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info@ComplianceTesting.com

# 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**<br>**1-1-32, Kamiminami**<br>**Hirano-Ku**<br>**Osaka 547-0003, Japan** |
| **Attention of:** | **Atsushi Tomiyama, General Manager of QA Department**<br>**Ph: +81 6 6793 8424**<br>**Email: world_support@icom.co.jp** |

**Prepared By**
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**Project No: p21a0006**

**Authorized By**

**Aaron S. Froehlich**
**Sr RF/EMC Engineer**

**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

## 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 (ºC)** | **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, π/4-DQPSK, 8DPSK |
| Data Rate(s) | 1/2/3 Mbps |
| Antenna | Type: Multilayer Monopole Chip<br>Part Number: AH 212M245001<br>Pk Gain: 0.9 dBi<br>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 | π/4-DQPSK | 19 | 17 |
| EDR 2-DH3 | 2 | π/4-DQPSK | 26 | 367 |
| EDR 3-DH3 | 3 | 8DPSK | 27 | 552 |
| EDR 2-DH5 | 2 | π/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:

| | |
|---|---|
| **X** | 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:

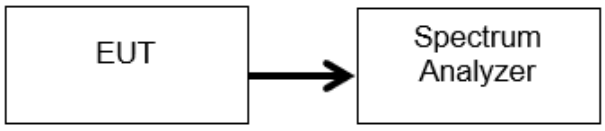
20 dB Occupied Bandwidth

| | |
|---|---|
| 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



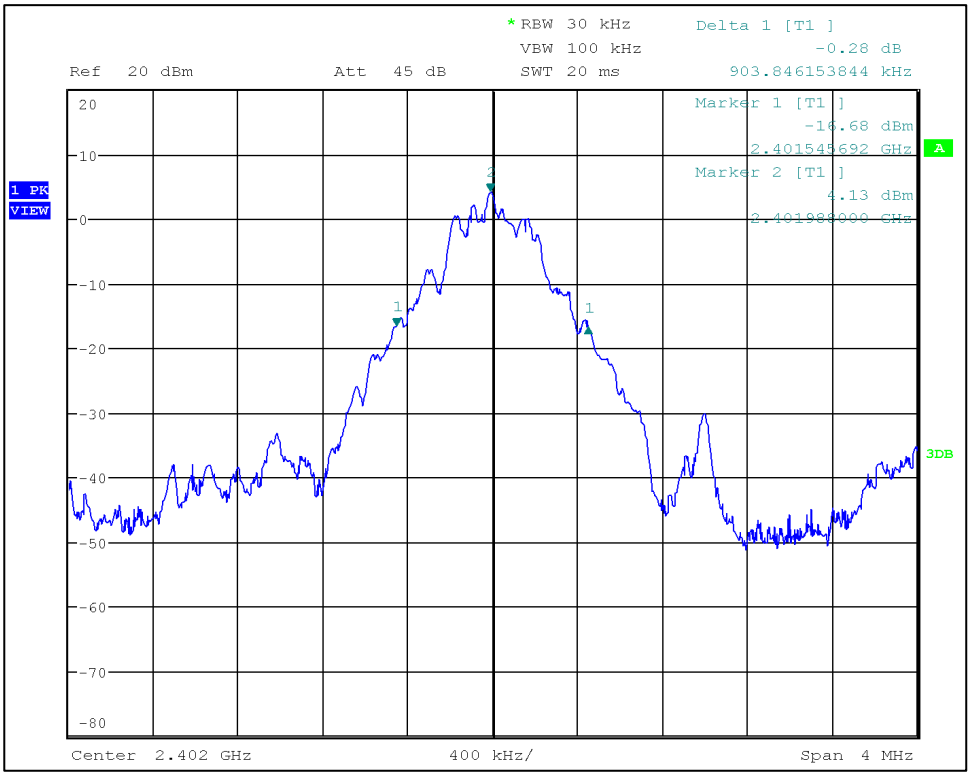
# Test Data

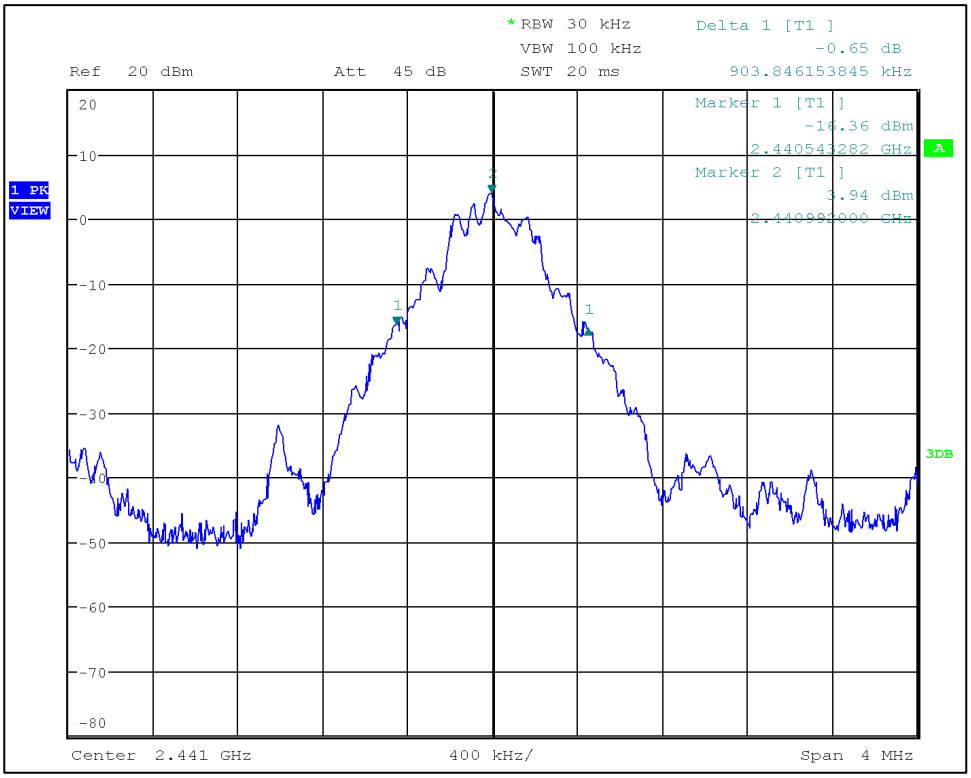
## Tabular Data

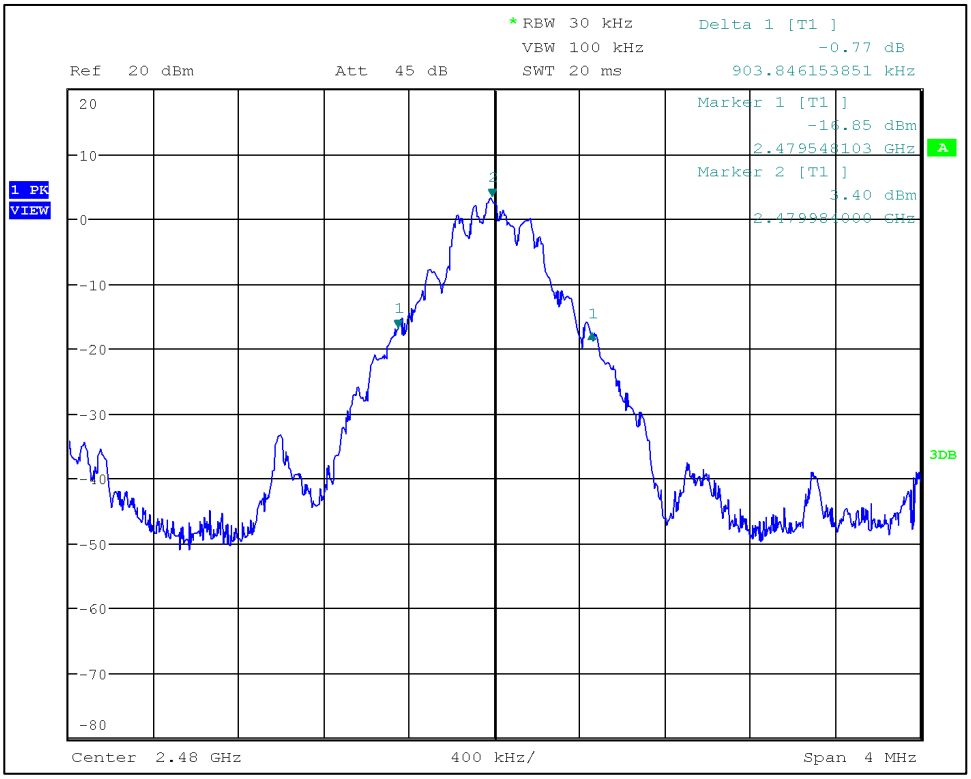
| Data Rate | Frequency | 20 dB BW | 99% OBW |
|---|---|---|---|
| | MHz | MHz | MHz |
| BDR DM1 | 2402 | 0.904 | 0.833 |
| BDR DM1 | 2441 | 0.904 | 0.821 |
| BDR DM1 | 2480 | 0.904 | 0.833 |
| BDR DH3 | 2402 | 0.942 | 0.853 |
| BDR DH3 | 2441 | 0.951 | 0.859 |
| BDR DH3 | 2480 | 0.950 | 0.853 |
| BDR 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*

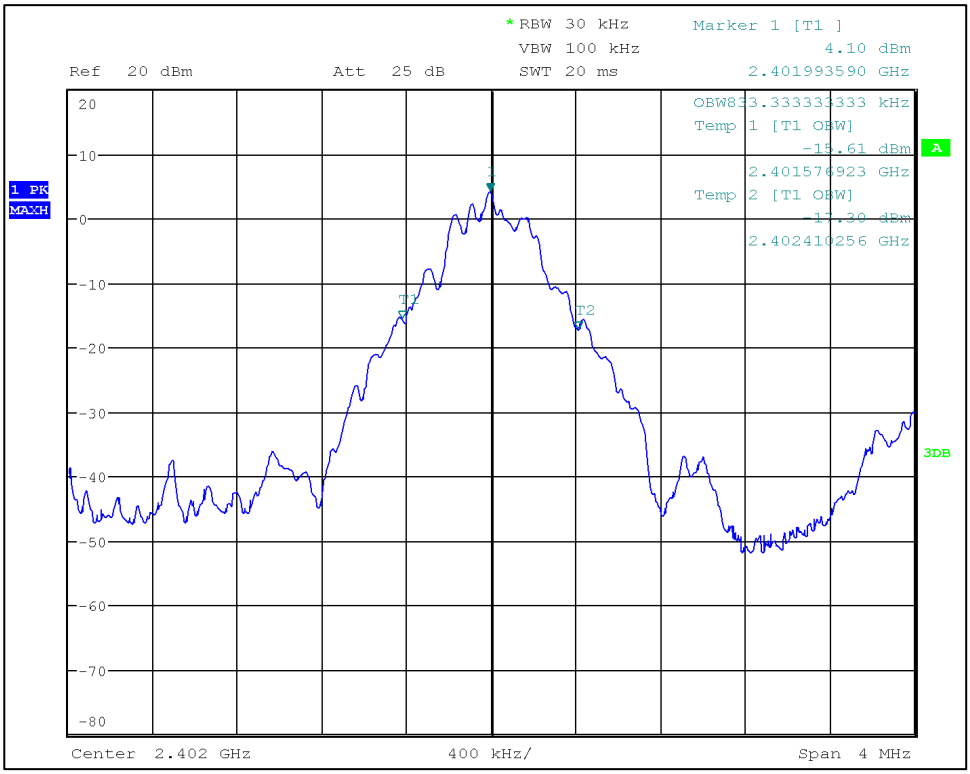


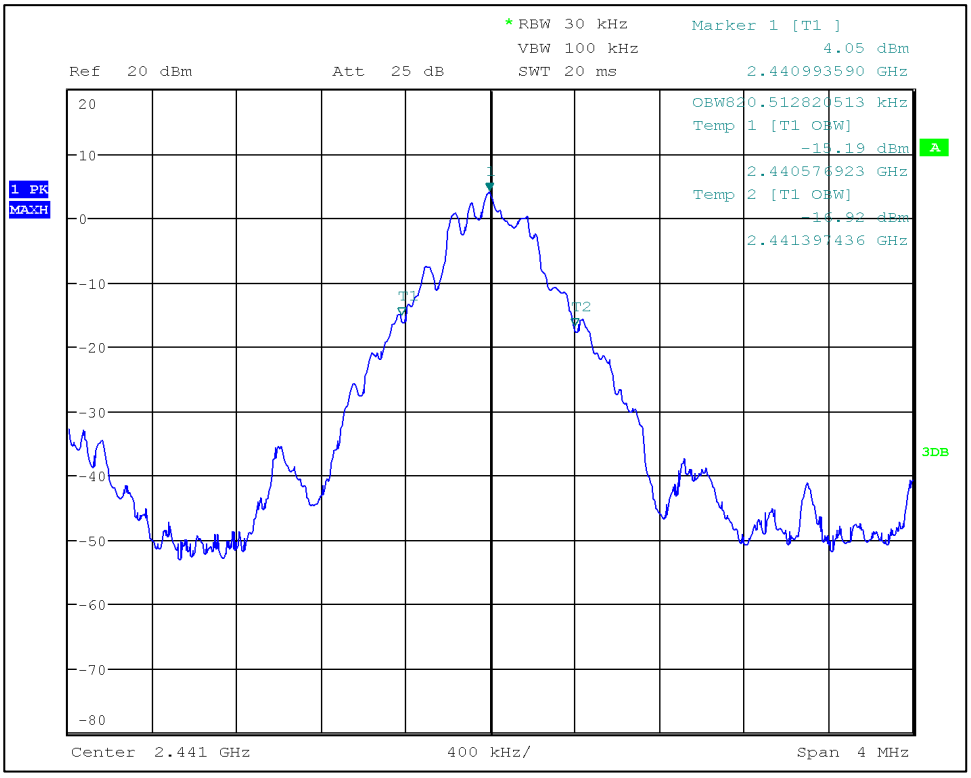



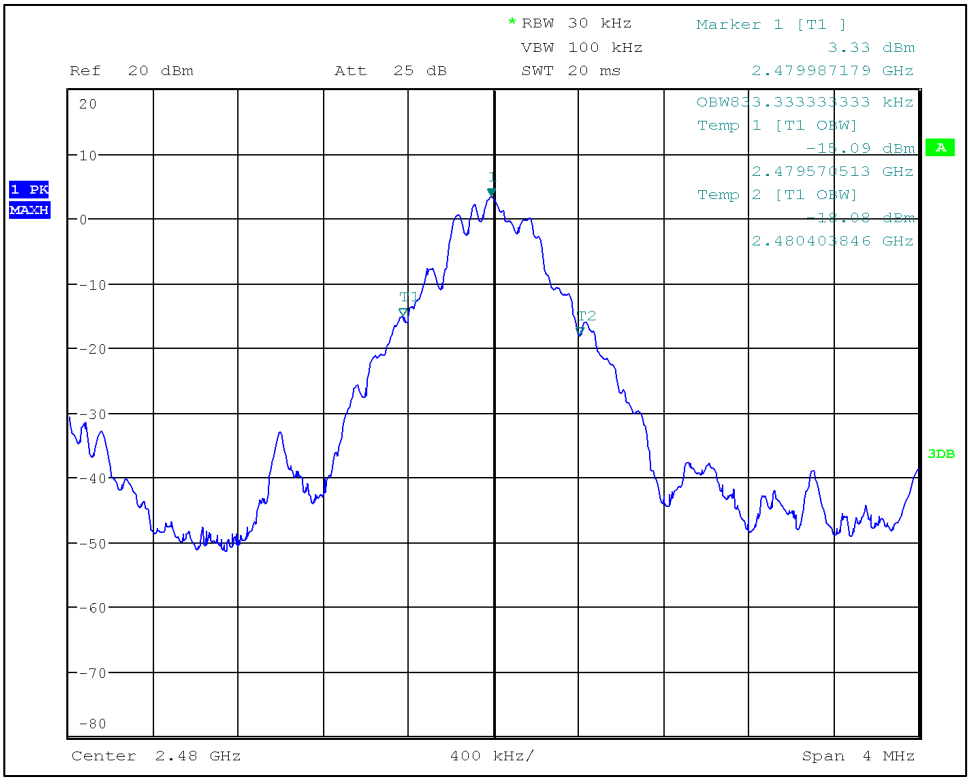

RBW 30 kHz
VBW 100 kHz
SWT 20 ms
Delta 1 [T1 ]
-0.77 dB
903.846153851 kHz
Ref 20 dBm
Att 45 dB
Marker 1 [T1 ]
-16.85 dBm
2.479548103 GHz
Marker 2 [T1 ]
3.40 dBm
2.479984000 GHz
1 PK
VIEW
A
3DB
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Center 2.48 GHz
400 kHz/
Span 4 MHz

## 99% Plots

*BDR DM1*




RBW 30 kHz
VBW 100 kHz
SWT 20 ms
Marker 1 [T1 ]
3.33 dBm
2.479987179 GHz
OBW833.333333333 kHz
Temp 1 [T1 OBW]
-15.09 dBm
2.479576513 GHz
Temp 2 [T1 OBW]
-18.08 dBm
2.480403846 GHz
Ref 20 dBm
Att 25 dB
1 PK
MAXH
A
3DB
T1
T2
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Center 2.48 GHz
400 kHz/
Span 4 MHz

# 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

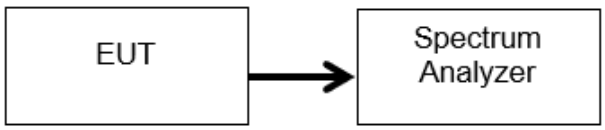
47 CFR 15.247(b)(1) & RSS 247 5.4.b.
For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 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 |

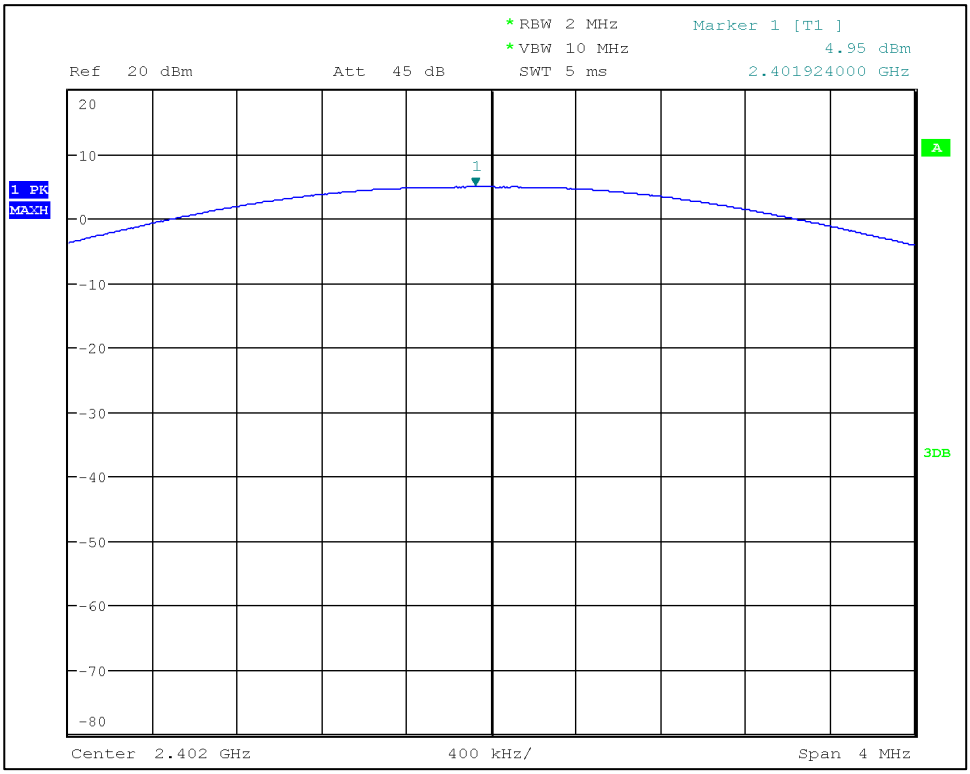
Final Pk = Raw Pk + Atten

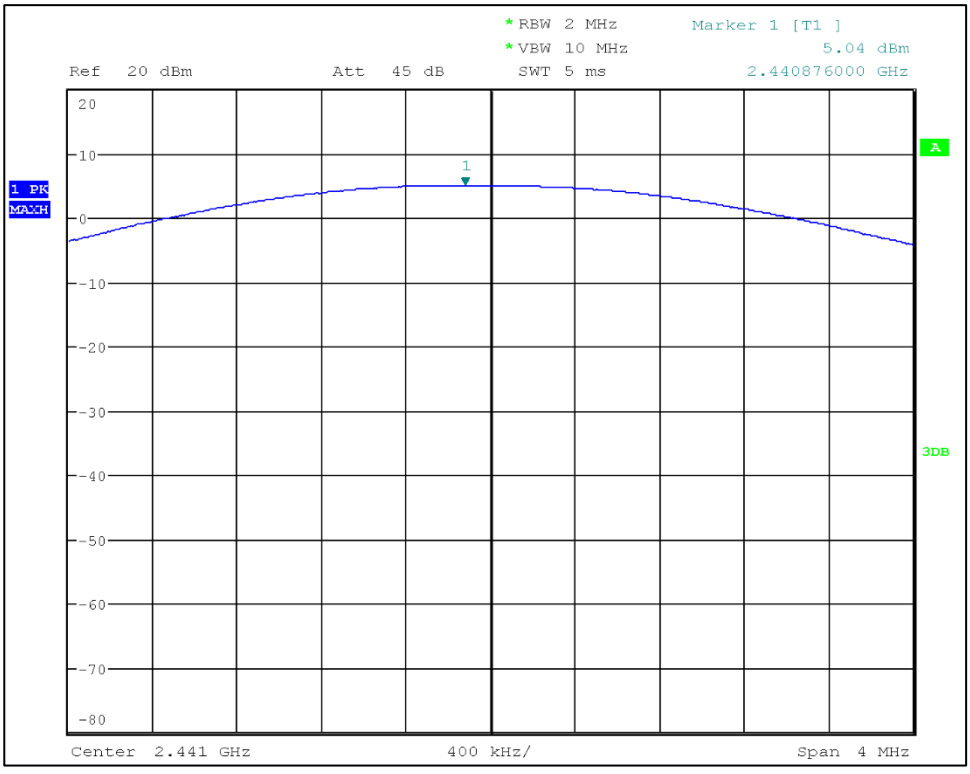
Maximum Output Power: 6.41 dBm, 4.38 mW

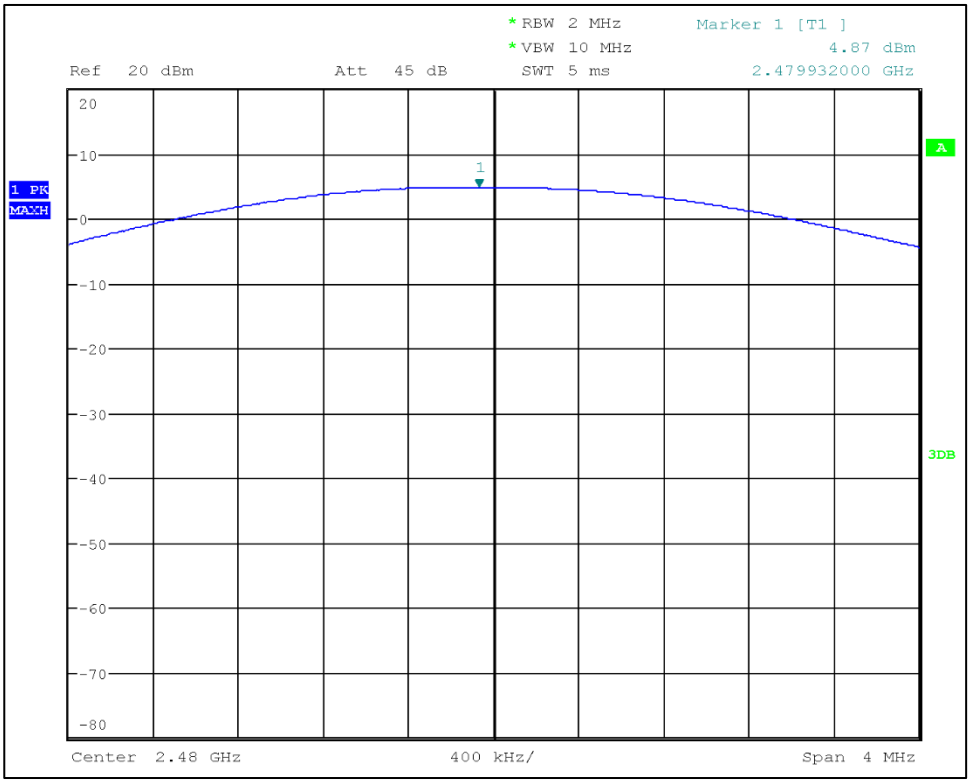
Highest Power [GFSK]: BDR DM1
Highest Power [DPSK]: EDR3 DH5

## Power Plots

*BDR DM1*




*RBW 2 MHz
*VBW 10 MHz
SWT 5 ms
Marker 1 [T1 ]
4.87 dBm
2.479932000 GHz
Ref 20 dBm
Att 45 dB
1 PK
MAXH
A
3DB
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Center 2.48 GHz
400 kHz/
Span 4 MHz

# Carrier Frequency Separation

**Engineer:** Aaron S. Froehlich
**Test Date:** 8/19/2022

## Test Procedure

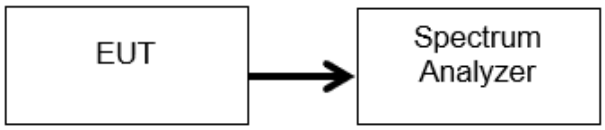
The test methods and settings of ANSI C63.10 Clause 7.8.2 were utilized to demonstrate compliance. The EUT was configured for BDR DM1 data rate during the test. Unmodulated frequency hopping was not possible.

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

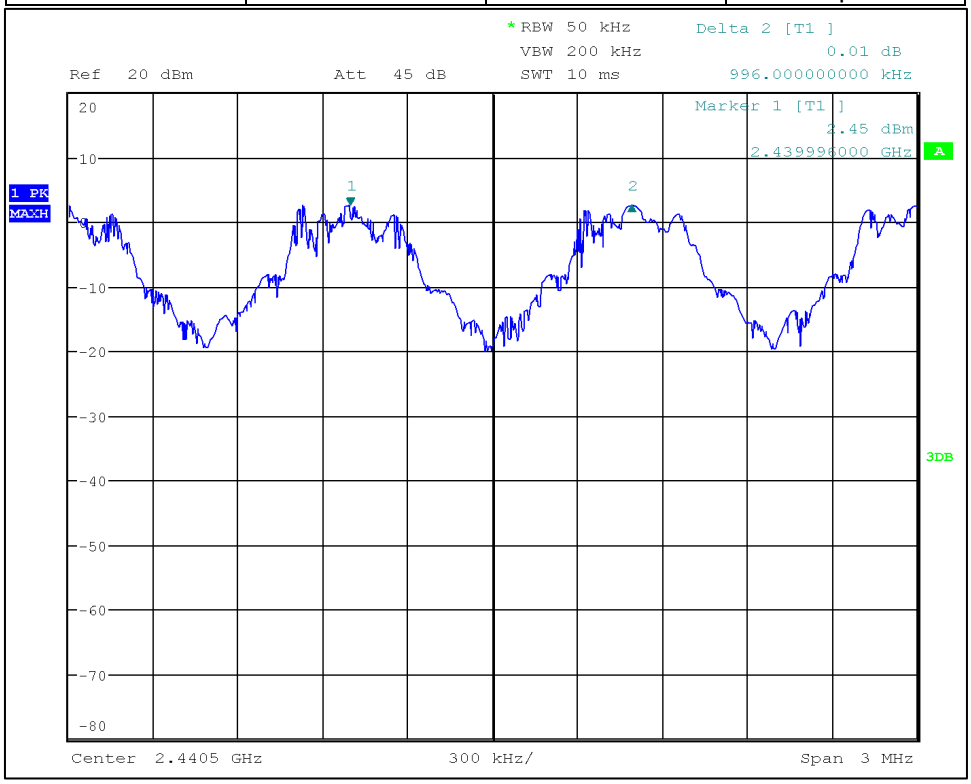
47 CFR 15.247(a)(1) & RSS 247 5.1.b.
Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

## Test Setup




## Test Data

| Min 20 dB BW (MHz) | CFS (MHz) | Margin (MHz) | Result |
|---|---|---|---|
| 0.598 | 0.996 | -0.398 | Compliant |



# Number of Hopping Frequencies

**Engineer:** Aaron S. Froehlich
**Test Date:** 8/19/2022

## Test Procedure

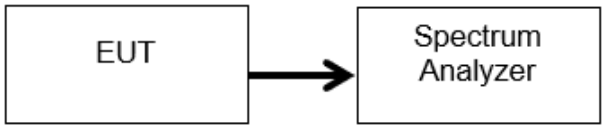
The test methods of ANSI C63.10 Clause 7.8.3 were utilized to demonstrate compliance. The EUT was configured for BDR DM1 with hopping during this test.

The number of frequencies were manually counted.

### Limit

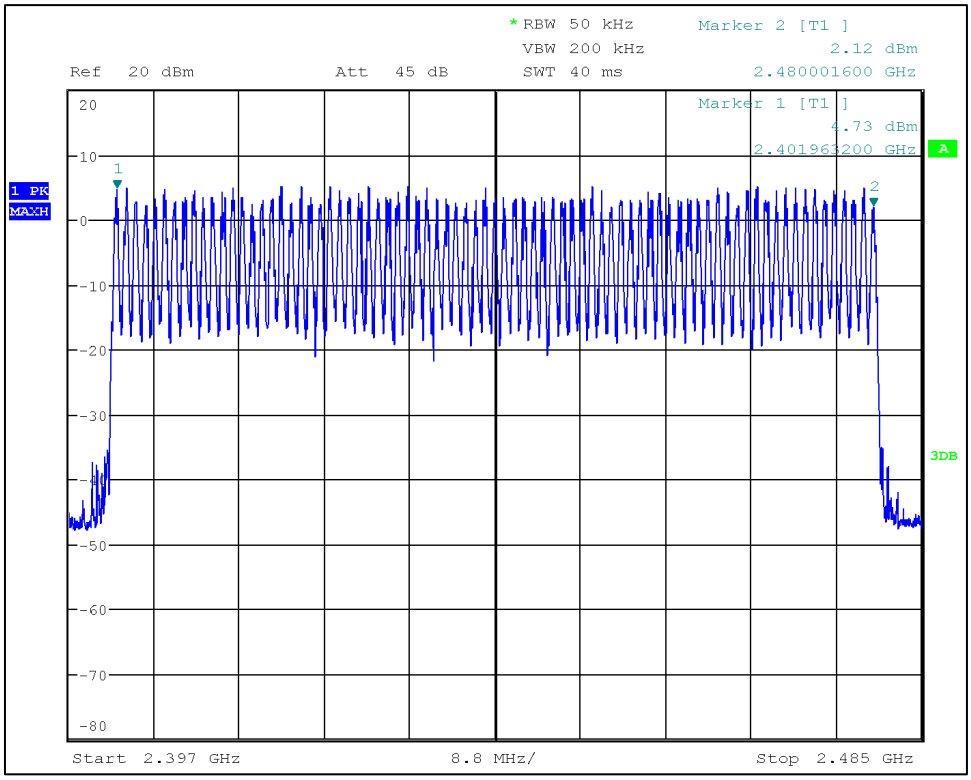
47 CFR 15.247(a)(1)(iii) & RSS 247 5.1.d.
Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.

## 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.

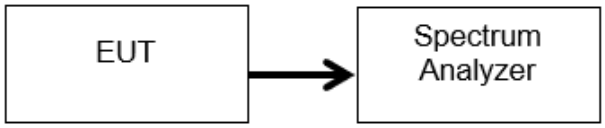
Video Triggering with a negative offset was utilized to allow accurate time domain measurements.

### 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.

$$Required\ Period = 0.4\ s \bullet 79\ channels = 31.6\ s$$

## Test Setup




## Test Data

### Tabular Data

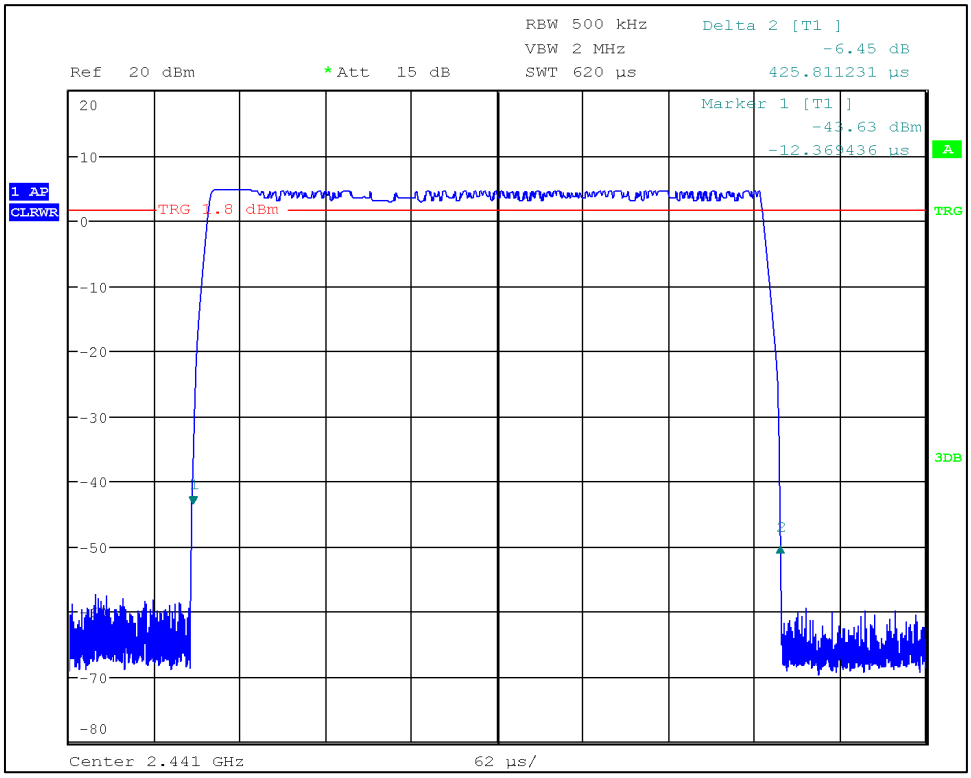
| Rate | Duration (MS) | Hops Observed | Required Period (S) | Sweep Time (S) | Total Hops | Total Occupancy (mS) | Limit (mS) | Margin (mS) | Result |
|---|---|---|---|---|---|---|---|---|---|
| BDR DM1 | 0.426 | 5 | 31.6 | 0.5 | 316 | 134.56 | 400 | -265.44 | Compliant |
| BDR DH3 | 1.680 | 5 | 31.6 | 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 |

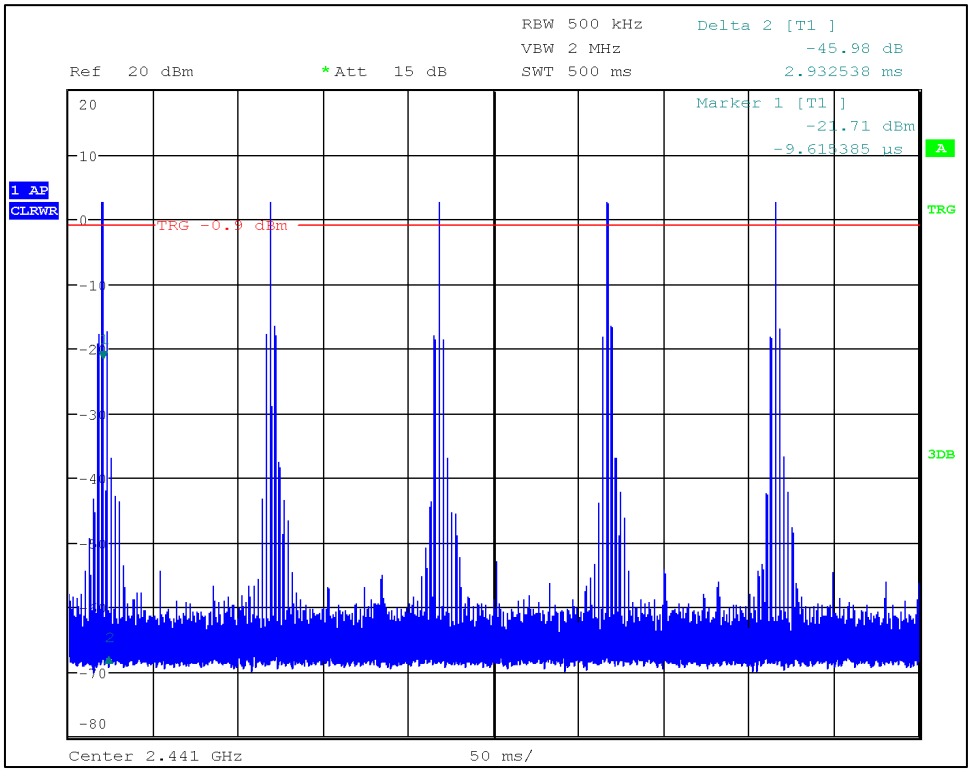
Total Hops = Hops Observed • Required Period / Sweep Time

Total Occupancy = Duration • Total Hops

## Plots

*BDR DM1*



# Duty Cycle

**Engineer:** Aaron S. Froehlich
**Test Date:** 8/18/2022

## Test Procedure

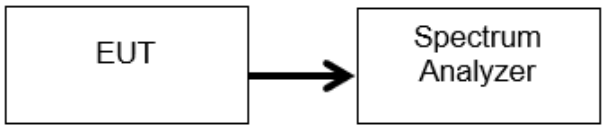
Duty Cycle was measured using the method of ANSI C63.10 Clause 11.6 option b.

### Limit

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

| | |
|---|---|
| Span | Zero Span |
| RBW | RBW ≥ OBW |
| VBW | ≥ RBW |
| Detector | Peak |

## Test Setup



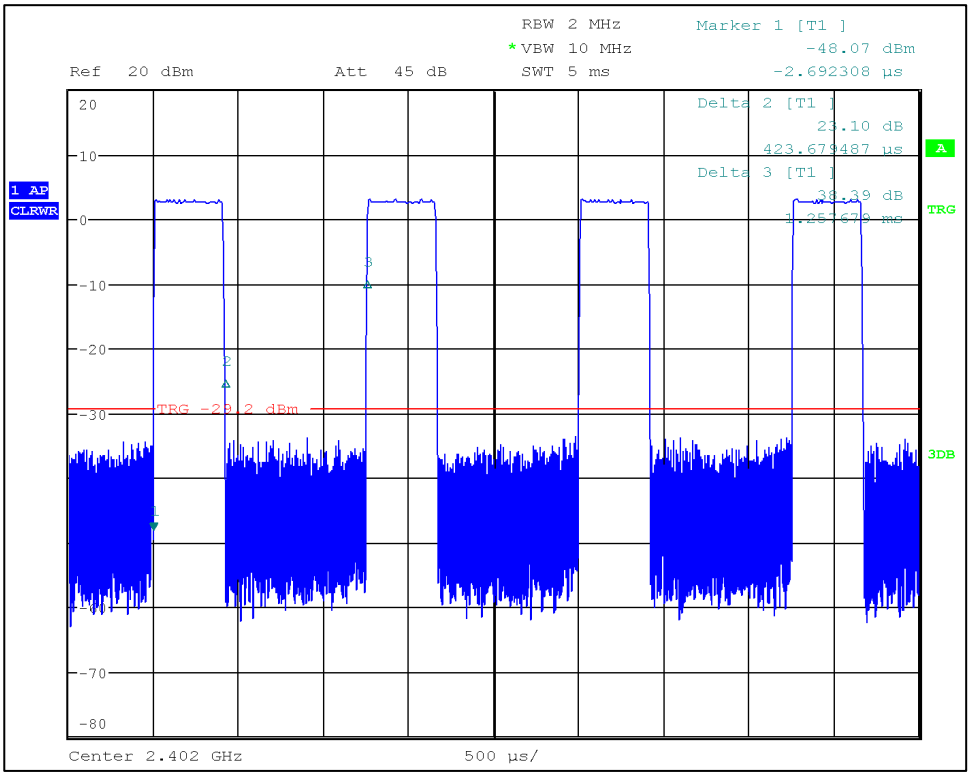

## Test Data

### 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**

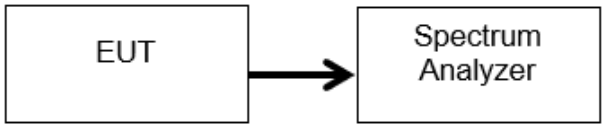
| Data Rate | CF | CL | DCCF | AG | Offset |
|---|---|---|---|---|---|
| | dB | dB | dB | dBi | Offset |
| BDR DM1 | 95.3 | 1.4 | 4.7 | 2.0 | 103.4 |
| BDR DH3 | 95.3 | 1.4 | 1.8 | 2.0 | 100.5 |
| BDR DH5 | 95.3 | 1.4 | 1.1 | 2.0 | 99.8 |
| EDR DM1 | 95.3 | 1.4 | 4.8 | 2.0 | 103.5 |
| EDR 2-DH3 | 95.3 | 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 • Log10(D) + 104.8
Where D = 3 meters
Offset = CF + CL + DCCF + AG

## Limits

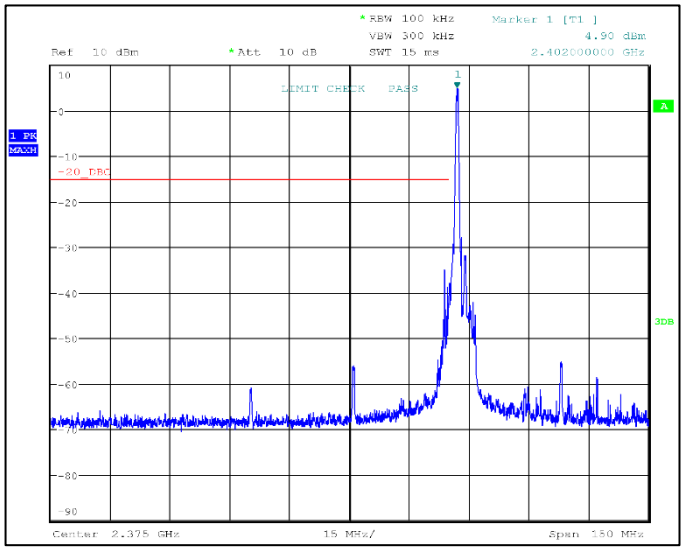
47 CFR 15.247(d) & RSS 247 Section 5.5
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth 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)).

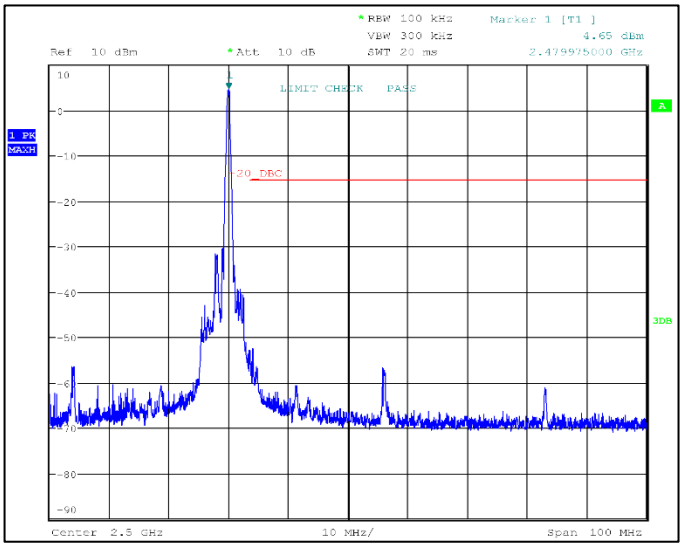
## Test Setup

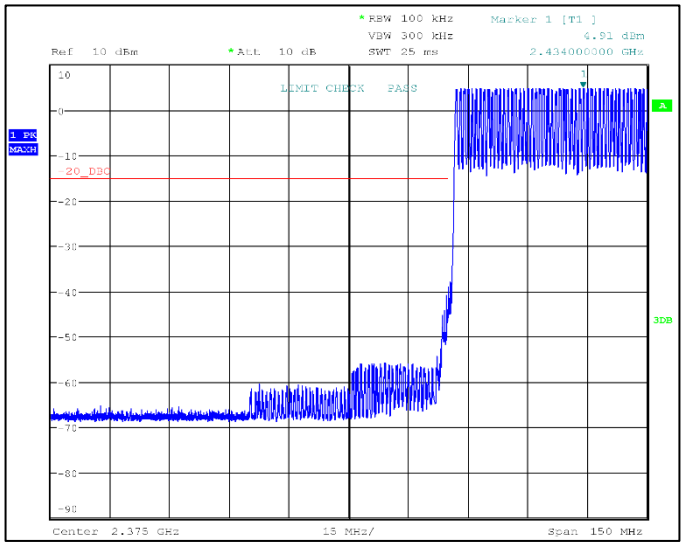


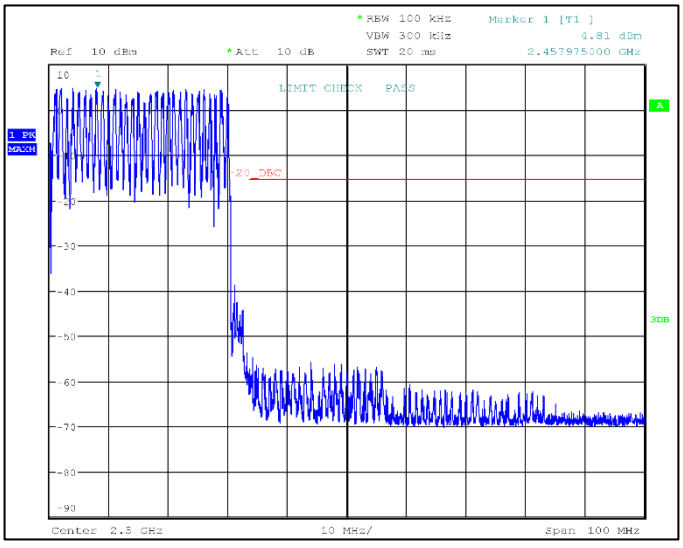
# Band Edge Test Data

## BDR DM1



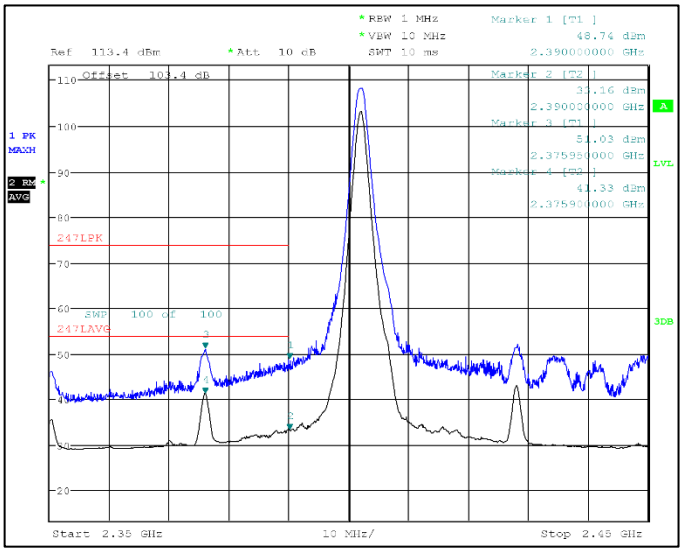



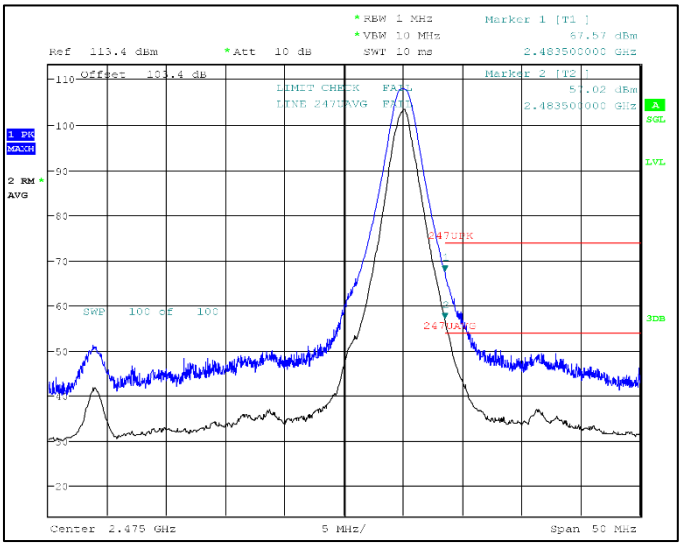



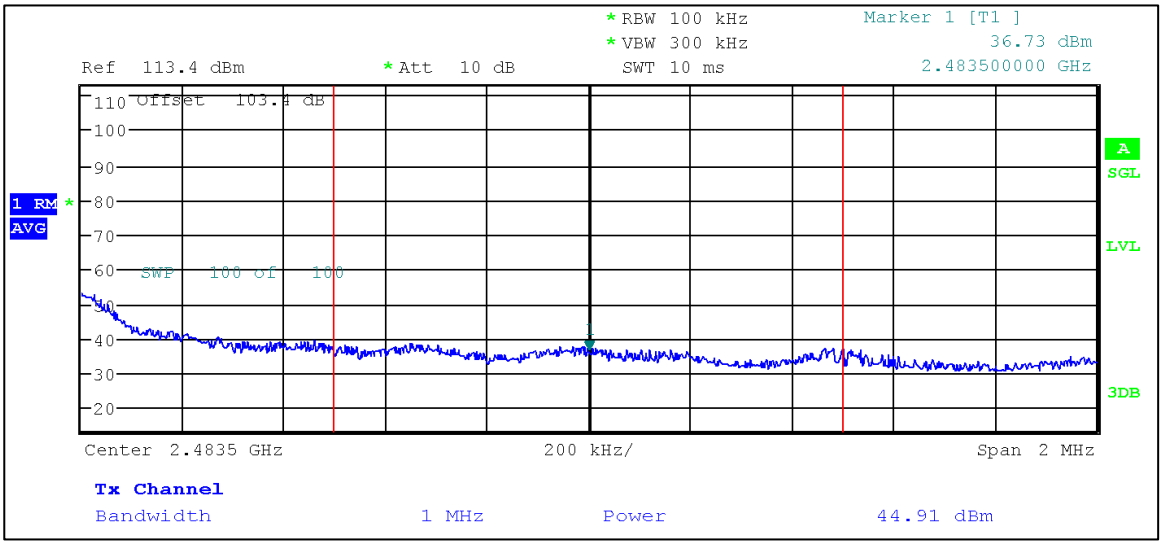



# Restricted-Band Band-Edge Test Data

## BDR DM1



# Conducted Spurious Emissions

**Engineer:** Aaron S. Froehlich
**Test Date:** 8/19/2022

## Test Procedure

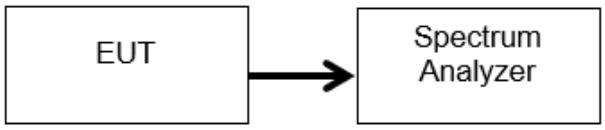
Conducted Spurious Emissions has been measured using the methods of ANSI C63.10 clause 7.8.8. The antenna port was connected to a spectrum analyzer and the range of 30 MHz to 10 times the operating frequency was scanned with a resolution bandwidth of 100 kHz, video bandwidth pf 300 kHz and a coupled 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

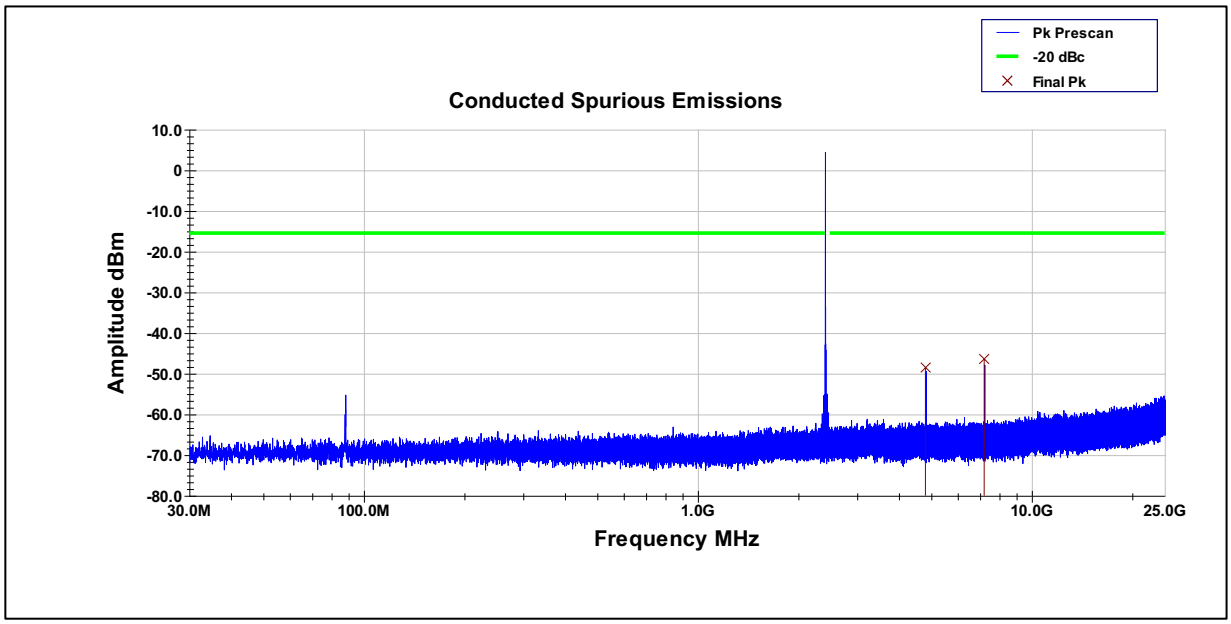
47 CFR 15.247(d) & RSS 247 Section 5.5
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth 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



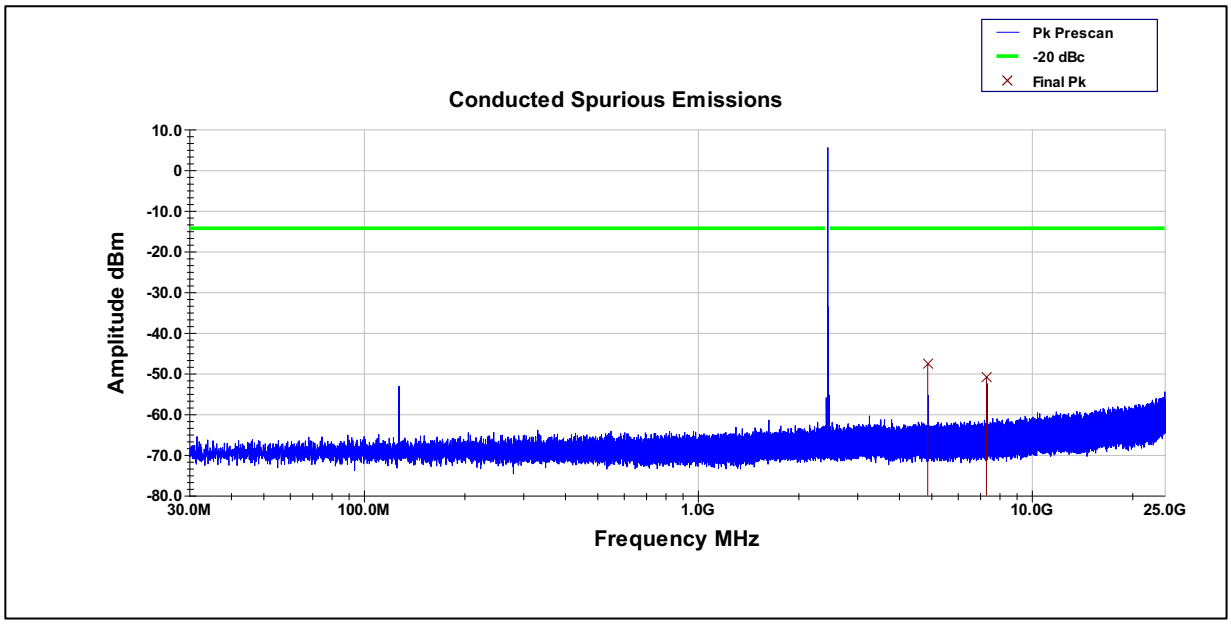
# Test Data

## BDR DM1 2402



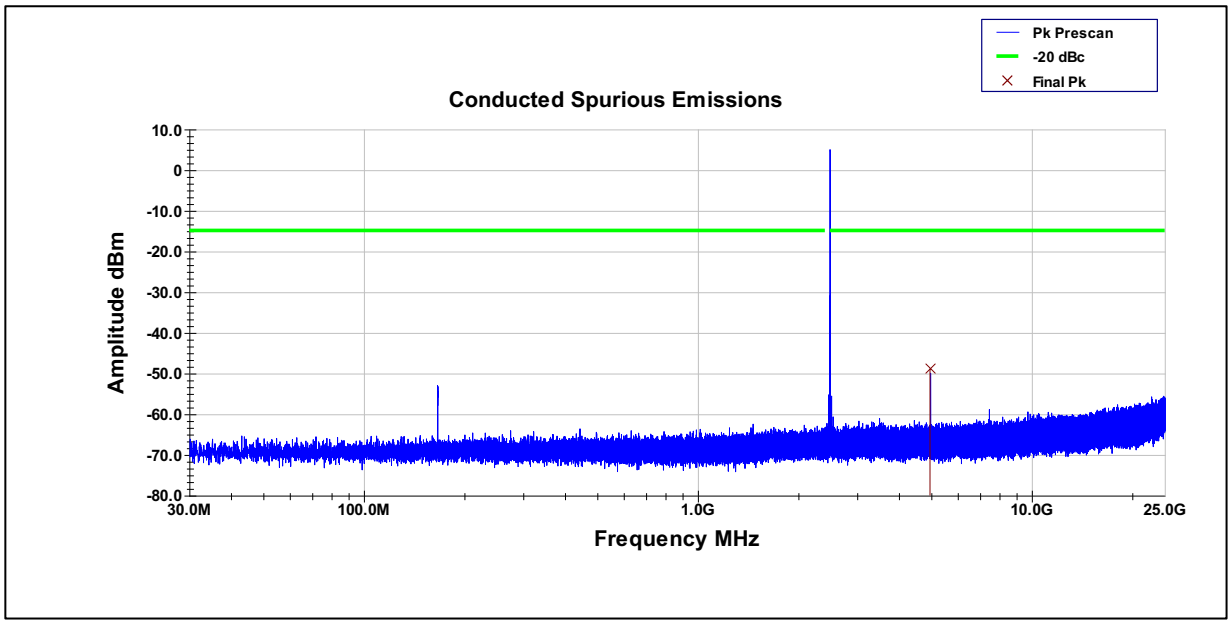

| Frequency | Raw Pk | Final Pk | Path Loss | Limit | Pk Margin |
|---|---|---|---|---|---|
| (MHz) | dBm | dBm | dB | dBm | dB |
| 4.804 GHz | -50.98 | -48.50 | 2.48 | -15.47 | -33.02 |
| 7.2055 GHz | -48.96 | -46.45 | 2.51 | -15.47 | -30.98 |
| | | | | | |
| Final = Raw + Path Loss | | | | | |
| Margin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

## BDR DM1 2441



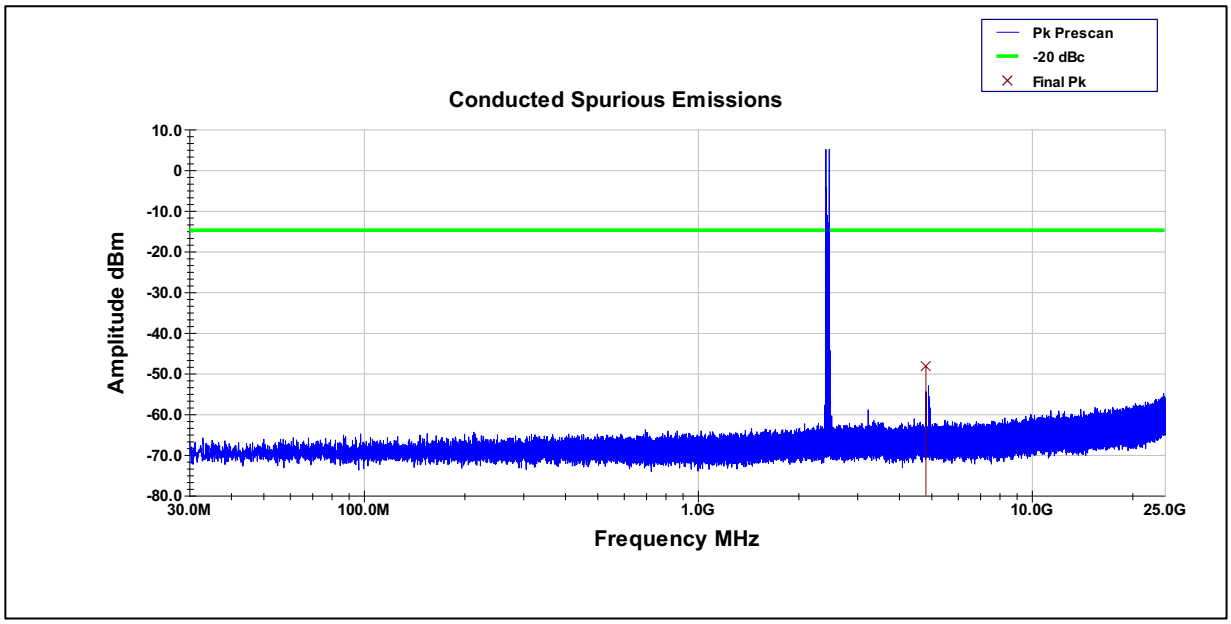

| Frequency | Raw Pk | Final Pk | Path Loss | Limit | Pk Margin |
|---|---|---|---|---|---|
| (MHz) | dBm | dBm | dB | dBm | dB |
| 4.8825 GHz | -50.21 | -47.74 | 2.47 | -14.35 | -33.39 |
| 7.3215 GHz | -53.40 | -50.81 | 2.59 | -14.35 | -36.46 |
| | | | | | |
| Final = Raw + Path Loss | | | | | |
| Margin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

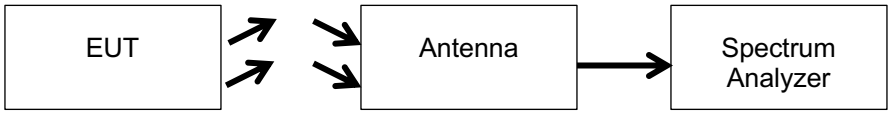
Per ANSI C63.10 Clause 5.6.2.2 b) the worst case modes to be tested for spurious emissions are BDR DM1 (GFSK modulated), and EDR3 DH5 (8-DPSK modulated).

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

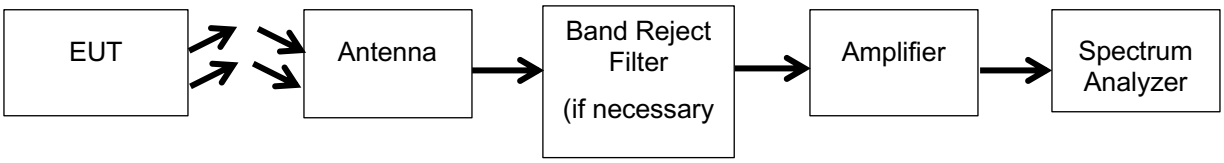



## Test Procedure: ≥ 1 GHz

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

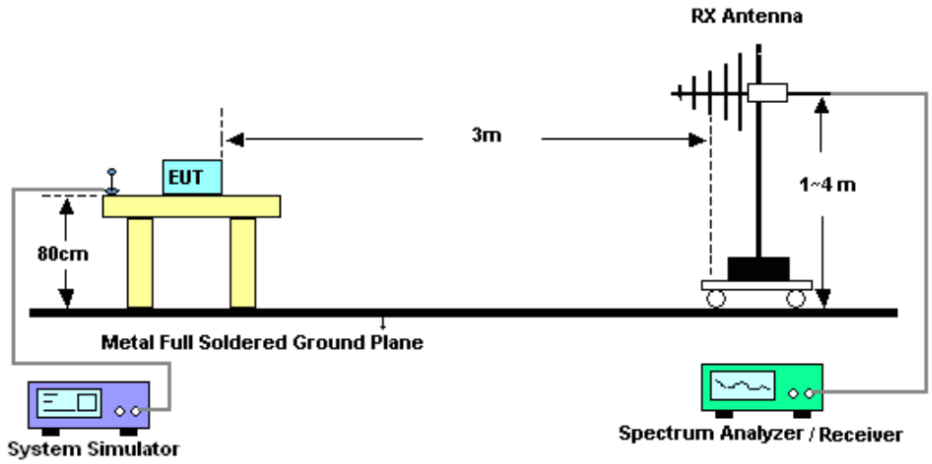
| Frequency | Azimuth | Height | Raw Pk | Raw Avg | Correction | Final Pk | Pk Limit | Pk Margin | Final Avg | Avg Limit | Avg Margin |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MHz | deg | cm | dBuV | dBuV | dB | dBuV/m | dBuV/m | dB | dBuV/m | dBuV/m | dB |
| 5234.235 | 173.00 | 351.00 |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

Final = Raw + Correction
Margin = Final - Limit

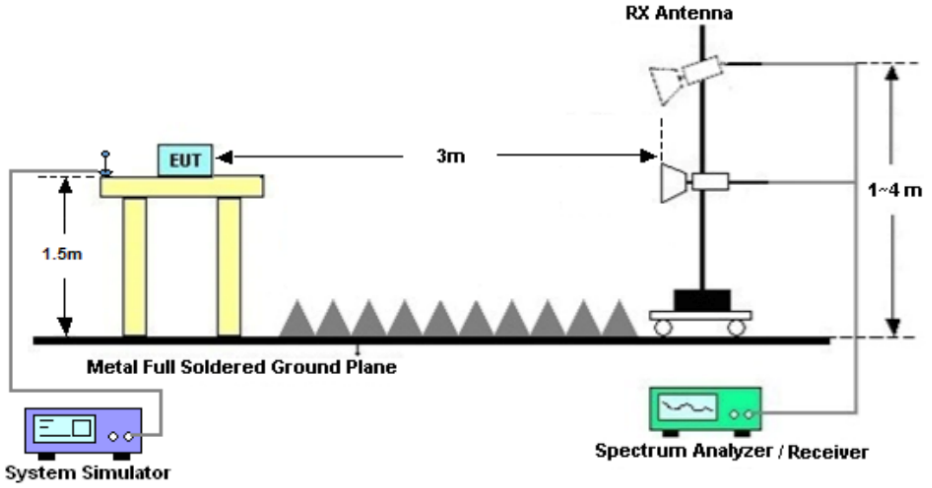
**See Annex A for full test data**

# Chamber Setup Diagrams

**For radiated emissions from 30MHz to 1GHz**



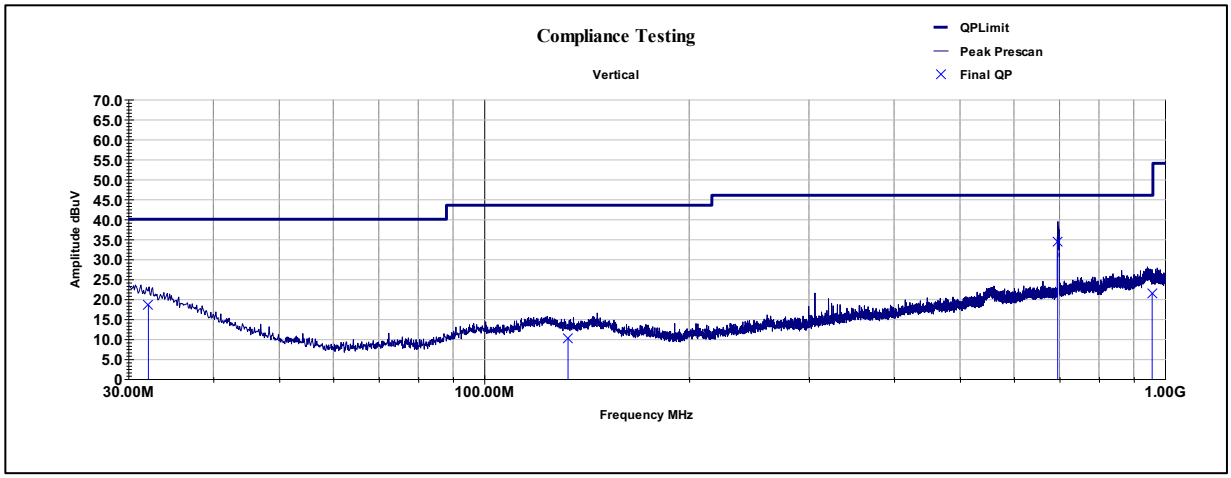

**For radiated emissions above 1GHz**



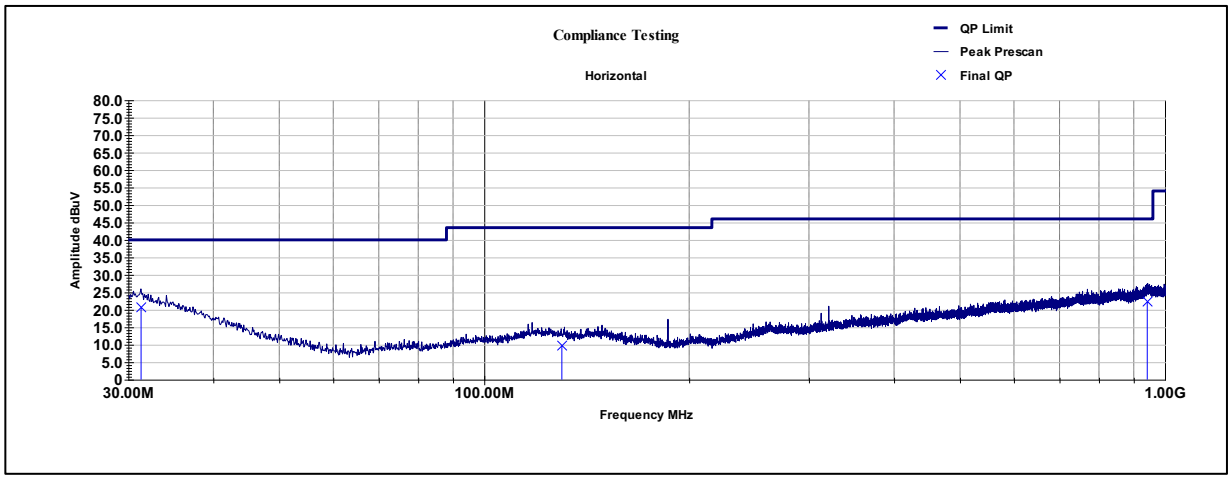
# Test Data

## 30-1000 MHz

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



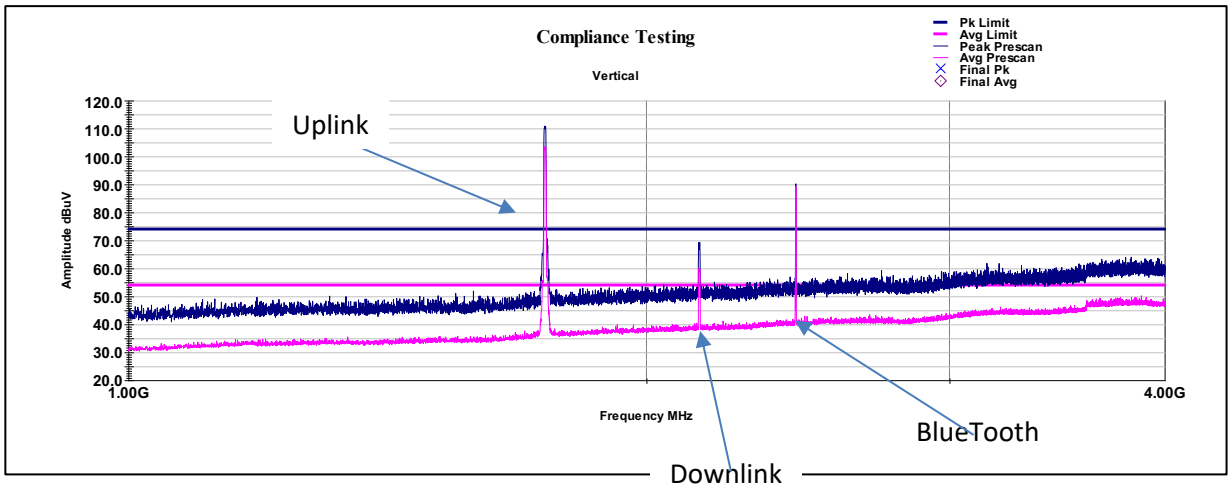

| Frequency | Azimuth | Height | Raw QP | Correction | Final QP | Limit | QP Margin |
|---|---|---|---|---|---|---|---|
| MHz | deg | cm | dBuV | dB | dBuV/m | dBuV/m | dB |
| 32.116 | 106 | 100 | 40.47 | -21.95 | 18.51 | 40.0 | -21.5 |
| 132.798 | 78 | 379 | 35.48 | -25.27 | 10.21 | 43.5 | -33.3 |
| 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 | | | | | | | |

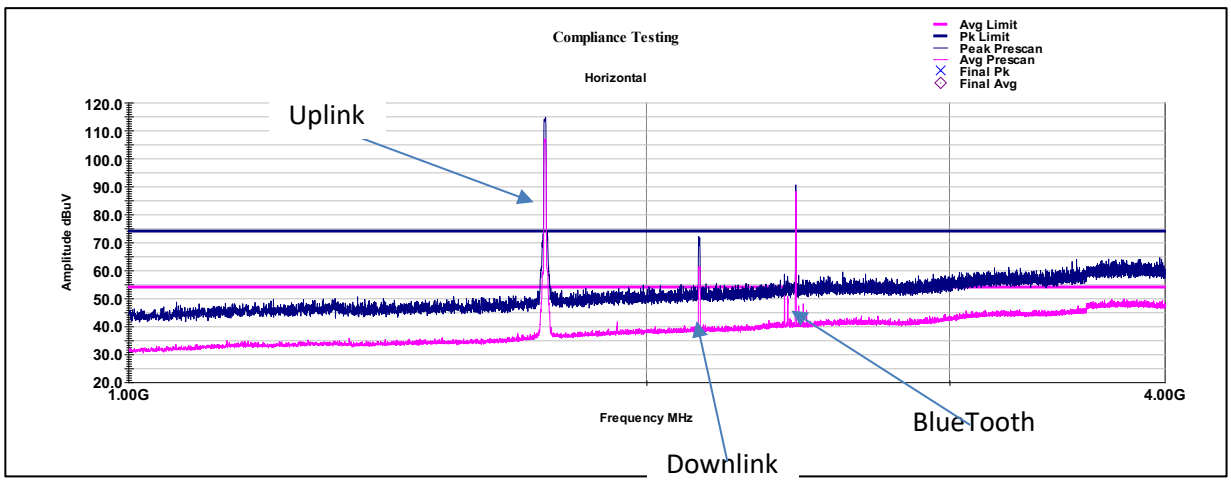



| Frequency | Azimuth | Height | Raw QP | Correction | Final QP | Limit | QP Margin |
|---|---|---|---|---|---|---|---|
| MHz | deg | cm | dBuV | dB | dBuV/m | dBuV/m | dB |
| 31.325 | 110 | 325 | 40.46 | -19.89 | 20.57 | 40.0 | -19.4 |
| 130.012 | 114 | 309 | 35.89 | -26.18 | 9.71 | 43.5 | -33.8 |
|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

## 1-4 GHz

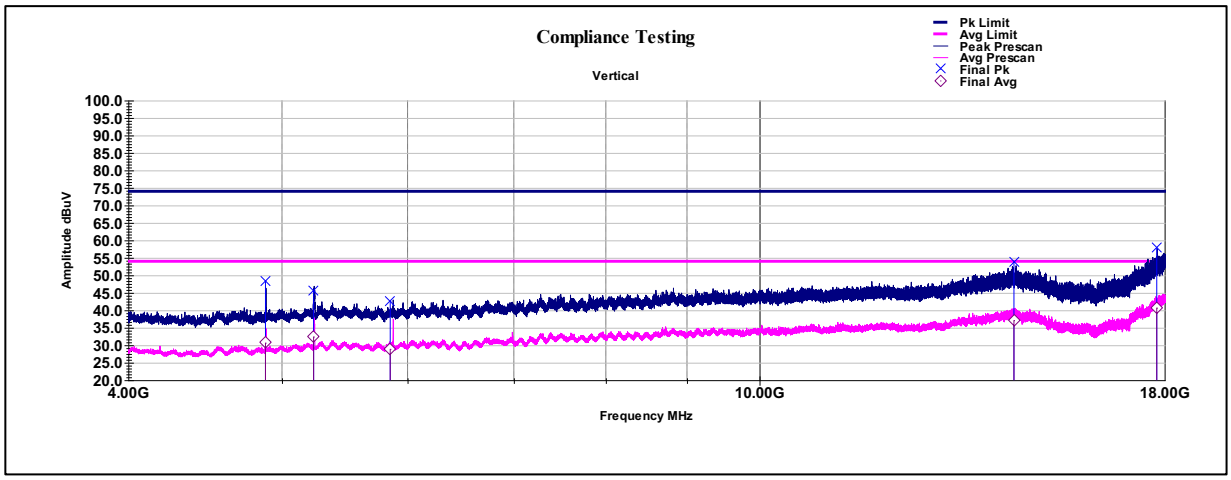
*X Axis BDR DM1 2441 w Band 66 5M Ch 132322*



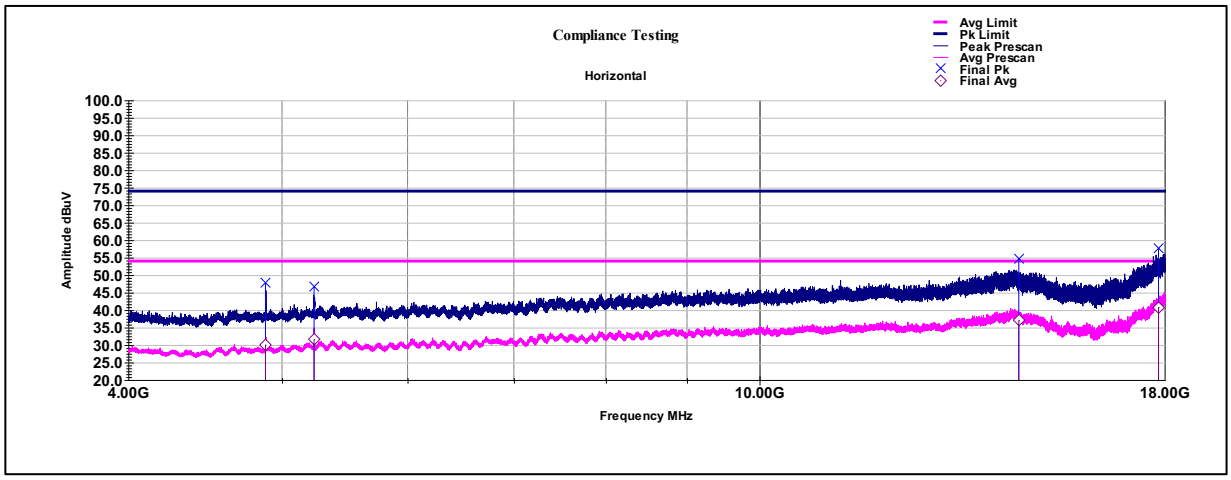



## 4-18 GHz

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



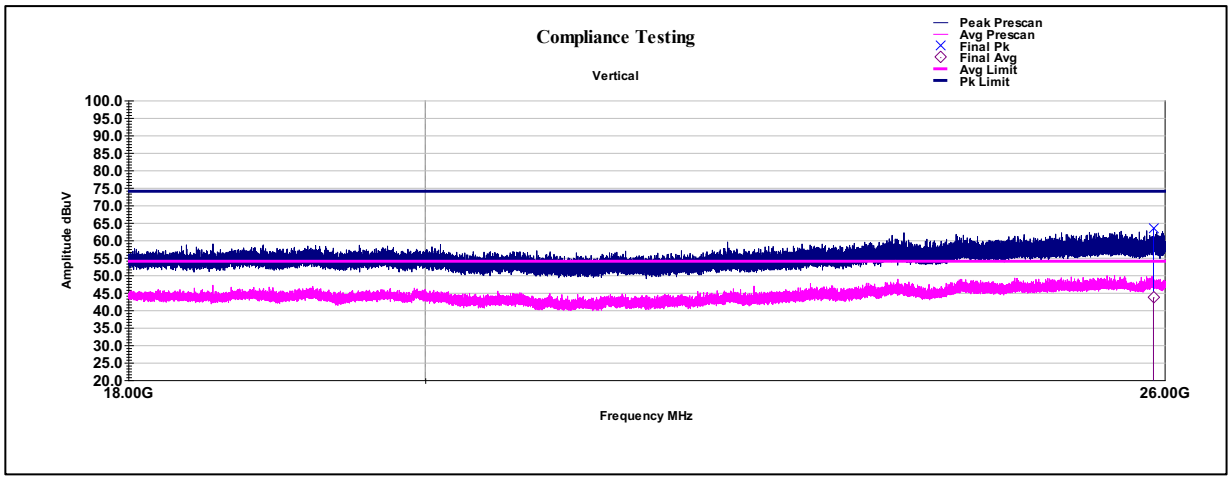

| Frequency | Azimuth | Height | Raw Pk | Raw Avg | Correction | Final Pk | Pk Limit | Pk Margin | Final Avg | Avg Limit | Avg Margin |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MHz | deg | cm | dBuV | dBuV | dB | dBuV/m | dBuV/m | dB | dBuV/m | dBuV/m | dB |
| 4881.983 | 350.00 | 175.00 | 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 | | | | | | | | | | | |



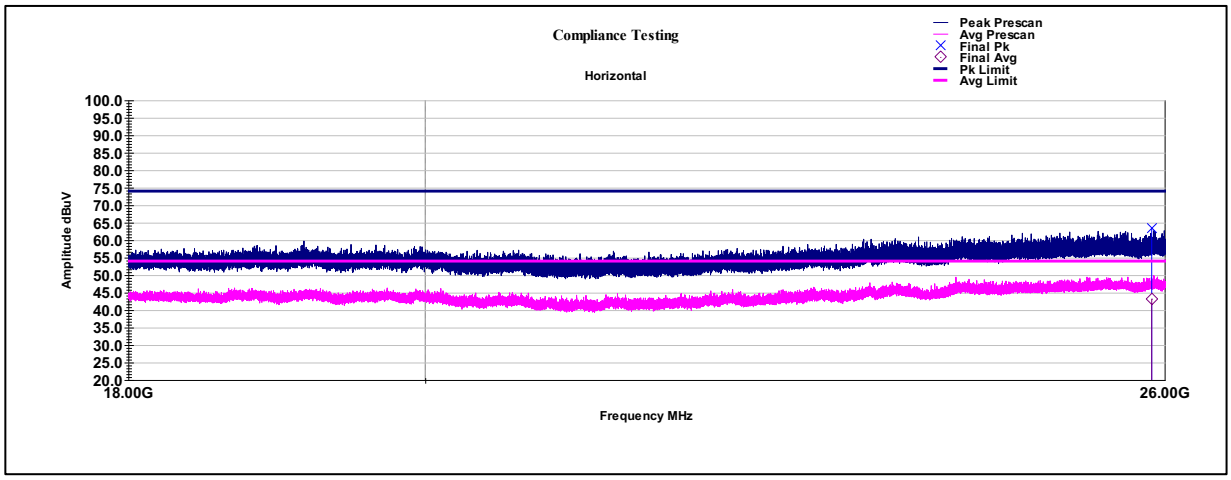

| Frequency | Azimuth | Height | Raw Pk | Raw Avg | Correction | Final Pk | Pk Limit | Pk Margin | Final Avg | Avg Limit | Avg Margin |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MHz | deg | cm | dBuV | dBuV | dB | dBuV/m | dBuV/m | dB | dBuV/m | dBuV/m | dB |
| 4881.973 | 0.00 | 400.00 | 52.99 | 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

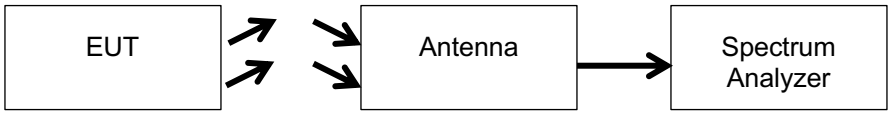
### Test Procedure: 30-1000 MHz

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

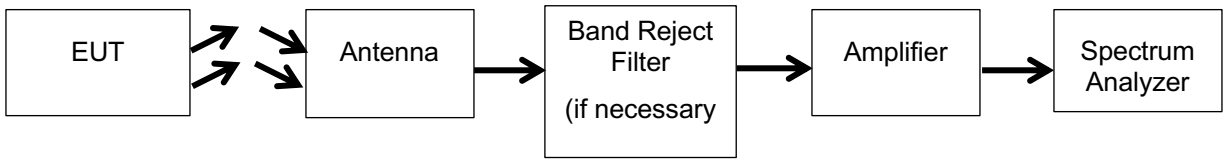



### Test Procedure: ≥ 1 GHz

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

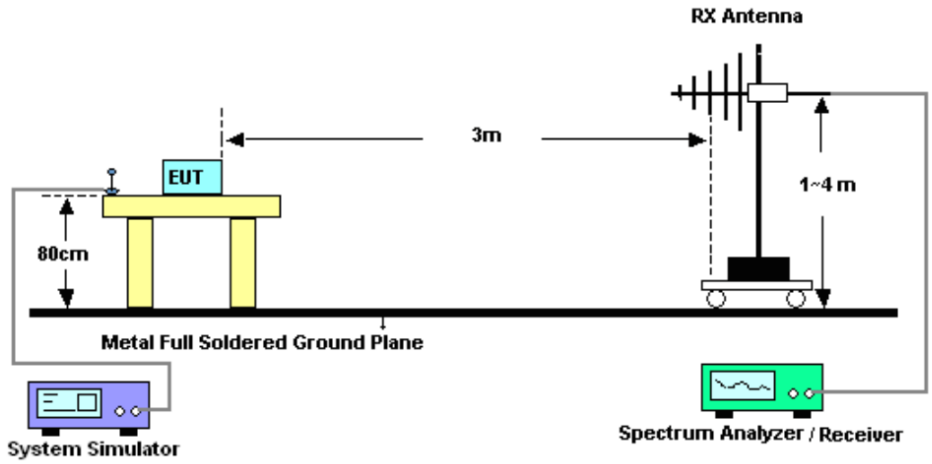
### Test Setup



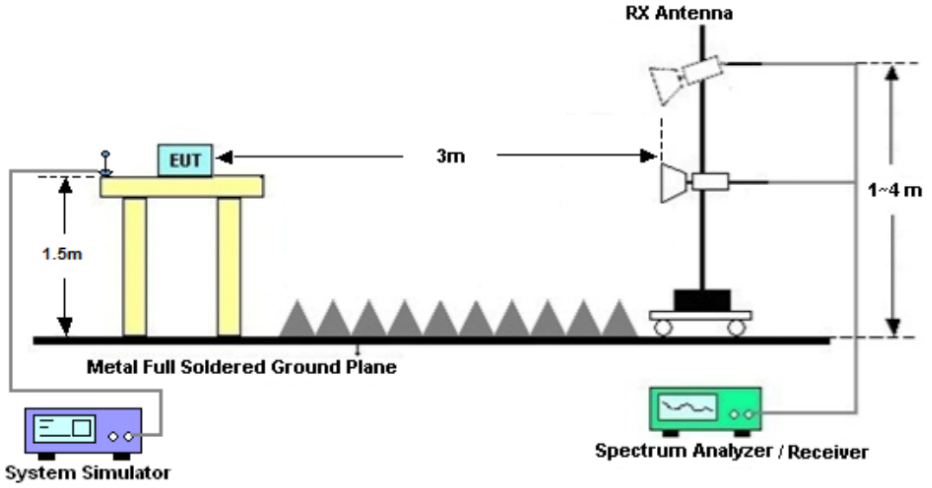

**See Annex A for full test data**

# Chamber Setup Diagrams

**For radiated emissions from 30MHz to 1GHz**



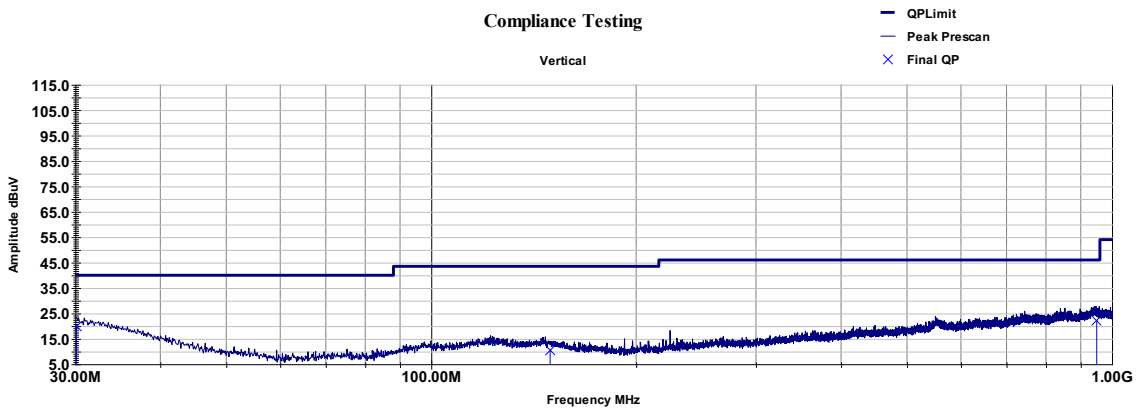

**For radiated emissions above 1GHz**



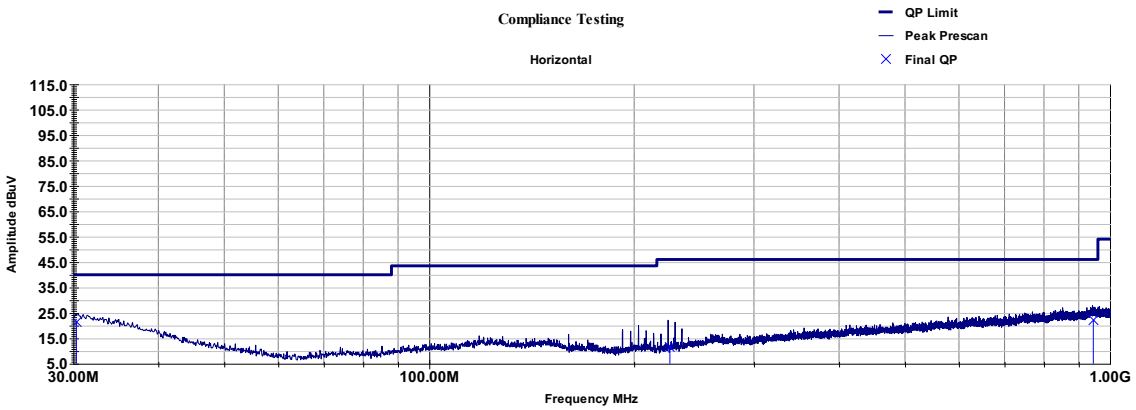

*Above 1 GHz an 80 cm table height was maintained per ANSI C63.4 test methods.

# Test Data

## 30-1000 MHz

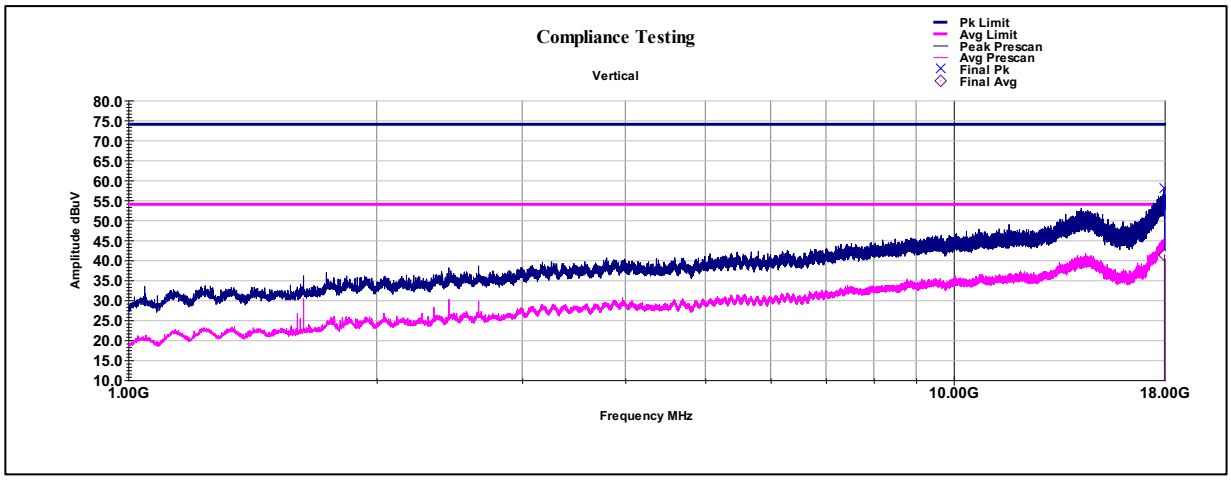



| Frequency | Azimuth | Height | Raw QP | Correction | Final QP | Limit | QP Margin |
|---|---|---|---|---|---|---|---|
| MHz | deg | cm | dBuV | dB | dBuV/m | dBuV/m | dB |
| 30.116 | 77 | 325 | 40.59 | -20.88 | 19.71 | 40.0 | -20.3 |
| 149.499 | 355 | 160 | 36.50 | -26.03 | 10.47 | 43.5 | -33.0 |
|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

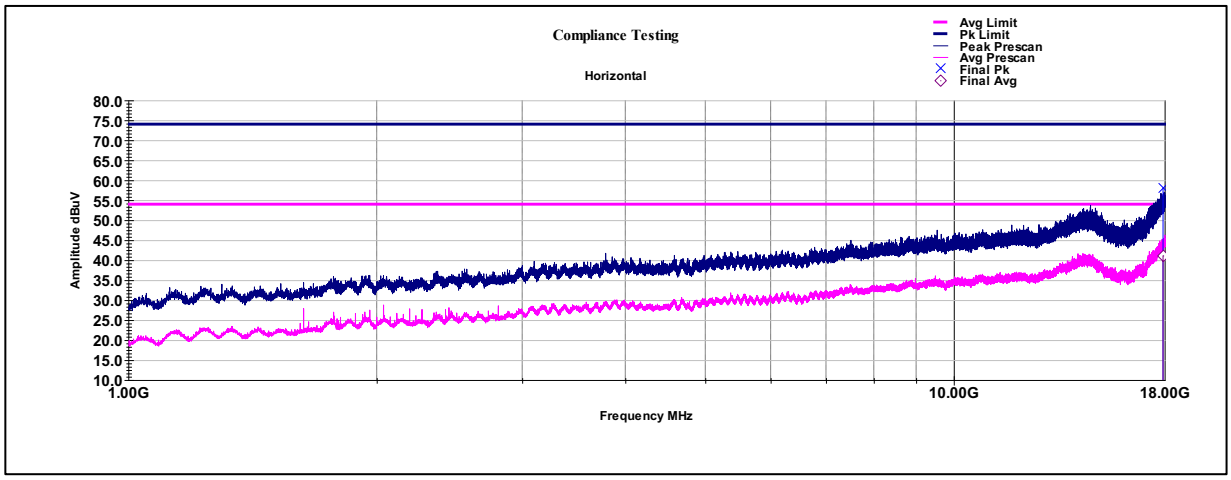



| Frequency | Azimuth | Height | Raw QP | Correction | Final QP | Limit | QP Margin |
|---|---|---|---|---|---|---|---|
| MHz | deg | cm | dBuV | dB | dBuV/m | dBuV/m | dB |
| 30.313 | 316 | 100 | 40.56 | -19.29 | 21.26 | 40.0 | -18.7 |
| 225.717 | 302 | 100 | 38.88 | -27.15 | 11.73 | 46.0 | -34.3 |
| 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 | ± 3.3 x $10^{-8}$ |
| 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 +/- $U_{lab}$(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