NVLAP®
Testing
NVLAP Lab Code 200087-0

Class 2 Permissive Change Engineering Test Report

FOR

Model: MUR1DXUFL
2402-2480 MHz
47CFR 15C (15.247)
License Exempt Intentional Radiator
Spread Spectrum Transmitter Module
FCC ID: 2AQ2Q-MUR1DXUFL

FOR

Cargt, Inc.

9753 Widmer Road
Lenexa, KS 66215

Test Report Number: 181120
FCC Designation: US5305
IC Test Site Registration: 3041A-1

Authorized Signatory: Scot D Rogers
Scot D. Rogers

NVLAP®
Testing
NVLAP Lab Code 200087-0

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

Class 2 Permissive Change Engineering Test Report For

FOR

47 CFR, PART 15C - Intentional Radiators Paragraph 15.247
License Exempt Intentional Radiator

For

Cargt, Inc.

9753 Widmer Road
Lenexa, KS 66215

Model: MUR1DXUFL

Spread Spectrum Transmitter Module

Frequency Range 2402-2480 MHz

FCC ID: 2AQ2Q-MUR1DXUFL

Test Date: November 20, 2018

Certifying Engineer: Scot D Rogers

Scot D. Rogers
Rogers Labs, Inc.
4405 West 259th Terrace
Louisburg, KS 66053
Telephone/Facsimile: (913) 837-3214

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Revisions

Revision 1 Issued February 5, 2019

Forward

The following information is submitted as documentation of compliance with regulations supporting Class 2 Permissible Change of Authorized Equipment. This product was authorized under Digital transmission system equipment per 47 CFR Paragraph 15.247 operating in the 2402–2480 MHz frequency band. The design was originally Granted as a module incorporating an integral antenna. The original product authorization remains intact and this report documents using the module with a Flat Patch style antenna. The patch antenna would be permanently attached to the module in a finished product. This provision will comply with the unique antenna port connector under 15.203. This Class 2 Permissible Change request documents and supports demonstration of compliance when using the associated external antenna. The product remains electrically identical as no modifications to the product were performed or required.

Name of Applicant: Cargt, Inc.
9753 Widmer Road
Lenexa, KS 66215

Model: MUR1DXUFL
FCC ID: 2AQ2Q-MUR1DXUFL

Opinion / Interpretation of Results

Tests Performed	Results
Radiated Emissions	Complies

Change to Equipment from Original Design

This request addresses use with a Flat Patch style antenna. Testing was performed using a model FXP72.07.0053A 4dBi gain antenna manufactured by Togals Antenna Solutions. The information contained in this report addresses radiated emissions measured when using the MUR1DXUFL and FXP72.07.0053A mounted on a flat panel. No modification in the transmitter circuitry was required or performed. The transmitter remains electrically identical and functionally equivalent to the original equipment authorization.

Equipment Tested

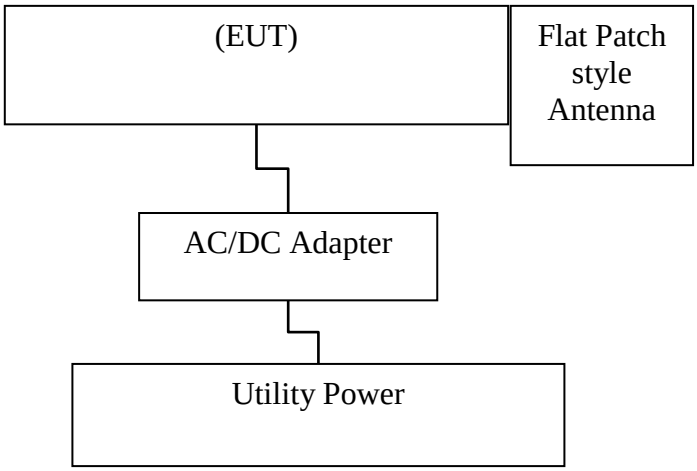
Equipment	Model	Serial Number	FCC I.D.
EUT	MUR1DXUFL	EUT1	2AQ2Q-MUR1DXUFL
Antenna	FXP72.07.0053A	N/A	

Test results in this report relate only to the items tested.

Equipment Function and Configuration

The EUT is a 2402-2480 MHz Spread Spectrum Transmitter Module using a 4dBi Gain antenna. The design provides operational capabilities across the 2402-2480 MHz Digital Transmissions System. The EUT provides broadband wireless connectivity to transmit and receive data. The design requires direct current power provided by the host support system. For testing purposes, the EUT was mounted on a flat supporting panel with integrated software providing testing personnel the ability to set channel and operational modes. This configuration provided operational control of the EUT. As requested by the manufacturer the equipment was tested for emissions compliance using the available configuration with the worst-case data presented. Test results in this report relate only to the products described in this report.

Equipment Configuration



Application for Certification

(1) Manufacturer: Cargt, Inc.
9753 Widmer Road
Lenexa, KS 66215

(2) Identification: Model: MUR1DXUFL
FCC I.D.: 2AQ2Q-MUR1DXUFL

(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 direct current power supplied from the host equipment. The module provides no interface to connect tot utility AC power.

(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. Not applicable to this filing.

(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.

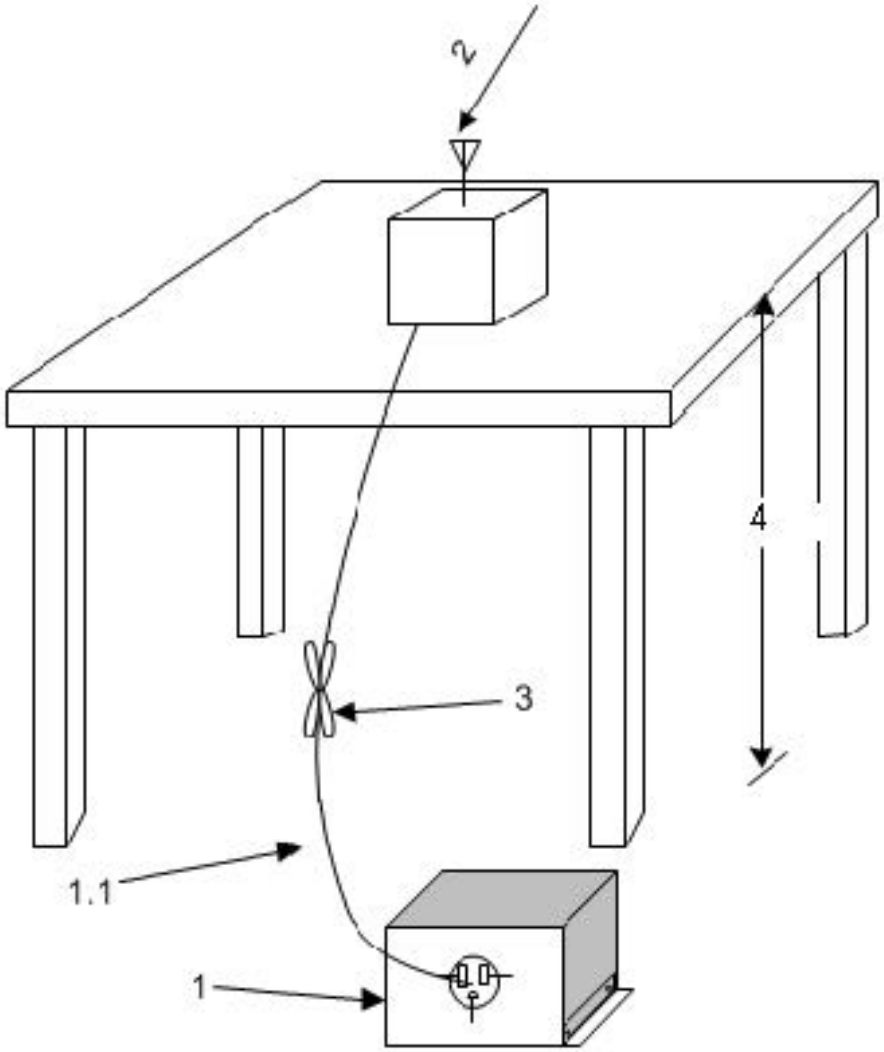
Applicable Standards & Test Procedures

In accordance with the Federal Communications Code of Federal Regulations, Title 47 (47CFR) dated November 20, 2018: Part 2, Subpart J, Paragraphs 2.1043, applicable parts of paragraph 15C, and KDB 178919 D01 Permissive Change Policy v06 operation in the 2400 – 2483.5 MHz Frequency band. Test procedures used are the established Methods of Measurement of Radio-Noise Emissions as described in ANSI C63.10-2013.

Equipment Testing Procedures

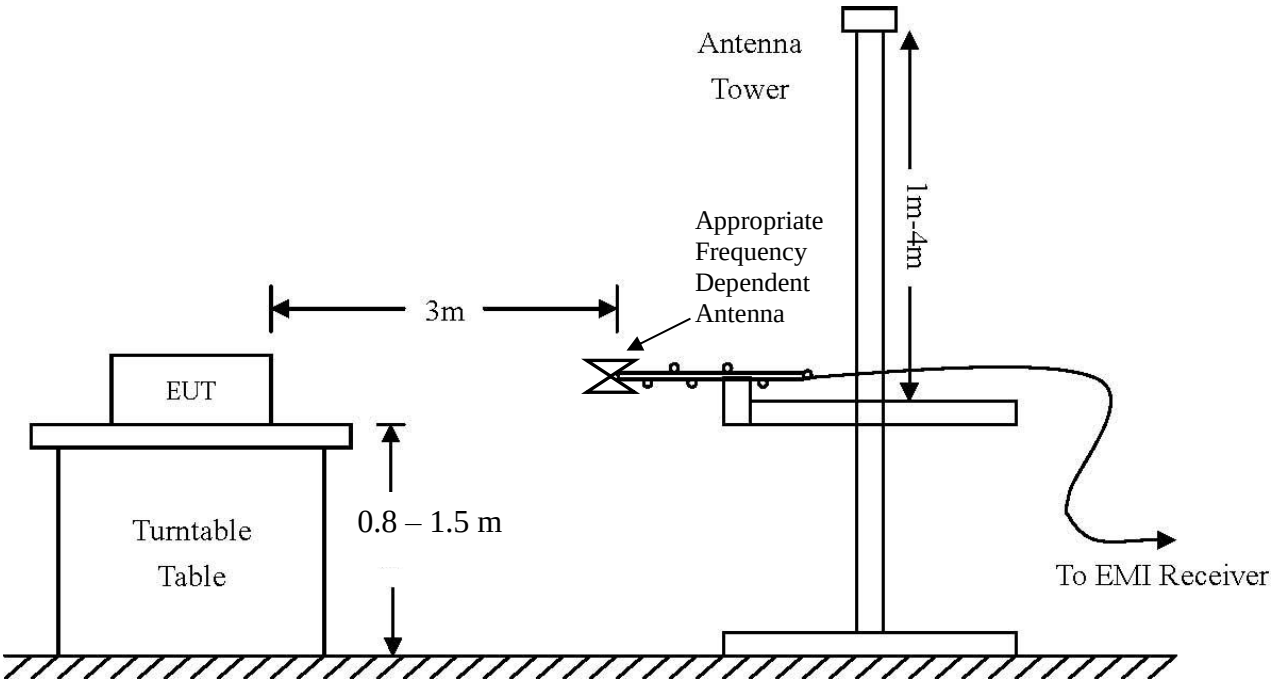
Radiated Emission Test Procedure

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. Radiated emissions testing was performed as required in the regulations and specified in ANSI C63.10-2013. 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 one and two showing typical test setup. Refer to photographs in the test setup exhibits for specific EUT placement during testing.



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 Ω 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 1 Test arrangement for radiated emissions



Radiated Emissions (9 kHz-30 MHz)		
RBW	Video. BW	Detector Function
9 kHz	30 kHz	Peak / Average
Radiated Emissions (30-1000 MHz)		
RBW	Video. BW	Detector Function
120 kHz	300 kHz	Peak / Quasi Peak
Radiated Emissions (Above 1000 MHz)		
RBW	Video BW	Detector Function
100 kHz	100 kHz	Peak
1 MHz	1 MHz	Peak / Average

Diagram 2 Test arrangement for radiated emissions tested on Open Area Test Site (OATS)

Test Site Locations

Antenna Port Conducted — Antenna Port conducted emissions testing performed in a shielded screen room located at Rogers Labs, Inc., 4405 West 259th 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 259th Terrace, Louisburg, KS

Site Registration — FCC Site Designation US5305, Industry Canada Registration: 3041A-1

NVLAP Accreditation — Lab code 200087-0

List of Test Equipment

Equipment	Manufacturer	Model (SN)	Band	Cal Date(m/d/y)	Due
☐ LISN	FCC	FCC-LISN-50-25-10(1PA) (160611)	.15-30MHz	5/2/2018	5/2/2019
☐ LISN	Compliance Design	FCC-LISN-2.Mod.cd,(126)	.15-30MHz	10/16/2018	10/16/2019
☒ Cable	Huber & Suhner Inc.	Sucoflex102ea(L10M)(303073)	9kHz-40 GHz	10/16/2018	10/16/2019
☒ Cable	Huber & Suhner Inc.	Sucoflex102ea(1.5M)(303069)	9kHz-40 GHz	10/16/2018	10/16/2019
☒ Cable	Huber & Suhner Inc.	Sucoflex102ea(1.5M)(303071)	9kHz-40 GHz	10/16/2018	10/16/2019
☐ Cable	Belden	RG-58 (L1-CAT3-11509)	9kHz-30 MHz	10/16/2018	10/16/2019
☐ Cable	Belden	RG-58 (L2-CAT3-11509)	9kHz-30 MHz	10/16/2018	10/16/2019
☐ Antenna	ARA	BCD-235-B (169)	20-350MHz	10/16/2018	10/16/2019
☐ Antenna	EMCO	3147 (40582)	200-1000MHz	10/16/2018	10/16/2019
☒ Antenna	ETS-Lindgren	3117 (200389)	1-18 GHz	5/2/2018	5/2/2020
☐ Antenna	Com Power	AH-118 (10110)	1-18 GHz	10/16/2018	10/24/2019
☒ Antenna	Com Power	AH-840 (101046)	18-40 GHz	5/15/2017	5/15/2019
☒ Antenna	Com Power	AL-130 (121055)	.001-30 MHz	10/16/2018	10/16/2019
☒ Antenna	Sunol	JB-6 (A100709)	30-1000 MHz	10/16/2018	10/16/2019
☒ Analyzer	Rohde & Schwarz	ESU40 (100108)	20Hz-40GHz	5/2/2018	5/2/2019
☒ Analyzer	Rohde & Schwarz	ESW44 (101534)	20Hz-44GHz	12/22/2017	12/22/2018
☐ Analyzer	Rohde & Schwarz	FS-Z60, 90, 140, and 220	40GHz-220GHz	12/22/2017	12/22/2019
☒ Amplifier	Com-Power	PA-010 (171003)	100Hz-30MHz	10/16/2018	10/16/2019
☒ Amplifier	Com-Power	CPPA-102 (01254)	1-1000 MHz	10/16/2018	10/16/2019
☒ Amplifier	Com-Power	PAM-118A (551014)	0.5-18 GHz	10/16/2018	10/16/2019
☒ Amplifier	Com-Power	PAM-840A (461328)	18-40 GHz	10/16/2018	10/16/2019
☐ Power Meter	Agilent	N1911A with N1921A	0.05-40 GHz	5/2/2018	5/2/2019
☐ Generator	Rohde & Schwarz	SMB100A6 (100150)	20Hz-6 GHz	5/2/2018	5/2/2019
☐ Generator	Rohde & Schwarz	SMBV100A6 (260771)	20Hz-6 GHz	5/2/2018	5/2/2019
☐ RF Filter	Micro-Tronics	BRC50722 (009).9G notch	30-1800 MHz	5/2/2018	5/2/2019
☐ RF Filter	Micro-Tronics	HPM50114 (017)1.5G HPF	30-18000 MHz	5/2/2018	5/2/2019
☐ RF Filter	Micro-Tronics	HPM50117 (063) 3G HPF	30-18000 MHz	5/2/2018	5/2/2019
☐ RF Filter	Micro-Tronics	HPM50105 (059) 6G HPF	30-18000 MHz	5/2/2018	5/2/2019
☐ RF Filter	Micro-Tronics	BRM50702 (172) 2G notch	30-1800 MHz	5/2/2018	5/2/2019
☐ RF Filter	Micro-Tronics	BRC50703 (G102) 5G notch	30-1800 MHz	5/2/2018	5/2/2019
☐ RF Filter	Micro-Tronics	BRC50705 (024) 5G notch	30-1800 MHz	5/2/2018	5/2/2019
☐ Attenuator	Fairview	SA6NFNF100W-14 (1625)	30-1800 MHz	5/2/2018	5/2/2019
☐ Attenuator	Mini-Circuits	VAT-3W2+ (1735)	30-6000 MHz	5/2/2018	5/2/2019
☐ Attenuator	Mini-Circuits	VAT-3W2+ (1436)	30-6000 MHz	5/2/2018	5/2/2019
☐ Attenuator	Mini-Circuits	VAT-3W2+ (14362)	30-6000 MHz	5/2/2018	5/2/2019
☐ Attenuator	Mini-Circuits	VAT-3W2+ (1445)	30-6000 MHz	5/2/2018	5/2/2019
☐ Attenuator	Mini-Circuits	VAT-3W2+ (14452)	30-6000 MHz	5/2/2018	5/2/2019
☐ Attenuator	Mini-Circuits	VAT-6W2+ (1438)	30-6000 MHz	5/2/2018	5/2/2019
☐ Attenuator	Mini-Circuits	VAT-6W2+ (1736)	30-6000 MHz	5/2/2018	5/2/2019
☐ Attenuator	JFW Industries	50FH-010-10 (1)	30-18000 MHz	5/2/2018	5/2/2019
☒ Weather station	Davis	6312 (A81120N075)		10/26/2018	10/26/2019

Units of Measurements

Conducted EMI Data is in dBµV; dB referenced to one microvolt

Radiated EMI Data is in dBµV/m; dB/m referenced to one microvolt per meter

Sample Calculation:

RFS = Radiated Field Strength, FSM = Field Strength Measured

A.F. = Receive antenna factor, Gain = amplification gains and/or cable losses

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

Environmental Conditions

Ambient Temperature	20.0° C
Relative Humidity	23%
Atmospheric Pressure	1033.0 mb

Statement of Modifications and Deviations

No modifications to the EUT were required during investigation for the equipment to demonstrate compliance with the 47CFR, Part 2.1043 and Part 15C requirements. There were no deviations to the specifications.

Intentional Radiators

The following information is submitted in support of demonstration of compliance with the requirements of 47CFR Parts 2 and 15C, Class 2 permissible change.

Operation in the 2400-2483.5 MHz Frequency Band

Radiated emissions were measured on the Open Area Test Site (OATS) at a three-meter distance. The production design MUR1DXUFL was mounted on a flat panel with the patch antenna during testing. Radiated emissions measurements were performed on the described configuration. Testing procedures defined in publication ANSI C63.10-2013 were used during compliance testing. The EUT was placed on a turntable elevated as required above the ground plane at a distance of 3 meters from the FSM antenna located on the OATS. The peak and quasi-peak amplitude of the frequencies below 1000 MHz were measured using a spectrum analyzer / EMC receiver. The peak and average amplitude of emissions above 1000 MHz were measured using a spectrum analyzer / EMC receiver. Emissions data was recorded from the measurement results. Data presented reflects measurement result corrected to account for measurement system gains and losses.

Transmitter Emissions Data

Table 1 Transmitter Radiated Emissions (DSS mode Worst-case)

Frequency in MHz	Horizontal Peak (dBµV/m)	Horizontal Average (dBµV/m)	Vertical Peak (dBµV/m)	Vertical Average (dBµV/m)	Limit @ 3m (dBµV/m)
2402.0	83.2	70.0	85.9	74.8	-
4804.0	47.8	34.9	48.1	34.9	54.0
7206.0	51.4	38.5	51.2	38.5	54.0
9608.0	53.8	41.2	53.7	41.3	54.0
12010.0	56.7	43.8	57.7	43.8	54.0
14412.0	59.0	46.6	59.6	46.6	54.0
16814.0	63.1	50.7	62.9	50.6	54.0
2440.0	80.4	67.0	82.3	70.6	-
4880.0	48.4	35.3	48.4	35.2	54.0
7320.0	52.0	39.0	51.7	39.0	54.0
9760.0	54.2	41.2	54.3	41.2	54.0
12200.0	57.6	44.4	57.5	44.6	54.0
14640.0	60.1	47.5	60.7	47.5	54.0
17080.0	63.2	50.0	63.0	50.1	54.0
2480.0	76.7	66.1	80.1	69.6	-
4960.0	48.1	35.0	47.9	35.0	54.0
7440.0	51.3	38.7	51.5	38.8	54.0
9920.0	54.1	41.4	54.4	41.4	54.0
12400.0	57.1	44.3	57.8	44.4	54.0
14880.0	60.2	47.0	59.4	47.0	54.0
17360.0	61.4	49.1	62.1	49.0	54.0

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded above for frequency range of 30-1000 MHz. Peak and Average amplitude emissions are recorded above for frequency range above 1000 MHz.

Summary of Results for Transmitter Radiated Emissions of Intentional Radiator

The EUT demonstrated compliance with the radiated emissions requirements of 47CFR Part 15.247. The minimum radiated harmonic emission provided -3.3 dB margin below requirements. There were no other significantly measurable emissions in the restricted bands other than those recorded in this report. Other emissions were present with amplitudes at least 20 dB below the requirements. There were no other deviations or exceptions to the requirements.

Statement of Modifications and Deviations

No modifications to the EUT were required for the unit to demonstrate compliance with the 47CFR Part 15C paragraph 15.247 emissions requirements. There were no deviations or modifications to the specifications.

Annex

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

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 Additional Test Equipment

List of Test Equipment	Calibration	Date (m/d/y)	Due
Antenna: Schwarzbeck Model: BBA 9106/VHBB 9124 (9124-627)		5/2/2018	5/2/2019
Antenna: Schwarzbeck Model: VULP 9118 A (VULP 9118 A-534)		5/2/2018	5/2/2019
Antenna: EMCO 6509		10/16/2018	10/16/2020
Antenna: EMCO 3143 (9607-1277) 20-1200 MHz		5/2/2018	5/2/2019
Antenna: EMCO Dipole Set 3121C		2/23/2018	2/23/2019
Antenna: C.D. B-101		2/23/2018	2/23/2019
Antenna: Solar 9229-1 & 9230-1		2/23/2018	2/23/2019
Cable: Belden 8268 (L3)		10/16/2018	10/16/2019
Cable: Time Microwave: 4M-750HF290-750		10/16/2018	10/16/2019
Frequency Counter: Leader LDC-825 (8060153		5/2/2018	5/2/2019
Oscilloscope Scope: Tektronix 2230		2/23/2018	2/23/2019
Wattmeter: Bird 43 with Load Bird 8085		2/23/2018	2/23/2019
R.F. Generator: SMB100A6 s/n 100623		5/2/2018	5/2/2019
R.F. Generator: SBMBV100A s/n: 260771		5/2/2018	5/2/2019
R.F. Generators: HP 606A, HP 8614A, HP 8640B		2/23/2018	2/23/2019
R.F. Power Amp 65W Model: 470-A-1010		2/23/2018	2/23/2019
R.F. Power Amp 50W M185- 10-501		2/23/2018	2/23/2019
R.F. Power Amp A.R. Model: 10W 1010M7		2/23/2018	2/23/2019
R.F. Power Amp EIN Model: A301		2/23/2018	2/23/2019
LISN: Compliance Eng. Model 240/20		5/2/2018	5/2/2019
LISN: Fischer Custom Communications Model: FCC-LISN-50-16-2-08		5/2/2018	5/2/2019
Audio Oscillator: H.P. 201CD		2/23/2018	2/23/2019
ESD Test Set 2010i		2/23/2018	2/23/2019
Oscilloscope Scope: Tektronix MDO 4104		2/23/2018	2/23/2019
EMC Transient Generator HVT TR 3000		2/23/2018	2/23/2019
AC Power Source (Ametech, California Instruments)		2/23/2018	2/23/2019
Fast Transient Burst Generator Model: EFT/B-101		2/23/2018	2/23/2019
Field Intensity Meter: EFM-018		2/23/2018	2/23/2019
KEYTEK Ecat Surge Generator		2/23/2018	2/23/2019
ESD Simulator: MZ-15		2/23/2018	2/23/2019
Shielded Room not required			

Annex C Rogers Qualifications

Scot D. Rogers, Engineer

Rogers Labs, Inc.

Mr. Rogers has approximately 30 years' experience in the field of electronics. Engineering experience includes six years in the automated controls industry and remaining 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

1) Bachelor of Science Degree in Electrical Engineering from Kansas State University.

2) Bachelor of Science Degree in Business Administration Kansas State University.

3) Several Specialized Training courses and seminars pertaining to Microprocessors and Software programming.

Scot D Rogers
Scot D. Rogers

Annex D Rogers Labs Certificate of Accreditation

United States Department of Commerce
National Institute of Standards and Technology

Certificate of Accreditation to ISO/IEC 17025:2005

NVLAP LAB CODE: 200087-0

Rogers Labs, Inc.
Louisburg, KS

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 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communique dated January 2009).

2018-02-21 through 2019-03-31
Effective Dates

For the National Voluntary Laboratory Accreditation Program