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Test Report

Certification

FCC ID	SWX-LTU5S
Equipment Under Test	LTU-LR
Test Report Serial No	V048525_01
Dates of Test	May 8, 14, 22, and 23, 2019, June 3 – 6, 13, and 19, 2019, and July 2, 3, 8, and 17, 2019
Report Issue Date	July 24, 2019

Test Specifications:	Applicant:
FCC Part 15, Subpart E	Ubiquiti Networks, Inc. 685 Third Avenue, 27th Floor New York, NY 10017 U.S.A.

NVLAP Testing
NVLAP Lab Code 100272-0

Certification of Engineering Report

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Applicant	Ubiquiti Networks, Inc.
Manufacturer	Ubiquiti Networks, Inc.
Brand Name	LTU
Model Number	LTU-LR
FCC ID	SWX-LTU5S

On this 24th day of July 2019, 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.

Radiated Measurements by: Norman P. Hansen

Conducted Measurements by: Jason Stewart

Reviewed by: Benjamin N. Antczak

Revision History		
Revision	**Description**	**Date**
01	Original Report Release	July 24, 2019
02	Corrected Conducted Power Tables	July 25, 2019

Table of Contents

1 Client Information

1.1 Applicant

Company Name	Ubiquiti Networks, Inc. 685 Third Avenue, 27th Floor New York, NY 10017 U.S.A.
Contact Name	Mark Feil
Title	Compliance Manager

1.2 Manufacturer

Company Name	Ubiquiti Networks, Inc. 685 Third Avenue, 27th Floor New York, NY 10017 U.S.A.
Contact Name	Mark Feil
Title	Compliance Manager

2 Equipment Under Test (EUT)

2.1 Identification of EUT

Brand Name	LTU
Model Number	LTU-LR
Hardware Version	07
Serial Number	None
Dimensions (cm)	37 diameter x 25

2.2 Description of EUT

The LTU-LR is a fixed point to point transceiver, meant for outdoor use, operating in the UNII-1 and UNII-3 frequency bands. A Bluetooth LE transceiver is included for device management. An Ethernet port is used for data transfer and to provide power using a POE-24V-5X-HD POE supply.

The UNII-1 transceiver and UNII-3 transceiver use 5 modulation bandwidths with channels spaced 5 MHz apart. Modulation bandwidths of 10 MHz, 20 MHz, 30 MHz, 40 MHz, and 50 MHz are used. There are 2 antennas on the PCB, one vertically polarized and on horizontally polarized, with reflectors. The maximum gain is 24 dBi. The table below show the channels used in each band with the different modulation bandwidths and maximum power settings.

Band	Modulation Bandwidth	Frequency (MHz)	Maximum Power Setting
UNII-1	10 MHz	5160	TP2
		5165	TP12
		5170, 5175, 5180, 5185, 5185, 5190, 5195, 5200, 5205, 5210, 5215, 5220, 5225, 5230, 5235, 5240, 5245	TP14
	20 MHz	5165	TP2
		5170, 5175, 5180	TP9
		5185, 5190, 5195, 5200	TP10
		5205, 5210, 5215, 5220, 5225, 5230, 5235, 5240	TP15
	30 MHz	5170	TP2
		5175	TP7
		5180	TP11
		5185	TP12
		5190, 5195	TP13
		5200, 5205, 5210, 5215, 5220, 5225, 5230, 5235	TP15
	40 MHz	5175	TP2
		5180	TP4
		5185	TP6

Band	Modulation Bandwidth	Frequency (MHz)	Maximum Power Setting
		5190, 5195	TP7
		5200, 5205, 5210	TP8
		5215, 5220, 5225, 5230	TP15
	50 MHz	5180	TP2
		5185	TP4
		5190, 5195, 5200, 5205	TP6
		5210, 5215, 5220, 5225	TP7
UNII-3	10 MHz	5730, 5735, 5740, 5745, 5750, 5755, 5760, 5765, 5770, 5775, 5780, 5785, 5790, 5795, 5800, 5805, 5810, 5815, 5820, 5825, 5830, 5835, 5840, 5845	TP19
	20 MHz	5735, 5740, 5745, 5750, 5755, 5760, 5765, 5770, 5775, 5780, 5785, 5790, 5795, 5800, 5805, 5810, 5815, 5820, 5825, 5830, 5835, 5840	TP19
	30 MHz	5740, 5745, 5750, 5755, 5760, 5765, 5770, 5775, 5780, 5785, 5790, 5795, 5800, 5805, 5810, 5815, 5820, 5825, 5830, 5835	TP19
	40 MHz	5745, 5750, 5755, 5760, 5765, 5770, 5775, 5780, 5785, 5790, 5795, 5800, 5805, 5810, 5815, 5820, 5825, 5830	TP19
	50 MHz	5750, 5755, 5760, 5765, 5770, 5775, 5780, 5785, 5790, 5795, 5800, 5805, 5810, 5815, 5820, 5825	TP19

2.2.1 Modes of Operation

The EUT is intended to operate outdoors as a master device. The EUT is fixed and capable of fixed point-to-point architecture, subject to relaxed limits when deployed as such.

2.2.2 DFS Capabilities

The EUT is designed to operate only in the UNII-1 and UNII-3 bands which are not subject to DFS requirements. The EUT shall not operate any part of its 26 dB emission bandwidth in the bands UNII-2 bands (5.25 – 5.35 GHz and 5.47 – 5.725 GHz).

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: LTU MN: LTU-LR (Note 1) SN: None	Point to Point Transceiver	See Section 2.4
BN: Ubiquiti MN: POE-24V-5X-HD (Note 1) SN: None	POE Supply	See Section 2.4
BN: Dell MN: XPS SN: None	Computer	Ethernet/Shielded Cat 5e cable (Note 2)

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

2.4.1 Interface ports on the LTU-LR

Name of Ports	No. of Ports Fitted to EUT	Cable Description/Length
POE/Data	1	Shielded Cat 5e cable/8 meters

2.4.2 Interface ports on the POE-24V-5X-HD Supply

Name of Ports	No. of Ports Fitted to EUT	Cable Description/Length
AC	1	3 conductor power cord/80 cm
Data	1	Shielded Cat 5e cable/1 meters
POE/Data	1	Shielded Cat 5e cable/8 meters

2.5 Modification Incorporated/Special Accessories on EUT

The following modifications were made to the EUT by the Client during testing to comply with the specification. This report is not complete without an accompanying signed attestation, that the product will have all of the documented modifications incorporated into the product when manufactured and placed on the market.

- Metal RF shields were placed over the UNII-1 and UNII-3 transceiver circuitry. The RF shields had RF absorber material placed inside between the components and the shield. Copper tape was placed on the shields, connecting them together and was soldered to the PCB ground plane. See Photographs 13 - 18.
- The maximum power settings were adjusted and will be limited in firmware as shown in the table of section 2.2 of this report.

2.6 Deviation from Test Standard

There were no deviations from the test specification.

2.7 Scope of This Report

This report covers the transmitter operating in the UNII-3 band only. The UNII-1 frequency band and Bluetooth LE transmitters are covered in separate reports, VPI Laboratories, Inc. reports V048427 and V048525. The circuitry of this device subject to FCC Part 15, Subpart B was found compliant and covered in VPI Laboratories, Inc. report #V048426.

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 D02 General U-NII Test Procedures New Rules v02r01 KDB 905462 D02 UNII DFS Compliance Procedures New Rules v02 KDB 662911 D02 MIMO with Cross-Polarized Antennas v01

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.

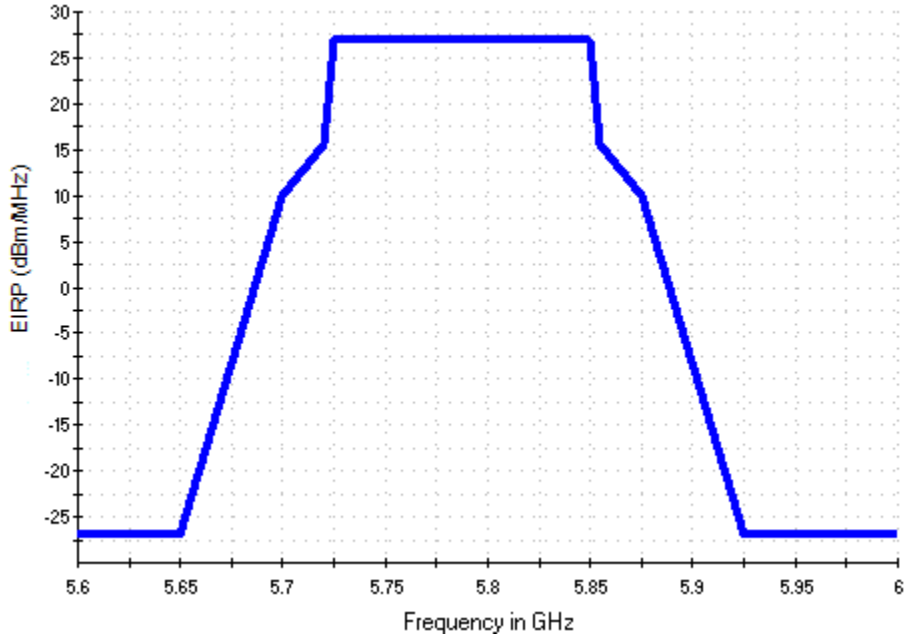


Figure 1. Emission limit for transmitters operating in the UNII-3 (5.725 – 5.850 GHz) band

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).

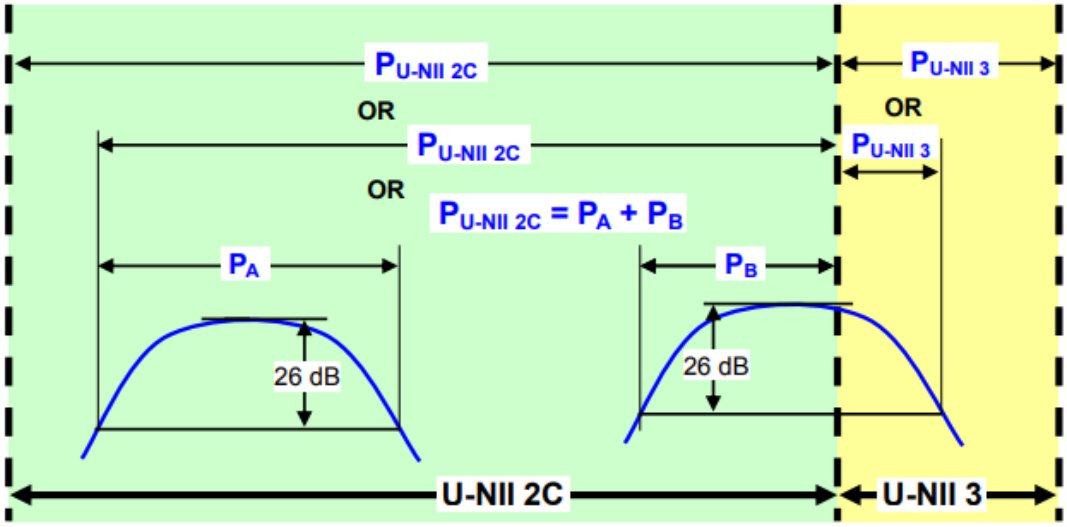


Figure 1. Conducted output power measurement examples (KDB 789033 D02 v02r01, p 21)

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.

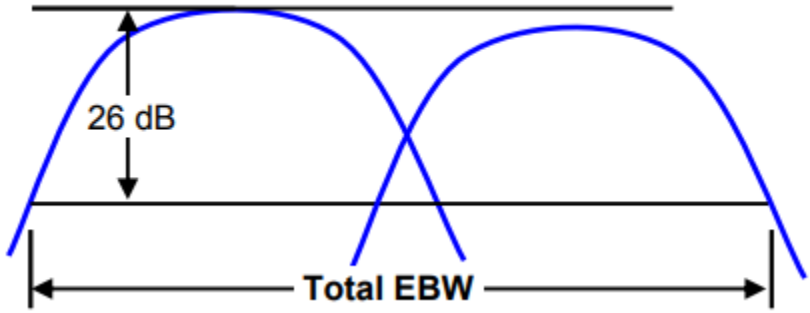


Figure 2. Overlapping emissions bandwidths (KDB 789033 D02 v02r01, p 18)

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.

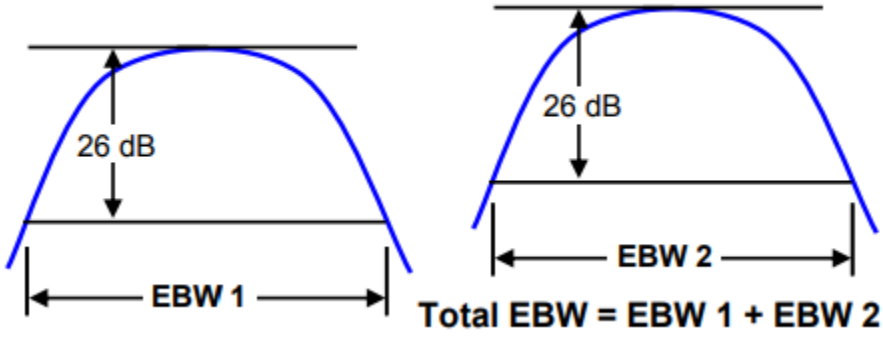


Figure 3. Non-overlapping emissions bandwidths (KDB 789033 D02 v02r01, p 18)

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.

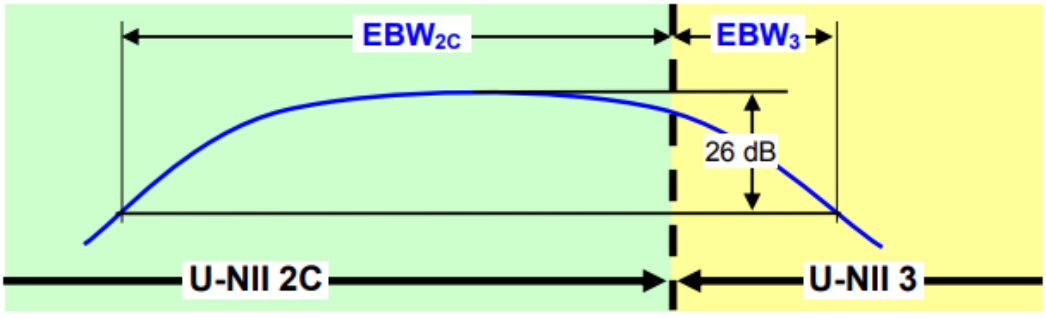


Figure 4. Non-overlapping emissions bandwidths (KDB 789033 D02 v02r01, p 19)

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, 2019. 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 while the UNII-3 transceiver was in a constant transmit mode at the upper, middle, and lower channels for each modulation bandwidth. The Bluetooth LE transceiver was active while testing the UNII-1 transceiver to assess any transmitter interactions. 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.

4.3 EUT Exercise Software

Ubiquiti test software and firmware were used to control the transceivers of the EUT.

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
15.203	Antenna Requirements	5725 - 5850	Complied
15.407(b)(6)	Conducted Disturbance at Mains Ports	0.15 to 30	Complied
15.407(b)(6)	Spurious Emissions Below 1000 MHz	0.009 - 1000	Complied
15.407(b)(7)	Spurious Emissions in Restricted Bands	0.009 - 40000	Complied
15.407(b)(1)	Emissions in the Out of Band Domain	0.009 - 40000	Complied
15.403(i)	26 dB Emissions Bandwidth	5725 - 5850	Reported
15.407(e)	Minimum Emission Bandwidth	5725 – 5850	Complied
15.407(a)	Maximum Conducted Output Power	5725 - 5850	Reported
15.407(a)(1)	EIRP above 30 Degrees	5150 – 5250	Note 1
15.407(a)	Maximum Power Spectral Density	5725 - 5850	Complied
Note 1: In this mode of operation, the EUT does not utilize UNII-1 band and therefore this 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, Results, and Power Limit Calculations

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. EUT utilizes the same antenna for all modulation bandwidths. Power limit calculations are based upon the maximum gain of the antenna.

6.1.1 §15.203 Antenna Requirements (All Modulation Bandwidths)

The EUT uses proprietary antennas with a maximum gain of 24 dBi that are soldered to the PCB and are not user accessible.

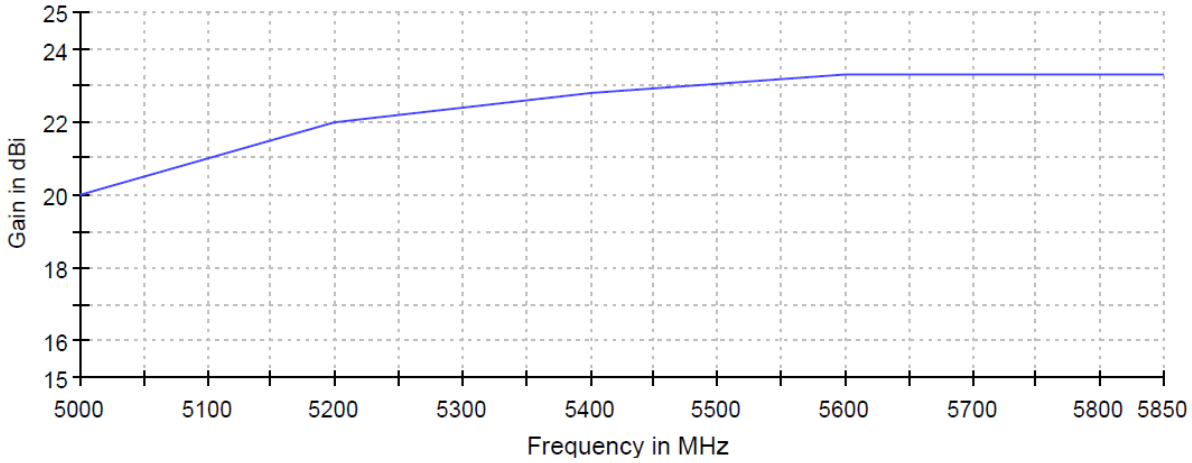


Figure 1: 24 dBi Antenna Gain Table

Result

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

6.1.2 §15.407(b)(6) Conducted Emissions at AC Mains Ports

There was no change in the AC mains emissions with changing transmitter frequencies, power levels, or modulation bandwidths.

Frequency (MHz)	AC Mains Lead	Detector	Measured Level (dBμV)	Limit (dBμV)	Margin (dB)
0.17	Hot Lead	Quasi-Peak (Note 2)	56.3	64.8	-8.5
0.17	Hot Lead	Average (Note 2)	37.4	54.8	-17.4
0.19	Hot Lead	Quasi-Peak (Note 2)	53.6	63.9	-10.3
0.19	Hot Lead	Average (Note 2)	36.4	53.9	-17.5
0.25	Hot Lead	Quasi-Peak (Note 1)	44.3	51.7	-7.4
0.64	Hot Lead	Quasi-Peak (Note 2)	46.9	56.0	-9.1
0.64	Hot Lead	Average (Note 2)	40.9	46.0	-5.1
1.09	Hot Lead	Peak (Note 1)	40.3	46.0	-5.7
4.73	Hot Lead	Peak (Note 1)	40.8	46.0	-5.2
0.16	Neutral Lead	Quasi-Peak (Note 1)	47.7	55.5	-7.8
0.19	Neutral Lead	Quasi-Peak (Note 2)	52.8	64.1	-11.3
0.19	Neutral Lead	Average (Note 2)	35.2	54.1	-18.9
0.22	Neutral Lead	Quasi-Peak (Note 1)	47.4	52.9	-5.5
0.26	Neutral Lead	Peak (Note 1)	45.2	51.5	-6.3
0.64	Neutral Lead	Quasi-Peak (Note 2)	48.0	56.0	-8.0
0.64	Neutral Lead	Average (Note 2)	41.7	46.0	-4.3
1.66	Neutral Lead	Peak (Note 1)	39.7	46.0	-6.3

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.
Note 2: The reference detector used for the measurements was quasi-peak and average and the data was compared to the respective limits.

Result

The EUT complied with the specification limit by a margin of 4.3 dB.

6.1.3 Calculated Conducted RF Power Limits (All Modulation Bandwidths)

Maximum conducted power limits for the UNII-3 band are adjusted based on the isotropic antenna gain and wireless architecture. A dBm reduction in limit for every dBi of antenna gain over 6 dBi is required for AP architecture. No such limiting reduction is required for fixed point-to-point architecture.

Wireless Architecture	Antenna Gain (dBi)	Default Gain (dBi)	Limit Change (dB)	Default Limit (dBm)	Adjusted Limit (dBm)
AP	24	6	-18.00	30	36
Fixed P-t-P	N/A	N/A	N/A	N/A	N/A

Table 2: UNII-3 maximum conducted power limits based upon antenna gain and Wireless Architecture.

6.2 Test Results (10 MHz Bandwidth)

6.2.1 §15.203 Antenna Requirements

See Section 6.1.1 of this report.

Result

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

6.2.2 §15.407(b)(6) Conducted Emissions at AC Mains Ports

See Section 6.1.2 of this report. There was no change in the AC mains emissions with changing transmitter frequencies, power levels, or modulation bandwidths.

Result

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

6.2.3 §15.407(b)(6) Radiated Emissions Below 1000 MHz

No emissions from the transmitter were seen in the frequency range of 0.009 to 1000 MHz when transmitting at the lowest, middle, or highest frequency. Emissions seen in this range are from the other circuitry of the device, meet the class B requirements of §15.109, the limits of §15.209, and are reported in VPI Laboratories, Inc. report #V048426.

Result

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

6.2.4 §15.407(b)(7) Emissions in the Restricted Bands of §15.205

The EUT uses various power settings based on the channel in use. In order to reduce test time, the radiated spurious emissions at the lowest, middle, and highest channel were measured at the maximum power of TP19.

Radiated Measurements when Transmitting on Low Channel (5730 MHz at TP19 Power Setting)

Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBµV)	Correction Factor (dB)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
22920.0	Peak	Vertical	10.0	52.7	62.7	74.0	-11.3
22920.0	Average	Vertical	-5.5	52.7	47.2	54.0	-6.8
22920.0	Peak	Horizontal	6.5	52.7	59.2	74.0	-14.8
22920.0	Average	Horizontal	-6.9	52.7	45.8	54.0	-8.2

Radiated Measurements when Transmitting on Middle Channel (5790 MHz at TP19 Power Setting)

Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBµV)	Correction Factor (dB)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
23160.0	Peak	Vertical	5.5	52.8	58.3	74.0	-15.7
23160.0	Average	Vertical	-9.5	52.8	43.3	54.0	-10.7
23160.0	Peak	Horizontal	10.4	52.8	63.2	74.0	-10.8
23160.0	Average	Horizontal	-6.5	52.8	46.3	54.0	-7.7

Radiated Measurements when Transmitting on High Channel (5845 MHz at TP 19 Power Setting)

Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBµV)	Correction Factor (dB)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
23380.0	Peak	Vertical	6.5	52.9	59.4	74.0	-14.6
23380.0	Average	Vertical	-9.8	52.9	43.1	54.0	-10.9
23380.0	Peak	Horizontal	9.4	52.9	62.3	74.0	-11.7
23380.0	Average	Horizontal	-8.0	52.9	44.9	54.0	-9.1

Result

The EUT complied with the specification limit by a margin of 6.8 dB.

6.2.5 §15.407(b)(7) Out of Band Emissions

The worst-case emissions seen outside of the restricted bands are shown below. Any other emissions were below the noise floor. Noise floor was a minimum of 6 dB below the limit.

Lower Channel Transmitting (5730 MHz)

Frequency (MHz)	e.i.r.p (dBm/MHz)	Limit (dBm/MHz)	Margin (dB)
6880	-43.8	-27.0	-16.8
17190	-38.9	-27.0	-11.9

Middle Channel Transmitting (5790 MHz)

Frequency (MHz)	e.i.r.p (dBm/MHz)	Limit (dBm/MHz)	Margin (dB)
6880	-43.9	-27.0	-16.9
17370	-38.6	-27.0	-11.6

Upper Channel Transmitting (5845 MHz)

Frequency (MHz)	e.i.r.p (dBm/MHz)	Limit (dBm/MHz)	Margin (dB)
6880	-43.2	-27.0	-16.2
17535	-38.7	-27.0	-11.7

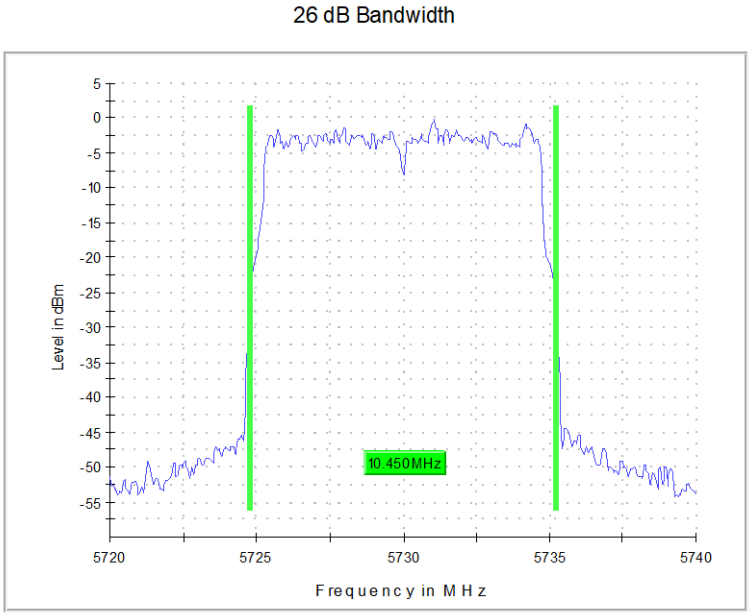
Result

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

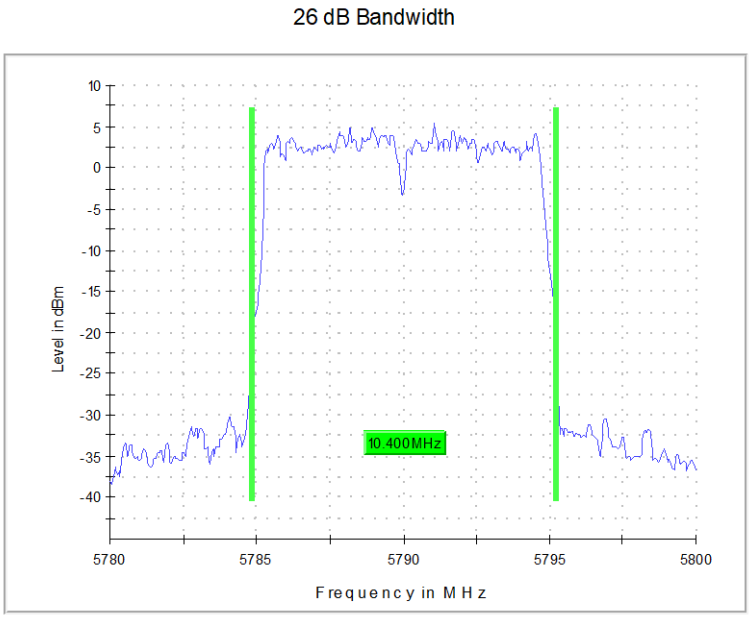
6.2.6 §15.403(i) 26dB Emissions Bandwidth

The 26 dB emissions bandwidths are shown in the table and plots below.

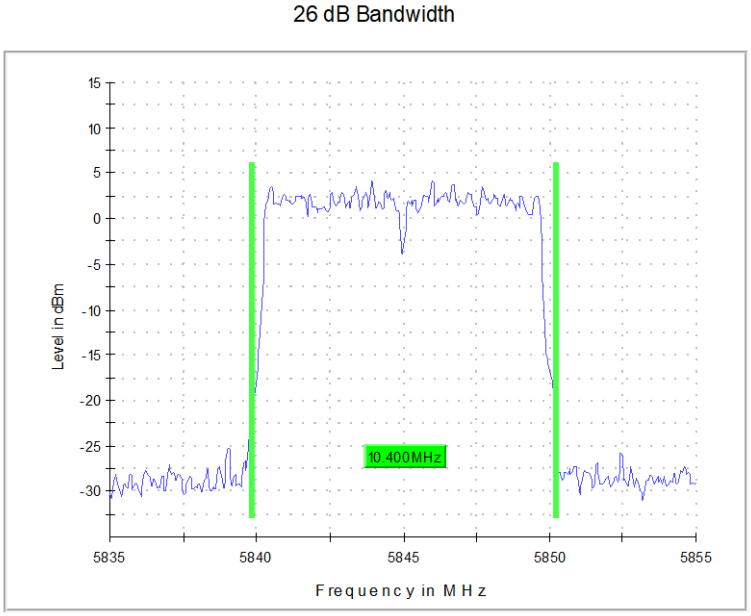
Frequency (MHz)	Emissions 26 dB bandwidth (MHz)
5730	10.45
5790	10.40
5845	10.40



Graph 1: Lowest Channel 26 dB Bandwidth



Graph 2: Middle Channel 26 dB Bandwidth



Graph 3: Highest Channel 26 dB Bandwidth

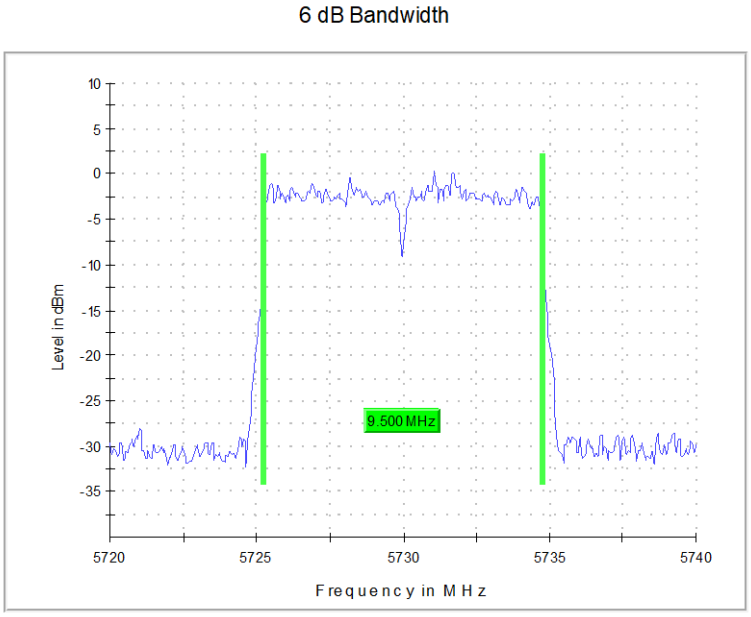
Result

The 26 dB bandwidths are reported for informational purposes.

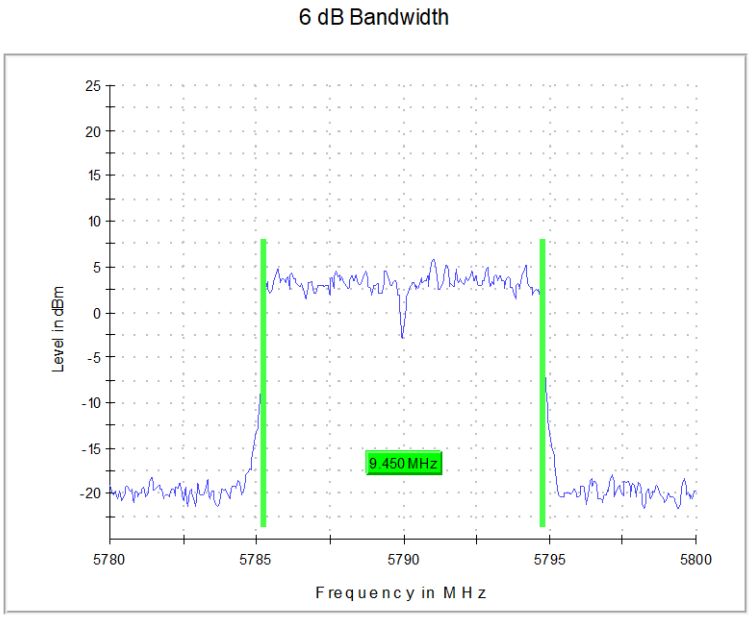
6.2.7 §15.407(e) UNII-3 Minimum 6dB Emissions Bandwidth

The UNII-3 minimum 6 dB emissions bandwidth for the channel is shown in the table and plots below.

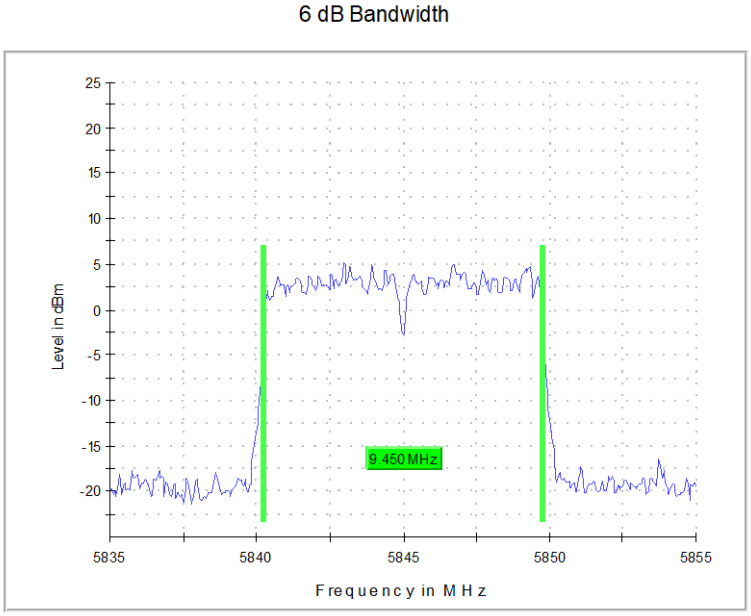
Frequency (MHz)	Emissions 6 dB bandwidth (MHz)
5730	9.50
5790	9.45
5845	9.45



Graph 4: UNII-3 Lowest Channel Minimum 6 dB Bandwidth



Graph 5: UNII-3 Middle Channel Minimum 6 dB Bandwidth

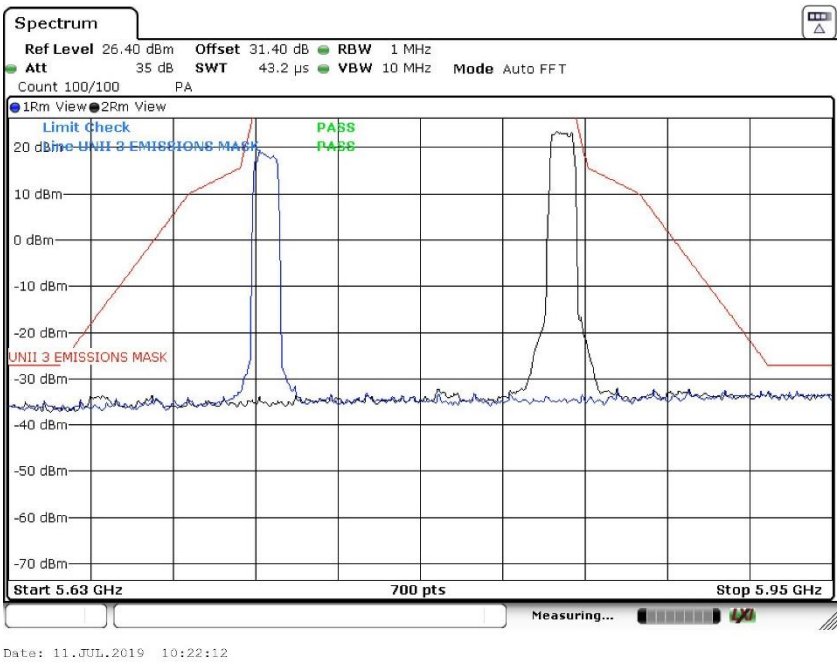


Graph 6: UNII-3 Highest Channel Minimum 6 dB Bandwidth

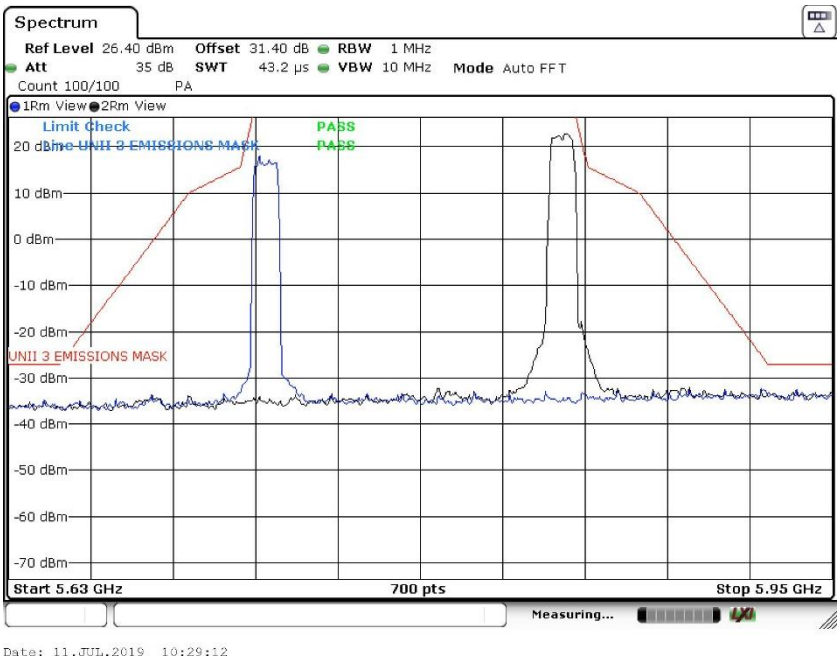
Result

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

6.2.8 §15.407(i) UNII-3 EIRP Emissions Limit



Graph 7: UNII-3 EIRP Emission Envelope Low and High Channel Transmitting (Port 0)



Graph 8: UNII-3 EIRP Emission Envelope Low and High Channel Transmitting (Port 1)

Result

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

6.2.9 Duty Cycle, Transmission Duration, and Maximum Power Control

EUT was capable of 100% duty cycle at maximum power control level. No correction factor is applied.

6.2.10 §15.407(a) Maximum Conducted Output Power

UNII-3 Conducted Power Measurements – Fixed Point-to-Point Architecture

Frequency (MHz)	Conducted Power (dBm)
5730	12.1
5790	18.0
5845	18.2

Result

The Conducted Power Measurement for Fixed Point-to-Point Architecture are reported for informational purposes.

6.2.11 §15.407(a) Maximum Power Spectral Density

UNII-3 Power Spectral Density Measurements

Frequency (MHz)	EIRP Density (dBm)	EIRP Density Limit (dBm)	Margin (dB)
5730	0.8	12.7	-11.9
5790	6.9	12.7	-5.8
5845	6.6	12.7	-6.1

Result: UNII-3 Fixed Point-to-Point Architecture

In the configurations tested the EUT complied with the requirements of the specification for fixed point-to-point architecture with a margin of 5.8 dB.

6.3 Test Results (20 MHz Bandwidth)

6.3.1 §15.203 Antenna Requirements

See Section 6.1.1 of this report.

Result

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

6.3.2 §15.407(b)(6) Conducted Emissions at AC Mains Ports

See Section 6.1.2 of this report. There was no change in the AC mains emissions with changing transmitter frequencies, power levels, or modulation bandwidths.

Result

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

6.3.3 §15.407(b)(6) Radiated Emissions Below 1000 MHz

No emissions from the transmitter were seen in the frequency range of 0.009 to 1000 MHz when transmitting at the lowest, middle, or highest frequency. Emissions seen in this range are from the other circuitry of the device, meet the class B requirements of §15.109, the limits of §15.209, and are reported in VPI Laboratories, Inc. report #V048426.

Result

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

6.3.4 §15.407(b)(7) Emissions in the Restricted Bands of §15.205

The EUT uses various power settings based on the channel in use. In order to reduce test time, the radiated spurious emissions at the lowest, middle, and highest channel were measured at the maximum power of TP19.

Radiated Measurements when Transmitting on Low Channel (5735 MHz at TP19 Power Setting)

Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBµV)	Correction Factor (dB)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
22940.0	Peak	Vertical	0.2	52.7	52.9	74.0	-21.1
22940.0	Average	Vertical	-9.3	52.7	43.4	54.0	-10.6
22940.0	Peak	Horizontal	8.0	52.7	60.7	74.0	-13.3
22940.0	Average	Horizontal	-8.3	52.7	44.4	54.0	-9.6

Radiated Measurements when Transmitting on Middle Channel (5790 MHz at TP19 Power Setting)

Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBµV)	Correction Factor (dB)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
23160.0	Peak	Vertical	4.2	52.8	57.0	74.0	-17.0
23160.0	Average	Vertical	-9.1	52.8	43.7	54.0	-10.3
23160.0	Peak	Horizontal	7.3	52.8	60.1	74.0	-13.9
23160.0	Average	Horizontal	-9.2	52.8	43.6	54.0	-10.4

Radiated Measurements when Transmitting on High Channel (5840 MHz at TP 19 Power Setting)

Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBµV)	Correction Factor (dB)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
23360.0	Peak	Vertical	3.0	52.9	55.9	74.0	-18.1
23360.0	Average	Vertical	-11.9	52.9	41.0	54.0	-13.0
23360.0	Peak	Horizontal	6.7	52.9	59.6	74.0	-14.4
23360.0	Average	Horizontal	-9.2	52.9	43.7	54.0	-10.3

Result

The EUT complied with the specification limit by a margin of 9.6 dB.

6.3.5 §15.407(b)(7) Out of Band Emissions

The worst-case emissions seen outside of the restricted bands are shown below. Any other emissions were below the noise floor. Noise floor was a minimum of 6 dB below the limit.

Lower Channel Transmitting (5735 MHz)

Frequency (MHz)	e.i.r.p (dBm/MHz)	Limit (dBm/MHz)	Margin (dB)
6880	-43.8	-27.0	-16.8
17205	-38.6	-27.0	-11.6

Middle Channel Transmitting (5790 MHz)

Frequency (MHz)	e.i.r.p (dBm/MHz)	Limit (dBm/MHz)	Margin (dB)
6880	-43.9	-27.0	-16.9
17370	-39.0	-27.0	-12.0

Upper Channel Transmitting (5840 MHz)

Frequency (MHz)	e.i.r.p (dBm/MHz)	Limit (dBm/MHz)	Margin (dB)
6880	-43.2	-27.0	-16.2
17520	-39.1	-27.0	-12.1

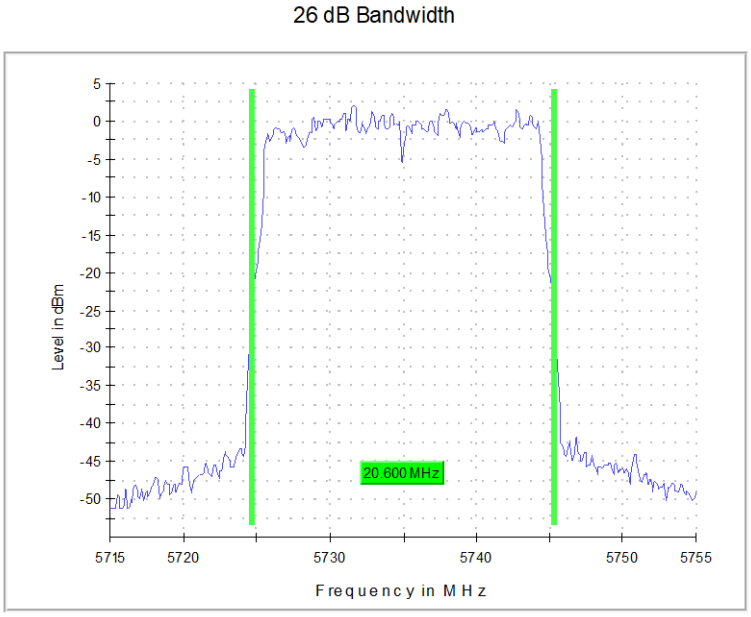
Result

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

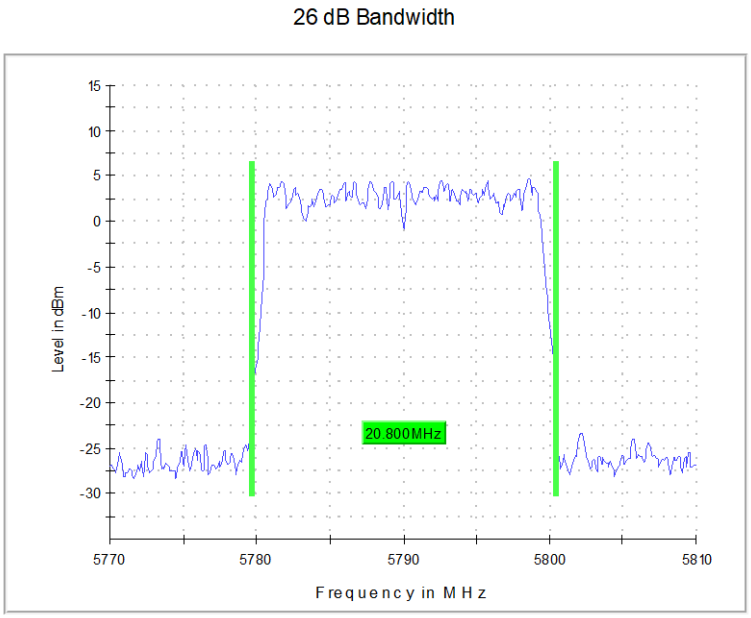
6.3.6 §15.403(i) 26dB Emissions Bandwidth

The 26 dB emissions bandwidths are shown in the table and plots below.

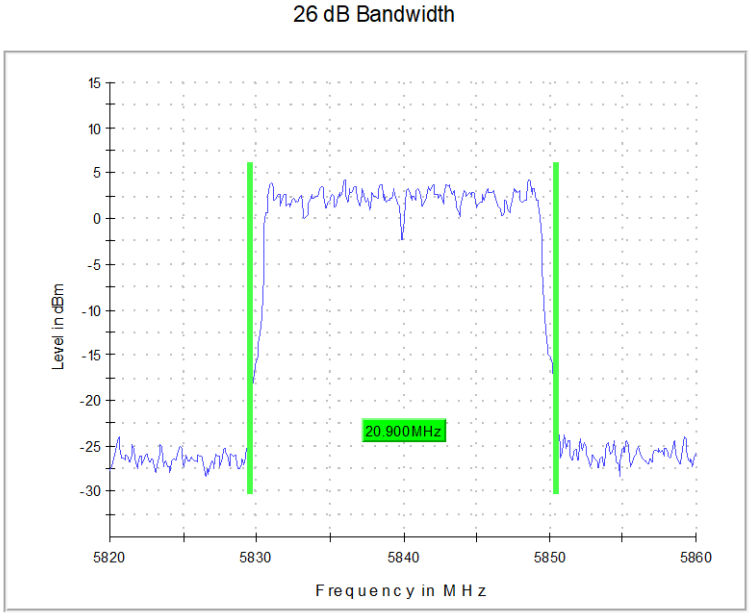
Frequency (MHz)	Emissions 26 dB bandwidth (MHz)
5735	20.6
5790	20.8
5840	20.9



Graph 9: Lowest Channel 26 dB Bandwidth



Graph 10: Middle Channel 26 dB Bandwidth



Graph 11: Highest Channel 26 dB Bandwidth

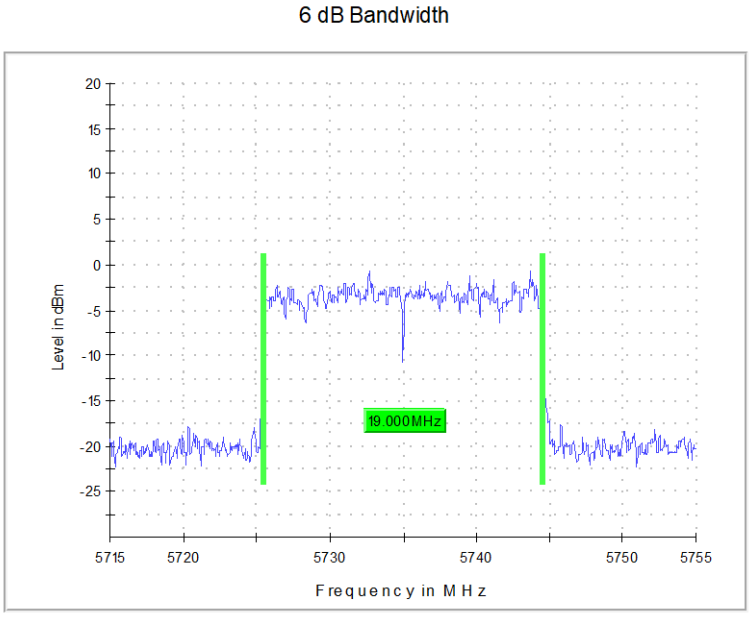
Result

The 26 dB bandwidths are reported for informational purposes.

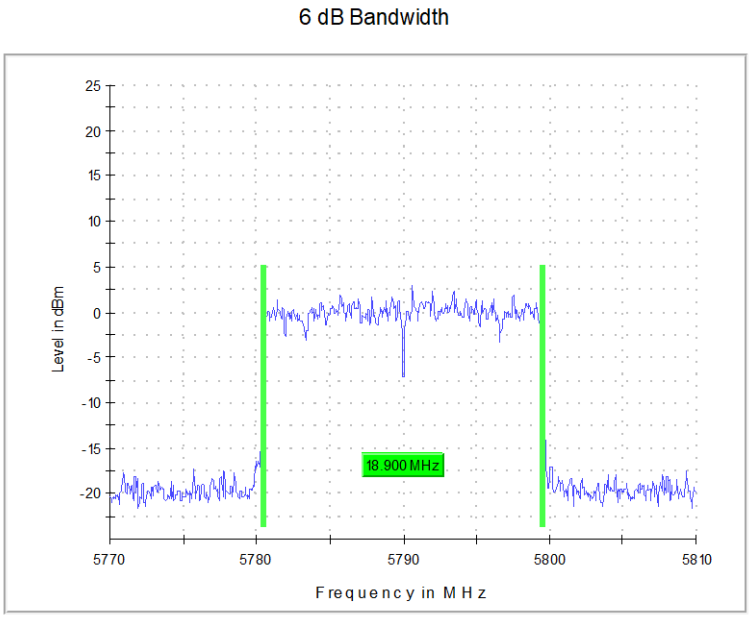
6.3.7 15.407(e) UNII-3 Minimum 6dB Emissions Bandwidth

The UNII-3 minimum 6 dB emissions bandwidth for the channel is shown in the table and plots below.

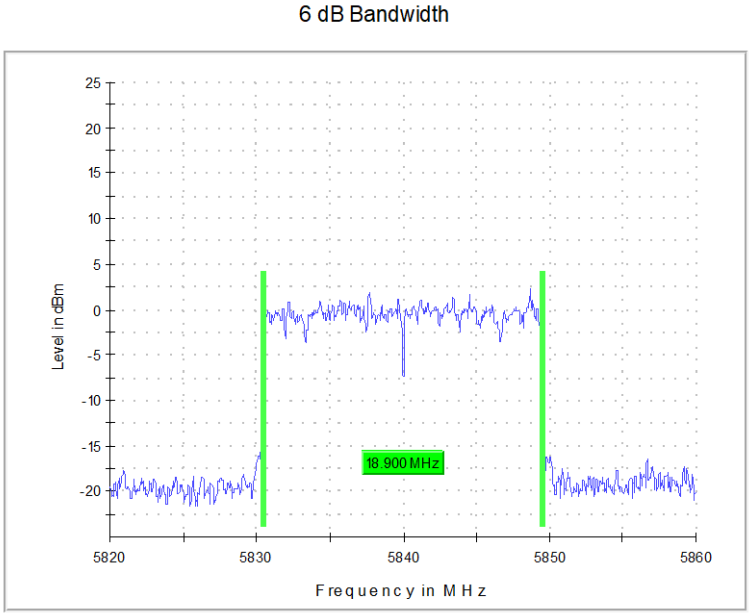
Frequency (MHz)	Emissions 6 dB bandwidth (MHz)
5735	19.0
5790	18.9
5840	18.9



Graph 12: UNII-3 Lowest Channel Minimum 6 dB Bandwidth



Graph 13: UNII-3 Middle Channel Minimum 6 dB Bandwidth

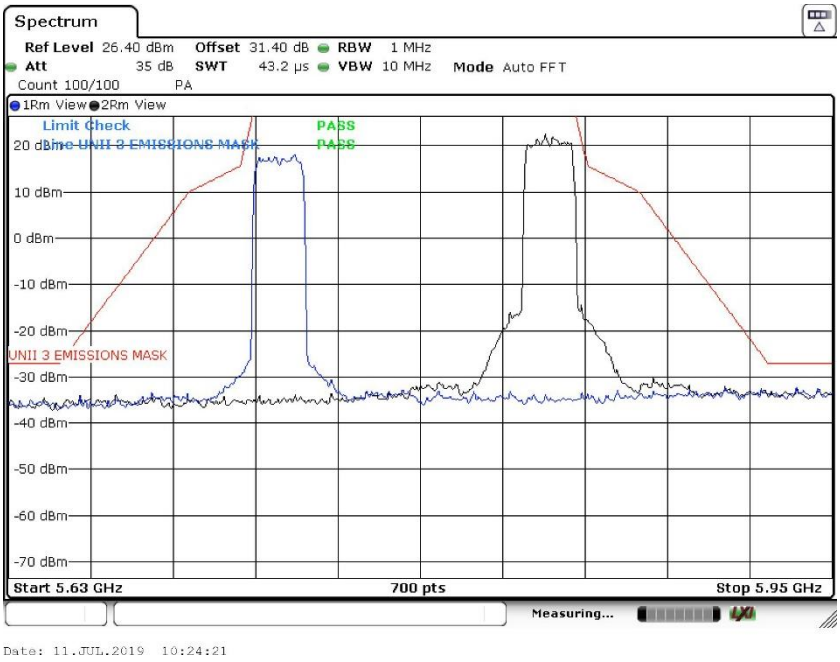


Graph 14: UNII-3 Highest Channel Minimum 6 dB Bandwidth

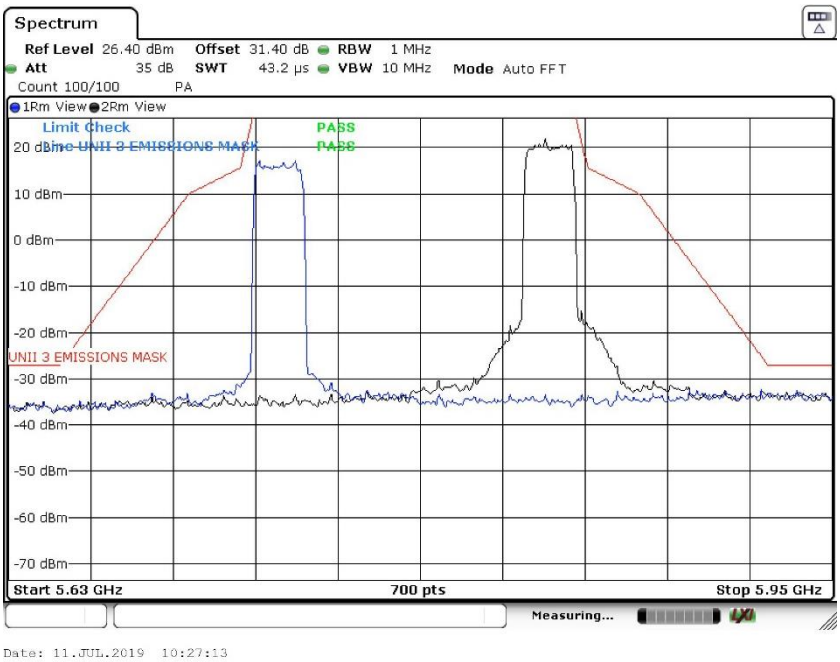
Result

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

6.3.8 §15.407(i) UNII-3 EIRP Emissions Limit



Graph 15: UNII-3 EIRP Emission Envelope Low and High Channel Transmitting (Port 0)



Graph 16: UNII-3 EIRP Emission Envelope Low and High Channel Transmitting (Port 1)

Result

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

6.3.9 Duty Cycle, Transmission Duration, and Maximum Power Control

EUT was capable of 100% duty cycle at maximum power control level. No correction factor is applied.

6.3.10 §15.407(a) Maximum Conducted Output Power

UNII-3 Conducted Power Measurements – Fixed Point-to-Point Architecture

Frequency (MHz)	Conducted Power (dBm)
5735	14.3
5790	18.2
5840	18.2

Result

The Conducted Power Measurement for Fixed Point-to-Point Architecture are reported for informational purposes.

6.3.11 §15.407(a) Maximum Power Spectral Density

UNII-3 Power Spectral Density Measurements

Frequency (MHz)	EIRP Density (dBm)	EIRP Density Limit (dBm)	Margin (dB)
5735	0.2	12.7	-12.5
5790	4.1	12.7	-8.6
5840	3.9	12.7	-8.8

Result: UNII-3 Fixed Point-to-Point Architecture

In the configurations tested the EUT complied with the requirements of the specification for fixed point-to-point architecture with a margin of 8.6 dB.

6.4 Test Results (30 MHz Bandwidth)

6.4.1 §15.203 Antenna Requirements

See Section 6.1.1 of this report.

Result

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

6.4.2 §15.407(b)(6) Conducted Emissions at AC Mains Ports

See Section 6.1.2 of this report. There was no change in the AC mains emissions with changing transmitter frequencies, power levels, or modulation bandwidths.

Result

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

6.4.3 §15.407(b)(6) Radiated Emissions Below 1000 MHz

No emissions from the transmitter were seen in the frequency range of 0.009 to 1000 MHz when transmitting at the lowest, middle, or highest frequency. Emissions seen in this range are from the other circuitry of the device, meet the class B requirements of §15.109, the limits of §15.209, and are reported in VPI Laboratories, Inc. report #V048426.

Result

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

6.4.4 §15.407(b)(7) Emissions in the Restricted Bands of §15.205

The EUT uses various power settings based on the channel in use. In order to reduce test time, the radiated spurious emissions at the lowest, middle, and highest channel were measured at the maximum power of TP19.

Radiated Measurements when Transmitting on Low Channel (5740 MHz at TP19 Power Setting)

Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBµV)	Correction Factor (dB)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
22960.0	Peak	Vertical	0.2	52.7	52.9	74.0	-21.1
22960.0	Average	Vertical	-9.4	52.7	43.3	54.0	-10.7
22960.0	Peak	Horizontal	4.7	52.7	57.4	74.0	-16.6
22960.0	Average	Horizontal	-10.6	52.7	42.1	54.0	-11.9

Radiated Measurements when Transmitting on Middle Channel (5790 MHz at TP19 Power Setting)

Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBµV)	Correction Factor (dB)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
23160.0	Peak	Vertical	1.4	52.8	54.2	74.0	-19.8
23160.0	Average	Vertical	-9.9	52.8	42.9	54.0	-11.1
23160.0	Peak	Horizontal	4.7	52.8	57.5	74.0	-16.5
23160.0	Average	Horizontal	-10.9	52.8	41.9	54.0	-12.1

Radiated Measurements when Transmitting on High Channel (5835 MHz at TP 19 Power Setting)

Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBµV)	Correction Factor (dB)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
23340.0	Peak	Vertical	0.6	52.9	53.5	74.0	-20.5
23340.0	Average	Vertical	-9.3	52.9	43.6	54.0	-10.4
23340.0	Peak	Horizontal	3.4	52.9	56.3	74.0	-17.7
23340.0	Average	Horizontal	-11.2	52.9	41.7	54.0	-12.3

Result

The EUT complied with the specification limit by a margin of 10.4 dB.

6.4.5 §15.407(b)(7) Out of Band Emissions

The worst-case emissions seen outside of the restricted bands are shown below. Any other emissions were below the noise floor. Noise floor was a minimum of 6 dB below the limit.

Lower Channel Transmitting (5740 MHz)

Frequency (MHz)	e.i.r.p (dBm/MHz)	Limit (dBm/MHz)	Margin (dB)
6880	-43.8	-27.0	-16.8
17205	-38.8	-27.0	-11.8

Middle Channel Transmitting (5790 MHz)

Frequency (MHz)	e.i.r.p (dBm/MHz)	Limit (dBm/MHz)	Margin (dB)
6880	-43.9	-27.0	-16.9
17370	-38.5	-27.0	-11.5

Upper Channel Transmitting (5835 MHz)

Frequency (MHz)	e.i.r.p (dBm/MHz)	Limit (dBm/MHz)	Margin (dB)
6880	-43.2	-27.0	-16.2
17505	-38.2	-27.0	-11.2

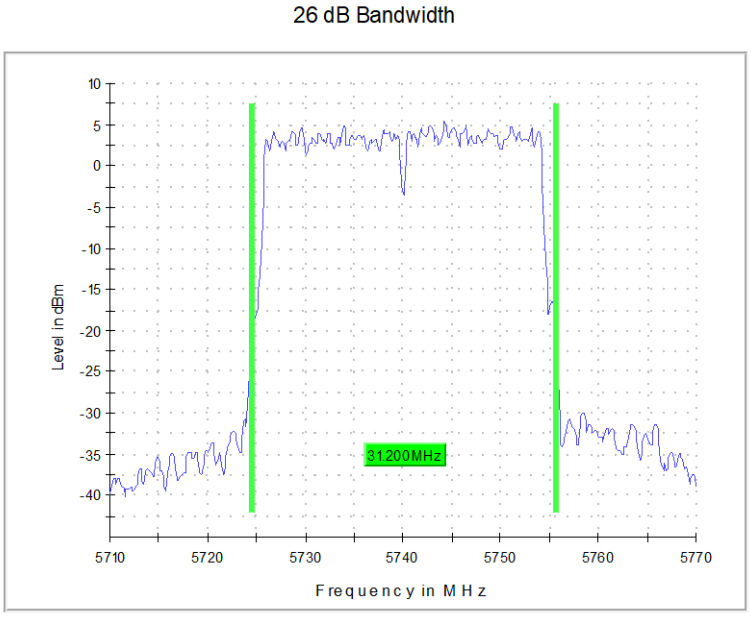
Result

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

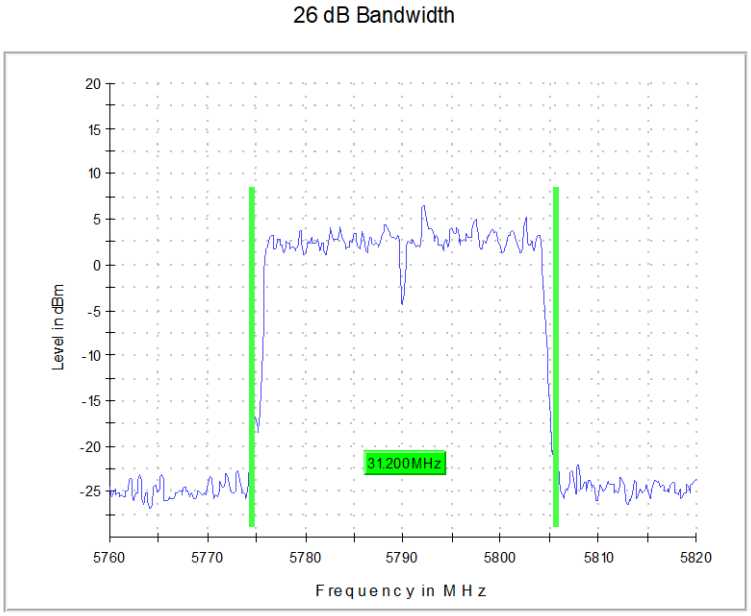
6.4.6 §15.403(i) 26dB Emissions Bandwidth

The 26 dB emissions bandwidths are shown in the table and plots below.

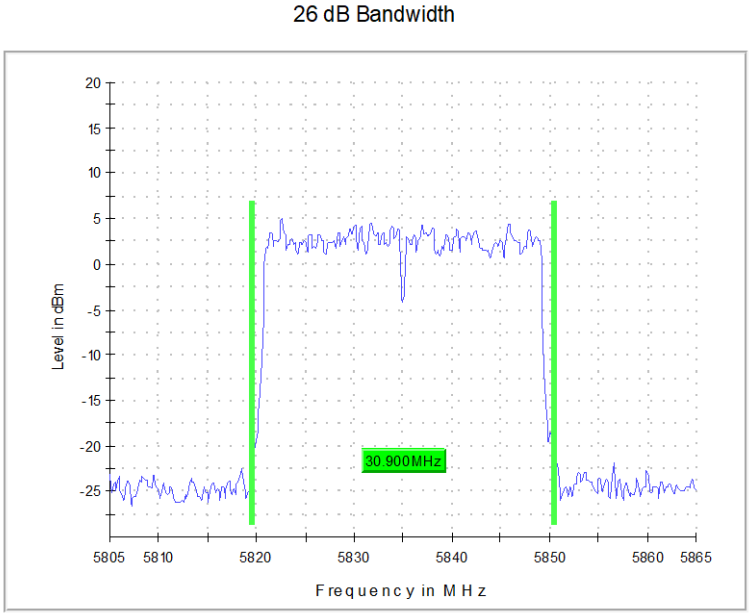
Frequency (MHz)	Emissions 26 dB bandwidth (MHz)
5740	31.2
5790	31.2
5835	30.9



Graph 17: Lowest Channel 26 dB Bandwidth



Graph 18: Middle Channel 26 dB Bandwidth



Graph 19: Highest Channel 26 dB Bandwidth

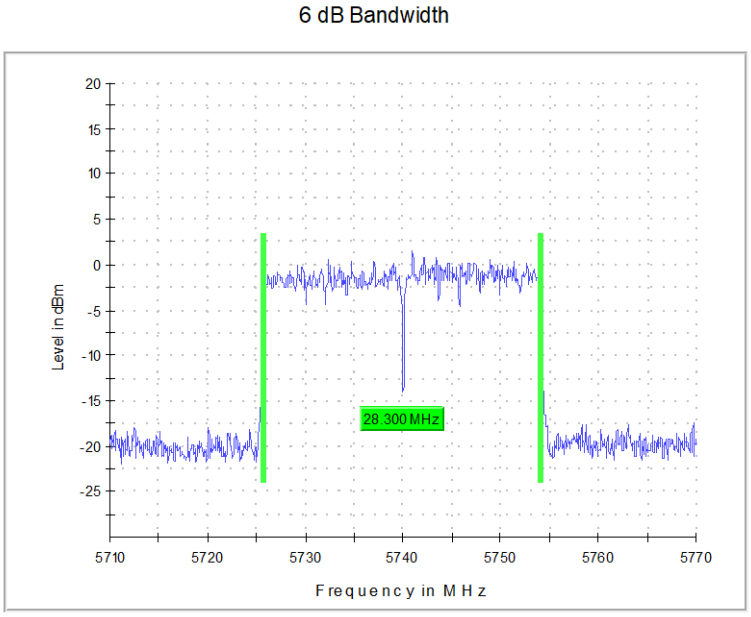
Result

The 26 dB bandwidths are reported for informational purposes.

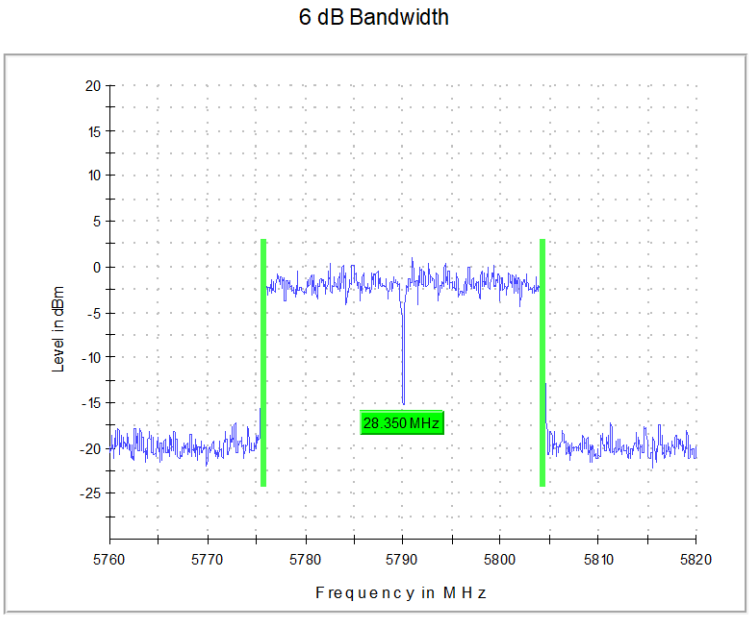
6.4.7 §15.407(e) UNII-3 Minimum 6dB Emissions Bandwidth

The UNII-3 minimum 6 dB emissions bandwidth for the channel is shown in the table and plots below.

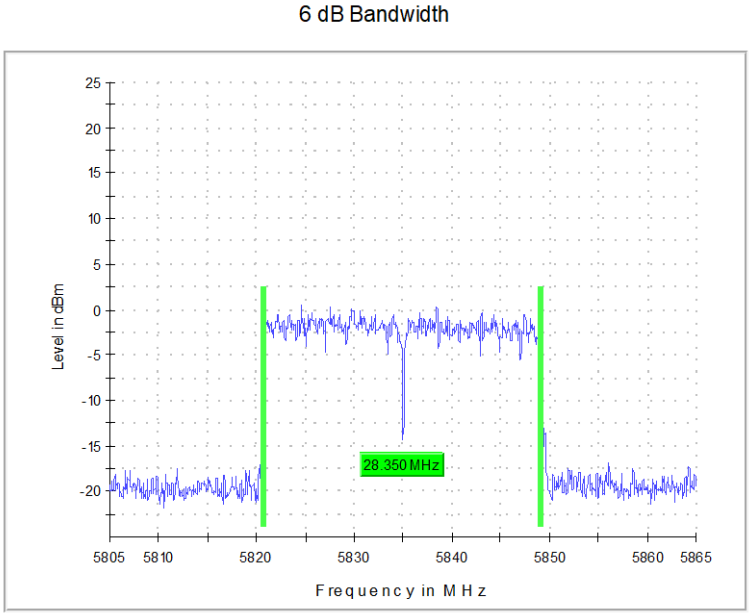
Frequency (MHz)	Emissions 6 dB bandwidth (MHz)
5740	28.3
5790	28.4
5835	28.4



Graph 20: UNII-3 Lowest Channel Minimum 6 dB Bandwidth



Graph 21: UNII-3 Middle Channel Minimum 6 dB Bandwidth

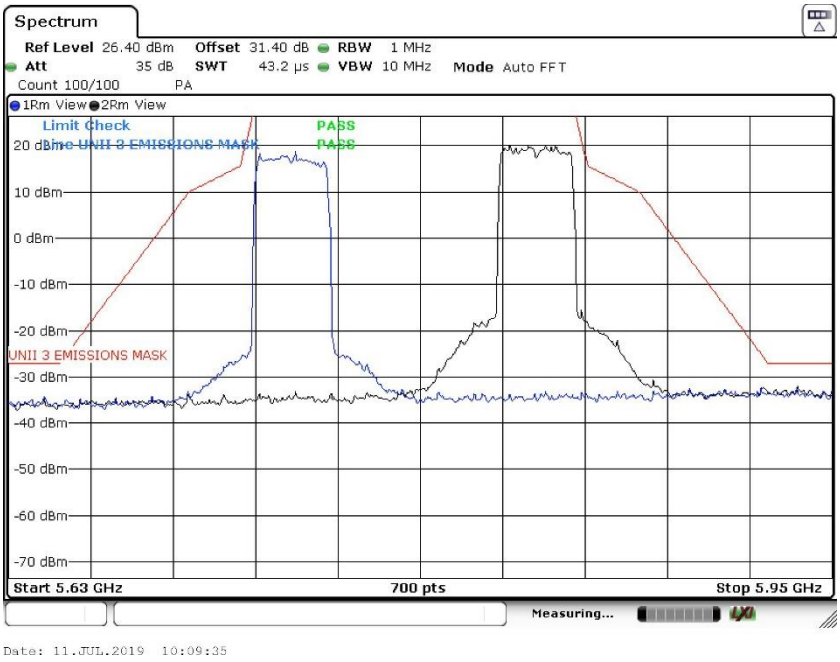


Graph 22: UNII-3 Highest Channel Minimum 6 dB Bandwidth

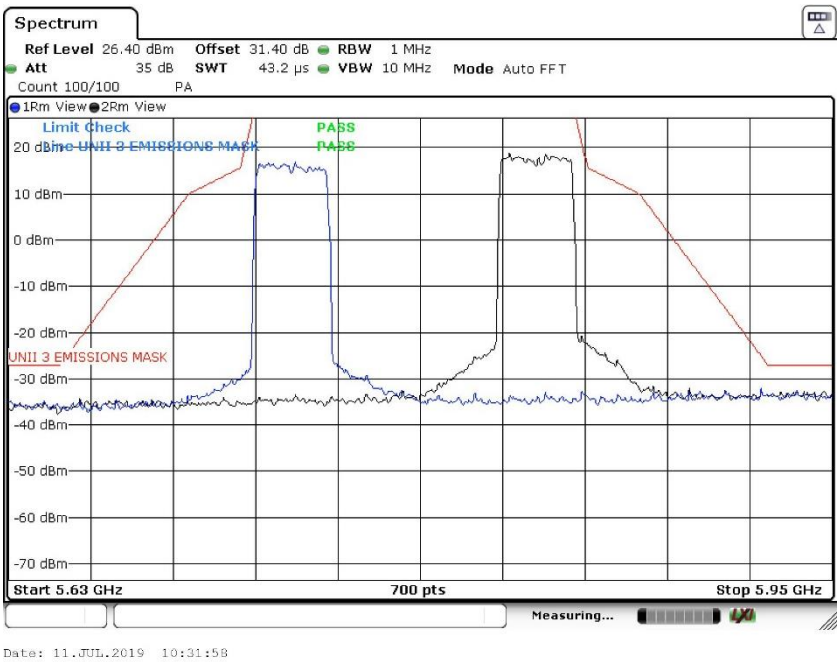
Result

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

6.4.8 §15.407(i) UNII-3 EIRP Emissions Limit



Graph 23: UNII-3 EIRP Emission Envelope Low and High Channel Transmitting (Port 0)



Graph 24: UNII-3 EIRP Emission Envelope Low and High Channel Transmitting (Port 1)

Result

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

6.4.9 Duty Cycle, Transmission Duration, and Maximum Power Control

EUT was capable of 100% duty cycle at maximum power control level. No correction factor is applied.

6.4.10 §15.407(a) Maximum Conducted Output Power

UNII-3 Conducted Power Measurements – Fixed Point-to-Point Architecture

Frequency (MHz)	Conducted Power (dBm)
5740	18.1
5790	18.0
5835	18.3

Result

The Conducted Power Measurement for Fixed Point-to-Point Architecture are reported for informational purposes.

6.4.11 §15.407(a) Maximum Power Spectral Density

UNII-3 Power Spectral Density Measurements

Frequency (MHz)	EIRP Density (dBm)	EIRP Density Limit (dBm)	Margin (dB)
5740	2.4	12.7	-10.3
5790	2.4	12.7	-10.3
5835	2.2	12.7	-10.5

Result: UNII-3 Fixed Point-to-Point Architecture

In the configurations tested the EUT complied with the requirements of the specification for fixed point-to-point architecture with a margin of 10.3 dB.

6.5 Test Results (40 MHz Bandwidth)

6.5.1 §15.203 Antenna Requirements

See Section 6.1.1 of this report.

Result

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

6.5.2 §15.407(b)(6) Conducted Emissions at AC Mains Ports

See Section 6.1.2 of this report. There was no change in the AC mains emissions with changing transmitter frequencies, power levels, or modulation bandwidths.

Result

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

6.5.3 §15.407(b)(6) Radiated Emissions Below 1000 MHz

No emissions from the transmitter were seen in the frequency range of 0.009 to 1000 MHz when transmitting at the lowest, middle, or highest frequency. Emissions seen in this range are from the other circuitry of the device, meet the class B requirements of §15.109, the limits of §15.209, and are reported in VPI Laboratories, Inc. report #V048426.

Result

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

6.5.4 §15.407(b)(7) Emissions in the Restricted Bands of §15.205

The EUT uses various power settings based on the channel in use. In order to reduce test time, the radiated spurious emissions at the lowest, middle, and highest channel were measured at the maximum power of TP19.

Radiated Measurements when Transmitting on Low Channel (5745 MHz at TP19 Power Setting)

Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBµV)	Correction Factor (dB)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
22980.0	Peak	Vertical	-0.6	52.7	52.1	74.0	-21.9
22980.0	Average	Vertical	-11.2	52.7	41.5	54.0	-12.5
22980.0	Peak	Horizontal	2.6	52.7	55.3	74.0	-18.7
22980.0	Average	Horizontal	-10.6	52.7	42.1	54.0	-11.9

Radiated Measurements when Transmitting on Middle Channel (5790 MHz at TP19 Power Setting)

Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBµV)	Correction Factor (dB)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
23160.0	Peak	Vertical	-1.4	52.8	51.4	74.0	-22.6
23160.0	Average	Vertical	-15.3	52.8	37.5	54.0	-16.5
23160.0	Peak	Horizontal	3.7	52.8	56.5	74.0	-17.5
23160.0	Average	Horizontal	-11.0	52.8	41.8	54.0	-12.2

Radiated Measurements when Transmitting on High Channel (5830 MHz at TP 19 Power Setting)

Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBµV)	Correction Factor (dB)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
23320.0	Peak	Vertical	0.2	52.9	53.1	74.0	-20.9
23320.0	Average	Vertical	-13.9	52.9	39.0	54.0	-15.0
23320.0	Peak	Horizontal	2.4	52.9	55.3	74.0	-18.7
23320.0	Average	Horizontal	-12.6	52.9	40.3	54.0	-13.7

Result

The EUT complied with the specification limit by a margin of 11.9 dB.

6.5.5 §15.407(b)(7) Out of Band Emissions

The worst-case emissions seen outside of the restricted bands are shown below. Any other emissions were below the noise floor. Noise floor was a minimum of 6 dB below the limit.

Lower Channel Transmitting (5745 MHz)

Frequency (MHz)	e.i.r.p (dBm/MHz)	Limit (dBm/MHz)	Margin (dB)
6880	-43.8	-27.0	-16.8
17235	-38.4	-27.0	-11.4

Middle Channel Transmitting (5790 MHz)

Frequency (MHz)	e.i.r.p (dBm/MHz)	Limit (dBm/MHz)	Margin (dB)
6880	-43.9	-27.0	-16.9
17370	-38.6	-27.0	-11.6

Upper Channel Transmitting (5830 MHz)

Frequency (MHz)	e.i.r.p (dBm/MHz)	Limit (dBm/MHz)	Margin (dB)
6880	-43.2	-27.0	-16.2
17490	-38.9	-27.0	-11.9

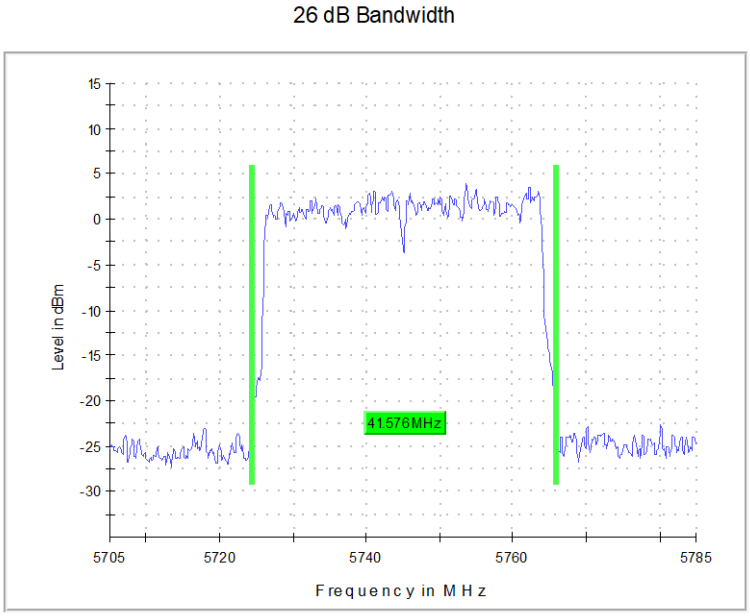
Result

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

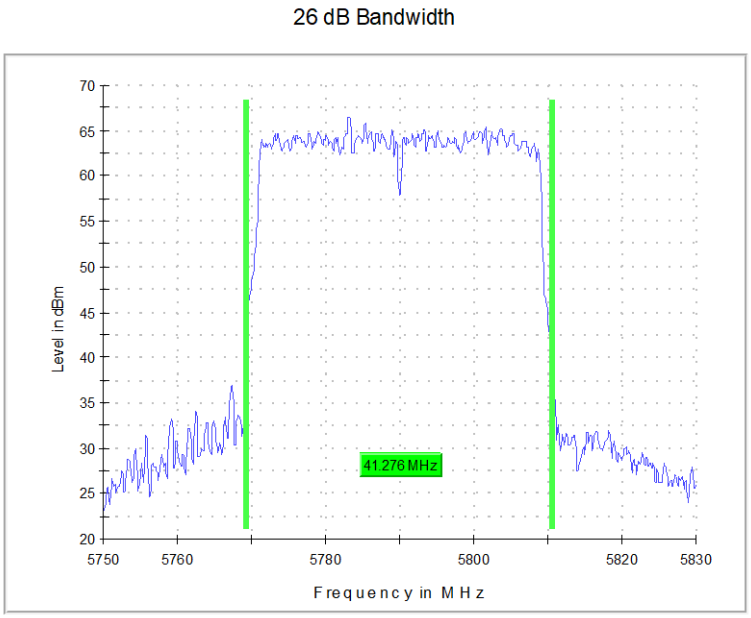
6.5.6 §15.403(i) 26dB Emissions Bandwidth

The 26 dB emissions bandwidths are shown in the table and plots below.

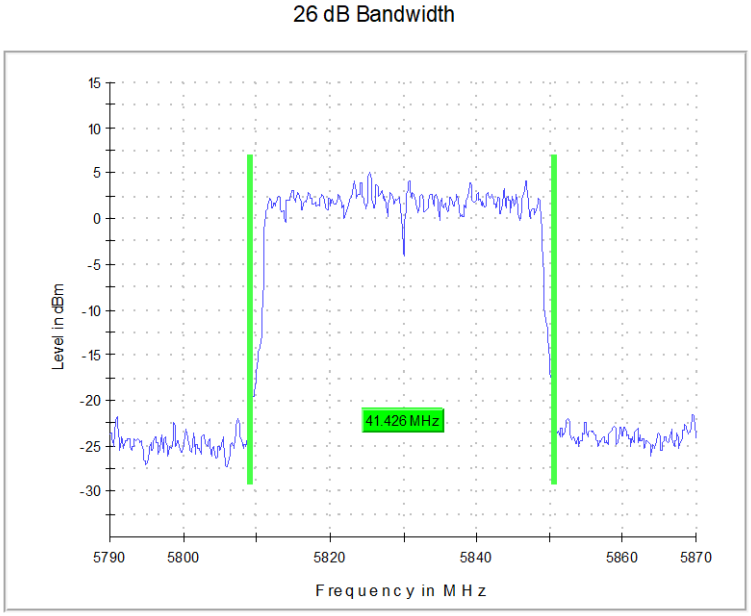
Frequency (MHz)	Emissions 26 dB bandwidth (MHz)
5745	41.58
5790	41.28
5830	41.43



Graph 25: Lowest Channel 26 dB Bandwidth



Graph 26: Middle Channel 26 dB Bandwidth



Graph 27: Highest Channel 26 dB Bandwidth

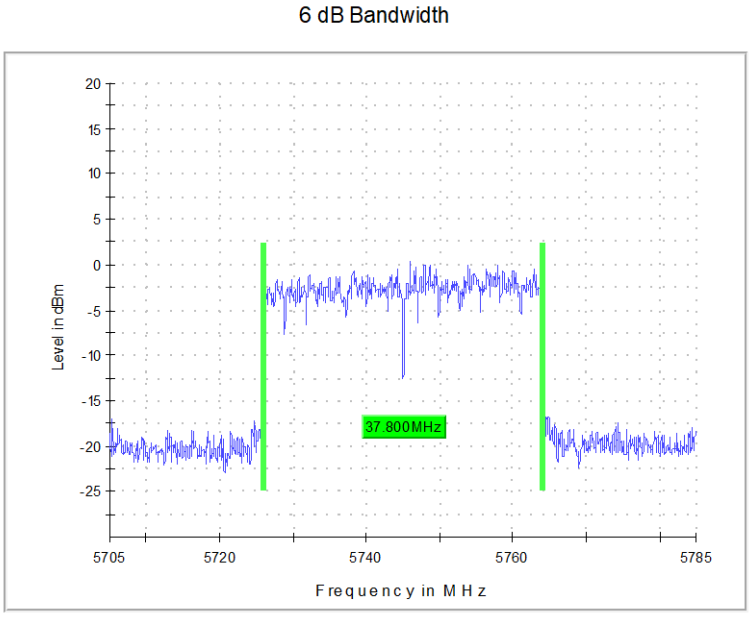
Result

The 26 dB bandwidths are reported for informational purposes.

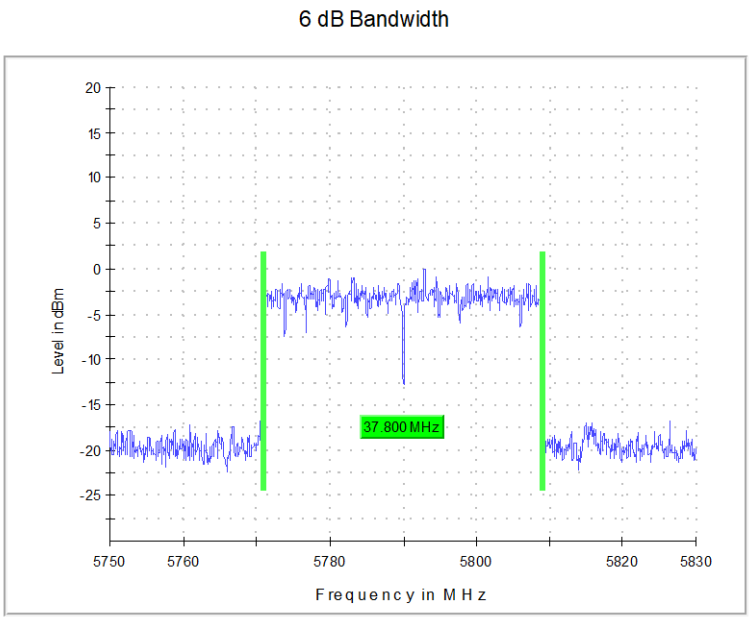
6.5.7 §15.407(e) UNII-3 Minimum 6dB Emissions Bandwidth

The UNII-3 minimum 6 dB emissions bandwidth for the channel is shown in the table and plots below.

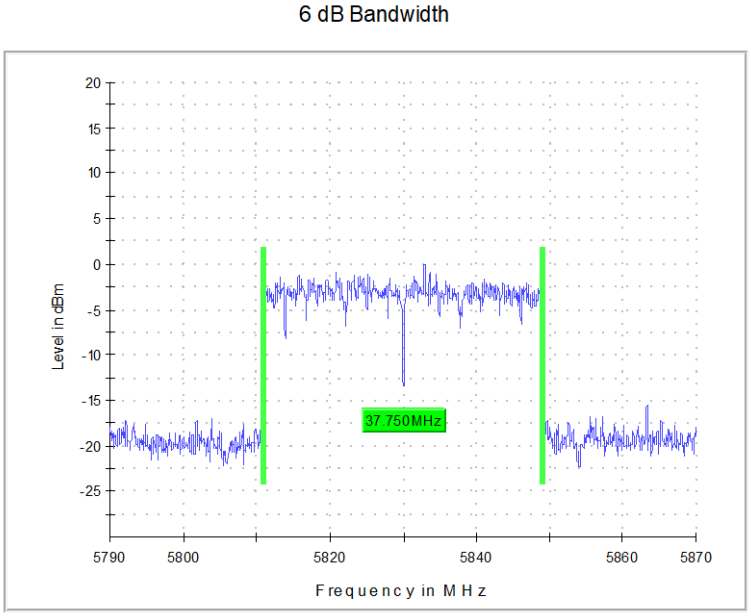
Frequency (MHz)	Emissions 6 dB bandwidth (MHz)
5745	37.8
5790	37.8
5830	37.8



Graph 28: UNII-3 Lowest Channel Minimum 6 dB Bandwidth



Graph 29: UNII-3 Middle Channel Minimum 6 dB Bandwidth

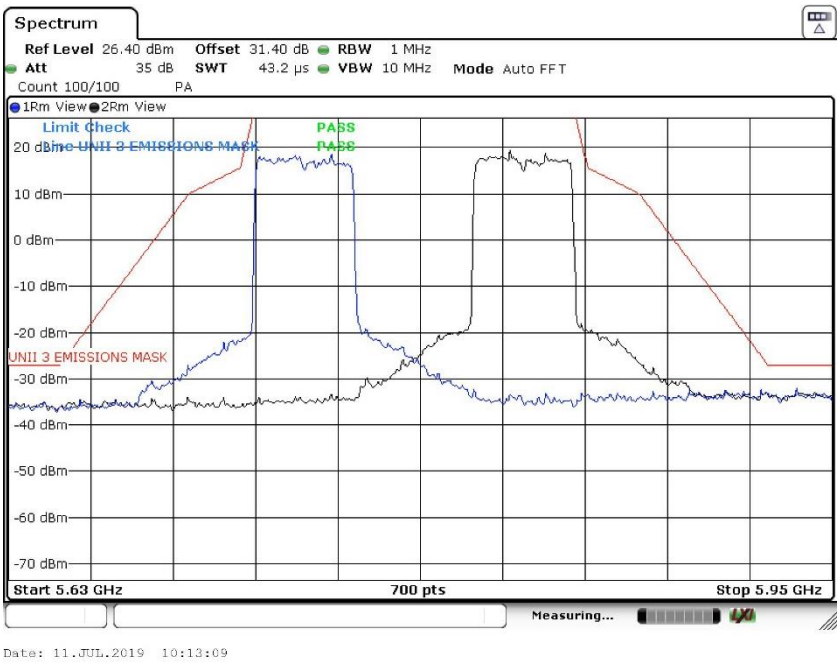


Graph 30: UNII-3 Highest Channel Minimum 6 dB Bandwidth

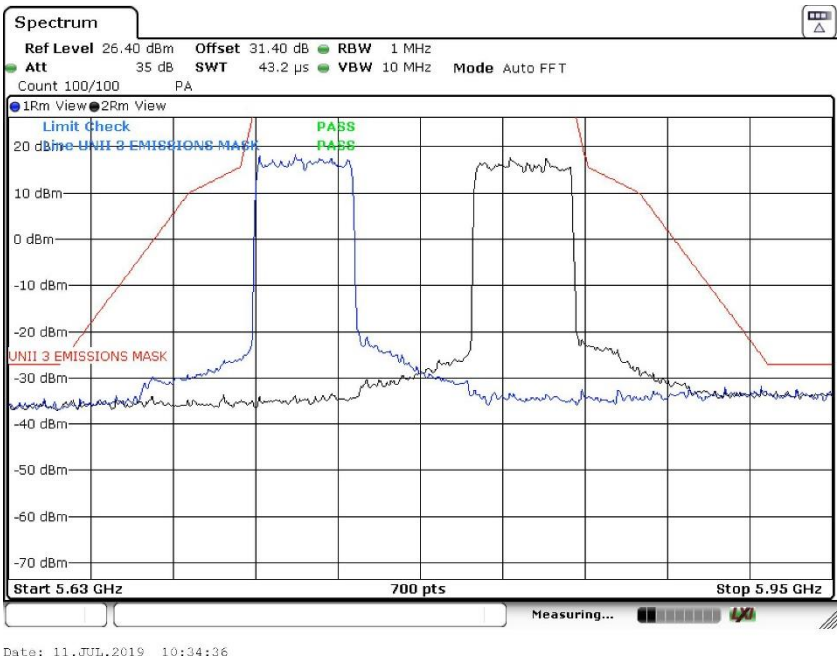
Result

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

6.5.8 §15.407(i) UNII-3 EIRP Emissions Limit



Graph 31: UNII-3 EIRP Emission Envelope Low and High Channel Transmitting (Port 0)



Graph 32: UNII-3 EIRP Emission Envelope Low and High Channel Transmitting (Port 1)

Result

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

6.5.9 Duty Cycle, Transmission Duration, and Maximum Power Control

EUT was capable of 100% duty cycle at maximum power control level. No correction factor is applied.

6.5.10 §15.407(a) Maximum Conducted Output Power

UNII-3 Conducted Power Measurements – Fixed Point-to-Point Architecture

Frequency (MHz)	Conducted Power (dBm)
5745	18.0
5790	18.8
5830	18.9

Result

The Conducted Power Measurement for Fixed Point-to-Point Architecture are reported for informational purposes.

6.5.11 §15.407(a) Maximum Power Spectral Density

UNII-3 Power Spectral Density Measurements

Frequency (MHz)	EIRP Density (dBm)	EIRP Density Limit (dBm)	Margin (dB)
5745	3.5	12.7	-9.2
5790	3.4	12.7	-9.3
5830	2.9	12.7	-9.8

Result: UNII-3 Fixed Point-to-Point Architecture

In the configurations tested the EUT complied with the requirements of the specification for fixed point-to-point architecture with a margin of 9.2 dB.

6.6 Test Results (50 MHz Bandwidth)

6.6.1 §15.203 Antenna Requirements

See Section 6.1.1 of this report.

Result

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

6.6.2 §15.407(b)(6) Conducted Emissions at AC Mains Ports

See Section 6.1.2 of this report. There was no change in the AC mains emissions with changing transmitter frequencies, power levels, or modulation bandwidths.

Result

The EUT complied with the specification limit by a margin of 4.3 dB.

6.6.3 §15.407(b)(6) Radiated Emissions Below 1000 MHz

No emissions from the transmitter were seen in the frequency range of 0.009 to 1000 MHz when transmitting at the lowest, middle, or highest frequency. Emissions seen in this range are from the other circuitry of the device, meet the class B requirements of §15.109, the limits of §15.209, and are reported in VPI Laboratories, Inc. report #V048426.

Result

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

6.6.4 §15.407(b)(7) Emissions in the Restricted Bands of §15.205

The EUT uses various power settings based on the channel in use. In order to reduce test time, the radiated spurious emissions at the lowest, middle, and highest channel were measured at the maximum power of TP19.

Radiated Measurements when Transmitting on Low Channel (5750 MHz at TP19 Power Setting)

Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBµV)	Correction Factor (dB)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
23000.0	Peak	Vertical	-1.1	52.7	51.6	74.0	-22.4
23000.0	Average	Vertical	-9.9	52.7	42.8	54.0	-11.2
23000.0	Peak	Horizontal	3.5	52.7	56.2	74.0	-17.8
23000.0	Average	Horizontal	-11.2	52.7	41.5	54.0	-12.5

Radiated Measurements when Transmitting on Middle Channel (5790 MHz at TP19 Power Setting)

Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBµV)	Correction Factor (dB)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
23160.0	Peak	Vertical	-1.5	52.8	51.3	74.0	-22.7
23160.0	Average	Vertical	-11.6	52.8	41.2	54.0	-12.8
23160.0	Peak	Horizontal	2.3	52.8	55.1	74.0	-18.9
23160.0	Average	Horizontal	-12.1	52.8	40.7	54.0	-13.3

Radiated Measurements when Transmitting on High Channel (5825 MHz at TP 19 Power Setting)

Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBµV)	Correction Factor (dB)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
23300.0	Peak	Vertical	-2.4	52.9	50.5	74.0	-23.5
23300.0	Average	Vertical	-11.4	52.9	41.5	54.0	-12.5
23300.0	Peak	Horizontal	1.5	52.9	54.4	74.0	-19.6
23300.0	Average	Horizontal	-13.5	52.9	39.4	54.0	-14.6

Result

The EUT complied with the specification limit by a margin of 5.6 dB.

6.6.5 §15.407(b)(7) Out of Band Emissions

The worst-case emissions seen outside of the restricted bands are shown below. Any other emissions were below the noise floor. Noise floor was a minimum of 6 dB below the limit.

Lower Channel Transmitting (5750 MHz)

Frequency (MHz)	e.i.r.p (dBm/MHz)	Limit (dBm/MHz)	Margin (dB)
6880	-43.8	-27.0	-16.8
17250	-38.8	-27.0	-11.8

Middle Channel Transmitting (5790 MHz)

Frequency (MHz)	e.i.r.p (dBm/MHz)	Limit (dBm/MHz)	Margin (dB)
6880	-43.9	-27.0	-16.9
17370	-38.8	-27.0	-11.8

Upper Channel Transmitting (5825 MHz)

Frequency (MHz)	e.i.r.p (dBm/MHz)	Limit (dBm/MHz)	Margin (dB)
6880	-43.2	-27.0	-16.2
17475	-38.7	-27.0	-11.7

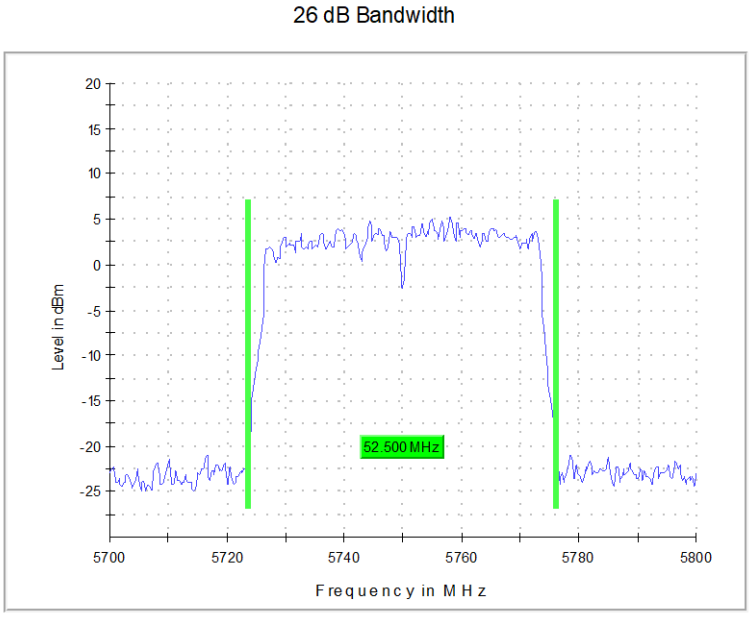
Result

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

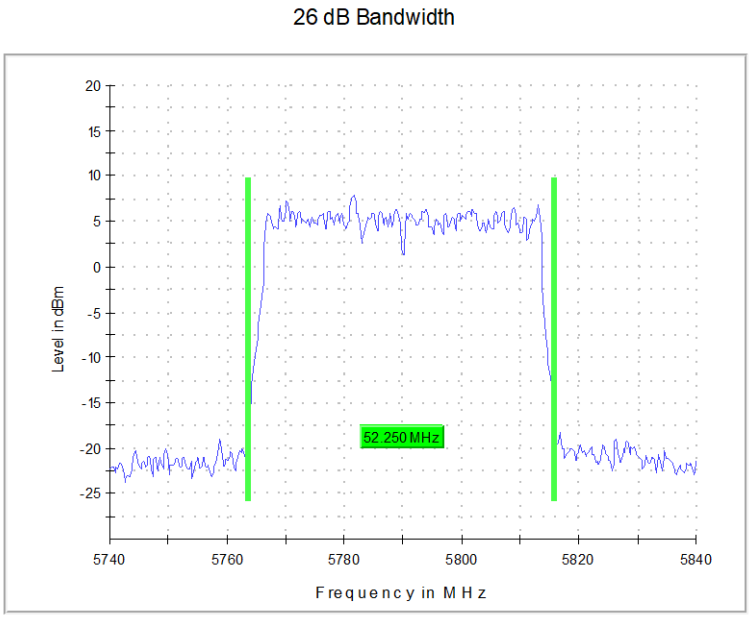
6.6.6 §15.403(i) 26dB Emissions Bandwidth

The 26 dB emissions bandwidths are shown in the table and plots below.

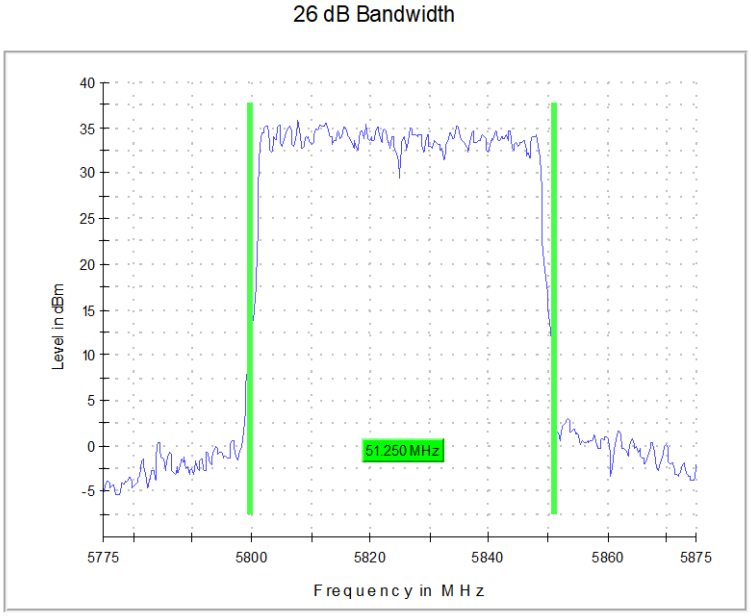
Frequency (MHz)	Emissions 26 dB bandwidth (MHz)
5750	52.5
5790	52.3
5825	51.3



Graph 33: Lowest Channel 26 dB Bandwidth



Graph 34: Middle Channel 26 dB Bandwidth



Graph 35: Highest Channel 26 dB Bandwidth

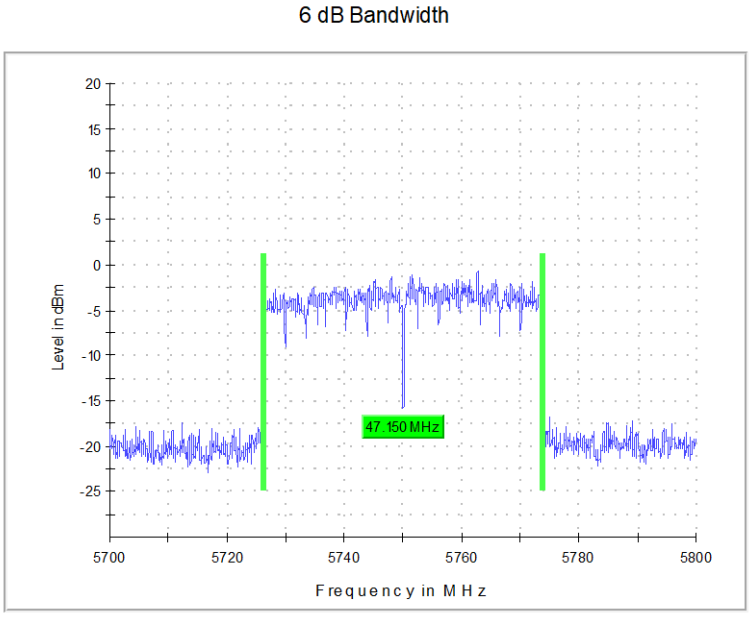
Result

The 26 dB bandwidths are reported for informational purposes.

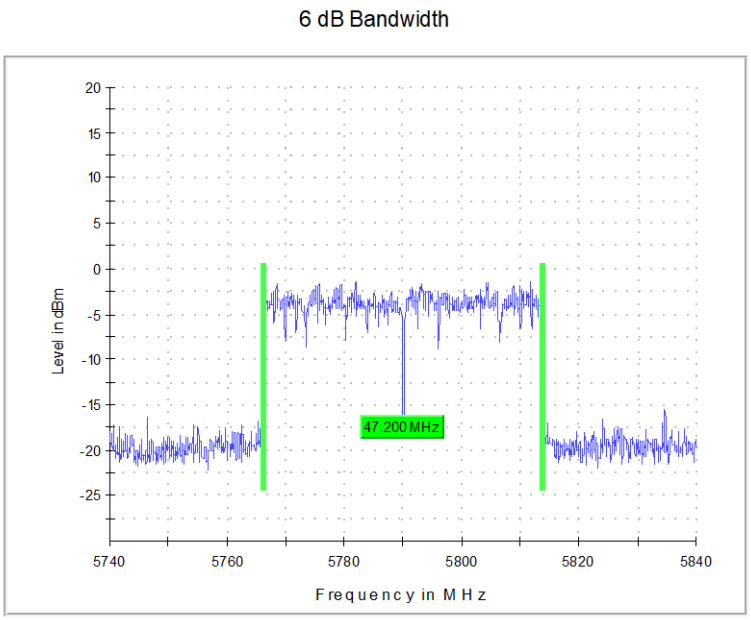
6.6.7 §15.407(e) UNII-3 Minimum 6dB Emissions Bandwidth

The UNII-3 minimum 6 dB emissions bandwidth for the channel is shown in the table and plots below.

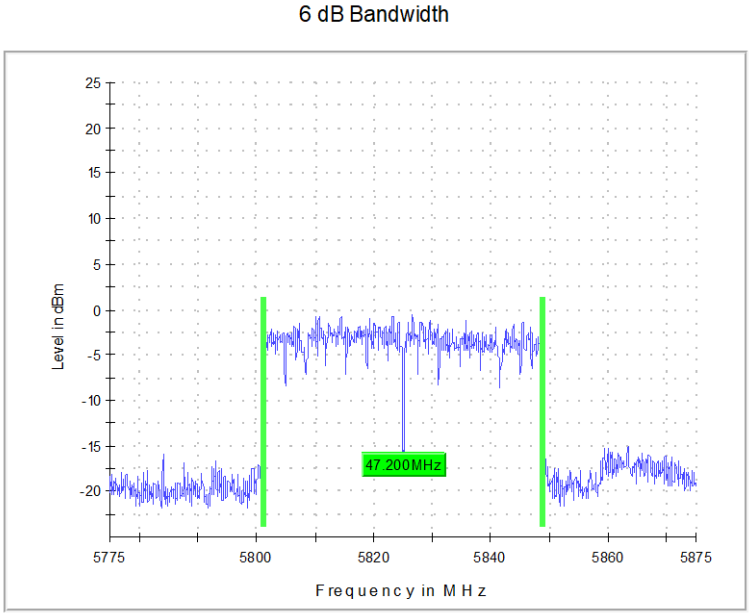
Frequency (MHz)	Emissions 6 dB bandwidth (MHz)
5750	47.2
5790	47.2
5825	47.2



Graph 36: UNII-3 Lowest Channel Minimum 6 dB Bandwidth



Graph 37: UNII-3 Middle Channel Minimum 6 dB Bandwidth

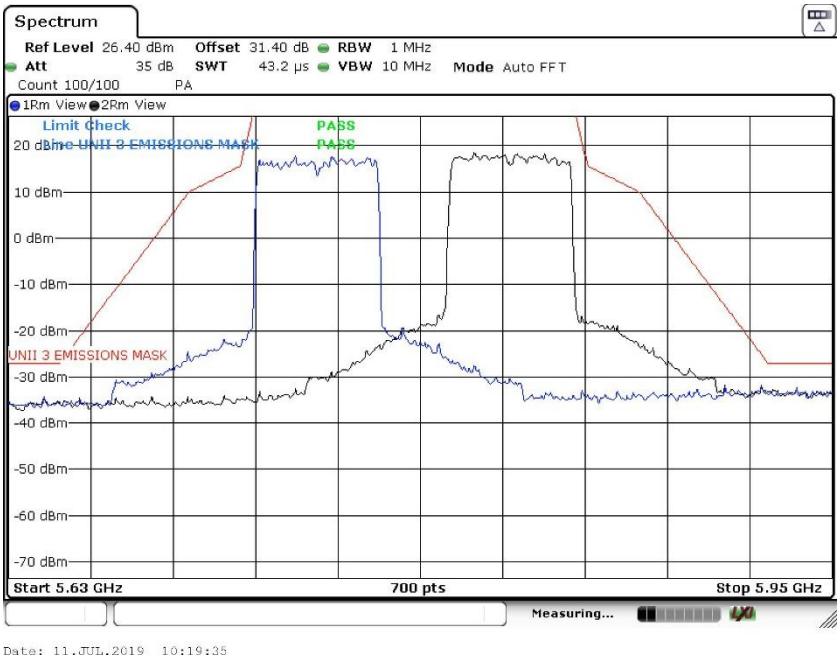


Graph 38: UNII-3 Highest Channel Minimum 6 dB Bandwidth

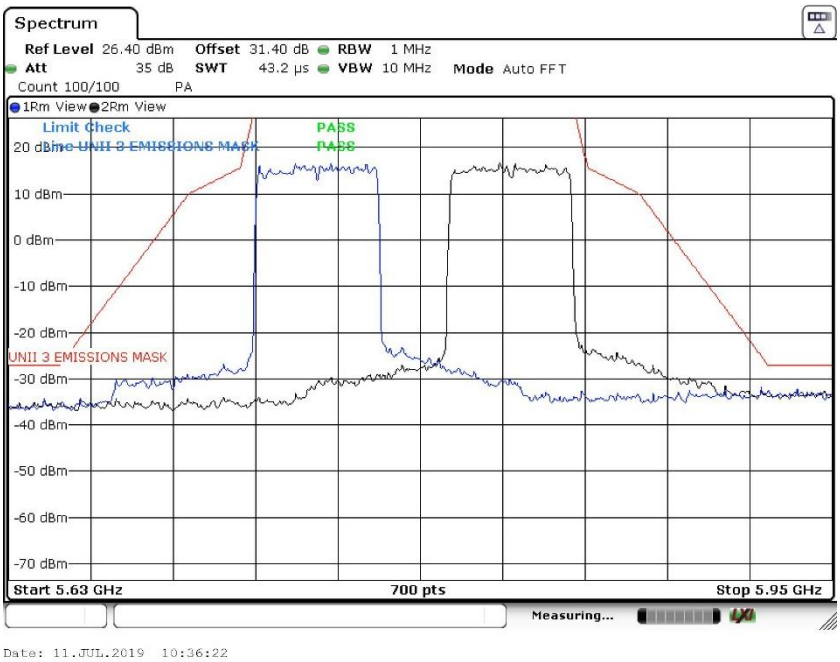
Result

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

6.6.8 §15.407(i) UNII-3 EIRP Emissions Limit



Graph 39: UNII-3 EIRP Emission Envelope Low and High Channel Transmitting (Port 0)



Graph 40: UNII-3 EIRP Emission Envelope Low and High Channel Transmitting (Port 1)

Result

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

6.6.9 Duty Cycle, Transmission Duration, and Maximum Power Control

EUT was capable of 100% duty cycle at maximum power control level. No correction factor is applied.

6.6.10 §15.407(a) Maximum Conducted Output Power

UNII-3 Conducted Power Measurements – Fixed Point-to-Point Architecture

Frequency (MHz)	Conducted Power (dBm)
5750	17.9
5790	18.8
5825	18.7

Result

The Conducted Power Measurement for Fixed Point-to-Point Architecture are reported for informational purposes.

6.6.11 §15.407(a) Maximum Power Spectral Density

UNII-3 Power Spectral Density Measurements

Frequency (MHz)	EIRP Density (dBm)	EIRP Density Limit (dBm)	Margin (dB)
5750	2.3	12.7	-10.4
5790	2.0	12.7	-10.7
5825	3.0	12.7	-9.7

Result: UNII-3 Fixed Point-to-Point Architecture

In the configurations tested the EUT complied with the requirements of the specification for fixed point-to-point architecture with a margin of 9.7 dB.

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	Hewlett Packard	8566B	V048078	05/26/2019	05/26/2020
Quasi-Peak Detector	Hewlett Packard	85650A	V039474	05/02/2018	05/02/2020
LISN	Teseq	NNB 51	V045406	07/13/2018	07/13/2020
Conductance Cable Wanship Upper Site	VPI Labs	Cable J	V034832	01/08/2019	01/08/2020
Filter	VPI Labs	47038	V047038	01/03/2019	01/03/2020
Test Software (AC)	VPI Labs	Revision 01	V035674	N/A	N/A

Table 3: List of equipment used for conducted emissions testing at mains ports.

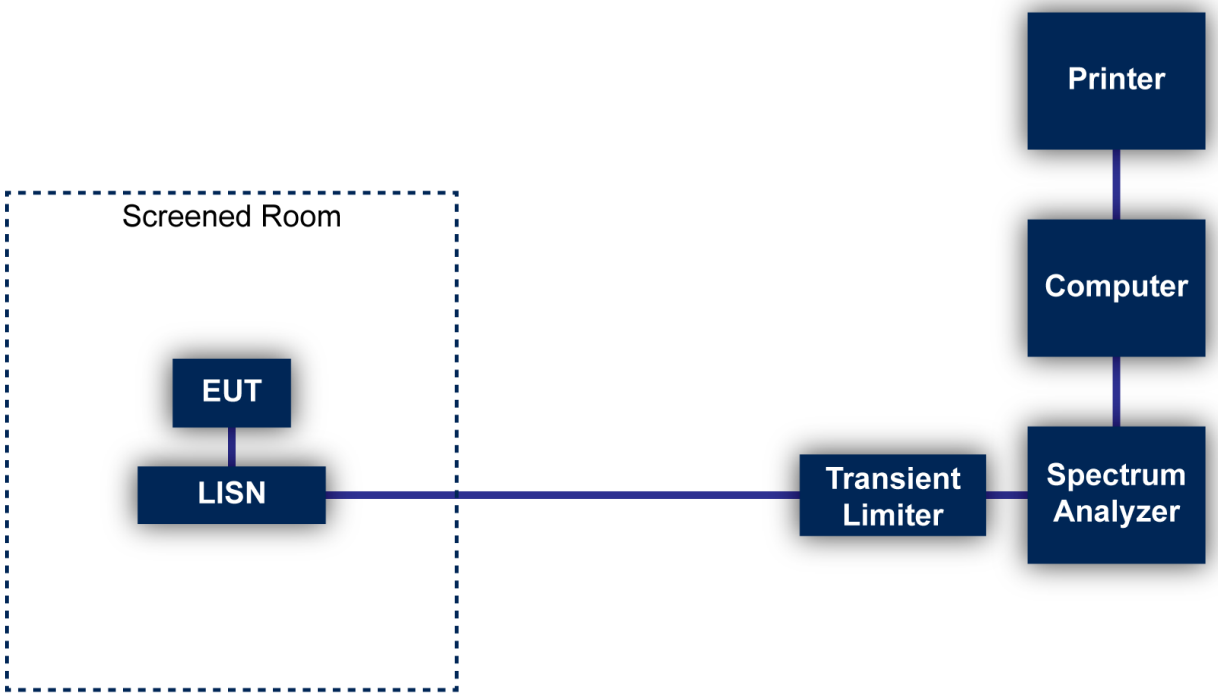


Figure 2: Mains Conducted Emissions Test

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	FSU40	V044352	04/01/2019	04/01/2020
Signal Generator	Rohde & Schwarz	SMB100A	V044485	04/03/2019	04/03/2020
Vector Signal Generator	Rohde & Schwarz	SMBV100A	V044217	04/01/2019	04/01/2020
40GHz Switch Extension	Rohde & Schwarz	OSP-150	V044486	04/19/2019	04/19/2020
40GHz Switch Base Unite	Rohde & Schwarz	OSP-120	V044487	04/16/2019	04/16/2020

Table 4: List of equipment used for conducted emissions testing at antenna ports.

7.2.1 Test Configuration Block Diagram

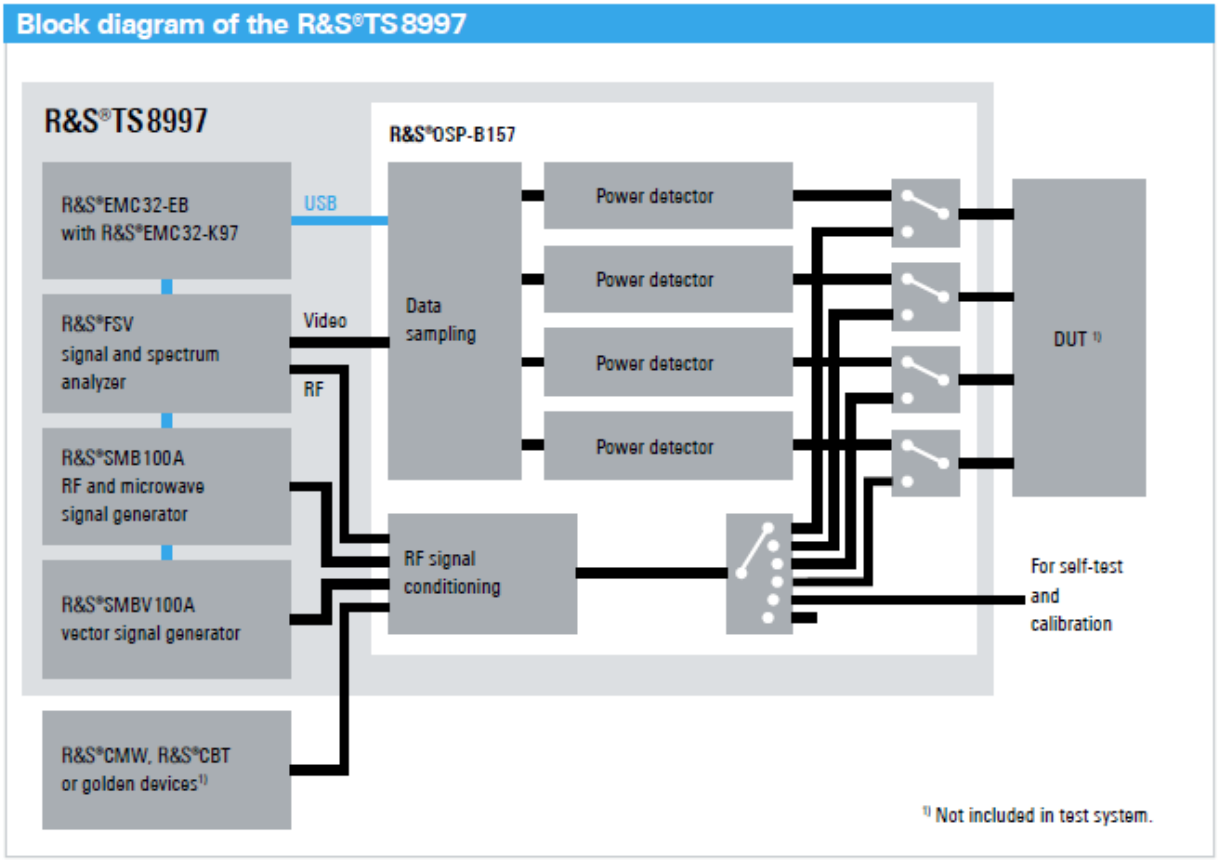


Figure 3: Direct Connection at the Antenna Port Test

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 of 51 dB 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	07/16/2018	07/16/2019
Spectrum Analyzer	Hewlett Packard	8566B	V048078	05/26/2019	05/26/2020
Quasi-Peak Detector	Hewlett Packard	85650A	V039474	05/02/2018	05/02/2020
Loop Antenna	EMCO	6502	V034216	02/11/2019	02/11/2021
Biconilog Antenna	EMCO	3142E-PA	V035736	07/05/2018	07/05/2020
Double Ridged Guide Antenna	EMCO	3115	V033469	04/13/2018	04/13/2020
Standard Gain Horn	ETS-Lindgren	3160-09	V034223	ICO	ICO
Standard Gain Horn	ETS-Lindgren	3160-10	V034224	ICO	ICO
High Frequency Amplifier	Miteq	AFS4-001018000-35-10P-4	V033997	01/08/2019	01/08/2020
High Frequency Amplifier	L3-Narda-Miteq	AMF-6F-18004000-37-8P	V042464	01/08/2019	01/08/2020
5.8 GHz High Pass Filter	Micro-Tronics	HPM50105	V034198	01/08/2019	01/08/2020
2.4 GHz Notch Filter	Micro-Tronics	BRM50702-03	V034213	01/08/2019	01/08/2020
6’ High Frequency Cable	Microcoax	UFB197C-0-0720-000000	V033638	01/08/2019	01/08/2020
20’ High Frequency Cable	Microcoax	UFB197C-1-3120-000000	V033979	01/08/2019	01/08/2020
3 Meter Radiated Emissions Cable Wanship Upper Site	Microcoax	UFB205A-0-4700-000000	V033639	01/08/2019	01/08/2020
Test Software (FCC)	VPI Labs	Revision 01	V035673	N/A	N/A

Table 5: List of equipment used for radiated emissions testing.

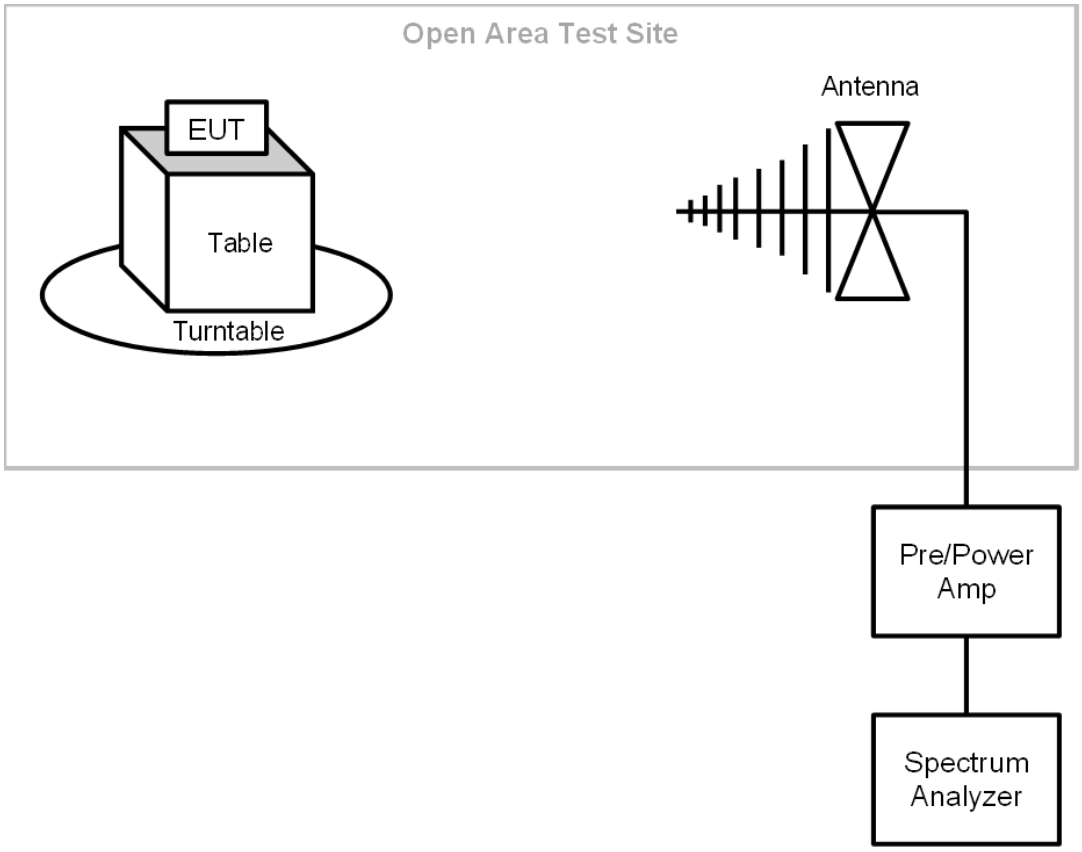


Figure 4: Radiated Emissions Below 1GHz Test

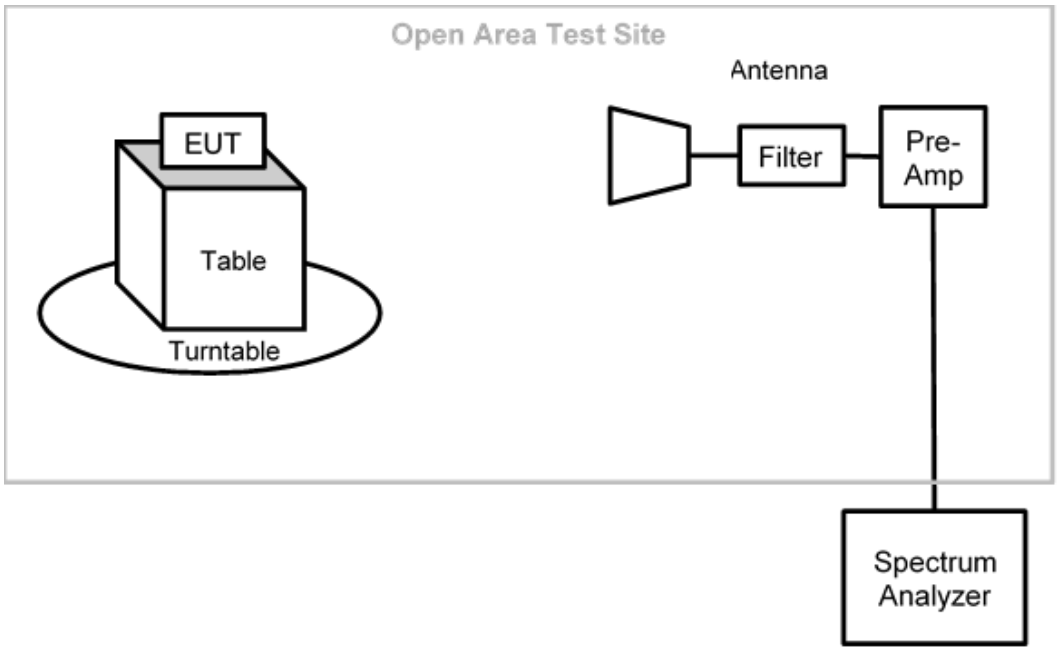


Figure 5: Radiated Emissions Above 1GHz Test

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 ---