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ROGERS LABS, INC.

4405 West 259th Terrace
Louisburg, KS 66053
Phone / Fax (913) 837-3214

Application For Grant of Certification

Title 47CFR, PART 15C - Intentional Radiators

47CFR Paragraph 15.225 and

Industry Canada RSS-210 Issue 10, RSS-Gen Issue 5

HVIN: FBXIR21

PMN: Spark

FCC ID: 2A29A-FBXIR21

IC: 27842-FBXIR21

NFC Operating in the band 13.110-14.010 MHz (13.56 MHz)

FireBoard Labs LLC

3305 Terrace St, Suite 100
Kansas City, MO 64111

FCC Designation: US5305

ISED Registration: 3041A-1

Test Report Number: 211004

Test Date: November 5, 2021

Authorized Signatory: *Scot D Rogers*

Scot D. Rogers
Rogers Labs, Inc.
4405 West 259th Terrace
Louisburg, KS 66053

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Rogers Labs, Inc.

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Phone/Fax: (913) 837-3214

Revision 1

FireBoard Labs LLC

HVIN: FBXIR21

Test: 211004

Test to: CFR47 15.225, RSS-210

File: FireBoard Spark NFC TstRpt 211004

SN's: FCC1 / FCC2

PMN: Spark FCC ID: 2A29A-FBXIR21

IC: 27842-FBXIR21

Date: November 18, 2021

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Revisions

Revision 1 Issued November 18, 2021

Rogers Labs, Inc.
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Revision 1

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Executive Summary

The following information is submitted for consideration in obtaining Grant of Certification for low power intentional radiator per Title 47 Code of Federal Regulations (47CFR) dated November 5, 2021, Paragraph 15.225, and Innovation, Science and Economic Development (ISED) RSS-210 Issue 10 operation at 13.56 MHz as Near Field Communications Device.

Name of Applicant: FireBoard Labs LLC
3305 Terrace St, Suite 100
Kansas City, MO 64111

M/N: FBXIR21 HVIN: FBXIR21 PMN: Spark

FCC ID: 2A29A-FBXIR21 IC: 27842-FBXIR21

Frequency Range: 13.56 MHz

Operating power: maximum peak power 70.3 dB μ V/m @ 3 meters, 99 percent occupied bandwidth 17.95 kHz

Operational communication mode

Mode	Peak Power (dB μ V/m@3m)	Average power (dB μ V/m@3m)	99% OBW (kHz)
Mode 0 NFC	62.8	57.4	428

This report addresses EUT Operations as Low Power Device using NFC 13.56 MHz transmission

Opinion / Interpretation of Results

Tests Performed	Margin (dB)	Results
Emissions as per 47CFR 15.205, RS-210 2.2	-22.7	Complies
Emissions as per 47CFR 15.207, RSS-GEN 8.8	-2.6	Complies
Emissions as per 47CFR 15.209, RSS-GEN 8.9	-14.1	Complies
Fundamental Emission per 47CFR 15.225, RSS-210 B.6	-61.2	Complies

Equipment Tested

Model: Spark

<u>Equipment</u>	<u>Model / PN</u>	<u>Serial Number</u>
EUT	FBXIR21	FCC1
EUT2	FBXIR21	FCC2
USB cable	N/A	N/A
AC Adapter	MKC-0501000VU	N/A

Test results in this report relate only to the items tested. Worst-case configuration data recorded in this report.

Firmware version: 179_20210114, Antennas: 13.56 MHz unity PCB coil, 2.4 GHz PIFA (3.96 dBi)

Equipment Operational Modes

Mode	Transmitter Operation
1	NFC
2	BLE (GMSK)
3	802.11b (CCK/DSS)
4	802.11g (OFDM)
5	802.11n (OFDM)
6	802.11n40 (OFDM with mcs)



Equipment Function

The EUT is a portable handheld thermometer typically used in the food industry. The design is used to measure the internal temperature of meat or other cooked food. The temperature is measured using a thermocouple sensor mounted in the attached metal probe or an external connected probe. The design provides fast and accurate temperature measurements and stores measurement reading internally before transmitting the data to compatible system. The design provides two input ports, one for external temperature probe and the other a USB-C port for charging. The design incorporates transmitter circuitry operating in the 13.56 MHz and 2404-2480 MHz frequency bands. The typical use configurations include charging the internal battery through the authorized USB-C cable and AC adapter, using external probe, or the attached fold out probe. The design incorporates a Near Field Communications (NFC) transmitter for use in reading NFC tags as well as BLE and 802.11 Wi-Fi operation in the 2400-2483.5 MHz band. The EUT operates from direct current power provided from internal battery system only. The EUT was arranged as described by the manufacturer emulating typical user configurations for testing purposes. The EUT offers no other interface connections than the configuration options as described by the manufacturer and presented below. For testing purposes, the EUT received power from fully charged internal battery power. Two test samples were provided for testing. Sample 1 was representative of production equipment with integral antenna systems. Sample 1 provided the ability to measure radiated emissions from the system. Sample 2 was provided which replaced the integral 2400 MHz antenna system with a 50-ohm connection port at the transmitter output. Sample 2 provide the ability to test system perform at the transmitter. Test software was provided which enabled defining transmitter mode and operation at near 100 percent duty cycle. During testing, the test system was configured to operate in manufacturer defined modes. As requested by the manufacturer the equipment was tested for emissions compliance using the available configurations with the worse-case data presented. Test results in this report relate only to the products described in this report.

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Equipment Configuration

- 1) EUT operating on internal battery



- 2) EUT connected to AC adapter through USB-C cable



- 3) EUT connected to external temperature probe





Application for Certification

(1) Manufacturer: FireBoard Labs LLC
3305 Terrace St, Suite 100
Kansas City, MO 64111

(2) Identification: Model: Spark
FCC ID: 2A29A-FBXIR21 IC: 27842-FBXIR21

(3) Instruction Book:
Refer to Exhibit for Instruction Manual.

(4) Description of Circuit Functions:
Refer to Exhibit of Operational Description.

(5) Block Diagram with Frequencies:
Refer to Exhibit of Operational Description.

(6) Report of Measurements:
Report of measurements follows in this Report.

(7) Photographs: Construction, Component Placement, etc.:
Refer to Exhibit for photographs of equipment.

(8) List of Peripheral Equipment Necessary for operation. The equipment operates from internal battery power. The EUT provides port for connection with external temperature probe and USB-C interface port for power as presented in this filing.

(9) Transition Provisions of 47CFR 15.37 are not requested.

(10) Not Applicable. The unit is not a scanning receiver.

(11) Not Applicable. The EUT does not operate in the 59 – 64 GHz frequency band.

(12) The equipment is not software defined and this section is not applicable.

(13) Applications for certification of U-NII devices in the 5.15-5.35 GHz and the 5.47-5.85 GHz bands must include a high-level operational description of the security procedures that control the radio frequency operating parameters and ensure that unauthorized modifications cannot be made. This requirement is not applicable to his DTS device.

(14) Contain at least one drawing or photograph showing the test set-up for each of the required types of tests applicable to the device for which certification is requested. These drawings or photographs must show enough detail to confirm other information contained in the test report. Any photographs used must be focused originals without glare or dark spots and must clearly show the test configuration used. This information is provided in this report and Test Setup Exhibits provided with the application filing.

Applicable Standards

In accordance with the Federal Communications 47CFR dated November 5, 2021: Part 2, Subpart J, Paragraphs 2.907, 2.911, 2.913, 2.925, 2.926, 2.1031 through 2.1057, and applicable parts of paragraph 15C Paragraph 15.225, Industry Canada RSS-210 Issue 10, and RSS-GEN issue 5, the following information is submitted. Test procedures used are the established Methods of Measurement of Radio-Noise Emissions as described in the ANSI C63.10-2013 Document.

Equipment Testing Procedures

AC Line Conducted Emission Test Procedure

Testing for the AC line-conducted emissions was performed as required in 47CFR 15C, RSS-210 Issue 10 and specified in ANSI C63.10-2013. The test setup, including the EUT, was arranged in the test configurations as presented during testing. The test configuration was placed on a 1 x 1.5-meter bench, 0.8 meters high located in a screen room. The power lines of the system were isolated from the power source using a standard LISN with a 50- μ Hy choke. EMI was coupled to the spectrum analyzer through a 0.1 μ F capacitor internal to the LISN. The LISN was positioned on the floor beneath the wooden bench supporting the EUT. The power lines and cables were draped over the back edge of the table. Refer to diagram one showing typical test arrangement and photographs in exhibits for EUT placement used during testing.

Radiated Emission Test Procedure

Radiated emissions testing was performed as required in 47CFR 15C, RSS-210 Issue 10 and specified in ANSI C63.10-2013. The EUT was placed on a rotating 0.9 x 1.2-meter platform, elevated as required above the ground plane at a distance of 3 meters from the FSM antenna. EMI energy was maximized by equipment placement permitting orientation in three orthogonal axes, raising, and lowering the FSM antenna, changing the antenna polarization, and by rotating the turntable. Each emission was maximized before data was taken and recorded. The frequency spectrum from 9 kHz to 25,000 MHz was searched for emissions during preliminary investigation. Refer to diagrams two and three showing typical test setup. Refer to photographs in the test setup exhibits for specific EUT placement during testing.

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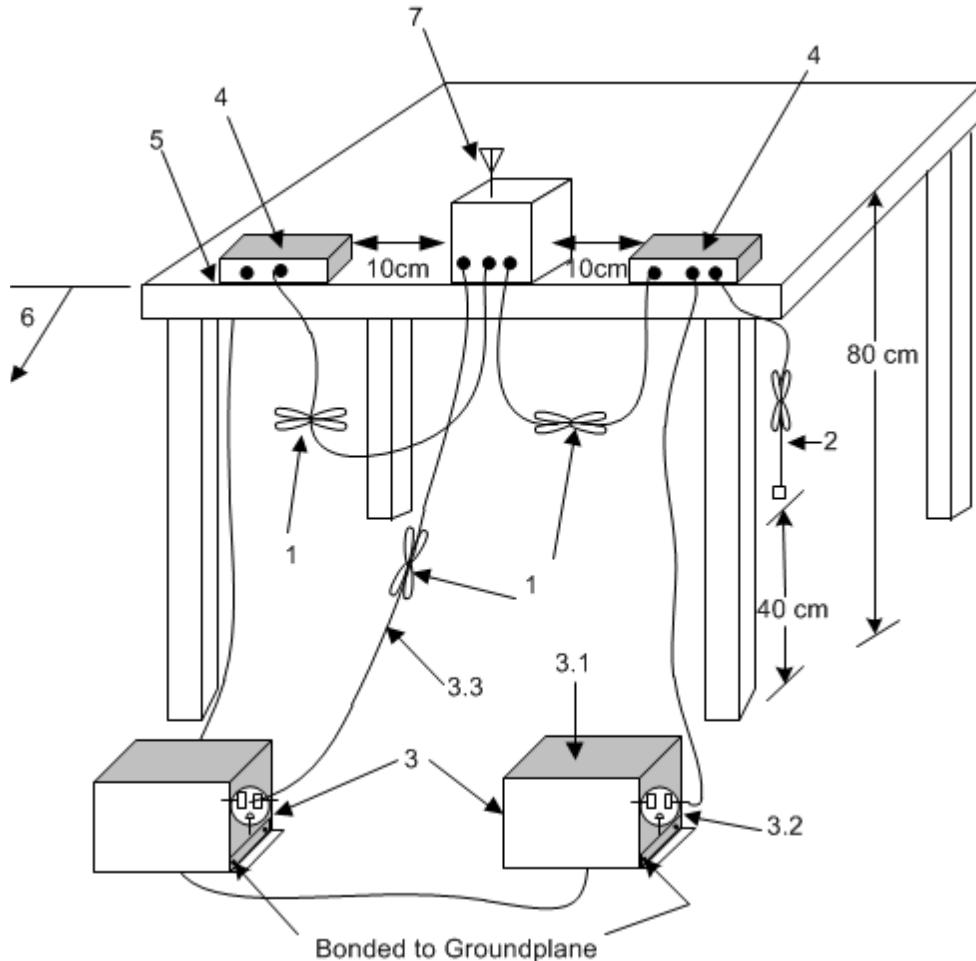
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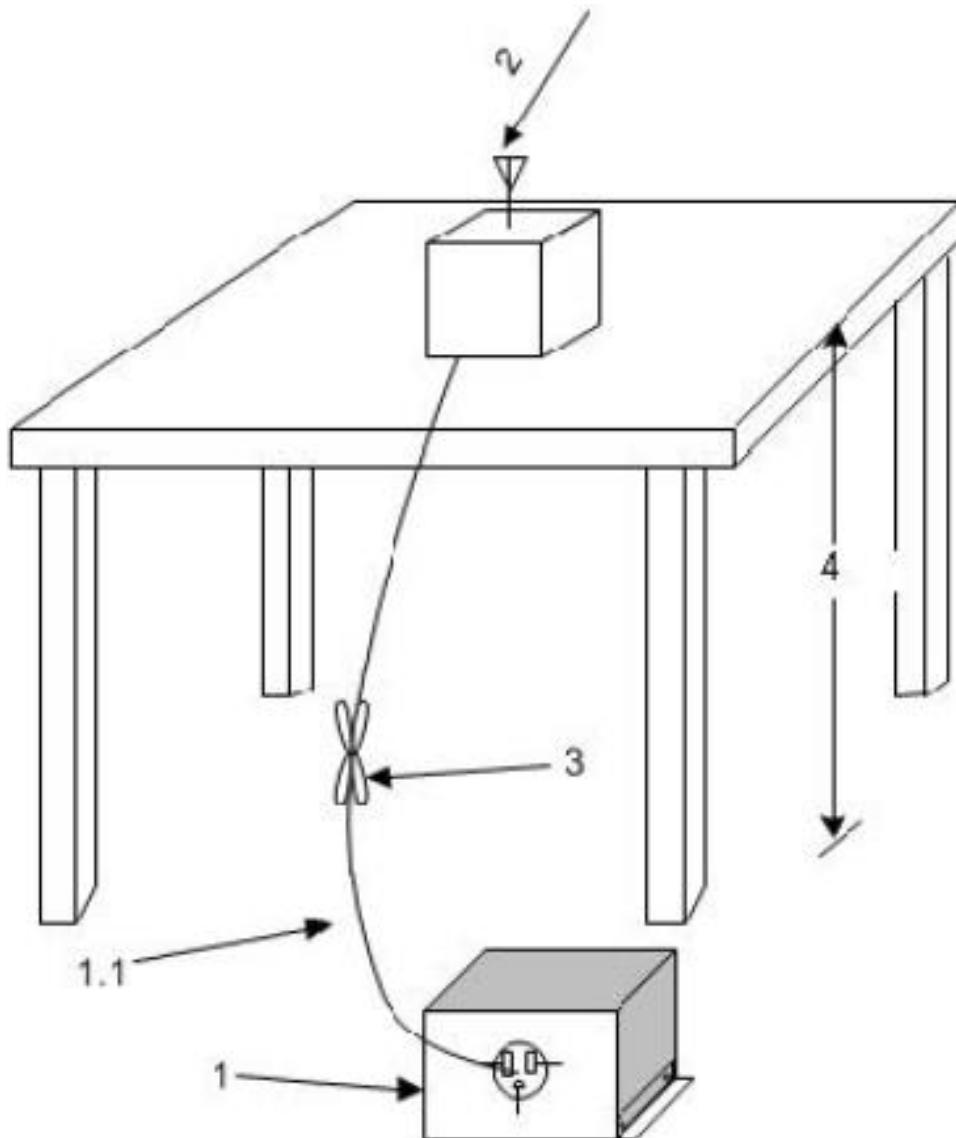
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Diagram 1 Test arrangement for Conducted emissions



1. Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 cm to 40 cm long see (see 6.2.3.1).
2. I/O cables that are not connected to an accessory shall be bundled in the center. The end of the cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m (see 6.2.2).
3. EUT connected to one LISN. Unused LISN measuring port connectors shall be terminated in 50 Ω loads. LISN can be placed on top of, or immediately beneath, reference ground plane (see 6.2.2 and 6.2.3).
 - 3.1 All other equipment powered from additional LISN(s).
 - 3.2 Multiple-outlet strip can be used for multiple power cords of non-EUT equipment.
 - 3.3 LISN at least 80 cm from nearest part of EUT chassis.
4. Non-EUT components of EUT system being tested.
5. Rear of EUT, including peripherals, shall all be aligned and flush with rear of tabletop (see 6.2.3.1).
6. Edge of tabletop shall be 40 cm removed from a vertical conducting plane that is bonded to the ground plane (see 6.2.2 for options).
7. Antenna may be integral or detachable. If detachable, the antenna shall be attached for this test.

Diagram 2 Test arrangement for radiated emissions of tabletop equipment



1—A LISN is optional for radiated measurements between 30 MHz and 1000 MHz but not allowed for measurements below 30 MHz and above 1000 MHz (see 6.3.1). If used, then connect EUT to one LISN. Unused LISN measuring port connectors shall be terminated in $50\ \Omega$ loads. The LISN may be placed on top of, or immediately beneath, the reference ground plane (see 6.2.2 and 6.2.3.2).

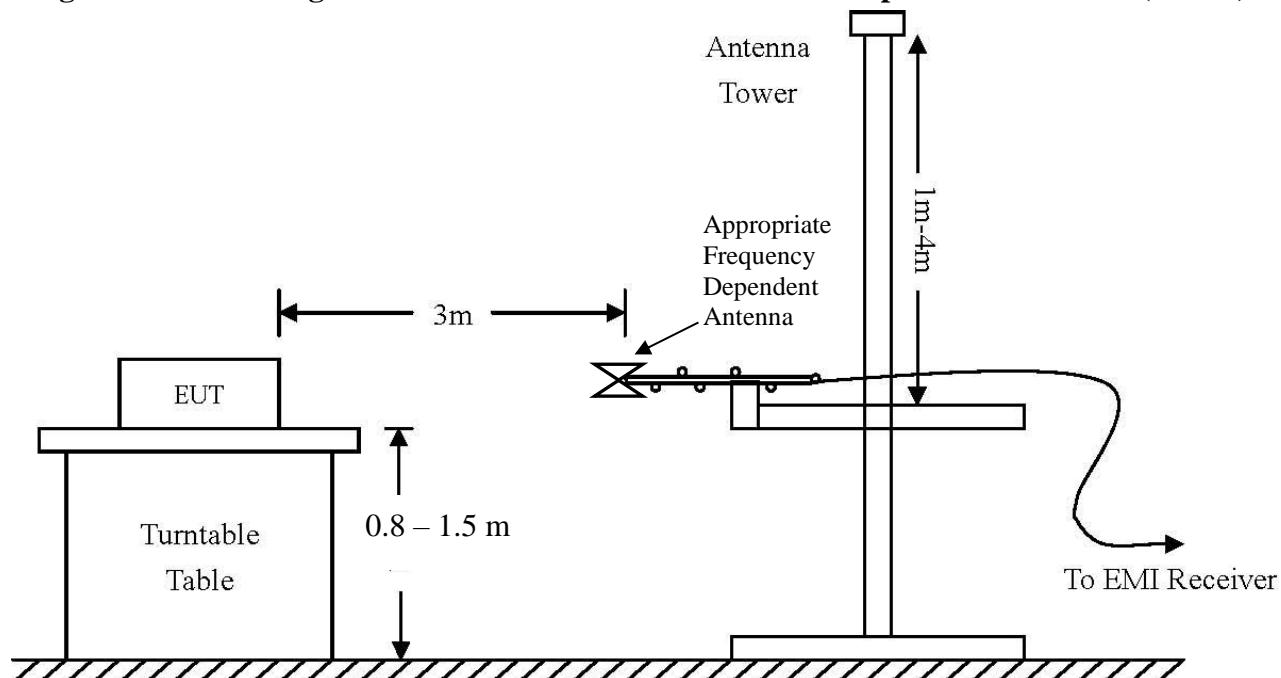
1.1—LISN spaced at least 80 cm from the nearest part of the EUT chassis.

2—Antenna can be integral or detachable, depending on the EUT (see 6.3.1).

3—Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 cm to 40 cm long (see 6.3.1).

4—For emission measurements at or below 1 GHz, the table height shall be 80 cm. For emission measurements above 1 GHz, the table height shall be 1.5 m for measurements, except as otherwise specified (see 6.3.1 and 6.6.3.1).

Diagram 3 Test arrangement for radiated emissions tested on Open Area Test Site (OATS)



Environmental Conditions

Ambient Temperature	22.0° C
Relative Humidity	42 %
Atmospheric Pressure	1020.3 mb



Test Site Locations

Conducted EMI	AC line conducted emissions testing performed in a shielded screen room located at Rogers Labs, Inc., 4405 West 259 th Terrace, Louisburg, KS
Antenna port	Antenna port conducted emissions testing was performed in a shielded screen room located at Rogers Labs, Inc., 4405 West 259 th Terrace, Louisburg, KS
Radiated EMI	The radiated emissions tests were performed at the 3 meters, Open Area Test Site (OATS) located at Rogers Labs, Inc., 4405 West 259 th Terrace, Louisburg, KS

Registered Site information: FCC Site: US5305, ISED: 3041A, CAB Identifier: US0096

NVLAP Accreditation Lab code 200087-0

Units of Measurements

Conducted EMI Data presented in dB μ V; dB referenced to one microvolt

Antenna port Conducted Data is in dBm; dB referenced to one milliwatt

Radiated EMI Data presented in dB μ V/m; dB referenced to one microvolt per meter

Note: Radiated limit may be expressed for measurement in dB μ V/m when the measurement is taken at a distance of 3 or 10 meters. Data taken for this report was taken at distance of 3 meters. Sample calculation demonstrates corrected field strength reading for Open Area Test Site using the measurement reading and correcting for receive antenna factor, cable losses, and amplifier gains.

Sample Calculation:

RFS = Radiated Field Strength, FSM = Field Strength Measured

A.F. = Receive antenna factor, Losses = attenuators/cable losses, Gain = amplification gains

RFS (dB μ V/m @ 3m) = FSM (dB μ V) + A.F. (dB/m) + Losses (dB) - Gain (dB)

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Statement of Modifications and Deviations

No modifications to the EUT were performed or required for the equipment to demonstrate compliance with the 47CFR Part 15C, Industry Canada RSS-210 Issue 10, and RSS-GEN emission requirements. There were no deviations to the specifications.

Intentional Radiators

The following information is submitted supporting demonstration of compliance with the requirements of 47CFR, Subpart C, paragraph 15.225 and RSS-210 Issue 10 the following information is submitted.

Antenna Requirements

The EUT incorporates integral antenna system and offers no provision for connection to alternate system. The antenna connection point complies with the unique antenna connection requirements. The unique antenna connection requirements are fulfilled. There are no deviations or exceptions to the specification.

Restricted Bands of Operation

Spurious emissions falling in the restricted frequency bands of operation were measured at the OATS. The EUT utilizes frequency determining circuitry, which generates harmonics falling in the restricted bands. Emissions were investigated at the OATS, using appropriate antennas or pyramidal horns, amplification stages, and a spectrum analyzer. Peak and average amplitudes of frequencies above 1000 MHz were compared to the required limits with worst-case data presented below. Test procedures of ANSI C63.10-2013 paragraph 6 were used during testing. No other significant emission was observed which fell into the restricted bands of operation. Computed emission values consider the received radiated field strength, receive antenna correction factor, amplifier gain stage, and test system cable losses.

Table 1 Radiated Emissions in Restricted Bands Data

Frequency (MHz)	Horizontal Peak (dB μ V/m)	Horizontal Quasi-Peak (dB μ V/m)	Vertical Peak (dB μ V/m)	Vertical Quasi-Peak (dB μ V/m)	Limit @ 3m (dB μ V/m)	Horizontal Margin (dBm)	Vertical Margin (dBm)
108.4	26.3	13.3	30.6	15.3	40.0	-26.7	-24.7
122.0	28.3	17.3	26.5	17.2	40.0	-22.7	-22.8

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency range below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

Summary of Results for Radiated Emissions in Restricted Bands

The EUT demonstrated compliance with the radiated emissions requirements of CFR Title 47 Part 15C and RSS-210 Issue 10 Intentional Radiators. The EUT demonstrated a worst-case minimum margin of -22.7 dB below the radiated emissions requirements in restricted frequency bands. Peak, Quasi-peak, and average amplitudes were checked for compliance with the regulations. Worst-case emissions are reported with other emissions found in the restricted frequency bands at least 20 dB below the requirements.



AC Line Conducted EMI Procedure

The EUT was arranged in typical equipment configurations operating from AC power adapter. Testing was performed with the EUT placed on a 1 x 1.5-meter wooden bench 80 cm above the conducting ground plane, floor of a screen room. The bench was positioned 40 cm away from the wall of the screen room. The LISN was positioned on the floor of the screen room 80-cm from the rear of the EUT. Testing for the line-conducted emissions were the procedures of ANSI C63.10-2013 paragraph 6. The AC adapter for the EUT was connected to the LISN for line-conducted emissions testing. A second LISN was positioned on the floor of the screen room 80-cm from the rear of the supporting equipment of the EUT. All power cords except the EUT were then powered from the second LISN. EMI was coupled to the spectrum analyzer through a 0.1 μ F capacitor, internal to the LISN. Power line conducted emissions testing was carried out individually for each current carrying conductor of the EUT. The excess length of lead between the system and the LISN receptacle was folded back and forth to form a bundle not exceeding 40 cm in length. The screen room, conducting ground plane, analyzer, and LISN were bonded together to the protective earth ground. Preliminary testing was performed to identify the frequencies of each of the emissions, which demonstrated the highest amplitudes. The cables were repositioned to obtain maximum amplitude of measured EMI level. Once the worst-case configuration was identified, plots were made of the EMI from 0.15 MHz to 30 MHz then data was recorded with maximum conducted emissions levels.

Refer to figures one and two for plots of the EUT – AC adapter Line conducted emissions.



Figure 1 AC Line Conducted emissions of EUT line 1 (EUT – AC Adapter)

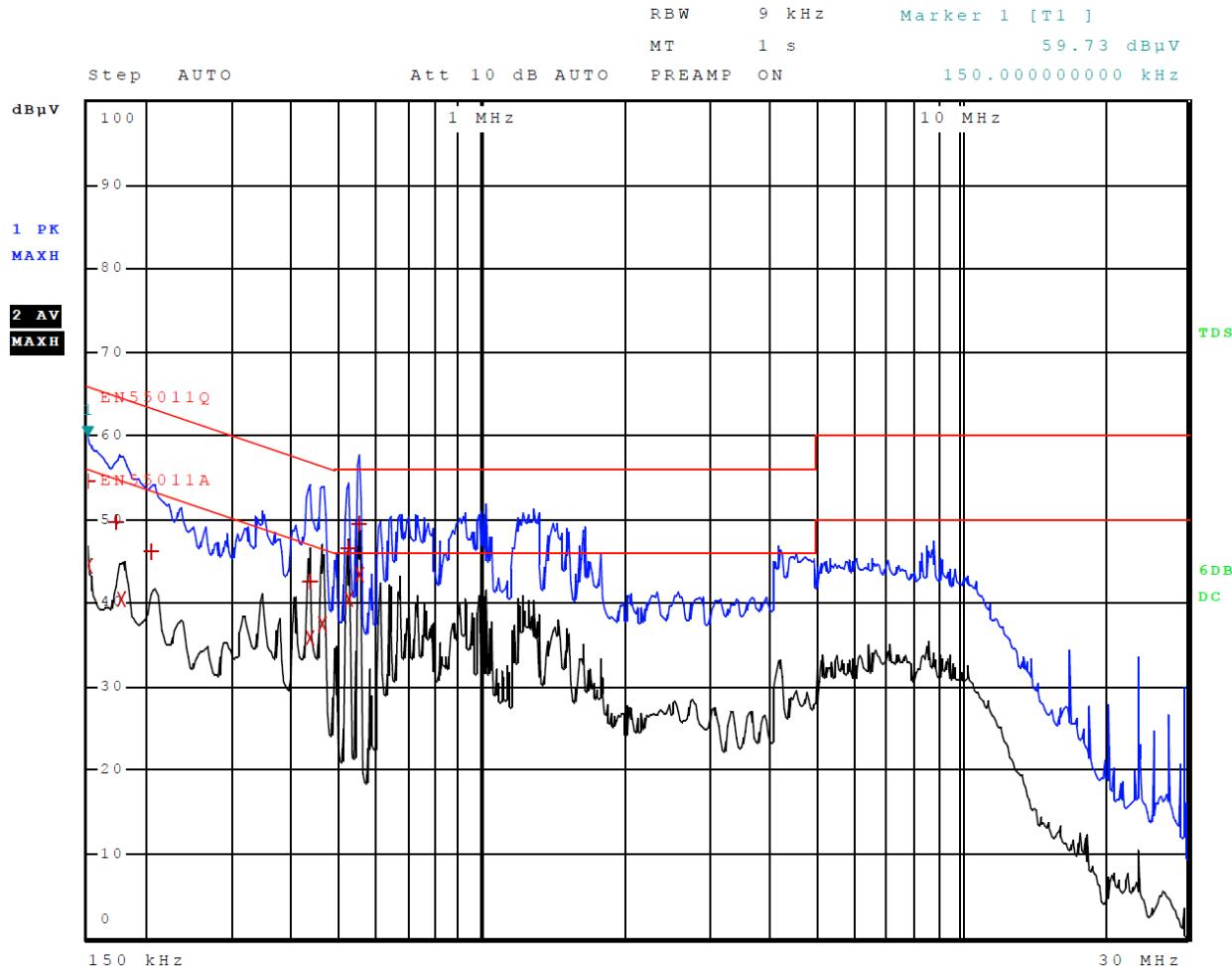




Figure 2 AC Line Conducted emissions of EUT line 2 (EUT – AC Adapter)

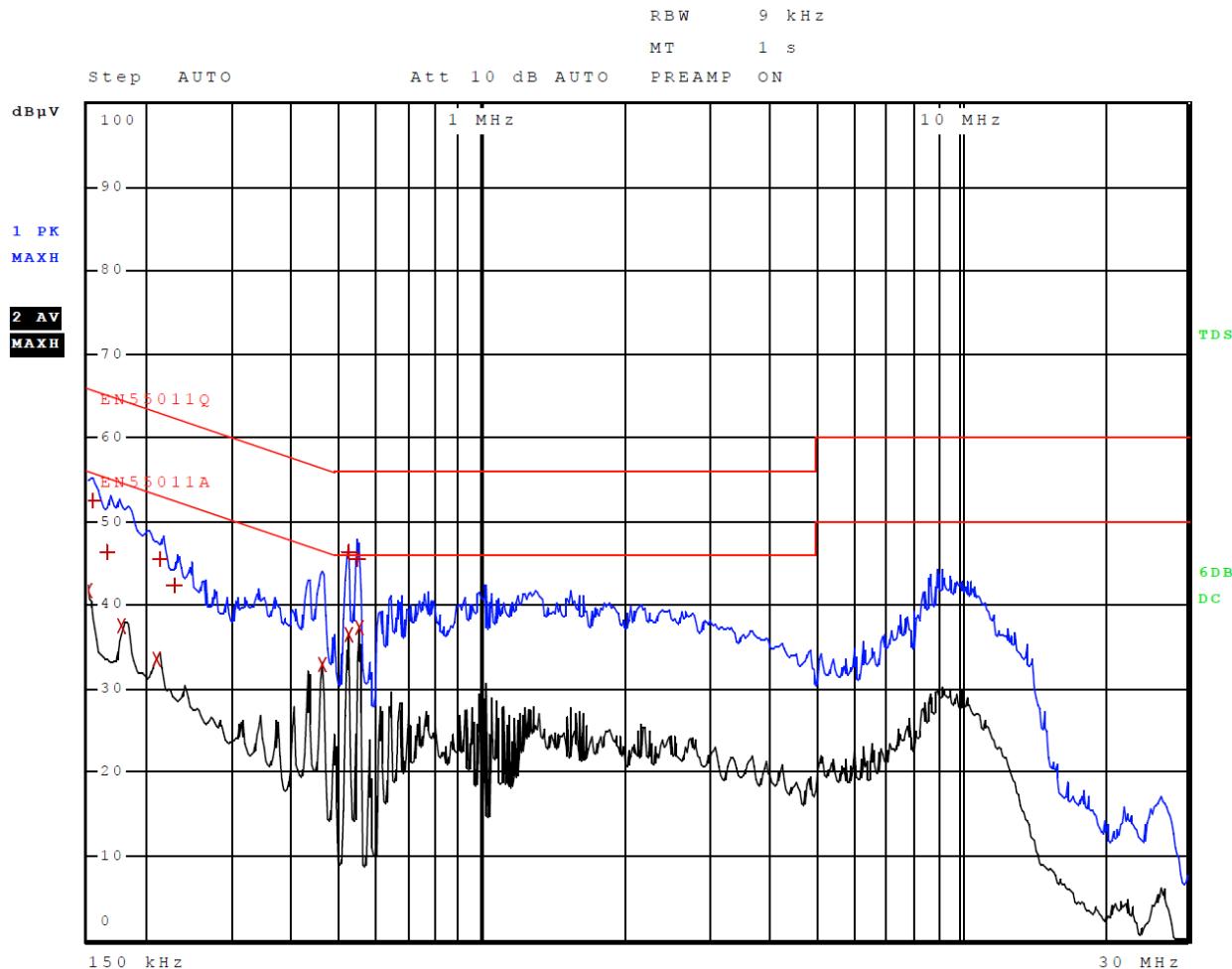


Table 2 AC Line Conducted Emissions Data L1 (EUT – AC Adapter)

Trace	Frequency	Level (dB μ V)	Detector	Delta Limit/dB
1	150.000000000 kHz	54.60	Quasi Peak	-11.40
2	150.000000000 kHz	44.40	Average	-11.60
1	174.000000000 kHz	49.79	Quasi Peak	-14.98
2	178.000000000 kHz	40.50	Average	-14.07
1	206.000000000 kHz	46.07	Quasi Peak	-17.29
2	434.000000000 kHz	35.88	Average	-11.30
1	434.000000000 kHz	42.60	Quasi Peak	-14.58
2	462.000000000 kHz	37.51	Average	-9.15
2	522.000000000 kHz	40.46	Average	-5.54
1	522.000000000 kHz	46.48	Quasi Peak	-9.52
2	550.000000000 kHz	43.38	Average	-2.62
1	550.000000000 kHz	49.53	Quasi Peak	-6.47

Other emissions present had amplitudes at least 20 dB below the limit.

Table 3 AC Line Conducted Emissions Data L2 (EUT – AC Adapter)

Trace	Frequency	Level (dB μ V)	Detector	Delta Limit/dB
2	150.000000000 kHz	41.79	Average	-14.21
1	154.000000000 kHz	52.33	Quasi Peak	-13.45
1	166.000000000 kHz	46.29	Quasi Peak	-18.87
2	178.000000000 kHz	37.54	Average	-17.04
2	210.000000000 kHz	33.59	Average	-19.61
1	214.000000000 kHz	45.51	Quasi Peak	-17.54
1	230.000000000 kHz	42.40	Quasi Peak	-20.05
2	462.000000000 kHz	32.97	Average	-13.69
2	522.000000000 kHz	36.44	Average	-9.56
1	522.000000000 kHz	46.37	Quasi Peak	-9.63
1	546.000000000 kHz	45.55	Quasi Peak	-10.45
2	550.000000000 kHz	37.24	Average	-8.76

Other emissions present had amplitudes at least 20 dB below the limit.

Summary of Results for AC Line Conducted Emissions Results

The EUT demonstrated compliance with the AC Line Conducted Emissions requirements of 47CFR Part 15C and other applicable emissions requirements. The EUT-AC adapter configuration worst-case configuration demonstrated a minimum margin of -2.6 dB below the requirement. Other emissions were present with amplitudes at least 20 dB below the limit and worst-case amplitudes recorded.

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General Radiated Emissions Procedure

The EUT was arranged in a typical equipment configuration and operated through all available mode during testing. Preliminary testing was performed in a screen room with the EUT positioned 1 meter from the FSM. Radiated emissions measurements were performed to identify the frequencies, which produced the highest emissions. Each radiated emission was then maximized at the OATS location before final radiated measurements were performed. Final data was taken with the EUT located at the OATS at 3 meters distance between the EUT and the receiving antenna. The frequency spectrum from 9 kHz to 25,000 MHz was searched for general radiated emissions. Measured emission levels were maximized by EUT placement on the table, rotating the turntable through 360 degrees, varying the antenna height between 1 and 4 meters above the ground plane and changing antenna position between horizontal and vertical polarization. Antennas used were Loop from 9 kHz to 30 MHz, Broadband Biconical from 30 to 200 MHz, Biconilog from 30 to 1000 MHz, Log Periodic from 200 MHz to 1 GHz and or double Ridge or pyramidal horns and mixers above 1 GHz, notch filters and appropriate amplifiers and external mixers were utilized.

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Table 4 General Radiated Emissions from EUT Data (Highest Emissions)

Frequency (MHz)	Horizontal Peak (dB μ V/m)	Horizontal Quasi-Peak (dB μ V/m)	Vertical Peak (dB μ V/m)	Vertical Quasi-Peak (dB μ V/m)	Limit @ 3m (dB μ V/m)	Horizontal Margin (dB)	Vertical Margin (dB)
84.0	30.1	25.9	33.7	25.7	40.0	-14.1	-14.3
123.6	25.6	16.5	28.3	14.7	40.0	-23.5	-25.3
127.2	23.7	17.5	22.5	15.1	40.0	-22.5	-24.9
123.9	24.7	20.1	25.3	16.8	40.0	-19.9	-23.2
122.5	29.3	16.1	21.5	16.3	40.0	-23.9	-23.7
126.2	24.0	17.8	25.5	15.6	40.0	-22.2	-24.4
141.2	29.1	24.9	27.3	19.0	40.0	-15.1	-21.0
134.6	25.8	19.0	26.6	18.7	40.0	-21.0	-21.3
300.0	22.6	16.2	23.0	16.1	47.0	-30.8	-30.9
320.0	28.4	25.0	26.3	22.9	47.0	-22.0	-24.1

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency range below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

Summary of Results for General Radiated Emissions

The EUT demonstrated compliance with the radiated emissions requirements of 47CFR Part 15C paragraph 15.209, RSS-210 Issue 10 and RSS-GEN Intentional Radiators. The EUT demonstrated a minimum margin of -14.1 below the requirements. Other emissions were present with amplitudes at least 20 dB below the Limits.



Operation in the Band 13.110 - 14.010 MHz Band

The transmitter output power; harmonic and general emissions were measured on an open area test site at 3 and 10 meters. Test procedures of ANSI C63.10-2013 were used during testing.

The EUT was placed on a turntable elevated as required above the ground plane and at a distance of 3 and 10 meters from the FSM antenna. The peak and quasi-peak amplitude of frequencies below 1000 MHz were measured using a spectrum analyzer. Plots were taken of transmitter performance for reference in this and other documentation. The amplitude of each radiated emission was measured on the OATS at a distance of 3 and/or 10 meters from the FSM antenna (OATS testing was performed on sample 1 representative of production equipment with integral antenna). The measured amplitude was then corrected for comparison with the limits.

Measurements taken at 3 meters of the fundamental and emissions below 30 MHz were corrected using the square of an inverse linear distance extrapolation factor (40 dB/decade) as provided in the standards and requirements. The amplitude of each radiated emission was maximized by varying the FSM antenna height, polarization, and by rotating the turntable. A Loop antenna was used for measuring emissions from 0.009 to 30 MHz, Biconilog Antenna for 30 to 1000 MHz, Double-Ridge, and/or Pyramidal Horn Antennas from 1 GHz to 25 GHz. Emissions were measured in $\text{dB}\mu\text{V/m}$ @ 3 meters. Testing performed demonstrated compliance with the following requirements (per 47CFR 15.225). Refer to figure five through nine showing the operation in the frequency band.

- (a) The field strength of any emissions within the band 13.553-13.567 MHz shall not exceed 15,848 microvolts/meter at 30 meters (84 dB μ V/M @ 30m).
- (b) Within the bands 13.410-13.553 MHz and 13.567-13.710 MHz, the field strength of any emissions shall not exceed 334 microvolts/meter at 30 meters (50.5 dB μ V/M @ 30m).
- (c) Within the bands 13.110-13.410 MHz and 13.710-14.010 MHz the field strength of any emissions shall not exceed 106 microvolts/meter at 30 meters (40.5 dB μ V/M @ 30m).
- (d) The field strength of any emissions appearing outside of the 13.110-14.010 MHz band shall not exceed the general radiated emission limits in § 15.209.
- (e) The frequency tolerance of the carrier signal shall be maintained within $\pm 0.01\%$ of the operating frequency over a temperature variation of -20 degrees to +50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery-operated equipment, the equipment tests shall be performed using a new battery.
- (f) In the case of radio frequency powered tags designed to operate with a device authorized under this section, the tag may be approved with the device or be considered as a separate device subject to its own authorization. Powered tags approved with a device under a single application shall be labeled with the same identification number as the device.

Figure 3 Plot of NFC Operation Across Frequency Spectrum

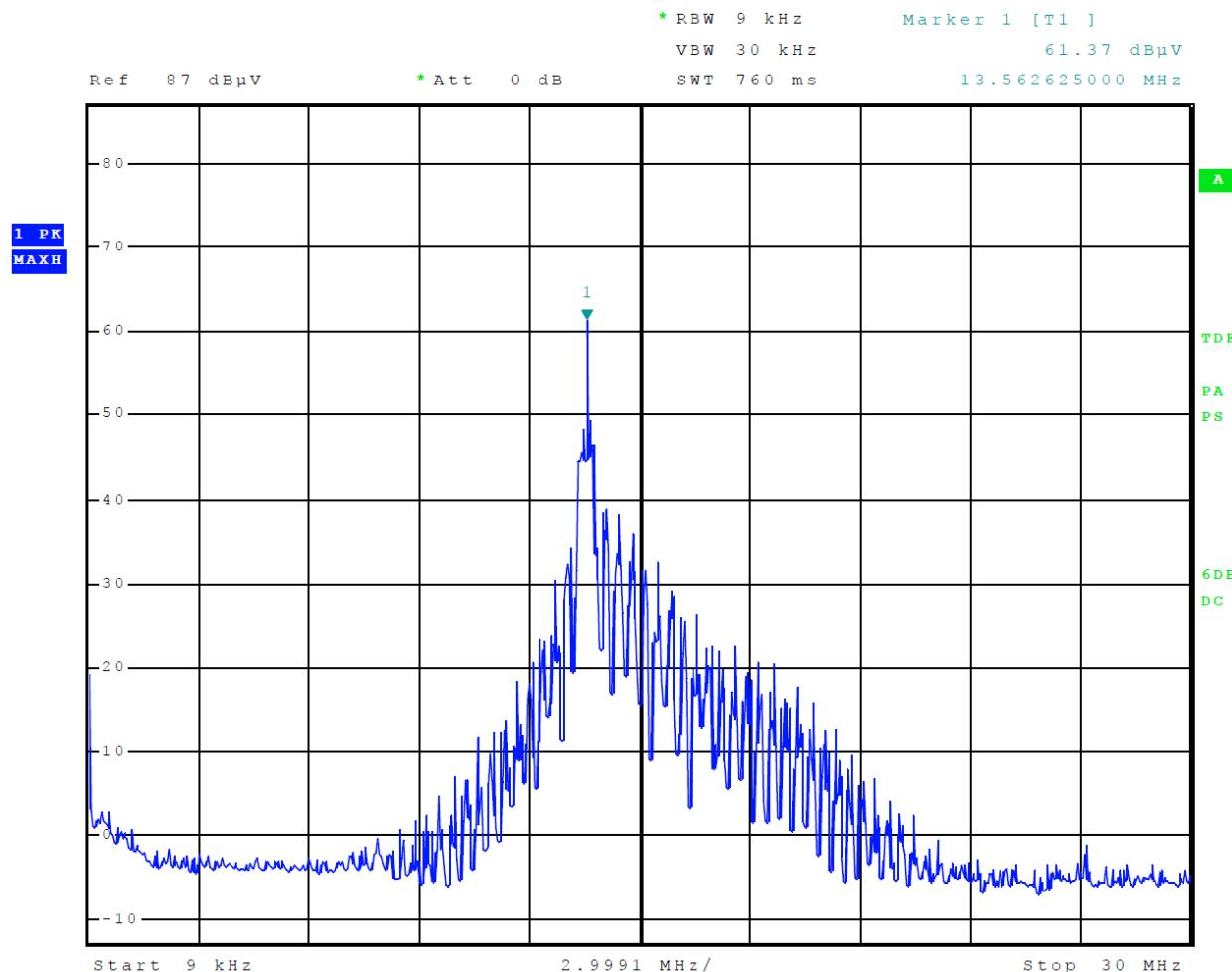


Figure 4 Plot of NFC Operation in Authorized Frequency Band

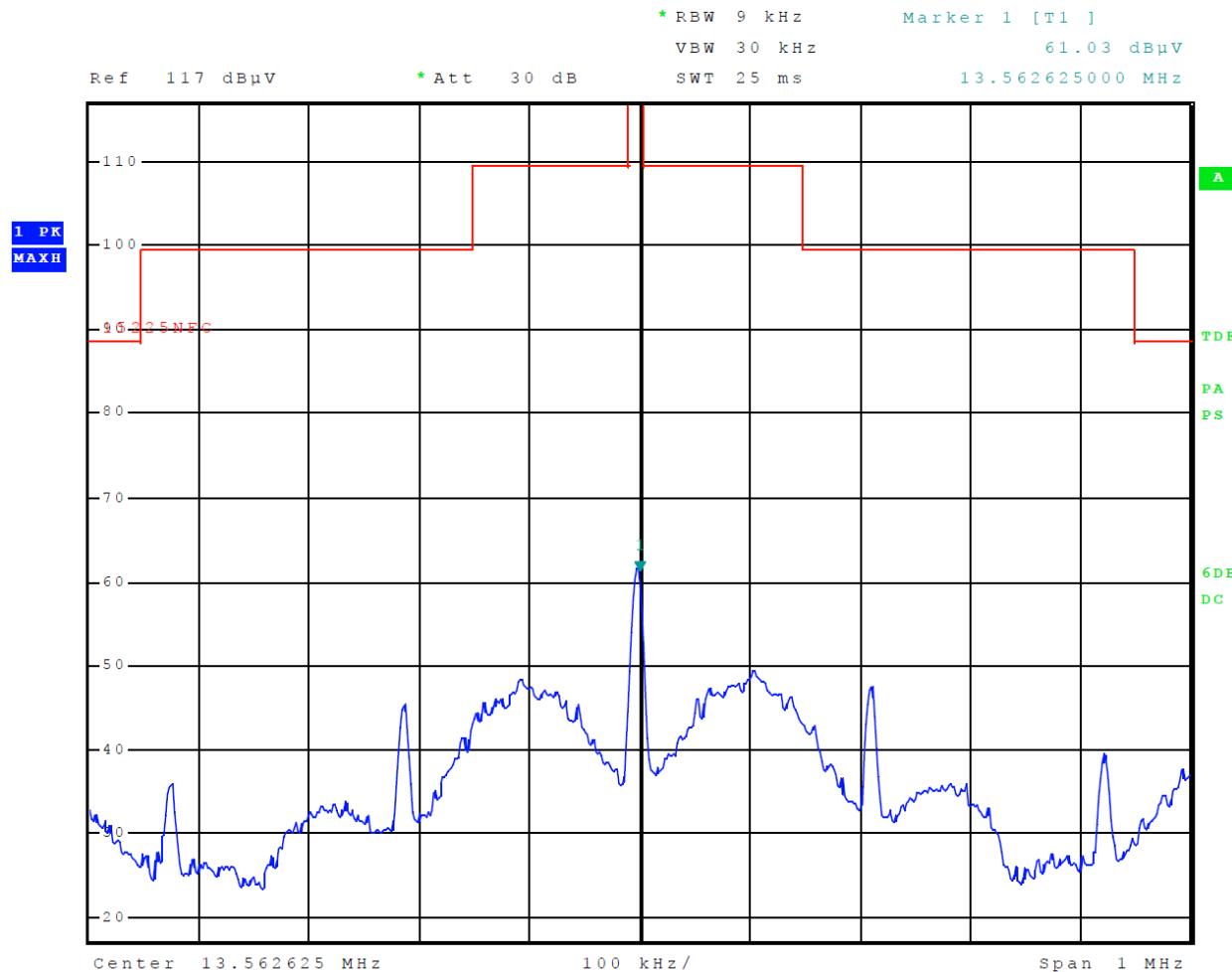


Figure 5 Plot of NFC 99 percent Occupied Bandwidth

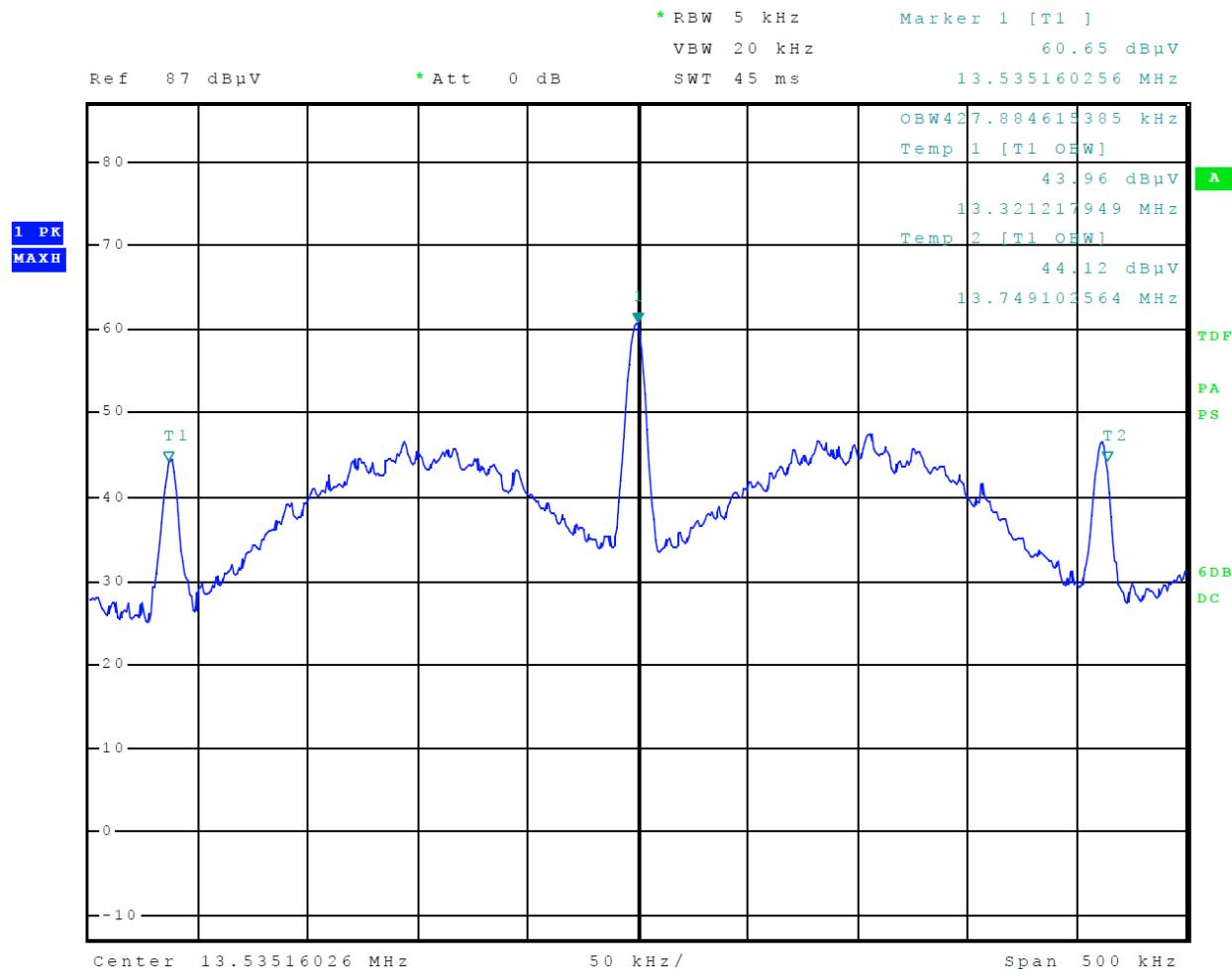


Table 5 NFC Transmitter Emissions in Frequency Band 13.110-14.010 MHz

Frequency in MHz	Peak Level (dB μ V/m)	Quasi-Peak Level (dB μ V/m)	Limit (dB μ V/m) @ 3m	Margin (dB)
13.560	62.8	57.4	124.0	-61.2

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded above for frequencies below 1000 MHz. Peak and Average amplitude emissions are recorded above for frequency range above 1000 MHz.

NOTES:

1. Fundamental radiated emission measurements were performed using a loop antenna. The test sample was positioned in three orthogonal positions (X front, Y side, Z top) and the position with the highest emission level was recorded.
2. The EUT was positioned in three orthogonal planes to determine the orientation resulting in the worst-case emissions. The worst-case emission was found when the front of the EUT was facing the receive antenna.
3. Measurements were performed at 3m, and the limit was extrapolated to the measurement distance of 3 m using the square of an inverse linear distance extrapolation factor (40 dB/decade) as specified in §15.31(f)(2).
Extrapolation Factor = $20 \log_{10} (30/3)^2 = 40$ dB
4. All measurements were recorded using a spectrum analyzer employing peak and quasi-peak detectors.
5. Field Strength Level [dB μ V/m] = Level read from Analyzer [dB μ V] + AFCL [dB/m] – Amplifier Gain (dB)
6. AFCL [dB/m] = Antenna Factor [dB/m] + Cable Loss [dB]
7. Margin [dB] = Field Strength Level [dB μ V/m] – Limit [dB μ V/m]

Table 6 Transmitter Harmonic Radiated Emissions Data

Frequency (MHz)	Horizontal Peak (dB μ V/m)	Horizontal Quasi-Peak (dB μ V/m)	Vertical Peak (dB μ V/m)	Vertical Quasi-Peak (dB μ V/m)	Limit @ 3m (dB μ V/m)	Horizontal Margin (dBm)	Vertical Margin (dBm)
40.7	28.6	22.9	34.8	29.1	40.0	40.0	-17.1
54.2	26.5	20.8	33.1	27.6	40.0	-19.2	-12.4
67.8	20.9	14.3	30.8	20.8	40.0	-25.7	-19.2
81.3	26.3	22.2	30.4	22.7	40.0	-17.8	-17.3
122.0	23.7	14.8	21.7	15.1	40.0	-25.2	-24.9
135.6	20.5	14.7	19.2	13.1	40.0	-25.3	-26.9

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency range below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

Rogers Labs, Inc.
4405 West 259th Terrace
Louisburg, KS 66053
Phone/Fax: (913) 837-3214
Revision 1
FireBoard Labs LLC
HVIN: FBXIR21
Test: 211004
Test to: CFR47 15.225, RSS-210
File: FireBoard Spark NFC TstRpt 211004
SN's: FCC1 / FCC2
FCC ID: 2A29A-FBXIR21
IC: 27842-FBXIR21
Date: November 18, 2021
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Summary of Results for Transmitter Radiated Emissions of Intentional Radiator

The EUT demonstrated compliance with the radiated emissions requirements of FCC 47 CFR Part 15.225, Industry Canada RSS-GEN issue 5, RSS-210 Issue 10 Intentional Radiator regulations. The EUT worst-case configuration demonstrated minimum margin of -61.2 dB below the limit for the fundamental. The EUT worst-case configuration demonstrated minimum radiated harmonic emission margin of -10.9 dB below the limit. No other radiated emissions were found in the restricted bands less than 20 dB below limits than those recorded in this report. Other emissions were present with amplitudes at least 20 dB below the limits.

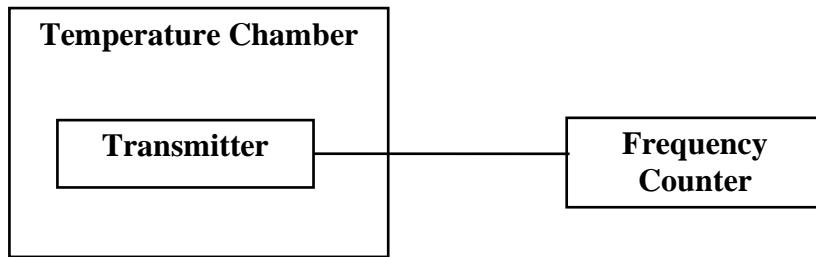
Frequency Stability

Measurements Required

The frequency stability shall be measured with variations of ambient temperature from -30° to +50° centigrade. Measurements shall be made at the extremes of the temperature range and at intervals of not more than 10° centigrade through the range. A period sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. In addition to temperature stability, the frequency stability shall be measured with variation of primary supply voltage as follows:

- (1) Vary primary supply voltage from 85 to 115 percent of the nominal value.
- (2) The supply voltage shall be measured at the input to the cable normally provided with the equipment, or at the power supply terminals if cables are not normally provided.

Test Arrangement



The measurement procedure outlined below shall be followed during measurement of frequency variation over temperature.

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Step 1: The transmitter shall be installed in an environmental test chamber whose temperature is controllable. Provision shall be made to measure the frequency of the transmitter.

Step 2: With the transmitter inoperative (power switched “OFF”), the temperature of the test chamber shall be adjusted to +25°C. After a temperature stabilization period of one hour at +25°C, the transmitter shall be switched “ON” with standard test voltage applied.

Step 3: The carrier shall be keyed “ON”, and the transmitter shall be operated at full radio frequency power output at the duty cycle, for which it is rated, for duration of at least 5 minutes. The radio frequency carrier frequency shall be monitored, and measurements shall be recorded.

Step 4: The test procedures outlined in Steps 2 and 3, shall be repeated after stabilizing the transmitter at the environmental temperatures specified, -30°C to +50°C in 10-degree increments.

The frequency stability was measured with variations in the power supply voltage from 85 to 115 percent of the nominal value. An AC Power Supply was used during measurement of frequency variation over input power to the AC power adapter. The frequency was measured and the variation in parts per million calculated. Data was taken per 47CFR Paragraphs 2.1055 and applicable paragraphs of part 15.225 and RSS-210 Issue 10.

Table 7 Frequency Stability vs. Temperature Results

Frequency 13.559888 MHz	Frequency Stability Vs. Temperature Ambient Frequency (13.559888 MHz)								
Temperature °C	-30	-20	-10	0	+10	+20	+30	+40	+50
Change (Hz)	-811	-583	-788	-588	37	-4	-688	-951	-962
%	-0.006	-0.004	-0.006	-0.004	0.000	0.000	-0.005	-0.007	-0.007
Limit (%)	±0.01	±0.01	±0.01	±0.01	±0.01	±0.01	±0.01	±0.01	±0.01



Table 8 Frequency Stability vs. Input Power Supply Voltage Results

Channel Frequency 13.559888 MHz	Frequency Stability Vs. Voltage Variation 120.0Vac volts nominal; Results in Hz change		
Voltage V _{dc}	102.0	120.0	138.0
Change (Hz)	0	0	0
%	0.000	0.000	0.000
Limit (%)	±0.01	±0.01	±0.01

The EUT demonstrated compliance with specifications of 47CFR Paragraph 2.1046(a) and applicable Parts of 15.225 and RSS-210 Issue 10. There are no deviations or exceptions to the specifications.



Annex

- Annex A Measurement Uncertainty Calculations
- Annex B Test Equipment List
- Annex C Rogers Qualifications
- Annex D Laboratory Certificate of Accreditation

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Annex A Measurement Uncertainty Calculations

The measurement uncertainty was calculated for all measurements listed in this test report according To CISPR 16-4. Result of measurement uncertainty calculations are recorded below. Component and process variability of production devices similar to those tested may result in additional deviations. The manufacturer has the sole responsibility of continued compliance.

Measurement	Expanded Measurement Uncertainty $U_{(lab)}$
3 Meter Horizontal 0.009-1000 MHz Measurements	4.16
3 Meter Vertical 0.009-1000 MHz Measurements	4.33
3 Meter Measurements 1-18 GHz	5.14
3 Meter Measurements 18-40 GHz	5.16
10 Meter Horizontal Measurements 0.009-1000 MHz	4.15
10 Meter Vertical Measurements 0.009-1000 MHz	4.32
AC Line Conducted	1.75
Antenna Port Conducted power	1.17
Frequency Stability	1.00E-11
Temperature	1.6°C
Humidity	3%

Annex B Test Equipment

Equipment	Manufacturer	Model (SN)	Band	Cal Date(m/d/y)	Due
<input checked="" type="checkbox"/> LISN	FCC	FCC-LISN-50-25-10(1PA) (160611)	.15-30MHz	4/6/2021	4/6/2022
<input checked="" type="checkbox"/> LISN	Compliance Design	FCC-LISN-2.Mod.cd,(126)	.15-30MHz	10/14/2021	10/14/2022
<input checked="" type="checkbox"/> Cable	Huber & Suhner Inc.	Sucoflex102ea(L10M)(303073)9kHz-40 GHz	10/14/2021	10/14/2022	
<input type="checkbox"/> Cable	Huber & Suhner Inc.	Sucoflex102ea(1.5M)(303069)9kHz-40 GHz	10/14/2021	10/14/2022	
<input checked="" type="checkbox"/> Cable	Huber & Suhner Inc.	Sucoflex102ea(1.5M)(303070)9kHz-40 GHz	10/14/2021	10/14/2022	
<input checked="" type="checkbox"/> Cable	Belden	RG-58 (L1-CAT3-11509)	9kHz-30 MHz	10/14/2021	10/14/2022
<input checked="" type="checkbox"/> Cable	Belden	RG-58 (L2-CAT3-11509)	9kHz-30 MHz	10/14/2021	10/14/2022
<input checked="" type="checkbox"/> Antenna	Com Power	AL-130 (121055)	.001-30 MHz	10/14/2021	10/14/2022
<input type="checkbox"/> Antenna:	EMCO	6509	.001-30 MHz	10/14/2020	10/14/2022
<input type="checkbox"/> Antenna	ARA	BCD-235-B (169)	20-350MHz	10/14/2021	10/14/2022
<input type="checkbox"/> Antenna:	Schwarzbeck Model	VHBB 9124 (1468)		10/14/2020	10/14/2022
<input checked="" type="checkbox"/> Antenna	Sunol	JB-6 (A100709)	30-1000 MHz	10/14/2021	10/14/2022
<input type="checkbox"/> Antenna	ETS-Lindgren	3147 (40582)	200-1000MHz	10/14/2020	10/14/2022
<input type="checkbox"/> Antenna:	Schwarzbeck Model:	VULP 9118 A (VULP 9118 A-534)		10/14/2020	10/14/2022
<input checked="" type="checkbox"/> Antenna	ETS-Lindgren	3117 (200389)	1-18 GHz	4/21/2020	4/21/2022
<input type="checkbox"/> Antenna	Com Power	AH-118 (10110)	1-18 GHz	10/14/2020	10/14/2022
<input checked="" type="checkbox"/> Antenna	Com Power	AH-840 (101046)	18-40 GHz	4/6/2021	4/6/2023
<input checked="" type="checkbox"/> Analyzer	Rohde & Schwarz	ESU40 (100108)	20Hz-40GHz	5/20/2021	5/20/2022
<input checked="" type="checkbox"/> Analyzer	Rohde & Schwarz	ESW44 (101534)	20Hz-44GHz	1/12/2021	1/12/2022
<input type="checkbox"/> Analyzer	Rohde & Schwarz	FS-Z60, 90, 140, and 220	40GHz-220GHz	12/22/2017	12/22/2027
<input checked="" type="checkbox"/> Amplifier	Com-Power	PA-010 (171003)	100Hz-30MHz	10/14/2021	10/14/2022
<input checked="" type="checkbox"/> Amplifier	Com-Power	CPPA-102 (01254)	1-1000 MHz	10/14/2021	10/14/2022
<input checked="" type="checkbox"/> Amplifier	Com-Power	PAM-118A (551014)	0.5-18 GHz	10/14/2021	10/14/2022
<input checked="" type="checkbox"/> Amplifier	Com-Power	PAM-840A (461328)	18-40 GHz	10/14/2021	10/14/2022
<input checked="" type="checkbox"/> Power Meter	Agilent	N1911A with N1921A	0.05-40 GHz	4/6/2021	4/6/2022
<input type="checkbox"/> Generator	Rohde & Schwarz	SMB100A6 (100150)	20Hz-6 GHz	4/6/2021	4/6/2022
<input type="checkbox"/> Generator	Rohde & Schwarz	SMBV100A6 (260771)	20Hz-6 GHz	4/6/2021	4/6/2022
<input type="checkbox"/> RF Filter	Micro-Tronics	BRC50722 (009).9G notch	30-18000 MHz	4/6/2021	4/6/2022
<input type="checkbox"/> RF Filter	Micro-Tronics	HPM50114 (017)1.5G HPF	30-18000 MHz	4/6/2021	4/6/2022
<input type="checkbox"/> RF Filter	Micro-Tronics	HPM50117 (063) 3G HPF	30-18000 MHz	4/6/2021	4/6/2022
<input type="checkbox"/> RF Filter	Micro-Tronics	HPM50105 (059) 6G HPF	30-18000 MHz	4/6/2021	4/6/2022
<input checked="" type="checkbox"/> RF Filter	Micro-Tronics	BRM50702 (172) 2G notch	30-18000 MHz	4/6/2021	4/6/2022
<input type="checkbox"/> RF Filter	Micro-Tronics	BRC50703 (G102) 5G notch	30-18000 MHz	4/6/2021	4/6/2022
<input type="checkbox"/> RF Filter	Micro-Tronics	BRC50705 (024) 5G notch	30-18000 MHz	4/6/2021	4/6/2022
<input type="checkbox"/> Attenuator	Fairview	SA6NFNF100W-40 (1625)	30-18000 MHz	4/6/2021	4/6/2022
<input type="checkbox"/> Attenuator	Mini-Circuits	VAT-3W2+ (1436)	30-6000 MHz	4/6/2021	4/6/2022
<input type="checkbox"/> Attenuator	Mini-Circuits	VAT-3W2+ (1445)	30-6000 MHz	4/6/2021	4/6/2022
<input type="checkbox"/> Attenuator	Mini-Circuits	VAT-3W2+ (1735)	30-6000 MHz	4/6/2021	4/6/2022
<input type="checkbox"/> Attenuator	Mini-Circuits	VAT-6W2+ (1438)	30-6000 MHz	4/6/2021	4/6/2022
<input type="checkbox"/> Attenuator	Mini-Circuits	VAT-6W2+ (1736)	30-6000 MHz	4/6/2021	4/6/2022
<input checked="" type="checkbox"/> Weather station	Davis	6312 (A81120N075)		11/4/2020	11/4/2021

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Test: 211004 IC: 27842-FBXIR21
Test to: CFR47 15.225, RSS-210 Date: November 18, 2021
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List of Test Equipment		Calibration	Date (m/d/y)	Due
<input type="checkbox"/> Antenna:	Schwarzbeck Model VHBB 9124 (9124-627)		4/21/2020	4/21/2022
<input type="checkbox"/> Antenna:	Schwarzbeck Model: VULP 9118 A (VULP 9118 A-534)		4/21/2020	4/21/2022
<input type="checkbox"/> Frequency Counter:	Leader LDC-825 (8060153)		4/6/2021	4/6/2022
<input type="checkbox"/> LISN:	Com-Power Model LI-220A		10/14/2020	10/14/2022
<input type="checkbox"/> LISN:	Com-Power Model LI-550C		10/14/2020	10/14/2022
<input type="checkbox"/> ISN:	Com-Power Model ISN T-8		4/6/2021	4/6/2022
<input type="checkbox"/> LISN:	Fischer Custom Communications Model: FCC-LISN-50-16-2-08		4/6/2021	4/6/2022
<input type="checkbox"/> Cable	Huber & Suhner Inc. Sucoflex102ea(1.5M)(303072) 9kHz-40 GHz	10/14/2021	10/14/2022	
<input type="checkbox"/> Cable	Huber & Suhner Inc. Sucoflex102ea(L1M)(281183) 9kHz-40 GHz	10/14/2021	10/14/2022	
<input type="checkbox"/> Cable	Huber & Suhner Inc. Sucoflex102ea(L4M)(281184) 9kHz-40 GHz	10/14/2021	10/14/2022	
<input type="checkbox"/> Cable	Huber & Suhner Inc. Sucoflex102ea(L10M)(317546)9kHz-40 GHz	10/14/2021	10/14/2022	
<input type="checkbox"/> Cable	Time Microwave 4M-750HF290-750 (4M) 9kHz-24 GHz	10/14/2021	10/14/2022	
<input type="checkbox"/> RF Filter	Micro-Tronics BRC17663 (001) 9.3-9.5 notch 30-1800 MHz	4/6/2021	4/6/2022	
<input type="checkbox"/> RF Filter	Micro-Tronics BRC19565 (001) 9.2-9.6 notch 30-1800 MHz	10/16/2018	4/6/2022	
<input type="checkbox"/> Analyzer	HP 8562A (3051A05950) 9kHz-125GHz	4/6/2021	4/6/2022	
<input type="checkbox"/> Wave Form Generator	Keysight 33512B (MY57400128)		4/21/2020	4/6/2022
<input type="checkbox"/> Antenna:	Solar 9229-1 & 9230-1		2/22/2021	2/22/2022
<input type="checkbox"/> CDN:	Com-Power Model CDN325E		10/14/2021	10/14/2022
<input type="checkbox"/> Injection Clamp	Luthi Model EM101		10/14/2021	10/14/2022
<input type="checkbox"/> Oscilloscope	Scope: Tektronix MDO 4104		2/22/2021	2/22/2022
<input type="checkbox"/> EMC Transient Generator	HVT TR 3000		2/22/2021	2/22/2022
<input type="checkbox"/> AC Power Source	(Ametech, California Instruments)		2/22/2021	2/22/2022
<input type="checkbox"/> Field Intensity Meter	EFM-018		2/22/2021	2/22/2022
<input type="checkbox"/> ESD Simulator	MZ-15		2/22/2021	2/22/2022
<input type="checkbox"/> R.F. Power Amp	ACS 230-50W		not required	
<input type="checkbox"/> R.F. Power Amp	EIN Model: A301		not required	
<input type="checkbox"/> R.F. Power Amp	A.R. Model: 10W 1010M7		not required	
<input type="checkbox"/> R.F. Power Amp	A.R. Model: 50U1000		not required	
<input type="checkbox"/> Tenney Temperature Chamber			not required	
<input checked="" type="checkbox"/> Shielded Room			not required	



Annex C Rogers Qualifications

Scot D. Rogers, Engineer

Rogers Labs, Inc.

Mr. Rogers has approximately 35 years' experience in the field of electronics. Working experience includes six years working in the automated controls industry and 6 years working with the design, development and testing of radio communications and electronic equipment.

Positions Held:

Systems Engineer: A/C Controls Mfg. Co., Inc. 6 Years

Electrical Engineer: Rogers Consulting Labs, Inc. 5 Years

Electrical Engineer: Rogers Labs, Inc. Current

Educational Background:

Bachelor of Science Degree in Electrical Engineering from Kansas State University

Bachelor of Science Degree in Business Administration Kansas State University

Several Specialized Training courses and seminars pertaining to Microprocessors and Software programming

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SN's: FCC1 / FCC2 FCC ID: 2A29A-FBXIR21
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Annex D Laboratory Certificate of Accreditation

United States Department of Commerce
National Institute of Standards and Technology



Certificate of Accreditation to ISO/IEC 17025:2017

NVLAP LAB CODE: 200087-0

Rogers Labs, Inc.

is accredited by the National Voluntary Laboratory Accreditation Program for specific services, listed on the Scope of Accreditation, for:

Electromagnetic Compatibility & Telecommunications

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated January 2009).

2021-02-19 through 2022-03-31

Effective Dates



For the National Voluntary Laboratory Accreditation Program

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