

FCC PART 15 SUBPART C

MEASUREMENT AND TEST REPORT

For

Meru Networks

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FCC ID: RE7-AP200R2

This Report Concerns: ☒ Class II Permissive Change: Supplemental Report		Product type: Single/Dual Radio 802.11a/b/g Wireless LAN Access Point AP200 Rev. 2
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GENERAL INFORMATION

Product Description for Equipment Under Test (EUT)

The Meru Networks product, FCC ID: RE7-AP200R2, or the “EUT” as referred to in this report is a Wireless Single/Dual Radio 802.11a/b/g Access Point, models: AP201 Rev 2 & AP208 Rev 2. Both models are similar; model AP201 Rev 2 is a single radio unit, model AP208 Rev 2 is a dual radio unit. Testing was conducted on model AP208 Rev 2 and is considered representative of both models. Verification testing was conducted on model AP201 Rev 2. The radios utilized in the EUT are capable of transmitting and receiving simultaneously. The EUT is a composite device of DTS and UNII. For the DTS part (802.11a/b/g), the frequency range is 2412.00 – 2462.00 MHz (for 802.11b/g), & 5725.00 – 5850.00 MHz (for 802.11a). For the UNII part (802.11a), the frequency range is 5150.00 – 5250.00 MHz, & 5250.00 – 5350.00 MHz. The EUT receives power through PoE (Power over Ethernet) rated at 48VDC/250mA.

Antenna Type	Gain (dBi)	Frequency
Directional Panel Antenna MP58013XFPT	12.5 dBi	5.15 – 5.25 GHz
Directional Panel Antenna MP51513XFPT	13.0 dBi	5.8 GHz

* The test data gathered are from production sample, serial number: Unit # 800-00010-0001 Rev A, provided by the manufacturer.

EUT Photo



Additional EUT photos in Exhibit C

Mechanical Description

The EUT is a Single/Dual Radio 802.11a/b/g Wireless LAN Access Point AP200 Rev. 2. It's approximate dimensions are 210 mmL x 159 mmW x 38 mmH.

Objective

This class II permissive change type approval report is prepared on behalf of *Meru Networks* in accordance with Title 47 Part 2, Subpart J, Part 15, Subparts A, C, and E of the Federal Communication Commissions rules.

This supplemental testing and report have been conducted due to changes made of the antenna of the device. The device was tested with two additional external antennae: 1) MaxRad, MP58013XFPT (12.5 dBi gain) and 2) MaxRad MP51513XFPT (13 dBi gain). The objective of the manufacturer is to demonstrate continued compliance with FCC rules for Antenna Requirements, Out of Band Emission and Spurious Emission.

Related Submittal(s)/Grant(s)

Please refer to BACL R0611296 for Original Submission test data to which this is the supplement. Additionally, please see BACL report R0703306-407 for FCC 15.407 related test data.

Test Methodology

All measurements contained in this report were conducted in accordance with 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.

Measurement Uncertainty

All measurements involve certain levels of uncertainties, especially in field of EMC. The factors contributing to uncertainties are spectrum analyzer, cable loss, antenna factor calibration, antenna directivity, antenna factor variation with height, antenna phase center variation, antenna factor frequency interpolation, measurement distance variation, site imperfections, mismatch (average), and system repeatability.

Based on NIS 81, The Treatment of Uncertainty in EMC Measurements, the values range from ± 2.0 for Conducted Emissions tests and ± 4.0 dB for Radiated Emissions tests are the most accurate estimates pertaining to uncertainty of EMC measurements at BACL.

Detailed instrumentation measurement uncertainties can be found in BACL report QAP-018.

All radiated and conducted emissions measurement was performed at Bay Area Compliance Laboratory, Corp. The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

Test Facility

The test site used by BACL Corp. to collect radiated and conducted emissions measurement data is located at its facility in Sunnyvale, California, USA.

The test site at BACL Corp. has been fully described in reports submitted to the Federal Communication Commission (FCC) and Voluntary Control Council for Interference (VCCI). The details of these reports have been found to be in compliance with the requirements of Section 2.948 of the FCC Rules on February 11, 1997 and December 10, 1997 and Article 8 of the VCCI regulations on December 25, 1997. The facility also complies with the test methods and procedures set forth in ANSI C63.4-2003 & TIA/EIA-603.

The Federal Communications Commission and Voluntary Control Council for Interference have the reports on file and they are listed under FCC registration number: 90464 and VCCI Registration No.: R-2463 and C-2698. The test site has been approved by the FCC and VCCI for public use and is listed in the FCC Public Access Link (PAL) database.

Additionally, BACL Corp. is a National Institute of Standards and Technology (NIST) accredited laboratory under the National Voluntary Laboratory Accredited Program (Lab Code 200167-0). The current scope of accreditations can be found at <http://ts.nist.gov/ts/htdocs/210/214/scopes/2001670.htm>.

SYSTEM TEST CONFIGURATION

Justification

The host system was configured for testing according to ANSI C63.4-2003.

The EUT was tested in the testing mode to represent *worst-case* results during the final qualification test.

The worst-case data rates are determined to be as follows for each mode based upon investigation by measuring the average power, peak power and PPSD across all data rates bandwidths, and modulations.

EUT Exercise Software

The EUT operates in Continuous Transmitting operation mode during radiated and conducted testing. The following DAC setting is used.

802.11a (high band)

DATA RATE = 9 Mbps

100% DUTY CYCLE

TX POWER = 16 dBm, CH149 ~ CH 165

Special Accessories

As shown in following test setup block diagram, all interface cables used for compliance testing are unshielded.

Schematics / Block Diagram

Please refer to appropriate exhibits.

Equipment Modifications

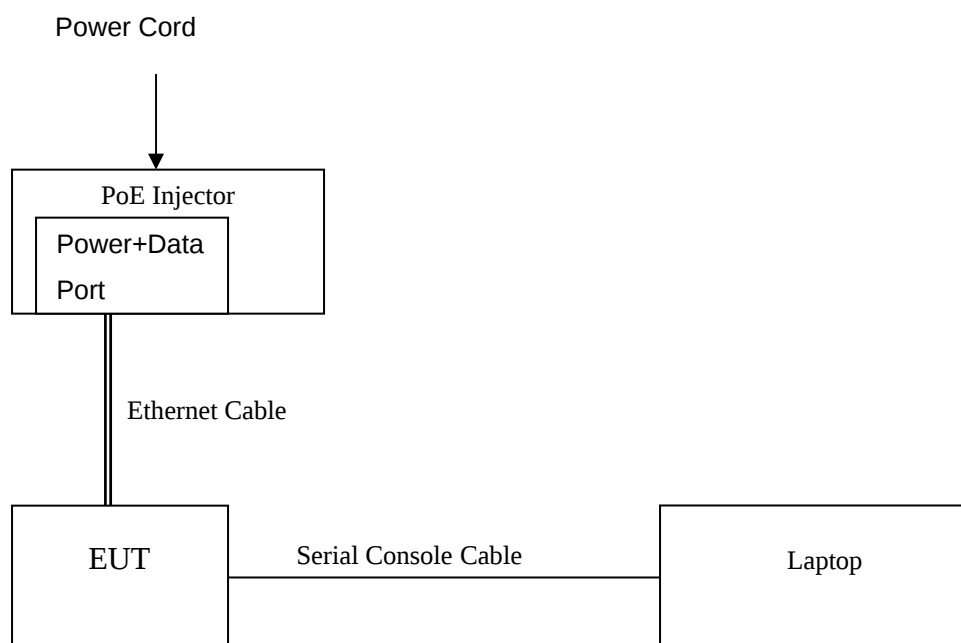
No modifications were made to the EUT.

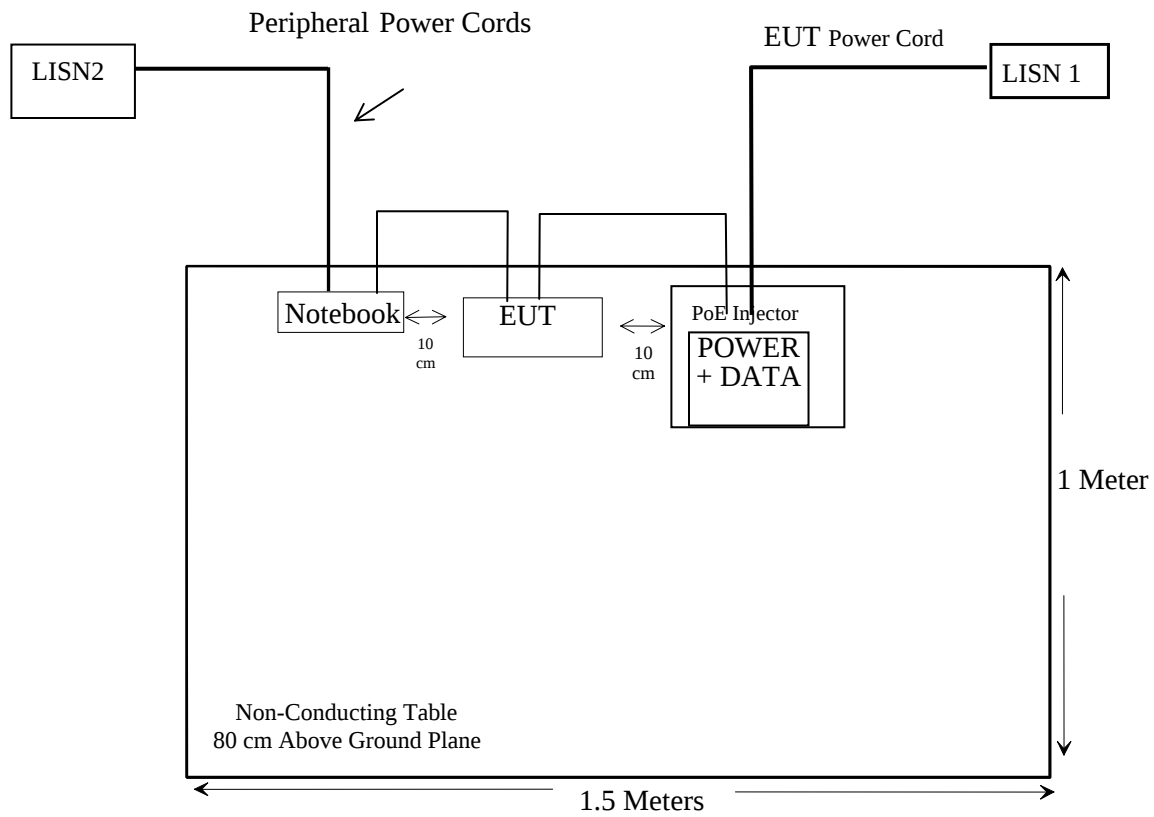
Power Supply Information

Manufacturer	Description	Model	Serial Number
3Com	PoE Injector	PW130	61-0127-001

External I/O Cabling List and Details

Cable Description	Length (M)	Port/From	To
Unshielded RJ45 Cable	1.5	EUT	PoE Injector
Serial console Cable	1	EUT	Laptop

Configuration of Test System

Test Setup Block Diagram

SUMMARY OF TEST RESULTS

Results reported relate only to the product tested.

FCC RULES	DESCRIPTION OF TEST	RESULT
§15.247(e)(i) §2.1091	RF Exposure	Compliant
§15.203	Antenna Requirement	Compliant
§ 15.207 (a)	Conducted Emissions	Compliant
§2.1051 & §15.247(d)	Spurious Emissions at Antenna Port	Compliant
§15.205	Restricted Band	Compliant
§15.109, 15.209 (a) & §15.247(d)	Radiated Spurious Emissions	Compliant
§15.247 (a)(2)	6 dB Bandwidth	Compliant
§15.247 (b)(3)	Maximum Peak Output Power	Compliant
§ 15.247 (d)	100 kHz Bandwidth of Frequency Band Edge	Compliant
§15.247 (e)	Power Spectral Density	Compliant

* Please refer to original submission BACL R0611296 for test results

§ 15.247 (e) (i) and § 2.1091 - RF EXPOSURE

According to §15.247(e)(1) & 15.407 and §1.1307(b)(1), systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

According to §1.1310 and §2.1091 RF exposure is calculated.

Limits for General Population/Uncontrolled Exposure				
Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Averaging Time (minute)
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

MPE Prediction

Predication of MPE limit at a given distance

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

$$S = PG/4\pi R^2$$

Where: S = power density

P = power input to antenna

G = power gain of the antenna in the direction of interest relative to an isotropic radiator

R = distance to the center of radiation of the antenna

802.11a

Maximum peak output power at antenna input terminal:	<u>16.00 (dBm)</u>
Maximum peak output power at antenna input terminal:	<u>39.81 (mW)</u>
Prediction distance:	<u>20 (cm)</u>
Predication frequency:	<u>5785 (MHz)</u>
Antenna Gain (typical):	<u>12.5 (dBi)</u>
antenna gain:	<u>17.78 (numeric)</u>
Power density at predication frequency at 20 cm:	<u>0.1408 (mW/cm²)</u>

MPE limit for uncontrolled exposure at prediction frequency: 1.0 (mW/cm²)

Test Result

The EUT is a mobile device. The worst power density levels at 20 cm for the maximum output power is 0.1408 mW/cm, which is below the uncontrolled limit of 1.0mW/cm².

§15.203 - ANTENNA REQUIREMENT

Applicable Standard

According to § 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

And according to § 15.247 (b) (4), if transmitting antennas 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.

Result: Compliant: This device uses one of two external panel antennae that connect with the EUT using a proprietary reverse polarity connector; please refer to the following photo that details the connector that issues from each antennae.



§15.109, §15.205, §15.209 & §15.247(d) - SPURIOUS RADIATED EMISSIONS

Applicable Standard

As per 15.35(d): Unless otherwise specified, on any frequency or frequencies above 1000 MHz, the radiated emission limits are based on the use of measurement instrumentation employing an average detector function. Unless otherwise specified, measurements above 1000 MHz shall be performed using a minimum resolution bandwidth of 1 MHz.

As per 15.209(a): Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table

Frequency (MHz)	Field Strength (micro volts/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.

As per 15.247(c)(1)(i): Systems operating in the 2400-2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

As Per 15.205(a) except as show in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 – 0.110	16.42 – 16.423	960 – 1240	4.5 – 5.15
0.495 – 0.505	16.69475 – 16.69525	1300 – 1427	5.35 – 5.46
2.1735 – 2.1905	25.5 – 25.67	1435 – 1626.5	7.25 – 7.75
4.125 – 4.128	37.5 – 38.25	1645.5 – 1646.5	8.025 – 8.5
4.17725 – 4.17775	73 – 74.6	1660 – 1710	9.0 – 9.2
4.20725 – 4.20775	74.8 – 75.2	1718.8 – 1722.2	9.3 – 9.5
6.215 – 6.218	108 – 121.94	2200 – 2300	10.6 – 12.7
6.26775 – 6.26825	123 – 138	2310 – 2390	13.25 – 13.4
6.31175 – 6.31225	149.9 – 150.05	2483.5 – 2500	14.47 – 14.5
8.291 – 8.294	156.52475 – 156.52525	2690 – 2900	15.35 – 16.2
8.362 – 8.366	156.7 – 156.9	3260 – 3267	17.7 – 21.4
8.37625 – 8.38675	162.0125 – 167.17	3.332 – 3.339	22.01 – 23.12
8.41425 – 8.41475	167.72 – 173.2	3.3458 – 3.358	23.6 – 24.0
12.29 – 12.293	240 – 285	3.600 – 4.400	31.2 – 31.8
12.51975 – 12.52025	322 – 335.4		36.43 – 36.5
12.57675 – 12.57725	399.9 – 410		Above 38.6
13.36 – 13.41	608 – 614		

As per 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)).

Test Setup

The radiated emissions tests were performed in the 3-meter open area test site, using the setup in accordance with ANSI C63.4-2003. The specification used was the FCC 15 Subpart C limits.

EUT Setup

The radiated emissions tests were performed using the setup accordance with the ANSI C63.4-2003. The specification used was the FCC 15C limits.

The spacing between the peripherals was 10 centimeters.

External I/O cables were draped along the edge of the test table and bundle when necessary.

Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date
Sonoma Instruments	Pre amplifier	317	260408	2007-03-02
Agilent	Pre amplifier	8449B	3008A01978	2006-08-10
Sunol Science Corp	Combination Antenna	JB3 Antenna	A020106-3	2007-02-14
Agilent	Spectrum Analyzer	8568EC	3946A00131	2006-01-24
A.R.A	Antenna Horn	DRG-118/A	1132	2006-08-17
Rohde & Schwaz	EMI Test Receiver	ESCI 1166.5950K03	100338	2007-04-05

* **Statement of Traceability:** BACL attests that all calibrations have been performed per the NVLAP requirements, traceable to NIST.

Test Procedure

For the radiated emissions test, the EUT, and all support equipment power cords was connected to the AC floor outlet.

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

The EUT is set 3 meter away from the testing antenna, which is varied from 1-4 mete, and the EUT is placed on a turntable, which is 0.8 meter above ground plane, the table shall be rotated for 360 degrees to find out the highest emission. The receiving antenna should be changed the polarization both of horizontal and vertical.

The spectrum analyzer or receiver is set as:

Below 1000MHz:

RBW = 100 kHz / VBW = 300 kHz / Sweep = Auto

Above 1000MHz:

- (1) Peak: RBW = 1MHz / VBW = 1MHz / Sweep = Auto
- (2) Average: RBW = 1MHz / VBW = 10Hz / Sweep = Auto

Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain from the Amplitude reading. The basic equation is as follows:

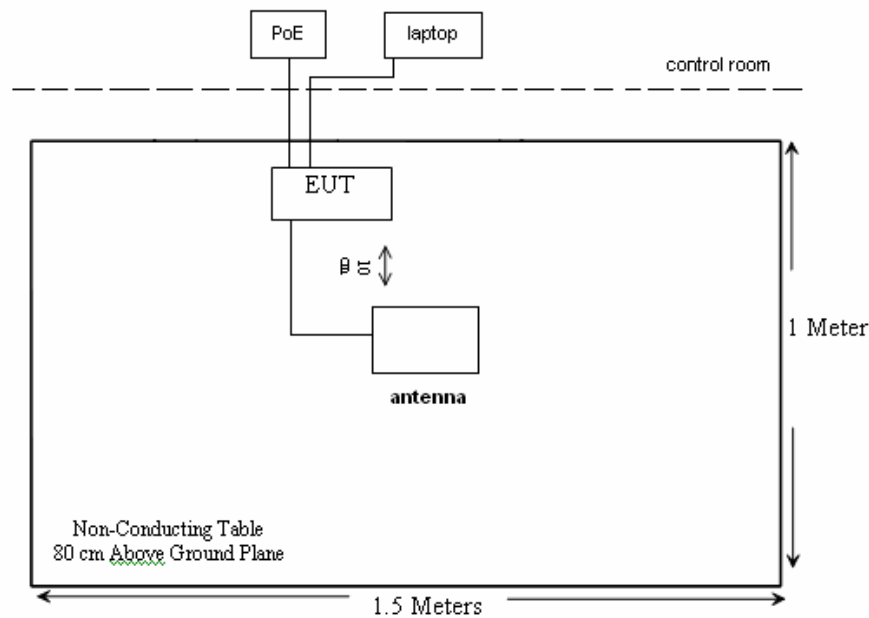
$$\text{Corrected Amplitude} = \text{Indicated Reading} + \text{Antenna Factor} + \text{Cable Factor} - \text{Amplifier Gain}$$

The “**Margin**” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of -7dB means the emission is 7dB below the maximum limit.

The equation for margin calculation is as follows:

$$\text{Margin} = \text{Corrected Amplitude} - \text{FCC Limit}$$

Test Setup Diagram



Environmental Conditions

Temperature:	21° C
Relative Humidity:	45 %
ATM Pressure:	103.8 kPa

* The testing was performed by Oscar Au from 2007-04-09.

Summary of Test Results

According to the data hereinafter, the EUT complied with the FCC Title 47, Part 15, Subpart C, section 15.205, 15.209 and 15.247, and the following are a summary of those readings found to be closest to the limit:

Intentional Radiated Emissions:**802.11a (5745 - 5825 MHz)**

- 9.0 dB at 5563.0000 MHz in the **Horizontal** polarization for Low Channel, 1GHz – 40GHz
- 4.4 dB at 11570.0000 MHz in the **Vertical** polarization for Middle Channel, 1GHz – 40GHz
- 5.4 dB at 11650.0000 MHz in the **Vertical** polarization for High Channel, 1GHz – 40GHz

Unintentional Radiated Emissions:

- 0.7 dB at 32.97 MHz in the Vertical polarization for 30 – 1000 MHz

802.11a: 5745 – 5825 MHz, Measured at 3 meters

Low channel 5745 MHz

Frequency (MHz)	Reading (dBμV)	Azimuth Degrees	Height (m)	Polar. H / V	Antenna Factor (dB/m)	Cable loss (dB)	Pre-Amp (dB)	Corrected Reading (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Comments
5563.0000	40.9	10	1.6	H	34.1	4.1	34.1	45.0	54	-9.0	Ave
5563.0000	40.8	5	1.5	V	34.1	4.1	34.1	44.9	54	-9.1	Ave
11490.0000	35.7	12	1.6	V	39.3	6.1	39.5	41.6	54	-12.4	Ave
5563.0000	53.4	10	1.6	H	34.1	4.1	34.1	57.5	74	-16.5	Peak
11490.0000	31.5	60	1.6	H	39.3	6.1	39.5	37.4	54	-16.6	Ave
5563.0000	52.5	5	1.5	V	34.1	4.1	34.1	56.6	74	-17.4	Peak
11490.0000	48.3	12	1.6	V	39.3	6.1	39.5	54.2	74	-19.8	Peak
11490.0000	43.9	60	1.6	H	39.3	6.1	39.5	49.8	74	-24.2	Peak

Mid channel 5785 MHz

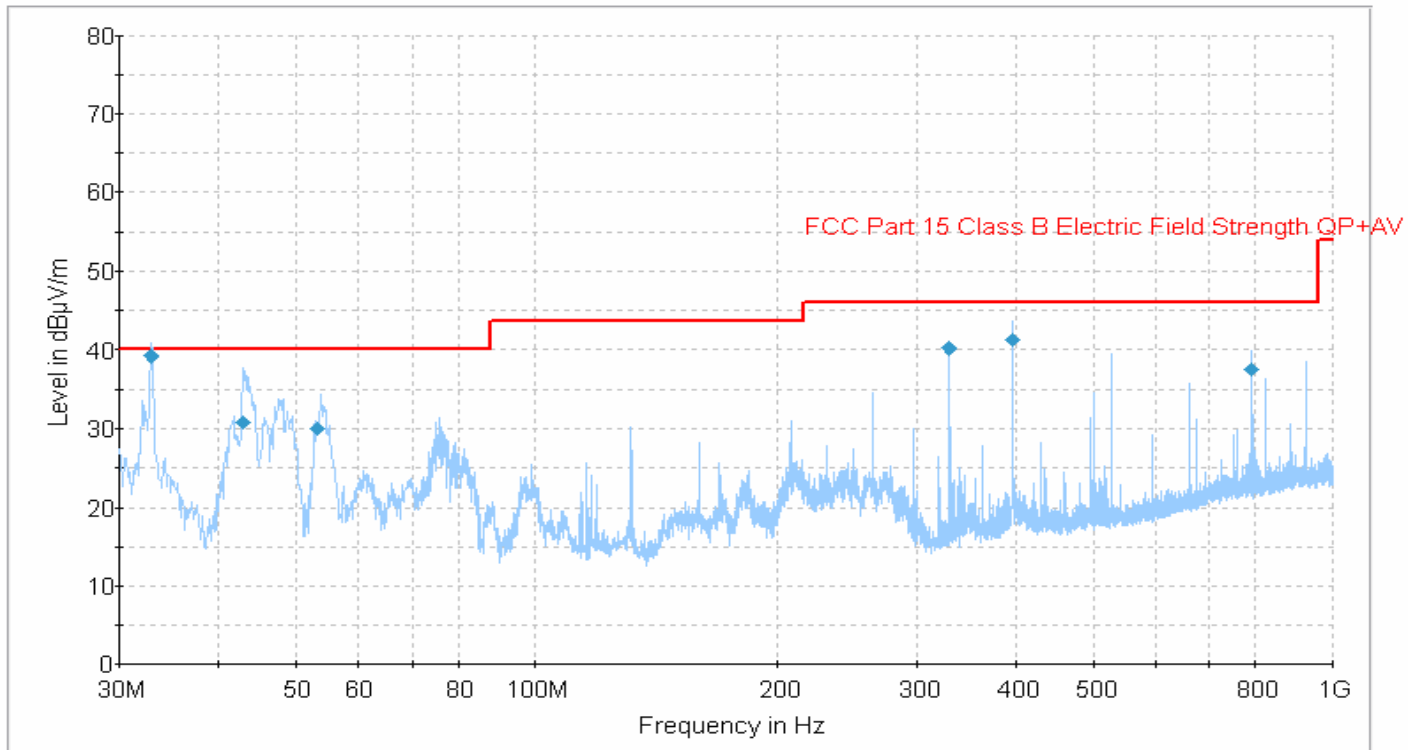
Frequency (MHz)	Reading (dBμV)	Azimuth Degrees	Height (m)	Polar. H / V	Antenna Factor (dB/m)	Cable loss (dB)	Pre-Amp (dB)	Corrected Reading (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Comments
11570.0000	35.9	5	1.5	V	39.5	6.1	32.0	49.6	54	-4.4	Ave
11570.0000	32.6	10	1.6	H	39.5	6.1	32.0	46.3	54	-7.7	Ave
11570.0000	49.8	5	1.5	V	39.5	6.1	32.0	63.5	74	-10.5	Peak
5564.0000	37.5	3	1.5	V	34.1	4.1	34.1	41.6	54	-12.4	Ave
5564.0000	35.8	10	1.3	H	34.1	4.1	34.1	39.9	54	-14.1	Ave
11570.0000	45.5	10	1.6	H	39.5	6.1	32.0	59.2	74	-14.8	Peak
5564.0000	50.2	3	1.5	V	34.1	4.1	34.1	54.3	74	-19.7	Peak
5564.0000	49.5	10	1.3	H	34.1	4.1	34.1	53.6	74	-20.4	Peak

High channel 5825 MHz

Frequency (MHz)	Reading (dBμV)	Azimuth Degrees	Height (m)	Polar. H / V	Antenna Factor (dB/m)	Cable loss (dB)	Pre-Amp (dB)	Corrected Reading (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Comments
11650.0000	34.8	4	1.5	V	39.5	6.2	32.0	48.6	54	-5.4	Ave
11650.0000	31.2	10	1.3	H	39.5	6.2	32.0	45.0	54	-9.0	Ave
11650.0000	48.1	4	1.5	V	39.5	6.2	32.0	61.9	74	-12.1	Peak
5579.0000	35.8	5	1.5	V	34.1	4.1	34.1	39.9	54	-14.1	Ave
5579.0000	34.1	15	1.6	H	34.1	4.1	34.1	38.2	54	-15.8	Ave
11650.0000	43.2	10	1.3	H	39.5	6.2	32.0	57.0	74	-17.0	Peak
5579.0000	48.3	5	1.5	V	34.1	4.1	34.1	52.4	74	-21.6	Peak
5579.0000	46.7	15	1.6	H	34.1	4.1	34.1	50.8	74	-23.2	Peak

Radiated Emissions Test plot & data:

Primary scan 30MHz -1GHz



Frequency (MHz)	Quasi Peak (dBµV/m)	Antenna Height (cm)	Ant. Polarity	Turntable Position (deg)	Limit (dBµV/m)	Margin (dB)
32.970000	39.3	100.9	V	190.0	40.0	-0.7
395.993750	41.2	264.0	H	100.0	46.0	-4.8
329.972500	40.1	100.9	H	113.0	46.0	-5.9
791.996250	37.7	100.9	H	288.0	46.0	-8.3
43.033750	30.8	128.0	V	4.0	40.0	-9.2
53.165000	30.0	111.9	V	7.0	40.0	-10.0