By:	**Intertek Testing Services Taiwan Ltd.** **No. 11, Lane 275, Ko-Nan 1 Street, Chia-Tung Li,** **Shiang-Shan District, Hsinchu City, Taiwan**

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These measurements were taken by:	Sign on File Jimmy Yang/ Engineer
The test report was reviewed by:	Arthur Tsai **Name** Arthur Tsai **Title** Engineer

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1. Summary of Test Data

Test/Requirement Description	Applicable Rule	Result
RF Power Output	CFR 47, Part 2, Para 2.1046 CFR 47, Part 27, Para 27.50(h)(1)	Pass
Occupied Bandwidth	CFR 47, Part 2, Para 2.1049 CFR 47, Part 27, Para 27.53(m)(6)	Pass
Spurious Emission at Antenna Terminals	CFR 47, Part 2, Para 2.1051 CFR 47, Part 27, Para 27.53(m)(2)(v)(6)	Pass
Field Strength of Spurious Radiation	CFR 47, Part 2, Para 2.1053 CFR 47, Part 15.209 CFR 47, Part 27, Para 27.53(m)(2)(v)(6)	Pass
AC Power Line Conducted Emission	CFR 47, Part 15.207	Pass
Frequency Stability	CFR 47, Part 2, Para 2.1055 CFR 47, Part 27, Para 27.54	Pass

2. General Information

Identification of the EUT

Product	WiMAX Outdoor CPE
Model No.	HES-309M
FCC ID.	I88HES309M
Frequency Range	5 MHz: 2502.5 MHz ~ 2687.5 MHz 10 MHz: 2505 MHz ~ 2685 MHz
Type(s) of Modulation	QPSK, 16QAM
Emission Designator	For 5MHz: 4M47D2D For 10MHz:9M13D2D
RF Power Output	41.21 dBm at antenna terminals
Rated Power	DC 48 V from PoE
Power Cord	3 C × 18 AWG × 1.8 meter unshielded cable
Sample Received	Nov. 24, 2010
Test Date(s)	Nov. 24, 2010 ~ Dec. 10, 2010

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Note 2: When determining the test conclusion, the Measurement Uncertainty of test has been considered.

EUT RF Profile of WiMax forum:

1. RF Profile:

Frequency Range (GHz)	Channel Frequency Step (kHz)	Channel Bandwidth(s)(MHz)	FFT size	Duplexing Mode
2.496 – 2.690	250	5	512	TDD
		10	1024	TDD

The RF profile of EUT is followed WiMax forum Document " WiMAX Forum™ Mobile System Profile Release 1.0 Approved Specification", The EUT is WiMAX device which used TDD mode. Following clause 4.1.1.2 table 6 of attachment 1, the EUT is compliant to not only frequency band (2496~2690MHz) of WiMAX Forum specification, but also lowest bandedge and highest bandedge of FCC Part 27 requirement.

2. PHY Parameter:

Parameter	Uplink	Uplink
System Bandwidth	5MHz	10MHz
FFT Size	512	1024
Null Sub-Carriers	104	184
Pilot Sub-Carriers	136	280
Data Sub-Carriers	272	560
Sub-Channels	17	35
Symbol Period, Ts	102.9 microseconds	
Frame Duration	5 millisecond	
OFDM Symbols/Frame	48	
Data OFDM Symbols	44	
Modulations	QPSK 1/2 CTC , QPSK 3/4 CTC 16QAM 1/2 CTC , 16QAM 3/4 CTC (The EUT is followed WiMAX forum document" WiMAX Forum™ Mobile System Profile Release 1.0 Approved Specification" as attachment 2, clause 7, and Table 131.)	

3. Voltage and current through final PA

According to 2.1033 (c) (8), the voltage is 157mV, and the current is 878mA

4. According to 2.1033 (c) (6), the range of operating power values are ±1dB, please also reference specification of manual.

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Description of EUT

The EUT is a WiMAX Outdoor CPE and was defined as fixed station, it has two type of Bandwidth, one is 5MHz, the other is 10MHz and was defined as information technology equipment.

The customer confirmed the models listed below were identical to model HES-309M (EUT). Different brands served as marketing strategy.

Trade Name	Model Number
ZyXEL	HES-309M
MitraStar	MAX308M

For more detail features, please refer to User's manual as file name “Installation guide.pdf”

Antenna description

The antenna is affixed to the EUT using a unique connector, which allows for replacement of a broken antenna, but DOES NOT use a standard antenna jack or electrical connector.

Antenna Gain	: 14dBi max
Antenna Type	: Directional patch antenna
Connector Type	: I-PAX

Test description

Since the EUT has 16QAM and QPSK modulation, after verifying both modulations, the maximum output power and the worst case were found at OFDMA QPSK 1/2 for 5 MHz Bandwidth and 10 MHz Bandwidth. The final tests has been executed under these conditions and recorded in this report individually.

The EUT was transmitted continuously during the test and subchannelizations as below (for 5MHz. &10MHz Bandwidth)

Plug the power cable of the PoE in socket. Connect the RJ-45 cable of the “IN” port to the PC and connect the RJ-45 cable of the “OUT” port to the EUT.

3. Test Equipment List

Intertek ID No.	Equipment	Brand	Model No.	Last Cal.	Cal. interval
EC1332	Horn Antenna	EMCO	3115	2010/8/13	1 Year
EC1348	X-WING Bilog Antenna	CHASE	CBL 6141	2009/8/12	2 Year
EC1352	Pre-Amplifier(1-20G)	AML	AML0120L3401	2010/8/13	1 Year
EC1354	Signal Generator	Rohde&schwarz	SMR27	2010/11/14	1 Year
EC1355-2	Pre-Amplifier(9k-3G)	Advantest	BB525C	2009/8/10	2 Year
EC1360	Microwave Amplifier	Agilent	8348A	2010/12/3	1 Year
EC1398	FSP30 Spectrum Analyzer	Rohde&Schwarz	FSP30	2010/3/2	1 Year
EC1303	EMI Test Receiver	Rohde&schwarz	ESCS30	2010/9/3	1 Year
EC1320	Two-Line -V-Network	Rohde&schwarz	ESH3-Z5	2010/10/15	1 Year
EC1384	Artificial Mains Network (LISN)	Schaffner	MN2050D	2010/8/24	1 Year
EC1401	EMI current probe	Schaffner	Solar 9208-1c	2010/8/25	1 Year
EC1405	Impedanz-stabilisierungs-Netzwerk	TESEQ	ISN T8	2010/8/3	1 Year
EC1363	Temperature&Humidity Test	TERCHY	MHU-225LRU(SA)	2010/8/6	1 Year
EC1365	Spectrum Analyzer	Rohde&schwarz	FSEK30	2010/8/6	1 Year
EC1404-4	Power Meter	Agilent	N1911A	2010/4/13	1 Year
EC1404-5	Power Sensor	Agilent	N1921A	2010/4/13	1 Year
EC1404-1	WiMAX PSA Spectrum Analyzer	Agilent	E4440A	2010/5/7	1 Year

Note: 1. The above equipments are within the valid calibration period.

Measurement Uncertainty:

Parameter	Uncertainty
Radiated Emission	±5.10 dB
Conducted Emission	±2.786 dB

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

4. RF Power Output

4.1 Conducted Power Measurement

Base Standard	FCC 2.1046 & 27.50(h)(1)(ii)

Test Result: Complies

Test Equipment: EC1404-4 and EC 1404-5

4.1.2 LIMITS OF RF Power Output

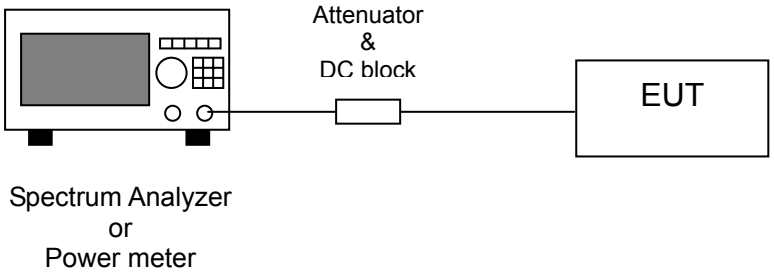
The radiated peak output power shall be according to the specific rule Part 27.50(h)(1)(ii) that “If a main or booster station sectorizes or otherwise uses one or more transmitting antennas with a non-omnidirectional horizontal plane radiation pattern, the maximum EIRP in dBW in a given direction shall be determined by the following formula: EIRP = 33 dBW + 10 log(X/Y) dBW + 10 log(360/beamwidth) dBW, where X is the actual channel width in MHz, Y is either (i) 6 MHz if prior to transition or the station is in the MBS following transition or (ii) 5.5 MHz if the station is in the LBS and UBS following transition, and beamwidth is the total horizontal plane beamwidth of the individual transmitting antenna for the station or any sector measured at the half-power points.”

Because the antenna of the EUT is directional and the beamwidth of antenna is “35°”, the power limit of this EUT is “” in the MBS and “” in the LBS and UBS.

4.1.3 Method of Measurement

The peak power at antenna terminals is measured using a Power Meter. Power output is measured with the maximum rated input level.

4.1.4 Test Diagram



4.1.5 Test Result

For 5 MHz

Modulation(Coding rate)	Frequency (MHz)	Reading	Cable loss	Antenna Gain	Calculated Power	Limit
		(dBm)	(dB)	(dBi)	(dBm)	(dBm)
QPSK (1/2)	2502.5	25.48	1.5	14	40.98	72.70
	2590	25.49	1.5	14	40.99	72.33
	2687.5	25.71	1.5	14	41.21	72.70
QPSK (3/4)	2502.5	25.17	1.5	14	40.67	72.70
	2590	25.28	1.5	14	40.78	72.33
	2687.5	25.48	1.5	14	40.98	72.70
16QAM (1/2)	2502.5	25.26	1.5	14	40.76	72.70
	2590	25.37	1.5	14	40.87	72.33
	2687.5	25.55	1.5	14	41.05	72.70
16QAM (3/4)	2502.5	25.32	1.5	14	40.82	72.70
	2590	25.47	1.5	14	40.97	72.33
	2687.5	25.63	1.5	14	41.13	72.70

For 10 MHz

Modulation(Coding rate)	Frequency (MHz)	Reading	Cable loss	Antenna Gain	Calculated Power	Limit
		(dBm)	(dB)	(dBi)	(dBm)	(dBm)
QPSK (1/2)	2505	25.11	1.5	14	40.61	75.71
	2590	25.34	1.5	14	40.84	75.34
	2685	25.62	1.5	14	41.12	75.71
QPSK (3/4)	2505	25.04	1.5	14	40.54	75.71
	2590	25.27	1.5	14	40.77	75.34
	2685	25.55	1.5	14	41.05	75.71
16QAM (1/2)	2505	25.07	1.5	14	40.57	75.71
	2590	25.29	1.5	14	40.79	75.34
	2685	25.58	1.5	14	41.08	75.71
16QAM (3/4)	2505	25.12	1.5	14	40.62	75.71
	2590	25.32	1.5	14	40.82	75.34
	2685	25.57	1.5	14	41.07	75.71

4.2 Radiated Power Measurement

Name of Test	EIRP Power
Base Standard	FCC 2.1046 & 27.50(h)

Test Equipment: EC1353

4.2.1 Method of Measurement

Tests were performed to identify the maximum equivalent isotropic radiated output power from the EUT.

The EIRP was measured with the EUT arranged on a non-conducting table on a fully-anechoic chamber,

The test procedure consist of three parts:

1. Measured the highest peak readings in horizontal & vertical polarity in the three orthogonal axes.
2. Use the substitution method to perform final tests.
   I. The EUT was substituted with a half wave dipole.
   II. The substituted antenna was set to the same center location as the EUT in horizontal or vertical polarity.
   III. The substituted antenna was connected with a 6dB attenuator for impedance matching purpose between S/G and substituted antenna.
   IV. The S/G was tuned to the frequency according to the measurement results and used a broadband S/G to generate the signal.
   V. The level of S/G was adjusted until the maximum reading is the same as recorded EUT level. (A power amplifier maybe used to produce the wanted power)
3. The EIRP was calculated as:

   EIRP = S/G level – cable loss + antenna gain

   The maximum EIRP test results are recorded in the following table

4.2.3 Test Result

For 5 MHz

Modulation(Coding rate)	Frequency (MHz)	compensation	Cable loss	Reading (EIRP)	Limit
		(dBm)	(dB)	(dBm)	(dBm)
QPSK (1/2)	2502.5	38.63	3.88	42.51	72.70
	2590	39.08	3.88	42.96	72.33
	2687.5	38.49	3.88	42.37	72.70
QPSK (3/4)	2502.5	38.74	3.88	42.62	72.70
	2590	38.9	3.88	42.78	72.33
	2687.5	38.41	3.88	42.29	72.70
16QAM (1/2)	2502.5	38.65	3.88	42.53	72.70
	2590	38.93	3.88	42.81	72.33
	2687.5	38.54	3.88	42.42	72.70
16QAM (3/4)	2502.5	38.51	3.88	42.39	72.70
	2590	38.7	3.88	42.58	72.33
	2687.5	38.48	3.88	42.36	72.70

For 10 MHz

Modulation(Coding rate)	Frequency (MHz)	compensation	Cable loss	Reading (EIRP)	Limit
		(dBm)	(dB)	(dBm)	(dBm)
QPSK (1/2)	2505	38.27	3.88	42.15	75.71
	2590	38.38	3.88	42.26	75.34
	2685	38.31	3.88	42.19	75.71
QPSK (3/4)	2505	38.47	3.88	42.35	75.71
	2590	38.38	3.88	42.26	75.34
	2685	38.53	3.88	42.41	75.71
16QAM (1/2)	2505	38.48	3.88	42.36	75.71
	2590	38.28	3.88	42.16	75.34
	2685	38.25	3.88	42.13	75.71
16QAM (3/4)	2505	38.39	3.88	42.27	75.71
	2590	38.43	3.88	42.31	75.34
	2685	38.23	3.88	42.11	75.71

5. Occupied Bandwidth

Base Standard	FCC 27.53(m)(6)

Test Equipment: EC1404-1

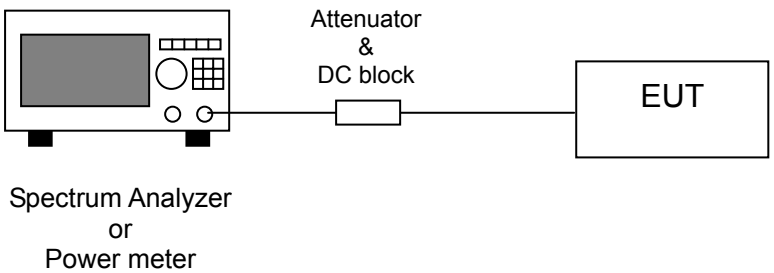
5.1 LIMITS OF Occupied Bandwidth Measurement

According to FCC 27.53(m)(6) specified that 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 26dB below the transmitter power.

5.2 Method of Measurement

A portion of the transmitted signal is coupled to a Spectrum Analyzer with a resolution bandwidth of at least 1% of the bandwidth of the transmitted signal. The resolution bandwidth is chosen so as not to reduce the peak level of the measured waveform. The appropriate bandwidth mask is applied to the output waveform to verify compliance.

5.3 Test Diagram

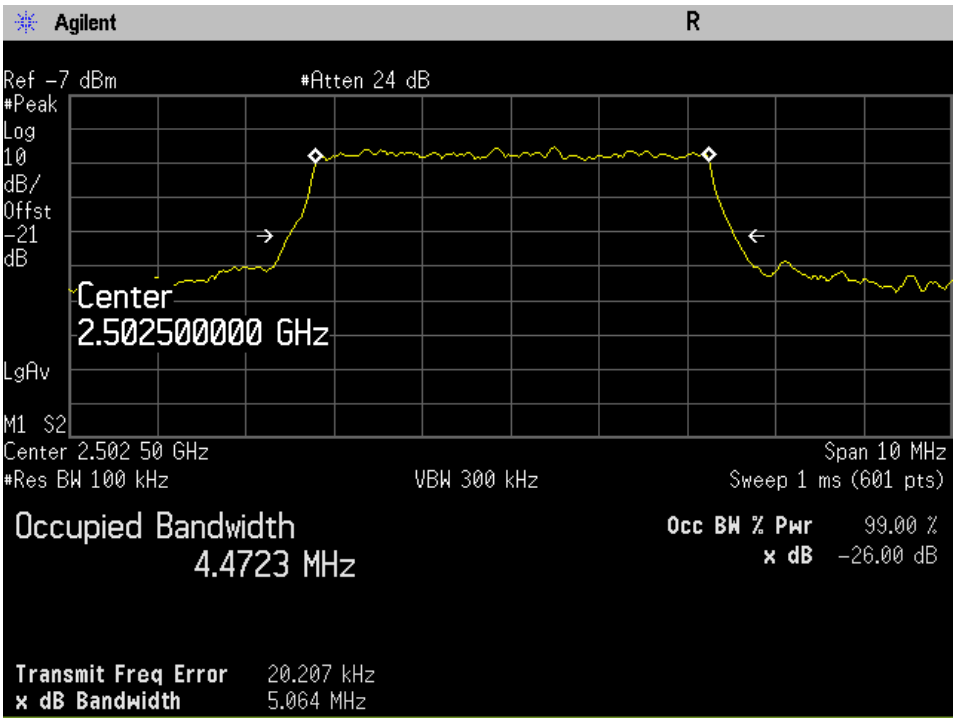


5.4 Test Result

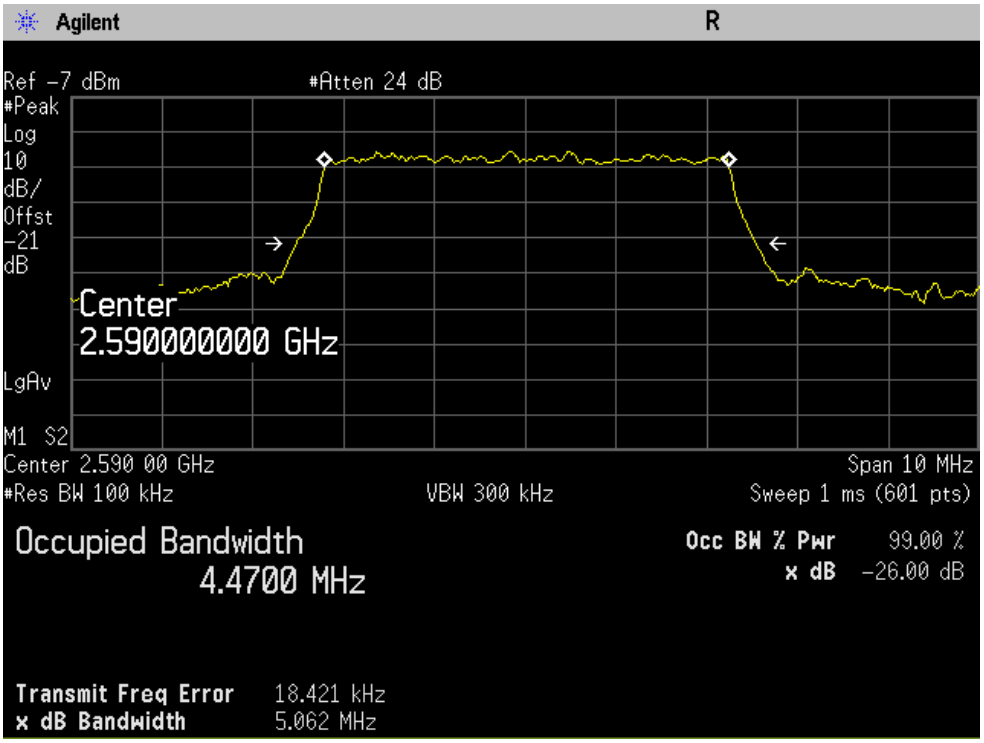
Note: The EUT was tested while in a continuous transmit mode.

Frequency (MHz)	Bandwidth (MHz)
2502.5	4.4723
2590.0	4.4700
2687.5	4.4704
2505	9.1338
2590	9.1320
2685	9.1307

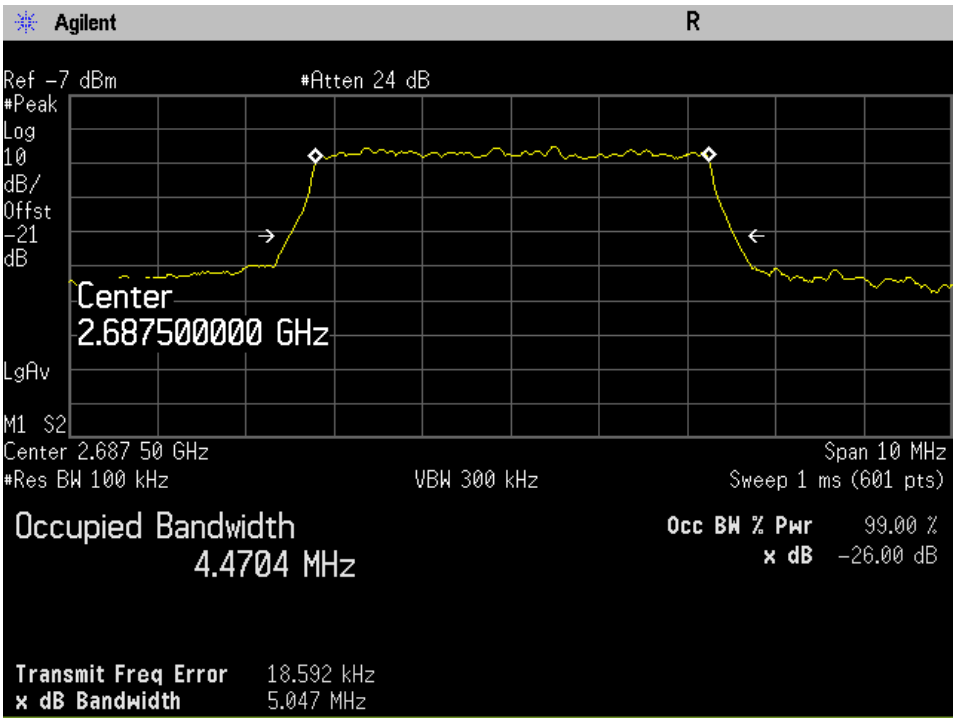
Occupied Bandwidth @ low channel (5MHz)



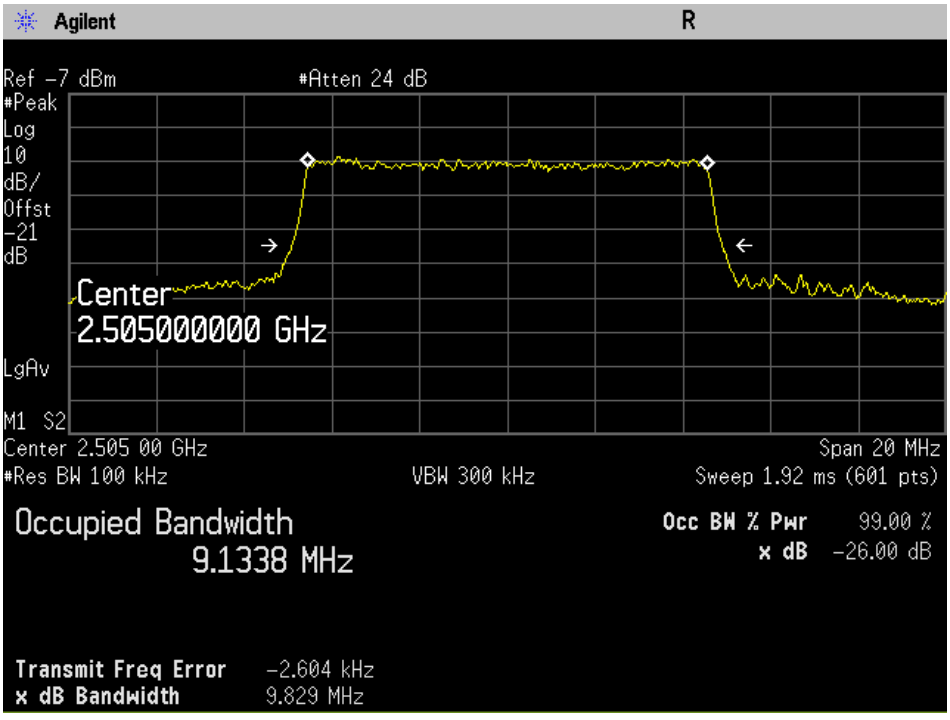
Occupied Bandwidth @ middle channel (5MHz)



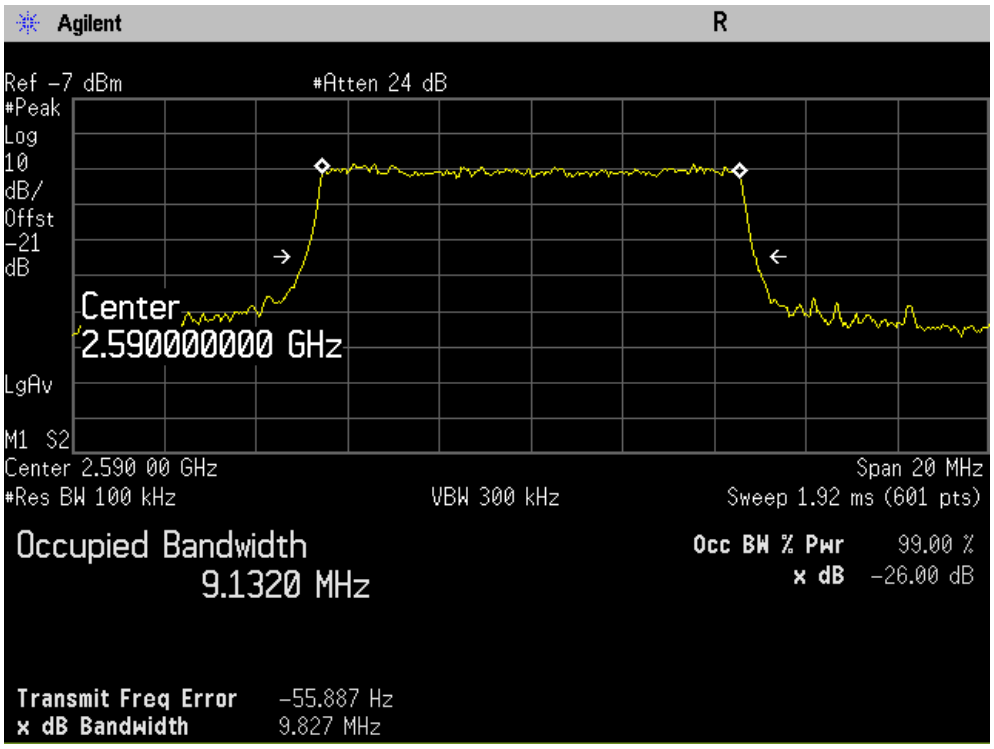
Occupied Bandwidth @ high channel (5MHz)



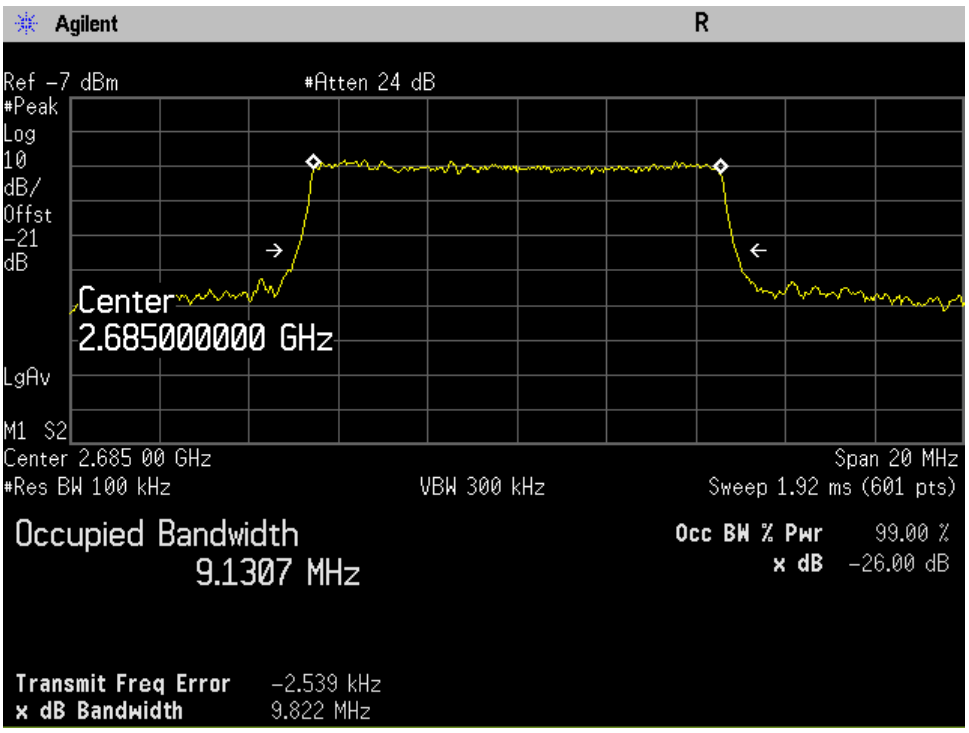
Occupied Bandwidth @ low channel (10MHz)



Occupied Bandwidth @ middle channel (10MHz)



Occupied Bandwidth @ high channel (10MHz)



6. Spurious Emissions at Antenna Terminals

Base Standard	FCC 27.53(m)(2)(v)

Test Equipment: EC1404-1& EC1365

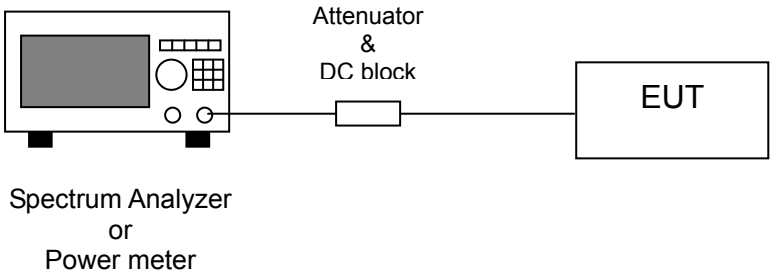
6.1 LIMITS OF Spurious Emissions at Antenna Terminals Measurement

In the FCC 27.53(m)(2)(v), On any frequency outside a licensee's frequency block, For all fixed digital user stations, the attenuation factor shall be not less than 43 + 10 log (P) dB at the channel edge.

6.2 Method of Measurement

A portion of the transmitted signal is coupled to a Spectrum Analyzer with a resolution bandwidth of 1 MHz for emissions above 1 GHz. Below 1 GHz the resolution bandwidth is chosen so as not to reduce the peak level of the measured waveform. The appropriate limit line is applied to the output waveform to verify compliance.

6.3 Test Diagram

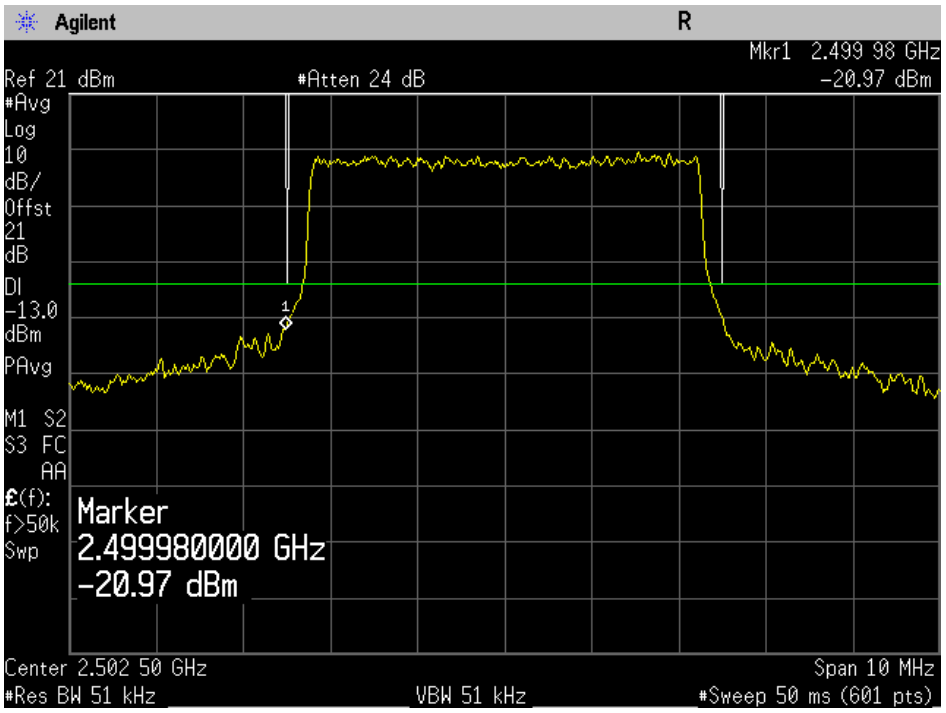


Note: (1) The EUT was tested while in a continuous transmit mode. The EUT was tuned to a low, middle and high channel.

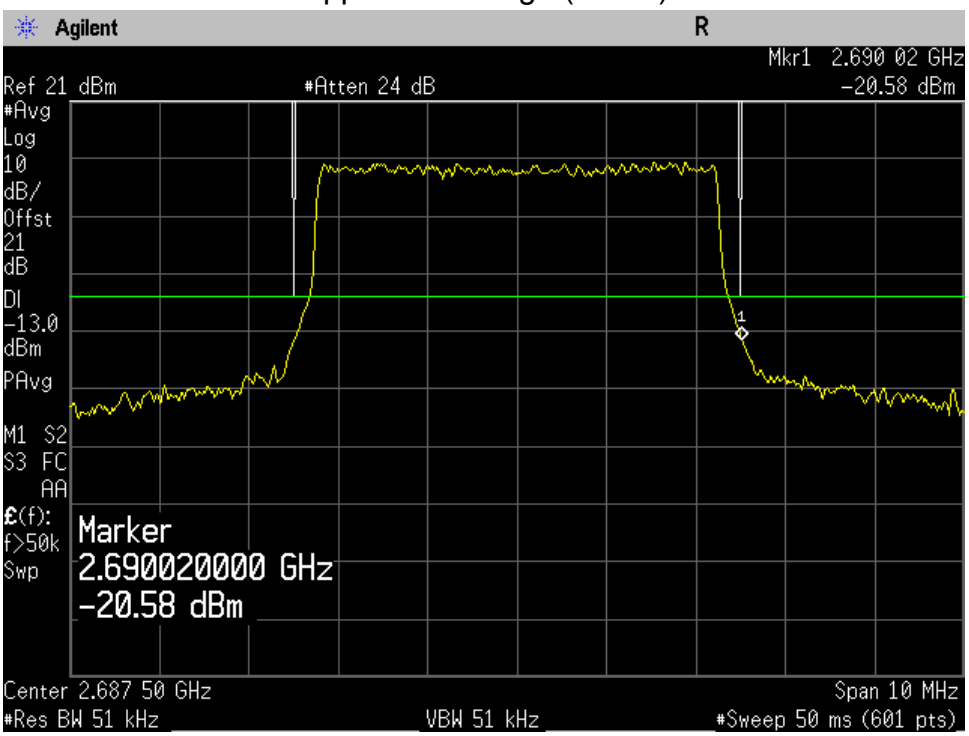
(2) The EUT operating at 2.5GHz band. Frequency Range scanned from 30MHz to 27GHz.

6.4 Test Result

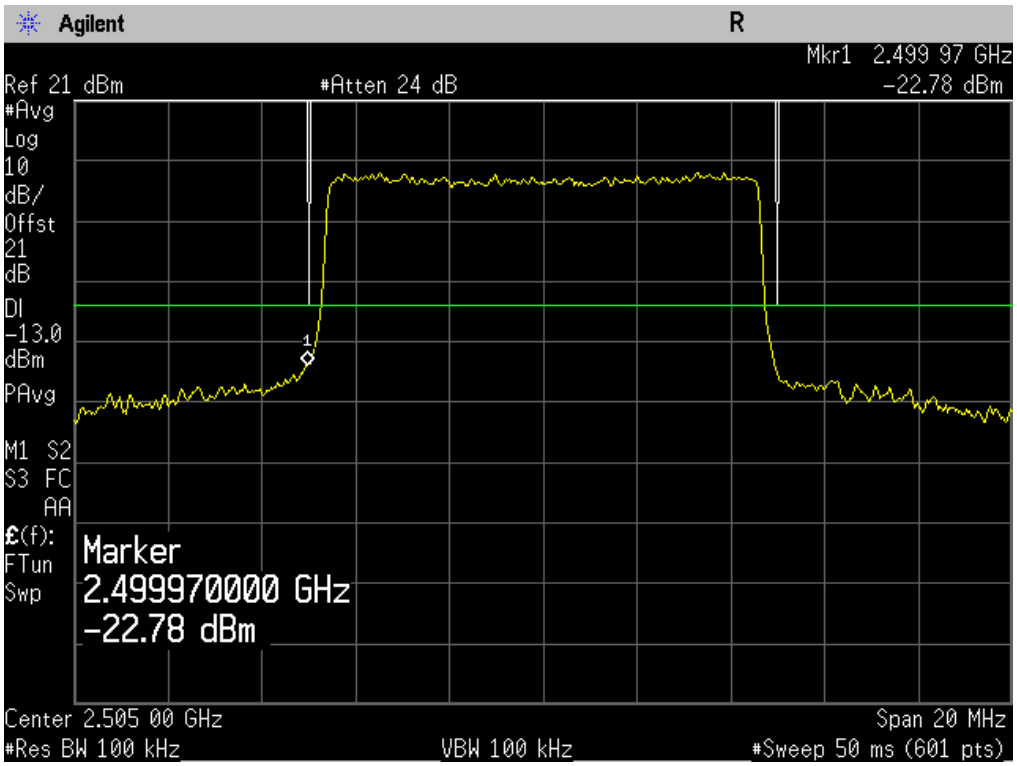
Lower Band Edge (5MHz)



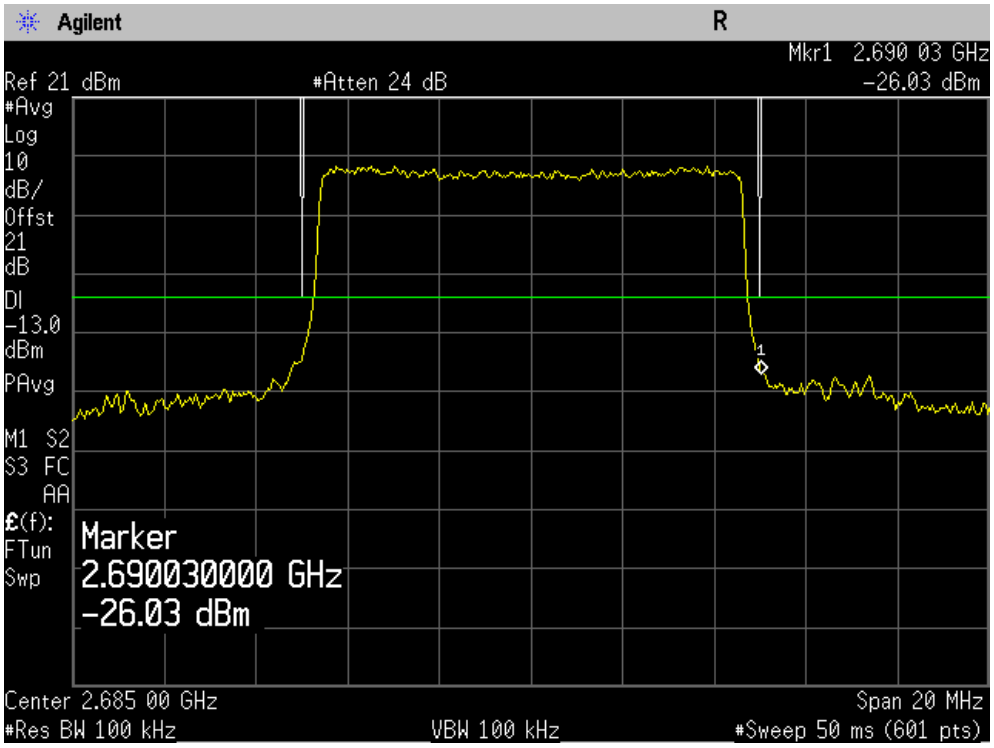
Upper Band Edge (5MHz)



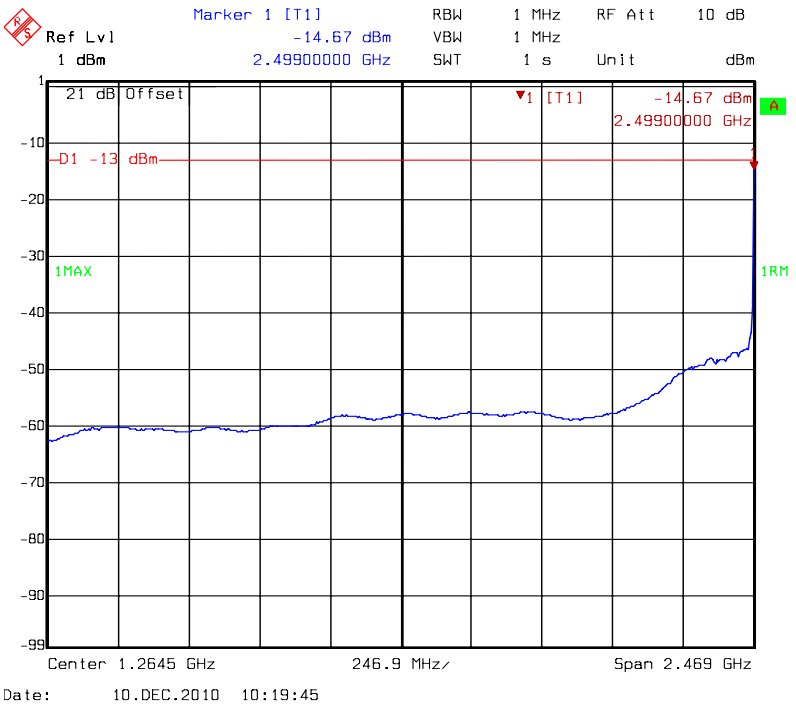
Lower Band Edge (10MHz)



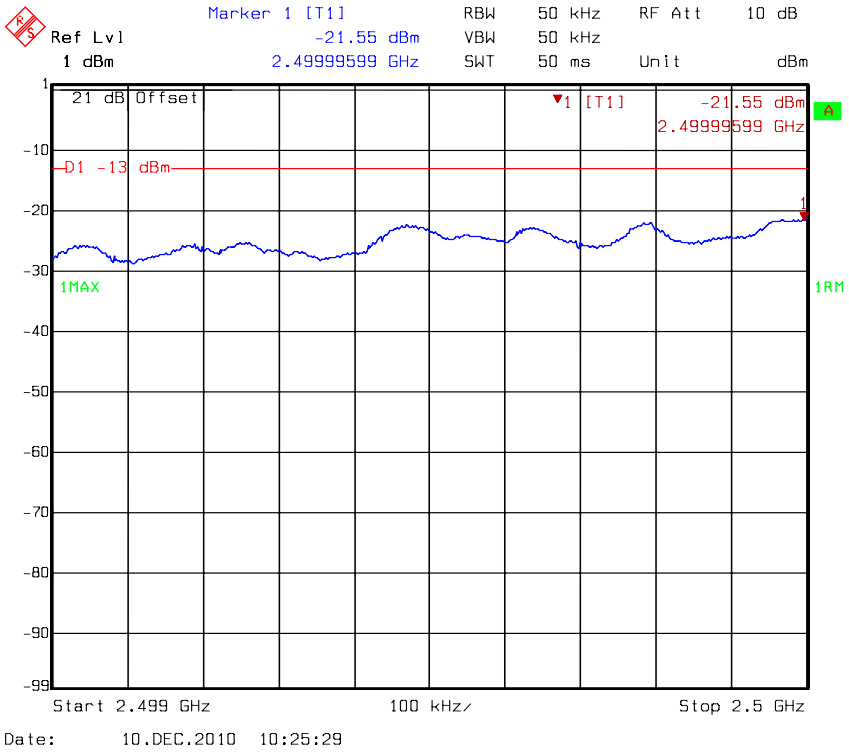
Upper Band Edge (10MHz)



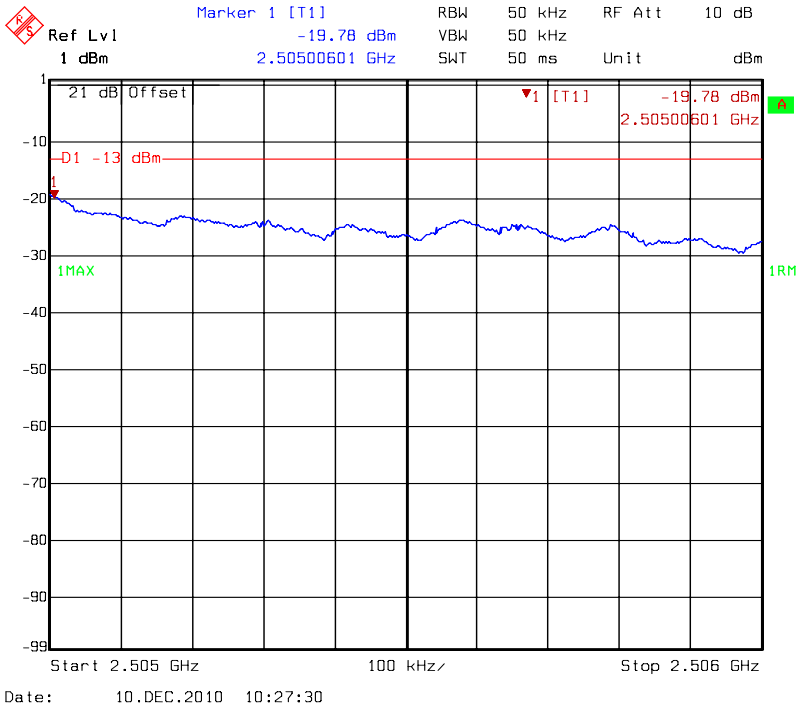
Spurious Emission at Antenna Terminals @ low channel (5MHz) - 1 of 4



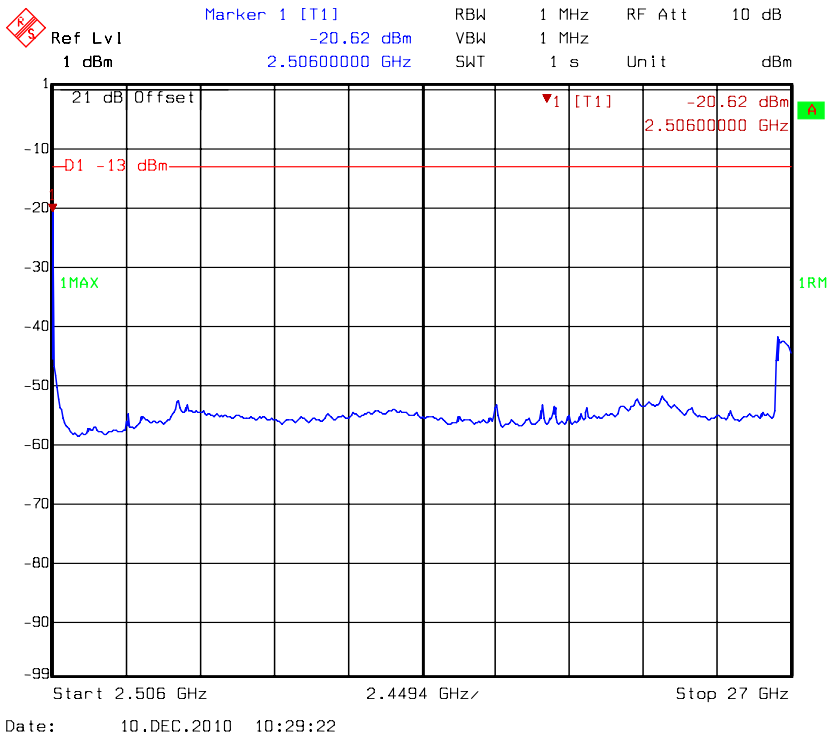
Spurious Emission at Antenna Terminals @ low channel (5MHz) - 2 of 4



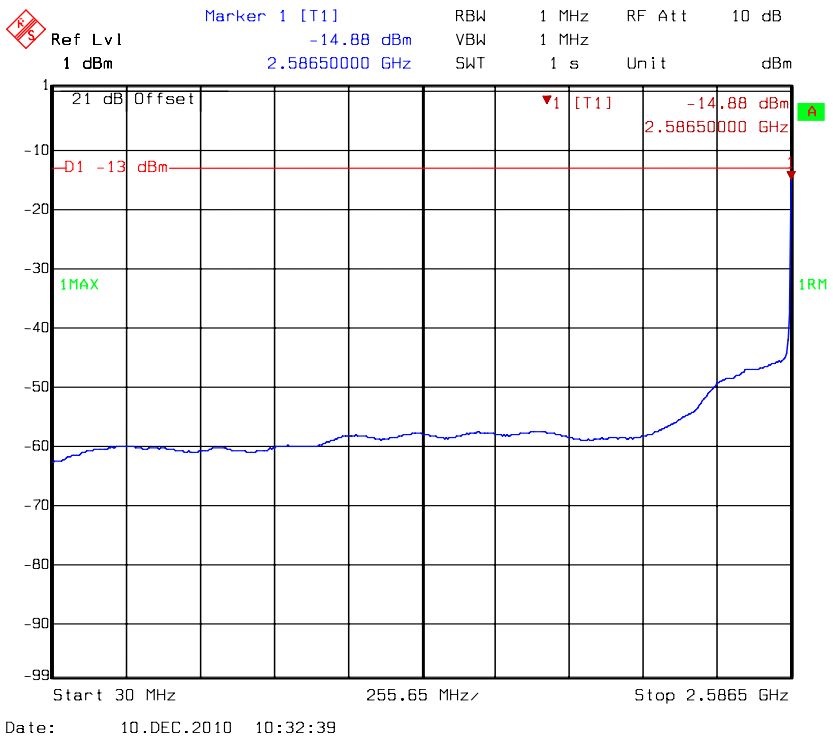
Spurious Emission at Antenna Terminals @ low channel (5MHz) - 3 of 4



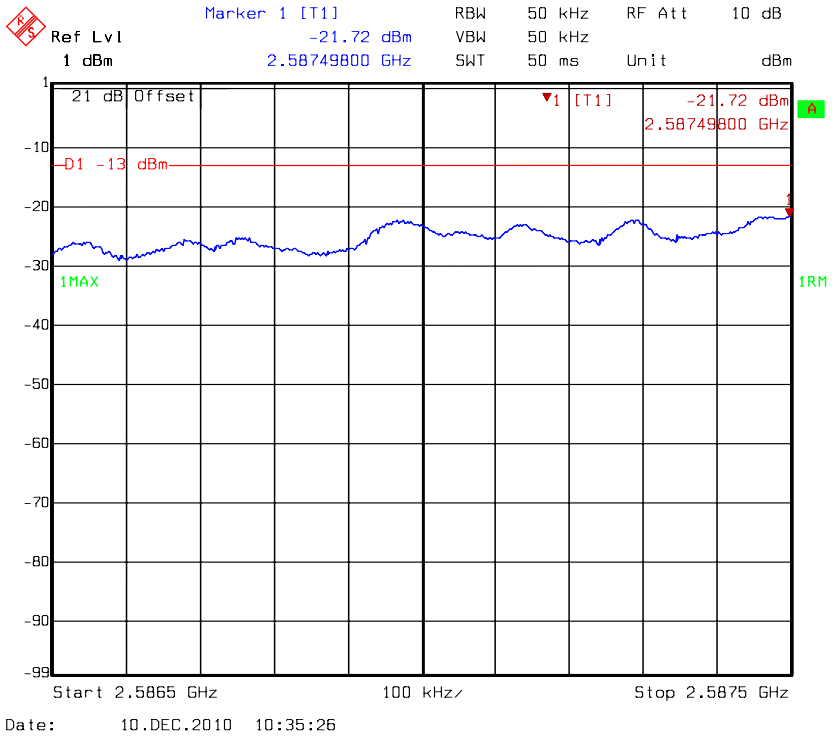
Spurious Emission at Antenna Terminals @ low channel (5MHz) - 4 of 4



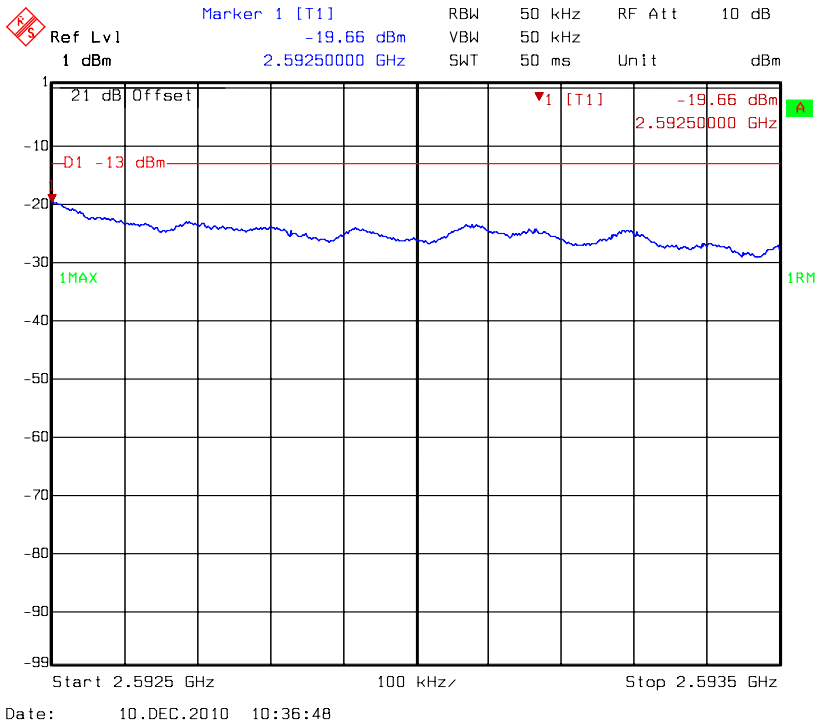
Spurious Emission at Antenna Terminals @ middle channel (5MHz) - 1 of 4



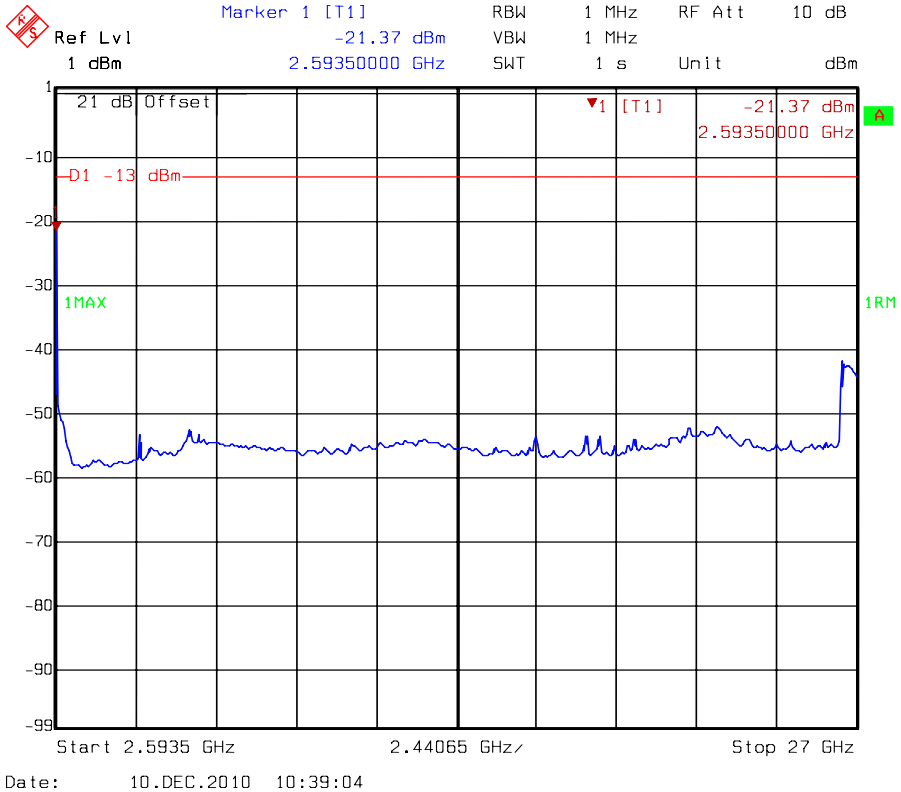
Spurious Emission at Antenna Terminals @ middle channel (5MHz) - 2 of 4



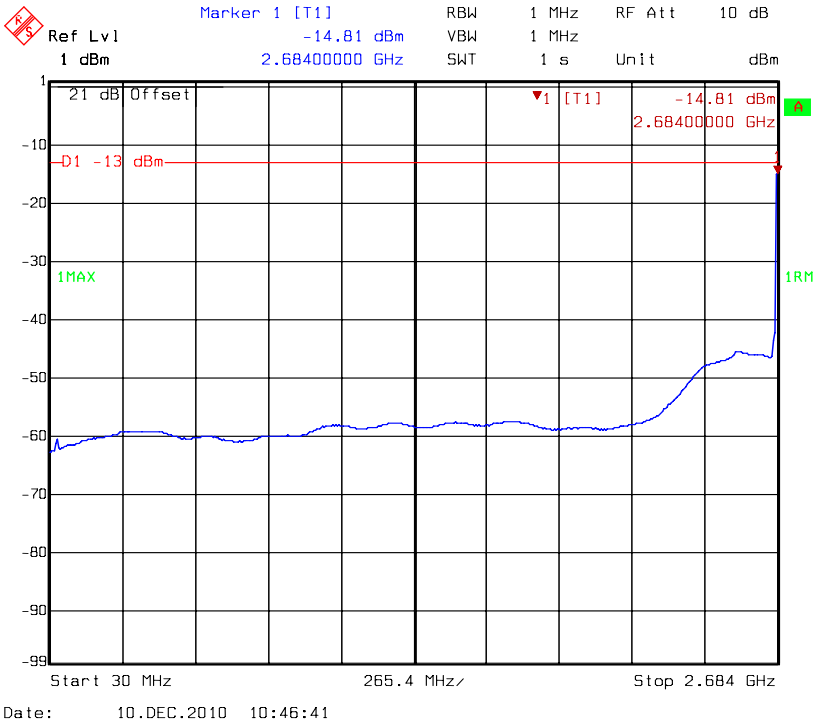
Spurious Emission at Antenna Terminals @ middle channel (5MHz) - 3 of 4



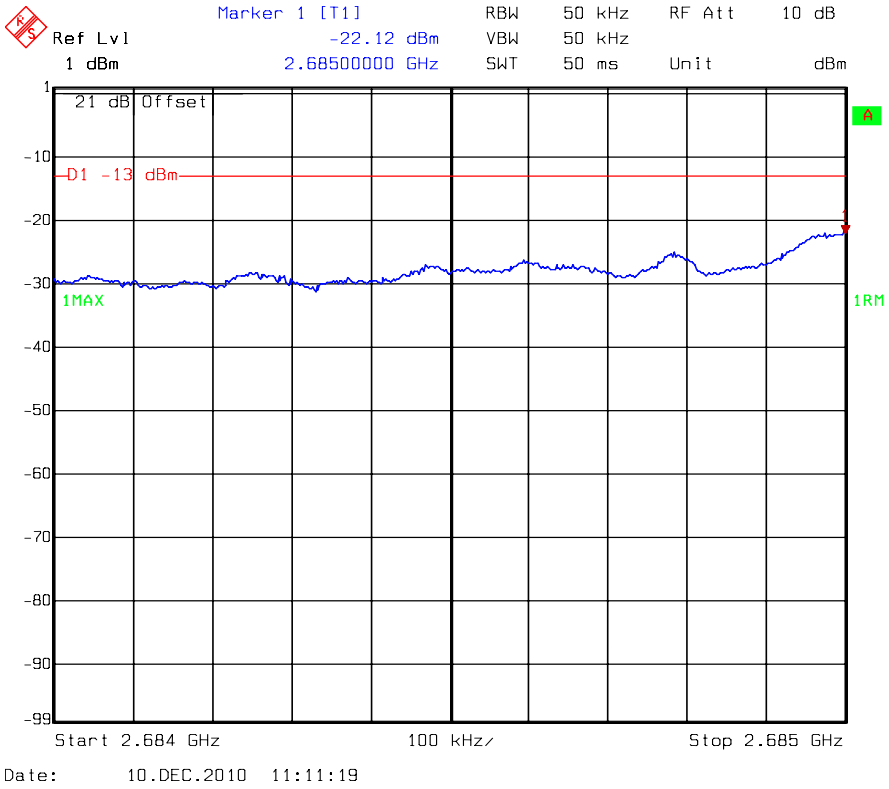
Spurious Emission at Antenna Terminals @ middle channel (5MHz) - 4 of 4



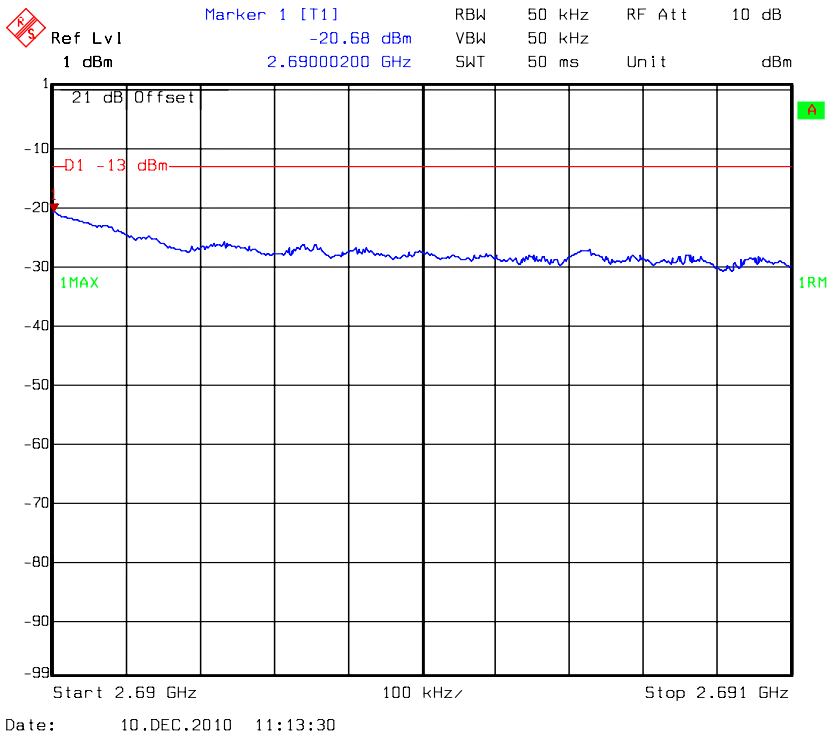
Spurious Emission at Antenna Terminals @ high channel (5MHz) - 1 of 4



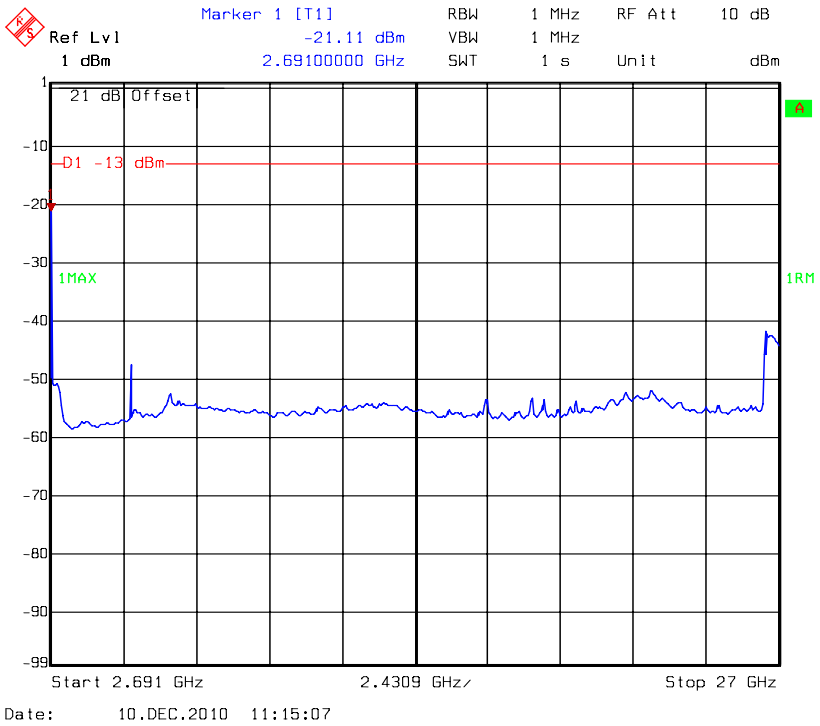
Spurious Emission at Antenna Terminals @ high channel (5MHz) - 2 of 4



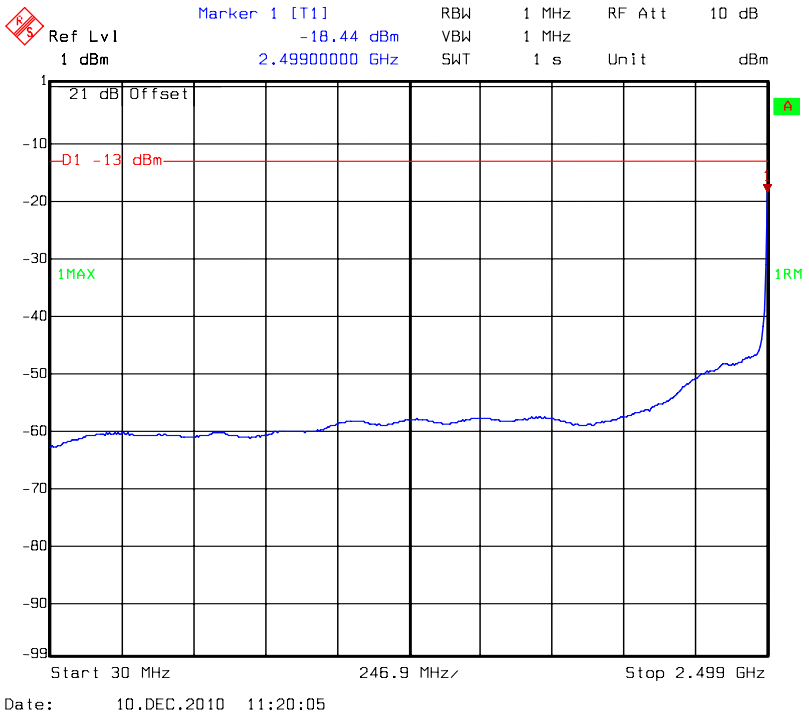
Spurious Emission at Antenna Terminals @ high channel (5MHz) - 3 of 4



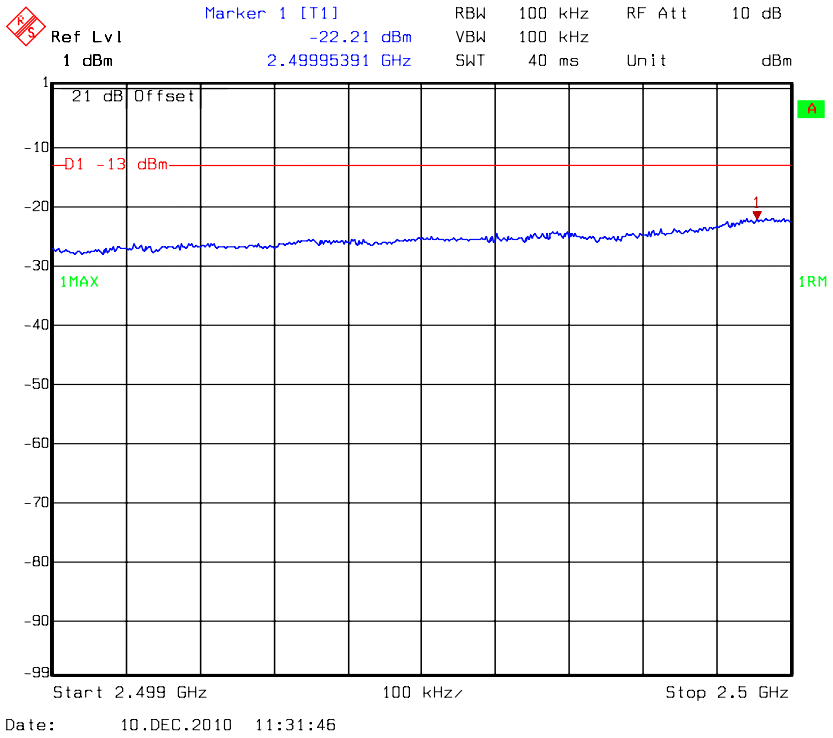
Spurious Emission at Antenna Terminals @ high channel (5MHz) - 4 of 4



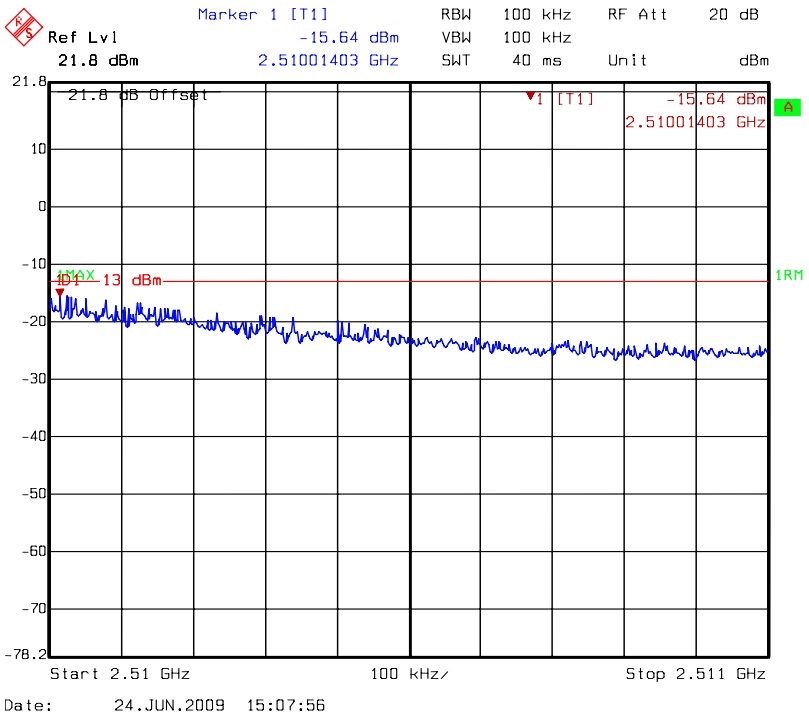
Spurious Emission at Antenna Terminals @ low channel (10MHz) - 1 of 4



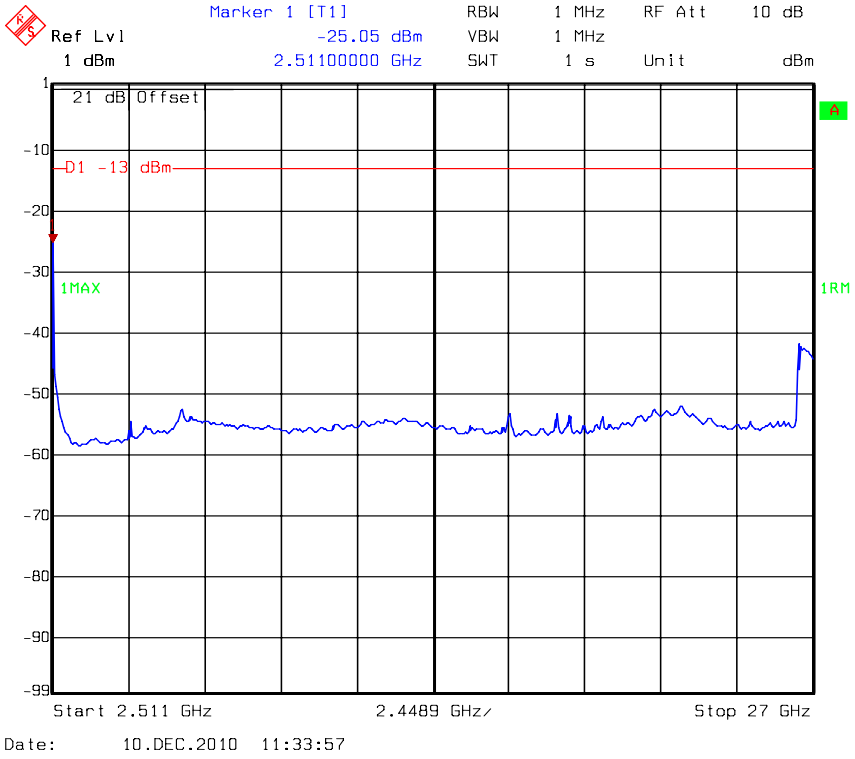
Spurious Emission at Antenna Terminals @ low channel (10MHz) - 2 of 4



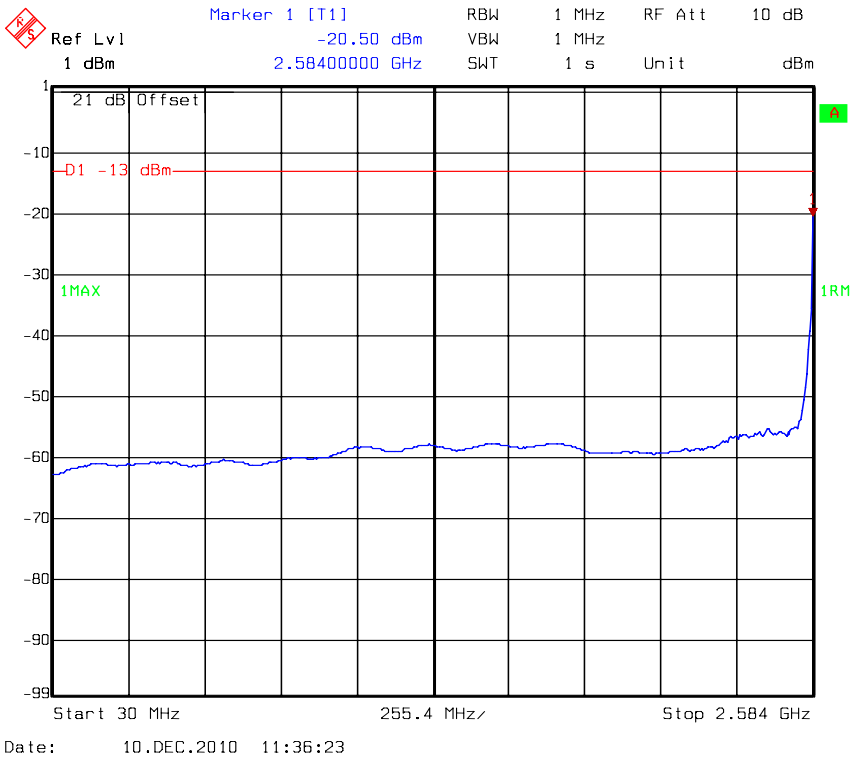
Spurious Emission at Antenna Terminals @ low channel (10MHz) - 3 of 4



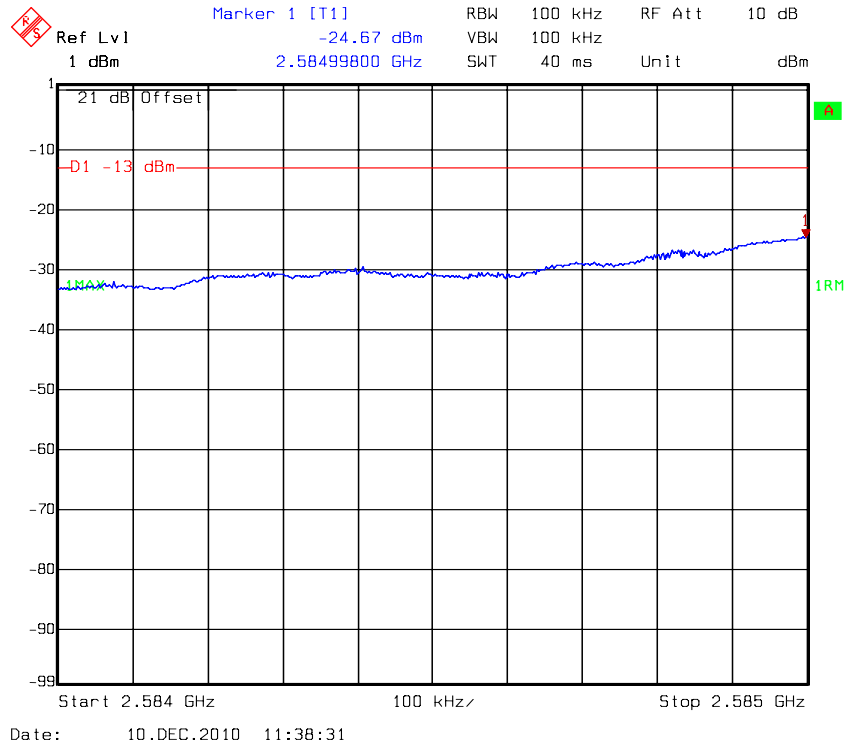
Spurious Emission at Antenna Terminals @ low channel (10MHz) - 4 of 4



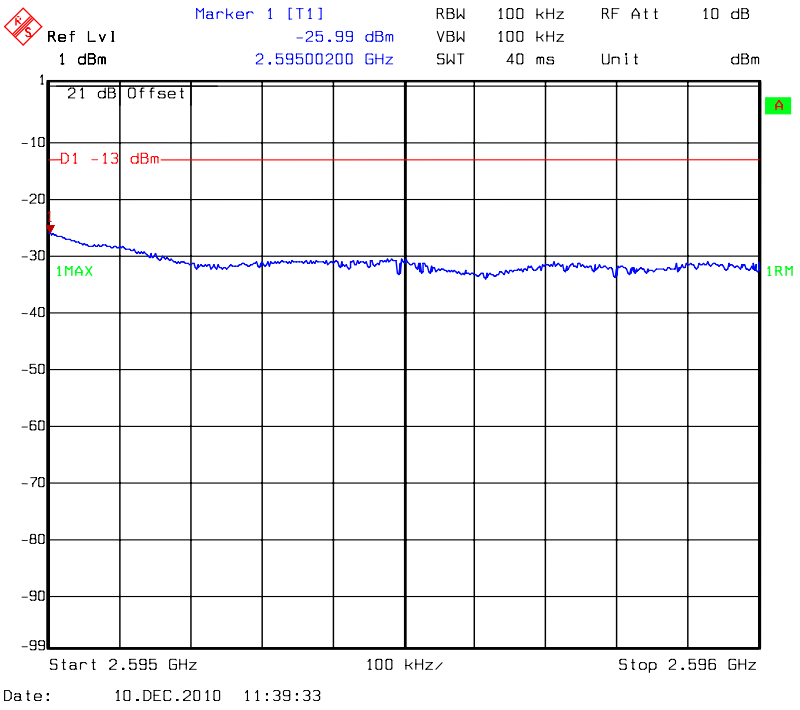
Spurious Emission at Antenna Terminals @ middle channel (10MHz) - 1 of 4



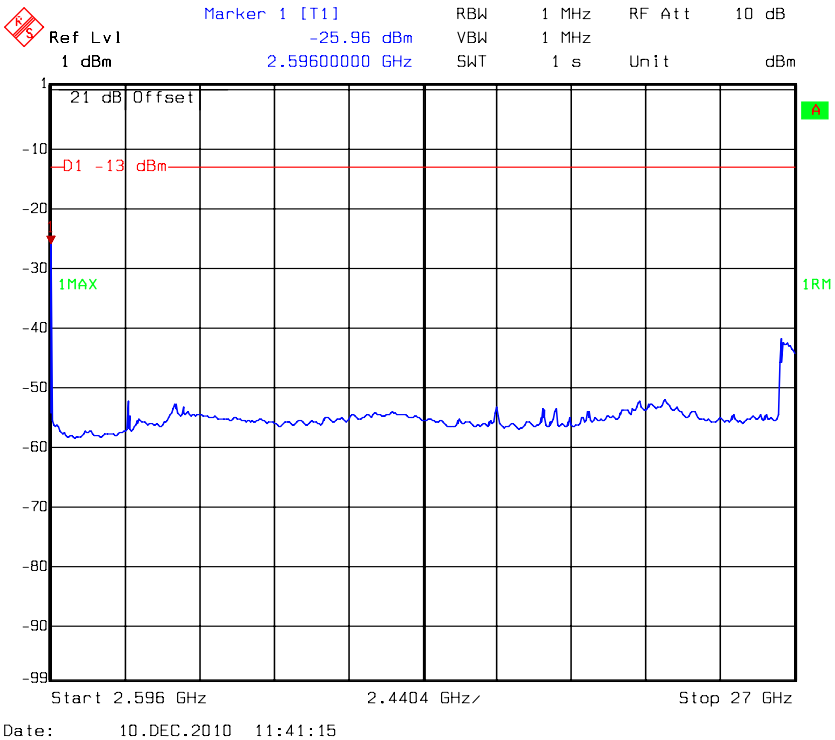
Spurious Emission at Antenna Terminals @ middle channel (10MHz) - 2 of 4



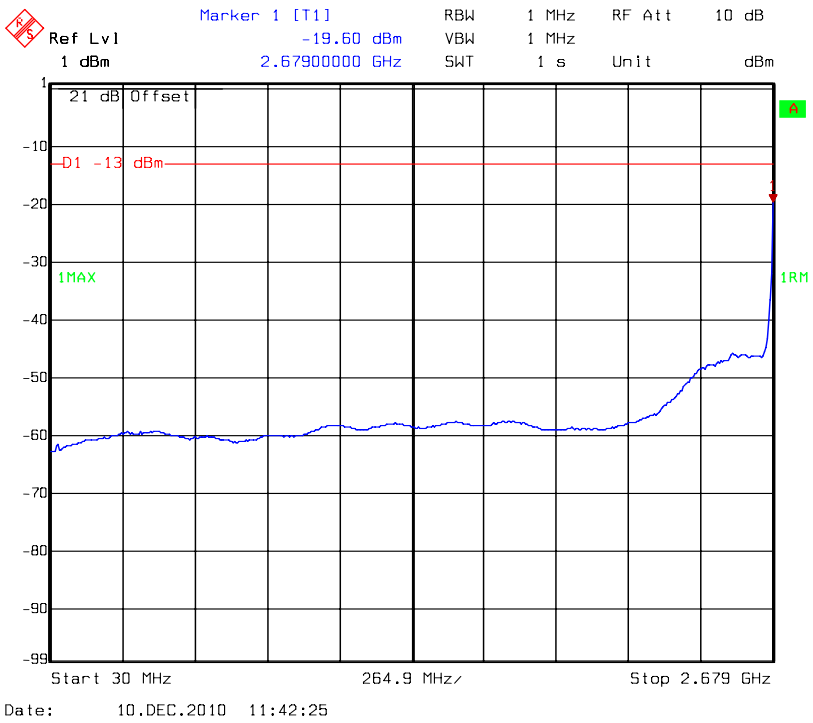
Spurious Emission at Antenna Terminals @ middle channel (10MHz) - 3 of 4



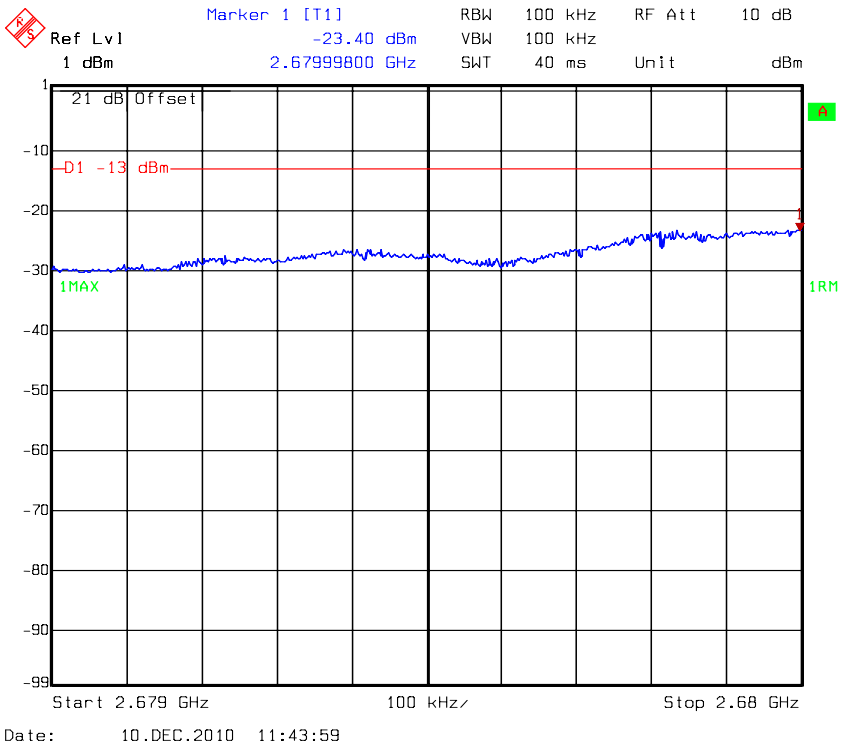
Spurious Emission at Antenna Terminals @ middle channel (10MHz) - 4 of 4



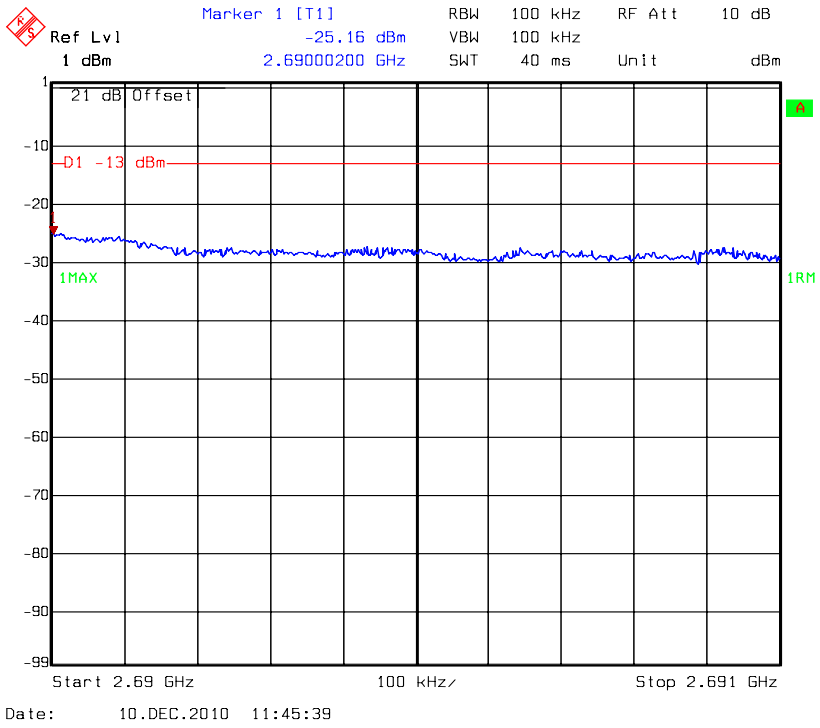
Spurious Emission at Antenna Terminals @ high channel (10MHz) - 1 of 4



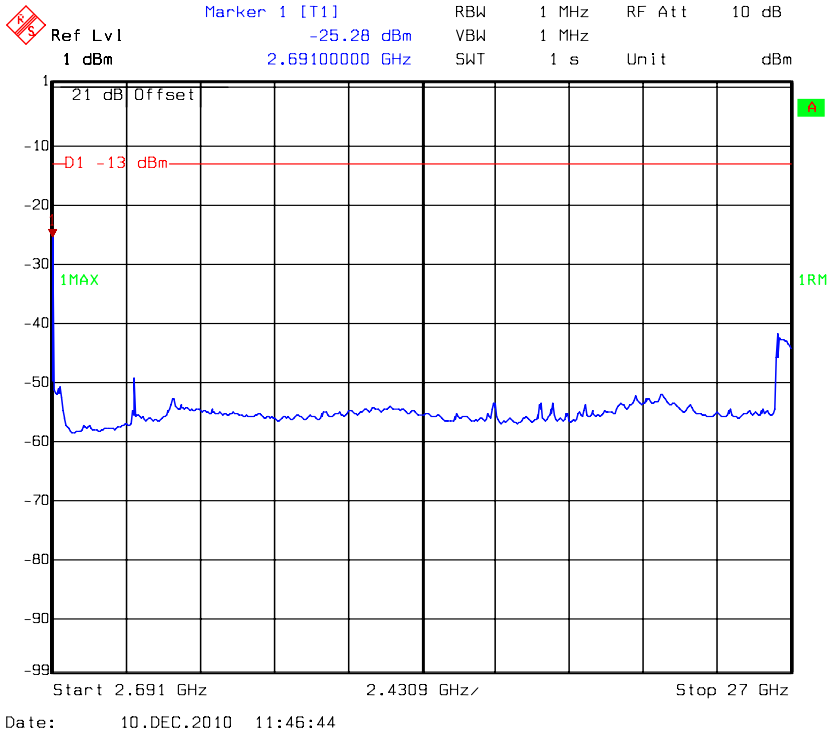
Spurious Emission at Antenna Terminals @ high channel (10MHz) - 2 of 4



Spurious Emission at Antenna Terminals @ high channel (10MHz) - 3 of 4



Spurious Emission at Antenna Terminals @ high channel (10MHz) - 4 of 4



7. Field Strength of Spurious Radiation

Base Standard	FCC 27.53(m)(2)(v)

Test Equipment: EC1353, EC1371, EC1373, EC1374, EP1364, EP1347

7.1 LIMITS OF Field Strength of Spurious Radiation MEASUREMENT

In the FCC 27.53(m)(2)(v), On any frequency outside a licensee's frequency block, For all fixed digital user stations, the attenuation factor shall be not less than 43 + 10 log (P) dB at the channel edge.

7.2 Test Procedure and Setup

If the antenna is detachable from the transmitter, it is removed and replaced with a 50 ohm load. Emissions are measured up to the 10th harmonic of the highest transmit frequency that the transmitter is capable of producing. If the antenna is not detachable from the transmitter, emissions are measured radiated only at a distance of 3 meters.

Note: (1) The EUT was tested while in a continuous transmit mode. The EUT was tuned to a low, middle and high channel.
(2) The EUT operating at 2.5GHz band. Frequency Range scanned from 30MHz to 27GHz.

7.3 Method of Measurement

7.3.1 Spurious Radiated Emission

The frequency range from 30MHz to 1000MHz using Bilog Antenna.
The frequency range over 1GHz using Horn Antenna.
The maximum field strength of the spurious emission is measured at a distance of 3 meters. The device under test is then replaced with a substitution antenna of known gain with respect to a Horn antenna. A calibrated signal source is used to feed the substitution antenna. The RF level to the substitution antenna is adjusted to repeat the previously measured field strength. The RF input level to the substitution antenna is the effective radiated power of the spurious emission after any correction for substitution antenna gain against a Horn antenna.

7.3.2 Radiated Field Strength

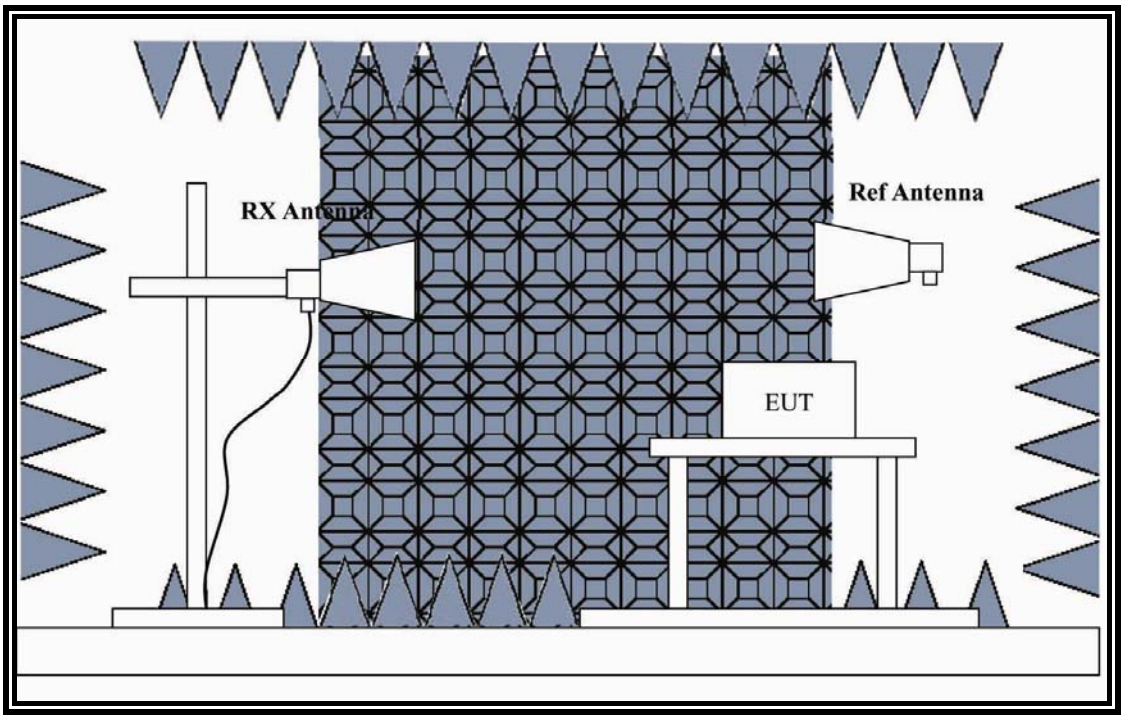
Radiated emissions were invested cover the frequency range from 30MHz to 1000MHz using a receiver RBW of 120kHz record QP reading

The EUT for testing is arranged on a wooden turntable. If some peripherals apply to the EUT, the peripherals will be connected to EUT and the whole system. During the test, all cables were arranged to produce worst-case emissions. The signal is maximized through rotation. The height of antenna and polarization is changing constantly for exploring for maximum signal level. The height of antenna can be up to 4 meters and down to 1 meter.

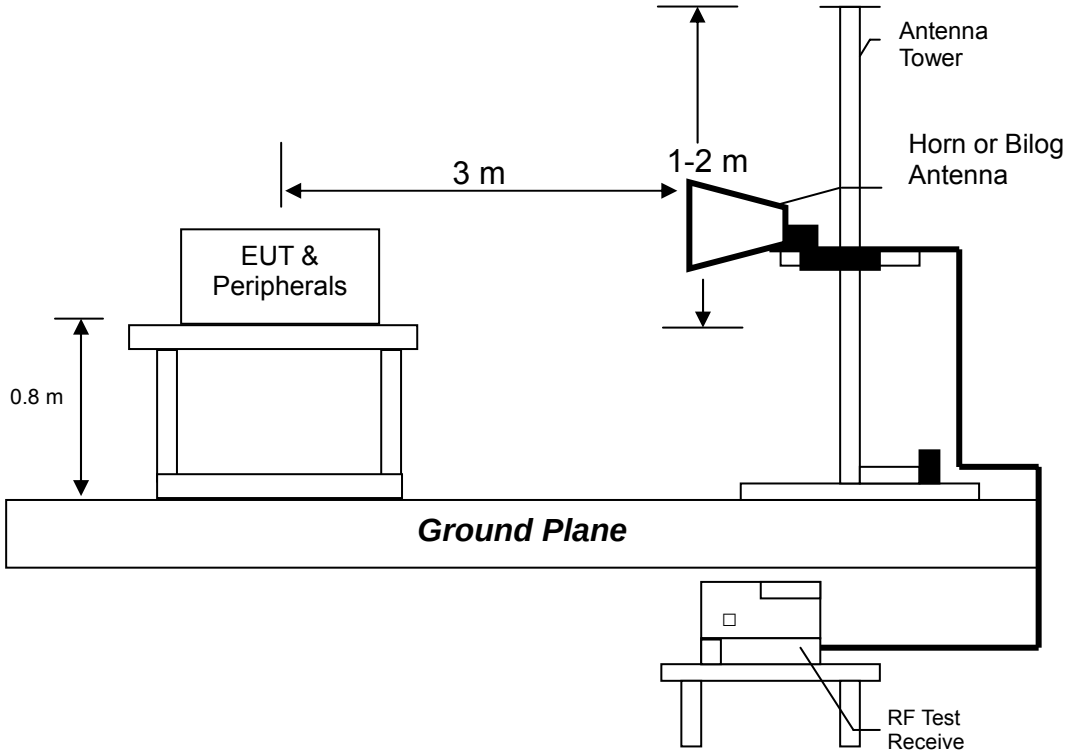
The measurement for radiated emission will be done at the distance of three meters unless the signal level is too low to measure at that distance. In the case of the reading under noise floor, a pre-amplifier is used and/or the test is conducted at a closer distance. And then all readings are extrapolated back to the equivalent 3 meter reading using inverse scaling with distance.

7.4 Test Diagram

7.4.1 Spurious Radiated Emission



7.4.2 Radiated Field Strength



7.5 Field Strength of Spurious Radiation Emission Limit

7.5.1 Spurious Radiated Emission

According to FCC 27.53(m) requirement, the spurious emission shall be attenuated at least 43 + 10 log(P) dB from the fundamental.

Sample Calculation:

Assume the EUT Pout= 2W = 33dBm

43 + 10 log(P)

43 + 10 log(2)

43 + 10 × 0.3

43 + 3 = 46 dB

33 dBm – 46 dB = -13 dBm

7.5.2 Radiated Field Strength

Frequency (MHz)	Distance(m)	Class A(dBμV/m)	Class B(dBμV/m)
30~230	10	40	30
230~1000	10	47	37

Note:

1. The tighter limit shall apply at the edge between two frequency bands.
2. Distance refers to the distance in meters between the measuring instrument Antenna and the closest point of EUT.

7.6 Test Result

Test Mode: Normal operating mode

Polarity: Vertical

Frequency	Factor	Reading	Emission	Limit	Margin
MHz	dB	dBuV	dBuV	dBuV	dB
30.00	13.89	17.30	31.19	40.00	-8.81
39.50	14.55	17.90	32.45	40.00	-7.55
60.20	14.35	21.90	36.25	40.00	-3.75
98.50	9.81	25.60	35.41	43.50	-8.09
250.00	14.20	15.61	29.81	46.00	-16.19
375.00	17.80	12.00	29.80	46.00	-16.20

Polarity: Horizontal

Frequency	Factor	Reading	Emission	Limit	Margin
MHz	dB	dBuV	dBuV	dBuV	dB
60.07	14.37	12.60	26.97	40.00	-13.03
99.90	9.98	18.80	28.78	43.50	-14.72
145.00	14.96	15.20	30.16	43.50	-13.34
162.00	15.39	13.70	29.09	43.50	-14.41
250.00	14.20	15.60	29.80	46.00	-16.20
374.90	17.79	12.20	29.99	46.00	-16.01

Test Mode: Spurious Radiated Emission

Frequency (MHz)
2502.5

Polarity (V/H)	Frequency (MHz)	SG Level (dBm)	Cable Loss (dB)	Substitution Ant. Gain (dB)	Net (dBm)	Limit (dBm)	Margin (dB)	Band Width (MHz)
H	80.44	-20.99	0.37	0.17	-21.19	-13	-8.19	5
H	101.78	-24.43	0.62	0.06	-24.99	-13	-11.99	5
H	175.5	-42.24	0.76	4.10	-38.90	-13	-25.9	5
H	224	-42.05	0.82	3.71	-39.16	-13	-26.16	5
H	538.28	-44.69	1.25	5.73	-40.21	-13	-27.21	5
V	49.40	-33.493	0.35	0.013	-33.83	-13	-20.83	5
V	76.56	-19.444	0.36	0.094	-19.71	-13	-6.71	5
V	95.96	-21.801	0.4	0.091	-22.11	-13	-9.11	5
V	163.86	-40.95	0.73	2.60	-39.08	-13	-26.08	5
V	175.5	-41.38	0.76	4.10	-38.04	-13	-25.04	5
V	224.0	-42.97	0.82	3.71	-40.08	-13	-27.08	5

Polarity (V/H)	Frequency (MHz)	SG Level (dBm)	Cable Loss (dB)	Substitution Ant. Gain (dB)	Net (dBm)	Limit (dBm)	Margin (dB)	Band Width (MHz)
V	1204	-51.33	2.05	5.7	-47.68	-13	-34.68	5
H	1856	-49.74	2.56	8.7	-43.6	-13	-30.6	5
H	2016	-38.42	2.63	8.7	-32.35	-13	-19.35	5
H	5000	-47.00	4.35	9.6	-41.75	-13	-28.75	5
V	5000	-50.15	4.35	9.6	-44.9	-13	-31.9	5
H	7510	-54.13	5.26	10.1	-49.29	-13	-36.29	5
V	7510	-58.38	5.26	10.1	-53.54	-13	-40.54	5
H	10010	-50.92	6.23	11.6	-45.55	-13	-32.55	5
V	10010	-56.15	6.23	11.6	-50.78	-13	-37.78	5
H	12510	-57.62	6.52	12.6	-51.54	-13	-38.54	5
V	12510	-62.18	6.52	12.6	-56.1	-13	-43.1	5

Remark: Net = SG Level - Cable Loss + Substitution Ant. Gain

Frequency (MHz)
2590

Polarity (V/H)	Frequency (MHz)	SG Level (dBm)	Cable Loss (dB)	Substitution Ant. Gain (dB)	Net (dBm)	Limit (dBm)	Margin (dB)	Band Width (MHz)
H	78.5	-20.534	0.36	0.094	-20.8	-13	-7.8	5
H	101.78	-23.92	0.62	0.06	-24.48	-13	-11.48	5
H	850.62	-39.8	1.83	5.5	-36.13	-13	-23.13	5
V	47.46	-33.243	0.35	0.013	-33.58	-13	-20.58	5
V	76.56	-18.624	0.36	0.094	-18.89	-13	-5.89	5
V	95.96	-21.401	0.4	0.091	-21.71	-13	-8.71	5
V	167.74	-40.37	0.74	2.6	-38.51	-13	-25.51	5
V	175.5	-41.62	0.76	4.1	-38.28	-13	-25.28	5

Polarity (V/H)	Frequency (MHz)	SG Level (dBm)	Cable Loss (dB)	Substitution Ant. Gain (dB)	Net (dBm)	Limit (dBm)	Margin (dB)	Band Width (MHz)
H	1132	-43.29	2.03	5.7	-39.62	-13	-26.62	5
V	1132	-44.88	2.03	5.7	-41.21	-13	-28.21	5
H	1256	-37.47	2.06	8	-31.53	-13	-18.53	5
V	1256	-40.13	2.06	8	-34.19	-13	-21.19	5
H	1408	-48.58	2.37	8	-42.95	-13	-29.95	5
V	1408	-48.89	2.37	8	-43.26	-13	-30.26	5
V	2000	-42.55	2.62	8.7	-36.47	-13	-23.47	5
H	2148	-35.12	2.71	8.7	-29.13	-13	-16.13	5
V	2148	-25.6	2.71	8.7	-19.61	-13	-6.61	5
H	5180	-56.8	4.42	9.6	-51.62	-13	-38.62	5
V	5180	-56.52	4.42	9.6	-51.34	-13	-38.34	5
H	7770	-53.51	5.29	10.1	-48.7	-13	-35.7	5
V	7770	-57.93	5.29	10.1	-53.12	-13	-40.12	5
H	10360	-48.52	6.01	12	-42.53	-13	-29.53	5
V	10360	-56.3	6.01	12	-50.31	-13	-37.31	5
H	12960	-56.85	6.68	11.8	-51.73	-13	-38.73	5
V	12960	-58.13	6.68	11.8	-53.01	-13	-40.01	5

Remark: Net = SG Level - Cable Loss + Substitution Ant. Gain

Frequency (MHz)
2687.5

Polarity (V/H)	Frequency (MHz)	SG Level (dBm)	Cable Loss (dB)	Substitution Ant. Gain (dB)	Net (dBm)	Limit (dBm)	Margin (dB)	Band Width (MHz)
H	78.5	-20.414	0.36	0.094	-20.68	-13	-7.68	5
H	101.78	-22.77	0.62	0.06	-23.33	-13	-10.33	5
H	163.86	-41.23	0.73	2.6	-39.36	-13	-26.36	5
H	175.5	-42.5	0.76	4.1	-39.16	-13	-26.16	5
H	198.78	-43.77	0.8	4.53	-40.04	-13	-27.04	5
H	224	-42.11	0.82	3.71	-39.22	-13	-26.22	5
V	47.46	-33.373	0.35	0.013	-33.71	-13	-20.71	5
V	76.56	-18.934	0.36	0.094	-19.2	-13	-6.2	5
V	95.96	-22.411	0.4	0.091	-22.72	-13	-9.72	5
V	167.74	-41.36	0.74	2.6	-39.5	-13	-26.5	5
V	175.5	-41.22	0.76	4.1	-37.88	-13	-24.88	5

Polarity (V/H)	Frequency (MHz)	SG Level (dBm)	Cable Loss (dB)	Substitution Ant. Gain (dB)	Net (dBm)	Limit (dBm)	Margin (dB)	Band Width (MHz)
H	1108	-23.76	2.02	5.7	-20.08	-13	-7.08	5
V	1108	-26.75	2.02	5.7	-23.07	-13	-10.07	5
H	2292	-35.15	2.83	9.3	-28.68	-13	-15.68	5
V	2292	-40	2.83	9.3	-33.53	-13	-20.53	5
H	5380	-56.31	4.51	9.6	-51.22	-13	-38.22	5
V	5380	-59.19	4.51	9.6	-54.1	-13	-41.1	5
H	8060	-56.77	5.48	10.9	-51.35	-13	-38.35	5
V	8060	-56.62	5.48	10.9	-51.2	-13	-38.2	5
H	10750	-53.9	6.15	12.1	-47.95	-13	-34.95	5
V	10750	-56.98	6.15	12.1	-51.03	-13	-38.03	5

Remark: Net = SG Level - Cable Loss + Substitution Ant. Gain

Frequency (MHz)
2505

Polarity (V/H)	Frequency (MHz)	SG Level (dBm)	Cable Loss (dB)	Substitution Ant. Gain (dB)	Net (dBm)	Limit (dBm)	Margin (dB)	Band Width (MHz)
H	78.5	-20.594	0.36	0.094	-20.86	-13	-7.86	10
H	103.72	-23.83	0.63	0.06	-24.4	-13	-11.4	10
H	175.5	-42.8	0.76	4.1	-39.46	-13	-26.46	10
H	196.84	-44.17	0.79	4.53	-40.43	-13	-27.43	10
H	224	-43.10	0.82	3.71	-40.21	-13	-27.21	10
H	532.46	-46.52	1.24	5.73	-42.03	-13	-29.03	10
V	49.4	-33.483	0.35	0.013	-33.82	-13	-20.82	10
V	76.56	-20.004	0.36	0.094	-20.27	-13	-7.27	10
V	95.96	-21.631	0.4	0.091	-21.94	-13	-8.94	10
V	175.5	-41.36	0.76	4.1	-38.02	-13	-25.02	10
V	224	-42.57	0.82	3.71	-39.68	-13	-26.68	10

Polarity (V/H)	Frequency (MHz)	SG Level (dBm)	Cable Loss (dB)	Substitution Ant. Gain (dB)	Net (dBm)	Limit (dBm)	Margin (dB)	Band Width (MHz)
H	2012	-44.26	2.63	8.7	-38.19	-13	-25.19	10
V	2012	-45.98	2.63	8.7	-39.91	-13	-26.91	10
H	5010	-49.97	4.36	9.6	-44.73	-13	-31.73	10
V	5010	-50.89	4.36	9.6	-45.65	-13	-32.65	10
H	7520	-56.82	5.26	10.1	-51.98	-13	-38.98	10
V	7520	-56.28	5.26	10.1	-51.44	-13	-38.44	10
H	10020	-55.84	6.23	11.6	-50.47	-13	-37.47	10
V	10020	-56.1	6.23	11.6	-50.73	-13	-37.73	10
H	12530	-60.8	6.52	12.6	-54.72	-13	-41.72	10
V	12530	-64.4	6.52	12.6	-58.32	-13	-45.32	10

Remark: Net = SG Level - Cable Loss + Substitution Ant. Gain

Frequency (MHz)
2590

Polarity (V/H)	Frequency (MHz)	SG Level (dBm)	Cable Loss (dB)	Substitution Ant. Gain (dB)	Net (dBm)	Limit (dBm)	Margin (dB)	Band Width (MHz)
H	78.5	-19.664	0.36	0.094	-19.93	-13	-6.93	10
H	101.78	-23.73	0.62	0.06	-24.29	-13	-11.29	10
H	163.86	-41.75	0.73	2.6	-39.88	-13	-26.88	10
H	175.5	-42.73	0.76	4.1	-39.39	-13	-26.39	10
H	224	-42.25	0.82	3.71	-39.36	-13	-26.36	10
H	497.54	-47.8	1.18	6.09	-42.89	-13	-29.89	10
V	49.4	-33.553	0.35	0.013	-33.89	-13	-20.89	10
V	76.56	-19.284	0.36	0.094	-19.55	-13	-6.55	10
V	95.96	-22.131	0.4	0.091	-22.44	-13	-9.44	10
V	165.8	-40.28	0.74	2.6	-38.42	-13	-25.42	10
V	175.5	-41.46	0.76	4.1	-38.12	-13	-25.12	10
V	224	-43.9	0.82	3.71	-41.01	-13	-28.01	10

Polarity (V/H)	Frequency (MHz)	SG Level (dBm)	Cable Loss (dB)	Substitution Ant. Gain (dB)	Net (dBm)	Limit (dBm)	Margin (dB)	Band Width (MHz)
H	1256	-46.33	2.05	8	-40.38	-13	-27.38	10
V	1256	-48.72	2.05	8	-42.77	-13	-29.77	10
V	2000	-49.51	2.62	8.7	-43.43	-13	-30.43	10
H	2148	-36.99	2.71	8.7	-31	-13	-18	10
V	2148	-35.73	2.71	8.7	-29.74	-13	-16.74	10
H	5180	-61.03	4.42	9.6	-55.85	-13	-42.85	10
V	5180	-58.05	4.42	9.6	-52.87	-13	-39.87	10
H	7770	-57.71	5.29	10.9	-52.1	-13	-39.1	10
V	7770	-62.52	5.29	10.9	-56.91	-13	-43.91	10
H	10360	-51.72	6.01	12	-45.73	-13	-32.73	10
V	10360	-57.88	6.01	12	-51.89	-13	-38.89	10
H	12950	-58.04	6.68	11.8	-52.92	-13	-39.92	10
V	12950	-60.01	6.68	11.8	-54.89	-13	-41.89	10

Remark: Net = SG Level - Cable Loss + Substitution Ant. Gain

Frequency (MHz)
2685

Polarity (V/H)	Frequency (MHz)	SG Level (dBm)	Cable Loss (dB)	Substitution Ant. Gain (dB)	Net (dBm)	Limit (dBm)	Margin (dB)	Band Width (MHz)
H	78.5	-20.314	0.36	0.094	-20.58	-13	-7.58	10
H	101.78	-24.48	0.62	0.06	-25.04	-13	-12.04	10
H	163.86	-41.7	0.73	2.6	-39.83	-13	-26.83	10
H	175.5	-42	0.76	4.1	-38.66	-13	-25.66	10
H	224	-42.19	0.82	3.71	-39.3	-13	-26.3	10
H	233.7	-43.48	0.84	4.68	-39.64	-13	-26.64	10
V	49.4	-33.693	0.35	0.013	-34.03	-13	-21.03	10
V	76.56	-19.464	0.36	0.094	-19.73	-13	-6.73	10
V	95.96	-21.861	0.4	0.091	-22.17	-13	-9.17	10
V	167.74	-38.86	0.74	2.6	-37	-13	-24	10
V	175.5	-41.22	0.76	4.1	-37.88	-13	-24.88	10
V	224	-43.08	0.82	3.71	-40.19	-13	-27.19	10

Polarity (V/H)	Frequency (MHz)	SG Level (dBm)	Cable Loss (dB)	Substitution Ant. Gain (dB)	Net (dBm)	Limit (dBm)	Margin (dB)	Band Width (MHz)
H	1100	-26.33	2.02	5.7	-22.65	-13	-9.65	10
V	1100	-29.85	2.02	5.7	-26.17	-13	-13.17	10
H	5370	-57.47	4.51	9.6	-52.38	-13	-39.38	10
V	5370	-61.05	4.51	9.6	-55.96	-13	-42.96	10
H	8050	-64.49	5.48	10.9	-59.07	-13	-46.07	10
V	8050	-59.07	5.48	10.9	-53.65	-13	-40.65	10
H	10740	-51.57	6.15	12.1	-45.62	-13	-32.62	10
V	10740	-56.46	6.15	12.1	-50.51	-13	-37.51	10

Remark: Net = SG Level - Cable Loss + Substitution Ant. Gain

8. AC power line conducted emission

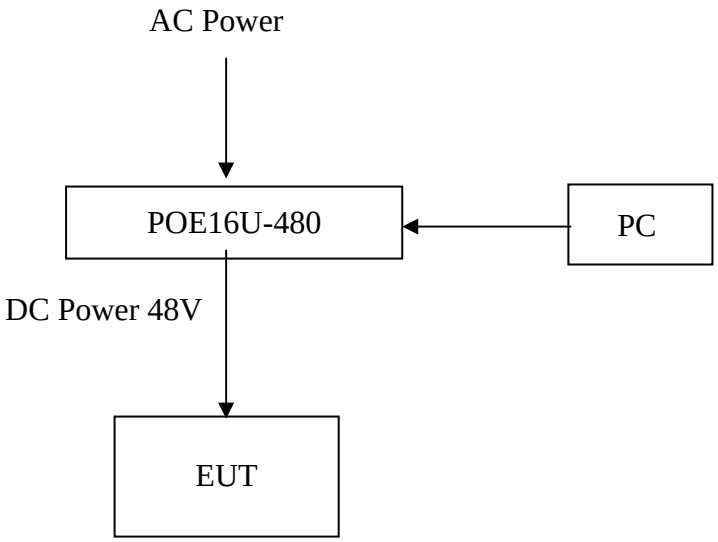
Base Standard	FCC 15.207

Test Equipment: EC1303

8.1 Method of Measurement

The EUT are connected to the main power through a line impedance stabilization network (LISN). This provides a 50 ohm/50uH coupling impedance for the measuring equipment. The peripheral devices are also connected to the main power through a LISN that provides a 50ohm/50uH coupling impedance with 50ohm termination.
Both sides (Line and Neutral) of AC line are checked for maximum conducted interference. In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.4/2003 on conducted measurement.
The bandwidth of the field strength meter (R & S Test Receiver ESCS 30) is set at 9kHz.

8.2 Test Diagram



8.3 Emission Limit

Freq. (MHz)	Conducted Limit (dBuV)	
	Q.P.	Ave.
0.15~0.50	66 – 56*	56 – 46*
0.50~5.00	56	46
5.00~30.0	60	50

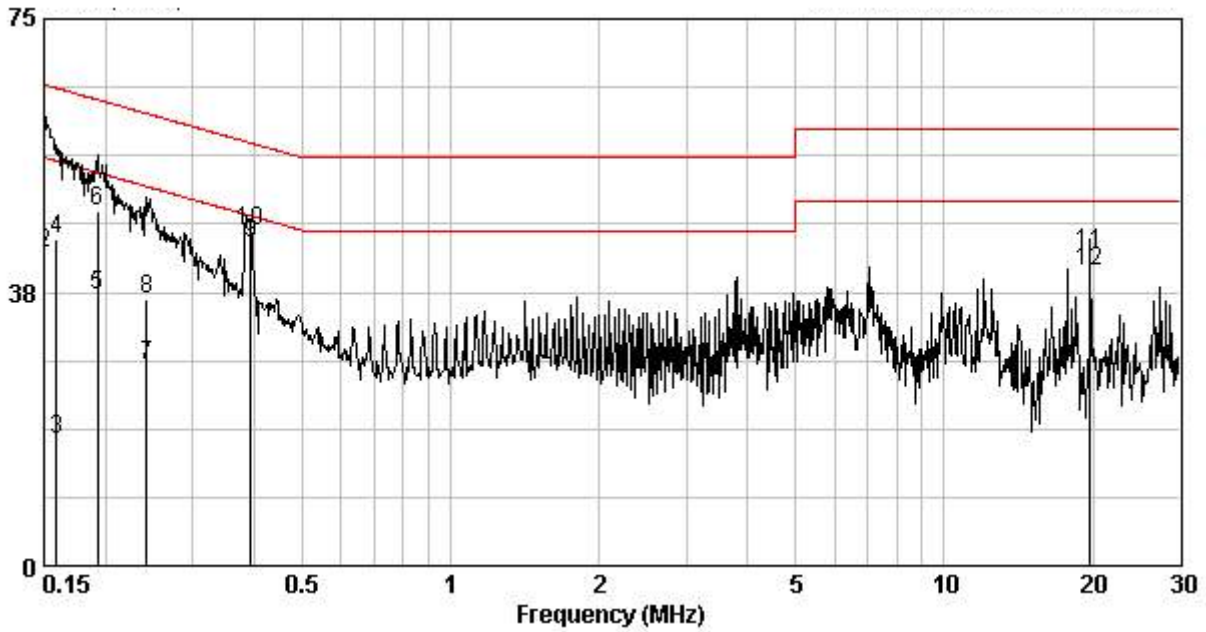
*Decreases with the logarithm of the frequency.

8.4 Test Result

Phase : Line
EUT : HES-309M
Test Condition : Normal operating mode

Frequency (MHz)	Corr. Factor (dB)	Level Qp (dBuV)	Limit Qp (dBuV)	Level Av (dBuV)	Limit Av (dBuV)	Margin (dB) Qp	Margin (dB) Av
0.15	0.81	55.39	66.00	42.98	56.00	-10.61	-13.02
0.16	0.81	44.75	65.52	17.21	55.52	-20.77	-38.31
0.19	0.81	48.52	63.93	37.09	53.93	-15.42	-16.85
0.24	0.61	36.44	62.04	27.41	52.04	-25.60	-24.63
0.39	0.12	45.75	58.00	44.26	48.00	-12.24	-3.73
19.71	0.91	42.90	60.00	40.45	50.00	-17.10	-9.55

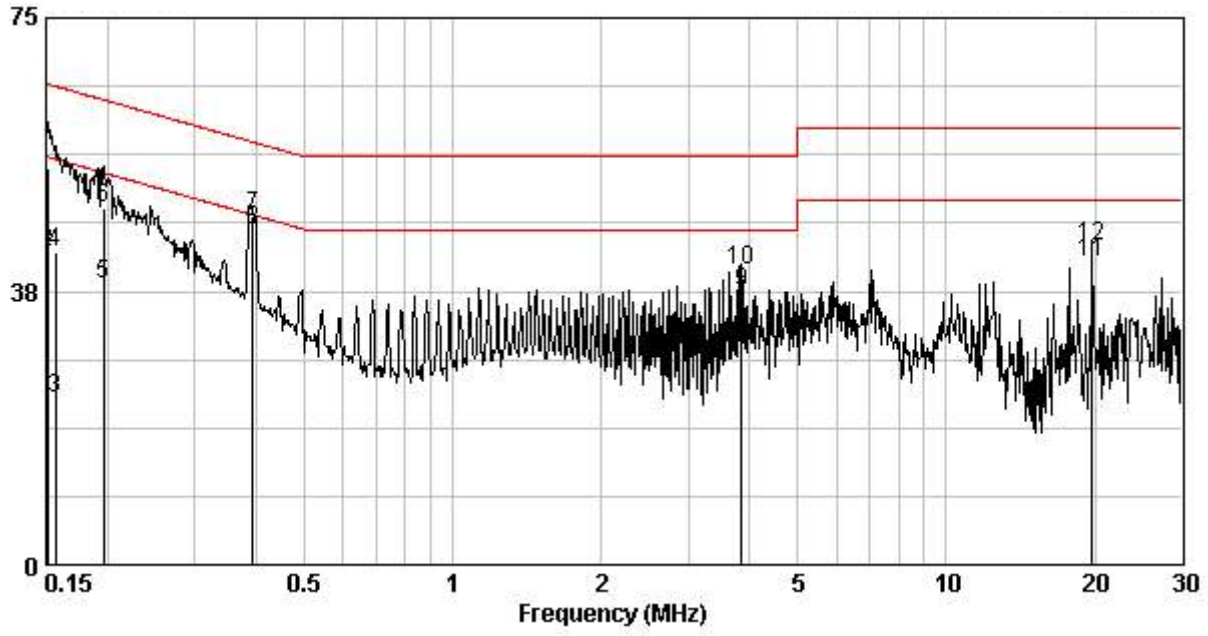
Remark:
1. Correction Factor (dB)= LISN Factor (dB) + Cable Loss (dB)
2. Margin (dB) = Level (dBuV) – Limit (dBuV)



Phase : Neutral
EUT : HES-309M
Test Condition : Normal operating mode

Frequency (MHz)	Corr. Factor (dB)	Level Qp (dBuV)	Limit Qp (dBuV)	Level Av (dBuV)	Limit Av (dBuV)	Margin (dB) Qp	Margin (dB) Av
0.15	0.11	54.49	65.96	42.97	55.96	-11.47	-12.99
0.16	0.11	42.91	65.65	22.71	55.65	-22.74	-32.94
0.20	0.11	48.96	63.76	38.60	53.76	-14.80	-15.16
0.39	0.11	47.67	57.97	45.88	47.97	-10.30	-2.09
3.85	0.24	40.26	56.00	37.50	46.00	-15.74	-8.50
19.71	0.51	43.80	60.00	41.35	50.00	-16.20	-8.65

Remark:
1. Correction Factor (dB)= LISN Factor (dB) + Cable Loss (dB)
2. Margin (dB) = Level (dBuV) – Limit (dBuV)



9. Frequency Stability

Base Standard	FCC 2.1055 & 27.54

Test Equipment: EC1365

9.1 Method of Measurement

According to the FCC part 2.1055 shall be tested the frequency stability. The rule is defined that" The frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block." The test extreme voltage is according to the 2.1055(d)(1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment and the extreme temperature rule is comply with specification of EUT -30℃ ~ 50℃.

Note: The EUT has been verified frequency stability of 5MHz and 10MHz Bandwidth, the temperature range from -30℃ ~ +50℃ in normal supplied voltage and the supplied voltage range from 85 to 115 percent of the nominal value in normal temperature.

9.2 Test Result

For 5MHz BW

Frequency (MHz)	Temperature (℃)	Test Results (ppm)
2590	-30	7.413
	-20	7.24
	-10	6.876
	0	7.475
	10	7.622
	20	7.755
	30	7.476
	40	7.403
	50	7.781

Frequency	Mains Voltage (Volts)	Tolerance (ppm)
2502.5	102	8.098
	120	8.075
	138	7.037
2590	102	7.502
	120	7.112
	138	6.614
2687.5	102	6.58
	120	6.918
	138	6.029

For 10MHz BW

Frequency (MHz)	Temperature (℃)	Test Results (ppm)
2590	-30	-1.022
	-20	-0.675
	-10	-0.188
	0	-0.787
	10	1.105
	20	0.63
	30	-1.476
	40	-1.56
	50	-0.344

Frequency	Mains Voltage (Volts)	Tolerance (ppm)
2505	102	-1.094
	120	-1.04
	138	3.048
2590	102	-0.251
	120	-0.022
	138	1.05
2685	102	-0.288
	120	-0.945
	138	-1.457

Attachment 1: PHY Profile

4. PHY Profile

4.1 *Profiles of BS and MS*

4.1.1 System Parameters

4.1.1.1 *PHY Mode*

Table 5. PHY Mode

Item	Description	Reference	Status	BS Required	MS Required	Comment
1	OFDMA	8.4	m	Y	Y	OFDMA is the sole PHY mode within the scope of this document.

4.1.1.2 Band Class Index

System profile requirements of this document are applied to the following band class indices. Each index shall specify one frequency range and one or more combinations of channel bandwidth, FFT size, channel raster and duplexing mode.

BS support for a particular band class requires support of a frequency range that is a subset of the complete frequency range defined by the band-class. The BS vendor shall provide a declaration of the supported frequency range. The supported frequency range shall be a minimum of three (3) times the largest supported channel bandwidth. MS must support the entire range of frequency defined by a band class (or sub-bands) while the BS is required to support only sub-range of the band class declared by vendor.

Table 6. Band Class Index

Band Class Index	Frequency Range (GHz)	Channel Frequency Step (kHz)	Channel Bandwidth(s) (MHz)	FFT Size	Duplexing Mode	Comments
1	2.3-2.4	250	5	512	TDD	Both bandwidths must be supported by the MS
			10	1024	TDD	
			8.75	1024	TDD	
2	2.305-2.320, 2.345-2.360	250	3.5	512	TDD	
			5	512	TDD	
			10	1024	TDD	
3	2.496-2.69	250 (200 KHz step size is also	5	512	TDD	Both bandwidths must be supported
			10	1024	TDD	

		recommended for band class 3 in Europe)				to by the MS
4	3.3-3.4	250	5	512	TDD	
			7	1024	TDD	
			10	1024	TDD	
5	3.4-3.8	250	5	512	TDD	
			7	1024	TDD	
			10	1024	TDD	
	3.4-3.6	250	5	512	TDD	
			7	1024	TDD	
			10	1024	TDD	
	3.6-3.8	250	5	512	TDD	
			7	1024	TDD	
			10	1024	TDD	

4.1.1.3 *Sampling Factor*

Table 7. Sampling Factor

Item	Description	Reference	Status	BS Required	MS Required	Comment
1	If channel bandwidth is a multiple of 1.75MHz then n=8/7 else if channel bandwidth is a multiple of any of 1.25, 1.5, 2 or 2.75 MHz then n=28/25 else if not otherwise specified then n=8/7.	8.4.2.3	m	Y	Y	

4.1.1.4 *Cyclic Prefix*

Table 8. Cyclic Prefix

Item	Description	Reference	Status	BS Required	MS Required	Comment
1	1/4	8.4.2.3	oi	N	N	
2	1/8	8.4.2.3	oi	Y	Y	
3	1/16	8.4.2.3	oi	N	N	
4	1/32	8.4.2.3	oi	N	N	

4.1.1.5 *Frame Length*

Table 9. Frame Length

Item	Description	Reference	Status	BS Required	MS Required	Comment
1	20 ms	8.4.5.2	oi	N	N	
2	12.5	8.4.5.2	oi	N	N	
3	10	8.4.5.2	oi	N	N	
4	8	8.4.5.2	oi	N	N	
5	5	8.4.5.2	oi	Y	Y	
6	4	8.4.5.2	oi	N	N	
7	2.5	8.4.5.2	oi	N	N	
8	2	8.4.5.2	oi	N	N	

Attachment 2: Power Class Profile

WiMAX Forum™ Mobile System Profile
Release 1.0 Approved Specification

(Revision 1.6.1: 2008-04-01)

7. Power Class Profile

The Power Classes listed in following table is developed to cover the complete target range of power levels while different interpretation of applicable modulation levels is addressed through a dual range requirement for QPSK and 16-QAM per Power Class.

Table 131. Power Classes

Class Identifier	Transmit Power (dBm) for 16-QAM	Transmit Power (dBm) for QPSK	MS Required
Power Class 1	18 <= PTx,max < 21	20 <= PTx,max < 23	oi
Power Class 2	21 <= PTx,max < 25	23 <= PTx,max < 27	oi
Power Class 3	25 <= PTx,max < 30	27 <= PTx,max < 30	oi
Power Class 4	30 <= PTx,max	30 <= PTx,max	oi

NOTE: The maximum MS output power may be limited by the value included in a MS Maximum Transmission Power Limitation Control TLV that may be included in the UCD.