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Test Report

Certification

FCC ID	2AA6Z-78T
Equipment Under Test	78T
Test Report Serial No	V049425_01
Dates of Test	August 13, 2019, September 24 and 30, 2019, and October 1 – 3, 2019 (Radiated) September 25-26, 2019 (Conducted at Antenna Port)
Report Issue Date	October 23, 2019

Test Specifications:	**Applicant:**
FCC Part 15, Subpart E	CaptionCall 4215 South Riverboat Road Salt Lake City, UT 84123 U.S.A.

NVLAP Testing
NVLAP Lab Code 100272-0

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	CaptionCall
Manufacturer	CaptionCall
Brand Name	CaptionCall
Model Number	78T
FCC ID	2AA6Z-78T

On this 23rd day of October 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 Emissions Tested by: Norman P. Hansen

Conducted Emissions at the Antenna Port Tested by: Benjamin N. Antczak

Reviewed by: Jason Stewart

Revision History		
Revision	**Description**	**Date**
01	Original Report Release	October 23, 2019

Table of Contents

1 Client Information

1.1 Applicant

Company Name	CaptionCall 4215 South Riverboat Road Salt Lake City, UT 84123 U.S.A.
Contact Name	Jasper Pan
Title	Hardware Engineering Manager

1.2 Manufacturer

Company Name	CaptionCall 4215 South Riverboat Road Salt Lake City, UT 84123 U.S.A.
Contact Name	Jasper Pan
Title	Hardware Engineering Manager

2 Equipment Under Test (EUT)

2.1 Identification of EUT

Brand Name	CaptionCall
Model Number	78T
Serial Number	None
Dimensions (cm)	27 x 23 x 5

2.2 Description of EUT

The 78T is a single-line telephone that incorporates a display and touch screen to quickly provide written captioning services (similar to captioned television) for anyone who has trouble hearing on the phone. It works like a regular telephone with keypad, handset, and speakerphone. Audio and frequency settings can be customized to each person's hearing loss. The 78T has a phone port, Ethernet port, and neckloop port. Power is provided by a Kwong Yuen DR12015U311 power supply. The 78T has a transceiver module incorporated. The transceiver module can operate in the 5 GHz frequency band using the UNII-1 and UNII-3 frequency bands and using 20 MHz or 40 MHz bandwidths, or in the 2.4 GHz frequency band using 802.11b/g/n or SDR/EDR Bluetooth. The antenna is an inverted F, trace antenna on a separate PCB connected to the Main PCB by a 190 mm coaxial cable with FLP-40 connectors.

This report covers the transceiver operating in the 5150 – 5250 MHz UNII-1 frequency band. The circuitry of the device subject to FCC Subpart B was found to be compliant and is covered in VPI Laboratories, Inc. report V049410. The transceiver, when operating in the 2400 – 2483.5 MHz frequency band using Bluetooth or 802.11bgn or in the UNII-3 frequency band is covered in separate testing and reports.

The UNII-1 transceiver uses 6 channels in the 5150 MHz to 5250 MHz frequency band. The EUT uses 20 MHz and 40 MHz channels. The table below shows the channels, frequencies and bandwidths used by the EUT.

Frequency (MHz)	Channel #	Modulation Bandwidth (MHz)
5180	36	20
5200	40	20
5220	44	20
5240	48	20
5190	38	40
5230	46	40

2.3 Modes of Operation

EUT is intended to operate indoors as a client device operating under §15.407(a)(1)(iv).

2.4 DFS Capabilities

EUT does not utilize DFS. Therefore, the device 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).

2.5 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: CaptionCall MN: 78T (Note 1) SN: None	Telephone with captioning	See Section 2.4
BN: ASUS MN: WL-520G SN: None	Router	WAN/Cat 5e cable Wireless connection to EUT
BN: Trendnet MN: TE100-S8P SN: 0243C3A16540	Network Switch	Ethernet/Cat 5e cable with RJ45 connectors (Note 2)
BN: Toshiba MN: 2020 SN: None	PBX	Phone/Modular phone cord with RJ11 connectors (Note 2)
BN: Plantronics MN: Neckloop SN: None	Neckloop	Audio/Cable with 3.5 mm audio jack (Note 2)
BN: Comdial MN: 201 SN: None	Telephone	Phone/Modular phone cord with RJ11 connectors

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.

2.6 Interface Ports on EUT

Name of Ports	No. of Ports Fitted to EUT	Cable Description/Length
Ethernet	1	Cat 5e cable with RJ45 connectors/7 meters
Phone line	1	Modular phone cord with RJ11 connectors/3 meters
Neckloop	1	Audio cable with 3.5 mm jack/2 meters

2.7 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.

- When the EUT is operating in the UNII-1 frequency band, the maximum output power allowed will be set in firmware to +14. This setting is not user accessible.

2.8 Deviation from Test Standard

There were no deviations from the test specification.

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.

3.3 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, 2020. 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 in a constant transmit mode at the upper, middle, and lower channels. All modulations/data rates were tested. 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

CaptionCall software for transmitter control incorporating firmware from Ampak was used to control the UNII-1 transceiver.

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	Structural	Complied
15.207 (15.407(b)(6))	Conducted Disturbance at Mains Ports	0.15 to 30	Complied
15.403(i)	Emission 26 dB Bandwidth	5150 – 5250	Complied
15.407(a)(1)	EIRP above 30 Degrees	5150 – 5250	Not Applicable (Note 1)
15.407(a)(1)(iv)	Maximum Conducted Output Power	5150 – 5250	Complied
15.407(a)(1)(iv)	Maximum Power Spectral Density	5150 – 5250	Complied
15.407(b)(1)	Unwanted Emissions	1000 – 40000	Complied
15.407(b)(6)	Unwanted Emissions	0.009 – 1000	Complied
Note 1: 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

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.

6.2 Test Results (20 MHz Bandwidth)

6.2.1 §15.203 Antenna Requirements

The EUT uses an inverted F trace antennal on a PCB for the antenna with a maximum gain of 1 dBi. The antenna is connected to the transceiver via a 190 mm coaxial cable with u.fl connectors. The antenna is not user accessible as the EUT must be disassembled to access the antenna.

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 (§15.207)

Frequency (MHz)	AC Mains Lead	Detector	Measured Level (dBµV)	Limit (dBµV)	Margin (dB)
0.15	Hot Lead	Peak (Note 1)	44.7	56.0	-11.3
0.56	Hot Lead	Peak (Note 1)	39.7	46.0	-6.3
14.58	Hot Lead	Peak (Note 1)	39.4	50.0	-10.6
14.90	Hot Lead	Peak (Note 1)	41.4	50.0	-8.6
15.55	Hot Lead	Peak (Note 1)	41.5	50.0	-8.5
16.30	Hot Lead	Peak (Note 1)	39.5	50.0	-10.5
0.15	Neutral Lead	Quasi-Peak (Note 1)	48.1	56.0	-7.9
0.21	Neutral Lead	Quasi-Peak (Note 1)	39.2	53.3	-14.1
0.29	Neutral Lead	Peak (Note 1)	41.1	50.6	-9.5
0.56	Neutral Lead	Peak (Note 1)	40.1	46.0	-5.9
14.20	Neutral Lead	Peak (Note 1)	40.3	50.0	-9.7
14.70	Neutral Lead	Peak (Note 1)	40.7	50.0	-9.3
15.55	Neutral Lead	Peak (Note 1)	41.1	50.0	-8.9
16.10	Neutral Lead	Peak (Note 1)	40.2	50.0	-9.8

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

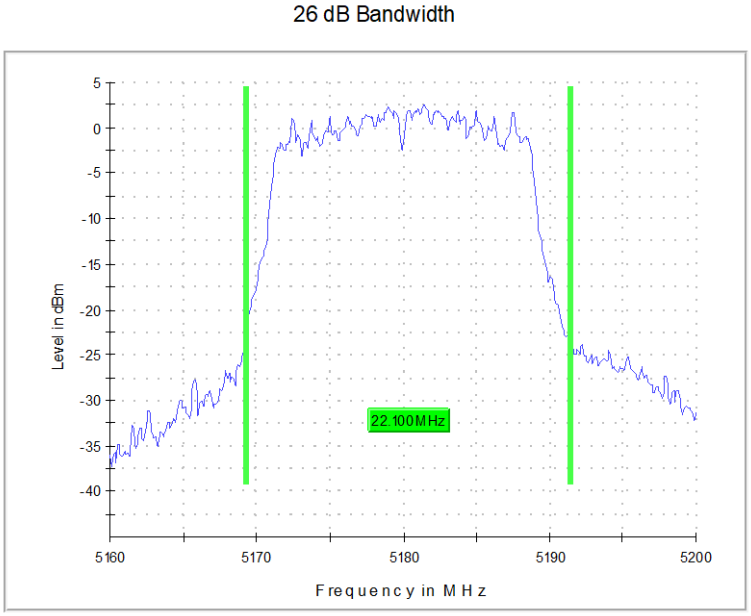
The EUT complied with the specification limit by a margin of 5.9 dB.

6.2.3 §15.403(i) 26 dB Emission Bandwidth

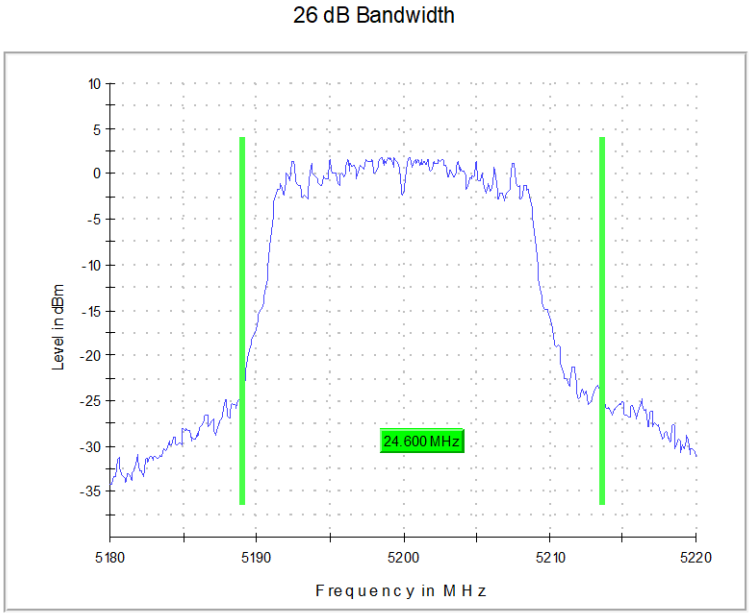
Frequency (MHz)	Emissions 26 dB bandwidth (MHz)
5180	22.1
5200	24.6
5240	24.6

Result

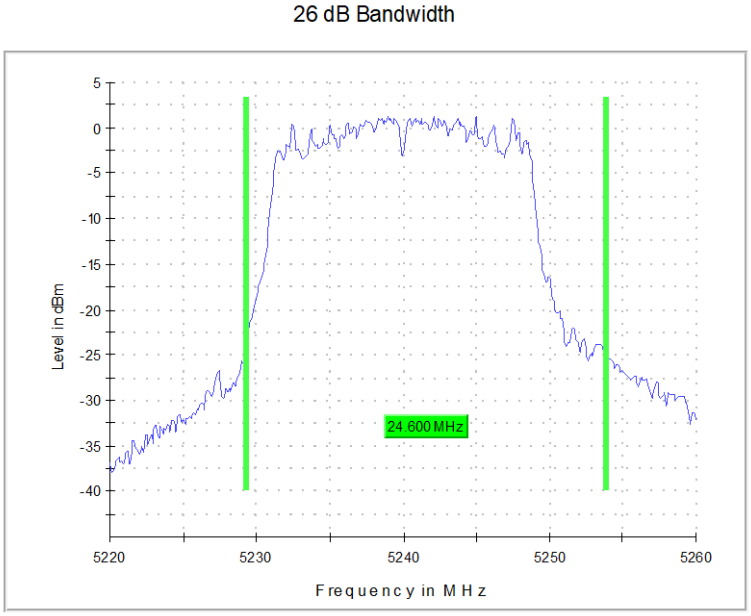
In the configuration tested, the 26 dB bandwidth is shown and the 26 dB bandwidth resides within the 5150 MHz to 5250 MHz frequency band; therefore, the EUT complied with the requirements of the specification. See the plots below.



Graph 1: Lowest Channel Bandwidth



Graph 2: Middle Channel Bandwidth



Graph 3: Highest Channel Bandwidth

6.2.4 §15.407(a)(1)(6) Power Limits: Maximum Conducted Output Power

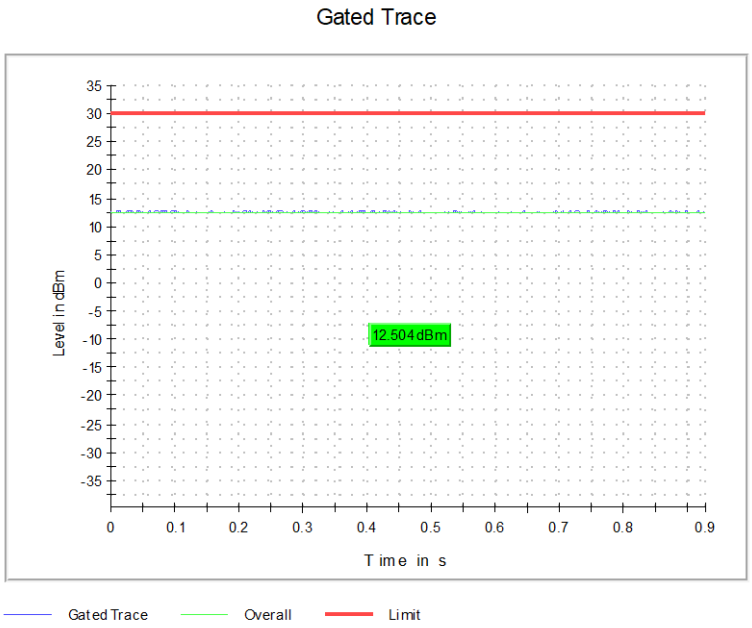
UNII-1 Conducted Power Measurement – Client Mode

The EUT uses an antenna with less than 6 dBi gain; therefore, no reduction in power is required.

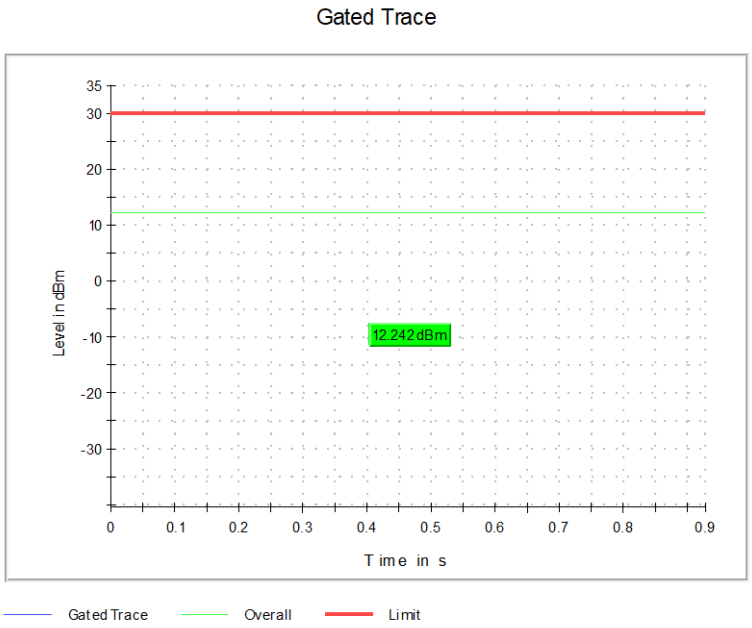
Frequency (MHz)	EIRP (dBm)	EIRP Limit (dBm)	Margin (dB)
5180	12.5	24.0	-11.5
5200	12.2	24.0	-11.8
5240	11.96	24.0	-12.0

Result

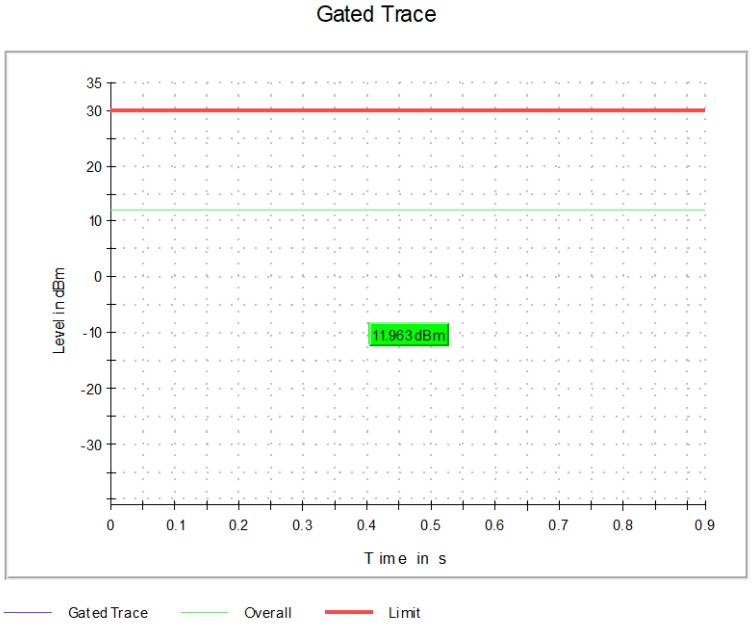
In the configurations tested the EUT complied with the requirements of the specification with a margin of 11.5 dB.



Graph 4: Lowest Channel Conducted Power Plot



Graph 5: Middle Channel Conducted Power Plot



Graph 6: Highest Channel Conducted Power Plot

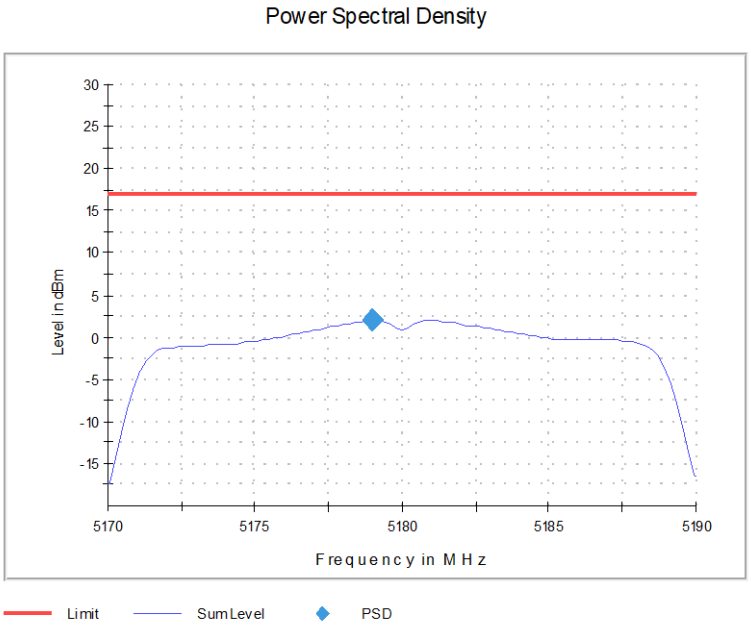
6.2.5 §15.407(a)(1)(iv) Power Limits: Maximum Power Spectral Density

UNII-1 Power Spectral Density Measurements – Client Mode

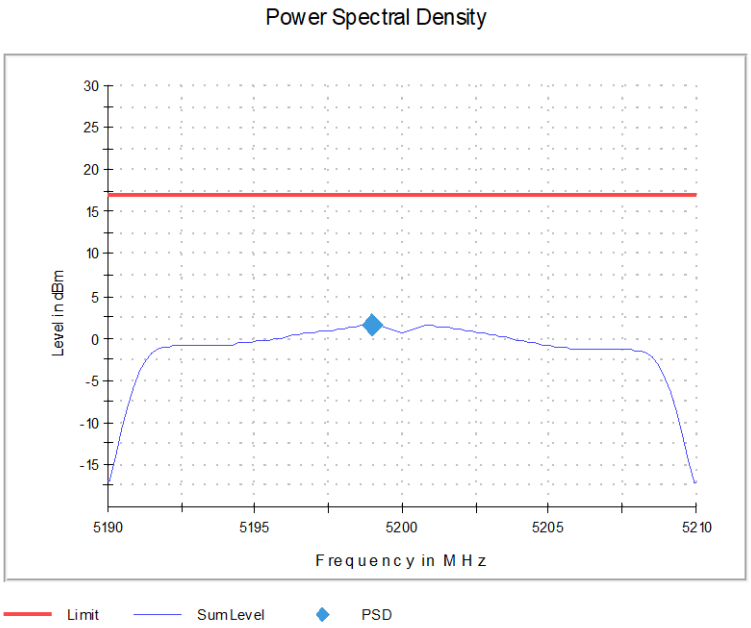
Frequency (MHz)	EIRP Density (dBm/MHz)	EIRP Density Limit (dBm/MHz)	Margin (dB)
5180	2.0	11.0	-9.0
5200	1.6	11.0	-9.4
5240	1.1	11.0	-9.9

Result

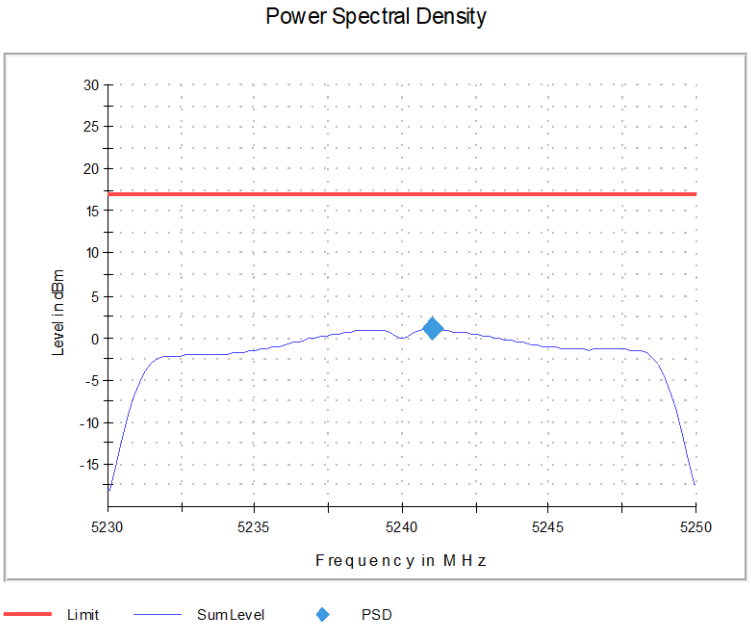
In the configurations tested the EUT complied with the requirements of the specification with a margin of 9.0 dB.



Graph 7: Lowest Channel Power Spectral Density Plot



Graph 8: Middle Channel Power Spectral Density Plot



Graph 9: Highest Channel Power Spectral Density Plot

6.2.6 §15.407(b)(1) and §15.407(b)(6) Undesirable Emissions

Undesirable emissions were measured using radiated methods. Emissions from 1000 MHz to 40 MHz were measured. Emissions outside of the 5.15 MHz to 5250 MHz band shall not exceed -27 dBm/MHz. Emissions in the restricted bands of §15.205 must meet the limits of §15.209.

Note that emissions not from the transmitter, but from the other circuitry in the device such as the display and telecom circuitry, were found compliant to the emission limits of §15.109 and are shown in VPI Laboratories report # V049410.

Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBµV)	Correction Factor (dB)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
1584.0	Peak	Vertical	22.2	28.7	50.9	68.3	-17.4
1584.0	Average	Vertical	-9.3	28.7	19.4	54.0	-34.6
1584.0	Peak	Horizontal	33.5	28.7	62.2	68.3	-6.1
1584.0	Average	Horizontal	2.2	28.7	30.9	54.0	-23.1
3696.0	Peak	Vertical	21.1	36.7	57.8	68.3	-10.5
3696.0	Average	Vertical	-3.0	36.7	33.7	54.0	-20.3
3696.0	Peak	Horizontal	20.3	36.7	57.0	68.3	-11.3
3696.0	Average	Horizontal	0.6	36.7	37.3	54.0	-16.7
10360.0	Peak	Vertical	4.2	46.3	50.5	68.3	-17.8
10360.0	Average	Vertical	-7.8	46.3	38.5	54.0	-15.5
10360.0	Peak	Horizontal	4.5	46.3	50.8	68.3	-17.5
10360.0	Average	Horizontal	-7.5	46.3	38.8	54.0	-15.2
Note: The requirement that all emissions, including those in the restricted bands, meet the -27 dBm/MHz EIRP indicates that the Peak measurement should be compared to that limit (68.2 dBµV/m at 3 meter measurement distance) instead of 20 dB above the Average limit of §15.35(b).							

Table 2: Transmitting at the Lowest Frequency

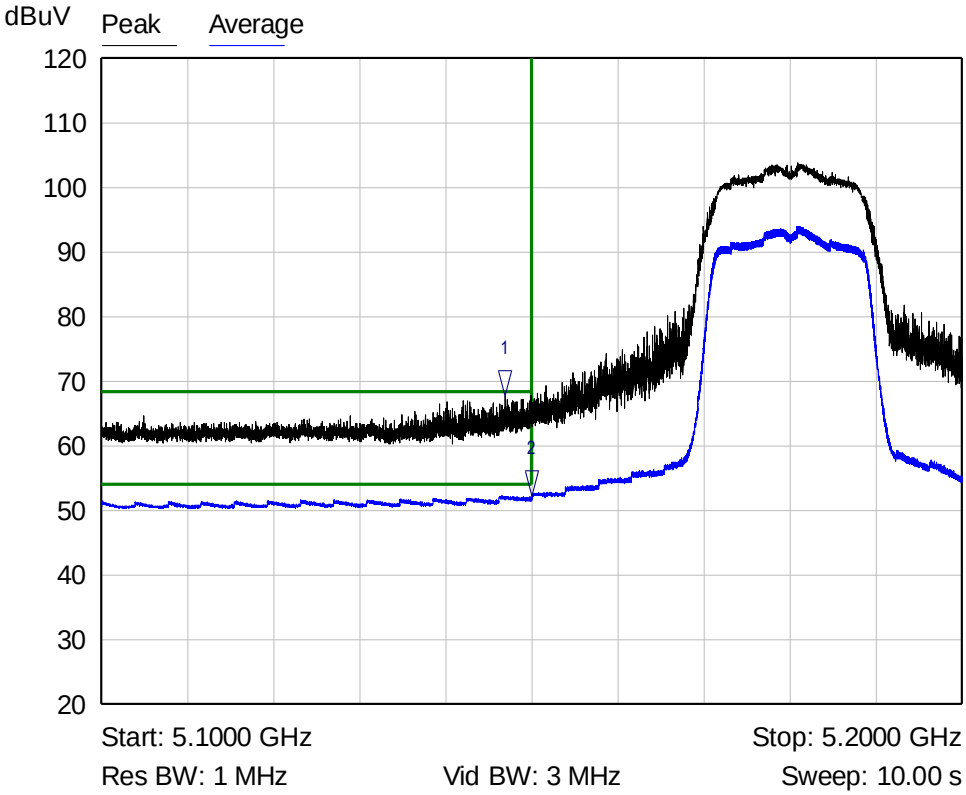
Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBµV)	Correction Factor (dB)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
1584.0	Peak	Vertical	16.1	28.7	44.8	68.3	-23.5
1584.0	Average	Vertical	-2.8	28.7	25.9	54.0	-28.1
1584.0	Peak	Horizontal	28.6	28.7	57.3	68.3	-11.0
1584.0	Average	Horizontal	1.1	28.7	29.8	54.0	-24.2
3696.0	Peak	Vertical	24.0	36.7	60.7	68.3	-7.6
3696.0	Average	Vertical	2.0	36.7	38.7	54.0	-15.3
3696.0	Peak	Horizontal	30.4	36.7	67.1	68.3	-1.2
3696.0	Average	Horizontal	8.2	36.7	44.9	54.0	-9.1
10400.0	Peak	Vertical	4.8	46.4	51.2	68.3	-17.1

Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBµV)	Correction Factor (dB)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
10400.0	Average	Vertical	-7.6	46.4	38.8	54.0	-15.2
10400.0	Peak	Horizontal	4.3	46.4	50.7	68.3	-17.6
10400.0	Average	Horizontal	-8.3	46.4	38.1	54.0	-15.9
Note: The requirement that all emissions, including those in the restricted bands, meet the -27 dBm/MHz EIRP indicates that the Peak measurement should be compared to that limit (68.2 dBµV/m at 3 meter measurement distance) instead of 20 dB above the Average limit of §15.35(b).							

Table 3: Transmitting at the Middle Frequency

Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBµV)	Correction Factor (dB)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
1584.0	Peak	Vertical	25.8	28.7	54.5	68.3	-13.8
1584.0	Average	Vertical	4.8	28.7	33.5	54.0	-20.5
1584.0	Peak	Horizontal	31.2	28.7	59.9	68.3	-8.4
1584.0	Average	Horizontal	6.0	28.7	34.7	54.0	-19.3
3696.0	Peak	Vertical	18.1	36.7	54.8	68.3	-13.5
3696.0	Average	Vertical	-3.7	36.7	33.0	54.0	-21.0
3696.0	Peak	Horizontal	18.5	36.7	55.2	68.3	-13.1
3696.0	Average	Horizontal	-3.9	36.7	32.8	54.0	-21.2
10480.0	Peak	Vertical	4.5	46.4	50.9	68.3	-17.4
10480.0	Average	Vertical	-6.4	46.4	40.0	54.0	-14.0
10480.0	Peak	Horizontal	4.3	46.4	50.7	68.3	-17.6
10480.0	Average	Horizontal	-6.4	46.4	40.0	54.0	-14.0
Note: The requirement that all emissions, including those in the restricted bands, meet the -27 dBm/MHz EIRP indicates that the Peak measurement should be compared to that limit (68.2 dBµV/m at 3 meter measurement distance) instead of 20 dB above the Average limit of §15.35(b).							

Table 4: Transmitting at the Highest Frequency



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Peak	5.1469 GHz	67.64 dBuV	
2 ▽	Average	5.1500 GHz	52.16 dBuV	

Graph 10: Lowest Channel Radiated Band Edge

Result

The EUT complies with the requirements for unwanted spurious emissions by 0.7 dB.

6.3 Test Results (40 MHz Bandwidth)

6.3.1 §15.203 Antenna Requirements

The EUT uses an inverted F trace antennal on a PCB for the antenna with a maximum gain of 1 dBi. The antenna is connected to the transceiver via a 190 mm coaxial cable with u.fl connectors. The antenna is not user accessible as the EUT must be disassembled to access the antenna.

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 (§15.207)

Frequency (MHz)	AC Mains Lead	Detector	Measured Level (dBμV)	Limit (dBμV)	Margin (dB)
0.15	Hot Lead	Peak (Note 1)	44.7	56.0	-11.3
0.56	Hot Lead	Peak (Note 1)	39.7	46.0	-6.3
14.58	Hot Lead	Peak (Note 1)	39.4	50.0	-10.6
14.90	Hot Lead	Peak (Note 1)	41.4	50.0	-8.6
15.55	Hot Lead	Peak (Note 1)	41.5	50.0	-8.5
16.30	Hot Lead	Peak (Note 1)	39.5	50.0	-10.5
0.15	Neutral Lead	Quasi-Peak (Note 1)	48.1	56.0	-7.9
0.21	Neutral Lead	Quasi-Peak (Note 1)	39.2	53.3	-14.1
0.29	Neutral Lead	Peak (Note 1)	41.1	50.6	-9.5
0.56	Neutral Lead	Peak (Note 1)	40.1	46.0	-5.9
14.20	Neutral Lead	Peak (Note 1)	40.3	50.0	-9.7
14.70	Neutral Lead	Peak (Note 1)	40.7	50.0	-9.3
15.55	Neutral Lead	Peak (Note 1)	41.1	50.0	-8.9
16.10	Neutral Lead	Peak (Note 1)	40.2	50.0	-9.8

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

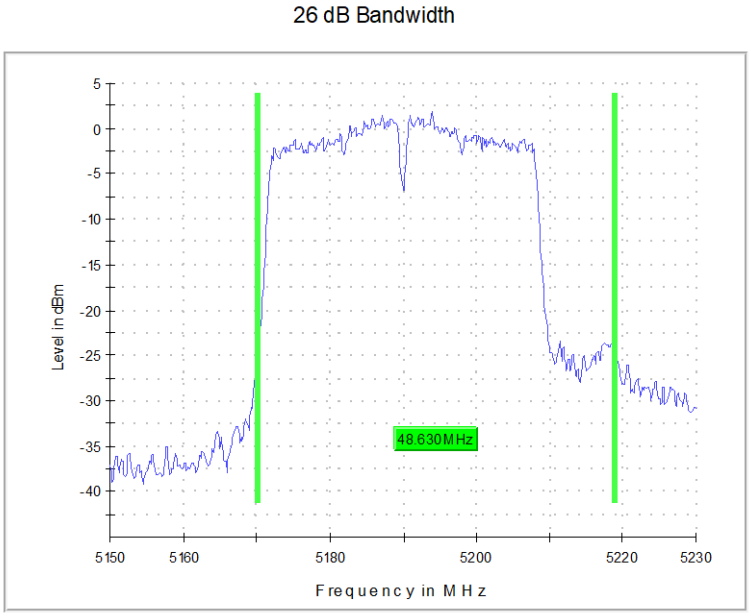
The EUT complied with the specification limit by a margin of 5.9 dB.

6.3.3 §15.403(i) 26 dB Emission Bandwidth

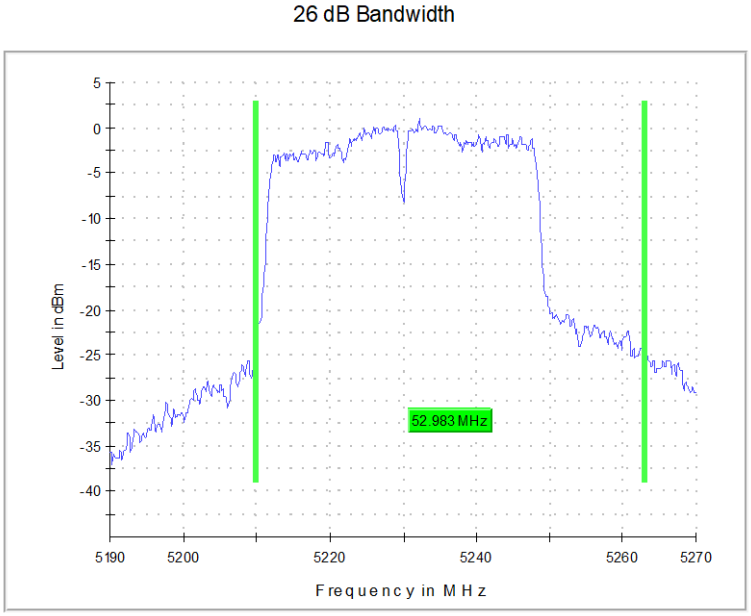
Frequency (MHz)	Emissions 26 dB bandwidth (MHz)
5190	48.6
5230	53.0

Result

In the configuration tested, the 26 dB bandwidth is shown and the 26 dB bandwidth resides within the 5150 MHz to 5250 MHz frequency band; therefore, the EUT complied with the requirements of the specification. See the plots below.



Graph 11: Lowest Channel Bandwidth



Graph 12: Highest Channel Bandwidth

6.3.4 §15.407(a)(1)(6) Power Limits: Maximum Conducted Output Power

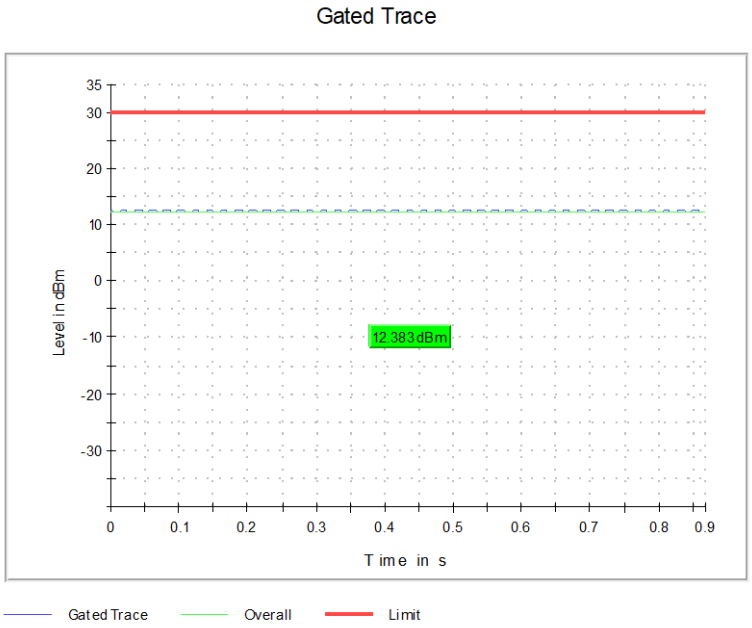
UNII-1 Conducted Power Measurement – Client Mode

The EUT uses an antenna with less than 6 dBi gain; therefore, no reduction in power is required.

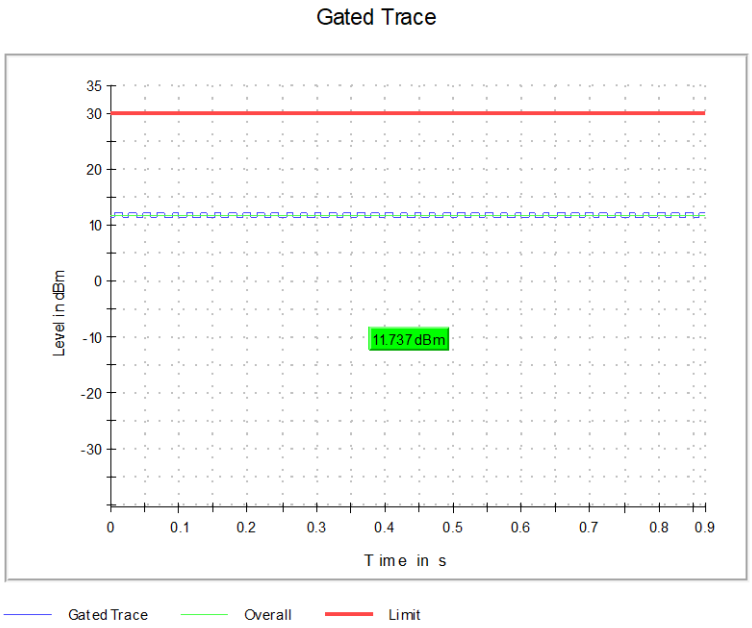
Frequency (MHz)	EIRP (dBm)	EIRP Limit (dBm)	Margin (dB)
5190	12.4	24.0	-11.6
5230	11.7	24.0	-12.3

Result

In the configurations tested the EUT complied with the requirements of the specification with a margin of 11.6 dB.



Graph 13: Lowest Channel Conducted Power Plot



Graph 14: Highest Channel Conducted Power Plot

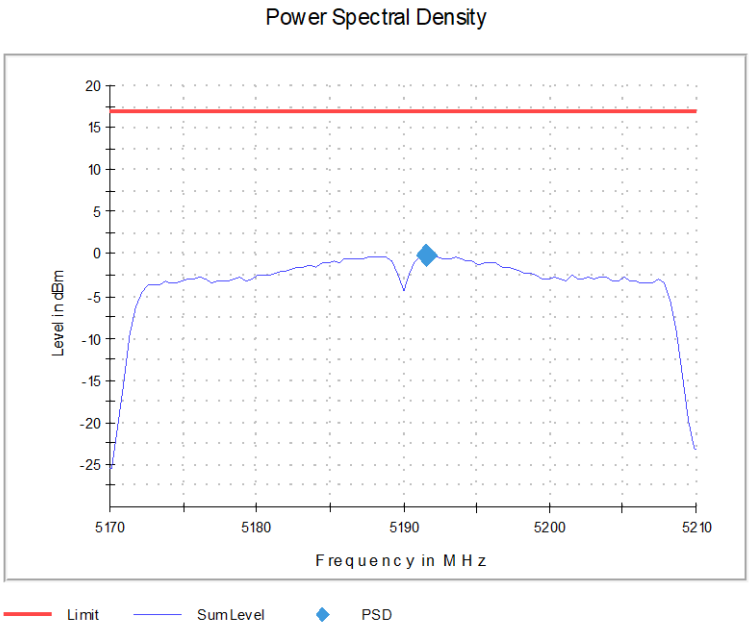
6.3.5 §15.407(a)(1)(iv) Power Limits: Maximum Power Spectral Density

UNII-1 Power Spectral Density Measurements – Client Mode

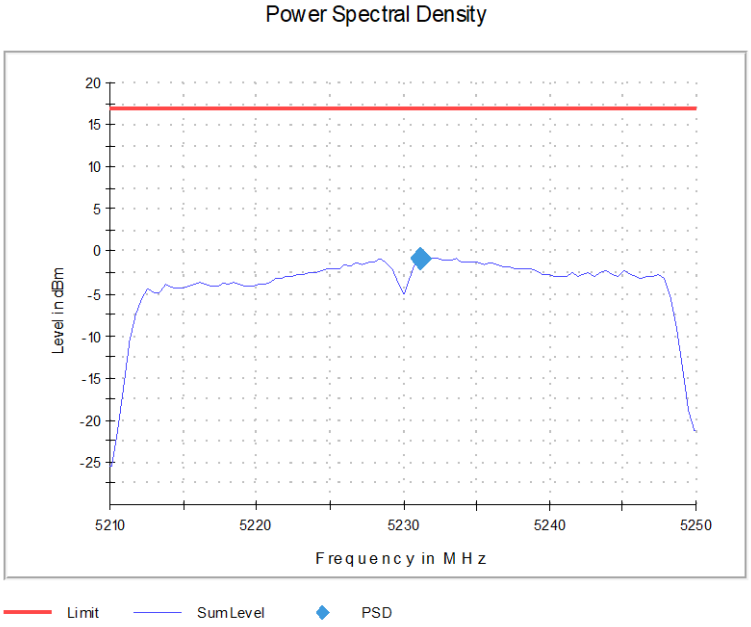
Frequency (MHz)	EIRP Density (dBm/MHz)	EIRP Density Limit (dBm/MHz)	Margin (dB)
5190	-0.2	11.0	-11.2
5230	-0.9	11.0	-11.9

Result

In the configurations tested the EUT complied with the requirements of the specification with a margin of 11.2 dB.



Graph 15: Lowest Channel Power Spectral Density Plot



Graph 16: Highest Channel Power Spectral Density Plot

6.3.6 §15.407(b)(1) and §15.407(b)(6) Undesirable Emissions

Undesirable emissions were measured using radiated methods. Emissions from 1000 MHz to 40 MHz were measured. Emissions outside of the 5.15 MHz to 5250 MHz band shall not exceed -27 dBm/MHz. Emissions in the restricted bands of §15.205 must meet the limits of §15.209.

Note that emissions not from the transmitter, but from the other circuitry in the device such as the display and telecom circuitry, were found compliant to the emission limits of §15.109 and are shown in VPI Laboratories report # V049410.

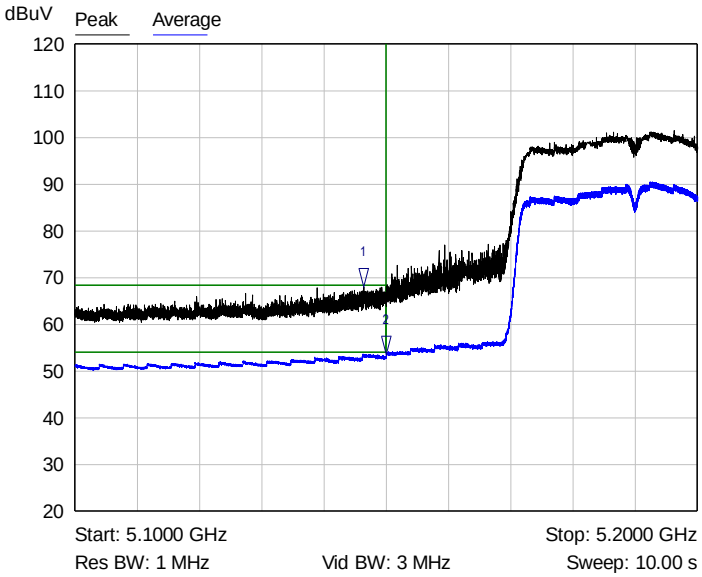
Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBµV)	Correction Factor (dB)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
1584.0	Peak	Vertical	25.8	28.7	54.5	68.3	-13.8
1584.0	Average	Vertical	4.8	28.7	33.5	54.0	-20.5
1584.0	Peak	Horizontal	31.2	28.7	59.9	68.3	-8.4
1584.0	Average	Horizontal	6.0	28.7	34.7	54.0	-19.3
3696.0	Peak	Vertical	18.1	36.7	54.8	68.3	-13.5
3696.0	Average	Vertical	-3.7	36.7	33.0	54.0	-21.0
3696.0	Peak	Horizontal	18.5	36.7	55.2	68.3	-13.1
3696.0	Average	Horizontal	-3.9	36.7	32.8	54.0	-21.2
10380.0	Peak	Vertical	4.3	46.4	50.7	68.3	-17.6
10380.0	Average	Vertical	-6.2	46.4	40.2	54.0	-13.8
10380.0	Peak	Horizontal	4.1	46.4	50.5	68.3	-17.8
10380.0	Average	Horizontal	-6.1	46.4	40.3	54.0	-13.7
Note: The requirement that all emissions, including those in the restricted bands, meet the -27 dBm/MHz EIRP indicates that the Peak measurement should be compared to that limit (68.2 dBµV/m at 3 meter measurement distance) instead of 20 dB above the Average limit of §15.35(b).							

Table 5: Transmitting at the Lowest Frequency

Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBµV)	Correction Factor (dB)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
1584.0	Peak	Vertical	22.2	28.7	50.9	68.3	-17.4
1584.0	Average	Vertical	-9.3	28.7	19.4	54.0	-34.6
1584.0	Peak	Horizontal	33.5	28.7	62.2	68.3	-6.1
1584.0	Average	Horizontal	2.2	28.7	30.9	54.0	-23.1
3696.0	Peak	Vertical	21.1	36.7	57.8	68.3	-10.5
3696.0	Average	Vertical	-3.0	36.7	33.7	54.0	-20.3
3696.0	Peak	Horizontal	20.3	36.7	57.0	68.3	-11.3
3696.0	Average	Horizontal	0.6	36.7	37.3	54.0	-16.7
10460.0	Peak	Vertical	3.9	46.4	50.3	68.3	-18.0
10460.0	Average	Vertical	-6.3	46.4	40.1	54.0	-13.9
10460.0	Peak	Horizontal	3.8	46.4	50.2	68.3	-18.1
10460.0	Average	Horizontal	-6.1	46.4	40.3	54.0	-13.7

Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBµV)	Correction Factor (dB)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
Note: The requirement that all emissions, including those in the restricted bands, meet the -27 dBm/MHz EIRP indicates that the Peak measurement should be compared to that limit (68.2 dBµV/m at 3 meter measurement distance) instead of 20 dB above the Average limit of §15.35(b).							

Table 6: Transmitting at the Highest Frequency



Mkr	Trace	X-Axis	Value	Notes
1	Peak	5.1464 GHz	67.96 dBuV	
2	Average	5.1500 GHz	53.47 dBuV	

Graph 17: Lowest Channel Radiated Band Edge

Result

The EUT complies with the requirements for unwanted spurious emissions by 0.3 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 7: List of equipment used for conducted emissions testing at mains ports.

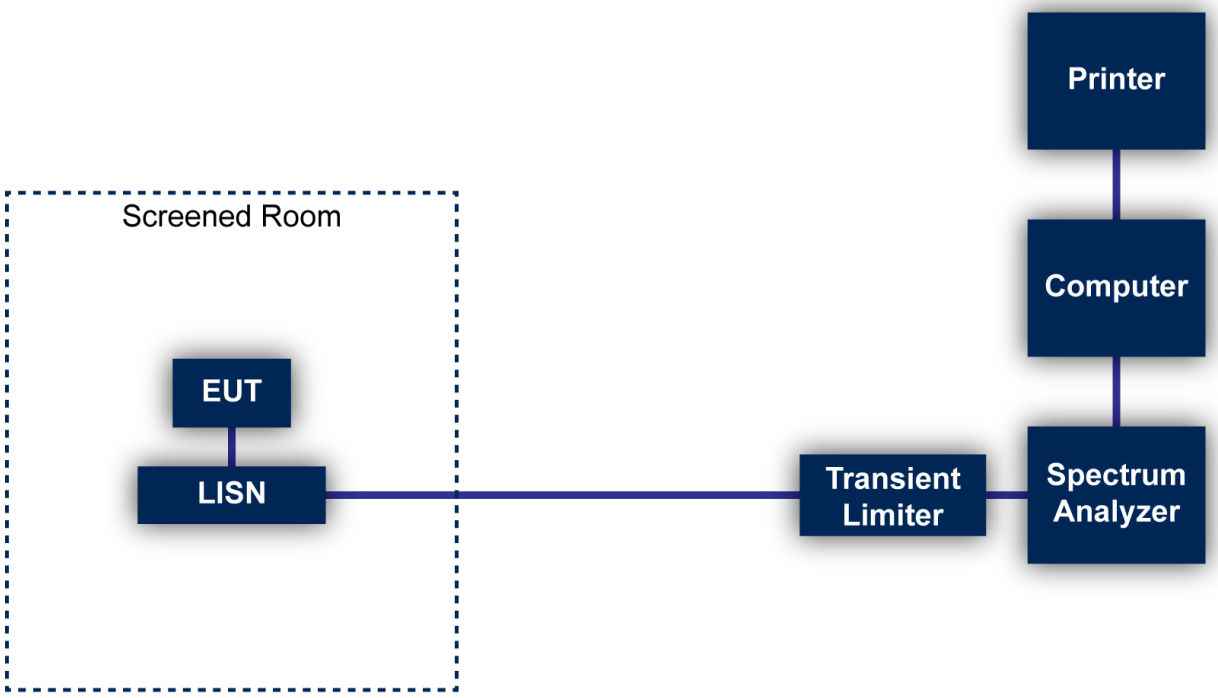


Figure 1: Mains Conducted Emissions Test

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

7.2.1 Test Configuration Block Diagram

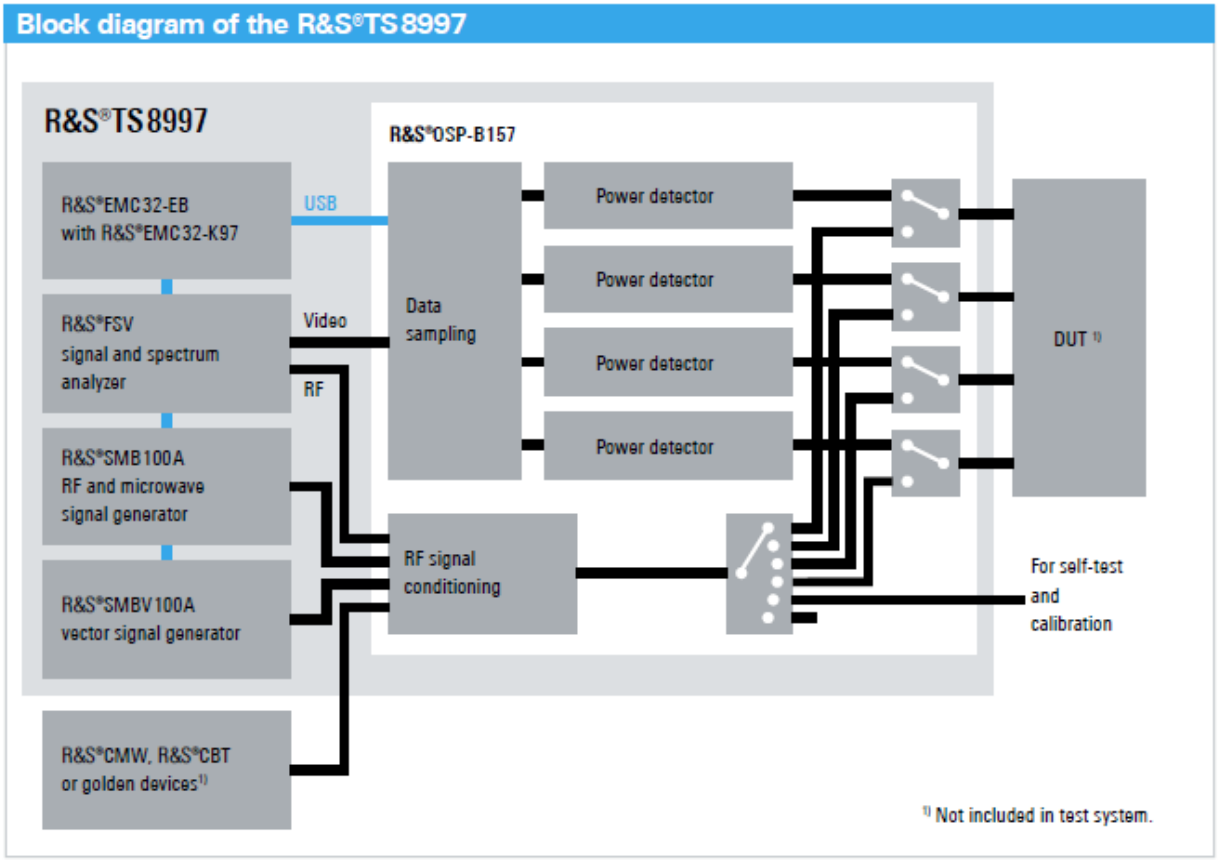


Figure 2: Direct Connection at the Antenna Port Test

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 or standard gain 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	08/01/2019	08/01/2020
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
5.9 GHz High Pass Filter	Microtronics	HPM50105	V034198	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 9: List of equipment used for radiated emissions testing.

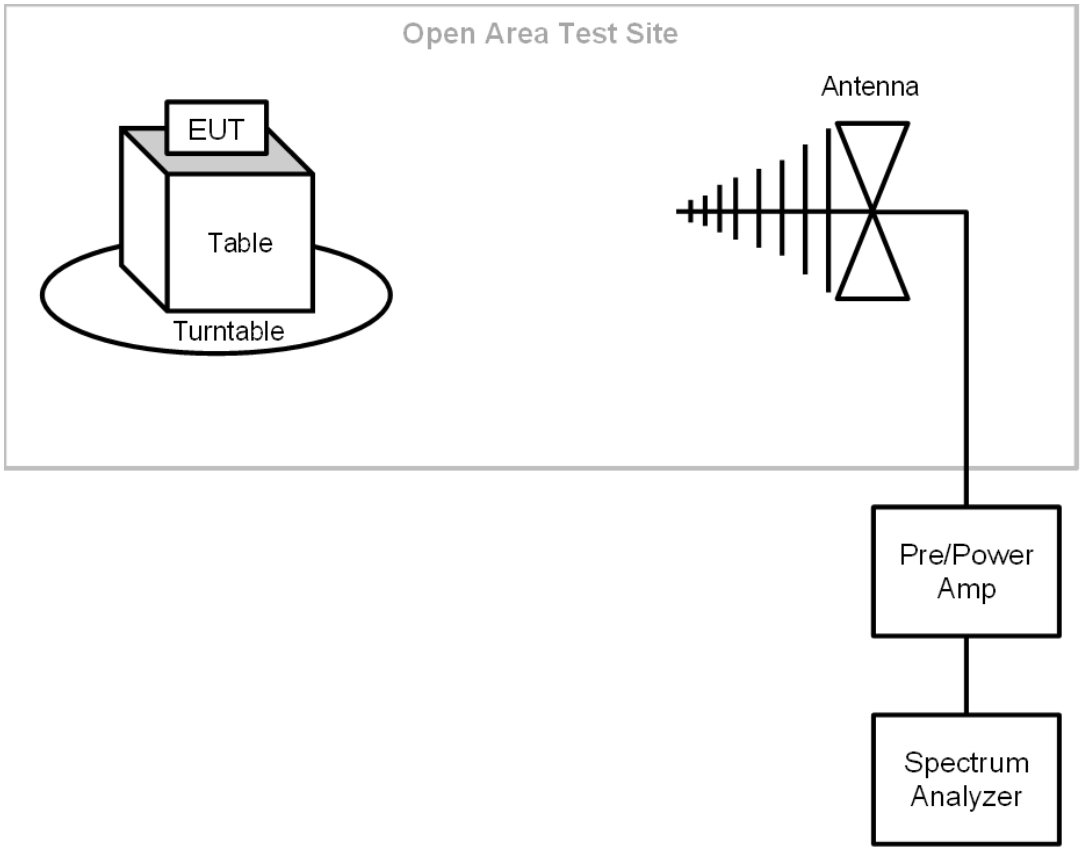


Figure 3: Radiated Emissions Below 1GHz Test

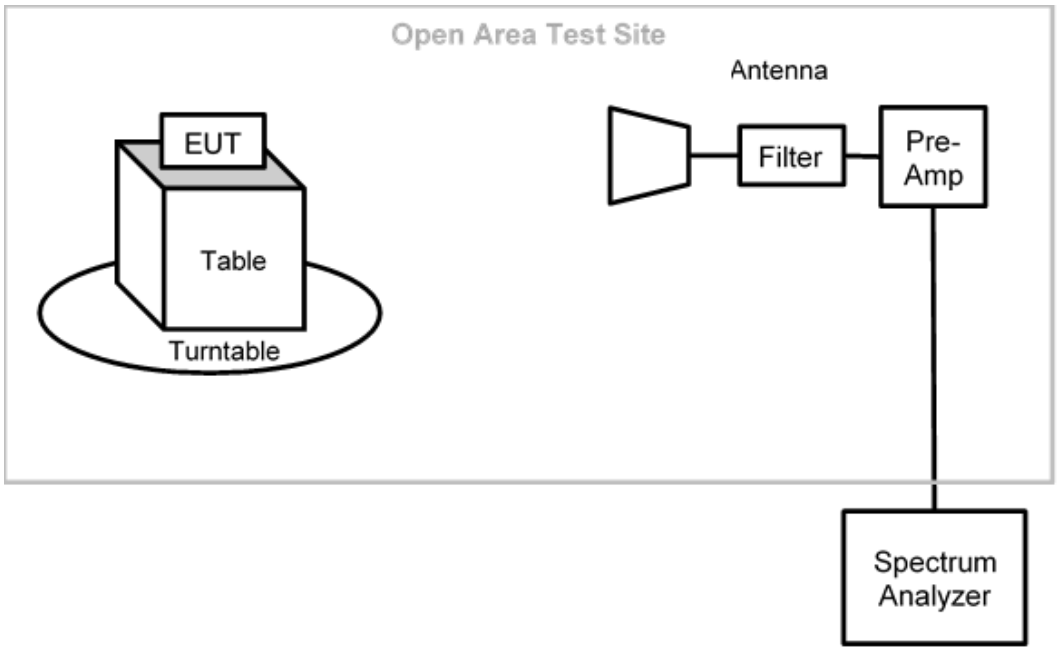


Figure 4: Radiated Emissions Above 1GHz Test

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

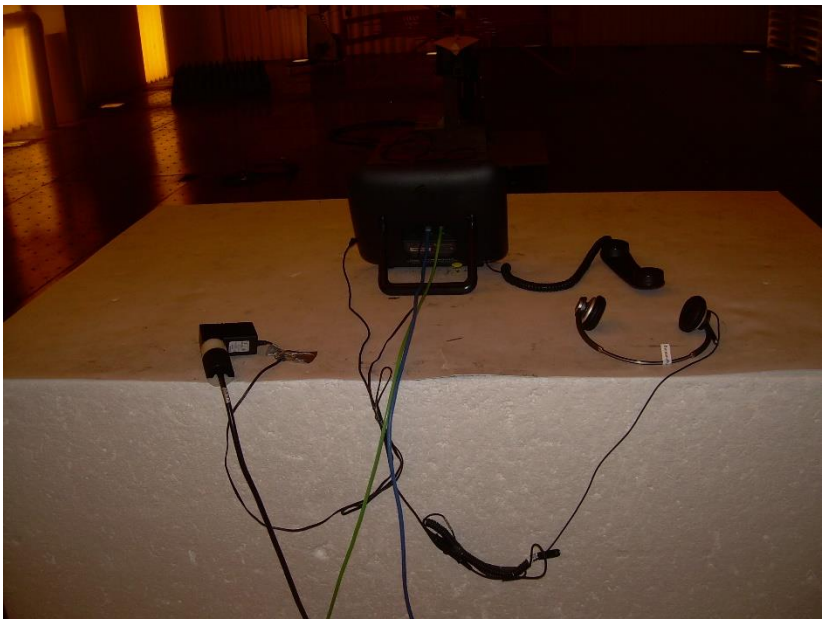
Test	Uncertainty (±dB)	Confidence (%)
Conducted Emissions	2.8	95
Radiated Emission (9 kHz to 30 MHz)	3.3	95
Radiated Emissions (30 MHz to 1 GHz)	3.4	95
Radiated Emissions (1 GHz to 18 GHz)	5.0	95
Radiated Emissions (18 GHz to 40 GHz)	4.1	95

8 Photographs

Photograph 1: Front View Conducted Emissions Worst-Case Configuration

Photograph 2: Back View Conducted Emissions Worst-Case Configuration

Photograph 3 – Front View Radiated Emissions Worst-Case Configuration – Below 1000 MHz



Photograph 4 – Back View Radiated Emissions Worst-Case Configuration – 30 MHz – 1000 MHz

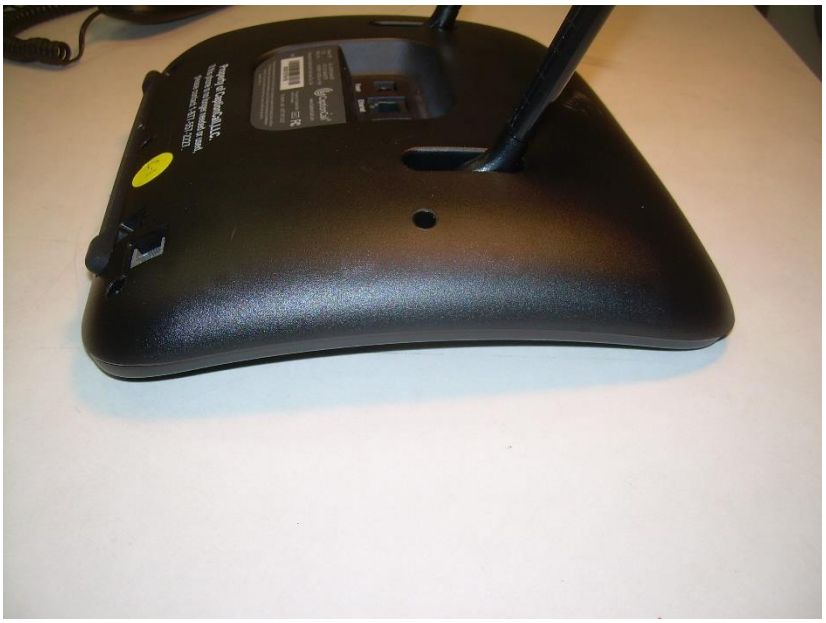
Photograph 5 – Front View Conducted Emissions Worst-Case Configuration – Above 1000 MHz

Photograph 6 – Back View Conducted Emissions Worst-Case Configuration – Above 1000 MHz

Photograph 7 – Front View of the EUT

Photograph 8 – Back View of the EUT

Photograph 9 – Right Side View of the EUT



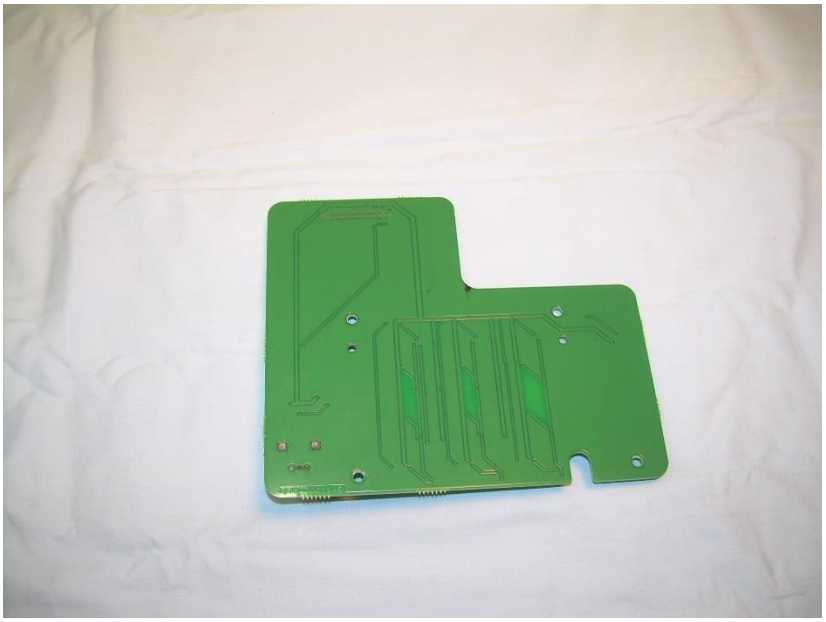
Photograph 10 – Left Side View of the EUT

Photograph 11 – Top View of the EUT

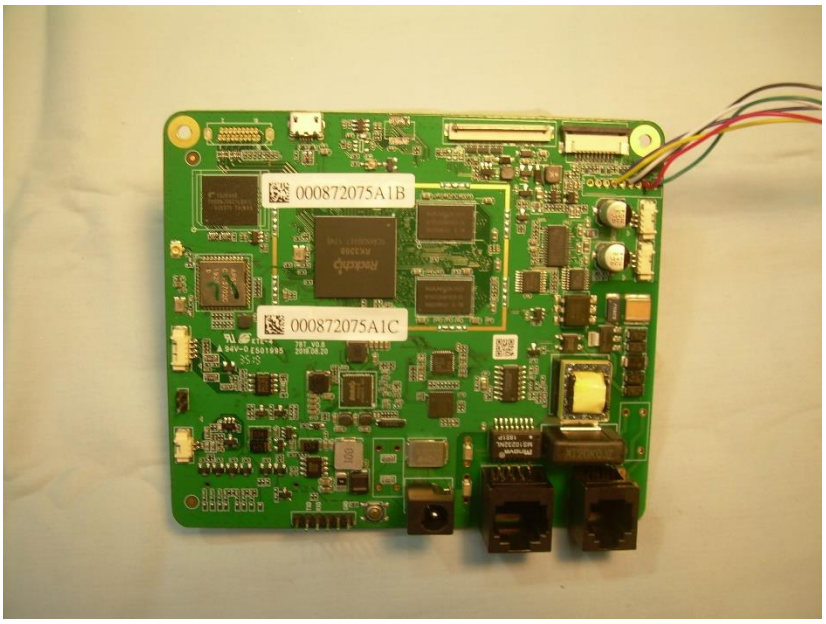
Photograph 12 – Bottom View of the EUT

Photograph 13 – View of the EUT with the Back Cover Removed

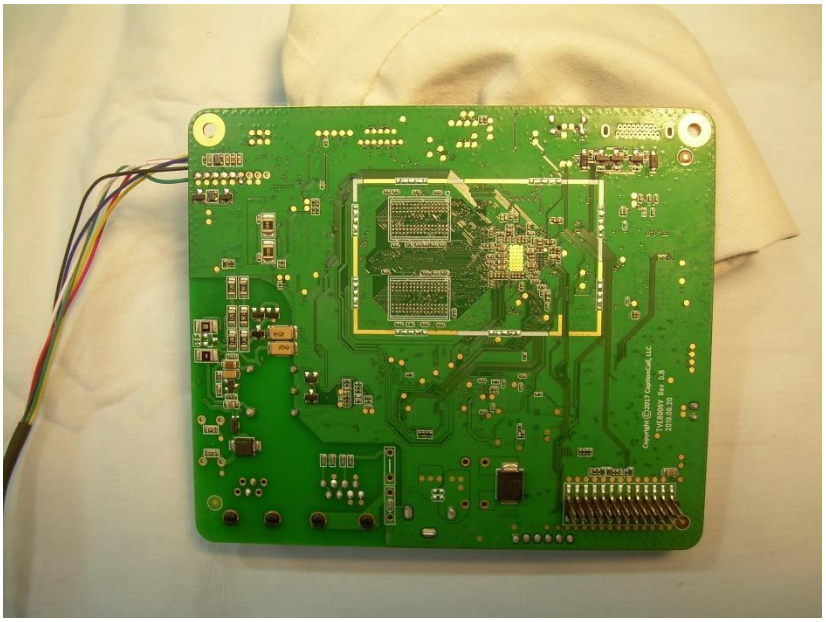
Photograph 14 – Top View of the Keypad Board



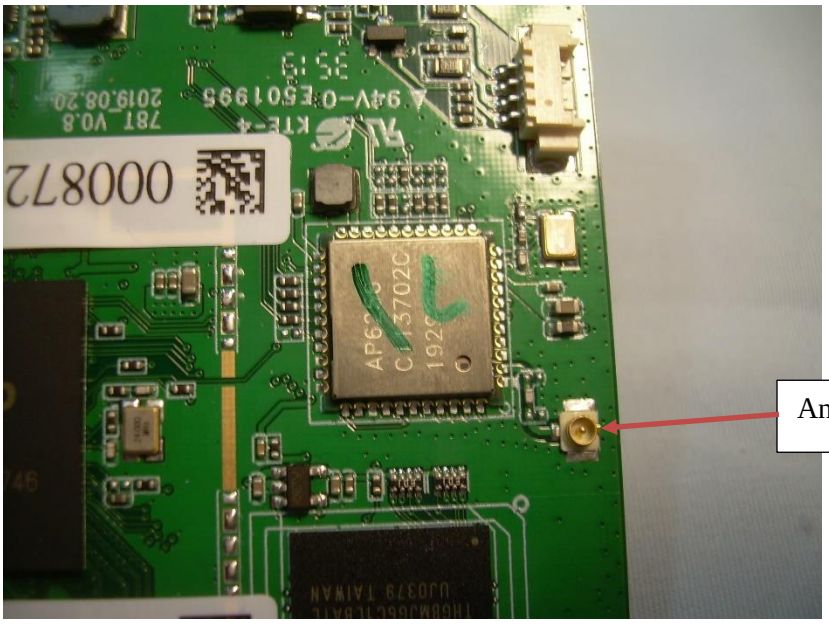
Photograph 15 – Bottom View of the Keypad Board



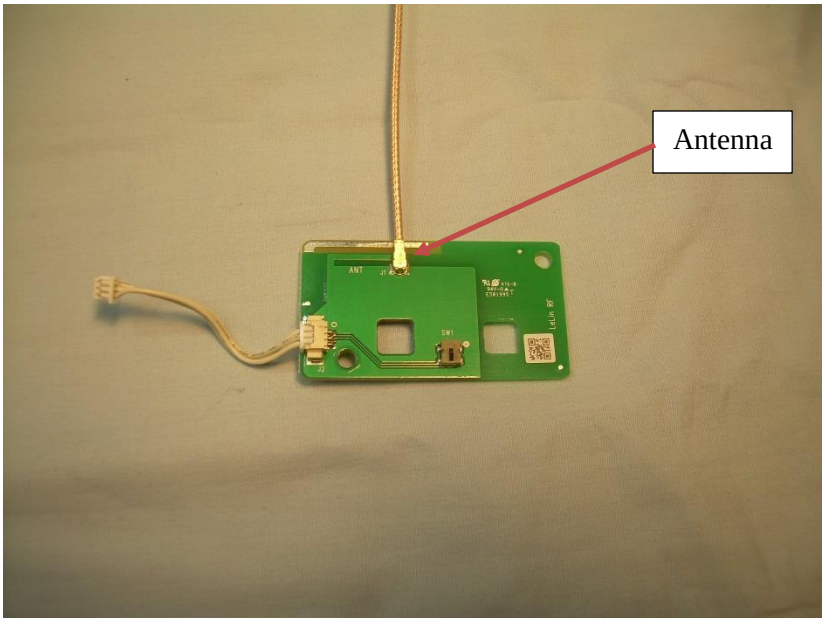
Photograph 16 – Front View of the PCB



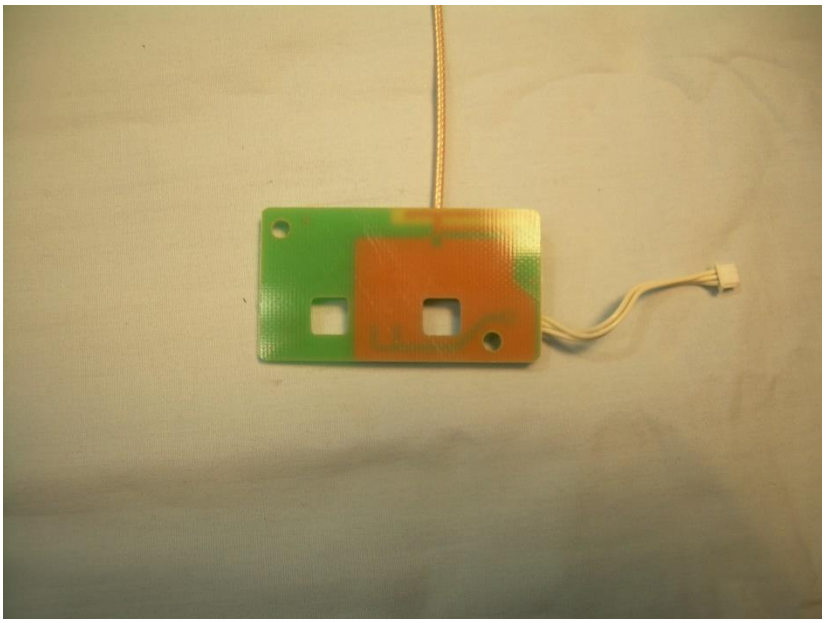
Photograph 17 – Back View of the Main PCB



Photograph 18 – View of the Transceiver Portion of the Main PCB



Photograph 19 – Front View of the Antenna PCB



Photograph 20 – Back View of the Antenna PCB

--- End of Report ---