WALSHIRE LABS

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47 C.F.R. Part 15 Subpart C FCC Rules Certification Test Record for a Periodic Operational Transmitter in the 260 - 470 MHz Band

Aveo Engineering STARFOB™ Model AVE-FOB-01CC-402

Equipment:	**Star Fob Model: AVE-FOB-01CC-402**
Client:	**Aveo Engineering, LLC**
Address:	**31 Lupi Ct Suite 240**
	Palm Coast, FL 32137

Test Report Number: FCCIR2-AVEO-03-20-14A
Date: April 4, 2014
Total Number of Pages: 44

NVLAP LAP Code: 200125-0

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1 IDENTIFICATION SUMMARY

1.1 Test Report

Test Report Number: FCCIR2-AVEO-03-20-14
Test Report Date: April 4, 2014

Report written and approved by:

April 4, 2014	Peter J. Walsh, NCE	
Date	Name	Signature

1.2 Testing Laboratory

Walshire Labs, LLC
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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.

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:	Aveo Engineering, LLC
Street:	31 Lupi Ct, Suite 240
City:	Palm Coast
State:	FL
Zip Code	32174
Country:	USA
Phone:	386-366-4774
Contact Person:	Damien Esmond
Phone:	386-366-4774
Email:	Damien@aveoengineering.com

1.5 Dates

Date of commission:	March 21, 2014
Date of receipt of DUT:	March 24, 2014
Date of test completion:	March 25, 2014

1.6 Device Under Test (DUT)

Name:	StarFob
Version:	MODEL: AVE-FOB-01CC-402
Serial Number:	AEM-115012
FCC ID:	FCC ID: 2AB4OAVEFOB-01CC
Antenna Type:	PCB helical trace antenna
Frequency:	433.927 MHz
Emission Designator:	K3D

2 GENERAL INFORMATION

2.1 Product Description

The StarFob Model AVE-FOB-01CC is a battery operated key fob type transmitter. It intended to allow the user to turn on and turn off the exterior ground illumination and halo lights mounted on an aircraft's wings. StarFob incorporates an illumination LED that will allow the user to inspect items such as fuel level, pilot tube opening, etc. The key fob communicates using an amplitude modulated 433.927 MHz radio frequency signal to transmit a secure control signal to a receiver/controller mounted in the fuselage of an aircraft. Refer to the operational description for a more complete, technical description.

2.2 Interface Cable Details

There were no interface cables used in the system.

2.3 Peripheral Devices

There were no peripheral devices used in the system as the transmission was one-way, towards the receiver.

2.4 Test Methodology

A radiated emission test was performed according to ANSI C63.4-2003, the 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).

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 button (S1) was held down to allow the radio to transmit its modulated signal continuously.

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 hand-held device. 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 two new batteries type CR2032. Note that one battery powers an illumination LED while the other powers the radio.

3.2 Special Accessories

None

3.3 Equipment Modifications

No modifications were required to achieve compliance.

Signature:		Date:	March 25, 2014
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)

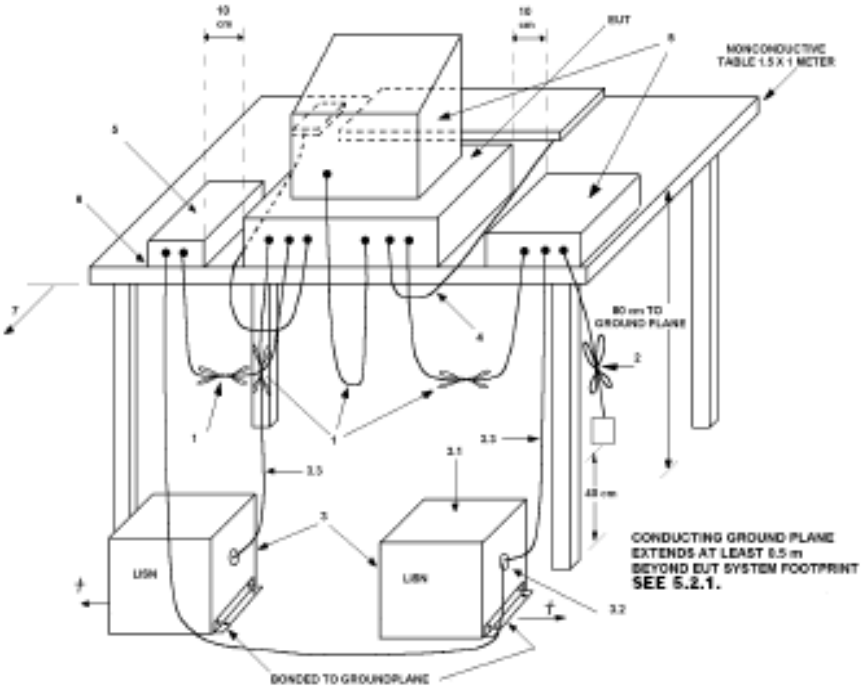
(a) Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz 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 25, 2014	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	09/04/2014

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.*

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. § 15.231

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:

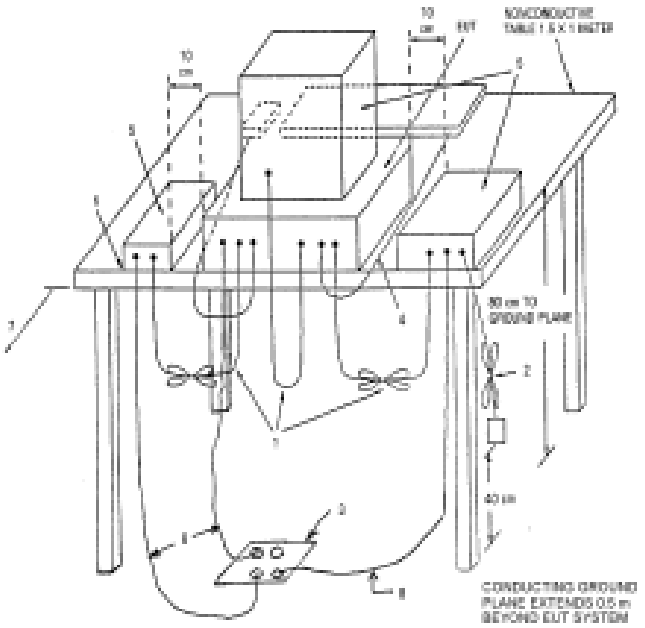
(a) On any frequency or frequencies below or equal to 1000 MHz, the limits shown are based on measuring equipment employing a CISPR quasi-peak detector function and related measurement bandwidths, unless otherwise specified. The specifications for the measuring instrument using the CISPR quasi-peak detector 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 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.



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, limits and margins. The highest frequency to which the radiated emissions had to be measured was 4.339 GHz, ten times the fundamental frequency.

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 433.927 MHz and the second harmonic exceeds the § 15.209 general radiated emissions limit. These frequencies do not lie in restricted bands and their levels are compliant.

Figure 5.2-2 shows the highest emissions between 1 and 4.339 GHz as measured with the peak detector.

Tables 5.2-1 and 5.2-2 show the six highest measured results within 20 dB of the peak and average limits respectively as set out in 15.231. 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 § 15.231 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 = 41.6667(F) – 7083.333 dBµV/m @ 3 m (eq. 1)

Limit = 41.6667(433.9) – 7083.333 dBµV/m = 10995 µV/m = 80.8 dBµV/m @ 3 m

Therefore the peak limit was 100.8 dBµV/m @ 3 m.

The limit for the harmonics is 20 dB down from the fundamental or 60.8 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:

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

Refer to Section 6 in this report for the DUT's time domain characteristics including the calculation of its duty cycle correction factor. Alternatively, the measurement may be performed using the QuasiPeak detector in which case duty cycle correction factor is not applied. The duty cycle correction factor was not applied. Measurements were performed using both the peak detector for comparison against the peak limit and the average detector for comparison against the average limit.

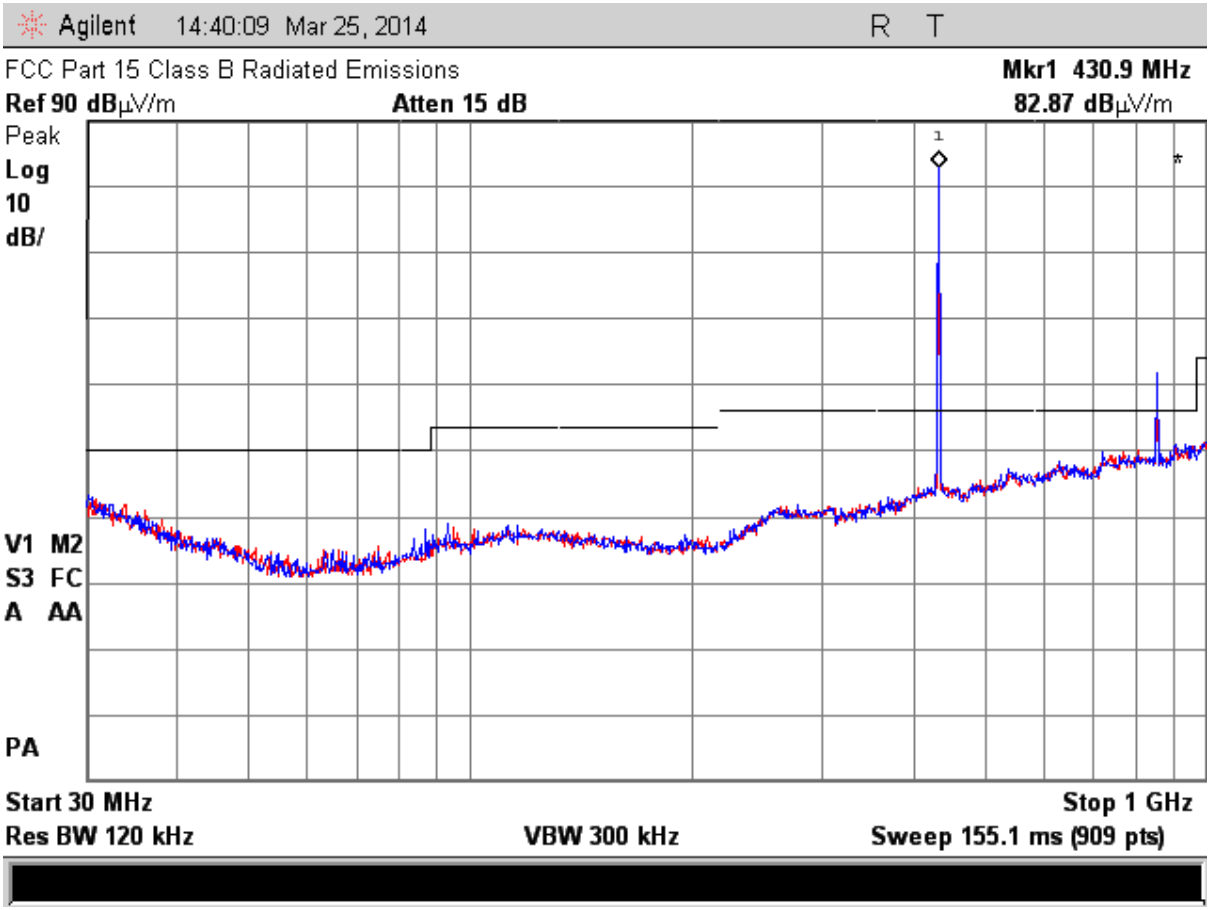


Figure 5.2-1 – Peak Detector Radiated Emissions 30 MHz to 1000 MHz

Notes:

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

Based upon exploratory tests with the StarFob rotated about its three orthogonal axis, the position that resulted in the highest field strength was the one in which the unit was laid flat horizontally on the table. The above plot shows the results of that scan.

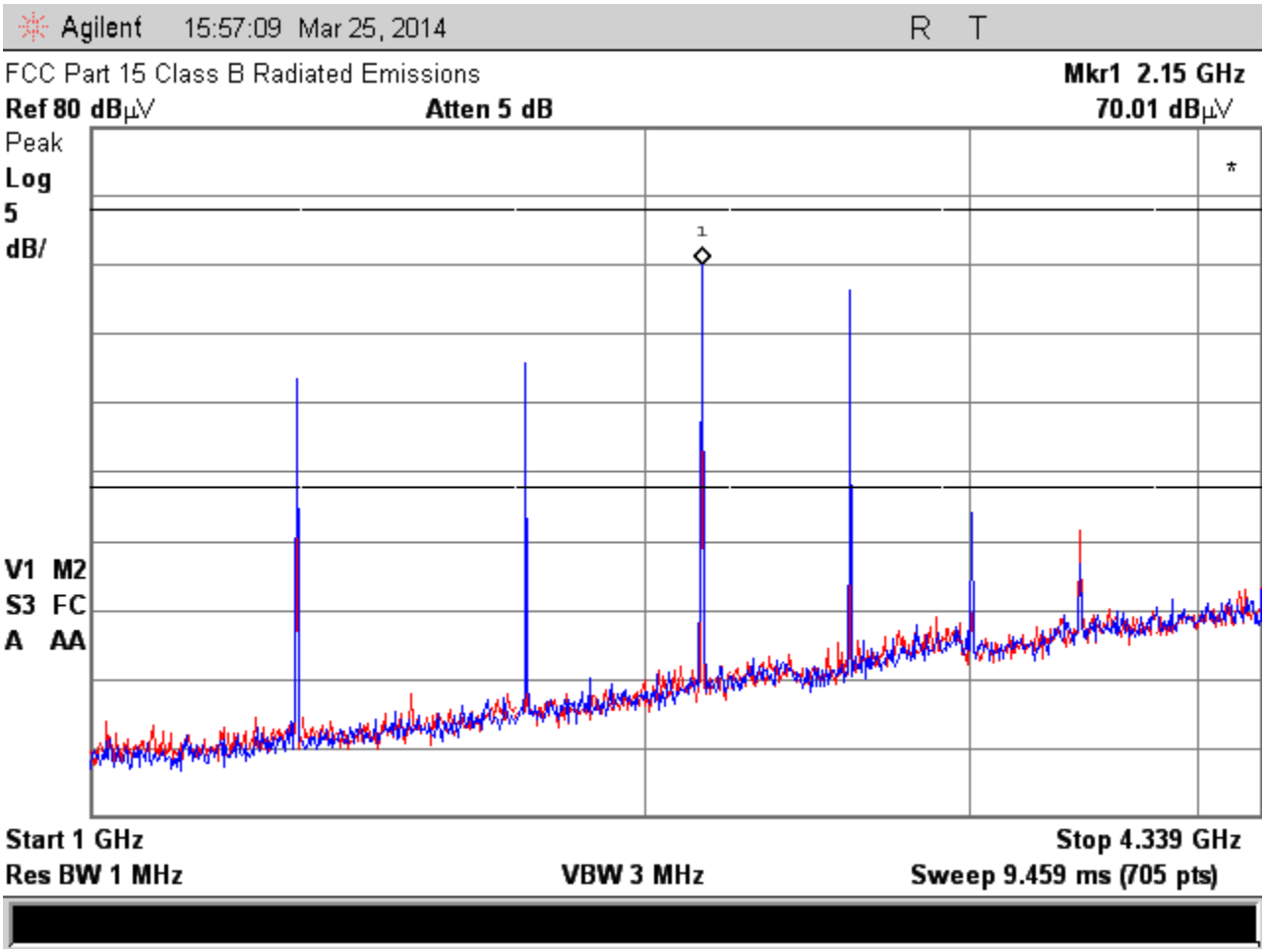


Figure 5.2-2 – Peak Detector Radiated Emissions Plot 1 – 4.339 GHz

NOTES:

In the above figure, the red trace shows vertical polarity; the blue trace shows horizontal polarity.

A scan from 1 to 4.339 GHz with the peak detector showed no emissions exceeded the peak limit. Because four emissions were above the average limit, those were re-measured with the average detector with the results shown in Table 5.2.2.

Table 5.2-1 – 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
433.927	83.5	240.0	Horz	182	100.8	17.3	Fundamental
867.854	50.8	321.0	Horz	15	80.8	30.0	2nd harmonic
1301.781	61.5	114.0	Horz	210	80.8	19.3	3rd harmonic
1735.708	62.8	125.0	Horz	360	80.8	18.0	4th harmonic
2169.635	65.9	120.0	Horz	331	80.8	14.9	5th harmonic
2603.562	67.0	134.0	Horz	310	80.8	13.8	6th harmonic

Table 5.2-2 – 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
433.927	76.1	240.0	Horz	182	80.8	4.7	Fundamental
867.854	41.6	321.0	Horz	15	60.8	19.2	2nd harmonic
1301.781	53.5	114.0	Horz	210	60.8	7.3	3rd harmonic
1735.708	54.9	125.0	Horz	360.0	60.8	5.9	4th harmonic
2169.635	57.8	120.0	Horz	331	60.8	3.0	5th harmonic
2603.562	58.7	134.0	Horz	310	60.8	2.1	6th harmonic

Minimum Margin: **2.1 dBµV/m**

Measurement Uncertainty: +4.8 dB, -5.2 dB

Test Personnel:

March 25, 2014	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

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

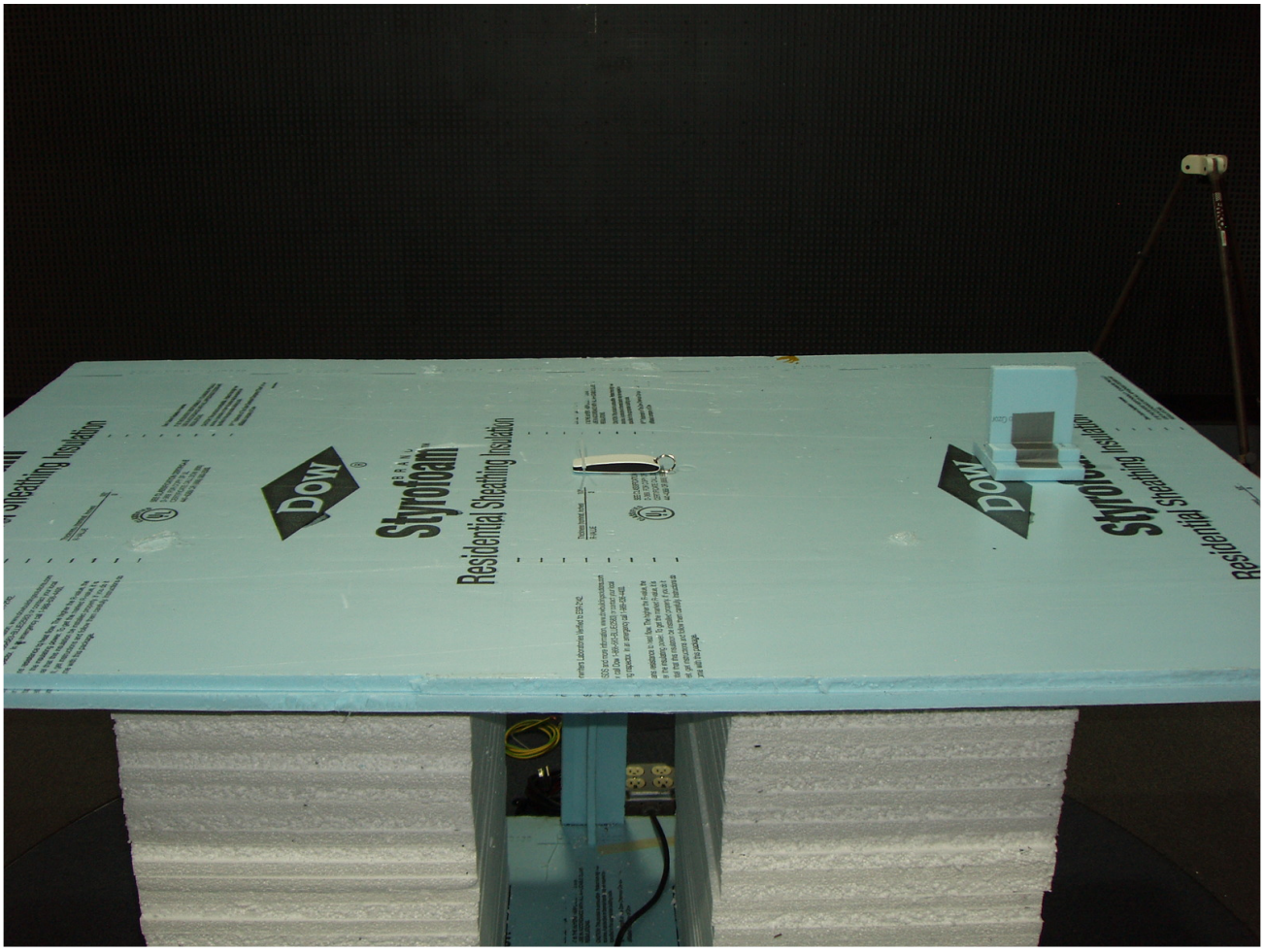


Photo 6.5-1 – Front View of the Radiated Emissions Test Set-up

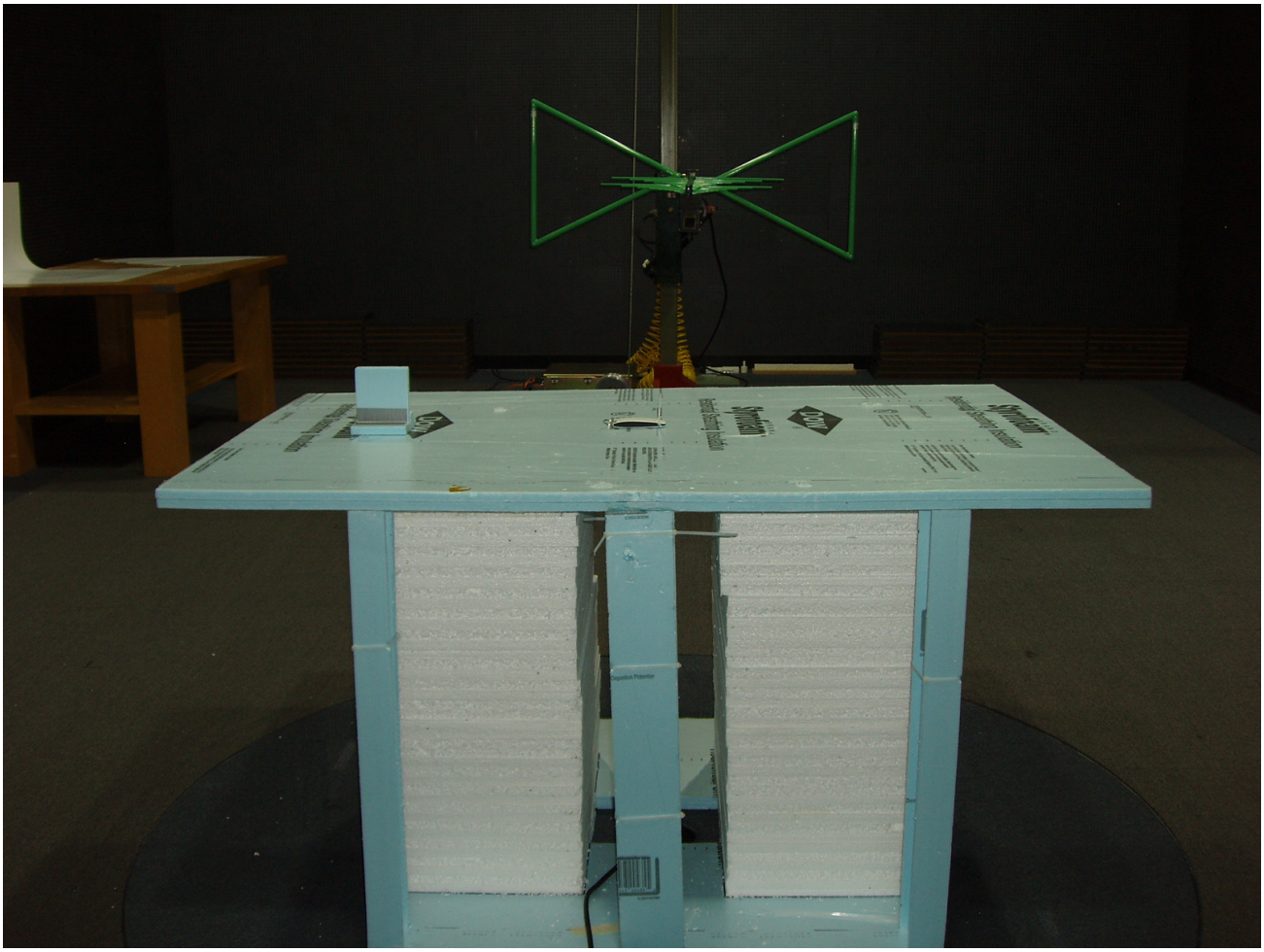


Photo 6.5-2 – Rear View of the Radiated Emissions Test Set-up

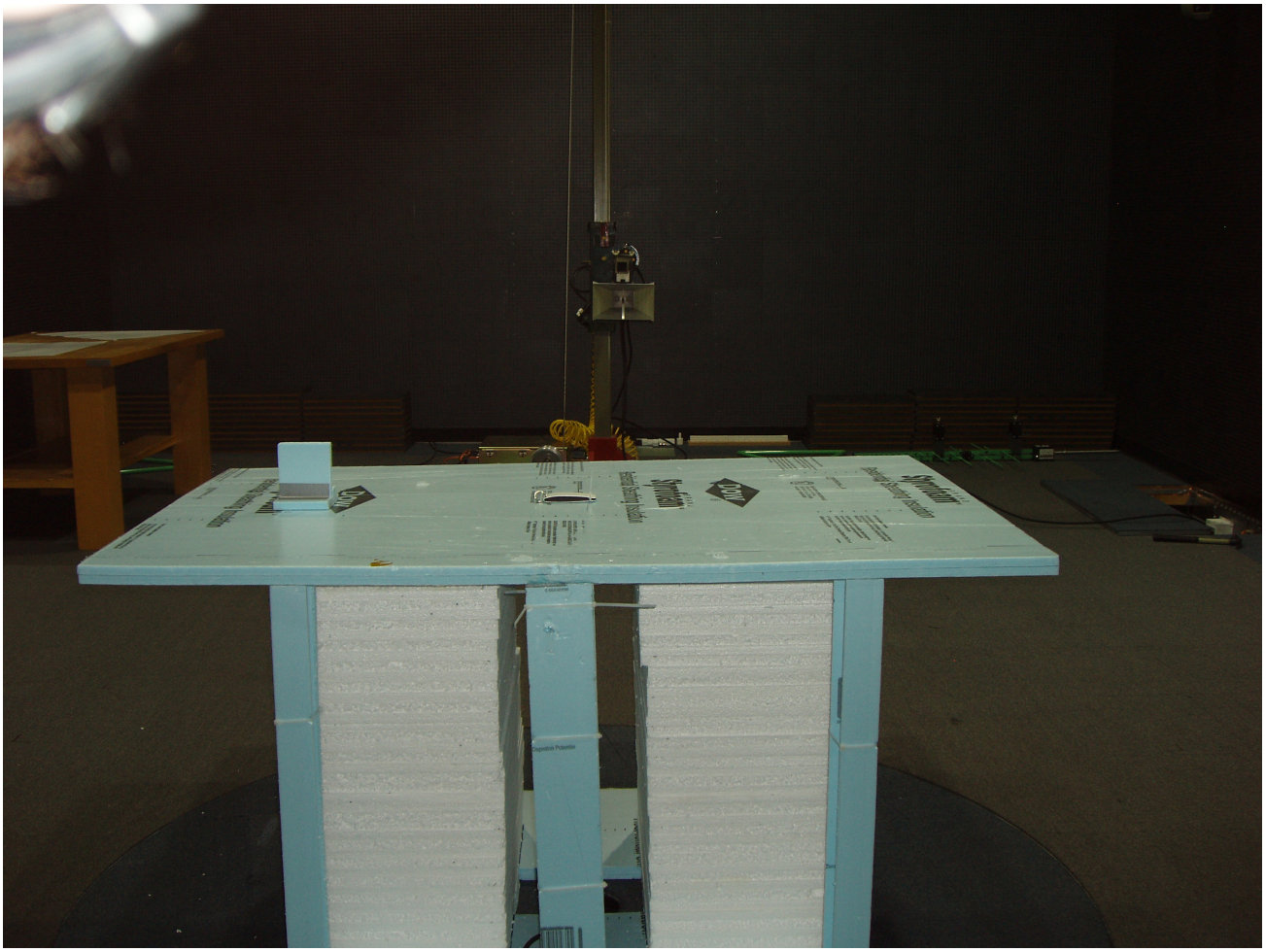


Photo 6.5-3 – Rear View of the Radiated Emissions Test Set-up for Frequencies above 1 GHz

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.

7.1 Test Procedure

The test procedure was as follows: A near field probe was placed next to the DUT. 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 manually by momentarily pressing the button.

7.2 Test Data

Compliance Verdict: PASS

Figure 7.2-1 below shows the response of the DUT, as a function of time, whilst transmitting an on/off command by momentarily pressing the on/off button. The DUT ceases transmission within 165.5 msec, well within the 15.231 (a) (1) requirement of 5 seconds.

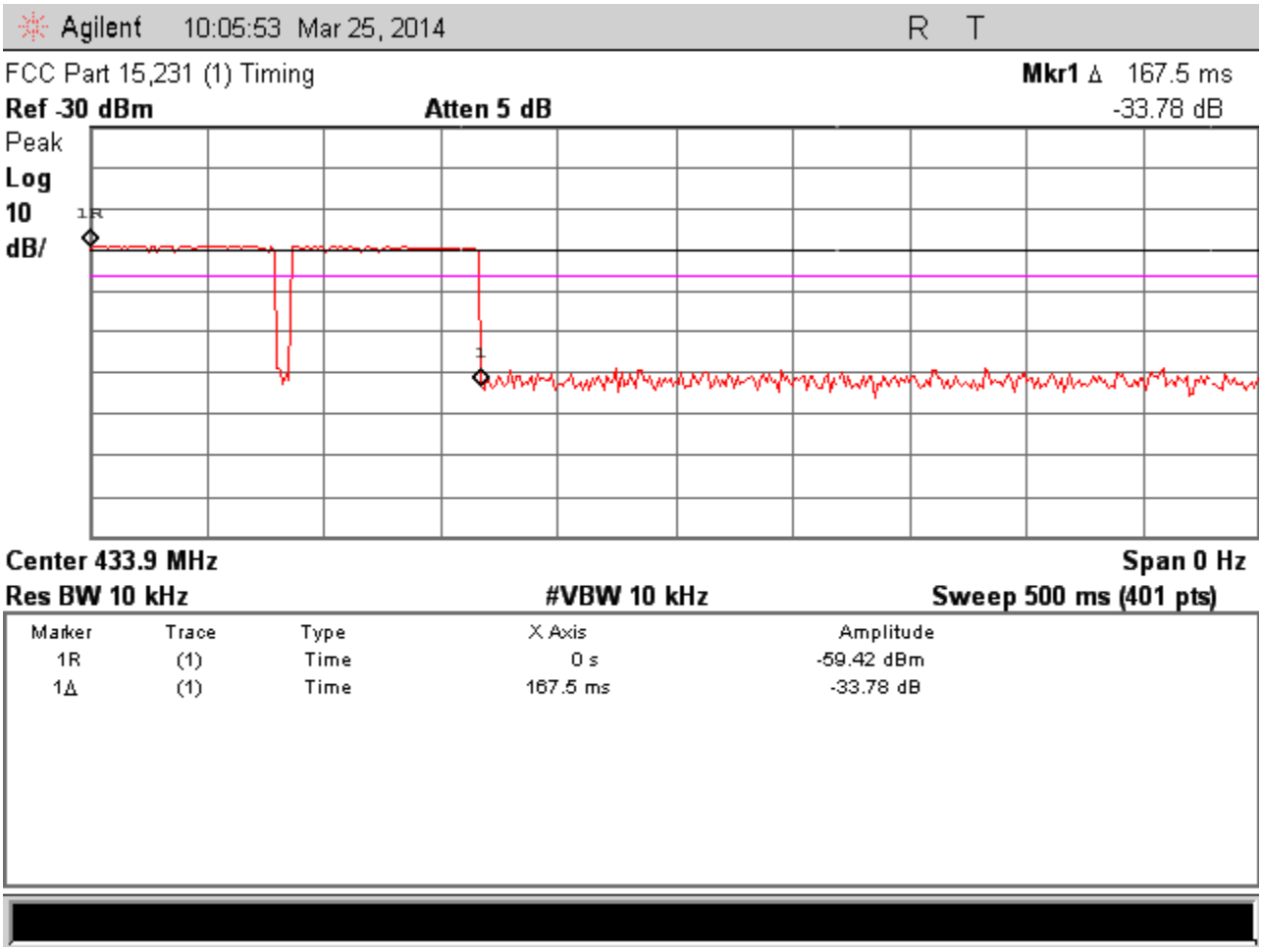


Figure 7.2-1 – Plot of the On/Off Command Transmission Event

Figure 7.2-2 below shows the response of the DUT, as a function of time, whilst holding down the up/down button continuously. The DUT transmits continuously pausing for 6.27 msec before transmitting another block of data for 81.45 msec.

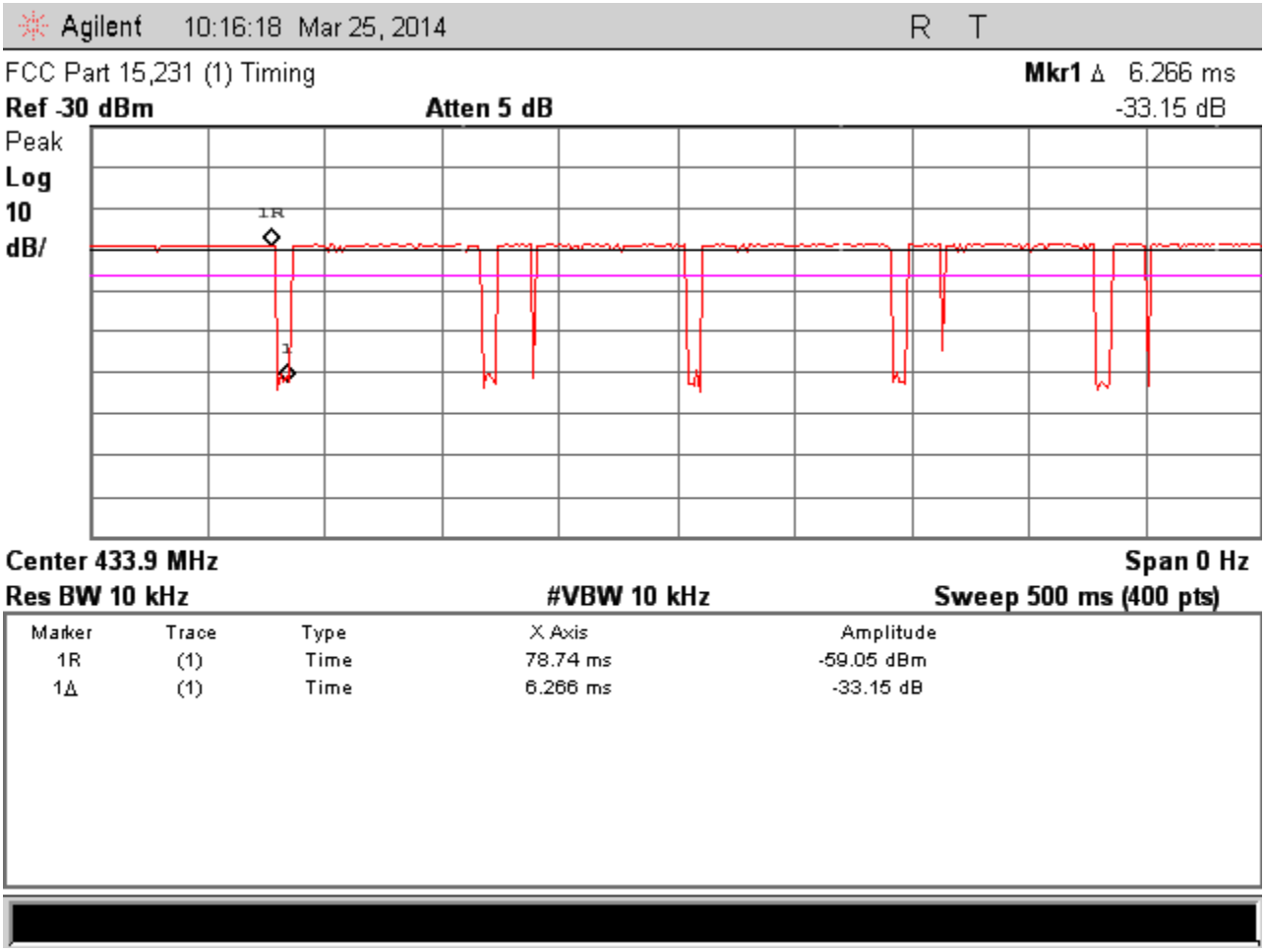


Figure 7.2-2 – Plot of a Continuous Transmission Event

Notes:

In normal operation only a momentary button push is required to the change the on/off state of the controlled lighting system. Holding the button just repeats the command sequence.

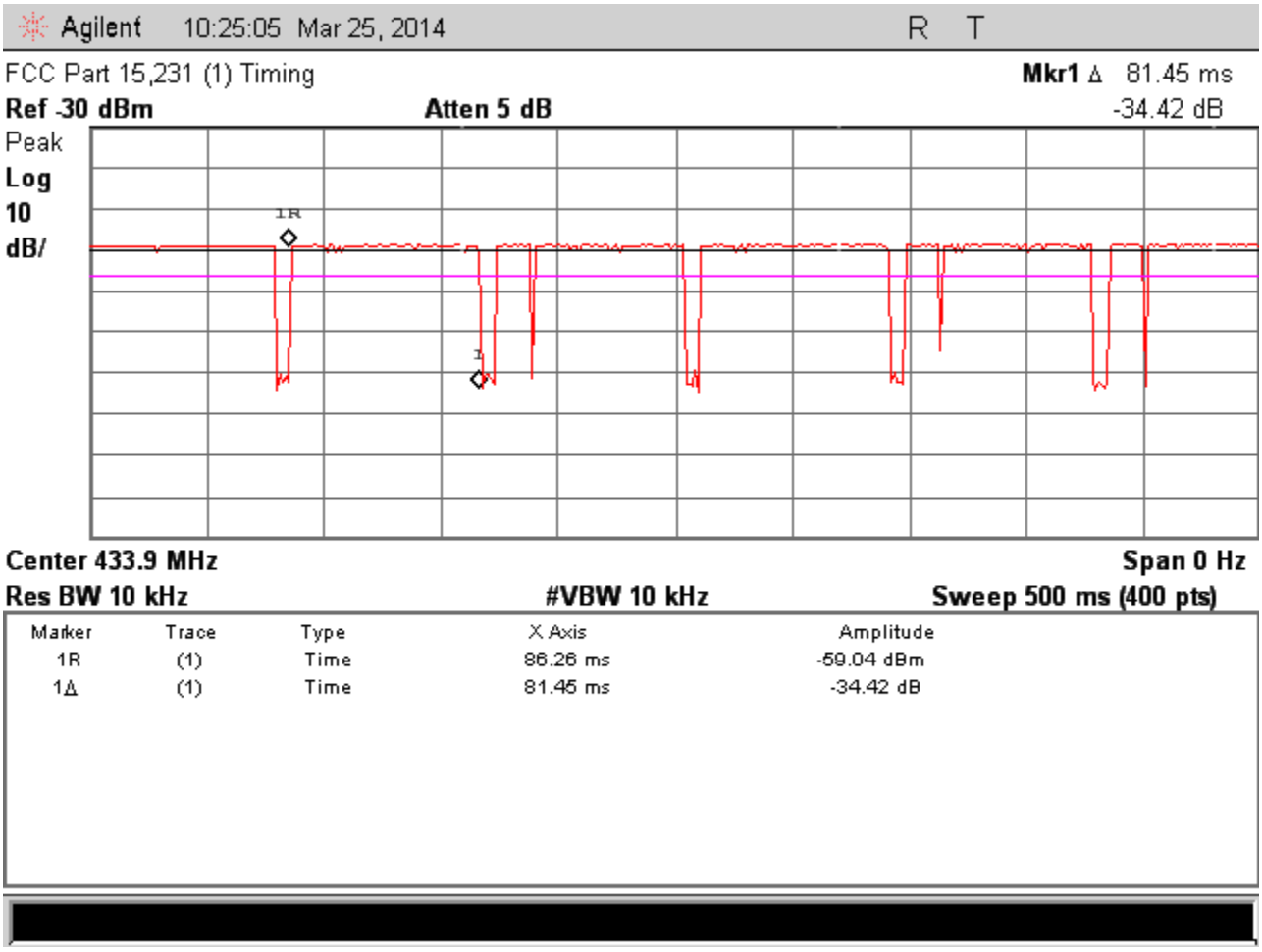


Figure 7.2-3 – Plot of the On Transmission Time

Table 7.2-1 – Time Domain Results

Parameter	Result	Notes
Transmitter deactivation time (seconds)	165.5 msec	Compliant with 15.231 (a) (1)
Permitted periodic transmissions	None	Transmission only occurs when the button is pressed.
T_{ON} (seconds)	81.45 msec	See Figure 7.2-3
T_{PERIOD} (seconds)	100 msec	FCC prescribed averaging period.
Duty Cycle	81.45 %	
Duty Cycle Correction Factor	-1.78 dB	This factor wasn't used because the average level is much lower due to the radio's AM modulation.

Notes:

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)

Test Personnel:

March 25, 2014	Peter J. Walsh, NCE	Peter J. Walsh
Date	Name	Signature

7.3 Test Instrumentation Used, Time Domain Measurement

Type	Manufacturer/ Model No.	Serial Number	Calibration Due Date
Spectrum Analyzer	Agilent E7405A	MY42000055	3-29-2015
Near Field Probe	Electro-Metrics / EHFP-30	196	NCR

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.

7.4 Time Domain Characteristics Photograph

Photo 7.4-1 – 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.

$BW = f_{center} \times 0.0025 = 433.868 \times 0.0025 = 1.0846$ MHz (eq. 4)

8.2 Test Data

Compliance Verdict: PASS

Figure 8.2-1 below shows the 20 dB bandwidth of the DUT's modulated carrier frequency. The measured bandwidth of 8.4 kHz was well within the maximum allowed bandwidth of 1.0846 MHz.

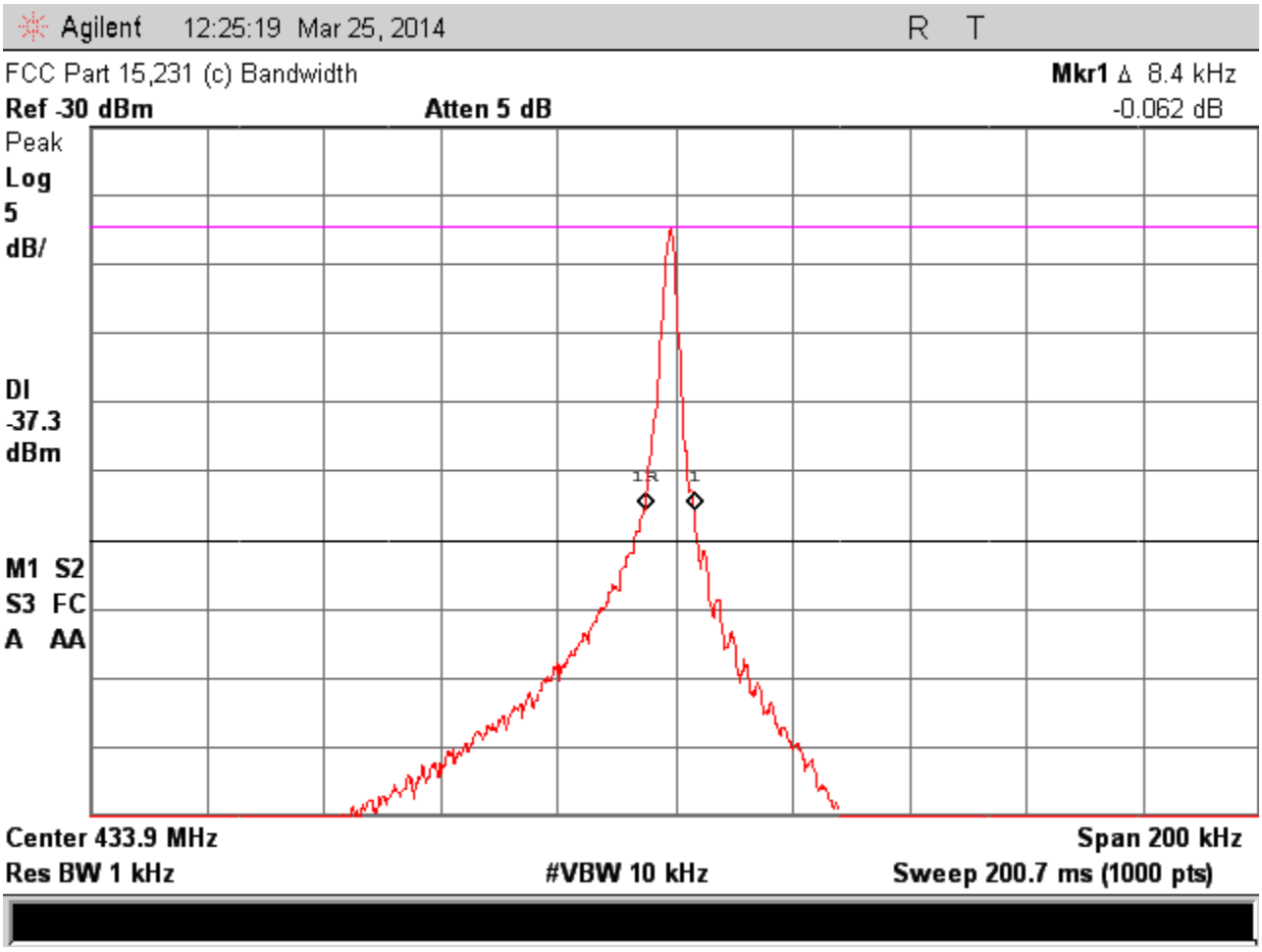


Figure 8.2-1 – 20 dB Bandwidth

Test Personnel:

March 25, 2014	Peter J. Walsh, NCE	
Date	Name	Signature

8.3 Test Instrumentation Used, Bandwidth Measurement

Type	Manufacturer/ Model No.	Serial Number	Calibration Due Date
Spectrum Analyzer	Agilent E7405A	MY42000055	3-29-2015
Near Field Probe	Electro-Metrics / EHFP-30	196	NCR

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.

8.4 Bandwidth Measurement Photograph

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 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.

9.1 Test Procedure

Inspect the DUT.

9.2 Test Data

Compliance Verdict: PASS

The DUT uses a trace on the circuit board its antenna. As such the antenna is considered permanently attached and not replaceable by the user.

9.3 Antenna Photographs

Photo 9.3-1 below shows the DUT's antenna.

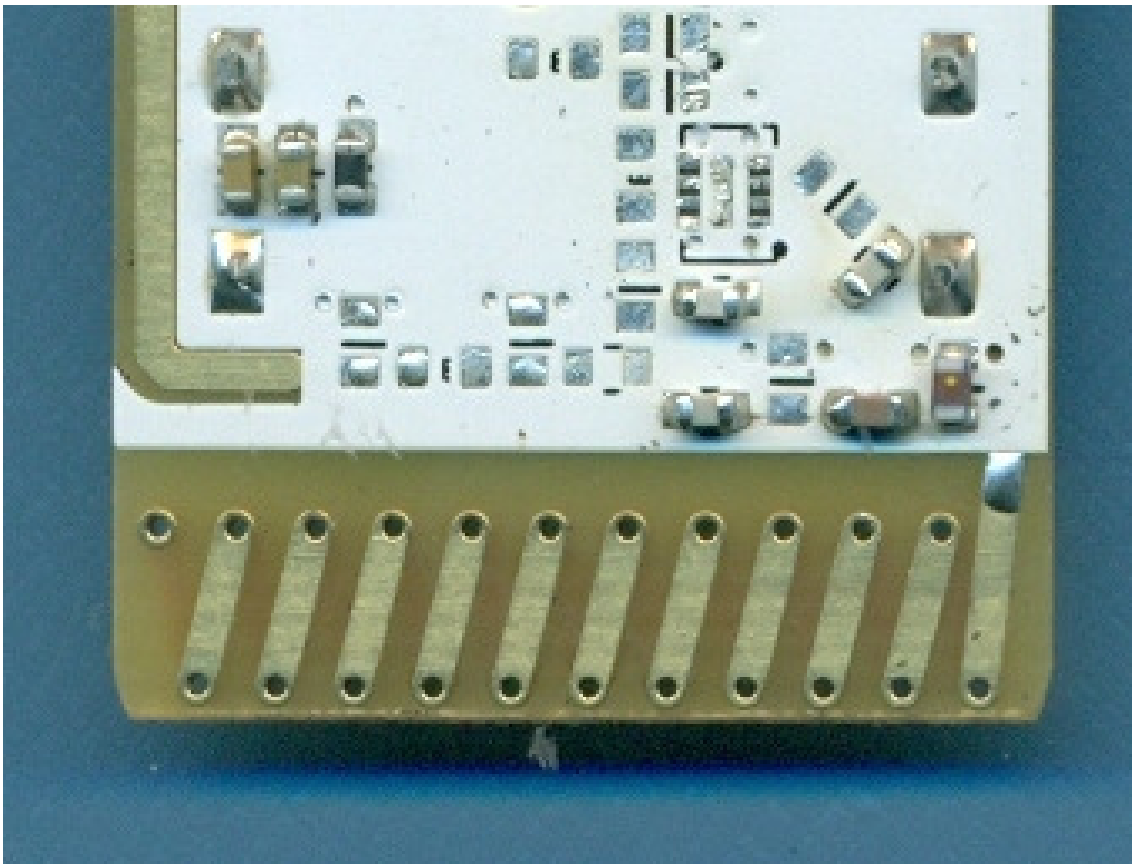


Photo 9.3-1 - Antenna

10 LABELING AND USER'S GUIDE REQUIREMENTS

10.1 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: 2AB4OAVEFOB-01CC

Figure 10.1-1 below shows a sample of the label and its placement on the DUT. Note that in production this will be laser etched for permanency of marking.

Figure 10.1-1 – Sample Label

10.2 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.

11 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."

Reference: 47 C.F.R §2.1093 Radiofrequency radiation exposure evaluation: portable devices.

(a) Requirements of this section are a consequence of Commission responsibilities under the National Environmental Policy Act to evaluate the environmental significance of its actions. See subpart I of part 1 of this chapter, in particular §1.1307(b).

(b) For purposes of this section, a portable device is defined as a transmitting device designed to be used so that the radiating structure(s) of the device is/are within 20 centimeters of the body of the user.

(c)(1) Portable devices that operate in the Cellular Radiotelephone Service pursuant to part 22 of this chapter; the Personal Communications Service (PCS) pursuant to part 24 of this chapter; the Satellite Communications Services pursuant to part 25 of this chapter; the Miscellaneous Wireless Communications Services pursuant to part 27 of this chapter; the Maritime Services (ship earth station devices only) pursuant to part 80 of this chapter; the Specialized Mobile Radio Service, the 4.9 GHz Band Service, and the 3650 MHz Wireless Broadband Service pursuant to part 90 of this chapter; the Wireless Medical Telemetry Service (WMTS) and the Medical Device Radiocommunication Service (MedRadio), pursuant to subparts H and I of part 95 of this chapter, respectively, and unlicensed personal communication service, unlicensed NII devices and millimeter wave devices authorized under §§15.253(f), 15.255(g), 15.257(g), 15.319(i), and 15.407(f) of this chapter are subject to routine environmental evaluation for RF exposure prior to equipment authorization or use.

(2) All other portable transmitting devices are categorically excluded from routine environmental evaluation for RF exposure prior to equipment authorization or use, except as specified in §§1.1307(c) and 1.1307(d) of this chapter.

In light of the fact that the Star Fob is a portable device and not within the category of equipment defined in paragraph c above, it is excluded from routine environmental evaluation for RF exposure.

Table 11-1 – Exposure Limits

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				

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).

2014-04-01 through 2015-03-31
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.