NVLAP®
Testing
NVLAP Lab Code 200087-0

Application For Grant of Certification

In accordance with FCC CFR 47 Part 2,
FCC CFR 47 Part 25 and
Industry Canada RSS-170 Issue 3

For

Model: A03302

1616.0-1626.5 MHz
Mobile Earth Station

FCC ID: IPH-03302
IC: 1792A-03302

FOR

Garmin International, Inc.

1200 East 151st Street
Olathe, KS 66062

FCC Designation: US5305
IC Test Site Registration: 3041A-1
Test Report Number: 170927

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

Engineering Test Report For Application for Grant of Authorization

In accordance with FCC CFR 47 Part 2, FCC CFR 47 Part 25 and
Industry Canada RSS-170 Issue 3
Licensed Non-Broadcast Short Burst Data Transceiver module

For

Garmin International, Inc.

1200 East 151st Street
Olathe, KS 66062

Model: A03302
Mobile Earth Station
Frequency Range 1616.0-1626.5 MHz
FCC ID: IPH-03302
IC: 1792A-03302

Test Date: September 29, 2017

Certifying Engineer: Scot D Rogers

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

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Revisions

Revision 3 Issued March 18, 2018 – Added data for E.I.R.P. density pages 36-40, including plots and updating tables and figure references

Revision 2 Issued March 13, 2018 – corrected emission mask information pages 17-18

Revision 1 Issued February 22, 2018

Foreword

The following information is submitted for consideration in processing for and obtaining Grant of Authorization. This report is intended to present verification of compliance of FCC CFR 47 Part, FCC CFR 47 Part 25 and Industry Canada RSS-170 Issue 3. The A03302 was investigated as the manufacturer provided. The product is a self-contained transceiver module operating in the 1616-1626.5 MHz frequency band.

Name of Applicant: Garmin International, Inc.
1200 East 151st Street
Olathe, KS 66062

Model: A03302
FCC I.D.: IPH-03302 IC: 1792A-03302
Frequency Range: 1616.0-1626.5 MHz
Operating Power: 1.479 Watts, Occupied Bandwidth 26-dB OBW 40.4 kHz, 99% 33.1 kHz
1792A-03302 module information, 1.479W, 1616-1626 MHz, 33K1Q7D

Opinion / Interpretation of Results

Specification Clause			Test Description	Result
47cfr Pt 25	47CFR Pt 2	RSS-170		
25.202 (d)	2.1055	5.2	Frequency Tolerance	Pass
25.202 (f)	2.1053	5.4.3.1	Emissions Limitations	Pass
25.204	2.1046	5.3	Power Limitations	Pass
--	2.1047	--	Modulation Characteristics	Pass
25.216	--	5.4.3	Limits on Emissions from MES for Protection of Aeronautical Radionavigation-Satellite Service	Pass
--	2.1049	4.6.1	Occupied Bandwidth	Pass

Equipment Tested

Equipment	Model / PN	Serial Number	FCC Identifier	IC Identifier
EUT	A03302	3954873491	IPH-03302	1792A-03302
Test Fixture	Not Available	N/A	N/A	N/A

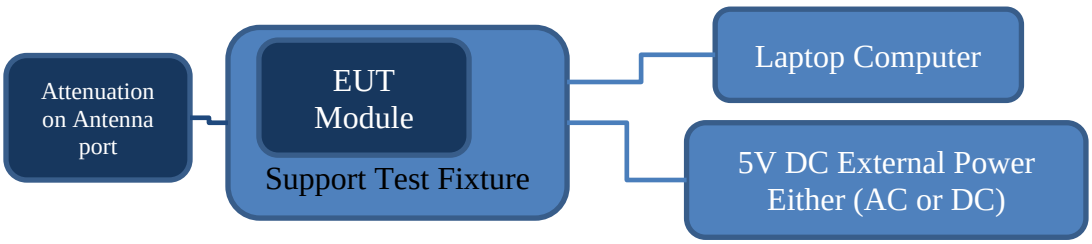
Test results in this report relate only to the items tested

Equipment Function and Configuration

The EUT is a Mobile Earth Satellite Station module providing short burst data transmission capability in the 1616.0-1626.5 MHz frequency band. The module design provides the ability to send data using the 1616-1626 MHz frequency data band. The product operates from direct current power received from the supporting installation. The design supports use as mobile configuration to comply with rf exposure requirements. The manufacturer has stated the module may be used with 3 dBi maximum gain antenna. For testing purposes, the module was placed on a test fixture which provided power to the module as well as communication interface. The test fixture was connected to a laptop computer through serial interface. The computer was used to send message and command information to the module. This test setup offered the module to be tested without an enclosure providing worst-case emissions performance. Additional testing was performed as required for compliance with other standards and specifications. The test sample configuration was provided with test software enabling testing personnel the ability to enable transmitter functions on defined channels and operational modes. The EUT module offers no other interface connections than those in the configuration options shown below. Test results in this report relate only to the products described in this report.

Equipment Configuration

1) Unit operating on test fixture



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 ID: IPH-03302 IC: 1792A-03302

(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. 40K4Q7D

(5) Frequency range. 1616.0-1626.5 MHz

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

1.4 W nominal at antenna port

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

Maximum allowable power output of 3θ dBW in any 4-kHz band for $0° < \theta \leq 5°$ as defined per 47CFR paragraph 25.202.

(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 5.0 volts @ 1.28 amps (6.4 watts)

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

Refer to Exhibit for 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 information 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.

(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 Drawings of 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.

Applicable Standards & Test Procedures

In accordance with the 47CFR, dated October 1, 2016, Part 2, Subpart J, Paragraphs 2.907, 2.911, 2.913, 2.925, 2.926, 2.1031 through 2.1057, and applicable parts of paragraphs 25.202, 25.204, 25.216, and Industry Canada standards RSS-GEN Issue 4, and RSS-170 Issue 3 the following information is submitted. Testing was performed as described in ANSI C63.26: 2015.

Test Site Locations

Conducted EMI	The AC power line conducted emissions testing performed in a shielded screen room located at Rogers Labs, Inc., 4405 West 259th Terrace, Louisburg, KS
Radiated EMI	The radiated emissions tests were performed at the 3 meters, Open Area Test Site (OATS) located at Rogers Labs, Inc., 4405 West 259th Terrace, Louisburg, KS
Site Registration	Refer to Annex for Site Registration Letters
NVLAP Accreditation	Lab code 200087-0

Units of Measurements

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

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

Sample Calculation:

RFS = Radiated Field Strength, FSM = Field Strength Measured

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

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

Environmental Conditions

Ambient Temperature	22.6° C
Relative Humidity	47%
Atmospheric Pressure	1021.9 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. Refer to the appendix for a complete list of test equipment.

AC Line Conducted Emissions (0.150 -30 MHz)		
RBW	AVG. BW	Detector Function
9 kHz	30 kHz	Peak / Quasi Peak
Emissions (30-1000 MHz)		
RBW	AVG. BW	Detector Function
120 kHz	300 kHz	Peak / Quasi Peak
Emissions (Above 1000 MHz)		
RBW	Video BW	Detector Function
100 kHz	100 kHz	Peak
1 MHz	1 MHz	Peak / Average

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	5/16	5/17

Statement of Modifications and Deviations

No modifications to the EUT were required for the unit to demonstrate compliance with the CFR47 Parts 2 and 25, RSS-GEN, and RSS-170 Issue 3 emission requirements. There were no deviations to the specifications.

Frequency Stability

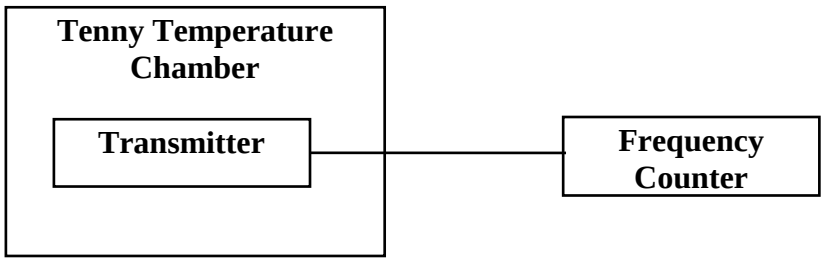
Measurements Required

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 were 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 25.202.

Table 1 Frequency Stability vs. Temperature Results

Chnl Frequency 1621.023 MHz	Frequency Stability Vs. Temperature Ambient Frequency (1621.023329 MHz)								
Temperature °C	-30	-20	-10	0	+10	+20	+30	+40	+50
Change (Hz)	-754	-412	-212	-104	-949	34	204	175	325
PPM	0.465	0.254	0.131	0.064	0.585	0.021	0.126	0.108	0.200
%	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Limit (PPM)	10	10	10	10	10	10	10	10	10

Table 2 Frequency Stability vs. Input Power Supply Voltage Results

Frequency (1621.023 MHz)	Frequency Stability Vs. Voltage Variation 5.0 volts nominal; Results in Hz change		
Voltage V_{dc}	4.25	5.00	5.75
Change (Hz)	21	0	9
PPM	0.007	0.000	0.006
Limit (PPM)	10	10	10

The EUT demonstrated compliance with specifications of CFR47 Paragraph 2.1046(a) and applicable Parts of 25.202. There are no deviations or exceptions to the specifications.

Emissions Limitations, Operation in the Band 1616.0-1626.5 MHz

The test was applied in accordance with the test method requirements of FCC CFR 47 Part 25.202(f), FCC CFR 47 Part 2.1051, 2.1053 and RSS-170 Issue 3.

For emissions removed less than 250% of the authorized bandwidth from the assigned frequency, measurements were performed conducted as follows:

The EUT antenna connection port was connected to a spectrum analyzer via a cable and attenuator. The EUT was transmitting at maximum power, for lowest, middle and highest channels. The EUT was modulated as stated in the manufactures application form from internal signal. The path loss between the EUT and analyzer was entered in to the spectrum analyzer as an attenuation offset. The reference level for the mask was set to the manufacturers declared maximum output power. The analyzer was configured with a RBW and VBW of 3 kHz and 100 kHz respectfully with the trace set to max hold using an RMS detector. 10Log (4/3) = 1.25 dB was added to the reference level offset to make the result relative to any 4-kHz band as per the requirement in 25.202(f). The mask as specified in clause 25.202(f) was then applied.

For emissions removed more than 250% of the authorized bandwidth from the assigned frequency, measurements were performed both conducted and radiated as follows:

Conducted: A network analyzer was used to measure the path loss and the worst case was entered as a reference level offset in to the spectrum analyzer. From 9 kHz to 3 GHz, the EUT was connected to a spectrum analyzer via an attenuator and cable. Between 3 GHz and 20 GHz a 3 GHz high pass filter was used. The EUT was configured to maximum power on lowest, middle or top highest channels with normal modulation (from EUT internal source). The spectrum analyzer was configured with an RBW and VBW of 1 MHz and 3 MHz respectfully with the trace set to max hold using an RMS detector.

Radiated; A preliminary profile of the Spurious Radiated Emissions was obtained up to a minimum of the 10th harmonic of the highest internally generated frequency by operating the EUT in a screen room. Measurements of emissions from the EUT were obtained with the Measurement Antenna in both Horizontal and Vertical Polarizations. The profiling produced a

list of the worst-case emissions. Using the information from the preliminary profiling of the EUT, the list of emissions was then confirmed on the Open Area Test Site (OATS). Emission levels were maximized by adjusting the receive antenna height, antenna polarization and turntable azimuth. The EUT was set to transmit on maximum power in turn on lowest, middle and highest channels.

For any emissions found the EUT was then removed from the OATS and replaced with a substitution antenna. Using a signal generator, the level was adjusted to achieve the same value on the measuring instrument as previously recorded with the EUT. The final result was determined by a calculation using the signal generator level, antenna gains and losses, and cable loss. Radiated emissions measurements were performed at a 3m distance unless otherwise stated.

Refer to figures 1 through 16 displaying plots of emissions information take at the antenna port demonstrating compliance with requirements. Refer to data presented in table 3 for antenna conducted emissions details.

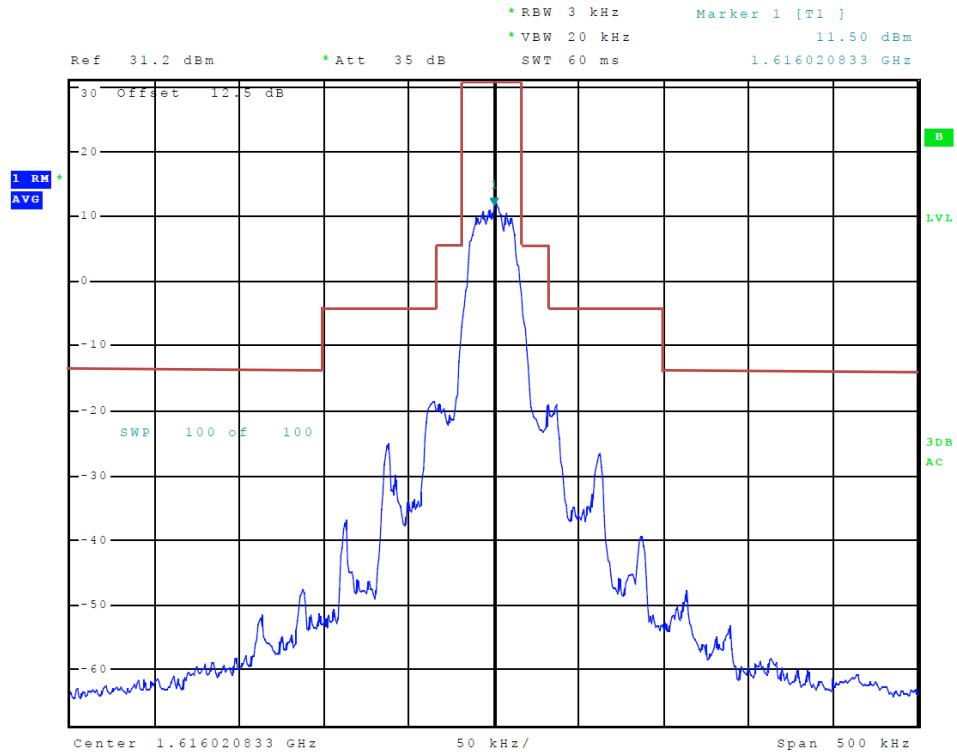


Figure 1 Plot of emissions with emission mask

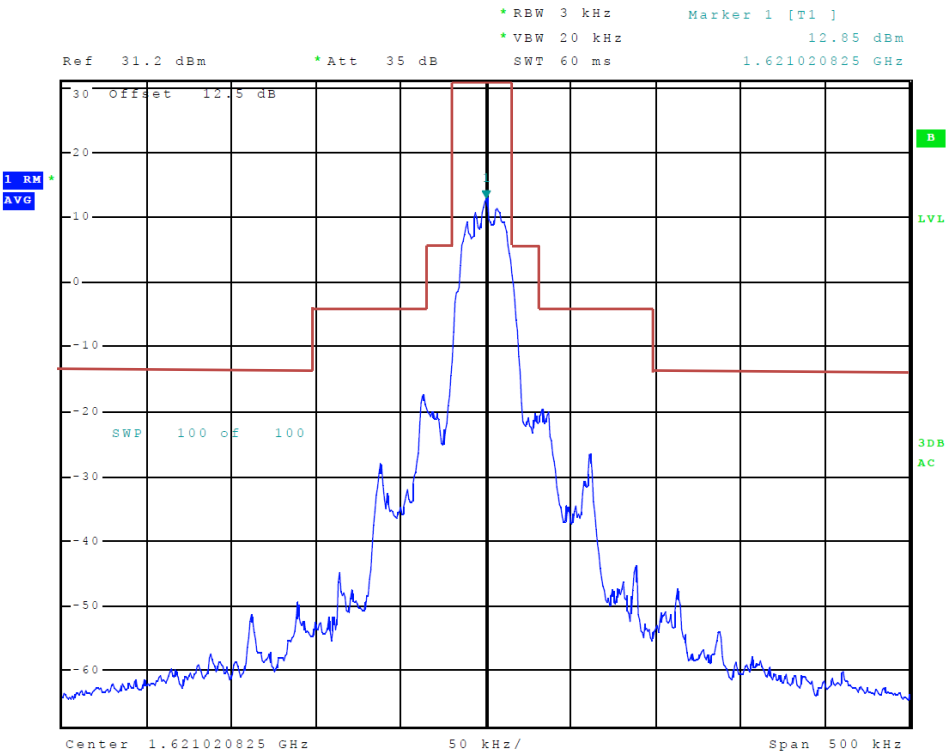


Figure 2 Plot of emissions with emission mask

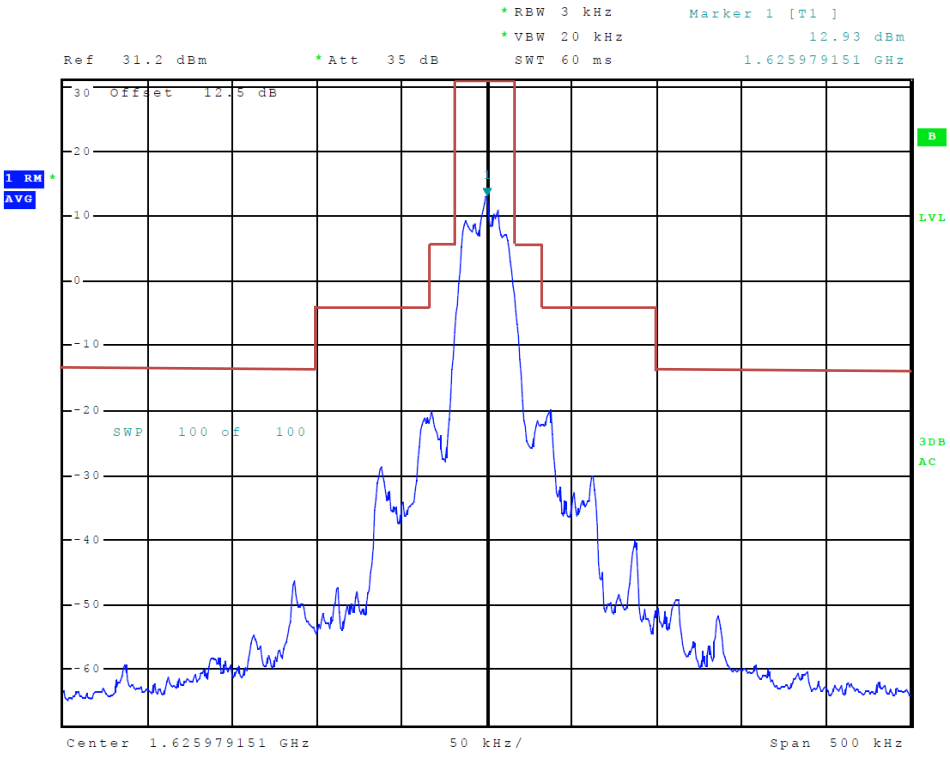


Figure 3 Plot of emissions with emission mask

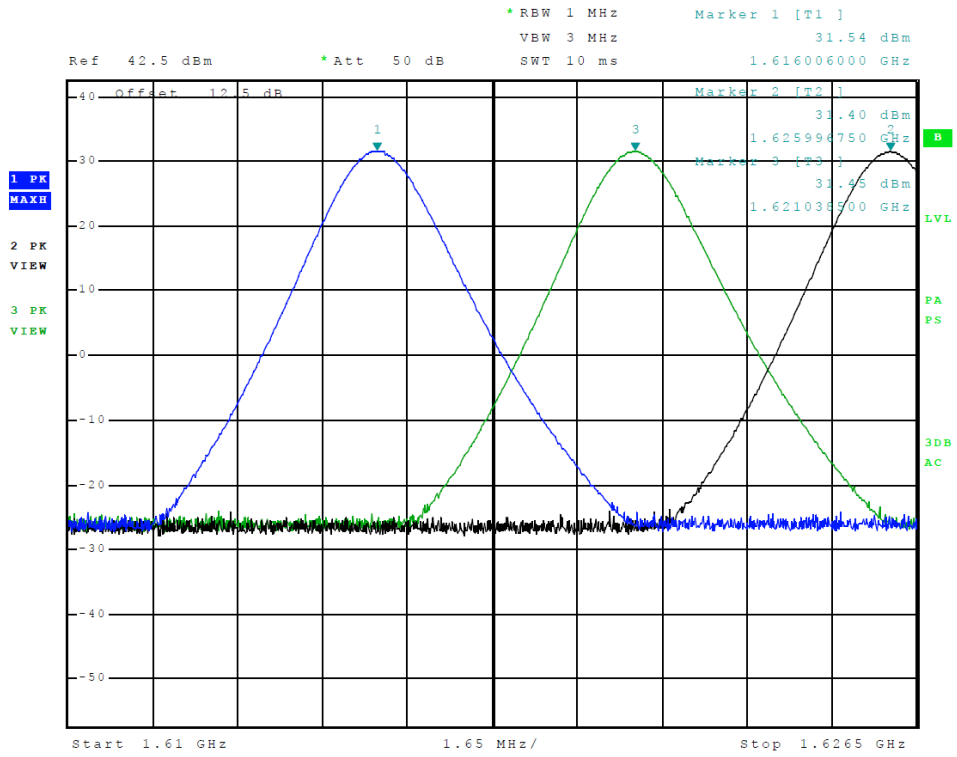


Figure 4 Plot of Operation across Frequency band

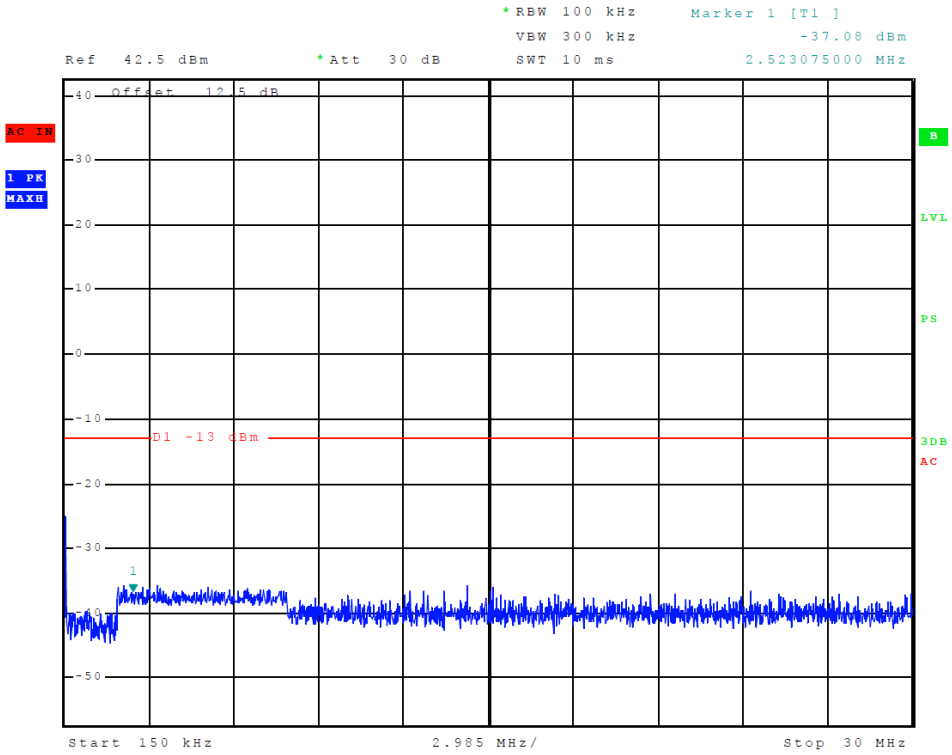


Figure 5 Plot of emissions across Frequency spectrum (Channel 1)

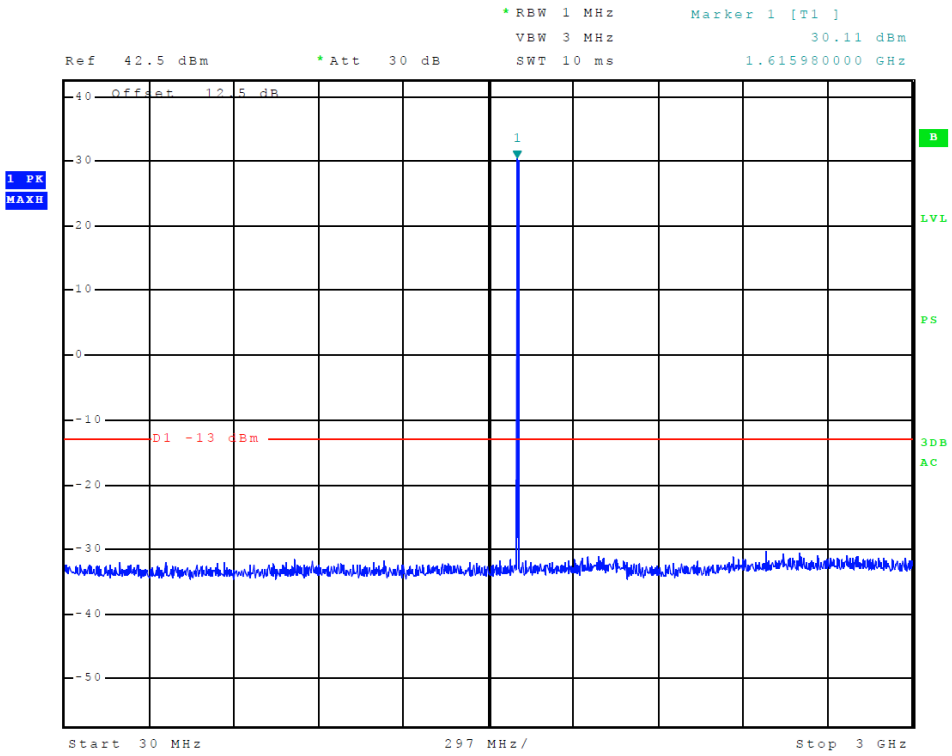


Figure 6 Plot of emissions across Frequency spectrum (Channel 1)

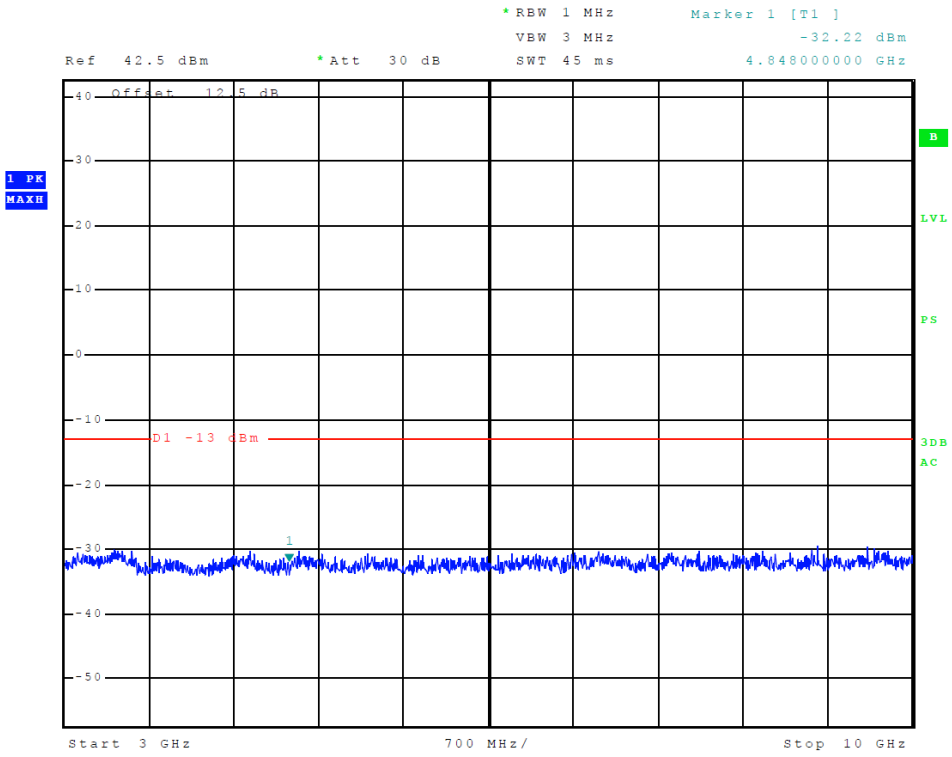


Figure 7 Plot of emissions across Frequency spectrum (Channel 1)

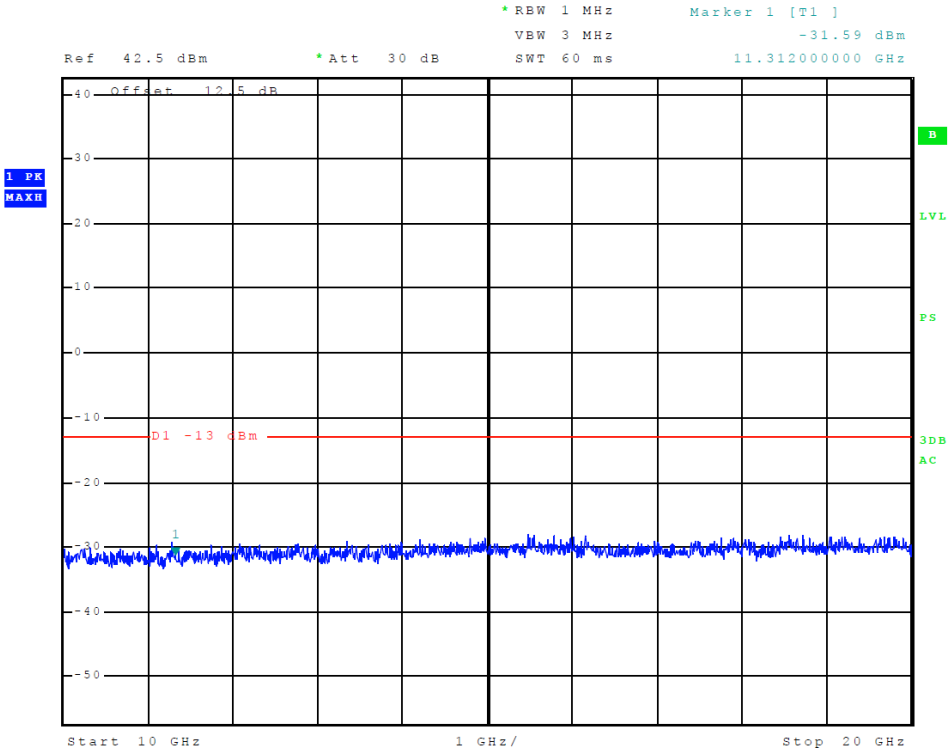


Figure 8 Plot of emissions across Frequency spectrum (Channel 1)

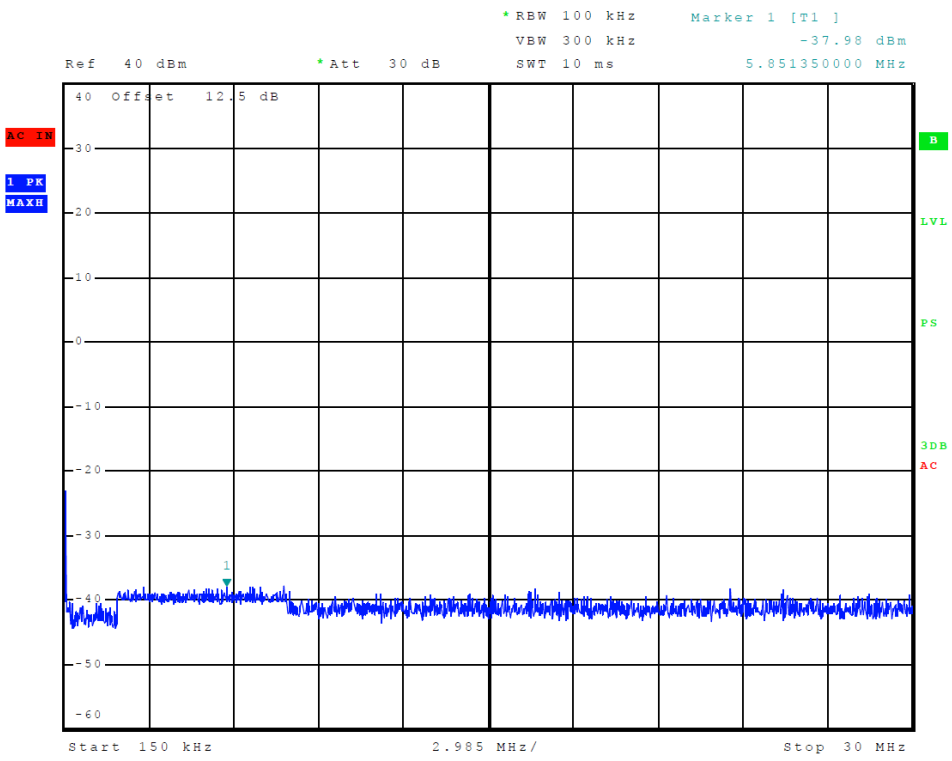


Figure 9 Plot of emissions across Frequency spectrum (Channel 121)

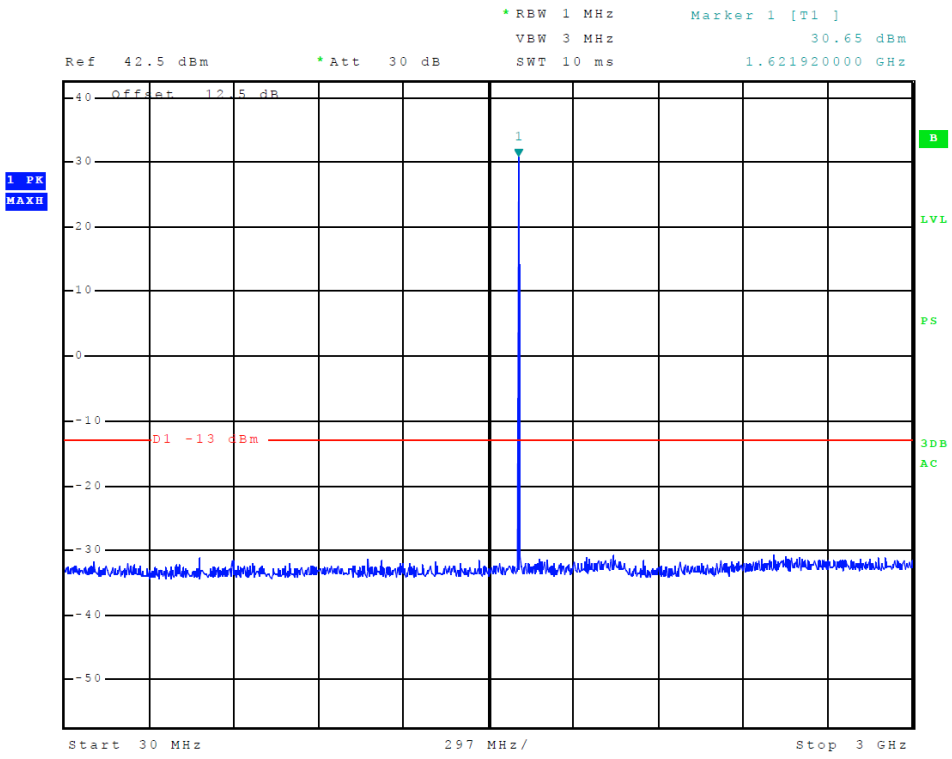


Figure 10 Plot of emissions across Frequency spectrum (Channel 121)

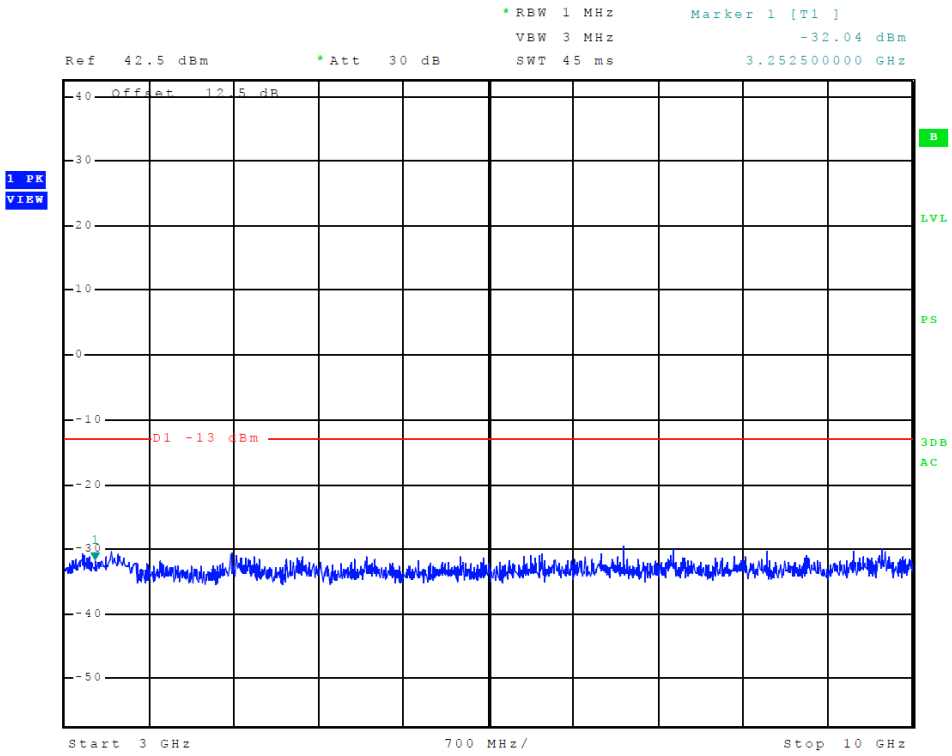


Figure 11 Plot of emissions across Frequency spectrum (Channel 121)

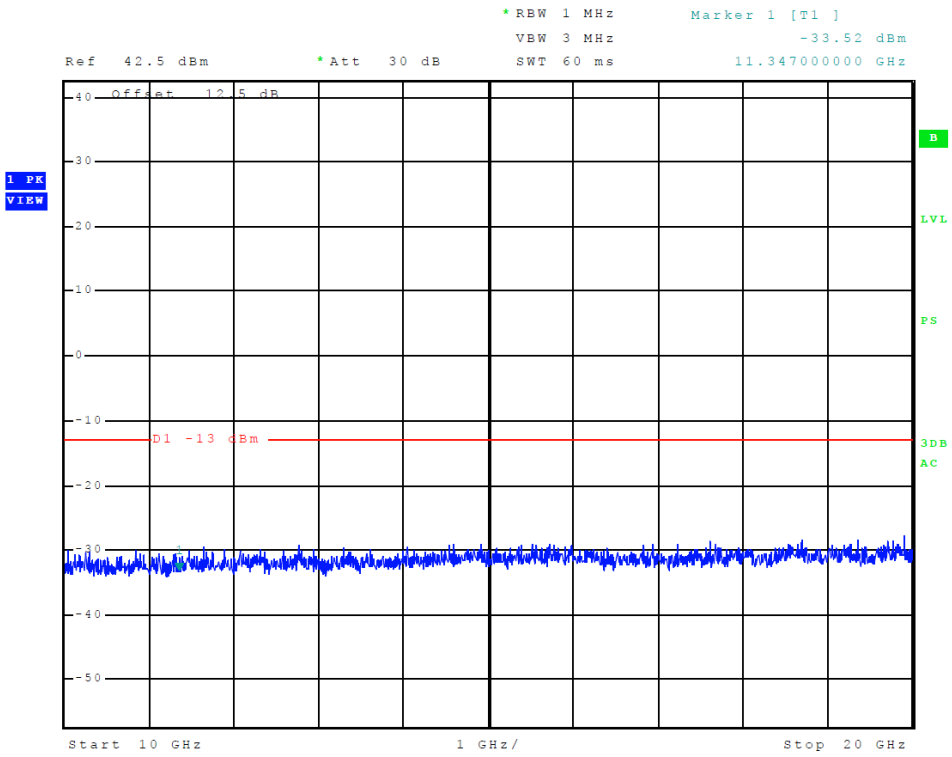


Figure 12 Plot of emissions across Frequency spectrum (Channel 121)

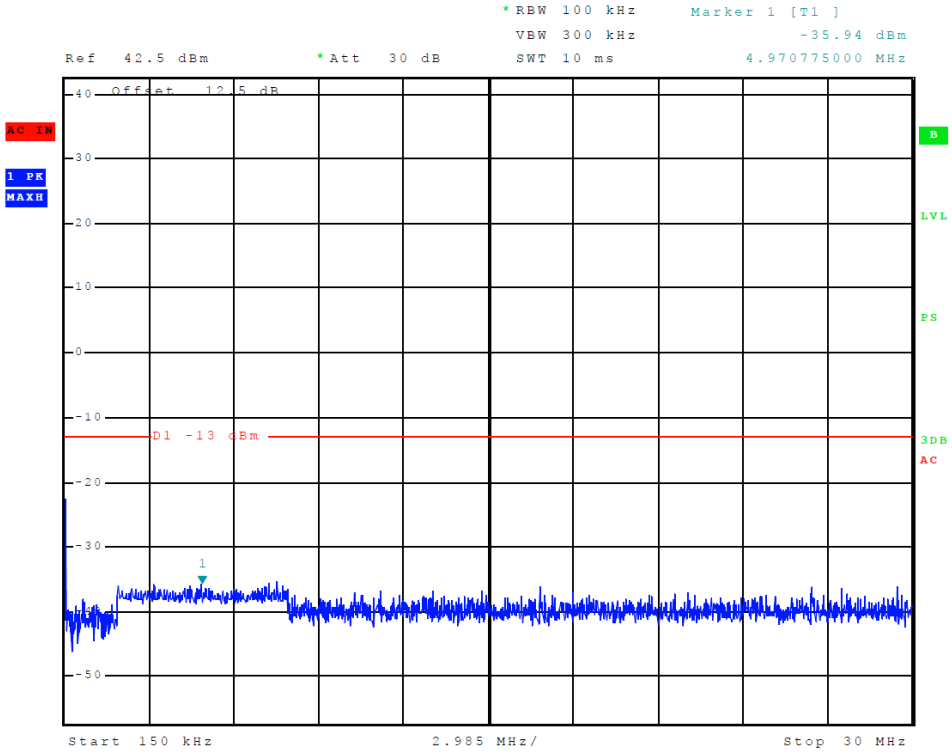


Figure 13 Plot of emissions across Frequency spectrum (Channel 240)

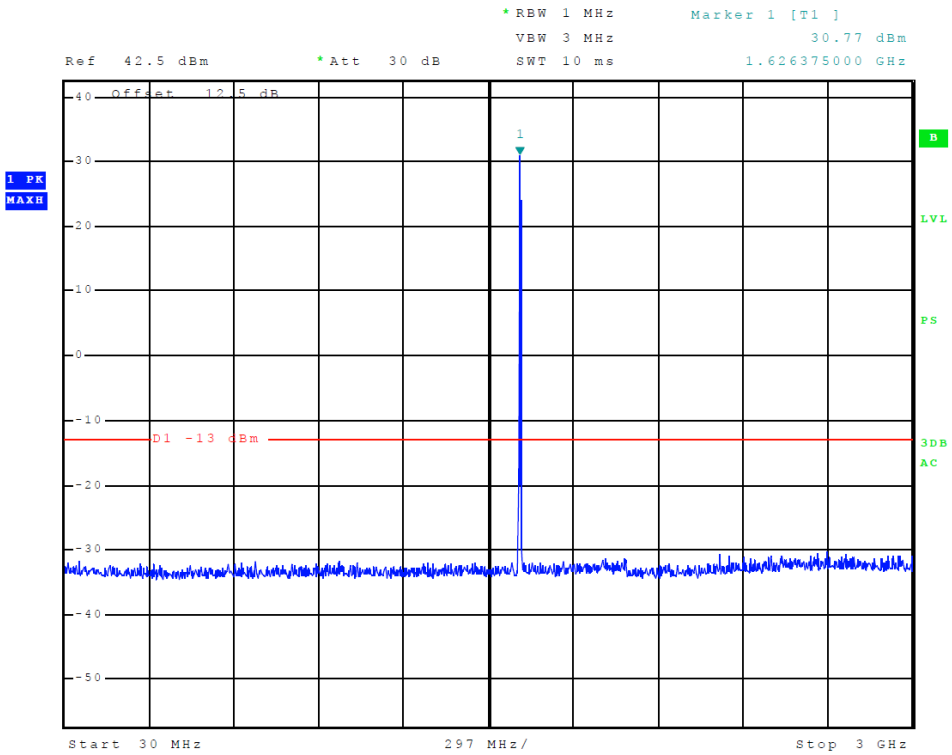


Figure 14 Plot of emissions across Frequency spectrum (Channel 240)

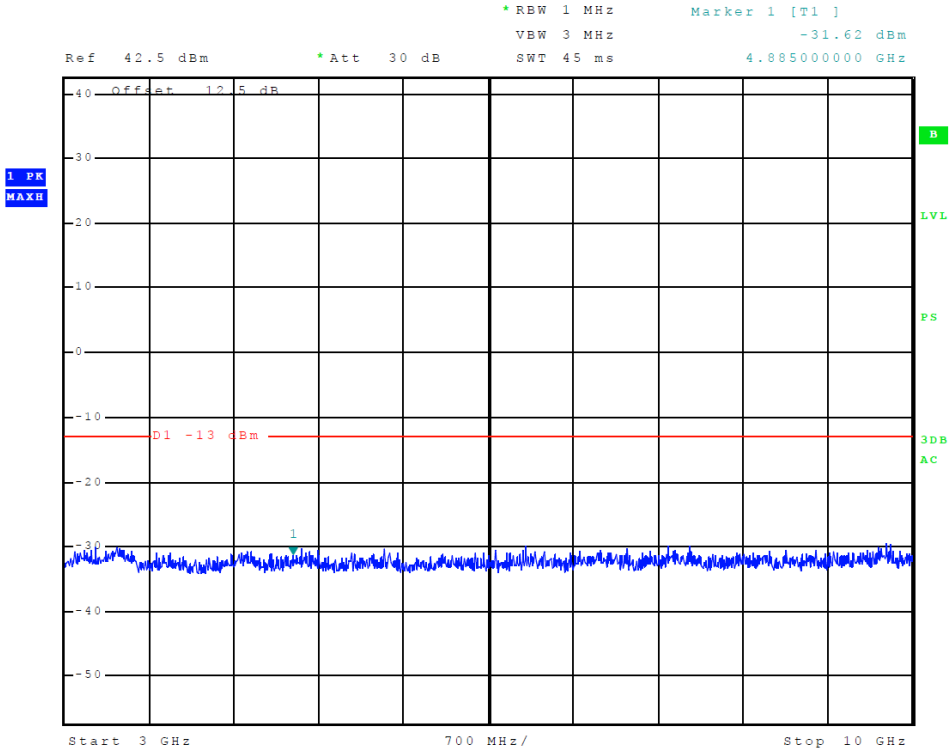


Figure 15 Plot of emissions across Frequency spectrum (Channel 240)

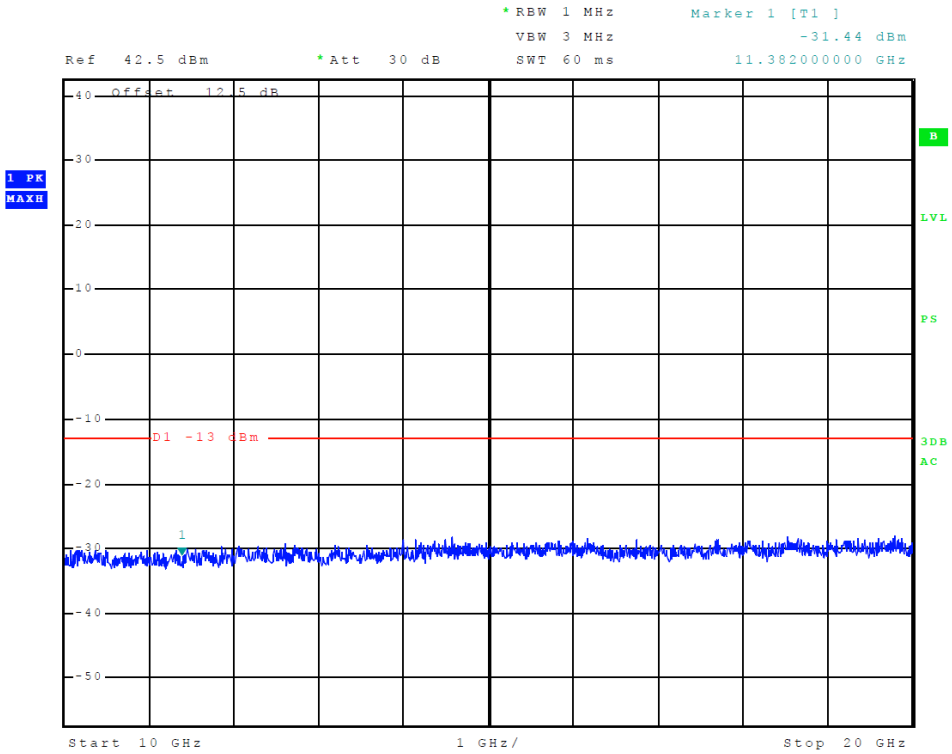


Figure 16 Plot of emissions across Frequency spectrum (Channel 240)

Table 3 Transmitter Antenna Conducted Emissions Data

Frequency (MHz)	Harmonic Frequency (MHz)	Output Power (dBm)
1616.0		31.54
	3232.0	-50.12
	4848.1	-63.42
	6464.1	-65.68
	8080.1	-67.32
1621.0		31.45
	3242.0	-48.57
	4863.1	-64.18
	6484.1	-66.28
	8105.1	-67.70
1626.0		31.40
	3252.0	-47.68
	4877.9	-65.59
	6503.9	-65.71
	8129.9	-67.27

Summary of Results for Emissions of Intentional Radiator

The EUT demonstrated antenna port conducted peak output power of 31.70 dBm, 1479.1 milliwatts (1.43 Watts). The EUT demonstrated a minimum out of band radiated emission margin of at least 20 dB below requirements. The EUT tested was observed in compliance with the emissions requirements of 47CFR Part 25 and Industry Canada RSS-170 Issue 3.

Spurious Emissions at Antenna Terminals

Measurements Required

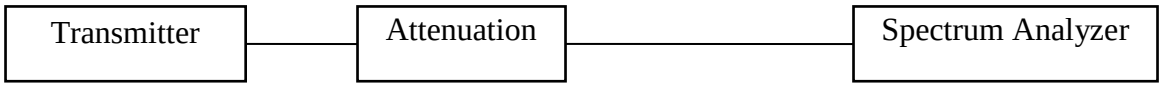
The radio frequency voltage or power generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna.

Emissions removed from the assigned frequency by more than 250 percent of the authorized bandwidth must be attenuated at least 43 +10log (Po) below the fundamental emission power level. The following equations represent the calculated attenuation offset level for the equipment operating with rated output power of 1.43 Watts.

Limit for 1.43-Watt transmitter

Limit (dBc) = 43 + 10 Log (Po)
= 43 + 10 Log (1.43)
= 45.6 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 modulated per section 2.1049 and operated in all normal modes. The frequency spectrum from 9 kHz to 35,000 MHz was observed.
Refer to data presented in table 4 for spurious emission at antenna port emission details.

Data was taken per CFR47 2.1051, 2.1057, and applicable paragraphs of Part 25.202. There are no deviations to the specifications.

Table 4 Spurious Emissions at Antenna Terminal Results (Worst-case)

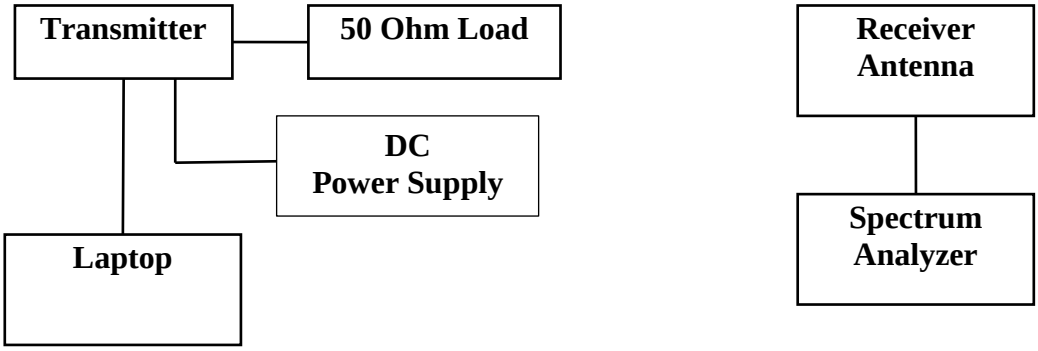
Channel MHz	Spurious Freq. (MHz)	Measured Level (dBm)	Level Below Carrier (dBc)
1616.0	3232.0	-50.12	-81.7
	4848.1	-63.42	-95.0
	6464.1	-65.68	-97.2
	8080.1	-67.32	-98.9
	9696.1	-66.70	-98.2
	11312.1	-64.93	-96.5
1621.0	3242.0	-48.57	-80.0
	4863.1	-64.18	-95.6
	6484.1	-66.28	-97.7
	8105.1	-67.70	-99.2
	9726.1	-66.32	-97.8
	11347.1	-65.64	-97.1
1626.0	3252.0	-47.68	-79.1
	4877.9	-65.59	-97.0
	6503.9	-65.71	-97.1
	8129.9	-67.27	-98.7
	9755.9	-66.56	-98.0
	3252.0	-47.68	-79.1

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 panels 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 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. A final radiated emission testing was performed with the transmitter placed on a supporting turntable platform 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 35,000 MHz was investigated during radiated emissions testing. A Loop antenna was used for measurements between 9 kHz and 30 MHz. 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 35,000 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. A description of the test facility is on file with the FCC and Industry Canada (refer to annex for site registration letters). 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.

Limit 1.43 Watts = 43 + 10 Log (Po)
= 43 + 10 Log (1.43)
= 44.55 dBc

Requirement 31.54 dB less the limit 44.55 dBc equates to an absolute level of -13 dBm

Refer to data presented in table 5 for radiated emission details.

Table 5 Spurious Radiated Emission Results

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	
3232.0	29.4	28.7	-65.83	-66.53	-97.4	-98.1	-13
4848.1	32.2	32.2	-63.03	-63.03	-94.6	-94.6	-13
6464.1	32.2	32.1	-63.03	-63.13	-94.6	-94.7	-13
8080.1	30.7	30.8	-64.53	-64.43	-96.1	-96.0	-13
9696.1	33.2	33.3	-62.03	-61.93	-93.6	-93.5	-13
3242.0	29.6	29.9	-65.63	-65.33	-97.1	-96.8	-13
4863.1	31.1	30.7	-64.13	-64.53	-95.6	-96.0	-13
6484.1	32.0	32.1	-63.23	-63.13	-94.7	-94.6	-13
8105.1	30.1	27.4	-65.13	-67.83	-96.6	-99.3	-13
9726.1	33.5	33.8	-61.73	-61.43	-93.2	-92.9	-13
3250.0	29.8	29.4	-65.43	-65.83	-96.8	-97.2	-13
4875.0	31.7	31.8	-63.53	-63.43	-94.9	-94.8	-13
6500.0	32.0	32.3	-63.23	-62.93	-94.6	-94.3	-13
8125.0	30.7	30.8	-64.53	-64.43	-95.9	-95.8	-13
9750.0	33.7	33.6	-61.53	-61.63	-92.9	-93.0	-13

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.

The EUT demonstrated compliance with specifications of CFR47 Paragraph 2.1046(a) and applicable Parts of 2 and 25.202. There are no deviations to the specifications. There are no deviations or exceptions to the specifications.

Transmitter Power Output

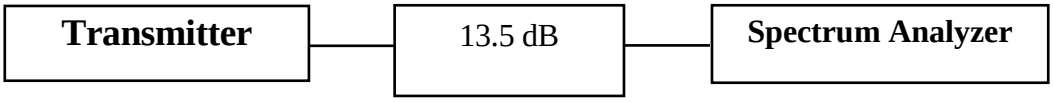
Measurements Required

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.

Test Arrangement



The radio frequency power output was measured at the antenna terminal by placing 13.5 dB attenuation in the antenna line and observing the emission with the spectrum analyzer. The spectrum analyzer and attenuation 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. Data was taken per CFR47 Paragraph 2.1046(a) and applicable paragraphs of Part 25.202.

P_{dBm} = power in dB above 1 milliwatt
Milliwatts $= 10^{(PdBm/10)}$
Watts = (Milliwatts)(0.001)(W/mW)
Milliwatts $= 10^{(31.54/10)}$
= 1425.6 mW
= 1.43 Watts power

Table 6 Transmitter Power Results

Frequency	Input Power	P_{dBm}	P_{mw}	e.i.r.p. with 3 dBi antenna	P_w
1616.0	5.0 V_{dc}	31.54	1425.6	2.85	1.43
1621.0	5.0 V_{dc}	31.45	1396.0	2.80	1.40
1626.0	5.0 V_{dc}	31.40	1380.4	2.80	1.38

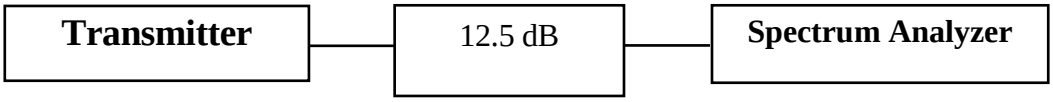
The EUT demonstrated compliance with specifications of CFR47 Paragraph 2.1046(a) and applicable Parts of 2 and 25.202. There are no deviations to the specifications.

Modulation Characteristics

Measurements Required

47CFR2.1047(d) requires 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 manufacturer provided description of the modulation. Support of the modulation description is provided in the following figures and plots. The radio frequency output was coupled to a Spectrum Analyzer were plots were produced.

Test Arrangement



Modulation Characteristic Results

The manufacturer provided the following modulation detail.

Traffic, broadcast, and ring alert channels use differentially encoded quaternary phase shift keyed (DE-QPSK) modulation with 40% square root raised cosine pulse shaping. The burst transmission rate is 25ksps or 50 kbps. The phase of the QPSK symbol states relative to the carrier phase is (Symbol State/Phase in deg): 00/0, 01/-90, 10/+90, 11/180.

The acquisition channel uses differentially encoded binary phase shift keyed (DE-BPSK) with 40% square root raised cosine pulse shaping. The burst rate on these channels is 25 kbps. The sync channel uses 25 kbps DE-BPSK on the uplink and 50 kbps DE-QPSK on the downlink. Both with 40% square root raised cosine pulse shaping."

Figures 17 through 22 were produced supporting the modulation description provided by the manufacturer.

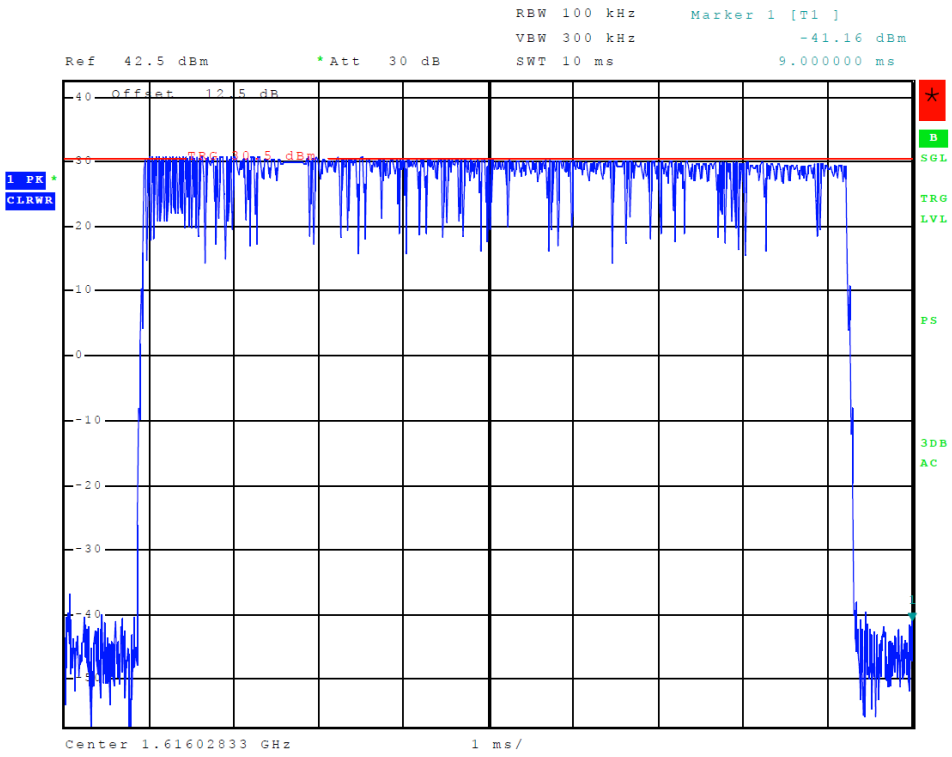


Figure 17 Plot of emissions supporting modulation characteristic Channel 1

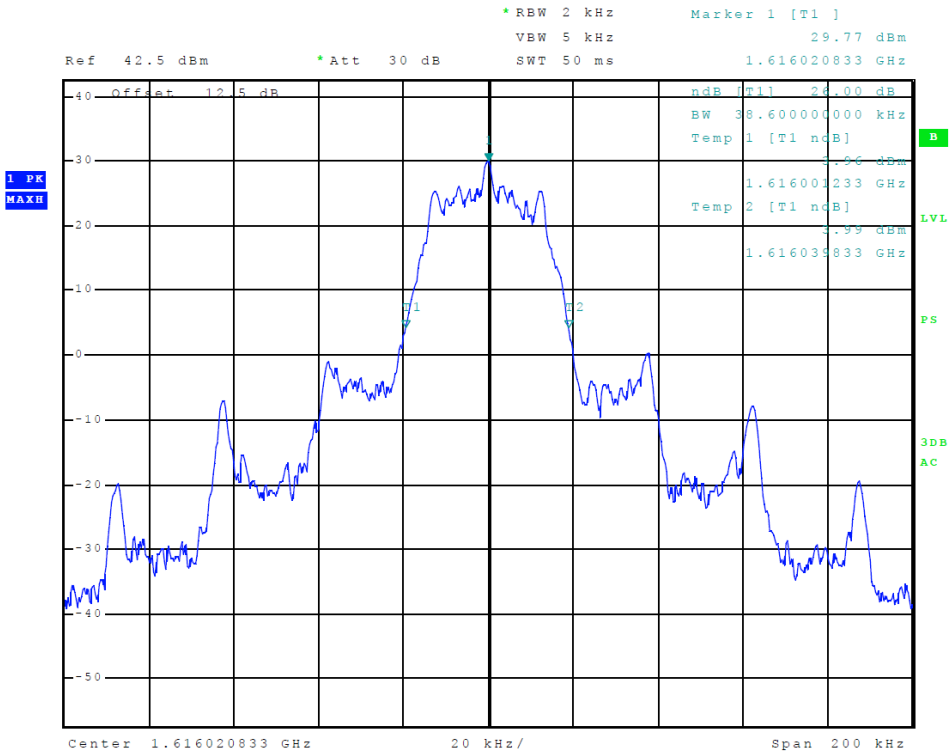


Figure 18 Plot of emissions supporting modulation characteristic Channel 1

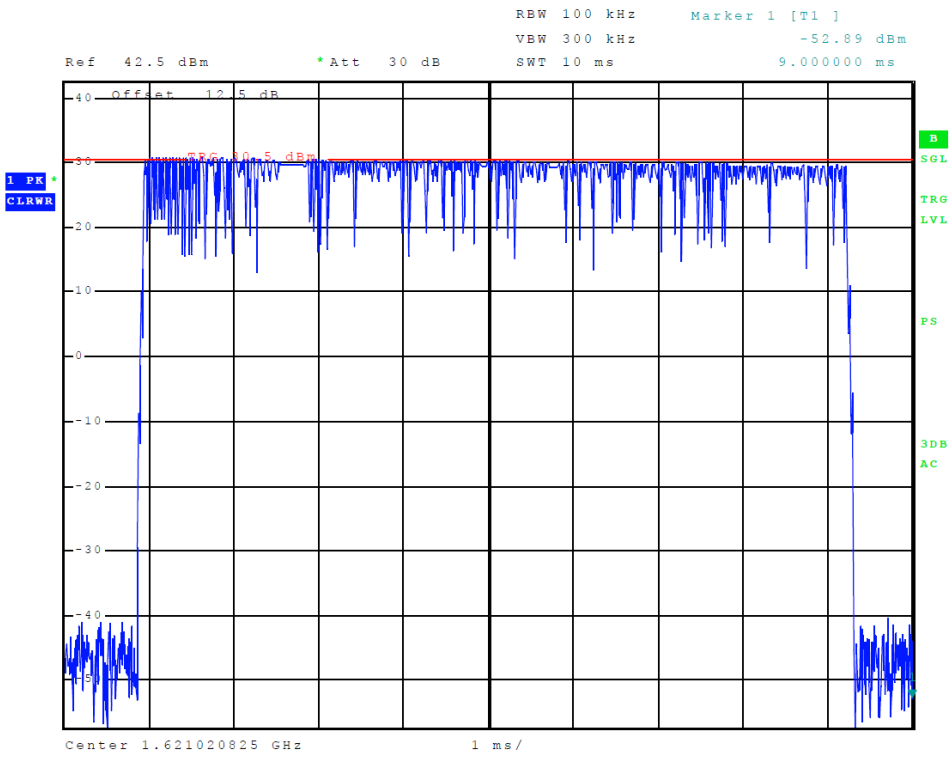


Figure 19 Plot of emissions supporting modulation characteristic Channel 121

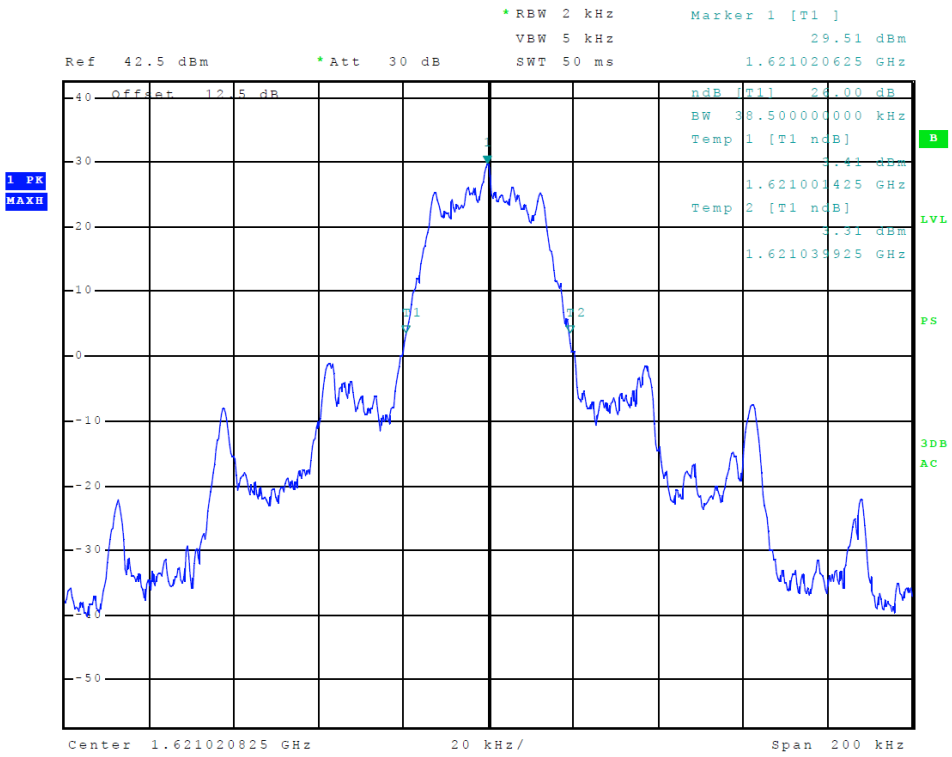


Figure 20 Plot of emissions supporting modulation characteristic Channel 121

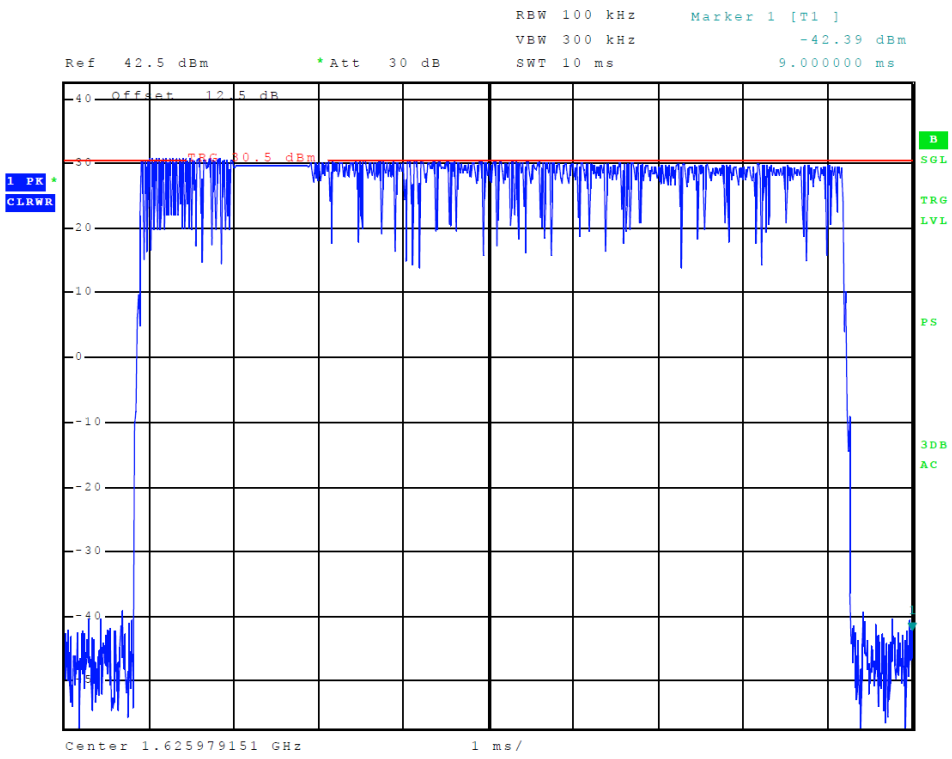


Figure 21 Plot of emissions supporting modulation characteristic Channel 240

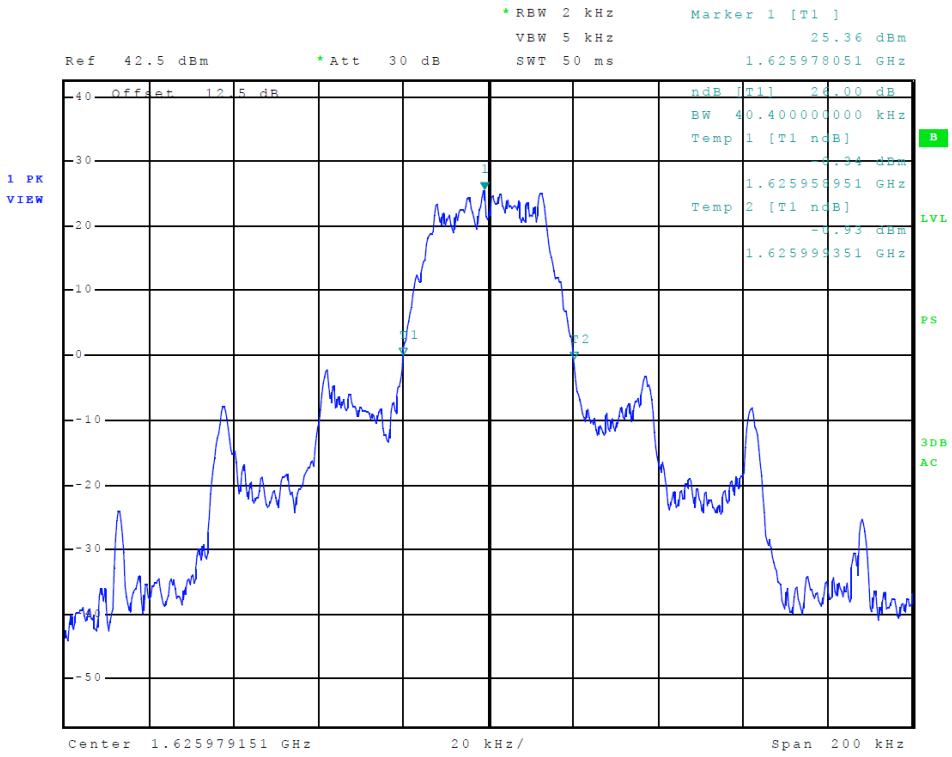


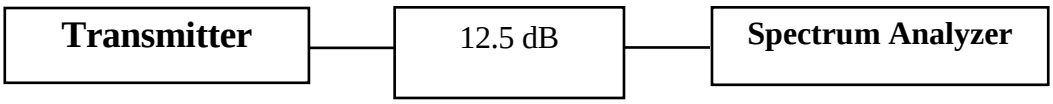
Figure 22 Plot of emissions supporting modulation characteristic Channel 240

E. I. R. P Density of Unwanted Emissions

Measurements Required

Measurements shall be made to establish the E.I.R.P Density of unwanted emissions in accordance with 47CFR 25.216 and RSS-170 Issue 3 paragraph 5.4.3. Measurements were made to confirm the power density of emissions in the 1605-1610 MHz band-segment, to an extent as determined by linear interpolation from −70 dBW/MHz at 1605 MHz to −10 dBW/MHz at 1610 MHz, averaged over any 2-millisecond active transmission interval demonstrated compliance. The e.i.r.p of discrete emissions of less than 700 Hz bandwidth from such stations shall not exceed a level determined by linear interpolation from −80 dBW at 1605 MHz to −20 dBW at 1610 MHz, averaged over any 2-millisecond active transmission interval.

Test Arrangement



The radio frequency power output was measured at the antenna terminal by placing 12.5 dB attenuation in the antenna line and observing the emission with the spectrum analyzer. The EUT was set to transmit at maximum power using modulation as described by the manufacturer directions. The EUT was connected to a spectrum analyzer via a cable and attenuator and tuned to the assigned frequency. The gated trigger of the analyzer was used so that average measurements were taken over a 2 ms period of the active burst. The spectrum analyzer was adjusted to show the frequency range of interest on screen with an RBW & VBW of 1 MHz and 3 MHz respectfully. Any spur within 20 dB of -70 dBW/MHz (-40 dBm/MHz) was investigated further to determine the bandwidth of the emission. Each spur was individually investigated and the RBW of the analyzer was reduced to allow an approximation of the emission bandwidth of the spur. It was confirmed that all discrete emissions demonstrated a power density less than -80 dBW/MHz. The limit was reduced by 3 dB to take in to consideration the maximum antenna gain allowed as declared by the manufacturer. Plots were made of antenna port conducted emissions in demonstration of compliance. Refer to figures 23 through 29 displaying compliance with E.I.R.P. requirements.

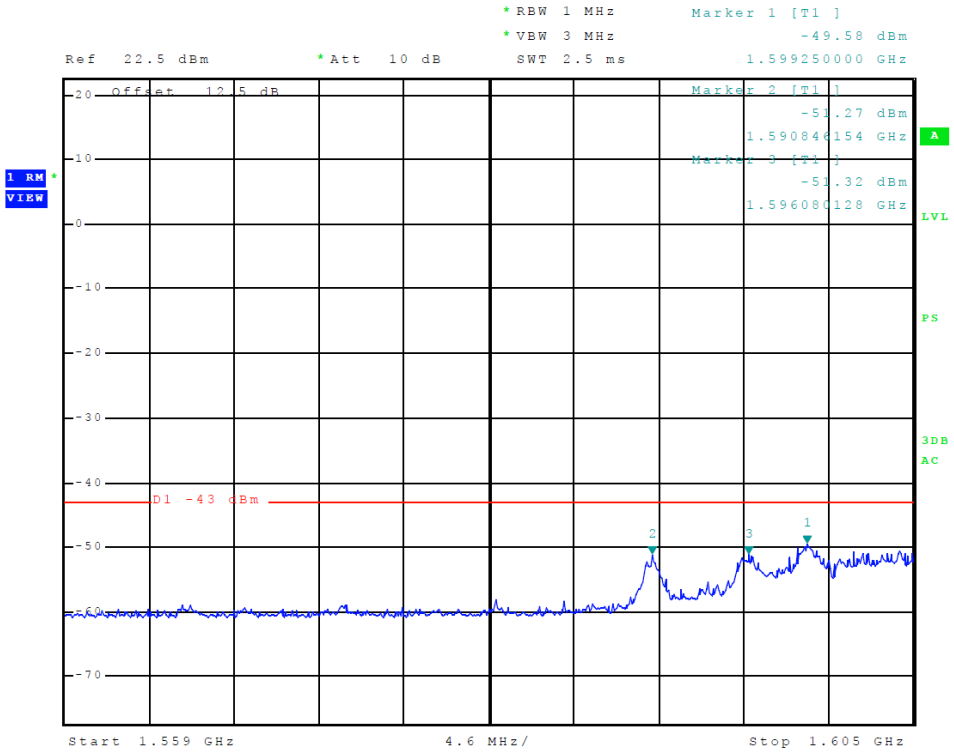


Figure 23 Plot of E.I.R.P. density of unwanted emissions 1616.0202833 MHz

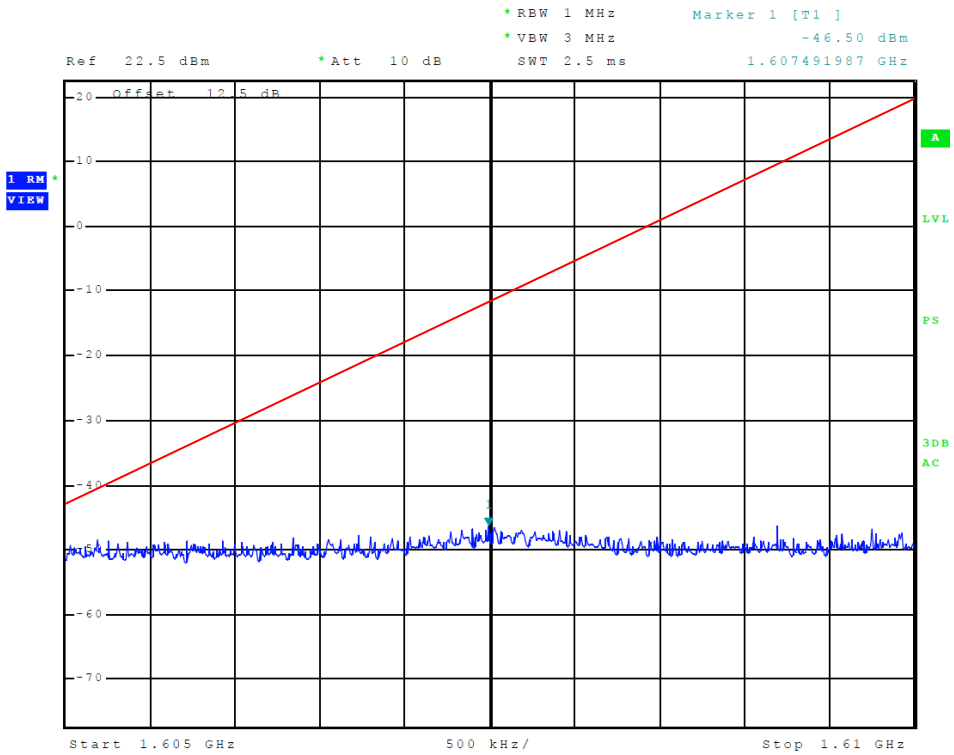


Figure 24 Plot of E.I.R.P. density of unwanted emissions 1616.0202833 MHz

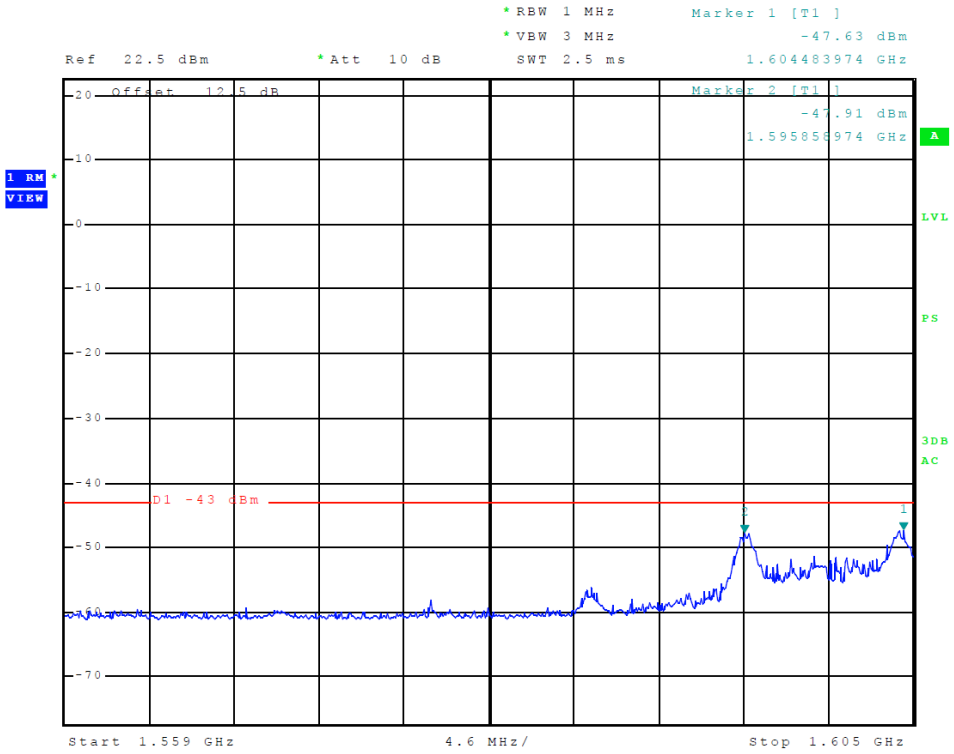


Figure 25 Plot of E.I.R.P. density of unwanted emissions 1621.020825MHz

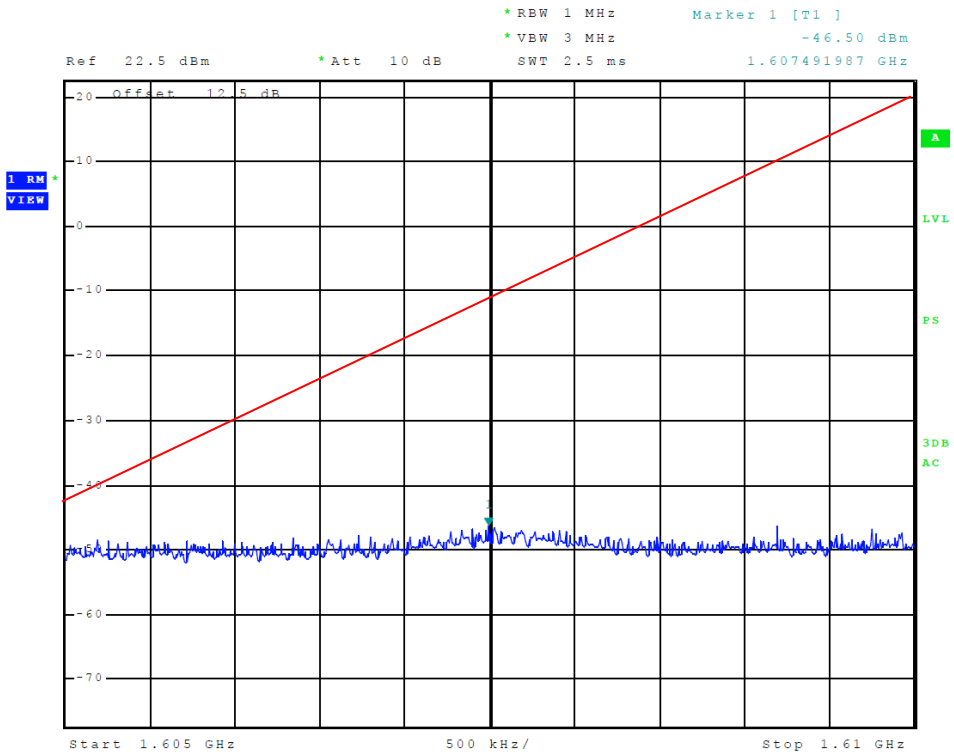


Figure 26 Plot of E.I.R.P. density of unwanted emissions 1621.020825MHz

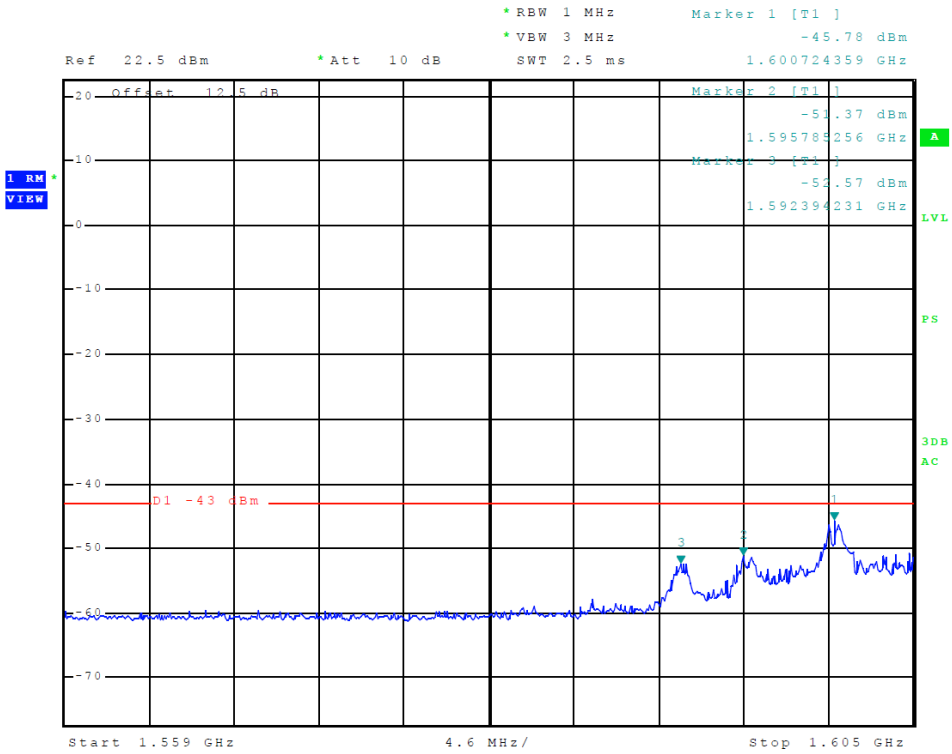


Figure 27 Plot of E.I.R.P. density of unwanted emissions 1625.979151MHz

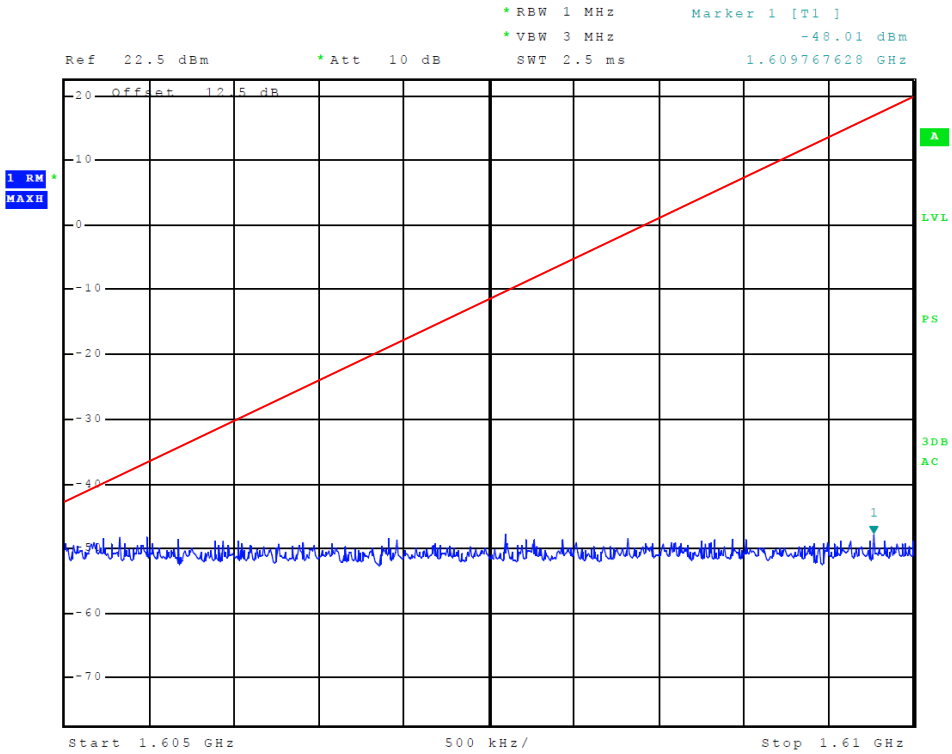


Figure 28 Plot of E.I.R.P. density of unwanted emissions 1625.979151MHz

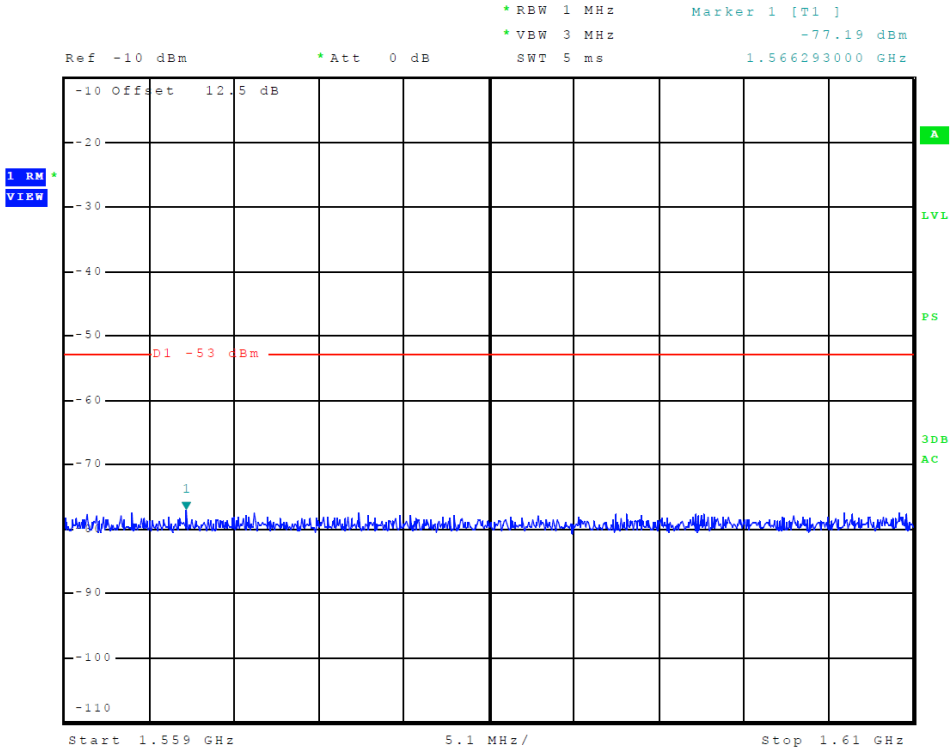


Figure 29 Plot of E.I.R.P. density of unwanted emissions carrier-off

Table 7 E.I.R.P. Density Broadband Emissions Data

Frequency	Greatest e.i.r.p. density dBW/MHz
1616.020833	-79.58
1621.020825	-77.63
1625.979151	-75.78

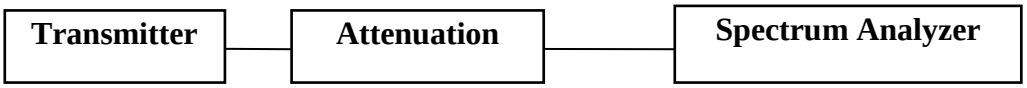
The EUT demonstrated compliance with specifications of CFR47 Paragraph 2.1046(a) and applicable Parts of 2 and 25.216(g) (h) and RSS-170 5.4.3.2.1 . There are no deviations to the specifications.

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 or the 26-dB down bandwidth.

Test Arrangement



A Rohde & Schwarz ESU 40 spectrum analyzer was used to observe the radio frequency spectrum with the transmitter operating in normal modes. The power ratio in dB representing 99% of the total mean power was recorded from the spectrum analyzer measurements. Refer to figures 30 through 32 displaying plots of 99% power occupied bandwidth measurements.

Table 8 Occupied Bandwidth Results

Frequency (MHz)	99% Occupied bandwidth (kHz)	26-dB Occupied bandwidth (kHz)
1616.020833	33.0	38.6
1621.020825	32.5	38.5
1625.979151	33.1	40.4

The EUT demonstrated compliance with specifications of CFR47 Paragraph 2.1046(a) and applicable Parts of 2 and 25.202. There are no deviations to the specifications.

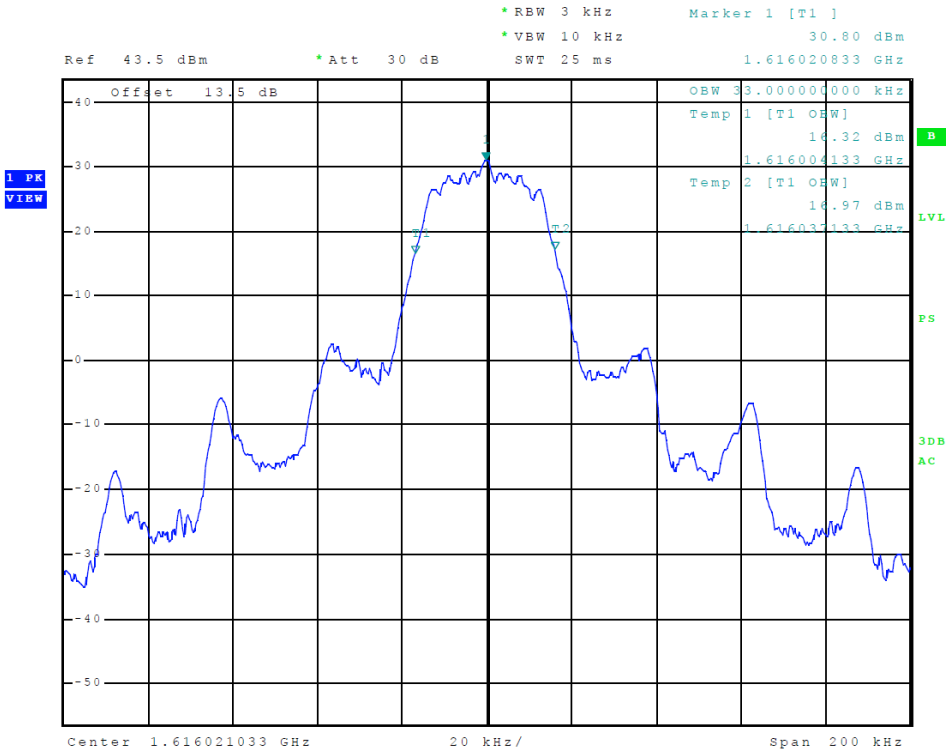


Figure 30 Plot of 99% Occupied Band Width Channel 1

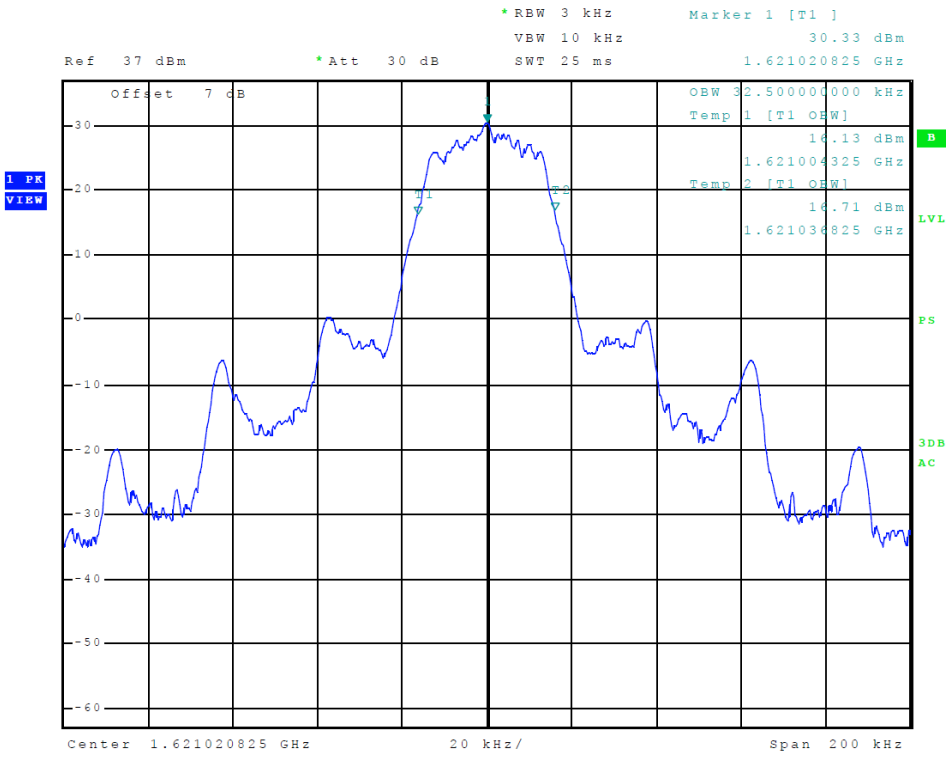


Figure 31 Plot of 99% Occupied Band Width Channel 121

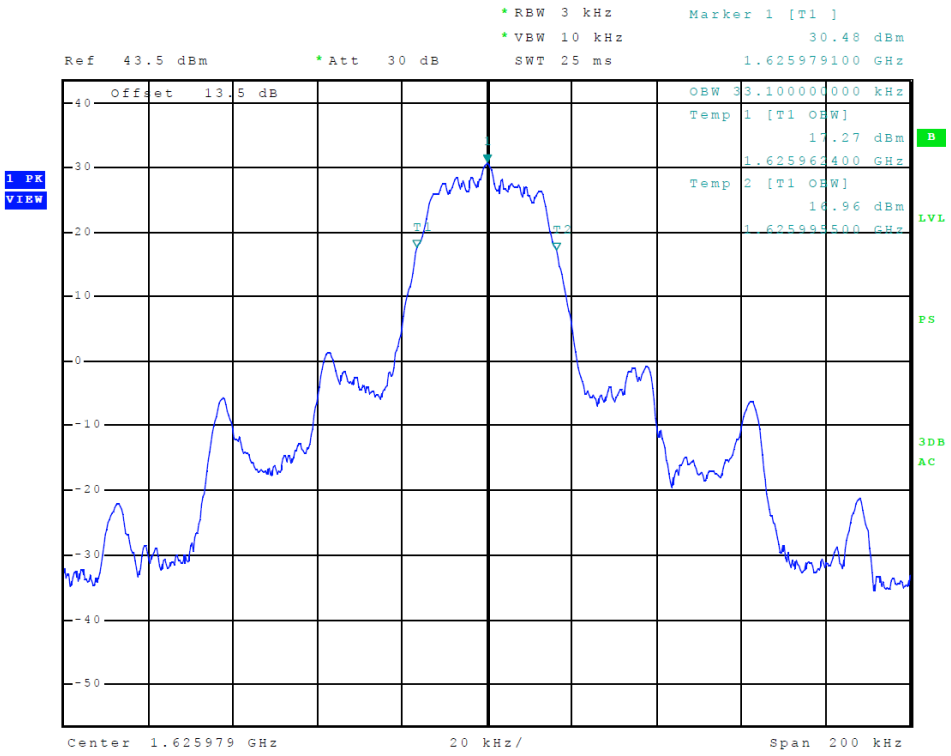


Figure 32 Plot of 99% Occupied Band Width Channel 240

Annex

- Annex A Measurement Uncertainty Calculations
- Annex B Rogers Labs Test Equipment List
- Annex C Rogers Qualifications
- Annex D Laboratory 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 Date	Due
Spectrum Analyzer: Rohde & Schwarz ESU40	5/17	5/18
Spectrum Analyzer: HP 8562A, HP Adapters: 11518, 11519, and 11520	5/17	5/18
Mixers: 11517A, 11970A, 11970K, 11970U, 11970V, 11970W		
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 ohms/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
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.

Annex D Laboratory 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).

2017-03-01 through 2018-03-31
Effective Dates

For the National Voluntary Laboratory Accreditation Program