ENGINEERING TEST REPORT

Ecobee Smart Thermostat
Model No.: EB-STAT-01

FCC ID: WR9EBSTAT

Applicant:

Ecobee Incorporated
333 Adelaide St. W 6th Floor
Toronto, Ontario, Canada, M5V 1R5

In Accordance With

Federal Communications Commission (FCC)
Part 15, Subpart C, Section 15.247
Digital Transmission System (DTS) Operating in 2400 – 2483.5 MHz Band

UltraTech's File No.: AVAN-005F15C247

This Test report is Issued under the Authority of Tri M. Luu, Professional Engineer, Vice President of Engineering UltraTech Group of Labs Date: November 25, 2008	
Report Prepared by: JaeWook Choi Issued Date: November 25, 2008	Tested by: Mr. Hung Trinh, EMI/RFI Technician Test Dates: November 5 & 12, 2008

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

3000 Bristol Circle, Oakville, Ontario, Canada, L6H 6G4
Tel.: (905) 829-1570 Fax.: (905) 829-8050
Website: www.ultratech-labs.com, Email: vic@ultratech-labs.com, Email: tri@ultratech-labs.com

ANSI	FC	VCCI	Industry Canada	NVLAP	BSMI	Korea MIC-RRL
0685	31040/SIT	C-1376	46390-2049	200093-0	SL2-IN-E-1119R	2005-82 & 83

TABLE OF CONTENTS

EXHIBIT 1. SUBMITTAL CHECK LIST

Annex No.	Exhibit Type	Description of Contents	Quality Check (OK)
--	Test Report	▪ Exhibit 1: Submittal check lists ▪ Exhibit 2: Introduction ▪ Exhibit 3: Performance Assessment ▪ Exhibit 4: EUT Operation and Configuration during Tests ▪ Exhibit 5: Summary of test Results ▪ Exhibit 6: Measurement Data ▪ Exhibit 7: Measurement Uncertainty	OK
1	Test Setup Photos	▪ Power Line Conducted Emissions Setup Photos ▪ Radiated Emissions Setup Photos	OK
2	External EUT Photos	External EUT Photos	OK
3	Internal EUT Photos	Internal EUT Photos	OK
4	Cover Letters	▪ Letter from Ultratech for Certification Request ▪ Letter from the Applicant to appoint Ultratech to act as an agent ▪ Letter from the Applicant to request for Confidentiality Filing	OK
5	Attestation Statements	--	--
6	ID Label/Location Info	ID Label and Location of Label	OK
7	Block Diagrams	Block Diagram	OK
8	Schematic Diagrams	Schematics	OK
9	Parts List/Tune Up Info	Parts List	OK
10	Operational Description	Operation Description	OK
11	RF Exposure Info	MPE estimation	OK
12	Users Manual	User's Guide	OK

EXHIBIT 2. INTRODUCTION

2.1. 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 Digital Transmission System (DTS) 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:	[ ] Commercial, industrial or business environment [x] Residential environment

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

None.

2.3. 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 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
KDB Publication No. 558074	2005	Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247)

EXHIBIT 3. PERFORMANCE ASSESSMENT

3.1. CLIENT INFORMATION

APPLICANT	
Name:	Ecobee Incorporated
Address:	333 Adelaide St. W 6th Floor Toronto, Ontario, Canada, M5V 1R5
Contact Person:	Mr. Quinto Petrucci Phone #: +1 416-987-1058 Fax #: +1 866-592-7344 Email Address: quinto@ecobee.com

MANUFACTURER	
Name:	Artaflex Inc
Address:	215 Konrad Crescent Markham, Ontario, Canada, L3R 8T9
Contact Person:	Mr. Wayne Embree Phone #: +1 905-479-0148 Fax #: +1 905-479-0149 Email Address: wayne_embree@artaflex.com

3.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

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

Marketing Name:	Ecobee Smart Thermostat
Product Description:	Programmable Thermostat
Model Name or Number:	EB-STAT-01
Serial Number:	Test Sample
Type of Equipment:	Digital Transmission System
Input Power Supply Type:	AC Power Adapter (120 VAC to 12 VDC, 1A)
Primary User Functions of EUT:	Adjust temperature and/or humidity to control heating and/or cooling systems within the home.

3.3. EUT'S TECHNICAL SPECIFICATIONS

TRANSMITTER	
Equipment Type:	Base Station (fixed use)
Intended Operating Environment:	Residential
Power Supply Requirement:	12.0VDC
RF Output Power Rating:	802.11b: 14.81 dBm peak conducted 802.11g: 12.42 dBm peak conducted
Operating Frequency Range:	2412 – 2462 MHz
Duty Cycle:	100 %
6 dB bandwidth:	802.11b: 9,592 kHz 802.11g: 16,610 kHz
Modulation Type:	802.11b: DBPSK(1Mbps), DQPSK(2Mbps), CCK(5.5/11Mbps) 802.11g: OFDM(6M-54Mbps)
Antenna Description:	Manufacturer: Antenova Type: SMD antenna Model: 3030A5839-01 Frequency Range: 2400-2500 MHz Gain (dBi): 2.1 dBi peak
Antenna Connector Type:	Integral

3.4. LIST OF EUT'S PORTS

Port Number	EUT's Port Description	Number of Identical Ports	Connector Type	Cable Type (Shielded/Non-shielded)
IDT (Touch Screen Display)				
1	12V DC power from EI (+12V)	1	4 screws terminal block	Non-Shielded
2	GND			
3	Data + communication line (D+)			
4	Data – communication line (D-)			
EI (Equipment Interface)				
5	12V DC power to IDT (+12V)	1	4 screws terminal block	Non-Shielded
6	GND			
7	Data + communication line (D+)			
8	Data – communication line (D-)			
9	1st stage cooling (y)	1	5 screws terminal block	Non-Shielded
10	1st stage heating (W)			
11	Fan 30V AC (G)			
12	2nd stage heating (W2)			
13	Heat transformer return (R/H)			
14	Cool transformer return (R/C)	1	5 screws terminal block	Non-Shielded
15	2nd stage cooling (y2)			
16	3rd stage heating (W3)			
17	1st accessory relay (ACC1)			
18	1st accessory relay return (ACC1r)			
19	2nd accessory relay (ACC2)	1	4 screws terminal block	Non-Shielded
20	2nd accessory relay return (ACC2r)			
21	3rd accessory relay (ACC3)			
22	3rd accessory relay return (ACC3r)			
23	Input 1 + (IN1 +)	1	4 screws terminal block	Non-Shielded
24	Input 1 – (IN1 -)			
25	Input 2 + (IN2 +)			
26	Input 2 – (IN2 -)			
27	AC/DC Power Adapter	1	DC Power Jack	N/A

3.5. ANCILLARY EQUIPMENT

None.

3.6. General Test Setup

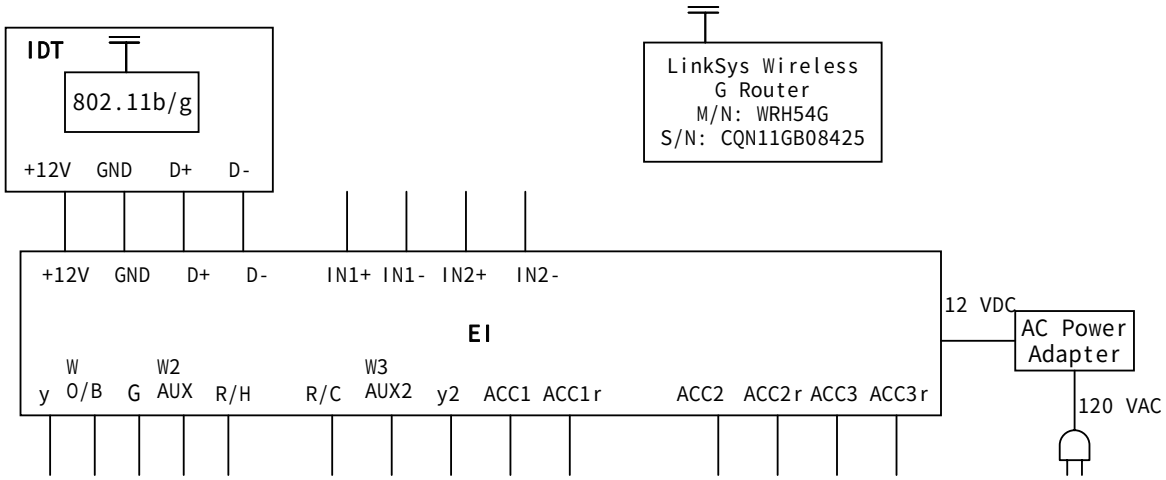


EXHIBIT 4. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

4.1. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS

Operating Modes:	Each of lowest, middle and highest channel frequencies transmits continuously for emissions measurements.
Special Test Software:	A wireless router was used to operate the EUT at each channel frequency continuously. For example, the transmitter will be operated at each of the lowest, middle and highest frequencies individually continuously during testing.
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):	2412– 2462 MHz
Frequency(ies) Tested: (Near lowest, near middle & near highest frequencies in the frequency range of operation.)	2412 MHz, 2437MHz and 2462MHz
RF Power Output: (measured maximum output power at antenna terminals)	802.11b: 14.81 dBm peak conducted 802.11g: 12.42 dBm peak conducted
Normal Test Modulation:	802.11b: DBPSK(1Mbps), DQPSK(2Mbps), CCK(5.5/11Mbps) 802.11g: OFDM(6M-54Mbps)
Modulating Signal Source:	Internal

EXHIBIT 5. SUMMARY OF TEST RESULTS

5.1. 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, 24'(L) by 16'(W) by 8'(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.: 31040/SIT 1300B3) and Industry Canada office (Industry Canada Site No.: 2049A-3, Expiry Date: May 17, 2009).

5.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC Section(s)	Test Requirements	Compliance (Yes/No)
15.203	Antenna requirements	Yes
15.207(a)	Power Line Conducted Emissions	Yes
15.247(a)(2)	6 dB Bandwidth	Yes*
15.247(b)(3)	Peak Conducted 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(e)	Power Spectral Density	Yes*
15.247(i) 1.1307 & 1.1310	RF Exposure	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. The engineering test report is available upon request.		

* See results from the attached test report for the integrated 802.11b/g transmitter (FCC ID: U9R-W2SW0001)

5.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None.

EXHIBIT 6. MEASUREMENTS, EXAMINATIONS & TEST DATA FOR EMC EMISSIONS

6.1. 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.

6.2. 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 8. for Measurement Uncertainties.

6.3. 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.

6.4. ESSENTIAL/PRIMARY FUNCTIONS AS DECLARED BY THE MANUACTURER

The Programmable Thermostat adjusts temperature and/or humidity to control heating and/or cooling systems within the home through wireless.

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

6.5.1. Limit(s)

The equipment shall meet the limits of the following table:

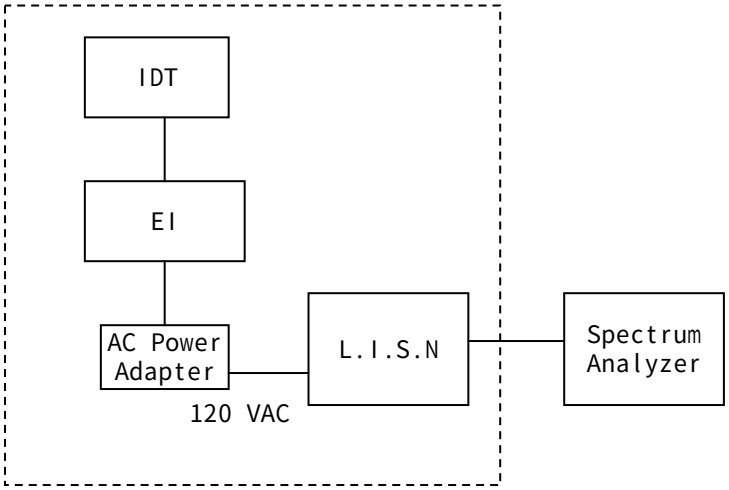
Frequency of emission (MHz)	Conducted Limits (dBμV)		Measuring Bandwidth
	Quasi-peak	Average	
0.15–0.5 .....……..	66 to 56*	56 to 46*	RBW = 9 kHz
0.5–5 .....……..	56	46	VBW ≥ 9 kHz for QP
5-30 ……..	60 .....……..	50	VBW = 1 Hz for Average

*Decreases linearly with the logarithm of the frequency

6.5.2. Method of Measurements

ANSI C63.4

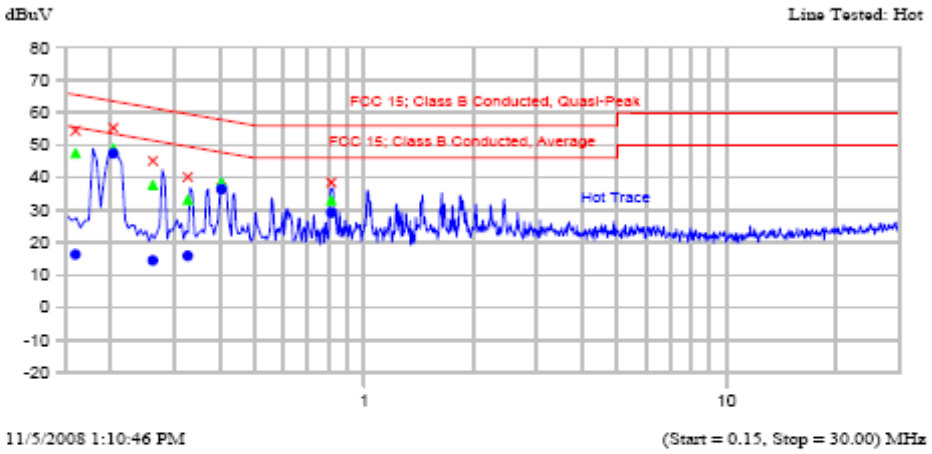
6.5.3. Test Arrangement



6.5.4. Test Data

Plot 6.5.4.1. Power Line Conducted Emissions
Line Voltage: 120 VAC 60 Hz
Line Tested: Hot

Current Graph

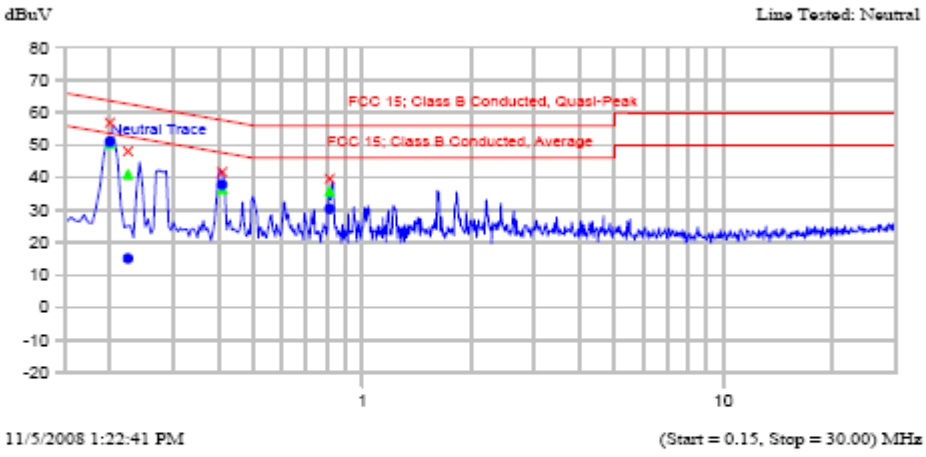


Current List

Frequency MHz	Peak dBuV	QP dBuV	Delta QP-QP Limit dB	Avg dBuV	Delta Avg-Avg Limit dB	Trace Name
0.160	54.4	47.5	-18.2	16.3	-39.4	Hot Trace
0.204	55.3	49.0	-15.5	47.4	-7.0	Hot Trace
0.262	45.1	37.7	-25.0	14.5	-38.2	Hot Trace
0.327	40.1	33.1	-27.8	15.9	-35.0	Hot Trace
0.404	37.0	38.4	-20.2	36.4	-12.3	Hot Trace
0.813	38.5	32.9	-23.1	29.1	-16.9	Hot Trace

Plot 6.5.4.2. Power Line Conducted Emissions
Line Voltage: 120 VAC 60 Hz
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
0.200	56.9	50.5	-14.1	51.0	-3.6	Neutral Trace
0.225	48.1	41.0	-22.9	15.1	-38.7	Neutral Trace
0.410	41.6	36.4	-22.1	37.8	-10.7	Neutral Trace
0.813	39.6	35.8	-20.2	30.4	-15.6	Neutral Trace

6.6. PEAK CONDUCTED OUTPUT POWER - DTS [§ 15.247(b)]

6.6.1. Limit(s)

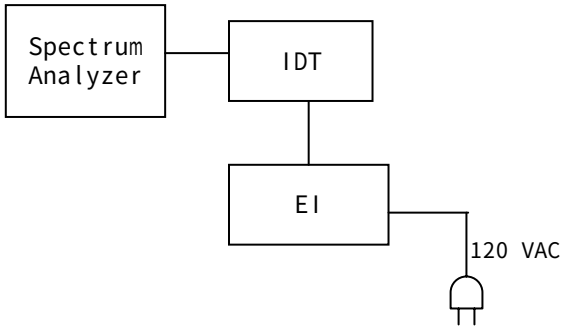
§ 15.247(b)(3): For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the *maximum conducted output power* is the highest total transmit power occurring in any mode.

§15.247(b)(4): The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

6.6.2. Method of Measurements & Test Arrangement

KDB Publication No. 558074: Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247): Power Output Option 1

6.6.3. Test Arrangement



6.6.4. Test Data

6.6.4.1. 802.11b mode

Channel	Frequency (MHz)	Channel Power (dBm)	Specification (dBm)
1 (11 Mbps)	2412	14.81	14.71
6 (11 Mbps)	2437	14.45	14.77
11 (11 Mbps)	2462	14.22	14.69

6.6.4.2. 802.11g mode

Channel	Frequency (MHz)	Channel Power (dBm)	Specification (dBm)
1 (54 Mbps)	2412	12.42	12.24
6 (54 Mbps)	2437	12.37	12.27
11 (54 Mbps)	2462	12.19	12.40

6.7. TRANSMITTER SPURIOUS RADIATED EMISSIONS AT 3 METERS [§§ 15.247(d), 15.209 & 15.205]

6.7.1. Limit(s)

§ 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 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)).

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

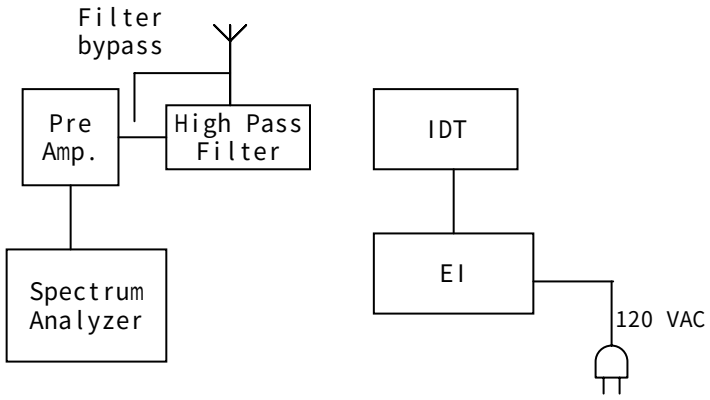
Section 15.209(a)
-- Field Strength Limits within Restricted Frequency Bands --

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

6.7.2. Method of Measurements

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

6.7.3. Test Arrangement

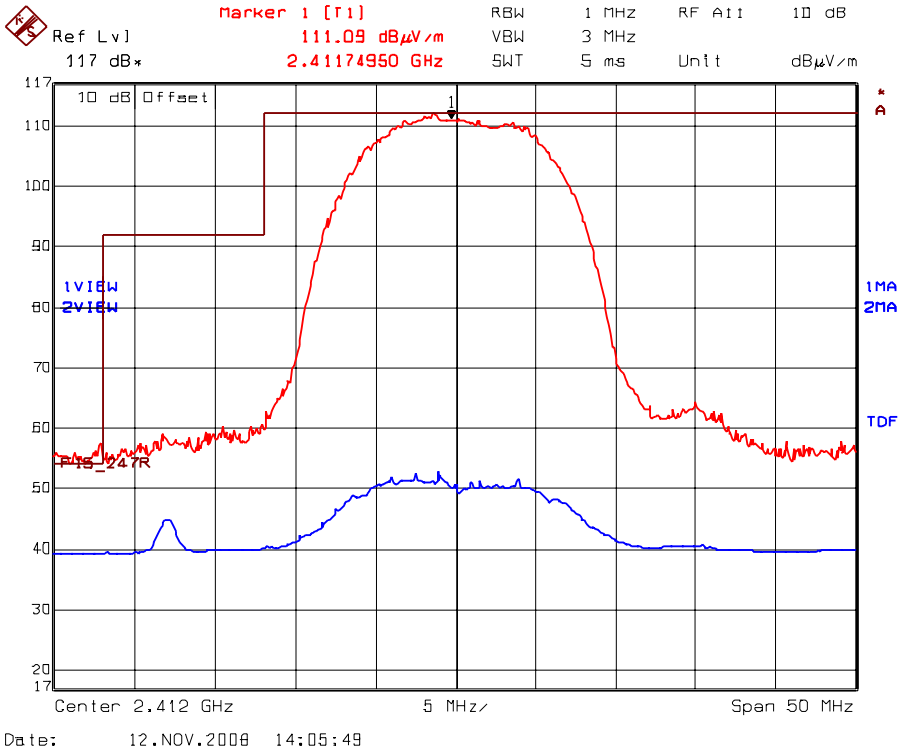


6.7.4. Test Data

6.7.4.1. Band-Edge RF Radiated Emissions @ 3m

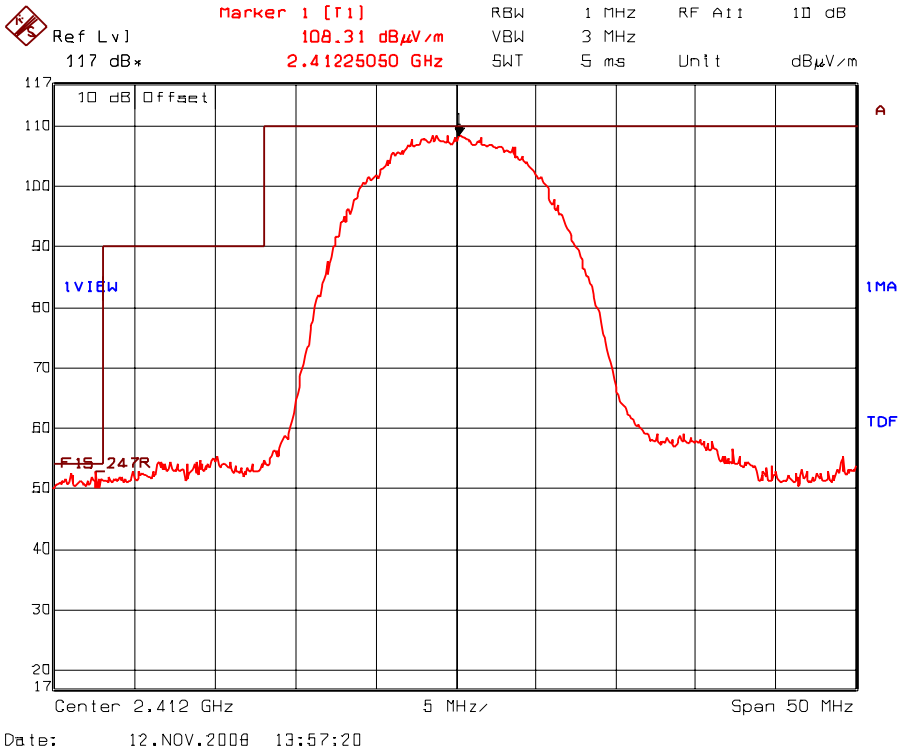
6.7.4.1.1. 802.11b mode, 11 Mbps data rate, CCK

Plot 6.7.4.1.1. Band-Edge RF Radiated Emissions @ 3 m
Low End of Frequency Band
Rx Antenna Orientation: Horizontal



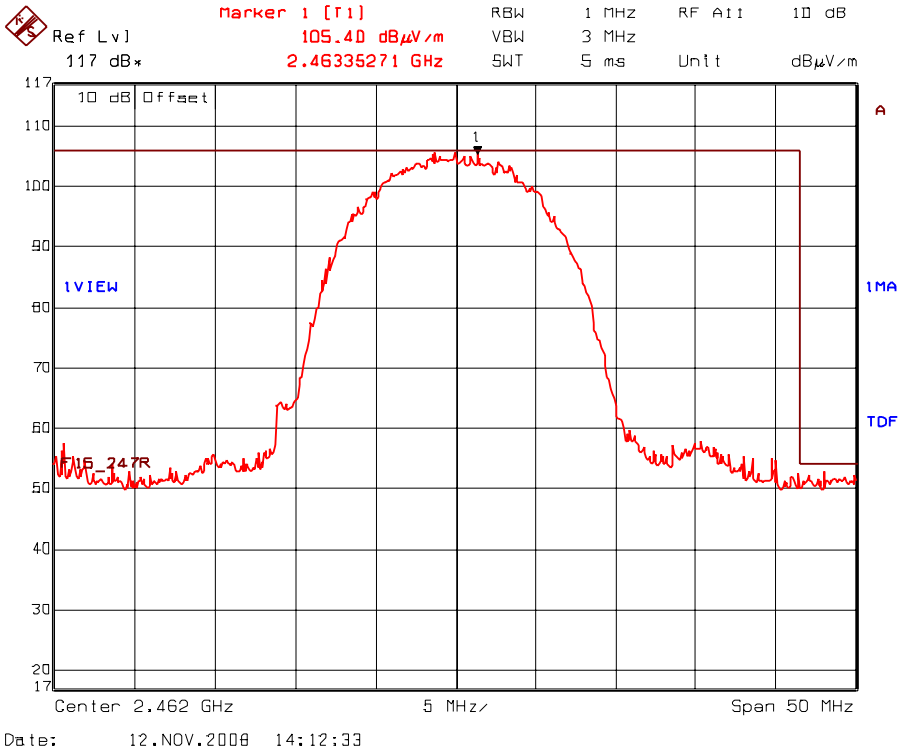
Trace 1: RBW= 1 MHz, VBW= 3 MHz
Trace 2: RBW= 1 MHz, VBW= 10Hz

Plot 6.7.4.1.1.2. Band-Edge RF Radiated Emissions @ 3 m
Low End of Frequency Band
Rx Antenna Orientation: Vertical



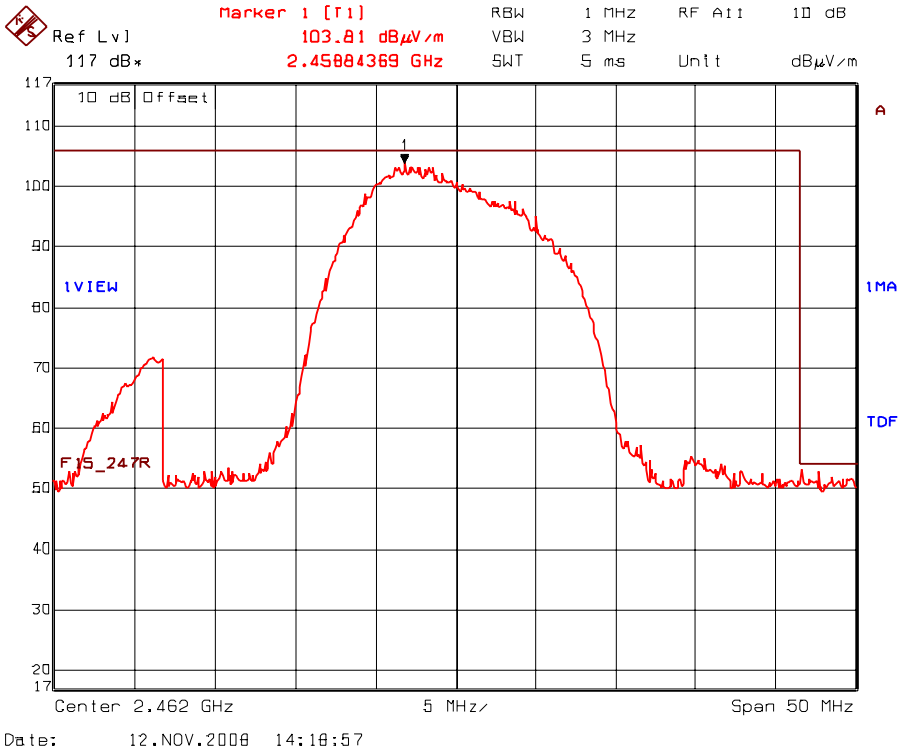
Trace 1: RBW= 1 MHz, VBW= 3 MHz
Average level was below limit as we tested at low end frequency

Plot 6.7.4.1.1.3. Band-Edge RF Radiated Emissions @ 3 m
High End of Frequency Band
Rx Antenna Orientation: Horizontal



Trace 1: RBW= 1 MHz, VBW= 3 MHz
Average level was below limit as we tested at low end frequency

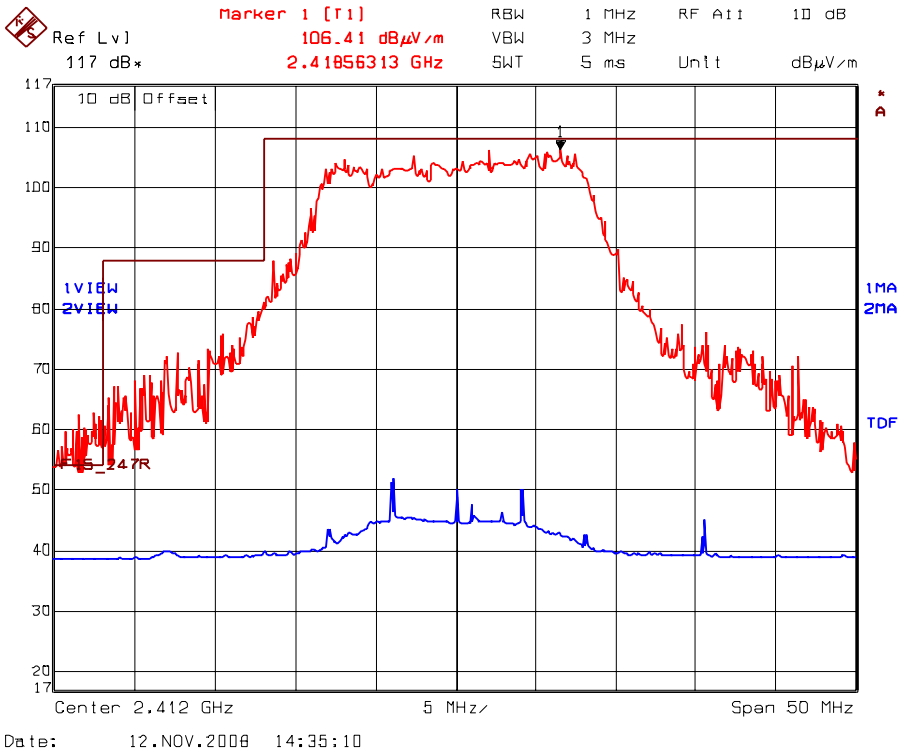
Plot 6.7.4.1.1.4. Band-Edge RF Radiated Emissions @ 3 m
High End of Frequency Band
Rx Antenna Orientation: Vertical



Trace 1: RBW= 1 MHz, VBW= 3 MHz
Average level was below limit as we tested at low end frequency

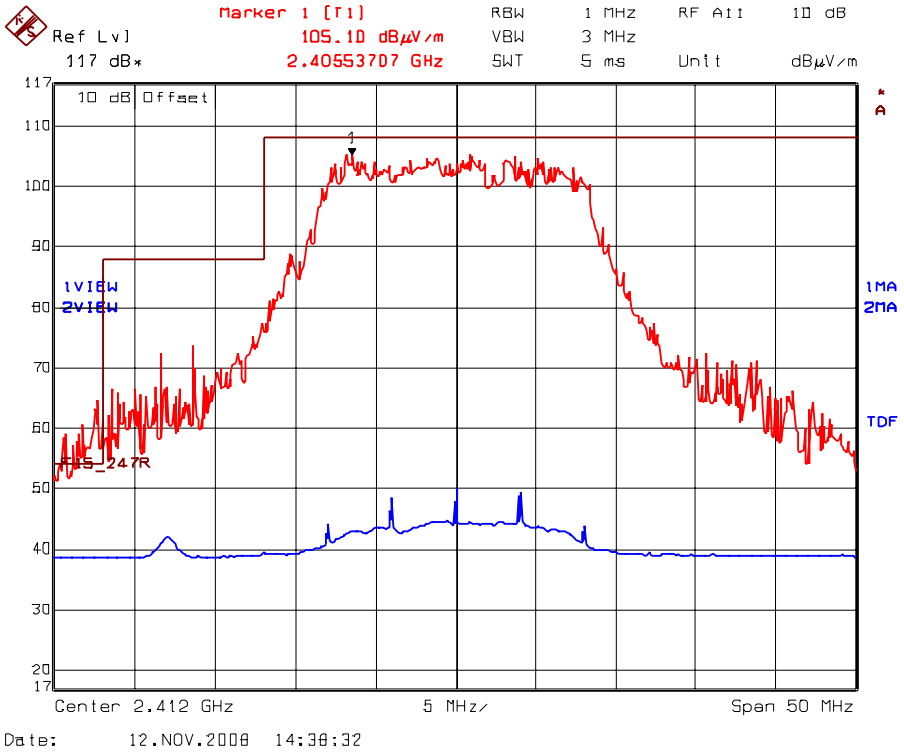
6.7.4.1.2. 802.11g mode, 54 Mbps data rate, 64QAM

Plot 6.7.4.1.2.1. Band-Edge RF Radiated Emissions @ 3 m
Low End of Frequency Band
Rx Antenna Orientation: Horizontal



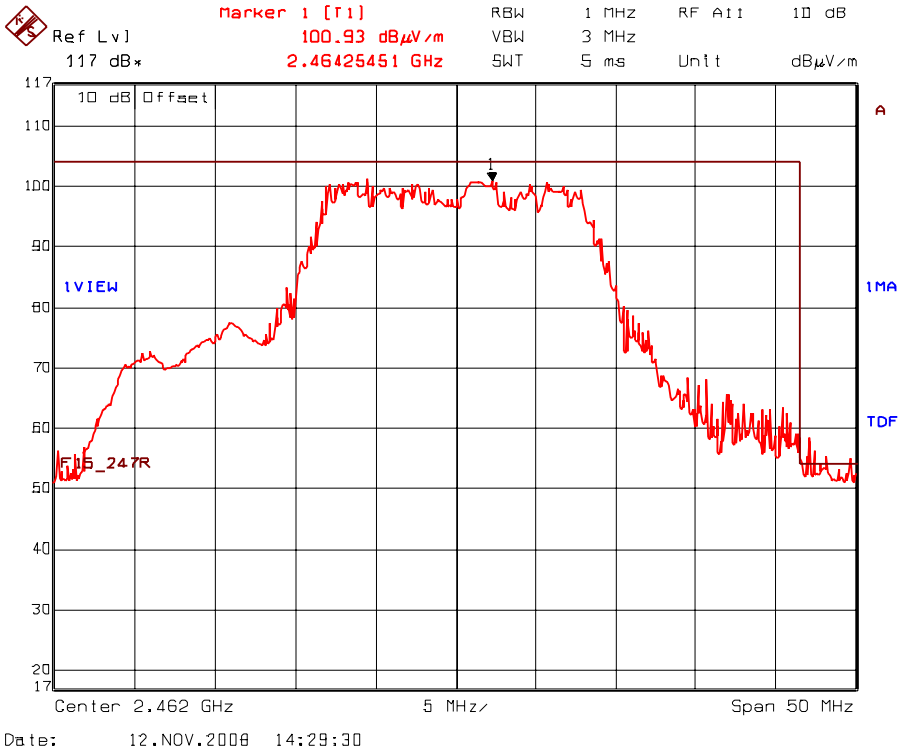
Trace 1: RBW= 1 MHz, VBW= 3 MHz
Trace 2: RBW= 1 MHz, VBW= 10Hz

Plot 6.7.4.1.2.2. Band-Edge RF Radiated Emissions @ 3 m
Low End of Frequency Band
Rx Antenna Orientation: Vertical



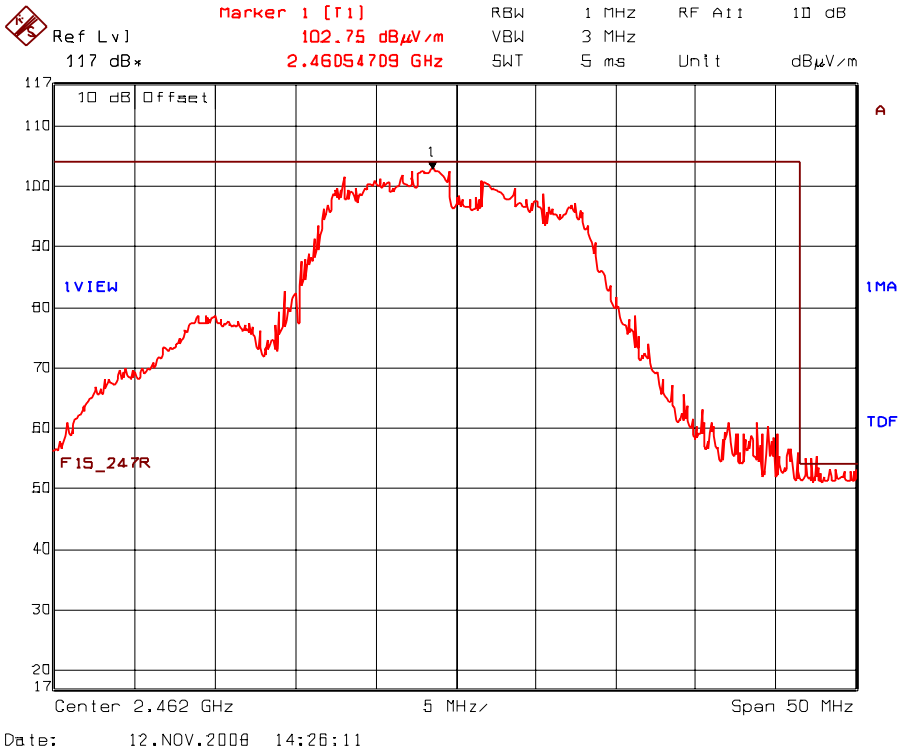
Trace 1: RBW= 1 MHz, VBW= 3 MHz
Trace 2: RBW= 1 MHz, VBW= 10Hz

Plot 6.7.4.1.2.3. Band-Edge RF Radiated Emissions @ 3 m
High End of Frequency Band
Rx Antenna Orientation: Horizontal



Trace 1: RBW= 1 MHz, VBW= 3 MHz
Average level was below limit as we tested at low end frequency

Plot 6.7.4.1.2.4. Band-Edge RF Radiated Emissions @ 3 m
High End of Frequency Band
Rx Antenna Orientation: Vertical



Trace 1: RBW= 1 MHz, VBW= 3 MHz
Average level was below limit as we tested at low end frequency

6.7.4.2. Spurious RF Radiated Emissions

Remarks:
- All spurious emissions that are in excess of 20 dB below the specified limit shall be recorded.
- EUT is tested in normal position (Rx vertical) and on battery side position (Rx horizontal).
- The following test results are the worst-case measurements in 802.11b mode and level in 802.11g mode were found to be lower than that in 802.11b mode.

Fundamental Frequency: 2412 MHz
Frequency Test Range: 30 MHz – 25 GHz

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
2412	108.31	--	V	--	--	--	--
2412	111.09	--	H	--	--	--	--
4824	53.12	34.19	V	54.0	91.09	-19.81	Pass*
4824	54.60	34.66	H	54.0	91.09	-19.34	Pass*

*Field strength of emissions appearing within restricted frequency bands shall not exceed the limits shown in § 15.209.

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

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	104.81	--	V	--	--	--	--
2437	106.41	--	H	--	--	--	--
4874	52.40	34.18	V	54.00	86.41	-19.82	Pass*
4874	51.28	33.95	H	54.00	86.41	-20.05	Pass*

*Field strength of emissions appearing within restricted frequency bands shall not exceed the limits shown in § 15.209.

Fundamental Frequency: 2462MHz
Frequency Test Range: 30 MHz – 25 GHz

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
2462	103.81	--	V	--	--	--	--
2462	105.40	--	H	--	--	--	--
4924	51.96	34.17	V	54.0	85.40	-19.83	Pass*
4924	51.29	34.11	H	54.0	85.40	-19.89	Pass*

*Field strength of emissions appearing within restricted frequency bands shall not exceed the limits shown in § 15.209.

6.8. RF Exposure [§§ 15.247(i), 1.1307 & 1.1310]

6.8.1. 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)
(A) Limits for Occupational/Control Exposures				
1500-100,000	...	...	5	6
(B) Limits for General Population/Uncontrolled Exposure				
1500-100,000	...	...	1.0	30

F = Frequency in MHz

6.8.2. MPE evaluation

Categorically excluded from routine environmental evaluation per section 1.1307(b).

6.8.2.1. MPE estimation

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

FCC radio frequency exposure limits may be exceeded at distances closer than r cm from the antenna of this device

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

FCC radio frequency exposure limits may not be exceeded at distances closer than r cm from the antenna of this device

MPE Limit for General Population/Uncontrolled Exposure, **S [mW/cm^2]** = 1.0
Maximum RF Power conducted, **P [dBm]** = 14.81
Maximum Antenna Gain, **G[dBi]** = 2.1
Maximum EIRP, **P_{EIRP}[dBm]** = 14.81 + 2.1 = 16.91
Calculated RF Safety Distance for General Population/Uncontrolled Exposure, **r [cm]** = 2

EXHIBIT 7. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Attenuator (10dB)	Narda	4768-20	N/A	DC – 40 GHz
Attenuator (10dB)	Narda	4768-10	N/A	DC – 40 GHz
Biconilog antenna	EMCO	3142C	34792	26 - 3000 MHz
High Pass Filter	K & L	11SH10-4000/T12000	4	Cut off 3.4 GHz
Horn Antenna	EMCO	3155	6570	1 – 18 GHz
Horn Antenna	EMCO	3160-09	1007	18 – 26.5 GHz
L.I.S.N.	Emco	3825/2	8.9E+07	9 kHz- 200 MHz (50ohms/50uH)
RF Amplifier	Com-Power	PA-103	161057	1 - 1000 MHz
RF Amplifier	Hewlett Packard	8449B	3008A00769	1 – 26.5 GHz
Spectrum Analyzer	Hewlett Packard	8593EM	3412A00103	9 kHz- 26.5 GHz
Spectrum Analyzer	Rohde & Schwarz	FSEK30	100077	20 Hz – 40 GHz
Transient Limiter	Hewlett Packard	11947A	3.1E+08	9 kHz- 200 MHz (10dB)

EXHIBIT 8. MEASUREMENT UNCERTAINTY

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

8.1. 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

8.2. 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 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