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INTENTIONAL RADIATOR TEST REPORT

Class II Permissive Change (C2PC)

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ACCREDITED
CERT #3657.02

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Manufacturer:	**Cooper Electrical Canada (Eaton)**
Address:	74-1833 Coast Meridian Rd. Port Coquitlam, BC, V3E 6G5, Canada
Equipment Tested:	**XPD2400 Radio Module**
Model Number(s):	XPD2400
FCC ID:	IA9XPD2400A
ISED ID:	1338B-XPD2400A
FVIN:	358403R48703

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REVISION HISTORY

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August 1, 2023	E10788-2303_Eaton_XPD2400_C2PC_FCC-ISED_Rev1.1	Revision	AH
All previous versions of this report have been superseded by the latest dated revision as listed in the above table. Please dispose of all previous electronic and paper printed revisions accordingly.			

REPORT AUTHORIZATION

The data documented in this report is for the test equipment provided by the manufacturer and the results relate only to the item tested. The tests were conducted on the sample equipment as requested by the manufacturer for the purpose of demonstrating compliance with the standards outlined in Section I of this report as agreed upon by the Manufacturer under the quote 22RH12053R1.

The Manufacturer is responsible for the tested product configurations, continued product compliance, and for the appropriate auditing of subsequent products as required.

This report may comprise a partial list of tests that are required for FCC and ISED Declaration of Conformity can only be produced by the manufacturer. This is to certify that the following report is true and correct to the best of our knowledge.

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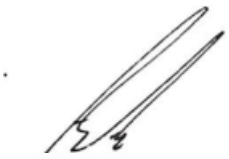

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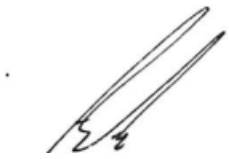

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QAI EMC ACCREDITATION

QAI EMC is your one-stop regulatory compliance partner for electromagnetic compatibility (EMC) and electromagnetic interference (EMI). Products are tested to the latest and applicable EMC/EMI requirements for domestic and international markets. QAI EMC goes above and beyond being a testing facility—we are your regulatory compliance partner. QAI EMC has the capability to perform RF Emissions and Immunity for all types of electronics manufacturing including Industrial, Scientific, Medical, Information Technology, Telecom, Wireless, Automotive, Marine and Avionics.

EMC Laboratory Location	FCC Designation (3m SAC)	IC Registration (3m SAC)	A2LA Certificate
Burnaby, BC, Canada	CA9543	9543A	3657.02

EMC Facility Burnaby BC, Canada

TABLE OF CONTENTS

REVISION HISTORY 2
REPORT AUTHORIZATION 2
QAI FACILITIES 3
QAI EMC ACCREDITATION 3
1 EXECUTIVE SUMMARY 7
1.1 PURPOSE 7
1.2 SCOPE 7
1.3 SUMMARY OF RESULTS 8
2 GENERAL INFORMATION 9
2.1 PRODUCT DESCRIPTION 9
2.2 ENVIRONMENTAL CONDITIONS 11
2.3 MEASUREMENT UNCERTAINTY 11
2.4 WORST TEST CASE 12
2.5 SAMPLE CALCULATIONS OF EMISSIONS DATA 12
2.6 TEST EQUIPMENT LIST 13
3 DATA & TEST RESULTS 14
3.1 RF PEAK OUTPUT POWER 14
3.2 20 DB BANDWIDTH 17
3.3 TIME OF OCCUPANCY (DWELL TIME) 20
3.4 NUMBER OF HOPPING CHANNELS 23
3.5 CHANNEL SEPARATION 25
3.6 OUT-OF-BAND EMISSIONS (BAND EDGE) 27
3.6.1 FSK Hopping: ON 28
3.6.2 FSK Hopping: OFF 29
3.7 RADIATED SPURIOUS EMISSIONS 30
3.7.1 150 kHz – 30 MHz 33
3.7.2 30 MHz to 1 GHz 38
3.7.3 1 GHz to 6 GHz 43
3.7.4 6 GHz to 18 GHz 48
3.7.5 18 GHz to 26 GHz 53
APPENDIX A: TEST SETUP PHOTOS 58
APPENDIX B: ABBREVIATIONS 61

LIST OF FIGURES

Figure 1: EUT 9
Figure 2: Peak Output Power – Lowest Frequency 15
Figure 3: Peak Output Power - Middle Frequency 15
Figure 4: Peak Output Power - Highest Frequency 16
Figure 5: 20 dB Bandwidth – Low Channel 18
Figure 6: 20 dB Bandwidth - Middle Channel 18
Figure 7: 20 dB Bandwidth - High Channel 19
Figure 8: Transmit Time per Hop Plot 21
Figure 9: Number of Hops Plot 21
Figure 10: Number of Hopping Channels Plot 24
Figure 11: Channel Separation Plot 26
Figure 12: Band Edge, Hopping ON - Low Channel 28
Figure 13: Band Edge, Hopping ON - High Channel 28
Figure 14: Band Edge, Hopping OFF - Low Channel 29
Figure 15: Band Edge, Hopping OFF - High Channel 29
Figure 16: Single Channel Duty Cycle Measured Over 100ms 32
Figure 17: Antenna 1, Radiated Emissions from 0.15-30MHz Measured at 3m, Vertically Polarized 33
Figure 18: Antenna 1, Radiated Emissions From 0.15-30MHz Measured at 3m, Horizontally Polarized 33
Figure 19: Antenna 2, Radiated Emissions from 0.15-30MHz Measured at 3m, Vertically Polarized 34
Figure 20: Antenna 2, Radiated Emissions From 0.15-30MHz Measured at 3m, Horizontally Polarized 34
Figure 21: Antenna 3, Radiated Emissions from 0.15-30MHz Measured at 3m, Vertically Polarized 35
Figure 22: Antenna 3, Radiated Emissions From 0.15-30MHz Measured at 3m, Horizontally Polarized 35
Figure 23: Antenna 4, Radiated Emissions from 0.15-30MHz Measured at 3m, Vertically Polarized 36
Figure 24: Antenna 4, Radiated Emissions From 0.15-30MHz Measured at 3m, Horizontally Polarized 36
Figure 25: Antenna 5, Radiated Emissions from 0.15-30MHz Measured at 3m, Vertically Polarized 37
Figure 26: Antenna 5, Radiated Emissions From 0.15-30MHz Measured at 3m, Horizontally Polarized 37
Figure 27: Antenna 1, Radiated Emissions from 30-1000MHz Measured at 3m 38
Figure 28: Antenna 2, Radiated Emissions from 30-1000MHz Measured at 3m 39
Figure 29: Antenna 3, Radiated Emissions from 30-1000MHz Measured at 3m 40
Figure 30: Antenna 4, Radiated Emissions from 30-1000MHz Measured at 3m 41
Figure 31: Antenna 5, Radiated Emissions from 30-1000MHz Measured at 3m 42
Figure 32: Antenna 1, Radiated Emissions from 1-6GHz Measured at 3m 43
Figure 33: Antenna 2, Radiated Emissions from 1-6GHz Measured at 3m 44
Figure 34: Antenna 3, Radiated Emissions from 1-6GHz Measured at 3m 45
Figure 35: Antenna 4, Radiated Emissions from 1-6GHz Measured at 3m 46
Figure 36: Antenna 5, Radiated Emissions from 1-6GHz Measured at 3m 47
Figure 37: Antenna 1, Radiated Emissions from 6-18GHz Measured at 3m 48
Figure 38: Antenna 2, Radiated Emissions from 6-18GHz Measured at 3m 49
Figure 39: Antenna 3, Radiated Emissions from 6-18GHz Measured at 3m 50
Figure 40: Antenna 4, Radiated Emissions from 6-18GHz Measured at 3m 51
Figure 41: Antenna 5, Radiated Emissions from 6-18GHz Measured at 3m, Vertically Polarized 52
Figure 42: Antenna 1, Radiated Emissions from 18-26GHz Measured at 1m, Vertically Polarized 53
Figure 43: Antenna 1, Radiated Emissions from 18-26GHz Measured at 1m, Horizontally Polarized 53
Figure 44: Antenna 2, Radiated Emissions from 18-26GHz Measured at 1m, Vertically Polarized 54
Figure 45: Antenna 2, Radiated Emissions from 18-26GHz Measured at 1m, Horizontally Polarized 54
Figure 46: Antenna 3, Radiated Emissions from 18-26GHz Measured at 1m, Vertically Polarized 55
Figure 47: Antenna 3, Radiated Emissions from 18-26GHz Measured at 1m, Horizontally Polarized 55
Figure 48: Antenna 4, Radiated Emissions from 18-26GHz Measured at 1m, Vertically Polarized 56
Figure 49: Antenna 4, Radiated Emissions from 18-26GHz Measured at 1m, Horizontally Polarized 56
Figure 50: Antenna 5, Radiated Emissions from 18-26GHz Measured at 1m, Vertically Polarized 57
Figure 51: Antenna 5, Radiated Emissions from 18-26GHz Measured at 1m, Horizontally Polarized 57
Figure 52: Conducted Measurements Setup 58
Figure 53: Radiated Emissions Setup: 0.15 MHz - 30 MHz 58
Figure 54: Radiated Emissions Setup: 30 MHz - 1000 MHz 59
Figure 55: Radiated Emissions Setup: 1 GHz - 18 GHz 59
Figure 56: Radiated Emissions Setup: 18 GHz - 26 GHz 60

LIST OF TABLES

Table 1: Applicable test standards and descriptions 8
Table 2: Sample Quasi-Peak Correction Data – Radiated 12
Table 3: Sample Quasi-Peak Correction Data - Conducted Emissions 12
Table 4: Sample Average Correction Data- Conducted Emissions 12
Table 5: Test Equipment List....13
Table 6: RF Peak Output Power 14
Table 7: 20 dB Bandwidth Results 17
Table 8: Time of Occupancy (Dwell Time) Results 20
Table 9: Number of Hopping Channels Results 23
Table 10: Channel Separation Results 25
Table 11: Band Edge Results....27
Table 12: Antenna 1, Radiated Emissions (30-1000 MHz) Measured at 3m....38
Table 13: Antenna 2, Radiated Emissions (30-1000 MHz) Measured at 3m....39
Table 14: Antenna 3, Radiated Emissions (30-1000 MHz) Measured at 3m....40
Table 15: Antenna 4, Radiated Emissions (30-1000 MHz) Measured at 3m....41
Table 16: Antenna 5, Radiated Emissions (30-1000 MHz) Measured at 3m....42
Table 17: Antenna 1, Radiated Emissions (1-6 GHz) Measured at 3m, Average....43
Table 18: Antenna 2, Radiated Emissions (1-6 GHz) Measured at 3m, Average....44
Table 19: Antenna 3, Radiated Emissions (1-6 GHz) Measured at 3m, Average....45
Table 20: Antenna 4, Radiated Emissions (1-6 GHz) Measured at 3m, Average....46
Table 21: Antenna 5, Radiated Emissions (1-6 GHz) Measured at 3m, Average....47
Table 22: Antenna 1, Radiated Emissions (6-18 GHz) Measured at 3m, Average....48
Table 23: Antenna 2, Radiated Emissions (6-18 GHz) Measured at 3m, Average....49
Table 24: Antenna 3, Radiated Emissions (6-18 GHz) Measured at 3m, Average....50
Table 25: Antenna 4, Radiated Emissions (6-18 GHz) Measured at 3m, Average....51
Table 26: Antenna 5, Radiated Emissions (6-18 GHz) Measured at 3m, Average....52

1 EXECUTIVE SUMMARY

1.1 Purpose

The purpose of this report is to demonstrate and document the compliance of XPD2400A as per Sections 1.2 and 1.3.

1.2 Scope

The information documented in this report is based on the test methods and levels as per Quote 22RH12053R1:

- **FCC Title 47 Part 15** – Radio Frequency Devices, Subpart C – Intentional Radiators 15.205: Restricted bands of operation
- **FCC Title 47 Part 15** – Radio Frequency Devices, Subpart C – Intentional Radiators 15.209: Radiated emission limits; general requirements
- **FCC Title 47 Part 15** – Radio Frequency Devices, Subpart C – Intentional Radiators 15.247: Operation in the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz
- **RSS-Gen Issue 5 –** General Requirements for Compliance of Radio Apparatus
- **RSS-102 Issue 5 –** Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)
- **RSS-247 Issue 2 –** Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and License-Exempt Local Area Network (LE-LAN) Devices
- **ICES-003 Issue 7 –** Information Technology Equipment (including Digital Apparatus)

1.3 Summary of Results

The following testing was performed pursuant to FCC Title 47 Part 15 and Industry Canada ICES-003 to demonstrate the testimony to "FCC, IC, & CE" mark Electromagnetic Compatibility testing for the product.

No.	Test	Applicable Standard	Description	Result
1	RF Peak Output Power	FCC 47 CFR Part 15.247 (b)(2) RSS-247 Issue 2 (5.1)(b)	Maximum peak conducted output power shall not exceed 0.125 W for systems employing at less than 75 hopping channels.	Complies
2	20 dB Bandwidth	FCC 47 CFR Part 15.247 (a)(1)(iii) RSS-247 Issue 2 (5.1)(c)	Maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.	Complies
3	Time of Occupancy	FCC 47 CFR Part 15.247 (a)(1)(iii) RSS-247 Issue 2 (5.1) (c)	Average time of occupancy on any frequency shall not be greater than 0.4 s within a 20 s period.	Complies
4	Number of Channels	FCC 47 CFR Part 15.247 (a)(1)(iii) RSS-247 Issue 2 (5.1) (c)	If the 20 dB bandwidth of the hopping channel is < 250 kHz, the system shall use at least 50 hopping channels.	Complies
5	Channel Separation	FCC 47 CFR Part 15.247 (a)(1) RSS-247 Issue 2 (5.1) (b)	Frequency hopping systems shall have channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.	Complies
6	Out of Band Emissions (Band-Edge)	FCC 47 CFR Part 15.247 (d)	In any 100 kHz bandwidth outside the frequency band in which the device is operating, the RF power shall be at least 20dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power.	Complies
7	Radiated Spurious Emissions	FCC 47 CFR Part 15.205 (a), 15.209 (a), and 15.247 (d) FCC 47 CFR Part 15.109 RSS-Gen Issue 5 (8.9) (8.10)	Radiated emissions requirements as stated in the Standards	Complies

Table 1: Applicable test standards and descriptions

Note: The gain of the antenna(s) is provided by the client to measure or calculate test results and is not independently measured by QAI.

2 GENERAL INFORMATION

2.1 Product Description

The information provided in this section is for the Equipment Under Test (EUT) and the corresponding Auxiliary Equipment needed to perform the tests as a complete system.

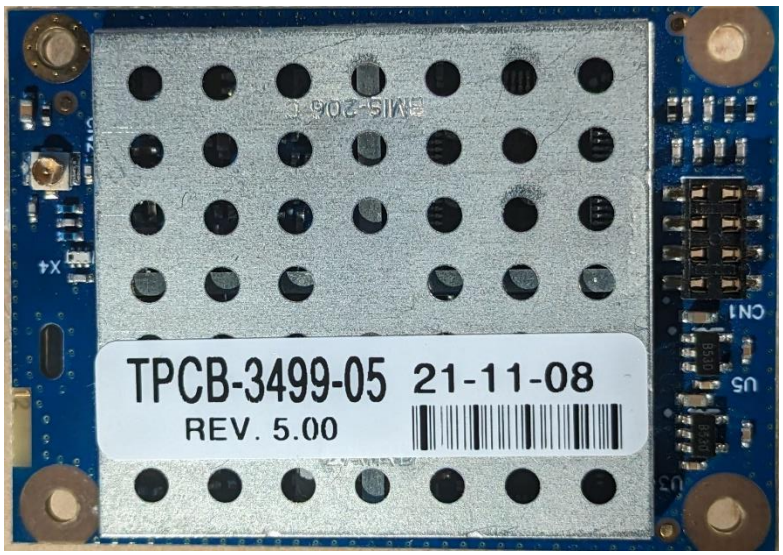

Figure 1: EUT

Equipment Under Test (EUT)

Equipment	XPD2400 Transceiver Radio Module
Description	2.4 GHz Transceiver Module using FHSS modulation
Manufacturer	Cooper Electrical
Model No.	XPD2400
Serial No.	3E096669
Clock frequencies tuned upon within the EUT:	8 MHz, 16 MHz, 20 MHz
Highest frequency generated within the EUT:	2479.8 MHz

Equipment Under Test (EUT) – RF Information

RF device type	Frequency Hopping Spread Spectrum Transceiver
Model No. (HVIN)	TPCB-3499-05
Operating frequency	2403.1 MHz – 2479.8 MHz
Number of available	768 channels from which 64 are used at a time
Channel separation	1200 kHz
Channel bandwidth	25.32 kHz
Output Power/Transmitter	17.58 dBm
Modulation type	2-level FSK
Test Channels (L, M, H)	2403.1 MHz, 2441.4 MHz, 2479.8 MHz
Data Rate	10416 BAUD
Adaptive	No
Geo-location-capable	No
Number of antennas	5
Antenna type 1	2.4-2.5 GHz, ½ λ Dipole (Gain = 3dBi)
Antenna type 2	2.4-2.5 Dual Closed Coil Whip (Gain = 5dBi)
Antenna type 3	2.4-2.5GHz ½ λ Dipole (Gain = 2.5dBi)
Antenna type 4	2.4-2.5GHz Edge Inverted L (Gain = 2.54dBi)
Antenna type 5	2.4-2.5GHz SMD Ceramic (Gain = 2.62dBi)

Notes: None.

Equipment Under Test (EUT) – General Information

Tested as	Table-top
Dimensions	5 x 7 x 0.5 cm
Declared operating temperature range:	-40 °C to +85 °C
Input power	6VDC, 1.5W
Grounded	No
Device use	Mobile and Portable – Used within 20 cm of the human body

Notes: None.

Test Modes

Test	Transmitter State	Power
1	ON – Transmitting Continuously	DC Power Supply
2	OFF – Receiver Mode	DC Power Supply

Auxiliary Manufacturer Supplied Equipment

Equipment	Manufacturer	Product Description	Model No.
Aux 1	Omnex/Eaton	Development board	N/A
Aux 2	Eaton	RS-232 adapter board	N/A
Aux 3	Eaton	2.4GHz Transceiver	XPD2400

Notes: Second transceiver module was used to obtain maximum time of occupancy

2.2 Environmental Conditions

The equipment under test was operated and tested under the following environmental conditions:

Parameter	Conditions
Location	QAI Burnaby – Indoors
Temperature	22 °C
Relative Humidity	54% RH

2.3 Measurement Uncertainty

Parameter	Uncertainty
Radiated Emissions, 30MHz-1GHz	± 2.40 dB
Radiated Emissions, 1GHz-40GHz	± 2.48 dB
Radio Frequency	±1.5 x 10-5 MHz
Total RF Power Conducted	±1.36 dB
Spurious Emissions, Conducted	±1.36 dB
RF Power Density, Conducted	±1.36 dB
Temperature	±1ºC
Humidity	±5 %
DC and low frequency voltages	±3 %

2.4 Worst Test Case

Worst-case orientation was determined during the preliminary testing. The final radiated emissions were performed in the worst-case orientation.

2.5 Sample Calculations of Emissions Data

Radiated and conducted emissions were performed using EMC32 software developed by Rohde & Schwarz. Transducer factors such as antenna factors, cable losses and amplifier gains were stored in the test templates which are used to perform the emissions measurements. After the test is finished, data is generated from the EMC32 consisting of product details, emission plots and final data tables as shown below.

Frequency (MHz)	Q-Peak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Ant. Ht. (cm)	Pol	Turntable Position (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
42.663900	33.0	1000.000	120.000	100.0	H	70.0	13.2	7.5	40.5

Table 2: Sample Quasi-Peak Correction Data – Radiated

Quasi-Peak reading shown in the table above is already corrected by the software using the correction factor shown in column "Corr." The correction factor listed under "Corr." table calculated as:

Corr.(dB) = Antenna factor + Cable loss

Or

Corr.(dB) = Antenna factor + Cable Loss - Amp gain (if pre-amplifier was used)

The final Quasi peak reading shown in the data is calculated by the software using following equation:

Corrected Quasi-Peak (dBµV/m) = Raw Quasi-Peak Reading + Antenna factor + Cable loss

To obtain the final Quasi-Peak or Average reading during power line conducted emissions, transducer factors are included in the final measurement as shown below.

Frequency (MHz)	Q-Peak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.150	44.3	1000.000	9.000	GND	0.6	21.7	66.0

Table 3: Sample Quasi-Peak Correction Data - Conducted Emissions

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.150	27.2	1000.000	9.000	GND	0.6	28.8	56.0

Table 4: Sample Average Correction Data- Conducted Emissions

Quasi Peak or Average reading shown in the preceding table is already corrected by the software using the correction factor shown in column "Corr." The correction factor listed under "Corr." table calculated as:

Corr.(dB) = Antenna factor + Cable loss

The final Quasi-peak or Average reading shown in the data is calculated by the software using following equation:

Corr. Quasi-Peak/Average Reading (dBµV) = Raw Quasi-Peak/Average Reading + Antenna factor + Cable loss

The allowable margin from the limits, as per the standards, were calculated for both radiated and conducted emissions:

Margin(dB) = Limit – Quasi-Peak or Average reading

2.6 Test Equipment List

The tables below contain all the equipment used by QAI Laboratories during the testing listed in Section 1 of this report.

Asset #	Manufacturer	Model	Description	Serial #	S/W Version	Calibration Due Date
1221162	Rohde & Schwarz	ESW44	EMI Receiver	101604	2.20 SP1	2025-Jul-19
1470	Rohde & Schwarz	FSU67	Spectrum Analyzer	101388	4.71 SP6	2025-May-13
1541	AH Systems	PAM118	18 GHz Amplifier	189	N/A	Conditional Use
1237	HP	8449B	26 GHz Amplifier	2933A00198	N/A	2025-Feb-15
1401	EMCO	6502	Loop Antenna	2178	N/A	2024-Dec-22
1601	Sunol Sciences	JB1	Biconilog Antenna	A070209	N/A	2026-Jan-04
1118	ETS-Lindgren	3117	Horn Antenna	75944	N/A	2026-Jan-28
1134	EMCO	3160-09	Horn Antenna	9701-1071	N/A	2025-Nov-02
1528	ETS-Lindgren	-	Turntable	13677	N/A	N/A
1645	Maturo Gmbh	BAM 4.0-P	Antenna Mast	365	3382.01	N/A
1556	ETS-Lindgren	S201 4X7LH	SAC 1	1030	N/A	N/A

Table 5: Test Equipment List

3 DATA & TEST RESULTS

3.1 RF Peak Output Power

Date Performed: April 20, 2023

Test Standard: FCC CFR 47 Part 15.247 (b)(1)
IC RSS-247 Issue 2 (5.4)(b)

Test Method: FCC KDB 558074 D01 DTS Measurement Guidance V04
Span = 1 MHz, RBW = 120 kHz, VBW = 300 kHz
Trace stabilization time: 3.5 minutes

Modifications: None.

Final Result: Complies

Applicable Regulation:

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.

Test Setup:

The EUT was tested outside the SAC via output conducted measurements per FCC KDB 558074 D01 DTS Measurement Guidance V04.

Measurement Data and Plots:

Carrier Frequency (MHz)	Raw Peak (dBm)	Correction Factor[1] (dB)	Corrected Peak Conducted Output Power (dBm)	Limit (dBm)	Margin (dB)	Results
2403.1	7.04	10.12	17.16	20.97	3.81	Complies
2441.4	7.29	10.12	17.41	20.97	3.56	Complies
2479.8	7.46	10.12	17.58	20.97	3.39	Complies

[1] Correction factor consists of cable loss, external attenuator, and adapter(s)

Table 6: RF Peak Output Power

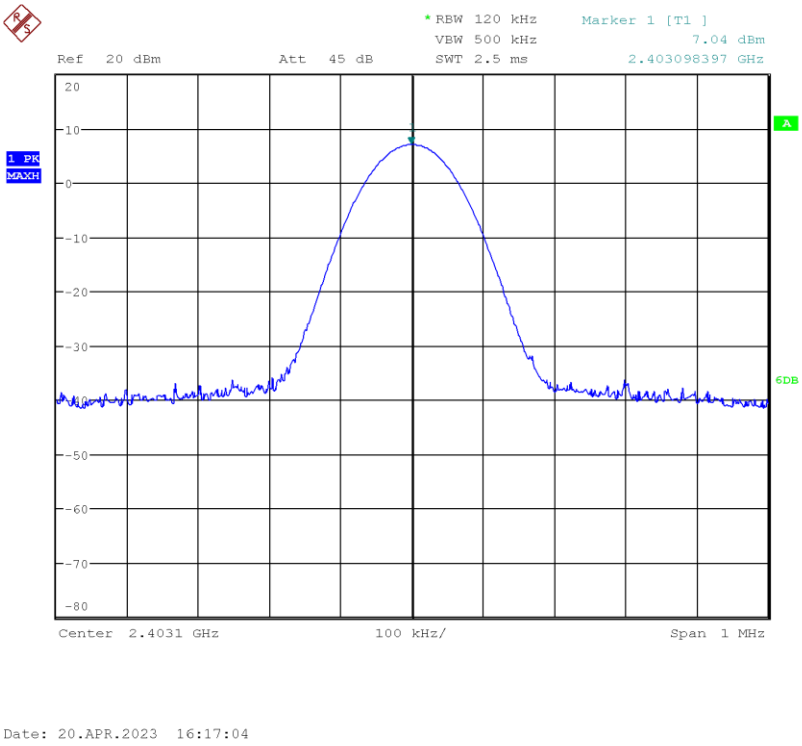

Figure 2: Peak Output Power – Lowest Frequency

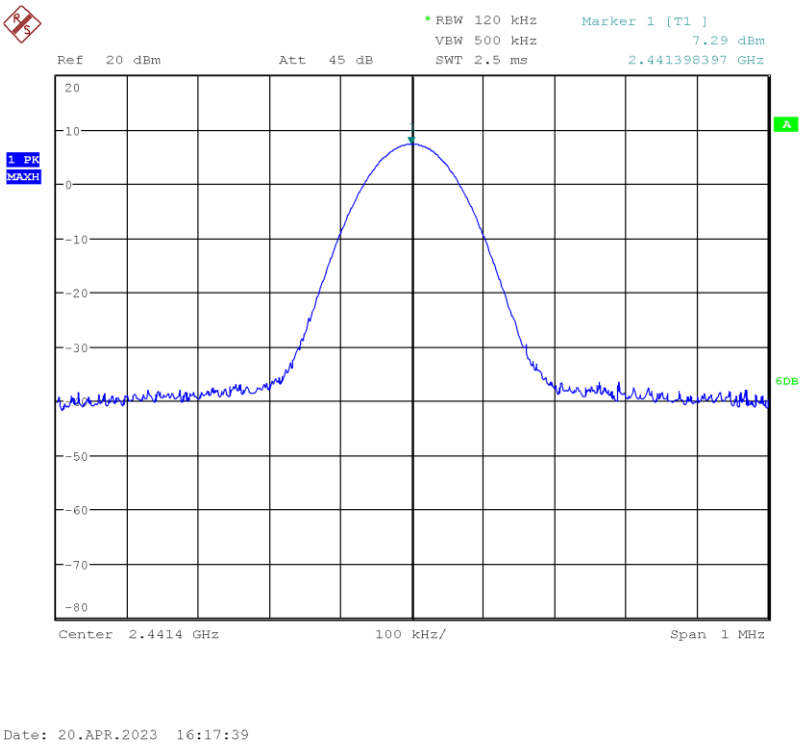

Figure 3: Peak Output Power - Middle Frequency

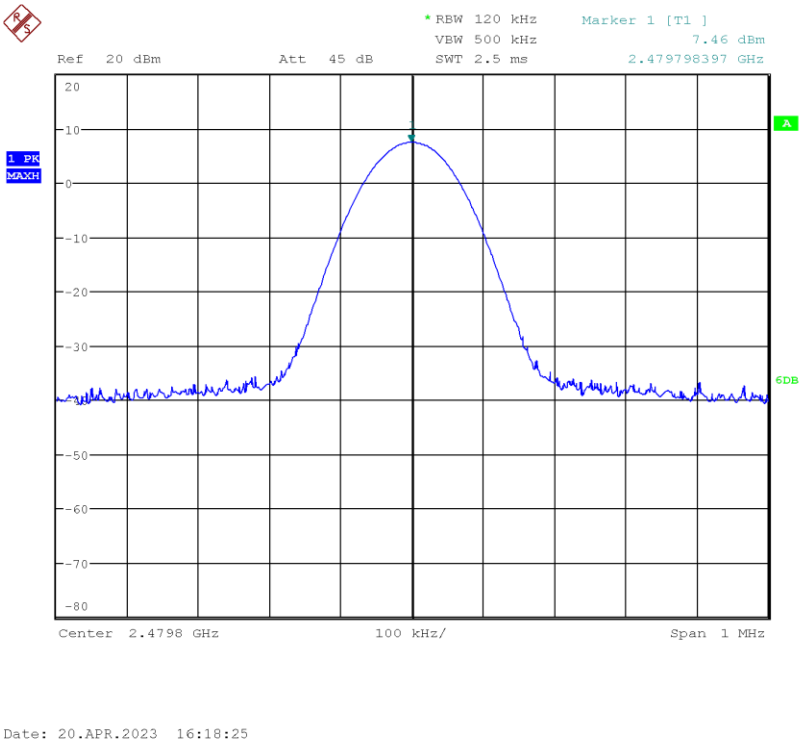

Figure 4: Peak Output Power - Highest Frequency

3.2 20 dB Bandwidth

Date Performed: April 20, 2023

Test Standard: FCC 47 CFR Part 15.247 (a)(1)(iii)
RSS-247 Issue 2 (5.1)(c)

Test Method: ANSI C63.10:2013
Span = 2 to 5 x OBW, RBW = 1 to 5% of OBW, VBW = 3 x RBW
Ref Level > 10log(OBW/RBW) above signal peak

Modifications: None

Final Result: Complies

Applicable Regulations:

Per KDB 558074: The maximum 20 dB bandwidth in the 2400 – 2483.5 MHz band is not specified.

Test Setup:

The EUT was tested outside the SAC via output conducted measurements per ANSI C63.10: 2013, 7.4.

A spectrum analyzer or other instrument providing a spectral display is recommended for these measurements. When using a spectrum analyzer or other instrument providing a spectral display, the video bandwidth shall be set to a value at least three times greater than the IF bandwidth of the measuring instrument to avoid the introduction of unwanted amplitude smoothing. Video filtering is not used during occupied bandwidth tests.

Measurement Data and Plots:

Channels	Carrier Frequency (MHz)	20dB Bandwidth (kHz)	Limit (kHz)	Result
Low	2403.1	25.16	N/A	Complies
Middle	2441.4	25.32	N/A	Complies
High	2479.8	25.32	N/A	Complies

Table 7: 20 dB Bandwidth Results

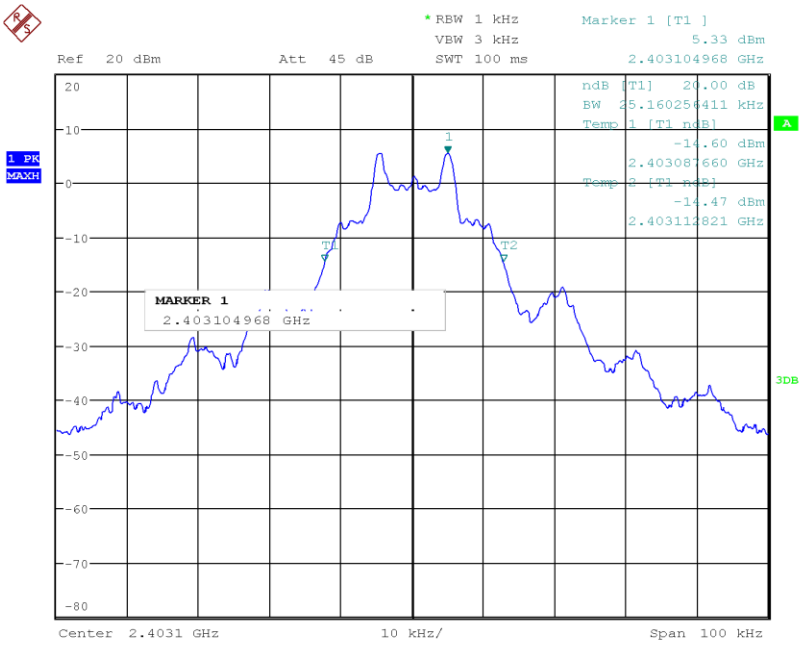

Figure 5: 20 dB Bandwidth – Low Channel

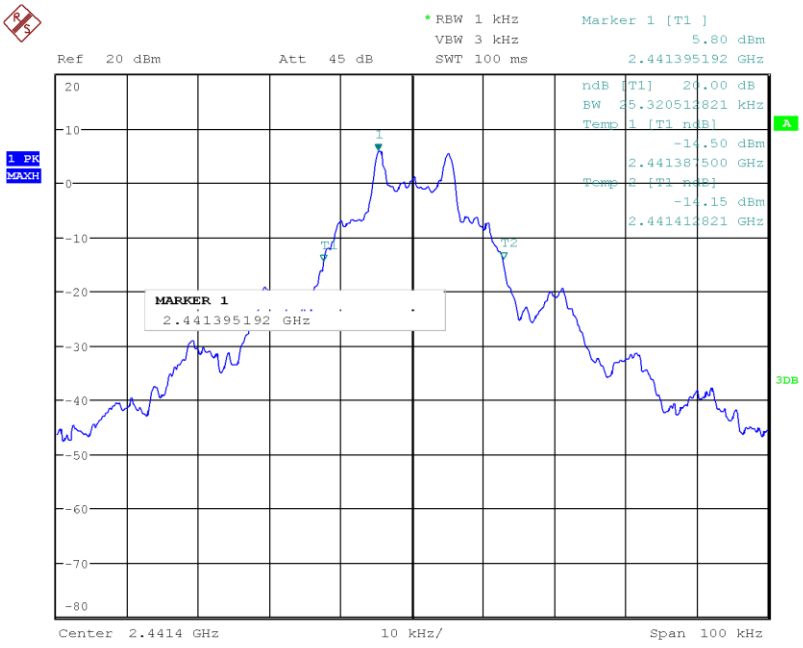

Figure 6: 20 dB Bandwidth - Middle Channel

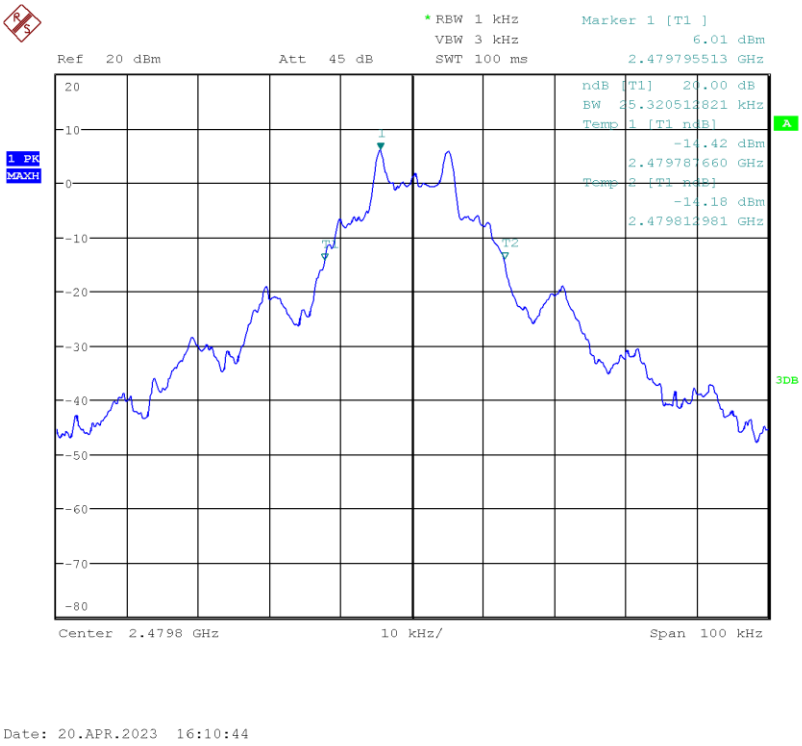

Figure 7: 20 dB Bandwidth - High Channel

3.3 Time of Occupancy (Dwell Time)

Date Performed: April 20, 2023

Test Standard: FCC 47 CFR Part 15.247 (a)(1)(iii)
RSS-247 Issue 2 (5.1)(c)

Test Method: ANSI C63.10:2013
Span = Zero span on a hopping channel.
RBW = ≤ Channel spacing and where possible RBW >> 1/*T* where *T* is the expected dwell time.
Detector: Peak, **Trace:** Max Hold

Modifications: None

Final Result: Complies

Applicable Standard:

Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. 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. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

Test Setup:

Bandwidth and band-edge measurements for frequency-hopping spread spectrum systems are typically made by connecting the spectrum analyzer to the active antenna port using a suitable RF attenuator. These measurements require verification that the antenna port selected is the active one if the system has more than one antenna. Testing shall be done using the maximum power output. The system shall be configured for normal operation using a pseudorandom hopping pattern.

Measurement Data and Plots:

Modulation	Number of Hopping Channels	Transmit Time per Burst (ms)	Number of Bursts	Time of Occupancy (ms)	Maximum Dwell Time (ms)	Result
FSK	63	14.34	15	215.1	400	Complies

Table 8: Time of Occupancy (Dwell Time) Results

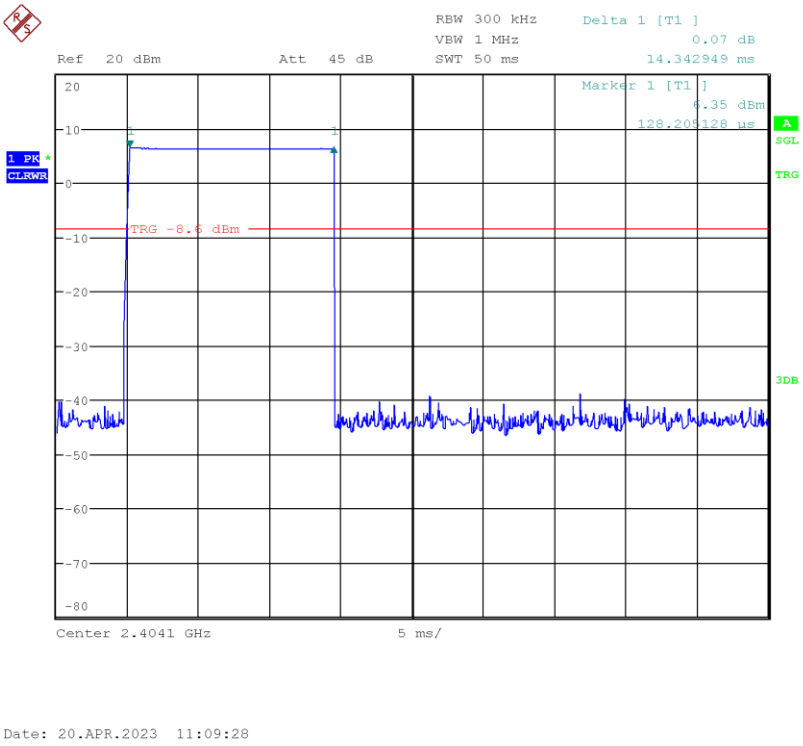

Figure 8: Transmit Time per Hop Plot

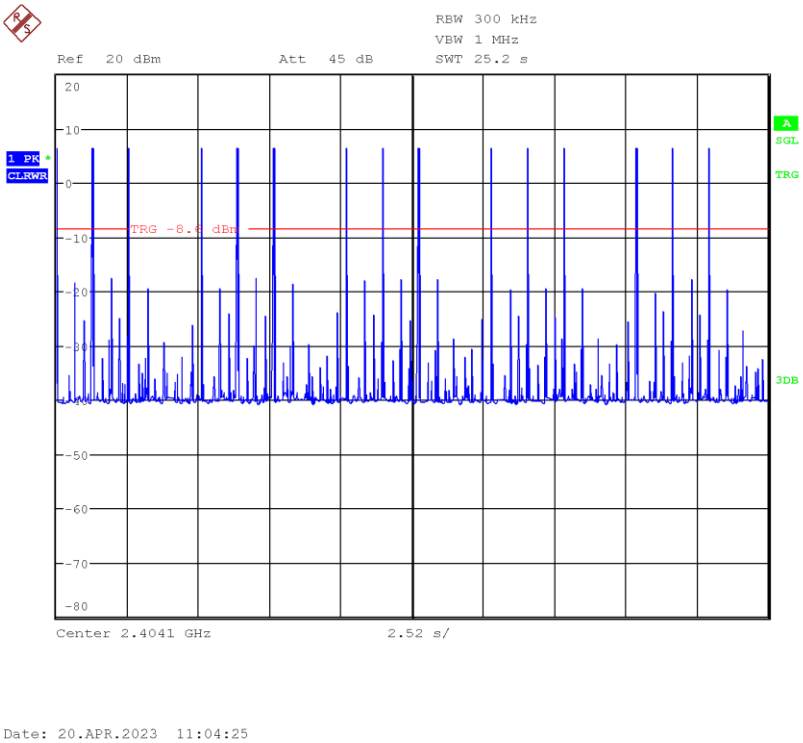

Figure 9: Number of Hops Plot

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 standard.

$$Time\ of\ Occupancy = N_{Bursts} \times T_{Burst}$$

Where,
N_{Bursts} is the number of bursts
T_{Burst} is the transmit time of each burst

The sweep time used to measure the time of occupancy is calculated as:

$$T_{Measurement} = 0.4 \times N_{channels}$$

Where,
$N_{channels}$ is the number of channels used

3.4 Number of Hopping Channels

Date Performed: April 20, 2023

Test Standard: FCC 47 CFR Part 15.247 (a)(1)(iii)
RSS-247 Issue 2 (5.1)(c)

Test Method: ANSI C63.10:2013
Span = The frequency band of operation. Depending on the number of channels the device
supports, it may be necessary to divide the frequency range of operation across multiple spans,
to allow the individual channels to be clearly seen.
RBW = 30% of the channel spacing or the 20 dB BW, whichever is smaller.
VBW ≥ RBW
Detector: Peak, **Trace:** Max Hold

Modifications: None

Final Result: Complies

Applicable Standard:

Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

Test Setup:

The EUT was tested outside the SAC via output conducted measurements per ANSI C63.10:2013.

The channel separation measurement was made by connecting the spectrum analyzer to the active antenna port using a 20 dB attenuator. Testing was done using the maximum power output with the system configured for normal operation using a pseudorandom hopping pattern.

Measurement Data and Plots:

Modulation	Number of Hopping Channels	Channel Separation (kHz)	Minimum Number of Channels	Result
FSK	63	1192.31	15	Complies

Table 9: Number of Hopping Channels Results

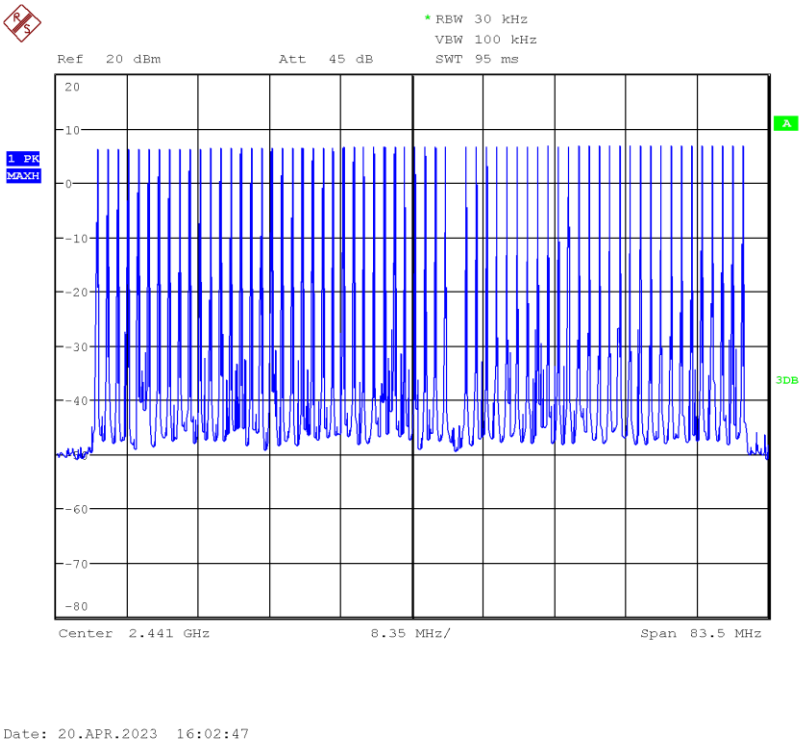

Figure 10: Number of Hopping Channels Plot

3.5 Channel Separation

Date Performed: April 20, 2023

Test Standard: FCC 47 CFR Part 15.247 (a)(1)(iii)
RSS-247 Issue 2 (5.1)(b)

Test Method: ANSI C63.10:2013
Span = Wide enough to capture the peak of two adjacent channels.
Ref Level = High enough to keep the signal from overdriving the input mixer
RBW = Approximately 30% of the channel spacing; adjusted as necessary to identify the center of each individual channel.
VBW ≥ RBW
Trace Detector: Peak, Trace: Max Hold

Modifications: None.

Final Result: Complies

Applicable Standard:

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. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

Test Setup:

The EUT was tested outside the SAC via output conducted measurements per ANSI C63.10:2013.

The channel separation measurement was made by connecting the spectrum analyzer to the active antenna port using a 20dB attenuator. Testing was done using the maximum power output with the system configured for normal operation using a pseudorandom hopping pattern.

Measurement Data and Plots:

Modulation	Channel Separation (kHz)	Limit (Maximum of)		Result
		20dB Bandwidth (kHz)	Minimum Limit (kHz)	
FSK	1192.31	25.32	25 kHz	Complies

Table 10: Channel Separation Results

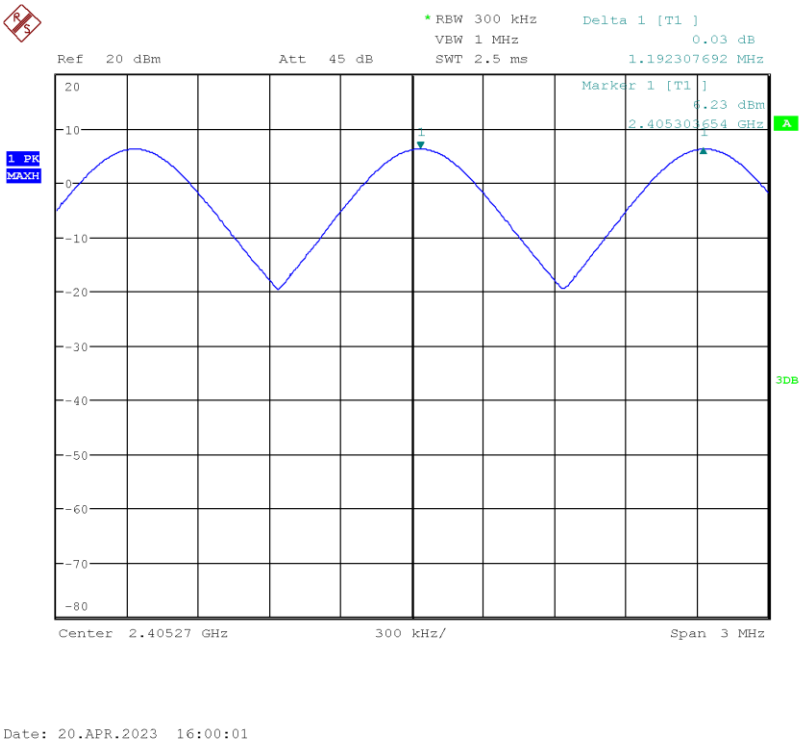

Figure 11: Channel Separation Plot

3.6 Out-Of-Band Emissions (Band Edge)

Date Performed: April 20, 2023

Test Standard: FCC 47 CFR Part 15.247 (d)

Test Method: ANSI C63.10:2013
Span = Wide enough to capture the peak level of the emission closest to the band edge, as well as any modulation products that fall outside of the band.
Ref Level = High enough to keep the signal from overdriving the input mixer
RBW = 100 kHz, VBW = 300 kHz
Trace Detector: Peak, Trace: Max Hold

Modifications: None

Final Result: Complies

Applicable Regulation:

In any 100kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, shall be at least 20 dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section A8.4 (4) of the standard, the attenuation required shall be 30 dB instead of 20dB.

Test Setup:

The EUT was tested outside the SAC via output conducted measurements per ANSI C63.10:2013.

This test was performed twice: once with the hopping function turned OFF and then repeated with the hopping function turn ON. The purpose of the test with the hopping function turned on is to confirm that the RF power remains OFF while the device is changing frequencies, and that the oscillator stabilizes at the new frequency before RF power is turned back ON. Overshoot of any oscillator, including phase-lock-loop stabilized oscillators, can cause the device to be temporarily tuned to frequencies outside the authorized band, and it is important that no transmissions occur during such temporary periods.

Measurement Data and Plots:

Band Edge	Hopping	Highest Out of Band Emission	Limit	Result
Low	On	-45.35 dB	-20 dB	Complies
High	On	-48.25 dB	-20 dB	Complies
Low	Off	-47.90 dB	-20 dB	Complies
High	Off	-48.09 dB	-20 dB	Complies

Table 11: Band Edge Results

3.6.1 FSK Hopping: ON

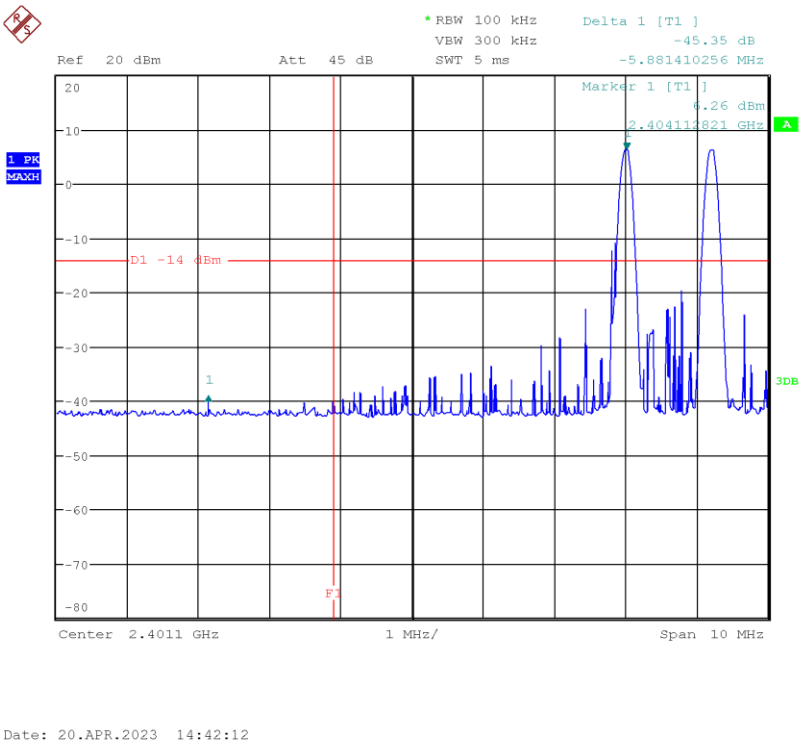

Figure 12: Band Edge, Hopping ON - Low Channel

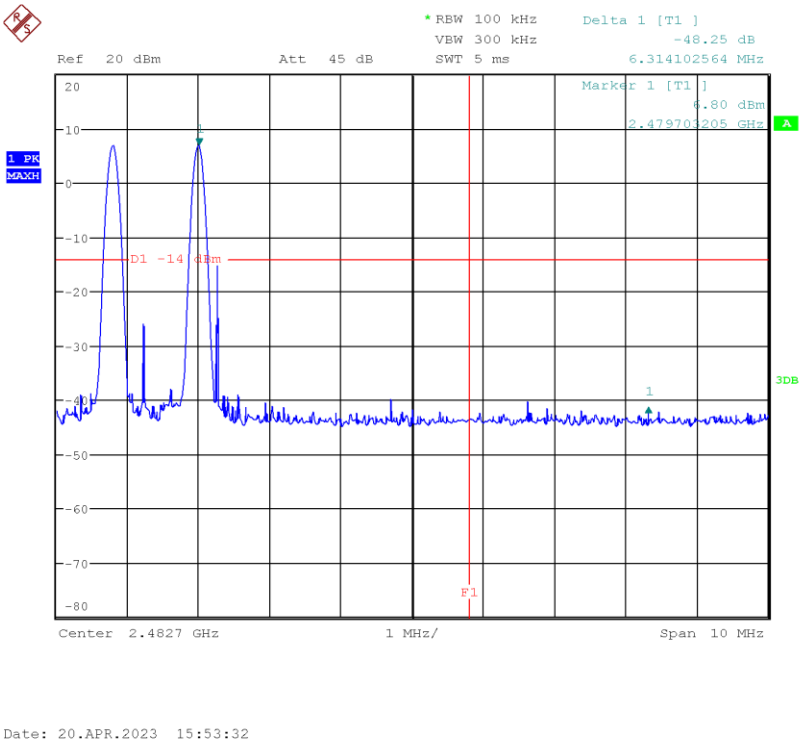

Figure 13: Band Edge, Hopping ON - High Channel

3.6.2 FSK Hopping: OFF

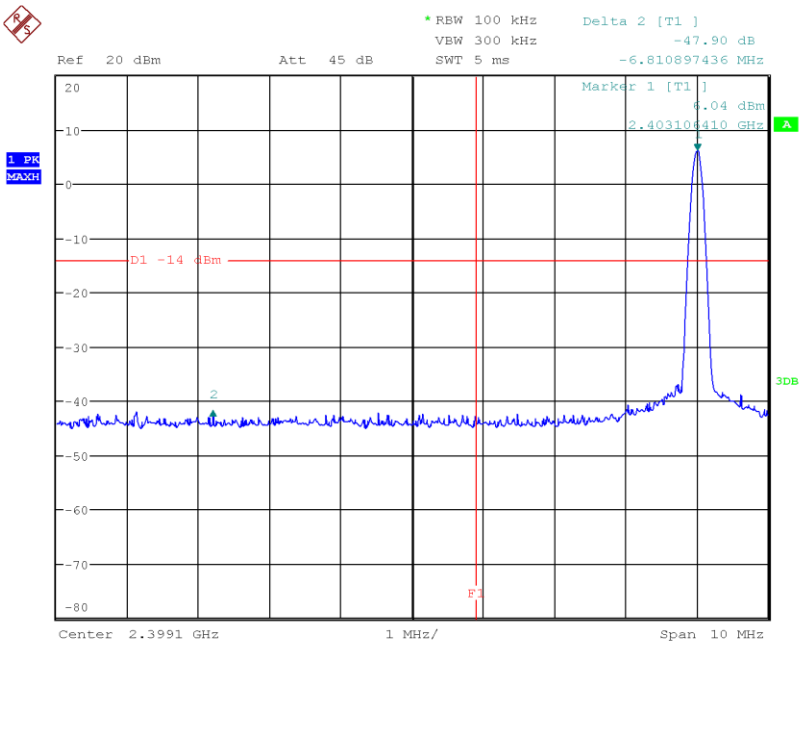

Figure 14: Band Edge, Hopping OFF - Low Channel

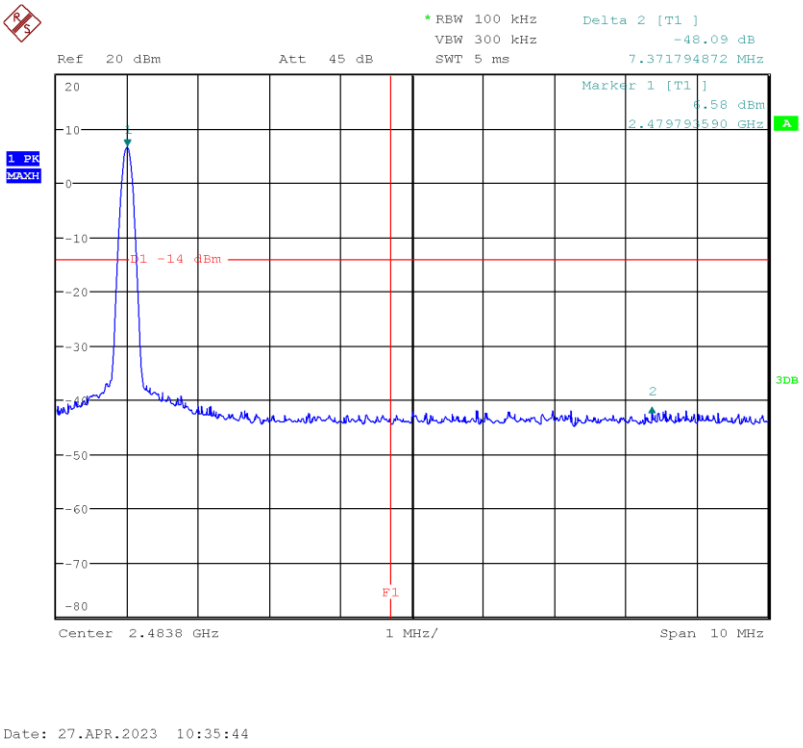

Figure 15: Band Edge, Hopping OFF - High Channel

3.7 Radiated Spurious Emissions

Date Performed: See Dates Below

Test Standard: FCC 47 CFR Part 15.33 (a)(1), (5)
FCC 47 CFR Part 15.205 (a), (b)
FCC 47 CFR Part 15.209 (a)
FCC 47 CFR Part 15.231 (b)
RSS-Gen 6.13

Test Method: ANSI C63.10:2013

Modifications: None

Final Result: Complies

Applicable Standard:

FCC 47 CFR Part 15.33 (a)(1), (5): Frequency range of radiated measurements

For an intentional radiator, the spectrum shall be investigated from the lowest radio frequency signal generated in the device, without going below 9 kHz, up to at least the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

FCC 47 CFR Part 15.205 (a), (b): Restricted bands of operation

Only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	
13.36-13.41			

The field strength of emissions appearing within these frequency bands shall not exceed the limits show in § 15.209

FCC 47 CFR Part 15.209 (a): Radiated emission limits; general requirements

The emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency, *f* (MHz)	**Maximum Field strength Quasi-peak (dBµV/m at 3 m)**
0.009 – 0.490	20*log(2400/F(kHz)) + 40 dB
0.490 – 1.705	20*log(24000/F(kHz)) + 20 dB
1.705 – 30.0	49.5
30 – 88	40.0
88 – 216	43.5
216 – 960	46.0
above 960	54.0
Note 1: The above field strength limits are specified at a distance of 3 meters. The tighter limits apply at the band edges. **Note 2:** The emissions limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz., 110-490 kHz. and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector	

RSS-Gen 6.13 Transmitter unwanted emissions

6.13.1 Detector

When the unwanted emissions limits are defined in absolute terms, unless otherwise stated in the applicable RSS, the following conditions shall apply:

a) Below 1 GHz, compliance with the limits shall be demonstrated using a CISPR quasi-peak detector and the related measurement bandwidth.
b) Above 1 GHz, compliance with the limits shall be demonstrated using a linear average detector with a minimum resolution bandwidth of 1 MHz.

6.13.2 Frequency range for measuring unwanted emissions

(a) In measuring unwanted emissions, the spectrum shall be investigated from 30 MHz or the lowest radio frequency signal generated or used in the equipment, whichever is lower, without going below 9 kHz, up to at least the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

Calculation of Duty Cycle Correction Factor for Pulsed Emissions:

Per FCC 47 CFR 15.35 (c) and Ansi C63.10:2013, when the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 s (100 ms). In cases where the pulse train exceeds 0.1 s, the measured field strength shall be determined during a 0.1 s interval. The average field strength may be found by measuring the peak pulse amplitude (in log equivalent units) and determining the duty cycle correction factor (in dB) associated with the pulse modulation as shown below:

$$\delta(dB) = 20\log(\Delta)$$

Where

δ is the duty cycle correction factor (dB)
Δ is the duty cycle (dimensionless)

This correction factor may then be subtracted from the peak pulse amplitude to find the average value of the emission.

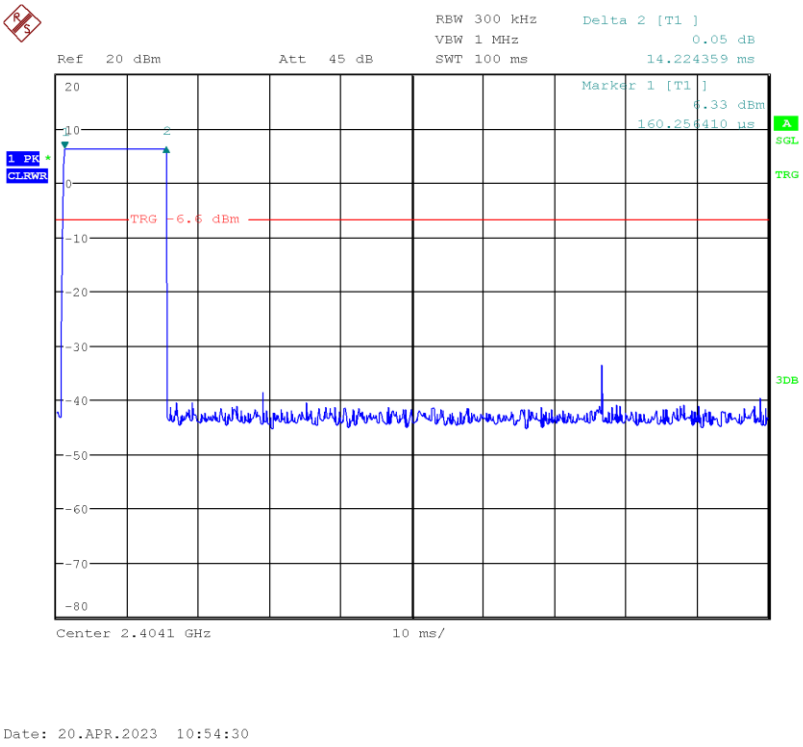

Figure 16: Single Channel Duty Cycle Measured Over 100ms

Using the channel ON time measured in the above figure, the DCCF was calculated as:

$$\delta(dB) = 20\log\left(\frac{14.22}{100}\right) = -16.94\ dB$$

Test Setup:

The EUT was tested in a 3 m SAC and was positioned on the front of the turntable. The transmitter was set for continuous transmission. The radiated output of the device was measured for all emissions from 150 kHz up to the 10th harmonic of the highest fundamental frequency. The EUT was pre-scanned in 3 different orthogonal orientations and was found to radiate highest when placed as indicated in the test photos.

Measurement Data and Plots:

3.7.1 150 kHz – 30 MHz

Antenna 1, Tested April 20, 2023:

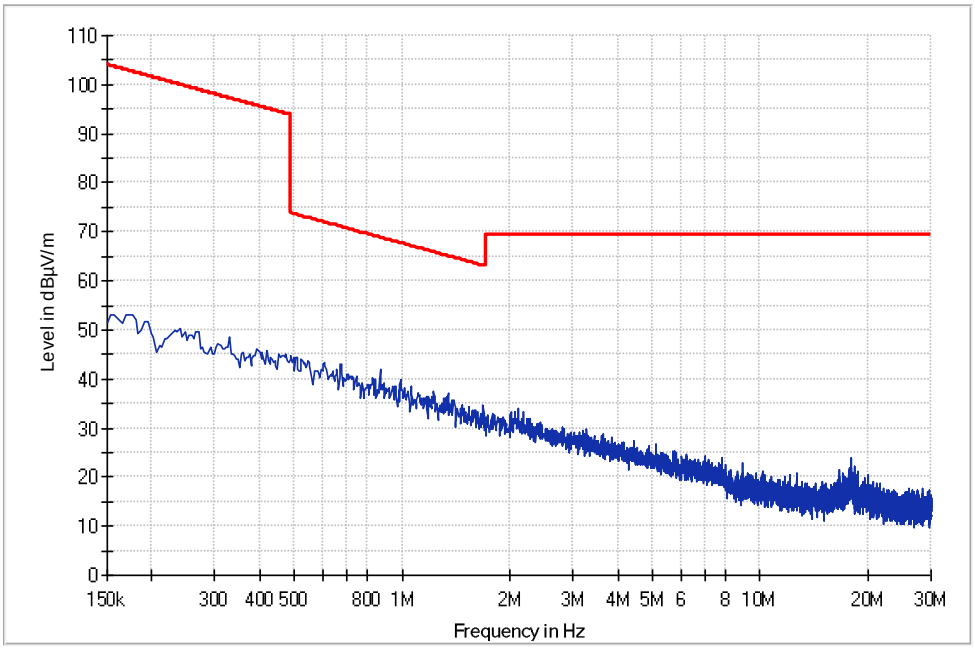

Figure 17: Antenna 1, Radiated Emissions from 0.15-30MHz Measured at 3m, Vertically Polarized

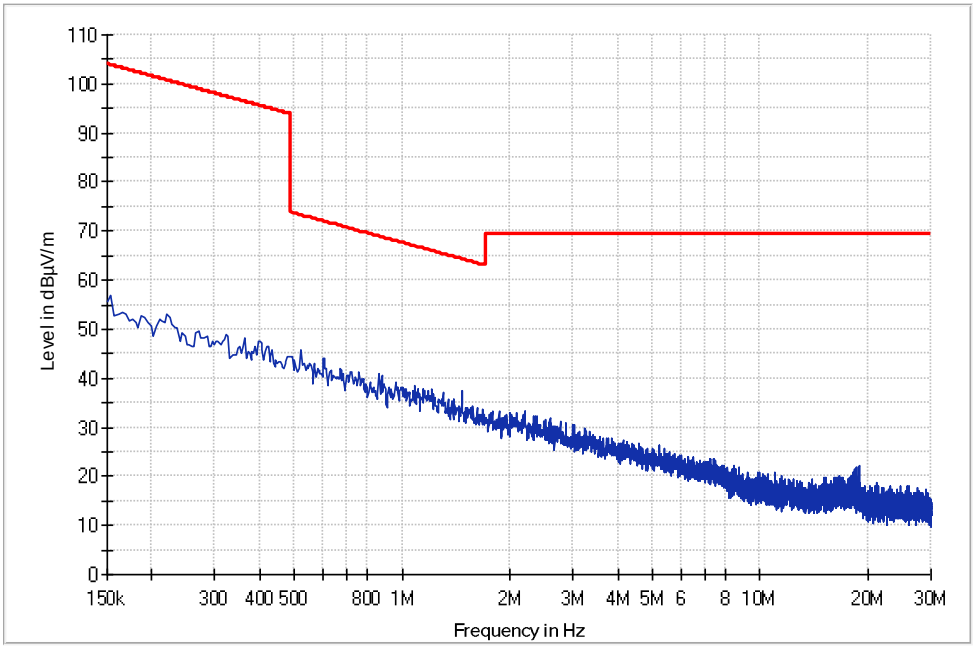

Figure 18: Antenna 1, Radiated Emissions From 0.15-30MHz Measured at 3m, Horizontally Polarized

No significant emissions were seen in either vertical or horizontal polarizations.

Antenna 2, Tested April 20, 2023:

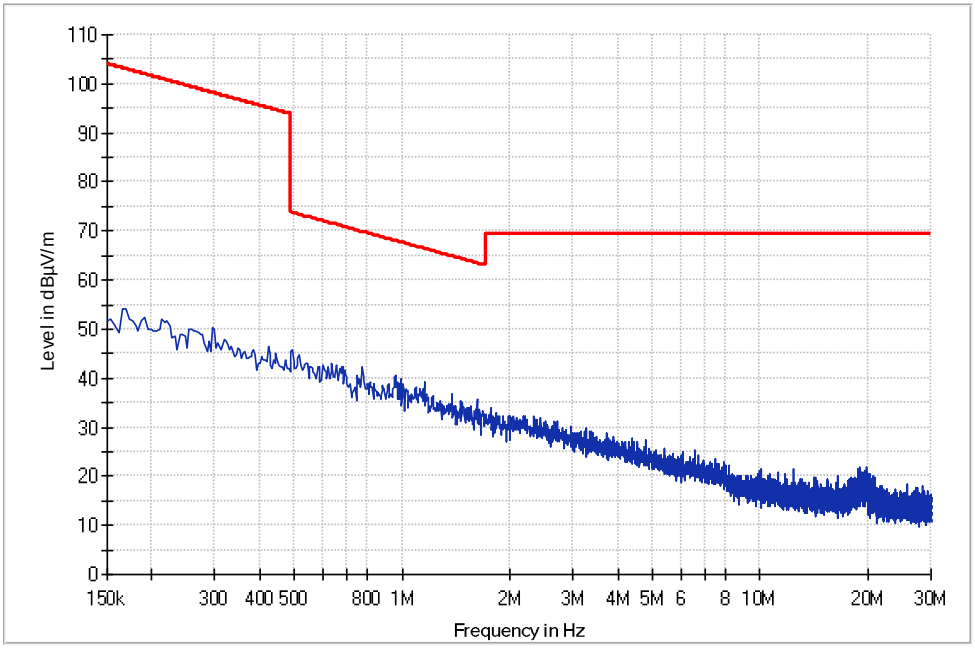

Figure 19: Antenna 2, Radiated Emissions from 0.15-30MHz Measured at 3m, Vertically Polarized

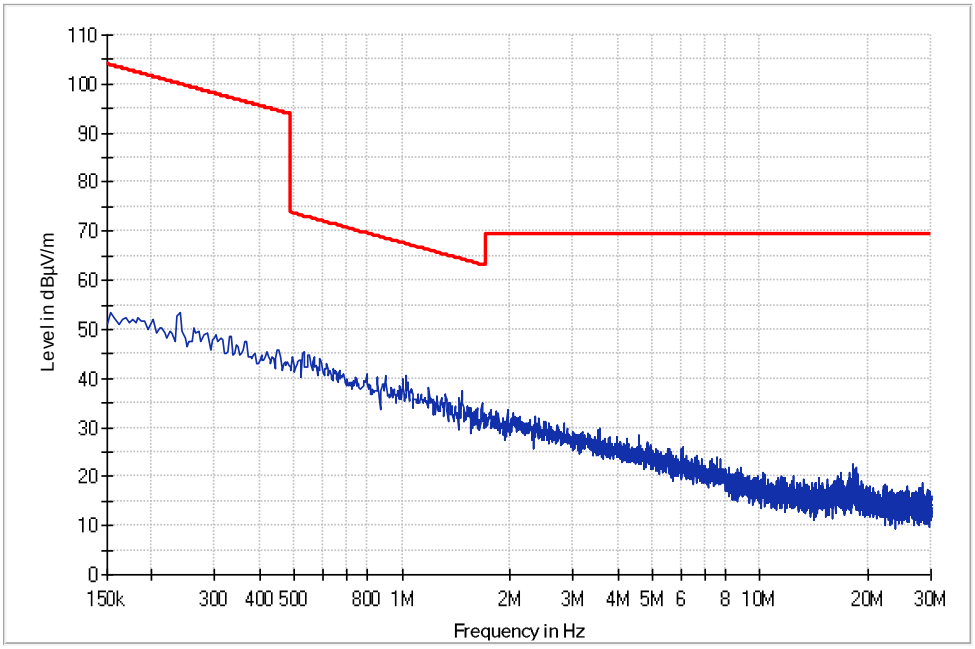

Figure 20: Antenna 2, Radiated Emissions From 0.15-30MHz Measured at 3m, Horizontally Polarized

No significant emissions were seen in either vertical or horizontal polarizations.

Antenna 3, Tested April 20, 2023:

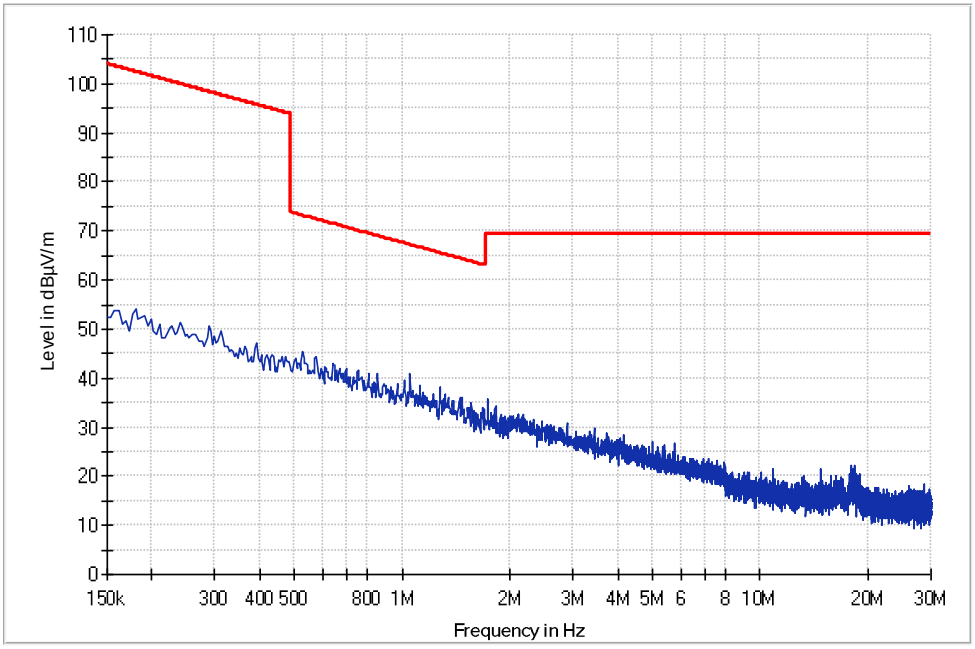

Figure 21: Antenna 3, Radiated Emissions from 0.15-30MHz Measured at 3m, Vertically Polarized

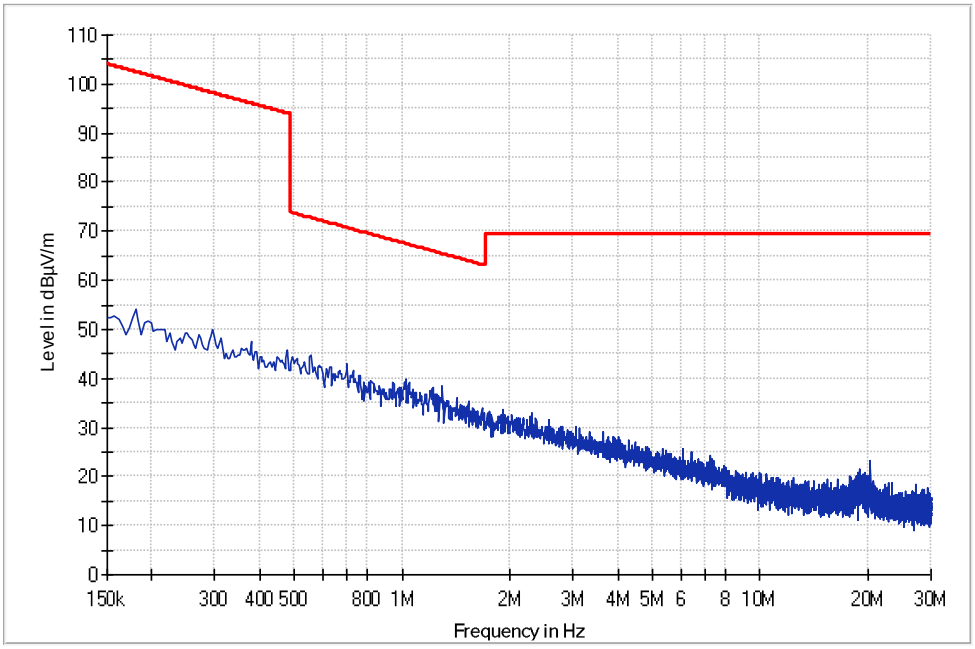

Figure 22: Antenna 3, Radiated Emissions From 0.15-30MHz Measured at 3m, Horizontally Polarized

No significant emissions were seen in either vertical or horizontal polarizations.

Antenna 4, Tested April 20, 2023:

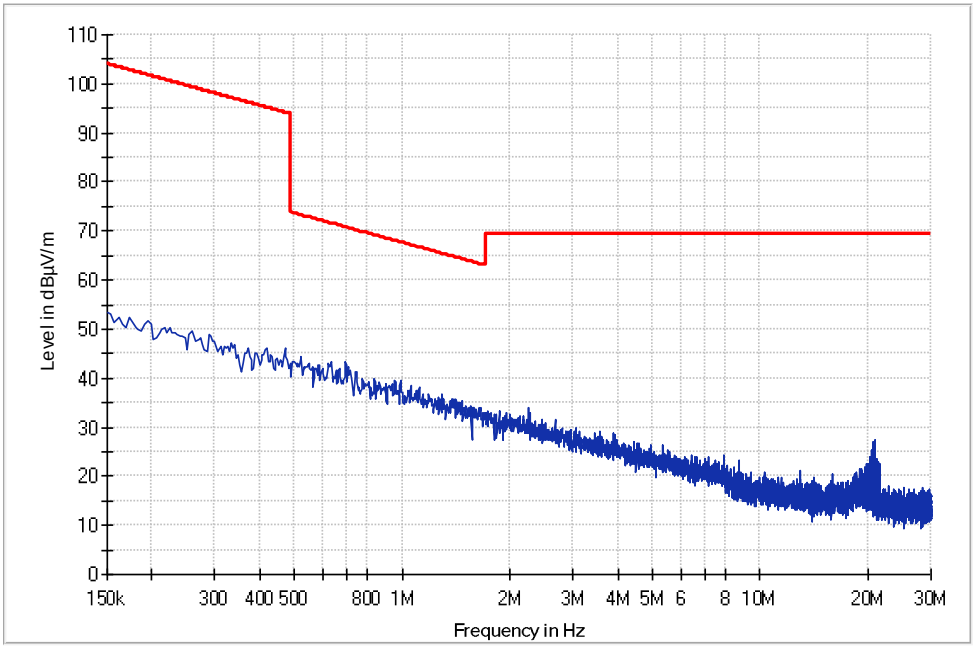

Figure 23: Antenna 4, Radiated Emissions from 0.15-30MHz Measured at 3m, Vertically Polarized

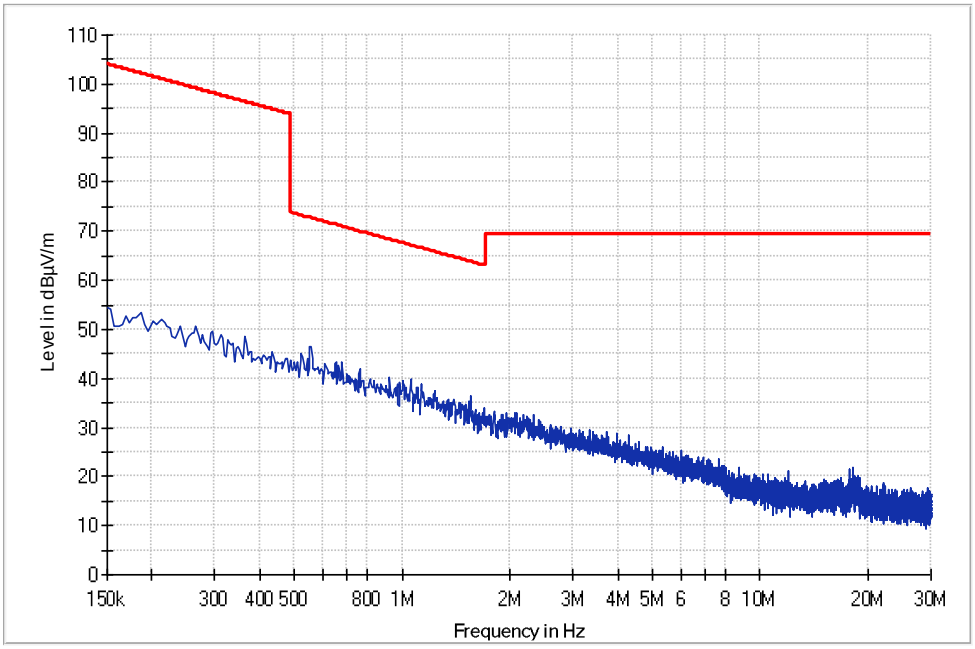

Figure 24: Antenna 4, Radiated Emissions From 0.15-30MHz Measured at 3m, Horizontally Polarized

No significant emissions were seen in either vertical or horizontal polarizations.

Antenna 5, Tested April 20, 2023:

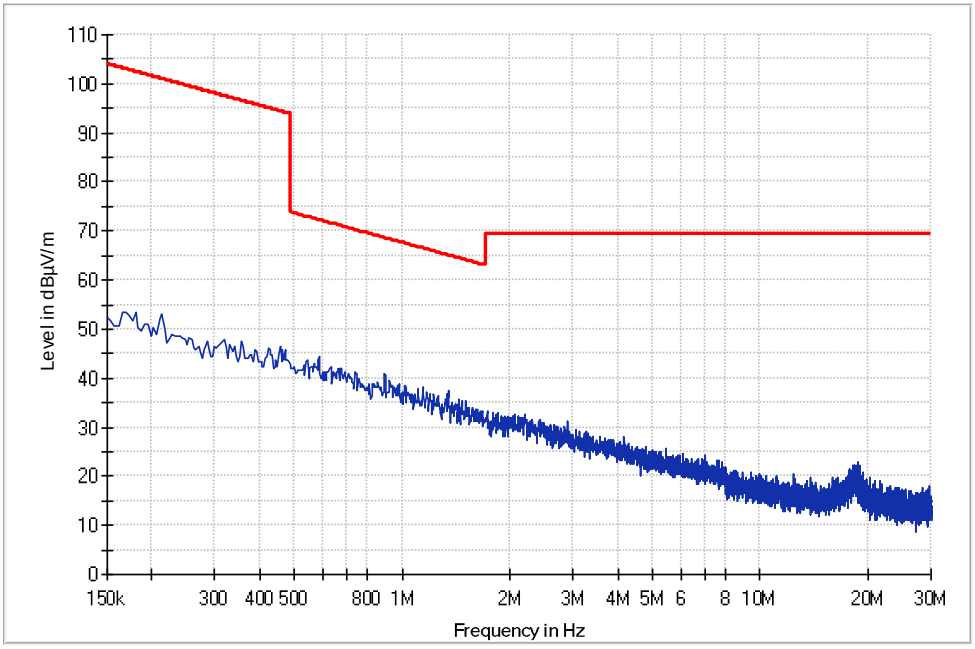

Figure 25: Antenna 5, Radiated Emissions from 0.15-30MHz Measured at 3m, Vertically Polarized

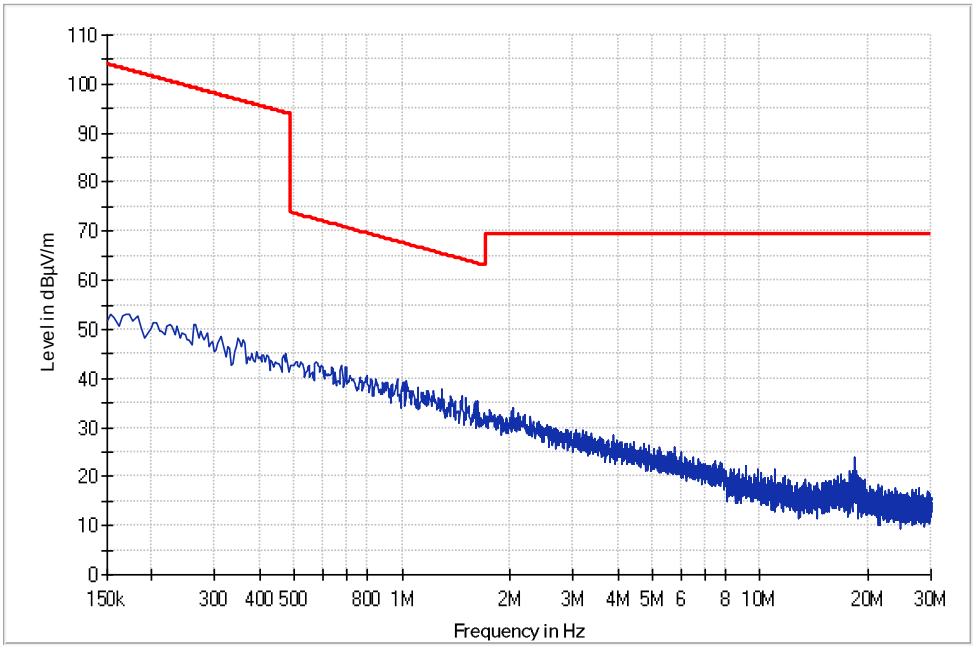

Figure 26: Antenna 5, Radiated Emissions From 0.15-30MHz Measured at 3m, Horizontally Polarized

No significant emissions were seen in either vertical or horizontal polarizations.

3.7.2 30 MHz to 1 GHz

Antenna 1, Tested April 25, 2023:

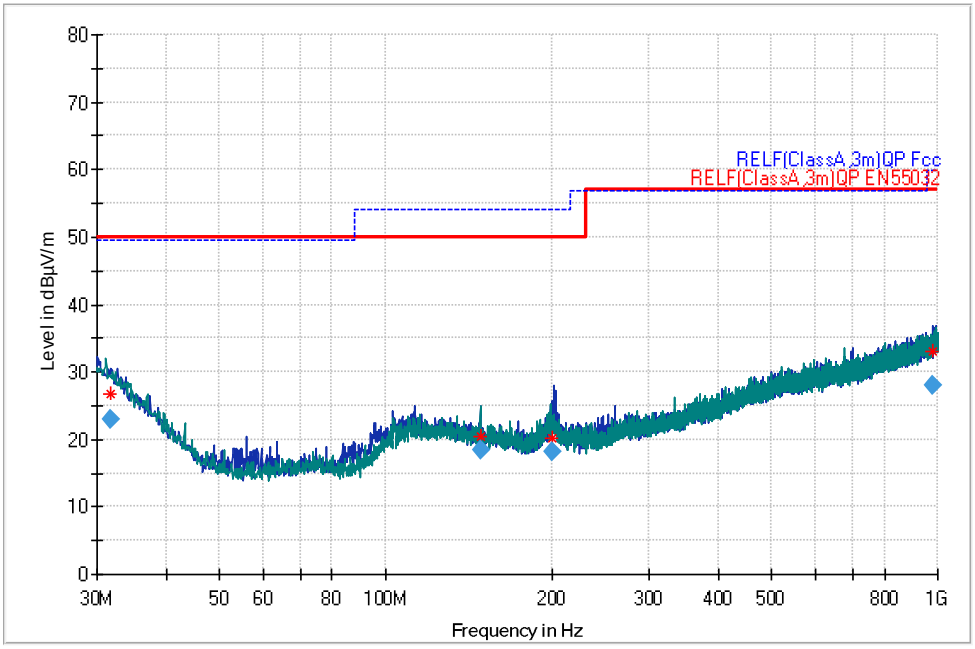

Figure 27: Antenna 1, Radiated Emissions from 30-1000MHz Measured at 3m

Frequency (MHz)	QuasiPeak (dBµV/m)	Height (cm)	Pol	Azimuth (°)	Corr. Factor (dB/m)	Limit (dBµV/m)	Margin (dB)	Result
31.7382	23.07	100	H	24	27.2	50	26.93	Complies
148.3308	18.54	225	H	188	20.2	50	31.46	Complies
200.2798	18.12	228	H	333	20.8	50	31.88	Complies
981.2456	28	156	H	145	32.1	57	29	Complies

Table 12: Antenna 1, Radiated Emissions (30-1000 MHz) Measured at 3m

Antenna 2, Tested April 20, 2023:

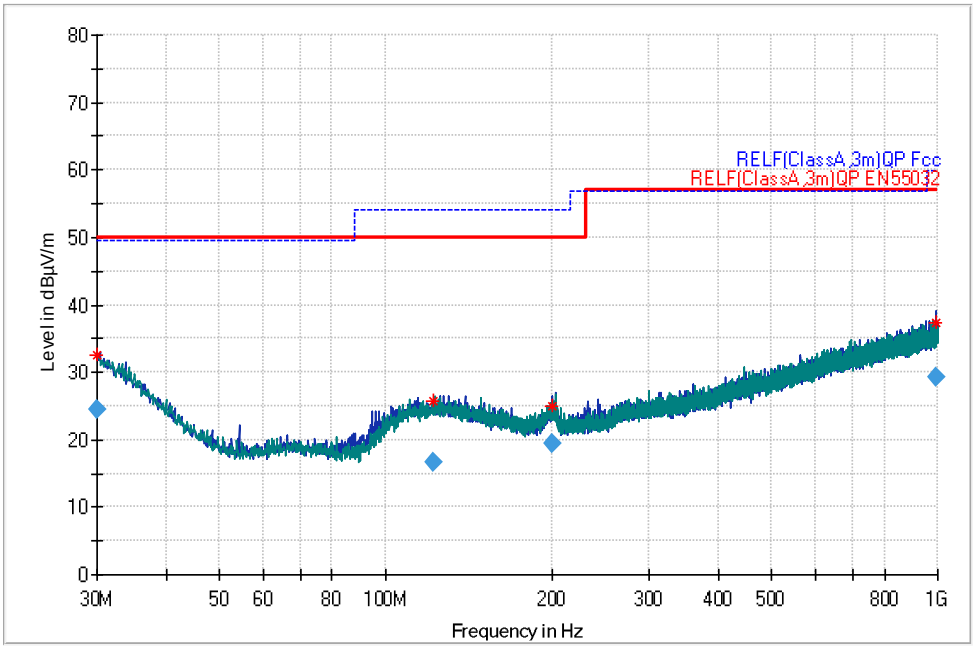

Figure 28: Antenna 2, Radiated Emissions from 30-1000MHz Measured at 3m

Frequency (MHz)	QuasiPeak (dBµV/m)	Height (cm)	Pol	Azimuth (°)	Corr. Factor (dB/m)	Limit (dBµV/m)	Margin (dB)	Result
30.028	24.37	198	H	152	28.4	50	25.63	Complies
121.8925	16.71	383	V	101	21.1	50	33.29	Complies
200.9524	19.49	321	H	279	20.8	50	30.51	Complies
994.0938	29.25	373	H	240	32.2	57	27.75	Complies

Table 13: Antenna 2, Radiated Emissions (30-1000 MHz) Measured at 3m

Antenna 3, Tested April 20, 2023:

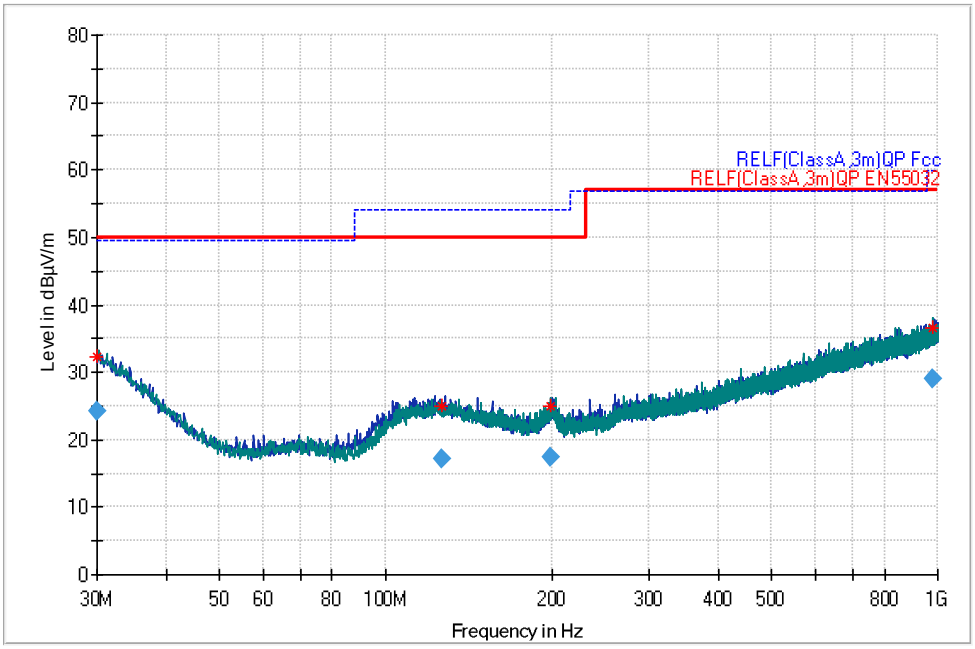

Figure 29: Antenna 3, Radiated Emissions from 30-1000MHz Measured at 3m

Frequency (MHz)	QuasiPeak (dBµV/m)	Height (cm)	Pol	Azimuth (°)	Corr. Factor (dB/m)	Limit (dBµV/m)	Margin (dB)	Result
30.0941	24.31	181	V	142	28.4	50	25.69	Complies
126.0122	17.28	270	H	48	21.1	50	32.72	Complies
198.3716	17.44	252	V	287	20.5	50	32.56	Complies
976.5256	28.97	225	V	36	32.1	57	28.03	Complies

Table 14: Antenna 3, Radiated Emissions (30-1000 MHz) Measured at 3m

Antenna 4, Tested April 20, 2023:

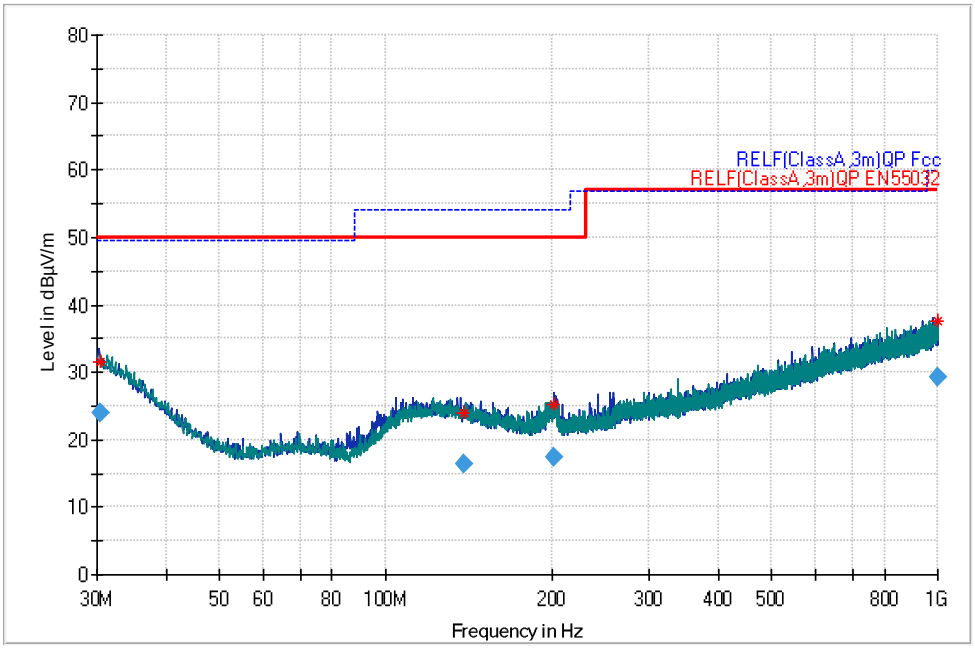

Figure 30: Antenna 4, Radiated Emissions from 30-1000MHz Measured at 3m

Frequency (MHz)	QuasiPeak (dBµV/m)	Height (cm)	Pol	Azimuth (°)	Corr. Factor (dB/m)	Limit (dBµV/m)	Margin (dB)	Result
30.3399	24.05	100	H	0	28.2	50	25.95	Complies
138.3836	16.5	178	H	141	20.7	50	33.5	Complies
202.3963	17.41	400	H	83	20.4	50	32.59	Complies
999.3418	29.4	365	V	177	32.4	57	27.6	Complies

Table 15: Antenna 4, Radiated Emissions (30-1000 MHz) Measured at 3m

Antenna 5, Tested April 20, 2023:

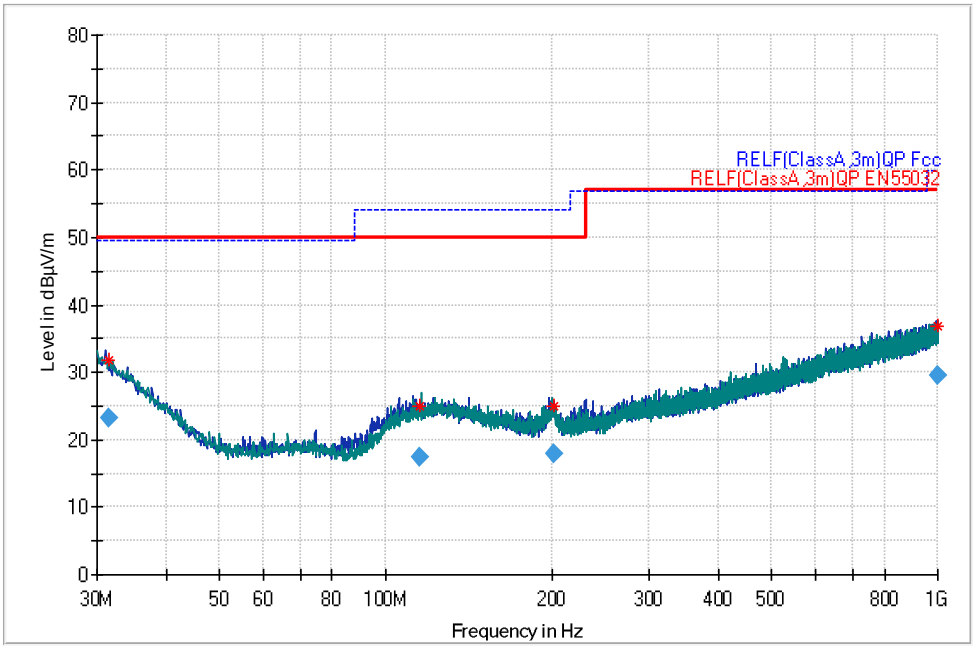

Figure 31: Antenna 5, Radiated Emissions from 30-1000MHz Measured at 3m

Frequency (MHz)	QuasiPeak (dBµV/m)	Height (cm)	Pol	Azimuth (°)	Corr. Factor (dB/m)	Limit (dBµV/m)	Margin (dB)	Result
31.5519	23.25	361	V	56	27.3	50	26.75	Complies
115.4443	17.34	185	V	233	20.7	50	32.66	Complies
201.8449	17.82	105	V	323	20.6	50	32.18	Complies
999.5279	29.48	368	H	75	32.4	57	27.52	Complies

Table 16: Antenna 5, Radiated Emissions (30-1000 MHz) Measured at 3m

3.7.3 1 GHz to 6 GHz

Antenna 1, Tested April 26, 2023:

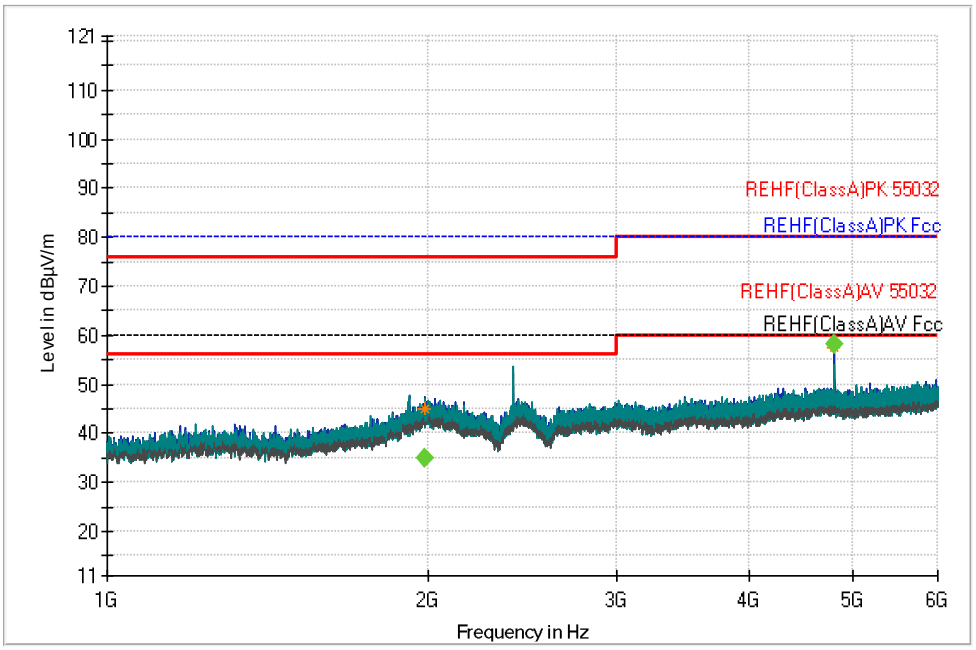

Figure 32: Antenna 1, Radiated Emissions from 1-6GHz Measured at 3m

Frequency (MHz)	Average (dBµV/m)	Height (cm)	Pol	Azimuth (°)	Corr. Factor (dB/m)	Limit (dBµV/m)	Margin (dB)	Result
1980.704	34.77	199	V	23	1.2	56	21.23	Complies
4806.156	41.09	349	H	179	-9.94 [1]	60	18.91	Complies

[1] Correction factor includes system gains and losses, as well as duty cycle correction factor calculated above.
[2] Emissions in the 2400 – 2483.5 MHz band are intentionally transmitted and therefor were not investigated.

Table 17: Antenna 1, Radiated Emissions (1-6 GHz) Measured at 3m, Average

Antenna 2, Tested April 26, 2023:

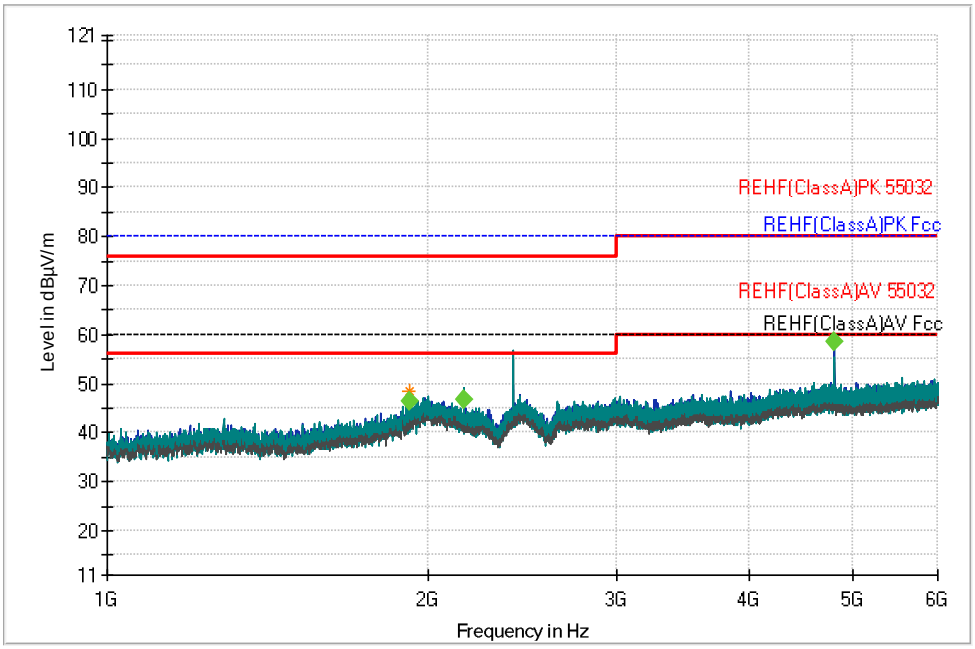

Figure 33: Antenna 2, Radiated Emissions from 1-6GHz Measured at 3m

Frequency (MHz)	Average (dBµV/m)	Height (cm)	Pol	Azimuth (°)	Corr. Factor (dB/m)	Limit (dBµV/m)	Margin (dB)	Result
1917.096	46.3	349	H	168	0.1	56	9.7	Complies
2160.08	29.84	149	H	0	-16.64 [1]	56	26.16	Complies
4806.176	41.55	249	H	3	-9.94 [1]	60	18.45	Complies

[1] Correction factor includes system gains and losses, as well as duty cycle correction factor calculated above.
[2] Emissions in the 2400 – 2483.5 MHz band are intentionally transmitted and therefor were not investigated.

Table 18: Antenna 2, Radiated Emissions (1-6 GHz) Measured at 3m, Average

Antenna 3, Tested July 26, 2023:

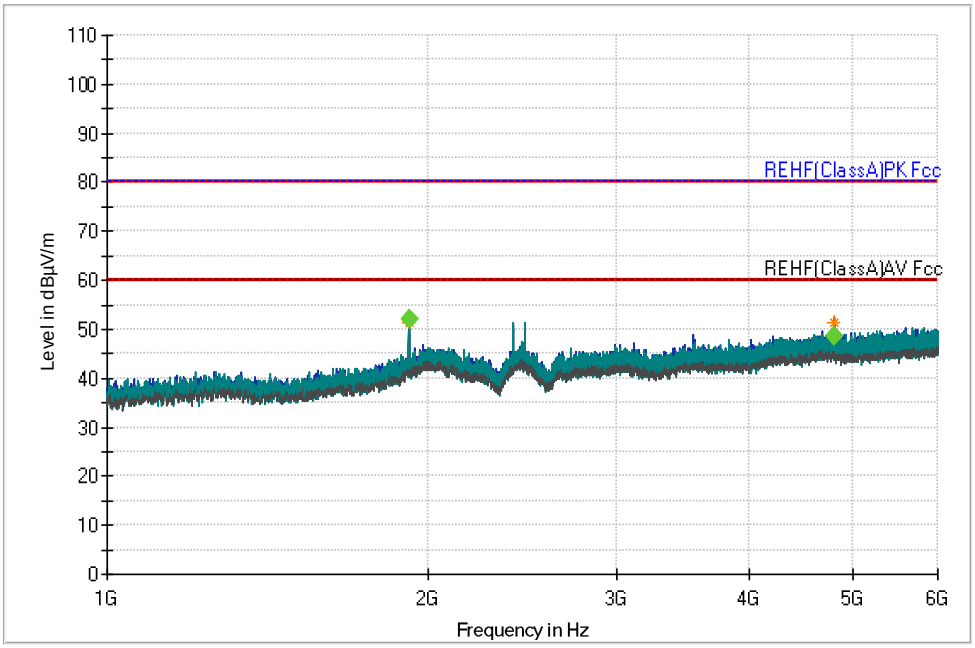

Figure 34: Antenna 3, Radiated Emissions from 1-6GHz Measured at 3m

Frequency (MHz)	Average (dBµV/m)	Height (cm)	Pol	Azimuth (°)	Corr. Factor (dB/m)	Limit (dBµV/m)	Margin (dB)	Result
1917.092	51.90	299	V	329	0.1	60	8.10	Complies
4806.252	31.72	150	V	59	-9.94 [1]	60	28.28	Complies

[1] Correction factor includes system gains and losses, as well as duty cycle correction factor calculated above.
[2] Emissions in the 2400 – 2483.5 MHz band are intentionally transmitted and therefor were not investigated.

Table 19: Antenna 3, Radiated Emissions (1-6 GHz) Measured at 3m, Average

Antenna 4, Tested April 26, 2023:

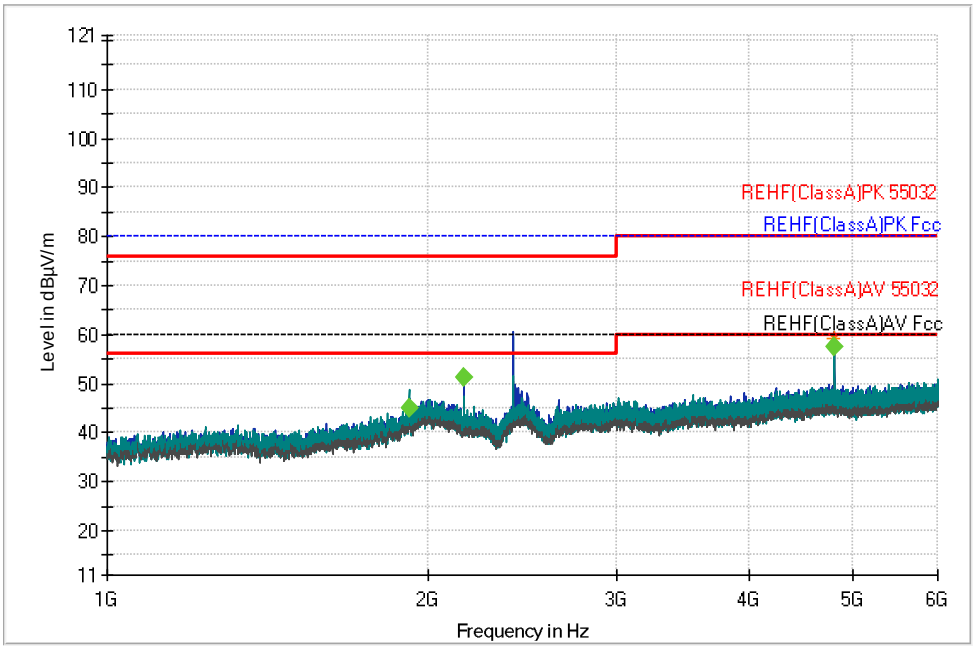

Figure 35: Antenna 4, Radiated Emissions from 1-6GHz Measured at 3m

Frequency (MHz)	Average (dBµV/m)	Height (cm)	Pol	Azimuth (°)	Corr. Factor (dB/m)	Limit (dBµV/m)	Margin (dB)	Result
1917.12	45.15	149	V	220	0.1	56	10.85	Complies
2160.052	34.32	149	H	16	-16.64 [1]	56	21.68	Complies
4806.204	40.43	249	H	94	-9.94 [1]	60	19.57	Complies

[1] Correction factor includes system gains and losses, as well as duty cycle correction factor calculated above.
[2] Emissions in the 2400 – 2483.5 MHz band are intentionally transmitted and therefor were not investigated.

Table 20: Antenna 4, Radiated Emissions (1-6 GHz) Measured at 3m, Average

Antenna 5, Tested April 26, 2023:

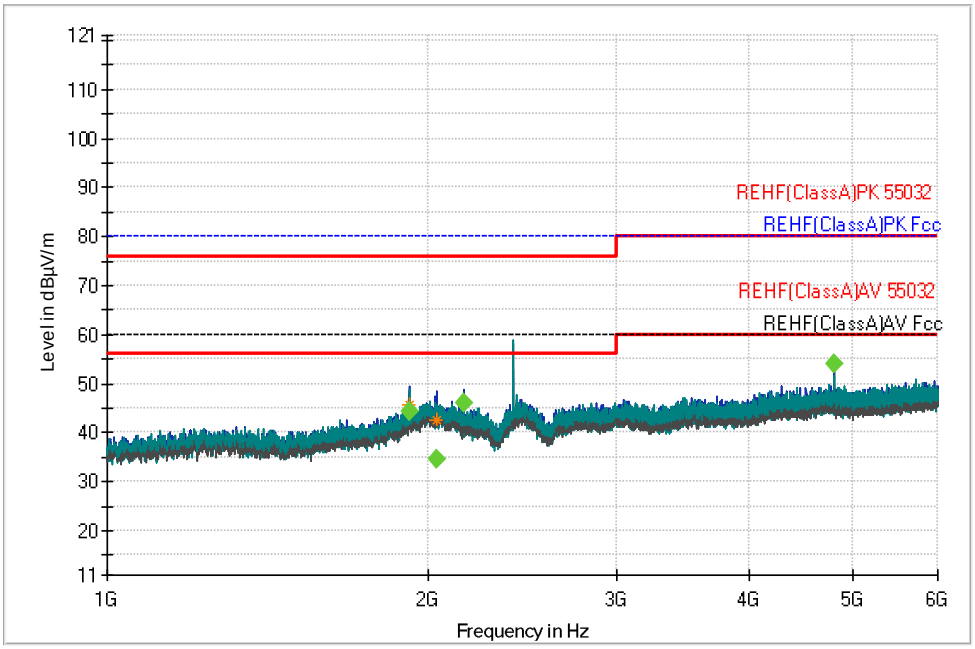

Figure 36: Antenna 5, Radiated Emissions from 1-6GHz Measured at 3m

Frequency (MHz)	Average (dBµV/m)	Height (cm)	Pol	Azimuth (°)	Corr. Factor (dB/m)	Limit (dBµV/m)	Margin (dB)	Result
1917.044	44.25	199	V	221	0.1	56	11.75	Complies
2039.32	34.43	249	H	166	1.2	56	21.57	Complies
2160.088	29.35	299	H	0	-16.64 [1]	56	26.65	Complies
4806.168	37.26	249	H	96	-9.94 [1]	60	22.74	Complies

[1] Correction factor includes system gains and losses, as well as duty cycle correction factor calculated above.
[2] Emissions in the 2400 – 2483.5 MHz band are intentionally transmitted and therefor were not investigated.

Table 21: Antenna 5, Radiated Emissions (1-6 GHz) Measured at 3m, Average

3.7.4 6 GHz to 18 GHz

Antenna 1, Tested April 26, 2023:

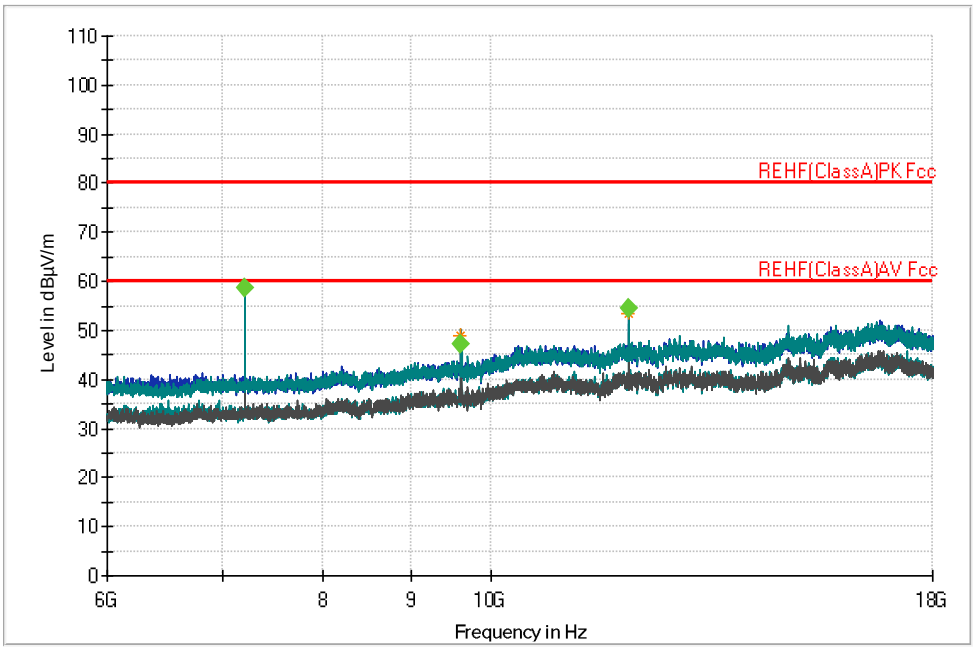

Figure 37: Antenna 1, Radiated Emissions from 6-18GHz Measured at 3m

Frequency (MHz)	Average (dBµV/m)	Height (cm)	Pol	Azimuth (°)	Corr. Factor (dB/m)	Limit (dBµV/m)	Margin (dB)	Result
7209.296	41.83	264	V	29	-22.04 [1]	60	18.17	Complies
9612.368	30.09	211	V	181	-16.04 [1]	60	29.91	Complies
12015.5	37.54	254	H	157	-8.64 [1]	60	22.46	Complies

[1] Correction factor includes system gains and losses, as well as duty cycle correction factor calculated above.

Table 22: Antenna 1, Radiated Emissions (6-18 GHz) Measured at 3m, Average

Antenna 2, Tested April 26, 2023:

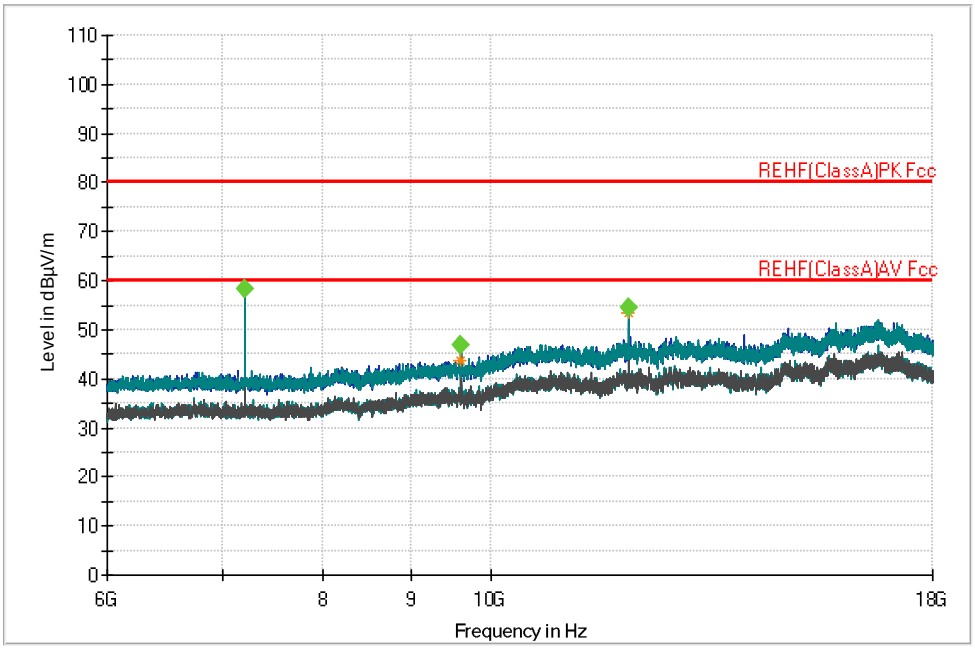

Figure 38: Antenna 2, Radiated Emissions from 6-18GHz Measured at 3m

Frequency (MHz)	Average (dBµV/m)	Height (cm)	Pol	Azimuth (°)	Corr. Factor (dB/m)	Limit (dBµV/m)	Margin (dB)	Result
7209.296	41.51	257	V	33	-22.04 [1]	60	18.49	Complies
9612.428	29.98	201	V	182	-16.04 [1]	60	30.02	Complies
12015.55	37.52	244	H	150	-8.64 [1]	60	22.48	Complies

[1] Correction factor includes system gains and losses, as well as duty cycle correction factor calculated above.

Table 23: Antenna 2, Radiated Emissions (6-18 GHz) Measured at 3m, Average

Antenna 3, Tested April 26, 2023:

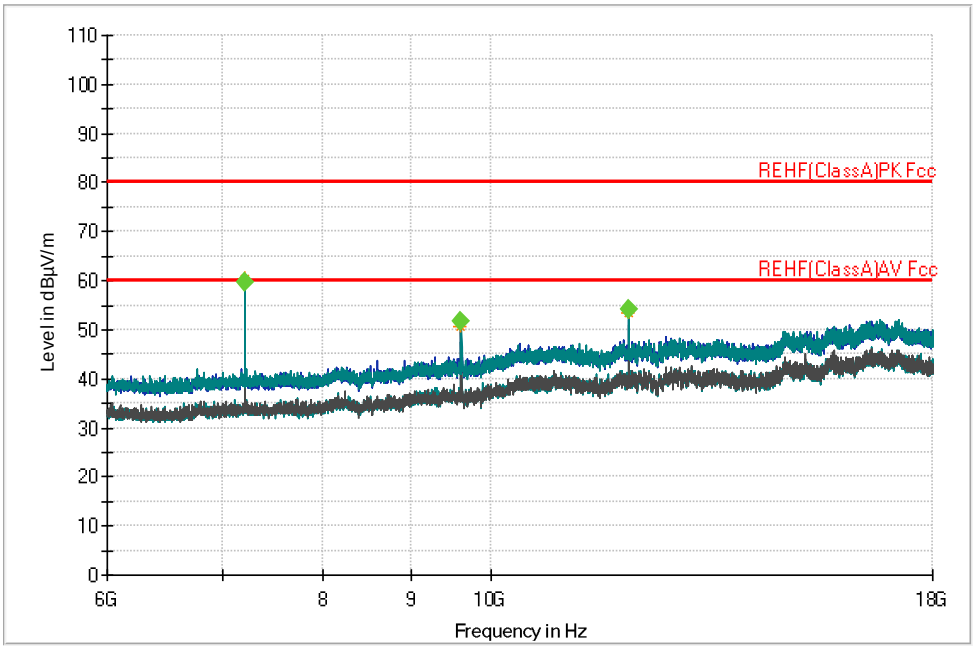

Figure 39: Antenna 3, Radiated Emissions from 6-18GHz Measured at 3m

Frequency (MHz)	Average (dBµV/m)	Height (cm)	Pol	Azimuth (°)	Corr. Factor (dB/m)	Limit (dBµV/m)	Margin (dB)	Result
7209.304	42.68	267	V	25	-22.04 [1]	60	17.32	Complies
9612.38	34.77	208	V	182	-16.04 [1]	60	25.23	Complies
12015.52	37.03	273	H	157	-8.64 [1]	60	22.97	Complies

[1] Correction factor includes system gains and losses, as well as duty cycle correction factor calculated above.

Table 24: Antenna 3, Radiated Emissions (6-18 GHz) Measured at 3m, Average

Antenna 4, Tested April 26, 2023:

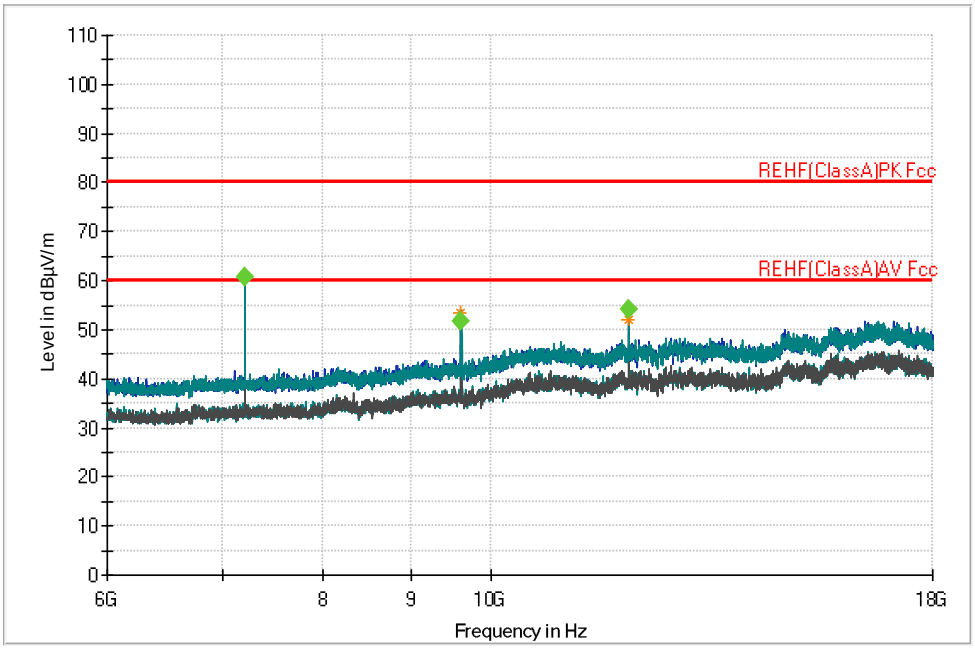

Figure 40: Antenna 4, Radiated Emissions from 6-18GHz Measured at 3m

Frequency (MHz)	Average (dBµV/m)	Height (cm)	Pol	Azimuth (°)	Corr. Factor (dB/m)	Limit (dBµV/m)	Margin (dB)	Result
7209.28	43.71	215	V	21	-22.04 [1]	60	16.29	Complies
9612.412	34.82	205	V	185	-16.04 [1]	60	25.18	Complies
12015.49	37.09	266	H	150	-8.64 [1]	60	22.91	Complies

[1] Correction factor includes system gains and losses, as well as duty cycle correction factor calculated above.

Table 25: Antenna 4, Radiated Emissions (6-18 GHz) Measured at 3m, Average

Antenna 5, Tested April 26, 2023:

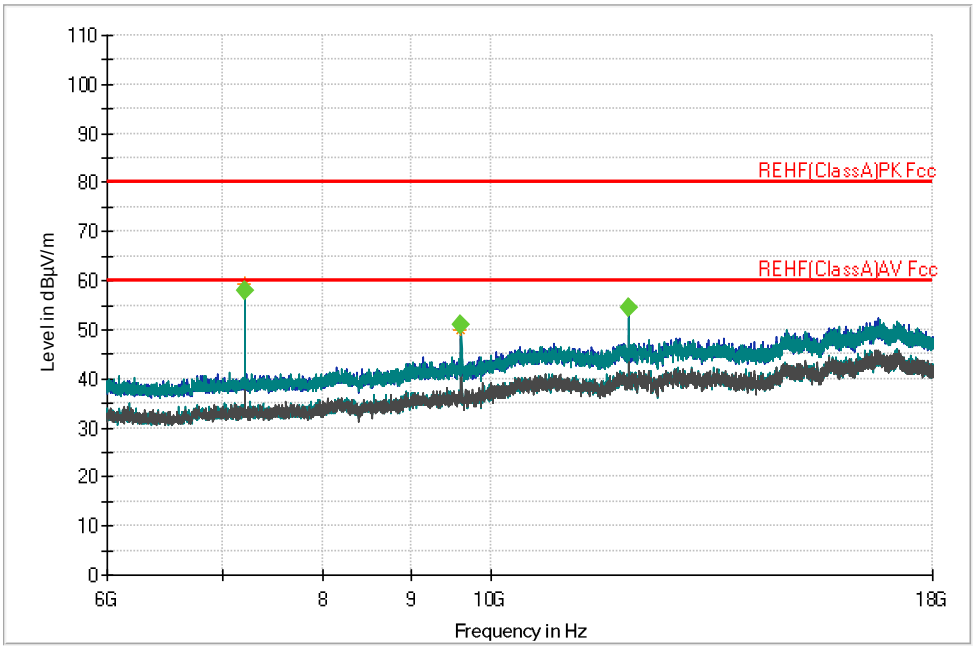

Figure 41: Antenna 5, Radiated Emissions from 6-18GHz Measured at 3m, Vertically Polarized

Frequency (MHz)	Average (dBµV/m)	Height (cm)	Pol	Azimuth (°)	Corr. Factor (dB/m)	Limit (dBµV/m)	Margin (dB)	Result
7209.308	41.18	201	V	15	-22.04 [1]	60	18.82	Complies
9612.384	34.07	208	V	182	-16.04 [1]	60	25.93	Complies
12015.5	37.66	267	H	151	-8.64 [1]	60	22.34	Complies

[1] Correction factor includes system gains and losses, as well as duty cycle correction factor calculated above.

Table 26: Antenna 5, Radiated Emissions (6-18 GHz) Measured at 3m, Average

3.7.5 18 GHz to 26 GHz

Antenna 1, Tested April 26, 2023:

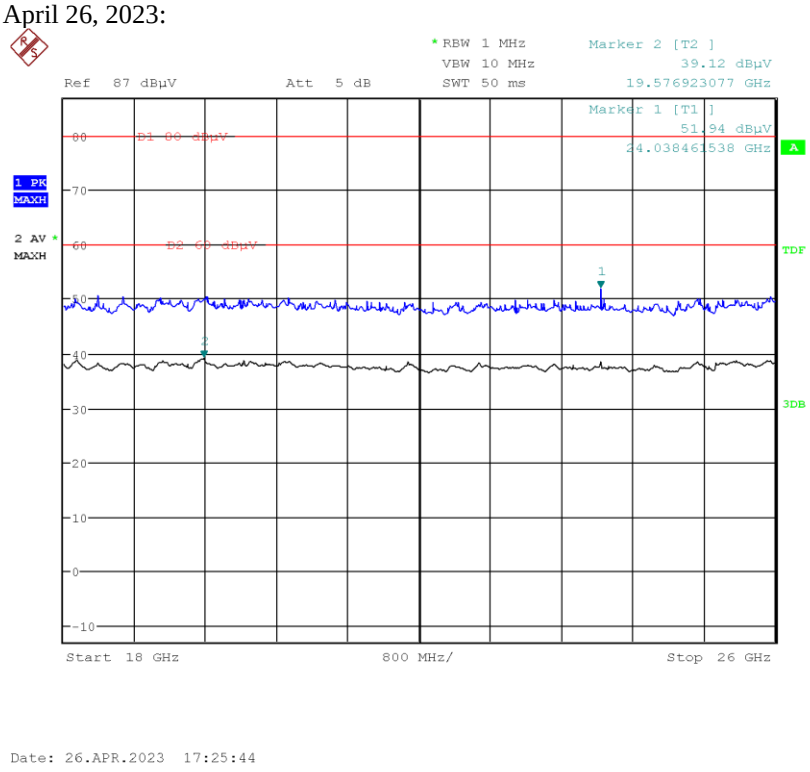

Figure 42: Antenna 1, Radiated Emissions from 18-26GHz Measured at 1m, Vertically Polarized

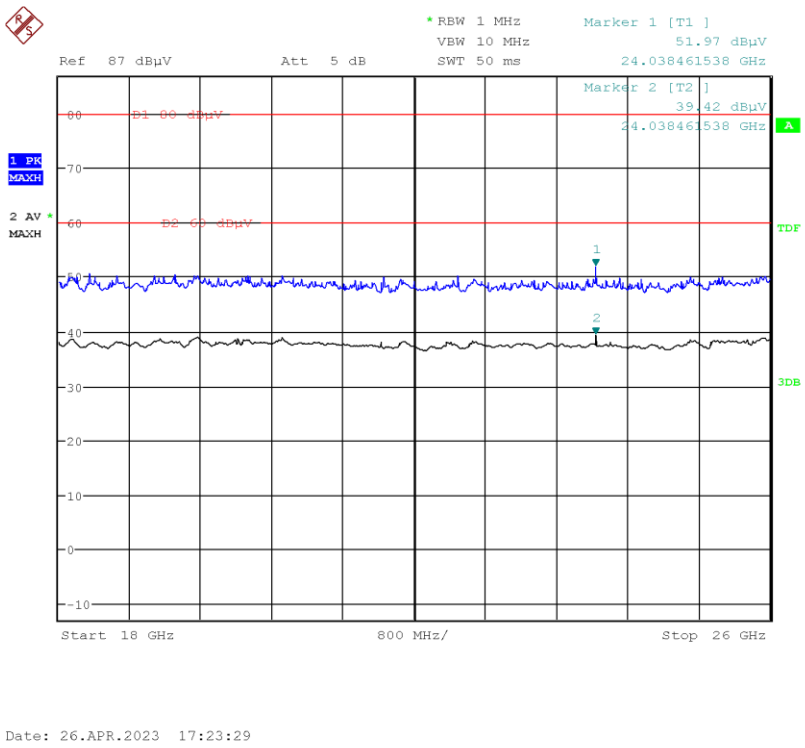

Figure 43: Antenna 1, Radiated Emissions from 18-26GHz Measured at 1m, Horizontally Polarized

No significant emissions were seen in either vertical or horizontal polarizations.

Antenna 2, Tested April 26, 2023:

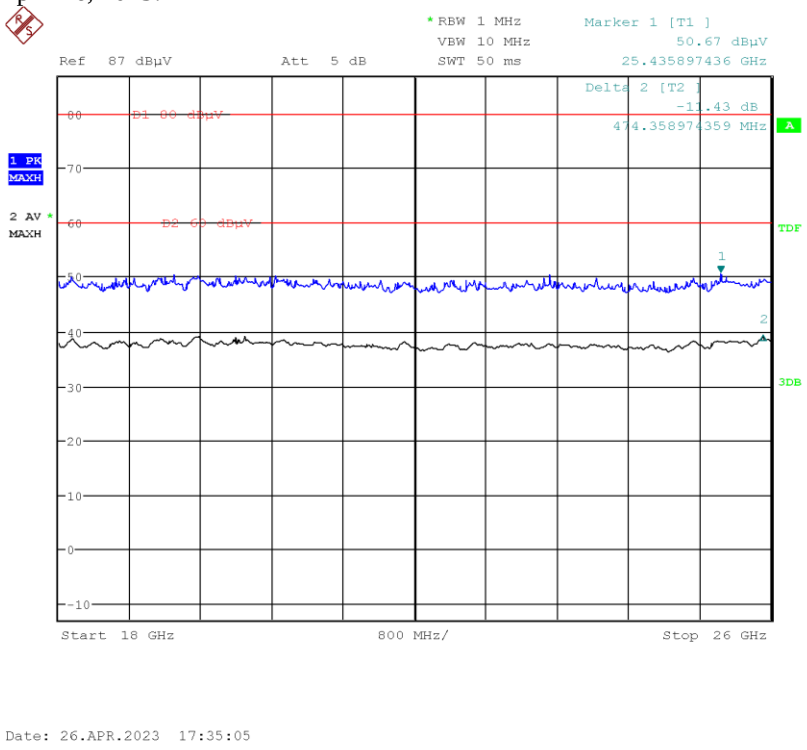

Figure 44: Antenna 2, Radiated Emissions from 18-26GHz Measured at 1m, Vertically Polarized

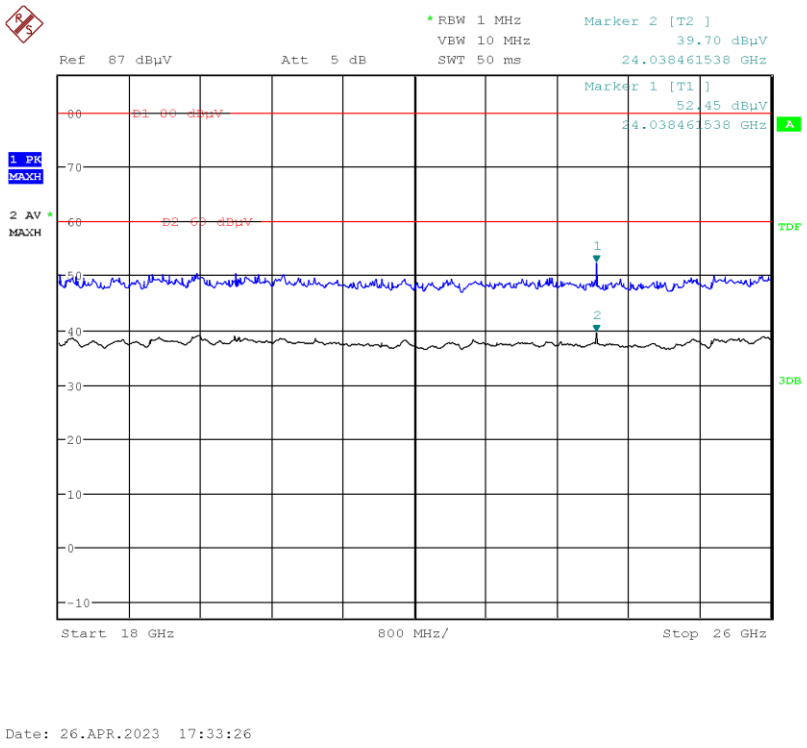

Figure 45: Antenna 2, Radiated Emissions from 18-26GHz Measured at 1m, Horizontally Polarized

No significant emissions were seen in either vertical or horizontal polarizations.

Antenna 3, Tested April 26, 2023:

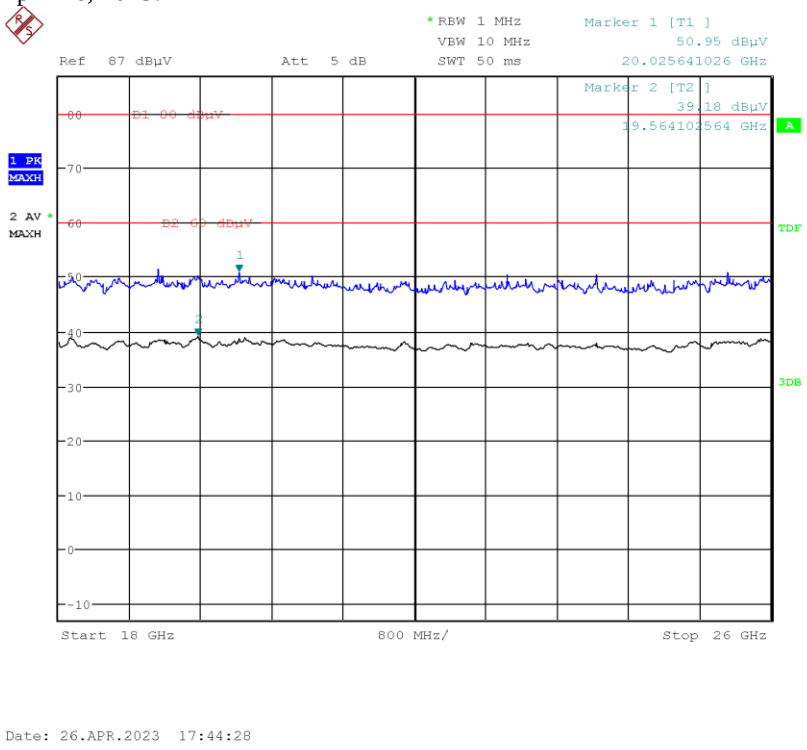

Figure 46: Antenna 3, Radiated Emissions from 18-26GHz Measured at 1m, Vertically Polarized

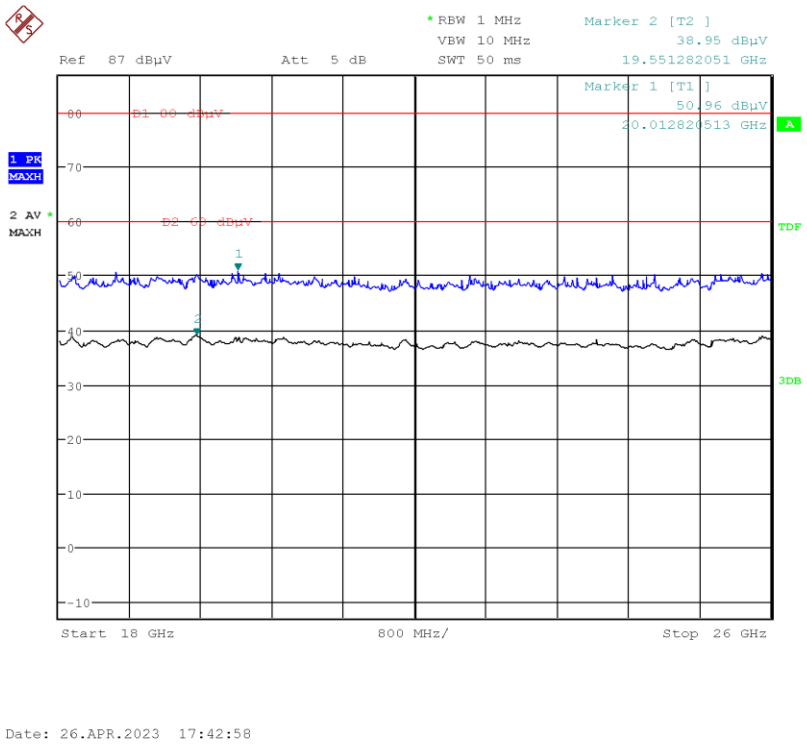

Figure 47: Antenna 3, Radiated Emissions from 18-26GHz Measured at 1m, Horizontally Polarized

No significant emissions were seen in either vertical or horizontal polarizations.

Antenna 4, Tested April 26, 2023:

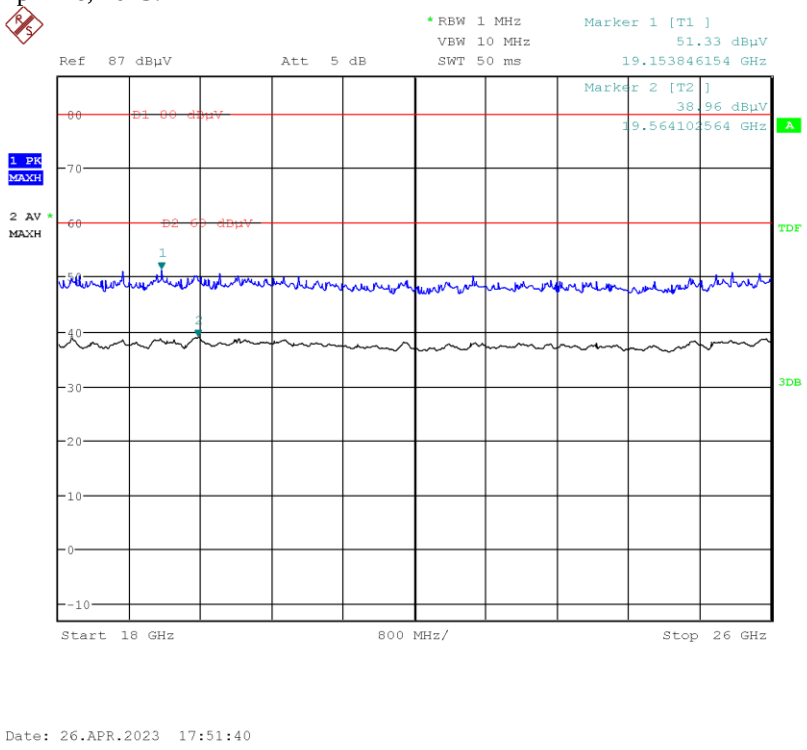

Figure 48: Antenna 4, Radiated Emissions from 18-26GHz Measured at 1m, Vertically Polarized

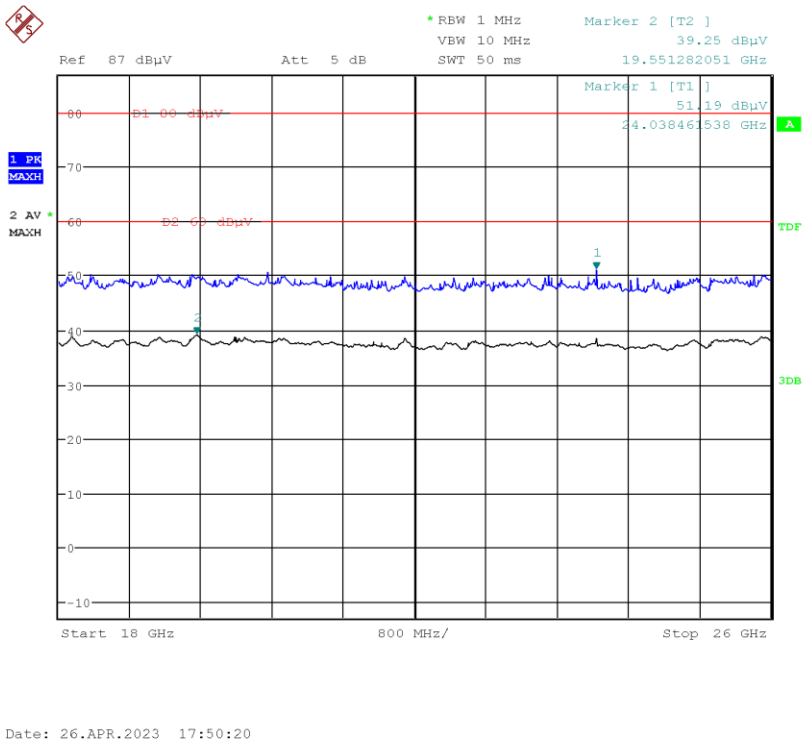

Figure 49: Antenna 4, Radiated Emissions from 18-26GHz Measured at 1m, Horizontally Polarized

No significant emissions were seen in either vertical or horizontal polarizations.

Antenna 5, Tested April 26, 2023:

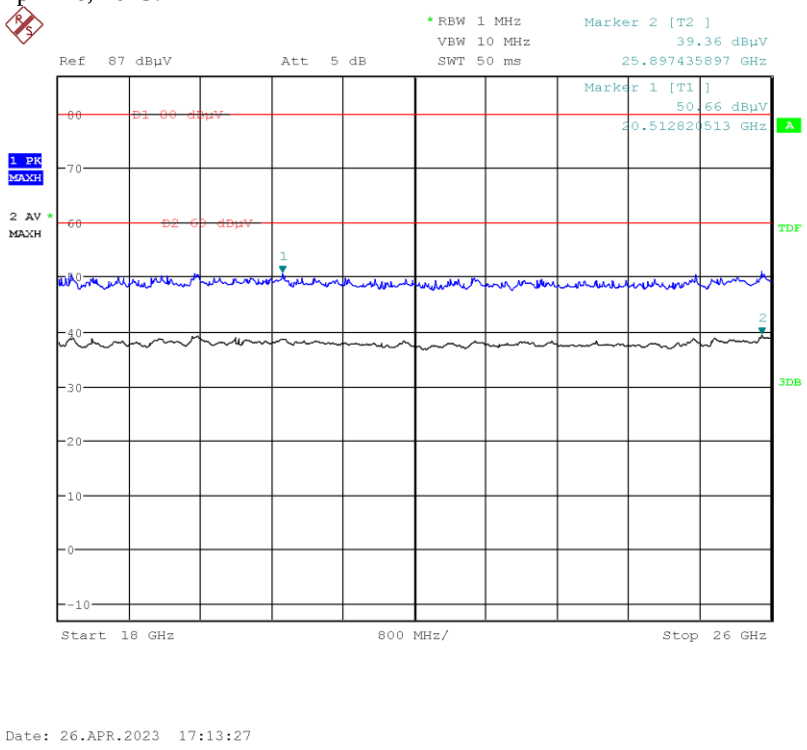

Figure 50: Antenna 5, Radiated Emissions from 18-26GHz Measured at 1m, Vertically Polarized

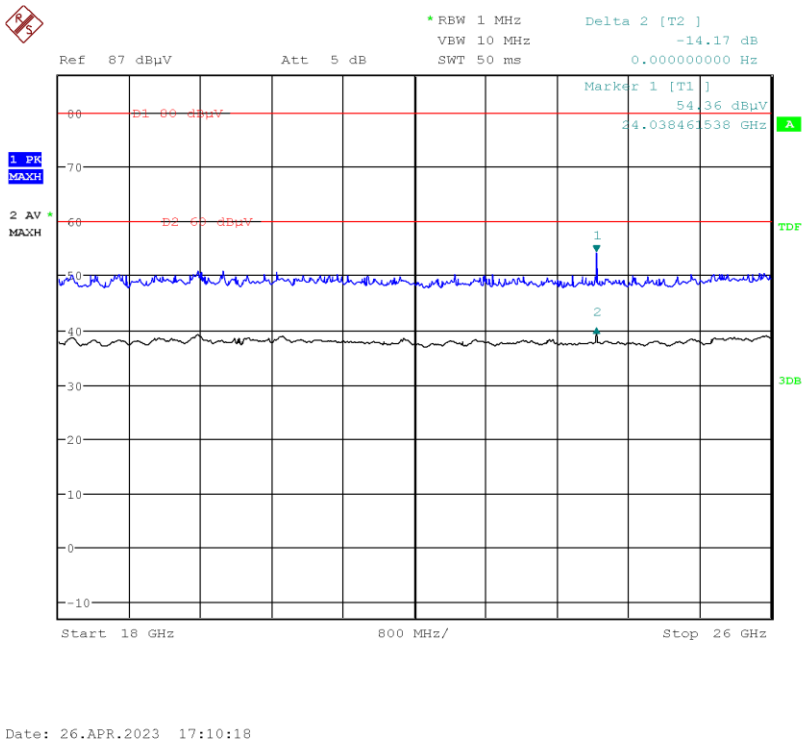

Figure 51: Antenna 5, Radiated Emissions from 18-26GHz Measured at 1m, Horizontally Polarized

No significant emissions were seen in either vertical or horizontal polarizations.

Appendix A: Test Setup Photos

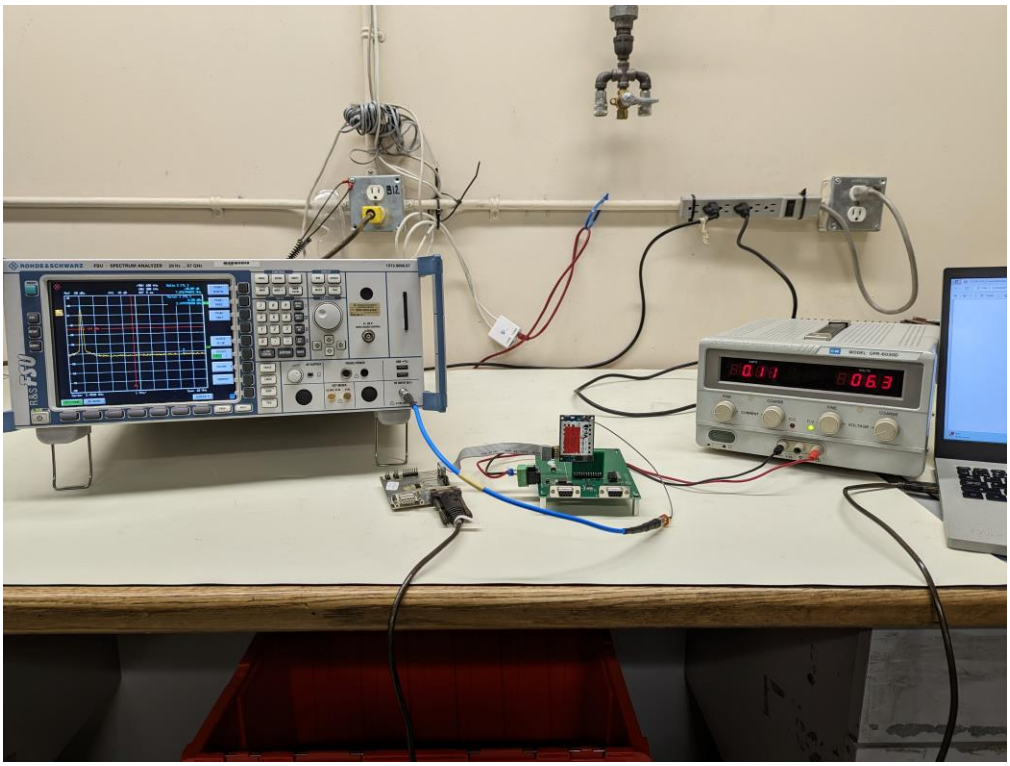

Figure 52: Conducted Measurements Setup

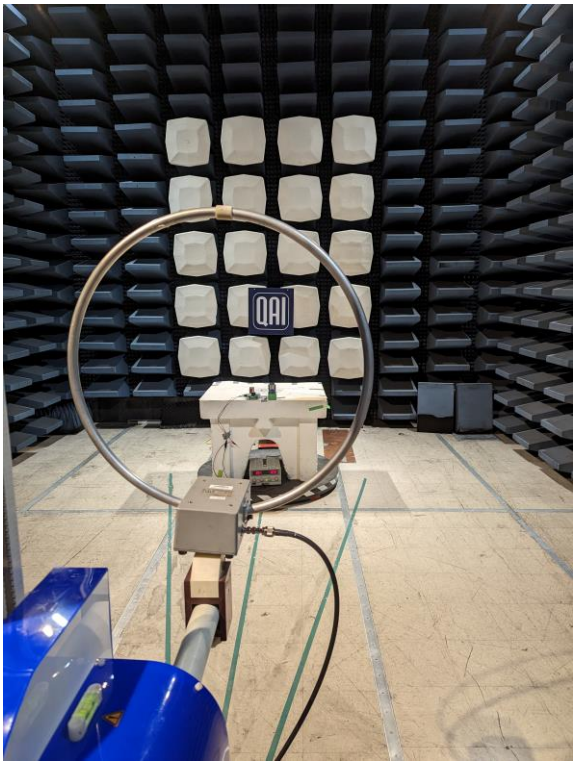

Figure 53: Radiated Emissions Setup: 0.15 MHz - 30 MHz

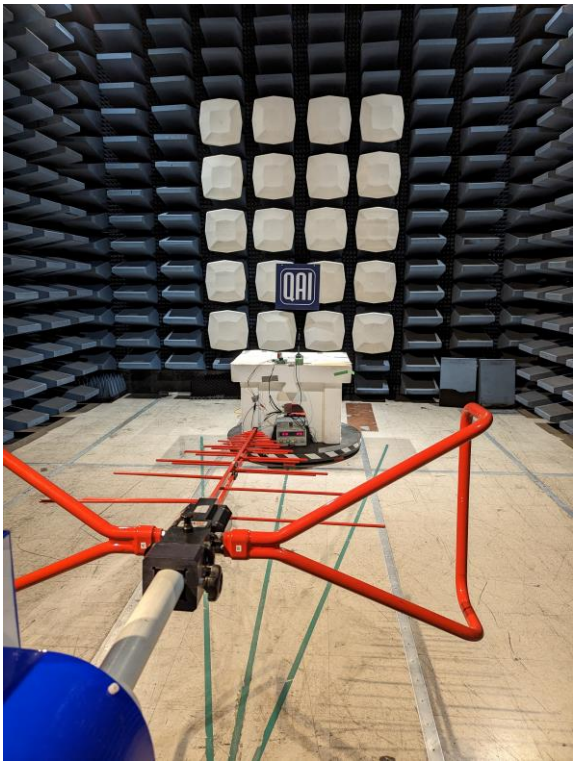

Figure 54: Radiated Emissions Setup: 30 MHz - 1000 MHz

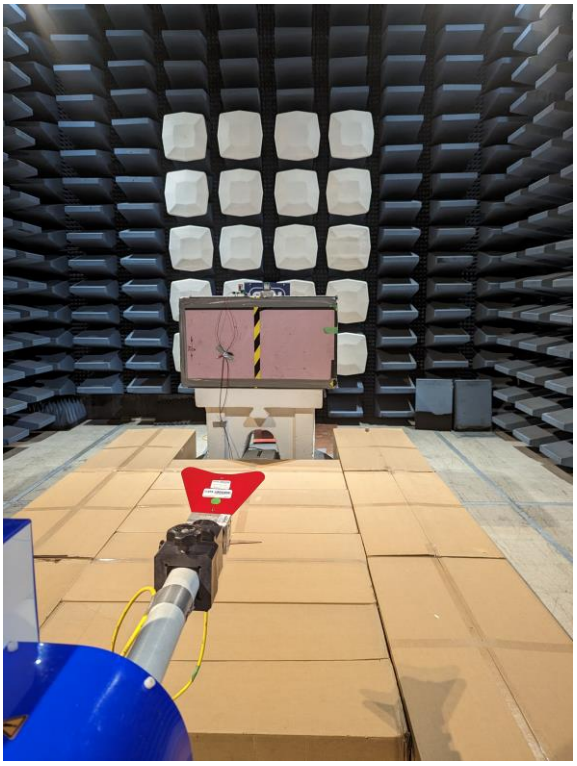

Figure 55: Radiated Emissions Setup: 1 GHz - 18 GHz

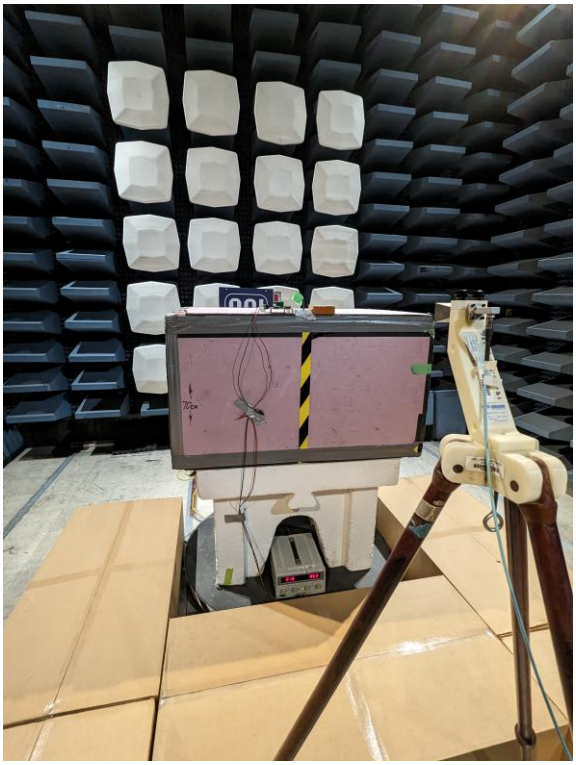

Figure 56: Radiated Emissions Setup: 18 GHz - 26 GHz

Appendix B: Abbreviations

Abbreviation	Definition
AC	Alternating Current
AM	Amplitude Modulation
CE	European Conformity
CISPR	Comité International Spécial des Perturbations Radioélectriques (International Special Committee on Radio Interference)
DC	Direct Current
EFT	Electrical Fast Transient
EMC	Electro Magnetic Compatibility
EMI	Electro Magnetic Interference
ESD	Electrostatic Discharge
EUT	Equipment Under Test
FCC	Federal Communications Commission
FVIN	Firmware Version Identification Number FVIN
IC	Industry Canada
ICES	Interference Causing Equipment Standard
IEC	International Electrotechnical Commission
LISN	Line Impedance Stabilizing Network
OATS	Open Area Test Site
RF	Radio Frequency
RMS	Root-Mean-Square
SAC	Semi-Anechoic Chamber

END OF REPORT