

Amended Test Report

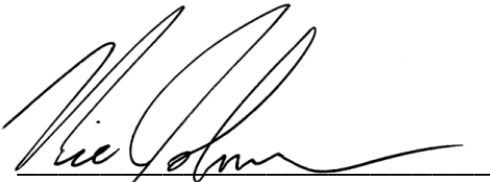
Includes NCEE Labs report R20140409-21-02C and its amendment in full

Company: Apollo America
25 Corporate Dr.
Auburn Hills, MI 48326

Product: Wireless Carbon Monoxide Detector
M/N 51000-305

Test Report No: R20140409-21-02D

FCC ID: 2ACE9-51000305
IC: 12011A-51000305

Approved by: 
Nic S. Johnson, NCE
EMC Test Engineering Manager/Technical Manager
iNARTE Certified EMC Engineer #EMC-003337-NE

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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 RSS-210 Sec 2.6	Radiated Emissions	Pass	Meets the requirement of the limit.
FCC Part 15.231 RSS-210 Annex I	Minimum Bandwidth, Limit: 862.5 kHz	Pass	Meets the requirement of the limit.
FCC Part 15.231 RSS-210 Sec 2.6	Transmitter Radiated Emissions, 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 Carbon Monoxide Detector manufactured by Apollo America. It is used to remotely communicate with fire stations in a state of emergency.

EUT Received Date: 2014 MAY 07

EUT Tested Date: 2014 MAY 07

PRODUCT	Carbon Monoxide Detector
MODEL	51000-305
POWER INPUT	3 VDC (1*3 VDC LI battery)
MODULATION TYPE	ASK-OOK
FREQUENCY RANGE	345 MHz
NUMBER OF CHANNELS	1
MAXIMUM OUTPUT POWER	-5.66 dBm EIRP
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 $44 \pm 4\%$

Temperature of $24 \pm 3^\circ$ 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 3 VDC (1*3 VDC LI battery) 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 ($\mu\text{V/m}$)	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) = $20 * \log * \text{Emission level (uV/m)}$.
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.

REMARKS:

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

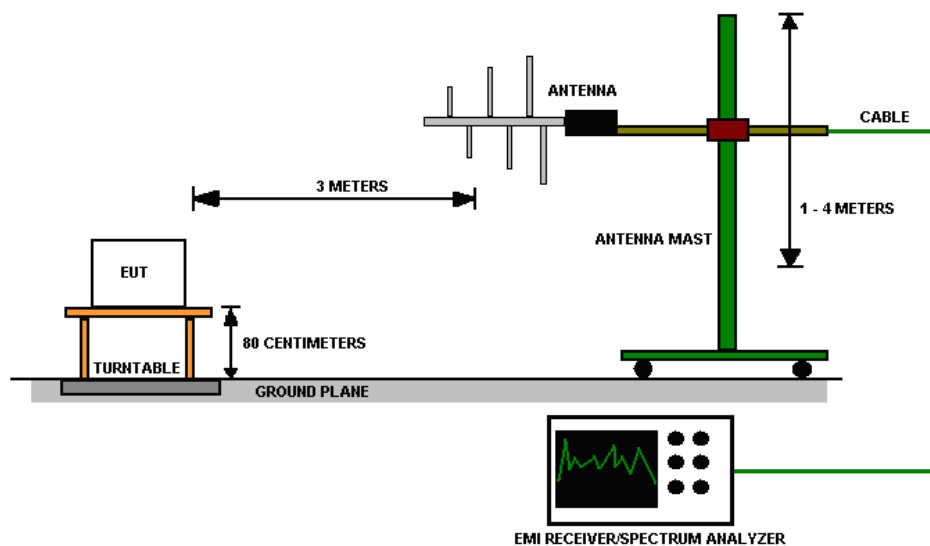


Figure 1 - Radiated Emissions Test Setup

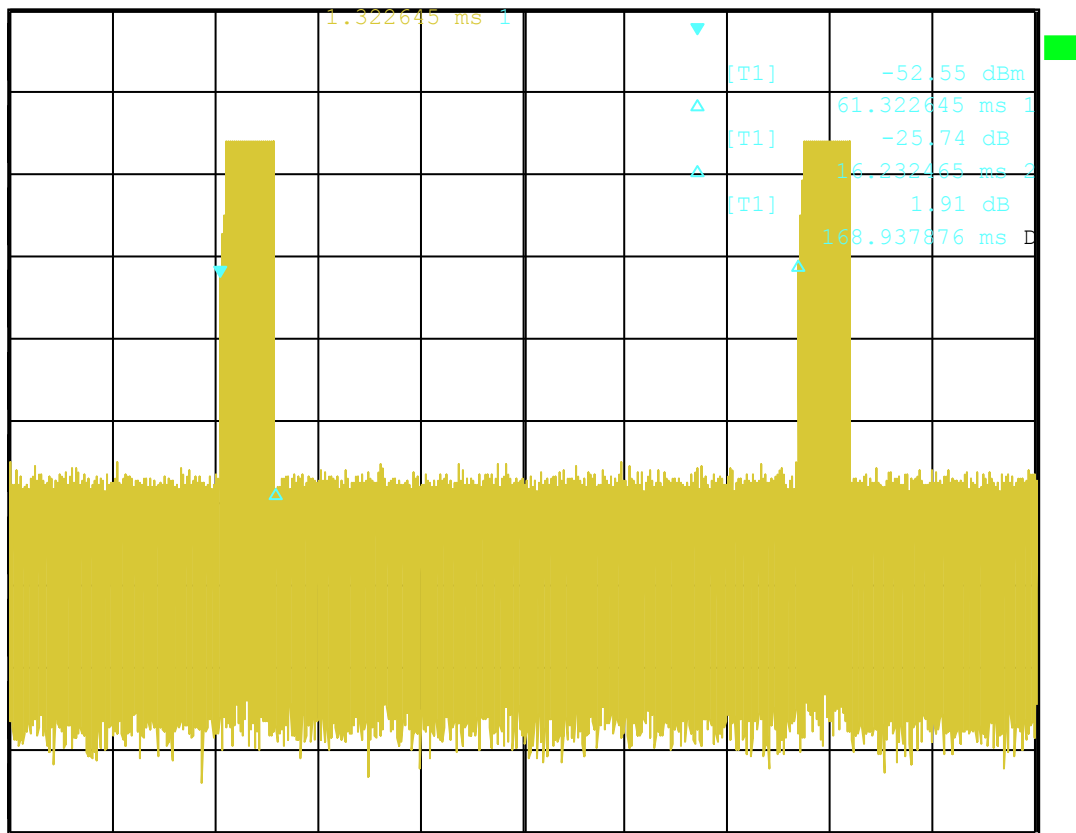
For the actual test configuration, please refer to Appendix A for photographs of the test configuration.

4.2.5 EUT operating conditions

See section 2.6.

4.2.6 Test results

EUT	Carbon Monoxide Detector	Model	51000-305
MODE	Continuous Transmit	FREQUENCY RANGE	30 MHz – 4 GHz
INPUT POWER (SYSTEM)	3 VDC	ORIENTATION	Horizontally Placed Facing the Floor
ENVIRONMENTAL CONDITIONS	44 % ± 5% RH 24 ± 3°C	TECHNICIAN	Kvempuri



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Figure 2 – Maximum Duty Cycle Plot, Alarm Mode

On time = 16.23 ms Period = 100 ms (maximum allowed)

Duty cycle = 16.23 ms / 100.00 ms = 16.23%

Duty cycle correction factor = $20 * \log(0.469) = -15.79 \text{ dB}$

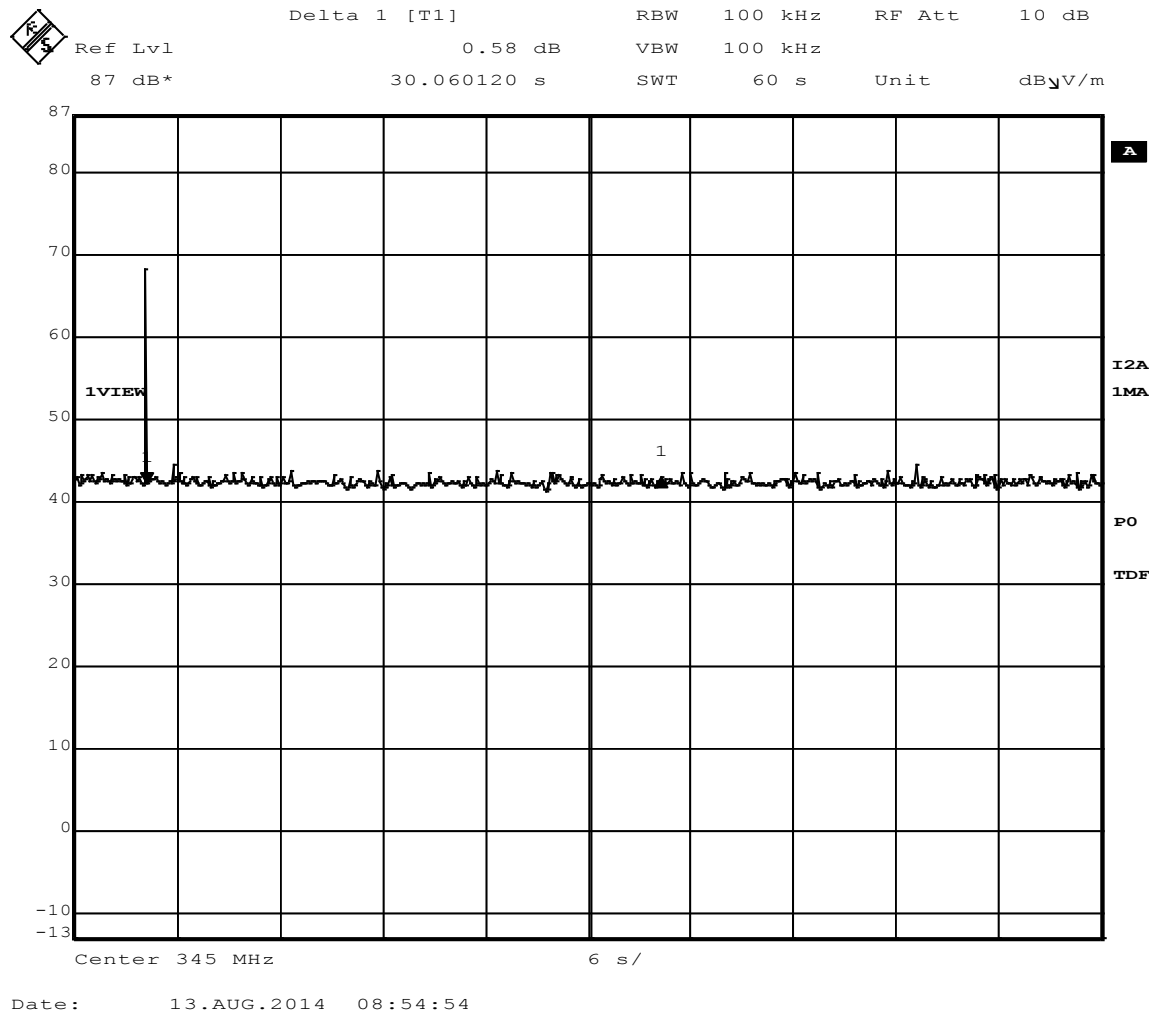


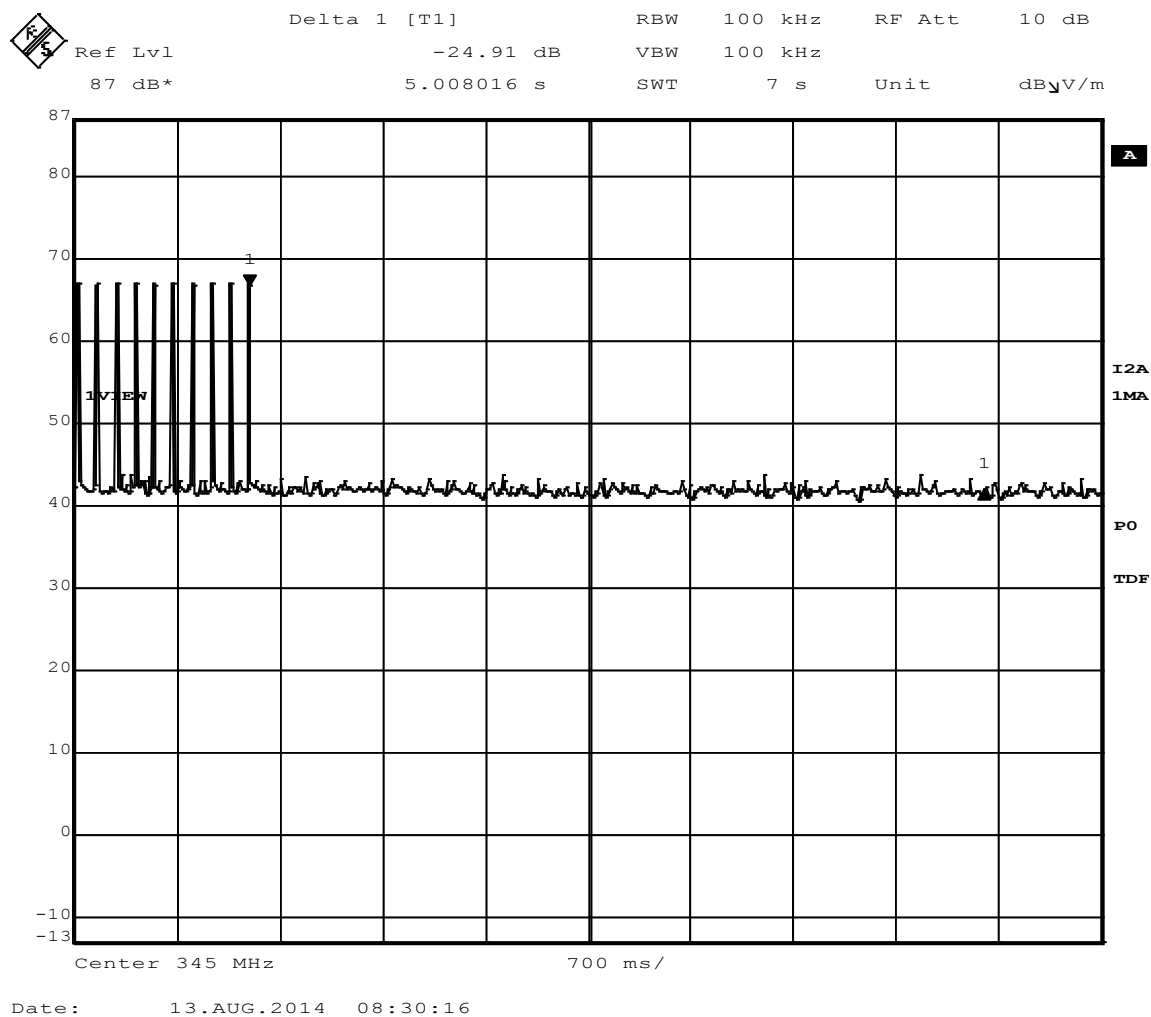
Figure 3 – Transmissions Stop Time, Standby Mode

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 ($16.23 \text{ ms} \times 60$)

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.

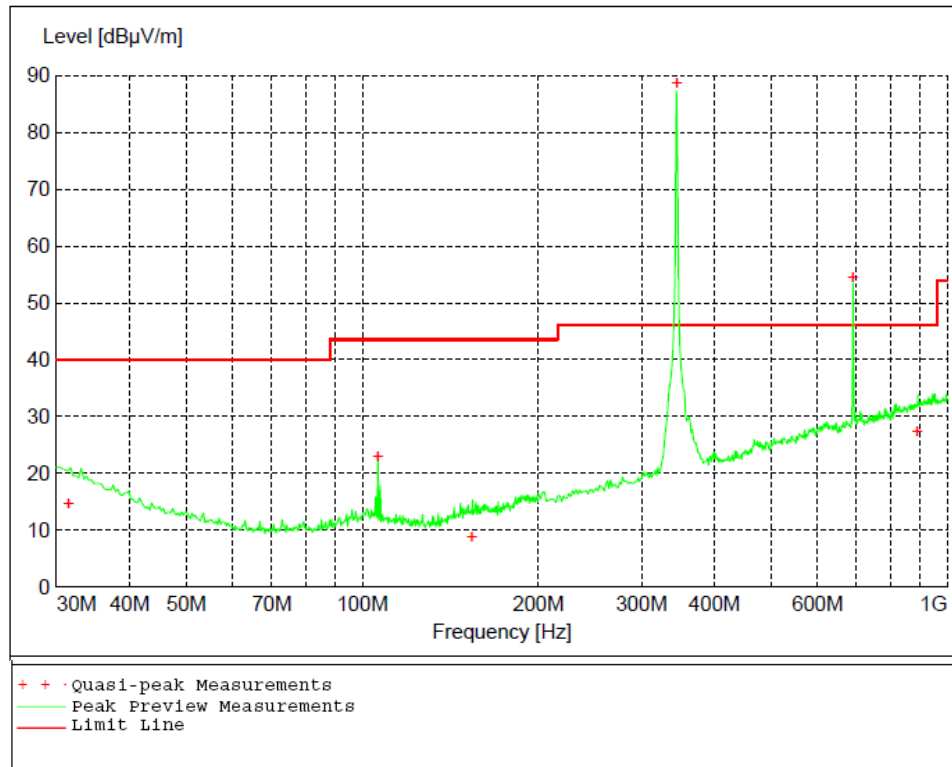


Figure 5 - Radiated Emissions Plot

Quasi-peak Measurements

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBμV/m	dBμV/m	dB	cm	deg	
31.440000	14.60	40.00	25.40	227	360	31.440000
106.260000	22.82	43.50	20.70	139	20	106.260000
154.020000	8.65	43.50	34.90	400	177	154.020000
345.000000	72.71**	77.26*	4.55	170	136	345.000000
690.000000	41.81***	57.26*	15.45	133	139	690.000000
889.860000	27.38	46.00	18.62	399	38	889.860000

*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 3

***Average measurement calculated from peak measurement of 57.60dBμVm with duty cycle correction factor applied per figure 3

Average Measurements

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBμV/m	dBμV/m	dB	cm	deg	
1035.000000	44.92	54.00	9.08	130	271	HORI
1380.000000	42.42	54.00	11.58	100	339	HORI
1725.000000	51.58	57.26	5.68	130	183	HORI
2070.000000	54.26	57.26	3.00	100	272	HORI
2415.000000	50.04	57.26	7.22	115	280	HORI
2760.000000	45.36	54.00	8.64	187	170	HORI
3105.000000	46.81	57.26	10.45	106	226	HORI
3450.000000	53.44	57.26	3.82	100	219	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	
1035.000000	60.71	74.00	13.29	130	271	HORI
1380.000000	58.21	74.00	15.79	100	339	HORI
1725.000000	67.37	77.26	9.89	130	183	HORI
2070.000000	70.05	74.00	3.95	100	272	HORI
2415.000000	65.83	77.26	11.43	115	280	HORI
2760.000000	61.15	77.26	16.11	187	170	HORI
3105.000000	62.60	77.26	14.66	106	226	HORI
3450.000000	69.23	77.26	8.03	100	219	HORI

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

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)

4.4 Bandwidth

4.4.1 Limits of bandwidth measurements

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

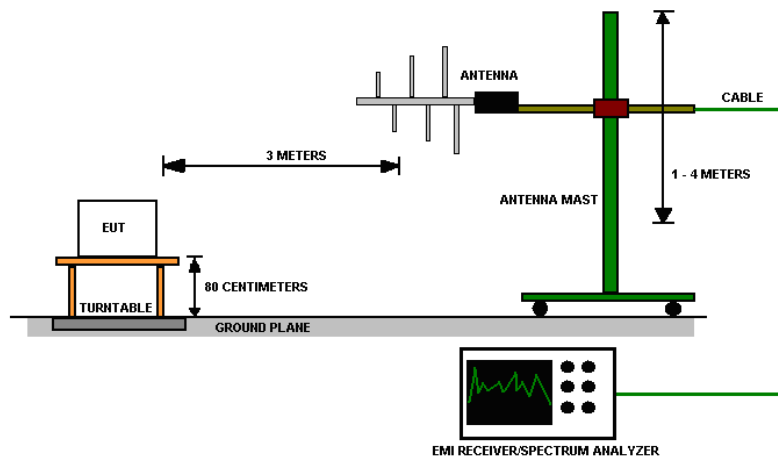
4.4.2 Test procedures

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	Carbon Monoxide Detector	Model	51000-305
MODE	Continuous Transmit	FREQUENCY RANGE	30 MHz – 4 GHz
INPUT POWER (SYSTEM)	3 VDC	ORIENTATION	Horizontally Placed Facing the Floor
ENVIRONMENTAL CONDITIONS	44 % \pm 5% RH 24 \pm 3°C	TECHNICIAN	Kvepuri

CHANNEL	CHANNEL FREQUENCY (MHz)	99% Occupied BW LIMIT (kHz)	99% Occupied BW (kHz)	RESULT
1	345.00	862.50	57.92	PASS

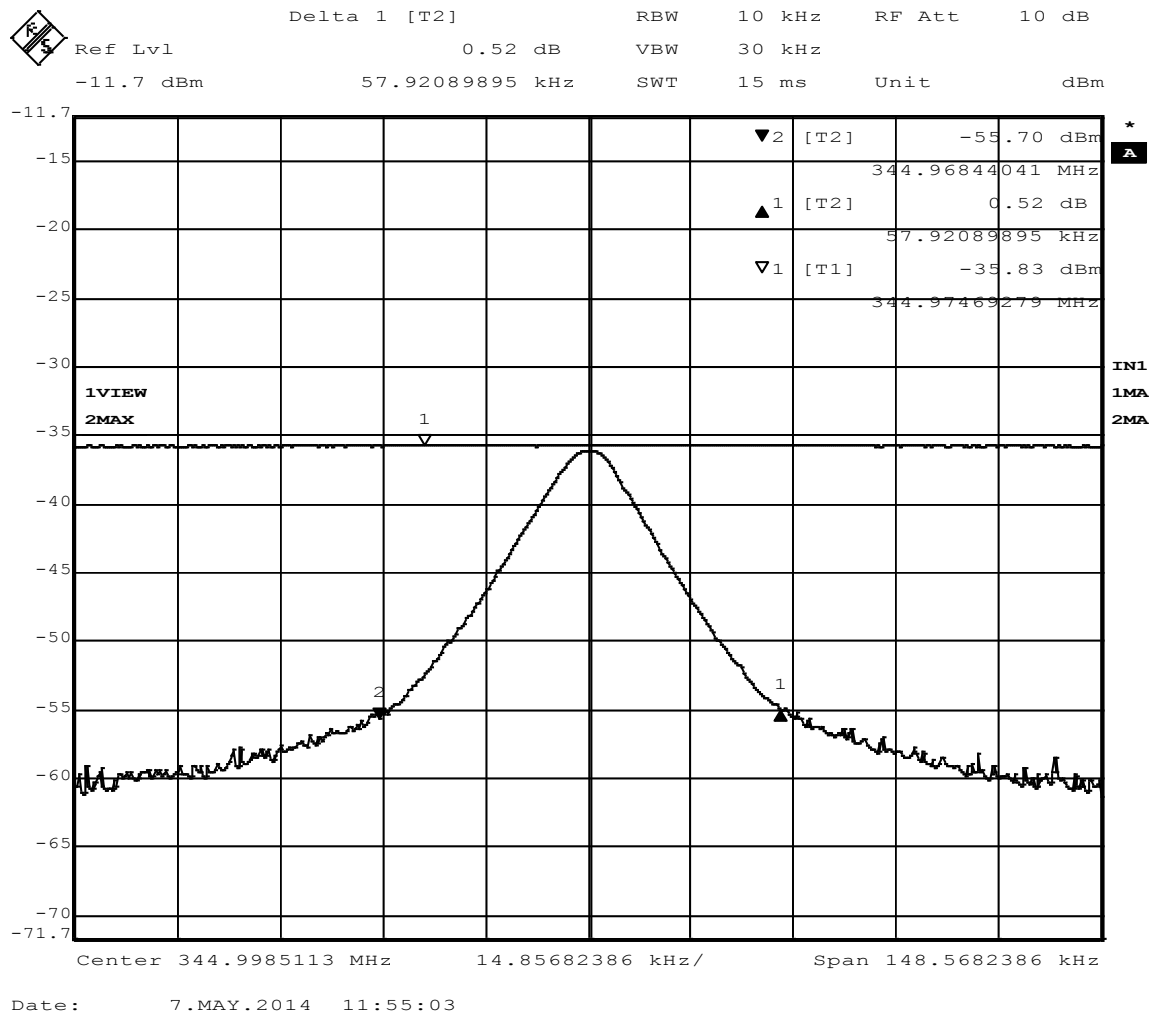


Figure 6 - 99% Occupied Bandwidth

4.5 *Maximum peak output power*

4.5.1 *Limits of power measurements*

Informational only

4.5.2 *Test procedures*

3. 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*

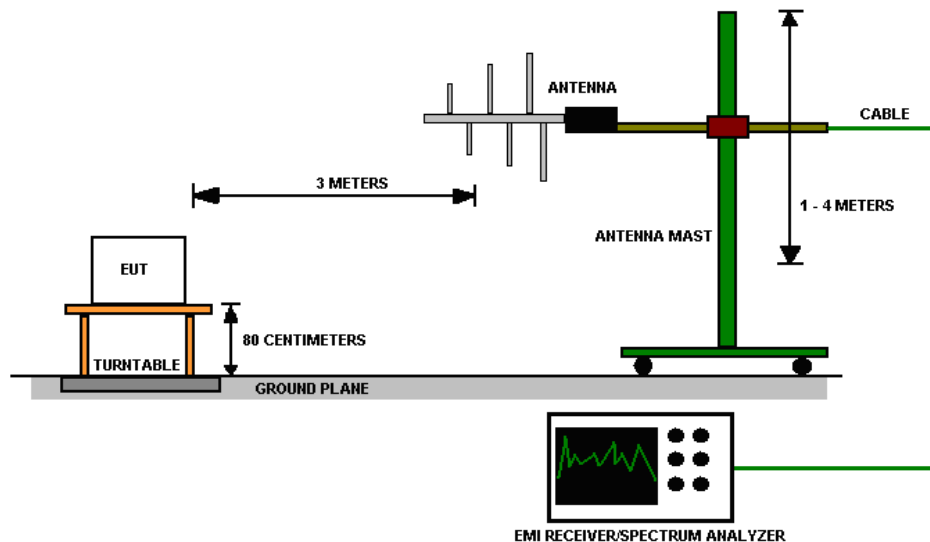


Figure 7 – Power Measurement Test Setup

4.5.5 *EUT operating conditions*

See Section 2.6

4.5.6 Test results

Maximum peak output power

EUT	Carbon Monoxide Detector	Model	51000-305
MODE	Continuous Transmit	FREQUENCY RANGE	30 MHz – 4 GHz
INPUT POWER (SYSTEM)	3 VDC	ORIENTATION	Horizontally Placed Facing the Floor
ENVIRONMENTAL CONDITIONS	44 % \pm 5% RH 24 \pm 3°C	TECHNICIAN	Kvepuri

CHANNEL	CHANNEL FREQUENCY (MHz)	EIRP PEAK POWER OUTPUT (dBm)	PEAK POWER LIMIT (dBm)	RESULT
1	345.00	-5.66	30	PASS

71.17 dB μ V/m at 3m with 10MHz resolution bandwidth (raw value)

Antenna factor correction = 15.5 dB

Cable loss correction = 2.9 dB

EIRP = -5.66 dBm.

4.6

Appendix A: Test Photos



Figure 8 - Radiated Emissions Test Setup

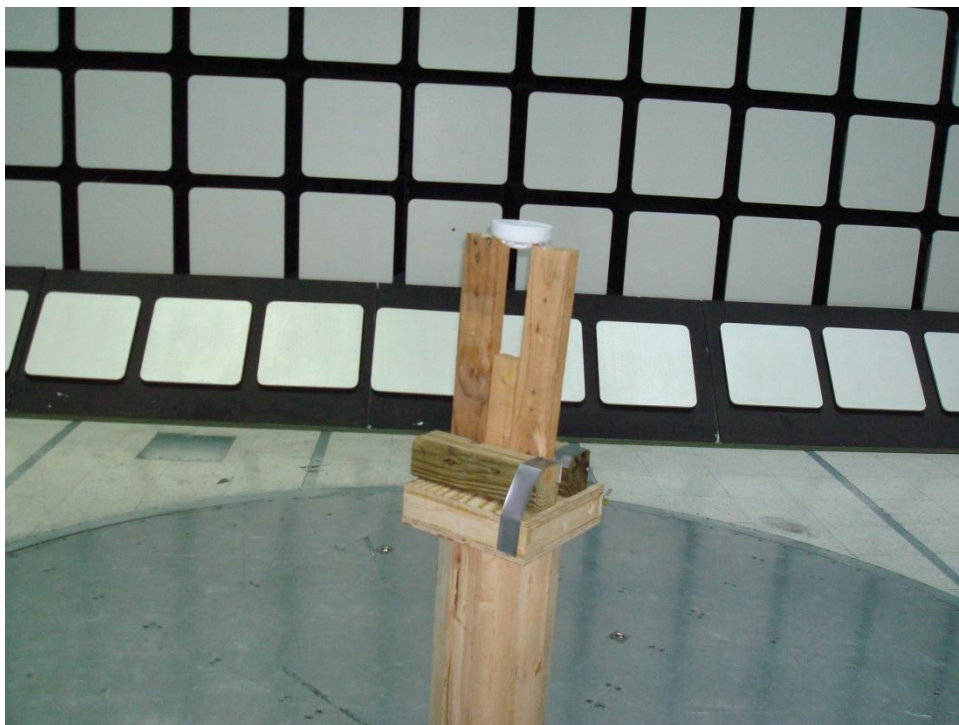


Figure 9 - Radiated Emissions Test Setup

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 dB μ V 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 dB μ V/m.

$$FS = 55 + 12 - (-1.1 + 20) + 0 = 48.1 \text{ dB}\mu\text{V/m}$$

The 48.1 dB μ V/m value can be mathematically converted to its corresponding level in μ V/m.

$$\text{Level in } \mu\text{V/m} = \text{Common Antilogarithm} [(48.1 \text{ dB}\mu\text{V/m})/20] = 254.1 \mu\text{V/m}$$

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

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;

$$EIRP \text{ (Watts)} = [Field \text{ Strength (V/m)} \times antenna \text{ distance (m)}]^2 / [30 \times Gain \text{ (numeric)}]$$

$$Power \text{ (watts)} = 10^{[Power \text{ (dBm)}/10]} \times 1000$$

$$Field \text{ Strength (dB}\mu\text{V/m)} = Field \text{ Strength (dBm)} = 107 \text{ (for } 50\Omega \text{ measurement systems)}$$

$$Field \text{ Strength (V/m)} = 10^{[Field \text{ Strength (dB}\mu\text{V/m)} / 20]} / 10^6$$

$$Gain = 1 \text{ (numeric gain for isotropic radiator)}$$