

Test Report

Prepared for: Icom Inc

EUT Name: IP Advanced Radio System
Model: IP504H

FCC ID: AFJ293100
IC: 202D-293100

To

FCC Part 15.247
And
ISED RSS-247

Date of Issue: 09/13/2022

On the behalf of the applicant:

ICOM Incorporated
1-1-32, Kamiminami
Hirano-Ku
Osaka 547-0003, Japan

Attention of:

Atsushi Tomiyama, General Manager of QA Department
Ph: +81 6 6793 8424
Email: world_support@icom.co.jp

Prepared By
Compliance Testing, LLC
1724 S. Nevada Way
Mesa, AZ 85204
(480) 926-3100 phone / (480) 926-3598 fax
www.compliancetesting.com
Project No: p21a0006

Authorized By

Aaron S. Froehlich
Sr RF/EMC Engineer

This report may not be reproduced, except in full, without written permission from Compliance Testing.
All results contained herein relate only to the sample tested.

Test Report Revision History

Revision	Date	Revised By	Reason for Revision
1.0	13 September 2022	Aaron S. Froehlich	Original Document
2.0	19 October 2022	Aaron S. Froehlich	Test Setup Photos removed to be held confidential

Table of Contents

<u>Description</u>	<u>Page</u>
Standard Test Conditions Engineering Practices	6
Occupied Bandwidth	10
Output Power	16
Carrier Frequency Separation.....	20
Number of Hopping Frequencies	21
Time of Occupancy (Dwell Time).....	22
Duty Cycle.....	24
Emissions at Band Edges	26
Conducted Spurious Emissions	29
Radiated Spurious Emissions	34
Receiver Radiated Spurious Emissions	43
Test Equipment Utilized	49
Measurement Uncertainty	50
Test Setup Photos	Error! Bookmark not defined.

ANAB

Compliance Testing, LLC, has been accredited in accordance with the recognized International Standard ISO/IEC 17025:2017. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to the joint ISO-ILAC-IAF Communiqué dated January 2009).

The tests results contained within this test report all fall within our scope of accreditation.

Please refer to <http://www.compliancetesting.com/labscope.html> for current scope of accreditation.



FCC Site Reg. #349717

IC Site Reg. #2044A-2

The applicant has been cautioned as to the following

15.21 - Information to User

The user's manual or instruction manual for an intentional 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.

15.27(a) - Special Accessories

Equipment marked to a consumer must be capable of complying with the necessary regulations in the configuration in which the equipment is marketed. Where special accessories, such as shielded cables and/or special connectors are required to enable an unintentional or intentional radiator to comply with the emission limits in this part, the equipment must be marketed with, i.e. shipped and sold with, those special accessories. However, in lieu of shipping or packaging the special accessories with the unintentional or intentional radiator, the responsible party may employ other methods of ensuring that the special accessories are provided to the consumer without an additional charge.

Information detailing any alternative method used to supply the special accessories for a grant of equipment authorization or retained in the verification records, as appropriate. The party responsible for the equipment, as detailed in § 2.909 of this chapter, shall ensure that these special accessories are provided with the equipment. The instruction manual for such devices shall include appropriate instructions on the first page of text concerned with the installation of the device that these special accessories must be used with the device. It is the responsibility of the user to use the needed special accessories supplied with the equipment.

Standard Test Conditions Engineering Practices

Except as noted herein, the following conditions and procedures were observed during the testing:

In accordance with ANSI C63.10-2013 and unless otherwise indicated in the specific measurement results, the ambient temperature of the actual EUT was maintained within the range of 10° to 40°C (50° to 104°F) unless the particular equipment requirements specified testing over a different temperature range. Also, unless otherwise indicated, the humidity levels were in the range of 10% to 90% relative humidity.

Measurement results, unless otherwise noted, are worst-case measurements.

Environmental Conditions		
Temperature (°C)	Humidity (%)	Pressure (mbar)
27.0	48.9	970.8

EUT Description

Product Marketing Name (PMN)	IP Advanced Radio system
Model:	IP504H
Hardware Version Identification Number (HVIN)	293100-01
Serial Number (SN)	NSN (Prototype)
Frequency Range	2402-2480 MHz
Number of Channels	79
Modulation(s)	GFSK, $\pi/4$ -DQPSK, 8DPSK
Data Rate(s)	1/2/3 Mbps
	Type: Multilayer Monopole Chip
	Part Number: AH 212M245001
Antenna	Pk Gain: 0.9 dBi
	Frequency Range: 2.4-2.5 GHz

General Description of EUT and its intended use:

The DUT is a battery powered handheld transceiver for audio transmission. The DUT cannot transmit while in its charging dock.

EUT operation during test:

A test mode sample with chip antenna attached was used for the Radiated Spurious Emissions (RSE) demonstration. All combinations of BT and LTE simultaneous transmission were investigated in 3 orthogonal axis and the worst case data has been reported. The built in SWG port was used to perform all other tests using Antenna Port Conducted measurements.

Test mode samples were operated via Qualcomm BlueSuite 2.4.13 BlueTest3 application. A BSCP to USB interface board was used with a support laptop. The commands utilized and their associated parameters are:

CFG PKT

Test Arguments:

Packet Type – Values between 3 and 31 corresponding to the data rate desired for test.

Packet Size – Always set to the maximum value allowable for that packet type.

TXDATA1 – Commands the DUT to transmit on a single frequency with PRBS9 data.

Test Arguments:

LO Freq: The frequency under test. Values used were 2402, 2441, 2480

Power (Ext, Int)

Ext – External amplification always set to a maximum value of 255

Int – Internal amplification, maximum value of 63 for Basic Data Rates, maximum value of 127 for Enhanced data rates

TXDATA2 – Commands the DUT to transmit with hopping active and PRBS9 data..

Test Arguments:

Country Code [obsolete command] = always 0

Power (Ext, Int)

Ext – External amplification always set to a maximum value of 255

Int – Internal amplification, maximum value of 63 for Basic Data Rates, maximum value of 127 for Enhanced data rates

RXDATA2 – enables the receiver with a simplified hop sequence.

Test Arguments:

Country Code = 0

Hi-side = 0

RX Attenuation = 0

Modes of Operation Tested:

Data Rate [Name]	Data Rate [Mbps]	Modulation	CFG PKT [Packet Type]	CFG PKT [Packet Size]
BDR DM1	1	GFSK	3	17
BDR DH3	1	GFSK	11	183
BDR DH5	1	GFSK	15	339
EDR DM1	2	$\pi/4$ -DQPSK	19	17
EDR 2-DH3	2	$\pi/4$ -DQPSK	26	367
EDR 3-DH3	3	8DPSK	27	552
EDR 2-DH5	2	$\pi/4$ -DQPSK	30	679
EDR 3-DH5	3	8DPSK	31	1021

BDR = Basic Data Rate

EDR = Enhanced Data Rate

Support Equipment

Qty	Description	Manufacturer	Model	S/N
1	Laptop	Dell	Latitude E6440	52YJQ32
1	Call Box	Rohde & Schwarz	CMW500	171198 / i00636

Support Cables:

Qty	Description	Length (M)	Shielding Y/N	Shielded Hood Y/N	Termination
1	USB 2.0	2.1	Y	Y	Communication Board

Modifications:

none

15.203: Antenna Requirement:

- ☒ The antenna is permanently attached to the EUT
- ☐ The antenna uses a unique coupling
- ☐ The EUT must be professionally installed
- ☐ The antenna requirement does not apply

Test Summary

FCC 15.247 Specification	RSS-247 Specification	Test Name	Pass, Fail, N/A	Comments
15.247(b)(1)	Section 5.4(b)	Output Power	Pass	
15.247(d)	Section 5.5	Conducted Spurious Emissions	Pass	
15.247(d), 15.209(a), 15.205	Section 5.5	Radiated Spurious Emissions	Pass	
NA	RSS-GEN Section 7.3	Receiver Radiated Emissions	Pass	
15.247(d), 15.209(a), 15.205	Section 5.5	Emissions At Band Edges	Pass	
15.247(a)(1)	Sections 5.1(a)	Occupied Bandwidth	Pass	RSS-Gen Section 6.7 99% BW Also Reported
15.247(a)	Section 5.1 (c)	Dwell Time	Pass	
15.247(a)	Section 5.1 (d)	Number of Hopping Channels	Pass	
15.247(a)	Section 5.1 (b)	Channel Separation	Pass	
15.207	RSS-GEN Section 8.8	A/C Powerline Conducted Emissions	N/A	No Connection to AC Mains

Statements of conformity are reported as:

- Pass - the measured value is below the acceptance limit, *acceptance limit = test limit*.
- Fail - the measured value is above the acceptance limit, *acceptance limit = test limit*.

References	Description
CFR47, Part 15, Subpart B	Unintentional Radiators
CFR47, Part 15, Subpart C	Intentional Radiators
RSS-247 Issue 2	Digital Transmission Systems (DTSs), Frequency Hoping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
RSS-GEN Issue 5	General Requirements for Compliance of Radio Apparatus
ANSI C63.10-2013	American National standard for testing Unlicensed Wireless Devices
ANSI C63.4-2014	Method and Measurements of Radio-Noise Emissions from low-Voltage Electrical and Electronic Equipment in the range 9kHz to 40GHz.
ISO/IEC 17025:2005	General requirements for the Competence of Testing and Calibrations Laboratories
KDB 558074 D01 v05r02	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating under §15.247

Occupied Bandwidth

Engineer: Aaron S. Froehlich

Test Date: 8/18/2022

Test Procedure

The method of ANSI C63.10 Clause 7.8.7, which references Clause 6.9.2 were utilized to measure the 20 dB Occupied Bandwidth. The “n dB down” function of the spectrum analyzer, with $n = 20$, was used as long as the marker did not settle in a null region. When that was the case the markers were manually configured from the edge of the emission until a value equal to or less than n dB below the peak was used.

The method of clause 6.9.3 was utilized to measure the 99% Occupied Bandwidth.

Limit 20 dB

None – Other limits are calculated from the 20 dB Occupied Bandwidth.

Limit 99%

RSS-Gen Section 6.7 requires the 99% Occupied Bandwidth be reported in addition to all other required bandwidths.

The Spectrum Analyzer was set to the following:

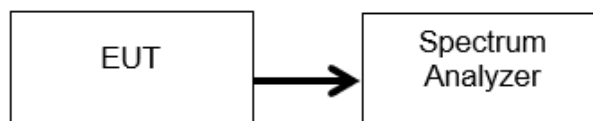
20 dB Occupied Bandwidth

Span	Between two times and five times the OBW
RBW	1% to 5% of the OBW
VBW	~3 time RBW

99% Occupied Bandwidth

Span	Between 1.5 times and 5.0 times the OBW
RBW	1% to 5% of the OBW
VBW	~3 time RBW

Test Setup



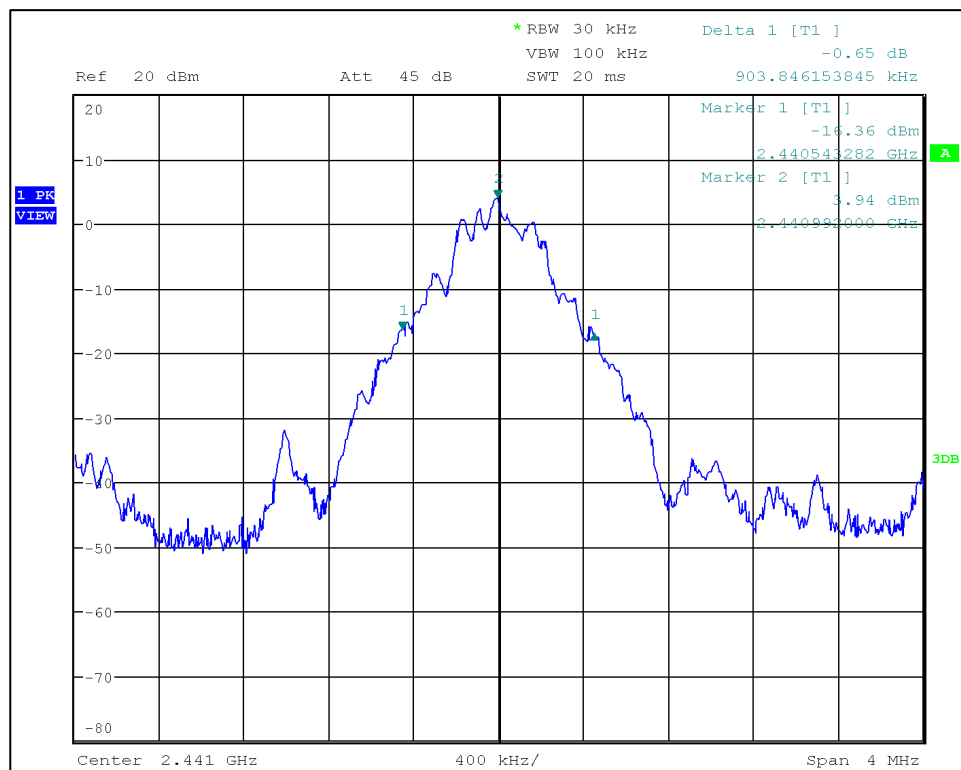
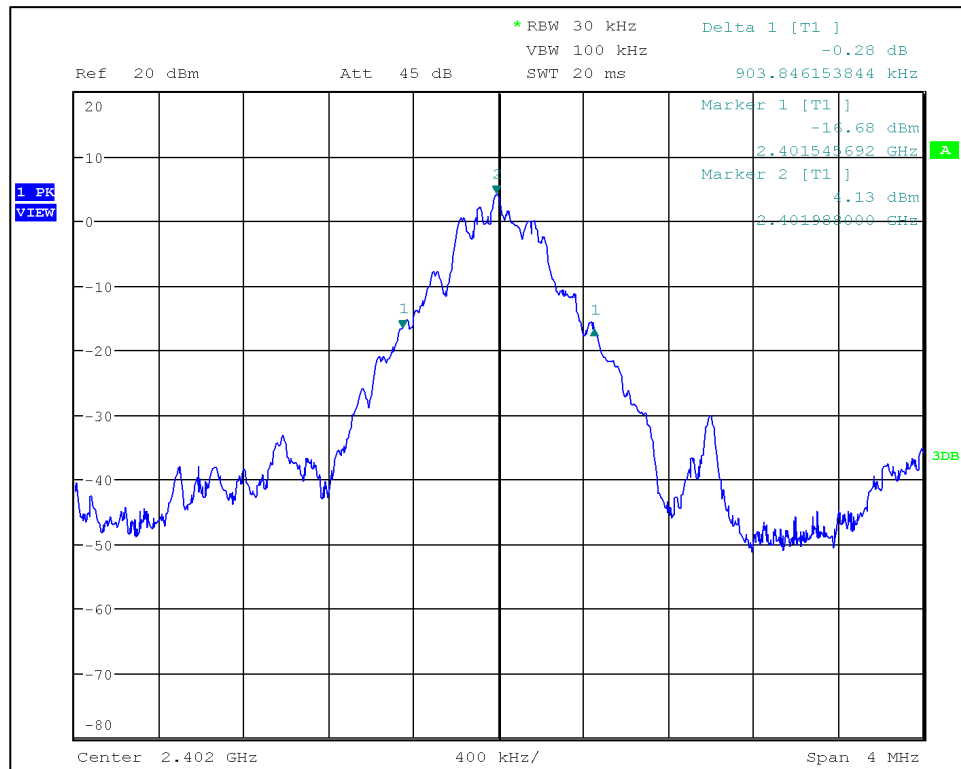
Test Data

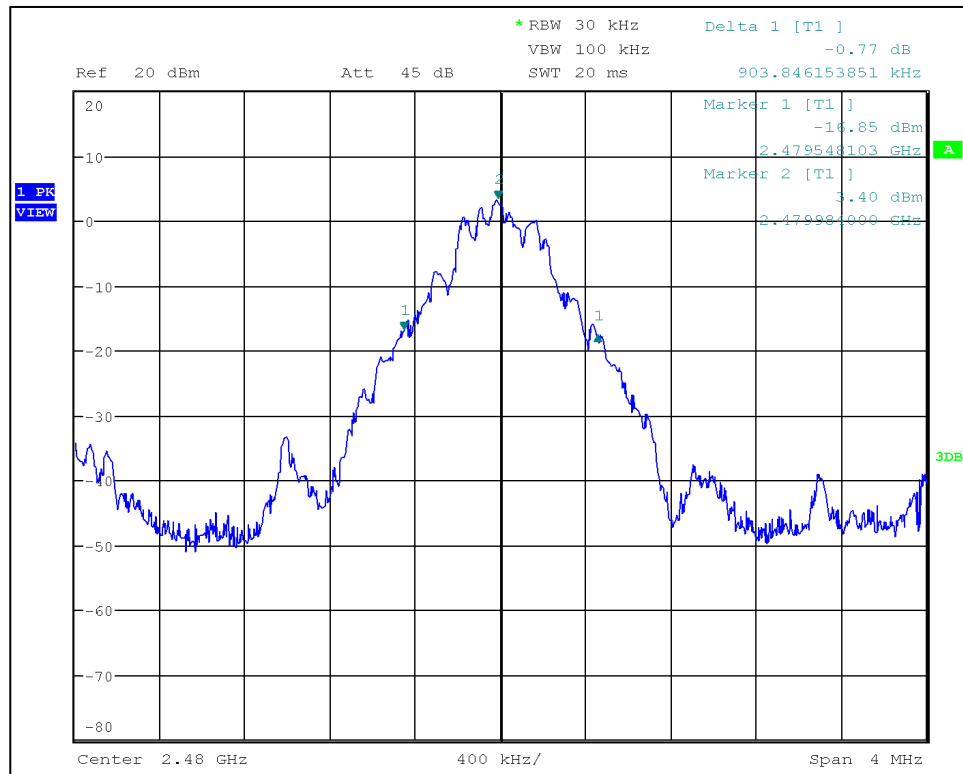
Tabular Data

Data Rate	Frequency	20 dB BW	99% OBW
	MHz	MHz	MHz
BDR DM1	2402	0.904	0.833
BDR DM1	2441	0.904	0.821
BDR DM1	2480	0.904	0.833
BDR DH3	2402	0.942	0.853
BDR DH3	2441	0.951	0.859
BDR DH3	2480	0.950	0.853
BDR DH5	2402	0.945	0.876
BDR DH5	2441	0.954	0.860
BDR DH5	2480	0.960	0.868
EDR DM1	2402	0.897	0.832
EDR DM1	2441	0.904	0.824
EDR DM1	2480	0.925	0.836
EDR 2-DH3	2402	1.236	1.176
EDR 2-DH3	2441	1.260	1.168
EDR 2-DH3	2480	1.268	1.168
EDR 3-DH3	2402	1.232	1.188
EDR 3-DH3	2441	1.264	1.172
EDR 3-DH3	2480	1.276	1.172
EDR 2-DH5	2402	1.252	1.192
EDR 2-DH5	2441	1.264	1.168
EDR 2-DH5	2480	1.276	1.172
EDR 3-DH5	2402	1.232	1.180
EDR 3-DH5	2441	1.268	1.172
EDR 3-DH5	2480	1.284	1.164

20 dB Plots

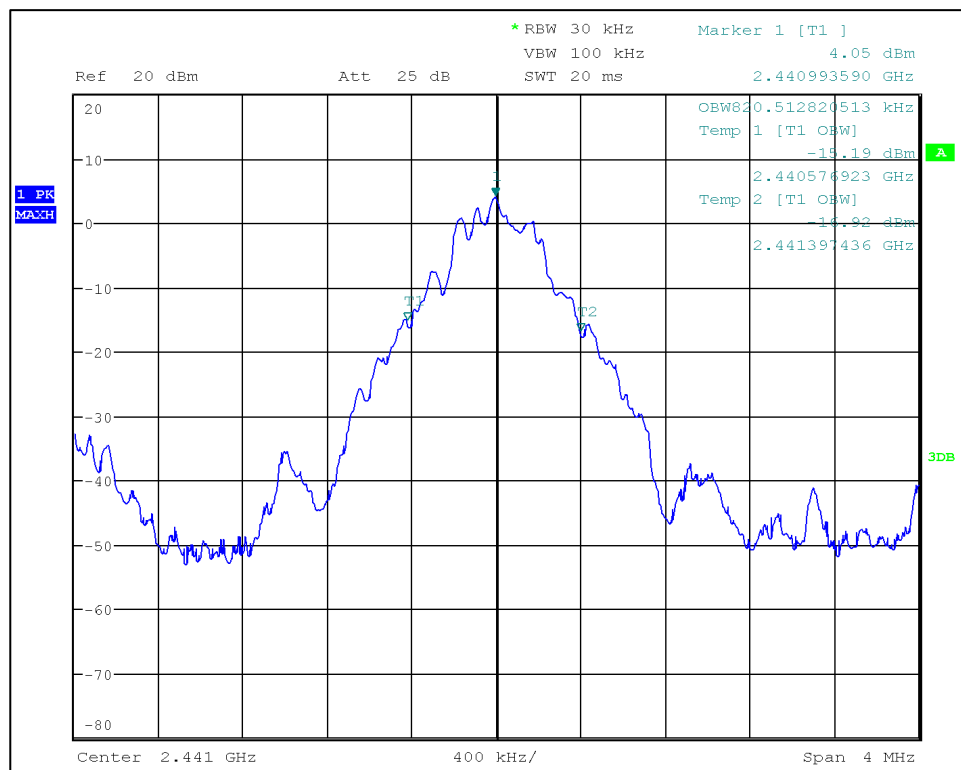
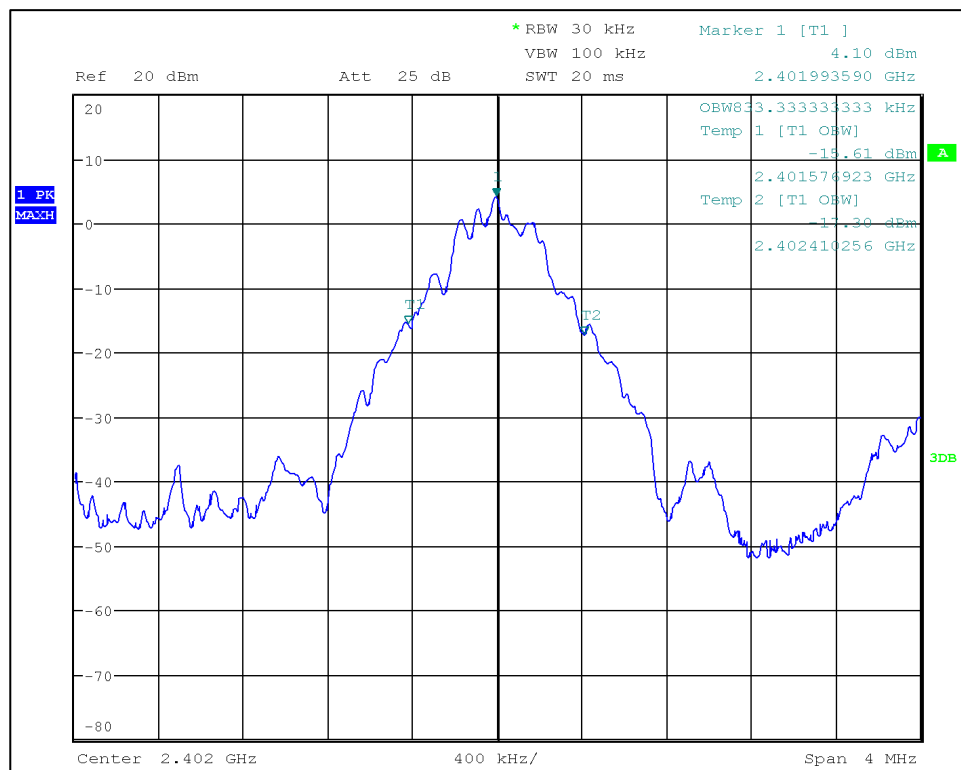
BDR DM1

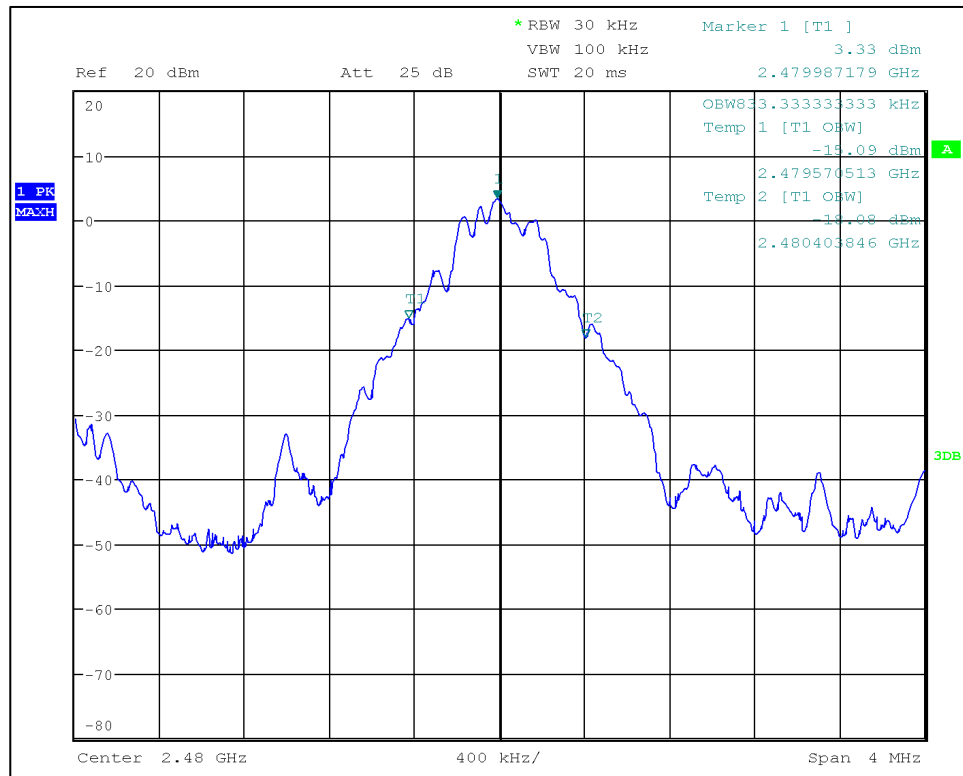




99% Plots

BDR DM1





Output Power

Engineer: Aaron S. Froehlich

Test Date: 8/18/2022

Test Procedure

The methods of ANSI C63.10 Clause 7.8.5 were utilized to demonstrate compliance of the DUT. All available data rates were tested and reported. The hopping function was disabled for this test; the DUT was tested while operating on a single channel.

Limit

47 CFR 15.247(b)(1) & RSS 247 5.4.b.

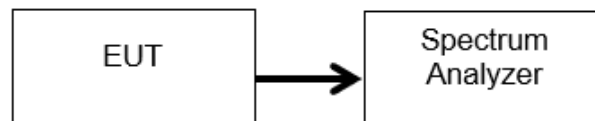
For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

The Spectrum Analyzer was set to the following:

Span	Approximately five times the 20 dB Bandwidth
RBW	> 20 dB BW
VBW	≥ RBW
Sweep	Auto
Detector	Peak
Trace Mode	Max Hold

The RF output power was measured using the spectrum analyzer's marker peak function

Test Setup



Test Data

Tabular Data

Data Rate	Frequency	Raw Pk	Atten	Final Pk	Final Pk
	MHz	dBm	dB	dBm	mW
BDR DM1	2402	4.95	1.41	6.36	4.33
BDR DM1	2441	5.04	1.37	6.41	4.38
BDR DM1	2480	4.87	1.38	6.25	4.21
BDR DH3	2402	4.74	1.41	6.15	4.12
BDR DH3	2441	4.96	1.37	6.33	4.30
BDR DH3	2480	4.78	1.38	6.16	4.13
BDR DH5	2402	4.68	1.41	6.09	4.07
BDR DH5	2441	4.77	1.37	6.14	4.11
BDR DH5	2480	4.75	1.38	6.13	4.10
EDR DM1	2402	3.14	1.41	4.55	2.85
EDR DM1	2441	3.03	1.37	4.40	2.76
EDR DM1	2480	2.66	1.38	4.04	2.53
EDR 2-DH3	2402	3.70	1.41	5.11	3.24
EDR 2-DH3	2441	3.68	1.37	5.05	3.20
EDR 2-DH3	2480	3.27	1.38	4.65	2.91
EDR 3-DH3	2402	3.77	1.41	5.18	3.30
EDR 3-DH3	2441	3.85	1.37	5.22	3.33
EDR 3-DH3	2480	3.59	1.38	4.97	3.14
EDR 2-DH5	2402	3.65	1.41	5.06	3.21
EDR 2-DH5	2441	3.62	1.37	4.99	3.16
EDR 2-DH5	2480	3.21	1.38	4.59	2.87
EDR 3-DH5	2402	3.80	1.41	5.21	3.32
EDR 3-DH5	2441	3.92	1.37	5.29	3.38
EDR 3-DH5	2480	3.68	1.38	5.06	3.20

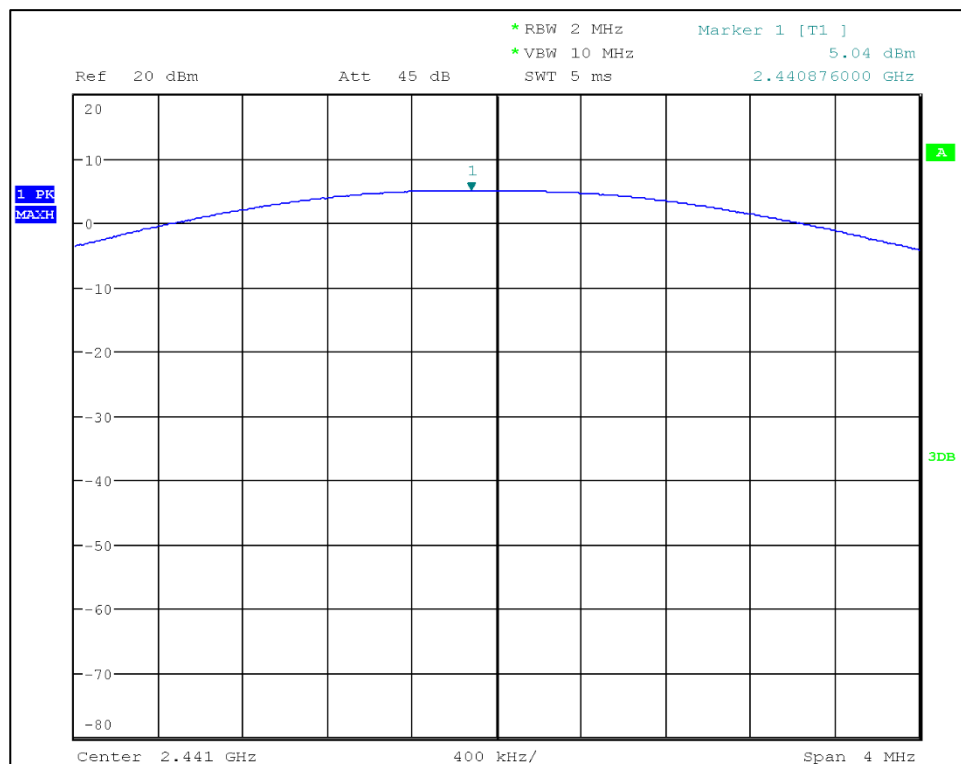
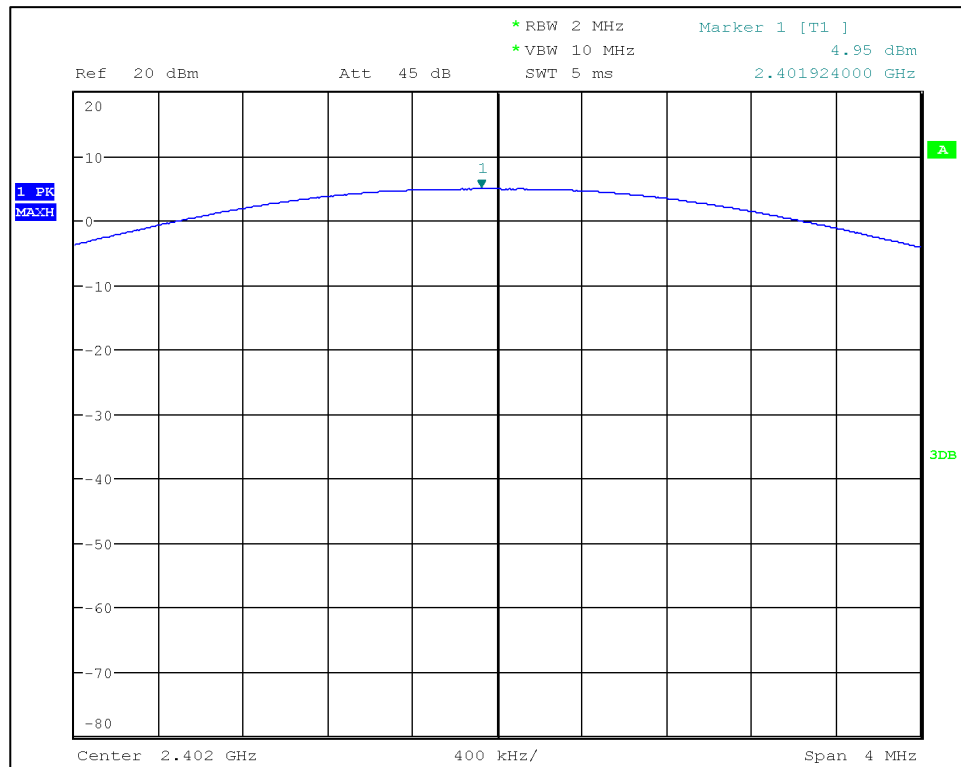
Final Pk = Raw Pk + Atten

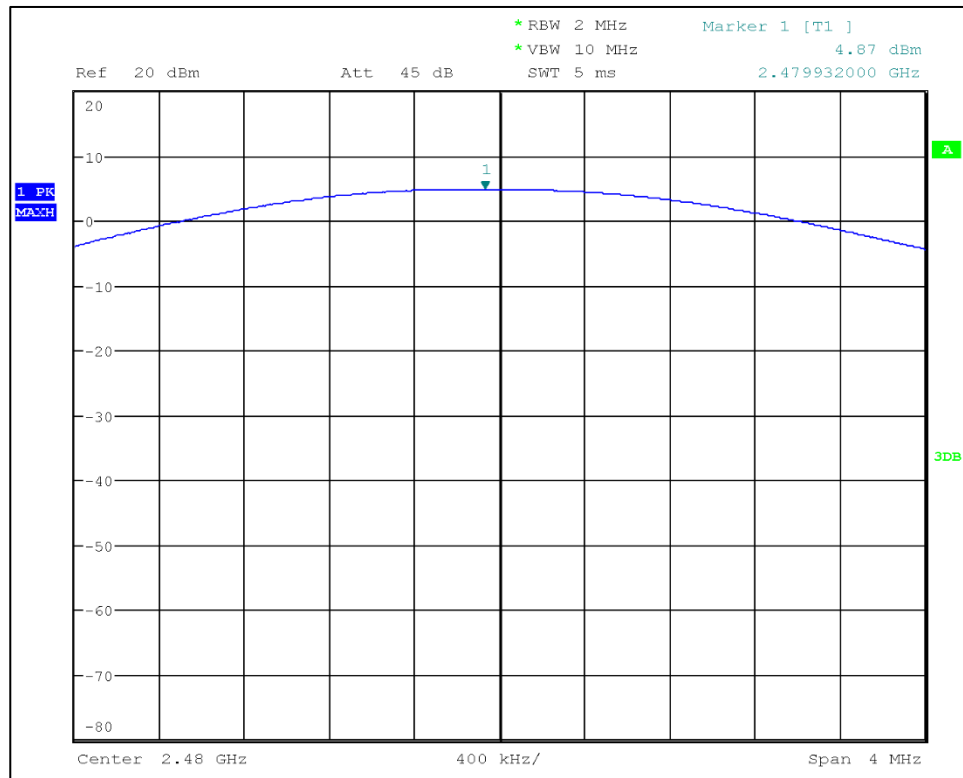
Maximum Output Power: 6.41 dBm, 4.38 mW

Highest Power [GFSK]: BDR DM1
 Highest Power [DPSK]: EDR3 DH5

Power Plots

BDR DM1





Carrier Frequency Separation

Engineer: Aaron S. Froehlich

Test Date: 8/19/2022

Test Procedure

The test methods and settings of ANSI C63.10 Clause 7.8.2 were utilized to demonstrate compliance. The EUT was configured for BDR DM1 data rate during the test. Unmodulated frequency hopping was not possible.

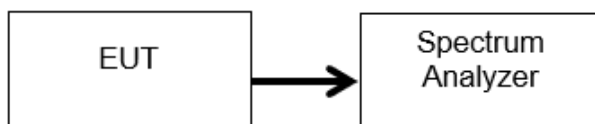
Markers were placed on the channel peak levels and the marker delta function was used to record the frequency separation between two adjacent channels.

Limit

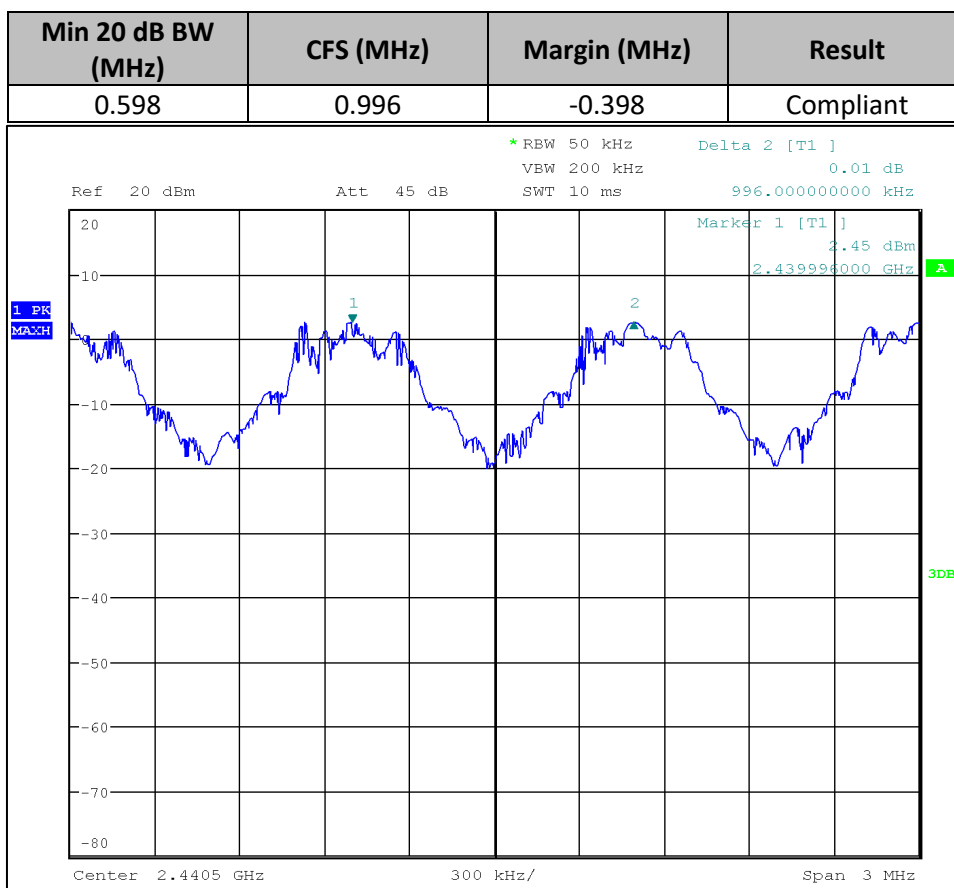
47 CFR 15.247(a)(1) & RSS 247 5.1.b.

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

Test Setup



Test Data



Number of Hopping Frequencies

Engineer: Aaron S. Froehlich

Test Date: 8/19/2022

Test Procedure

The test methods of ANSI C63.10 Clause 7.8.3 were utilized to demonstrate compliance. The EUT was configured for BDR DM1 with hopping during this test.

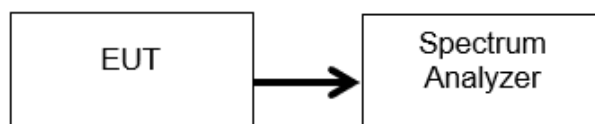
The number of frequencies were manually counted.

Limit

47 CFR 15.247(a)(1)(iii) & RSS 247 5.1.d.

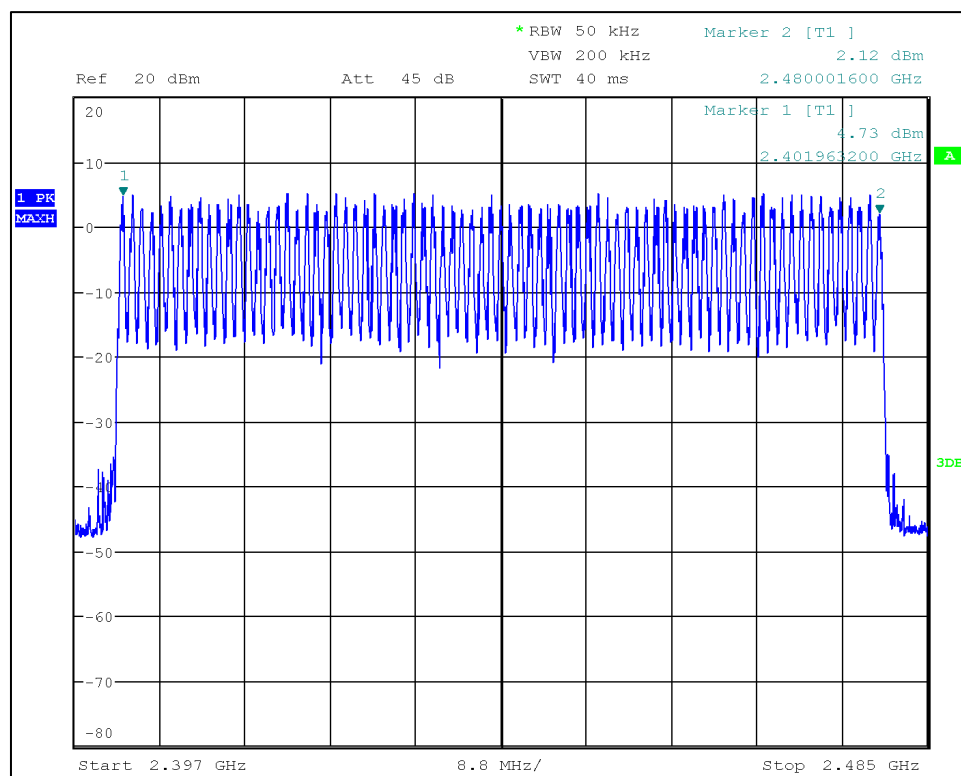
Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.

Test Setup



Test Data

Number of Hopping Frequencies: 79



Time of Occupancy (Dwell Time)

Engineer: Aaron S. Froehlich

Test Date: 8/19/2022

Test Procedure

The method of ANSI C63.10 Clause 7.8.4 was used to demonstrate compliance. Two measurements were made for each mode of operation. A short sweep to determine the transmit time per hop, followed by a longer sweep time to count the number of transmissions within the observation period. The number of hops in the longer sweep has been multiplied by the ratio of the requirement period to the sweep time. The average time of occupancy is calculated from the transmit time per hop multiplied by the number of hops in the period specified in the requirements.

Video Triggering with a negative offset was utilized to allow accurate time domain measurements.

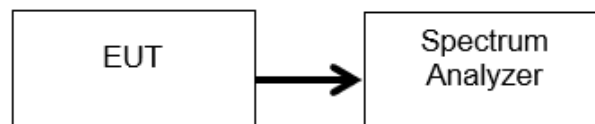
Limit

47 CFR 15.247(a)(1)(iii)

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

$$\text{Required Period} = 0.4 \text{ s} \cdot 79 \text{ channels} = 31.6 \text{ s}$$

Test Setup



Test Data

Tabular Data

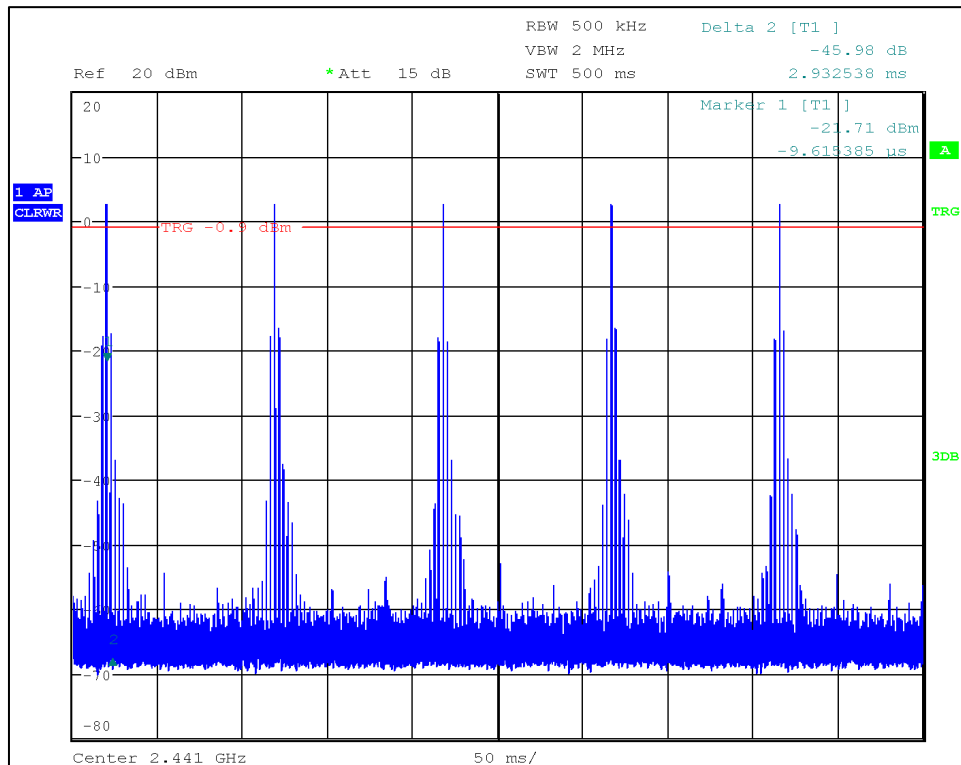
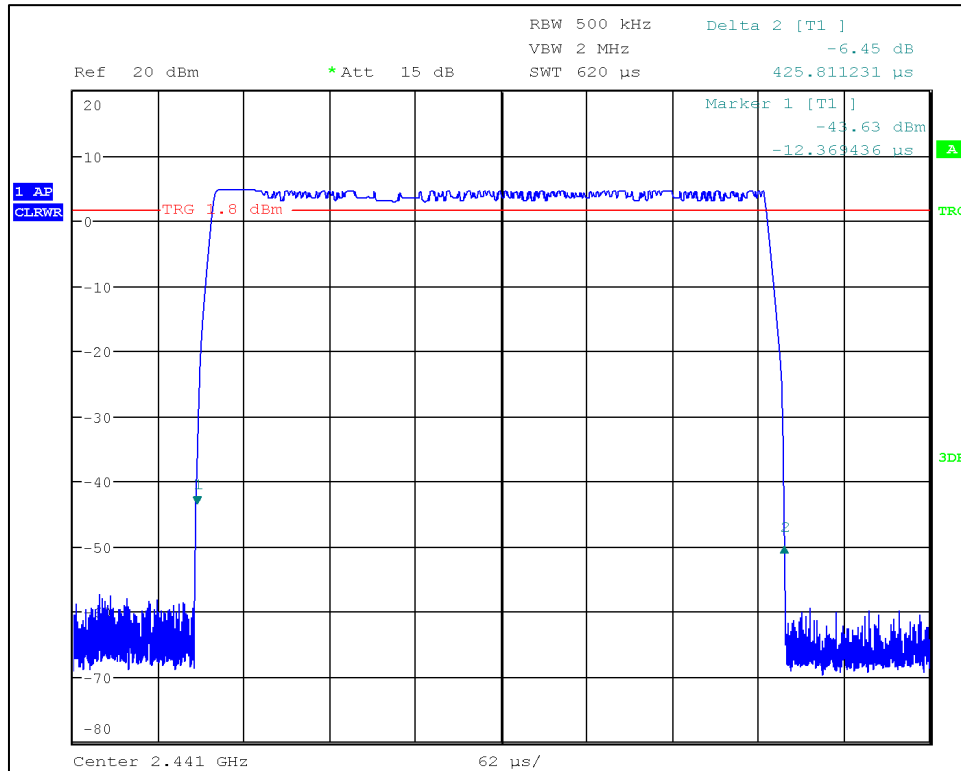
Rate	Duration (MS)	Hops Observed	Required Period (S)	Sweep Time (S)	Total Hops	Total Occupancy (mS)	Limit (mS)	Margin (mS)	Result
BDR DM1	0.426	5	31.6	0.5	316	134.56	400	-265.44	Compliant
BDR DH3	1.680	5	31.6	1	158	265.49	400	-134.51	Compliant
BDR DH5	2.926	7	31.6	2	110.6	323.64	400	-76.36	Compliant
EDR DM1	0.424	5	31.6	0.5	316	134.09	400	-265.91	Compliant
EDR 2-DH3	1.687	5	31.6	1	158	266.54	400	-133.46	Compliant
EDR 3-DH3	1.687	5	31.6	1	158	266.54	400	-133.46	Compliant
EDR 2-DH5	2.933	7	31.6	2	110.6	324.34	400	-75.66	Compliant
EDR 3-DH5	2.933	7	31.6	2	110.6	324.34	400	-75.66	Compliant

Total Hops = Hops Observed • Required Period / Sweep Time

Total Occupancy = Duration • Total Hops

Plots

BDR DM1



Duty Cycle

Engineer: Aaron S. Froehlich

Test Date: 8/18/2022

Test Procedure

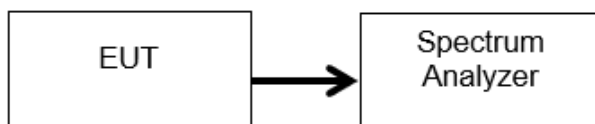
Duty Cycle was measured using the method of ANSI C63.10 Clause 11.6 option b.

Limit

None – This data has been used to calculate Duty Cycle Correction Factors.

Span	Zero Span
RBW	RBW $\geq$ OBW
VBW	$\geq$ RBW
Detector	Peak

Test Setup



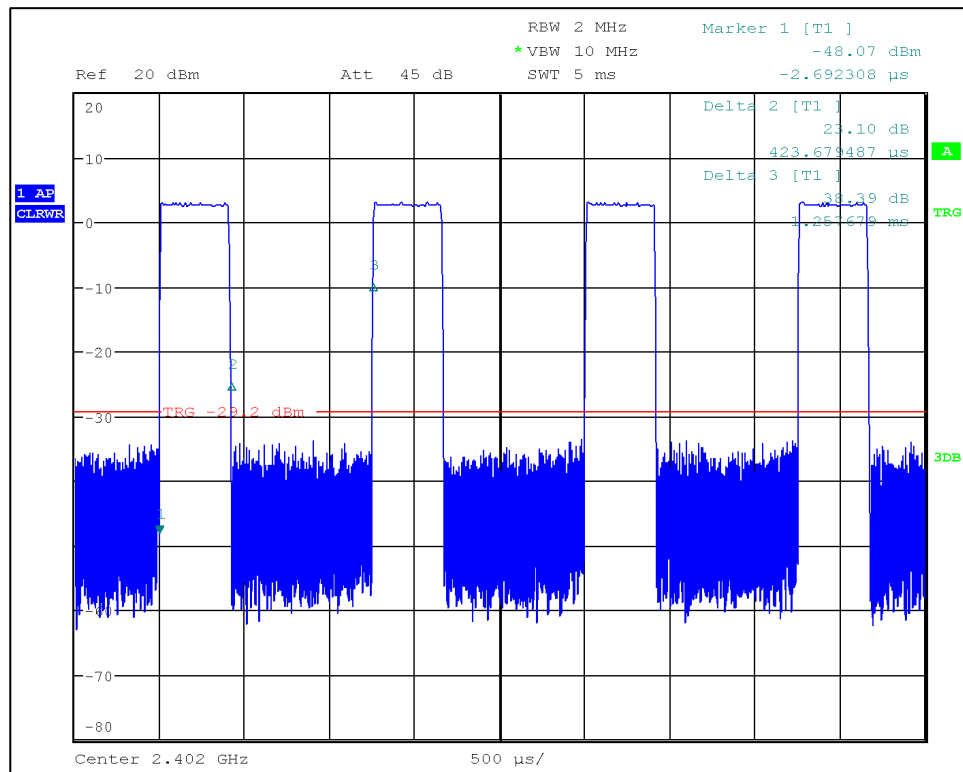
Test Data

Tabular Data

Data Rate	Frequency	On Time	Period	DC	DCCF
	MHz	ms	ms	%	dB
BDR DM1	2441	0.424	1.258	33.69%	4.7
BDR DH3	2441	1.675	2.508	66.81%	1.8
BDR DH5	2441	2.932	3.748	78.22%	1.1
EDR DM1	2441	0.414	1.251	33.06%	4.8
EDR 2-DH3	2441	1.679	2.503	67.09%	1.7
EDR 3-DH3	2441	1.681	2.500	67.26%	1.7
EDR 2-DH5	2441	2.922	3.756	77.79%	1.1
EDR 3-DH5	2441	2.922	3.756	77.79%	1.1

Plots

BDR DM1



Emissions at Band Edges

Engineer: Aaron S. Froehlich

Test Date: 11/01/21

Test Procedure

Clause 7.8.6 of ANSI C63.10 directs the use of the methods of Clause 6.10 for Band Edge measurements of DSS devices, in both single channel and hopping modes of operation. The relative method of Clause 6.10.4 was used to demonstrate Band Edge Compliance with the 2400-2483.5 MHz Band.

Additionally, the method of Clause 6.10.5.2 was used to demonstrate Restricted-Band Band-Edge for the adjacent 2310-2390 MHz, and 2483.5-2500 MHz bands.

Both measurements were made using antenna port conducted measurements. The Restricted-Band Band-Edge (RB BE) data has been converted into equivalent radiated field strengths using the equation of Clause 11.12.2.2, as a reference level offset. Per Clause 11.12.2.6 a minimum antenna gain (AG) of 2 dBi has been applied. Finally, duty cycle correction factors (DCCF) and worst case cable losses (CL) were also accounted for in the final Reference Level offset. Peak compliance has been demonstrated with a Max Hold on trace 1; Average compliance with an RMS detector averaged over 100 sweeps of Trace 2.

When the average measurement obtained using this method was greater than the limit, an additional measurement at the Band Edge was performed using the integration method of Clause 11.13.3.4 to demonstrate compliance.

RB BE Offset Calculations

Data Rate	CF	CL	DCCF	AG	Offset
	dB	dB	dB	dBi	Offset
BDR DM1	95.3	1.4	4.7	2.0	103.4
BDR DH3	95.3	1.4	1.8	2.0	100.5
BDR DH5	95.3	1.4	1.1	2.0	99.8
EDR DM1	95.3	1.4	4.8	2.0	103.5
EDR 2-DH3	95.3	1.4	1.7	2.0	100.4
EDR 3-DH3	95.3	1.4	1.7	2.0	100.4
EDR 2-DH5	95.3	1.4	1.1	2.0	99.8
EDR 3-DH5	95.3	1.4	1.1	2.0	99.8

CF (Conversion Factor) = $-20 \cdot \log_{10}(D) + 104.8$

Where D = 3 meters

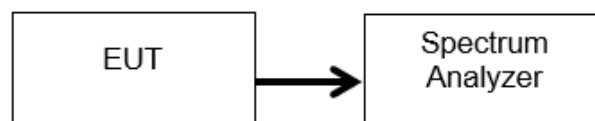
Offset = CF + CL + DCCF + AG

Limits

47 CFR 15.247(d) & RSS 247 Section 5.5

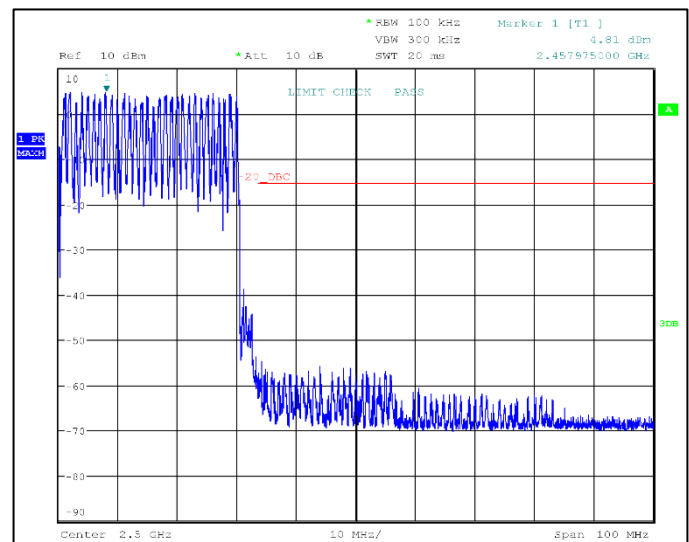
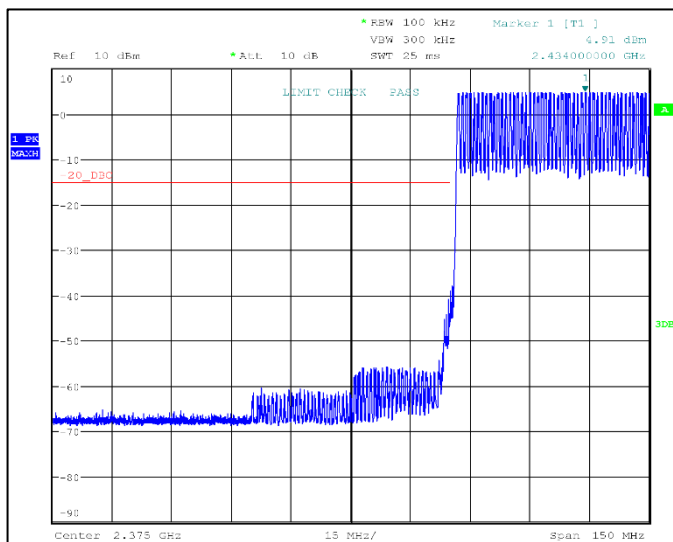
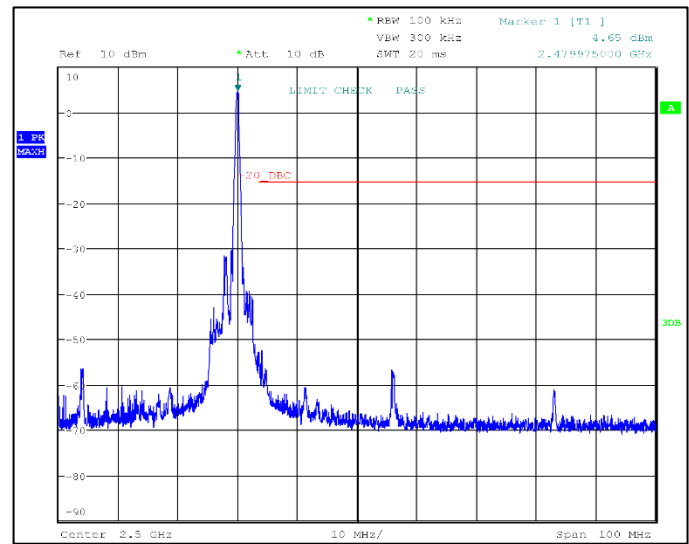
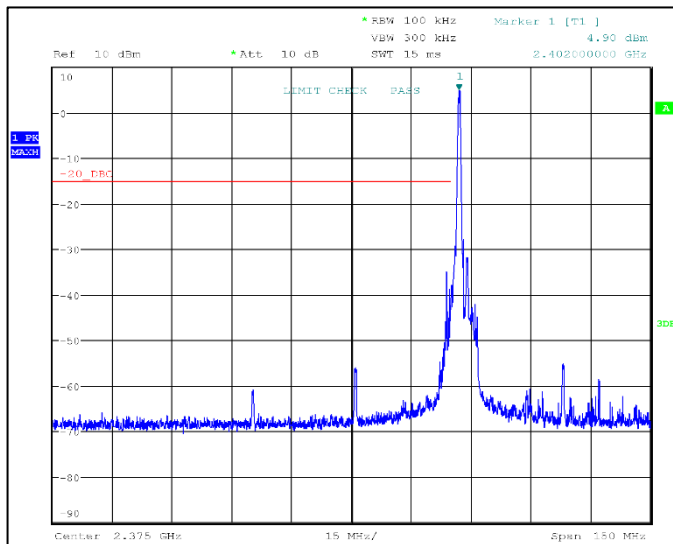
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. In addition, radiated emissions which fall in the restricted bands, as defined in [§ 15.205\(a\)](#), must also comply with the radiated emission limits specified in [§ 15.209\(a\)](#) (see [§ 15.205\(c\)](#)).

Test Setup



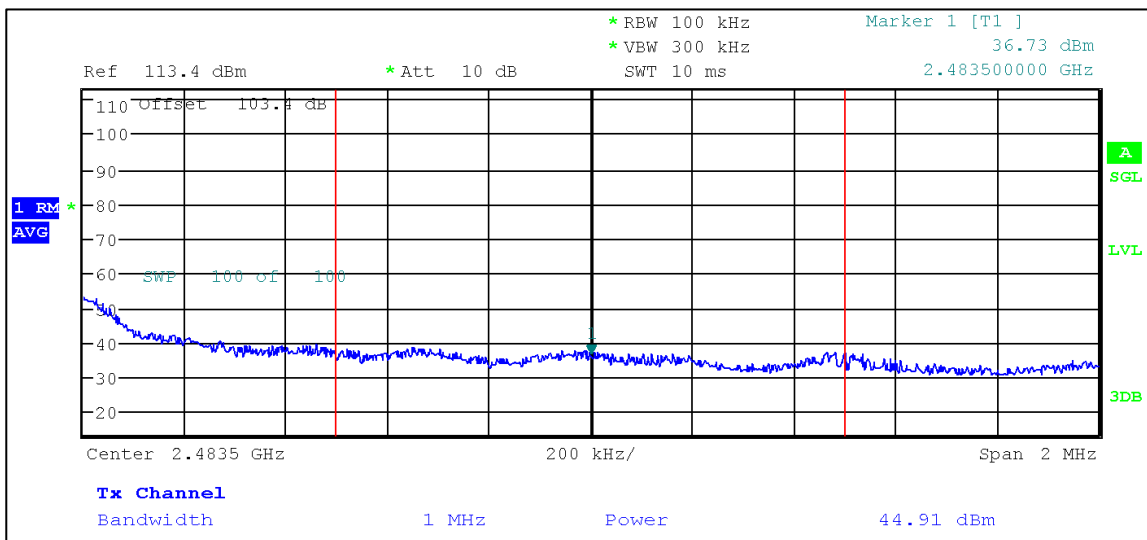
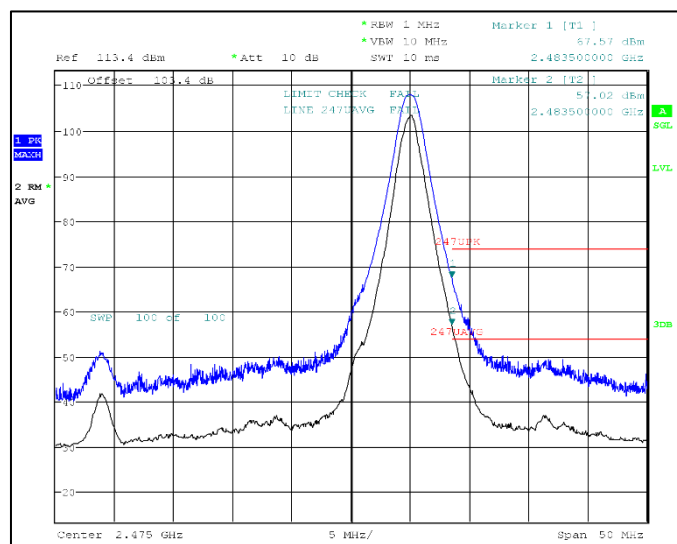
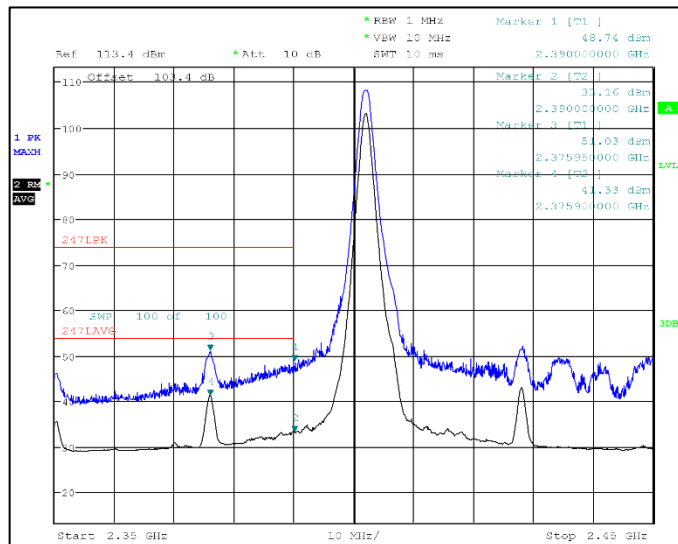
Band Edge Test Data

BDR DM1



Restricted-Band Band-Edge Test Data

BDR DM1



Conducted Spurious Emissions

Engineer: Aaron S. Froehlich

Test Date: 8/19/2022

Test Procedure

Conducted Spurious Emissions has been measured using the methods of ANSI C63.10 clause 7.8.8. The antenna port was connected to a spectrum analyzer and the range of 30 MHz to 10 times the operating frequency was scanned with a resolution bandwidth of 100 kHz, video bandwidth of 300 kHz and a coupled sweep time. The frequency range was subdivided into 17 evenly spaced subranges with 30001 sweep points per subrange.

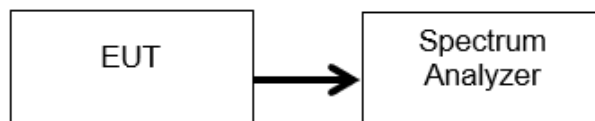
Per ANSI C63.10 Clause 5.6.2.2 b) the mode with the highest output power for each modulation family has been tested and reported.

Limits

47 CFR 15.247(d) & RSS 247 Section 5.5

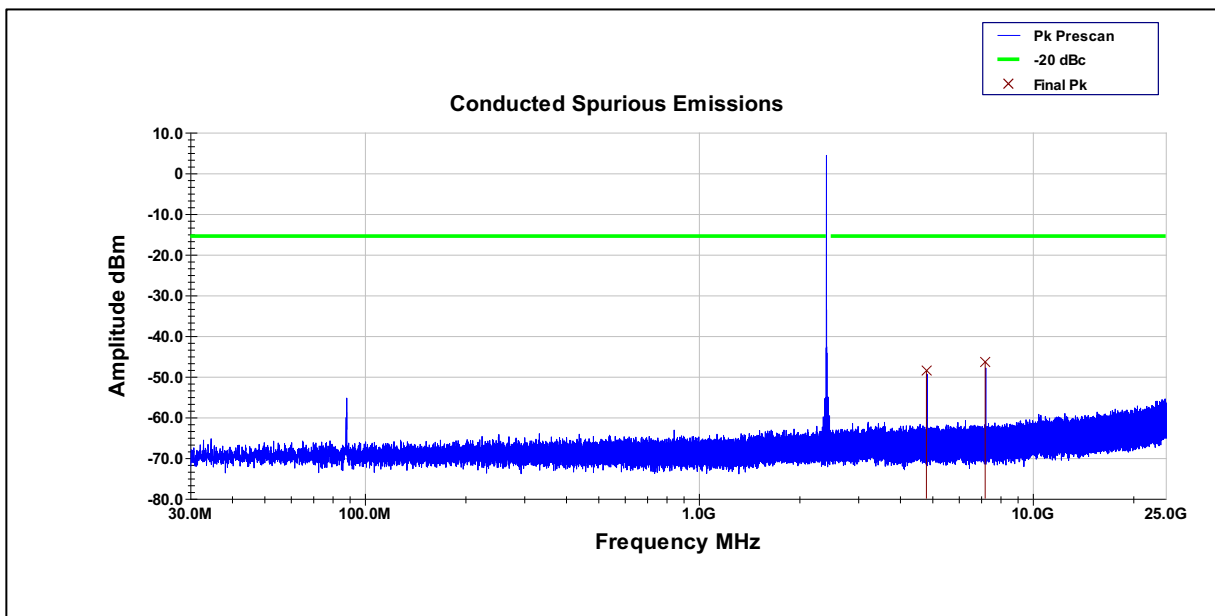
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. In addition, radiated emissions which fall in the restricted bands, as defined in [§ 15.205\(a\)](#), must also comply with the radiated emission limits specified in [§ 15.209\(a\)](#) (see [§ 15.205\(c\)](#)).

Test Setup



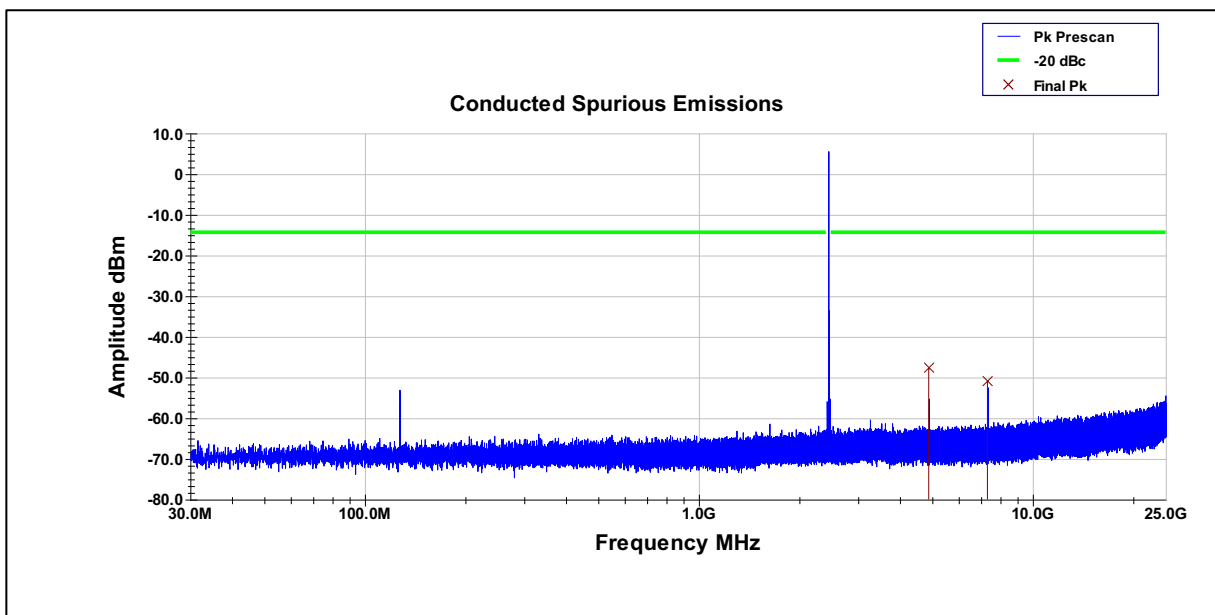
Test Data

BDR DM1 2402



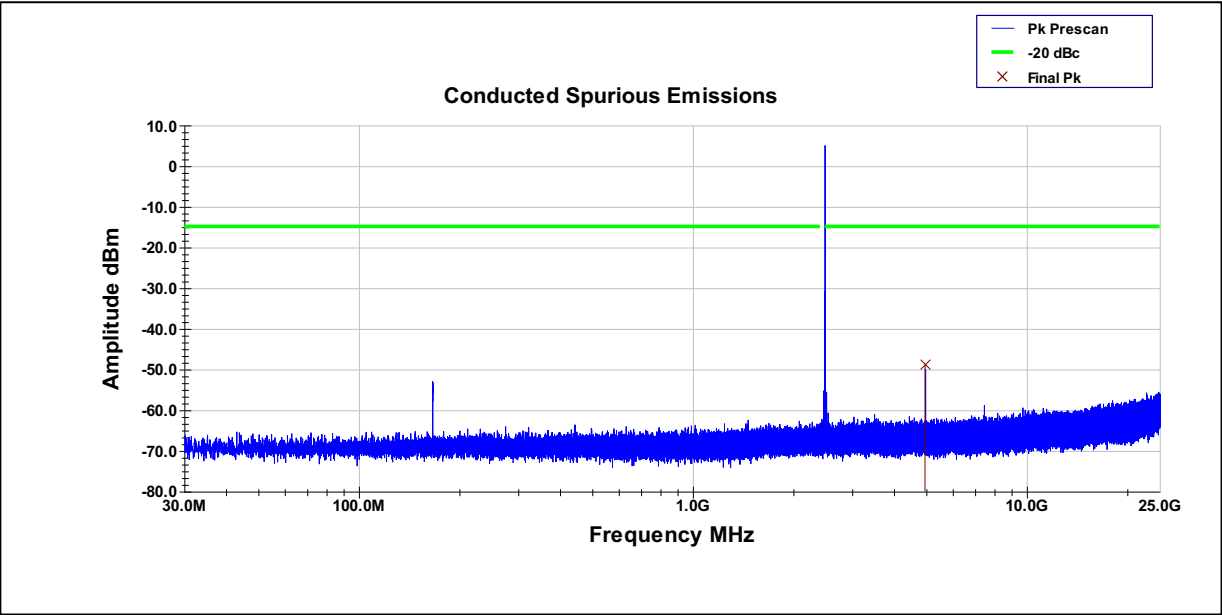
Frequency	Raw Pk	Final Pk	Path Loss	Limit	Pk Margin
(MHz)	dBm	dBm	dB	dBm	dB
4.804 GHz	-50.98	-48.50	2.48	-15.47	-33.02
7.2055 GHz	-48.96	-46.45	2.51	-15.47	-30.98
Final = Raw + Path Loss					
Margin = Final - Limit					

BDR DM1 2441



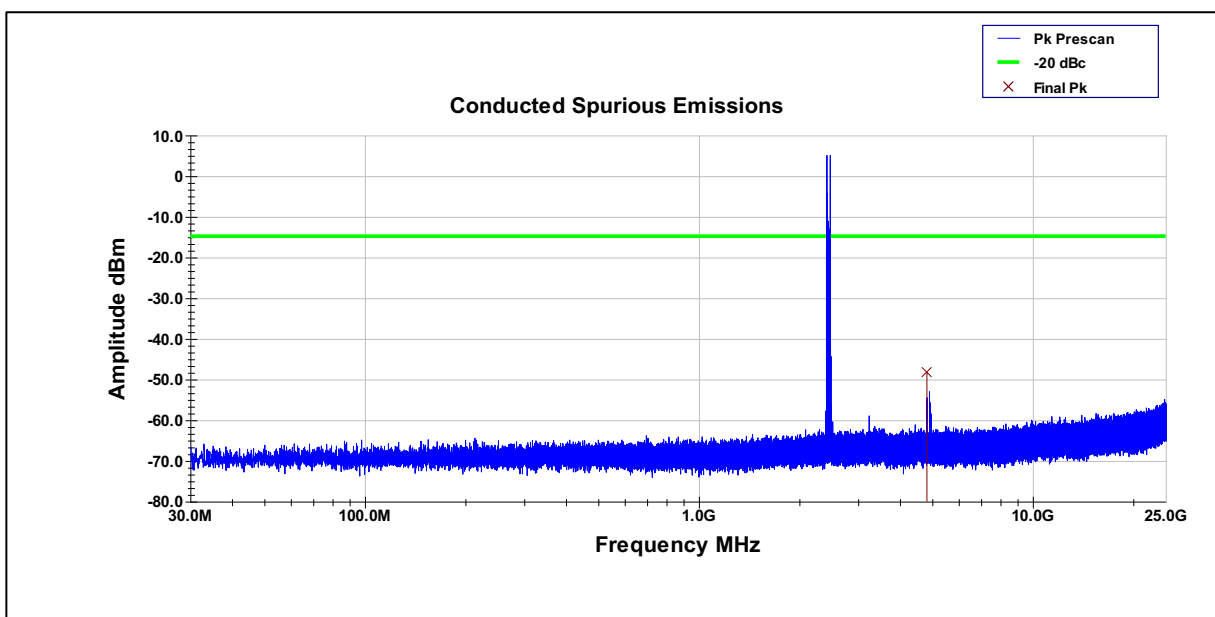
Frequency	Raw Pk	Final Pk	Path Loss	Limit	Pk Margin
(MHz)	dBm	dBm	dB	dBm	dB
4.8825 GHz	-50.21	-47.74	2.47	-14.35	-33.39
7.3215 GHz	-53.40	-50.81	2.59	-14.35	-36.46
Final = Raw + Path Loss					
Margin = Final - Limit					

BDR DM1 2480



Frequency	Raw Pk	Final Pk	Path Loss	Limit	Pk Margin
(MHz)	dBm	dBm	dB	dBm	dB
4.9598 GHz	-51.25	-48.81	2.44	-14.87	-33.94
Final = Raw + Path Loss					
Margin = Final - Limit					

BDR DM1 HOP



Frequency	Raw Pk	Final Pk	Path Loss	Limit	Pk Margin
(MHz)	dBm	dBm	dB	dBm	dB
4.8223 GHz	-50.86	-48.36	2.50	-14.81	-33.55
Final = Raw + Path Loss					
Margin = Final - Limit					

Radiated Spurious Emissions

Engineer: Aaron S. Froehlich

Test Date: 9/2/2022

Test Procedure: 30-1000 MHz

Per ANSI C63.10 Clause 5.6.2.2 b) the worst case modes to be tested for spurious emissions are BDR DM1 (GFSK modulated), and EDR3 DH5 (8-DPSK modulated).

The EUT was setup in a semi-anechoic test chamber set 3m from the receiving antenna. The EUT was set to transmit on the lowest, middle and highest frequency of operation, as well as frequency hopping, at the maximum power level. The EUT was tested, in 3 orthogonal axis, by rotating it 360° with the receive antenna in both the vertical and horizontal orientation while raised from 1 to 4 meters to ensure the TX signal levels were maximized. A spectrum analyzer was used to verify that the EUT met the requirements for Radiated Spurious Emissions.

All emissions from 30 MHz to 1 GHz were examined.

Measured Level includes antenna and receiver cable correction factors.

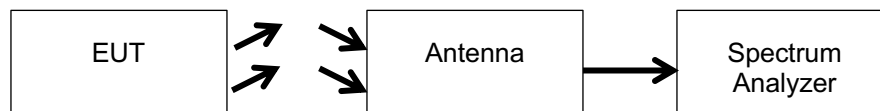
Correction factors were input into the spectrum analyzer before recording "Measured Level".

RBW = 100 KHz

VBW = 300 KHz

Detector – Quasi Peak

Test Setup



Test Procedure: ≥ 1 GHz

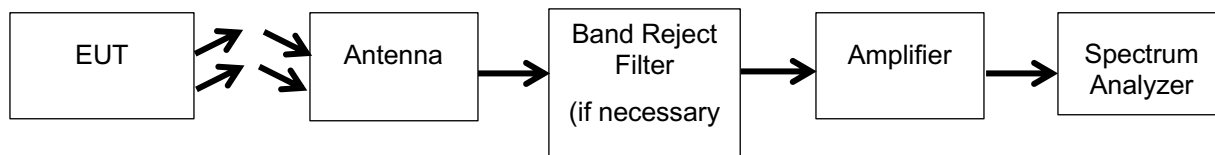
The EUT was setup in a semi-anechoic test chamber set 3m from the receiving antenna. The EUT was set to transmit on the lowest, middle and highest frequency of operation at the maximum power level. The EUT was tested, in 3 orthogonal axis, by rotating it 360° with the receive antenna in both the vertical and horizontal orientation while raised from 1 to 4 meters to ensure the TX signal levels were maximized. A spectrum analyzer was used to verify that the EUT met the requirements for Radiated Spurious Emissions.

RBW = 1 MHz

VBW = 3 MHz

Detector – Peak

Test Setup



Worst Case Emission: BDR DM1 X Axis, 2480 MHz, Simultaneous with Band 66 5 MHz BW Ch 132322 QPSK

Frequency	Azimuth	Height	Raw Pk	Raw Avg	Correction	Final Pk	Pk Limit	Pk Margin	Final Avg	Avg Limit	Avg Margin
MHz	deg	cm	dBuV	dBuV	dB	dBuV/m	dBuV/m	dB	dBuV/m	dBuV/m	dB
5234.235	173.00	351.00	57.70	46.50	-4.02	53.68	74.00	-20.32	42.48	53.98	-11.50

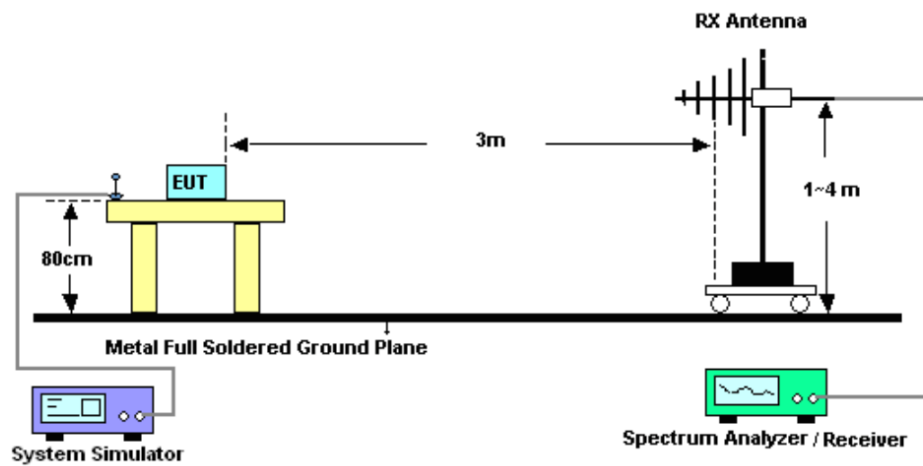
Final = Raw + Correction

Margin = Final - Limit

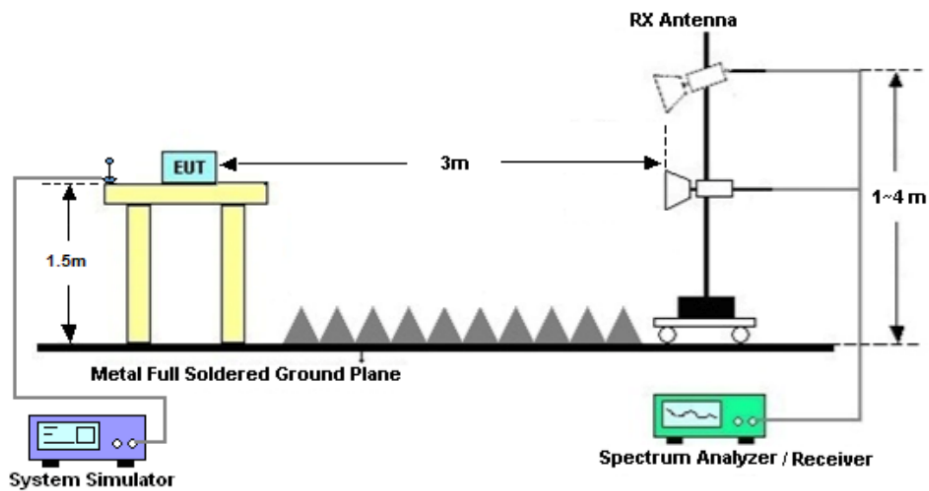
See Annex A for full test data

Chamber Setup Diagrams

For radiated emissions from 30MHz to 1GHz



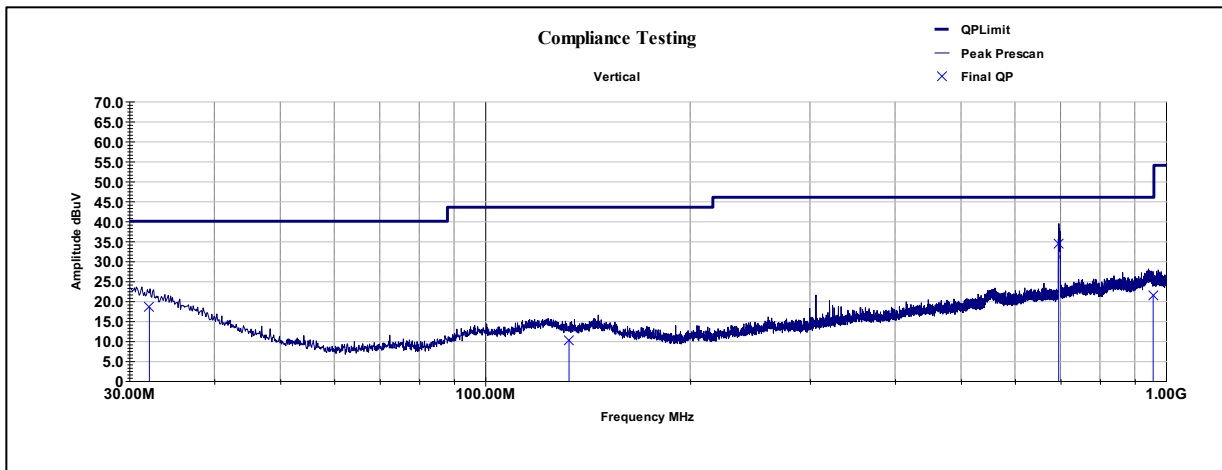
For radiated emissions above 1GHz



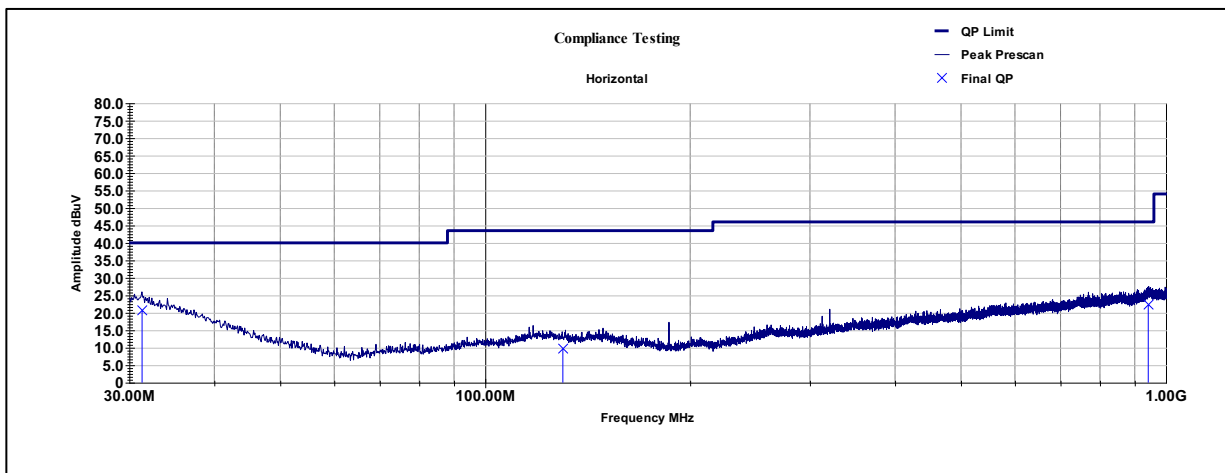
Test Data

30-1000 MHz

X Axis BDR DM1 2441 w Band 66 5M Ch 132322



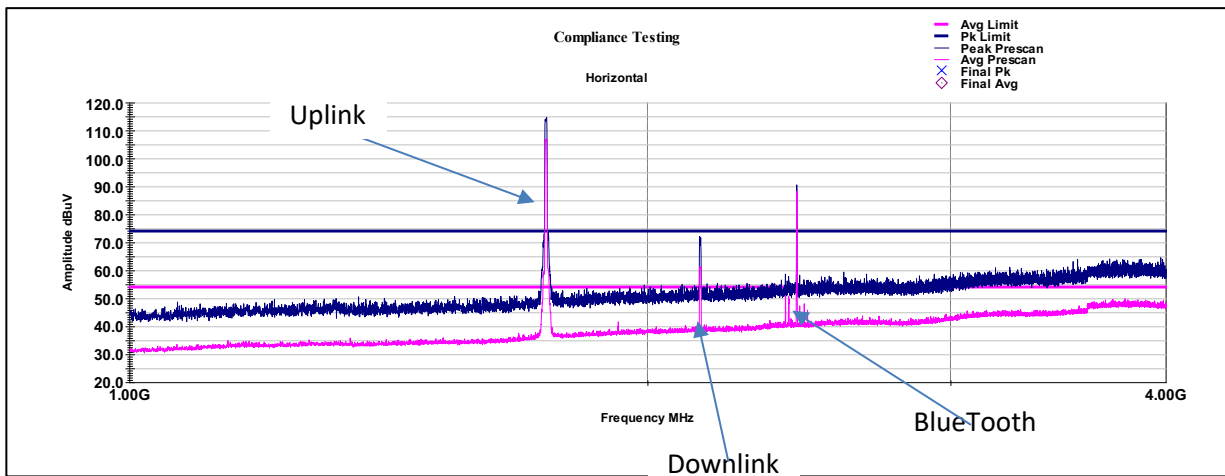
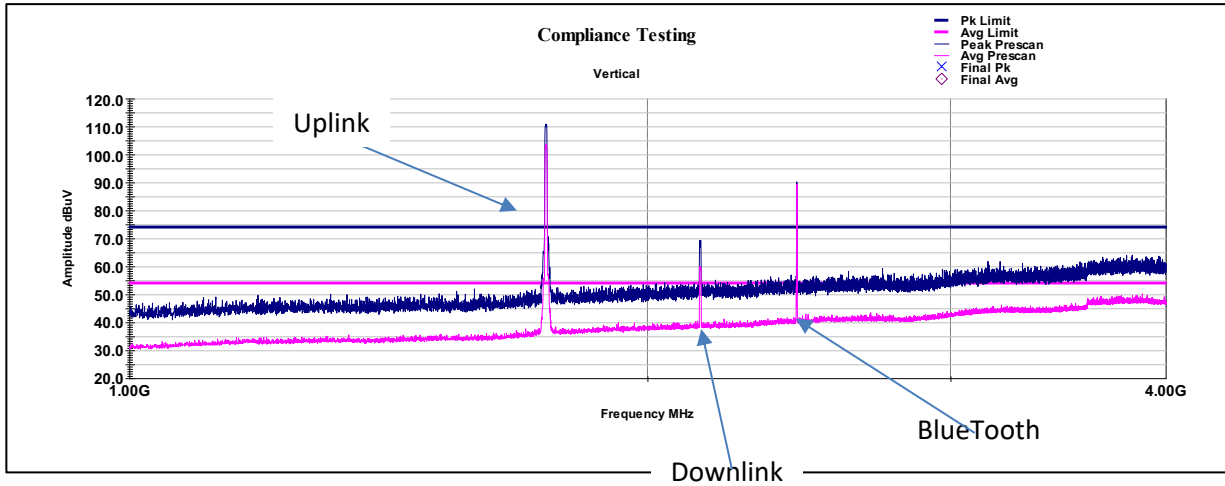
Frequency	Azimuth	Height	Raw QP	Correction	Final QP	Limit	QP Margin
MHz	deg	cm	dBuV	dB	dBuV/m	dBuV/m	dB
32.116	106	100	40.47	-21.95	18.51	40.0	-21.5
132.798	78	379	35.48	-25.27	10.21	43.5	-33.3
695.751	305	100	49.36	-14.96	34.40	46.0	-11.6
957.586	20	100	31.96	-10.44	21.52	46.0	-24.5
Final = Raw + Path Loss							
Margin = Final - Limit							



Frequency	Azimuth	Height	Raw QP	Correction	Final QP	Limit	QP Margin
MHz	deg	cm	dBuV	dB	dBuV/m	dBuV/m	dB
31.325	110	325	40.46	-19.89	20.57	40.0	-19.4
130.012	114	309	35.89	-26.18	9.71	43.5	-33.8
942.030	232	386	32.83	-10.59	22.24	46.0	-23.8
Final = Raw + Path Loss							
Margin = Final - Limit							

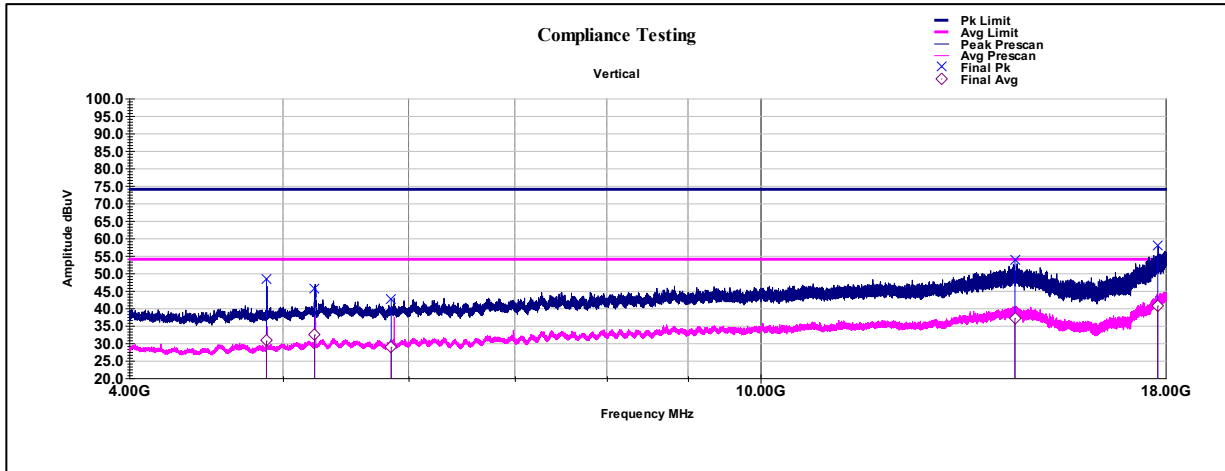
1-4 GHz

X Axis BDR DM1 2441 w Band 66 5M Ch 132322

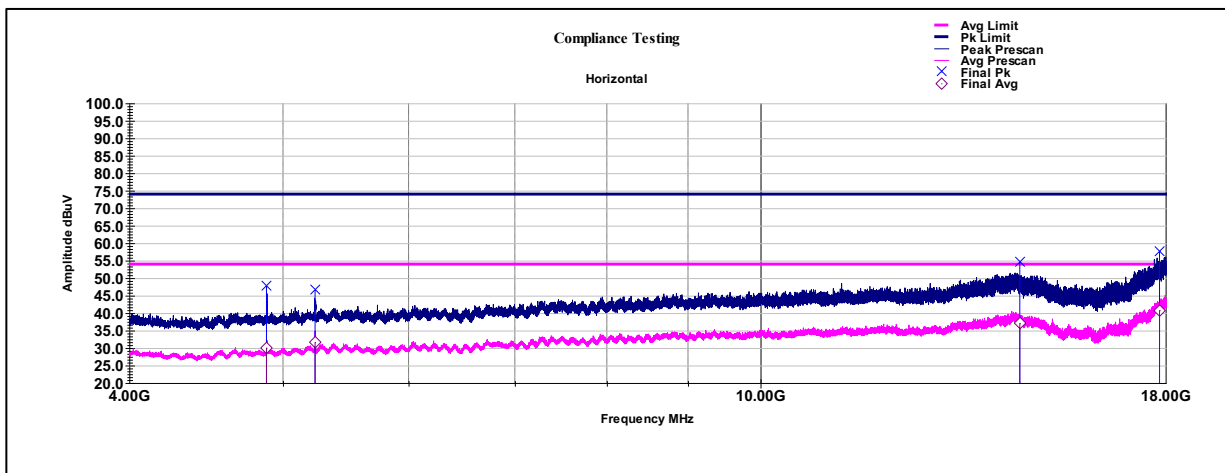


4-18 GHz

X Axis BDR DM1 2441 w Band 66 5M Ch 132322



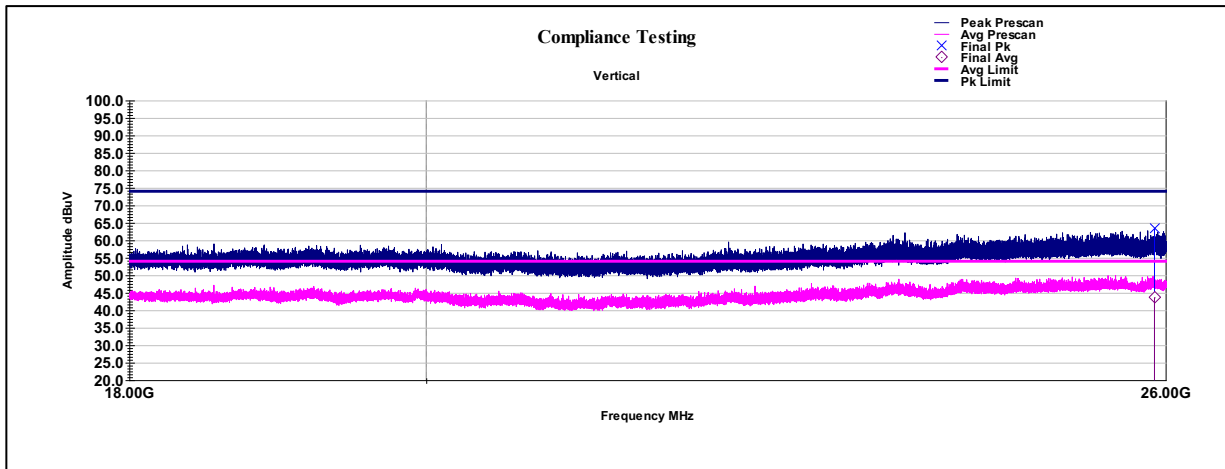
Frequency	Azimuth	Height	Raw Pk	Raw Avg	Correction	Final Pk	Pk Limit	Pk Margin	Final Avg	Avg Limit	Avg Margin
MHz	deg	cm	dBuV	dBuV	dB	dBuV/m	dBuV/m	dB	dBuV/m	dBuV/m	dB
4881.983	350.00	175.00	53.74	35.96	-5.26	48.48	74.00	-25.52	30.70	53.98	-23.28
5234.959	15.00	293.00	49.76	36.45	-4.01	45.75	74.00	-28.25	32.44	53.98	-21.54
5850.585	346.00	325.00	45.72	31.98	-3.06	42.66	74.00	-31.34	28.92	53.98	-25.06
14464.386	321.00	325.00	39.41	22.64	14.49	53.91	74.00	-20.09	37.14	53.98	-16.84
17796.28	83.00	147.00	37.67	20.54	20.19	57.86	74.00	-16.14	40.73	53.98	-13.25
Final = Raw + Path Loss											
Margin = Final - Limit											



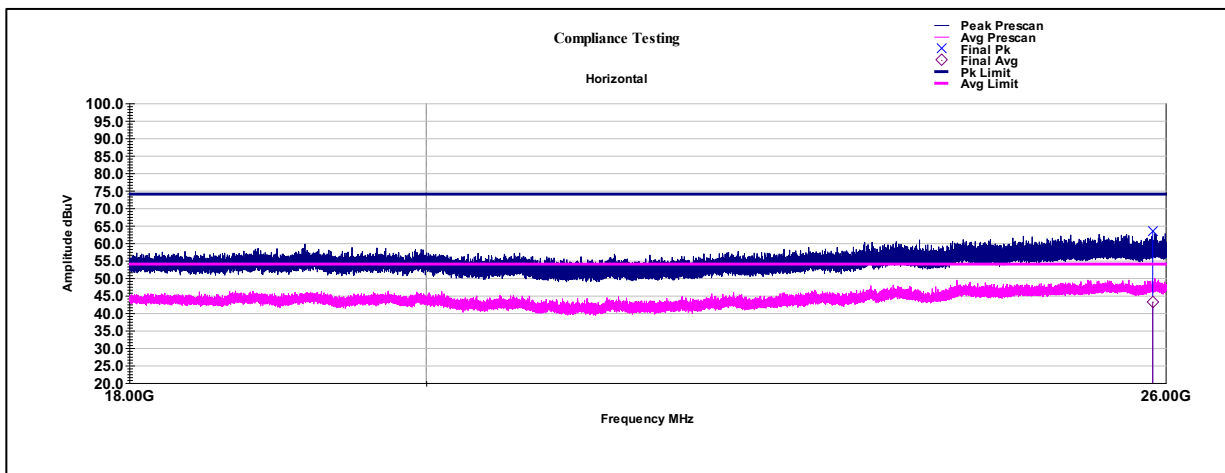
Frequency	Azimuth	Height	Raw Pk	Raw Avg	Correction	Final Pk	Pk Limit	Pk Margin	Final Avg	Avg Limit	Avg Margin
MHz	deg	cm	dBuV	dBuV	dB	dBuV/m	dBuV/m	dB	dBuV/m	dBuV/m	dB
4881.973	0.00	400.00	52.99	35.33	-5.26	47.72	74.00	-26.28	30.07	53.98	-23.91
5238.518	195.00	400.00	50.61	35.66	-4.00	46.61	74.00	-27.39	31.66	53.98	-22.32
14566.338	38.00	400.00	40.06	22.51	14.57	54.63	74.00	-19.37	37.08	53.98	-16.90
17843.19	107.00	295.00	37.36	20.44	20.36	57.72	74.00	-16.28	40.81	53.98	-13.17
Final = Raw + Path Loss											
Margin = Final - Limit											

18-26 GHz

No emissions detected regardless of axis, modulation, channel, or simultaneous transmit conditions.



Frequency	Azimuth	Height	Raw Pk	Raw Avg	Correction	Final Pk	Pk Limit	Pk Margin	Final Avg	Avg Limit	Avg Margin
MHz	deg	cm	dBuV	dBuV	dB	dBuV/m	dBuV/m	dB	dBuV/m	dBuV/m	dB
25897.253	187.00	105.00	39.72	19.97	23.69	63.41	74.00	-10.59	43.67	53.98	-10.32
Final = Raw + Path Loss											
Margin = Final - Limit											



Frequency	Azimuth	Height	Raw Pk	Raw Avg	Correction	Final Pk	Pk Limit	Pk Margin	Final Avg	Avg Limit	Avg Margin
MHz	deg	cm	dBuV	dBuV	dB	dBuV/m	dBuV/m	dB	dBuV/m	dBuV/m	dB
25881.039	18.00	172.00	39.70	19.55	23.67	63.37	74.00	-10.63	43.22	53.98	-10.76
Final = Raw + Path Loss											
Margin = Final - Limit											

Receiver Radiated Spurious Emissions

Engineer: Aaron S. Froehlich

Test Date: 9/2/2022

Test Procedure: 30-1000 MHz

The EUT was setup in a semi-anechoic test chamber set 3m from the receiving antenna. The EUT was set to receive in hopping mode. The EUT was tested, in 3 orthogonal axis, by rotating it 360° with the receive antenna in both the vertical and horizontal orientation while raised from 1 to 4 meters to ensure signal levels were maximized.

All emissions from 30 MHz to 1 GHz were examined.

Measured Level includes antenna and receiver cable correction factors.

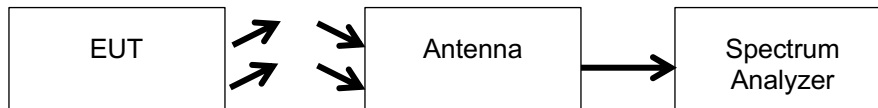
Correction factors were input into the spectrum analyzer before recording "Measured Level".

RBW = 100 KHz

VBW = 300 KHz

Detector – Quasi Peak

Test Setup



Test Procedure: ≥ 1 GHz

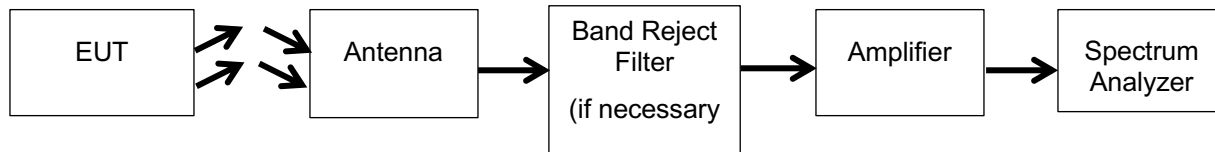
The EUT was setup in a semi-anechoic test chamber set 3m from the receiving antenna. The EUT was set to receive in hopping mode. The EUT was tested, in 3 orthogonal axis, by rotating it 360° with the receive antenna in both the vertical and horizontal orientation while raised from 1 to 4 meters to ensure the TX signal levels were maximized.

RBW = 1 MHz

VBW = 3 MHz

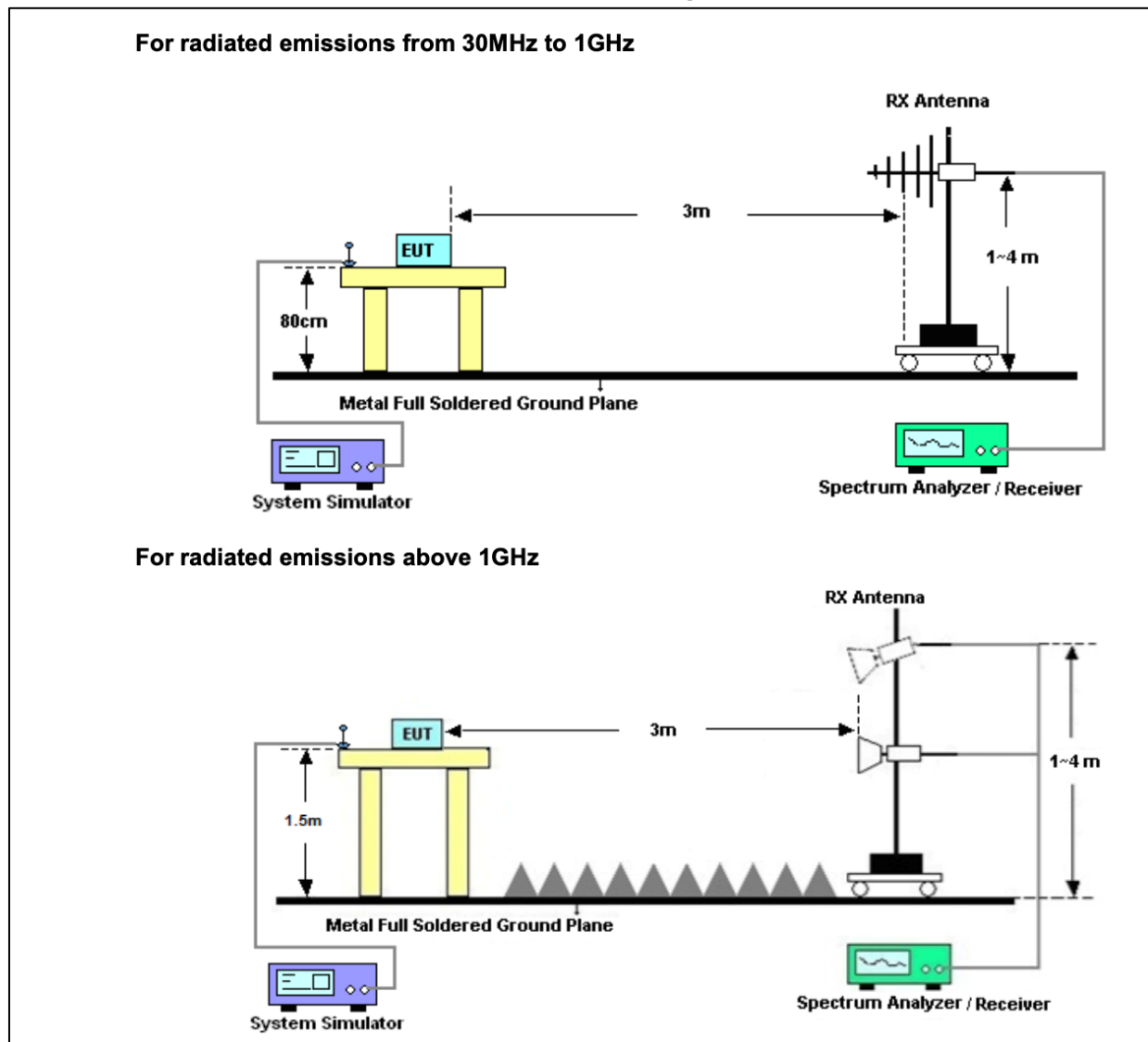
Detector – Peak

Test Setup



See Annex A for full test data

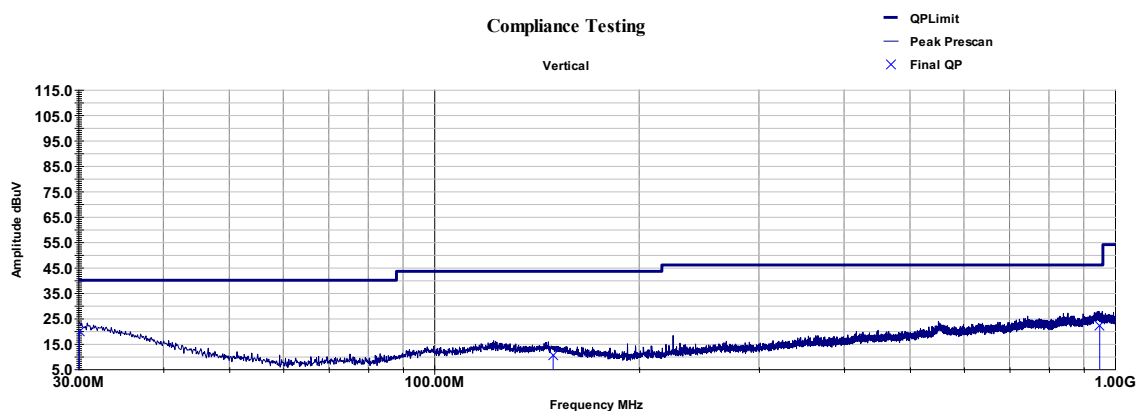
Chamber Setup Diagrams



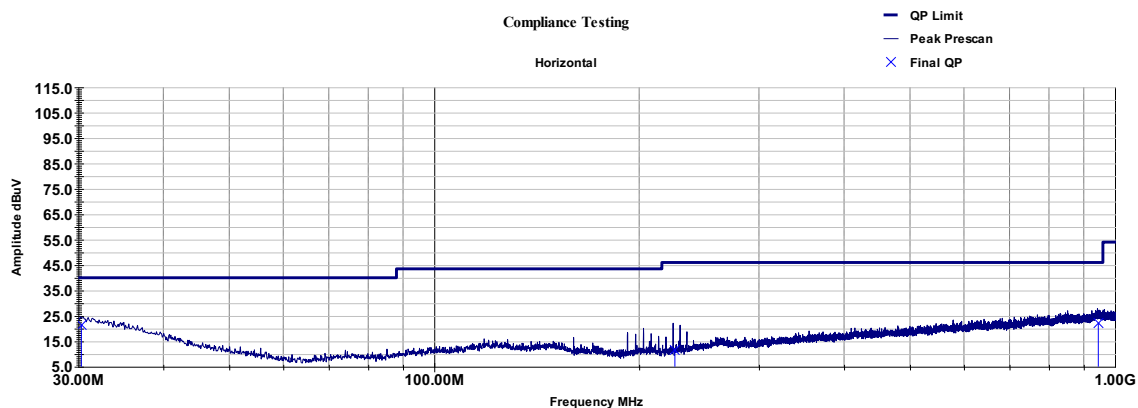
*Above 1 GHz an 80 cm table height was maintained per ANSI C63.4 test methods.

Test Data

30-1000 MHz

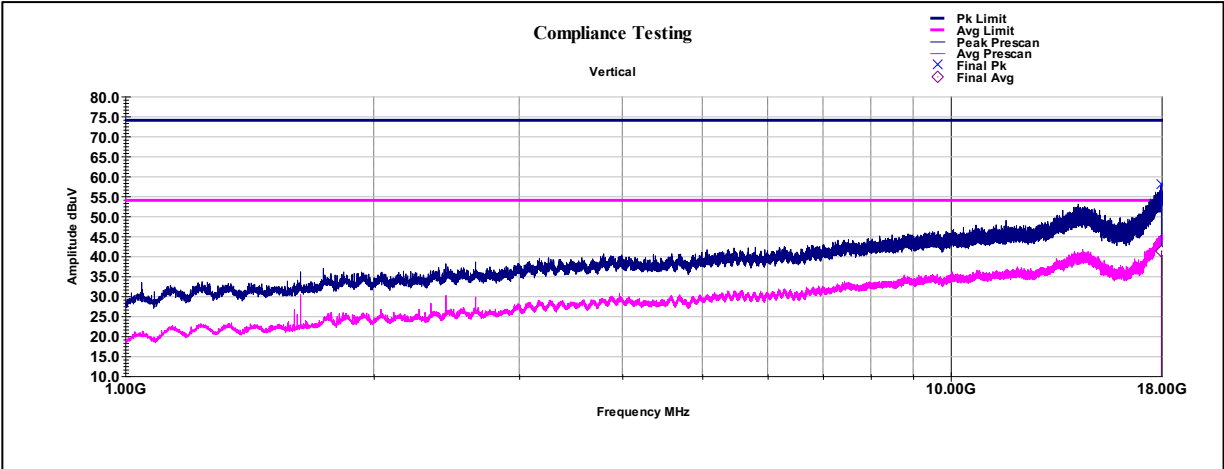


Frequency	Azimuth	Height	Raw QP	Correction	Final QP	Limit	QP Margin
MHz	deg	cm	dBuV	dB	dBuV/m	dBuV/m	dB
30.116	77	325	40.59	-20.88	19.71	40.0	-20.3
149.499	355	160	36.50	-26.03	10.47	43.5	-33.0
949.861	79	109	32.39	-10.17	22.22	46.0	-23.8
Final = Raw + Path Loss							
Margin = Final - Limit							

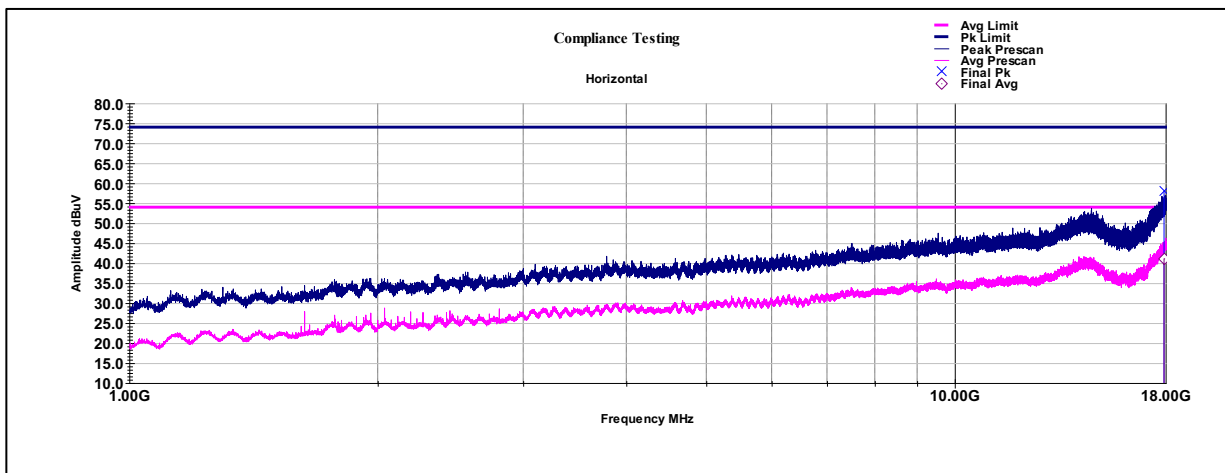


Frequency	Azimuth	Height	Raw QP	Correction	Final QP	Limit	QP Margin
MHz	deg	cm	dBuV	dB	dBuV/m	dBuV/m	dB
30.313	316	100	40.56	-19.29	21.26	40.0	-18.7
225.717	302	100	38.88	-27.15	11.73	46.0	-34.3
945.317	91	141	32.56	-10.48	22.08	46.0	-23.9
Final = Raw + Path Loss							
Margin = Final - Limit							

1-18 GHz



Frequency	Azimuth	Height	Raw Pk	Raw Avg	Correction	Final Pk	Pk Limit	Pk Margin	Final Avg	Avg Limit	Avg Margin
MHz	deg	cm	dBuV	dBuV	dB	dBuV/m	dBuV/m	dB	dBuV/m	dBuV/m	dB
17993.627	72.00	325.00	37.30	20.68	20.71	58.00	74.00	-16.00	41.39	53.98	-12.59
Final = Raw + Path Loss											
Margin = Final - Limit											



Frequency	Azimuth	Height	Raw Pk	Raw Avg	Correction	Final Pk	Pk Limit	Pk Margin	Final Avg	Avg Limit	Avg Margin
MHz	deg	cm	dBuV	dBuV	dB	dBuV/m	dBuV/m	dB	dBuV/m	dBuV/m	dB
17923.238	88.00	319.00	37.56	20.57	20.57	58.14	74.00	-15.86	41.14	53.98	-12.84
Final = Raw + Path Loss											
Margin = Final - Limit											

Test Equipment Utilized

Description	Manufacturer	Model #	CT Asset #	Last Cal Date	Cal Due Date
Preamplifier	Eravant	SBB-0115034018-2F2F-E3	i00646	Verified on: 8/10/22	
Bi-Log antenna	Chase	CBL6111C	i00349	2/27/22	2/27/24
Humidity / Temp Meter*	Omega	IBTHX-W-5	i00631	11/3/21	11/3/22
3 Meter Semi-Anechoic Chamber	Panashield	3 Meter Semi-Anechoic Chamber	i00428	7/17/20	7/17/23
Horn Antenna	EMCO	3115	i00103	2/23/21	2/23/23
Horn Antenna	EMCO	3116	i00085	2/22/21	2/22/23
EMI Analyzer	Rohde & Schwarz	FSU 26	i00501	5/10/22	5/10/23
EMI Receiver	Keysight	N9038A	i00552	2/24/22	2/24/23

In addition to the above listed equipment standard RF connectors and cables were utilized in the testing of the described equipment. Prior to testing these components were tested to verify proper operation.

Measurement Uncertainty

Measurement Uncertainty (U_{lab}) for Compliance Testing is listed in the table below.

Measurement	U_{lab}
Radio Frequency	$\pm 3.3 \times 10^{-8}$
RF Power, conducted	± 1.5 dB
RF Power Density, conducted	± 1.0 dB
Conducted Emissions	± 1.8 dB
Radiated Emissions	± 4.5 dB
Temperature	± 1.5 deg C
Humidity	± 4.3 %
DC voltage	± 0.20 VDC
AC Voltage	± 1.2 VAC

The reported expanded uncertainty $\pm U_{lab}(\text{dB})$ has been estimated at a 95% confidence level ($k=2$)

U_{lab} is less than or equal to U_{ETSI} therefore

- Compliance is deemed to occur if no measured disturbance exceeds the disturbance limit
- Non-Compliance is deemed to occur if any measured disturbance exceeds the disturbance limit