Engineering and Testing for EMC and Safety Compliance

LIMITED MODULAR CERTIFICATION APPLICATION REPORT
FCC PART 15.247 & INDUSTRY CANADA RSS-210

Test Lab:	Applicant Information:
Rhein Tech Laboratories, Inc. 360 Herndon Parkway Suite 1400 Herndon, VA 20170	Phone: 703-689-0368 Fax: 703-689-2056 Web Site: www.rheintech.com E-Mail: ATCBINFO@rheintech.com	Zebra Technologies Contact: Bob Heon 30 Plan Way Warwick, RI 02886	Phone: 401-739-5800 ext. 352 Fax: 401-732-0145 E-Mail: bheon@zebra.com

FCC ID:	I28MD-QL3021	**GRANTEE FRN NUMBER:**	0006304075
PLAT FORM:	QL 320 / QL 420	**RTL WORK ORDER NUMBER:**	2003175
MODEL NUMBER / NAME:	AN16973-1	**RTL QUOTE NUMBER:**	QRTL03-142
DATE OF TEST REPORT:	December 15, 2003		

American National Standard Institute:	ANSI C63.4: 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:	DSS – Part 15 Spread Spectrum Transmitter Frequency Hopping
FCC Rule Part(s):	Part 15.247: Operation within the bands 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz Frequency Hopping System
Industry Canada Standard:	RSS-210: Low Power License-Exempt Radio Communication Devices (All Frequency Bands)
Digital Interface Information	Digital Interface was found to be compliant

Frequency Range (MHz)	Output Power* (W)	Frequency Tolerance	Emission Designator
2402-2480	0.107	N/A	N/A

* output power is maximum peak conducted

We, 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.

Furthermore, there was no deviation from, additions to, or exclusions from the FCC Part 2, FCC Part 15, Industry Canada RSS-210, and ANSI C63.4

Signature: _____ Date: December 15, 2003

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

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1 GENERAL INFORMATION

1.1 SCOPE

FCC Rules Part 15.247: 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. FCC DA 00-705 Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems was also used for guidance.

IC RSS-210 Section 6.2.2(o): 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.

The EUT utilizes a frequency hopping system operating in the 2402–2480 MHz band.

1.2 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 1992).

1.3 RELATED SUBMITTAL(S)/GRANT(S)

This is an original certification application for **limited modular transmitter approval** based on the guidelines in FCC Publication DA 00-1407, for Zebra Technologies Corp. Model # AN16973-1 under FCC ID: I28MD-QL3021. The applicant requests limited modular approval to allow the use of this radio in Zebra QL320 and QL420 printers. SAR compliance is represented for this module in both the QL320 and QL420 printers. A cover letter exhibit includes a letter from the client justifying the limited modular approval request. The IF, LO and up to the 2nd LO were investigated and tested.

1.4 MODIFICATIONS

No modifications were made to the EUT.

2 TEST INFORMATION

2.1 TEST JUSTIFICATION

The EUT was tested in all three orthogonal planes in order to determine worst-case emissions. 2402 MHz, 2440 MHz and 2480 MHz were tested and investigated from 9 kHz to 24.8 GHz. Data for all three frequencies is presented in this report.

2.2 EXERCISING THE EUT

The EUT was provided with software to continuously transmit on one channel or in the hopping mode during testing. The carrier was also checked to verify that information was being transmitted.

2.3 TEST RESULT SUMMARY

TABLE 2-1: TEST RESULT SUMMARY FOR FCC RULES AND REGULATIONS

STANDARD	TEST	PASS/FAIL OR N/A
FCC 15.205	Compliance with the Restricted Band Edge	Pass
FCC 15.207	Conducted Emissions	Pass
FCC 15.209	Radiated Emissions	Pass
FCC 15.247(a)(2)	Modulated Bandwidth	Pass
FCC 15.247(b)	Power Output	Pass
FCC 15.247(c)	Spurious Emissions	Pass

2.4 TEST SYSTEM DETAILS

The FCC identifiers for all applicable equipment, plus descriptions of all cables used in the tested system, are identified in Table 2-2.

TABLE 2-2: EQUIPMENT UNDER TEST (EUT)

Part	Manufacturer	Model	Serial Number	FCC Identifier	Cable Description	RTL Barcode
Charger/AC Power Adapter (8.4 VDC)	Zebra Technologies	L172 (FW 7511/Q7)	0702	N/A	2 meter unshielded	15480
Wireless LAN Card	Symbol	LA-3021-100-US	00B00H32U	H9PLA3021-100	N/A	15482
Wireless LAN Card	Symbol	LA-3021-100-US	48.8mW 16.9dBm	H9PLA3021-100	N/A	15472
Wireless LAN Card	Symbol	LA-3021-100-US	00B00H23M	H9PLA3021-100	N/A	15469
Mobile Printer	Zebra Technologies	QL320	XXQT03-08-0014	SAMPLE	N/A	15473
Mobile Printer	Zebra Technologies	QL420	XXQF02-12-0090	SAMPLE	N/A	15470
Charger/AC Power Adapter (8.4 VDC)	Zebra Technologies	L172 (FW 7511/Q7)	0702	N/A	2 meter unshielded	15481
Charger/AC Power Adapter (8.4 VDC)	Zebra Technologies	L172 (FW 7511/Q7)	0702	N/A	2 meter unshielded	15479
Battery	Zebra Technologies	AT16293	N/A	N/A	N/A	15478
Battery	Zebra Technologies	AT16004	N/A	N/A	N/A	15477
Battery	Zebra Technologies	AT16293	N/A	N/A	N/A	15476
Battery	Zebra Technologies	AT16004	N/A	N/A	N/A	15475
Battery	Zebra Technologies	AT16004	N/A	N/A	N/A	15474
Battery	Zebra Technologies	AT16004	N/A	N/A	N/A	15471

2.5 CONFIGURATION OF TESTED SYSTEM

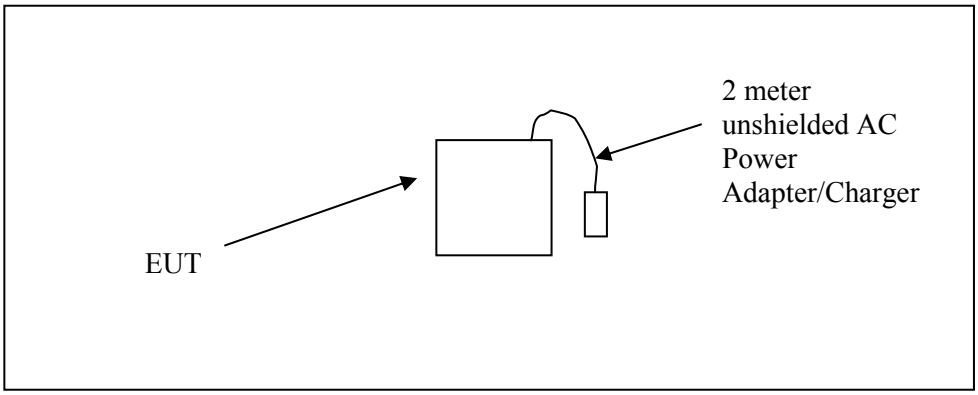


FIGURE 1: WORST CASE CONFIGURATION OF SYSTEM UNDER TEST

3 COMPLIANCE WITH FCC §15.31(m)

In accordance with FCC 15.31(m), and because the EUT utilizes an operating band greater than 10 MHz, three frequencies were investigated for those tests that required the hopping function to be disabled. The following frequencies were tested: 2402 MHz, 2440 MHz and 2480 MHz.

4 COMPLIANCE WITH FCC §15.203

The RF connector used for antenna attachment is a connector which is not readily available to users through retail distribution.

5 COMPLIANCE WITH FCC §15.204

Please see Appendix B for antenna specifications.

6 COMPLIANCE WITH THE BAND EDGE – FCC §15.247(c), §15.205; IC RSS-210 §6.3

6.1 TEST PROCEDURE

Compliance with the band edges was performed using the FCC's "Radiated Measurement at a Band Edge" guidance document. The data taken in this report represents the worst case operation.

6.2 BAND EDGE TEST EQUIPMENT

TABLE 6-1: 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	7/15/04
900772	EMCO	3161-02	Horn Antenna (2 - 4 GHz)	9804-1044	3/15/04

6.3 RESTRICTED BAND EDGE PLOTS

Calculation of Upper Band Edge

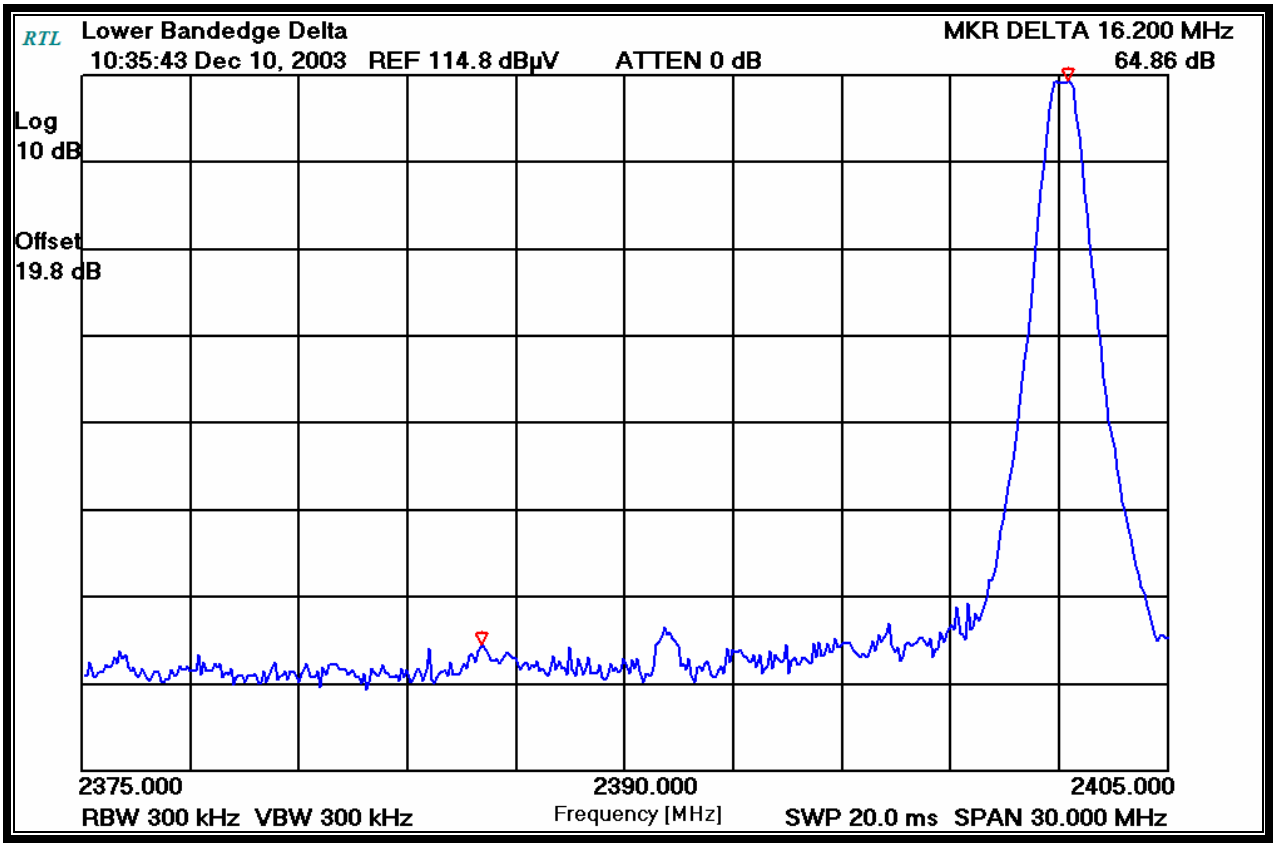
The level 114.8 dBuV/m is the peak field strength measurement (worst case), from which the delta measurement of 64.9 dB is subtracted (reference plots), which is equivalent to a level of 49.9 dB. This level has a margin of 4.1 dB below the limit of 54 dBuV/m.

Calculation: 114.8 dBuV/m – 64.9 dB – 54 dBuV/m = -4.1 dB

Peak field strength of Upper Band Edge (1 MHz RBW/1 MHz VBW) = 114.8 dBuV/m
Average field strength of Upper Band Edge(1 MHz RBW/10 Hz VBW) = 114.1 dBuV/m

Delta measurement = 64.9 dB

PLOT 6-1: LOWER BAND EDGE: MARKER-DELTA METHOD (TX FREQUENCY: 2402 MHZ)



Calculation of Upper Band Edge

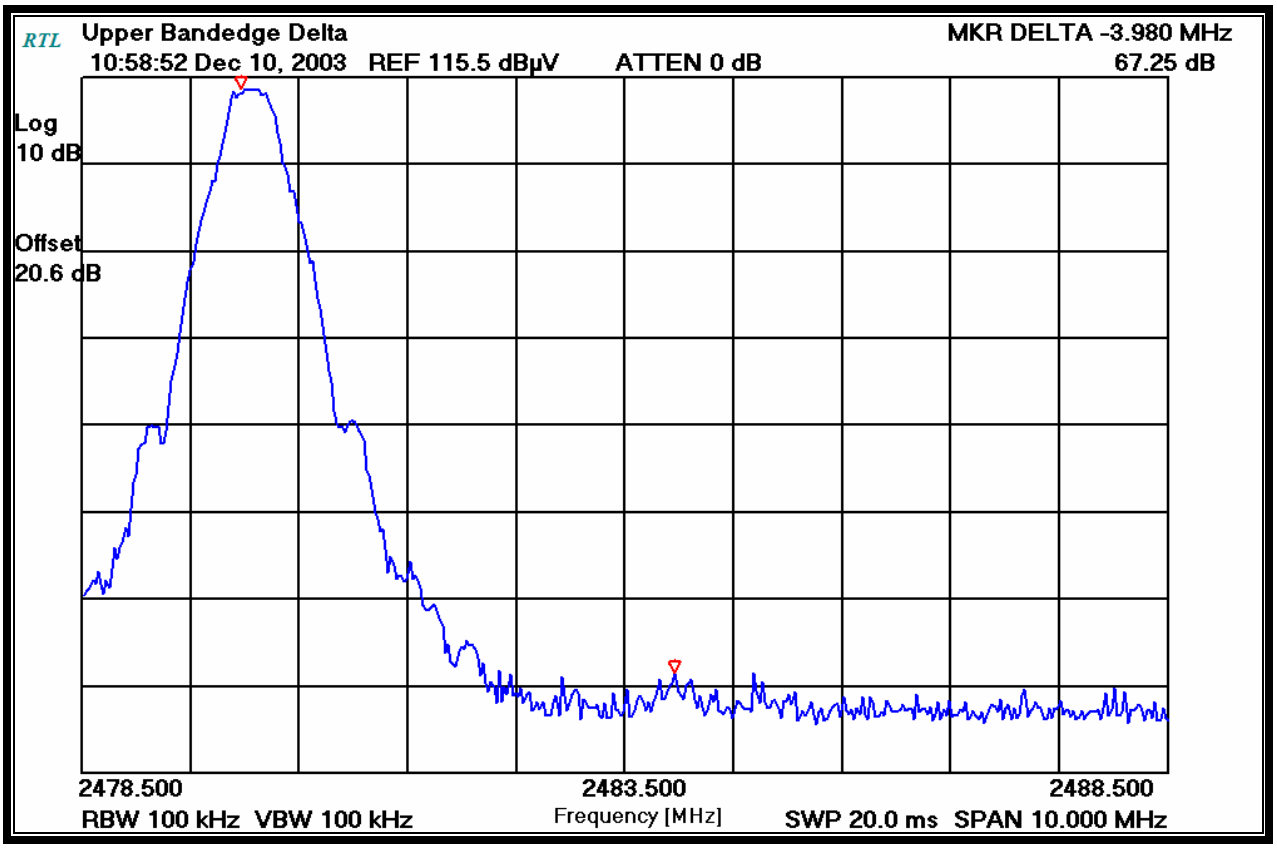
The level 115.5 dBuV/m is the peak field strength measurement (worst case), from which the delta measurement of 67.3 dB is subtracted (reference plots), which is equivalent to a level of 48.2 dB. This level has a margin of 5.8 dB below the limit of 54 dBuV/m.

Calculation: 115.5 dBuV/m – 67.3 dB – 54 dBuV/m = -5.8 dB

Peak field strength of Upper Band Edge (1 MHz RBW/1 MHz VBW) = 115.5 dBuV/m
Average field strength of Upper Band Edge(1 MHz RBW/10 Hz VBW) = 114.7 dBuV/m

Delta measurement = 67.3 dB

PLOT 6-2: UPPER BAND EDGE: MARKER-DELTA METHOD (TX FREQUENCY: 2480 MHZ)



TEST PERSONNEL:

Daniel W. Baltzell	Daniel W. Baltzell	December 10, 2003
Test Engineer	Signature	Dates Of Test

7 CONDUCTED LIMITS - §15.207

7.1 TEST METHODOLOGY FOR CONDUCTED LINE EMISSIONS MEASUREMENTS

The power line conducted emission measurements were performed in a Series 81 type shielded enclosure manufactured by Rayproof. The EUT was assembled on a wooden table 80 centimeters high. Power was fed to the EUT through a 50 ohm / 50 microhenry Line Impedance Stabilization Network (EUT LISN). The EUT LISN was fed power through an A.C. filter box on the outside of the shielded enclosure. The filter box and EUT LISN housing are bonded to the ground plane of the shielded enclosure. A second LISN, the peripheral LISN, provides isolation for the EUT test peripherals. This peripheral LISN was also fed A.C. power. A metal power outlet box, which is bonded to the ground plane and electrically connected to the peripheral LISN, powers the EUT host peripherals.

The spectrum analyzer was connected to the A.C. line through an isolation transformer. The 50-ohm output of the EUT LISN was connected to the spectrum analyzer input through a Solar high-pass filter. The filter is used to prevent overload of the spectrum analyzer from noise below 100 kHz. Conducted emission levels were measured on each current-carrying line with the spectrum analyzer operating in the CISPR quasi-peak mode (or peak mode if applicable). The analyzer's 6 dB bandwidth was set to 9 kHz. No video filter less than 10 times the resolution bandwidth was used. Average measurements are performed in linear mode using a 10 kHz resolution bandwidth, a 1 Hz video bandwidth, and by increasing the sweep time in order to obtain a calibrated measurement. The emission spectrum was scanned from 150 kHz to 30 MHz. The highest emission amplitudes relative to the appropriate limit were measured and have been recorded in this report.

Note: Rhein Tech Laboratories, Inc. has implemented procedures to minimize errors that occur from test instruments, calibration, procedures, and test setups. Test instrument and calibration errors are documented from the manufacturer or calibration lab. Other errors have been defined and calculated within the Rhein Tech Quality Manual, section 6.1. Rhein Tech implements the following procedures to minimize errors that may occur: yearly as well as daily calibration methods, technician training, and emphasis to employees on avoiding error.

7.2 CONDUCTED LINE EMISSION TEST

The conducted test was performed with the EUT exercise program loaded, and the emissions were scanned between 150 kHz to 30 MHz on the NEUTRAL SIDE and PHASE SIDE.

7.3 CONDUCTED LINE TEST EQUIPMENT

TABLE 7-1: CONDUCTED LINE TEST EQUIPMENT

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
900931	Hewlett Packard	8566B	Spectrum Analyzer (100 Hz - 22 GHz)	3138A07771	5/12/04
901084	AFJ international	LS16	16A LISN	16010020082	11/4/03

7.4 CONDUCTED LINE EMISSION TEST DATA, RECEIVE MODE

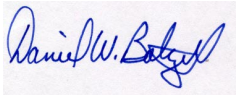
TABLE 7-2: CONDUCTED EMISSIONS (NEUTRAL SIDE)

Emission Frequency (MHz)	Test Detector	Analyzer Reading (dBuV)	Site Correction Factor (dB)	Emission Level (dBuV)	QP Limit (dBuV)	QP Margin (dBuV)	AV Limit (dBuV)	AV Margin (dBuV)
0.240	Qp	42.5	1.4	43.9	62.1	-18.2	52.1	-8.2
0.241	Av	29.4	1.4	30.8	62.1	-31.3	52.1	-21.3
0.422	Qp	44.4	1.0	45.4	57.4	-12.0	47.4	-2.0
0.422	Av	30.1	1.0	31.1	57.4	-26.3	47.4	-16.3
0.845	Qp	42.1	0.9	43.0	56.0	-13.0	46.0	-3.0
0.845	Av	29.0	0.9	29.9	56.0	-26.1	46.0	-16.1
1.751	Qp	40.0	1.3	41.3	56.0	-14.7	46.0	-4.7
1.751	Av	22.9	1.3	24.2	56.0	-31.8	46.0	-21.8
3.017	Qp	40.3	1.5	41.8	56.0	-14.2	46.0	-4.2
3.017	Av	24.8	1.5	26.3	56.0	-29.7	46.0	-19.7
5.670	Pk	43.0	2.0	45.0	60.0	-15.0	50.0	-5.0
25.500	Pk	34.3	4.3	38.6	60.0	-21.4	50.0	-11.4

TABLE 7-3: CONDUCTED EMISSIONS (PHASE SIDE)

Emission Frequency (MHz)	Test Detector	Analyzer Reading (dBuV)	Site Correction Factor (dB)	Emission Level (dBuV)	QP Limit (dBuV)	QP Margin (dBuV)	AV Limit (dBuV)	AV Margin (dBuV)
0.242	Av	32.0	1.4	33.4	62.0	-28.6	52.0	-18.6
0.242	Qp	45.6	1.4	47.0	62.0	-15.0	52.0	-5.0
0.242	Pk	47.3	1.4	48.7	62.0	-13.3	52.0	-3.3
0.422	Av	35.5	1.0	36.5	57.4	-20.9	47.4	-10.9
0.424	Pk	45.2	1.0	46.2	57.4	-11.2	47.4	-1.2
0.424	Qp	39.9	1.0	40.9	57.4	-16.5	47.4	-6.5
0.424	Av	34.5	1.0	35.5	57.4	-21.9	47.4	-11.9
1.987	Av	33.3	1.4	34.7	56.0	-21.3	46.0	-11.3
1.987	Qp	41.4	1.4	42.8	56.0	-13.2	46.0	-3.2
5.800	Pk	46.3	2.1	48.4	60.0	-11.6	50.0	-1.6
9.230	Pk	42.3	2.6	44.9	60.0	-15.1	50.0	-5.1
18.620	Pk	30.4	3.7	34.1	60.0	-25.9	50.0	-15.9
23.000	Pk	31.0	4.2	35.2	60.0	-24.8	50.0	-14.8

TEST PERSONNEL:



Daniel W. Baltzell		October 21, 2003
EMC Test Engineer	Signature	Date Of Test

7.5 CONDUCTED LINE EMISSION TEST DATA, TRANSMIT MODE, LOW CHANNEL (2402 MHZ)

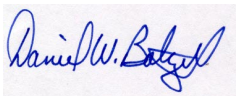
TABLE 7-4: CONDUCTED EMISSIONS (NEUTRAL SIDE)

Emission Frequency (MHz)	Test Detector	Analyzer Reading (dBuV)	Site Correction Factor (dB)	Emission Level (dBuV)	QP Limit (dBuV)	QP Margin (dBuV)	AV Limit (dBuV)	AV Margin (dBuV)
0.181	Pk	49.8	1.8	51.6	64.4	-12.8	54.4	-2.8
0.242	Pk	46.3	1.4	47.7	62.0	-14.3	52.0	-4.3
0.421	Pk	46.3	1.0	47.3	57.4	-10.1	47.4	-0.1
0.421	Qp	46.1	1.0	47.1	57.4	-10.3	47.4	-0.3
0.421	Av	36.6	1.0	37.6	57.4	-19.8	47.4	-9.8
2.592	Qp	42.8	1.5	44.3	56.0	-11.7	46.0	-1.7
2.592	Av	32.5	1.5	34.0	56.0	-22.0	46.0	-12.0
5.180	Pk	44.9	2.0	46.9	60.0	-13.1	50.0	-3.1
9.080	Pk	39.4	2.6	42.0	60.0	-18.0	50.0	-8.0
18.000	Pk	27.0	3.7	30.7	60.0	-29.3	50.0	-19.3
25.740	Pk	29.5	4.3	33.8	60.0	-26.2	50.0	-16.2

TABLE 7-5: CONDUCTED EMISSIONS (PHASE SIDE)

Emission Frequency (MHz)	Test Detector	Analyzer Reading (dBuV)	Site Correction Factor (dB)	Emission Level (dBuV)	QP Limit (dBuV)	QP Margin (dBuV)	AV Limit (dBuV)	AV Margin (dBuV)
0.180	Qp	48.0	1.8	49.8	64.5	-14.7	54.5	-4.7
0.180	Av	33.5	1.8	35.3	64.5	-29.2	54.5	-19.2
0.421	Av	30.1	1.0	31.1	57.4	-26.3	47.4	-16.3
0.421	Qp	41.9	1.0	42.9	57.4	-14.5	47.4	-4.5
2.894	Pk	43.5	1.5	45.0	56.0	-11.0	46.0	-1.0
8.520	Pk	38.2	2.5	40.7	60.0	-19.3	50.0	-9.3
23.090	Pk	34.2	4.2	38.4	60.0	-21.6	50.0	-11.6
25.950	Pk	34.2	4.3	38.5	60.0	-21.5	50.0	-11.5

TEST PERSONNEL:



Daniel W. Baltzell		October 21, 2003
EMC Test Engineer	Signature	Date Of Test

7.6 CONDUCTED LINE EMISSION TEST DATA, TRANSMIT MODE, MIDDLE CHANNEL (2440 MHZ)

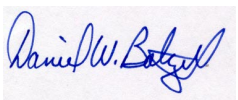
TABLE 7-6: CONDUCTED EMISSIONS (NEUTRAL SIDE)

Emission Frequency (MHz)	Test Detector	Analyzer Reading (dBuV)	Site Correction Factor (dB)	Emission Level (dBuV)	QP Limit (dBuV)	QP Margin (dBuV)	AV Limit (dBuV)	AV Margin (dBuV)
0.181	Av	33.4	1.8	35.2	64.4	-29.2	54.4	-19.2
0.181	Qp	44.3	1.8	46.1	64.4	-18.3	54.4	-8.3
0.422	Av	30.3	1.0	31.3	57.4	-26.1	47.4	-16.1
0.422	Qp	41.8	1.0	42.8	57.4	-14.6	47.4	-4.6
1.808	Pk	44.0	1.3	45.3	56.0	-10.7	46.0	-0.7
1.810	Av	23.5	1.3	24.8	56.0	-31.2	46.0	-21.2
1.810	Qp	38.1	1.3	39.4	56.0	-16.6	46.0	-6.6
2.109	Pk	33.3	1.4	34.7	56.0	-21.3	46.0	-11.3
2.111	Av	22.3	1.4	23.7	56.0	-32.3	46.0	-22.3
2.111	Qp	28.4	1.4	29.8	56.0	-26.2	46.0	-16.2
6.630	Pk	43.3	2.2	45.5	60.0	-14.5	50.0	-4.5
19.600	Pk	31.8	3.8	35.6	60.0	-24.4	50.0	-14.4
26.180	Pk	33.1	4.3	37.4	60.0	-22.6	50.0	-12.6

TABLE 7-7: CONDUCTED EMISSIONS (PHASE SIDE)

Emission Frequency (MHz)	Test Detector	Analyzer Reading (dBuV)	Site Correction Factor (dB)	Emission Level (dBuV)	QP Limit (dBuV)	QP Margin (dBuV)	AV Limit (dBuV)	AV Margin (dBuV)
0.181	Pk	50.4	1.8	52.2	64.4	-12.2	54.4	-2.2
0.243	Pk	46.8	1.4	48.2	62.0	-13.8	52.0	-3.8
0.423	Av	36.8	1.0	37.8	57.4	-19.6	47.4	-9.6
0.423	Qp	43.6	1.0	44.6	57.4	-12.8	47.4	-2.8
1.447	Av	33.1	1.1	34.2	56.0	-21.8	46.0	-11.8
1.447	Qp	41.5	1.1	42.6	56.0	-13.4	46.0	-3.4
2.111	Av	33.2	1.4	34.6	56.0	-21.4	46.0	-11.4
2.111	Qp	40.8	1.4	42.2	56.0	-13.8	46.0	-3.8
9.110	Pk	39.2	2.6	41.8	60.0	-18.2	50.0	-8.2
18.650	Pk	26.4	3.7	30.1	60.0	-29.9	50.0	-19.9
26.750	Pk	29.3	4.4	33.7	60.0	-26.3	50.0	-16.3

TEST PERSONNEL:



Daniel W. Baltzell		October 21, 2003
EMC Test Engineer	Signature	Date Of Test

7.7 CONDUCTED LINE EMISSION TEST DATA, TRANSMIT MODE, HIGH CHANNEL (2480 MHZ)

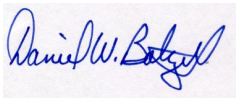
TABLE 7-8: CONDUCTED EMISSIONS (NEUTRAL SIDE)

Emission Frequency (MHz)	Test Detector	Analyzer Reading (dBuV)	Site Correction Factor (dB)	Emission Level (dBuV)	QP Limit (dBuV)	QP Margin (dBuV)	AV Limit (dBuV)	AV Margin (dBuV)
0.421	Av	30.6	1.0	31.6	57.4	-25.8	47.4	-15.8
0.421	Qp	42.3	1.0	43.3	57.4	-14.1	47.4	-4.1
0.664	Pk	43.6	0.8	44.4	56.0	-11.6	46.0	-1.6
0.664	Qp	36.8	0.8	37.6	56.0	-18.4	46.0	-8.4
0.664	Av	28.0	0.8	28.8	56.0	-27.2	46.0	-17.2
0.845	Av	28.3	0.9	29.2	56.0	-26.8	46.0	-16.8
0.845	Qp	36.8	0.9	37.7	56.0	-18.3	46.0	-8.3
2.594	Pk	40.5	1.5	42.0	56.0	-14.0	46.0	-4.0
19.390	Pk	30.8	3.7	34.5	60.0	-25.5	50.0	-15.5
26.420	Pk	34.6	4.3	38.9	60.0	-21.1	50.0	-11.1

TABLE 7-9: CONDUCTED EMISSIONS (PHASE SIDE)

Emission Frequency (MHz)	Test Detector	Analyzer Reading (dBuV)	Site Correction Factor (dB)	Emission Level (dBuV)	QP Limit (dBuV)	QP Margin (dBuV)	AV Limit (dBuV)	AV Margin (dBuV)
0.182	Pk	50.5	1.8	52.3	64.4	-12.1	54.4	-2.1
0.242	Pk	46.9	1.4	48.3	62.0	-13.7	52.0	-3.7
0.304	Pk	44.9	1.0	45.9	60.1	-14.2	50.1	-4.2
0.422	Av	36.8	1.0	37.8	57.4	-19.6	47.4	-9.6
0.422	Qp	43.8	1.0	44.8	57.4	-12.6	47.4	-2.6
0.482	Av	34.1	0.9	35.0	56.3	-21.3	46.3	-11.3
0.482	Qp	42.1	0.9	43.0	56.3	-13.3	46.3	-3.3
1.086	Av	34.2	1.0	35.2	56.0	-20.8	46.0	-10.8
1.086	Qp	42.6	1.0	43.6	56.0	-12.4	46.0	-2.4
18.800	Pk	28.5	3.7	32.2	60.0	-27.8	50.0	-17.8
25.420	Pk	29.4	4.3	33.7	60.0	-26.3	50.0	-16.3

TEST PERSONNEL:



Daniel W. Baltzell		October 21, 2003
EMC Test Engineer	Signature	Date Of Test

8 RADIATED EMISSION LIMITS DIGITAL INTERFACE – FCC §15.209; IC RSS-210 §7.3

8.1 DIGITAL INTERFACE RADIATED EMISSION LIMITS TEST PROCEDURE

Emissions from the digital portion of the transceiver circuitry of the EUT were tested and found to comply with the requirements of FCC Part 15.209.

8.2 DIGITAL INTERFACE RADIATED EMISSIONS TEST EQUIPMENT

TABLE 8-1: DIGITAL INTERFACE RADIATED EMISSIONS TEST EQUIPMENT

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
900889	Hewlett Packard	85685A	RF Preselector for HP 8566B or 8568B (20 Hz - 2 GHz)	3146A01309	11/21/03
900905	Rhein Tech Labs	PR-1040	Amplifier	900905	9/15/04
900969	Hewlett Packard	85650A	Quasi-Peak Adapter	2412A00414	5/12/04
901053	Schaffner Chase	CBL6112B	Bi-Log Antenna (20 MHz - 2 GHz)	2648	7/03/04
900930	Hewlett Packard	85662A	Spectrum Analyzer Display Section	3144A20839	5/12/04
900931	Hewlett Packard	8566B	Spectrum Analyzer (100 Hz - 22 GHz)	3138A07771	5/12/04

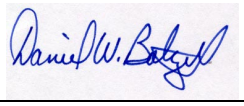
8.3 DIGITAL INTERFACE RADIATED EMISSION LIMITS TEST DATA

TABLE 8-2: DIGITAL INTERFACE RADIATED EMISSION

Temperature: 48°F Humidity: 93%									
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)**
280.008	Qp	H	160	1.5	47.3	-24.5	22.8	46.0	-23.2
300.006	Qp	H	170	1.5	48.5	-24.0	24.5	46.0	-21.5
320.004	Qp	V	70	1.0	46.7	-24.2	22.5	46.0	-23.5
340.002	Qp	V	80	1.0	43.8	-23.4	20.4	46.0	-25.6
360.001	Qp	H	180	1.5	43.5	-22.4	21.1	46.0	-24.9
379.999	Qp	V	90	1.0	47.3	-22.2	25.1	46.0	-20.9
399.997	Qp	V	90	1.0	53.2	-21.6	31.6	46.0	-14.4
439.993	Qp	V	150	1.0	31.7	-20.9	10.8	46.0	-35.2
459.991	Qp	H	350	1.0	38.3	-20.2	18.1	46.0	-27.9

QP: RES. =100 KHZ, VID= 100 KHZ

TEST PERSONNEL:



Daniel W. Baltzell		October 29, 2003
EMC Test Engineer	Signature	Date Of Test

9 RADIATED EMISSION LIMITS; SPURIOUS AND HARMONICS – FCC §15.247(C); IC RSS-210 §6.3

9.1 RADIATED SPURIOUS EMISSION LIMITS TEST PROCEDURE

Radiated Spurious Emissions applies to harmonics and spurious emissions that fall in the restricted and non-restricted bands. The restricted bands are listed in Part 15.205. The maximum permitted average field strength for the restricted band is listed in Part 15.209. The EUT was tested in the 3 orthogonal planes. Frequency hopping was disabled and the carrier was non-pulsing.

9.2 RADIATED SPURIOUS TEST EQUIPMENT

TABLE 9-1: RADIATED SPURIOUS EMISSIONS TEST EQUIPMENT

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
900772	EMCO	3161-02	Horn Antenna (2 - 4 GHz)	9804-1044	3/15/04
900323	EMCO	3160-7	Horn Antennas (8.2 - 12.4 GHz)	9605-1054	6/10/04
900356	EMCO	3160-08	Horn Antennas (12.4 – 18 GHz)	9607-1044	6/10/04
900321	EMCO	3161-03	Horn Antenna (4.0 - 8.2 GHz)	9508-1020	4/10/04
901053	Schaffner & Chase	CBL6112B	Bilog Antenna (20 MHz - 2 GHz)	2648	7/3/04
900932	Hewlett Packard	8449B	Microwave Preamplifier (1 - 26.5 GHz)	3008A00505	4/22/04
901020	Hewlett Packard	8564E	Portable Spectrum Analyzer (9 kHz - 40 GHz)	3943A01719	7/15/04
901232	IW Microwave Products	KPW-1503-2400-KPS	High Frequency RF Cables	240"	1/30/04
901235	IW Microwave Products	KPS-1503-360-KPS	High Frequency RF Cables	36"	1/30/04

9.3 RADIATED EMISSIONS HARMONICS/SPURIOUS TEST DATA

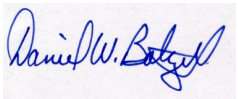
Field Strength at 100 kHz = 114.8 – 20 = 94.8 limit for non-restricted band spurious emissions.

TABLE 9-2: RADIATED EMISSIONS HARMONICS/SPURIOUS (TX FREQUENCY: 2402 MHZ)

Emission Frequency (MHz)	Analyzer Reading (dBuV) Peak	Analyzer Reading (dBuV) Average	Site Correction Factor (dB/m)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
760.000	59.0	51.5	-17.2	34.3	94.8	-60.5
800.000	53.5	50.2	-16.8	33.4	94.8	-61.4
1642.742	59.8	52.8	-9.8	43.0	94.8	-51.8
1660.050	57.3	53.3	-9.8	43.5	54.0	-10.5
1702.000	55.3	51.0	-9.6	41.4	54.0	-12.6
2030.995	37.3	29.5	15.0	44.5	94.8	-50.3
2772.685	39.7	29.2	9.9	39.1	54.0	-14.9
4804.000	41.3	30.8	13.6	44.4	54.0	-9.6
7206.000	31.2	19.8	12.7	32.5	94.8	-62.3
9608.000	33.2	21.7	15.1	36.8	94.8	-58.0
12010.000	32.8	20.2	18.8	39.0	54.0	-15.0
14412.000	32.7	20.5	20.3	40.8	94.8	-54.0
16814.000	30.8	19.3	19.5	38.8	94.8	-56.0
19216.000	31.8	19.5	22.1	41.6	54.0	-12.4
21618.000	29.3	17.0	22.9	39.9	94.8	-54.9
24020.000	30.7	17.3	23.8	41.1	94.8	-53.7

PEAK: RES. =1 MHZ, VID= 1MHZ; AVERAGE: RES. =1 MHZ, VID= 10HZ

TEST PERSONNEL:



Daniel W. Baltzell		October 29, 2003
EMC Test Engineer	Signature	Date Of Test

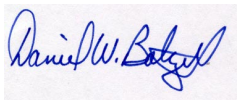
Field Strength at 100 kHz = 115.2 – 20 = 95.2 limit for non-restricted band spurious emissions.

TABLE 9-3: RADIATED EMISSIONS HARMONICS/SPURIOUS (TX FREQUENCY: 2440 MHZ)

Emission Frequency (MHz)	Analyzer Reading (dBuV) Peak	Analyzer Reading (dBuV) Average	Site Correction Factor (dB/m)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
371.025	65.0	56.0	-22.8	33.2	95.2	-62.0
479.998	64.5	63.9	-20.1	43.8	95.2	-51.4
720.000	49.2	46.9	-17.4	29.5	95.2	-65.7
760.000	48.5	47.5	-17.2	30.3	95.2	-64.9
820.000	51.4	49.5	-16.3	33.2	95.2	-62.0
1698.000	45.2	38.0	-9.6	28.4	54.0	-25.6
2469.000	36.7	30.9	10.7	41.6	95.2	-53.6
4880.000	47.2	38.3	13.2	51.5	54.0	-2.5
7320.000	36.5	24.7	12.6	37.3	54.0	-16.7
9760.000	34.0	22.0	14.5	36.5	95.2	-58.7
12200.000	38.5	27.3	18.4	45.7	54.0	-8.3
14640.000	32.2	19.5	22.5	42.0	95.2	-53.2
17080.000	32.0	19.5	20.4	39.9	95.2	-55.3
19520.000	32.3	20.2	21.2	41.4	54.0	-12.6
21960.000	27.5	16.2	23.0	39.2	95.2	-56.0
24400.000	27.8	14.2	23.9	38.1	95.2	-57.1

PEAK: RES. =1 MHZ, VID= 1MHZ; AVERAGE: RES. =1 MHZ, VID= 10HZ

TEST PERSONNEL:



Daniel W. Baltzell		October 29, 2003
EMC Test Engineer	Signature	Date Of Test

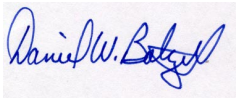
Field Strength at 100 kHz = 115.5– 20 = 95.5 limit for non-restricted band spurious emissions.

TABLE 9-4: RADIATED EMISSIONS HARMONICS/SPURIOUS (TX FREQUENCY: 2480 MHZ)

Emission Frequency (MHz)	Analyzer Reading (dBuV) Peak	Analyzer Reading (dBuV) Average	Site Correction Factor (dB/m)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
719.998	46.2	42.4	-17.4	25.0	95.5	-70.5
760.005	49.0	46.5	-17.2	29.3	95.5	-66.2
820.000	50.4	48.5	-16.4	32.1	95.5	-63.4
2348.988	21.7	12.7	8.5	21.2	54.0	-32.8
2509.000	23.5	15.5	9.8	25.3	95.5	-70.2
2850.858	24.5	11.9	9.1	21.0	54.0	-33.0
4960.000	44.7	34.4	13.7	48.1	54.0	-5.9
7440.000	32.6	24.0	12.6	36.6	54.0	-17.4
9920.000	37.7	27.2	14.6	41.8	95.5	-53.7
12400.000	36.9	25.4	20.9	46.3	54.0	-7.7
14880.000	30.7	18.5	22.9	41.4	95.5	-54.1
17360.000	31.5	19.5	18.7	38.2	95.5	-57.3
19840.000	32.2	19.3	22.4	41.7	54.0	-12.3
22320.000	30.0	17.2	23.3	40.5	54.0	-13.5
24800.000	29.2	15.8	24.2	40.0	95.5	-55.5

PEAK: RES. =1 MHZ, VID= 1MHZ; AVERAGE: RES. =1 MHZ, VID= 10HZ

TEST PERSONNEL:

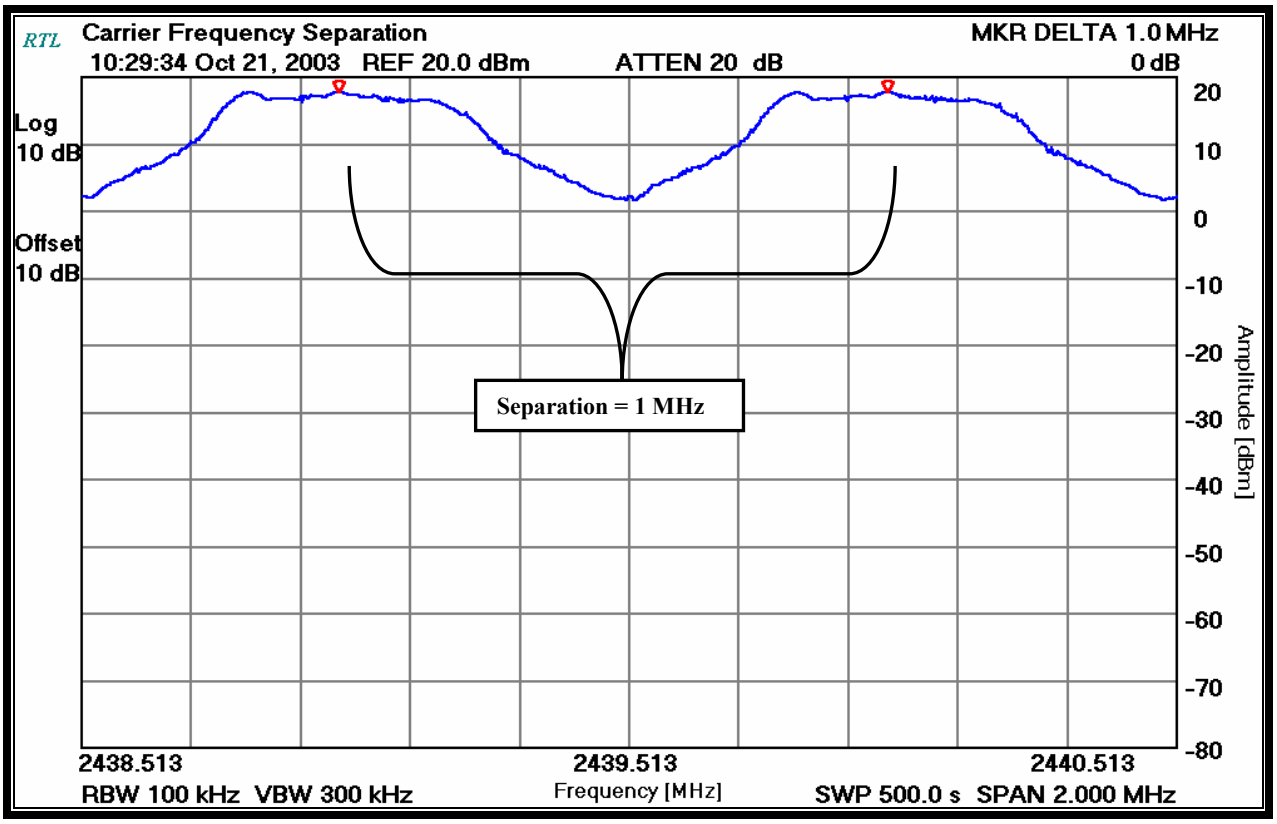


Daniel W. Baltzell		October 29, 2003
EMC Test Engineer	Signature	Date Of Test

10 CARRIER FREQUENCY SEPARATION - §15.247(a)(1)

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. The greatest measured 20 dB bandwidth was 998 kHz; since this is greater than 25 kHz, 998 kHz should be used as the minimum separation. As shown by the plot below, the EUT met this requirement.

PLOT 10-1: CARRIER FREQUENCY SEPARATION



TEST PERSONNEL:

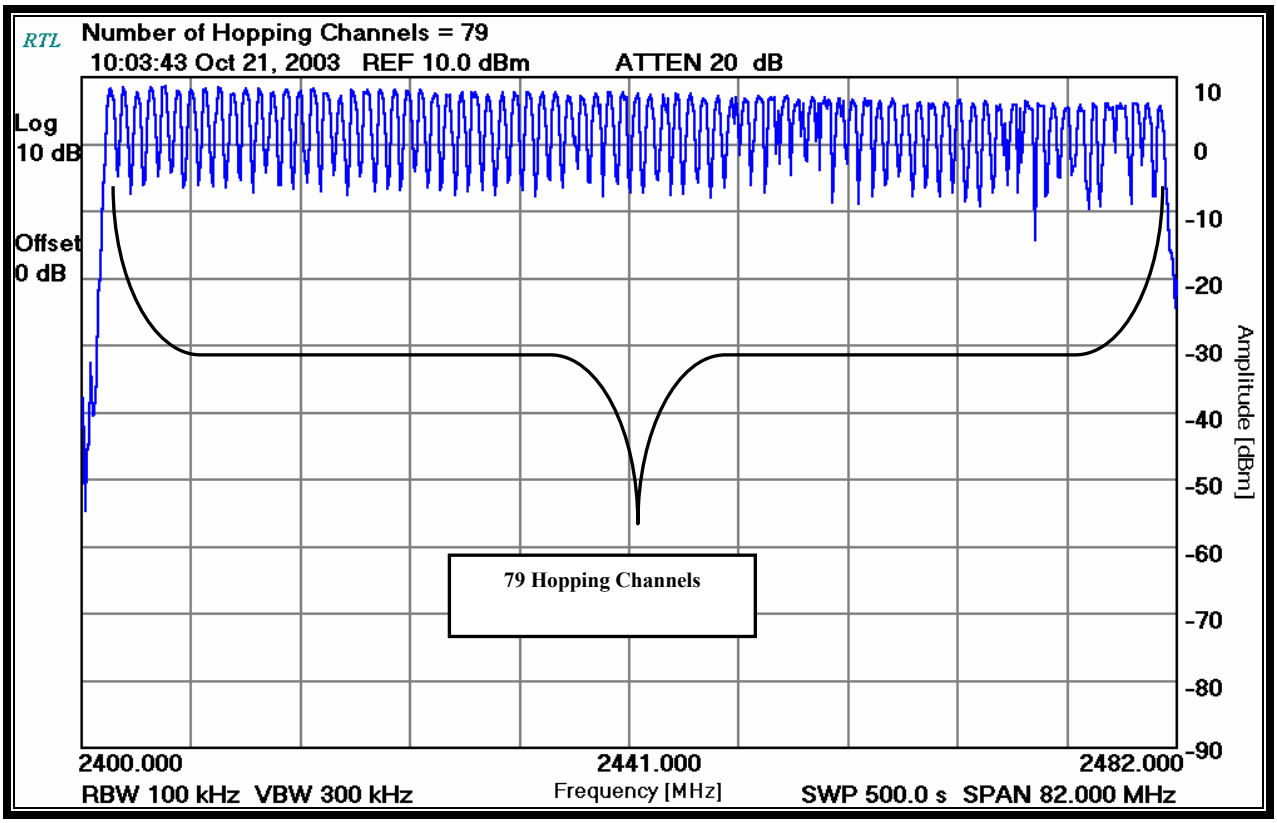
Daniel W. Baltzell		October 21, 2003
EMC Test Engineer	Signature	Date Of Test

11 HOPPING CHARACTERISTICS – FCC §15.247 (a)(1)(iii); IC RSS-210 §6.2.2(O)

Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 non-overlapping channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems which use fewer than 75 hopping frequencies may employ intelligent hopping techniques to avoid interference with other transmissions. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 non-overlapping channels are used.

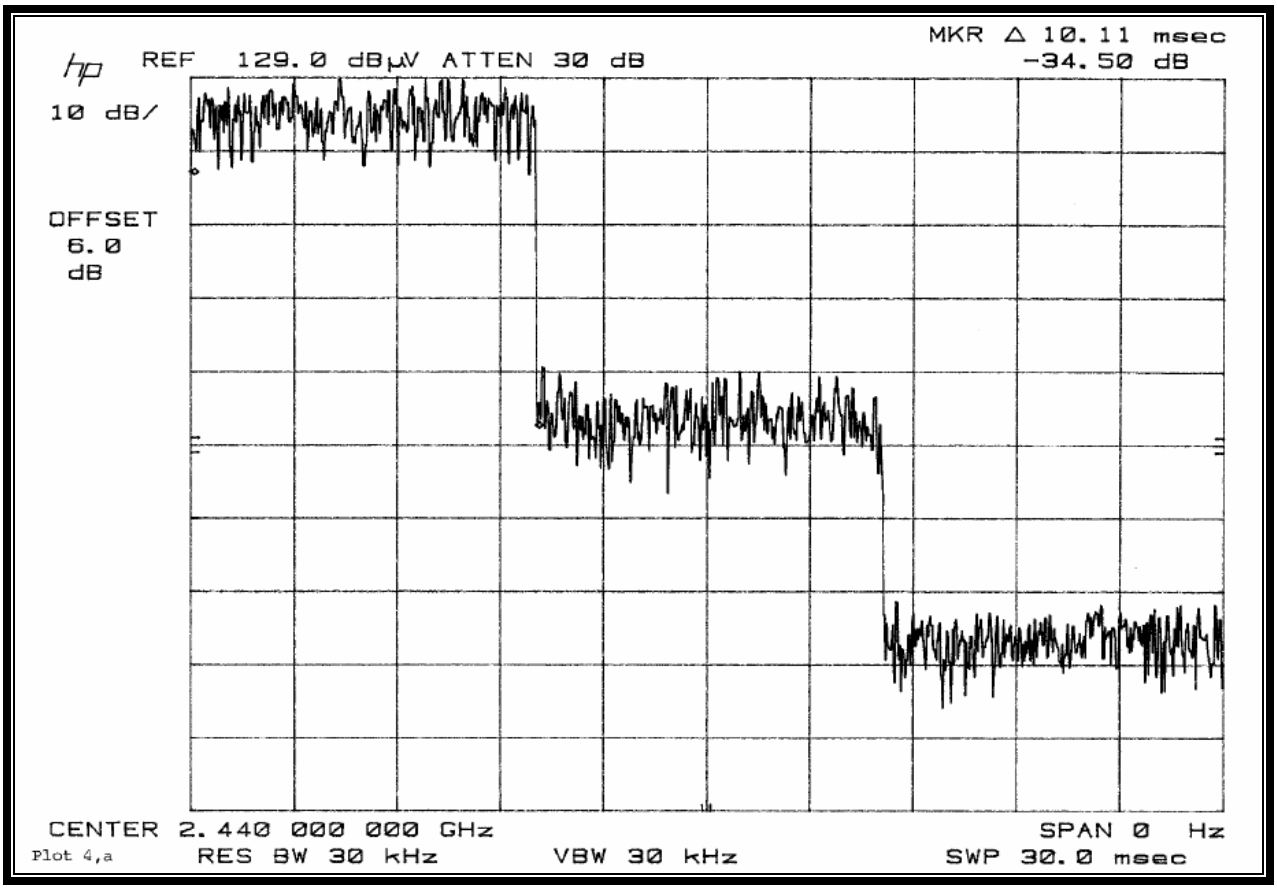
11.1 NUMBER OF HOPPING FREQUENCIES

PLOT 11-1: NUMBER OF HOPPING FREQUENCIES

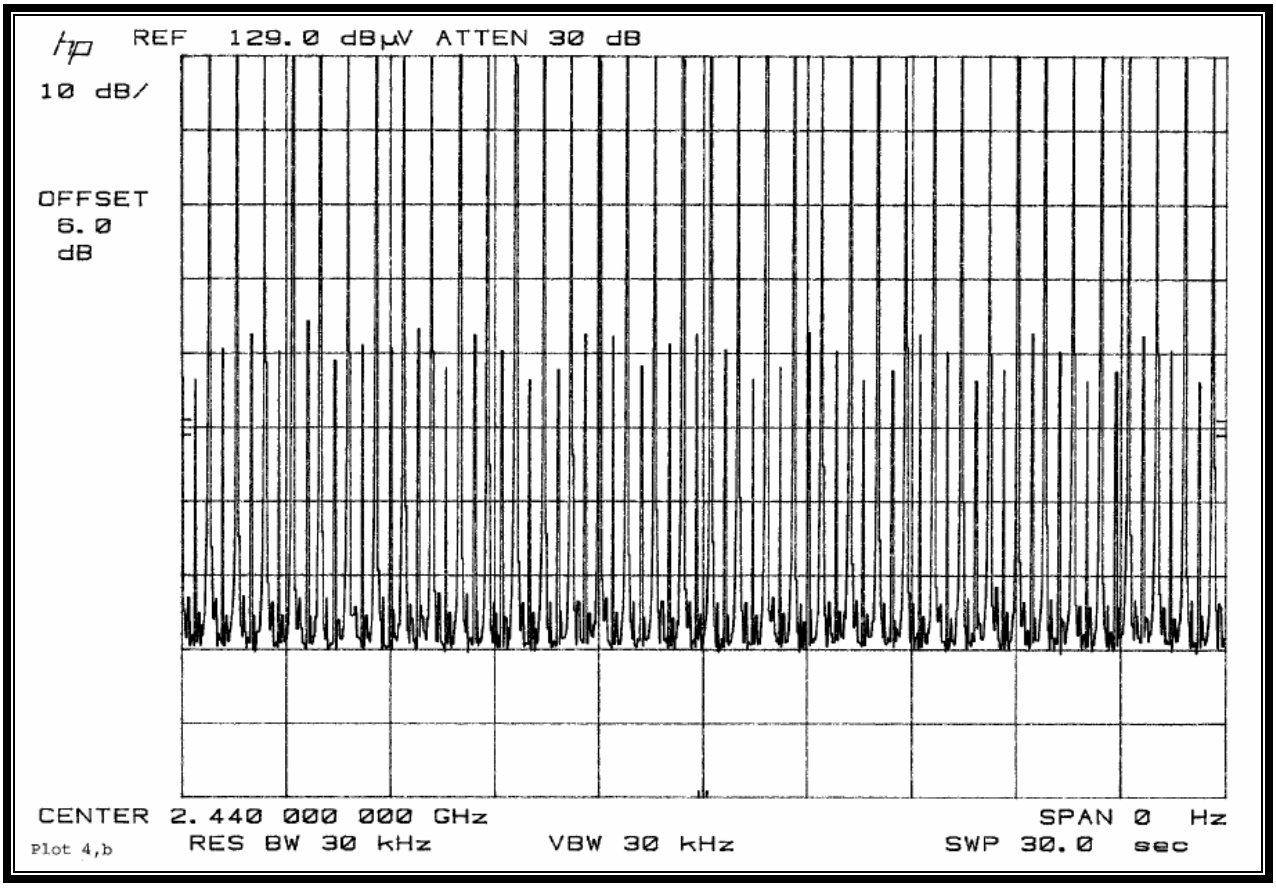


11.2 AVERAGE TIME OF OCCUPANCY

PLOT 11-2: AVERAGE TIME OF OCCUPANCY



PLOT 11-3: TIME OF OCCUPANCY (30 SECOND SWEEP)



Since the average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed (0.4 x 79 = 31.6), and there are 37 pulses within a period of 30 seconds and each pulse is 10.11 ms in width, it can be determined that:

10.11 ms width x ((37 x 31.6)/30) = 394.0 ms

TEST PERSONNEL:

Daniel W. Baltzell		December 12, 2003
EMC Test Engineer	Signature	Date Of Test

11.3 20 dB BANDWIDTH – FCC §15.247 (a)(1)(iii); IC RSS-210 §5.9.1

The minimum 20 dB bandwidths were measured using a 50 ohm spectrum analyzer. The carrier was adjusted on the analyzer so that it was displayed entirely on the Spectrum Analyzer. The sweep time was set to auto and allowed through several sweeps with the max hold function used in peak detector mode. The resolution bandwidth was set to 10 kHz, and the video bandwidth set at 300 kHz. The minimum 20 dB bandwidths were measured using the spectrum analyzer delta marker set 20 dB down from the peak of the carrier.

TABLE 11-1: 20 DB BANDWIDTH TEST EQUIPMENT

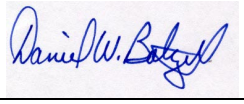
RTL ASSET #	MANUFACTURER	MODEL	PART TYPE	SERIAL NUMBER	CALIBRATION DUE DATE
900931	Hewlett Packard	8566B	Spectrum Analyzer (100 Hz – 22 GHz)	3138A07771	5/12/04

TABLE 11-2: MODULATED BANDWIDTH TEST DATA

Minimum 20 dB bandwidths

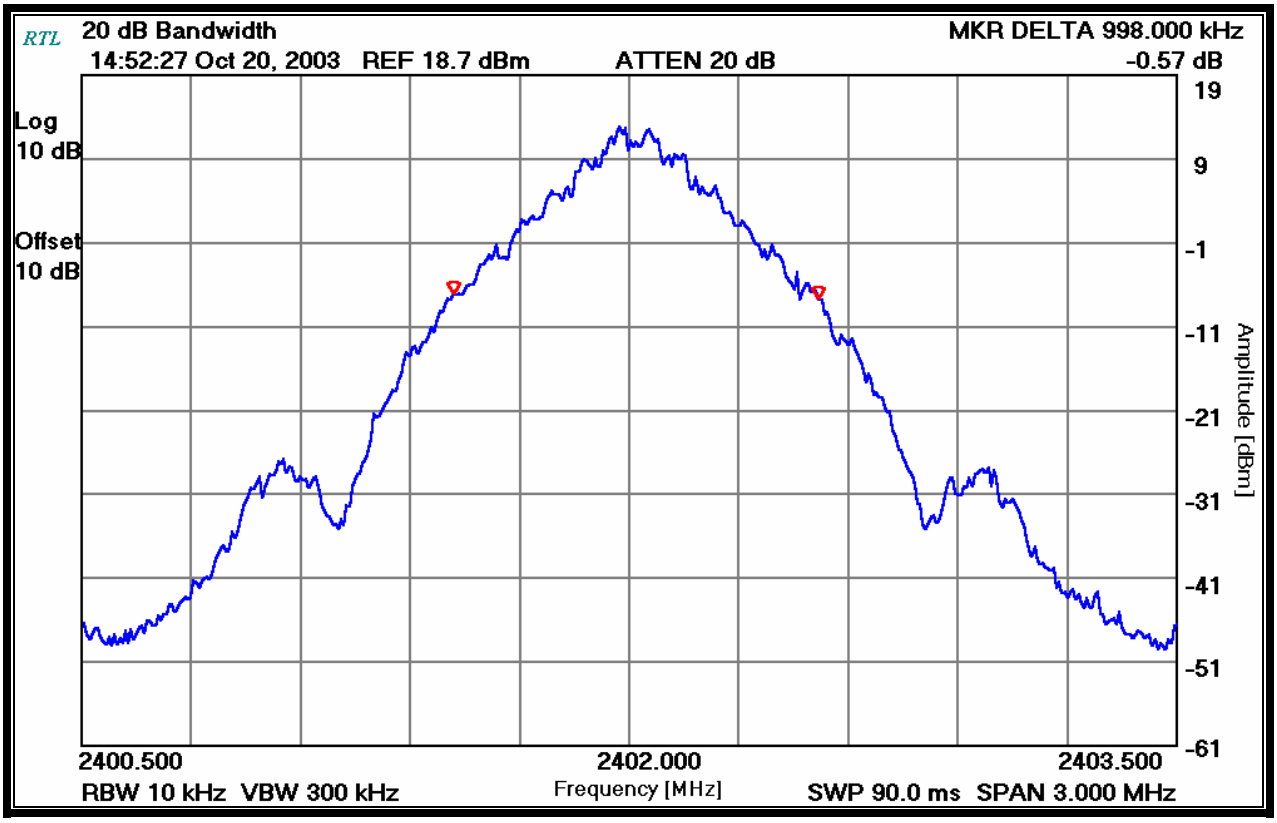
FREQUENCY (MHz)	20 dB BANDWIDTH (kHz)
2402	998
2440	998
2480	998

TEST PERSONNEL:

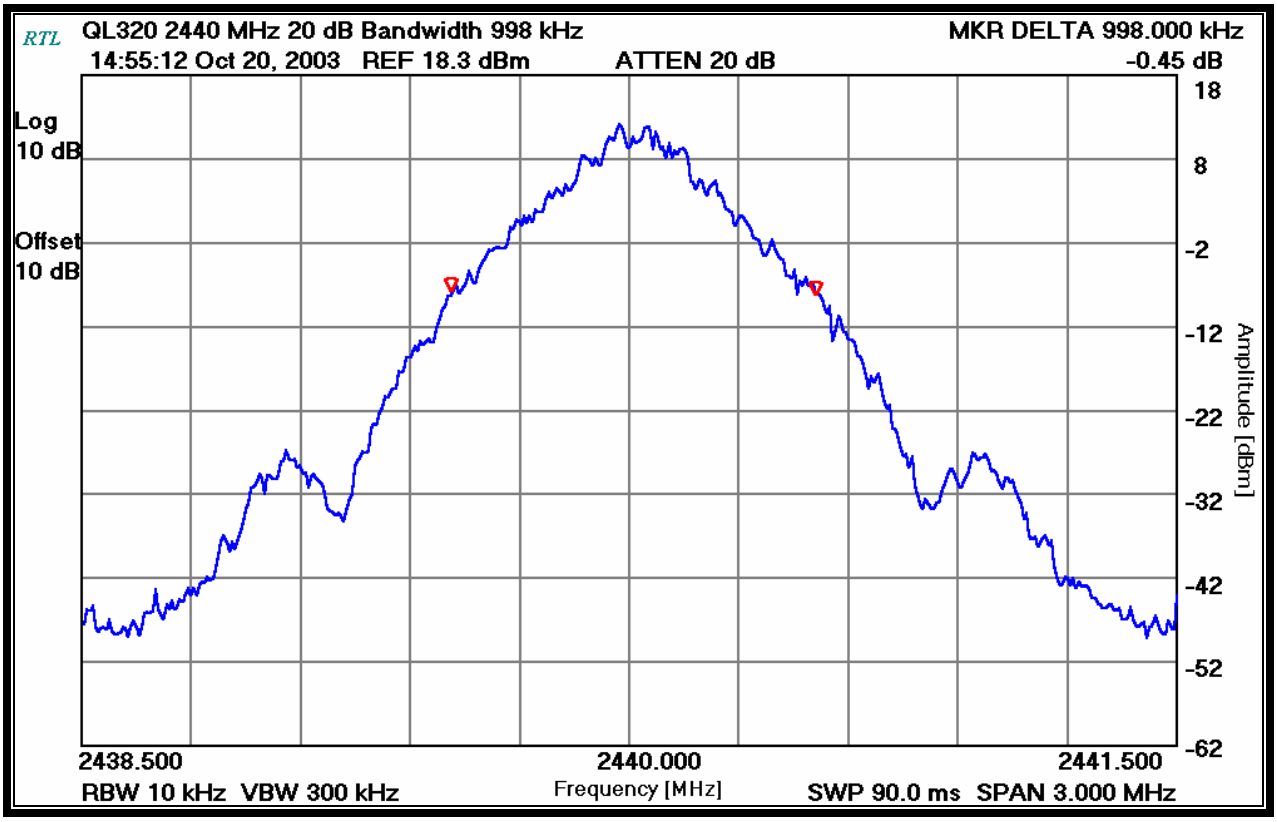


Daniel W. Baltzell		October 20, 2003
EMC Test Engineer	Signature	Date Of Test

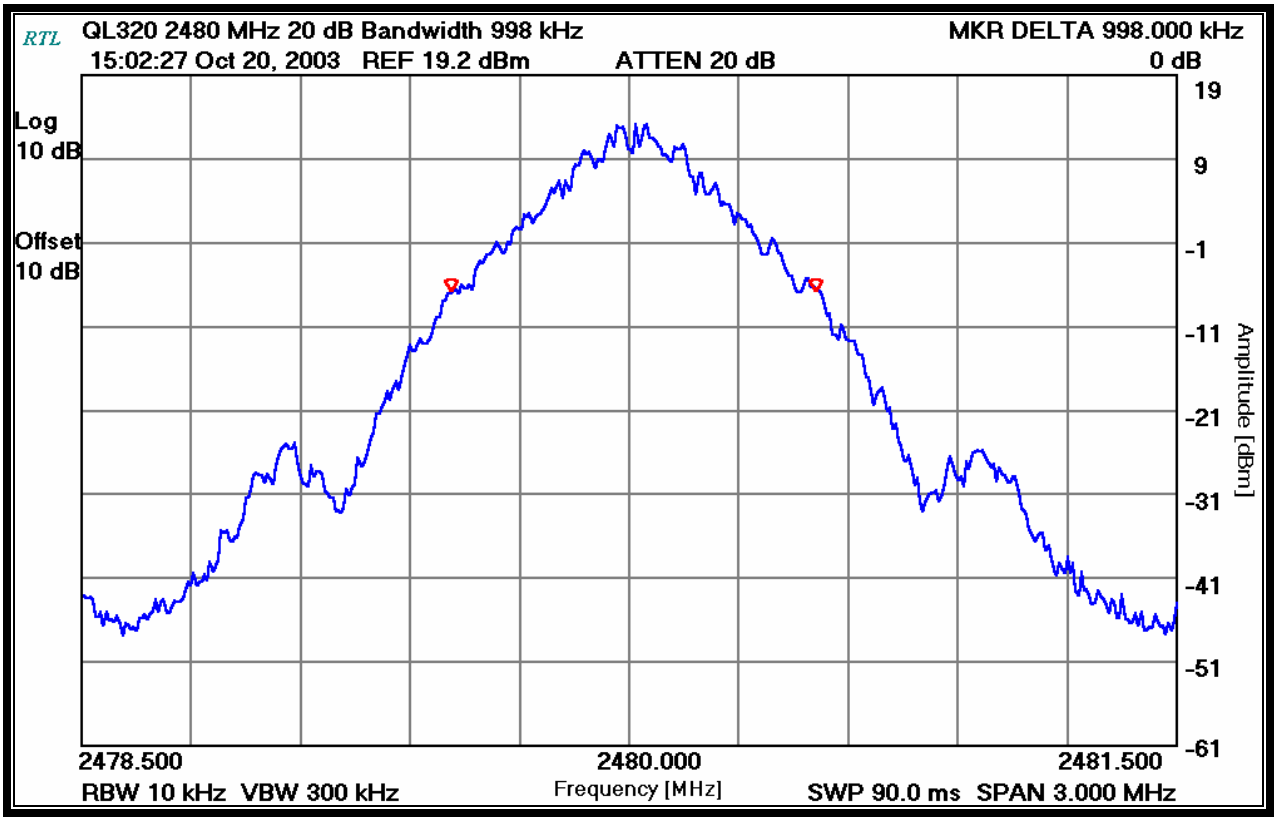
PLOT 11-4: 20 DB BANDWIDTH (TX FREQUENCY: 2402 MHZ)



PLOT 11-5: 20 DB BANDWIDTH (TX FREQUENCY: 2440 MHZ)



PLOT 11-6: 20 DB BANDWIDTH (TX FREQUENCY: 2480 MHZ)



TEST PERSONNEL:

Daniel W. Baltzell		October 20, 2003
EMC Test Engineer	Signature	Date Of Test

12 PEAK OUTPUT POWER - FCC §15.247(b)(1); IC RSS-210 §6.2.2(o)(b)

The maximum peak output power of the intentional radiator shall not exceed the following:

For frequency hopping systems in the 2400-2483.5 MHz band employing at least 75 hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 Watt.

As shown by the table below, the EUT met this requirement.

12.1 CONDUCTED ANTENNA PORT 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.

12.2 CONDUCTED ANTENNA PORT POWER OUTPUT TEST EQUIPMENT

TABLE 12-1: CONDUCTED ANTENNA PORT POWER OUTPUT TEST EQUIPMENT

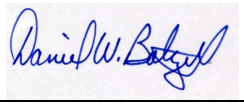
RTL ASSET #	MANUFACTURER	MODEL	PART TYPE	SERIAL NUMBER	CALIBRATION DUE DATE
901186	Agilent Technologies	E9323A	Peak & Avg. Power Sensor (50 MHz - 6 GHz)	US40410380	7/30/04
901184	Agilent Technologies	E4416A	EPM-P Power Meter, Single Channel	GB41050573	7/30/04
901140	Weinschel Corp.	47-10-34 DC-18GHz	Attenuator, 50W 10dB	BK6203	5/13/04

12.3 CONDUCTED ANTENNA PORT POWER OUTPUT TEST DATA

TABLE 12-2: CONDUCTED ANTENNA PORT POWER OUTPUT TEST DATA

FREQUENCY (MHz)	PEAK POWER CONDUCTED OUTPUT POWER SETTING (dBm)	PEAK POWER CONDUCTED OUTPUT POWER SETTING (mW)
2402	19.6	91.2
2440	20.0	100
2480	20.3	107

TEST PERSONNEL:



Daniel W. Baltzell		December 12, 2003
EMC Test Engineer	Signature	Date Of Test

13 ANTENNA CONDUCTED SPURIOUS EMISSIONS - §15.247(c); IC RSS-210 §6.2.2(o)(e1)

13.1 ANTENNA CONDUCTED SPURIOUS EMISSIONS TEST PROCEDURES

Antenna spurious emission per FCC 15.247(c) was 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 300 kHz. The modulated carrier was identified at the following frequencies: 2402 MHz, 2440 MHz and 2480 MHz. No other harmonics or spurs were found within 20 dB of the carrier level from 9 kHz to the carrier 10th harmonic. See the Antenna Conducted Spurious Noise Table. The low, middle, and high frequencies were investigated and tested.

13.2 ANTENNA CONDUCTED SPURIOUS TEST EQUIPMENT

TABLE 13-1: ANTENNA CONDUCTED SPURIOUS TEST EQUIPMENT

RTL ASSET #	MANUFACTURER	MODEL	PART TYPE	SERIAL NUMBER	CALIBRATION DUE DATE
900931	Hewlett Packard	8566B	Spectrum Analyzer (100 Hz – 22 GHz)	3138A07771	5/12/04

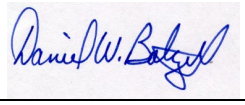
13.3 ANTENNA CONDUCTED SPURIOUS EMISSIONS (TX FREQUENCY: 2402 MHz)

Operating Frequency (MHz): 2402
Measured Level (dBm): 19.6
Limit (dBm): -0.4

TABLE 13-2: CONDUCTED SPURIOUS EMISSIONS (TX FREQUENCY: 2402 MHZ)

Frequency (MHz)	Measured Level (dBm)	Measured Level (dBc)	Limit (dBc)	Margin (dB)
371.025	-51.2	70.8	20.0	-50.8
441.375	-49.4	69.0	20.0	-49.0
700.013	-53.0	72.6	20.0	-52.6
739.975	-54.9	74.5	20.0	-54.5
760.000	-48.3	67.9	20.0	-47.9
800.000	-51.9	71.5	20.0	-51.5
1642.550	-38.3	57.9	20.0	-37.9
1660.050	-49.9	69.5	20.0	-49.5
1681.988	-52.6	72.2	20.0	-52.2
1702.000	-57.3	76.9	20.0	-56.9
2030.995	-50.3	69.9	20.0	-49.9
2510.000	-50.1	69.7	20.0	-49.7
2772.838	-49.2	68.8	20.0	-48.8
4804.000	-61.1	80.7	20.0	-60.7
7206.000	-70.3	89.9	20.0	-69.9
9608.000	-69.0	88.6	20.0	-68.6
12010.000	-66.4	86.0	20.0	-66.0
14412.000	-83.7	103.3	20.0	-83.3
16814.000	-85.2	104.8	20.0	-84.8
19216.000	-85.7	105.3	20.0	-85.3
21618.000	-84.2	103.8	20.0	-83.8
24020.000	-80.2	99.8	20.0	-79.8

TEST PERSONNEL:



Daniel W. Baltzell		October 20, 2003
EMC Test Engineer	Signature	Date Of Test

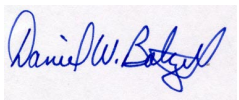
13.4 ANTENNA CONDUCTED SPURIOUS EMISSIONS (TX FREQUENCY: 2440 MHz)

Operating Frequency (MHz): 2440
Measured Level (dBm): 20.0
Limit (dBm): 0

TABLE 13-3: CONDUCTED SPURIOUS EMISSIONS (TX FREQUENCY: 2440 MHZ)

Frequency (MHz)	Measured Level (dBm)	Measured Level (dBc)	Limit (dBc)	Margin (dB)
371.025	-54.4	74.4	20.0	-54.4
479.395	-48.7	68.7	20.0	-48.7
720.000	-48.3	68.3	20.0	-48.3
760.000	-48.9	68.9	20.0	-48.9
820.000	-48.8	68.8	20.0	-48.8
1698.000	-52.7	72.7	20.0	-52.7
2469.000	-46.4	66.4	20.0	-46.4
2808.000	-55.3	75.3	20.0	-55.3
4880.000	-59.6	79.6	20.0	-59.6
7320.000	-69.8	89.8	20.0	-69.8
9760.000	-68.5	88.5	20.0	-68.5
12200.000	-68.1	88.1	20.0	-68.1
14640.000	-83.8	103.8	20.0	-83.8
17080.000	-84.5	104.5	20.0	-84.5
19520.000	-84.5	104.5	20.0	-84.5
21960.000	-83.8	103.8	20.0	-83.8
24400.000	-83.3	103.3	20.0	-83.3

TEST PERSONNEL:



Daniel W. Baltzell		October 20, 2003
EMC Test Engineer	Signature	Date Of Test

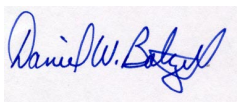
13.5 ANTENNA CONDUCTED SPURIOUS EMISSIONS (TX FREQUENCY: 2480 MHz)

Operating Frequency (MHz): 2480
Measured Level (dBm): 20.3
Limit (dBm): 0.3

TABLE 13-4: CONDUCTED SPURIOUS EMISSIONS (TX FREQUENCY: 927.7695 MHZ)

Frequency (MHz)	Measured Level (dBm)	Measured Level (dBc)	Limit (dBc)	Margin (dB)
519.395	-46.6	66.9	20.0	-46.9
719.998	-48.2	68.5	20.0	-48.5
760.003	-49.7	70.0	20.0	-50.0
820.000	-48.9	69.2	20.0	-49.2
860.000	-53.1	73.4	20.0	-53.4
1738.013	-56.9	77.2	20.0	-57.2
1759.563	-35.5	55.8	20.0	-35.8
2348.988	-50.3	70.6	20.0	-50.6
2509.000	-47.5	67.8	20.0	-47.8
2850.858	-57.8	78.1	20.0	-58.1
4960.000	-56.0	76.3	20.0	-56.3
7440.000	-68.2	88.5	20.0	-68.5
9920.000	-65.3	85.6	20.0	-65.6
12400.000	-65.9	86.2	20.0	-66.2
14880.000	-83.8	104.1	20.0	-84.1
17360.000	84.5	-64.2	20.0	84.2
19840.000	-84.3	104.6	20.0	-84.6
22320.000	-83.8	104.1	20.0	-84.1
24800.000	-81.3	101.6	20.0	-81.6

TEST PERSONNEL:



Daniel W. Baltzell		October 20, 2003
EMC Test Engineer	Signature	Date Of Test

14 CONCLUSION

The data in this measurement report shows that the EUT as tested, FCC ID: I28MD-QL3021, complies with all the applicable requirements of Parts 2 and 15 of the FCC Rules and Regulations, and Industry Canada RSS-210.