NVLAP Testing
NVLAP Lab Code 200087-0

Class 2 Permissible Change Test Report

47CFR Part 90 and Industry Canada RSS-137 Application for Grant of Certification

Model: AI 1422E

Location and Monitoring Service Transmitter

902.75-903.75, 909.75-921.75 MHz

FCC ID: FIHAI1422E

IC: 1584A-AI1422E

FOR

Transcore - Amtech Technology Center

8600 Jefferson Street, NE
Albuquerque, NM 87113

FCC Site Registration: 315994
IC Test Site Registration: 3041A-1
Report Number 170711

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 Permissible Change Test Report For Application of Certification

For

Transcore
Amtech Technology Center

8600 Jefferson Street, NE
Albuquerque, NM 87113
Phone: (505) 856-8101

Model: AI 1422E

Location Monitoring Service Transmitter
Frequency Range: 902.25 – 907.35, 910.00 - 921.50, and 911.75 – 919.75 MHz
FCC ID: FIHAI1422E
IC: 1584A-AI1422E

Test Date: July 11, 2017

Certifying Engineer: Scot D Rogers

Scot D. Rogers
Rogers Labs, Inc.
4405 W. 259th Terrace
Louisburg, KS 66053
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Revision History

Revision 2 Issued September 29, 2017 – added reference to ANSI C63.26-2015

Revision 1 Issued August 31, 2017

Executive Summary

The following information is submitted for consideration in processing Class 2 Permissible Change of certified equipment operating under 47CFR Paragraph 90 (M) and Industry Canada RSS-137 Location Monitoring Service (LMS) transmitter equipment. The original Authorization provided for CW signal use only. The following information and associated application address the addition of RFID modulated signaling applications.

Name of Applicant: Transcore
Amtech Technology Center 8600 Jefferson Street, NE
Albuquerque, NM 87113
Phone: (505) 856-8000

Model: AI 1422E Original Grant Date 9/15/2016

FCC ID: FIHAI1422E IC: 1584A-AI1422E

Frequency of Operation: 902.75-903.75, 909.75-921.75 MHz (for ATA operation), and 911.75-919.75 MHz (for IAG, eGo, SeGo, EPC operation)

Transmit Power: 0.063-2.0 watts, occupied bandwidths ATA 0kHz, IAG 677.5 kHz, eGo 702.5 kHz, SeGo 705.0 kHz, and EPC 485.0 kHz

Opinion / Interpretation of Results

Tests Performed	Results
Emissions Tests	
Requirements per 47CFR paragraphs 2.1031-2.1057 and RSS-137, Issue 2	Complies
Requirements per 47CFR paragraphs 90.205 and RSS-137	Complies
Requirements per 47CFR paragraphs 90.207 and RSS-137	Complies
Requirements per 47CFR paragraphs 90.209 and RSS-137	Complies
Requirements per 47CFR paragraphs 90.210 and RSS-137	Complies
Requirements per 47CFR paragraphs 90.213 and RSS-137	Complies

Equipment Under Test

Equipment	Model / PN	Serial Number
EUT	AI 1422E	17164896
DC Power Supply	1745	209C13

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

Equipment Function and Configuration

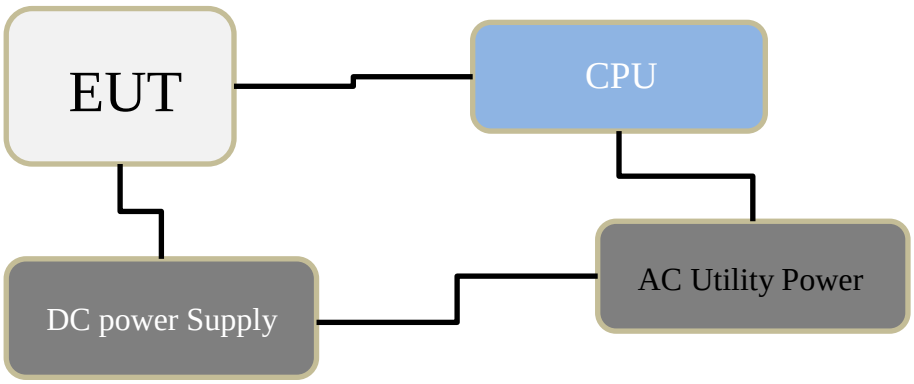
The EUT is a rack mounted location and monitoring transceiver operating in the 902-904 and 909.75-921.75 MHz frequency bands. Operation of the design utilizes industry standardized modulation schemes offering ability to interface and respond with Industry Radio Frequency Identification Device (RFID) interrogation systems. The system operates from 24-110 V_{dc} and provides serial interface for communications. The production design provides female N connector to accommodate remotely located antenna system. This port provided the 50-ohm antenna port which was used for taking antenna port conducted emission measurements. Software was provided which allowed testing personnel operational control of the transmitter for testing purposes. The unit operates from external direct power provided from installation and provides no provision for alternative power source. The EUT functions as an active transponder operating in the 902-921 MHz LMRS frequency band providing communications with referenced industry standard protocol systems. Test results in this report relate only to the products described in this report.

Modification to Equipment Design

The modified version of the transceiver model AI1422E system include software change to provide additional modulations, updates in the baseband receiver sections and transmitter sections. The design remains electrically identical and functionally equivalent to the original design. The transmitter changes are described in the following sections. Change to the transmitter included replacement of obsolete mixers our P/N 52069-01 manufacture Analog Devices/Hittite P/N HMC207S with or P/N 52171-01 manufacture Analog Devices/Hittite P/N HMC208AMS8. Circuit changes included adjustments in internal RF power levels to the RF input of the mixers and baseband drive to the IF inputs. All consideration to the baseband drive was considered to ensure the spectral emission would be equivalent to the original design. The

layout changes of the printed circuit board were required due to pinout differences between the two parts. The forward power control attenuator was changed from our P/N 21018-01 manufacture Mini-Circuits P/N DAT-31R5A-PP+T a 0.5db step attenuator to our P/N 52149-01 manufacture Peregrine Semiconductor P/N PE43713A-Z which is a 0.25dB step attenuator. This change was done to improve power accuracy by going to a finer step attenuation control of a 0.25dB.

Equipment Configuration



Application for Certification

1. Manufacturer: Transcore
   Amtech Technology Center 8600 Jefferson Street, NE
   Albuquerque, NM 87113

2. Identification: **Model**: AI 1422E **FCC ID**: FIHAI1422E **IC**: 1584A-AI1422E

3. A copy of the installation and operating instructions furnished to the end user. Refer to the instruction manual furnished with this application for details.

4. Emission Types: Continuous wave (N0N) and Modulated in width/duration/data – L1D

Frequency (MHz)	Emission Designator
902.25 - 903.75	N0N
909.75 - 921.75	N0N
911.75 - 919.75	L1D

5. Frequency Range: 902.75-903.75, 909.75-921.75 MHz and 911.75-919.75 MHz

6. Range of operating power values or specific operating power levels, and description of any means provided for variation of operating power. Minimum to maximum Watts (0.063 – 2.0 Watts). Adjustable in 0.25 dB attenuation increments from 0 to 15 dB.

7. Maximum power rating as defined in the applicable part(s) of the rules. As stated in 47CFR, 90.205(k) the maximum permissible output power allowed is 30 watts.

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. Highest power mode, the final amplification stage requires 11.45 volts consuming 0.750 amps and lowest power mode operates at 11.45 volts and 0.400 amps of current.

9. Provide the tune-up procedure over the power range, or at specific operating power levels. Refer to the tune-up procedure furnished with this application for details.

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 the schematics and technical exhibits furnished with this application for details.

11. A photograph or drawing of the equipment identification plate, or label showing the information to be placed thereon shall be provided. Refer to the identification label exhibit and information furnished with this application for details.

12. Photographs (8" x 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 the exhibits of this report and or additional information furnished with the application for details.

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. Information about modulation is contained in Operational description exhibit.

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

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 Section 2.1060 of this part. This paragraph does not apply to this equipment.

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 meets the emission limitations of section 73.44. This paragraph does not apply to this equipment.

17. A single application may be filed for a composite system that incorporates devices subject to certification under multiple rule parts; however, the appropriate fee must be included for each device. Separate applications must be filed if different FCC Identifiers will be used for each device.

18. The device is not a software-defined radio and requirements of 2.944 do not apply to this 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.

20. Applications for certification of 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) shall include a Compliance Assessment Program Supplier's Declaration of Conformity and Summary Test Report or, alternatively, shall include a document detailing how the applicant determined that its equipment complies with §90.548 of this chapter and that the equipment is interoperable across vendors.

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.

Applicable Standards and Test Procedures

In accordance with the Federal Communications Code of Federal Regulations, 47CFR dated July 11, 2017, Part 2 Subpart J, Paragraphs 2.907, 2.911, 2.913, 2.925, 2.926, 2.1031 through 2.1057; 90.201 through 90.217, 90.350 through 90.363 and RSS-137 the following information is submitted for consideration in processing Class 2 Permissible Change of Certified Equipment. Test procedures used were the established Methods of Measurement of Radio-Noise Emissions as described in ANSI/TIA-603-E-2016, ANSI C63.26-2015, and ANSI 63.4-2014.

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	The AC power line conducted emissions testing performed in a shielded screen room located at Rogers Labs, Inc., 4405 W. 259th Terrace, Louisburg, KS.
Radiated EMI	The radiated emissions testing performed at the 3 meters, Open Area Test Site (OATS) located at Rogers Labs, Inc., 4405 W. 259th Terrace, Louisburg, KS.
Site Registration	Refer to Annex for FCC Site Registration Letter, # 90910, and Industry Canada Site Registration Letter, IC3041A-1.

Environmental Conditions

Ambient Temperature	24.8° C
Relative Humidity	41%
Atmospheric Pressure	1008.8 mb

List of Test Equipment

A Rohde and Schwarz ESU40 and/or Hewlett Packard 8591EM was used as the measuring device for the emissions testing of frequencies below 1 GHz. A Rohde and Schwarz ESU40 and/or Hewlett Packard 8562A Spectrum Analyzer was used as the measuring device for testing the emissions at frequencies above 1 GHz. The analyzer settings used are described in the following table.

Frequency: 9 kHz-30 MHz	Frequency: 30 MHz- 1 GHZ	Frequency: Above 1 GHz
Loop Antenna	Broadband Biconilog	Horn
RBW = 9 kHz	RBW = 120 kHz	RBW = 1 MHz
VBW = 30 kHz	VBW = 500 kHz	VBW = 3 MHz
Sweep time = Auto	Sweep time = Auto	Sweep time = Auto
Detector = PK, QP	Detector = PK, QP	Detector = PK, AV
Antenna Height 1m	Antenna Height 1-4m	Antenna Height 1-4m

Equipment	Manufacturer	Model (SN)	Band	Cal Date	Due
☐ LISN	FCC	FCC-LISN-50-2-10(1PA) (160611)	.15-30MHz	5/17	5/18
☒ Cable	Time Microwave	750HF290-750 (L10M)	9kHz-40 GHz	10/16	10/17
☐ Cable	Belden	RG-58 (L1-CAT3-11509)	9kHz-30 MHz	10/16	10/17
☐ Cable	Belden	RG-58 (L2-CAT3-11509)	9kHz-30 MHz	10/16	10/17
☐ Antenna	ARA	BCD-235-B (169)	20-350MHz	10/16	10/17
☐ Antenna	EMCO	3147 (40582)	200-1000MHz	10/16	10/17
☒ Antenna	ETS-Lindgren	3117 (200389)	1-18 GHz	5/17	5/18
☐ Antenna	Com Power	AH-118 (10110)	1-18 GHz	10/15	10/17
☒ Antenna	Com Power	AH-840 (101046)	18-40 GHz	5/17	5/18
☒ Antenna	Com Power	AL-130 (121055)	.001-30 MHz	10/16	10/17
☒ Antenna	Sunol	JB-6 (A100709)	30-1000 MHz	10/16	10/17
☐ Antenna	EMCO	3143 (9607-1277)	20-1200 MHz	5/17	5/18
☐ Analyzer	HP	8591EM (3628A00871)	9kHz-1.8GHz	5/17	5/18
☐ Analyzer	HP	8562A (3051A05950)	9kHz-110GHz	5/17	5/18
☐ Analyzer	HP External Mixers	11571, 11970	25GHz-110GHz	5/17	5/18
☒ Analyzer	Rohde & Schwarz	ESU40 (100108)	20Hz-40GHz	5/17	5/18
☒ Amplifier	Com-Power	PA-010 (171003)	100Hz-30MHz	10/16	10/17
☒ Amplifier	Com-Power	CPPA-102 (01254)	1-1000 MHz	10/16	10/17
☒ Amplifier	Com-Power	PAM-118A (551014)	0.5-18 GHz	10/16	10/17
☒ Power Mtr	Agilent	N1911A with N1921A	0.05-18 GHz	5/17	5/18

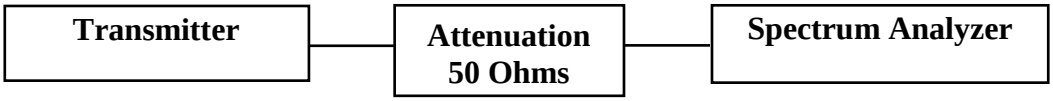
Transmitter Power Output

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 10.6-dB attenuation in the antenna line and observing the emission with the spectrum analyzer. The spectrum analyzer offered an impedance of 50Ω to match the impedance of the standard antenna and inline attenuation. 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 Figure 1 showing maximum output power of the transmitter in both highest output power and lowest power modes. Data was taken per 47CFR Paragraph 2.1046(a) and applicable paragraphs of Part 90 and RSS-137.

P_{dBm} = power in dB above 1 milliwatt

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

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

Milliwatts = $10^{(32.96/10)}$

= 1976.97 mW

= 2.0 Watts power

Table 1 Transmitter Power Results

Frequency (MHz)	P_{dBm}	P_{mw}	P_w	OBW (kHz)
ATA				
902.25	32.96	1976.97	2.0	--
903.75	32.71	1866.4	1.9	--
910.0	32.90	1949.8	2.0	--
921.5	32.77	1892.0	1.9	--
IAG				
911.75	29.09	811.0	0.8	677.5
915.00	29.03	799.8	0.8	652.5
919.75	28.83	763.8	0.8	670.0
eGo				
911.75	32.76	1880.0	1.9	702.5
915.00	32.71	1866.3	1.9	697.5
919.75	32.90	1927.5	1.9	692.0
SeGo				
911.75	32.84	1923.1	1.9	705.0
915.00	32.79	1901.1	1.9	700.0
919.75	32.94	1967.9	1.9	692.0
EPC				
911.75	32.90	1949.8	2.0	485.0
915.00	32.90	1949.8	2.0	480.0
919.75	32.82	1914.3	1.9	480.0

The EUT demonstrated compliance with spe3cifications of 47CFR Paragraph 2.1046(a) and applicable Parts of 2 and 90.205 and RSS-137. There are no deviations to the specifications.

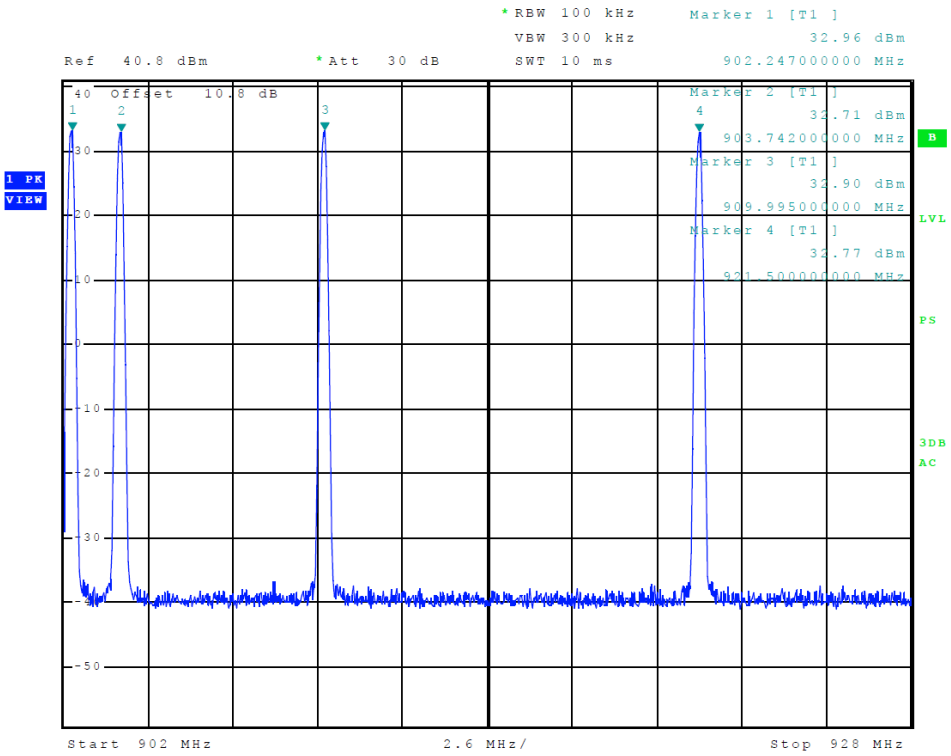


Figure 1 Transmitter Output Across Frequency Band (ATA modulation)

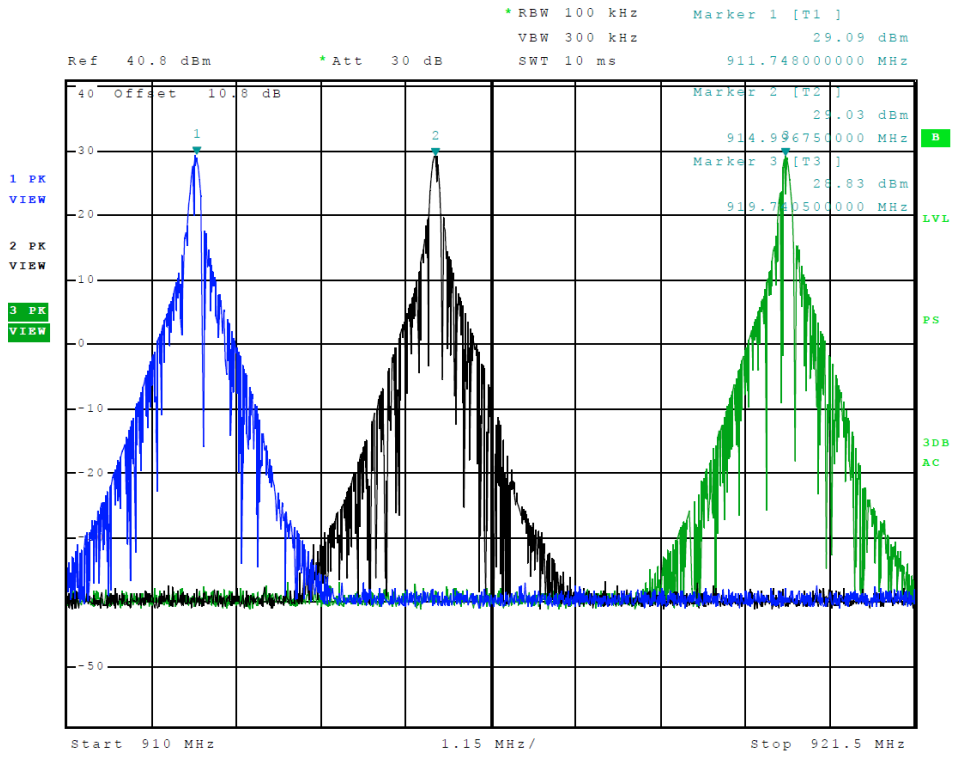


Figure 2 Transmitter Output Across Frequency Band (IAG modulation)

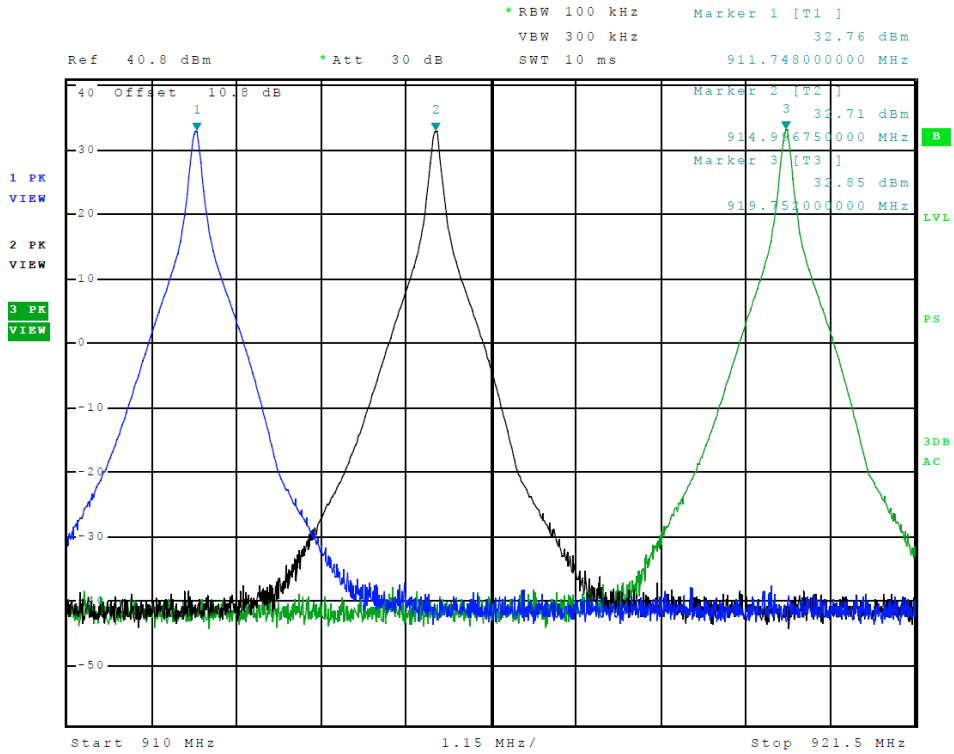


Figure 3 Transmitter Output Across Frequency Band (eGo modulation)

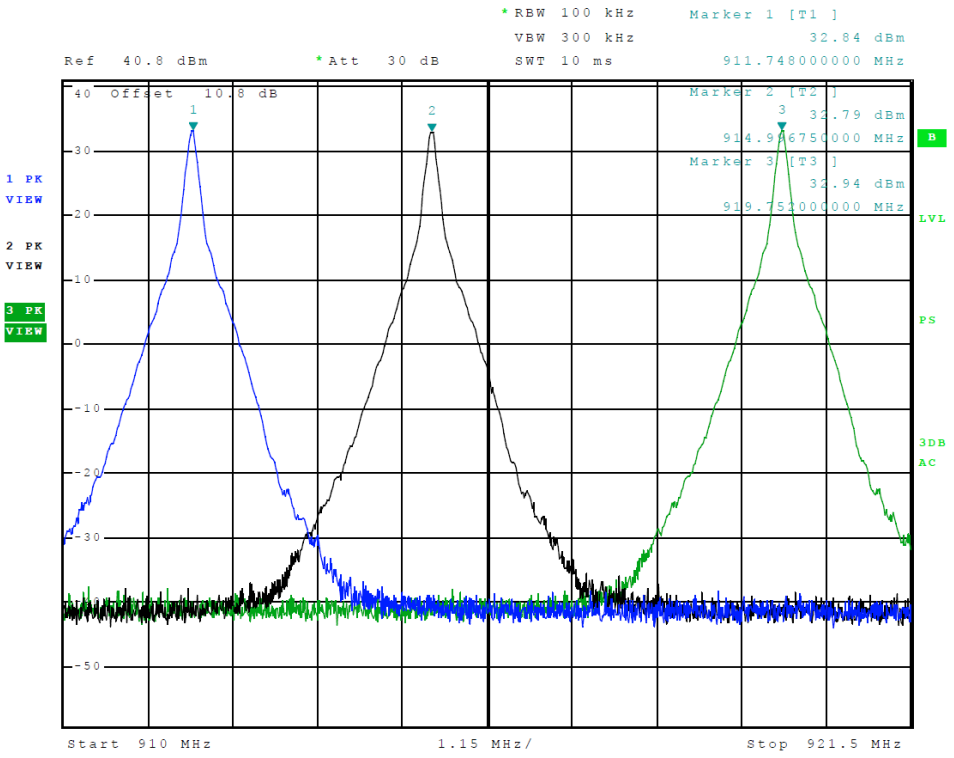


Figure 4 Transmitter Output Across Frequency Band (SeGo modulation)

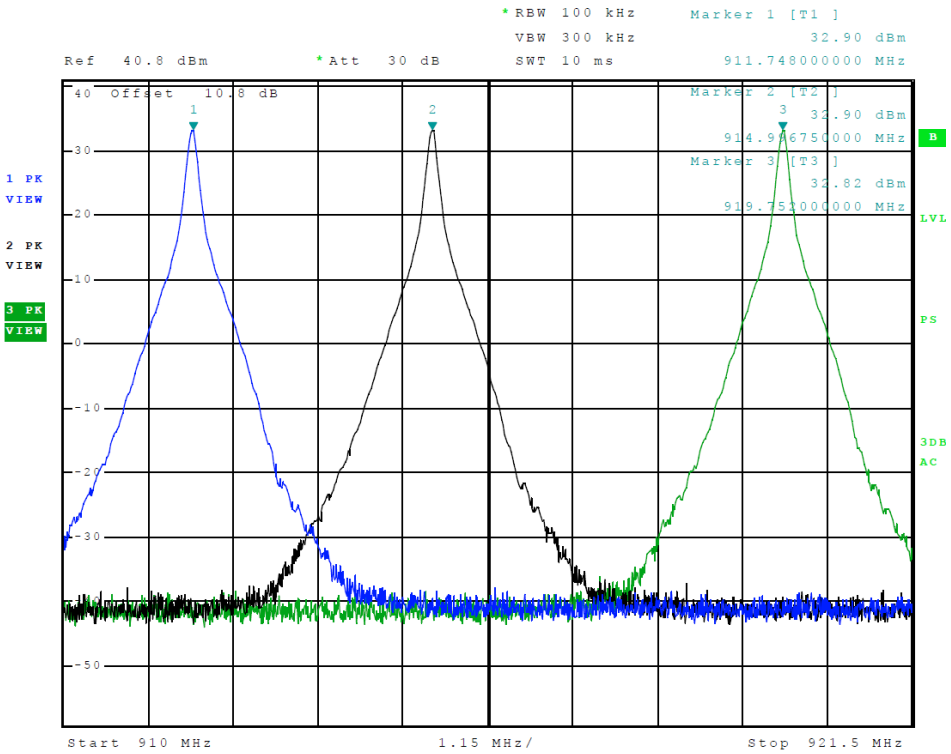


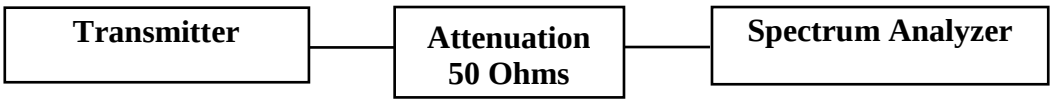
Figure 5 Transmitter Output Across Frequency Band (EPC modulation)

Modulation Characteristics

Measurements Required

A curve or equivalent data that shows that the equipment will meet the modulation requirements of the rules under which the equipment is to be licensed shall be submitted.

Test Arrangement



The radio frequency output was coupled to a Rohde &Schwarz ESU40 Spectrum Analyzer. The spectrum analyzer was used to observe the radio frequency spectrum with the transmitter operating in its normal mode.

Results Modulation Characteristics

The transmitter operates providing digital data, transmitted signals modulated in amplitude/width/duration. The EUT demonstrated compliance with the specifications of Paragraphs 2.1046(a), 90.205 and RSS-137. 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. Refer to figure two displaying plot of the occupied bandwidth measurement.

Test Arrangement

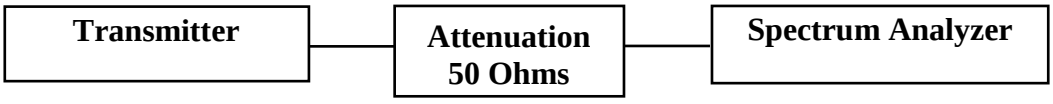


Table 2 Occupied Bandwidth Results

Operational Frequency Band (MHz)	Occupied Bandwidth (kHz)
ATA	
902.25-903.75, 910-921.5	0
IAG	
911.75	677.5
915.00	652.5
919.75	670.0
eGo	
911.75	702.5
915.00	697.5
919.75	692.5
SeGo	
911.75	705.0
915.00	700.0
919.75	692.5
EPC	
911.75	485.0
915.00	480.0
919.75	480.0

The EUT demonstrated compliance with the requirements of Paragraphs 2.1046(a) 90.209 and RSS-137 paragraph 6.1. There are no deviations to the specifications.

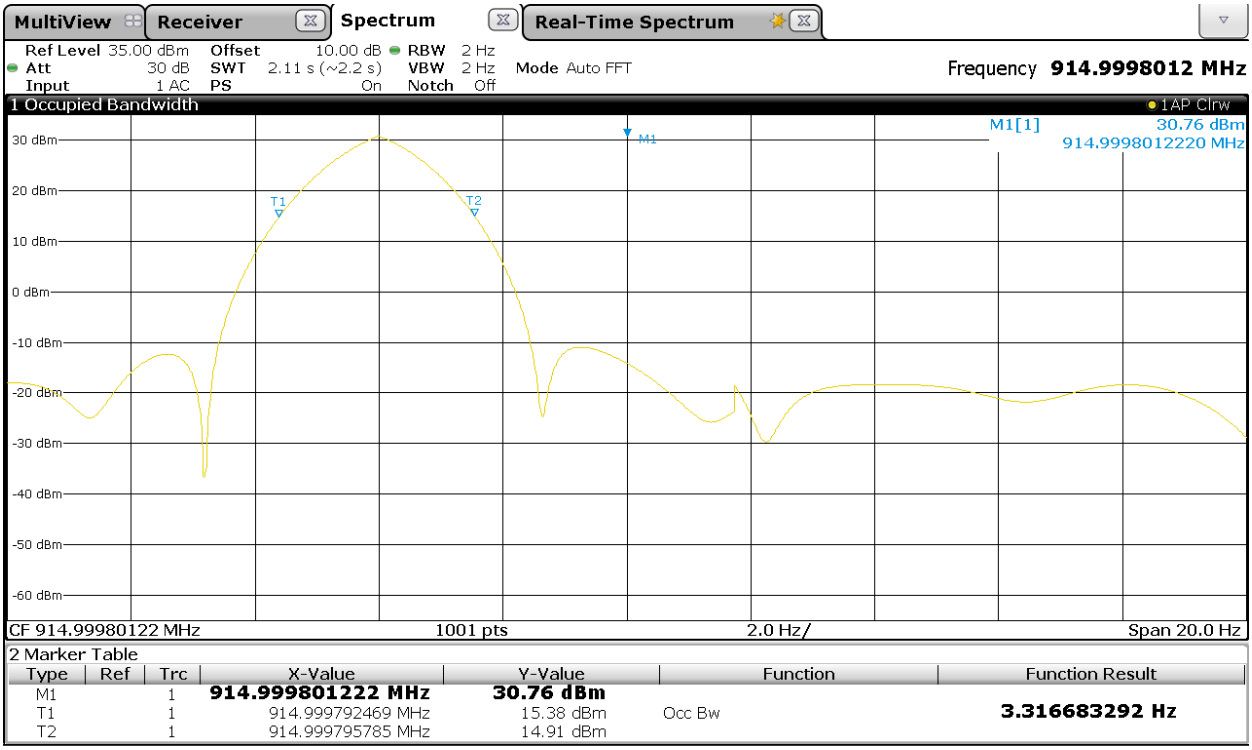


Figure 6 Occupied Bandwidth (ATA, CW)

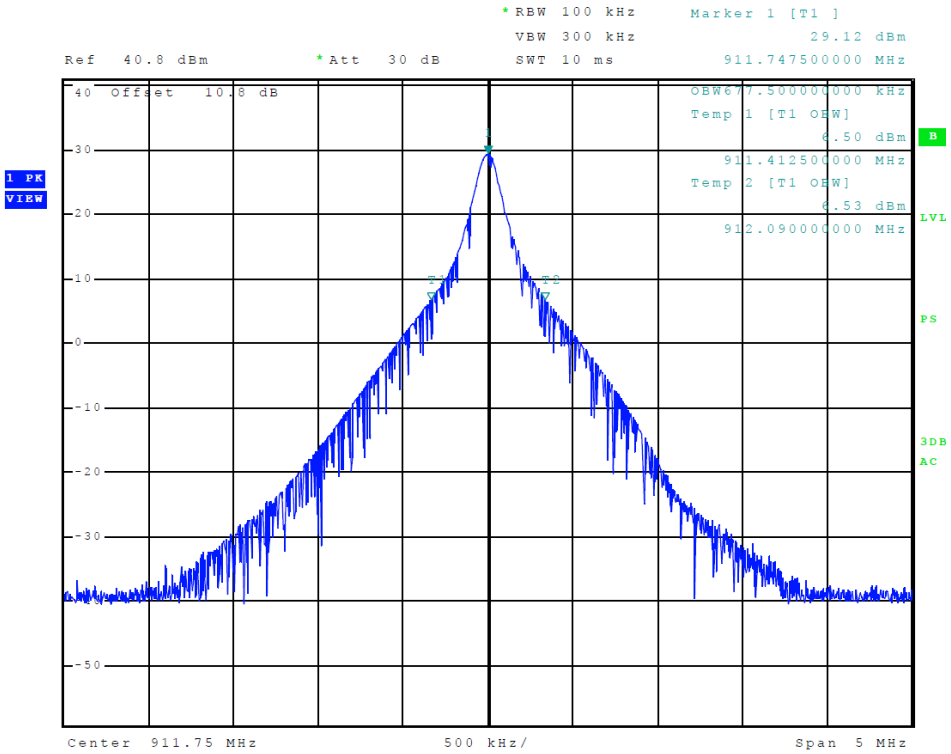


Figure 7 Occupied Bandwidth (IAG modulation)

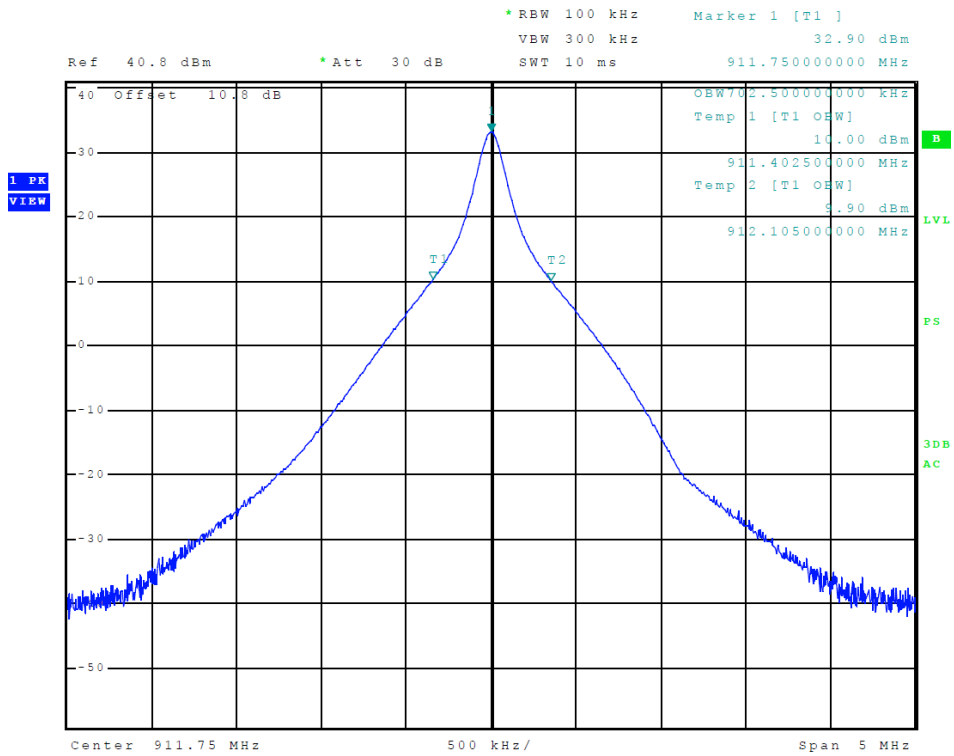


Figure 8 Occupied Bandwidth (eGo modulation)

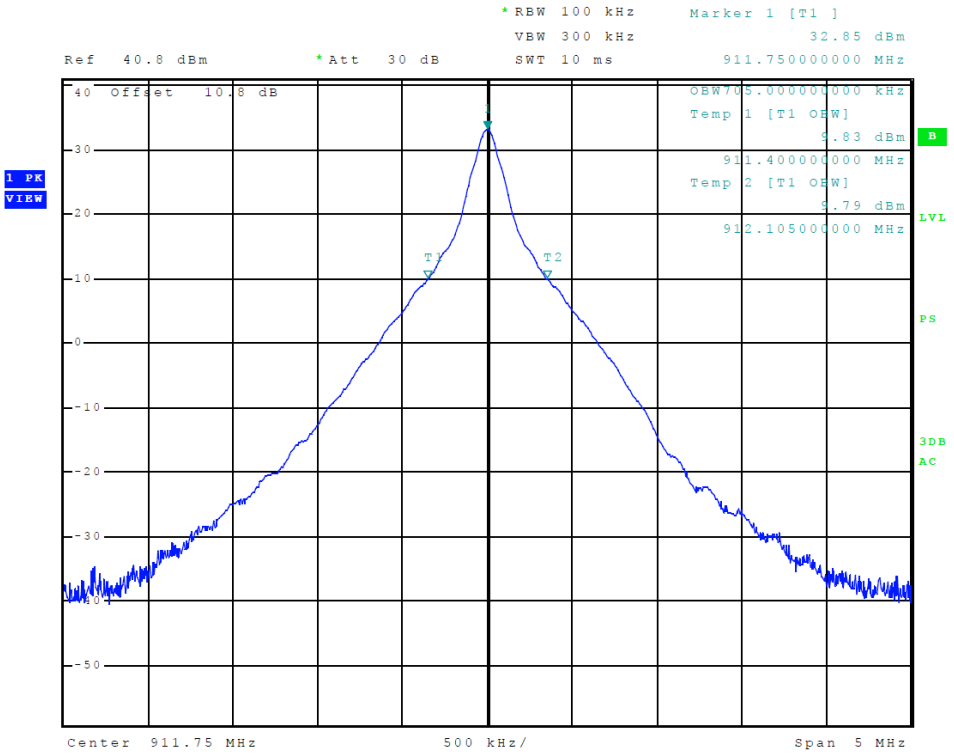


Figure 9 Occupied Bandwidth (SeGo modulation)

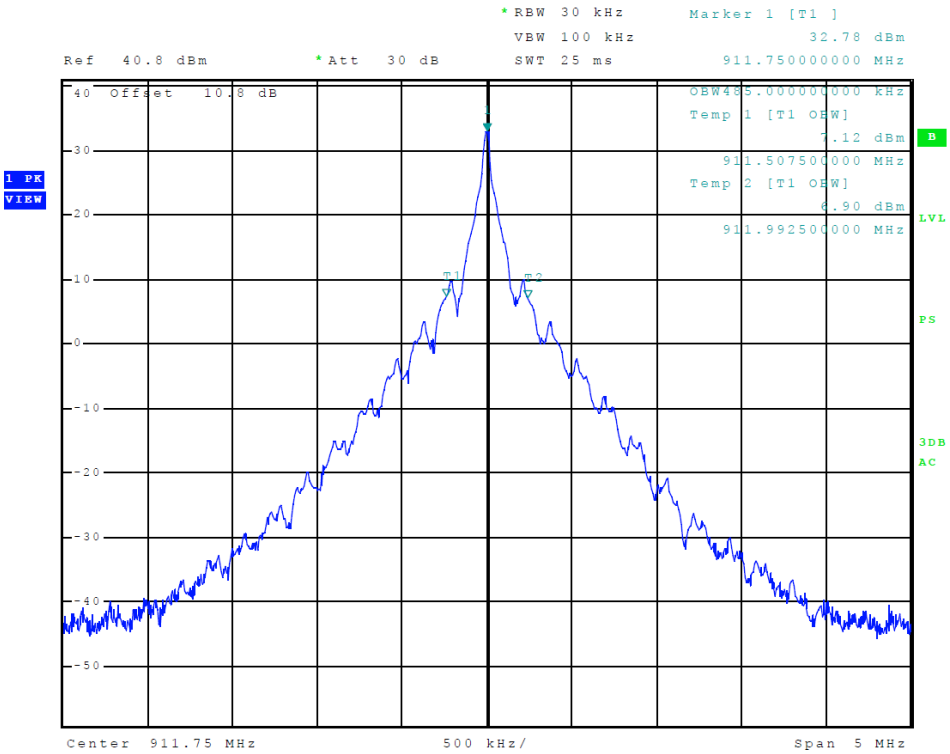


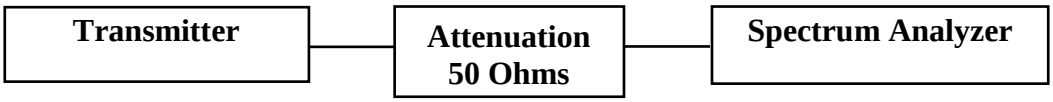
Figure 10 Occupied Bandwidth (EPC modulation)

Spurious Emissions

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. To gain dynamic range in the test equipment, a high pass filter attenuated the fundamental frequency of operation was used to observe the harmonic emissions.

Test Arrangement



The radio frequency output was passively coupled to a Rohde &Schwarz ESU40 Spectrum Analyzer. The spectrum analyzer was used to observe the radio frequency spectrum with the transmitter operating in its normal mode. The frequency spectrum from 9 kHz to 10 GHz was observed. Data was taken per 47CFR 2.1051 and applicable paragraphs of Part 90 and RSS-137.

Limit: Spurious emissions must be attenuated below the peak output power by the at least 55 + 10 Log (P_o) dB.

2.0-watt transmitter limit requires the out of band emissions must be suppressed by at least 58.0 dBc and for full high power

Attenuation = $55 + 10 \text{ Log}_{10}(P_w)$

= $55 + 10 \text{ Log}_{10} (0.001)$

= 58.0 dBc

Table 3 Spurious Emissions Results (ATA modulation)

Channel MHz	Spurious Freq. (MHz)	Measured Level (dBm)	Level Below Carrier (dBc)
902.25	1804.5	-43.50	76.5
	2706.8	-73.90	106.9
	3609.0	-73.10	106.1
	4511.3	-72.50	105.5
	5413.5	-71.30	104.3
	6315.8	-73.50	106.5
903.75	1807.5	-42.40	75.1
	2711.3	-73.70	106.4
	3615.0	-73.20	105.9
	4518.8	-72.20	104.9
	5422.5	-70.40	103.1
	6326.3	-73.20	105.9
910.00	1820.0	-40.60	73.5
	2730.0	-74.40	107.3
	3640.0	-72.50	105.4
	4550.0	-72.70	105.6
	5460.0	-70.90	103.8
	6370.0	-72.00	104.9
921.50	1843.0	-45.90	78.7
	2764.5	-75.70	108.5
	3686.0	-74.10	106.9
	4607.5	-72.80	105.6
	5529.0	-71.30	104.1
	6450.5	-73.70	106.5

Data was taken per 2.1051 and applicable parts of 47CFR 90.210 and RSS-137. The EUT demonstrated compliance with the specifications of Paragraphs 47CFR 2.1051, 2.1057 and 90.210(k) and RSS-137 paragraph 6.5. There are no deviations to the specifications.

Table 4 Spurious Emissions Results (IAG modulation)

Channel MHz	Spurious Freq. (MHz)	Measured Level (dBm)	Level Below Carrier (dBc)
911.75	1823.5	-47.80	76.9
	2735.3	-75.50	104.6
	3647.0	-74.10	103.2
	4558.8	-752.10	781.2
	5470.5	-72.30	101.4
	6382.3	-73.20	102.3
915.00	1830.0	-48.10	77.1
	2745.0	-75.60	104.6
	3660.0	-73.70	102.7
	4575.0	-71.50	100.5
	5490.0	-72.20	101.2
	6405.0	-72.30	101.3
919.75	1839.5	-49.00	77.8
	2759.3	-75.30	104.1
	3679.0	-73.20	102.0
	4598.8	-72.60	101.4
	5518.5	-72.00	100.8
	6438.3	-72.40	101.2

Data was taken per 2.1051 and applicable parts of 47CFR 90.210 and RSS-137. The EUT demonstrated compliance with the specifications of Paragraphs 47CFR 2.1051, 2.1057 and 90.210(k) and RSS-137 paragraph 6.5. There are no deviations to the specifications.

Table 5 Spurious Emissions Results eGo modulation)

Channel MHz	Spurious Freq. (MHz)	Measured Level (dBm)	Level Below Carrier (dBc)
911.75	1823.5	-40.30	73.1
	2735.3	-62.00	94.8
	3647.0	-41.00	73.8
	4558.8	-72.90	105.7
	5470.5	-70.80	103.6
	6382.3	-72.50	105.3
915.00	1830.0	-41.60	74.3
	2745.0	-56.50	89.2
	3660.0	-73.70	106.4
	4575.0	-72.50	105.2
	5490.0	-72.20	104.9
	6405.0	-73.40	106.1
919.75	1839.5	-42.60	75.5
	2759.3	-61.10	94.0
	3679.0	-73.90	106.8
	4598.8	-73.40	106.3
	5518.5	-73.00	105.9
	6438.3	-73.20	106.1

Data was taken per 2.1051 and applicable parts of 47CFR 90.210 and RSS-137. The EUT demonstrated compliance with the specifications of Paragraphs 47CFR 2.1051, 2.1057 and 90.210(k) and RSS-137 paragraph 6.5. There are no deviations to the specifications.

Table 6 Spurious Emissions Results (SeGo modulation)

Channel MHz	Spurious Freq. (MHz)	Measured Level (dBm)	Level Below Carrier (dBc)
911.75	1823.5	-40.40	73.2
	2735.3	-75.50	108.3
	3647.0	-73.30	106.1
	4558.8	-73.50	106.3
	5470.5	-71.40	104.2
	6382.3	-73.30	106.1
915.00	1830.0	-41.80	74.6
	2745.0	-75.30	108.1
	3660.0	-73.70	106.5
	4575.0	-72.70	105.5
	5490.0	-72.10	104.9
	6405.0	-73.50	106.3
919.75	1839.5	-42.16	75.1
	2759.3	-74.60	107.5
	3679.0	-73.70	106.6
	4598.8	-73.40	106.3
	5518.5	-71.40	104.3
	6438.3	-73.50	106.4

Data was taken per 2.1051 and applicable parts of 47CFR 90.210 and RSS-137. The EUT demonstrated compliance with the specifications of Paragraphs 47CFR 2.1051, 2.1057 and 90.210(k) and RSS-137 paragraph 6.5. There are no deviations to the specifications.

Table 7 Spurious Emissions Results (EPC modulation)

Channel MHz	Spurious Freq. (MHz)	Measured Level (dBm)	Level Below Carrier (dBc)
911.75	1823.5	-39.90	72.8
	2735.3	-75.70	108.6
	3647.0	-73.60	106.5
	4558.8	-72.00	104.9
	5470.5	-71.00	103.9
	6382.3	-39.90	72.8
915.00	1830.0	-48.10	77.1
	2745.0	-75.60	104.6
	3660.0	-73.70	102.7
	4575.0	-71.50	100.5
	5490.0	-72.20	101.2
	6405.0	-72.30	101.3
919.75	1839.5	-42.40	75.2
	2759.3	-75.00	107.8
	3679.0	-73.20	106.0
	4598.8	-72.90	105.7
	5518.5	-72.70	105.5
	6438.3	-42.40	75.2

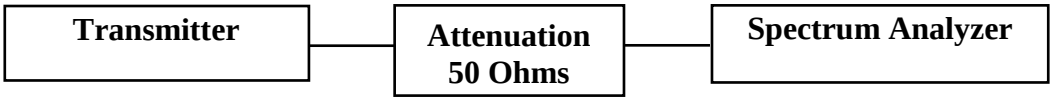
Data was taken per 2.1051 and applicable parts of 47CFR 90.210 and RSS-137. The EUT demonstrated compliance with the specifications of Paragraphs 47CFR 2.1051, 2.1057 and 90.210(k) and RSS-137 paragraph 6.5. There are no deviations to the specifications.

Emission Mask

Measurements Required

Transmitters used in the radio services governed by this part must comply with the emissions masks outlined in this section. Paragraph 90.210(K) specifies the out of band emission limitations for this equipment. The spurious emissions for the device were measured at the maximum output power condition.

Test Arrangement



The radio frequency output was passively coupled to a Rohde &Schwarz ESU40 Spectrum Analyzer. The spectrum analyzer was used to observe the radio frequency spectrum with the transmitter operating through normal modes with maximum output power. The frequency spectrum at the band edges were observed and plots produced. Refer to figures three and four for plots presenting compliance with emission mask requirements at the band edges. Data was taken per 47CFR 2.1051 and applicable parts of Part 90.210 (k) and RSS-137.

Results Emission Mask

The EUT demonstrated compliance with the specifications of Paragraphs 47CFR 2.1051, 2.1057 and 90.210(k) and RSS-137 paragraph 6.5. There are no deviations to the specifications.

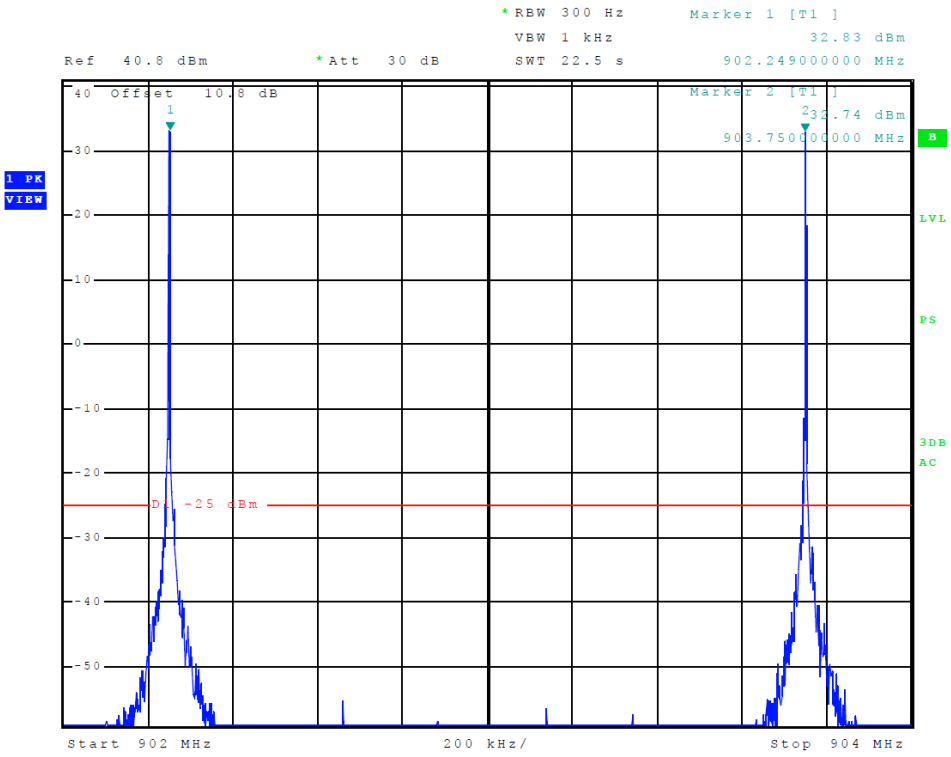


Figure 11 Emissions Mask (ATA modulation, 902-904 MHz)

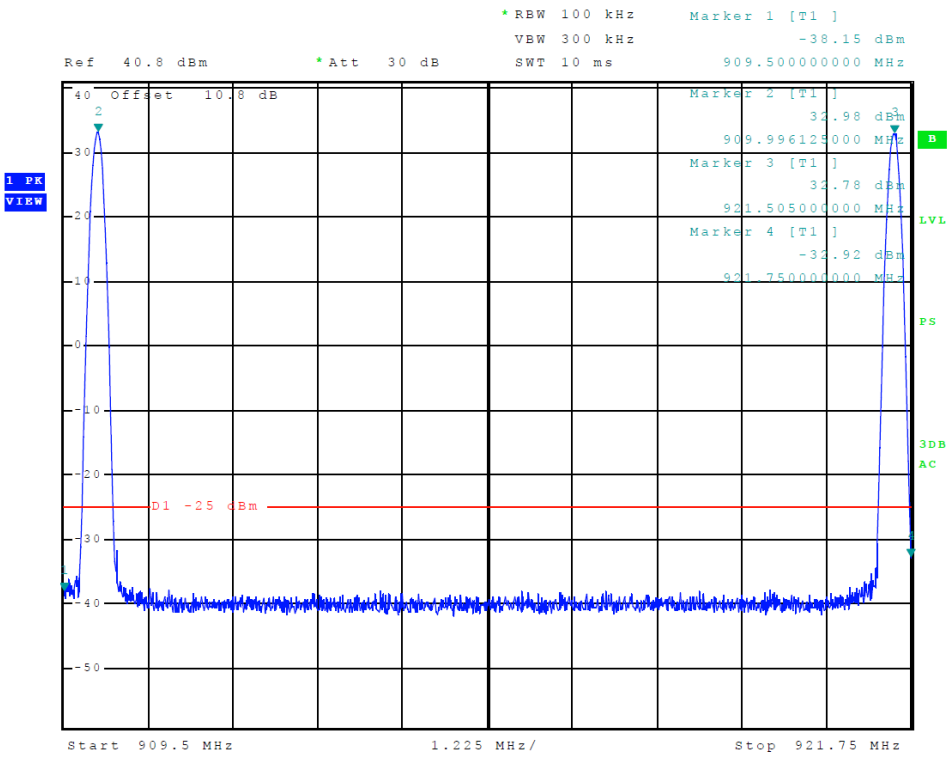


Figure 12 Emissions Mask (ATA modulation, 909.50-921.75 MHz)

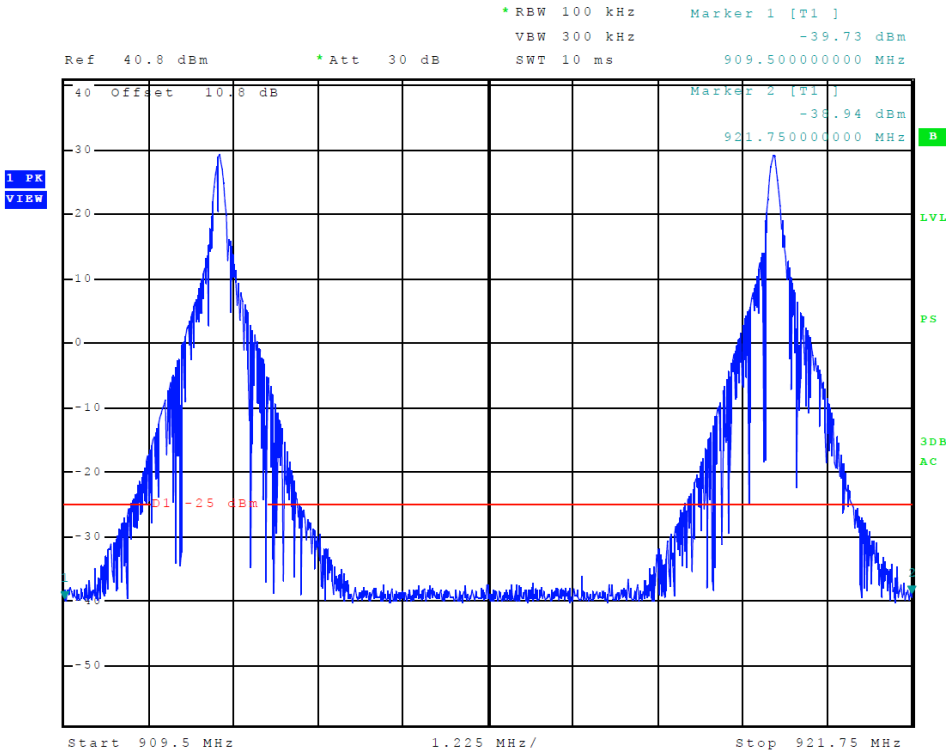


Figure 13 Emissions Mask (IAG modulation, 909.50-921.75 MHz)

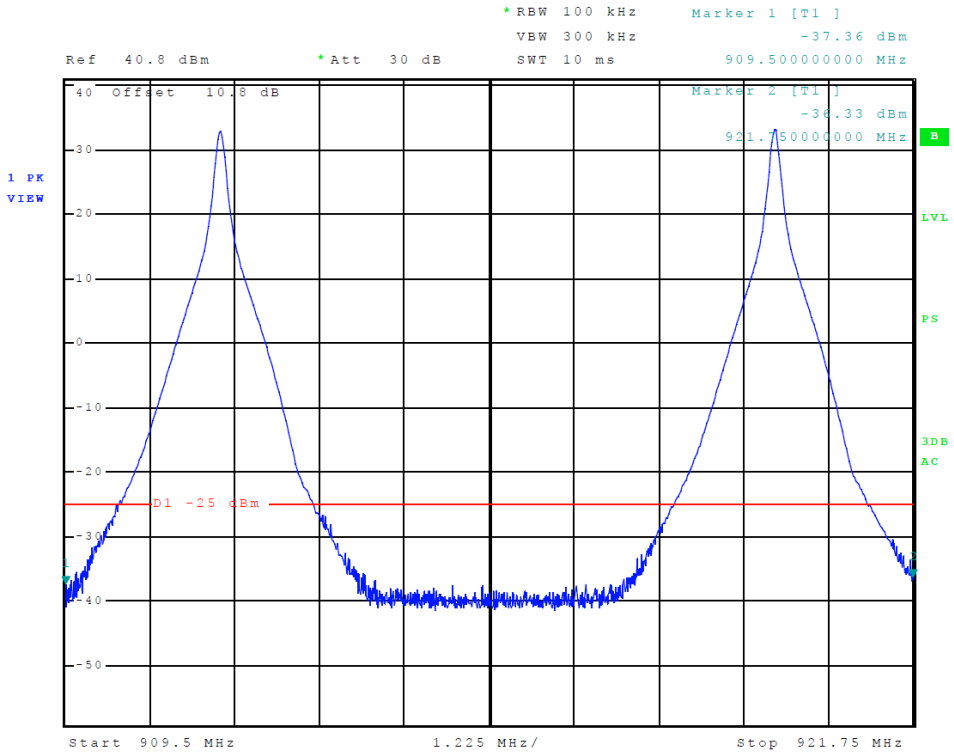


Figure 14 Emissions Mask (eGo modulation, 909.50-921.75 MHz)

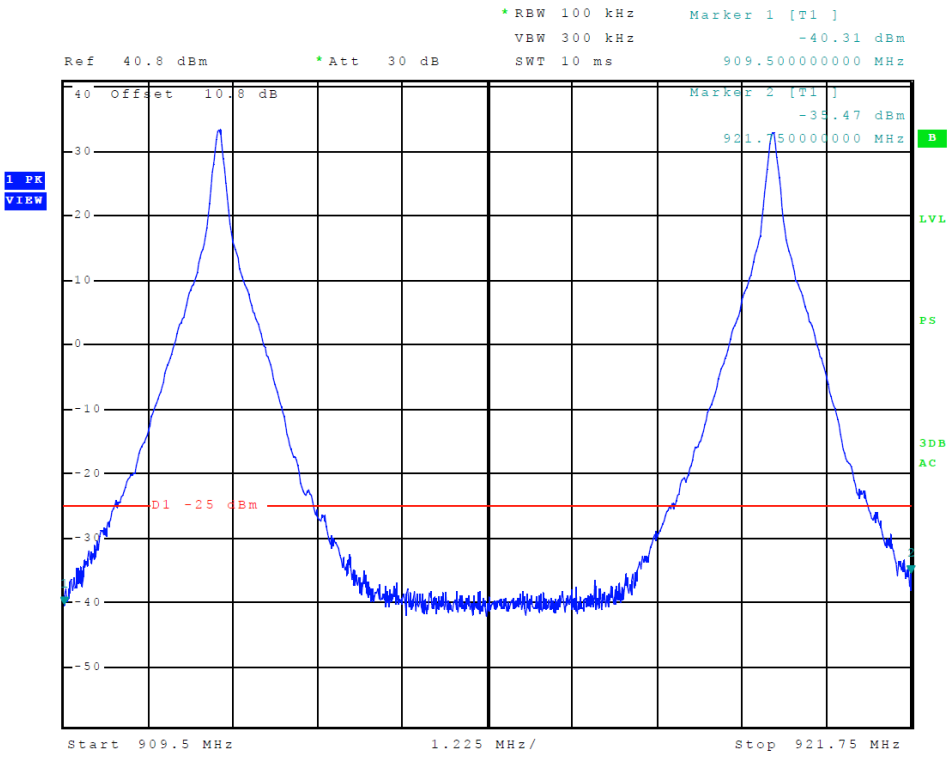


Figure 15 Emissions Mask (SeGo modulation, 909.50-921.75 MHz)

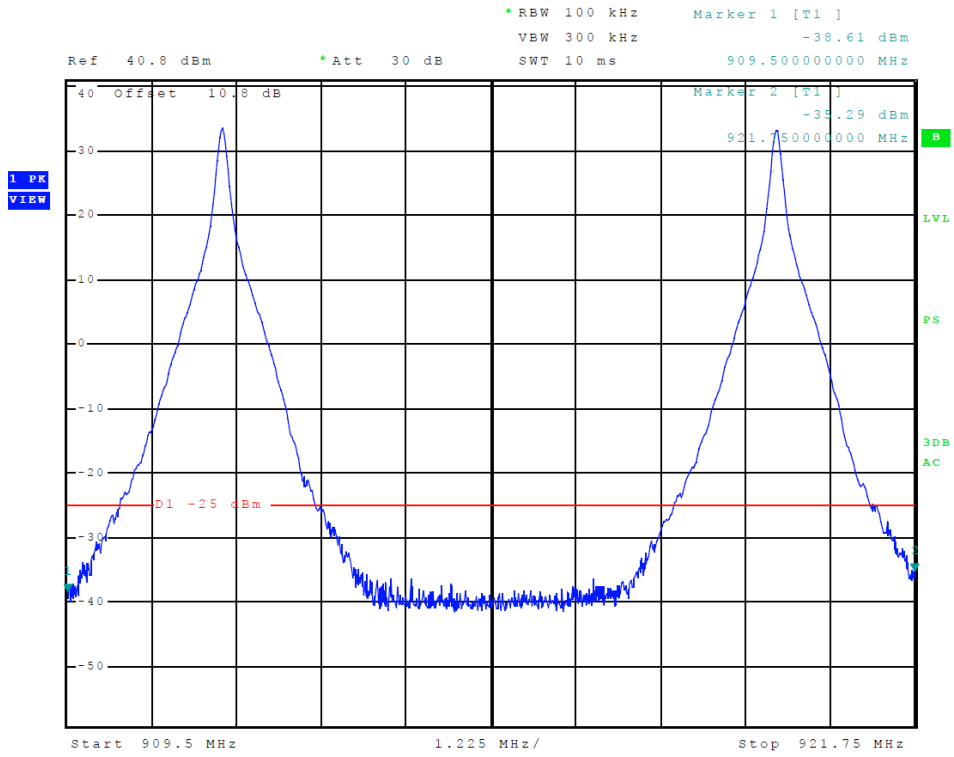


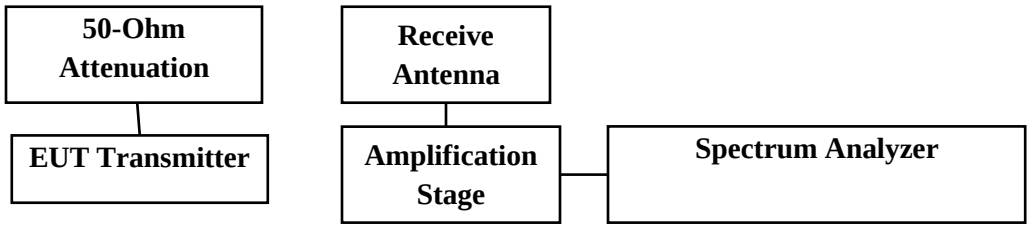
Figure 16 Emissions Mask (EPC modulation, 909.50-921.75 MHz)

Field Strength of Spurious Radiation

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.

Test Arrangement



Preliminary radiated emissions investigation was made in a screen room to determine frequencies of emissions for investigation on the Open Area Test Site (OATS). The transmitter spurious emissions were measured on the OATS. The EUT was placed on a turntable elevated as required above the ground plane at a distance of 3 meters from the FSM antenna. The turntable was rotated though 360 degrees to locate the position registering the highest amplitude emission. The frequency spectrum was then searched for spurious emissions generated from the transmitter. Raising and lowering the FSM antenna and rotating the turntable to maximize the emission. Data was measured and recorded for the maximum amplitude of each spurious emission. 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 above 1 GHz. Emissions were measured in dBµV/m @ 3 meters. The substitution method was used to measure harmonic emissions. Harmonic emission levels from the EUT were measured and amplitude levels were recorded. The EUT transmitter was then removed and replaced with a substitution antenna, which was powered from a signal generator. The output 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.

The limits for the spurious radiated emissions are defined by the following equation.

Limit = Amplitude of the spurious emission must be attenuated by this amount below the level of the fundamental. On any frequency removed from the assigned frequency outside the assigned sub-band edges: at least 55 + 10 Log (P_o) dB.

0.004-watt transmitter limit specifies the level below the carrier must be suppressed more than 31.0 dB.

Attenuation $= 55 + 10 \text{ Log}_{10}(P_w)$

$= 55 + 10 \text{ Log}_{10} (2.0)$

$= 58.0$ dBc

Therefore, emissions must be less than 33- 58= -25 dBm

Data was taken per 2.1051 and applicable parts of 47CFR 90. The EUT demonstrated compliance with the specifications of Paragraphs 47CFR 2.1051, 2.1057 and 90.210(k) and RSS-137 paragraph 6.5. There are no deviations to the specifications.

Table 8 General Radiated Emission Results (worst-case)

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	
63.9	52.2	55.6	-45.33	-43.83	78.33	76.83	58
69.5	53.2	54.5	-45.63	-42.93	78.63	75.93	58
72.2	54.3	57.1	-45.03	-40.93	78.03	73.93	58
84.8	56.2	55.1	-40.43	-41.43	73.43	74.43	58
124.7	47.5	47.1	-49.73	-50.03	82.73	83.03	58
160.3	48.0	41.6	-48.43	-56.73	81.43	89.73	58
240.0	49.6	41.8	-49.73	-56.03	82.73	89.03	58
256.9	48.0	36.6	-48.93	-60.93	81.93	93.93	58
320.0	46.3	42.5	-50.93	-53.53	83.93	86.53	58

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.

Table 9 Results Spurious Radiation

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	
1804.50	38.5	39.4	-69.43	-69.23	102.4	102.2	58
2706.75	41.9	41.4	-66.53	-66.43	99.5	99.4	58
3609.00	41.8	41.9	-66.33	-66.33	99.3	99.3	58
4511.25	42.5	42.4	-65.83	-65.93	98.8	98.9	58
5413.50	43.8	43.9	-64.13	-64.13	97.1	97.1	58
6315.75	43.1	43.2	-65.23	-65.03	98.2	98.0	58
1830.00	40.4	39.6	-68.33	-68.43	101.3	101.4	58
2745.00	42.1	42.2	-66.33	-66.33	99.3	99.3	58
3660.00	44.0	43.8	-64.33	-64.33	97.3	97.3	58
4575.00	43.6	43.5	-64.73	-64.73	97.7	97.7	58
5490.00	44.9	46.2	-62.93	-62.93	95.9	95.9	58
6405.00	44.9	44.5	-63.53	-63.43	96.5	96.4	58
1843.00	40.1	40.4	-68.13	-68.23	101.1	101.2	58
2764.50	41.2	41.9	-66.43	-66.53	99.4	99.5	58
3686.00	43.4	43.7	-64.43	-64.43	97.4	97.4	58
4607.50	44.6	44.7	-63.33	-63.33	96.3	96.3	58
5529.00	44.4	44.9	-64.13	-64.13	97.1	97.1	58

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.

Frequency Stability

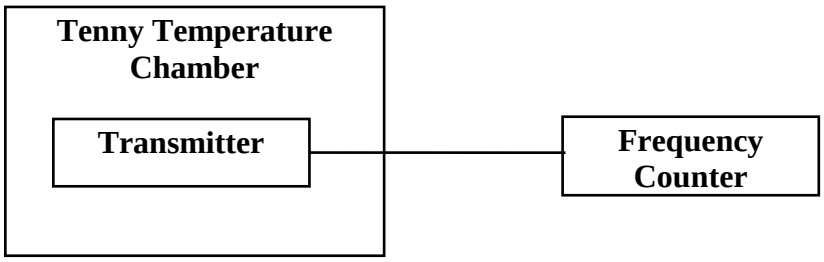
Measurements Required

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. A Sorensen DC Power Supply was used to vary the DC voltage for the power input nominally (12.0 V_{dc}) from 10.2 V_{dc} to 13.80 V_{dc}. 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 90.213 and RSS-137.

Table 10 Frequency Stability Results

Frequency 915.001552 MHz	Frequency Stability Vs Temperature								
Temperature °C	-30	-20	-10	0	+10	+20	+30	+40	+50
Change (Hz)	-357	-78	43	78	39	20	-133	-146	-163
PPM	-0.390	-0.085	0.047	0.085	0.043	0.022	-0.145	-0.160	-0.178
%	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Limit (PPM)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Frequency 915.001552 MHz	Frequency Stability Vs Voltage Variation 12 volts nominal; Results in Hz change		
Voltage V_{dc}	10.2	12.00	13.80
Change (Hz)	-102	0.000	-111

The EUT demonstrated compliance with specifications of 47CFR Paragraph 2.1046(a) and applicable Parts of 90.213 and RSS-137. 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 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 Date	Due
Spectrum Analyzer: Rohde & Schwarz ESU40	5/17	5/18
Spectrum Analyzer: HP 8562A, HP Adapters: 11518, 11519, and 11520 Mixers: 11517A, 11970A, 11970K, 11970U, 11970V, 11970W	5/17	5/18
Spectrum Analyzer: HP 8591EM	5/17	5/18
Antenna: EMCO Biconilog Model: 3143	5/17	5/18
Antenna: Sunol Biconilog Model: JB6	10/16	10/17
Antenna: EMCO Log Periodic Model: 3147	10/16	10/17
Antenna: Com Power Model: AH-118	10/16	10/17
Antenna: Com Power Model: AH-840	5/17	5/18
Antenna: Antenna Research Biconical Model: BCD 235	10/16	10/17
Antenna: Com Power Model: AL-130	10/16	10/17
Antenna: EMCO 6509	10/16	10/17
LISN: Compliance Design Model: FCC-LISN-2.Mod.cd, 50 µHy/50 ohm/0.1 µf	10/16	10/17
R.F. Preamp CPPA-102	10/16	10/17
Attenuator: HP Model: HP11509A	10/16	10/17
Attenuator: Mini Circuits Model: CAT-3	10/16	10/17
Attenuator: Mini Circuits Model: CAT-3	10/16	10/17
Cable: Belden RG-58 (L1)	10/16	10/17
Cable: Belden RG-58 (L2)	10/16	10/17
Cable: Belden 8268 (L3)	10/16	10/17
Cable: Time Microwave: 4M-750HF290-750	10/16	10/17
Cable: Time Microwave: 10M-750HF290-750	10/16	10/17
Frequency Counter: Leader LDC825	2/17	2/18
Oscilloscope Scope: Tektronix 2230	2/17	2/18
Wattmeter: Bird 43 with Load Bird 8085	2/17	2/18
Power Supplies: Sorensen SRL 20-25, SRL 40-25, DCR 150, DCR 140	2/17	2/18
R.F. Generators: HP 606A, HP 8614A, HP 8640B	2/17	2/18
R.F. Power Amp 65W Model: 470-A-1010	2/17	2/18
R.F. Power Amp 50W M185- 10-501	2/17	2/18
R.F. Power Amp A.R. Model: 10W 1010M7	2/17	2/18
R.F. Power Amp EIN Model: A301	2/17	2/18
LISN: Compliance Eng. Model 240/20	2/17	2/18
LISN: Fischer Custom Communications Model: FCC-LISN-50-16-2-08	2/17	2/18
Antenna: EMCO Dipole Set 3121C	2/17	2/18
Antenna: C.D. B-101	2/17	2/18
Antenna: Solar 9229-1 & 9230-1	2/17	2/18
Audio Oscillator: H.P. 201CD	2/17	2/18
ELGAR Model: 1751	2/17	2/18
ELGAR Model: TG 704A-3D	2/17	2/18
ESD Test Set 2010i	2/17	2/18
Fast Transient Burst Generator Model: EFT/B-101	2/17	2/18
Field Intensity Meter: EFM-018	2/17	2/18
KEYTEK Ecat Surge Generator	2/17	2/18
Shielded Room 5 M x 3 M x 3.0 M		

Annex C Rogers Qualifications

Scot D. Rogers, Engineer

Rogers Labs, Inc.

Mr. Rogers has approximately 17 years' experience in the field of electronics. Work experience includes six years working 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.