ENGINEERING TEST REPORT

VOIP Telephone with Bluetooth
Model No.: 6739i
FCC ID: SDV60-001254

Applicant:

Aastra Telecom Inc.
155 Snow Blvd.
Concord, ON
Canada, L4K 4N9

In Accordance With

Federal Communications Commission (FCC)
Part 15, Subpart C, Section 15.247
Frequency Hopping System and DTS
Operating in 2402-2480 MHz Band

UltraTech's File No.: AAST-054F15C247

This Test report is Issued under the Authority of Tri M. Luu, Professional Engineer, Vice President of Engineering UltraTech Group of Labs Date: July 27, 2009	
Report Prepared by: JaeWook Choi Issued Date: July 27, 2009	Tested by: Hung Tringh, RFI Technician Test Dates: March 5, 2009 & July 10, 14, 15, 18 & 20, 2009

- *The results in this Test Report apply only to the sample(s) tested, and the sample tested is randomly selected.*
- *This report must not be used by the client to claim product endorsement by NVLAP or any agency of the US Government.*

UltraTech Group of Labs

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91038	1309	46390-2049	200093-0	SL2-IN-E-1119R	CA2049

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EXHIBIT 1. INTRODUCTION

1.1. SCOPE

Reference:	FCC Part 15, Subpart C, Section 15.247
Title:	Code of Federal Regulations (CFR), Title 47 – Telecommunication, Part 15
Purpose of Test:	Equipment Certification for Frequency Hopping System Transmitter Operating in the Frequency Band 2400-2483.5 MHz
Test Procedures:	Both conducted and radiated emissions measurements were conducted 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 in the Range of 9 kHz to 40 GHz.
Environmental Classification:	[x] Commercial, industrial or business environment [ ] Residential environment

1.2. RELATED SUBMITTAL(S)/GRANT(S)

None.

1.3. NORMATIVE REFERENCES

Publication	Year	Title
47 CFR Parts 0-19	2008	Code of Federal Regulations – Telecommunication
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 22 & EN 55022	2006 2006	Information Technology Equipment - Radio Disturbance Characteristics – Limits and Methods of Measurement
CISPR 16-1-1 +A1 +A2	2006 2006 2007	Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-1: Measuring Apparatus
CISPR 16-1-2 +A1 +A2	2003 2004 2006	Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-2: Conducted disturbances
KDB Publication No. 558074	2005	Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247)
KDB Publication No. 447498	2008	Mobile and Portable Device RF Exposure Procedure and Equipment Authorization Policies

EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1. CLIENT INFORMATION

APPLICANT	
Name:	Aastra Telecom Inc.
Address:	155 Snow Blvd. Concord, ON Canada, L4K 4N9
Contact Person:	Mr. James Wong Phone #: 1.905.760.4278 Fax #: 1.905.760.4235 Email Address: jwong@aastra.com

MANUFACTURER	
Name:	Aastra Telecom Inc.
Address:	155 Snow Blvd. Concord, ON Canada, L4K 4N9
Contact Person:	Mr. James Wong Phone #: 1.905.760.4278 Fax #: 1.905.760.4235 Email Address: jwong@aastra.com

2.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

The following information (with the exception of the Date of Receipt) has been supplied by the applicant.

Brand Name	Aastra Telecom Inc.
Product Name:	VOIP Telephone with Bluetooth
Model Name or Number:	6739i
Serial Number:	Test Sample
Type of Equipment:	VOIP Telephone with Bluetooth
Input Power Supply Type:	48 VDC
Primary User Functions of EUT:	Telephone Communication Device

2.3. EUT'S TECHNICAL SPECIFICATIONS

BLUETOOTH TRANSMITTER		
Equipment Type:	Base station	
Intended Operating Environment:	Commercial, industrial or business environment	
Power Supply Requirement:	48 VDC	
RF Output Power Rating:	5.49 dBm peak conducted	
Operating Frequency Range:	2402-2480 MHz	
Duty Cycle:	100 %	
20 dB Bandwidth:	968 kHz	
Modulation Type:	G1D	
Antenna Connector Type:	Integral antenna housed inside the enclosure.	
Antenna Description:	Manufacturer: Type Model Gain: Frequency Range:	Johanson Technology Ceramic Chip 2450AT18B100 0.5 dBi (peak) 2400 ~ 2500 MHz

2.4. LIST OF EUT'S PORTS

Port Number	EUT's Port Description	Number of Identical Ports	Connector Type
1	Handset Port	1	RJ11
2	Headset Port	1	RJ11
3	AUX Port	1	RJ45
4	Expansion Port (Legacy)	1	RJ45
5	Expansion Port (New)	1	Edge Rate Socket, 60 Positions
6	USB	1	USB
7	LAN	1	RJ45
8	PC	1	RJ45
9	DC Power	1	Power Jack

2.5. ANCILLARY EQUIPMENT

The EUT was tested while connected to the following representative configuration of ancillary equipment necessary to exercise the ports during tests:

Ancillary Equipment # 1	
Description:	AC Power Adapter
Brand Name:	GlobTek, Inc.
Model Name or Number:	GT-41052-1548
Serial Number:	N/A
Cable Length & Type:	< 3 m, Non-shielded
Connected to EUT's Port:	DC Power

2.6. General Block Diagram

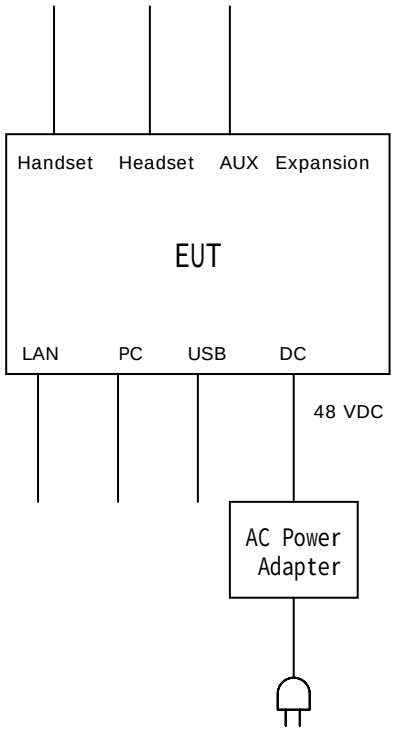


EXHIBIT 3. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

3.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

Temperature:	21°C
Humidity:	51%
Pressure:	102 kPa

3.2. OPEPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS

Operating Modes:	For testing purpose only, the EUT was set to transmit continuously by setting the unit into the 1st test state.
Special Test Software:	None.
Special Hardware Used:	None.
Transmitter Test Antenna:	The EUT is tested with the antenna fitted in a manner typical of normal intended use as integral antenna equipment.

Transmitter Test Signals	
Frequency Band(s):	2402-2480 MHz
RF Power Output:	5.49 dBm peak conducted
Normal Test Modulation:	GFSK, 8DPSK and π/4 DPQSK
Modulating Signal Source:	Internal

EXHIBIT 4. SUMMARY OF TEST RESULTS

4.1. LOCATION OF TESTS

All of the measurements described in this report were performed at Ultratech Group of Labs located in the city of Oakville, Province of Ontario, Canada.

Power Line Conducted Emissions were performed in UltraTech's shielded room, 16'(L) by 12'(W) by 12'(H).

Radiated Emissions were performed at the Ultratech's 3-10 TDK Semi-Anechoic Chamber situated in the Town of Oakville, province of Ontario. This test site been calibrated in accordance with ANSI C63.4, and found to be in compliance with the requirements of Sec. 2.948 of the FCC Rules. The descriptions and site measurement data of the Oakville 3-10 TDK Semi-Anechoic Chamber has been filed with FCC office (FCC File No.: 91038) and Industry Canada office (Industry Canada File No.: 2049A-3). Expiry Date: 2011-05-01.

4.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC Section(s)	Test Requirements	Compliance (Yes/No)
2.1091	Radiofrequency radiation exposure evaluation: mobile devices	Yes
15.207(a)	Power Line Conducted Emissions	Yes
15.247(a)(1)	Hopping Frequency Separation	Yes
15.247(a)(1)(iii)	Number of Hopping Channels and Average Time of Occupancy	Yes
15.247(b)(1)	Peak Output Power	Yes
15.247(d)	Band-Edge and RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
15.247(d), 15.209 & 15.205	Transmitter Spurious Radiated Emissions	Yes
15.247(d) & 15.247(f)	Peak Power Spectral Density	Yes
VOIP Telephone with Bluetooth, **Model No.: 6739i**, by **G4S Justice Service Canada, Inc** has also been tested and found to comply with **FCC Part 15, Subpart B - Class B Digital Devices**. The engineering test report has been documented and kept on file and it is available upon request.		

4.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None.

EXHIBIT 5. MEASUREMENTS, EXAMINATIONS & TEST DATA FOR EMC EMISSIONS

5.1. TEST PROCEDURES

This section contains test results only. Details of test methods and procedures can be found in ANSI C63.4; FCC KDB Publication No. 558074: Guidance on Measurements for Digital Transmission Systems.

5.2. MEASUREMENT UNCERTAINTIES

The measurement uncertainties stated were calculated in accordance with requirements of UKAS Document NIS 81 with a confidence level of 95%. Please refer to EXHIBIT 6. for Measurement Uncertainties.

5.3. MEASUREMENT EQUIPMENT USED

The measurement equipment used complied with the requirements of the Standards referenced in the Methods & Procedures ANSI C63.4 and CISPR 16-1-1.

5.4. ESSENTIAL/PRIMARY FUNCTIONS AS DECLARED BY THE MANUACTURER

Telephone communications device.

5.5. RF EXPOSURE REQUIREMENTS [§§ 1.1310 & 2.1091]

5.5.1. Limits

§ **1.1310:** The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in 1.1307(b).

LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Average Time (minutes)
(B) Limits for General Population/Uncontrolled Exposure				
30-300	27.5	0.073	0.2	30
300-1500	--	--	f/1500	30
1500-100,000	--	--	1.0	30

Note: f is frequency in MHz

5.5.2. Method of Measurements

Calculation Method of RF Safety Distance:

$$S = \frac{PG}{4\pi \cdot r^2} = \frac{EIRP}{4\pi \cdot r^2}$$

Where, P: power input to the antenna in mW
EIRP: Equivalent (effective) isotropic radiated power.
S: power density mW/cm^2
G: numeric gain of antenna relative to isotropic radiator
r: distance to centre of radiation in cm

$$r = \sqrt{\frac{PG}{4\pi \cdot S}} = \sqrt{\frac{EIRP}{4\pi \cdot S}}$$

5.5.3. Evaluation of RF Exposure Compliance Requirements

Maximum RF Power conducted, $\mathbf{P_{conducted}[dBm]}$ = 5.49 at 2441 MHz

Maximum Antenna Gain, **G[dBi]** = 0.5

Maximum EIRP, $\mathbf{P_{EIRP}[dBm]}$ = 5.99

MPE Limit for General Population/Uncontrolled Exposure, $\mathbf{S_{uncontrolled}[mW/cm^2]}$ = 1.0

Calculated RF Safety Distance for General Population/Uncontrolled Exposure, $\mathbf{r_{safety\_uncontrolled}[cm]}$ = 0.56

5.6. POWER LINE CONDUCTED EMISSIONS [§ 15.207(a)]

5.6.1. Limits

The equipment shall meet the limits of the following table:

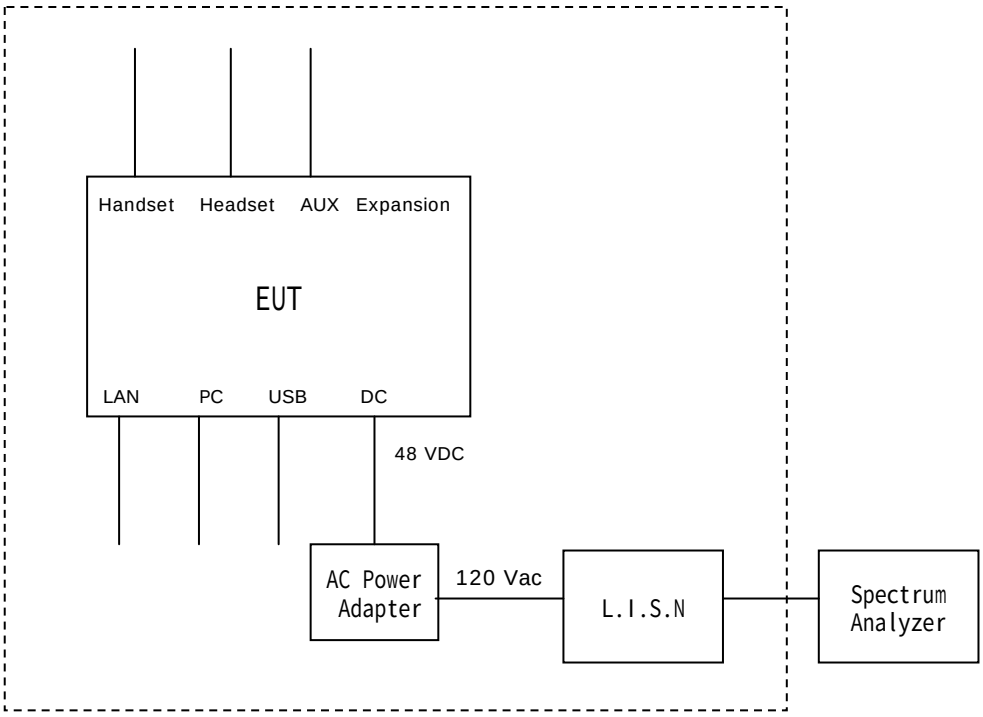
Frequency of Emissions (MHz)	Class B Conducted Limit (dBμV)	
	Quasi-Peak	Average
0.15 to 0.5	66 to 56*	56 to 46*
0.5 to 5	56	46
5 to 30	60	50

* Decreasing linearly with logarithm of frequency

5.6.2. Method of Measurements

Refer to Ultratech Test Procedures ULTR-P001-200 & ANSI C63.4 for method of measurements.

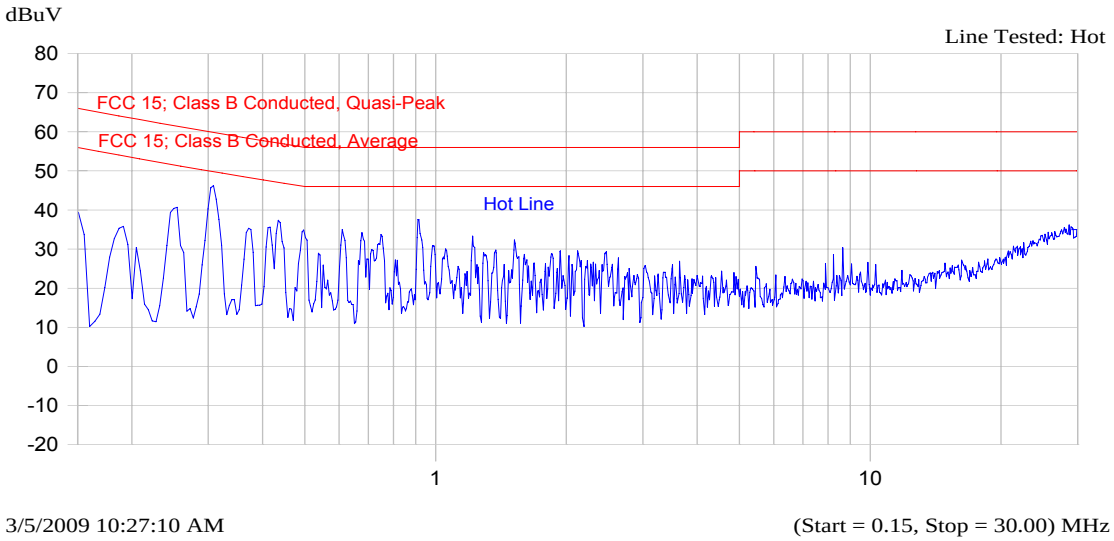
5.6.3. Test Arrangement



5.6.4. Test Data

< 120 VAC, Line Tested: Hot >

Current Graph

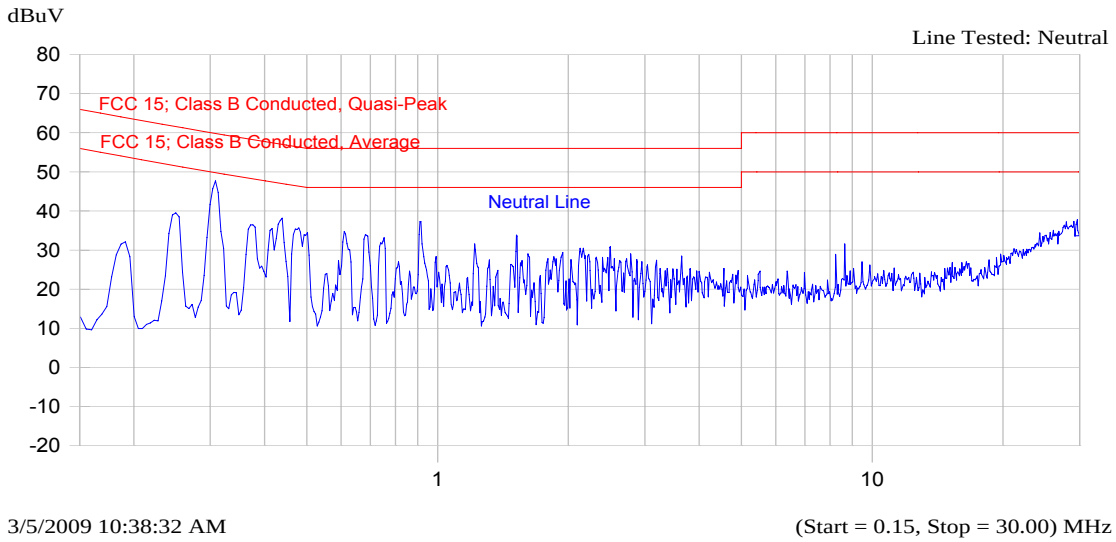


Current List

Frequency MHz	Peak dBuV	QP dBuV	Delta Qp-Qp Limit dB	Avg dBuV	Delta Avg-Avg Limit dB	Trace Name
0.183	44.8	35.2	-29.1	29.3	-25.0	Hot Line
0.248	44.7	40.9	-20.9	38.2	-13.6	Hot Line
0.304	48.0	46.2	-13.9	44.3	-5.8	Hot Line
0.434	39.6	36.9	-20.3	33.7	-13.4	Hot Line
0.608	39.2	35.4	-20.6	32.3	-13.7	Hot Line
0.910	38.1	36.2	-19.8	35.4	-10.6	Hot Line
1.518	35.0	32.1	-23.9	30.9	-15.1	Hot Line
28.968	35.6	30.7	-29.3	24.5	-25.5	Hot Line

< 120 VAC, Line Tested: Neutral >

Current Graph



Current List

Frequency MHz	Peak dBuV	QP dBuV	Delta Qp-Qp Limit dB	Avg dBuV	Delta Avg-Avg Limit dB	Trace Name
0.176	43.9	35.1	-29.6	16.9	-37.8	Neutral Line
0.250	42.6	40.5	-21.3	35.9	-15.9	Neutral Line
0.304	48.1	46.5	-13.7	44.3	-5.8	Neutral Line
0.432	40.1	37.5	-19.7	34.9	-12.3	Neutral Line
0.606	39.1	35.2	-20.8	32.1	-13.9	Neutral Line
0.684	35.1	32.4	-23.6	26.7	-19.3	Neutral Line
0.911	37.8	36.3	-19.7	35.5	-10.5	Neutral Line
1.517	35.1	32.4	-23.6	31.2	-14.8	Neutral Line
8.641	32.9	30.3	-29.7	29.5	-20.5	Neutral Line
29.654	36.6	31.0	-29.0	24.8	-25.2	Neutral Line

5.7. COMPLIANCE WITH FCC PART 15 – GENERAL TECHNICAL REQUIREMENTS

FCC Section	FCC Rules	Manufacturer's Clarification
15.31(m)	The hoping function must be disabled for 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.	Hoping function was disabled for the required tests at low, middle and high channels.
15.203	Described 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 EUT must be professionally installed. In order to demonstrate that professional installation is required, the following 3 points must be addressed: ➢ The application (or intended use) of the EUT ➢ The installation requirements of the EUT ➢ The method by which the EUT will be marketed	The antenna is integrated or employs unique antenna connectors: Integral ceramic chip antenna
15.204	Provided the information for every antenna proposed for use with the EUT: ➢ type (e.g. Yagi, patch, grid, dish, etc…), ➢ manufacturer and model number ➢ gain with reference to an isotropic radiator	Manufacturer: Johanson Technology Type: Ceramic Chip Model: 2450AT18B100 Freq. Range: 2400 ~ 2500 MHz Gain: 0.5 dBi peak
15.247(a)	Description of how the EUT meets the definition of a frequency hopping spread spectrum, found in Section 2.1. Based on the technical description.	Bluetooth device
15.247(a)	Pseudo 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 requirements specified in the definition of a frequency hopping spread spectrum system, found in Section 2.1	Bluetooth device

FCC Section	FCC Rules	Manufacturer's Clarification
15.247(a)	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 final channel used in the previous transmission events).	Bluetooth device
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	Bluetooth device
15.247(h)	Describe how the EUT complies with the requirement that it not have the ability to coordinated with other FHSS is an effort to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitters	Bluetooth device
Public Notice DA 00-705	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.	Bluetooth device
Public Notice DA 00-705	System Receiver Hopping Capability: Describe how the associated receiver(s) has the ability to shift frequencies in synchronization with the transmitted signals	Bluetooth device

5.8. PROVISIONS FOR FREQUENCY HOPPING SYSTEMS [§ 15.247(a)(1)]

5.8.1. Limit

§ 15.247(a)(1): Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudorandomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

5.8.2. Method of Measurements

FCC Public Notice DA 00-705

Carrier Frequency Separation:

The hopping function of the EUT is enabled. Use the spectrum analyzer setting as follows:

- Span = wide enough to capture the peaks of two adjacent channels
- RBW = 1% of the span
- VBW ≥ RBW
- Sweep = Auto
- Detector = peak
- Trace = max hold

Number of hopping frequency:

The hopping function of the EUT is enabled. Use the spectrum analyzer setting as follows:

- Span = the frequency band of operation
- RBW = 1% of the span
- VBW ≥ RBW
- Sweep = Auto
- Detector = peak
- Trace = max hold

Time of Occupancy (Dwell Time):

The hopping function of the EUT is enabled. Use the spectrum analyzer setting as follows:

- Span = 0 Hz centered on a hopping channel
- RBW = 1 MHz
- VBW ≥ RBW
- Sweep = as necessary to capture the entire dwell time per hopping channel
- Detector = peak
- Trace = max hold

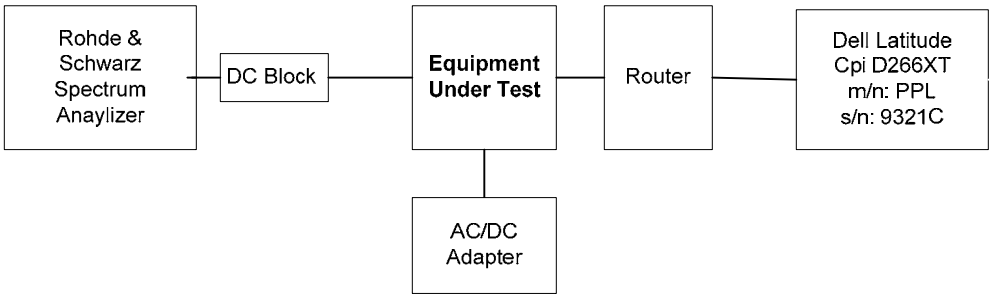
If possible, use the marker-delta function to determine the dwell time. If this value varies with different modes of operation (e.g. date rate modulation format, etc.), repeat this test for each variation. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s). An oscilloscope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

20 dB Bandwidth:

Use the spectrum analyzer setting as follows:

- Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel
- RBW = 1% of the 20 dB bandwidth
- VBW ≥ RBW
- Sweep = auto
- Detector = peak
- Trace = max hold
- The transmitter shall 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 on both sides of the emission.
- The 20 dB BW is the delta reading in frequency between two markers.

5.8.3. Test Arrangement



5.8.4. Test Equipment List

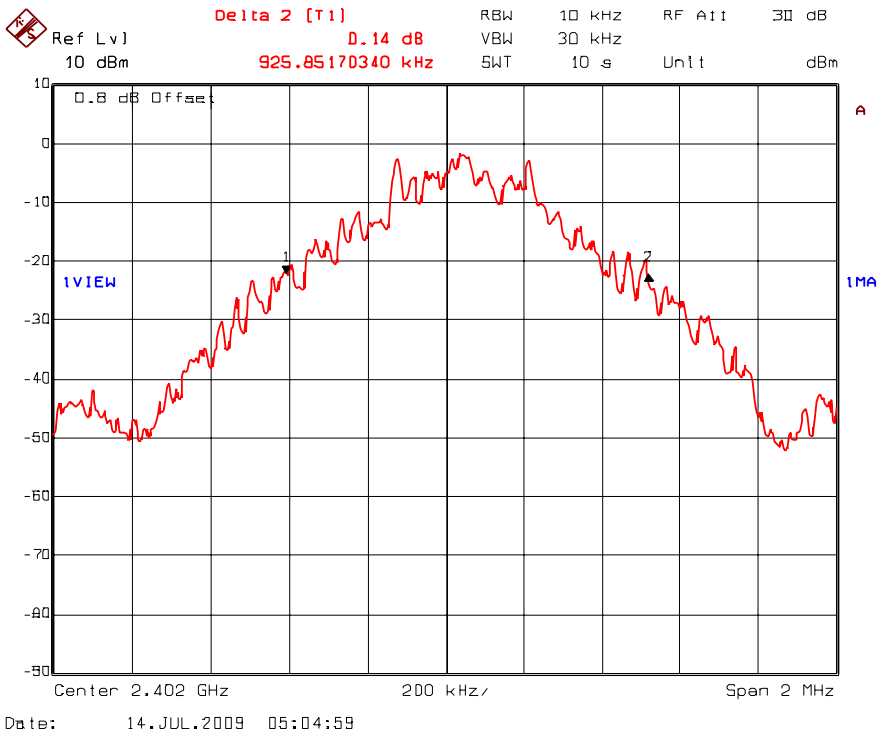
Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Rohde & Schwarz	FSEK20/B4/B21	834157/005	9 kHz – 40 GHz with external mixer
DC Block	Hewlett Packard	11742A	12460	0.045 – 26.5 GHz

5.8.5. Test Data

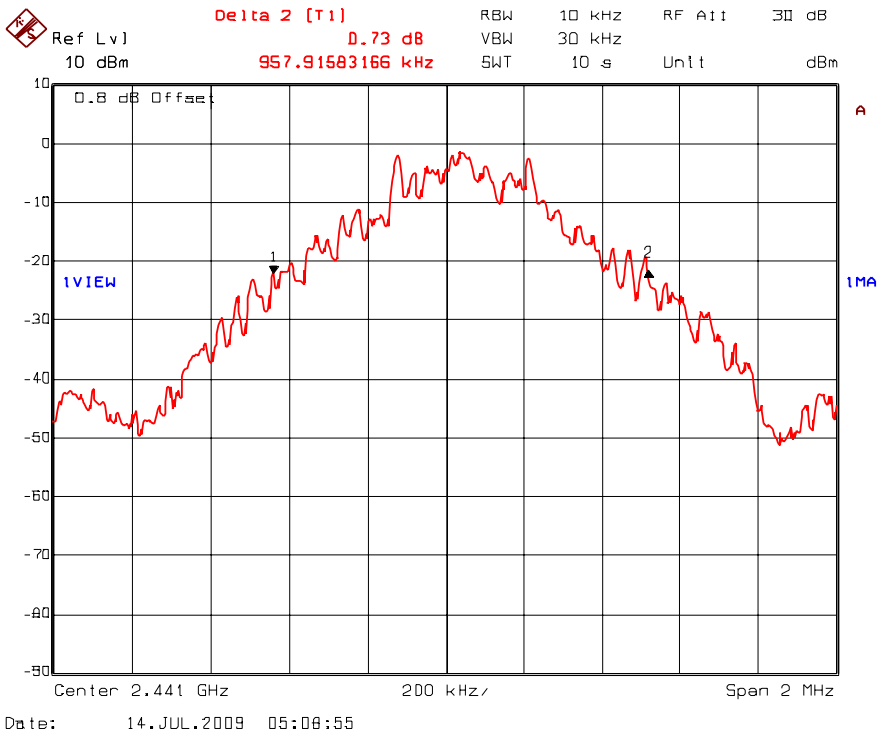
Test Description	FCC Specification	Measured Values
Channel Hopping Frequency Separation	Minimum of 25 kHz or two-third of 20dB BW, whichever is greater.	1.068 MHz
Number of hopping frequencies	5 MHz band shall use at least 15 channels	79 hopping frequencies
Average Time of Occupancy	The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.	134.67 ms for GFSK 89.92 ms for 8DPSK 57.60 ms for π/4 DPQSK

Remark: See the following plots for details.

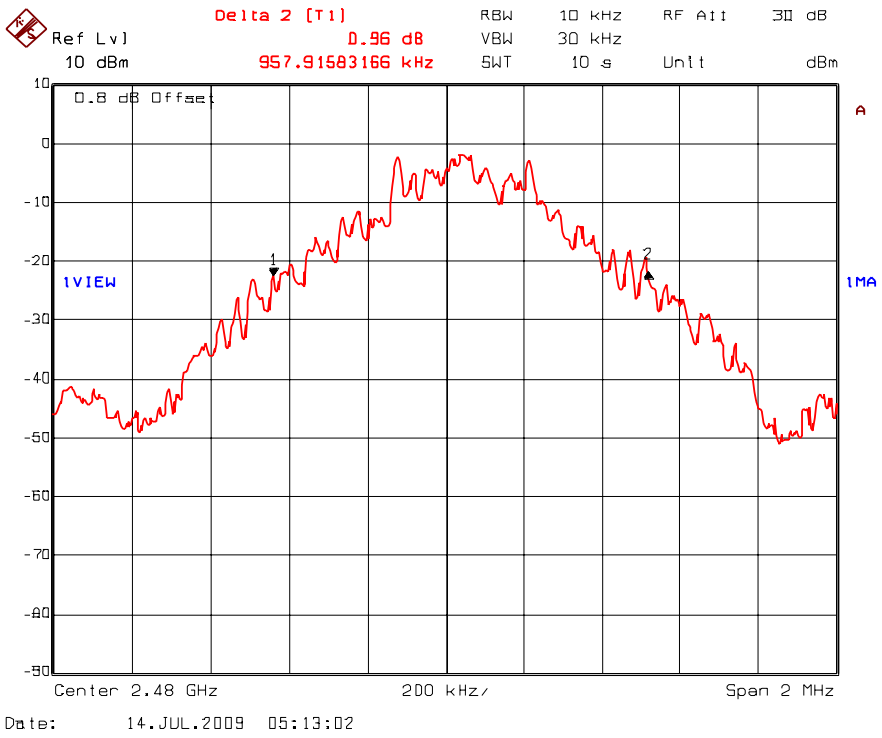
Plot 5.8.5.1. 20 dB Bandwidth
Test Frequency: 2402 MHz. GFSK Modulation



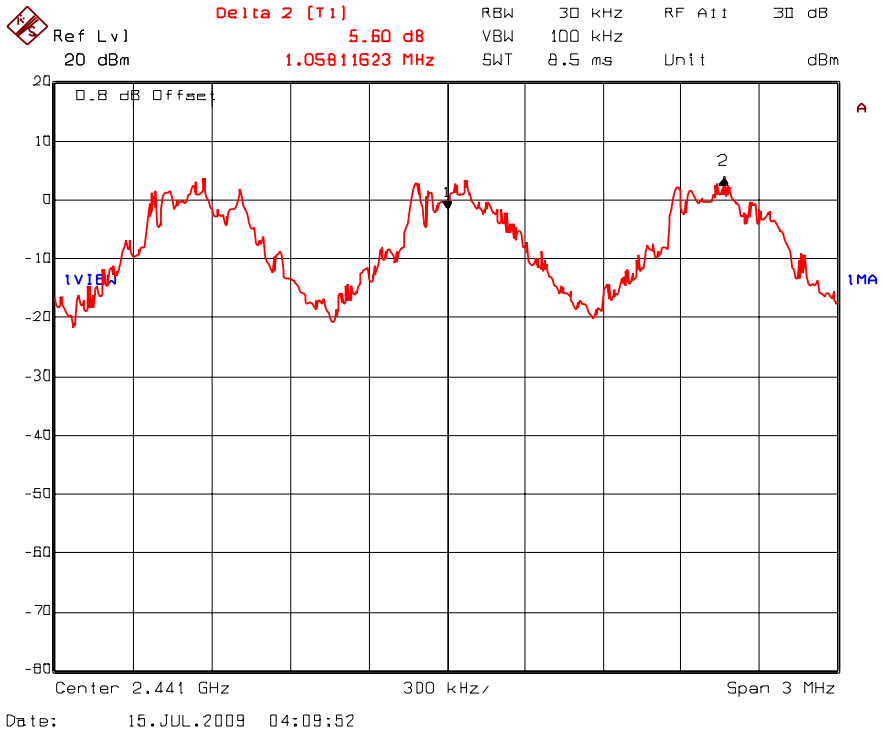
Plot 5.8.5.2. 20 dB Bandwidth
Test Frequency: 2441 MHz. GFSK Modulation



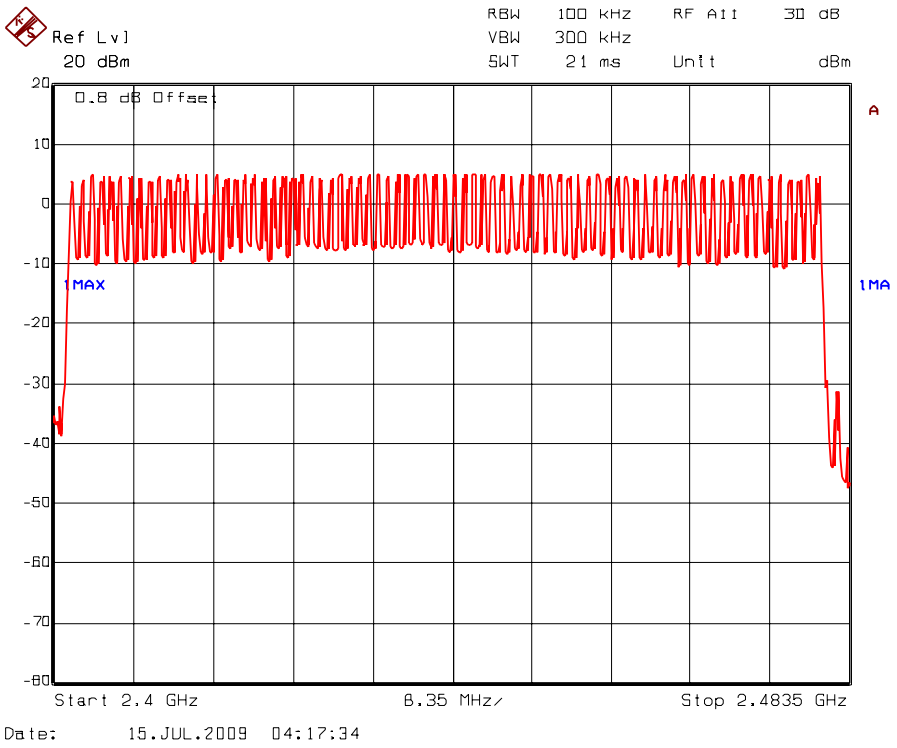
Plot 5.8.5.3. 20 dB Bandwidth
Test Frequency: 2480 MHz. GFSK Modulation



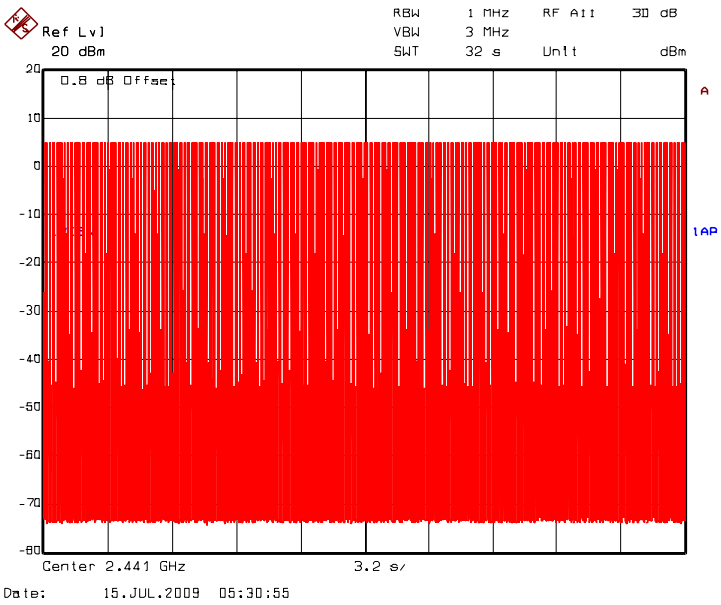
Plot 5.8.5.4. Carrier Frequency Separation

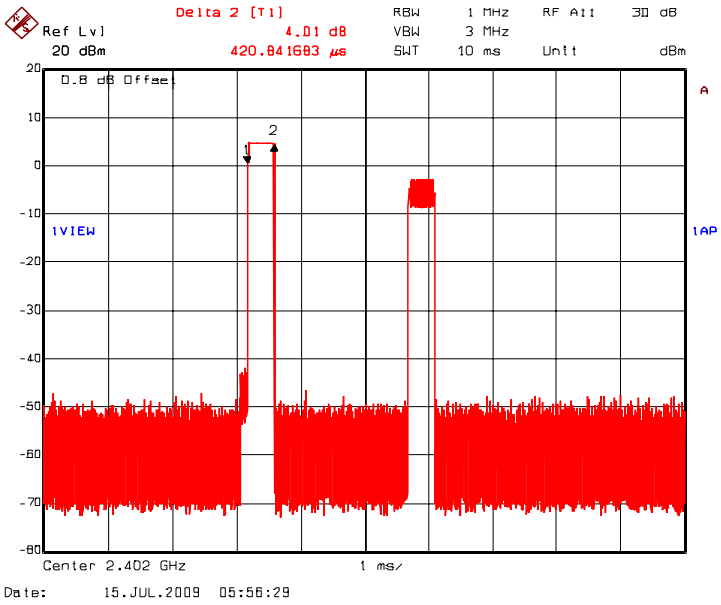


Plot 5.8.5.5. Number of Hopping Frequencies
79 hopping channels, GFSK Modulation

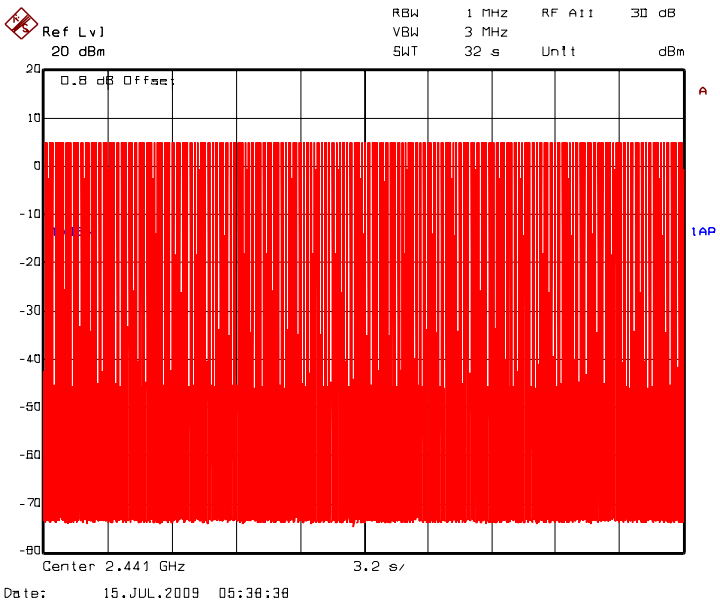


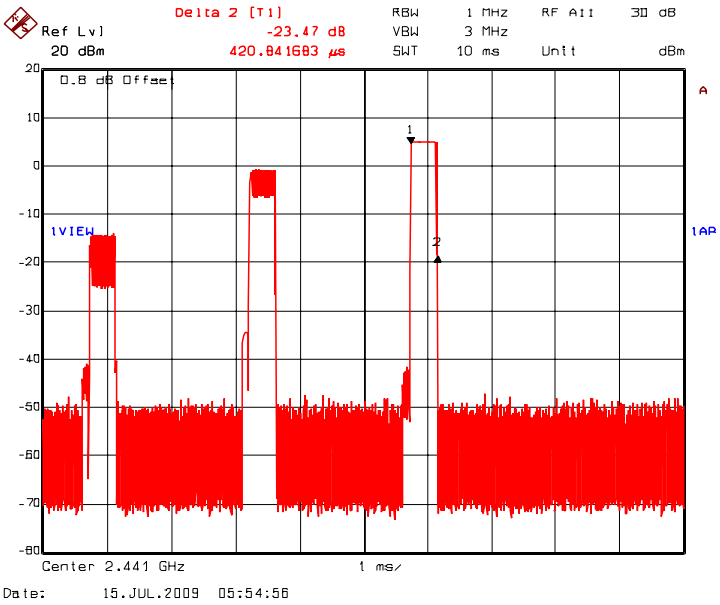
Plot 5.8.5.6. Time of Occupancy
Test Frequency: 2402 MHz, GFSK modulation
320 * 420.84µs= 134.67ms < 400ms in 32s



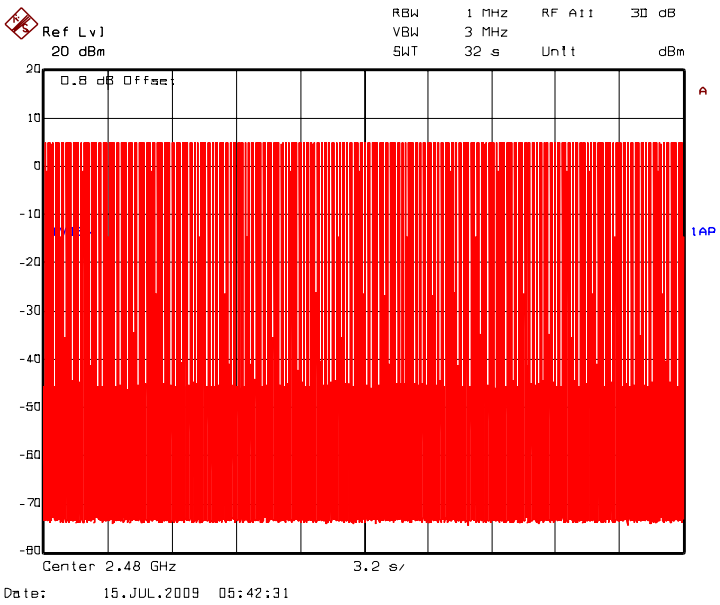


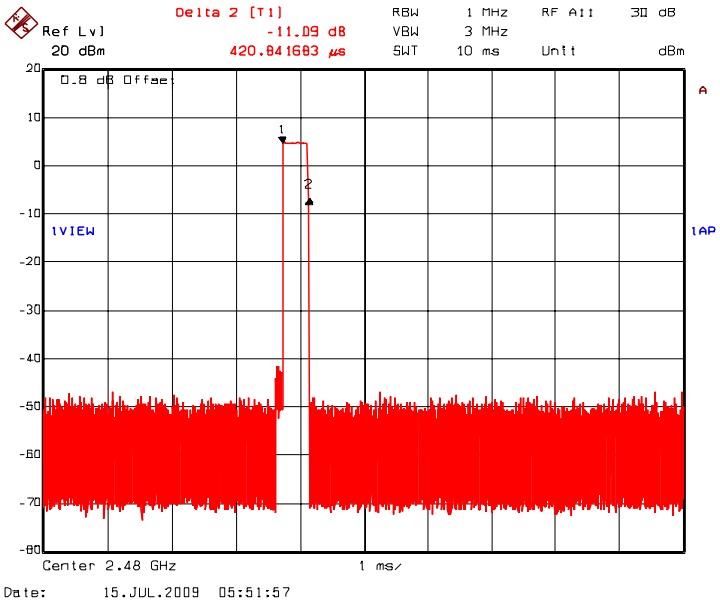
Plot 5.8.5.7. Time of Occupancy
Test Frequency: 2441 MHz, GFSK modulation
320 * 420.84μs= 134.67ms < 400ms in 32s



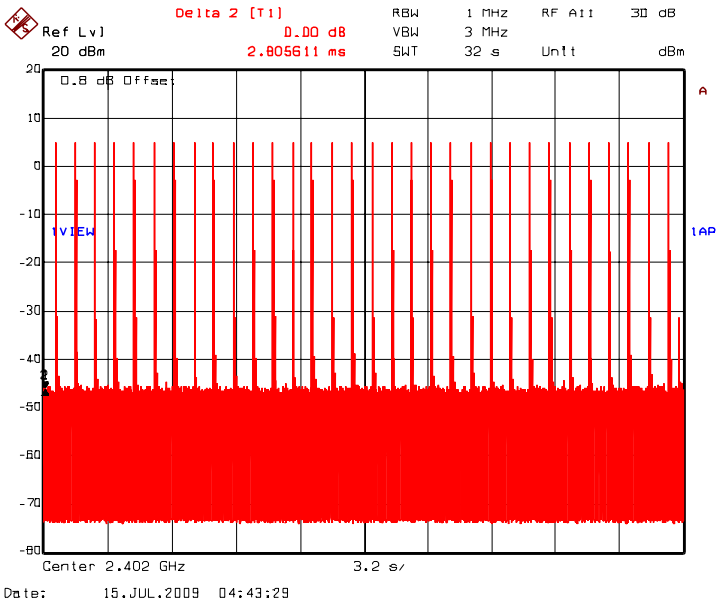


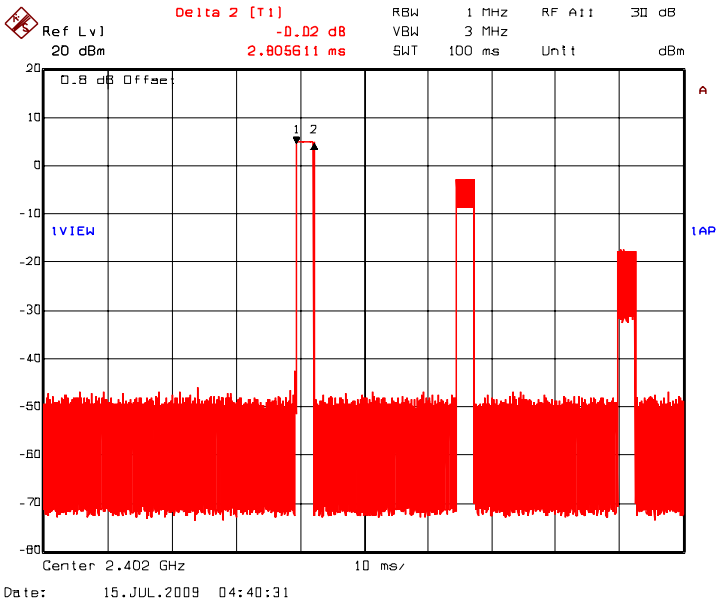
Plot 5.8.5.8. Time of Occupancy
Test Frequency: 2480 MHz, GFSK modulation
320 * 420.84μs= 134.67ms < 400ms in 32s



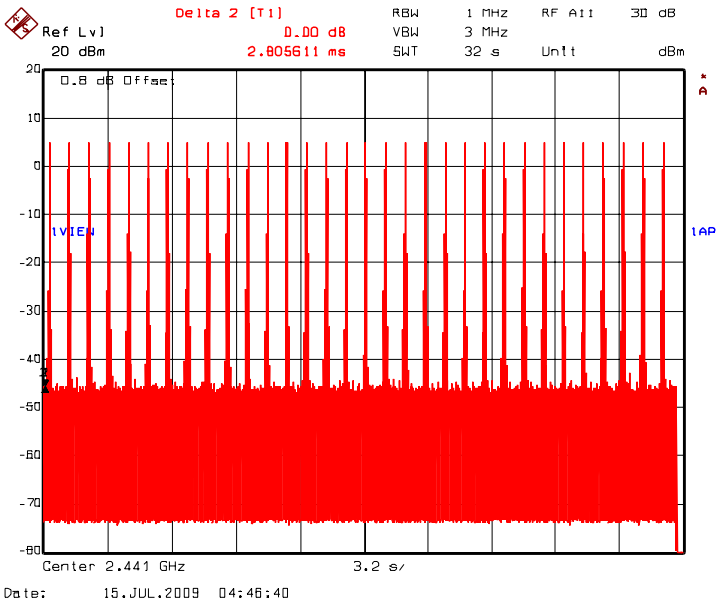


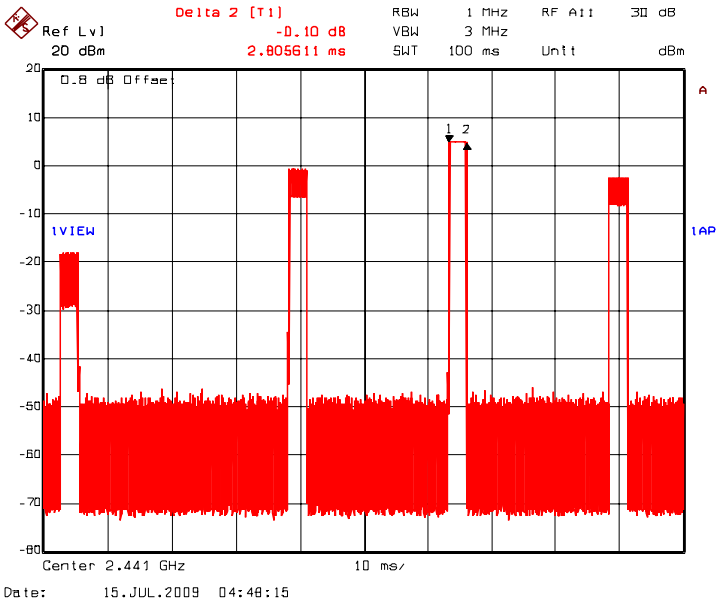
Plot 5.8.5.9. Time of Occupancy
Test Frequency: 2402 MHz, 8DPSK modulation
32 * 2.81ms= 89.92ms < 400ms in 32s



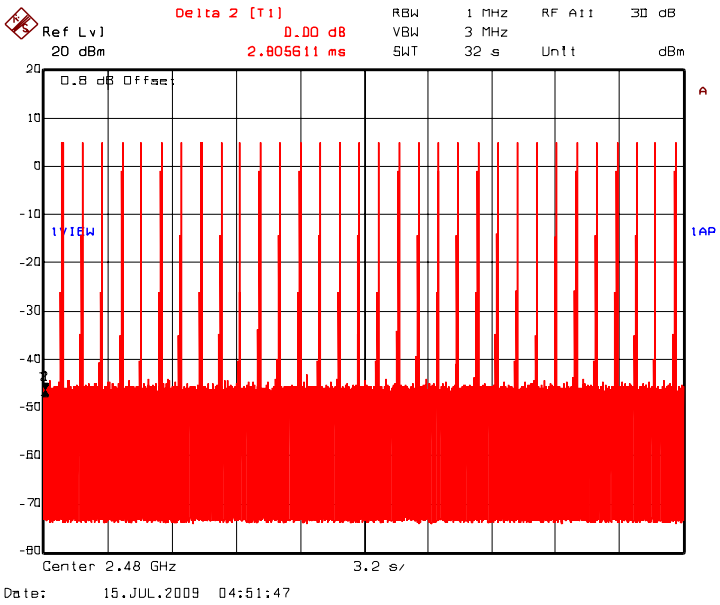


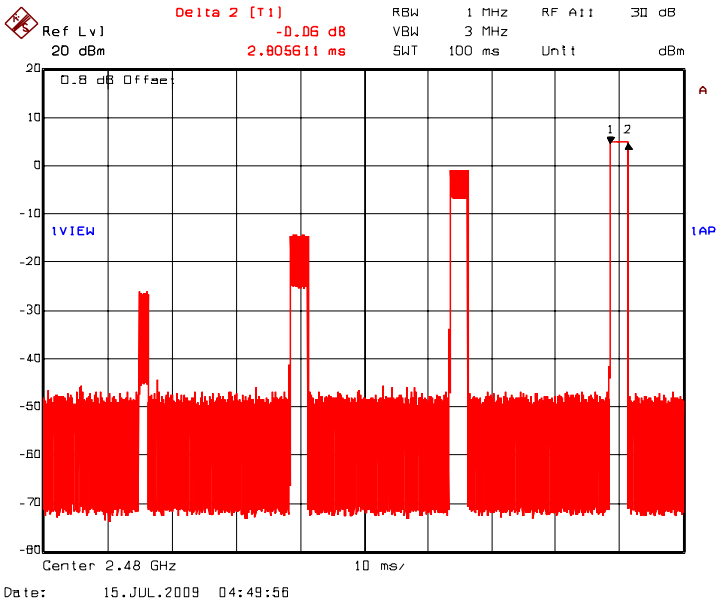
Plot 5.8.5.10. Time of Occupancy
Test Frequency: 2441 MHz, 8DPSK modulation
32 * 2.81ms= 89.92ms < 400ms in 32s



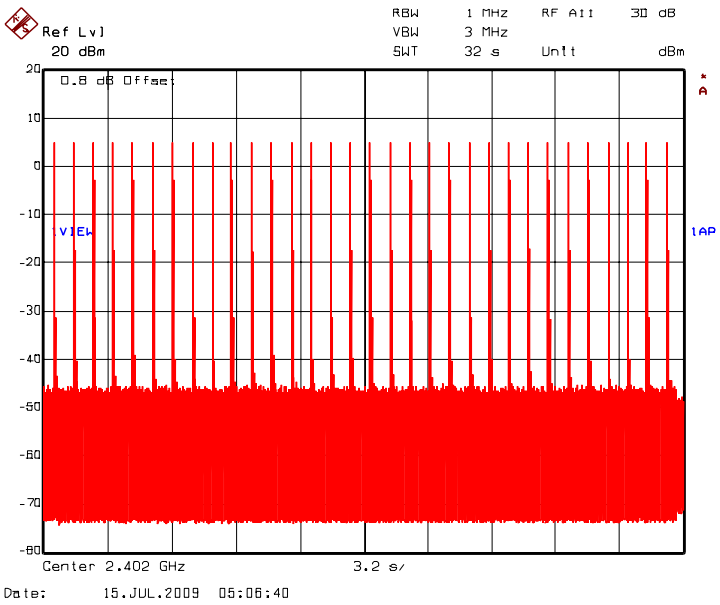


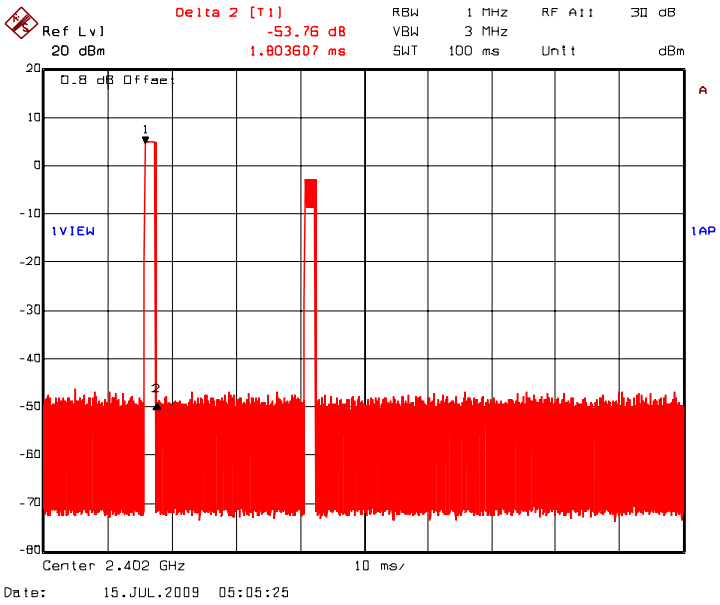
Plot 5.8.5.11. Time of Occupancy
Test Frequency: 2480 MHz, 8DPSK modulation
32 * 2.81ms= 89.92ms < 400ms in 32s



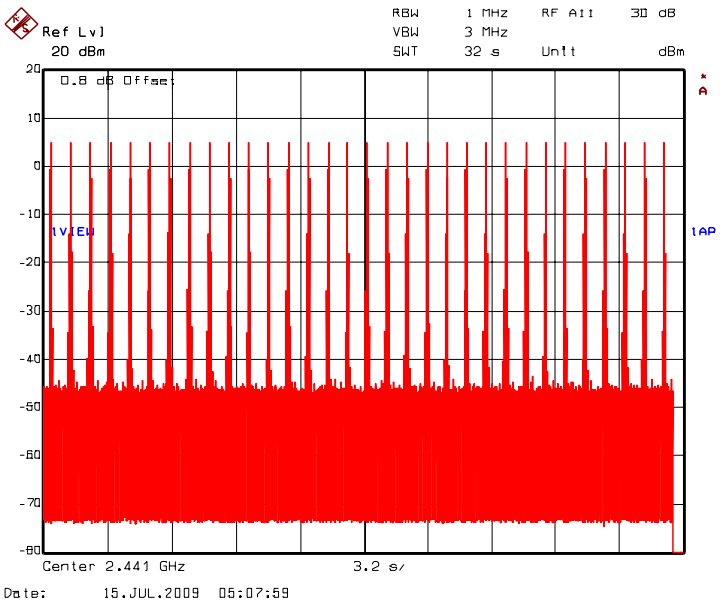


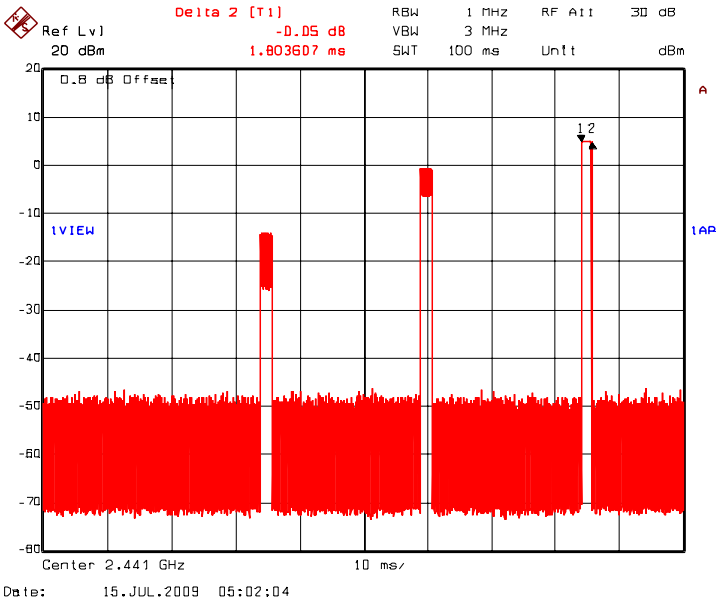
Plot 5.8.5.12. Time of Occupancy
Test Frequency: 2402 MHz, π/4 DPQSK modulation
32 * 1.80ms= 57.60ms < 400ms in 32s



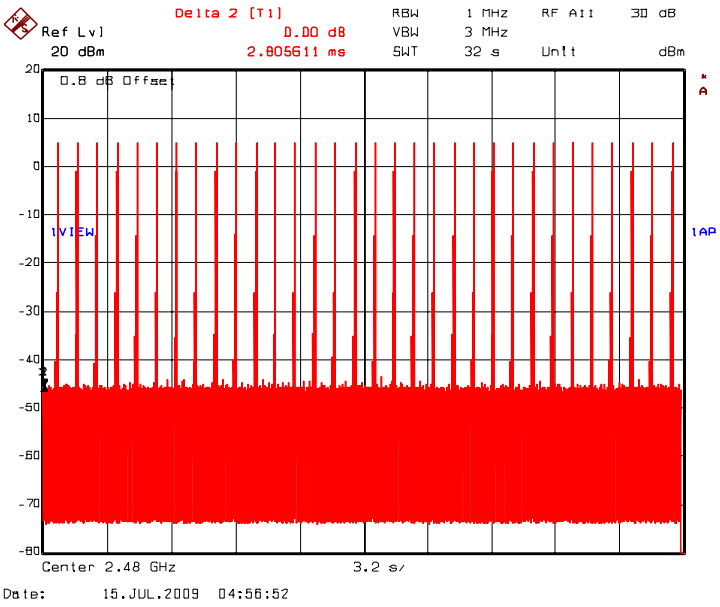


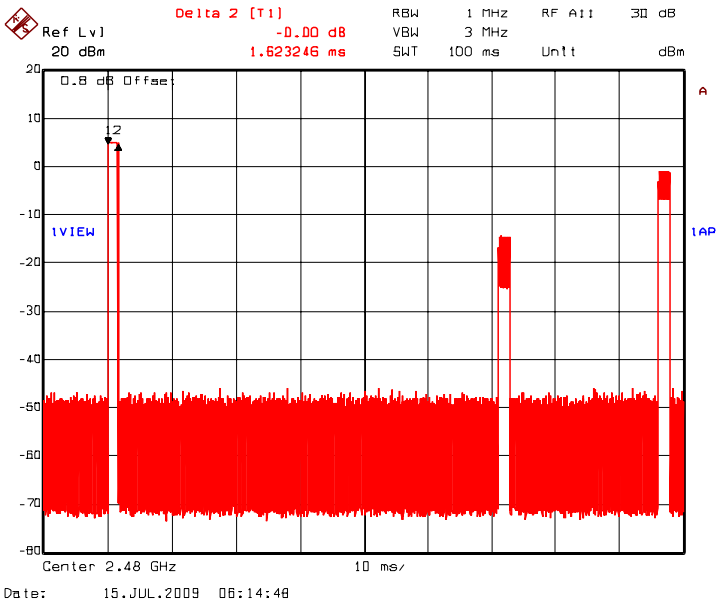
Plot 5.8.5.13. Time of Occupancy
Test Frequency: 2441 MHz, π/4 DPQSK modulation
32 * 1.80ms= 57.60ms < 400ms in 32s





Plot 5.8.5.14. Time of Occupancy
Test Frequency: 2480 MHz, π/4 DPQSK modulation
32 * 1.62ms= 51.84ms < 400ms in 32s





5.9. 6 dB BANDWIDTH [§ 15.247(a)(2)]

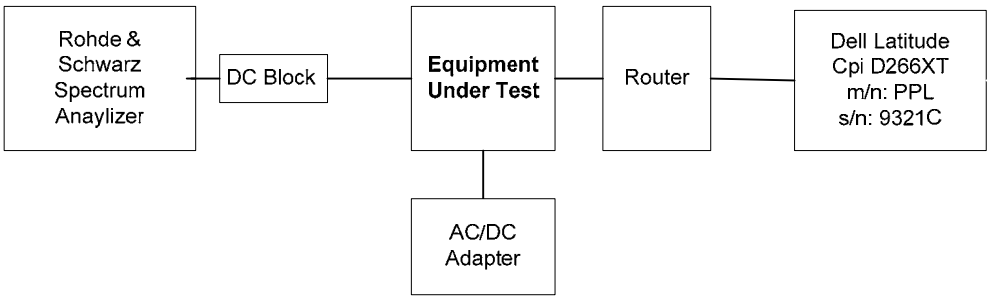
5.9.1. Limit

§15.247(a)(2) Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

5.9.2. Method of Measurements

FCC Public Notice DA 00-705 and ANSI C63.4.

5.9.3. Test Arrangement



5.9.4. Test Equipment List

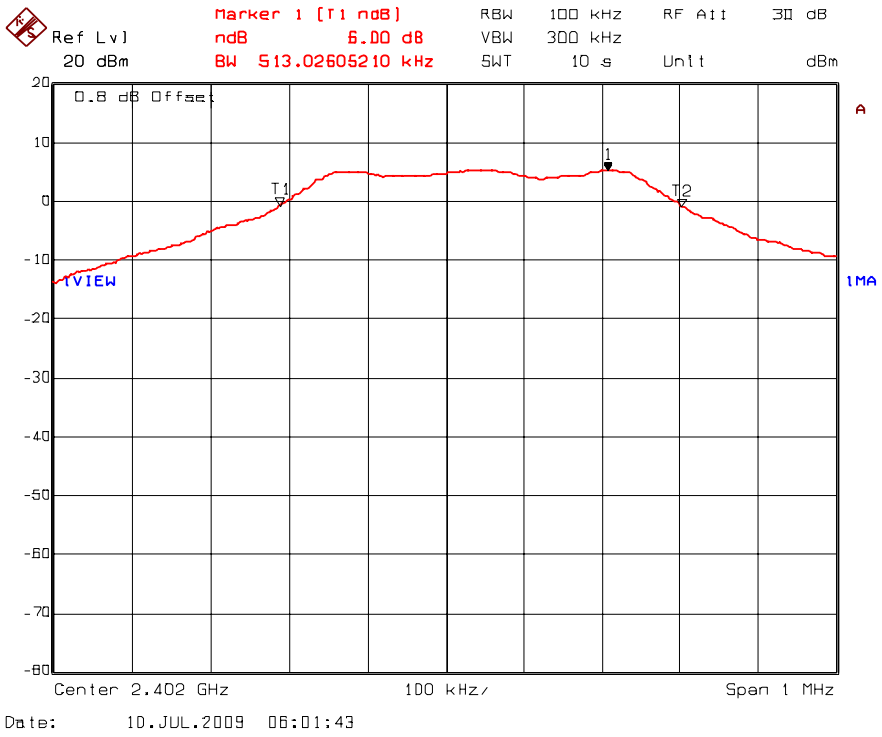
Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Rohde & Schwarz	FSEK20/B4/B21	834157/005	9 kHz – 40 GHz with external mixer
DC Block	Hewlett Packard	11742A	12460	0.045 – 26.5 GHz

5.9.5. Test Data

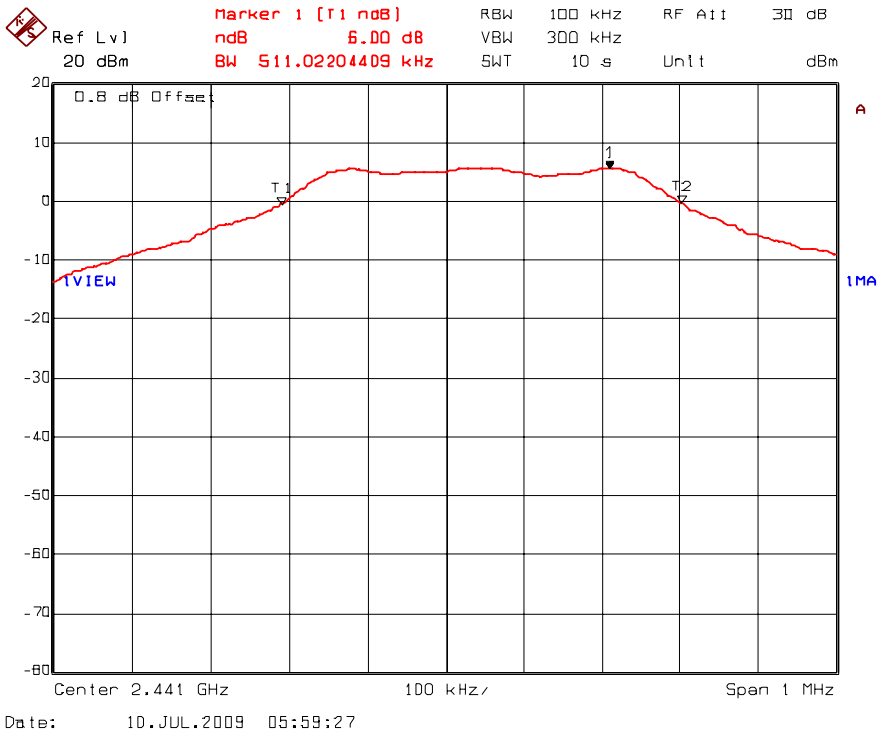
Transmitter Channel	Frequency (MHz)	6 dB Bandwidth (kHz)
Lowest	2402	513.026
Middle	2441	511.022
Highest	2480	511.022

Remark: See the following plots for details.

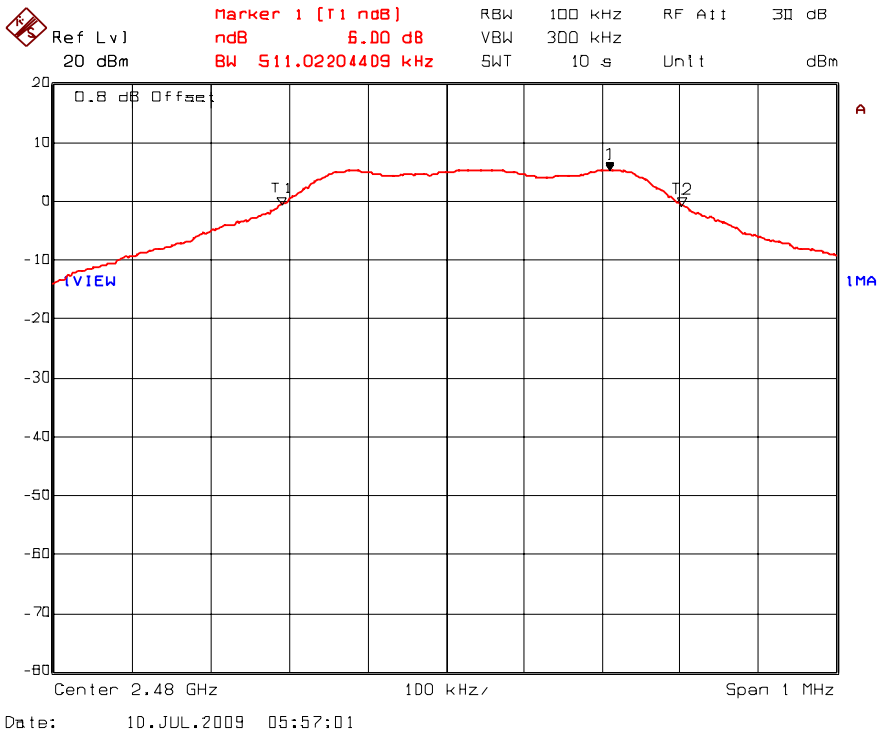
Plot 5.9.5.1. 6 dB Bandwidth
Test Frequency: 2402 MHz, GFSK Modulation



Plot 5.9.5.2. 6 dB Bandwidth
Test Frequency: 2441 MHz, GFSK Modulation



Plot 5.9.5.3. 6 dB Bandwidth
Test Frequency: 2480 MHz, GFSK Modulation



5.10. PEAK OUTPUT POWER & EQUIVALENT ISOTROPIC RADIATED POWER (EIRP) [§ 15.247(b)(1)]

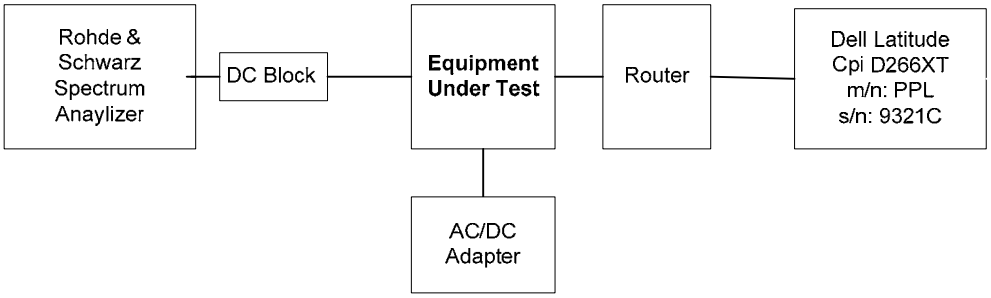
5.10.1. Limit

§15.247(b)(1) For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

5.10.2. Method of Measurements

FCC Public Notice DA 00-705 and ANSI C63.4.

5.10.3. Test Arrangement



5.10.4. Test Equipment List

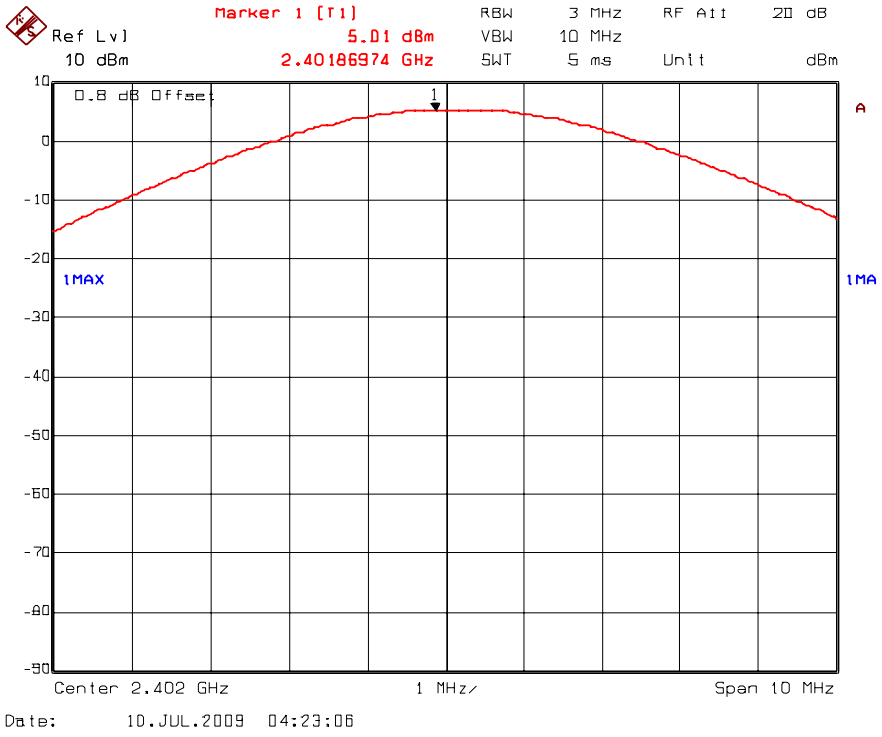
Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Rohde & Schwarz	FSEK20/B4/B21	834157/005	9 kHz – 40 GHz with external mixer
DC Block	Hewlett Packard	11742A	12460	0.045 – 26.5 GHz

5.10.5. Test Data

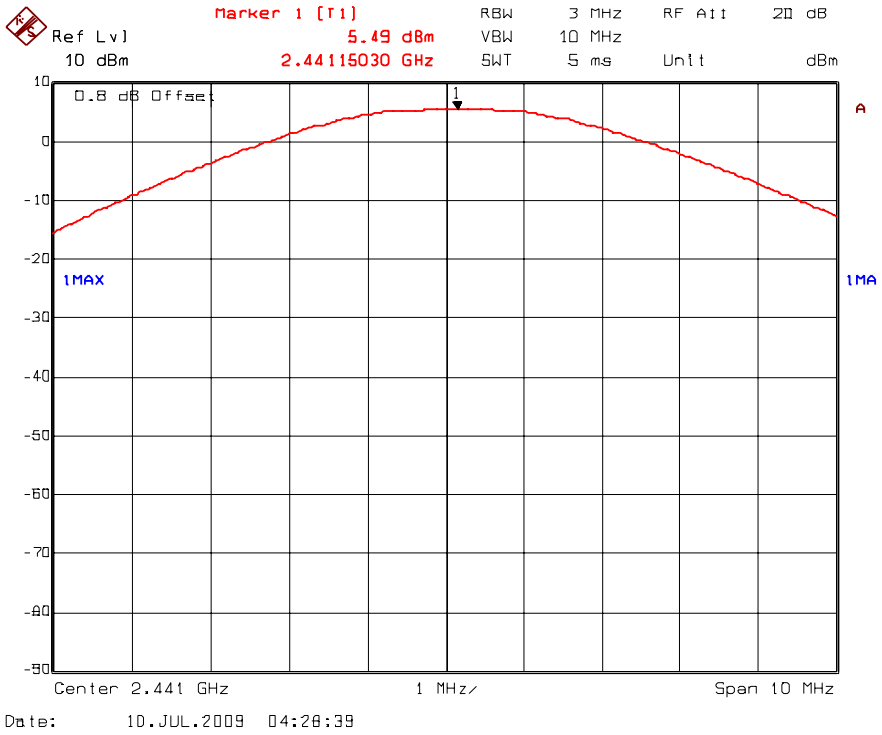
Transmitter Channel	Frequency (MHz)	Peak Output Power at Antenna Terminal (dBm)	Calculated EIRP (dBm)	Peak Output Power Limit (dBm)	EIRP Limit (dBm)
Lowest	2402	5.01	5.51	30.0	36.0
Middle	2441	5.49	5.99	30.0	36.0
Highest	2480	5.37	5.87	30.0	36.0

Remark: See the following plots for details.

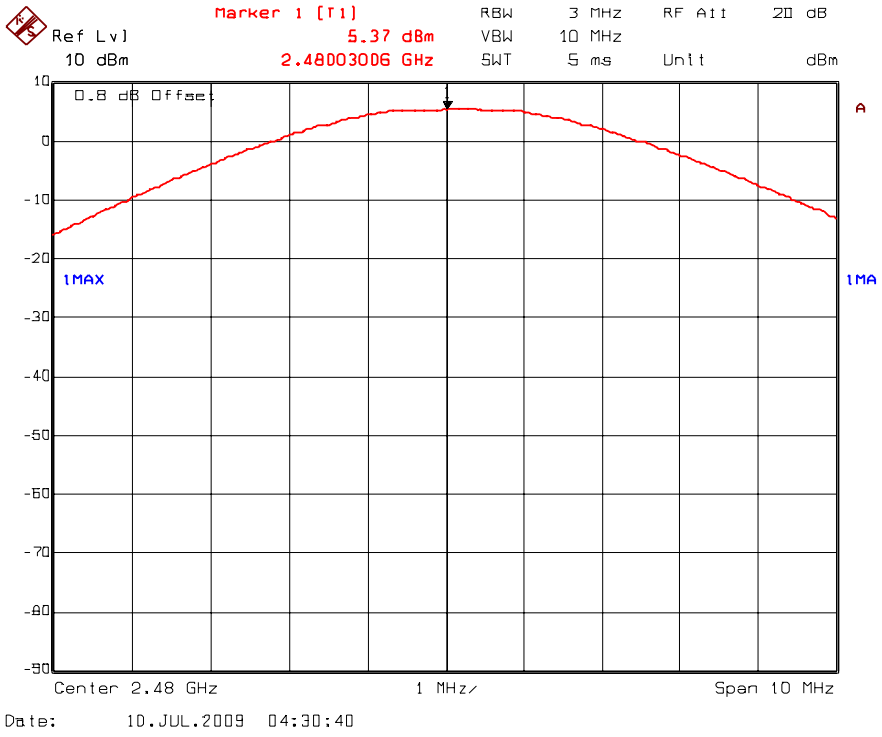
Plot 5.10.5.1. Peak Output Power
Test Frequency: 2402 MHz, GFSK Modulation
Power Supply Voltage: 48.0 VDC



Plot 5.10.5.2. Peak Output Power
Test Frequency: 2441 MHz, GFSK Modulation
Power Supply Voltage: 48.0 VDC



Plot 5.10.5.3. Peak Output Power
Test Frequency: 2480 MHz, GFSK Modulation
Power Supply Voltage: 48.0 VDC



5.11. TRANSMITTER BAND-EDGE & SPURIOUS CONDUCTED EMISSIONS [§ 15.247(d)]

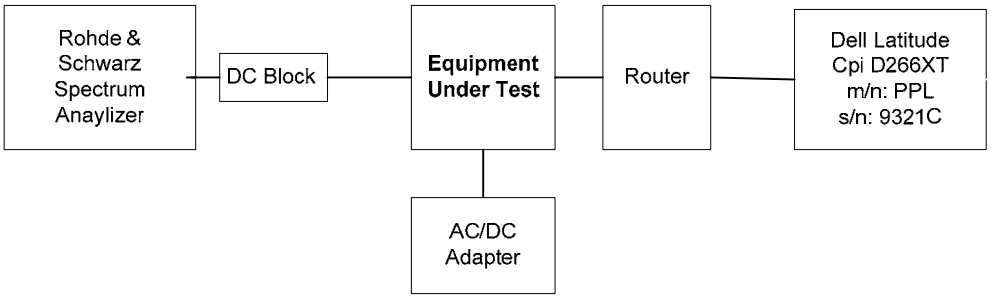
5.11.1. Limits

§ 15.247 (d): 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 least 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, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a) (see § 15.205(c)).

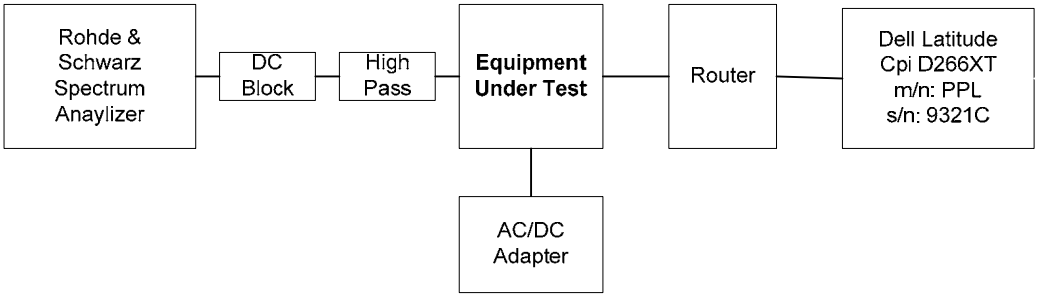
5.11.2. Method of Measurements

FCC Public Notice DA 00-705.

5.11.3. Test Arrangement



< Band-edge RF conducted measurement >



< Spurious RF conducted measurement >

5.11.4. Test Equipment List

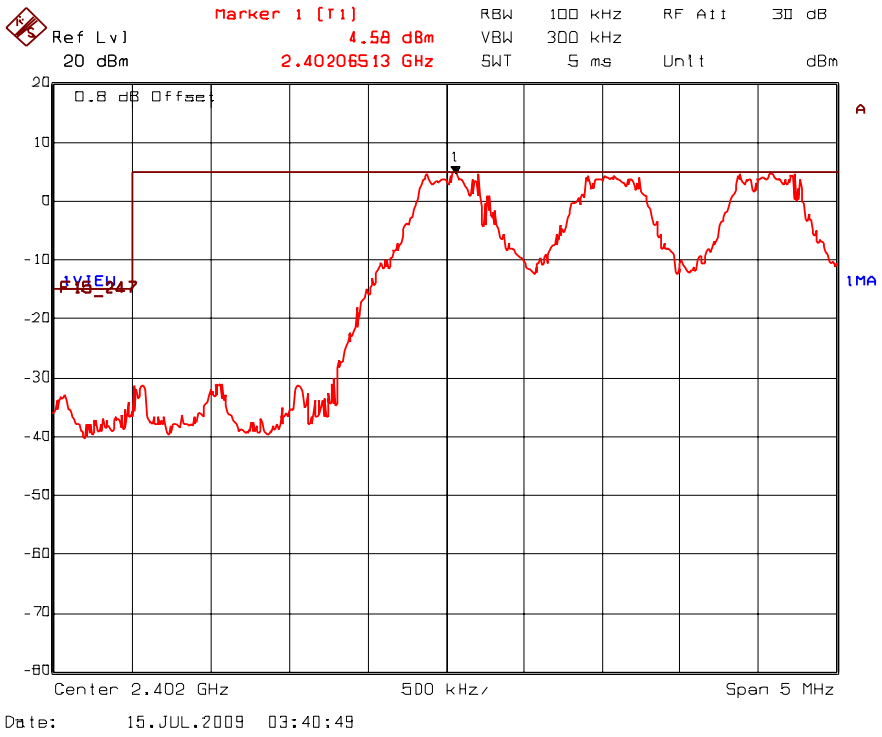
Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Rohde & Schwarz	FSEK20/B4/B21	834157/005	9 kHz – 40 GHz with external mixer
High Pass Filter	K & L	11SH10-4000/T12000	4	Cut off 2.4 GHz
DC Block	Hewlett Packard	11742A	12460	0.045 – 26.5 GHz

5.11.5. Test Data

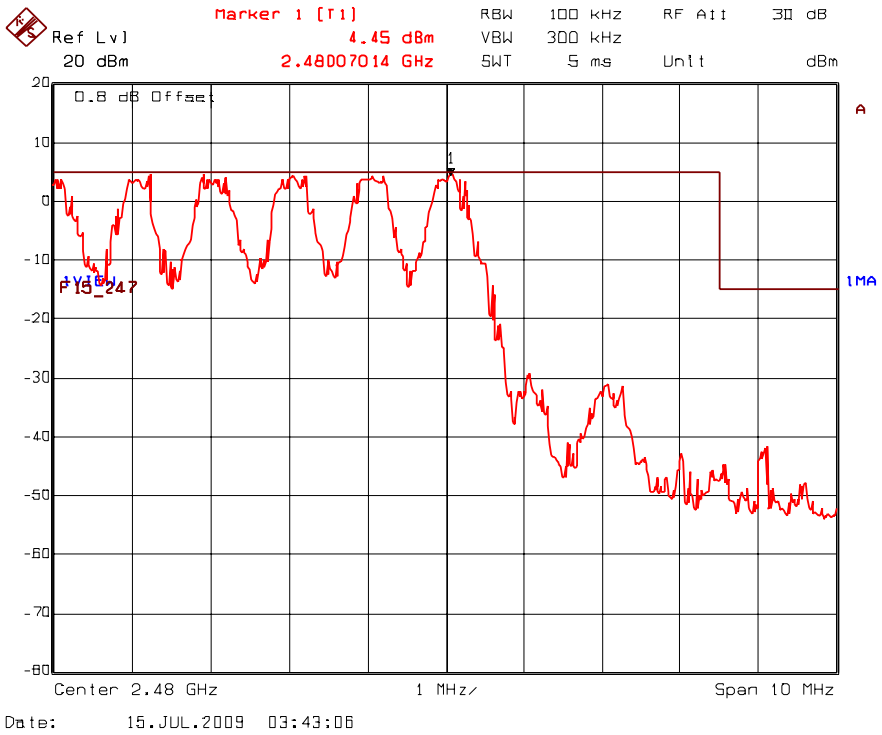
5.11.5.1. Band-Edge RF Conducted Emissions

See the following test data plots for measurement results:

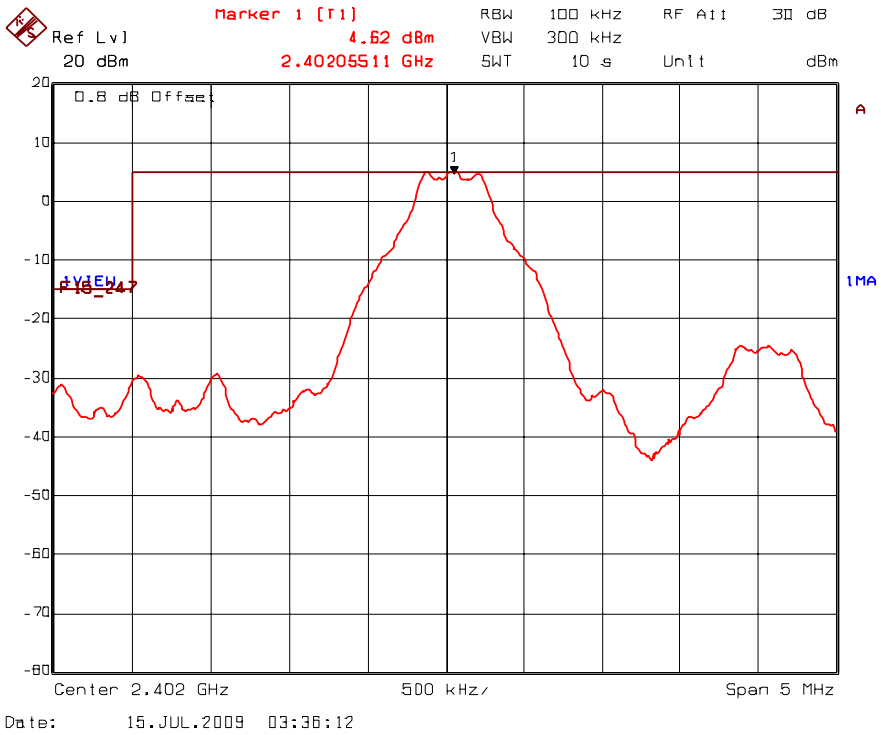
Plot 5.11.5.1.1. Band-Edge RF Conducted Emissions
Hopping Mode, Low End of Frequency Band



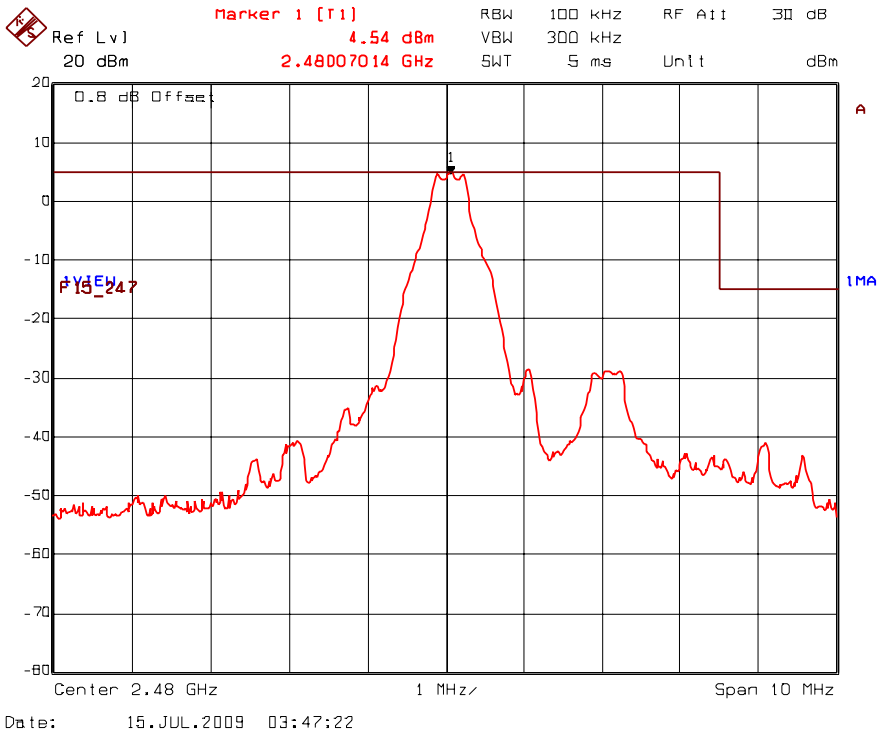
Plot 5.11.5.1.2. Band-Edge RF Conducted Emissions
Hopping Mode, High End of Frequency Band



Plot 5.11.5.1.3. Band-Edge RF Conducted Emissions
Continuous Mode, Low End of Frequency Band



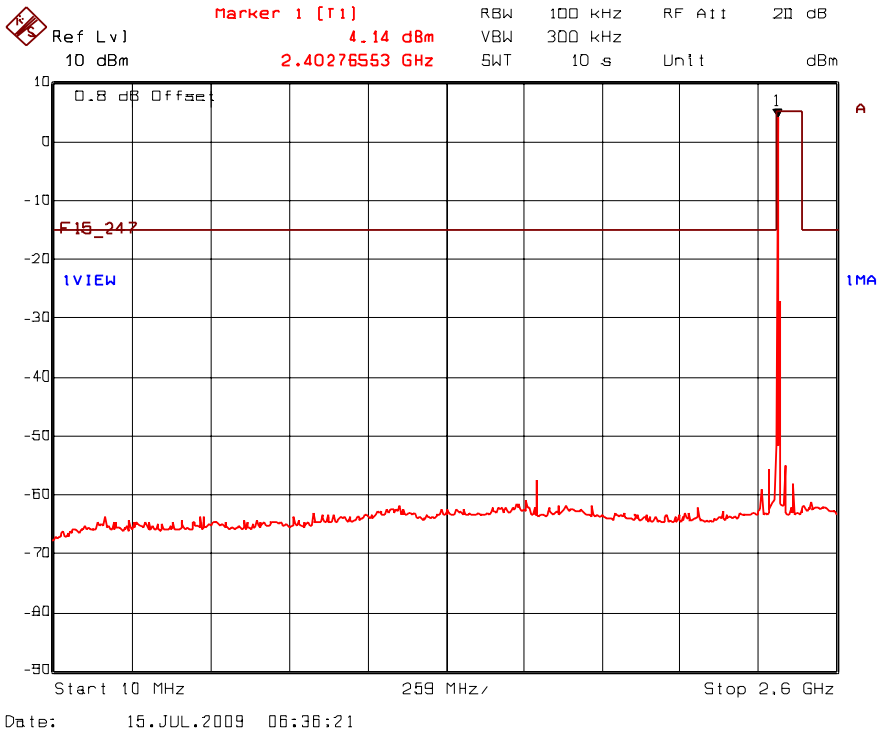
Plot 5.11.5.1.4. Band-Edge RF Conducted Emissions
Continuous Mode, High End of Frequency Band



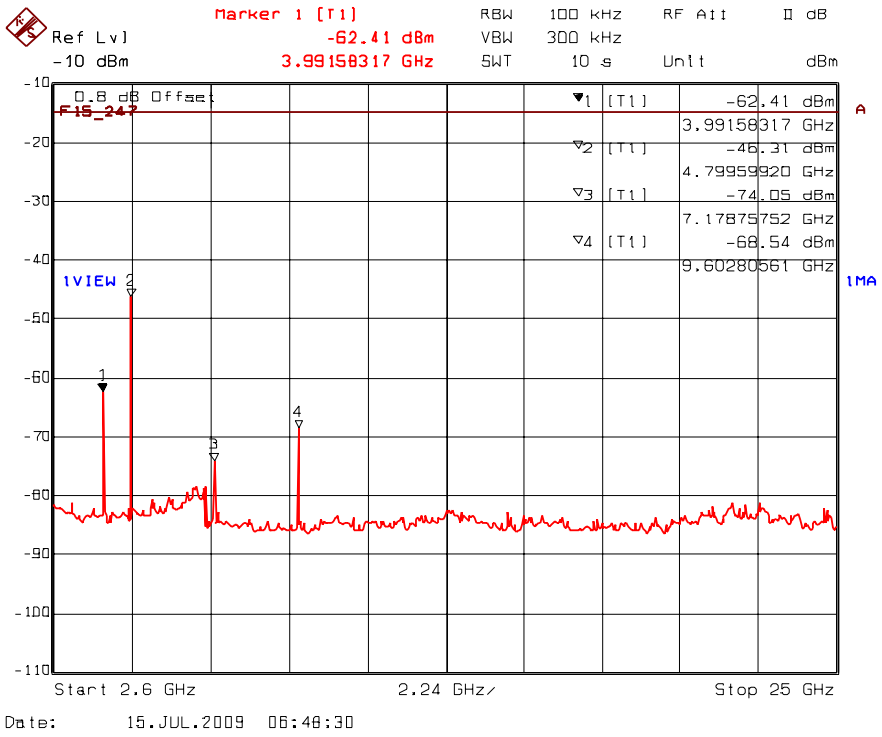
5.11.5.2. Spurious RF Conducted Emissions

The emissions were scanned from 10 MHz to 10 GHz; see the following test data plots for measurement results.

Plot 5.11.5.2.1. Spurious RF Conducted Emissions
Test Frequency: 2402 MHz, GFSK Modulation

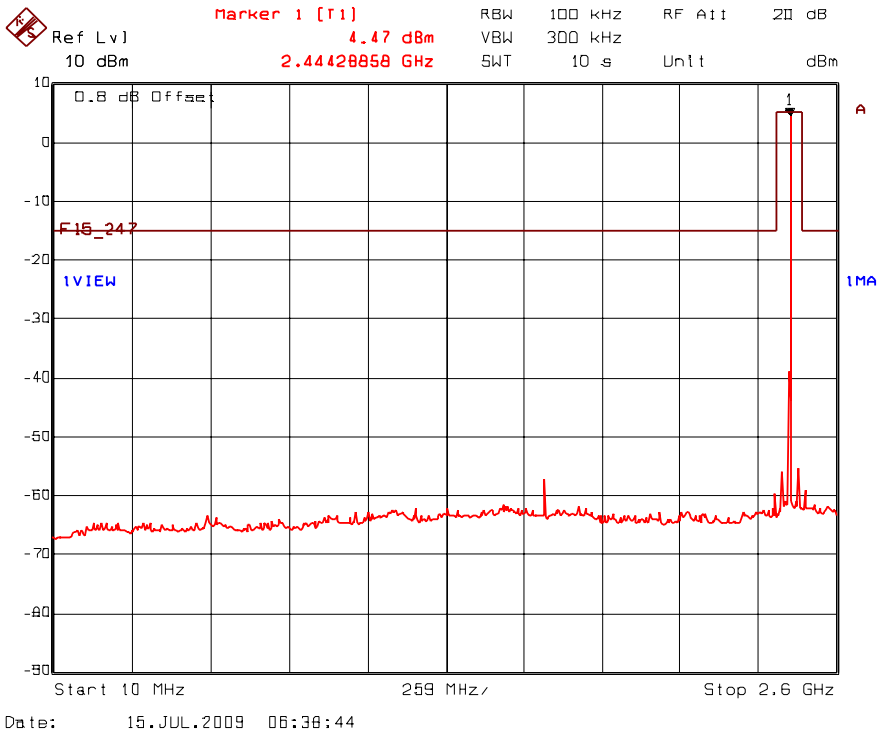


Plot 5.11.5.2.2. Spurious RF Conducted Emissions
Test Frequency: 2402 MHz, GFSK Modulation

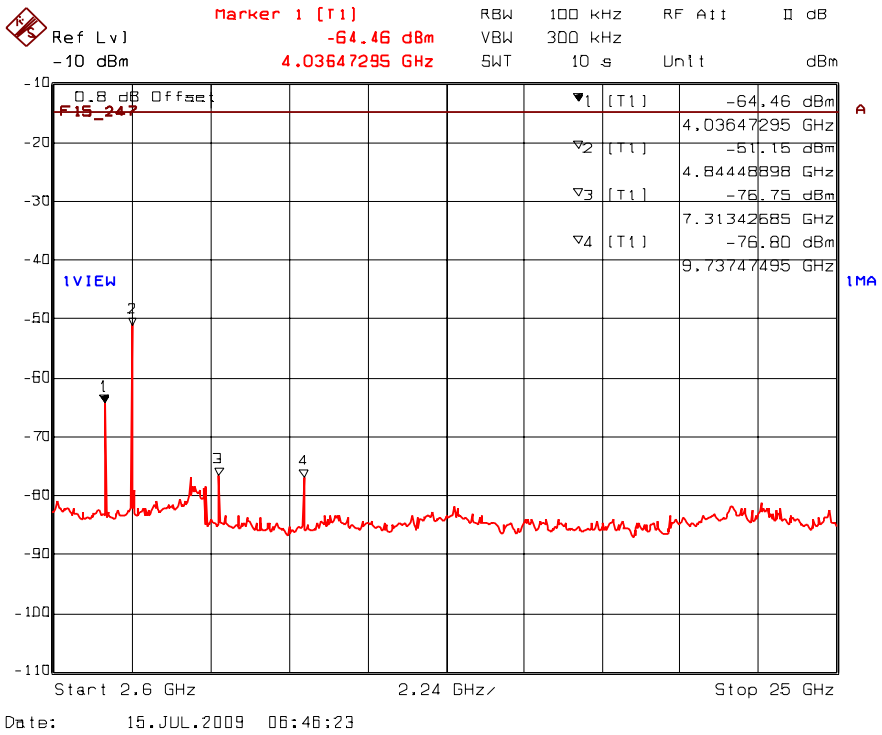


All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

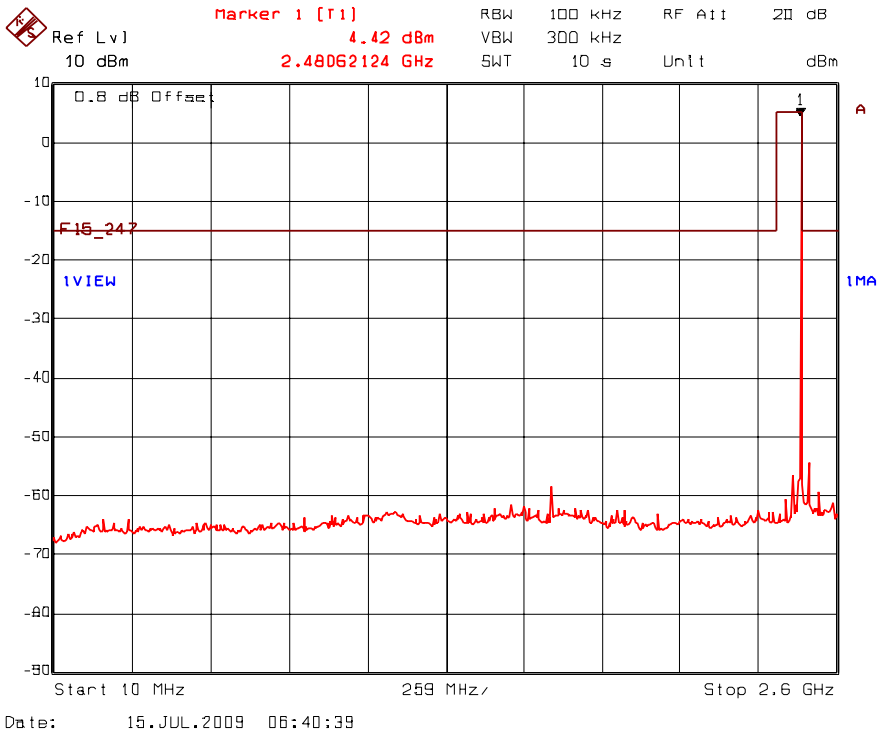
Plot 5.11.5.2.3. Spurious RF Conducted Emissions
Test Frequency: 2441 MHz, GFSK Modulation



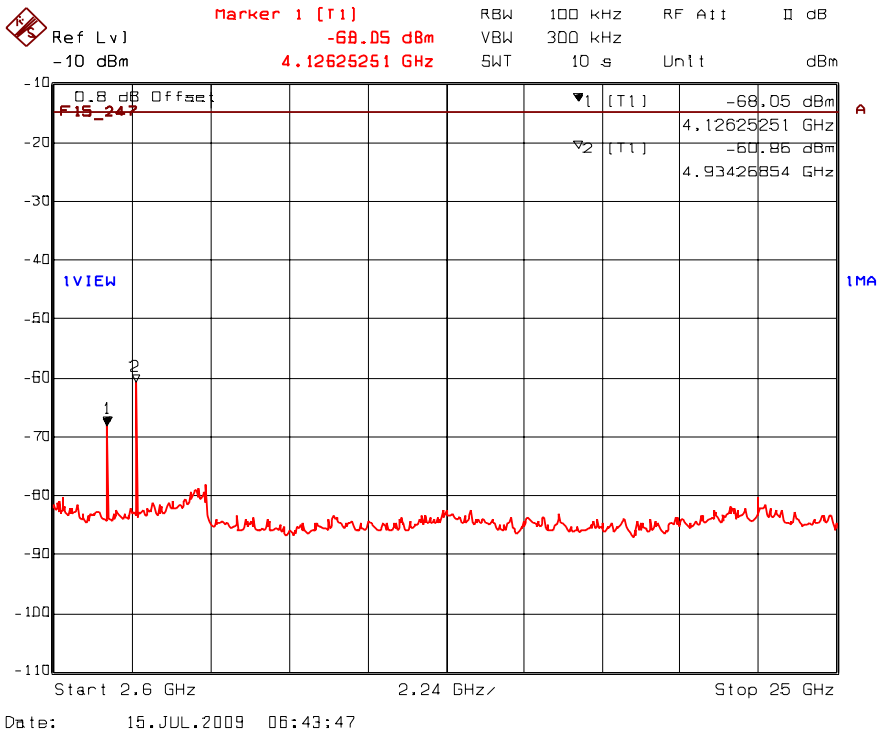
Plot 5.11.5.2.4. Spurious RF Conducted Emissions
Test Frequency: 2441 MHz, GFSK Modulation



Plot 5.11.5.2.5. Spurious RF Conducted Emissions
Test Frequency: 2480 MHz, GFSK Modulation



Plot 5.11.5.2.6. Spurious RF Conducted Emissions
Test Frequency: 2480 MHz, GFSK Modulation



5.12. TRANSMITTER BAND-EDGE & SPURIOUS RADIATED EMISSIONS [§§ 15.247(d), 15.209 & 15.205]

5.12.1. Limits

§ 15.247 (d): 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 least 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, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a) (see § 15.205(c)).

Section 15.205(a) - Restricted Bands of Operation

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
[1] 0.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675	156.7–156.9	2655–2900	22.01–23.12
8.41425–8.41475	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725	322–335.4	3600–4400	[2]
13.36–13.41.			

[1] Until February 1, 1999, this restricted band shall be 0.490–0.510 MHz.
[2] Above 38.6

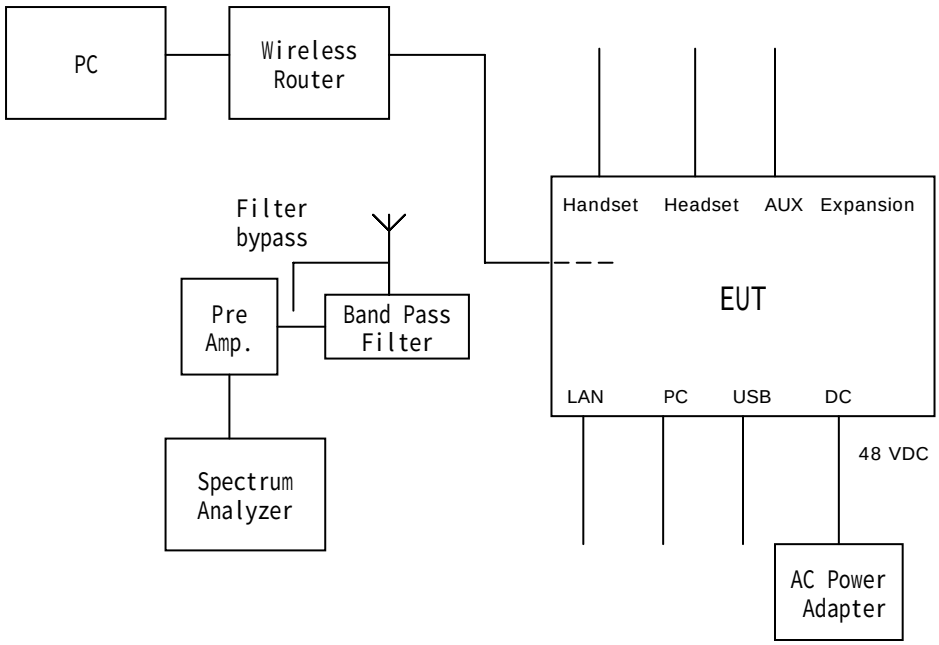
Section 15.209(a)
-- Field Strength Limits within Restricted Frequency Bands --

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 - 0.490	2,400 / F (kHz)	300
0.490 - 1.705	24,000 / F (kHz)	30
1.705 - 30.0	30	30
30 – 88	100	3
88 – 216	150	3
216 – 960	200	3
Above 960	500	3

5.12.2. Method of Measurements

KDB Publication No. 558074: Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247)

5.12.3. Test Arrangement



< Spurious radiated emissions measurement >

5.12.4. Test Equipment List

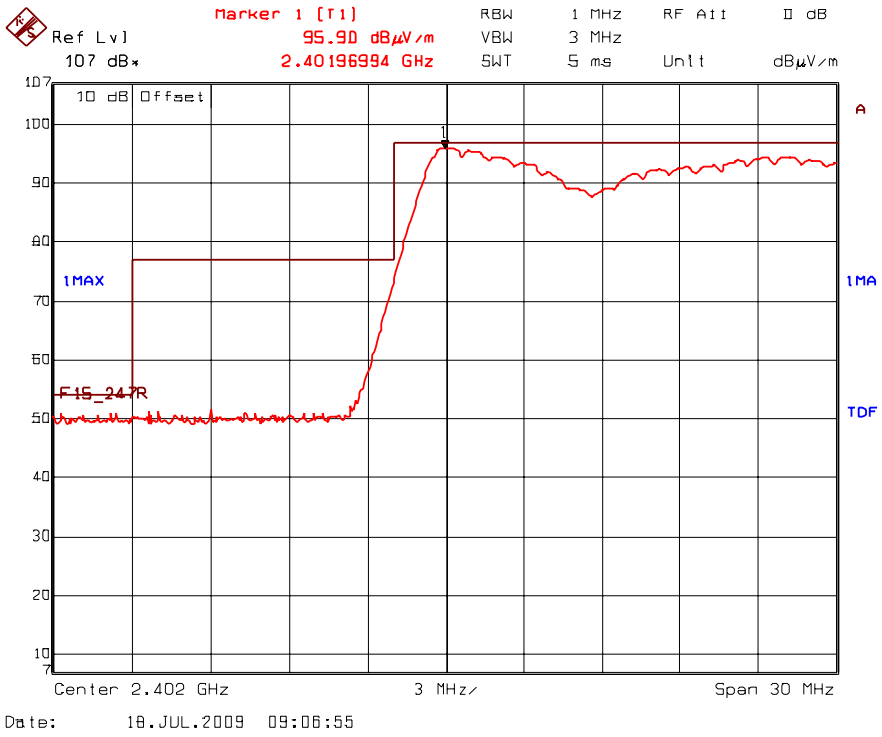
Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Rhode & Schwarz	FSEK 20	834157	9 kHz - 40 GHz
Microwave Amplifier	Hewlett Packard	HP 8449B	8008A00769	1 GHz – 26.5 GHz
Biconilog antenna	EMCO	3142	10005	30 MHz – 2 GHz
Dipole Antenna	EMCO	3121C	8907-434	30 MHz – 1 GHz
Dipole Antenna	EMCO	3121C	8907-440	30 MHz – 1 GHz
Horn Antenna	EMCO	3155	9701-5061	1 GHz – 18 GHz
Horn Antenna	EMCO	3155	9701-5955	1 GHz – 18 GHz
High Pass Filter	K & L	11SH10-4000 / T12000-0/0	4	2 – 26 GHz

5.12.5. Test Data

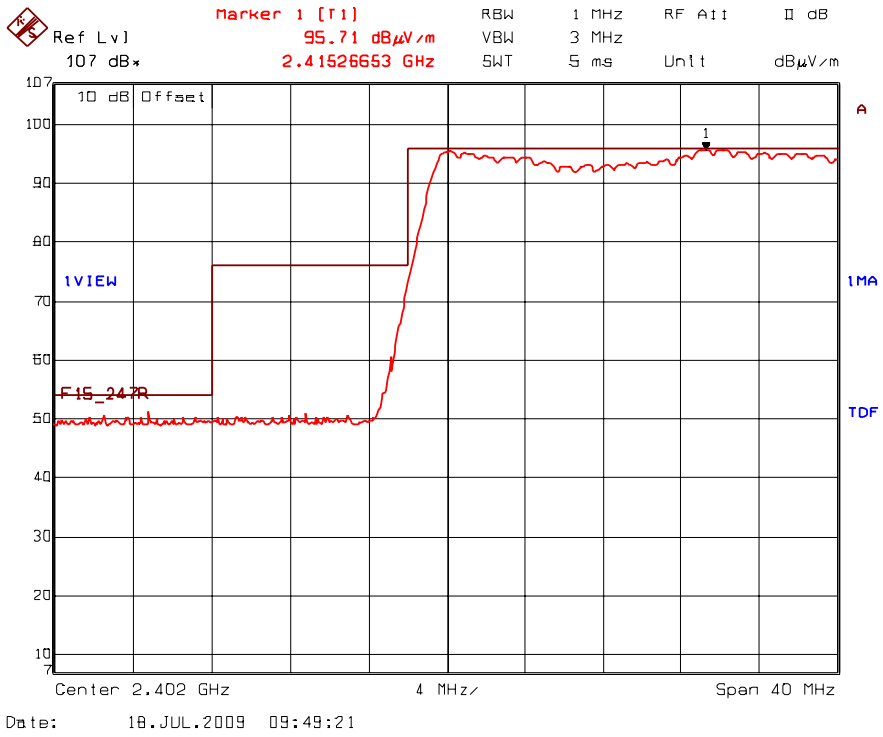
5.12.5.1. Band-Edge RF Radiated Emissions

See the following test data plots for measurement results:

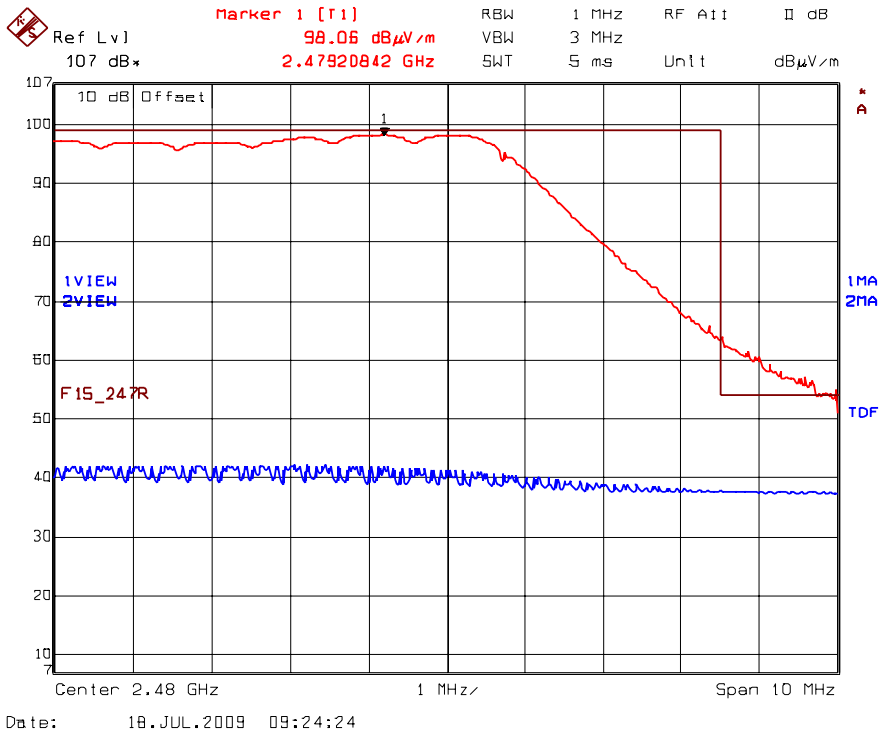
Plot 5.12.5.1.1. Band-Edge RF Radiated Emissions
Hopping Mode, Low End of Frequency Band, Horizontal



Plot 5.12.5.1.2. Band-Edge RF Radiated Emissions
Hopping Mode, Low End of Frequency Band, Vertical

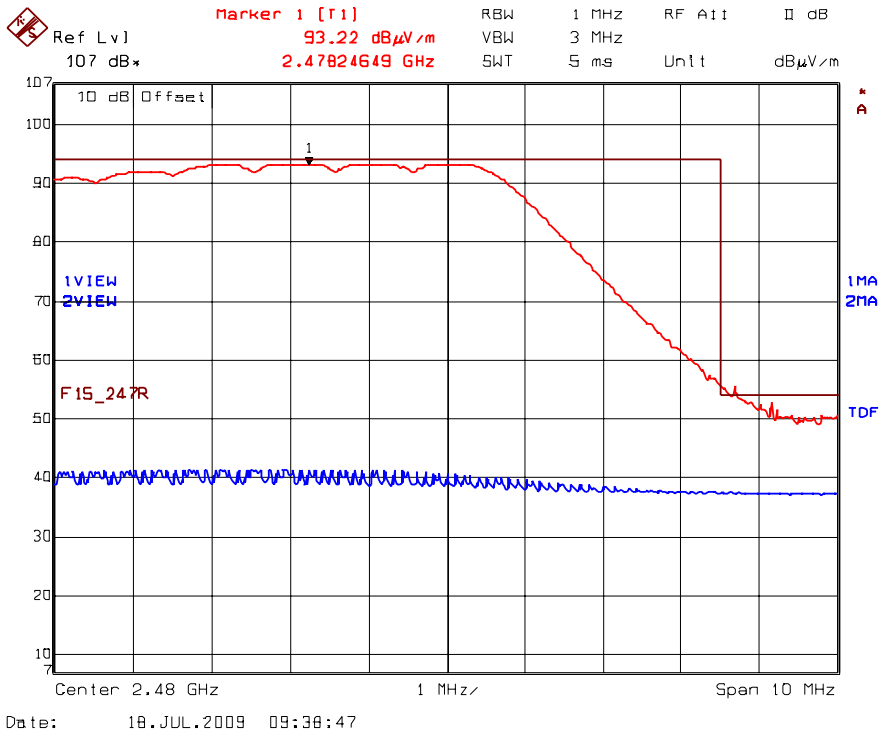


Plot 5.12.5.1.3. Band-Edge RF Conducted Emissions
Hopping Mode, High End of Frequency Band, Horizontal



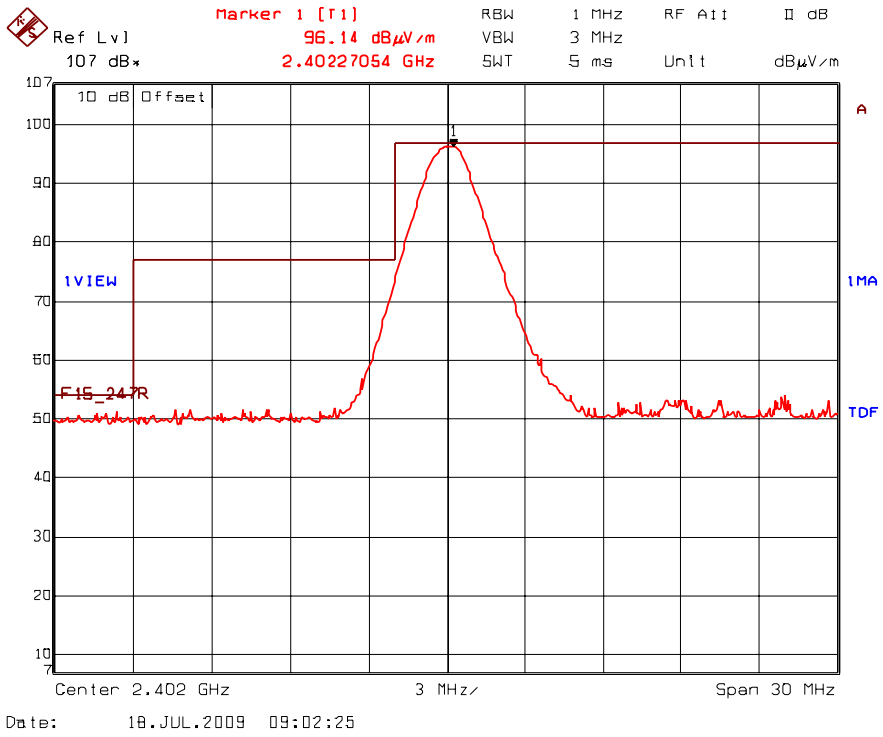
Trace 1: RBW= 1 MHz, VBW= 3 MHz
Trace 1: RBW= 1 MHz, VBW= 10 Hz

Plot 5.12.5.1.4. Band-Edge RF Conducted Emissions
Hopping Mode, High End of Frequency Band, Vertical

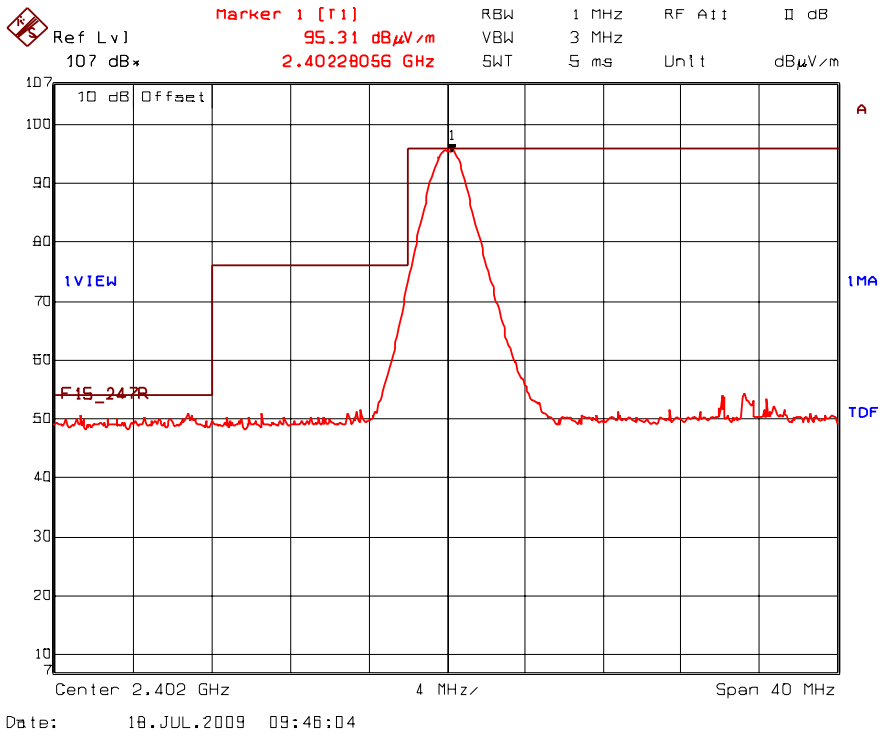


Trace 1: RBW= 1 MHz, VBW= 3 MHz
Trace 1: RBW= 1 MHz, VBW= 10 Hz

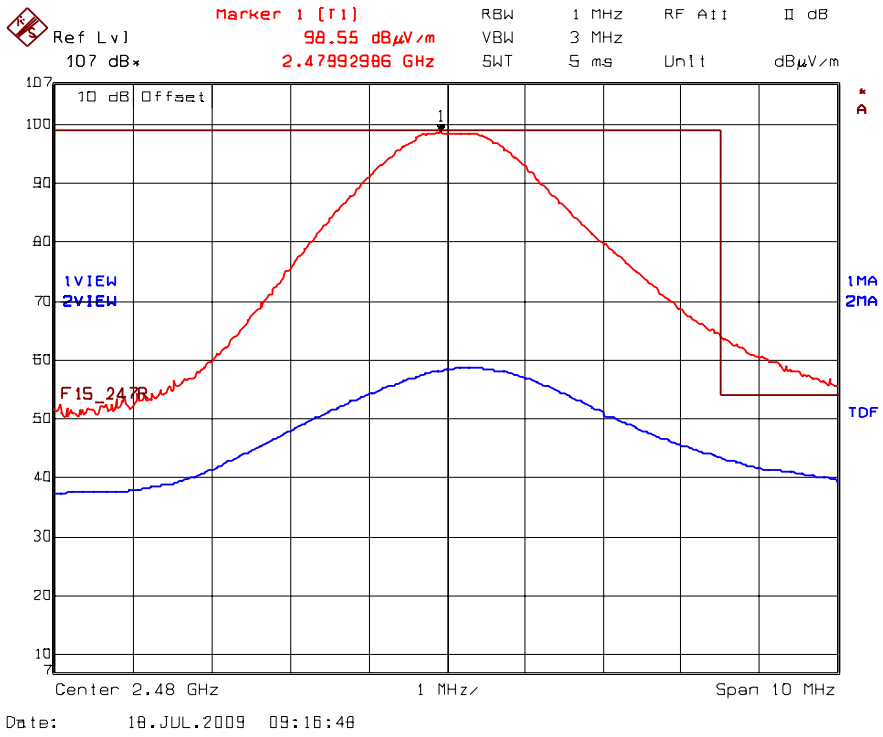
Plot 5.12.5.1.5. Band-Edge RF Conducted Emissions
Continuous Mode, Low End of Frequency Band, Horizontal



Plot 5.12.5.1.6. Band-Edge RF Conducted Emissions
Continuous Mode, Low End of Frequency Band, Vertical

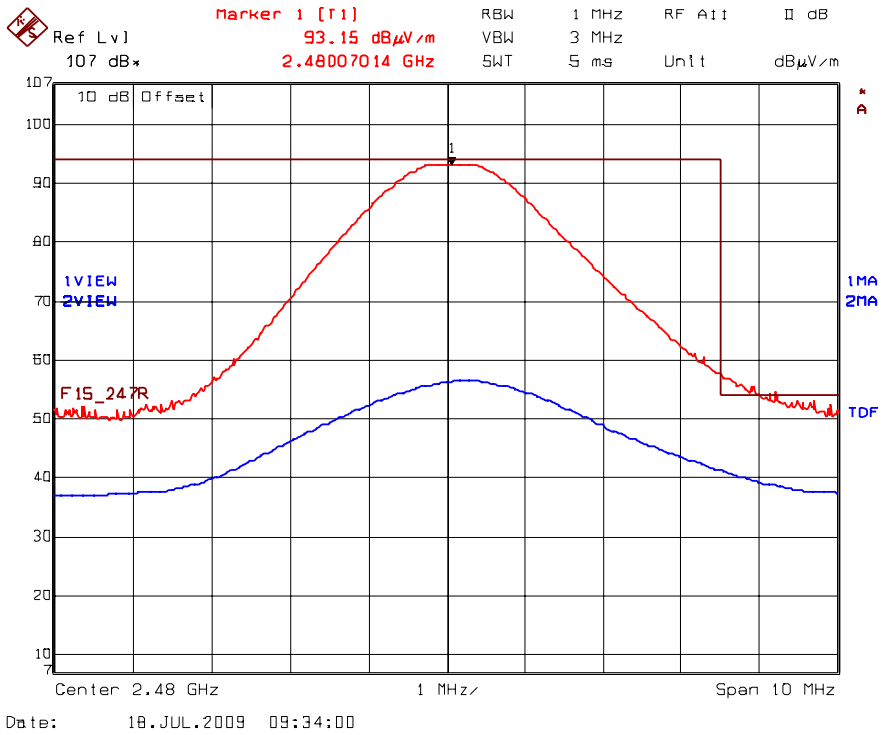


Plot 5.12.5.1.7. Band-Edge RF Conducted Emissions
Continuous Mode, High End of Frequency Band, Horizontal



Trace 1: RBW= 1 MHz, VBW= 3 MHz
Trace 1: RBW= 1 MHz, VBW= 10 Hz

Plot 5.12.5.1.8. Band-Edge RF Conducted Emissions
Continuous Mode, High End of Frequency Band, Vertical



Trace 1: RBW= 1 MHz, VBW= 3 MHz
Trace 1: RBW= 1 MHz, VBW= 10 Hz

5.12.5.2. Spurious RF Radiated Emissions

Fundamental Frequency:	2402 MHz
Test Frequency Range:	30 MHz – 25 GHz

All emissions within 20 dB below the limit are recorded.

Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/ Fail
2402	95.31	--	V	--	--	--	--
2402	96.14	--	H	--	--	--	--
4804*	60.84	40.41	V	54	76.14	-13.59	Pass
4804*	63.31	41.03	H	54	76.14	-12.97	Pass

Fundamental Frequency:	2437 MHz
Test Frequency Range:	30 MHz – 25 GHz

All emissions within 20 dB below the limit are recorded.

Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/ Fail
2437	94.26	--	V	--	--	--	--
2437	97.34	--	H	--	--	--	--
4882*	60.68	39.17	V	54	77.34	-14.83	Pass
4882*	63.03	40.68	H	54	77.34	-13.32	Pass

Fundamental Frequency:	2480 MHz
Test Frequency Range:	30 MHz – 25 GHz

All emissions within 20 dB below the limit are recorded.

Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/ Fail
2480	93.15	--	V	--	--	--	--
2480	98.55	--	H	--	--	--	--
4960*	59.24	40.02	V	54	78.55	-13.98	Pass
4960*	60.49	40.56	H	54	78.55	-13.44	Pass

5.13. POWER SPECTRAL DENSITY [§ 15.247(e)]

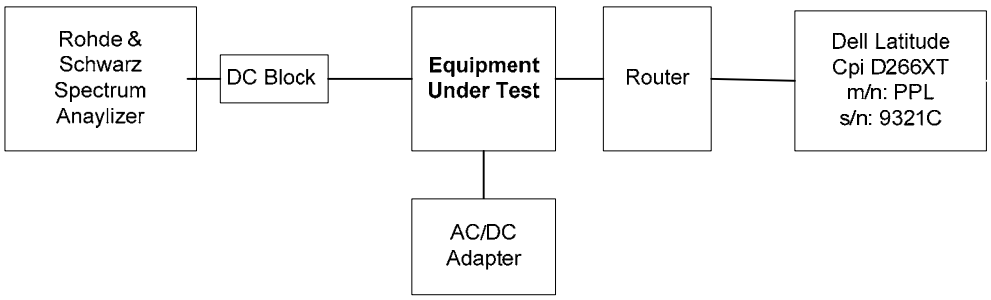
5.13.1. Limit(s)

For digitally modulated 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.

5.13.2. Method of Measurements

KDB Publication No. 558074: Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247), PSD Option 2 method.

5.13.3. Test Arrangement



5.13.4. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Rohde & Schwarz	FSEK20/B4/B21	834157/005	9 kHz – 40 GHz with external mixer
DC Block	Hewlett Packard	11742A	12460	0.045 – 26.5 GHz

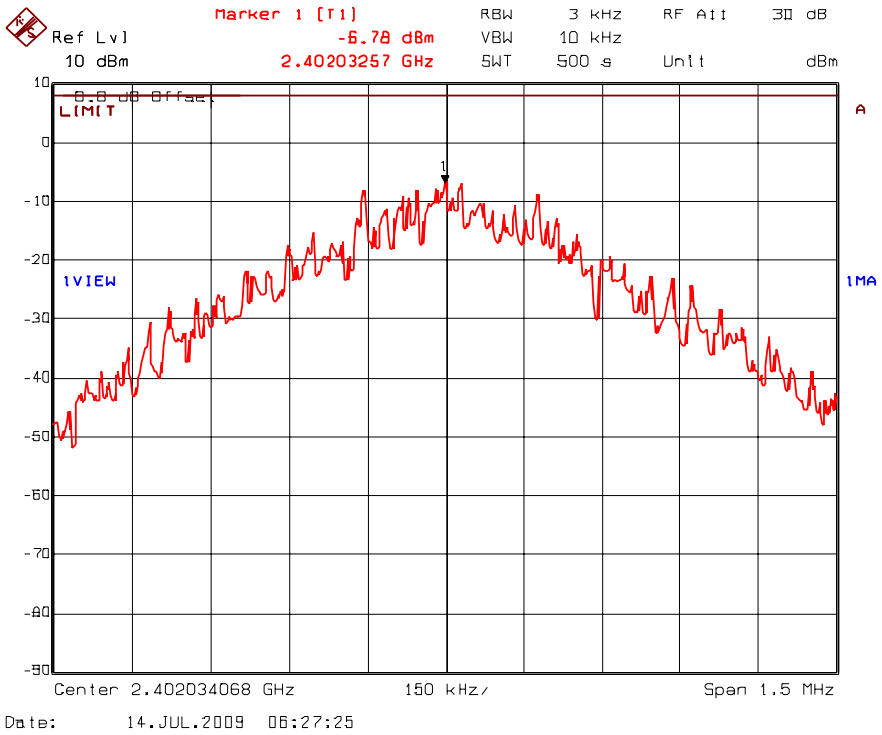
5.13.5. Test Data

Remark: Measurement method: Power spectral density (PSD) Option 2.

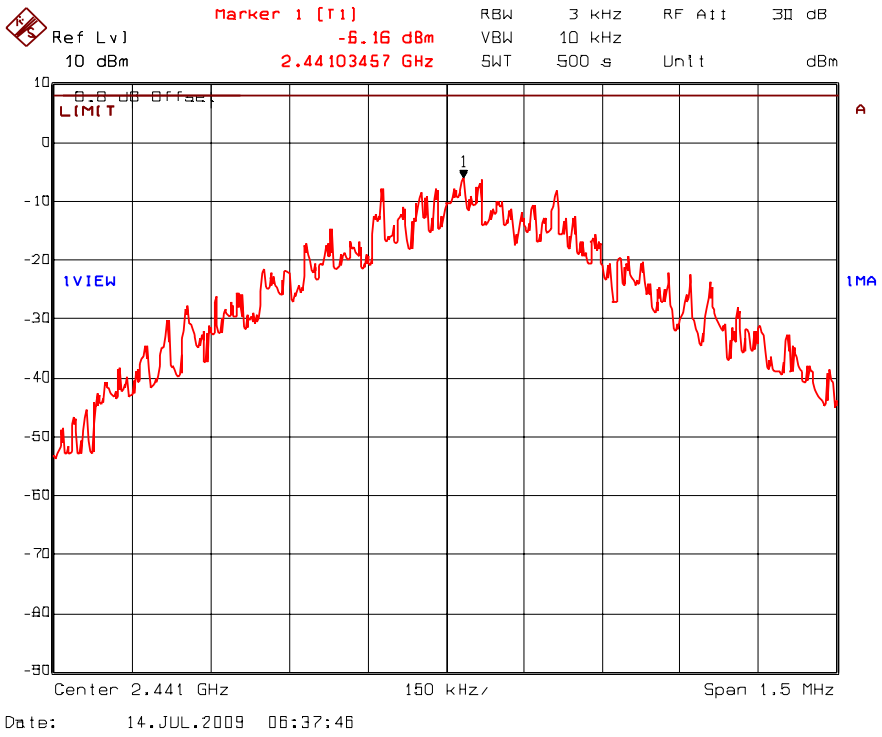
Frequency (MHz)	Modulation	*PSD in 3 kHz BW (dBm)	Limit (dBm)	Margin (dB)	Comments (Pass/Fail)
2402	GFSK	-6.78	8.0	-14.78	Pass
2441	GFSK	-6.16	8.0	-14.16	Pass
2480	GFSK	-6.40	8.0	-14.40	Pass

*See the following plots for measurement details.

Plot 5.13.5.1. Power Spectral Density
Frequency: 2402 MHz, GFSK Modulation



Plot 5.13.5.2. Power Spectral Density
Frequency: 2441 MHz, GFSK Modulation



Plot 5.13.5.3. Power Spectral Density
Frequency: 2480 MHz, GFSK Modulation

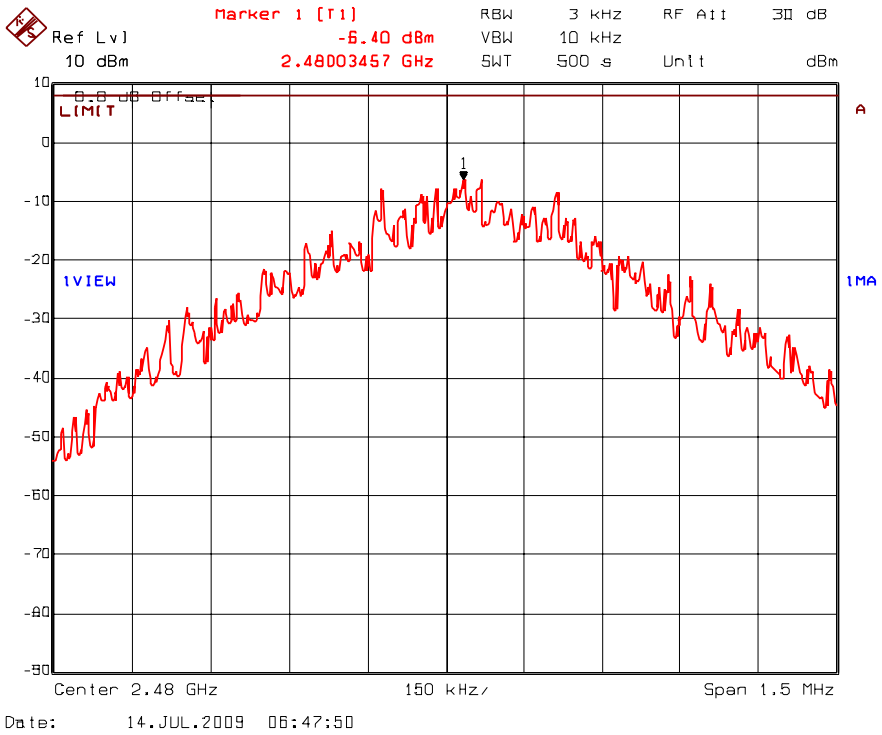


EXHIBIT 6. MEASUREMENT UNCERTAINTY

The measurement uncertainties stated were calculated in accordance with the requirements of NIST Technical Note 1297 and NIS 81 (1994)

6.1. LINE CONDUCTED EMISSION MEASUREMENT UNCERTAINTY

CONTRIBUTION (Line Conducted)	PROBABILITY DISTRIBUTION	UNCERTAINTY (dB)	
		9-150 kHz	0.15-30 MHz
EMI Receiver specification	Rectangular	±1.5	±1.5
LISN coupling specification	Rectangular	±1.5	±1.5
Cable and Input Transient Limiter calibration	Normal (k=2)	±0.3	±0.5
Mismatch: Receiver VRC $\Gamma_1 = 0.03$ LISN VRC $\Gamma_R = 0.8$(9 kHz) 0.2 (30 MHz) Uncertainty limits $20\text{Log}(1\pm\Gamma_1\Gamma_R)$	U-Shaped	±0.2	±0.3
System repeatability	Std. deviation	±0.2	±0.05
Repeatability of EUT	--	--	--
Combined standard uncertainty	Normal	±1.25	±1.30
Expanded uncertainty U	Normal (k=2)	±2.50	±2.60

Sample Calculation for Measurement Accuracy in 450 kHz to 30 MHz Band:

$$u_c(y) = \sqrt{\sum_{I=1}^{m} u_i^2(y)} = \pm \sqrt{(1.5^2 + 1.5^2)/3 + (0.5/2)^2 + (0.05/2)^2 + 0.35^2} = \pm 1.30 \text{ dB}$$

$U = 2u_c(y) = \pm 2.6$ dB

6.2. RADIATED EMISSION MEASUREMENT UNCERTAINTY

CONTRIBUTION (Radiated Emissions)	PROBABILITY DISTRIBUTION	UNCERTAINTY (± dB)	
		3 m	10 m
Antenna Factor Calibration	Normal (k=2)	±1.0	±1.0
Cable Loss Calibration	Normal (k=2)	±0.3	±0.5
EMI Receiver specification	Rectangular	±1.5	±1.5
Antenna Directivit	Rectangular	+0.5	+0.5
Antenna factor variation with height	Rectangular	±2.0	±0.5
Antenna phase center variation	Rectangular	0.0	±0.2
Antenna factor frequency interpolation	Rectangular	±0.25	±0.25
Measurement distance variation	Rectangular	±0.6	±0.4
Site imperfections	Rectangular	±2.0	±2.0
Mismatch: Receiver VRC $\Gamma_1 = 0.2$ Antenna VRC $\Gamma_R = 0.67$(Bi) 0.3 (Lp) Uncertainty limits $20\text{Log}(1\pm\Gamma_1\Gamma_R)$	U-Shaped	+1.1 -1.25	±0.5
System repeatability	Std. Deviation	±0.5	±0.5
Repeatability of EUT		-	-
Combined standard uncertainty	Normal	+2.19 / -2.21	+1.74 / -1.72
Expanded uncertainty U	Normal (k=2)	+4.38 / -4.42	+3.48 / -3.44

Calculation for maximum uncertainty when 3m biconical antenna including a factor of k = 2 is used:

$U = 2u_c(y) = 2x(+2.19) = +4.38$ dB And $U = 2u_c(y) = 2x(-2.21) = -4.42$ dB