313 West 12800 South, Suite 311

Draper, UT 84020

(801) 260-4040

Test Report

Certification

FCC ID	2AJAC-TSSA1200
Equipment Under Test	TS-SA1-200
Test Report Serial No	V070354_02
Dates of Test	August 2-23, 2023
Report Issue Date	November 21, 2023

Test Specifications:	Applicant:
FCC Part 15, Subpart E	Snap One LLC 1800 Continental Blvd., Suite 200-300 Charlotte NC 28273 U.S.A.

NVLAP TESTING
NVLAP LAB CODE 100272-0

ilac-MRA

Certification of Engineering Report

This report has been prepared by VPI Laboratories, Inc. to document compliance of the device described below with the requirements of Federal Communications Commission (FCC) Part 15, Subpart E. This report may be reproduced in full. Partial reproduction of this report may only be made with the written consent of the laboratory. The results in this report apply only to the sample tested.

Applicant	Snap One LLC
Manufacturer	Snap One LLC
Brand Name	Snap One
Model Number	TS-SA1-200
FCC ID	2AJAC-TSSA1200

On this 21st day of November 2023, I, individually and for VPI Laboratories, Inc., certify that the statements made in this engineering report are true, complete, and correct to the best of my knowledge, and are made in good faith.

Although NVLAP has accredited the VPI Laboratories, Inc. EMC testing facilities, this report must not be used to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the federal government.

VPI Laboratories, Inc.

Tested by: Benjamin N. Antczak

Reviewed by: Jason Stewart

Revision History		
Revision	**Description**	**Date**
01	Original Report Release	November 21, 2023
02	Removing Photographs from Report	December 29, 2023

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1 Client Information

1.1 Applicant

Company Name	Snap One LLC 1800 Continental Blvd., Suite 200-300 Charlotte NC 28273 U.S.A.
Contact Name	Roger Midgley
Title	Sr. Regulatory Compliance Engineer

1.2 Manufacturer

Company Name	Snap One LLC 1800 Continental Blvd., Suite 200-300 Charlotte NC 28273 U.S.A.
Contact Name	Roger Midgley
Title	Sr. Regulatory Compliance Engineer

2 Equipment Under Test (EUT)

2.1 Identification of EUT

Brand Name	Snap One
Model Number	TS-SA1-200
Serial Number	ST232200250316F230
MAC Address	000FFF0C41BB
Dimensions (cm)	22 x 22 x 7
Antenna Gain (dBi)	Variable (See manufacturer-provided data) Peak In-Band: 2.6

2.2 Description of EUT

The TS-SA1-200 ("SA-1" or "EUT") is a streaming amplifier for use in Snap One home automation systems. It is powered by AC Mains. The SA-1 contains wireless circuitry that use the 2.4 GHz ISM band and the UNII bands.

This report covers the transmitter operating in the UNII-1 frequency band. Channel assignments, frequencies and maximum power settings are shown in the table below.

Channel	Frequency (MHz)	Maximum Power Setting
36	5180	16
40	5200	20
44	5220	20
48	5240	20

2.2.1 Modes of Operation

EUT is intended to operate indoors as a client device. The EUT is not fixed and therefore incapable of fixed point-to-point architecture.

2.2.2 DFS Capabilities

This report covers the circuitry of the device operating in the UNII-1 band (5.15 GHz – 5.25 GHz). Operation in the UNII-1 band is not subject to DFS requirements.

2.3 EUT and Support Equipment

The EUT and support equipment used during the test are listed below.

Brand Name Model Number Serial Number	Description	Name of Interface Ports / Interface Cables
BN: Snap One MN: TS-SA1-200 (Note 1) SN: ST232200250316F230 MAC: 000FFF0C41BB	Streaming Amplifier with Wireless Capabilities	See Section 2.4

Brand Name Model Number Serial Number	Description	Name of Interface Ports / Interface Cables
BN: Trendnet MN: TEG-S50TXE SN: CA06225006898	Network Router	Network / Ethernet Cat 5e
BN: Panasonic MN: CF-31 SN: 3DTYB38805	Controller Laptop	Network / Ethernet Cat 5e

Notes: (1) EUT

(2) Interface port connected to EUT (See Section 2.4)

The support equipment listed above was not modified in order to achieve compliance with this standard.

2.4 Interface Ports on EUT

Name of Ports	No. of Ports Fitted to EUT	Cable Description/Length
Network	1 of 1	Ethernet Cat 5e / 7 meters

2.5 Modifications Incorporated/Special Accessories on EUT

There were no modifications or special accessories required to comply with the specification.

2.6 Deviation from Test Standard

There were no deviations from the test specification.

2.7 Scope of This Report

This report covers the circuitry of the devices subject to FCC Part 15, Subpart E for the UNII-1 band. Circuitry for other UNII bands were found to be compliant in VPI Laboratories, Inc. reports V070355, V070356, and V070357. VPI The circuitry of the device is additionally subject to, and found to be compliant with, FCC Part 15 Subparts C. Compliance with Subpart C is covered in VPI Laboratories, Inc. report V070353.

The circuitry of the UNII device is additionally subject to FCC Part 15 Subparts B. Compliance with Subpart B was not evaluated by VPI Laboratories, Inc.

3 Test Specification, Methods and Procedures

3.1 Test Specification

Title	FCC PART 15, Subpart E (47 CFR 15) 15.203, 15.207, 15.209, and 15.407
Purpose of Test	The tests were performed to demonstrate initial compliance
UNII References	KDB 789033 Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices Part 15, Subpart E KDB 905462 D02 UNII DFS Compliance Procedures New Rules v02

3.2 Methods & Procedures

3.2.1 §15.203 Antenna Requirement

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered in compliance with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of Sections 15.211, 15.213, 15.217, 15.219, or 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with Section 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded.

3.2.2 §15.207 Conducted Limits

For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency range (MHz)	Limit (dBμV)	
	Quasi-peak	Average
0.15 to 0.50*	66 to 56*	56 to 46*
0.50 to 5	56	46
5 to 30	60	50

*Decreases with the logarithm of the frequency.

Table 1: Limits for conducted emissions at mains ports of Class B ITE.

3.2.3 §15.407 Operation within the UNII Bands

Emission bandwidth is determined by measuring the width of the signal between points that are 26 dB down relative to the maximum level of the carrier center frequency.

Maximum conducted output power is the total transmit power delivered to all antennas, averaged across all symbols when operating at maximum power control level. If multiple modulation methods are possible, then the highest total transmit power in any mode is considered the maximum conducted output power.

Power spectral density is the total energy output per unit bandwidth from a transmitter operating at maximum power level divided by the total duration of transmission.

Measurements for UNII operation are taken over intervals of continuous transmissions. Measurements are taken using a minimum of resolution bandwidth of 1 MHz. If lower resolution bandwidths are used, measurement energies must be integrated to show the total power over 1 MHz. Emission limits are taken at the highest and lowest channels available to the manufacturer.

Although not covered in this test report, frequency stability must be ensured by manufacturer under all conditions of normal operation.

3.2.3.1 Power Limits in the Band 5150 – 5250 MHz ("UNII-1")

Access points operating either indoors or outdoors, maximum conducted output power over the frequency band 5.15 – 5.25 GHz ("UNII-1") shall not exceed 1 W (30 dBm) as long as the maximum antenna gain does not exceed 6 dBi. In addition, maximum power spectral density shall not exceed 17 dBm in any 1 MHz band. If maximum antenna gain exceeds 6 dBi, then the maximum conducted output power and maximum power spectral density shall be reduced by the amount (in dB) that the directional gain of the antenna exceeds 6 dBi.

Outdoor access points additionally may not exceed 125 mW (21 dBm) maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon.

Only fixed point-to-point access points may employ antennas with directional gain of up to 23 dBi without reducing conducted output power. However, for every 1 dB gain over 23 dBi, maximum conducted output power and maximum power spectral density must be reduced by 1 dB. The 23 dBi exception is only applicable to fixed, point-to-point access points, and is not acceptable for point to multi-point, omni-directional, or multi-point to point architectures.

Client devices shall not exceed conducted output power of 250 mW (24 dBm) as long as the maximum antenna gain does not exceed 6 dBi. In addition, maximum power spectral density shall not exceed 11 dBm for any 1 MHz band. If maximum antenna gain exceeds 6 dBi, then the maximum conducted output power and maximum power spectral density shall be reduced by the amount (in dB) that the directional gain of the antenna exceeds 6dBi.

Emissions outside the band 5.15 – 5.35 GHz shall not exceed an e.i.r.p. of -27 dBm/MHz.

3.2.3.2 Power Limits in the Bands 5250 – 5350 MHz and 5470 – 5725 MHz ("UNII-2")

Maximum conducted output power over the frequency bands 5.25-5.35 GHz and 5.47-5.725 GHz ("UNII-2A" and "UNII-2C," collectively, "UNII-2") shall not exceed the lesser of: 250 mW (24 dBm); or 11 dBm + 10 log B, where B is the 26 dB emission bandwidth in megahertz (MHz). Maximum power spectral density shall additionally not exceed 11 dBm in any 1 MHz band. If maximum antenna gain exceeds 6 dBi, then the maximum conducted output power and maximum power spectral density shall be reduced by the amount (in dB) that the directional gain of the antenna exceeds 6 dBi.

For transmitters operating in the UNII-2A band, emissions outside the band 5.15 – 5.35 GHz shall not exceed an e.i.r.p. of -27 dBm/MHz. For those transmitters operating in the UNII-2C band, emissions outside the UNII-2C band shall not exceed an e.i.r.p. of -27 dBm/MHz.

Transmitters operating in the UNII-2 bands for which e.i.r.p. exceeds 500 mW (27 dBm) must employ a transmit power control (TPC) mechanism, giving the device the capability of operating at least 6 dB below the mean EIRP of 30 dBm.

3.2.3.3 Power Limits in the Band 5725 – 5850 MHz ("UNII-3")

Maximum conducted output power over the frequency bands 5.725 – 5.85 GHz ("UNII-3") shall not exceed 1 W (30 dBm). Maximum power spectral density shall not exceed 30 dBm in any 500 kHz band. If maximum antenna gain exceeds 6 dBi, then the maximum conducted output power and maximum power spectral density shall be reduced by the amount (in dB) that the directional gain of the antenna exceeds 6 dBi. Fixed point-to-point operations may utilize antennas exceeding 6 dBi without reducing the transmitter conducted power; this exception is only applicable to fixed, point-to-point transmitters, and is not acceptable for point to multi-point, omni-directional, or multi-point to point architectures.

For transmitters operating in the UNII-3 band, emissions 75 MHz above or below the band-edge shall not exceed an e.i.r.p. of -27 dBm/MHz. For those emissions within 75M Hz and 25 MHz of the band-edge the limit increases linearly to 10 dBm/MHz. For those emissions within 25 MHz and 5 MHz of the band-edge the limit increases linearly to 15.6 dBm/MHz. For those emissions within 5 MHz of the band-edge the limit increases linearly to the band-edge to 27 dBm/MHz.

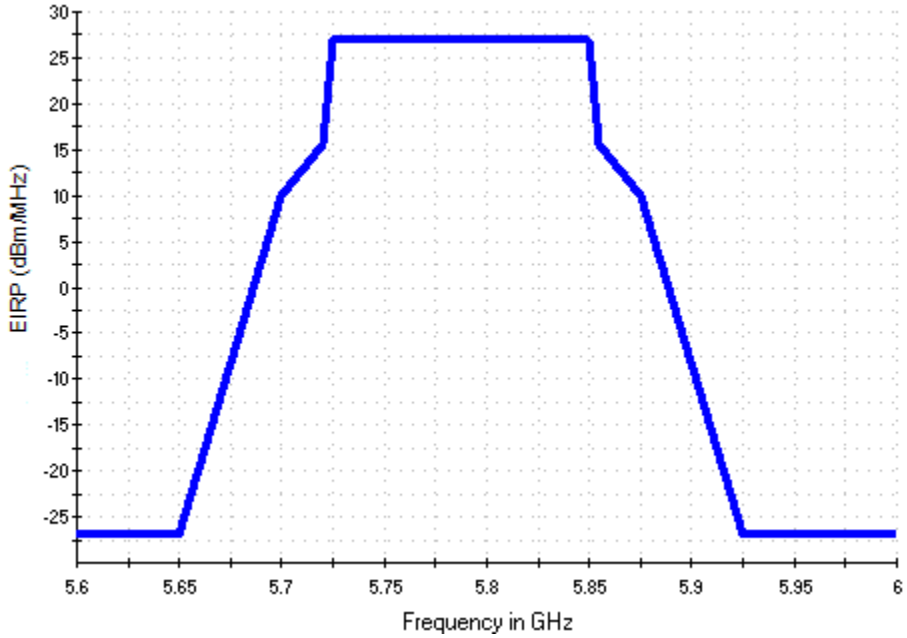


Figure 1. Emission limit for transmitters operating in the UNII-3 (5.725 – 5.850 GHz) band

Transmitters operating in the UNII-3 band shall also have a 6 dB bandwidth of at least 500 kHz.

3.2.3.4 Radar Detection Function of Dynamic Frequency Selection

UNII devices that operate with any part of their 26 dB emission bandwidth in the UNII-2 bands must employ a DFS radar detection mechanism to avoid co-channel operation with radar systems. Upon detection of radar signals, the channel must be flagged as containing a radar system and must not be utilized for at least 30 minutes ("Non-occupancy Period").

All DFS devices must fulfil the Channel Move Time requirement, forcing all transmissions to cease operating on a channel within 10 seconds of detecting a radar signal. Transmissions may continue with normal traffic for a maximum of 200 ms after the detection of radar, but only control and management signals may exist after 200 ms to assist in the vacating of the occupied channel. Control and management signals are not allowed after 10 seconds.

Only DFS devices operating as a master device must fulfil the Channel Availability Check time requirement. Master devices must check if there are radar signals already operating on a channel before initiating transmission (or changing channels). If no radar signals are detected above the DFS detection threshold within 60 seconds, the channel may be utilized. Initial channel selection may be either randomly selected or manually selected.

The DFS detection threshold is -64 dBm for devices with a maximum e.i.r.p. between 200 mW and 1 W. Devices for which e.i.r.p. is less than 200 mW and for which maximum power spectral density is less than 10 dBm per 1 MHz band shall have a DFS threshold of -62 dBm.

Radar signals must be detected at 100 percent of the device's emission bandwidth. DFS detection threshold is the received power averaged over 1µs and referenced to a 0 dBi antenna.

Some standards such as IEEE 801.11.ax allow wideband transmissions that are "notched" or "punctured" upon radar detection (e.g., 160 MHz wideband transmissions wherein a 20 MHz portion of the bandwidth is not utilized). For such transmission schemes, the remaining emissions of the notched signal shall not bleed into the notch (i.e., 26 dB or 99% bandwidth is outside the notch). Channel closing and moving times must be met when notches are utilized.

3.2.4 UNII Band Channel Aggregation

EUTs which utilize "straddle" channels (Channel 50 at 160 MHz BW, Channel 138 at 80 MHz BW, Channel 142 at 40 MHz BW, or Channel 144 at 20 MHz BW) are subject to the requirements of the bands they straddle. For example, Channel 42 + 138 (80 MHz + 80 MHz) are distributed over (and straddle) the UNII-1 and UNII-2 bands.

Straddle channel 50 is considered operating in both UNII-1 and UNII-2A; straddle channels 138, 142, and 144 are considered operating in both UNII-2C and UNII-3.

3.2.4.1 Conducted Output Power in the Case of Channel Aggregation

For such transmissions, conducted output power is calculated as the summed power of segments located within the band, where the band edge replaces the -26 dB point of the straddling signal. In the example shown in Figure 1, power requirements must be met for both UNII-2 and UNII-3. While it is acceptable to sum the power of the entire transmission in a band (e.g., top-line $P_{U\text{-}NII\text{-}2C}$ and $P_{U\text{-}NII\text{-}3}$), individual measurements over the 26 dB bandwidth of each carrier frequency (or to the band edge) may also be summed ($P_A + P_B$ for UNII-2 band requirements and $P_{U\text{-}NII\ 3}$ for UNII-3 band requirements).

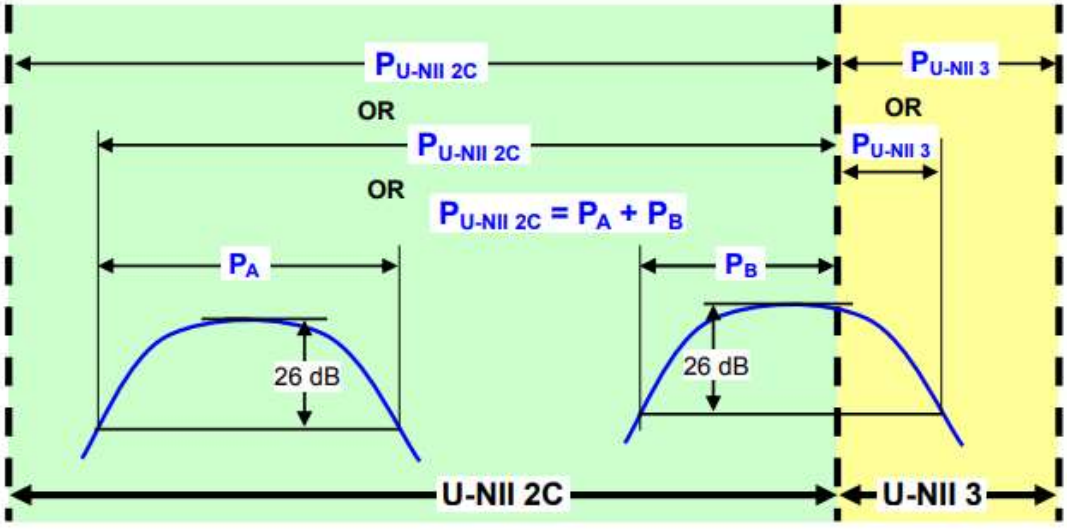


Figure 1. Conducted output power measurement examples (KDB 789033 D02 v02r01, p 21)

3.2.4.2 Emissions Bandwidths in the Case of Channel Aggregation

Emissions bandwidth is defined based upon overlap of the 26 dB bandwidths of each channel individually.

For those transmissions where the 26 dB bandwidths overlap, the emission bandwidth (EWB) is the difference between the outer -26 dB points.

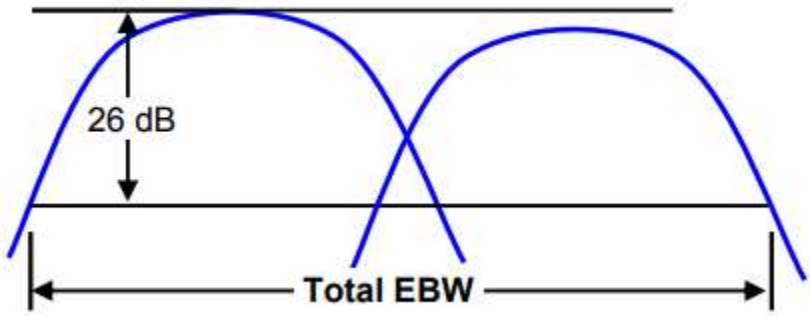


Figure 2. Overlapping emissions bandwidths (KDB 789033 D02 v02r01, p 18)

For those transmissions where the 26 dB bandwidths do not overlap, the emission bandwidth is the sum of the individual 26 dB bandwidths, and each segment is measured independently.

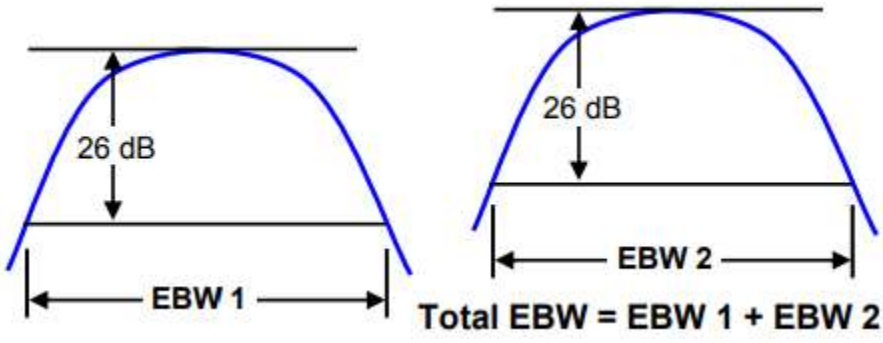


Figure 3. Non-overlapping emissions bandwidths (KDB 789033 D02 v02r01, p 18)

Finally, for those transmissions which cross into other UNII bands, the band boundary serves as one edge for that band, while the other edge is measured from the peak of the contiguous segment.

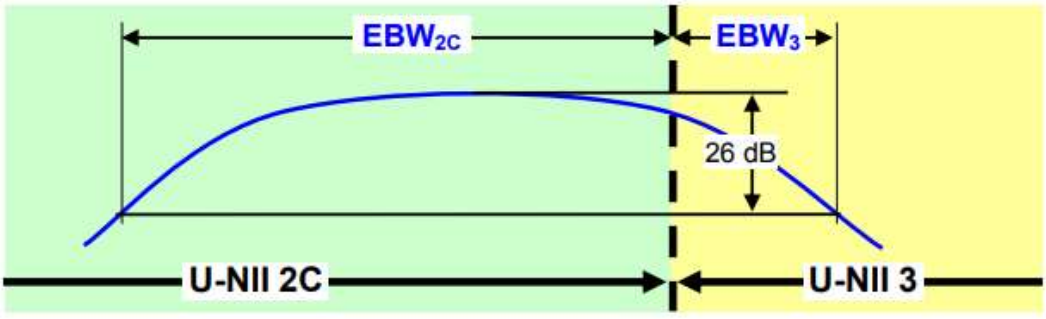


Figure 4. Non-overlapping emissions bandwidths (KDB 789033 D02 v02r01, p 19)

3.2.4.3 Additional Requirements for UNII Devices

UNII devices are subject to requirements imposed by the National Environmental Policy Act. Manufacturers are responsible for applying RF radiation exposure requirements specified in 47 CFR 1.1307(b), 2.1091, and 2.1093 as appropriate (47 CFR 15.407(f)). Such requirements include (but are not limited to) routine environmental evaluation for RF exposure prior to equipment authorization or use (47 CFR 1.1307(b)(2)(i)) and additional evaluation of RF radiation exposure for mobile and portable devices (47 CFR 2.1091 and 2.1093, respectively).

3.3 Test Procedure

VPI Laboratories, Inc. is accredited by National Voluntary Laboratory Accreditation Program (NVLAP); NVLAP Lab Code: 100272-0, which is effective until September 30, 2024. VPI Laboratories, Inc. carries FCC Accreditation Designation Number US5263. VPI Laboratories main office is located at 313 W 12800 S, Suite 311, Draper, UT 84020. The testing was performed according to the procedures in ANSI C63.10-2013, KDB 789033, and 47 CFR Part 15. Radiated testing was performed at the VPI Laboratories, Inc. Wanship Upper Open Area Test Site, located at 29145 Old Lincoln Highway, Wanship, UT. Conducted testing was performed at VPI Laboratories main office. This location is listed on NVLAP scope under the lines for C63.4 and C63.10.

4 Operation of EUT During Testing

4.1 Operating Environment

Power Supply	120 VAC
AC Mains Frequency	60 Hz

4.2 Operating Modes

The transmitter was tested on a single table-top axis. The AC mains voltage to the AC adapter was varied as required by §15.31(e) with no change seen in the voltage supplied to the transmitter or in transmitter characteristics.

The EUT has a single antenna that adjusts to vertical and horizontal positions. Each radiated measurement was taken with the EUT antenna adjusted for maximum coupling to the measurement antenna (horizontal for horizontally polarized measurements, and vertical for vertically polarized measurements).

The worst-case data rate was found to be MCS4. Transmitter was tested while in a constant transmit mode at the upper, middle, and lower channels.

4.3 EUT Exercise Software

Snap One firmware was used to exercise and control the transmitter for testing, which was managed by a laptop PC out of the test area and connected via network router, also out of the test area.

5 Summary of Test Results

5.1 FCC Part 15, Subpart E

5.1.1 Summary of Tests

Section	Environmental Phenomena	Frequency Range (MHz)	Result
15.205 (15.407(b)(7))	Spurious Emissions in Restricted Bands	0.009 - 40000	Complied
15.207 (15.407(b)(6))	Conducted Disturbance at Mains Ports	0.15 to 30	Complied
15.209 (15.407(b)(6))	General Field Strength Limits	0.009 - 40000	Complied
15.403(i)	Emissions Bandwidth	5150 – 5250	Complied
15.407(e)	Minimum Emission Bandwidth	5725 – 5850	Note 1
15.407(a)	Maximum Conducted Output Power	5150 – 5250	Complied
15.407(a)(1)	EIRP above 30 Degrees	5150 – 5250	Note 2
15.407(a)	Maximum Power Spectral Density	5150 – 5250	Complied
15.407(b)(6)	Unwanted Emissions	0.009 - 40000	Complied
Note 1: EUT does not utilize UNII-3 band and therefore requirement is not applicable. Note 2: UNII-1 capable EUT does not operate outdoors and therefore requirement is not applicable.			

5.2 Result

In the configuration tested, the EUT complied with the requirements of the specification.

6 Measurements, Examinations and Derived Results

6.1 General Comments and Results

This section contains the test results only. Details of the test methods used and a list of the test equipment used during the measurements can be found in Section 7 of this report.

6.1.1 §15.203 Antenna Requirements

The EUT uses a reverse-polarization screw-on antenna with a max gain in the UNII-1 band of 2.6 dBi. The same antenna is used for multiple bands.

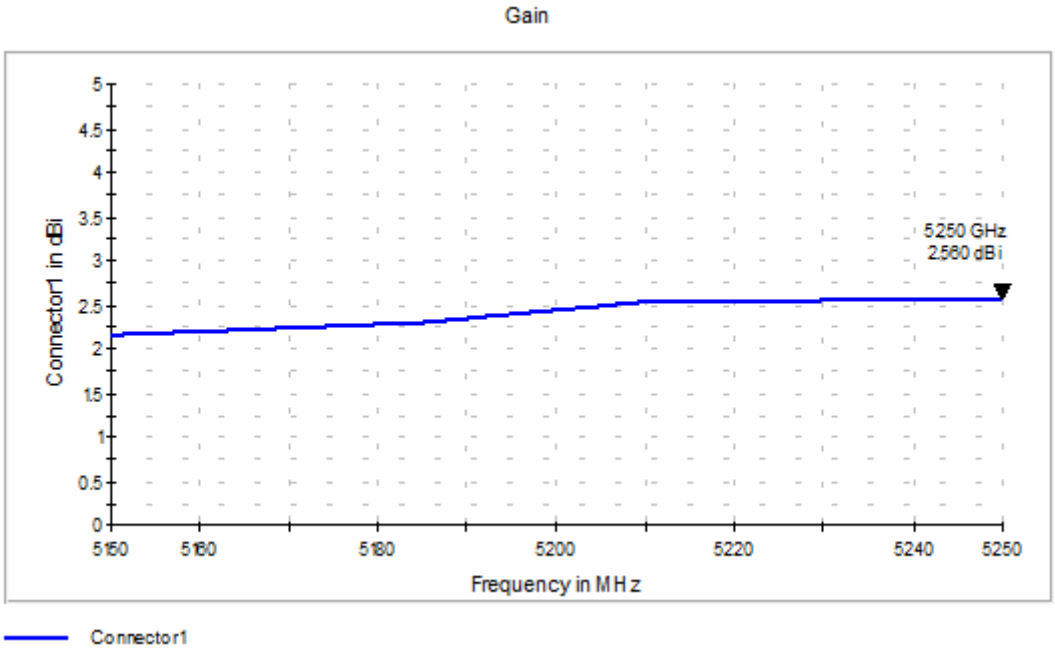


Figure 1: Antenna Gain Table

For antennas with gain greater than 6 dBi, limits become tighter in certain UNII bands and operational modes. See the relevant test result section for adjusted conducted power and power spectral density limits.

Result

In the configurations tested the EUT complied with the requirements of the specification.

6.1.2 §15.207 Conducted Emissions at AC Mains Ports

All modes were evaluated at the maximum possible power level (20) and no changes to emissions on the AC Mains port were observed.

Hot Lead 120VAC:

Frequency (MHz)	Detector	Receiver Reading (dBµV)	Correction Factor (dB)	Measured Level (dBµV)	Class B Limit (dBµV)	Margin (dB)
0.25	Peak (Note 1)	28.5	9.9	38.3	51.7	-13.4
0.37	Peak (Note 1)	28.5	9.9	38.5	48.4	-10.0
0.43	Peak (Note 1)	26.1	9.9	36.1	47.2	-11.2
0.88	Peak (Note 1)	24.5	10.0	34.5	46.0	-11.5
1.7	Peak (Note 1)	20.1	10.0	30.1	46.0	-15.9
5.0	Peak (Note 1)	17.7	10.3	28.0	46.0	-18.0
17.4	Peak (Note 1)	17.4	11.1	28.4	50.0	-21.6
Note 1: The reference detector used for the measurements was Quasi-Peak or Peak and the data was compared to the average limit; therefore, the EUT was deemed to meet both the average and quasi-peak limits.						

Neutral Lead 120VAC:

Frequency (MHz)	Detector	Receiver Reading (dBµV)	Correction Factor (dB)	Measured Level (dBµV)	Class B Limit (dBµV)	Margin (dB)
0.15	Peak (Note 1)	30.5	9.9	40.4	56.0	-15.6
0.17	Peak (Note 1)	25.9	9.9	35.8	54.8	-19.0
0.42	Peak (Note 1)	21.0	10.0	31.0	47.5	-16.5
0.65	Peak (Note 1)	17.8	10.0	27.8	46.0	-18.2
5.0	Peak (Note 1)	17.9	10.3	28.2	46.0	-17.8
15.4	Peak (Note 1)	20.1	10.9	31.0	50.0	-19.0
18.1	Peak (Note 1)	18.1	11.1	29.2	50.0	-20.8
29.2	Peak (Note 1)	14.9	12.1	27.0	50.0	-23.0
Note 1: The reference detector used for the measurements was Quasi-Peak or Peak and the data was compared to the average limit; therefore, the EUT was deemed to meet both the average and quasi-peak limits.						

Result

The EUT complied with the specification limit by a margin of 10.0 dB.

6.2 Test Results (20 MHz Bandwidth)

6.2.1 Duty Cycle, Transmission Duration, and Maximum Power Control

EUT was incapable of 100% duty cycle at maximum power control. Duty cycle and maximum-power transmission duration for each tested mode of operation is as follows:

Mode	Duty Cycle	Channel Occupancy Duration	Transmission Duration	Correction Factor
N-Mode MCS4	71.1%	256.1 µS	357.75µS	+1.44

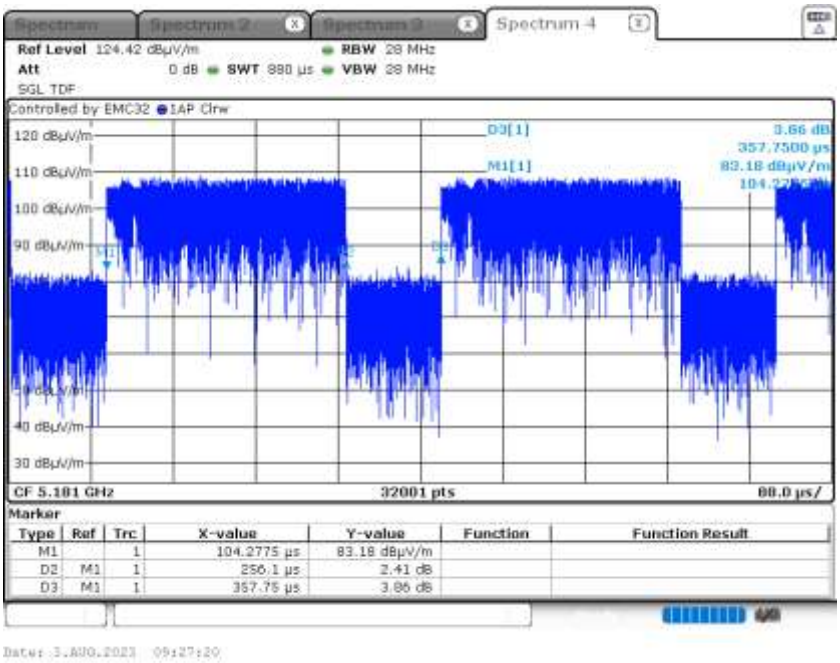


Figure 1. Duty Cycle Measurement

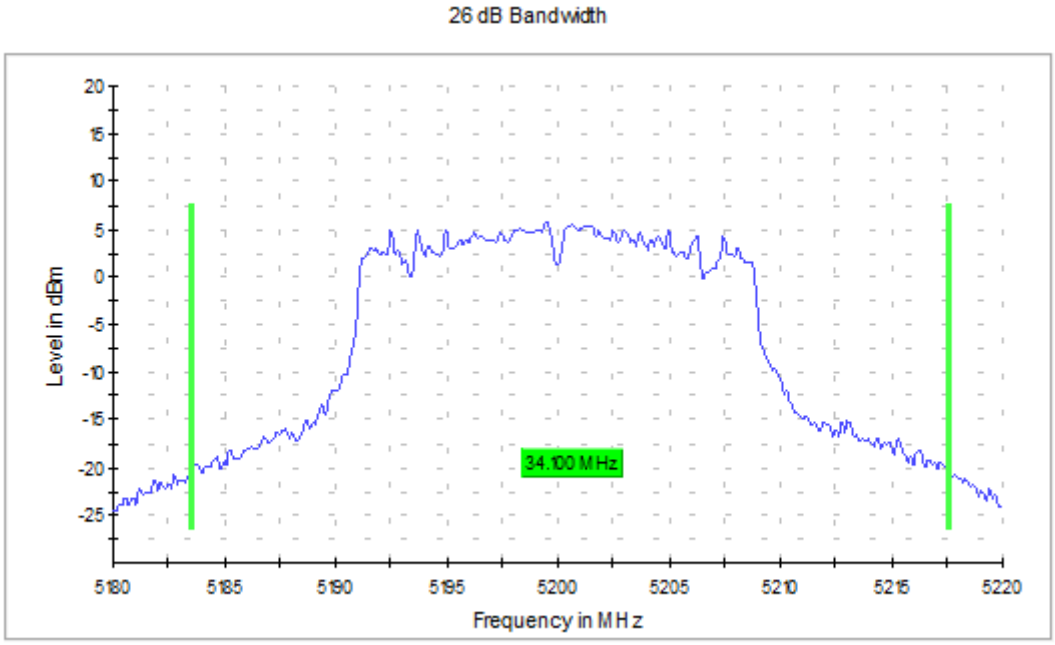
6.2.2 §15.403 26dB Bandwidth

Bandwidths were measured at the intended power set level per channel.

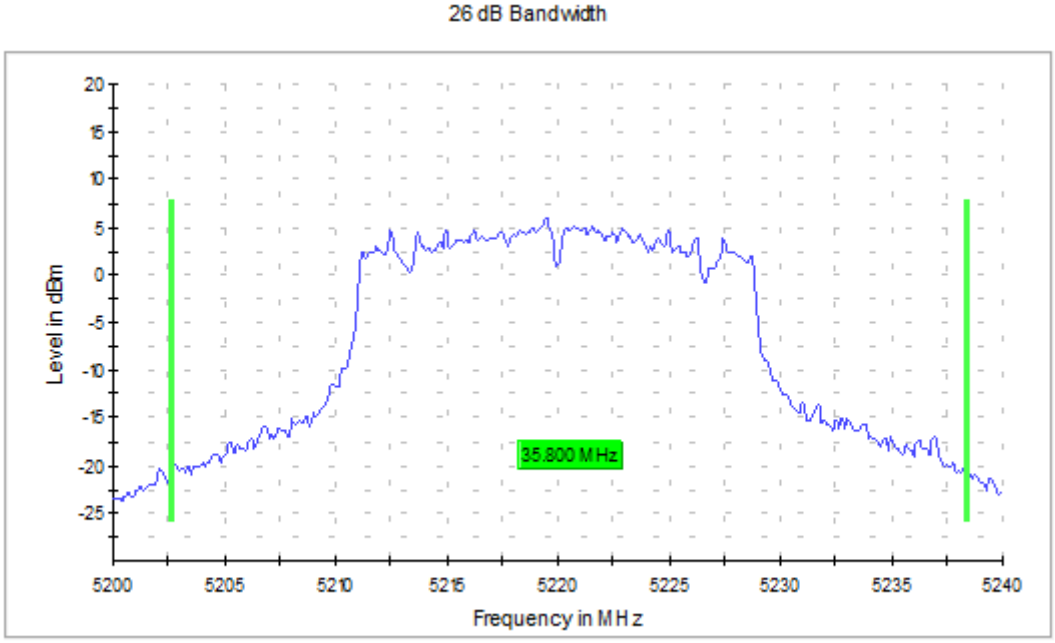
Frequency (MHz)	Emissions 26 dB Bandwidth (MHz)
5180	21.5
5200	34.1
5220	35.8
5240	33.7

Table 2: 26 dB Emissions Bandwidth

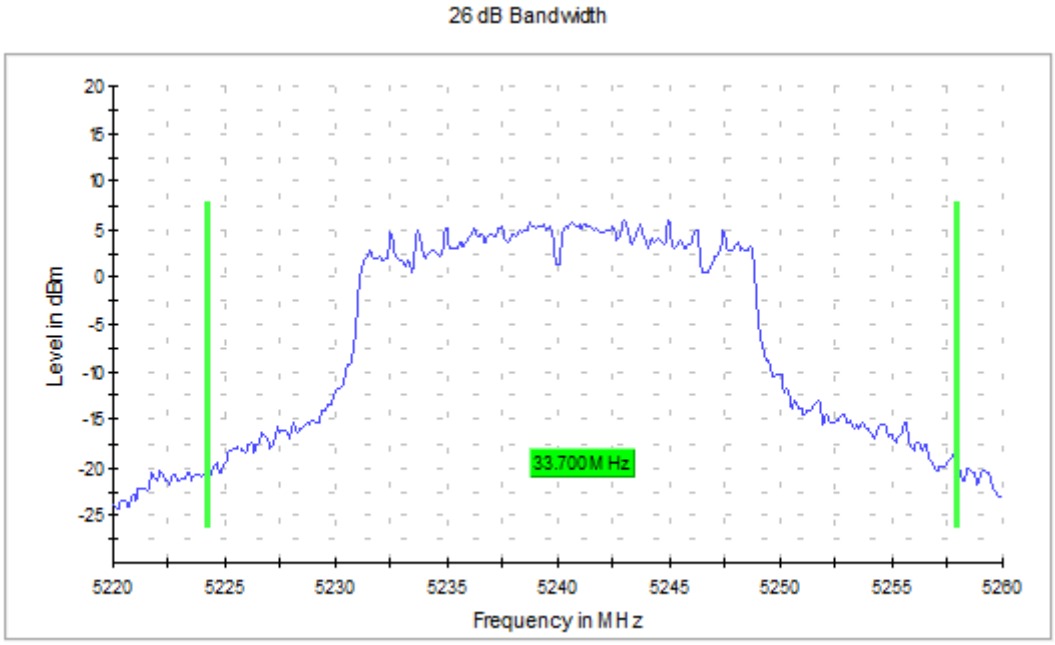
Graph 1: 26 dB Emissions Bandwidth Transmitting at 5180 MHz



Graph 2: 26 dB Emissions Bandwidth Transmitting at 5200 MHz



Graph 3: 26 dB Emissions Bandwidth Transmitting at 5220 MHz



Graph 4: 26 dB Emissions Bandwidth Transmitting at 5240 MHz

6.2.3 §15.407(a) Power Limits: Maximum Conducted Output Power

The following tables show the adjusted conducted power limits.

UNII-1 Conducted Power Limits

Maximum conducted power limits for the UNII-1 band are adjusted based on the isotropic antenna gain, wireless architecture, and the mode of operation.

Wireless Architecture	Operating Mode	Antenna Gain (dBi)	Default Gain (dBi)	Limit Change (dB)	Default Limit (dBm)	Adjusted Limit (dBm)
AP	Client	2.6	6	0.0	24	24

Table 3: UNII-1 maximum conducted power limits based upon antenna gain and operational mode.

EIRP was measured at the intended power set level per channel using method SA-3 and the FSV40's band-power function across the span of the 99%BW.

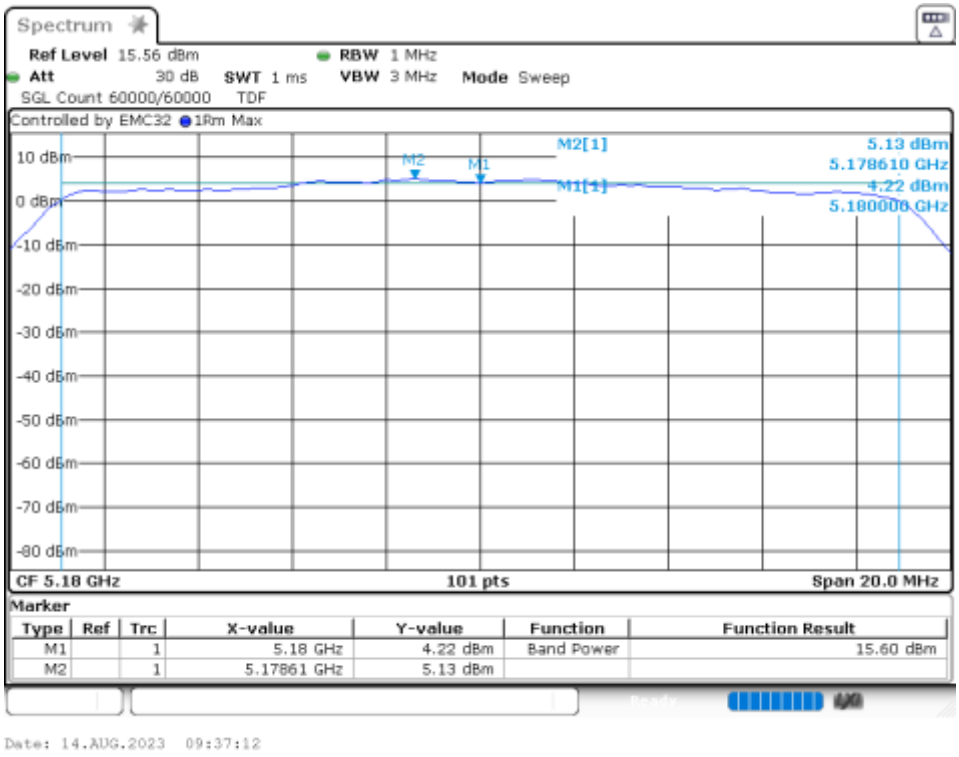
Frequency (MHz)	Emission 99%BW (MHz)
5180	17.8
5200	19.3
5220	19.8
5240	19.8

UNII-1 Conducted Power Measurement – AP Architecture, Client Mode

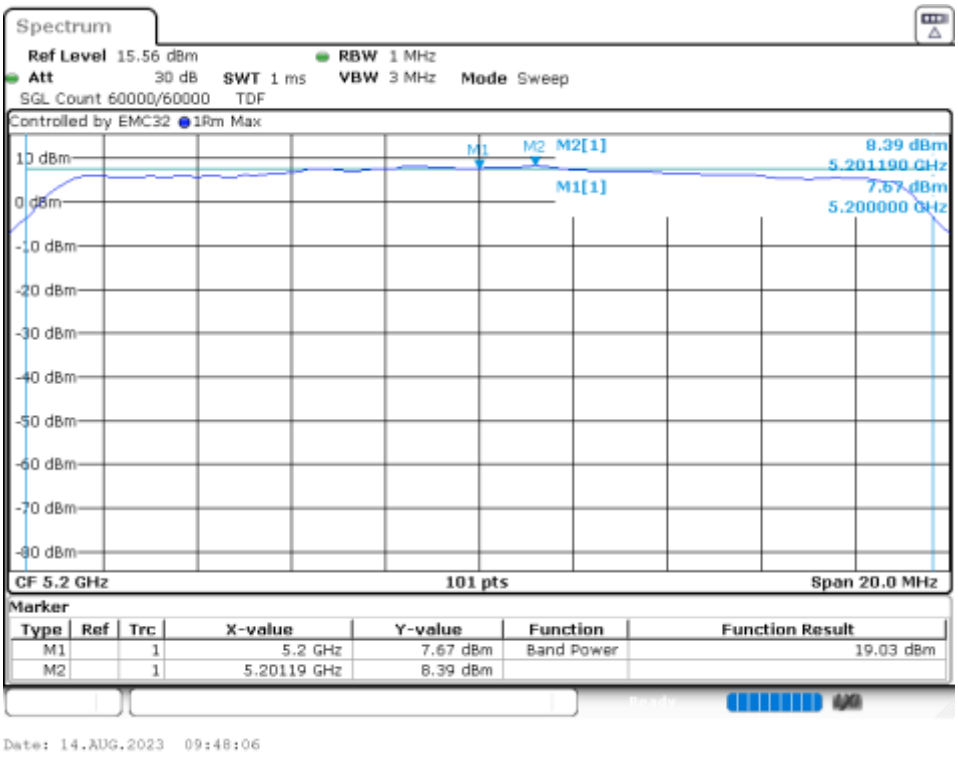
Frequency (MHz)	Conducted Power (dBm)	Conducted Power Limit (dBm)	Margin (dB)
5180	15.6	24	-8.4
5200	19.0	24	-5.0
5220	19.4	24	-4.6
5240	19.3	24	-4.7

Result: UNII-1 AP Architecture, Client Mode

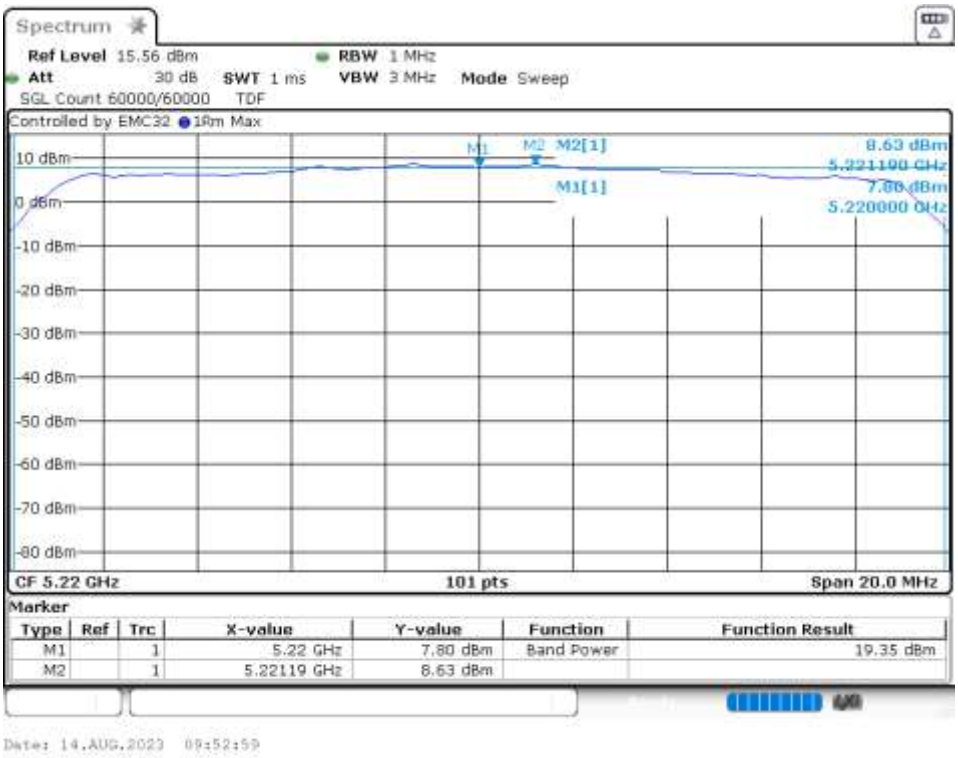
In the configurations tested the EUT complied with the requirements of the specification with a margin of 4.6 dB.



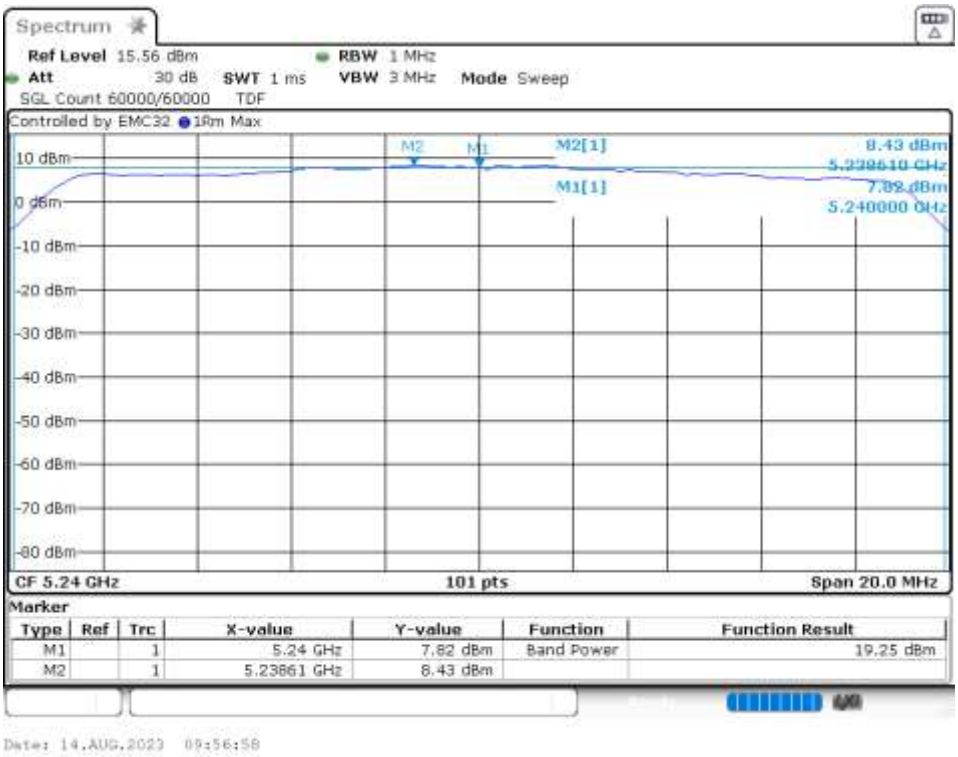
Graph 5: SA-3 Power and PSD Transmitting at 5180 MHz (Power Level 16)



Graph 6: SA-3 Power and PSD Transmitting at 5200 MHz (Power Level 20)



Graph 7: SA-3 Power and PSD Transmitting at 5220 MHz (Power Level 20)



Graph 8: SA-3 Power and PSD Transmitting at 5240 MHz (Power Level 20)

6.2.4 §15.407(a) Power Limits: Maximum Power Spectral Density

The following tables show the adjusted power spectral density limits.

UNII-1 Power Spectral Density Limits

Power spectral density limits for the UNII-1 band are adjusted based on isotropic antenna gain, wireless architecture, and the mode of operation.

Wireless Architecture	Operational Mode	Antenna Gain (dBi)	Default Gain (dBi)	Limit Adjustment (dB)	Default Limit (dBm)	Adjusted Limit (dBm)
AP	Client	2.6	6	0	11	11

Table 4: UNII-1 Power spectral density limits based upon antenna gain and operational mode.

PSD was measured at the intended power set level per channel using Method SA-3. See Section 6.2.3 for measurement graphics.

UNII-1 Power Spectral Density Measurements – AP Architecture, Client Mode

Frequency (MHz)	Conducted Power Density (dBm/MHz)	Conducted Power Density Limit (dBm/MHz)	Margin (dB)
5160	5.1	11	-5.9
5200	8.4	11	-2.6
5220	8.6	11	-2.4
5240	8.4	11	-2.6

Result: UNII-1 AP Architecture, Client Mode

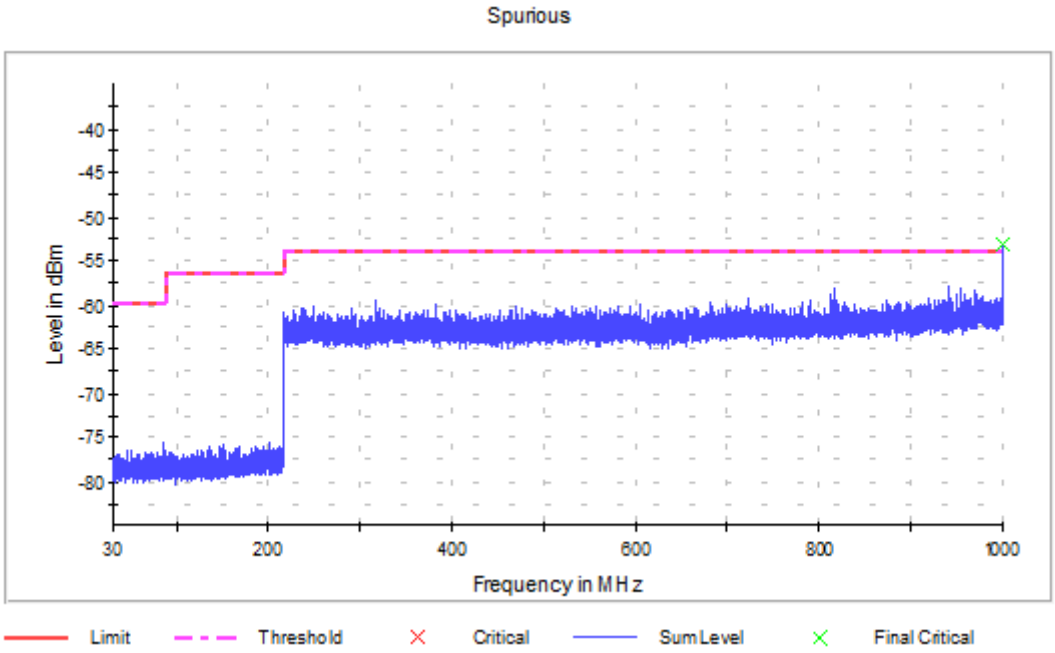
In the configurations tested the EUT complied with the requirements of the specification with a margin of 2.4 dB.

6.2.5 §15.247(b) Undesirable Emissions – Restricted Bands

Undesirable emissions in the restricted bands above 1GHz were tested radiated at the low, middle, and high channels at the maximum possible power setting (20).

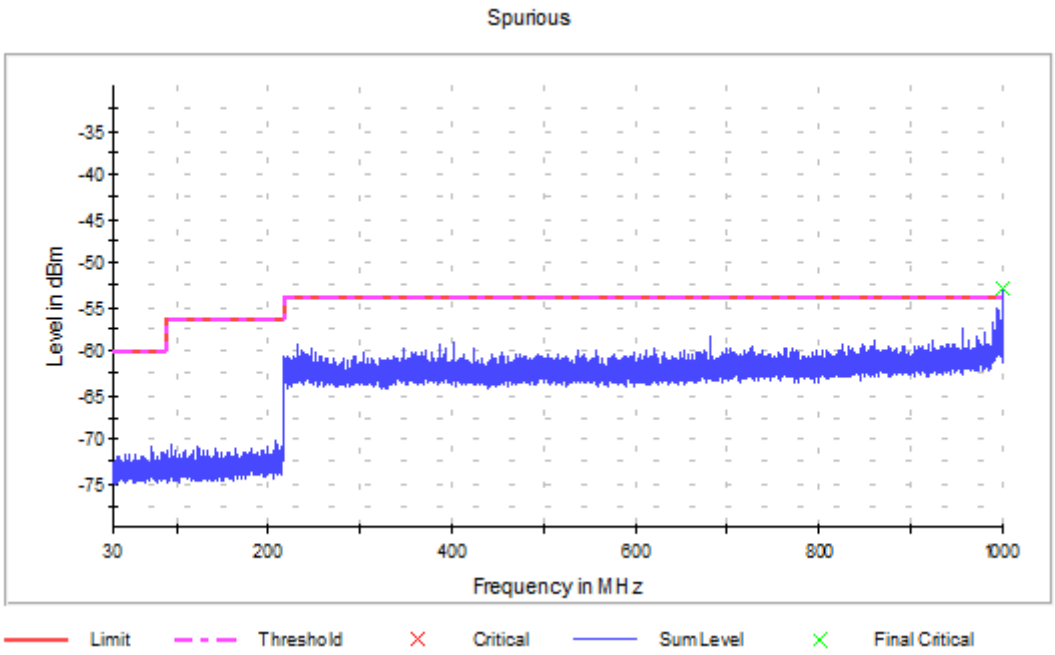
Undesirable Emissions below 1000MHz were measured conducted at the Antenna Port with 100kHz RBW at the intended power set level per channel. Measurement graphs show max-peak detector results. Critical frequencies were measured with a quasi-peak detector to determine compliance.

Emissions Below 1000MHz Transmitting 5180 MHz at Power Level 16:



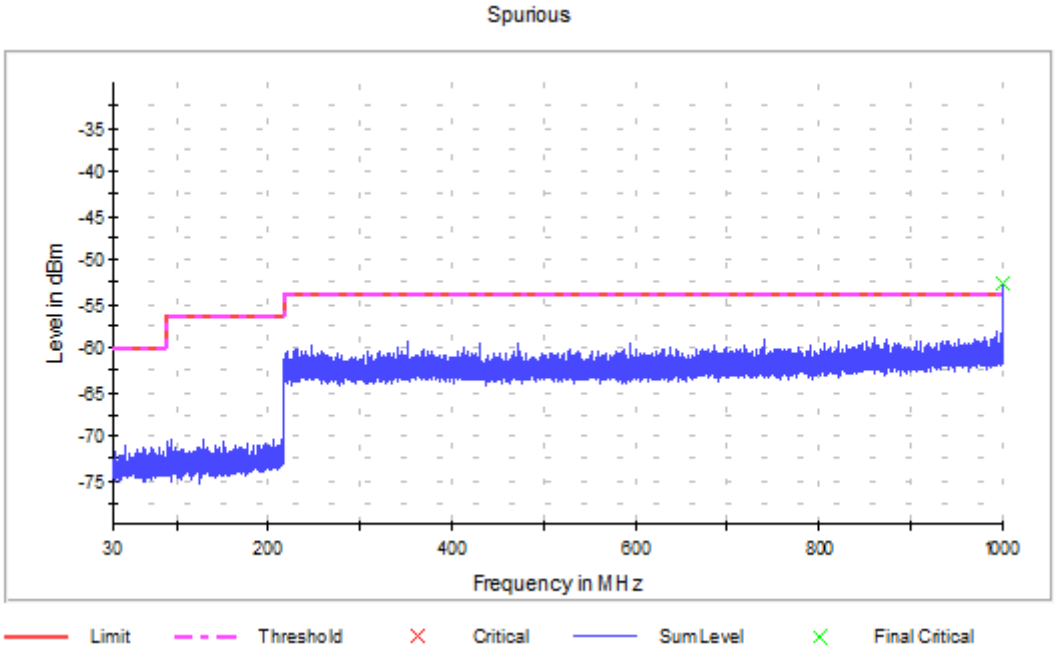
Critical Frequency (MHz)	Quasi-Peak (dBm)	Quasi-Peak Limit (dBm)	Margin (dB)
1000	-55.7	-53.9	-1.8

Emissions Below 1000MHz Transmitting 5200 MHz at Power Level 20:



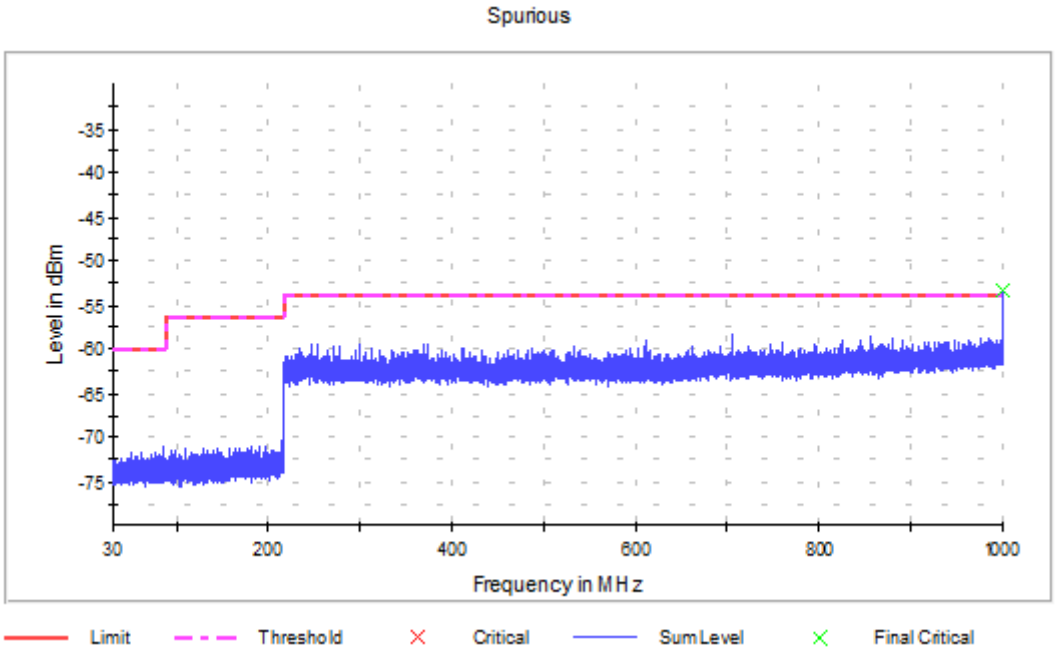
Critical Frequency (MHz)	Quasi-Peak (dBm)	Quasi-Peak Limit (dBm)	Margin (dB)
1000	-55.6	-53.9	-1.7

Emissions Below 1000MHz Transmitting 5220 MHz at Power Level 20:



Critical Frequency (MHz)	Quasi-Peak (dBm)	Quasi-Peak Limit (dBm)	Margin (dB)
1000	-55.5	-53.9	-1.6

Emissions Below 1000MHz Transmitting 5240 MHz at Power Level 20:



Critical Frequency (MHz)	Quasi-Peak (dBm)	Quasi-Peak Limit (dBm)	Margin (dB)
1000	-55.4	-53.9	-1.5

Radiated Emissions Above 1000MHz Transmitting 5180 MHz at Power Level 20:

Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBµV)	Correction Factor (dB)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
1000	Peak	Vertical	24.4	27.0	51.3	74.0	-22.7
1000	Average	Vertical	20.8	27.0	47.7	54.0	-6.3
1000	Peak	Horizontal	27.3	27.0	54.3	74.0	-19.8
1000	Average	Horizontal	24.2	27.0	51.1	54.0	-2.9
1500	Peak	Vertical	16.9	28.6	45.5	74.0	-28.5
1500	Average	Vertical	7.9	28.6	36.5	54.0	-17.5
1500	Peak	Horizontal	17.2	28.6	45.8	74.0	-28.2

Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBµV)	Correction Factor (dB)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
1500	Average	Horizontal	9.9	28.6	38.5	54.0	-15.5
3000	Peak	Vertical	16.6	34.9	51.5	74.0	-22.5
3000	Average	Vertical	7.7	34.9	42.7	54.0	-11.3
3000	Peak	Horizontal	17.1	34.9	52.0	74.0	-22.0
3000	Average	Horizontal	6.1	34.9	41.1	54.0	-12.9
10358.5	Peak	Vertical	29.8	21.7	51.5	74.0	-22.6
10358.5	Average	Vertical	17.5	21.7	39.2	54.0	-14.8
10358.5	Peak	Horizontal	29.6	21.7	51.3	74.0	-22.7
10358.5	Average	Horizontal	16.9	21.7	38.6	54.0	-15.4
15536	Peak	Vertical	59.2	-14.3	44.9	74.0	-29.1
15536	Average	Vertical	46.2	-14.3	31.9	54.0	-22.2
15541	Peak	Horizontal	59.5	-14.4	45.2	74.0	-28.8
15541	Average	Horizontal	46.9	-14.4	32.5	54.0	-21.5

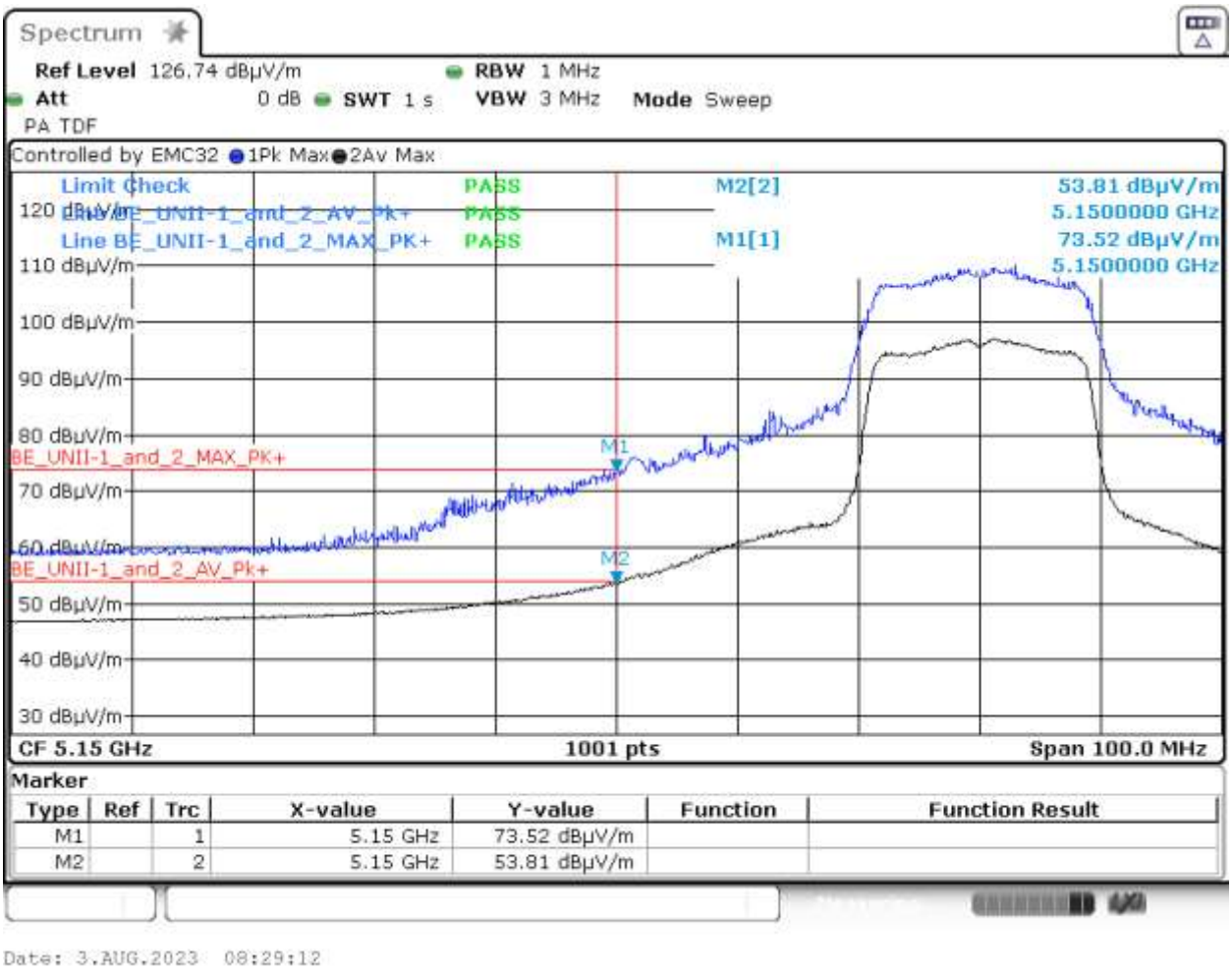
Radiated Emissions Above 1000MHz Transmitting 5220 MHz at Power Level 20:

Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBµV)	Correction Factor (dB)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
1000	Peak	Vertical	24.5	27.0	51.4	74.0	-22.6
1000	Average	Vertical	20.7	27.0	47.6	54.0	-6.4
1000	Peak	Horizontal	27.3	27.0	54.2	74.0	-19.8
1000	Average	Horizontal	24.4	27.0	51.3	54.0	-2.7
1500	Peak	Vertical	17.0	28.6	45.6	74.0	-28.4
1500	Average	Vertical	7.7	28.6	36.3	54.0	-17.7
1500	Peak	Horizontal	18.5	28.6	47.1	74.0	-26.9
1500	Average	Horizontal	10.3	28.6	38.9	54.0	-15.1
3000	Peak	Vertical	17.7	34.9	52.7	74.0	-21.3
3000	Average	Vertical	7.7	34.9	42.6	54.0	-11.4
3000	Peak	Horizontal	17.0	34.9	51.9	74.0	-22.1
3000	Average	Horizontal	6.1	34.9	41.0	54.0	-13.0
10439	Peak	Vertical	29.1	21.7	50.8	74.0	-23.2
10439	Average	Vertical	17.3	21.7	39.0	54.0	-15.0
10440	Peak	Horizontal	29.2	21.7	50.9	74.0	-23.1

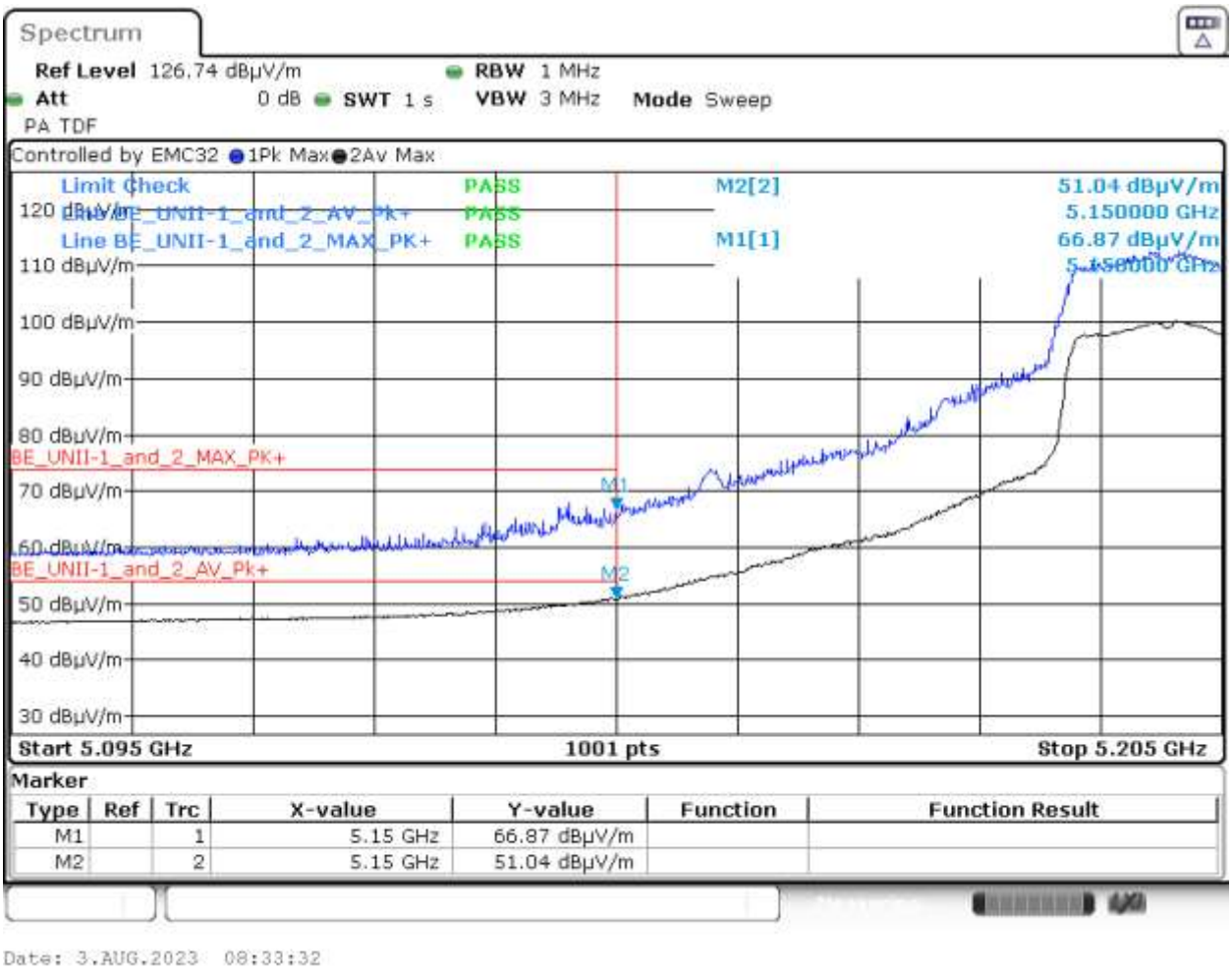
Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBµV)	Correction Factor (dB)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
10440	Average	Horizontal	16.9	21.7	38.6	54.0	-15.4
15656.5	Peak	Vertical	58.7	-14.3	44.3	74.0	-29.7
15656.5	Average	Vertical	46.5	-14.3	32.2	54.0	-21.8
15660.5	Peak	Horizontal	57.8	-14.3	43.5	74.0	-30.5
15660.5	Average	Horizontal	45.9	-14.3	31.6	54.0	-22.4

Radiated Emissions Above 1000MHz Transmitting 5240 MHz at Power Level 20:

Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBµV)	Correction Factor (dB)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
1000	Peak	Vertical	24.4	27.0	51.4	74.0	-22.6
1000	Average	Vertical	21.1	27.0	48.1	54.0	-5.9
1000	Peak	Horizontal	27.1	27.0	54.1	74.0	-19.9
1000	Average	Horizontal	24.9	27.0	51.8	54.0	-2.2
1500	Peak	Vertical	16.6	28.6	45.2	74.0	-28.8
1500	Average	Vertical	7.6	28.6	36.2	54.0	-17.8
1500	Peak	Horizontal	17.5	28.6	46.2	74.0	-27.8
1500	Average	Horizontal	10.1	28.6	38.7	54.0	-15.3
3000	Peak	Vertical	17.0	34.9	51.9	74.0	-22.1
3000	Average	Vertical	7.8	34.9	42.7	54.0	-11.3
3000	Peak	Horizontal	16.3	34.9	51.2	74.0	-22.8
3000	Average	Horizontal	5.9	34.9	40.8	54.0	-13.2
10479	Peak	Vertical	29.1	21.7	50.9	74.0	-23.1
10479	Average	Vertical	17.0	21.7	38.7	54.0	-15.3
10479	Peak	Horizontal	29.8	21.7	51.5	74.0	-22.5
10479	Average	Horizontal	16.8	21.7	38.5	54.0	-15.5
15718.5	Peak	Vertical	58.8	-14.3	44.4	74.0	-29.6
15718.5	Average	Vertical	46.4	-14.3	32.1	54.0	-21.9
15722.5	Peak	Horizontal	59.0	-14.3	44.6	74.0	-29.4
15722.5	Average	Horizontal	47.2	-14.3	32.9	54.0	-21.2



Graph 9: Radiated Restricted Band Edge Transmitting at 5180 MHz (Power Level 20, -0.2dB Margin)



Graph 10: Radiated Restricted Band Edge Transmitting at 5200 MHz (Power Level 20, -3.0 dB Margin)

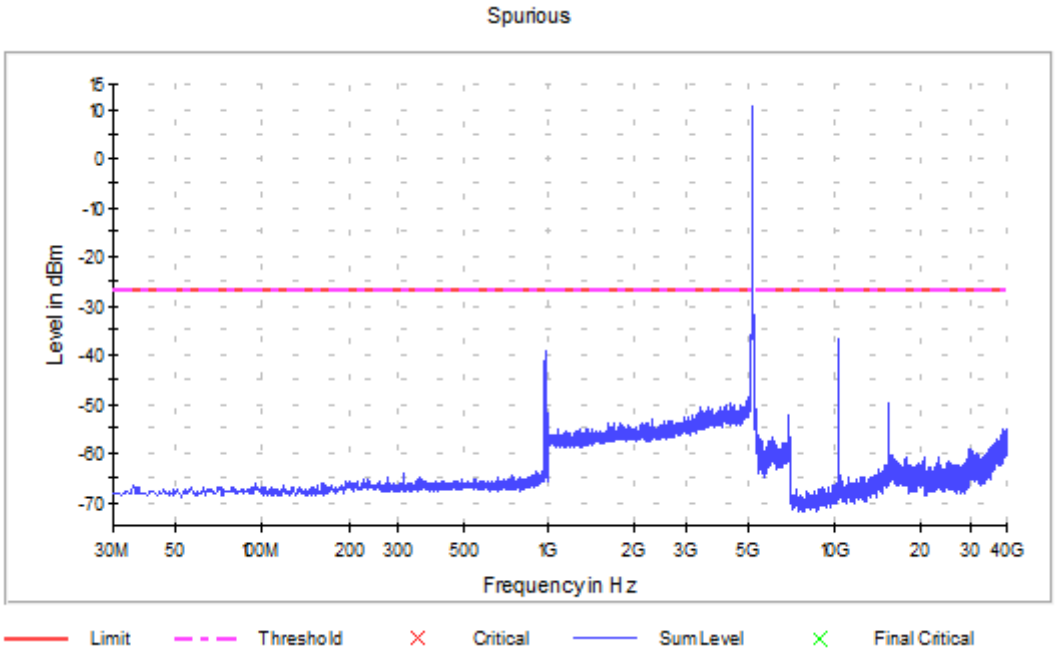
Result

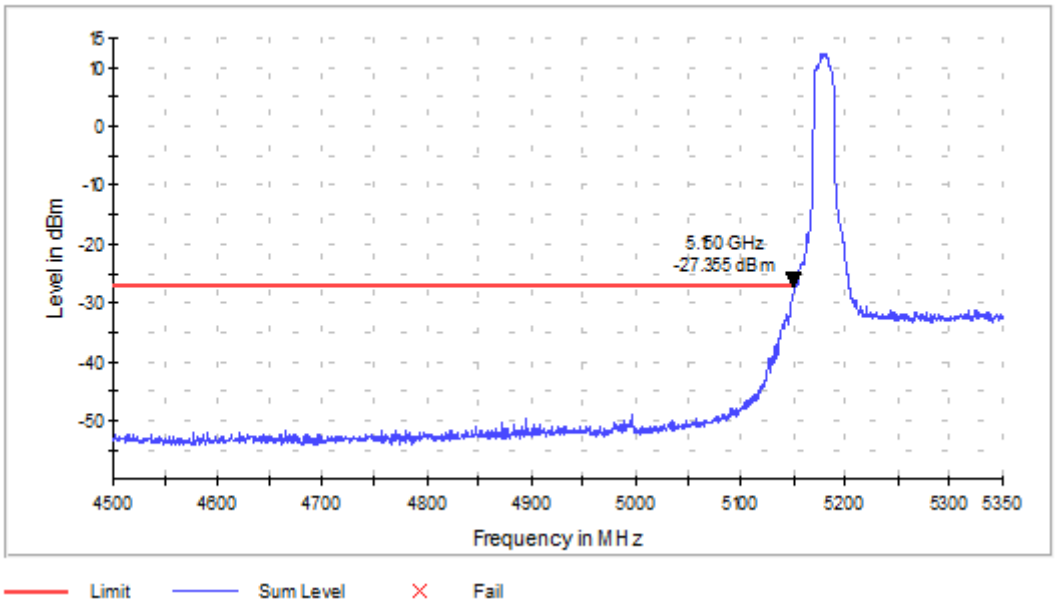
The EUT complied with the specification limit by a margin of 0.2 dB.

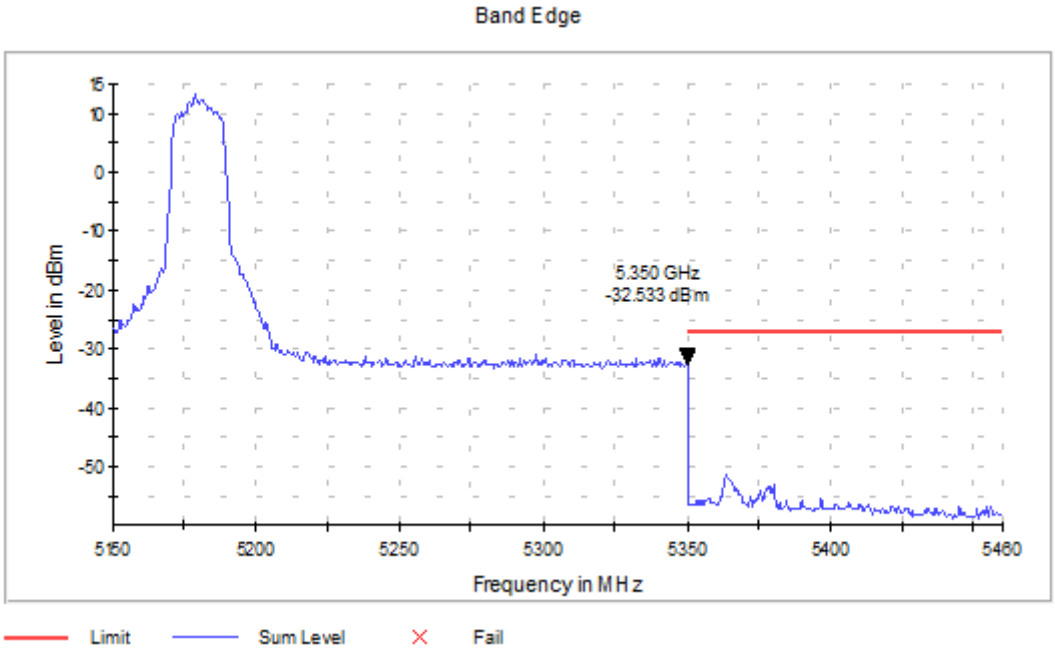
6.2.6 §15.407(b) Undesirable Emissions (Full Spectrum and Band Edges)

Band Edge and Spurious Emissions were tested as antenna-port conducted at the intended power setting per channel. No undesirable emissions were detected that exceeded -27dBm/MHz.

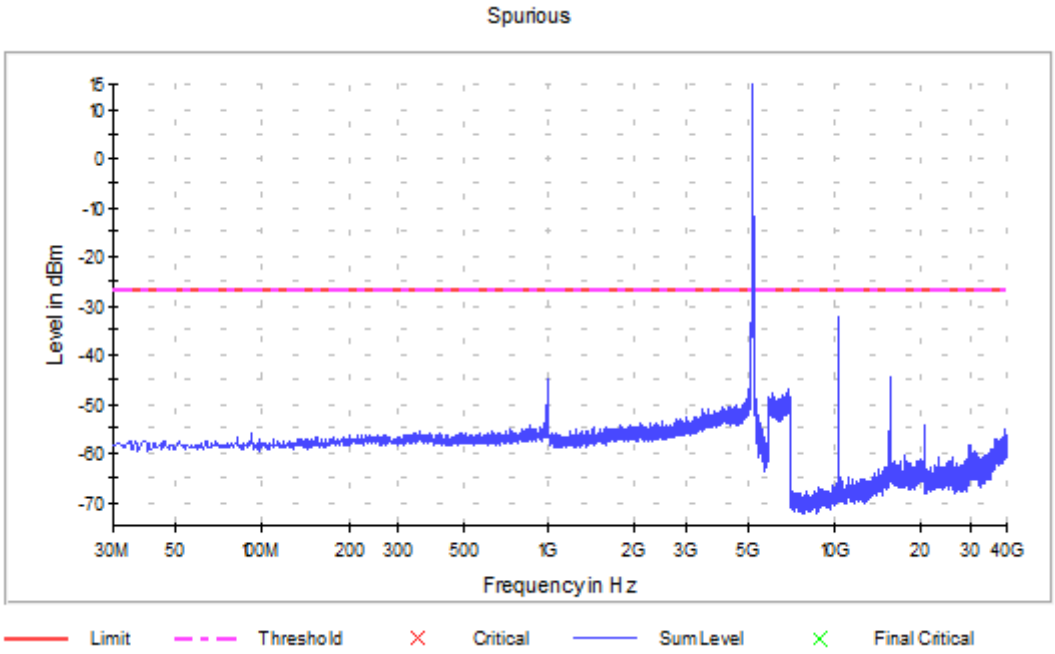
Transmitting on 5180 MHz (Power Level 16):



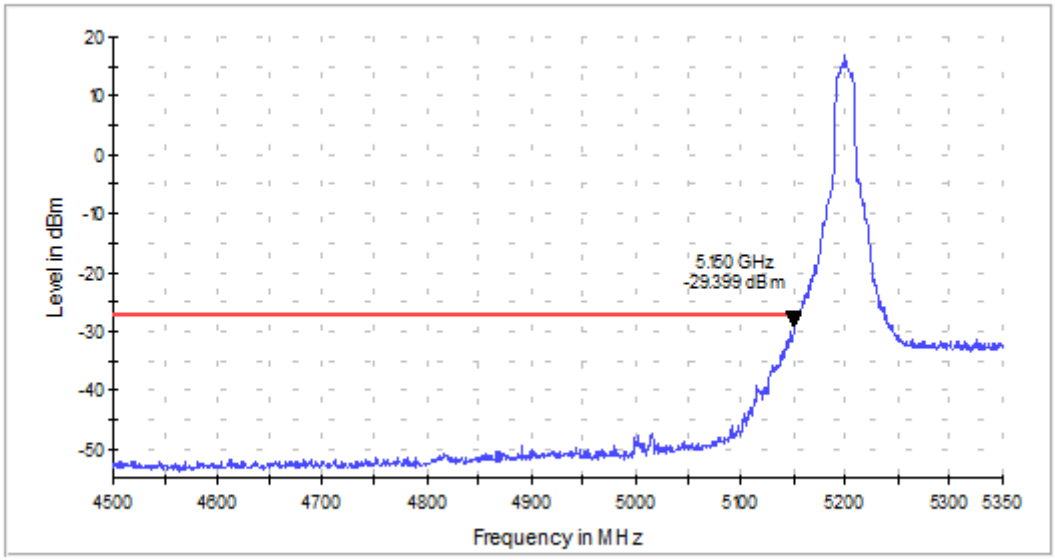




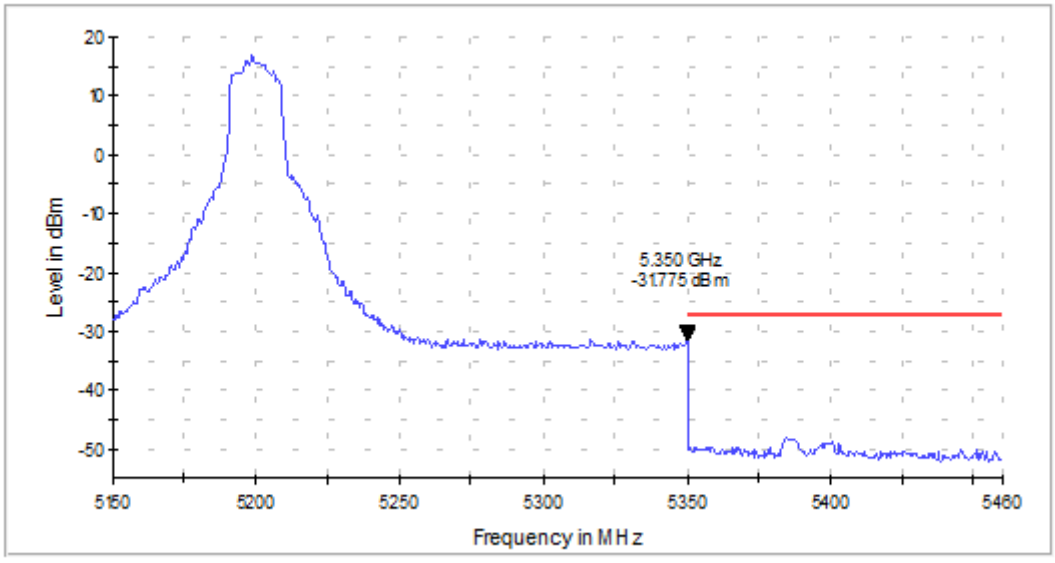
Transmitting on 5200 MHz (Power Level 20):



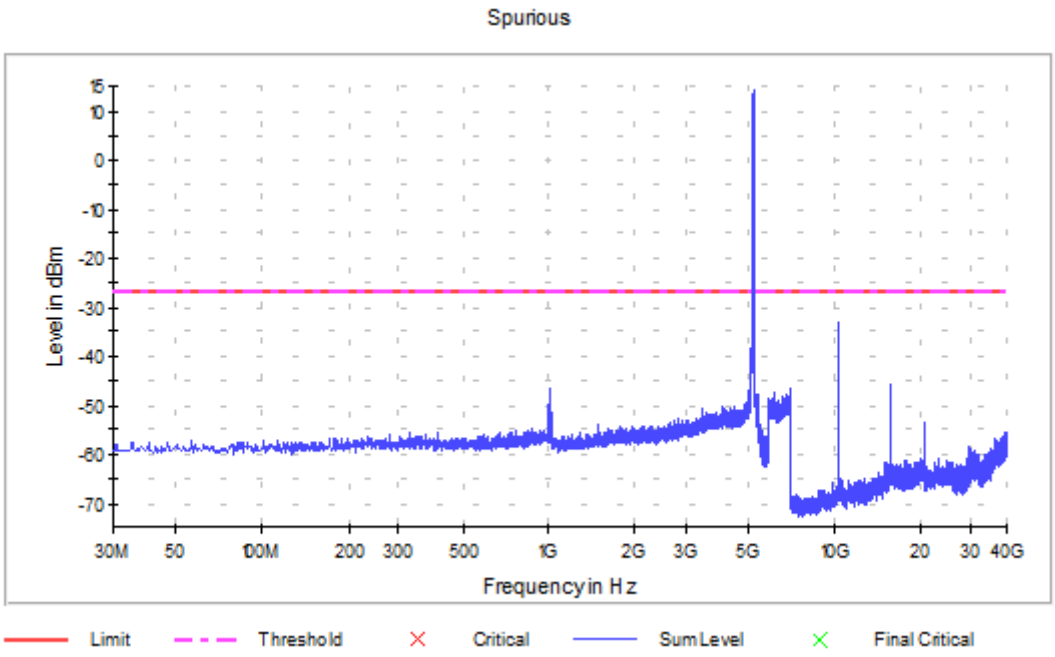
Band Edge

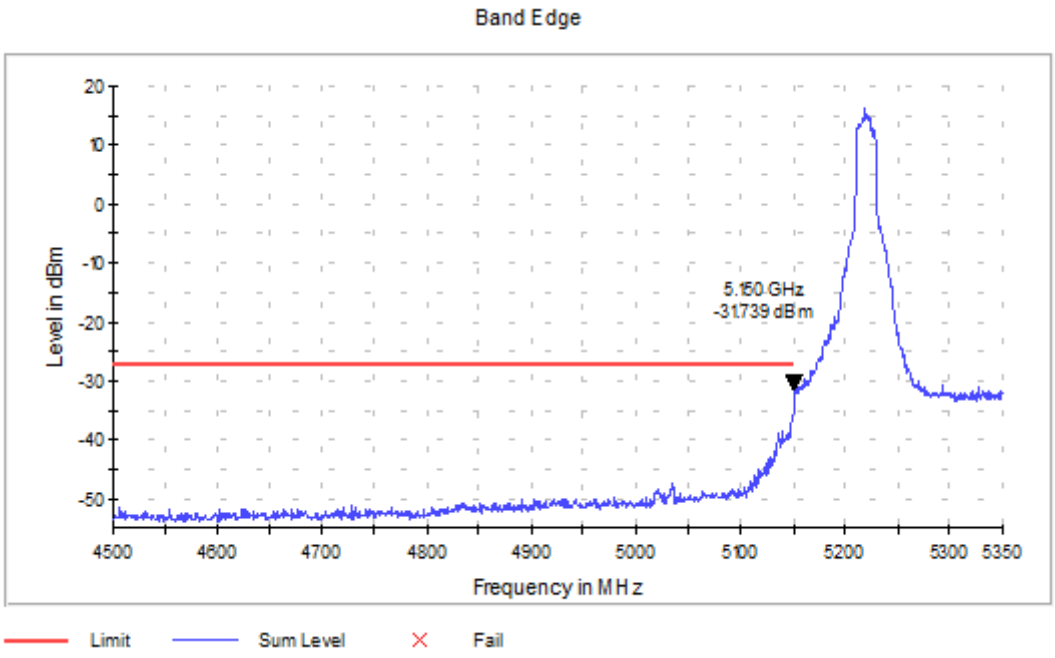


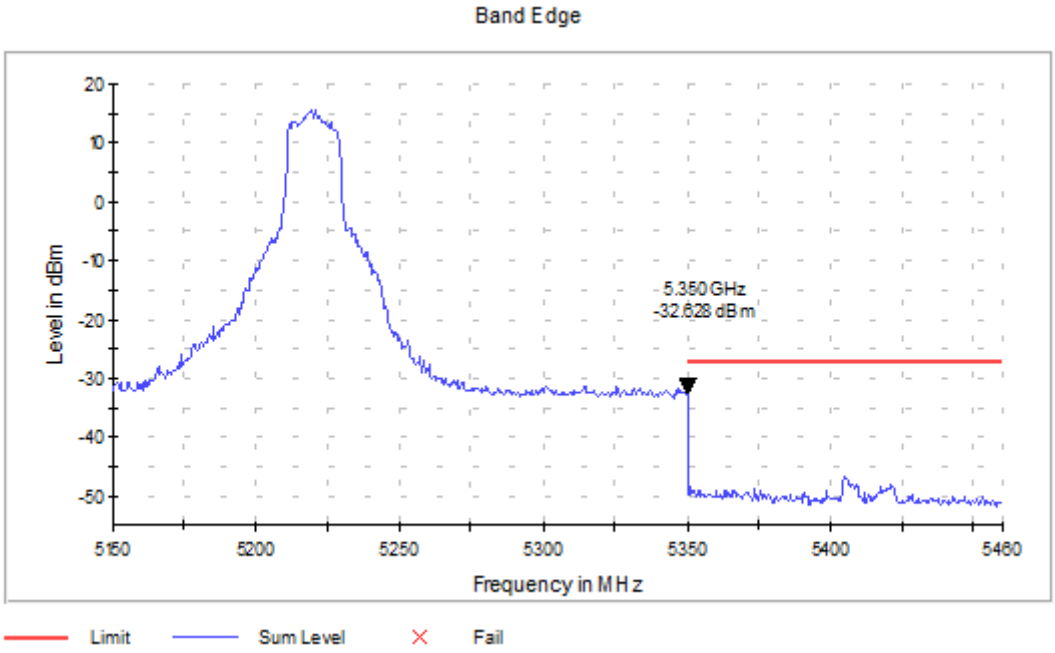
Band Edge



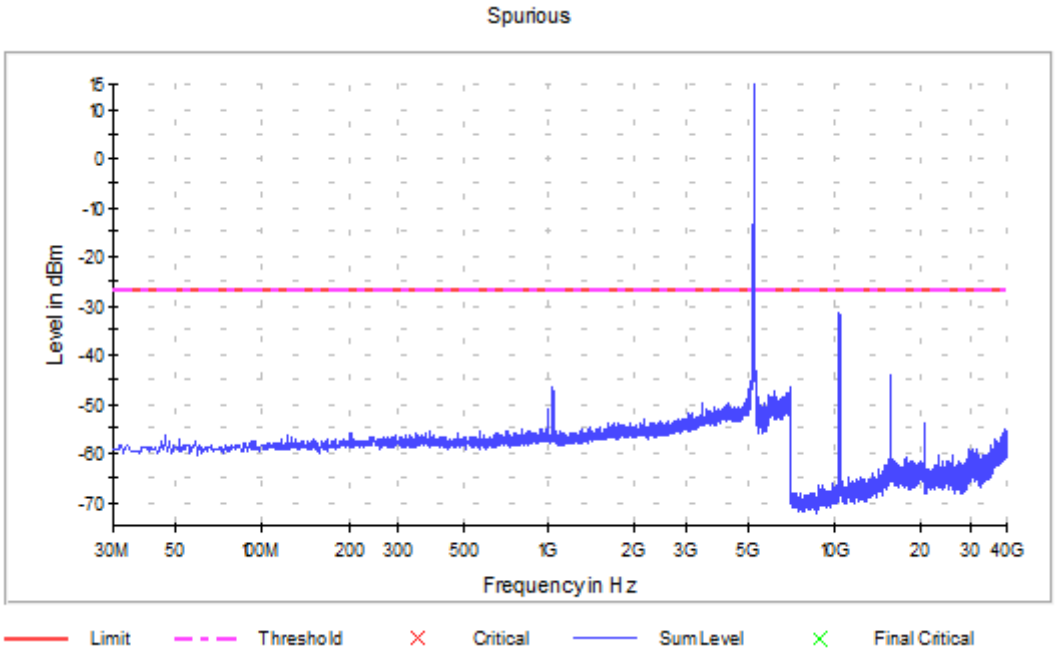
Transmitting on 5220 MHz (Power Level 20):

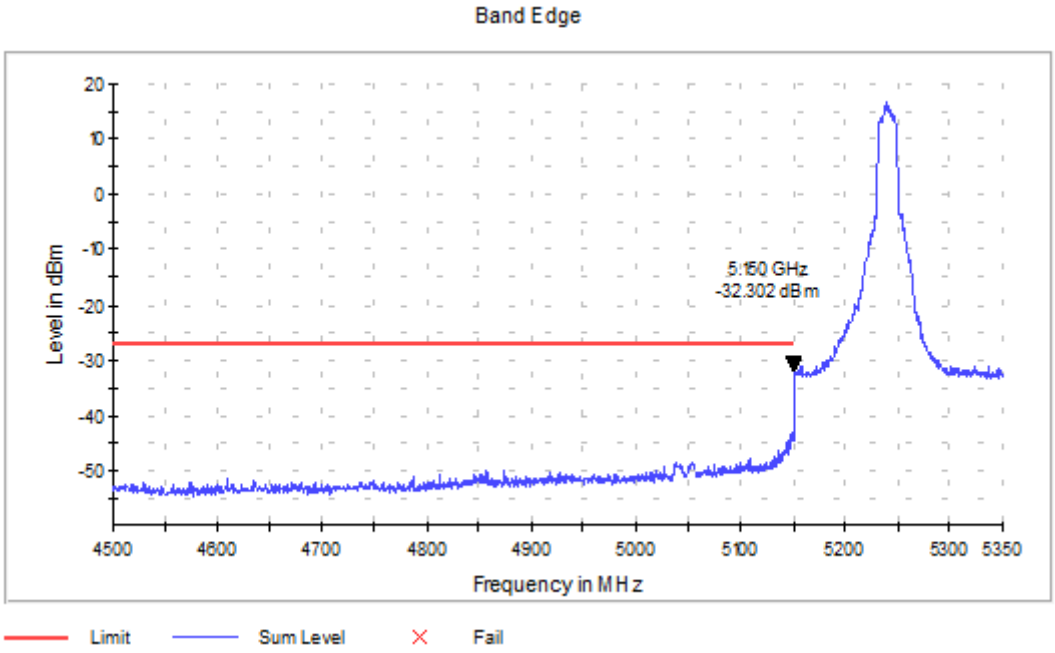


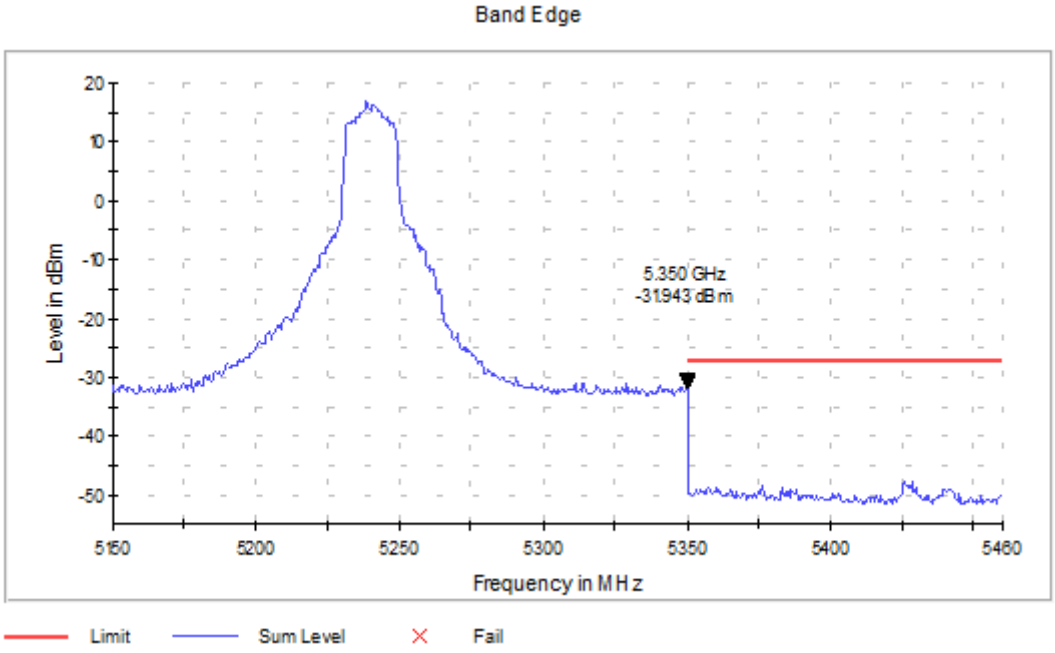




Transmitting on 5240 MHz (Power Level 20):







Result

The EUT complied with the specification.

6.2.7 §15.407(a)(1) Power Limits: UNII-1 Outdoor EIRP

EUT does not operate outdoors.

Result

In the configurations tested the EUT complied with the requirements of the specification.

7 Test Procedures and Test Equipment

7.1 Conducted Emissions at Mains Ports

The conducted emissions at mains and telecommunications ports from the EUT were measured using a spectrum analyzer with a quasi-peak adapter for peak, quasi-peak and average readings. The quasi-peak adapter uses a bandwidth of 9 kHz, with the spectrum analyzer's resolution bandwidth set at 100 kHz, for readings in the 150 kHz to 30 MHz frequency ranges.

The conducted emissions at mains ports measurements are performed in a screen room using a (50 Ω/50 µH) Line Impedance Stabilization Network (LISN).

Where mains flexible power cords are longer than 1 m, the excess cable is folded back and forth as far as possible so as to form a bundle not exceeding 0.4 m in length.

Where the EUT is a collection of devices with each device having its own power cord, the point of connection for the LISN is determined from the following rules:

- Each power cord, which is terminated in a mains supply plug, shall be tested separately.
- Power cords, which are not specified by the manufacturer to be connected via a host unit, shall be tested separately.
- Power cords which are specified by the manufacturer to be connected via a host unit or other power supplying equipment shall be connected to that host unit and the power cords of that host unit connected to the LISN and tested.
- Where a special connection is specified, the necessary hardware to effect the connection is supplied by the manufacturer for the testing purpose.
- When testing equipment with multiple mains cords, those cords not under test are connected to an artificial mains network (AMN) different than the AMN used for the mains cord under test.

For testing, desktop EUT are placed on a non-conducting table at least 0.8 meters from the metallic floor and placed 40 cm from the vertical coupling plane (copper plating in the wall behind EUT table). Floor standing equipment is placed directly on the earth grounded floor.

Type of Equipment	Manufacturer	Model Number	Asset Number	Date of Last Calibration	Due Date of Calibration
Spectrum Analyzer/Receiver	Rohde & Schwarz	ESU40	V033119	08/24/2022	08/24/2023
Spectrum Analyzer/ Signal Analyzer	Rohde & Schwarz	FSV40	V044352	03/08/2022	03/08/2024
LISN	Teseq	NNB 51	V045406	12/05/2022	12/05/2023
Conductance Cable Wanship Upper Site	VPI Labs	Cable J	V034832	12/23/2022	12/23/2023
EMC32 Test Software	Rohde & Schwarz	10.60.20	N/A	N/A	N/A

Table 5: List of equipment used for conducted emissions testing at mains ports.

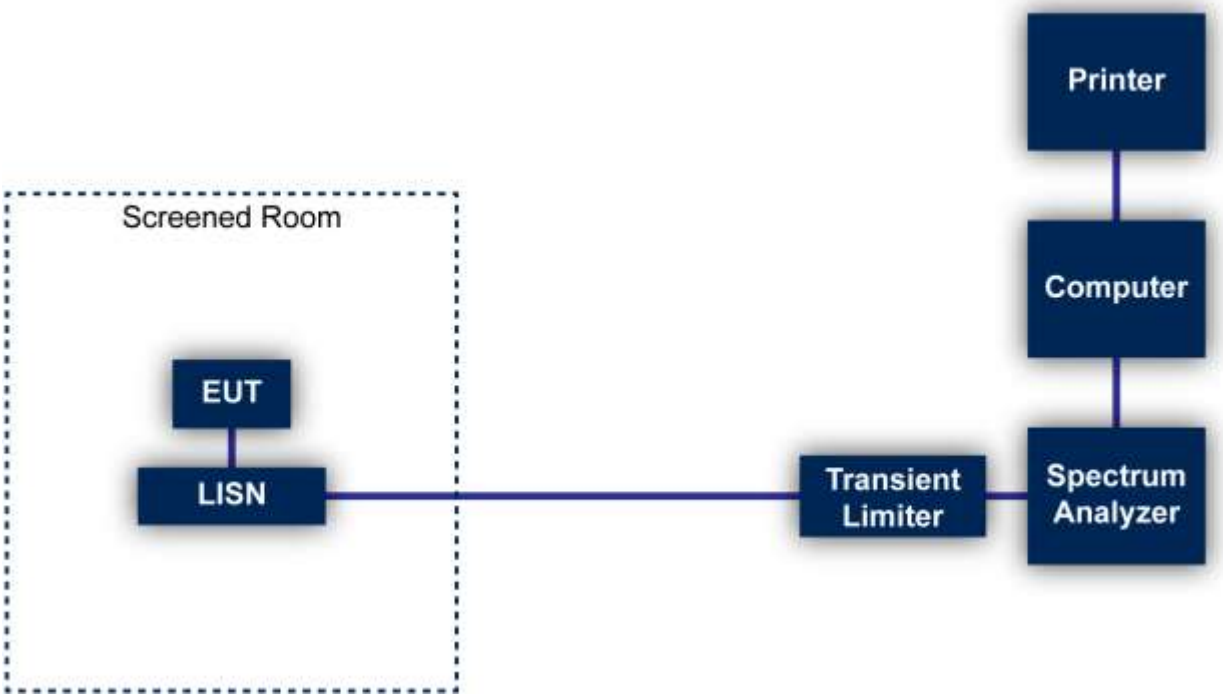


Figure 2: Mains Conducted Emissions Test

7.2 Direct Connection at the Antenna Port Test

Type of Equipment	Manufacturer	Model Number	Asset Number	Date of Last Calibration	Due Date of Calibration
Spectrum Analyzer	Rohde & Schwarz	FSV40	V044352	03/08/2022	03/08/2024
40GHz Switch Base Unit	Rohde & Schwarz	OSP-120	V044487	03/23/2022	04/30/2024

Table 6: List of equipment used for conducted emissions testing at antenna ports.

7.2.1 Test Configuration Block Diagram

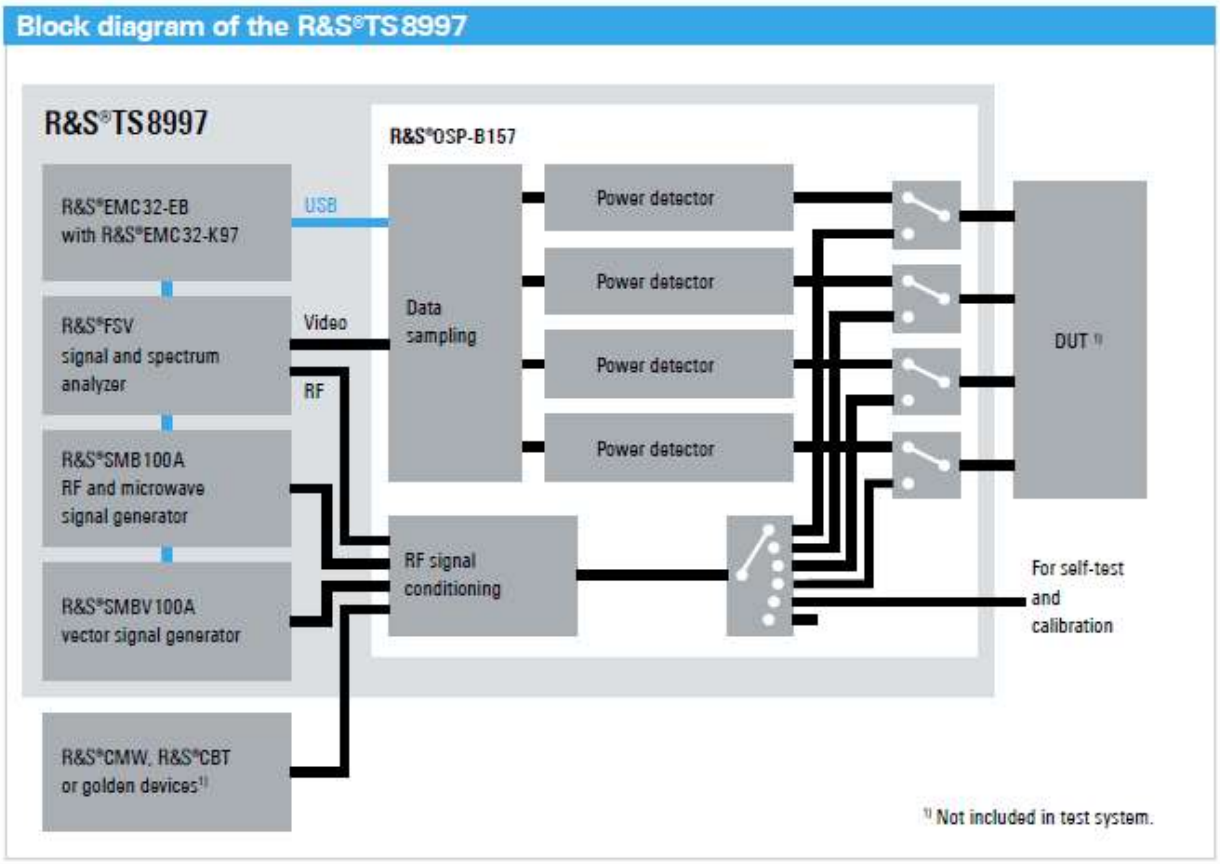


Figure 3: Direct Connection at the Antenna Port Test

7.3 Radiated Emissions

The radiated emissions from the EUT were measured using a spectrum analyzer with a quasi-peak adapter for peak and quasi-peak readings.

A preamplifier with a fixed gain was used to increase the sensitivity of the measuring instrumentation. The quasi-peak adapter uses a bandwidth of 120 kHz, with the spectrum analyzer's resolution bandwidth set at 1 MHz, for readings in the 30 to 1000 MHz frequency ranges. For frequencies below 30 MHz, a 9 kHz resolution Bandwidth was used.

A loop antenna was used to measure frequencies below 30 MHz. A biconilog antenna was used to measure the frequency range of 30 to 1000 MHz, at a distance of 3 meters from the EUT. The readings obtained by these antennas are correlated to the levels obtained with a tuned dipole antenna by adding antenna factors. A double-ridged guide antenna was used to measure the emissions at frequencies above 1000 MHz at a 3 meter or 1 meter distance from the EUT.

The configuration of the EUT was varied to find the maximum radiated emission. The EUT was connected to the peripherals listed in Section 2.3 via the interconnecting cables listed in Section 2.4. A technician manually manipulated these interconnecting cables to obtain worst-case radiated emissions. The EUT was rotated 360 degrees, and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission. Where there were multiple interface ports all of the same type, cables are either placed on all of the ports or cables added to these ports until the emissions do not increase by more than 2 dB.

Desktop EUT are measured on a non-conducting table 0.8 meters above the ground plane. For frequencies above 1000 MHz, the EUT is placed on a table 1.5 meters above the ground plane. The table is placed on a turntable, which is level with the ground plane. For equipment normally placed on floors, the equipment shall be placed directly on the turntable.

For radiated emissions testing that is performed at distances closer than the specified distance; an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

Type of Equipment	Manufacturer	Model Number	Asset Number	Date of Last Calibration	Due Date of Calibration
Spectrum Analyzer/Receiver	Rohde & Schwarz	ESU40	V033119	08/24/2022	08/24/2023
Spectrum Analyzer/ Signal Analyzer	Rohde & Schwarz	FSV40	V044352	03/08/2022	03/08/2024
Loop Antenna	EMCO	6502	V034216	04/27/2023	04/27/2024
Biconilog Antenna	EMCO	3142E	V057461	06/06/2023	06/06/2025
Power Amplifier	HP	5086-7005	V067767	03/14/2023	03/14/2024
Double Ridged Guide Antenna	EMCO	3115	V034413	01/25/2023	01/25/2025
Standard Gain Horn	ETS-Lindgren	3160-09	V034223	ICO	ICO
High Frequency Amplifier	Miteq	AFS4-001018000-35-10P-4	V033997	12/21/2022	12/21/2023
900 MHz High Pass Filter	Micro-Tronics	HPM50108-03	V034185	12/21/2022	12/21/2023
2.4 GHz High Pass Filter	Micro-Tronics	HPM50111-03	V034183	12/21/2022	12/21/2023
2.4 GHz Notch Filter	Micro-Tronics	BRM50702-03	V034213	12/21/2022	12/21/2023
6’ High Frequency Cable	Microcoax	UFB197C-0-0720-000000	V033638	12/21/2022	12/21/2023
20’ High Frequency Cable	Microcoax	UFB197C-1-3120-000000	V033979	12/21/2022	12/21/2023
3 Meter Radiated Emissions Cable Wanship Upper Site	Microcoax	UFB205A-0-4700-000000	V033639	12/21/2022	12/21/2023
EMC32 Test Software	Rohde & Schwarz	10.60.20	N/A	N/A	N/A

Table 7: List of equipment used for radiated emissions testing.

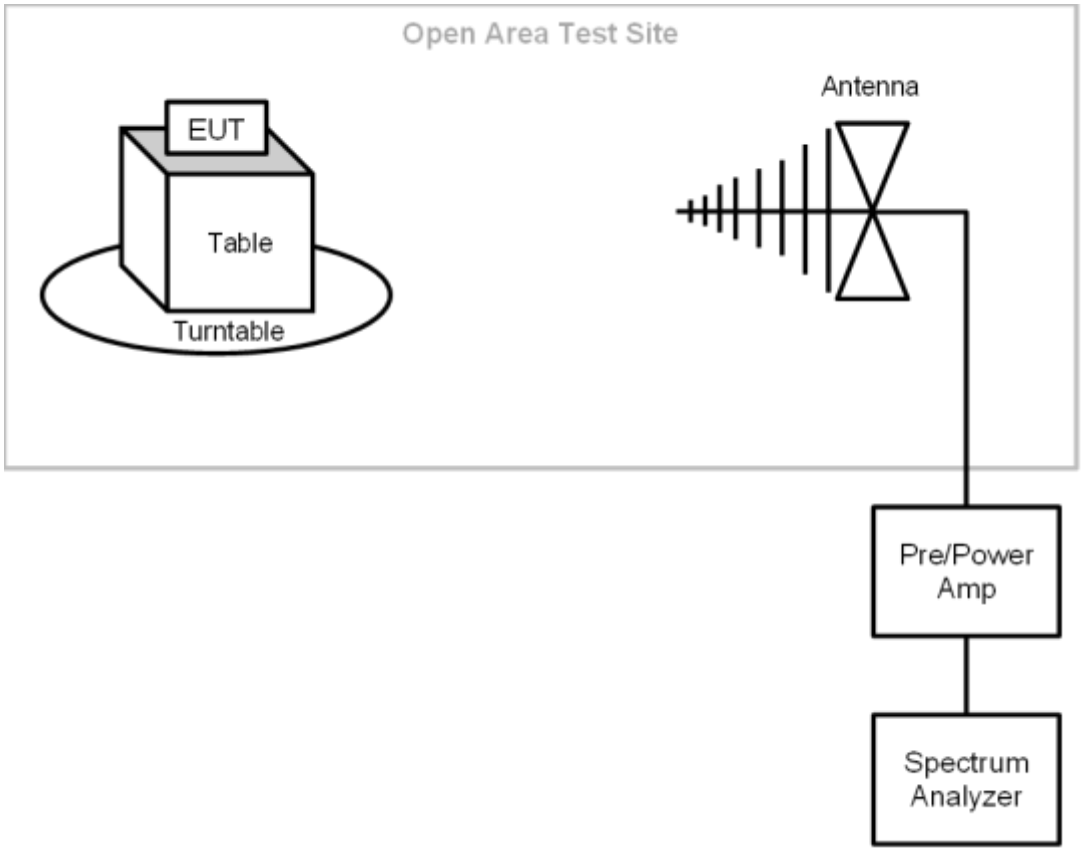


Figure 4: Radiated Emissions Below 1GHz Test

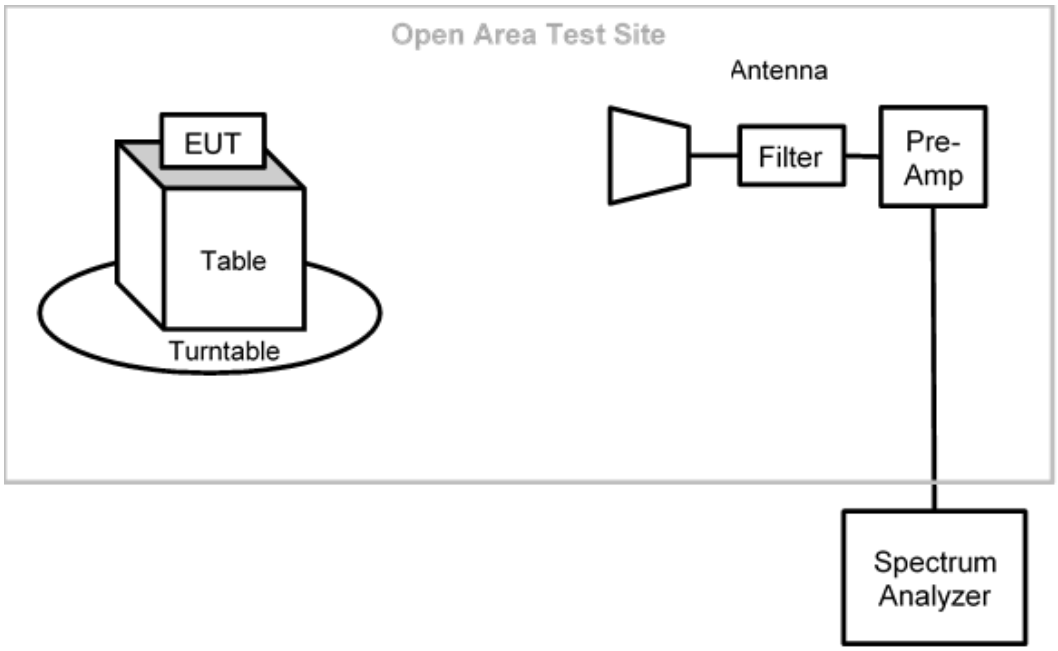


Figure 5: Radiated Emissions Above 1GHz Test

7.4 Equipment Calibration

All applicable equipment is calibrated using either an independent calibration laboratory or VPI Laboratories, Inc. personnel at intervals defined in ANSI C63.4:2014 following outlined calibration procedures. All measurement instrumentation is traceable to the National Institute of Standards and Technology (NIST). Supporting documentation relative to tractability is on file and is available for examination upon request.

7.5 Measurement Uncertainty

Test	Uncertainty (±dB)	Confidence (%)
Conducted Emissions	2.8	95
Radiated Emission (9 kHz to 30 MHz)	3.3	95
Radiated Emissions (30 MHz to 1 GHz)	3.4	95
Radiated Emissions (1 GHz to 18 GHz)	5.0	95
Radiated Emissions (18 GHz to 40 GHz)	4.1	95

8 Photographs

Photographs are contained in an external appendix.

--- End of Report ---