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EMC Test Report

Company: Radiotronix
905 Messenger Lane
Moore, OK 73160

Contact: Tom Marks

Product: Wi.USB-DTS, DTS-mode
FCC ID: Q7V-3F090012X

Test Report No: R121405-05-01a

APPROVED BY: Doug Kramer
Senior Test Engineer

DATE: 6 April 2006

Total Pages: 36

A handwritten signature in black ink, appearing to read "Doug Kramer", is written over a horizontal line.

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1.0 Summary of test results**1.1 Test Results**

Based on the data collected with the unit as configured:

Test	Test Specification	Results
CFR 47, FCC Part 15.203	Part 15.203	Complies
CFR 47, FCC Part 15.207	Part 15.207, Class B	N/A
CFR 47, FCC Part 15.209	Part 15.209, Class B	Complies
CFR 47, FCC Part 15.247	Part 15.247	Complies

1.2 Test Methods**1.2.1 Conducted Emissions**

The EUT contains no direct connection to the AC mains supply network. All power is supplied from a host machine via a USB connection. The EUT was found not to effect the host equipment conducted emissions.

1.2.2 Radiated Emissions

Compliance to CFR 47 Parts 15.209 and 15.247 was tested in accordance with the methods of ANSI/IEEE C63.4: 2003. Several configurations were examined and the results presented represent a worst-case scenario. The EUT was placed on a wooden table approximately 80cm high and centered on a 4m diameter turntable. The table was rotated to find the angles of maximum emissions and the receiving antenna was moved from 1m to 4m in both vertical and horizontal positions. All measurements were taken at a distance of 3m from the EUT for Part 15.209 intentional radiator measurements, and 3m for 15.247 measurements of the fundamental frequency in the 902MHz to 928MHz band and subsequent harmonics.

1.3 Reason for amendment

This report has been amended to correct the gain of the antenna and thusly the results that relate the radiated field strength back to the output power of the EUT. Errors in the power spectral density measurements were also corrected.

2.0 Description

2.1 Equipment under test

The Equipment under test (EUT) was a Radiotronix wireless USB module (Wi.USB-DTS, FCC ID: Q7V-3F090012X). The EUT connected to a host machine via a USB cable and was controlled by the PC using Radiotronix evaluation software. The EUT was operating in DTS-mode with channel 0 through 31 representing frequencies between 902.971 MHz through 926.277 MHz.

2.1.1 Identification: Wi.USB-DTS

2.1.2 EUT received date: 1 December 2005

2.1.3 EUT tested dates: 7, 21, 31 Jan 06, 1 Feb 06 (additional PSD measurements performed 6Apr06)

2.1.4 Manufacturer: Radiotronix

2.1.5 Serial number: NCEE Test 1

2.2 Laboratory description

All testing was performed at the NCEE Lincoln facility, which is a FCC registered lab. This site has been fully described in a report submitted to your office, and accepted in a letter dated May 4, 2001. Laboratory environmental conditions varied slightly throughout the tests:

Relative humidity of $46 \pm 4\%$

Temperature of $20 \pm 3^\circ$ Celsius

2.3 Special equipment or setup

The EUT was connected to a Dell PC with monitor, keyboard and mouse during testing. The EUT received power from the USB cable. The EUT was set to a BAUD rate of 19200 (rate at which the emissions were maximized), and the transmitter was set to "15dBm" in DTS-mode, which was the highest possible output setting in the configuration software.

3.0 Test equipment used

<i>Serial #</i>	<i>Manufacturer</i>	<i>Model</i>	<i>Description</i>	<i>Last cal.</i>
1647	EMCO	3142B	Biconilog antenna	10-Mar-05
1654	EMCO	3142B	Biconilog antenna	13-Mar-06
6416	EMCO	3115	DRG Horn	12-Oct-05
100037	Rohde & Schwarz	ESIB26	EMI Test Receiver	10-Aug-05
082001/003	Rohde & Schwarz	TS-PR18	Preamplifier	N/A
2575	Rohde & Schwarz	ES-K1	Software v1.60	N/A

4.0 Detailed Results

Radiated emissions measurements were made by first using a spectrum analyzer getting a rough signal spectrum. Any points were then measured using a CISPR 16 compliant receiver with the following bandwidth setting:

30MHz - 1 GHz: 120kHz IF bandwidth, 60kHz steps

1GHz - 10GHz: 1MHz IF bandwidth, 500kHz steps

4.1 FCC Part 15.203 unique connector for antenna

The antenna is not removable from the EUT; it is attached via a screw to the PCB. This is considered sufficient to comply with FCC Part 15.203.

4.2 FCC Part 15.207 Conducted Emissions

The EUT contains no direct connection to the AC mains supply network. All power is supplied from a host machine via a USB connection. The EUT was found not to effect the host equipment conducted emissions as shown in Figures 9 and 10 and tables 3 through 6. Figures 3 and 4 show the test setup.

4.3 FCC Part 15.209 Radiated Emissions

The EUT was found to comply with the published limits. The EUT was tested at 3m and compared to FCC Class B limits, results can be seen in Figures 6, 7 and 8. No emissions were found to exceed the limits.

4.4 FCC Part 15.247 Operation Within the 902-928 MHz Band

The EUT was tested at three different frequencies, one at the lowest possible transmitting frequency, one at the highest and one in the middle. These corresponded to channel 0, channel 31 and channel 16 respectively. The EUT was found to comply with the published regulations for the 902-928MHz band from FCC Part 15.247. All measurements were taken at a 3m distance.

4.4.1 Harmonics

Appendix B, Figures 6, 7 and 8 show the radiated emissions plots from 30 MHz to 1 GHz and tables 1, 2 and 3 display the quasi-peak measurements. Tables 8, 9 and 10 of Appendix C show the harmonics measurements above 1 GHz up to the 6th harmonic.

4.4.2 Bandwidth and Bandedge

Appendix D, Figures 11 through 13 show measurements of the 6 dB bandwidth of the three operating frequencies tested, which are to be greater than 500 kHz. Figures 14 and 15 show the upper and lower bandedges of the 902-928 MHz operating band, at which measurements are to be at least 20 dB below that of the highest emission. Bandwidth and bandedge measurements can be found in tables 11 and 12.

4.4.3 Channel Power and Power Spectral Density

The maximum allowed output power is 30dBm according to Part 15.247. In this system the effective output power is less than 15dBm into the antenna. The maximum power spectral density is less than 8dBm. The channel power and power spectral density measurements can be found in Table 13 and Figures 16 through 21.

Appendix A: Test Photos



Figure 1 - Radiated Emissions Test Setup



Figure 2 - Radiated Emissions Test Setup

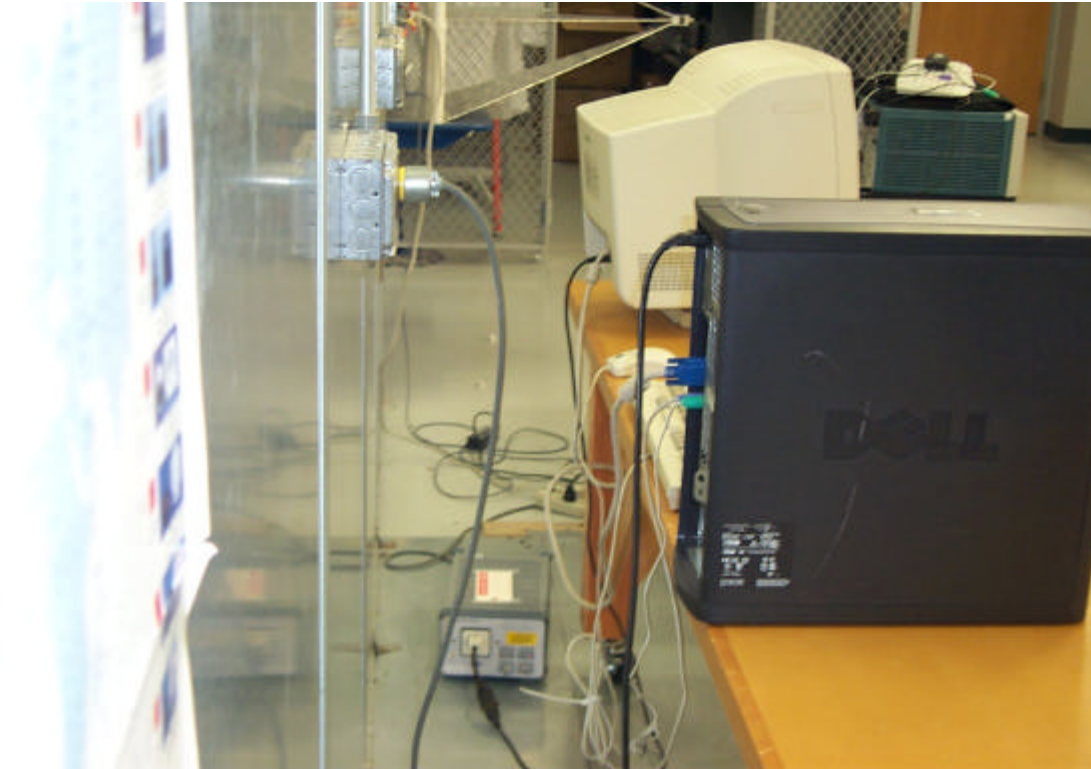


Figure 3 - Conducted Emissions Setup, EUT Not Present

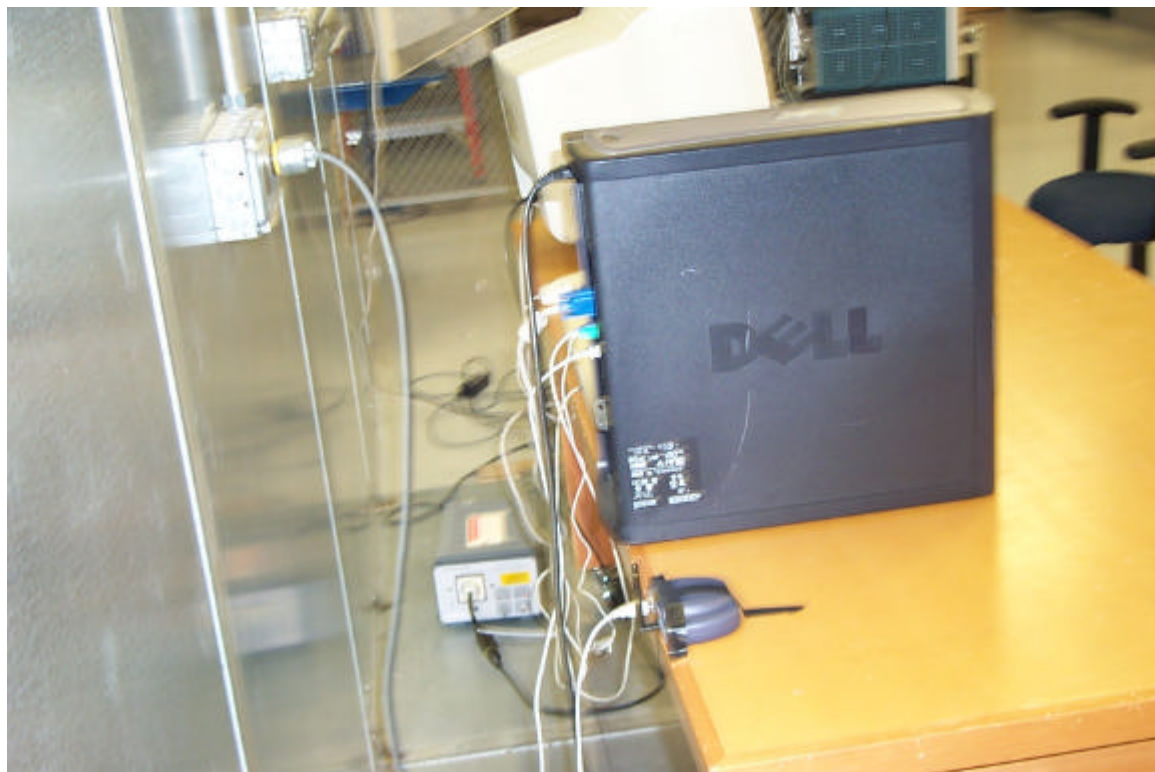


Figure 4 - Conducted Emissions Setup, EUT Present



Figure 5 - Conducted Emissions Test Setup

Appendix B: Emissions Plots

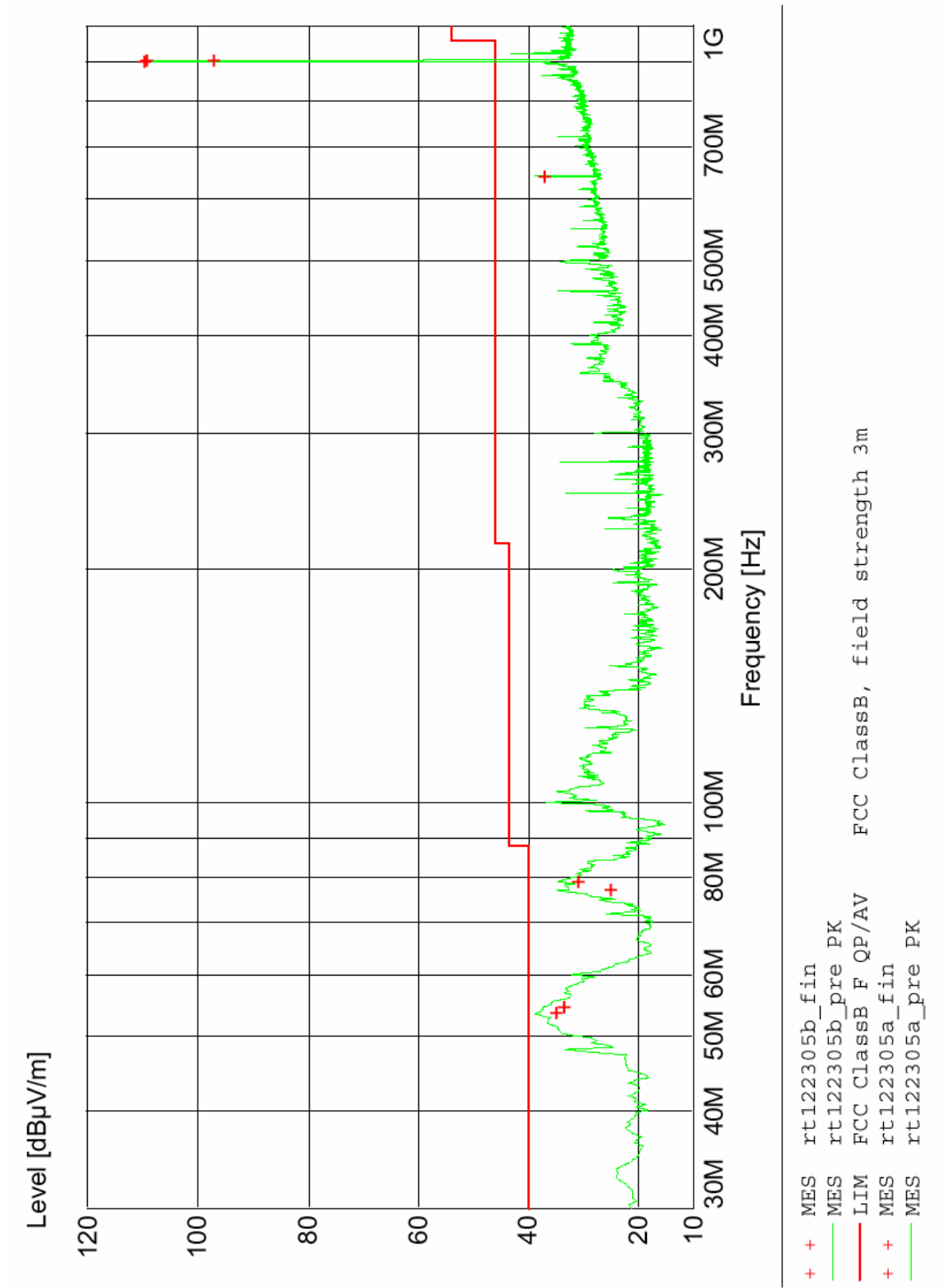


Figure 6 - Radiated Emissions Plot, Channel 0

Table 1 – Channel 0, Quasi- Peak Measurements

Frequency	QP Level	QP Limit	Margin	Height	Angle	Pol.
MHz	dBμV/m	dBμV/m	dB	cm	deg	
639.240000	36.95	46.0	9.1	346.0	226	HORI
902.700000	109.54	109.54	N/A	99.0	318	HORI
903.010000	97.07	109.54	N/A	99.0	318	HORI
903.250000	109.22	190.54	N/A	99.0	318	HORI

Maximum allowed output power is 30dBm. In this system the effective output power is less than 15dBm into the antenna.

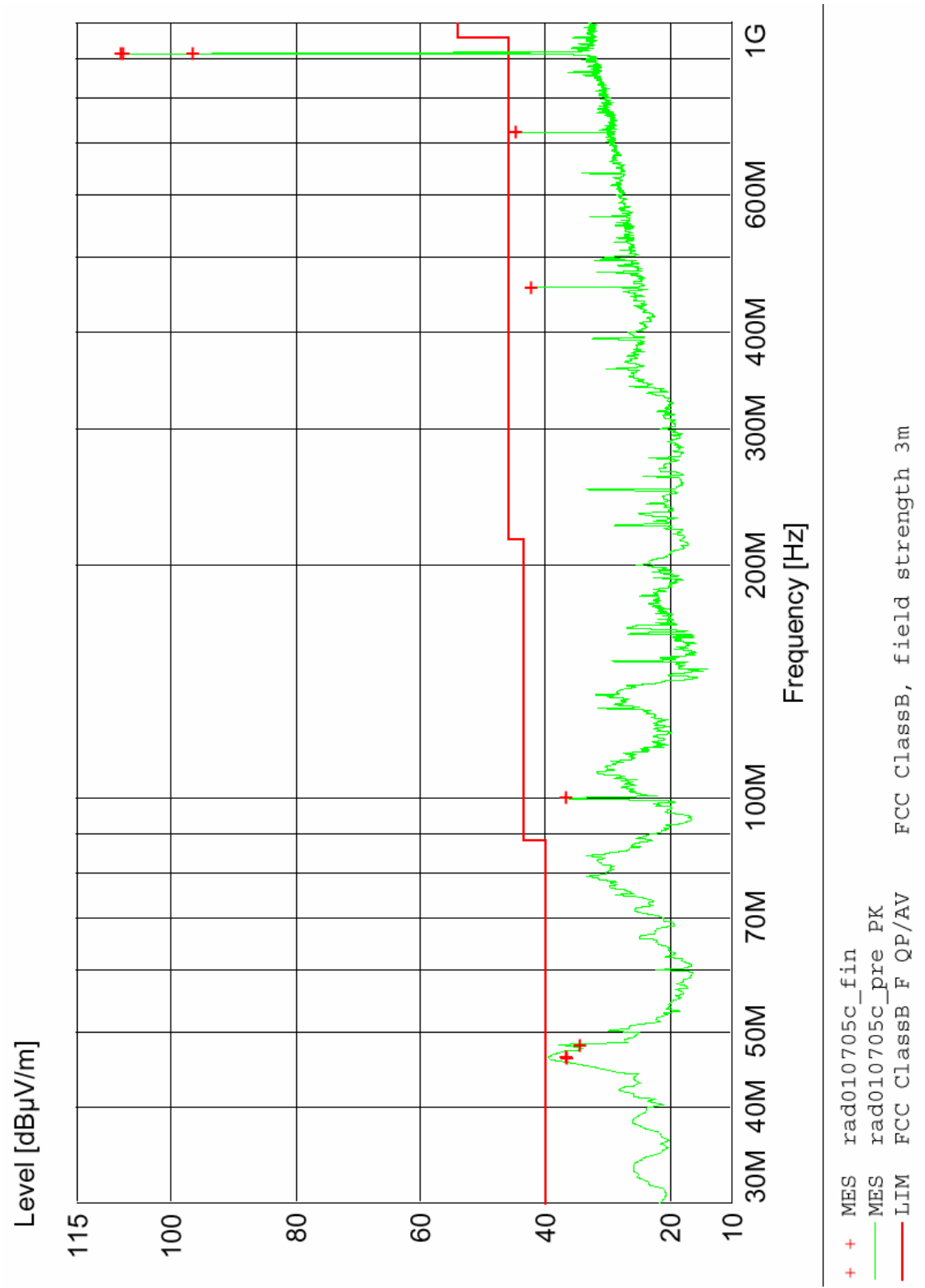


Figure 7 - Radiated Emissions Plot, Channel 16

Table 2 – Channel 16, Quasi- Peak Measurements

Frequency	QP Level	QP Limit	Margin	Height	Angle	Pol.
MHz	dB μ V/m	dB μ V/m	dB	cm	deg	
46.140000	36.53	40.0	3.5	100.0	54	VERT
46.260000	36.75	40.0	3.2	100.0	76	VERT
48.000000	34.36	40.0	5.6	100.0	4	VERT
100.020000	36.69	43.5	6.8	100.0	95	VERT
456.060000	42.27	46.0	3.7	172.0	58	VERT
723.240000	44.81	46.0	1.2	100.0	255	VERT
914.720000	108.06	108.06	N/A	100.0	318	HORI
915.000000	96.41	108.06	N/A	100.0	318	HORI
915.285000	107.69	108.06	N/A	100	318	HORI

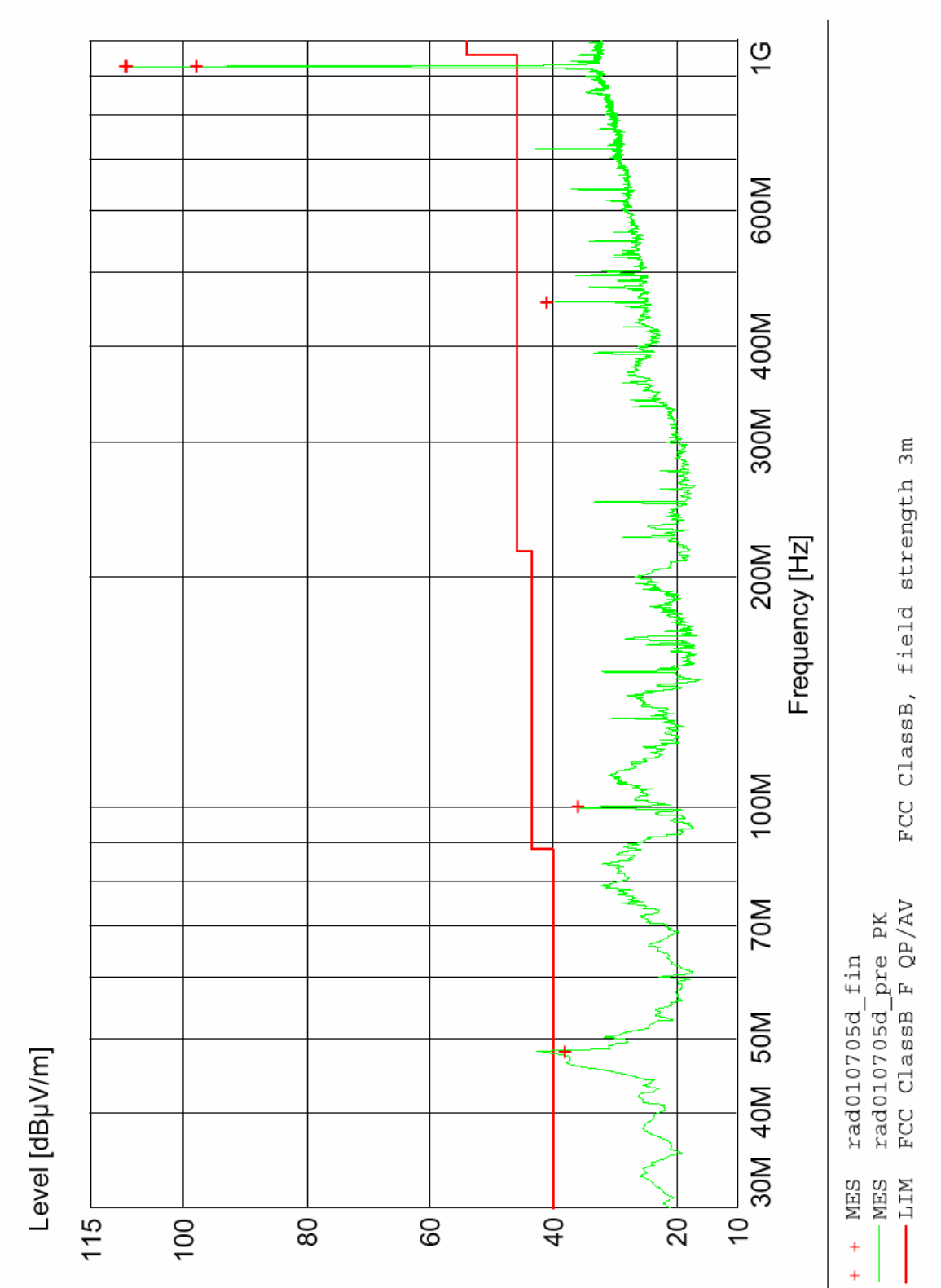


Figure 8 - Radiated Emissions Plot, Channel 31

Table 3 – Channel 31, Quasi- Peak Measurements

Frequency	QP Level	QP Limit	Margin	Height	Angle	Pol.
MHz	dB μ V/m	dB μ V/m	dB	cm	deg	
48.000000	38.11	40.0	1.9	99.0	24	VERT
100.020000	36.10	43.5	7.4	100.0	140	VERT
456.060000	41.14	46.0	4.9	150.0	46	VERT
925.990000	109.21	109.37	N/A	100.0	323	HORI
926.270000	97.93	109.37	N/A	100.0	322	HORI
926.560000	109.37	109.37	N/A	100.0	324	HORI

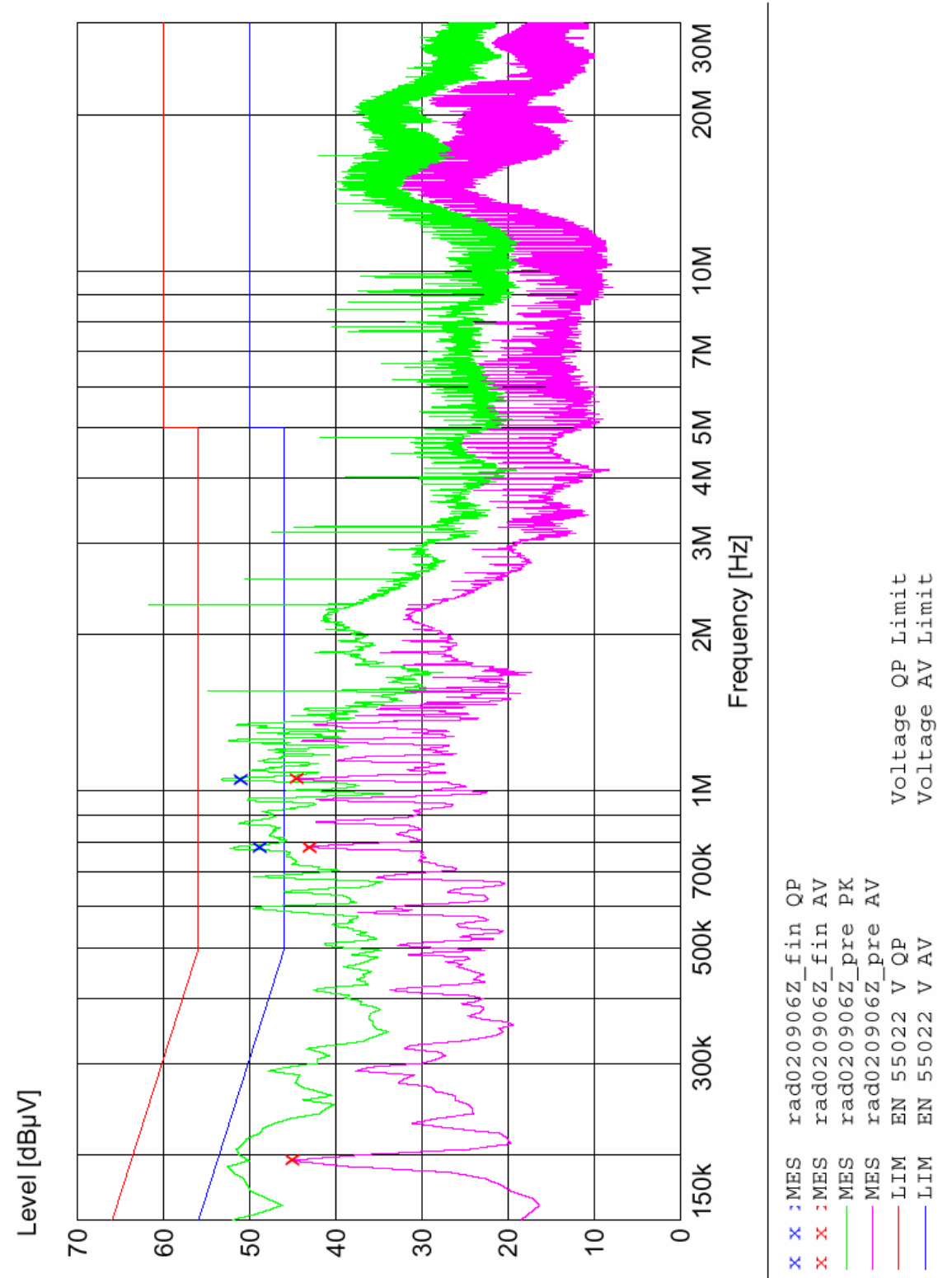


Figure 9 - Conducted Emissions plot, EUT Not Present

**Table 4- Conducted Emissions Measurements
Quasi-Peak Measurements, EUT Not Present**

Frequency	Level	Limit	Margin	Line	PE
MHz	dB μ V	dB μ V	dB		
0.780000	49.10	56	6.9	N	FLO
1.050000	51.30	56	4.7	L1	GND

**Table 5- Conducted Emissions Measurements
Average Measurements, EUT Not Present**

Frequency	Level	Limit	Margin	Line	PE
MHz	dB μ V	dB μ V	dB		
0.195000	45.30	54	8.5	L1	FLO
0.780000	43.30	46	2.7	N	GND
1.055000	44.80	46	1.2	N	GND

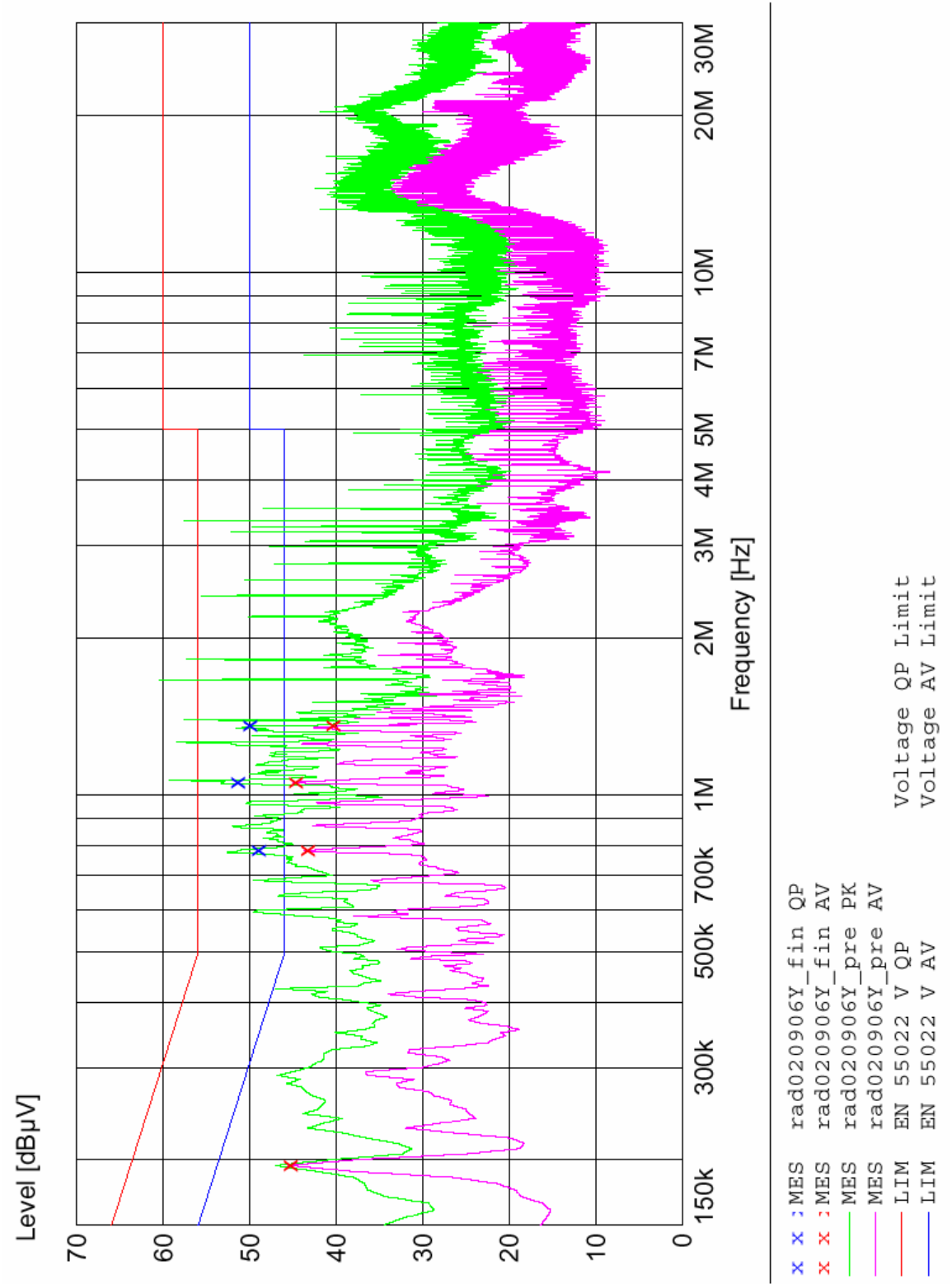


Figure 10 - Conducted Emissions plot, EUT Present

**Table 6- Conducted Emissions Measurements
Quasi-Peak Measurements, EUT Present**

Frequency	Level	Limit	Margin	Line	PE
MHz	dB μ V	dB μ V	dB		
0.780000	49.20	56	6.8	L1	GND
1.050000	51.60	56	4.4	L1	FLO
1.350000	50.20	56	5.8	N	GND

**Table 7- Conducted Emissions Measurements
Average Measurements, EUT Present**

Frequency	Level	Limit	Margin	Line	PE
MHz	dB μ V	dB μ V	dB		
0.195000	45.50	54	8.3	L1	GND
0.780000	43.50	46	2.5	N	FLO
1.055000	44.90	46	1.1	L1	FLO
1.350000	40.60	46	5.4	L1	FLO

Appendix C: Harmonics Measurements

Table 8- Radiated Emissions Measurements
Channel 0, DTS-mode 15dBm setting, 1 MHz RBW, 5 Sec. Measurement Time

Frequency	Level Pk	Level Av.	Limit Av.	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dBµV/m	dB	cm	deg	
1805.5	59.8	52.0	89.54	37.54*	199	34	V
2709.5	56.3	44.5	53.9	9.4	106	234	H
3613.0	56.8	43.0	53.9	10.9	150	22	V
4502.5	57.6	44.6	53.9	9.26	194	39	H
5424.5	62.6	49.5	53.9	4.4	199	250	H
6315.5	66.0	52.2	53.9	1.69	158	63	H

Table 9 - Radiated Emissions Measurements
Channel 16, DTS-mode 15dBm setting, 1 MHz RBW, 5 Sec. Measurement Time

Frequency	Level Pk	Level Av.	Limit Av.	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dBµV/m	dB	cm	deg	
1829.5	61.3	53.2	88.06	34.86*	181.0	15.0	V
2744.0	57.4	45.6	53.9	8.3	199.0	29.0	V
3652.5	56.3	43.1	53.9	10.8	200.0	332.0	H
4572.5	58.5	44.9	53.9	9.0	150.0	0.0	H
5598.0	64.5	51.4	53.9	2.5	149.0	106.0	V
6424.0	65.8	51.9	53.9	2.0	150.0	325.0	V

Table 10 - Radiated Emissions Measurements
Channel 31, DTS-mode 15dBm setting, 1 MHz RBW, 5 Sec. Measurement Time

Frequency	Level Pk	Level Av.	Limit Av.	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dBµV/m	dB	cm	deg	
1853.0	63.5	56.2	89.37	33.17*	100.0	136.0	H
2794.5	58.6	49.8	53.9	4.1	171.0	2.0	H
3702.5	56.8	46.0	53.9	7.9	181.0	65.0	H
4629.5	58.5	47.9	53.9	6.0	99.0	18.0	V
5579.5	64.7	53.6	53.9	0.3	117.0	125.0	H
6475.5	65.6	52.3	53.9	1.6	150.0	323.0	V

*Emission does not lie within a restricted band, therefore according to 15.247 paragraph (c), the harmonic measurement must be at least 20 dB below that of the highest level.

Appendix D: Bandwidth and bandedge data

Table 11

Bandwidth Measurements

Channel	6dB Bandwidth (kHz)	20dB Bandwidth (kHz)	6 dB BW Minimum (kHz)	Margin (kHz)
0	779.12	1060.84	> 500	279.12
16	796.73	1056.44	> 500	296.73
31	805.54	1055.24	> 500	205.54

Table 12

Bandedge Measurements

Channel	Band edge (MHz)	Delta between peak and maximum out-of-band emission (dB)	Minimum (dB)	Margin (dB)
0	902	42.66	20	22.66
31	928	44.44	20	24.44

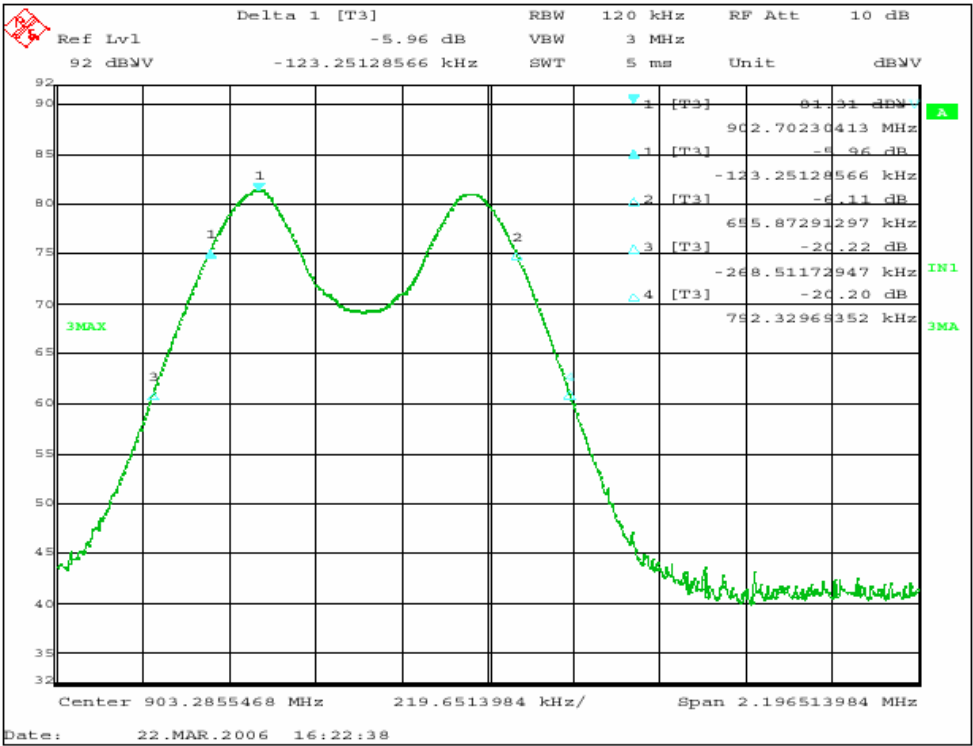


Figure 11 - Channel 0, 6db and 20dB Bandwidths

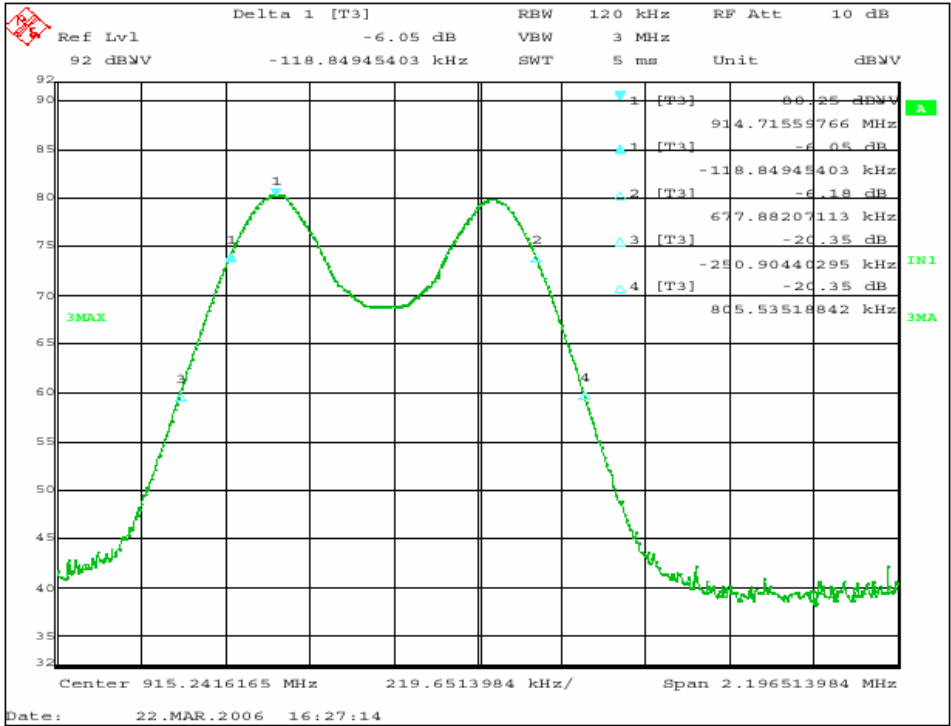


Figure 12 - Channel 16, 6db and 20dB Bandwidths

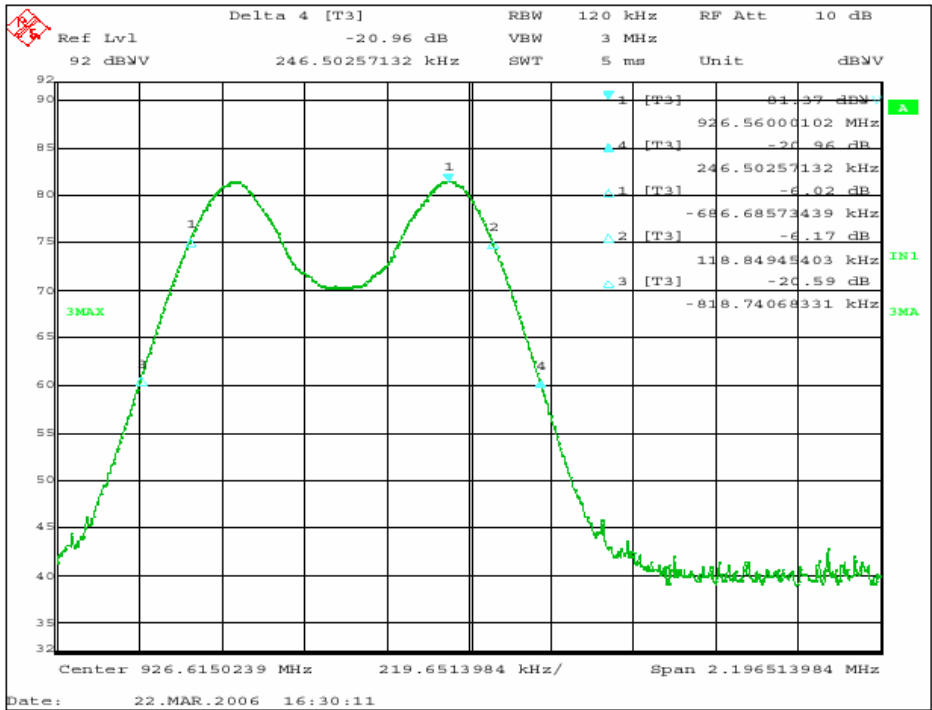


Figure 13 - Channel 31, 6db and 20dB Bandwidths

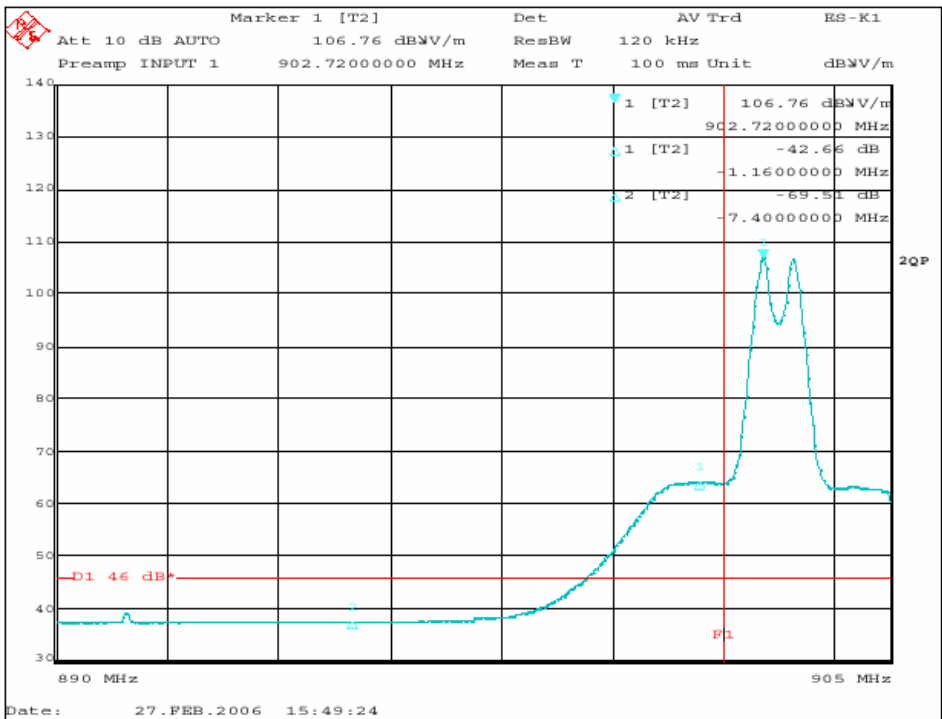


Figure 14 - Channel 0, 902MHz Bandedge, 42.66 dB below fundamental

Vertical red line depicts 902MHz bandedge, horizontal red line depicts FCC 15.209 limit

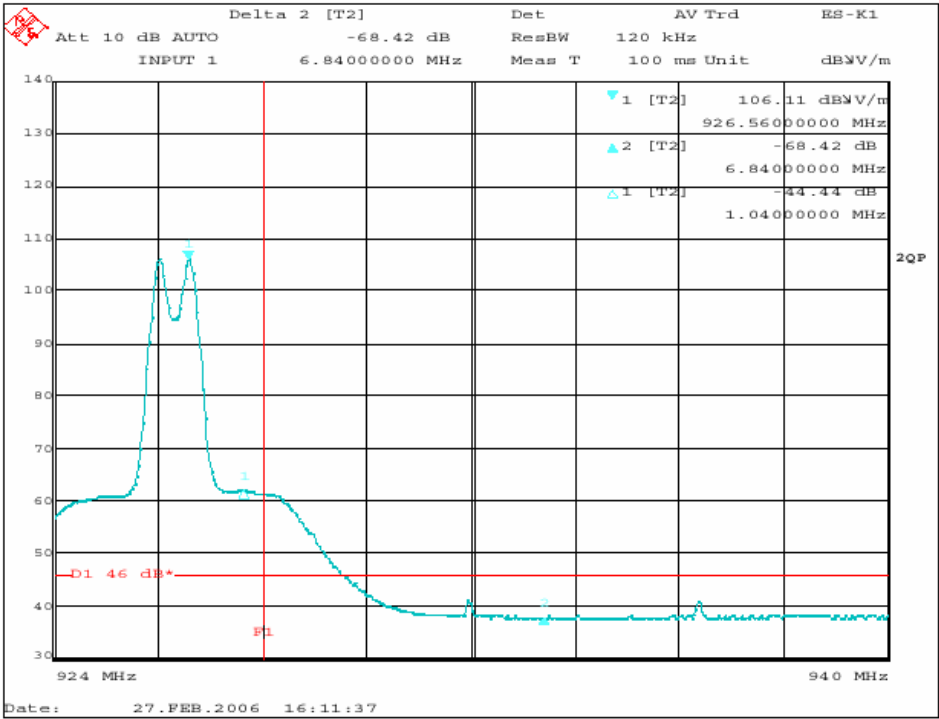


Figure 15 - Channel 31, 928MHz Bandedge, 44.44 dB below fundamental

Vertical red line depicts 928MHz bandedge, horizontal red line depicts FCC 15.209 limit

Appendix E: Channel Power and Power Spectral Density Measurements (Radiated)

Table 13
Channel Power and Power Spectral Density Measurements

Channel	Field Strength, dBuV/m	Channel Power, mW (dBm)	PSD, dBuV/m	PSD, dBm	Limit, dBm	Margin (dB)
0	109.54	16.3 (12.11)	102.62	5.19	8	2.81
16	108.06	11.6 (10.63)	99.73	2.30	8	5.7
31	109.37	15.6 (11.94)	99.14	1.71	8	6.29

*Note: Channel power and power spectral density are to be made as conducted measurements from the antenna port of the EUT. Because the EUT did not have an accessible antenna port, measurements had to be made as radiated measurements, and mathematically converted to conducted measurements using the following equation:

E is the measured maximum field strength in V/m utilizing the widest available RBW.
G = 1.7, is the numeric gain of the transmitting antenna (2.2dB) over an isotropic radiator.

d = 3, is the distance in meters from which the field strength was measured.

P is the power in watts for which you are solving:

$$P = \frac{(Ed)^2}{30G}$$

All Measurements in Table 13 are calculated using the maximum radiated field measurements as seen in this report. Antenna gain is taken from manufacturer's application note.

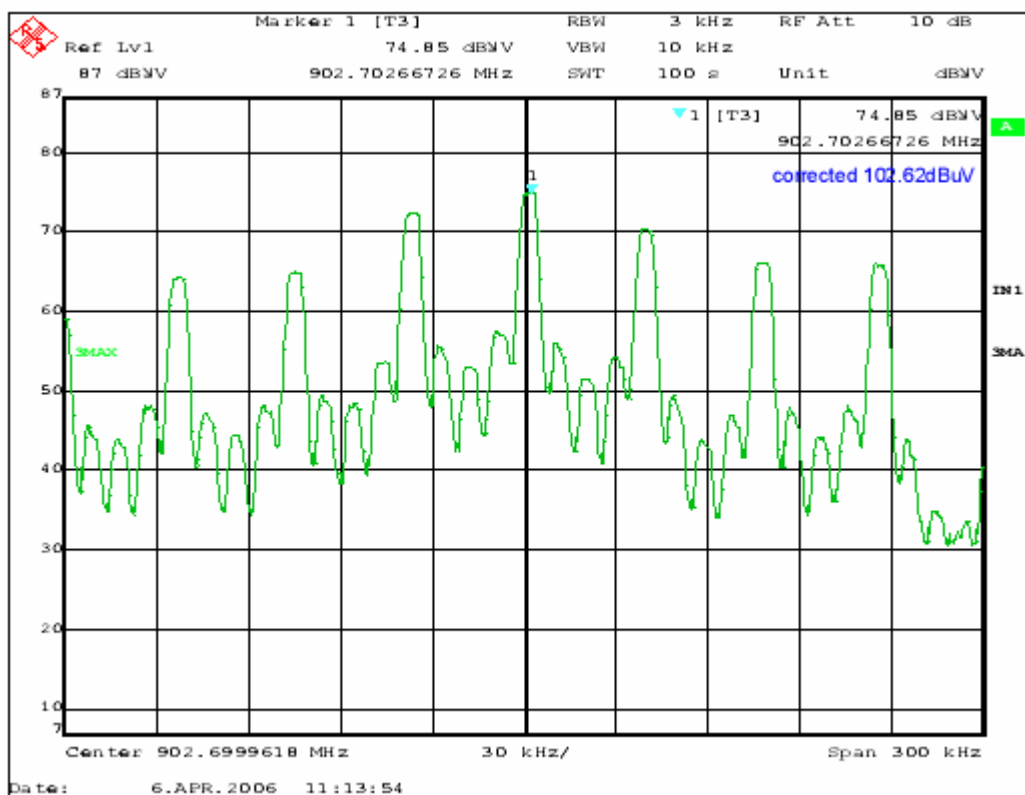


Figure 16 - Power Spectral Density, Channel 0, Radiated

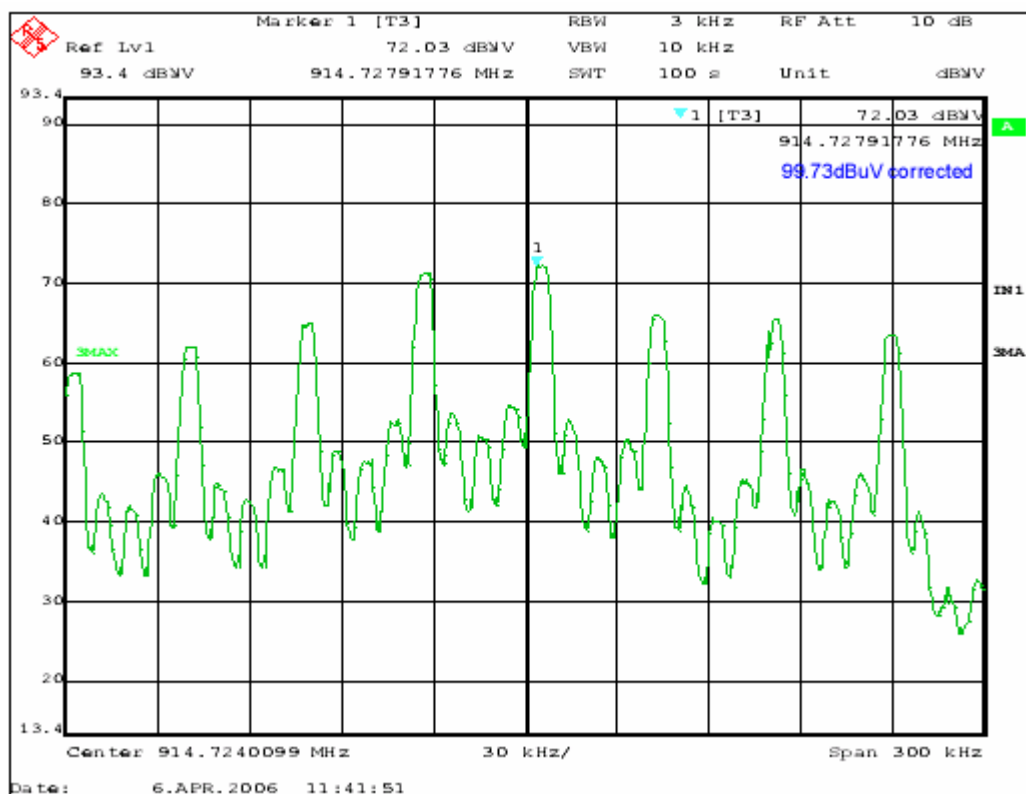


Figure 17 - Power Spectral Density, Channel 16, Radiated

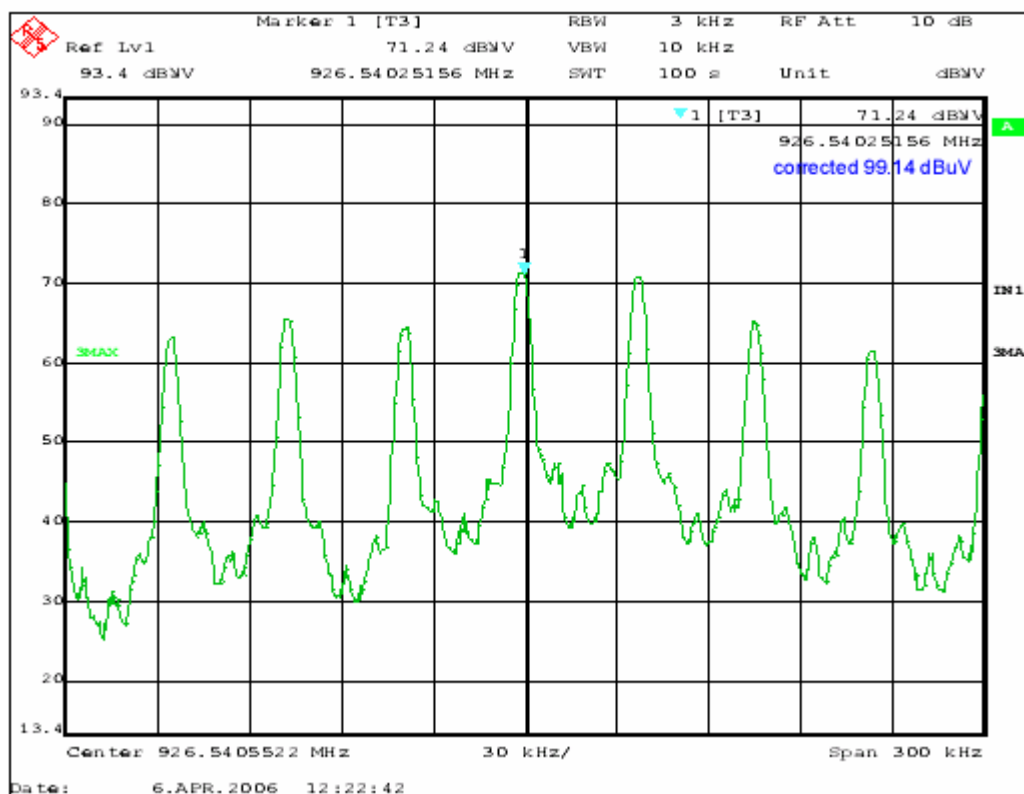


Figure 18 - Power Spectral Density, Channel 31, Radiated

Appendix F: Sample Calculation

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF - (-CF + AG) + AV$$

where FS = Field Strength

RA = Receiver Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

AG = Amplifier Gain

AV = Averaging Factor (if applicable)

Assume a receiver reading of 55 dBμV is obtained. The Antenna Factor of 12 and a Cable Factor of 1.1 is added. The Amplifier Gain of 20 dB is subtracted, giving a field strength of 48.1 dBμV/m.

$$FS = 55 + 12 - (-1.1 + 20) + 0 = 48.1 \text{ dB}\mu\text{V/m}$$

The 48.1 dBμV/m value can be mathematically converted to its corresponding level in μV/m.

$$\text{Level in } \mu\text{V/m} = \text{Common Antilogarithm} [(48.1 \text{ dB}\mu\text{V/m})/20] = 254.1 \mu\text{V/m}$$

AV is calculated by the taking the $20 \cdot \log(T_{\text{on}}/100)$ where T_{on} is the maximum transmission time in any 100ms window.

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