

2.4 GHz Bluetooth Low Energy Radio Test Report

(DTS)

For

SPK-SHARE Dongle

supports

2.4 GHz/5.0 GHz Wi-Fi Radio 802.11a/ac/b/g/n+ Bluetooth v2.1+EDR, BTLE v4.0

FCC ID: LDKSPKSH1576

ISED ID: 2461L-SPKSH1576

Against the following Specifications :

47 CFR 15.247

47 CFR 15.209

47 CFR 15.205

RSS-Gen issue 4

RSS-247 Issue 2

Cisco Systems

EMC Laboratory

170 West Tasman Drive

San Jose, CA 95134



Author: Danh Le Tested By: Danh Le, Farida Rahmanzai, Zain Ali	Approved By: Diana Canafoglia Title: Compliance Manager Revision: See EDCS

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Section 1: Overview

1.1 Test Summary

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

RF Specifications
47 CFR Part 15.247 47 CFR Part 15.209 47 CFR Part 15.205 RSS-Gen Issue 4 RSS-247 Issue 2

Measurements were performed in accordance with

- ANSI C63.10:2013
- KDB 558074 D01 DTS Meas Guidance v4
- RSS Gen Issue 4 General Requirements for Compliance of Radio Apparatus

Section 2: Assessment Information

2.1 General

This report contains an assessment of an apparatus against Electromagnetic Compatibility 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*%

*[Where applicable] For ESD testing the humidity limits used were 30% to 60% and for EFT/B tests the humidity limits used were 25% to 75%.
- e) All AC testing was performed at the following supply voltage:
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:

$$\text{Emission level [dBuV]} = \text{Indicated voltage level [dBuV]} + \text{Cable Loss [dB]} + \text{Other correction factors [dB]}$$

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:-

$$\text{Level in uV/m} = \text{Common Antilogarithm} [(X \text{ dBuV/m})/20] = Y \text{ uV/m}$$

Measurement Uncertainty Values

voltage and power measurements	± 2 dB
conducted emissions measurements	± 1.4 dB
radiated emissions measurements	± 3.2 dB
frequency measurements	$\pm 2.4 \cdot 10^{-7}$
temperature measurements	$\pm 0.54^\circ$.
humidity measurements	$\pm 2.3\%$
DC and low frequency measurements	$\pm 2.5\%$.

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
1.0 GHz – 10.0 GHz	± 4.0 dB
10.0 GHz – 18.0 GHz	± 8.2 dB
18.0 GHz – 26.5 GHz	± 4.1 dB
26.5 GHz – 40.0 GHz	± 3.9 dB

Conducted emissions (expanded uncertainty, confidence interval 95%)

30 MHz – 40.0 GHz	± 0.38 dB
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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.



2.3 Testing Dates

19-Oct-2017 – 12-Jan-2018

2.4 Report Issue Date

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2.5 Testing facilities

This assessment was performed by:

Testing Laboratory

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

Headquarters

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

Registration Numbers for Industry 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 Engineer(s)

Danh Le
Farida Rahmanzai
Zain Ali

2.6 Equipment Assessed (EUT)

SPK-SHARE

2.7 EUT Description

Cisco SPK-SHARE dongle is the next generation cloud collaboration platform that unifies messaging, meeting and calling and content-sharing. Cisco SPK-Share provides HDMI support for connection to a display and USB Type-C interface to receive 5V power. Cisco SPK-Share offers both wired and wireless solution with Ethernet via USB 2.0 external adapter and 802.11a/b/g/n/ac, Bluetooth classic and Bluetooth LE radios.

Below are brief summary of the SPK-SHARE hardware specifications:

Wired Protocol support

- USB Type C main interface (Power, Ethernet via USB2)
- External POE Ethernet adapter (Ethernet Injector accessory connected via USB type C)
 - Ethernet: 10/100/1000BASE-T Ethernet network (IEEE 802.3i/802.3u/802.3ab/802.3az)
- External 18W power supply (Direct connected via USB)

Wireless Protocols support

- Wi-Fi: IEEE 802.11a, 802.11b, 802.11g, 802.11n, 802.11ac
- Bluetooth: IEEE 802.15 Basic Rate v2.1+ EDR, Low Energy v4.0

2.4GHz FHSS Radio Supported Modes:

- 802.15 BlueTooth ver 2.1+EDR (1Mbps – 3Mbps, Single stream)

2.4GHz BTLE Radio Supported Modes:

- 802.15 BlueTooth ver 4.0 (1Mbps, Single stream)

2.4GHz WLAN Radio Supported Modes:

- 802.11b (1Mbps – 11Mbps)
- 802.11g (6Mbps - 54Mbps)
- 802.11n (HT20, M0 – M15)
- 802.11n (HT40, M0 – M15)

5GHz WLAN Radio Supported Modes:

- 802.11a (6Mbps – 54Mbps,)
- 802.11n (HT20, M0 – M15)
- 802.11n (HT40, M0 – M15)
- 802.11ac (VHT20, M0 – M8)
- 802.11ac (VHT40, M0 – M9)
- 802.11ac (VHT80, M0 – M9)



Model Differences

SPK-SHARE
SPK-SHARE-K9

Both have identical components, PCB layout, electronics circuitries and enclosure. The only difference is the encryption software being offered for SPK_SHARE-K9

Section 3: Result Summary

3.1 Results Summary Table

RF Conducted Emissions		
Standard(s)	Test Details / Comments	Result
FCC15.247(a)(2) RSS-247 5.2(a)	<p>99% & 6 dB Bandwidth: FCC/RSS: 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.</p> <p>The 6 dB emission bandwidth 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 6 dB relative to the maximum level measured in the fundamental emission.</p> <p>Systems using digital modulation techniques may operate in the 2400-2483.5 MHz band. The minimum 6dB bandwidth shall be at least 500 kHz</p>	Pass
FCC15.247(b)(3) RSS-247 5.4(d)	<p>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.</p> <p>FCC: 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.</p> <p>RSS: 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. As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power. Systems operating in the 2400-2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.</p>	Pass
FCC15.247(e) RSS-247 5.2(b)	<p>Power Spectral Density FCC/RSS: 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.</p>	Pass

RF Conducted Emissions (continue)		
FCC15.247(d)/ RSS-247 5.5	Conducted Band-Edge / Out of band emissions: FCC/RSS: 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. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in FCC§15.209(a) & RSS-Gen is not required.	Pass
FCC15.247(d) RSS-Gen 8.10	Restricted band: FCC: In addition, radiated emissions which fall in the restricted bands, as defined in FCC §15.205(a), must also comply with the radiated emission limits specified in Sec. 15.209(a). RSS-Gen: Unwanted emissions falling into restricted bands of Table 6 shall comply with the limits of Table 4 specified in RSS-Gen 8.9.	Pass

Radiated Emissions		
Basic Standard	Test Details / Comments	Result
FCC 15.209/205 RSS-Gen6.13(a)/8.10	TX Spurious Emissions & Restricted Bands FCC: Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the field strength limits table in this section. In addition, radiated emissions which fall in the restricted bands as defined in FCC §15.205(a), must also comply with the radiated emission limits specified in Sec. 15.209(a). RSS: In measuring unwanted emissions, the spectrum shall be investigated from 30 MHz or the lowest radio frequency signal generated in the equipment, whichever is lower, without going below 9 kHz, up to at least the frequency given below: a) If the equipment operates below 10 GHz; to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower. RSS: Unwanted emissions falling into restricted bands of Table 6 shall comply with the limits of Table 4 specified in RSS-Gen 8.9.	Pass

AC Conducted Emissions		
Basic Standard	Test Details / Comments	Result
FCC15.207 RSS-Gen 8.8	AC Conducted Emissions FCC: (a) Except as shown in paragraphs (b) and (c) of this section, 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 μ H/50 ohms line impedance stabilization network (LISN). RSS: A radio apparatus that is designed to be connected to the public utility (AC) power line shall ensure that the radio frequency voltage, which is conducted back onto the AC power line on any frequency or frequencies within the band 0.15 MHz to 30 MHz shall not exceed the limits in Table 3 shown in this section.	Pass

* MPE calculation to be reported in separate reports

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. Please also refer to the “Justification for worst Case test Configuration” section of this report for further details on the selection of EUT samples.

4.1 Sample Details

Sample Number	Equipment Description	Manufacturer / Model#	Hardware Rev.	Firmware Rev.	Serial Number
S01	Wireless dongle (radiated sample)	Cisco / SPK-SHARE	P3	novum1.1.0 PreAlpha1 2017-10-03	FCH2138EAMB
S02	Wireless dongle (conducted sample)	Cisco / SPK-SHARE	P3	novum1.1.0 PreAlpha1 2017-10-03	FCH2135DG58
S03	Switching Power Supply	Cisco / AQ18A-59CFA	Production	-----	PH1212400BC

4.2 System Details

System #	Description	Samples
1	Radiated Radio Test Sample and Power Supply	S01 & S03
2	RF Conducted Radio Test Sample and Power Supply	S02 & S03

4.3 Mode of Operation Details

Mode#	Description	Comments
1	802.15 (BTLE) Test Mode	System shall be placed in a continuous Transmitter Mode at various data rate and channel combinations per all Transmitter Test Requirements.

4.4 Test Mode, Modulation and Data Rate Description

Mode#	Test Mode	Modulation	Data Rate
1	802.15 Bluetooth LE	GFSK	1 Mbps

4.5 Software Used for Testing

Tool#	Description	Comments
1	EMIsoft Vasona, version 6.0	Vasona is Windows based automated software PC controlled tool kit designed to run radiated emissions.
2	QRCT Radio Control Software version 3.0.242.0	QRCT is the Windows based software tool kit designed to control radio setting for RF conducted

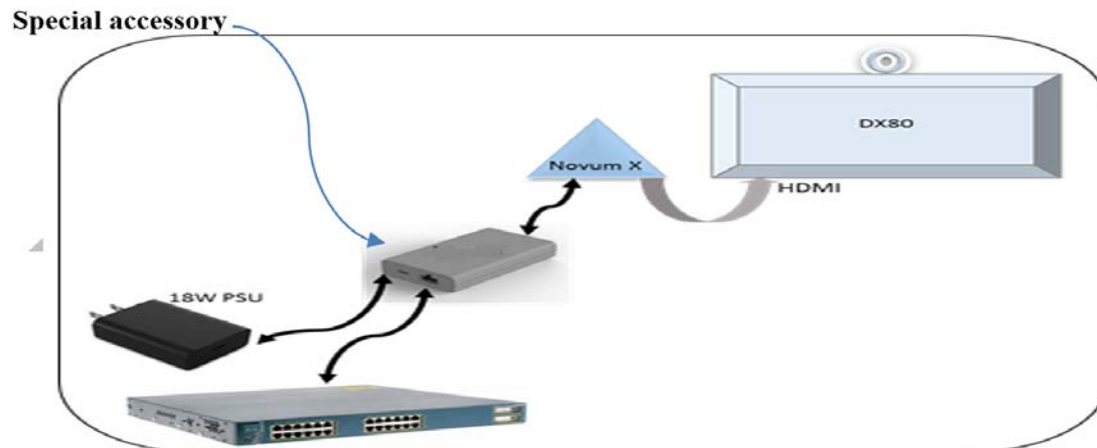
4.6 Antenna Information

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

Frequency (MHz)	Part Number	Antenna Type	Antenna Gain Peak (dBi)
2400 – 2500	CI8847-11-000-R-FA	PIFA	1.24
5150 – 5250	CI8847-11-000-R-FA	PIFA	4.26
5250 – 5350	CI8847-11-000-R-FA	PIFA	4.26
5470 – 5725	CI8847-11-000-R-FA	PIFA	3.77
5725 – 5850	CI8847-11-000-R-FA	PIFA	2.85

4.7 Special Accessories included in the test setup

Due to hardware design limitation, an **external Ethernet adapter** was used as a special accessory to access into the EUT in order to execute all required radio test command scripts.



Section 5: Modifications

5.1 Sample Modifications Performed During Assessment

No modifications were performed during assessment.

Appendix A: RF Conducted Test Results

Target Maximum Channel Power

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. During preliminary testing, slowest data rate setting was evaluated to determine the “Worst Case” mode.

The following table details the maximum supported Total Channel Power for all operating modes.

Operating Mode / Data Rate	Maximum Channel Power (dBm)		
	Frequency (MHz)		
	2402	2442	2480
802.15 (BTLE) / 1 Mbps	----	----	2.3

A.1 Duty Cycle

Duty Cycle Test Requirement

From KDB 558074 D01 DTS Meas Guidance v4

B. Duty Cycle (x), Transmission Duration (T), and Maximum Power Control Level

1. All measurements are to be performed with the EUT transmitting at 100 percent duty cycle at its maximum power control level; however, if 100 percent duty cycle cannot be achieved, measurements of duty cycle, x , and maximum-power transmission duration, T , are required for each tested mode of operation.

A.1.1 Duty Cycle Test Method

From KDB 558074 D01 DTS Meas Guidance v4

B. Duty Cycle (x), Transmission Duration (T), and Maximum Power Control Level

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 $RBW \geq OBW$ if possible; otherwise, set RBW to the largest available value. Set $VBW \geq RBW$. 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 $T \leq 16.7$ microseconds.)

Duty Cycle Correction Factor and Duty Cycle Percentage can be derived by using the following formulas:

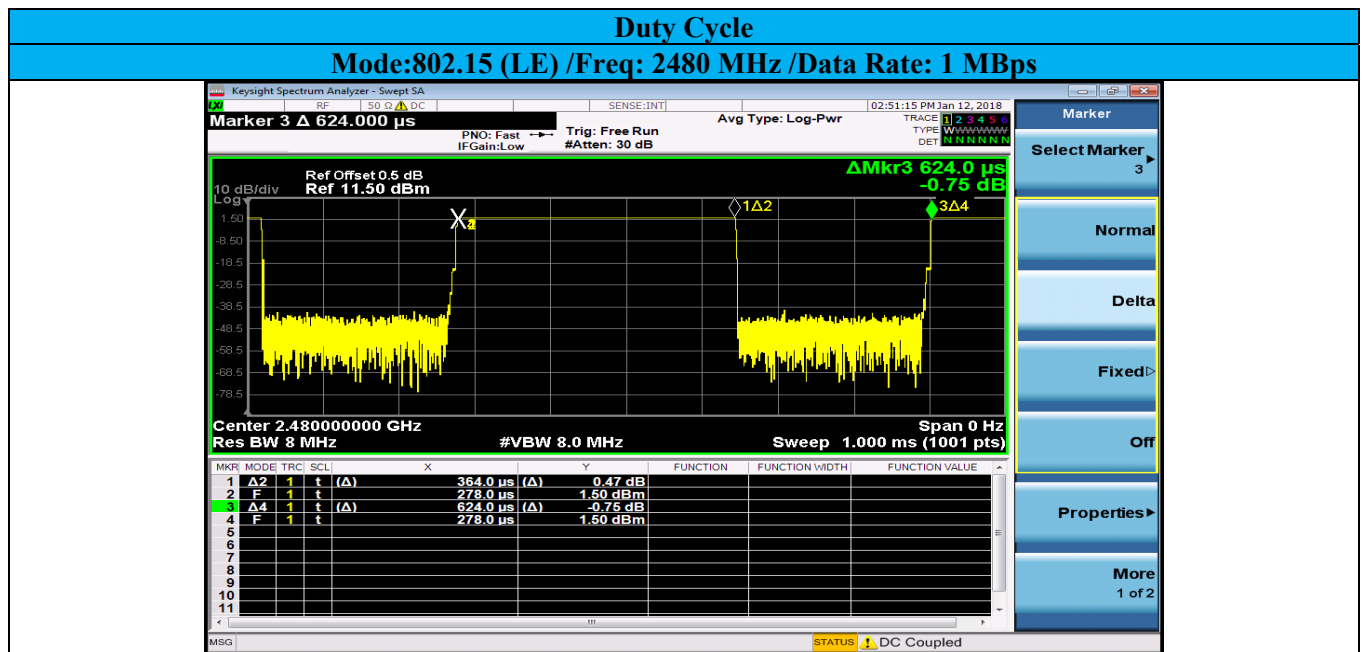
$$DCCF = 10 \log (1 / (TX_{on} / TX_{on} + TX_{off}))$$

$$DC \% = (TX_{on} / TX_{on} + TX_{off}) * 100$$

A.1.2 Duty Cycle Data Table

Mode	Data Rate	On-time (ms)	Total on+off Time (ms)	Duty Cycle (%)	Correction Factor (dB)
802.15 (LE)	1	0.364	0.624	58.3	2.34

A.1.3 Duty Cycle Graphical Test results



Tested By: Farida Rahmanzai	Date of testing: 12-Jan-20178
Test Result : PASS	

A.2 99% and 6dB 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 6 dB emission bandwidth is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated 6 dB below the maximum in-band spectral density of the modulated signal.

A.2.1 Limit

FCC 15.247(a) (2); RSS-247 5.2 (a)

The minimum 6 dB bandwidth shall be at least 500 kHz.

A.2.2 Test Procedure

Ref. KDB 558074 DTS Meas Guidance v4 section 8.1 Option 2 / RSS-Gen issue 4 section 6.6

99% BW and EBW (6dB)

Test Procedure

1. The radio is configured in the continuous transmitting mode.
2. Allow the trace to stabilize.
3. Setting the x-dB bandwidth mode to -6dB and OBW power function 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.

99% BW and EBW (6dB)

Test parameters

Span =Wide enough to capture the entire emission bandwidth
RBW =100 kHz
VBW $\geq 3 \times$ RBW
Detector =Peak
Trace = Max. Hold
Sweep = Auto couple

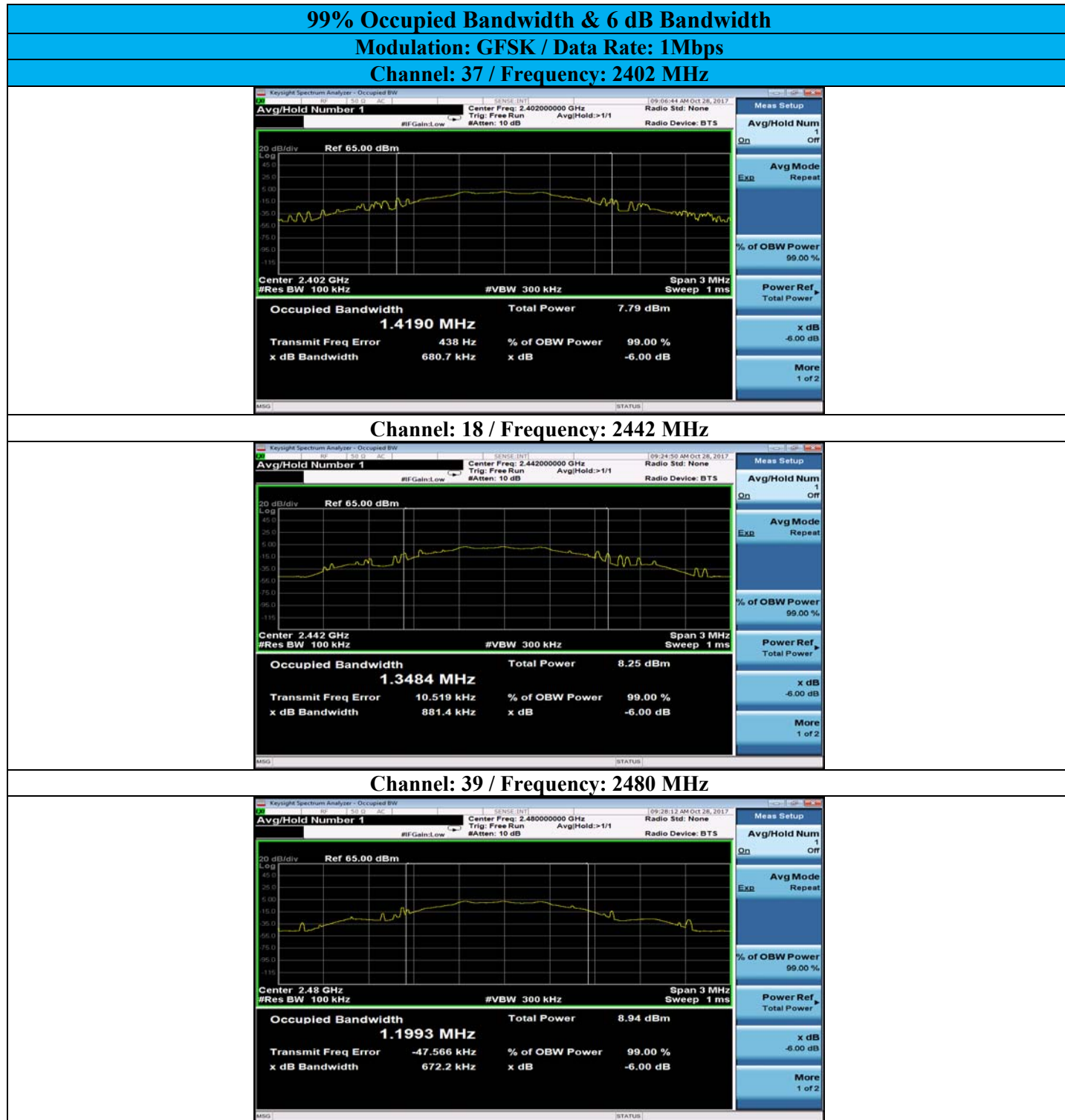


A.2.3 99% and 6dB Occupied Bandwidth Data Table

99% and 6dB Bandwidth							
Frequency (MHz)	Data Rate (Mbps)	Ant. Port0 99% BW (MHz)	Ant. Port0 6dB BW (MHz)	Ant. Port1 99% BW (MHz)	Ant. Port1 6dB BW (MHz)	Limit 6dB BW (kHz)	Result
Mode: 802.15 (BTLE)							
2402	1	1.419	0.681	-----	-----	≥ 500	Pass
2442	1	1.348	0.881	-----	-----	≥ 500	Pass
2480	1	1.199	0.672	-----	-----	≥ 500	Pass

Tested By: Danh Le	Date of testing: 28-Oct-2017
Test Result : PASS	

A.2.4 99% & 6dB Occupied Bandwidth Graphical Test Results



A.3 Maximum Conducted Output power

A.3.1 Limits

FCC15.247 (b) (3): The maximum conducted output power of the intentional radiator for systems using digital modulation in the 2400-2483.5MHz 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 5.4 (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).

A.3.2 Test Procedure

Ref. KDB 558074 DTS Meas Guidance v4 section 9.1 / Method 9.1.1

Max. Conducted Output Power

Test Procedure

- | |
|--|
| <ol style="list-style-type: none">1. Set the radio in the transmitting mode.2. Center frequency of interest.3. Allow trace to fully stabilize.4. Use peak marker function to determine the peak amplitude of emission level.5. Capture graphs and record pertinent measurement data. |
|--|

Test parameters

<p>Span ≥ 3 times the RBW RBW ≥ 1 DTS Bandwidth VBW $\geq 3 \times$ RBW Detector = Peak Trace mode \geq Max. Hold Sweep = Auto Sweep Points $\geq 2 \times$ span/ RBW.</p>



A.3.3 Maximum Output Power Recorded Test Data:

Maximum Conducted Output Power								
Mode: 802.15 (BTLE) / Modulation: GFSK / Date Rate: 1Mbps								
Antenna Gain = 1.24 dBi								
Frequency (MHz)	Data Rate (Mbps)	Ant. Port0 Max. Conducted Output Power (dBm)	Ant. Port1 Max. Conducted Output Power (dBm)	Total Power Ant.P0+Ant.P1 (mW) / (dBm)		Total EIRP = Total Power + Ant.G (dBm)	Conducted Limit (dBm)	EIRP Limit (dBm)
2402	1	0.965	-----	-----	-----	2.205	30	36
2442	1	1.469	-----	-----	-----	2.709	30	36
2480	1	2.304	-----	-----	-----	3.544	30	36
								Result: Pass

A.3.4 Maximum Output Power Graphical Test Results

Maximum Conducted Output Power

Modulation: GFSK / Data Rate: 1Mbps

Channel: 0 / Frequency: 2402 MHz



Channel: 18 / Frequency: 2442 MHz



Channel: 39 / Frequency: 2480 MHz



A.4 Power Spectral Density

The Power Spectral Density is the total energy output per unit bandwidth from a pulse or sequence of pulses for which the transmit power is at its maximum level, divided by the total duration of the pulses, This total time does not include the time between pulses during which the transmit power is off or below its maximum level.

A.4.1 Limits

FCC 15.247(e)/ RSS-247 5.2(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.

A.4.2 Test Procedure

Ref. KDB 558074 DTS Meas Guidance v4 section 10.2

Power Spectral Density
Test Procedure
1. Set the radio in the continuous transmitting mode. 2. Set Analyzer center frequency to DTS channel center frequency. 3. Allow trace to fully stabilize. 4. Use peak marker function to determine the peak amplitude of emission level. 5. If measured value exceeds limit, reduce RBW (no less than 3kHz) and repeat. 6. Capture graphs and record pertinent measurement data

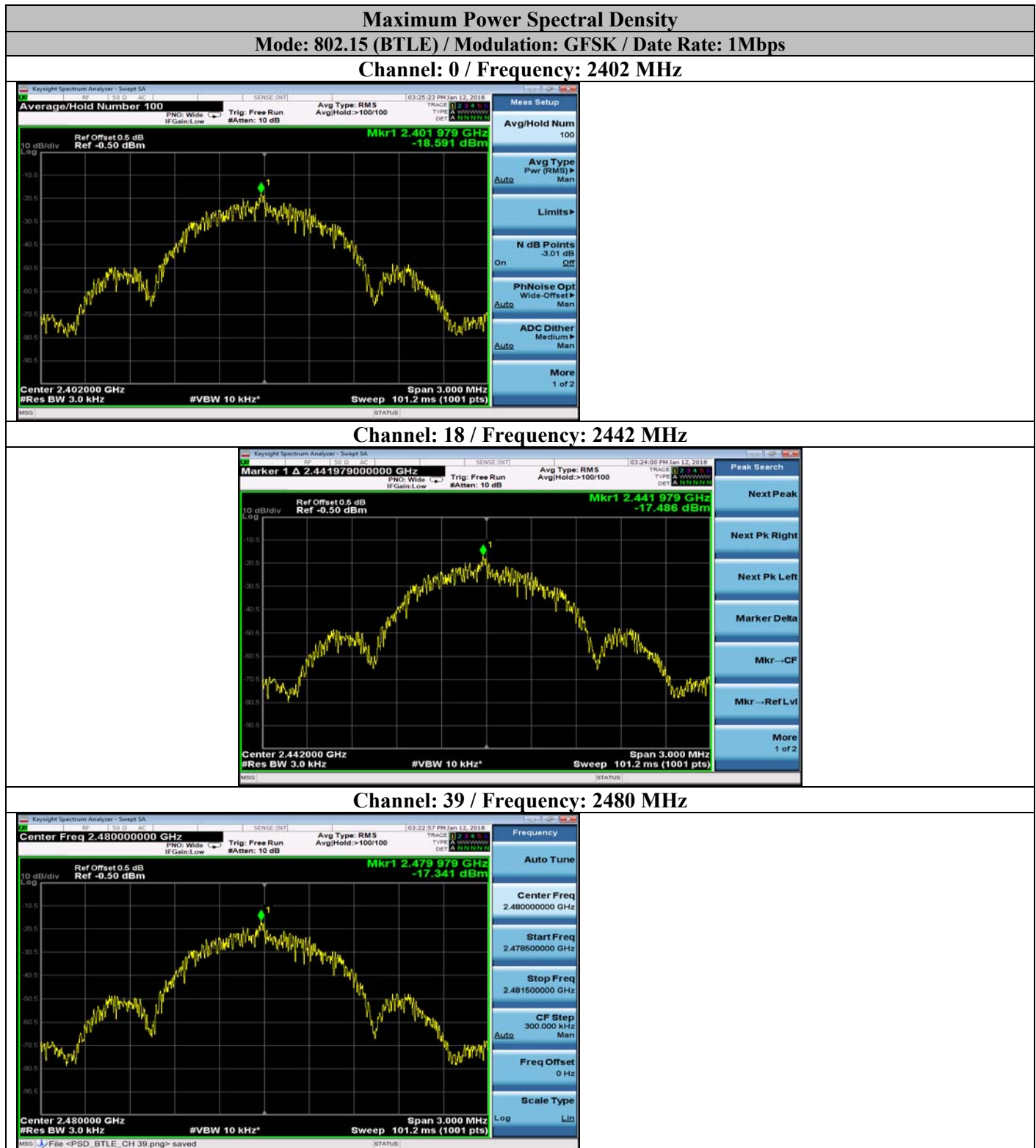
Power Spectral Density
Test parameters
Span ≥ 1.5 times the OBW RBW ≥ 3 kHz VBW $\geq 3 \times$ RBW Detector = Peak Trace mode = Max. Hold Sweep time \geq auto



A.4.3 Power Spectral Density Test Data:

Power Spectral Density								
Mode: 802.15 (BTLE) / Modulation: GFSK / Data Rate: 1Mbps								
Antenna Gain = 1.24 dBi								
Frequency (MHz)	Data Rate (Mbps)	Ant. Port0 Max. Conducted Output Power (dBm)	Ant. Port1 Max. Conducted Output Power (dBm)	Total Power Ant.P0+Ant.P1 (mW) / (dBm)		Total EIRP = Total Power + Ant.G (dBm)	Conducted Limit (dBm)	EIRP Limit (dBm)
2402	1	-18.59	-----	-----	-----	-17.35	30	36
2442	1	-17.49	-----	-----	-----	-16.25	30	36
2480	1	-17.34	-----	-----	-----	-16.11	30	36
Result: Pass								

A.4.4 Power Spectral Density Graphical Test Results:



A.5 Conducted Band Edge

A.5.1 Limits

FCC 15.247(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. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in FCC§15.209(a).

RSS-247 5.5

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 radiated measurement, provided that the transmitter demonstrates compliance with 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 attention required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

A.5.2 Test Procedure

Ref. KDB 558074 DTS Meas Guidance v4 section 11.1 (a) / Test Method section 11.2

Reference Level Measurement
Test Procedure
1. If maximum conducted (peak) output power was used to demonstrate compliance as described in A.3, then the peak power in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz (i.e., 20 dBc).
2. The radio is configured in the continuous transmitting mode.
3. Allow trace to fully stabilize. Use peak search marker function to determine the maximum PSD level.
Emission Level Measurement
Test Procedure
4. Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) are attenuated by at least the minimum requirements specified in 11.1 a) or 11.1 b).
5. Capture the transmitter waveforms on the spectrum analyzer, and record the pertinent measurements data.



Ref. KDB 558074 DTS Meas Guidance v4 section 11.2

Reference Level Measurement & Emission Level Measurement

Test parameters

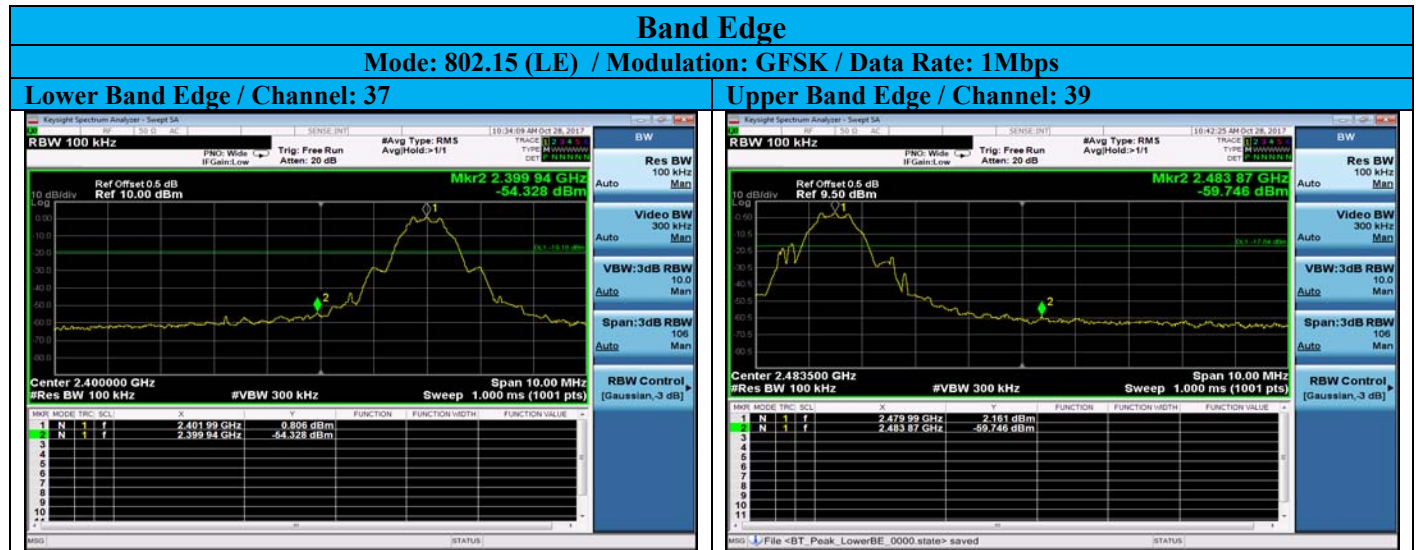
Span ≥ 1.5 times the DTS bandwidth RBW ≥ 100 kHz VBW $\geq 3 \times$ RBW Detector = Peak Sweep = Auto Trace Mode = Max. Hold

A.5.3 Band Edge Recorded Test Data:

802.15 (LE) Band Edge						
Operating Frequency (MHz)	Data Rate (Mbps)	Ant. Port0 Power Level @Band Edge (dBm)	Ant. Port1 Power Level @Band Edge (dBm)	Limit -20dBc Ant. P0 / Ant. P1 (dBm)		Results
Lower Band Edge Average Test Results						
2402	1	-53.19	-----	-19.18	-----	Pass
Upper Band Edge Average Test Results						
2480	1	-58.55	-----	-17.84	-----	Pass

Note: correction factors (ext. attenuation + cable loss) are compensated in the offset function of the Spectrum Analyzer.

A.5.4 Band Edge Graphical Test Results:



A.6 Restricted Bands

A.6.1 Limits

FCC 15.205/ 15.247(d): Radiated emissions which fall in the restricted bands, as defined in FCC §15.205(a), must also comply with the radiated emission limits specified in Sec. 15.209(a).

RSS-Gen 8.10: Except where otherwise indicated, the following restrictions apply:

- (a) Fundamental components of modulation of licence-exempt radio apparatus shall not fall within the restricted bands of Table 6 except for apparatus complying under RSS-287;
- (b) Unwanted emissions that fall into restricted bands of Table 6 shall comply with the limits specified in RSS-Gen; and
- (c) Unwanted emissions that do not fall within the restricted frequency bands of Table 6 shall comply either with the limits specified in the applicable RSS or with those specified in this RSS-Gen.

Restricted Bands Table			
MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
10.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	Above 38.6
13.36-13.41			

**Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz

A.6.2 Test Procedure

Ref. KDB 558074 DTS Meas Guidance v4 section12.2.4 / 12.2.5.1

Test Procedure
1. The radio is configured in the continuous transmitting mode. 2. Allow trace to fully stabilize. 3. Use marker peak search function to determine the maximum emissions amplitude within the restricted band. 4. Capture the transmitter waveforms on the spectrum analyzer, and record pertinent measurement data.

Ref. KDB 558074 DTS Meas Guidance v4 section12.2.4

Restricted Bands Peak Measurement
Test parameters Span = Enough to capture the full restricted band of interest RBW= 1 MHz VBW $\geq 3 \times$ RBW Detector= Peak Trace Mode= Max. Hold Sweep time= Auto

Ref. KDB 558074 DTS Meas Guidance v4 section12.2.5.1

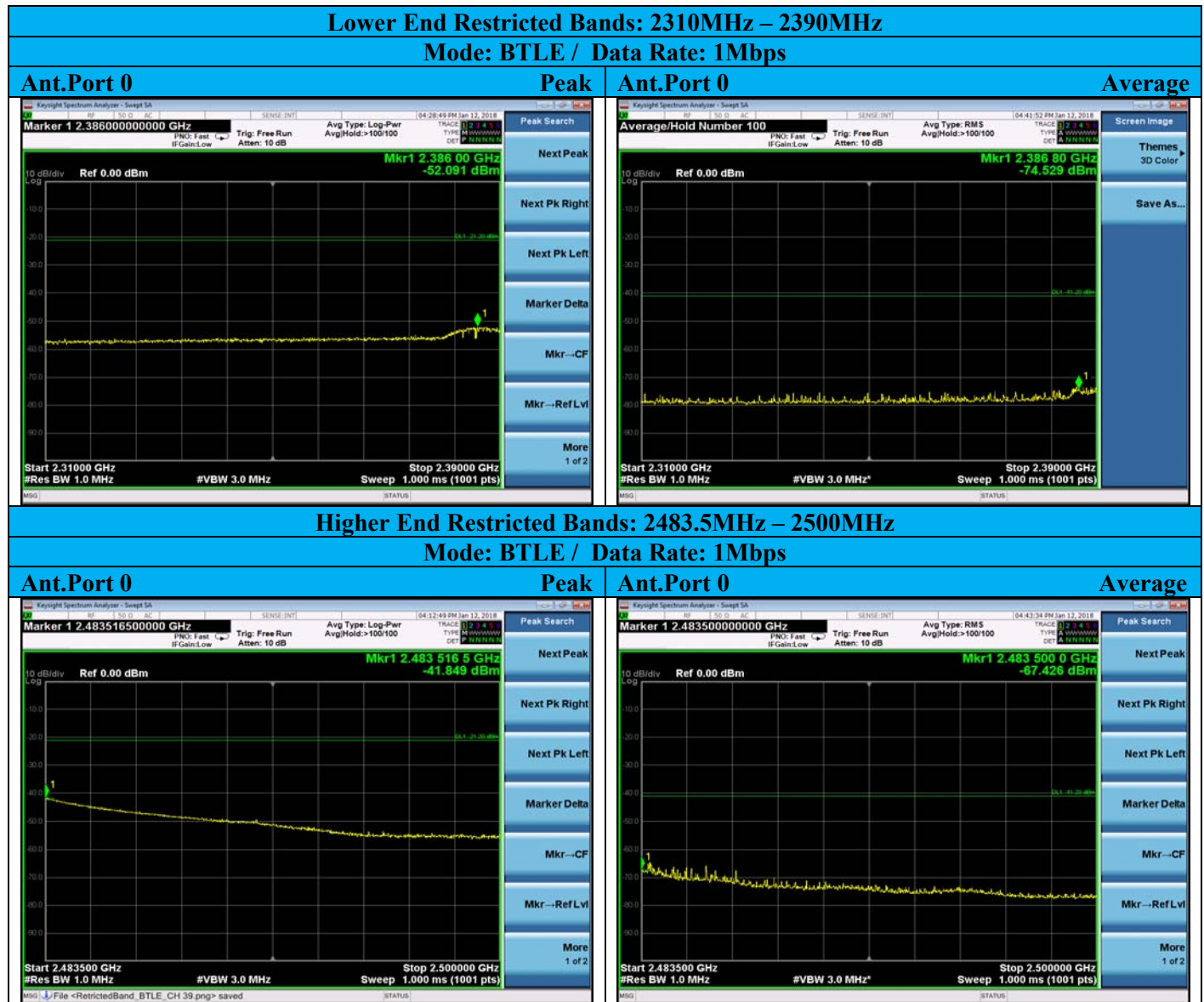
Restricted Bands Average Measurement
Test parameters Span = Enough to capture the full restricted band of interest RBW = 1 MHz VBW $\geq 3 \times$ RBW Detector = RMS Averaging Type = Power average (RMS) Trace Average ≥ 100 Sweep time = Auto
Allow trace to fully stabilize. Use marker peak search function to determine the maximum emissions amplitude within the restricted band. Record data.



A.6.3 Restricted Bands Recorded Test Data:

802.15 (BTLE) Restricted Bands Test Results									
Mode: 802.15 (BTLE)/ Antenna Gain = 1.24 dBi									
Frequency	Data Rate	Restricted Bands	Ant. Port0 Max. Power Level	Ant. Port1 Max. Power Level	Total Power Ant.P0+Ant.P1		EIRP	Limit	Result
(MHz)	(Mbps)	(MHz)	(dBm)	(dBm)	(mW) / (dBm)		(dBm)	(dBm)	
2402	1	2310–2390	-52.09	-----	-----	-----	-50.85	-21.2	Pass
2402	1	2310–2390	-74.53	-----	-----	-----	-73.29	-41.2	Pass
2480	1	2483.5-2500	-41.85	-----	-----	-----	-40.61	-21.2	Pass
2480	1	2483.5-2500	-67.43	-----	-----	-----	-66.19	-41.2	Pass

A.6.4 Restricted Bands Graphical Test Results:



Appendix B: Radiated Test Results

B.1 Transmitter Radiated Spurious Emissions & Restricted Bands

Emissions on a frequency or frequencies which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out-of-band emissions.

FCC 15.209: The level of any unwanted emissions from an intentional radiator operating under these general provisions shall not exceed the level of the fundamental emission. Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the table specified in the table in FCC§15.209(a).

RSS-Gen 6.13: In measuring unwanted emissions, the spectrum shall be investigated from 30 MHz or the lowest radio frequency signal generated in the equipment, whichever is lower, without going below 9 kHz, up to at least the frequency given below:

- (a) If the equipment operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.
- (b) If the equipment operates at or above 10 GHz: to the fifth harmonic of the highest fundamental frequency or to 100 GHz, whichever is lower.

Restricted Bands

FCC15.247 (d)

FCC: In addition, radiated emissions which fall in the restricted bands, as defined in FCC §15.205(a), must also comply with the radiated emission limits specified in Sec. 15.209(a).

FCC15.205

FCC: Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the field strength limits table in this section. In addition, radiated emissions which fall in the restricted bands as defined in FCC §15.205(a), must also comply with the radiated emission limits specified in Sec. 15.209(a).

FCC Restricted Bands Table			
MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	Above 38.6
13.36-13.41			

RSS-Gen 8.10 (b) Unwanted emissions that fall into restricted bands of [Table 6](#) shall comply with the limits specified in RSS-Gen; and **(c)** Unwanted emissions that do not fall within the restricted frequency bands of [Table 6](#) shall comply either with the limits specified in the applicable RSS or with those specified in this RSS-Gen.

Table 6

RSS-Gen Restricted Bands Table		
MHz	MHz	GHz
0.090-0.110	74.8-75.2	9.0-9.2
2.1735-2.1905	108-138	9.3-9.5
3.020-3.026	156.52475-156.52525	10.6-12.7
4.125-4.128	156.7-156.9	13.25-13.4
4.17725-4.17775	240-285	14.47-14.5
4.20725-4.20775	322-335.4	15.35-16.2
5.677-5.683	399.9-410	17.7-21.4
6.215-6.218	608-614	22.01-23.12
6.26775-6.26825	960-1427	23.6-24.0
6.31175-6.31225	1435-1626.5	31.2-31.8
8.291-8.294	1645.5-1646.5	36.43-36.5
8.362-8.366	1660-1710	Above 38.6
8.37625-8.38675	1718.8-1722.2	*
8.41425-8.41475	2200-2300	
12.29-12.293	2310-2390	
12.51975-12.52025	2655-2900	
12.57675-12.57725	3260-3267	
13.36-13.41	3332-3339	
16.42-16.423	3345.8-3358	
16.69475-16.69525	3500-4400	
16.80425-16.80475	4500-5150	
25.5-25.67	5350-5460	
37.5-38.25	7250-7750	
73-74.6	8025-8500	

B.1.1 Limits

FCC 15.209; RSS-Gen 8.9 Issue 4

FCC 15.209: The level of any unwanted emissions from an intentional radiator operating under these general provisions shall not exceed the level of the fundamental emission. Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the table specified in the table in FCC§15.209(a).

RSS-Gen 8.9: Except when the requirements applicable to a given device state otherwise, emissions from licence-exempt transmitters shall comply with the field strength limits shown in Table 4 or Table 5. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.

Frequency (MHz)	Field strength (uV/meter)	Field strength (dBuV/meter)	Measurement distance (meters)
30-88	100**	40 Qp	3
88-216	150**	43.5 Qp	3
216-960	200**	46 Qp	3
Above 960	500	54 Av / 74 Pk	3

**Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§15.231 and 15.241.

The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

B.1.2 Test Procedure

Ref. C63.10-2013 section 6.5 & 6.6

Test Procedure

1. Using Vasona software, configure the spectrum analyzer as shown below (be sure to enter all losses between the transmitter output and the spectrum analyzer).
2. Place the radio in continuous transmit mode. Maximize Turntable (find worst case table angle) and maximize Antenna (find worst case height).
3. Use the peak marker function to determine the maximum amplitude level.
4. Center marker frequency and perform final measurement in Quasi-peak (≤ 1 GHz) and Average (above 1 GHz)
4. Record at least 6 highest readings for the worst case operating mode.

Ref. C63.10-2013 section 4 / CISPR16-1-1

Test Parameters

Span = Entire frequency range or segment if necessary.
Reference Level = 80 dBuV
RBW = 100 kHz (less than or equal to 1 GHz); 1 MHz (above 1 GHz)
VBW $\geq 3 \times$ RBW
Detector = Peak & Quasi-Peak (frequency range 30 MHz to 1 GHz);
 Peak & Average (frequency range above 1 GHz);
 Changing VBW to 10 Hz for average measurement
Sweep Time = Couple

. These data represent the worst case mode data for all supported operating modes and antennas.

- For emissions below 1000 MHz, measurements shall be performed using a CISPR quasi-peak detector and the related measurement bandwidth. As an alternative to CISPR quasi-peak measurement, compliance with the emission limit can be demonstrated using measuring equipment employing a peak detector function properly adjusted for factors such as pulse desensitization as required, with an equal or greater measurement bandwidth relative to the applicable CISPR quasi-peak bandwidth.
- Above 1000 MHz, measurements shall be performed using an average detector with a minimum resolution bandwidth of 1 MHz.

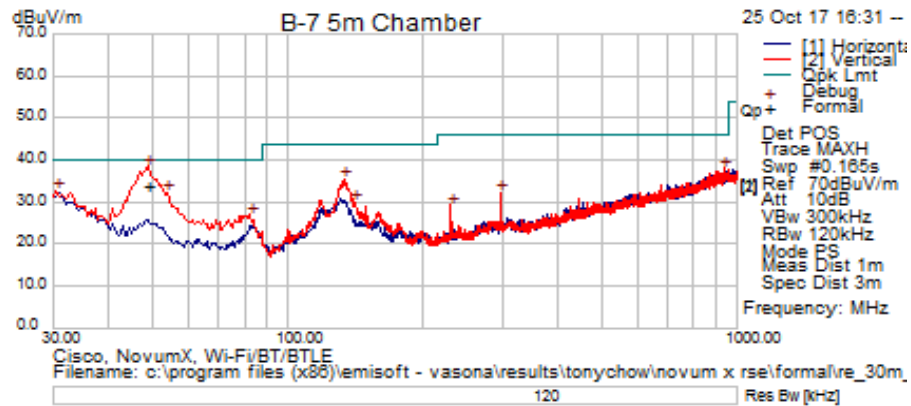
Note1: 10 dB external attenuator was used during formal testing from 1 – 18GHz to help prevent the front end of the analyzer from over loading. The corrected levels were compensated by adding 10 dB to the raw data.

Note2: The data displayed on the plots detailed in this appendix were measured using a 'Peak Detector'. Please refer to the results table for the detectors used during formal measurements

B.1.3 TX Spurious Emissions Test Data and Graphical Test Results

TX Spurious Emissions Test Result Tables for 802.15 (BTLE)

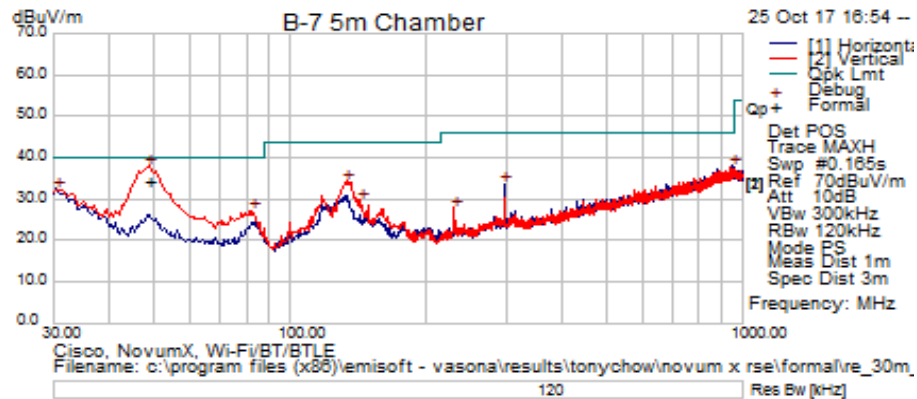
Subtest Date:	25-Oct-2017
Engineer	Danh Le, Zain Ali
Lab Information	Building 7, 5m Anechoic
Subtest Title	Transmitter Spurious Emissions
Frequency Range	30MHz - 1GHz
Comments on the above Test Results	TX Channel 37 (2402 MHz), 802.15 BTLE/ GFSK modulation – 1 Mbps



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
48.538	34.18	0.77	-1.06	33.89	Quasi Max	V	152	329	40	-6.11	48.538	TX / Ch 37



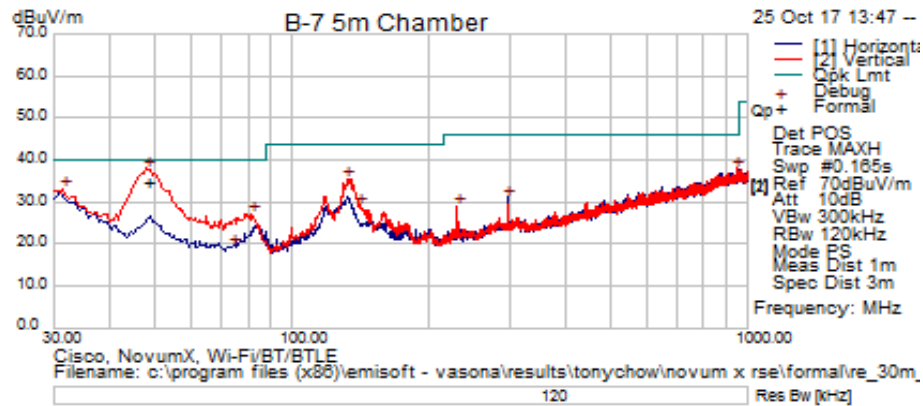
Subtest Date:	25-Oct-2017
Engineer	Danh Le, Zain Ali
Lab Information	Building 7, 5m Anechoic
Subtest Title	Transmitter Spurious Emissions
Frequency Range	30MHz - 1GHz
Comments on the above Test Results	TX Channel 18 (2442 MHz), 802.15 BTLE – 1 Mbps



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
48.839	34.92	0.77	-1.18	34.52	Quasi Max	V	147	357	40	-5.48	48.839	TX / Ch 18

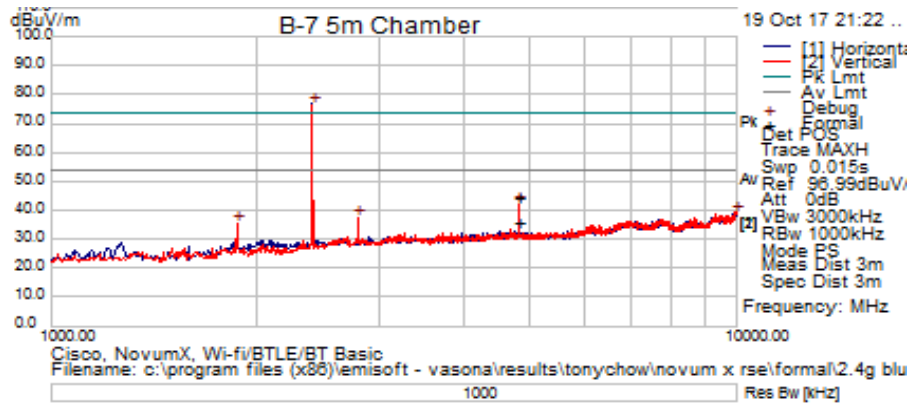


Subtest Date:	25-Oct-2017
Engineer	Danh Le, Zain Ali
Lab Information	Building 7, 5m Anechoic
Subtest Title	Transmitter Spurious Emissions
Frequency Range	30MHz - 1GHz
Comments on the above Test Results	TX Channel 39 (2480 MHz), 802.15 BTLE/ GFSK modulation – 1 Mbps



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
47.922	34.77	0.76	-0.8	34.74	Quasi Max	V	107	325	40	-5.26	47.922	TX / Ch 39

Subtest Date:	19-Oct-2017
Engineer	Danh Le, Zain Ali
Lab Information	Building 7, 5m Anechoic
Subtest Title	Transmitter Spurious Emissions
Frequency Range	1GHz-10GHz
Comments on the above Test Results	TX Channel 37 (2402 MHz), 802.15 BTLE/ GFSK modulation – 1 Mbps



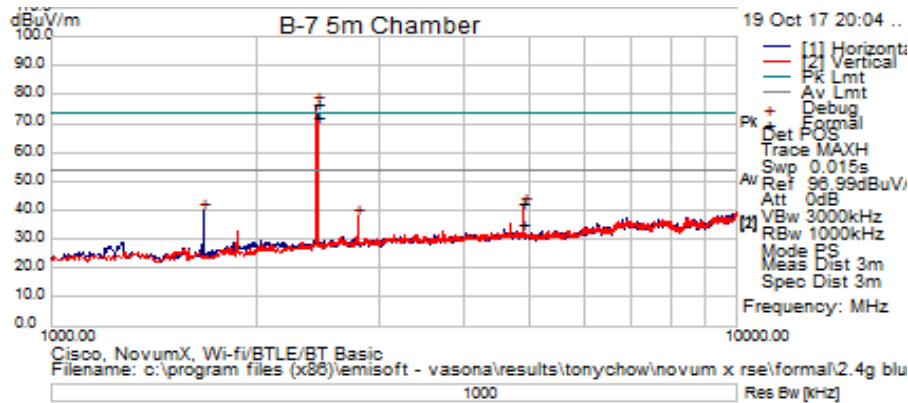
Title: TX Spurious Emissions from 1-10GHz – Ch37 (2402 MHz)

Frequency (MHz)	Raw (dBuV)	Cab Loss (dB)	AF (dB)	Level (dBuV)	Corrected Level +10dB (dBuV)	Detector	Polarity	Height (cm)	Azt (Deg)	Limit (dBuV)	Margin (dB)	Results Pass / Fail	Comments
2400.625	82.46	5.8	-11.39	76.87	86.87	Peak	H	200	197	N/A	N/A	Ignored	Fundamental
4802.5	42.55	8.53	-8.97	42.11	52.11	Peak	V	150	128	74	-21.89	Pass	2 nd harmonic
4804.305	36.31	8.53	-8.96	35.88	45.88	Average	V	165	126	54	-8.12	Pass	2 nd harmonic
2800	42.09	6.33	-10.78	37.65	47.65	Peak	V	200	187	54	-6.35	Pass	Tx/Ch 37
1866.25	42.79	5.05	-12.4	35.44	45.44	Peak	V	282	11	54	-8.56	Pass	Tx/Ch 37
9988.75	29.87	13.12	-3.94	39.06	49.06	Peak	H	150	333	54	-4.94	Pass	Tx/Ch 37

Note1: 10 dB external attenuator was added at the input port of the spectrum Analyzer to maintain at least 10 dB of headroom and prevent overloading. The corrected levels were compensated by adding 10 dB in the corrected level column above from the raw data.

Note2: Where limits are specified by regulations for both average and peak detection, if the maximized peak measured value complies with the average limit, then it is unnecessary to perform an average measurement

Subtest Date:	19-Oct-2017
Engineer	Danh Le, Zain Ali
Lab Information	Building 7, 5m Anechoic
Subtest Title	Transmitter Spurious Emissions
Frequency Range	1GHz-10GHz
Comments on the above Test Results	TX Channel 18 (2442 MHz), 802.15 BTLE/ GFSK modulation – 1 Mbps



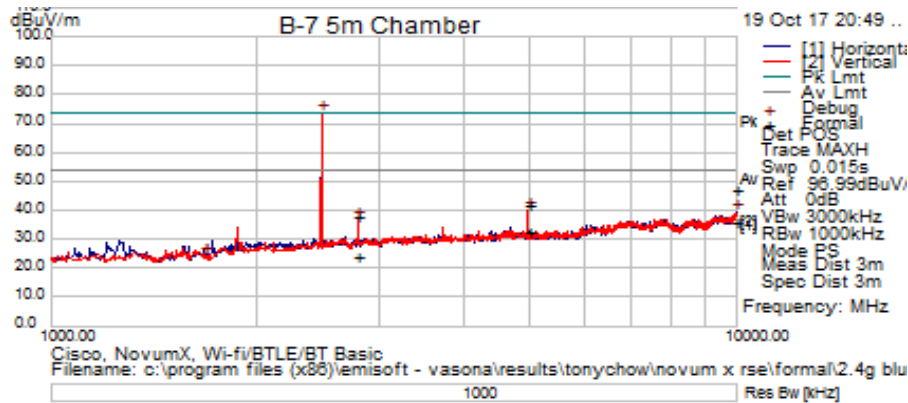
Title: TX Spurious Emissions from 1-10GHz – Ch18 (2442 MHz)

Frequency (MHz)	Raw (dBuV)	Cab Loss (dB)	AF (dB)	Level (dBuV)	Corrected Level +10dB (dBuV)	Detector	Polarity	Height (cm)	Azt (Deg)	Limit (dBuV)	Margin (dB)	Results Pass / Fail	Comments
2440	81.53	5.85	-10.98	76.4	86.4	Peak	H	100	155	N/A	N/A	Ignored	Fundamental
4886.875	42.04	8.61	-9.13	41.53	51.53	Peak	V	150	125	54	-2.47	Pass	2 nd harmonic
1669.375	49.65	4.77	-14.63	39.79	49.79	Peak	H	100	51	54	-4.21	Pass	Tx/Ch 18
10000	30.39	13.14	-3.98	39.56	49.56	Peak	H	100	8	54	-4.44	Pass	Tx/Ch 18
2800	42.37	6.33	-10.78	37.92	47.92	Peak	V	200	192	54	-6.08	Pass	Tx/Ch 18

Note1: 10 dB external attenuator was added at the input port of the spectrum Analyzer to maintain at least 10 dB of headroom and prevent overloading. The corrected levels were compensated by adding 10 dB in the corrected level column above from the raw data.

Note2: Where limits are specified by regulations for both average and peak detection, if the maximized peak measured value complies with the average limit, then it is unnecessary to perform an average measurement

Subtest Date:	19-Oct-2017
Engineer	Danh Le, Zain Ali
Lab Information	Building 7, 5m Anechoic
Subtest Title	Transmitter Spurious Emissions
Frequency Range	1GHz-10GHz
Comments on the above Test Results	TX Channel 39 (2480 MHz), 802.15 BTLE/ GFSK modulation – 1 Mbps



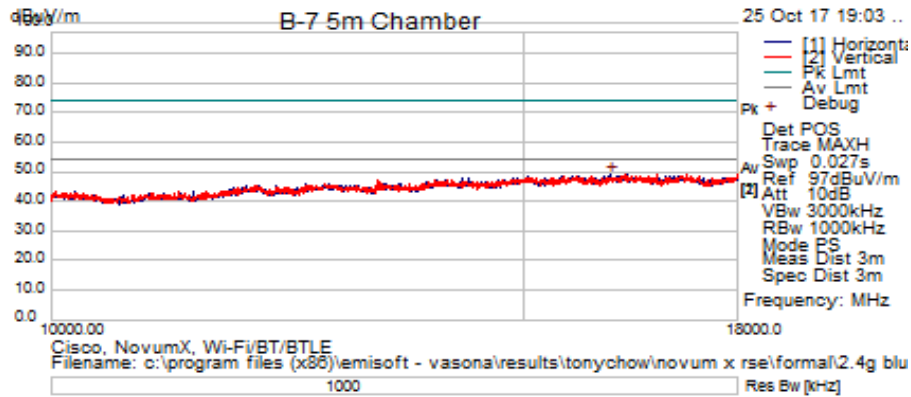
Title: TX Spurious Emissions from 1-10GHz – Ch39 (2480 MHz)

Frequency (MHz)	Raw (dBuV)	Cab Loss (dB)	AF (dB)	Level (dBuV)	Corrected Level +10dB (dBuV)	Detector	Polarity	Height (cm)	Azt (Deg)	Limit (dBuV)	Margin (dB)	Results Pass / Fail	Comments
2479.375	78.72	5.92	-10.82	73.82	83.82	Peak	H	100	189	N/A	N/A	Ignored	Fundamental
4960	40.36	8.72	-8.91	40.17	50.17	Peak	V	200	124	54	-3.83	Pass	2 nd harmonic
9994.375	30.3	13.13	-3.96	39.47	49.47	Peak	V	200	118	54	-4.53	Pass	Tx/Ch 39
2800	41.51	6.33	-10.78	37.07	47.07	Peak	V	200	180	54	-6.93	Pass	Tx/Ch 39
1680.738	34.11	4.78	-14.35	24.53	34.53	Peak	V	271	170	54	-19.47	Pass	Tx/Ch 39
1680.738	34.11	4.78	-14.35	24.53	34.53	Peak	V	271	170	54	-19.47	Pass	Tx/Ch 39

Note1: 10 dB external attenuator was added at the input port of the spectrum Analyzer to maintain at least 10 dB of headroom and prevent overloading. The corrected levels were compensated by adding 10 dB in the corrected level column above from the raw data.

Note2: Where limits are specified by regulations for both average and peak detection, if the maximized peak measured value complies with the average limit, then it is unnecessary to perform an average measurement.

Subtest Date:	25-Oct-2017
Engineer	Danh Le, Zain Ali
Lab Information	Building 7, 5m Anechoic
Subtest Title	Transmitter Spurious Emissions
Frequency Range	10GHz - 18GHz
Comments on the above Test Results	TX Channel 37 (2402 MHz), 802.15 BTLE/ GFSK modulation – 1 Mbps



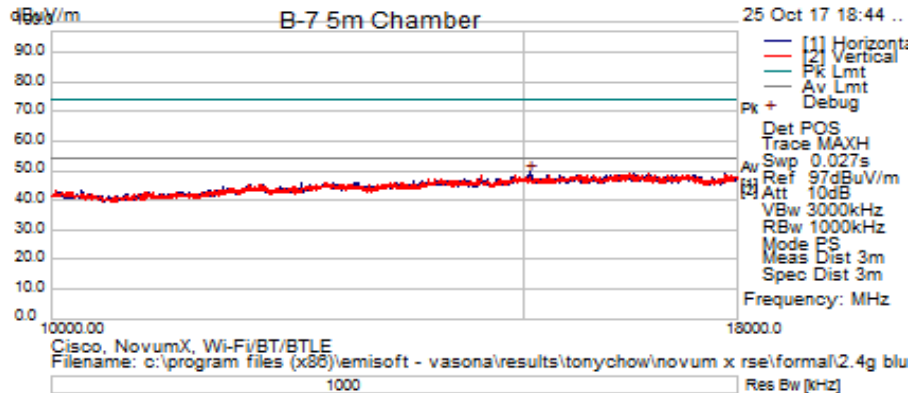
Title: TX Spurious Emissions from 10-18GHz – Ch37 (2402 MHz) – Peak Trace

Legend: — 74dBμV/m (Peak); — 54 dBμV/m (Average)

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
16135	44.09	17.57	-12.37	49.29	Peak [Scan]	H	350	177	54	-4.71	Pass	TX / Ch 37



Subtest Date:	25-Oct-2017
Engineer	Danh Le, Zain Ali
Lab Information	Building 7, 5m Anechoic
Subtest Title	Transmitter Spurious Emissions
Frequency Range	10GHz - 18GHz
Comments on the above Test Results	TX Channel 18 (2442 MHz), 802.15 BTLE/ GFSK modulation – 1 Mbps

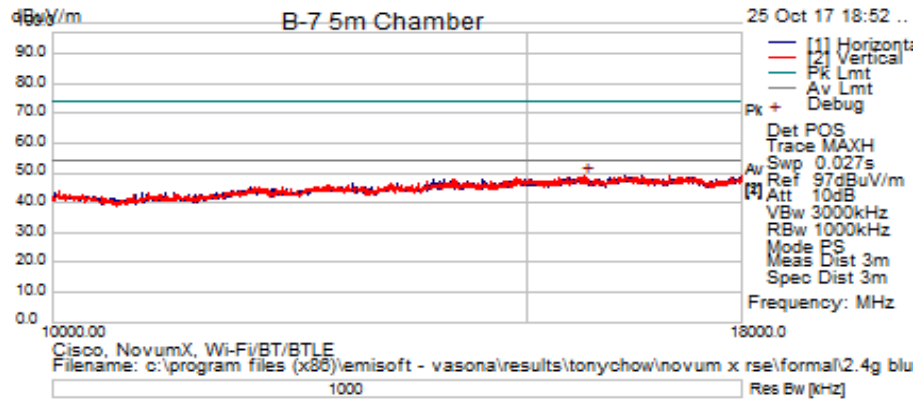


Title: TX Spurious Emissions from 10-18GHz – Ch18 (2442 MHz) – Peak Trace

Legend: — 74dB μ V/m (Peak); — 54 dB μ V/m (Average)

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
15065	45.65	16.97	-13.17	49.45	Peak	H	400	9	54	-4.55	Pass	TX / Ch 18

Subtest Date:	25-Oct-2017
Engineer	Danh Le, Zain Ali
Lab Information	Building 7, 5m Anechoic
Subtest Title	Transmitter Spurious Emissions
Frequency Range	10GHz - 18GHz
Comments on the above Test Results	TX Channel 39 (2480 MHz), 802.15 BTLE/ GFSK modulation – 1 Mbps

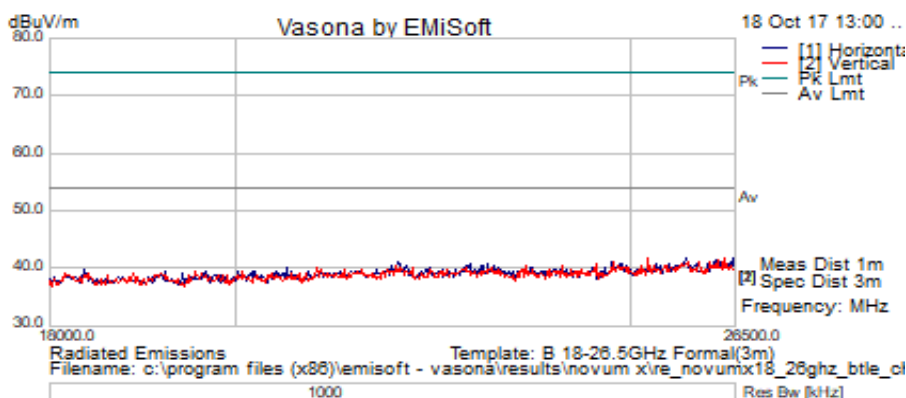


Title: TX Spurious Emissions from 10-18GHz – Ch39 (2480 MHz) – Peak Trace

Legend: — 74dBμV/m (Peak); — 54 dBμV/m (Average)

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
15745	44.51	17.51	-12.85	49.17	Peak	V	400	4	54	-4.83	Pass	TX / Ch 39

Subtest Date:	18-Oct-2017
Engineer	Danh Le, Zain Ali
Lab Information	Building 7, 5m Anechoic
Subtest Title	Transmitter Spurious Emissions
Frequency Range	18GHz - 26GHz
Comments on the above Test Results	TX Channel 18 (2442 MHz), 802.15 BTLE/ GFSK modulation – 1 Mbps



Title: TX Spurious Emissions from 10-18GHz – Ch18 (2442 MHz)

Legend: — 74dBuV/m (Peak); — 54 dBuV/m (Average);

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
26465.931	32.74	0	9.13	41.86	Peak	H	100	0	54	-12.14	Pass	TX / Ch18

B.2 AC Conducted Emissions

B.2.1 Limits.

FCC 15.207 / RSS-Gen 8.8 issue4

FCC 15.207

(a) Except as shown in paragraphs (b) and (c) of this section, 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 μ H/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.

RSS-Gen 8.8

A radio apparatus that is designed to be connected to the public utility (AC) power line shall ensure that the radio frequency voltage, which is conducted back onto the AC power line on any frequency or frequencies within the band 0.15 MHz to 30 MHz shall not exceed the limits in Table 3 shown in this section.

Frequency of Emission (MHz)	Conducted Limits	
	Quasi-Peak	Average
0.15 – 0.5	66 to 56*	56 to 46*
0.5 – 5	56	46
5 – 30	60	50

*Decreases with the logarithm of the frequency

B.2.2 Test Procedure

Ref: C63.10:2013, section 6.2.2

Section 6.2.2 Measurement requirements

Measured levels of ac power-line conducted emission shall be the emission voltages from the voltage probe or across the 50 Ω LISN port (to which the EUT is connected), where permitted, terminated into a 50 Ω measuring instrument, or where permitted or required, the emission currents on the power line sensed by a current probe. All emission voltage and current measurements shall be made on each current-carrying conductor at the plug end of the EUT power cord by the use of mating plugs and receptacles on the LISN, if used. Equipment shall be tested with power cords that are normally supplied or recommended by the manufacturer, and that have electrical and shielding characteristics that are the same as those cords normally supplied or recommended by the manufacturer. For those measurements, using a LISN, the 50 Ω measuring port is terminated by a measuring instrument having a 50 Ω input impedance. All other ports are terminated in 50 Ω loads. Figure 5, Figure 6, and Figure 7 show typical test setups for ac power-line conducted emissions testing (see 6.13). For information about the use of a RF-shielded (screen) room, vertical conducting plane and voltage probe, see ANSI C63.4.

Tabletop devices shall be placed on a platform of nominal size, 1 m by 1.5 m, raised 80 cm above the reference ground plane. The vertical conducting plane or wall of an RF-shielded (screen) room shall be located 40 cm to the rear of the EUT. Floor-standing devices shall be placed either directly on the reference ground-plane or on insulating material as described in ANSI C63.4. All other surfaces of tabletop or floor standing EUTs shall be at least 80 cm from any other grounded conducting surface, including the case or cases of one or more LISNs.

Section 6.2.5 Final ac power-line conducted emission measurements

Based on the exploratory tests of the EUT performed in 6.2.4, the one EUT cable configuration and arrangement and mode of operation that produced the emission with the highest amplitude relative to the limit is selected for the final measurement, while applying the appropriate modulating signal to the EUT. If the EUT is relocated from an exploratory test site to a final test site, the highest emissions shall be remaximized at the final test location before final ac power-line conducted emission measurements are performed. The final test on all current-carrying conductors of all of the power cords to the equipment that comprises the EUT (but not the cords associated with other non-EUT equipment in the system) is then performed for the full frequency range for which the EUT is being tested for compliance without further variation of the EUT arrangement, cable positions, or EUT mode of operation. If the EUT is comprised of equipment units that have their own separate ac power connections, e.g., floor-standing equipment with independent power cords for each shelf that are able to connect directly to the ac power network, each current-carrying conductor of one unit is measured while the other units are connected to a second (or more) LISN(s). All units shall be separately measured. If a power strip is provided by the manufacturer, to supply all of the units making up the EUT, only the conductors in the power cord of the power strip shall be measured.

Record the six highest EUT emissions relative to the limit of each of the current-carrying conductors of the power cords of the equipment that comprises the EUT over the frequency range specified by the procuring or regulatory agency.

Ref. C63.10:2013, section 6.2

Test Procedure

- | |
|---|
| <ol style="list-style-type: none">1. Using Vasona software, configure the spectrum analyzer as shown above (be sure to enter all losses between the transmitter output and the spectrum analyzer).2. Set the radio in continuous transmit mode.3. Connect cable end to LISN Hot port and other cable end to the spectrum Analyzer/EMC receiver RF input port. Terminate the LISN neutral port with a 50 Ω impedance terminator.4. Sweep the frequency range from 150 kHz to 30 MHz (segment if necessary)5. Use the peak marker function to determine the maximum amplitude level.6. Center marker frequency and perform final measurement using applicable detector (Quasi-Pk/Average).7. Record at least 6 highest reading for the worst case operating modes in Quasi-peak/Average.8. Repeat the test on Neutral lead.9. Repeat step 3 – 7 with the radio sets in the Receiver mode.10. Record at least 6 highest reading in Quasi-peak/Average |
|---|

Ref. C63.10-2013 section 4 / CISPR16-1-1

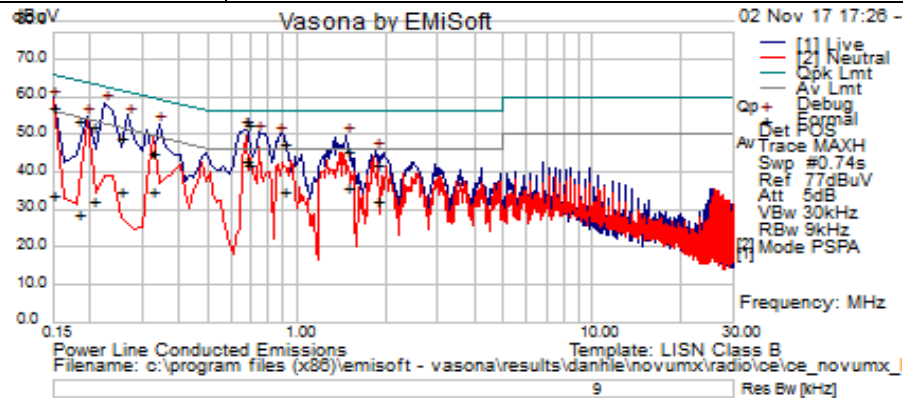
Test Parameters

Span = Entire frequency range or segment if necessary. Reference Level = 70 dBuV RBW = 9 kHz VBW $\geq 3 \times$ RBW Sweep Time = Couple Detector = Quasi-Peak & Average

B.2.3 AC Conducted Emissions Test Data and Graphical Test Results

Conducted Emissions Test Result Tables for BTLE (TX Ch18/ Quasi-Peak & Average)

Subtest Date:	02-Nov-2017
Engineer	Danh Le and Zain Ali
Lab Information	Building B, 3m Anechoic
Subtest Title	Conducted Emissions
Frequency Range	150 kHz - 30 MHz
Comments on the above Test Results	TX Channel 18 (2442 MHz), 802.15 BTLE/ GFSK modulation – 1 Mbps



Frequency (MHz)	Raw (dBuV)	Cab Loss (dB)	Factors (dB)	Level (dBuV)	Detector	Lines (Live/Neutral)	Limit (dBuV)	Margin (dB)	Results Pass / Fail	Comments
6.950796	29.62	20.12	0.12	49.86	Quasi Peak	Live	60	-10.14	Pass	TX / Ch18
4.881786	25.72	20.07	0.07	45.86	Quasi Peak	Live	56	-10.14	Pass	TX / Ch18
3.968877	25.42	20.05	0.09	45.55	Quasi Peak	Live	56	-10.45	Pass	TX / Ch18
0.758664	28.59	19.99	0.06	48.65	Quasi Peak	Live	56	-7.35	Pass	TX / Ch18
7.141203	27.92	20.12	0.11	48.16	Quasi Peak	Live	60	-11.84	Pass	TX / Ch18
3.852459	22.44	20.05	0.1	42.59	Quasi Peak	Live	56	-13.41	Pass	TX / Ch18
1.447629	26.78	19.98	0.06	46.82	Quasi Peak	Live	56	-9.18	Pass	TX / Ch18
5.01033	27.56	20.08	0.08	47.71	Quasi Peak	Live	60	-12.29	Pass	TX / Ch18
0.68034	28.1	19.99	0.05	48.15	Quasi Peak	Neutral	56	-7.85	Pass	TX / Ch18
3.939932	20.47	20.05	0.09	40.6	Quasi Peak	Neutral	56	-15.4	Pass	TX / Ch18
6.950796	7.34	20.12	0.12	27.58	Average	Live	50	-22.42	Pass	TX / Ch18
4.881786	12.16	20.07	0.07	32.31	Average	Live	46	-13.69	Pass	TX / Ch18
3.968877	3.49	20.05	0.09	23.63	Average	Live	46	-22.37	Pass	TX / Ch18
0.758664	17.19	19.99	0.06	37.25	Average	Live	46	-8.75	Pass	TX / Ch18
7.141203	6.04	20.12	0.11	26.28	Average	Live	50	-23.72	Pass	TX / Ch18
3.852459	3.38	20.05	0.1	23.53	Average	Live	46	-22.47	Pass	TX / Ch18
1.447629	16.76	19.98	0.06	36.8	Average	Live	46	-9.2	Pass	TX / Ch18
5.01033	4.28	20.08	0.08	24.44	Average	Live	50	-25.56	Pass	TX / Ch18
0.68034	13.71	19.99	0.05	33.76	Average	Neutral	46	-12.24	Pass	TX / Ch18
3.939932	-1.78	20.05	0.09	18.35	Average	Neutral	46	-27.65	Pass	TX / Ch18

Appendix C: Test Equipment/Software Used to perform the test

Equip#	Manufacturer/ Model	Description	Last Cal	Next Due	Test Item
Radiated Emissions					
CIS008113	Cisco/NSA 5m Chamber	NSA 5m Chamber	06-Sep-17	06-Sep-18	B1
CIS034741	ETS Lindgren / 3117	Double Ridged Guide Horn Antenna	09-Aug-17	09-Aug-18	B1
CIS045723	Cisco / TH0118	Mast Mount Preamplifier Array, 1-18GHz	27-Feb-17	27-Feb-17	B1
CIS033670	Sunol Sciences / JB1	Combination Bi-Log Antenna, 30MHz-2GHz	09-Mar-17	09-Mar-18	B1
CIS036710	Cisco/1840	18-40GHz EMI Test Head/Verification Fixture	14-Dec-17	14-Dec-18	BI
CIS018231	Rohde & Schwarz /ESI 40(ESIB 40)	EMI RECEIVER TEST 20Hz-40GHz	03-Feb-17	03-Feb-18	BI
CIS041955	Rohde & Schwarz / ESCI	EMI Test Receiver	07-Mar-17	07-Mar-18	B1
CIS040604	Agilent / E4440A	Precision Spectrum Analyzer	20-Oct-17	20-Oct-18	B1
CIS055178	Huber+Suhner /Sucoflex 106PA	RF Coaxial Cable, to 18GHz, 8.5 m	30-Nov-17	30-Nov-18	B1
CIS025660	Huber+Suhner /Sucoflex 106PA	RF Coaxial Cable, to 18GHz, 8.5 m	30-Nov-17	30-Nov-18	B1
CIS025640	Micro-Coax / UFB311A-0-2720-520520	Coaxial Cable, 272.0 in. to 18GHz	30-Nov-17	30-Nov-18	B1
CIS037557	JFW/50HF-010N	10dB Attenuator	02-Feb-17	02-Feb-18	B1
AC Conducted Emissions					
CIS42014	Rohde & Schwarz / ESCI	EMI Test Receiver	21-Apr-17	21-Apr-18	B2
CIS019210	TTE / H785-150K-50-21378	High Pass Filter 150KHz	28-Feb-17	28-Feb-18	B2
CIS05039	Fisher Custom Com / 50/250-50-2-02	LISN (9kHz-30MHz)	21-Feb-17	21-Feb-18	B2
CIS034158	Fisher Custom Com / 50-2-RA-NEMA-5-20R	LISN Receptacle Adaptor	21-Feb-17	21-Feb-18	B2
CIS040532	Huber + Suhner / RG-223	25 ft RG-223 Cable	04-Dec-16	04-Dec-17	B2
RF Conducted Emissions					
Equip#	Manufacturer/ Model	Description	Last Cal	Next Due	Test Item
CIS042660	Gore/ EJR01R01036.0	SMA RF Cable 26.5GHz	18-Oct-17	18-Oct-18	A1, A2, A3, A4, A5, A6
CIS056098	Keysight (Agilent/HP) / N9020A-526	MXA Spectrum Analyzer, 10Hz-26.5GHz	20-Sep-17	20-Sep-18	A1, A2, A3, A4, A5, A6

Appendix D: 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

Appendix E: Software Used to Perform Testing

EMIssoft Vasona, version 6.024

QRCT Radio Control Software version 3.0.242.0

Appendix F: Test Procedures

Measurements were made in accordance with

- ANSI C63.10:2013 Procedure for Compliance Testing of Unlicensed Wireless Devices
- KDB 558074 D01 DTS Meas Guidance v4
- RSS Gen Issue 4 General Requirements for Compliance of Radio Apparatus

Appendix G: 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>

Note: FCC 15.205, FCC 15.207 and FCC 15.209 are additional requirement not covered under the scope of accreditation

Appendix H: Test Assessment Plan

Compliance Test Plan (Excel) EDCS- 11790857
Target Power Tables EDCS-12164400

Appendix I: Worst Case Justification

Worst case modes were selected by ANSI C63.10 2013 Section **5.6.2.2**

For devices with multiple operating modes, measurements on the middle channel can be used to determine the worst-case mode(s). The worst-case modes are as follows:

- a) Band edge requirements—Measurements on the mode with the widest bandwidth can be used to cover the same channel (center frequency) on modes with narrower bandwidth that have the same or lower output power for each modulation family (e.g., OFDM and direct sequence spread spectrum).
- b) Spurious emissions—Measure the mode with the highest output power and the mode with the highest output power spectral density for each modulation family (e.g., OFDM and direct sequence spread spectrum).
- c) In-band PSD—Measurements on the mode with the narrowest bandwidth can be used to cover all modes within the same modulation family of an equal or lower output power provided the result is less than 50% of the limit.