Application for Grant of Certification

FCC CFR47 Part 87 and Industry Canada RSS-141

GMN-00832
Market Label: GDR 66
IC M/N: GMN-00832
GPN: 011-02303-0( )
118-136.992 MHz
Aviation Communications Transceiver

FCC ID: IPH-0183700
IC: 1792A-0183700

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

Test Report Number 120119

Authorized Signatory: Scot D Rogers
Scot D. Rogers

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. Van Ruggles
Director of Quality Assurance

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Test Date: January 19, 2012

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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In accordance with the Federal Communications, Code of Federal Regulations dated October 1, 2010, Part 2 Subpart J, Paragraphs 2.907, 2.911, 2.913, 2.915, 2.925, 2.926, 2.1031 through 2.1057, and Part 87, Subchapter D, Paragraphs 87.131 through 87.147, and Industry Canada RSS-141 Issue 2, June 2010 the following information is submitted for consideration in obtaining Grant of Certification.

Opinion / Interpretation of Results

Tests Performed	Results
Emissions Tests	
Requirements per CFR47 paragraphs 2.1031-2.1057 and RSS-141, Issue 2	Complies
Requirements per CFR47 paragraphs 87.131 and RSS-141 paragraph 5.1	Complies
Requirements per CFR47 paragraphs 87.133 and RSS-141 paragraph 5.1	Complies
Requirements per CFR47 paragraphs 87.135 and RSS-141 paragraph 5.1	Complies
Requirements per CFR47 paragraphs 87.139 and RSS-141 paragraph 5.2.2	Complies
Requirements per CFR47 paragraphs 87.141 and RSS-141 paragraph 5.1	Complies

Applicable Standards & Test Procedures

In accordance with the Federal Communications Code of Federal Regulations, dated October 1, 2011, Part 2, Subpart J, Paragraphs 2.907, 2.911, 2.913, 2.925, 2.926, 2.1031 through 2.1057, and applicable paragraphs of Part 87, and RSS-141, Issue 2 the following is submitted for consideration in obtaining Grant of Certification. Test procedures used are the established Methods of Measurement of Radio-Noise Emissions as described in ANSI C63.4-2009 and TIA/EIA 603-C (2004).

Environmental Conditions

Ambient Temperature	21.2° C
Relative Humidity	25%
Atmospheric Pressure	1023.9 mb

Application for Certification

1) Manufacturer: Garmin International, Inc. 1200 East 151st Street Olathe, KS 66062

2) Identification: FCC I.D.: IPH-0183700 IC: 1792A-0183700

3) Instruction Book: Refer to exhibit for Draft Instruction Manual.

4) Emission Type: Emissions designator 6k00A3E (25 kHz) or 5k60A3E (8.33 kHz), 13k0A2D (VDL Mode A, ACARS), and 14k0G1D (VDL Mode 2, D8PSK)

5) Frequency Range: 118-136.975 MHz (25 kHz channel operation) and 118—136.992 (8.33 kHz channel operation)

6) Operating Power Level: 20 W, 43 dBm (28 Volt) or 10 W, 40 dBm (14-volt) operation

7) Maximum P_o: 20 Watts delivered from this EUT. Maximum allowable power output of 55 Watts as defined per CFR 47 paragraph 87.131 and RSS-141 paragraph 5.1.

8) Power into final amplifying circuitry: Power delivered into final amplifier 28 volts @ 5 amps (140 watts) maximum 28-volt (AM 25/8k, ACARS) operation and 17.5 volts @ 5.5 amps (96.25 watts) maximum 14-volt (AM 25/8k, ACARS) operation.

9) Tune Up Procedure for Output Power: Refer to Exhibit for Transceiver Alignment Procedure.

10) Circuit Diagrams; description of circuits, frequency stability, spurious suppression, and power and modulation limiting: Refer to Exhibit for Circuit information and theory of operation.

11) Photograph or drawing of the Identification Plate: Refer to Exhibit for Photograph or Drawing.

12) Drawings of Construction and Layout: Refer to Exhibit for Drawings of Components Layout and Chassis Drawings.

13) Detail Description of Digital Modulation: VDL Mode A (ACARS) – VDL Mode A modulation (ACARS) uses minimum shift keying (MSK) with 1200 and 2400 Hz tones to AM Modulate the transmitter. The data rate for ACARS is 2400 bps. VDL Mode 2 – VDL Mode 2 modulation is a differentially encoded eight phase shift keying (D8PSK) modulations providing a 31.5 kbps bit rate.

14) Data required by CFR47 paragraphs 2.1046 through 2.1057 are contained in this application.

15) External power amplifier requirements do not apply to this device or application.

16) AM broadcast requirements do not apply to this device or application.

17) Requirements of CFR47 paragraph 25.129 do not apply to this device or application.

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

Units of Measurements

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 line conducted emissions testing was performed in a shielded screen room located at Rogers Labs, Inc., 4405 W. 259th Terrace, Louisburg, KS.
Radiated EMI	The radiated emissions testing was 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.

List of Test Equipment

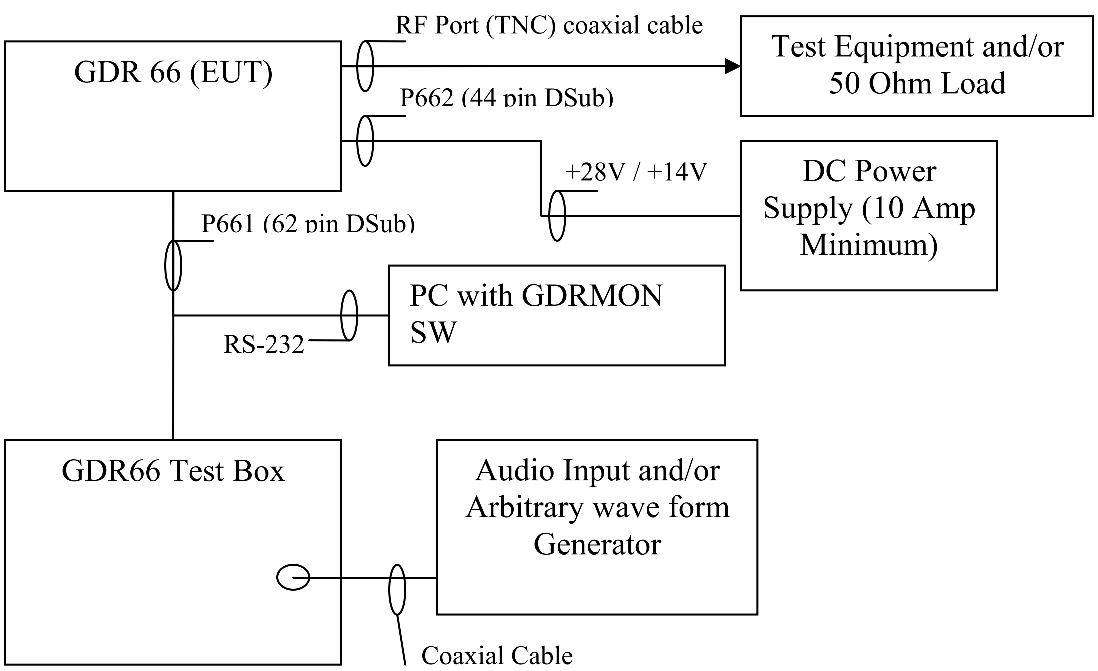
A Rohde & Schwarz ESU40 and/or Hewlett Packard 8591EM Spectrum Analyzer was used as the measuring device for the emissions testing of frequencies below 1 GHz. A Rohde & Schwarz ESU40 and/or Hewlett Packard 8562A Spectrum Analyzer was used as the measuring device for testing the emissions at frequencies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

Analyzer Settings		
AC Line Conducted Emissions:		
RBW	AVG. BW	Detector Function
9 kHz	30 kHz	Peak/Quasi Peak
Radiated Emissions 30-1000 MHz		
RBW	AVG. BW	Detector Function
100 kHz	100 kHz	Peak
120 kHz	300 kHz	Peak/Quasi Peak
Radiated Emissions Above 1000 MHz		
RBW	Video BW	Detector Function
1 MHz	1 MHz	Peak / Average

Equipment	Manufacturer	Model	Calibration Date	Due
LISN	Comp. Design	FCC-LISN-2-MOD.CD	10/11	10/12
Antenna	ARA	BCD-235-B	10/11	10/12
Antenna	EMCO	3147	10/11	10/12
Antenna	Sunol	JB6	10/11	10/12
Antenna	Com Power	AH-118	10/11	10/12
Antenna	EMCO	3143	5/11	5/12
Analyzer	HP	8591EM	5/11	5/12
Analyzer	HP	8562A	5/11	5/12
Analyzer	Rohde & Schwarz	ESU40	5/11	5/12

System Description

The GMN-00832 is an aeronautical data/communications transceiver. The transmitter operational frequency band is either 118.000 to 136.975 MHz (25 kHz mode) or 118.000 to 136.992 MHz (8.33 kHz mode). The device is marketed as a Remote Mounted Integrated Avionics Unit Including a Multi-Mode Aviation-Band VHF Transceiver with the following modes of operation: 25 kHz Channel Spacing DSB-AM, 8.33 kHz Channel Spacing DSB-AM, VDL Mode A (ACARS), and VDL Mode 2.



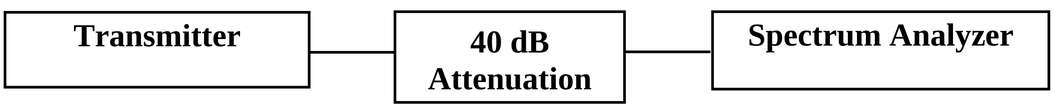
Transmitter Power Output

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. Output transmitter power is not user selectable but installation defined. The design offers 20 watts output power in 28-volt input and 10 watts output power in 14-volt installations.

Test Arrangement



The radio frequency power output was measured at the antenna terminal by placing 40-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. 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 (28 volt input) and Figure 2 displaying output power with 14-volt input. Data was taken per CFR47 Paragraph 2.1046(a) and applicable paragraphs of Part 87 and RSS-141.

P_{dBm}	= power in dB above 1 milliwatt	
Milliwatts	$= 10^{(PdBm/10)}$	
Watts	= (Milliwatts)(0.001)(W/mW)	
Milliwatts	$= 10^{(43.17/10)}$	$= 10^{(40.09/10)}$
	= 20,749 mW	= 10,209 mW
	= 20.8 Watts Peak power	= 10.2 Watts Peak power

Transmitter Power Results

Frequency	Input Power	P_{dBm}	P_{mw}	P_w
118.000	28 Vdc	42.64	18,365	18.4
127.000	28 Vdc	42.70	18,621	18.6
136.975	28 Vdc	42.96	19,769	19.8
136.99167	28 Vdc	43.17	20,749	20.8
118.000	14 Vdc	39.56	9,036	9.0
127.000	14 Vdc	39.66	9,247	9.3
136.975	14 Vdc	40.06	10,139	10.1
136.99167	14 Vdc	40.09	10,209	10.2

The EUT demonstrated compliance with specifications of CFR47 Paragraph 2.1046(a) and applicable Parts of 2 and 87.131 and RSS-141 paragraph 5.1. There are no deviations to the specifications.

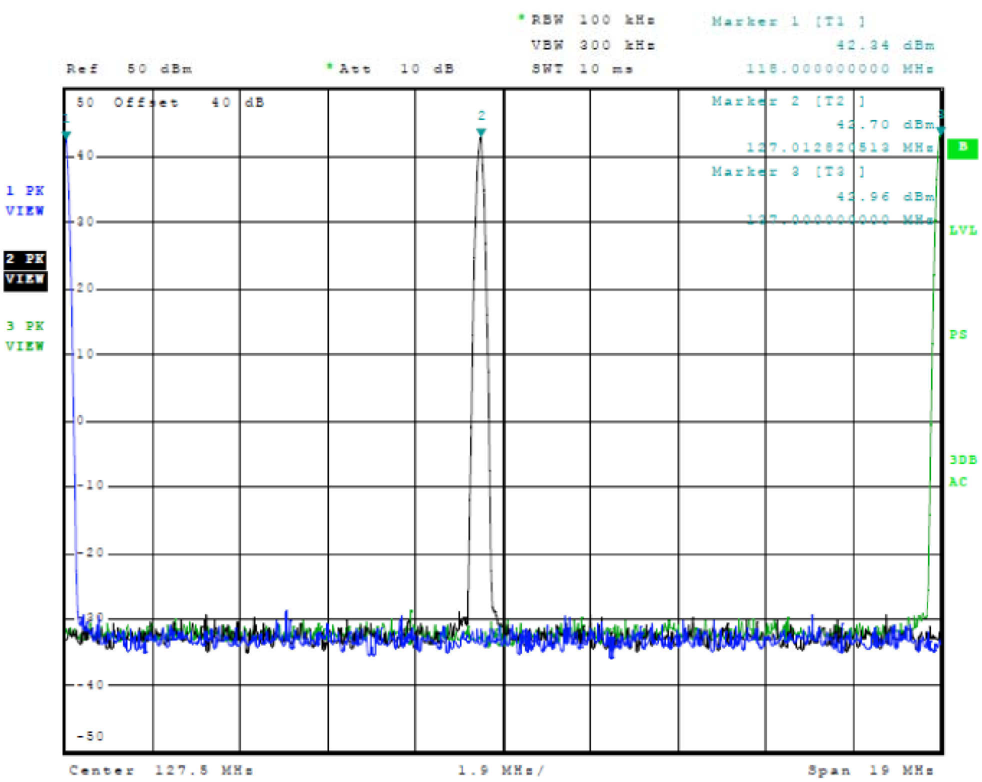


Figure 1 Maximum Power Output (28 Volt Input)

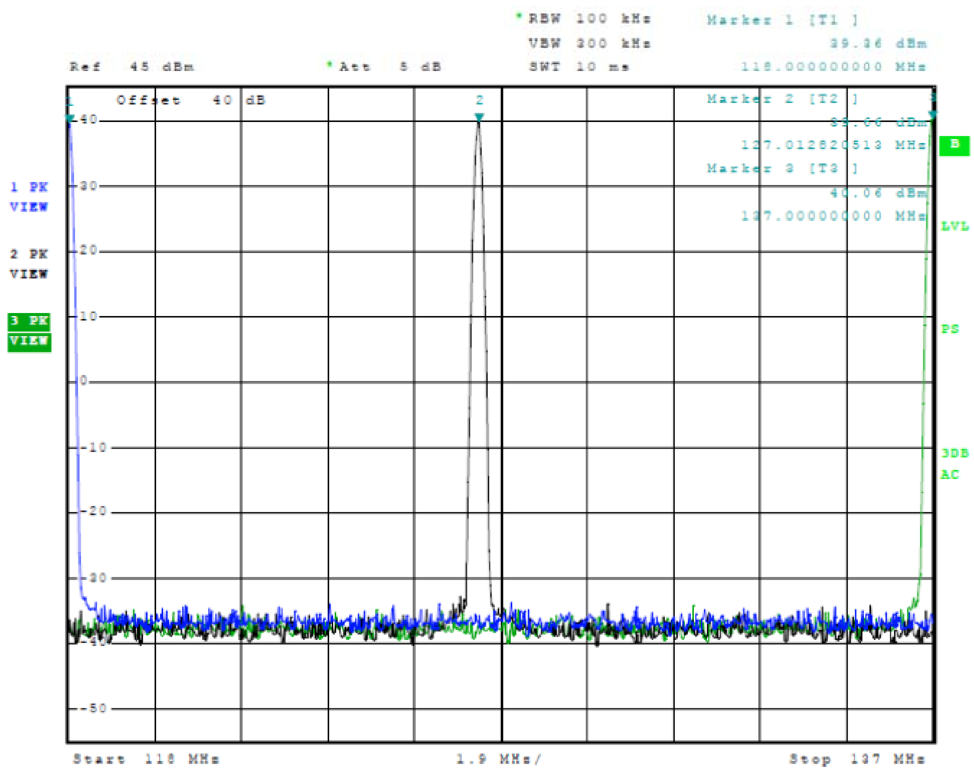


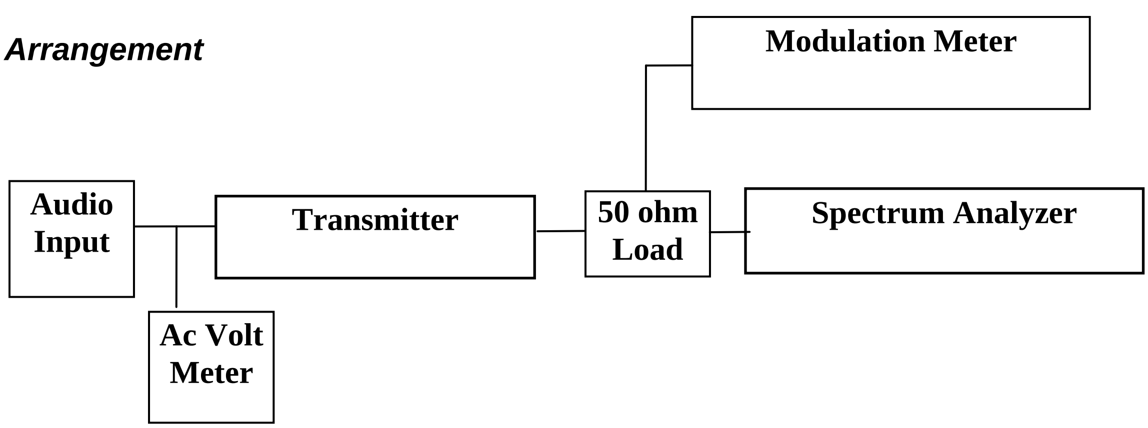
Figure 2 Maximum Power Output (14 Volt Input)

Modulation Characteristics

Measurements Required

A curve or equivalent data, which shows that the equipment will meet the modulation requirements of the rules, under which the equipment is licensed, shall be submitted. The radio frequency output was coupled to a Spectrum Analyzer and a modulation meter. The spectrum analyzer was used to observe the radio frequency spectrum with the transmitter operating in its various modes. The modulation meter was used to measure the percent modulation.

Test Arrangement



Modulation Characteristic Results

Figure 3 displays the graph made showing the audio frequency response of the modulator. The frequency generator was set to 1 kHz frequency and injected into the audio input port of the EUT. The input voltage amplitude was adjusted to obtain 50% modulation at 1000 Hz. This level was then taken as the 0-dB reference. The frequency of the generator was then varied and the output voltage level was adjusted to maintain the 50% modulation. The output level required for 50% modulation then recorded. This level was normalized to the level required for 50% modulation at 1000 Hz.

Figure 4 shows the modulation characteristics of six frequencies while the input voltage was varied. The frequency is held constant and the percent modulation is read from the modulation meter.

Figure 5 shows the frequency response of the audio low pass filter.

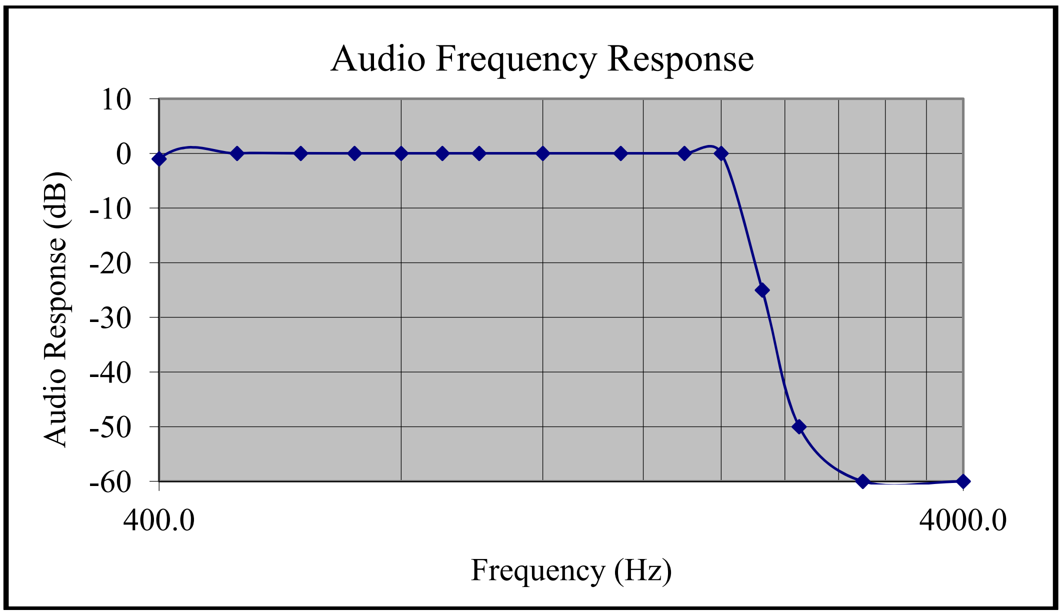


Figure 3 Audio Frequency Response / Modulation Characteristics

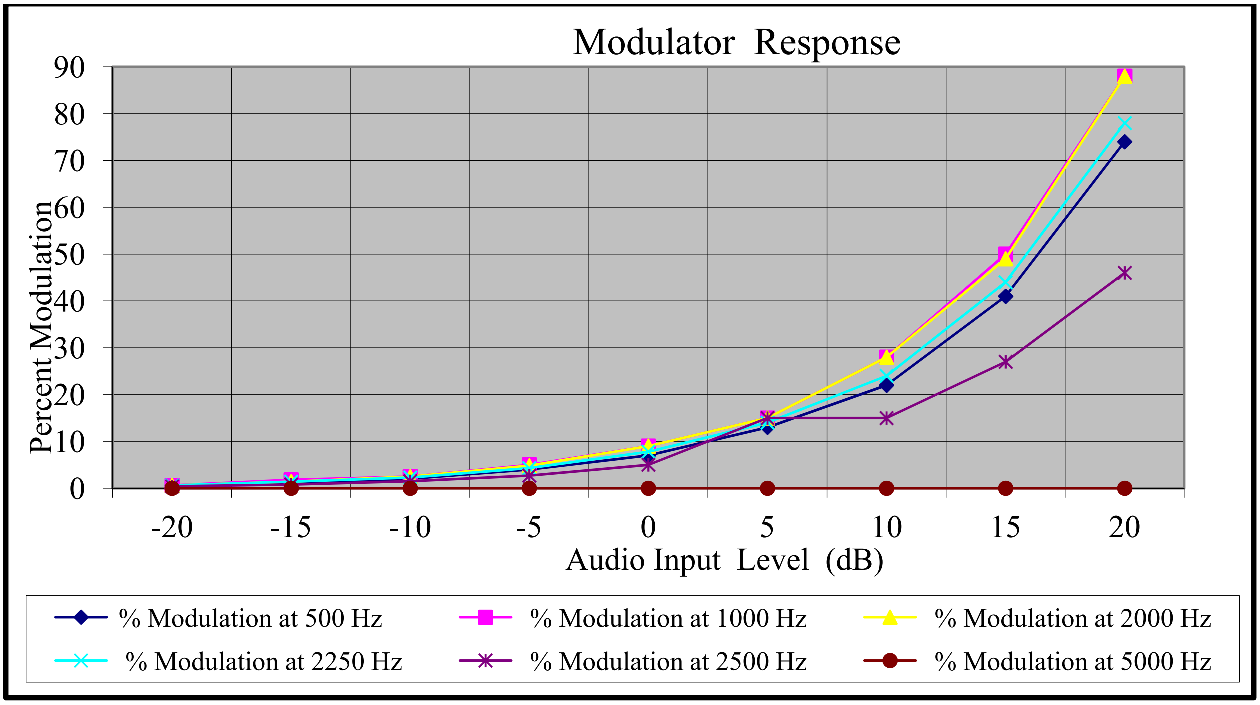


Figure 4 Modulation Characteristics

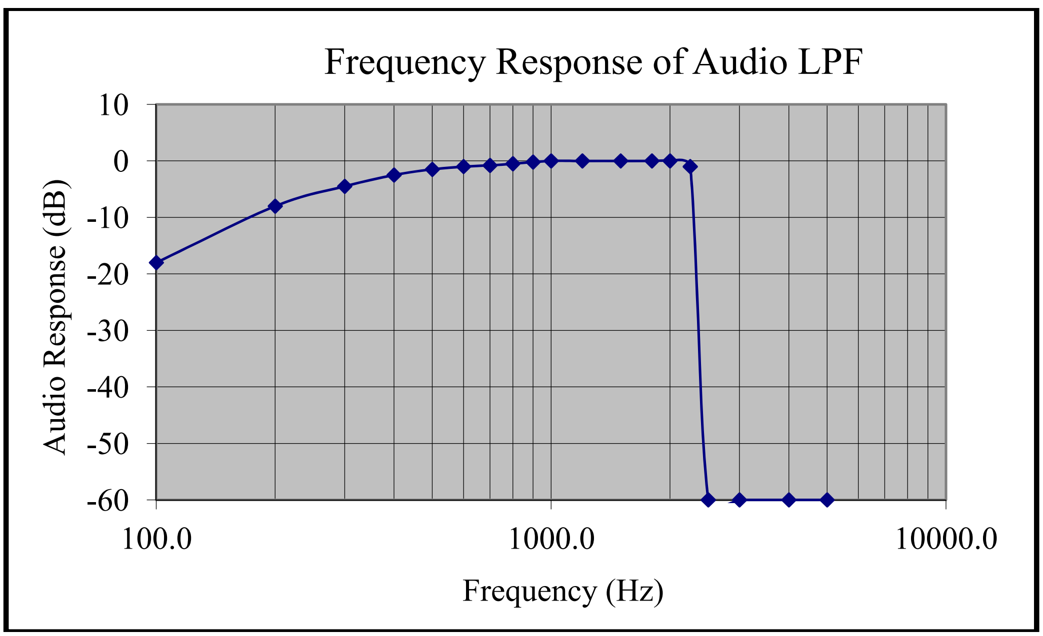


Figure 5 Frequency Response of Audio Low pass Filter

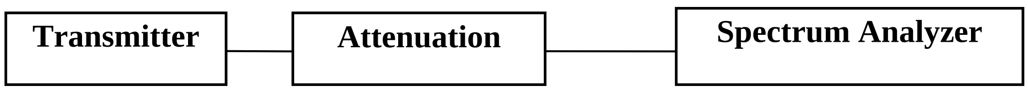
The EUT demonstrated compliance with specifications of CFR47 Paragraph 2.1046(a) and applicable Parts of 2 and 87.141 and RSS-141. There are no deviations to the specifications.

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 Rohde & Schwarz ESU 40 spectrum analyzer was used to observe the radio frequency spectrum with the transmitter operating in normal modes. Characteristics for audio communications were obtained with the EUT modulated by a frequency of 2500 Hz at a level 16 dB above 50% modulation. Other modulation schemes were measured using appropriate input signals as defined by other standards. The power ratio in dB representing 99% of the total mean power was recorded from the spectrum analyzer measurements. Refer to figures 6 through 15 for plots displaying the 99% power occupied bandwidth.

Occupied Bandwidth Results

Frequency (MHz)	Occupied bandwidth Voice (kHz)	Occupied bandwidth VDL Mode A ACARS (kHz)	Occupied bandwidth VDL Mode 2 (kHz)
118.000	5.45	5.87	12.1
127.000	5.42	5.83	12.2
136.975	5.42	5.87	12.2
136.992	5.42	N/A	N/A

The EUT demonstrated compliance with specifications of CFR47 Paragraph 2.1046(a) and applicable Parts of 2 and 87.135 and RSS-141 paragraph 5.1. There are no deviations to the specifications.

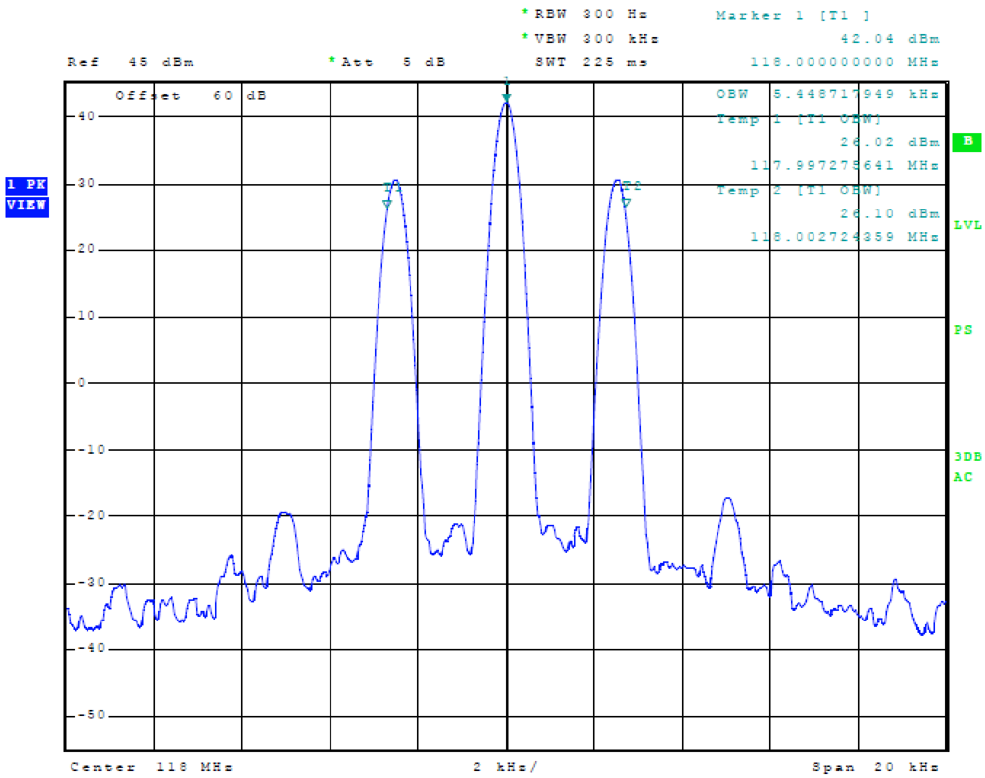


Figure 6 Occupied Band Width Carrier frequency 118.000 MHz (AM Voice Modulation)

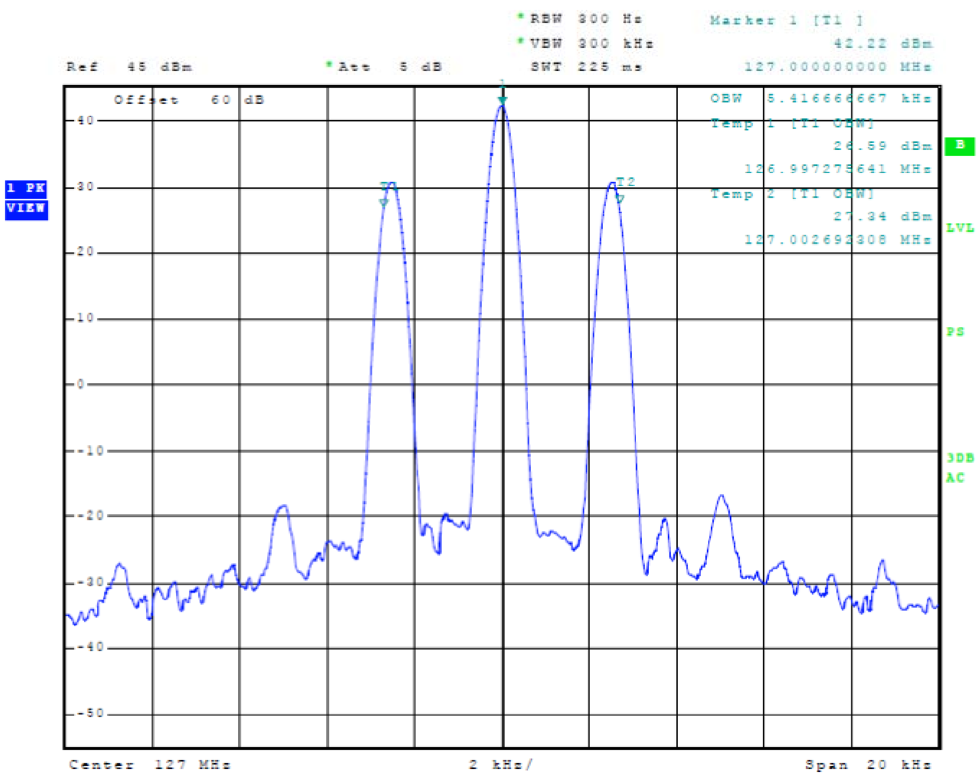


Figure 7 Occupied Band Width Carrier frequency 127.000 MHz (AM Voice Modulation)

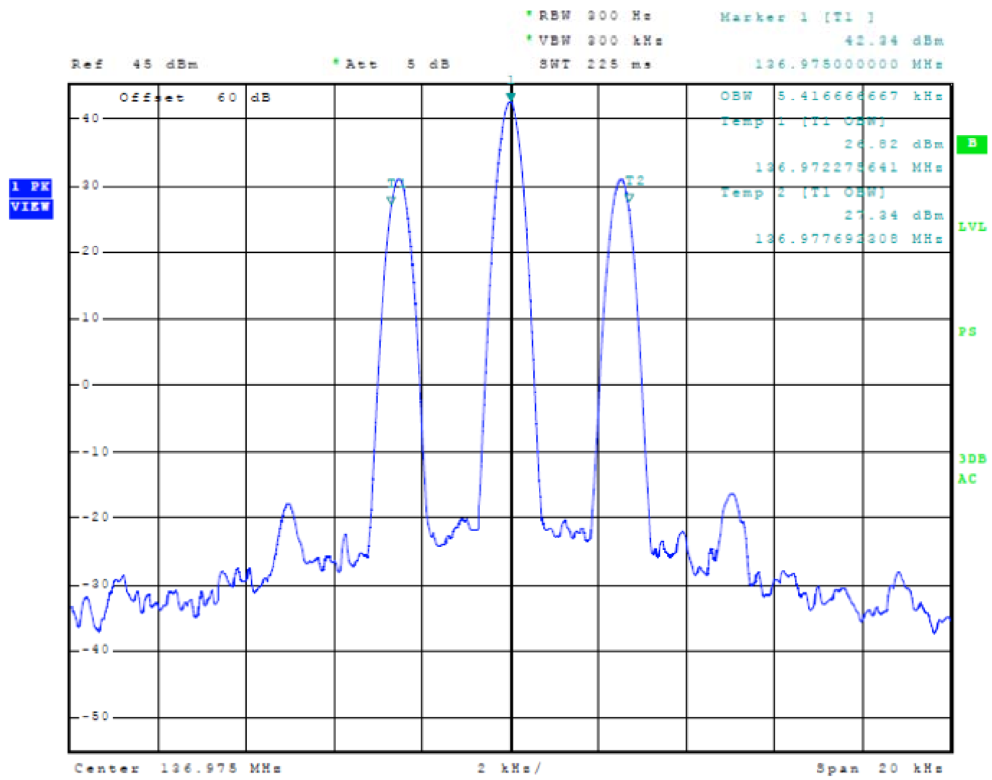


Figure 8 Occupied Band Width Carrier frequency 136.975 MHz (AM Voice Modulation)

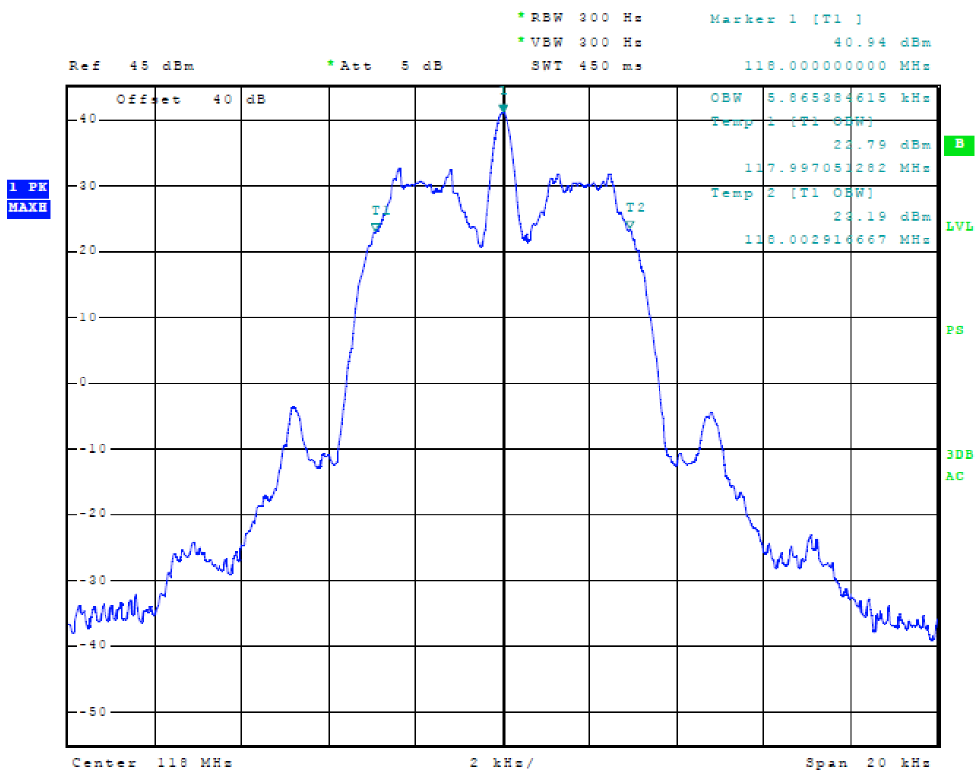


Figure 9 Occupied Band Width Carrier frequency 118.000 MHz (ACARS Modulation)

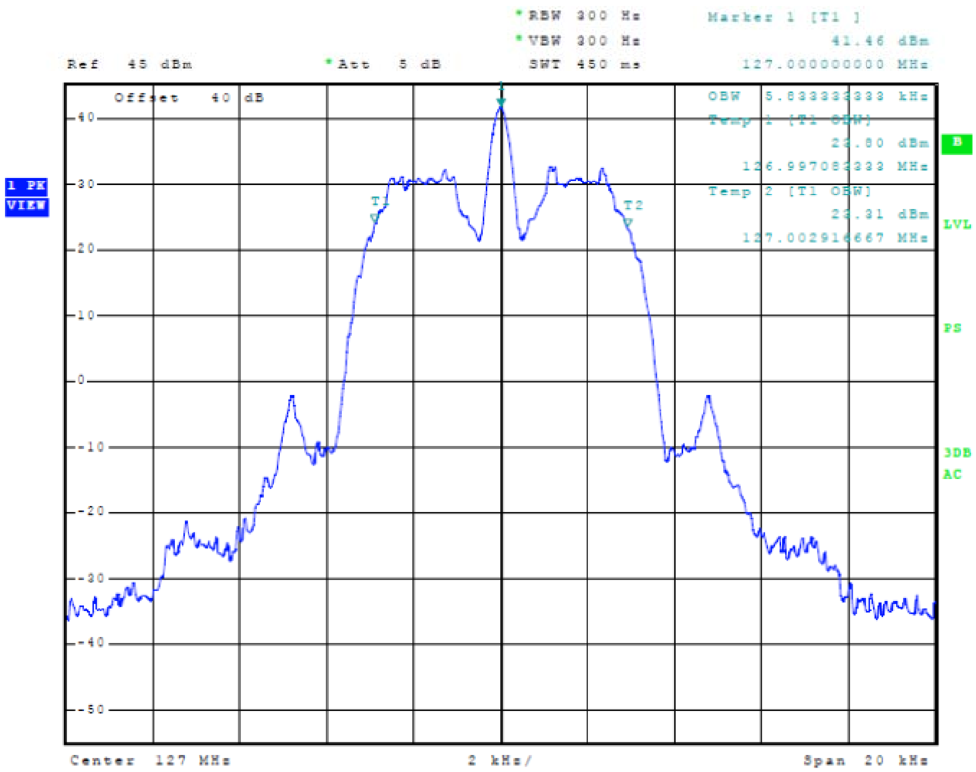


Figure 10 Occupied Band Width Carrier frequency 127.000 MHz (ACARS Modulation)

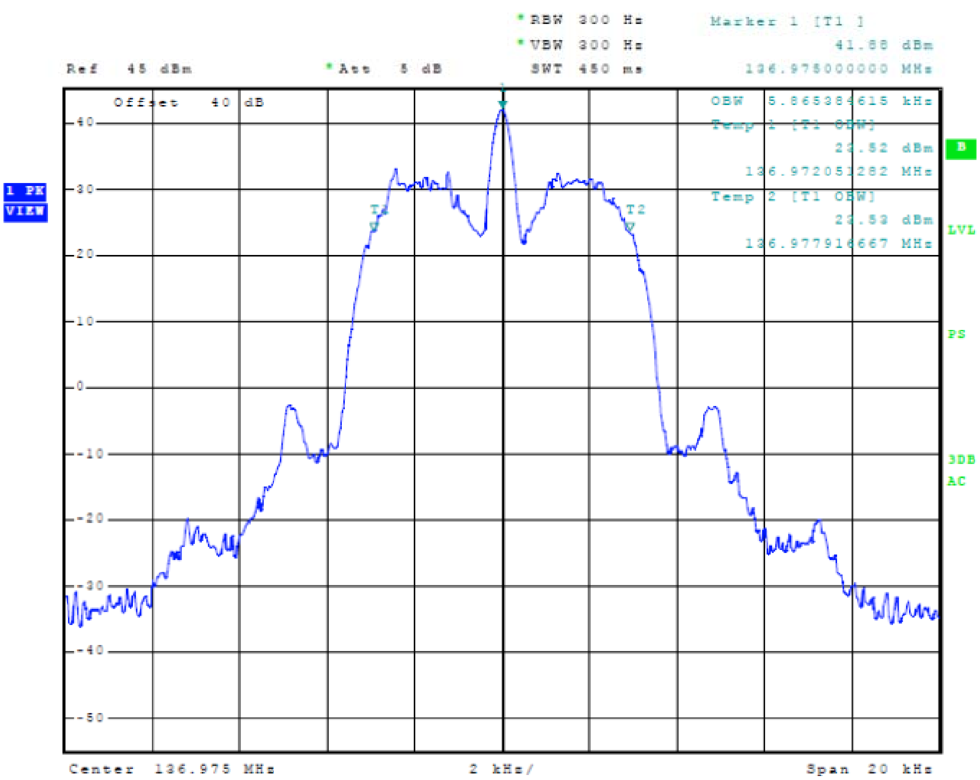


Figure 11 Occupied Band Width Carrier frequency 136.975 MHz (ACARS Modulation)

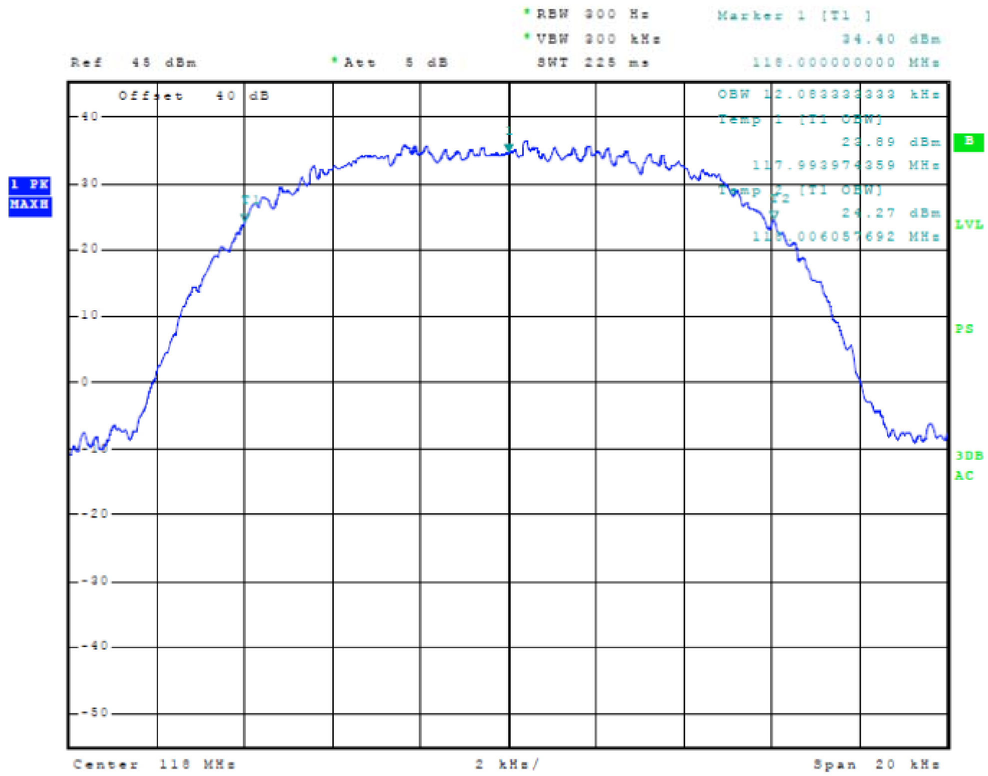


Figure 12 Occupied Band Width Carrier frequency 118.000 MHz (VDL Mode 2)

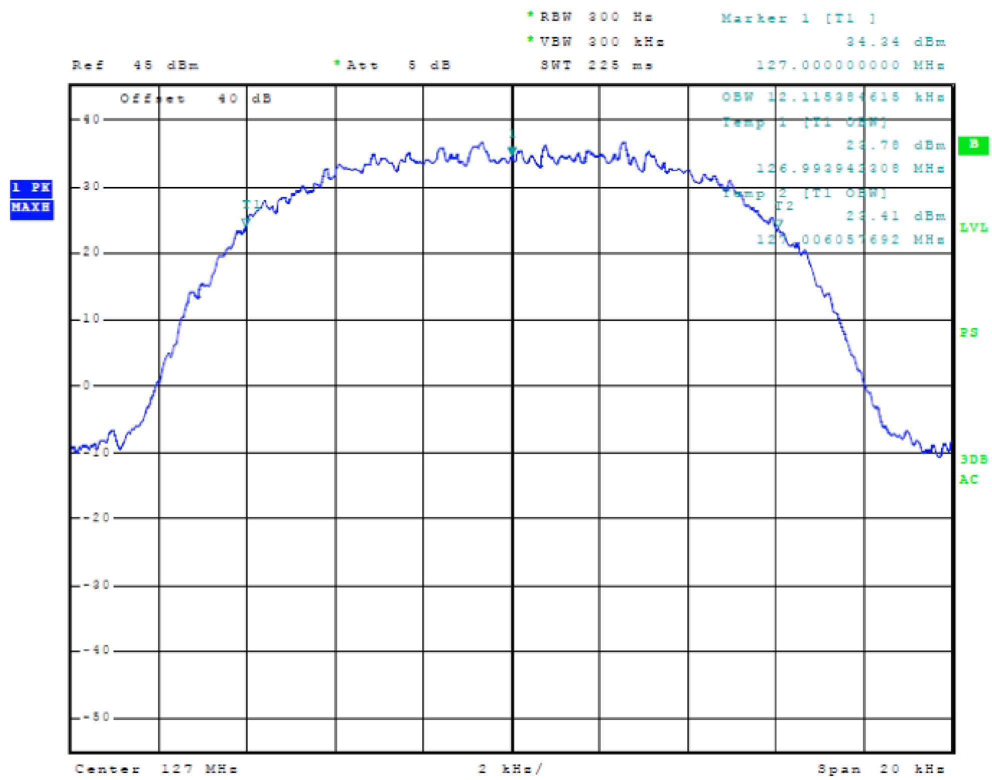


Figure 13 Occupied Band Width Carrier frequency 127.000 MHz (VDL Mode 2)

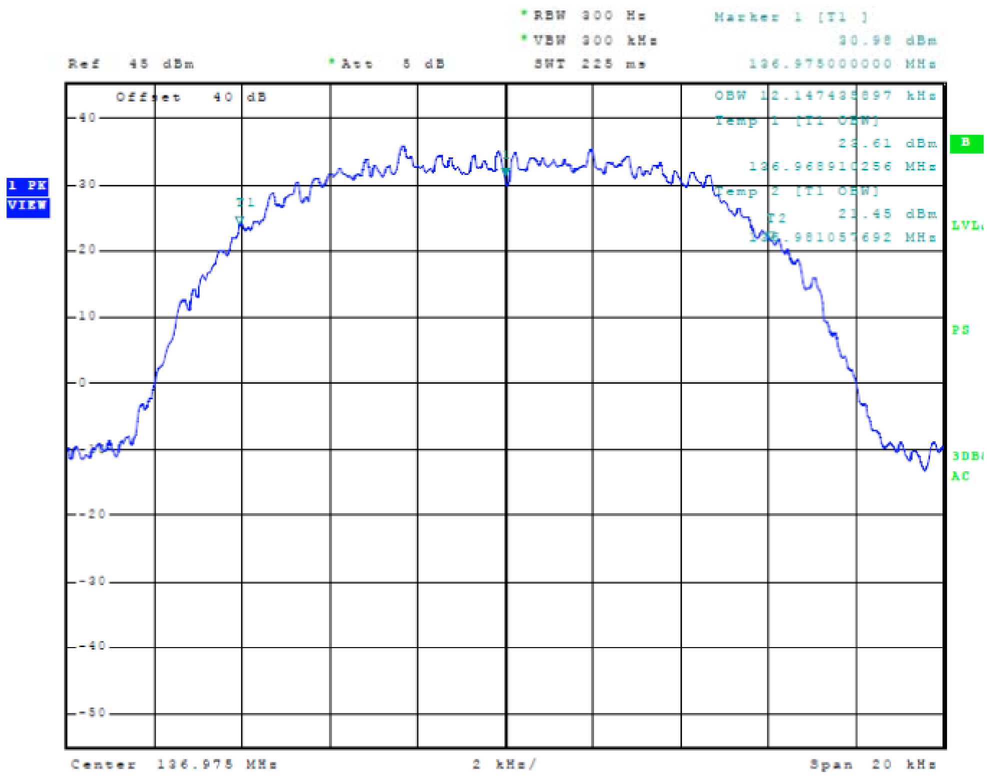


Figure 14 Occupied Band Width Carrier frequency 136.975 MHz (VDL Mode 2)

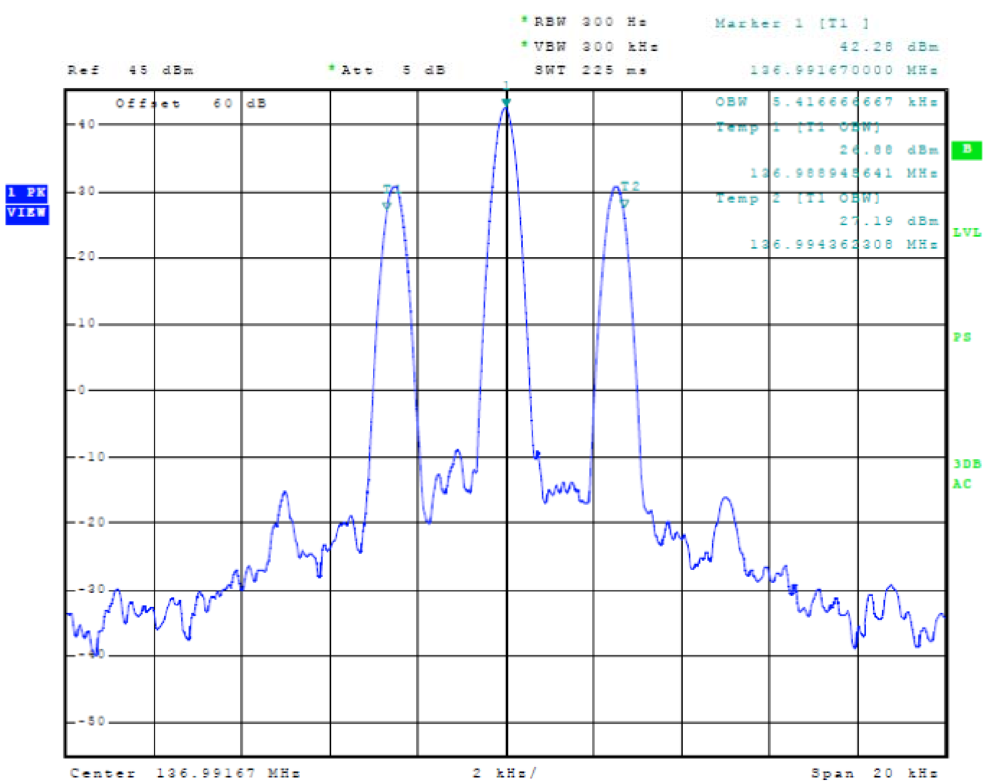


Figure 15 Occupied Band Width Carrier frequency 136.99167 MHz (AM Voice Modulation)

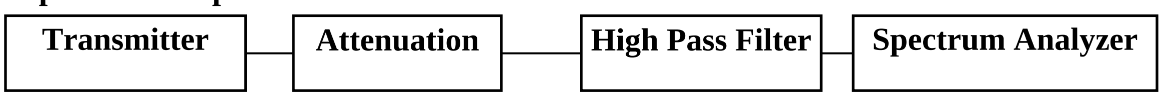
Spurious Emissions at Antenna Terminals

Measurements Required

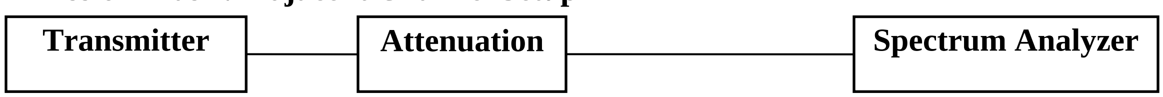
The radio frequency voltage or power generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Refer to figures 16 through 21 for plots of antenna port emissions, mask, and adjacent channel power.

Test Arrangement

Spurious Setup



Emission Mask / Adjacent Channel Setup



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 modulated per section 2.1049 and operated in all normal modes. The frequency spectrum from 30 MHz to 1,500 MHz was observed and plot produced of the frequency spectrum displayed on the test equipment. Figures 16 and 17 represent data for the antenna spurious emissions of the GMN-00832 operating in high and low power modes. Data was taken per CFR47 2.1051, 2.1057, and applicable paragraphs of Part 87.139, and RSS-141.

Spurious Emissions at Antenna Terminal Results

The output of the unit was coupled to a Rohde & Schwarz ESU40 Spectrum Analyzer and the frequency emissions were measured. Data was taken as per CFR47 2.1051 and applicable paragraphs of Part 87 and RSS-141. The EUT demonstrated compliance with specifications of CFR47 Paragraph 2.1046(a) and applicable Parts of 2 and 87.139, and RSS-141 paragraph 5. There are no deviations to the specifications.

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

10 Watts	= 43 + 10 Log(Po)	20 Watts	= 43 + 10 Log(Po)
	= 43 + 10 Log(10)		= 43 + 10 Log(20)
	= 53.0		= 56.0

Antenna Port Conducted Spurious Emissions Data (10-Watt operation)

Channel MHz	Spurious Freq. (MHz)	Measured Level (dBm)	Level Below Carrier (dBc)
118.000	236.0	-86.76	-126.3
	354.0	-66.57	-106.1
	472.0	-87.58	-127.1
	590.0	-86.68	-126.2
127.000	254.0	-85.81	-125.5
	381.0	-67.65	-107.3
	508.0	-87.78	-127.4
	635.0	-87.39	-127.1
136.975	274.0	-85.18	-125.2
	410.9	-67.32	-107.4
	547.9	-87.26	-127.3
	684.9	-87.92	-128.0
136.99167	274.0	-84.73	-124.8
	411.0	-67.15	-107.2
	548.0	-86.56	-126.7
	685.0	-87.30	-127.4

Antenna Port Conducted Spurious Emissions Data (20-Watt operation)

Channel MHz	Spurious Freq. (MHz)	Measured Level (dBm)	Level Below Carrier (dBc)
118.000	236.0	-87.31	-130.0
	354.0	-73.75	-116.4
	472.0	-87.26	-129.9
	590.0	-86.96	-129.6
127.000	254.0	-87.39	-130.1
	381.0	-72.53	-115.2
	508.0	-88.35	-131.1
	635.0	-86.54	-129.2
136.975	274.0	-87.74	-130.7
	410.9	-68.61	-111.6
	547.9	-85.25	-128.2
	684.9	-87.34	-130.3
136.99167	274.0	-85.83	-129.0
	411.0	-68.13	-111.3
	548.0	-88.25	-131.4
	685.0	-88.39	-131.6

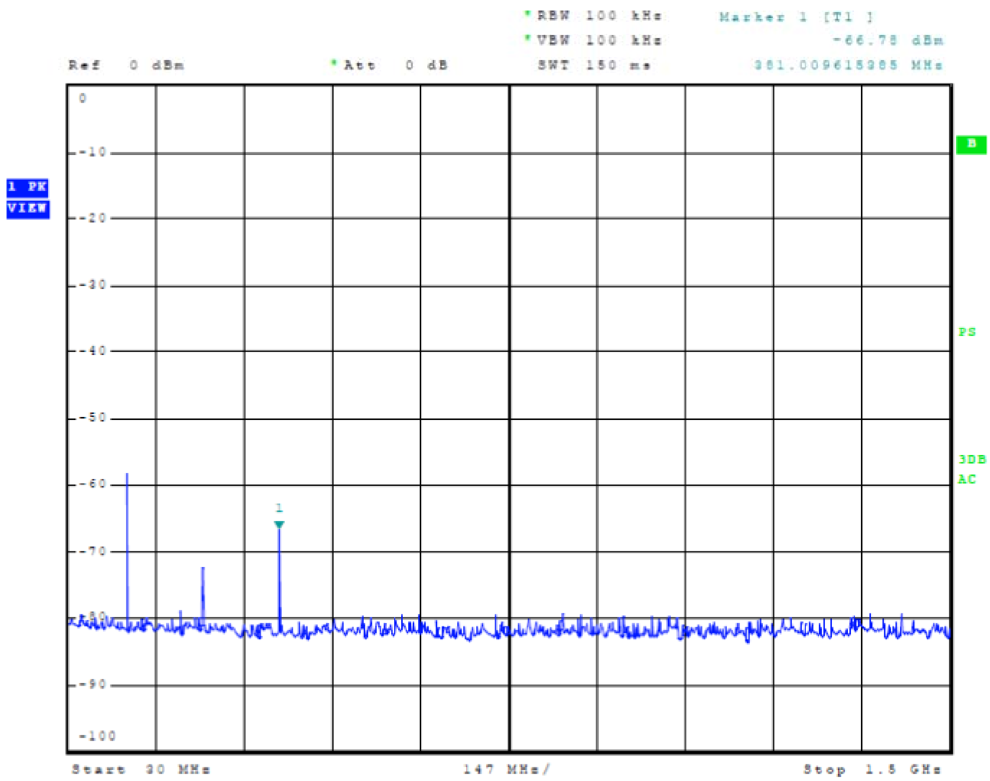


Figure 16 Spurious Emissions at Antenna Terminal (10-Watt mode)

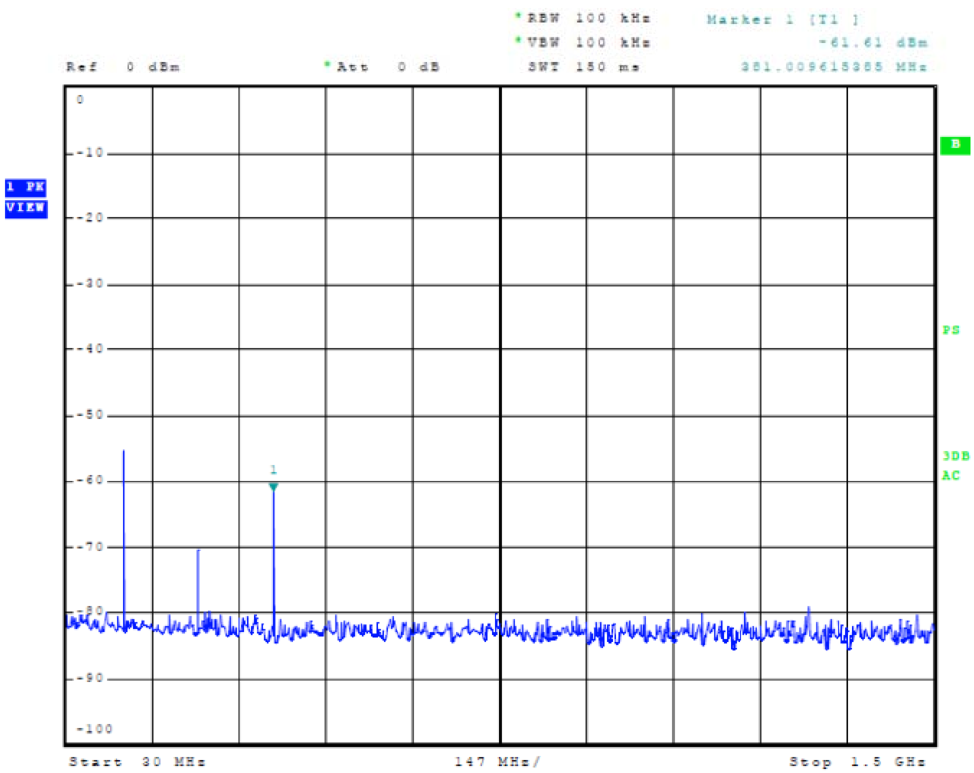


Figure 17 Spurious Emissions at Antenna Terminal (20-Watt mode)

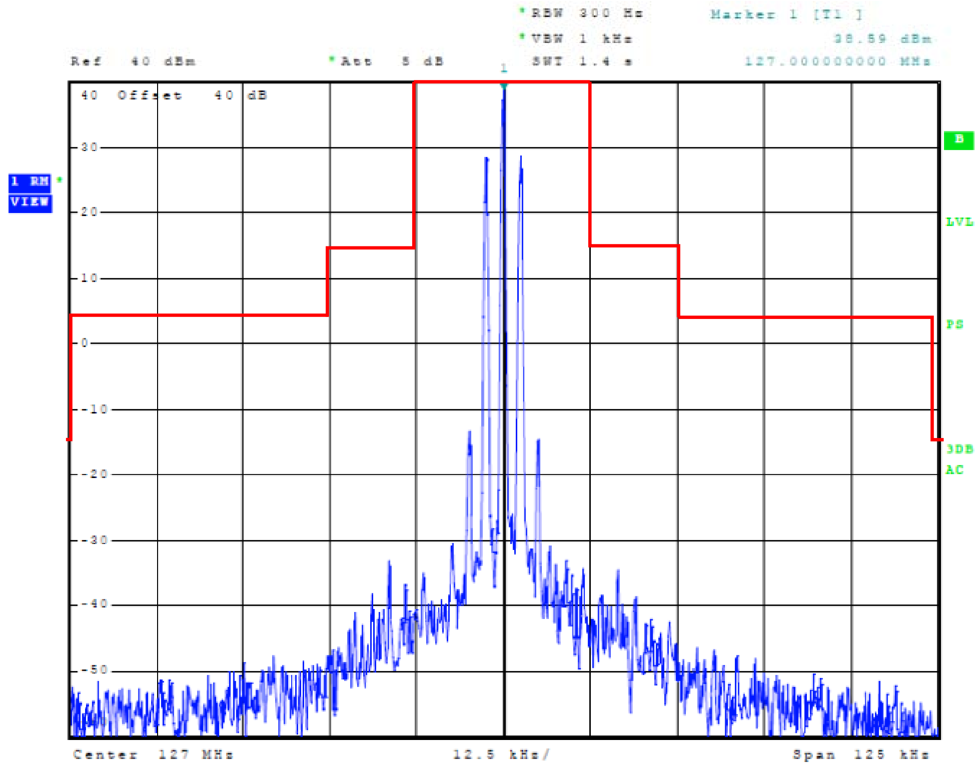


Figure 18 Emission Mask 10 Watt (A3E Emissions Designator)

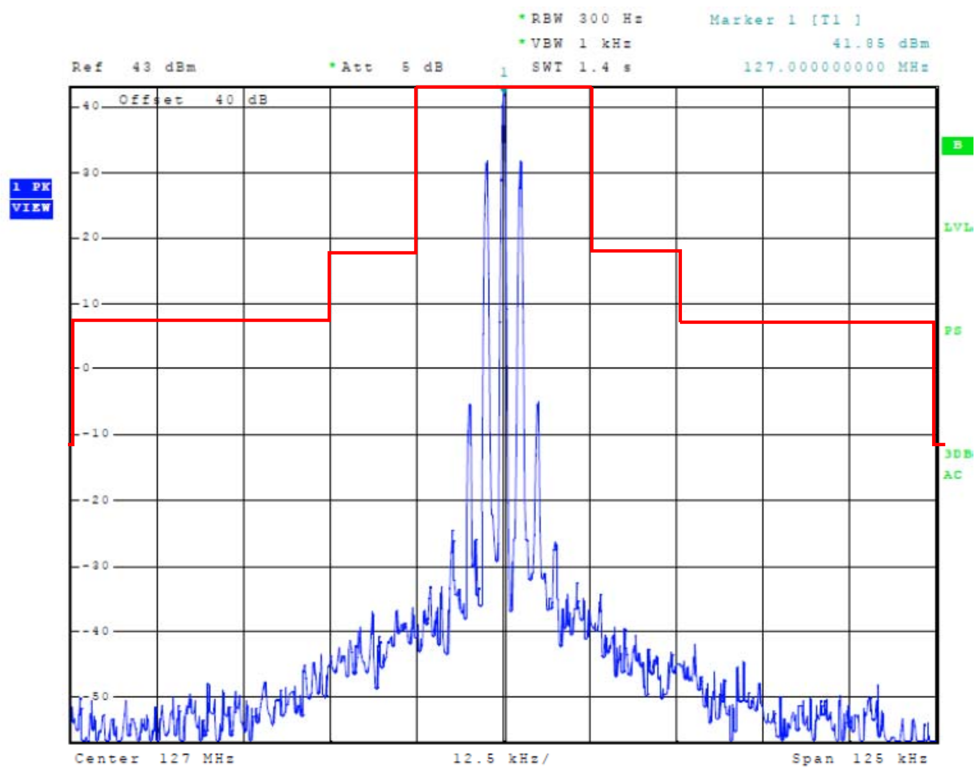
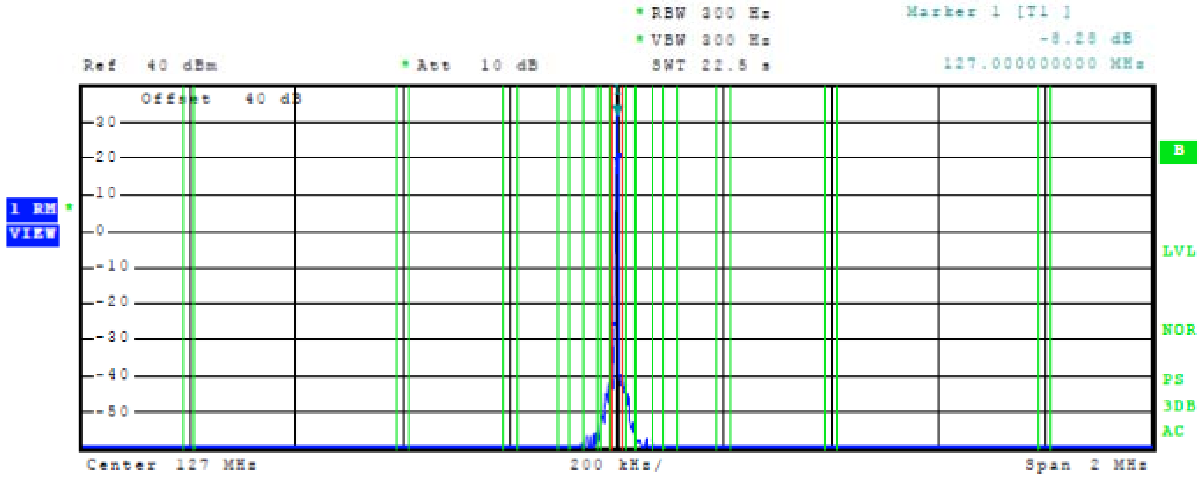
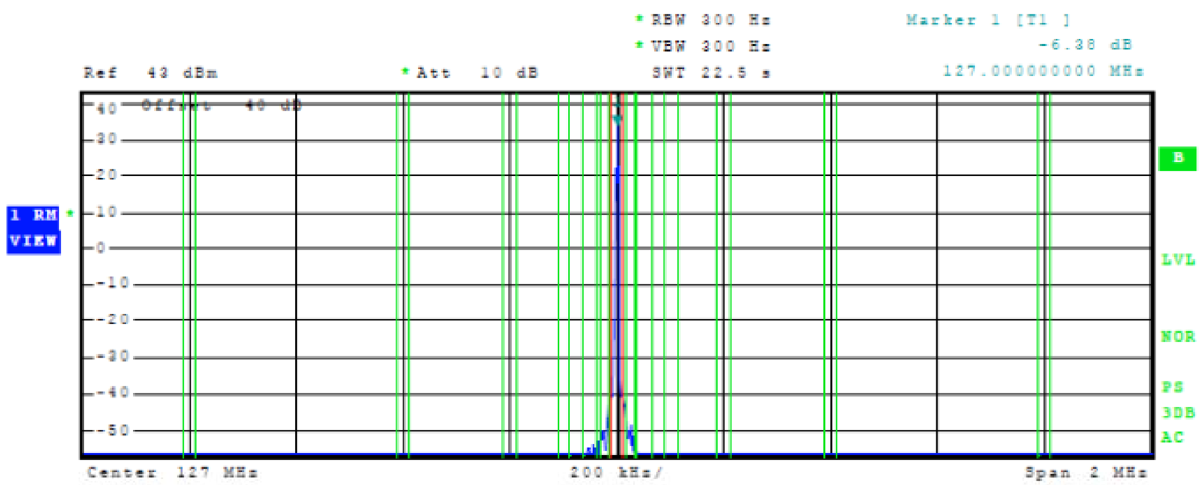


Figure 19 Emission Mask 20 Watt (A3E Emissions Designator)



Channel	Bandwidth	Spacing	Lower	Upper
Tx Channel	25.000 kHz		39.50 dBm	
Adjacent	16.000 kHz	25.000 kHz	-31.76 dB	-32.37 dB
Alternate	25.000 kHz	25.000 kHz	-28.94 dB	-28.52 dB
2nd Alt	25.000 kHz	50.000 kHz	-39.70 dB	-40.27 dB
3rd Alt	25.000 kHz	75.000 kHz	-42.63 dB	-41.63 dB
4th Alt	25.000 kHz	100.000 kHz	-43.70 dB	-43.94 dB
5th Alt	25.000 kHz	200.000 kHz	-46.61 dB	-47.44 dB
6th Alt	25.000 kHz	400.000 kHz	-52.61 dB	-52.22 dB
7th Alt	25.000 kHz	800.000 kHz	-59.97 dB	-59.70 dB

Figure 20 Adjacent Channel Power 10 Watt



Channel	Bandwidth	Spacing	Lower	Upper
Tx Channel	25.000 kHz		41.39 dBm	
Adjacent	16.000 kHz	25.000 kHz	-34.39 dB	-33.64 dB
Alternate	25.000 kHz	25.000 kHz	-30.11 dB	-29.36 dB
2nd Alt	25.000 kHz	50.000 kHz	-38.68 dB	-39.09 dB
3rd Alt	25.000 kHz	75.000 kHz	-42.96 dB	-41.88 dB
4th Alt	25.000 kHz	100.000 kHz	-44.21 dB	-43.54 dB
5th Alt	25.000 kHz	200.000 kHz	-46.32 dB	-47.01 dB
6th Alt	25.000 kHz	400.000 kHz	-51.42 dB	-52.11 dB
7th Alt	25.000 kHz	800.000 kHz	-57.64 dB	-59.41 dB

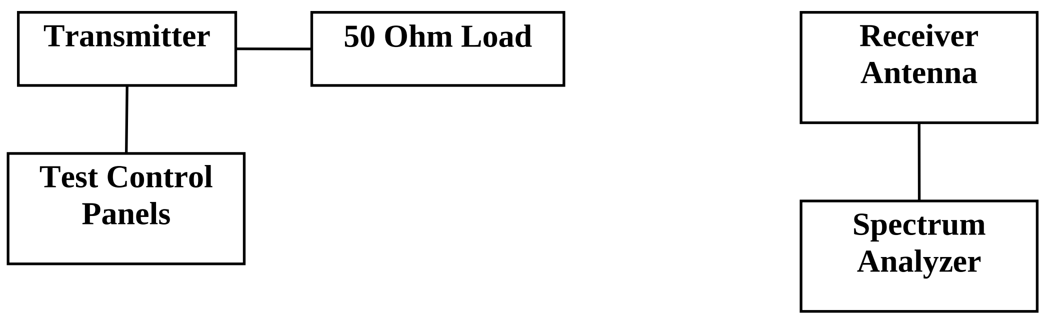
Figure 21 Adjacent Channel Power 20 Watt

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. This equipment is typically remote mounted with interface cabling connecting the display control unit to the cabinet. The test sample offered for testing required interfacing with additional test control panel and support equipment offering operation and communications with all functions of transmitter.

Test Arrangement



The test setup was assembled in a screen room for preliminary screening. The transmitter was placed on a wooden turntable 0.8 meters above the ground plane and at a distance of 1 meter from the receive antenna, plots were taken of the radiated emissions.

Final radiated emissions testing was performed with the transmitter placed on a wooden turntable 0.8 meters above the ground plane and at a distance of 3 meters from the Field Strength Measuring (FSM) antenna. The EUT was operational and radiating into a 50Ω load. 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 1,500 MHz was investigated during radiated emissions testing. A Biconilog antenna was used for frequency measurements of 30 to 1000 MHz. A double-ridge horn antenna was used for frequencies of 1000 MHz to 12,000 MHz. Emission levels were measured and recorded from the spectrum analyzer in dBμV. 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. Data was taken at the Rogers Labs, Inc. 3 meters open area test site (OATS). A description of the test facility is on file with the FCC and Industry Canada (refer to annex for site registration letters). The testing procedures used conform to the procedures stated in the TIA/EIA-603-C (2004) document.

Spurious Radiated Emission Results

The EUT was connected to the 50-ohm load and operated in all available normal modes while radiated emissions testing were performed. The amplitude of each spurious emission was maximized and amplitude levels recorded while operating at the open area test site at a distance of 3-meters.

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

10 Watts	= 43 + 10 Log (Po)	20 Watts	= 43 + 10 Log (Po)
	= 43 + 10 Log (10)		= 43 + 10 Log (20)
	= 53.0		= 56.0

Spurious Emission Limit as presented below was calculated by subtracting the spurious limit form the total Transmit power.

10 Watts	Limit	= 40 – 53	20 Watts	Limit	= 43 – 56
		= -13 dBm			= -13 dBm

Radiated Emissions Channel Frequency 118.000

Frequency	Amplitude of Emission (dBµV)		Signal Level to dipole required to Reproduce(dBm)		Emission level below carrier (dBc)		Limit (dBm)
MHz	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical	
236.00	40.1	39.0	-73.13	-74.23	-115.7	-116.8	-13.0
354.00	39.5	38.4	-70.33	-71.43	-112.9	-114.0	-13.0
472.00	31.3	31.2	-76.13	-76.23	-118.7	-118.8	-13.0
590.00	36.7	36.5	-68.83	-69.03	-111.4	-111.6	-13.0
708.00	29.9	30.5	-74.43	-73.83	-117.0	-116.4	-13.0

Radiated Emissions Channel Frequency 127.000

Frequency	Amplitude of Emission (dBµV)		Signal Level to dipole required to Reproduce(dBm)		Emission level below carrier (dBc)		Limit (dBm)
MHz	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical	
254.00	44.1	43.1	-68.83	-69.83	-111.4	-112.4	-13.0
381.00	35.6	33.7	-73.83	-75.73	-116.4	-118.3	-13.0
508.00	32.8	32.0	-74.23	-75.03	-116.8	-117.6	-13.0
635.00	31.7	34.4	-73.43	-70.73	-116.0	-113.3	-13.0
762.00	30.3	29.6	-73.43	-74.13	-116.0	-116.7	-13.0

Radiated Emissions Channel Frequency 136.975

Frequency	Amplitude of Emission (dBµV)		Signal Level to dipole required to Reproduce(dBm)		Emission level below carrier (dBc)		Limit (dBm)
MHz	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical	
273.95	37.0	35.8	-74.43	-75.63	-117.0	-118.2	-13.0
410.93	35.2	35.0	-73.63	-73.83	-116.2	-116.4	-13.0
547.90	33.7	29.1	-72.83	-77.43	-115.4	-120.0	-13.0
684.88	31.7	31.0	-72.83	-73.53	-115.4	-116.1	-13.0
821.85	27.9	28.2	-75.03	-74.73	-117.6	-117.3	-13.0

General Radiated Emissions comparison against unintentional radiator general limits

Frequency in MHz	Horizontal Peak (dBµV/m)	Horizontal Quasi-Peak (dBµV/m)	Horizontal Average (dBµV/m)	Vertical Peak (dBµV/m)	Vertical Quasi-Peak (dBµV/m)	Vertical Average (dBµV/m)	Limit @ 3m (dBµV/m)
124.3	35.5	31.1	N/A	31.1	37.8	N/A	43.5
133.2	39.1	35.0	N/A	35.0	43.4	N/A	43.5
141.6	39.1	35.3	N/A	35.3	43.3	N/A	43.5
200.0	32.4	28.0	N/A	28.0	33.8	N/A	43.5
216.0	35.5	30.6	N/A	30.6	33.3	N/A	46.0
300.0	38.6	35.7	N/A	35.7	32.5	N/A	46.0
1270.0	36.2	N/A	30.4	29.2	N/A	17.4	54.0
1400.0	34.6	N/A	28.5	35.0	N/A	33.0	54.0
1600.0	34.3	N/A	31.8	38.4	N/A	34.9	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.

The EUT demonstrated compliance with specifications of CFR47 Paragraph 2.1046(a) and applicable Parts of 2 and 87.139, and RSS-141 paragraph 5. There are no deviations to the specifications. There are no deviations or exceptions to the specifications.

Frequency Stability

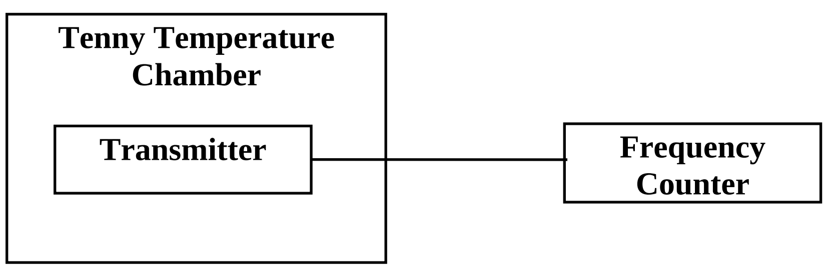
Measurements Required

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. A Sorensen DC Power Supply was used to vary the DC voltage for the power input from 11.90 Vdc to 32.20 Vdc. 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 and RSS-141.

Frequency Stability Results

Frequency 127.000 MHz)	Frequency Stability Vs Temperature								
Temperature °C	-30	-20	-10	0	+10	+20	+30	+40	+50
Change (Hz)	-45.0	-69.0	-76.0	-54.0	-50.0	-43.0	-40.0	-48.0	-63.0
PPM	-0.4	-0.5	-0.6	-0.4	-0.4	-0.3	-0.3	-0.4	-0.5
%	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Limit (PPM)	20	20	20	20	20	20	20	20	20

Frequency (127.000 MHz)	Frequency Stability Vs Voltage Variation 28.0 volts nominal; Results In Hz change		
Voltage V_{dc}	11.90	28.00	32.20
Change (Hz)	0.0	0.0	0.0

The EUT demonstrated compliance with specifications of CFR47 Paragraph 2.1046(a) and applicable Parts of 87.133(d) and RSS-141 paragraph 5.1. There are no deviations or exceptions to the specifications.

Receiver Spurious Emissions

Receiver Radiated EMI Procedure

Test procedures of ANSI 63.4-2009 paragraphs 8.3 were used during radiated emissions testing. For testing purposes, the EUT was arranged as shown in the testing configuration shown above and operated in all standard modes of operation. Preliminary testing was performed in a screen room with the EUT positioned 1 meter from the FSM. Radiated emissions measurements were performed to identify the frequencies, which produced the highest emissions. The EUT and cable locations were noted and reconfigured at the open area test site. Each radiated emission was then maximized at the OATS location before final radiated emissions measurements were performed. Final data was taken with the EUT located at the OATS at a distance of 3-meters between the EUT and the receiving antenna. The frequency spectrum from 30 MHz to 6,000 MHz was searched for radiated emissions. Measured emission levels were maximized by EUT placement on the table, changing cable location, rotating the turntable through 360 degrees, varying the antenna height between 1 and 4 meters above the ground plane and changing antenna position between horizontal and vertical polarization. Antennas used were Biconilog from 30 to 1000 MHz and Pyramidal Horns and mixers above 1 GHz.

Receiver Antenna Power Conduction

Receivers which provide terminals for the connection of an external receiving antenna may be tested to demonstrate compliance with the provisions of CFR 47 15.109 with the antenna terminals shielded and terminated. Termination of antenna port shall be equal to the impedance specified for the antenna, provided these receivers also comply with the following: With the receiver antenna terminal connected to a resistive termination equal to the impedance specified or employed for the antenna, the power at the antenna terminal at any frequency within the range of measurements specified in 15.33 shall not exceed 2.0 nanowatts (-57 dBm). The antenna port was connected to a spectrum analyzer through a short coaxial cable for testing the antenna-conducted emissions. The spectrum analyzer provided the 50-ohm load for the antenna port. Refer to figure 22 showing the plot of the antenna port conducted emissions. The frequency spectrum was investigated at the antenna port with the worst case data presented. Compliance to antenna port conducted emission requirements are demonstrated in radiated emissions test data as tested at 3 meter OATS with data presented elsewhere in this report.

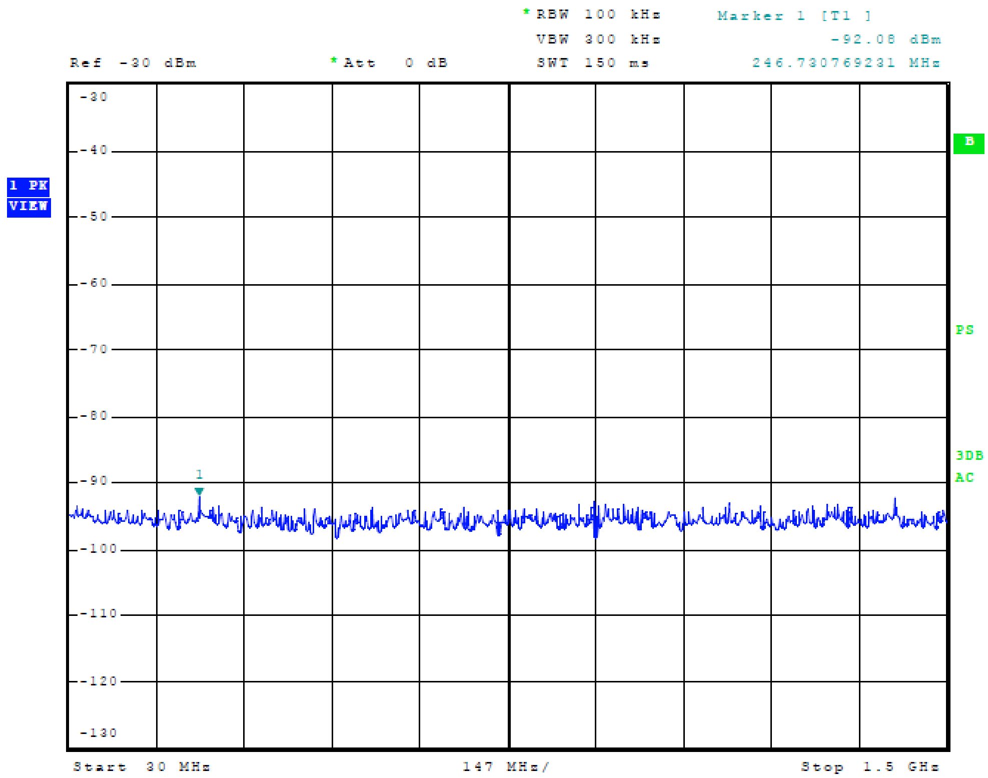


Figure 22 Antenna Port Conducted Emissions Plot

Receiver Radiated Emissions (worst-case emissions)

Frequency In MHz	FSM Hor. QP (dBµV)	FSM Vert. QP (dBµV)	Ant. Fact. (dB/m)	Amp. Gain (dB)	Comp. Hor. (dBµV/m) @ 3m	Comp. Vert. (dBµV/m) @ 3 m	Limit (dBµV/m) @ 3m
124.3	43.3	51.0	13.8	30	27.1	34.8	43.5
133.2	50.8	52.2	13.5	30	34.3	35.7	43.5
141.6	47.2	50.5	13.3	30	30.5	33.8	43.5
147.0	51.2	52.5	13.3	30	34.5	35.8	43.5
200.0	50.8	46.6	13.0	30	33.8	29.6	43.5
216.0	47.3	48.0	11.3	30	28.6	29.3	46.0
300.0	50.6	46.5	14.1	30	34.7	30.6	46.0
1270.0	21.3	21.4	25.9	30	17.2	17.3	54.0
1400.0	32.6	39.8	26.1	30	28.7	35.9	54.0
1600.0	32.3	41.7	25.4	30	27.7	37.1	54.0

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

Receiver Antenna Conducted Emissions Data

Frequency (MHz)	Emission Level (dBm)	Limit (dBm)	Margin (dB)
147.0	-96.83	-57.0	-39.8

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

Receiver Spurious Emission Summary Of Results

Receiver Radiated Emissions Results

The radiated emissions for the EUT demonstrated compliance with the requirements of RSS-GEN, RSS-141, CISPR 22, and CFR 47 Receiver Equipment. The GMN-00832 and test system demonstrated a minimum margin of -7.7 dB below the CFR 47 and RSS-GEN requirements. Other emissions were present with amplitudes at least 20 dB below the limit.

Receiver Antenna Port Conducted Emissions Results

The antenna port conducted emissions of the EUT demonstrated compliance with the requirements of RSS-141, RSS-GEN, and CFR 47 Part 15B. The GMN-00832 and test system demonstrated a minimum margin of -39.8 dB below the requirements. Other emissions were present with amplitudes at least 20 dB below the limit.

Annex

- Annex A Measurement Uncertainty Calculations
- Annex B Rogers Labs Test Equipment List
- Annex C Rogers Qualifications
- Annex D FCC Test Site Registration Letter
- Annex E Industry Canada Test Site Registration Letter

Annex A Measurement Uncertainty Calculations

Radiated Emissions Measurement Uncertainty Calculation

Measurement of vertically polarized radiated field strength over the frequency range 30 MHz to 1 GHz on an open area test site at 3m and 10m includes following uncertainty:

Contribution	Probability Distribution	Uncertainty (dB)
Antenna factor calibration	normal (k = 2)	±0.58
Cable loss calibration	normal (k = 2)	±0.2
Receiver specification	rectangular	±1.0
Antenna directivity	rectangular	±0.1
Antenna factor variation with height	rectangular	±2.0
Antenna factor frequency interpolation	rectangular	±0.1
Measurement distance variation	rectangular	±0.2
Site Imperfections	rectangular	±1.5

Combined standard uncertainty $u_c(y)$ is

$$U_c(y) = \pm \sqrt{\left[\frac{1.0}{2}\right]^2 + \left[\frac{0.2}{2}\right]^2 + \left[\frac{1.0^2 + 0.1^2 + 2.0^2 + 0.1^2 + 0.2^2 + 1.5^2}{3}\right]}$$

$U_c(y) = \pm 1.6$ dB

It is probable that $u_c(y) / s(q_k) > 3$, where $s(q_k)$ is estimated standard deviation from a sample of n readings unless the repeatability of the EUT is particularly poor, and a coverage factor of k = 2 will ensure that the level of confidence will be approximately 95%, therefore:

$$s(q_k) = \sqrt{\frac{1}{(n-1)} \sum_{k-1}^{n} (q_k - \bar{q})^2}$$

$U = 2\, U_c(y) = 2 \times \pm 1.6 \text{ dB} = \pm 3.2 \text{ dB}$

Notes:

1.1 Uncertainties for the antenna and cable were estimated, based on a normal probability distribution with k = 2.

1.2 The receiver uncertainty was obtained from the manufacturer's specification for which a rectangular distribution was assumed.

1.3 The antenna factor uncertainty does not take account of antenna directivity.

1.4 The antenna factor varies with height and since the height was not always the same in use as when the antenna was calibrated an additional uncertainty is added.

1.5 The uncertainty in the measurement distance is relatively small but has some effect on the received signal strength. The increase in measurement distance as the antenna height is increased is an inevitable consequence of the test method and is therefore not considered a contribution to uncertainty.

1.6 Site imperfections are difficult to quantify but may include the following contributions:
-Unwanted reflections from adjacent objects.
-Ground plane imperfections: reflection coefficient, flatness, and edge effects.
-Losses or reflections from "transparent" cabins for the EUT or site coverings.
-Earth currents in antenna cable (mainly effect Biconical antennas).

The specified limits for the difference between measured site attenuation and the theoretical value (± 4 dB) were not included in total since the measurement of site attenuation includes uncertainty contributions already allowed for in this budget, such as antenna factor.

Conducted Measurements Uncertainty Calculation

Measurement of conducted emissions over the frequency range 9 kHz to 30 MHz includes following uncertainty:

Contribution	Probability Distribution	Uncertainty (dB)
Receiver specification	rectangular	±1.5
LISN coupling specification	rectangular	±1.5
Cable and input attenuator calibration	normal (k=2)	±0.5

Combined standard uncertainty $u_c(y)$ is

$$U_c(y) = \pm \sqrt{\left[\frac{0.5}{2}\right]^2 + \frac{1.5^2 + 1.5^2}{3}}$$

$U_c(y) = \pm$ 1.2 dB

As with radiated field strength uncertainty, it is probable that $u_c(y) / s(q_k) > 3$ and a coverage factor of k = 2 will suffice, therefore:

$U = 2\,U_c(y) = 2 \times \pm 1.2$ dB = ± 2.4 dB

Annex B Rogers Labs Test Equipment List

The test equipment is maintained in calibration and good operating condition. Use of this calibrated equipment ensures measurements are traceable to national standards.

List of Test Equipment	Calibration Date
Spectrum Analyzer: Rohde & Schwarz ESU40	5/11
Spectrum Analyzer: HP 8562A, HP Adapters: 11518, 11519, and 11520 Mixers: 11517A, 11970A, 11970K, 11970U, 11970V, 11970W	5/11
Spectrum Analyzer: HP 8591EM	5/11
Antenna: EMCO Biconilog Model: 3143	5/11
Antenna: Sunol Biconilog Model: JB6	10/11
Antenna: EMCO Log Periodic Model: 3147	10/11
Antenna: Antenna Research Biconical Model: BCD 235	10/11
LISN: Compliance Design Model: FCC-LISN-2.Mod.cd, 50 µHy/50 ohm/0.1 µf	10/11
R.F. Preamp CPPA-102	10/11
Attenuator: HP Model: HP11509A	10/11
Attenuator: Mini Circuits Model: CAT-3	10/11
Attenuator: Mini Circuits Model: CAT-3	10/11
Cable: Belden RG-58 (L1)	10/11
Cable: Belden RG-58 (L2)	10/11
Cable: Belden 8268 (L3)	10/11
Cable: Time Microwave: 4M-750HF290-750	10/11
Cable: Time Microwave: 10M-750HF290-750	10/11
Frequency Counter: Leader LDC825	2/11
Oscilloscope Scope: Tektronix 2230	2/11
Wattmeter: Bird 43 with Load Bird 8085	2/11
Power Supplies: Sorensen SRL 20-25, SRL 40-25, DCR 150, DCR 140	2/11
R.F. Generators: HP 606A, HP 8614A, HP 8640B	2/11
R.F. Power Amp 65W Model: 470-A-1010	2/11
R.F. Power Amp 50W M185- 10-501	2/11
R.F. Power Amp A.R. Model: 10W 1010M7	2/11
R.F. Power Amp EIN Model: A301	2/11
LISN: Compliance Eng. Model 240/20	2/11
LISN: Fischer Custom Communications Model: FCC-LISN-50-16-2-08	2/11
Antenna: EMCO Dipole Set 3121C	2/11
Antenna: C.D. B-101	2/11
Antenna: Solar 9229-1 & 9230-1	2/11
Antenna: EMCO 6509	2/11
Audio Oscillator: H.P. 201CD	2/11
Peavey Power Amp Model: IPS 801	2/11
ELGAR Model: 1751	2/11
ELGAR Model: TG 704A-3D	2/11
ESD Test Set 2010i	2/11
Fast Transient Burst Generator Model: EFT/B-101	2/11
Field Intensity Meter: EFM-018	2/11
KEYTEK Ecat Surge Generator	2/11

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.

Annex D FCC Test Site Registration Letter

FEDERAL COMMUNICATIONS COMMISSION
Laboratory Division
7435 Oakland Mills Road
Columbia, MD 21046

November 01, 2011

Registration Number: 90910

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

Attention: Scot Rogers,

Re: Measurement facility located at Louisburg
3 & 10 meter site
Date of Renewal: November 01, 2011

Dear Sir or Madam:

Your request for renewal of the registration of the subject measurement facility has been received. The information submitted has been placed in your file and the registration has been renewed. The name of your organization will remain on the list of facilities whose measurement data will be accepted in conjunction with applications for Certification under Parts 15 or 18 of the Commission's Rules. Please note that the file must be updated for any changes made to the facility and the registration must be renewed at least every three years.

Measurement facilities that have indicated that they are available to the public to perform measurement services on a fee basis may be found on the FCC website www.fcc.gov under E-Filing, OET Equipment Authorization Electronic Filing, Test Firms.

Sincerely,

Phyllis Parrish
Industry Analyst

Annex E Industry Canada Test Site Registration Letter

Industry Canada Industrie Canada

December 28, 2011

OUR FILE: 46405-3041
Submission No: 152685

Rogers Labs Inc.
4405 West 259th Terrance
Louisburg, KS, 66053
USA

Attention: Mr. Scot D. Rogers

Dear Sir/Madame:

The Bureau has received your application for the renewal of 3/10m OATS. Be advised that the information received was satisfactory to Industry Canada. The following number(s) is now associated to the site(s) for which registration / renewal was sought **(Site# 3041A-1).** Please reference the appropriate site number in the body of test reports containing measurements performed on the site. In addition, please keep for your records the following information;

- The company address code associated to the site(s) located at the above address is: **3041A**

Furthermore, to obtain or renew a unique site number, the applicant shall demonstrate that the site has been accredited to ANSI C63.4-2003 or later. A scope of accreditation indicating the accreditation by a recognized accreditation body to ANSI C63.4-2003 or later shall be accepted. Please indicate in a letter the previous assigned site number if applicable and the type of site (example: 3 metre OATS or 3 metre chamber). If the test facility is not accredited to ANSI C63.4-2003 or later, the test facility shall submit test data demonstrating full compliance with the ANSI standard. The Bureau will evaluate the filing to determine if recognition shall be granted.

The frequency for re-validation of the test site and the information that is required to be filed or retained by the testing party shall comply with the requirements established by the accrediting organization. However, in all cases, test site re-validation shall occur on an interval not to **exceed three years**. There is no fee or form associated with an OATS filing. OATS submissions are encouraged to be submitted electronically to the Bureau using the following URL;
http://strategis.ic.gc.ca/epic/internet/inceb-bhst.nsf/en/h_tt00052e.html.

If you have any questions, you may contact the Bureau by e-mail at certification.bureau@ic.gc.ca Please reference our file and submission number above for all correspondence.

Yours sincerely,

Dalwinder Gill

Dalwinder Gill
For: Wireless Laboratory Manager
Certification and Engineering Bureau
3701 Carling Ave., Building 94
P.O. Box 11490, Station "H"
Ottawa, Ontario K2H 8S2
Email: dalwinder.gill@ic.gc.ca
Tel. No. (613) 998-8363
Fax. No. (613) 990-4752