Engineering and Testing for EMC and Safety Compliance

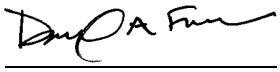
Certification Application Report
FCC Part 15.247 & Industry Canada RSS-210

Test Lab:	Applicant:
Rhein Tech Laboratories, Inc. Phone: 703-689-0368 360 Herndon Parkway Fax: 703-689-2056 Suite 1400 Web: www.rheintech.com Herndon, VA 20170 E-Mail: ATCBINFO@RHEINTECH.COM	Vocollect, Inc. Phone: 412-349-2652 Contact: Joe Lesik Fax: 412-829-1063 703 Rodi Road Pittsburgh, PA 15235 E-Mail: jlesik@vocollect.com

FCC ID/ IC ID:	MQOTT601-10000/ 2570A-TT601100	**Test Report Date:**	May 24, 2006
Platform:	N/A	**RTL Work Order Number:**	2006053
Model Name/ Model Number:	T2x/TT-601_R WF	**RTL Quote Number:**	QRTL06-177
American National Standard Institute:	ANSI C63.4-2003: Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz		
FCC Classification:	DTS – Part 15 Digital Transmission System		
FCC Rule Part(s):	FCC Rules Part 15.247 (10-01-05): Operation within the bands 920-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz Direct Sequence System		
Industry Canada:	RSS-210, Issue 6 September 2005: Low Power License-Exempt Communications Devices		
Digital Interface Information	Digital Interface was found to be compliant		

Frequency Range (MHz)	Output Power (W)	Frequency Tolerance	Emission Designator
2412-2462	0.0776	N/A	10M3G7D

I, the undersigned, hereby declare that the equipment tested and referenced in this report conforms to the identified standard(s) as described in this test report. No modifications were made to the equipment during testing in order to achieve compliance with these standards. Furthermore, there was no deviation from, additions to, or exclusions from, the applicable parts of FCC Part 2, FCC Part 15, FCC 97-114, ANSI C63.4, and Industry Canada RSS-210.

Signature:  Date: May 24, 2006

Typed/Printed Name: Desmond A. Fraser Position: President

Table of Contents

Figure Index

Table Index

Plot Index

Appendix Index

Photograph Index

1 General Information

1.1 Scope

Applicable Standards:

- FCC Rules Part 15.247 (10-01-05): Frequency Hopping, Direct Spread Spectrum and Hybrid Systems that are in operation within the bands of 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz.
- Industry Canada RSS-210 (Issue 6 September 2005): Low Power License-Exempt Communications Devices

1.2 Description of EUT

Equipment Under Test	Body Worn Terminal
Model Name/Number	T2x/TT-601_R WF
Power Supply	Battery operated
Modulation Type	DSSS
Transfer Rate	1, 2, 5.5, 11 Mbps
Frequency Range	2412 – 2462 MHz
Antenna Connector Type	Internal
Antenna Types	Internal

1.3 Test Facility

The open area test site and conducted measurement facility used to collect the radiated data is located at 360 Herndon Parkway, Suite 1400, Herndon, Virginia 20170. This site has been fully described in a report and approved by the Federal Communications Commission to perform AC line conducted and radiated emissions testing (ANSI C63.4 2003).

1.4 Related Submittal(s)/Grant(s)

This is an original application for FCC certification for Vocollect, Inc. Model: T2x, FCC ID: MQOTT601-10000, and Industry Canada IC: 2570A-TT601100.

1.5 Modifications

No modifications were required for compliance.

2 Test Information

2.1 Description of Test Modes

In accordance with FCC 15.31(m), and because the EUT utilizes an operating band greater than 10 MHz, the following frequencies were tested:

Table 2-1: Channels Tested

Channel	Frequency
1	2412
6	2437
11	2462

2.2 Exercising the EUT

The EUT was tested in all three orthogonal planes in order to determine worst-case emissions. The EUT was provided with software to continuously transmit during testing. The carrier was also checked to verify that information was being transmitted. There were no deviations from the test standard(s) and/or methods. The test results reported relate only to the item tested.

2.3 Test Result Summary

Table 2-2: Test Result Summary – FCC Part 15, Subpart C (Section 15.247)

Standard	Test	Pass/Fail or N/A
FCC 15.207	AC Power Conducted Emissions	N/A
FCC 15.209	Radiated Emissions	Pass
FCC 15.247(a)(2)	6 dB Bandwidth	Pass
FCC 15.247(b)	Maximum Peak Power Output	Pass
FCC 15.247(d)	Antenna Conducted Spurious Emissions	Pass
FCC 15.247(e)	Power Spectral Density	Pass
FCC 15.247(d)	Band Edge Measurement	Pass

2.4 Test System Details

The test sample was received on May 10, 2006. The FCC identifiers for all applicable equipment, plus descriptions of all cables used in the tested system, are identified in the following tables.

Table 2-3: Equipment Under Test

Part	Manufacturer	Model	Serial Number	FCC ID	Cable Description	RTL Bar Code
WLAN terminal	Vocollect, Inc.	T2x	096060036	MQOTT601-10000	N/A	17212
WLAN terminal	Vocollect, Inc.	T2x	097060014	MQOTT601-10000	N/A	17213
WLAN terminal	Vocollect, Inc.	T2x	096060035	MQOTT601-10000	N/A	17214
WLAN terminal	Vocollect, Inc.	T2x	096060024	MQOTT601-10000	N/A	17215
Battery	Vocollect, Inc.	730021	04310056	N/A	N/A	17216
Battery	Vocollect, Inc.	730021	04180574	N/A	N/A	17217
Battery	Vocollect, Inc.	730022	04180014	N/A	N/A	17218
Serial Cable	Vocollect, Inc	N/A	N/A	N/A	1.9 m shielded I/O	15505
Headset	Vocollect, Inc	N/A	N/A	N/A	1.4 m shielded I/O	16762

2.5 Configuration of Tested System

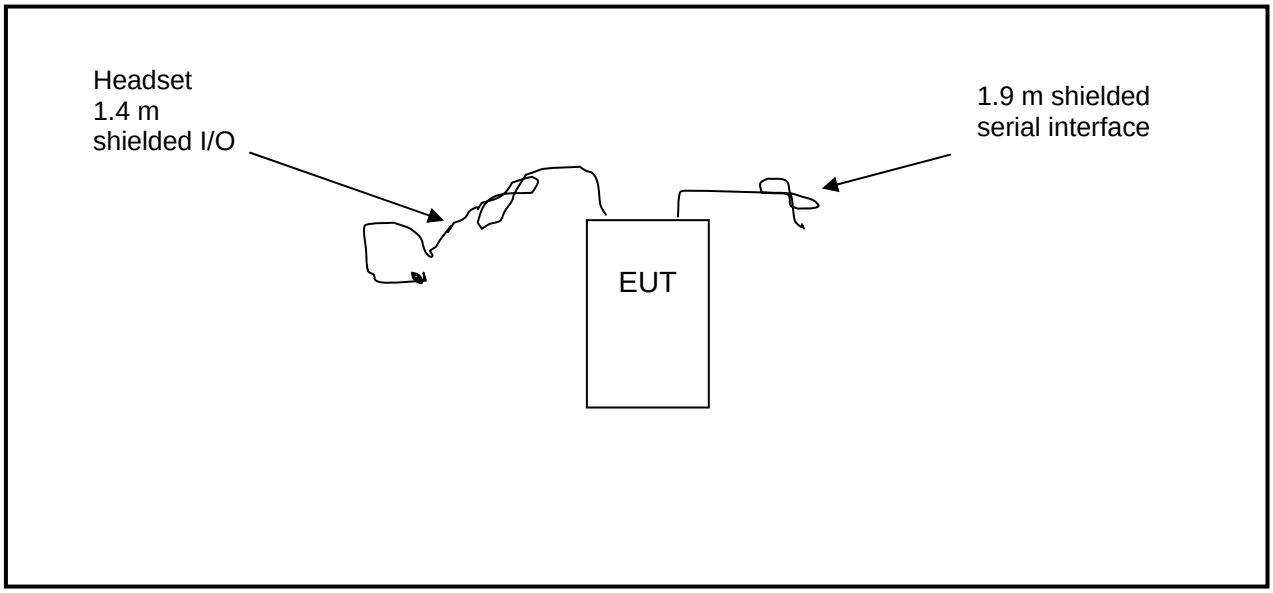


Figure 2-1: Configuration of System Under Test

3 Peak Output Power - §15.247(b)(1); RSS-210 §A8.4(4)

3.1 Power Output Test Procedure

A conducted power measurement of the EUT was taken using an Agilent 4416A EPM-P Series Power Meter with an E9323A Peak and Average Power Sensor.

Table 3-1: Power Output Test Equipment

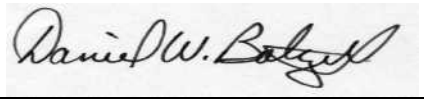
RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
901184	Agilent Technologies	E4416A	EPM-P Power Meter, single channel	GB41050573	9/21/06
901356	Agilent Technologies	E9323A	Power Sensor	31764-264	9/21/06

3.2 Power Output Test Data

Table 3-2: Power Output Test Data

Channel	Frequency (MHz)	Peak Power Conducted Output (dBm)
1	2412	18.6
6	2437	18.7
11	2462	18.9

Test Personnel:



Daniel W. Baltzell		May 23, 2006
Test Engineer	Signature	Dates Of Test

4 Compliance with the Band Edge – FCC §15.247(d); RSS-210 §2.2

4.1 Band Edge Test Procedure

The transmitter output was connected to its appropriate antenna. Peak (1 MHz RBW/VBW) and average (1 MHz RBW/10 Hz VBW) radiated measurements were taken with a suitable span to encompass the peak of the fundamental. A delta measurement was performed from the highest peak in the restricted band to the peak of the fundamental, and subtracted from the field strength; the result was compared to the limit in the restricted band (54 dBuV/m).

Table 4-1: Band Edge Test Equipment

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
901020	Hewlett Packard	8564E	Portable Spectrum Analyzer (9 kHz - 40 GHz)	3943A01719	9/14/06
900878	Rhein Tech Labs	AM3-1197-0005	3 meter antenna mast, polarizing	Outdoor Range 1	Not Required
901231	IW Microwave Products	KPS-1503-2400-KPS	High frequency RF cables	240"	9/1/06
901232	IW Microwave Products	KPS-1503-2400-KPS	High frequency RF cables	240"	9/1/06
901235	IW Microwave Products	KPS-1503-360-KPS	High frequency RF cables	36"	9/1/06
901242	Rhein Tech Labs	WRT-000-0003	Wood rotating table	N/A	Not Required
900772	EMCO	3161-02	Horn Antenna (2 - 4 GHz)	9804-1044	5/20/07

4.2 Restricted Band Edge Test Results

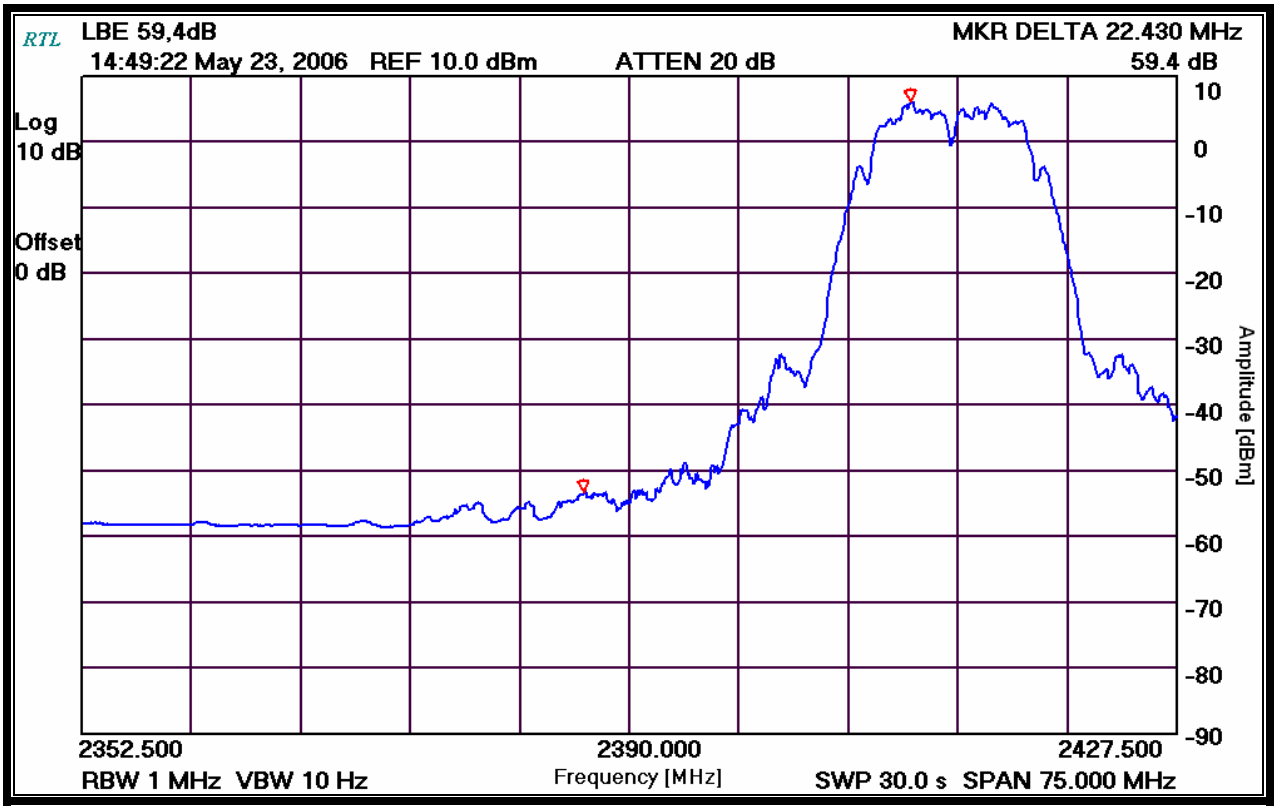
4.2.1 Calculation of Lower Band Edge

99.8 dBuV/m is the field strength measurement, from which the delta measurement of 59.4 dB is subtracted (reference plots), resulting in a level of 40.4 dB. This level has a margin of 13.6 dB below the limit of 54 dBuV/m.

Calculation: 99.8 dBuV/m – 59.4 dB – 54 dBuV/m = -13.6 dB

Peak Field Strength of Lower Band Edge (1 MHz RBW/1 MHz VBW) = 104.4 dBuV/m
Average Field Strength of Lower Band Edge (1 MHz RBW/10 Hz VBW) = 99.8 dBuV/m
Delta measurement = 59.4 dB

Plot 4-1: Lower Band Edge: Average Measurement Channel 1 (TX Frequency: 2412 MHz)



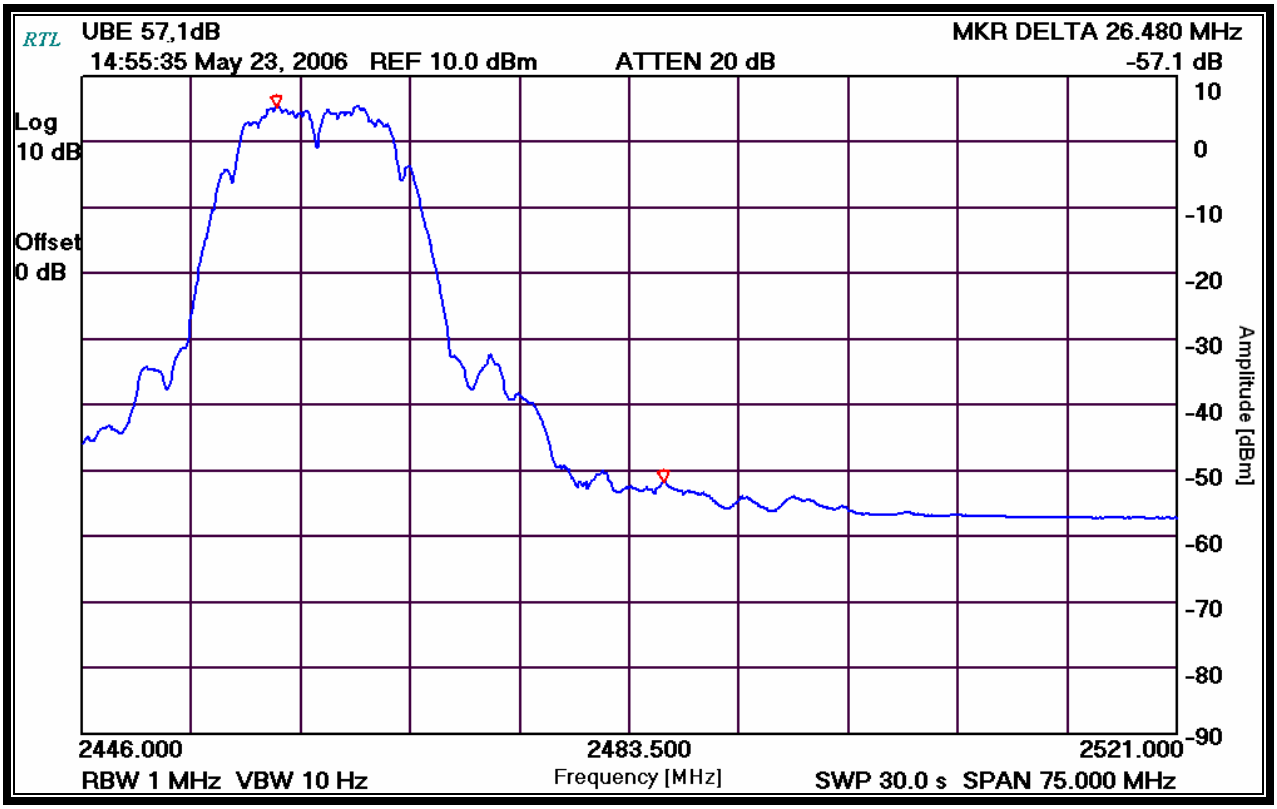
4.2.2 Calculation of Upper Band Edge

101.1 dBuV/m is the field strength measurement, from which the delta measurement of 57.1 dB is subtracted (reference plots), resulting in a level of 44.0 dB. This level has a margin of 10.0 dB below the limit of 54 dBuV/m.

Calculation: 101.1 dBuV/m – 57.1 dB – 54 dBuV/m = -10.0 dB

Peak Field Strength of Lower Band Edge (1 MHz RBW/1 MHz VBW) = 105.4 dBuV/m
Average Field Strength of Lower Band Edge (1 MHz RBW/10 Hz VBW) = 101.1 dBuV/m
Delta measurement = 57.1 dB

Plot 4-2: Upper Band Edge: Average Measurement Channel 11 (TX Frequency: 2462 MHz)



Test Personnel:

Daniel W. Baltzell	Daniel W. Baltzell	May 23, 2006
Test Engineer	Signature	Dates Of Test

5 Antenna Conducted Spurious Emissions - §15.247(d); RSS-210 RSS-Gen

5.1 Antenna Conducted Spurious Emissions Test Procedures

Antenna spurious emissions per FCC 15.247(c) were measured from the EUT antenna port using a 50 ohm spectrum analyzer with the resolution bandwidth set at 100 kHz, and the video bandwidth set at 100 kHz. The modulated carrier was identified at the following frequencies: 2412 MHz, 2437 MHz and 2462 MHz.

5.2 Antenna Conducted Spurious Emissions Test Results

No harmonics or spurs were found within 20 dB (note that we are reporting power as peak) of the limit from the carrier to the 10th harmonic of the carrier frequency. Per FCC 15.31(o), no data is being reported.

Table 5-1: Antenna Conducted Spurious Test Equipment

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
901413	Agilent	E4448A	Spectrum Analyzer (3 Hz – 50 GHz)	US440203416	11/02/06

Test Personnel:

Richard B. McMurray	Richard B. McMurray	May 11, 2006
EMC Test Engineer	Signature	Date Of Test

6 6 dB Bandwidth - §15.247(a)(2); RSS-210 §A8.2

6.1 6 dB Bandwidth Test Procedure – Minimum 6 dB Bandwidth

The minimum 6 dB bandwidths per FCC 15.247(a)(2) were measured using a 50-ohm spectrum analyzer with the resolution bandwidth set at 100 kHz, and the video bandwidth set at 300 Hz. The device was modulated. The minimum 6 dB bandwidths are presented below.

Table 6-1: 6 dB Bandwidth Test Equipment

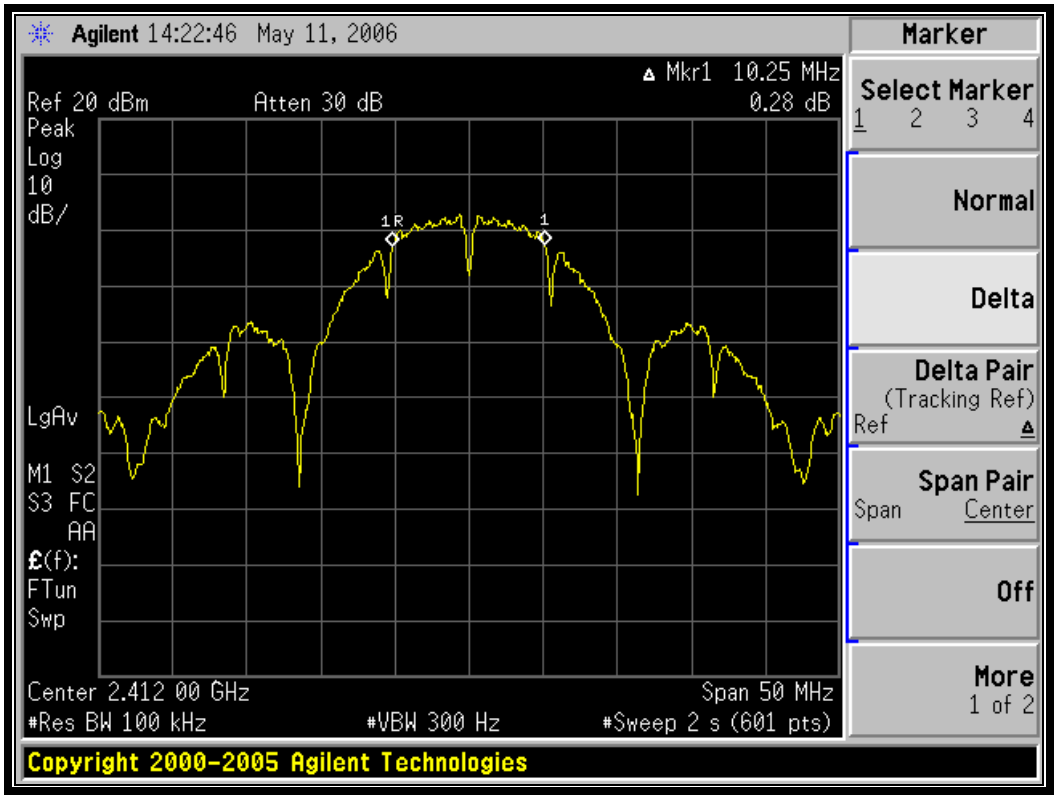
RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
901413	Agilent	E4448A	Spectrum Analyzer (3 Hz – 50 GHz)	US440203416	11/02/06

6.2 6 db Bandwidth Test Results

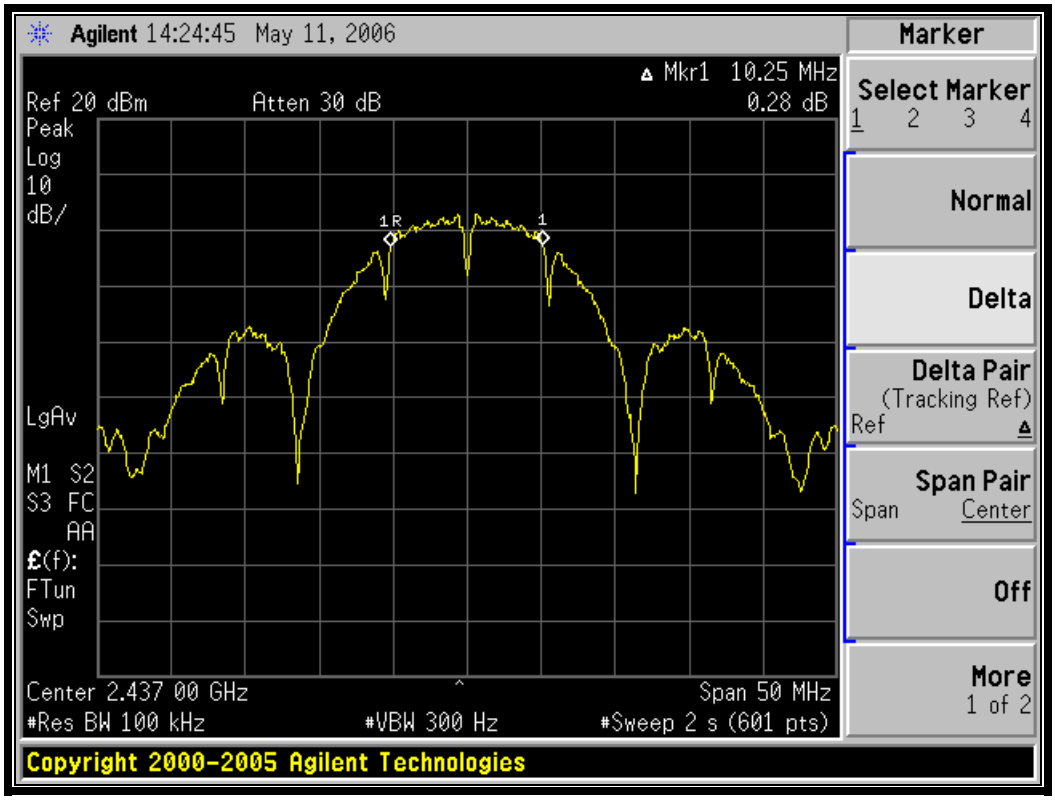
Table 6-2: 6 db Bandwidth Test Data

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)	Pass/Fail
1	2412	10.25	0.5	Pass
6	2437	10.25	0.5	Pass
11	2462	10.25	0.5	Pass

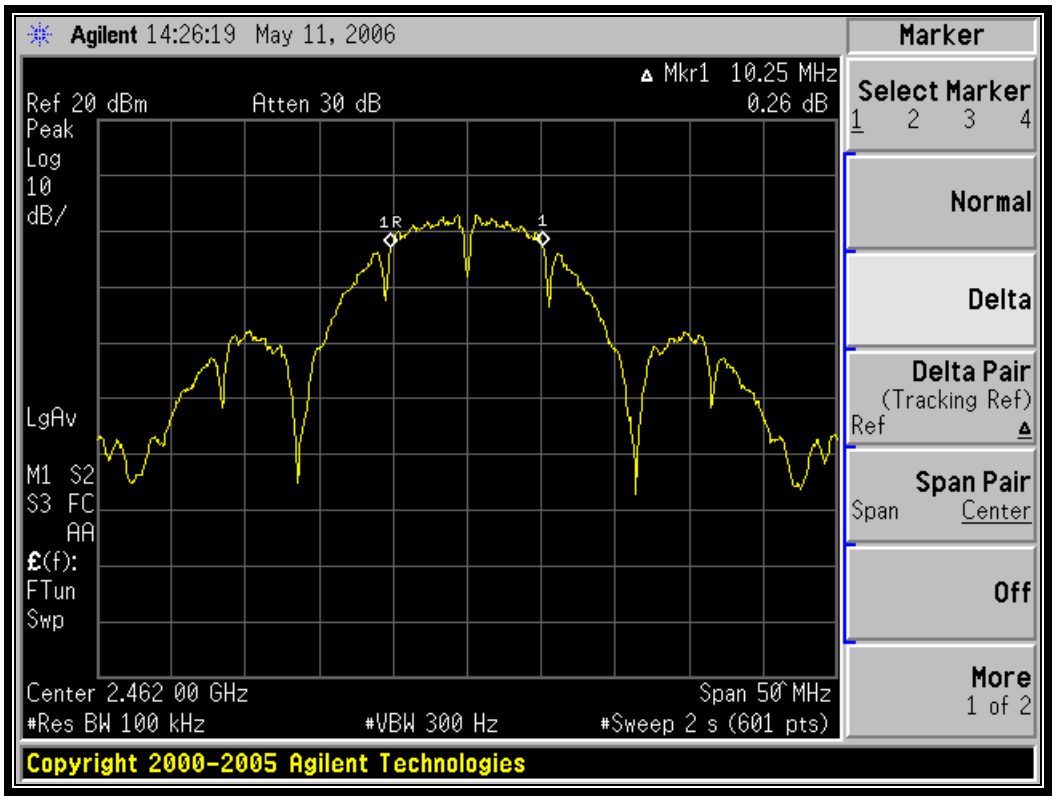
Plot 6-1: 6 dB Bandwidth Channel 1 (TX Frequency: 2412 MHz)



Plot 6-2: 6 dB Bandwidth Channel 6 (TX Frequency: 2437 MHz)



Plot 6-3: 6 dB Bandwidth Channel 11 (TX Frequency: 2462 MHz)



Test Personnel:

Richard B. McMurray	Richard B. McMurray	May 11, 2006
EMC Test Engineer	Signature	Date Of Test

7 Power Spectral Density - §15.247(e); RSS-210 §A8.2

7.1 Power Spectral Density Test Procedure

The power spectral density per FCC 15.247(d) was measured using a 50-ohm spectrum analyzer with the resolution bandwidth set at 3 kHz, the video bandwidth set at 30 kHz, and the sweep time set at 500 seconds. The spectral lines were resolved for the modulated carriers at 2.412 GHz, 2.437 GHz, and 2.462 GHz respectively. These levels are below the +8 dBm limit. See the power spectral density table and plots.

Table 7-1: Power Spectral Density Test Equipment

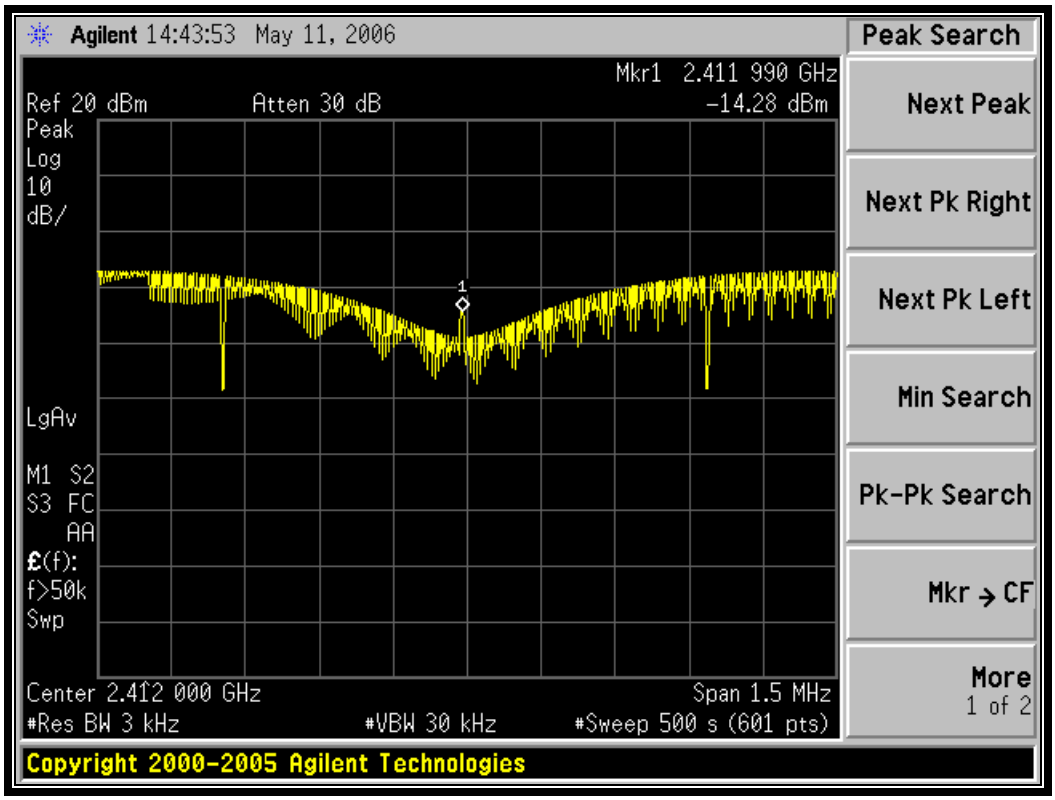
RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
901413	Agilent	E4448A	Spectrum Analyzer (3 Hz – 50 GHz)	US440203416	11/02/06

7.2 Power Spectral Density Test Data

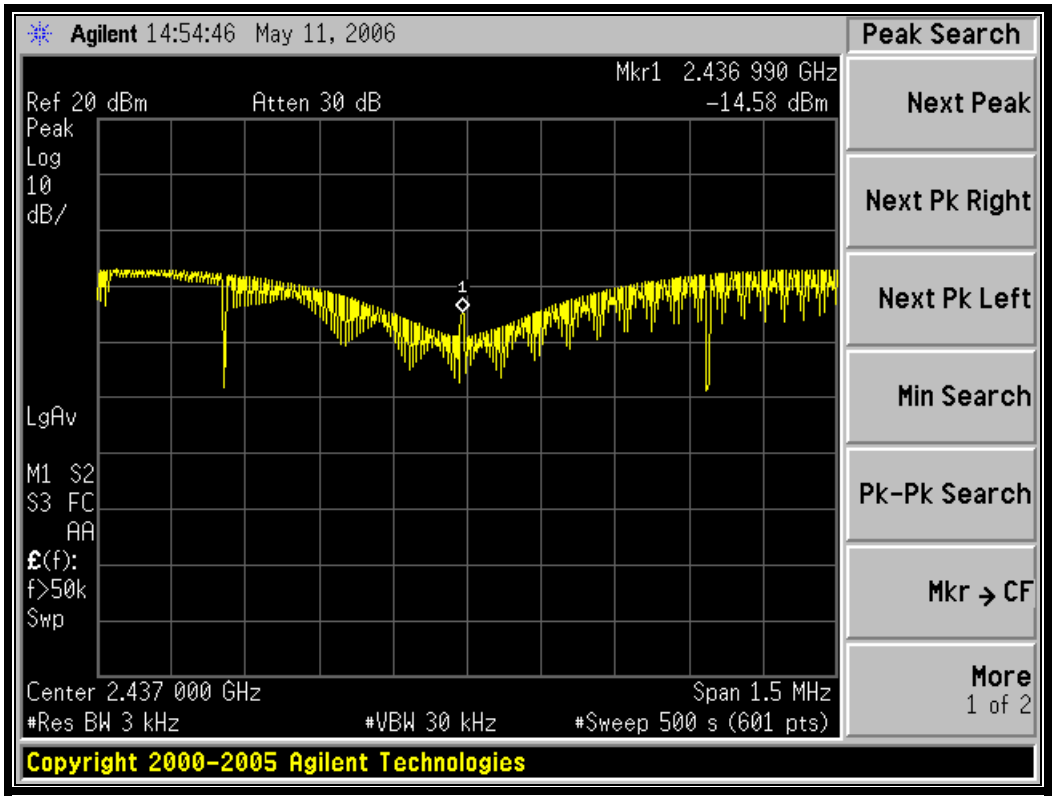
Table 7-2: Power Spectral Density Test Data

Channel	Frequency (MHz)	RF Power Level (dBm)	Maximum Limit +8dBm	Pass/Fail
1	2412	-14.3	8	Pass
6	2437	-14.6	8	Pass
11	2462	-14.5	8	Pass

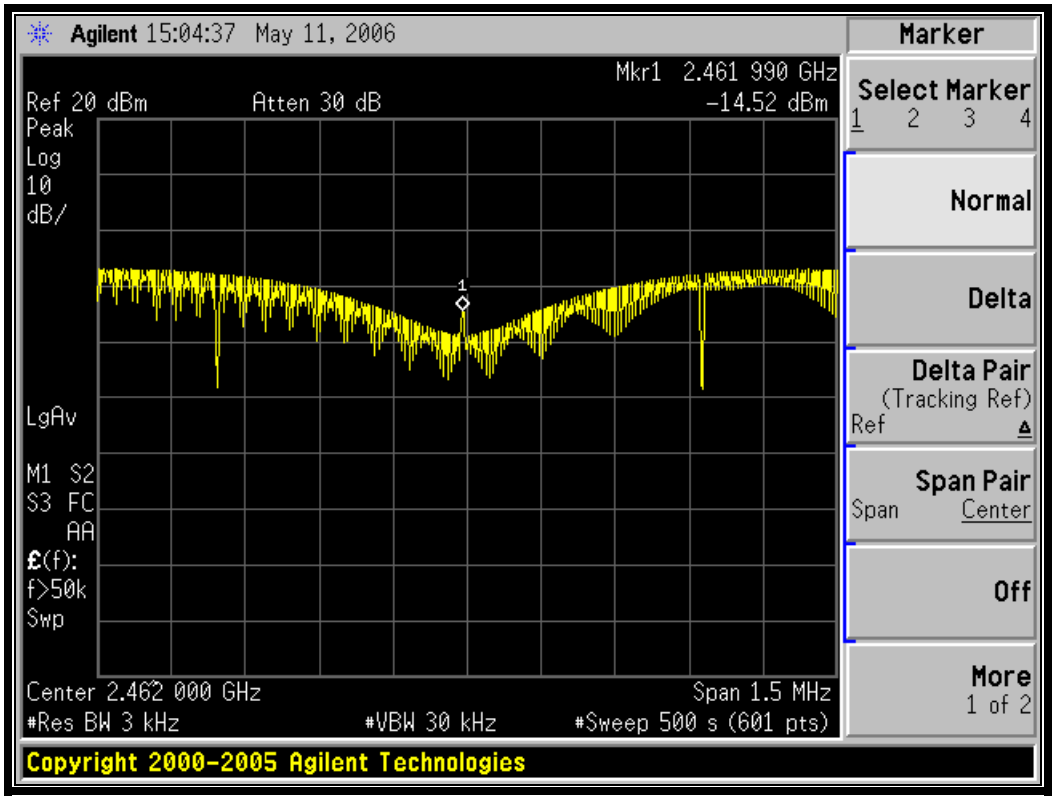
Plot 7-1: Power Spectral Density: Channel 1 (2412 MHz)



Plot 7-2: Power Spectral Density: Channel 6 (2437 MHz)



Plot 7-3: Power Spectral Density: Channel 11 (2462 MHz)



Test Personnel:

Richard B. McMurray	Richard B. McMurray	May 11, 2006
EMC Test Engineer	Signature	Date Of Test

8 Conducted Emissions Measurement Limits – FCC §15.207; RSS-Gen

8.1 Limits of Conducted Emissions Measurement

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	Quasi-peak	Average
0.15-0.5	66-56	56-46
0.5-5.0	56	46
5.0-30.0	60	50

8.2 Conducted Emissions Measurement Test Procedure

Note: This test was not applicable as the EUT is battery operated.

9 Radiated Emissions - §15.209; RSS-210 §A8.5 and RSS-Gen

9.1 Limits of Radiated Emissions Measurement

Frequency (MHz)	Field Strength (uV/m)	Measurement Distance (m)
0.009-0.490	2400/f (kHz)	300
0.490-1.705	2400/f (kHz)	30
1.705-30.0	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

As shown in 15.35(b), for frequencies above 1000 MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20 dB under any circumstances of modulation.

9.2 Radiated Emissions Measurement Test Procedure

Before final measurements of radiated emissions were made on the open-field three/ten meter range, the EUT was scanned indoors at one and three meter distances. This was done in order to determine its emissions spectrum signature. The physical arrangement of the test system and associated cabling was varied in order to determine the effect on the EUT's emissions in amplitude, direction and frequency. This process was repeated during final radiated emissions measurements on the open-field range, at each frequency, in order to ensure that maximum emission amplitudes were attained.

Final radiated emissions measurements were made on the three/ten-meter, open-field test site. The EUT was placed on a nonconductive turntable 0.8 meters above the ground plane. The spectrum was examined from 9 kHz to the 10^{th} harmonic of the highest fundamental transmitter frequency (24.8 GHz).

At each frequency, the EUT was rotated 360°, and the antenna was raised and lowered from 1 to 4 meters in order to determine the emission's maximum level. Measurements were taken using both horizontal and vertical antenna polarizations. For frequencies between 30 and 1000 MHz, the spectrum analyzer's 6 dB bandwidth was set to 120 kHz, and the analyzer was operated in the CISPR quasi-peak detection mode. For emissions above 1000 MHz, emissions are measured using the average detector function with a minimum resolution bandwidth of 1 MHz. No video filter less than 10 times the resolution bandwidth was used. The highest emission amplitudes relative to the appropriate limit were measured and recorded in this report.

Table 9-1: Radiated Emissions Test Equipment

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
900151	Rohde and Schwarz	HFH2-Z2	Antenna (Loop antenna, (9 kHz - 30 MHz)	827525/019	8/25/06
901365	MITEQ	JS4-00102600-41-5P	Amplifier, 15 V, 0.1-26 GHz, 28 dB gain, power 5 dB	1094152	3/24/07
901020	Hewlett Packard	8564E	Portable Spectrum Analyzer (9 kHz - 40 GHz)	3943A01719	9/14/06
900905	Rhein Tech Labs	PR-1040	OATS 1 Preamplifier 40dB (30 MHz – 2 GHz)	1006	3/15/07
900878	Rhein Tech Labs	AM3-1197-0005	3 meter antenna mast, polarizing	Outdoor Range 1	Not Required
901231	IW Microwave Products	KPS-1503-2400-KPS	High frequency RF cables	240"	9/1/06
901232	IW Microwave Products	KPS-1503-2400-KPS	High frequency RF cables	240"	9/1/06
901235	IW Microwave Products	KPS-1503-360-KPS	High frequency RF cables	36"	9/1/06
901242	Rhein Tech Labs	WRT-000-0003	Wood rotating table	N/A	Not Required
900772	EMCO	3161-02	Horn Antenna (2 - 4 GHz)	9804-1044	5/20/07
900321	EMCO	3161-03	Horn Antennas (4 - 8,2 GHz)	9508-1020	5/20/07
900323	EMCO	3160-7	Horn Antennas (8,2 - 12,4 GHz)	9605-1054	5/20/07
900356	EMCO	3160-08	Horn Antenna (12.4 - 18 GHz)	9607-1044	5/20/07
900325	EMCO	3160-9	Horn Antennas (18 - 26.5 GHz)	9605-1051	5/20/07
901218	EMCO	3301B	Horn Antenna (18 - 26.5 GHz)	960281-003	5/20/07
900392	Hewlett Packard	1197OK	Harmonic Mixer (18 – 26.5 GH)z	3525A00159	11/27/07
900931	Hewlett Packard	8566B	Spectrum Analyzer (100 Hz - 22 GHz)	3138A07771	8/3/06
900930	Hewlett Packard	85662A	Spectrum Analyzer Display Section	3144A20839	8/3/06
900889	Hewlett Packard	85685A	RF Preselector (20 Hz - 2 GHz)	3146A01309	4/12/07

9.3 Radiated Emissions Test Results

9.3.1 Radiated Emissions – Digital Test Data

Table 9-2: Digital Radiated Emissions

Temperature: 71°F Humidity: 71%										
Emission Frequency (MHz)	**Test Detector**	**Antenna Polarity (H/V)**	**Turntable Azimuth (deg)**	**Antenna Height (m)**	**Analyzer Reading (dBuV)**	**Site Correction Factor (dB/m)**	**Emission Level (dBuV/m)**	**Limit (dBuV/m)**	**Margin (dB)**	**Pass/ Fail**
287.583	Qp	H	0	1.0	38.3	-16.7	21.6	46.0	-24.4	Pass
294.876	Qp	H	0	1.0	34.7	-16.4	18.3	46.0	-27.7	Pass
331.725	Qp	H	0	1.0	35.3	-15.4	19.9	46.0	-26.1	Pass
336.425	Qp	H	0	1.0	41.5	-15.0	26.5	46.0	-19.5	Pass
344.099	Qp	H	0	1.0	41.3	-14.6	26.7	46.0	-19.3	Pass
352.000	Qp	V	0	1.0	39.7	-14.8	24.9	46.0	-21.1	Pass
385.399	Qp	V	0	1.0	44.2	-14.1	30.1	46.0	-15.9	Pass
393.173	Qp	H	0	1.0	38.0	-13.8	24.2	46.0	-21.8	Pass
405.483	Qp	H	355	1.0	35.0	-13.8	21.2	46.0	-24.8	Pass

9.3.2 Radiated Emissions Harmonics/Spurious Test Data

Table 9-3: Radiated Emissions Harmonics/Spurious Channel 1 (TX Frequency: 2412 MHz)

Emission Frequency (MHz)	Peak Analyzer Reading (dBuV) (1 MHz RBW/VBW)	Average Analyzer Reading (dBuV) (1 MHz RBW/ 10 Hz VBW)	Site Correction Factor (dB/m)	Average Emission Level (dBuV/m)	Average Limit (dBuV/m)	Average Margin (dB)
4824.0	55.5	52.7	0.5	53.2	54.0	-0.8
7236.0	47.7	41.2	3.3	44.5	79.8	-35.3
9648.0	44.0	37.5	8.4	45.9	79.8	-33.9
12060.0	39.7	27.8	11.3	39.1	54.0	-14.9
14472.0	41.2	28.5	15.3	43.8	54.0	-10.2
16884.0	41.2	28.2	16.3	44.5	79.8	-35.3

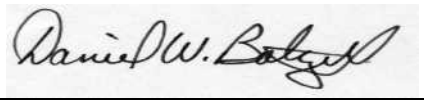
Table 9-4: Radiated Emissions Harmonics/Spurious Channel 6 (TX Frequency: 2437 MHz)

Emission Frequency (MHz)	Peak Analyzer Reading (dBuV) (1 MHz RBW/VBW)	Average Analyzer Reading (dBuV) (1 MHz RBW/ 10 Hz VBW)	Site Correction Factor (dB/m)	Average Emission Level (dBuV/m)	Average Limit (dBuV/m)	Average Margin (dB)
4874.0	52.8	48.7	0.1	48.8	54.0	-5.2
7311.0	56.2	39.7	2.9	42.6	54.0	-11.4
9748.0	45.5	41.7	8.6	50.3	79.9	-29.6
12185.0	31.8	31.0	10.5	41.5	54.0	-12.5
14622.0	41.8	30.2	15.6	45.8	79.9	-34.1
17059.0	41.3	28.5	16.0	44.5	79.9	-35.4

Table 9-5: Radiated Emissions Harmonics/Spurious Channel 11 (TX Frequency: 2462 MHz)

Emission Frequency (MHz)	Peak Analyzer Reading (dBuV) (1 MHz RBW/VBW)	Average Analyzer Reading (dBuV) (1 MHz RBW/ 10 Hz VBW)	Site Correction Factor (dB/m)	Average Emission Level (dBuV/m)	Average Limit (dBuV/m)	Average Margin (dB)
4924.0	52.3	47.8	0.4	48.2	54.0	-5.8
7386.0	57.3	42.0	4.0	46.0	54.0	-8.0
9848.0	47.7	43.2	9.3	52.5	81.1	-28.6
12310.0	42.2	31.7	10.2	41.9	54.0	-12.1
14772.0	41.0	29.5	14.7	44.2	81.1	-36.9
17234.0	41.3	28.8	16.2	45.0	81.1	-36.1

Test Personnel:



Daniel W. Baltzell		May 12, 2006
EMC Test Engineer	Signature	Date Of Test

10 Conclusion

The data in this measurement report shows that the EUT as tested, Vocollect, Inc. Model Name: T2x, Model # TT-601_R WF, FCC ID: MQOTT601-10000, IC: 2570A-TT601100, complies with all the applicable requirements of Parts 2 and 15 of the FCC Rules and Regulations, and Industry Canada RSS-210.