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Apollo America Inc.

TEST REPORT

SCOPE OF WORK

EMC TESTING – SANDTRAP

REPORT NUMBER

103404981LEX-004

ISSUE DATE

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27

DOCUMENT CONTROL NUMBER

Non-Specific EMC Report Shell Rev. December 2017
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EMC TEST REPORT (FULL COMPLIANCE)

Report Number: 103404981LEX-004

Project Number: G103404981

Report Issue Date: 3/13/2018

Model(s) Tested: Sandtrap

Standards: FCC Part 15.231

RSS-210 Issue 9

Tested by:

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1 Introduction and Conclusion

The tests indicated in section 2 were performed on the product constructed as described in section 3. The remaining test sections are the verbatim text from the actual data sheets used during the investigation. These test sections include the test name, the specified test method, a list of the actual test equipment used, documentation photos, results and raw data. No additions, deviations, or exclusions have been made from the standard(s) unless specifically noted.

Based on the results of our investigation, we have concluded the product tested complied with the requirements of the standard(s) indicated. The results obtained in this test report pertain only to the item(s) tested.

The INTERTEK-Lexington is located at 731 Enterprise Drive, Lexington Kentucky, 40510. The radiated emission test site is a 10-meter semi-anechoic chamber. The chamber meets the characteristics of CISPR 16-1 and ANSI C63.4: 2009. For measurements, a remotely controlled flush-mount metal-top turntable is used to rotate the EUT a full 360 degrees. A remote controlled non-conductive antenna mast is used to scan the antenna height from one to four meters. The test site is listed with the FCC under registration number 485103. The test site is listed with Industry Canada under site number IC 2042M-1.

2 Test Summary

Page	Test full name	FCC Reference	IC Reference	Result
10	Duty Cycle Correction Factor	ANSI C63.10: 2013	ANSI C63.10: 2013	---
14	Transmission Timing Measurements	§ 15.231(a)	RSS-210 (A1.1.1)	Pass
16	Occupied Bandwidth	§ 15.231(c)	RSS-210 (A1.1.3)	Pass
17	Radiated Emissions	§ 15.231(b)	RSS-210 (A1.1.2)	Pass
25	Antenna Requirement per FCC Part 15.203	§ 15.203	RSS-Gen (7.1.2)	Pass
---	Conducted Emission Limits	§ 15.207	RSS-Gen (7.2.4)	N/A ¹

1: The test is not applicable because the device is battery powered and does not connect to the AC Mains



3 Description of Equipment Under Test

Equipment Under Test	
Manufacturer	Apollo America Inc.
Model Number	Sandtrap
Serial Number	1001
Receive Date	2/13/2018
Test Start Date	2/13/2018
Test End Date	3/1/2018
Device Received Condition	Good
Test Sample Type	Production
Transmission Control	Firmware
Transmit Frequencies	345MHz
Transmit Output Power	0.0000067 W
Antenna Type (15.203)	Permanent internal PCB antenna
Operating Voltage	4.5 VDC via 3 AAA batteries

Description of Equipment Under Test	
Wireless smoke detector.	

Operating modes of the EUT:

No.	Descriptions of EUT Exercising
1	Idle, transmitting every 65 minutes
2	Continuously transmitting



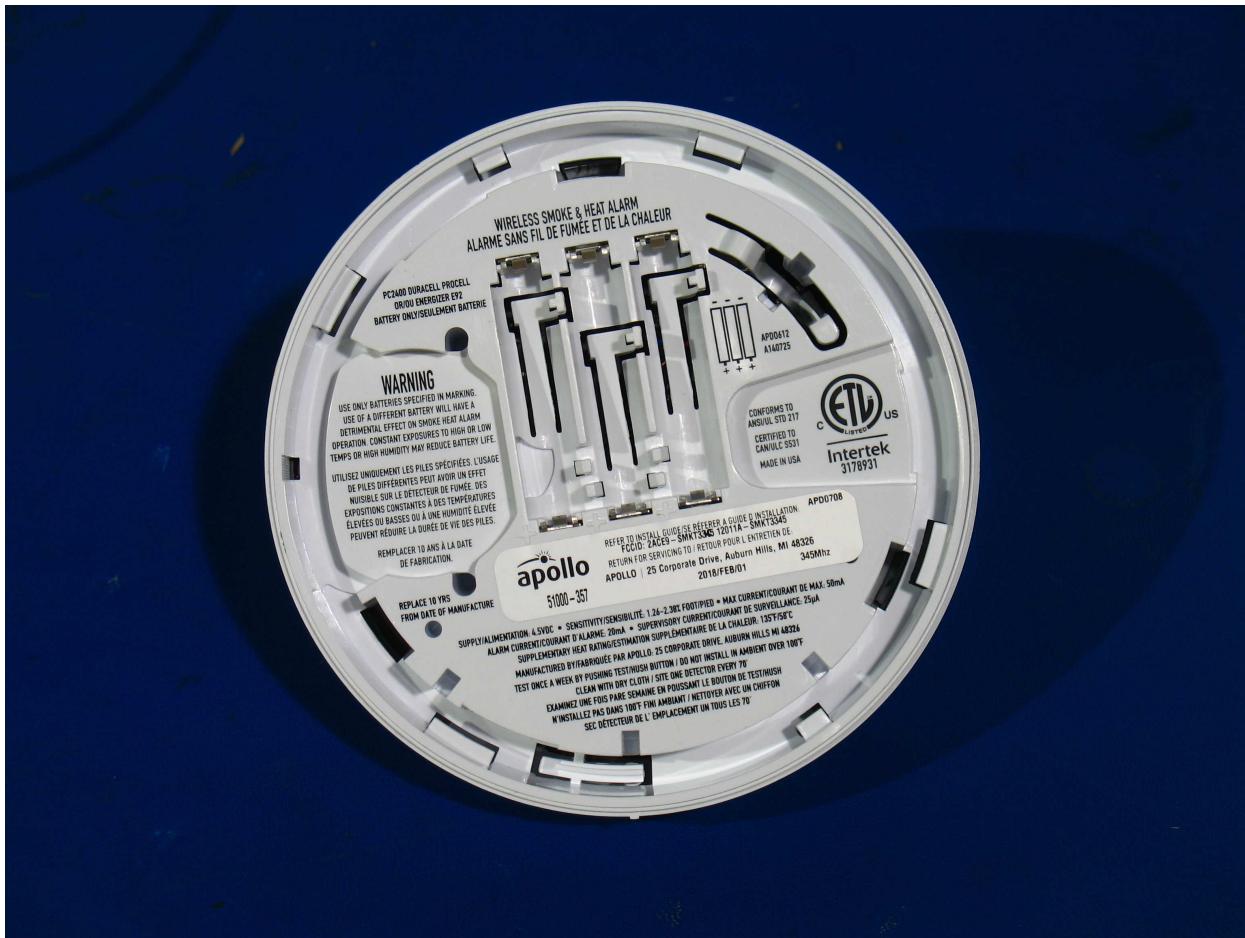
3.1 Photographs of Test Sample



Front



Back

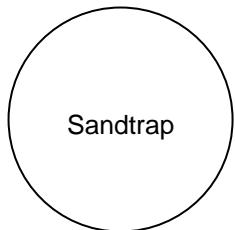


Bottom



3.2 System setup including cable interconnection details, support equipment and simplified block diagram

3.3 EUT Block Diagram:



3.4 Cables:

None

3.5 Support Equipment:

None



4 Duty Cycle Correction Factor

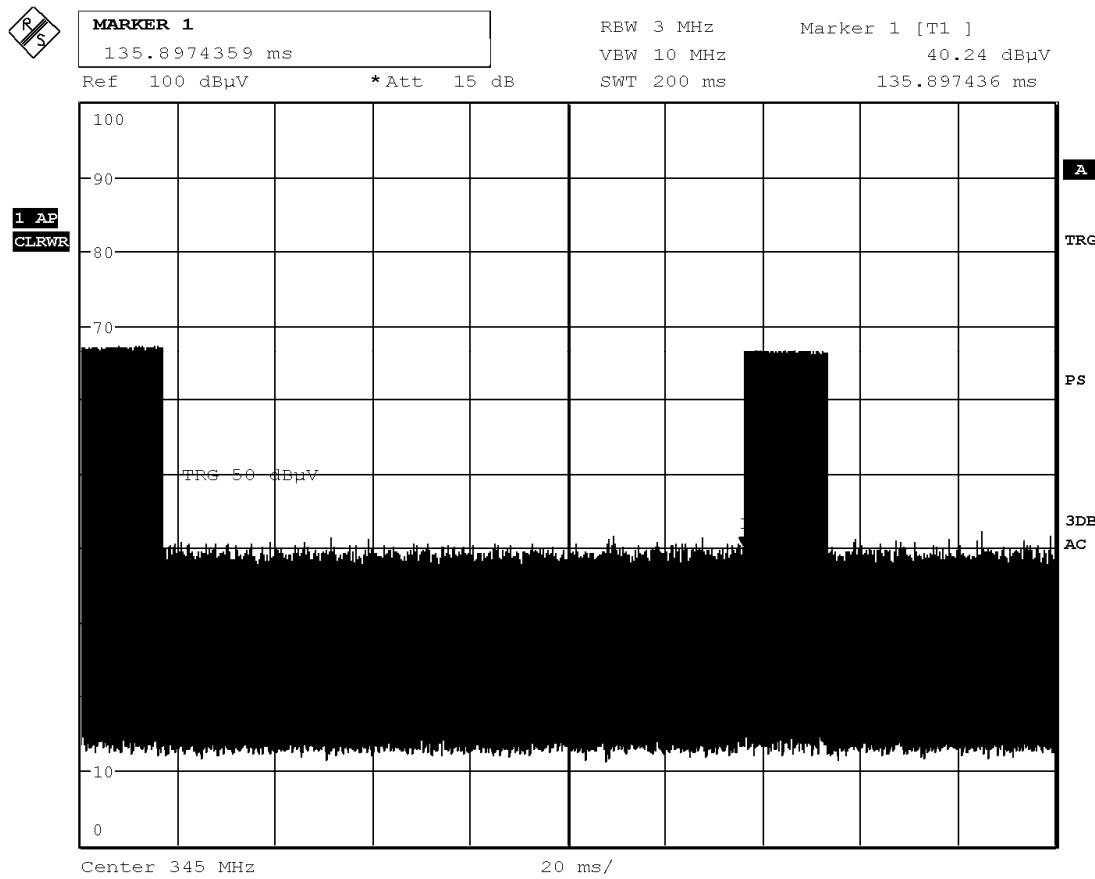
4.1 Test Procedure

ANSI C63.10: 2013 Section 7.5 was followed for measuring the duty cycle and calculating the duty cycle correction factor. When necessary the duty cycle correction factor was used to compute the average value of pulsed emissions during the radiated testing.

4.2 Test Equipment Used:

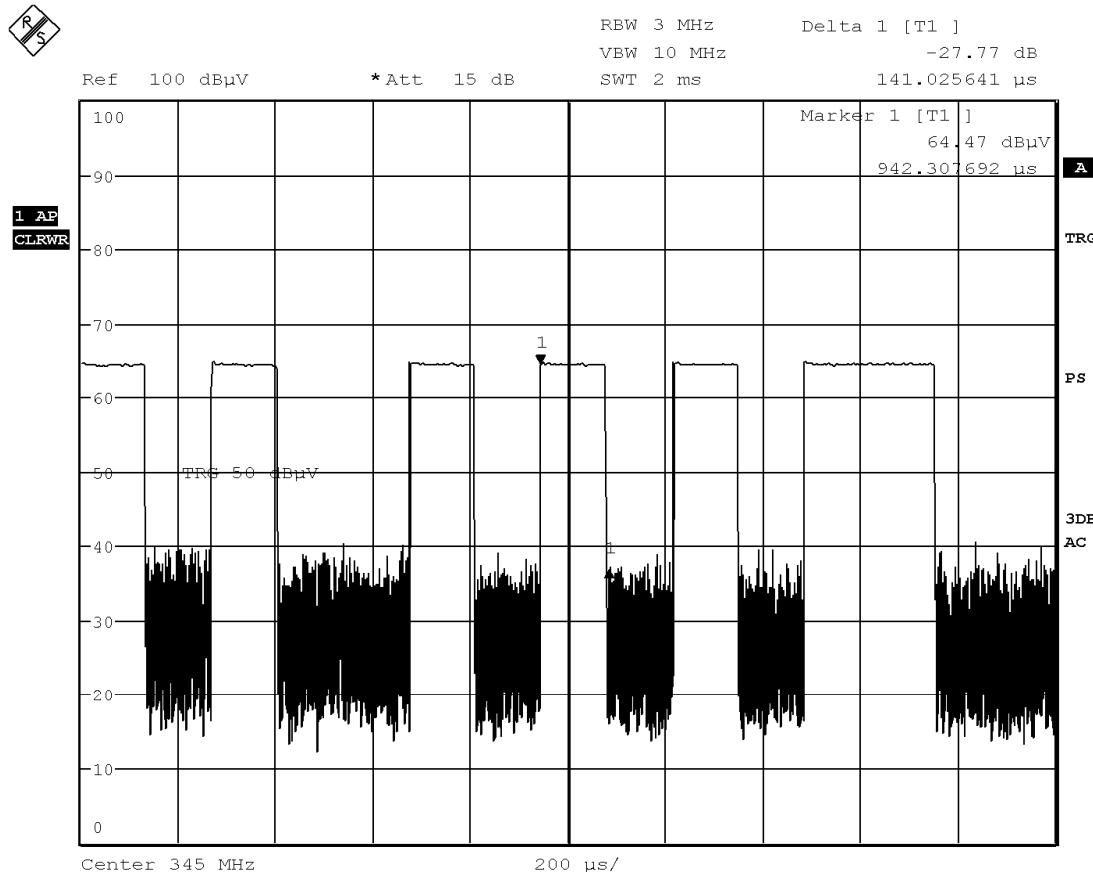
Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
EMI Test Receiver	10887490.26	Rohde & Schwarz	ESU40	10/12/2017	10/12/2018

4.3 Duty Cycle Correction Factor Results (345MHz):



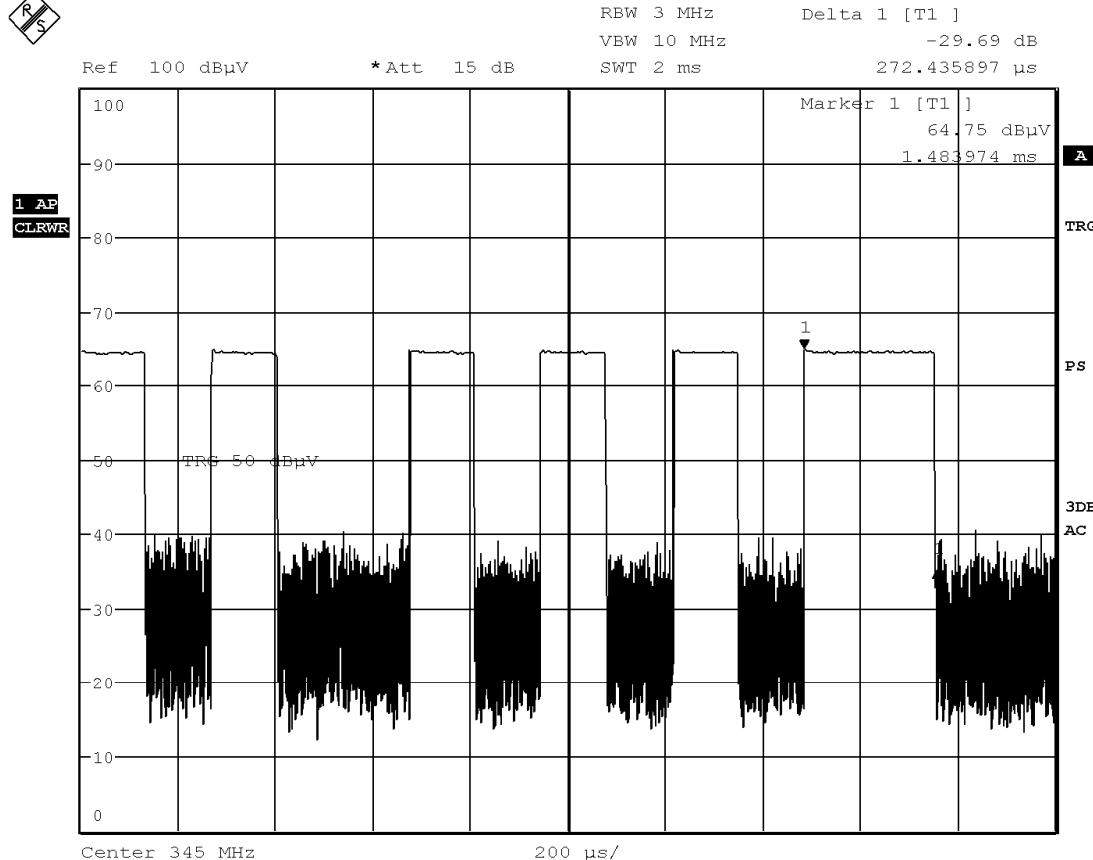
Date: 28.FEB.2018 16:57:17

Cycle Time = 135ms
So no more than one pulse occurs in any 100ms window



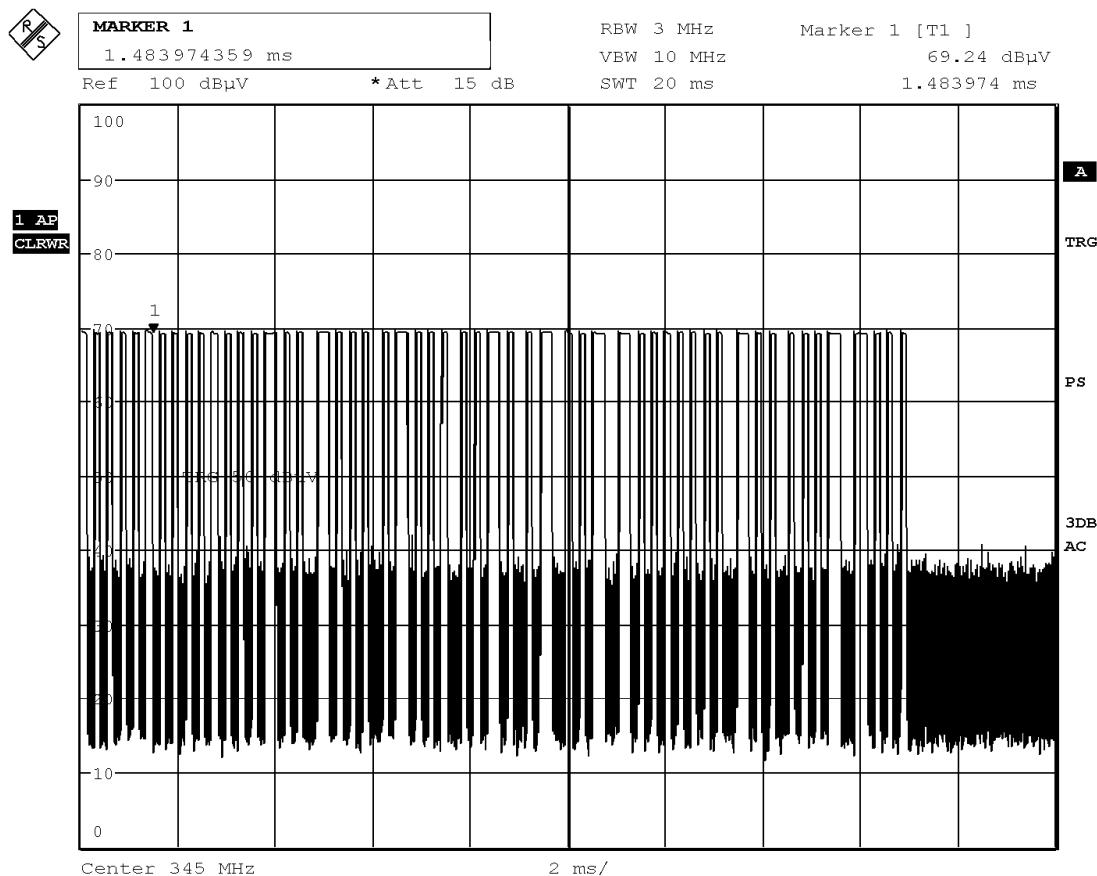
Date: 28.FEB.2018 17:02:11

Short Pulse = 0.141ms



Date: 28.FEB.2018 17:03:14

Long Pulse = 0.272ms



Date: 28.FEB.2018 17:04:40

Total Number of Short Pulses = 43

Duration of All Short Pulses = $43 \times 0.141\text{ms} = 6.063\text{ms}$

Total Number of Long Pulses = 11

Duration of All Long Pulses = $11 \times 0.272\text{ms} = 2.992\text{ms}$

Total "On Time" per Cycle = $6.063\text{ms} + 2.992\text{ms} = 9.055\text{ms}$

Duty Cycle Correction Factor = $20\log(9.055\text{ms} / 100\text{ms}) = -20.86\text{dB}$



5 Transmission Timing

§ 15.231(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 transmissions 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.

5.1 Test Procedure

The sample was set up in its normal operating mode. A small antenna connected to a spectrum analyzer was placed in close proximity to the sample. The scope was configured to trigger when the sample transmitted data. Condition 3 above was used to evaluate compliance.

5.2 Test Equipment Used:

Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
EMI Test Receiver	10887490.26	Rohde & Schwarz	ESU40	10/12/2017	10/12/2018

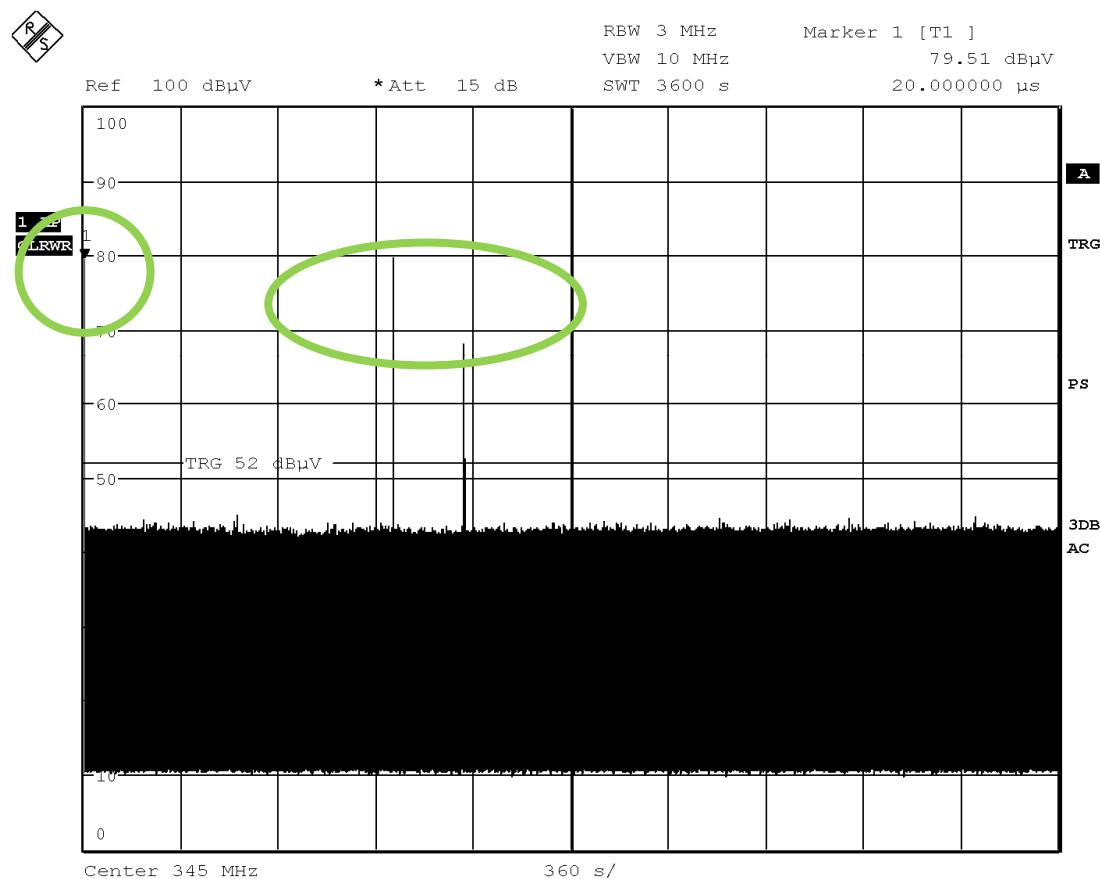


5.3 Transmission Timing Results

- (1) The device is not manually operated
- (2) The device is a safety device that is allowed continuous transmission during an alarm
- (3) See below
- (4) The device is a smoke alarm that is employed for safety of life
- (5) The device is not manually triggered and is a safety of life device.

Three pulses were measured over a 1 hour sweep as shown below. The “on time” for each of the three pulses was 9.055ms (27.165ms total) which is less than two seconds per hour.

1 Hour Sweep



Date: 28.FEB.2018 18:37:10



6 Occupied Bandwidth

6.1 Test Limits

§ 15.231(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.

6.2 Test Procedure

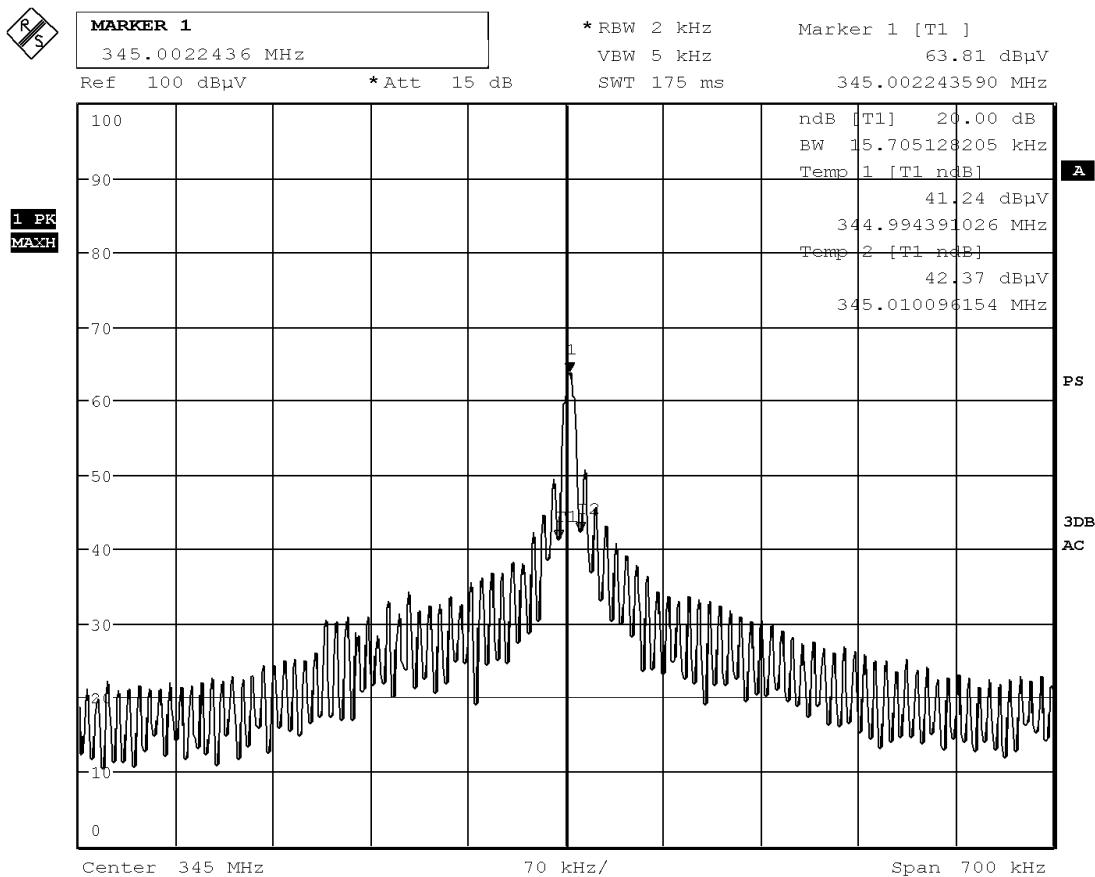
ANSI C63.10: 2013

6.3 Test Equipment Used:

Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
EMI Test Receiver	10887490.26	Rohde & Schwarz	ESU40	10/12/2017	10/12/2018



6.4 Results: 20dB Bandwidth Measurement



Date: 28.FEB.2018 16:44:46

345MHz 20dB Bandwidth = 15.7kHz



MARKER 1
345.0044872 MHz

Ref 100 dB μ V * Att 15 dB

* RBW 2 kHz

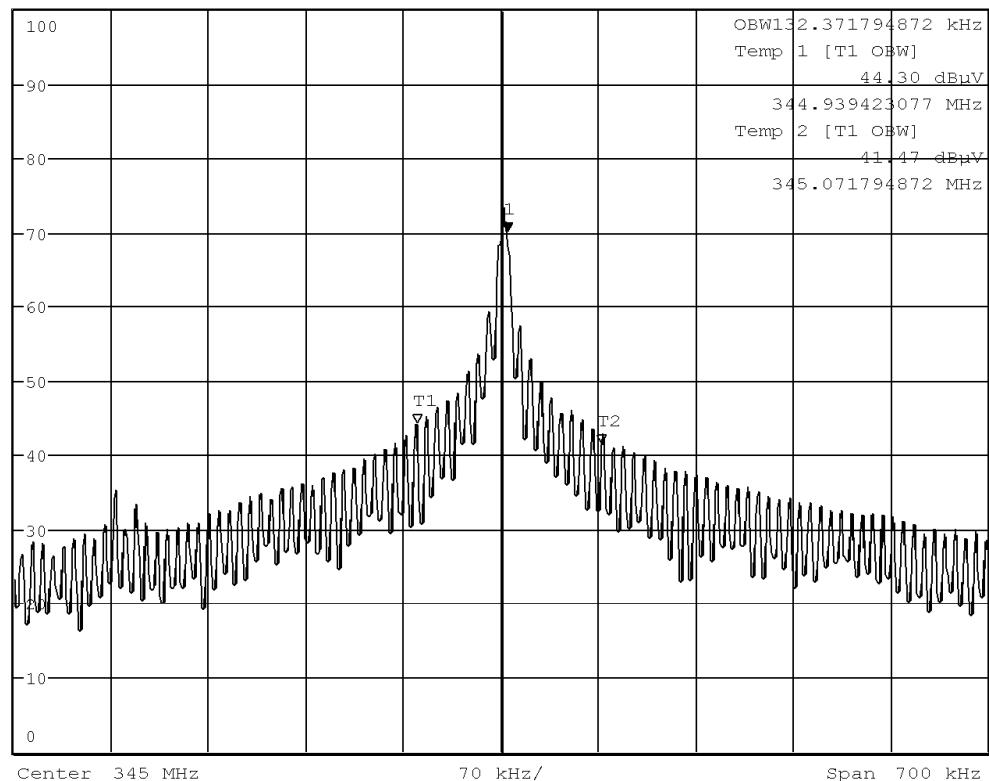
VBW 5 kHz

SWT 175 ms

Marker 1 [T1]

70.00 dB μ V

345.004487179 MHz



Date: 28.FEB.2018 16:51:01

345MHz 99% Bandwidth = 132.3kHz



7 Radiated Spurious Emissions (Transmitter)

7.1 Test Limits

§ 15.231(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

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

(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.

(b) In addition to the provisions of §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 1,250 to 3,750	¹ 125 to 375
174-260	3,750	375
260-470	¹ 3,750 to 12,500	¹ 375 to 1,250
Above 470	12,500	1,250

¹Linear interpolations.

(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 §15.35 for averaging pulsed emissions and for limiting peak emissions apply. Further, compliance with the provisions of §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 §15.209, whichever limit permits a higher field strength.

**Part 15.205(a): Restricted Bands of Operations**

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
¹ 0.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675	156.7–156.9	2655–2900	22.01–23.12
8.41425–8.41475	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725	322–335.4	3600–4400	(²)
13.36–13.41.			

¹ Until February 1, 1999, this restricted band shall be 0.490–0.510 MHz.² Above 38.6**Part 15.209(a): Field Strength Limits for Restricted Bands of Operation**

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 - 0.490	2,400 / F (kHz)	300
0.490 - 1.705	24,000 / F (kHz)	30
1.705 - 30.0	30	30
30 – 88	100	3
88 – 216	150	3
216 – 960	200	3
Above 960	500	3



7.2 Test Procedure

ANSI C63.10: 2013

7.3 Example of Field Strength Calculation Method:

The measured field strength was calculated by summing the readings taken from the spectrum analyzer with the appropriate correction factors associated with the antenna losses and cable losses. The calculation formula and sample calculations are listed below:

Formula:

$$FS = RA + AF + CF$$

FS = Field Strength in dB μ V/m

RA = Receiver Amplitude in dB μ V

AF = Antenna Factor in dB

CF = Cable Attenuation Factor in dB (Including preamplifier and filter attenuation)

Example Calculation:

RA = 19.48 dB μ V

AF = 18.52 dB

CF = 0.78 dB

$$FS = 19.48 + 18.52 + 0.78 = 38.78 \text{ dB}\mu\text{V/m}$$

Level in μ V/m = Common Antilogarithm $[(38.78 \text{ dB}\mu\text{V/m})/20] = 86.89 \mu\text{V/m}$

7.4 Test Equipment Used:

Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
EMI Test Receiver	10887490.26	Rohde & Schwarz	ESU40	10/12/2017	10/12/2018
Preamplifier	122005	Rohde & Schwarz	TS-PR18	11/29/2017	11/29/2018
Biconnilog Antenna	00051864	ETS	3142C	4/6/2017	4/6/2018
Horn Antenna	00154521	ETS	3117	6/5/2017	6/5/2018
System Controller	121701-1	Sunol Sciences	SC99V	Time of Use	Time of Use
EMC Software	Version 9.15.02	Rohde & Schwarz	EMC32	Time of Use	Time of Use
High Pass Filter	1	Wainwright	WHKX12-2533.85-2710-18000-40SS	Time of Use	Time of Use



7.5 Results:

All fundamental and spurious emissions not falling into the restricted bands met the limits outlined in FCC Part 15.231(b). Additionally, all emissions falling within restricted bands of operation were found to be below the limit specified in Part 15.209(a). The emissions listed in the following tables are the worst case emissions and were investigated with the sample positioned in three orthogonal axis in order to report the highest possible field strength.

Worst Case Spurious Measurements (345MHz)

Fundamental

Frequency (MHz)	Final Result (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Measured (dB μ V/m)	Duty Cycle Correction Factor (dB)	Measurement Detector
345.02	93.25	97.26	4.01	103	H	347	93.25	0	MaxPeak
345.02	74.55	77.26	2.71	103	H	347	95.41	-20.86	Average

Spurious Emissions Below 1GHz(Max Peak)

Frequency (MHz)	MaxPeak (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
30.04	35.86	57.26	21.4	120	223.1	V	9	24.6
37.857	31.93	57.26	25.33	120	238.7	V	284	21.2
244.12	33.24	57.26	24.02	120	353.7	H	21	21.4
360.94	40.9	57.26	16.36	120	102.8	H	-1	25.6
697.04	46.25	57.26	11.01	120	190.8	V	0	33.5
857.34	48.53	57.26	8.73	120	345	H	240	35
968.04	50.24	57.26	7.02	120	152.1	H	285	36.7

*Note: All Peak Detected Emissions Meet the average limit



Spurious Emissions Above 1GHz(Max Peak)

Frequency (MHz)	MaxPeak (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1379.918	38.47	57.26	18.79	1000	143	V	50	-1.6
1725.0045	52.5	57.26	4.76	1000	200	V	35	-0.2
2070.0665	48.4	57.26	8.86	1000	157	V	22	2.4
2415.0025	54.01	57.26	3.25	1000	175	H	50	3.9
2760.1285	49.52	57.26	7.74	1000	200	H	50	4.2
3105.02	57.13	57.26	0.13	1000	183	V	0	4.9
3450.0545	46.77	57.26	10.49	1000	182	V	0	5.3
3795.088	43.28	57.26	13.98	1000	178	V	24	6.2
4139.9345	45.89	57.26	11.37	1000	248	V	240	6.6
4139.9855	43.8	57.26	13.46	1000	172	V	0	6.6
4140.014	43.88	57.26	13.38	1000	200	H	50	6.6
4485.1135	51.59	57.26	5.67	1000	129	V	50	7.6
5174.9205	50.68	57.26	6.58	1000	200	H	50	8
5520.1735	53.66	57.26	3.6	1000	200	H	27	9.5
5865.0435	46.66	57.26	10.6	1000	173	H	24	9.3
6209.944	46.17	57.26	11.09	1000	136	H	26	9.6
6555.0965	48.5	57.26	8.76	1000	100	H	38	10.4
8625.0735	47.37	57.26	9.89	1000	156	V	0	12
10005.111	49.77	57.26	7.49	1000	200	H	50	14.4
10695.005	49.23	57.26	8.03	1000	147	V	38	14.8
15530.53	50.89	57.26	6.37	1000	137	H	18	18.8

*Note: All Peak Detected Emissions Meet the average limit



Spurious Emissions Above 1GHz(Average)

Frequency (MHz)	MaxPeak (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1379.918	17.61	57.26	39.65	1000	143	V	50	-1.6
1725.0045	31.64	57.26	25.62	1000	200	V	35	-0.2
2070.0665	27.54	57.26	29.72	1000	157	V	22	2.4
2415.0025	33.15	57.26	24.11	1000	175	H	50	3.9
2760.1285	28.66	57.26	28.6	1000	200	H	50	4.2
3105.02	36.27	57.26	20.99	1000	183	V	0	4.9
3450.0545	25.91	57.26	31.35	1000	182	V	0	5.3
3795.088	22.42	57.26	34.84	1000	178	V	24	6.2
4139.9345	25.03	57.26	32.23	1000	248	V	240	6.6
4139.9855	22.94	57.26	34.32	1000	172	V	0	6.6
4140.014	23.02	57.26	34.24	1000	200	H	50	6.6
4485.1135	30.73	57.26	26.53	1000	129	V	50	7.6
5174.9205	29.82	57.26	27.44	1000	200	H	50	8
5520.1735	32.8	57.26	24.46	1000	200	H	27	9.5
5865.0435	25.8	57.26	31.46	1000	173	H	24	9.3
6209.944	25.31	57.26	31.95	1000	136	H	26	9.6
6555.0965	27.64	57.26	29.62	1000	100	H	38	10.4
8625.0735	26.51	57.26	30.75	1000	156	V	0	12
10005.111	28.91	57.26	28.35	1000	200	H	50	14.4
10695.005	28.37	57.26	28.89	1000	147	V	38	14.8
15530.53	30.03	57.26	27.23	1000	137	H	18	18.8

*The duty cycle correction factor (-20.86dB) was applied to the peak detected emissions in order to arrive at the average measurements above.



8 Antenna Requirement per FCC Part 15.203

8.1 Test Limits

§ 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 §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 §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

8.2 Results:

The sample tested met the antenna requirement. The antenna used was permanently attached to the PCB.



9 Measurement Uncertainty

The measured value related to the corresponding limit will be used to decide whether the equipment meets the requirements.

The measurement uncertainty figures were calculated and correspond to a coverage factor of $k = 2$, providing a confidence level of respectively 95.45 % in the case where the distributions characterizing the actual measurement uncertainties are normal (Gaussian).

Measurement uncertainty Table

Parameter	Uncertainty	Notes
Radiated emissions, 30 to 1000 MHz	+3.9dB	
Radiated emissions, 1 to 18 GHz	+4.2dB	
Radiated emissions, 18 to 40 GHz	+4.3dB	
Power Port Conducted emissions, 150kHz to 30 MHz	+2.8dB	



10 Revision History

Revision Level	Date	Report Number	Notes
0	3/13/2018	103404981LEX-004	Original Issue