

INGERSOLL RAND, INDUSTRIAL U.S., INC. **TEST REPORT**

SCOPE OF WORK

RADIO TESTING – 802.15.4 RADIO MODULE (TA-ICX-499-154RAD)

REPORT NUMBER

106326393ATL-001

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Non-Specific Radio Report Shell Rev. January 2025

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RADIO TEST REPORT**Report Number:** 106326393ATL-001**Project Number:** G106326393**Report Issue Date:** 03 October 2025**Revision Date:** 21 October 2025**Model/HVIN:** TA-ICX-499-154RAD**FCC ID:** 2ATB3-ICXSTM32WB**IC:** 25117-ICXSTM32WB

Standards: 47 CFR Part 15 Subpart C, 15.247
RSS-247, Issue 4
ANSI C63.10-2020+Cor.1-2023
RSS-GEN, Issue 5

Test Location

Intertek
1950 Evergreen Blvd., Suite 100
Duluth, GA 30096 USA
FCC Designation: US1046
CAB Designator: US0128

Client

Ingersoll-Rand Industrial U.S.Inc.
53 Frontage Rd Ste 250
Hampton, NJ 08827-4032 USA

Report prepared by:

Jeremy Pickens / Senior Staff Engineer

Report reviewed by:

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1 Introduction and Conclusion

The tests indicated in Section 2 were performed on the product constructed as described in Section 4. The remaining test sections are the verbatim text from the actual data sheets used during the investigation. These test sections include the test name, the specified test Method, a list of the actual Test Equipment Used, documentation Photos, Results and raw Data. No additions, deviations, or exclusions have been made from the standard(s) unless specifically noted.

Based on the results of our investigation, we have concluded the product tested **complies** with the requirements of the standard(s) indicated. The results obtained in this test report pertain only to the item(s) tested. Intertek does not make any claims of compliance for samples or variants which were not tested.

2 Test Summary

Section	Test Description	Test Specification		Result
		FCC	ISED	
5	Occupied and DTS Bandwidth	15.247(a)(2)	RSS-247 S5.2(a) RSS-GEN S6.7	Compliant
6	Peak Output Power	15.247(b)(3)	RSS-247 S5.4(d)	Compliant
7	Power Spectral Density	15.247(e)	RSS-247 S5.2(b)	Compliant
8	Conducted Spurious Emissions / Band Edge	15.247(d)	RSS-247 S5.5	Compliant
9	Emissions in Restricted Frequency Bands	15.247(d) 15.205(a), 15.209(a)	RSS-GEN S8.9-8.10	Compliant
10	AC Mains Conducted Emissions	15.207	RSS-GEN S8.8	Compliant
NA	Antenna Requirement	15.203	RSS-GEN S6.8	Compliant ¹

- 1) The Raspberry Pi antenna is a reverse polarity SMA, and the PIFA antennas connect directly to the u.fl port on the module.

3 Client Information

This evaluation was performed at the request of:

Client: Ingersoll-Rand Industrial U.S.Inc.
53 Frontage Rd Ste 250
Hampton, NJ 08827-4032 USA

Contact: Andres Cruz

Email: andres.cruz@irco.com

4 Description of Equipment Under Test and Variant Models

Manufacturer: Ingersoll-Rand Industrial U.S.Inc.
53 Frontage Rd Ste 250
Hampton, NJ 08827-4032 USA

Equipment Under Test			
Description	Manufacturer	Model Number	Serial Number
802.15.4 Radio Module	Ingersoll-Rand	TA-ICX-499-154RAD	QC1 ¹
802.15.4 Radio Module	Ingersoll-Rand	TA-ICX-499-154RAD	QC3 ²
802.15.4 Radio Module	Ingersoll-Rand	TA-ICX-499-154RAD	QC4 ³

- 1) Antenna port conducted tests
- 2) Radiated spurious emissions tests – Raspberry Pi Antenna
- 3) Radiated spurious emissions tests – PIFA Antenna

Receive Date:	05 September 2025
Received Condition:	Good
Type:	Production

Description of Equipment Under Test (provided by client)

The DUT was an 802.15.4 radio module utilizing channels 11 through 25.

Radio/Receiver Characteristics	
Frequency Range / Number of Channels	2405-2475MHz / 15 Channels
Data Rate / Modulation Type(s)	QPSK
Channel Separation:	5MHz
Maximum Conducted Output Power:	6.6dBm (4.57mW)
Equipment Type	Portable – 20cm Separation Distance
Antenna Type and Gain	PIFA: +2.0 dBi (Ezurio, P/N: EFG2401A3S-10MHF1) PIFA: +2.0 dBi (Ezurio, P/N: 001-0014) Dipole: +2.0dBi (Raspberry Pi, P/N: SC0480) (Intertek takes no responsibility for the accuracy of this information.)

Software

No.	Description of EUT Software
1	Visual Studio Code, V1.103.2

4.1 Justification

All testing performed in this report was for the radio only.

For antenna conducted port measurements, the 802.15.4 radio was directly connected to the test system via a u.fl adapter cable. Prior to testing, the u.fl cable with additional SMA cable was swept with the analog signal generator and receiver. These losses were accounted for in the measurement data.

For radiated spurious emission measurements the DUT was placed on a non-conductive platform 0.8m or 1.5m off the ground plane depending on the frequency range. The EUT was tested at low, mid, and high channels while in a constant modulated transmit mode. Two antennas were investigated: a Raspberry Pi dipole antenna and the worst-case Ezurio PIFA antenna (EZ-ANT-DS-iFlexPIFA-Mini). The DUT was evaluated in three orientations with the worst-case being the Y-Axis (module vertically oriented with the u.fl connector at the top). These results are reported.

A GUI built on Python scripts was provided for controlling the radio channel, power, and TX/RX modes.

Software setting for testing: 4

4.2 Modifications Required for Compliance

No modifications were made during compliance testing in order to bring the product into compliance.

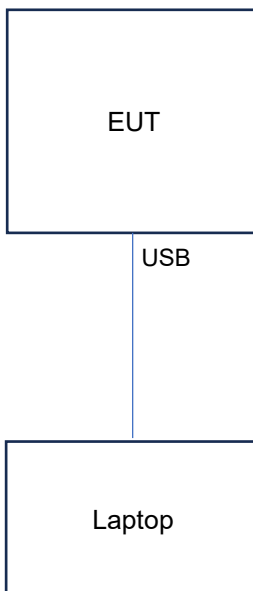
4.3 Additions, Deviations and Exclusions from Standards

No additions, deviations or exclusion have been made from standard.

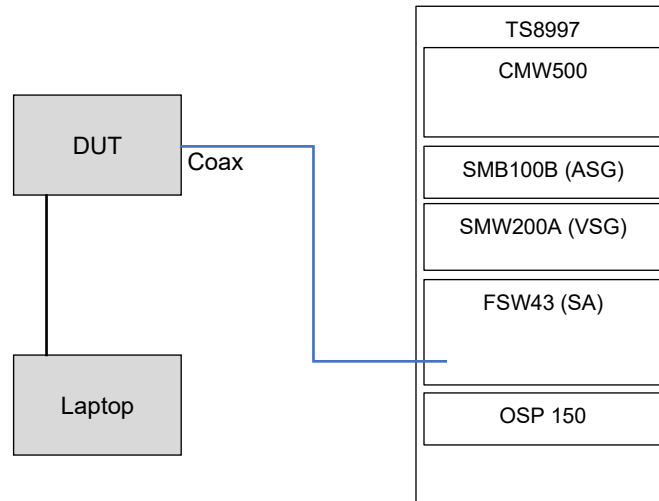
4.4 Method

Configuration as required by ANSI C63.10.

4.5 EUT Block Diagram – Radiated Measurements



4.6 EUT Block Diagram – Conducted Measurements



5 Bandwidth

5.1 Method

The procedures from ANSI C63.10 clause 11.8 and 558074 D01 DTS Meas Guidance v05r2 were used to determine the 6 dB bandwidth.

The procedures from ANSI C63.10 clause 6.9.3 were used to measure the 99% Occupied Bandwidth.

TEST SITE: RF Bench

The RF bench consists of a Rohde & Schwarz TS8997 automated test system coupled with a temperature/humidity environmental chamber. Measurements are automated using the Rohde & Schwarz EMC32 test software. The TS8997 system houses a switch matrix (OSP), along with a spectrum analyzer, vector network analyzer, and analog signal generator.

5.2 Test Equipment

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
212164	Temperature/Pressure/Humidity Sensor	Extech	SD700	109402	07/08/2025	07/08/2026
213500	Analog Signal Generator (8kHz-40GHz)	Rohde & Schwarz	SMB100B	106096	05/08/2025	05/08/2027
213502	Spectrum Analyzer (2Hz-43.5GHz)	Rohde & Schwarz	FSW43	102972	08/01/2024	08/01/2026

Software Utilized

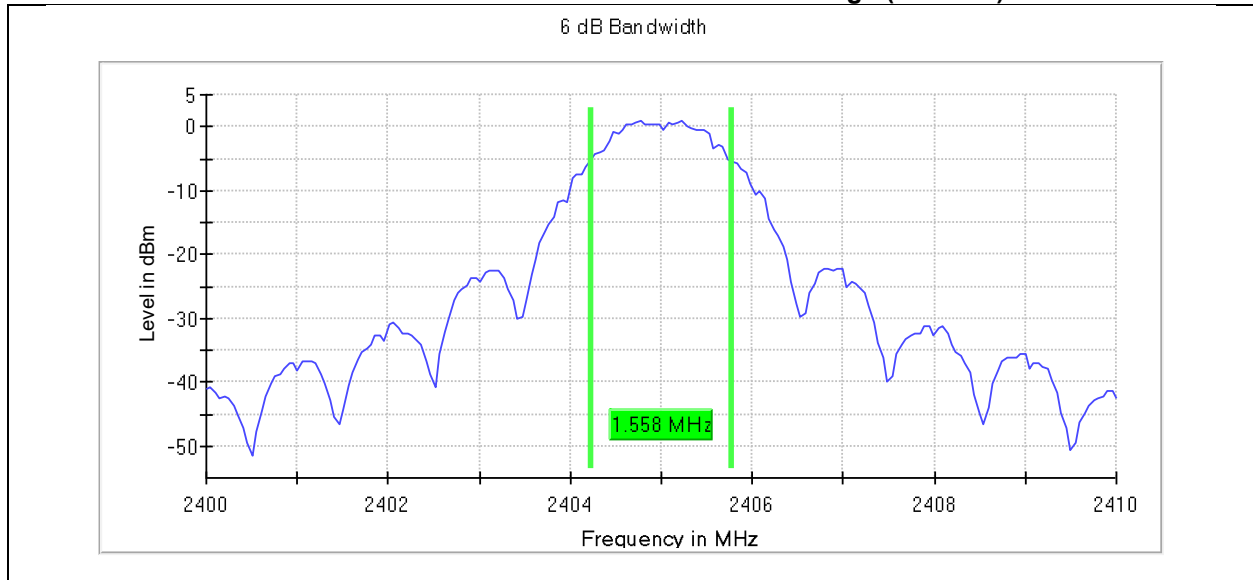
Name	Manufacturer	Version
EMC32	Rohde & Schwarz	11.70.00

5.3 Test Data

Frequency (MHz)	6dB Bandwidth (kHz)	Limit (kHz)	Result
2405.0	1558	>500	Compliant
2440.0	1658	>500	Compliant
2475.0	1658	>500	Compliant

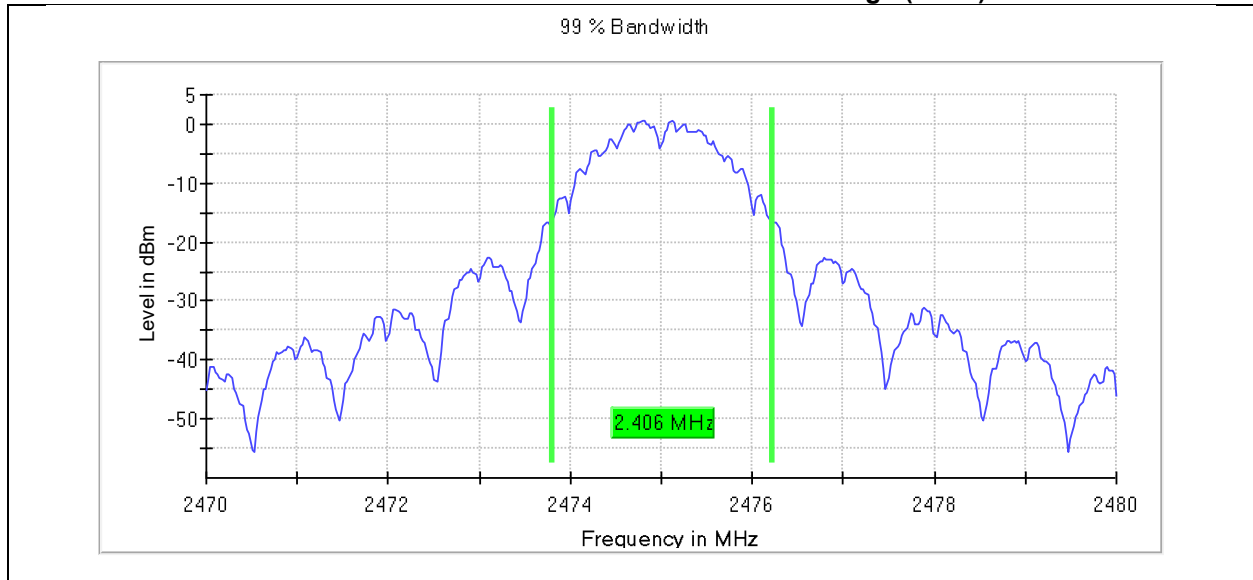
Frequency (MHz)	99% OBW (kHz)	Limit (kHz)	Result
2405.0	2406	NA	Reported
2440.0	2406	NA	Reported
2475.0	2406	NA	Reported

Worst-Case Results Plot and Instrument Settings (6dB BW)



Setting	Instrument Value	Target Value
Start Frequency	2.40000 GHz	2.40000 GHz
Stop Frequency	2.41000 GHz	2.41000 GHz
Span	10.000 MHz	10.000 MHz
RBW	100.000 kHz	~ 100.000 kHz
VBW	300.000 kHz	~ 300.000 kHz
SweepPoints	200	~ 200
Sweeptime	41.830 μ s	AUTO
Reference Level	0.000 dBm	0.000 dBm
Attenuation	10.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	FFT	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	11 / max. 150	max. 150
Stable	5 / 5	5
Max Stable Difference	0.08 dB	0.50 dB

Worst-Case Results Plot and Instrument Settings (OBW)



Setting	Instrument Value	Target Value
Start Frequency	2.47000 GHz	2.47000 GHz
Stop Frequency	2.48000 GHz	2.48000 GHz
Span	10.000 MHz	10.000 MHz
RBW	50.000 kHz	≥ 50.000 kHz
VBW	200.000 kHz	≥ 150.000 kHz
SweepPoints	400	~ 400
Swepttime	83.660 μ s	AUTO
Reference Level	0.000 dBm	0.000 dBm
Attenuation	10.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	FFT	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.30 dB	0.30 dB
Run	13 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.11 dB	0.30 dB

Test Personnel: Jeremy Pickens 
Supervising/Reviewing
Engineer:
(Where Applicable) _____
Product Standard: ANSI C63.10
Input Voltage: 5Vdc (USB-C)

Test Date: 23 September 2025

Ambient Temperature: 21.7°C

Relative Humidity: 46.1%

Atmospheric Pressure: 98.1kPa

6 Peak Output Power

6.1 Method

The procedures from KDB 558074 D01 DTS Meas Guidance v05r2 and ANSI C63.10 Clause 11.9.1.1 were used to measure the peak output power.

TEST SITE: RF Bench

The RF bench consists of a Rohde & Schwarz TS8997 automated test system coupled with a temperature/humidity environmental chamber. Measurements are automated using the Rohde & Schwarz EMC32 test software. The TS8997 system houses a switch matrix (OSP), along with a spectrum analyzer, vector network analyzer, and analog signal generator.

6.2 Test Equipment

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
212164	Temperature/Pressure/Humidity Sensor	Extech	SD700	109402	07/08/2025	07/08/2026
213500	Analog Signal Generator (8kHz-40GHz)	Rohde & Schwarz	SMB100B	106096	05/08/2025	05/08/2027
213502	Spectrum Analyzer (2Hz-43.5GHz)	Rohde & Schwarz	FSW43	102972	08/01/2024	08/01/2026

Software Utilized

Name	Manufacturer	Version
EMC32	Rohde & Schwarz	11.70.00

6.3 Results

The sample tested was found to Comply.

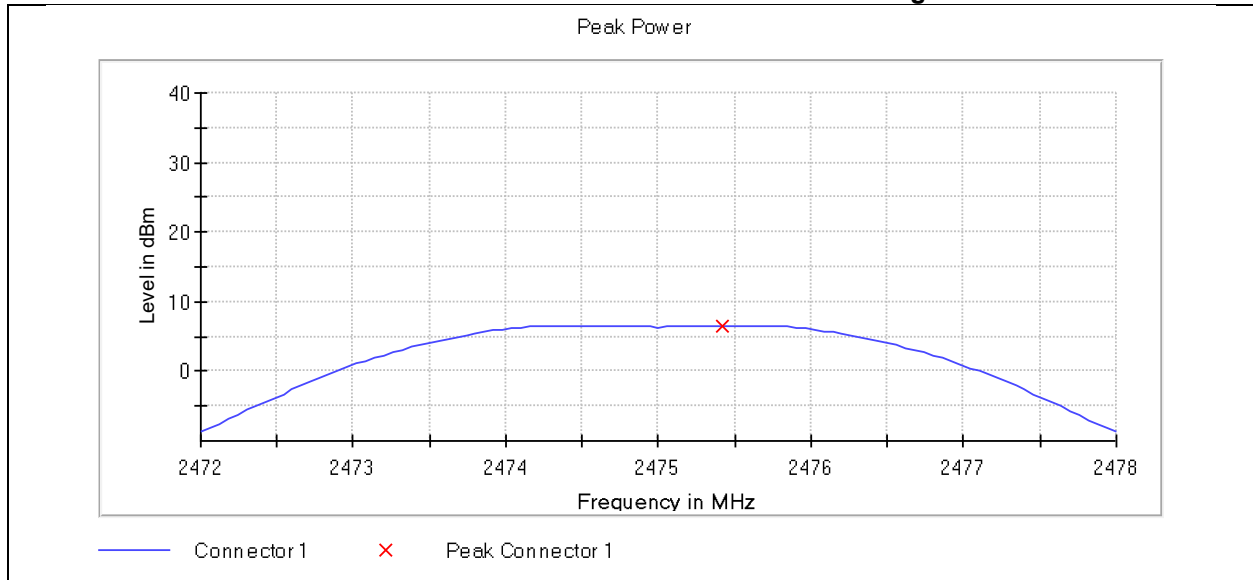
6.4 Test Data

Frequency (MHz)	Conducted Peak Power (dBm)	Conducted Limit (dBm)	Result
2405.0	4.8	30	Pass
2440.0	5.7	30	Pass
2475.0	6.6	30	Pass

Frequency (MHz)	Conducted Peak Power	Antenna Gain (dBi)	EIRP (dBm)	IC EIRP Limit (dBm)	Result
2405.0	4.8	2.0	6.8	34	Pass
2440.0	5.7	2.0	7.7	34	Pass
2475.0	6.6	2.0	8.6	34	Pass

$$\text{EIRP} = \text{Peak Power} + \text{Antenna Gain}$$

Worst-Case Results Plot and Instrument Settings



Setting	Instrument Value	Target Value
Start Frequency	2.47200 GHz	2.47200 GHz
Stop Frequency	2.47800 GHz	2.47800 GHz
Span	6.000 MHz	6.000 MHz
RBW	2.000 MHz	≥ 1.658 MHz
VBW	10.000 MHz	≥ 6.000 MHz
SweepPoints	101	~ 101
Sweeptime	1.000 ms	AUTO
Reference Level	10.000 dBm	10.000 dBm
Attenuation	20.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	Sweep	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	4 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.10 dB	0.50 dB

Test Personnel: Jeremy Pickens 
Supervising/Reviewing
Engineer:
(Where Applicable) _____
Product Standard: ANSI C63.10
Input Voltage: 5Vdc (USB-C)

Test Date: 23 September 2025

Ambient Temperature: 21.7°C

Relative Humidity: 46.1%

Atmospheric Pressure: 98.1kPa

7 Peak Power Spectral Density

7.1 Method

The procedures from KDB 558074 D01 DTS Meas Guidance v05r2 and ANSI C63.10 Clause 11.10.2 were used to measure the peak PSD.

TEST SITE: RF Bench

The RF bench consists of a Rohde & Schwarz TS8997 automated test system coupled with a temperature/humidity environmental chamber. Measurements are automated using the Rohde & Schwarz EMC32 test software. The TS8997 system houses a switch matrix (OSP), along with a spectrum analyzer, vector network analyzer, and analog signal generator.

7.2 Test Equipment

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
212164	Temperature/Pressure/Humidity Sensor	Extech	SD700	109402	07/08/2025	07/08/2026
213500	Analog Signal Generator (8kHz-40GHz)	Rohde & Schwarz	SMB100B	106096	05/08/2025	05/08/2027
213502	Spectrum Analyzer (2Hz-43.5GHz)	Rohde & Schwarz	FSW43	102972	08/01/2024	08/01/2026

Software Utilized

Name	Manufacturer	Version
EMC32	Rohde & Schwarz	11.70.00

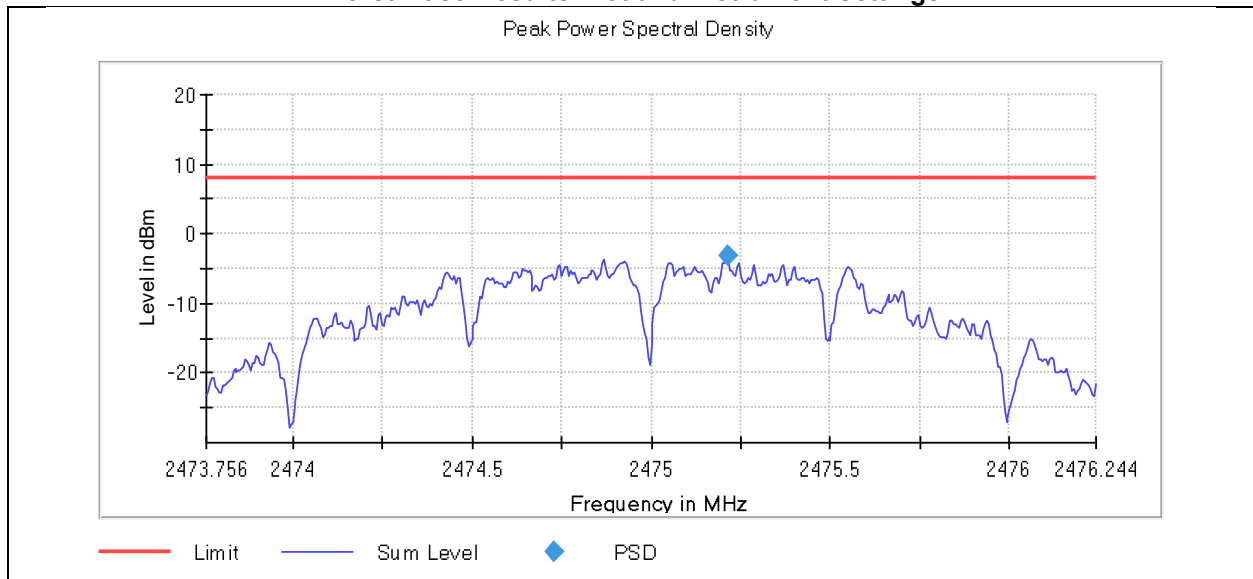
7.3 Results

The sample tested was found to Comply.

7.4 Test Data

Frequency (MHz)	Peak PSD (dBm/10kHz)	Limit (dBm/3kHz)	Result
2405.0	-5.646	8	Pass
2440.0	-4.348	8	Pass
2480.0	-3.174	8	Pass

Worst-Case Results Plot and Instrument Settings



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Setting	Instrument Value	Target Value
Start Frequency	2.47376 GHz	2.47376 GHz
Stop Frequency	2.47624 GHz	2.47624 GHz
Span	2.487 MHz	2.487 MHz
RBW	10.000 kHz	<= 10.000 kHz
VBW	30.000 kHz	>= 30.000 kHz
SweepPoints	497	~ 497
Sweeptime	2.490 ms	AUTO
Reference Level	0.000 dBm	0.000 dBm
Attenuation	10.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	Sweep	Sweep
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	21 / max. 150	max. 150
Stable	2 / 2	2
Max Stable Difference	0.49 dB	0.50 dB

Test Personnel: Jeremy Pickens
 Supervising/Reviewing
 Engineer:
 (Where Applicable) _____
 Product Standard: ANSI C63.10
 Input Voltage: 5Vdc (USB-C)

Test Date: 23 September 2025

Ambient Temperature: 21.7°C
 Relative Humidity: 46.1%
 Atmospheric Pressure: 98.1kPa

8 Conducted Spurious Emissions / Band Edge

8.1 Method

The procedures from KDB 558074 D01 DTS Meas Guidance v05r2 and ANSI C63.10 Clause 11.11 were used to measure the conducted spurious emissions and allocated band edges.

The limit is 20 dB below the measured peak power in any 100kHz band.

TEST SITE: RF Bench

The RF bench consists of a Rohde & Schwarz TS8997 automated test system coupled with a temperature/humidity environmental chamber. Measurements are automated using the Rohde & Schwarz EMC32 test software. The TS8997 system houses a switch matrix (OSP), along with a spectrum analyzer, vector network analyzer, and analog signal generator.

8.2 Test Equipment

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
212164	Temperature/Pressure/Humidity Sensor	Extech	SD700	109402	07/08/2025	07/08/2026
213500	Analog Signal Generator (8kHz-40GHz)	Rohde & Schwarz	SMB100B	106096	05/08/2025	05/08/2027
213502	Spectrum Analyzer (2Hz-43.5GHz)	Rohde & Schwarz	FSW43	102972	08/01/2024	08/01/2026

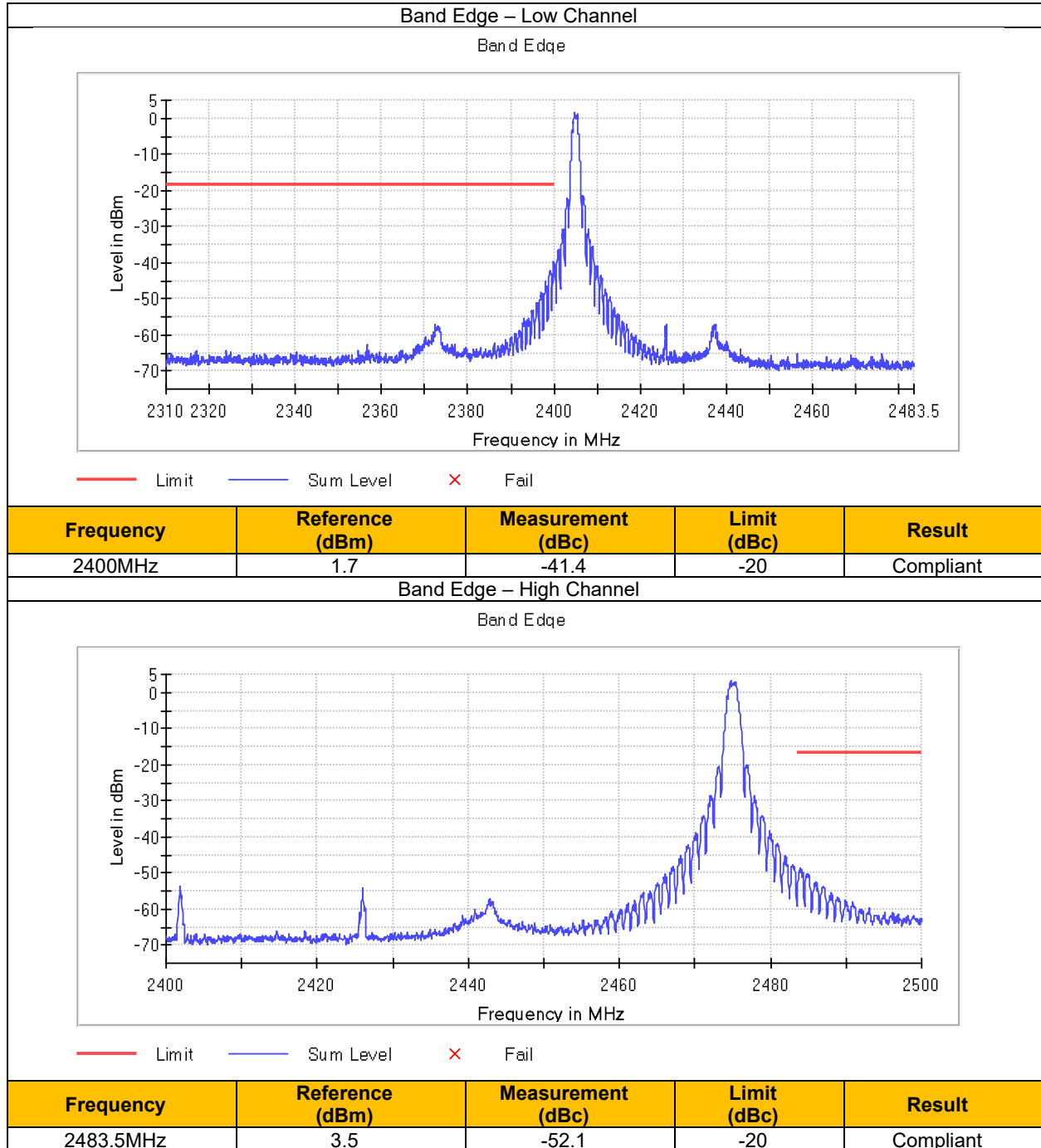
Software Utilized

Name	Manufacturer	Version
EMC32	Rohde & Schwarz	11.70.00

8.3 Results

The sample tested was found to Comply.

8.4 Plots/Data



Instrument Settings (Low Channel)

Setting	Instrument Value	Target Value
Start Frequency	2.31000 GHz	2.31000 GHz
Stop Frequency	2.40000 GHz	2.40000 GHz
Span	90.000 MHz	90.000 MHz
RBW	100.000 kHz	<= 100.000 kHz
VBW	300.000 kHz	>= 300.000 kHz

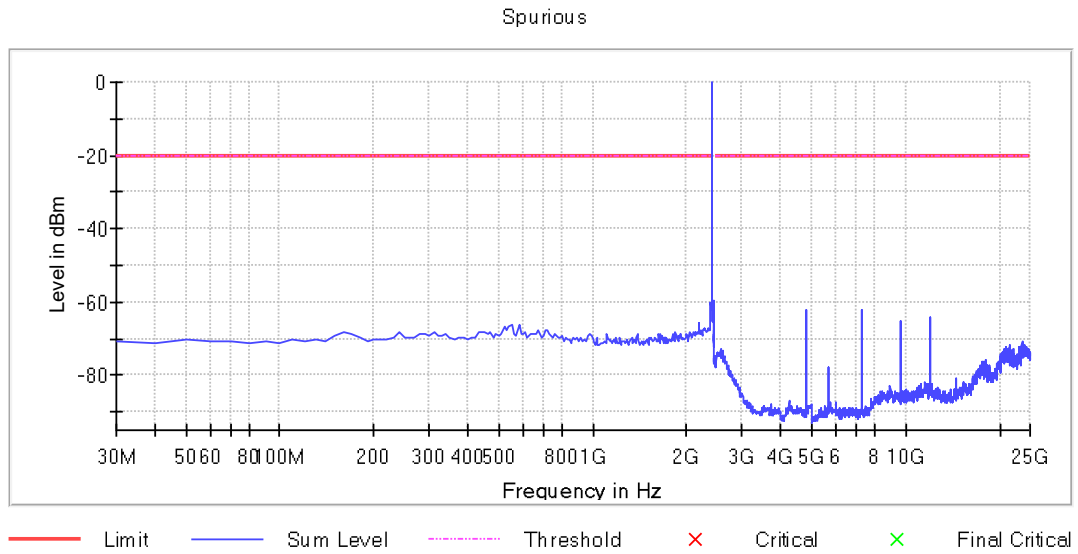
Intertek

Report Number: 106326393ATL-001

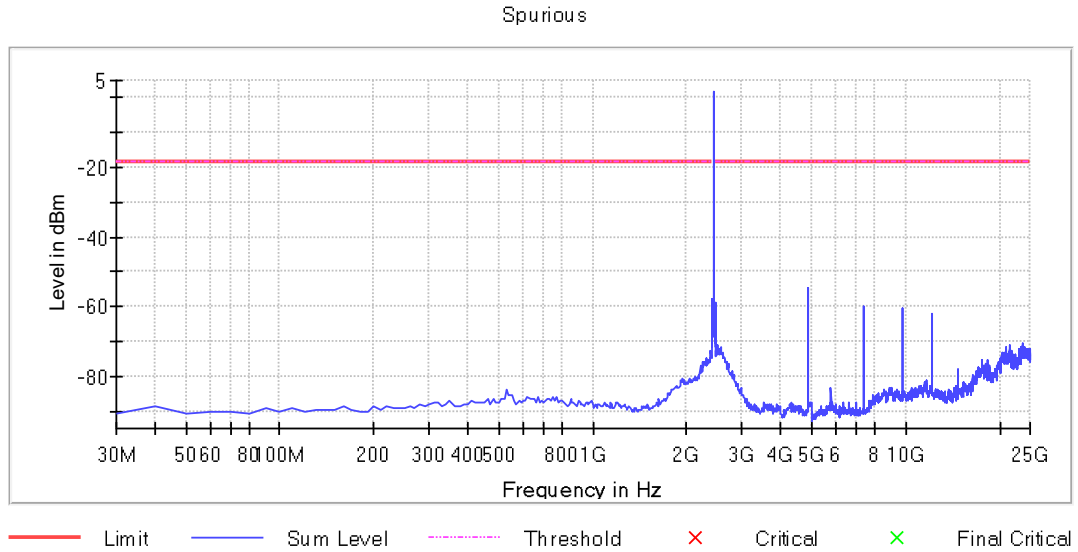
Revised: 21 October 2025

Setting	Instrument Value	Target Value
SweepPoints	1800	~ 1800
Sweeptime	1.800 ms	AUTO
Reference Level	0.000 dBm	0.000 dBm
Attenuation	10.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	Sweep	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	8 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.22 dB	0.50 dB

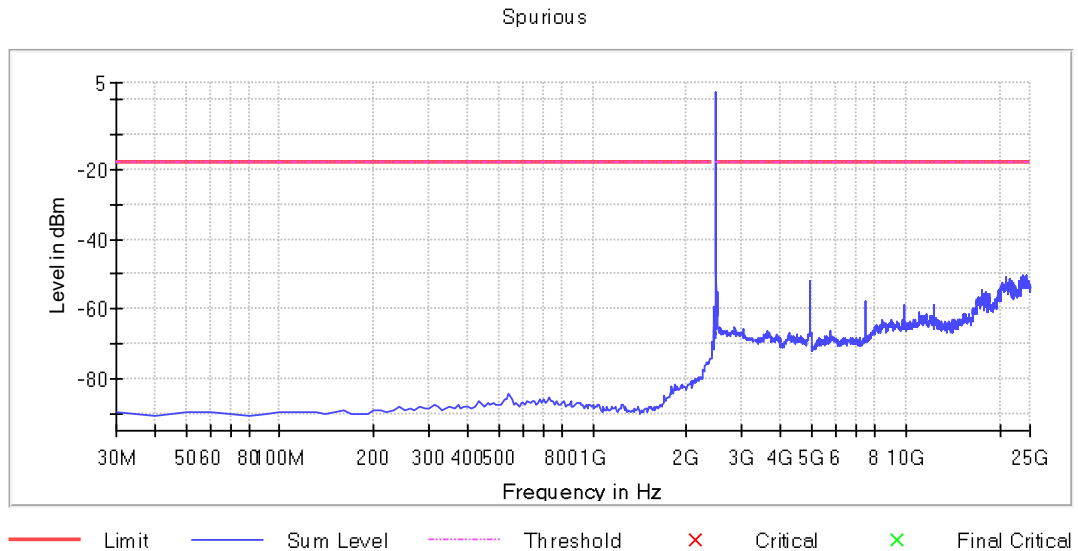
Conducted Spurious Emissions (Low Channel)



Conducted Spurious Emissions (Mid Channel)



Conducted Spurious Emissions (High Channel)



Instrument Settings (High Channel – Low Range)

Setting	Instrument Value	Target Value
RBW	100.000 kHz	<= 100.000 kHz
VBW	300.000 kHz	>= 300.000 kHz
SweepPoints	238	~ 238
Sweptime	23.700 ms	AUTO
Reference Level	-30.000 dBm	-30.000 dBm
Attenuation	0.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	3	3
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	Sweep	AUTO
Preamplifier	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	20 / max. 40	max. 40
Stable	3 / 3	3
Max Stable Difference	0.31 dB	0.50 dB

Test Personnel: Jeremy Pickens 
Supervising/Reviewing
Engineer:
(Where Applicable) _____
Product Standard: ANSI C63.10
Input Voltage: 5Vdc (USB-C)

Test Date: 23 September 2025

Ambient Temperature: 21.7°C

Relative Humidity: 46.1%

Atmospheric Pressure: 98.1kPa

9 Radiated Spurious Emissions / Restricted Frequency Bands

9.1 Method

Tests were performed in accordance with ANSI C63.10. The EUT was tested at a height of 0.8m for measurements below 1GHz and at 1.5 meters for measurements above 1GHz.

TEST SITE: 10 Meter Chamber

10 Meter Semi-Anechoic Chamber The test site for radiated emissions is located at 1950 Evergreen Blvd, Suite 100, Duluth, Georgia 30096. It is a 10-meter semi-anechoic chamber manufactured by Panashield. Embedded in the floor is a 3-meter diameter turntable.

Sample Calculation

The field strength was calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CF - AG$$

Where

- FS = Field Strength in dB μ V/m
- RA = Receiver Amplitude (including preamplifier) in dB μ V
- CF = Cable Attenuation Factor in dB
- AF = Antenna Factor in dB
- AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 dB μ V is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dB μ V/m. This value in dB μ V/m was converted to its corresponding level in μ V/m.

$$\begin{aligned} FS &= 32 \text{ dB}\mu\text{V/m} \\ RA &= 52.0 \text{ dB}\mu\text{V} \\ CF &= 1.6 \text{ dB} \\ AF &= 7.4 \text{ dB/m} \\ AG &= 29.0 \text{ dB} \end{aligned}$$

To convert from dB μ V to μ V or mV the following was used

$$\begin{aligned} UF &= 10^{(NF / 20)} \text{ where } UF = \text{Net Reading in } \mu\text{V} \\ NF &= \text{Net Reading in dB}\mu\text{V} \end{aligned}$$

Example

$$\begin{aligned} FS &= RA + AF + CF - AG = 52.0 + 7.4 + 1.6 - 29.0 = 32.0 \text{ dB}\mu\text{V/m} \\ UF &= 10^{(32 \text{ dB}\mu\text{V/m} / 20)} = 39.8 \mu\text{V/m} \end{aligned}$$

9.2 Test Equipment

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
200074	Preamplifier, 10 MHz to 2000 MHz	Mini-Circuits	ZKL-2	D011105	01/24/2025	01/24/2026
200080	Preamplifier, 18-40GHz, 29 dB Gain	Miteq	JS41800400-30-5P-S	818197	10/17/2024	10/17/2025
200162	EMI Receiver (20Hz-40GHz)	Rohde & Schwarz	ESU 40	100314	9/26/2024	09/26/2025
211262	Controller - Turntable and Mast	Sunol	SC99V	SC99V-1	VBV	VBV
211264	Mast - Antenna	Sunol	TWR95	NNN2	VBV	VBV
211386	Antenna, BiLog, 20-2000MHz	Chase	CBL6112B	2622	06/30/2025	06/30/2026
212166	Temperature/Pressure/Humidity Sensor	Extech	SD700	110392	04/02/2025	04/02/2026
213023	Antenna, Horn, 18-40 GHz	EMCO	3116	9310-2222	02/19/2025	02/19/2026
213058A	Antenna, Horn, <18 GHz	A.H. Systems	SAS-200/571	246	04/03/2025	04/03/2026
213365	PreAmplifier 100Hz-30MHz	Com-Power	PAL-010	181492	06/18/2025	06/18/2026
213451	Omni -directional Comb Generator	Com-Power	CGO-520	281266	VBV	VBV
213453	Preamplifier 500MHz-18GHz	Com-Power	PAM-118A	18040030	10/16/2024	10/16/2025
213462	Band reject Filter 2.4-2.5GHz	Micro Tronics	BRM50702	G357	05/21/2025	05/21/2026
E401	Cable E401, 40 GHz, 2.9, 9"	Megaphase	TM40 K1K1 9	E401	10/17/2024	10/17/2025
MM1	RF Coax Cable 9KHz-18GHz	Maury Microwave	UC-N-MM36	161471	10/21/2024	10/21/2025
MM5	RF Coax Cable 10KHz-18GHz	Maury Microwave	UC-N-MM-118	163203	04/01/2025	04/01/2026
MM8	RF Coax Cable 9kHz-18GHz	Fairview Microwave	UC-N-MM-267	1635289	06/18/2025	06/18/2026
MP10	RF Coax Cable 9KHz-18GHz	Fairview Microwave	FMCA1282-394	MP10	06/18/2025	06/18/2026
MP12	RF Coax Cable 9KHz-18GHz	Fairview Microwave	SCE180060505-700CM	MP12	01/23/2025	01/23/2026
NYM-EMC-36	Antenna, Loop, Passive (10 kHz - 30 MHz)	EMCO	6512	9810-1228	07/14/2025	07/14/2026

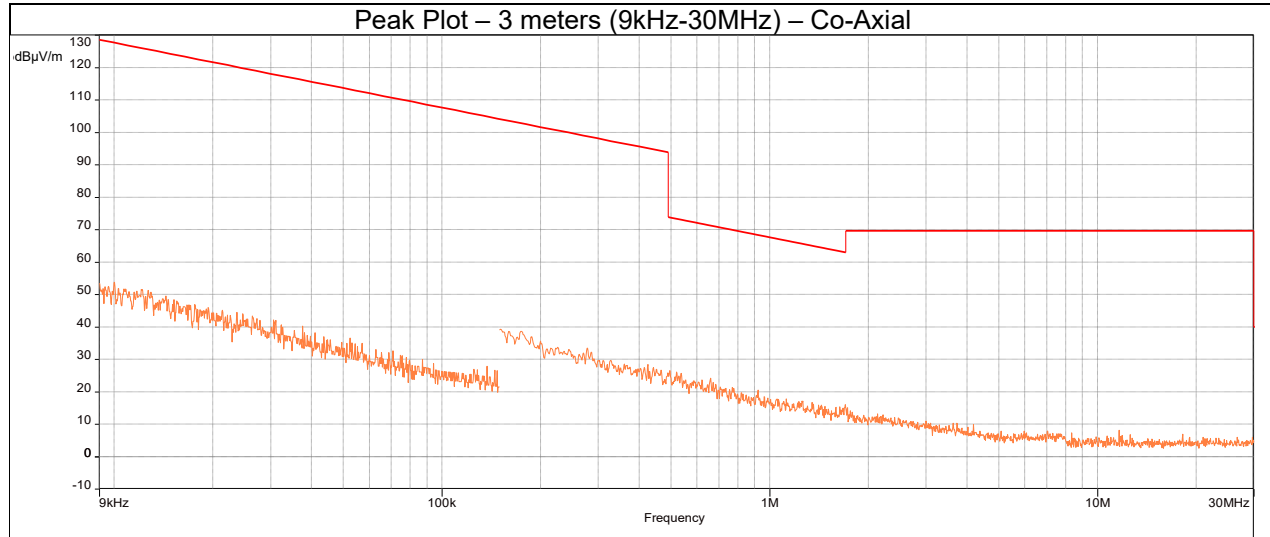
Software Utilized

Name	Manufacturer	Version
BAT EMC	NEXIO	3.19.1.18

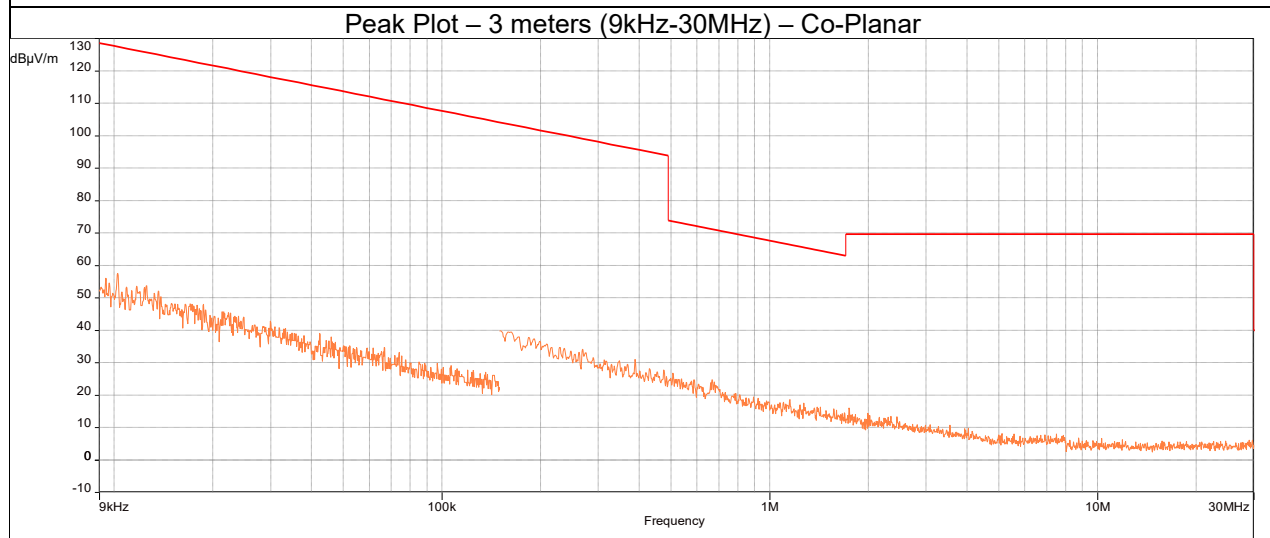
9.3 Results

The sample tested was found to Comply.

9.4 Plots/Data – Spurious Emissions (Raspberry Pi Antenna)

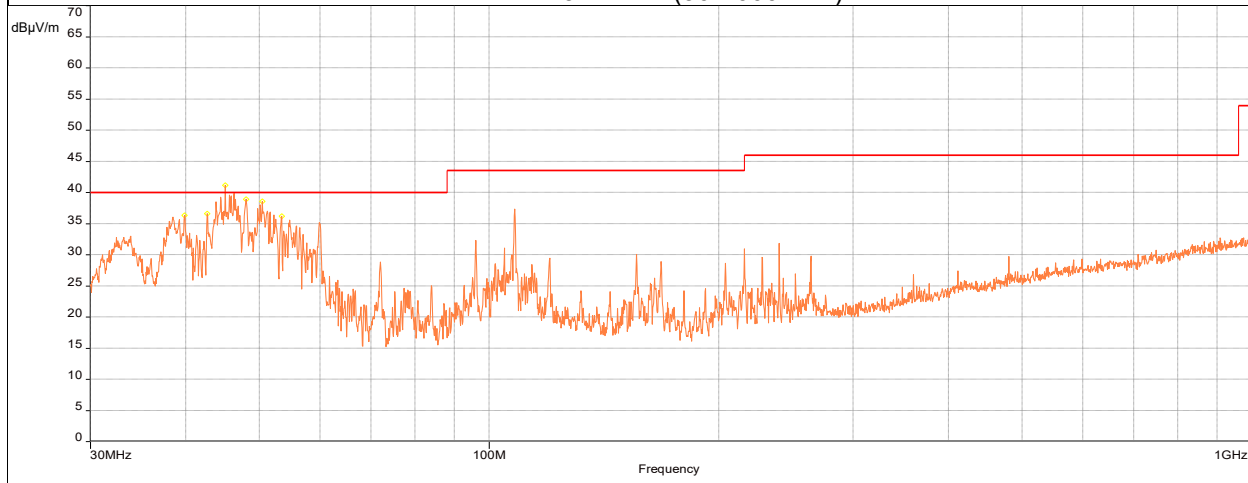


Note: There was no discernible difference among channels in this frequency range – worst-case power/PSD data presented (Channel 25)



Note: There was no discernible difference among channels in this frequency range – worst-case power/PSD data presented (Channel 25)

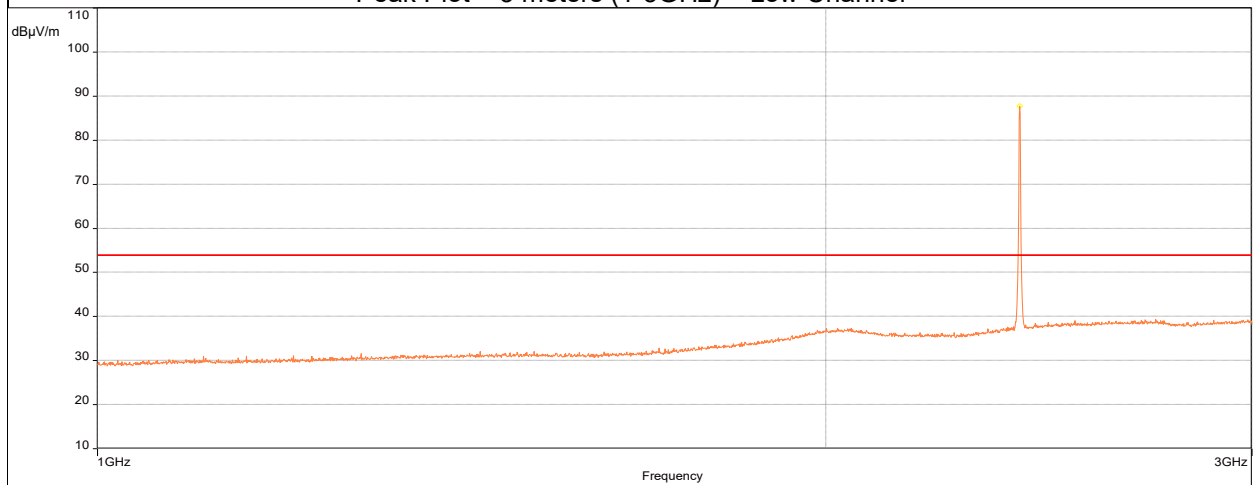
Peak Plot – 3 meters (30-1000MHz)



FCC Part 15/FCC 15.209_9kHz-40GHz

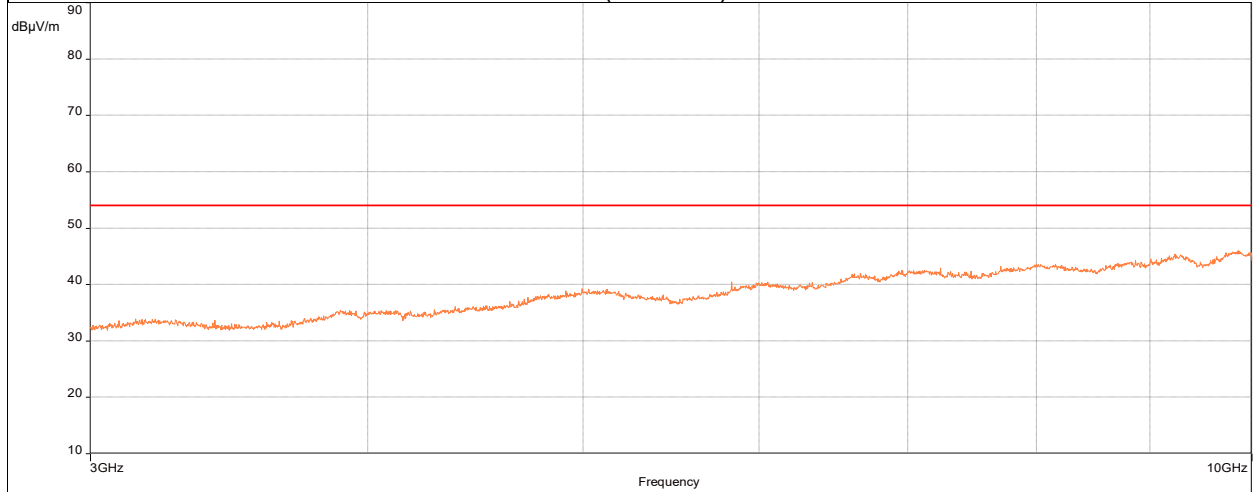
Note: There was no discernible difference among channels in this frequency range – no detected emissions were associated with the radio and, therefore, not subject to the 15.209 limits. – worst-case power/PSD data presented (Channel 25)

Peak Plot – 3 meters (1-3GHz) – Low Channel



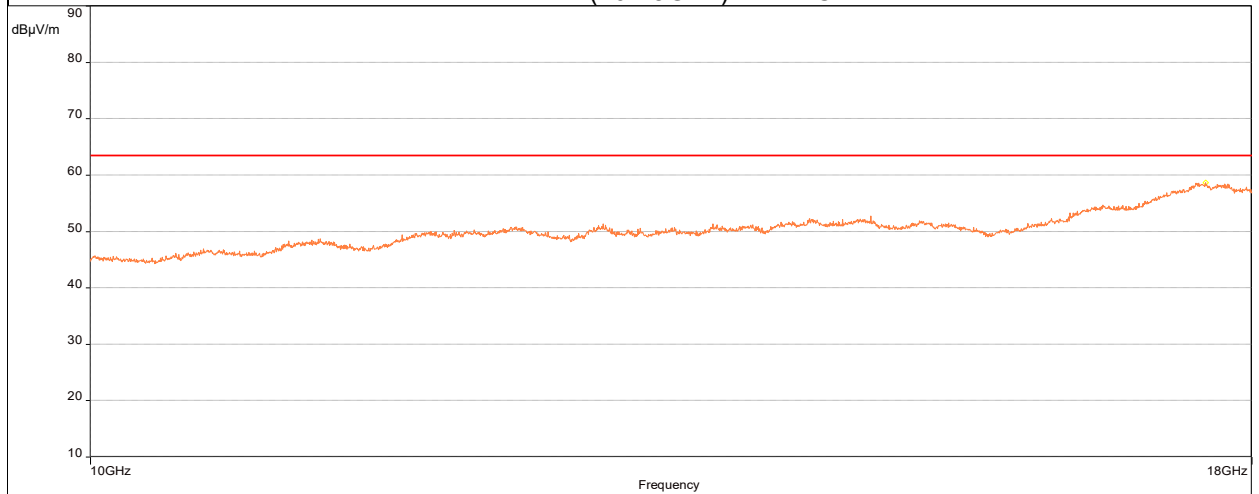
FCC Part 15/FCC 15.209_9kHz-40GHz

Peak Plot – 3 meters (3-10GHz) – Low Channel



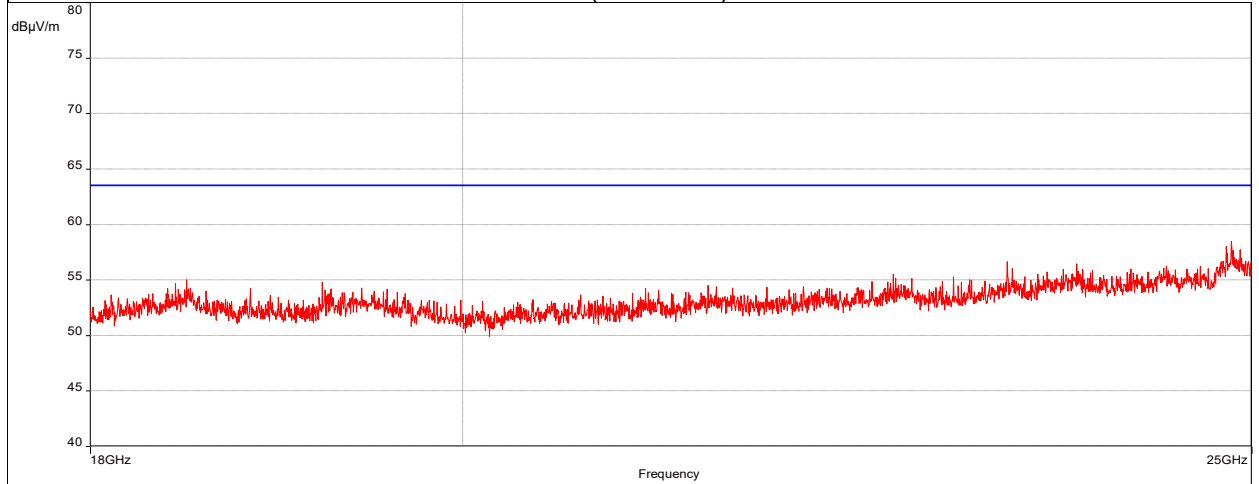
FCC Part 15/FCC 15.209_9kHz-40GHz

Peak Plot – 1 meter (10-18GHz) – Low Channel



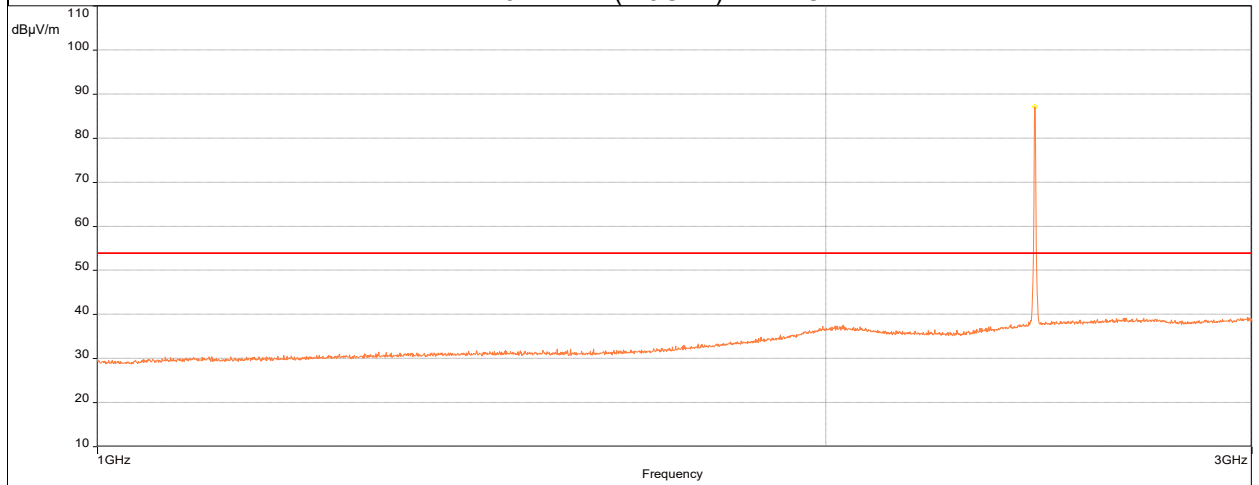
FCC Part 15 Transmitters/FCC 15.209

Peak Plot – 1 meter (18-25GHz) – Low Channel

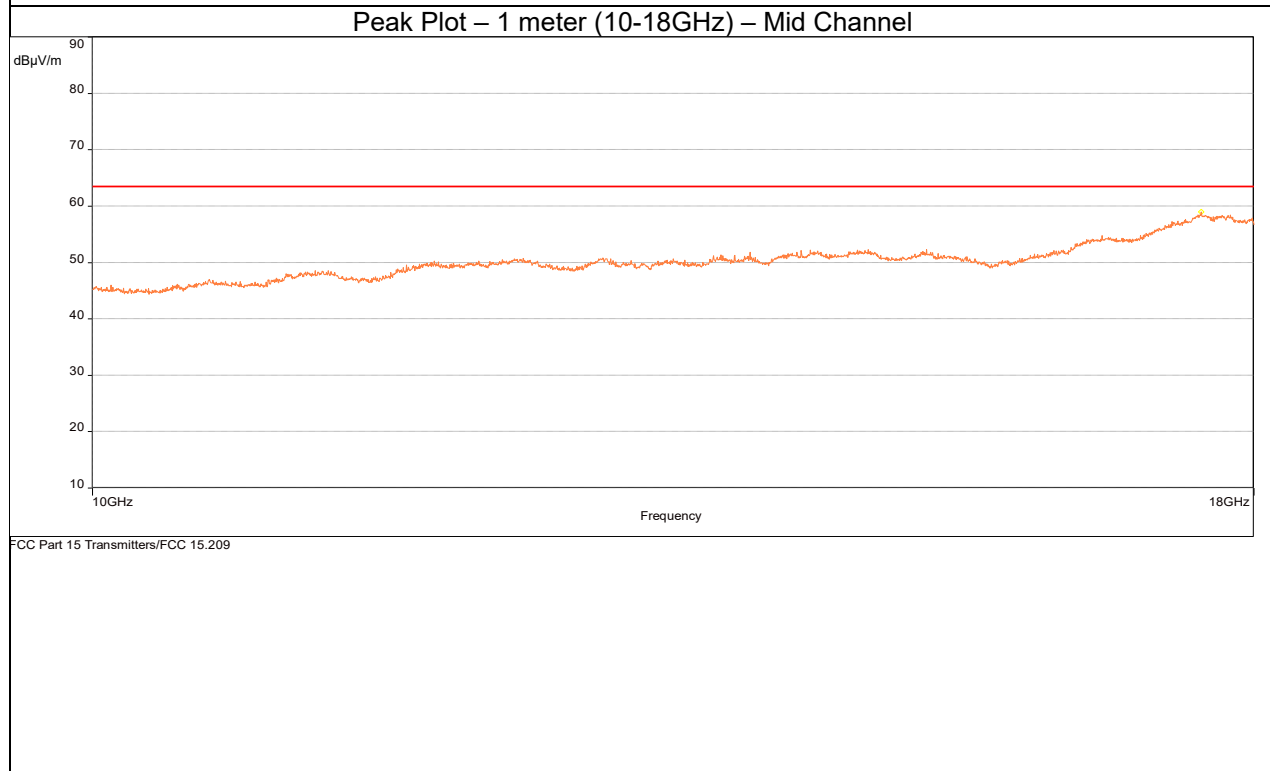
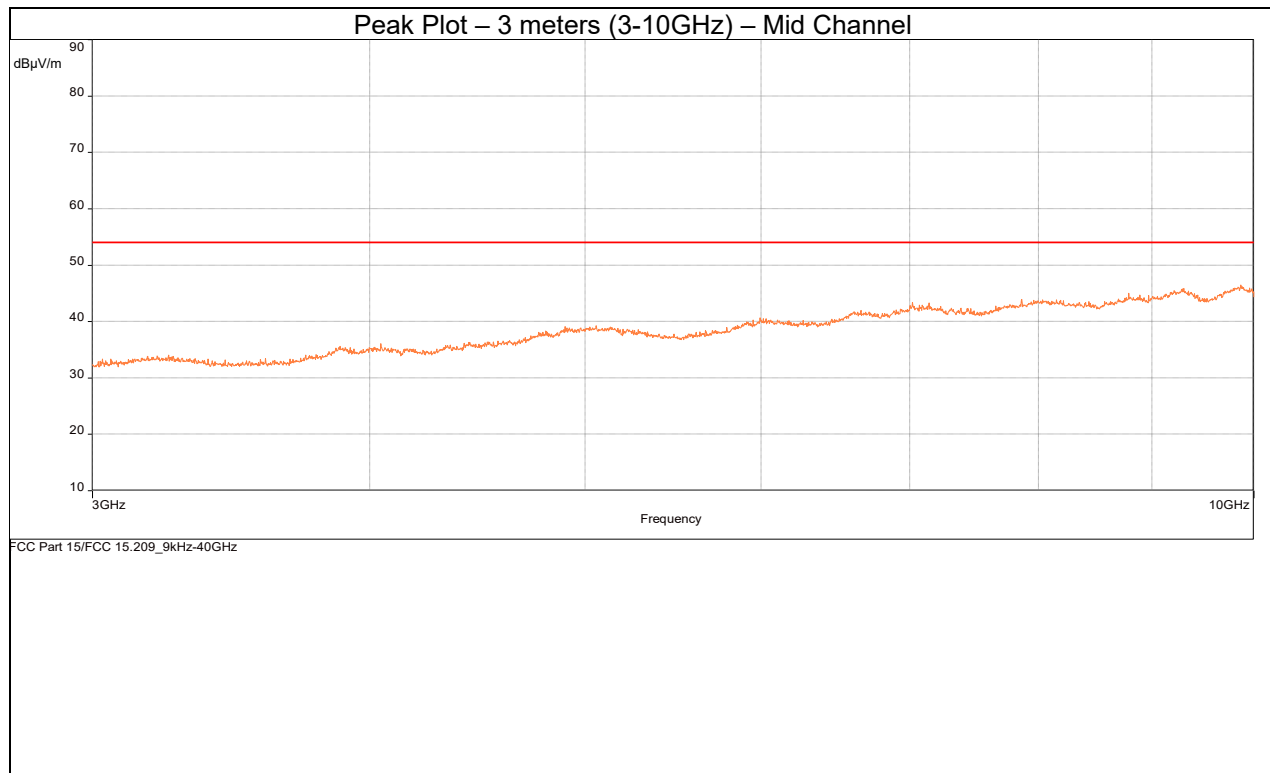


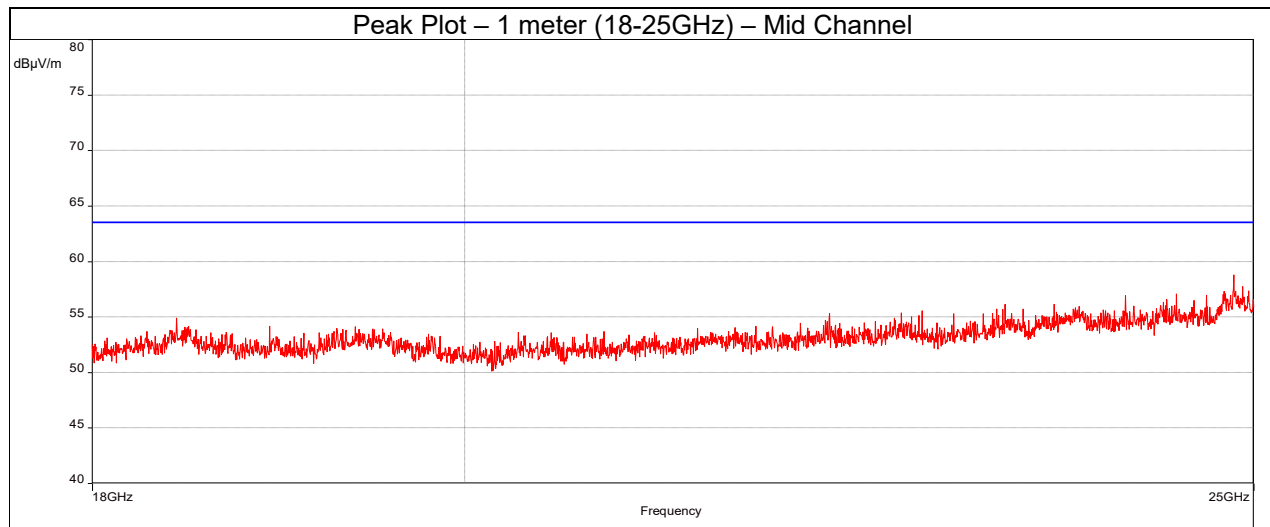
FCC Part 15 Transmitters/FCC 15.209

Peak Plot – 3 meters (1-3GHz) – Mid Channel

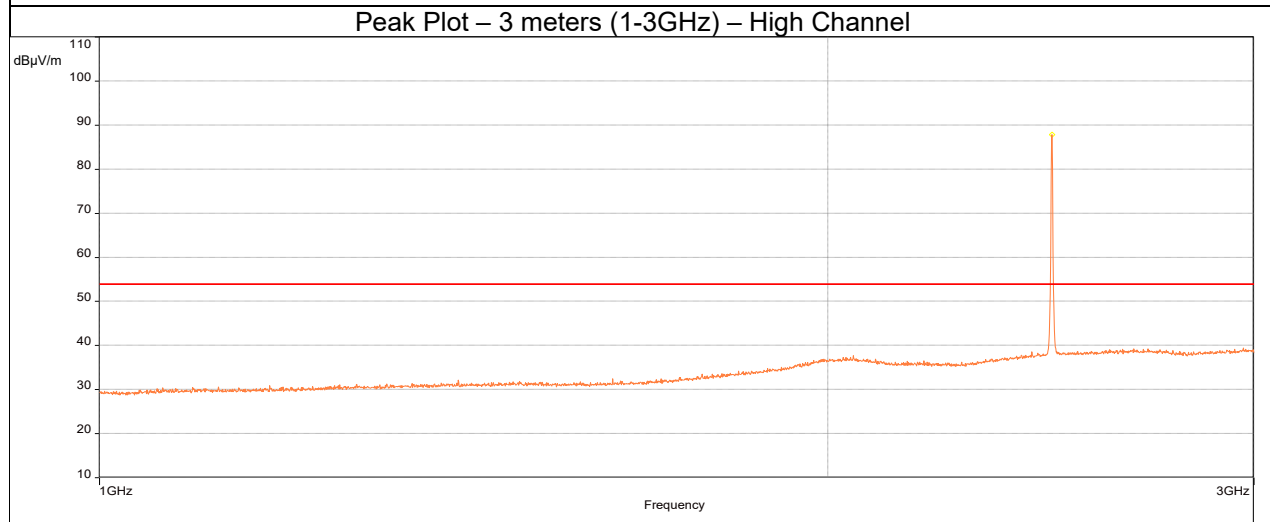


FCC Part 15/FCC 15.209_9kHz-40GHz



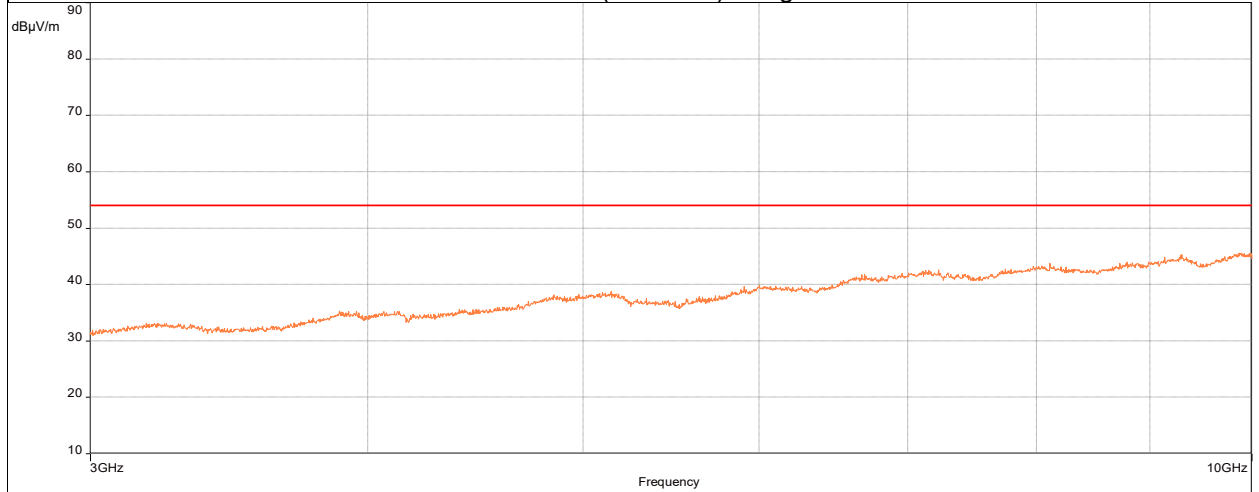


FCC Part 15 Transmitters/FCC 15.209



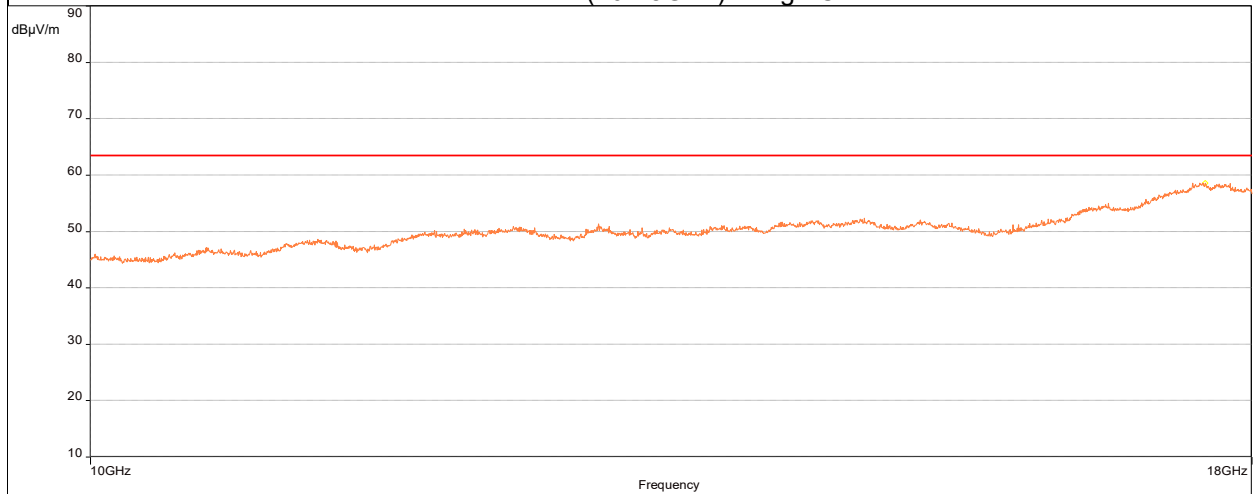
FCC Part 15/FCC 15.209_9kHz-40GHz

Peak Plot – 3 meters (3-10GHz) – High Channel

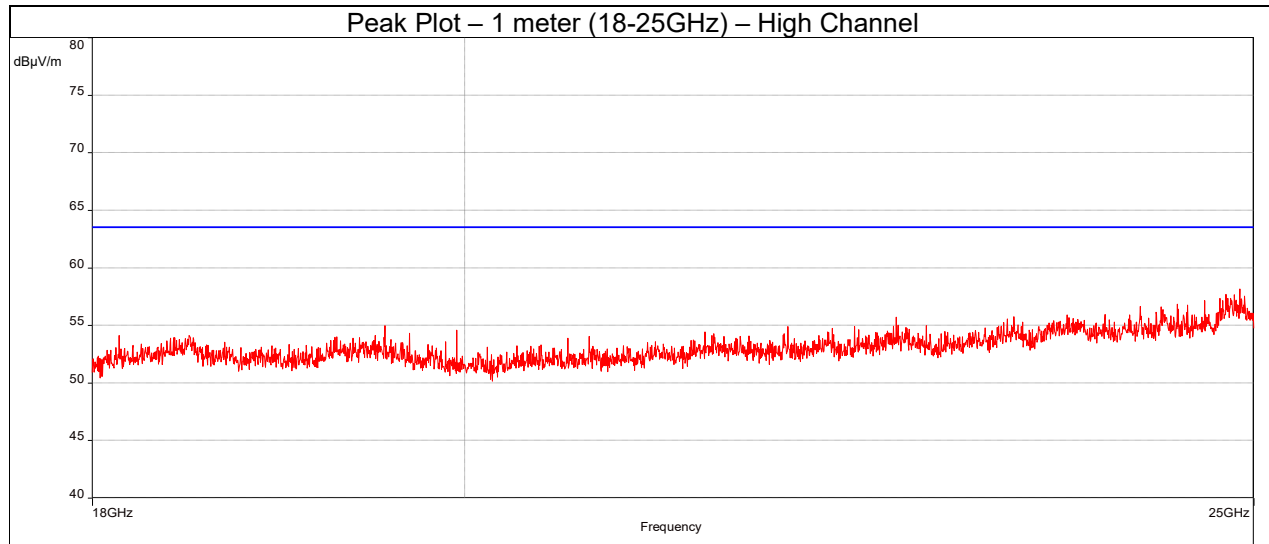


FCC Part 15/FCC 15.209_9kHz-40GHz

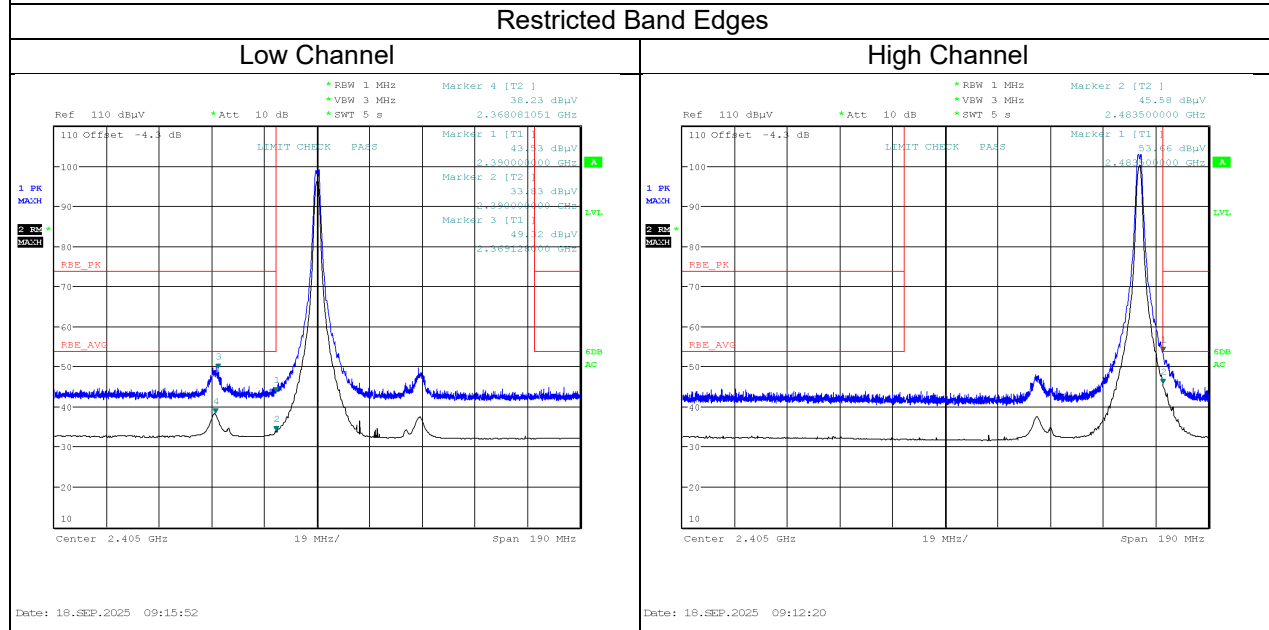
Peak Plot – 1 meter (10-18GHz) – High Channel



FCC Part 15 Transmitters/FCC 15.209



FCC Part 15 Transmitters/FCC 15.209



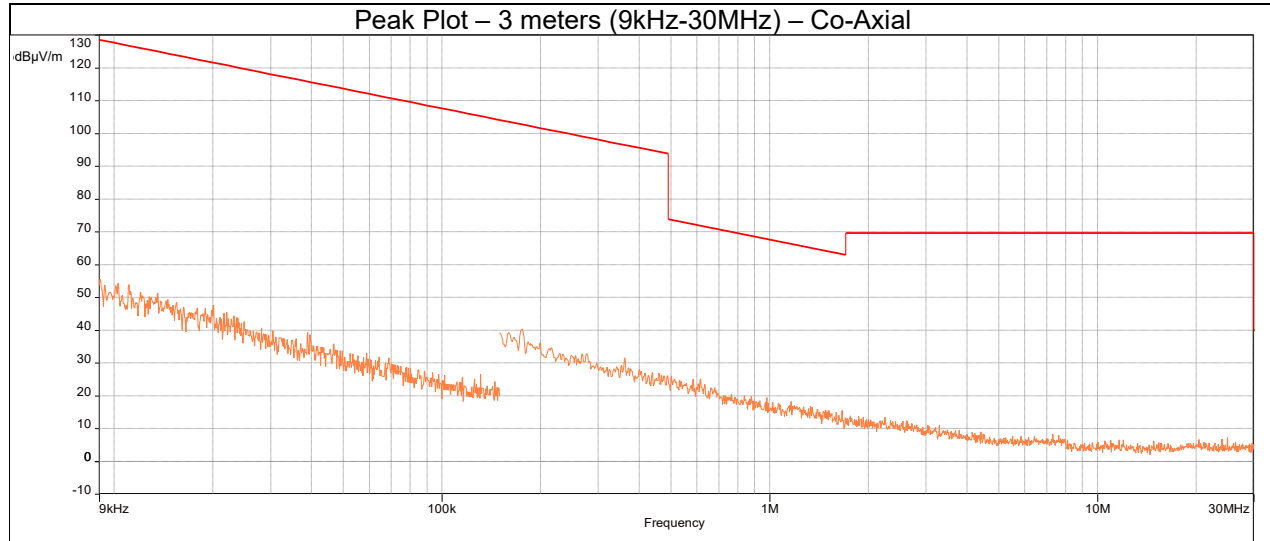
Tabular Data

Channel	Frequency (MHz)	Peak Level (dBuV/m)	Peak Limit (dBuV/m)	Peak Margin (dB)	Azimuth (°)	Height (m)	Polarity	RBW (MHz)	Correction (dB)
11	2368.081	49.32	74	-24.68	306	297	Horizontal	1	-4.3
11	2390.000	43.53	74	-30.47	306	297	Horizontal	1	-4.3
25	2483.500	53.66	74	-20.34	328	294	Vertical	1	-4.3

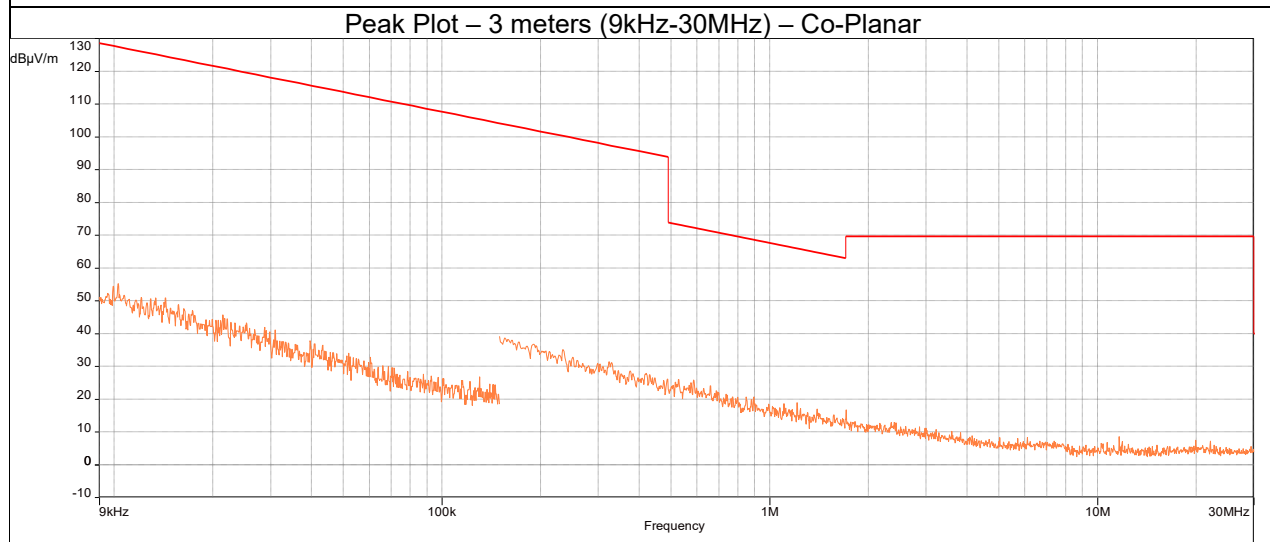
Average

Channel	Frequency (MHz)	AVG Level (dBuV/m)	AVG Limit (dBuV/m)	AVG Margin (dB)	Azimuth (°)	Height (m)	Polarity	RBW (MHz)	Correction (dB)
11	2368.081	38.23	54	-15.77	306	297	Horizontal	1	-4.3
11	2390.000	33.83	54	-20.17	306	297	Horizontal	1	-4.3
25	2483.500	45.58	54	-8.42	328	294	Vertical	1	-4.3

9.5 Plots/Data – Spurious Emissions (PIFA Antenna)

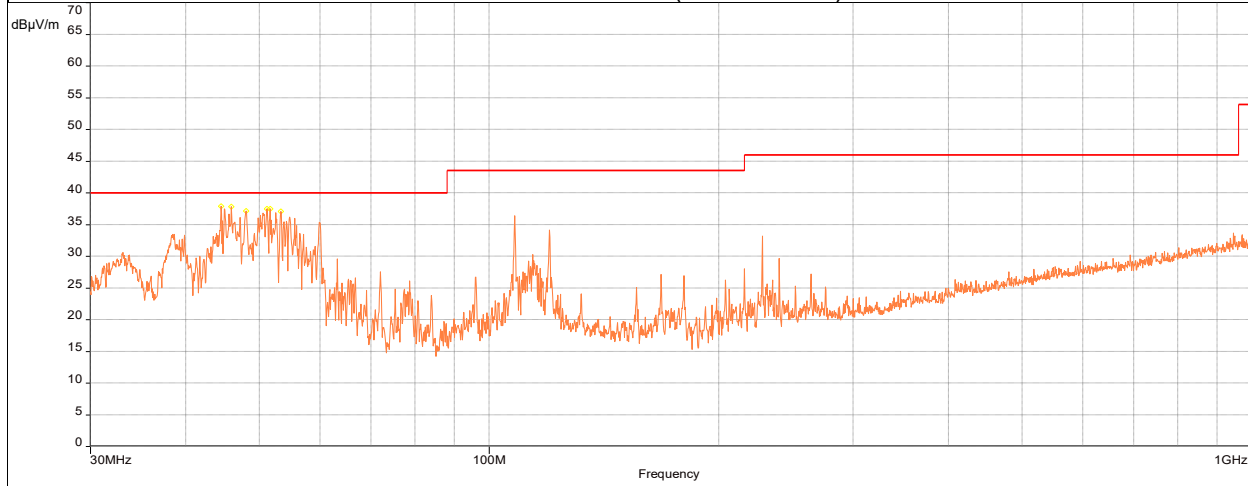


Note: There was no discernible difference among channels in this frequency range – worst-case power/PSD data presented (Channel 25)



Note: There was no discernible difference among channels in this frequency range – worst-case power/PSD data presented (Channel 25)

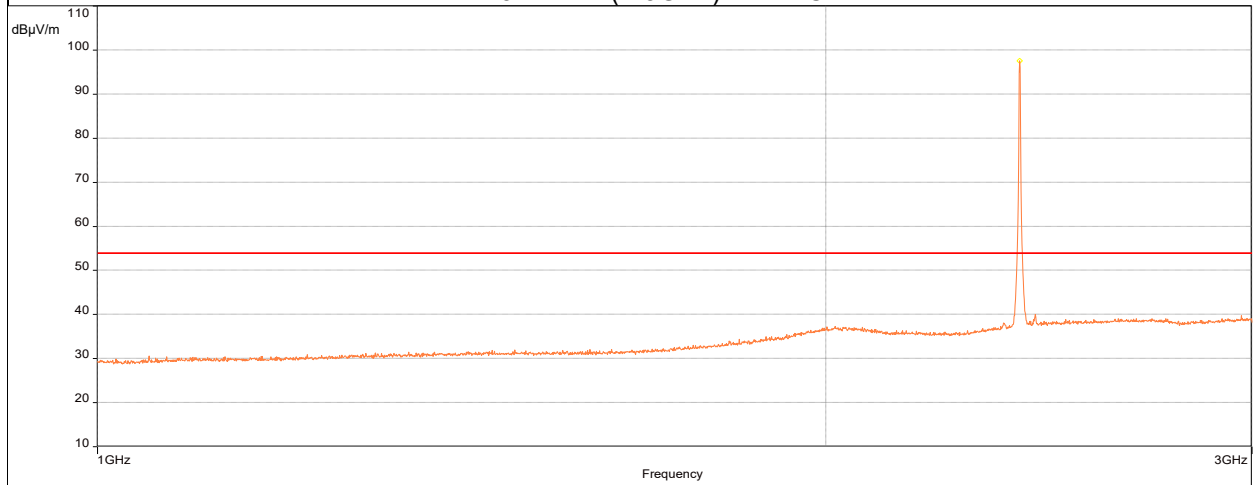
Peak Plot – 3 meters (30-1000MHz)



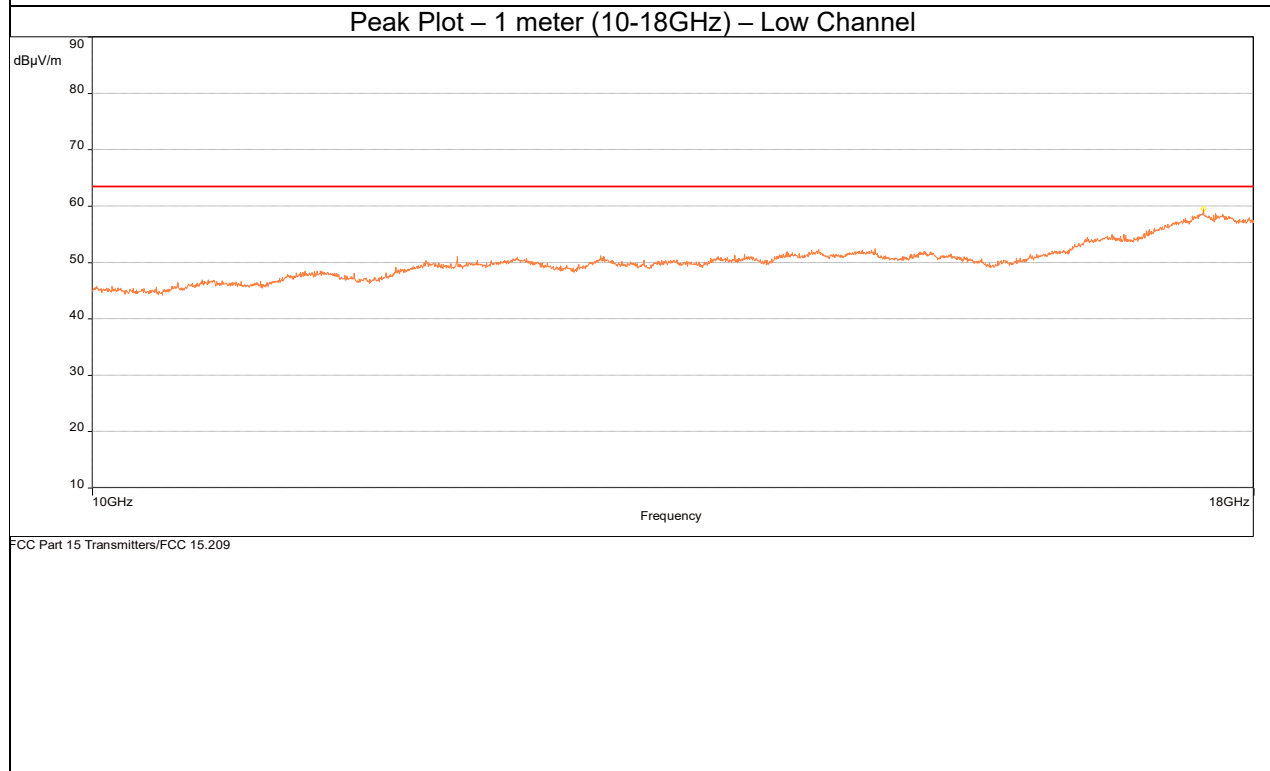
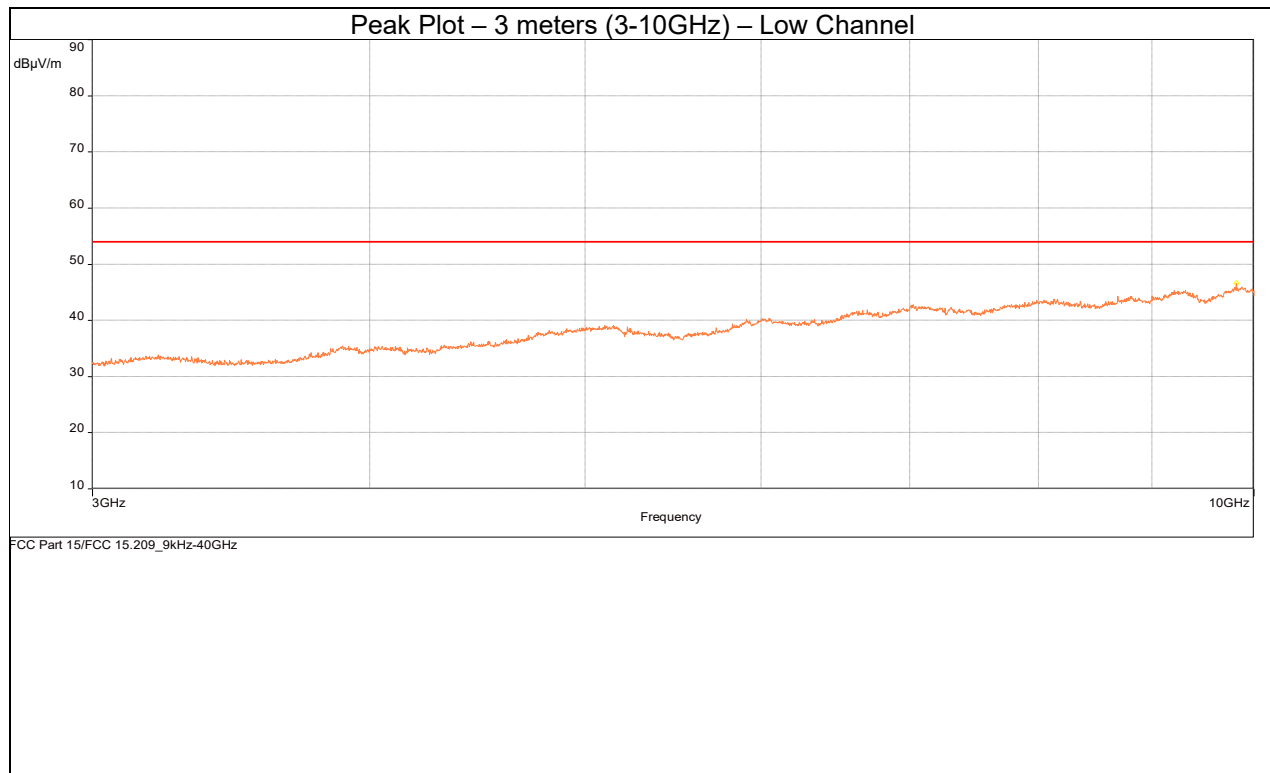
FCC Part 15/FCC 15.209_9kHz-40GHz

Note: There was no discernible difference among channels in this frequency range – no detected emissions were associated with the radio and, therefore, not subject to the 15.209 limits. – worst-case power/PSD data presented (Channel 25)

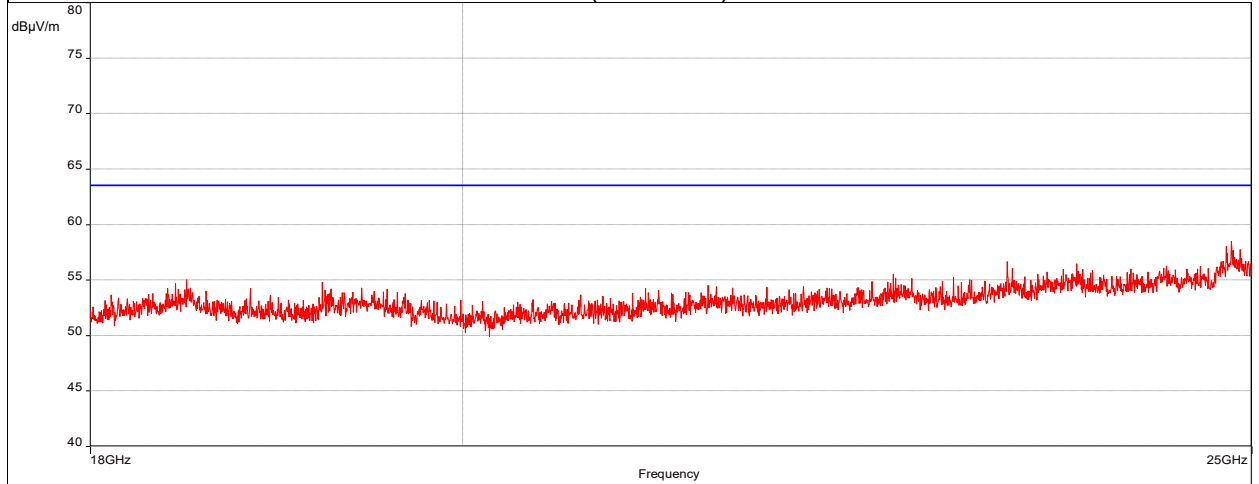
Peak Plot – 3 meters (1-3GHz) – Low Channel



FCC Part 15/FCC 15.209_9kHz-40GHz

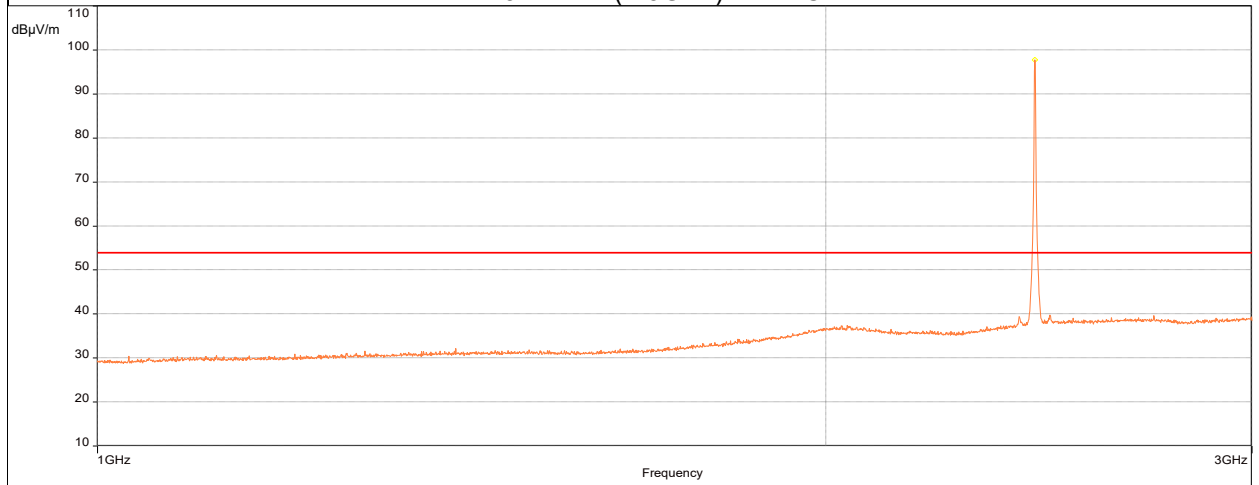


Peak Plot – 1 meter (18-25GHz) – Low Channel



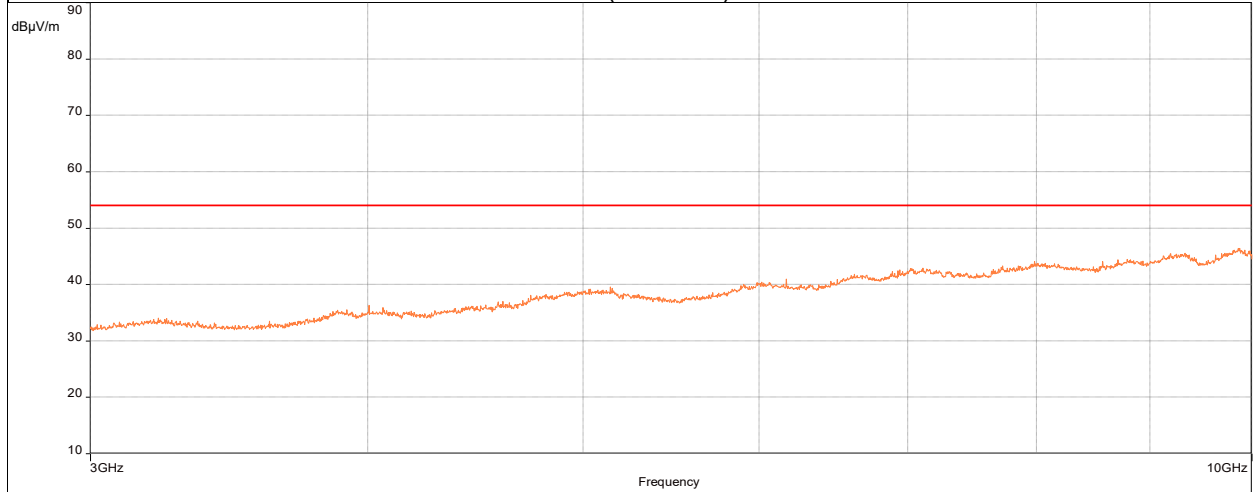
FCC Part 15 Transmitters/FCC 15.209

Peak Plot – 3 meters (1-3GHz) – Mid Channel



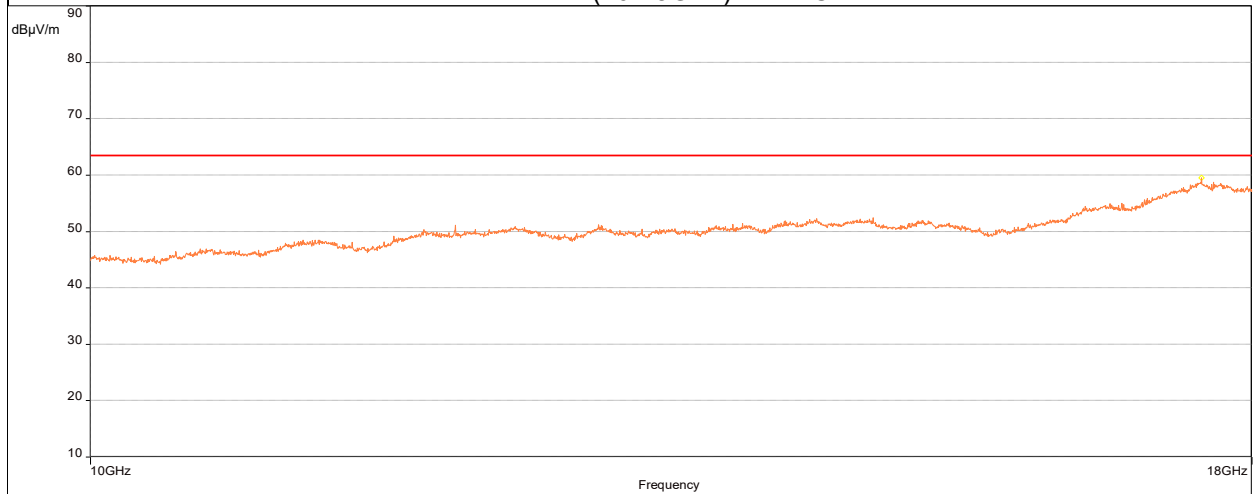
FCC Part 15/FCC 15.209_9kHz-40GHz

Peak Plot – 3 meters (3-10GHz) – Mid Channel

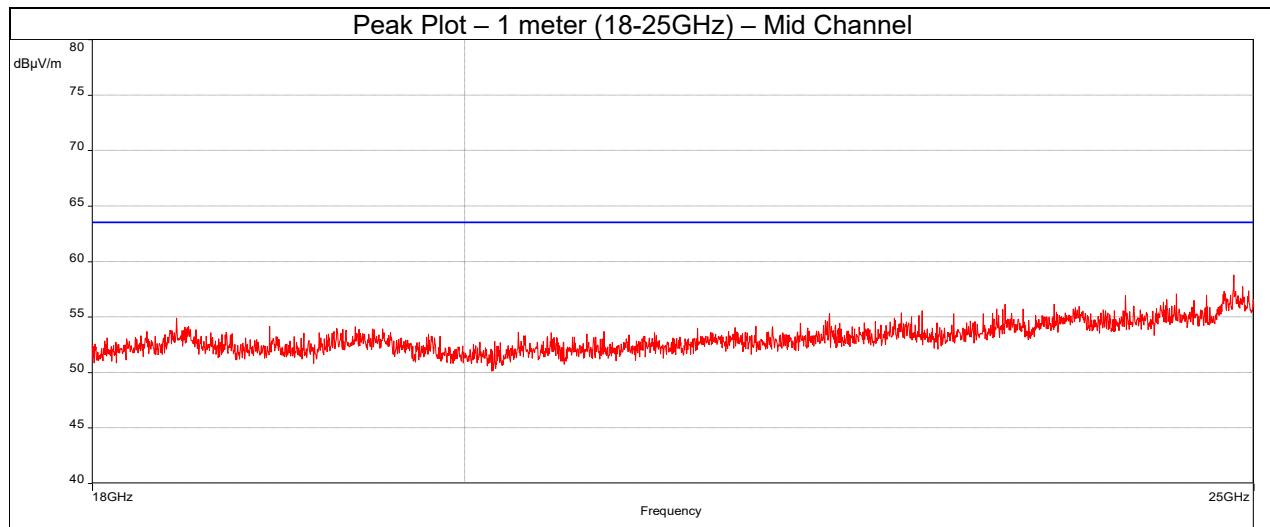


FCC Part 15/FCC 15.209_9kHz-40GHz

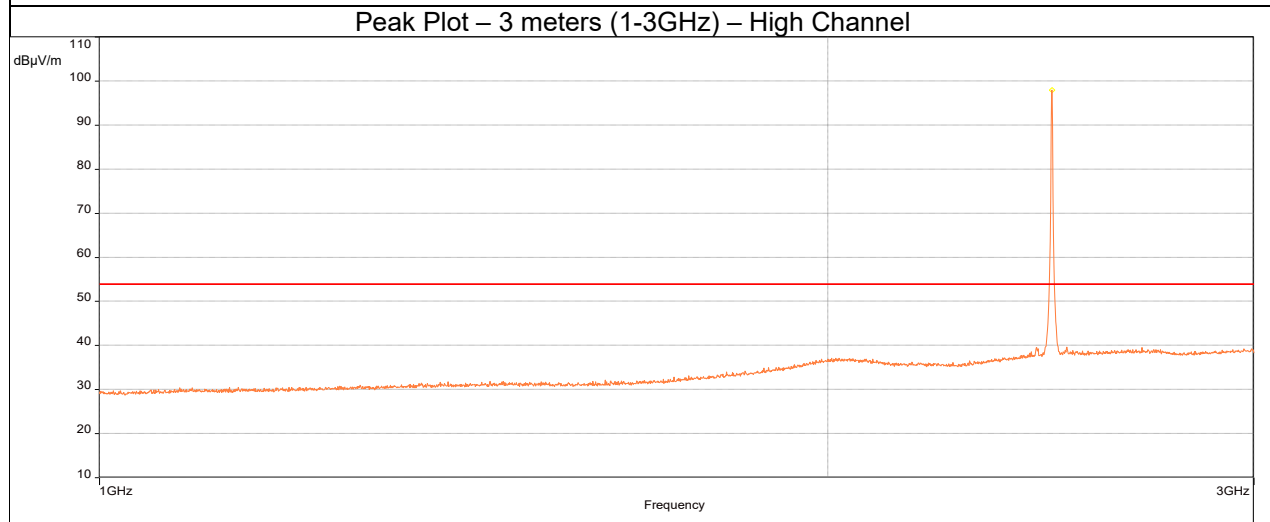
Peak Plot – 1 meter (10-18GHz) – Mid Channel



FCC Part 15 Transmitters/FCC 15.209

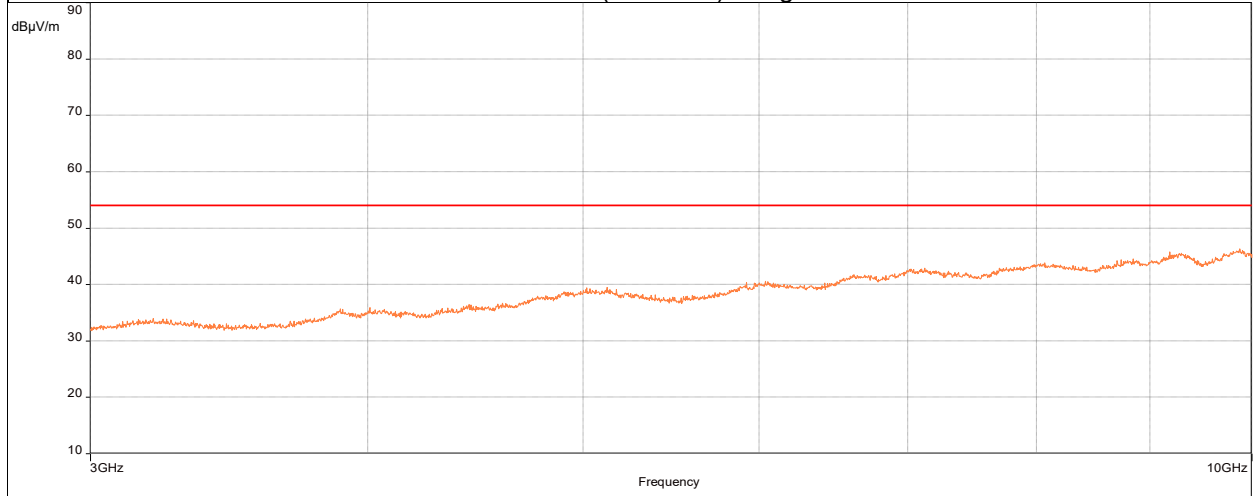


FCC Part 15 Transmitters/FCC 15.209



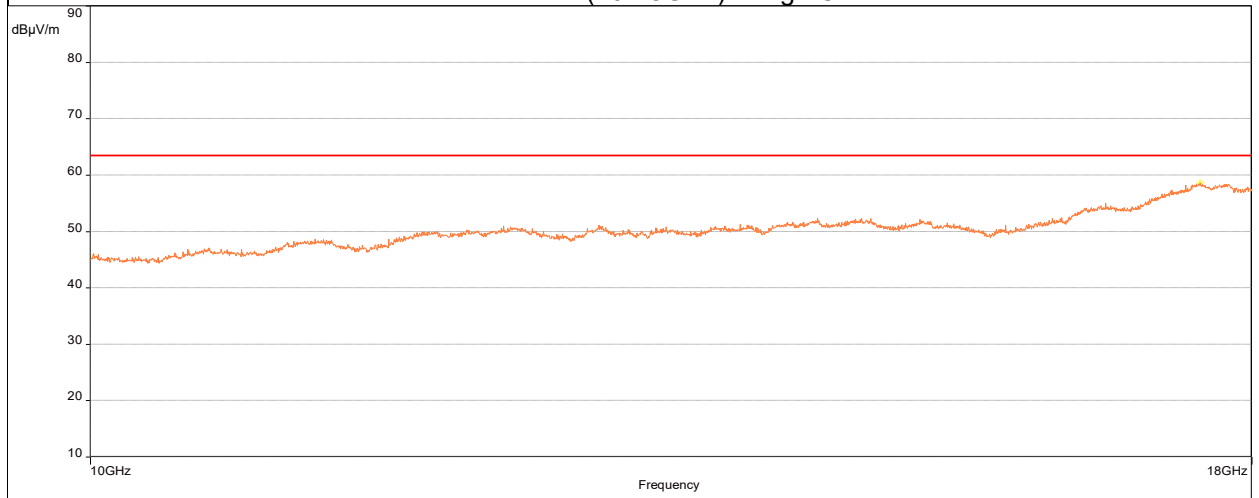
FCC Part 15/FCC 15.209_9kHz-40GHz

Peak Plot – 3 meters (3-10GHz) – High Channel



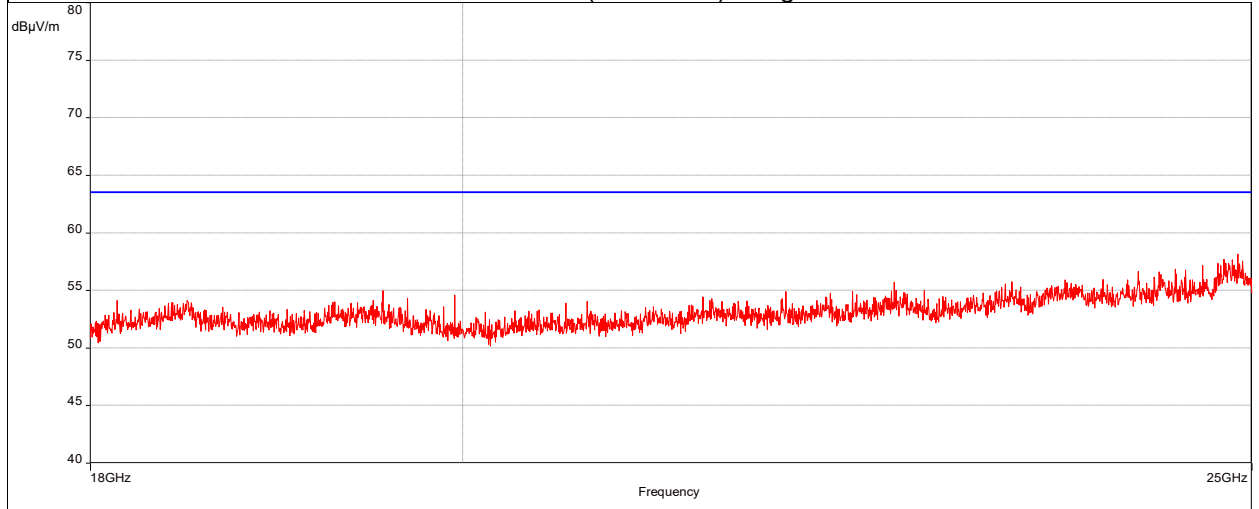
FCC Part 15/FCC 15.209_9kHz-40GHz

Peak Plot – 1 meter (10-18GHz) – High Channel



FCC Part 15 Transmitters/FCC 15.209

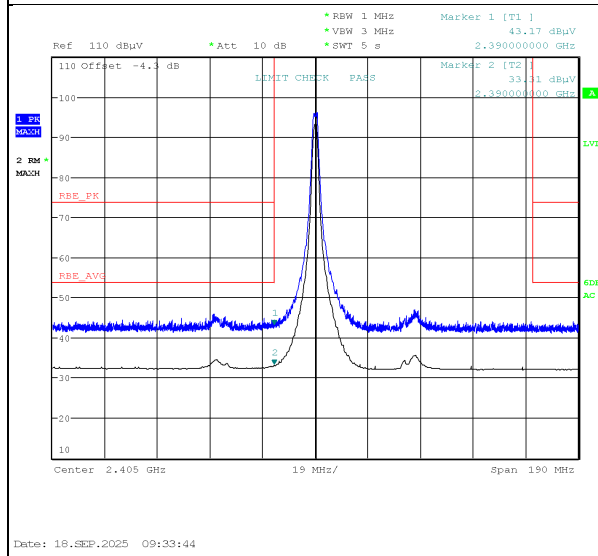
Peak Plot – 1 meter (18-25GHz) – High Channel



FCC Part 15 Transmitters/FCC 15.209

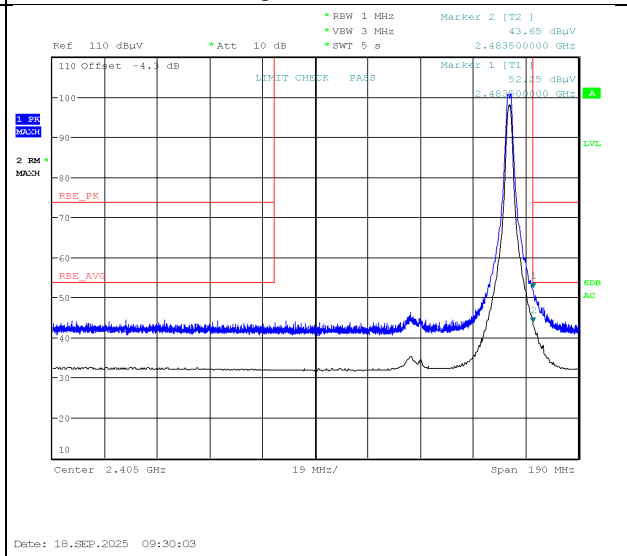
Restricted Band Edges

Low Channel



Date: 18.SEP.2025 09:33:44

High Channel



Date: 18.SEP.2025 09:30:03

Tabular Data

Peak

Channel	Frequency (MHz)	Peak Level (dBuV/m)	Peak Limit (dBuV/m)	Peak Margin (dB)	Azimuth (°)	Height (m)	Polarity	RBW (MHz)	Correction (dB)
11	2390.000	43.17	74	-30.83	306	297	Horizontal	1	-4.3
25	2483.500	52.25	74	-21.75	328	294	Vertical	1	-4.3

Average

Channel	Frequency (MHz)	AVG Level (dBuV/m)	AVG Limit (dBuV/m)	AVG Margin (dB)	Azimuth (°)	Height (m)	Polarity	RBW (MHz)	Correction (dB)
11	2390.000	33.31	54	-20.69	306	297	Horizontal	1	-4.3
25	2483.500	43.65	54	-10.35	328	294	Vertical	1	-4.3

Test Personnel: Jeremy Pickens
Supervising/Reviewing: Jean Rene
Engineer: _____
(Where Applicable) _____
Product Standard: ANSI C63.10
Input Voltage: 5Vdc (USB-C)
Pretest Verification w/
Ambient Signals or
BB Source: BB

Test Date: 11-23 September 2025Limit Applied: 15.209Ambient Temperature: 20.3 – 23.4°CRelative Humidity: 36.6 – 41.0%Atmospheric Pressure: 98.1 – 98.5kPa

Deviations, Additions, or Exclusions: None

10 AC Conducted Emissions

10.1 Method

Tests were performed in accordance with ANSI C63.10.

TEST SITE: 10 Meter Chamber

10 Meter Semi-Anechoic Chamber The test site for radiated emissions is located at 1950 Evergreen Blvd, Suite 100, Duluth, Georgia 30096. It is a 10 meter semi-anechoic chamber manufactured by Panashield. Embedded in the floor is a 3-meter diameter turntable.

Sample Calculations

The following calculations were used to determine the net line-conducted measurements:

$$NF = RF + LF + CF + AF$$

Where NF = Net Reading in dB μ V

RF = Reading from receiver in dB μ V

LF = LISN or ISN Correction Factor in dB

CF = Cable Correction Factor in dB

AF = Attenuator Loss Factor in dB

To convert from dB μ V to μ V or mV the following was used:

$$UF = 10^{(NF / 20)} \text{ where } UF = \text{Net Reading in } \mu\text{V}$$

$$NF = \text{Net Reading in dB}\mu\text{V}$$

Example:

$$NF = RF + LF + CF + AF = 28.5 + 0.2 + 0.4 + 20.0 = 49.1 \text{ dB}\mu\text{V}$$

$$UF = 10^{(49.1 \text{ dB}\mu\text{V} / 20)} = 285.1 \mu\text{V/m}$$

10.2 Test Equipment

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
212165	Temp/Pressure/Humidity Sensor	Extech	110344	04/29/2025	04/29/2026	110344
213498	2-Line LISN	Rohde & Schwarz	ENV216	101577	09/27/2024	09/27/2025
232944	EMI Receiver 10Hz-26.5GHz	Agilent	MXE-9038A	MY51210135	11/06/2024	11/06/2025
MM8	RF Coax Cable 9kHz-18GHz	Fairview Microwave	UC-N-MM-267	1635289	06/18/2025	06/18/2026

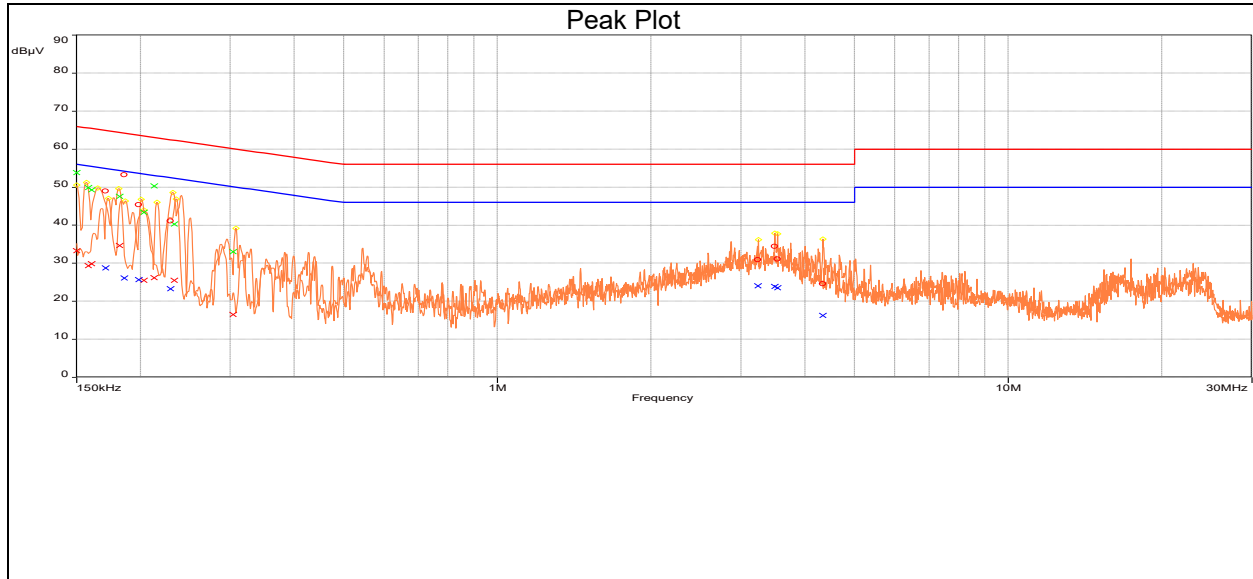
Software Utilized

Name	Manufacturer	Version
EMC BAT	Nexio	3.19.1.18

10.3 Results

The sample tested was found to Comply.

10.4 Plots/Data



Tabular Data

Frequency (MHz)	AVG Level (dBμV)	QP Level (dBμV)	AVG Limit (dBμV)	QP Limit (dBμV)	AVG Margin (dB)	QPeak Margin (dB)	Position	Correction (dB)
0.171	28.72	48.94	54.9	64.9	-26.2	-16.0	Phase 1	10.0
0.186	26.08	53.26	54.2	64.2	-28.1	-11.0	Phase 1	10.0
0.198	25.71	45.35	53.7	63.7	-28.0	-18.3	Phase 1	10.0
0.229	23.28	41.06	52.5	62.5	-29.2	-21.4	Phase 1	9.8
3.238	24.03	30.9	46.0	56.0	-22.0	-25.1	Phase 1	9.8
3.490	23.85	34.38	46.0	56.0	-22.2	-21.6	Phase 1	9.8
3.532	23.49	31.1	46.0	56.0	-22.5	-24.9	Phase 1	9.8
4.331	16.28	24.54	46.0	56.0	-29.7	-31.5	Phase 1	9.8
0.149	33.31	53.83	56.0	66.0	-22.7	-12.2	Phase 2	10.9
0.158	29.37	49.9	55.6	65.6	-26.2	-15.7	Phase 2	10.4
0.161	29.82	49.24	55.4	65.4	-25.6	-16.2	Phase 2	10.3
0.182	34.7	47.56	54.4	64.4	-19.7	-16.8	Phase 2	10.0
0.203	25.52	43.36	53.5	63.5	-28.0	-20.1	Phase 2	9.9
0.213	26.22	50.29	53.1	63.1	-26.9	-12.8	Phase 2	9.8
0.233	25.54	40.28	52.4	62.4	-26.8	-22.1	Phase 2	9.7
0.304	16.55	32.99	50.1	60.1	-33.6	-27.2	Phase 2	9.7

Test Personnel: Jean Rene
 Supervising/Reviewing Engineer:
 (Where Applicable) _____
 Product Standard: ANSI C63.10
 Input Voltage: 120Vac, 60Hz to USB Adapter
 Pretest Verification w/ Ambient Signals or BB Source: BB

Test Date: 17 September 2025

Limit Applied: 15.207 / RSS-Gen S8.8

Ambient Temperature: 22.1°C

Relative Humidity: 45.4%

Atmospheric Pressure: 98.3kPa

Deviations, Additions, or Exclusions: None

11 Measurement Uncertainty

Parameter	Expanded Uncertainty for Normal k factor equal to 2
Radio Frequency	0.07
Total RF Power (Conducted)	0.65
Power Density (Conducted)	0.65
RF Spurious (Conducted)	1.8 dB
Radiated Emissions (9kHz-30MHz)	4.7 dB
Radiated Emissions (30MHz-1GHz)	4.1 dB
Radiated Emissions (1GHz-18GHz)	4.5dB
Radiated Emissions (18GHz-40GHz)	4.7 dB
AC Line Conducted Emissions	2.8 dB
Temperature	0.7°
Humidity	3.9%

12 Revision History

Revision Level	Date	Prepared By	Reviewed By	Notes
0	03 October 2025	JOP	MC	Original Issue
1	21 October 2025	JOP	MC	• Removed ANSI C63.10 2013 dated references throughout body of report • Clarified the module was evaluated in 3 orientations • Corrected modulation from GFSK to QPSK • Corrected low channel test frequencies from 2402 to 2405MHz where required • Clarified ANSI section references