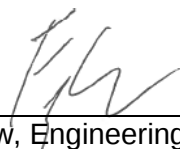


EMC Test Report

Project Number: 4129490**Report Number: 4129490EMC03****Revision Level: 0****Client: Carnegie Robotics LLC****Equipment Under Test: Module - Platform****Model: 56104543****FCC ID: 2AMDR00067****Applicable Standards: FCC Part 15 Subpart C, § 15.231****ANSI C63.10: 2013****Report issued on: 10 August 2017****Test Result: Compliant**

Tested by:


Fendy Liauw, Engineering Technician

Reviewed by:


David Schramm, Operations Manager

Remarks: This report details the results of the testing carried out on one sample, the results contained in this test report do not relate to other samples of the same product. The manufacturer should ensure that all products in series production are in conformity with the product sample detailed in this report.

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1 Summary of Test Results

Test Description	Test Specification	Test Result
Antenna Requirement	15.203	Compliant (1)
Occupied Bandwidth	15.231(c)	Compliant
Radiated Emissions	15.205 and 15.231(b)	Compliant
Transmitter De-activation Time	15.231(a)	Compliant
Duty Cycle Correction Factor	ANSI C63.10:2013	Reported
AC Power Line Conducted Emission	15.107, 15.207	NA(2)

(1) External, Detachable, Reverse SMA polarity

(2) The device does not connect to the AC mains

1.1 Modifications Required to Compliance

None

2 General Information

2.1 *Client Information*

Name: Carnegie Robotics LLC
Address: 4501 Hatfield Street
City, State, Zip, Country: Pittsburgh, PA 15201

2.2 *Test Laboratory*

Name: SGS Consumer Testing and Retail Services
Address: 620 Old Peachtree Road NW, Suite 100
City, State, Zip, Country: Suwanee, GA 30024, USA

2.3 *General Information of EUT*

Type of Product: Module - Platform
Model: 56104543
Serial Number: 00000041

Frequency Range: 433.92MHz

Antenna: External, 7" Detachable Monopole Antenna (Reverse SMA)

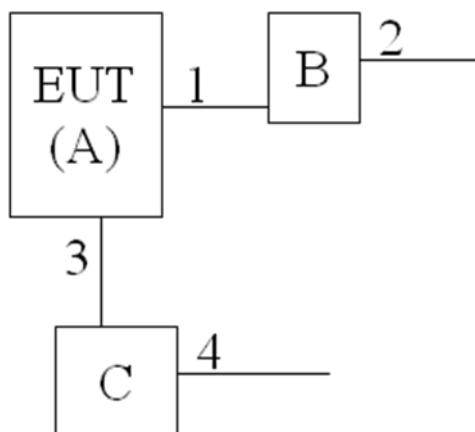
Rated Voltage: 24 VDC

Sample Received Date: 10 April 2017
Dates of testing: 11 – 27 April 2017 / 10 August 2017

2.4 *Operating Modes and Conditions*

During spurious emissions testing, software was used to configure the device for continuous transmissions.

2.5 EUT Connection Block Diagram



2.6 System Configurations

Device reference	Manufacturer	Description	Model Number	Serial Number
A	Carnegie Robotics LLC	Module - Platform	56104543	00000041
B	DR Meter	DC Power Supply	PS-305DM	NSN
C	HP	Laptop	HP 15-f233wm	5CD6415H9V

2.7 Cable List

Cable reference	Port Name	Start	End	Cable Length (m)	Ferrite installed?	Shielded?
1	DC Input	DC Power Supply	EUT	3.5	No	No
2	AC Input	AC Main	DC Power supply	1.5	No	No
3	Data Line	EUT	Laptop	3.5	No	No
4	AC Input	AC Main	Laptop	1.5	No	No

3 Occupied Bandwidth

3.1 Test Result

Test Description	Basic Standards	Test Result
20dB Bandwidth	15.231(c)(1) ANSI C63.10: 2013	Reported

3.2 Test Method

Measurements were recorded using the methods defined in ANSI C63.10, Clause 6.9.2. The 20dB bandwidth (ndB down) measurement function of the spectrum analyzer was employed.

3.2.1 Limit

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 a device operating at 433.92MHz, the limit is 1.08MHz.

3.3 Test Site

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature: 22.4 °C

Relative Humidity: 43.5 %

3.4 Test Equipment

Test Date: 27-Apr-2017

Tester: JOP

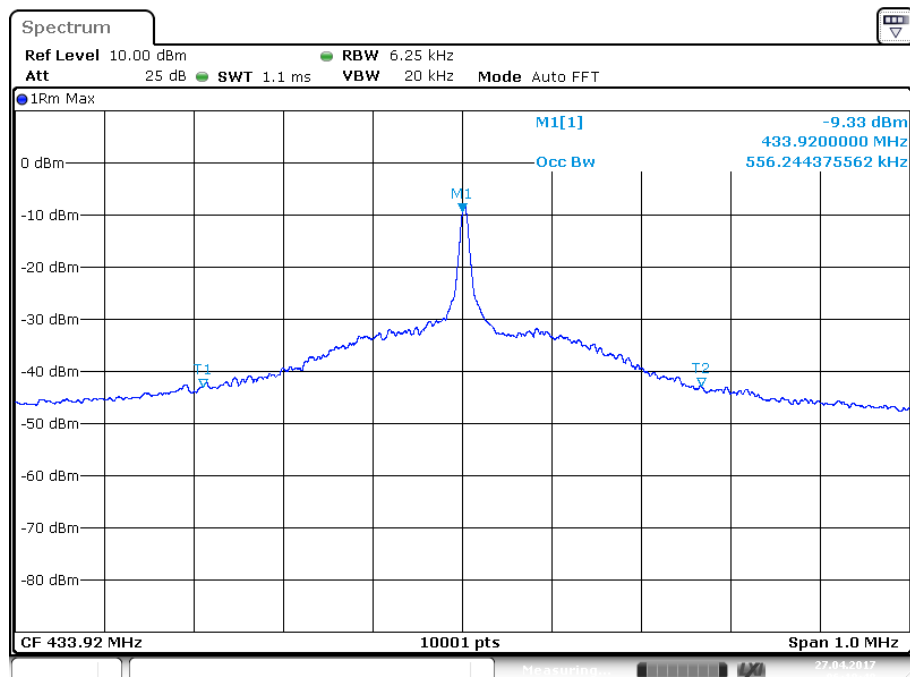
Equipment	Model	Manufacturer	Asset Number	Cal Due Date
SIGNAL ANALYZER	FSV30	ROHDE & SCHWARZ	B085749	8-Oct-2017
RF CABLE	141	HUBER & SUHNER	B095588	26-Jul-2017
ATTENUATOR, 10DB	10DB	ROHDE & SCHWARZ	B095591	27-Jul-2017

Note: The equipment calibration period is 1 year except for the FSV which is on a 2-year calibration cycle.

3.5 Test Data

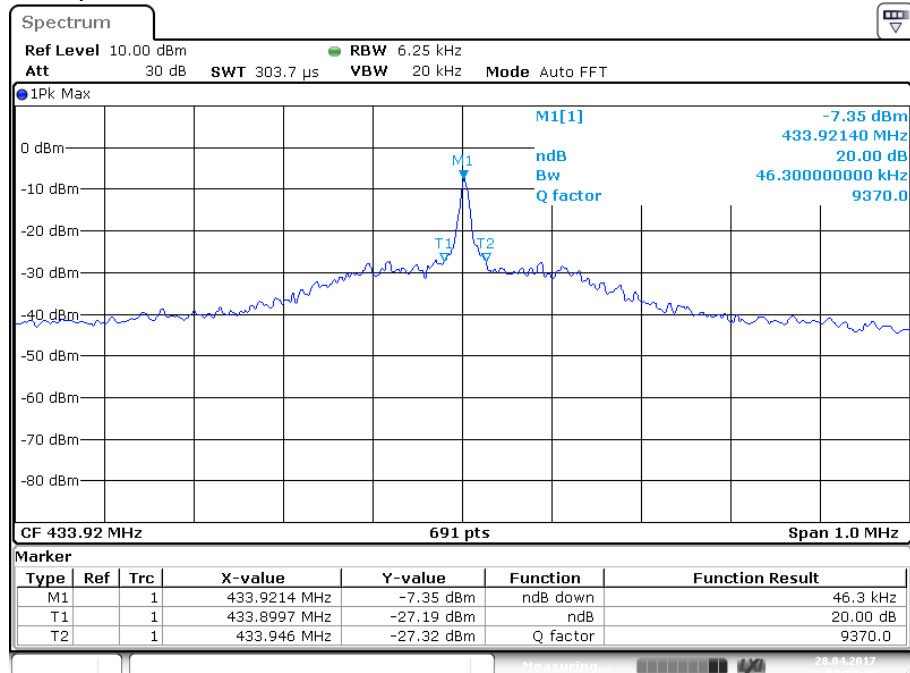
Frequency (MHz)	20 dB bandwidth (MHz)	99% OBW (MHz)
433.92	0.0463	0.5562

Sample Plots 20dB Bandwidth



Date: 27.APR.2017 06:18:48

Occupied Bandwidth = 556.2kHz



Date: 28.APR.2017 03:10:49

20dB Bandwidth = 46.3kHz

4 Radiated Emissions

4.1 Test Result

Test Description	Basic Standards	Test Result
Radiated Emissions	15.231(b) 15.209 ANSI C63.10:2013	Compliant

4.2 Test Method

Radiated emissions were measured using the methods defined in ANSI C63.10, Clauses 6.5 and 6.6. Because the fundamental transmission frequency was 433.92MHz, measurements were limited to 5GHz.

4.2.1 Limits

Fundamental Frequency (MHz)	Field strength of fundamental (μV/m)	Field strength of spurious emission (μV/m)
40.66-40.70	1000	100
70-130	500	50
130-174	500 to 1500 ⁽¹⁾	50 to 150 ⁽¹⁾
174-260	1500	150
260-470	1500 to 5000 ⁽¹⁾	150 to 500 ⁽¹⁾
Above 470	5000	500

(1) Linear interpolations

At 433.92, the average limits for the fundamental and spurious emissions are 10996.7μV/m (80.8dBμV/m) and 1099.7μV/m (60.8dBμV/m) respectively when measured at a distance of 3 meters.

15.209 Radiated emissions limits (Restricted Bands of Operation)

Frequency Range (MHz)	Limits (uV/m) Quasi-Peak or Average	Measurement Distance (m)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/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

Note: Limits were converted to dBuV/m using the equation $20 \cdot \text{LOG}(x)$. Additionally, for measurements below 30MHz, the limits were adjusted to a distance of 3m using a 40dB/decade correction per §15.31(f)(2)

Example: at 20MHz, the limit is expressed as 30uV/m at 30m

$$20 \cdot \log(30) = 29.5 \text{ dBuV/m}$$

30 to 3 meters is a single decade, so $29.5 + 40 = 69.5 \text{ dBuV/m}$

4.3 Test Site

3m Absorber Lined Shielded Enclosure (ALSE), Suwanee, GA

Environmental Conditions

Temperature: 25.1 °C
Relative Humidity: 37.4 %
Atmospheric Pressure: 98.2 kPa

4.4 Test Equipment

Test Date: 13-Apr-2017

Tester: FL

Equipment	Model	Manufacturer	Asset Number	Cal Due Date
ANTENNA, BILOG	JB6	SUNOL	B079689	8-Sep-2017
RF CABLE	NFS-290-78.7-NFS	FLORIDA RF LABS	B095019	28-Jul-2017
RF CABLE	NMS-290-236.2-NMS	FLORIDA RF LABS	B095020	29-Jul-2017
RF CABLE	SF106	HUBER & SUHNER	B079661	29-Jul-2017
RF CABLE	SUCOFLEX 100	HUBER & SUHNER	B108523	4-Aug-2017
LOW NOISE AMPLIFIER	TS-PR18	ROHDE & SCHWARZ	15003	29-Jul-2017
EMI TEST RECEIVER	ESU40	ROHDE & SCHWARZ	B079629	25-Apr-2018
FILTER, HIGH PASS (>1150MHZ)	HPM50108	MICRO-TRONICS	B079802	28-Jul-2017
ANTENNA, DRG HORN (MEDIUM)	3117	ETS LINDGREN	B079699	26-Apr-2017

Note: The equipment calibration period is 1 year.

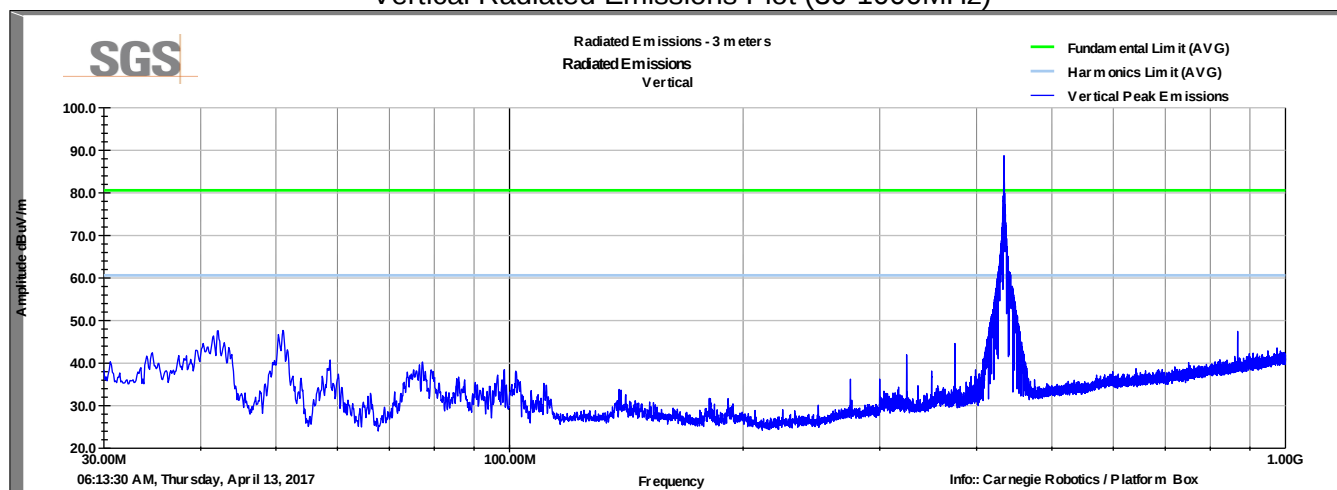
Software:

"Radiated Emissions" TILE! profile dated Dec 2015

4.5 Test Data

There were no emissions detected below 30MHz.

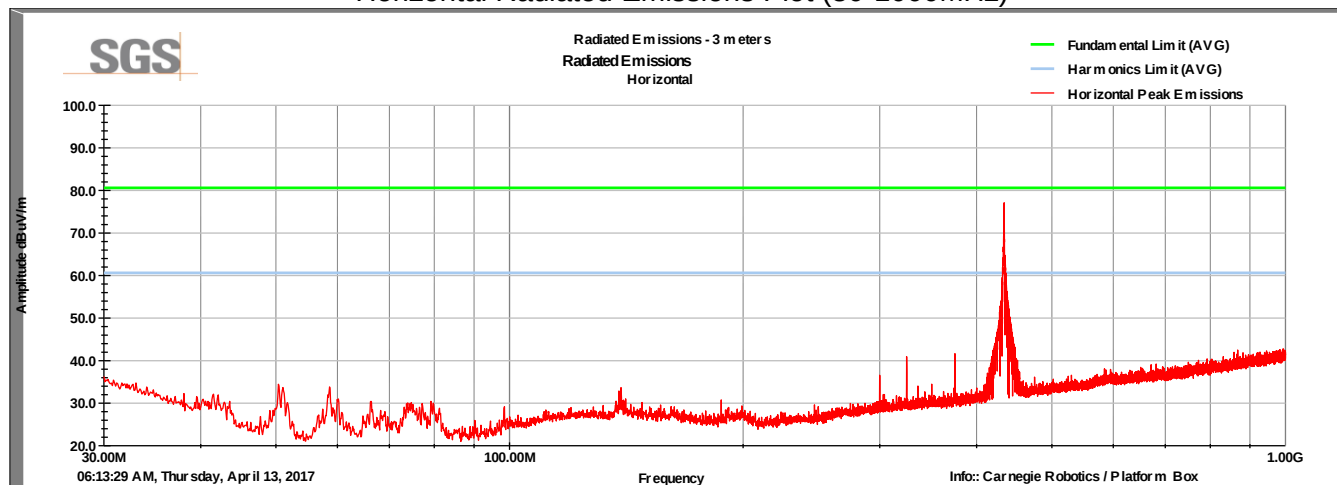
Vertical Radiated Emissions Plot (30-1000MHz)



Vertical Radiated Emissions Data (30-1000MHz)

Frequency MHz	Raw PK (dBuV)	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	DCCF (dB)	Corr Value (dBuV/m)	Limit (dBuV/m)	Margin (dB)
433.93	70.5	V	32.0	127.0	17.0	1.2	0.0	88.7	100.6	-11.9
433.93	70.5	V	32.0	127.0	17.0	1.2	13.1	75.6	80.6	-5.0
867.86	29.3	V	45.0	138.0	17.0	1.2	0.0	47.5	80.6	-33.1
867.86	29.3	V	45.0	138.0	17.0	1.2	13.1	34.4	60.6	-26.2
Corrected Value = Level + AF + CL - DCCF										
Margin = Corrected Value - Limit										

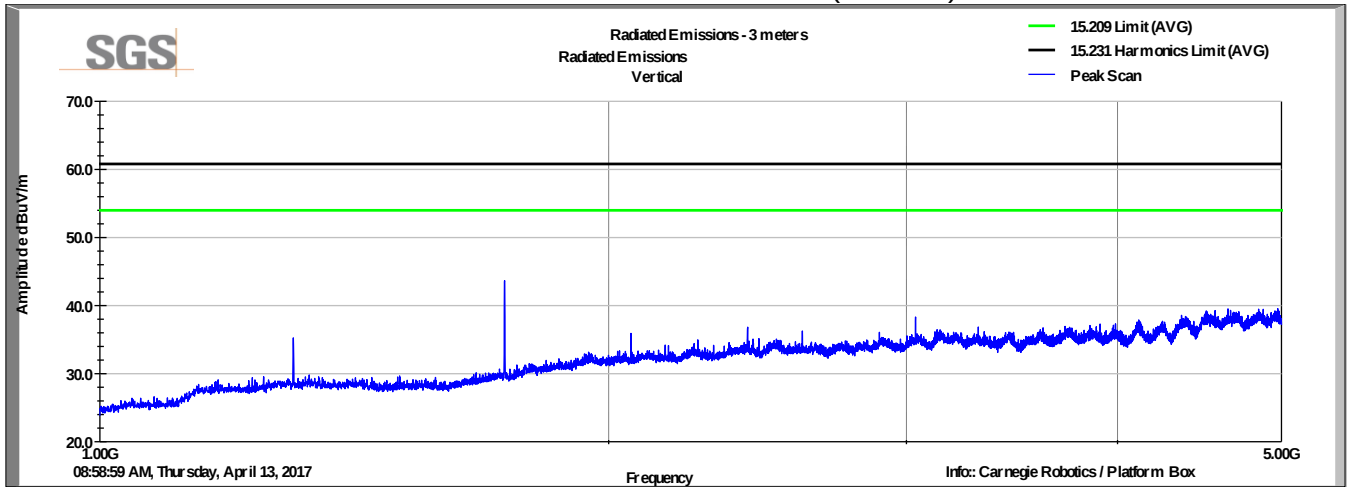
Horizontal Radiated Emissions Plot (30-1000MHz)



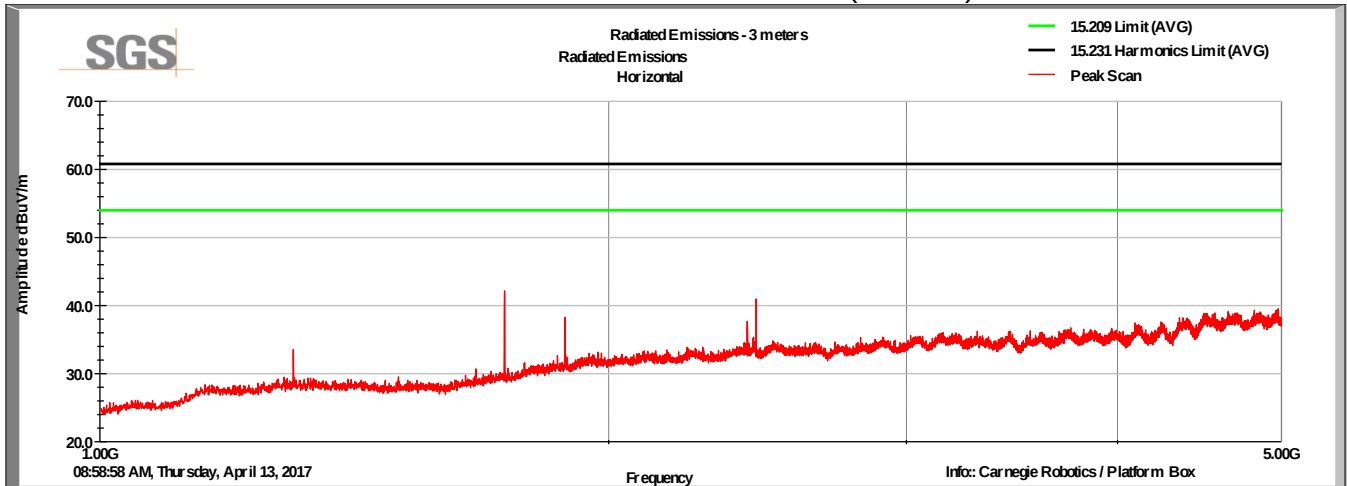
Horizontal Radiated Emissions Data (30-1000MHz)

Frequency MHz	Raw PK (dBuV)	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	DCCF (dB)	Corr Value (dBuV/m)	Limit (dBuV/m)	Margin (dB)
433.93	58.9	H	48.0	272.0	17.0	1.2	0.0	77.1	100.6	-23.5
433.93	58.9	H	48.0	272.0	17.0	1.2	13.1	64.0	80.6	-16.6
Corrected Value = Level + AF + CL - DCCF										
Margin = Corrected Value - Limit										

Vertical Radiated Emissions Plot (1–5GHz)



Horizontal Radiated Emissions Plot (1–5GHz)



Tabular Data – 1-5GHz

Frequency MHz	Raw Peak Meas (dBuV)	Polarity (V/H)	Correction (dB/m)	DCCF (dB)	Corr Value dBuV/m	Limit (dBuV/m)	Margin (dB)	
1301.76	32.9	V	-2.4	0.0	35.3	74.0	-38.7	*
1301.76	32.9	V	-2.4	13.1	22.2	54.0	-31.8	*
1735.68	42.2	V	-1.5	0.0	43.7	80.8	-37.1	
1735.68	42.2	V	-1.5	13.1	30.6	60.8	-30.2	
1301.76	31.2	H	-2.4	0.0	33.6	74.0	-40.4	*
1301.76	31.2	H	-2.4	13.1	20.5	54.0	-33.5	*
1735.68	40.6	H	-1.5	0.0	42.1	80.8	-38.7	
1735.68	40.6	H	-1.5	13.1	29.0	60.8	-31.8	

* Restricted band of operation

5 Transmitter De-activation Time

5.1 Test Result

Test Description	Basic Standards	Test Result
Transmitter De-activation Time	15.231(a)	Compliant

5.2 Test Method

Tests were performed using the methods defined in ANSI C63.10, Clause 7.4.

5.2.1 Limit

- (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.

5.3 Test Site

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions	13 April 2017	10 August 2017
Temperature:	22.4 °C	25.3 °C
Relative Humidity:	43.5 %	48.3 %

5.4 Test Equipment

Test Date: 13-Apr-2017

Tester: JOP

Equipment	Model	Manufacturer	Asset Number	Cal Due Date
SIGNAL ANALYZER	FSV30	ROHDE & SCHWARZ	B085749	8-Oct-2017
RF CABLE	141	HUBER & SUHNER	B095588	26-Jul-2017

Test Date: 10-Aug-2017

Tester: JOP

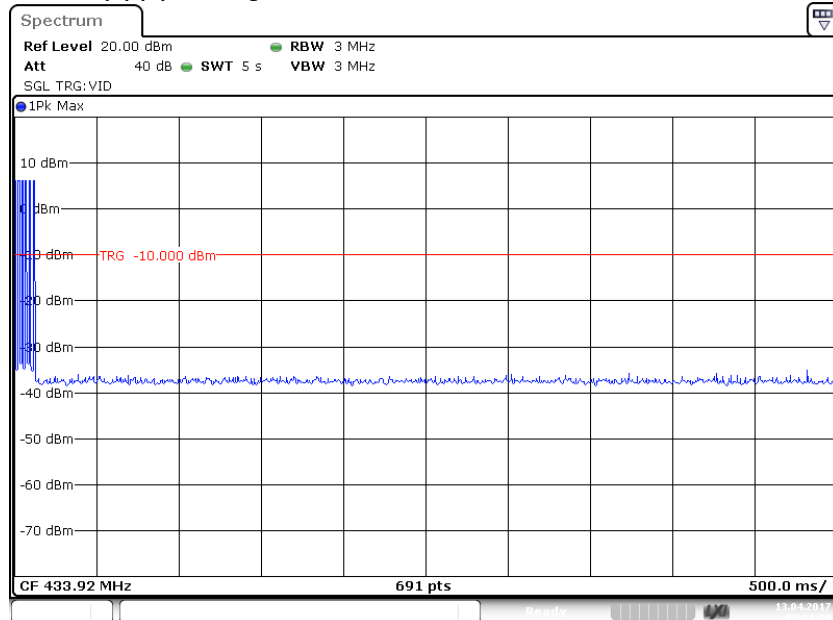
Equipment	Model	Manufacturer	Asset Number	Cal Due Date
SIGNAL ANALYZER	FSV30	ROHDE & SCHWARZ	B085749	8-Oct-2017
RF CABLE	141	HUBER & SUHNER	B095590	26-Jul-2018

Note: The equipment calibration period is 1 year except for the FSV which is on a 2-year calibration cycle.

5.5 Test Data

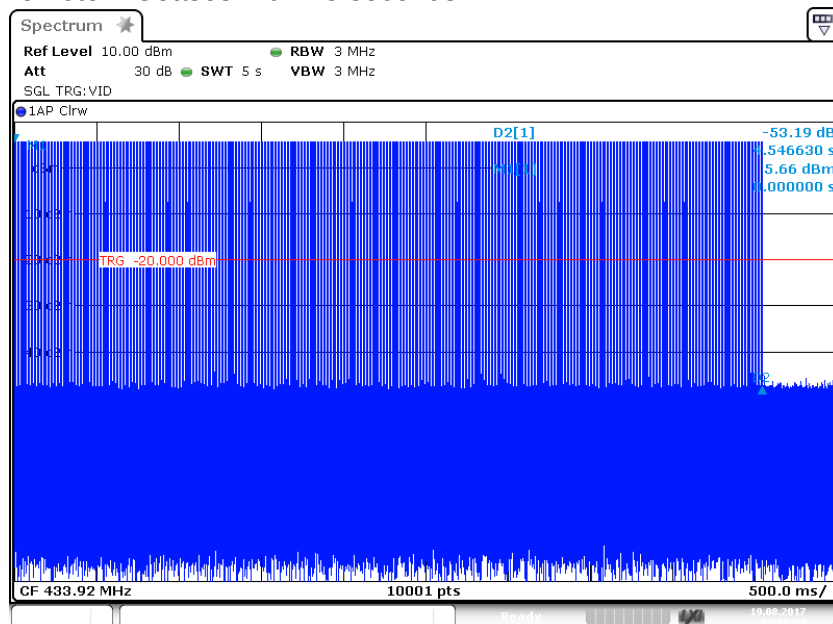
15.231(a)(1) – The device is not a manually operated transmitter.

15.231(a)(2) – Single status transmission – ceases within 5 seconds.



Date: 13.APR.2017 05:11:29

15.231(a)(2) – Initial boot sequence – Platform transmits every different message in sequence to the remote – Ceases within 5 seconds



Date: 19.AUG.2017 13:18:12

15.231(a)(3) – The device does not poll or send periodic transmissions. The only times a transmission is instigated is due to an alarm condition or when the status is requested.

15.231(a)(4) – Not applicable, the device is not employed for radio control purposes during emergencies.

15.231(a)(5) – Not applicable, the device is not used in security systems.

6 Duty Cycle

6.1 Test Result

Test Description	Basic Standards	Test Result
Duty Cycle	ANSI C63.10: 2013	Compliant

6.2 Test Method

Tests were performed using the methods defined in 15.231(a) and ANSI C63.10, Clause 7.5.

6.2.1 Limit

No limit is defined for the duty cycle. The resulting correction factor was used to compensate the measured peak fundamental and harmonic emissions for comparison to the average limits.

6.3 Test Site

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature: 22.4 °C

Relative Humidity: 43.5 %

6.4 Test Equipment

Test Date: 10-Apr-2017

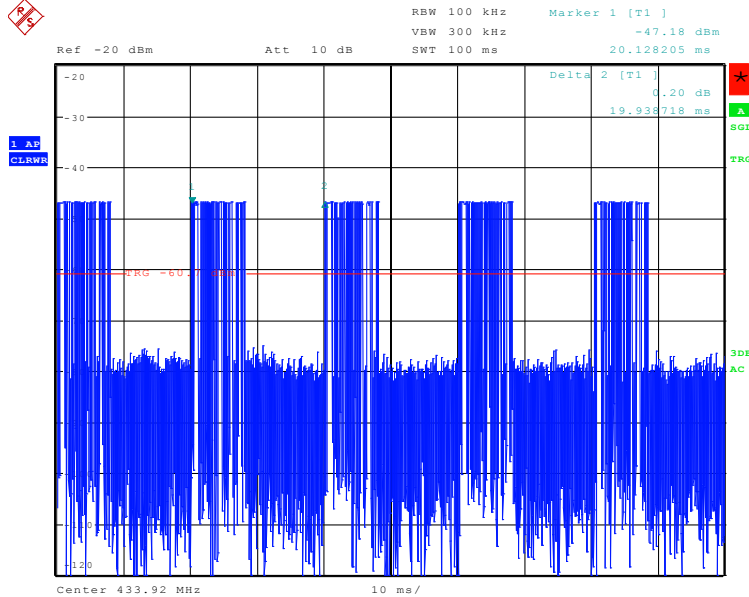
Tester: JOP

Equipment	Model	Manufacturer	Asset Number	Cal Due Date
SIGNAL ANALYZER	FSV30	ROHDE & SCHWARZ	B085749	8-Oct-2017
RF CABLE	141	HUBER & SUHNER	B095588	26-Jul-2017

Note: The equipment calibration period is 1 year except for the FSV which is on a 2-year calibration cycle.

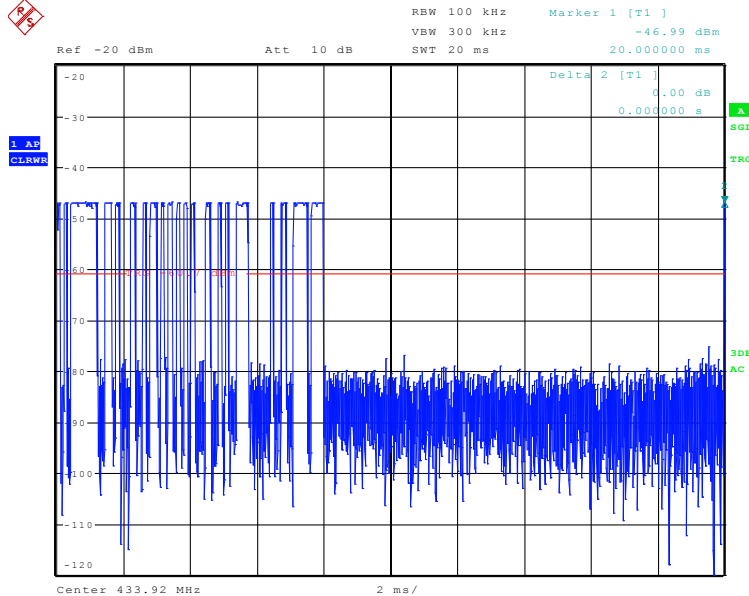
6.5 Test Data

100ms pulse train



Date: 10.APR.2017 11:05:58

Single Message



Date: 10.APR.2017 11:08:44

The trace data was loaded into an excel spreadsheet that calculated the on and off times over a single 20ms pulse train. The resulting on time was 4.43ms (22.17%DC). Applying $20 \cdot \log(1/DC) = 13.1\text{dB}$ DCCF. Note: there were four types of messages (Status1, Status2, Alarm, and Power Off) and they all resulted in the same duty-cycle measurement.

7 Revision History

Revision Level	Description of changes	Revision Date
0	Initial release	10 August 2017