

05/18/2021

Sirius XM Satellite Radio
1500 Eckington Place, NE
Washington, District of Columbia 20002

Dear Beejay Jolayemi,

Enclosed is the EMC Wireless test report for compliance testing of the Sirius XM Satellite Radio, DBESR-20W. The Sirius XM Satellite Radio DBESR-20W was tested to the requirements of the FCC Certification rules under Title 47 of the Code of Federal Regulations (CFR), Part 25 for Satellite Communications.

Thank you for using the services of Eurofins Electrical and Electronics Testing NA, Inc. If you have any questions regarding these results or if we can be of further service to you, please feel free to contact me.

Sincerely yours,
EUROFINS ELECTRICAL AND ELECTRONICS TESTING NA, INC.



Joel Huna
Documentation Department

Reference: (\Sirius XM Satellite Radio\WIR112630-FCC25)

Certificates and reports shall not be reproduced except in full, without the written permission of Eurofins Electrical and Electronic Testing NA, Inc. While use of the A2LA logo in this report reflects Eurofins Electrical and Electronic Testing NA, Inc. accreditation under these programs, the report must not be used by the client to claim product certification, approval, or endorsement by A2LA, or any agency of the Federal Government. This letter of transmittal is not a part of the attached report.

Eurofins Electrical and Electronic Testing NA, Inc. is part of the Eurofins Electrical & Electronics (E&E) global compliance network.

Electromagnetic Compatibility Criteria Test Report

For the

**Sirius XM Satellite Radio
DBESR-20W**

Tested under

**FCC Certification Rules
Title 47 of the CFR, Part 25 for Satellite Communications**

Report: WIR112630-FCC25

05/18/2021

Prepared For:

**Sirius XM Satellite Radio
1500 Eckington Place, NE
Washington, District of Columbia 20002**

Prepared By:
Eurofins Electrical and Electronics Testing NA, Inc.
914 W. Patapsco Ave.
Baltimore, MD 21230

Electromagnetic Compatibility Criteria Test Report

For the

**Sirius XM Satellite Radio
DBESR-20W**

**FCC Certification Rules
Title 47 of the CFR, Part 25 for Satellite Communications**



Donald Salguero
Electromagnetic Compatibility Lab



Joel Huna
Documentation Department

Engineering Statement: The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of Title 47 of the CFR, Part 25 of the FCC Rules under normal use and maintenance.



Deepak Giri
Electromagnetic Compatibility Lab

Report Status Sheet

Revision	Report Date	Reason for Revision
Ø	05/18/2021	Initial Issue

Table of Contents

1. Executive Summary	1
1.1. Purpose of Test	2
1.2. Requirements Summary.....	2
2. Equipment Configuration.....	3
2.1. Overview.....	4
2.2. References.....	5
2.3. Test Site	5
2.4. Description of Test Sample.....	5
2.5. Equipment Configuration.....	6
2.6. Support Equipment	6
2.7. Ports and Cabling Information.....	7
2.8. Mode of Operation.....	7
2.9. Monitoring Method.....	7
2.10. Modifications.....	7
2.10.1. Modifications to EUT	7
2.10.2. Modifications to Test Standard.....	7
2.11. Disposition of EUT	7
3. Electromagnetic Compatibility Criteria for Intentional Radiators	8
3.1. §2,1046, 25.214 (d)(1) RF Output Power	9
3.2. §25.214 (d)(1) Peak to Average Ratio (PAPR).....	11
3.3. §25.202(h)(1) Spurious at Antennas	13
3.4. §2.1049 Occupied Bandwidth.....	17
3.5. §25.202(d) Frequency Stability.....	19
3.6. §2.1053 Cabinet Spurious Radiation.....	21
4. Test Equipment	25
5. Certification Label & User's Manual Information	27
5.1. Certification Information.....	28
5.2. Label and User's Manual Information	32

List of Tables

Table 1: Requirements Summary of EMC Part 25 Compliance Testing	2
Table 2: EUT Summary Table	4
Table 3: Standard References	5
Table 4: Equipment Configuration	6
Table 5: Ports and Cabling Information	7
Table 6: RF Output Power, Test Results	9
Table 7: Peak-to-Average Ratio (PAPR), Test Results	11
Table 8: Occupied Bandwidth, Test Results	17
Table 9: Frequency Stability, Test Results, Low Band	20
Table 10: Frequency Stability, Test Results, High Band	20
Table 11: Test Equipment List	26

List of Figures

Figure 5: Block Diagram of Test Configuration	6
Figure 8: Conducted Output Power - Average - Dual Band Channel	9
Figure 9: Conducted Output Power - Average - High Band Channel	10
Figure 10: Conducted Output Power - Average - Low Band Channel	10
Figure 12: PAPR - high band channel	12
Figure 13: PAPR - low band channel	12
Figure 14: Conducted Spurious Emissions - 30-1000 MHz	14
Figure 15: Conducted Spurious Emissions - 1-4 GHz	14
Figure 16: Conducted Spurious Emissions - 4-8 GHz	14
Figure 17: Conducted Spurious Emissions - 8-12 GHz	15
Figure 18: Conducted Spurious Emissions - 12-16 GHz	15
Figure 19: Conducted Spurious Emissions - 16-20 GHz	15
Figure 20: Conducted Spurious Emissions - 20-24 GHz	16
Figure 22: 99% Occupied Bandwidth - Low Band Channel	17
Figure 23: 99% Occupied Bandwidth - High Band Channel	18
Figure 24: Cabinet Spurious Emissions, TX OFF, 30-1000 MHz	21
Figure 25: Cabinet Spurious Emissions, TX ON, 30-1000 MHz	22
Figure 26: Cabinet Spurious Emissions, TX ON, 1-6 GHz, Horizontal	22
Figure 27: Cabinet Spurious Emissions, TX ON, 1-6 GHz, Vertical	22
Figure 28: Cabinet Spurious Emissions, TX ON, 2x harmonic	23

List of Terms and Abbreviations

AC	Alternating Current
ACF	Antenna Correction Factor
Cal	Calibration
d	Measurement Distance
dB	Decibels
dBμA	Decibels above one microamp
dBμV	Decibels above one microvolt
dBμA/m	Decibels above one microamp per meter
dBμV/m	Decibels above one microvolt per meter
DC	Direct Current
E	Electric Field
DSL	Digital Subscriber Line
ESD	Electrostatic Discharge
EUT	Equipment Under Test
f	Frequency
FCC	Federal Communications Commission
GRP	Ground Reference Plane
H	Magnetic Field
HCP	Horizontal Coupling Plane
Hz	Hertz
IEC	International Electrotechnical Commission
kHz	kilohertz
kPa	kilopascal
kV	kilovolt
LISN	Line Impedance Stabilization Network
MHz	Megahertz
μH	microhenry
μ	microfarad
μs	microseconds
NEBS	Network Equipment-Building System
PRF	Pulse Repetition Frequency
RF	Radio Frequency
RMS	Root-Mean-Square
TWT	Traveling Wave Tube
V/m	Volts per meter
VCP	Vertical Coupling Plane

I. Executive Summary

A. Purpose of Test

An EMC evaluation to determine compliance of the Sirius XM Satellite Radio model DBESR-20W with the requirements of Part 25 was performed. All references are to the most current version of Title 47 of the Code of Federal Regulations in effect. In accordance with §2.1033, the following data is presented in support of the Certification of the Sirius XM Satellite Radio model DBESR-20W. Sirius XM Satellite Radio should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the DBESR-20W has been **permanently** discontinued.

B. Requirements Summary

The following tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 25, in accordance with Sirius XM Satellite Radio, quote number 1SIR1103R1. All tests were conducted using measurement procedure ANSI C63.26-2015.

FCC Reference	Description	Compliance
§25.214 (d)(1)	Peak to Average Ratio (PAPR)	Compliant
§2.1051, 25.202(h)(1)	Spurious at Antennas; Out-of-Band Emissions Limits	Compliant
§2,1046, 25.214 (d)(1)	RF Output Power	Compliant
§2.1049	Occupied Bandwidth	Compliant
§25.202(d)	Frequency Stability over Temperature/Voltage	Compliant
§2.1053, 25.202 (h) (1)	Cabinet Spurious Radiation	Compliant
§1.1310	RF Exposure	Compliant

Table 1: Requirements Summary of EMC Part 25 Compliance Testing

II. Equipment Configuration

A. Overview

Eurofins Electrical and Electronics Testing NA, Inc. was contracted by Sirius XM Satellite Radio to perform testing on the DBESR-20W, under Sirius XM Satellite Radio's PO number 415715.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Sirius XM Satellite Radio, DBESR-20W.

The results obtained relate only to the item(s) tested.

Model Tested:	DBESR-20W		
Model Covered:	DBESR-20W		
EUT Specifications:	Primary Power:	120/208 VAC	
	FCC ID:	RS2DBESR20W	
	Type of Modulations:	COFDM	
	EUT Frequency Ranges:	Center Frequency (MHz)	Bandwidth (MHz)
		2338.75	5.00
		2326.255	4.00
Analysis:	The results obtained relate only to the item(s) tested.		
Environmental Test Conditions:	Temperature: 15-35° C		
	Relative Humidity: 30-60%		
	Barometric Pressure: 860-1060 mbar		
Evaluated by:	Donald Salguero		
Report Date:	05/18/2021		

Table 2: EUT Summary Table

B. References

CFR 47, Part 25	Federal Communication Commission, Code of Federal Regulations, Title 47, Part 25: Satellite Communications
ANSI C63.4:2014	Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical And Electronic Equipment in the Range of 9 kHz to 40 GHz
ISO/IEC 17025:2017	General Requirements for the Competence of Testing and Calibration Laboratories
KDB 971168 D01 v03r01	Measurement Guidance for Certification of Licensed Digital Transmitters
ANSI C63.26:2015	American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services.

Table 3: Standard References

C. Test Site

All testing was performed at Eurofins Electrical and Electronics Testing NA, Inc., 914 W. Patapsco Avenue, Baltimore, MD 21230. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology.

Radiated Emissions measurements were performed in semi-anechoic chamber. In accordance with §2.948(a)(3), a complete site description is contained at Eurofins Electrical and Electronics Testing NA, Inc.

D. Description of Test Sample

The DBESR-20W is a rack mounted signal repeater device for satellite programming transmission. The repeater repeats our satellite coverage in densely building populated cities/terrains. The Sirius XM DBE Spot Repeater ingests proprietary High Band and Low Band Ethernet based UDP streams via an Ethernet based router. The router provides signal path routing to the 2 DBE's UDP Exciters located in the rack mounted DBE Spot Repeater.. The 2 DBEs remove the UDP transport packaging and converts the data into a UDP based High Band and Low Band Terrestrial COFDM waveform. The two COFDM waveforms are GPS time synchronized and launched in exact time with Satellite based DRU Terrestrial COFDM waveforms implemented by Sirius XM DRU Repeaters.

E. Equipment Configuration

Name/Description	Model Number
Outdoor/Indoor Enclosure DBE Spot Repeater Cabinet	OD-50DXC
DBE 1 & 2	
SDARS Terrestrial Diplexer Filter Network	DFN-2332-xxx
Cisco Router	ISR-4200
MPA 1	MPA-2332-35
MPA 2	MPA-2332-35
Battery	SLA12-8F2
20W SDAR Directional Coupler/Detector	DCD-2332-xxx
Cooling Unit	N28
Dummy Load	

Table 4: Equipment Configuration

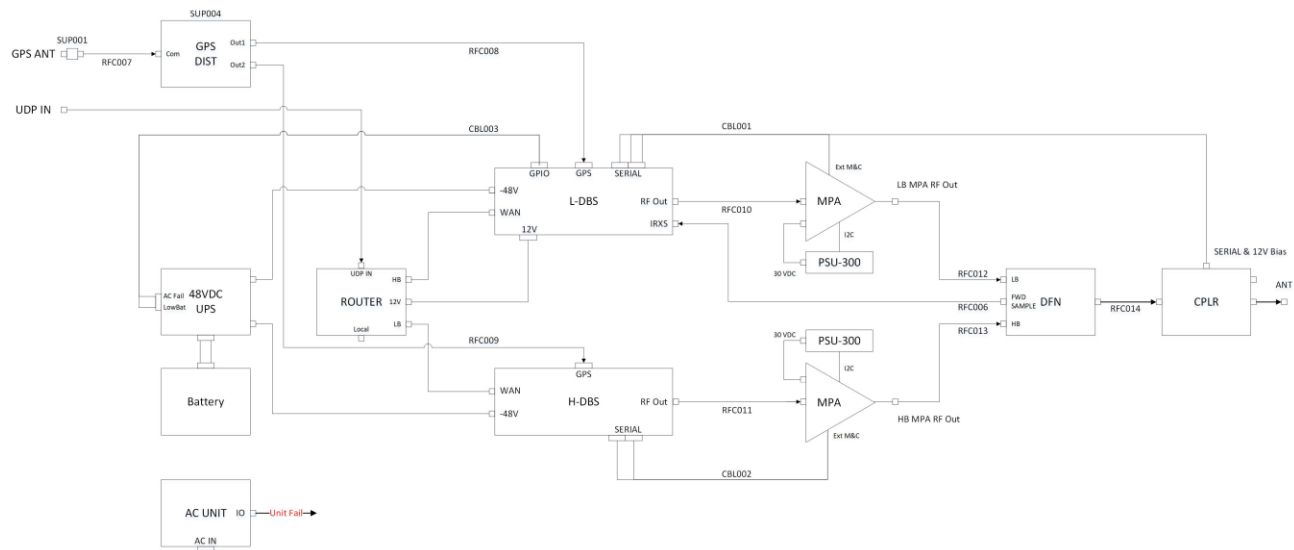


Figure 1: Block Diagram of Test Configuration

F. Support Equipment

The EUT did not require support equipment for testing or monitoring.

G. Ports and Cabling Information

Ref.ID	Port Name on EUT	Cable Desc. or reason for none	QTY	Length as tested (m)	Max Length (m)	Shielded?	Termination Box ID & Port Name
	Output port.	RF Coax Cable	1			Yes	
	Low Band DBE 'Ethernet' port.	Ethernet Cable	1			Yes	
	GPS	RG59 Coax	1	30	60	Yes	GPS Input
	AC Input	3 conductor, 18 awg	1	2	3	Yes	(208-240v/50hz)

Table 5: Ports and Cabling Information

H. Mode of Operation

The EUT would operate normally under testing circumstances when powered on and put in the TX (only) mode via a PC, which would simulate normal field operations with a total power output of 46 dBm (40W), i.e., 23 dBm (20W) for each frequency operational band (high & low band) at the output port of the unit. This power output is terminated into a dummy load during the testing exercise. The EUT is pre-programmed via an Ethernet port via a PC to configure the unit to behave normally as designed to behave under normal operational circumstances with a synchronized GPS source.

I. Monitoring Method

1. Confirm all devices in the EUT are on and operating normally, with their normal indicator LED lights lit.
2. Confirm error-free data is being transferred from the Ethernet devices to both DBE devices.
3. Confirm that there's always a GPS lock on both DBEs via the GUI display on the PC.
4. Lastly, confirm that the power output from the EUT is always 46 dBm (40W) via the GUI display on the PC.

J. Modifications

a) Modifications to EUT

No modifications were made to the EUT.

b) Modifications to Test Standard

No modifications were made to the Test Standard.

K. Disposition of EUT

The test sample including all support equipment submitted to the Electro-Magnetic Compatibility Lab for testing was returned to Sirius XM Satellite Radio upon completion of testing.

III. Electromagnetic Compatibility Criteria for Intentional Radiators

Electromagnetic Compatibility Criteria for Satellite Communications

§2,1046, 25.214 (d)(1) RF Output Power

Test Requirement(s): §25.214(d)(1): *Power limit for SDARS terrestrial repeaters.* (1) SDARS terrestrial repeaters must be operated at a power level less than or equal to 12-kW average EIRP, with a maximum peak-to-average power ratio of 13 dB.

Test Procedures: The EUT was connected directly to a spectrum analyzer using appropriate attenuation. Settings for the spectrum analyzer were followed using the guidance provided in FCC KDB 971168 D01, section 5.2.2 which references subclause 5.2.4.4.1 of ANSI C63.26-2015. An RMS Power averaging detector was selected and the trace was averaged over at least 100 traces. The RF Output Power was recorded.

Test Results: The EUT is **compliant** with the requirements of this section.

Test Engineer: Donald Salguero

Test Date: April 27, 2021

Channel	Average Conducted Output Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit (kW)	Limit (dBm)	Margin (dB)
Dual Channel	45.88	18	63.88	12	70.79	-6.91
Low Band Channel	42.9	18	60.9	12	70.79	-9.89
High Band Channel	43.06	18	61.06	12	70.79	-9.73

Table 6: RF Output Power, Test Results

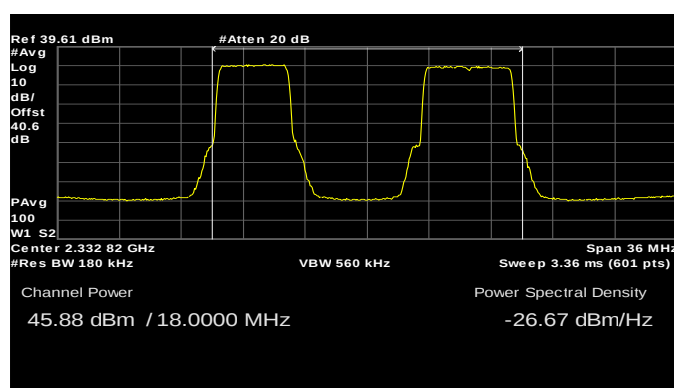


Figure 2: Conducted Output Power - Average - Dual Band Channel

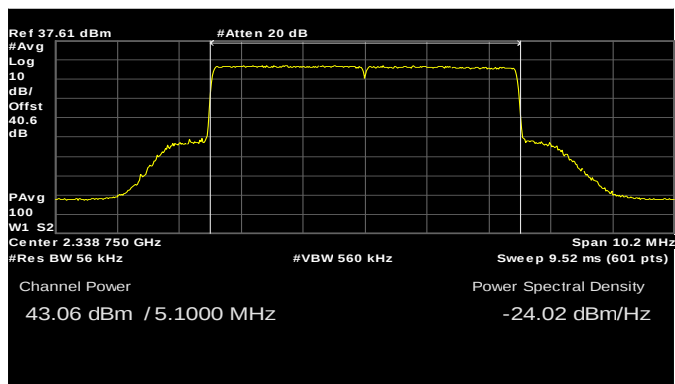


Figure 3: Conducted Output Power - Average - High Band Channel

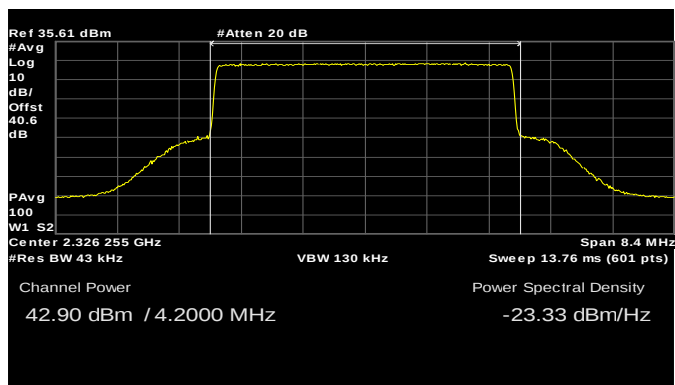


Figure 4: Conducted Output Power - Average - Low Band Channel

Electromagnetic Compatibility Criteria for Satellite Communications

§25.214 (d)(1) Peak to Average Ratio (PAPR)

Test Requirement(s): §25.144(e)(7)(ii): In addition to the procedures set forth in subpart J of part 2 of this chapter, power measurements for SDARS repeater transmitters may be made in accordance with a Commission-approved average power technique. Peak-to-average power ratio (PAPR) measurements for SDARS repeater transmitters should be made using either an instrument with complementary cumulative distribution function (CCDF) capabilities to determine that the PAPR will not exceed 13 dB for more than 0.1 percent of the time or another Commission approved procedure. The measurement must be performed using a signal corresponding to the highest PAPR expected during periods of continuous transmission.

§25.214(d)(1): *Power limit for SDARS terrestrial repeaters.* (1) SDARS terrestrial repeaters must be operated at a power level less than or equal to 12-kW average EIRP, with a maximum peak-to-average power ratio of 13 dB.

Test Procedures: The EUT was connected to a spectrum analyzer using appropriate attenuation and the CCDF measurement function was used to measure the Peak to Average Power Ratio. Settings for the spectrum analyzer were set to the parameters provided in FCC KDB 971168 D01. The measurement bandwidth was set to a value greater than the 99% Bandwidth. The measurement interval used was 1 ms. The maximum PAPR level associated with a probability of 0.1% was compared to the limit.

Test Results: The EUT is **compliant** with the requirements of this section.

Test Engineer: Donald Salguero

Test Date: 04/27/2021

Center Frequency (MHz)	Average Conducted Output Power (dBm)	PAPR at 0.1% (dB)	Peak Conducted Output Power (dBm)
2326.255	42.9	8.07	51.95
2338.75	43.06	8.18	51.95

Table 7: Peak-to-Average Ratio (PAPR), Test Results

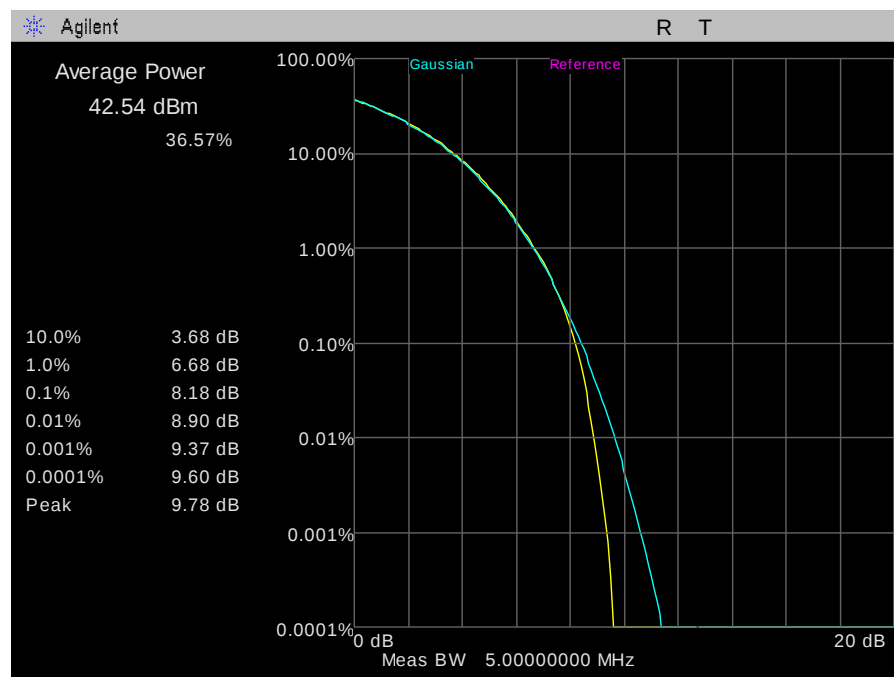


Figure 5: PAPR - high band channel

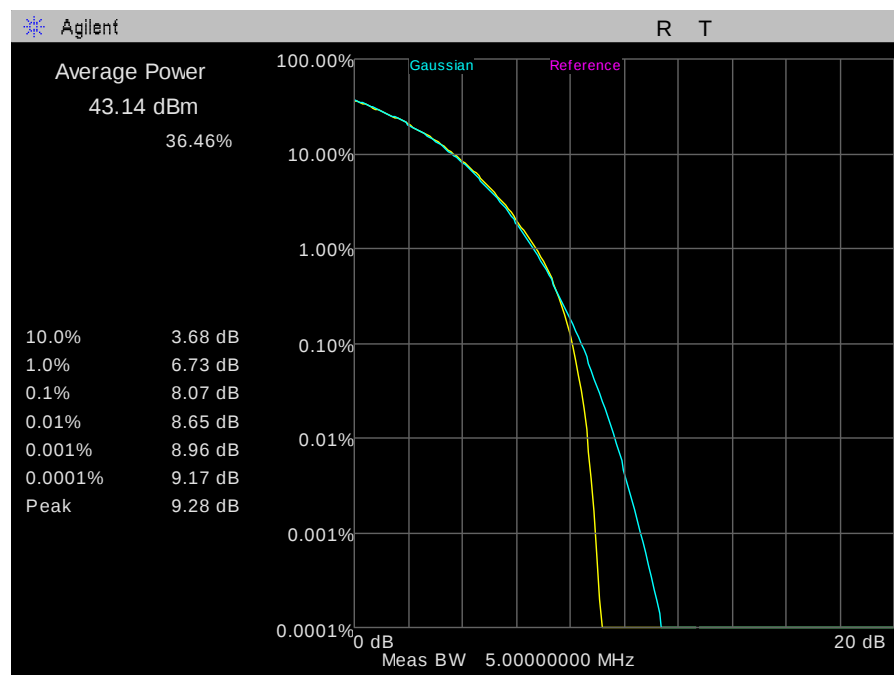


Figure 6: PAPR - low band channel

Electromagnetic Compatibility Criteria for Satellite Communications

§25.202(h)(1) Spurious at Antenna Port

Test Requirement(s): §25.202(h): *Out-of-band emission limitations for SDARS terrestrial repeaters.* (1) Any SDARS terrestrial repeater operating at a power level greater than 2-watt average EIRP is required to attenuate its out-of-band emissions below the transmitter power P by a factor of not less than $90 + 10 \log(P)$ dB in a 1-megahertz bandwidth outside the 2320-2345 MHz band, where P is average transmitter output power in watts.

Test Procedures: The EUT was connected to a spectrum analyzer using appropriate attenuation and a tuned band reject filter centered at the transmit frequency. Care was taken to ensure that the appropriate adjustments for cable and reject filter losses were used for each measurement range.

For below 1 GHz measurements, cables losses and band reject attenuation were loaded into the spectrum analyzers corrections option. An external attenuator of 10 dB was added to the front end of the analyzer.

For above 1 GHz measurements, an external attenuator of 10 dB was added to the front end of the spectrum analyzer. The cable losses, band reject were swept, together for corrections, and loaded into the analyzers corrections option.

The correct limit is based on $90 + 10 \log(P)$ dB; -60 dBm.

Note: Out of Band Edge Emissions were investigated and deemed to be compliant under the $(90 + 10 \log(P))/1$ MHz guideline.

Test Results: The EUT is **compliant** with the requirements of this section.

Test Engineer: Donald Salguero

Test Date: 04/29/2021

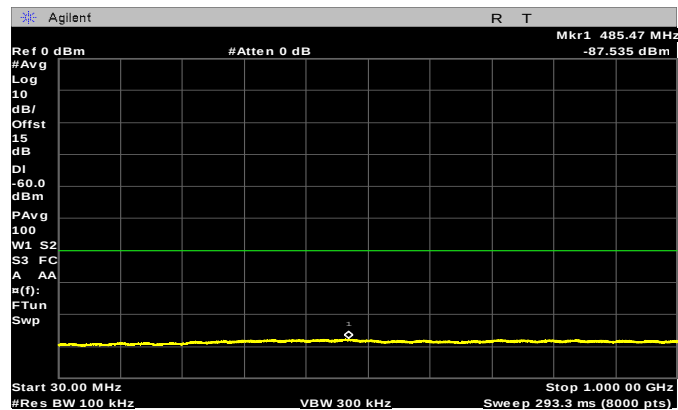


Figure 7: Conducted Spurious Emissions - 30-1000 MHz

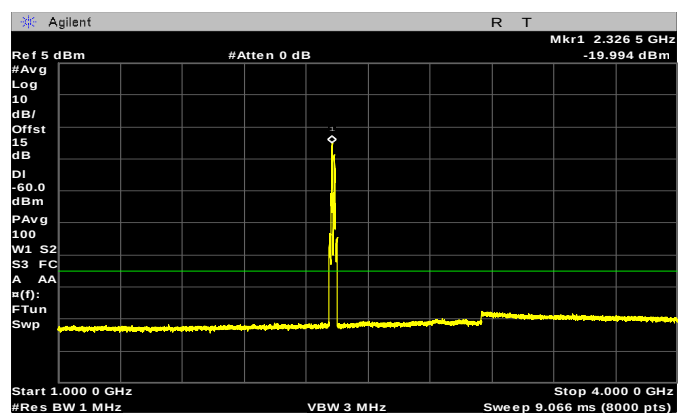


Figure 8: Conducted Spurious Emissions - 1-4 GHz

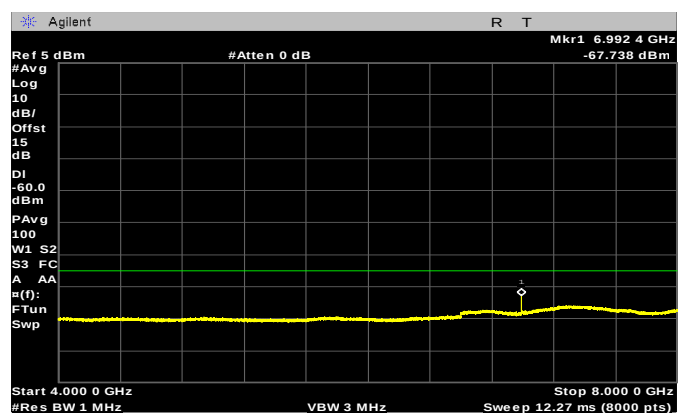


Figure 9: Conducted Spurious Emissions - 4-8 GHz

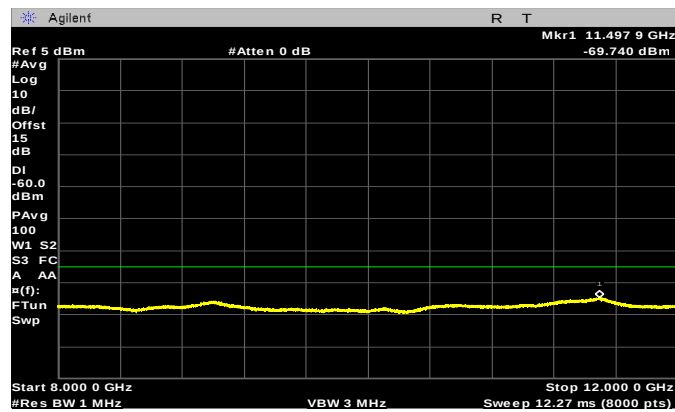


Figure 10: Conducted Spurious Emissions - 8-12 GHz

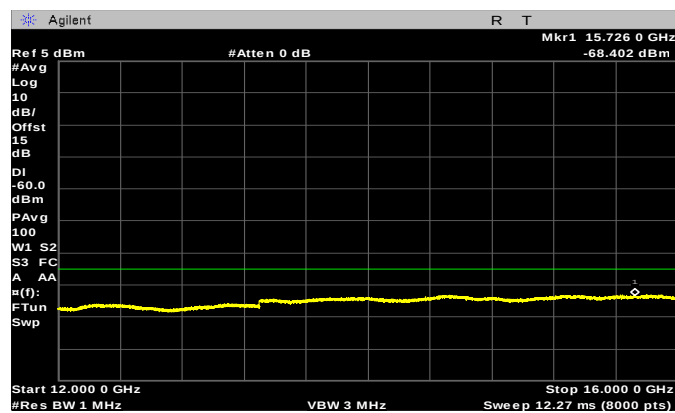


Figure 11: Conducted Spurious Emissions - 12-16 GHz

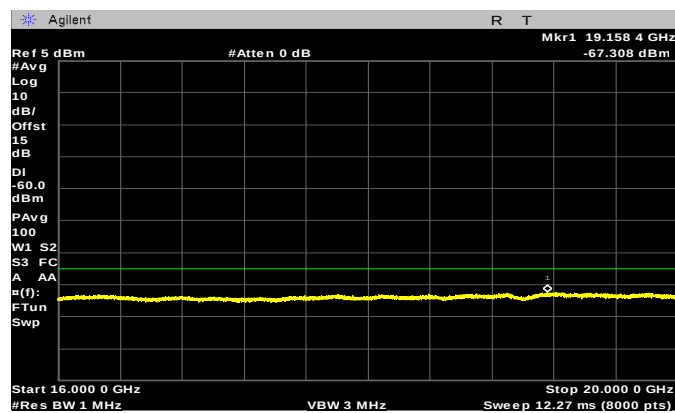


Figure 12: Conducted Spurious Emissions - 16-20 GHz

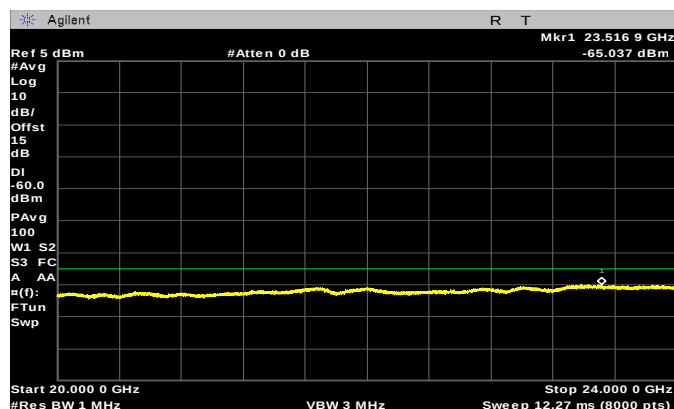


Figure 13: Conducted Spurious Emissions - 20-24 GHz

Electromagnetic Compatibility Criteria for Satellite Communications

§2.1049 Occupied Bandwidth

Test Requirement(s): §2.1049

Test Procedures: As required by 47 CFR 2.1049, *occupied bandwidth measurements* were made at the RF output terminals using a Spectrum Analyzer.

A laptop was connected to EUT to control the RF power output and frequency channel. The EUT was connected to a Spectrum Analyzer via attenuator. The measured highest Average Power was set relative to zero dB reference. The RBW of the Spectrum Analyzer was set to at least 1% of the channel bandwidth. The EUT power was adjusted at the maximum output power level.

Test Results: The EUT is **compliant** with the requirements of this section.

Test Engineer: Donald Salguero

Test Date: 04/26/2021

Center Frequency (MHz)	99% Occupied Bandwidth (MHz)
2326.255	3.9728
2338.75	4.9546

Table 8: Occupied Bandwidth, Test Results

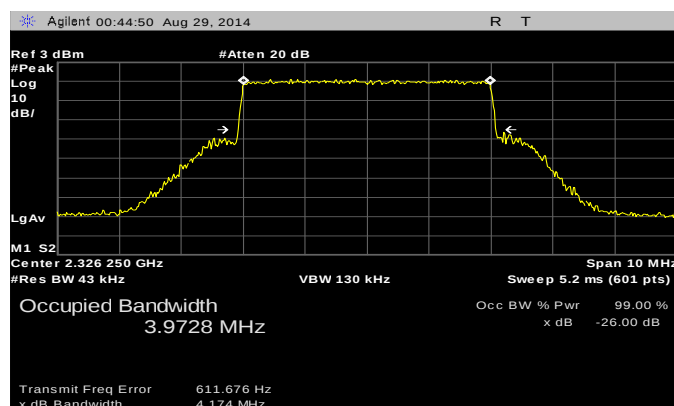


Figure 14: 99% Occupied Bandwidth - Low Band Channel

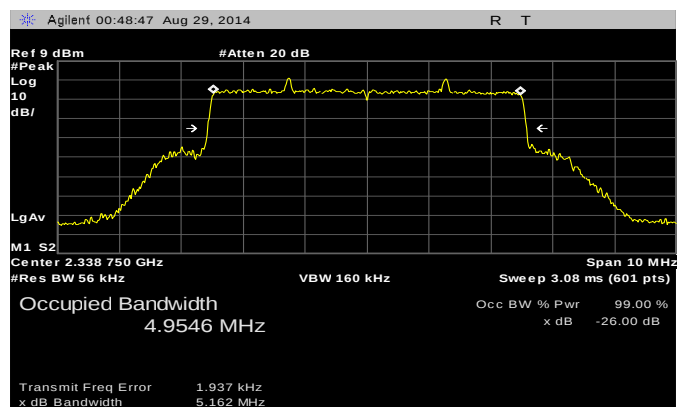


Figure 15: 99% Occupied Bandwidth - High Band Channel

Electromagnetic Compatibility Criteria for Satellite Communications

§25.202(d) Frequency Stability

Test Requirement(s): §25.202(d) **Frequency Tolerance, Earth Stations** – The carrier frequency of each earth station transmitter authorized in these services shall be maintained within 0.001 percent of the reference frequency.

Test Procedures: The resolution bandwidth of the spectrum analyzer was set to 1 kHz and the trace was set to max hold. The EUT was set to transmit at max power. At nominal input voltage and at 20°C, the center frequency of each channel was measured using a frequency counter. At 20°C, the input voltage was varied between 85% and 115% of nominal and the measurement was repeated. The temperature was increased and decreased in increments of no more than 10°C and the center frequency measurement was repeated. For each case, the measured center frequency was compared to the reference frequency taken at 20°C and 120vac.

Test Results: The EUT is **compliant** with the requirements of this section.

Test Engineer: Donald Salguero

Test Date: 04/28/2021

Low band					
AC Voltage (V)	Temperature (°C)	Frequency Low (MHz)	Frequency High (MHz)	Center Frequency (MHz)	Deviation (%)
120	50	2324.18000	2328.32000	2326.25000	0.00000
120	40	2324.17000	2328.33000	2326.25000	0.00000
120	30	2324.19000	2328.33000	2326.26000	0.00043
120	20	2324.18000	2328.33000	2326.25500	0.00021
120	10	2324.17000	2328.33000	2326.25000	0.00000
120	0	2324.18000	2328.33000	2326.25500	0.00021
120	-10	2324.17000	2328.33000	2326.25000	0.00000
120	-20	2324.18000	2328.32000	2326.25000	0.00000
120	-30	2324.18000	2328.33000	2326.25500	0.00021
102	20	2324.18000	2328.33000	2326.25500	0.00021
138	20	2324.16000	2328.34000	2326.25000	0.00000

Table 9: Frequency Stability, Test Results, Low Band

High band					
AC Voltage (V)	Temperature (°C)	Frequency Low (MHz)	Frequency High (MHz)	Center Frequency (MHz)	Deviation (%)
120	50	2336.18000	2341.32000	2338.75000	0.00021
120	40	2336.20000	2341.31000	2338.75500	0.00000
120	30	2336.18000	2341.31000	2338.74500	0.00043
120	20	2336.18000	2341.34000	2338.76000	0.00021
120	10	2336.20000	2341.31000	2338.75500	0.00000
120	0	2336.20000	2341.30000	2338.75000	0.00021
120	-10	2336.20000	2341.30000	2338.75000	0.00021
120	-20	2336.20000	2341.32000	2338.76000	0.00021
120	-30	2336.20000	2341.32000	2338.76000	0.00021
102	20	2336.20000	2341.32000	2338.76000	0.00021
138	20	2336.20000	2341.30000	2338.75000	0.00021

Table 10: Frequency Stability, Test Results, High Band

Electromagnetic Compatibility Criteria for Satellite Communications

§2.1053 Cabinet Spurious Radiation

Test Requirement(s): §2.1053

Test Procedures: The EUT was placed on the turntable inside a semi-anechoic chamber. A biconilog receiving antenna on an antenna mast was positioned at a distance of 1 meter for measurements in the 30-1000MHz range. For all measurements above 1000MHz, a horn antenna was used at a distance of 0.5 meters and hand measurements were recorded inside the chamber with a spectrum analyzer. Measurements were recorded with both polarizations, using calibrated antennas and spectrum analyzers; no emissions of concern were observed.

Field strength measurements were converted to EIRP values and compared to the -60dBm limit using the following formula:

$EIRP \text{ (dBm)} = E \text{ (dB}\mu\text{V/m)} + 20\log(d) - 104.8$, where 'd' is the measuring distance in meters.

Test Results: The EUT is **compliant** with the requirements of this section. Emissions were investigated up to 10th harmonic. Only noise floor observed on the higher frequencies, noise floor was below applicable limits.

Test Engineer: Donald Salguero

Test Date: October 8, 2019

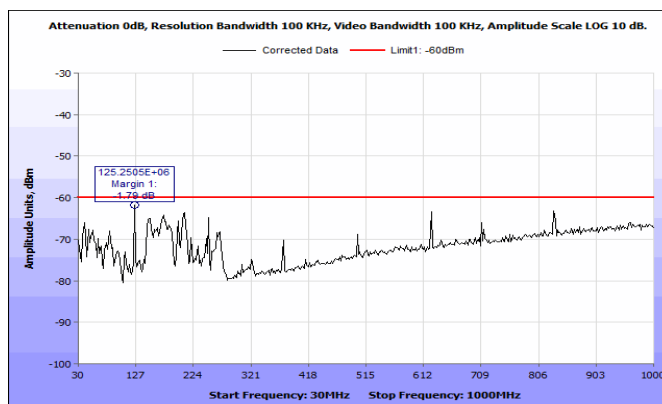


Figure 16: Cabinet Spurious Emissions, TX OFF, 30-1000 MHz.

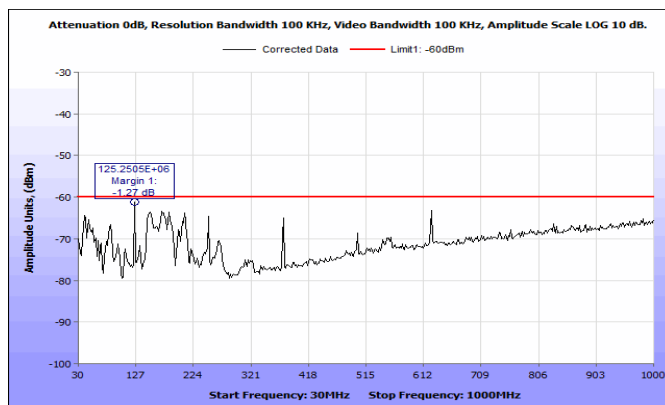


Figure 17: Cabinet Spurious Emissions, TX ON, 30-1000 MHz.

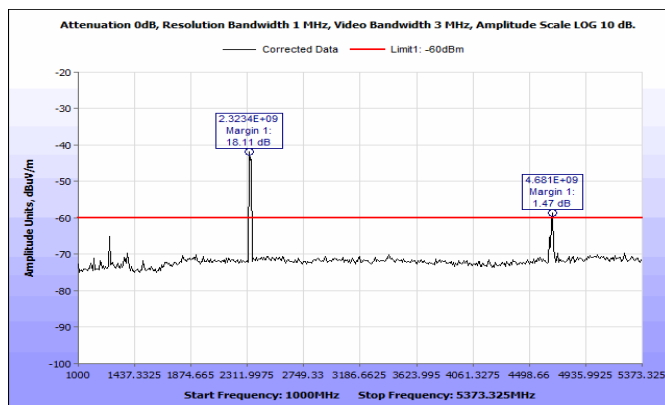


Figure 18: Cabinet Spurious Emissions, TX ON, 1-6 GHz, Horizontal.

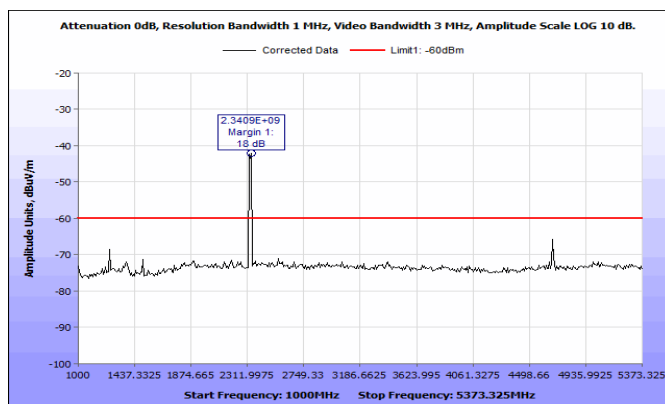


Figure 19: Cabinet Spurious Emissions, TX ON, 1-6 GHz, Vertical.

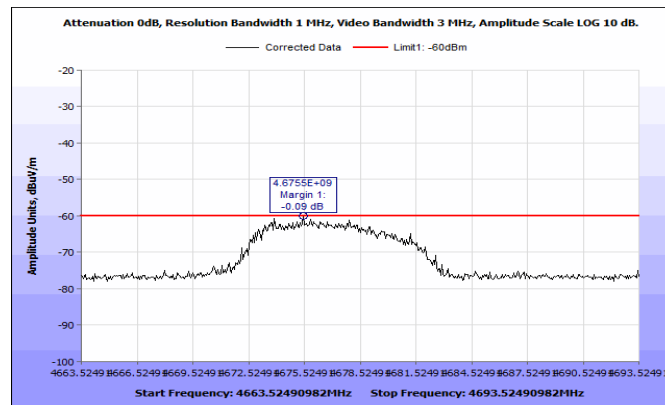


Figure 20: Cabinet Spurious Emissions, TX ON, 2x harmonic.

Electromagnetic Compatibility Criteria for Satellite Communications

§1.1310 Radiofrequency radiation exposure limits

RF Exposure Requirements: **§1.1307(b)(1) and §1.1307(b)(2):** Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

As required by §§ 2.1091(d)(2) and 2.1093(d)(5), RF exposure compliance must be determined at the maximum average power level according to source-based time-averaging requirements to determine compliance for general population exposure conditions. Unless it is specified differently in the published RF exposure KDB procedures, these requirements also apply to test reduction and test exclusion considerations. Time-averaged maximum conducted output power applies to SAR and, as required by § 2.1091(c), time-averaged effective radiated power applies to MPE

RF Radiation Exposure Limit: **§1.1310:** As specified in this section, the Maximum Permissible Exposure (MPE) Limit shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in Sec. 1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of Sec. 2.1093 of this chapter.

MPE Limit: EUT's operating frequencies @ 2326.250 - 2338.755 MHz; **Limit for Uncontrolled exposure: 1 mW/cm² or 10 W/m²**

$$S = PG / 4\pi R^2 \quad \text{or} \quad R = \sqrt{(PG / 4\pi S)}$$

where, S = Power Density (mW/cm²)
P = Power Input to antenna (mW)
G = Antenna Gain (numeric value)
R = Distance (cm)

Result:

FCC									
Frequency (MHz)	Con. Pwr. (dBm)	Con. Pwr. (mW)	Ant. Gain (dBi)	Ant. Gain numeric	Pwr. Density (mW/cm ²)	Limit (mW/cm ²)	Margin	Distance (cm)	Result
2338.755	47	50118.723	18	63.096	1	1	0	501.643	Pass

*Conducted power accounts for a +1dB of tune up tolerance.

The safe distance where Power Density is less than the MPE Limit listed above was found to be 501.643 cm.

IV. Test Equipment

Test Equipment

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ISO/IEC 17025:2017.

MET ASSET#	EQUIPMENT	MANUFACTURER	MODEL#	CAL DATE	CAL DUE
1T4300B	Semi-Anechoic 3m Chamber sVSWR	EMC TEST SYSTEMS	NONE	8/16/2019	8/16/2021
1T4300	SEMI-ANECHOIC CHAMBER (NSA)	EMC TEST SYSTEMS	NONE	8/16/2019	8/16/2021
1T4753	Antenna - Bilog	Sunol Sciences	JB6	12/21/2020	6/21/2022
1T4757	Antenna; Horn	ETS-Lindgren	3117	6/29/2020	12/29/2021
1T8743	Preamplifier	A.H. Systems, Inc.	PAM-0118P	Func Verify	
1T4409	EMI Receiver	Rohde & Schwarz	ESIB7	1/21/2021	1/21/2022
1T8744	Spectrum Analyzer (PSA)	Agilent Technologies	E4440A	12/14/2020	6/14/2022
1T4205	Attenuator	WEINSCHEL CORP	53-40-33	Func Verify	
2T5826	Environmental Chamber (H5)	Thermotron	Controller THCM4-40-40	9/19/2019	9/19/2020
1T8374	Power Supply	Ametek Programmable Power	CSW5550-160-208-704	Func Verify	

Table 11: Test Equipment List

Note: Functionally verified test equipment is verified using calibrated instrumentation at time of testing.

V. Certification & User's Manual Information

Certification Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart I — Marketing of Radio frequency devices:

§ 2.801 Radio-frequency device defined.

As used in this part, a radio-frequency device is any device which in its operation is capable of Emitting radio-frequency energy by radiation, conduction, or other means. Radio- frequency devices include, but are not limited to:

- (a) The various types of radio communication transmitting devices described throughout this chapter.
- (b) *The incidental, unintentional and intentional radiators defined in Part 15 of this chapter.*
- (c) The industrial, scientific, and medical equipment described in Part 18 of this chapter.
- (d) Any part or component thereof which in use emits radio-frequency energy by radiation, conduction, or other means.

§ 2.803 Marketing of radio frequency devices prior to equipment authorization.

- (a) Except as provided elsewhere in this chapter, no person shall sell or lease, or offer for sale or lease (including advertising for sale or lease), or import, ship or distribute for the purpose of selling or leasing or offering for sale or lease, any radio frequency device unless:
 - (1) In the case of a device subject to certification, such device has been authorized by the Commission in accordance with the rules in this chapter and is properly identified and labeled as required by §2.925 and other relevant sections in this chapter; or
 - (2) In the case of a device that is not required to have a grant of equipment authorization issued by the Commission, but which must comply with the specified technical standards prior to use, such device also complies with all applicable administrative (including verification of the equipment or authorization under a Declaration of Conformity, where required), technical, labeling and identification requirements specified in this chapter.
- (d) Notwithstanding the provisions of paragraph (a) of this section, the offer for sale solely to business, commercial, industrial, scientific or medical users (but not an offer for sale to other parties or to end users located in a residential environment) of a radio frequency device that is in the conceptual, developmental, design or pre-production stage is permitted prior to equipment authorization or, for devices not subject to the equipment authorization requirements, prior to a determination of compliance with the applicable technical requirements *provided* that the prospective buyer is advised in writing at the time of the offer for sale that the equipment is subject to the FCC rules and that the equipment will comply with the appropriate rules before delivery to the buyer or to centers of distribution.
- (e)(1) Notwithstanding the provisions of paragraph (a) of this section, prior to equipment authorization or determination of compliance with the applicable technical requirements any radio frequency device may be operated, but not marketed, for the following purposes and under the following conditions:

- (i) *Compliance testing;*
 - (ii) Demonstrations at a trade show provided the notice contained in paragraph (c) of this section is displayed in a conspicuous location on, or immediately adjacent to, the device;
 - (iii) Demonstrations at an exhibition conducted at a business, commercial, industrial, scientific or medical location, but excluding locations in a residential environment, provided the notice contained in paragraphs (c) or (d) of this section, as appropriate, is displayed in a conspicuous location on, or immediately adjacent to, the device;
 - (iv) Evaluation of product performance and determination of customer acceptability, provided such operation takes place at the manufacturer's facilities during developmental, design or pre-production states; or
 - (v) Evaluation of product performance and determination of customer acceptability where customer acceptability of a radio frequency device cannot be determined at the manufacturer's facilities because of size or unique capability of the device, provided the device is operated at a business, commercial, industrial, scientific or medical user's site, but not at a residential site, during the development, design or pre-production stages.
- (e)(2) For the purpose of paragraphs (e)(1)(iv) and (e)(1)(v) of this section, the term *manufacturer's facilities* includes the facilities of the party responsible for compliance with the regulations and the manufacturer's premises, as well as the facilities of other entities working under the authorization of the responsible party in connection with the development and manufacture, but not the marketing, of the equipment.
- (f) For radio frequency devices subject to verification and sold solely to business, commercial, industrial, scientific and medical users (excluding products sold to other parties or for operation in a residential environment), parties responsible for verification of the devices shall have the option of ensuring compliance with the applicable technical specifications of this chapter at each end user's location after installation, provided that the purchase or lease agreement includes a proviso that such a determination of compliance be made and is the responsibility of the party responsible for verification of the equipment.

The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart J —
Equipment Authorization Procedures:

§ 2.901 Basis and Purpose

- (a) In order to carry out its responsibilities under the Communications Act and the various treaties and international regulations, and in order to promote efficient use of the radio spectrum, the Commission has developed technical standards for radio frequency equipment and parts or components thereof. The technical standards applicable to individual types of equipment are found in that part of the rules governing the service wherein the equipment is to be operated.¹ *In addition to the technical standards provided, the rules governing the service may require that such equipment be verified by the manufacturer or importer*, be authorized under a Declaration of Conformity, or receive an equipment authorization from the Commission by one of the following procedures: certification or registration.
- (b) The following sections describe the verification procedure, the procedure for a Declaration of Conformity, and the procedures to be followed in obtaining certification from the Commission and the conditions attendant to such a grant.

§ 2.907 Certification

- (a) Certification is an equipment authorization issued by the Commission, based on representation and test data submitted by the applicant.
- (b) Certification attaches to all units subsequently marketed by the grantee which are identical (see Section 2.908) to the sample tested except for permissive changes or other variations authorized by the Commission pursuant to Section 2.1043.

¹ In this case, the equipment is subject to the rules of Part 15. More specifically, the equipment falls under Subpart B (of Part 15), which deals with unintentional radiators.

§ 2.948 Description of measurement facilities.

- (a) Each party making measurements of equipment that is subject to an equipment authorization under Part 15 or Part 18 of this chapter, regardless of whether the measurements are filed with the Commission or kept on file by the party responsible for compliance of equipment marketed within the U.S. or its possessions, shall compile a description of the measurement facilities employed.
 - (1) If the measured equipment is subject to the verification procedure, the description of the measurement facilities shall be retained by the party responsible for verification of the equipment.
 - (i) *If the equipment is verified through measurements performed by an independent laboratory, it is acceptable for the party responsible for verification of the equipment to rely upon the description of the measurement facilities retained by or placed on file with the Commission by that laboratory. In this situation, the party responsible for the verification of the equipment is not required to retain a duplicate copy of the description of the measurement facilities.*
 - (ii) If the equipment is verified based on measurements performed at the installation site of the equipment, no specific site calibration data is required. It is acceptable to retain the description of the measurement facilities at the site at which the measurements were performed.
 - (2) If the equipment is to be authorized by the Commission under the certification procedure, the description of the measurement facilities shall be filed with the Commission's Laboratory in Columbia, Maryland. The data describing the measurement facilities need only be filed once but must be updated as changes are made to the measurement facilities or as otherwise described in this section. At least every three years, the organization responsible for filing the data with the Commission shall certify that the data on file is current.

L. Label and User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 15, Subpart A — General:

§ 15.19 Labeling requirements.

(a) *In addition to the requirements in Part 2 of this chapter, a device subject to certification or verification shall be labeled as follows:*

- (1) Receivers associated with the operation of a licensed radio service, e.g., FM broadcast under Part 73 of this chapter, land mobile operation under Part 90, etc., shall bear the following statement in a conspicuous location on the device:

This device complies with Part 15 of the FCC Rules. Operation is subject to the condition that this device does not cause harmful interference.

- (2) A stand-alone cable input selector switch, shall bear the following statement in a conspicuous location on the device:

This device is verified to comply with Part 15 of the FCC Rules for use with cable television service.

- (3) All other devices shall bear the following statement in a conspicuous location on the device:

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

- (4) Where a device is constructed in two or more sections connected by wires and marketed together, the statement specified under paragraph (a) of this section is required to be affixed only to the main control unit.

- (5) When the device is so small or for such use that it is not practicable to place the statement specified under paragraph (a) of this section on it, the information required by this paragraph shall be placed in a prominent location in the instruction manual or pamphlet supplied to the user or, alternatively, shall be placed on the container in which the device is marketed. However, the FCC identifier or the unique identifier, as appropriate, must be displayed on the device.

§ 15.21 Information to user.

The user's manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

The following is extracted from Title 47 of the Code of Federal Regulations, Part 15, Subpart B — Unintentional Radiators:

§ 15.105 Information to the user.

- (a) For a Class B digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a residential environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

End of Report