BLE Radio Test Report

C9115AXI-B, C9115AXI-A, C9115AXI-T

FCC ID: LDKSLTSP1905

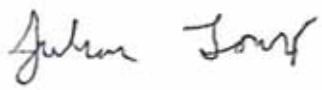
IC: 2461N-SLTSP1905

2400-2483.5 MHz

Against the following Specifications:

CFR47 Part 15.247
RSS-247
RSS-Gen Issue 5
LP0002 (2018-01-10)

Cisco Systems
170 West Tasman Drive
San Jose, CA 95134

	
Author: Julian Land **Tested By:** Julian Land	**Approved By:** Gerard Thorpe **Title:** Compliance Manager **Revision:** 2.1

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Section 1: Overview

1.1 Test Summary

The samples were assessed against the tests detailed in section 3 under the requirements of the following specifications:

Specifications
CFR47 Part 15.247
RSS-247 Issue 2: Feb 2017
RSS-Gen Issue 5: Apr 2018
LP0002 (2018-01-10)

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Section 2: Assessment Information

2.1 General

This report contains an assessment of an apparatus against Radio Standards based upon tests carried out on the samples submitted. The testing was performed by and for the use of Cisco systems Inc:

With regard to this assessment, the following points should be noted:

a) The results contained in this report relate only to the items tested and were obtained in the period between the date of the initial assessment and the date of issue of the report. Manufactured products will not necessarily give identical results due to production and measurement tolerances.

b) The apparatus was set up and exercised using the configuration and modes of operation defined in this report only.

c) Where relevant, the apparatus was only assessed using the susceptibility criteria defined in this report and the Test Assessment Plan (TAP).

d) All testing was performed under the following environmental conditions:

Temperature	15°C to 35°C (54°F to 95°F)
Atmospheric Pressure	860mbar to 1060mbar (25.4" to 31.3")
Humidity	10% to 75*%

1.All AC testing was performed at one or more of the following supply voltages:

110V 60 Hz (+/-20%)

2.2 Units of Measurement

The units of measurements defined in the appendices are reported in specific terms, which are test dependent. Where radiated measurements are concerned these are defined at a particular distance. Basic voltage measurements are defined in units of [dBuV]

As an example, the basic calculation for all measurements is as follows:

Emission level [dBuV] = Indicated voltage level [dBuV] + Cable Loss [dB] + Other correction factors [dB]

The combinations of correction factors are dependent upon the exact test configurations [see test equipment lists for further details] and may include:-

Antenna Factors, Pre Amplifier Gain, LISN Loss, Pulse Limiter Loss and Filter Insertion Loss..

Note: to convert the results from dBuV/m to uV/m use the following formula:-

Level in uV/m = Common Antilogarithm [(X dBuV/m)/20] = Y uV/m

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Measurement Uncertainty Values

voltage and power measurements	± 2 dB
conducted EIRP measurements	± 1.4 dB
radiated measurements	± 3.2 dB
frequency measurements	± 2.4 10-7
temperature measurements	± 0.54º.
humidity measurements	± 2.3%
DC and low frequency measurements	± 2.5%.

Where relevant measurement uncertainty levels have been estimated for tests performed on the apparatus. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

Radiated emissions (expanded uncertainty, confidence interval 95%)

30 MHz - 300 MHz	+/- 3.8 dB
300 MHz - 1000 MHz	+/- 4.3 dB
1 GHz - 10 GHz	+/- 4.0 dB
10 GHz - 18GHz	+/- 8.2 dB
18GHz - 26.5GHz	+/- 4.1 dB
26.5GHz - 40GHz	+/- 3.9 dB

Conducted emissions (expanded uncertainty, confidence interval 95%)

30 MHz – 40GHz	+/- 0.38 dB

A product is considered to comply with a requirement if the nominal measured value is below the limit line.
The product is considered to not be in compliance in case the nominal measured value is above the limit line.

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2.3 Date of testing (initial sample receipt date to last date of testing)

10-OCT-2018 to 12-DEC-2018

2.4 Report Issue Date

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2.5 Testing facilities

This assessment was performed by:

Headquarters

Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134
USA

Testing Laboratory

Cisco Systems, Inc.
125 West Tasman Drive (Building P)
San Jose, CA 95134
USA

Registration Numbers for ISED (Innovation, Science and Economic Development Canada)

Cisco System Site	Address	Site Identifier
Building P, 10m Chamber	125 West Tasman Dr San Jose, CA 95134 United States	Company #: 2461N-2
Building P, 5m Chamber	125 West Tasman Dr San Jose, CA 95134 United States	Company #: 2461N-1
Building I, 5m Chamber	285 W. Tasman Drive San Jose, California 95134 United States	Company #: 2461M-1
Building 7, 5m Chamber	425 E. Tasman Drive San Jose, California 95134 United States	Company #: 2461N-3

Test Engineers

Julian Land

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2.6 Equipment Assessed (EUT)

C9115AXI-B, C9115AXI-A, C9115AXI-T

2.7 EUT Description

The C9115AXI is a next generation access point. The dual band 2.4GHz and 5GHz WIFI radio supports the next generation WIFI protocol of 802.11ax and is backwards compatible with 802.11a, b, g, n, ac. The access point features 4 internal antennas and operates in a 4x4 configuration in both the 2.4GHz and 5GHz bands.

The following antennas are supported by this product series.
The data included in this report represent the worst-case data for all antennas.

Frequency	Part Number	Antenna Type	Antenna Gain (dBi)
2.4GHz / 5GHz	(A antenna port)	Dual Band Omnidirectional	2.3 / 4.1
2.4GHz / 5GHz	(B antenna port)	Dual Band Omnidirectional	2.6 / 4.1
2.4GHz / 5GHz	(C antenna port)	Dual Band Omnidirectional	2.2 / 4.1
2.4GHz / 5GHz	(D antenna port)	Dual Band Omnidirectional	2.4 / 4.1

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Section 3: Result Summary

3.1 Results Summary Table

3.1.1 Radio Port Results

Basic Standard	Technical Requirements / Details	Result
FCC 15.247 RSS-247 LP0002 (2018-01-10) (3.10.1.6) (2)(A)	**6dB Bandwidth** Systems using digital modulation techniques may operate in the 2400-2483.5MHz band. The minimum 6dB bandwidth shall be at least 500 kHz	Pass
FCC 15.247 RSS-247	**99% & 26 dB Bandwidth**: The 99% occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission. There is no limit for 99% OBW. The 26 dB emission is the width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 26 dB relative to the maximum level measured in the fundamental emission.	Pass
FCC 15.247 RSS-247 LP0002 (2018-01-10) (3.10.1.2) (1) (C)	**Output Power**: **15.247** The maximum conducted output power of the intentional radiator for systems using digital modulation in the 2400-2483.5 MHz band shall not exceed 1 Watt (30dBm). If transmitting antennas of directional gain greater than 6 dBi are used, the maximum conducted output power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. **RSS-247** For DTSs employing digital modulation techniques operating in the band 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1W. Except as provided in Section 5.4(e), the e.i.r.p. shall not exceed 4 W.	Pass
FCC 15.247 RSS-247 LP0002 (2018-01-10) (3.10.1.6) (2) (B)	**Power Spectral Density** For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.	Pass
FCC 15.247 RSS-247 LP0002 (2018-01-10) (3.10.1.5) 2.8	**Conducted Spurious Emissions / Band-Edge**: In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated	Pass

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	measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.	
FCC 15.247 RSS-247 FCC 15.205 RSS-Gen Issue 5	**Restricted band**: Unwanted emissions falling within the restricted bands, as defined in FCC 15.205 (a) and RSS-Gen 8.10 must also comply with the radiated emission limits specified in FCC 15.209 (a) and RSS-Gen 8.9	Pass

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3.1.2 Radiated Emissions (General requirements)

Basic Standard	Technical Requirements / Details	Result
FCC 15.209 RSS-Gen Issue 5 LP0002 (2018-01-10) (3.10.1.5) 2.8	**TX Spurious Emissions:** Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the filed strength limits table in this section. Unwanted emissions falling within the restricted bands, as defined in FCC 15.205 (a) and RSS-Gen 8.10 must also comply with the radiated emission limits specified in FCC 15.209 (a) and RSS-Gen 8.9	Pass
RSS-Gen Issue 5 LP0002 (2018-01-10) (3.10.1.5) 2.8	**RX Spurious Emissions:** **RSS-Gen 7.3** Radiated emission measurements shall be performed with the receiver antenna connected to the receiver antenna ports. The search for spurious emissions shall be from the lowest frequency internally generated or used in the receiver (e.g. local oscillator, intermediate or carrier frequency), or 30 MHz, whichever is higher, to at least five times the highest tunable or local oscillator frequency, whichever is higher, without exceeding 40 GHz. Spurious emissions from receivers shall not exceed the radiated emissions limits shown in table 3	Pass
FCC 15.207 RSS-Gen Issue 5 LP0002 (2018-01-10) 2.3	**AC conducted Emissions:** Except when the requirements applicable to a given device state otherwise, for any radio apparatus equipped to operate from the public utility AC power supply, either directly or indirectly (such as with a battery charger), the radio frequency voltage of emissions conducted back onto the AC power lines in the frequency range of 0.15 MHz to 30 MHz shall not exceed the limits shown in the table in these sections. The more stringent limit applies at the frequency range boundaries.	N/A (Unit only powered by DC power i.e. POE)

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Section 4: Sample Details

Note: Each sample was evaluated to ensure that its condition was suitable to be used as a test sample prior to the commencement of testing.

4.1 Sample Details

Sample No.	Equipment Details	Manufacturer	Hardware Rev.	Firmware Rev.	Software Rev.	Serial Number
S01	C9115AXI	Cisco Systems, Inc.	07 (P2C)		8.9.1.73	FOC22204U51
S02	Catalyst 3850 48 PoE+	Cisco Systems, Inc.	M0	1.2 (cat3k_caa-universalk9)	03.03.03SE	FOC18218BFL
S03	C9115AXI	Cisco Systems, Inc.	07 (P2C)	17.10 RC25.11	AP Image: 8.8.1.10 (Compiled Sep 25 09:42:55 PDT 2018)	FOC22204U4T
S04	AIR-PWRINJ6	Cisco Systems, Inc.	V01	N/A	N/A	C154566630000 00625

4.2 System Details

System #	Description	Samples
1	EUT and Power Supply (Conducted Tests)	S01, S02
2	EUT and Power Supply (Radiated Tests)	S03, S04

4.3 Mode of Operation Details

Mode#	Description	Comments
1	GFSK	Receive and Idle

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Section 5: Radio Port Results

5.1 Duty Cycle

5.1.1 Duty Cycle Test Requirement

From KDB 558074, Section 6

6.0 Duty cycle, transmission duration and maximum power control level

Preferably, all measurements of maximum conducted (average) output power will be performed with the EUT transmitting continuously (*i.e.*, with a duty cycle of greater than or equal to 98%). When continuous operation cannot be realized, then the use of sweep triggering/signal gating techniques can be utilized to ensure that measurements are made only during transmissions at the maximum power control level. … When continuous transmission cannot be achieved and sweep triggering/signal gating cannot be implemented, alternate procedures are provided that can be used to measure the average power; however, they will require an additional measurement of the transmitter duty cycle. Within this guidance document, the duty cycle refers to the fraction of time over which the transmitter is on and is transmitting at its maximum power control level. The duty cycle is considered to be constant if variations are less than ± 2 percent, otherwise the duty cycle is considered to be non-constant.

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5.1.2 Duty Cycle Test Method

From KDB 558074, Section 6:

> The zero-span mode on a spectrum analyzer or EMI receiver if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the on and off times of the transmitted signal. Set the center frequency of the instrument to the center frequency of the transmission. Set RBW ≥ OBW if possible; otherwise, set RBW to the largest available value. Set VBW ≥ RBW. Set detector = peak or average. The zero-span measurement method shall not be used unless both RBW and VBW are > 50/T and the number of sweep points across duration T exceeds 100. (For example, if VBW and/or RBW are limited to 3 MHz, then the zero-span method of measuring duty cycle shall not be used if T ≤ 16.7 microseconds.)

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5.1.3 Duty Cycle Test Information

Samples, Systems, and Modes

System Number	Description	Samples	System under test	Support equipment
1	EUT	S01	☑	☐
	Support	S02	☐	☑

Tested By:	Date of testing:
Julian Land	December 12, 2018
Test Result: Pass	

Test Equipment

See Appendix A for list of test equipment

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5.1.4 Duty Cycle Data Table

Duty Cycle table and screen captures are shown below for power/psd modes.

Mode	Duty Cycle (%)	Correction Factor (dB)
GFSK	100	0

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5.1.5 Duty Cycle Data Screenshots

GFSK 2402MHz, 1Mbps


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5.2 6dB Bandwidth

5.2.1 6dB Bandwidth Test Requirement

For the FCC / LP0002 (2018-01-10) (3.10.1.6) (2) (A):

15.247 (2)

Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

For Industry Canada:

RSS-247 5.2 (a)

5.2 Digital transmission systems

DTSs include systems that employ digital modulation techniques resulting in spectral characteristics similar to direct sequence systems. The following applies to the bands 902-928 MHz and 2400-2483.5 MHz:
a) The minimum 6 dB bandwidth shall be 500 kHz.

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5.2.2 6dB Bandwidth Test Procedure

Ref. KDB 558074 D01 DTS Meas. Guidance v04, 8.2 Option 2
ANSI C63.10: 2013

6dB BW Test Procedure
1. Set the radio in the continuous transmitting mode. 2. Allow the trace to stabilize. 3. Setting the x-dB bandwidth mode to -6dB within the measurement set up function. 4. Select the automatic OBW measurement function of an instrument to perform bandwidth measurement. 5. Capture graphs and record pertinent measurement data.

Ref. KDB 558074 D01 DTS Meas. Guidance v04, 8.2 Option 2
ANSI C63.10: 2013 section 11.8.2 Option 2

6dB BW
Test parameters

8.0 DTS bandwidth

One of the following procedures may be used to determine the modulated *DTS bandwidth*.

8.1 Option 1

a) Set RBW = 100 kHz.
b) Set the video bandwidth (VBW) ≥ 3 × RBW.
c) Detector = Peak.
d) Trace mode = max hold.
e) Sweep = auto couple.
f) Allow the trace to stabilize.
g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

8.2 Option 2

The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described above (*i.e.*, RBW = 100 kHz, VBW ≥ 3 × RBW, peak detector with maximum hold) is implemented by the instrumentation function. When using this capability, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥ 6 dB.

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5.2.3 6dB Bandwidth Test Information

Tested By: Julian Land	**Date of testing:** December 12, 2018
Test Result: Pass	

Test Equipment

See Appendix A for list of test equipment

Samples, Systems, and Modes

System Number	Description	Samples	System under test	Support equipment
1	EUT	S01	☑	☐
	Support	S02	☐	☑

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5.2.4 6dB Bandwidth Data Table

Frequency (MHz)	Mode	Data Rate (Mbps)	6dB BW (MHz)	Limit (kHz)	Margin (MHz)
2402	GFSK	1	1.079	>500	0.579
2426	GFSK	1	1.078	>500	0.578
2480	GFSK	1	1.076	>500	0.576

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5.2.5 6dB Bandwidth Screenshots

6dB Bandwidth, 2402MHz, GFSK 1Mbps


6dB Bandwidth, 2426MHz, GFSK 1Mbps


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6dB Bandwidth, 2480MHz, GFSK 1Mbps


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5.3 Occupied Bandwidth

5.3.1 Occupied Bandwidth Test Requirement

The 99% occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission. There is no limit for 99% OBW.

The 26 dB emission is the width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 26 dB relative to the maximum level measured in the fundamental emission.

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5.3.2 Occupied Bandwidth Test Method

Ref. ANSI C63.10: 2013

26 BW & 99% BW Test Procedure
1. Set the radio in the continuous transmitting mode. 2. Allow the trace to stabilize. 3. Setting the x-dB bandwidth mode to -26dB & OBW to 99% within the measurement set up function. 4. Select the automatic OBW measurement function of an instrument to perform bandwidth measurement. 5. Capture graphs and record pertinent measurement data.

Ref. ANSI C63.10: 2013 section 6.9.3

26 BW & 99% BW Test parameters

6.9.3 Occupied bandwidth—power bandwidth (99%) measurement procedure

The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission. The following procedure shall be used for measuring 99% power bandwidth:

a) The instrument center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be between 1.5 times and 5.0 times the OBW.

b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW, and VBW shall be approximately three times the RBW, unless otherwise specified by the applicable requirement.

c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level. Specific guidance is given in 4.1.5.2.

d) Step a) through step c) might require iteration to adjust within the specified range.

e) Video averaging is not permitted. Where practical, a sample detection and single sweep mode shall be used. Otherwise, peak detection and max hold mode (until the trace stabilizes) shall be used.

f) Use the 99% power bandwidth function of the instrument (if available) and report the measured bandwidth.

g) If the instrument does not have a 99% power bandwidth function, then the trace data points are recovered and directly summed in linear power terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached; that frequency is recorded as the lower frequency. The process is repeated until 99.5% of the total is reached; that frequency is recorded as the upper frequency. The 99% power bandwidth is the difference between these two frequencies.

h) The occupied bandwidth shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

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5.3.2 Occupied Bandwidth Test Information

Tested By: Julian Land	**Date of testing:** December 12, 2018
Test Result: Pass	

Test Equipment

See Appendix A for list of test equipment

Samples, Systems, and Modes

System Number	Description	Samples	System under test	Support equipment
1	EUT	S01	☑	☐
	Support	S02	☐	☑

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5.3.4 Occupied Bandwidth Data Table

Frequency (MHz)	Mode	Data Rate (Mbps)	26dB BW (MHz)	99% BW (MHz)
2402	GFSK	1	1.294	1.057
2426	GFSK	1	1.295	1.065
2480	GFSK	1	1.305	1.057

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5.3.5 Occupied Bandwidth Screenshots

26dB / 99% Bandwidth, 2402, GFSK, 1Mbps


26dB / 99% Bandwidth, 2402, GFSK, 1Mbps


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26dB / 99% Bandwidth, 2402, GFSK, 1Mbps


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5.4 Maximum Conducted Output Power

5.4.1 Maximum Conducted Output Power Test Requirement

FCC, 15.247:

> (b) The maximum peak conducted output power of the intentional radiator shall not exceed the following: (3) For systems using digital modulation in the 902-928 MHz, **2400-2483.5 MHz**, and 5725-5850 MHz bands: **1 Watt**. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.
> (4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6dBi.

Industry Canada, RSS-247:

> 5.4 Transmitter output power and equivalent isotropically radiated power (e.i.r.p.) requirements
>
> d) For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).
>
> As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power. The maximum conducted output power is the total transmit power delivered to all antennas and antenna elements, averaged across all symbols in the signalling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or transmitting at a reduced power level. If multiple modes of operation are implemented, the maximum conducted output power is the highest total transmit power occurring in any mode.

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5.4.2 Maximum Conducted Output Power Test Method

Ref. KDB 558074 D01 DTS Meas. Guidance v04
ANSI C63.10: 2013

Maximum Conducted Output power Test Procedure
1. Set the radio in the continuous transmitting mode at full power 2. Compute power by integrating the spectrum across the EBW (or alternatively entire 99% OBW) of the signal using the instrument's band power measurement function. The integration shall be performed using the spectrum analyzer band-power measurement function with band limits set equal to the EBW or the OBW band edges. 3. Capture graphs and record pertinent measurement data.

Ref. 558074 D01 DTS Meas. Guidance v04, section 9.2.2.4 Method **AVGSA-2**
ANSI C63.10: 2013, section 11.9.2.2.4 **Method AVGSA-2**

Maximum Conducted Output power Test parameters
9.2.2.4 Method AVGSA-2 (trace averaging across on and off times of the EUT transmissions, followed by duty cycle correction) a) Measure the duty cycle, x, of the transmitter output signal as described in 6.0. b) Set span to at least 1.5 times the OBW. c) Set RBW = 1-5% of the OBW, not to exceed 1 MHz. d) Set VBW ≥ 3 x RBW. e) Number of points in sweep ≥ 2 × span / RBW. (This gives bin-to-bin spacing ≤ RBW/2, so that narrowband signals are not lost between frequency bins.) f) Sweep time = auto. g) Detector = RMS (*i.e.*, power averaging), if available. Otherwise, use sample detector mode. h) Do not use sweep triggering. Allow the sweep to "free run". i) Trace average at least 100 traces in power averaging (*i.e.*, RMS) mode; however, the number of traces to be averaged shall be increased above 100 as needed such that the average accurately represents the true average over the on and off periods of the transmitter. j) Compute power by integrating the spectrum across the OBW of the signal using the instrument's band power measurement function with band limits set equal to the OBW band edges. If the instrument does not have a band power function, sum the spectrum levels (in power units) at intervals equal to the RBW extending across the entire OBW of the spectrum. k) Add 10 log (1/x), where x is the duty cycle, to the measured power in order to compute the average power during the actual transmission times (because the measurement represents an average over both the on and off times of the transmission). For example, add 10 log (1/0.25) = 6 dB if the duty cycle is 25 %.

The "measure-and-sum technique" is used for measuring in-band transmit power of a device. In the measure-and-sum approach, the conducted emission level is measured at each antenna port. The measured results at the various antenna ports are then summed mathematically to determine the total emission level from the device. Summing is performed in linear power units. (See ANSI C63.10 section 14.3 for Guidance)

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5.4.3 Maximum Conducted Output Power Test Information

Samples, Systems, and Modes

System Number	Description	Samples	System under test	Support equipment
1	EUT	S01	☑	☐
	Support	S02	☐	☑

Tested By: Julian Land	**Date of testing:** December 12, 2018
Test Result: Pass	

Test Equipment

See Appendix A for list of test equipment

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5.4.4 Maximum Conducted Output Power Data Table

Frequency (MHz)	Mode	Tx Paths	Index Power (dBm)	Correlated Antenna Gain (dBi)	Total TX Channel Power (dBm)	Limit (dBm)	Margin (dB)
2402	GFSK, 1Mbps	1	5	3	5.3	30.0	24.7
2426	GFSK, 1Mbps	1	5	3	5.1	30.0	24.9
2480	GFSK, 1Mbps	1	5	3	4.5	30.0	25.5

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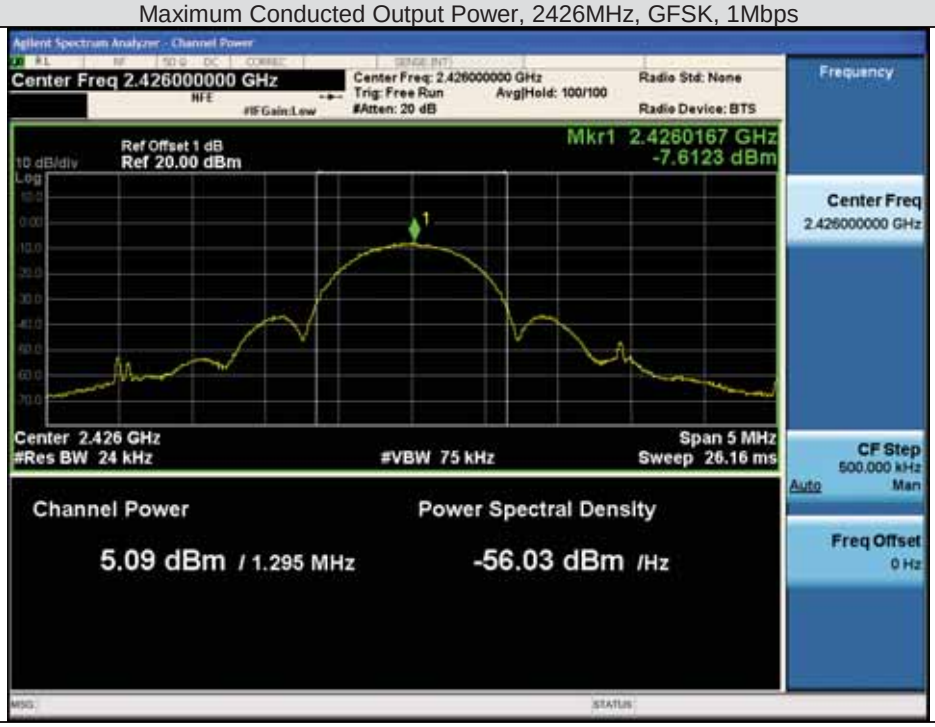
5.4.5 Maximum Conducted Output Power Screenshots

Maximum Conducted Output Power, 2402MHz, GFSK, 1Mbps


Maximum Conducted Output Power, 2426MHz, GFSK, 1Mbps


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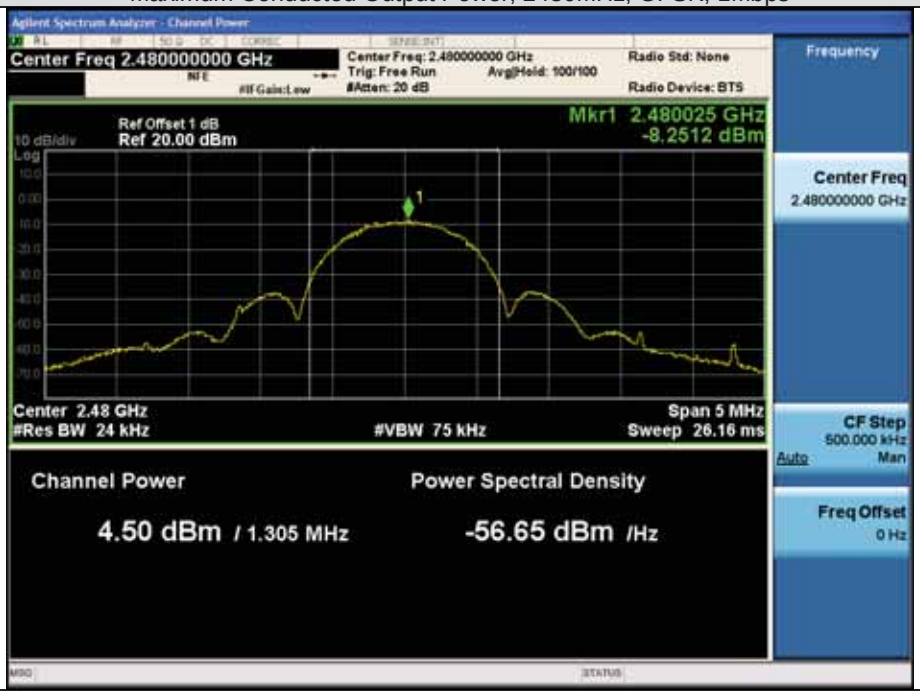
Maximum Conducted Output Power, 2480MHz, GFSK, 1Mbps


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5.5 Power Spectral Density

5.5.1 Power Spectral Density Test Requirement

15.247 (e) / RSS-247 5.2 (b) / LP0002 (2018-01-10) (3.10.1.6) (2) (B):

5.2 Digital transmission systems

DTSs include systems that employ digital modulation techniques resulting in spectral characteristics similar to direct sequence systems. The following applies to the bands 902-928 MHz and 2400-2483.5 MHz:

b) The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of section 5.4(d), (i.e. the power spectral density shall be determined using the same method as is used to determine the conducted output power).

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5.5.2 Power Spectral Density Test Method

Ref. KDB 558074 D01 DTS Meas. Guidance v04
ANSI C63.10: 2013

Power Spectral Density Test Procedure
1. Set the radio in the continuous transmitting mode at full power 2.Configure Spectrum analyzer as per test parameters below and Peak search marker 3. Capture graphs and record pertinent measurement data.

Ref. 558074 D01 DTS Meas. Guidance v04, section 10.2 Peak PSD
ANSI C63.10: 2013, section 11.10.2 Peak PSD

Power Spectral Density Test parameters
10.2 Method PKPSD (peak PSD) This procedure shall be used if maximum peak conducted output power was used to demonstrate compliance, and is optional if the maximum conducted (average) output power was used to demonstrate compliance. a) Set analyzer center frequency to DTS channel center frequency. b) Set the span to 1.5 times the *DTS bandwidth*. c) Set the RBW to: 3 kHz ≤ RBW ≤ 100 kHz. d) Set the VBW ≥ 3 × RBW. e) Detector = peak. f) Sweep time = auto couple. g) Trace mode = max hold. h) Allow trace to fully stabilize. i) Use the peak marker function to determine the maximum amplitude level within the RBW. j) If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

The “Measure and add 10 log(N) dB technique”, where N is the number of outputs, is used for measuring in-band Power Spectral Density. With this technique, spectrum measurements are performed at each output of the device, and the quantity 10 log(4) (or 6dB) is added to the worst case spectrum value before comparing to the emission limit. (See ANSI C63.10 section 14.3.2.3)

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5.5.3 Power Spectral Density Test Information

Tested By: Julian Land	**Date of testing:** December 12, 2018
Test Result: Pass	

Test Equipment

See Appendix A for list of test equipment

Samples, Systems, and Modes

System Number	Description	Samples	System under test	Support equipment
1	EUT	S01	☑	☐
	Support	S02	☐	☑

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5.5.4 Power Spectral Density Data Table

Frequency (MHz)	Mode	Tx Paths	Index Power (dBm)	Correlated Antenna Gain (dBi)	Total PSD - (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
2412	GFSK, 1Mbps	1	17	3	-6.21	8.0	
2437	GFSK, 1Mbps	1	17	3	-7.52	8.0	
2462	GFSK, 1Mbps	1	17	3	-7.46	8.0	

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5.5.5 Power Spectral Density Screenshots

Power Spectral Density, 2402, GFSK, 1Mbps

Power Spectral Density, 2426, GFSK, 1Mbps

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Power Spectral Density, 2480, GFSK, 1Mbps


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5.6 Conducted Spurious Emissions

5.6.1 Conducted Spurious Emissions Test Requirement

15.205 / RSS-Gen Issue 5 / LP0002 (2018-01-10) (3.10.1.5) (2.8)

Radiated emissions which fall in the restricted bands, as defined in Section 15.205(a) and RSS-GEN section 8.10, must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)) and RSS-Gen Issue 5 section 8.9

RSS-Gen Issue 5 Section 8.9

Except where otherwise indicated in the applicable RSS, radiated emissions shall comply with the field strength limits shown in table 5 and table 6. Additionally, the level of any transmitter unwanted emission shall not exceed the level of the transmitter's fundamental emission.

RSS-Gen Issue 5 Section 8.10

(b)

Unwanted emissions that fall into restricted frequency bands listed in table 7 shall comply with the limits specified in table 5 and table 6.

(c)

Unwanted emissions that do not fall within the restricted frequency bands listed in table 7 shall comply either with the limits specified in the applicable RSS or with those specified in table 5 and table 6.

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5.6.2 Conducted Spurious Emissions Test Method

Ref. KDB 558074 D01 DTS Meas. Guidance v04
ANSI C63.10: 2013

Conducted Spurious Emissions Test Procedure
1. Connect the antenna port(s) to the spectrum analyzer input. 2. Place the radio in continuous transmit mode 3. Configure Spectrum analyzer as per test parameters below (be sure to enter all losses between the transmitter output and the spectrum analyzer). 4. Use the marker function to determine the maximum spurs amplitude level. 5. The “measure-and-sum technique” is used for measuring in-band transmit power of a device. In the measure-and-sum approach, the conducted emission level is measured at each antenna port. The measured results at the various antenna ports are then summed mathematically to determine the total emission level from the device. Summing is performed in linear power units. The worst case output is recorded. (see ANSI C63.10 2013 section 14.3.2.2) 6. Capture graphs and record pertinent measurement data.

Ref. 558074 D01 DTS Meas. Guidance v04 section 11.1b, 11.2-3, 12.2.4 & 12.2.5.3
ANSI C63.10: 2013 section 11.10.3 & 11.12.2.4 & 11.12.2.5.3

Conducted Spurious Emissions Test parameters
Span = 30 MHz-18GHz / 18GHz –Tenth Harmonic RBW = 1 MHz VBW ≥ 3 x RBW for Peak, 1kHz for Average Sweep = Auto couple Detector = Peak Trace = Max Hold.

KDB 558074 D01 DTS Meas. Guidance v04 section 12.2.2 © add the max antenna gain + ground reflection factor (4.7 dB for frequencies between 30 MHz and 1000 MHz, and 0 dB for frequencies > 1000 MHz).

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5.6.3 Conducted Spurious Emissions Test Information

Samples, Systems, and Modes

System Number	Description	Samples	System under test	Support equipment
1	EUT	S01	☑	☐
	Support	S02	☐	☑

Tested By: Julian Land	**Date of testing:** December 12, 2018
Test Result: Pass	

Test Equipment

See Appendix A for list of test equipment

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5.6.4 Conducted Spurious Emissions Data Table - Average

Frequency (MHz)	Mode	Tx Paths	Index Power (dBm)	Correlated Antenna Gain (dBi)	Conducted Spur TX (dBm/MHz)	Total Conducted Spur - EIRP (dBm/MHz)	Limit (dBm)	Margin (dB)
2412	GFSK, 1Mbps	1	5	3	-76.48	-73.48	-41.25	32.23
2426	GFSK, 1Mbps	1	5	3	-75.45	-72.45	-41.25	31.20
2480	GFSK, 1Mbps	1	5	3	-75.50	-72.50	-41.25	31.25

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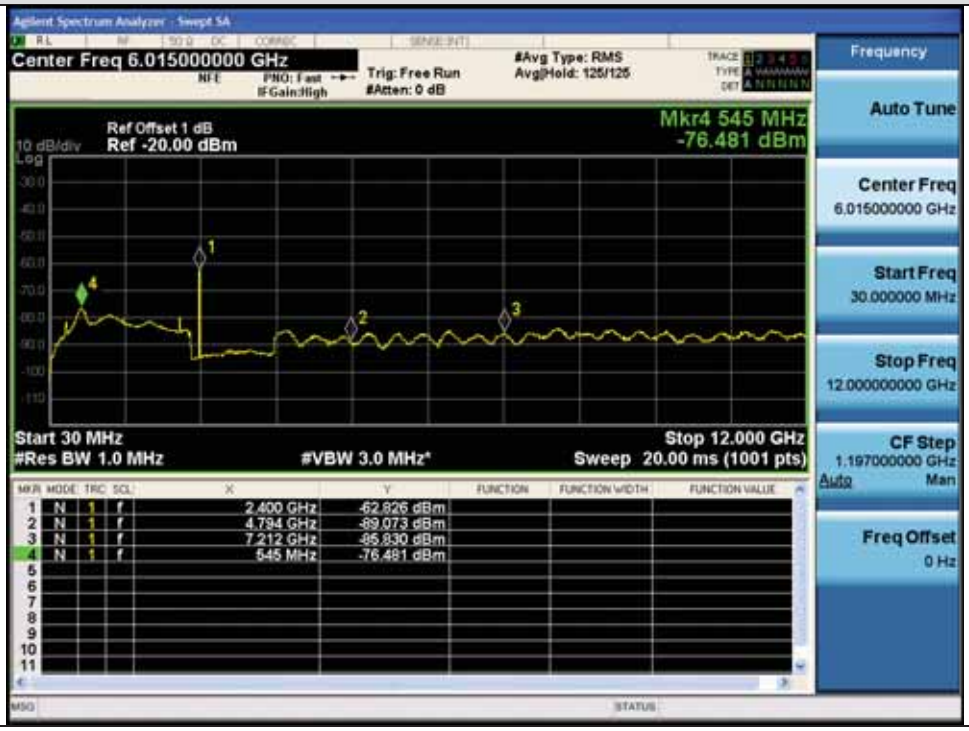
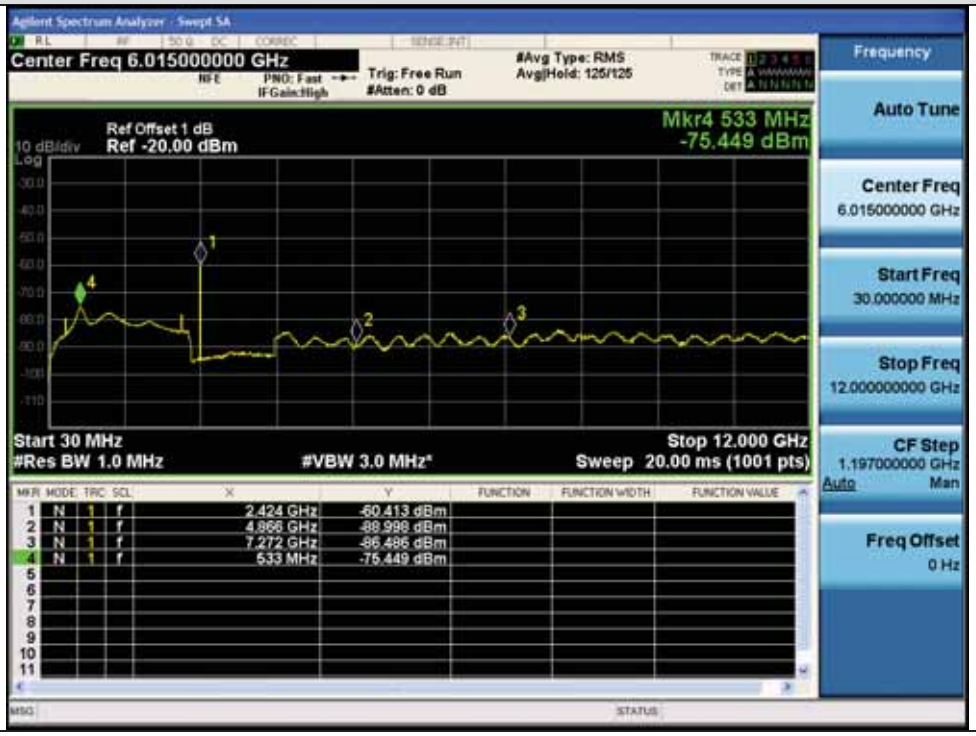
5.6.5 Conducted Spurious Average Screenshots 1GHz-12GHz

Conducted Spurious Average, 2402, GFSK, 1Mbps



Conducted Spurious Average, 2426, GFSK, 1Mbps



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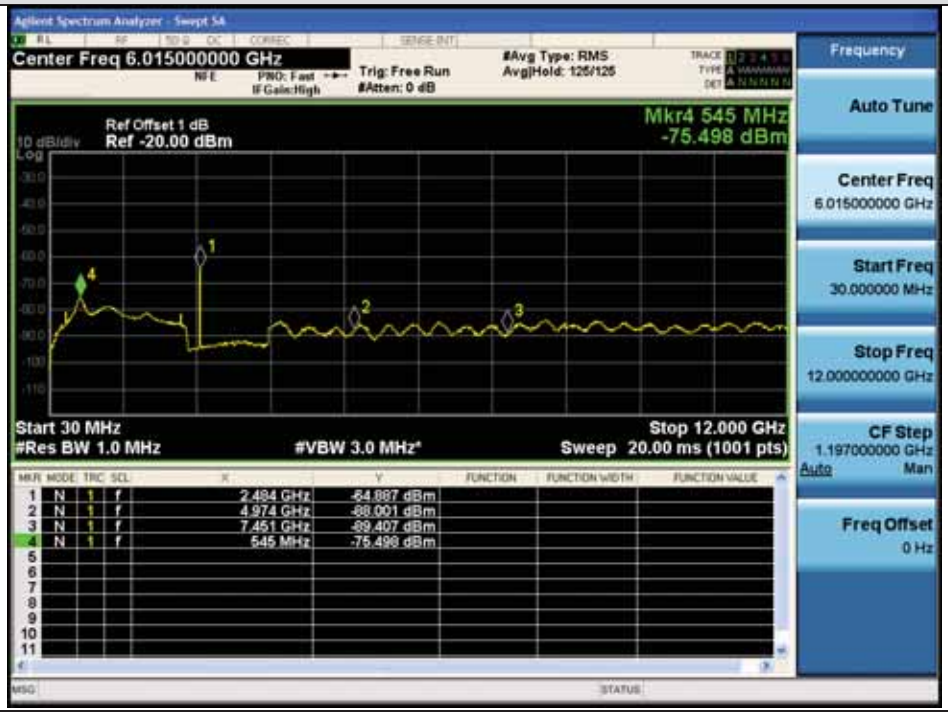
Conducted Spurious Average, 2480, GFSK, 1Mbps


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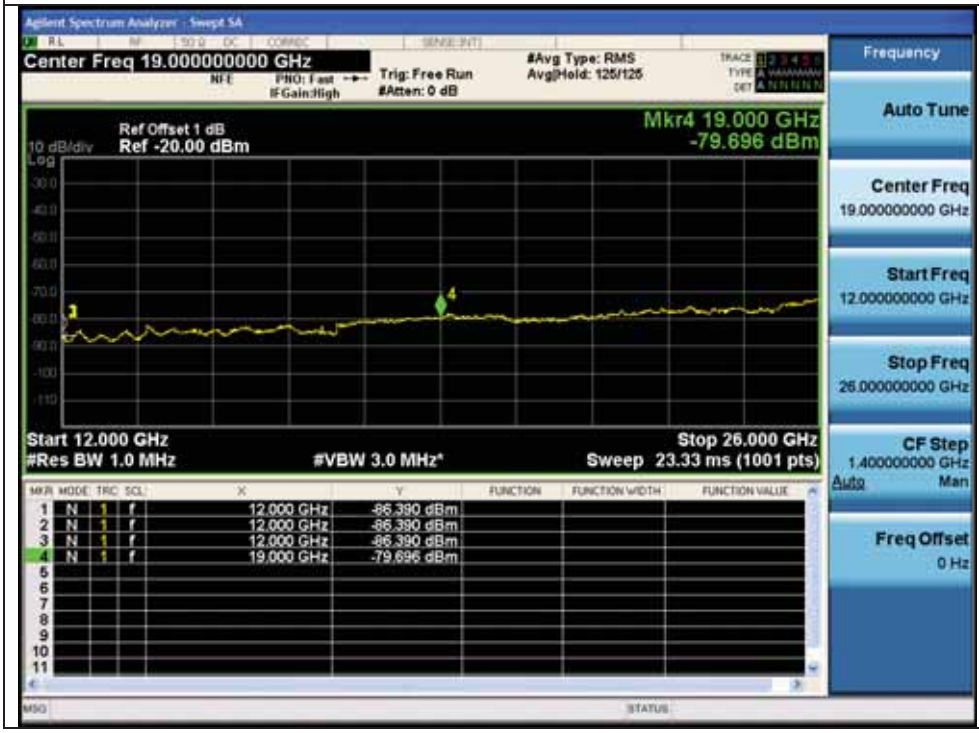
5.6.6 Conducted Spurious Average Screenshots 12GHz-26GHz

Plots representative of all modes

Conducted Spurious Average 12GHz-26GHz index power 5dBm
Antenna A



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5.6.7 Conducted Spurious Emissions Data Table – Peak

Frequency (MHz)	Mode	Tx Paths	Index Power (dBm)	Correlated Antenna Gain (dBi)	Conducted Spur TX (dBm/MHz)	Total Conducted Spur - EIRP (dBm/MHz)	Limit (dBm)	Margin (dB)
2412	GFSK, 1Mbps	1	5	3	-66.21	-63.21	-21.25	41.96
2426	GFSK, 1Mbps	1	5	3	-64.49	-61.49	-21.25	40.24
2480	GFSK, 1Mbps	1	5	3	-65.35	-62.35	-21.25	41.10

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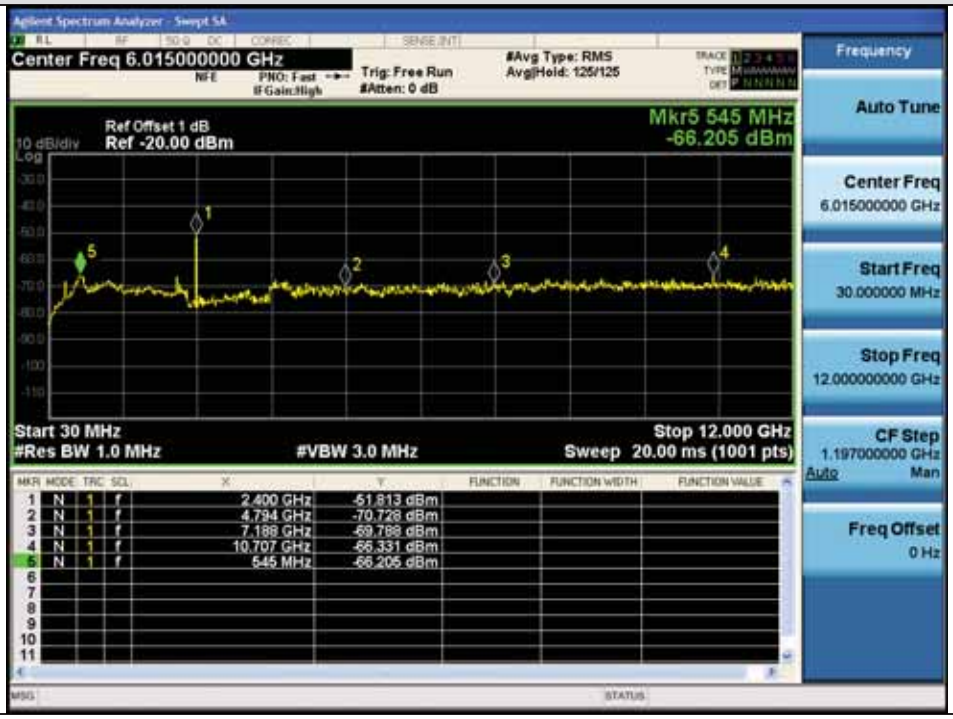
5.6.8 Conducted Spurious Peak Screenshots 1GHz – 12GHz

Conducted Spurious Peak, 2402, GFSK, 1Mbps



Conducted Spurious Peak, 2426, GFSK, 1Mbps

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Conducted Spurious Average, 2480, GFSK, 1Mbps


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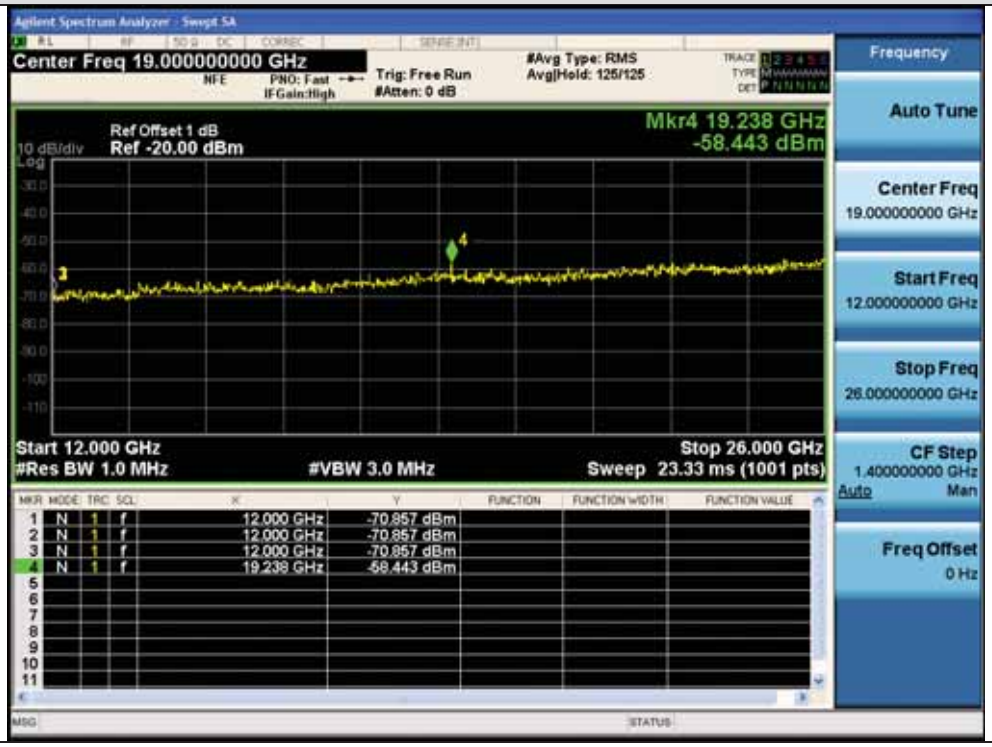
5.6.9 Conducted Spurious Peak Screenshots 12GHz-26GHz

Plots representative of all modes

Conducted Spurious Peak 12GHz-26GHz index power 5dBm



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5.7 Conducted Band Edge

5.7.1 Conducted Band Edge Test Requirement

15.247 / LP0002 (2018-01-10) (3.10.1.5) (2.8):

(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

RSS-247

5.5 Unwanted emissions

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

15.205 / RSS-Gen Issue 5

Radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), and RSS-Gen Issue 5 Section 8.10 must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)) and RSS-Gen Issue 5 Section 8.9.

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5.7.2 Conducted Band Edge Test Method

Ref. KDB 558074 D01 DTS Meas. Guidance v04
ANSI C63.10: 2013

Conducted Band Edge Test Procedure
1. Connect the antenna port(s) to the spectrum analyzer input. 2. Place the radio in continuous transmit mode. Use the procedures in KDB 558074 D01 DTS Meas. Guidance v04 to substitute conducted measurements in place of radiated measurements. 3. Configure Spectrum analyzer as per test parameters below (be sure to enter all losses between the transmitter output and the spectrum analyzer). 4. Place a marker at the end of the restricted band closest to the transmit frequency to show compliance. Also measure any emissions in the restricted bands. 5. The “measure-and-sum technique” is used for measuring in-band transmit power of a device. In the measure-and-sum approach, the conducted emission level is measured at each antenna port. The measured results at the various antenna ports are then summed mathematically to determine the total emission level from the device. Summing is performed in linear power units. The worst case output is recorded. 6. Place a marker at the end of the restricted band closest to the transmit frequency to show compliance. Also measure any emissions in the restricted bands 7. Capture graphs and record pertinent measurement data.

Conducted Band Edge Test parameters non-restricted Band KDB 558074 D01 v04 section 11.1b, 11.2-3, also see ANSI C63.10: 2013 section 11.10.3	**Conducted Band Edge** Test parameters restricted Band KDB 558074 D01 v04 section 12.2.4 & 12.2.5.3 also see ANSI C63.10: 2013 section 11.12.4 & 11.12.5.3
RBW = 100 kHz VBW ≥ 3 x RBW Sweep = Auto couple Detector = Peak Trace = Max Hold.	RBW = 1 MHz VBW ≥ 3 x RBW for Peak, 100Hz for Average Sweep = Auto couple Detector = Peak Trace = Max Hold.

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5.7.3 Conducted Band Edge Test Information

Samples, Systems, and Modes

System Number	Description	Samples	System under test	Support equipment
1	EUT	S01	☑	☐
	Support	S02	☐	☑

Tested By:	Date of testing:
Julian Land	December 12, 2018
Test Result: Pass	

Test Equipment

See Appendix A for list of test equipment

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5.7.4 Conducted Band Edge (Restricted Band) Data Table Average

Frequency (MHz)	Mode	Tx Paths	Index Power (dBm)	Correlated Antenna Gain (dBi)	Conducted Spur TX (dBm/MHz)	Total Conducted Spur EIRP (dBm)	Limit (dBm)	Margin (dB)
2402	GFSK, 1Mbps	1	5	3	-62.13	-59.13	-41.25	17.88
2480	GFSK, 1Mbps	1	5	3	-58.53	-55.53	-41.25	14.28

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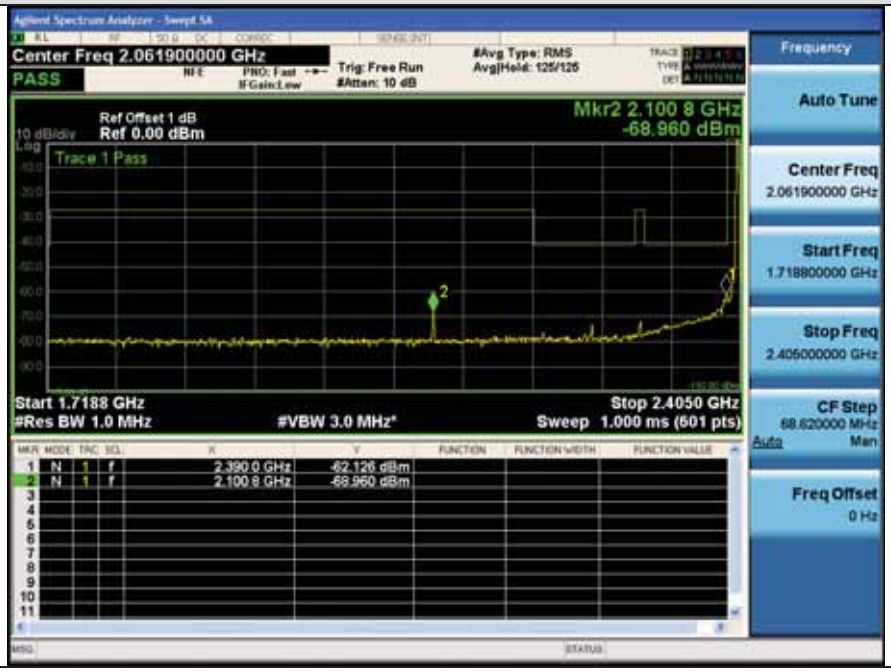
5.7.5 Conducted Band Edge (Restricted Band) Screenshots Average

Conducted Band Edge Restricted Band Average, 2402, GFSK, 1Mbps



Conducted Band Edge Restricted Band Average, 2480, GFSK, 1Mbps

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5.7.6 Conducted Band Edge (Restricted Band) Data Table Peak

Frequency (MHz)	Mode	Tx Paths	Index Power (dBm)	Correlated Antenna Gain (dBi)	Conducted Spur TX path 1 (dBm)	Total Conducted Spur EIRP (dBm)	Limit (dBm)	Margin (dB)
2402	GFSK, 1Mbps	1	5	3	-55.14	-52.14	-21.25	30.89
2480	GFSK, 1Mbps	1	5	3	-48.51	-45.51	-21.25	24.26

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5.7.7 Conducted Band Edge Screenshots Peak

Conducted Band Edge Restricted Band Peak, 2402, GFSK, 1Mbps

Conducted Band Edge Restricted Band Peak, 2480, GFSK, 1Mbps

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5.8 Conducted Band Edge (Non-Restricted Band)

5.8.1 Emissions in non-restricted frequency bands - Test Requirement

15.247 / LP0002 (2018-01-10) (3.10.1.5) (2.8):

(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

RSS-Gen Issue 5 Section 8.9

Except where otherwise indicated in the applicable RSS, radiated emissions shall comply with the field strength limits shown in table 5 and table 6. Additionally, the level of any transmitter unwanted emission shall not exceed the level of the transmitter's fundamental emission.

RSS-Gen Issue 5 Section 8.10

(b)

Unwanted emissions that fall into restricted frequency bands listed in table 7 shall comply with the limits specified in table 5 and table 6.

(c)

Unwanted emissions that do not fall within the restricted frequency bands listed in table 7 shall comply either with the limits specified in the applicable RSS or with those specified in table 5 and table 6.

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5.8.2 Emissions in non-restricted frequency bands - Test Method

Ref**.** KDB 558074 D01 DTS Meas. Guidance v04
ANSI C63.10: 2013

Emissions in non-restricted frequency bands - Conducted Test Procedure
1. Connect the antenna port(s) to the spectrum analyzer input. 2. Place the radio in continuous transmit mode 3. Configure Spectrum analyzer as per test parameters below (be sure to enter all losses between the transmitter output and the spectrum analyzer). 4. Use the marker function to determine the maximum spurs amplitude level. 5. Capture graphs and record pertinent measurement data.

Ref**.** 558074 D01 DTS Meas. Guidance v04 section 11.1b, 11.2, 11.3
ANSI C63.10: 2013 section 11.11.1b, 11.11.12, 11.11.13

Emissions in non-restricted frequency bands - Conducted Test parameters	
11.2 Reference Level measurement Establish a reference level by using the following procedure: a) Set instrument center frequency to DTS channel center frequency. b) Set the span to ≥ 1.5 x *DTS bandwidth*. c) Set the RBW = 100 kHz. d) Set the VBW ≥ 3 x RBW. e) Detector = peak. f) Sweep time = auto couple. g) Trace mode = max hold. h) Allow trace to fully stabilize. i) Use the peak marker function to determine the maximum PSD level.	**11.3 Emission Level Measurement** a) Set the center frequency and span to encompass frequency range to be measured. b) Set the RBW = 100 kHz. c) Set the VBW ≥ 3 x RBW. d) Detector = peak. e) Sweep time = auto couple. f) Trace mode = max hold. g) Allow trace to fully stabilize. h) Use the peak marker function to determine the maximum amplitude level.

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5.8.3 Emissions in non-restricted frequency bands – Test Information

Samples, Systems, and Modes

System Number	Description	Samples	System under test	Support equipment
1	EUT	S01	☑	☐
	Support	S02	☐	☑

Tested By : Julian Land	**Date of testing:** December 12, 2018
Test Result : Pass	

Test Equipment

See Appendix A for list of test equipment

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5.8.4 Emissions in non-restricted frequency bands – Data Tables

Frequency (MHz)	Mode	Tx Paths	Index Power (dBm)	Conducted Spur TX path 1 (dBm/100kHz)	Conducted Spur Delta (dBc)	Limit (dBc)	Margin (dB)
2402	GFSK, 1Mbps	1	5	-43.93	48.88	>30	20.86
2480	GFSK, 1Mbps	1	5	-54.36	57.67	>30	27.67

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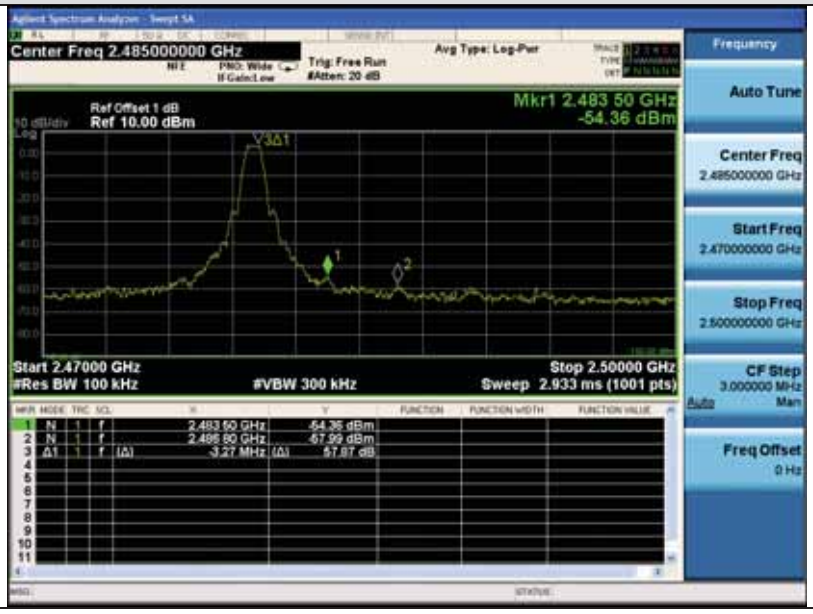
5.8.5 Emissions in non-restricted frequency bands – Screenshots

Conducted Band Edge Non-Restricted Band Peak, 2402, GFSK, 1Mbps


Conducted Band Edge Non-Restricted Band Peak, 2402, GFSK, 1-11 Mbps


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Section 6: System Test Results

Testing Laboratory: Cisco Systems, Inc., 125 West Tasman Drive, San Jose, CA 95134, USA

6.1 Radiated Spurious Emissions

6.1.1 Radiated Transmitter Spurious Emissions – Test Requirement

15.205 / RSS-Gen / LP0002 (2018-01-10) (3.10.1.5) (2.8):

Radiated emissions which fall in the restricted bands, as defined in Section 15.205(a) and RSS-Gen 8.10, must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)) and RSS-Gen 8.9.

RSS-Gen Issue 5 Section 8.9

Except where otherwise indicated in the applicable RSS, radiated emissions shall comply with the field strength limits shown in table 5 and table 6. Additionally, the level of any transmitter unwanted emission shall not exceed the level of the transmitter's fundamental emission.

RSS-Gen Issue 5 Section 8.10

(b)

Unwanted emissions that fall into restricted frequency bands listed in table 7 shall comply with the limits specified in table 5 and table 6.

(c)

Unwanted emissions that do not fall within the restricted frequency bands listed in table 7 shall comply either with the limits specified in the applicable RSS or with those specified in table 5 and table 6.

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6.1.2 Radiated Transmitter Spurious Emissions - Test Method

Ref. ANSI C63.10: 2013 section 4.1.4.2.2, 4.1.4.2.3, 6.6.4 & 11.12.2

Radiated Spurious Emissions Test parameters	
Peak Span = 1-18GHz /18GHz-26.5GHz RBW = 1 MHz VBW ≥ 3 MHz Sweep = Auto couple Detector = Peak Trace = Max Hold.	**Average** Span = 1-18GHz /18GHz-26.5GHz RBW = 1 MHz VBW ≥ 3 MHz Sweep = Auto couple Detector = RMS Power Averaging

Using Vasona, configure the spectrum analyzer as shown above (be sure to enter all losses between the transmitter output and the spectrum analyzer). Place the radio in continuous transmit mode. Terminate the access Point RF ports with 50 ohm loads.

Maximize Turntable (find worst case table angle), Maximize Antenna (find worst case height)

Save 2 plots: 1) Average Plot (Vertical and Horizontal), Limit= 54dBuV/m @3m
2) Peak plot (Vertical and Horizontal), Limit = 74dBuV/m @3m

Place a marker at the end of the restricted band closest to the transmit frequency to show compliance.
Also measure any emissions in the restricted bands.

This report represents the worst case data for all supported operating modes and antennas.

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6.1.3 Radiated Transmitter Spurious Emissions – Test Information

Tested By : Julian Land	**Date of testing:** October 10, 2018 – December 11, 2018
Test Result : PASS	

See Appendix A for list of test equipment

System Number	Description	Samples	System under test	Support equipment
2	EUT	S03	☑	☐
	Support	S04	☐	☑

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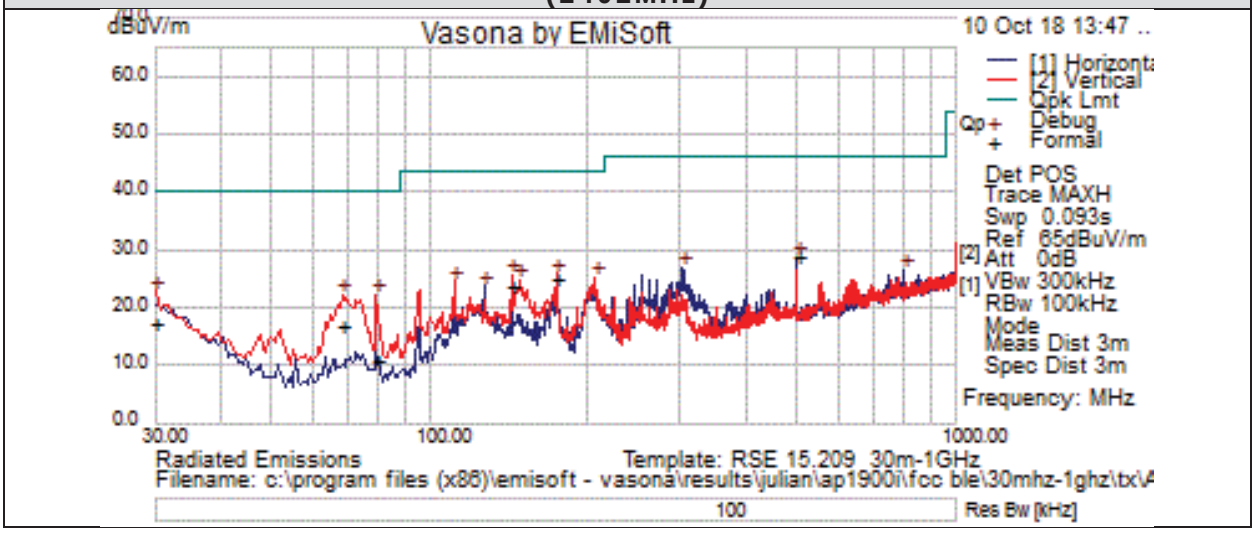
6.1.4 Radiated Transmitter Spurious Emissions 30MHz-1GHz

Transmitter Radiated Spurious Emissions 30MHz to 1GHz, GFSK 1Mps (2402MHz)



Frequency (MHz)	Raw (dBuV)	Cab Loss (dB)	AF (dB)	Level (dBuV)	Detector	Polarity	Height (cm)	Azt (Deg)	Limit (dBuV)	Margin (dB)	Results Pass / Fail	Comments
30	23	0.5	-5.9	17.6	Quasi Max	V	110	143	40	-22.4	Pass	
500.003	36.4	2.2	-9.7	29	Quasi Max	H	153	122	46	-17	Pass	
174.538	38.9	1.3	-15.1	25.1	Quasi Max	V	103	276	43.5	-18.4	Pass	
68.194	35	0.8	-18.8	17	Quasi Max	V	113	86	40	-23	Pass	
79.106	29.1	0.8	-19.1	10.8	Quasi Max	V	125	239	40	-29.2	Pass	
142.788	36.4	1.1	-13.6	24	Quasi Max	V	103	150	43.5	-19.6	Pass	

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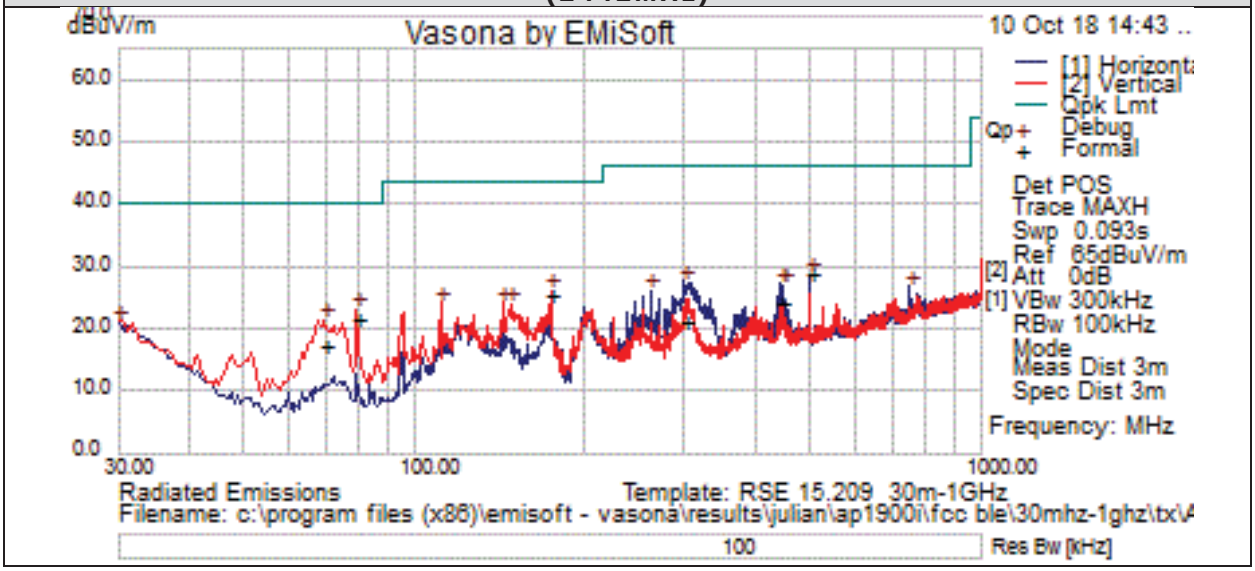
Transmitter Radiated Spurious Emissions 30MHz to 1GHz, GFSK 1Mps (2442MHz)



Frequency (MHz)	Raw (dBuV)	Cab Loss (dB)	AF (dB)	Level (dBuV)	Detector	Polarity	Height (cm)	Azt (Deg)	Limit (dBuV)	Margin (dB)	Results Pass / Fail	Comments
79.338	40.2	0.8	-19.2	21.9	Quasi Max	V	120	215	40	-18.1	Pass	
500.003	36.3	2.2	-9.7	28.8	Quasi Max	H	153	123	46	-17.2	Pass	
174.531	39.3	1.3	-15.1	25.4	Quasi Max	V	111	290	43.5	-18.1	Pass	
299.781	32.4	1.7	-12.8	21.3	Quasi Max	H	104	114	46	-24.7	Pass	
69.606	35.2	0.8	-18.8	17.2	Quasi Max	V	108	102	40	-22.8	Pass	
443.622	32.8	2.1	-10.5	24.4	Quasi Max	H	137	350	46	-21.6	Pass	

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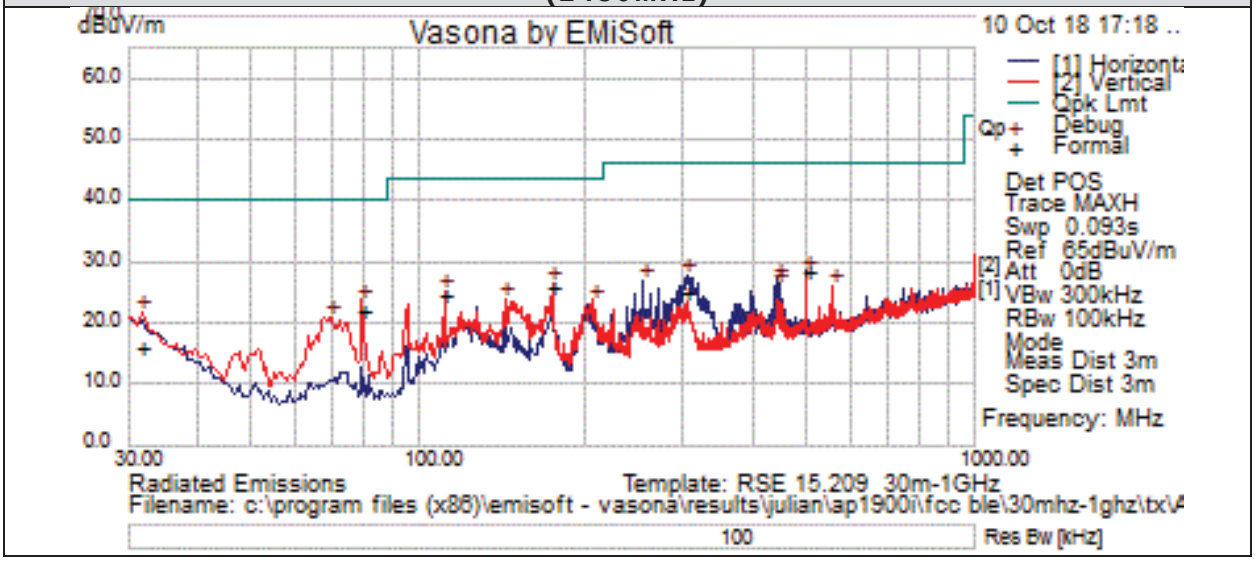
Transmitter Radiated Spurious Emissions 30MHz to 1GHz, GFSK 1Mps (2480MHz)



Frequency (MHz)	Raw (dBuV)	Cab Loss (dB)	AF (dB)	Level (dBuV)	Detector	Polarity	Height (cm)	Azt (Deg)	Limit (dBuV)	Margin (dB)	Results Pass / Fail	Comments
79.338	40.3	0.8	-19.2	21.9	Quasi Max	V	105	208	40	-18.1	Pass	
174.547	39.7	1.3	-15.1	25.9	Quasi Max	V	123	276	43.5	-17.6	Pass	
499.994	36.2	2.2	-9.7	28.8	Quasi Max	H	157	120	46	-17.2	Pass	
31.819	22.6	0.5	-7.1	16	Quasi Max	V	107	218	40	-24	Pass	
304.025	35.9	1.7	-12.7	25	Quasi Max	H	104	226	46	-21	Pass	
111.072	37.4	1	-13.8	24.6	Quasi Max	V	114	219	43.5	-18.9	Pass	

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6.1.5 Radiated Transmitter Spurious Emissions – 1-10GHz

Note: Emissions tests were done with all radios on simultaneously (i.e. BLE, 2.4GHz, and 5GHz radios)

Peak - Transmitter Radiated Spurious Emissions 1GHz to 10GHz, 2402MHz

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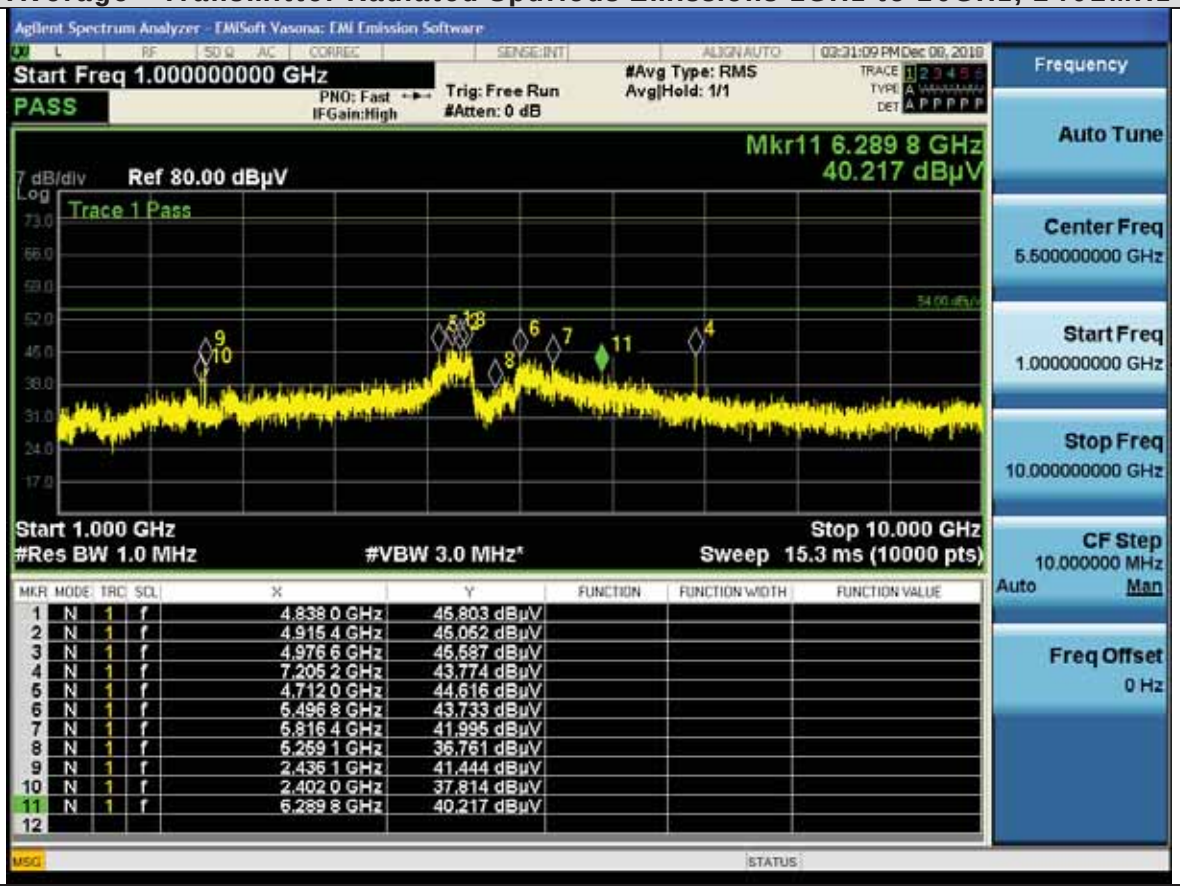
Note: Emissions tests were done with all radios on simultaneously (i.e. BLE, 2.4GHz, and 5GHz radios)

Average - Transmitter Radiated Spurious Emissions 1GHz to 10GHz, 2402MHz



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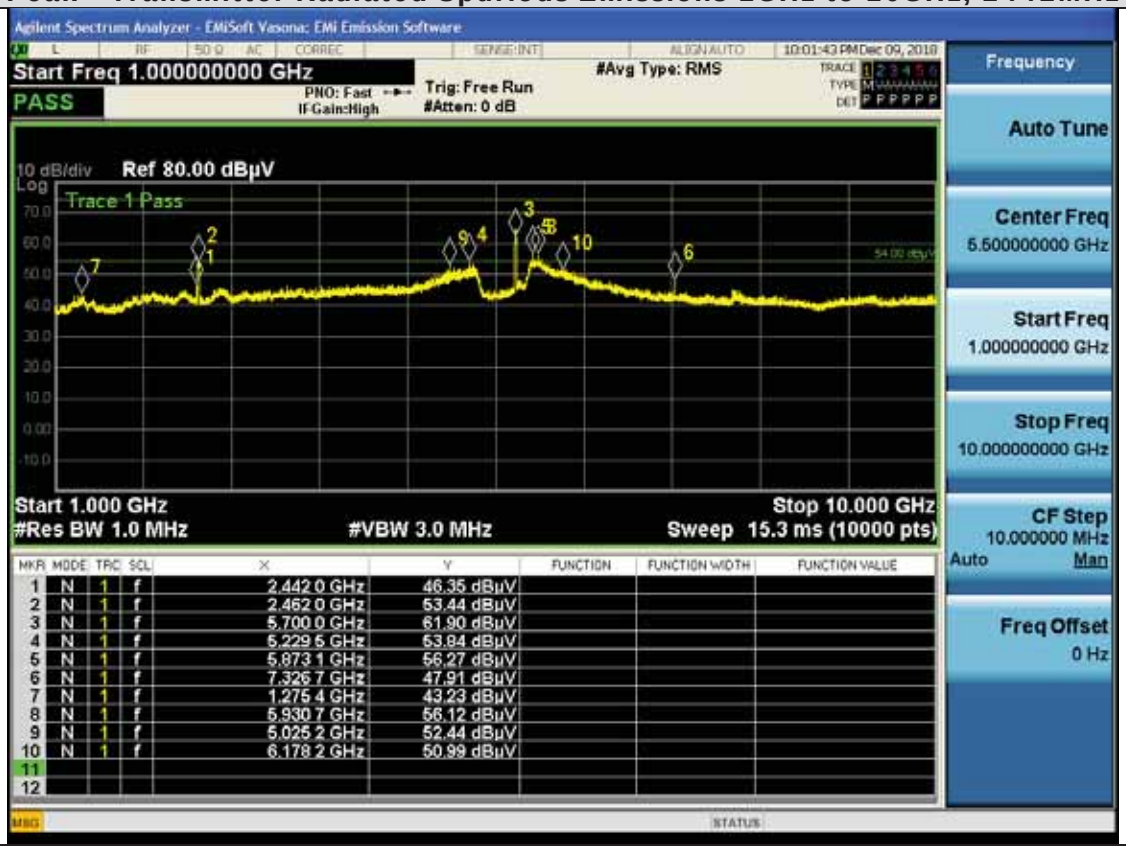
Note: Emissions tests were done with all radios on simultaneously (i.e. BLE, 2.4GHz, and 5GHz radios)

Peak - Transmitter Radiated Spurious Emissions 1GHz to 10GHz, 2442MHz



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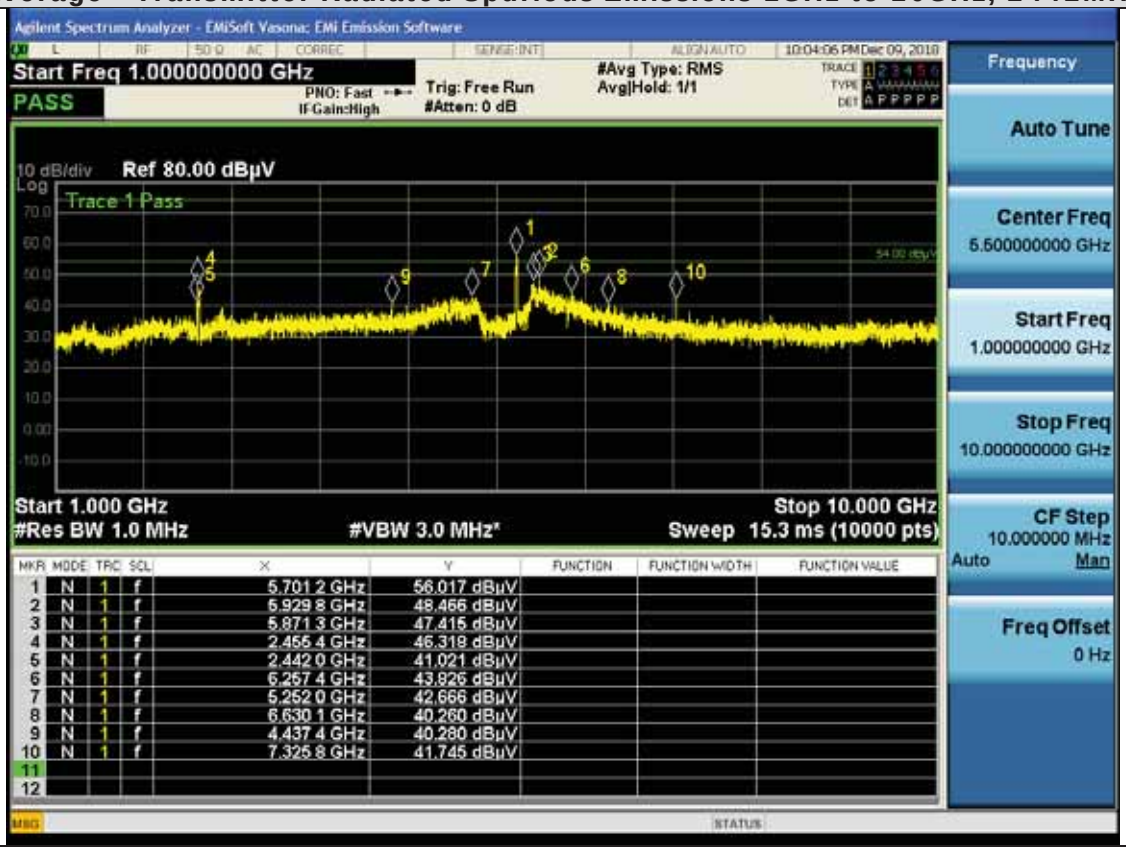
Note: Emissions tests were done with all radios on simultaneously (i.e. BLE, 2.4GHz, and 5GHz radios)

Average - Transmitter Radiated Spurious Emissions 1GHz to 10GHz, 2442MHz



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Note: Emissions tests were done with all radios on simultaneously (i.e. BLE, 2.4GHz, and 5GHz radios)

Peak - Transmitter Radiated Spurious Emissions 1GHz to 10GHz, 2480MHz

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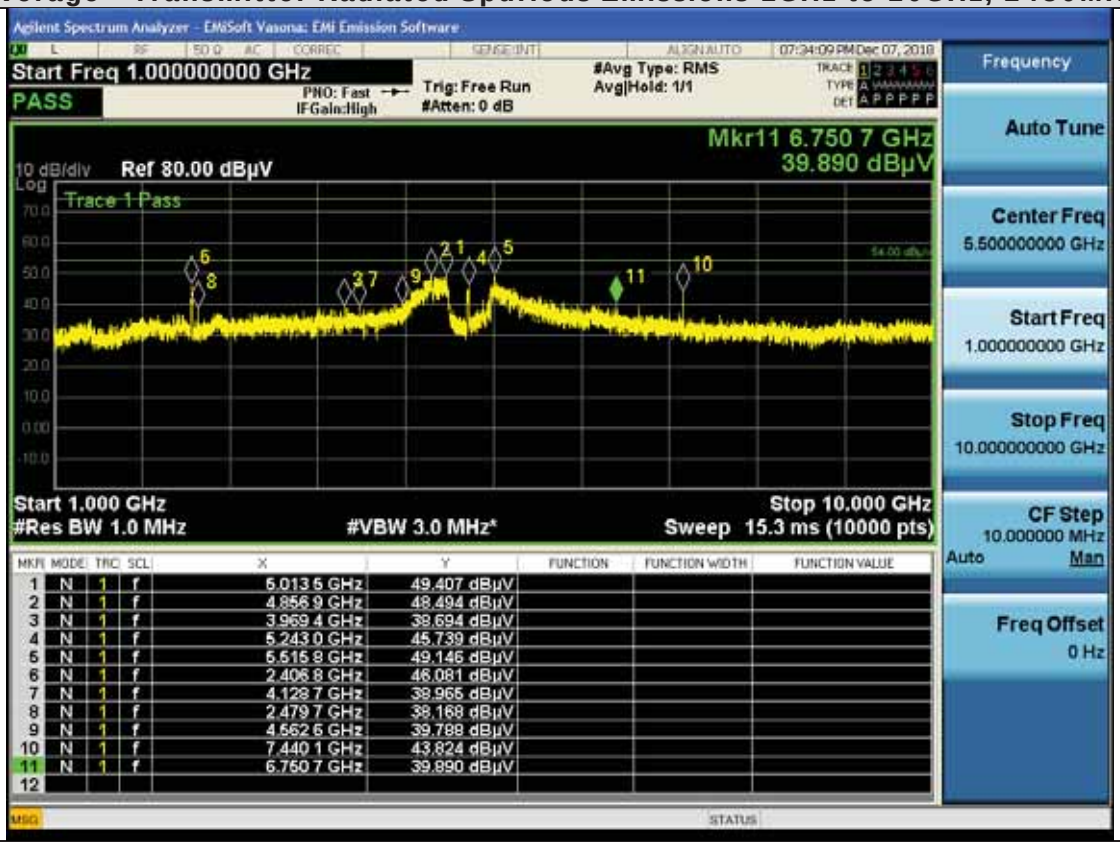
Note: Emissions tests were done with all radios on simultaneously (i.e. BLE, 2.4GHz, and 5GHz radios)

Average - Transmitter Radiated Spurious Emissions 1GHz to 10GHz, 2480MHz



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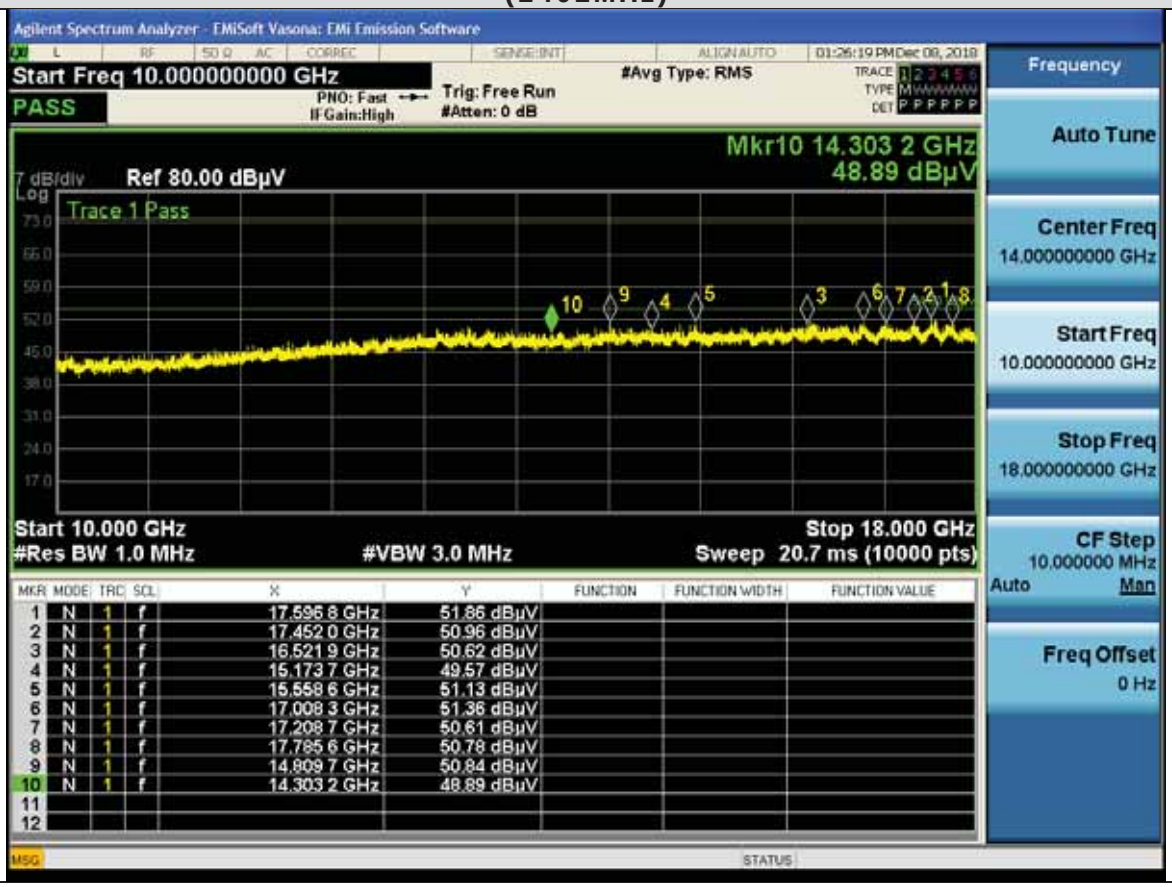
6.1.6 Radiated Transmitter Spurious Emissions – 10-18GHz

Note: Emissions tests were done with all radios on simultaneously (i.e. BLE, 2.4GHz, and 5GHz radios)

Peak - Transmitter Radiated Spurious Emissions 10GHz to 18GHz, GFSK (2402MHz)



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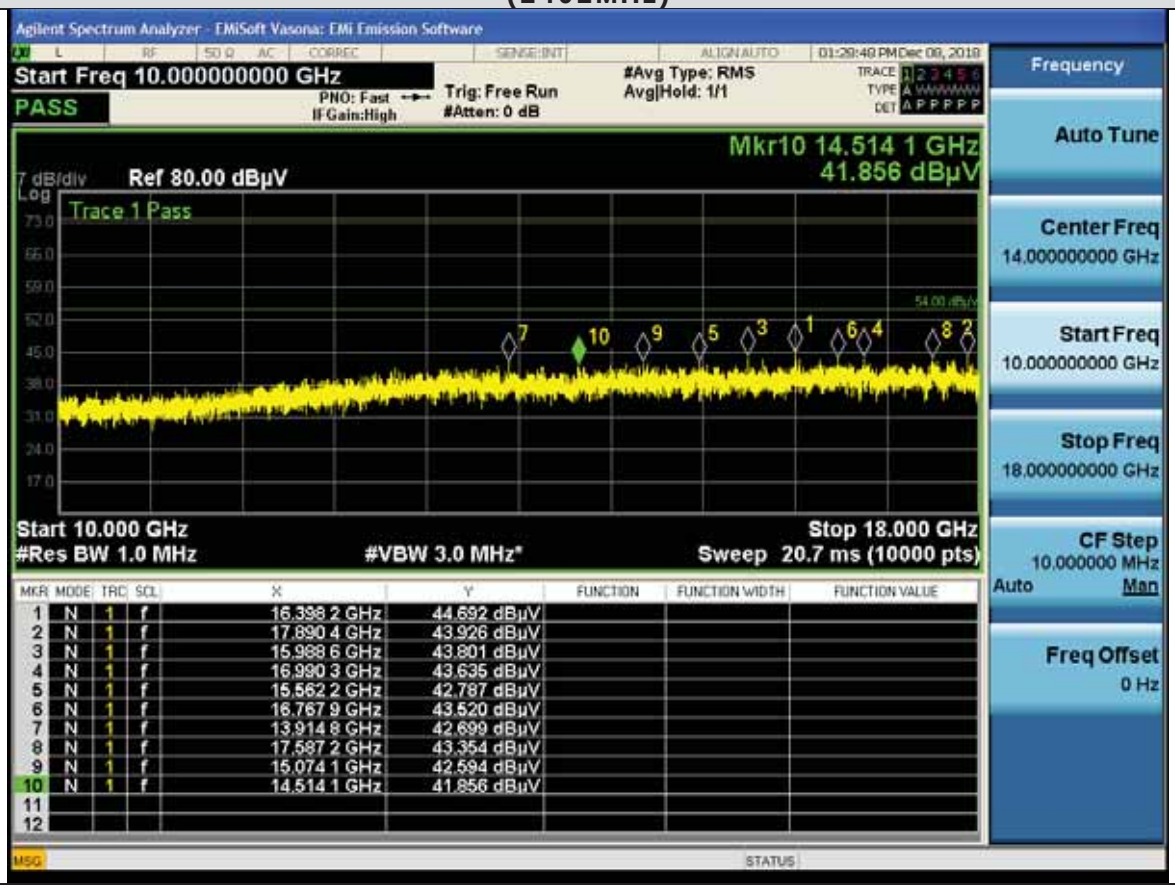
Note: Emissions tests were done with all radios on simultaneously (i.e. BLE, 2.4GHz, and 5GHz radios)

Average - Transmitter Radiated Spurious Emissions 10GHz to 18GHz, GFSK (2402MHz)



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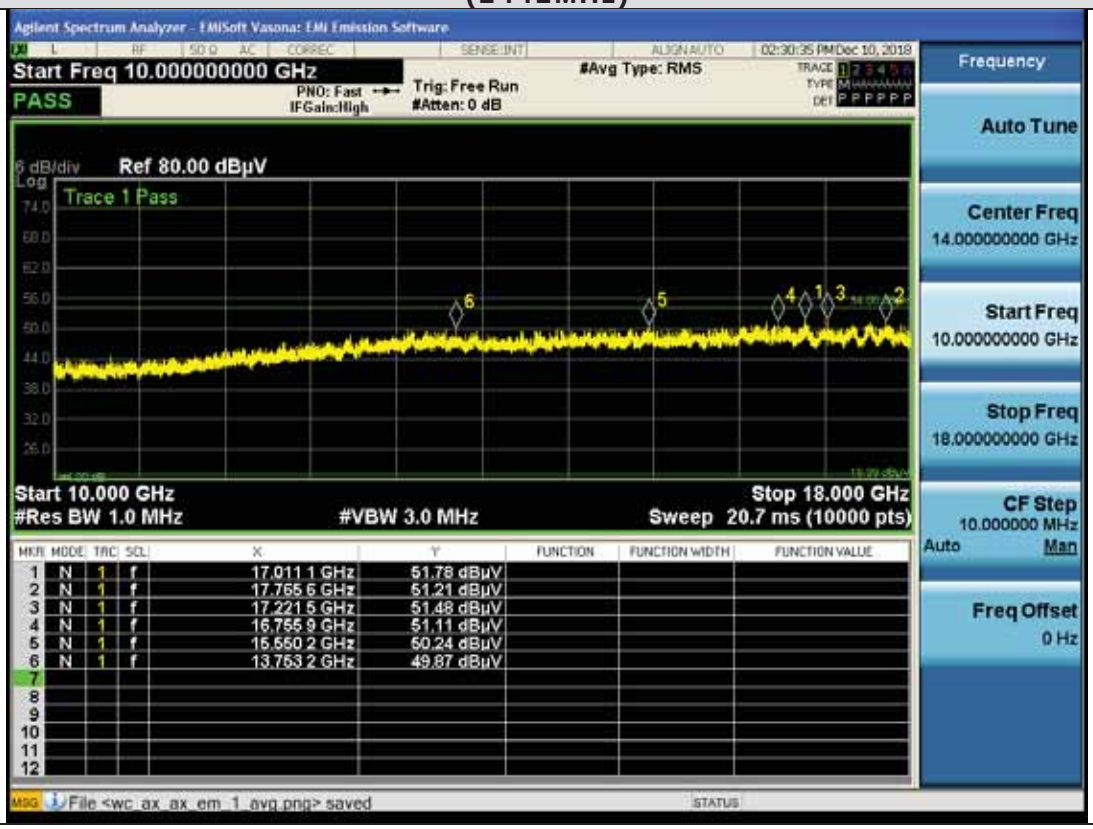
Note: Emissions tests were done with all radios on simultaneously (i.e. BLE, 2.4GHz, and 5GHz radios)

Peak - Transmitter Radiated Spurious Emissions 10GHz to 18GHz, GFSK (2442MHz)



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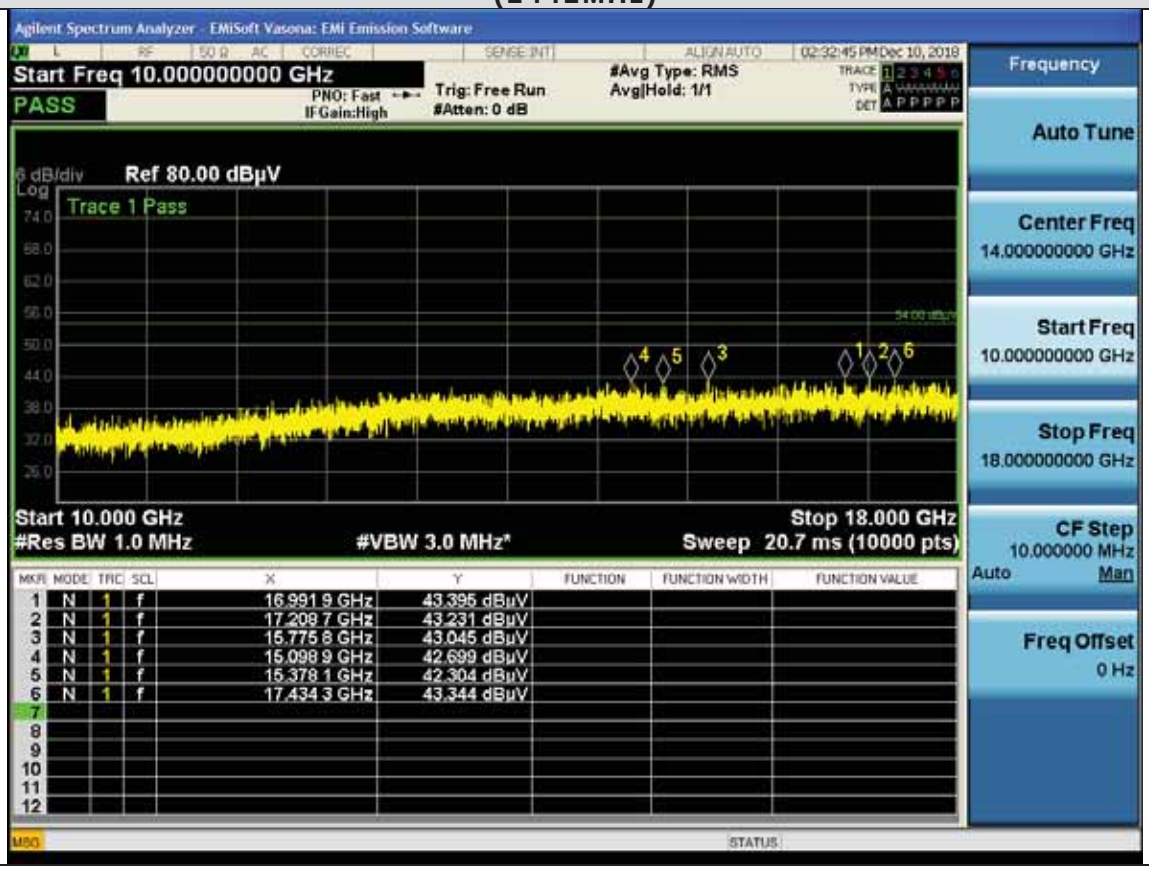
Note: Emissions tests were done with all radios on simultaneously (i.e. BLE, 2.4GHz, and 5GHz radios)

Average - Transmitter Radiated Spurious Emissions 10GHz to 18GHz, GFSK (2442MHz)



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Note: Emissions tests were done with all radios on simultaneously (i.e. BLE, 2.4GHz, and 5GHz radios)

Peak - Transmitter Radiated Spurious Emissions 10GHz to 18GHz, GFSK (2462MHz)

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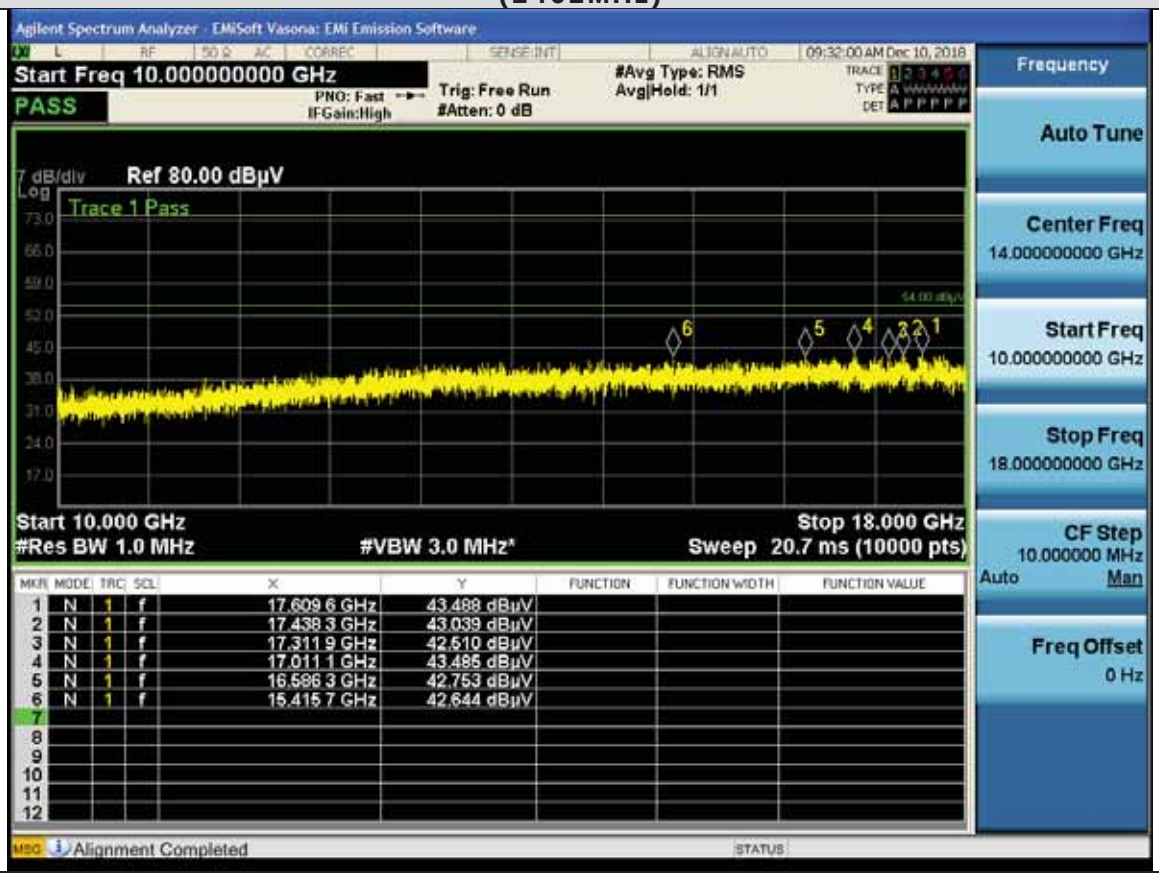
Note: Emissions tests were done with all radios on simultaneously (i.e. BLE, 2.4GHz, and 5GHz radios)

Average - Transmitter Radiated Spurious Emissions 10GHz to 18GHz, GFSK (2462MHz)



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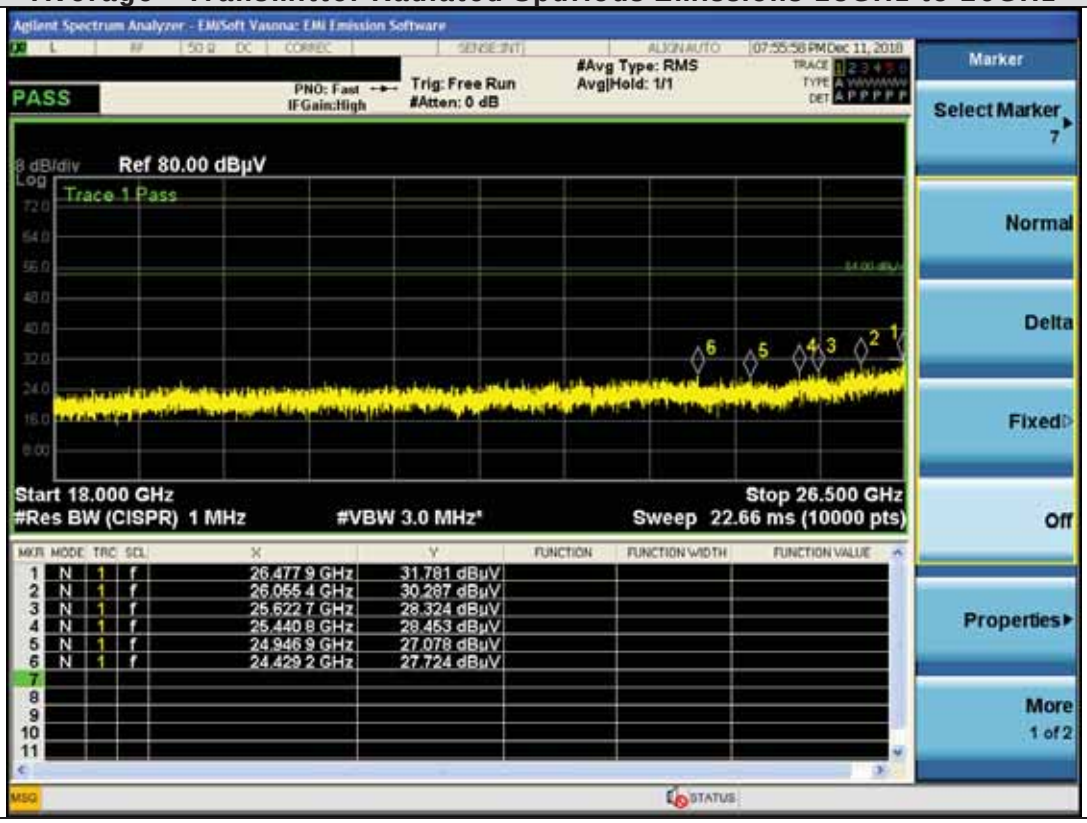
6.1.7 Radiated Transmitter Spurious Emissions – 18-26GHz

Note: Emissions tests were done with all radios on simultaneously (i.e. BLE, 2.4GHz, and 5GHz radios). EUT is in worst case mode

Average - Transmitter Radiated Spurious Emissions 18GHz to 26GHz



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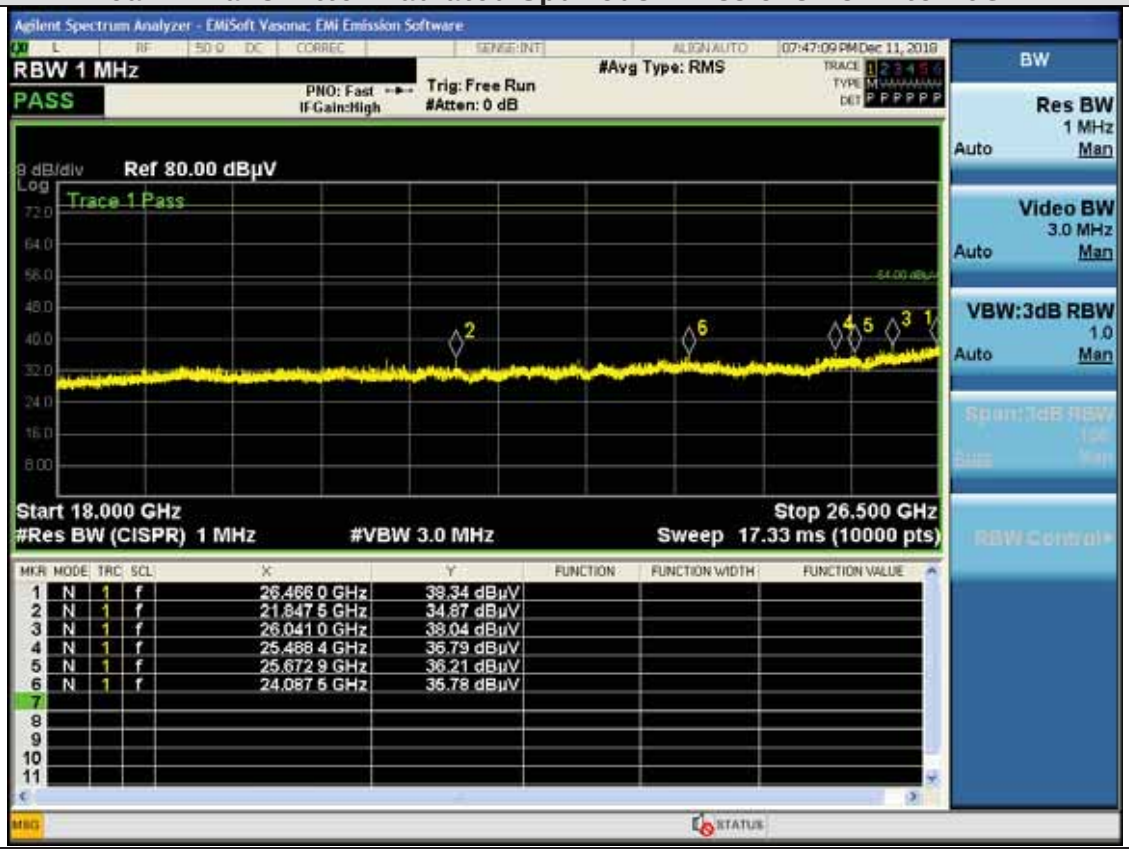
Note: Emissions tests were done with all radios on simultaneously (i.e. BLE, 2.4GHz, and 5GHz radios). EUT is in worst case mode

Peak - Transmitter Radiated Spurious Emissions 18Hz to 26GHz



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6.2 Receiver Spurious Emissions

6.2.1 Receiver Spurious Emissions – Test Requirement

RSS-GEN Issue 5 Section 7.1:

> Compliance with the limits set out in this section shall be demonstrated using the method of measurement described in ANSI C63.4, as per section 3.2 of this standard. For emissions at frequencies below 1 GHz, measurements shall be performed using a CISPR quasi-peak detector and the related measurement bandwidth (see section 6.9). At frequencies above 1 GHz, measurements shall be performed using a linear average detector with a minimum resolution bandwidth of 1 MHz (see section 6.10). For AC power-line conducted emissions, both quasi-peak and average detectors having the characteristics specified in CAN/CSA-CISPR 16-1-1:15 for the 150 kHz to 30 MHz frequency range shall be employed, as per table 4.

RSS-GEN Issue 5 Section 7.3:

> Radiated emission measurements shall be performed with the receiver antenna connected to the receiver antenna ports. The search for spurious emissions shall be from the lowest frequency internally generated or used in the receiver (e.g. local oscillator, intermediate or carrier frequency), or 30 MHz, whichever is higher, to at least five times the highest tunable or local oscillator frequency, whichever is higher, without exceeding 40 GHz. Spurious emissions from receivers shall not exceed the radiated emissions limits shown in table 3.

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6.2.2 Receiver Spurious Emissions - Test Method

Above 1GHz

Ref. ANSI C63.10: 2013 section 4.1.4.2.2, 4.1.4.2.3, 6.6.4 & 11.12.2

Radiated Spurious Emissions Test parameters	
Peak Span = 1-18GHz /18GHz-26.5GHz RBW = 1 MHz VBW ≥ 3 MHz Sweep = Auto couple Detector = Peak Trace = Max Hold.	**Average** Span = 1-18GHz /18GHz-26.5GHz RBW = 1 MHz VBW ≥ 3 MHz Sweep = Auto couple Detector = RMS Power Averaging

Using Vasona, configure the spectrum analyzer as shown above (be sure to enter all losses between the transmitter output and the spectrum analyzer). Terminate the access Point RF ports with 50 ohm loads.

Maximize Turntable (find worst case table angle), Maximize Antenna (find worst case height)

Save 2 plots:

1) Average Plot (Vertical and Horizontal), Limit= 54dBuV/m @3m
2) Peak plot (Vertical and Horizontal), Limit = 74dBuV/m @3m

Place a marker at the end of the restricted band closest to the transmit frequency to show compliance.
Also measure any emissions in the restricted bands.

This report represents the worst case data for all supported operating modes and antennas.

Below 1GHz

Ref. ANSI C63.10: 2013 section 6.5
Using Vasona, configure the spectrum analyzer as shown below (be sure to enter all losses between the transmitter output and the spectrum analyzer). Place the radio in continuous transmit mode.

Span: 30MHz – 1GHz
Reference Level: 80 dBuV
Attenuation: 10 dB
Sweep Time: Coupled
Resolution Bandwidth: 100kHz
Video Bandwidth: 300kHz
Detector: Peak for Pre-scan, Quasi-Peak
Compliance shall be determined using CISPR quasi-peak detection; however, peak detection is permitted as an alternative to quasi-peak detection.

Terminate the access Point RF ports with 50 ohm loads.

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Maximize Turntable (find worst case table angle), Maximize Antenna (find worst case height)

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6.2.3 Receiver Spurious Emissions – Test Information

System Number	Description	Samples	System under test	Support equipment
2	EUT	S03	☑	☐
	Support	S04	☐	☑

Tested By:	Date of testing:
Julian Land	October 11, 2018 – December 11, 2018
Test Result: Pass	

See Appendix A for list of test equipment

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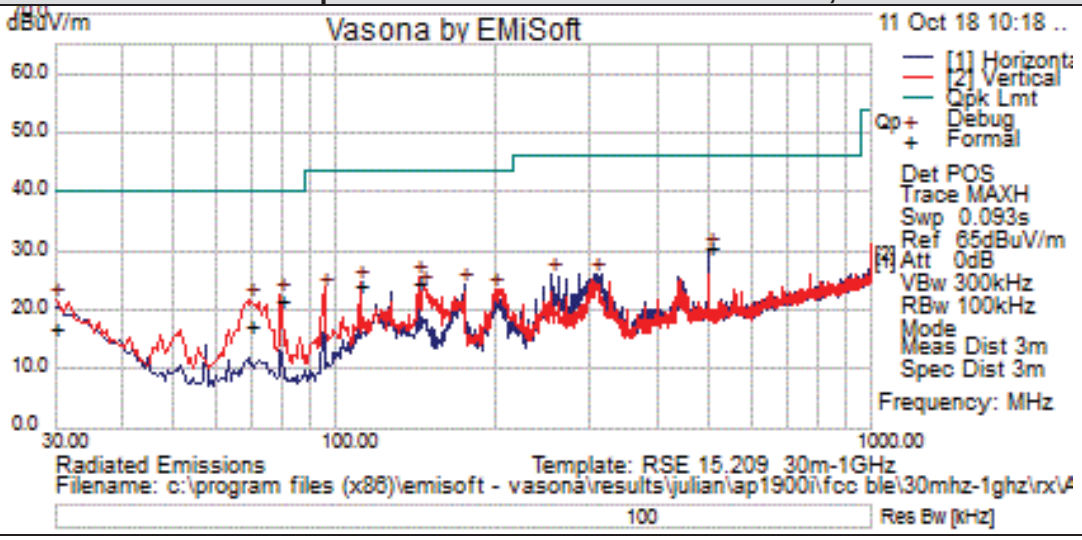
6.2.4 Receiver Spurious Emissions – 30MHz-1GHz

Receiver Radiated Spurious Emissions 30MHz to 1GHz, Receive Mode



Frequency (MHz)	Raw (dBuV)	Cab Loss (dB)	AF (dB)	Level (dBuV)	Detector	Polarity	Height (cm)	Azt (Deg)	Limit (dBuV)	Margin (dB)	Results Pass / Fail	Comments
500.003	38.3	2.2	-9.7	30.8	Quasi Max	H	150	308	46	-15.2	Pass	
79.341	39.9	0.8	-19.2	21.6	Quasi Max	V	133	230	40	-18.4	Pass	
142.8	37.2	1.1	-13.6	24.7	Quasi Max	V	101	143	43.5	-18.8	Pass	
30	22.6	0.5	-5.9	17.1	Quasi Max	V	192	288	40	-22.9	Pass	
69.616	35.5	0.8	-18.8	17.5	Quasi Max	V	102	94	40	-22.5	Pass	
111.072	36.9	1	-13.8	24.1	Quasi Max	V	111	196	43.5	-19.4	Pass	

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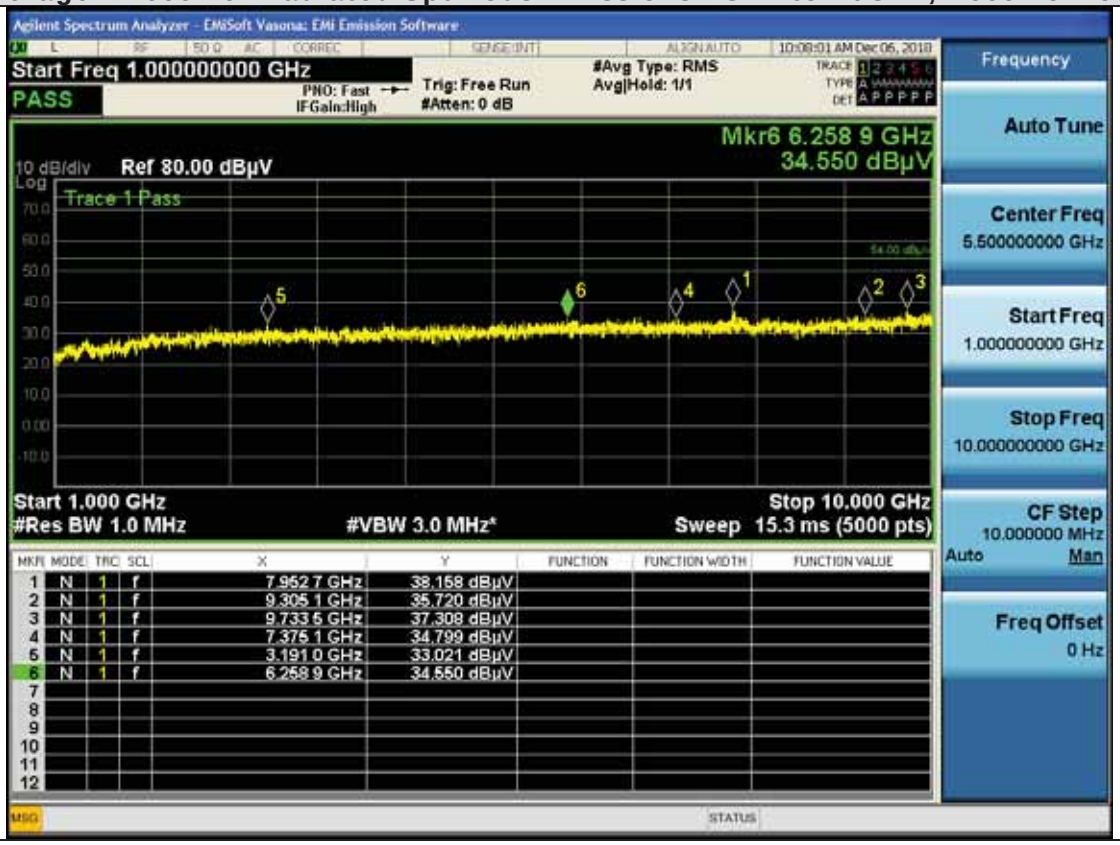
Average - Receiver Radiated Spurious Emissions 1GHz to 10GHz, Receive Mode



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Peak - Receiver Radiated Spurious Emissions 1GHz to 10GHz, Receive Mode

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6.2.6 Receiver Spurious Emissions – 10GHz-18GHz

Average - Receiver Radiated Spurious Emissions 10GHz to 18GHz, Receive Mode

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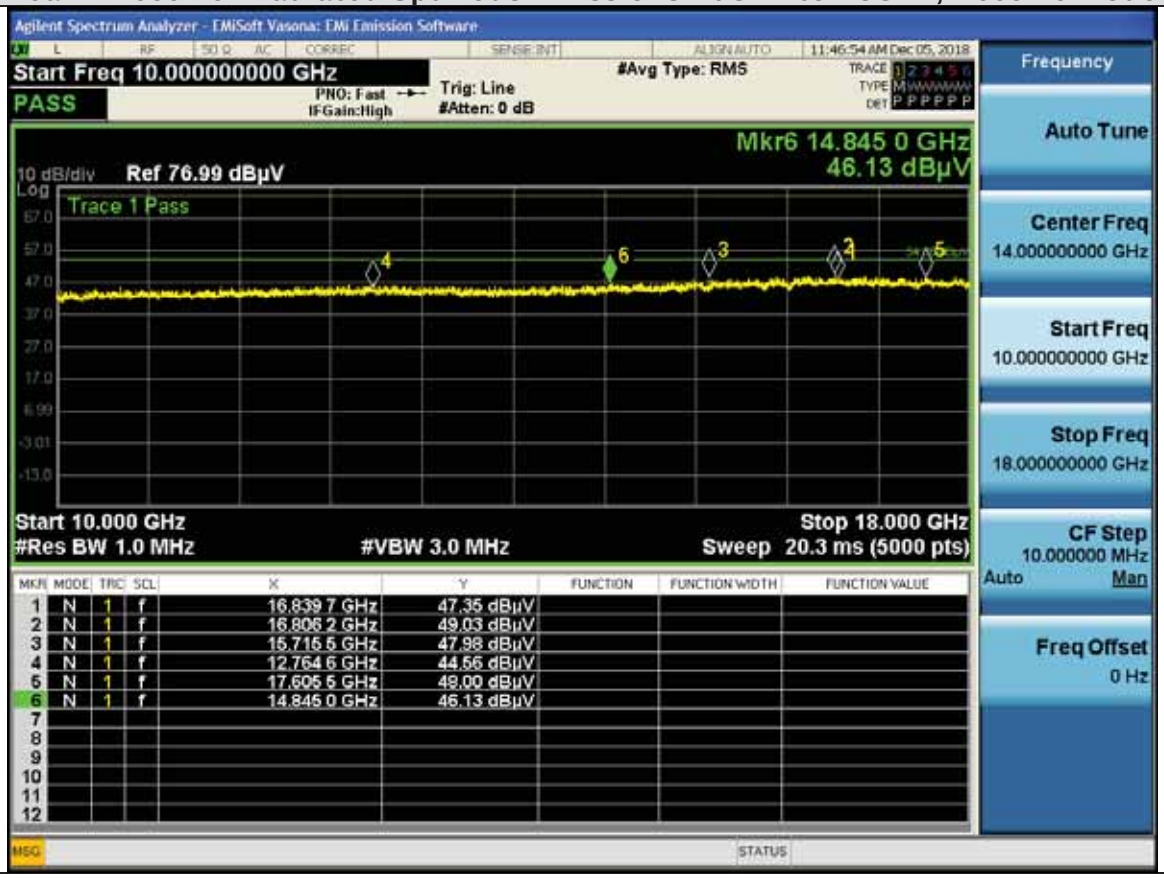
Peak - Receiver Radiated Spurious Emissions 10GHz to 18GHz, Receive Mode



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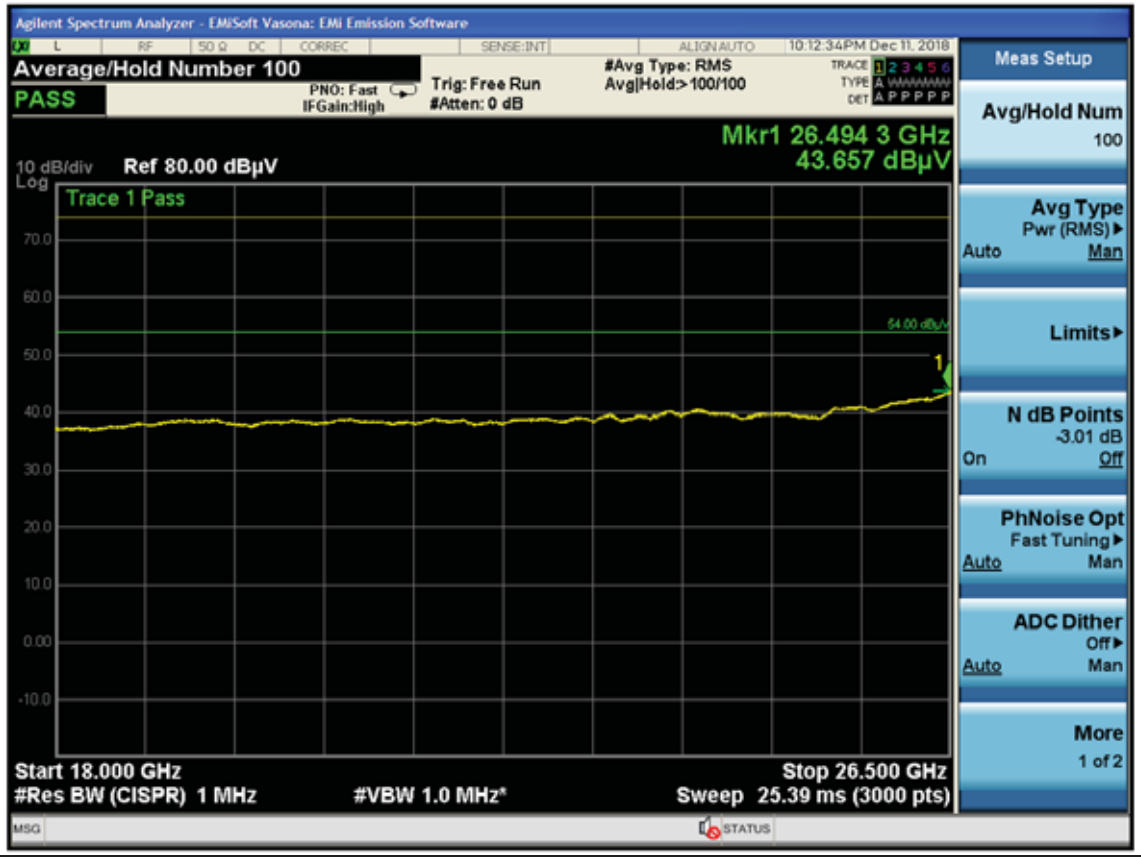
6.2.7 Receiver Spurious Emissions – 18GHz-26GHz

Average - Receiver Radiated Spurious Emissions 18GHz to 26GHz, Receive Mode



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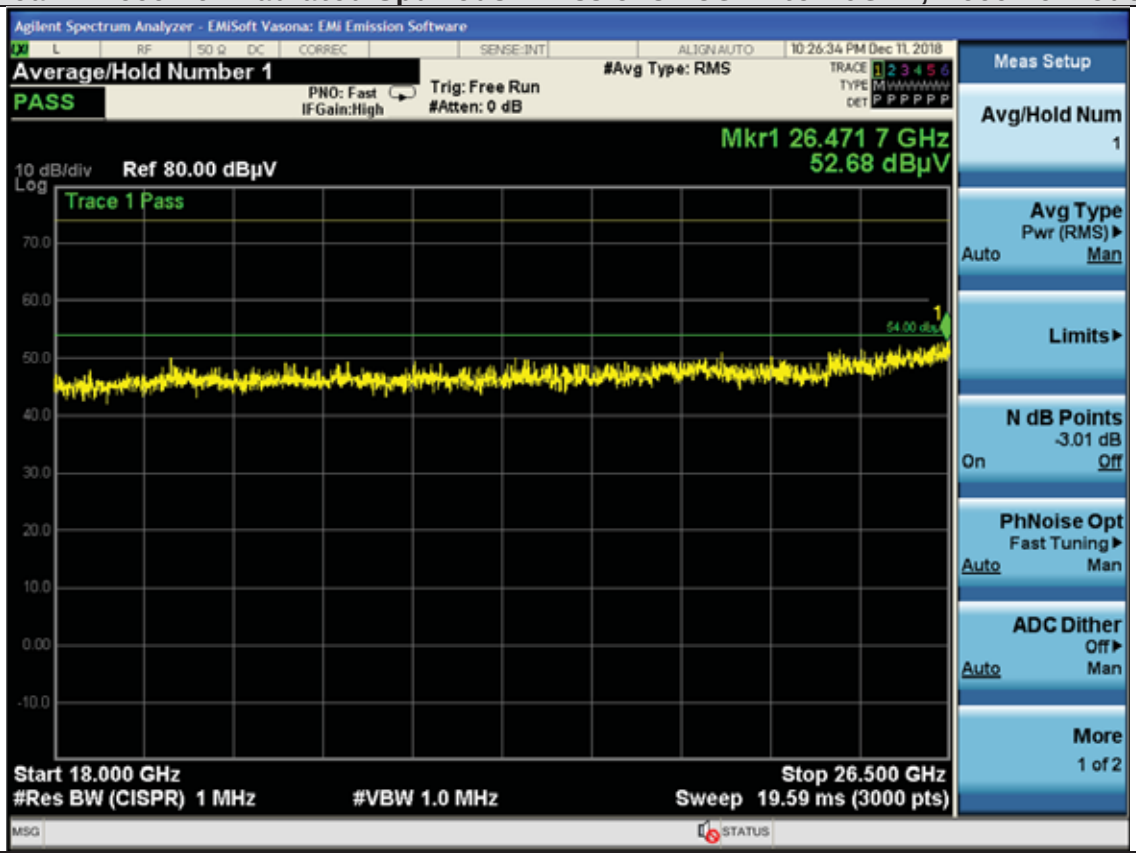
Peak - Receiver Radiated Spurious Emissions 18GHz to 26GHz, Receive Mode



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6.3 AC Conducted Emissions

Note: Only DC power is supplied to the unit.

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Appendix A: List of Test Equipment Used to perform the test

Equip#	Manufacturer/ Model	Description	Last Cal	Next Due
Test Equipment Used for Radiated Emissions for 10/10/2018 – 10/11/2018				
3038	Keysight (Agilent/HP) / 8447F	Amplifier	20 Jun. 2018	20 Jun. 2019
20975	Micro-Coax/ UFB311A-0-1344-520520	Coaxial Cable 18GHz	19 Feb. 2018	19 Feb. 2019
25001	Micro-Coax UFB197C-1-0240-504504	Coaxial RF Cable, 26.5GHz	24 Apr. 2018	24 Apr. 2019
27233	York / CNE V	Comparison Noise Emitter	Cal. not required	Cal. not required
30652	Micro-Coax / UFB197C-1-0240-504504	Coaxial RF Cable 26.5GHz	24 Apr. 2018	24 Apr. 2019
36772	Fluke / 175	True RMS Multimeter	22 May 2018	22 May 2019
47300	Keysight (Agilent/HP) / N9038A	EMI Receiver	19 Apr. 2018	19 Apr. 2019
54645	Stanley / 33-428	26' Tape Measure	Cal. not required	Cal. not required
55936	Huber + Suhner / 106PA	RF Type N Antenna Cable 18GHz 8.5m	19 Oct. 2017	19 Oct. 2018
56154	Huber + Suhner / Sucoflex 104PEA	Sucoflex N Type blue 7ft Cable	18 Jan. 2018	18 Jan. 2019
Test Equipment used for Radiated Emissions 12/5/2018 – 12/11/2018				
5687	Fluke / 73 III	Digital Multimeter	02 Nov. 2018	02 Nov. 2019
8171	Keysight (Agilent/HP) / 8491B Opt 010	Attenuator	25 Apr. 2018	25 Apr. 2019
21117	Micro-Coax / UFB311A-0-2484-520520	Coaxial Cable – 18GHz	13 Aug. 2018	13 Aug. 2019
27233	York / CNE V	Comparison Noise Emitter	Cal. not required	Cal. not required
30654	Sunol Sciences / JB1	Combination Antenna, 30MHz – 2GHz	20 Apr. 2018	20 Apr. 2019
32544	ETS Lindgren / 3117	Double Ridged Horn Antenna	20 Sep. 2018	20 Sep. 2019
34075	Schaffner / RSG 2000	Reference Spectrum Generator, 1-18GHz	Cal. not required	Cal. not required
34304	Micro-Tronics / BRM50702-02	Band Reject Filter	26 Jun. 2018	26 Jun. 2019
35608	Micro-Tronics / BRC50703-02	Notch Filter	17 Aug. 2018	17 Aug. 2019
35616	Micro-Tronics / HPM50112-02	Notch Filter	03 Jul. 2018	03 Jul. 2019
39123	Cisco / TH0118	Mast Mount Preamplifier Array, 1-18GHz	02 Apr. 2018	02 Apr. 2019
42015	ETS Lindgren / 3117	Double Ridged Horn Antenna	03 Mar. 2018	03 Mar. 2019
47286	Huber + Suhner / Sucoflex 102E	40GHz Cable K Connector	04 Sep. 2018	04 Sep. 2019
47300	Keysight (Agilent/HP) / N9038A	EMI Receiver	19 Apr. 2018	19 Apr. 2019
49563	Huber + Suhner / Sucoflex 106A	Coaxial Cable, 8m	13 Aug. 2018	13 Aug. 2019
54611	Megaphase / RA08-S1S1-12	SMA Cable	31 Jul. 2018	31 Jul. 2019
54624	Megaphase / RA08-S1S1-18	SMA Cable	31 Jul. 2018	31 Jul. 2019
54654	Micro-Tronics / BRC50703-02	Notch Filter	07 Aug. 2018	07 Aug. 2019

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55594	Megaphase / GC12-8181-16	SMA Cable	10 May 2018	10 May 2019
56066	Miteq / TTA1800-30-HG-S	18GHz SMA Pre-Amplifier	21 May 2018	21 May 2019
56159	Huber + Suhner / Sucoflex 104PEA	Sucoflex N Type blue7ft cable	18 Jan. 2018	18 Jan. 2019
RF Conducted test equipment 11/5/2018 – 11/8/2018				
53614	Keysight (Agilent/HP) / N9030A-550	PXA Signal Analyzer, 3Hz to 50GHz	17 Jul. 2018	17 Jul. 2019
57477	Cisco	Automated Radio Testing Station	Verify Before Use	Verify Before Use
06325	Lufft / 5063-33W	Dial Hygrometer	27 Aug. 2018	27 Aug. 2019
56330	Pasternack / PE5019-1	Torque Wrench	28 Feb. 2018	28 Feb. 2019

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Appendix B: Abbreviation Key and Definitions

The following table defines abbreviations used within this test report.

Abbreviation	Description	Abbreviation	Description
EMC	Electro Magnetic Compatibility	°F	Degrees Fahrenheit
EMI	Electro Magnetic Interference	°C	Degrees Celsius
EUT	Equipment Under Test	Temp	Temperature
ITE	Information Technology Equipment	S/N	Serial Number
TAP	Test Assessment Schedule	Qty	Quantity
ESD	Electro Static Discharge	emf	Electromotive force
EFT	Electric Fast Transient	RMS	Root mean square
EDCS	Engineering Document Control System	Qp	Quasi Peak
Config	Configuration	Av	Average
CIS#	Cisco Number (unique identification number for Cisco test equipment)	Pk	Peak
Cal	Calibration	kHz	Kilohertz ($1x10^3$)
EN	European Norm	MHz	MegaHertz ($1x10^6$)
IEC	International Electro technical Commission	GHz	Gigahertz ($1x10^9$)
CISPR	International Special Committee on Radio Interference	H	Horizontal
CDN	Coupling/Decoupling Network	V	Vertical
LISN	Line Impedance Stabilization Network	dB	decibel
PE	Protective Earth	V	Volt
GND	Ground	kV	Kilovolt ($1x10^3$)
L1	Line 1	µV	Microvolt ($1x10^{-6}$)
L2	Line2	A	Amp
L3	Line 3	µA	Micro Amp ($1x10^{-6}$)
DC	Direct Current	mS	Milli Second ($1x10^{-3}$)
RAW	Uncorrected measurement value, as indicated by the measuring device	µS	Micro Second ($1x10^{-6}$)
RF	Radio Frequency	µS	Micro Second ($1x10^{-6}$)
SLCE	Signal Line Conducted Emissions	m	Meter
Meas dist	Measurement distance	Spec dist	Specification distance
N/A or NA	Not Applicable	SL	Signal Line (or Telecom Line)
P	Power Line	L	Live Line
N	Neutral Line	R	Return
S	Supply	AC	Alternating Current

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Appendix C: Software Used to Perform Testing

EMIsoft Vasona: version 6.047
Automated Testing Software: RF_Automation.vi version 44

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Appendix D: Test Procedures

Measurements were made in accordance with

- KDB 558074 - D01 DTS Meas. Guidance v04
- KDB 662911 - MIMO
- ANSI C63.4 2014 Unintentional Radiators
- ANSI C63.10 2013 Intentional Radiators

Test procedures are summarized below

FCC 2.4GHz Test Procedures	EDCS # 1445042
FCC 2.4GHz RSE Test Procedures	EDCS # 1480386

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Appendix E: Scope of Accreditation (A2LA certificate number 1178-01)

The scope of accreditation of Cisco Systems, Inc. can be found on the A2LA web page at:

http://www.a2la.org/scopepdf/1178-01.pdf

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Appendix F: Test Assessment Plan

Test Plan EDCS# 15438021
Power Tables EDCS# 11793772

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