

EMC EMISSIONS - TEST REPORT (Full)



Test Report No.	BC204209	Issue Date:	Tue 10/Sep/2002
Model / Serial No.	FGMR-115 / SN: EMC1		
Product Type	2.4GHz wireless transceiver.		
Client	Freewave Technology		
Manufacturer	Freewave Technology		
License holder	Freewave Technology		
Address	1880 S. Flatiron Ct Boulder, Co 80301		
Test Criteria Applied	FCC part 15 PASS BC204209 48 Title 47 CFR 15: Radio Frequency Devices		
Test Result			
Test Project Number			
References			
Total Pages			
Including			
Appendices:			
Reviewed By : Todd Seeley	Approved By : Robert Cresswell		

TÜV Product Service Inc is a subcontractor to TÜV Product Service, GmbH according to the principles outlined in ISO/IEC Guide 17025 and EN 45001.

TÜV Product Service Inc reports apply only to the specific samples tested under stated test conditions. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. TÜV Product Service Inc shall have no liability for any deductions, inferences or generalizations drawn by the client or others from TÜV Product Service Inc issued reports.

This report is the confidential property of the client. As a mutual protection to our clients, the public and ourselves, extracts from the test report shall not be reproduced except in full without our written approval of TÜV Product Service. This report shall not be used by the client to claim product endorsement by NVLAP (No. 100271-1) or any agency of the US government.

TÜV Product Service Inc and its professional staff hold government and professional organization certifications and are members of AAMI, ACIL, AEA, ANSI, IEEE, NVLAP, and VCCI



NVLAP Lab code 100271-1



DIRECTORY

Documentation	Page(s)
Test report	<u>1 – 48</u>
Directory	<u>2</u>
Test Regulations	<u>3</u>
General Remarks	<u>3</u>
Test-setup Photographs	<u>4 - 5</u>
Appendix A	
Test Data Sheets and Test Equipment Used	<u>6 - 35</u>
Appendix B	
Test Plan/Constructional Data Form	<u>36 36</u>
Appendix C	
Measurement Protocol/Test Procedures	<u>37 - 48</u>

STATEMENT OF MEASUREMENT UNCERTAINTY

The data and results referenced in this document are true and accurate. The measurement uncertainty for Conducted Emissions in the frequency range of 150kHz – 30MHz is calculated to be $\pm 2.30\text{dB}$ and for Radiated Emissions is calculated to be $\pm 3.60\text{dB}$ in the frequency range of 30MHz – 200MHz and $\pm 3.38\text{dB}$ in the frequency range of 200MHz – 1000MHz.

EUT Received Date: 10-Sep-2002

Testing Start Date: 10-Sep-2002

Testing End Date: 10-Sep-2002

The tests were performed according to following regulations:

1. FCC Part 15.247/15.205/15.209: 2001

Emission Test Results:

Conducted Emissions, Powerline - N/A

Test Result

Minimum limit margin _____ dB at _____ MHz

Maximum limit exceeding _____ dB at _____ MHz

Remarks: _____

Radiated Emissions (Electric Field) -

Test Result

Minimum limit margin _____ -2.6 dB at _____ 84.78 MHz

Maximum limit exceeding _____ dB at _____ MHz

Remarks: _____

GENERAL REMARKS:

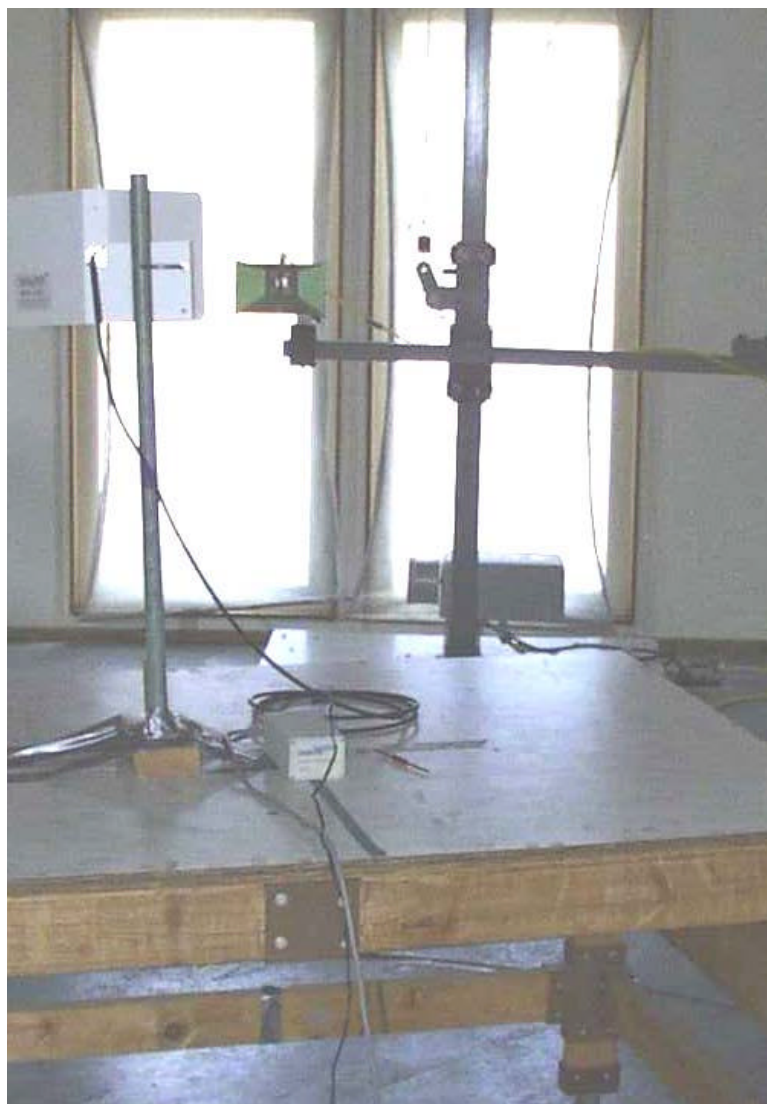
Modifications required to pass:

Test Specification Deviations: Additions to or Exclusions from:

Test-setup photo(s):
Radiated Emissions



Test-setup photo(s):
Radiated Emissions



Appendix A

Test Data Sheets
and
Test Equipment Used

Radiated Electromagnetic Emissions



Test Report #: **BC204209 Run 01**
 Test Method: **FCC Part 15**
 EUT Model #: **FGMR-115**
 EUT Serial #: **EMC1**
 Manufacturer: **Freewave Technologies**
 EUT Description: **2.4GHz wireless transceiver.**
 Notes: The testing covered on the following sheets was conducted in accordance with public
 DA 00-705, Released March 30, 2000

Test Area: **Pinewood Site 1 (3m)**
 Test Date: **07-Aug-2002**
 EUT Power: **12 VDC**

Temperature: **21.5** °C
 Relative Humidity: **54** %
 Air Pressure: **80** kPa
 Page: 7 of 36

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av – Average	

FCC CFR47 Part 15.209						
FREQ	LEVEL	CABLE / ANT / PREAMP	FINAL	POL / HGT / AZ	DELTA1 (dB)	DELTA2 (dB)
(MHz)	(dBuV)	(dB) (dBm) (dB)	(dBuV/m)	(m) (DEG)	FCC B (< 1GHz)	FCC A (< 1GHz)
33.55	33.8 Qp	0.2 / 12.6 / 22.4	24.3	V / 1.0 / 0.0	-15.7	-25.3
37.05	32.6 Qp	0.2 / 12.3 / 22.4	22.7	V / 1.0 / 0.0	-17.3	-26.9
37.75	36.8 Qp	0.2 / 12.2 / 22.4	26.8	V / 1.0 / 0.0	-13.2	-22.8
41.94	41.3 Qp	0.3 / 11.7 / 22.4	30.9	V / 1.0 / 0.0	-9.1	-18.7
68.81	46.7 Qp	0.4 / 8.4 / 21.9	33.7	V / 1.0 / 0.0	-6.3	-15.9
Maximized						
67.58	47.8 Qp	0.4 / 8.5 / 21.9	34.9	V / 1.0 / 0.0	-5.1	-14.7
73.11	39.5 Qp	0.5 / 8.0 / 21.9	26.0	V / 1.0 / 0.0	-14.0	-23.6
84.17	49.6 Qp	0.5 / 7.4 / 22.2	35.4	V / 1.0 / 0.0	-4.6	-14.2
109.98	39.1 Qp	0.6 / 10.3 / 23.1	26.9	V / 1.0 / 0.0	-16.6	-27.1
125.34	40.3 Qp	0.6 / 12.0 / 23.9	29.0	V / 1.0 / 0.0	-14.5	-25.0
159.75	41.6 Qp	0.7 / 12.7 / 25.9	29.1	V / 1.0 / 0.0	-14.4	-24.9
173.88	48.3 Qp	0.7 / 12.8 / 26.7	35.1	V / 1.0 / 0.0	-8.4	-18.9
183.71	44.4 Qp	0.7 / 13.2 / 27.2	31.2	V / 1.0 / 0.0	-12.3	-22.8
33.55	34.0 Qp	0.2 / 12.6 / 22.4	24.5	V / 1.0 / 90.0	-15.5	-25.1
73.11	40.4 Qp	0.5 / 8.0 / 21.9	27.0	V / 1.0 / 90.0	-13.0	-22.6
84.17	50.4 Qp	0.5 / 7.4 / 22.2	36.2	V / 1.0 / 90.0	-3.8	-13.4
109.98	41.0 Qp	0.6 / 10.3 / 23.1	28.8	V / 1.0 / 90.0	-14.7	-25.2
125.34	41.1 Qp	0.6 / 12.0 / 23.9	29.9	V / 1.0 / 90.0	-13.6	-24.1
159.75	46.1 Qp	0.7 / 12.7 / 25.9	33.6	V / 1.0 / 90.0	-9.9	-20.4
84.78	51.3 Qp	0.5 / 7.4 / 22.2	37.0	V / 1.0 / 90.0	-3.0	-12.6

Tested by: **Mike Spataro**
 Printed

Michael Spataro
 Signature

Reviewed by: **Todd Seeley**
 Printed

Todd Seeley
 Signature

Radiated Electromagnetic Emissions



Test Report #: **BC204209 Run 01**
 Test Method: **FCC Part 15**
 EUT Model #: **FGMR-115**
 EUT Serial #: **EMC1**
 Manufacturer: **Freewave Technologies**
 EUT Description: **2.4GHz wireless transceiver.**
 Notes: The testing covered on the following sheets was conducted in accordance with public
 DA 00-705, Released March 30, 2000

Test Area: **Pinewood Site 1 (3m)**
 Test Date: **07-Aug-2002**
 EUT Power: **12 VDC**

Temperature: **21.5** °C
 Relative Humidity: **54** %
 Air Pressure: **80** kPa
 Page: **8** of **36**

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av – Average	

FCC CFR47 Part 15.209						
FREQ	LEVEL	CABLE / ANT / PREAMP	FINAL	POL / HGT / AZ	DELTA1 (dB)	DELTA2 (dB)
(MHz)	(dBuV)	(dB) (dBm) (dB)	(dBuV/m)	(m) (DEG)	FCC B (< 1GHz)	FCC A (< 1GHz)
165.28	48.8 Qp	0.7 / 12.8 / 26.2	36.1	V / 1.0 / 90.0	-7.4	-17.9
33.55	33.9 Qp	0.2 / 12.6 / 22.4	24.4	V / 1.0 / 180.0	-15.6	-25.2
73.11	40.6 Qp	0.5 / 8.0 / 21.9	27.2	V / 1.0 / 180.0	-12.8	-22.4
125.34	42.1 Qp	0.6 / 12.0 / 23.9	30.8	V / 1.0 / 180.0	-12.7	-23.2
173.88	48.9 Qp	0.7 / 12.8 / 26.7	35.7	V / 1.0 / 180.0	-7.8	-18.3
183.71	44.4 Qp	0.7 / 13.2 / 27.2	31.1	V / 1.0 / 180.0	-12.4	-22.9
33.55	34.1 Qp	0.2 / 12.6 / 22.4	24.6	V / 1.0 / 270.0	-15.4	-25.0
84.17	50.6 Qp	0.5 / 7.4 / 22.2	36.4	V / 1.0 / 270.0	-3.6	-13.2
109.98	42.4 Qp	0.6 / 10.3 / 23.1	30.3	V / 1.0 / 270.0	-13.2	-23.7
125.34	42.2 Qp	0.6 / 12.0 / 23.9	30.9	V / 1.0 / 270.0	-12.6	-23.1
183.71	49.1 Qp	0.7 / 13.2 / 27.2	35.8	V / 1.0 / 270.0	-7.7	-18.2
The following were maximized between 30 and 200 MHz.						
183.71	49.3 Qp	0.7 / 13.2 / 27.2	36.0	V / 1.0 / 274.0	-7.5	-18.0
173.88	49.3 Qp	0.7 / 12.8 / 26.7	36.2	V / 1.0 / 170.0	-7.3	-17.8
165.28	49.6 Qp	0.7 / 12.8 / 26.2	36.9	V / 1.0 / 102.0	-6.6	-17.1
84.78	51.6 Qp	0.5 / 7.4 / 22.2	37.4	V / 1.0 / 102.0	-2.6	-12.2

Tested by: **Mike Spataro**
 Printed

Michael Spataro
 Signature

Reviewed by: **Todd Seeley**
 Printed

Todd Seeley
 Signature

Radiated Electromagnetic Emissions



Test Report #: **BC204209 Run 01**
 Test Method: **FCC Part 15**
 EUT Model #: **FGMR-115**
 EUT Serial #: **EMC1**
 Manufacturer: **Freewave Technologies**
 EUT Description: **2.4GHz wireless transceiver.**
 Notes: The testing covered on the following sheets was conducted in accordance with public
 DA 00-705, Released March 30, 2000

Test Area: **Pinewood Site 1 (3m)**
 Test Date: **07-Aug-2002**
 EUT Power: **12 VDC**

Temperature: **21.5** °C
 Relative Humidity: **54** %
 Air Pressure: **80** kPa
 Page: 9 of 36

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av - Average	

FCC CFR47 Part 15.209						
FREQ	LEVEL	CABLE / ANT / PREAMP	FINAL	POL / HGT / AZ	DELTA1 (dB)	DELTA2 (dB)
(MHz)	(dBuV)	(dB) (dB/m) (dB)	(dBuV/m)	(m) (DEG)	FCC B (< 1GHz)	FCC A (< 1GHz)
84.17	50.7 Qp	0.5 / 7.4 / 22.2	36.4	V / 1.0 / 115.0	-3.6	-13.2

Tested by: **Mike Spataro**
 Printed

Michael Spataro
 Signature

Reviewed by: **Todd Seeley**
 Printed

Todd Seeley
 Signature

Radiated Electromagnetic Emissions



Test Report #: **BC204209 Run 01**
 Test Method: **FCC Part 15**
 EUT Model #: **FGMR-115**
 EUT Serial #: **EMC1**
 Manufacturer: **Freewave Technologies**
 EUT Description: **2.4GHz wireless transceiver.**
 Notes: The testing covered on the following sheets was conducted in accordance with public
 DA 00-705, Released March 30, 2000

Test Area: **Pinewood Site 1 (3m)**
 Test Date: **07-Aug-2002**
 EUT Power: **12 VDC**

Temperature: **21.5** °C
 Relative Humidity: **54** %
 Air Pressure: **80** kPa
 Page: **10** of **26**

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av – Average	

Cables were maximized.						
68.81	40.9 Qp	0.4 / 8.4 / 21.9	27.8	H / 1.5 / 0.0	-12.2	-21.8
165.28	39.2 Qp	0.7 / 12.8 / 26.2	26.5	H / 1.5 / 0.0	-17.0	-27.5
173.88	41.1 Qp	0.7 / 12.8 / 26.7	27.9	H / 1.5 / 0.0	-15.6	-26.1
183.71	40.2 Qp	0.7 / 13.2 / 27.2	27.0	H / 1.5 / 0.0	-16.5	-27.0
84.17	45.8 Qp	0.5 / 7.4 / 22.2	31.6	H / 1.5 / 90.0	-8.4	-18.0
84.78	46.8 Qp	0.5 / 7.4 / 22.2	32.6	H / 1.5 / 90.0	-7.4	-17.0
109.98	46.9 Qp	0.6 / 10.3 / 23.1	34.7	H / 1.5 / 90.0	-8.8	-19.3
173.87	49.7 Qp	0.7 / 12.8 / 26.7	36.6	H / 1.5 / 90.0	-6.9	-17.4
86.63	48.1 Qp	0.5 / 7.5 / 22.3	33.8	H / 1.5 / 90.0	-6.2	-15.8
110.59	47.0 Qp	0.6 / 10.4 / 23.1	34.9	H / 1.5 / 90.0	-8.6	-19.1
169.57	50.9 Qp	0.7 / 12.9 / 26.4	38.1	H / 1.5 / 90.0	-5.4	-15.9
No higher emissions found: 180Deg, Horizontal.						
84.17	45.7 Qp	0.5 / 7.4 / 22.2	31.5	H / 1.5 / 270.0	-8.5	-18.1
84.78	46.8 Qp	0.5 / 7.4 / 22.2	32.5	H / 1.5 / 270.0	-7.5	-17.1
86.63	48.0 Qp	0.5 / 7.5 / 22.3	33.7	H / 1.5 / 270.0	-6.3	-15.9
125.34	42.8 Qp	0.6 / 12.0 / 23.9	31.5	H / 1.5 / 270.0	-12.0	-22.5
165.27	51.8 Qp	0.7 / 12.8 / 26.2	39.1	H / 1.5 / 270.0	-4.4	-14.9
169.57	52.6 Qp	0.7 / 12.9 / 26.4	39.7	H / 1.5 / 270.0	-3.8	-14.3
173.87	51.1 Qp	0.7 / 12.8 / 26.7	37.9	H / 1.5 / 270.0	-5.6	-16.1
The following were maximized between 30 and 200 MHz						

Tested by: **Mike Spataro**
 Printed

Michael Spataro
 Signature

Reviewed by: **Todd Seeley**
 Printed

Todd Seeley
 Signature

Radiated Electromagnetic Emissions



Test Report #: **BC204209 Run 01**
 Test Method: **FCC Part 15**
 EUT Model #: **FGMR-115**
 EUT Serial #: **EMC1**
 Manufacturer: **Freewave Technologies**
 EUT Description: **2.4GHz wireless transceiver.**
 Notes: The testing covered on the following sheets was conducted in accordance with public
 DA 00-705, Released March 30, 2000

Test Area: **Pinewood Site 1 (3m)**
 Test Date: **07-Aug-2002**
 EUT Power: **12 VDC**

Temperature: **21.5** °C
 Relative Humidity: **54** %
 Air Pressure: **80** kPa
 Page: **11** of **26**

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av – Average	

86.63	50.8 Qp	0.5 / 7.5 / 22.3	36.6	H / 3.4 / 254.0	-3.4	-13.0
165.27	52.4 Qp	0.7 / 12.8 / 26.2	39.7	H / 1.9 / 255.0	-3.8	-14.3
169.57	53.3 Qp	0.7 / 12.9 / 26.4	40.5	H / 1.9 / 276.0	-3.0	-13.5
200.29	33.2 Qp	0.8 / 11.5 / 28.1	17.3	V / 1.0 / 0.0	-26.2	-36.7
200.90	33.9 Qp	0.8 / 11.6 / 28.1	18.1	V / 1.0 / 0.0	-25.4	-35.9
208.89	37.8 Qp	0.8 / 12.5 / 28.1	22.9	V / 1.0 / 0.0	-20.6	-31.1
223.64	33.8 Qp	0.8 / 14.1 / 28.1	20.5	V / 1.0 / 0.0	-25.5	-36.4
240.03	38.4 Qp	0.8 / 14.3 / 28.1	25.4	V / 1.0 / 0.0	-20.6	-31.5
245.75	45.9 Qp	0.8 / 14.4 / 28.1	33.0	V / 1.0 / 0.0	-13.0	-23.9
272.05	40.1 Qp	0.9 / 14.1 / 28.1	27.0	V / 1.0 / 0.0	-19.0	-29.9
294.90	36.1 Qp	0.9 / 14.3 / 28.1	23.3	V / 1.0 / 0.0	-22.7	-33.6
336.05	41.4 Qp	1.0 / 14.6 / 28.0	28.9	V / 1.0 / 0.0	-17.1	-28.0
339.14	34.2 Qp	1.0 / 14.6 / 28.0	21.8	V / 1.0 / 0.0	-24.2	-35.1
372.27	36.2 Qp	1.0 / 14.9 / 27.9	24.2	V / 1.0 / 0.0	-21.8	-32.7
384.06	32.4 Qp	1.1 / 16.0 / 27.9	21.6	V / 1.0 / 0.0	-24.4	-35.3
386.58	32.3 Qp	1.1 / 16.2 / 27.9	21.7	V / 1.0 / 0.0	-24.3	-35.2
393.20	33.9 Qp	1.1 / 17.0 / 27.9	24.2	V / 1.0 / 0.0	-21.8	-32.7
442.36	38.0 Qp	1.2 / 16.8 / 27.8	28.2	V / 1.0 / 0.0	-17.8	-28.7
644.32	31.5 Qp	1.4 / 21.0 / 30.0	23.9	V / 1.0 / 0.0	-22.1	-33.0
701.58	30.8 Qp	1.5 / 20.8 / 32.1	21.1	V / 1.0 / 0.0	-24.9	-35.8
720.12	36.7 Qp	1.5 / 20.9 / 31.2	27.9	V / 1.0 / 0.0	-18.1	-29.0
737.27	35.3 Qp	1.5 / 21.1 / 30.5	27.5	V / 1.0 / 0.0	-18.5	-29.4
768.12	28.8 Qp	1.6 / 21.7 / 29.1	23.0	V / 1.0 / 0.0	-23.0	-33.9
786.40	28.9 Qp	1.6 / 21.9 / 28.2	24.2	V / 1.0 / 0.0	-21.8	-32.7
816.12	33.4 Qp	1.6 / 22.4 / 27.5	29.9	V / 1.0 / 0.0	-16.1	-27.0

Tested by: **Mike Spataro**
 Printed

Michael Spataro
 Signature

Reviewed by: **Todd Seeley**
 Printed

Todd Seeley
 Signature

Radiated Electromagnetic Emissions



Test Report #: **BC204209 Run 01**
 Test Method: **FCC Part 15**
 EUT Model #: **FGMR-115**
 EUT Serial #: **EMC1**
 Manufacturer: **Freewave Technologies**
 EUT Description: **2.4GHz wireless transceiver.**
 Notes: The testing covered on the following sheets was conducted in accordance with public
 DA 00-705, Released March 30, 2000

Test Area: **Pinewood Site 1 (3m)**
 Test Date: **07-Aug-2002**
 EUT Power: **12 VDC**

Temperature: **21.5** °C
 Relative Humidity: **54** %
 Air Pressure: **80** kPa
 Page: **12** of **26**

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av – Average	

235.92	33.1 Qp	0.8 / 14.3 / 28.1	20.0	V / 1.0 / 0.0	-26.0	-36.9
250.67	33.9 Pk	0.8 / 14.4 / 28.1	21.0	V / 1.0 / 0.0	-25.0	-35.9
309.65	34.3 Qp	0.9 / 14.4 / 28.0	21.5	V / 1.0 / 0.0	-24.5	-35.4
339.14	32.7 Qp	1.0 / 14.6 / 28.0	20.3	V / 1.0 / 0.0	-25.7	-36.6
427.61	28.7 Qp	1.2 / 16.7 / 27.8	18.7	V / 1.0 / 0.0	-27.3	-38.2
545.58	25.1 Qp	1.3 / 18.9 / 28.0	17.3	V / 1.0 / 0.0	-28.7	-39.6
235.92	34.2 Qp	0.8 / 14.3 / 28.1	21.1	V / 1.0 / 90.0	-24.9	-35.8
427.61	31.2 Qp	1.2 / 16.7 / 27.8	21.3	V / 1.0 / 90.0	-24.7	-35.6
206.44	34.2 Qp	0.8 / 12.2 / 28.1	19.0	V / 1.0 / 90.0	-24.5	-35.0
200.29	36.9 Qp	0.8 / 11.5 / 28.1	21.1	V / 1.0 / 180.0	-22.4	-32.9
200.90	36.8 Qp	0.8 / 11.6 / 28.1	21.0	V / 1.0 / 180.0	-22.5	-33.0
206.44	35.7 Qp	0.8 / 12.2 / 28.1	20.5	V / 1.0 / 180.0	-23.0	-33.5
427.61	32.4 Qp	1.2 / 16.7 / 27.8	22.4	V / 1.0 / 180.0	-23.6	-34.5
200.29	42.1 Qp	0.8 / 11.5 / 28.1	26.3	V / 1.0 / 270.0	-17.2	-27.7
208.89	43.4 Qp	0.8 / 12.5 / 28.1	28.5	V / 1.0 / 270.0	-15.0	-25.5
206.44	42.4 Pk	0.8 / 12.2 / 28.1	27.2	V / 1.0 / 270.0	-16.3	-26.8
245.75	29.3 Qp	0.8 / 14.4 / 28.1	16.4	V / 1.0 / 270.0	-29.6	-40.5
427.61	36.5 Qp	1.2 / 16.7 / 27.8	26.5	V / 1.0 / 270.0	-19.5	-30.4
the following measurements are maximized						
200.29	42.6 Qp	0.8 / 11.5 / 28.1	26.7	V / 1.0 / 279.0	-16.8	-27.3
200.29	20.6 Qp	0.8 / 11.5 / 28.1	4.7	H / 2.5 / 0.0	-38.8	-49.3
223.64	22.5 Qp	0.8 / 14.1 / 28.1	9.2	H / 2.5 / 0.0	-36.8	-47.7
235.92	26.1 Qp	0.8 / 14.3 / 28.1	13.1	H / 2.5 / 0.0	-32.9	-43.8

Tested by: **Mike Spataro**
 Printed

Michael Spataro
 Signature

Reviewed by: **Todd Seeley**
 Printed

Todd Seeley
 Signature

Radiated Electromagnetic Emissions



Test Report #: **BC204209 Run 01**
 Test Method: FCC Part 15
 EUT Model #: FGMR-115
 EUT Serial #: EMC1
 Manufacturer: Freewave Technologies
 EUT Description: 2.4GHz wireless transceiver.
 Notes: The testing covered on the following sheets was conducted in accordance with public
 DA 00-705, Released March 30, 2000

Test Area: Pinewood Site 1 (3m)
 Test Date: 07-Aug-2002
 EUT Power: 12 VDC

Temperature: 21.5 °C
 Relative Humidity: 54 %
 Air Pressure: 80 kPa
 Page: 13 of 26

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av – Average	

294.90	20.6 Qp	0.9 / 14.3 / 28.1	7.8	H / 2.5 / 0.0	-38.2	-49.1
339.14	23.9 Qp	1.0 / 14.6 / 28.0	11.5	H / 2.5 / 0.0	-34.5	-45.4
427.61	28.5 Qp	1.2 / 16.7 / 27.8	18.6	H / 2.5 / 0.0	-27.4	-38.3
442.36	30.2 Qp	1.2 / 16.8 / 27.8	20.4	H / 2.5 / 0.0	-25.6	-36.5
200.29	17.0 Qp	0.8 / 11.5 / 28.1	1.1	H / 2.5 / 90.0	-42.4	-52.9
200.90	17.1 Qp	0.8 / 11.6 / 28.1	1.3	H / 2.5 / 90.0	-42.2	-52.7
206.44	17.7 Qp	0.8 / 12.2 / 28.1	2.5	H / 2.5 / 90.0	-41.0	-51.5
208.89	19.1 Qp	0.8 / 12.5 / 28.1	4.1	H / 2.5 / 90.0	-39.4	-49.9
235.92	16.5 Qp	0.8 / 14.3 / 28.1	3.5	H / 2.5 / 90.0	-42.5	-53.4
294.90	4.5 Qp	0.9 / 14.3 / 28.1	-8.4	H / 2.5 / 90.0	-54.4	-65.3
427.61	4.9 Qp	1.2 / 16.7 / 27.8	-5.0	H / 2.5 / 90.0	-51.0	-61.9
442.36	-3.4 Qp	1.2 / 16.8 / 27.8	-13.2	H / 2.5 / 180.0	-59.2	-70.1
427.61	2.2 Qp	1.2 / 16.7 / 27.8	-7.7	H / 2.5 / 180.0	-53.7	-64.6
339.14	-2.5 Qp	1.0 / 14.6 / 28.0	-14.8	H / 2.5 / 180.0	-60.8	-71.7
309.65	-4.0 Qp	0.9 / 14.4 / 28.0	-16.7	H / 2.5 / 180.0	-62.7	-73.6
235.92	1.8 Qp	0.8 / 14.3 / 28.1	-11.2	H / 2.5 / 180.0	-57.2	-68.1
200.29	16.9 Qp	0.8 / 11.5 / 28.1	1.0	H / 2.5 / 270.0	-42.5	-53.0
200.90	16.6 Qp	0.8 / 11.6 / 28.1	0.8	H / 2.5 / 270.0	-42.7	-53.2
206.44	14.6 Qp	0.8 / 12.2 / 28.1	-0.6	H / 2.5 / 270.0	-44.1	-54.6
208.89	17.0 Qp	0.8 / 12.5 / 28.1	2.1	H / 2.5 / 270.0	-41.4	-51.9
235.92	14.5 Qp	0.8 / 14.3 / 28.1	1.4	H / 2.5 / 270.0	-44.6	-55.5
294.90	6.3 Qp	0.9 / 14.3 / 28.1	-6.5	H / 2.5 / 270.0	-52.5	-63.4
442.36	8.6 Qp	1.2 / 16.8 / 27.8	-1.2	H / 2.5 / 270.0	-47.2	-58.1
No higher emissions found 200-1000MHz						

Tested by: Mike Spataro
 Printed

Michael Spataro
 Signature

Reviewed by: Todd Seeley
 Printed

Todd Seeley
 Signature

Radiated Electromagnetic Emissions



Test Report #: **BC204209 Run 01**
 Test Method: **FCC Part 15**
 EUT Model #: **FGMR-115**
 EUT Serial #: **EMC1**
 Manufacturer: **Freewave Technologies**
 EUT Description: **2.4GHz wireless transceiver.**
 Notes: The testing covered on the following sheets was conducted in accordance with public
 DA 00-705, Released March 30, 2000

Test Area: **Pinewood Site 1 (3m)**
 Test Date: **07-Aug-2002**
 EUT Power: **12 VDC**

Temperature: **21.5** °C
 Relative Humidity: **54** %
 Air Pressure: **80** kPa
 Page: **14** of **26**

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av – Average	

No maximization of emissions needed						
No emissions found 1GHz to 12.5GHz (Except for the intentional signal and its harmonics, limits covered under 15.247 & 15.205: data below)						
No maximization of emissions needed						

Tested by: **Mike Spataro**
 Printed

Michael Spataro
 Signature

Reviewed by: **Todd Seeley**
 Printed

Todd Seeley
 Signature

Radiated Electromagnetic Emissions



Test Report #: **BC204209 Run 01**
 Test Method: **FCC Part 15**
 EUT Model #: **FGMR-115**
 EUT Serial #: **EMC1**
 Manufacturer: **Freewave Technologies**
 EUT Description: **2.4GHz wireless transceiver.**
 Notes: The testing covered on the following sheets was conducted in accordance with public
 DA 00-705, Released March 30, 2000

Test Area: **Pinewood Site 1 (3m)**
 Test Date: **07-Aug-2002**
 EUT Power: **12 VDC**

Temperature: **21.5** °C
 Relative Humidity: **54** %
 Air Pressure: **80** kPa
 Page: **15** of **26**

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av – Average	

FCC CFR47 Part 15.209						
FREQ	LEVEL	CABLE / ANT / PREAMP	FINAL	POL / HGT / AZ	DELTA1 (dB)	DELTA2 (dB)
(MHz)	(dBuV)	(dB) (dB/m) (dB)	(dBuV/m)	(m) (DEG)	FCC B (< 1GHz)	FCC A (< 1GHz)
***** Measurement Summary *****						
84.78	51.6 Qp	0.5 / 7.4 / 22.2	37.4	V / 1.0 / 102.0	-2.6	-12.2
169.57	53.3 Qp	0.7 / 12.9 / 26.4	40.5	H / 1.9 / 276.0	-3.0	-13.5
86.63	50.8 Qp	0.5 / 7.5 / 22.3	36.6	H / 3.4 / 254.0	-3.4	-13.0
84.17	50.7 Qp	0.5 / 7.4 / 22.2	36.4	V / 1.0 / 115.0	-3.6	-13.2
165.27	52.4 Qp	0.7 / 12.8 / 26.2	39.7	H / 1.9 / 255.0	-3.8	-14.3
67.58	47.8 Qp	0.4 / 8.5 / 21.9	34.9	V / 1.0 / 0.0	-5.1	-14.7
173.87	51.1 Qp	0.7 / 12.8 / 26.7	37.9	H / 1.5 / 270.0	-5.6	-16.1
68.81	46.7 Qp	0.4 / 8.4 / 21.9	33.7	V / 1.0 / 0.0	-6.3	-15.9
183.71	49.3 Qp	0.7 / 13.2 / 27.2	36.0	V / 1.0 / 274.0	-7.5	-18.0
110.59	47.0 Qp	0.6 / 10.4 / 23.1	34.9	H / 1.5 / 90.0	-8.6	-19.1
109.98	46.9 Qp	0.6 / 10.3 / 23.1	34.7	H / 1.5 / 90.0	-8.8	-19.3
41.94	41.3 Qp	0.3 / 11.7 / 22.4	30.9	V / 1.0 / 0.0	-9.1	-18.7
159.75	46.1 Qp	0.7 / 12.7 / 25.9	33.6	V / 1.0 / 90.0	-9.9	-20.4
125.34	42.8 Qp	0.6 / 12.0 / 23.9	31.5	H / 1.5 / 270.0	-12.0	-22.5
73.11	40.6 Qp	0.5 / 8.0 / 21.9	27.2	V / 1.0 / 180.0	-12.8	-22.4
245.75	45.9 Qp	0.8 / 14.4 / 28.1	33.0	V / 1.0 / 0.0	-13.0	-23.9
37.75	36.8 Qp	0.2 / 12.2 / 22.4	26.8	V / 1.0 / 0.0	-13.2	-22.8
208.89	43.4 Qp	0.8 / 12.5 / 28.1	28.5	V / 1.0 / 270.0	-15.0	-25.5
33.55	34.1 Qp	0.2 / 12.6 / 22.4	24.6	V / 1.0 / 270.0	-15.4	-25.0
816.12	33.4 Qp	1.6 / 22.4 / 27.5	29.9	V / 1.0 / 0.0	-16.1	-27.0
206.44	42.4 Pk	0.8 / 12.2 / 28.1	27.2	V / 1.0 / 270.0	-16.3	-26.8
200.29	42.6 Qp	0.8 / 11.5 / 28.1	26.7	V / 1.0 / 279.0	-16.8	-27.3

Tested by: **Mike Spataro**
 Printed

Signature

Reviewed by: **Todd Seeley**
 Printed

Signature

Radiated Electromagnetic Emissions



Test Report #: **BC204209 Run 01**
 Test Method: **FCC Part 15**
 EUT Model #: **FGMR-115**
 EUT Serial #: **EMC1**
 Manufacturer: **Freewave Technologies**
 EUT Description: **2.4GHz wireless transceiver.**
 Notes: The testing covered on the following sheets was conducted in accordance with public
 DA 00-705, Released March 30, 2000

Test Area: **Pinewood Site 1 (3m)**
 Test Date: **07-Aug-2002**
 EUT Power: **12 VDC**

Temperature: **21.5** °C
 Relative Humidity: **54** %
 Air Pressure: **80** kPa
 Page: **16** of **26**

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av – Average	

FCC CFR47 Part 15.209						
FREQ	LEVEL	CABLE / ANT / PREAMP	FINAL	POL / HGT / AZ	DELTA1 (dB)	DELTA2 (dB)
(MHz)	(dBuV)	(dB) (dBm) (dB)	(dBuV/m)	(m) (DEG)	FCC B (< 1GHz)	FCC A (< 1GHz)
336.05	41.4 Qp	1.0 / 14.6 / 28.0	28.9	V / 1.0 / 0.0	-17.1	-28.0
37.05	32.6 Qp	0.2 / 12.3 / 22.4	22.7	V / 1.0 / 0.0	-17.3	-26.9
442.36	38.0 Qp	1.2 / 16.8 / 27.8	28.2	V / 1.0 / 0.0	-17.8	-28.7
720.12	36.7 Qp	1.5 / 20.9 / 31.2	27.9	V / 1.0 / 0.0	-18.1	-29.0
737.27	35.3 Qp	1.5 / 21.1 / 30.5	27.5	V / 1.0 / 0.0	-18.5	-29.4
272.05	40.1 Qp	0.9 / 14.1 / 28.1	27.0	V / 1.0 / 0.0	-19.0	-29.9
427.61	36.5 Qp	1.2 / 16.7 / 27.8	26.5	V / 1.0 / 270.0	-19.5	-30.4
240.03	38.4 Qp	0.8 / 14.3 / 28.1	25.4	V / 1.0 / 0.0	-20.6	-31.5
372.27	36.2 Qp	1.0 / 14.9 / 27.9	24.2	V / 1.0 / 0.0	-21.8	-32.7
393.20	33.9 Qp	1.1 / 17.0 / 27.9	24.2	V / 1.0 / 0.0	-21.8	-32.7
786.40	28.9 Qp	1.6 / 21.9 / 28.2	24.2	V / 1.0 / 0.0	-21.8	-32.7
644.32	31.5 Qp	1.4 / 21.0 / 30.0	23.9	V / 1.0 / 0.0	-22.1	-33.0
200.90	36.8 Qp	0.8 / 11.6 / 28.1	21.0	V / 1.0 / 180.0	-22.5	-33.0
294.90	36.1 Qp	0.9 / 14.3 / 28.1	23.3	V / 1.0 / 0.0	-22.7	-33.6
768.12	28.8 Qp	1.6 / 21.7 / 29.1	23.0	V / 1.0 / 0.0	-23.0	-33.9
339.14	34.2 Qp	1.0 / 14.6 / 28.0	21.8	V / 1.0 / 0.0	-24.2	-35.1
386.58	32.3 Qp	1.1 / 16.2 / 27.9	21.7	V / 1.0 / 0.0	-24.3	-35.2
384.06	32.4 Qp	1.1 / 16.0 / 27.9	21.6	V / 1.0 / 0.0	-24.4	-35.3
309.65	34.3 Qp	0.9 / 14.4 / 28.0	21.5	V / 1.0 / 0.0	-24.5	-35.4
235.92	34.2 Qp	0.8 / 14.3 / 28.1	21.1	V / 1.0 / 90.0	-24.9	-35.8
701.58	30.8 Qp	1.5 / 20.8 / 32.1	21.1	V / 1.0 / 0.0	-24.9	-35.8
250.67	33.9 Pk	0.8 / 14.4 / 28.1	21.0	V / 1.0 / 0.0	-25.0	-35.9
223.64	33.8 Qp	0.8 / 14.1 / 28.1	20.5	V / 1.0 / 0.0	-25.5	-36.4
545.58	25.1 Qp	1.3 / 18.9 / 28.0	17.3	V / 1.0 / 0.0	-28.7	-39.6

Tested by: **Mike Spataro**
 Printed

Signature

Reviewed by: **Todd Seeley**
 Printed

Signature

Radiated Electromagnetic Emissions



Test Report #: **BC204209 Run 01**
 Test Method: **FCC Part 15**
 EUT Model #: **FGMR-115**
 EUT Serial #: **EMC1**
 Manufacturer: **Freewave Technologies**
 EUT Description: **2.4GHz wireless transceiver.**
 Notes: The testing covered on the following sheets was conducted in accordance with public
 DA 00-705, Released March 30, 2000

Test Area: **Pinewood Site 1 (3m)**
 Test Date: **07-Aug-2002**
 EUT Power: **12 VDC**

Temperature: **21.5** °C
 Relative Humidity: **54** %
 Air Pressure: **80** kPa
 Page: **17** of **26**

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av - Average	

FCC CFR47 Part 15.209						
FREQ	LEVEL	CABLE / ANT / PREAMP	FINAL	POL / HGT / AZ	DELTA1 (dB)	DELTA2 (dB)
(MHz)	(dBuV)	(dB) (dB/m) (dB)	(dBuV/m)	(m) (DEG)	FCC B (< 1GHz)	FCC A (< 1GHz)

Tested by: **Mike Spataro**
 Printed

Michael Spataro
 Signature

Reviewed by: **Todd Seeley**
 Printed

Todd Seeley
 Signature

Radiated Electromagnetic Emissions



Test Report #: **BC204209 Run 01**
 Test Method: **FCC Part 15**
 EUT Model #: **FGMR-115**
 EUT Serial #: **EMC1**
 Manufacturer: **Freewave Technologies**
 EUT Description: **2.4GHz wireless transceiver.**
 Notes: The testing covered on the following sheets was conducted in accordance with public
 DA 00-705, Released March 30, 2000

Test Area: **Pinewood Site 1 (3m)**
 Test Date: **07-Aug-2002**
 EUT Power: **12 VDC**

Temperature: **21.5** °C
 Relative Humidity: **54** %
 Air Pressure: **80** kPa
 Page: **18** of **26**

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av – Average	

FCC CFR47 Part 15.205 Mobilemark 14 dbi directional antenna.						
FREQ	LEVEL	CABLE / ANT / PREAMP	FINAL	POL / HGT / AZ	DELTA1 (dB)	DELTA2 (dB)
(MHz)	(dBuV)	(dB) (dB/m) (dB)	(dBuV)	(m) (DEG)	FCC (< 1GHz)	FCC 15.205 (> 1GHz)
Mobilemark 14 dbi directional antenna.						
All readings are maximized						
Low frequency						
4800.62	52.3 Avg	4.6 / 34.5 / 40.5	50.9	V / 1.0 / 0.0	N/A	-3.1
7200.97	48.6 Avg	5.3 / 37.3 / 40.9	50.3	V / 1.0 / 0.0	N/A	-3.7
Mid Frequency						
4891.20	51.4 Avg	4.6 / 34.8 / 40.8	50.0	V / 1.0 / 0.0	N/A	-4.0
7336.81	47.7 Avg	5.4 / 37.7 / 40.9	49.9	V / 1.0 / 0.0	N/A	-4.1
High frequency						
4966.52	52.4 Avg	4.7 / 35.0 / 41.0	51.1	V / 1.0 / 0.0	N/A	-2.9
7449.80	48.4 Avg	5.5 / 38.0 / 41.4	50.5	V / 1.0 / 0.0	N/A	-3.5

Tested by: **Mike Spataro**
 Printed

Michael Spataro
 Signature

Reviewed by: **Todd Seeley**
 Printed

Todd Seeley
 Signature

Radiated Electromagnetic Emissions



Test Report #: **BC204209 Run 01**
 Test Method: **FCC Part 15**
 EUT Model #: **FGMR-115**
 EUT Serial #: **EMC1**
 Manufacturer: **Freewave Technologies**
 EUT Description: **2.4GHz wireless transceiver.**
 Notes: The testing covered on the following sheets was conducted in accordance with public DA 00-705, Released March 30, 2000

Test Area: **Pinewood Site 1 (3m)**
 Test Date: **07-Aug-2002**
 EUT Power: **12 VDC**

Temperature: **21.5** °C
 Relative Humidity: **54** %
 Air Pressure: **80** kPa
 Page: **19** of **26**

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av – Average	

FCC CFR47 Part 15.247(b) Mobilemark 14 dbi directional antenna.						
FREQ	LEVEL	CABLE / ANT / PREAMP	FINAL	POL / HGT / AZ	Actual Peak	DELTA Margin (dB)
(MHz)	(dBuV)	(dB) (dB/m) (dB)	(dBuV)	(m) (DEG)	(dBm)	15.247(b)
The testing covered on the following sheets was conducted in accordance with public DA 00-705, Released March 30, 2000						
Mobilemark 14 dbi directional antenna.						
All readings are maximized						
Low frequency						
2400.30	99.0 Pk	3.1 / 30.3 / 0.0	132.5	V / 1.0 / 0.0	25.5	-6.5
Mid Frequency						
2445.61	98.8 Pk	3.1 / 30.5 / 0.0	132.4	V / 1.0 / 0.0	25.4	-6.6
High frequency						
2483.20	98.6 Pk	3.2 / 30.6 / 0.0	132.3	V / 1.0 / 0.0	25.3	-6.7

Tested by: **Mike Spataro**
 Printed

Michael Spataro
 Signature

Reviewed by: **Todd Seeley**
 Printed

Todd Seeley
 Signature

Radiated Electromagnetic Emissions



Test Report #: **BC204209 Run 01**
 Test Method: **FCC Part 15**
 EUT Model #: **FGMR-115**
 EUT Serial #: **EMC1**
 Manufacturer: **Freewave Technologies**
 EUT Description: **2.4GHz wireless transceiver.**
 Notes: The testing covered on the following sheets was conducted in accordance with public
 DA 00-705, Released March 30, 2000

Test Area: **Pinewood Site 1 (3m)**
 Test Date: **07-Aug-2002**
 EUT Power: **12 VDC**

Temperature: **21.5** °C
 Relative Humidity: **54** %
 Air Pressure: **80** kPa
 Page: **20** of **26**

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av – Average	

FCC CFR47 Part 15.205 Maxrad 5 dbi omnidirectional antenna.						
FREQ	LEVEL	CABLE / ANT / PREAMP	FINAL	POL / HGT / AZ	DELTA1 (dB)	DELTA2 (dB)
(MHz)	(dBuV)	(dB) (dB/m) (dB)	(dBuV)	(m) (DEG)	FCC (< 1GHz)	FCC 15.205 (> 1GHz)
Maxrad 5 dbi omnidirectional antenna.						
All readings are maximized						
Low frequency						
4800.61	34.3 Avg	4.6 / 34.5 / 40.5	32.9	V / 1.0 / 0.0	N/A	-21.1
7200.90	31.6 Avg	5.3 / 37.3 / 40.9	33.3	V / 1.0 / 0.0	N/A	-20.7
Mid Frequency						
4891.18	33.8 Avg	4.6 / 34.8 / 40.8	32.4	V / 1.0 / 0.0	N/A	-21.6
7336.79	31.2 Avg	5.4 / 37.7 / 40.9	33.4	V / 1.0 / 0.0	N/A	-20.6
High frequency						
4966.51	34.1 Avg	4.7 / 35.0 / 41.0	32.8	V / 1.0 / 0.0	N/A	-21.2
7449.79	31.4 Avg	5.5 / 38.0 / 41.4	33.5	V / 1.0 / 0.0	N/A	-20.5

Tested by: **Mike Spataro**
 Printed

Michael Spataro
 Signature

Reviewed by: **Todd Seeley**
 Printed

Todd Seeley
 Signature

Radiated Electromagnetic Emissions



Test Report #: **BC204209 Run 01**
 Test Method: FCC Part 15
 EUT Model #: FGMR-115
 EUT Serial #: EMC1
 Manufacturer: Freewave Technologies
 EUT Description: 2.4GHz wireless transceiver.
 Notes: The testing covered on the following sheets was conducted in accordance with public DA 00-705, Released March 30, 2000

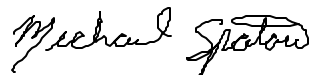
Test Area: Pinewood Site 1 (3m)
 Test Date: 07-Aug-2002
 EUT Power: 12 VDC

Temperature: 21.5 °C
 Relative Humidity: 54 %
 Air Pressure: 80 kPa
 Page: 21 of 26

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av – Average	

FCC CFR47 Part 15.247(b) Maxrad 5 dbi omnidirectional antenna.						
FREQ	LEVEL	CABLE / ANT / PREAMP	FINAL	POL / HGT / AZ	Actual Peak	DELTA Margin (dB)
(MHz)	(dBuV)	(dB) (dB/m) (dB)	(dBuV)	(m) (DEG)	(dBm)	15.247(b)
The testing covered on the following sheets was conducted in accordance with public DA 00-705, Released March 30, 2000						
Maxrad 5 dbi omnidirectional antenna.						
All readings are maximized						
Low frequency						
2400.29	88.4 Pk	3.1 / 30.3 / 0.0	121.8	V / 1.0 / 0.0	14.8	-15.2
Mid frequency						
2445.53	87.7 Pk	3.1 / 30.5 / 0.0	121.3	V / 1.0 / 0.0	14.3	-15.7
High frequency						
2483.26	87.2 Pk	3.2 / 30.6 / 0.0	120.9	V / 1.0 / 0.0	13.9	-16.1

Tested by: Mike Spataro
 Printed


 Signature

Reviewed by: Todd Seeley
 Printed


 Signature

Radiated Electromagnetic Emissions



Test Report #: **BC204209 Run 01**
 Test Method: **FCC Part 15**
 EUT Model #: **FGMR-115**
 EUT Serial #: **EMC1**
 Manufacturer: **Freewave Technologies**
 EUT Description: **2.4GHz wireless transceiver.**
 Notes: The testing covered on the following sheets was conducted in accordance with public
 DA 00-705, Released March 30, 2000

Test Area: **Pinewood Site 1 (3m)**
 Test Date: **07-Aug-2002**
 EUT Power: **12 VDC**

Temperature: **21.5** °C
 Relative Humidity: **54** %
 Air Pressure: **80** kPa
 Page: **22** of **26**

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av – Average	

FCC CFR47 Part 15.205 Maxrad adjustable gain antenna.

FREQ	LEVEL	CABLE / ANT / PREAMP	FINAL	POL / HGT / AZ	DELTA1 (dB)	DELTA2 (dB)
(MHz)	(dBuV)	(dB) (dB/m) (dB)	(dBuV)	(m) (DEG)	FCC (< 1GHz)	FCC 15.205 (> 1GHz)
Maxrad adjustable gain antenna.						
All readings are maximized						
Low frequency						
4800.62	47.4 Pk	4.6 / 34.5 / 40.5	46	V / 1.0 / 0.0	N/A	-8.0
7201.01	38.0 Pk	5.3 / 37.3 / 40.9	39.7	V / 1.0 / 0.0	N/A	-14.3
Mid Frequency						
4891.19	47.1 Pk	4.6 / 34.8 / 40.8	45.7	V / 1.0 / 0.0	N/A	-8.3
7336.79	38.4 Pk	5.4 / 37.7 / 40.9	40.6	V / 1.0 / 0.0	N/A	-13.4
High frequency						
4966.55	46.8 Pk	4.7 / 35.0 / 41.0	45.5	V / 1.0 / 0.0	N/A	-8.5
7449.78	38.5 Pk	5.5 / 38.0 / 41.4	40.6	V / 1.0 / 0.0	N/A	-13.4

Tested by: **Mike Spataro**

Printed

Signature

Reviewed by: **Todd Seeley**

Printed

Signature

Radiated Electromagnetic Emissions



Test Report #: **BC204209 Run 01**
 Test Method: **FCC Part 15**
 EUT Model #: **FGMR-115**
 EUT Serial #: **EMC1**
 Manufacturer: **Freewave Technologies**
 EUT Description: **2.4GHz wireless transceiver.**
 Notes: The testing covered on the following sheets was conducted in accordance with public DA 00-705, Released March 30, 2000

Test Area: **Pinewood Site 1 (3m)**
 Test Date: **07-Aug-2002**
 EUT Power: **12 VDC**

Temperature: **21.5** °C
 Relative Humidity: **54** %
 Air Pressure: **80** kPa
 Page: **23** of **26**

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av – Average	

FCC CFR47 Part 15.247(b) Maxrad adjustable gain antenna.						
FREQ	LEVEL	CABLE / ANT / PREAMP	FINAL	POL / HGT / AZ	Actual Peak	DELTA Margin (dB)
(MHz)	(dBuV)	(dB) (dB/m) (dB)	(dBuV)	(m) (DEG)	(dBm)	15.247(b)
The testing covered on the following sheets was conducted in accordance with public DA 00-705, Released March 30, 2000						
Maxrad adjustable gain antenna.						
All readings are maximized						
45 Deg element						
Low frequency						
2400.31	100.7 Pk	3.1 / 30.3 / 0.0	134.1	V / 1.0 / 0.0	-6.3	-36.3
Mid frequency						
2445.53	102.1 Pk	3.1 / 30.5 / 0.0	135.7	V / 1.0 / 0.0	-4.9	-34.9
High frequency						
2483.26	101.5 Pk	3.2 / 30.6 / 0.0	135.2	V / 1.0 / 0.0	-6.5	-36.5
60 Deg, element						
2445.58	101.8 Pk	3.1 / 30.5 / 0.0	135.4	V / 1.0 / 0.0	-5.2	-35.2
90 Deg element						
2445.58	99.8 Pk	3.1 / 30.5 / 0.0	133.4	V / 1.0 / 0.0	-7.2	-37.2

Tested by: **Mike Spataro**
 Printed

Michael Spataro
 Signature

Reviewed by: **Todd Seeley**
 Printed

Todd Seeley
 Signature

Radiated Electromagnetic Emissions



Test Report #: **BC204209 Run 01**
 Test Method: **FCC Part 15**
 EUT Model #: **FGMR-115**
 EUT Serial #: **EMC1**
 Manufacturer: **Freewave Technologies**
 EUT Description: **2.4GHz wireless transceiver.**

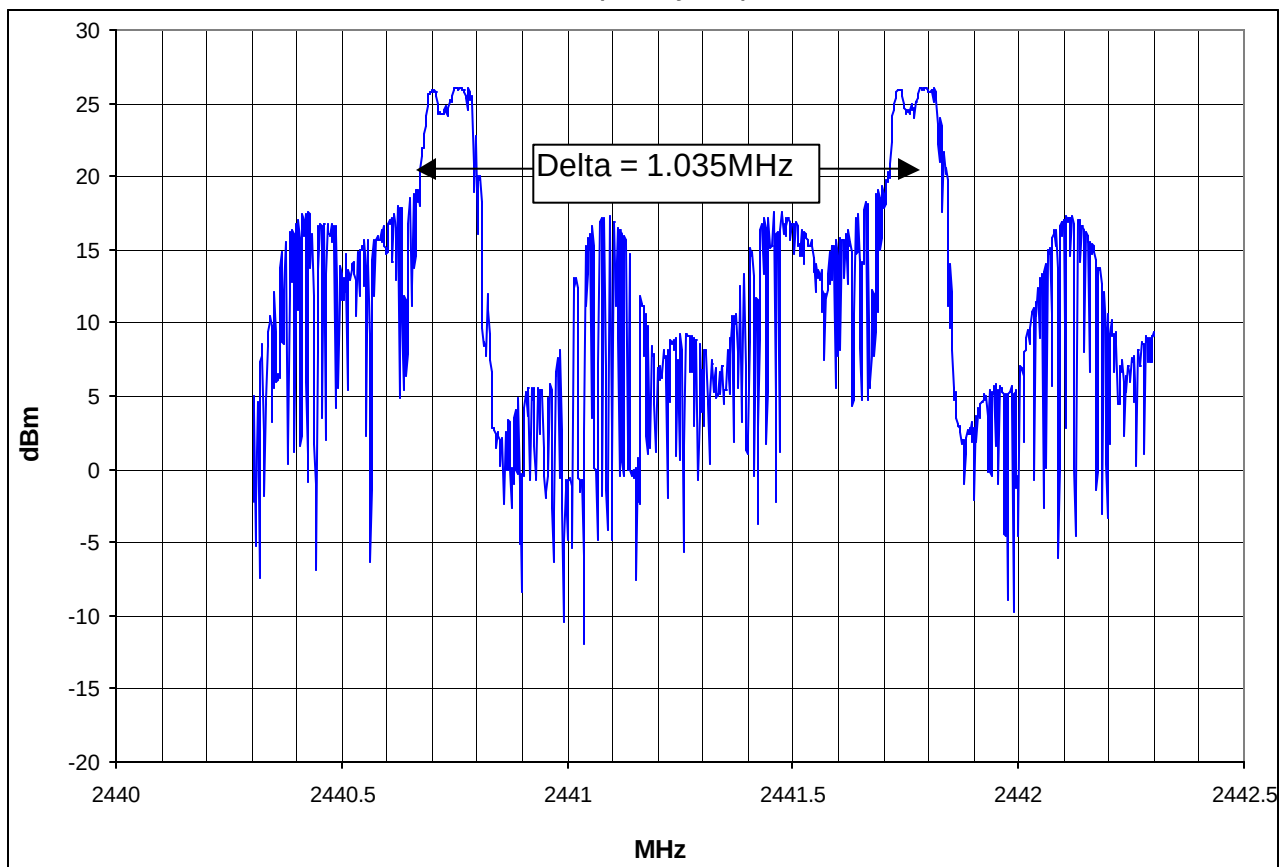
Test Area: **Pinewood Site 1 (3m)**
 Test Date: **07-Aug-2002**
 EUT Power: **12 VDC**

Notes: The testing covered on the following sheets was conducted in accordance with public
 DA 00-705, Released March 30, 2000

Temperature: **21.5** °C
 Relative Humidity: **54** %
 Air Pressure: **80** kPa
 Page: **24** of **26**

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av – Average	

Sec. 15.247 (a) Carrier Frequency Separation



Tested by: **Mike Spataro**
 Printed

Michael Spataro
 Signature

Reviewed by: **Todd Seeley**
 Printed

Todd Seeley
 Signature

Radiated Electromagnetic Emissions



Test Report #: **BC204209 Run 01**
 Test Method: **FCC Part 15**
 EUT Model #: **FGMR-115**
 EUT Serial #: **EMC1**
 Manufacturer: **Freewave Technologies**
 EUT Description: **2.4GHz wireless transceiver.**

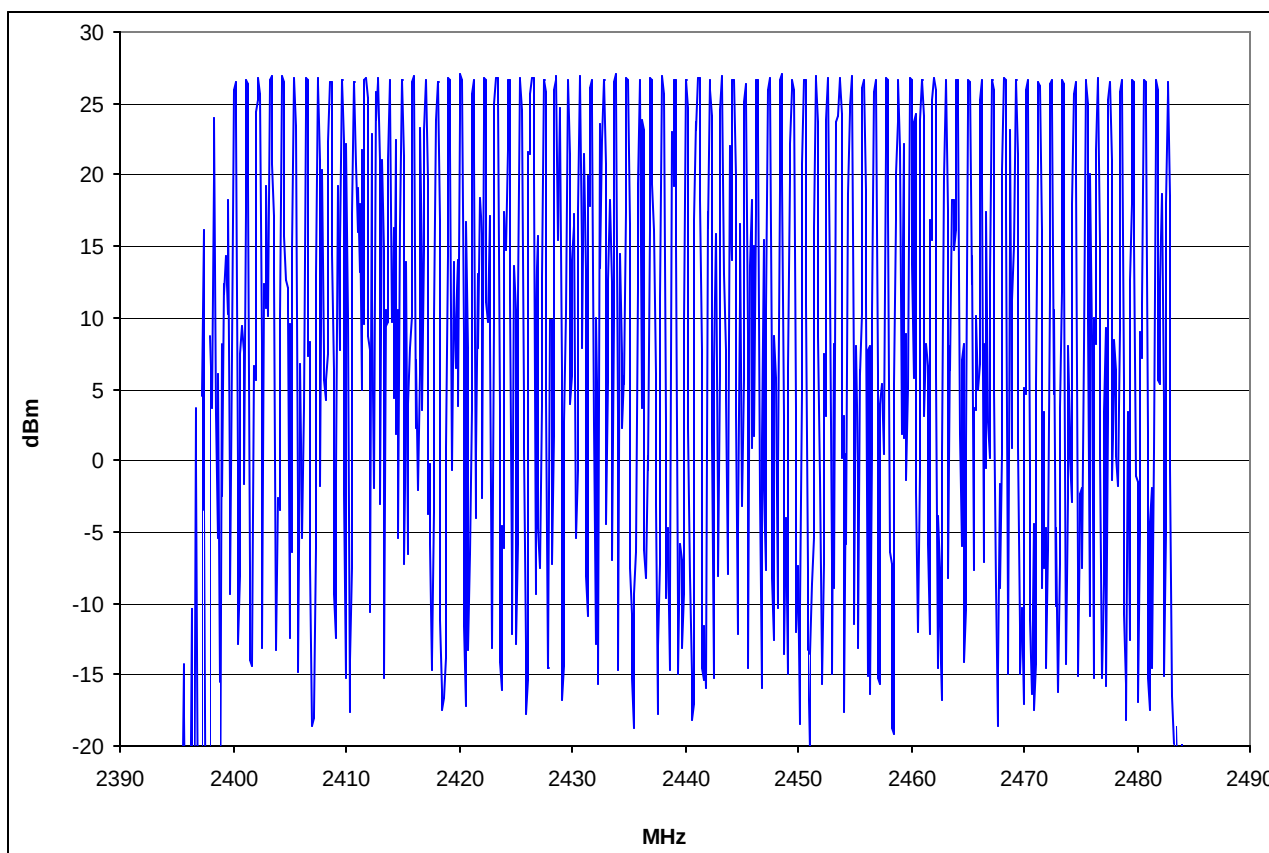
Test Area: **Pinewood Site 1 (3m)**
 Test Date: **07-Aug-2002**
 EUT Power: **12 VDC**

Notes: The testing covered on the following sheets was conducted in accordance with public
 DA 00-705, Released March 30, 2000

Temperature: **21.5** °C
 Relative Humidity: **54** %
 Air Pressure: **80** kPa
 Page: **25** of **26**

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av – Average	

Sec. 15.247 (a) Number of Hopping Frequencies 80 Total



Tested by: **Mike Spataro**
 Printed

Michael Spataro
 Signature

Reviewed by: **Todd Seeley**
 Printed

Todd Seeley
 Signature

Radiated Electromagnetic Emissions



Test Report #: **BC204209 Run 01**
 Test Method: **FCC Part 15**
 EUT Model #: **FGMR-115**
 EUT Serial #: **EMC1**
 Manufacturer: **Freewave Technologies**
 EUT Description: **2.4GHz wireless transceiver.**

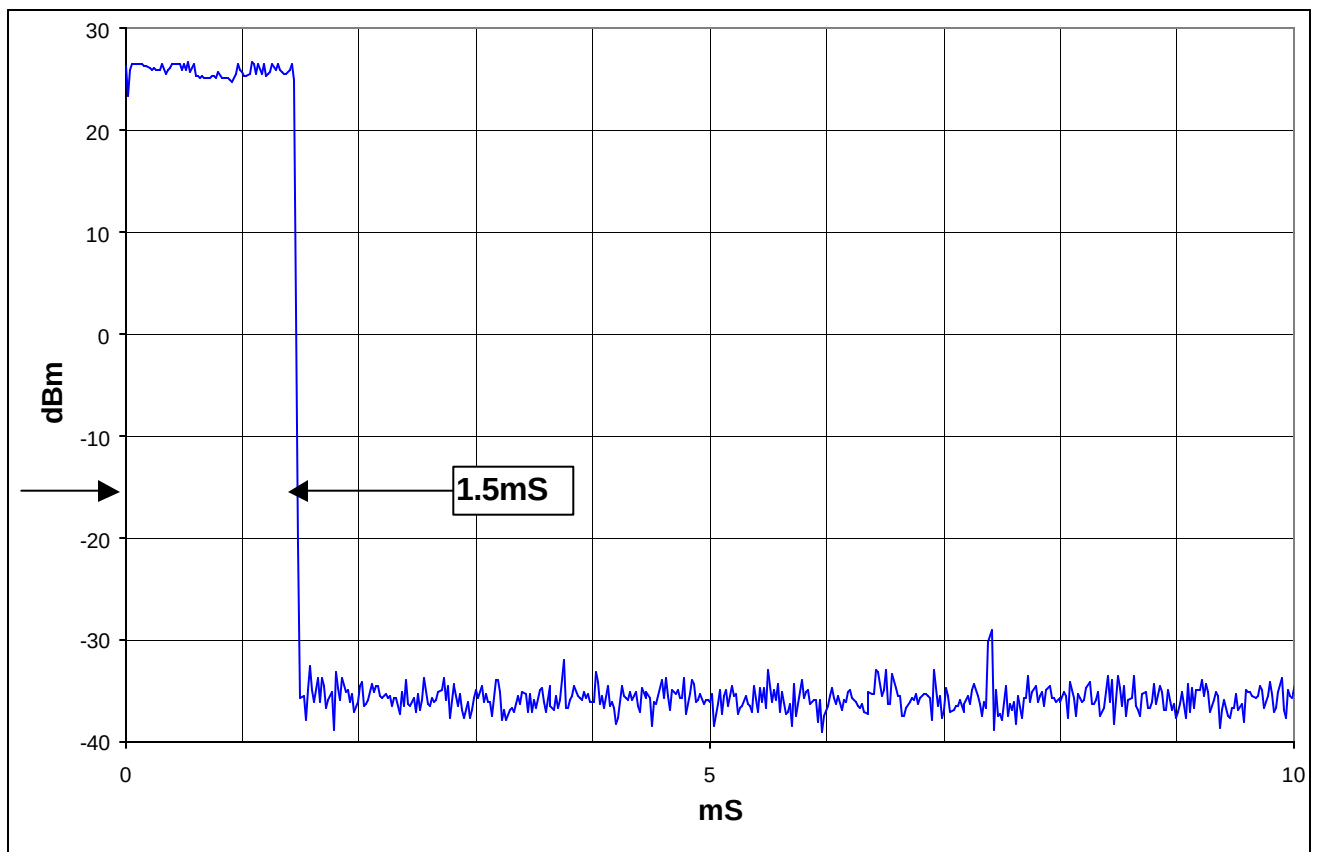
Test Area: **Pinewood Site 1 (3m)**
 Test Date: **07-Aug-2002**
 EUT Power: **12 VDC**

Notes: The testing covered on the following sheets was conducted in accordance with public
 DA 00-705, Released March 30, 2000

Temperature: **21.5** °C
 Relative Humidity: **54** %
 Air Pressure: **80** kPa
 Page: **26** of **26**

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av - Average	

Sec. 15.247 (a) Dwell Time of a single hopping frequency



Tested by: **Mike Spataro**
 Printed

Michael Spataro
 Signature

Reviewed by: **Todd Seeley**
 Printed

Todd Seeley
 Signature

Radiated Electromagnetic Emissions



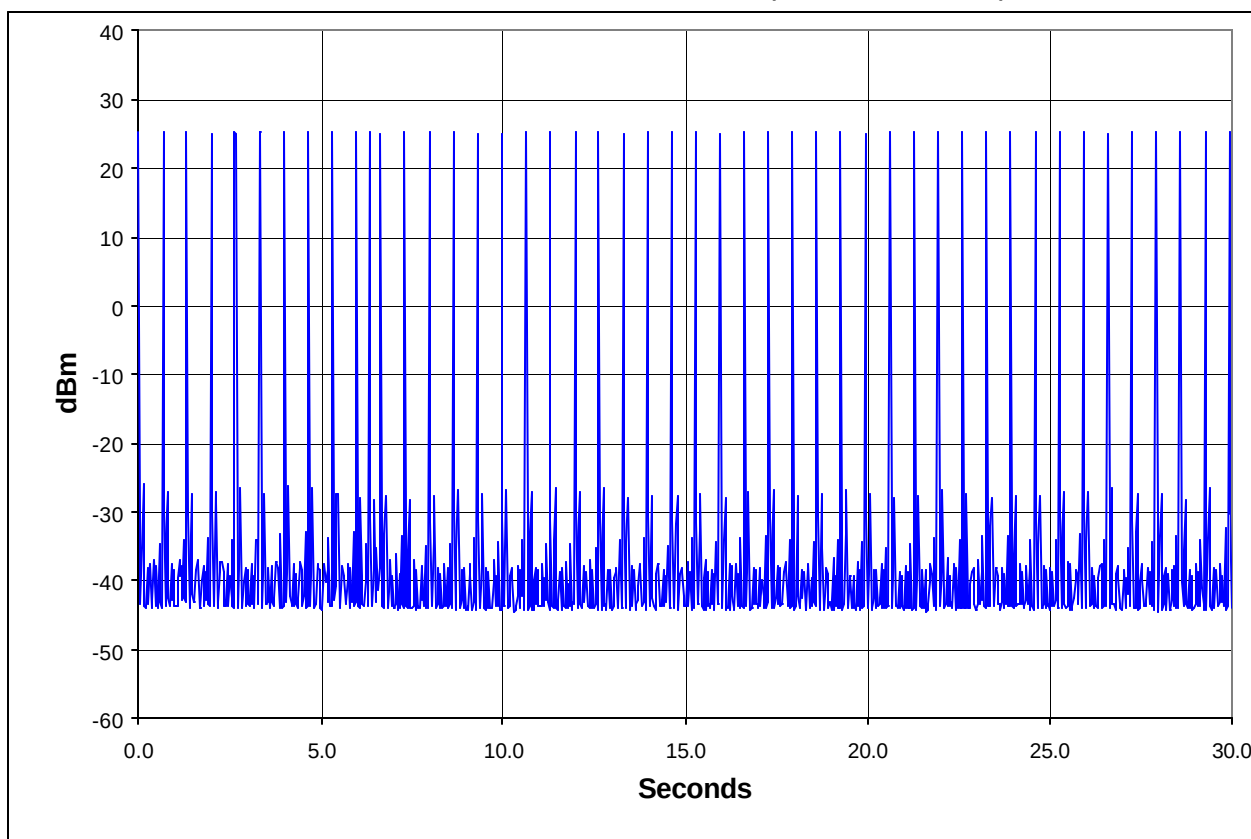
Test Report #: **BC204209 Run 01**
 Test Method: FCC Part 15
 EUT Model #: FGMR-115
 EUT Serial #: EMC1
 Manufacturer: Freewave Technologies
 EUT Description: 2.4GHz wireless transceiver.
 Notes: The testing covered on the following sheets was conducted in accordance with public
 DA 00-705, Released March 30, 2000

Test Area: Pinewood Site 1 (3m)
 Test Date: 07-Aug-2002
 EUT Power: 12 VDC

Temperature: 21.5 °C
 Relative Humidity: 54 %
 Air Pressure: 80 kPa
 Page: 27 of 28

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av – Average	

Sec. 15.247 (a)
 Dwell Time of a single hopping frequency
 45 occurrences x 1.5 ms = 67.5 ms (400 ms allowed)



Tested by: Mike Spataro
 Printed

Michael Spataro
 Signature

Reviewed by: Todd Seeley
 Printed

Todd Seeley
 Signature

Radiated Electromagnetic Emissions



Test Report #: **BC204209 Run 01**
 Test Method: **FCC Part 15**
 EUT Model #: **FGMR-115**
 EUT Serial #: **EMC1**
 Manufacturer: **Freewave Technologies**
 EUT Description: **2.4GHz wireless transceiver.**

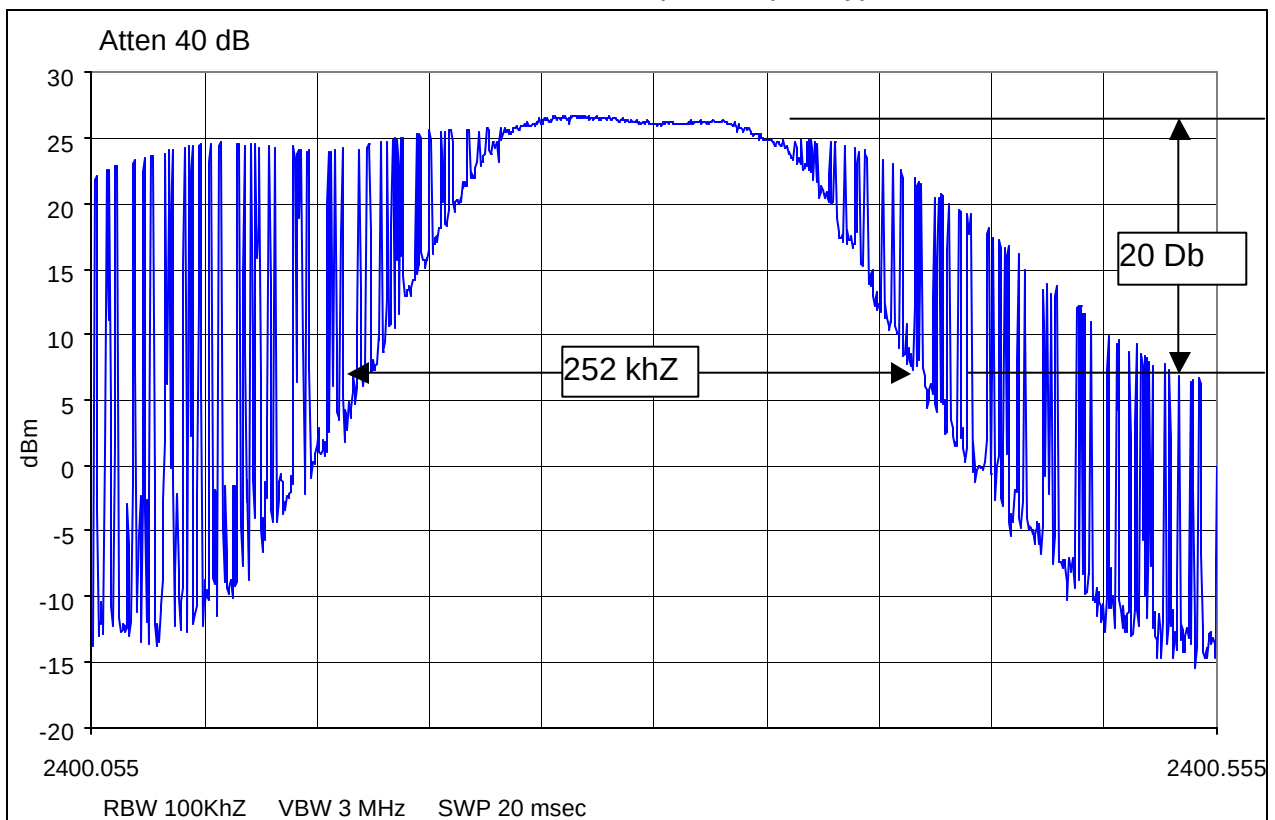
Test Area: **Pinewood Site 1 (3m)**
 Test Date: **07-Aug-2002**
 EUT Power: **12 VDC**

Notes: The testing covered on the following sheets was conducted in accordance with public
 DA 00-705, Released March 30, 2000

Temperature: **21.5** °C
 Relative Humidity: **54** %
 Air Pressure: **80** kPa
 Page: **28** of **36**

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av - Average	

Sec. 15.247 (a) 20 dB Bandwidth (low frequency)



Tested by: **Mike Spataro**
 Printed

Michael Spataro
 Signature

Reviewed by: **Todd Seeley**
 Printed

Todd Seeley
 Signature

Radiated Electromagnetic Emissions



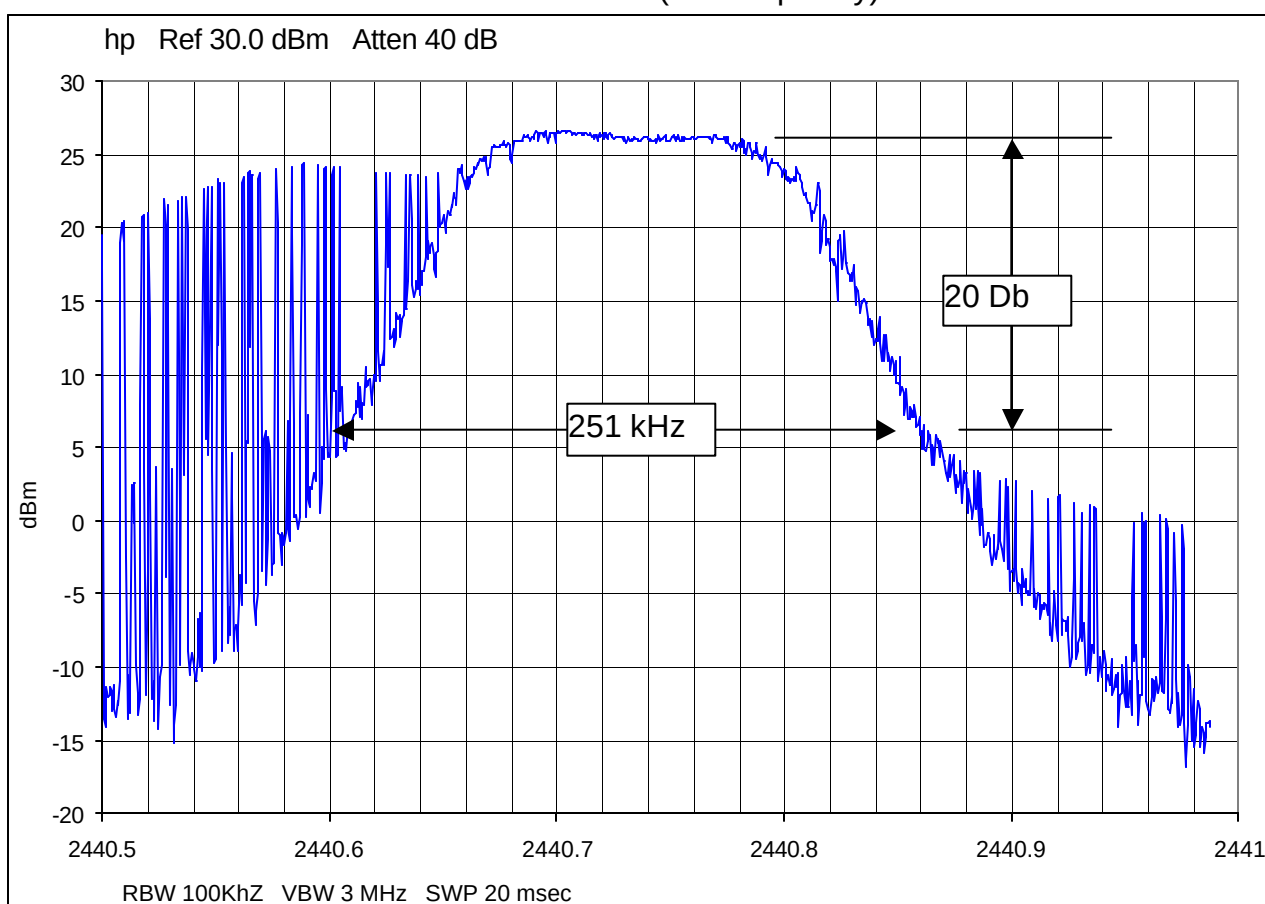
Test Report #: **BC204209 Run 01**
 Test Method: FCC Part 15
 EUT Model #: FGMR-115
 EUT Serial #: EMC1
 Manufacturer: Freewave Technologies
 EUT Description: 2.4GHz wireless transceiver.
 Notes: The testing covered on the following sheets was conducted in accordance with public
 DA 00-705, Released March 30, 2000

Test Area: Pinewood Site 1 (3m)
 Test Date: 07-Aug-2002
 EUT Power: 12 VDC

Temperature: 21.5 °C
 Relative Humidity: 54 %
 Air Pressure: 80 kPa
 Page: 29 of 30

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av - Average	

Sec. 15.247 (a) 20 dB Bandwidth (mid frequency)



Tested by: Mike Spataro
 Printed

Michael Spataro
 Signature

Reviewed by: Todd Seeley
 Printed

Todd Seeley
 Signature

Radiated Electromagnetic Emissions



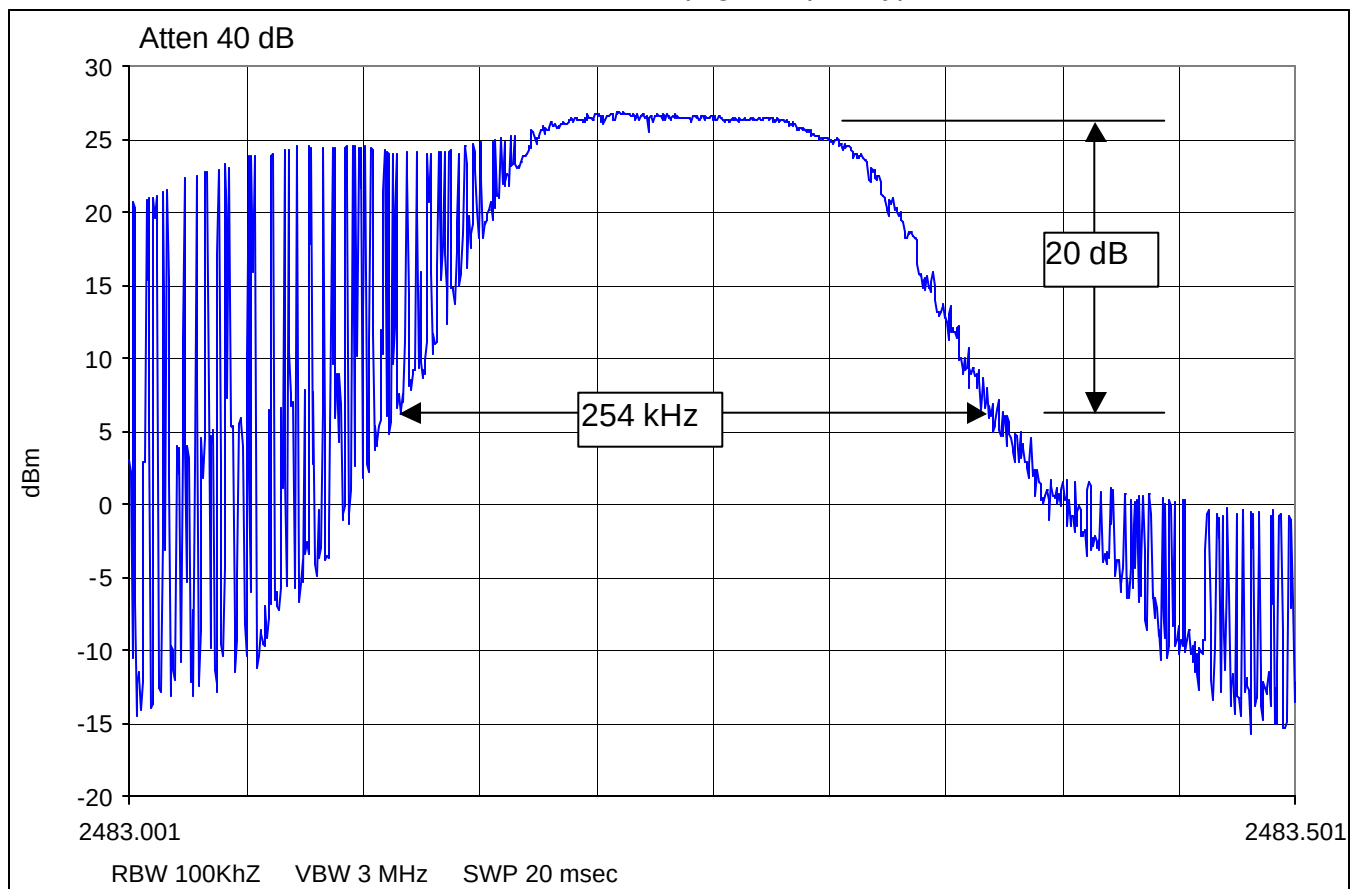
Test Report #: **BC204209 Run 01**
 Test Method: FCC Part 15
 EUT Model #: FGMR-115
 EUT Serial #: EMC1
 Manufacturer: Freewave Technologies
 EUT Description: 2.4GHz wireless transceiver.
 Notes: The testing covered on the following sheets was conducted in accordance with public DA 00-705, Released March 30, 2000

Test Area: Pinewood Site 1 (3m)
 Test Date: 07-Aug-2002
 EUT Power: 12 VDC

Temperature: 21.5 °C
 Relative Humidity: 54 %
 Air Pressure: 80 kPa
 Page: 30 of 36

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av - Average	

Sec. 15.247 (a) 20 dB Bandwidth (high frequency)



Tested by: Mike Spataro
 Printed

Michael Spataro
 Signature

Reviewed by: Todd Seeley
 Printed

Todd Seeley
 Signature

Radiated Electromagnetic Emissions



Test Report #: **BC204209 Run 01**
Test Method: **FCC Part 15**
EUT Model #: **FGMR-115**
EUT Serial #: **EMC1**
Manufacturer: **Freewave Technologies**
EUT Description: **2.4GHz wireless transceiver.**
Notes: The testing covered on the following sheets was conducted in accordance with public
DA 00-705, Released March 30, 2000

Test Area: **Pinewood Site 1 (3m)**
Test Date: **07-Aug-2002**
EUT Power: **12 VDC**

Temperature: **21.5 °C**
Relative Humidity: **54 %**
Air Pressure: **80 kPa**
Page: **31** of **36**

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av – Average	

Sec. 15.247 (c) Band-Edge Compliance Measurements

Measurements were taken in accordance to Public Notice DA 00-705, Released March 30, 2000. No emissions were detected outside the band edge.
The following Measurements:

14dBi antenna:
2390MHz: 52.0dBuV Avg.
2483.5MHz: 51.3dBuV

5dBi antenna:
2390MHz: 47.6dBuV Avg.
2483.5MHz: 47.3dBuV Avg.

Adjustable Gain antenna:
45deg element
2390MHz: 52.3dBuV Avg.
2483.5MHz: 51.6dBuV Avg.

60deg element
2390MHz: 53.1dBuV Avg.
2483.5MHz: 52.6dBuV Avg.

90deg element
2390MHz: 51.2dBuV Avg.
2483.5MHz: 50.8dBuV Avg.

****all measurements are maximized at 0.0Az and 1m H*****

The bandedge measurements were performed using worst-case antenna.

Tested by:

Mike Spataro

Printed

Signature

Reviewed
by:

Todd Seeley

Printed

Signature

Radiated Electromagnetic Emissions



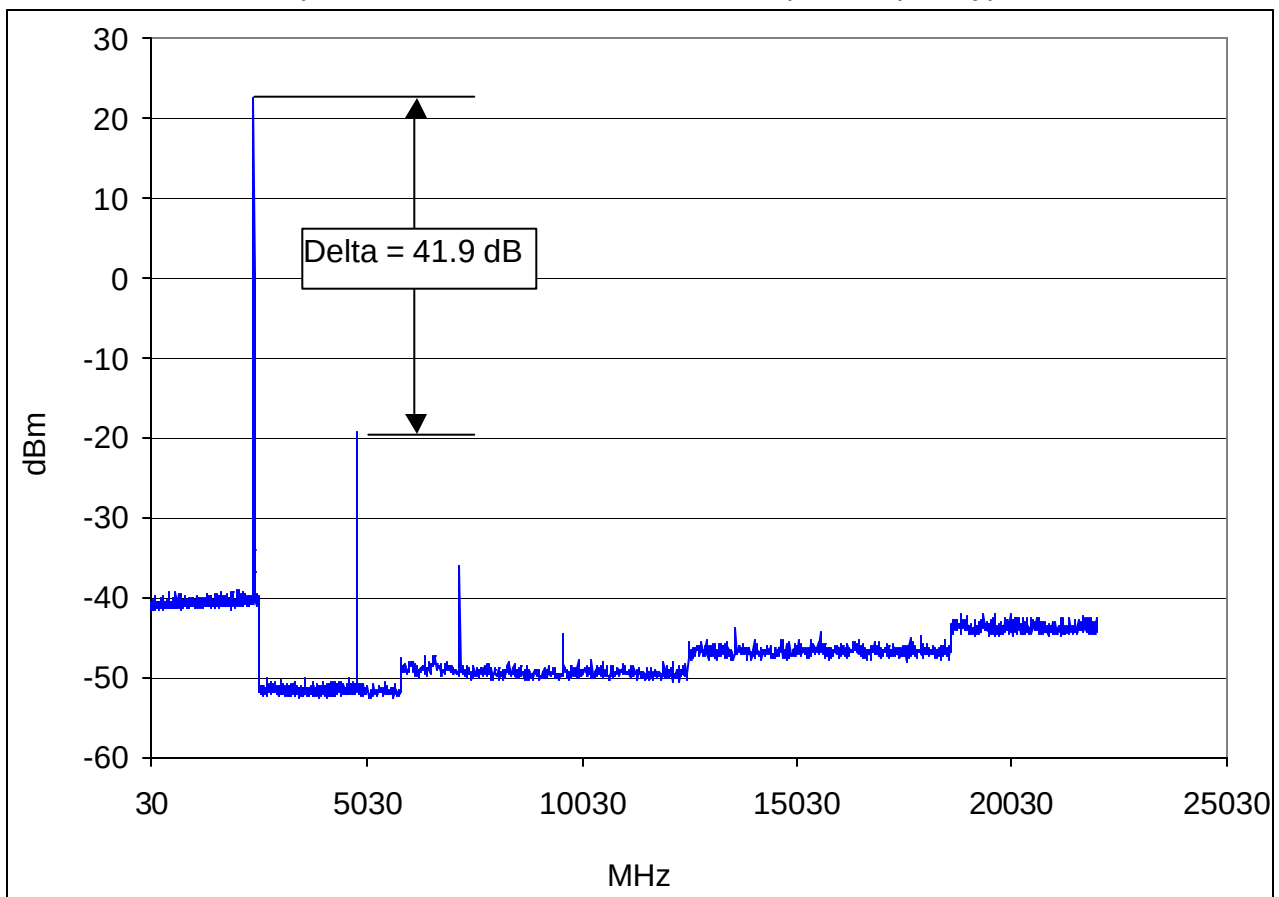
Test Report #: **BC204209 Run 01**
 Test Method: FCC Part 15
 EUT Model #: FGMR-115
 EUT Serial #: EMC1
 Manufacturer: Freewave Technologies
 EUT Description: 2.4GHz wireless transceiver.
 Notes: The testing covered on the following sheets was conducted in accordance with public
 DA 00-705, Released March 30, 2000

Test Area: Pinewood Site 1 (3m)
 Test Date: 07-Aug-2002
 EUT Power: 12 VDC

Temperature: 21.5 °C
 Relative Humidity: 54 %
 Air Pressure: 80 kPa
 Page: 32 of 36

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av – Average	

Sec. 15.247 (c) Spurious RF Conducted Emissions (low frequency)



Tested by: Mike Spataro
 Printed

Michael Spataro
 Signature

Reviewed by: Todd Seeley
 Printed

Todd Seeley
 Signature

Radiated Electromagnetic Emissions



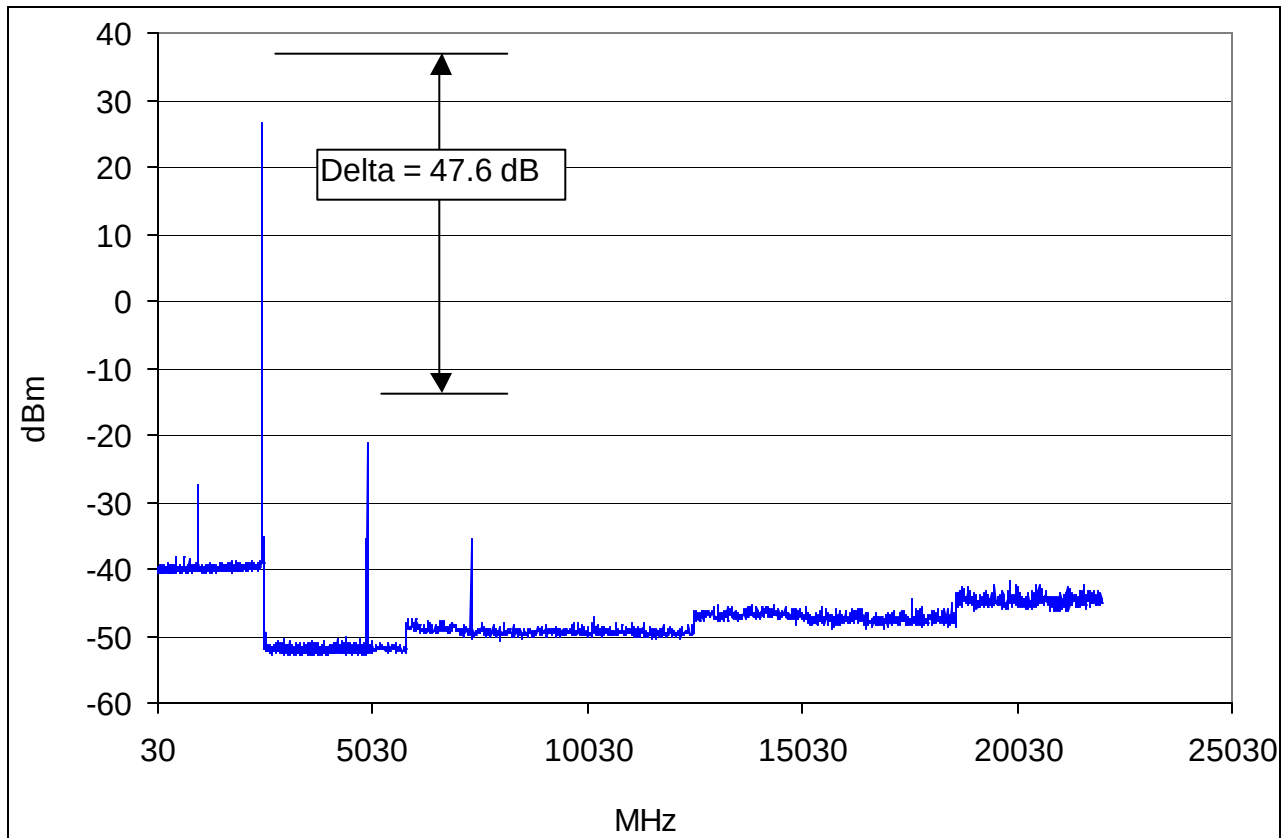
Test Report #: **BC204209 Run 01**
 Test Method: FCC Part 15
 EUT Model #: FGMR-115
 EUT Serial #: EMC1
 Manufacturer: Freewave Technologies
 EUT Description: 2.4GHz wireless transceiver.
 Notes: The testing covered on the following sheets was conducted in accordance with public
 DA 00-705, Released March 30, 2000

Test Area: Pinewood Site 1 (3m)
 Test Date: 07-Aug-2002
 EUT Power: 12 VDC

Temperature: 21.5 °C
 Relative Humidity: 54 %
 Air Pressure: 80 kPa
 Page: 33 of 36

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av – Average	

Sec. 15.247 (c) Spurious RF Conducted Emissions (mid frequency)



Tested by: Mike Spataro
 Printed

Michael Spataro
 Signature

Reviewed by: Todd Seeley
 Printed

Todd Seeley
 Signature

Radiated Electromagnetic Emissions



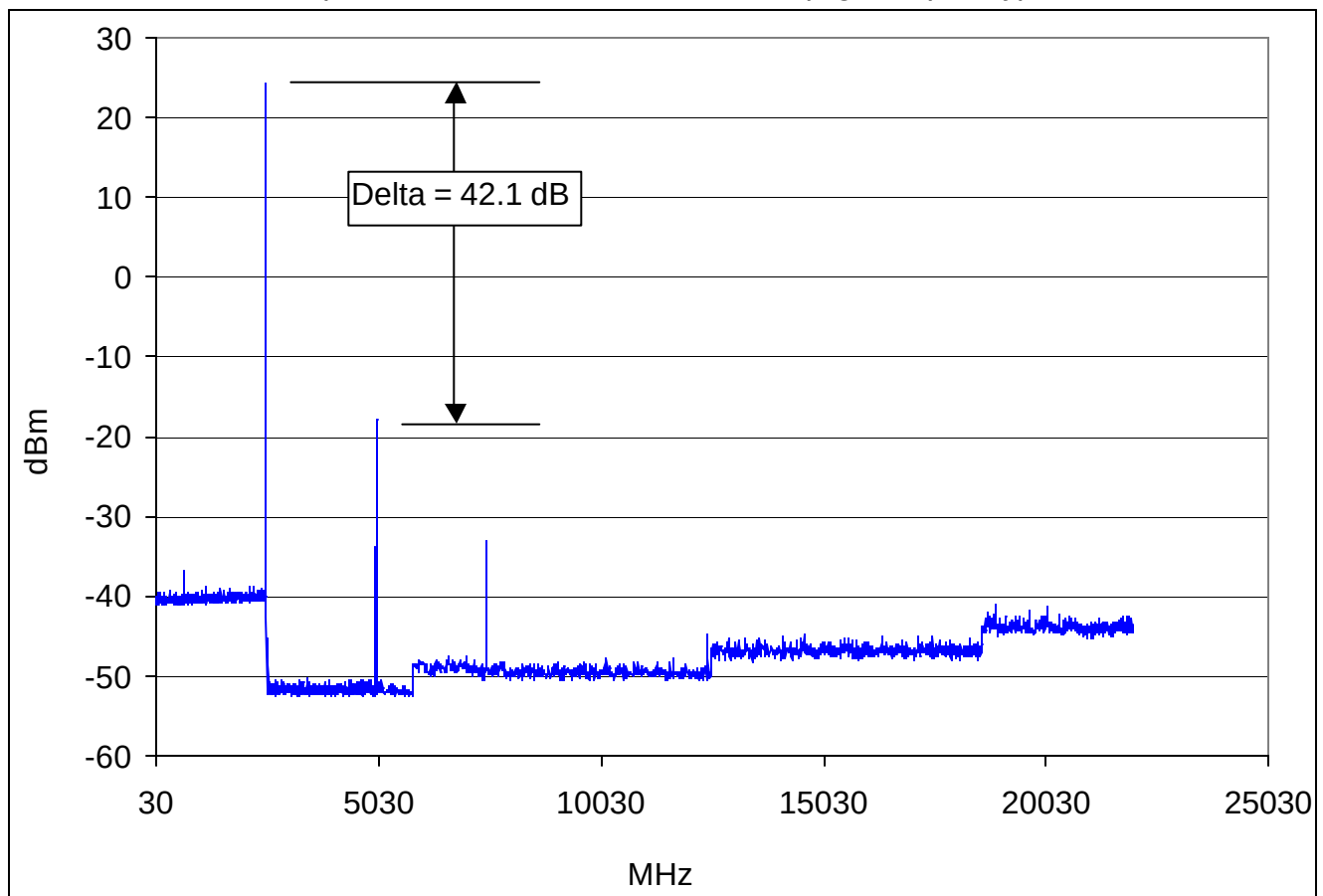
Test Report #: **BC204209 Run 01**
 Test Method: FCC Part 15
 EUT Model #: FGMR-115
 EUT Serial #: EMC1
 Manufacturer: Freewave Technologies
 EUT Description: 2.4GHz wireless transceiver.
 Notes: The testing covered on the following sheets was conducted in accordance with public
 DA 00-705, Released March 30, 2000

Test Area: Pinewood Site 1 (3m)
 Test Date: 07-Aug-2002
 EUT Power: 12 VDC

Temperature: 21.5 °C
 Relative Humidity: 54 %
 Air Pressure: 80 kPa
 Page: 34 of 36

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av - Average	

Sec. 15.247 (c) Spurious RF Conducted Emissions (high frequency)



Tested by: Mike Spataro
 Printed

Michael Spataro
 Signature

Reviewed by: Todd Seeley
 Printed

Todd Seeley
 Signature

Equipment Report

21-Aug-2002

Project Number: BC204209

Project Date: 21-Aug-2002

Company Name: Freewave Technologies

Equip ID	Manufacturer	Model Number	Serial Number	Description	Date	Calibration Interval	Due	Cal Code
<u>Test Performed</u> R		<u>Radiated Emissions</u>						
8176	TENSOR	4105	2020	Ridged Guide Antenna	27-May-2002	12	27-May-2003	G
7617	MINI-CIRCUITS LAB	ZHL-42	N052792-2	Amplifier	23-Apr-2002	12	23-Apr-2003	B
8014	EMCO	3146	9203-3376	Log Periodic Antenna	28-Aug-2001	12	28-Aug-2002	G
8207	AVANTEK	AWT-18037	1002	RF Pre-Amplifier (8-18 GHz)	23-Apr-2001	12	23-Apr-2002	B
8208	AVANTEK	AFT97-8434-10F	1007	RF Pre-Amplifier (4-8 GHz)	23-Apr-2002	12	23-Apr-2003	B
8213	HEWLETT PACKARD	8566B	2410A00154	Spectrum Analyzer (dc-22 GHz)	04-May-2002	12	04-May-2003	G
8214	HEWLETT PACKARD	85662A	2403A08749	Display Section	04-May-2002	12	04-May-2003	G
7514	A.H.SYSTEMS	SAS-200/512	104	Log Periodic Antenna (200-1500 MHz)	26-Sep-2001	12	26-Sep-2002	G
7637	MITEQ	AM-2A-000110-N	848495	RF Pre-Amplifier	5-May-2002	12	5-May-2003	G
8040	HEWLETT PACKARD	8594E	3223A00145	Spectrum Analyzer	31-Jan-2002	12	31-Jan-2003	G
8225	EMCO	3108	7059203-2457	Biconical Dipole Antenna	16-Aug-2002	12	16-Aug-2003	G

Cal Code Legend: G=Out Source, Y=No Cal required, R=Out of Service, B=In-House Verification Required

1 of 1

Appendix B

Test Plan
and
Constructional Data Form



PUBLIC NOTICE

Federal Communications Commission
445 12th St., S.W.
Washington, D.C. 20554

News Media Information 202 / 418-0500
Fax-On-Demand 202 / 418-2830
TTY 202 / 418-2555
Internet: <http://www.fcc.gov>
<ftp.fcc.gov>

DA 00-705
Released March 30, 2000

Filing and Measurement Guidelines **for Frequency Hopping Spread Spectrum Systems**

Part 15.247 of the FCC Rules provides for operation of frequency hopping spread spectrum transmitters. Examples of devices that operate under these rules include wireless local area networks, cordless telephones, wireless cash registers and wireless inventory tracking systems.

The FCC has no established test procedure for frequency hopping spread spectrum devices. Such tests are to be performed following the general guidance in Section 15.31 of the FCC Rules, using good engineering practice. The following provides both information on the measurement techniques that have been accepted in the past for equipment authorization purposes, as well as general filing guidelines which may be used to address the various technical requirements for frequency hopping spread spectrum transmitters.

NOTE: Unless otherwise specified, the following measurements should be made in an RF conducted manner, with a direct connection between the antenna port of the EUT and the measuring instrument. If any attenuation is required between the EUT and the measuring instrument, this value, in addition to the measured cable loss, must be added to the measured levels. If a direct connection cannot be made to the antenna port, alternative procedures are outlined at the end of this document. All measurement results should be consistent with the technical specifications and descriptions of the EUT with respect to frequency range of operation, peak output power, etc.

Section 15.31(m):

This rule specifies the number of operating frequencies to be examined for tunable equipment. Unless otherwise specified, the hopping function must be disabled for the following tests, which should be performed with the EUT transmitting on the number of frequencies specified in this Section. The measurements made at the upper and lower ends of the band of operation should be made with the EUT tuned to the highest and lowest available channels.

Section 15.203:

Describe how the EUT complies with the requirement that either its antenna is permanently attached, or that it employs a unique antenna connector, for every antenna proposed for use with the EUT. The exception is in those cases where the EUT must be professionally installed. In order to demonstrate that professional installation is required, the following three points must be addressed: (a) the application (or intended use) of the EUT, (b) the installation requirements of the EUT, and (c) the method by which the EUT will be marketed.

Section 15.204:

Provide the following information for every antenna proposed for use with the EUT: (a) type (e.g., Yagi, patch, grid, dish, etc.), (b) manufacturer and model number, and (c) gain with reference to an isotropic radiator.

Section 15.207:

If the unit is designed to be connected to the public utility power line, the voltage conducted back onto the AC power line must be measured, in order to demonstrate compliance with the limit specified in this Section. See ANSI C63.4-1992 for the proper set up and procedures.

Section 15.247(a):

Describe how the EUT meets the definition of a frequency hopping spread spectrum system, found in Section 2.1, based on the technical description.

Carrier Frequency Separation

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:

Span = wide enough to capture the peaks of two adjacent channels

Resolution (or IF) Bandwidth (RBW) $\geq$ 1% of the span

Video (or Average) Bandwidth (VBW) $\geq$ RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The limit is specified in one of the subparagraphs of this Section. Submit this plot.

Number of Hopping Frequencies

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:

Span = the frequency band of operation

RBW $\geq$ 1% of the span

VBW $\geq$ RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize. It may prove necessary to break the span up to sections, in order to clearly show all of the hopping frequencies. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s).

Time of Occupancy (Dwell Time)

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:

Span = zero span, centered on a hopping channel

RBW = 1 MHz

$VBW \geq RBW$

Sweep = as necessary to capture the entire dwell time per hopping channel

Detector function = peak

Trace = max hold

If possible, use the marker-delta function to determine the dwell time. If this value varies with different modes of operation (e.g., data rate, modulation format, etc.), repeat this test for each variation. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s). An oscilloscope may be used instead of a spectrum analyzer.

20 dB Bandwidth

Use the following spectrum analyzer settings:

Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel

$RBW \geq 1\%$ of the 20 dB bandwidth

$VBW \geq RBW$

Sweep = auto

Detector function = peak

Trace = max hold

The EUT should be transmitting at its maximum data rate. Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. Use the marker-delta function to measure 20 dB down one side of the emission. Reset the marker-delta function, and move the marker to the other side of the emission, until it is (as close as possible to) even with the reference marker level. The marker-delta reading at this point is the 20 dB bandwidth of the emission. If this value varies with different modes of operation (e.g., data rate, modulation format, etc.), repeat this test for each variation. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s).

Pseudorandom Frequency Hopping Sequence

Describe how the hopping sequence is generated. Provide an example of the hopping sequence channels, in order to demonstrate that the sequence meets the requirement specified in the definition of a frequency hopping spread spectrum system, found in Section 2.1.

Equal Hopping Frequency Use

Describe how each individual EUT meets the requirement that each of its hopping channels is used equally on average (e.g., that each new transmission event begins on the next channel in the hopping sequence after the final channel used in the previous transmission event).

System Receiver Input Bandwidth

Describe how the associated receiver(s) complies with the requirement that its input bandwidth (either RF or IF) matches the bandwidth of the transmitted signal.

System Receiver Hopping Capability

Describe how the associated receiver(s) has the ability to shift frequencies in synchronization with the transmitted signals.

Section 15.247(b):

Peak Output Power

Use the following spectrum analyzer settings:

Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel

RBW > the 20 dB bandwidth of the emission being measured

VBW $\geq$ RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. The indicated level is the peak output power (see the NOTE above regarding external attenuation and cable loss). The limit is specified in one of the subparagraphs of this Section. Submit this plot. A peak responding power meter may be used instead of a spectrum analyzer.

De Facto EIRP Limit

Describe how the EUT complies with the *de facto* EIRP limit for every antenna proposed for use with the EUT. This includes those devices that will be used in point-to-point applications. If the peak output power, as measured above, must be reduced so that the *de facto* EIRP limit may be met for a particular antenna, describe exactly how much it will be reduced for that antenna. If the peak output power level is raised above the limit in order to compensate for cable loss between the EUT and the antenna, specify the minimum length of cable which will always be used, the type of cable, and its loss, in dB per unit length, for the frequency of the emission. The limit is specified in one of the subparagraphs of this Section. Also, specify who will be responsible for ensuring that compliant operation is maintained for every antenna that will be used with the EUT.

Point-to-Point Operation

If the EIRP relaxation for point-to-point operation is proposed for any particular antenna, describe who will be responsible for ensuring that the EUT is only used in such an application.

RF Exposure Compliance Requirements

Spread spectrum transmitters operating under Section 15.247 are categorically excluded from routine environmental evaluation for demonstrating RF exposure compliance with respect to MPE and/or SAR limits. These devices are not exempted from compliance. As indicated in Section 15.247(b)(4), these transmitters are required to operate in a manner that ensures that exposure to the public (users and nearby persons) does not exceed the Commission's RF exposure guidelines (see Sections 1.1307, 2.1091 and 2.1093). Unless a device operates at substantially low output power levels, with a low gain antenna(s), supporting information is generally needed to establish the various potential operating configurations and exposure conditions of a transmitter and its antenna(s), in order to determine compliance with the RF exposure guidelines.

In order to demonstrate compliance with MPE requirements (see Section 2.1091), the following information is typically needed: (1) calculations that estimate the minimum

separation distance (20 cm or more) between an antenna and persons required to satisfy power density limits (defined for free-space), (2) antenna installation and device operating instructions for installers (professional and/or unskilled users), and the parties responsible for ensuring compliance with the RF exposure requirements, (3) any caution statements and/or warning labels that are necessary in order for a device to comply with the exposure limits, and (4) any other RF exposure related issues that may affect MPE compliance.

For portable transmitters (see Section 2.1093), or devices designed to operate next to a person's body, compliance is determined with respect to the SAR limit (defined in body tissues) for near-field exposure conditions. If the maximum average output power, operating configurations, and exposure conditions are comparable to those of existing cellular and PCS phones, an SAR evaluation may be required in order to determine if such a device complies with the SAR limit. When SAR data is not available, and the additional supporting information cannot assure compliance, the Commission may request that an SAR evaluation be performed, as provided for in Section 1.1307(d).

Installation/Operation Manual Requirements

Submit a copy of the information/instructions that will be included in the installation/operation manual pertaining to: (a) correct peak output power settings required for compliant operation for every antenna proposed for use with the EUT, (b) point-to-point operational requirements and responsibilities, (c) any RF exposure compliance requirements.

Section 15.247(c):

Band-edge Compliance of RF Conducted Emissions

Use the following spectrum analyzer settings:

Span = wide enough to capture the peak level of the emission operating on the channel closest to the bandedge, as well as any modulation products which fall outside of the authorized band of operation

RBW $\geq$ 1% of the span

VBW $\geq$ RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize. Set the marker on the emission at the bandedge, or on the highest modulation product outside of the band, if this level is greater than that at the bandedge. Enable the marker-delta function, then use the marker-to-peak function to move the marker to the peak of the in-band emission. The marker-delta value now displayed must comply with the limit specified in this Section. Submit this plot.

Now, using the same instrument settings, enable the hopping function of the EUT. Allow the trace to stabilize. Follow the same procedure listed above to determine if any spurious emissions caused by the hopping function also comply with the specified limit. Submit this plot.

Spurious RF Conducted Emissions

Use the following spectrum analyzer settings:

Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.

RBW = 100 kHz

VBW $\geq$ RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize. Set the marker on the peak of any spurious emission recorded. The level displayed must comply with the limit specified in this Section. Submit these plots.

Spurious Radiated Emissions

This test is required for any spurious emission or modulation product that falls in a Restricted Band, as defined in Section 15.205. It must be performed with the highest gain of each type of antenna proposed for use with the EUT. Use the following spectrum analyzer settings:

Span = wide enough to fully capture the emission being measured

RBW = 1 MHz for $f \geq 1$ GHz, 100 kHz for $f < 1$ GHz

VBW $\geq$ RBW

Sweep = auto

Detector function = peak

Trace = max hold

Follow the guidelines in ANSI C63.4-1992 with respect to maximizing the emission by rotating the EUT, measuring the emission while the EUT is situated in three orthogonal planes (if appropriate), adjusting the measurement antenna height and polarization, etc. A pre-amp and a high pass filter are required for this test, in order to provide the measuring system with sufficient sensitivity. Allow the trace to stabilize. The peak reading of the emission, after being corrected by the antenna factor, cable loss, pre-amp gain, etc., is the peak field strength, which must comply with the limit specified in Section 15.35(b). Submit this data.

Now set the VBW to 10 Hz, while maintaining all of the other instrument settings. This peak level, once corrected, must comply with the limit specified in Section 15.209. If the dwell time per channel of the hopping signal is less than 100 ms, then the reading obtained with the 10 Hz VBW may be further adjusted by a "duty cycle correction factor", derived from $20\log(\text{dwell time}/100 \text{ ms})$, in an effort to demonstrate compliance with the 15.209 limit. Submit this data.

If the emission on which a radiated measurement must be made is located at the edge of the authorized band of operation, then the alternative "marker-delta" method, listed at the end of this document, may be employed.

Section 15.247(g):

Describe how the EUT complies with the requirement that it be designed to be capable of operating as a true frequency hopping system.

Section 15.247(h):

Describe how the EUT complies with the requirement that it not have the ability to be coordinated with other FHSS systems in an effort to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitters.

ALTERNATIVE TEST PROCEDURES

If antenna conducted tests cannot be performed on this device, radiated tests to show compliance with the peak output power limit specified in Section 15.247(b) and the spurious RF conducted emission limit specified in Section 15.247(c) are acceptable. As stated previously, a pre-amp, and, in the latter case, a high pass filter, are required for the following measurements.

1) Calculate the transmitter's peak power using the following equation:

$$E = \frac{\sqrt{30PG}}{d}$$

Where: E is the measured maximum fundamental field strength in V/m, utilizing a RBW $\geq$ the 20 dB bandwidth of the emission, VBW > RBW, peak detector function. Follow the procedures in C63.4-1992 with respect to maximizing the emission.

G is the numeric gain of the transmitting antenna with reference to an isotropic radiator.

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

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

$$P = \frac{(E*d)^2}{30G}$$

2) To demonstrate compliance with the spurious RF conducted emission requirement of Section 15.247(c), use the following spectrum analyzer settings:

Span = wide enough to fully capture the emission being measured

RBW = 100 kHz

VBW $\geq$ RBW

Sweep = auto

Detector function = peak

Trace = max hold

Measure the field strength of both the fundamental emission and all spurious emissions with these settings. Follow the procedures in C63.4-1992 with respect to maximizing the emissions. The measured field strength of all spurious emissions must be below the measured field strength of the fundamental emission by the amount specified in Section 15.247(c). Note that if the emission falls in a Restricted Band, as defined in Section 15.205, the procedure for measuring spurious radiated emissions, listed above, must be followed.

Marker-Delta Method

In making radiated band-edge measurements, there can be a problem obtaining meaningful data since a measurement instrument that is tuned to a band-edge frequency may also capture some in-band signals when using the resolution bandwidth (RBW) required by measurement procedure ANSI C63.4-1992 (hereafter C63.4). In an effort to compensate for this problem, we have developed the following technique for determining band-edge compliance.

STEP 1) Perform an in-band field strength measurement of the fundamental emission using the RBW and detector function required by C63.4 and our Rules for the frequency being measured. For example, for a device operating in the 902-928 MHz band under Section 15.249, use a 120 kHz RBW with a CISPR QP detector (a peak detector with 100 kHz RBW may alternatively be used). For transmitters operating above 1 GHz, use a 1 MHz RBW, a 1 MHz VBW, and a peak detector (as required by Section 15.35). Repeat the measurement with an average detector (i.e., 1 MHz RBW with 10 Hz VBW). Note: For pulsed emissions, other factors must be included. Please contact the FCC Lab for details if the emission under investigation is pulsed. Also, please note that radiated measurements of the fundamental emission of a transmitter operating under 15.247 are not normally required, but they are necessary in connection with this procedure.

STEP 2) Choose a spectrum analyzer span that encompasses both the peak of the fundamental emission and the band-edge emission under investigation. Set the analyzer RBW to 1% of the total span (but never less than 30 kHz) with a video bandwidth equal to or greater than the RBW. Record the peak levels of the fundamental emission and the relevant band-edge emission (i.e., run several sweeps in peak hold mode). Observe the stored trace and measure the amplitude delta between the peak of the fundamental and the peak of the band-edge emission. This is not a field strength measurement, it is only a relative measurement to determine the amount by which the emission drops at the band-edge relative to the highest fundamental emission level.

STEP 3) Subtract the delta measured in step (2) from the field strengths measured in step (1). The resultant field strengths (CISPR QP, average, or peak, as appropriate) are then used to determine band-edge compliance as required by Section 15.205.

STEP 4) The above "delta" measurement technique may be used for measuring emissions that are up to two "standard" bandwidths away from the band-edge, where a "standard" bandwidth is the bandwidth specified by C63.4 for the frequency being measured. For example, for band-edge measurements in the restricted band that begins at 2483.5 MHz, C63.4 specifies a measurement bandwidth of at least 1 MHz. Therefore you may use the "delta" technique for measuring emissions up to 2 MHz removed from the band-edge. Radiated emissions that are removed by more than two "standard" bandwidths must be measured in the conventional manner.

Questions pertaining to this document may be directed to Gregory Czumak, phone: (301) 362-3052, e-mail: GCZUMAK@FCC.GOV

The Equipment Under Test (EUT) is configured in a typical user arrangement in accordance with the manufacturer's instructions. A cable is connected to each available port and either terminated with a peripheral into it's characteristic impedance or left unterminated. When appropriate, the cables are manually manipulated with respect to each other to obtain maximum emissions from the unit.

CONDUCTED EMISSIONS

The final level, expressed in dBμV, is arrived at by taking the reading directly from the EMI receiver. This level is compared directly to the applicable limit.

To convert between dBμV and μV, the following conversions apply:

- $\text{dB}\mu\text{V} = 20(\log \mu\text{V})$
- $\mu\text{V} = \text{Inverse log}(\text{dB}\mu\text{V}/20)$

RADIATED EMISSIONS

The final level, expressed in dBμV/m, is arrived at by taking the reading from the spectrum analyzer (Level dBμV) and adding the antenna correction factor and cable loss factor (Factor dB) to it. This result then has the applicable limit subtracted from it to provide the Delta which gives the tabular data as shown in the data sheets in Attachment B. The amplifier gain is automatically accounted for by using an analyzer offset.

Example: At a Test Frequency of 30 MHz, with a peak reading on the spectrum analyzer or measuring receiver of 14 dBmV:

Measured Level	+	Transducer & Cable Loss factor	=	Corrected Reading	Specification Limit	-	Corrected Reading	=	Delta Specification
(dBμV)		(dB)		(dBμV/m)	(dBμV/m)		(dBμV/m)		
14.0		14.9		28.9	40.0		28.9		-11.1

Conducted emissions on the 50 Hz and/or 60 Hz power interface of the EUT are measured in the frequency range of 150 kHz to 30 MHz. The measurements are performed using a receiver, which has CISPR characteristic bandwidth and quasi-peak detection, and a Line Impedance Stabilization Network (LISN), with 50 Ω /50 μ H (CISPR 16) characteristics. Table top equipment is placed on a non-conducting table 80 centimeters above the floor and is positioned 40 centimeters from the vertical ground plane (wall) of the screen room. In some cases, a pre-scan using a spectrum analyzer is initially performed on the units comprising the system under test to locate the highest emissions. If the minimum passing margin appears to be less than 20 dB with a peak mode measurement, the emissions are re-measured using a tuned receiver or spectrum analyzer with quasi-peak and average detection and recorded on the data sheets.

Radiated Emissions

Radiated emissions from the EUT are measured in the frequency range of 30 to 22GHz using a spectrum analyzer and appropriate broadband linearly polarized antennas. Measurements between 30 MHz and 1000 MHz are made with 120 kHz/6 dB bandwidth and quasi-peak detection and measurements above 1000 MHz are made with a 1 MHz/6 dB bandwidth and peak detection. Table top equipment is placed on a 1.0 X 1.5 meter non-conducting table 80 centimeters above the ground plane. Floor standing equipment is placed directly on the turntable/ground plane. Interface cables that are closer than 40 centimeters to the ground plane are bundled in the center in a serpentine fashion so they are at least 40 centimeters from the ground plane. Cables to simulators/testers (if used in this test) are routed through the center of the table and to a screen room located outside the test area. The antenna is positioned 3, 10 or 30 meters horizontally from the EUT. To locate maximum emissions from the test sample the antenna is varied in height from 1 to 4 meters, measurement scans are made with both horizontal and vertical antenna polarizations and the EUT are rotated 360 degrees.

Conducted Emissions Diagram:

