WALSHIRE LABS

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47 C.F.R. Part 15 Subpart C FCC Rules Certification Test Record for an Automatic Periodic Transmitter Operating in the 260 – 470 MHz Band

MONOXIVENT
Source Capture Systems

Monoxivent Model TR-GEN 1

Equipment:	Model TR-GEN 1
Client:	Monoxivent
Address:	1306 Mill Street
	Rock Island, IL, 61201- 6120

Test Report Number: FCCIR3-MONOXIVENT-04-11-16A
Date: May 10, 2016
Total Number of Pages: 45

NVLAP®

NVLAP LAP Code: 200125-0

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1 IDENTIFICATION SUMMARY

1.1 Test Report

Test Report Number: FCCIR3-MONOXIVENT-04-11-16A
Test Report Date: May 10, 2016

Report written and approved by:

Date	Name	Signature
May 10, 2016	Peter J. Walsh, NCE	

1.2 Testing Laboratory

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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. This report has been re-issued for the purpose of correcting a typographical error in the client's street address and supersedes test report FCCIR3-MONOXIVENT-04-11-16.

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:	Monoxivent
Street:	1306 Mill Street
City:	Rock Island
State:	IL
Zip Code	61201- 6120
Country:	USA
Phone:	(309) 794-1000
Contact Person:	Jim Wischhusen
Phone:	(309) 794-1000 ext. 40
Email:	jimw@monoxivent.com

1.5 Dates

Date of commission:	February 22, 2016
Date of receipt of DUT:	May 3, 2016
Date of test completion:	May 7, 2016

1.6 Device Under Test (DUT)

Name:	Model TR-GEN 1
Serial Number:	Not labeled
FCC ID:	FCC ID: 2AHHNTR-GEN1
Frequency:	390.06 MHz

2 GENERAL INFORMATION

2.1 Product Description

The TR-GEN 1 is a short range periodic transmitter that has been designed for installation in fire engines. It sends a signal to a receiver to activate machinery to vent exhaust gases from the fire engine upon its entrance into the fire station. It is powered by the truck's 12 VDC or 24 VDC battery and as such does not connect to the ac mains. The device functions like a garage door opener however it operates periodically and does not require manual control by the firemen.

Because the device is used exclusively in a transportation vehicle, it is exempt from FCC Part 15 Subpart B. It is however subject to Part 15, Subpart C, Section 15.231.

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 1.8m long DC power cable to a DC power source.

2.3 Peripheral Devices

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

2.4 Test Methodology

Testing was performed according to ANSI C63.10-2013, the procedure referenced by Part 15, FCC Rules. Radiated emissions tests were performed at an antenna to EUT distance of 3 meters.

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 site is NVLAP Accredited (200125-0).

2.6 Deviations

No deviations were exercised during the course of the testing.

3 SYSTEM TEST CONFIGURATION

3.1 Justification

The DUT is intended to be installed in a fixed horizontal position. As such, the DUT was tested in a table top configuration lying flat in the center of the table. The effective height of the table was 80 cm for radiated emissions tests up to 1000 MHz and 1.5 meters for tests above 1 GHz. As the DUT was 12 VDC or 24 VDC powered by the vehicle's battery, the ac power line conducted emissions test was not applicable.

For time domain tests, the DUT was tested in its normal mode of operation whereby automatic, periodic transmission was performed consistent with the permissible timing requirements. For radiated emissions tests, the DUT was tested in a manner which forced the DUT to repeat its normal transmission sequence continuously. This mode isn't accessible to the user and required that a switch be shorted after the DUT booted up.

3.2 Special Accessories

None.

3.3 Equipment Modifications

No modifications were made to the DUT as submitted for final compliance testing.

Signature:		Date:	May 7, 2016
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. § 15.207 (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.

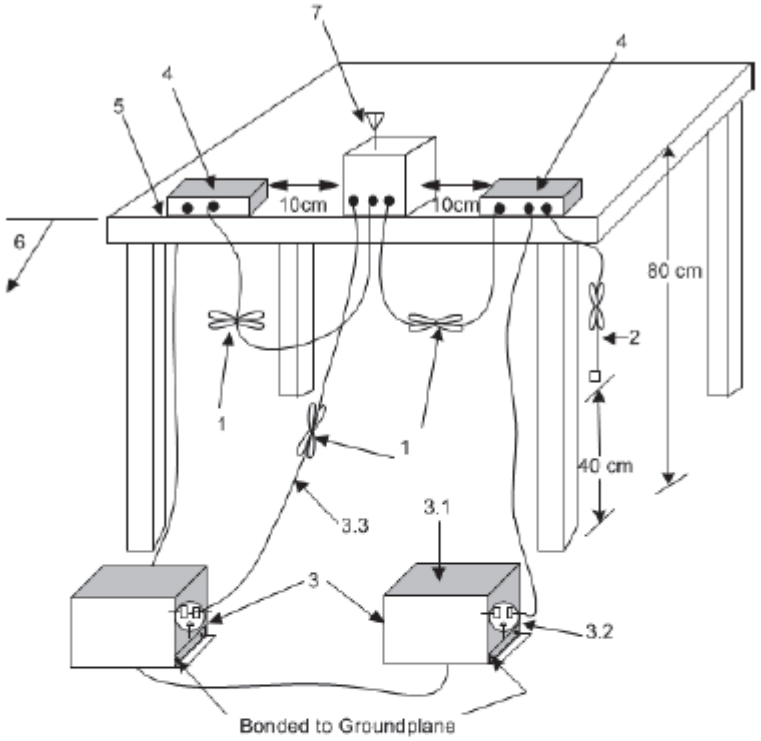
Table 4-1

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 is performed in accordance with ANSI C63.10-2013 § 6.2. The test setup is consistent with Figure 5 as shown below. The test is performed in a semi-anechoic chamber. As the use of the vertical conducting plane is optional, it was not used.



1—Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 cm to 40 cm long see (see 6.2.3.2).
2—The I/O cables that are not connected to an accessory 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 6.2.2).
3—EUT connected to one LISN. Unused LISN measuring port connectors shall be terminated in 50 Ω loads. LISN may be placed on top of, or immediately beneath, reference ground plane (see 6.2.2 and 6.2.3).
3.1—All other equipment powered from additional LISN(s).
3.2—A multiple-outlet strip may be used for multiple power cords of non-EUT equipment.
3.3—LISN at least 80 cm from nearest part of EUT chassis.
4—Non-EUT components of EUT system being tested.
5—Rear of EUT, including peripherals, shall all be aligned and flush with edge of tabletop (see 6.2.3.2).
6—Edge of tabletop shall be 40 cm removed from a vertical conducting plane that is bonded to the ground plane (see 6.2.2 for options).
7—Antenna can be integral or detachable. If detachable, then the antenna shall be attached for this test.

Figure 5—Test arrangement for power-line conducted emissions (product with accessories)

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 was DC powered (12 or 24 VDC) by the vehicle's battery, the ac power line conducted emissions test was not applicable.

4.3 Conducted Emissions Test Instrumentation

Type	Manufacturer/ Model No.	SW/FW Rev	Serial Number	Calibration Due Date
EMI Receiver	Rohde & Schwarz ESCS 30	8.54.00	825788/002	12/4/2017
LISN	Rohde & Schwarz ESH3-Z5	2.3002.0102.36	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 with a calibration interval of 24 months.

4.4 Conducted Emissions Photographs

No photographs were taken as the test was not applicable.

5 RADIATED EMISSIONS DATA

References: 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.

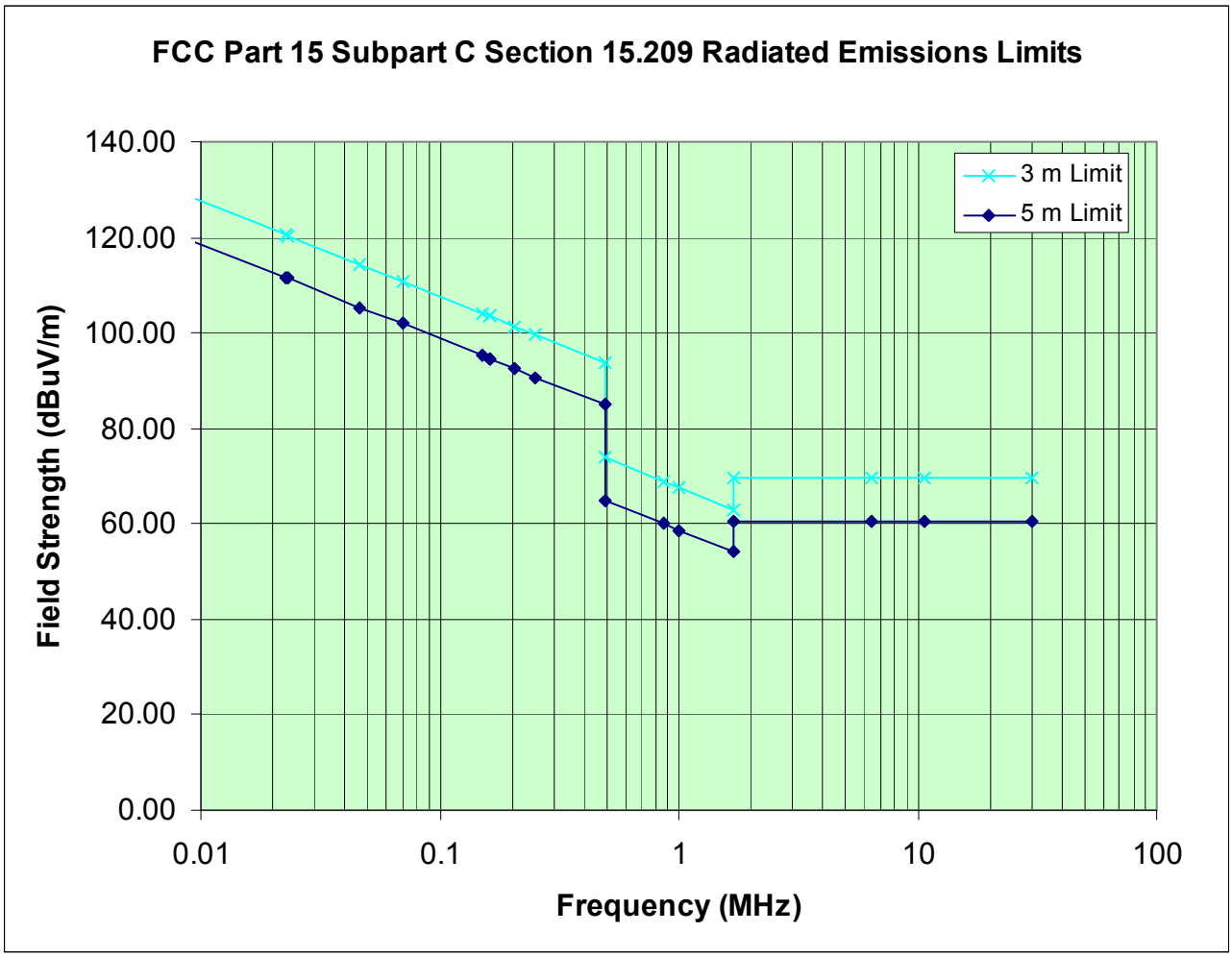


Figure 5-1 – Adjusted Field Strength Limits

References: 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. § 15.231

Section 15.231 Periodic operation in the band 40.66 - 40.70 MHz and above 70 MHz.

(a) The provisions of this Section are restricted to periodic operation within the band 40.66 - 40.70 MHz and above 70 MHz. Except as shown in paragraph (e) of this Section, the intentional radiator is restricted to the transmission of a control signal such as those used with alarm systems, door openers, remote switches, etc. Continuous transmissions, voice, video and the radio control of toys are not permitted. Data is permitted to be sent with a control signal. The following conditions shall be met to comply with the provisions for this periodic operation:

(1) A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released.

(2) A transmitter activated automatically shall cease transmission within 5 seconds after activation.

(3) Periodic transmissions at regular predetermined intervals are not permitted. However, polling or supervision transmissions, including data, to determine system integrity of transmitters used in security or safety applications are allowed if the total duration of transmissions does not exceed more than two seconds per hour for each transmitter. There is no limit on the number of individual transmissions, provided the total transmission time does not exceed two seconds per hour.

(4) Intentional radiators which are employed for radio control purposes during emergencies involving fire, security, and safety of life, when activated to signal an alarm, may operate during the pendency of the alarm condition.

(5) Transmission of set-up information for security systems may exceed the transmission duration limits in paragraphs (a)(1) and (a)(2) of this section, provided such transmission are under the control of a professional installer and do not exceed ten seconds after a manually operated switch is released or a transmitter is activated automatically. Such set-up information may include data.

(b) In addition to the provisions of Section 15.205, the field strength of emissions from intentional radiators operated under this Section shall not exceed the following:

Fundamental Frequency (MHz)	Field Strength of Fundamental (microvolts/meter)	Field Strength of Spurious Emissions (microvolts/meter)
40.66 - 40.70	2,250	225
70 - 130	1,250	125
130 - 174	1,250 to 3,750 **	125 to 375 **
174 - 260	3,750	375
260 - 470	3,750 to 12,500 **	375 to 1,250 **
Above 470	12,500	1,250

** linear interpolations

[Where F is the frequency in MHz, the formulas for calculating the maximum permitted fundamental field strengths are as follows: for the band 130-174 MHz, μV/m at 3 meters = 56.81818(F) - 6136.3636; for the band 260-470 MHz, μV/m at 3 meters = 41.6667(F) - 7083.3333. The maximum permitted unwanted emission level is 20 dB below the maximum permitted fundamental level.]
(1) The above field strength limits are specified at a distance of 3 meters. The tighter limits apply at the band edges.

(2) Intentional radiators operating under the provisions of this Section shall demonstrate compliance with the limits on the field strength of emissions, as shown in the above table, based on the average value of the measured emissions. As an alternative, compliance with the limits in the above table may be based on the use of measurement instrumentation with a CISPR quasi-peak detector. The specific method of measurement employed shall be specified in the application for equipment authorization. If average emission measurements are employed, the provisions in Section 15.35 for averaging pulsed emissions and for limiting peak emissions apply. Further, compliance with the provisions of Section 15.205 shall be demonstrated using the measurement instrumentation specified in that section.

(3) The limits on the field strength of the spurious emissions in the above table are based on the fundamental frequency of the intentional radiator. Spurious emissions shall be attenuated to the average (or, alternatively, CISPR quasi-peak) limits shown in this table or to the general limits shown in Section 15.209, whichever limit permits a higher field strength.

(c) The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5% of the center frequency. Bandwidth is determined at the points 20 dB down from the modulated carrier.

(d) For devices operating within the frequency band 40.66 - 40.70 MHz, the bandwidth of the emission shall be confined within the band edges and the frequency tolerance of the carrier shall be ± 0.01%. This frequency tolerance shall be maintained for 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.

(e) Intentional radiators may operate at a periodic rate exceeding that specified in paragraph (a) and may be employed for any type of operation, including operation prohibited in paragraph (a), provided the intentional radiator complies with the provisions of paragraphs (b) through (d) of this Section, except the field strength table in paragraph (b) is replaced by the following:

Fundamental Frequency (MHz)	Field Strength of Fundamental (microvolts/meter)	Field Strength of Spurious Emission (microvolts/meter)
40.66 - 40.70	1,000	100
70 - 130	500	50
130 - 174	500 to 1,500 **	50 to 150 **
174 - 260	1,500	150
260 - 470	1,500 to 5,000 **	150 to 500 **
Above 470	5,000	500

** linear interpolations

[Where F is the frequency in MHz, the formulas for calculating the maximum permitted fundamental field strengths are as follows: for the band 130-174 MHz, μV/m at 3 meters = 22.72727(F) - 2454.545; for the band 260-470 MHz, μV/m at 3 meters = 16.6667(F) - 2833.3333. The maximum permitted unwanted emission level is 20 dB below the maximum permitted fundamental level.]
In addition, devices operated under the provisions of this paragraph shall be provided with a means for automatically limiting operation so that the duration of each transmission shall not be greater than one second

and the silent period between transmissions shall be at least 30 times the duration of the transmission but in no case less than 10 seconds.

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:

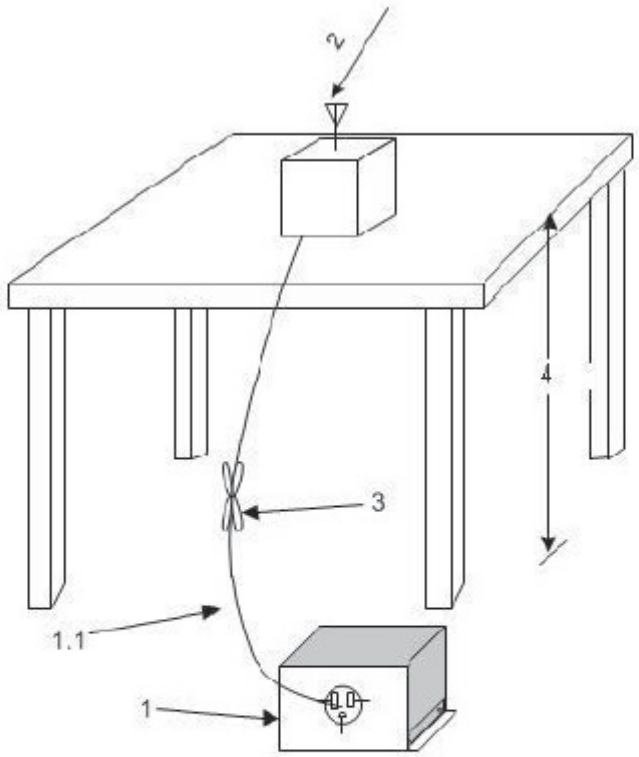
(a) On any frequency or frequencies below or equal to 1000 MHz, the limits shown are based on measuring equipment employing a CISPR quasi-peak detector function and related measurement bandwidths, unless otherwise specified. The specifications for the measuring instrument using the CISPR quasi-peak detector 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 is performed in accordance with ANSI C63.10-2013 § 6.38. The test setup is consistent with ANSI C63.10-2013 Figure 4 below.



1—A LISN is optional for radiated measurements between 30 MHz and 1000 MHz but not allowed for measurements below 30 MHz and above 1000 MHz (see 6.3.1). If used, then connect EUT to one LISN. Unused LISN measuring port connectors shall be terminated in 50 Ω loads. The LISN may be placed on top of, or immediately beneath, the reference ground plane (see 6.2.2 and 6.2.3.2).
1.1—LISN spaced at least 80 cm from the nearest part of the EUT chassis.
2—Antenna can be integral or detachable, depending on the EUT (see 6.3.1).
3—Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 cm to 40 cm long (see 6.3.1).
4—For emission measurements at or below 1 GHz, the table height shall be 80 cm. For emission measurements above 1 GHz, the table height shall be 1.5 m for measurements, except as otherwise specified (see 6.3.1 and 6.6.3.1).

Figure 4—Test arrangement for radiated emissions (tabletop product)

The following data lists the significant emission frequencies, amplitude levels (including cable correction and antenna factors), plus the limit. The frequency range investigated was 15 MHz to 3.9 GHz. The highest frequency to which the DUT must be measured is 3.9 GHz as this is ten times the highest operating frequency of the DUT. The lowest frequency tested was determined by a crystal frequency of 15 MHz.

5.2 Test Data

Compliance Verdict: PASS

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. Note that only the fundamental frequency of 390.06 MHz exceeds the general field strength limit and the level is below the permissible limit set out in 15.231(e).

Figure 5.2-2 shows the highest emissions between 1 and 3.9 GHz as measured with an average detector. There were no emissions within 20 dB of the peak limit.

Tables 5.2-1 and 5.2-2 show the highest measured results within 20 dB of the peak and average limits respectively as set out in 15.231. Measurements within 20 dB of the limit were taken out to the tenth harmonic of the fundamental frequency. These final measurements were maximized by adjustment of the receiving antenna height, polarity, and turntable position. The detector used to show compliance with the average limit of the fundamental and second harmonic was the average detector set for a measurement time of 100 msec.

The radiated emissions limits set out in 15.231 are based on the average value of the measured emissions. The peak level is derived from the average limit by adding 20 dB. The limit at the fundamental frequency is calculated from the below formula:

Limit = 16.667(F) – 2833.3333 µV/m @ 3 m[1] (eq. 1)

Limit = 16.667(390.06) – 2833.3333 = 3668 µV/m or 71.3 dBµV/m @ 3 m

Therefore the peak limit was 91.3 dBµV/m @ 3 m.

The limit for the harmonics is 20 dB down from the fundamental or 51.3 dBµV/m @ 3 m.[2]

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:

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

A duty cycle correction factor was not applied as the measurements were made using the average detector and peak detector.

[1] The more restrictive field strength limit of 15.231 (e) had to be applied because the DUT's periodic transmissions did not comply with the requirements set out in 15.231 (a) (3).

[2] This limit is in some cases tighter than the limit set out for the restricted bands.

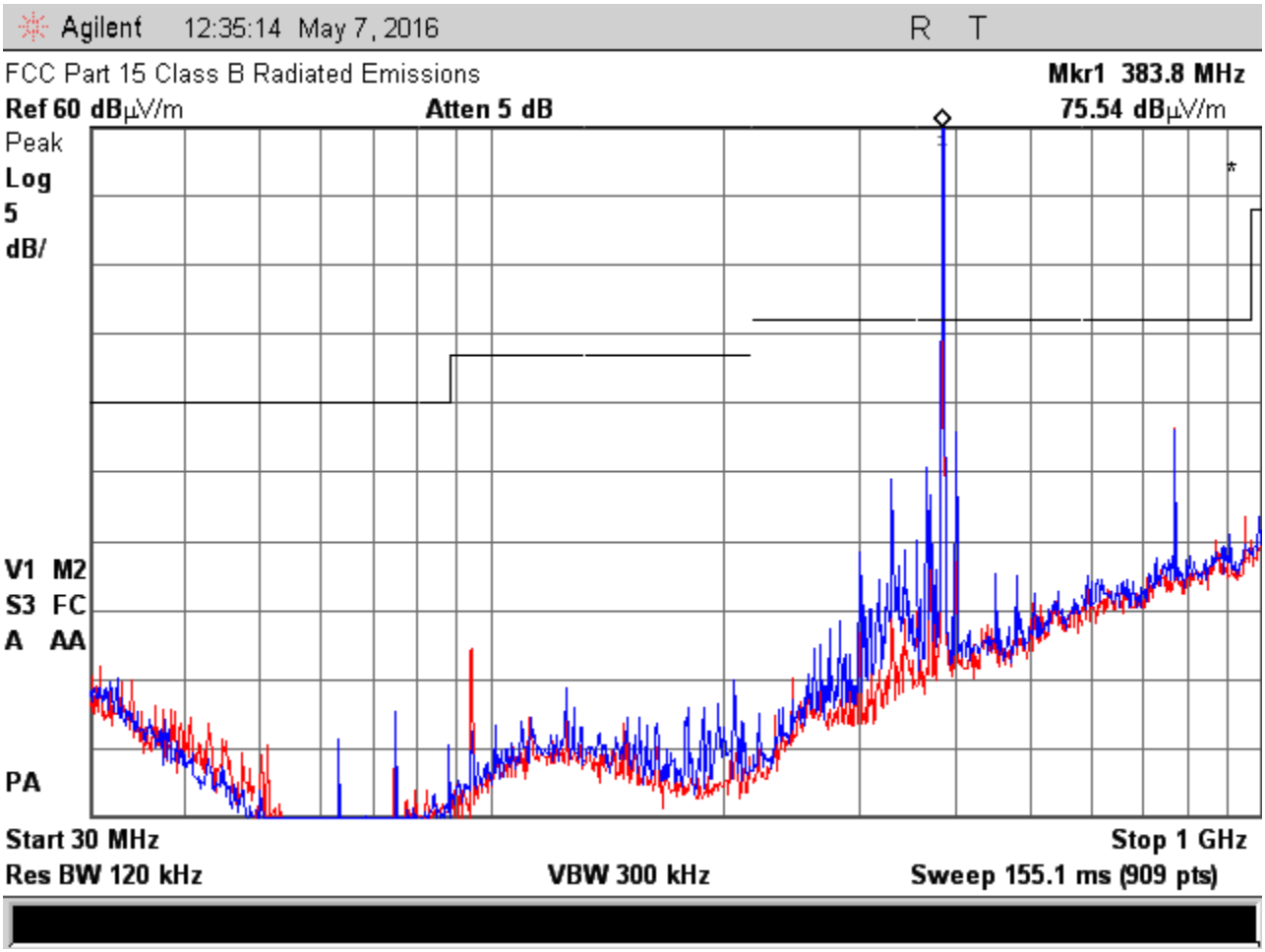


Figure 5.2-1 – Peak Detector Radiated Emissions 30 MHz to 1000 MHz

Notes:

The red trace was with vertical polarity. The blue trace was with horizontal polarity. All harmonics and spurious emissions were below the limit.

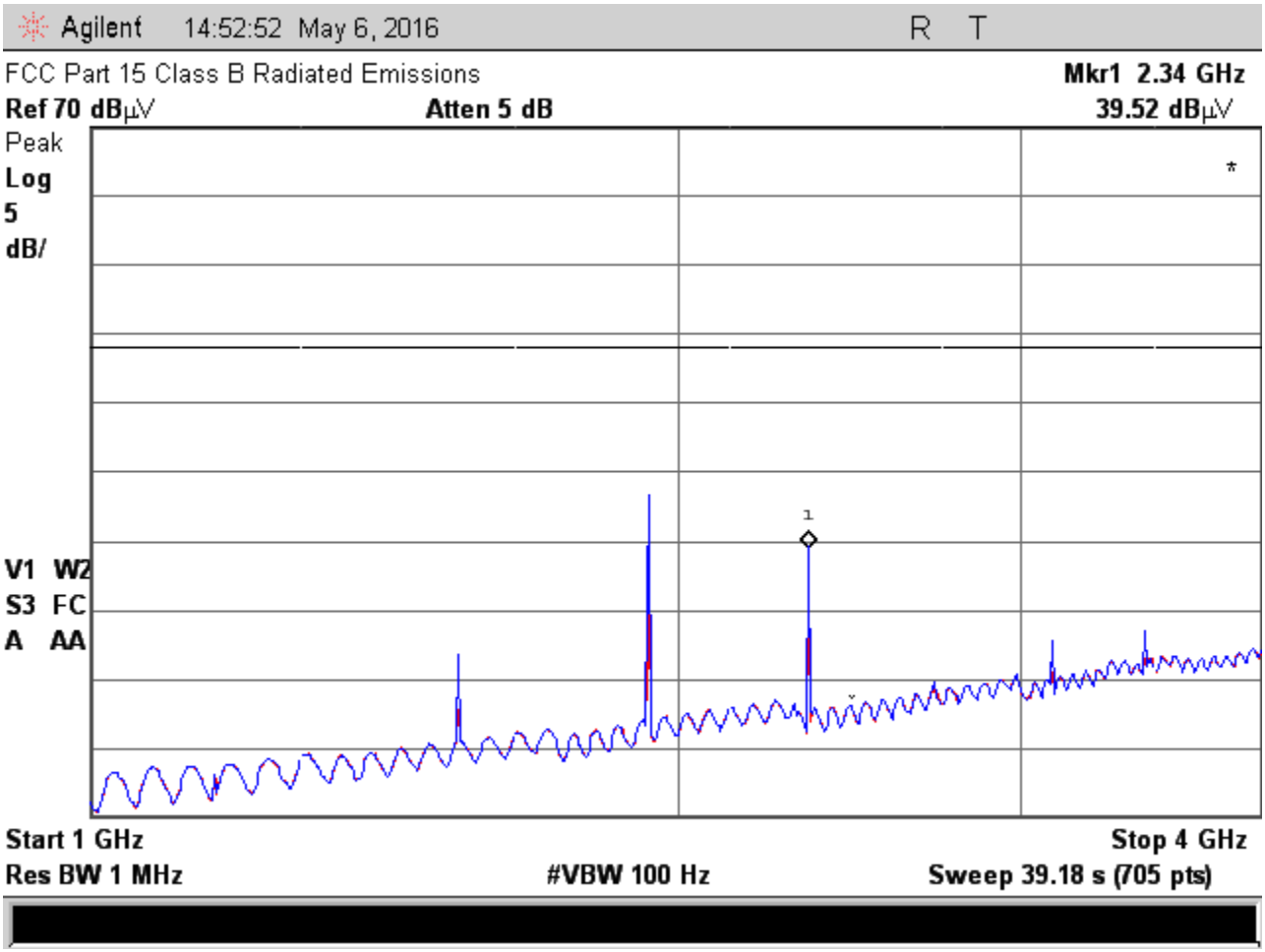


Figure 5.2-2 – Average Detector Radiated Emissions 1 – 3.9 GHz

Notes:

In the above figure, the red trace shows vertical polarity; the blue trace shows horizontal polarity. A scan from 1 to 3.9 GHz with the peak detector showed no emissions within 20 dB of the peak limit.

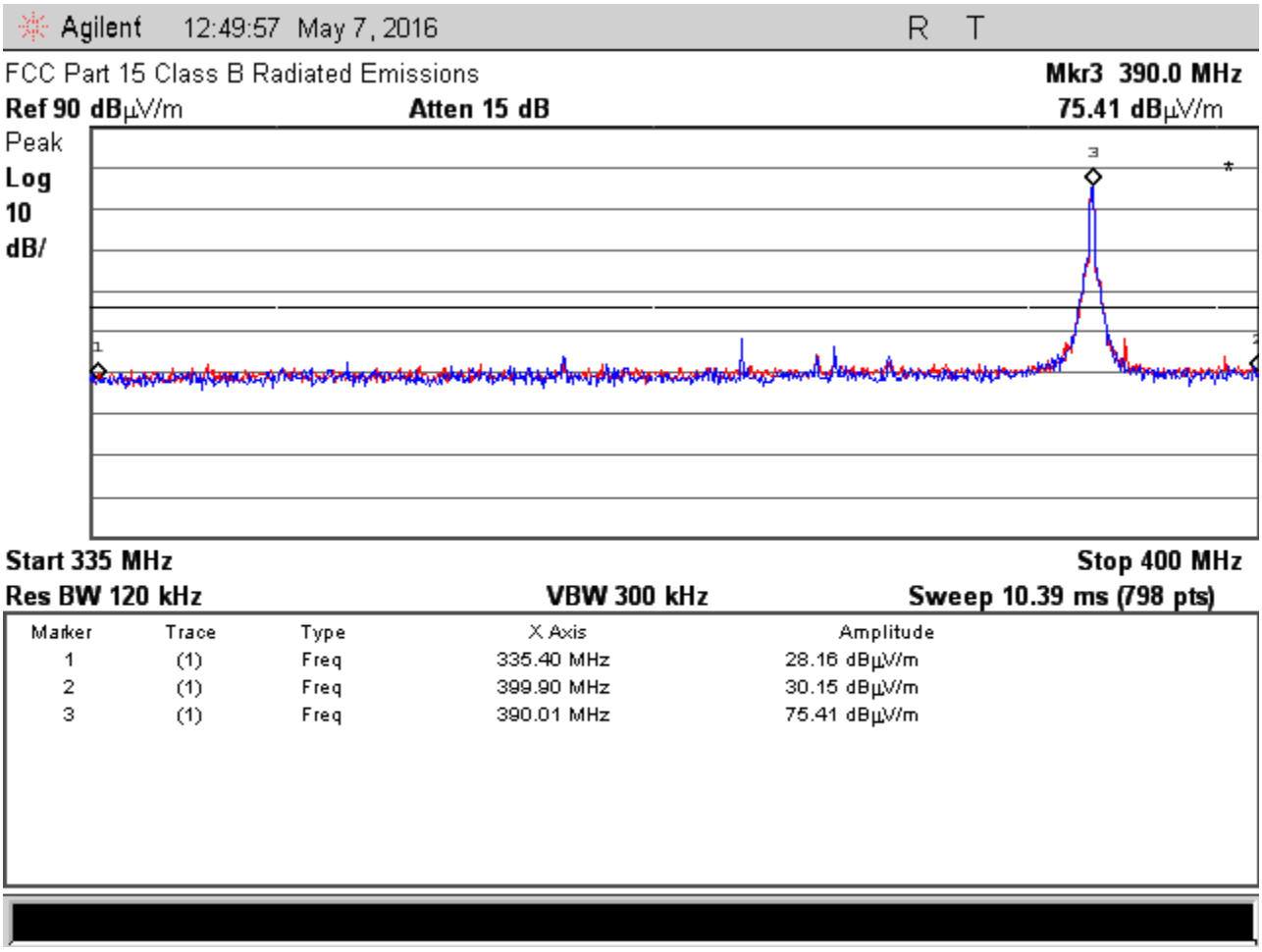


Figure 5.2-4 – FCC Part 15 Radiated Emissions Peak Detector Band Edge Plot

Notes:

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

The closest frequency that lied within a restricted band below the operating band was 335.4 MHz. Marker 1 was placed at this frequency.

The closest frequency that lied within a restricted band above the operating band was 399.9 MHz. Marker 2 was placed at this frequency.

Marker 3 was placed on the peak level of the fundamental.

Table 6.2-1 – Worst Case Radiated Emissions Relative to the Peak Limit

Frequency (MHz)	Peak (dBµV/m)	Antenna height (cm)	Polarity	Turntable position (deg)	Limit (dBµV/m)	Margin (dB)	Notes
390.06	76.4	100	Horz.	235	91.3	14.9	Fundamental
780.12	47.6	100	Vertical	360	71.3	23.7	2nd Harmonic

Table 6.2-2 – Worst Case Radiated Emissions Relative to the Average Limit

Frequency (MHz)	Average (dBµV/m)	Antenna height (cm)	Polarity	Turntable position (deg)	Limit (dBµV/m)	Margin (dB)	Notes
390.06	69.6*	100	Horz.	235	71.3	1.7	Fundamental
780.12	35.6*	100	Vertical	360	51.3	15.7	2nd Harmonic
1950.3	43.3	100	Horz.	204	51.3	8.0	5TH Harmonic not in restricted band
2340.4	39.7	100	Horz.	204	54.0	14.3	6th Harmonic in a restricted band

* Denotes readings taken with the Rohde & Schwarz ESCS30 receiver using peak or average detector with 100 msec averaging.

The results shown in Table 5.2-1b below show the effects of ± 15% variation of the nominal supply voltages.

Table 5.2-1b – Radiated Emissions Average Detector Levels with Varied Input Voltage

Frequency (MHz)	Average (dBµV/m)	Antenna height (cm)	Polarity	Turntable position (deg)	Margin (dB)	Limit (dBµV/m)	Voltage (V)
390.06	69.5	100	Vertical	216	1.8	71.3	10.2
390.06	69.5	100	Vertical	216	1.8	71.3	12.0
390.06	69.5	100	Vertical	216	1.8	71.3	13.8
390.06	69.5	100	Vertical	216	1.8	71.3	20.4
390.06	69.5	100	Vertical	216	1.8	71.3	24.0
390.06	69.6	100	Vertical	216	1.7	71.3	27.6

Notes:

* CF is the antenna correction factor plus cable loss. The unit has onboard voltage regulation so the transmit power was not significantly affected by variations in the supply voltage.

Minimum Margin: **1.7 dBµV/m**

Measurement Uncertainty 30 MHz – 1000 MHz: +/- 5.85dB
Measurement Uncertainty above 1 GHz: +/- 4.74 dB

Test Personnel:

May 7, 2016	Peter J. Walsh, NCE	
Date	Name	Signature

5.3 Test Instrumentation Used, Radiated Measurement

Type	Manufacturer/ Model No.	SW/FW Rev	Serial Number	Calibration Due Date
EMI Receiver	Rohde & Schwarz ESCS 30	8.54.00	825788/002	12/4/2017
Spectrum Analyzer	Agilent E7405A	2.3002.0102.36	MY42000055	4/10/2017
Preamplifier	Com-Power PA-122	A.09.02	181925	11/9/2017
Antenna	Chase EMCCBL6112B	N/A	2579	12/17/2017
Antenna	EMCO Horn Model 3115	N/A	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 with a calibration interval of 24 months.

5.4 Field Strength Calculation

The field strength (FS) is calculated by adding the antenna correction factor (ACF), cable loss (CL), filter loss (FL) 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) FL (dB) – AG (dB)

FS = 25 + 12.1 + 0.7 + 0.3 + 0 = 38.1 dBµV/m

The Rohde & Schwarz Model ESCS 30 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.

5.5 Radiated Emissions Photographs

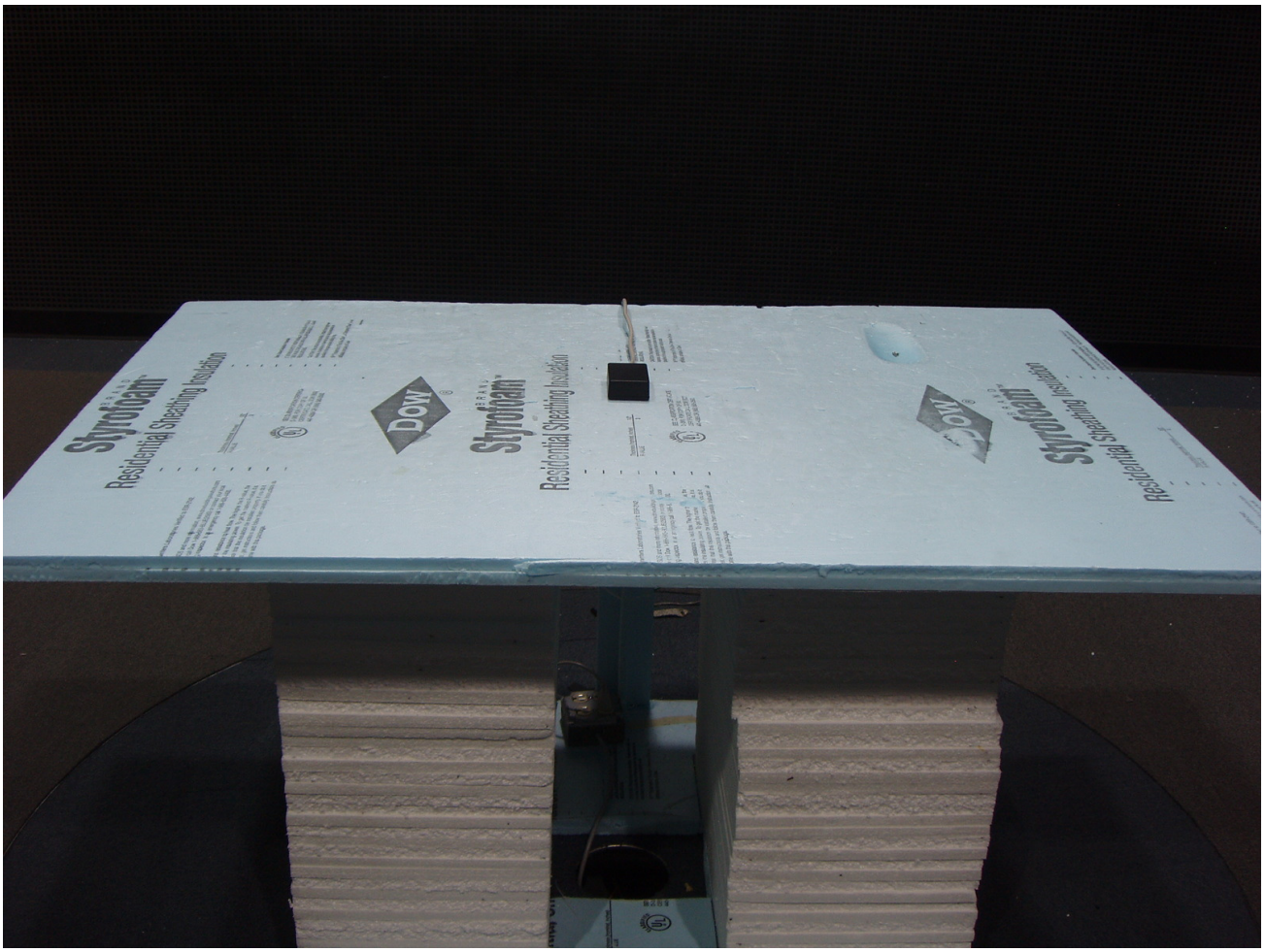


Photo 5.5-1 - Front View of the 30 – 1000 MHz Radiated Emissions Test Set-up

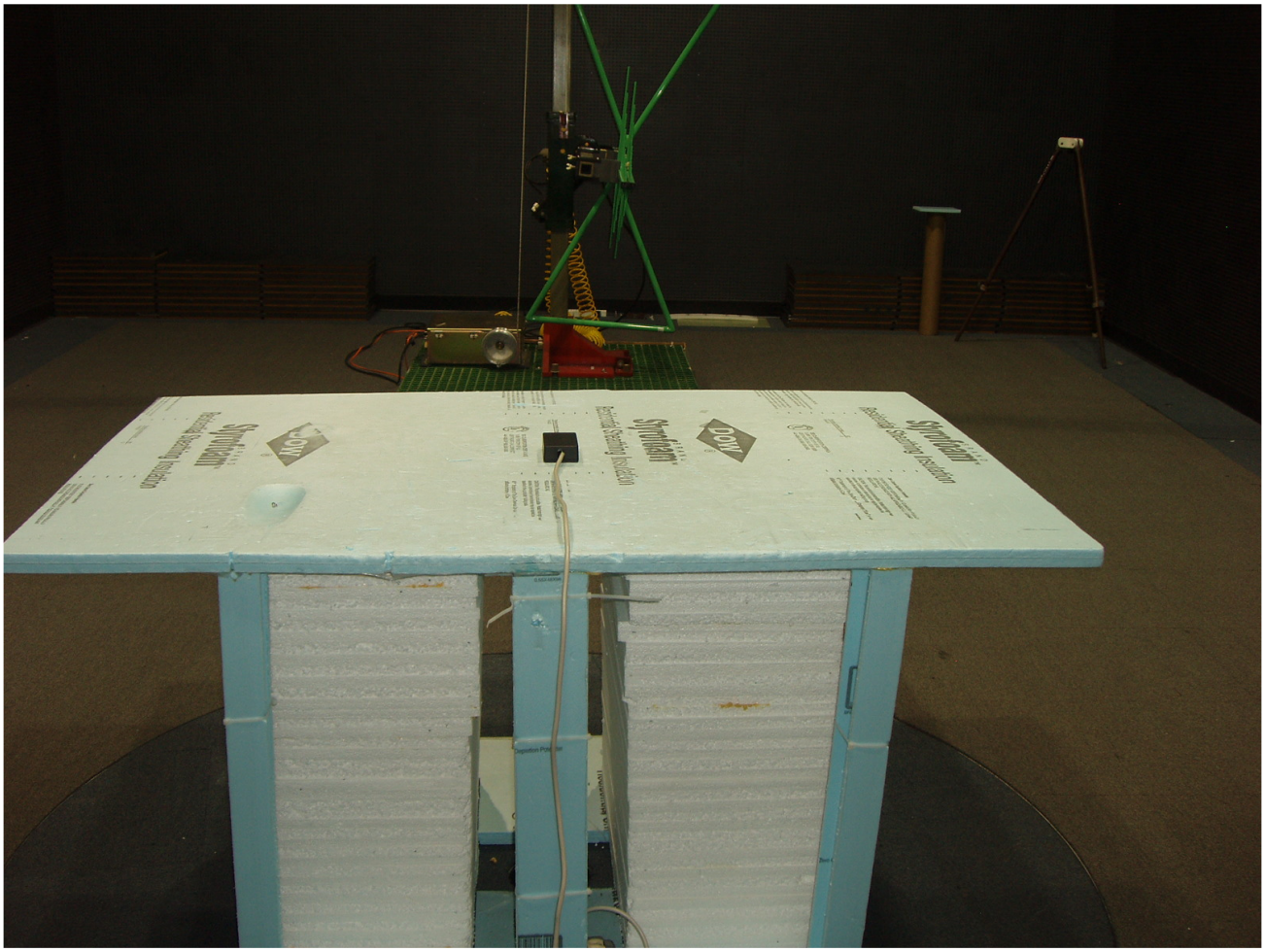


Photo 5.5-2 - Rear View of the Radiated Emissions Test Set-up 30 – 1000 MHz

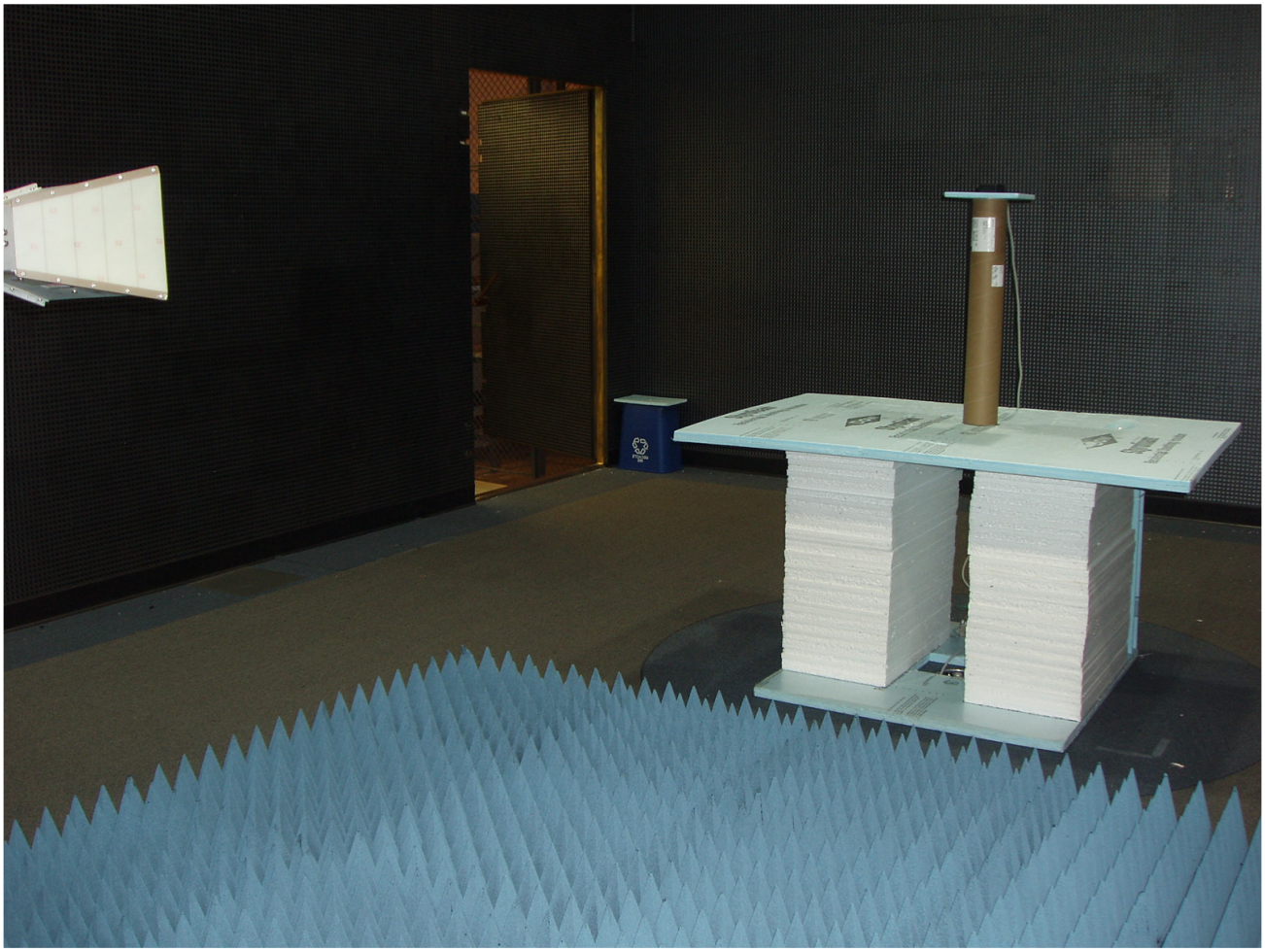


Photo 5.5-3 – Front / Side View of the Radiated Emissions Test Set-up above 1 GHz

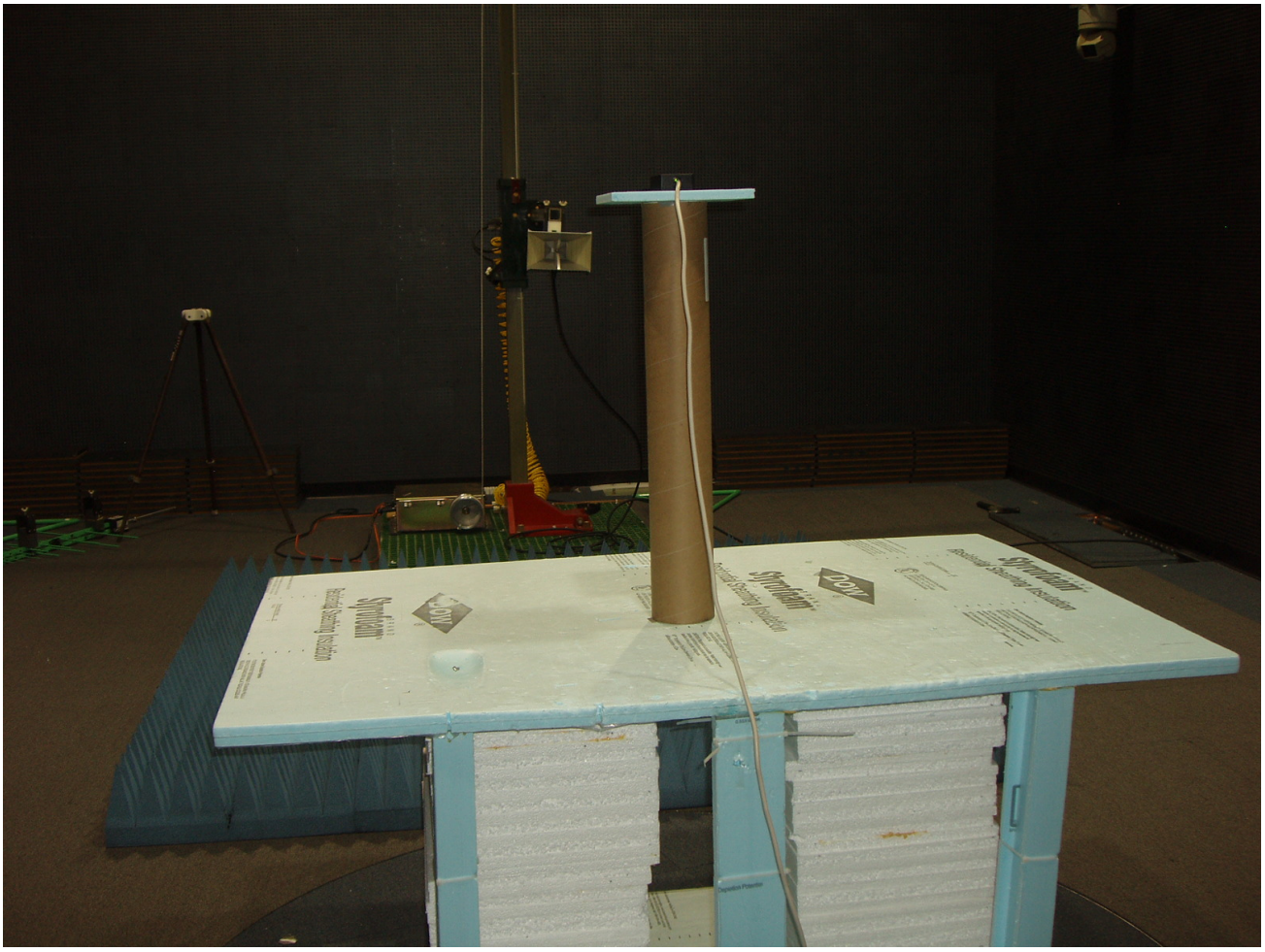


Photo 5.5-4 – Rear View of the Radiated Emissions Test Set-up above 1 GHz

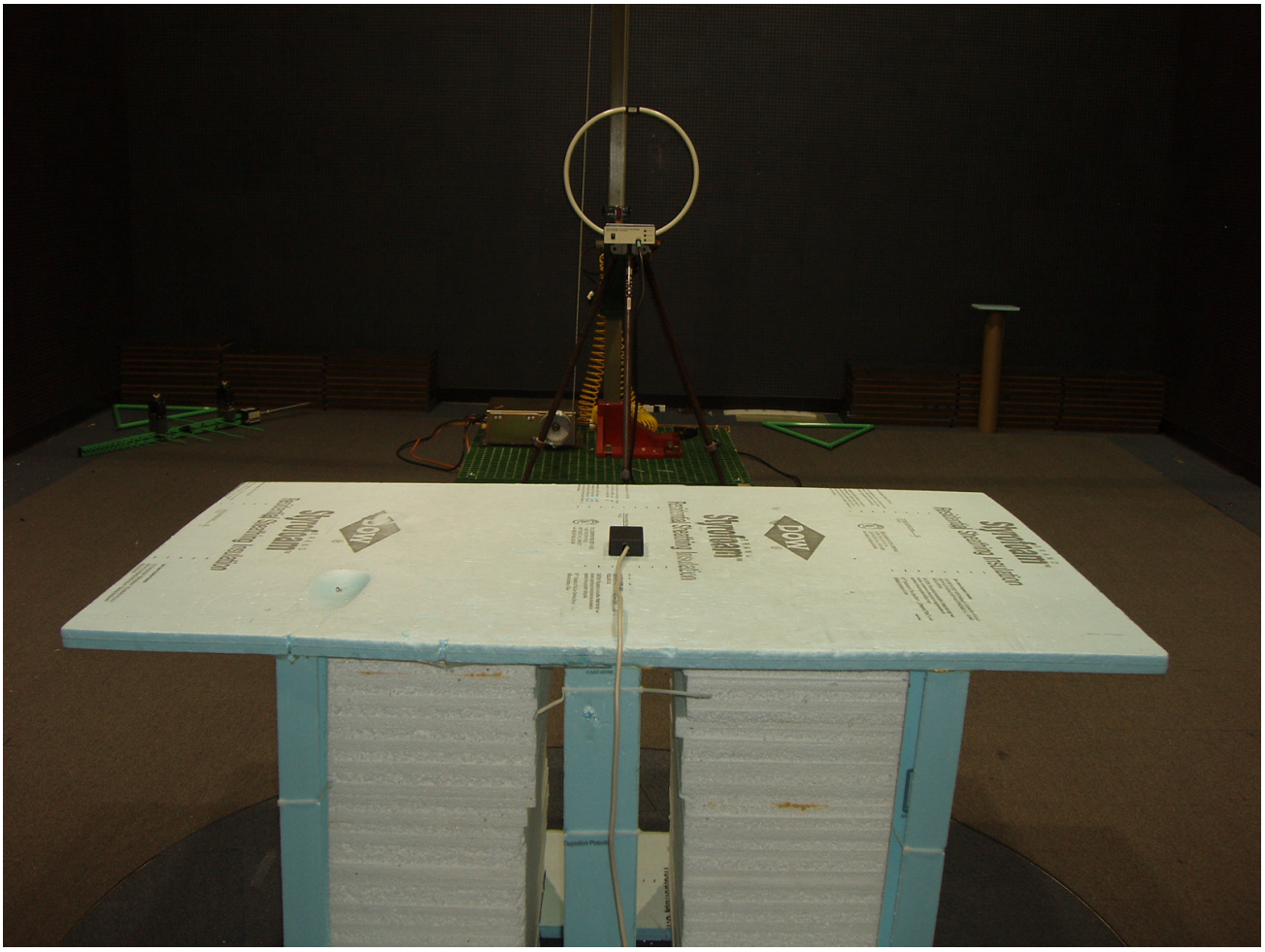


Photo 5.5-5 - Rear View of the Radiated Emissions Test Set-up 15 - 30 MHz

6 ANTENNA REQUIREMENT

References: 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.

6.1 Test Procedure

Inspect the DUT.

6.2 Test Data

Compliance Verdict: PASS

This requirement is met because the antenna is permanently attached. It is a PCB trace antenna.

6.3 Antenna Photograph

Photo 6.3-1 below shows the DUT's antenna.

Photo 6.3-1 – Antenna

7 TIME DOMAIN CHARACTERISTICS

Reference: 47 C.F.R. § 15.231

Section 15.231 Periodic operation in the band 40.66 - 40.70 MHz and above 70 MHz.

(a) The provisions of this Section are restricted to periodic operation within the band 40.66 - 40.70 MHz and above 70 MHz. Except as shown in paragraph (e) of this Section, the intentional radiator is restricted to the transmission of a control signal such as those used with alarm systems, door openers, remote switches, etc. Continuous transmissions, voice, video and the radio control of toys are not permitted. Data is permitted to be sent with a control signal. The following conditions shall be met to comply with the provisions for this periodic operation:

(1) A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released.

(2) A transmitter activated automatically shall cease transmission within 5 seconds after activation.

(3) Periodic transmissions at regular predetermined intervals are not permitted. However, polling or supervision transmissions, including data, to determine system integrity of transmitters used in security or safety applications are allowed if the total duration of transmissions does not exceed more than two seconds per hour for each transmitter. There is no limit on the number of individual transmissions, provided the total transmission time does not exceed two seconds per hour.

(4) Intentional radiators which are employed for radio control purposes during emergencies involving fire, security, and safety of life, when activated to signal an alarm, may operate during the pendency of the alarm condition.

(5) Transmission of set-up information for security systems may exceed the transmission duration limits in paragraphs (a)(1) and (a)(2) of this section, provided such transmission are under the control of a professional installer and do not exceed ten seconds after a manually operated switch is released or a transmitter is activated automatically. Such set-up information may include data.

In addition, devices operated under the provisions of this paragraph shall be provided with a means for automatically limiting operation so that the duration of each transmission shall not be greater than one second and the silent period between transmissions shall be at least 30 times the duration of the transmission but in no case less than 10 seconds.

The above paragraph applied to the DUT because it was subject to § 15.231 (e).

7.1 Test Procedure

The test procedure was as follows: A near field probe as placed close to the DUT's antenna. The probe was connected to the spectrum analyzer with its center frequency set to the transmitter's fundamental frequency and its span set to 0 Hz to make time domain measurements. The DUT's transmitter was activated in the normal operating mode.

7.2 Test Data

Compliance Verdict: PASS

Figure 7.2-1 below shows the response of the DUT as a function of time with the markers set to measure the transmission time.

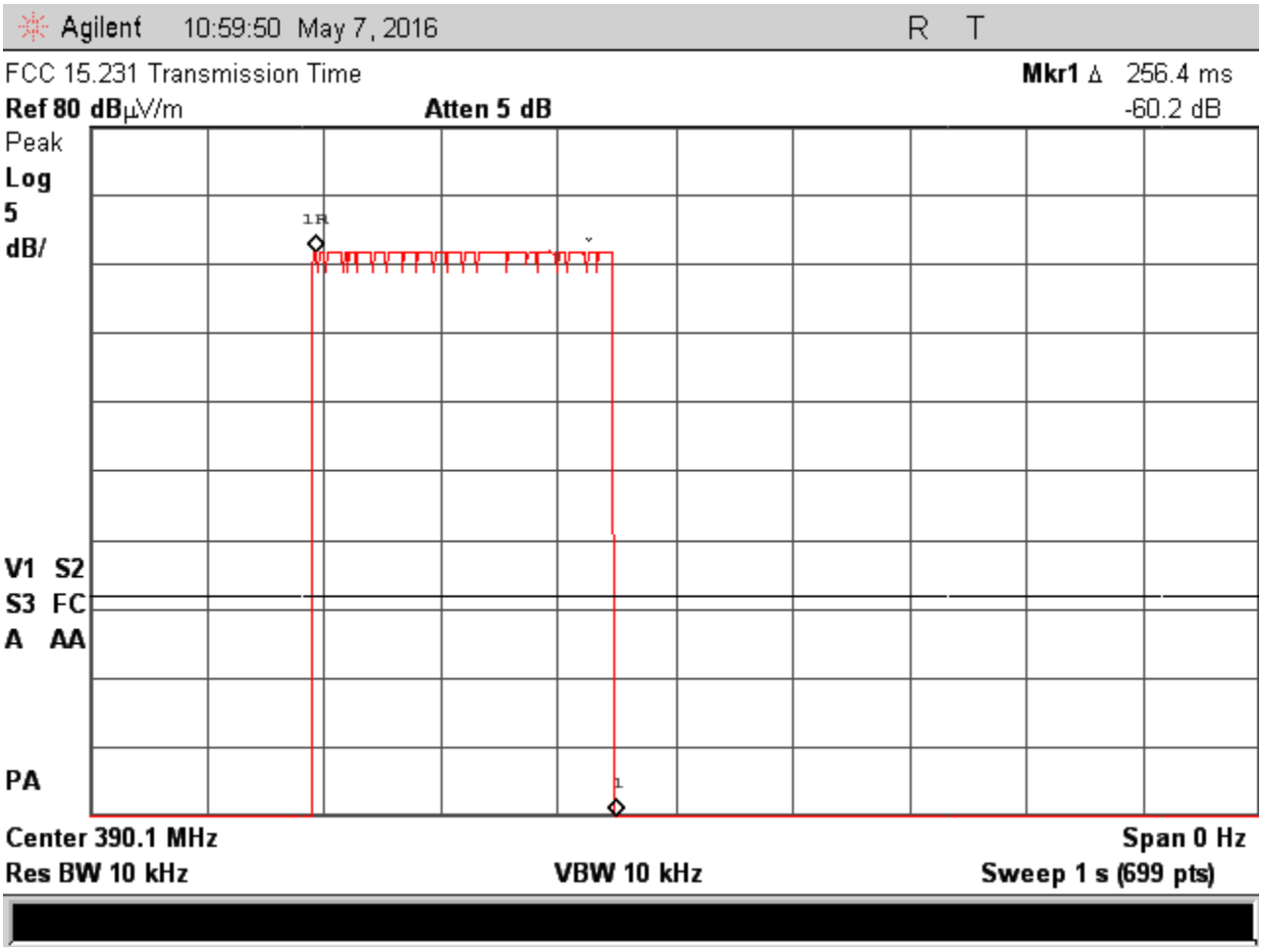


Figure 7.2-1 – Plot of the Transmission Event

Figure 7.2-2 below shows the response of the DUT, as a function of time. The markers have been placed to measure the silent period between transmissions.

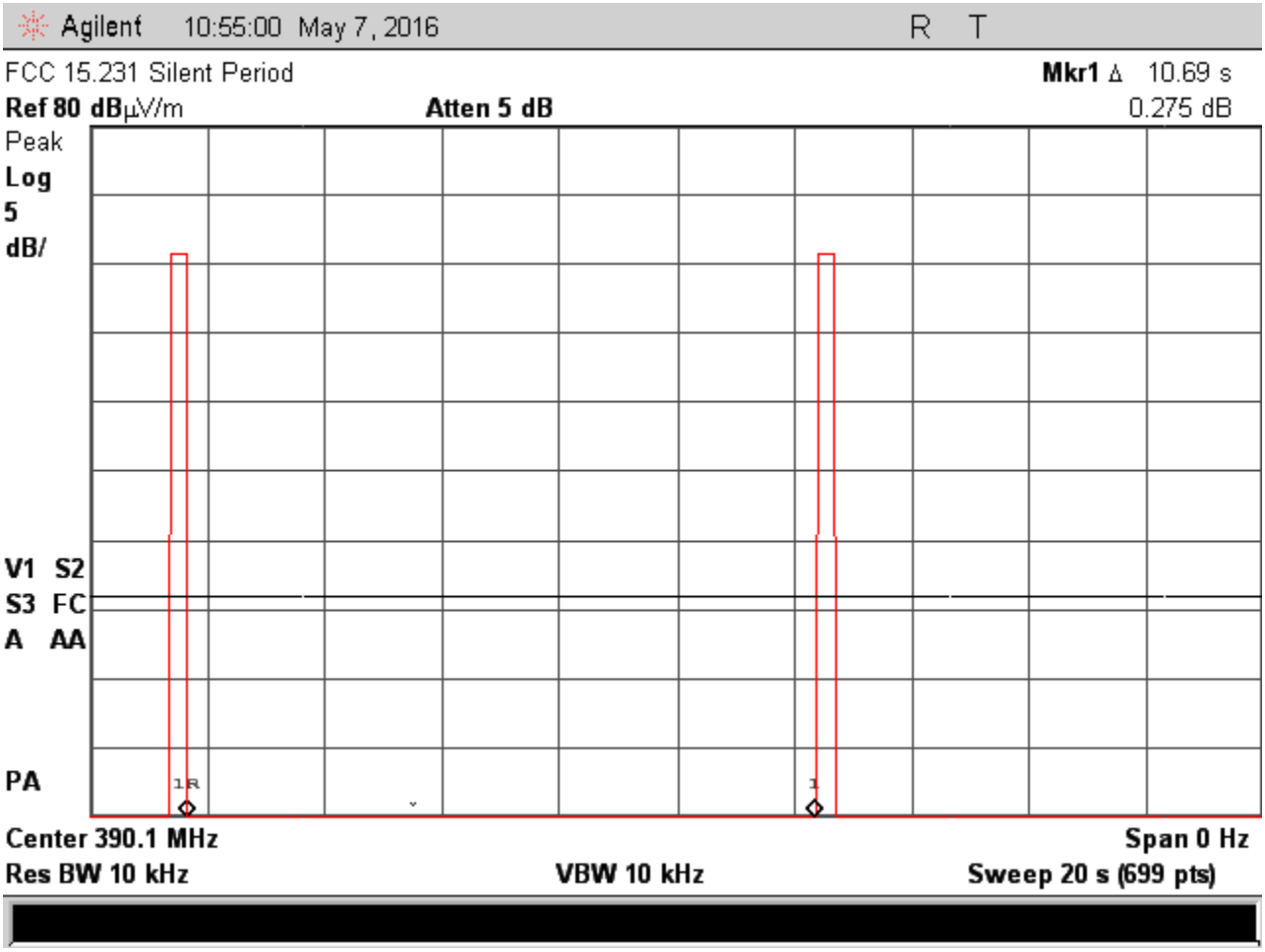


Figure 7.2-2 – Silent Period between Transmissions

Table 7.2-1 – Time Domain Results

Parameter	Result	Notes
Duration of Transmission (seconds)	256.4 msec	Compliant with 15.231 (e) (< 1 second)
Silent Period (seconds)	10.69 seconds	Compliant with 15.231 (e) (> 10 seconds and > 30 times the duration of the transmission)
Permitted periodic transmissions	Yes	Compliant with the above two constraints.

Notes:

The duty cycle wasn't calculated since the transmitter was on longer than the FCC prescribed 100 msec averaging period. Rather, the average detector was used to measure the DUT's field strength instead of calculating and applying a duty cycle correction factor to the peak detector readings.

Test Personnel:

May 7, 2016	Peter J. Walsh, NCE	
Date	Name	Signature

7.3 Test Instrumentation Used, Time Domain Measurement

Type	Manufacturer/ Model No.	SW/FW Rev	Serial Number	Calibration Due Date
Spectrum Analyzer	Agilent E7405A	2.3002.0102.36	MY42000055	4/10/2017
Near Field Probe	Electro-Metrics / EHFP-30	N/A	196	Not Applicable

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

7.4 Time Domain Test Set-up Photographs

Photo 7.4-1 – Bandwidth and Time Domain Test Set-up

8 BANDWIDTH REQUIREMENT

Reference: 47 C.F.R. § 15.231

Section 15.231 Periodic operation in the band 40.66 - 40.70 MHz and above 70 MHz.

(c) The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5% of the center frequency. Bandwidth is determined at the points 20 dB down from the modulated carrier.

8.1 Test Procedure

The test procedure was the same used for the time domain tests as described in Section 7 of this report except that the spectrum analyzer's resolution bandwidth was set to 10 kHz, the center frequency was set to the transmitter's fundamental frequency and its span set to 500 kHz in order to make the bandwidth measurement. The bandwidth limit was calculated using eq. 4 below.

$BW = f_{center} \times 0.0025 = 390.06 \times 0.0025 = 0.975$ MHz (eq. 4)

8.2 Test Data

Compliance Verdict: PASS

Figure 8.2-1 below shows the 20 dB bandwidth of the DUT's signal. The measured bandwidth of 93.1 kHz was well within the maximum allowed bandwidth of 975 kHz.

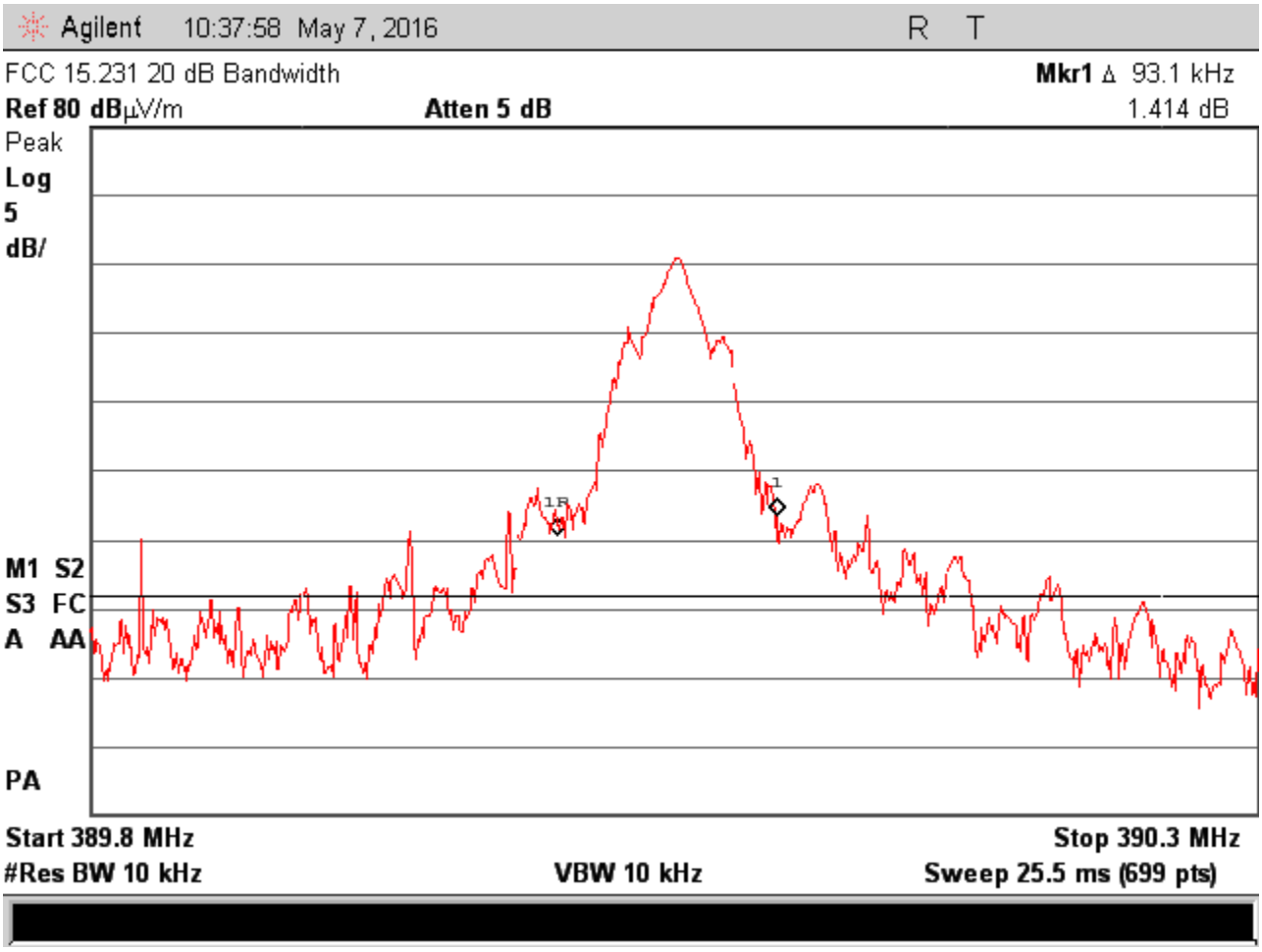


Figure 8.2-1 – 20 dB Bandwidth

Test Personnel:

May 7, 2016	Peter J. Walsh, NCE	Peter J. Walsh
Date	Name	Signature

8.3 Test Instrumentation Used, Bandwidth Measurement

Type	Manufacturer/ Model No.	SW/FW Rev	Serial Number	Calibration Due Date
Spectrum Analyzer	Agilent E7405A	2.3002.0102.36	MY42000055	4/10/2017
Near Field Probe	Electro-Metrics / EHFP-30	N/A	196	Not Applicable

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

8.4 Bandwidth Test Set-up Photographs

Refer to Section 7.4 in this report for a photograph of the test set-up as it was the same as for the time domain measurements.

9 LABELING AND USER'S GUIDE REQUIREMENTS

9.1 FCC Label Statement

Figure 9.1-1 below shows a sample of the label.

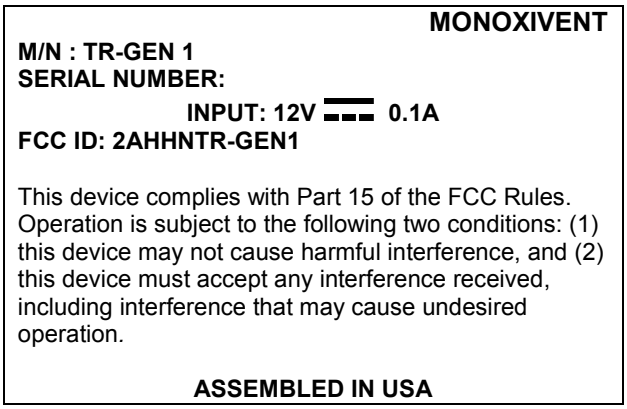


Figure 9.1-1 - Sample Label

9.2 Instruction Manual Statements

The instruction manual must contain the following statements:

FCC Notices

Model: TR-GEN 1 FCC ID: 2AHHNTR-GEN1

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 equipment has been tested and found to comply with the limits for Class B Digital Device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.

- This device may only be used with the approved antenna that is shipped with the unit and installed per the installation instructions. The use of any other antennas will invalidate the units' FCC Part 15 certifications.
- 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 antenna will ensure that this requirement is met.

This equipment generates and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.
If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures.

- Reorient or relocate the receiving antenna
- Increase the separation between the equipment and receiver
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected
- Consult the dealer or an experienced radio/TV technician for help

Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. 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:	-18.86	(dBm)
Maximum peak output power at antenna terminal:	0.0130	(mW)
Antenna Gain (typical):	0.00	(dBi)
Maximum Antenna Gain:	1.00	(numeric)
Prediction Distance:	20.00	(cm)
Prediction Frequency:	390.00	(MHz)
MPE Limit for Uncontrolled Exposure at Prediction Frequency:	0.26	(mW/cm^2)
Power Density at the Prediction Frequency:	0.0000026	(mW/cm^2)
Maximum Allowable Antenna Gain:	50.02	(dBi)
Margin of Compliance at 20 cm:	50.02	(dB)

Notes:

The peak power was calculated using the measure field strength of 76.4 dBµV/m @ 3 m. It is an effective radiated power figure by setting the antenna gain to 0 dBi.

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 & 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).

2016-03-28 through 2017-03-31
Effective Dates

DEPARTMENT OF COMMERCE · UNITED STATES OF AMERICA

For the National Voluntary Laboratory Accreditation Program

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 within 15 days of receipt by Client.