Nebraska Center for Excellence in Electronics
4740 Discovery Drive
Lincoln, NE 68521
Phone: 402.323.6233
Fax: 402.323.6238

Amended Test Report

Includes NCEE Labs test report R20140103-21A and its amendment in full

Company:	Shur-Co, LLC 2309 Shur-Lok, St. Yankton, SD 57078-0713
Product:	SMART1PLUS
FCC ID: IC :	2ABPI-SCS1P 11681A-SCS1P
Test Report No:	R20140103-21B
Approved By:	Nic S. Johnson, NCE Technical Manager iNARTE Certified EMC Engineer #EMC-003337-NE
DATE:	11 August 2014
Total Pages:	20

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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**
15.203	Unique Antenna Requirement	N/A	N/A
15.207	Conducted Emissions	N/A	N/A
15.209	Radiated Emissions	Pass	Meets the requirement of the limit.
15.231(a)	Minimum Bandwidth, Limit: 1085 MHz	Pass	Meets the requirement of the limit.
15.231(a)	Transmitter Radiated Emissions, Limit: Table 15.209	Pass	Meets the requirement of the limit.

1.1 Reason for Amendment

Duty cycle factor was corrected.
The table under Section 1.0 was corrected.
The standards in Section 2.4 were corrected.
Section 4.2.2(g) was updated to include clarification that all 3 axis were tested.

2.0 Description

2.1 Equipment under test

The Equipment Under Test (EUT) was a SMART1PLUS key fob. It is used to remotely operate the doors on trucks.

EUT Received Date: 10 April 2014
EUT Tested Date: 10 May 2014,
12 Aug 2014 (5sec. timeout only)

PRODUCT	Key Fob
MODEL	NCEETEST 1 (assigned)
POWER INPUT	3 VDC (2*1.5 VDC AAA)
MODULATION TYPE	OOK (On-off keying)
FREQUENCY RANGE	433.92 MHz
NUMBER OF CHANNELS	1
MAXIMUM OUTPUT POWER	-13.66 dBm EIRP 81.57 dBµV/m at 3m
ANTENNA TYPE	PCB Trace Antenna
SERIAL NUMBER OF TEST UNIT	NCEETEST 1 (assigned)
POWER SUPPLY	Battery only, no recharging.

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 22 ± 4%

Temperature of 23 ± 3° Celsius

2.3 Description of test modes

Channel	Frequency
1	433.92 MHz

2.4 Applied standards

The EUT is a digital transmission device operating at 433.92 MHz. According to the specifications of the manufacturer, it must comply with the requirements of the following standards:

1. *FCC Part 15, Subpart c (15.231) using;*
   ANSI/IEEE C63.4:2009
   ANSI/IEEE C63.10:2009
2. *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 3VDC (2*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.

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
Rohde & Schwarz Preamplifier	TS-PR18	NCEEPAHF20	26 Mar 2014*

*Internal characterization

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 mounted 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.

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.

g. In order to test the EUT is all three axis, The EUT was tested in both a horizontal and vertical orientation and the turntable was rotated 360deg. The vertical orientation produces the highest emissions, so all measurements were made with the EUT in this orientation.

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

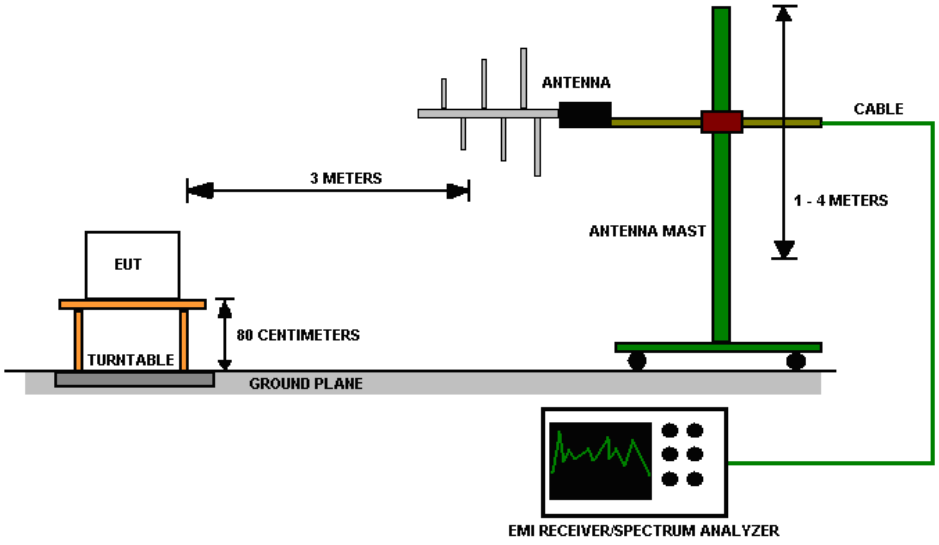


Figure 1 - Radiated Emissions Test Setup

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	Key Fob	Model	NCEETEST 1 (assigned)
MODE	Continuous Transmit	FREQUENCY RANGE	30 MHz – 5 GHz
INPUT POWER (SYSTEM)	3 VDC	ORIENTATION	Horizontally Placed
ENVIRONMENTAL CONDITIONS	23 % ± 5% RH 25 ± 3ºC	TECHNICIAN	NGavvala

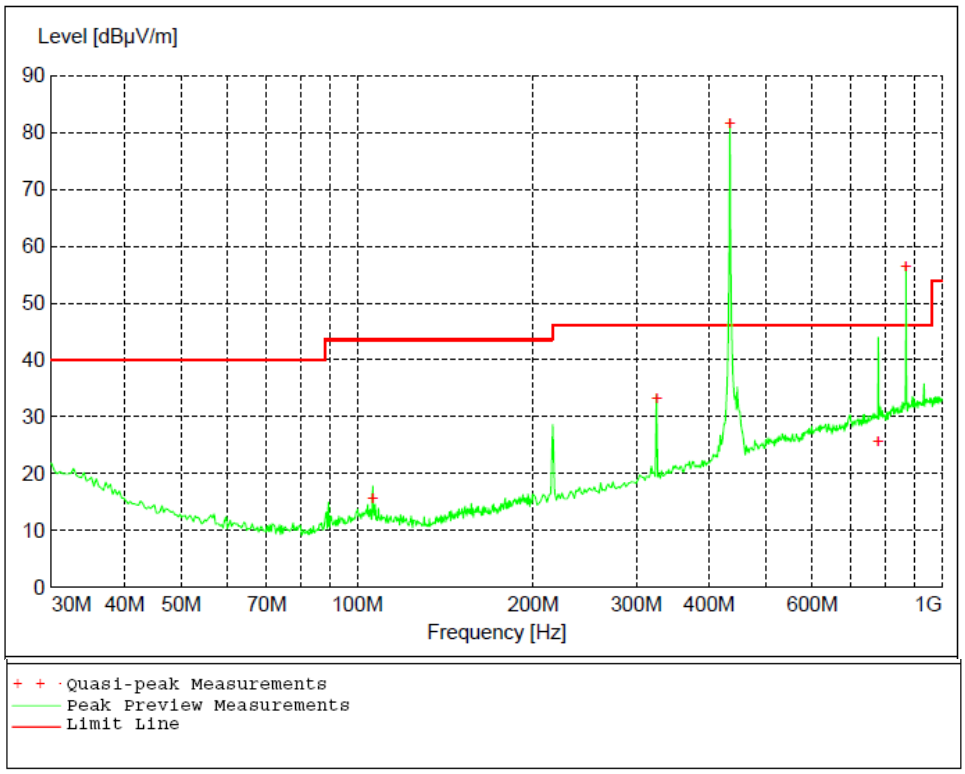


Figure 2 - Radiated Emissions Plot

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

Quasi-peak/Average Measurements

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	cm	deg	
106.260000	15.65	43.50	27.90	111	248	HORI
325.440000	33.14	46.00	12.90	100	99	HORI
433.920000	79.32**	80.83*	1.51	101	102	HORI
777.420000	25.49	46.00	20.50	251	67	VERT
867.900000	56.47	62.00*	5.53	99	180	HORI

*Limit from FCC Part 15.231 (b)

**Average measurement calculated from Peak measurement of 82.36 dBµV/m + AF (-3.04 dB, see Fig. 4)

Average Measurements

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	cm	deg	
1301.800000	40.37	54.00	13.63	112	198	HORI
1735.800000	40.36	54.00	13.64	100	193	VERT
2169.800000	42.28	54.00	11.72	139	60	VERT
2604.000000	39.65	54.00	14.35	101	360	VERT
3037.600000	45.78	54.00	8.22	99	360	VERT
3471.800000	39.29	54.00	14.71	99	221	HORI
3905.600000	44.58	54.00	9.42	103	236	VERT
4324.600000	39.82	54.00	14.18	140	360	VERT

Note: Average Level = Peak Level – AF
AF is calculated in Figures 3 and 4

Peak Measurements

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	cm	deg	
1301.800000	43.41	74.00	30.60	112	198	HORI
1735.800000	43.40	74.00	30.60	100	193	VERT
2169.800000	45.32	74.00	28.70	139	60	VERT
2604.000000	42.69	74.00	31.30	101	360	VERT
3037.600000	48.82	74.00	25.20	99	360	VERT
3471.800000	42.33	74.00	31.70	99	221	HORI
3905.600000	47.62	74.00	26.40	103	236	VERT
4324.600000	42.86	74.00	31.10	140	360	VERT

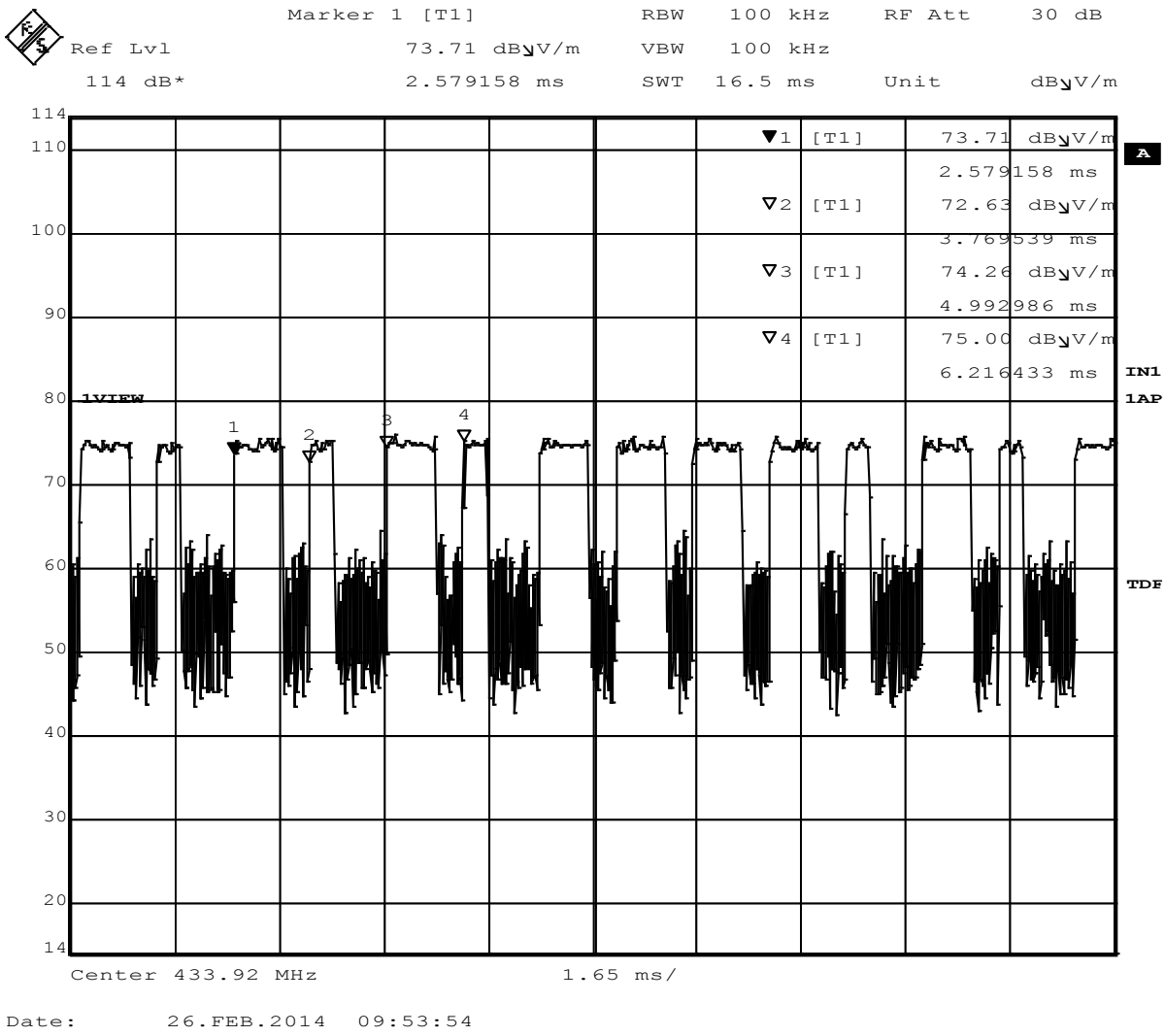


Figure 3 - Period = 1.22ms

The longest measured pulse was used to calculate the duty cycle

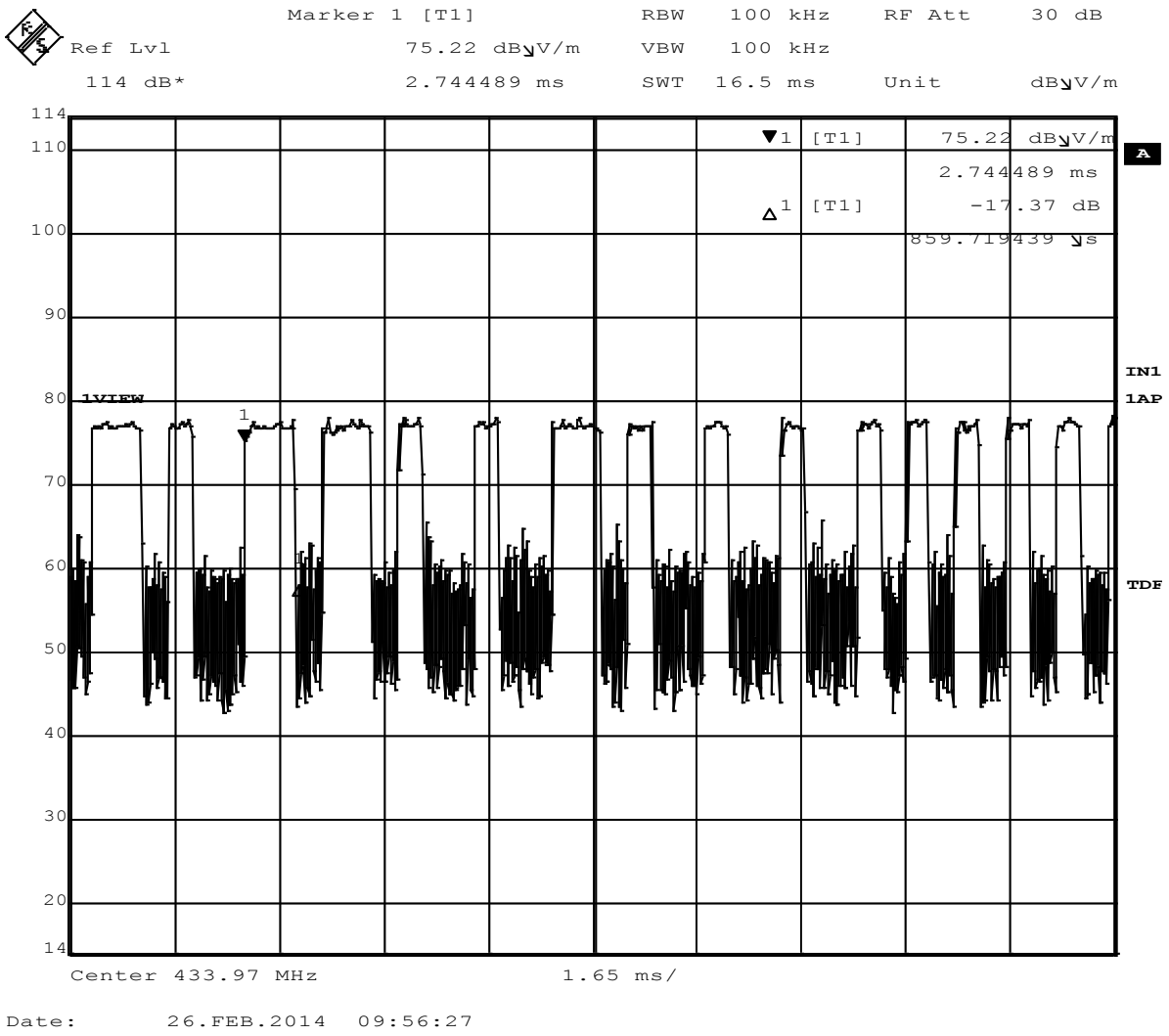


Figure 4 – Maximum Pulse Width = 0.860 ms

Averaging Factor = 20*log(0.860/1.22) = -3.04 dB

*Note: The pulses appear in two variations of durations, indicated a “0” or a “1” in the OOK modulation. The longer pulse was used to calculate the duty cycle.

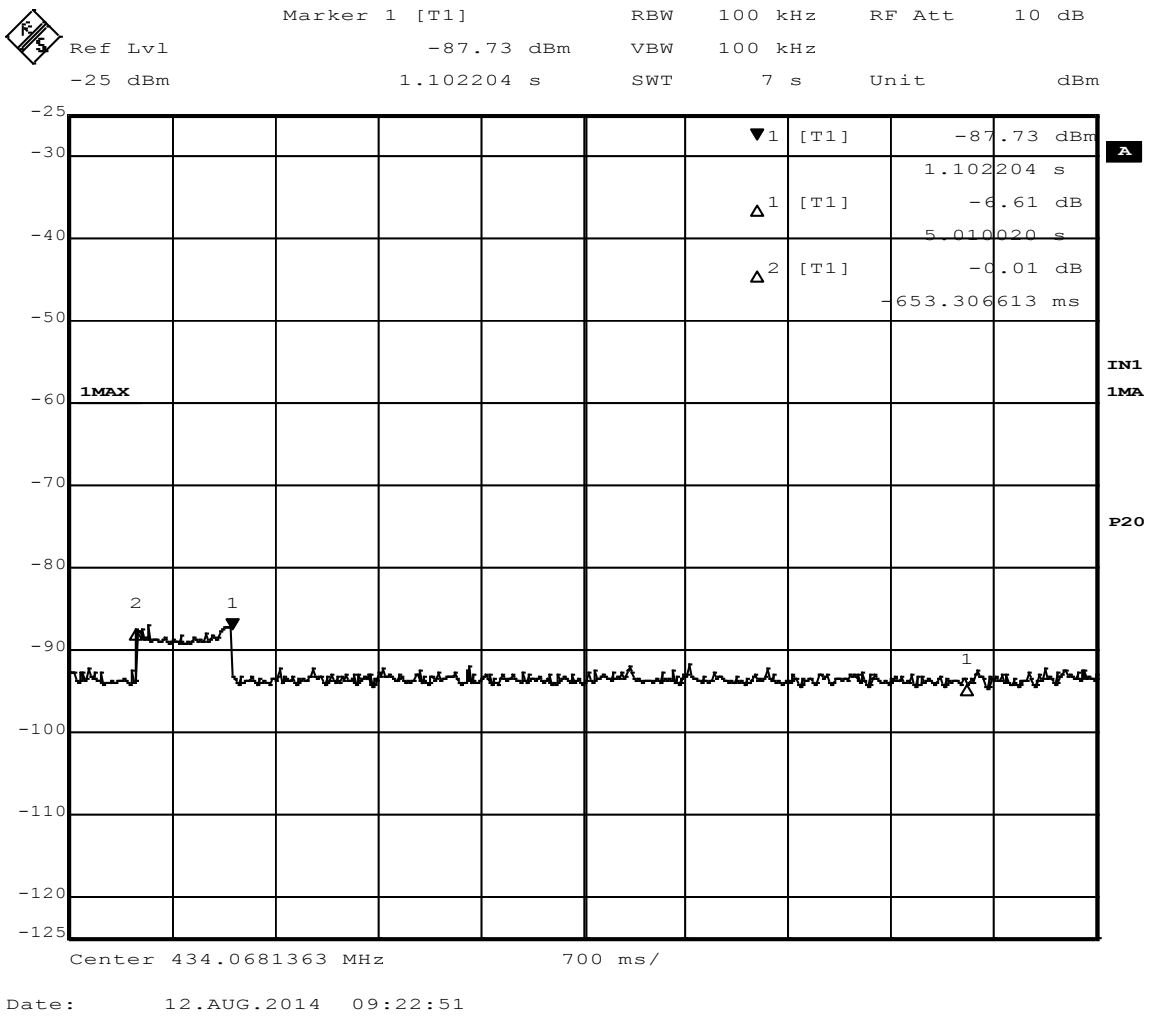


Figure 5 - % second Requirement

The EUT stops transmitting within 5 seconds of releasing the button

Per FCC Part 15.231(a)(1), A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released.

4.4 Bandwidth

4.4.1 Limits of bandwidth measurements

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

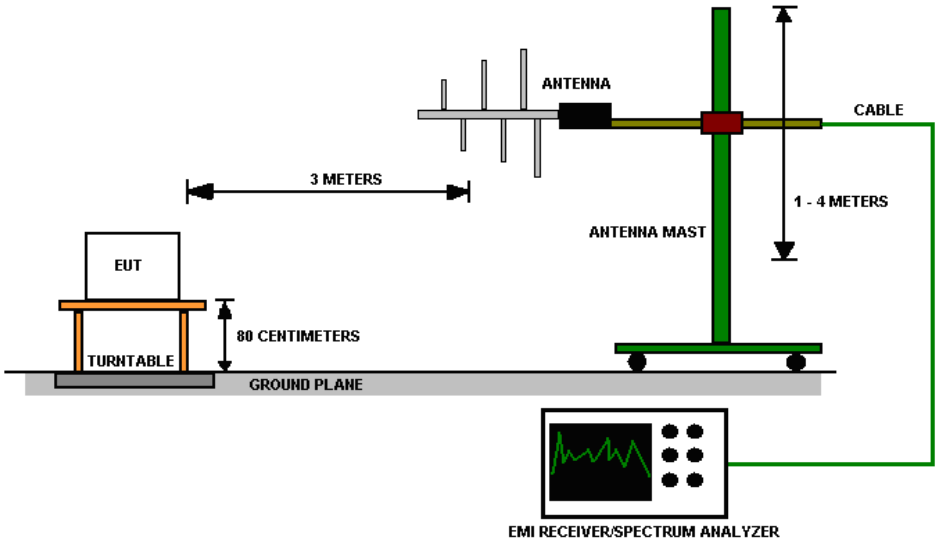
4.4.2 Test procedures

The transmitter output was connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured by spectrum analyzer with 100 kHz RBW and 500 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 largest resolution bandwidth possible (10MHz) and this value was recorded. The signal was then captured with a 100kHz 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	Key Fob	Model	NCEETEST 1 (assigned)
MODE	Continuous Transmit	FREQUENCY RANGE	30 MHz – 5 GHz
INPUT POWER (SYSTEM)	3 VDC	ORIENTATION	Horizontally Placed
ENVIRONMENTAL CONDITIONS	23 % ± 5% RH 25 ± 3ºC	TECHNICIAN	NGavvala

CHANNEL	CHANNEL FREQUENCY (MHz)	99% Occupied BW LIMIT (kHz)	99% Occupied BW (kHz)	RESULT
1	433.92	1085	668.01	PASS

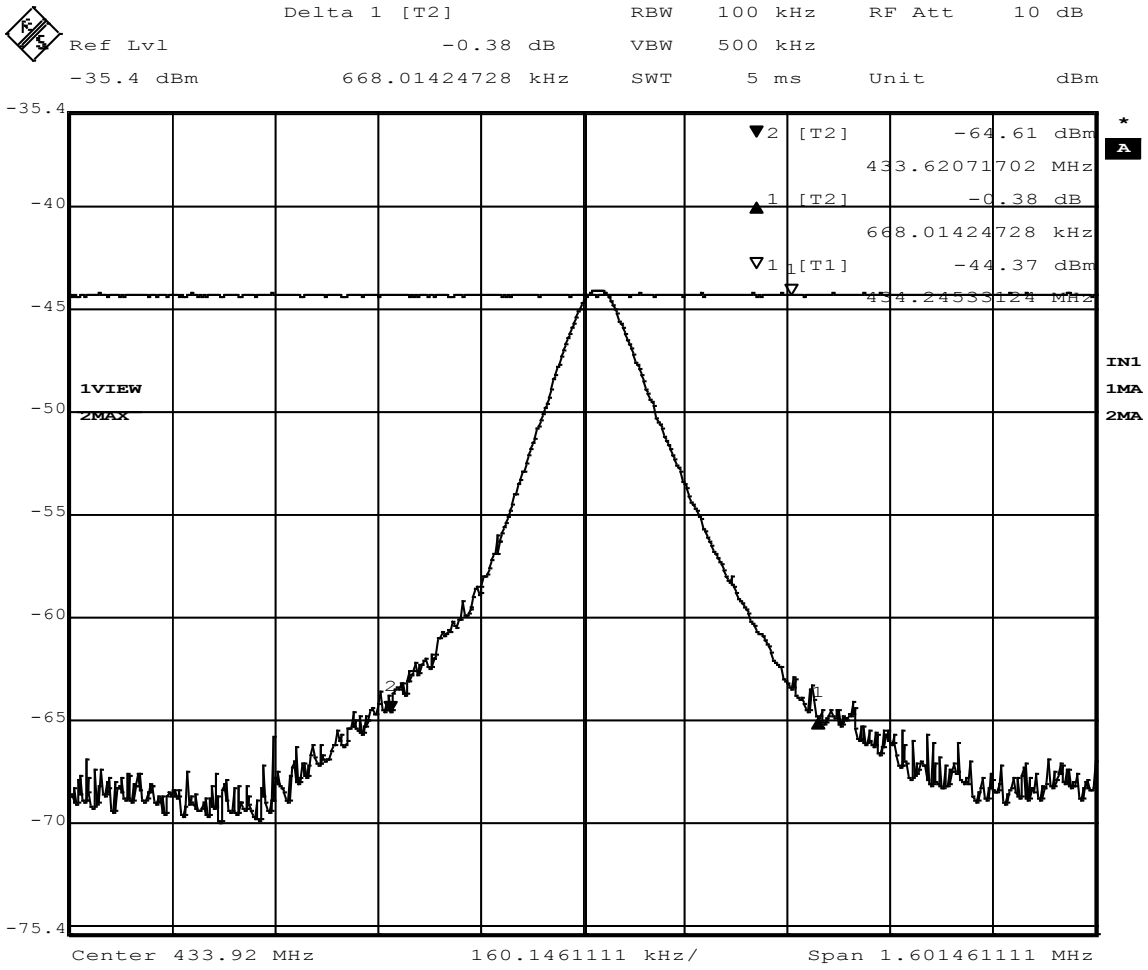


Figure 6 - 99% Occupied Bandwidth

4.5 Maximum peak output power

4.5.1 Limits of power measurements

N/A – peak limits are specified in field strength for Part 15.231, as found in Section 4.2. The data is presented for informational purposes only.

4.5.2 Test procedures

1. The EUT was placed in the maximum configuration as found in the measurements in section 4.2.

2. The resolution bandwidth was set to 10MHz and the video bandwidth was set to 10MHz to capture the maximum amount of signal. The analyzer used a peak detector in max hold mode. This represented the maximum output power in EIRP.

4.5.3 Deviations from test standard

No deviation.

4.5.4 Test setup

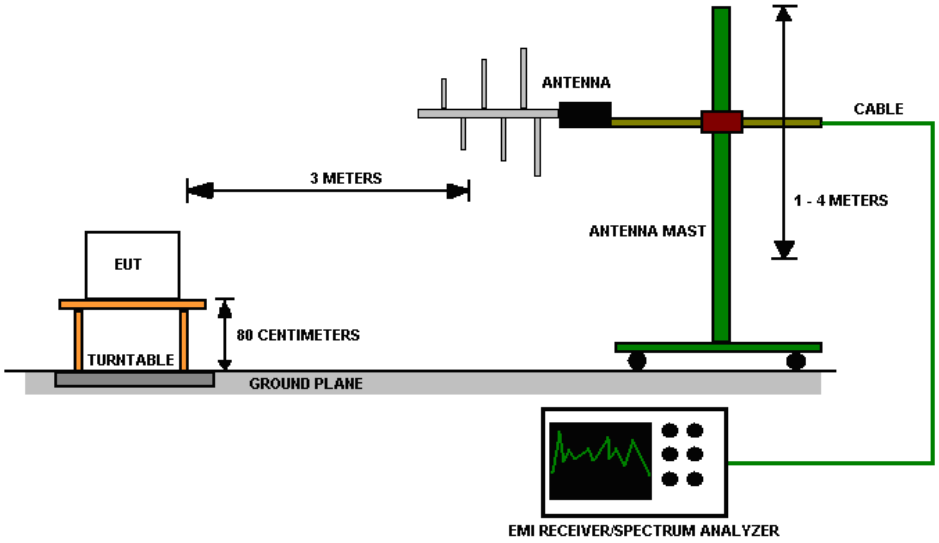


Figure 7 – Power Measurement Test Setup

4.5.5 EUT operating conditions

See Section 2.6

4.5.6 Test results

Maximum peak output power

EUT	Key Fob	Model	NCEETEST 1 (assigned)
MODE	Continuous Transmit	FREQUENCY RANGE	30 MHz – 5 GHz
INPUT POWER (SYSTEM)	3 VDC	ORIENTATION	Horizontally Placed
ENVIRONMENTAL CONDITIONS	23 % ± 5% RH 25 ± 3ºC	TECHNICIAN	NGavvala

CHANNEL	CHANNEL FREQUENCY (MHz)	EIRP PEAK POWER OUTPUT (dBm)	PEAK POWER LIMIT (dBm)	RESULT
1	433.92	-13.66	N/A*	PASS

Power measurement is included for informational purposes only and is not required in FCC Part 15.231.

4.6

Appendix A: Test Photos

Figure 8 - Radiated Emissions Test Setup

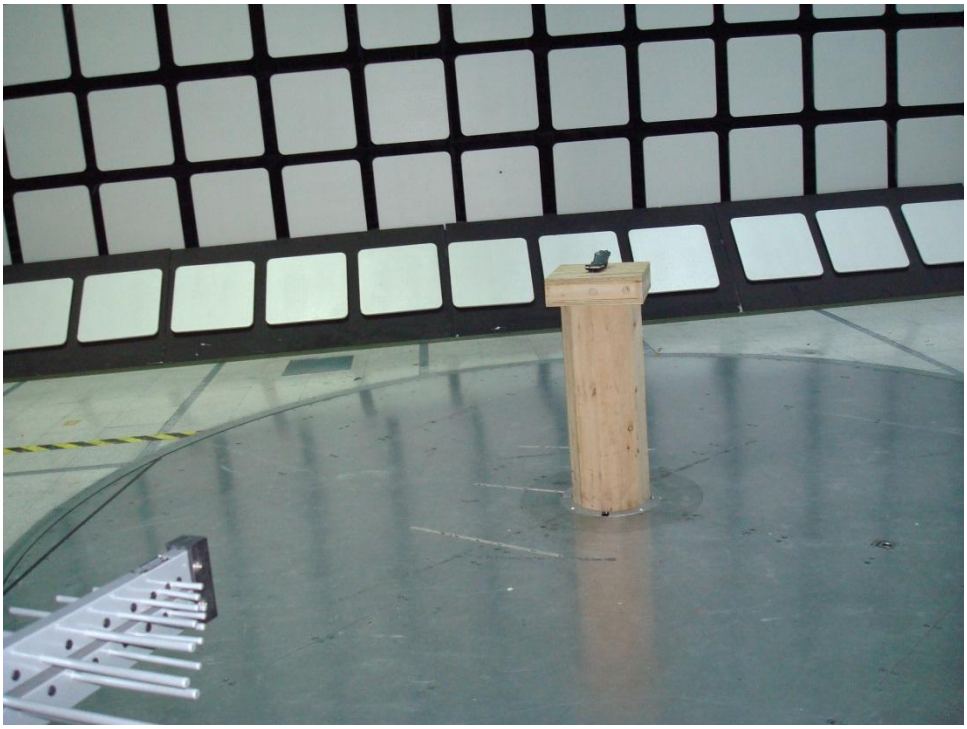


Figure 9 - Radiated Emissions Test Setup

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 Strength (V/m) x antenna distance (m)]^2 / [30 x Gain (numeric)]

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

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

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

Gain = 1 (numeric gain for isotropic radiator