NVLAP®
Testing
NVLAP Lab Code 200087-0

Application For
Grant of Certification
FCC CFR47 Part 87

Model: GMN-0121611

1090 MHz
Aviation Transponder
FCC ID: IPH-0225611

Garmin International, Inc.

1200 East 151st Street
Olathe, KS 66062

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

Test Report Number 180320

Authorized Signatory: Scot D Rogers
Scot D. Rogers

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NVLAP Lab Code 200087-0

ROGERS LABS, INC.

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

Test Report For Application of Certification

For

Garmin International, Inc.

1200 East 151st Street
Olathe, KS 66062
Phone: (913) 397-8200

Mr. Doug Kealey
Regulatory and Environmental Affairs Manager

Model: GMN-0121611

Aviation Transponder

FCC ID: IPH-0225611
Frequency Range: 1090 MHz

Test Date: March 20, 2018

Certifying Engineer: Scot D Rogers

Scot D. Rogers
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Revision History

Revision 1 Issued August 23, 2018

Foreword

In accordance with the Federal Communications, Code of Federal Regulations dated March 20. 2018, Part 2 Subpart J, Paragraphs 2.907, 2.911, 2.915, 2.925, 2.926, 2.1031 through 2.1057, and Part 87, Subchapter D, Paragraphs 87.131 through 87.147. The following information is submitted for consideration on obtaining Grant of Certification.

Opinion / Interpretation of Results

Tests Performed	Results
Emissions Tests	
Requirements per CFR47 paragraphs 2.1031-2.1057	Complies
Requirements per CFR47 paragraphs 87.131	Complies
Requirements per CFR47 paragraphs 87.133	Complies
Requirements per CFR47 paragraphs 87.135	Complies
Requirements per CFR47 paragraphs 87.139	Complies
Requirements per CFR47 paragraphs 87.141	Complies

Applicable Standards & Test Procedures

Applicable requirements include the 47CFR Part 2, Subpart J, Paragraphs 2.907, 2.911, 2.915, 2.925, 2.926, 2.1031 through 2.1057, and applicable paragraphs of Part 87. Test procedures used are the established Methods of Measurement of Radio-Noise Emissions as described in ANSI C63.26-2015 and C63.4-2014.

Application for Certification

(1) The full name and mailing address of the manufacturer of the device and the applicant for certification.

Garmin International, Inc. 1200 East 151st Street Olathe, KS 66062

(2) FCC identifier. FCC I.D.: IPH-0225611

(3) A copy of the installation and operating instructions to be furnished the user. A draft copy of the instructions may be submitted if the actual document is not available. The actual document shall be furnished to the FCC when it becomes available.

Refer to exhibit for Draft Instruction Manual.

(4) Type or types of emission. 12M0M1D

(5) Frequency range. 1090 MHz

(6) Range of operating power values or specific operating power levels, and description of any means provided for variation of operating power.

363 Watts peak, 3.99 Watts average power for 28/14-volt installation / operation

(7) Maximum power rating as defined in the applicable part(s) of the rules.

Maximum power output as determined by appropriate standards during certification per CFR 47 paragraph 87.131.

(8) The dc voltages applied to and dc currents into the several elements of the final radio frequency amplifying device for normal operation over the power range.

Power delivered into final amplifier 28.0 Volts @ 20.0 Amps (560 Watts peak)

(9) Tune-up procedure over the power range, or at specific operating power levels.

Refer to Exhibit for Transceiver Alignment Procedure.

(10) A schematic diagram and a description of all circuitry and devices provided for determining and stabilizing frequency, for suppression of spurious radiation, for limiting modulation, and for limiting power.

Refer to Exhibit for Circuit Schematic and Theory of Operation.

(11) A photograph or drawing of the equipment identification plate or label showing the information to be placed thereon.

Refer to Exhibit for Photograph or Drawing of Label exhibit

(12) Photographs (8″ × 10″) of the equipment of sufficient clarity to reveal equipment construction and layout, including meters, if any, and labels for controls and meters and sufficient views of the internal construction to define component placement and chassis assembly. Insofar as these requirements are met by photographs or drawings contained in instruction manuals supplied with the certification request, additional photographs are necessary only to complete the required showing.

Refer to Exhibit for Components Layout and Chassis Drawings.

(13) For equipment employing digital modulation techniques, a detailed description of the modulation system to be used, including the response characteristics (frequency, phase and amplitude) of any filters provided, and a description of the modulating wave train, shall be submitted for the maximum rated conditions under which the equipment will be operated.

Not applicable

(14) The data required by §2.1046 through 2.1057, inclusive, measured in accordance with the procedures set out in §2.1041.

Data is contained in this application

(15) The application for certification of an external radio frequency power amplifier under part 97 of this chapter need not be accompanied by the data required by paragraph (b)(14) of this section. In lieu thereof, measurements shall be submitted to show compliance with the technical specifications in subpart C of part 97 of this chapter and such information as required by §2.1060 of this part.

Does not apply to this device or application.

(16) An application for certification of an AM broadcast stereophonic exciter-generator intended for interfacing with existing certified, or formerly type accepted or notified transmitters must include measurements made on a complete stereophonic transmitter. The instruction book must include complete specifications and circuit requirements for interconnecting with existing transmitters. The instruction book must also provide a full description of the equipment and measurement procedures to monitor modulation and to verify that the combination of stereo exciter-generator and transmitter meet the emission limitations of §73.44.

Does not apply to this device or application.

(17) Applications for certification required by §25.129 of this chapter shall include any additional equipment test data required by that section.

Does not apply to this device or application.

(18) An application for certification of a software defined radio must include the information required by §2.944.

Does not apply to this device or application.

(19) Applications for certification of equipment operating under part 27 of this chapter, that a manufacturer is seeking to certify for operation in the:

(i) 1755-1780 MHz, 2155-2180 MHz, or both bands shall include a statement indicating compliance with the pairing of 1710-1780 and 2110-2180 MHz specified in §§27.5(h) and 27.75 of this chapter.

(ii) 1695-1710 MHz, 1755-1780 MHz, or both bands shall include a statement indicating compliance with §27.77 of this chapter.

(iii) 600 MHz band shall include a statement indicating compliance with §27.75 of this chapter.

Does not apply to this device or application.

(20) Before equipment operating under part 90 of this chapter and capable of operating on the 700 MHz interoperability channels (See §90.531(b)(1) of this chapter) may be marketed or sold, the manufacturer thereof shall have a Compliance Assessment Program Supplier's Declaration of Conformity and Summary Test Report or, alternatively, a document detailing how the manufacturer determined that its equipment complies with §90.548 of this chapter and that the equipment is interoperable across vendors. Submission of a 700 MHz narrowband radio for certification will constitute a representation by the manufacturer that the radio will be shown, by testing, to be interoperable across vendors before it is marketed or sold.

Does not apply to this device or application.

(21) 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.

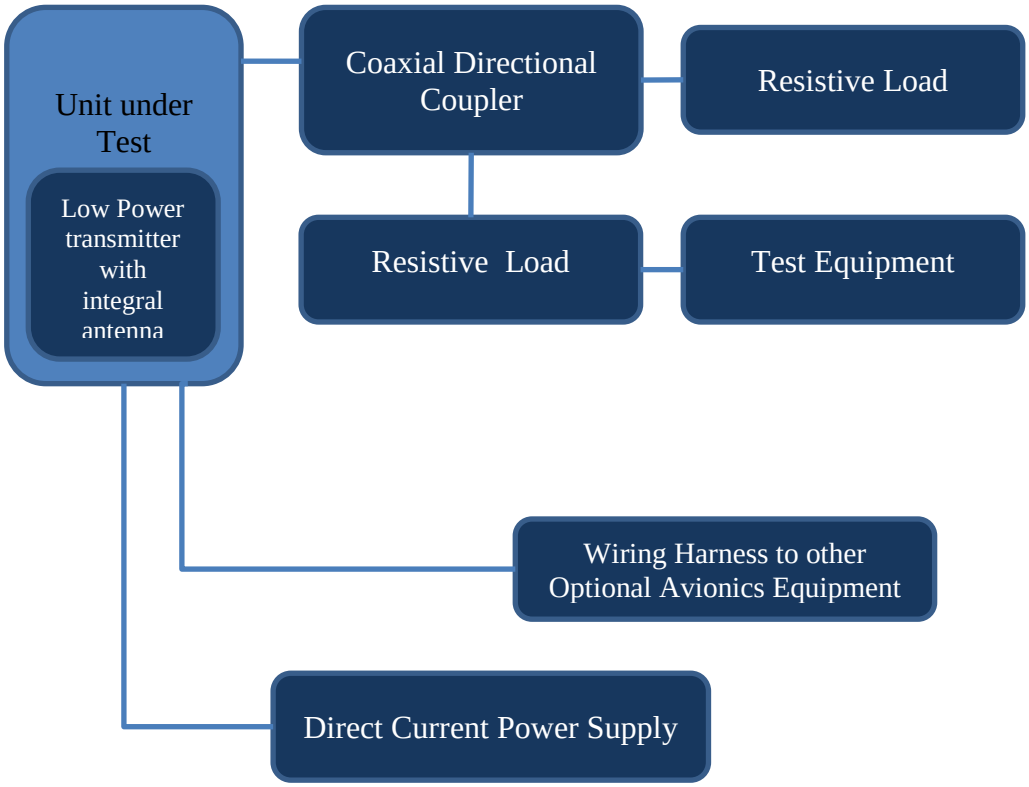
Data is contained in this application or application exhibits.

System Description

The EUT is a Mode A and S avionics transponder, designed to be mounted in the panel of the aircraft. The design provides a response when it receives a radio-frequency interrogation to assist in identifying the aircraft. The unit operates on aviation-defined frequencies, receiving ground radar interrogations at 1030 MHz and transmitting a coded response of pulses back at 1090 MHz. This design also incorporates a low power transmitter providing additional wireless connectivity inside the aircraft with compatible equipment. The low power transmitter functions in the 2402-2480 MHz frequency band. This report documents operation for this application as authorized in 47CFR 87 Subparts D and F.

Equipment Configuration

1) EUT powered by Bench DC power supply and connected to interface cabling



Environmental Conditions

Ambient Temperature	21.3° C
Relative Humidity	38%
Atmospheric Pressure	1015.1 mb

Units of Measurements

AC Line 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

Antenna Conducted Data is in dBm, dB referenced to one milliwatt

Test Site Locations

Conducted EMI Conducted emission testing was performed in a shielded screen room located at Rogers Labs, Inc., 4405 West 259th Terrace, Louisburg, KS

Radiated EMI Radiated emission testing was 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-50-2-10(1PA) (160611)	.15-30MHz	5/15/17	5/15/18
☒ Cable	Huber & Suhner Inc.	Sucoflex102ea(L10M)(303073)	9kHz-40 GHz	10/24/17	10/24/18
☒ Cable	Huber & Suhner Inc.	Sucoflex102ea(1.5M)(303069)	9kHz-40 GHz	10/24/17	10/24/18
☐ Cable	Belden	RG-58 (L1-CAT3-11509)	9kHz-30 MHz	10/24/17	10/24/18
☐ Cable	Belden	RG-58 (L2-CAT3-11509)	9kHz-30 MHz	10/24/17	10/24/18
☐ Antenna	ARA	BCD-235-B (169)	20-350MHz	10/24/17	10/24/18
☐ Antenna	EMCO	3147 (40582)	200-1000MHz	10/24/17	10/24/18
☒ Antenna	ETS-Lindgren	3117 (200389)	1-18 GHz	5/15/17	5/15/18
☐ Antenna	Com Power	AH-118 (10110)	1-18 GHz	10/24/17	10/24/19
☐ Antenna	Com Power	AH-840 (101046)	18-40 GHz	5/15/17	5/15/19
☒ Antenna	Com Power	AL-130 (121055)	.001-30 MHz	10/24/17	10/24/18
☒ Antenna	Sunol	JB-6 (A100709)	30-1000 MHz	10/24/17	10/24/18
☐ Antenna	EMCO	3143 (9607-1277)	20-1200 MHz	5/15/17	5/15/18
☒ Analyzer	Rohde & Schwarz	ESU40 (100108)	20Hz-40GHz	5/15/17	5/15/18
☒ Analyzer	Rohde & Schwarz	ESW44 (101534)	20Hz-44GHz	12/22/17	12/22/18
☐ Analyzer	Rohde & Schwarz	FS-Z60, 90, 140, and 220	40GHz-220GHz	12/22/17	12/22/19
☐ Analyzer	HP	8591EM (3628A00871)	9kHz-1.8GHz	5/15/17	5/15/18
☐ Analyzer	HP	8562A (3051A05950)	9kHz-125GHz	5/15/17	5/15/18
☐ Analyzer	HP External Mixers	11571, 11970	25GHz-110GHz	5/15/17	5/15/18
☒ Amplifier	Com-Power	PA-010 (171003)	100Hz-30MHz	10/24/17	10/24/18
☒ Amplifier	Com-Power	CPPA-102 (01254)	1-1000 MHz	10/24/17	10/24/18
☒ Amplifier	Com-Power	PAM-118A (551014)	0.5-18 GHz	10/24/17	10/24/18
☒ Power Mtr	Agilent	N1911A with N1921A	0.05-18 GHz	5/15/17	5/15/18
☐ Generator	Rohde & Schwarz	SMB100A6 (100150)	20Hz-6 GHz	5/15/17	5/15/18
☐ Generator	Rohde & Schwarz	SMBV100A6 (260771)	20Hz-6 GHz	5/15/17	5/15/18
☐ RF Filter	Micro-Tronics	BRC50722 (009).9G notch	30-1800 MHz	5/15/17	5/15/18
☐ RF Filter	Micro-Tronics	HPM50114 (017)1.5G HPF	30-18000 MHz	5/15/17	5/15/18
☐ RF Filter	Micro-Tronics	HPM50117 (063) 3G HPF	30-18000 MHz	5/15/17	5/15/18
☐ RF Filter	Micro-Tronics	HPM50105 (059) 6G HPF	30-18000 MHz	5/15/17	5/15/18
☐ RF Filter	Micro-Tronics	BRM50702 (172) 2G notch	30-1800 MHz	5/15/17	5/15/18
☐ RF Filter	Micro-Tronics	BRC50703 (G102) 5G notch	30-1800 MHz	5/15/17	5/15/18
☐ RF Filter	Micro-Tronics	BRC50705 (024) 5G notch	30-1800 MHz	5/15/17	5/15/18
☐ RF Filter	Micro-Tronics	BRC17663 (001) 9G notch	30-1800 MHz	5/15/17	5/15/18
☒ Attenuator	Fairview	SA6NFNF100W-14 (1625)	30-1800 MHz	5/15/17	5/15/18
☐ Attenuator	Mini-Circuits	VAT-3W2+ (1735)	30-6000 MHz	5/15/17	5/15/18
☐ Attenuator	Mini-Circuits	VAT-3W2+ (1436)	30-6000 MHz	5/15/17	5/15/18
☐ Attenuator	Mini-Circuits	VAT-3W2+ (14362)	30-6000 MHz	5/15/17	5/15/18
☐ Attenuator	Mini-Circuits	VAT-3W2+ (1445)	30-6000 MHz	5/15/17	5/15/18
☐ Attenuator	Mini-Circuits	VAT-6W2+ (1438)	30-6000 MHz	5/15/17	5/15/18
☒ Coupler	NARDA	3002-20	0.5GHz-3GHz	5/15/17	5/15/18
☒ Weather station	Davis	6312 (A70927D44N)		10/24/2017	10/24/2018

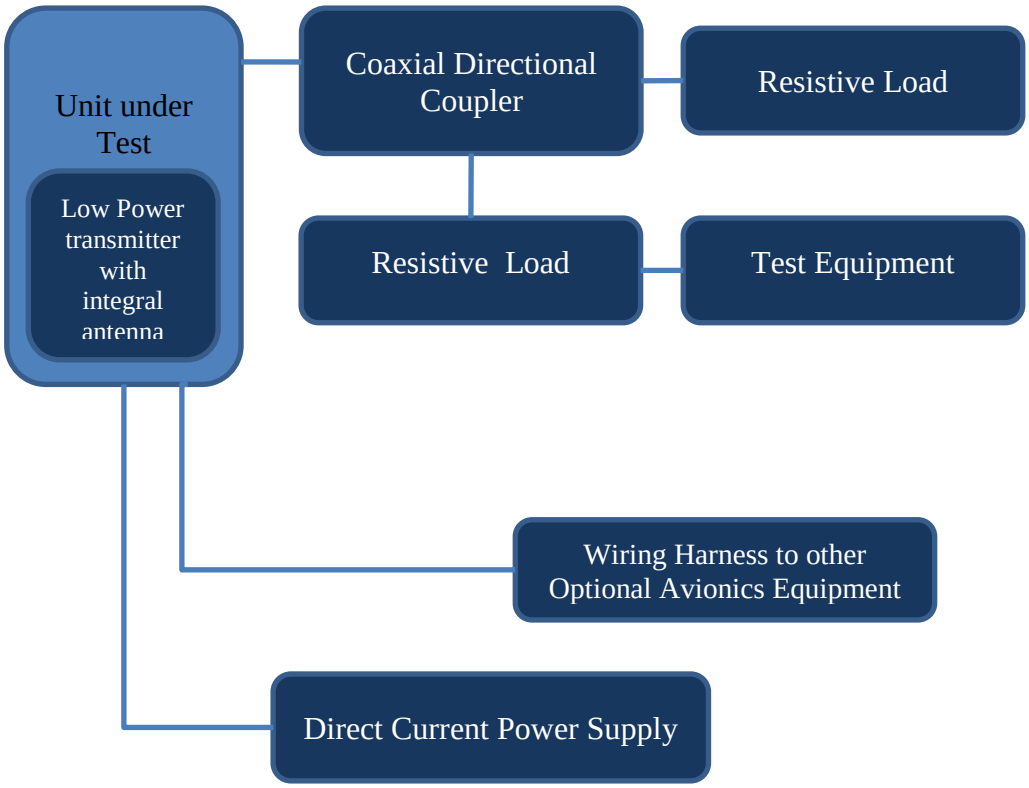
Transmitter Power Output

Measurements Required

Measurements shall be made to establish the radio frequency power delivered by the transmitter into the standard output termination. The power output shall be monitored and recorded and no adjustment shall be made to the transmitter after the test has begun, except as noted below:

If the power output is adjustable, measurements shall be made for the highest and lowest power levels.

Test Arrangement



The radio frequency power output was measured at the antenna terminal by placing a power splitter and attenuation in the antenna line and observing the transmitter emissions with the spectrum analyzer. The spectrum analyzer and attenuation provided an impedance of 50Ω to match the impedance of the standard antenna. A Rohde & Schwarz ESU40 Spectrum Analyzer was used to measure the radio frequency power at the antenna port. Data was taken in dBm and converted to watts as shown in the following Table. Refer to Figures one and two showing plots of output power of the transmitter across the frequency band. Data was taken per CFR47 Paragraph 2.1046(a) and applicable paragraphs of Part 87.131.

Peak Output Power:

P_{dBm} = power in dB above 1 milliwatt

Milliwatts = $10^{(PdBm/10)}$

Watts = (Milliwatts)(0.001)(W/mW)

	A-Mode	S-Mode
Milliwatts	$= 10^{(55.53/10)}$	$= 10^{(55.60/10)}$
	= 357,272.8 mW	= 363,078.0 mW
	= 357.3 Watts power	= 363.1 Watts power

Average output power is calculated using 1.1% duty cycle.

Average output power:

A-Mode	S-Mode
357.3*0.011 = 3.93W (ave)	363.1*0.011 = 3.99W (ave)

Table 1 Transmitter Power Results

Frequency (MHz)	P_{dBm} (Peak)	P_{mw} (Peak)	P_w (Peak)	P_w (Average)
1090 (A-Mode)	55.53	357,272.8	357.3	3.93
1090 (S-Mode)	55.60	363,078.0	363.1	3.99

The EUT demonstrated compliance with specifications of CFR47 Paragraph 2.1046(a) and applicable Parts of 2 and 87.131. There are no deviations to the specifications.

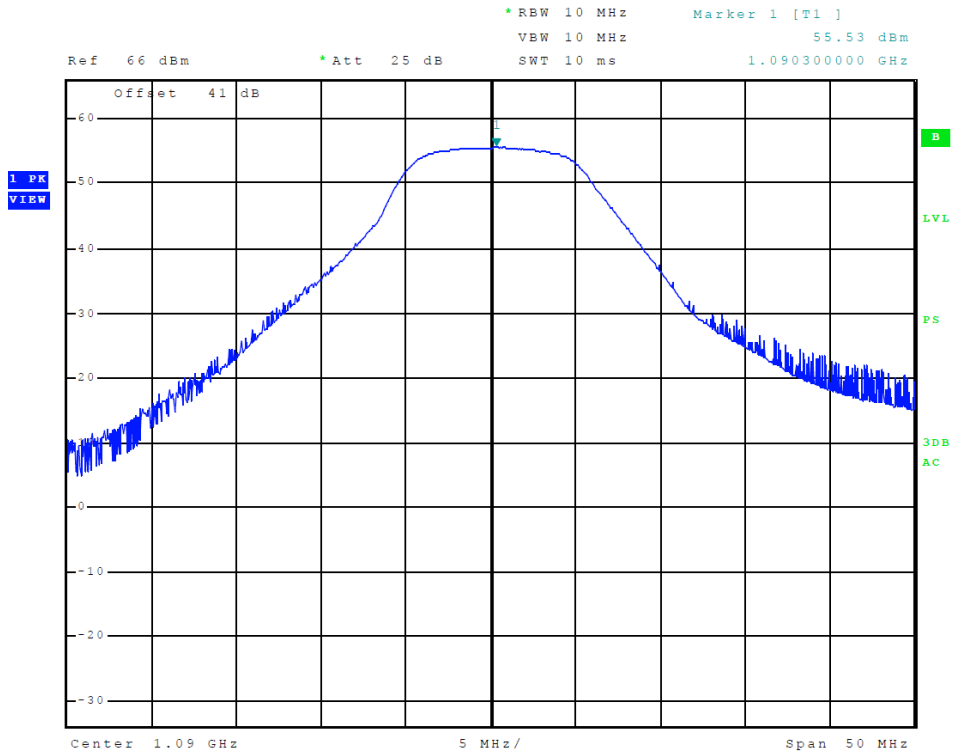


Figure 1 Maximum Power Output Mode-A

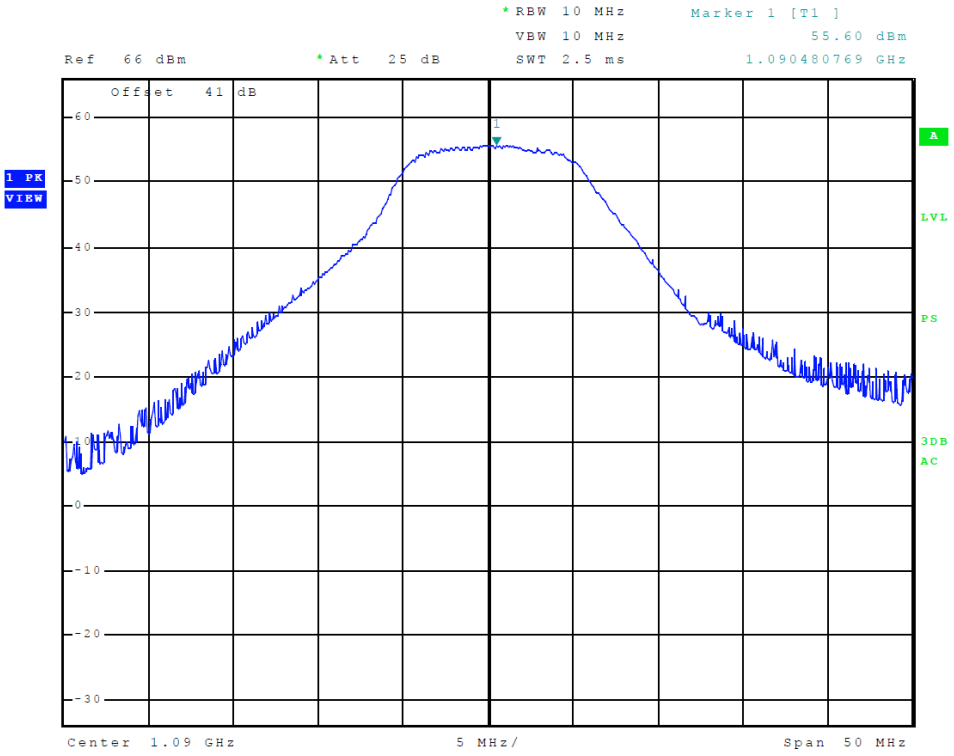


Figure 2 Maximum Power Output mode-S

Modulation Characteristics

A curve or equivalent data, which shows that the equipment will meet the modulation requirements of the rules, under which the equipment is to be licensed, shall be submitted. The modulation specifications are defined by the RTCA DO-181E.

The following specifications apply to ATCRBS reply pulses:

Specification	Data	Unit
Rise Time (10%/90%)	50-100	ns
Fall Time (90%/10%)	50-200	ns
Pulse width	450 +/- 100	ns

The following specifications apply to Mode-S reply pulses:

Specification	Data	Unit
Rise Time (10%/90%)	50-100	ns
Fall Time (90%/10%)	50-200	ns
Pulse Width (preamble pulses)	500 +/- 50	ns
Pulse Width (data pulses)	500 +/- 50	ns
Pulse Width (data pulses)	1 +/- 0.05	us

Modulation Characteristics Results

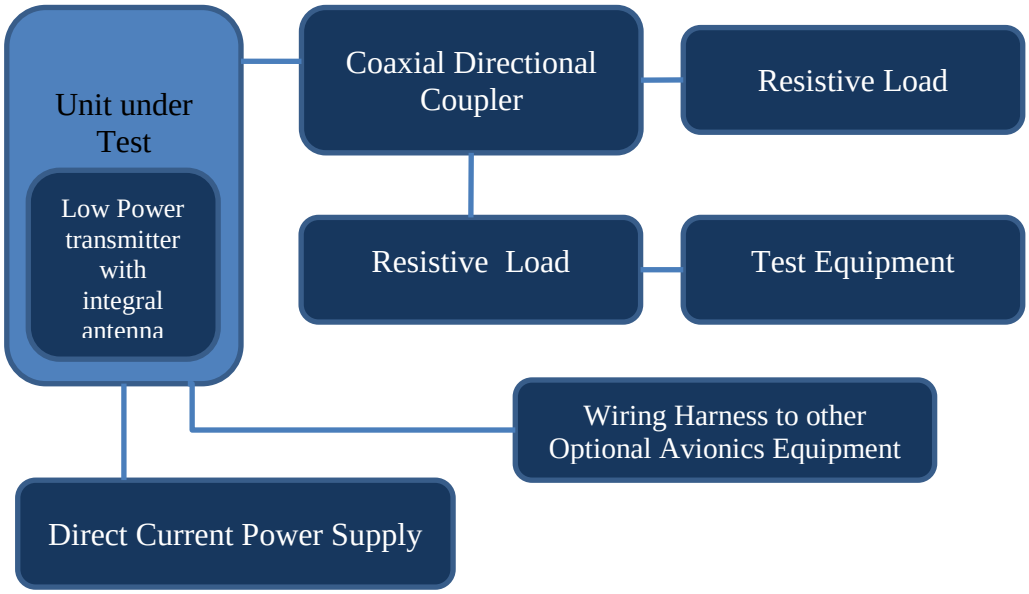
The modulation characteristics are defined in aviation standards and regulations. This equipment complies with the pulse timing requirements as defined above. The requirements of 47CFR 2.1047(d) and applicable paragraphs of Part 87.141 are met. There are no deviations to the specifications.

Occupied Bandwidth

Measurements Required

The occupied bandwidth, that is the frequency bandwidth such that below its lower and above its upper frequency limits, the mean powers radiated are equal to 0.5 percent of the total mean power radiated by a given emission.

Test Arrangement



A spectrum analyzer was used to observe the radio frequency spectrum with the transmitter operating in all normal modes. The EUT was set to transmit in normal modes while measurements were made. The power ratio in dB representing 99.5% of the total mean power was recorded from the spectrum analyzer. Refer to figures three and four showing the plot of the 99.5% power occupied bandwidth for operational modes.

Table 2 Occupied Bandwidth Results

Frequency (MHz)	Mode	Occupied bandwidth(kHz)	FAA Authorized Occupied bandwidth(kHz)
1090.00	Mode A	8,505.0	12,000.0
1090.00	Mode S	6,795.0	12,000.0

The requirements of 47CFR 2.1049(h) and applicable paragraphs of Part 87.135 are met. There are no deviations to the specifications.

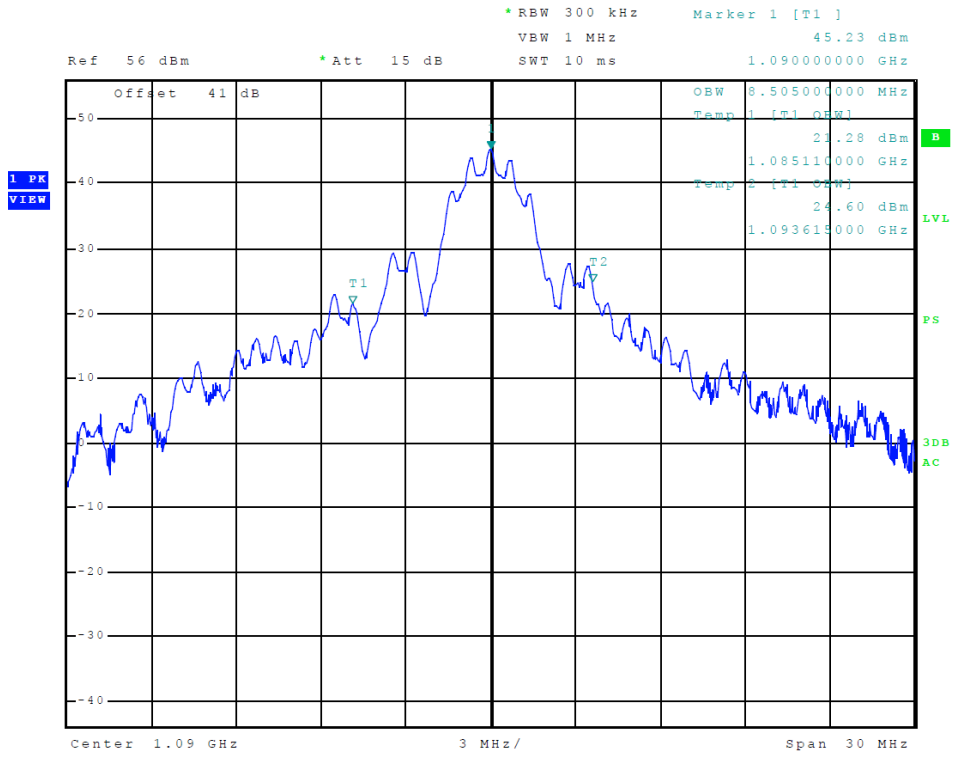


Figure 3 Occupied Band Width Mode A

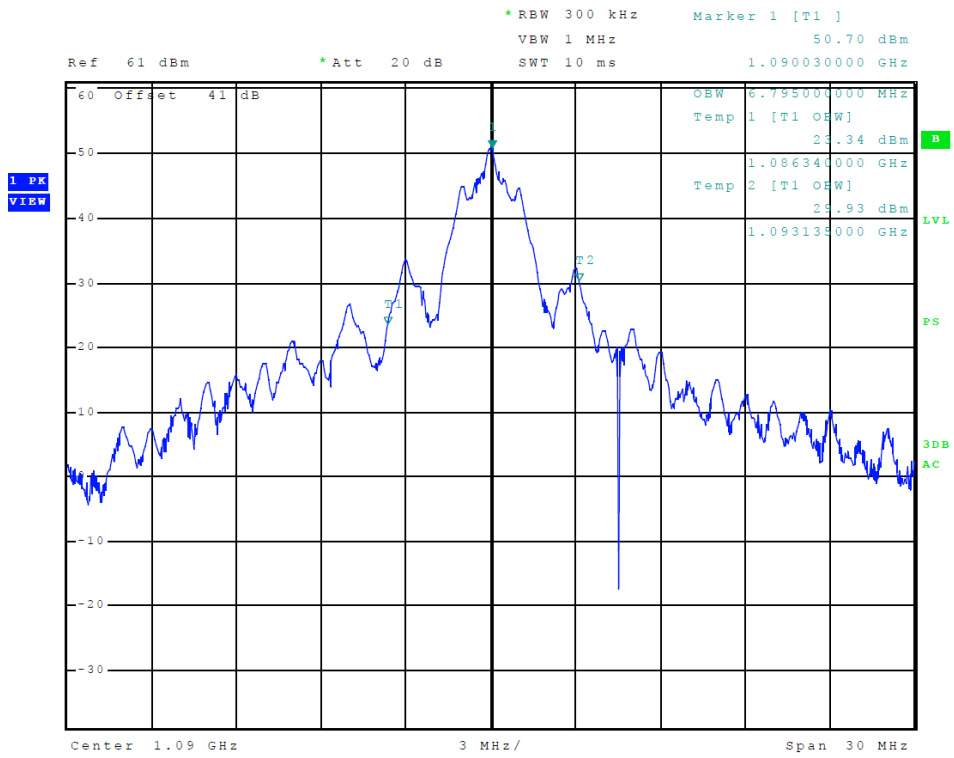


Figure 4 Occupied Band Width Mode S

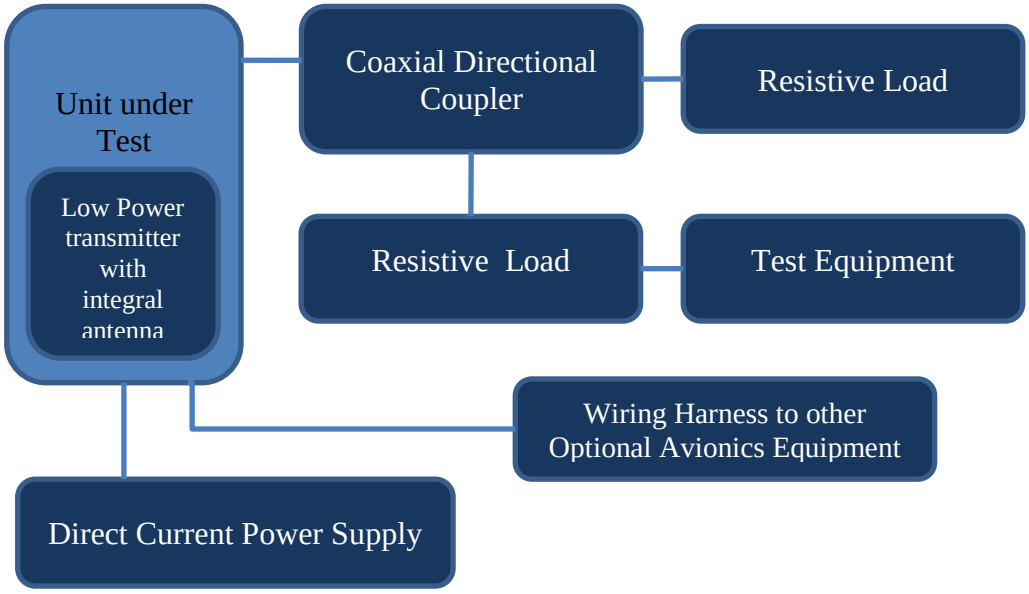
Spurious Emissions at Antenna Terminals

Measurements Required

The radio frequency voltage or power generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. All spurious emissions must be attenuated at least 43 +10log (pY) [pY=mean power] below the fundamental emission power level. The following equations represent the calculated attenuation level for the equipment operating with rated average output power of 3.99 Watts.

Limit (dBc) = 43 + 10 Log (pY)
= 43 + 10 Log (3.99)
= 49.0 dBc

Test Arrangement



The radio frequency output was coupled to a Rohde & Schwarz ESU40 Spectrum Analyzer during antenna port conducted emissions measurements. The spectrum analyzer was used to observe the radio frequency spectrum with the transmitter operated in all normal modes. The frequency spectrum from 30 MHz to 12,000 MHz was observed and plots produced of the frequency spectrum displayed on the test equipment. Refer to figures five through eleven for plots of the spurious emissions at antenna port. Data was taken per CFR47 2.1051, 2.1057, and applicable paragraphs of Part 87.139. There are no deviations to the specifications.

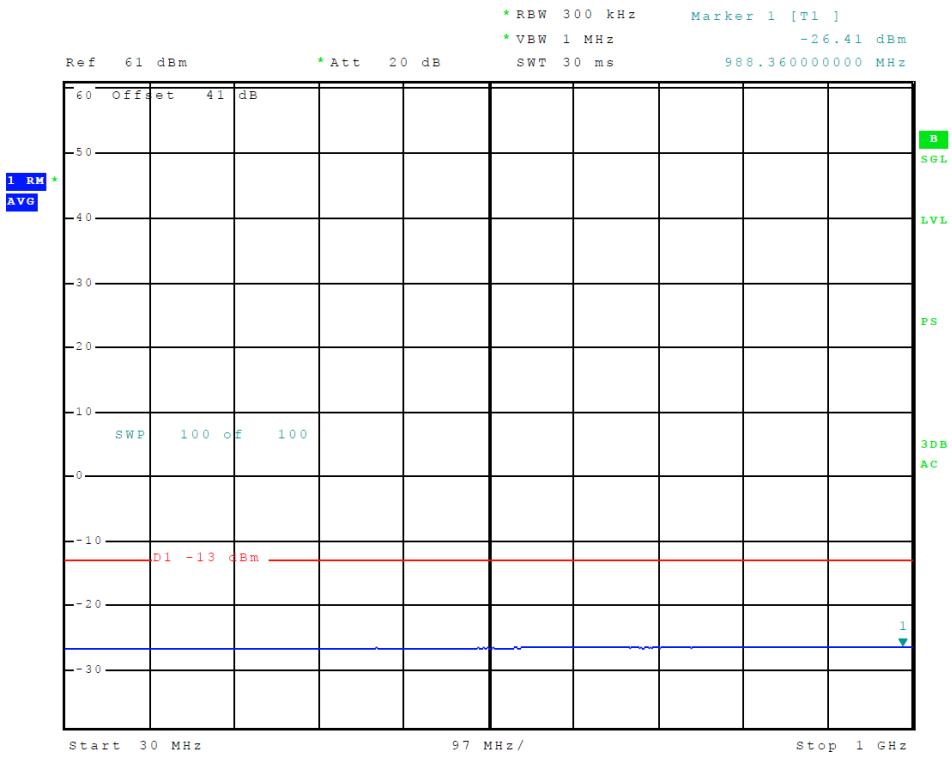


Figure 5 Spurious Emissions at Antenna Terminal

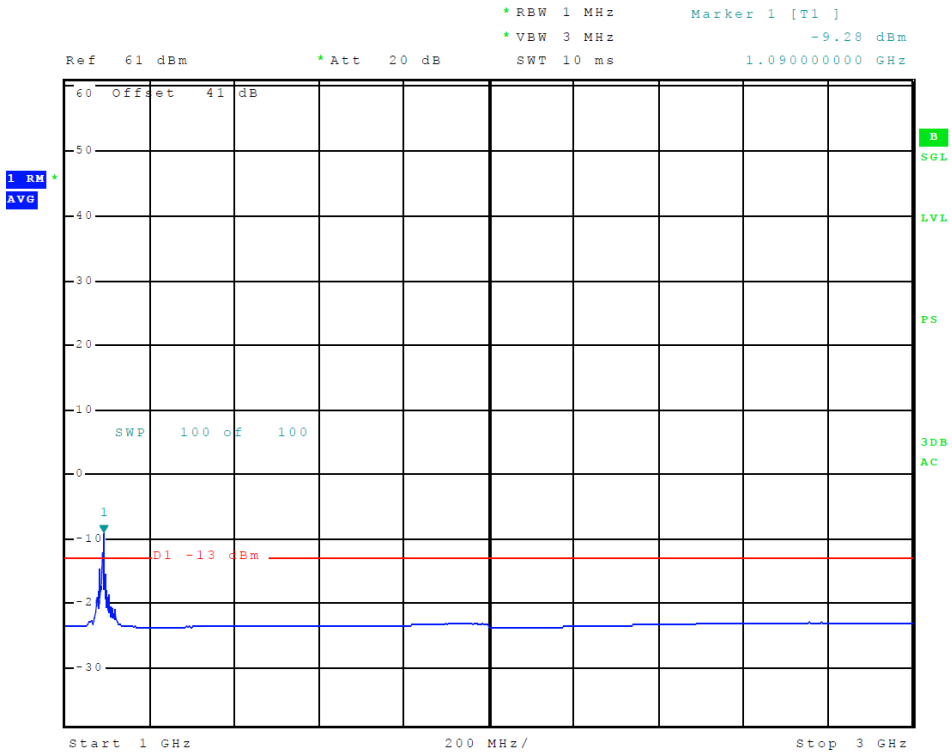


Figure 6 Spurious Emissions at Antenna Terminal

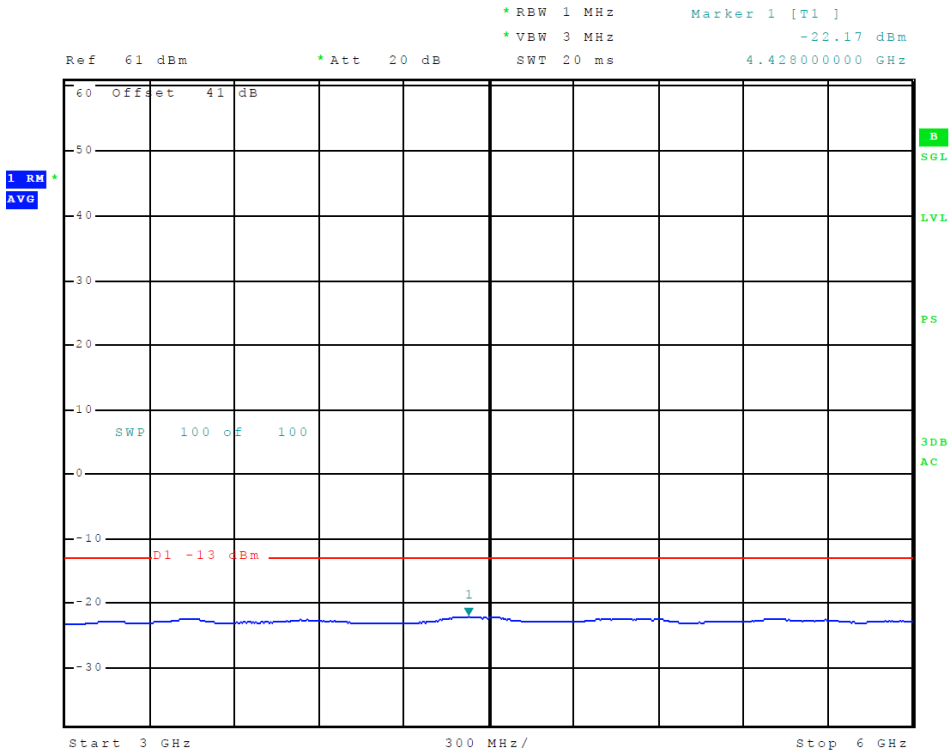


Figure 7 Spurious Emissions at Antenna Terminal

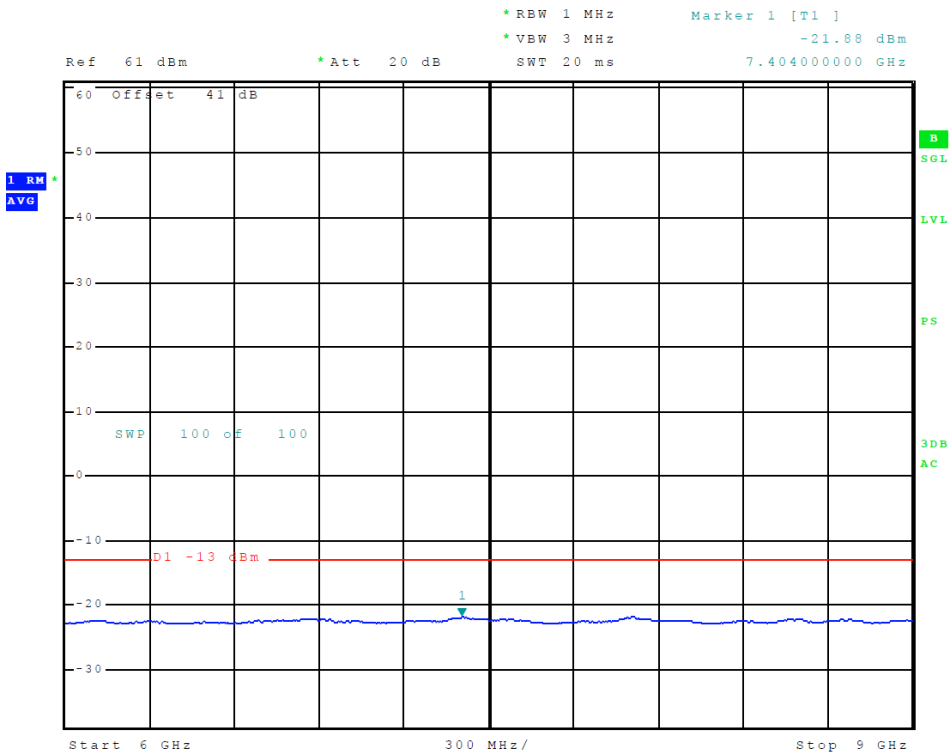


Figure 8 Spurious Emissions at Antenna Terminal

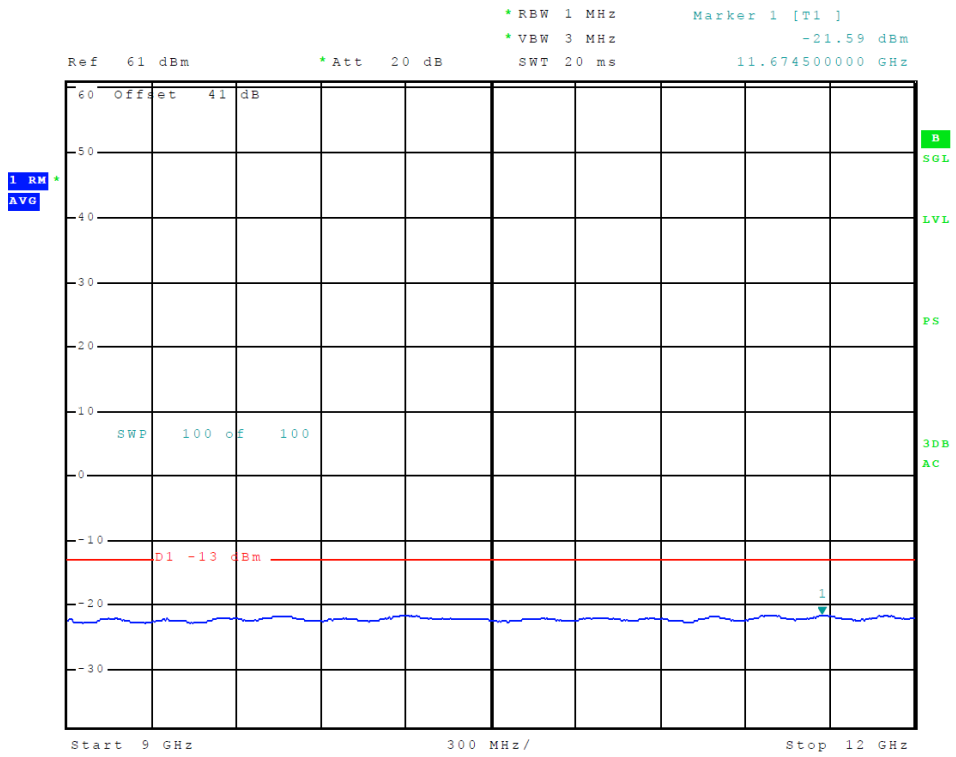


Figure 9 Spurious Emissions at Antenna Terminal

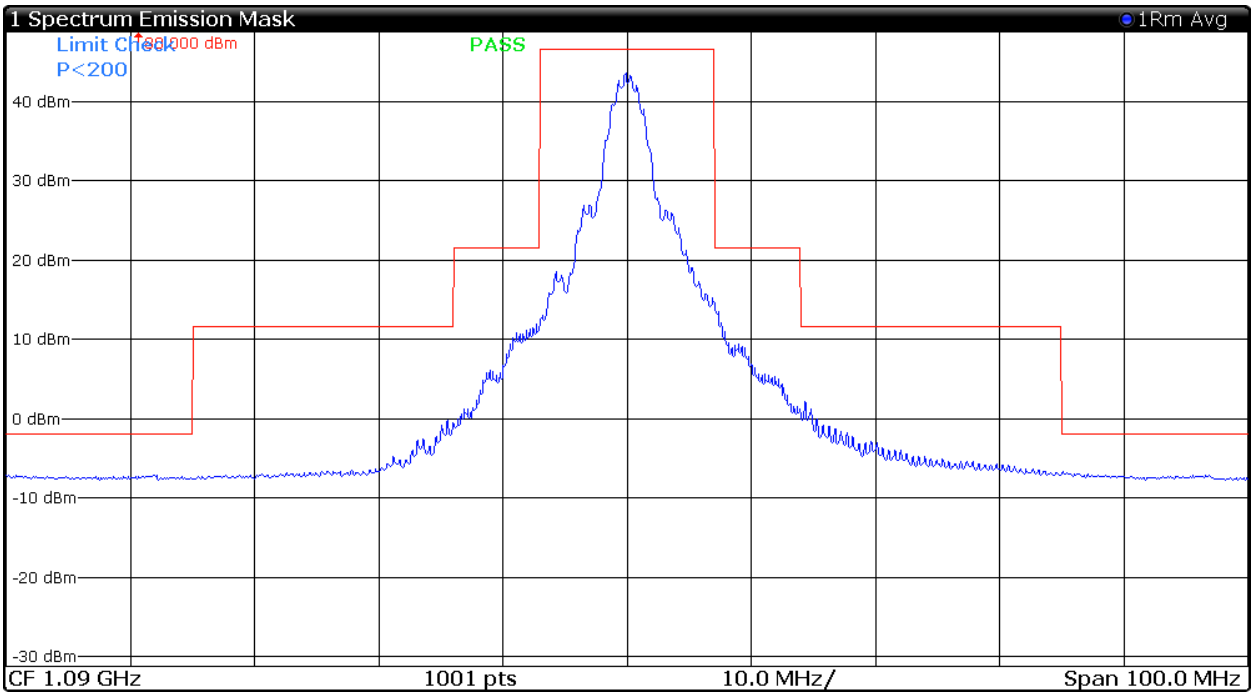


Figure 10 Emissions Mask (Mode-A)

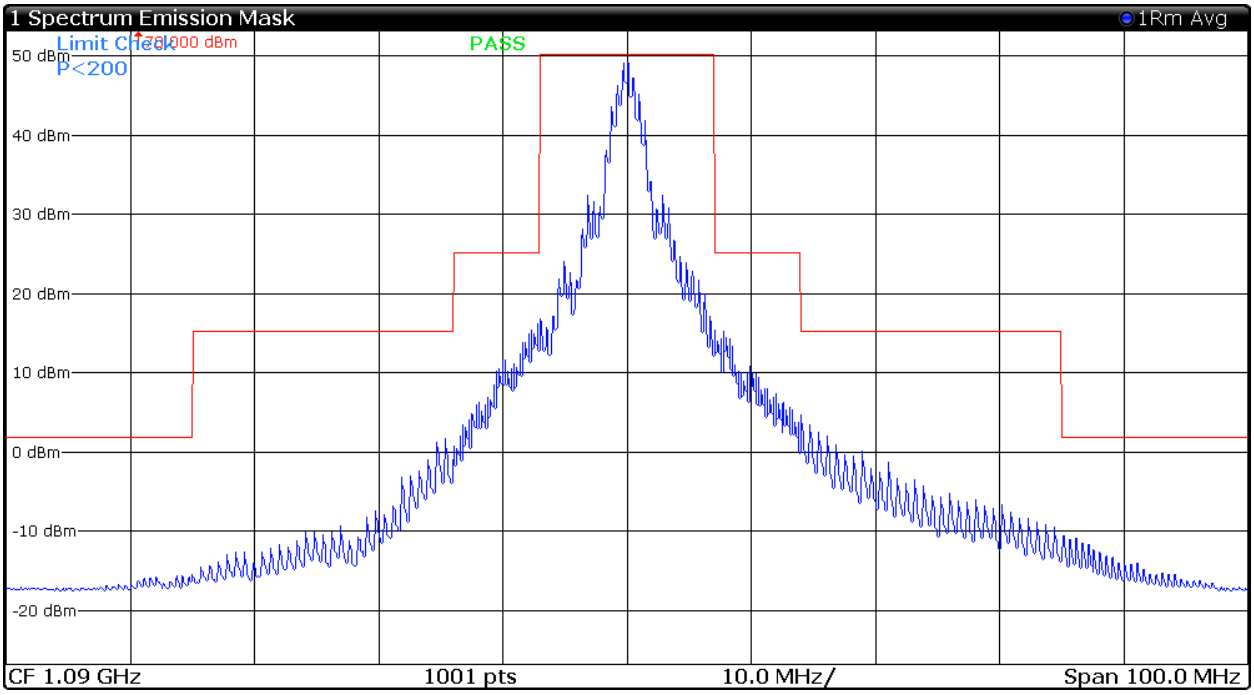


Figure 11 Emissions Mask (Mode-S)

All spurious emissions must be attenuated at least 43 +10log (pY) [pY=mean power] below the fundamental emission power level. The following equations represent the calculated attenuation levels for the equipment.

Spurious Emissions Limit shall be attenuated at least 49.0 dB below fundamental carrier (dBc).

Limit (dBc) = 43 + 10 Log (Po)
= 43 + 10 Log (3.99)
= 49.0 dBc

Table 2 Spurious Emissions at Antenna Terminal Results Mode-A

Channel MHz	Spurious Freq. (MHz)	Measured Level (dBm)	Level Below Carrier (dBc)
1090.00	2180.0	-30.70	86.2
	3270.0	-38.90	94.4
	4360.0	-20.40	75.9
	5450.0	-48.00	103.5
	6540.0	-51.70	107.2
	7630.0	-35.00	90.5
	8720.0	-52.00	107.5
	9810.0	-36.40	91.9
	10900.0	-26.70	82.2

Table 3 Spurious Emissions at Antenna Terminal Results Mode-S

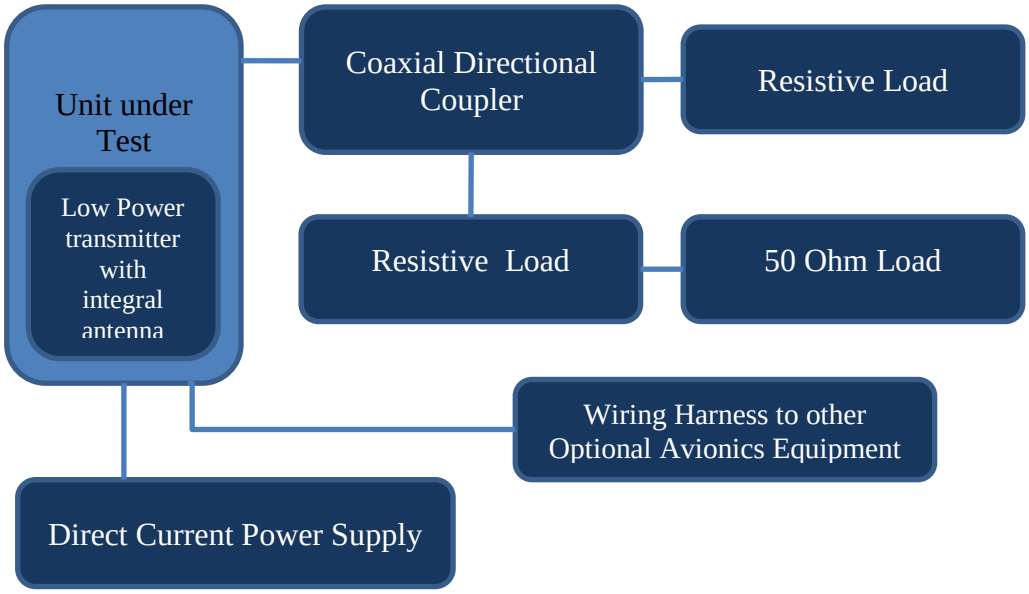
Channel MHz	Spurious Freq. (MHz)	Measured Level (dBm)	Level Below Carrier (dBc)
1090.00	2180.0	-27.20	82.7
	3270.0	-37.80	93.3
	4360.0	-16.50	72.0
	5450.0	-46.30	101.8
	6540.0	-52.20	107.7
	7630.0	-31.10	86.6
	8720.0	-51.30	106.8
	9810.0	-31.20	86.7
	10900.0	-22.10	77.6

Field Strength of Spurious Radiation (Unwanted Emissions)

Measurements Required

Measurements shall be made to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. The sample offered for testing utilized interfacing with laptop computer to provide operational control with all functions of the transmitter.

Test Arrangement



The test setup was assembled in a screen room for preliminary screening. The transmitter was placed on a supporting platform 0.8 meters above the ground plane and at a distance of 1 meter from the receive antenna, plots were taken of the general radiated emissions. Final radiated emission testing was performed with the transmitter placed on a supporting turntable platform 0.8 meters above the ground plane at a distance of 3 meters from the Field Strength Measuring (FSM) antenna. The EUT was operational and radiating into a 50Ω load during testing. The receiving antenna was raised and lowered from 1m to 4m in height to obtain the maximum reading of spurious radiation from the EUT, cabinet, and interface cabling. The turntable was

rotated though 360 degrees to locate the position registering the highest amplitude of emission. The frequency spectrum was then searched for spurious emissions generated from the transmitter, interface cabling, and test setup. The amplitude of each spurious emission was maximized by raising and lowering the FSM antenna, and rotating the turntable before final data was recorded. The frequency spectrum from 9 kHz to 11 GHz was investigated during radiated emissions testing. A loop antenna was used for measuring frequencies from 9 kHz to 30 MHz, a Biconilog antenna was used for frequency measurements of 30 to 1000 MHz. Double-ridge horns were used for measuring frequencies above 1000 MHz. Emission levels were measured and recorded from the spectrum analyzer in dBµV. Data was taken at the Rogers Labs, Inc. 3 meters open area test site (OATS). The transmitter was then removed and replaced with a substitution antenna, amplification as required, and signal generator. The signal from the generator was then adjusted such that the amplitude received was the same as that previously recorded for each frequency. This step was repeated for both horizontal and vertical polarizations. The power in dBm required to produce the desired signal level was then recorded from the signal generator. The power in dBm was then calculated by reducing the previous readings by the gain in the substitution antenna.

All spurious emissions must be attenuated at least 43 +10log (pY) [pY=mean power] below the fundamental emission power level. The following equation represents the calculated attenuation levels for the equipment.

Limit (dBc) = 43 + 10 Log (pY)
= 43 + 10 Log (3.99)
= 49.0 dBc

Requirement average output power 36.0 dBm less the requirement 49.0 dBc equates to an absolute level of -13 dBm.

Table 4 General Spurious Radiated Emission Results

Frequency	Amplitude of Emission (dBµV)		Signal Level to dipole required to Reproduce(dBm)		Emission level below carrier (dBc)		Limit (dBc)
MHz	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical	
66.5	21.1	22.4	-73.63	-72.43	109.2	108.0	49.0
84.3	21.6	22.8	-71.83	-68.03	107.4	103.6	49.0
100.2	23.4	27.2	-71.33	-79.03	106.9	114.6	49.0
150.7	23.9	16.2	-76.53	-78.13	112.1	113.7	49.0
166.3	18.7	17.1	-75.93	-78.73	111.5	114.3	49.0
300.0	19.3	16.5	-75.33	-76.73	110.9	112.3	49.0
375.0	19.9	18.5	-55.73	-61.93	91.3	97.5	49.0
625.0	39.5	33.3	-68.53	-67.53	104.1	103.1	49.0
680.0	26.7	27.7	-73.63	-72.43	109.2	108.0	49.0

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 frequencies above 1000 MHz.

Table 5 Spurious Radiated Emission Results Harmonics

Frequency	Amplitude of Emission (dBµV)		Signal Level to dipole required to Reproduce(dBm)		Emission level below carrier (dBc)		Limit (dBc)
MHz	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical	
2180.0	28.2	28.8	-67.03	-66.43	102.6	102.0	49.0
3270.0	30.7	31.4	-64.53	-63.83	100.1	99.4	49.0
4360.0	36.5	34.9	-58.73	-60.33	94.3	95.9	49.0
5450.0	33.4	32.8	-61.83	-62.43	97.4	98.0	49.0
6540.0	32.4	32.3	-62.83	-62.93	98.4	98.5	49.0
7630.0	31.9	32.0	-63.33	-63.23	98.9	98.8	49.0

The EUT demonstrated compliance with specifications of CFR47 Paragraph 2.1053, 2.1057, and 87.139. There are no deviations to the specifications. There are no deviations or exceptions to the specifications.

Frequency Stability

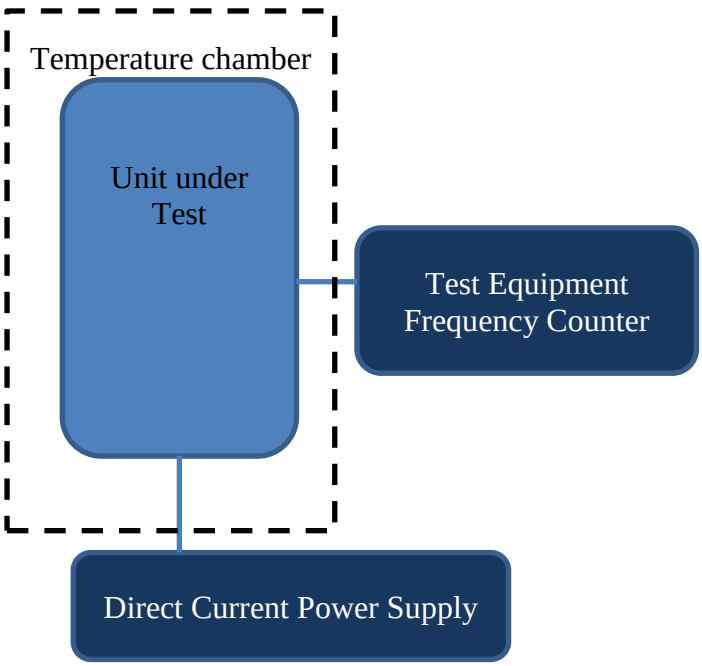
Measurements Required

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.

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. The frequency was measured and the variation in parts per million calculated. Data was taken per CFR47 Paragraphs 2.1055 and applicable paragraphs of part 87.133.

Table 6 Frequency Stability vs. Temperature Results

Frequency 1089.975 MHz	Frequency Stability Vs. Temperature Ambient Frequency (1089.975 MHz)								
Temperature °C	-30	-20	-10	0	+10	+20	+30	+40	+50
Change (kHz)	12	23	27	14	11	-15	-6	-27	-11
PPM	11.0	21.1	24.8	12.8	10.1	-13.8	-5.5	-24.8	-10.1
%	0.001	0.002	0.002	0.001	0.001	-0.001	-0.001	-0.002	-0.001
Limit (PPM)	1000	1000	1000	1000	1000	1000	1000	1000	1000

Table 7 Frequency Stability vs. Input Power Supply Voltage (14-V) Results

Frequency 1089.974 MHz	Frequency Stability Vs. Voltage Variation 28.0 volts nominal; Results in Hz change		
Voltage V_{dc}	11.9	14.0	16.1
Change (kHz)	-1	-12	9.0
PPM	-0.92	-11.01	8.26
%	0.001	0.000	0.002
Limit (PPM)	1000	1000	1000

The EUT demonstrated compliance with specifications of CFR47 Paragraph 2.1055 and applicable Parts of 87.133(a). There are no deviations or exceptions to the specifications.

Table 8 Frequency Stability vs. Input Power Supply Voltage (28-V) Results

Frequency 1089.974 MHz	Frequency Stability Vs. Voltage Variation 28.0 volts nominal; Results in Hz change		
Voltage V_{dc}	23.8	28.0	32.2
Change (kHz)	3	0	-3
PPM	2.752	0.000	-2.752
%	0.000	0.000	0.000
Limit (PPM)	1000	1000	1000

The EUT demonstrated compliance with specifications of CFR47 Paragraph 2.1055 and applicable Parts of 87.133(a). There are no deviations or exceptions to the specifications.

Annex

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

Annex A Measurement Uncertainty Calculations

Measurement uncertainty calculations were made for the laboratory. Result of measurement uncertainty calculations are recorded below for AC line conducted and radiated emission measurements.

Measurement Uncertainty	$U_{(E)}$	$U_{(lab)}$
3 Meter Horizontal 30-200 MHz Measurements	2.08	4.16
3 Meter Vertical 30-200 MHz Measurements	2.16	4.33
3 Meter Vertical Measurements 200-1000 MHz	2.99	5.97
10 Meter Horizontal Measurements 30-200 MHz	2.07	4.15
10 Meter Vertical Measurements 30-200 MHz	2.06	4.13
10 Meter Horizontal Measurements 200-1000 MHz	2.32	4.64
10 Meter Vertical Measurements 200-1000 MHz	2.33	4.66
3 Meter Measurements 1-6 GHz	2.57	5.14
3 Meter Measurements 6-18 GHz	2.58	5.16
AC Line Conducted	1.72	3.43

Annex B Rogers Labs Test Equipment List

List of Test Equipment	Calibration Cal Date(m/d/y)	Due
Spectrum Analyzer: Rohde & Schwarz ESU40	5/15/17	5/15/18
Spectrum Analyzer: HP 8562A, HP Adapters: 11518, 11519, and 11520 Mixers: 11517A, 11970A, 11970K, 11970U, 11970V, 11970W	5/15/17	5/15/18
Spectrum Analyzer: HP 8591EM	5/15/17	5/15/18
Antenna: Schwarzbeck Model: BBA 9106/VHBB 9124 (9124-627)	5/15/17	5/15/18
Antenna: Schwarzbeck Model: VULP 9118 A (VULP 9118 A-534)	5/15/17	5/15/18
Antenna: EMCO Log Periodic Model: 3147	10/24/17	10/24/18
Antenna: EMCO 6509	10/24/17	24/10/19
LISN: Compliance Design Model: FCC-LISN-2.Mod.cd, 50 µHy/50 ohms/0.1 µf	10/24/17	10/24/18
R.F. Preamp CPPA-102	10/24/17	10/24/18
Attenuator: HP Model: HP11509A	10/24/17	10/24/18
Cable: Belden 8268 (L3)	10/24/17	10/24/18
Cable: Time Microwave: 4M-750HF290-750	10/24/17	10/24/18
Cable: Time Microwave: 10M-750HF290-750	10/24/17	10/24/18
Frequency Counter: Leader LDC825	2/23/18	2/23/19
Oscilloscope Scope: Tektronix 2230	2/23/18	2/23/19
Wattmeter: Bird 43 with Load Bird 8085	2/23/18	2/23/19
Power Supplies: Sorensen SRL 20-25, SRL 40-25, DCR 150, DCR 140	2/23/18	2/23/19
R.F. Generators: HP 606A, HP 8614A, HP 8640B	2/23/18	2/23/19
R.F. Power Amp 65W Model: 470-A-1010	2/23/18	2/23/19
R.F. Power Amp 50W M185- 10-501	2/23/18	2/23/19
R.F. Power Amp A.R. Model: 10W 1010M7	2/23/18	2/23/19
R.F. Power Amp EIN Model: A301	2/23/18	2/23/19
LISN: Compliance Eng. Model 240/20	2/23/18	2/23/19
LISN: Fischer Custom Communications Model: FCC-LISN-50-16-2-08	2/23/18	2/23/19
Antenna: EMCO Dipole Set 3121C	2/23/18	2/23/19
Antenna: C.D. B-101	2/23/18	2/23/19
Antenna: Solar 9229-1 & 9230-1	2/23/18	2/23/19
Audio Oscillator: H.P. 201CD	2/23/18	2/23/19
ESD Test Set 2010i	2/23/18	2/23/19
Fast Transient Burst Generator Model: EFT/B-101	2/23/18	2/23/19
Field Intensity Meter: EFM-018	2/23/18	2/23/19
KEYTEK Ecat Surge Generator	2/23/18	2/23/19
Shielded Room Calibration not required		

Annex C Rogers Qualifications

Scot D. Rogers, Engineer

Rogers Labs, Inc.

Mr. Rogers has approximately 27 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