WALSHIRE LABS

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47 C.F.R. Part 15 Subpart C FCC Rules Certification Test Record for a Low Power Transmitter Operating in the 2.400 – 2.4835 GHz Band

Ubicquia Aurora Model WL-C15005

Equipment:	Model WL-C15005
Client:	Ubicquia, LLC
Address:	10691 Versailles Blvd. Wellington, FL 33449

Test Report Number: FCCIR3-UBICQUIA-03-06-15B
Date: April 8, 2015
Total Number of Pages: 41

NVLAP LAP Code: 200125-0

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1 IDENTIFICATION SUMMARY

1.1 Test Report

Test Report Number: FCCIR3-UBICQUIA-03-06-15A
Test Report Date: April 8, 2015

Report written and approved by:

April 8, 2015	Peter J. Walsh, NCE	
Date	Name	Signature

1.2 Testing Laboratory

Walshire Labs, LLC
8545 126th Avenue North
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1.3 Limits and Reservations

The test results in this report apply only to the particular Device Under Test (DUT) and component Implementations Under Test (IUTs) declared in this test report. The results and associated conclusions apply only to the DUT while operating in the configuration and modes described herein.

This test report shall not be reproduced except in full without the written permission of Walshire Labs or its assigns. It has been re-issued for the purpose of updating the NVLAP certificate of accreditation and calibration due date of the horn antenna.

The test report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the federal government.

1.4 Client Information

Name:	Ubicquia, LLC
Street:	10691 Versailles Blvd.
City:	Wellington
State:	FL
Zip Code	33449
Country:	USA
Phone:	310-293-0850
Contact Person:	Tre Zimmerman
Phone:	310-293-0850
Email:	tzimmerman@ubicquia.net

1.5 Dates

Date of commission:	March 3, 2015
Date of receipt of DUT:	March 3, 2015
Date of test completion:	March 6, 2015

1.6 Device Under Test (DUT)

Name:	Aurora
Version:	Model: WL-C15005
Serial Number:	Not labeled
FCC ID:	FCC ID: 2AECKWL-C15005
Antenna Type:	Chip
Antenna Gain:	3 dBi peak
Frequency:	2.476 GHz
Emission Designator:	1M880V1D

2 GENERAL INFORMATION

2.1 Product Description

Aurora is a more efficient IOT platform to build Smart Home, Smart Business and Smart City capabilities. It reduces network congestion both on localized networks and the internet at large when connecting controllers and sensors.

Aurora is an Atmel ATMEGA328P-AU based board with built in wireless capabilities that allow it to communicate with other Aurora boards. It can collect data from sensors as well as control motors, servos and relays. These capabilities allow the base station to remotely control various types of appliances and devices wirelessly.

Refer to the operational description for a more complete, technical description of the radio.

2.2 Interface Cable Details

No interface cables were used in the system other than a 10 cm long DC power cable to a 9 V battery pack.

2.3 Peripheral Devices

No test support devices were used in the test set-up.

2.4 Test Methodology

A radiated emission test was performed according to ANSI C63.4-2003, the current procedure referenced by Part 15, FCC Rules. Radiated emissions tests were performed at an antenna to DUT distance of 3 meters. As the DUT was battery powered, a conducted emissions test was not performed. The DUT was placed in the center of the turntable and orientated in a manner that produced the highest emissions by rotating the DUT along each of its orthogonal axis. The position that produced the highest level of emissions was with the DUT orientated horizontally as shown in Photo 5.5-1.

2.5 Test Facility

The 3-meter semi-anechoic test chamber and measurement facility used to collect the radiated and conducted data is located at 8545 126th Avenue N., Largo FL 33773. This laboratory is NVLAP Accredited (NVLAP Lab Code 200125-0). The site has been registered with the FCC under registration number 830450.

2.6 Deviations

No deviations were exercised during the course of the testing.

3 SYSTEM TEST CONFIGURATION

3.1 Justification

For field strength tests of the DUT's radio transmitter, the device was operating in the normal mode of operation whereby it transmitted a 16 byte message every 1 second.

ANSI C63.4 2003 section 12.1.4.1 requires that hand-held or body-worn devices shall include rotation of the EUT through three orthogonal axes to determine the attitude that maximizes the emissions. The DUT is a not a hand-held device but it may be mounted either horizontally or vertically. As such, preliminary tests were performed to determine the orientation that produced the highest level of emissions. This was with the DUT orientated horizontally as shown in Photo 5.5-1.

All measurements were performed with the DUT powered by a fresh 9V battery.

3.2 Special Accessories

None

3.3 Equipment Modifications

No modifications were required to achieve compliance.

Signature:		Date:	March 6, 2015
Typed/Printed Name:	Peter J. Walsh		
Position:	Regulatory Lab Manager		

If modifications were needed to achieve compliance, the client shall acknowledge these by signing below.

Signature:		Date:	
Typed/Printed Name:			
Position:			

4 CONDUCTED EMISSIONS DATA

References:

47 C.F.R. § 15.107 (a)

Except for Class A digital devices, for equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 µH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the band edges.

47 C.F.R. § 15.207 (a)

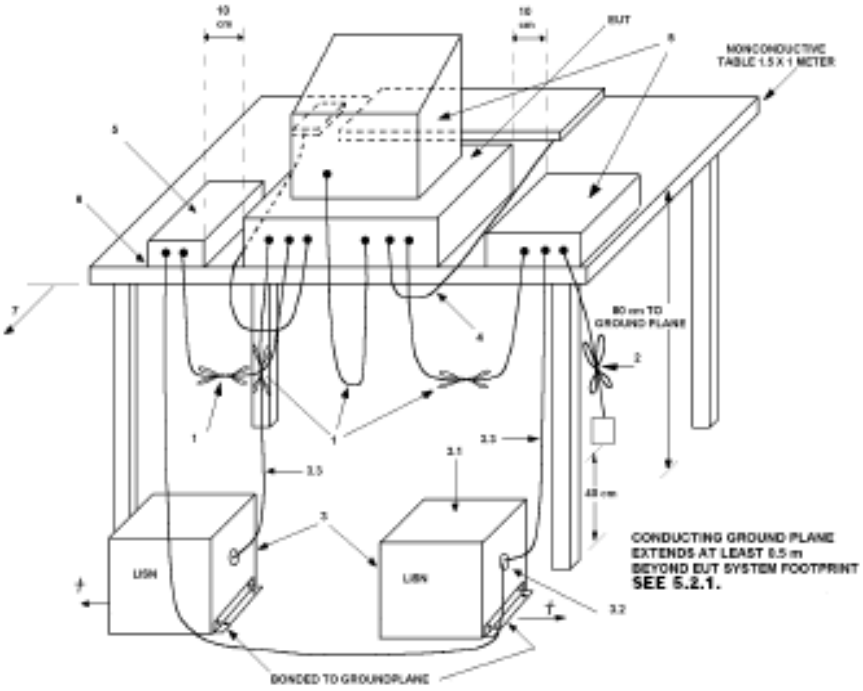
(a) Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 µH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	Quasi-peak	Average
0.15-0.5	66 to 56 *	56 to 46 *
0.5-5	56	46
5-30	60	50

* Decreases with the logarithm of the frequency.

4.1 Test Procedure

The test would be performed in accordance with ANSI C63.4-2003 § 7. The test setup was consistent with ANSI C63.4-2003 Figure 10a below. The test would be performed in a semi-anechoic chamber. As such, the optional vertical conducting plane would not be used.



LEGEND:

1) Interconnecting cables that hang closer than 40 cm to the groundplane shall be folded back and forth in the center forming a bundle 30 to 40 cm long (see 6.1.4 and 11.2.4).
2) I/O cables that are not connected to a peripheral shall be bundled in the center. The end of the cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m (see 6.1.4).
3) EUT connected to one LISN. Unused LISN measuring port connectors shall be terminated in 50 Ω. LISN can be placed on top of, or immediately beneath, reference groundplane (see 5.2.3 and 7.2.1).
   3.1) All other equipment powered from additional LISN(s).
   3.2) Multiple outlet strip can be used for multiple power cords of non-EUT equipment.
   3.3) LISN at least 80 cm from nearest part of EUT chassis.
4) Cables of hand-operated devices, such as keyboards, mice, etc., shall be placed as for normal use (See 6.2.1.3 and 11.2.4).
5) Non-EUT components of EUT system being tested (see also Figure 13).
6) Rear of EUT, including peripherals, shall all be aligned and flush with rear of tabletop (see 6.2.1.1 and 6.2.1.2).
7) Rear of tabletop shall be 40 cm removed from a vertical conducting plane that is bonded to the groundplane (see 5.2.2 for options).

Figure 10a—Test arrangement for conducted emissions

Conducted emissions measurements are first made using a peak detector and average detector simultaneously. The receiver then performs the final measurements using a quasi-peak detector for comparison with the quasi-peak limit and an average detector for comparison with the average limit.

4.2 Measured Data

Compliance Verdict: None

As the DUT is battery powered, the ac mains conducted emissions test is not applicable.

Test Personnel:

Date	Name	Signature
March 6, 2015	Peter J. Walsh, NCE	

4.3 Conducted Emissions Test Instrumentation

Type	Manufacturer/ Model No.	Serial Number	Calibration Due Date
EMI Receiver	Rohde & Schwarz ESCS 30	825788/002	12/14/2015
LISN	Rohde & Schwarz ESH3-Z5	840730/005	09/05/2016

Calibration and Traceability: All measuring and test equipment are calibrated and are traceable to the National Institute for Standards and Technology (NIST) and Methods. The interval is 24 months.

4.4 Conducted Emissions Photographs

No photos were taken as the test was not performed.

5 SUBPART C RADIATED EMISSIONS DATA

Reference: 47 C.F.R. § 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:

Table 5-1

Frequency of Emission (MHz)	Field Strength (3 m) (microvolts/meter)	Field Strength (3 m) (dBµV/m)
0.009 – 0.490	2400/F (kHz) @ 300 m	300
0.490 – 1.705	24000/F (kHz) @ 30 m	30
1.705 – 30.0	30 @ 30 m	30
30 - 88	100**	40.0
88 - 216	150**	43.5
216 - 960	200**	46.0
Above 960	500	54.0

*** 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.*

The field strength limits for frequencies below 30 MHz were calculated for a measurement distance of 3 m using the prescribed 40 dB/decade correction factor as shown in Figure 5-1.

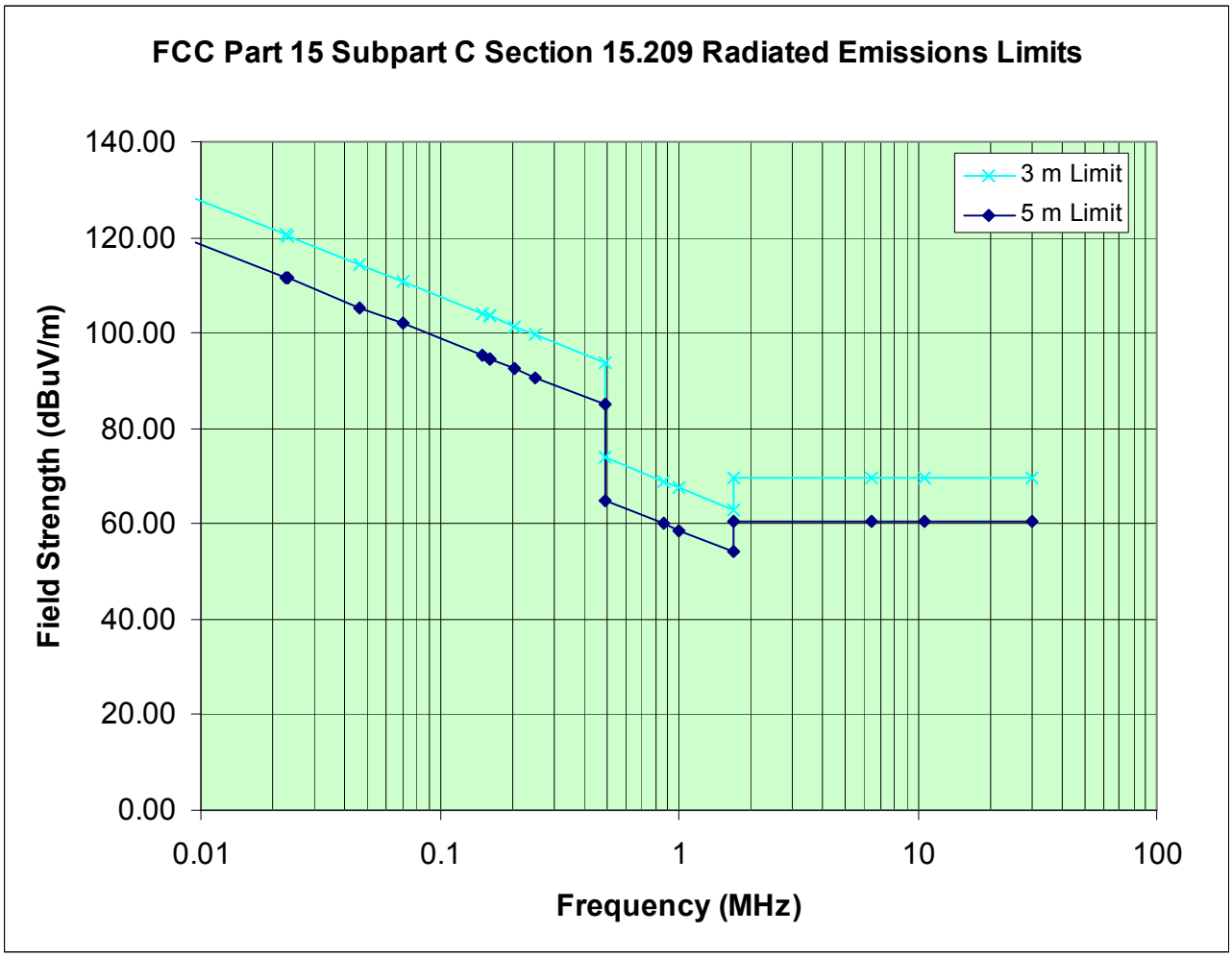


Figure 5-1 – Adjusted Field Strength Limits

Reference: 47 C.F.R. § 15.205

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

Table 5-2

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			

(b) Except as provided in paragraphs (d) and (e), the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

Reference: 47 C.F.R. § 15.249

§15.249 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, 5725-5875 MHZ, and 24.0-24.25 GHz.

(a) Except as provided in paragraph (b) of this section, the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Fundamental frequency	***Field strength of fundamental (millivolts/meter)***	***Field strength of harmonics (microvolts/meter)***
902-928 MHz	*50*	*500*
2400-2483.5 MHz	*50*	*500*
5725-5875 MHz	*50*	*500*
24.0-24.25 GHz	*250*	*2500*

(b) Fixed, point-to-point operation as referred to in this paragraph shall be limited to systems employing a fixed transmitter transmitting to a fixed remote location. Point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information are not allowed. Fixed, point-to-point operation is permitted in the 24.05-24.25 GHz band subject to the following conditions:

(1) The field strength of emissions in this band shall not exceed 2500 millivolts/meter.

(2) The frequency tolerance of the carrier signal shall be maintained within ±0.001% of the operating frequency over a temperature variation of -20 degrees to +50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

(3) Antenna gain must be at least 33 dBi. Alternatively, the main lobe beamwidth must not exceed 3.5 degrees. The beamwidth limit shall apply to both the azimuth and elevation planes. At antenna gains over 33 dBi or beamwidths narrower than 3.5 degrees, power must be reduced to ensure that the field strength does not exceed 2500 millivolts/meter.

(c) Field strength limits are specified at a distance of 3 meters.

(d) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.

(e) As shown in §15.35(b), for frequencies above 1000 MHz, the field strength limits in paragraphs (a) and (b) of this section are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. For point-to-point operation under paragraph (b) of this section, the peak field strength shall not exceed 2500 millivolts/meter at 3 meters along the antenna azimuth.

Reference: 47 C.F.R. § 15.35

Measurement detector functions and bandwidths.

The conducted and radiated emission limits shown in this Part are based on the following, unless otherwise specified elsewhere in this Part:

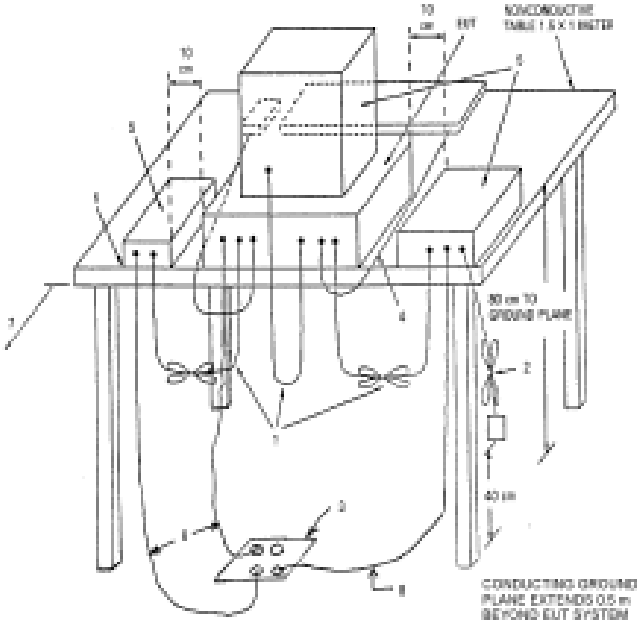
(a) On any frequency or frequencies below or equal to 1000 MHz, the limits shown are based on measuring equipment employing a CISPR quasi-peak detector function and related measurement bandwidths, unless otherwise specified. The specifications for the measuring instrument using the CISPR quasi-peak detector can be found in Publication 16 of the International Special Committee on Radio Interference (CISPR) of the International Electrotechnical Commission. As an alternative to CISPR quasi-peak measurements, the responsible party, at its option, may demonstrate compliance with the emission limits using measuring equipment employing a peak detector function, properly adjusted for such factors as pulse desensitization, as long as the same bandwidths as indicated for CISPR quasi-peak measurements are employed.
Note: For pulse modulated devices with a pulse-repetition frequency of 20 Hz or less and for which CISPR quasi-peak measurements are specified, compliance with the regulations shall be demonstrated using measuring equipment employing a peak detector function, properly adjusted for such factors as pulse desensitization, using the same measurement bandwidths that are indicated for CISPR quasi-peak measurements.

(b) 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. When average radiated emission measurements are specified in this part, including average emission measurements below 1000 MHz, there also is a limit on the peak level of the radio frequency emissions. Unless otherwise specified, e.g., see §§ 15.250, 15.252, 15.255, and 15.509-15.519 of this part, the limit on peak radio frequency emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test. This peak limit applies to the total peak emission level radiated by the device, e.g., the total peak power level. Note that the use of a pulse desensitization correction factor may be needed to determine the total peak emission level. The instruction manual or application note for the measurement instrument should be consulted for determining pulse desensitization factors, as necessary.

(c) Unless otherwise specified, e.g. Section 15.255(b), when the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value. The exact method of calculating the average field strength shall be submitted with any application for certification or shall be retained in the measurement data file for equipment subject to notification or verification.

5.1 Test Procedure

The test was performed in accordance with ANSI C63.4-2003 § 8. The test setup was consistent with ANSI C63.4-2003 Figure 11a below except that the DUT was located in the center of the table. The test was performed in a semi-anechoic chamber. For frequencies between 16 MHz and 30 MHz, a shielded magnetic loop antenna was used. As a guidance document FCC/OET MP-5 was used.



LEGEND:

1) Interconnecting cables that hang closer than 40 cm to the groundplane shall be folded back and forth in the center, forming a bundle 30 to 40 cm long (see 6.1.4 and 11.2.4).

2) I/O cables that are not connected to a peripheral shall be bundled in the center. The end of the cable may be terminated if required using the correct terminating impedance. The total length shall not exceed 1 m (see 6.1.4).

3) If LISNs are kept in the test setup for radiated emissions, it is preferred that they be installed under the groundplane with the receptacle flush with the groundplane (see 6.1.4).

4) Cables of hand-operated devices, such as keyboards, mice, etc., shall be placed as for normal use (see 6.2.1.3 and 11.2.4).

5) Non-EUT components of EUT system being tested (see also Figure 13).

6) Rear of EUT, including peripherals, shall all be aligned and flush with rear of tabletop (see 6.2.1.1 and 6.2.1.2).

7) No vertical conducting plane used (see 5.2.2).

8) Power cords drape to the floor and are routed over to receptacle (see 6.1.4).

Figure 11a—Test arrangement for radiated emissions tabletop equipment

The following data lists the significant emission frequencies, amplitude levels, margins, and limits. The frequency range investigated was 16.0 MHz to 24.76 GHz, ten times the fundamental frequency. The lowest frequency tested (16.0 MHz) was determined by a crystal frequency of 16.0 MHz used in the transceiver.

5.2 Test Data

Compliance Verdict: PASS

There were no emissions within 20 dB of the FCC Part 15 limit over the frequency range of 16 – 30 MHz.

Figure 5.2-1 shows a composite graph of the radiated emissions levels from 30 to 1000 MHz measured with a peak detector in both vertical (red trace) and horizontal (blue trace) antenna polarities at turntable angles from 0 to 360 degrees and antenna heights of 1, 2.5, and 4 meters. The resolution bandwidth was 120 kHz.

Figure 5.2-2 shows the highest level of the fundamental as measured with the peak detector. Figure 5.2-3 shows the emissions below the operating band between 1 GHz and 2.390 GHz. Figure 5.2-4 shows the significant emissions above the operating band between 2.483 GHz and 5 GHz. There were no significant emissions above 5 GHz.

Tables 5.2-1 - 5.2-3 show the highest measured results within 20 dB of the limits. Measurements were taken out to the tenth harmonic of the fundamental frequency. These final measurements were maximized by adjustment of the receiving antenna height, polarity, DUT orientation and turntable position.

The radiated emissions limits set out in § 15.249 are based on the average value of the measured emissions. The average limit is 94 dBµV/m; the peak level is derived from the average limit by adding 20 dB, 114 dBµV/m. The limit for the harmonics is 54 dBµV/m @ 3 m.

When determining the permissible average value of the radiated emissions, a duty cycle correction factor may be applied. This correction factor may be calculated using the following formula:

$$DC_{CORR} = 20LOG(T_{on} / T_{period}) \qquad \text{(eq. 2)}$$

Refer to Section 7 in this report for the DUT's time domain characteristics including the calculation of its duty cycle correction factor. The duty cycle correction factor was applied to determine the average level of the fundamental emission.

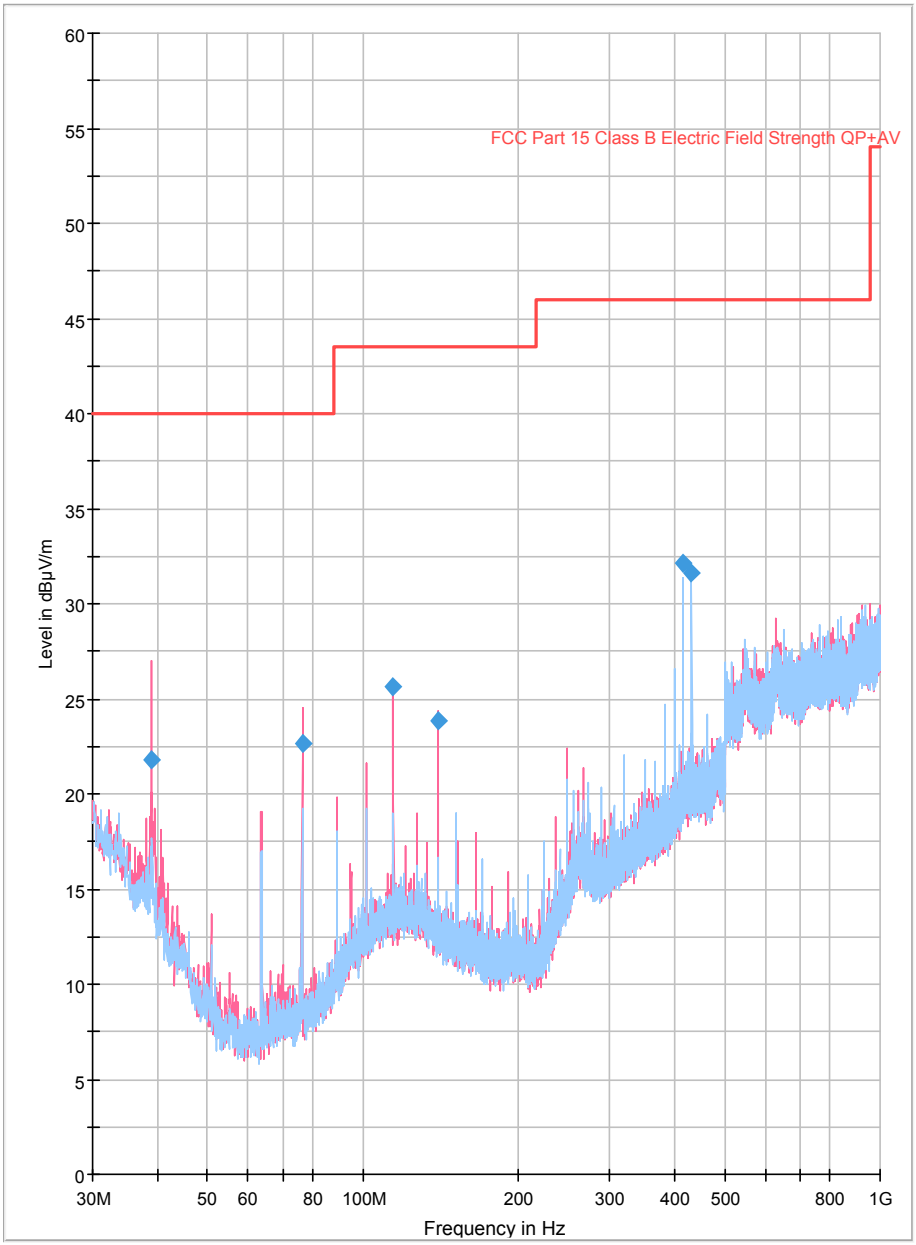


Figure 5.2-1 – Peak Detector Radiated Emissions 30 MHz to 1000 MHz

Notes:

In the above figure, the red trace was with vertical polarity and the blue trace was with horizontal polarity.

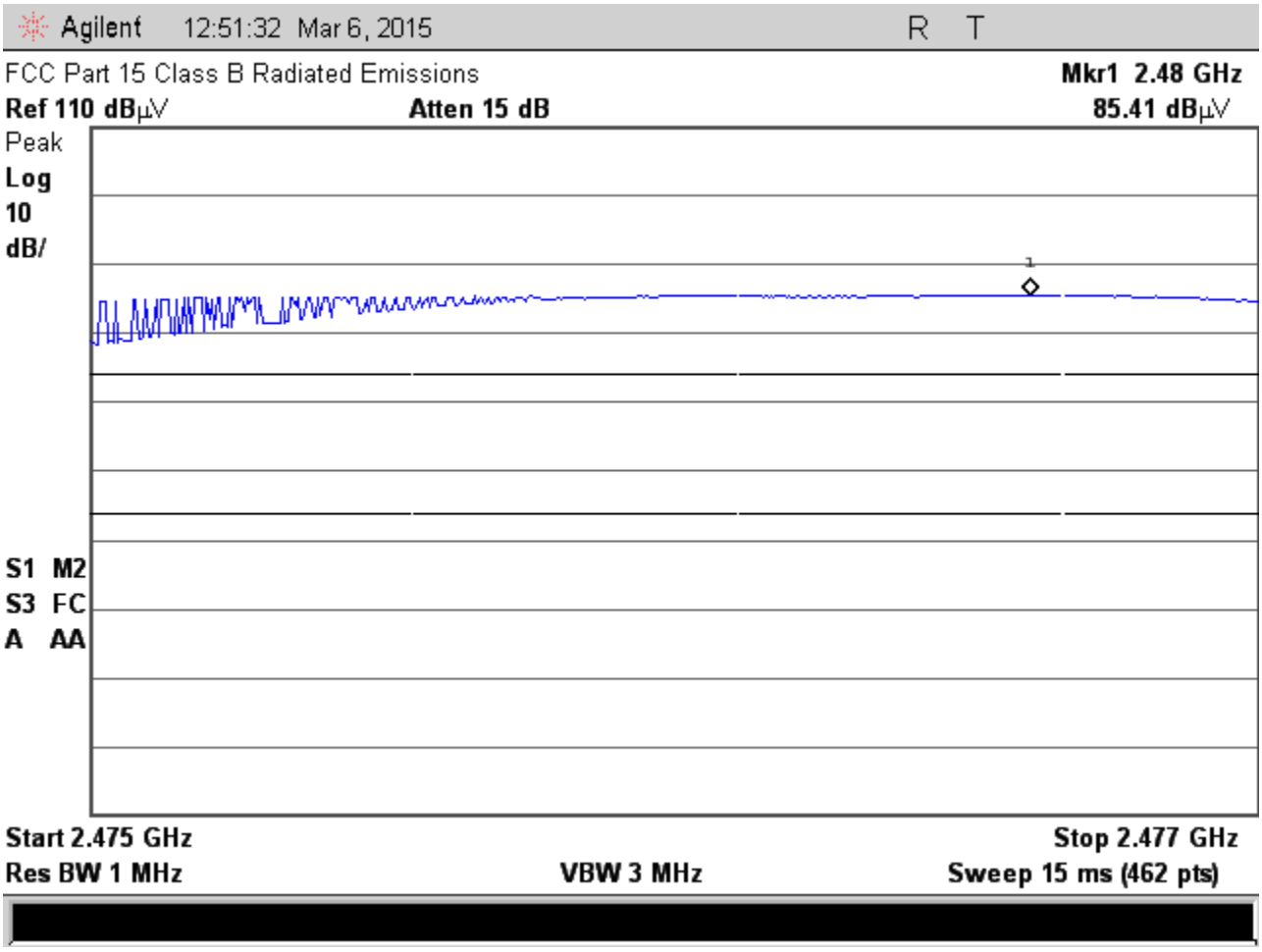


Figure 5.2-2 – Peak Detector Radiated Emissions Plot of the Fundamental

NOTES:

The above peak detector level was observed with the DUT positioned horizontally and the antenna positioned horizontally.

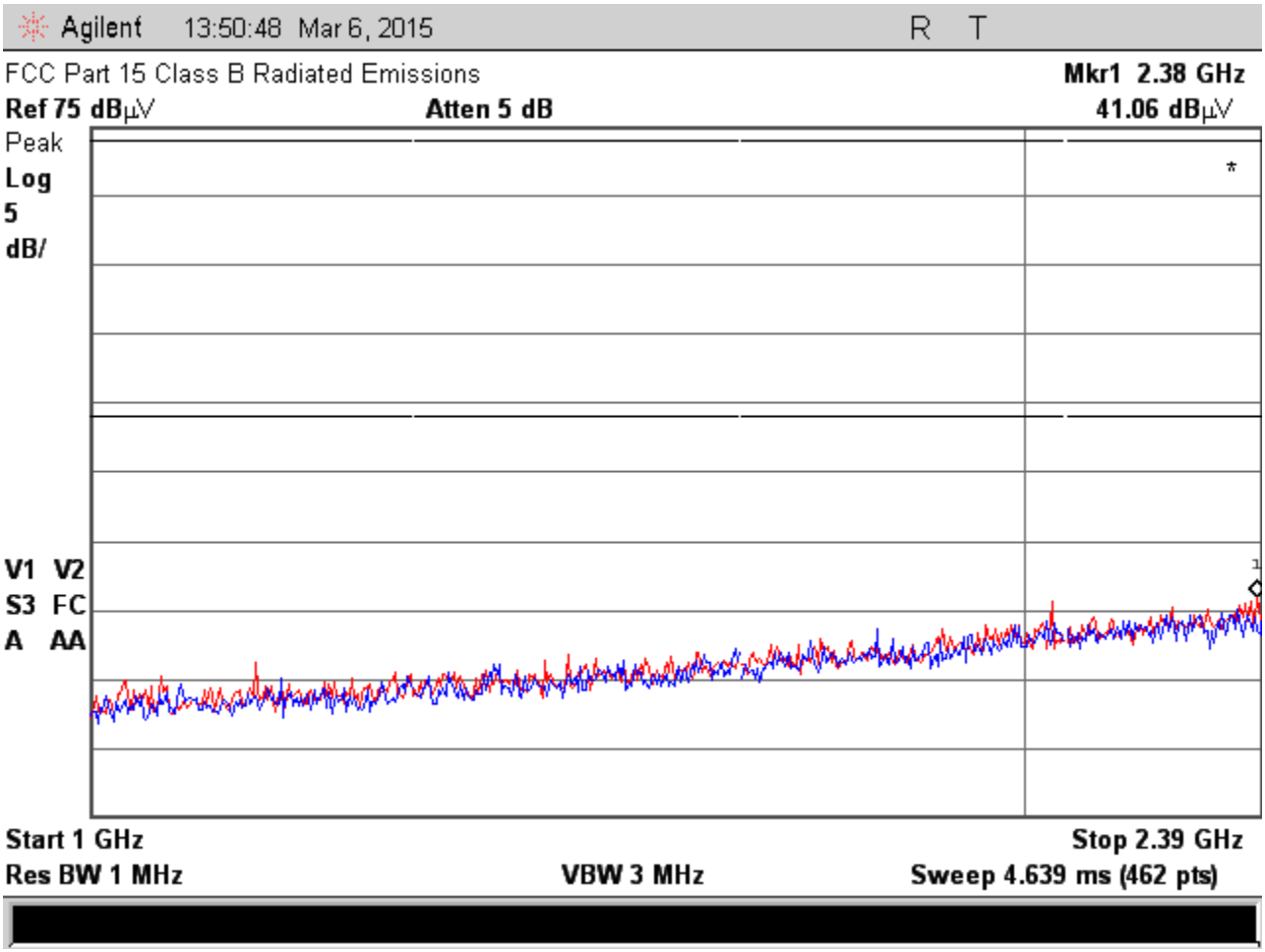


Figure 5.2-3 – Peak Detector Radiated Emissions Plot below the Operating Band

NOTES:

The red trace was with vertical polarity. The blue trace was with horizontal polarity.

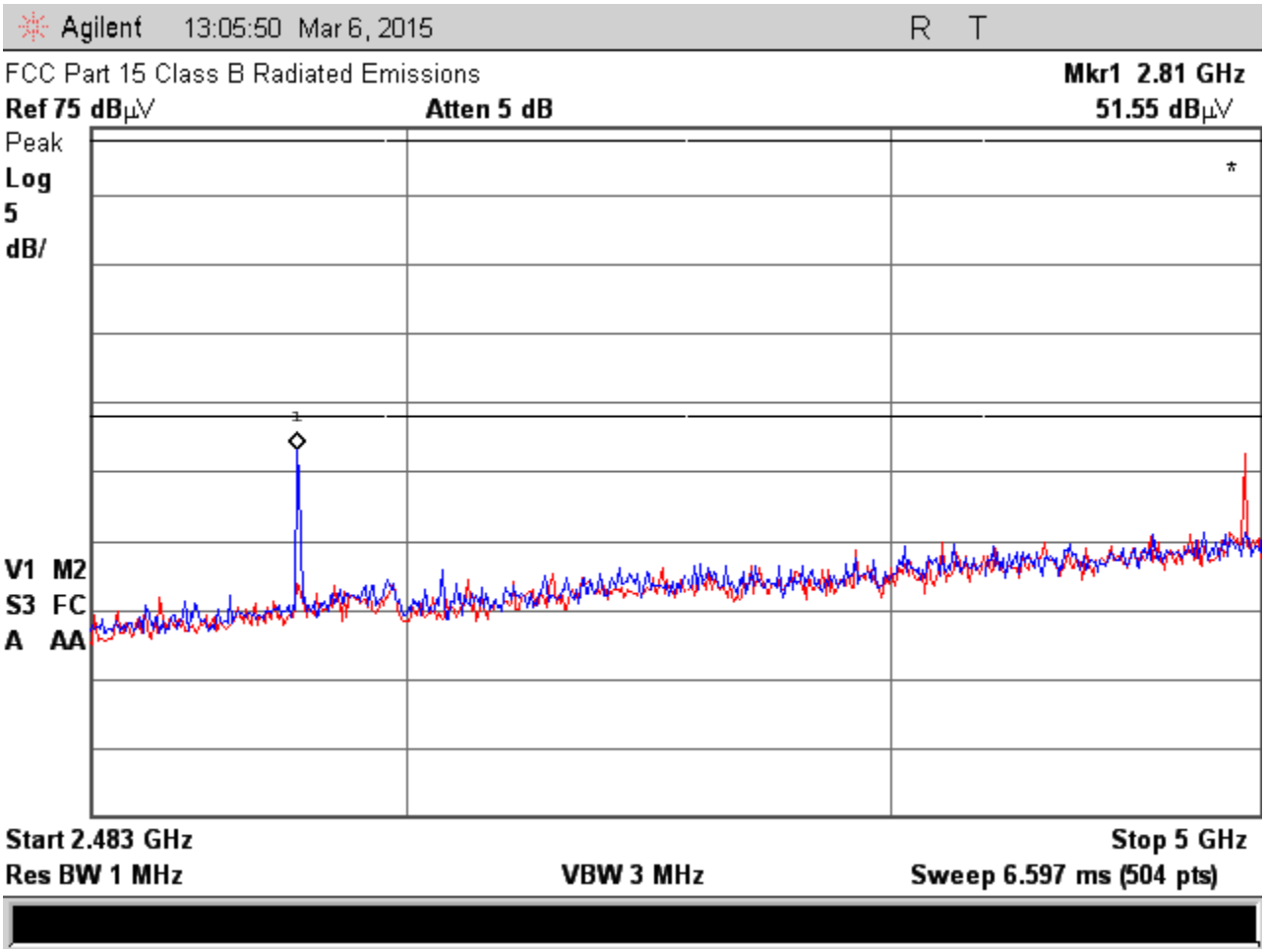


Figure 5.2-4 – Peak Detector Radiated Emissions Plot above the Operating Band

NOTES:

The red trace was with vertical polarity. The blue trace was with horizontal polarity.

Table 5.2-1 - Quasi-Peak Detector Results for Emissions up to 1 GHz

Frequency (MHz)	QuasiPeak (dBµV/m)	Height (cm)	Polarization	Azimuth (deg)	CF* (dB)	Margin (dB)	Limit (dBµV/m)
39.000000	21.8	198.0	V	105.0	13.7	18.2	40.0
76.320000	22.6	248.0	V	15.0	7.4	17.4	40.0
114.420000	25.6	247.0	V	45.0	13.0	17.9	43.5
139.860000	23.9	197.0	V	238.0	12.2	19.6	43.5
416.280000	32.1	240.0	H	170.0	19.0	13.9	46.0
432.300000	31.6	249.0	H	179.0	19.1	14.4	46.0

* CF is the antenna correction factor and cable loss.

Minimum Margin: 13.9 dBµV/m

Measurement Uncertainty: +/- 4.61 dB

Test Personnel:

March 4, 2015	Peter J. Walsh, NCE	Peter J. Walsh
Date	Name	Signature

Table 5.2-3 – Worst Case Radiated Emissions above 1 GHz Relative to the Peak Limit

Frequency (GHz)	Peak (dBµV/m)	Antenna height (cm)	Polarity	Turntable position (deg)	Limit (dBµV/m)	Margin (dB)	Notes
2.476	85.4	109	H	310	114	28.6	Fundamental
2.384	41.1	109	V	360	74	32.9	Lower Restricted Band
2.832	54.1	119	H	296	74	19.9	Upper Restricted Band
4.952	53.2	109	V	298	74	20.8	2nd Harmonic

Table 5.2-4 – Worst Case Radiated Emissions above 1 GHz Relative to the Average Limit

Frequency (GHz)	Average (dBµV/m)	Antenna height (cm)	Polarity	Turntable position (deg)	Limit (dBµV/m)	Margin (dB)	Notes
2.476	61.1	109	H	310	94	32.9	Fundamental
2.384	26.7	109	V	360	54	27.3	Lower Restricted Band
2.832	52.4	119	H	296	54	1.6	Upper Restricted Band
4.952	34.4	109	V	298	54	19.6	2nd Harmonic

Minimum Margin: **1.6 dBµV/m**

Measurement Uncertainty: +4.8 dB, -5.2 dB

Test Personnel:

March 6, 2015	Peter J. Walsh, NCE	Peter J. Walsh
Date	Name	Signature

5.3 Test Instrumentation Used, Radiated Measurement

Type	Manufacturer/ Model No.	Serial Number	Calibration Due Date
EMI Receiver	Rohde & Schwarz ESCS 30	825788/002	12/4/2015
Spectrum Analyzer	Agilent E7405A	MY42000055	3/29/2015
Preamplifier	Com-Power PA-122	181925	5/31/2015
Antenna	Chase EMCCBL6112B	2579	1/9/2016
Antenna	EMCO Horn Model 3115	9002-3393	3/7/2015
Antenna	Com-Power AL-130	121033	4/17/2015
Antenna	Schwarzbeck Mess - Electronik Model BBHA 9170 Horn Antenna	BBHA9170398	4/15/2015

Calibration and Traceability: All measuring and test equipment are calibrated and are traceable to the National Institute for Standards and Technology (NIST) and Methods. The interval is 24 months.

6.4 Field Strength Calculation

The field strength (FS) is calculated by adding the antenna correction factor (ACF) and cable loss (CL) and subtracting the amplifier gain (AG) if any to the measured reading. The formula and a sample calculation are:

FS = Reading (dBµV/m) + ACF (dB) + CL (dB) – AG (dB)

FS = 25 + 12.1 + 0.7 + 0 = 37.8 dBµV/m

The Rohde & Schwarz Model ESCS30 receiver and Agilent E7405A spectrum analyzer have the capability of automatically performing the field strength calculations. The amplitude level displayed on the receiver or analyzer represents the total measured field strength. This level is directly compared to the appropriate FCC limit to determine the actual margin of the DUT.

6.5 Radiated Emissions Photographs

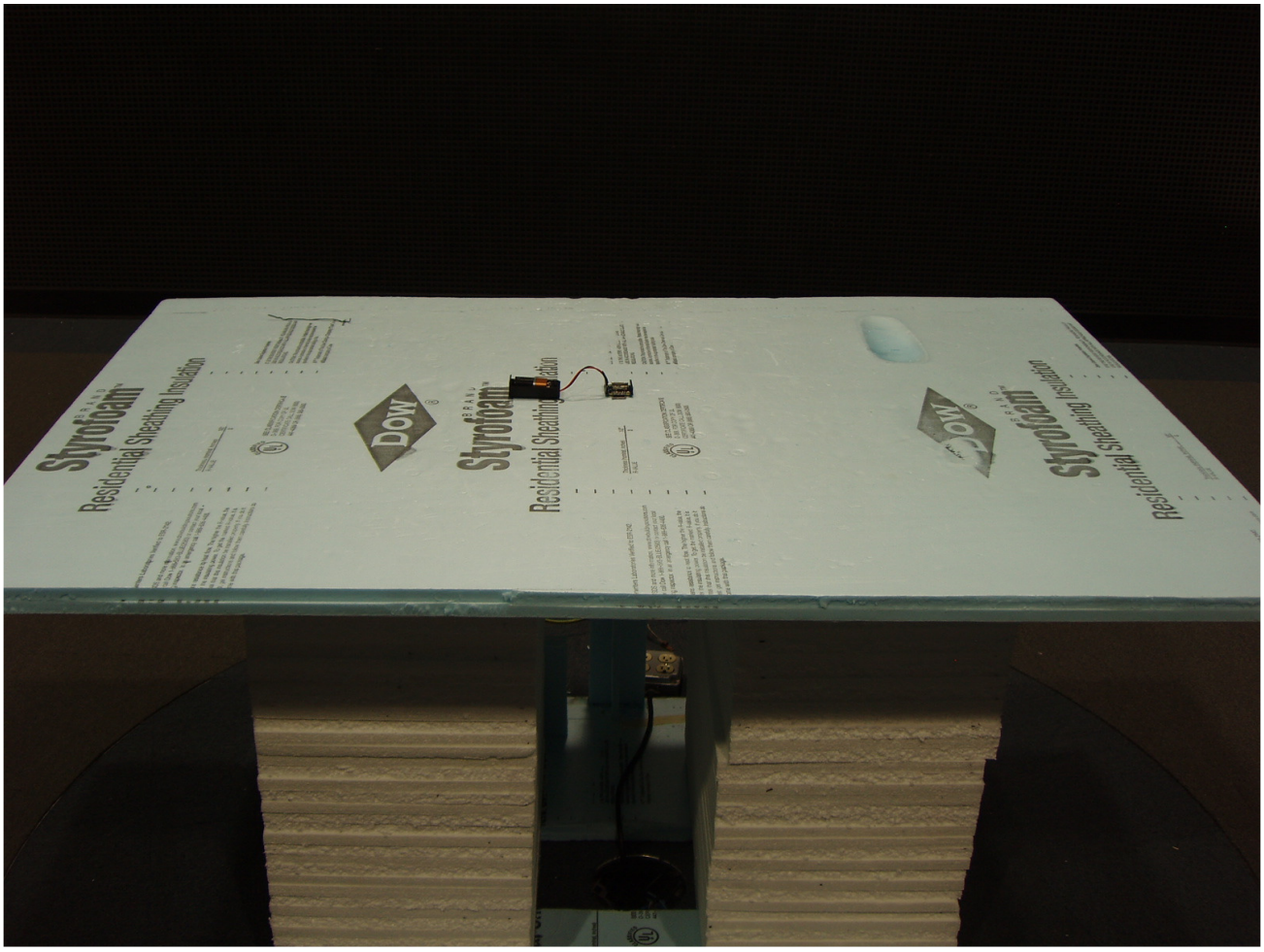


Photo 6.5-1 – Front View of the Radiated Emissions Test Set-up

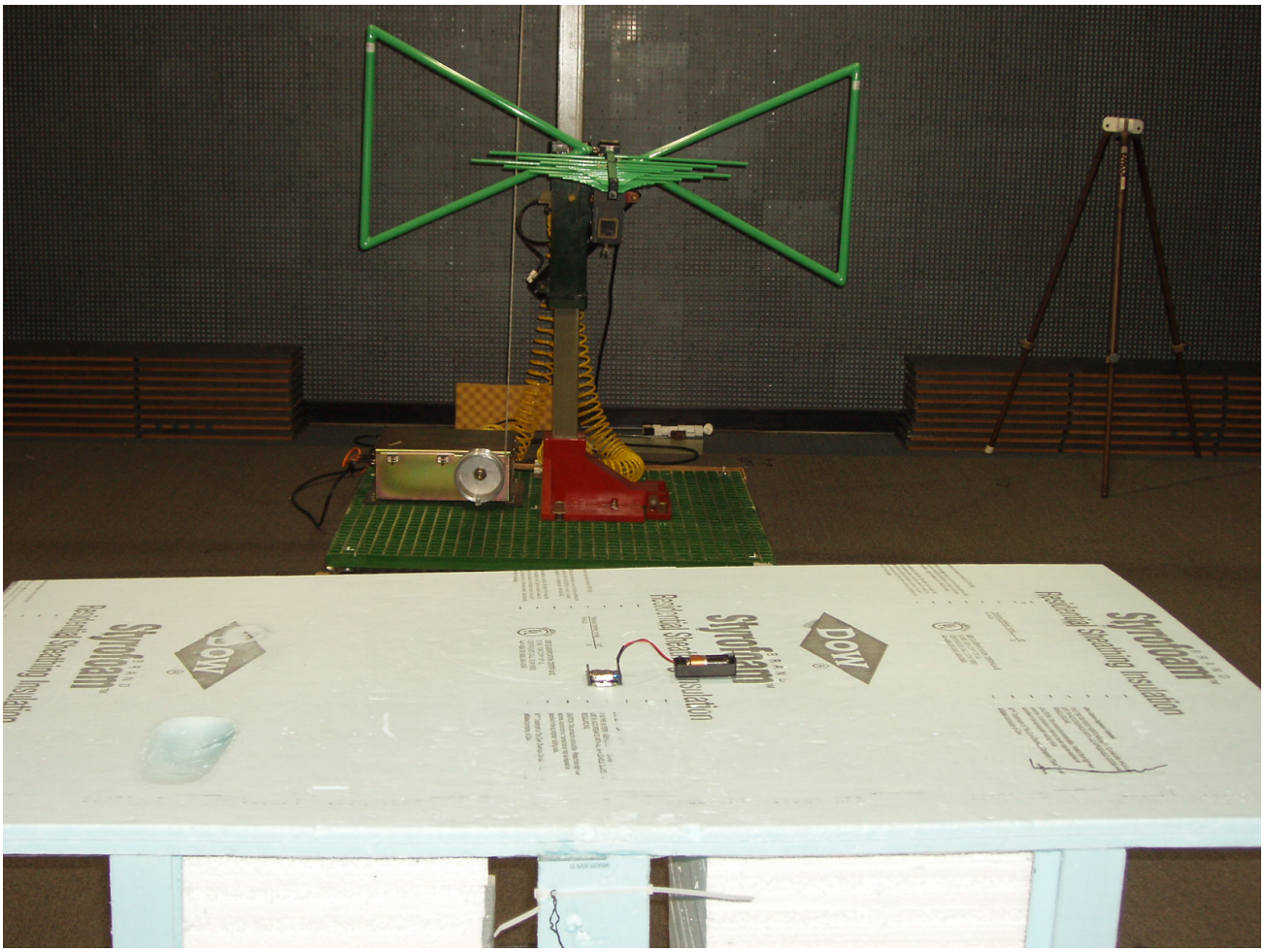


Photo 6.5-2 – Rear View of the Radiated Emissions Test Set-up

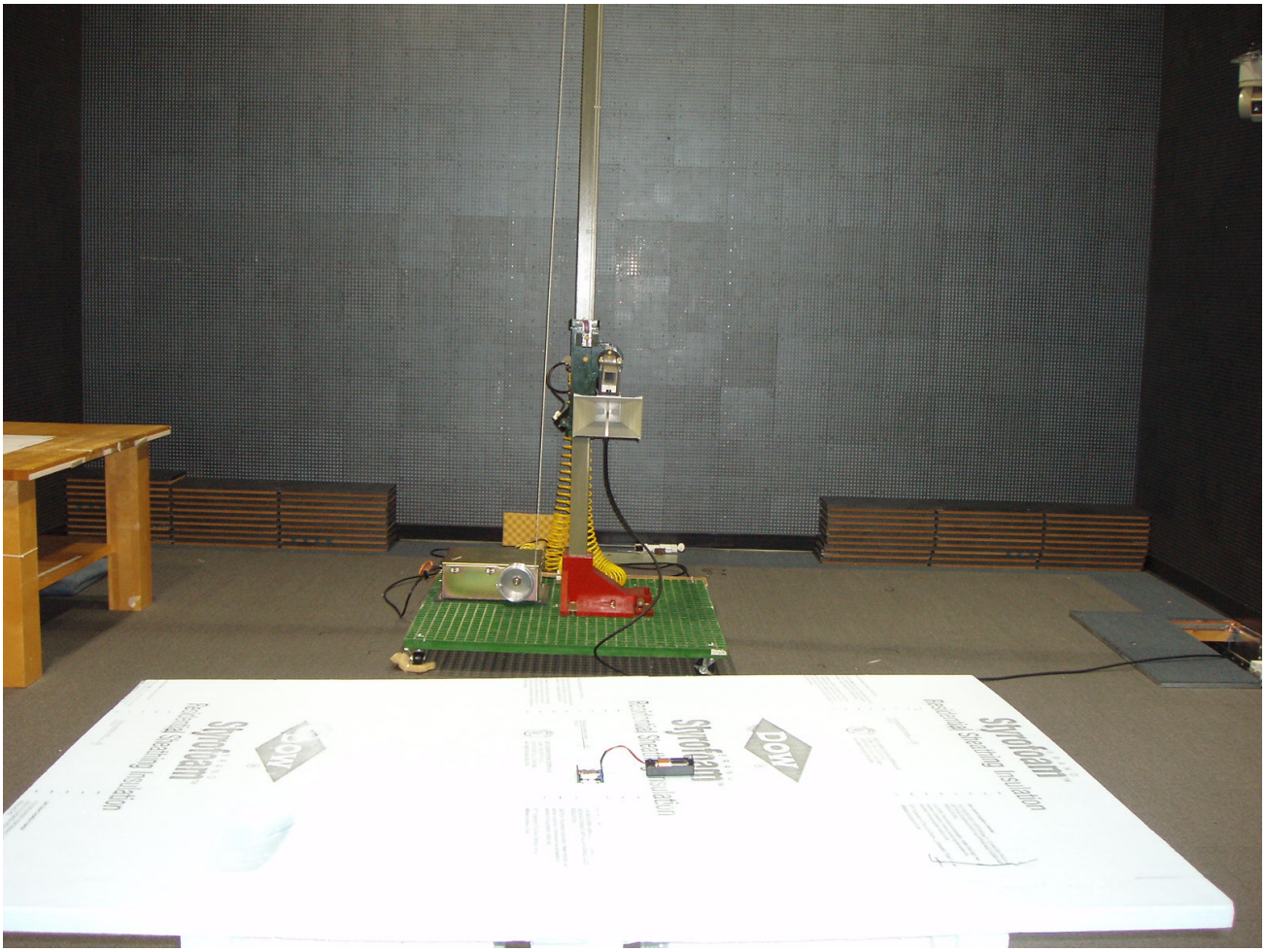


Photo 6.5-3 – Rear View of the Radiated Emissions Test Set-up for Frequencies above 1 GHz

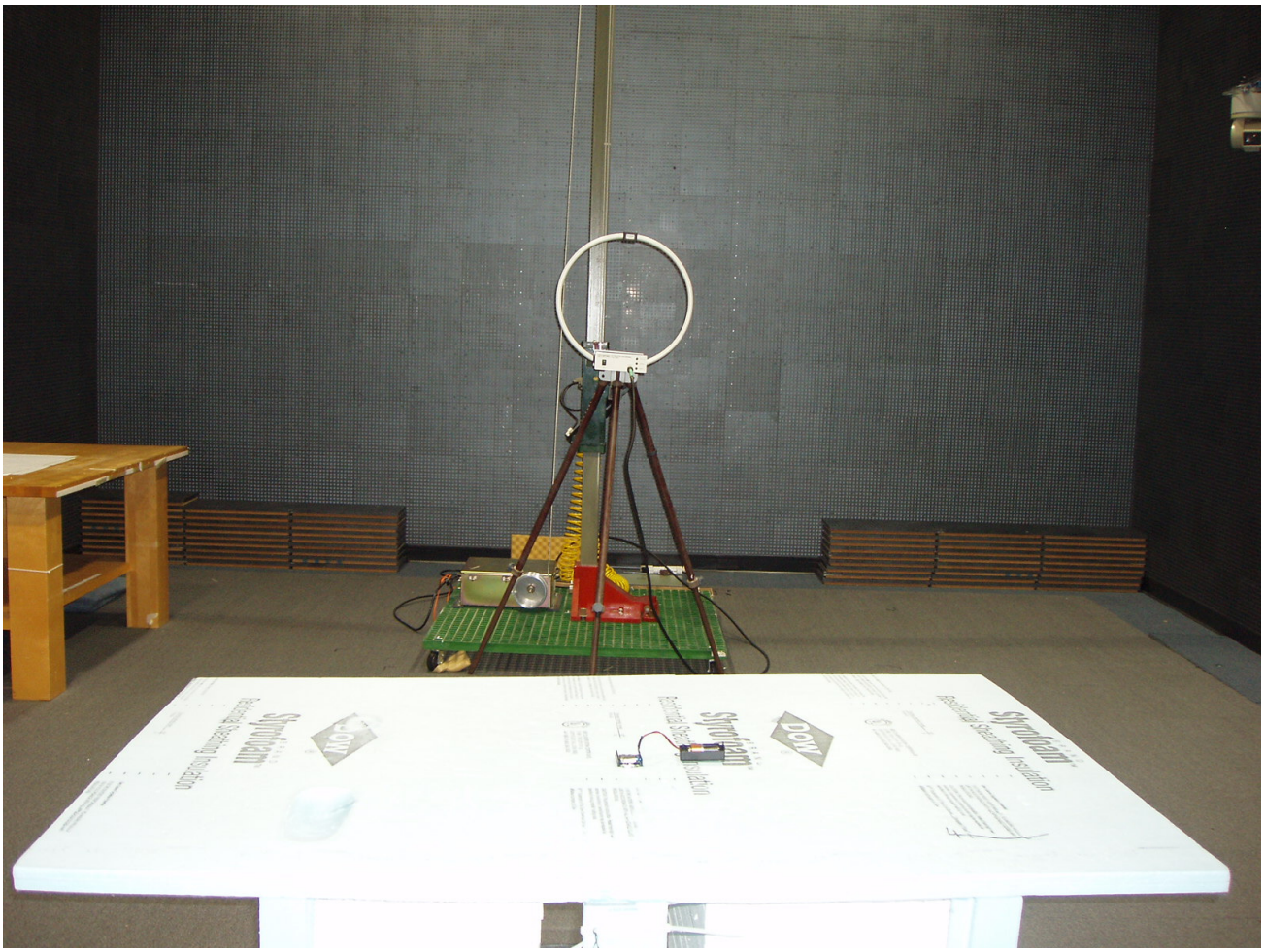


Photo 6.5-4 – Rear View of the Radiated Emissions Test Set-up for Frequencies below 30 MHz

7 TIME DOMAIN CHARACTERISTICS

There are no time domain restrictions for equipment operating under § 15.249. Measurements were taken to calculate the duty cycle correction factor.

7.1 Test Procedure

The test procedure was as follows: A radiated emissions measurement was made with the spectrum analyzer's center frequency set to the transmitter's fundamental frequency and its span set to 0 Hz to make time domain measurements.

7.2 Test Data

Compliance Verdict: PASS

Figure 7.2-1 below shows the response of the DUT, as a function of time.

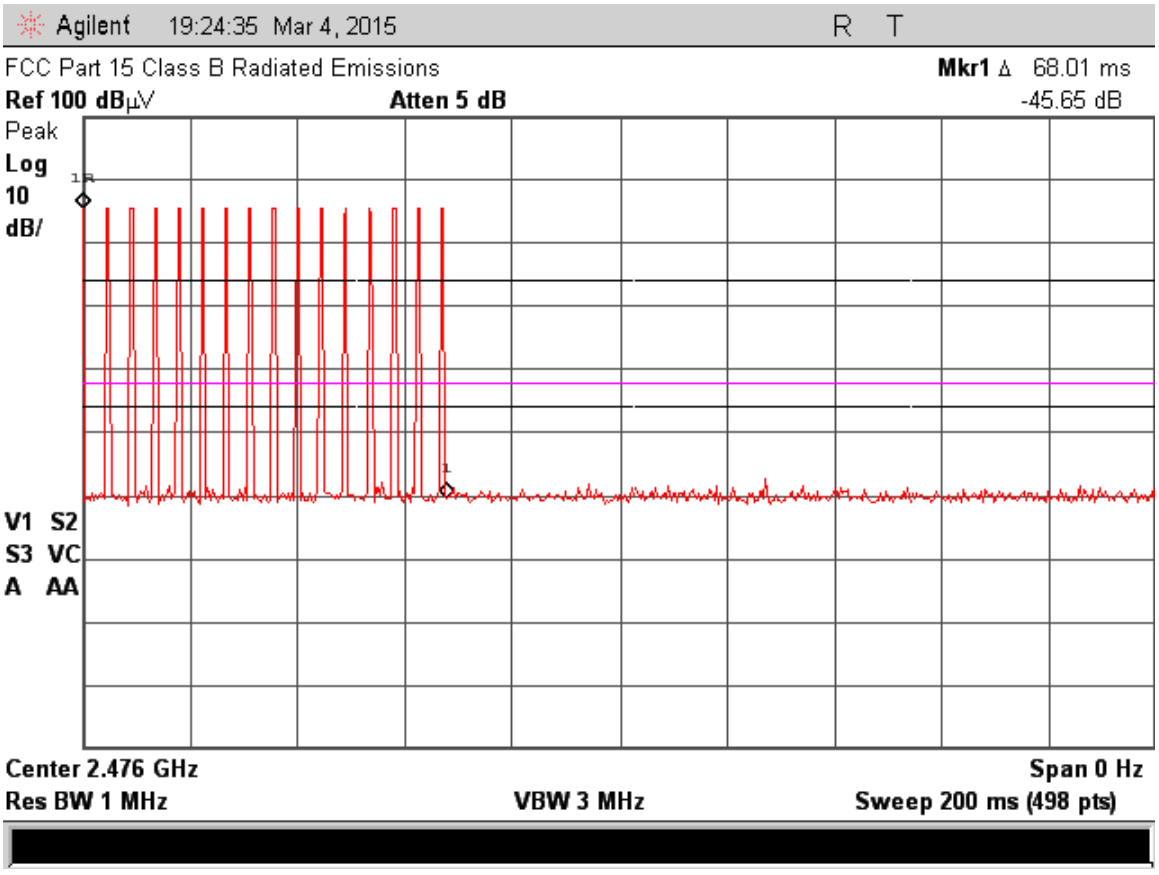


Figure 7.2-1 – Packet Duration

Note:

The above plot shows a 16 Byte transmission for a total packet duration of 68.01 msec.

Figure 7.2-2 below shows the duration of a single Byte.

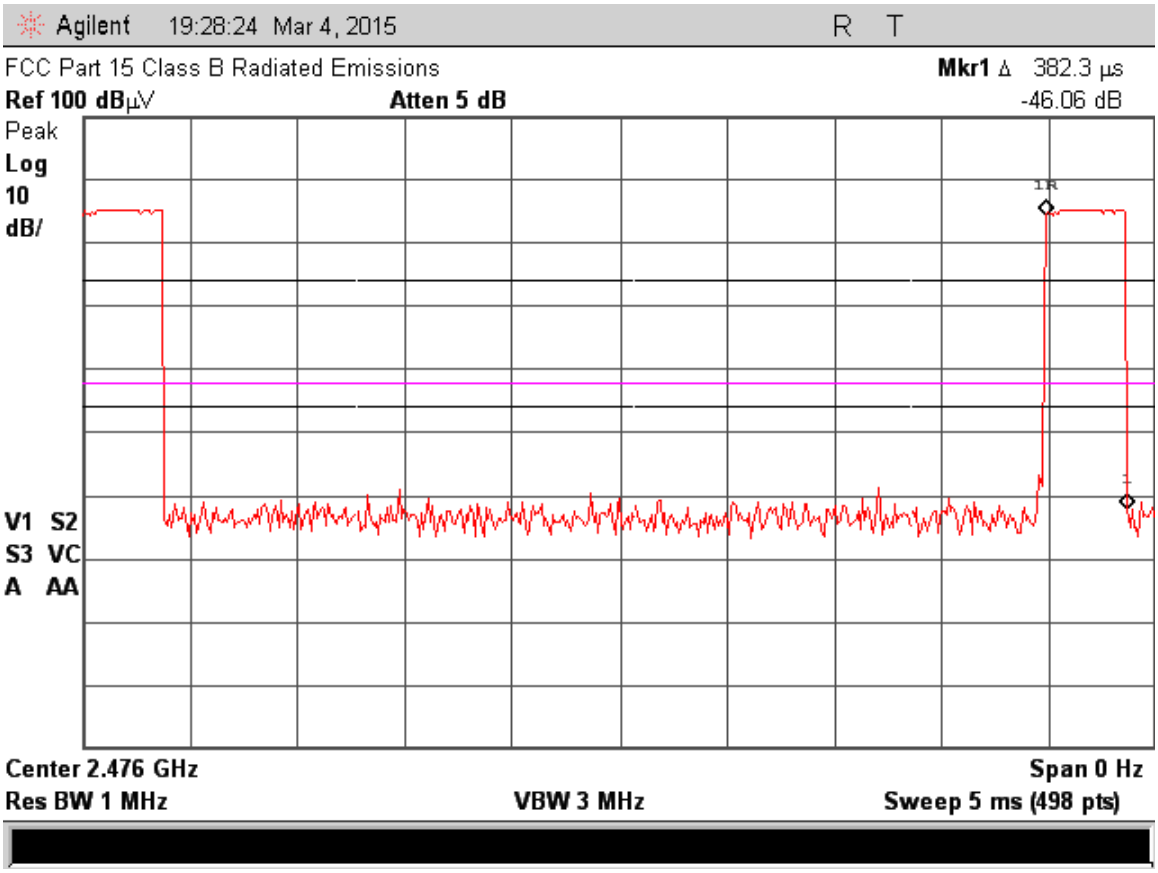


Figure 7.2-2 – Byte Transmission Duration

T_{ON} was measured. T_{PERIOD} was the FCC prescribed period of 100 msec. The duty cycle was calculated using eq. 3. The duty cycle correction factor was calculated using eq. 2.

$DC = (T_{on} / T_{period})$ (eq. 3)

$DC_{CORR} = 20LOG(T_{on} / T_{period})$ (eq. 2)

Total on time for transmission = 16 X 0.3823 msec = 6.1168 msec

Duty cycle over 100 msec = 6.1168/100 = 6.1%.

Duty cycle correction factor calculation

$DC_{CORR} = 20LOG(T_{on} / T_{period}) = 20LOG(6.1168/100) = -24.26$ dB.

Test Personnel:

March 4, 2015	Peter J. Walsh, NCE	
Date	Name	Signature

7.3 Test Instrumentation Used

Type	Manufacturer/ Model No.	Serial Number	Calibration Due Date
EMI Receiver	Rohde & Schwarz ESCS 30	825788/002	12/4/2015
Spectrum Analyzer	Agilent E7405A	MY42000055	3/29/2015
Preamplifier	Com-Power PA-122	181925	5/31/2015
Antenna	EMCO Horn Model 3115	9002-3393	3/19/2017

Calibration and Traceability: All measuring and test equipment are calibrated and are traceable to the National Institute for Standards and Technology (NIST) and Methods at an interval of 24 months.

8 ANTENNA REQUIREMENT

Reference: 47 C.F.R. § 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. This requirement does not apply to carrier current devices or to devices operated under the provisions of Sections 15.211, 15.213, 15.217, 15.219, or 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with Section 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded.

8.1 Test Procedure

Inspect the DUT.

8.2 Test Data

Compliance Verdict: PASS

The DUT uses a chip antenna soldered to a circuit board. As such the antenna is considered permanently attached and not replaceable by the user.

8.3 Antenna Photographs

Photo 8.3-1 below shows the DUT's antenna.

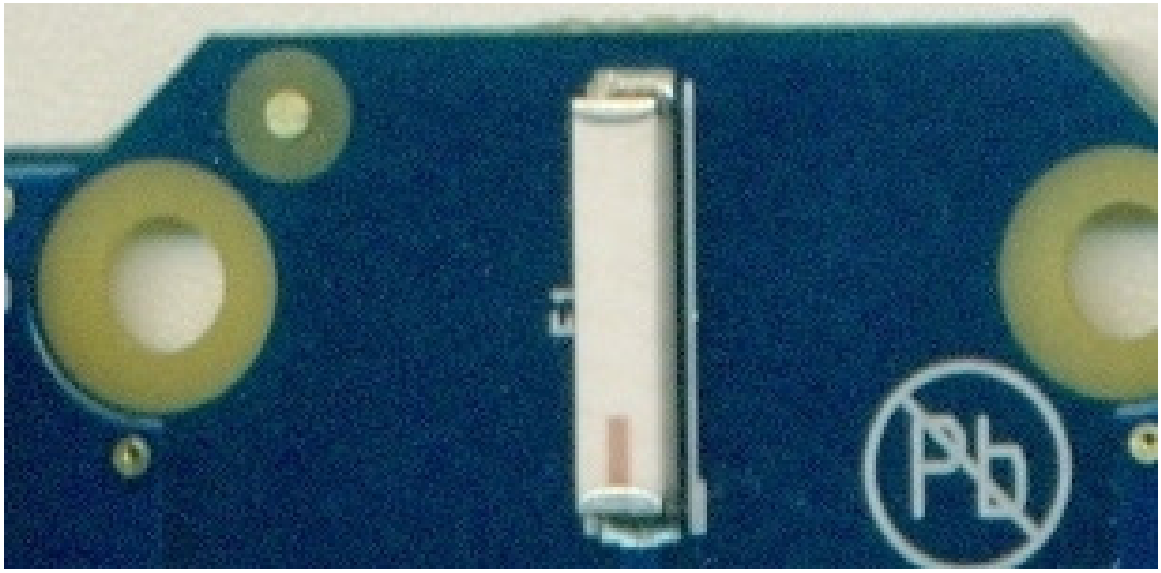


Photo 8.3-1 - Antenna

9 LABELING AND USER'S GUIDE REQUIREMENTS

9.1 FCC Label Statement

The FCC compliance label should include the following information:

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Note that because of the physical size of the unit, the above warning will be included in the user manual.

The FCC identifier or the unique identifier, as appropriate, must be displayed on the device.

The FCC ID number will be: 2AECKWL-C15005

Figure 9.1-1 below shows a sample of the label and its placement on the DUT. Note that in production this will silk screened on the printed wiring board for permanency of marking.

Figure 9.1-1 – Sample Label

9.2 Instruction Manual Statement

The instruction manual must contain the following statements:

- Changes or modifications not expressly approved by the responsible party could void the user's authority to operate the equipment.
- This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.
- This device may only be used with the approved internal antenna that is shipped with the unit and installed by the manufacturer. The use of any other antennas will invalidate the unit's FCC Part 15 certification.
- To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that permitted for successful communication. Operating the device with the supplied, internal antenna will ensure that this requirement is met.
- A separation distance of 20 cm should be observed to maintain compliance with the FCC's RF exposure guidelines set out in OET Bulletin 65.

10 MPE CONSIDERATIONS

References: 47 C.F.R. § 1.1310

Radiofrequency radiation exposure limits.

The criteria listed in table 1 shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in § 1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of § 2.1093 of this chapter. Further information on evaluating compliance with these limits can be found in the FCC's OST/OET Bulletin Number 65, "Evaluating Compliance with FCC-Specified Guidelines for Human Exposure to Radiofrequency Radiation."

Table 13-1

Table 1—Limits for Maximum Permissible Exposure (MPE) **Frequency range (MHz)**	**Electric field strength (V/m)**	**Magnetic field strength (A/m)**	**Power density (mW/cm2)**	**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/f2)	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/f2)	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				

2.5.2 Exemption from Routine Evaluation Limits – RF Exposure Evaluation
RF exposure evaluation is required if the separation distance between the user and the device's radiating element is greater than 20 cm, except when the device operates as follows:

below 1.5 GHz and the maximum e.i.r.p. of the device is equal to or less than 2.5 W;

at or above 1.5 GHz and the maximum e.i.r.p. of the device is equal to or less than 5 W.

In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the e.i.r.p. was derived.

Prediction of MPE Limit for a Specified Distance

Reference: OET Bulletin 65, Edition 97-01

The power density formula is as follows:

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

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

Table 13-2 – MPE Calculation for OET Bulletin 65 Compliance

Maximum peak output power at antenna terminal:	0.00	(dBm)
Maximum peak output power at antenna terminal:	1.00	(mW)
Antenna Gain (typical):	3.00	(dBi)
Maximum Antenna Gain:	2.00	(numeric)
Prediction Distance:	20.00	(cm)
Prediction Frequency:	2476.00	(MHz)
MPE Limit for Uncontrolled Exposure at Prediction Frequency:	1.00	(mW/cm^2)
Power Density at the Prediction Frequency:	0.0004	(mW/cm^2)
Maximum Allowable Antenna Gain:	37.01	(dBi)
Margin of Compliance at 20 cm:	34.01	(dB)

ANNEX A NVLAP CERTIFICATE of ACCREDITATION

United States Department of Commerce
National Institute of Standards and Technology

NVLAP®

Certificate of Accreditation to ISO/IEC 17025:2005

NVLAP LAB CODE: 200125-0

Walshire Labs, LLC
Largo, FL

is accredited by the National Voluntary Laboratory Accreditation Program for specific services, listed on the Scope of Accreditation, for:

ELECTROMAGNETIC COMPATIBILITY AND TELECOMMUNICATIONS

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communique dated January 2009).

2015-04-01 through 2016-03-31
Effective dates

For the National Institute of Standards and Technology

NVLAP-01C (REV. 2009-01-28)

ANNEX B DISCLOSURE STATEMENT

Walshire Labs, LLC represents to the client that testing was done in accordance with standard procedures as applicable and that reported test results are accurate within generally accepted commercial ranges of accuracy. Walshire Labs Inc. test reports only apply to the specific sample(s) tested. This report is the property of the client. This report shall not be reproduced except in full without the expressed written approval of Walshire Labs, LLC.

TERMS and CONDITIONS

ARTICLE 1 *- Services, Walshire Labs will:*

1.1 Act for Client in a professional manner, using the degree of care and skill ordinarily exercised by and consistent with the standards of the profession.

1.2 Provide only those services that lie within the technical and professional area of expertise and capability of the Lab.

1.3 Perform all technical services in accordance with accepted laboratory test principles and practices.

1.4 Use test equipment which has been calibrated within a period not exceeding the manufacturer's recommendation and which is traceable to the NIST.

1.6 Consider all reports to be the confidential property of the client, and distribute reports only to those persons designated by the client.

ARTICLE 2 *- Client's Responsibilities, The Client will:*

2.1 Provide all information necessary for proper performance of technical services.

2.2 Designate a person who is authorized to transmit instructions, receive information and test data reports, interpret and define Client's policies, and make decisions regarding technical services, as may be required at Clients expense.

2.3 Deliver without cost, representative samples of product for technical evaluation, together with any relevant data.

2.4 Furnish such labor and equipment necessary to handle sample product and to facilitate the technical evaluation.

2.5 The Client shall provide prior to the start of evaluation testing a signed Purchase Order for the amount agreed to by both parties.

ARTICLE 3 *- General Requirements.*

3.1 The only warranty made by Walshire Labs, in connection with services performed thereunder is that it will use that degree of care and skill as stated in Article 1.1 and 1.3 above. No other warranty, expressed or implied, is made or intended for services provided thereunder.

3.2 Walshire Labs shall supply technical services and prepare reports based solely on product samples submitted. The Client understands that application of the data to other devices is highly speculative and should be applied with extreme caution.

3.3 Walshire Labs agrees to exercise ordinary care in receiving, preserving, and shipping any test sample to be tested, but assumes no responsibility for damages, either direct or consequential, which arise or are alleged to arise from loss, damage or destruction of the sample due to the act of examination, modification or testing, or technical analysis, or circumstances beyond our control.

3.4 The Client recognizes that generally accepted error variances apply and agrees to consider such error variances in its use of test data.

3.5 It is agreed between Walshire Labs and Client that no distribution of any test reports, etc. shall be made to any third party without the prior written consent of both parties.

3.6 Test Reports may not be used by the Client to claim product endorsement by NVLAP or any agency of the U.S. Government.

ARTICLE 4 *- Payment.*

4.1 The Client agrees to pay for services and expenses as covered in the Purchase Order or modified by Article 2.2. Walshire Labs will present an invoice at the completion of work and will be paid upon receipt by Client.