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# Amended Test Report

Includes NCEE Labs report R20140409-21-02D and its amendment in full

| | |
|---|---|
| **Company:** | **Apollo America**<br>**25 Corporate Dr.**<br>**Auburn Hills, MI 48326** |
| **Product:** | **Wireless Smoke Detector**<br>**M/N 51000-355** |
| **Test Report No:** | **R20140409-21-01E** |
| **FCC ID:**<br>**IC:** | **2ACE9-51000355**<br>**12011A-51000355** |
| **Approved by:** | **Nic S. Johnson, NCE**<br>**EMC Test Engineering Manager/Technical Manager**<br>**iNARTE Certified EMC Engineer #EMC-003337-NE** |
| **Date:** | **20 August 2014** |
| **Total Pages:** | **21** |

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CERTIFICATE NO. 1953.01

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## 1.0 Summary of test results

The EUT has been tested according to the following specifications:

| APPLIED STANDARDS: FCC Part 15, Subpart C | | | |
|---|---|---|---|
| **Standard Section** | **Test Type and Limit** | **Result** | **Remark** |
| FCC Part 15.203 | Unique Antenna Requirement | N/A | N/A |
| FCC Part 15.209<br>RSS-210 Sec 2.5 | Radiated Emissions | Pass | Meets the requirement of the limit. |
| FCC Part 15.231<br>RSS-210 Annex I | Minimum Bandwidth,<br>Limit: 862.5 kHz | Pass | Meets the requirement of the limit. |
| FCC Part 15.231<br>RSS-210 Sec 2.5 | Transmitter Radiated Emissions,<br>Limit: Table 15.209 | Pass | Meets the requirement of the limit. |

## 2.0 Description

### *2.1 Equipment under test*

The Equipment Under Test (EUT) was a Smoke Detector manufactured by Apollo America. It is used to remotely communicate with fire stations in a state of emergency.

EUT Received Date: 7 May 2014
EUT Tested Date: 7 May 2014

| | |
|---|---|
| PRODUCT | Smoke Detector |
| MODEL | 51000-355 |
| POWER INPUT | 4.5 VDC (3*1.5 VDC AAA) |
| MODULATION TYPE | ASK-OOK |
| FREQUENCY RANGE | 345 MHz |
| NUMBER OF CHANNELS | 1 |
| MAXIMUM OUTPUT POWER | -7.30 dBm |
| ANTENNA TYPE | Trace Antenna |
| SERIAL NUMBER OF TEST UNIT | 0020122 |

**NOTE:**
1. For more detailed features description, please refer to the manufacturer's specifications or User's Manual.

### *2.2 Laboratory description*

All testing was performed at the NCEE Lincoln facility, which is a FCC and IC registered lab. This site has been fully described in previously submitted reports. Laboratory environmental conditions varied slightly throughout the tests:

Relative humidity of 44 ± 4%
Temperature of 24 ± 3° Celsius

### *2.3 Description of test modes*

The EUT transmits on only one frequency;

| Channel | Frequency |
|---|---|
| 1 | 345.00 MHz |

### *2.4 Applied standards*

The EUT is a digital transmission device operating at 345 MHz. According to the specifications of the manufacturer, it must comply with the requirements of the following standards:

**FCC Part 15, Subpart a (15.231) using;**
**ANSI/IEEE C63.4: 2009**
**ANSI/IEEE C63.10:2009**
**Industry Canada, RSS 210, Issue 8, Category I Equipment**

All test items have been performed and recorded as per the above standards.

### *2.5 Description of support units*

None

### *2.6 Configuration of system under test*

The EUT was powered by 4.5 VDC (3*1.5 VDC AAA batteries) for all the tests and had no auxiliary devices. It was tested by itself. The EUT was programmed by the manufacturer to transmit continually for testing purposes only.
The EUT was modified by the manufacturer to test with the device continuously transmitting a series of 1's and 0's, for testing purposes.

The EUT was tested in the orientation that is specified in the user's manual.

## 3.0 Test equipment used

| DESCRIPTION AND MANUFACTURER | MODEL NO. | SERIAL NO. | LAST CALIBRATION DATE |
|---|---|---|---|
| Rohde & Schwarz Test Receiver | ESIB26 | 100037 | 21 Jan 2014 |
| EMCO Biconilog Antenna | 3142B | 1647 | 07 Aug 2013 |
| EMCO Horn Antenna | 3115 | 6416 | 14 Jan 2014 |

## 4.0 Detailed results

### *4.1 Unique antenna requirement*

#### *4.1.1 Standard applicable*

For intentional device, according to FCC 47 CFR Section 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.

#### *4.1.2 Antenna description*

The antenna supplied with the EUT is an internal PCB trace antenna and not interchangeable.

### *4.2 Radiated emissions*

#### *4.2.1 Limits for radiated emissions measurements*

Emissions radiated outside of the specified bands shall be applied to the limits in 15.209 as followed:

| FREQUENCIES (MHz) | FIELD STRENGTH (μV/m) | MEASUREMENT DISTANCE (m) |
|---|---|---|
| 0.009-0.490 | 2400/F(kHz) | 300 |
| 0.490-1.705 | 24000/F(kHz) | 30 |
| 1.705-30.0 | 30 | 3 |
| 30-88 | 100 | 3 |
| 88-216 | 150 | 3 |
| 216-960 | 200 | 3 |
| Above 960 | 500 | 3 |

**NOTE:**

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 * log * Emission level (uV/m).
3. As shown in 15.35(b), for frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits by more than 20dB under any condition of modulation.

**REMARK**S:

1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value.
5. *Radiated limits according to 15.209 do not apply within the 902MHz to 928MHz band for transmitters.
6.**For frequencies not in a restricted band as specified in 15.205, spurious emissions shall be at least 20dB less than the field strength at the fundamental frequency.

*4.2.2 Test procedures*

a. The EUT was placed on the top of a rotating table 0.8 meters above the ground plane in a 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.

b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c. The antenna was a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are used to make the measurement.

d. For each suspected emission, the EUT was arranged to maximize its emissions and then the antenna height was varied from 1 meter to 4 meters and the rotating table was turned from 0 degrees to 360 degrees to find the maximum emission reading.

e. The test-receiver system was set to use a peak detector with a specified resolution bandwidth. For spectrum analyzer measurements, the composite maximum of several analyzer sweeps was used for final measurements.

f. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10 dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

**NOTE:**
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Peak detection (PK) and Quasi-peak detection (QP) at frequencies below 1GHz.

2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz for peak and average detectors at frequencies above 1GHz.

### *4.2.3 Deviations from test standard*

No deviation.

### *4.2.4 Test setup*

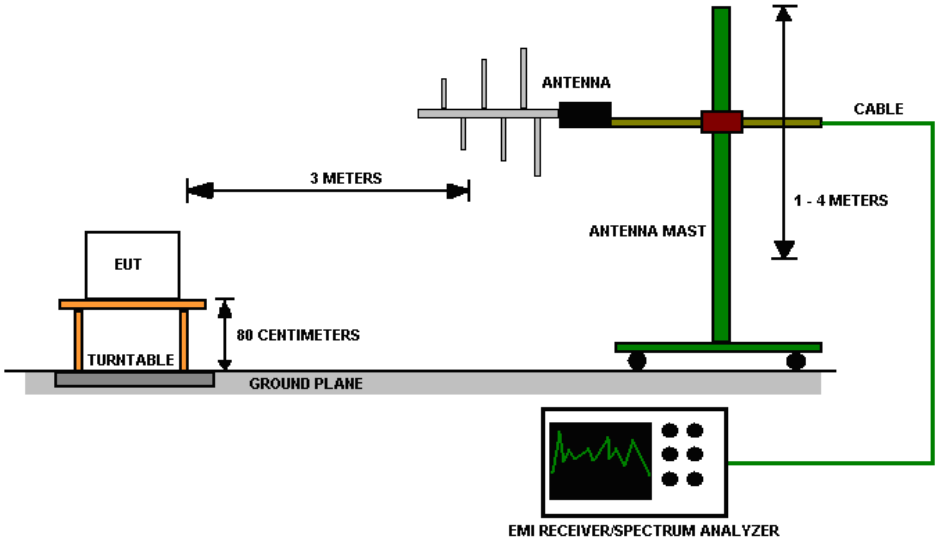



**Figure 1 - Radiated Emissions Test Setup**

For the actual test configuration, please refer to Appendix A for photographs of the test configuration.

### *4.2.5 EUT operating conditions*

See section 2.6.

### *4.2.6 Test results*

| | | | |
|---|---|---|---|
| EUT | Smoke Detector | Model | 51000-355 (xxx) |
| MODE | Continuous Transmit | FREQUENCY RANGE | 30 MHz – 4 GHz |
| INPUT POWER (SYSTEM) | 4.5 VDC | ORIENTATION | Horizontally Placed Facing the Floor |
| ENVIRONMENTAL CONDITIONS | 44 % ± 5% RH<br>24 ± 3ºC | TECHNICIAN | Kvepuri |

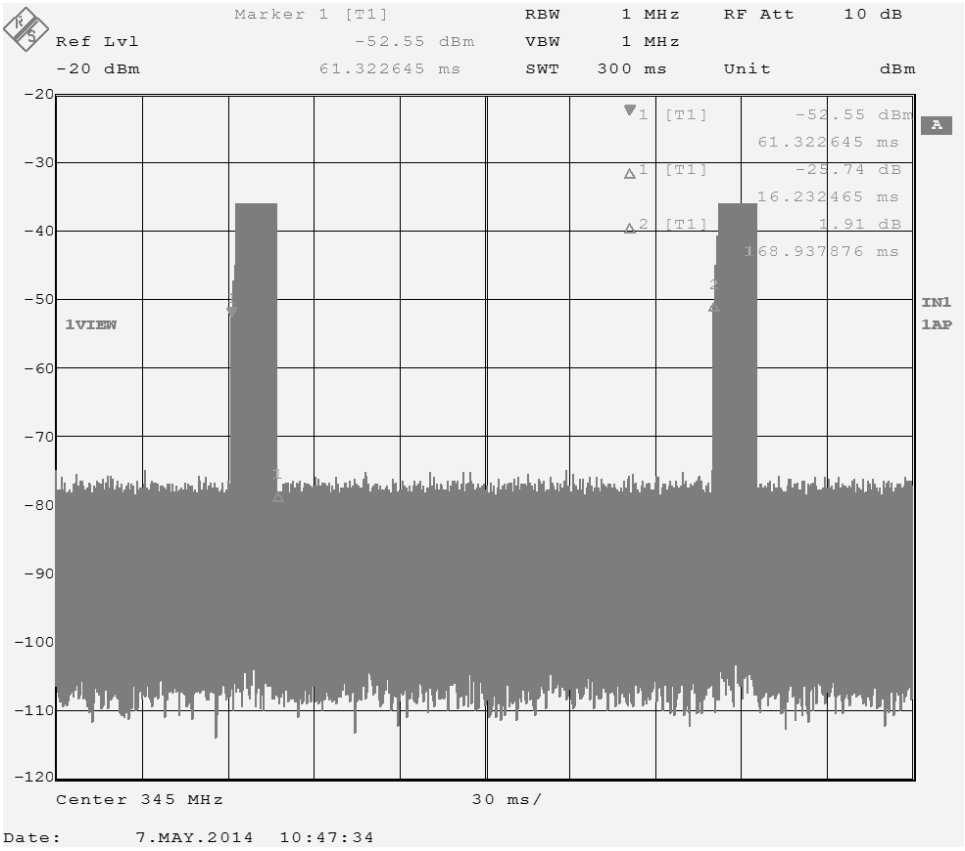



**Figure 2 – Duty Cycle Plot**

On time = 16.23 ms
Period = 100 ms (maximum allowed)
Duty cycle = 16.23 ms / 100.00 ms = 16.23%
Duty cycle correction factor = 20 * log (0.469) = -15.79 dB

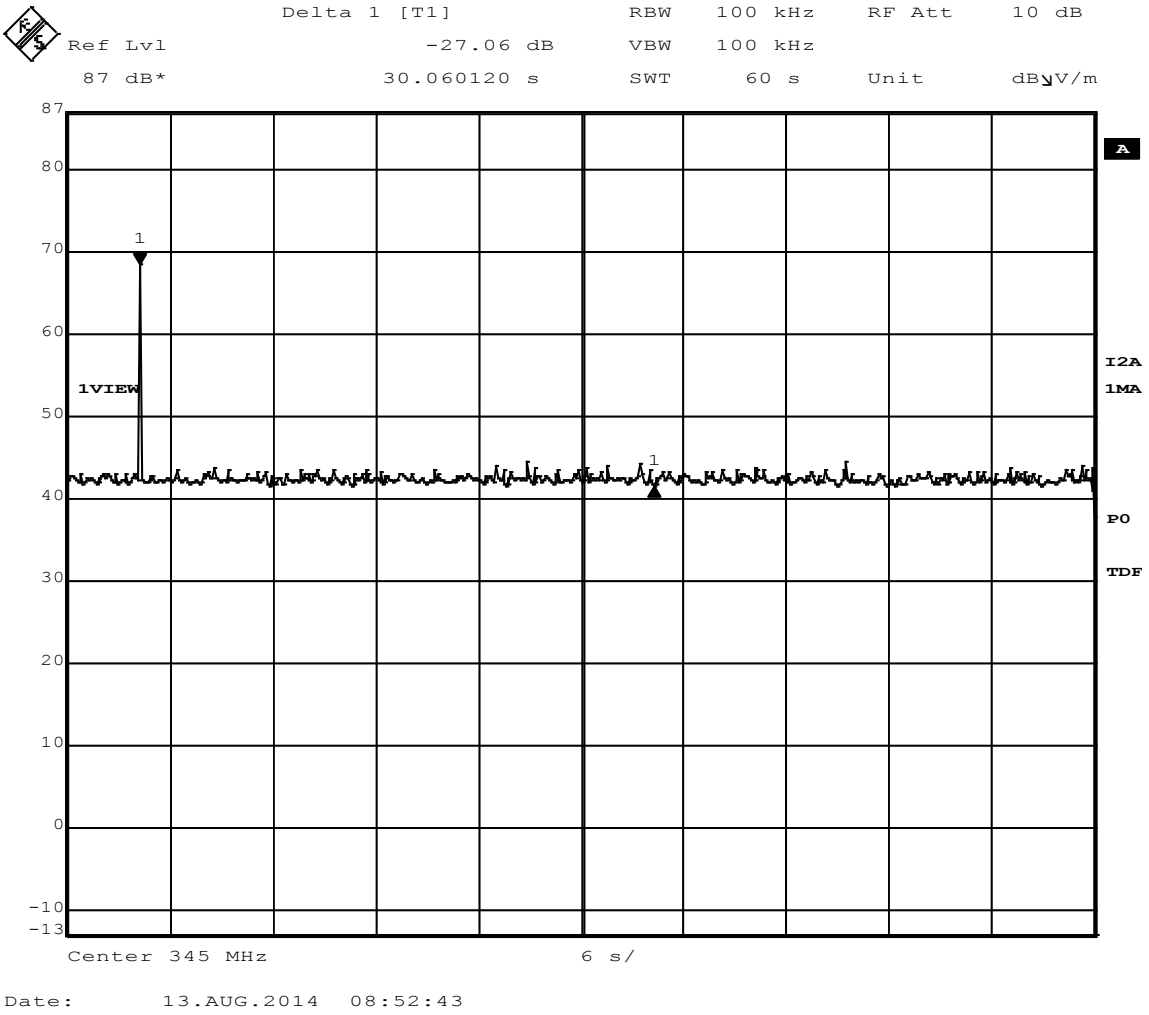



**Figure 3 - Transmissions Stop Time, Standby Mode**

Interval greater than 60 sec. between periodic transmissions
Transmissions length = 16.23 ms (see Fig. 2)
Total transmissions time in 1 hour = less than 0.97 second (16.23 ms × 60)

Requirement: Less than 2 seconds per hour from FCC Part 15.231(a)(3). The transmitter is also required to cease transmission within 5sec. per FCC Part 15.231(a)2). This is also demonstrated in the plot.

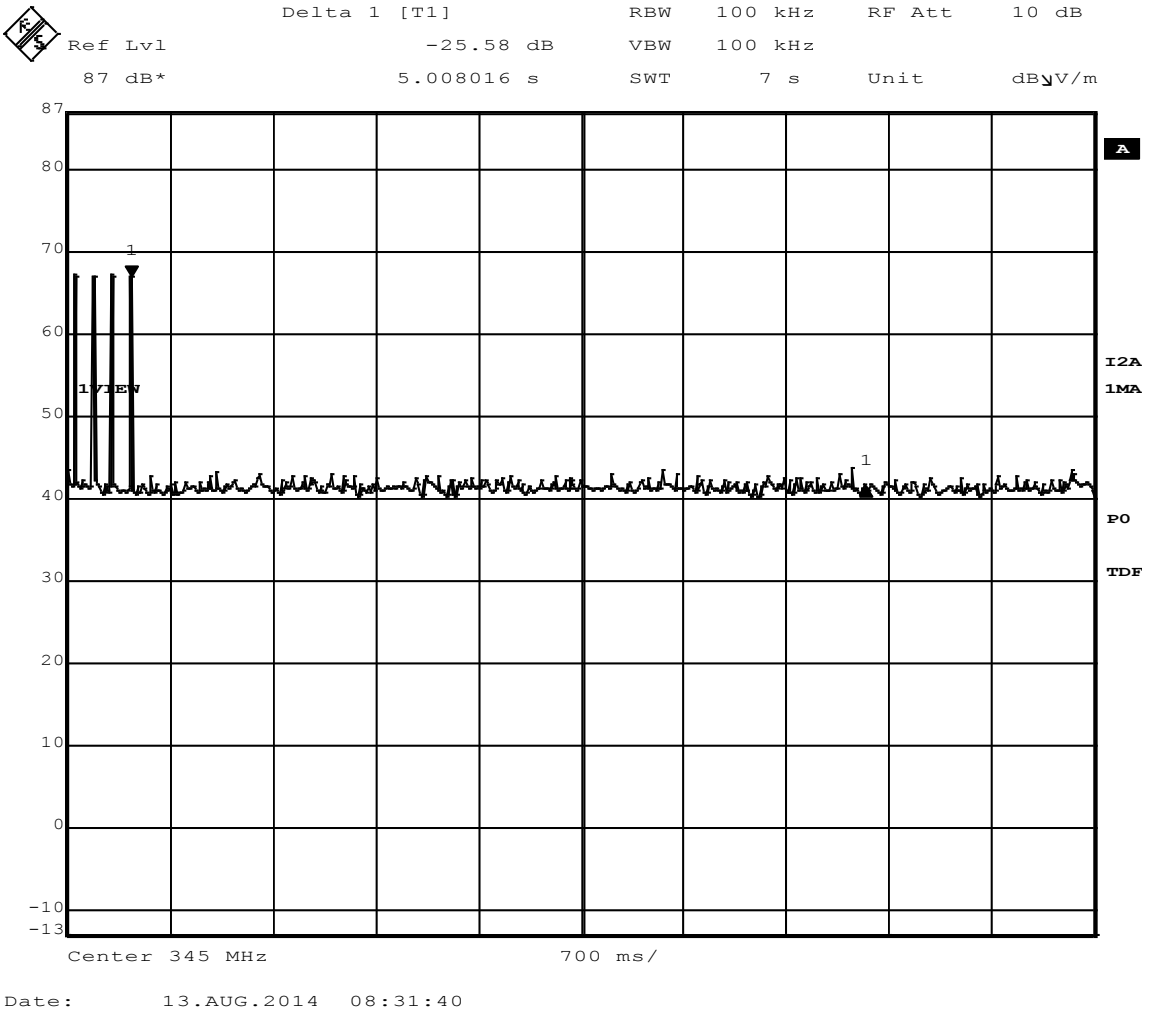



**Figure 4 - Transmissions Stop Time, Alarm Mode**

Requirement: The transmitter is required to cease transmission within 5sec. per FCC Part 15.231(a)2). This is demonstrated in the plot. Marker 1 indicated when the alarm mode was stopped.

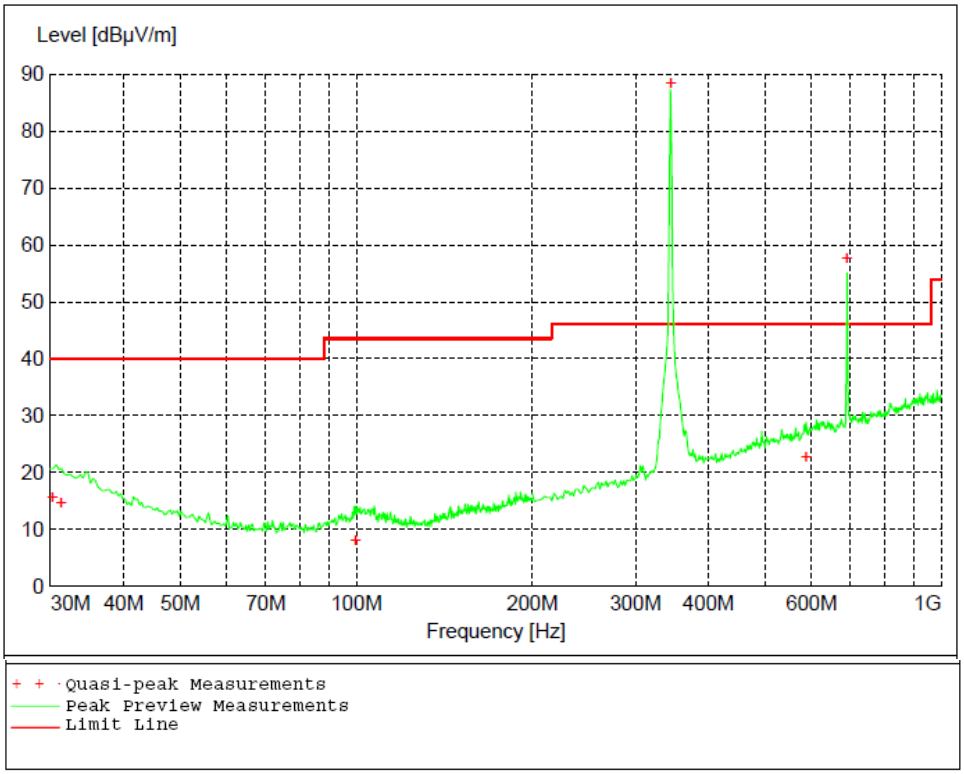



**Figure 5 - Radiated Emissions Plot**

**Quasi-peak Measurements**

| Frequency | Level | Limit | Margin | Height | Angle | Pol. |
|---|---|---|---|---|---|---|
| MHz | dBµV/m | dBµV/m | dB | cm | deg | |
| 30.240000 | 15.43 | 40.00 | 24.60 | 172 | 229 | HORI |
| 31.320000 | 14.69 | 40.00 | 25.30 | 377 | 146 | HORI |
| 99.720000 | 7.86 | 43.50 | 35.70 | 291 | 167 | VERT |
| 345.000000 | 72.71** | 77.26* | 4.55 | 169 | 120 | HORI |
| 588.120000 | 22.56 | 46.00 | 23.40 | 394 | 81 | HORI |
| 690.000000 | 41.81*** | 57.26* | 15.45 | 136 | 325 | HORI |

*Limit from FCC Part 15.231 (a) in an unrestricted band
**Average measurement calculated from peak measurement of 88.50dBµVm with duty cycle correction factor applied per figure 2
***Average measurement calculated from peak measurement of 57.60dBµVm with duty cycle correction factor applied per figure 2

**Average Measurements**

| Frequency | Level | Limit | Margin | Height | Angle | Pol. |
|---|---|---|---|---|---|---|
| MHz | dBµV/m | dBµV/m | dB | cm | deg | |
| 1035.0000 | 41.9 | 54.00 | 12.10 | 130 | 271 | HORI |
| 1380.0000 | 43.46 | 54.00 | 10.54 | 100 | 339 | HORI |
| 1725.0000 | 48.24 | 57.26 | 9.02 | 130 | 183 | HORI |
| 2070.0000 | 51.84 | 57.26 | 5.42 | 100 | 272 | HORI |
| 2415.0000 | 48.16 | 57.26 | 9.10 | 115 | 280 | HORI |
| 2760.0000 | 48.08 | 54.00 | 5.92 | 187 | 170 | HORI |
| 3105.0000 | 46.15 | 57.26 | 11.11 | 106 | 226 | HORI |
| 3450.0000 | 54.07 | 57.26 | 3.19 | 100 | 219 | HORI |
| 3795.0000 | 49.81 | 54.00 | 4.19 | 187 | 314 | HORI |

Average measurements = Peak measurements – Duty Cycle Correction (See figure 3)
Restricted band frequencies from FCC Part 15.205; Limit from FCC Part 15.209
Unrestricted band frequencies from FCC Part 15.205; Limit from FCC Part 15.231(a)

**Peak Measurements**

| Frequency | Level | Limit | Margin | Height | Angle | Pol. |
|---|---|---|---|---|---|---|
| MHz | dBµV/m | dBµV/m | dB | cm | deg | |
| 1035.0000 | 57.69 | 74.00 | 16.31 | 130 | 271 | HORI |
| 1380.0000 | 59.25 | 74.00 | 14.75 | 100 | 339 | HORI |
| 1725.0000 | 64.03 | 77.26 | 13.23 | 130 | 183 | HORI |
| 2070.0000 | 67.63 | 77.26 | 9.63 | 100 | 272 | HORI |
| 2415.0000 | 63.95 | 77.26 | 13.31 | 115 | 280 | HORI |
| 2760.0000 | 63.87 | 74.00 | 10.13 | 187 | 170 | HORI |
| 3105.0000 | 61.94 | 77.26 | 15.32 | 106 | 226 | HORI |
| 3450.0000 | 69.86 | 77.26 | 7.40 | 100 | 219 | HORI |
| 3795.0000 | 65.6 | 74.00 | 8.40 | 187 | 314 | HORI |

Note: Peak measurements must be less than average limits + 20 dB

## *4.4 Bandwidth*

### *4.4.1 Limits of bandwidth measurements*

The 20 dB Band width must be less than 0.25% of center frequency.

### *4.4.2 Test procedures*

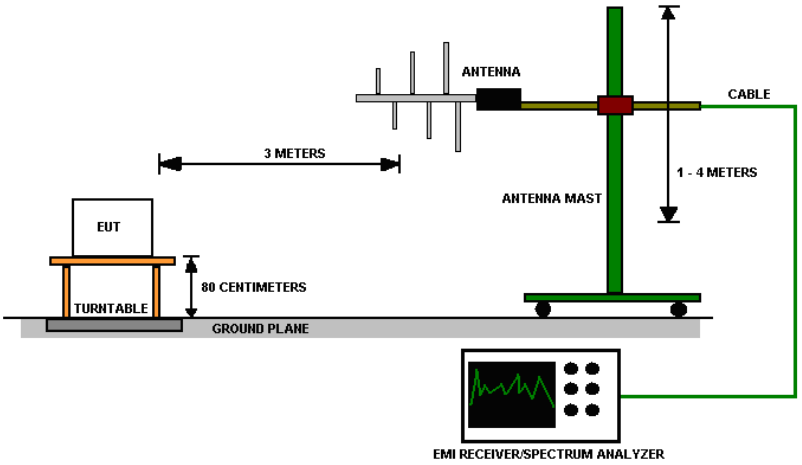
1. The EUT was tested as described in Section 4.1. The EUT orientation was adjusted to produce the maximum emission.

2. The bandwidth of the fundamental frequency was measured by spectrum analyzer with 10 kHz RBW and 30 kHz VBW. The 99% occupied is defined as the bandwidth at which 99% of the signal power is found. This corresponds to 20dB down from the maximum power level. The maximum power was measured with the large resolution bandwidth (1 MHz) and this value was recorded. The signal was then captured with a 10 kHz resolution bandwidth and the frequencies where the measurements were 20dB below the maximum power were marked. The bandwidth between these frequencies was recorded as the 99% occupied bandwidth.

### *4.4.3 Deviations from test standard*

No deviation.

### *4.4.4 Test setup*




### *4.4.5 EUT operating conditions*

See section 2.6.

*4.4.6 Test results*

| | | | |
|---|---|---|---|
| EUT | Smoke Detector | Model | 51000-355 |
| MODE | Continuous Transmit | FREQUENCY RANGE | 30 MHz – 4 GHz |
| INPUT POWER (SYSTEM) | 4.5 VDC | ORIENTATION | Horizontally Placed Facing the Floor |
| ENVIRONMENTAL CONDITIONS | 44 % ± 5% RH<br>24 ± 3ºC | TECHNICIAN | Kvepuri |

| CHANNEL | CHANNEL FREQUENCY (MHz) | 99% Occupied BW LIMIT (kHz) | 99% Occupied BW (kHz) | RESULT |
|---|---|---|---|---|
| 1 | 345.00 | 862.50 | 60.57 | PASS |

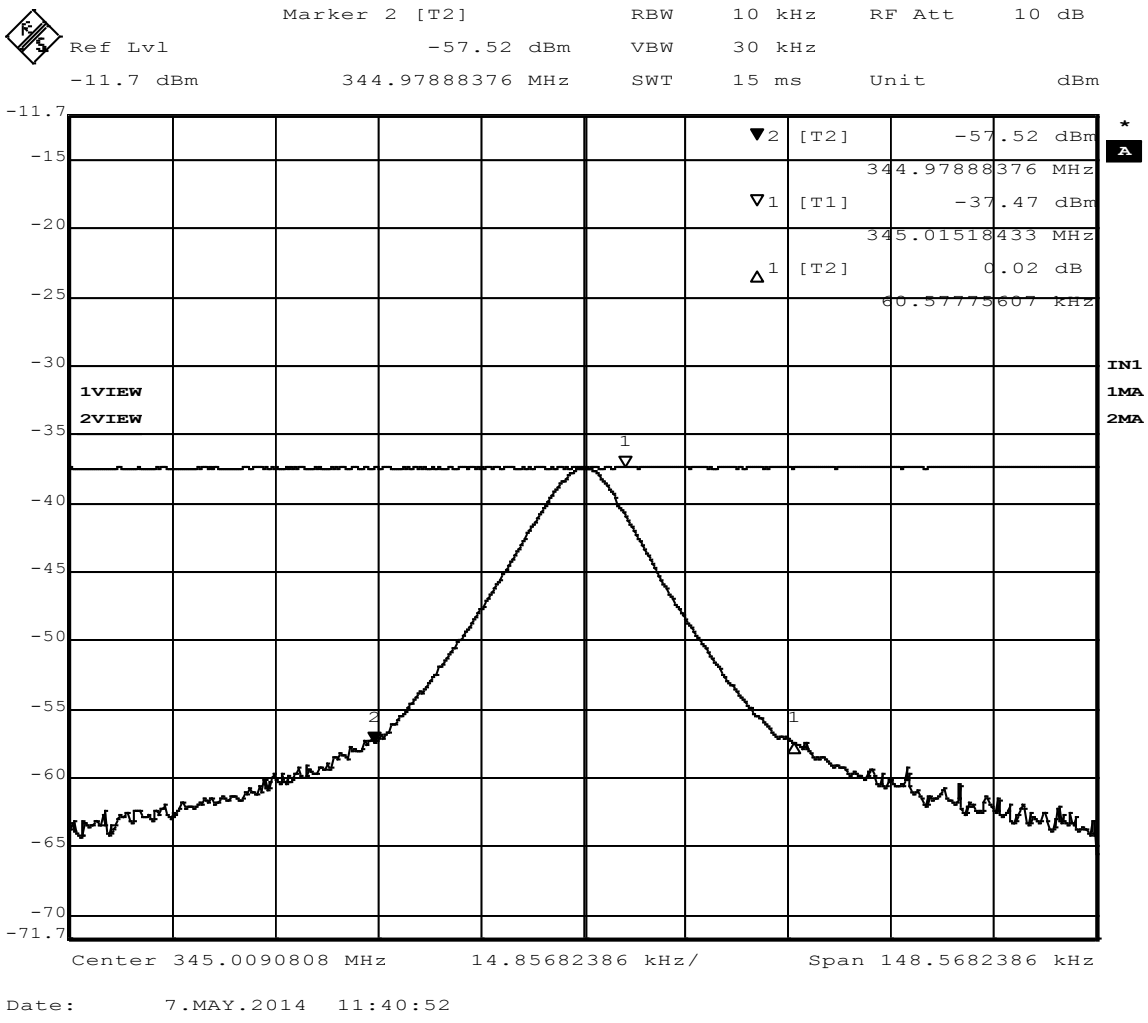



**Figure 6 - 99% Occupied Bandwidth**

## *4.5 Maximum peak output power*

### *4.5.1 Limits of power measurements*

Informational only

### *4.5.2 Test procedures*

1. The EUT was tested as described in Section 4.1. The EUT orientation was adjusted to produce the maximum emission.

2. The resolution bandwidth was set to 1 MHz and the video bandwidth was set to 1 MHz to capture the maximum amount of signal. The analyzer used a peak detector in max hold mode. This represented the maximum output power.

### *4.5.3 Deviations from test standard*

No deviation.

### *4.5.4 Test setup*

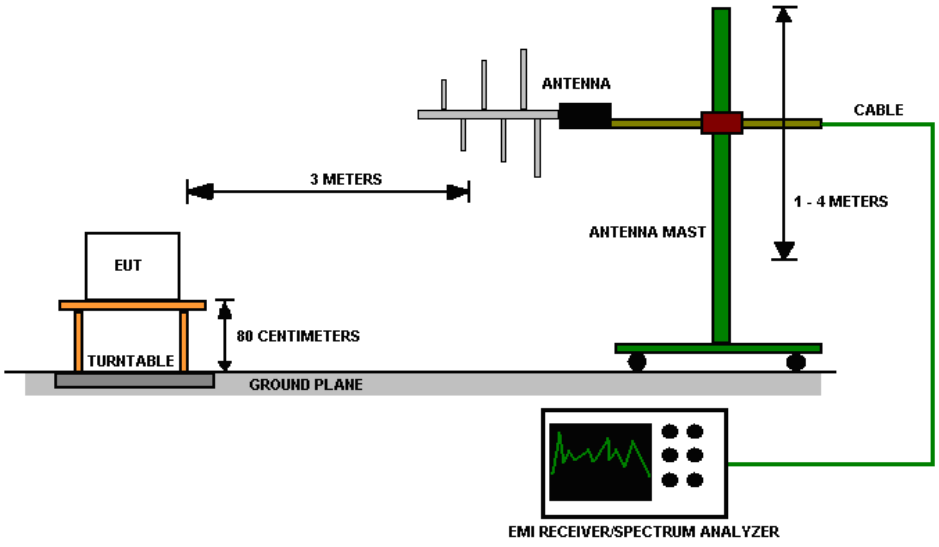



**Figure 7 – Power Measurement Test Setup**

### *4.5.5 EUT operating conditions*

See Section 2.6

### *4.5.6 Test results*

**Maximum peak output power**

| | | | |
|---|---|---|---|
| EUT | Smoke Detector | Model | 51000-355 (xxx) |
| MODE | Continuous Transmit | FREQUENCY RANGE | 30 MHz – 4 GHz |
| INPUT POWER (SYSTEM) | 4.5 VDC | ORIENTATION | Horizontally Placed Facing the Floor |
| ENVIRONMENTAL CONDITIONS | 44 % ± 5% RH 24 ± 3ºC | TECHNICIAN | Kvepuri |

| CHANNEL | CHANNEL FREQUENCY (MHz) | EIRP PEAK POWER OUTPUT (dBm) | PEAK POWER LIMIT (dBm) | RESULT |
|---|---|---|---|---|
| 1 | 345.00 | -7.30 | 30 | PASS |

69.38 dBµV/m at 3m with 10MHz resolution bandwidth.

Antenna factor correction = 15.5 dB

Cable loss correction = 2.9 dB

EIRP = -7.30 dBm.

*4.6*

# Appendix A: Test Photos

**Figure 8 - Radiated Emissions Test Setup**

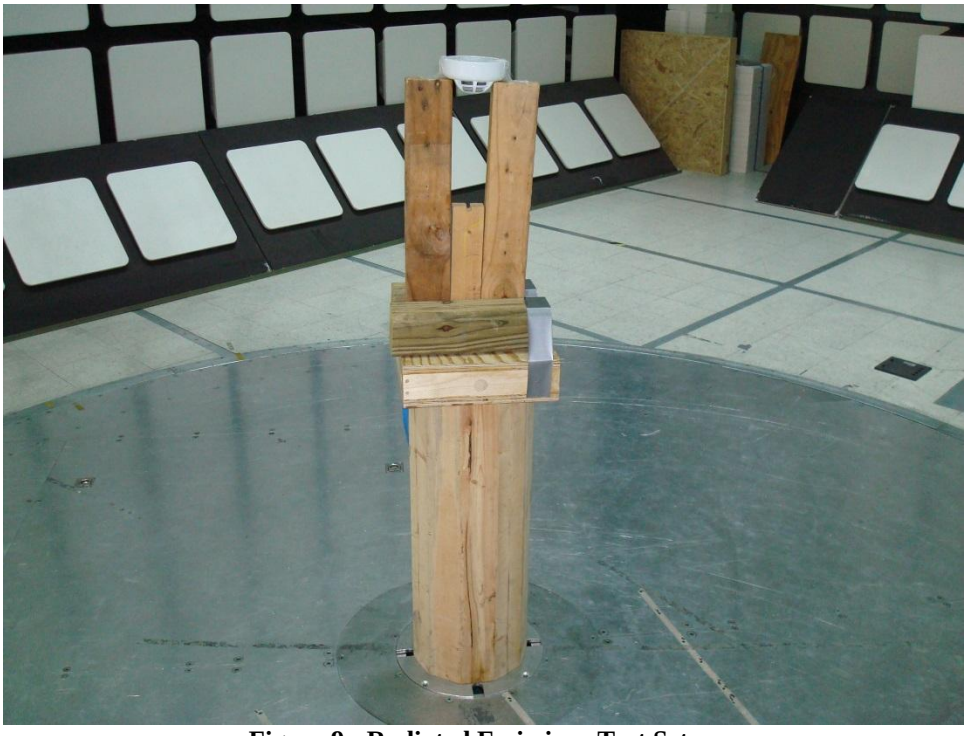


**Figure 9 - Radiated Emissions Test Setup**

# Appendix B: Sample Calculation

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:
FS = RA + AF – (-CF + AG) + AV

where FS = Field Strength

RA = Receiver Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

AG = Amplifier Gain

AV = Averaging Factor (if applicable)

Assume a receiver reading of 55 dBμV is obtained. The Antenna Factor of 12 and a Cable Factor of 1.1 is added. The Amplifier Gain of 20 dB is subtracted, giving a field strength of 48.1 dBμV/m.

FS = 55 + 12 – (-1.1 + 20) + 0 = 48.1 dBμV/m

The 48.1 dBμV/m value can be mathematically converted to its corresponding level in μV/m.

Level in μV/m = Common Antilogarithm [(48.1 dBμV/m)/20]= 254.1 μV/m

**AV is calculated by the taking the 20*log($T_{on}$/100) where $T_{on}$ is the maximum transmission time in any 100ms window**

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**EIRP Calculations**

In cases where direct antenna port measurement is not possible or would be inaccurate, output power is measured in EIRP. The maximum field strength is measured at a specified distance and the EIRP is calculated using the following equation;

*EIRP (Watts) = [Field Stregnth (V/m) x antenna distance (m)]$^2$ / [30 x Gain (numeric)]*

*Power (watts) = 10^[Power (dBm)/10] x 1000*

*Field Strength (dBµV/m) = Field Stregth (dBm) = 107 (for 50Ω measurement systems)*

*Field Stregnth (V/m) = 10^[Field Stregnth (dBµV/m) / 20] / 10^6*

***Gain = 1 (numeric gain for isotropic radiator)***