LS Research, LLC
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ENGINEERING TEST REPORT # 308337B Module TX
ENGINEERING Job # R-425

Compliance Testing of:
Russound Module 2.4 GHz Radio
Model # RFR-E5

Test Date(s):
July 22-30, 2008; January 12-29, 2009

Prepared For:
Russound
Attn.: Allan Dion
5 Forbes Road
Newmarket, NH 03857

In accordance with:
Federal Communications Commission (FCC)
Part 15, Subpart C, Section 15.247
Digital Modulation Transmitters (DTS) Operating in the
Frequency Band 2400 MHz – 2483.5 MHz

This Test Report is issued under the Authority of:
Kenneth L. Boston, PE, Sr. EMC Engineer

Signature:  Date: Feb. 9, 2009

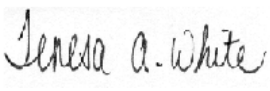
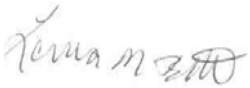
Test Report Prepared by:	**Tested by:**
Teresa A. White, Quality Manager	Laura Bott, EMC Engineer
Signature: 	Signature: 
Date: Feb. 9, 2009	Date: Feb. 9, 2009

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EXHIBIT 1. INTRODUCTION

1.1 SCOPE

References:	FCC Part 15, Subpart C, Section 15.247
Title:	Telecommunication – Code of Federal Regulations, CFR 47, Part 15
Purpose of Test:	To gain FCC Certification Authorization for Digital Modulation Transmitters operating in the Frequency Band of 2400 MHz – 2483.5 MHz
Test Procedures:	Both conducted and radiated emissions measurements were performed in accordance with American National Standards Institute ANSI C63.4 – American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment from 9 kHz to 40 GHz.
Environmental Classification:	• Commercial, Industrial or Business • Residential

1.2 NORMATIVE REFERENCES

Publication	Year	Title
47 CFR, Parts 0-15 (FCC)	2005	Code of Federal Regulations - Telecommunications
ANSI C63.4	2003	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
CISPR 16-1-1	2003	Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-1: Measuring Apparatus.
CISPR 16-2-1	2003	Specification for radio disturbance and immunity measuring apparatus and methods. Part 201: Conducted disturbance measurement.
FCC Public Notice DA 00-1407	2000	Part 15 Unlicensed Modular Transmitter Approval
FCC ET Docket No. 99-231	2002	Amendment to FCC Part 15 of the Commission's Rules Regarding Spread Spectrum Devices.
FCC Procedures	2005, 03-23	Measurement of Digital Transmission Systems operating under Section 15.247.

1.3 LS Research, LLC TEST FACILITY

LS Research, LLC is accredited by A2LA (American Association for Laboratory Accreditation) to conform to ISO/IEC 17025, 2005 “General Requirements for the Competence of Calibration and Testing Laboratories”.

LS Research, LLC’s scope of accreditation includes all test methods listed herein, unless otherwise noted. A copy of the accreditation may be accessed on our web site: www.lsr.com. Accreditation status can be verified at A2LA’s web site: www.a2la2.net.

1.4 LOCATION OF TESTING

All testing was performed at LS Research, LLC, W66 N220 Commerce Court, Cedarburg, Wisconsin, 53012 USA, utilizing the facilities listed below, unless otherwise noted.

List of Facilities Located at LS Research, LLC:

- Compact Chamber
- Semi-Anechoic Chamber
- Open Area Test Site (OATS)

1.5 TEST EQUIPMENT UTILIZED

A complete list of equipment utilized in testing is provided in Appendix A of this test report. Calibration dates are indicated in Appendix A. All test equipment is calibrated in accordance with A2LA standards.

EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1 CLIENT INFORMATION

Manufacturer Name:	**Russound**
Address:	**5 Forbes Road** **Newmarket, NH 03857**
Contact Person:	**Allan Dion** **603.292.0588** **alland@russound.com**

2.2 EQUIPMENT UNDER TEST (EUT) INFORMATION

The following information has been supplied by the applicant.

Product Name:	Russound Remote Control
Model Number:	RFR-E5
Serial Number:	n/a

2.3 ASSOCIATED ANTENNA DESCRIPTION

Inverted F non-detachable trace antenna with a calculated gain of 5.03 dBi, which was determined using conducted output power and peak fundamental measurements taken over a ground plane.

2.4 EUT'S TECHNICAL SPECIFICATIONS

Additional Information:

Frequency Range (in MHz)	2400-2483.5
RF Power in Watts	0.094 Watts
Conducted Output Power (in dBm)	19.74 dBm
Field Strength (and at what distance)	120.0 dBµV/m @ 3 meters (2480 MHz)
Occupied Bandwidth (99% BW)	2658 kHz
Type of Modulation	O-QPSK
Emission Designator	G1D1M608
EIRP (in mW)	299.92 mW
Transmitter Spurious (worst case)	60.1 dBµV/m at 1 meter (12200 MHz)
Frequency Tolerance %, Hz, ppm	100 ppm
Microprocessor Model # (if applicable)	XAP2b
Antenna Information	
Detachable/non-detachable	Non-detachable
Type	Inverted F
Gain (in dBi)	5.03 dBi
EUT will be operated under FCC Rule Part(s)	15.247
Modular Filing	☐ Yes ☒ No

RF Technical Information:

Type of Evaluation (check one)		SAR Evaluation: Device Used in the Vicinity of the Human Head
		SAR Evaluation: Body-worn Device
	x	RF Evaluation

If RF Evaluation checked above, test engineer to complete the following:

- Evaluated against exposure limits: ☒ General Public Use ☐ Controlled Use
- Duty Cycle used in evaluation: 7 %
- Standard used for evaluation: OCT 65
- Measurement Distance: 3 m
- RF Value: 0.00596 ☐ V/m ☐ A/m ☒ W/m^2
  ☐ Measured ☐ Computed ☒ Calculated

2.5 PRODUCT DESCRIPTION

The Russound RF remote is the end-users wireless interface to the Russound multi-zone controller (wired). The radio on board is an 802.15.4/Zigbee radio based upon the Ember EM250 transceiver operating in the 2.4 GHz ISM band. The modulation is standard IEEE 802.15.4 format, O-QPSK with half sine filtering operating at a chip rate of 2 Mcps. The effective bit rate is 250 kbps. The modulation data is generated by the EM 260 transceiver itself and spread using 16 orthogonal sequences. 16 channels are used at 5 MHz steps between 2405 and 2480 MHz. The RF remote is powered by a regulated 3.3 V supply sourced from the onboard batteries. A virtual serial port is provided to program the radio into the test modes necessary for testing. A single on board PCB antenna is used.

PHOTO (Optional)

External View

Internal View
(with radio module)

EXHIBIT 3. EUT OPERATING CONDITIONS & CONFIGURATIONS DURING TESTS

3.1 CLIMATE TEST CONDITIONS

Temperature:	20-25°C
Humidity:	30-60%
Pressure:	86-106 kPa

3.2 APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC Paragraph	Test Requirements	Compliance (yes/no)
15.207	Power Line Conducted Emissions Measurements	N/A
15.247(a)(2)	6 dB Bandwidth of a Digital Modulation System	Yes
15.247(b) & 1.1310	Maximum Output Power	Yes
15.247(i), 1.1307, 1.1310, 2.1091 & 2.1093	RF Exposure Limit	Yes
15.247(c)	RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
15.247(d)	Transmitted Power Spectral Density of a Digital Modulation System	Yes
15.247(c), 15.209 & 15.205	Transmitter Radiated Emissions	Yes
The digital circuit portion of the EUT has been tested and verified to comply with FCC Part 15, Subpart B, Class B Digital Devices and the associated Radio Receiver has also been tested and found to comply with Part 15, Subpart B – Radio Receivers. The Receiver Test Report is available upon request.		

3.3 MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

☐ **None** ☒ **Yes (explain below)**

In order to meet band edge compliance, the following channel power settings must be used:

Channel f (2480 MHz) : -25 dBm
Channel e (2475 MHz): -e dBm

3.4 DEVIATIONS & EXCLUSIONS FROM TEST SPECIFICATIONS

☒ **None** ☐ **Yes (explain below)**

EXHIBIT 4. DECLARATION OF CONFORMITY

The EUT was found to meet the requirements as described within the specification of FCC Title 47, CFR Part 15.247, and Industry Canada RSS-210 Issue 7 (2007), Section Annex 8 (section 8.2) for a Digital Spread Spectrum (DTS) Transmitter.

If some emissions are seen to be within 3 dB of their respective limits:
As these levels are within the tolerances of the test equipment and site employed, there is a possibility that this unit, or a similar unit selected out of production may not meet the required limit specification if tested by another agency.

LS Research, LLC certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specifications. The results in this Test Report apply only to the item(s) tested on the above-specified dates. Any modifications made to the EUT subsequent to the indicated test date(s) will invalidate the data herein, and void this certification.

EXHIBIT 5. RADIATED EMISSIONS TEST

5.1 Test Setup

The test setup was assembled in accordance with Title 47, CFR FCC Part 15 and ANSI C63.4-2003. The EUT was placed on an 80cm high non-conductive pedestal, centered on a flush mounted 2-meter diameter turntable inside a 3 meter Semi-Anechoic, FCC listed Chamber, where the measurement antenna is 3 meters from the EUT radiating element.

The EUT was tested in continuous transmit mode. Power was supplied to the EUT by two batteries. The unit has the capability to operate on 16 channels, controllable via a pc interface using hyperterminal.

The radiated emissions limits for unintentional radiators, denoted in FCC §15.109 apply at a 3 meter distance. Measurements above 4 GHz were performed at a 1.0 meter separation distance. The calculations to determine these limits are detailed in the following pages. Please refer to Appendix A for a complete list of test equipment. The test sample was operated on one of three (3) standard channels: low (2405 MHz), middle (2440 MHz) and high (2480 MHz) to comply with FCC § 15.35.

5.2 Test Procedure

Radiated Emissions measurements from 30 - 4000 MHz were performed a 3 meter Semi-Anechoic, FCC listed Chamber and measurements from 4000-25000 MHz were taken at a 1 meter separation distance in an FCC Listed mini chamber. The radiated RF emission levels were manually noted at discrete turntable azimuths and measurement antenna heights, corresponding to peak emission levels at various frequencies. A Biconical Antenna was used to measure emissions from 30 MHz to 300 MHz, and a Log Periodic Antenna was used to measure emissions from 300 MHz to 1000 MHz. A Double-Ridged Waveguide Horn Antenna was used from 1 GHz to 10 GHz. The maximum radiated RF emissions were found by rotating the EUT 360°, and raising and lowering the antenna between 1 and 4 meters, using both horizontal and vertical antenna polarities.

The EUT was rotated along three orthogonal axes during the investigations to find the highest emission levels.

5.3 Test Equipment Utilized

A list of the test equipment and antennas utilized for the Radiated Emissions test can be found in Appendix A. This list includes calibration information and equipment descriptions. All equipment is calibrated and used according to the operation manuals supplied by the manufacturers. All calibrations of the antennas used were performed at an N.I.S.T. traceable site. In addition, the Connecting Cables were measured for losses using a calibrated Signal Generator and a HP 8546A EMI Receiver. The resulting correction factors and the cable loss factors from these calibrations were entered into the HP 8546A EMI Receiver database. As a result, the data taken from the HP 8546A EMI Receiver accounts for the antenna correction factor as well as cable loss or other corrections, and can therefore be entered into the database as a corrected meter reading. The HP 8546A EMI Receiver was operated with a resolution bandwidth of 120 kHz for measurements below 1 GHz (video bandwidth of 300 kHz), and a bandwidth of 1 MHz for measurements above 1 GHz (video bandwidth of 1 MHz. From 4 GHz to 18 GHz, an HP E4407B Spectrum Analyzer and an EMCO Horn Antenna were used. From 18 GHz to 25 GHz, the HP E4407B Spectrum Analyzer with a standard gain horn, and preamp were used.

Test Equipment List

Test Equipment	Manufacturer	Model No.	Serial No.
EMI Receiver	HP	8546A	3617A00320
EMI Receiver Pre-Select.	HP	85460A	3448A00296
Spectrum Analyzer	Agilent	E4446A	US45300564
Log Periodic Antenna	EMCO	93146	9701-4855
Horn Antenna	EMCO	3115	6907
Bicon Antenna	EMCO	93110B	9702-2918
Pre-Amp	Adv. Microwave	WLA612	1145A04094
Horn Antenna – Std. Gain	EMCO	3160-09	9809-1120

5.4 Test Results

The EUT was found to meet the Radiated Emissions requirements of Title 47 CFR, FCC Part 15.247 for a DTS transmitter [Canada RSS-210 Issue 7 (2007), Annex 8 (section 8.2). The frequencies with significant RF signal strength were recorded and plotted as shown in the Data Charts and Graphs.

5.5 CALCULATION OF RADIATED EMISSIONS LIMITS

The maximum peak output power of an intentional radiator in the 2400-2483.5 MHz band, as specified in Title 47 CFR 15.247 (b)(3), is 1 Watt. The harmonic and spurious RF emissions, measured in any 100 kHz bandwidth, as specified in 15.247 (d), shall be at least 20 dB below the measured power of the desired signal, and must also meet the requirements described in 15.205(c).

The following table depicts the general radiated emission limits above 30 MHz. These limits are obtained from Title 47 CFR, Part 15.209, for radiated emissions measurements. These limits were applied to any signals found in the 15.205 restricted bands.

Frequency (MHz)	3 m Limit μV/m	3 m Limit (dBμV/m)	1 m Limit (dBμV/m)
30-88	100	40.0	-
88-216	150	43.5	-
216-960	200	46.0	-
960-24,000	500	54.0	63.5

Sample conversion from field strength μV/m to dBμV/m:
$dB\mu V/m = 20 \log_{10} (100)$
= 40 dBμV/m (from 30-88 MHz)

For measurements made at 1.0 meter, a 9.5 dB correction has been invoked.

960 MHz to 10,000 MHz
500μV/m or 54.0 dB/μV/m at 3 meters
54.0 + 9.5 = 63.5 dB/μV/m at 1 meter

For measurements made at 0.3 meter, a 20 dB correction has been invoked.

960 MHz to 10,000 MHz
500μV/m or 54.0 dB/μV/m at 3 meters
54.0 + 20 = 74 dB/μV/m at 0.3 meters

5.6 RADIATED EMISSIONS DATA CHART

3 Meter Measurements of Electromagnetic Radiated Emissions
Test Standard: 47CFR, Part 15.205 and 15.247(DTS)
Frequency Range Inspected: 30 MHz to 25000 MHz

Manufacturer:	Russound						
Date(s) of Test:	7/22-28, 2008						
Test Engineer(s):	Laura Bott						
Voltage:	3.3 VDC						
Operation Mode:	Normal, continuous transmit, modulated mode						
Environmental Conditions in the Lab:	Temperature: 20 – 25˚C Relative Humidity: 30 – 60 %						
EUT Power:		Single Phase ___VAC		3 Phase ___VAC			
	x	Battery		Other: bench power supply			
EUT Placement:	x	80cm non-conductive table		10cm Spacers			
EUT Test Location:	x	3 Meter Semi-Anechoic FCC Listed Chamber		3/10m OATS			
Measurements:		Pre-Compliance		Preliminary	x	Final	
Detectors Used:	x	Peak	x	Quasi-Peak	x	Average	

The following tables depict the level of significant spurious radiated RF emissions found:

Fundamentals:

Frequency (MHz)	Height (m)	Azimuth (degree)	Average Reading (dBµV/m)	FCC 15.209 Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
2405	1.05	16	118.7	125	6.3	Horizontal	Flat
2440	1.13	194	118.3	125	6.7	Horizontal	Side
2480	1.04	335	120.0	125	5.0	Horizontal	Vertical

RADIATED EMISSIONS DATA CHART

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 0:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Peak with relaxation (dBµV/m)	FCC 15.209 Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
4810	1.00	174	74.46	54.46	63.5	9.0423	Vertical	Vertical
7215	1.05	210	58.36	38.36	108.2	54.9383	Horizontal	Side
9620	1.04	227	61.88	41.88	108.2	51.4193	Horizontal	Vertical
12025	1.10	195	70.22	50.22	63.5	13.2813	Vertical	Side
14430	1.00	199	66.61	46.61	108.2	46.6863	Vertical	Side
16835	1.06	75	67.38	47.38	108.2	45.9213	Horizontal	Vertical
19240	1.00	130	74.02	54.02	74	19.98	Horizontal	Vertical
21645	1.00	174	73.57	53.57	117.7	49.73	Vertical	Vertical
24050	1.00	170	70.04	50.04	117.7	53.26	Vertical	Vertical

RADIATED EMISSIONS DATA CHART *(continued)*

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 7:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Peak Reading (dBµV/m)	FCC 15.209 Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
4880	1.00	104	71.91	51.91	63.5	11.5903	Horizontal	Side
7320	1.15	108	62.49	42.49	63.5	21.0103	Horizontal	Vertical
9760	1.00	227	68.32	48.32	107.8	42.4803	Horizontal	Vertical
12200	1.05	165	73.79	53.79	63.5	9.7123	Vertical	Side
14640	1.03	226	66.30	46.30	107.8	44.4993	Vertical	Side
17080	1.02	138	69.55	49.55	107.8	41.2473	Horizontal	Vertical
19520	1.00	181	76.07	56.07	74	17.93	Horizontal	Vertical
21960	1.00	202	75.87	55.87	117.3	44.93	Vertical	Vertical
24400	1.00	217	71.44	51.44	117.3	49.36	Vertical	Vertical

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel f:

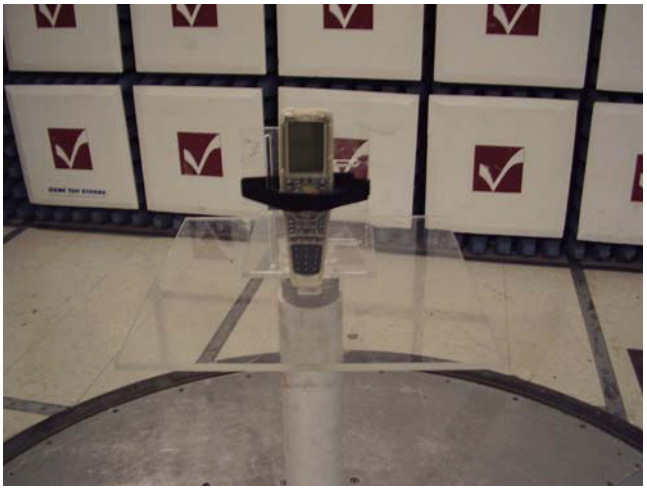
Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Peak Reading (dBµV/m)	FCC 15.209 Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
4960	1.00	105	71.90	51.90	63.5	11.6	Horizontal	Side
7440	1.03	39	63.89	43.89	63.5	19.61	Vertical	Flat
9920	1.00	210	74.96	54.96	110	36.14	Horizontal	Side
12400	1.00	152	77.59	57.59	63.5	5.91	Horizontal	Side
14880	1.00	225	67.12	47.12	110	43.98	Vertical	Side
17360	1.17	155	72.51	52.51	110	38.59	Horizontal	Vertical
19840	1.00	133	75.05	55.05	74	18.95	Horizontal	Vertical
22320	1.00	208	76.08	56.08	74	17.92	Vertical	Vertical
24800	1.00	207	70.28	50.28	119.5	50.82	Vertical	Vertical

Notes:

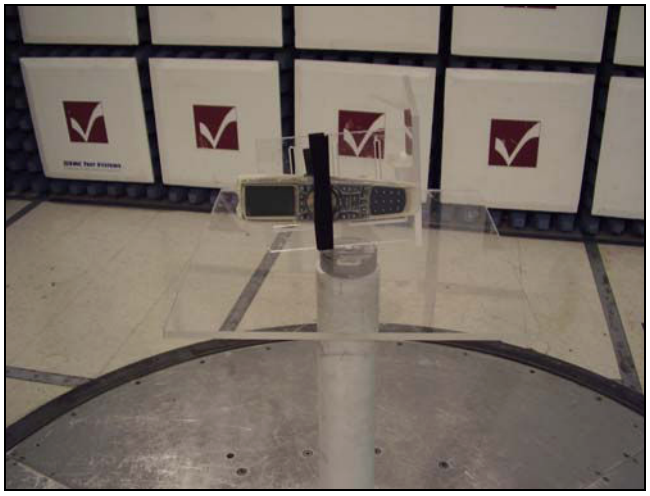
1) A Quasi-Peak Detector was used in measurements below 1 GHz, and a Peak as well as an Average Detector was used in measurements above 1 GHz. Only the results from the peak detector with relaxation applied are published in the table above.
2) Measurements above 4 GHz were made at 1 meters of separation from the EUT, and at 0.3 m separation for frequencies between 18 – 25 GHz.
3) For measurements of the fundamental power, because of spectral bandwidth, the receiver was set to RBW=VBW=3 MHz.
4) A relaxation of the limit is invoked based on the average duty factor of the transmitter on-air-time. Justification appears in Appendix B. The measurements have been recalculated and reduced by 20 dB as justified by the averaging factor.

5.7 Test Setup Photo(s) – Radiated Emissions Test

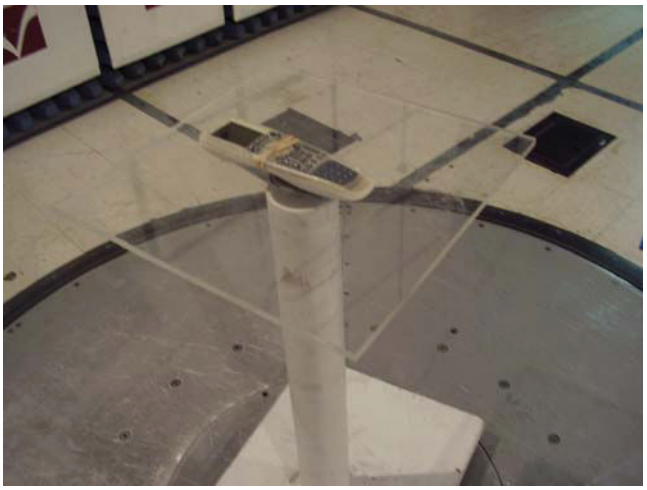
Vertical Orientation



Side Orientation



Flat Orientation

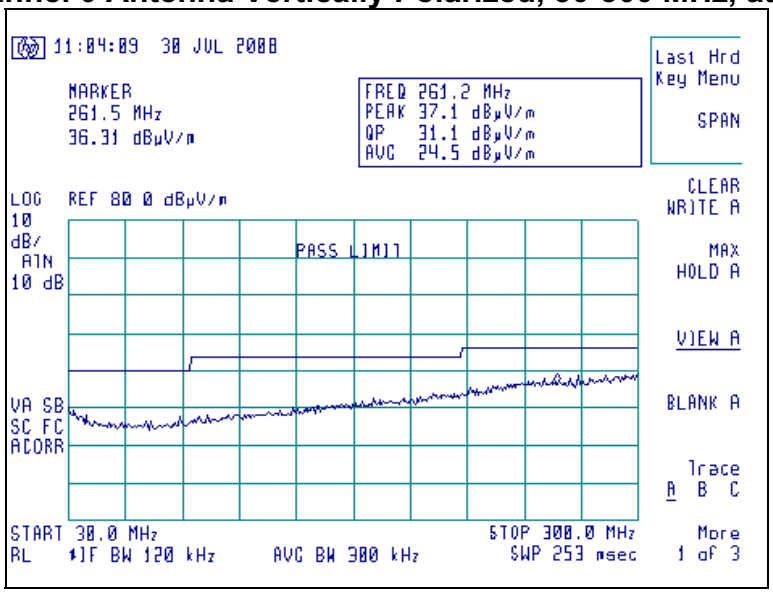


5.8 Screen Captures - Radiated Emissions Testing

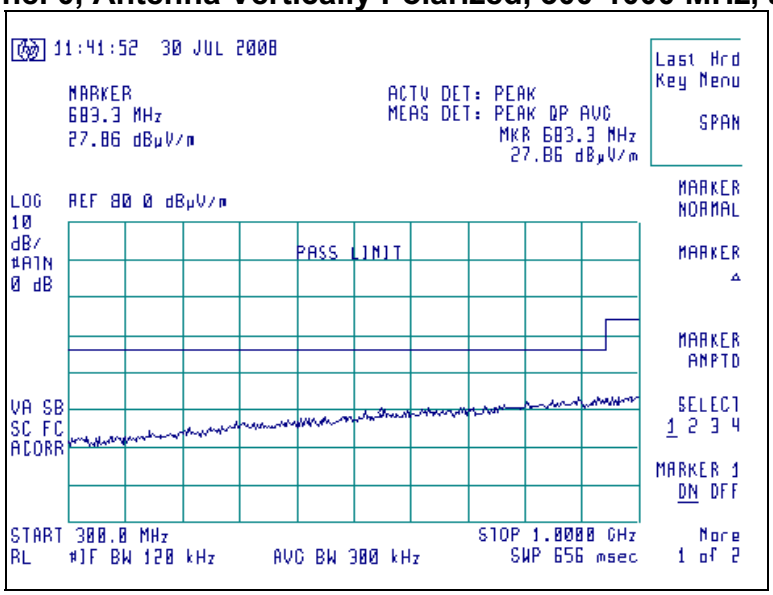
These screen captures represent Peak Emissions. For radiated emission measurements, a Quasi-Peak detector function is utilized when measuring frequencies below 1 GHz, and an Average detector function is utilized when measuring frequencies above 1 GHz.

The signature scans shown here are from worst-case emissions, as measured on channels 0, 7, or F, with the sense antenna both in vertical and horizontal polarity for worst case presentations.

Channel 0 Antenna Vertically Polarized, 30-300 MHz, at 3m

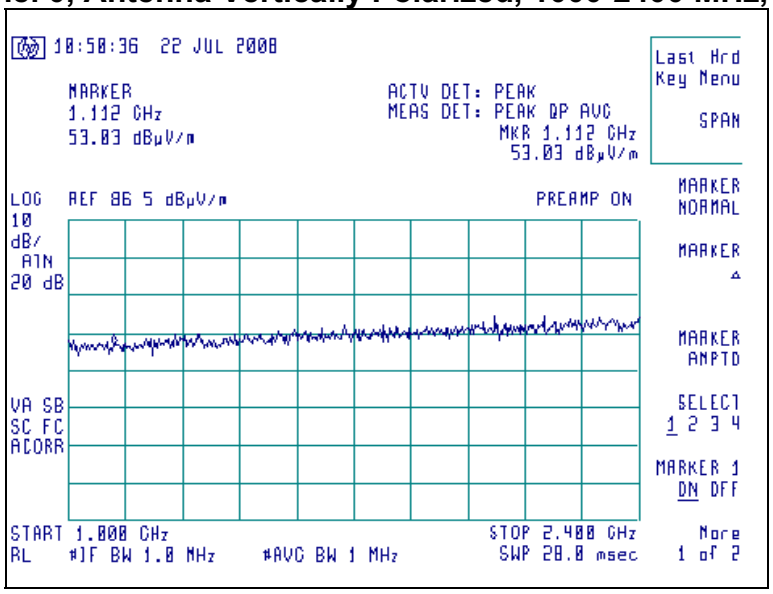


Channel 0, Antenna Vertically Polarized, 300-1000 MHz, at 3m

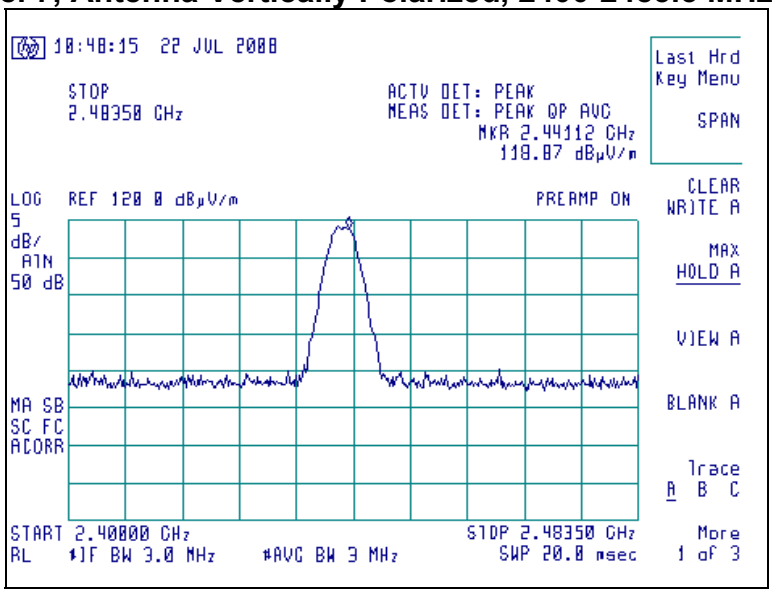


Screen Captures - Radiated Emissions Testing ***(continued)***

Channel 0, Antenna Vertically Polarized, 1000-2400 MHz, at 3m

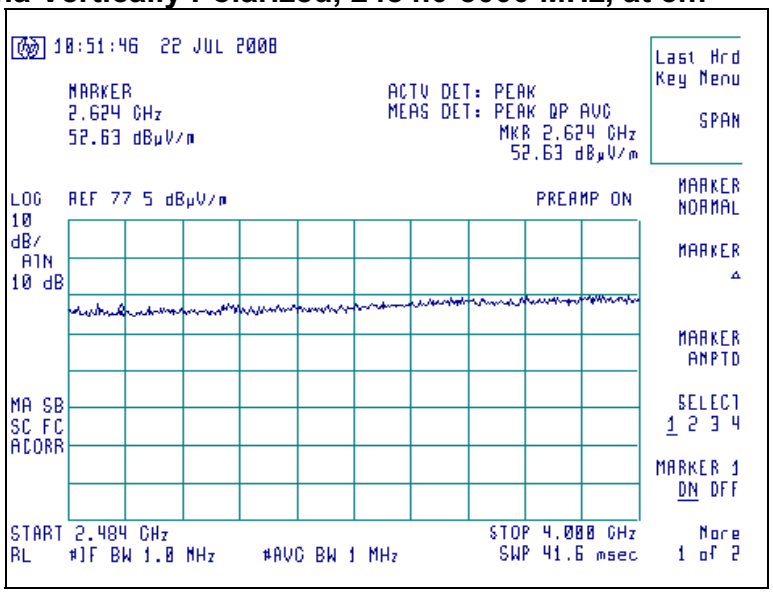


Channel 7, Antenna Vertically Polarized, 2400-2483.5 MHz, at 3m

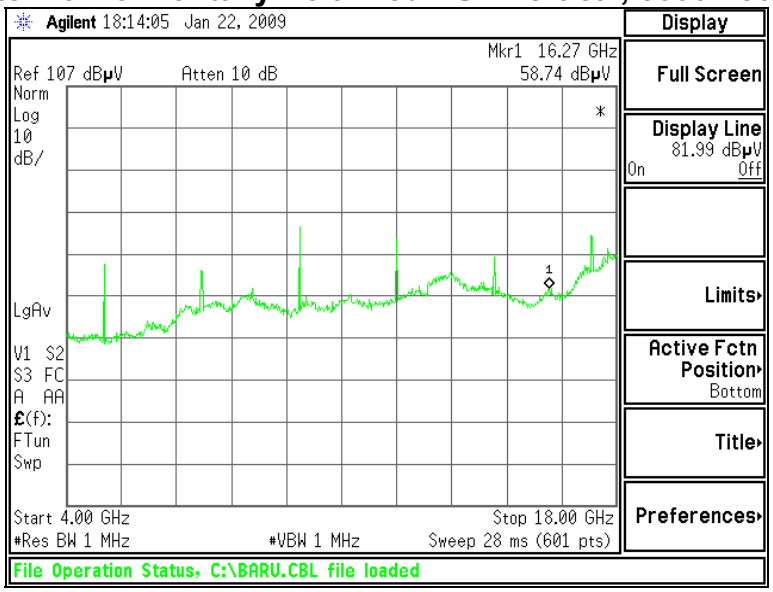


Screen Captures - Radiated Emissions Testing *(continued)*

Channel f, Antenna Vertically Polarized, 2484.0-5000 MHz, at 3m



Channel f, Antenna Horizontally Polarized EUT Vertical, 5000-18000 MHz, at 1m



Channel 0, Antenna Horizontally Polarized, EUT Vertical 18000-25000 MHz, at 30cm

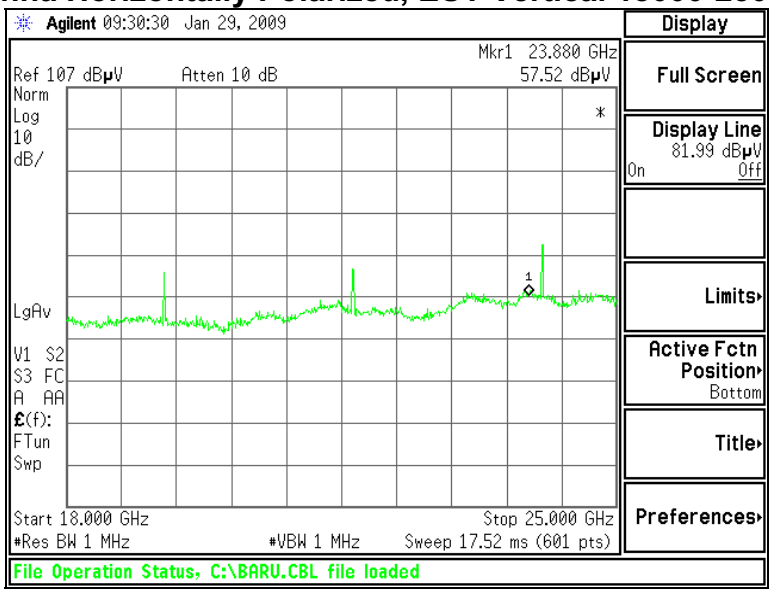


EXHIBIT 7. OCCUPIED BANDWIDTH: 15.247(a)(2)

7.1 Limits

For a Digital Modulation System, the 6 dB bandwidth shall be at least 500 kHz.

7.2 Method of Measurements

Refer to ANSI C63.4 and FCC Procedures (March 23, 2005) for Digital Transmission Systems operating under 15.247.

The transmitter output was connected to the Spectrum Analyzer. The bandwidth of the fundamental frequency was measured with the Spectrum Analyzer using 100 kHz RBW and VBW=300 kHz.

For this portion of the tests, a direct measurement of the transmitted signal was performed at the antenna port of the EUT, via a cable connection to the HP E4446A spectrum analyzer. An attenuator was placed in series with the cable to protect the spectrum analyzer. Correction factors for the RF cable were loaded onto the spectrum analyzer and the loss from the attenuator was added on the analyzer as gain offset.

The EUT was configured to run in a continuous transmit, modulated mode. The spectrum analyzer was used in peak-hold mode while measurements were made, as presented in the chart below.

Test Data

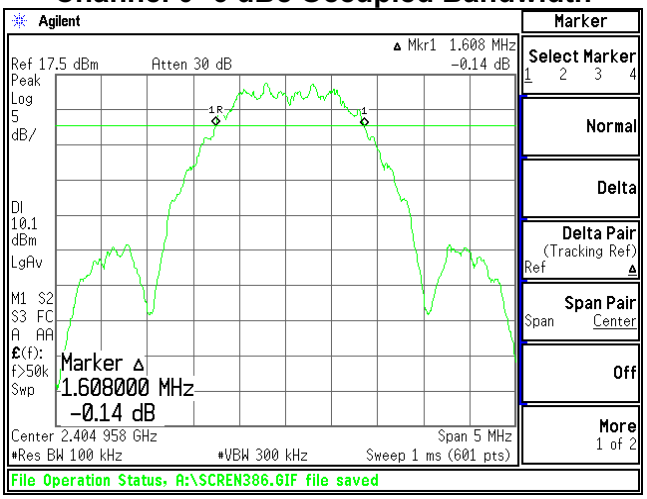
Channel	Center Frequency (MHz)	Measured -6 dBc Occupied Bandwidth (kHz)	Minimum -6 dBc Limit (kHz)	Measured -20 dBc Occupied Bandwidth (kHz)
0	2405	1608	500	2658
7	2440	1600	500	2658
F	2480	1600	500	2658

7.3 Test Equipment List

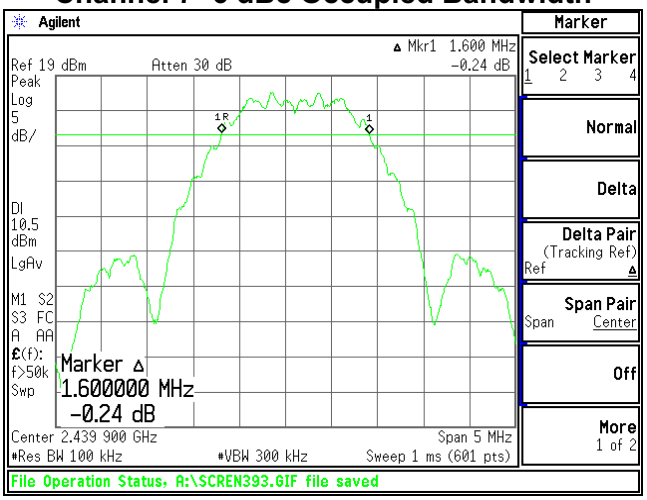
Test Equipment	Manufacturer	Model No.	Serial No.
Spectrum Analyzer	Agilent	E4407B	US39160256
Spectrum Analyzer	Agilent	E4446A	US45300564

7.4 Screen Captures - OCCUPIED BANDWIDTH

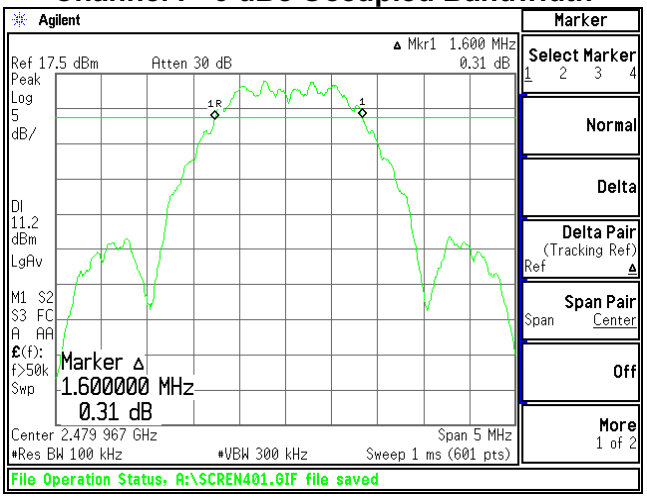
Channel 0 -6 dBc Occupied Bandwidth



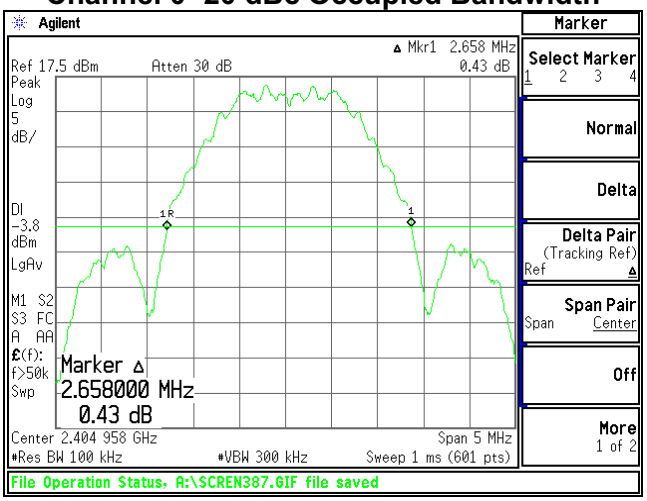
Channel 7 -6 dBc Occupied Bandwidth



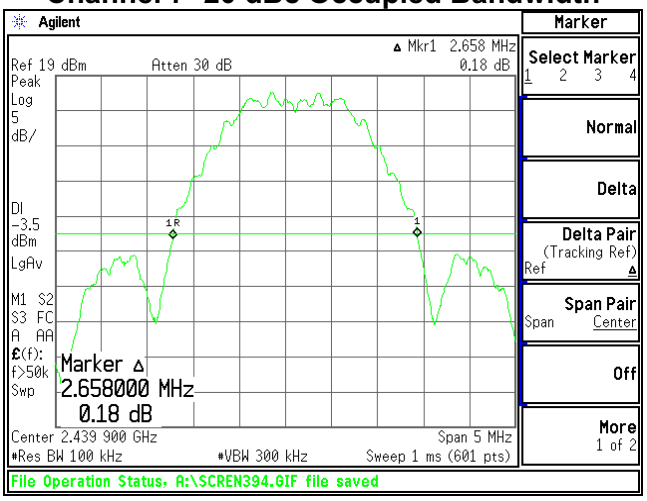
Channel F -6 dBc Occupied Bandwidth



Channel 0 -20 dBc Occupied Bandwidth



Channel 7 -20 dBc Occupied Bandwidth



Channel F -20 dBc Occupied Bandwidth

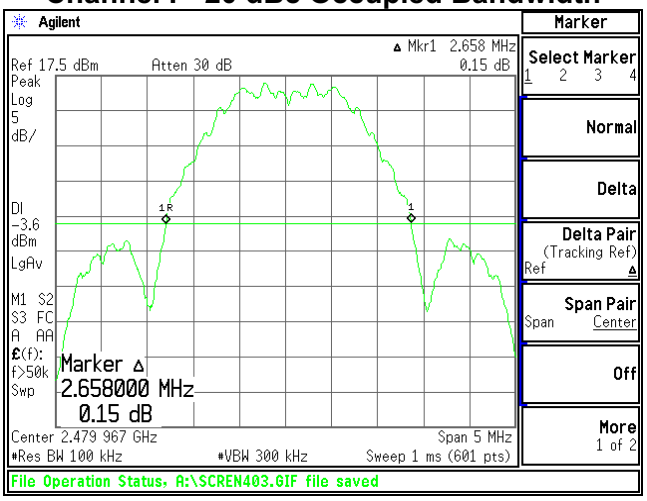


EXHIBIT 8. BAND-EDGE MEASUREMENTS

8.1 Method of Measurements

FCC 15.209(b) and 15.247(d) require a measurement of spurious emission levels to be at least 20 dB lower than the fundamental emission level, in particular at the Band-Edges where the intentional radiator operates. The following screen captures demonstrate compliance of the intentional radiator at the 2400-2483.5 MHz Band-Edges. The EUT was operated in continuous transmit mode with continuous modulation, with internally generated data as the modulating source. The EUT was operated at the lowest channel for the investigation of the lower Band-Edge, and at the highest channel for the investigation of the higher Band-Edge.

Lower Band-Edge Limit,

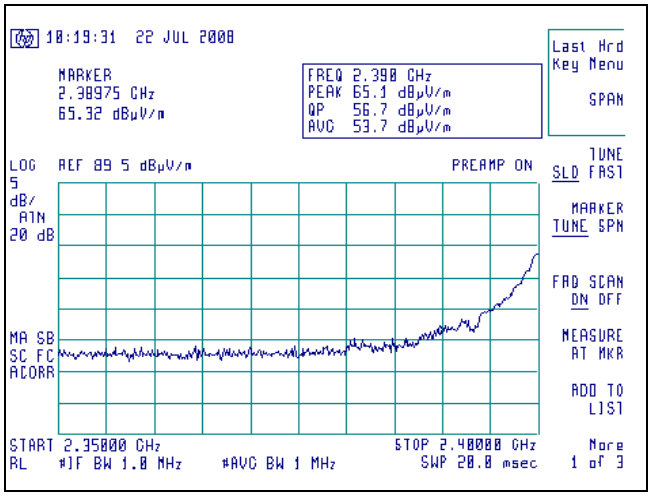
2.39 GHz = +54 dBµV/m at 3m

2.40 GHz = -20 dBc with respect to the peak fundamental radiated emissions.

Upper Band-Edge Limi,

2.4835 GHz =e + 54 dBµV/m at 3m.

Screen Capture Demonstrating Compliance at the Lower Band-Edge



Screen Capture Demonstrating Compliance at the Higher Band-Edge

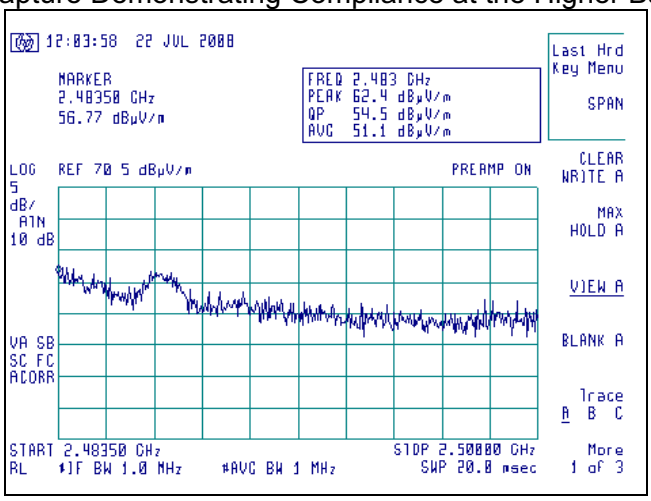


EXHIBIT 9. POWER OUTPUT (CONDUCTED): 15.247(b)

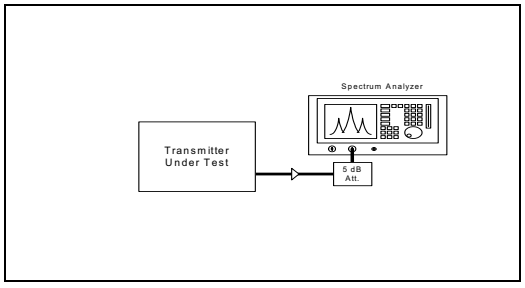
9.1 Method of Measurements

The conducted RF output power of the EUT was measured at the antenna port using a short RF cable along with an attenuator as protection for the spectrum analyzer. Correction factors for the RF cable were loaded onto the spectrum analyzer and the loss from the attenuator was added on the analyzer as gain offset. The unit was configured to run in a continuous transmit mode. The spectrum analyzer was used with resolution and video bandwidths set to 3 MHz, and a span of 5 MHz, with measurements from a peak detector presented in the chart below.

9.2 Test Data

Channel	Center Frequency (MHz)	Measured Power (dBm)	Limit (dBm)	Margin (dB)	Calculated EIRP (dBm)	EIRP Limit (dBm)	Calculated EIRP (mw)
0	2405	19.44	30	10.56	24.47	36.0	279.90
7	2440	19.72	30	10.28	24.75	36.0	298.54
F	2480	19.74	30	10.26	24.77	36.0	299.92

(1) EIRP Calculation:
EIRP = (Peak power at antenna terminal in dBm) + (EUT Antenna gain in dBi)



Rated RF power output (in watts): 0.1 watts

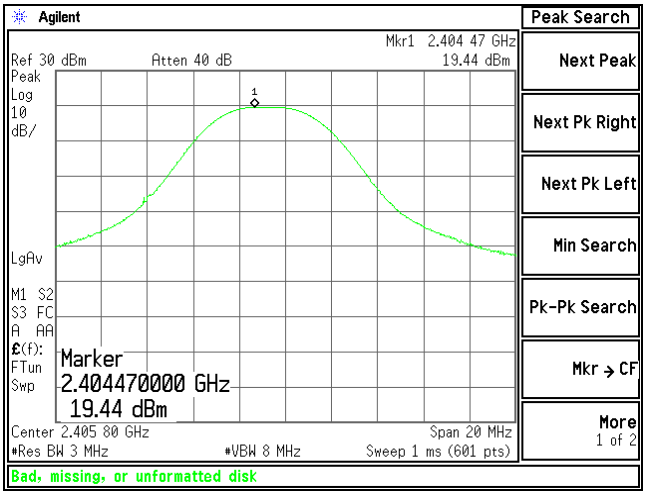
Measured RF Power Output (in Watts): 0.094 watts
Declared RF Power Output (in Watts): 0.1 watts

9.3 Test Equipment List

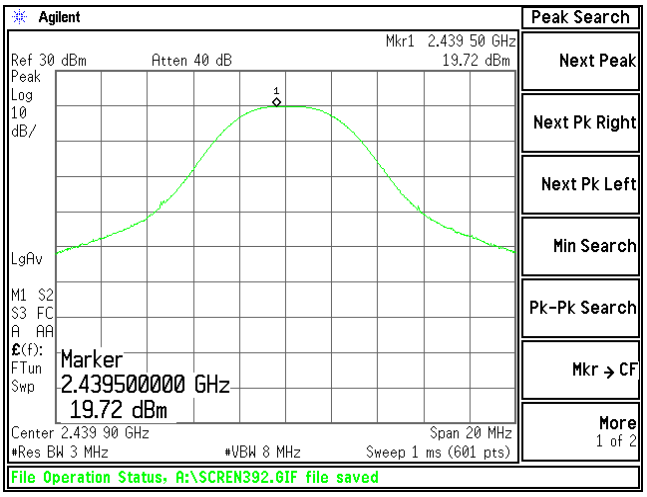
Test Equipment	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Agilent	E4446A	US45300564	To 44 GHz

9.4 Screen Captures – Power Output (Conducted)

Channel 0: 2405 MHz



Channel 7: 2440 MHz



Channel F: 2480 MHz

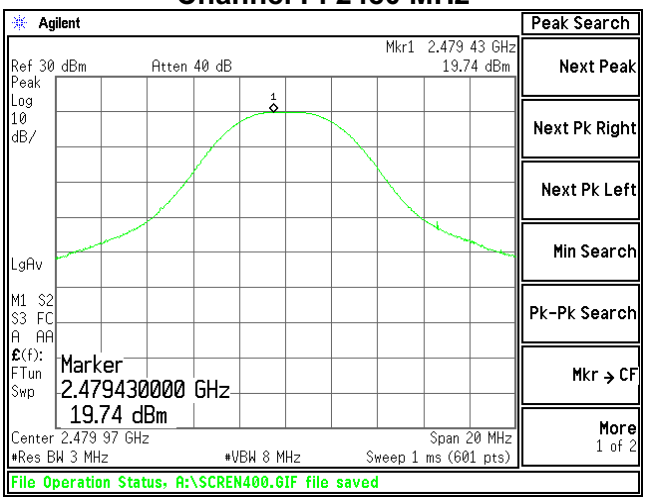


EXHIBIT 10. POWER SPECTRAL DENSITY: 15.247(e)

10.1 Limits

For digitally modulate systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

In accordance with FCC Part 15.247(e), the peak power spectral density should not exceed +8 dBm in any 3 kHz band. This measurement was performed along with the conducted power output readings performed as described in previous sections. The peak output frequency for each representative frequency was scanned, with a narrow bandwidth, and reduced sweep, and a power density measurement was performed using the utility built into the HP Analyzer. The resultant density was then corrected to a 3 kHz bandwidth..

10.2 Test Equipment List

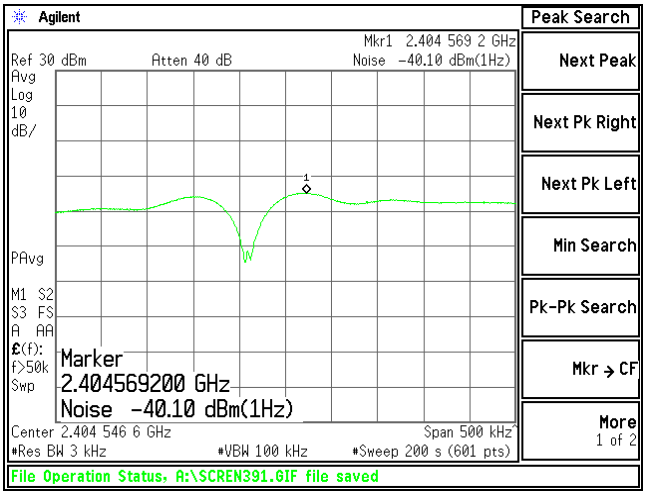
Test Equipment	Manufacturer	Model No.	Serial No.
Spectrum Analyzer	Agilent	E4446A	US45300564

10.3 Test Data

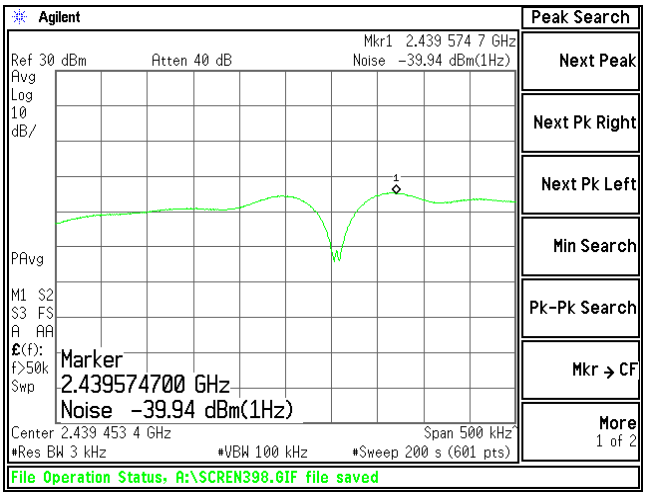
Channel	Center Frequency (MHz)	Measured Channel Power (dBm/1Hz)	3 kHz Correction (dB)	Corrected Power Measurement (dBm/3kHz)	Limit (dBm)	Margin
0	2405	-40.10	34.77	-5.33	8.0	13.3
7	2440	-39.94	34.77	-5.17	8.0	13.2
F	2480	-39.68	34.77	-4.91	8.0	12.9

10.4 Screen Captures – Power Spectral Density

Channel 0



Channel 7



Channel F

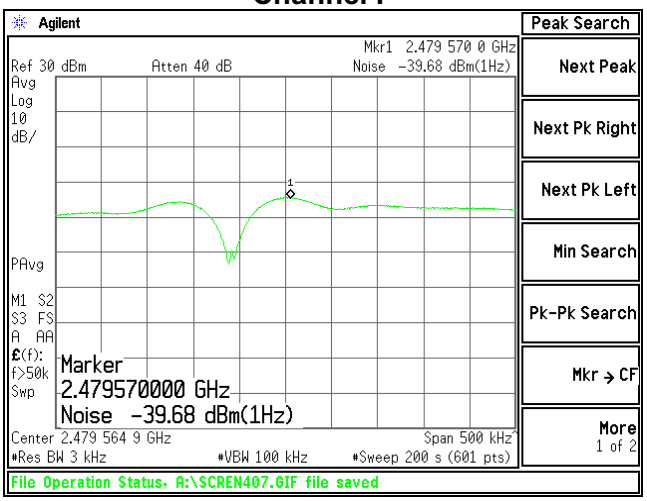


EXHIBIT 11. SPURIOUS CONDUCTED EMISSIONS: 15.247(d)

11.1 Limits

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at lease 20 db below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

For data from the radiated measurements, please refer to section 5.6 of this report.

FCC Part 15.247(d) requires a measurement of conducted harmonic and spurious RF emission levels, as reference to the carrier level when measured in a 100 kHz bandwidth. For this test, the spurious and harmonic RF emissions from the EUT were measured at the EUT antenna port using a short RF cable. The cable calibration file was loaded into the spectrum analyzer to compensate for the loss of the cable between the antenna port of the EUT to the spectrum analyzer. A Hewlett Packard model E4446A spectrum analyzer was used with the resolution bandwidth set to 100 kHz for this portion of the tests. The unit was configured to run in a continuous transmit mode. The spectrum analyzer was used with measurements from a peak detector presented in the chart below. Screen captures were acquired and any noticeable spurious and harmonic signals were identified and measured.

11.2 Test Equipment List

Test Equipment	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Agilent	E4446A	US45300564	To 44 GHz

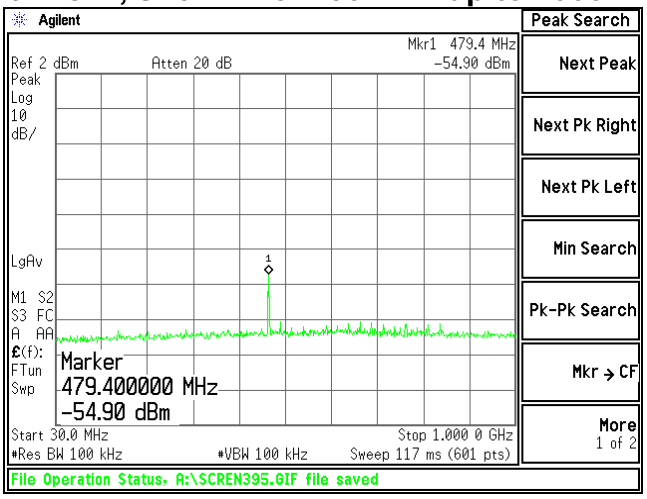
11.3 Test Data

No significant emissions could be noted within -50 dBc of the fundamental level for this product.

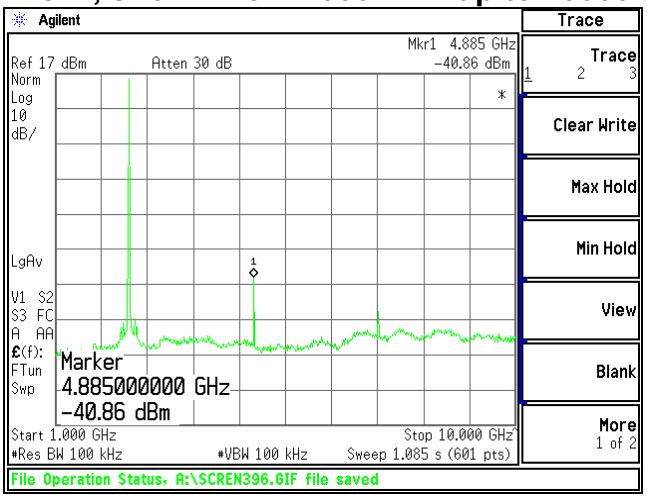
	Channel 0	Channel 7	Channel F
	Power in dBm		
Fundamental	14.19	14.77	15.66
2nd Harmonic	-39.05	-40.86	-43.78
3rd Harmonic	-52.15	-50.65	-49.01
4th Harmonic	-62.18	-68.15	-66.81
5th Harmonic	-57.97	-53.44	-51.31
6th Harmonic	-65.66	-65.49	-65.83
7th Harmonic	-55.07	-53.91	-53.85
8th Harmonic	-61.31	-60.62	-57.65
9th Harmonic	-63.54	-63.30	-60.99
10th Harmonic	-72.27	-70.00	-70.79

11.4 Screen Captures – Spurious Radiated Emissions

Channel 7, shown from 30 MHz up to 1000 MHz



Channel 7, shown from 1000 MHz up to 10000 MHz



Channel 7, shown from 10000 MHz up to 25000 MHz

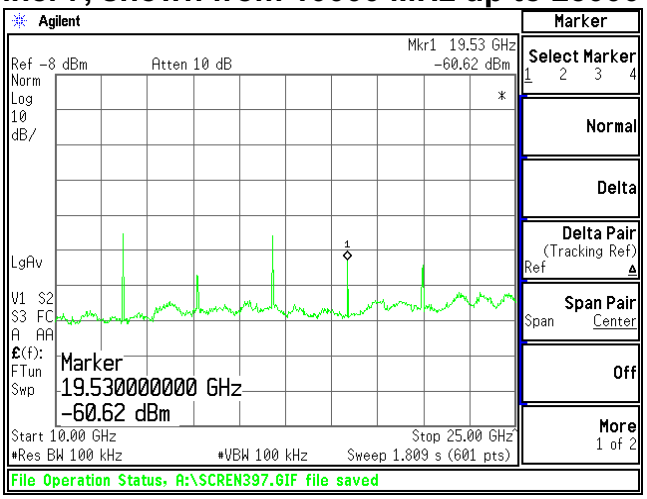


EXHIBIT 12. FREQUENCY & POWER STABILITY OVER VOLTAGE VARIATIONS

The stability of the device was examined as a function of the input voltage available to the EUT. A Spectrum Analyzer was used to measure the frequency at the appropriate frequency markers. The transmitter of the EUT placed in modulated continuous transmit mode. Power was supplied by an external bench-type variable power supply, and the frequency of operation was monitored using the spectrum analyzer.

In this case, the EUT uses a single type operates on a nominal voltage of 3.0 VDC. The test was performed to measure the stability of the frequency and power at ±15% of the nominal operating voltage: 2.55V and 3.45V.

A spectrum analyzer was used to measure the frequency at the appropriate frequency markers. For this test, the EUT was placed in continuous transmit CW mode. Power to the EUT was supplied by an external bench-type variable power supply. The frequency of operation was monitored using the spectrum analyzer with RBW=VBW=10Hz settings while the voltage was varied.

	DC/AC Voltage Source		
	2.805 VDC	3.3 VDC	3.795 VDC
Channel 0	2405.003000 MHz	2405.003170 MHz	2405.003170 MHz
Channel 7	2440.007130 MHz	2440.008330 MHz	2440.007800 MHz
Channel F	2480.006130 MHz	2480.004400 MHz	2480.005270 MHz

The RF Power Output of the EUT was also monitored in a separate test, also using a Spectrum Analyzer with RBW=VBW=1 MHz setting while the voltage was varied.

	DC/AC Voltage Source		
	2.805 VDC	3.3 VDC	3.795 VDC
Channel 0	19.68 dBm	19.76 dBm	19.82 dBm
Channel 7	19.77 dBm	19.84 dBm	19.91 dBm
Channel F	19.86 dBm	19.96 dBm	19.98 dBm

EXHIBIT 13. MPE CALCULATIONS

The following MPE calculations are based on a 1.8 centimeter inverted-F printed circuit board trace antenna, with a measured ERP of 120.0 dBµV/m, at 3 meters, and conducted RF power of +19.74 dBm as presented to the antenna. The calculated gain of this antenna, based on the ERP fundamental measurements taken over a ground plane is 5.03 dB.

Prediction of MPE limit at a given distance

Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = \frac{PG}{4\pi R^2}$$

where: S = power density
P = power input to the antenna
G = power gain of the antenna in the direction of interest relative to an isotropic radiat
R = distance to the center of radiation of the antenna

Maximum peak output power at antenna input terminal:	19.74	(dBm)
Maximum peak output power at antenna input terminal:	94.189	(mW)
Antenna gain(typical):	5.03	(dBi)
Maximum antenna gain:	3.184	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	2400	(MHz)
MPE limit for uncontrolled exposure at prediction frequency:	1	(mW/cm^2)
Power density at prediction frequency:	0.059666	(mW/cm^2)
Maximum allowable antenna gain:	17.3	(dBi)
Margin of Compliance at 20 cm =	12.2	dB

APPENDIX A

Test Equipment List

Asset #	Manufacturer	Model #	Serial #	Description	Date	Due
AA960008	EMCO	3816/2NM	9701-1057	Line Impedance Stabilization Network	12/6/07	12/6/08
AA960031	HP	119474A	3107A01708	Transient Limiter	Note 1	Note 1
AA960077	EMCO	93110B	9702-2918	Biconical Antenna	9/19/07	9/19/08
AA960078	EMCO	93146	9701-4855	Log-Periodic Antenna	9/19/07	9/19/08
AA960081	EMCO	3115	6907	Double Ridge Horn Antenna	12/04/07	12/04/08
CC00221C	Agilent	E4407B	US39160256	Spectrum Analyzer	1/11/07	1/11/08
EE960004	EMCO	2090	9607-1164	Device Controller	N/A	N/A
EE960013	HP	8546A	3617A00320	Receiver RF Section	9/20/07	9/20/08
EE960014	HP	85460A	3448A00296	Receiver Pre-Selector	9/20/07	9/20/08
EE960073	Agilent	E4446A	US45300564	Spectrum Analyzer	8/17/07	8/17/08
N/A	LSC	Cable	0011	3 Meter ½" Armored Cable	Note 1	Note 1
N/A	LSC	Cable	0050	10 Meter RG 214 Cable	Note 1	Note 1
N/A	Pasternack	Attenuator	N/A	10 dB Attenuator	Note 1	Note 1

Note 1 - Equipment calibrated within a traceable system

Uncertainty Statement

This uncertainty represents an expanded uncertainty expressed at approximately the 95 % confidence level, using a coverage factor of k=2.

Table of Expanded Uncertainty Values, (K=2) for Specified Measurements

Measurement Type	Particular Configuration	Uncertainty Values
Radiated Emissions	3 – Meter chamber, Biconical Antenna	4.24 dB
Radiated Emissions	3-Meter Chamber, Log Periodic Antenna	4.8 dB
Radiated Emissions	10-Meter OATS, Biconical Antenna	4.18 dB
Radiated Emissions	10-Meter OATS, Log Periodic Antenna	3.92 dB
Conducted Emissions	Shielded Room/EMCO LISN	1.60 dB
Radiated Immunity	3 Volts/Meter in 3-Meter Chamber	1.128 Volts/Meter
Conducted Immunity	3 Volts level	1.0 V

Appendix B

Justifications of Average Duty Factor Calculations

Average (Relaxation) Factor

Average Factor = 20* Log_{10} (Worst Case EUT On-time over 100 ms time window)

The transmit packet occupies 1.4 ms of time, within any 10 ms window.

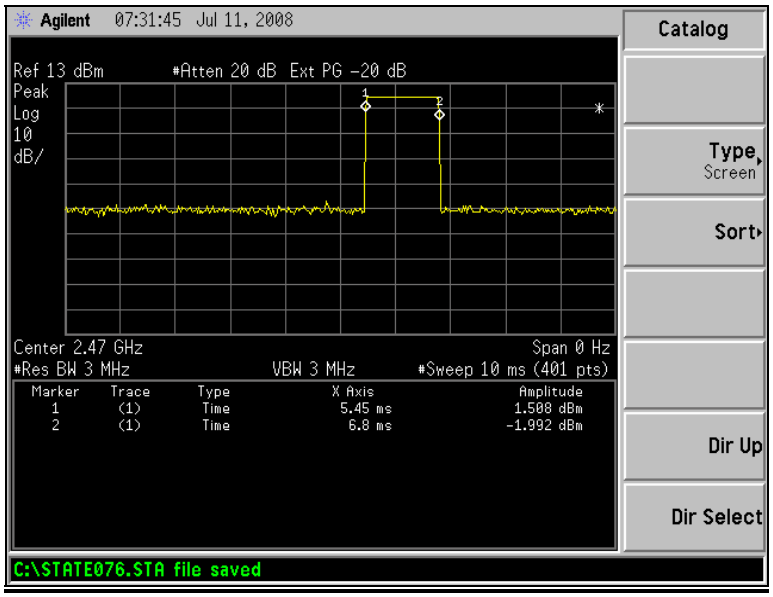
With the communication protocol and the response time from the cradle, the maximum number of packets possibly sent in a 100 millisecond window is 6.

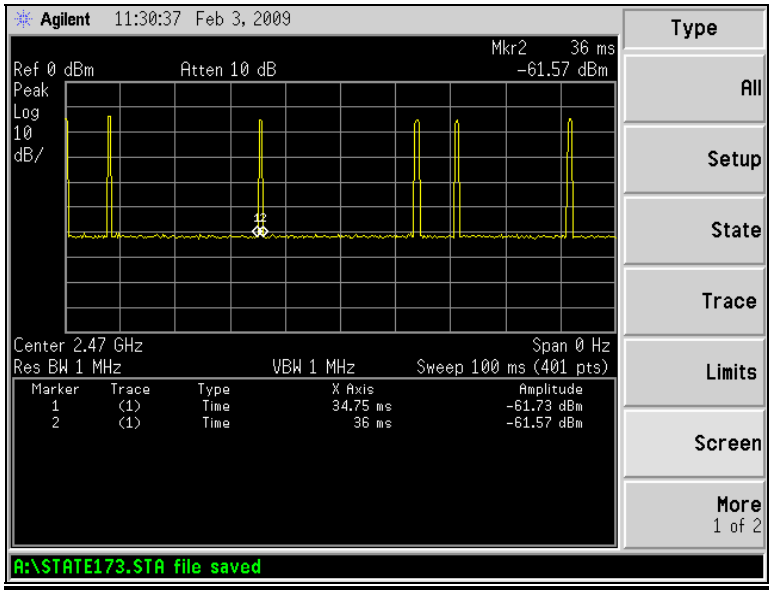
6*1.4 = 8.4 ms total transmit time in a 100 ms window.

Therefore, the relaxation factor allowance is calculated as:

Average Factor = 20* Log_{10} (8.4 / 100 ms) = -21.51

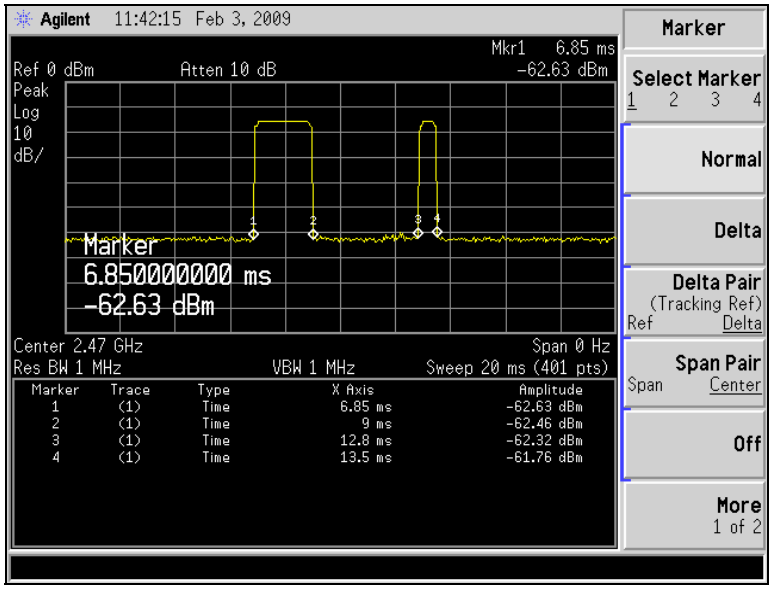
A relaxation factor of 20 dB would be allowable for this product.

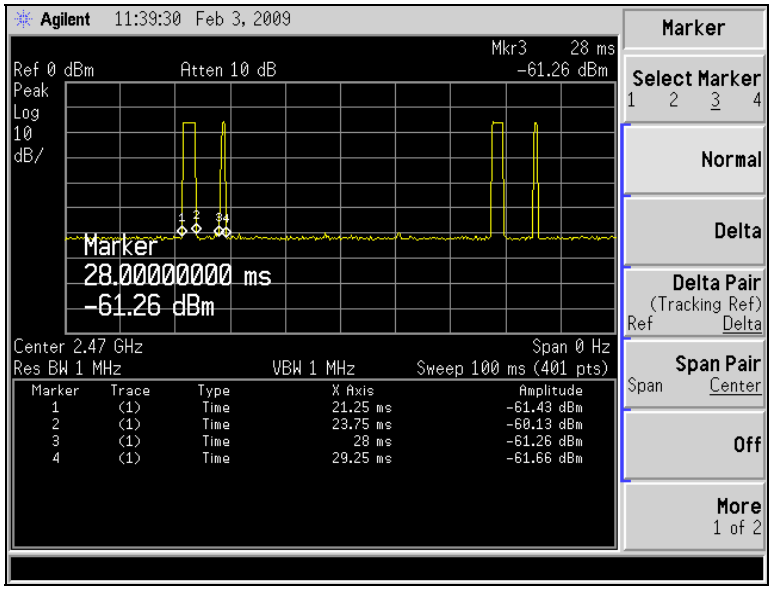




In the second mode, there are two long bursts and two short bursts:

Duty cycle = 2 x 2.1msec + 2 x 0.7msec = 5.6msec or 5.6%.
=20*log(5.6/100) = -25.04




Agilent 11:39:30 Feb 3, 2009
Mkr3 28 ms
Ref 0 dBm
Atten 10 dB
-61.26 dBm
Peak
Log
10
dB/
Marker
28.00000000 ms
-61.26 dBm
Center 2.47 GHz
Span 0 Hz
Res BW 1 MHz
VBW 1 MHz
Sweep 100 ms (401 pts)
Marker Trace Type X Axis Amplitude
1 (1) Time 21.25 ms -61.43 dBm
2 (1) Time 23.75 ms -60.13 dBm
3 (1) Time 28 ms -61.26 dBm
4 (1) Time 29.25 ms -61.66 dBm
Marker
Select Marker
1 2 3 4
Normal
Delta
Delta Pair
(Tracking Ref)
Ref Delta
Span Pair
Span Center
Off
More
1 of 2