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MPB TECHNOLOGIES INC.

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MPBT Report No.: c05e3078-1 Release 2 Date: 7 September 2004

Emissions Testing of AL411

In accordance with FCC Part 22 Public Mobile Services, Subpart H Cellular Radiotelephone Service (1999)

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Prepared for: CSI Wireless Inc.

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_____
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1.0 INTRODUCTION

1.1 SCOPE

The purpose of this report is to present the findings and results of compliance testing performed in accordance with CFR 47 FCC Part 22, Subpart H, Cellular Radiotelephone Service.

1.2 APPLICANT

This test report has been prepared for CSI Wireless Inc., located in Calgary, Alberta, Canada.

1.3 APPLICABILITY

All test procedures, limits, and results defined in this document apply to the CSI Wireless Inc. AL411 unit, referred to herein as the Equipment Under Test (EUT).

The results contained in this report relate only to the item tested.

This report does not imply product endorsement by NVLAP or the Canadian or US governments.

1.4 TEST SAMPLE DESCRIPTION

The test sample provided for testing was an AL411:

Product Type:	Vehicle location/monitor
Model Number:	AL411
Serial Number:	n/a
Cables:	GPS/AMPS antenna
Power Requirements:	13 VDC
Peripheral Equipment:	antenna

More detailed information is provided by CSI Wireless Inc. in Appendix A.

1.5 GENERAL TEST CONDITIONS AND ASSUMPTIONS

The EUT was set up and exercised using the configurations, modes of operation and arrangements defined in this report only. All inputs and outputs to and from other equipment associated with the EUT were adequately simulated by client-supplied setups.

Where relevant, the EUT was only tested using the monitoring methods and test criteria defined in this report.

All testing, unless otherwise noted, was performed under the following environmental conditions:

Temperature:	17 to 23 °C
Humidity:	45 to 75 %
Barometric Pressure:	68 to 106 kPa

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1.6 SCOPE OF TESTING

Testing was performed in accordance with FCC Part 22 Subpart H.

1.6.1 VARIATIONS IN TEST METHODS

There were no variations from the test procedures outlined above.

1.6.2 MARGINAL EMISSIONS MEASUREMENTS

There were no radiated emissions measured to be closer to the specified limits than -6 dB.

1.6.3 TEST SAMPLE CONFIGURATION & MODIFICATIONS

The EUT met the requirements without modifications.

2.0 ABBREVIATIONS

CE -Conducted Emissions
E -Field - Electric Field
H -Field - Magnetic Field
n/t -Not Tested
n/a -Not Applicable
RE -Radiated Emissions

3.0 MEASUREMENT UNCERTAINTY

For Radiated E-Field Emissions and Conducted Emissions, the uncertainties in the measurements were calculated using the methods outlined in the NAMAS document, NIS81: May 1984.

Frequency	= ± 1 kHz
Amplitude (RE)	= ± 4.01 dB
Amplitude (CE)	= ± 3.25 dB

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4.0 TEST CONCLUSION

Statement of Compliance

The client equipment referred to in this report was found to comply with the requirements as stated below.

The EUT was subjected to the following tests. Compliance status is reported as **PASS** or **FAIL**. Test conditions that are not applicable to the EUT are marked **n/a**. If testing was not performed at this time, the appropriate field is marked **n/t**.

TEST CASE	TEST TYPE	SPECIFICATION	MODIFICATIONS	CONFIGURATION	RESULT
§4.1	Conducted Emissions on AC Power Lines	FCC Part 15.207	nil	See § 1.6.3	**n/a**
§4.2	Radiated Emissions (unintentional)	FCC Part 15.109	nil	See § 1.6.3	**PASS**
§4.3	RF Output Power	FCC Part 2.1046	nil	See § 1.6.3	**PASS**
§4.4	Modulation Characteristics	FCC Part 2.1047	nil	See § 1.6.3	**PASS**
§4.5	Modulation Requirements	FCC Part 22.915	nil	See § 1.6.3	**PASS**
§4.6	Occupied Bandwidth	FCC Part 2.1049	nil	See § 1.6.3	**PASS**
§4.7	Emission Limitations For Cellular	FCC Part 22.917	nil	See § 1.6.3	**PASS**
§4.8	Spurious Emissions at Antenna Terminals	FCC Part 2.1051	nil	See § 1.6.3	**PASS**
§4.9	Field Strength Of Spurious Radiation	FCC Part 2.1053	nil	See § 1.6.3	**PASS**
§4.10	Frequency Stability	FCC Part 2.1055	nil	See § 1.6.3	**PASS**
§4.11	Effective Radiated Power	FCC Part 22.913	nil	See § 1.6.3	**PASS**

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4.1 CONDUCTED EMISSIONS ON AC POWER LINES (§ 15.207)

Test Lab: Electronics Test Centre (Airdrie) Test Personnel: n/a Test Date: n/a	Product: AL411
Test Result, AL411: **Not Applicable**	
Objectives/Criteria The Conducted emissions produced by a system or sub-system shall not exceed the limits for the specifications as stated. **Emission levels should meet the requirements with a margin of 6dB**.	Specification: Frequency (MHz) QP Avg 0.150 - 0.50 66 – 56 56 – 46 0.50 – 5.0 56 46 5 – 30 60 50 Units of measurement are dBμV.
The AL411 was not tested for Conducted Emissions. This is a DC powered device. The power source is provided by the end user, not CSI Wireless Inc.. There is no connection to the AC mains.	

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4.2 RADIATED EMISSIONS (UNINTENTIONAL) (§ 15.109)

Test Lab: MPB Technologies Inc. Airdrie Test Personnel: S. Malwes Test Date: 21 June 2004	Product: AL411

Test Result, AL411: **PASS**

Objectives/Criteria The Radiated E-Field emissions produced by a system or sub-system, measured at a distance of 3m from the EUT, shall not exceed the limits for the specifications as stated. **Emission levels should meet the requirements with a margin of 6dB.** The EUT was assessed against the requirements of **Class B**. Temperature = 19 °C Humidity = 42 %	Specification: FCC Part 15 Subpart C Frequency [MHz] / Class A QP @ 3m / Class B QP @ 3m 30 – 88 / 49.54 / 40.00 88 – 216 / 53.98 / 43.52 216 – 960 / 56.90 / 46.02 above 960 / 60.00 / 53.98

Horizontal:			**Vertical:**		
Frequency [MHz]	Field Strength [dBμV/m]	Delta [dB from limit]	Frequency [MHz]	Field Strength [dBμV/m]	Delta [dB from limit]
892.7896	30.49	-15.53	40.3987	27.89	-12.11
40.4100	21.30	-18.70	44.4366	26.34	-13.66
60.1533	20.05	-19.95	102.5943	17.06	-26.46

There were no more emissions measured within -20 dB of the specified limit.
Refer to the test data and plots for more detail.

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Radiated Emissions Data:

The emissions data is presented in tabular form, showing the uncorrected spectrum analyzer reading, the correction factors applied, the net result, the value(s) of up to 4 limits at the frequency measured, and the margin between the result and the limit(s).

For example:

```
                                                                  ⇓
Test    Meter  Gain/Loss Transducer Level Limit:1      2      3      4
Frequency Reading  Factor    Factor    [dB(uVolts)]
  [MHz]   [dB(uV)]  [dB]      [dB]
=============================================================================
94.0036    37.1 qp   2.2      8.5      47.8   54      43.5   50.5   40.5
Azimuth: 156  Height:113 Vert    Margin [dB]  -6.2    4.3    -2.7   7.3
```

⇓		The applicable Limit
Test Frequency [MHz]	94.0036	Test Frequency f = 94.0036 MHz
Meter Reading [dB (uV)]	37.1 qp	The reading with Quasi-Peak detector
Gain/Loss Factor [dB]	2.2	Net correction for preamp gain & cable loss
Transducer Factor [dB]	8.5	Correction for antenna loss
Level [dB (uVolts)]	47.8	Corrected value for field strength
Azimuth:	156	The turntable was 156 degrees CW from facing the antenna
Height:	113	The antenna was 113 cm above the ground
Limit: 1 Margin [dB]	54 -6.2	The value of Limit 1 at 94.0036 MHz The field strength is 6.2 dB below Limit 1
Limit: 2 Margin [dB]	43.5 4.3	The value of Limit 2 at 94.0036 MHz The field strength is 4.3 dB above Limit 2
Limit: 3 Margin [dB]	50.5 -2.7	The value of Limit 3 at 94.0036 MHz The field strength is 2.7 dB below Limit 3
Limit: 4 Margin [dB]	40.5 7.3	The value of Limit 4 at 94.0036 MHz The field strength is 7.3 dB above Limit 4

Meter Reading in dBuV + Gain/Loss Factor in dB + Transducer Factor in dB = Corrected Field Strength

Note: When a preamp is used, the resulting gain is compensated.
Highlighting indicates a margin of less than 6 dB.

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CSI Wireless
Rx AMPS Mid 880.92 & GPS On
Project#c05e3078

Test Frequency [MHz]	Meter Reading [dB(uV)]		Gain/Loss Factor [dB]	Transducer Factor [dB]	Level dB[uVolts/meter]	Limit:1	2	3 ⇓	4
Range: 1 30 - 1000MHz									
40.41	4.08	qp	1.62	15.6	21.3	49.54	50	40	40.46
Azimuth: 227	Height:101	Horz		Margin [dB]:		-28.24	-28.7	-18.7	-19.16
60.1533	7.97	qp	2.28	9.8	20.05	49.54	50	40	40.46
Azimuth: 262	Height:268	Horz		Margin [dB]:		-29.49	-29.95	-19.95	-20.41
892.7896	.34	qp	8.09	22.06	30.49	56.9	57	46.02	47.46
Azimuth: 0	Height:384	Horz		Margin [dB]:		-26.41	-26.51	-15.53	-16.97
Range: 1 30 - 1000MHz									
40.3987	12.61	qp	1.62	13.66	27.89	49.54	50	40	40.46
Azimuth: 266	Height:102	Vert		Margin [dB]:		-21.65	-22.11	-12.11	-12.57
44.4366	11.96	qp	1.88	12.5	26.34	49.54	50	40	40.46
Azimuth: 52	Height:100	Vert		Margin [dB]:		-23.2	-23.66	-13.66	-14.12
102.5943	4.88	qp	2.69	9.49	17.06	53.98	50	43.52	40.46
Azimuth: 358	Height:102	Vert		Margin [dB]:		-36.92	-32.94	-26.46	-23.4

LIMIT 1: FCC Part 15 Class A 3m

LIMIT 2: ICES-003 Class A 3m

LIMIT 3: FCC Part 15 Class B 3m ⇐

LIMIT 4: ICES-003 Class B 3m

qp - Quasi-Peak detector

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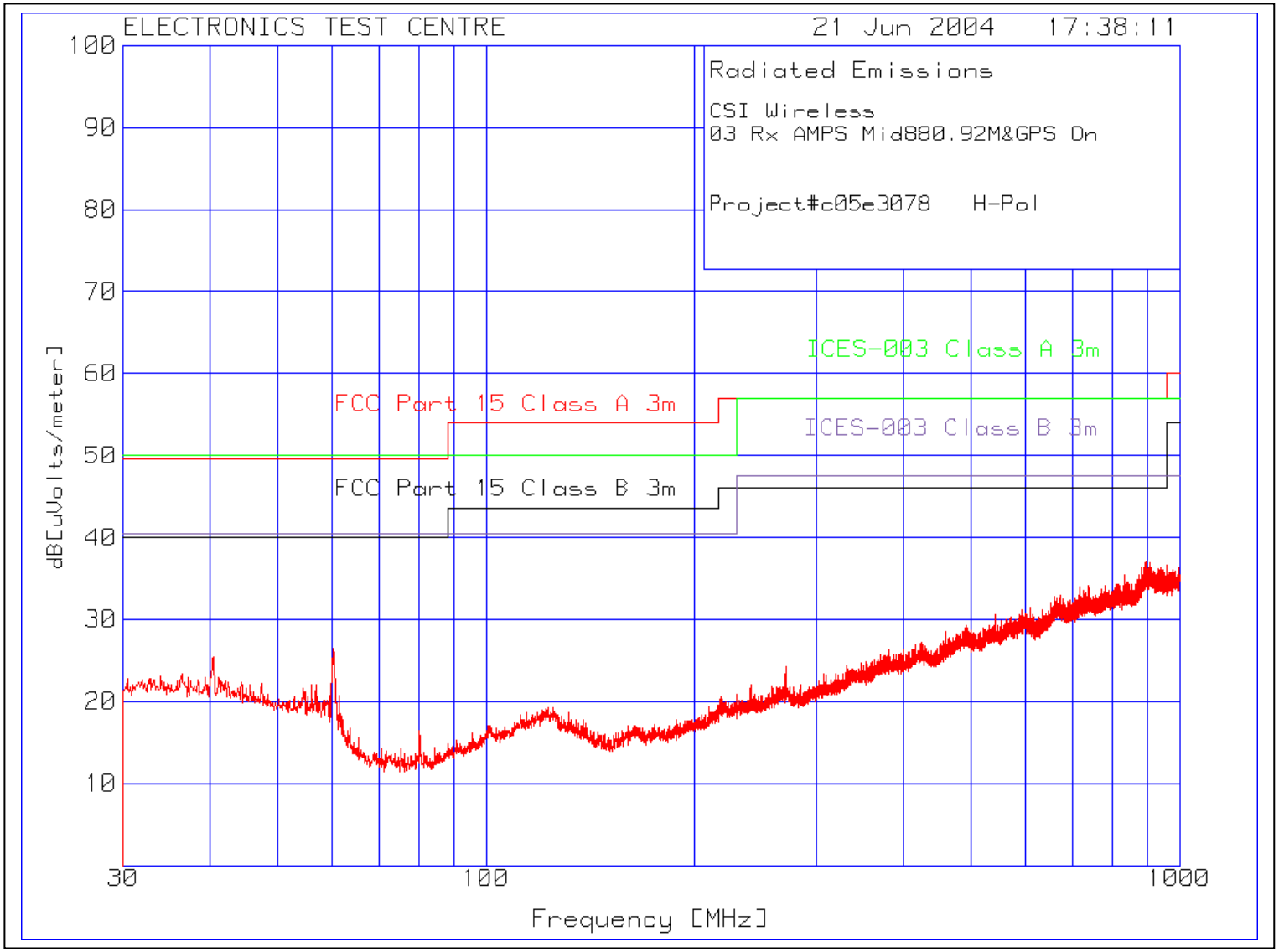
Plot of Radiated Emissions:



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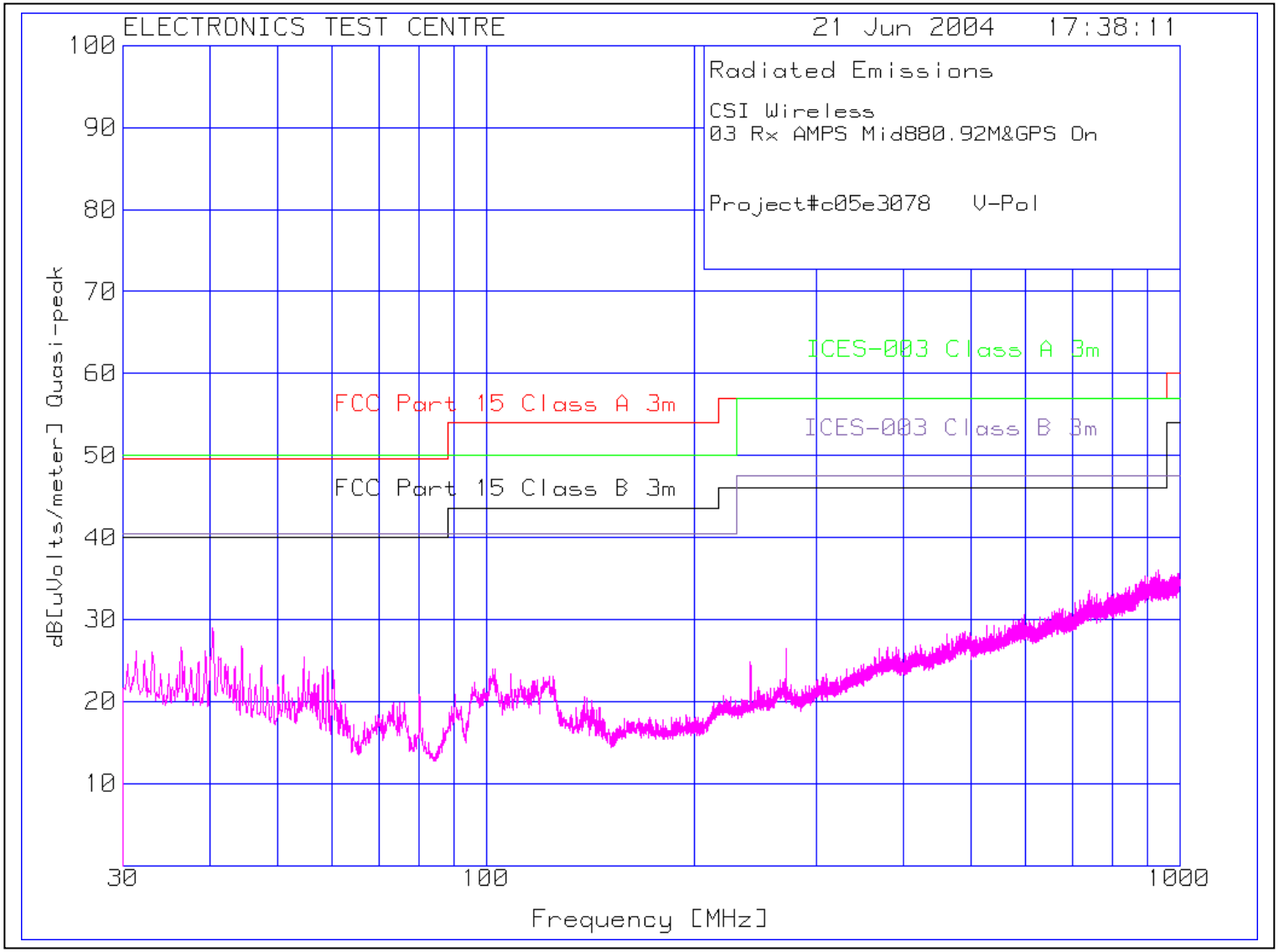
Plot of Radiated Emissions:



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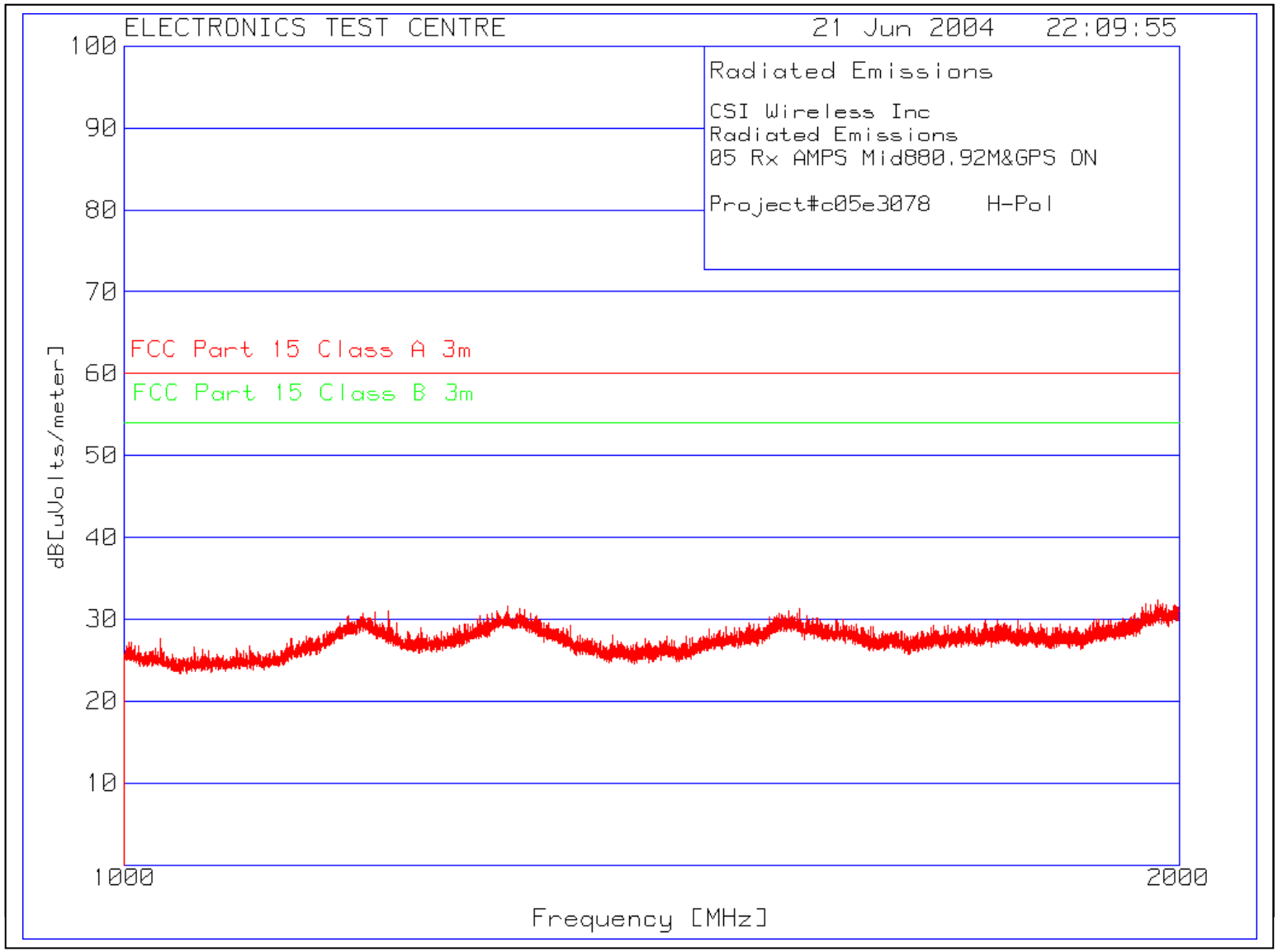
Plot of Radiated Emissions:



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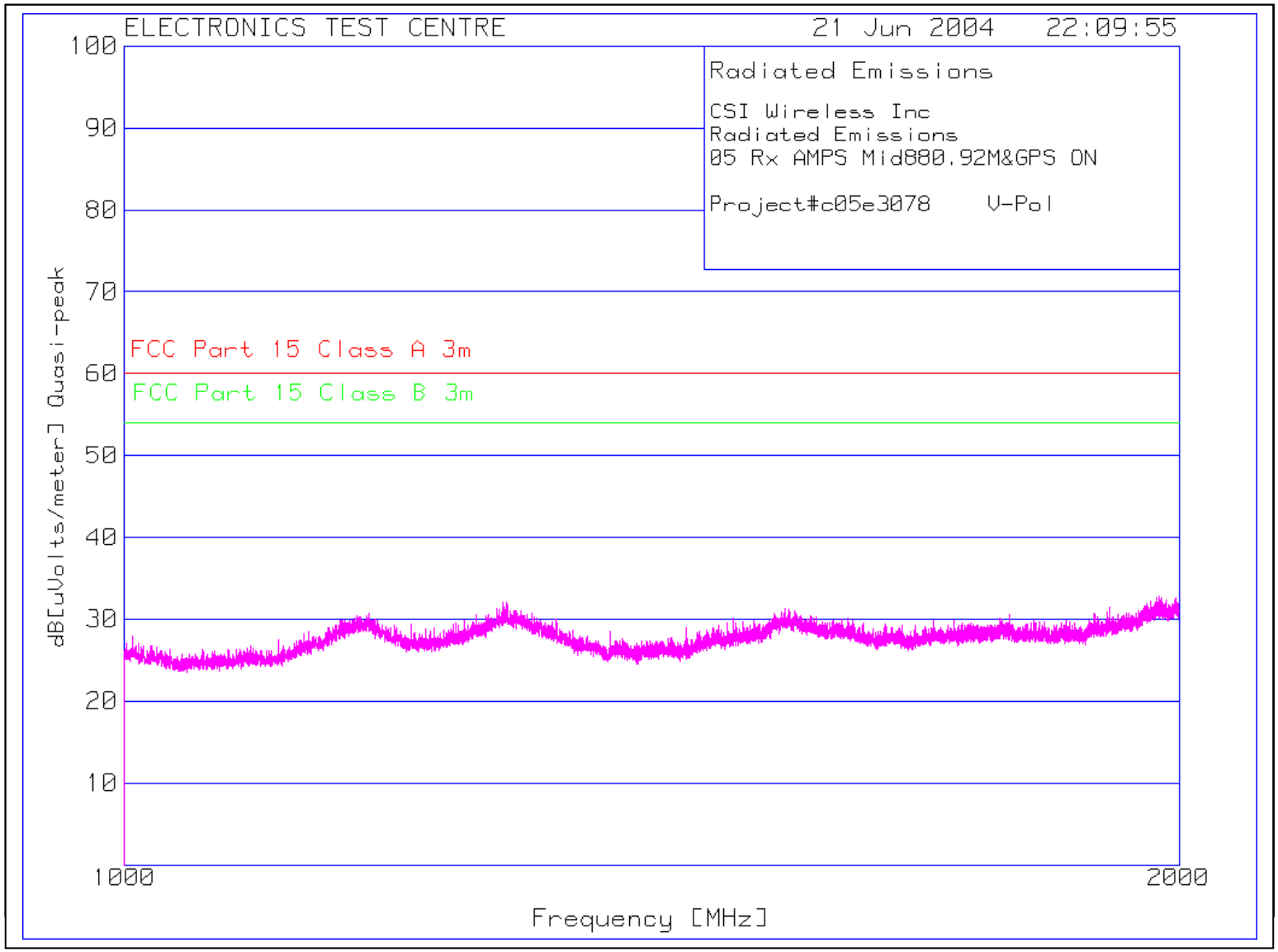
Plot of Radiated Emissions:



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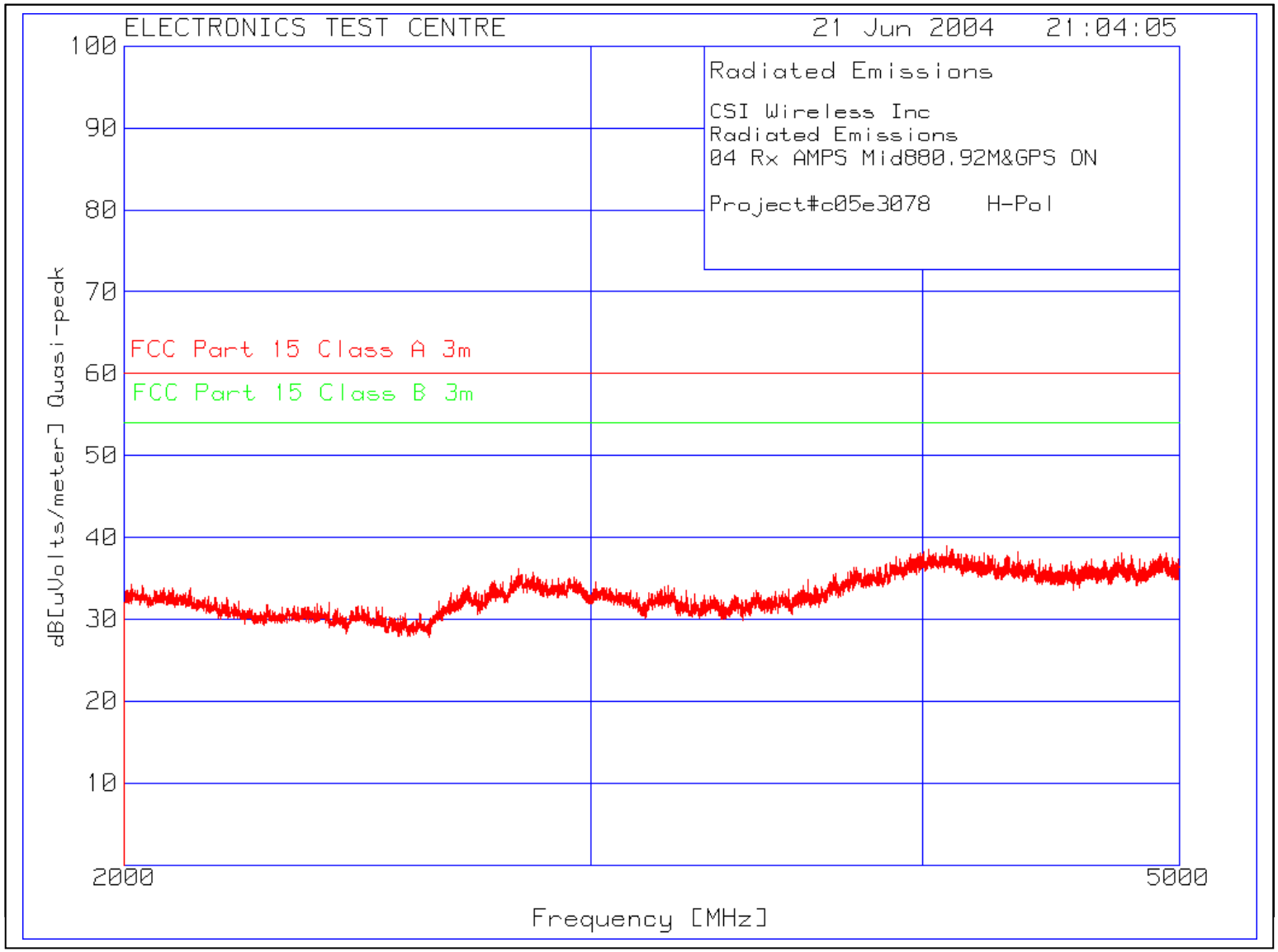
Plot of Radiated Emissions:



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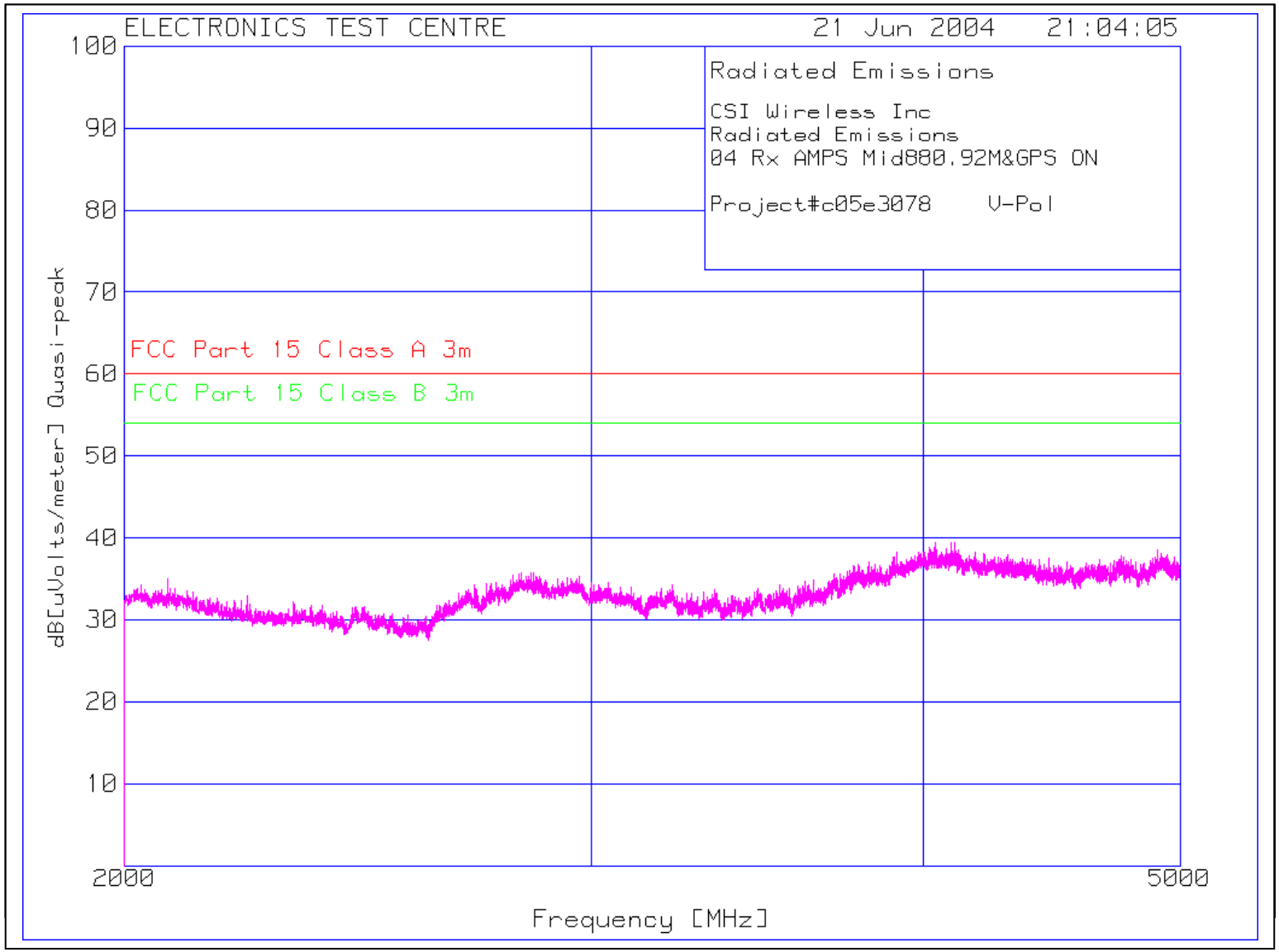
Plot of Radiated Emissions:



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4.3 RF POWER OUTPUT (§ 2.1046)

Test Lab: Electronics Test Centre (Airdrie) Test Personnel: David Raynes Test Date: 21 June 2004		Product: AL411	
Test Result, AL411: **PASS**			
Objectives/Criteria The effective radiated power emitted by a device at its carrier frequency, measured at the antenna terminal, shall not exceed the limits as specified.		Specifications FCC Part 22.913 $P \leq 500$ W or 57.0 dBm (Base Station) $P \leq 7$ W or 38.5 dBm (Mobile) $P_{measured} = P_{rated} \pm 1$dB	
Channel	Frequency [MHz]	P_{rated} [dBm]	$P_{measured}$ [dBm]
991	824.04	1 Watt (30.0 dBm)	-32.50 (+ 62.67 dB attenuator) = **30.17**
367	835.02	1 Watt (30.0 dBm)	-32.30 (+ 62.70 dB attenuator) = **30.40**
799	848.97	1 Watt (30.0 dBm)	-32.30 (+ 62.72 dB attenuator) = **30.42**

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4.4 MODULATION CHARACTERISTICS (§ 2.1047)

Test Lab: SignalCraft Technologies Inc. (Calgary) Test Personnel: Les Yu (CSI Wireless) Test Date: 23 August 2004	Product: AL411
Test Result: AL411: PASS	
Objectives/Criteria	Specifications
Cellular transmitters must be equipped with circuitry that automatically prevents modulation levels for voice transmissions from exceeding the limits specified. Show modulation limiting capability throughout the range of modulating frequencies and input modulating signal levels.	FCC Part 2.1047(b) The modulation deviation limit is 12kHz.
Comments: Refer to the test data plots for more details. Noise level from unmodulated transmitter is 0.300 kHz (50Hz HPF, >99kHz LP)	

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Modulation Characteristics: Modulation Frequency constant at 300Hz

Modulation Input (mV)	FM Deviation including noise (kHz)	FM Deviation minus noise (kHz)	FCC Limit (kHz)	Pass/Fail
1	0.37	0.070	12.00	
2	0.47	0.170	12.00	
4	0.663	0.363	12.00	Pass
6	0.880	0.580	12.00	Pass
8	1.232	0.932	12.00	Pass
10	1.440	1.140	12.00	Pass
12	1.670	1.370	12.00	Pass
14	1.910	1.610	12.00	Pass
16	2.121	1.821	12.00	Pass
18	2.370	2.070	12.00	Pass
20	2.620	2.320	12.00	Pass
22	2.820	2.520	12.00	Pass
24	3.070	2.770	12.00	Pass
26	3.320	3.020	12.00	Pass
28	3.520	3.220	12.00	Pass
30	3.770	3.470	12.00	Pass
35	4.377	4.077	12.00	Pass
40	4.970	4.670	12.00	Pass
45	5.570	5.270	12.00	Pass
50	6.188	5.888	12.00	Pass
55	6.860	6.560	12.00	Pass
60	7.460	7.160	12.00	Pass
65	8.050	7.750	12.00	Pass
70	8.630	8.330	12.00	Pass
75	9.070	8.770	12.00	Pass
80	9.790	9.490	12.00	Pass
85	10.150	9.850	12.00	Pass
90	10.560	10.260	12.00	Pass
95	11.300	11.000	12.00	Pass
100	11.850	11.550	12.00	Pass
200	8.779	8.479	12.00	Pass
300	10.600	10.300	12.00	Pass
400	11.050	10.750	12.00	Pass
500	11.000	10.700	12.00	Pass

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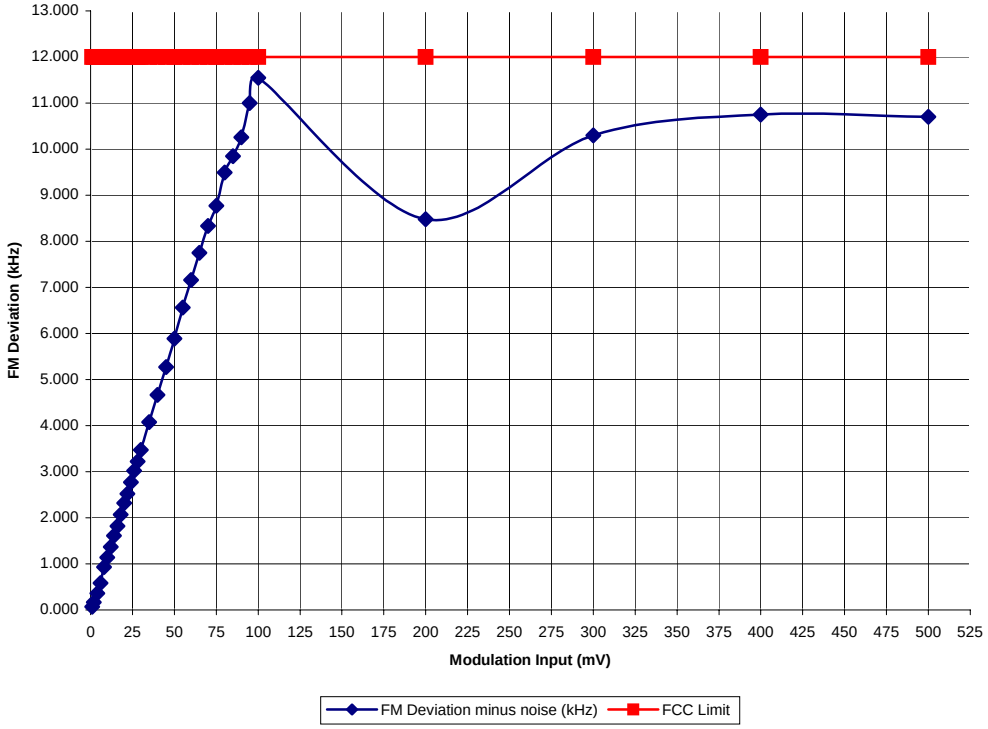
AL4xx Deviation Limting Characteristics - 300Hz tone



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Modulation Characteristics: Modulation Frequency constant at 1000Hz

Modulation Input (mV)	FM Deviation including noise (kHz)	FM Deviation minus noise (kHz)	FCC Limit (kHz)	Pass/Fail
1	0.622	0.322	12.00	
2	1.124	0.824	12.00	
4	1.960	1.660	12.00	Pass
6	2.840	2.540	12.00	Pass
8	3.735	3.435	12.00	Pass
10	4.490	4.190	12.00	Pass
12	5.400	5.100	12.00	Pass
14	6.330	6.030	12.00	Pass
16	7.070	6.770	12.00	Pass
18	7.990	7.690	12.00	Pass
20	8.890	8.590	12.00	Pass
22	9.640	9.340	12.00	Pass
24	10.550	10.250	12.00	Pass
26	11.340	11.040	12.00	Pass
28	11.460	11.160	12.00	Pass
30	11.620	11.320	12.00	Pass
35	11.530	11.230	12.00	Pass
40	11.700	11.400	12.00	Pass
45	11.330	11.030	12.00	Pass
50	11.300	11.000	12.00	Pass
55	11.700	11.400	12.00	Pass
60	11.500	9.340	12.00	Pass
65	11.650	11.350	12.00	Pass
70	11.400	11.100	12.00	Pass
75	11.430	11.130	12.00	Pass
80	11.300	11.000	12.00	Pass
85	11.480	11.180	12.00	Pass
90	11.450	11.150	12.00	Pass
95	11.350	11.050	12.00	Pass
100	11.280	10.980	12.00	Pass
200	11.890	11.590	12.00	Pass
300	11.180	10.880	12.00	Pass
400	10.930	10.630	12.00	Pass
500	11.080	10.780	12.00	Pass

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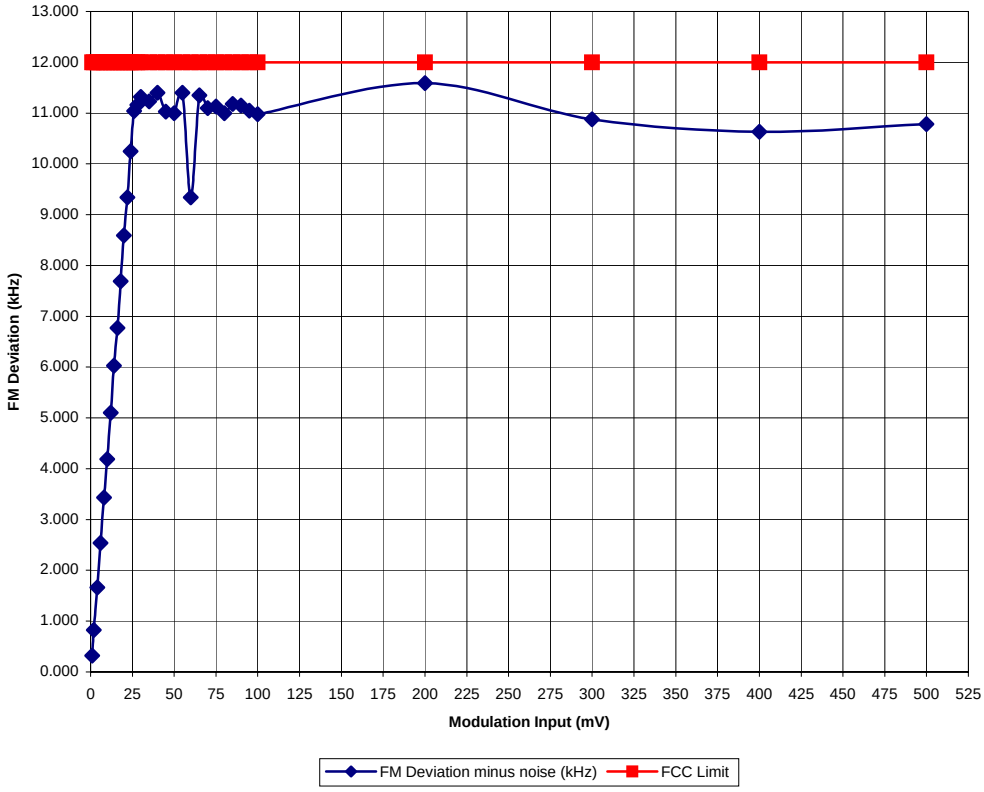
AL4xx Deviation Limiting Characteristics - 1000Hz tone



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Modulation Characteristics: Modulation Frequency constant at 3000Hz

Modulation Input (mV)	FM Deviation including noise (kHz)	FM Deviation minus noise (kHz)	FCC Limit (kHz)	Pass/Fail
1	1.08	0.780	12.00	
2	2.1	1.800	12.00	
4	3.910	3.610	12.00	Pass
6	5.760	5.460	12.00	Pass
8	7.690	7.390	12.00	Pass
10	8.540	8.240	12.00	Pass
12	8.430	8.130	12.00	Pass
14	8.430	8.130	12.00	Pass
16	8.460	8.160	12.00	Pass
18	8.560	8.260	12.00	Pass
20	8.580	8.280	12.00	Pass
22	8.440	8.140	12.00	Pass
24	8.450	8.150	12.00	Pass
26	8.520	8.220	12.00	Pass
28	8.580	8.280	12.00	Pass
30	8.430	8.130	12.00	Pass
35	8.450	8.150	12.00	Pass
40	8.450	8.150	12.00	Pass
45	8.500	8.200	12.00	Pass
50	8.470	8.170	12.00	Pass
55	8.440	8.140	12.00	Pass
60	8.500	8.200	12.00	Pass
65	8.450	8.150	12.00	Pass
70	8.570	8.270	12.00	Pass
75	8.580	8.280	12.00	Pass
80	8.480	8.180	12.00	Pass
85	8.430	8.130	12.00	Pass
90	8.530	8.230	12.00	Pass
95	8.460	8.160	12.00	Pass
100	8.480	8.180	12.00	Pass
200	8.550	8.250	12.00	Pass
300	8.470	8.170	12.00	Pass
400	8.445	8.145	12.00	Pass
500	8.440	8.140	12.00	Pass

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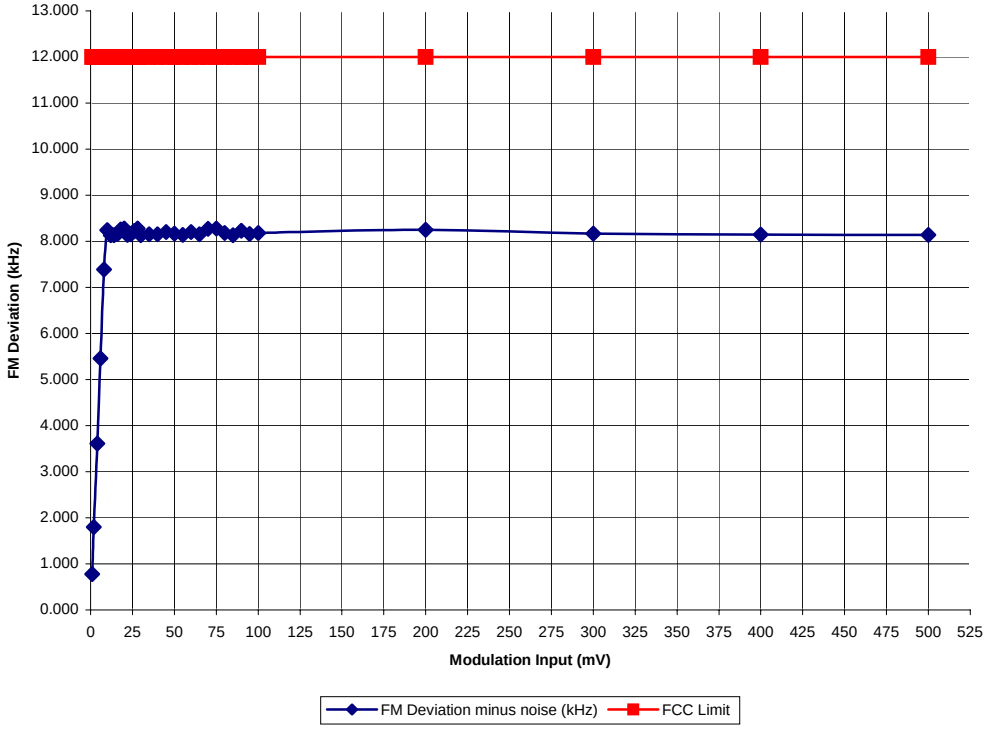
AL4xx Deviation Limiting Characteristics - 3000Hz tone



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4.5 MODULATION REQUIREMENTS (§ 22.915)

Test Lab: SignalCraft Technologies Inc. (Calgary) Test Personnel: Les Yu (CSI Wireless) Test Date: 20 August 2004	Product: AL411
Test Result: AL411: PASS	
Objectives/Criteria	Specifications
The cellular radio shall have its transmit audio frequency deviation response follow the prescribed 6dB/octave pre-emphasis characteristic. Radiotelephony signals applied to the modulator from the modulation limiter must be attenuated as a function of frequency as specified.	FCC Part 22.915(d) From 300-3000Hz, the audio response shall not vary more than +1 to –3dB from a true 6dB / octave pre-emphasis characteristic relative to 1kHz (with the exception of a permissible 6dB / octave roll-off from 2.5-3.0kHz). Signals must be attenuated, relative to 3kHz, as follows: 3-5.9kHz and 6.1-15kHz by –40 log (f/3) dB, 5.9-6.1kHz by –35dB, > 15kHz by –28dBm
Comments: Input level at 6.1mV from 300-3000Hz and 90mV from 3-15kHz Noise level from unmodulated transmitter is 0.300 kHz (50Hz HPF, >99kHz LP)	

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Modulation Requirements – Deviation from Microphone Input:

Modulation Frequency (Hz)	FM Deviation including noise (kHz)	FM Deviation minus noise (kHz)	FM Deviation relative to 1kHz (kHz)	FM Deviation relative to 3kHz (kHz)	FCC Limit (kHz)	Upper Limit (kHz)	Lower Limit (kHz)	Pass/ Fail
100	0.305	0.005	-54.35					
200	0.4	0.100	-28.33					
300	0.980	0.680	-11.68		-10.46	-9.46	-13.46	Pass
400	1.320	1.020	-8.16		-7.96	-6.96	-10.96	Pass
500	1.580	1.280	-6.19		-6.02	-5.02	-9.02	Pass
600	1.850	1.550	-4.53		-4.44	-3.44	-7.44	Pass
700	2.120	1.820	-3.13		-3.10	-2.10	-6.10	Pass
800	2.390	2.090	-1.93		-1.94	-0.94	-4.94	Pass
900	2.650	2.350	-0.91		-0.92	0.08	-3.92	Pass
1000	2.910	2.610	0.00		0.00	1.00	-3.00	Pass
1200	3.390	3.090	1.47		1.58	2.58	-1.42	Pass
1400	3.870	3.570	2.72		2.92	3.92	-0.08	Pass
1600	4.380	4.080	3.88		4.08	5.08	1.08	Pass
1800	4.980	4.680	5.07		5.11	6.11	2.11	Pass
2000	5.650	5.350	6.23		6.02	7.02	3.02	Pass
2200	6.440	6.140	7.43		6.85	7.85	3.85	Pass
2400	7.190	6.890	8.43		7.60	8.60	4.60	Pass
2500	7.430	7.130	8.73		7.96	8.96	4.96	Pass
2600	7.500	7.200	8.81		7.96	8.96	4.96	Pass
2700	7.360	7.060	8.64		7.96	8.96	4.96	Pass
2800	6.980	6.680	8.16		7.96	8.96	4.96	Pass
2900	6.450	6.150	7.44		7.96	8.96	4.96	Pass
3000.000	5.850	5.550	6.55		7.96	8.96	4.96	Pass

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Modulation Frequency (Hz)	FM Deviation including noise (kHz)	FM Deviation minus noise (kHz)	FM Deviation relative to 1kHz (kHz)	FM Deviation relative to 3kHz (kHz)	FCC Limit (kHz)	Upper Limit (kHz)	Lower Limit (kHz)	Pass/ Fail
3000	8.480	8.180		0.00	0			Pass
3100	7.970	7.670		-0.56	-0.57			Pass
3200	7.520	7.220		-1.08	-1.12			Pass
3300	6.900	6.600		-1.86	-1.66			Pass
3400	5.090	4.790		-4.65	-2.17			Pass
3500	2.640	2.340		-10.87	-2.68			Pass
4000	0.470	0.170		-33.65	-5			Pass
4500	0.490	0.190		-32.68	-7.04			Pass
5000	0.440	0.140		-35.33	-8.87			Pass
5500	0.610	0.310		-28.43	-10.5			Pass
5800	0.350	0.050		-44.28	-11.5			Pass
5900	0.340	0.040		-46.21	-35			Pass
6000	0.330	0.030		-48.71	-35			Pass
6100	0.330	0.030		-48.71	-35			Pass
6200	0.320	0.020		-52.23	-12.6			Pass
6500	0.310	0.010		-58.26	-13.4			Pass
7000	0.301	0.001		-78.26	-14.7			Pass
7500	0.301	0.001		-78.26	-15.9			Pass
8000	0.301	0.001		-78.26	-17			Pass
8500	0.301	0.001		-78.26	-18.1			Pass
9000	0.301	0.001		-78.26	-19.1			Pass
9500	0.301	0.001		-78.26	-20			Pass
10000	0.301	0.001		-78.26	-20.9			Pass
11000	0.301	0.001		-78.26	-22.6			Pass
12000	0.301	0.001		-78.26	-24.1			Pass
13000	0.301	0.001		-78.26	-25.5			Pass
14000	0.301	0.001		-78.26	-26.8			Pass
15000	0.301	0.001		-78.26	-28			Pass
16000	0.301	0.001		-78.26	-28			Pass
17000	0.301	0.001		-78.26	-28			Pass
18000	0.301	0.001		-78.26	-28			Pass
19000	0.301	0.001		-78.26	-28			Pass
20000	0.301	0.001		-78.26	-28			Pass
21000	0.301	0.001		-78.26	-28			Pass
22000	0.301	0.001		-78.26	-28			Pass
23000	0.301	0.001		-78.26	-28			Pass
24000	0.301	0.001		-78.26	-28			Pass
25000	0.301	0.001		-78.26	-28			Pass
26000	0.301	0.001		-78.26	-28			Pass
27000	0.301	0.001		-78.26	-28			Pass
28000	0.301	0.001		-78.26	-28			Pass
29000	0.301	0.001		-78.26	-28			Pass
30000	0.301	0.001		-78.26	-28			Pass

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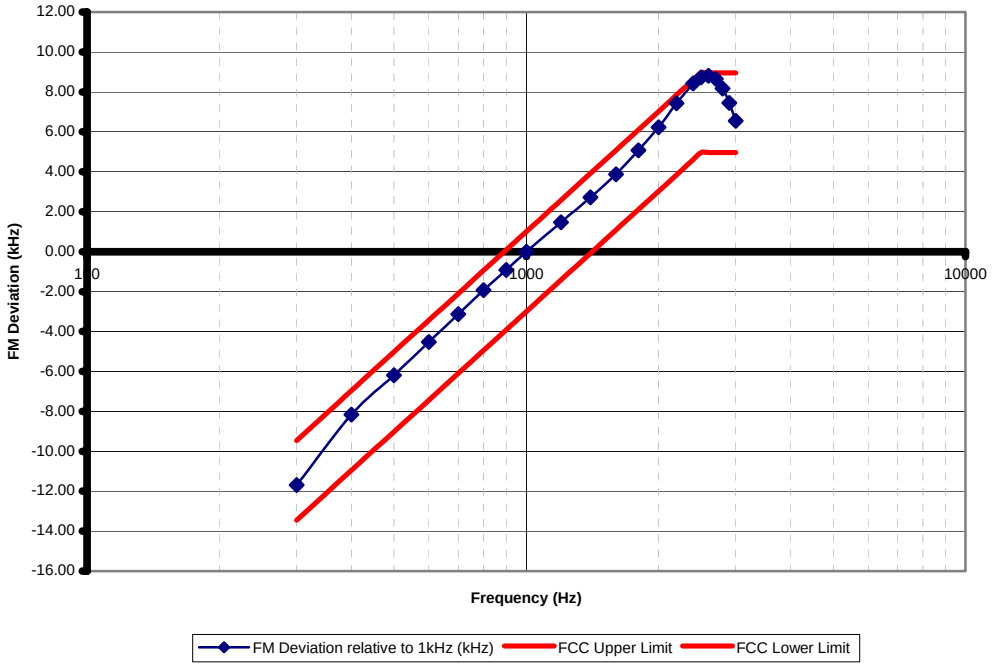
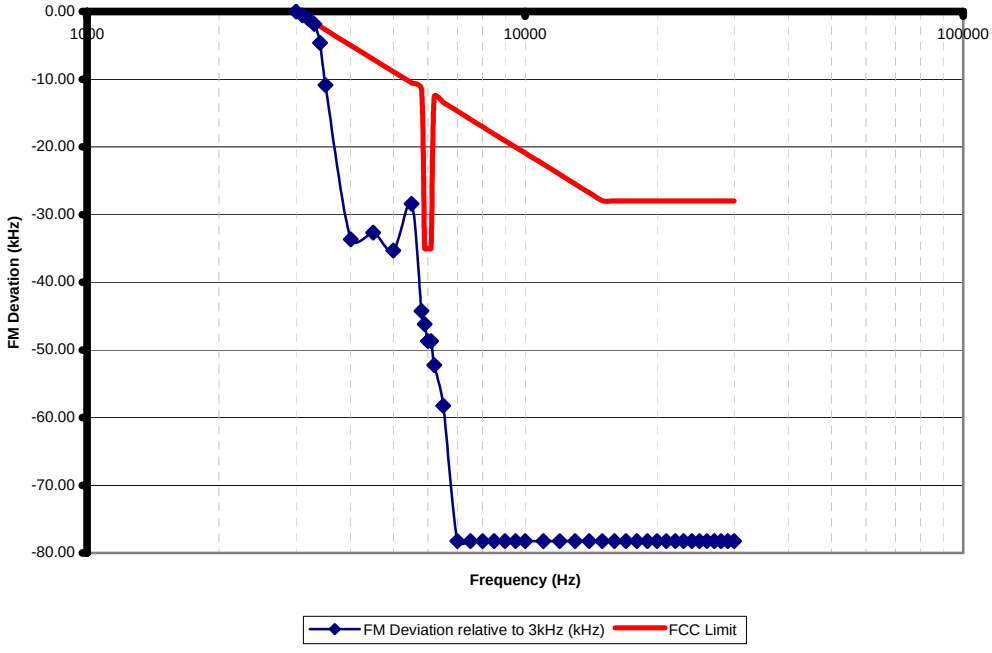
FM Deviation relative to 1kHz (300Hz-3000Hz)



FM Deviation relative to 3kHz (3kHz-30kHz)



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4.6 OCCUPIED BANDWIDTH (§ 2.1049)

Test Lab: SignalCraft Technologies Inc. (Calgary) Test Personnel: Les Yu (CSI Wireless) Test Date: 23 August 2004	Product: AL411

Test Result: AL411: PASS

Objectives/Criteria

The occupied bandwidth shall be measured at its antenna terminal at the carrier frequency such that:

99.0% of the total mean power (area under the curve of spectral density vs. frequency) emitted by the device is within the occupied bandwidth;

0.5% of the total mean power lies below the lower frequency limit of the occupied bandwidth; and

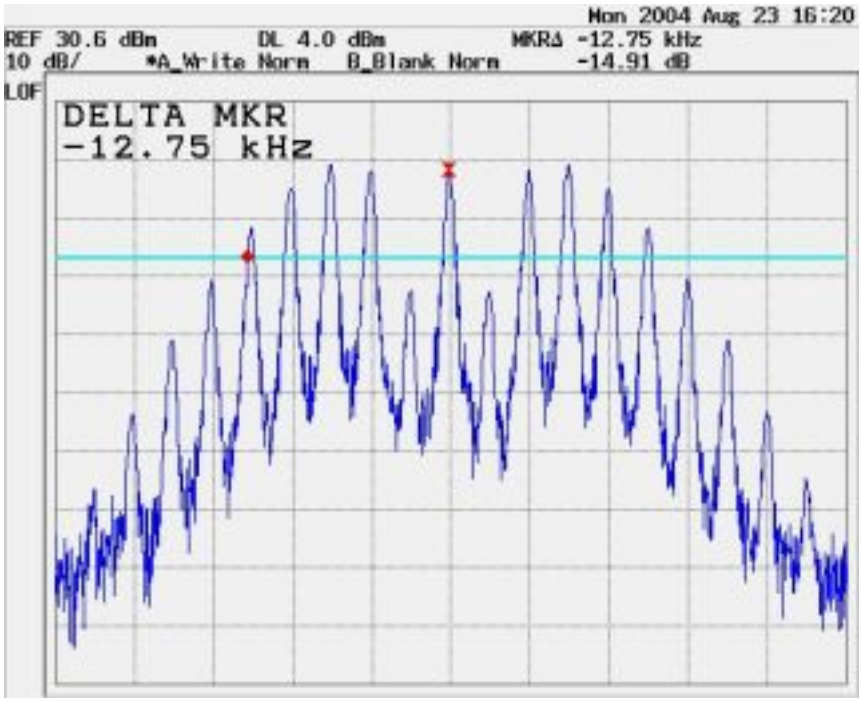
0.5% of the total mean power lies above the higher frequency limit of the occupied bandwidth

Specifications: FCC Part 2.1049(c)

The occupied bandwidth and channel spacing for the AL411 is 30kHz.

Channel	Frequency [MHz]	Occupied Bandwidth [kHz]
367	836.01	25.5

Screenshot of occupied bandwidth measurement:



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4.7 EMISSION LIMITS FOR CELLULAR (§ 22.917)

Test Lab: SignalCraft Technologies Inc. (Calgary) Test Personnel: Les Yu (CSI Wireless) Test Date: 20 August 2004	Product: AL411
Test Result: AL411: PASS	
Objectives/Criteria	Specifications
The emissions limits govern the spectral characteristics of emissions in the cellular radiotelephone service as specified below the mean power of the unmodulated carrier.	FCC Part 22.917(b)(d) Mask is defined as: > +/- 20kHz, -26dB > +/- 45kHz, -45dB > +/- 90 kHz up to 1st harmonic, -60dB or –(43+10 log P) dB (whichever is the lesser attenuation)
Comments: Voice modulating signal at 2.5kHz @ 284mV	

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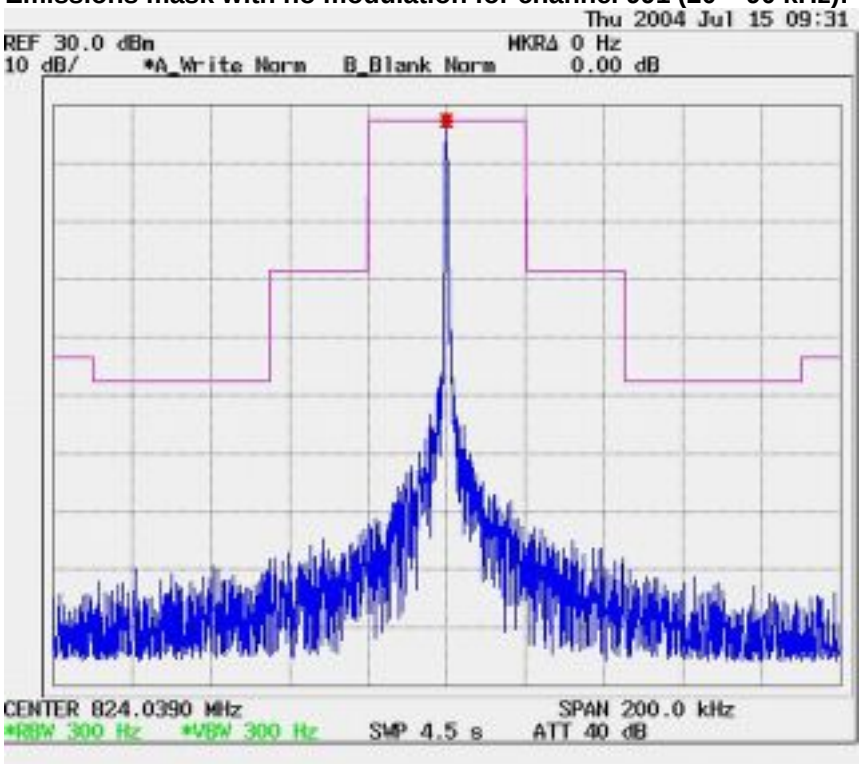
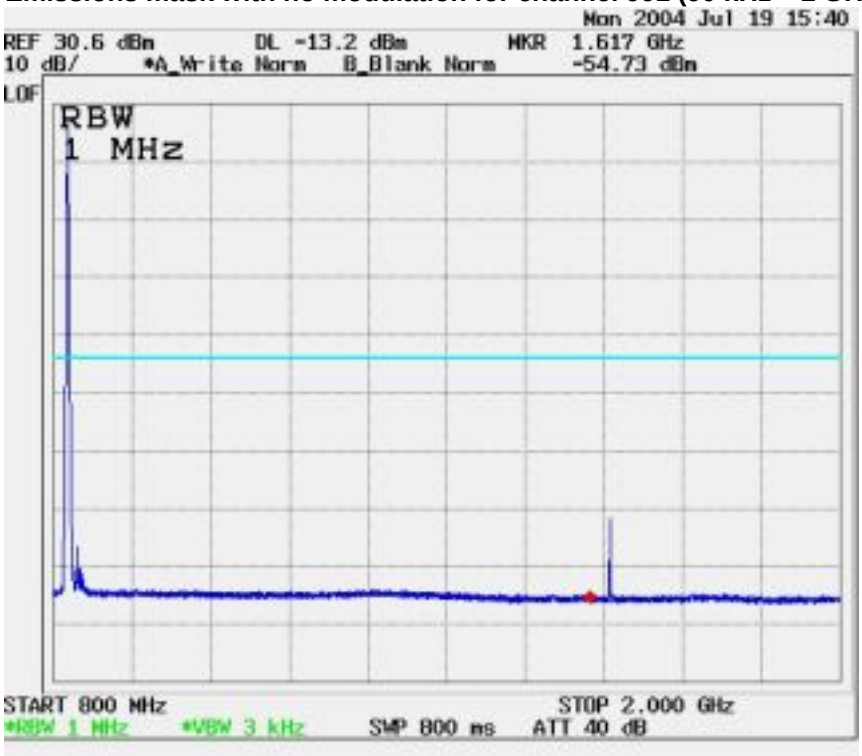
Emissions mask with no modulation for channel 991 (20 – 90 kHz):



Emissions mask with no modulation for channel 991 (90 kHz – 2 GHz):



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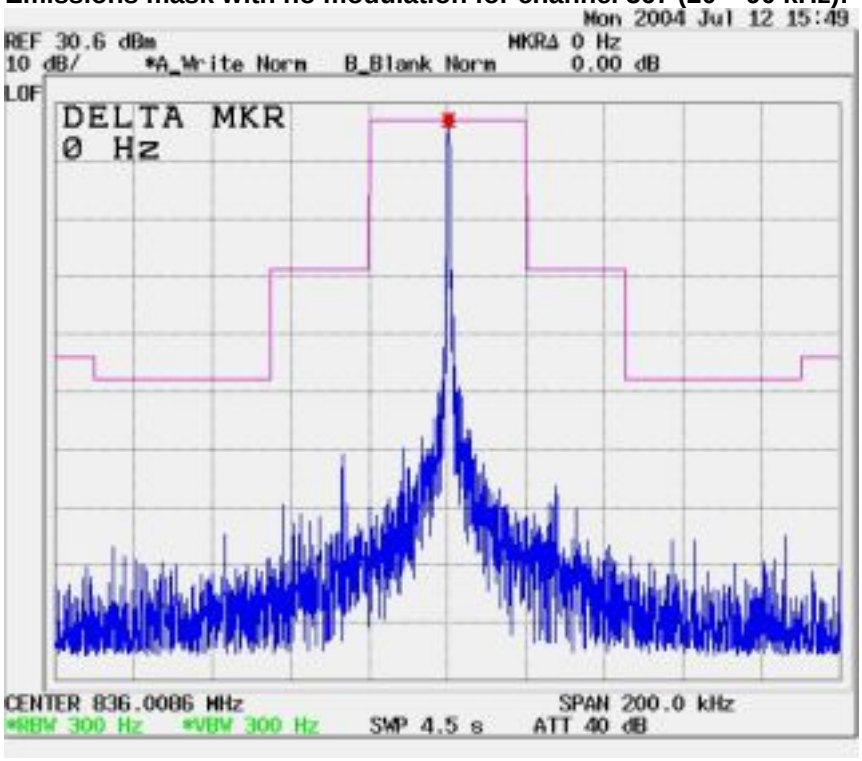
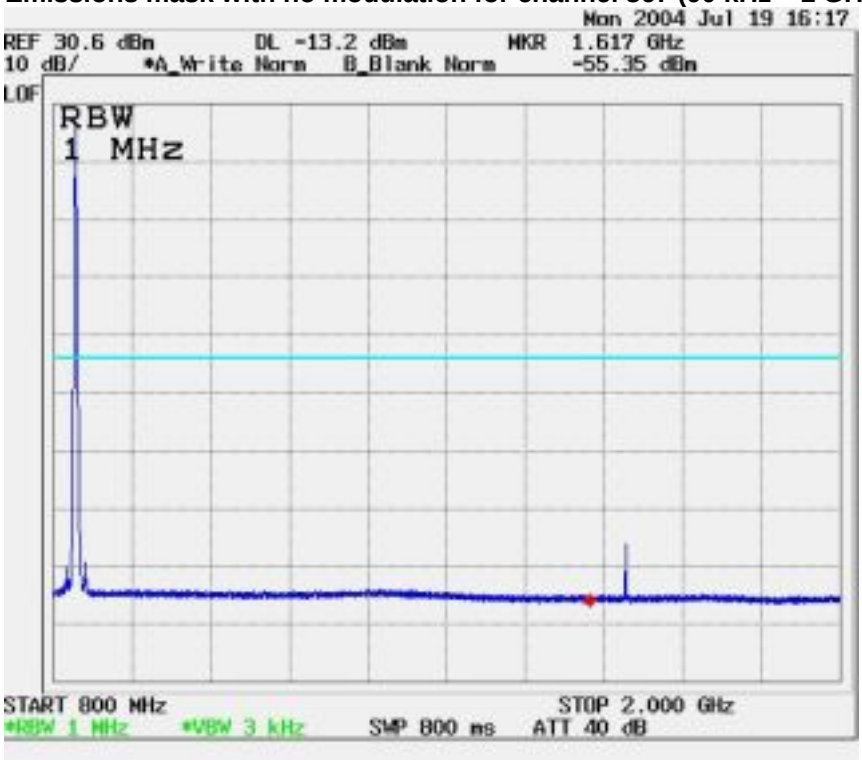
Emissions mask with no modulation for channel 367 (20 – 90 kHz):



Emissions mask with no modulation for channel 367 (90 kHz – 2 GHz):



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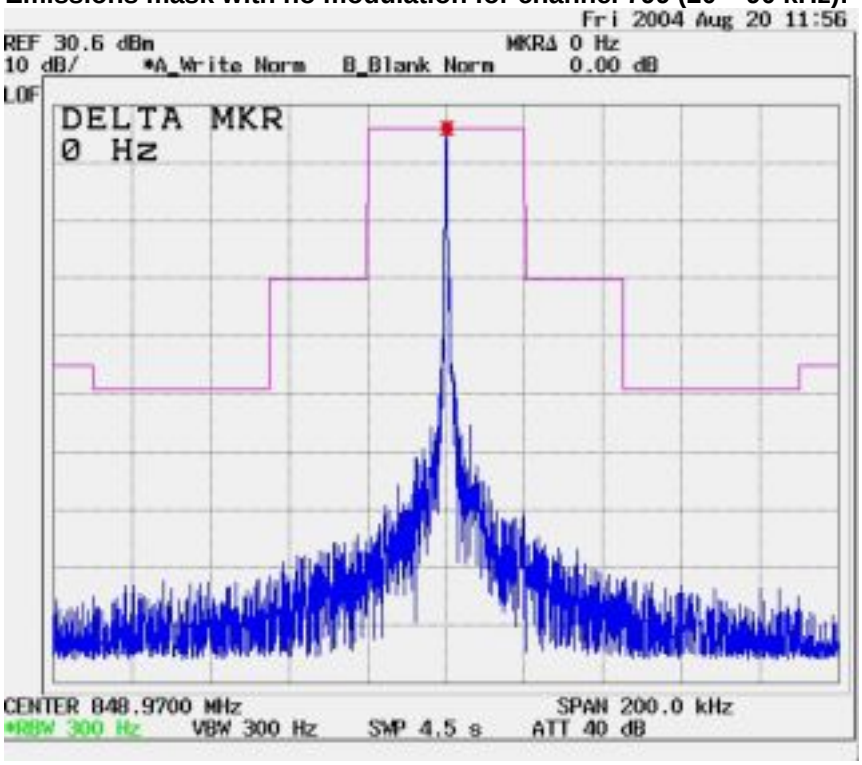
Emissions mask with no modulation for channel 799 (20 – 90 kHz):



Emissions mask with no modulation for channel 799 (90 kHz – 2 GHz):

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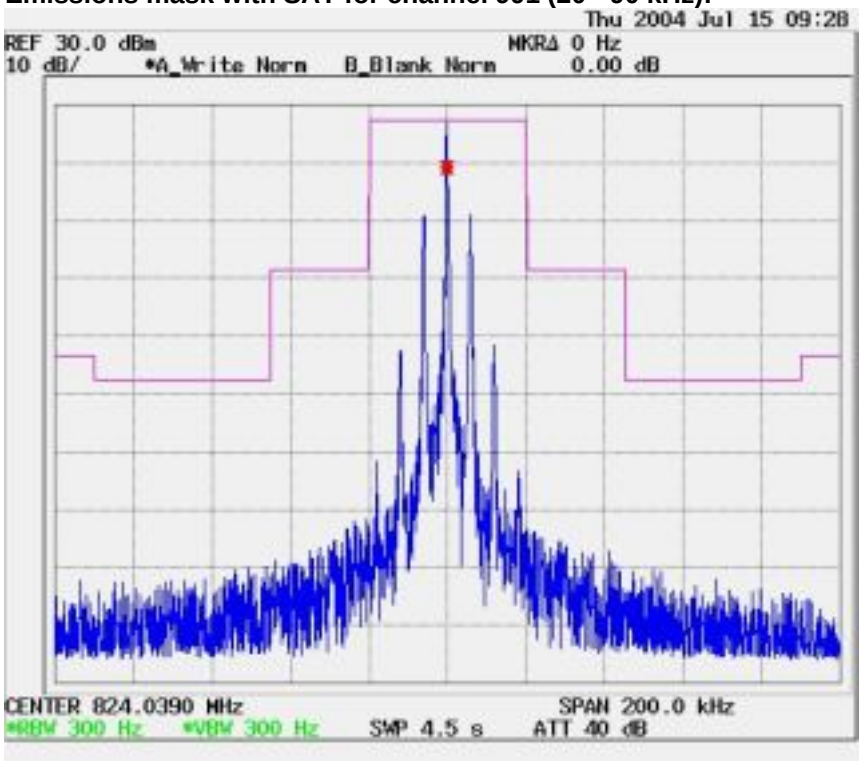
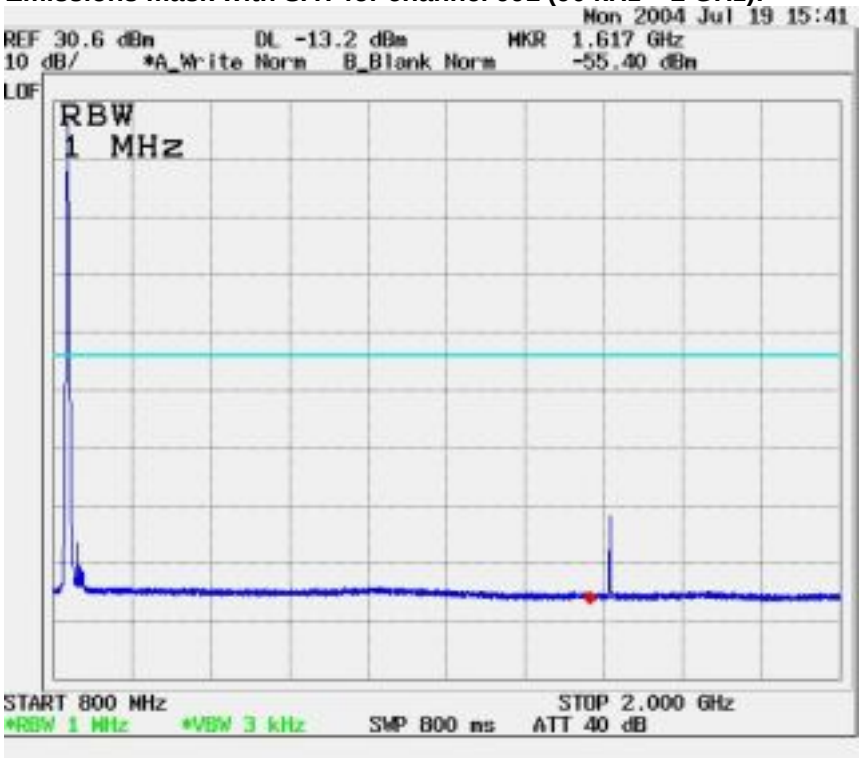
Emissions mask with SAT for channel 991 (20 - 90 kHz):



Emissions mask with SAT for channel 991 (90 kHz – 2 GHz):



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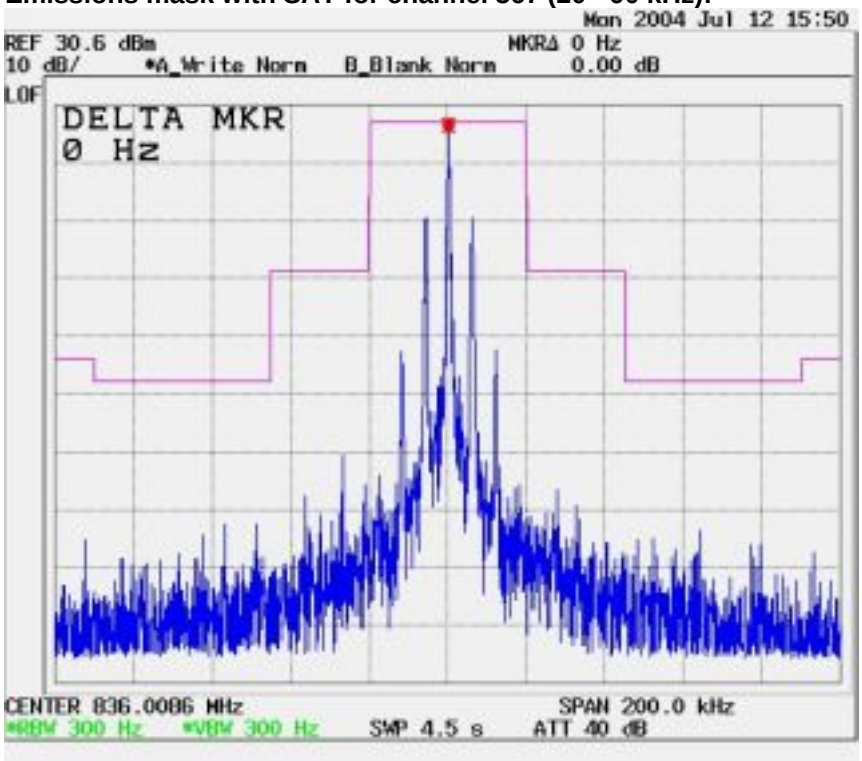
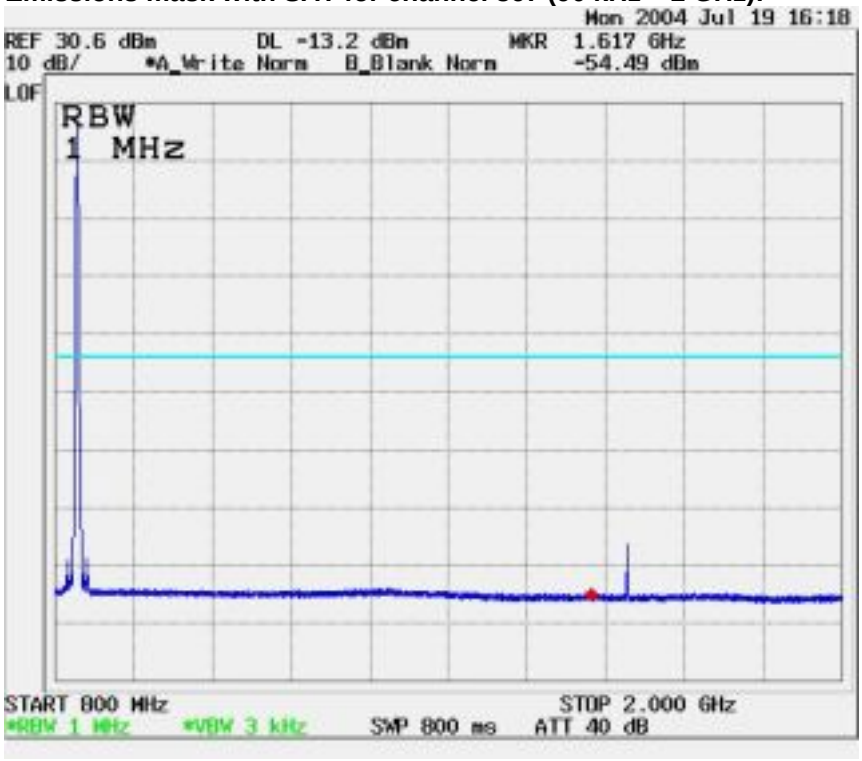
Emissions mask with SAT for channel 367 (20 - 90 kHz):



Emissions mask with SAT for channel 367 (90 kHz – 2 GHz):



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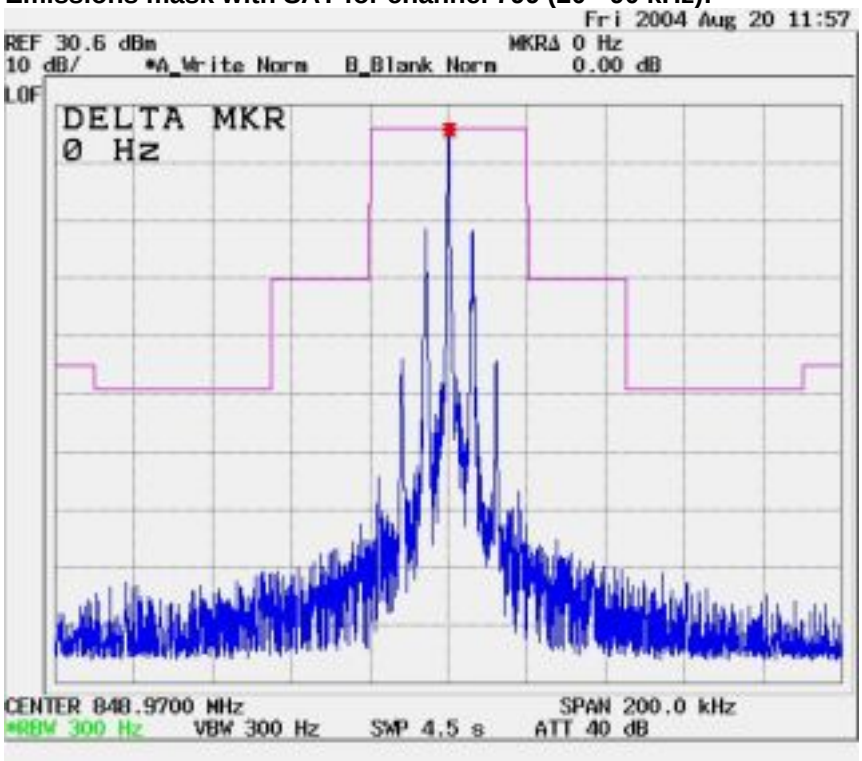
Emissions mask with SAT for channel 799 (20 - 90 kHz):



Emissions mask with SAT for channel 799 (90 kHz – 2 GHz):

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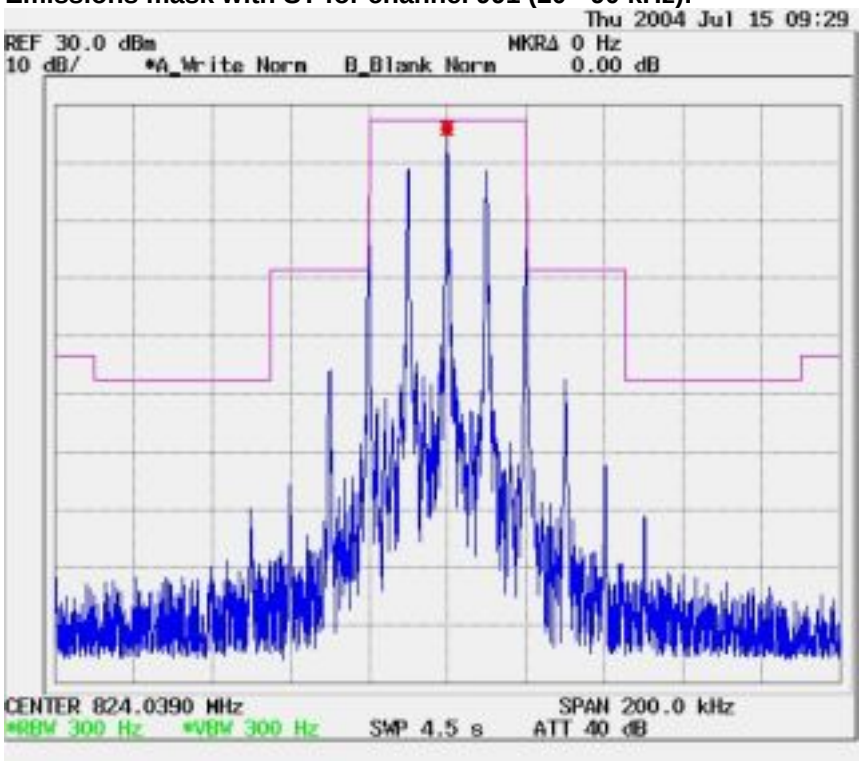
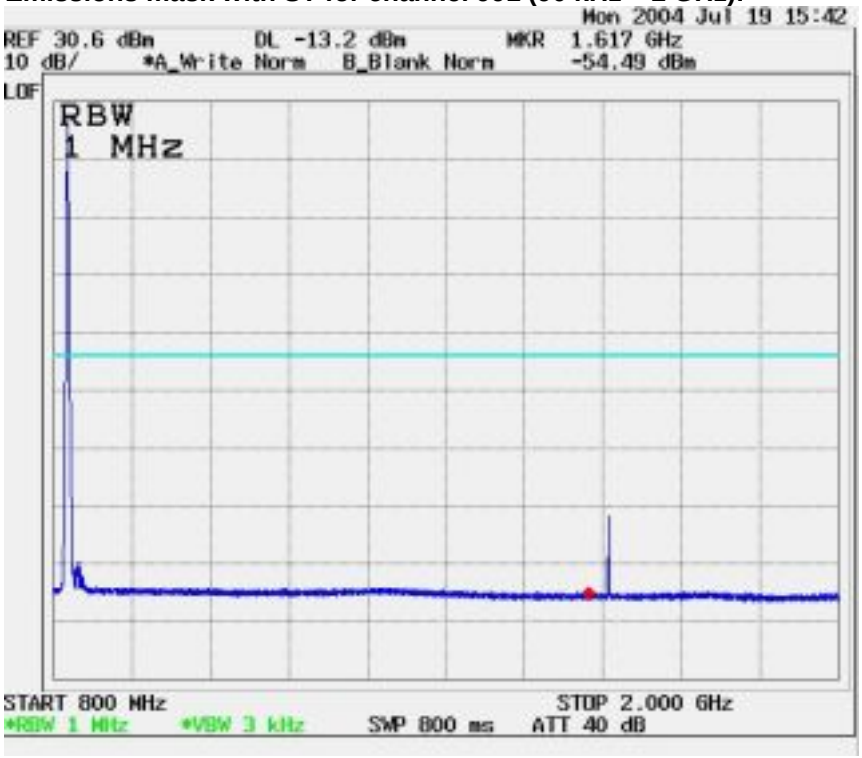
Emissions mask with ST for channel 991 (20 - 90 kHz):



Emissions mask with ST for channel 991 (90 kHz – 2 GHz):



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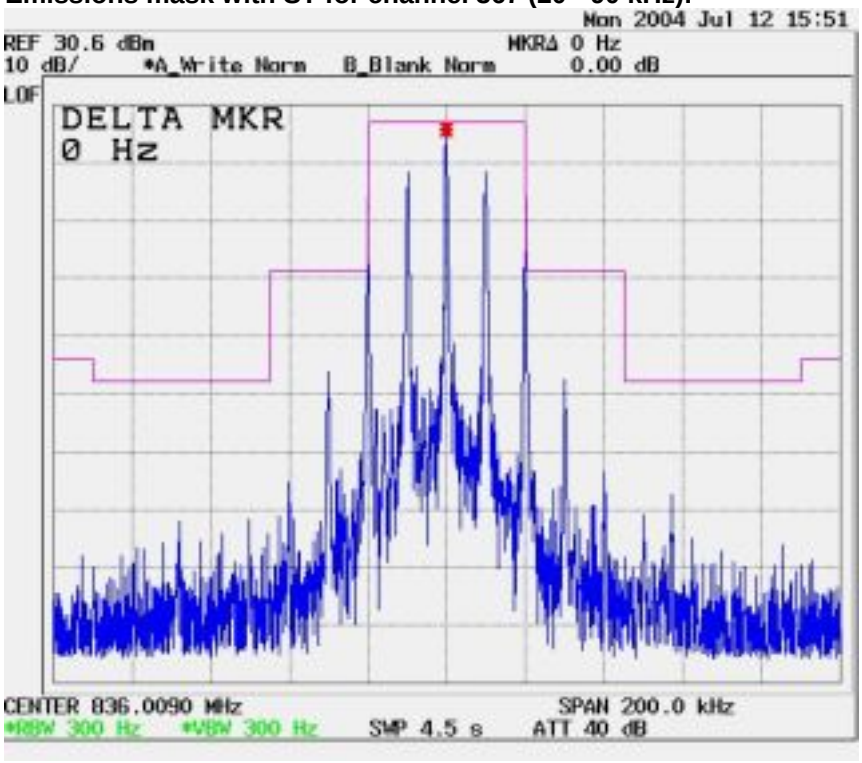
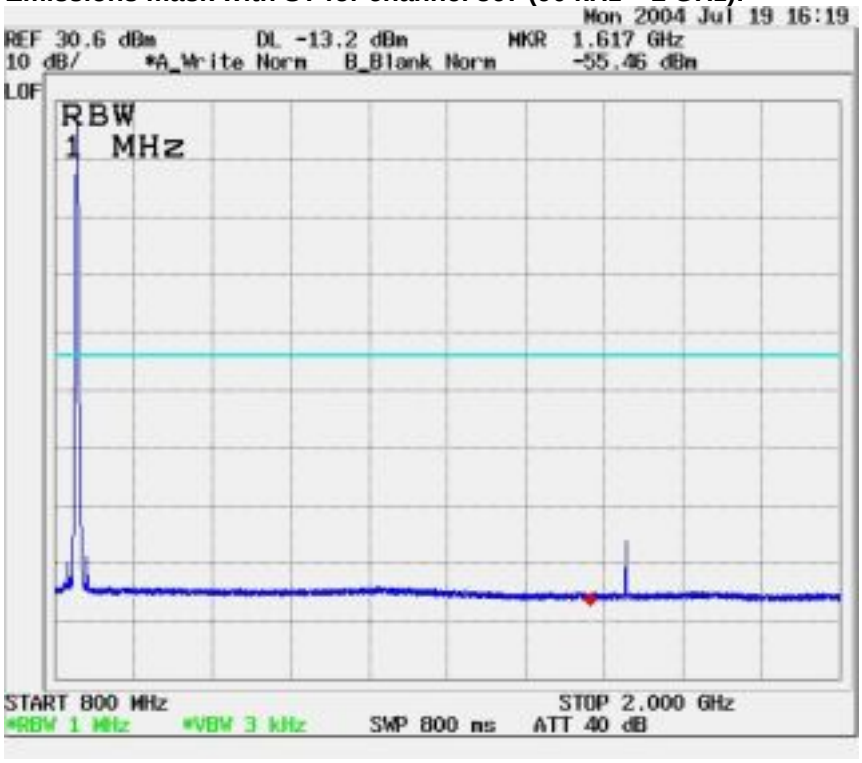
Emissions mask with ST for channel 367 (20 - 90 kHz):



Emissions mask with ST for channel 367 (90 kHz – 2 GHz):



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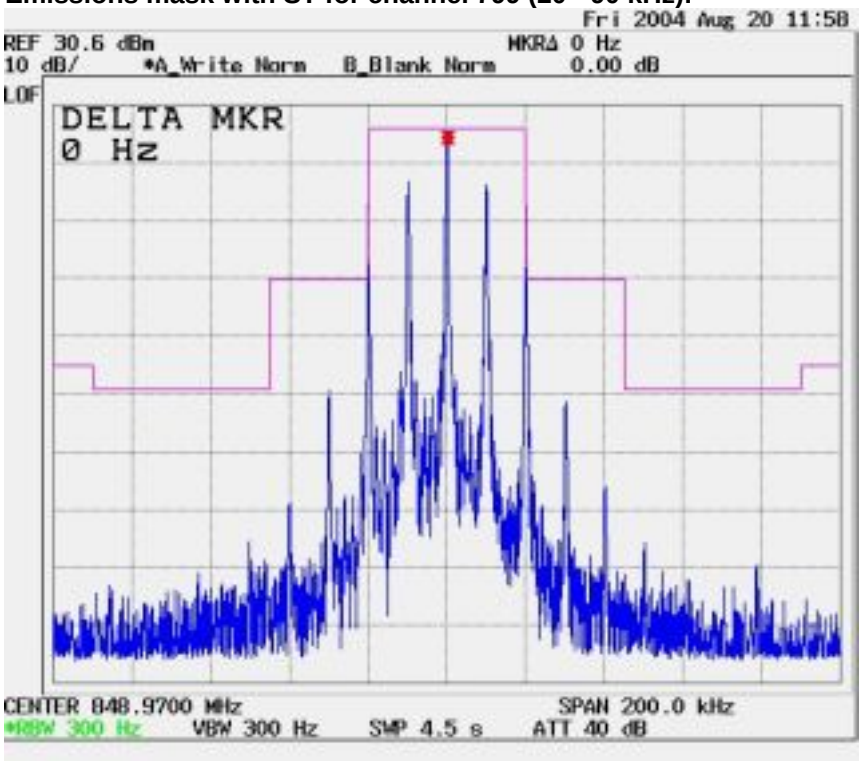
Emissions mask with ST for channel 799 (20 - 90 kHz):



Emissions mask with ST for channel 799 (90 kHz – 2 GHz):

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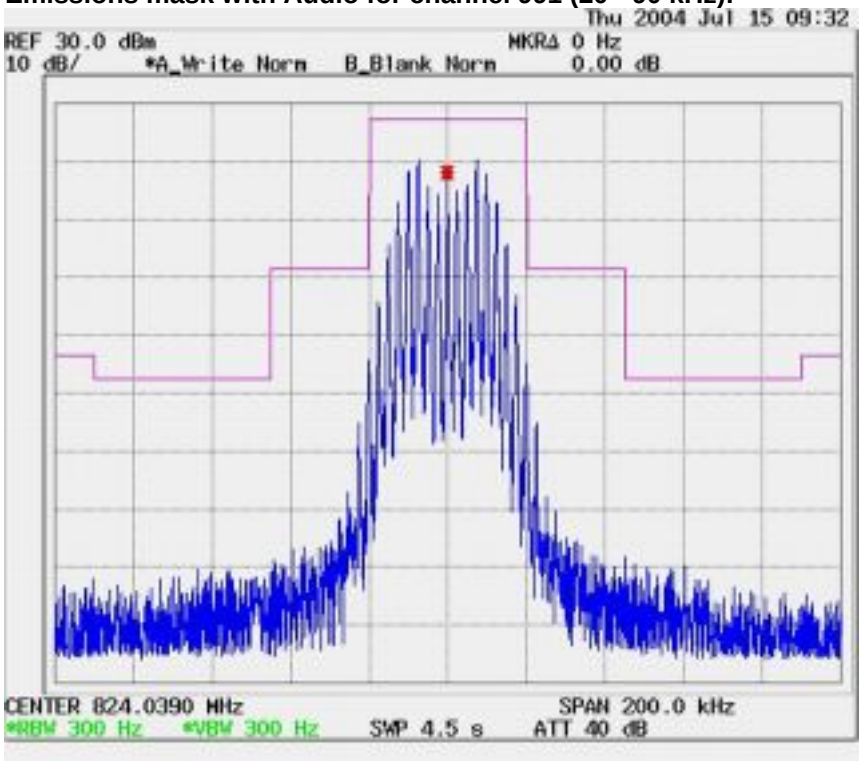
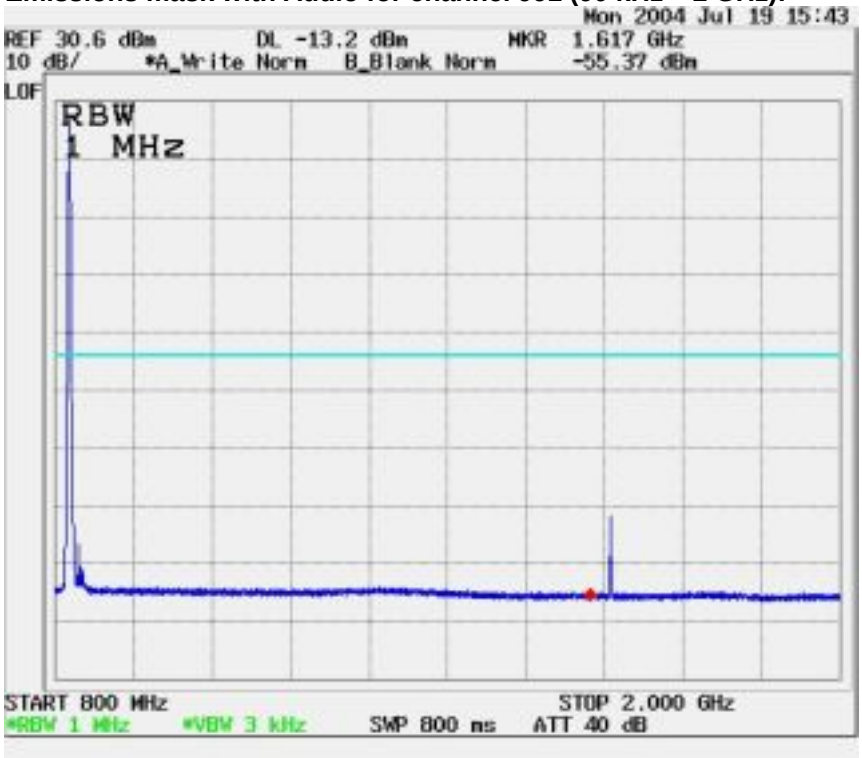
Emissions mask with Audio for channel 991 (20 - 90 kHz):



Emissions mask with Audio for channel 991 (90 kHz – 2 GHz):



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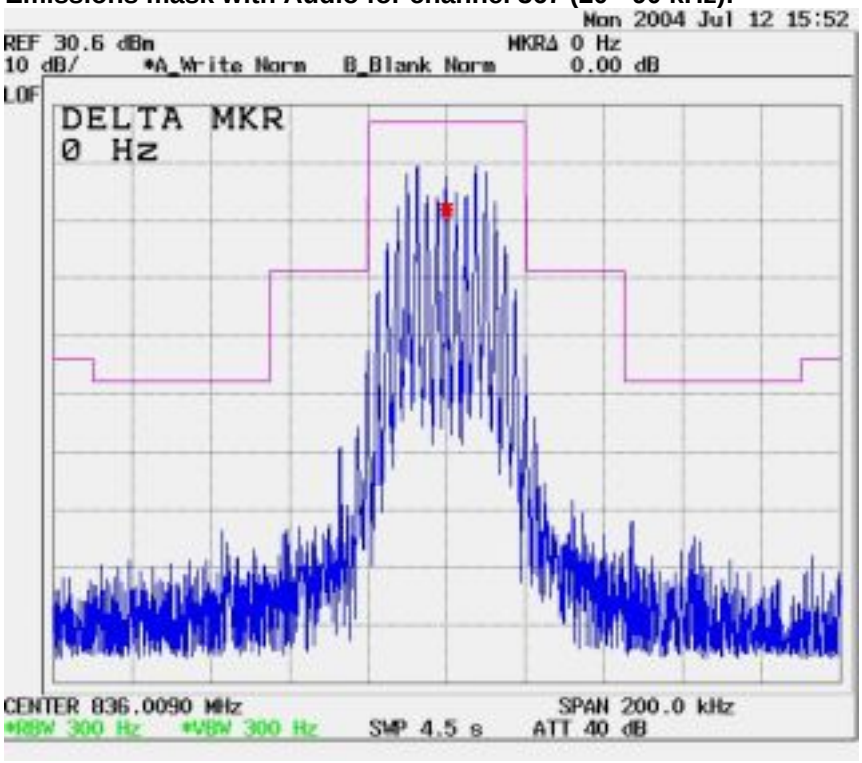
Emissions mask with Audio for channel 367 (20 - 90 kHz):



Emissions mask with Audio for channel 367 (90 kHz – 2 GHz):

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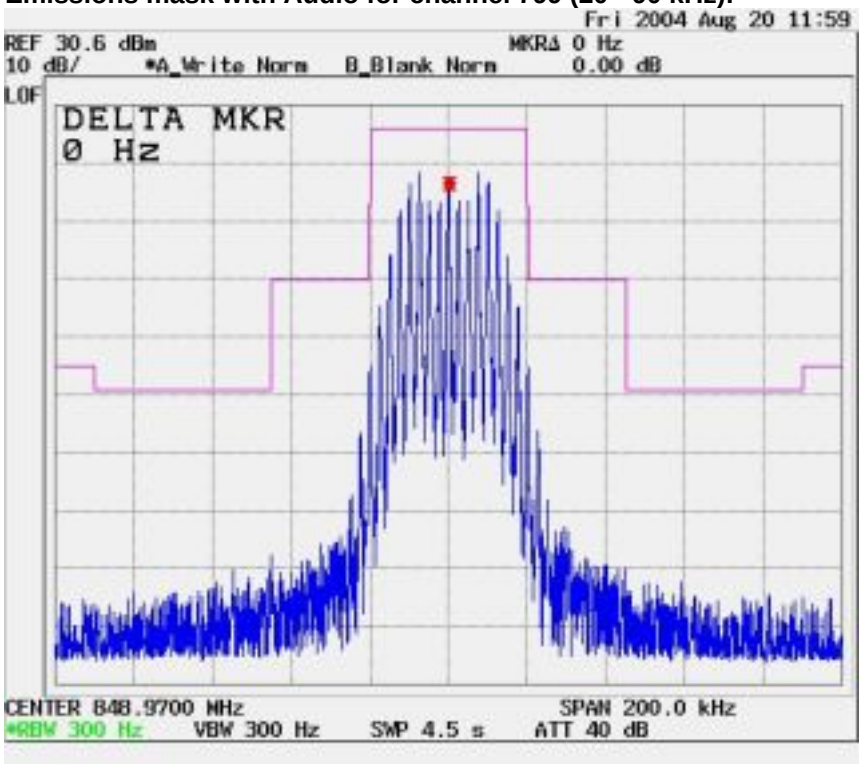
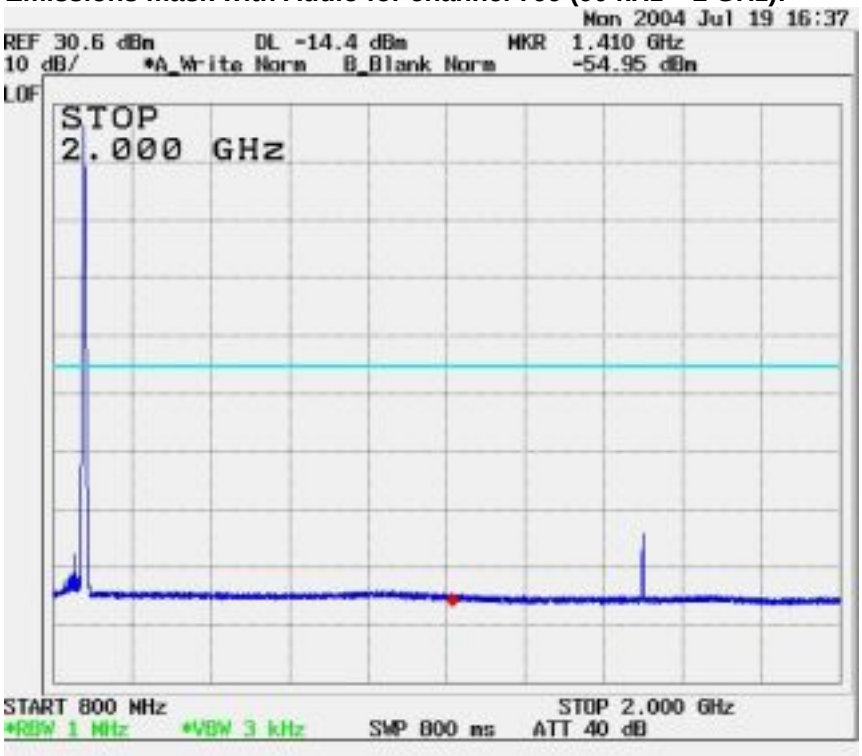
Emissions mask with Audio for channel 799 (20 - 90 kHz):



Emissions mask with Audio for channel 799 (90 kHz – 2 GHz):



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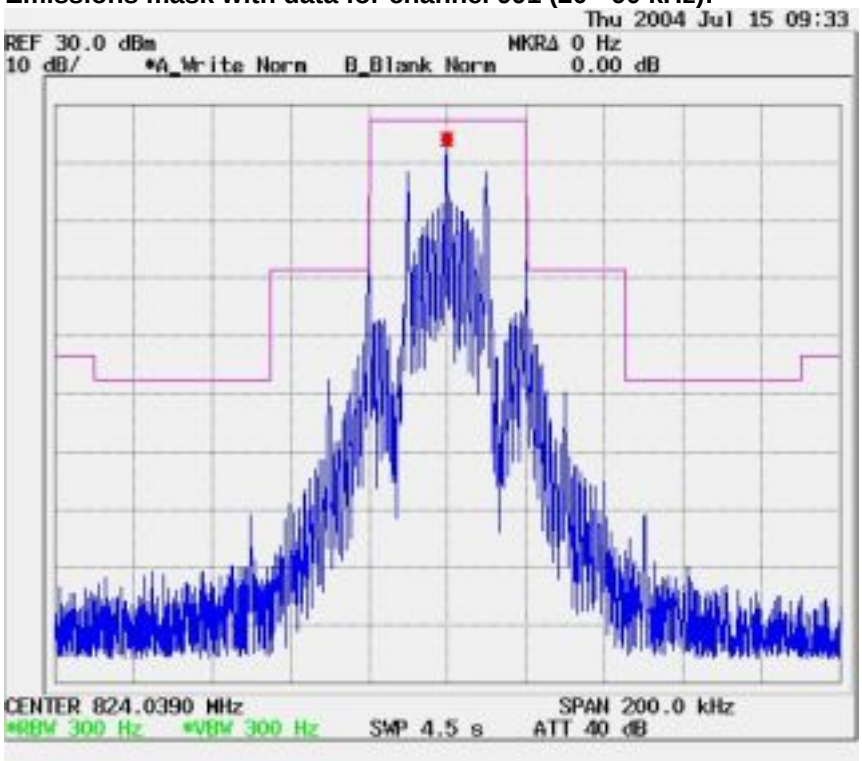
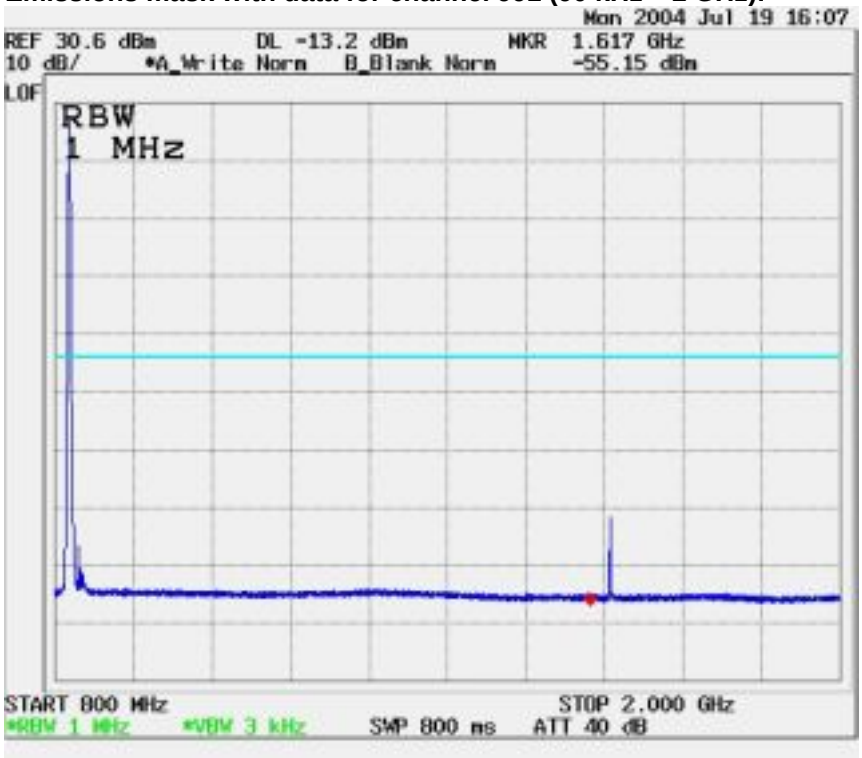
Emissions mask with data for channel 991 (20 - 90 kHz):



Emissions mask with data for channel 991 (90 kHz – 2 GHz):



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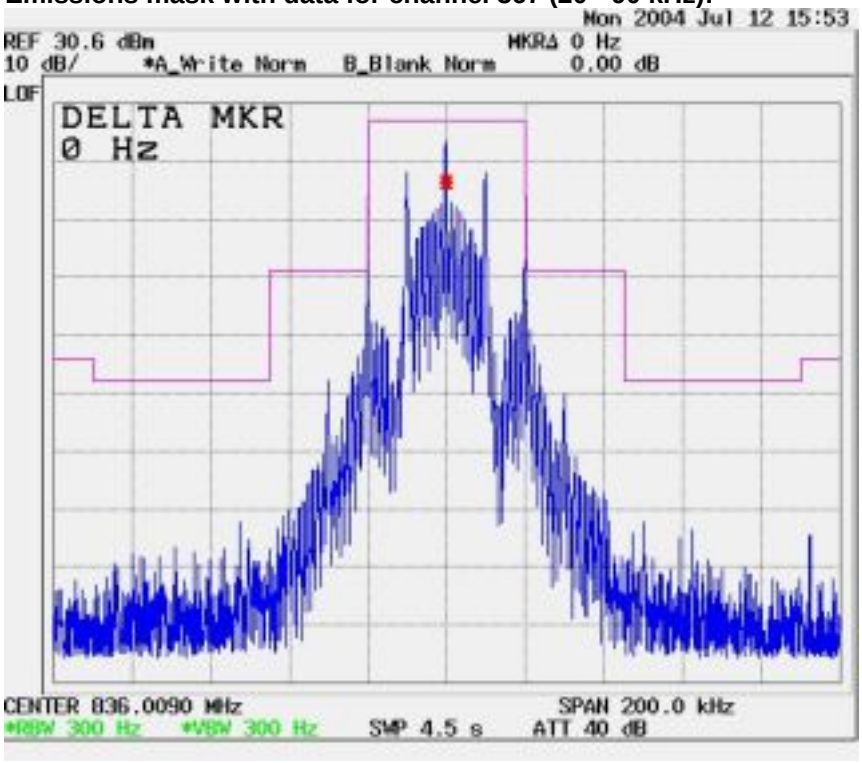
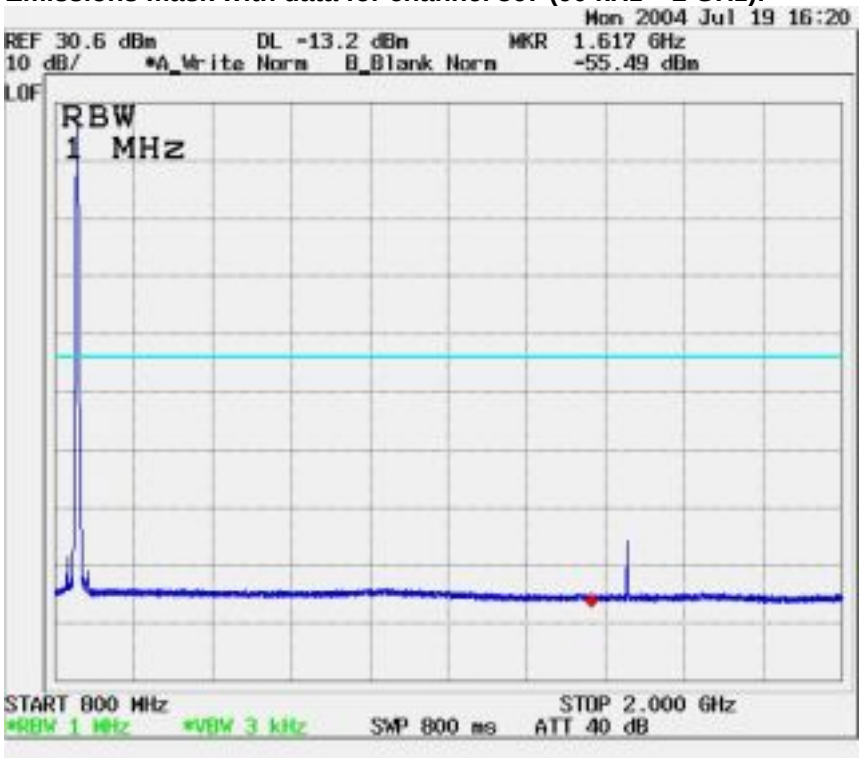
Emissions mask with data for channel 367 (20 - 90 kHz):



Emissions mask with data for channel 367 (90 kHz – 2 GHz):



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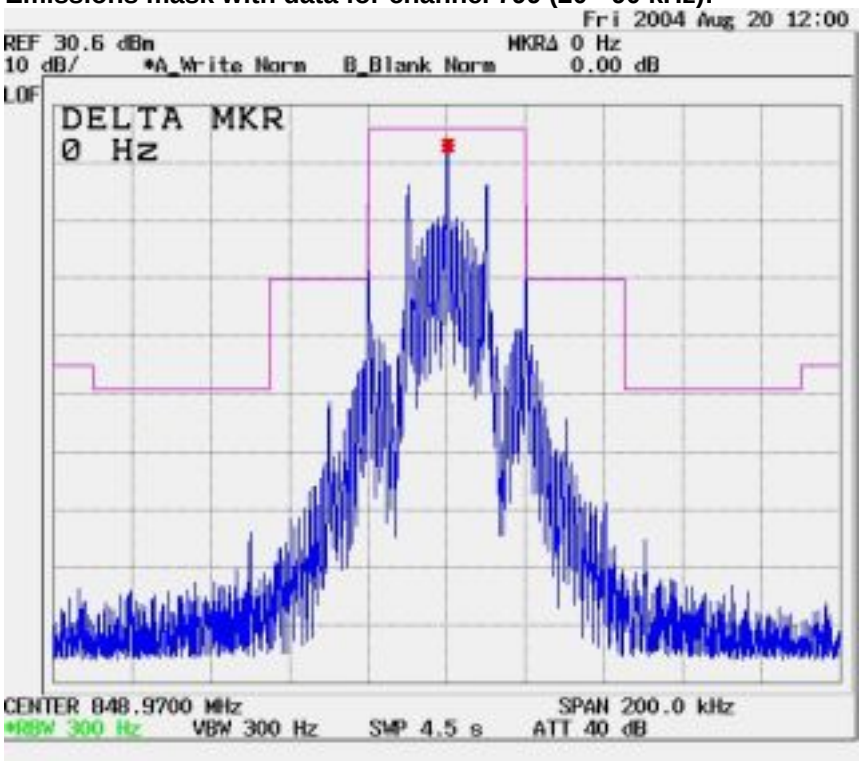
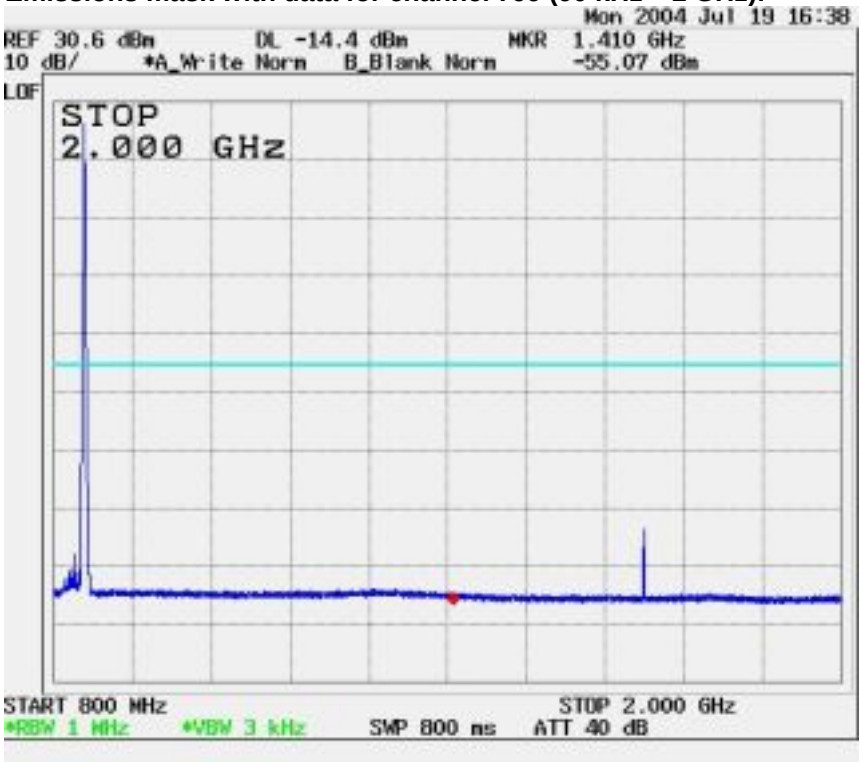
Emissions mask with data for channel 799 (20 - 90 kHz):



Emissions mask with data for channel 799 (90 kHz – 2 GHz):



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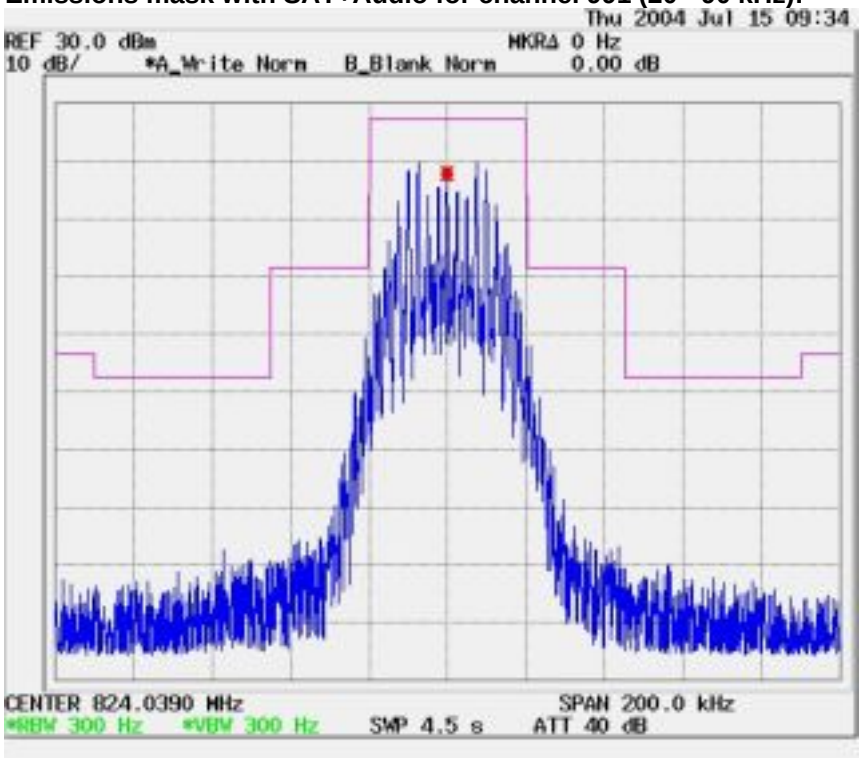
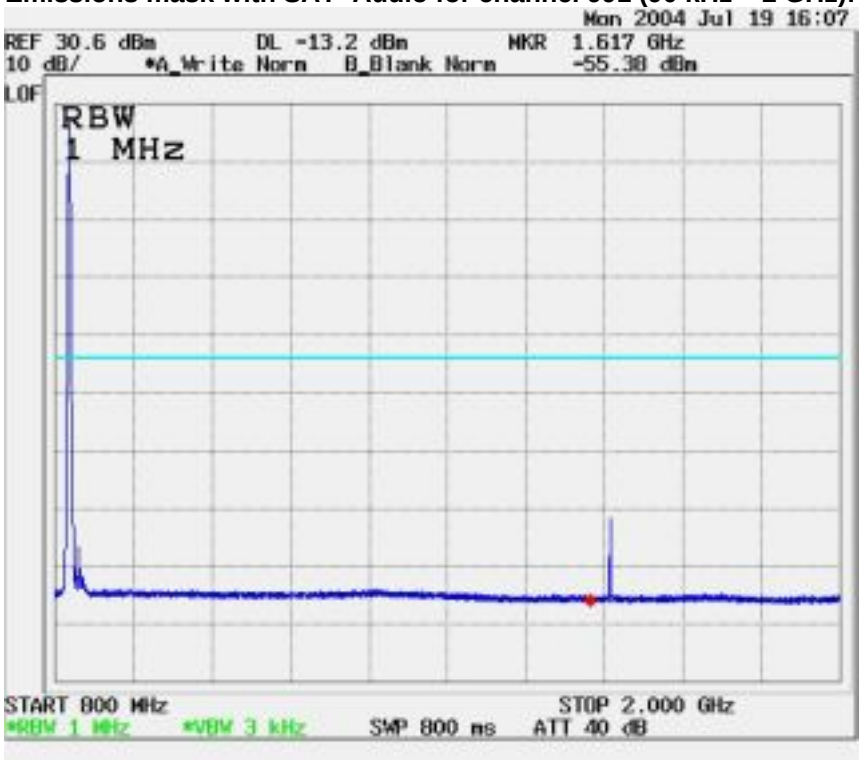
Emissions mask with SAT+Audio for channel 991 (20 - 90 kHz):



Emissions mask with SAT+Audio for channel 991 (90 kHz – 2 GHz):



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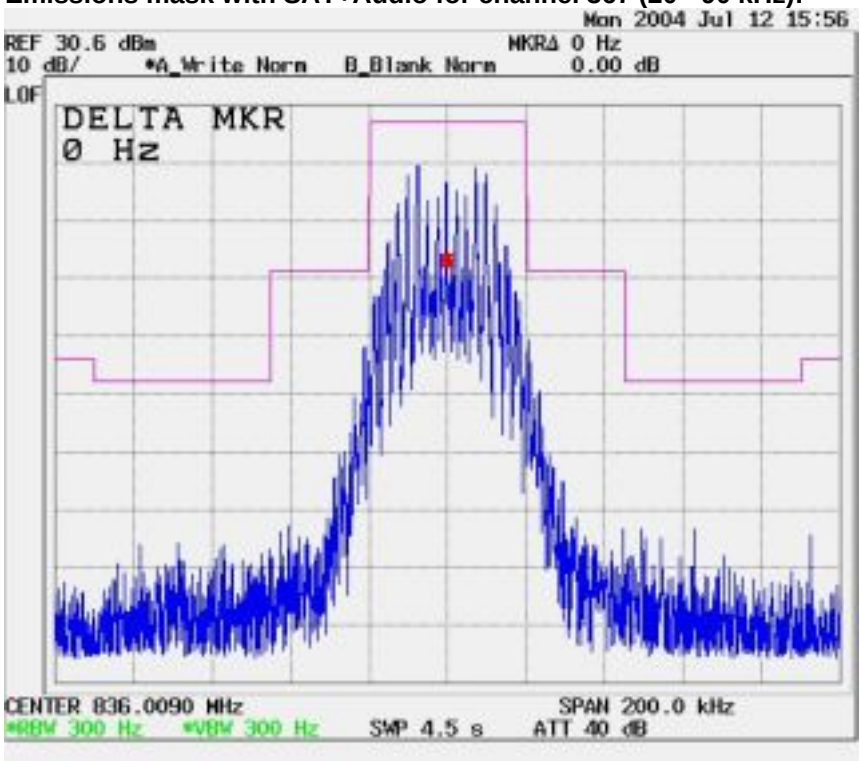
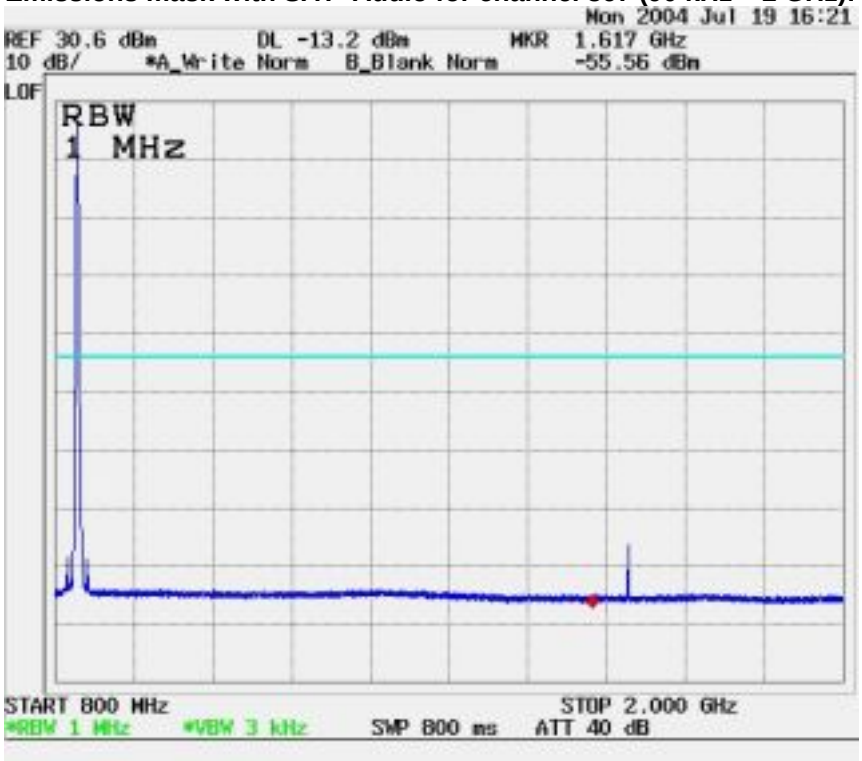
Emissions mask with SAT+Audio for channel 367 (20 - 90 kHz):



Emissions mask with SAT+Audio for channel 367 (90 kHz – 2 GHz):



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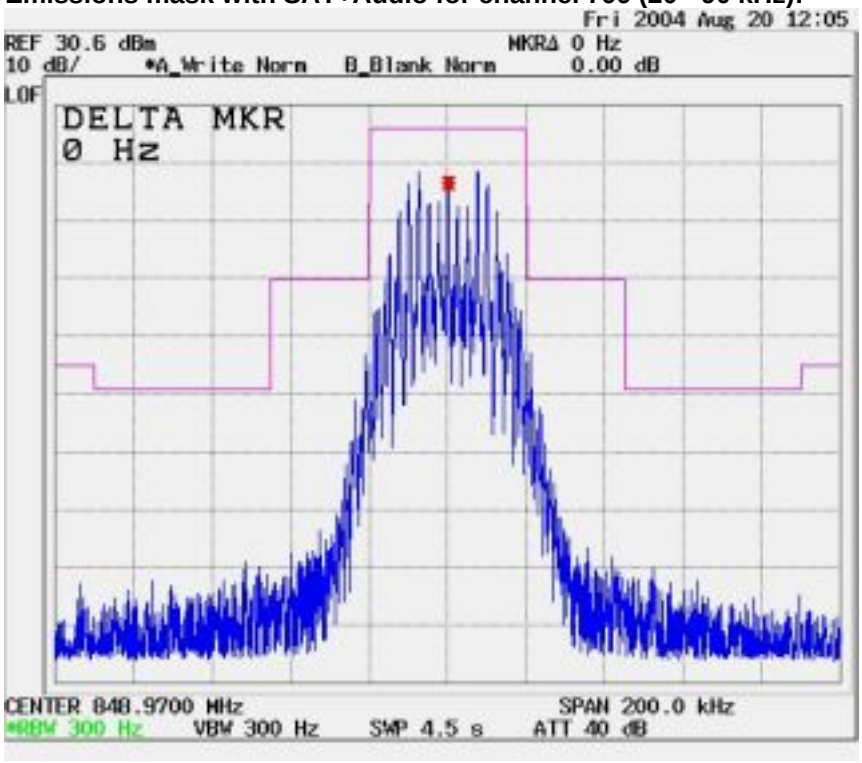
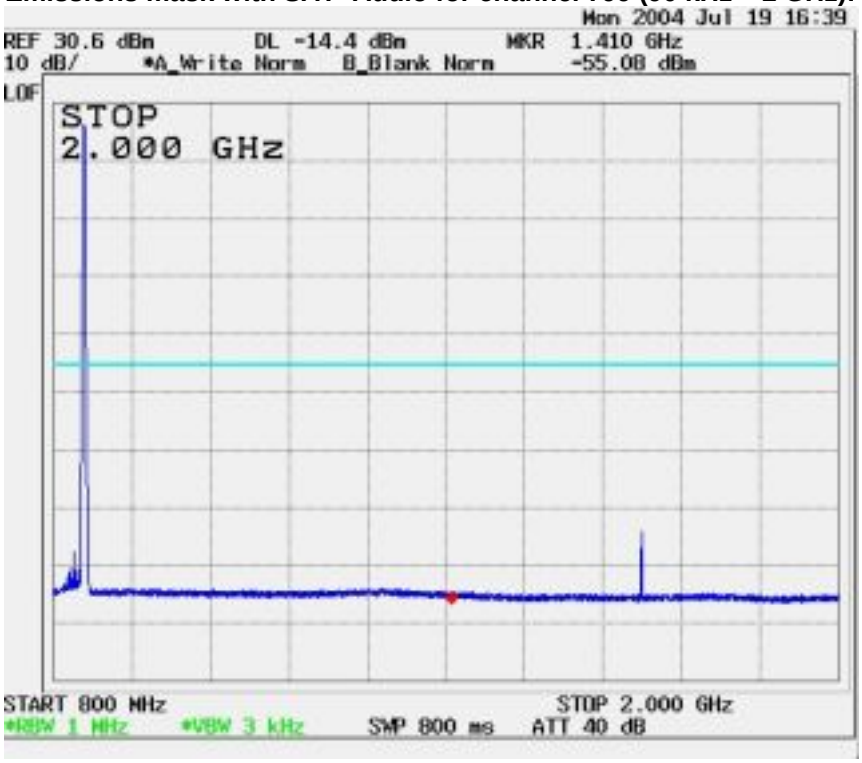
Emissions mask with SAT+Audio for channel 799 (20 - 90 kHz):



Emissions mask with SAT+Audio for channel 799 (90 kHz – 2 GHz):



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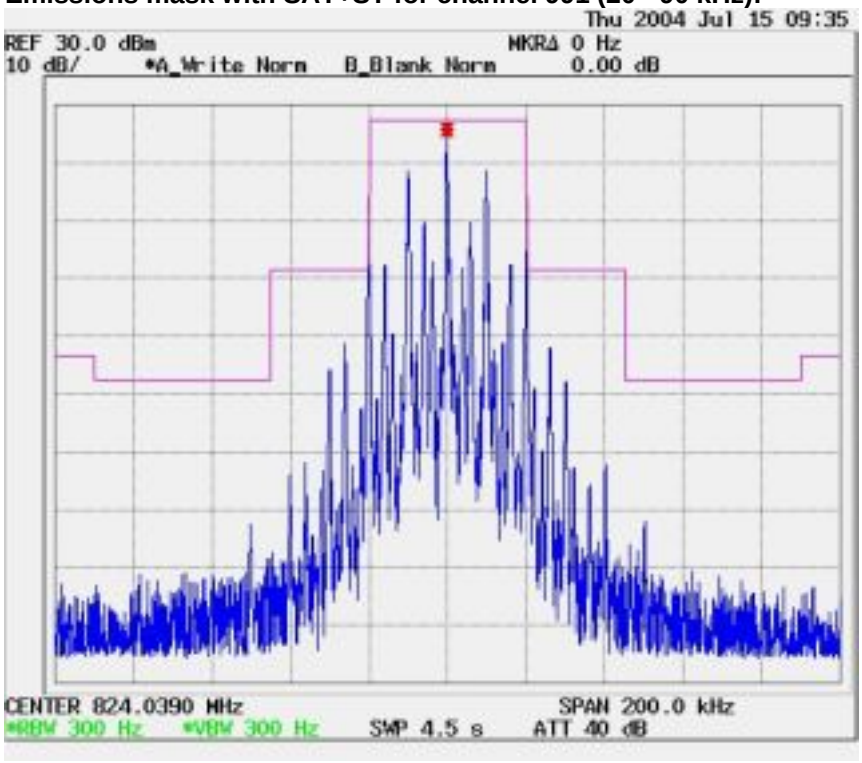
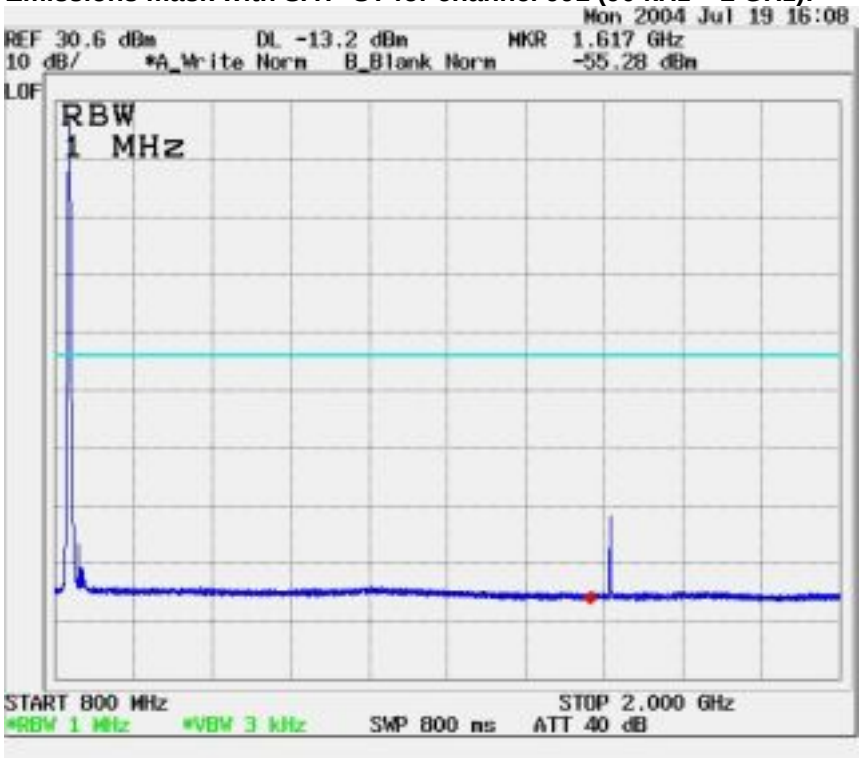
Emissions mask with SAT+ST for channel 991 (20 - 90 kHz):



Emissions mask with SAT+ST for channel 991 (90 kHz – 2 GHz):



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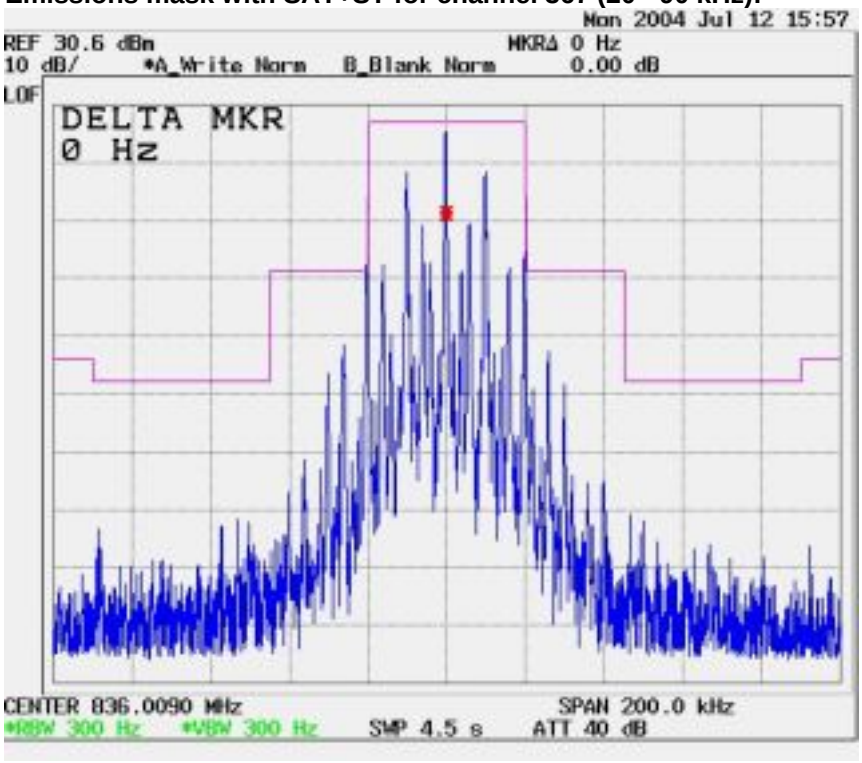
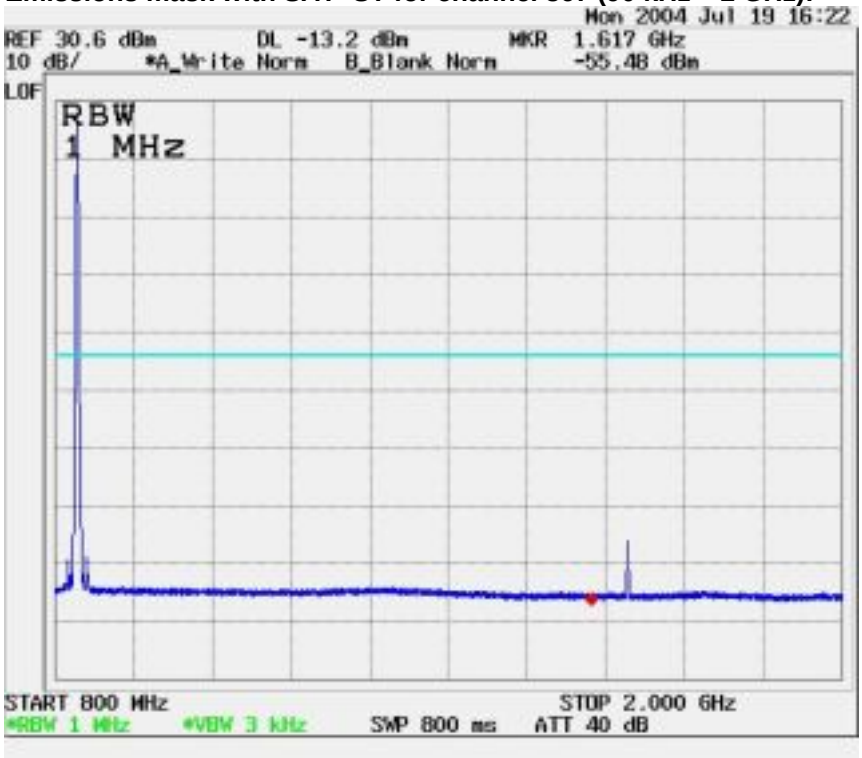
Emissions mask with SAT+ST for channel 367 (20 - 90 kHz):



Emissions mask with SAT+ST for channel 367 (90 kHz – 2 GHz):



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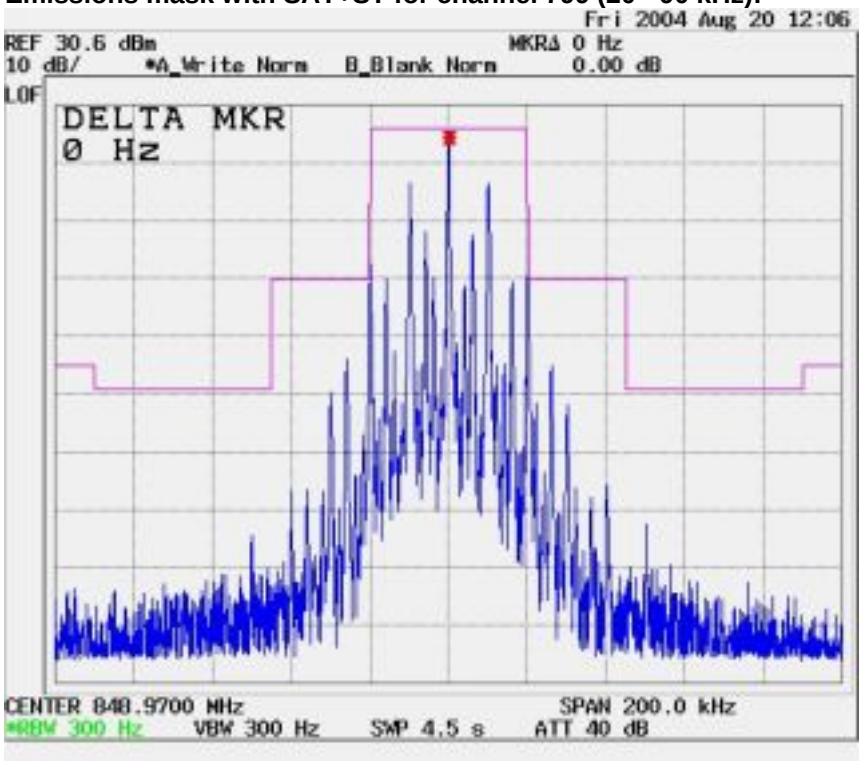
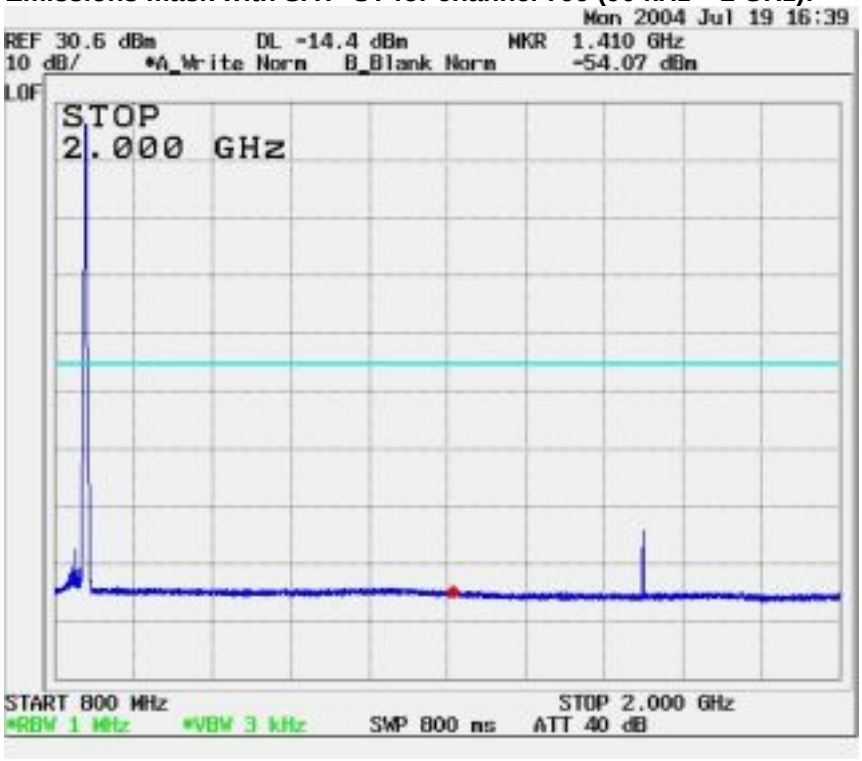
Emissions mask with SAT+ST for channel 799 (20 - 90 kHz):



Emissions mask with SAT+ST for channel 799 (90 kHz – 2 GHz):



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4.8 SPURIOUS EMISSIONS AT ANTENNA TERMINALS (§ 2.1051)

Test Lab: MPB Technologies Inc. Airdrie Test Personnel: D. Raynes Test Date: 21 June 2004	Product: AL411

Test Result, AL411: PASS

Objectives/Criteria	Specifications	
The spurious emissions at the antenna terminals shall not exceed the limits for the specifications as stated. Emission levels should meet the requirements with a margin of 6dB. (NB. f_c denotes carrier frequency)	FCC Part 2.1051 and 2.1057 FCC Part 22.917 Frequency	Emission Level
	9 kHz to lower edge of f_c	-13 dBm or 94 dBμV
	upper edge of f_c to the tenth harmonic of f_c	-13 dBm or 94 dBμV

There were no emissions measured to be within -20 dB of the specified limit.
Refer to the test data plots for more details.

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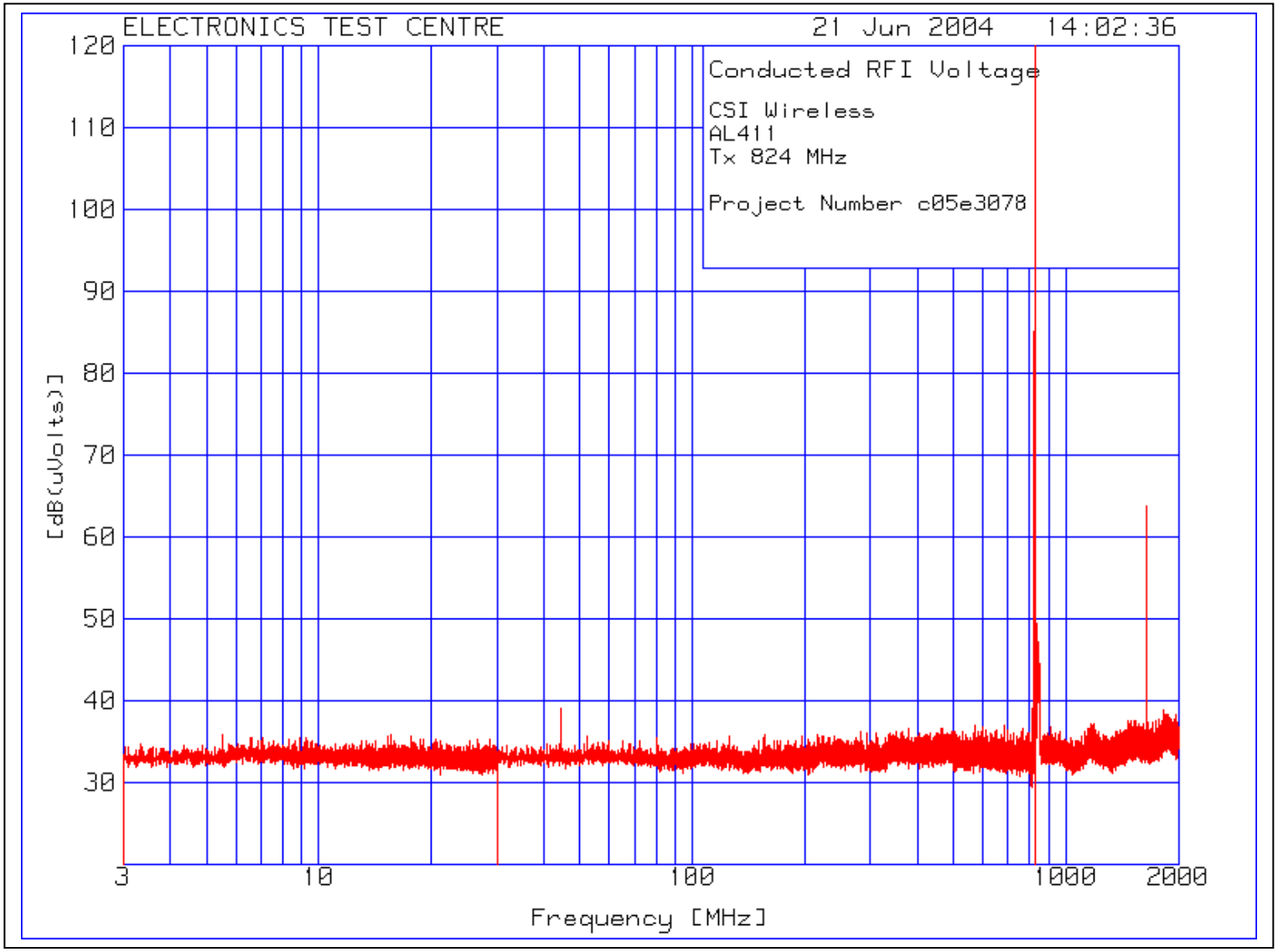
Plot of Conducted Emissions:



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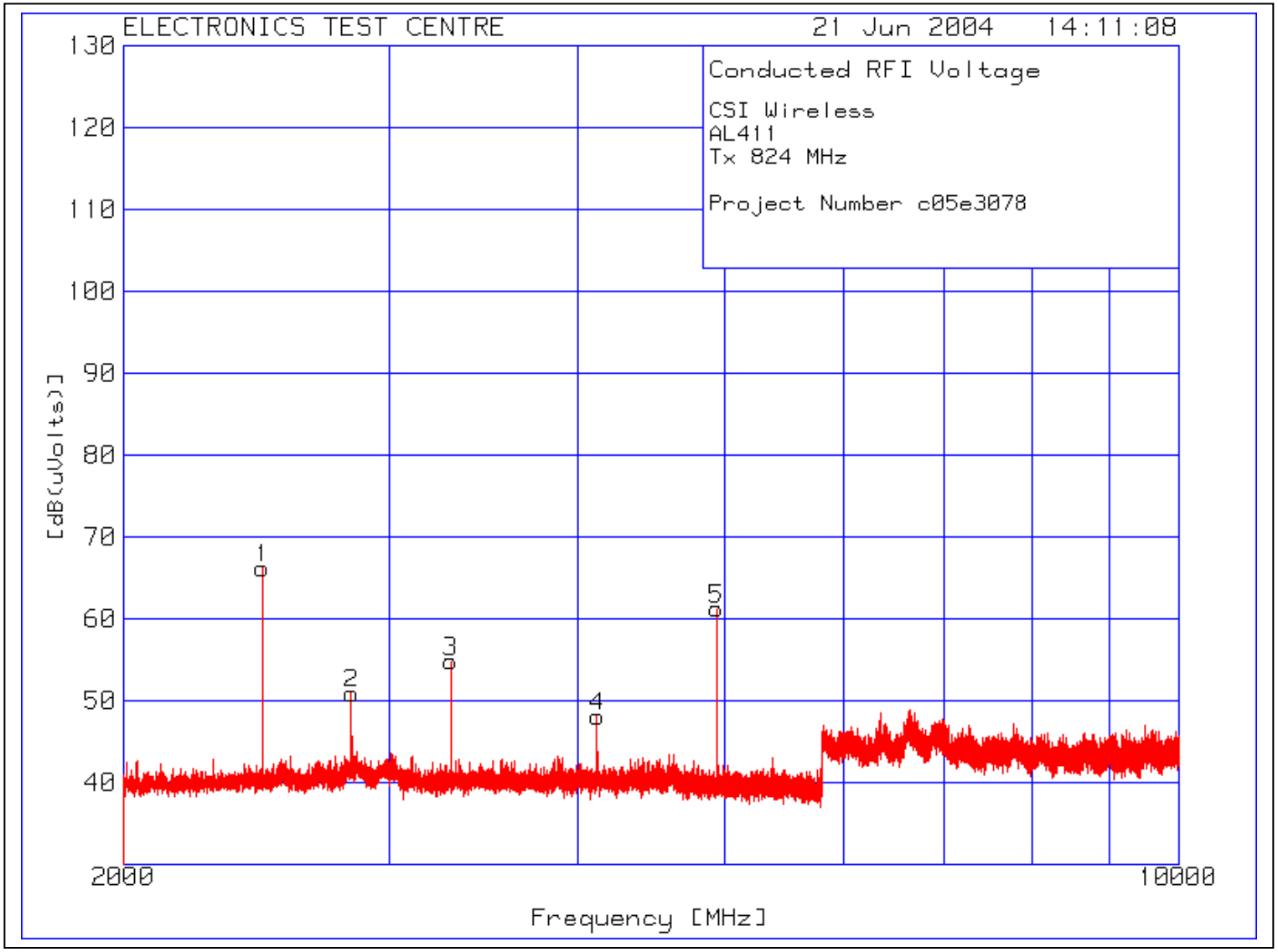
Plot of Conducted Emissions:



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CSI Wireless
AL411
Tx 824 MHz
Project Number C05e3078

	Test Frequency [MHz]	Meter Reading [dB(uV)]	Gain/Loss Factor [dB]	Transducer Factor [dB]	Level dB[uVolts]
Range: 1 2000 – 10000MHz					
1	2473.057	44.8 pk	21.4	0	66.2
2	2832.22	29.5 pk	21.4	0	50.9
3	3296.784	23 pk	21.4	0	54.8
4	4120.012	26.7 pk	21.4	0	48.1
5	4945.239	39.8 pk	21.4	0	61.2

pk - Peak detector

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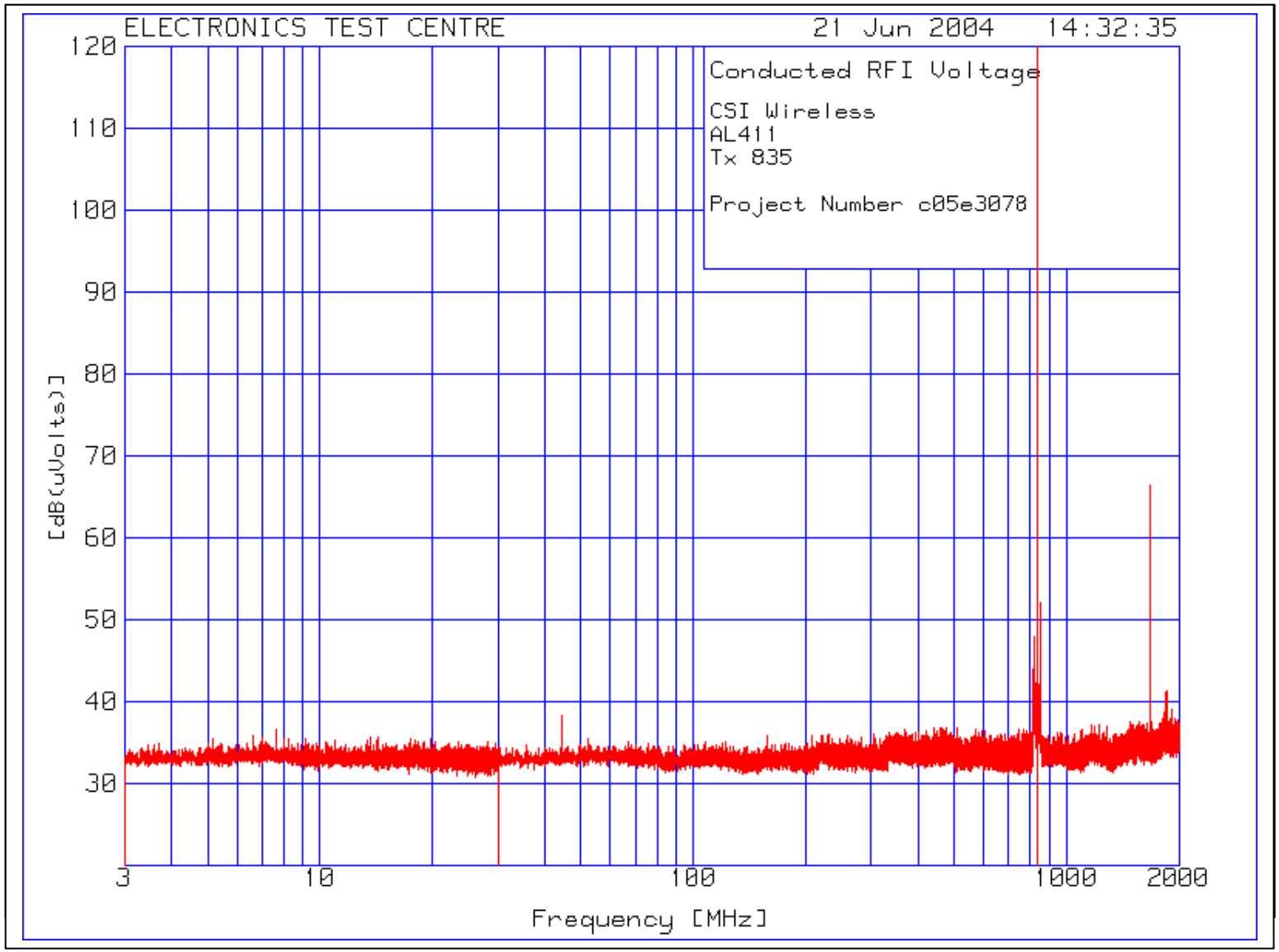
Plot of Conducted Emissions:



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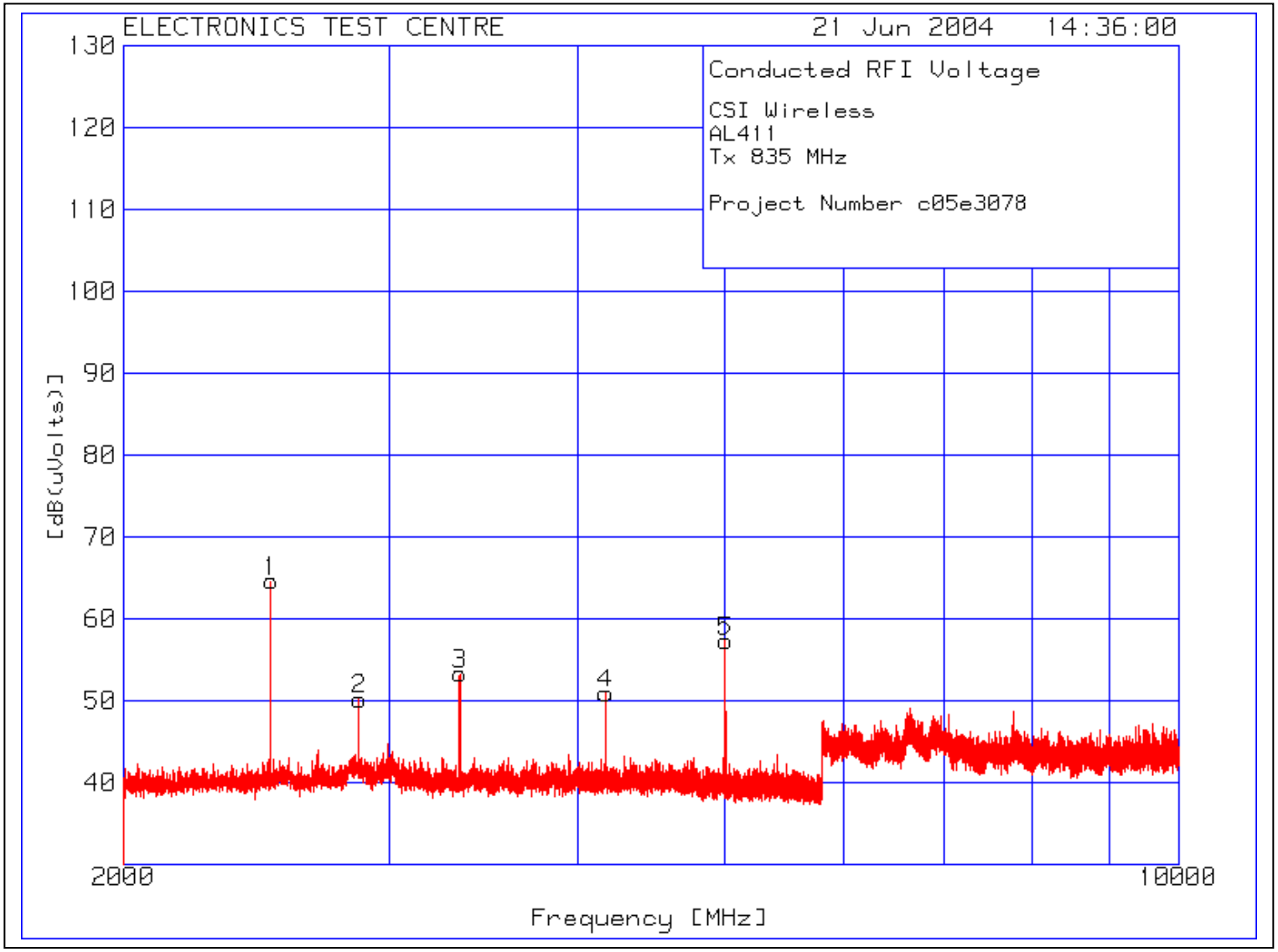
Plot of Conducted Emissions:



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CSI Wireless
AL411
Tx 835 MHz
Project Number C05e3078

	Test Frequency [MHz]	Meter Reading [dB(uV)]	Gain/Loss Factor [dB]	Transducer Factor [dB]	Level dB[uVolts]
Range: 1 2000 – 10000MHz					
1	2504.777	43.2 pk	21.4	0	64.6
2	2865.189	28.8 pk	21.4	0	50.2
3	3340.743	31.9 pk	21.4	0	53.3
4	4174.961	29.5 pk	21.4	0	50.9
5	5010.178	35.9 pk	21.4	0	57.3

pk - Peak detector

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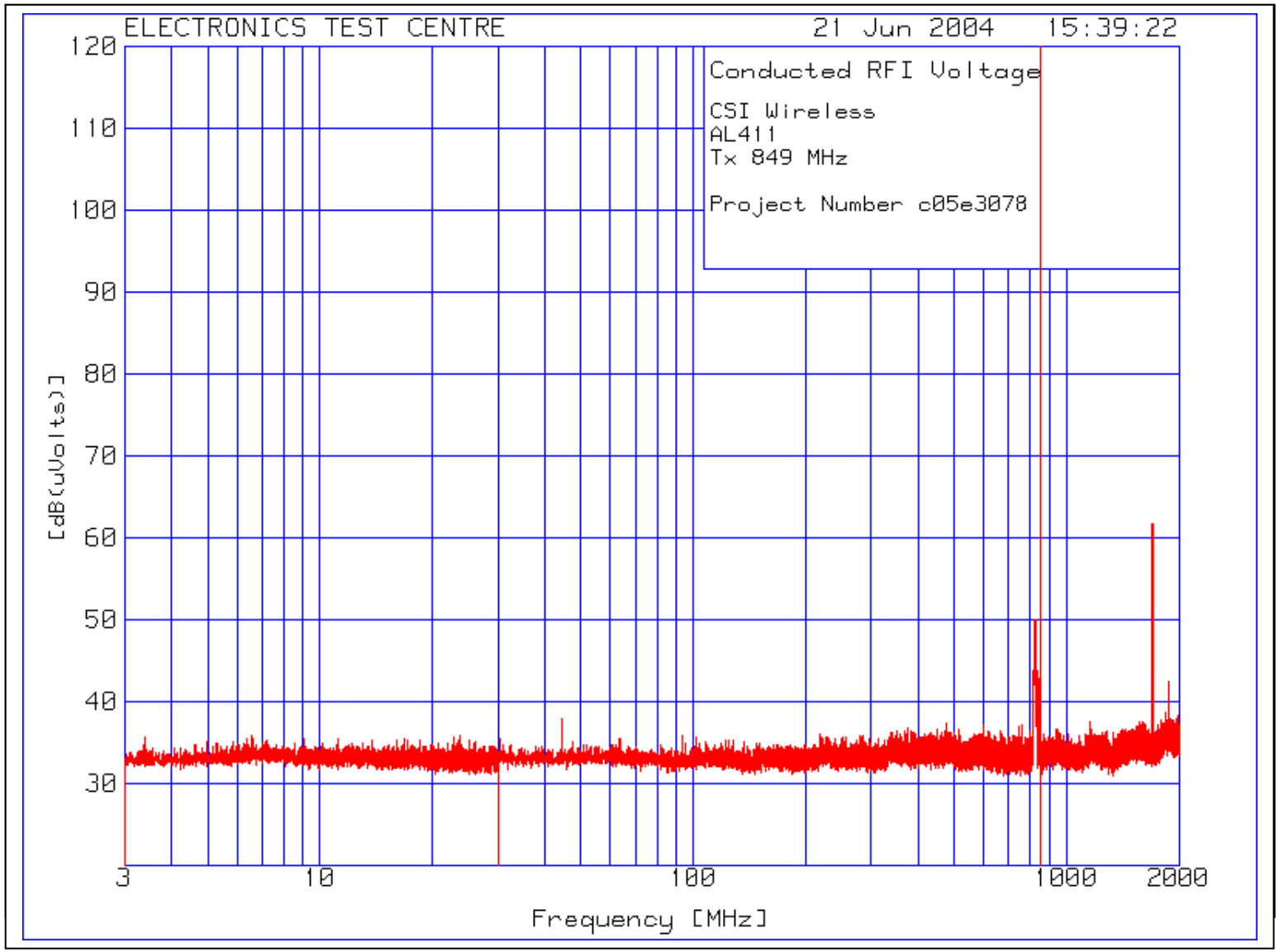
Plot of Conducted Emissions:



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CSI Wireless
AL411
Tx 849 MHz
Project Number C05e3078

Test Frequency [MHz]	Meter Reading [dB(uV)]	Gain/Loss Factor [dB]	Transducer Factor [dB]	Level dB[uVolts]
Range: 1 30 – 2000MHz				
1 1878.387	21 pk	21.4	0	42.4

pk - Peak detector

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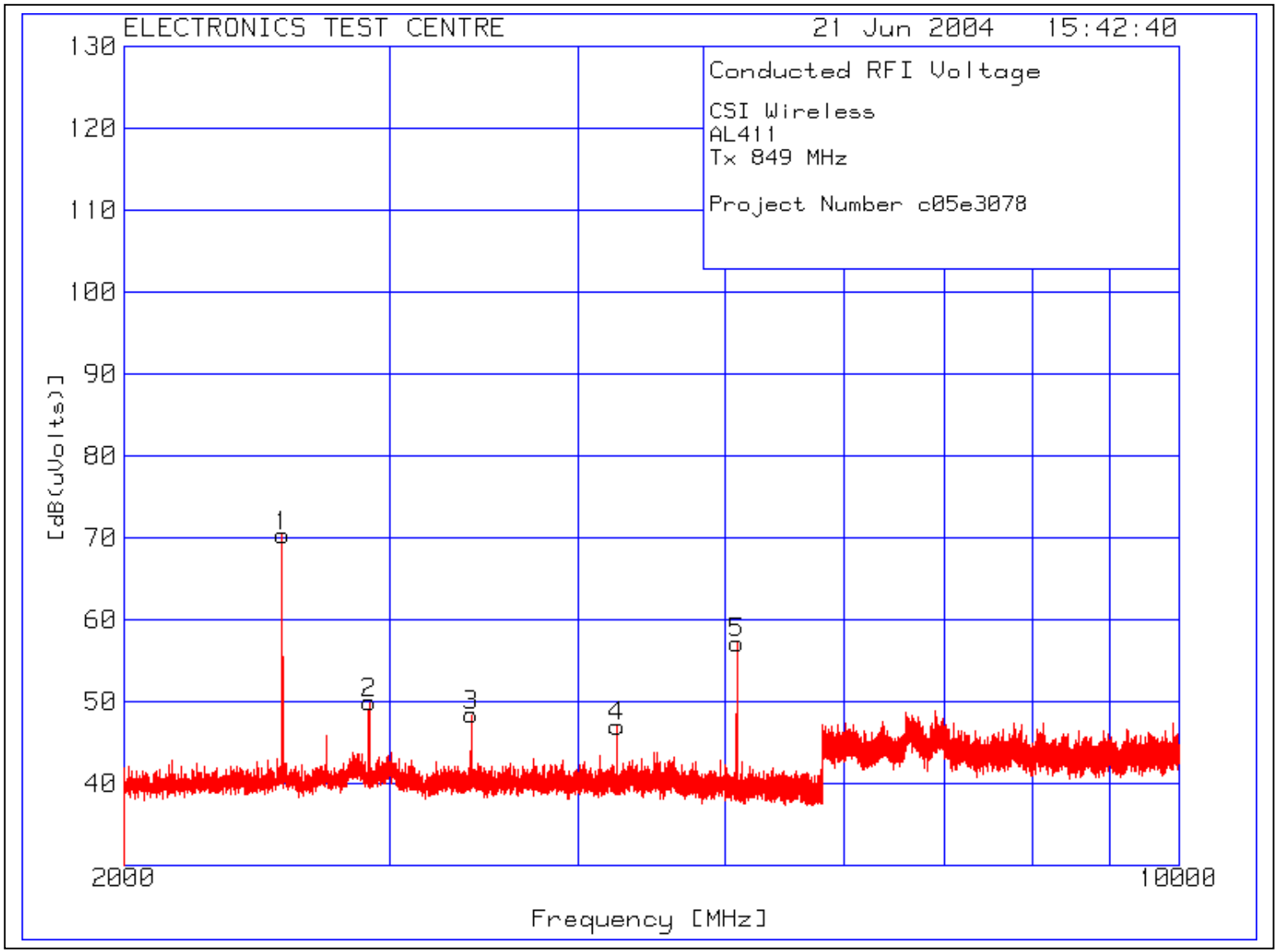
Plot of Conducted Emissions:



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CSI Wireless
AL411
Tx 849 MHz
Project Number C05e3078

	Test Frequency [MHz]	Meter Reading [dB(uV)]	Gain/Loss Factor [dB]	Transducer Factor [dB]	Level dB[uVolts]
Range: 1 2000 – 10000MHz					
1	2546.987	48.9 pk	21.4	0	70.3
2	2907.15	28.5 pk	21.4	0	49.9
3	3396.191	27 pk	21.4	0	48.4
4	4244.396	25.6 pk	21.4	0	47
5	5094.099	35.8 pk	21.4	0	57.2

pk - Peak detector

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4.9 FIELD STRENGTH OF SPURIOUS RADIATION (§ 2.1053, 2.1057 & 22.917)

Test Lab: MPB Technologies Inc. Airdrie Test Personnel: S. Malwes Date: 23 – 24 June 2004	Product: AL411
Test Result, AL411: **PASS**	

Objectives/Criteria

The Radiated E-Field emissions produced by EUT, measured at a distance of 3m, shall not exceed these limits within the restricted bands of operation as defined in 15.205. Any emissions lying outside these bands shall be at least 20 dB down from the level of the fundamental. Attenuation below the limits of 15.209 is not required.

Note: See the table below for the Restricted Bands of Operation per 15.205

The radiated spurious emissions from the EUT case and cabling shall not exceed the limits for the specifications as stated.

Emission levels should meet the requirements with a margin of 6dB.

(NB. f_c denotes carrier frequency)

Specification: FCC Part 15.209

Frequency [MHz]	Limit (QP @ 3m) [dBμV/m]
.009 – 0.490	88.5 – 53.8
.490 – 1.7	53.8 – 43
1.7 – 30	49.50
30 – 88	40.00
88 – 216	43.52
216 – 960	46.02
above 960	53.98

Emission levels should meet the requirements with a margin of 6dB.

FCC Part 2.1053 and 2.1057

FCC Part 22.917

Frequency	Emission Level
9 kHz to lower edge of f_c	-13 dBm or $-(43 + 10_{log10} P)$ dB_c
upper edge of f_c to the tenth harmonic of f_c	-13 dBm or $-(43 + 10_{log10} P)$ dB_c

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Restricted Bands of Operation per FCC Part 15.205, and Industry Canada RSS-210:

MHz	MHz	MHz	MHz	MHz	GHz	GHz
0.0900000 – 0.1100000	8.2910000 - 8.2940000	16.804250 - 16.804750	156.70000 - 156.90000	1435.0000 – 1626.5000	3.3458000 – 3.3580000	13.250000 – 13.400000
0.4950000 - 0.5050000 *	8.3620000 - 8.3660000	25.500000 - 25.670000	162.01250 - 167.17000 *	1645.5000 – 1646.5000	3.5000000 – 3.6000000 **	14.470000 – 14.500000
2.1735000 - 2.1905000	8.3762500 - 8.3867500	37.500000 - 38.250000	167.72000 - 173.20000 *	1660.0000 – 1710.0000	3.6000000 – 4.4000000	15.350000 – 16.200000
4.1250000 - 4.1280000	8.4142500 - 8.4147500	73.000000 - 74.600000	240.00000 – 285.00000	1718.8000 – 1722.2000	4.5000000 – 5.1500000	17.700000 – 21.400000
4.1772500 - 4.1777500	12.290000 - 12.293000	74.800000 - 75.200000	322.00000 - 335.40000	2200.0000 – 2300.0000	5.3500000 – 5.4600000	22.010000 – 23.120000
4.2072500 - 4.2077500	12.519750 - 12.520250	108.00000 - 121.94000	399.90000 – 410.00000	2310.0000 – 2390.0000	7.2500000 – 7.7500000	23.600000 – 24.000000
5.6770000 - 5.6830000	12.576750 - 12.577250	121.94000 – 123.00000 **	608.00000 – 614.00000	2483.5000 – 2500.0000 *	8.0250000 – 8.5000000	31.200000 – 31.800000
6.2150000 - 6.2180000	13.360000 - 13.410000	123.00000 - 138.00000	960.00000 – 1240.0000	2655.0000 – 2900.0000	9.0000000 – 9.2000000	36.430000 – 36.500000
6.2677500 - 6.2682500	16.420000 - 16.423000	149.90000 - 150.05000 *	1240.000 – 1300.000 **	3260..0000 – 3267.0000	9.3000000 – 9.5000000	Above 38.600000
6.3117500 - 6.3122500	16.694750 - 16.695250	156.52475-156.52525	1300.0000 – 1427.0000	3332.0000 – 3339.0000	10.600000 – 12.700000	

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Radiated Emissions Data:

f_c = 824.04 MHz (Channel 991):

f (MHz)	Field Strength (dBμV/m)	Limit (dBμV/m)	Delta (dB)	Antenna Polarization	Antenna Height (cm)	Azimuth (Degrees) (Note 1)
2442.1200	28.42	53.98	-25.56	V	100	120
2473.0570	-					
2832.2200	-					
3296.7840	-					
4120.0120	-					
4945.2390	-					

f_c = 835.00 MHz (~ Channel 367):

f (MHz)	Field Strength (dBμV/m)	Limit (dBμV/m)	Delta (dB)	Antenna Polarization	Antenna Height (cm)	Azimuth (Degrees) (Note 1)
2504.7770	-					
2865.1890	-					
3340.7430	-					
4174.9610	-					
5010.1780	-					

f_c = 848.97 MHz (Channel 799):

f (MHz)	Field Strength (dBμV/m)	Limit (dBμV/m)	Delta (dB)	Antenna Polarization	Antenna Height (cm)	Azimuth (Degrees) (Note 1)
2546.9870	-					
2907.1500	-					
3396.1910	-					
4244.3960	-					
5094.0990	-					

Note 1: The EUT faced the receiving antenna at 120° of azimuth.
Note 2: Investigation was conducted to 10 GHz. All other spurious emissions were below the measurement equipment noise floor, that is, at least –65 dB_c and at least 12 dB below the limits of Part 15.205.

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4.10 FREQUENCY STABILITY (§ 2.1055)

Test Lab: MPB Technologies Inc. Airdrie Test Personnel: D. Raynes Date: 18 & 25 June 2004	Product: AL411

Test Result, AL411: **PASS**

Objectives/Criteria

The Tx frequency must remain within specified limits when the EUT is operated at ambient temperatures specified for the service environment.

Specification: FCC Part 2.1055 (excerpt)

(a) The frequency stability shall be measured with variation of ambient temperature as follows:

(1) From -30 deg. to +50 deg. centigrade for all equipment except that specified in paragraphs (a) (2) and (3) of this section.

(d) The frequency stability shall be measured with variation of primary supply voltage as follows:

(1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.

Comments: The listed range of frequency variation was noted at 20° C and 12.8 VDC.

The observed frequency drift remained within this range under all test conditions.

Temp. (°C)	Frequency (Hz)	Temp. (°C)	Frequency (Hz)	Temp. (°C)	Frequency (Hz)
+50	824039261 ± 427 835018675 ± 217 848968732 ± 305	+20	824039261 ± 427 835018675 ± 217 848968732 ± 305	-10	824039261 ± 427 835018675 ± 217 848968732 ± 305
+40	824039261 ± 427 835018675 ± 217 848968732 ± 305	+10	824039261 ± 427 835018675 ± 217 848968732 ± 305	-20	824039261 ± 427 835018675 ± 217 848968732 ± 305
+30	824039261 ± 427 835018675 ± 217 848968732 ± 305	0	824039261 ± 427 835018675 ± 217 848968732 ± 305	-30	824039261 ± 427 835018675 ± 217 848968732 ± 305

Voltage (VDC)	Frequency (Hz)	Voltage (VDC)	Frequency (Hz)
10.2	824039261 ± 427 835018675 ± 217 848968732 ± 305	24.0	824039261 ± 427 835018675 ± 217 848968732 ± 305
12.0	824039261 ± 427 835018675 ± 217 848968732 ± 305	27.6	824039261 ± 427 835018675 ± 217 848968732 ± 305

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4.11 EFFECTIVE RADIATED POWER (§ 22.913)

Test Lab: MPB Technologies Inc. Airdrie Test Personnel: S. Malwes Date: 24 June 2004	Product: AL411
Test Result, AL411: **PASS**	

Sec. 22.913 Effective radiated power limits:

The effective radiated power (ERP) of transmitters in the Cellular Radiotelephone Service must not exceed the limits in this section.

(a) Maximum ERP. The effective radiated power (ERP) of base transmitters and cellular repeaters must not exceed 500 Watts. The ERP of mobile transmitters and auxiliary test transmitters must not exceed 7 Watts.

Channel	Frequency (MHz)	Field Strength (dBμV/m)	ERP (mW)	ERP Limit (Watts)
991	824.04	114.61	33.806	7.000
~367	835.01	111.99	13.274	7.000
799	848.97	106.98	4.217	7.000

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5.0 TEST FACILITY

5.1 LOCATION

The EUT was tested for Electromagnetic Compatibility at the Electronics Test Centre, located in Airdrie, Alberta, Canada.

The RF Anechoic Chamber (RFAC) is identified as Chamber 1, located in the main building complex at the Electronics Test Centre. Its usable working space measures 10.6 m long x 7.3 m wide x 6.5 m high.

This test site is listed with the FCC under Registration Number 99541. Measurements taken at this site are accepted by Industry Canada per file number IC 2046-1.

The floor, walls and ceiling consist of annealed steel panels. The walls and ceiling are covered with ferrite tile, augmented by RF absorbant foam material on the end wall nearest the turntable, and on the adjacent walls and the ceiling. The chamber floor supports a 15 cm high internal floor, constructed of annealed steel panels, that forms the ground plane, and is bonded to the chamber walls.

The 3-m diameter turntable is flush-mounted with the floor. A sub-floor cable-way is provided to route cables between the turntable pit and EUT support equipment. Cables reach the EUT through an opening in the centre of the turntable.

Test instrumentation and EUT support equipment is located in two shielded vestibules located at the side of the main room. Cables are routed through bulkhead panels between the rooms as required. Power feeds are routed into the main room and vestibules through line filters providing at least 100 dB of attenuation between 10 kHz and 10 GHz.

5.2 GROUNDING PLAN

The EUT was located on a wooden table 80 cm above the ground plane.

In accordance with CSI Wireless Inc. specifications, the EUT was not grounded.

5.3 POWER

AC power was supplied via an Underwriter's Laboratories ULW100-69, 100 dB, 100 Ampere wall mounted filter. Bonding to ground is implemented at the chamber wall.

5.4 EMISSIONS PROFILE

Ambient conducted and radiated electromagnetic emission profiles were generated throughout the tests and are included in the test data.

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5.5 TEST CONFIGURATION

5.5.1 RF OUTPUT POWER

Figure 1 illustrates the configuration of the test and measurement equipment used for RF Output Power (FCC Part 2.1046).

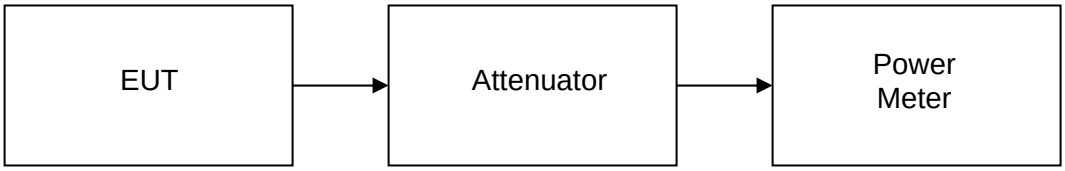

Figure 1 - Measurement Setup for RF Output

5.5.2 OCCUPIED BANDWIDTH AND SPURIOUS EMISSIONS AT ANTENNA TERMINALS

Figure 2 illustrates the configuration of the test and measurement equipment used for Occupied Bandwidth and Spurious Emissions at Antenna Terminals (FCC Part 2.1049, 2.1051 and 2.1057).

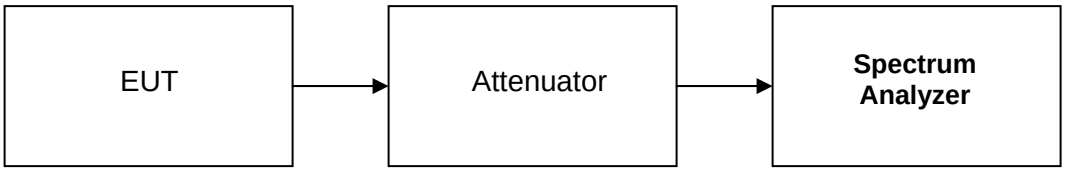

Figure 2 - Measurement Setup for Occupied Bandwidth and Spurious Emissions at Antenna Terminals

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5.5.3 Radiated Emissions

Figure 3 illustrates the configuration of the test and measurement equipment used for Radiated Emissions (FCC Part 2.1053 and 2.1057) for *Rack-Mounted* equipment.

Radiated Emissions

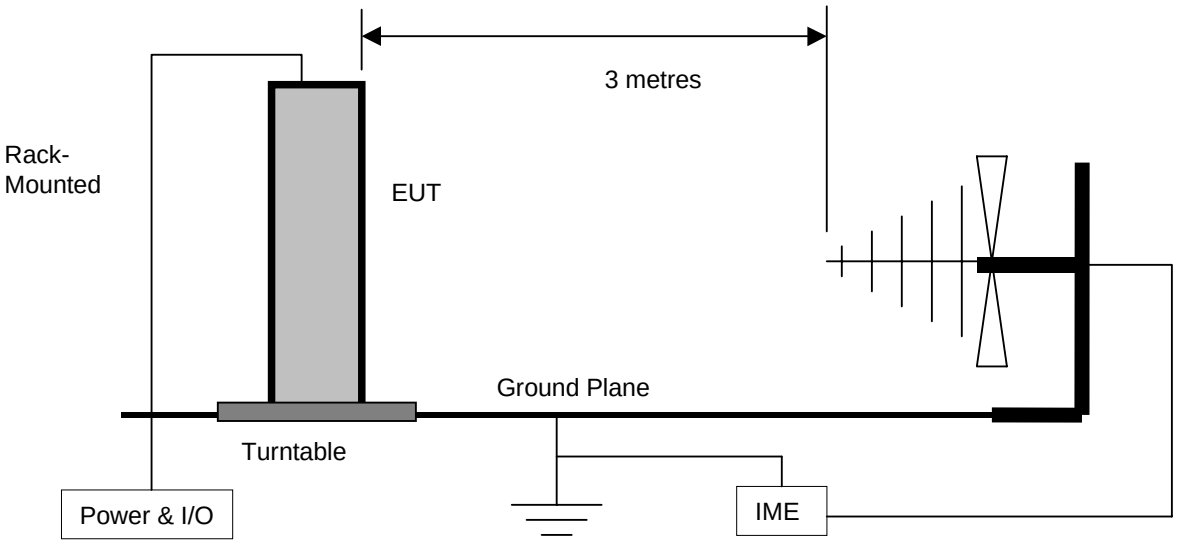

Figure 3 - Radiated Emissions for Rack-Mounted Equipment

Figure 4 illustrates the configuration of the test and measurement equipment used for Radiated Emissions (FCC Part 2.1053 and 2.1057) for *Tabletop* equipment.

Radiated Emissions

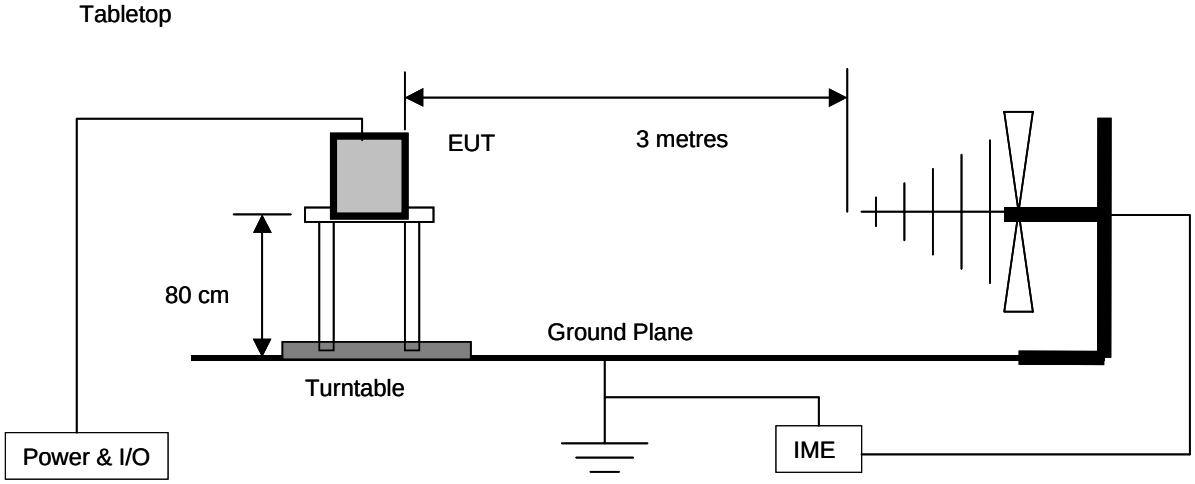

Figure 4 - Radiated Emissions for Tabletop Equipment

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6.0 TEST EQUIPMENT

The following equipment was used for this procedure. All measurement devices are calibrated annually, traceable to NIST.

6.1 EQUIPMENT USED

The following equipment was used for this procedure. All measurement devices are calibrated annually, traceable to NIST.

RF Output Power, Occupied Bandwidth and Spurious Emissions at Antenna Terminals

- Power Meter
- Spectrum Analyzer with RF Preselector
- Personal Computer and EMC Software

Radiated Emissions

- Spectrum Analyzer with RF Preselector
- CISPR Quasi-Peak Adapter
- Power Isolation Transformers
- Biconilog Antenna (25 MHz to 2 GHz)
- DRG Horn Antenna (1 to 18 GHz)
- Low-Noise Amplifier (1 to 18 GHz)
- Antenna Mast Positioner and Controller
- Flush-mounted Turntable and Controller
- Personal Computer and EMC Software

6.2 CALIBRATION

All measurement instrumentation conforms to ANSI C63.2. Calibration is maintained in accordance with manufacturer recommendations and ISO Guide 25. Each measurement device is labeled with its ETC asset number and calibration due date.

6.2.1 CALIBRATION ACCURACY

Test equipment used to provide quantitative measurements are calibrated with standards traceable to the National Research Council, National Institute of Standards and Technology or other national standards. Instrumentation systems for emissions measurements have the following measurement uncertainties:

Frequency = ± 1 kHz
Amplitude (RE) = ± 4.01 dB
Amplitude (CE) = ± 3.25 dB

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6.2.2 TEST EQUIPMENT DESCRIPTION

The equipment used in the tests was selected from the following list.

Instrument	Manufacturer	Model No.	Asset No.	Calibration Due
Spectrum Analyzer	Hewlett Packard	8566B	9565	18 July 2004
Spectrum Analyzer	Hewlett Packard	8566B	9168	19 August 2004
RF Preselector	Hewlett Packard	85685A	9728	19 August 2004
RF Preselector	Hewlett Packard	85685A	9563	18 July 2004
Quasi-Peak Adapter	Hewlett Packard	85650A	4411	19 August 2004
Quasi-Peak Adapter	Hewlett Packard	85650A	9243	18 July 2004
Measurement System Software	Underwriters Laboratories	Version 6.0	4443	n/a
Line Impedance Stabilization Network	EMCO	3825/2r	9331	2 November 2004
Line Impedance Stabilization Network	EMCO	3825/2r	9259	2 November 2004
Biconilog Antenna	ARA	Lpb-2520/A	4318	2 August 2004
Log-Periodic Antenna	EMCO	3147	21720	5 August 2004
Dual Ridged Guide Antenna	EMCO	3115	9588	2 August 2004
RF Communication Test Set	Hewlett Packard	8920B	QCE0019	8 April 2005
Spectrum Analyzer	AdvantTest	R3267	1041664	21 April 2005
Low Noise Amplifier	MITEQ	JS43-01001800-21-5P	4354	3 November 2004

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Appendix A

AL411

Test Sample Description

(from data provided by CSI Wireless Inc.)

Product Application	**Product Category**	
Commercial ✗ Military o	Telecommunications o Information Technology ✗ Surface Transportation o	Aerospace o Test & Measurement o Other o _____
Product Name	Asset Link 411	
Part/Model No.	AL411	
Serial Number	n/a	
Power Requirements: **(Voltage, AC/DC, Hz, Current)**	13 VDC	
Typical Installation Instructions or Configuration	In vehicle	
Ground Connection **(in addition to power cord)**	nil	
Internally Generated Frequencies	32.768 kHz, 260 kHz, 8.0 MHz, 14.85 MHz 24.5535 MHz, 914 – 926 MHz	
Peripheral Support Equipment	Antenna	
Description and number of interconnecting Leads & Cables	GPS/AMPS antenna cable	

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