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Test Report

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525 Metro Place North, Ste 100
Dublin, OH 43017
Contact: Kedar Kapoor

Product: SSU-01H2BR-SG4100
FCC ID: Q7O-0003

Test Report No: R120403-01-0

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General Manager

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DATE: 23 February 2004
Total Pages: 72

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1.0 Summary of test results

1.1 Test Results

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	Complies
CFR 47, FCC Part 15.209	Part 15.109, Class B	Complies
CFR 47, FCC Part 15.247	Parts 15.209 and 15.247	Complies

1.2 Test Methods

1.2.1 Conducted Emissions

Measurements of conducted emissions to the limits set in CFR 47 Part 15.207 were conducted using the methods shown in ANSI/IEEE C63.4, 2001. Several configurations were examined the results presented represent a worst-case scenario. The EUT was placed on a wooden table approximately 80 centimeters high, positioned 40 centimeters from the vertical ground plane and 80 centimeters or more away from any other conductive surface.

1.2.2 Radiated Emissions

Compliance to CFR 47 Parts 15.109/209 and 15.247 was tested in accordance with the methods of ANSI/IEEE C63.4, 2001. Several configurations were examined the results presented represent a worst-case scenario. The EUT was mounted on a wooden table 80 centimeters high and centered on a 4 meter diameter turntable. The table was rotated to maximize emissions. All measurements below 18GHz were taken at a distance of 3 meters from the EUT. Measurements above 18GHz were made at a distance of 1 meter.

2.0 Description

2.1 Equipment under test

The SSU-01H2BR-SG4100 product uses the PRA-0005 (FCC ID: Q7O-0003) and combines it with a KarlNet KN-100 WPRG+, BA200-0107 interface board for operation in the band of 2412-2462MHz. The standard panel antenna as tested is a 19dBi patch antenna from Arc Wireless Model No. FWA-SL-19-2.4-001-INT. The SSU-01H2BR-SG4100 is the baseline unit for the modular approval of the PRA-0005 radio card.

2.1.1 Identification: SSU-01H2BR-SG4100

2.1.2 EUT received date: 04 December 2003

2.1.3 EUT tested dates: 8th, 9th, 12th, 15th – 17th December 2003
12th – 14th January 2004

2.1.4 Manufacturer: KarlNet, Inc

2.1.5 Serial number: Prototype 2

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 the FCC office, and accepted in a letter dated May 4, 2001. Laboratory environmental conditions varied slightly throughout the tests:

Relative humidity of 46 ± 10%
Temperature of 21 ± 3° Celsius

2.3 Special equipment or setup

The device was continuously transmitting at the maximum rate in the software defined “Antenna Alignment” mode for the transmit testing. A ferrite bead was added to the power supply input right before entering the power over ethernet box for 30MHz – 1GHz radiated emissions testing. The ferrite part number is 0431164281 from Fair-Rite Products.

3.0 Test equipment used

Serial #	*Manufacturer*	*Model*	*Description*	*Last cal.*
1654	EMCO	3142B	Biconilog antenna	03-May-03
6415	EMCO	3115	DRG Horn	29-Apr-03
2576	EMCO	3116	DRG Horn	29-Apr-03
100037	Rohde & Schwarz	ESIB26	EMI Test Receiver	02-Jul-03
100007	Rohde & Schwarz	ESIB7	EMI Test Receiver	26-May-03
082001/003	Rohde & Schwarz	TS-PR18	Preamplifier	N/A
2575	Rohde & Schwarz	ES-K1	Software v1.60	N/A
836679/010	Rohde & Schwarz	ESH3-Z5	Artificial Mains	29-Apr-03

4.0 Detailed Results

All measurement results are located in the corresponding interval with a probability of approximately 95% (coverage factor k=2). The interval for these measurements is U_x (expanded uncertainty).

Conducted Emissions, 150kHz – 30MHz: U_x = +/- 3.1 dB
Radiated Emissions, 30MHz – 1GHz, 3m distance: U_x = +/- 3.4 dB
Radiated Emissions, 1GHz – 18GHz, 3m distance: U_x = +/- 3.5 dB
Radiated Emissions, above 18GHz, 1m distance: U_x = +/- 3.2 dB

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 - 1GHz: 120kHz IF bandwidth, 60kHz steps
Above 1GHz: 1MHz IF bandwidth, 500kHz steps

Conducted measurements were made using a CISPR 16 compliant receiver with the IF bandwidth set to 9kHz taking 5kHz steps through the range 150kHz to 30MHz.
All results shown are corrected to incorporate cables losses, antenna factors, and any amplification.

4.1 FCC Part 15.203 Unique Connector for Antenna

The antenna is attached to the PRA-0005 via a custom pigtail and is located physically internal to SSU-01H2BR-SG4100. No external connectors exist for the connection of an auxiliary antenna external to the overall EUT. Figures 9 and 10 show the antenna connector. Other antennas and their specifications to be used with the PRA-0005 are in Appendix G.

4.2 FCC Part 15.207 Conducted Emissions

The EUT was tested in two modes; one was with the transmitter operating in full speed antenna alignment and the other, normal mode of operation, when no signal is present to be repeated. The setup can be seen in Figures 2 and 3. The normal operation mode provided the highest emissions and those results can be seen in Figure 23. No emissions as measured with a quasi-peak detector were detected within 12dB of the limit. The plot shown Figure 23 is a composite worst-case of the Line and Neutral conductors.

4.3 FCC Part 15.109 Radiated Emissions, Receive only

The EUT was found to not produce any emissions in excess of the Class 'B' limits. The test setup can be seen in Figure 1. More information on the radiated emissions can be found in Section 4.4. The transmitter was not active for these measurements. Appendix C shows the measured values denoted by a red '+' or blue '+' in Figures 22 and 23. The red '+' is the quasi-peak or average measurement while the blue '+' in Figures 22 and 23 show the peak values. No values were found to be in excess of the limits. A table of the values can be seen in Appendix C. All measurements were made at a distance of 3 meters.

4.4 FCC Parts 15.209 and 15.247 Radiated Emissions, Transmit only

The EUT was tested at three frequencies with the transmitter continuously operating, in the lower, middle and upper portions of the band. The frequencies chosen were Channel 1 (2.412GHz), Channel 5 (2.432GHz), and Channel 11 (2.462GHz). Measurements were made from 30MHz to 18 GHz at a distance of 3 meters and from 18GHz to 25GHz at a distance of 1 meter; no spurious emissions were noted above 18GHz. Figures 12 through 20 show the worst-case emissions for each channel in the ranges of 30MHz – 1GHz, 1GHz – 3GHz, and 3GHz – 18GHz while the EUT was transmitting. The peak and quasi-peak measurements below 1GHz were found not to exceed the limits. The peak and average measurements between 1GHz and 3GHz did not exceed limits outside of the transmitters operating band. The peak and average measurement between 3GHz and 18GHz did not exceed the limits. Figure 1 shows the configuration of the EUT during radiated emissions testing. The EUT was mounted on a table 80 centimeters above a ground plane. Appendix D contains the results of testing the 3 transmitter frequencies. Appendix B shows the measured values denoted by a red '+' or a blue '+' in Figures 12 through 20. The red '+' is the quasi-peak or average measurement while the blue '+' in Figures 12 through 20 show the peak values.

4.5 Bandedge and Conducted Power Measurements

The EUT was tested at Channel 1 and Channel 11 for the bandedge measurements. The EUT was tested on Channels 1, 5 and 11 for the conducted power measurements. Appendix F shows the results and the plots of bandedge and conducted power measurements. The radiated peak and average values were tested at the location that the maximum value for the radiated emissions testing was found. These positions can be found in Appendix D. The maximum calculated emission in the 2.31GHz –2.39GHz restricted band is 55.32dBuV/m for peak and 50.4dBuV/m for average. The maximum calculated emission in the 2.4835GHz – 2.5GHz restricted band is 63.83dBuV/m for peak and 53.4dBuV/m for average. The maximum emission in the lower restricted band fell within 2MHz of 2.39GHz as shown in Figures 37 and 40.

	Channel		
	1	5	11
6dB Bandwidth	12.6 MHz	11.1 MHz	11.5 MHz
Maximum Power	17.85 dBm	17.07 dBm	17.25 dBm
Maximum PSD	-8.1 dBm	-7.87 dBm	-8.02 dBm

Appendix A: Photos

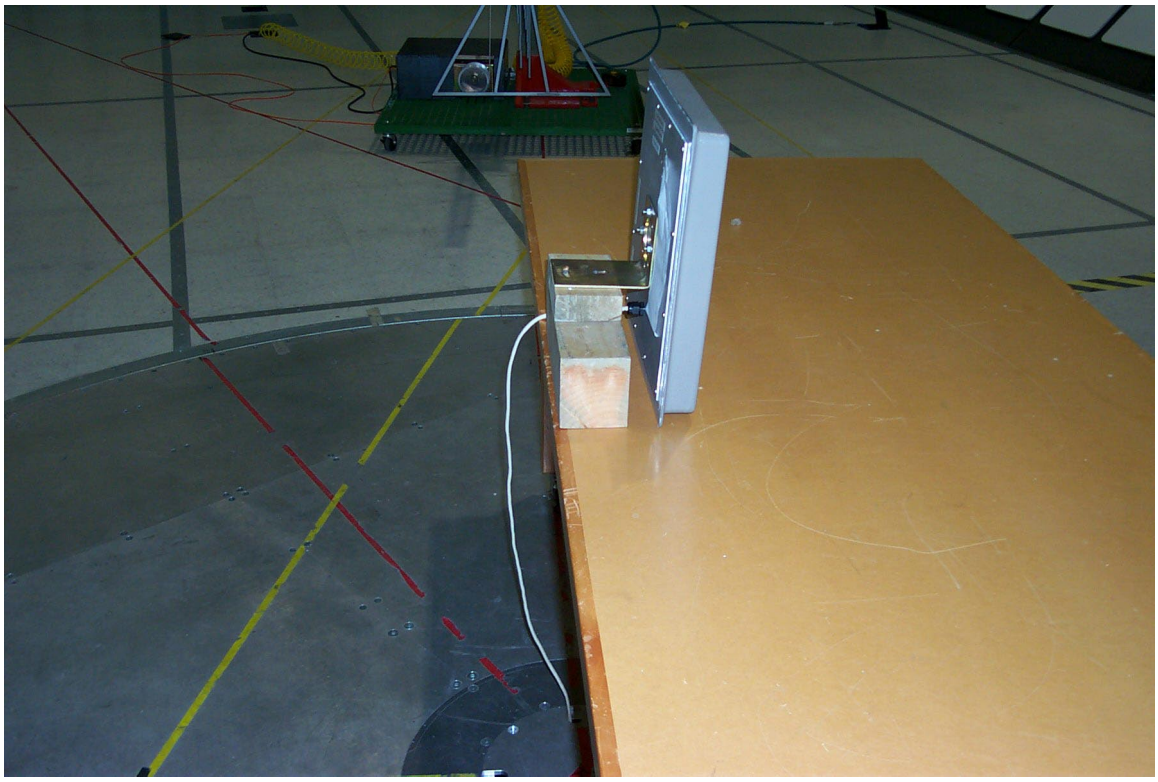

Figure 1 Radiated Emissions Test Setup

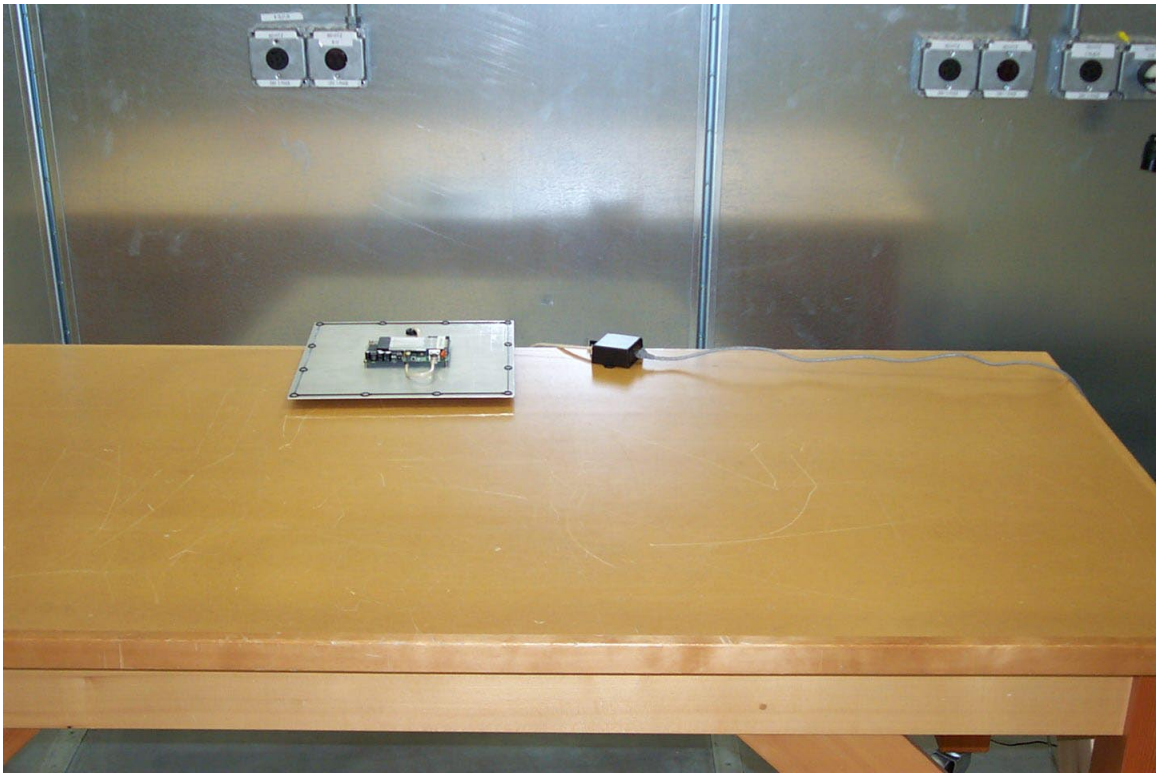

Figure 2 Conducted Emissions Test Setup

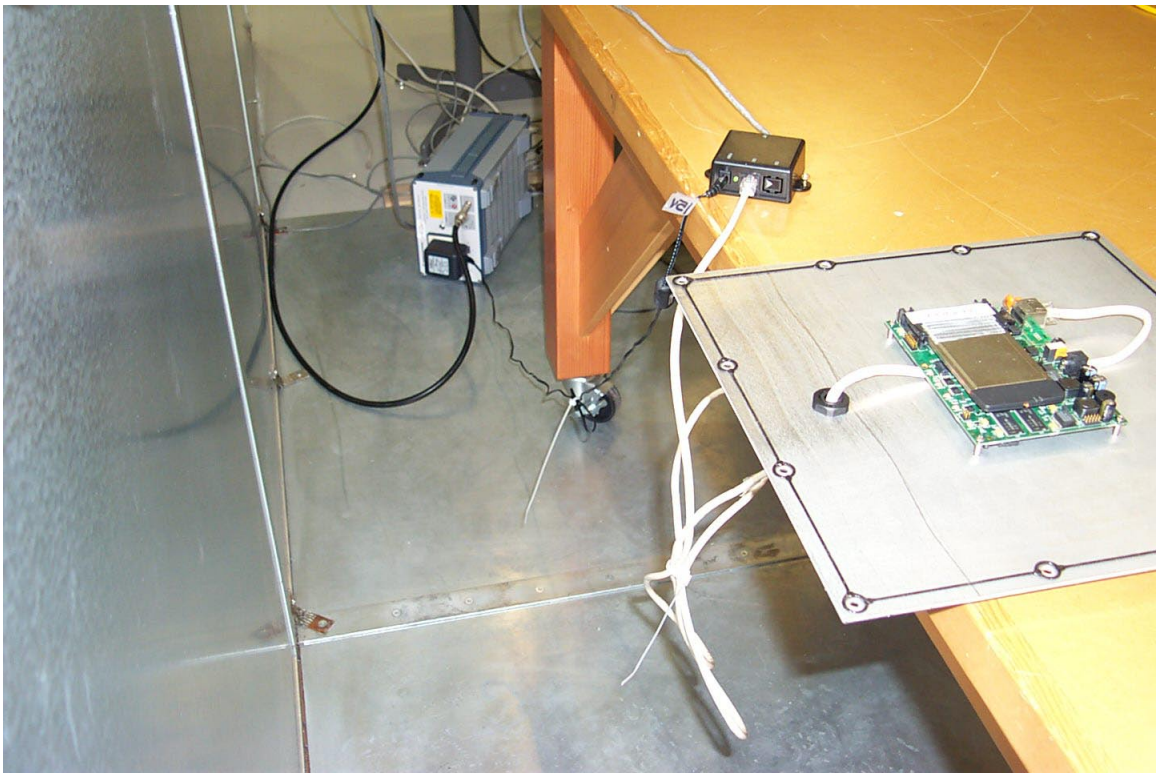

Figure 3 Conducted Emissions Test Setup

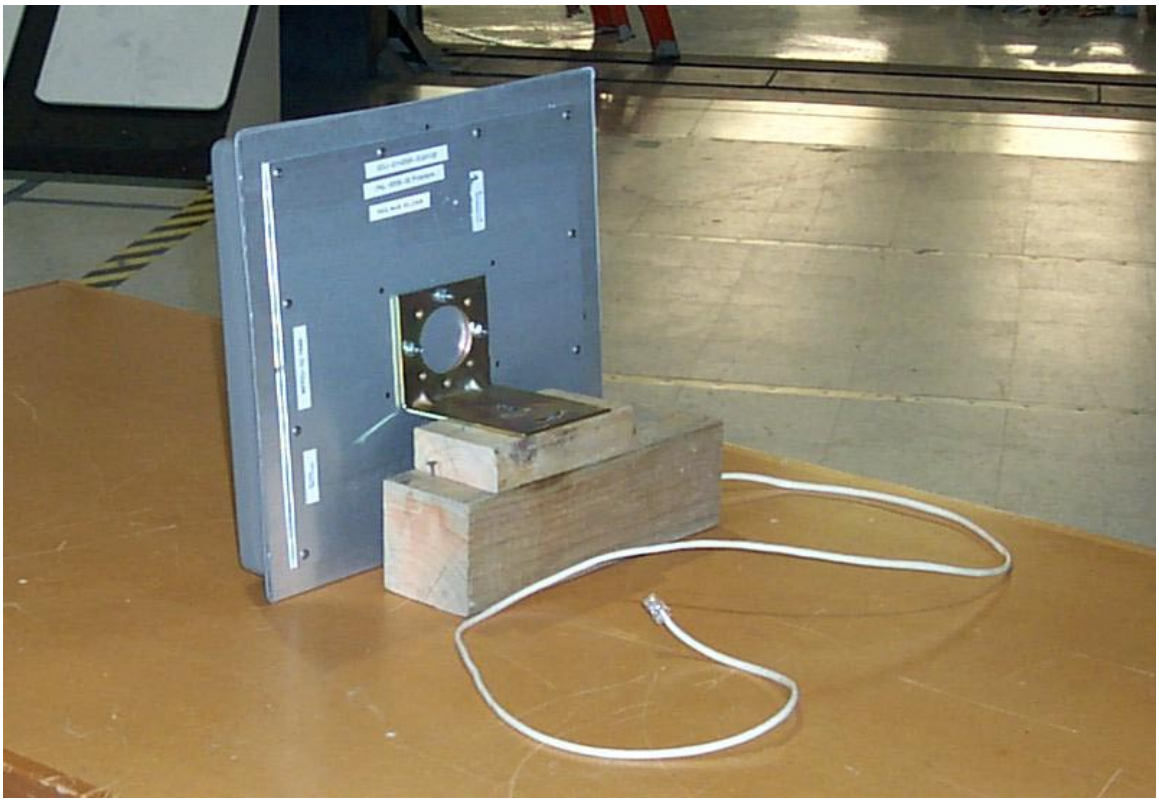

Figure 4 Arc Wireless 19dBi Antenna Back

Figure 5 Arc Wireless 19dBi Antenna Front

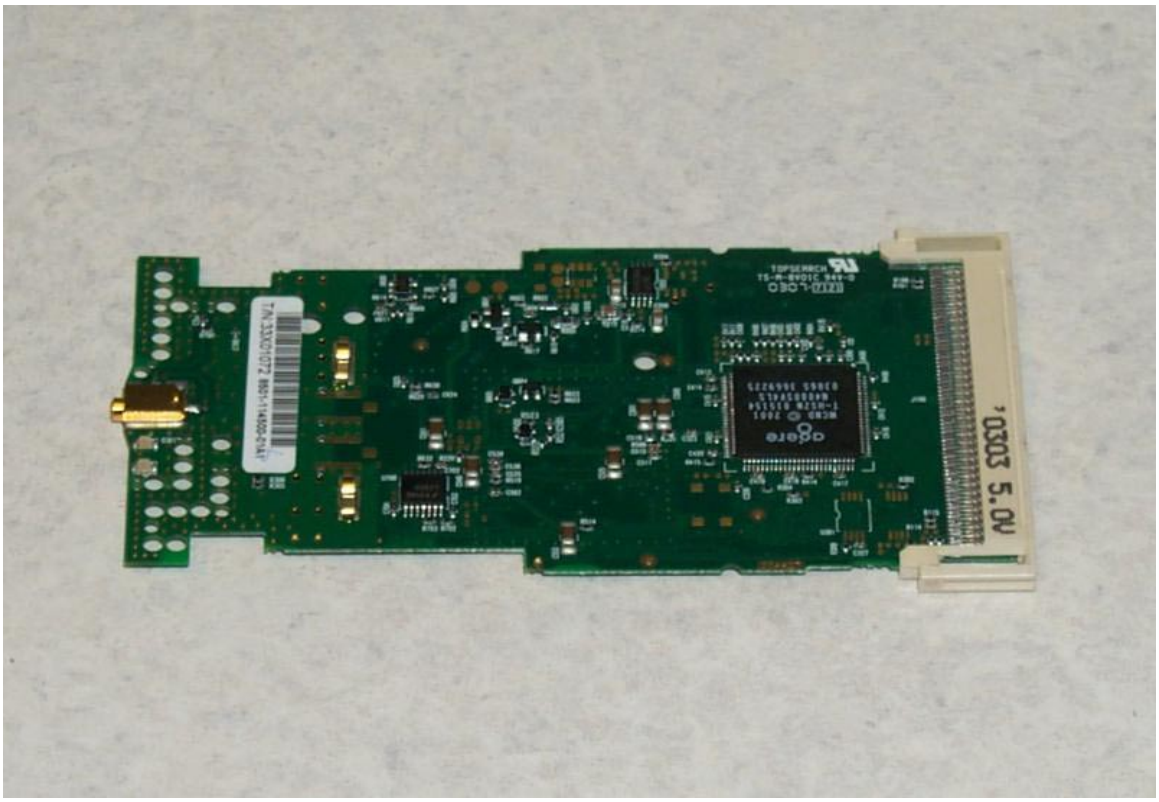

Figure 6 PRA-0005 PCB Top

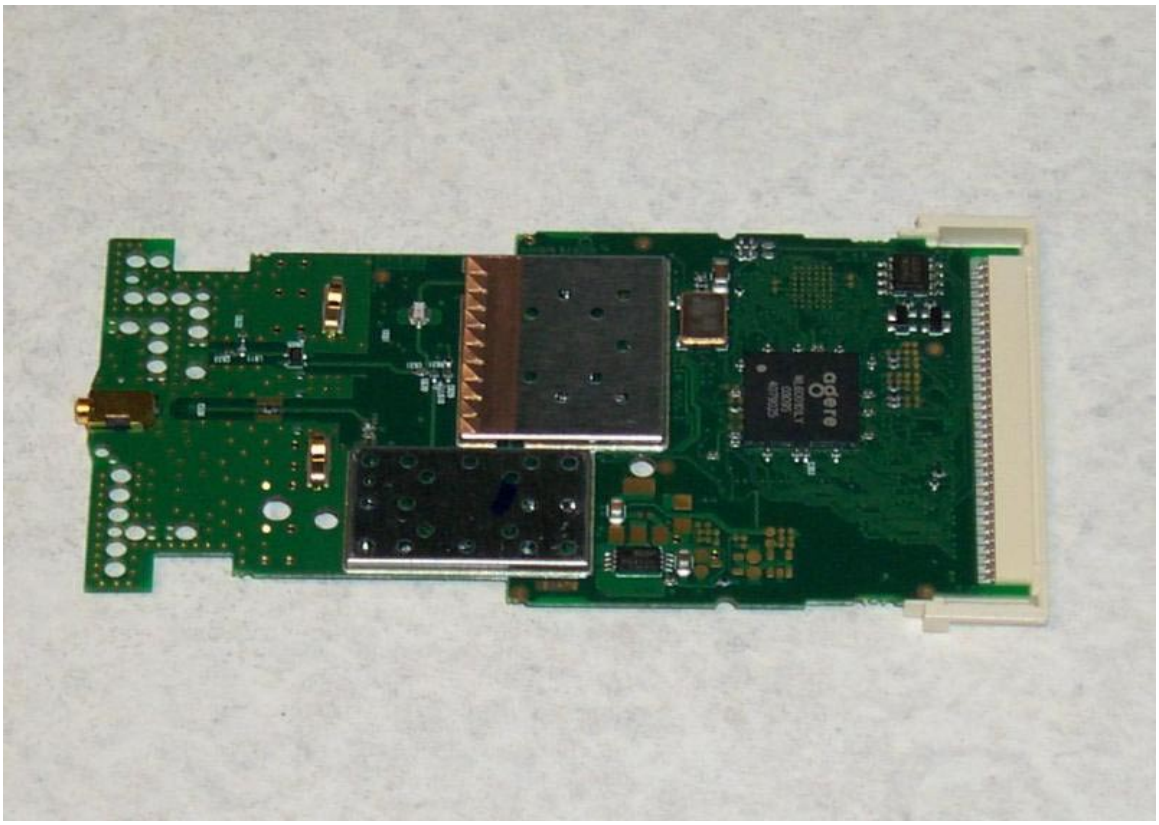

Figure 7 PRA-0005 PCB Bottom with Internal RF Shielding

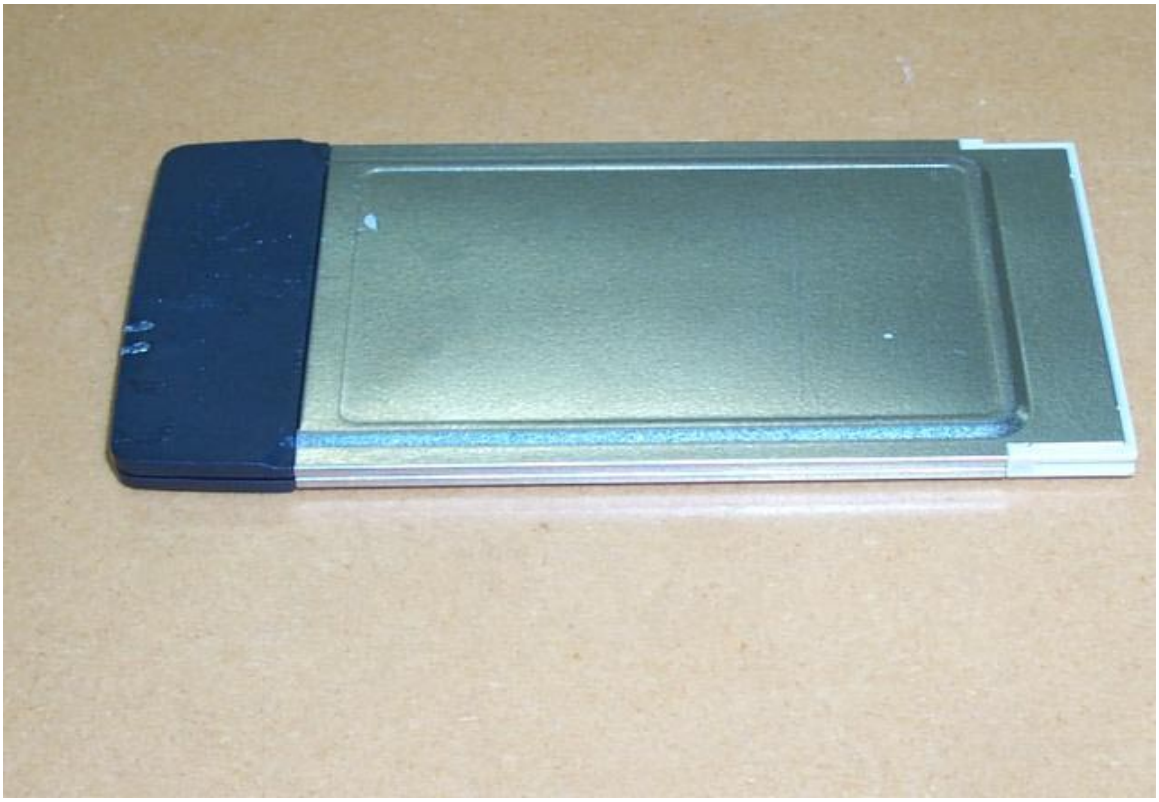

Figure 8 PRA-0005 PCMCIA Metal Housing

Figure 9 PRA-0005 Antenna Connector

Figure 10 Pigtail Antenna Connector

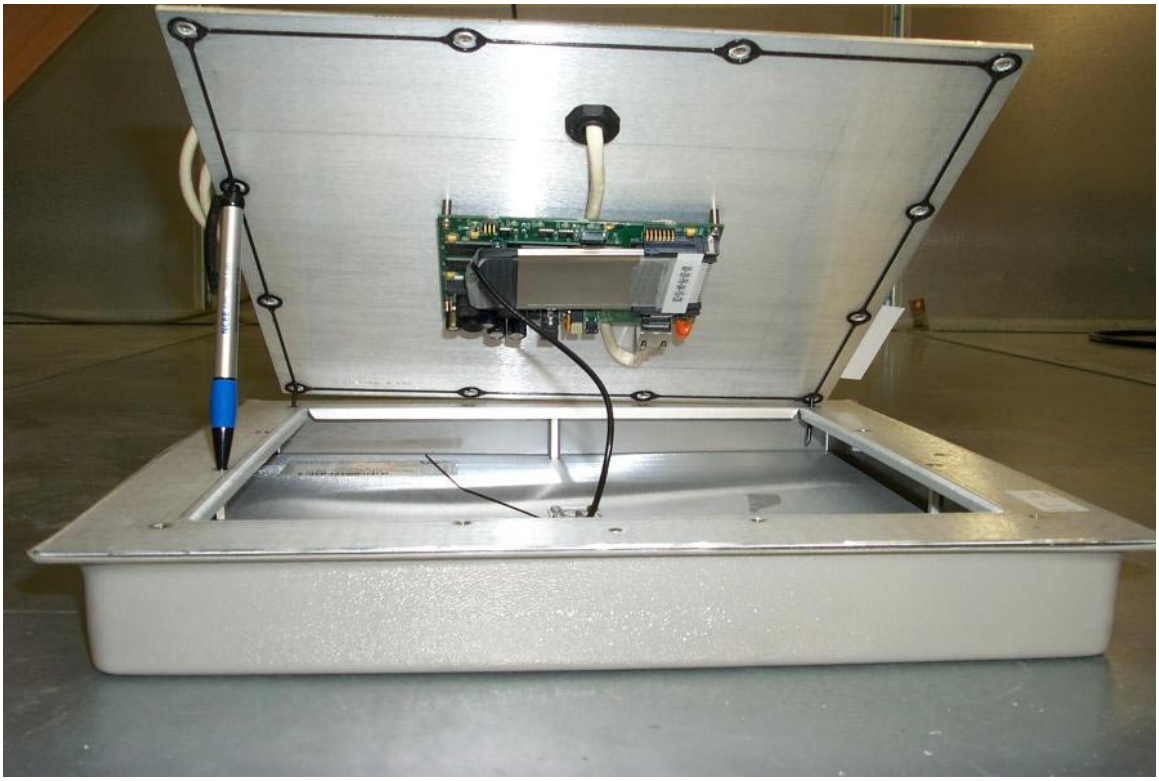

Figure 11 PRA-0005 and KN-100 mounted inside Arc Wireless 19dBi Antenna

Appendix B: Emissions Plots

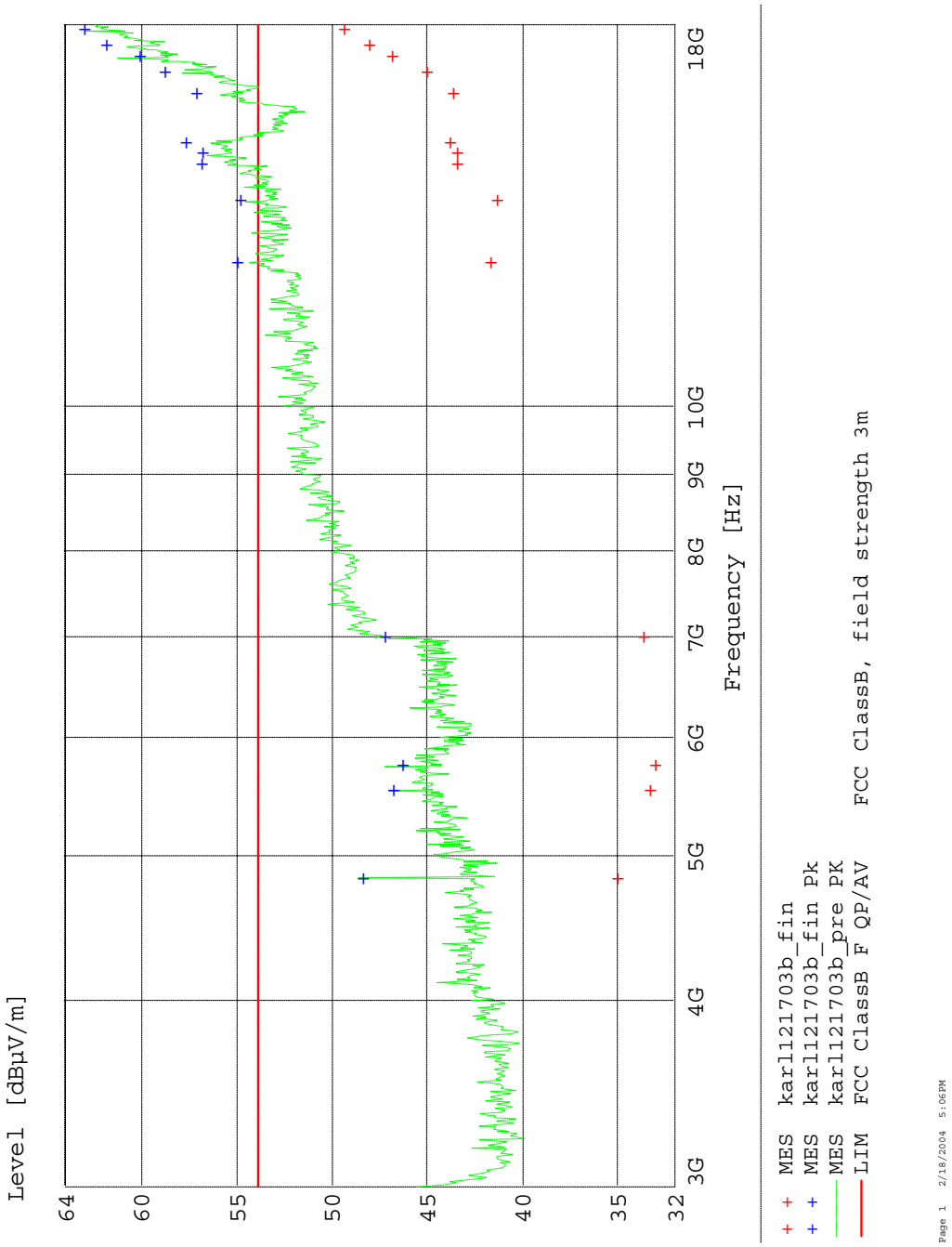

Figure 12 Channel 1 Radiated Emissions Plot

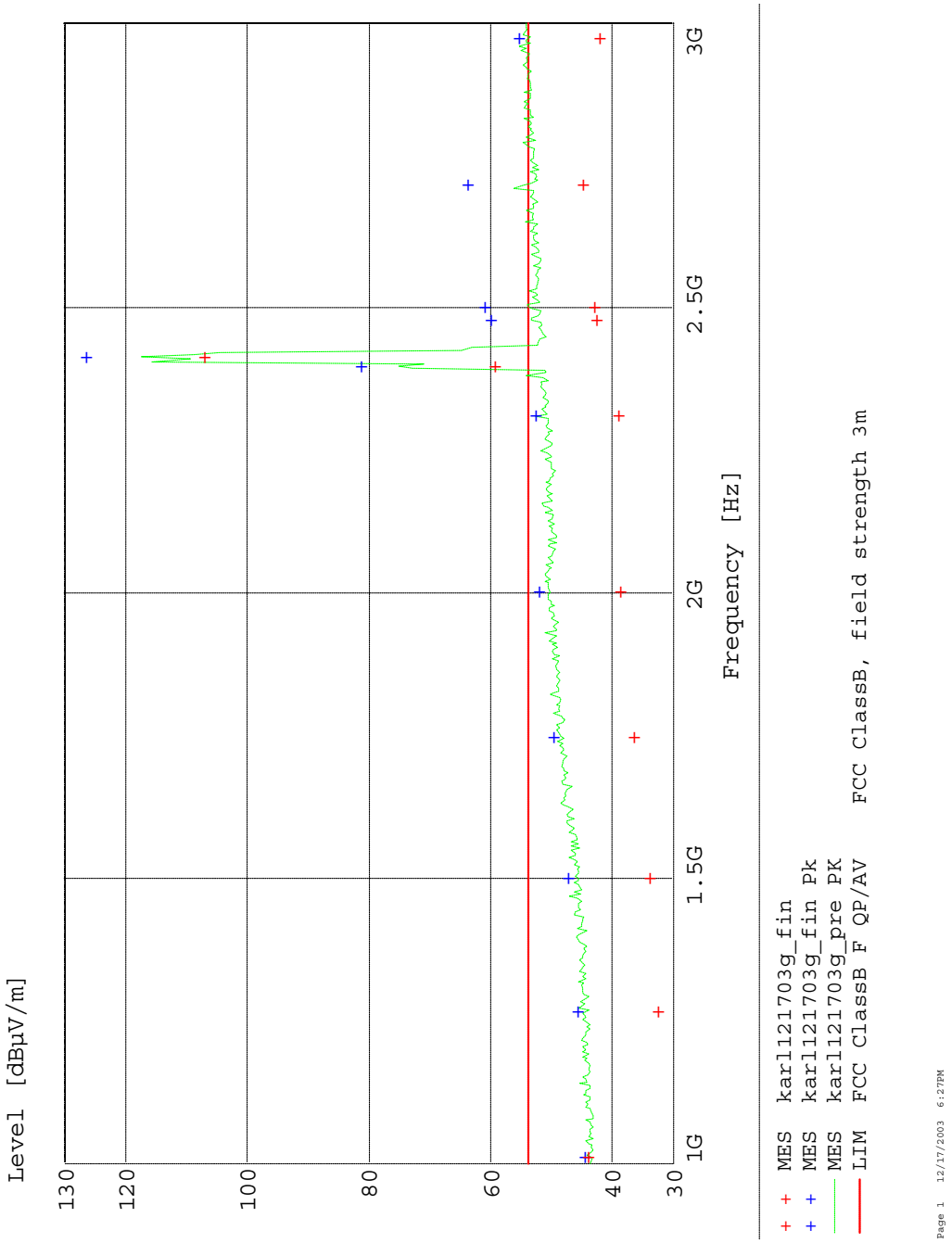

Figure 13 Channel 1 Radiated Emissions Plot

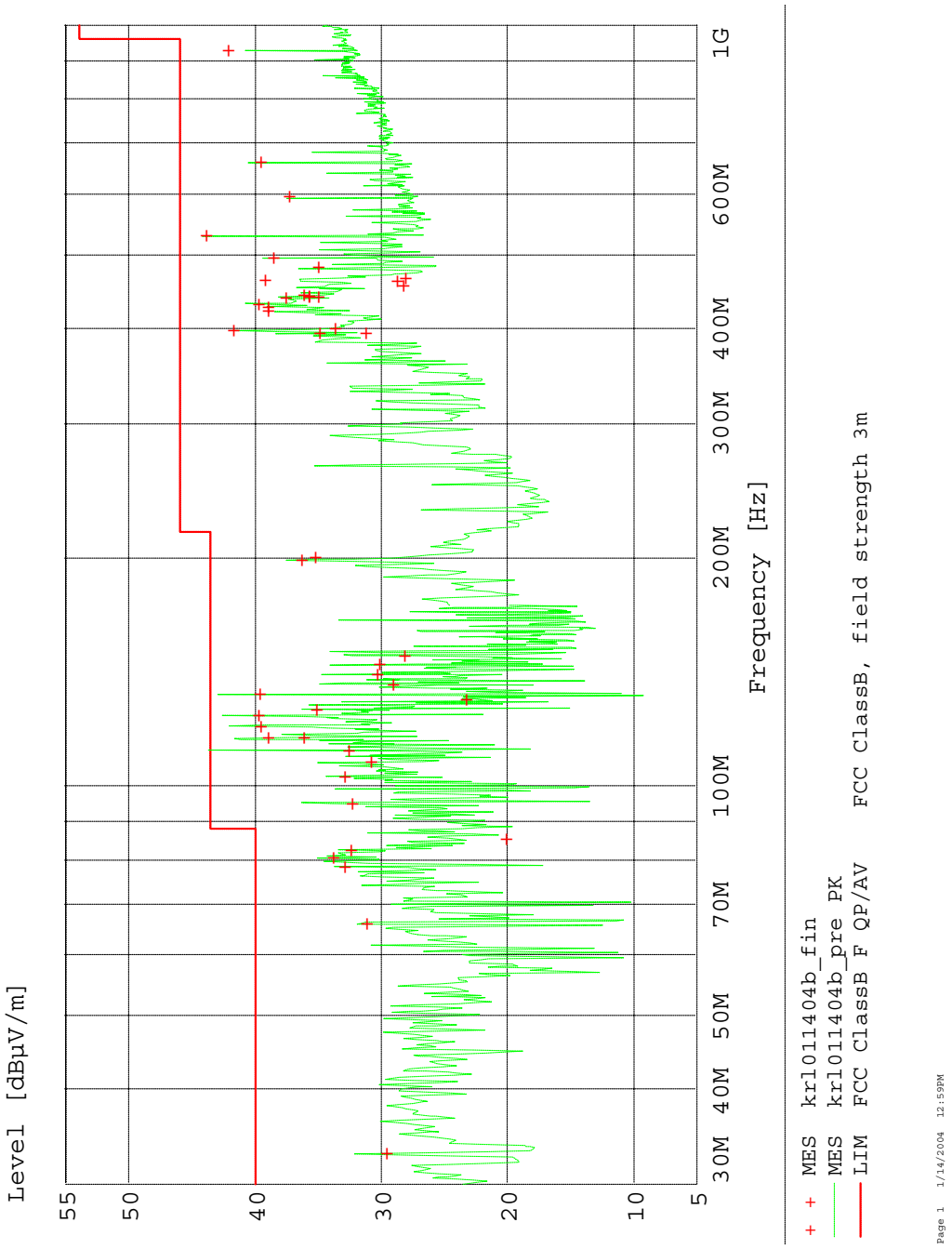

Figure 14 Channel 1 Radiated Emissions Plot

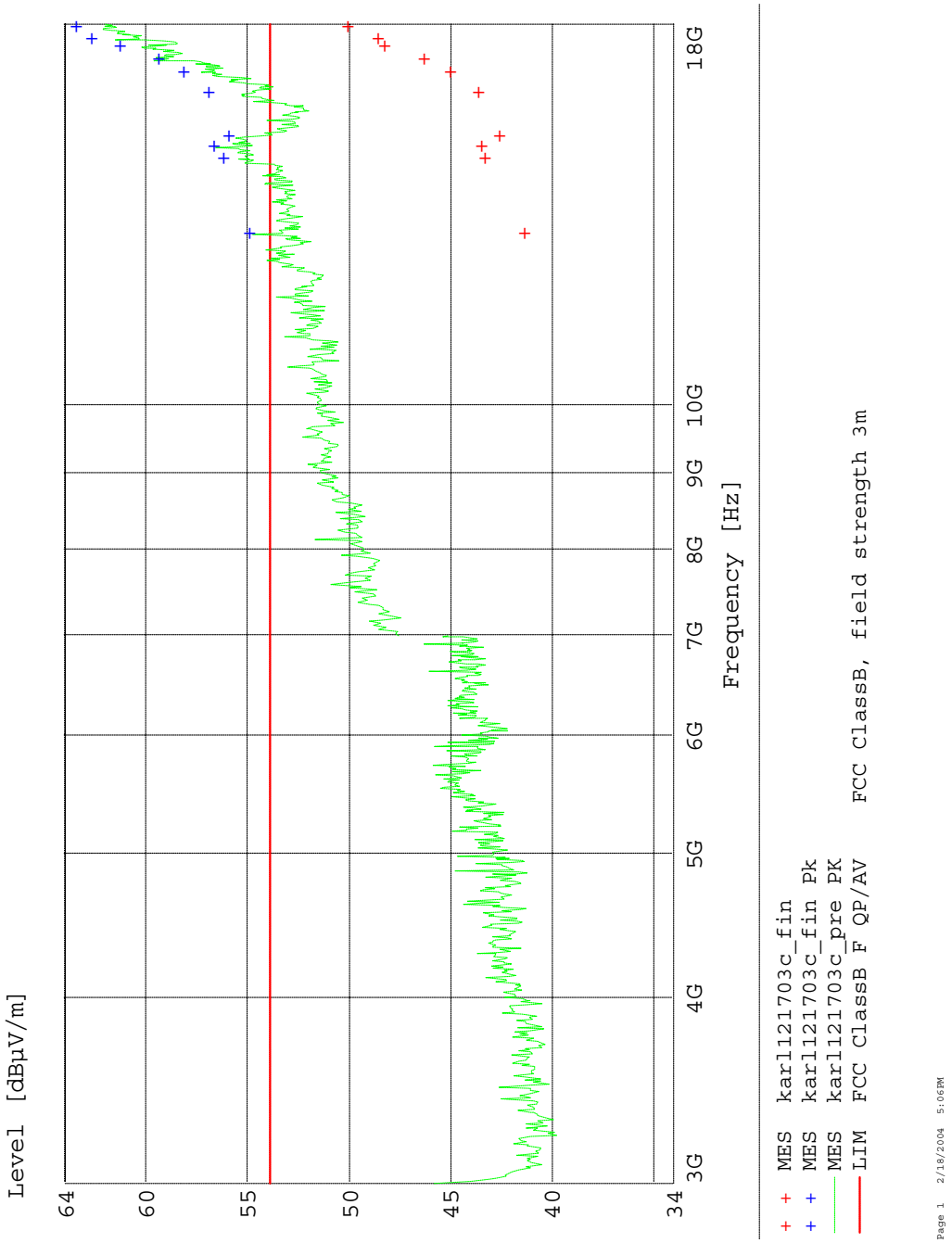

Figure 15 Channel 5 Radiated Emissions Plot

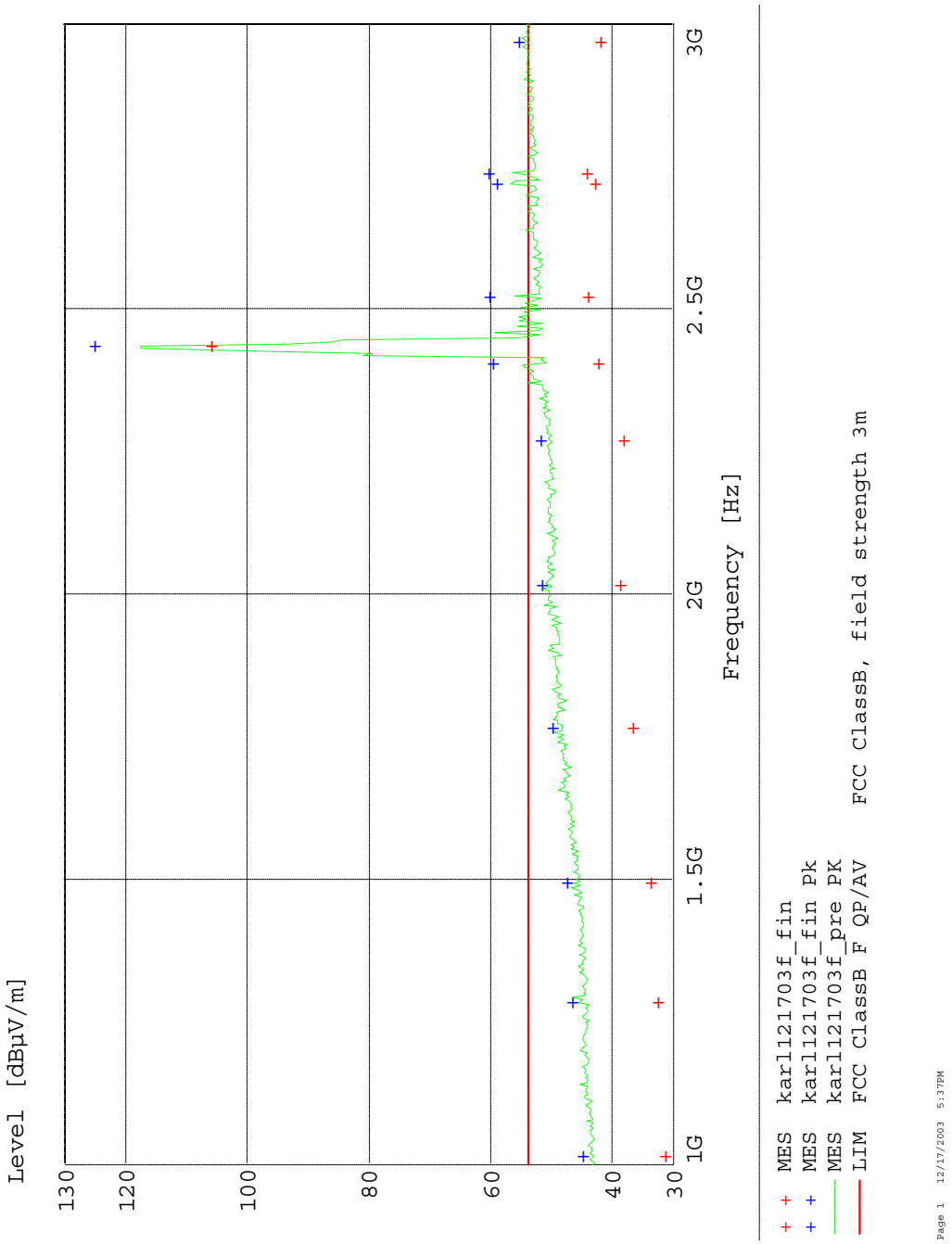

Figure 16 Channel 5 Radiated Emissions Plot

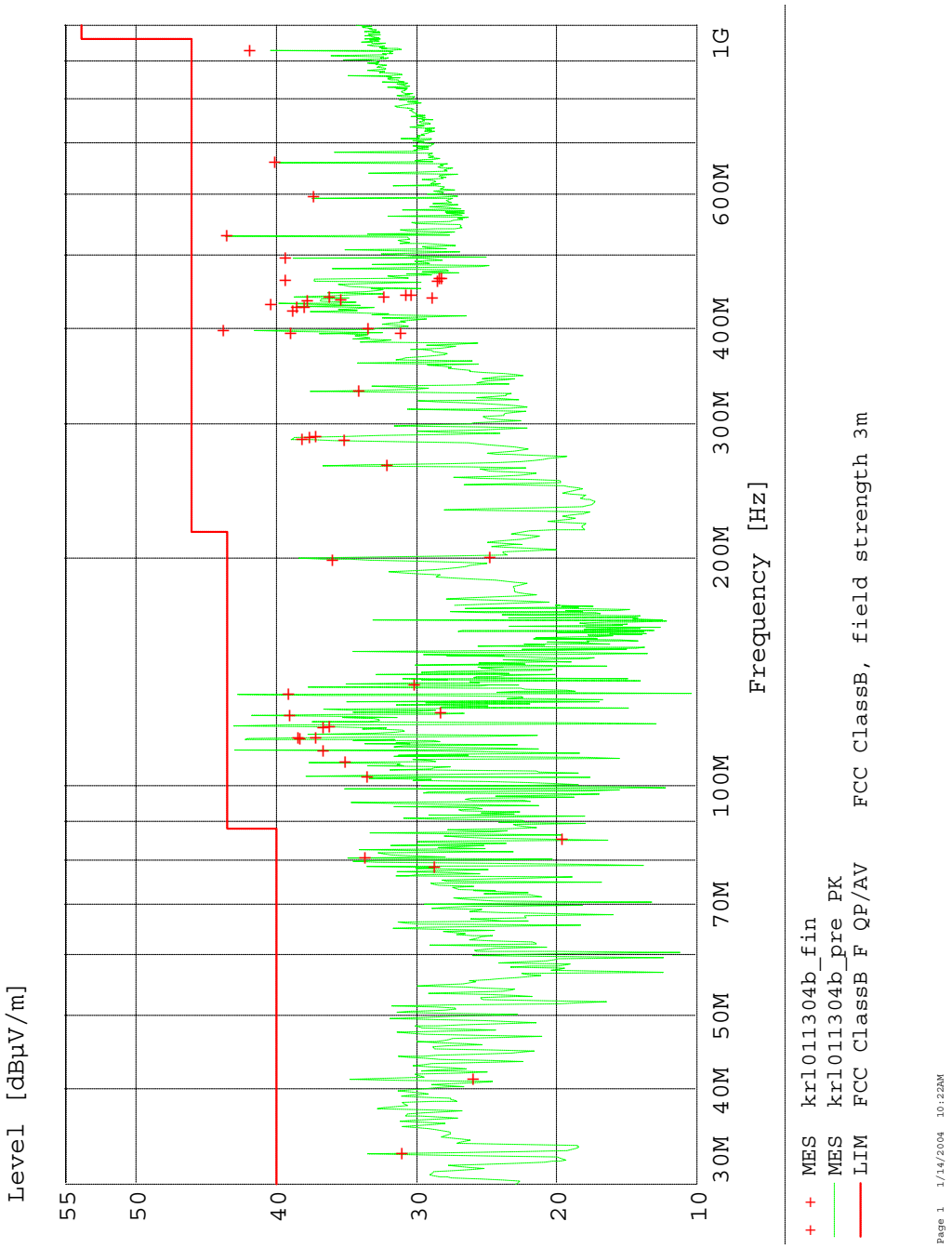

Figure 17 Channel 5 Radiated Emissions Plot

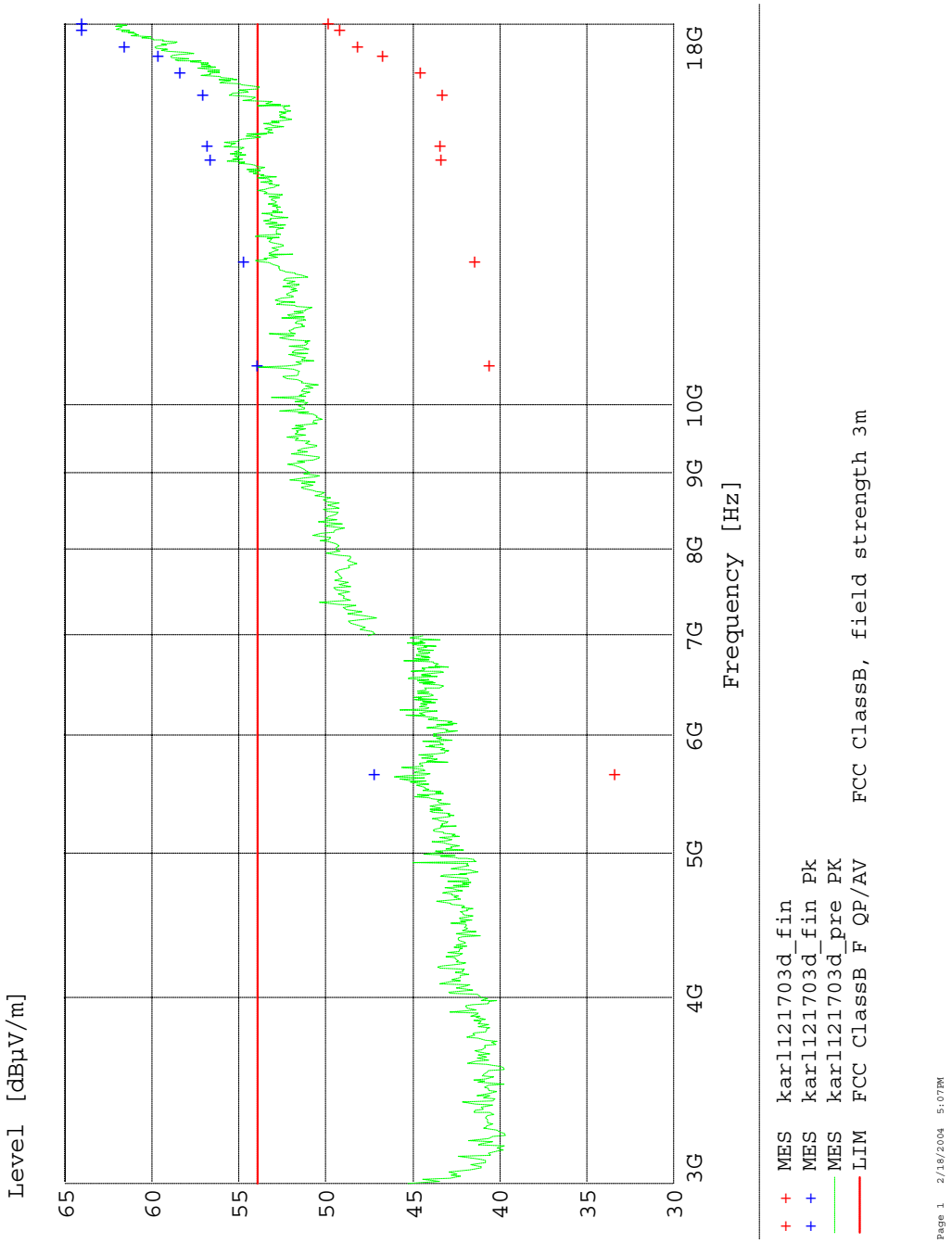

Figure 18 Channel 11 Radiated Emissions Plot

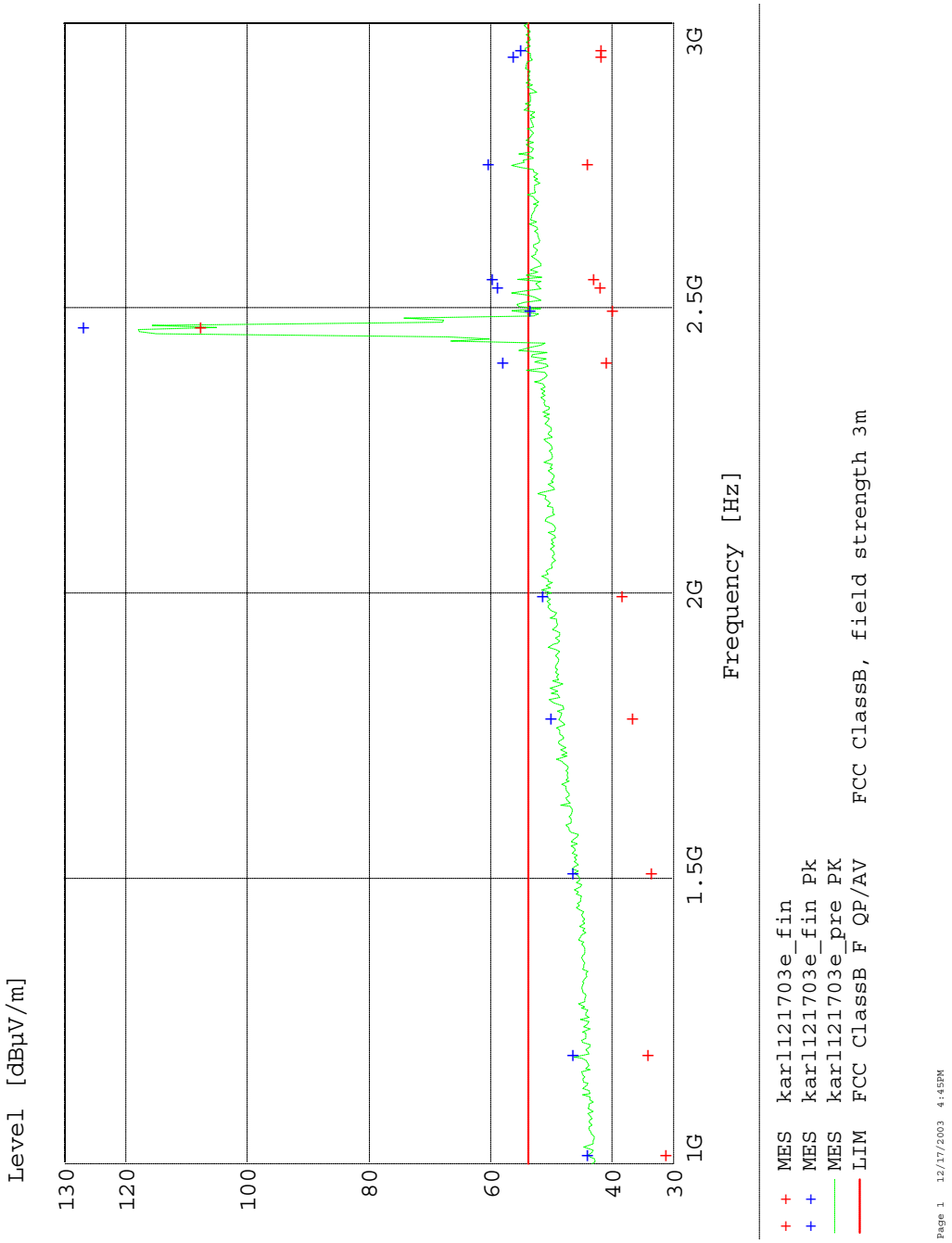

Figure 19 Channel 11 Radiated Emissions Plot

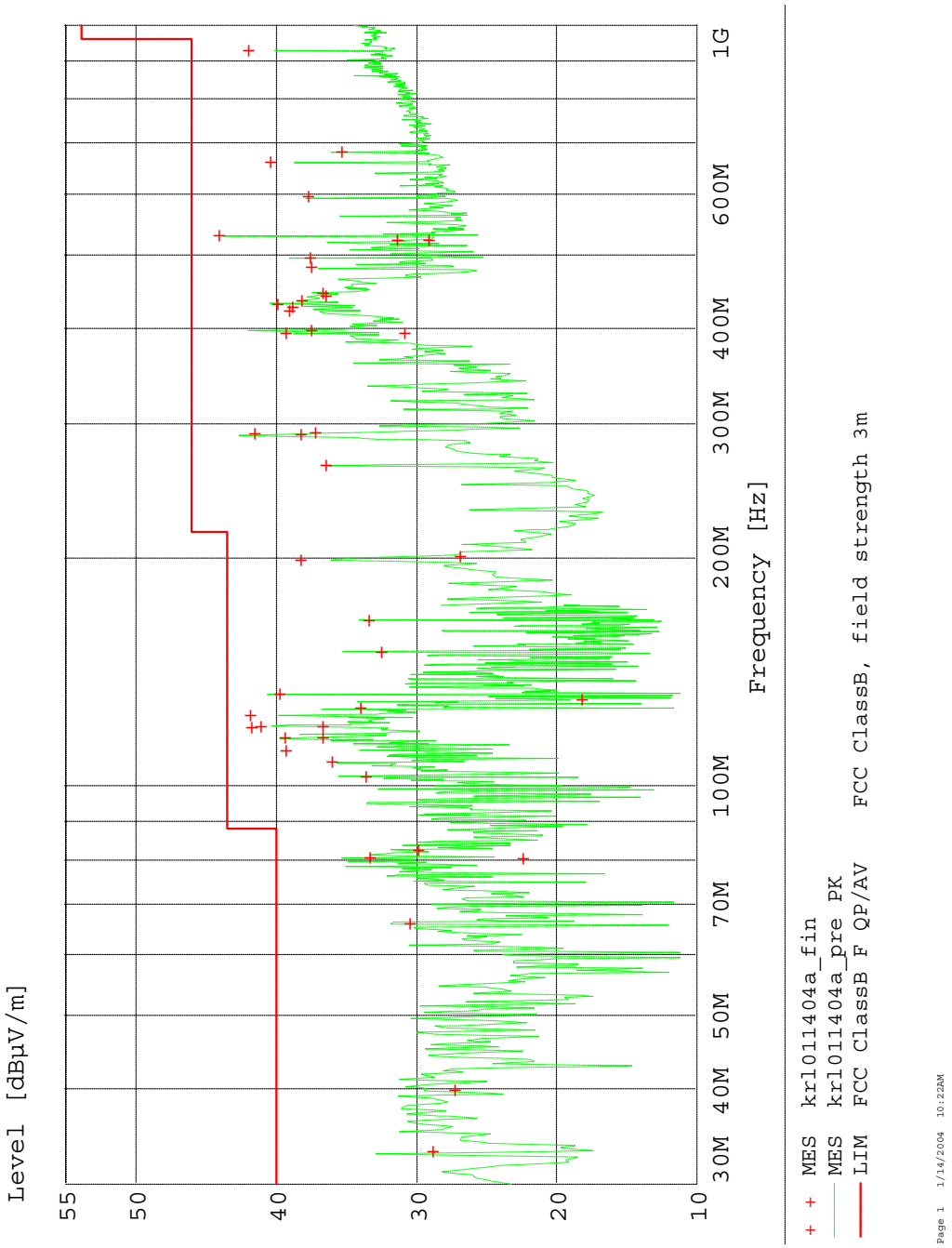

Figure 20 Channel 11 Radiated Emissions Plot

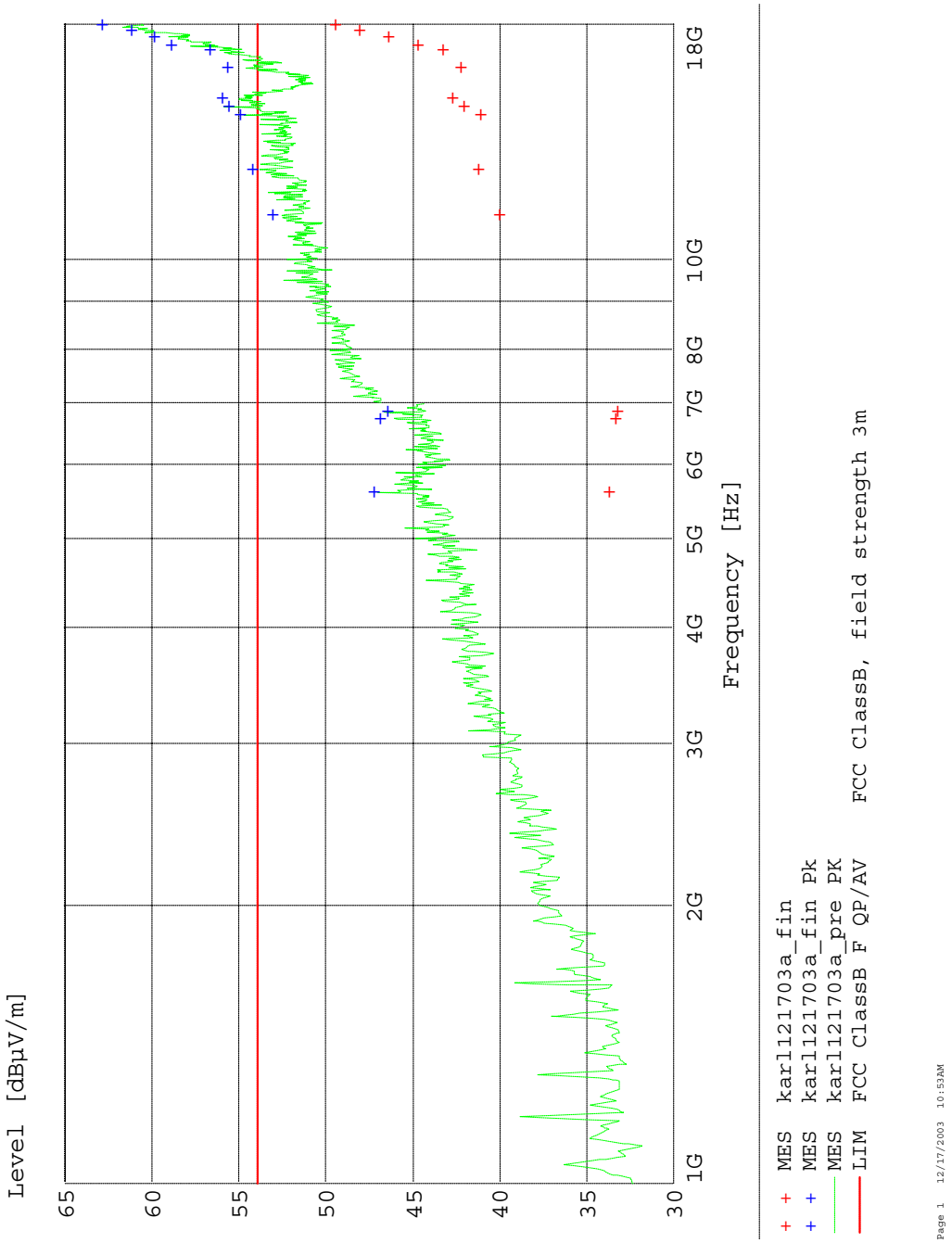

Figure 21 Receive Only Radiated Emissions Plot

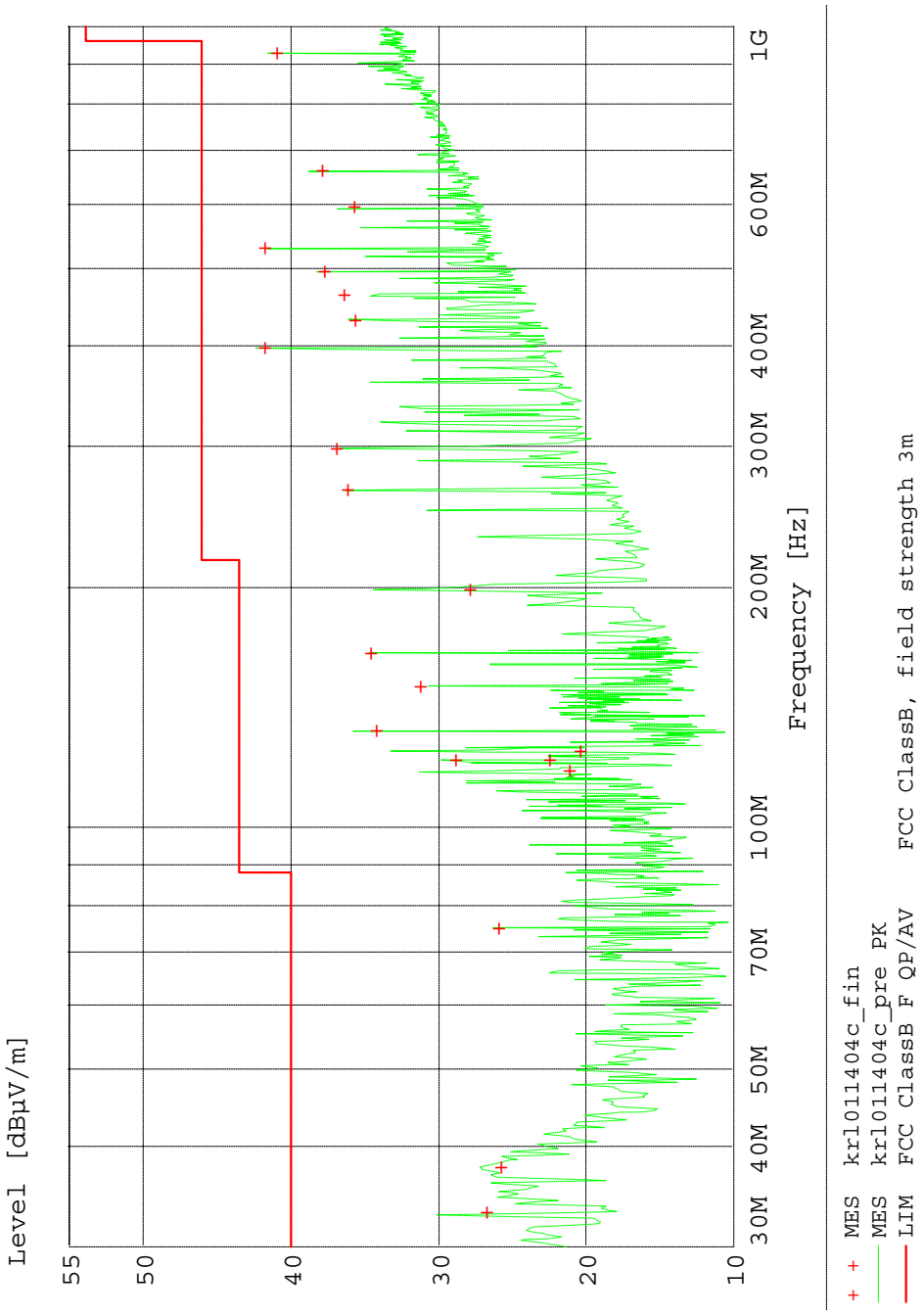

Figure 22 Receive Only Radiated Emissions Plot

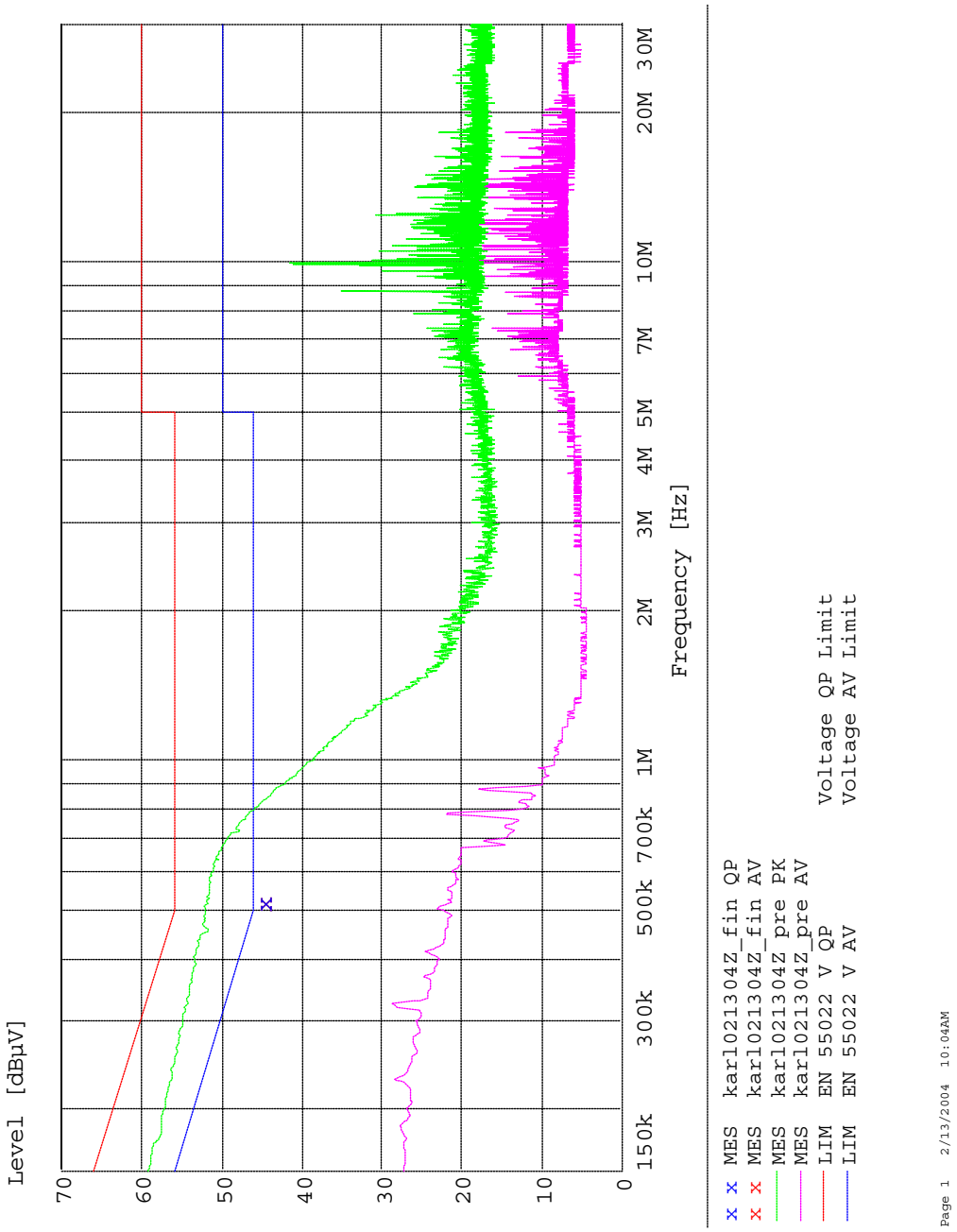

Figure 23 AC Mains Conducted Emissions Plot

Appendix C: Emissions Results, Receive, 3-Meter Measurement Distance

Receive Only QuasiPeak Results 30MHz – 1GHz

Frequency MHz	QuasiPeak Level dBµV/m	QuasiPeak Measured dBµV	Transd dB	Cables dB	Limit dBµV/m	Margin dB	Height cm	Angle deg	Pol.
33.06	26.95	9.94	16.4	-0.6	40	13.1	109	86	VERT
37.56	25.99	11.39	13.9	-0.7	40	14	107	265	VERT
75	26.11	18.26	6.8	-1.1	40	13.9	109	350	VERT
117.42	21.39	12.09	8	-1.4	43.5	22.1	98	190	VERT
121.38	22.77	13.74	7.6	-1.4	43.5	20.7	115	54	VERT
121.44	29.06	20.03	7.6	-1.4	43.5	14.4	150	272	VERT
124.74	20.55	11.69	7.4	-1.4	43.5	22.9	106	214	VERT
132.12	34.43	25.48	7.4	-1.5	43.5	9.1	100	351	VERT
150	31.43	21.03	8.8	-1.6	43.5	12.1	102	221	VERT
165.12	34.78	23.89	9.2	-1.7	43.5	8.7	188	319	HORI
198.12	28.1	15.63	10.7	-1.8	43.5	15.4	150	152	VERT
264.18	36.42	21.6	12.8	-2	46	9.6	185	80	VERT
297.18	37.14	21.74	13.2	-2.2	46	8.9	100	186	HORI
396.24	41.99	22.63	16.8	-2.6	46	4	125	268	VERT
429.3	35.87	16.47	16.8	-2.6	46	10.1	100	273	VERT
462.3	36.57	15.9	17.9	-2.7	46	9.4	99	275	VERT
495.3	37.92	16.57	18.5	-2.9	46	8.1	120	273	VERT
528.36	41.97	19.73	19.3	-2.9	46	4	99	300	VERT
594.42	35.96	12.64	20.2	-3.1	46	10	101	308	HORI
660.42	38.11	13.79	21	-3.3	46	7.9	204	274	VERT
924.6	41.17	13.65	23.5	-4	46	4.8	99	254	HORI

Receive Only Average Results 1GHz – 18GHz

Frequency MHz	Average Level dBµV/m	Average Measured dBµV	Transd dB	Cables dB	Limit dBµV/m	Margin dB	Height cm	Angle deg	Pol.
5594.5	33.84	15.61	36.5	18.2	53.9	20.1	165	358	VERT
6726.5	33.49	15.75	37.4	19.6	53.9	20.4	100	126	HORI
6837.5	33.37	15.42	37.6	19.6	53.9	20.5	278	312	HORI
11150.5	40.17	16.88	40.7	17.4	53.9	13.7	141	235	HORI
12517	41.35	16.64	41.3	16.6	53.9	12.6	314	346	VERT
14354.5	41.21	16.45	42.7	17.9	53.9	12.7	150	144	VERT
14639	42.18	16.51	42.9	17.3	53.9	11.7	150	42	HORI
14953	42.85	16.68	43	16.8	53.9	11	249	212	HORI
16136.5	42.33	18.67	40.4	16.7	53.9	11.6	379	139	HORI
16869	43.4	16.39	42.9	15.9	53.9	10.5	398	358	HORI
17071	44.86	16.38	43.7	15.2	53.9	9	327	287	VERT
17429	46.52	16.03	45.1	14.6	53.9	7.4	100	8	VERT
17691.5	48.25	16.44	46.2	14.4	53.9	5.6	350	29	VERT
17900.5	49.57	16.47	47.2	14.1	53.9	4.3	314	265	VERT

Receive Only Peak Results 1GHz – 18GHz

Frequency MHz	Peak Level dBµV/m	Peak Measured dBµV	Transd dB	Cables dB	Limit dBµV/m	Margin dB	Height cm	Angle deg	Pol.
5594.5	47.37	29.14	36.5	18.2	53.9	6.5	165	358	VERT
6726.5	46.99	29.25	37.4	19.6	53.9	6.9	100	126	HORI
6837.5	46.6	28.64	37.6	19.6	53.9	7.3	278	312	HORI
11150.5	53.19	29.9	40.7	17.4	53.9	0.7	141	235	HORI
12517	54.34	29.64	41.3	16.6	53.9	-0.4	314	346	VERT
14354.5	55.05	30.29	42.7	17.9	53.9	-1.1	150	144	VERT
14639	55.69	30.02	42.9	17.3	53.9	-1.8	150	42	HORI
14953	56.07	29.9	43	16.8	53.9	-2.2	249	212	HORI
16136.5	55.78	32.11	40.4	16.7	53.9	-1.9	379	139	HORI
16869	56.77	29.77	42.9	15.9	53.9	-2.9	398	358	HORI
17071	59.04	30.55	43.7	15.2	53.9	-5.1	327	287	VERT
17429	59.99	29.51	45.1	14.6	53.9	-6.1	100	8	VERT
17691.5	61.32	29.51	46.2	14.4	53.9	-7.4	350	29	VERT
17900.5	63	29.9	47.2	14.1	53.9	-9.1	314	265	VERT

Appendix D: Emissions Results, Transmit, 3-Meter Measurement Distance

Channel 1 QuasiPeak Results 30MHz-1GHz

Frequency MHz	QuasiPeak Level dBµV/m	QuasiPeak Measured dBµV	Transd dB	Cables dB	Limit dBµV/m	Margin dB	Height cm	Angle deg	Pol.
33	29.87	12.83	16.4	-0.6	40	10.1	107	266	VERT
66.06	31.41	23.45	7	-1	40	8.6	149	56	VERT
78.42	33.1	25.15	6.9	-1.1	40	6.9	100	335	VERT
80.52	34.01	26.01	6.9	-1.1	40	6	149	203	VERT
82.5	32.64	24.66	6.8	-1.1	40	7.4	112	186	VERT
85.02	20.34	12.39	6.8	-1.2	40	19.7	131	274	VERT
94.92	32.5	23.32	8	-1.2	43.5	11	100	204	VERT
103.14	33.15	23.29	8.7	-1.2	43.5	10.3	115	170	VERT
107.28	31.1	21.29	8.6	-1.2	43.5	12.4	105	64	VERT
111.36	32.85	23.21	8.4	-1.2	43.5	10.6	99	321	VERT
115.62	39.2	29.75	8.1	-1.3	43.5	4.3	100	340	VERT
115.68	36.43	26.98	8.1	-1.3	43.5	7.1	99	203	VERT
119.76	39.83	30.71	7.7	-1.4	43.5	3.7	101	198	VERT
123.84	39.95	31.05	7.5	-1.4	43.5	3.5	100	188	VERT
126.24	35.41	26.55	7.4	-1.5	43.5	8.1	117	227	VERT
130.02	23.5	14.6	7.4	-1.5	43.5	20	100	115	VERT
132.06	39.86	30.92	7.4	-1.5	43.5	3.6	100	204	VERT
136.14	29.38	20.24	7.6	-1.5	43.5	14.1	101	329	VERT
139.98	30.58	20.98	8.1	-1.5	43.5	12.9	112	193	VERT
144.42	30.36	20.54	8.3	-1.5	43.5	13.1	99	193	VERT
148.56	28.46	18.22	8.7	-1.6	43.5	15	99	206	VERT
198.12	36.59	24.11	10.7	-1.8	43.5	6.9	249	251	VERT
199.98	35.54	23.13	10.6	-1.8	43.5	8	251	252	VERT
393.48	31.51	12.31	16.7	-2.5	46	14.5	125	277	VERT
394.2	35.11	15.89	16.7	-2.5	46	10.9	109	285	VERT
396.3	41.94	22.57	16.8	-2.6	46	4.1	114	275	VERT
399	33.88	14.27	17	-2.6	46	12.1	109	270	VERT
420	39.24	19.84	16.8	-2.6	46	6.8	100	263	VERT
427.2	39.19	19.79	16.8	-2.6	46	6.8	103	269	VERT
429.3	39.94	20.54	16.8	-2.6	46	6.1	101	256	VERT
437.52	37.81	18.41	16.8	-2.6	46	8.2	100	268	VERT
438.54	36	16.56	16.8	-2.6	46	10	100	256	VERT
438.6	35.22	15.78	16.8	-2.6	46	10.8	100	287	VERT
440.04	35.95	16.45	16.9	-2.6	46	10	99	277	VERT
441.66	36.37	16.79	17	-2.6	46	9.6	101	268	VERT
459.48	28.96	8.36	17.9	-2.7	46	17	101	278	VERT
462.3	39.48	18.81	17.9	-2.7	46	6.5	99	278	VERT
479.94	35.18	13.98	18.4	-2.8	46	10.8	99	258	VERT
495.3	38.83	17.48	18.5	-2.9	46	7.2	100	262	VERT
528.36	44.18	21.95	19.3	-2.9	46	1.8	98	278	VERT
594.42	37.56	14.24	20.2	-3.1	46	8.4	99	305	HORI
660.42	39.84	15.52	21	-3.3	46	6.2	214	267	VERT
924.6	42.37	14.86	23.5	-4	46	3.6	100	244	HORI

Channel 1 Average Results 1GHz-18GHz

Frequency MHz	Average Level dBµV/m	Measured dBµV	Transd dB	Cables dB	Limit dBµV/m	Margin dB	Height cm	Angle deg	Pol.
1010	44.31	14.04	26.2	-4	53.9	9.6	150	224	VERT
1263.5	32.83	1.53	26.8	-4.5	53.9	21.1	250	18	HORI
1498.5	34.27	2.07	27.2	-5	53.9	19.6	115	354	VERT
1745	36.81	3.07	28.4	-5.4	53.9	17.1	398	160	HORI
2002.5	39.02	3.71	29.4	-5.9	53.9	14.9	100	156	VERT
2309.5	39.34	2.83	30.1	-6.4	53.9	14.6	100	242	HORI
2395.5	59.62	22.93	30.3	-6.4	53.9	-5.7	119	268	VERT
2413.5	107.39	70.61	30.3	-6.5	53.9	-53.5	106	270	VERT
2477	43.08	6.08	30.5	-6.5	53.9	10.8	106	268	VERT
2500	43.45	6.45	30.5	-6.5	53.9	10.5	99	270	VERT
2713.5	45.23	7.06	31.2	-7	53.9	8.7	107	270	VERT
2971	42.53	3.18	32	-7.3	53.9	11.4	119	270	HORI
4824	35.15	20.53	35.5	20.8	53.9	18.8	106	329	VERT
5514.5	33.4	15.42	36.4	18.4	53.9	20.5	169	36	VERT
5739	33.14	13.21	36.5	16.6	53.9	20.8	128	347	VERT
6994	33.78	14.32	37.9	18.4	53.9	20.1	398	337	HORI
12477	41.74	16.44	41.3	16	53.9	12.2	356	349	HORI
13702.5	41.47	16.05	42.2	16.7	53.9	12.4	393	269	VERT
14518.5	43.6	16.66	42.9	16	53.9	10.3	249	176	VERT
14738.5	43.57	16.82	42.9	16.2	53.9	10.3	356	115	HORI
14989	43.89	16.52	43	15.6	53.9	10	106	285	HORI
16166.5	43.77	18.56	40.5	15.3	53.9	10.1	249	210	VERT
16712	45.09	16.94	42.3	14.1	53.9	8.8	350	282	HORI
17089.5	46.95	16.04	43.8	12.9	53.9	7	399	0	VERT
17406	48.16	16	45	12.9	53.9	5.7	269	83	VERT
17831.5	49.5	15.64	46.9	13	53.9	4.4	250	24	HORI

Channel 1 Peak Results 1GHz-18GHz

Frequency MHz	Peak Level dBµV/m	Measured dBµV	Transd dB	Cables dB	Limit dBµV/m	Margin dB	Height cm	Angle deg	Pol.
1010	44.84	14.58	26.2	-4	74	29.2	150	224	VERT
1263.5	46.15	14.84	26.8	-4.5	74	27.9	250	18	HORI
1498.5	47.59	15.4	27.2	-5	74	26.4	115	354	VERT
1745	49.97	16.23	28.4	-5.4	74	24.0	398	160	HORI
2002.5	52.46	17.14	29.4	-5.9	74	21.5	100	156	VERT
2309.5	53	16.49	30.1	-6.4	74	21.0	100	242	HORI
2395.5	81.7	45.01	30.3	-6.4	74	-7.7	119	268	VERT
2413.5	126.73	89.95	30.3	-6.5	74	-52.7	106	270	VERT
2477	60.35	23.35	30.5	-6.5	74	13.7	106	268	VERT
2500	61.42	24.42	30.5	-6.5	74	12.6	99	270	VERT
2713.5	64.25	26.08	31.2	-7	74	9.8	107	270	VERT
2971	55.71	16.36	32	-7.3	74	18.3	119	270	HORI
4824	48.49	33.87	35.5	20.8	74	25.5	106	329	VERT
5514.5	46.88	28.9	36.4	18.4	74	27.1	169	36	VERT
5739	46.4	26.47	36.5	16.6	74	27.6	128	347	VERT
6994	47.33	27.87	37.9	18.4	74	26.7	398	337	HORI
12477	55.07	29.77	41.3	16	74	18.9	356	349	HORI
13702.5	54.93	29.51	42.2	16.7	74	19.1	393	269	VERT
14518.5	56.96	30.02	42.9	16	74	17.0	249	176	VERT
14738.5	56.91	30.16	42.9	16.2	74	17.1	356	115	HORI
14989	57.79	30.42	43	15.6	74	16.2	106	285	HORI
16166.5	57.2	31.99	40.5	15.3	74	16.8	249	210	VERT
16712	58.83	30.68	42.3	14.1	74	15.2	350	282	HORI
17089.5	60.16	29.25	43.8	12.9	74	13.8	399	0	VERT
17406	61.93	29.77	45	12.9	74	12.1	269	83	VERT
17831.5	63.1	29.25	46.9	13	74	10.9	250	24	HORI

Channel 5 QuasiPeak Results 30MHz – 1GHz

Frequency MHz	QuasiPeak Level dBµV/m	Measured dBµV	Transd dB	Cables dB	Limit dBµV/m	Margin dB	Height cm	Angle deg	Pol.
33	31.28	14.24	16.4	-0.6	40	8.7	101	240	VERT
41.22	26.2	13.28	12.2	-0.7	40	13.8	128	203	VERT
78.48	28.98	21.03	6.9	-1.1	40	11	99	340	VERT
80.52	33.89	25.89	6.9	-1.1	40	6.1	122	212	VERT
85.02	19.9	11.95	6.8	-1.2	40	20.1	109	273	VERT
103.14	33.76	23.9	8.7	-1.2	43.5	9.7	100	287	VERT
107.34	35.39	25.58	8.6	-1.2	43.5	8.1	102	78	VERT
111.48	36.9	27.26	8.4	-1.2	43.5	6.6	98	17	VERT
115.5	38.52	29.06	8.1	-1.3	43.5	5	100	310	VERT
115.56	37.48	28.02	8.1	-1.3	43.5	6	110	67	VERT
115.62	38.68	29.23	8.1	-1.3	43.5	4.8	100	0	VERT
119.64	36.93	27.8	7.7	-1.4	43.5	6.6	115	350	VERT
120	36.48	27.38	7.7	-1.4	43.5	7	100	350	VERT
123.78	39.3	30.39	7.5	-1.4	43.5	4.2	115	39	VERT
124.98	28.55	19.7	7.4	-1.5	43.5	14.9	99	198	VERT
132.12	39.38	30.44	7.4	-1.5	43.5	4.1	100	22	VERT
136.2	30.4	21.26	7.6	-1.5	43.5	13.1	117	301	VERT
198.12	36.21	23.74	10.7	-1.8	43.5	7.3	149	138	HORI
199.98	25.03	12.63	10.6	-1.8	43.5	18.5	150	137	HORI
264.24	32.33	17.5	12.8	-2	46	13.7	99	189	HORI
285	35.41	20.16	13.1	-2.1	46	10.6	100	29	HORI
286.02	38.43	23.21	13.1	-2.1	46	7.6	100	358	HORI
286.98	37.9	22.71	13.1	-2.1	46	8.1	99	359	HORI
288	37.39	22.23	13	-2.1	46	8.6	99	359	HORI
330.24	34.35	17.24	14.8	-2.3	46	11.6	100	167	HORI
393.48	31.41	12.21	16.7	-2.5	46	14.6	101	292	VERT
394.2	39.25	20.02	16.7	-2.5	46	6.8	114	275	VERT
396.24	44.01	24.64	16.8	-2.6	46	2	118	278	VERT
399	33.67	14.06	17	-2.6	46	12.3	112	271	VERT

Channel 5 QuasiPeak Results 30MHz – 1GHz (continued)

Frequency MHz	QuasiPeak Level dBµV/m	QuasiPeak Measured dBµV	Transd dB	Cables dB	Limit dBµV/m	Margin dB	Height cm	Angle deg	Pol.
420	39.12	19.72	16.8	-2.6	46	6.9	115	264	VERT
426.72	38.24	18.84	16.8	-2.6	46	7.8	112	273	VERT
427.2	38.75	19.35	16.8	-2.6	46	7.2	99	259	VERT
429.3	40.63	21.23	16.8	-2.6	46	5.4	99	263	VERT
434.46	38.07	18.76	16.7	-2.6	46	7.9	101	264	VERT
435.48	35.65	16.33	16.7	-2.6	46	10.3	99	266	VERT
437.04	29.19	9.81	16.8	-2.6	46	16.8	101	273	VERT
438.48	32.56	13.12	16.8	-2.6	46	13.4	100	269	VERT
438.54	36.48	17.03	16.8	-2.6	46	9.5	101	264	VERT
440.52	30.62	11.1	16.9	-2.6	46	15.4	103	268	VERT
442.08	31.05	11.45	17	-2.6	46	14.9	98	263	VERT
459.48	28.73	8.13	17.9	-2.7	46	17.3	99	280	VERT
462.3	39.55	18.88	17.9	-2.7	46	6.4	101	282	VERT
465.06	28.65	7.9	18	-2.8	46	17.4	99	280	VERT
465.12	28.48	7.73	18	-2.8	46	17.5	100	273	VERT
495.3	39.61	18.26	18.5	-2.9	46	6.4	125	261	VERT
528.36	43.78	21.54	19.3	-2.9	46	2.2	99	282	VERT
594.36	37.6	14.29	20.2	-3.1	46	8.4	100	303	HORI
660.42	40.33	16.01	21	-3.3	46	5.7	206	279	VERT
924.6	42.15	14.63	23.5	-4	46	3.9	101	242	HORI

Channel 5 Average Results 1GHz – 18GHz

Frequency MHz	Average Level dBµV/m	Measured dBµV	Transd dB	Cables dB	Limit dBµV/m	Margin dB	Height cm	Angle deg	Pol.
1011	31.67	1.39	26.2	-4	53.9	22.2	314	328	HORI
1283	32.9	1.51	26.8	-4.6	53.9	21	349	98	VERT
1492	34.2	2.02	27.2	-5	53.9	19.7	191	204	HORI
1762.5	37.04	3.18	28.4	-5.4	53.9	16.9	191	185	HORI
2015	39.03	3.67	29.4	-5.9	53.9	14.9	150	0	HORI
2267	38.63	2.28	30	-6.3	53.9	15.3	141	0	HORI
2403	42.59	5.87	30.3	-6.4	53.9	11.3	117	264	VERT
2433.5	106.22	69.32	30.4	-6.5	53.9	-52.3	119	268	VERT
2518.5	44.37	7.23	30.6	-6.6	53.9	9.5	106	273	VERT
2719	43.14	4.93	31.2	-7	53.9	10.8	119	271	VERT
2734.5	44.53	6.2	31.3	-7	53.9	9.4	99	271	VERT
2967	42.4	3.06	32	-7.3	53.9	11.5	227	18	HORI
2988	34.9	19	32.1	16.2	53.9	19	278	143	HORI
13020.5	41.44	15.82	42	16.4	53.9	12.5	356	237	HORI
14599	43.4	16.33	42.9	15.8	53.9	10.5	250	58	VERT
14886	43.58	16.28	43	15.7	53.9	10.3	169	222	VERT
15111.5	42.69	16.79	42.4	16.5	53.9	11.2	249	121	VERT
16158.5	43.76	18.57	40.4	15.3	53.9	10.1	178	340	HORI
16703	45.1	16.98	42.2	14.1	53.9	8.8	249	305	VERT
17020	46.42	16.68	43.5	13.7	53.9	7.5	349	176	HORI
17383	48.37	16.21	44.9	12.8	53.9	5.5	398	330	VERT
17600	48.69	16.45	45.8	13.6	53.9	5.2	165	70	VERT
17879.5	50.21	16.26	47.1	13.1	53.9	3.7	249	337	HORI

Channel 5 Peak Results 1GHz – 18GHz

Frequency MHz	Peak Level dBµV/m	Measured dBµV	Transd dB	Cables dB	Limit dBµV/m	Margin dB	Height cm	Angle deg	Pol.
1011	45.25	14.98	26.2	-4	74	28.8	314	328	HORI
1283	46.92	15.54	26.8	-4.6	74	27.1	349	98	VERT
1492	47.85	15.68	27.2	-5	74	26.2	191	204	HORI
1762.5	50.22	16.36	28.4	-5.4	74	23.8	191	185	HORI
2015	51.99	16.62	29.4	-5.9	74	22.0	150	0	HORI
2267	52.17	15.82	30	-6.3	74	21.8	141	0	HORI
2403	60.06	23.35	30.3	-6.4	74	13.9	117	264	VERT
2433.5	125.51	88.61	30.4	-6.5	74	-51.5	119	268	VERT
2518.5	60.48	23.35	30.6	-6.6	74	13.5	106	273	VERT
2719	59.38	21.17	31.2	-7	74	14.6	119	271	VERT
2734.5	60.76	22.44	31.3	-7	74	13.2	99	271	VERT
2967	55.83	16.49	32	-7.3	74	18.2	227	18	HORI
2988	48.19	32.29	32.1	16.2	74	25.8	278	143	HORI
13020.5	55	29.38	42	16.4	74	19.0	356	237	HORI
14599	56.33	29.25	42.9	15.8	74	17.7	250	58	VERT
14886	56.8	29.51	43	15.7	74	17.2	169	222	VERT
15111.5	56.06	30.16	42.4	16.5	74	17.9	249	121	VERT
16158.5	57.05	31.86	40.4	15.3	74	17.0	178	340	HORI
16703	58.28	30.16	42.2	14.1	74	15.7	249	305	VERT
17020	59.5	29.77	43.5	13.7	74	14.5	349	176	HORI
17383	61.41	29.25	44.9	12.8	74	12.6	398	330	VERT
17600	62.79	30.55	45.8	13.6	74	11.2	165	70	VERT
17879.5	63.59	29.64	47.1	13.1	74	10.4	249	337	HORI

Channel 11 QuasiPeak Results 30MHz – 1GHz

Frequency MHz	QuasiPeak Level dBµV/m	Measured dBµV	Transd dB	Cables dB	Limit dBµV/m	Margin dB	Height cm	Angle deg	Pol.
33.06	29.07	12.06	16.4	-0.6	40	10.9	109	165	VERT
39.9	27.45	14	12.7	-0.7	40	12.6	99	268	VERT
66.06	30.66	22.7	7	-1	40	9.3	99	31	VERT
80.28	22.64	14.64	6.9	-1.1	40	17.4	146	190	VERT
80.52	33.55	25.56	6.9	-1.1	40	6.4	99	271	VERT
82.5	30.12	22.15	6.8	-1.1	40	9.9	146	270	VERT
103.2	33.84	23.98	8.7	-1.2	43.5	9.7	99	238	VERT
107.34	36.25	26.45	8.6	-1.2	43.5	7.2	100	208	VERT
111.42	39.54	29.89	8.4	-1.2	43.5	4	99	217	VERT
115.62	39.58	30.13	8.1	-1.3	43.5	3.9	101	319	VERT
115.68	36.86	27.42	8.1	-1.3	43.5	6.6	100	323	VERT
119.7	42	32.88	7.7	-1.4	43.5	1.5	99	39	VERT
119.76	41.35	32.23	7.7	-1.4	43.5	2.1	100	352	VERT
120	36.92	27.82	7.7	-1.4	43.5	6.6	100	0	VERT
123.78	42.08	33.16	7.5	-1.4	43.5	1.4	150	337	VERT
126.3	34.26	25.4	7.4	-1.5	43.5	9.2	99	216	VERT
129.9	18.48	9.58	7.4	-1.5	43.5	25	113	120	VERT
132.06	39.96	31.02	7.4	-1.5	43.5	3.5	98	186	VERT
150	32.73	22.33	8.8	-1.6	43.5	10.8	101	359	VERT
165.12	33.59	22.69	9.2	-1.7	43.5	9.9	100	321	VERT
198.12	38.45	25.97	10.7	-1.8	43.5	5.1	150	299	HORI
200.04	27.11	14.71	10.6	-1.8	43.5	16.4	168	299	HORI
264.18	36.66	21.84	12.8	-2	46	9.3	101	182	HORI
288.96	38.48	23.35	13	-2.1	46	7.5	99	356	HORI
289.98	41.72	26.62	13	-2.1	46	4.3	101	9	HORI
291	37.4	22.27	13	-2.1	46	8.6	100	351	HORI
393.48	31.11	11.9	16.7	-2.5	46	14.9	100	287	VERT
394.2	39.51	20.28	16.7	-2.5	46	6.5	115	277	VERT
396.3	37.73	18.36	16.8	-2.6	46	8.3	99	27	HORI
420	39.26	19.86	16.8	-2.6	46	6.7	101	262	VERT
427.2	39.08	19.68	16.8	-2.6	46	6.9	100	268	VERT
429.3	40.14	20.74	16.8	-2.6	46	5.9	100	280	VERT
434.46	38.43	19.11	16.7	-2.6	46	7.6	99	268	VERT
440.04	36.66	17.16	16.9	-2.6	46	9.3	100	269	VERT
445.38	36.91	17.14	17.1	-2.7	46	9.1	100	273	VERT
480	37.73	16.53	18.4	-2.8	46	8.3	101	258	VERT
495.36	37.81	16.46	18.5	-2.9	46	8.2	102	240	VERT
519.9	31.54	9.44	19.2	-2.9	46	14.5	135	249	VERT
528.36	44.3	22.07	19.3	-2.9	46	1.7	98	277	VERT
594.36	37.93	14.62	20.2	-3.1	46	8.1	100	305	HORI
660.42	40.65	16.34	21	-3.3	46	5.3	201	275	VERT
682.02	35.52	10.38	21.8	-3.3	46	10.5	185	268	VERT
924.6	42.21	14.69	23.5	-4	46	3.8	100	246	HORI

Channel 11 Average Results 1GHz – 18GHz

Frequency MHz	Average Level dBµV/m	Measured dBµV	Transd dB	Cables dB	Limit dBµV/m	Margin dB	Height cm	Angle deg	Pol.
1011.5	31.62	1.35	26.2	-4	53.9	22.3	268	183	HORI
1188.5	34.57	3.56	26.6	-4.4	53.9	19.3	100	219	VERT
1508	34.17	1.93	27.2	-5	53.9	19.7	398	12	HORI
1778	37.09	3.13	28.5	-5.5	53.9	16.8	398	213	VERT
1993.5	38.82	3.57	29.4	-5.9	53.9	15.1	150	121	HORI
2402.5	41.35	4.63	30.3	-6.4	53.9	12.6	115	271	VERT
2463.5	108.11	71.11	30.4	-6.6	53.9	-54.2	107	269	VERT
2492	40.49	3.49	30.5	-6.5	53.9	13.4	250	356	HORI
2532.5	42.5	5.26	30.6	-6.6	53.9	11.4	100	271	VERT
2548.5	43.62	6.26	30.7	-6.7	53.9	10.3	99	271	VERT
2749.5	44.67	6.24	31.3	-7.1	53.9	9.2	99	269	VERT
2938.5	42.4	3.22	31.9	-7.3	53.9	11.5	369	218	VERT
2949	42.33	3.09	31.9	-7.3	53.9	11.6	156	14	HORI
5632.5	33.51	14.19	36.5	17.2	53.9	20.4	100	286	HORI
10600	40.74	16.4	40.6	16.3	53.9	13.2	201	97	HORI
12459.5	41.59	16.48	41.2	16.1	53.9	12.3	349	359	VERT
14575.5	43.52	16.48	42.9	15.9	53.9	10.4	106	195	VERT
14890.5	43.6	16.28	43	15.7	53.9	10.3	150	288	VERT
16116	43.48	18.41	40.3	15.3	53.9	10.4	115	322	HORI
16652	44.73	16.69	42	14	53.9	9.2	149	242	VERT
17085.5	46.89	16.05	43.7	12.9	53.9	7	150	112	HORI
17370	48.38	16.24	44.9	12.8	53.9	5.5	249	214	VERT
17800	49.33	15.55	46.7	12.9	53.9	4.6	149	117	VERT
17970.5	50.01	15.6	47.5	13.1	53.9	3.9	314	172	VERT

Channel 11 Peak Results 1GHz – 18GHz

Frequency MHz	Peak Level dBµV/m	Measured dBµV	Transd dB	Cables dB	Limit dBµV/m	Margin dB	Height cm	Angle deg	Pol.
1011.5	44.58	14.31	26.2	-4	74	29.4	268	183	HORI
1188.5	47.1	16.1	26.6	-4.4	74	26.9	100	219	VERT
1508	47.08	14.84	27.2	-5	74	26.9	398	12	HORI
1778	50.58	16.62	28.5	-5.5	74	23.4	398	213	VERT
1993.5	51.87	16.62	29.4	-5.9	74	22.1	150	121	HORI
2402.5	58.39	21.68	30.3	-6.4	74	15.6	115	271	VERT
2463.5	127.42	90.42	30.4	-6.6	74	-53.4	107	269	VERT
2492	54.01	17.01	30.5	-6.5	74	20.0	250	356	HORI
2532.5	59.3	22.06	30.6	-6.6	74	14.7	100	271	VERT
2548.5	60.18	22.82	30.7	-6.7	74	13.8	99	271	VERT
2749.5	60.87	22.44	31.3	-7.1	74	13.1	99	269	VERT
2938.5	56.72	17.55	31.9	-7.3	74	17.3	369	218	VERT
2949	55.6	16.36	31.9	-7.3	74	18.4	156	14	HORI
5632.5	47.32	28	36.5	17.2	74	26.7	100	286	HORI
10600	54.11	29.77	40.6	16.3	74	19.9	201	97	HORI
12459.5	54.87	29.77	41.2	16.1	74	19.1	349	359	VERT
14575.5	56.8	29.77	42.9	15.9	74	17.2	106	195	VERT
14890.5	56.96	29.64	43	15.7	74	17.0	150	288	VERT
16116	57.18	32.11	40.3	15.3	74	16.8	115	322	HORI
16652	58.59	30.55	42	14	74	15.4	149	242	VERT
17085.5	59.83	28.99	43.7	12.9	74	14.2	150	112	HORI
17370	61.77	29.64	44.9	12.8	74	12.2	249	214	VERT
17800	64.21	30.42	46.7	12.9	74	9.8	149	117	VERT
17970.5	64.18	29.77	47.5	13.1	74	9.8	314	172	VERT

Appendix E: 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 dBμV/m

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

Level in μV/m = Common Antilogarithm [(48.1 dBμV/m)/20]= 254.1 μV/m

Appendix F: Bandedge and Conducted Power Measurements

The following pages contain information about the signal of interest in relation to the restricted bands of 2.31GHz to 2.39GHz and 2.4835GHz to 2.5GHz.

	Radiated		Radiated	
Channel	Peak (dBuV/m)	Fig.	Average (dBuV/m)	Fig.
1	127.39	26	116.71	29
11	128.53	38	118.29	41

	Conducted Peak					
Channel	100kHz RBW (dBm)	Fig.	RestBand (dBm)	Fig.	Freq (Ghz)	1MHz RBW(dBm)
1	3.46	27	-62.3	27	2.3896	9.77
11	4.53	39	-60.17	39	2.4875	10.35

	Conducted Average					
Channel	100kHz RBW (dBm)	Fig.	RestBand (dBm)	Fig.	Freq (Ghz)	1MHz RBW (dBm)
1	-1.98	30	-68.29	30	2.3872	3.72
11	-2.18	42	-67.07	42	2.4877	3.85

	Delta dB		
Channel	Peak (dB)		Average (dB)
1	65.76		66.31
11	64.70		64.89

	Mhz from BandEdge		
Channel	Peak (Mhz)		Average (Mhz)
1	0.40		2.80
11	4.00		4.20

	BW Delta dB (1MHz vs 100kHz)		
Channel	Peak (dB)		Average (dB)
1	6.31		0.00
11	0.00		0.00

	Restricted Band Calculated Values (dBuV/m)		
Channel	Peak		Average
1	55.32		50.40
11	63.83		53.40

	Restricted Bands	
	Freq (Ghz)	
	Miniumum	Maximum
Lower	2.3100	2.3900
Upper	2.4835	2.5000

	Limits (dBuV/m)
Average	54
Peak	74

Conducted and radiated average measurements were taken with a VBW=2 * ($1/T_0$) where T_0 is the on time of the signal being measured. This is done because the EUT did not have a continuous RF on mode of operation. The signals shown in Figures 24 and 25 of this Appendix show provide the duty cycle information used to make the determination of T_0.

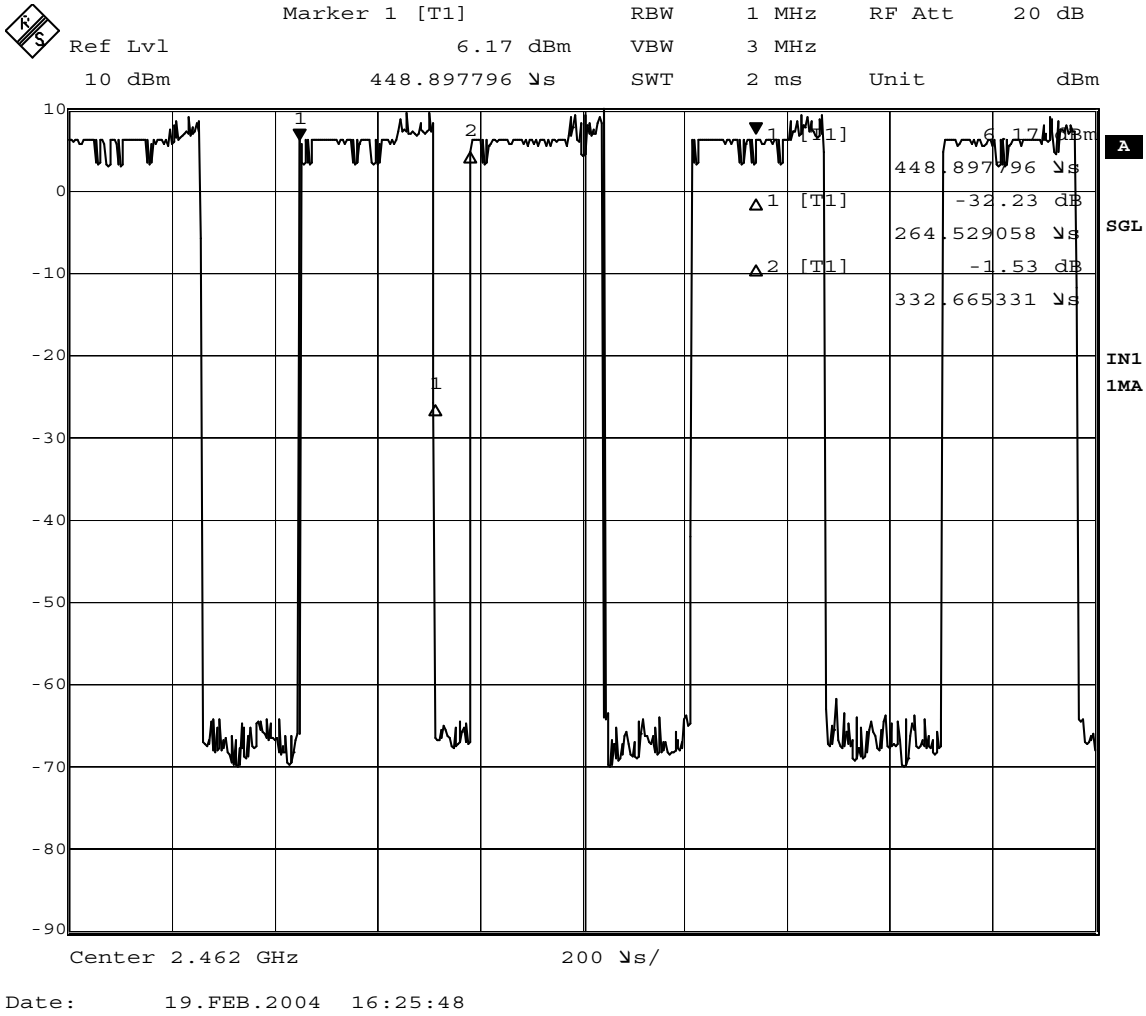

Figure 24 Duty cycle information 2ms window

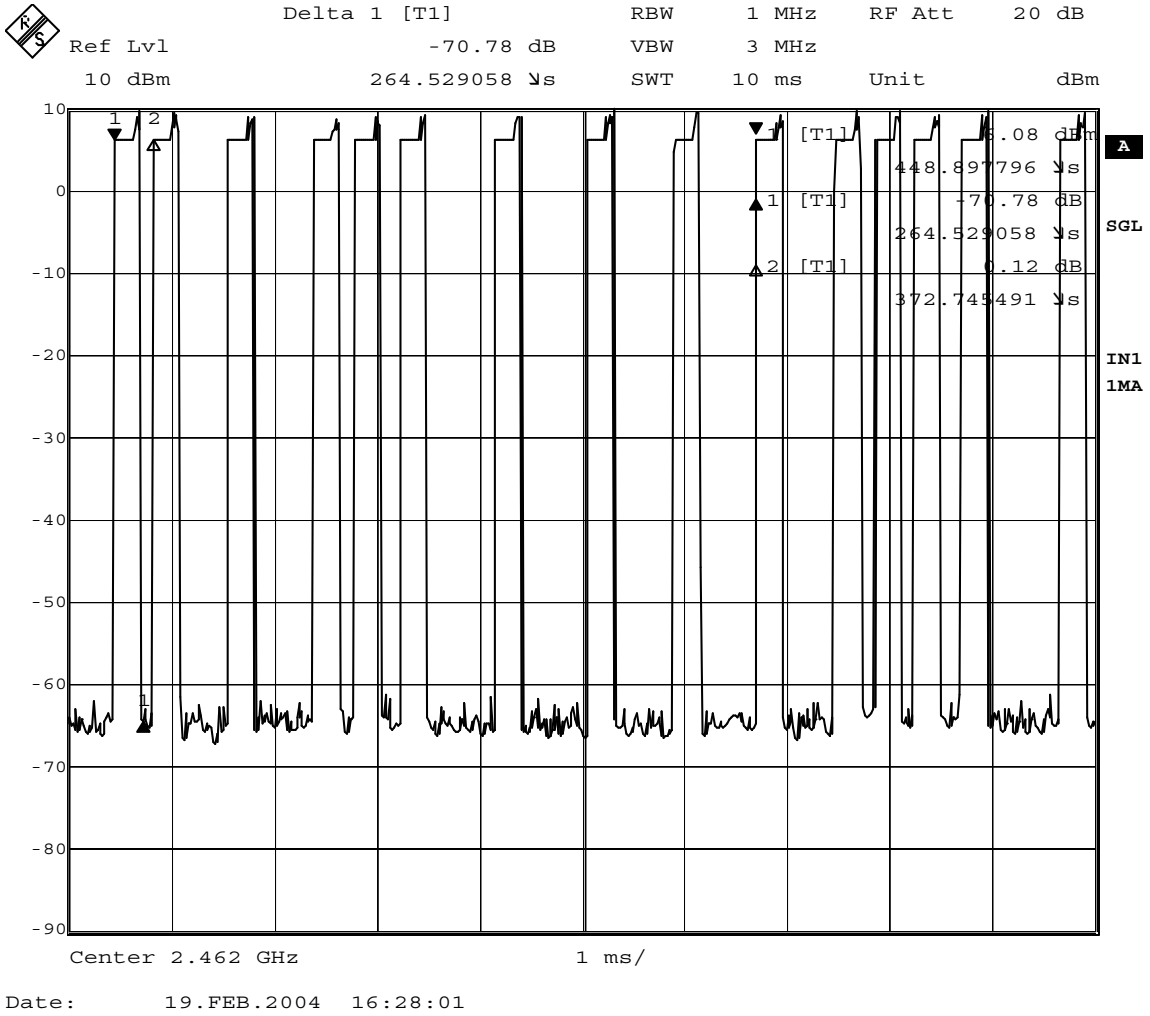

Figure 25 Duty cycle information 10ms window

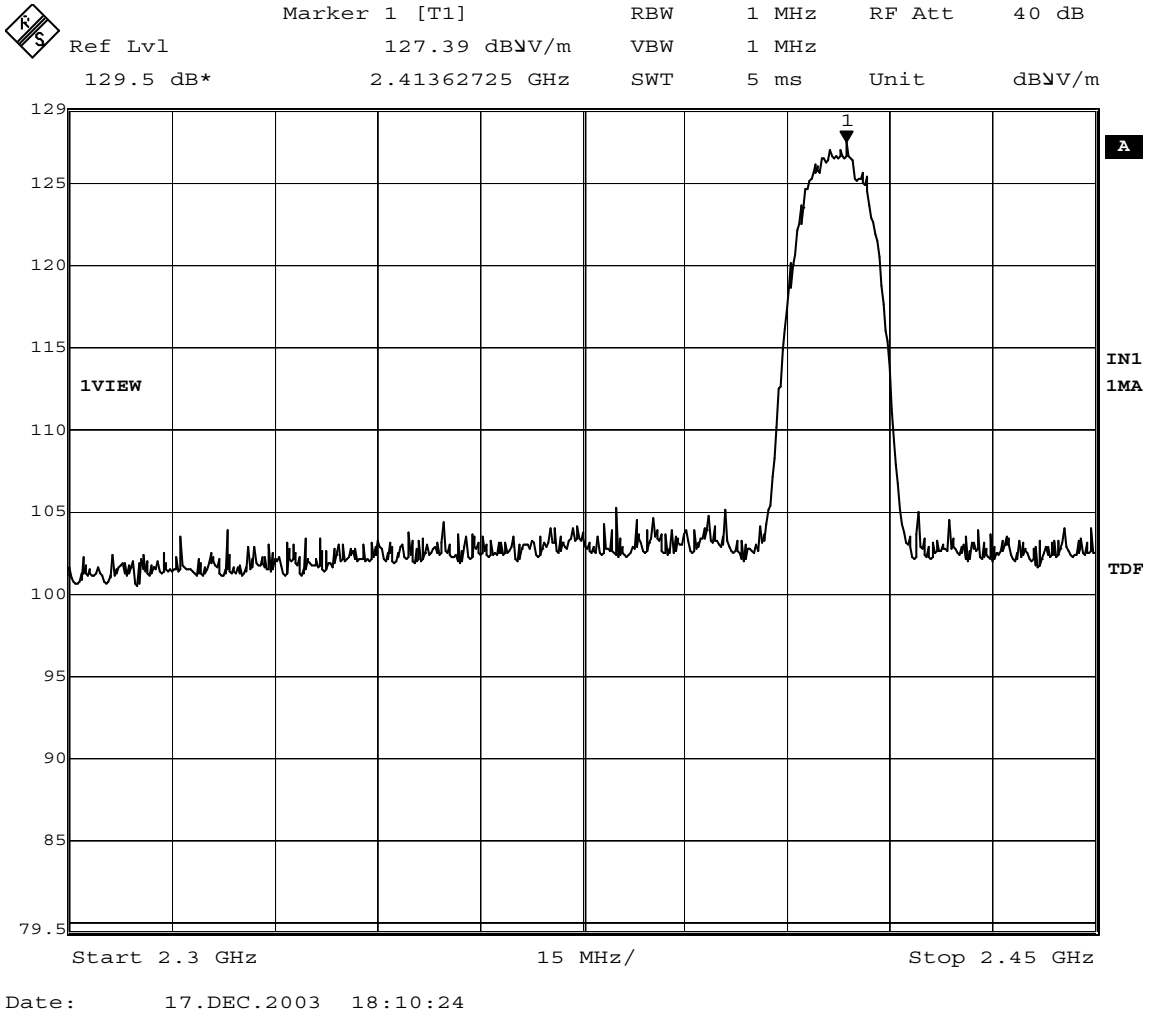

Figure 26 Channel 1 Radiated Peak Plot RBW=VBW=1MHz

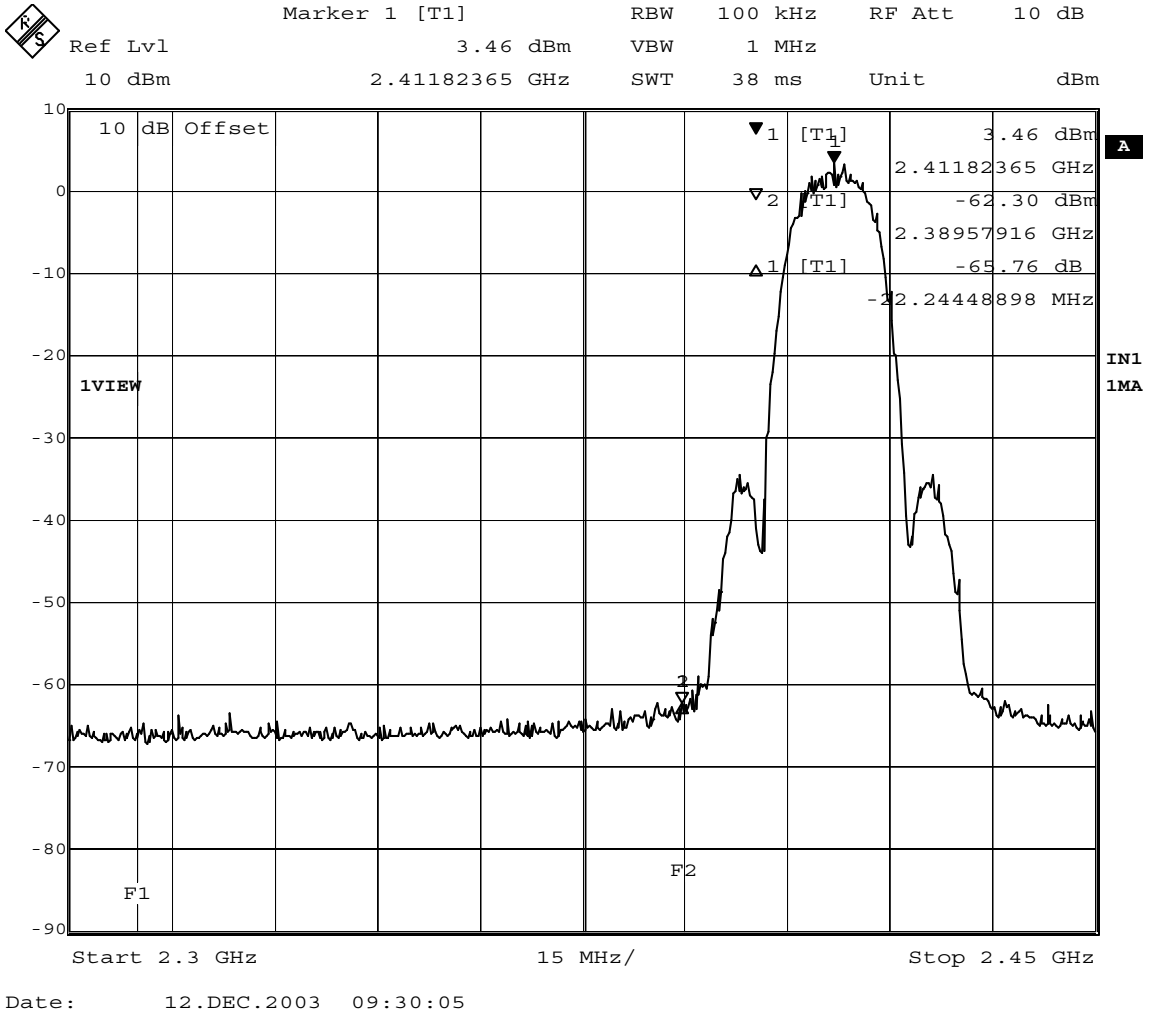

Figure 27 Channel 1 Conducted Peak Plot RBW=100kHz, VBW=1MHz

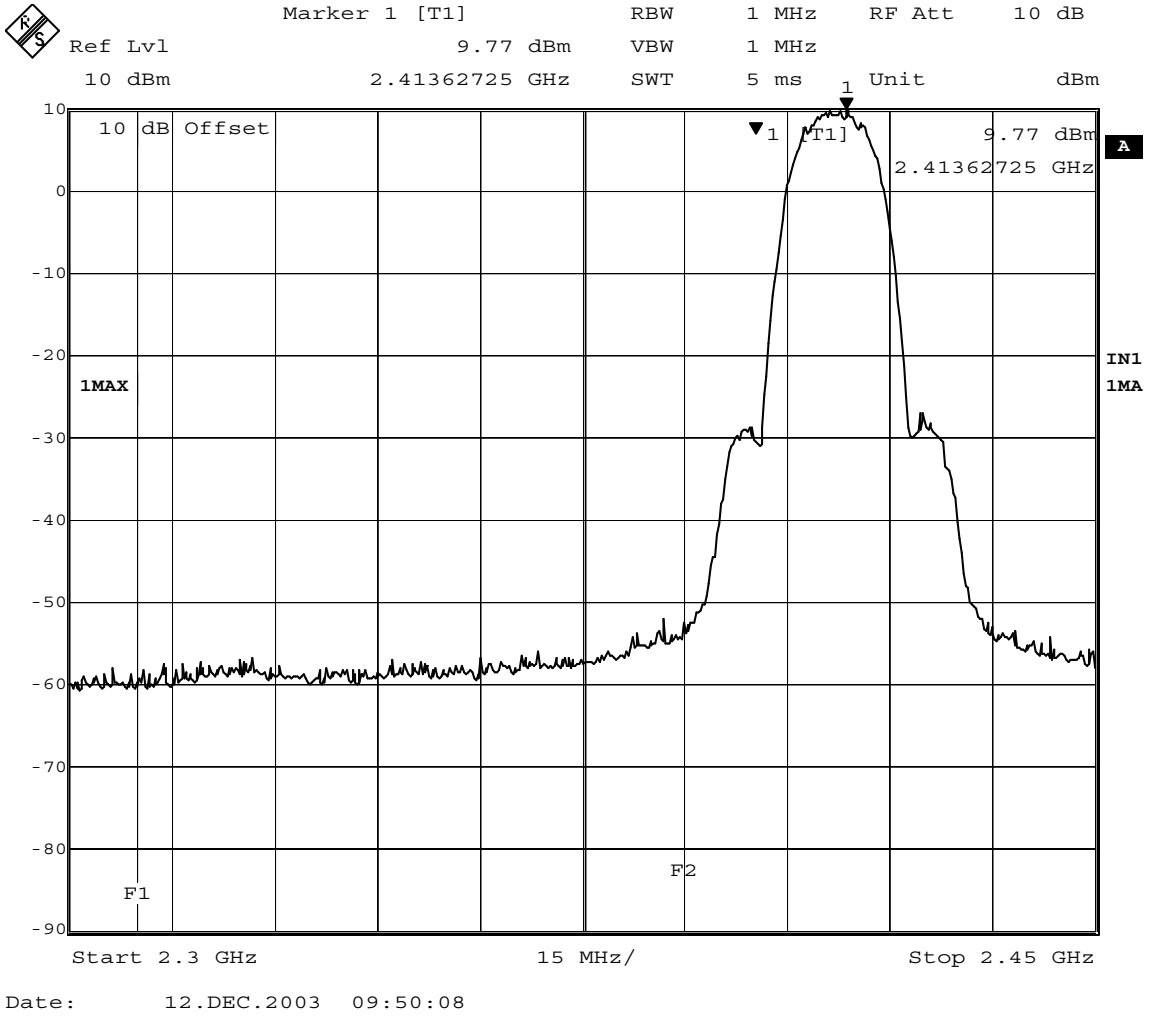

Figure 28 Channel 1 Conducted Peak Plot RBW=VBW=1MHz

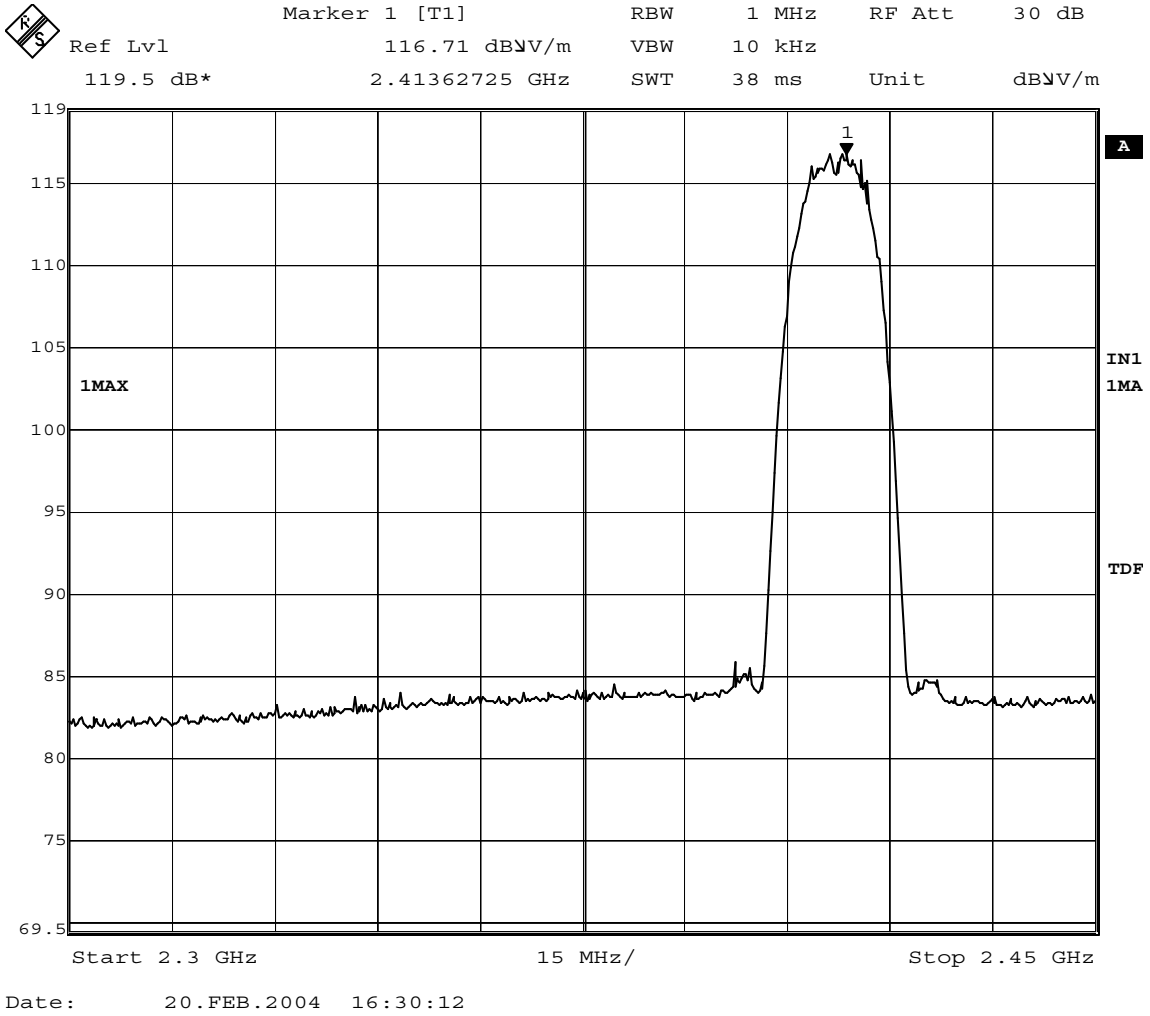

Figure 29 Channel 1 Radiated Average Plot RBW=1MHz, VBW=10kHz

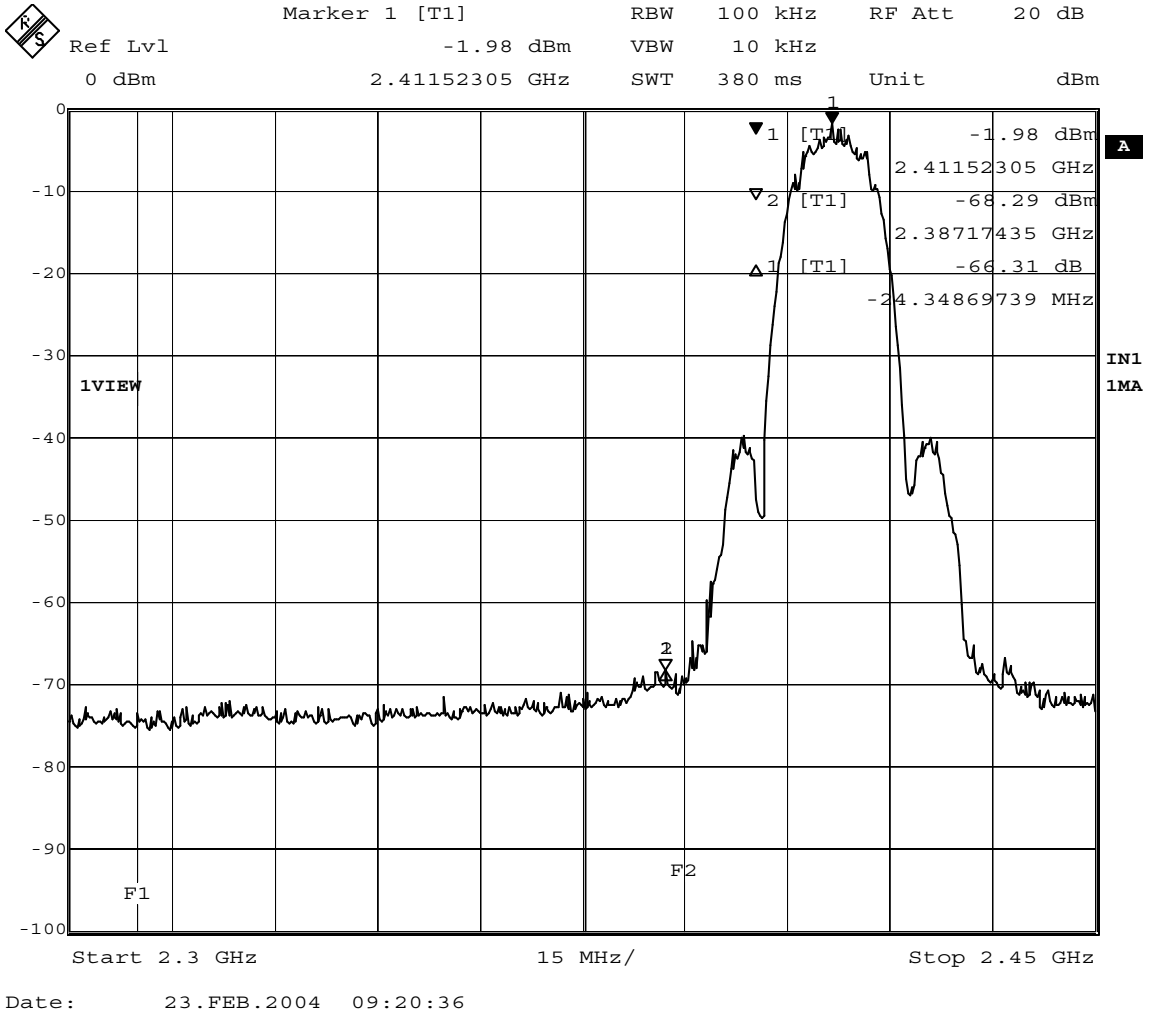

Figure 30 Channel 1 Conducted Average Plot RBW=100kHz, VBW=10kHz

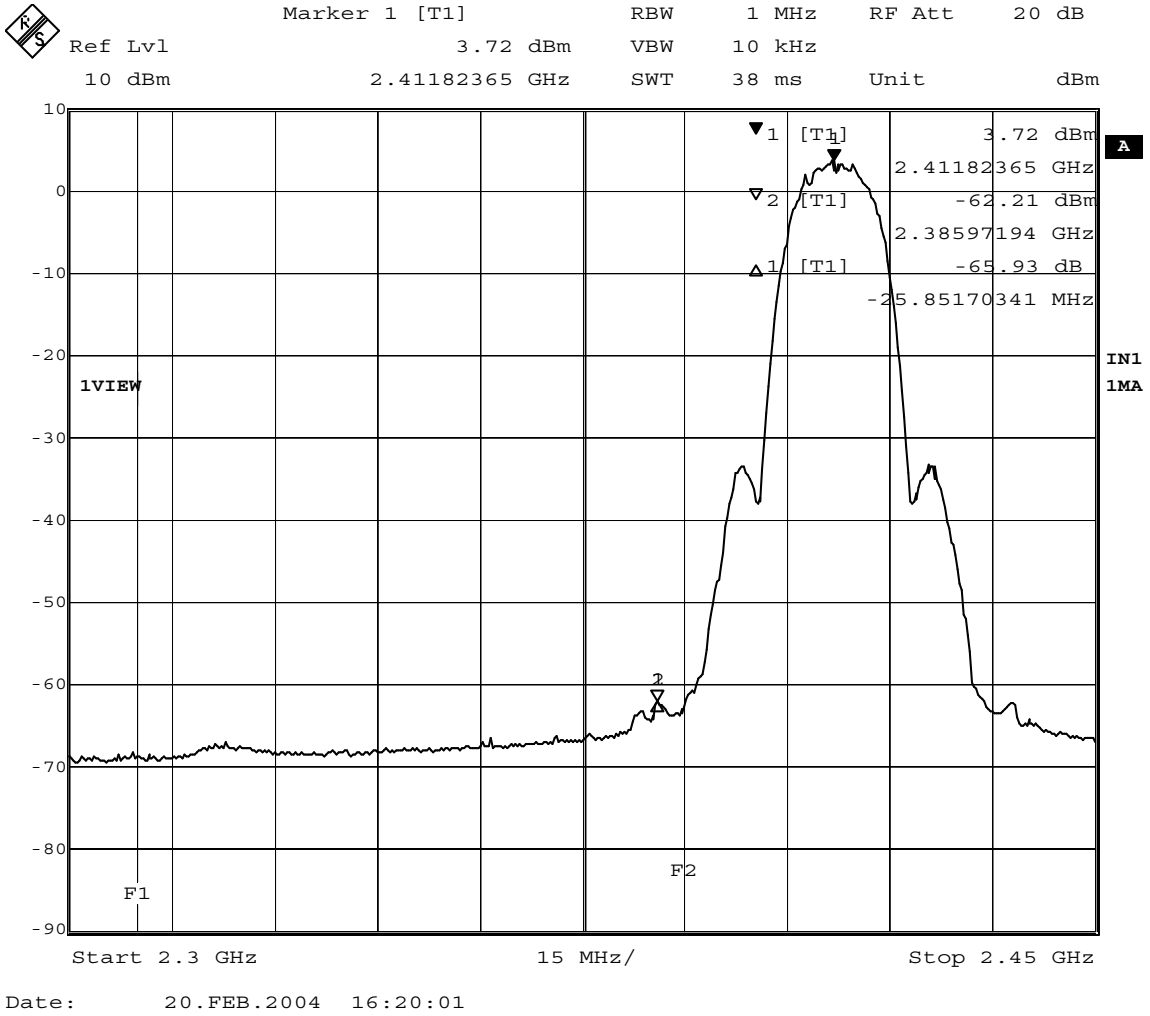

Figure 31 Channel 1 Conducted Average Plot RBW=1MHz, VBW=10kHz

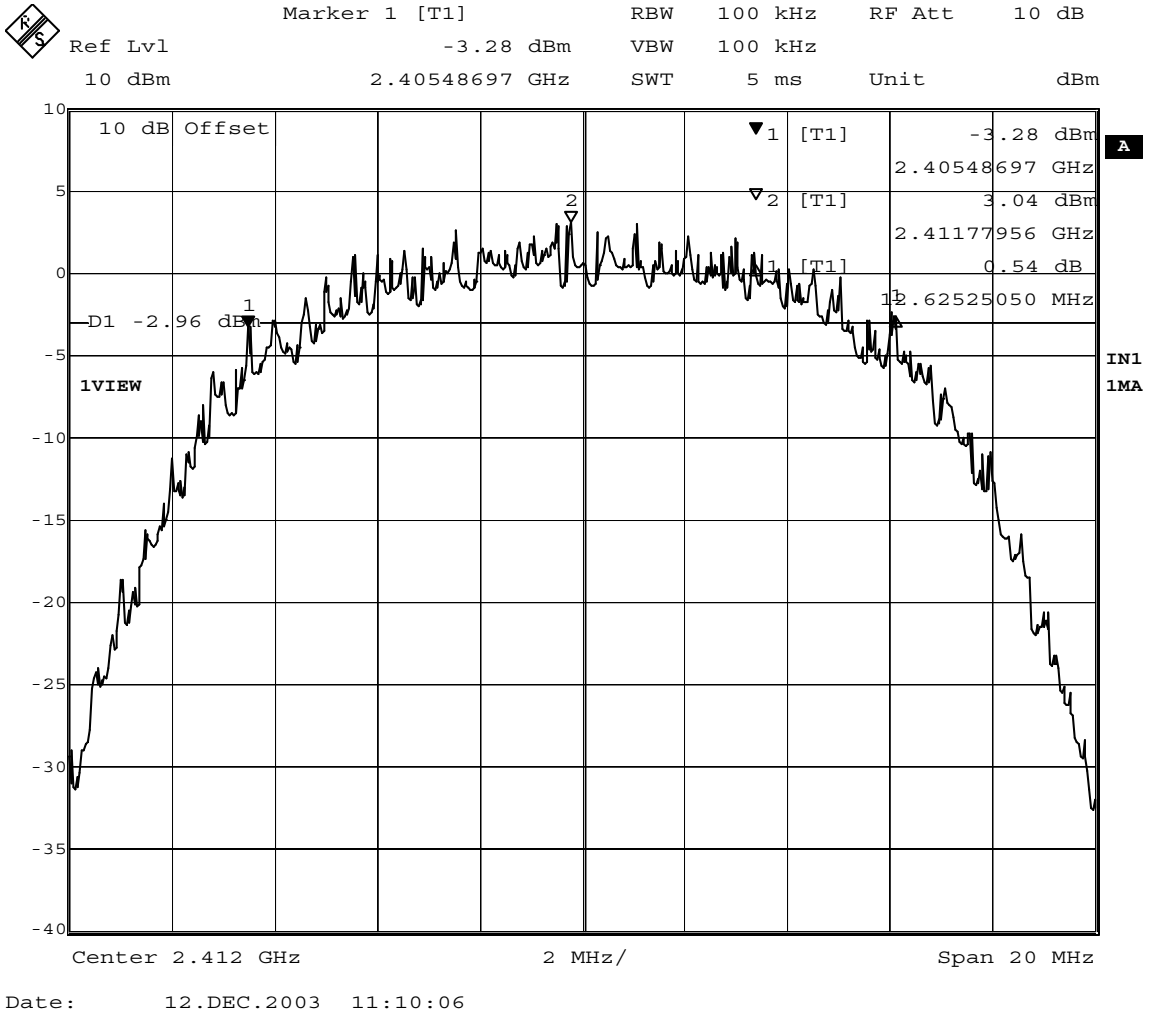

Figure 32 Channel 1 Conducted 6dB Bandwidth

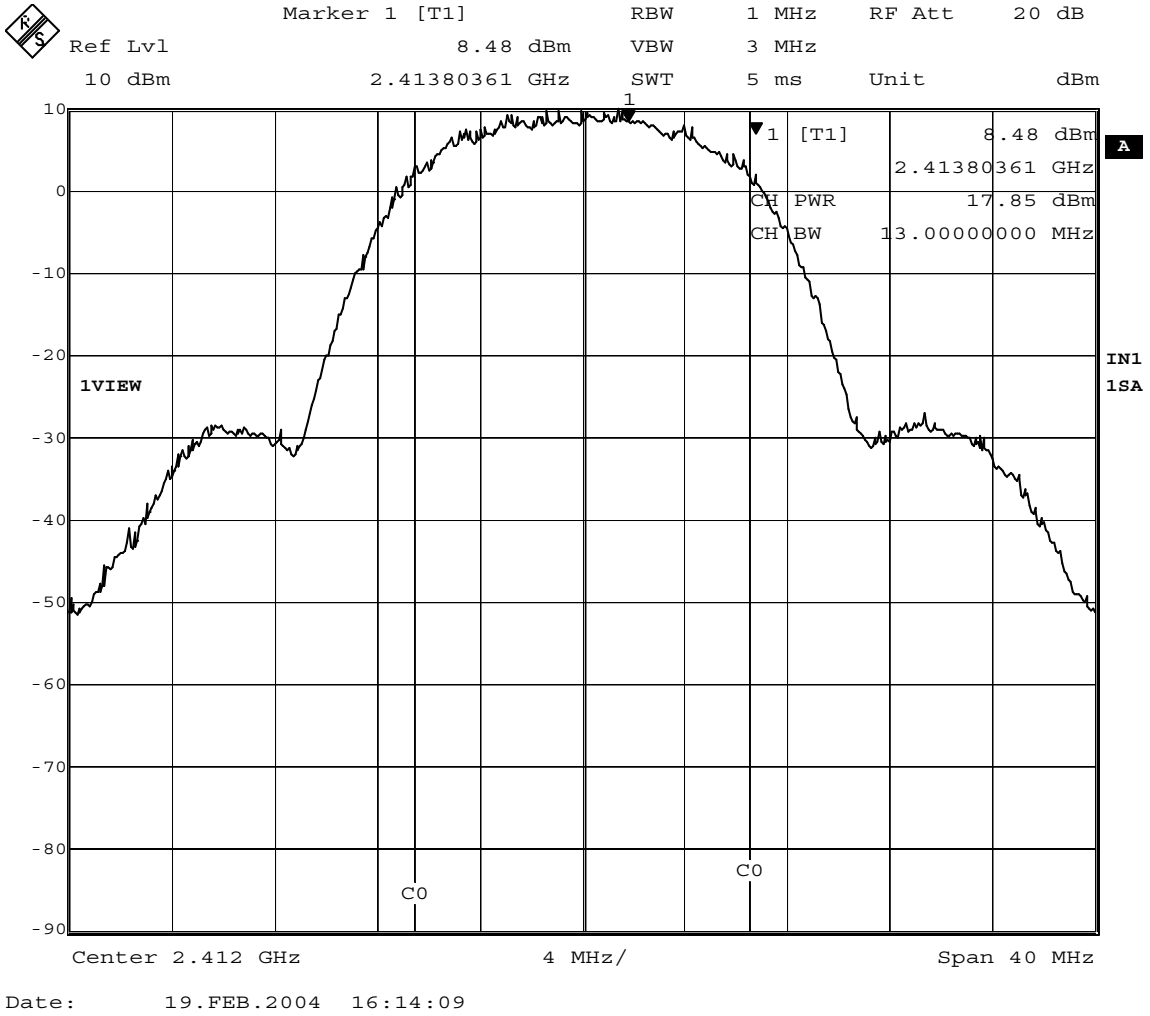

Figure 33 Channel 1 Conducted Power RBW=1MHz, VBW=3MHz, PBW=13MHz

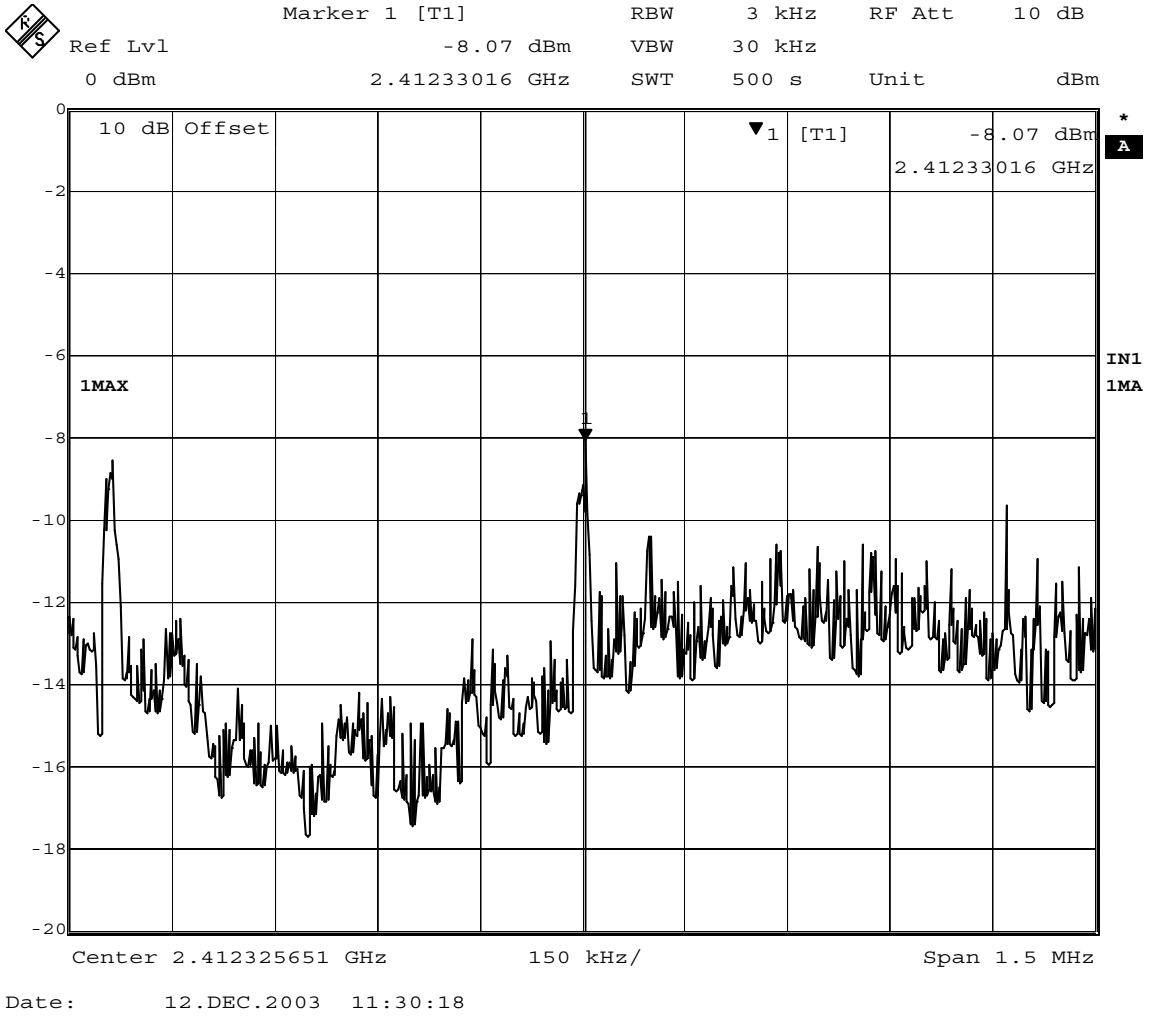

Figure 34 Channel 1 Conducted PSD

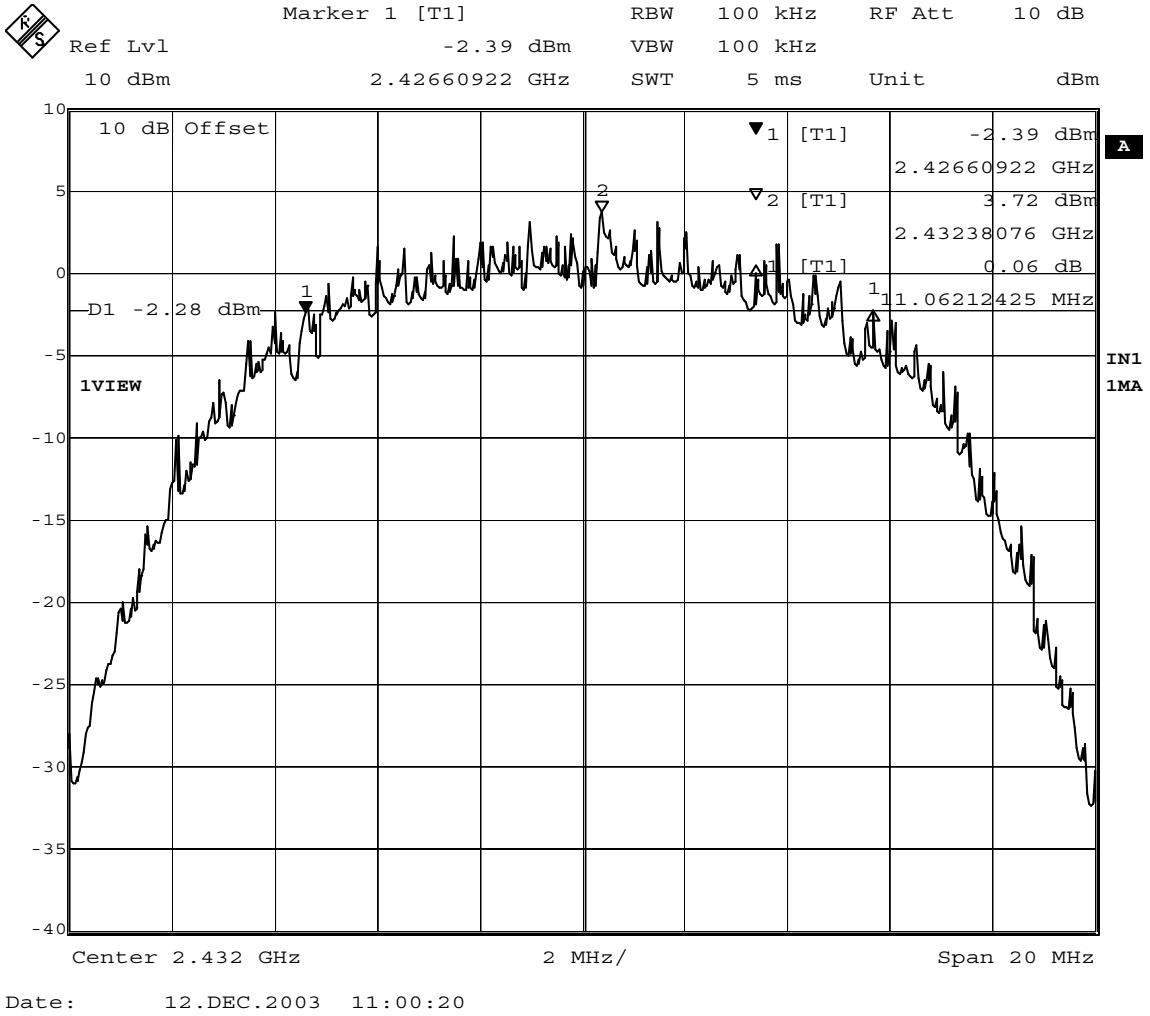

Figure 35 Channel 5 Conducted 6dB Bandwidth

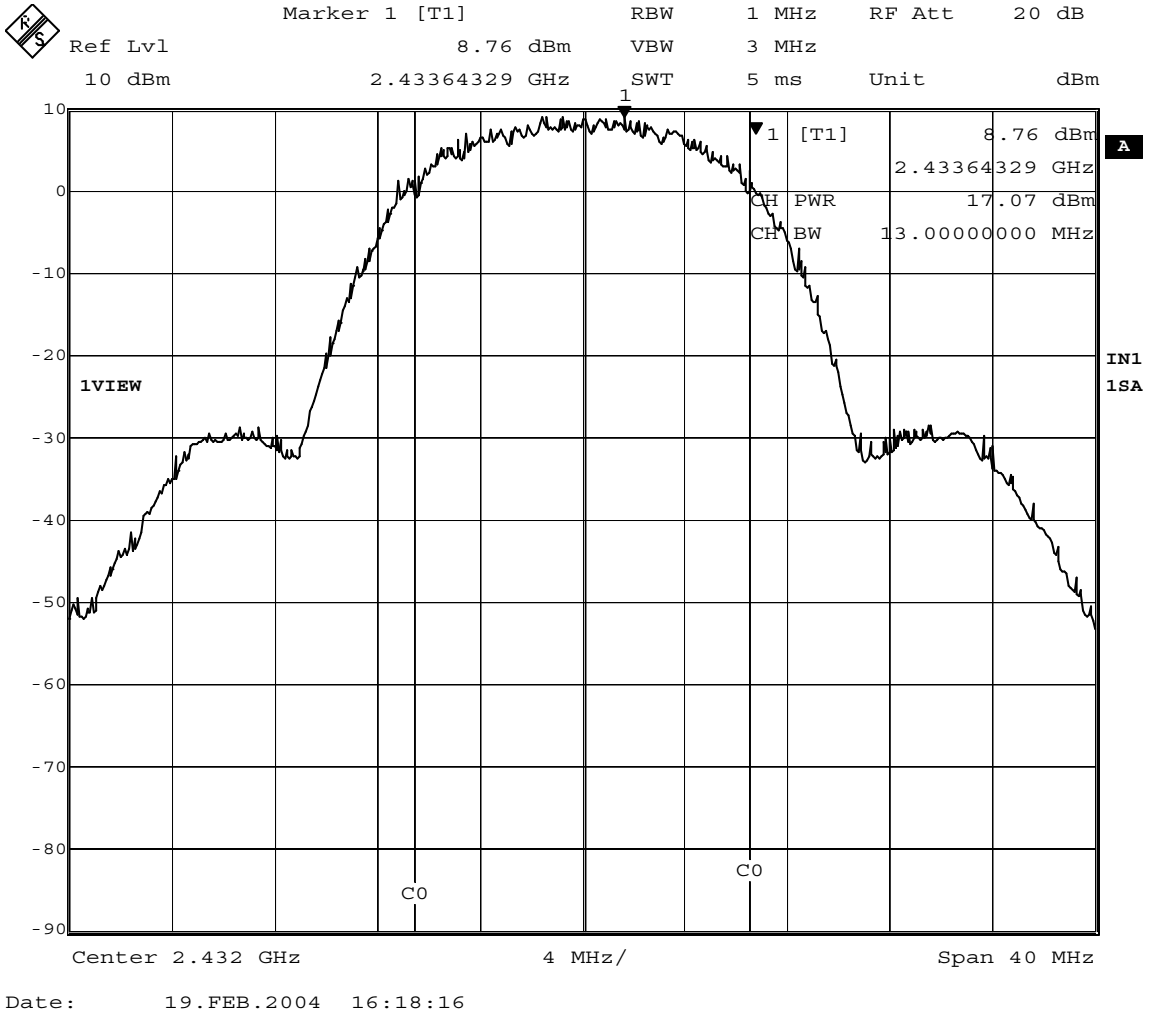

Figure 36 Channel 5 Conducted Power RBW=1MHz, VBW=3MHz, PBW=13MHz

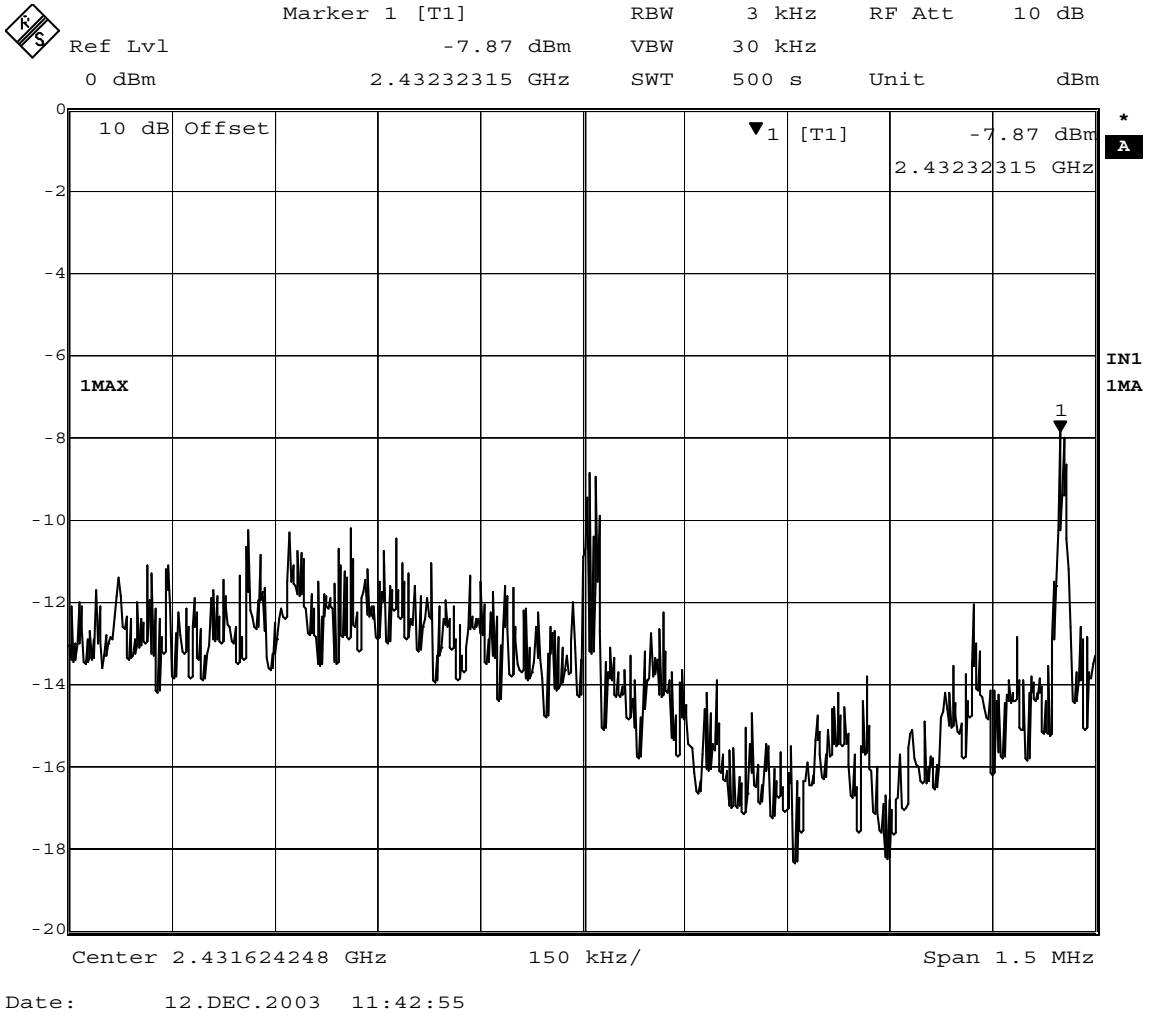

Figure 37 Channel 5 Conducted PSD

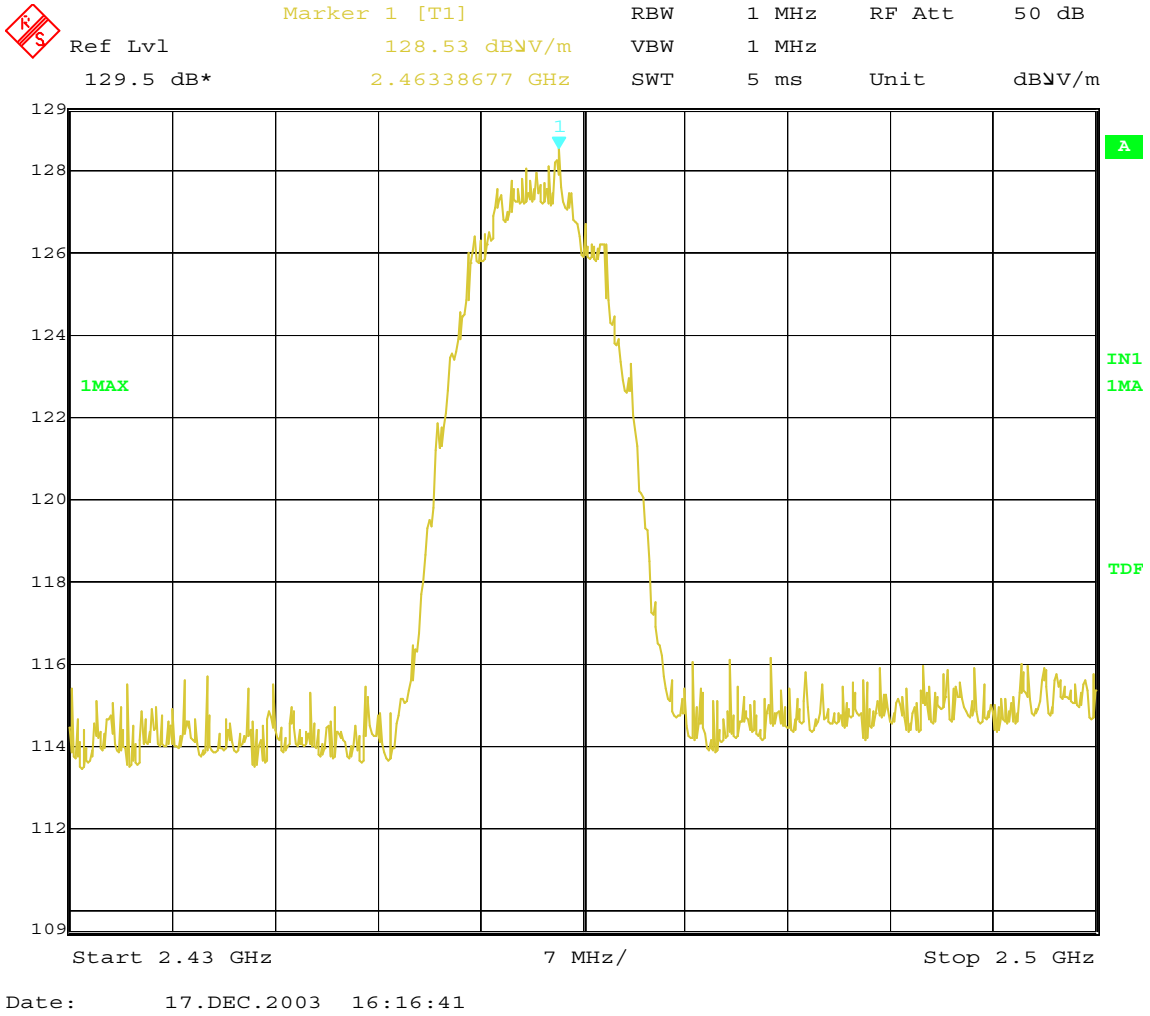

Figure 38 Channel 11 Radiated Peak Plot RBW=VBW=1MHz

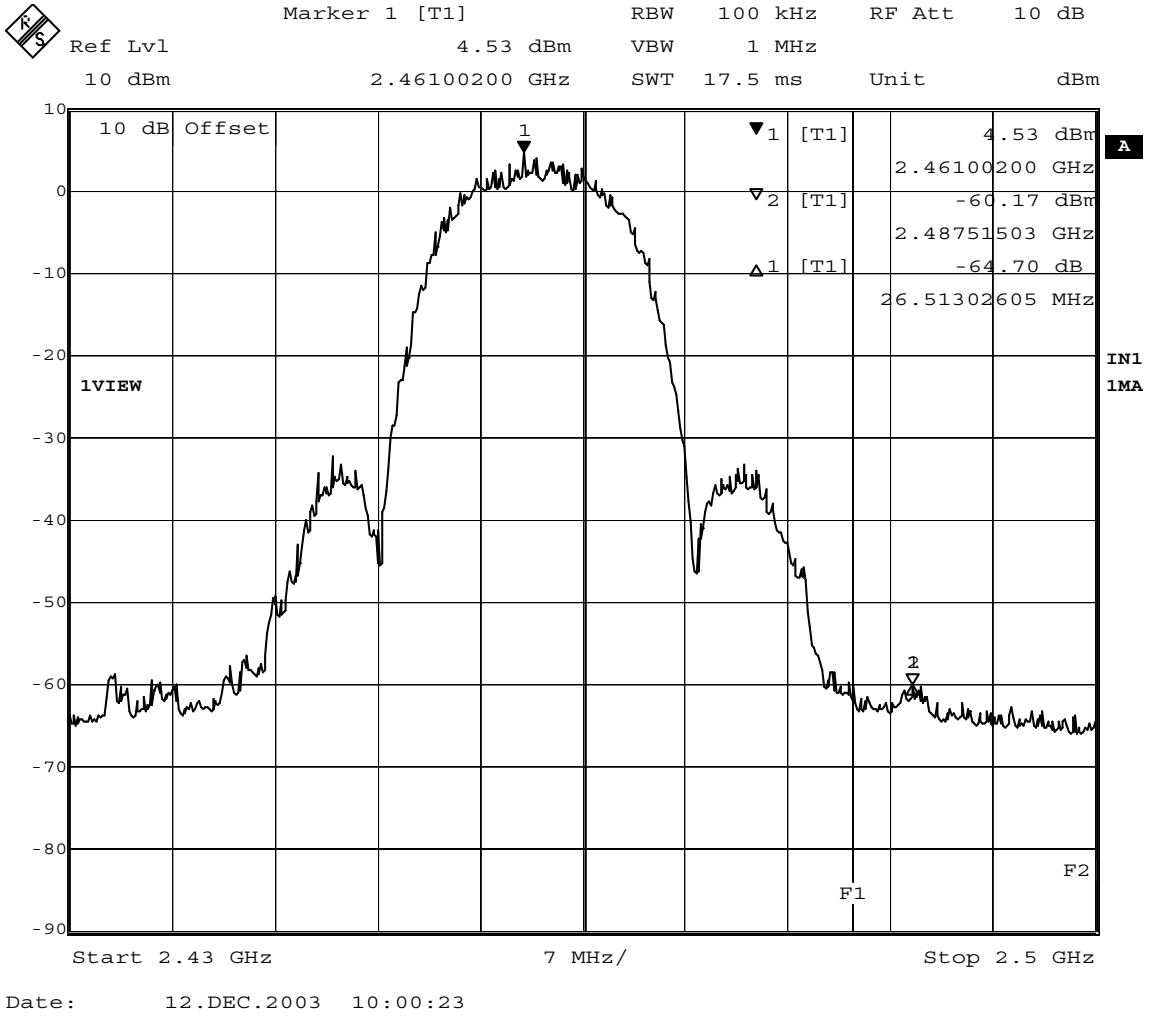

Figure 39 Channel 11 Conducted Peak Plot RBW=100kHz, VBW=1MHz

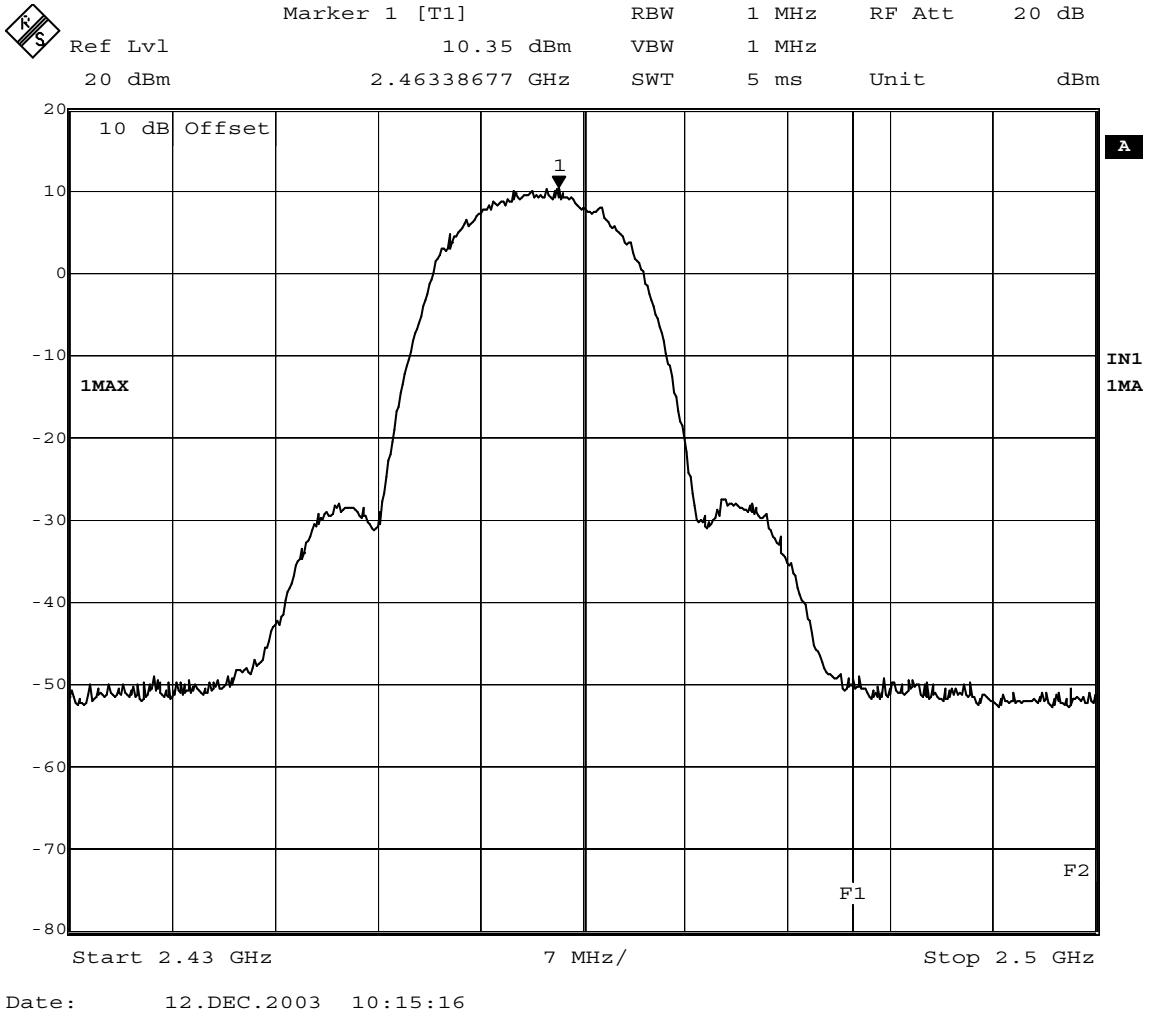

Figure 40 Channel 11 Conducted Peak Plot RBW=VBW=1MHz

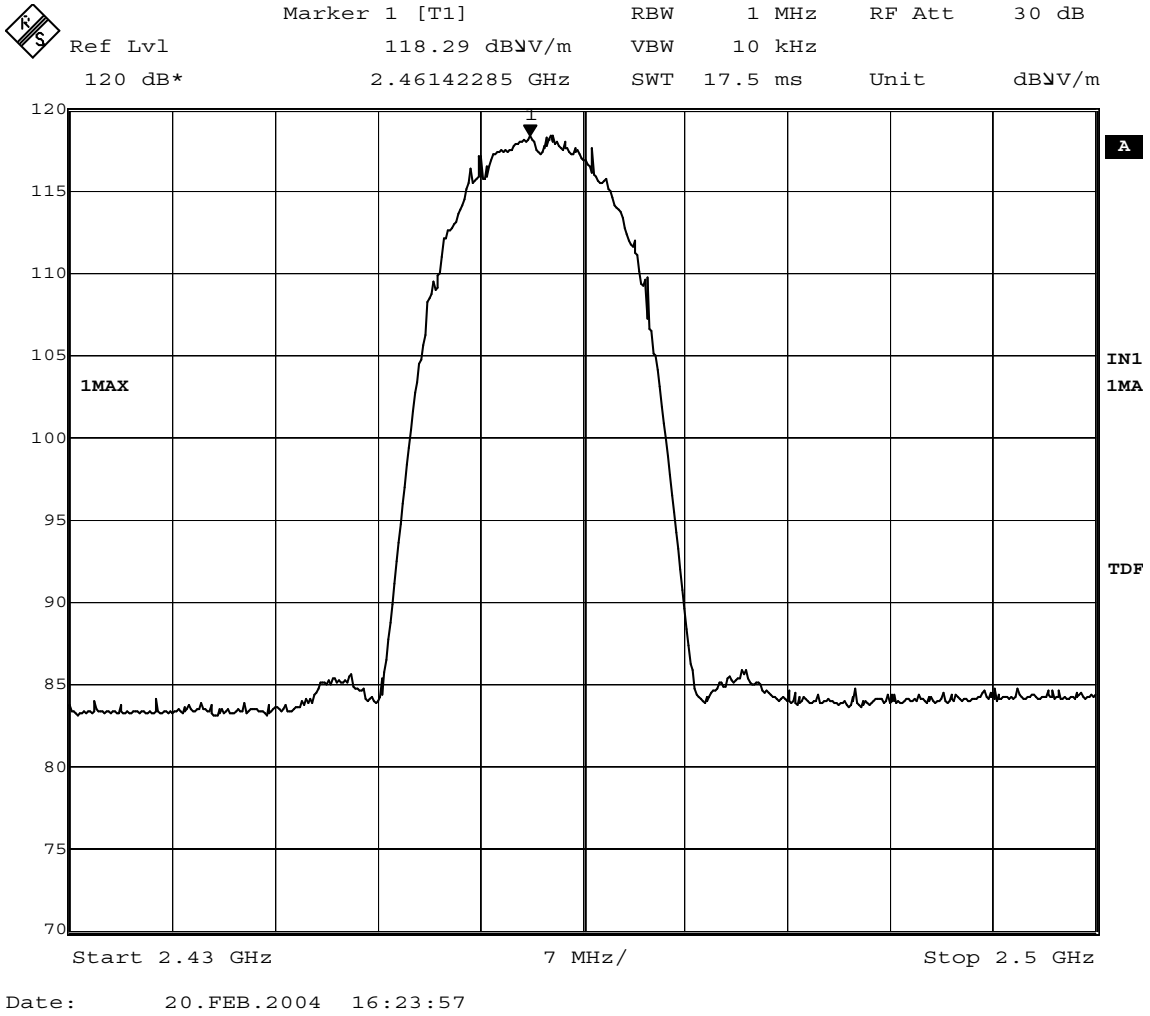

Figure 41 Channel 11 Radiated Average Plot RBW=1MHz, VBW=10kHz

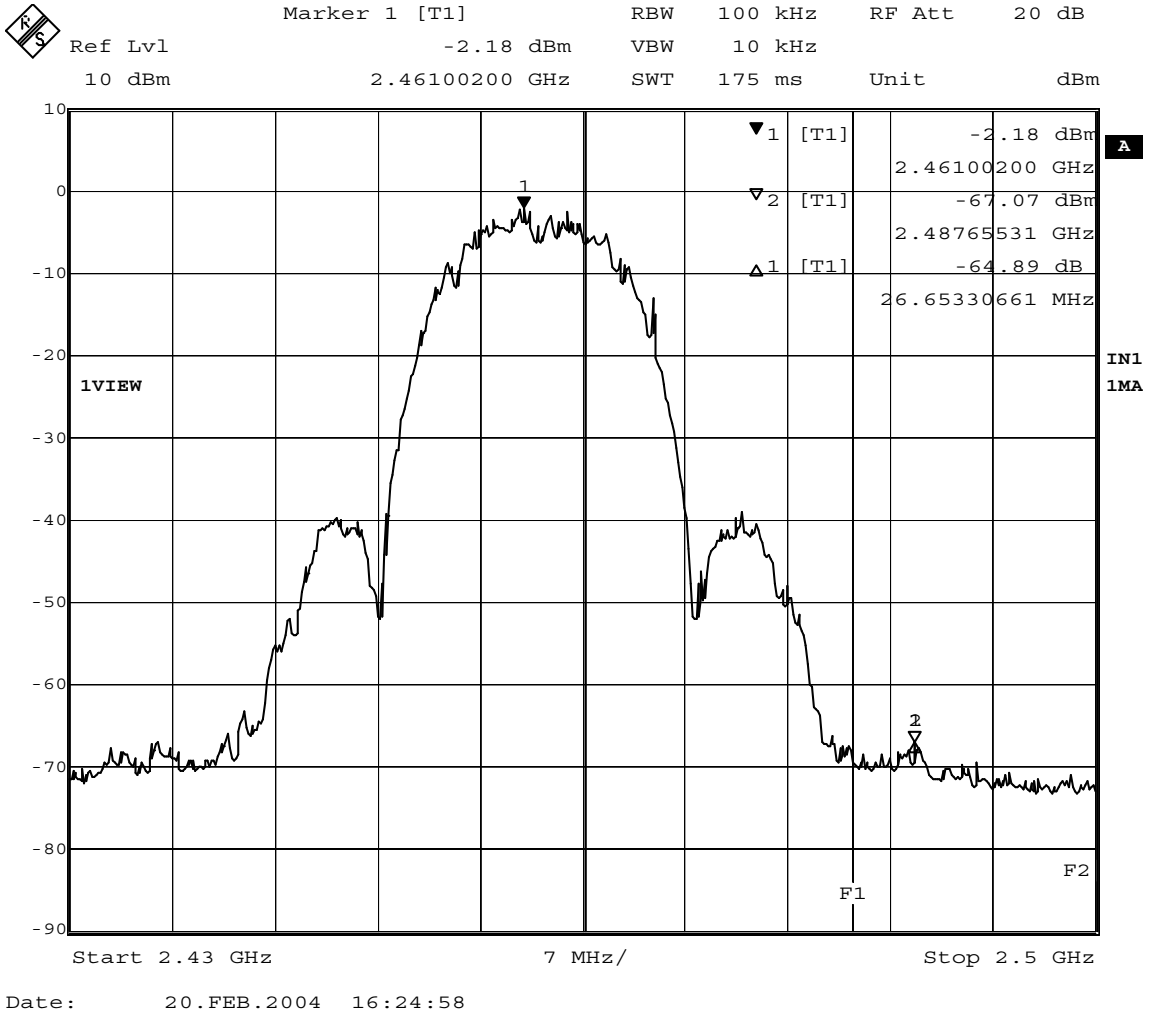

Figure 42 Channel 11 Conducted Average Plot RBW=100kHz, VBW=10kHz

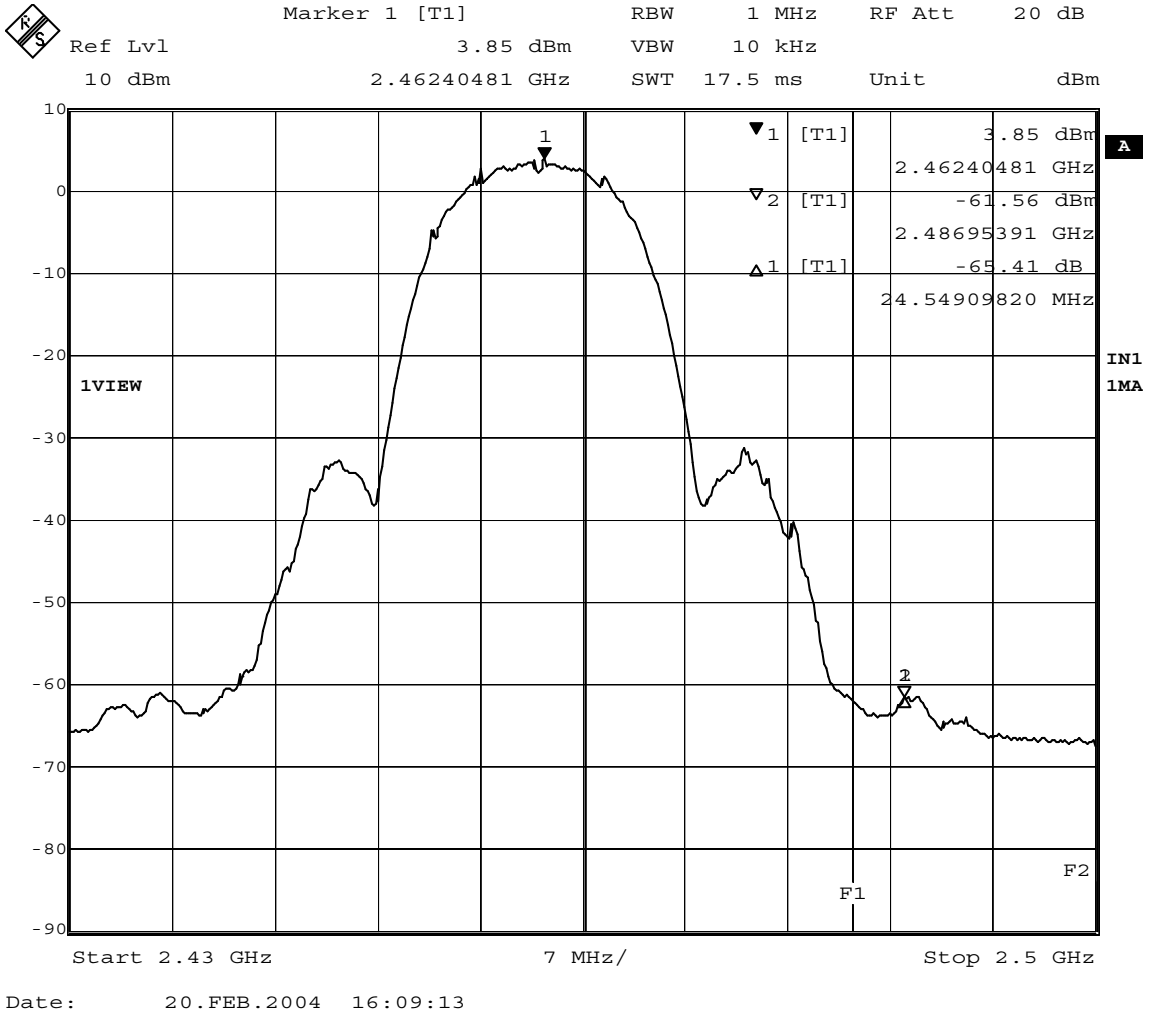

Figure 43 Channel 11 Conducted Average Plot RBW=1MHz, VBW=10kHz

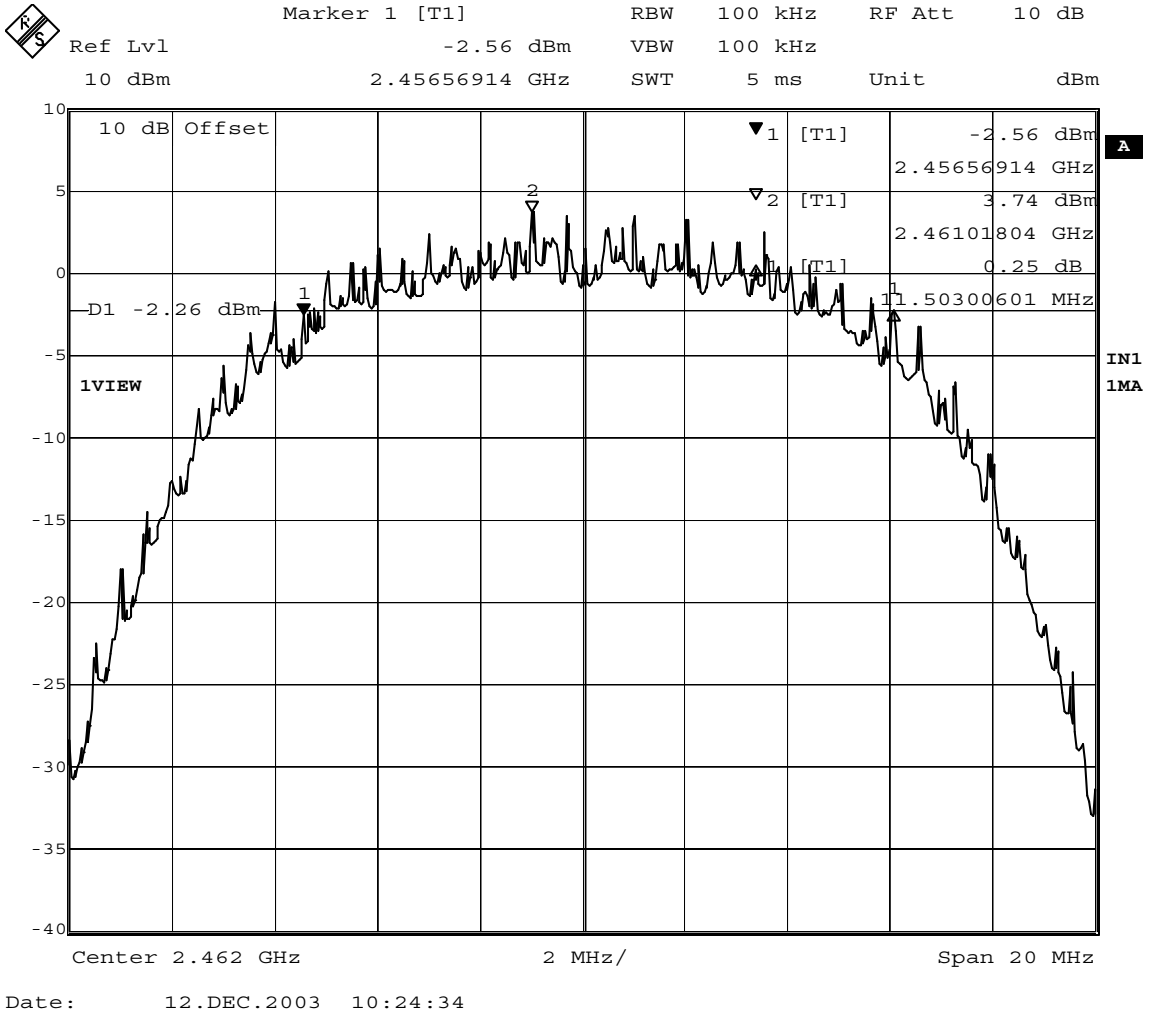

Figure 44 Channel 11 Conducted 6dB Bandwidth

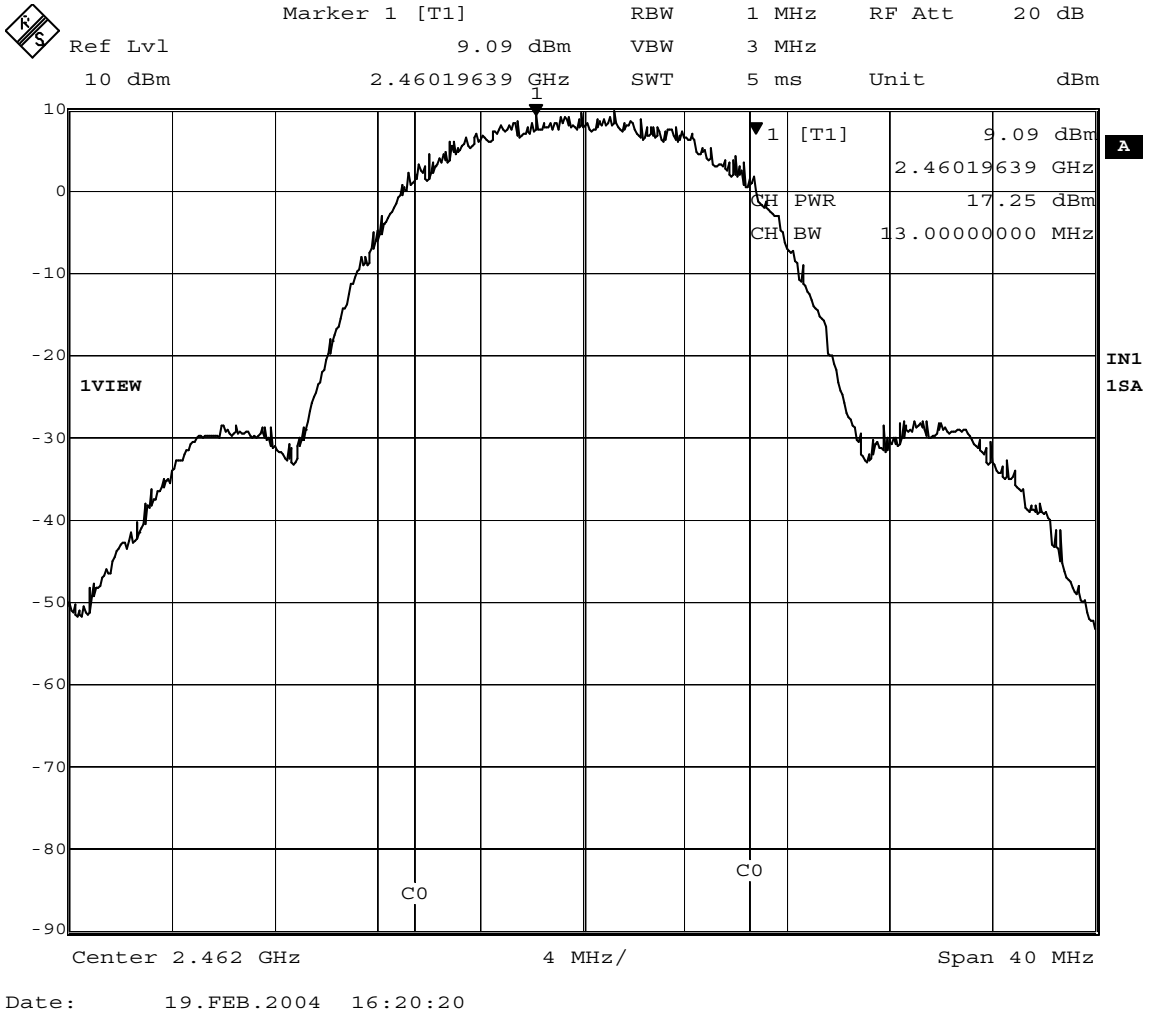

Figure 45 Channel 11 Conducted Power RBW=1MHz, VBW=3MHz, PBW=13MHz

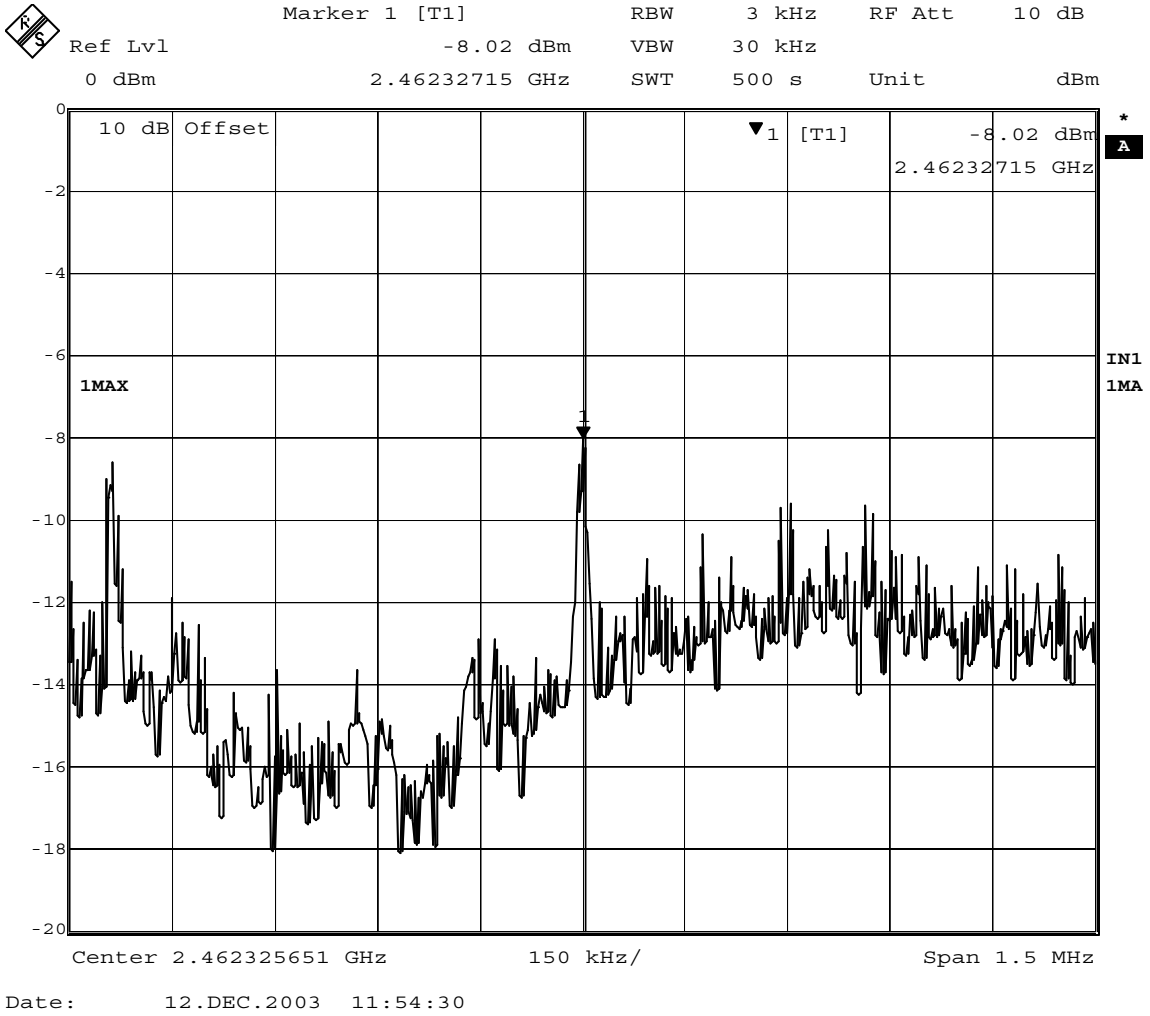

Figure 46 Channel 11 Conducted PSD

Appendix G: Specifications of Antennas

The beamwidth and gain specifications for the patch antennas covered in the initial modular approval.

Antenna	Nominal Gain	Beamwidth	Beamwidth Polarization
Arc Wireless FWA-SL-19-2.4-001-INT	19dBi	18 degrees	Vertical
Telex 2474KN	18dBi	18 degrees	Vertical
Arc Wireless FWA-VR-13-2.45-INT	13dBi	38 degrees	Vertical
KarlNet Inc. ANT-0005	6dBi	64 degrees	Vertical

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