ENGINEERING TEST REPORT

Vehicle-Mount Computer
Model No.: 8515

FCC ID: GM38515BT

Applicant:

Psion Teklogix Inc.
2100 Meadowvale Blvd.
Toronto, Ontario
Canada L5N 7J9

In Accordance With

FEDERAL COMMUNICATIONS COMMISSION (FCC)
PART 15, SUBPART C, SECTION 15.247
Frequency Hopping and Digital Modulation Systems (Bluetooth)
Operating in the Frequency Band 2402-2480 MHz

UltraTech's File No.: TEK-585F15C247

This Test report is Issued under the Authority of Tri M. Luu, Professional Engineer, Vice President of Engineering UltraTech Group of Labs Date: March 05, 2007	
Report Prepared by: Dan Huynh Issued Date: March 05, 2007	Tested by: Hung Trinh, RFI Technologist Test Dates: February 13-16, 2007

- *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.*

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EXHIBIT 1 INTRODUCTION

1.1 SCOPE

Reference:	Part 15, Subpart C, Section 15.247
Title:	Telecommunication - Code of Federal Regulations, CFR 47, Part 15
Purpose of Test:	1. To gain FCC Equipment Authorization for Frequency Hopping and Digital Modulation Systems (Bluetooth) Operating in the Frequency Band 2402-2480 MHz. 2. Co-location operation to address the integration of Psion Teklogix RA2040 'g' radio (FCC ID: GM3RA2040) into this computer.
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:	Commercial, light industry & heavy industry

1.2 RELATED SUBMITTAL(S)/GRANT(S)

None.

1.3 NORMATIVE REFERENCES

Publication	Year	Title
FCC 47CFR Parts 0-19	2005	Code of Federal Regulations, Title 47 – 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 +A1 EN 55022	2003-04-10 2004-10-14 2003	Limits and Methods of Measurements of Radio Disturbance Characteristics of Information Technology Equipment
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 2-1: Conducted disturbance measurement
CISPR 16-2-3	2003	Specification for radio disturbance and immunity measuring apparatus and methods. Part 2-3: Radiated disturbance measurement
FCC Public Notice DA 00-705	2000	Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems
KDB Publication No. 558074	2005	Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247)

EXHIBIT 2 PERFORMANCE ASSESSMENT

2.1 CLIENT INFORMATION

APPLICANT:	
Name:	Psion Teklogix Inc.
Address:	2100 Meadowvale Blvd. Mississauga, ON Canada, L5N 7J9
Contact Person:	Mr. Sada Dharwarkar Phone #: 905-812-6200 (3358) Fax #: 905-812-6301 Email Address: Sada.Dharwarkar@psionteklogix.com

MANUFACTURER:	
Name:	Psion Teklogix Inc.
Address:	2100 Meadowvale Blvd. Mississauga, ON Canada, L5N 7J9
Contact Person:	Mr. Sada Dharwarkar Phone #: 905-812-6200 (3358) Fax #: 905-812-6301 Email Address: Sada.Dharwarkar@psionteklogix.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:	Psion Teklogix Inc.
Product Name:	Vehicle-Mount Computer
Model Name or Number:	8515
Serial Number:	Eng 001
Type of Equipment:	FHSS/DTS (Bluetooth)
Input Power Supply Type:	12V DC Battery
Primary User Functions of EUT:	Transmit and receive data

2.3 EUT'S TECHNICAL SPECIFICATIONS

TRANSMITTER	
Equipment Type:	Mobile
Intended Operating Environment:	Commercial, light industry & heavy industry
Power Supply Requirement:	12V DC battery
RF Output Power Rating:	0.004 Watts EIRP
Operating Frequency Range:	2402-2480 MHz
RF Output Impedance:	50 Ω
Channel Spacing:	1 MHz
Duty Cycle:	100%
Modulation Type:	Bluetooth
Antenna Connector Type:	Integral (the antenna component is soldered onto the radio printed circuit board and located inside the enclosure)
Antenna Description:	Manufacturer: Antenova Ltd. Type: Mica 2.4 GHz SMD Part No.: 3030A5645-01 Frequency Range: 2.4 – 2.5 GHz Gain: 1.2 dBi Max

2.4 LIST OF EUT'S PORTS

Port Number	EUT's Port Description	Number of Identical Ports	Connector Type	Cable Type (Shielded/Non-shielded)
1	Serial Port	1	DB-9	Non-shielded
2	USB port	1	USB Type A	Non-shielded
3	USB port	1	USB Type A	Non-shielded
4	USB port	1	USB Type B	Non-shielded
5	Antenna (802.11/g)	1	SMA Rev. Polarity	Shielded
6	Power Port	1	AMP CPC	Non-shielded

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:	Scanner
Brand name:	Symbol Technologies Inc.
Serial Number:	M1J42A97T
Connected to EUT's Port:	USB Type A

2.6 TEST SETUP BLOCK DIAGRAM

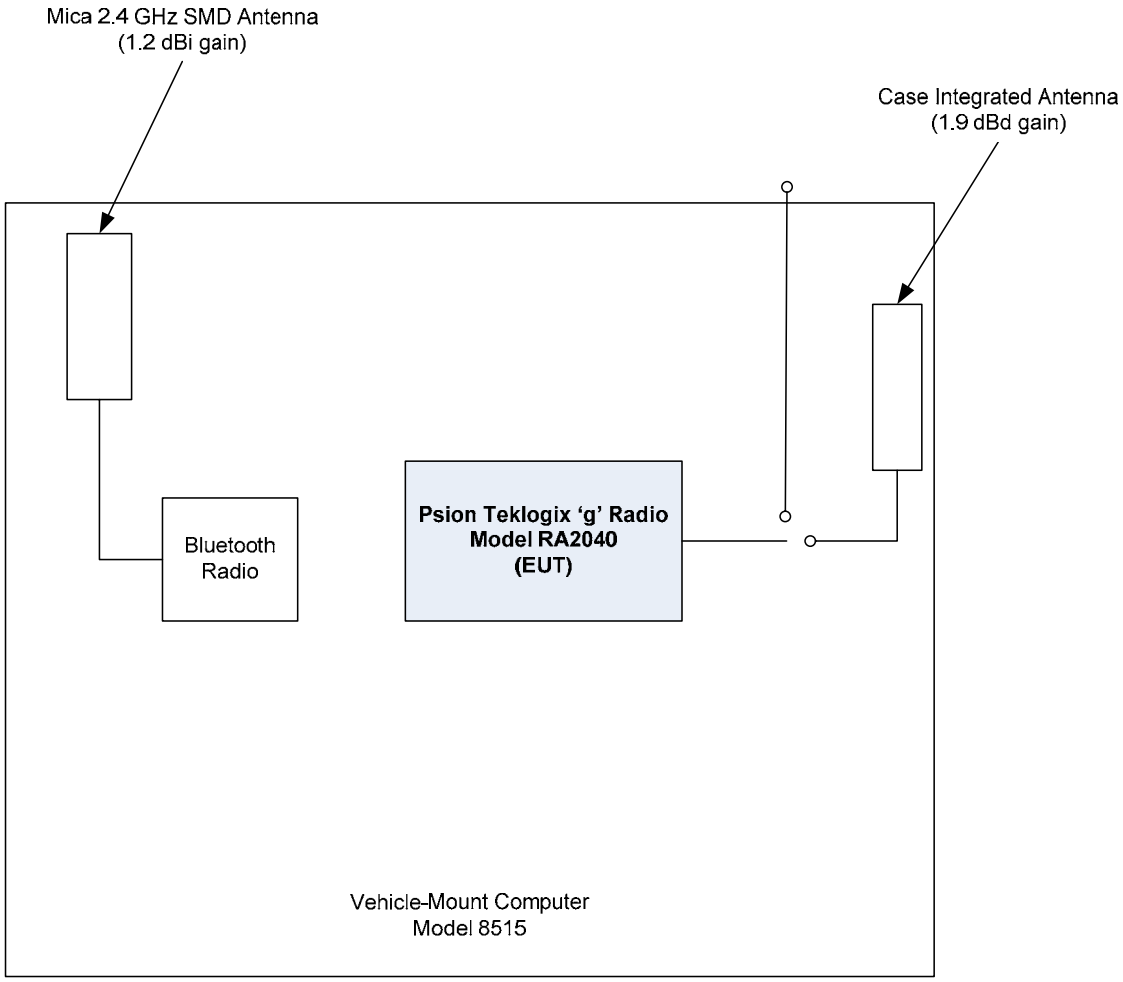


EXHIBIT 3 EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

3.1 CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

Temperature:	21°C
Humidity:	51%
Pressure:	102 kPa
Power input source:	12V DC

3.2 OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS

Operating Modes:	▪ Each of lowest, middle and highest channel frequencies transmits continuously for emissions measurements. ▪ The EUT operates in frequency hopping mode and direct sequence or digital modulation mode.
Special Test Software:	Special software is provided by the applicant to select and operate the EUT at each channel frequency continuously and mode of operation such as frequency hopping and direct sequence or digital modulation for testing purpose.
Special Hardware Used:	N/A
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
Frequency(ies) Tested: (Near lowest, near middle & near highest frequencies in the frequency range of operation.)	2402, 2441 & 2480 MHz.
RF Power Output:	0.004 W EIRP
Normal Test Modulation:	Bluetooth
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.

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.: 31040/SIT 1300B3) and Industry Canada office (Industry Canada File No.: IC2049-1). Last Date of Site Calibration: June 20, 2006

4.2 APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC Section(s)	Test Requirements	Compliance (Yes/No)
15.107(a) /15.207(a)	AC Power Conducted Emissions	N/A
15.109(a)	Class B Radiated Emissions	Yes (Note 1) (Note 3)
15.247(a)(1)&(2)	20dB & 6 dB Bandwidth	Yes (Note 3)
15.247(b)(1) & (3)	Peak Output Power	Yes (Note 3)
15.247(d), 15.209 & 15.205	Spurious Radiated Emissions	Yes (Note 3) (Note 4)
15.247(e)&(f)	Power Spectral Density	Yes (Note 3)
15.247(f)	Average Time of Occupancy	Yes
15.247(i), 1.1310 & 2.1091	RF Exposure	Yes (Note 2)

Notes:

(1) A separate engineering test report for compliance with FCC Part 15, Subpart B – Class B Unintentional Radiators will be provided upon request.
(2) Co-location operation to address the integration of Psion Teklogix RA2040 ‘g’ radio (FCC ID: GM3RA2040) into this computer was verified for compliance with RF exposure requirement.
(3) Refer to the EMC test reports for Psion Teklogix RA2040 ‘g’ radio. (FCC ID: GM3RA2040).
(4) The device was also tested for intermodulation products and spurious radiation while co-located and transmitting simultaneously and the results are well within the FCC limits.

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; KDB Publication No. 558074: Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247); FCC Public Notice DA 00-705: Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

5.2 MEASUREMENT UNCERTAINTIES

The measurement uncertainties stated were calculated in accordance with requirements of UKAS Document LAB 34 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.

5.4 COMPLIANCE WITH FCC PART 15 – GENERAL TECHNICAL REQUIREMENTS

FCC Section	FCC Rules	
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 integral antenna is permanently mounted on the printed circuit board and located inside the enclosure
15.204	Provided the information for every antenna proposed for use with the EUT: (a) type (e.g. Yagi, patch, grid, dish, etc…), (b) manufacturer and model number (c) gain with reference to an isotropic radiator	Manufacturer: Antenova Ltd. Type: Mica 2.4 GHz SMD Part No.: 3030A5645-01 Frequency Range: 2.4 – 2.5 GHz Gain: 1.2 dBi Max

5.5 6 dB & 20 dB Bandwidth [§15.247(a)(1)&(2)]

5.5.1. Limits

- For Frequency Hopping System, minimum of 25 kHz.
- For a Digital Modulation System, the 6 dB bandwidth shall be at least 500 KHz.

5.5.2. Method of Measurements

Refer to FCC Public Notice DA 00-705, KDB Publication No. 558074 and ANSI C63.4 for measurement methods.

5.5.3. Test Arrangement

See Section 2.6 of this test report.

5.5.4. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Rohde & Schwarz	FSEK20/B4/B21	834157/005	9 kHz – 40 GHz with external mixer
Horn Antenna	EMCO	3155	9701-5061	1 GHz – 18 GHz

5.5.5. Test Data

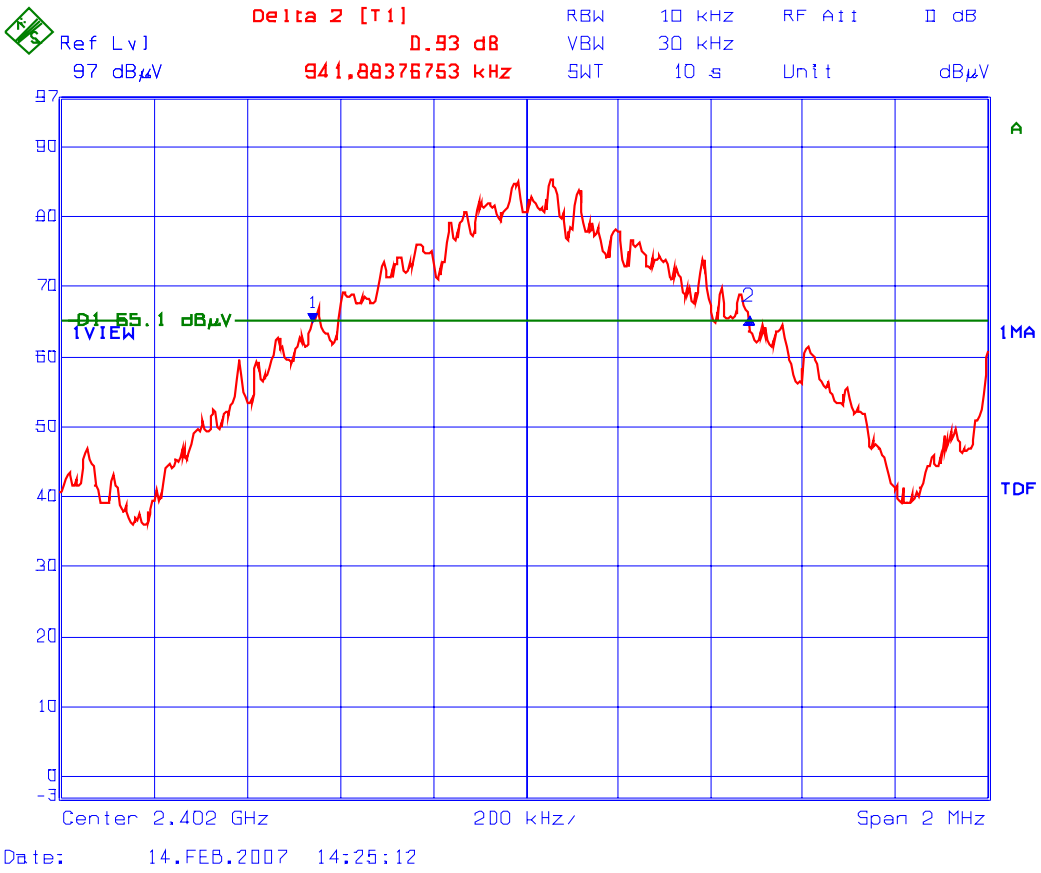
Note: Bandwidth measurements were done using the built-in auto function of the analyzer.

5.5.5.1. For Frequency Hopping Spread Spectrum Mode

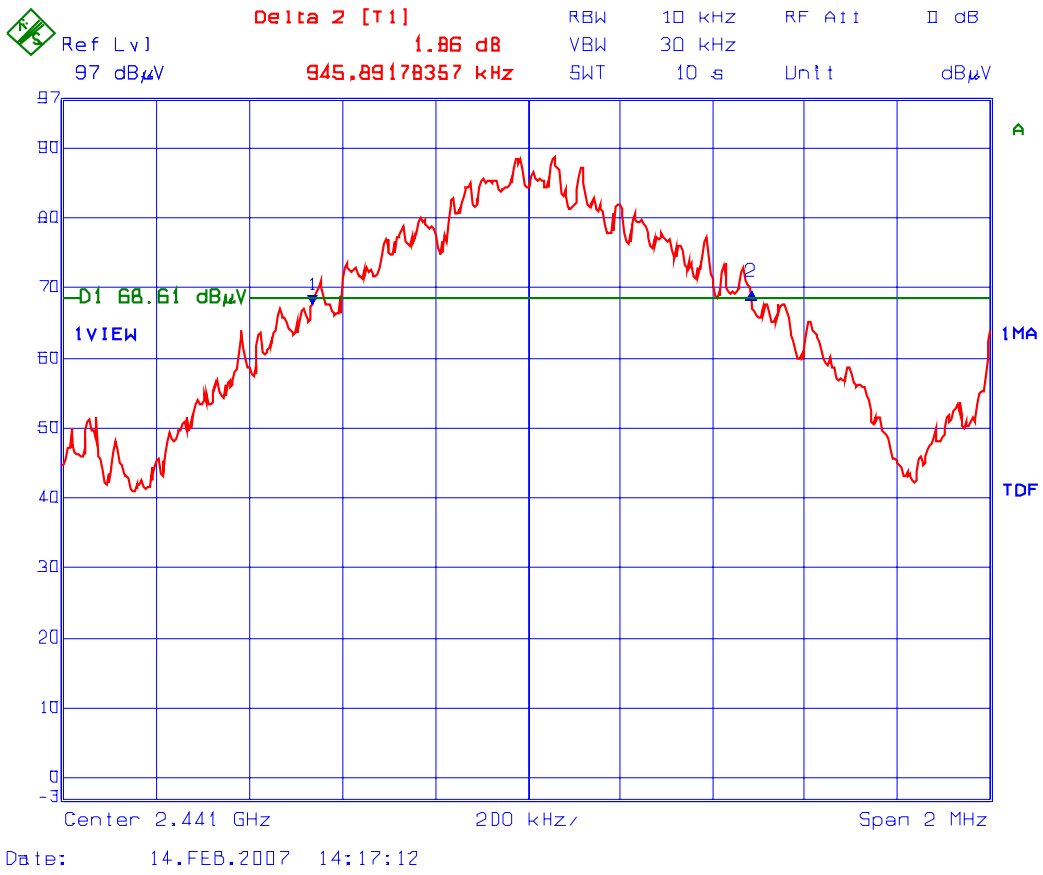
Frequency (MHz)	20 dB Bandwidth (kHz)
2402	941.98
2441	945.99
2480	949.89

See the following plots for detailed measurements.

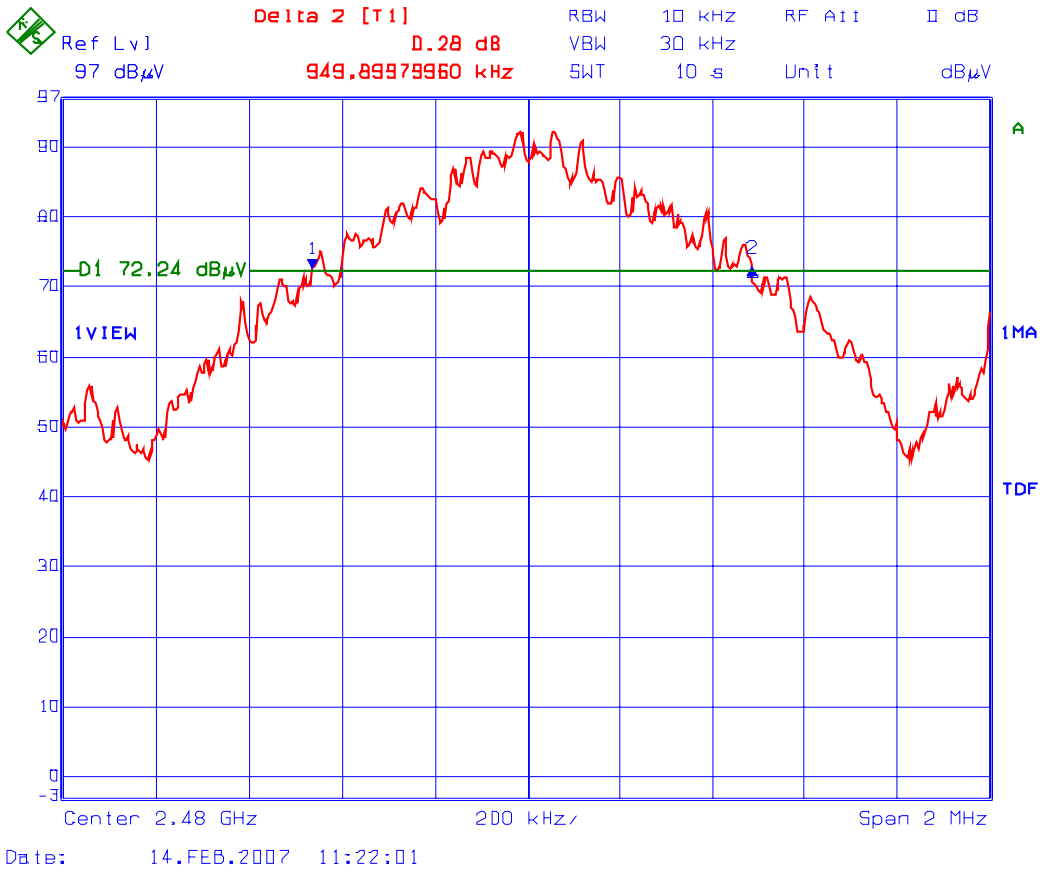
Plot 5.5.5.1.1: 20 dB Bandwidth
Test Frequency: 2402 MHz



Plot 5.5.5.1.2: 20 dB Bandwidth
Test Frequency: 2441 MHz



Plot 5.5.5.1.3: 20 dB Bandwidth
Test Frequency: 2480 MHz

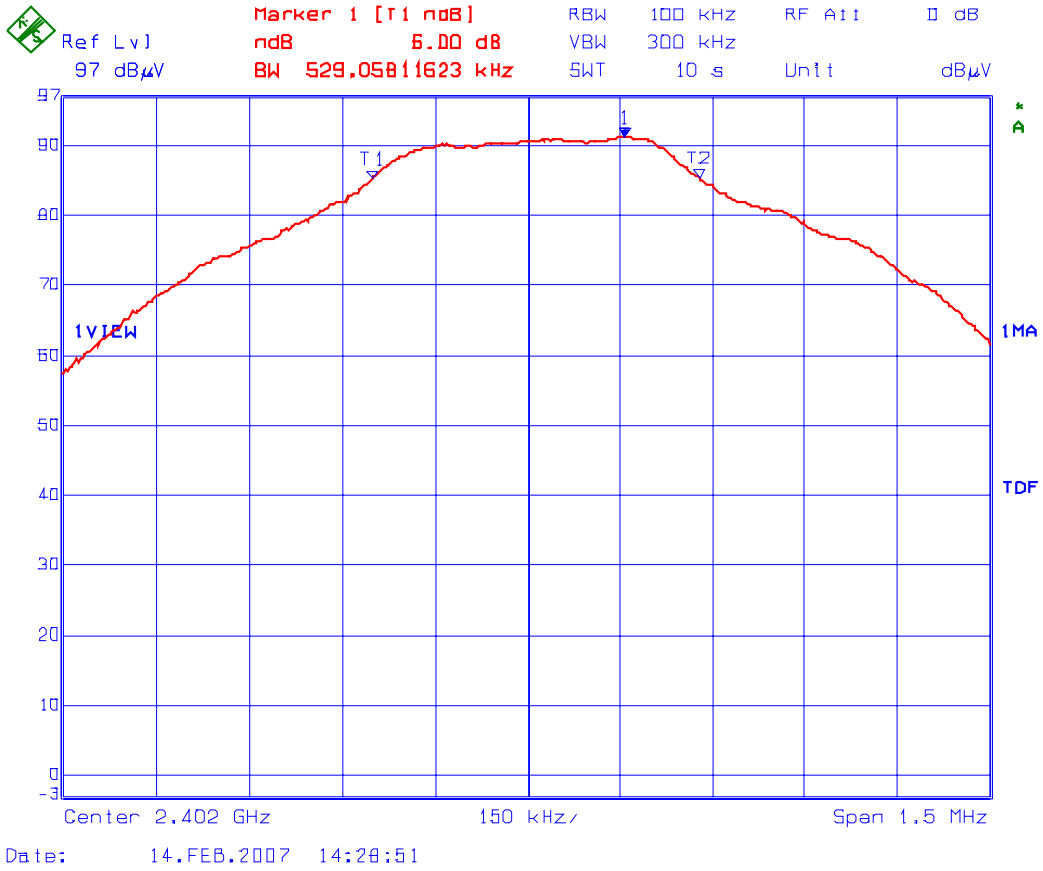


5.5.5.2. For DTS Mode

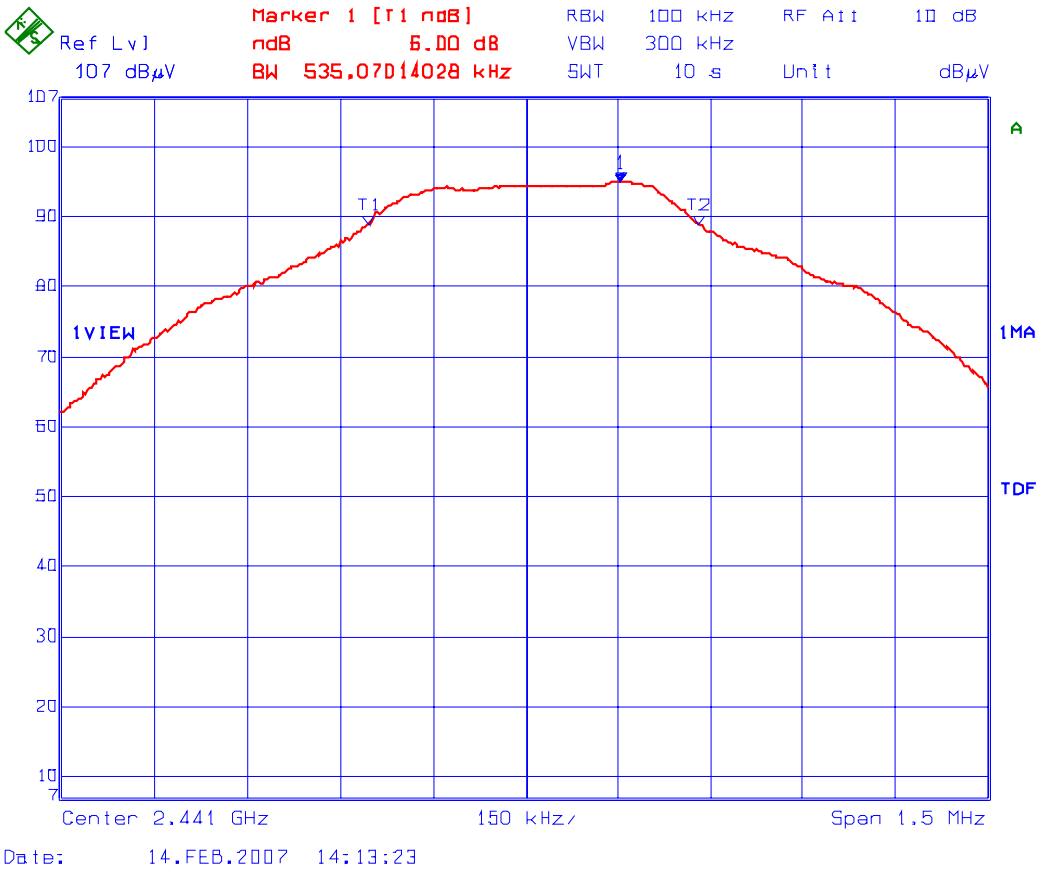
Frequency (MHz)	6 dB Bandwidth (kHz)
2402	529.06
2441	535.07
2480	550.10

See the following plots for detailed measurements.

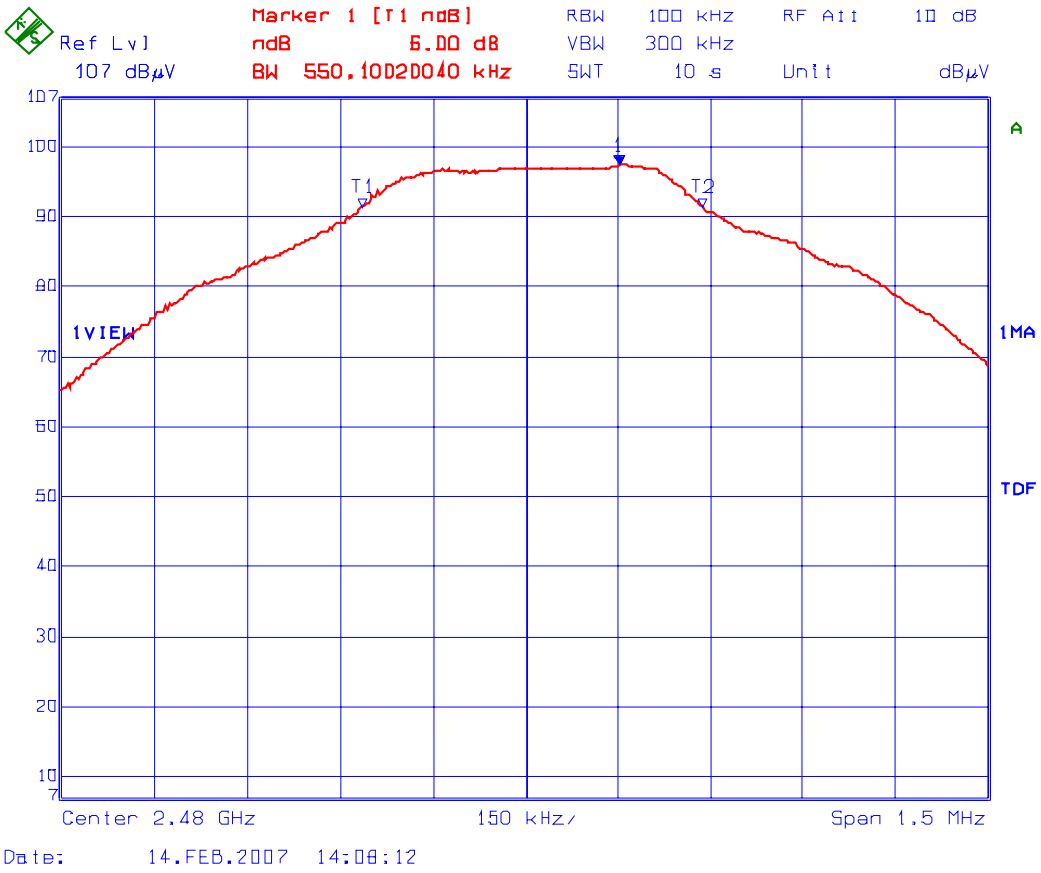
Plot 5.5.5.2.1: 6 dB Bandwidth
Test Frequency: 2402 MHz



Plot 5.5.5.2.2: 6 dB Bandwidth
Test Frequency: 2441 MHz



Plot 5.5.5.2.3: 6 dB Bandwidth
Test Frequency: 2480 MHz



5.6 PEAK OUTPUT POWER [§§ 15.247(b)(1)&(3)]

5.6.1. Limits

- **FCC 15.247(b)(1):** Maximum peak output power of the transmitter shall not exceed 1 Watt.
- **FCC 15.247(b)(4(i):** If the device is not for fixed point to point radio, the antenna of directional gain greater than 6 dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

5.6.2. Method of Measurements

Refer to FCC Public Notice DA 00-705, KDB Publication No. 558074 and ANSI C63.4 for measurement methods.

5.6.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Rohde & Schwarz	FSEK20/B4/B21	834157/005	9 kHz – 40 GHz with external mixer
Horn Antenna	EMCO	3155	9701-5061	1 GHz – 18 GHz

5.6.4. Test Data

Frequency (MHz)	E-Field in 1 MHz @ 3m (dBuV/m)	Antenna Polarization (V/H)	*Calculated Peak Power (Watt)
2402	95.04	V	0.0007263
2402	92.77	H	0.0004306
2441	96.84	V	0.0010993
2441	93.73	H	0.0005372
2480	98.78	V	0.0017184
2480	95.61	H	0.0008282

*Peak power is calculated using the following equation:

P = (E x D) squared / (30 x G)

Where: E = the measured maximum field strength in V/m
G = the numeric gain of the transmitting antenna over an isotropic radiator.
D = the distance in meters from which the field strength was measured.
P = the power in watts

5.7 SPURIOUS RADIATED EMISSIONS @ 3 METERS [§ 15.247(d)]

5.7.1. 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 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 Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

47 CFR 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	2690 - 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

47 CFR 15.209(a) - Radiated emission limits, general requirements

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/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
** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.		

5.7.2. Method of Measurements

Refer to Ultratech Test Procedures, Files # ULTR P002-2004 or ULTR P003-2004 and ANSI C63.4 for measurement methods

5.7.3. Test Arrangement

Refer to Section 2.6 of this test report for test setup.

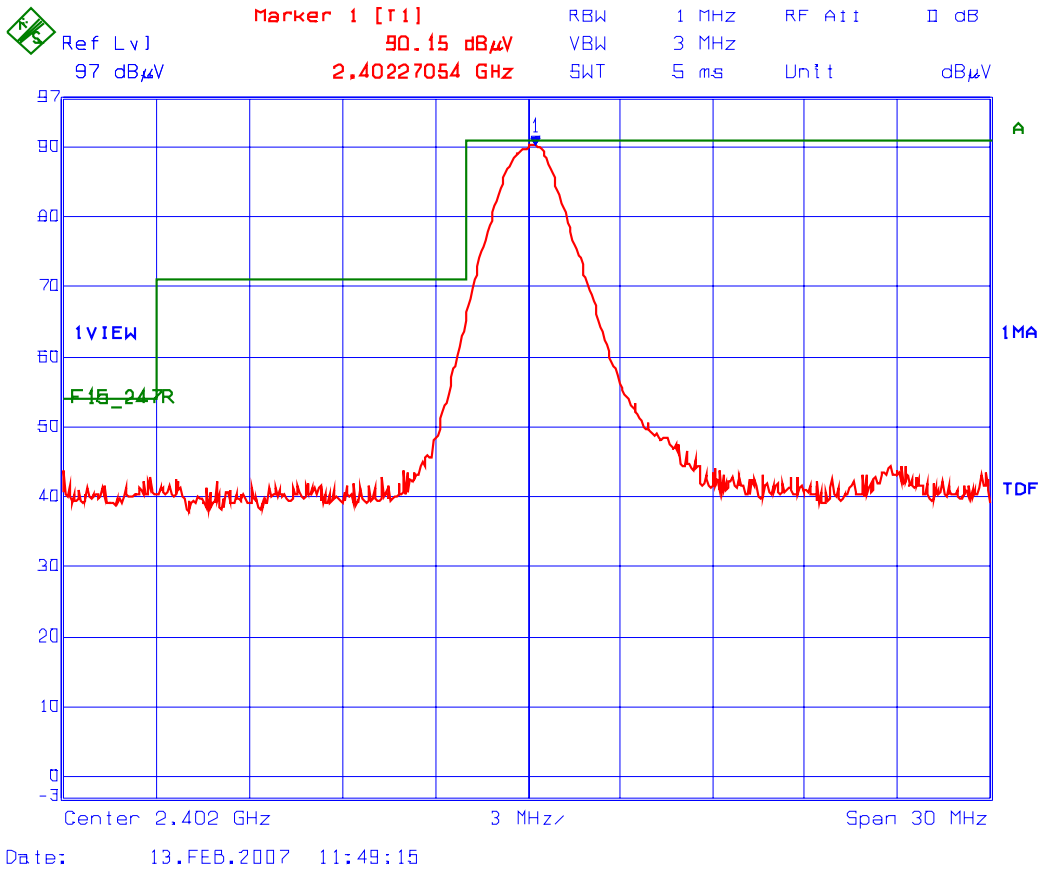
5.7.4. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Rohde & Schwarz	FSEK20/B4/B21	834157/005	9 kHz – 40 GHz with external mixer
Microwave Amplifier	Hewlett Packard	HP 83017A		1 GHz to 26.5 GHz
Biconilog Antenna	EMCO	3143	1029	20 MHz to 2 GHz
Horn Antenna	EMCO	3155	9701-5061	1 GHz – 18 GHz
Horn Antenna	EMCO	3160-09	..	18 GHz – 26.5 GHz
Horn Antenna	EMCO	3160-10	..	26.5 GHz – 40 GHz
Mixer	Tektronix	118-0098-00	..	18 GHz – 26.5 GHz
Mixer	Tektronix	119-0098-00	..	26.5 GHz – 40 GHz

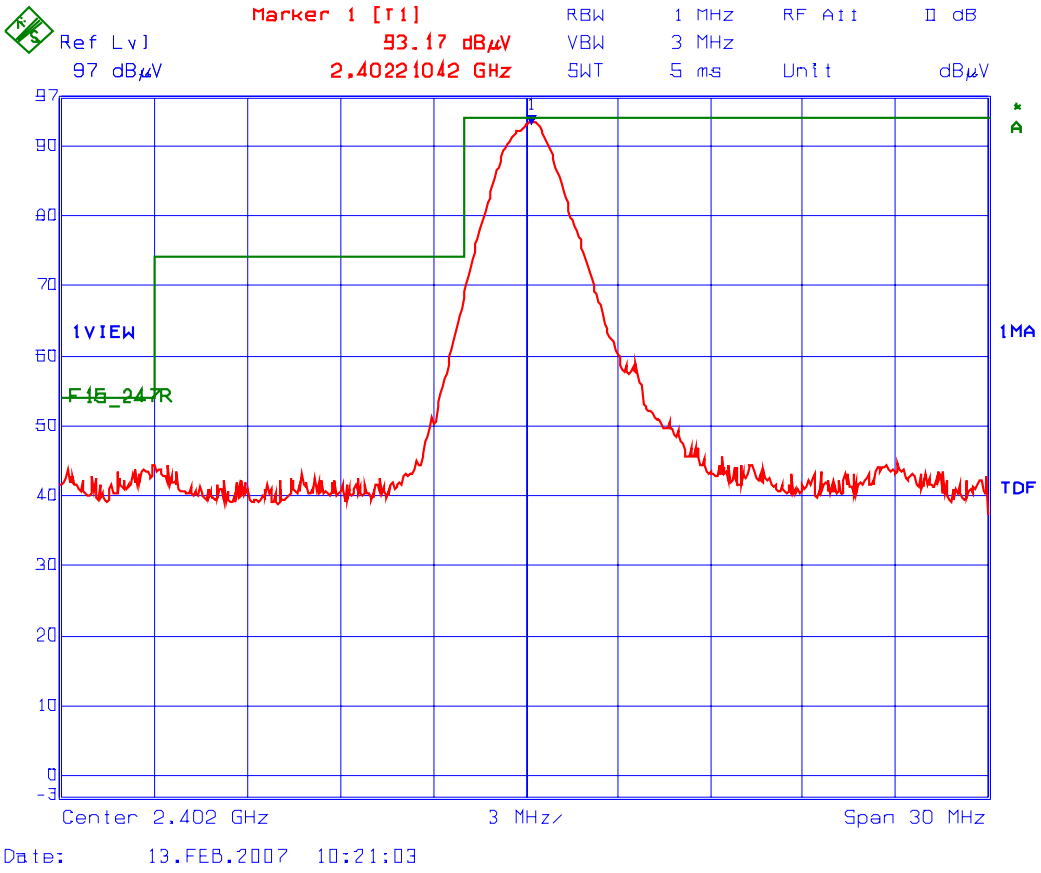
5.7.5. Test Data

5.7.5.1. Band-edge Radiated Emissions

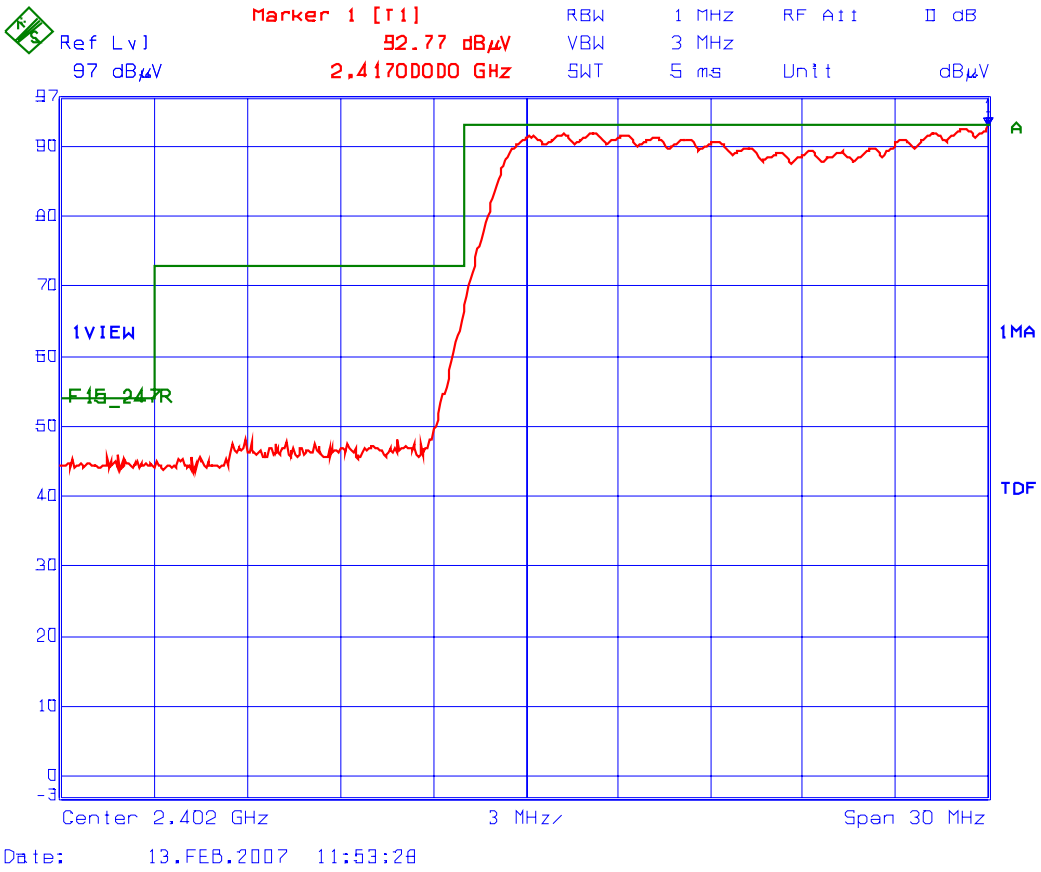
Plot 5.7.5.1.1: Band-Edge Radiated Emissions @ 3 meters
Vertical Polarization, Low End of Frequency Band, Single Frequency Mode



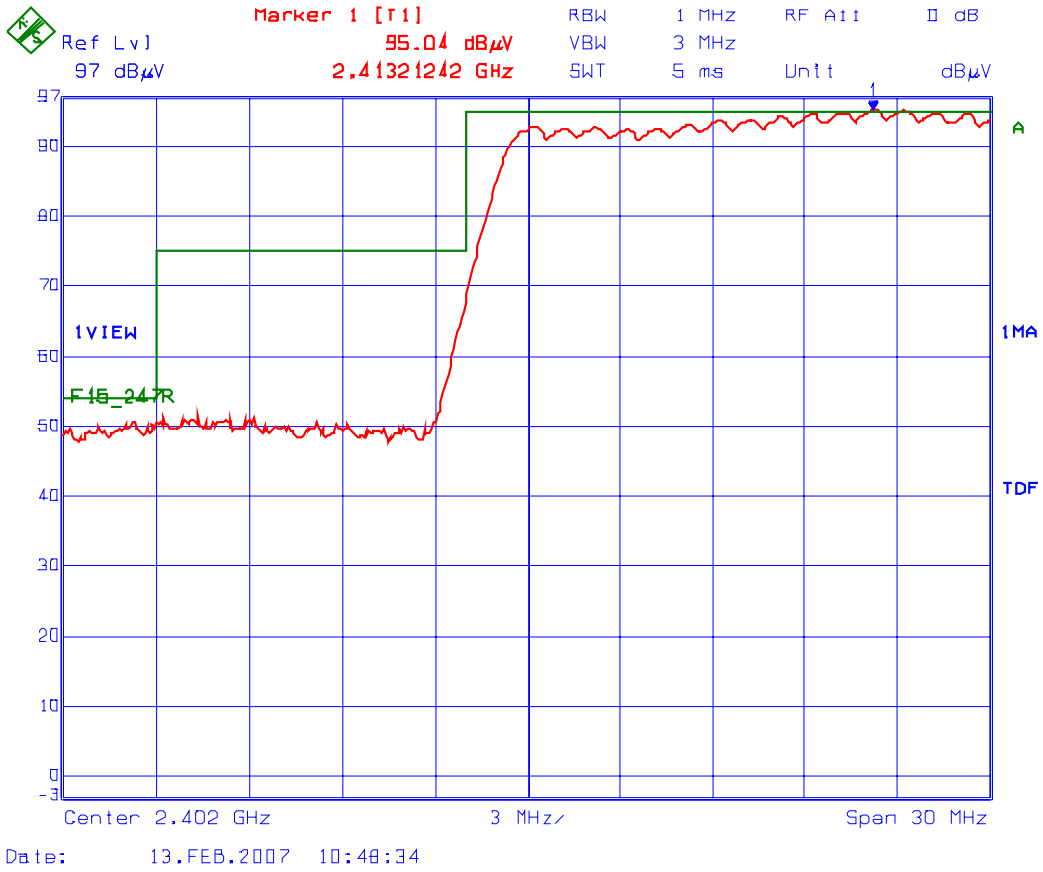
Plot 5.7.5.1.2: Band-Edge Radiated Emissions @ 3 meters
Horizontal Polarization Low End of Frequency Band, Single Frequency Mode



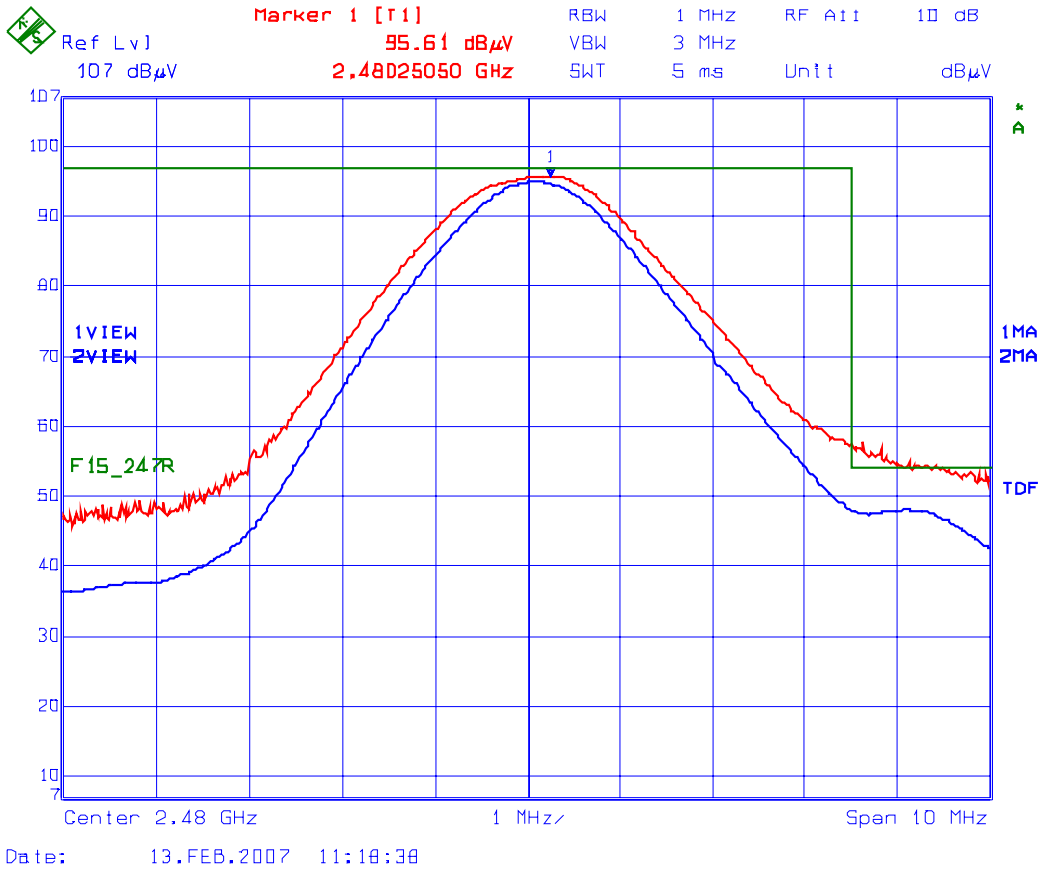
Plot 5.7.5.1.3: Band-Edge Radiated Emissions @ 3 meters,
Vertical Polarization Low End of Frequency Band, Pseudorandom Channel Hopping Mode



Plot 5.7.5.1.4: Band-Edge Radiated Emissions @ 3 meters
Horizontal Polarization, Low End of Frequency Band, Pseudorandom Channel Hopping Mode

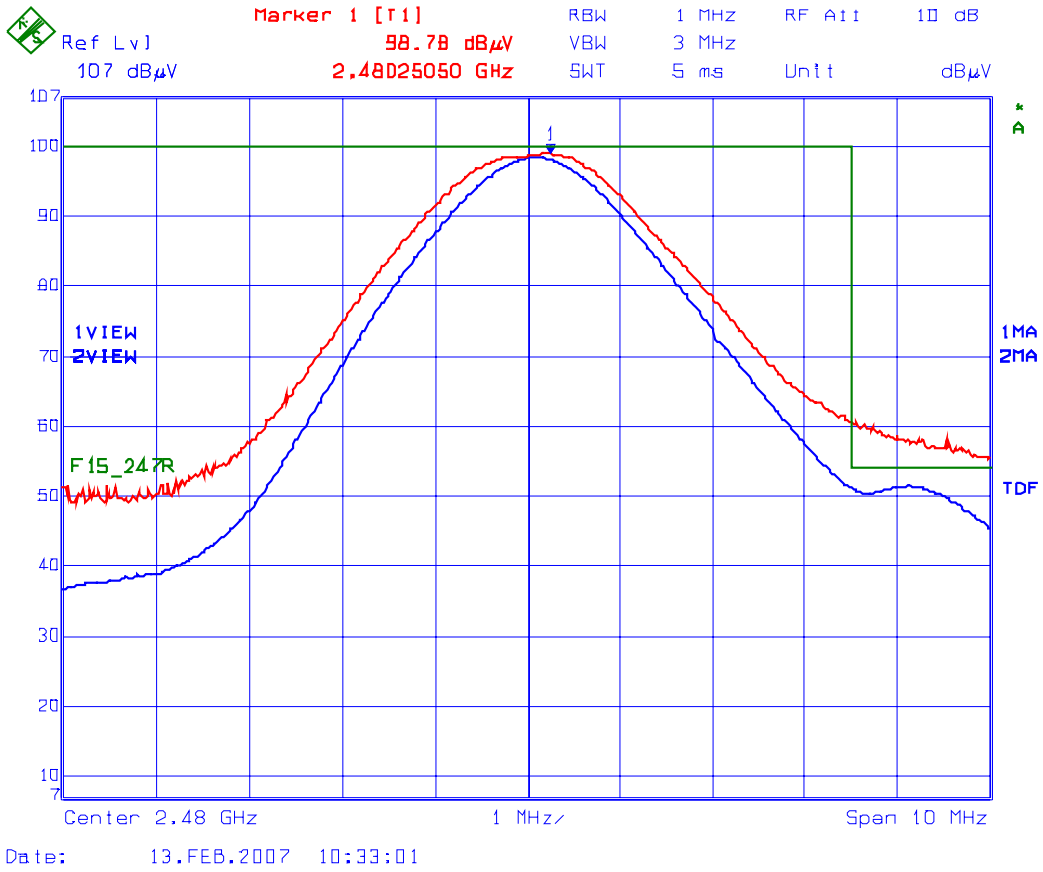


Plot 5.7.5.1.5: Band-Edge Radiated Emissions @ 3 meters
Vertical Polarization, Upper End of Frequency Band, Single Frequency Mode



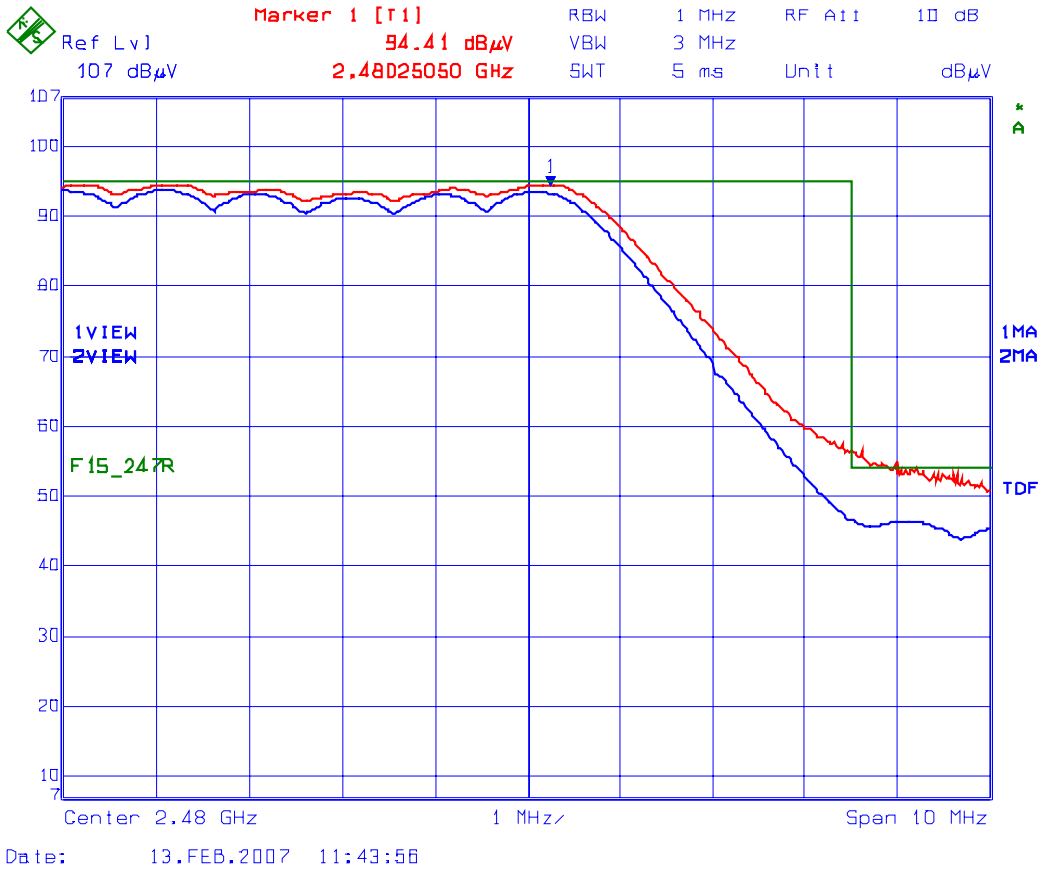
Trace 1: RBW= 1 MHz, VBW= 3 MHz
Trace 2: RBW= 1 MHz, VBW= 10 Hz

Plot 5.7.5.1.6: Band-Edge Radiated Emissions @ 3 meters
Horizontal Polarization, Upper End of Frequency Band, Single Frequency Mode



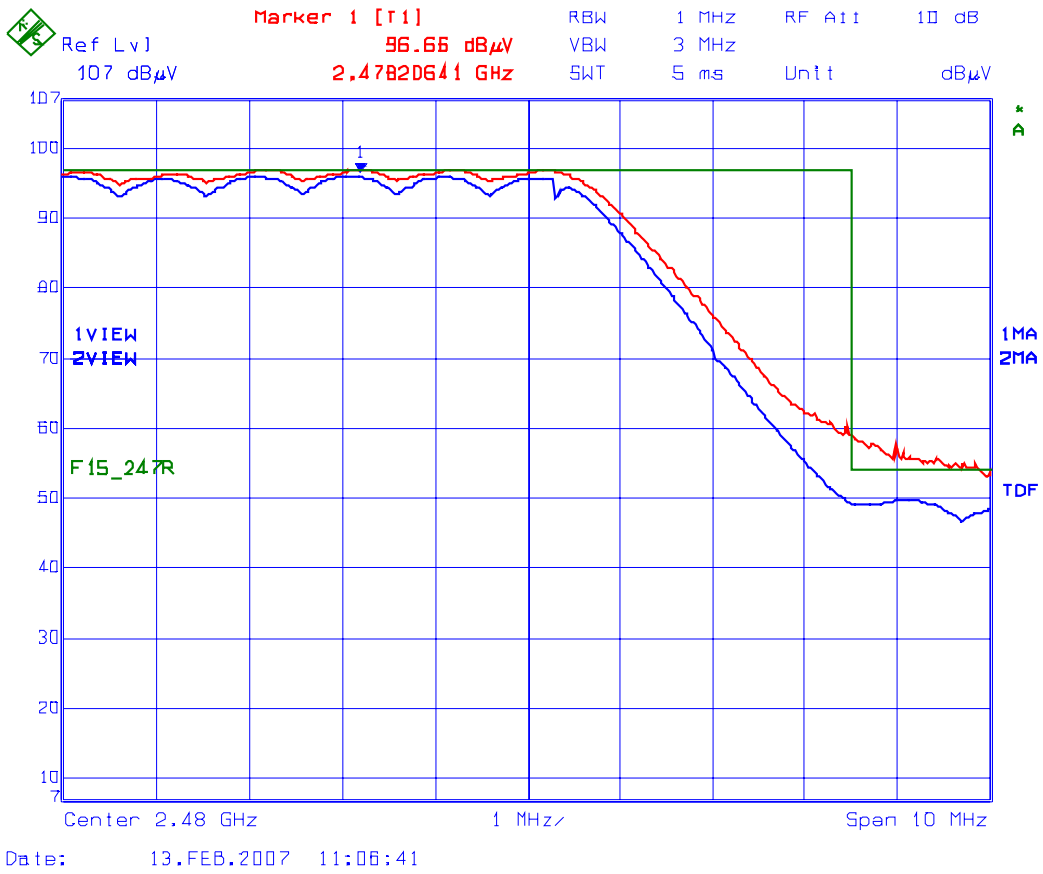
Trace 1: RBW= 1 MHz, VBW= 3 MHz
Trace 2: RBW= 1 MHz, VBW= 10 Hz

Plot 5.7.5.1.7: Band-Edge Radiated Emissions @ 3 meters
Vertical Polarization, Upper End of Frequency Band, Pseudorandom Channel Hopping Mode



Trace 1: RBW= 1 MHz, VBW= 3 MHz
Trace 2: RBW= 1 MHz, VBW= 10 Hz

Plot 5.7.5.1.8: Band-Edge Radiated Emissions @ 3 meters
Horizontal Polarization, Upper End of Frequency Band, Pseudorandom Channel Hopping Mode



Trace 1: RBW= 1 MHz, VBW= 3 MHz
Trace 2: RBW= 1 MHz, VBW= 10 Hz

5.7.5.2. Transmitter Radiated Spurious Emissions

The emissions were scanned from 30 MHz to 25 GHz; all signals within 20 dB below the permissible limit were recorded in the table below.

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
Fundamental Frequency: 2402 MHz							
2402	95.04	-	V	-	-	-	-
2402	92.77	-	H	-	-	-	-
Fundamental Frequency: 2441 MHz							
2441	96.84	-	V	-	-	-	-
2441	93.73	-	H	-	-	-	-
4882	50.09	39.41	V	54.0	78.0	-14.6	Pass*
4882	49.87	38.14	H	54.0	78.0	-15.9	Pass*
Fundamental Frequency: 2480 MHz							
2480	98.78	-	V	-	-	-	-
2480	95.61	-	H	-	-	-	-
4960	53.77	45.81	V	54.0	74.3	-8.2	Pass*
4960	51.07	42.71	H	54.0	74.3	-11.3	Pass*

* Emission in restricted bands.

5.8 POWER SPECTRAL DENSITY [§ 15.247(e) & (f)]

5.8.1. Limits

For a digitally modulated system, the power spectral density conducted from the intentional radiator to the antenna shall not be grater than 8 dBm in any 3 KHz bandwidth within this band during any time interval of continuous transmission.

5.8.2. Method of Measurements

KDB Publication No. 558074: Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247), using Alternative Test Procedures.

5.8.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Rohde & Schwarz	FSEK20/B4/B21	834157/005	9 kHz – 40 GHz with external mixer
Horn Antenna	EMCO	3155	9701-5061	1 GHz – 18 GHz

5.8.4. Test Data

Frequency (MHz)	Peak E-Field in 3 kHz BW @ 3m (dBµV/m)	Tx Ant. Gain (dBi)	*Calculated SPD (dBm)	Limit dBm)	Margin (dBm)
2402	81.90	1.2	-14.5	+8	-22.5
2441	84.26	1.2	-12.2	+8	-20.2
2480	87.55	1.2	-8.9	+8	-16.9

*SPD is calculated using the following equation:

P = (E x D) squared / (30 x G)

Where: E = the measured maximum field strength in V/m
G = the numeric gain of the transmitting antenna over an isotropic radiator.
D = the distance in meters from which the field strength was measured.
P = the power in watts

5.9 AVERAGE TIME OF OCCUPANCY [§ 15.247(f)]

5.9.1. Limits

The frequency hopping operation of the hybrid system, with the direct sequence or digital modulation operation turned off shall have an average time of occupancy on any frequency not to exceed 0.4 seconds with in a time period in seconds equal to the number of hopping frequencies employed multiplied by 0.4.

5.9.2. Method of Measurements

Refer to FCC DA-00-705 and ANSI C63.4 for measurement methods.

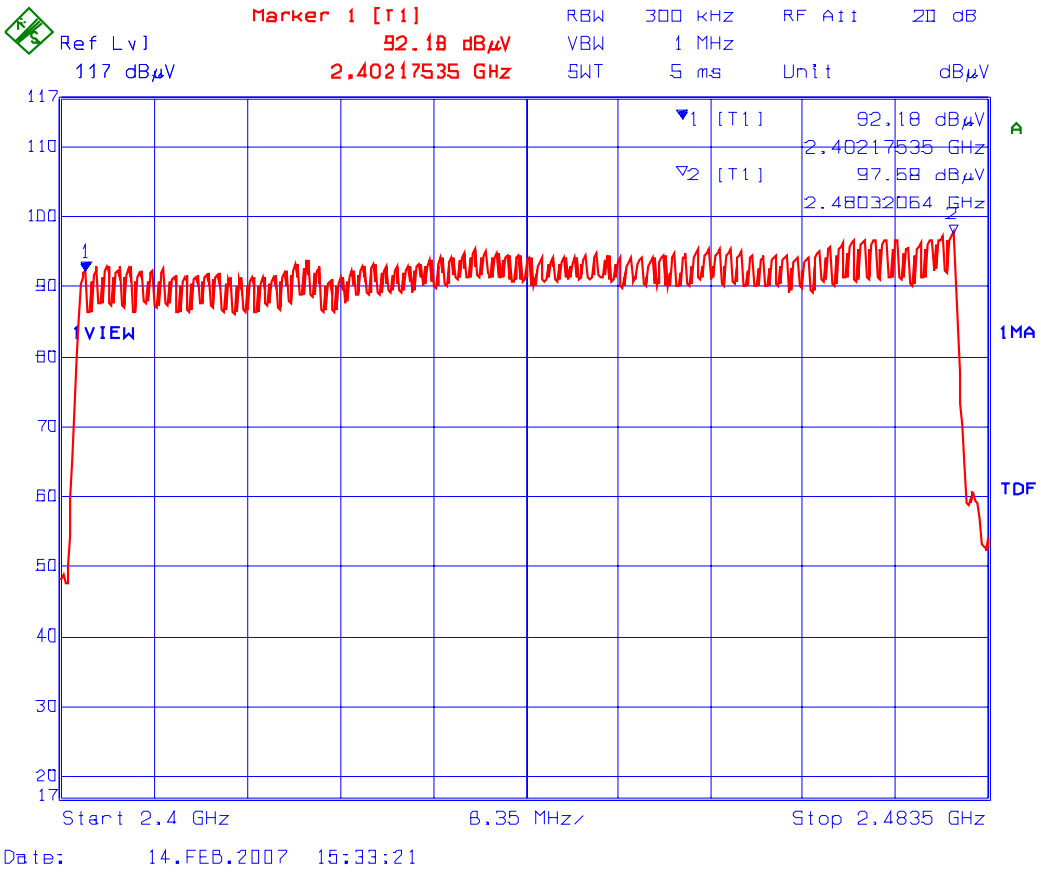
5.9.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Rohde & Schwarz	FSEK20/B4/B21	834157/005	9 kHz – 40 GHz with external mixer
Horn Antenna	EMCO	3155	9701-5061	1 GHz – 18 GHz

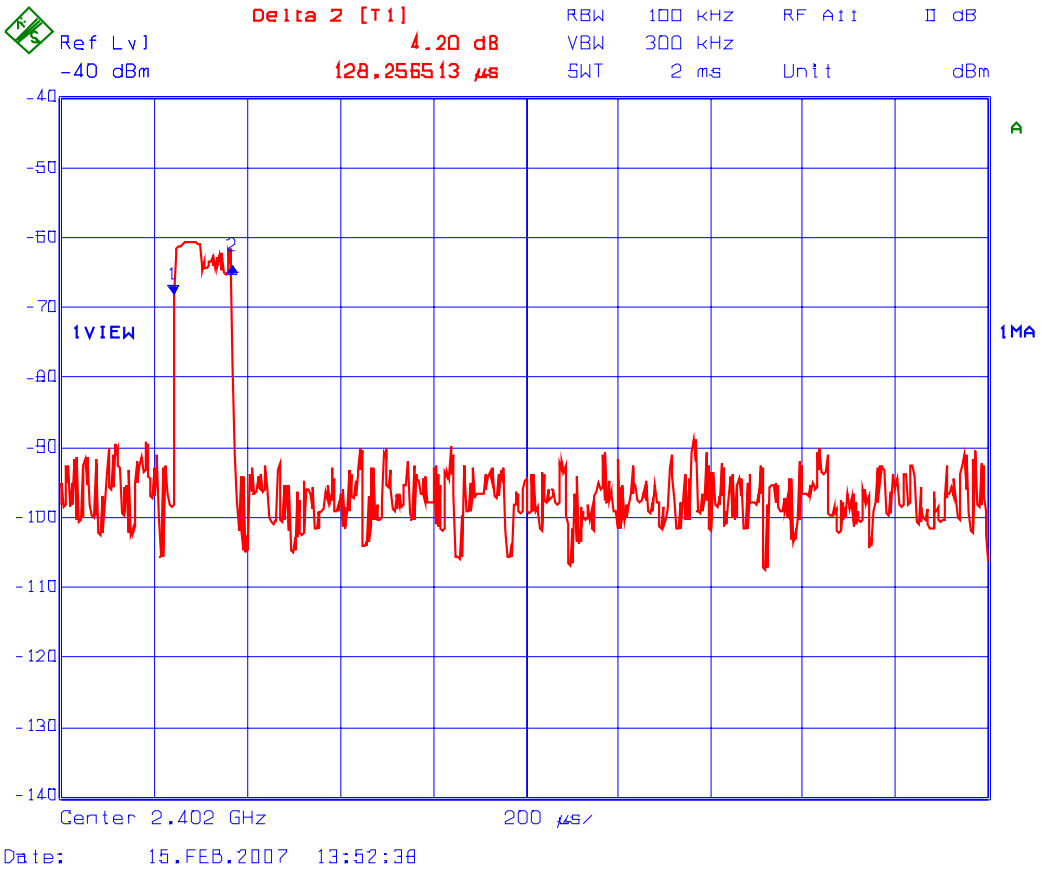
5.9.4. Test Data

See the following plots for measurement details.

Plot 5.9.4.1: Number of Hopping Frequencies
79 channels

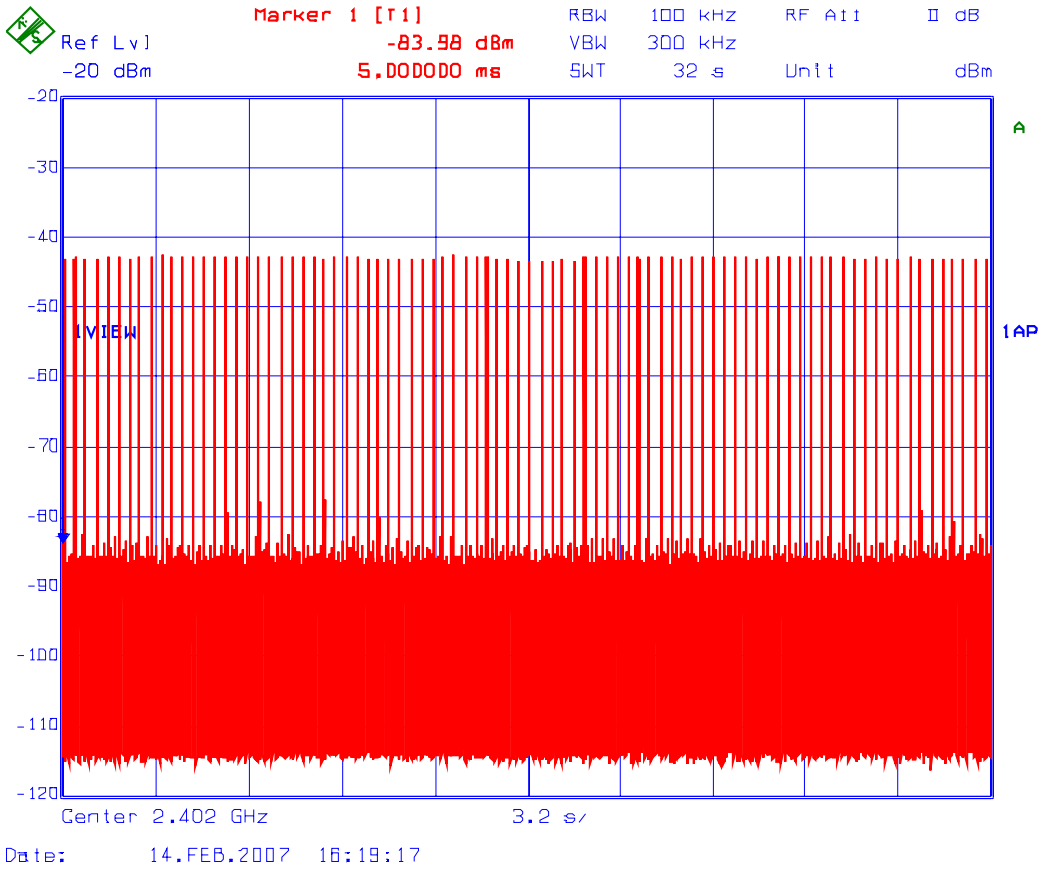


Plot 5.9.4.2: Time of Occupancy
Test Frequency: 2402 MHz



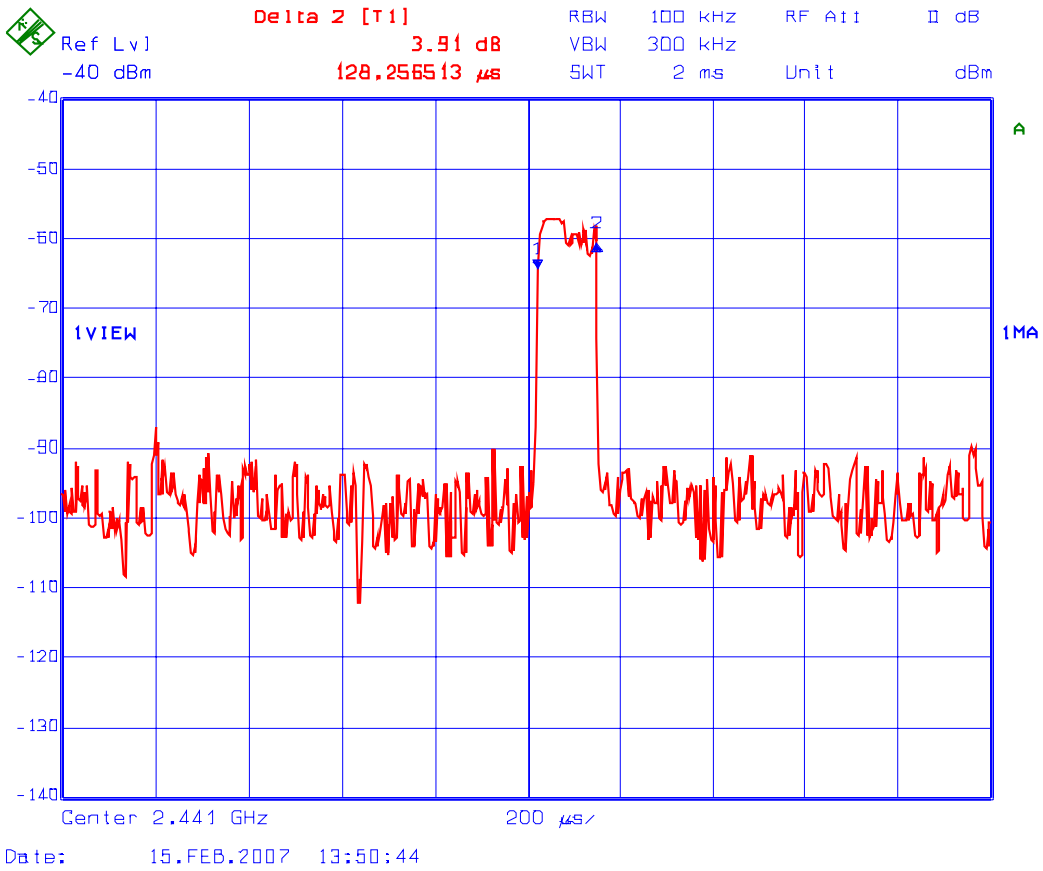
Dwell Time @ 2402 MHz = 128.256513 µs

Plot 5.9.4.3: Time of Occupancy
Test Frequency: 2402 MHz



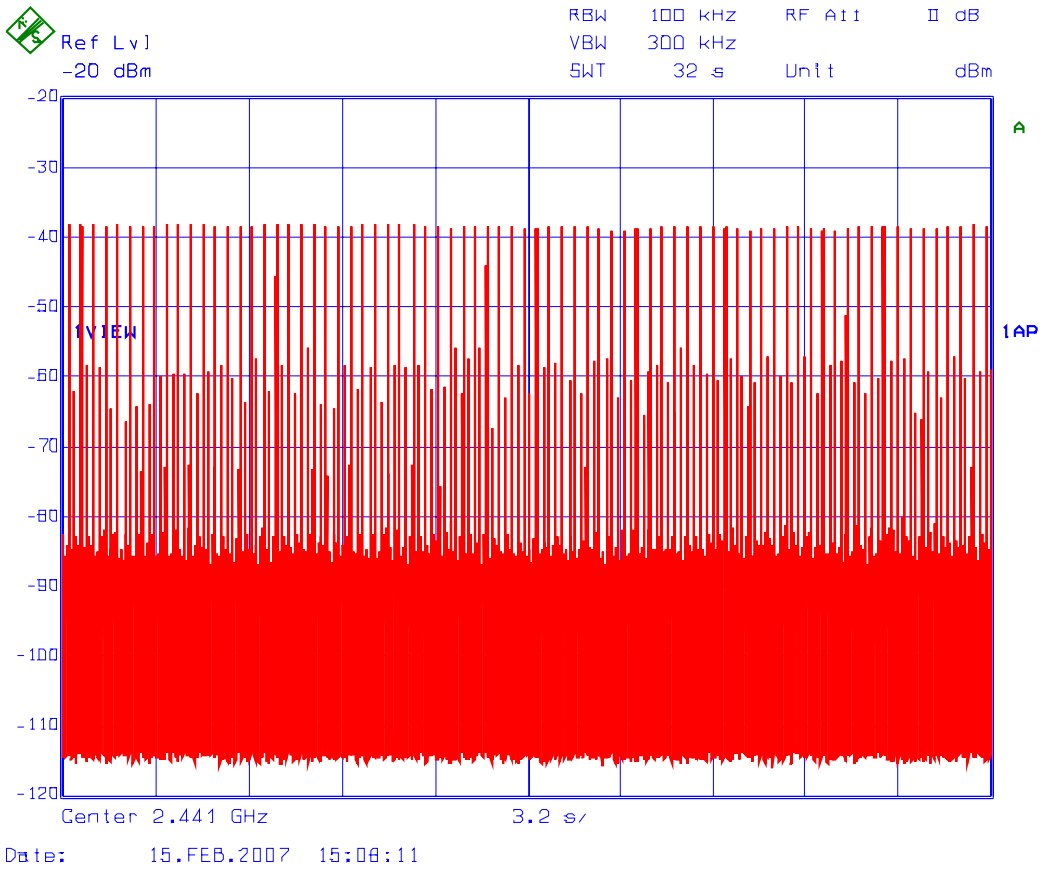
Average time of occupancy in 31.6 s = (Dwell Time @ 2402 MHz) x (number of hops in 31.6 s)
= 128.256513 µs x 90
= 11.54 ms

Plot 5.9.4.4: Time of Occupancy
Test Frequency: 2441 MHz



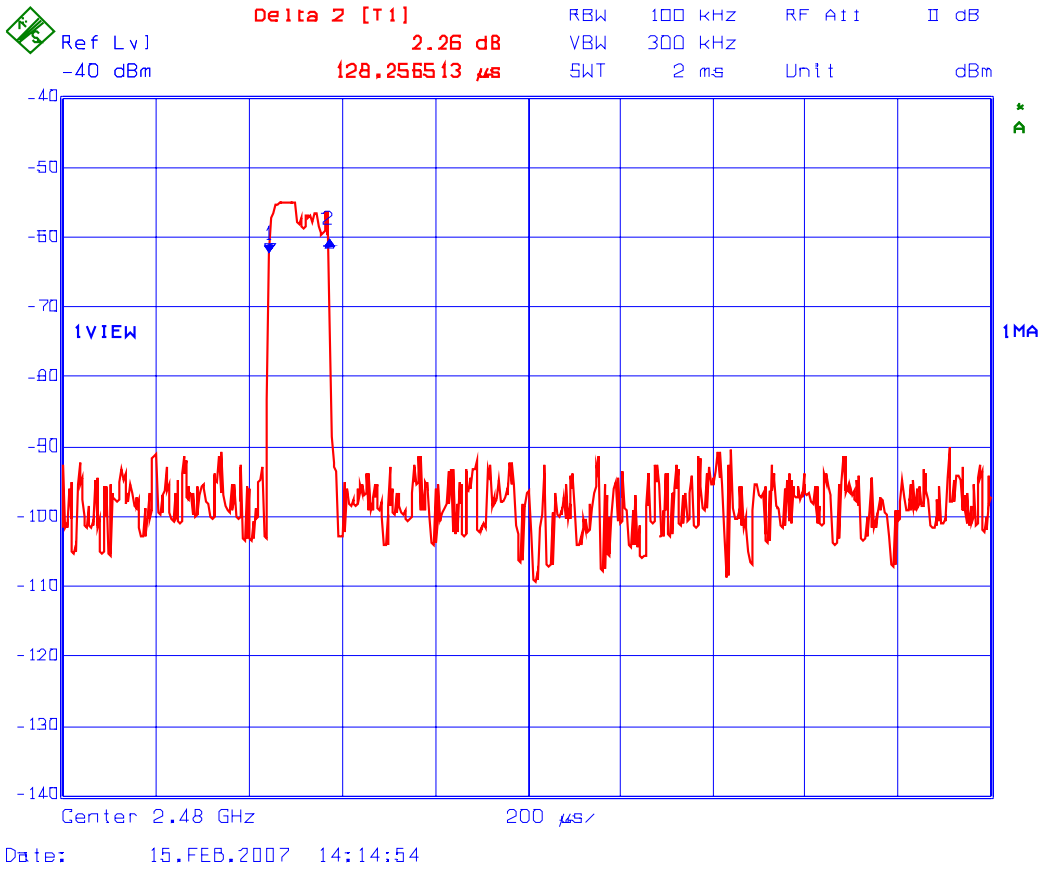
Dwell Time @ 2441 MHz = 128.256513 µs

Plot 5.9.4.5: Time of Occupancy
Test Frequency: 2441 MHz



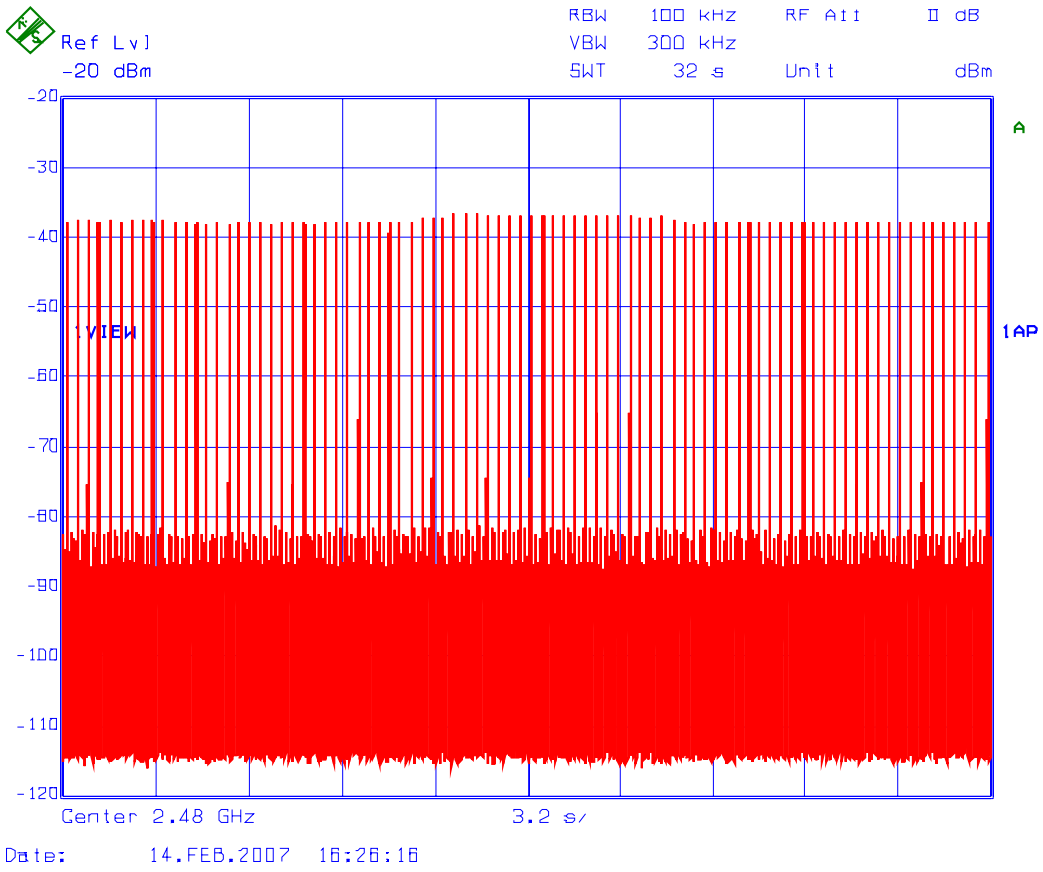
Average time of occupancy in 31.6 s = (Dwell Time @ 2441 MHz) x (number of hops in 31.6 s)
= 128.256513 µs x 90
= 11.54 ms

Plot 5.9.4.6: Time of Occupancy
Test Frequency: 2480 MHz



Dwell Time @ 2480 MHz = 128.256513 µs

Plot 5.9.4.7: Time of Occupancy
Test Frequency: 2480 MHz



Average time of occupancy in 31.6 s = (Dwell Time @ 2480 MHz) x (number of hops in 31.6 s)
= 128.256513 µs x 90
= 11.54 ms

5.10 RF Exposure Requirement [§ 15.247 (i), 1.1310 & 2.1091]

5.10.1. Limits

- **§ 15.247(i):** Systems operating under provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines. See 1.1307(b)(1).
- **§ 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).

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3–3.0	614	1.63	*(100)	6
3.0–30	1842/f	4.89/f	*(900/f^2)	6
30–300	61.4	0.163	1.0	6
300–1500	.....	.....	f/300	6
1500–100,000	.....	.....	5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3–1.34	614	1.63	*(100)	30
1.34–30	824/f	2.19/f	*(180/f^2)	30
30–300	27.5	0.073	0.2	30
300–1500	.....	.....	f/1500	30
1500–100,000	.....	.....	1.0	30

f = frequency in MHz
* = Plane-wave equivalent power density

NOTE 1 TO TABLE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2 TO TABLE 1: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

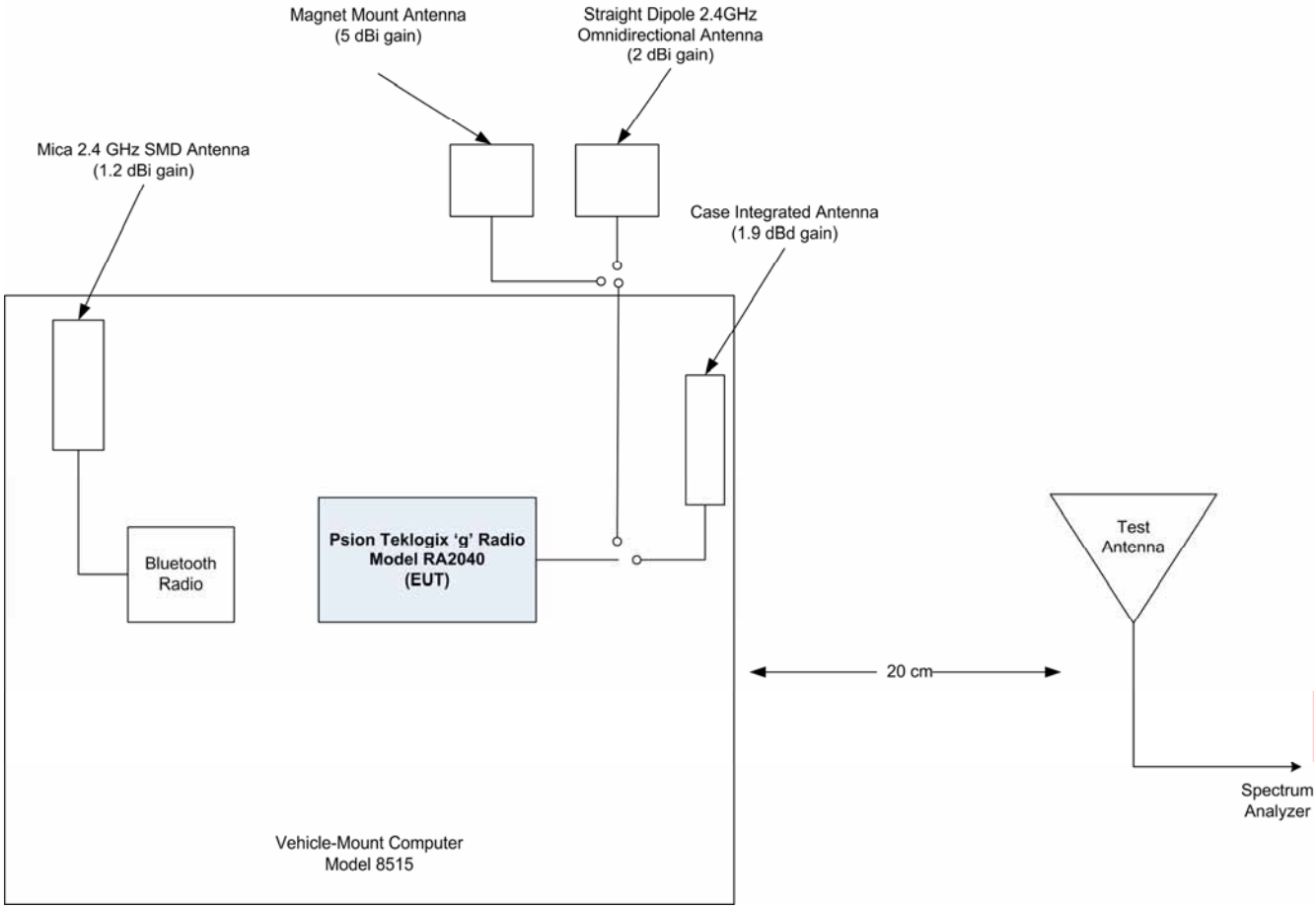
5.10.2. Method of Measurements

MPE measurements were conducted for each transmitter individually per the procedures described in the following.

(1) Connect the transmitter under test to it's antenna with maximum gain as specified by the manufacturer and terminate the other Tx antenna ports with 50 Ohm load.
(2) Set the transmitter to operate at it's test frequency and maximum power as rated by the manufacturer
(3) Place the test antenna in vertical polarization at a test distance of 20 cm from the EUT.
(4) Rotate the EUT 360 degrees to maximize and obtain the highest amplitude signal. Record this reading.
(5) Repeat steps (3) to (4) with the test antenna in horizontal polarization
(6) Repeat steps (2) to (5) for all other test frequencies.
(7) Repeat steps (1) to (6) for remaining transmitters and tabulate results.

The highest E-field from each transmitter individually was converted to power density S. Final results representing the maximum combined exposure of radios were obtained by summing the highest ratios, between actual (S) and maximum allowed (MPE) exposure level from each transmitter.

5.10.3. Test Arrangement



5.10.4. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Rohde & Schwarz	FSEK20/B4/B21	834157/005	9 kHz to 40 GHz
Horn Antenna	EMCO	3115	9701-5061	1 GHz – 18 GHz

5.10.5. Test Data

Remarks:

- The Manufacturer has specified 20cm as minimum separation distance; hence E-field is measured at 20 cm from antenna.
- Measured E-field is converted to equivalent power density using the following formula:

  $S = E^2 / 120\ \pi$
  where E is the electric field strength in V/m and S is the power density in W/m^2
- Compliance of all transmitters is determined by summing the individual ratios, between actual (S) and maximum allowed (MPE) exposure level. Compliance it achieved if the total exposure level (T) is less than one.

  $T = S_1 / MPE_1 + S_2 / MPE_2 + \ldots < 1$

  Limits for general population/uncontrolled exposure are used to demonstrate compliance

5.10.5.1. Test Configuration 1: Bluetooth with Mica 2.4 GHz SMD Antenna and RA2040 with Magnet Mount Antenna

Bluetooth with Mica 2.4 GHz SMD antenna, 1.2dBi gain

Test Frequency (MHz)	E-Field @ 20 cm (dBµV/m)		Peak E-Field (V/m)
	Vertical Polarization	Horizontal Polarization	
2402	104.26	105.43	0.186
2441	104.16	107.09	0.226
2480	106.20	105.94	0.204

Power Density $S_1 = E^2/120\pi\ W/m^2 = (0.226)^2/377 = 0.00013548\ W/m^2 = 0.000013548\ mW/cm^2$

RA2040 with Magnet Mount antenna, 5.0dBi gain

Test Frequency (MHz)	E-Field @ 20 cm (dBµV/m)		Peak E-Field (V/m)
	Vertical Polarization	Horizontal Polarization	
2412	111.78	111.06	0.388
2437	112.52	112.47	0.422
2462	111.14	112.82	0.437

Power Density $S_2 = E^2/120\pi\ W/m^2 = (0.437)^2/377 = 0.0005065\ W/m^2 = 0.00005065\ mW/cm^2$

Total Exposure Level:

$T = S_1 / MPE_1 + S_2 / MPE_2$
$T = 0.000013548 / 1.0 + 0.00005065 / 1.0 = 0.000064198 < 1$

5.10.5.2. Test Configuration 2: Bluetooth with Mica 2.4 GHz SMD Antenna and RA2040 with Straight Dipole Antenna

Bluetooth with Mica 2.4 GHz SMD antenna, 1.2dBi gain

Test Frequency (MHz)	E-Field @ 20 cm (dBµV/m)		Peak E-Field (V/m)
	Vertical Polarization	Horizontal Polarization	
2402	107.36	105.87	0.233
2441	107.68	106.34	0.242
2480	110.78	110.09	0.346

Power Density $S_1 = E^2/120\pi$ W/m^2 = $(0.346)^2/377$ = 0.0003175 W/m^2 = 0.00003175 mW/cm^2

RA2040 with Straight Dipole antenna, 2.0dBi gain

Test Frequency (MHz)	E-Field @ 20 cm (dBµV/m)		Peak E-Field (V/m)
	Vertical Polarization	Horizontal Polarization	
2412	111.73	111.25	0.386
2437	111.08	112.32	0.413
2462	112.79	112.16	0.436

Power Density $S_2 = E^2/120\pi$ W/m^2 = $(0.436)^2/377$ = 0.0005042 W/m^2 = 0.00005042 mW/cm^2

Total Exposure Level:

$T = S_1 / MPE_1 + S_2 / MPE_2$
$T = 0.00003175 / 1.0 + 0.00005042 / 1.0 = 0.00008217 < 1$

5.10.5.3. Test Configuration 3: Bluetooth with Mica 2.4 GHz SMD Antenna and RA2040 with Case Integrated PCB Antenna

Bluetooth with Mica 2.4 GHz SMD antenna, 1.2dBi gain

Test Frequency (MHz)	E-Field @ 20 cm (dBµV/m)		Peak E-Field (V/m)
	Vertical Polarization	Horizontal Polarization	
2402	105.17	106.10	0.202
2441	105.77	106.04	0.200
2480	108.88	109.56	0.301

Power Density $S_1 = E^2/120\pi$ W/m^2 = $(0.301)^2/377$ = 0.0002403 W/m^2 = 0.00002403 mW/cm^2

RA2040 with Case Integrated PCB antenna, 1.9dBd gain

Test Frequency (MHz)	E-Field @ 20 cm (dBµV/m)		Peak E-Field (V/m)
	Vertical Polarization	Horizontal Polarization	
2412	126.68	128.94	2.799
2437	127.22	130.14	3.214
2462	127.92	131.47	3.745

Power Density $S_2 = E^2/120\pi$ W/m^2 = $(3.745)^2/377$ = 0.0372016 W/m^2 = 0.00372016 mW/cm^2

Total Exposure Level:

$T = S_1 / MPE_1 + S_2 / MPE_2$
$T = 0.00002403 / 1.0 + 0.00372016 / 1.0 = 0.00374419 < 1$

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 Γ_1 = 0.03 LISN VRC Γ_R = 0.8(9 kHz) 0.2 (30 MHz) Uncertainty limits 20Log(1±$\Gamma_1\Gamma_R$)	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:

$u_c(y) = \sqrt{\sum_{I=1}^{m} u_i^2(y)} = \pm \sqrt{(1.5^2 + 1.5^2)/3 + (0.5/2)^2 + (0.05/2)^2 + 0.35^2} = \pm 1.30$ 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 Directivity	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 Γ_1 = 0.2 Antenna VRC Γ_R = 0.67(Bi) 0.3 (Lp) Uncertainty limits 20Log(1±$\Gamma_1\Gamma_R$)	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