Radio Test Report

AIR-RM-VBLE2-K9=

BLE Beacon Point Module

FCC ID: LDK825321596

IC: 2461N-825321596

2400-2483.5 MHz

Against the following Specifications:

CFR47 Part 15.247
RSS-247
RSS-Gen

Cisco Systems
170 West Tasman Drive
San Jose, CA 95134

Author: Chris Blair **Tested By: Chris Blair**	**Approved By:** See EDCS **Revision:** See EDCS

This report replaces any previously entered test report under EDCS – This test report has been electronically authorized and archived using the CISCO Engineering Document Control system. Test Report Template EDCS# 703456

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 4: Nov 2014

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

Measurement Uncertainty Values

voltage and power measurements	± 2 dB
conducted EIRP measurements	± 1.4 dB
radiated measurements	± 3.2 dB
frequency measurements	± 2.5 10^{-7}
temperature measurements	± 0.7ºC.
humidity measurements	± 2.5%
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	+/- 5.1 dB
300 MHz - 1000 MHz	+/- 5.5 dB
1 GHz - 10 GHz	+/- 5.3 dB
10 GHz - 18GHz	+/- 5.2 dB
18GHz - 26.5GHz	+/- 4.1 dB
26.5GHz - 40GHz	+/- 3.9 dB

Conducted emissions (expanded uncertainty, confidence interval 95%)

150kHz - 30 MHz	+/- 3.1 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.

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

06-JUN-2017 to 03-OCT-2017

2.4 Report Issue Date

Cisco uses an electronic system to issue, store and control the revision of test reports. This system is called the Engineering Document Control System (EDCS). The actual report issue date is embedded into the original file on EDCS. Any copies of this report, either electronic or paper, that are not on EDCS must be considered uncontrolled

2.5 Testing facilities

This assessment was performed by: Chris Blair

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 Engineers

Chris Blair

2.6 Equipment Assessed (EUT)

AIR-RM-VBLE2-K9=

2.7 EUT Description

"Vulcano" is a project for launching the Virtual BLE Module for the Cisco Aironet AP 3800. The vBLE module is intended to provide highly accurate indoor location delivered in real time, without the site survey or deployment of battery-operated physical BLE beacons on site. Vulcano snugly fits around the AP and helps deliver an integrated solution to customers that is cohesive, easy to deploy & maintain over the duration of its lifetime. Vulcano top use cases 1.Indoor navigation with turn-by-turn guidance 2.Proximity messaging and engagement Info taken from PRD: EDCS-11499611

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)
2400MHz – 2483.5MHz	XKAA-N29	Integrated, patch	5.8

Section 3: Result Summary

3.1 Results Summary Table

Conducted emissions

Basic Standard	Technical Requirements / Details	Result
FCC 15.247 RSS-247	**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	**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	**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	**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 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.	Pass
FCC 15.247 RSS-247 FCC 15.205 RSS-Gen	**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

Radiated Emissions (General requirements)

Basic Standard	Technical Requirements / Details	Result
FCC 15.209 RSS-Gen	**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	**RX Spurious Emissions:** **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 and Table 5 below. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission. **RSS-Gen 8.10 Restricted Bands** 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.	Pass
FCC 15.207 RSS-Gen	**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.	Pass

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 No.	Equipment Details	Manufacturer	Hardware Rev.	Firmware Rev.	Software Rev.	Serial Number
S01	AIR-RM-VBLE2-K9=	WNC	20	apfw-0.1.11711-master-94b1	2017-08-03_00:19:33_UTC	KWC2121083K
S02	AIR-AP3802E-B-K9	Cisco	068-100532-01	2.4.18 = NSS FW ver.	8.5.107.2	FOC20310WKV
S03	ADP-48DR BC LPS	Delta	341-100460-01	NA	NA	DAB2016S1HV
S04	AIR-RM-VBLE2-K9=	WNC	20	apfw-0.1.11711-master-94b1	2017-08-03_00:19:33_UTC	KWC2120068S
S05	AIR-RM-VBLE2-K9=	WNC	20	apfw-0.1.11711-master-94b1	2017-08-03_00:19:33_UTC	KWC21210855
S06	ADP-48DR BC	Delta	341-100460-01	NA	NA	DAB2016S1JD
S07	AIR-AP3802E-B-K9	Cisco	068-100532-01	2.4.18 = NSS FW ver.	8.5.107.2	FOC20310W7Q

4.2 System Details

System #	Description	Samples
1	Radio Conducted Emissions Tests	S01, S02, S03
2	RSE	S04, S02, S03
3	AC Conducted Emissons	S05, S06, S07

4.3 Mode of Operation Details

Mode#	Description	Comments
1	Continuous Transmitting, Conducted Tests	Continuous transmit. 62.4% duty cycle. 390us on, 235us off, regular. BLE (GFSK). See Appendix J for details.
2	Continuous Transmitting, Radiated Tests	Continuous transmit. 87.5% duty cycle. 1094us on, 156us off, regular. BLE (GFSK). See Appendix J for details.

Appendix A: Emission Test Results

Maximum Channel Power

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

Note: The power setting is fixed in firmware.

	Maximum Channel Power (dBm)		
	Frequency (MHz)		
Operating Mode	2402	2442	2480
BLE (GFSK)	1.4	1.8	1.4

A.1 Duty Cycle

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.

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.)

Duty Cycle Test Information

Tested By : Chris Blair	**Date of testing:** August 8, 2017
Test Result : Duty cycle = 62.4%	

Test Equipment

See Appendix C for list of test equipment

Samples, Systems, and Modes

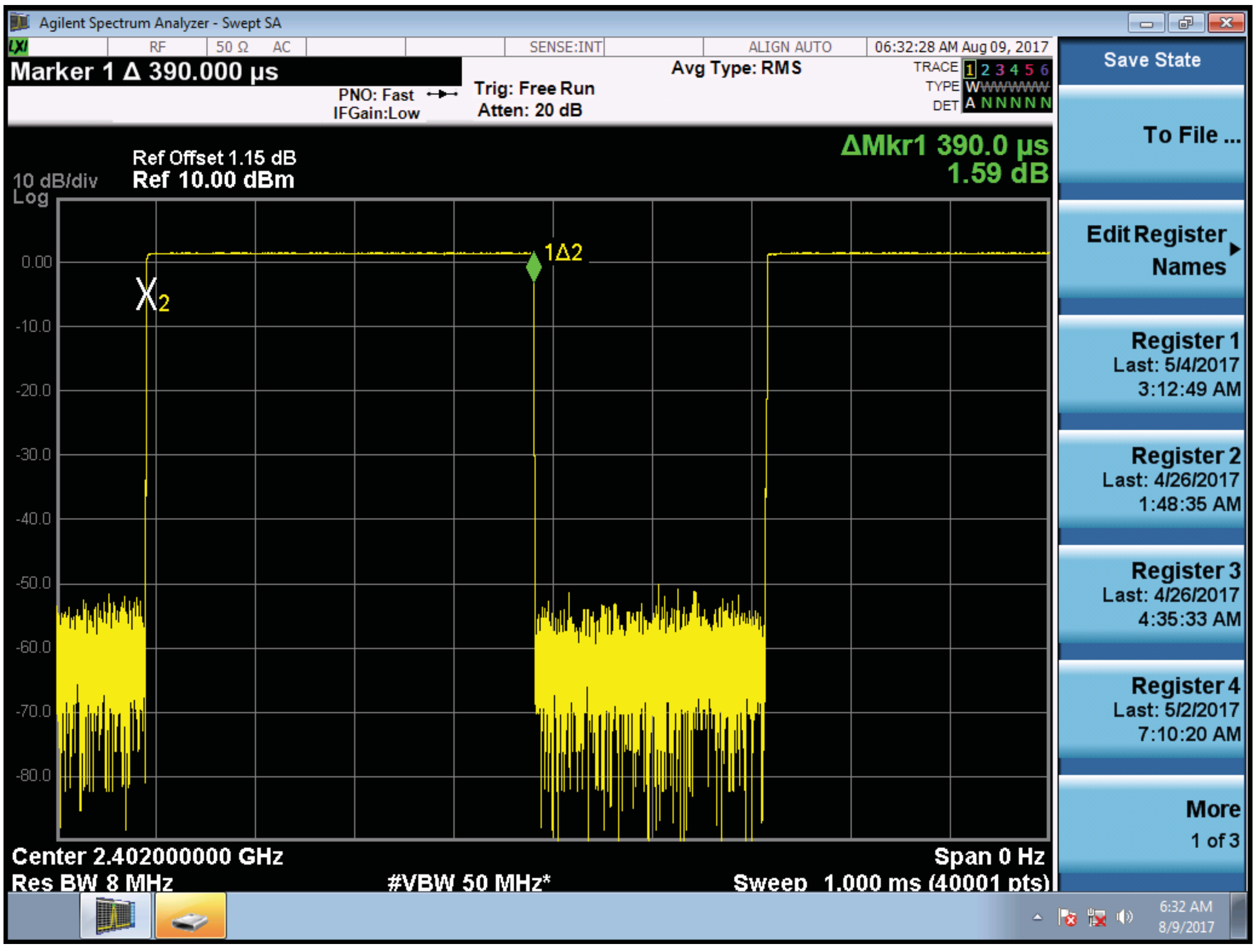
System Number	Description	Samples	System under test	Support equipment
1	EUT	S01	☑	☐
	Support	S02, S03	☐	☑

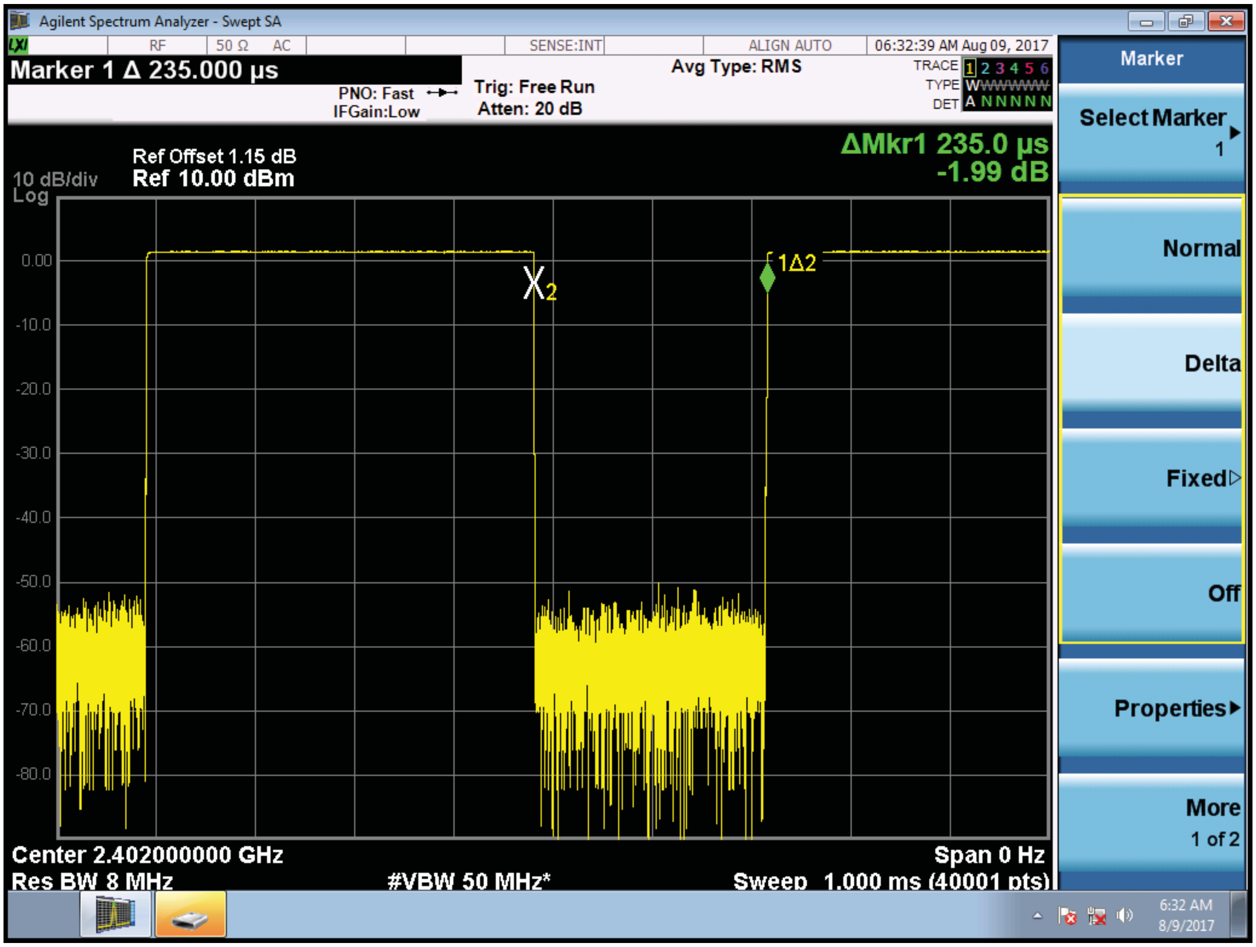
Duty Cycle Data Table

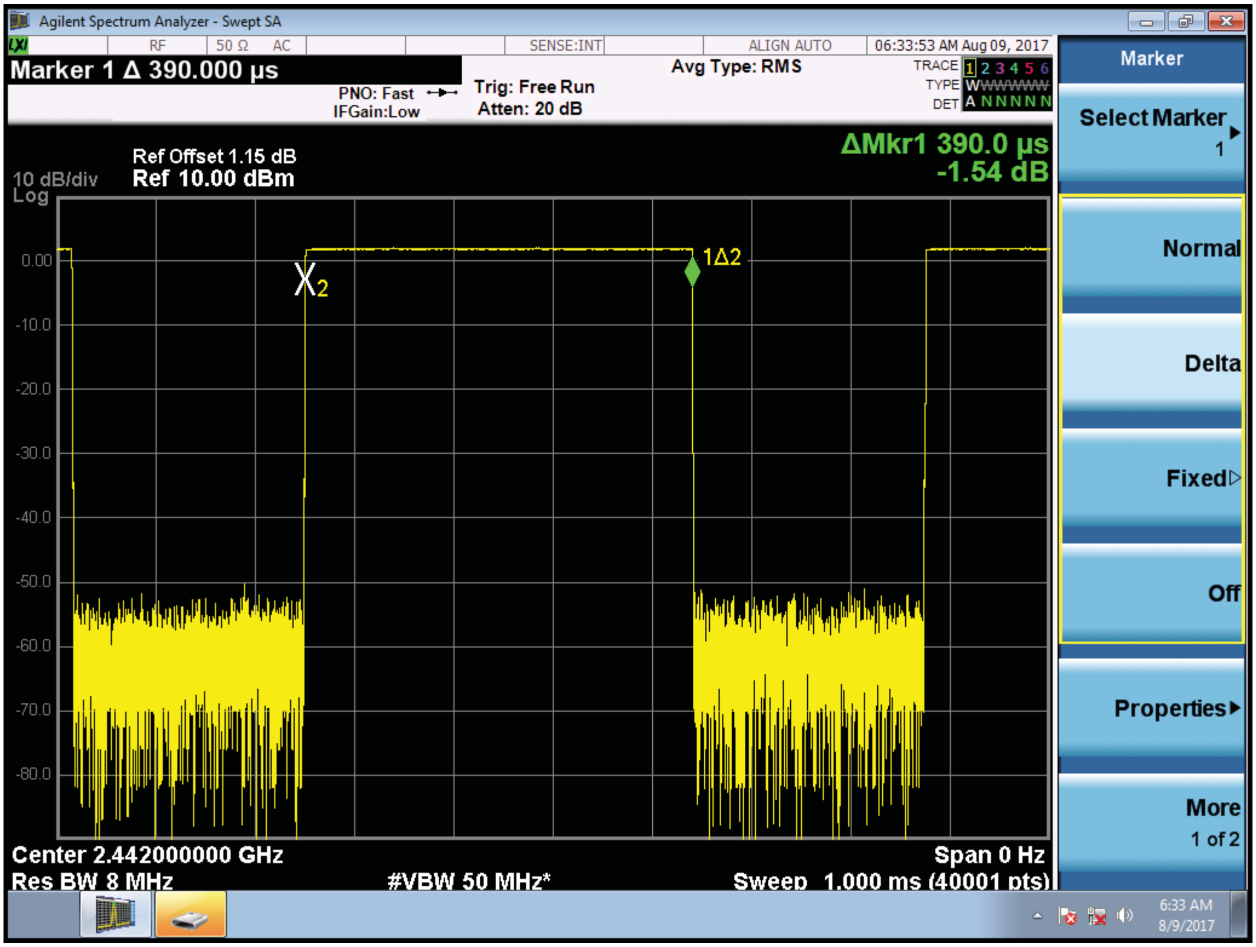
Duty Cycle table and screen captures are shown below for power/psd modes.

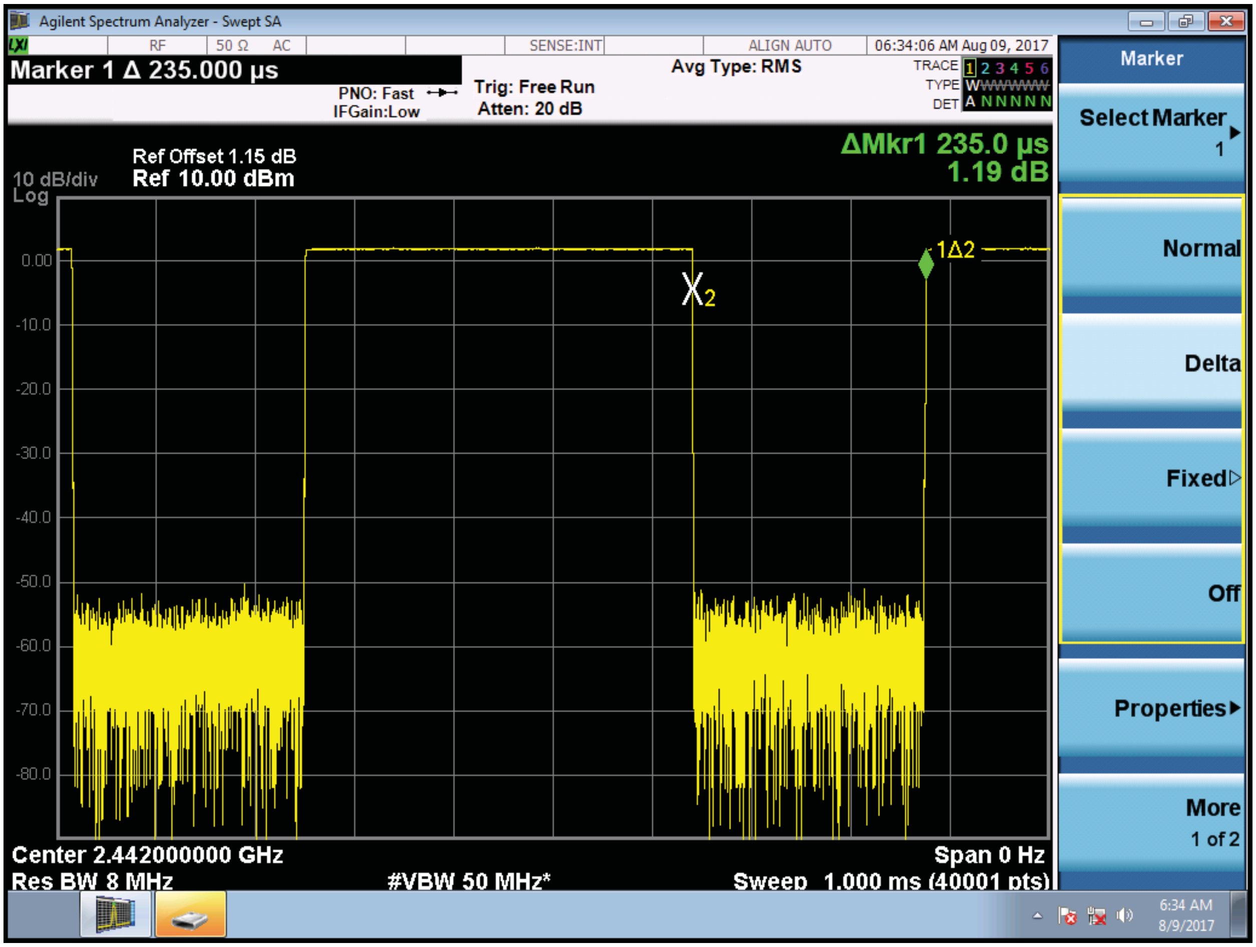
Channel	Mode	Data Rate	On-time (ms)	Total Time (ms)	Duty Cycle (%)	Correction Factor (dB) = 10*log (1/x), where x = duty cycle
2402	BLE (GFSK)	1Mbps	.390	.625	62.4%	10*log (1/.624) = +2.05dB
2442	BLE (GFSK)	1Mbps	.390	.625	62.4%	10*log (1/.624) = +2.05dB
2480	BLE (GFSK)	1Mbps	.390	.625	62.4%	10*log (1/.624) = +2.05dB

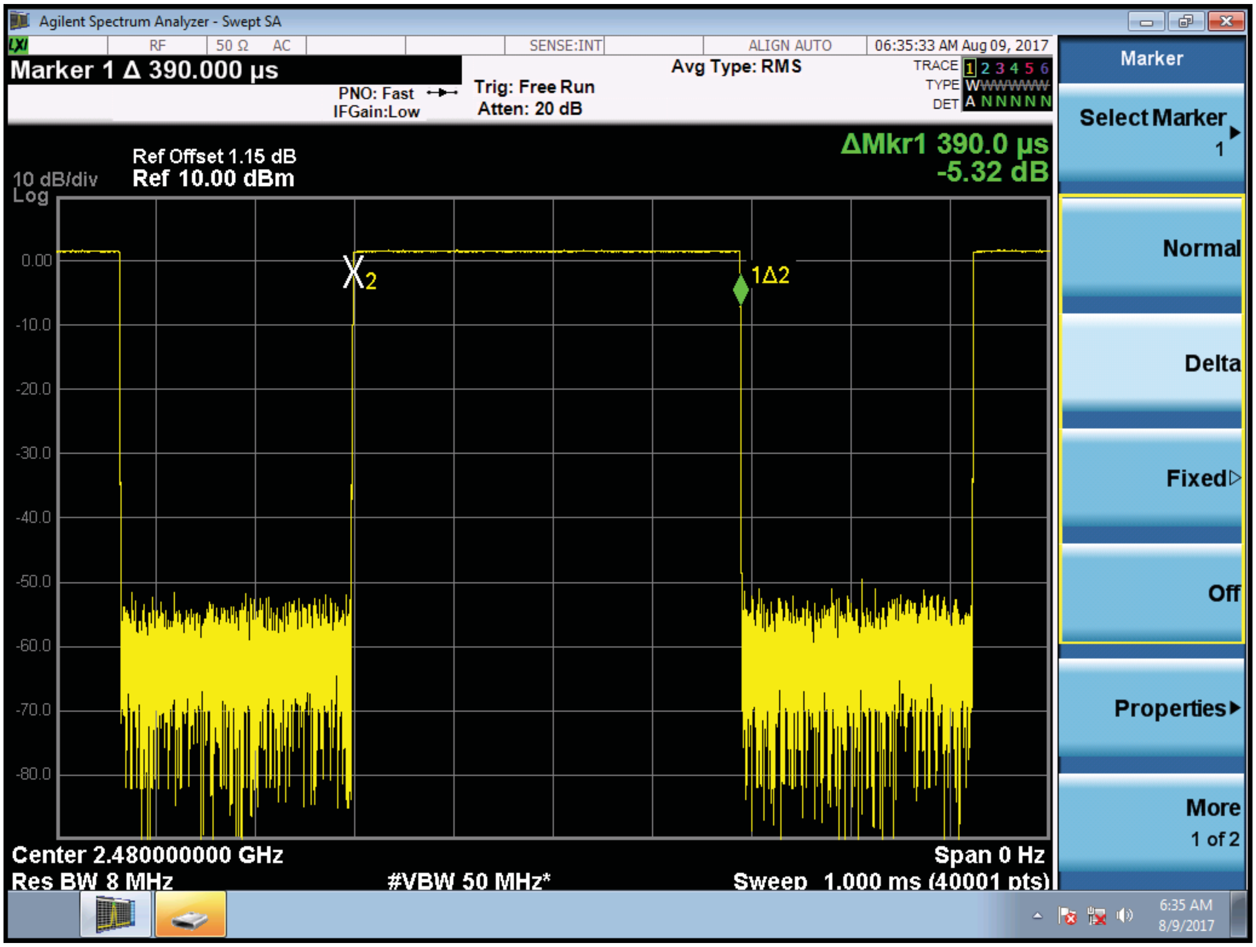
Duty Cycle Data Screenshots

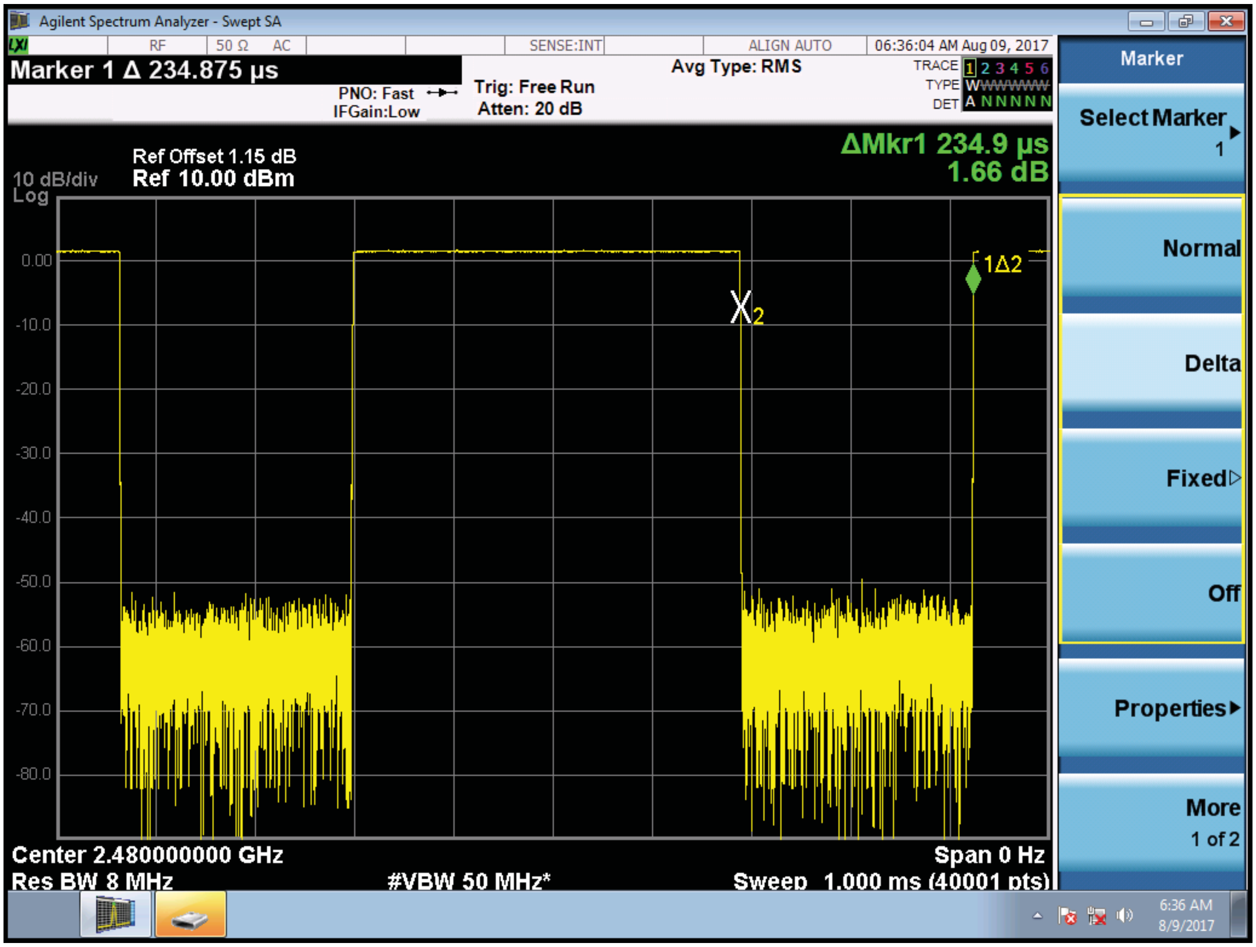



Agilent Spectrum Analyzer - Swept SA
RF 50 Ω AC SENSE:INT ALIGN AUTO 06:32:39 AM Aug 09, 2017
Marker 1 Δ 235.000 µs
PNO: Fast IFGain:Low
Trig: Free Run Atten: 20 dB
Avg Type: RMS
TRACE 1 2 3 4 5 6 TYPE W DET A N N N N N
Ref Offset 1.15 dB
10 dB/div Ref 10.00 dBm
Log
ΔMkr1 235.0 µs -1.99 dB
Center 2.402000000 GHz
Res BW 8 MHz
#VBW 50 MHz*
Span 0 Hz
Sweep 1.000 ms (40001 pts)
Marker
Select Marker 1
Normal
Delta
Fixed
Off
Properties
More 1 of 2


Agilent Spectrum Analyzer - Swept SA
RF
50 Ω AC
SENSE:INT
ALIGN AUTO
06:33:53 AM Aug 09, 2017
Marker 1 Δ 390.000 µs
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 20 dB
Avg Type: RMS
TRACE 1 2 3 4 5 6
TYPE WWWWWW
DET A N N N N N
Ref Offset 1.15 dB
10 dB/div
Log
Ref 10.00 dBm
ΔMkr1 390.0 µs
-1.54 dB
1Δ2
X2
0.00
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
Center 2.442000000 GHz
Res BW 8 MHz
#VBW 50 MHz*
Span 0 Hz
Sweep 1.000 ms (40001 pts)
Marker
Select Marker
1
Normal
Delta
Fixed
Off
Properties
More
1 of 2
6:33 AM
8/9/2017


Agilent Spectrum Analyzer - Swept SA
RF 50 Ω AC SENSE:INT ALIGN AUTO 06:34:06 AM Aug 09, 2017
Marker 1 Δ 235.000 µs
PNO: Fast IFGain:Low
Trig: Free Run Atten: 20 dB
Avg Type: RMS
TRACE 1 2 3 4 5 6 TYPE W DET A N N N N N
Ref Offset 1.15 dB
10 dB/div Log Ref 10.00 dBm
ΔMkr1 235.0 µs 1.19 dB
0.00
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
1Δ2
X2
Center 2.442000000 GHz
Res BW 8 MHz
#VBW 50 MHz*
Span 0 Hz
Sweep 1.000 ms (40001 pts)
Marker
Select Marker 1
Normal
Delta
Fixed
Off
Properties
More 1 of 2
6:34 AM 8/9/2017


Agilent Spectrum Analyzer - Swept SA
RF 50 Ω AC SENSE:INT ALIGN AUTO 06:35:33 AM Aug 09, 2017
Marker 1 Δ 390.000 µs
PNO: Fast IFGain:Low
Trig: Free Run Atten: 20 dB
Avg Type: RMS
TRACE 1 2 3 4 5 6 TYPE WWWWWW DET A N N N N N
Ref Offset 1.15 dB
10 dB/div Ref 10.00 dBm
Log
ΔMkr1 390.0 µs -5.32 dB
0.00 -10.0 -20.0 -30.0 -40.0 -50.0 -60.0 -70.0 -80.0
X2
1Δ2
Center 2.480000000 GHz
Res BW 8 MHz
#VBW 50 MHz*
Span 0 Hz
Sweep 1.000 ms (40001 pts)
Marker
Select Marker 1
Normal
Delta
Fixed
Off
Properties
More 1 of 2
6:35 AM 8/9/2017


Agilent Spectrum Analyzer - Swept SA
RF
50 Ω AC
SENSE:INT
ALIGN AUTO
06:36:04 AM Aug 09, 2017
Marker 1 Δ 234.875 µs
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 20 dB
Avg Type: RMS
TRACE 1 2 3 4 5 6
TYPE WWWWWW
DET A NNNNN
ΔMkr1 234.9 µs
1.66 dB
Ref Offset 1.15 dB
10 dB/div
Log
Ref 10.00 dBm
0.00
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
X2
1Δ2
Center 2.480000000 GHz
Res BW 8 MHz
#VBW 50 MHz*
Span 0 Hz
Sweep 1.000 ms (40001 pts)
Marker
Select Marker
1
Normal
Delta
Fixed
Off
Properties
More
1 of 2
6:36 AM
8/9/2017

A.2 6dB Bandwidth

6dB Bandwidth Test Requirement

For the FCC:
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.

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.

Samples, Systems, and Modes

System Number	Description	Samples	System under test	Support equipment
1	EUT	S01	☑	☐
	Support	S02, S03	☐	☑

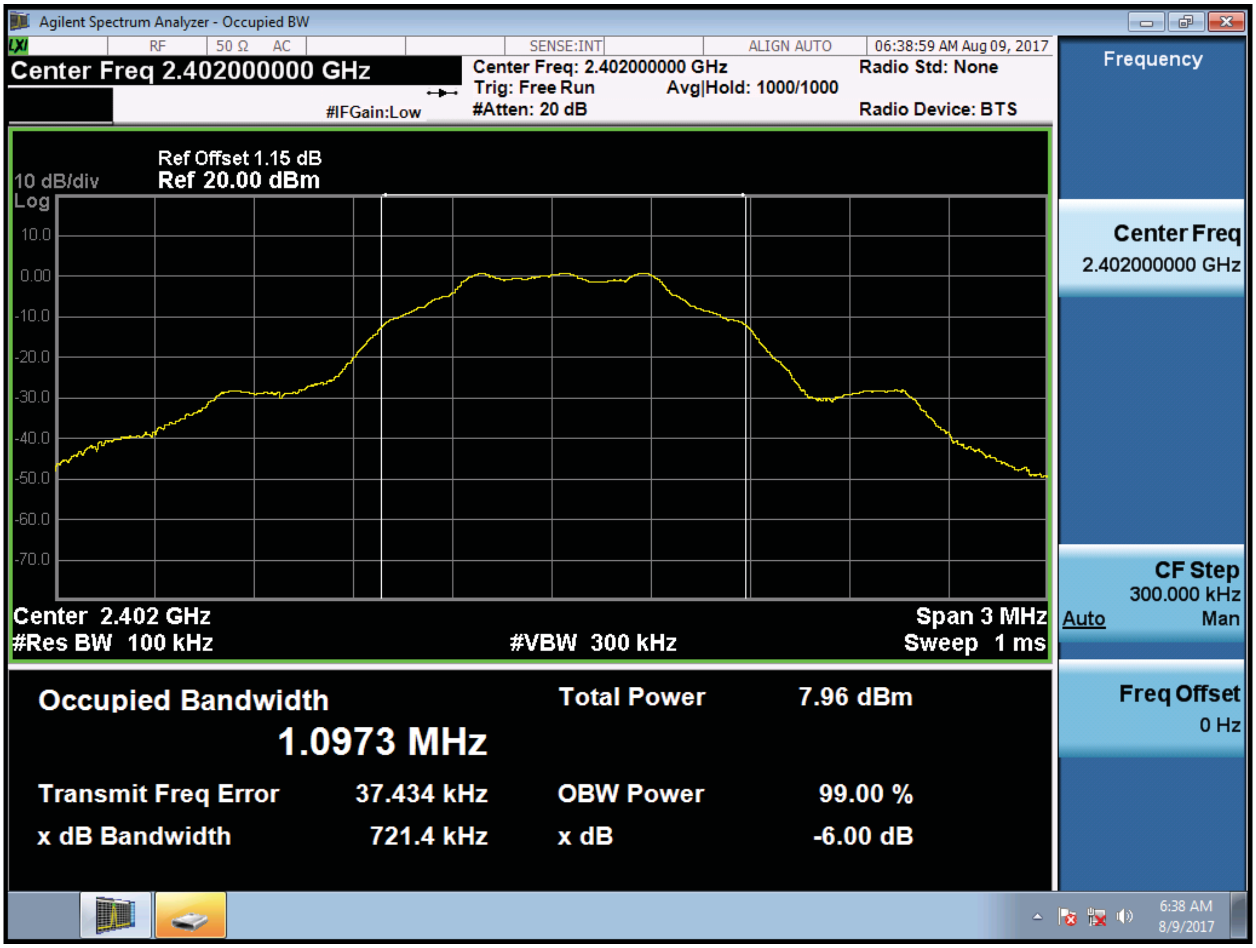
Tested By :	Date of testing:
Chris Blair	August 8, 2017
Test Result : PASS	

Test Equipment
See Appendix C for list of test equipment

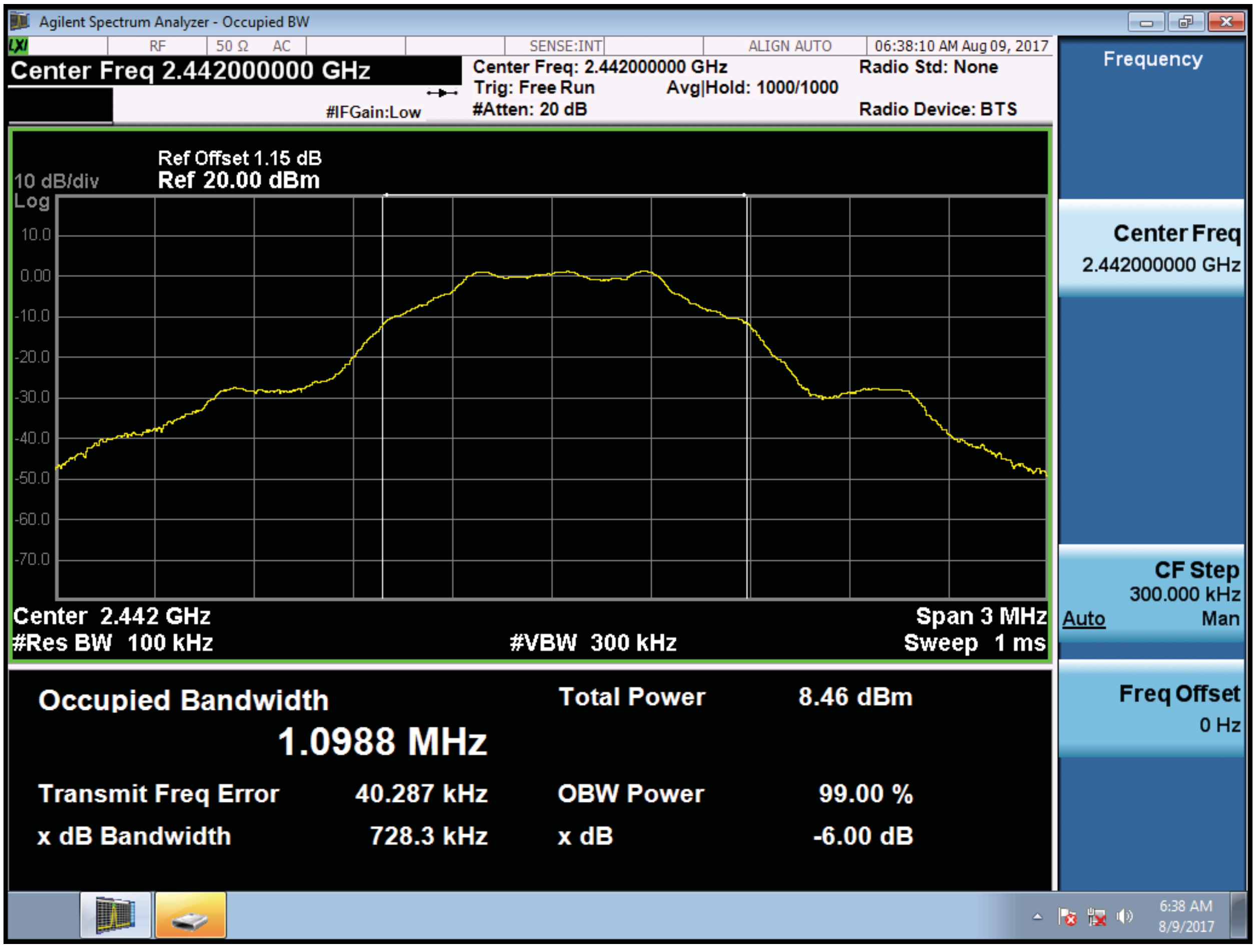
6dB Bandwidth Data Table

Frequency (MHz)	Mode	Data Rate (Mbps)	6dB BW (kHz)	Minimum (kHz)	Margin (kHz)
2402	BLE (GFSK)	1	**721.4**	500	**221.4**
2442	BLE (GFSK)	1	**728.3**	500	**228.3**
2480	BLE (GFSK)	1	**726.6**	500	**226.6**

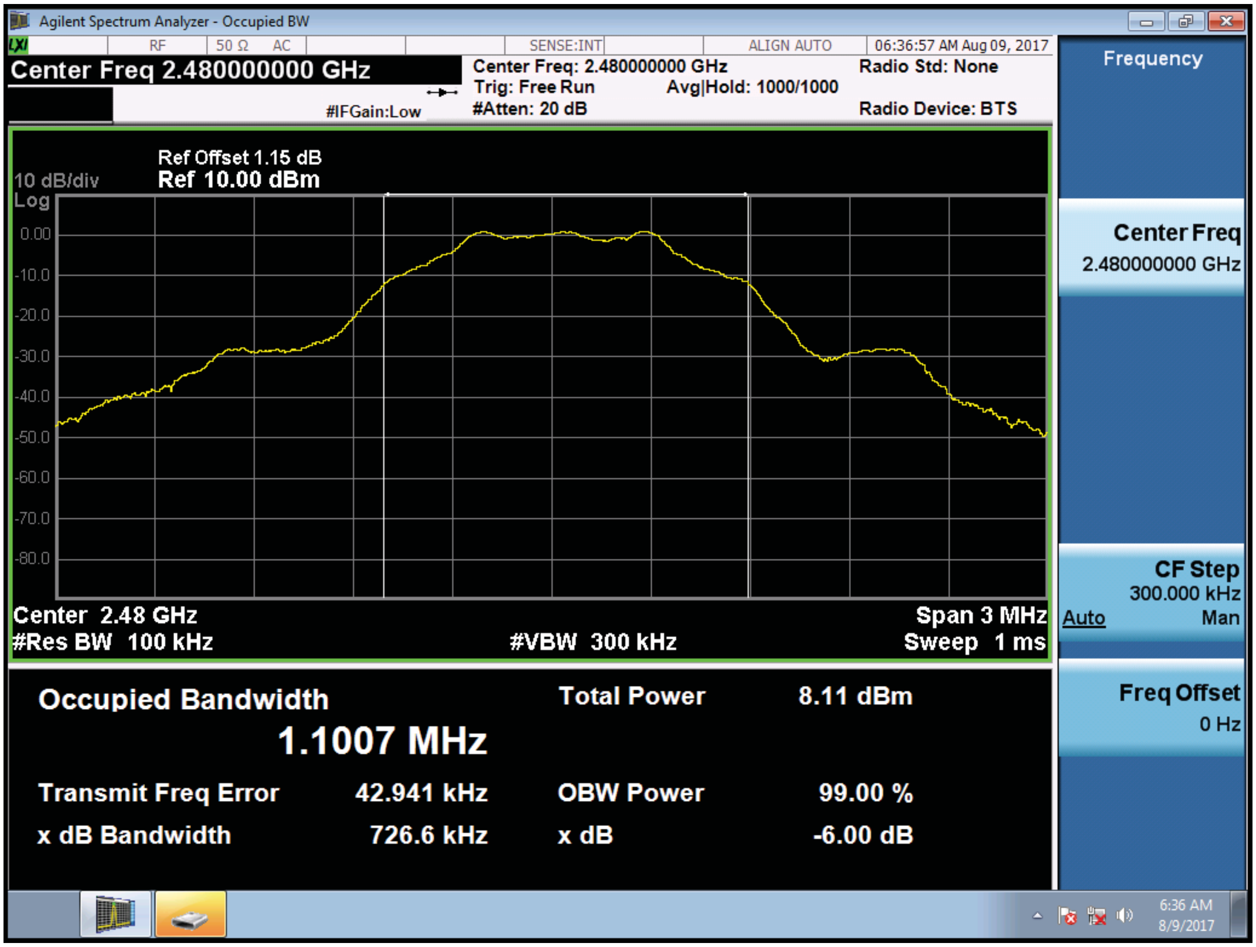
6dB Bandwidth, 2402 MHz, 1Mbps, GFSK



6dB Bandwidth, 2442 MHz, 1Mbps, GFSK



6dB Bandwidth, 2480 MHz, 1Mbps, GFSK



A.3 Occupied Bandwidth

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.

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).

Samples, Systems, and Modes

System Number	Description	Samples	System under test	Support equipment
1	EUT	S01	☑	☐
	Support	S02, S03	☐	☑

Tested By : Chris Blair	**Date of testing:** August 8, 2017
Test Result : PASS	

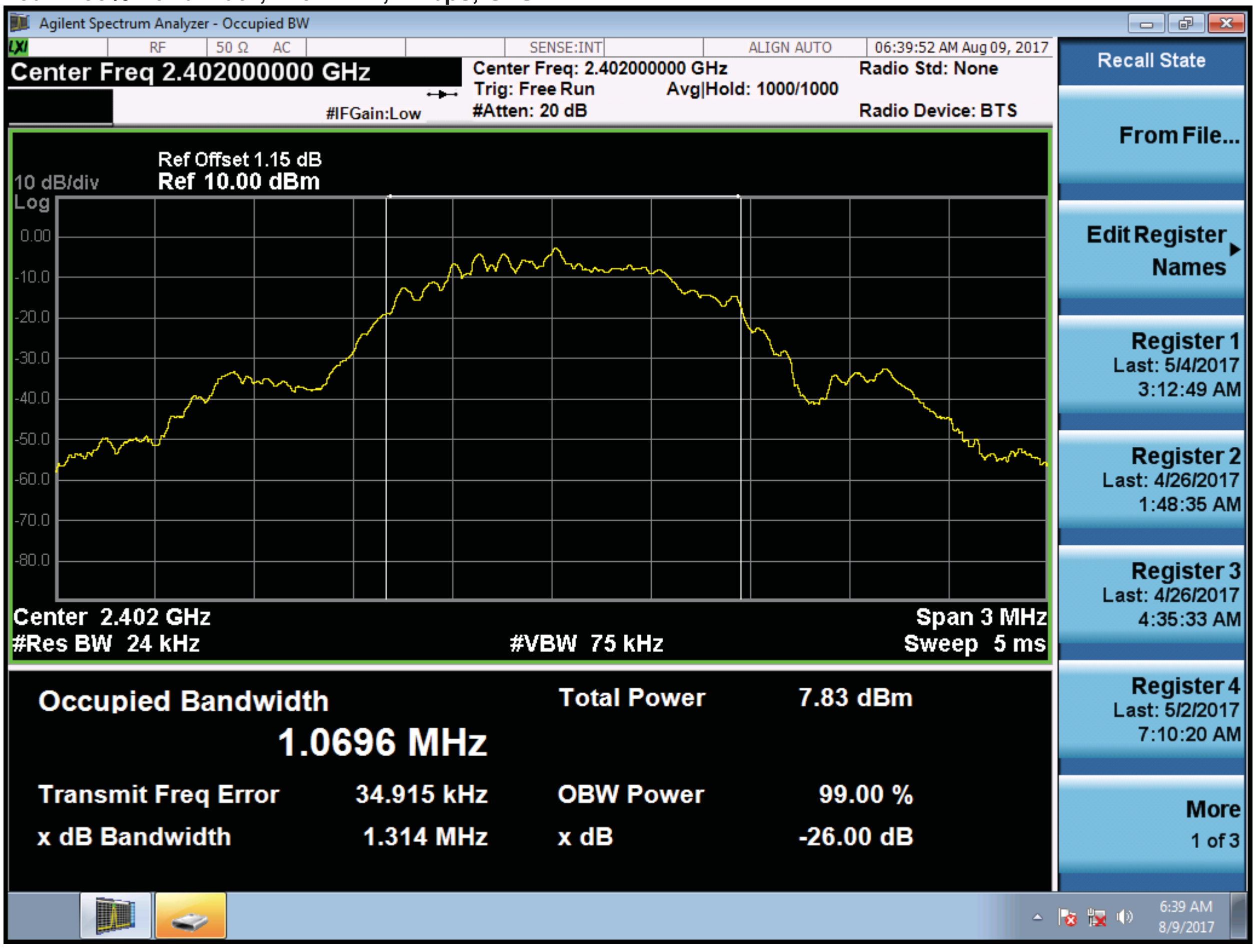
Test Equipment

See Appendix C for list of test equipment

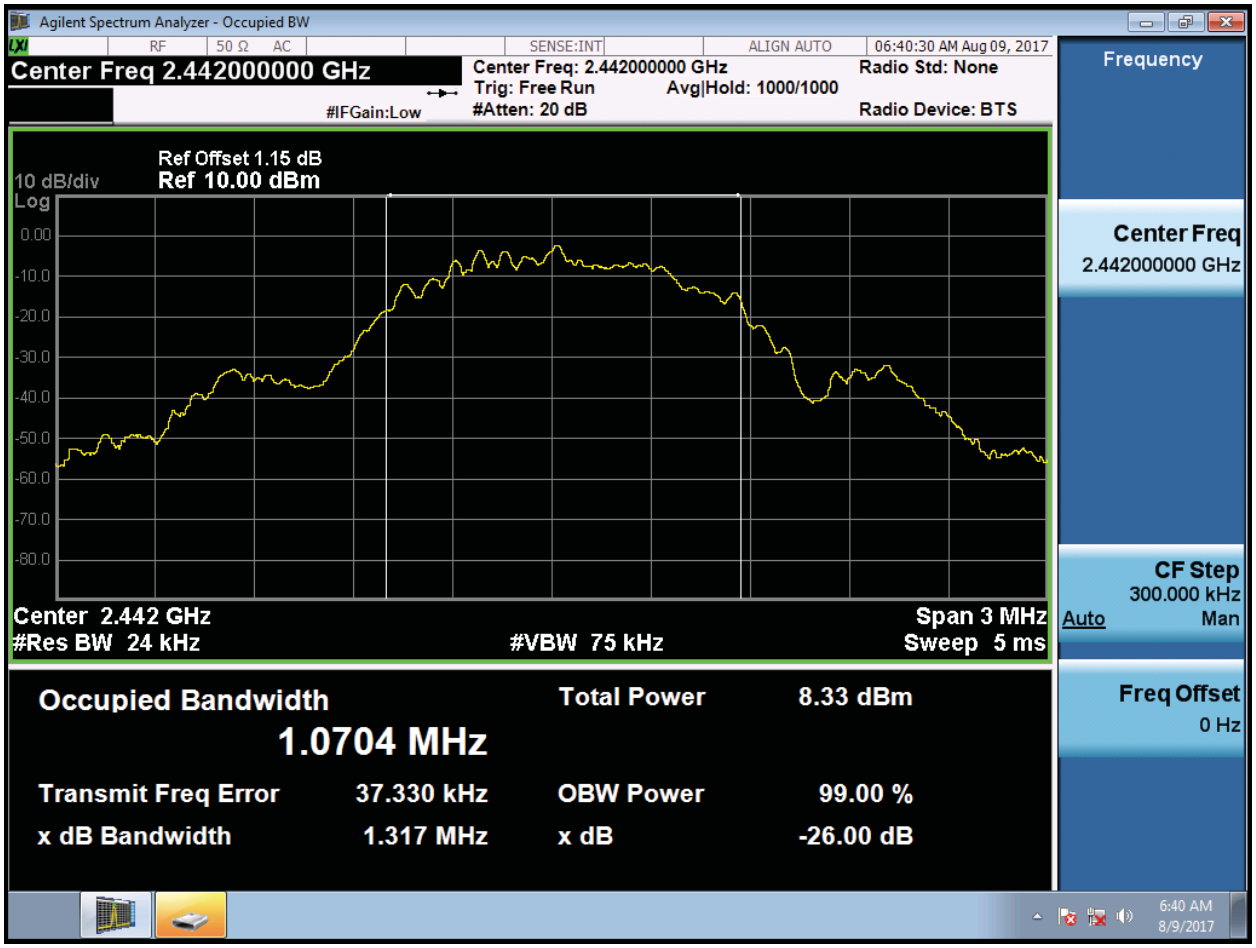
Occupied Bandwidth Data Table

Frequency (MHz)	Mode	Data Rate (Mbps)	26dB BW (MHz)	99% BW (MHz)
2402	BLE (GFSK)	1	**1.314**	1.07
2442	BLE (GFSK)	1	**1.317**	1.07
2480	BLE (GFSK)	1	**1.319**	1.07

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



26dB / 99% Bandwidth, 2442 MHz, 1Mbps, GFSK



26dB / 99% Bandwidth, 2480 MHz, 1Mbps, GFSK

A.4 Maximum Conducted Output Power

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 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi 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 6 dBi.

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.

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)

Samples, Systems, and Modes

System Number	Description	Samples	System under test	Support equipment
1	EUT	S01	☑	☐
	Support	S02, S03	☐	☑

Tested By : Chris Blair	**Date of testing:** August 8, 2017
Test Result : PASS	

Test Equipment
See Appendix C for list of test equipment.

Maximum Conducted Output Power Data Table

Frequency (MHz)	Mode	Tx Paths	Correlated Antenna Gain (dBi)	Duty Cycle (%)	Correction Factor (dB) = 10*log (1/x) where x = duty cycle	Tx 1 Max Power (dBm)	Tx 2 Max Power (dBm)	Tx 3 Max Power (dBm)	Tx 4 Max Power (dBm)	Total Tx Channel Power (dBm)	Total TX Channel Power (dBm), corrected for duty cycle	Limit (dBm)	Margin (dB)
2402	BLE (GFSK)	1	5.8	62.4%	+2.05	-0.68	-	-	-	-0.68	+1.37	30	28.63
2442	BLE (GFSK)	1	5.8	62.4%	+2.05	-0.24	-	-	-	-0.24	+1.81	30	28.19
2480	BLE (GFSK)	1	5.8	62.4%	+2.05	-0.62	-	-	-	-0.62	+1.43	30	28.57

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

Maximum Conducted Output Power, 2442 MHz, 1Mbps, GFSK

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

A.5 Power Spectral Density

Power Spectral Density Test Requirement

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

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 10.5 **AVG-PSD-2 (Average PSD with Duty Cycle Correction)**

Power Spectral Density Test parameters
10.5 Method AVGPSD-2 (trace averaging across on and off times of the EUT transmissions, followed by duty cycle correction) This procedure is applicable when the EUT cannot be configured to transmit continuously (*i.e.*, duty cycle < 98%), and when sweep triggering/signal gating cannot be used to measure only when the EUT is transmitting at its maximum power control level, and when the transmission duty cycle is constant (*i.e.*, duty cycle variations are less than ± 2 percent): a) Measure the duty cycle (x) of the transmitter output signal as described in 6.0. b) Set instrument center frequency to DTS channel center frequency. c) Set span to at least 1.5 times the OBW. d) Set RBW to: 3 kHz ≤ RBW ≤ 100 kHz.. e) Set VBW ≥3 x RBW. f) Detector = power averaging (RMS) or sample detector (when RMS not available). g) Ensure that the number of measurement points in the sweep ≥ 2 x span/RBW. h) Sweep time = auto couple. i) Do not use sweep triggering. Allow sweep to "free run". j) Employ trace averaging (RMS) mode over a minimum of 100 traces. k) Use the peak marker function to determine the maximum amplitude level. l) Add 10 log (1/x), where x is the duty cycle measured in step (a, to the measured PSD to compute the average PSD during the actual transmission time. m) If resultant value exceeds the limit, then reduce RBW (no less than 3 kHz) and repeat (note that this may require zooming in on the emission of interest and reducing the span in order to meet the minimum measurement point requirement as the RBW is reduced).

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)

Samples, Systems, and Modes

System Number	Description	Samples	System under test	Support equipment
1	EUT	S01	☑	☐
	Support	S02, S03	☐	☑

Tested By : Chris Blair	**Date of testing:** August 8, 2017
Test Result : PASS	

Test Equipment

See Appendix C for list of test equipment

Power Spectral Density Data Table

Frequency (MHz)	Mode	Tx Paths	Correlated Antenna Gain (dBi)	Duty Cycle (%)	Correction Factor (dB) = 10*log (1/x) where x = duty cycle	Tx 1 PSD (dBm/3kHz)	Tx 2 PSD (dBm/3kHz)	Tx 3 PSD (dBm/3kHz)	Tx 4 PSD (dBm/3kHz)	Highest PSD value per antenna (dBm/3kHz), corrected for duty cycle.	Total PSD (dBm/3kHz)[1]	Limit (dBm/3kHz)	Margin (dB)
2402	BLE (GFSK)	1	5.8	62.4%	+2.05	-15.085	-	-	-	-13.035	-13.035	8	21.035
2442	BLE (GFSK)	1	5.8	62.4%	+2.05	-14.000	-	-	-	-11.950	-11.950	8	19.950
2480	BLE (GFSK)	1	5.8	62.4%	+2.05	-14.469	-	-	-	-12.419	-12.419	8	20.419

[1] PSD is presented in dBm/10kHz, per the test method cited. This is conservative and < the PSD in dBm/3kHz.

Power Spectral Density, 2402 MHz, 1Mbps, GFSK

Power Spectral Density, 2442 MHz, 1Mbps, GFSK

Power Spectral Density, 2480 MHz, 1Mbps, GFSK

A.6 Conducted Spurious Emissions

Conducted Spurious Emissions Test Requirement

15.205 / RSS-Gen

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 section 8.9

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 and Table 5 below. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.

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.

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).

Samples, Systems, and Modes

System Number	Description	Samples	System under test	Support equipment
	EUT	S01	☑	☐
	Support	S02, S03	☐	☑

Tested By : Chris Blair	**Dates of testing:** August 15, 2017 & September 19-20, 2017
Test Result : PASS	

Test Equipment

See Appendix C for list of test equipment

Conducted Spurious Emissions Data Table - Peak

Frequency (MHz)	Mode	Tx Paths	Correlated Antenna Gain (dBi)	Tx 1 Spur Power (dBm)	Total Conducted Spur (dBm) = Tx 1 Spur power (dBm) + Antenna Gain (dBi) + Ground Reflection Factor (dB), if applicalble.	Limit (dBm)	Margin (dB)
2402	BLE (GFSK)	1	5.8	-51.39	-45.59	-21.25	24.34
2442	BLE (GFSK)	1	5.8	-49.50	-43.70	-21.25	22.45
2480	BLE (GFSK)	1	5.8	-47.83	-42.03	-21.25	20.78

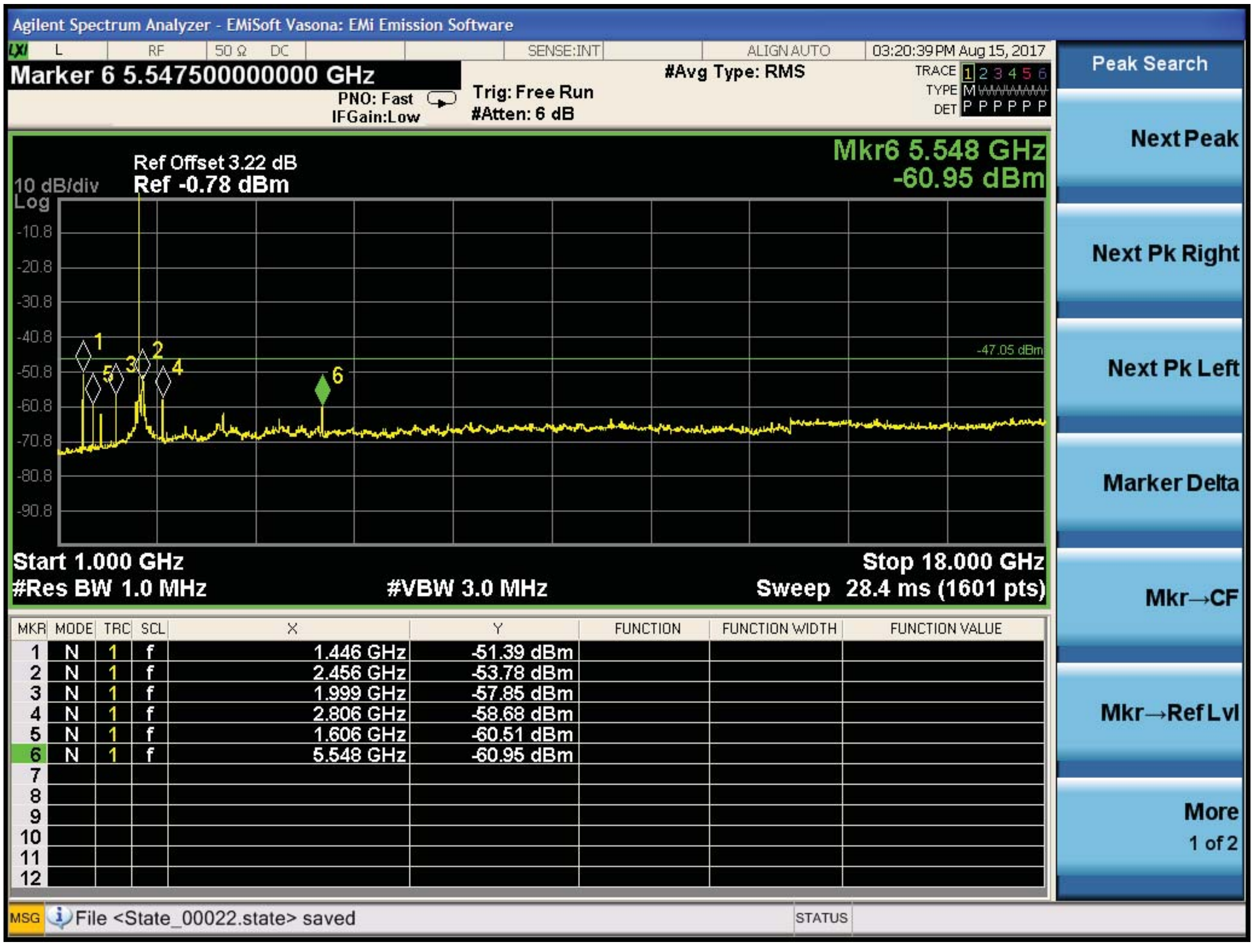
Conducted Spurious Emissions Data Table – Average

*Separate average measurements (RBW=1kHz) not performed, since peak measurements were under average limits for average (-41.25dBm).

Frequency (MHz)	Mode	Tx Paths	Correlated Antenna Gain (dBi)	Tx 1 Spur Power (dBm)*	Total Conducted Spur (dBm)	Limit (dBm)	Margin (dB)
2402	BLE (GFSK)	1	5.8	-51.39	-45.59	-41.25	4.34
2442	BLE (GFSK)	1	5.8	-49.50	-43.70	-41.25	2.45
2480	BLE (GFSK)	1	5.8	-47.83	-42.03	-41.25	0.78

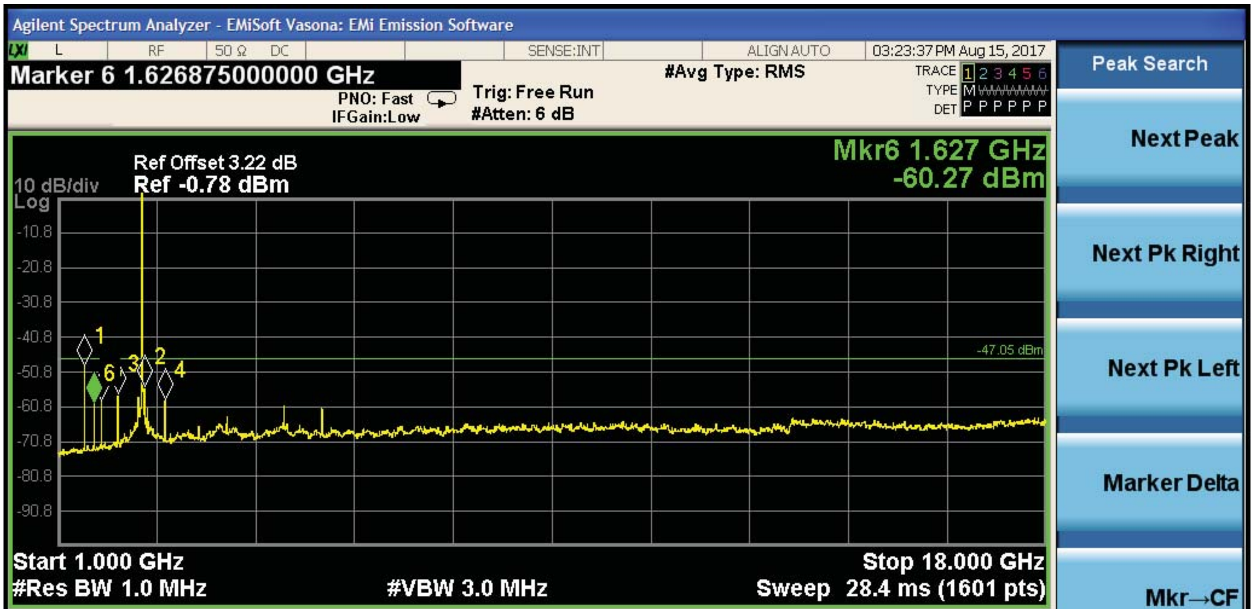
***Conducted Spurs Peak, 1-18GHz*, 2402MHz, BLE (GFSK)**

5.8dBi antenna gain reflected in limit line: -41.25dBm (avg limit) – 5.8dBi = -47.05dBm.



***Conducted Spurs Peak, 1-18GHz*, 2442MHz, BLE (GFSK)**

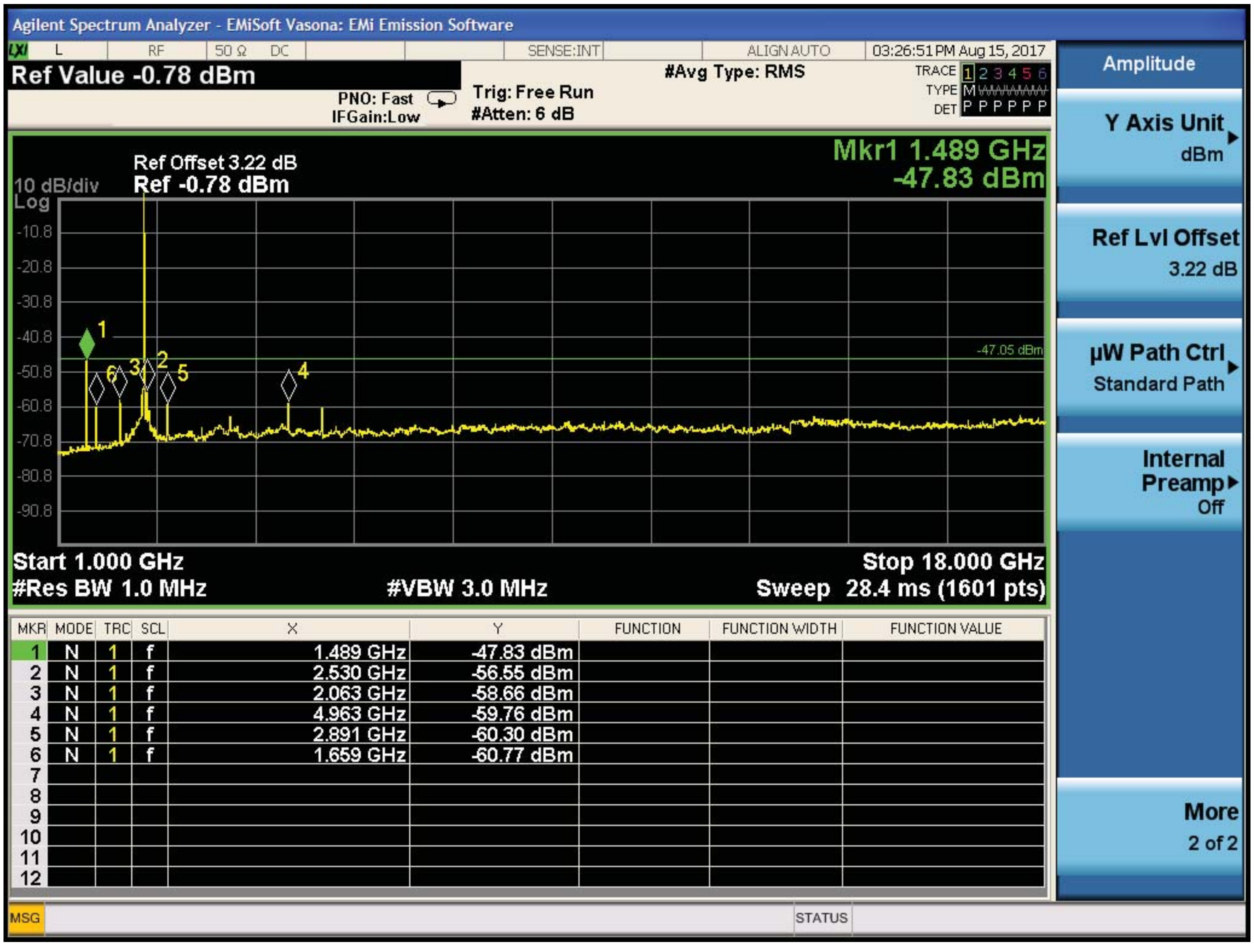
5.8dBi antenna gain reflected in limit line: -41.25dBm (avg limit) – 5.8dBi = -47.05dBm.



MKR	MODE	TRC	SCL	X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE
1	N	1	f	1.468 GHz	-49.50 dBm			
2	N	1	f	2.488 GHz	-55.48 dBm			
3	N	1	f	2.031 GHz	-57.68 dBm			
4	N	1	f	2.849 GHz	-59.20 dBm			
5	N	1	f	1.754 GHz	-59.54 dBm			
6	N	1	f	1.627 GHz	-60.27 dBm			
7								
8								
9								
10								
11								
12								

***Conducted Spurs Peak, 1-18GHz*, 2480MHz, BLE (GFSK)**

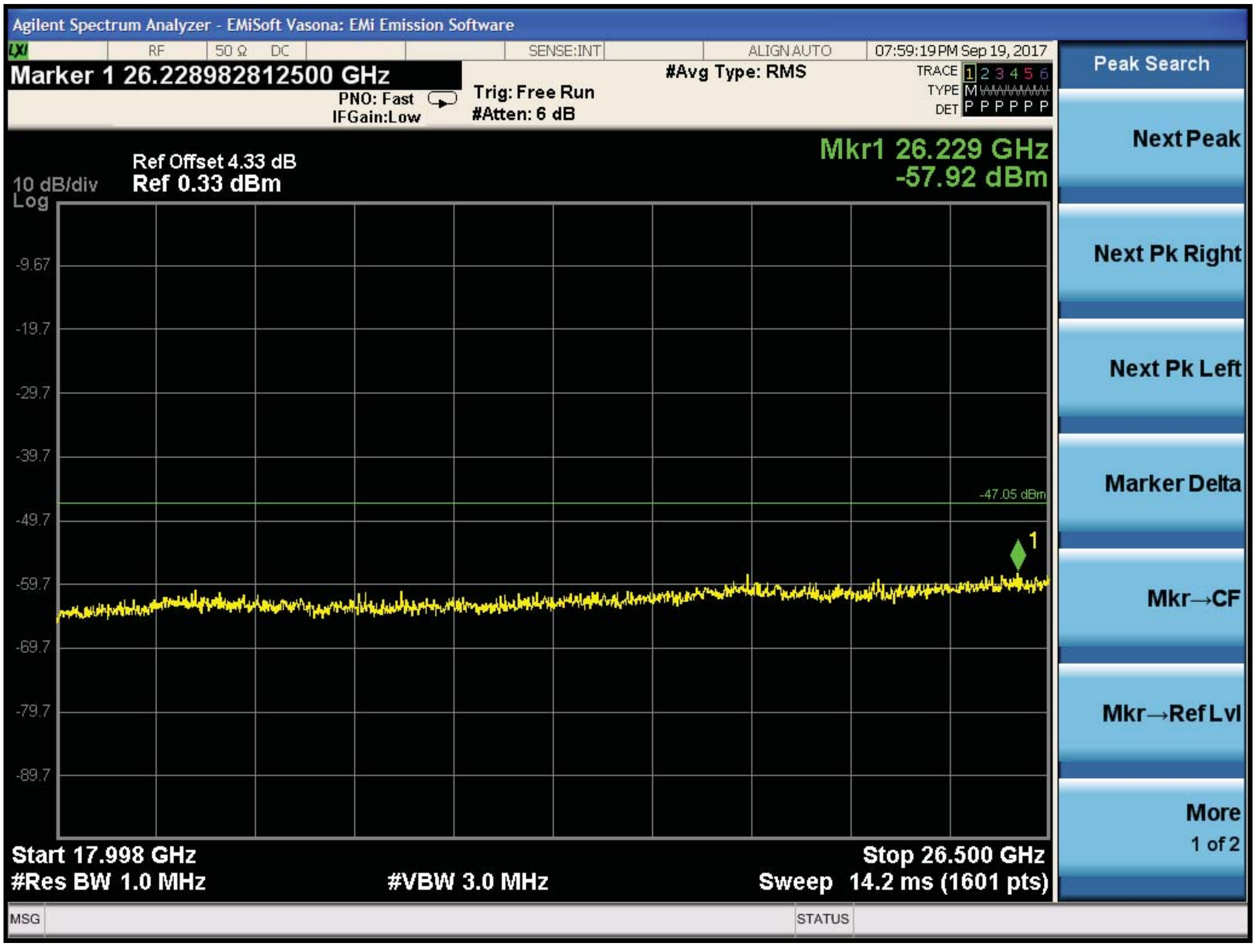
5.8dBi antenna gain reflected in limit line: -41.25dBm (avg limit) – 5.8dBi = -47.05dBm.



MKR	MODE	TRC	SCL	X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE
1	N	1	f	1.489 GHz	-47.83 dBm			
2	N	1	f	2.530 GHz	-56.55 dBm			
3	N	1	f	2.063 GHz	-58.66 dBm			
4	N	1	f	4.963 GHz	-59.76 dBm			
5	N	1	f	2.891 GHz	-60.30 dBm			
6	N	1	f	1.659 GHz	-60.77 dBm			
7								
8								
9								
10								
11								
12								

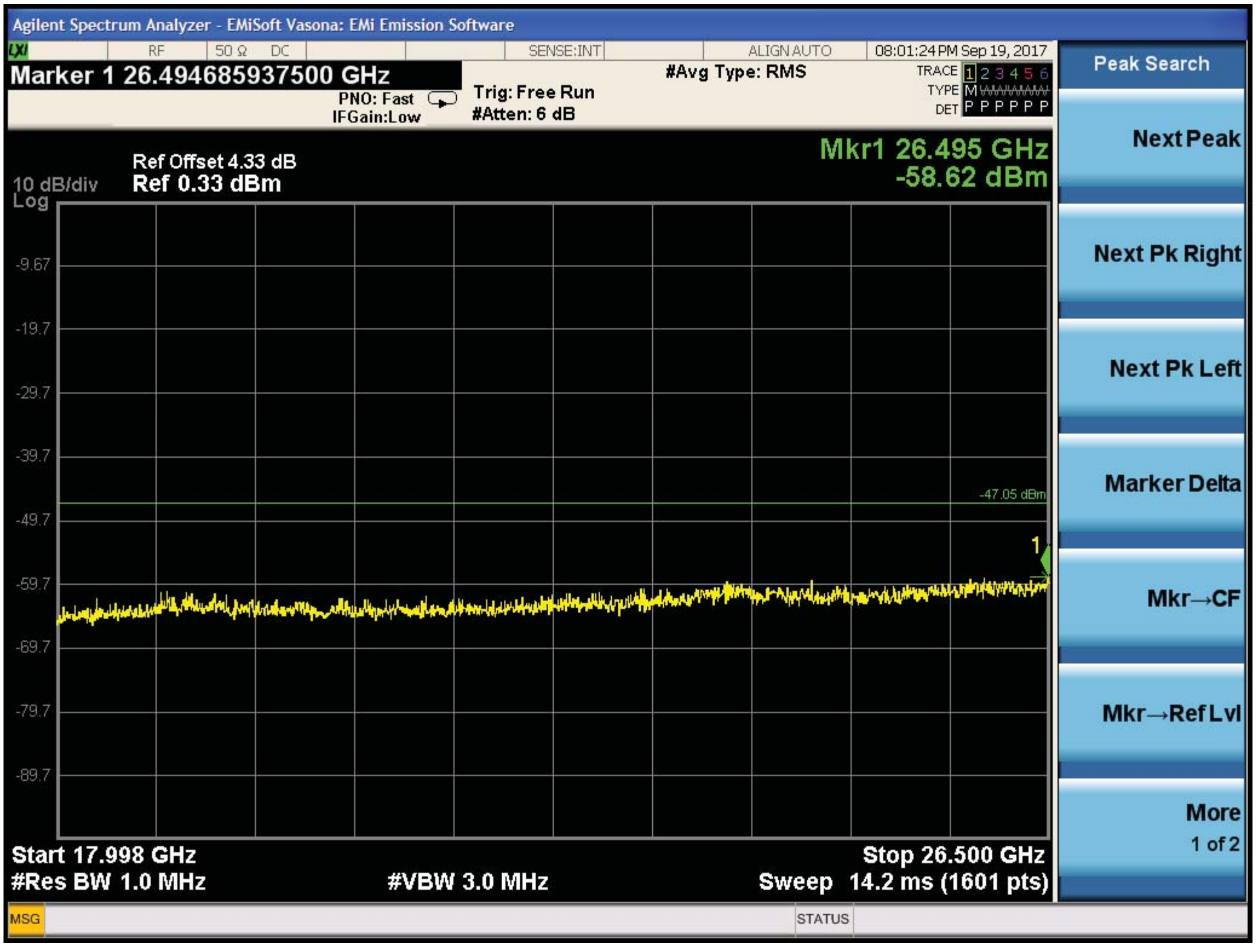
***Conducted Spurs Peak, 18-26GHz*, 2402MHz, BLE (GFSK)**

5.8dBi antenna gain reflected in limit line: -41.25dBm (avg limit) – 5.8dBi = -47.05dBm.



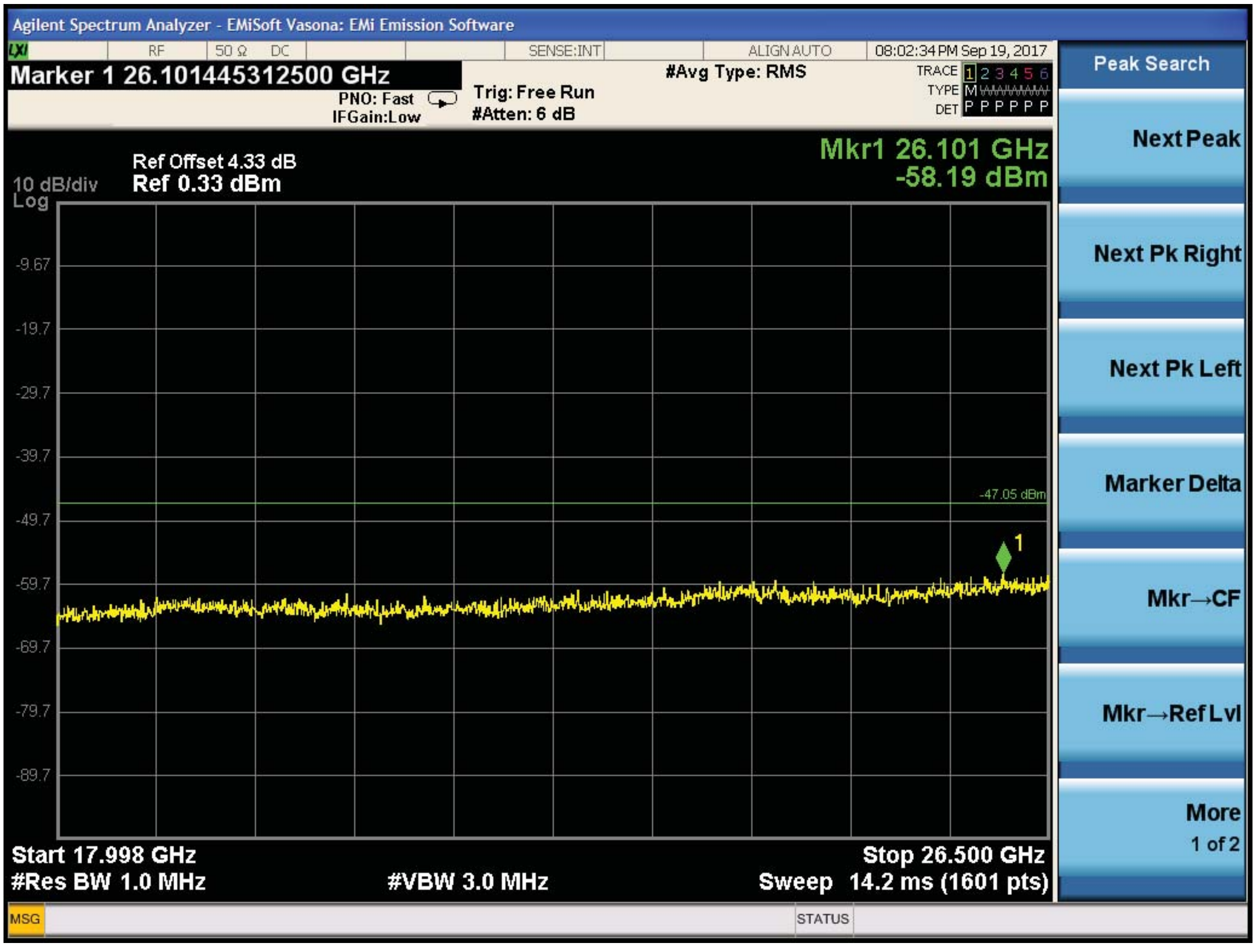
***Conducted Spurs Peak, 18-26GHz*, 2442MHz, BLE (GFSK)**

5.8dBi antenna gain reflected in limit line: -41.25dBm (avg limit) – 5.8dBi = -47.05dBm.



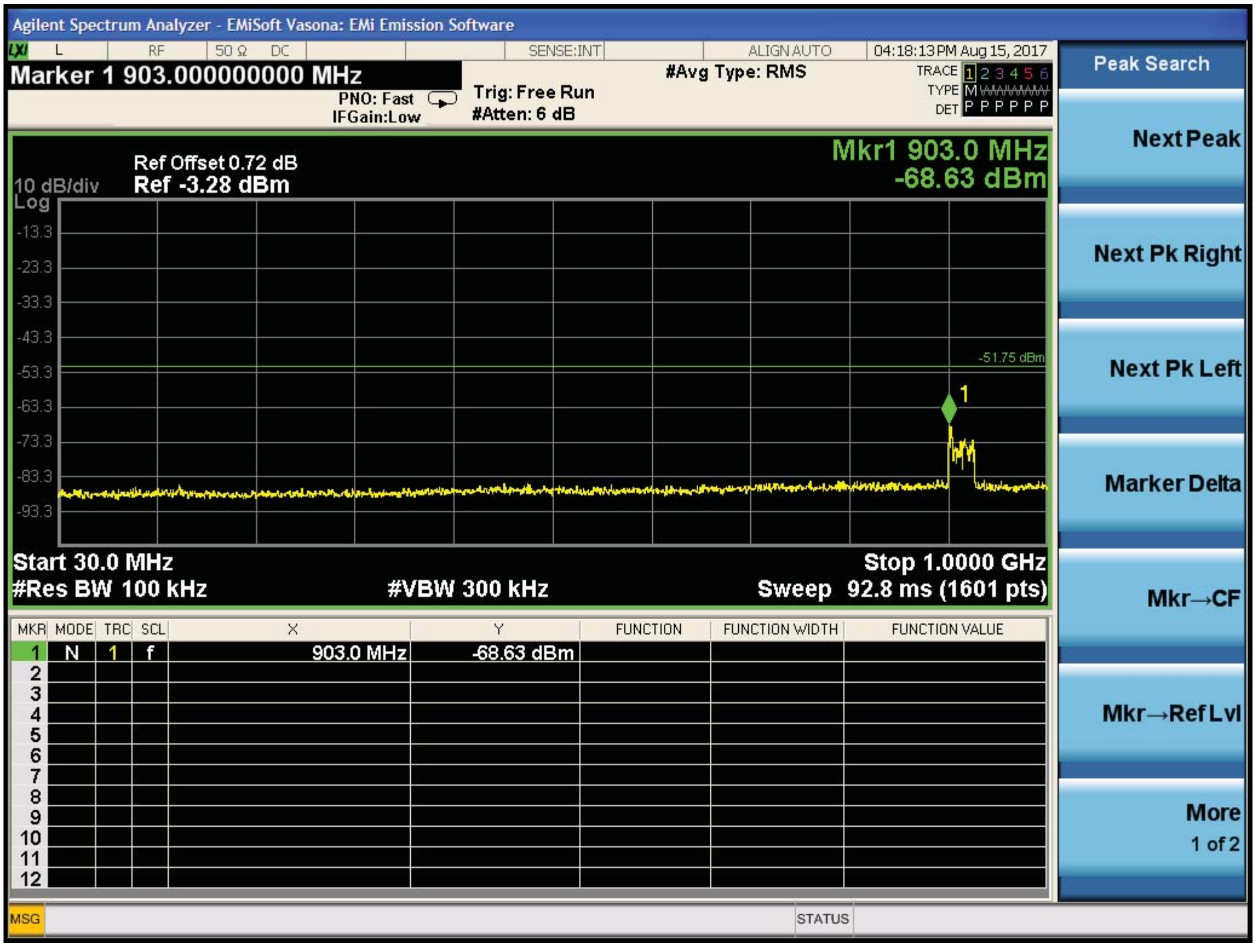
***Conducted Spurs Peak, 18-26GHz*, 2480MHz, BLE (GFSK)**

5.8dBi antenna gain reflected in limit line: -41.25dBm (avg limit) – 5.8dBi = -47.05dBm.



Conducted Spurs Peak, 30M-1GHz, 2402MHz, BLE (GFSK)

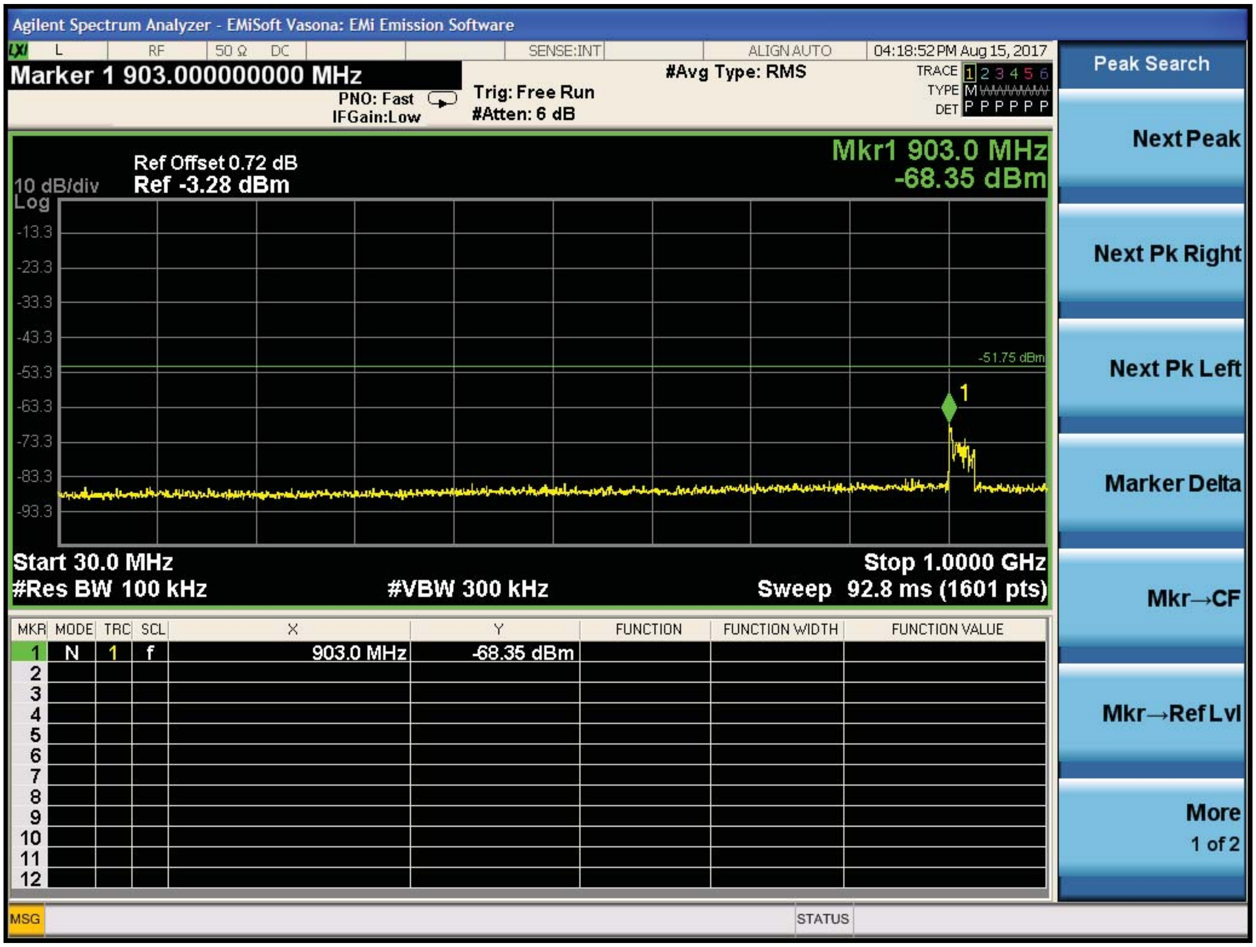
5.8dBi antenna gain and 4.7dB ground reflection factor reflected in limit line:
-41.25dBm (avg limit) – 5.8dBi – 4.7dB = -51.75dBm.



Conducted Spurs Peak, 30M-1GHz, 2442MHz, BLE (GFSK)

5.8dBi antenna gain and 4.7dB ground reflection factor reflected in limit line:

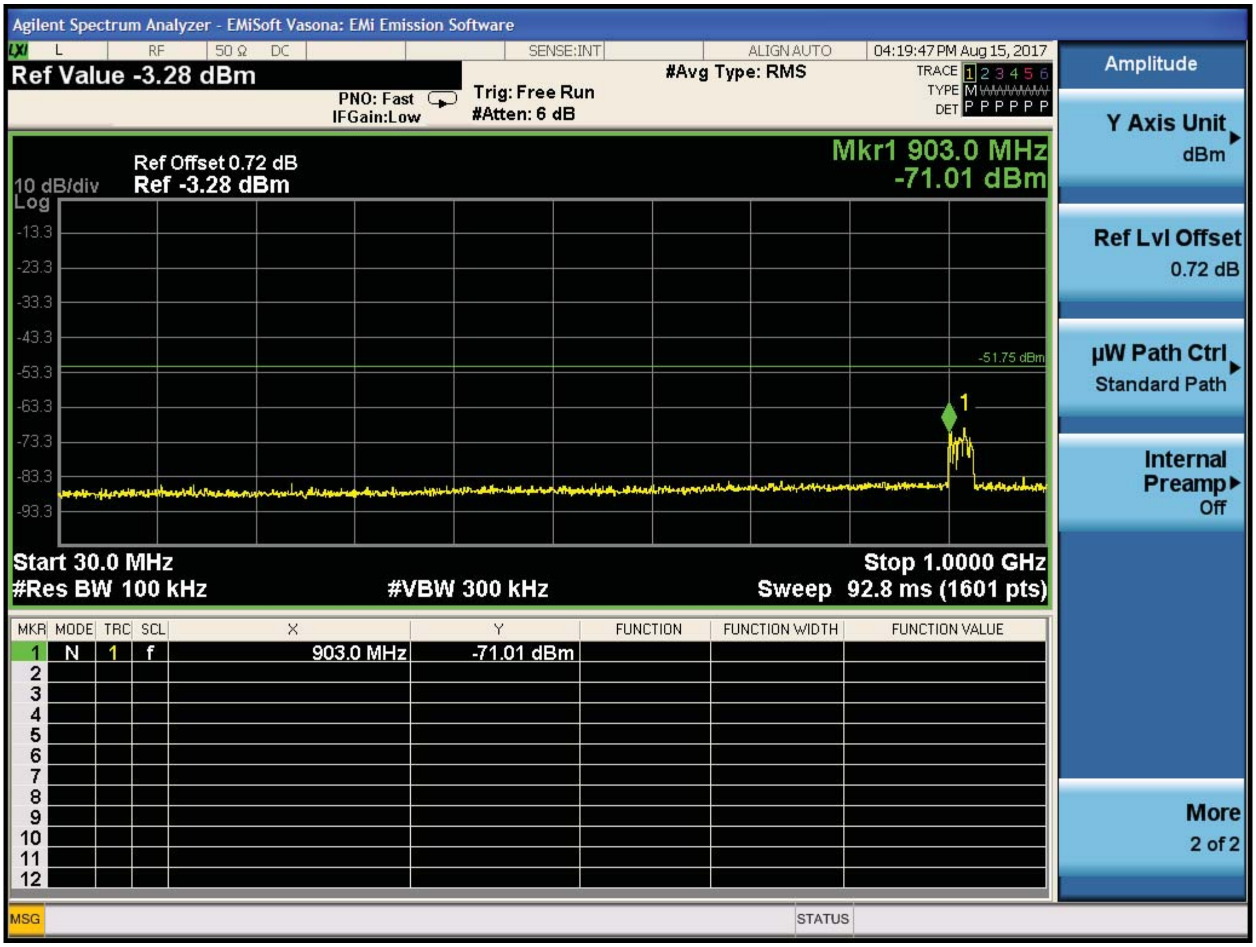
-41.25dBm (avg limit) – 5.8dBi – 4.7dB = -51.75dBm.



Conducted Spurs Peak, 30M-1GHz, 2480MHz, BLE (GFSK)

5.8dBi antenna gain and 4.7dB ground reflection factor reflected in limit line:

-41.25dBm (avg limit) – 5.8dBi – 4.7dB = -51.75dBm.



A.7 Conducted Band Edge

Conducted Band Edge Test Requirement

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, 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-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 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

15.205 / RSS-Gen

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.

Conducted Bandedge Test Method

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

Conducted Bandedge 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 Sweep = Auto couple Detector = Peak & Average Trace = Max Hold.

Samples, Systems, and Modes

System Number	Description	Samples	System under test	Support equipment
	EUT	S01	☑	☐
	Support	S02, S03	☐	☑

Tested By : Chris Blair	**Date of testing:** August 15, 2017& September 19-20, 2017
Test Result : PASS	

Test Equipment

See Appendix C for list of test equipment

Conducted Band Edge (Non-Restricted Band 2390-2400MHz) - Peak

Channel and *Band Edge Frequency* (MHz)	Mode	Tx Paths	Max power in 100kHz BW (dBm)	Power in 100kHz BW at band edge (dBm)	Total Attenuation (dB)	Limit (dB)	Margin (dB)
2402 *2400*	BLE (GFSK)	1	0.79	-57.51	58.3	30	28.3

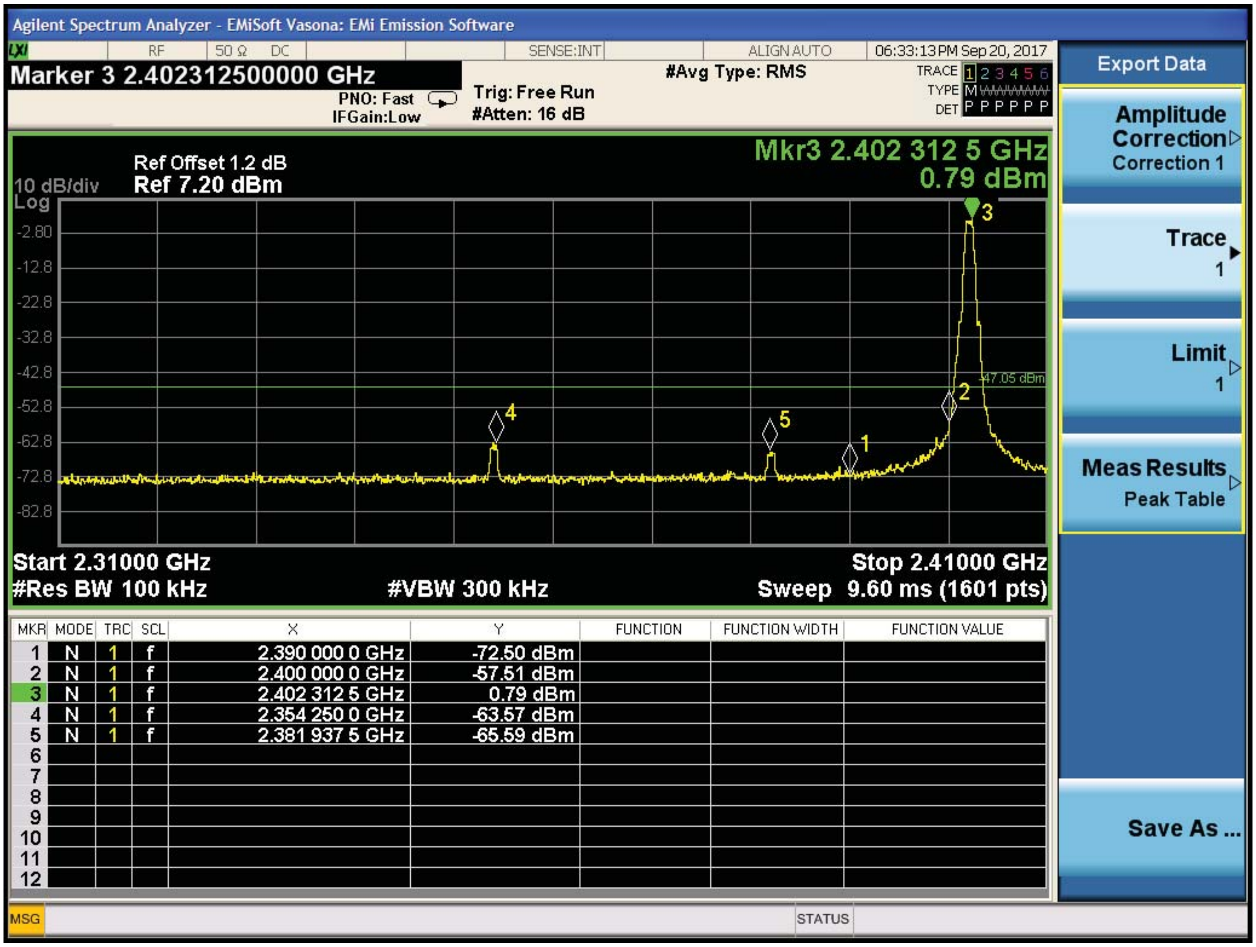
Conducted Band Edge - Peak

Channel and *Band Edge Frequency* (MHz)	Mode	Tx Paths	Correlated Antenna Gain (dBi)	Tx 1 Band Edge Level (dBm)	Total Band Edge Level (dBm) = Tx 1 Spur power (dBm) + Antenna Gain (dBi)	Limit (dBm)	Margin (dB)
2402 *2390*	BLE (GFSK)	1	5.8	-63.24	-57.44	-21.25	36.19
2480 *2483.5*	BLE (GFSK)	1	5.8	-54.45	-48.65	-21.25	27.4

Conducted Band Edge - Average

Channel and *Band Edge* Frequency (MHz)	Mode	Tx Paths	Correlated Antenna Gain (dBi)	Tx 1 Band Edge Level (dBm)	Total Band Edge Level (dBm) = Tx 1 Spur power (dBm) + Antenna Gain (dBi)	Limit (dBm)	Margin (dB)
2402 *2390*	BLE (GFSK)	1	5.8	-72.805	-67.005	-41.25	25.755
2480 *2483.5*	BLE (GFSK)	1	5.8	-64.795	-57.44	-41.25	16.19

Conducted Band Edge, channel=2402 MHz, BLE (GFSK), Peak – Non-Restricted Band 2390-2400MHz

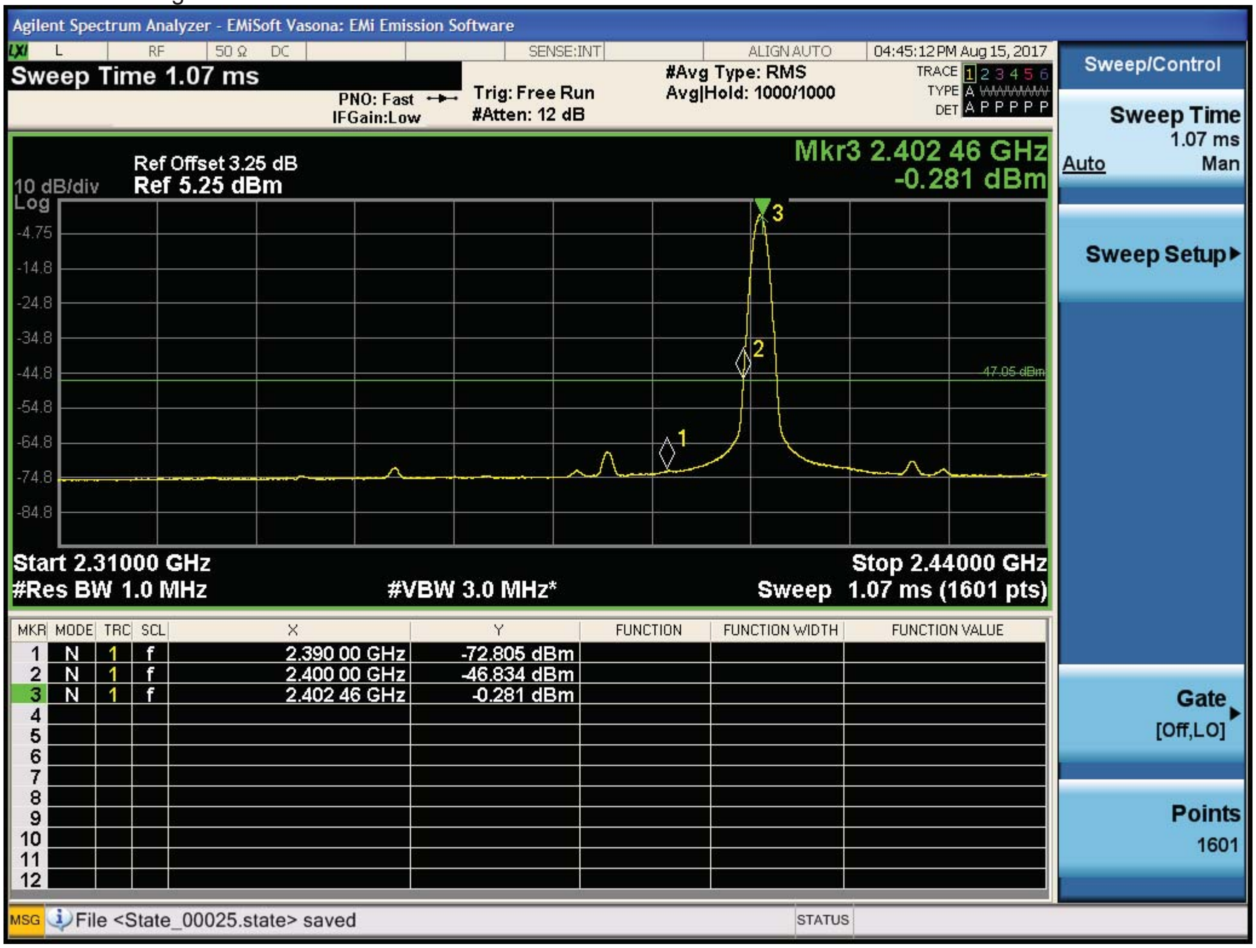


MKR	MODE	TRC	SCL	X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE
1	N	1	f	2.390 000 0 GHz	-72.50 dBm			
2	N	1	f	2.400 000 0 GHz	-57.51 dBm			
3	N	1	f	2.402 312 5 GHz	0.79 dBm			
4	N	1	f	2.354 250 0 GHz	-63.57 dBm			
5	N	1	f	2.381 937 5 GHz	-65.59 dBm			

Conducted Band Edge, channel=2402 MHz, BLE (GFSK), Average

+2.05dB correction factor for duty cycle included in ref level offset.

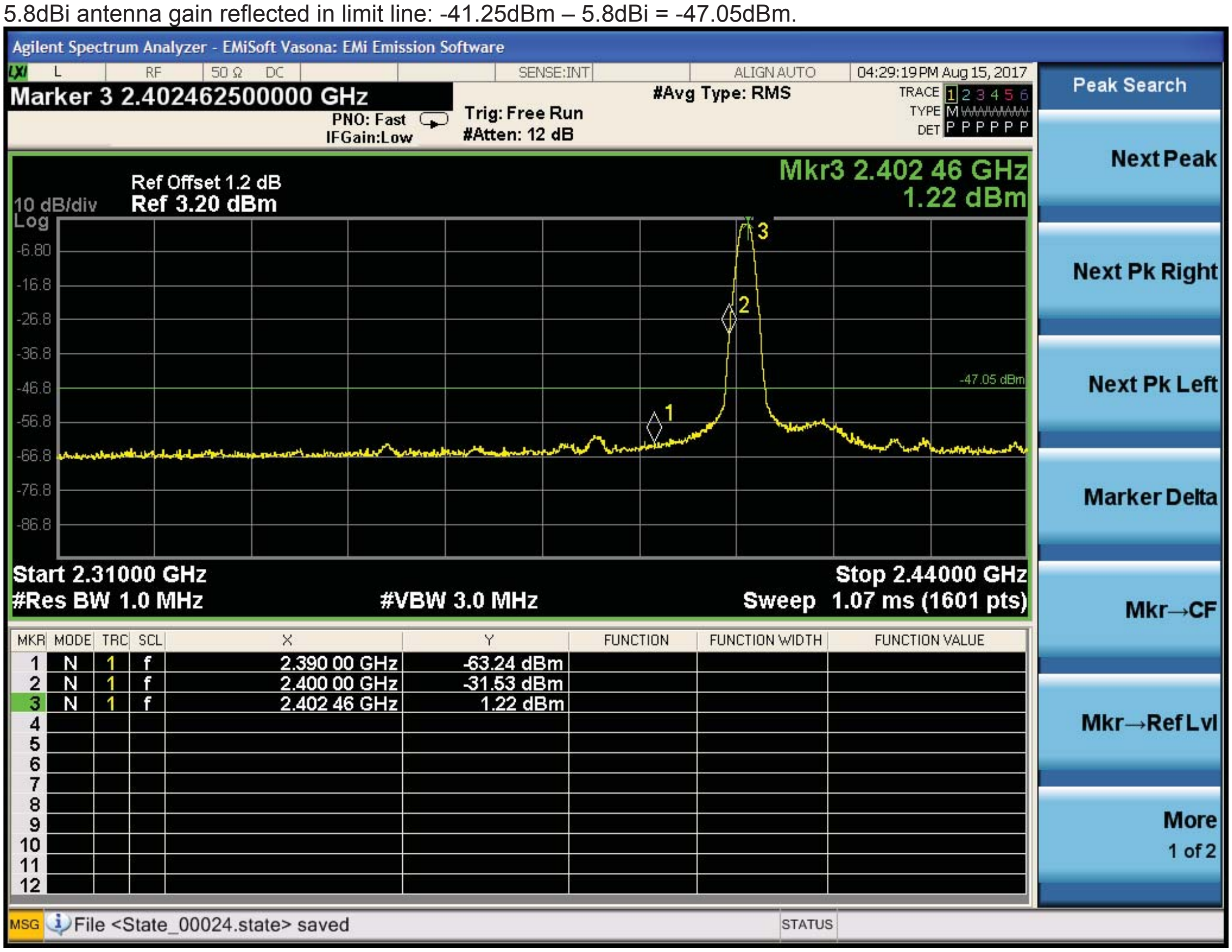
5.8dBi antenna gain reflected in limit line: -41.25dBm – 5.8dBi = -47.05dBm.



MKR	MODE	TRC	SCL	X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE
1	N	1	f	2.390 00 GHz	-72.805 dBm			
2	N	1	f	2.400 00 GHz	-46.834 dBm			
3	N	1	f	2.402 46 GHz	-0.281 dBm			
4								
5								
6								
7								
8								
9								
10								
11								
12								

Conducted Band Edge, 2402 MHz, BLE (GFSK), Peak

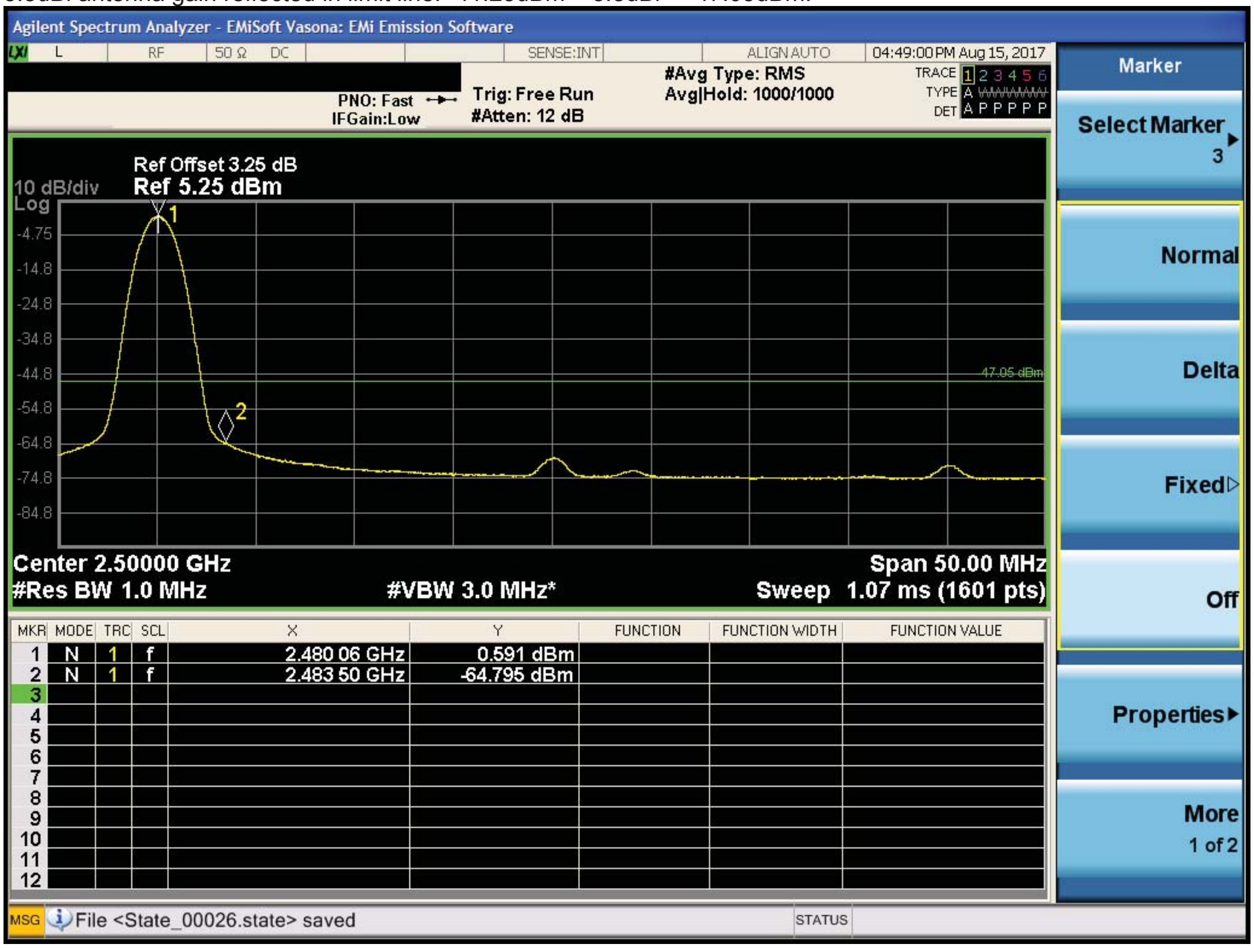
5.8dBi antenna gain reflected in limit line: -41.25dBm – 5.8dBi = -47.05dBm.



Conducted Band Edge, 2480 MHz, BLE (GFSK), Average

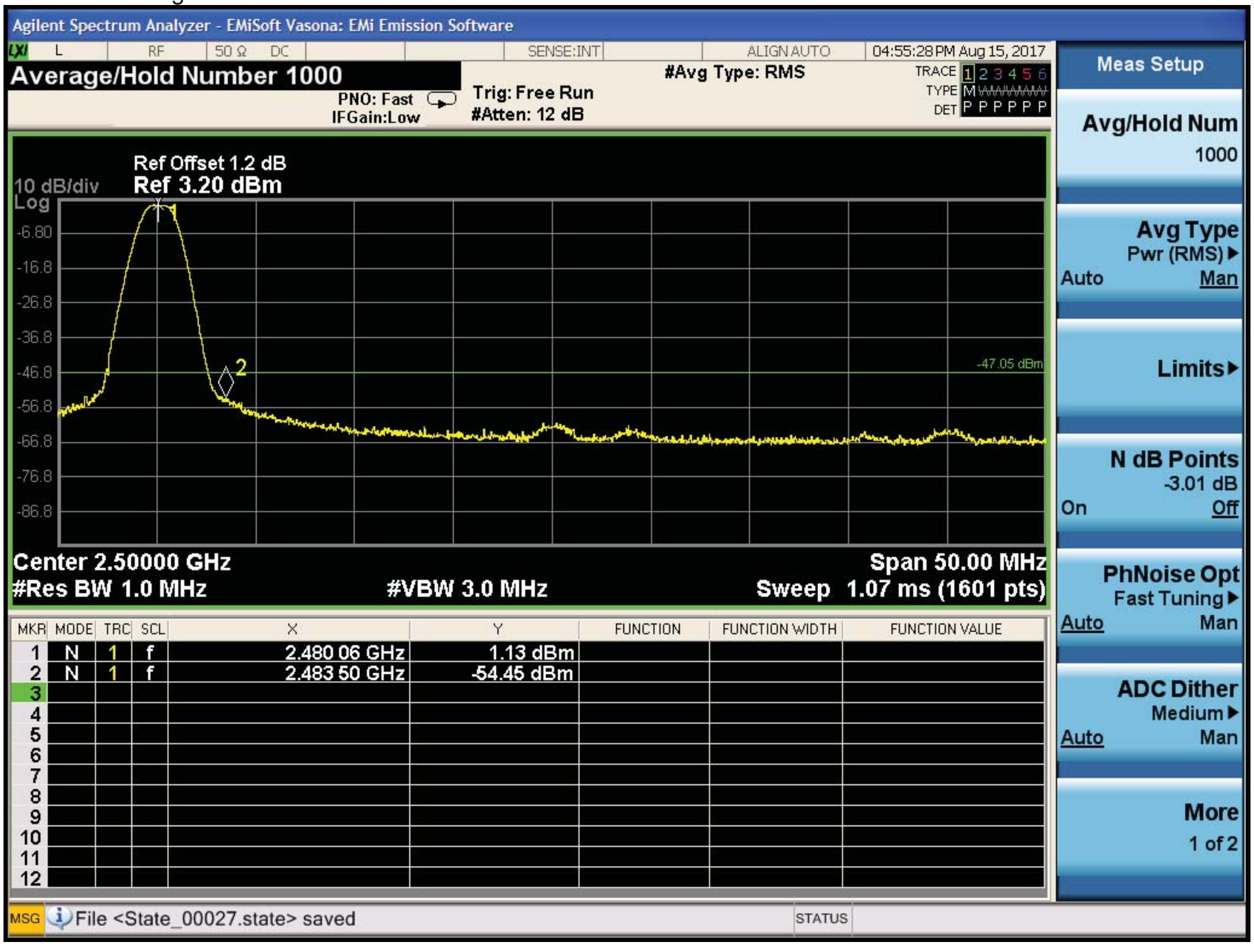
+2.05dB correction factor for duty cycle included in ref level offset.

5.8dBi antenna gain reflected in limit line: -41.25dBm – 5.8dBi = -47.05dBm.



Conducted Band Edge, 2480 MHz, BLE (GFSK), Peak

5.8dBi antenna gain reflected in limit line: -41.25dBm – 5.8dBi = -47.05dBm.



Appendix B: Emission Test Results

Testing Laboratory:

Cisco Systems, Inc., 125 West Tasman Drive & 425 East Tasman Drive, San Jose, CA 95134, USA

B.1 Radiated Spurious Emissions

15.205 / RSS-Gen: 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.

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

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: 1GHz – 18GHz / 18GHz – 26.5GHz
Sweep Time: Coupled
Resolution Bandwidth: 1MHz
Video Bandwidth: 3 MHz for peak, 1 kHz for average
Detector: Peak

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.

System Number	Description	Samples	System under test	Support equipment
	EUT	S04	☑	☐
	Support	S03, S02	☐	☑

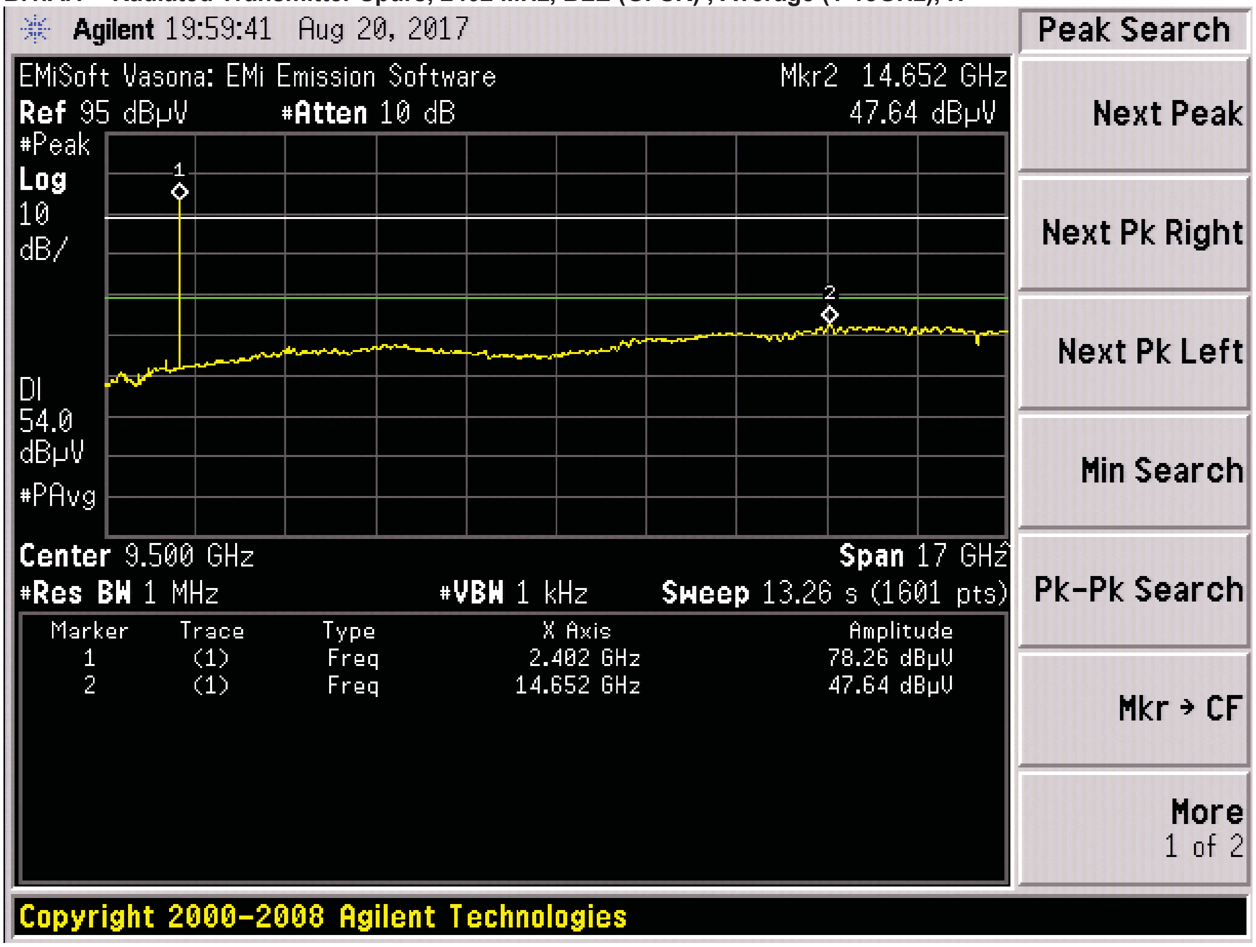
Tested By : Chris Blair	Date of testing: August 18-25, 2017
Test Result : PASS	

See Appendix C for list of test equipment
Note that duty cycle was increased to 87.5% for RSE. This duty cycle was not available at the time that conducted tests were done. See Appendix J for details.

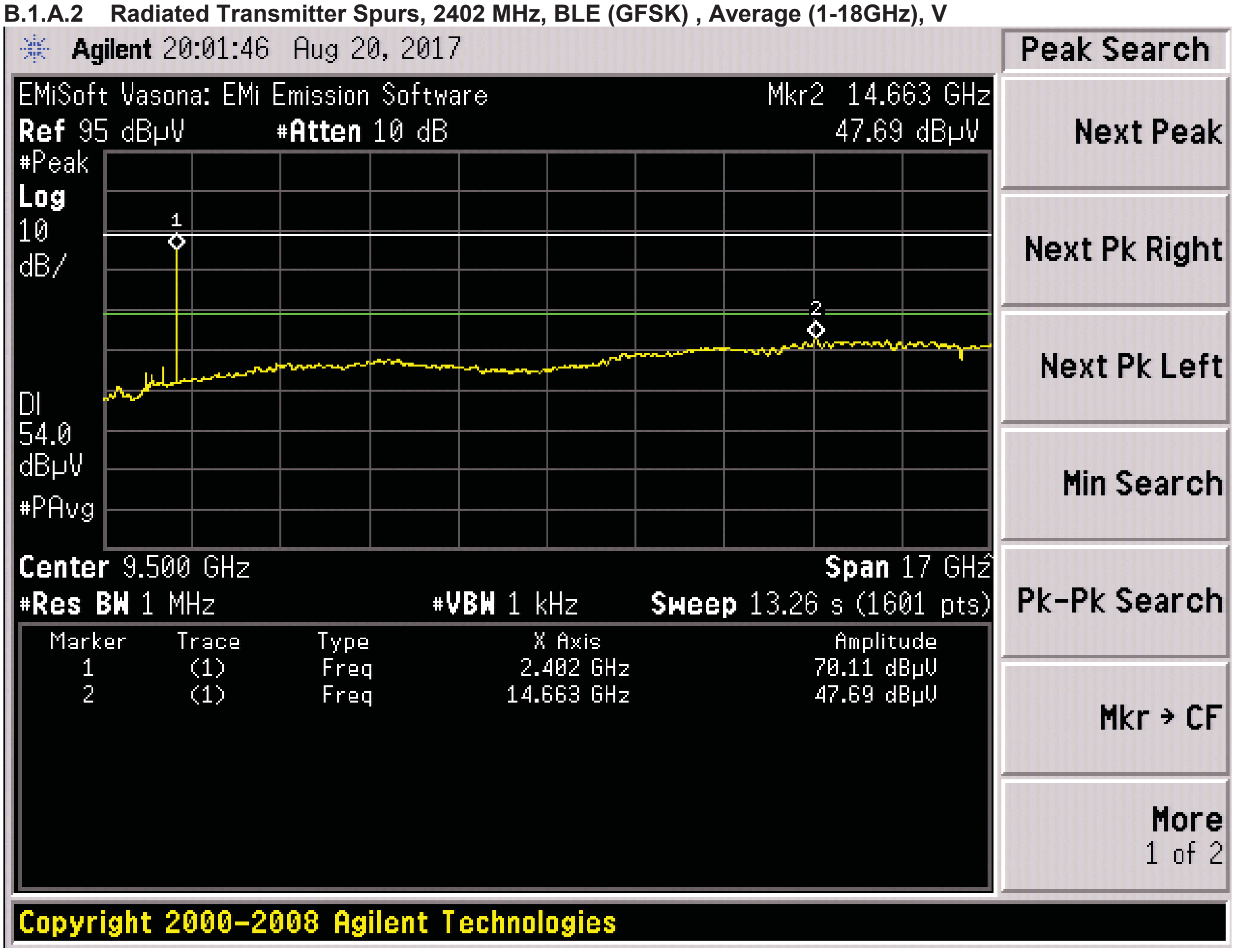
B.1.A Transmitter Radiated Spurious Emissions-Average

Frequency (MHz)	Mode	Data Rate (Mbps)	Spurious Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2402	BLE, GFSK	1	**47.64 H**	**<54**	6.36
2402	BLE, GFSK	1	**47.69 V**	**<54**	6.31
2442	BLE, GFSK	1	**47.45 H**	**<54**	6.55
2442	BLE, GFSK	1	**47.60 V**	**<54**	6.40
2480	BLE, GFSK	1	**47.57 H**	**<54**	6.43
2480	BLE, GFSK	1	**47.70 V**	**<54**	6.30

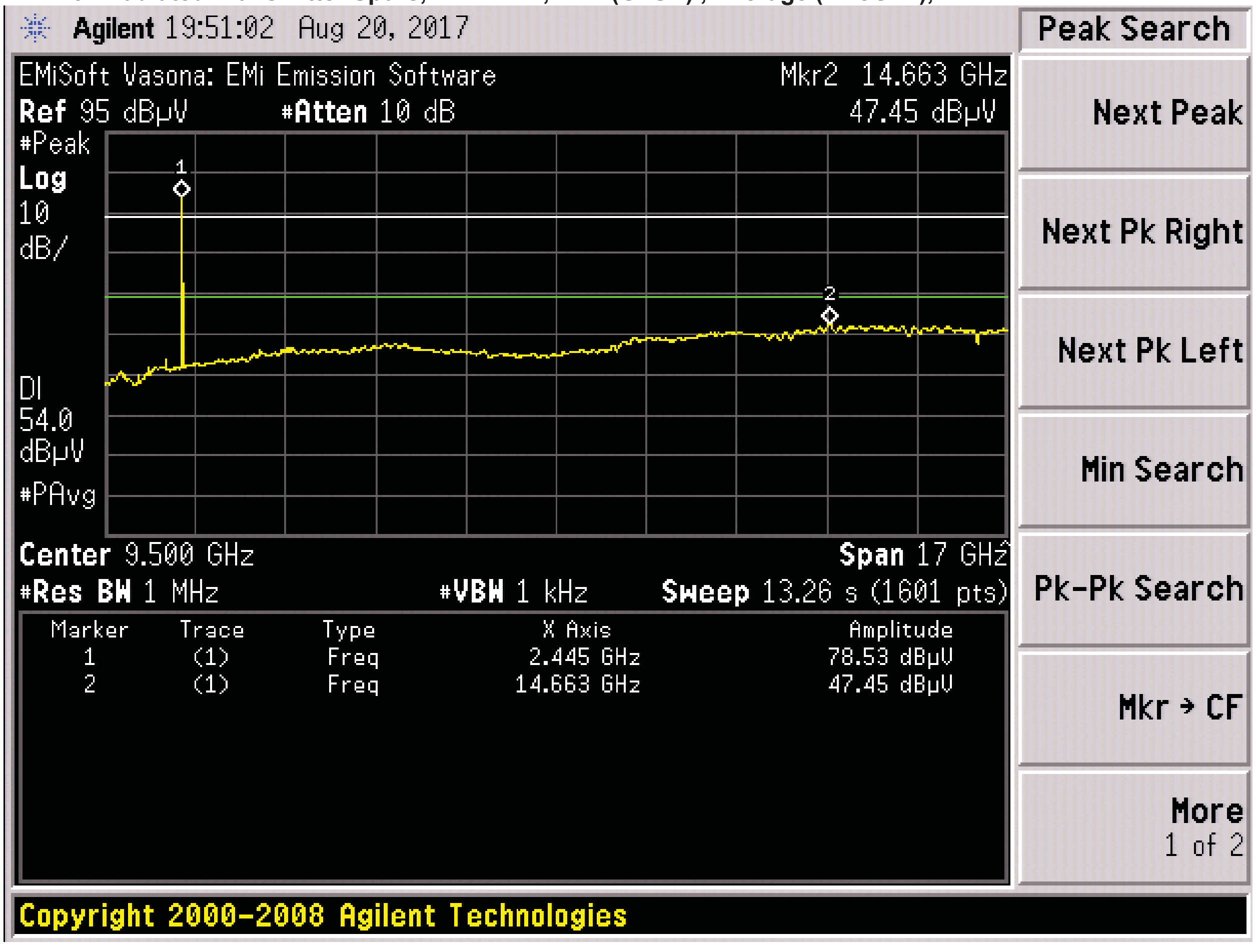
B.1.A.1 Radiated Transmitter Spurs, 2402 MHz, BLE (GFSK) , Average (1-18GHz), H



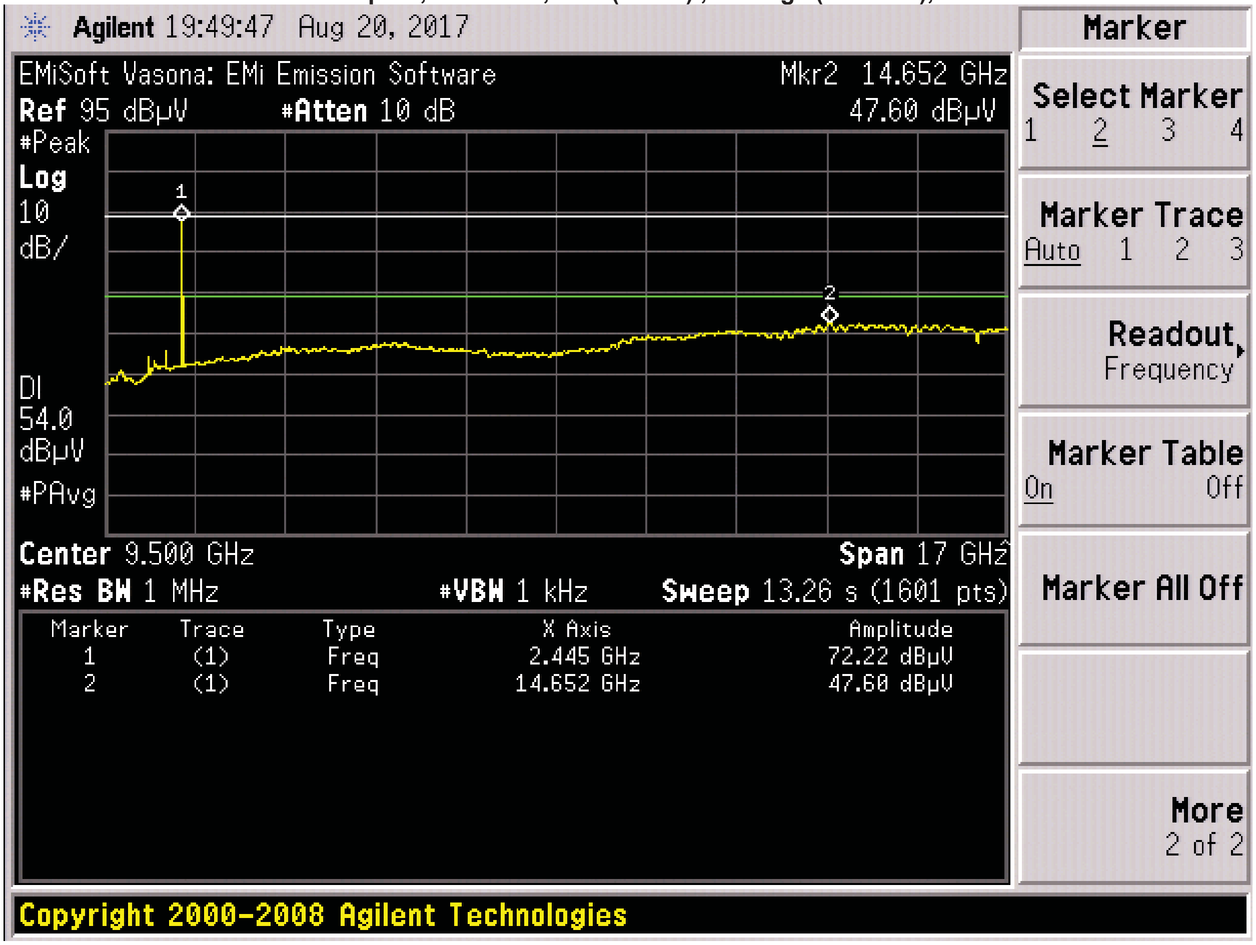
B.1.A.2 Radiated Transmitter Spurs, 2402 MHz, BLE (GFSK) , Average (1-18GHz), V



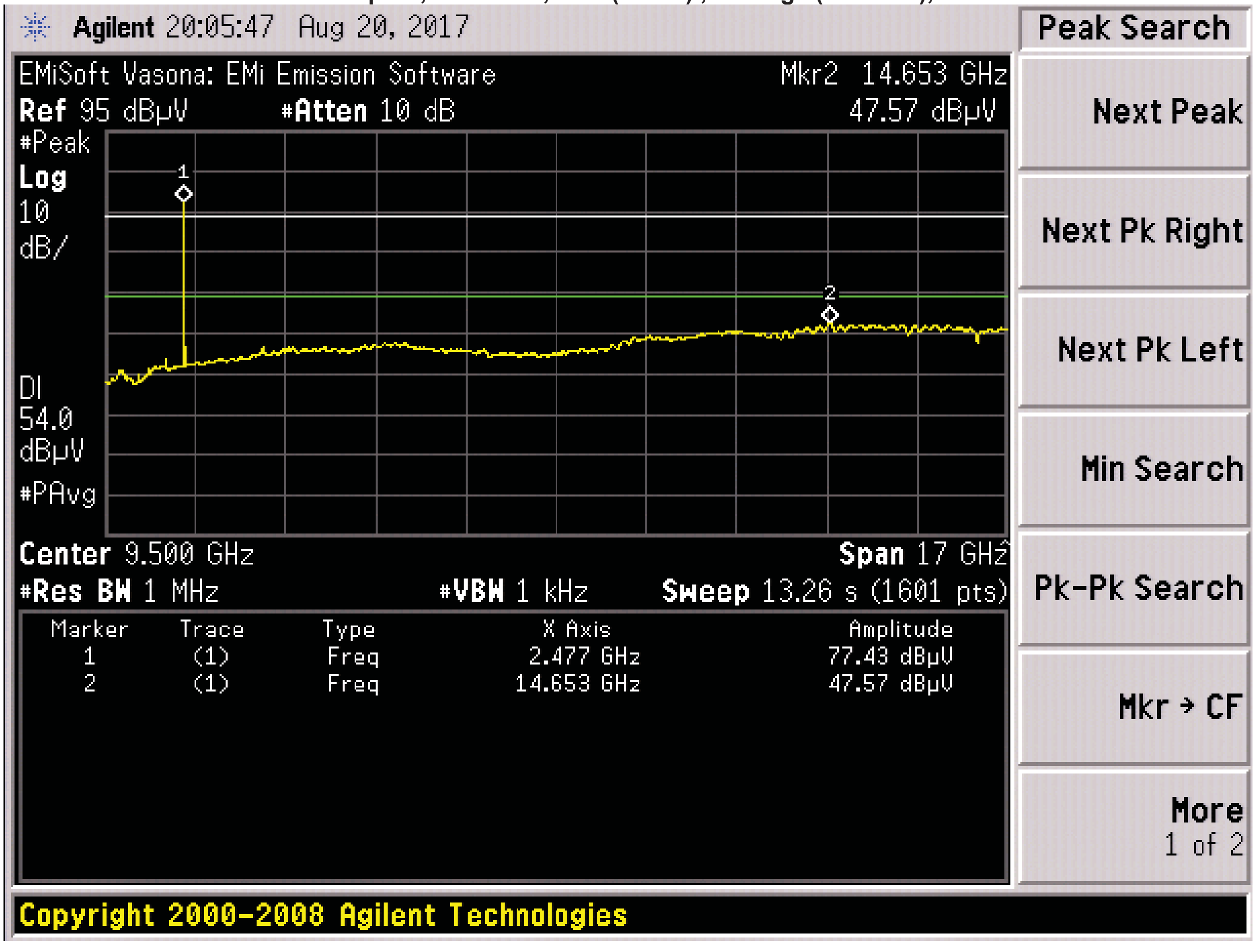
B.1.A.3 Radiated Transmitter Spurs, 2442 MHz, BLE (GFSK) , Average (1-18GHz), H



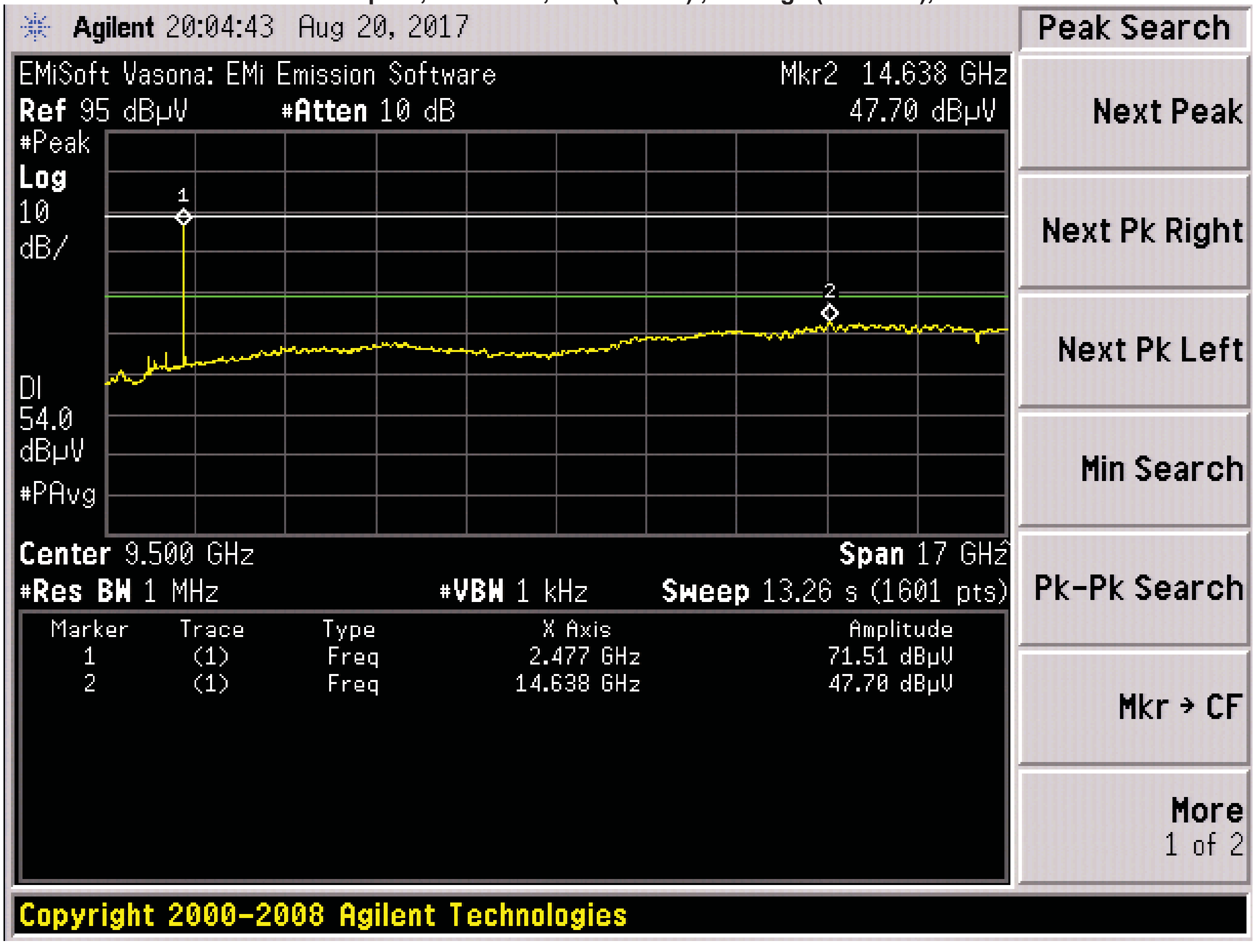
B.1.A.4 Radiated Transmitter Spurs, 2442 MHz, BLE (GFSK) , Average (1-18GHz), V



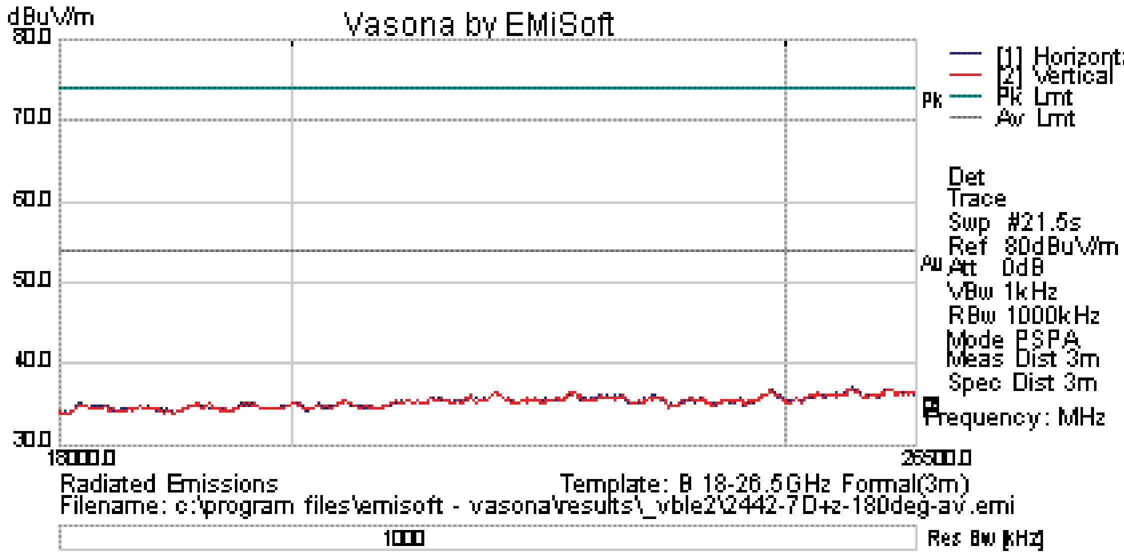
B.1.A.5 Radiated Transmitter Spurs, 2480 MHz, BLE (GFSK) , Average (1-18GHz), H



B.1.A.6 Radiated Transmitter Spurs, 2480 MHz, BLE (GFSK) , Average (1-18GHz), V



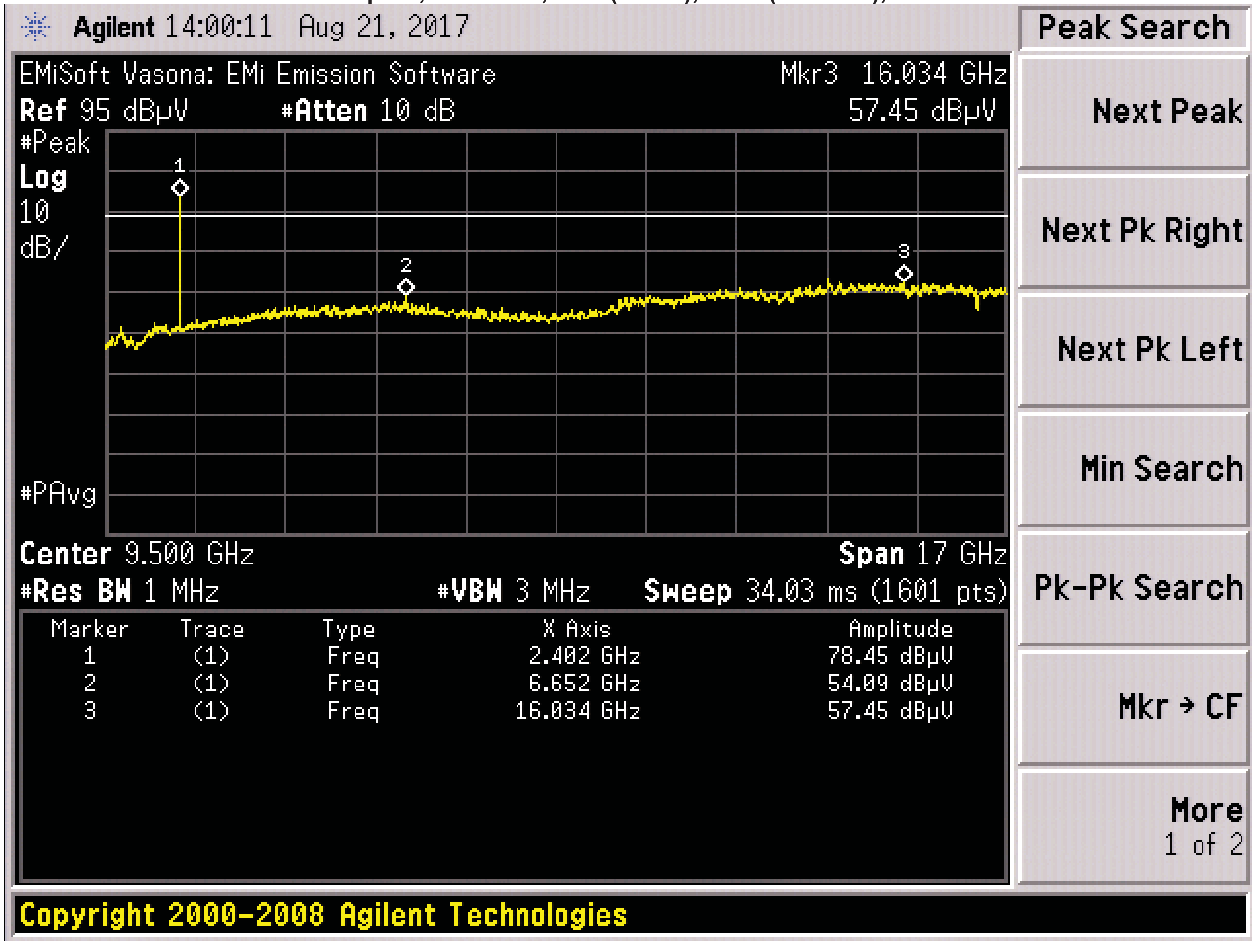
B.1.A.7 Radiated Transmitter Spurs, All rate, All modes, Average (18-26.5GHz)



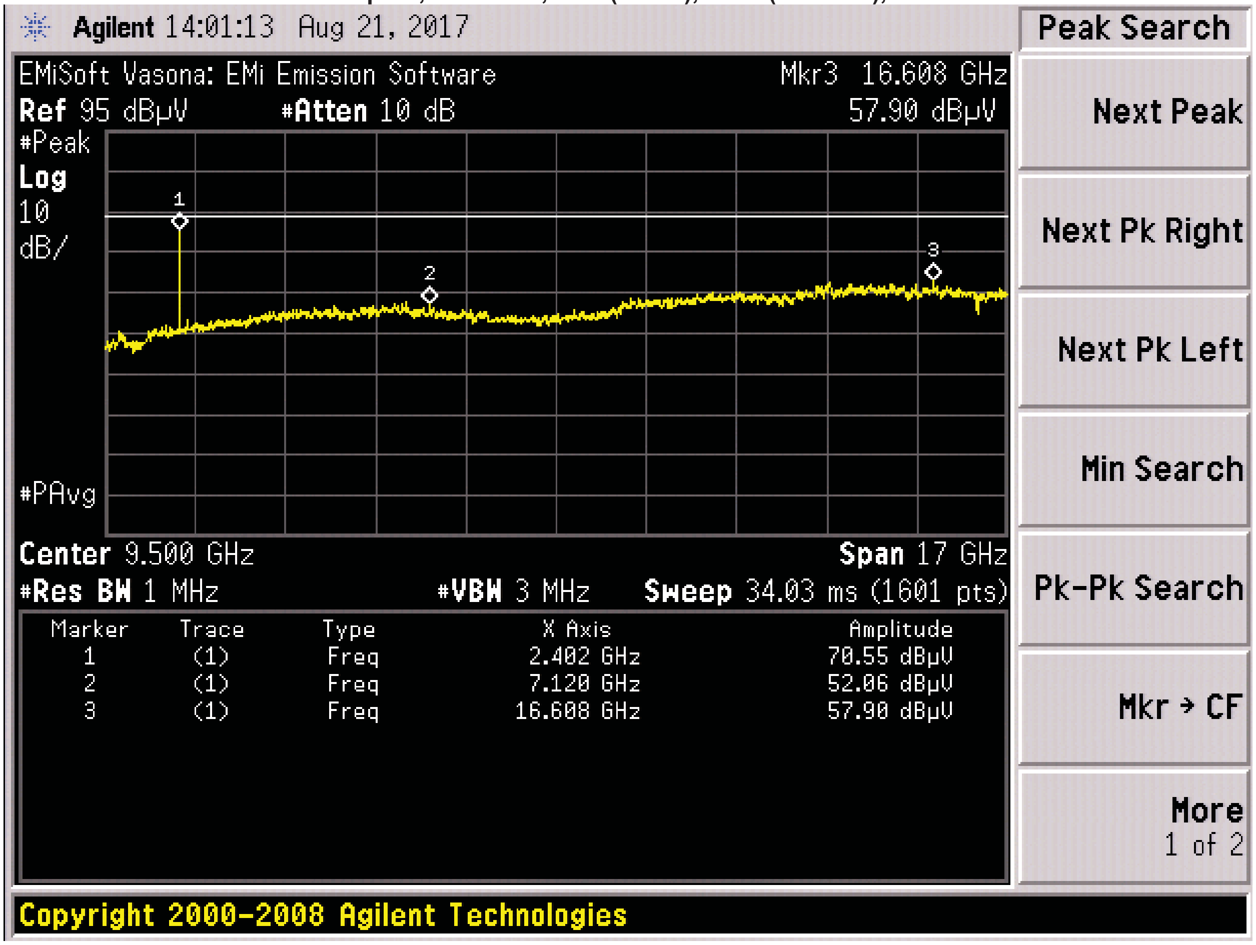
B.1.P Transmitter Radiated Spurious Emissions-Peak

Frequency (MHz)	Mode	Data Rate (Mbps)	Spurious Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2402	BLE, GFSK	1	**57.45 H**	**<74**	16.55
2402	BLE, GFSK	1	**57.90 V**	**<74**	16.10
2442	BLE, GFSK	1	**57.59 H**	**<74**	16.41
2442	BLE, GFSK	1	**57.47 V**	**<74**	16.53
2480	BLE, GFSK	1	**57.83 H**	**<74**	16.17
2480	BLE, GFSK	1	**56.89 V**	**<74**	17.11

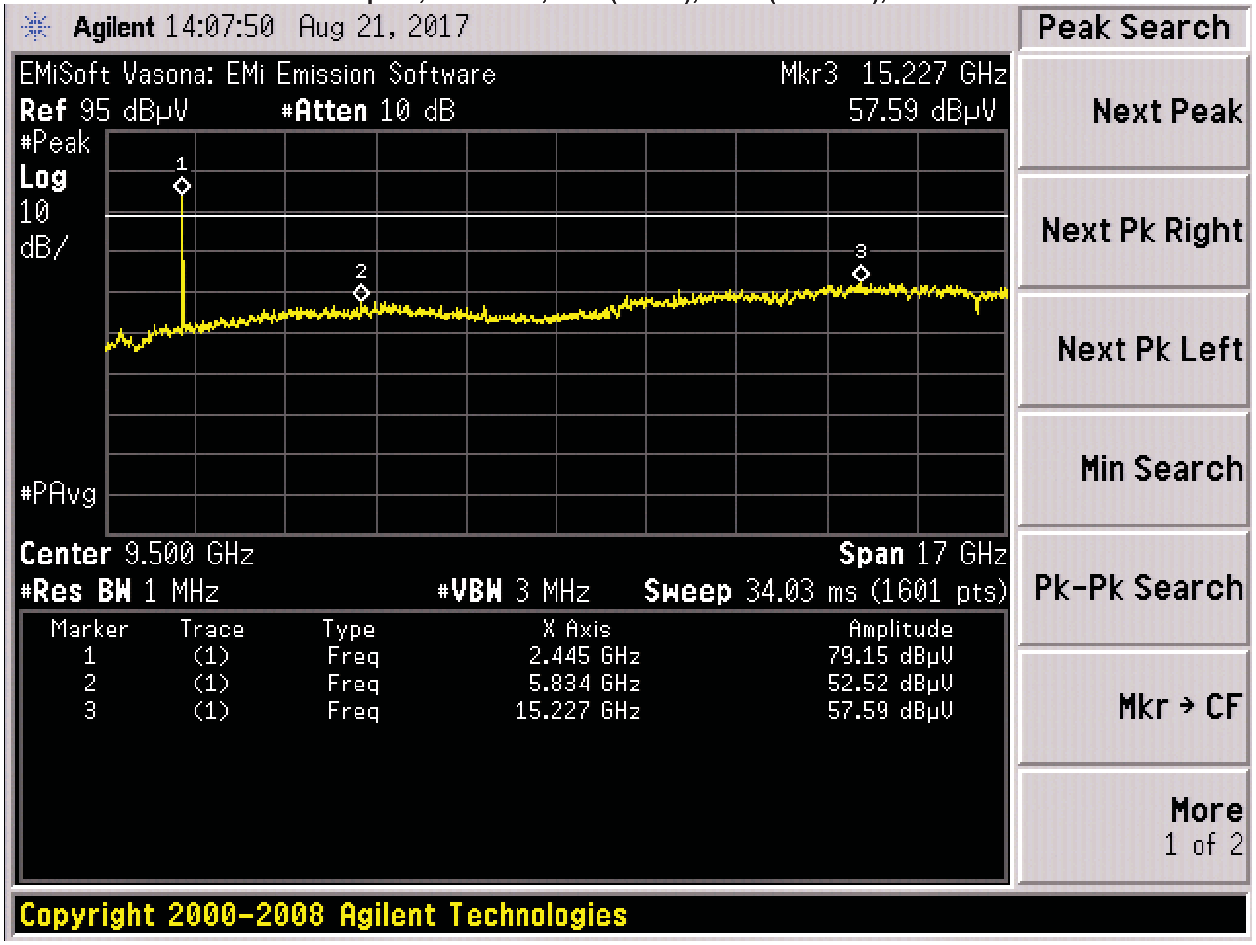
B.1.P.1 Radiated Transmitter Spurs, 2402 MHz, BLE (GFSK), Peak (1-18GHz), H



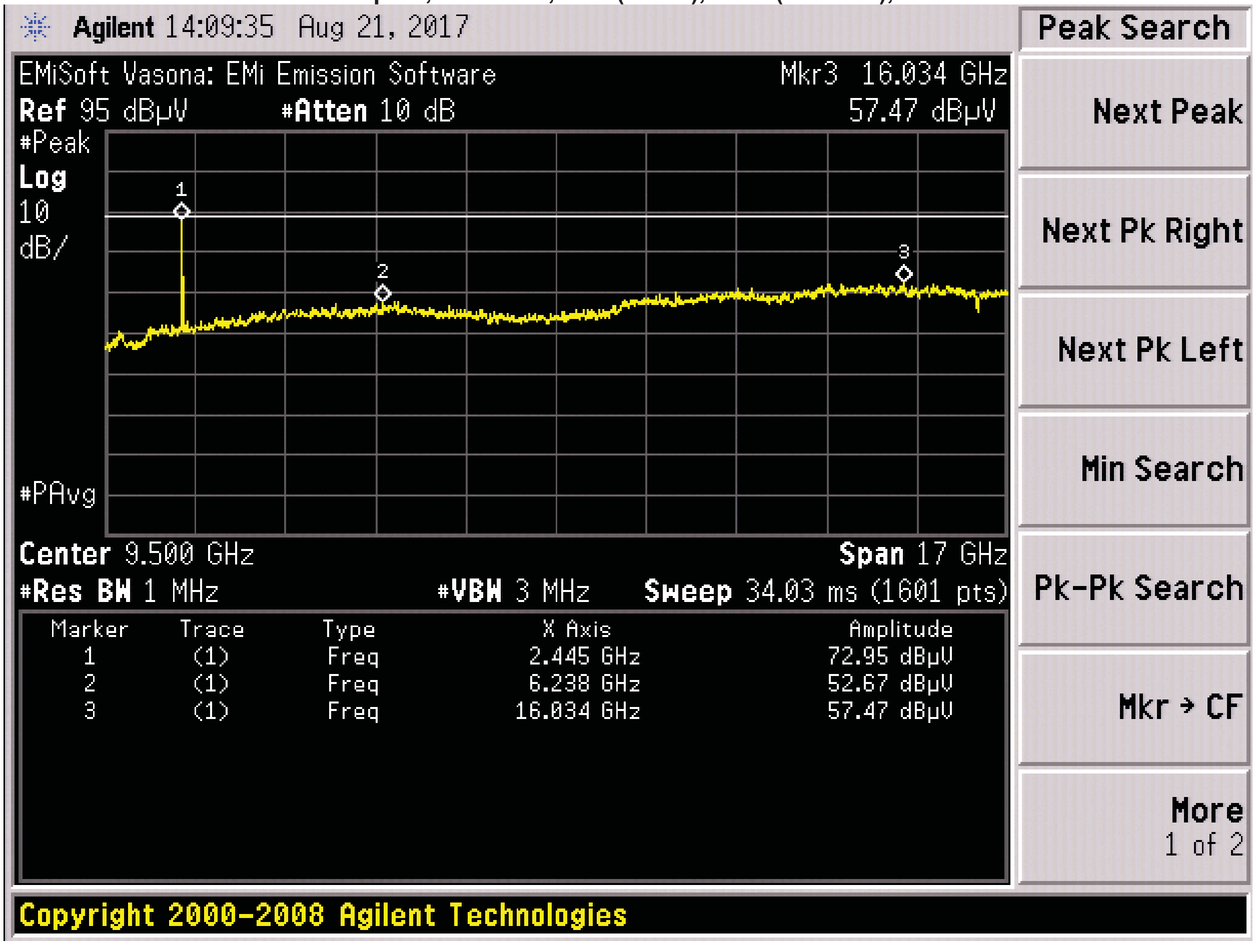
B.1.P.2 Radiated Transmitter Spurs, 2402 MHz, BLE (GFSK), Peak (1-18GHz), V



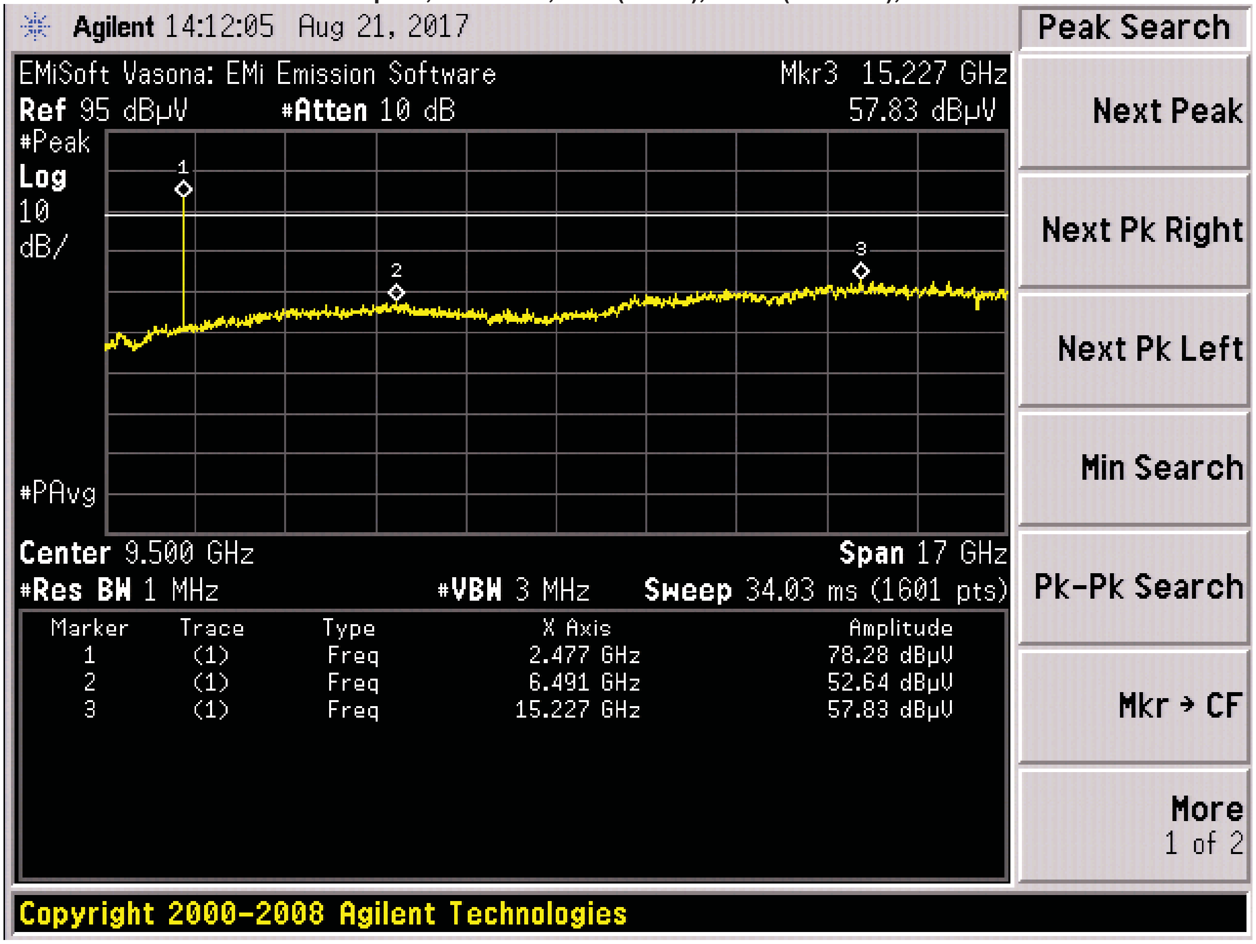
B.1.P.3 Radiated Transmitter Spurs, 2442 MHz, BLE (GFSK), Peak (1-18GHz), H



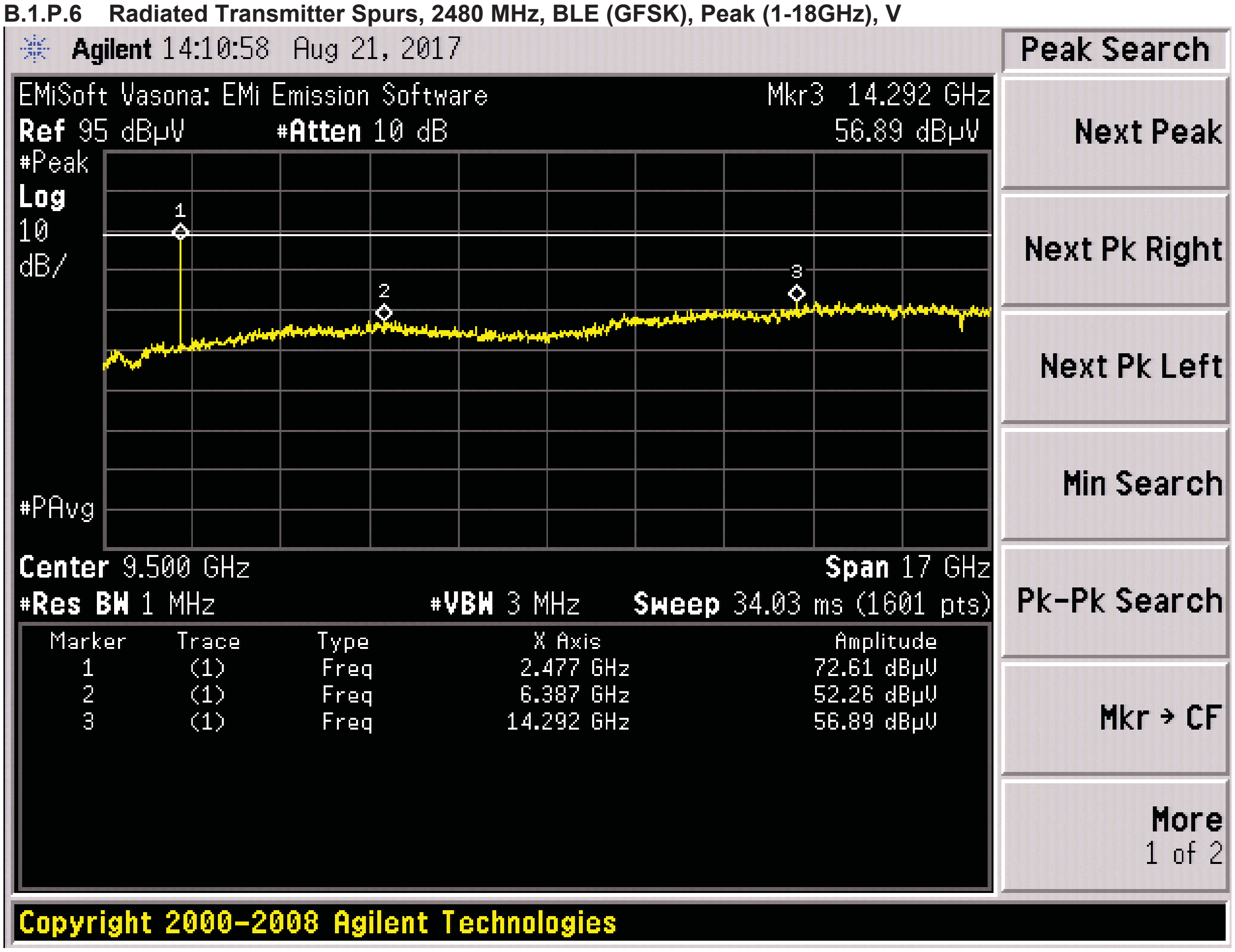
B.1.P.4 Radiated Transmitter Spurs, 2442 MHz, BLE (GFSK), Peak (1-18GHz), V



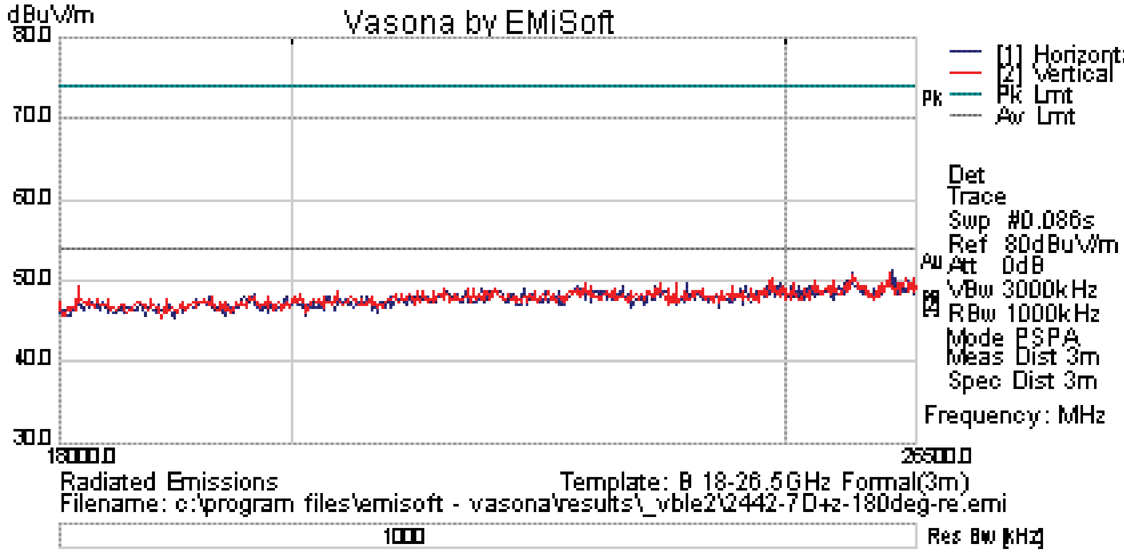
B.1.P.5 Radiated Transmitter Spurs, 2480 MHz, BLE (GFSK), Peak (1-18GHz), H



B.1.P.6 **Radiated Transmitter Spurs, 2480 MHz, BLE (GFSK), Peak (1-18GHz), V**



B.1.P.7 Radiated Transmitter Spurs, All rate, All modes, Peak (18-26.5GHz)



B.2 Receiver Spurious Emissions

RSS-GEN:
Receivers are required to comply with the limits of spurious emissions as set out in this section. Receiver emission measurements are to be performed as per the normative test method referenced in section 3.

Radiated emissions which fall in the restricted bands, as defined in RSS-Gen section 8.10, must also comply with the radiated emission limits specified in RSS-Gen section 8.9.

For emissions at frequencies below 1 GHz, measurements shall be performed using a CISPR quasi-peak detector and the related measurement bandwidth. At frequencies above 1 GHz, measurements shall be performed using a linear average detector with a minimum resolution bandwidth of 1 MHz.

Test Procedure

Ref. RSS-GEN sec 8.9 & 8.10
ANSI C63.10: 2013 section 4.1.4.2.2, 4.1.4.2.3, 6.6.4 & 11.12.2

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 Rx mode.

Span:	1GHz – 18GHz / 18GHz – 26.5GHz
Sweep Time:	Coupled
Resolution Bandwidth:	1MHz
Video Bandwidth:	3MHz for Peak, 1 kHz for average
Detector:	Peak

Radiated emission measurements shall be performed with the receiver antenna connected to the receiver antenna terminals.

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

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

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

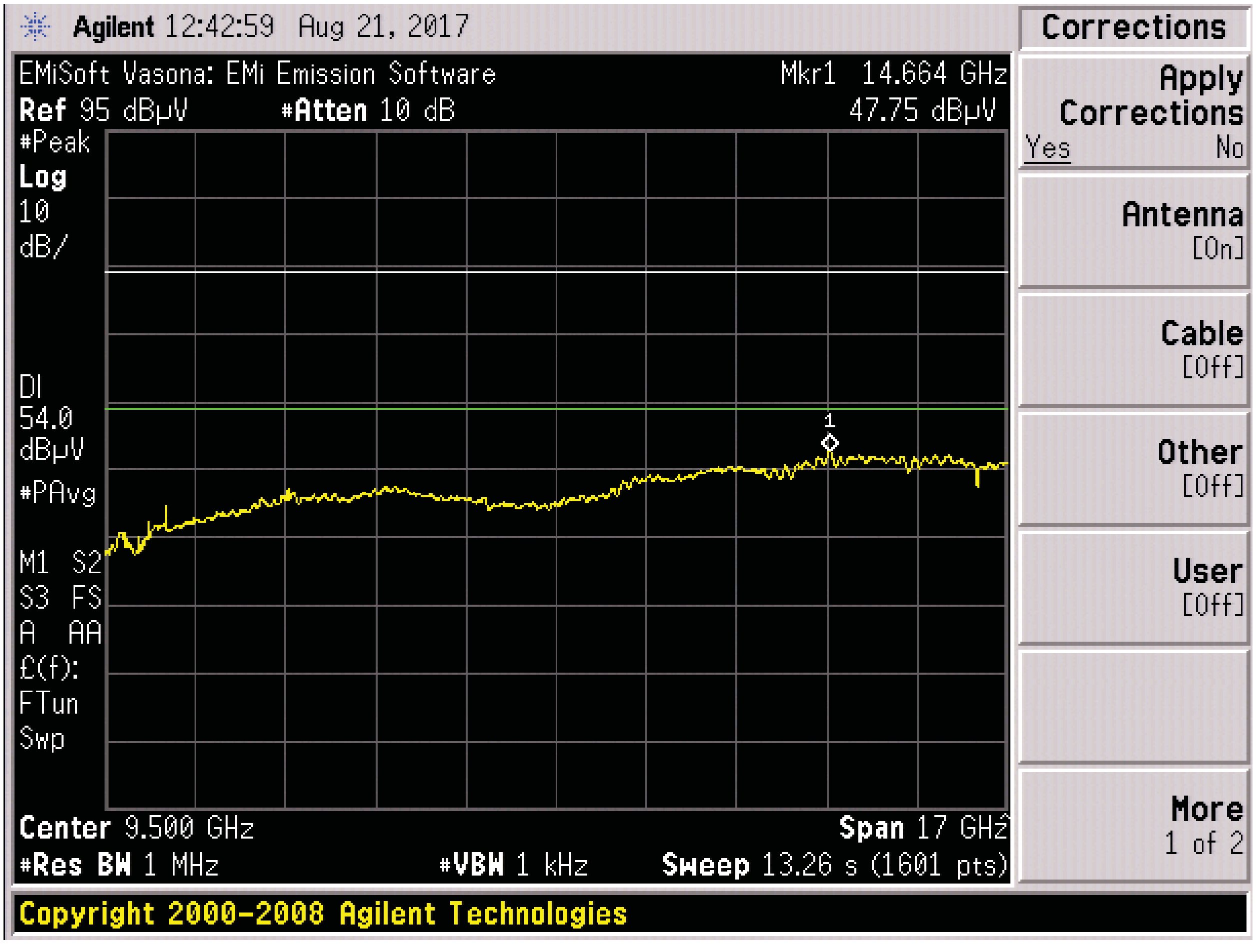
System Number	Description	Samples	System under test	Support equipment
	EUT	S04	☑	☐
	Support	S03, S02	☐	☑

Tested By :	Date of testing:	
Chris Blair	August 18-25, 2017	Peak & Average Measurements
Test Result : PASS		

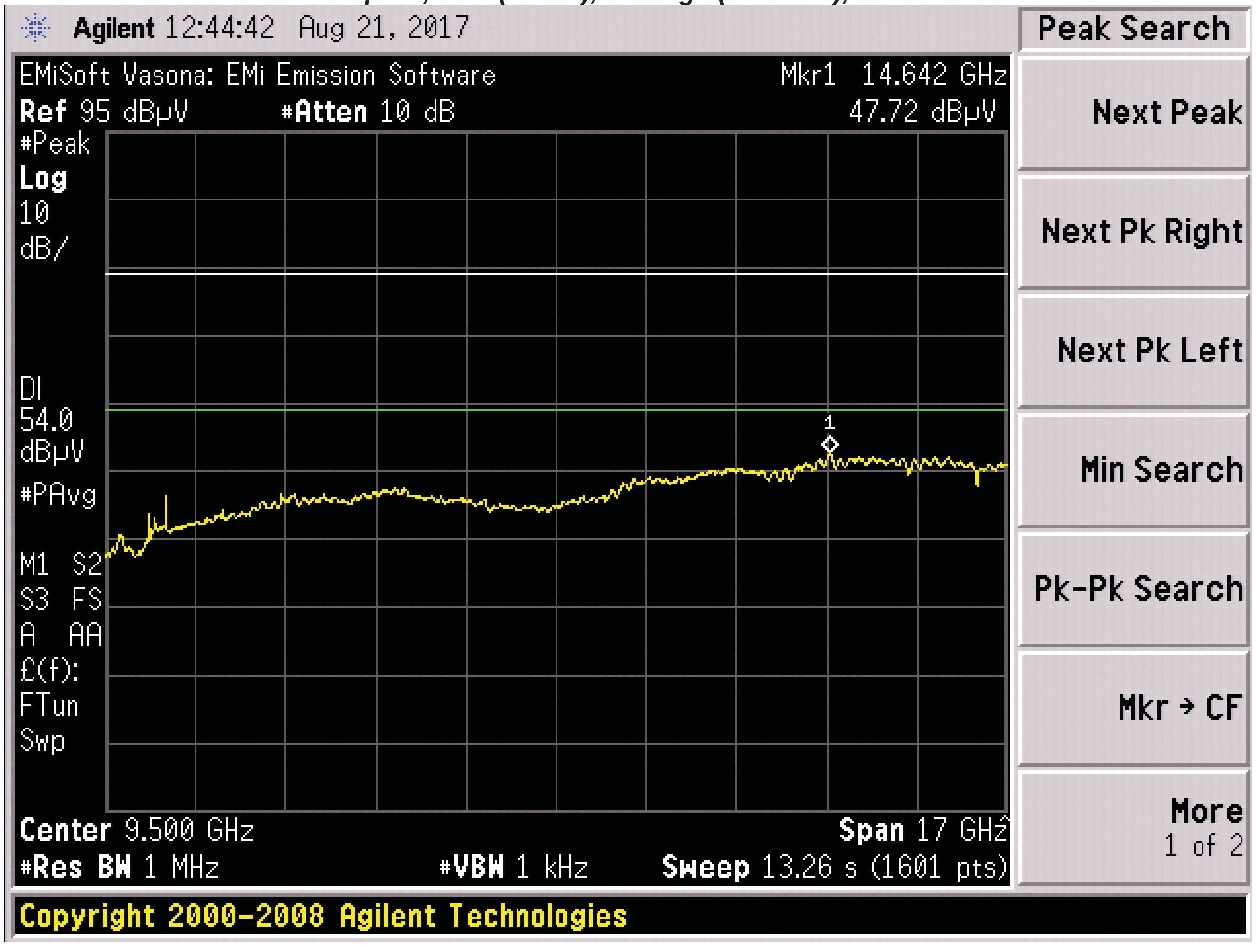
See Appendix C for list of test equipment

B.2.A Receiver Radiated Spurious Emissions (Average Measurements)

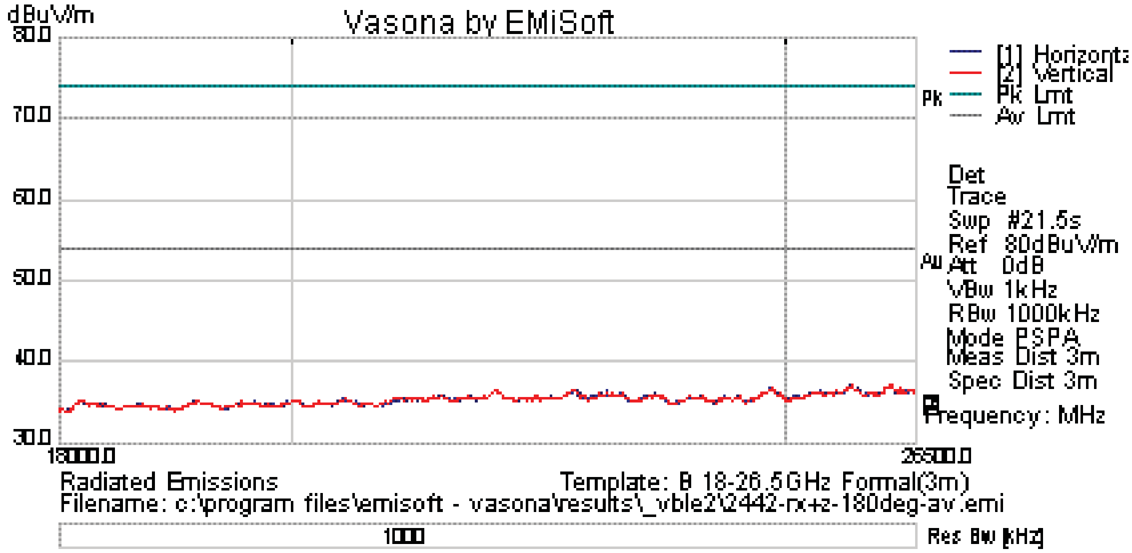
B.2.A.1 Radiated Receiver Spurs, BLE (GFSK), Average (1-18GHz) Horizontal



B.2.A.2 Radiated Receiver Spurs, BLE (GFSK), Average (1-18GHz), Vertical

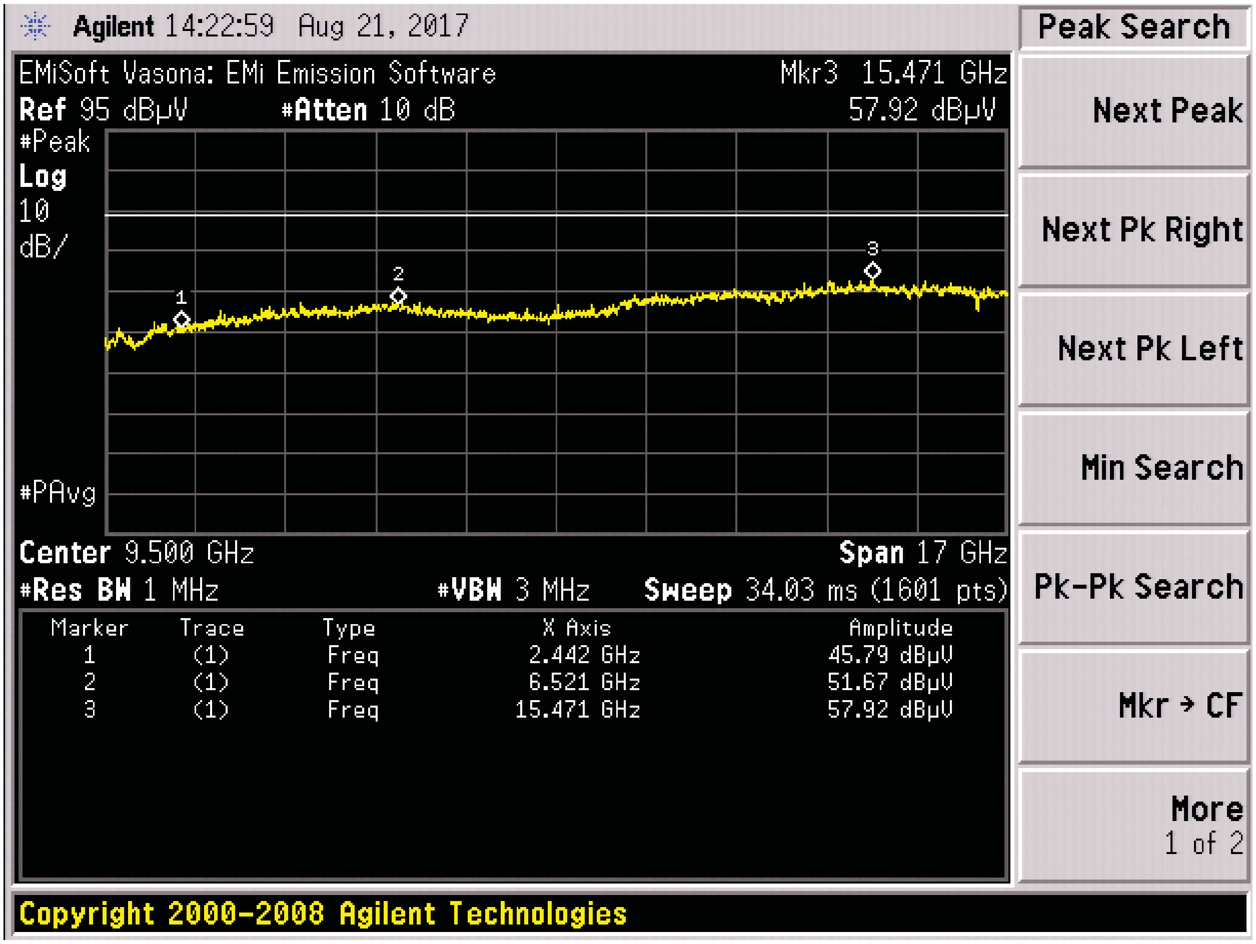


B.2.A.3 Radiated Receiver Spurs, BLE (GFSK), Average (18-26.5GHz), H+V

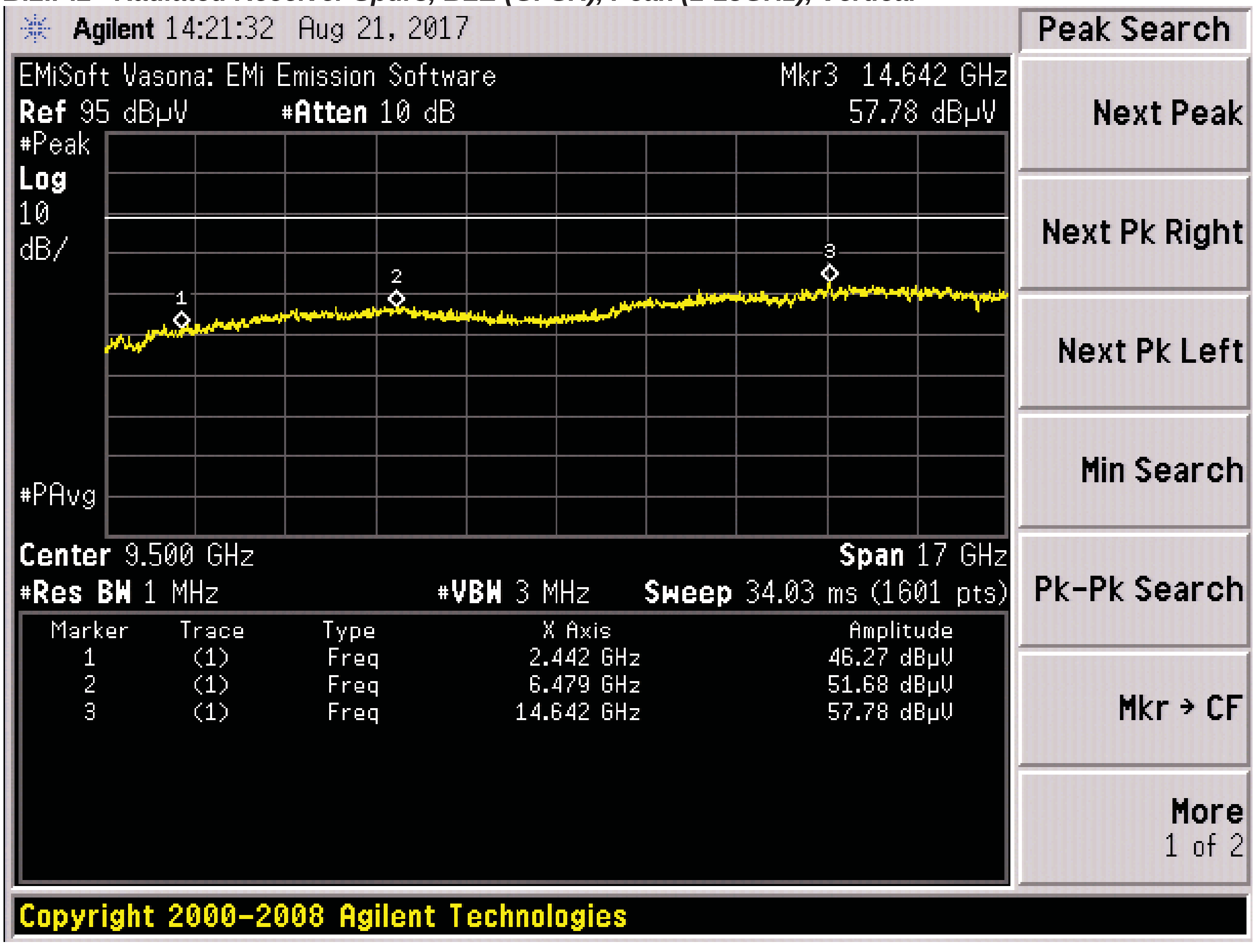


B.2.P Receiver Radiated Spurious Emissions (Peak Measurements)

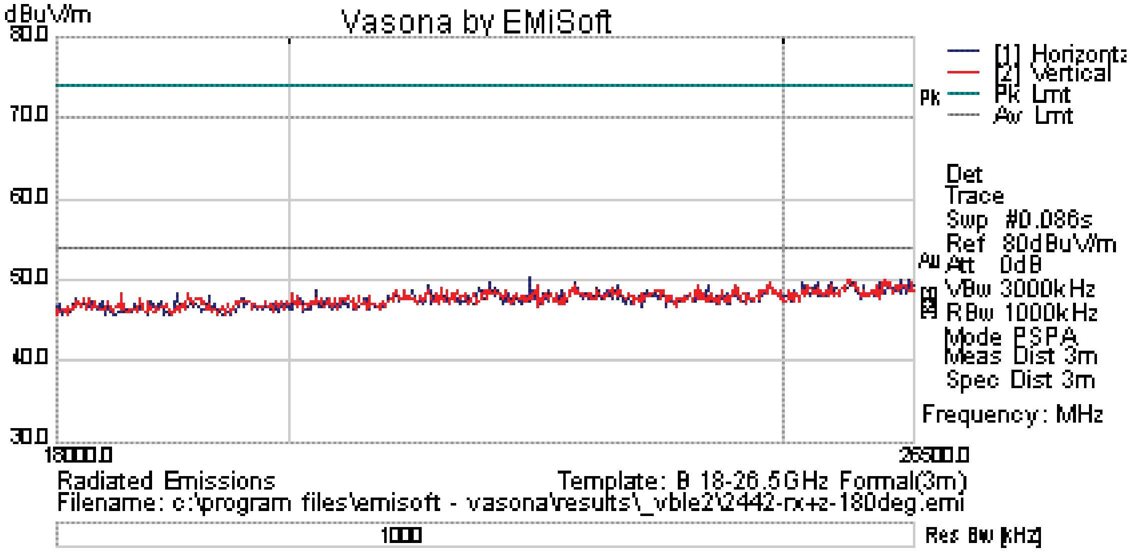
B.2.P.1 Radiated Receiver Spurs, BLE (GFSK), Peak (1-18GHz), Horizontal



B.2.P.2 Radiated Receiver Spurs, BLE (GFSK), Peak (1-18GHz), Vertical



B.2.P.3 Radiated Receiver Spurs, BLE (GFSK), Peak (18-26.5GHz)



B.3 Radiated Emissions 30MHz to 1GHz

15.205 / 15.209 / RSS-Gen:
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 section 8.9.

Test Procedure

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
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.

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

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

System Number	Description	Samples	System under test	Support equipment
	EUT	S04	☑	☐
	Support	S03, S02	☐	☑

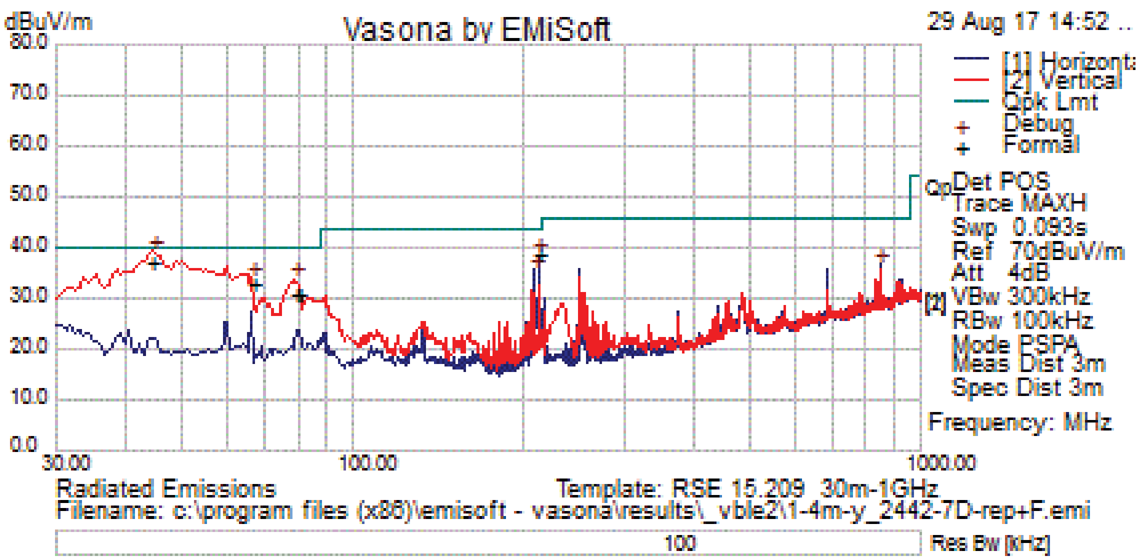
Tested By : Chris Blair	Date of testing: August 29, 2017
Test Result : PASS	

See Appendix C for list of test equipment

Transmitter Radiated Emission

EMiSoft - Vasona Results	
Test	Radiated Emissions [Electric Field]
Class/Spec	B / B RE FCC 30M-1GHz (3M)
Range	30 - 1000MHz
For	cblair
Template	RSE 15.209 30m-1GHz
Date/Time	29 Aug 17/14:52, Status: Filed on

Graphical Data



Formal Data

No	Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measure Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comment
1	44.245	25.8	.7	10.8	37.3	Quasi Max	V	106	169	40.0	-2.7	Pass	hand/wide
2	212.891	26.7	1.4	10.5	38.6	Quasi Max	H	128	347	43.5	-4.9	Pass	hand
3	66.362	24.3	.8	7.9	33.0	Quasi Max	V	113	260	40.0	-7.0	Pass	hand
4	80.000	22.5	.9	7.4	30.7	Quasi Max	V	144	314	40.0	-9.3	Pass	hand
5	79.116	22.8	.8	7.5	31.1	Quasi Max	V	125	348	40.0	-8.9	Pass	hand/wide

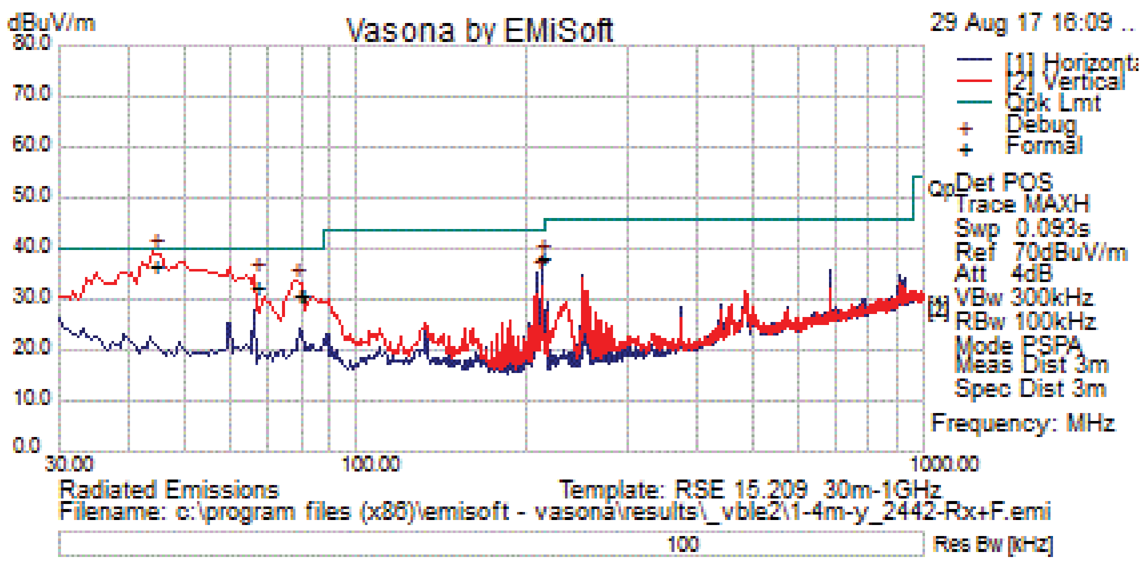
Debug Data

No	Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measure Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comment
1	44.55	27.9	0.7	10.6	39.2	Peak [Scan]	V	100	132	40	-0.8	Pass	
2	213.087	26.6	1.4	10.5	38.5	Peak [Scan]	H	100	352	43.5	-5	Pass	
3	66.375	25.4	0.8	7.9	34.1	Peak [Scan]	V	100	288	40	-5.9	Pass	
4	79.106	25.3	0.8	7.5	33.7	Peak [Scan]	V	100	325	40	-6.3	Pass	
5	208.844	23.7	1.4	10.5	35.6	Peak [Scan]	H	150	324	43.5	-7.9	Pass	
6	848.438	11.7	2.8	22.1	36.5	Peak [Scan]	H	100	291	46	-9.5	Pass	

Receiver Radiated Emission

EMiSoft - Vasona Results	
est	Radiated Emissions [Electric Field]
Class/Spec	B / B RE FCC 30M-1GHz (3M)
Range	30 - 1000MHz
For	cblair
Template	RSE 15.209 30m-1GHz
Date/Time	29 Aug 17/16:09, Status: Filed on

Graphical Data



Formal Data

No	Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comment
1	44.244	25.1	.7	10.8	36.5	Quasi Max	V	111	285	40.0	-3.5	Pass	wide/hand
2	212.897	26.6	1.4	10.5	38.5	Quasi Max	H	137	348	43.5	-5.0	Pass	hand
3	66.363	23.8	.8	7.9	32.5	Quasi Max	V	137	271	40.0	-7.5	Pass	hand
4	78.844	22.3	.8	7.5	30.7	Quasi Max	V	132	300	40.0	-9.3	Pass	wide/hand
5	79.999	22.9	.9	7.4	31.1	Quasi Max	V	108	314	40.0	-8.9	Pass	wide/hand

Debug Data

No	Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comment

1	43.944	27.7	0.7	11	39.4	Peak [Scan]	V	100	201	40	-0.6	Pass	
2	213.087	26.7	1.4	10.5	38.6	Peak [Scan]	H	100	338	43.5	-4.9	Pass	
3	66.375	26	0.8	7.9	34.7	Peak [Scan]	V	100	252	40	-5.3	Pass	
4	78.5	25.4	0.8	7.5	33.8	Peak [Scan]	V	100	101	40	-6.2	Pass	
5	208.844	23.6	1.4	10.5	35.4	Peak [Scan]	H	150	323	43.5	-8.1	Pass	

B.4 AC Conducted Emissions

FCC 15.207 (a) & RSS-Gen 8.8
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.

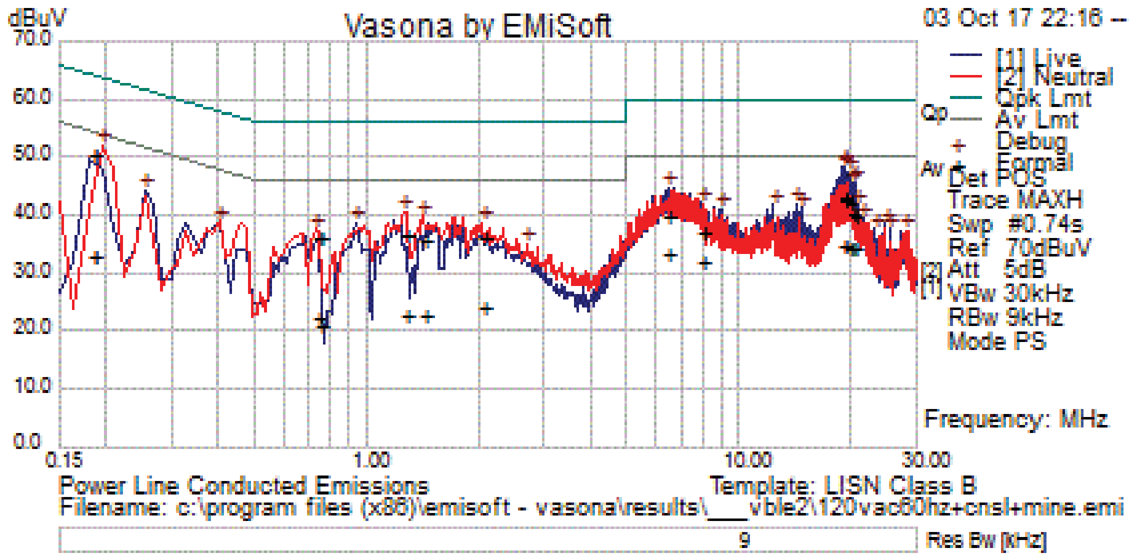
Measurement Procedure
Accordance with ANSI C63.10:2013 section 6.2

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: 150 KHz – 30 MHz
Sweep Time: Coupled
Resolution Bandwidth: 9 KHz
Video Bandwidth: 30 KHz
Detector: Quasi-Peak / Average

System Number	Description	Samples	System under test	Support equipment
	EUT	S05	☑	☐
	Support	S06, S07	☐	☑

Tested By : Chris Blair	Date of testing: 03 Oct 2017
Test Result : PASS	



Formal Data

No	Frequency MHz	Raw dBuV	Cable Loss	Factors dB	Level dBuV	Measurement Type	Line	Limit dBuV	Margin dB	Pass /Fail	Comment
1	19.995	19.9	20.4	.2	40.5	Quasi Peak	Live	60.0	-19.5	Pass	
2	19.312	14.3	20.4	.2	34.9	Average	Live	50.0	-15.1	Pass	
3	6.489	19.9	20.1	.1	40.1	Quasi Peak	Live	60.0	-19.9	Pass	
4	20.634	19.2	20.4	.3	39.8	Quasi Peak	Live	60.0	-20.2	Pass	
5	19.752	21.5	20.4	.2	42.1	Quasi Peak	Live	60.0	-17.9	Pass	
6	19.125	14.2	20.4	.2	34.8	Average	Live	50.0	-15.2	Pass	
7	20.634	13.9	20.4	.3	34.5	Average	Live	50.0	-15.5	Pass	
8	19.752	13.9	20.4	.2	34.5	Average	Live	50.0	-15.5	Pass	
9	19.995	13.7	20.4	.2	34.4	Average	Live	50.0	-15.6	Pass	
10	6.489	13.6	20.1	.1	33.7	Average	Live	50.0	-16.3	Pass	
11	19.312	22.5	20.4	.2	43.1	Quasi Peak	Live	60.0	-16.9	Pass	
12	19.125	22.0	20.4	.2	42.6	Quasi Peak	Live	60.0	-17.4	Pass	
13	1.286	16.8	19.9	.0	36.8	Quasi Peak	Neutral	56.0	-19.2	Pass	
14	8.008	11.9	20.1	.1	32.1	Average	Neutral	50.0	-17.9	Pass	
15	.187	29.9	20.8	.1	50.8	Quasi Peak	Neutral	64.2	-13.4	Pass	
16	.760	16.2	19.9	.0	36.2	Quasi Peak	Neutral	56.0	-19.8	Pass	hft

17	1.428	16.0	19.9	.0	36.0	Quasi Peak	Neutral	56.0	-20.0	Pass	
18	.187	12.3	20.8	.1	33.2	Average	Neutral	54.2	-21.0	Pass	
19	.187	29.8	20.8	.1	50.7	Quasi Peak	Neutral	64.2	-13.5	Pass	hft
20	2.071	16.5	20.0	.1	36.5	Quasi Peak	Neutral	56.0	-19.5	Pass	
21	.747	16.1	19.9	.0	36.1	Quasi Peak	Neutral	56.0	-19.9	Pass	
22	.187	12.1	20.8	.1	33.0	Average	Neutral	54.2	-21.2	Pass	hft
23	2.071	4.1	20.0	.1	24.1	Average	Neutral	46.0	-21.9	Pass	
24	8.008	17.0	20.1	.1	37.2	Quasi Peak	Neutral	60.0	-22.8	Pass	
25	1.428	3.0	19.9	.0	23.0	Average	Neutral	46.0	-23.0	Pass	
26	1.286	2.9	19.9	.0	22.9	Average	Neutral	46.0	-23.2	Pass	
27	.747	2.5	19.9	.0	22.5	Average	Neutral	46.0	-23.5	Pass	
28	.760	.9	19.9	.0	20.9	Average	Neutral	46.0	-25.1	Pass	hft

No	Frequency MHz	Raw dBuV	Cable Loss	Factors dB	Level dBuV	Measurement Type	Line	Limit dBuV	Margin dB	Pass /Fail	Comment
1	19.299	27.8	20.4	.2	48.4	Peak [Scan]	Live	50.0	-1.6	Pass	
2	.195	31.3	20.8	.1	52.1	Peak [Scan]	Neutral	53.8	-1.7	Pass	
3	19.135	27.6	20.4	.2	48.2	Peak [Scan]	Live	50.0	-1.8	Pass	
4	19.747	27.0	20.4	.2	47.6	Peak [Scan]	Live	50.0	-2.4	Pass	
5	20.642	25.1	20.4	.3	45.8	Peak [Scan]	Live	50.0	-4.2	Pass	
6	19.985	24.8	20.4	.2	45.4	Peak [Scan]	Live	50.0	-4.6	Pass	
7	6.493	24.7	20.1	.1	44.8	Peak [Scan]	Live	50.0	-5.2	Pass	
8	1.269	20.7	19.9	.0	40.6	Peak [Scan]	Neutral	46.0	-5.4	Pass	
9	1.419	19.8	19.9	.0	39.8	Peak [Scan]	Neutral	46.0	-6.2	Pass	
10	.254	23.8	20.5	.0	44.4	Peak [Scan]	Live	51.6	-7.2	Pass	
11	2.060	18.7	20.0	.0	38.7	Peak [Scan]	Neutral	46.0	-7.3	Pass	
12	.941	18.7	19.9	.0	38.6	Peak [Scan]	Live	46.0	-7.4	Pass	
13	14.224	21.6	20.3	.2	42.0	Peak [Scan]	Live	50.0	-8.0	Pass	
14	8.001	21.7	20.1	.1	41.9	Peak [Scan]	Neutral	50.0	-8.1	Pass	
15	20.926	21.2	20.4	.3	41.8	Peak [Scan]	Live	50.0	-8.2	Pass	
16	12.403	21.5	20.2	.1	41.8	Peak [Scan]	Live	50.0	-8.2	Pass	

17	.732	17.6	19.9	.0	37.6	Peak [Scan]	Neutral	46.0	-8.4	Pass	
18	14.732	20.8	20.3	.2	41.2	Peak [Scan]	Live	50.0	-8.8	Pass	
19	.404	18.9	20.0	.0	39.0	Peak [Scan]	Neutral	47.8	-8.8	Pass	
20	9.045	20.7	20.1	.1	40.9	Peak [Scan]	Live	50.0	-9.1	Pass	
21	21.687	18.5	20.4	.3	39.1	Peak [Scan]	Live	50.0	-10.9	Pass	
22	2.687	15.1	20.0	.0	35.1	Peak [Scan]	Neutral	46.0	-10.9	Pass	
23	24.896	17.7	20.5	.3	38.5	Peak [Scan]	Live	50.0	-11.5	Pass	
24	23.194	16.8	20.4	.3	37.5	Peak [Scan]	Live	50.0	-12.5	Pass	
25	25.448	16.7	20.5	.3	37.5	Peak [Scan]	Live	50.0	-12.5	Pass	
26	28.119	16.3	20.5	.4	37.3	Peak [Scan]	Neutral	50.0	-12.7	Pass	

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

Equip#	Manufacturer/ Model	Description	Last Cal	Next Due	Test Item
Test Equipment used for Radiated Emissions (Radio)					
32544	ETS Lindgren 3117	Double Ridged Horn Antenna	12 Jul 2017	12 Jul 2018	
54393	Huber+Suhner Sucoflex 102	RF Cable 2.4mm - N Type 18GHz	27 Apr 2017	27 Apr 2018	
54398	Huber+Suhner Sucoflex 102	RF Cable 2.4mm - N Type 18GHz	27 Apr 2017	27 Apr 2018	
56053	Miteq TTA1800-30-HG	SMA 18GHz Pre Amplifier	08 Mar 2017	08 Mar 2018	
55178	Huber+Suhner Sucoflex 106PA	RF Type N Antenna Cable 18 GHz 8.5m	02 Dec 2016	02 Dec 2017	
25640	Micro-coax UFB311A-0-2720-520520	Coaxial Cable, 272.0 in. to 18GHz	02 Dec 2016	02 Dec 2017	
25660	Micro-coax UFB311A-1-0840-504504	Coaxial Cable, 84.0 in. to 18GHz	02 Dec 2016	02 Dec 2017	
40604	Keysight 4440A	Spectrum Analyzer 3Hz-26.5GHz	11 Nov 2016	11 Nov 2017	
51688	Dynawave 5400-9810-6251	SMA 50 Ohm Termination 18GHz	29 Jun 2017	29 Jun 2018	
53964	Newport iBTHP-5-DB9	5 inch Temp/RH/Press Sensor w/20ft cable	09 Feb 2017	09 Feb 2018	
33041	Fluke 175	True RMS DMM	01 Jun 2017	01 Jun 2018	
35237	Stanley 33-696	TAPE RULE 5M	NA	NA	
35233	Stanley 33-696	TAPE RULE 5M	NA	NA	
34072	SCHAFFNER RSG 2000	Reference Spectrum Generator, 1-18GHz	NA	NA	
37557	JFW 50HF-010N	Attenuator	02 Feb 2017	02 Feb 2018	
4226	Emco 3115	Horn Antenna	NA	NA	
20490	Keysight 8710-1765	PRESET TORQUE WRENCH, 8lb-in	06 Feb 2017	06 Feb 2018	
8113	Cisco NSA 5m Chamber	NSA 5m Chamber	31 Aug 2016	31 Aug 2017	
43024	Cisco Above 1GHz Site Cal	1GHz Cispr Site Verification	03 Oct 2016	03 Oct 2017	
34740	ETS Lindgren 3117	Double Ridged Horn Antenna	19 Oct 2016	19 Oct 2017	

39126	Cisco TH0118	Mast Mount Preamplifier Array, 1-18GHz	02 May 2017	02 May 2018	
39131	Cisco TH0118-PS	Power Supply for TH0118 1-18GHz Preamplifier	NA	NA	
37234	JFW 50CB-015	Control Box, GPIB	NA	NA	
38404	Sunol Sciences JB1	Combination Antenna, 30MHz-2GHz	05 Oct 2016	05 Oct 2017	
5732	York CNE V	COMPARISON NOISE EMITTER	NA	NA	
55589	Keysight 5173B	EXG-B MW ANALOG SIGNAL GENERATOR	07 Jul 2017	07 Jul 2018	
18231	Rhode & Schwarz ESI 40	RECEIVER TEST 20Hz-40GHz	03 Feb 2017	03 Feb 2018	
36710	Cisco 1840	18-40GHz EMI Test Head/Verification Fixture	17 Nov 2016	17 Nov 2017	
Test Equipment used for AC Mains Conducted Emissions (EMC)					
04003	Fischer Custom Communications FCC-801-M2-32A	CDN, 2-LINE, 32A	2017-03-16	2018-03-16	
005466	Keithley580	Micro-Ohmmeter	2016-10-31	2017-10-31	
056329	Pasternack PE5019-1	Torque Wrench	2017-03-01	2018-03-01	
041933	Newport iBTHP-5-DB9	5 inch Temp/RH/Press Sensor w/20ft cable	2016-12-22	2017-12-22	
045991	Fischer Custom Communications F-090527-1009-2	Lisn Adapter	2017-06-15	2018-06-15	
049468	Coleman RG223	BNC 25 ft Cable	2017-03-10	2018-03-10	
008357	Coleman RG-223	1.5 ft RG-223 Cable	2017-04-12	2018-04-12	
046715	Bird5-T-MB	5W 50 Ohm BNC Termination 4GHz	2017-03-16	2018-03-16	
008496	FCC-450B-2.4-N	Instrumentation Limiter	2017-05-16	2018-05-16	
033041	Fluke175	Multimeter	2017-06-01	2018-06-01	
018963	York CNE V	Comparison Noise Emitter, 30 - 1000MHz	NA	NA	
045050	Rohde & Schwarz ESCI	EMI Test Receiver	2016-11-09	2017-11-09	
045990	Fischer Custom Communications F-090527-1009-1	Line Impedance Stabilization Network	2017-06-15	2018-06-15	
007448	Fischer Custom Communications F-201-32mm	Absorbing Clamp	NA	NA	
046714	Bird5-T-MB	5W 50 Ohm BNC Termination 4GHz	2016-11-28	2017-11-28	
049531	TTE H785-150K-50-21378	High Pass Filter	2017-05-03	2018-05-03	
054647	Stanley33-605	10meter Measuring Tape	NA	NA	
Test Equipment Used for RF Conducted Tests					

55980	Keysight N9020A-508	MXA Signal Analyzer, 10Hz-8.4GHz	11 Oct 2016	11 Oct 2017	
51799	Huber+Suhner Sucoflex101PE	40 GHz Cable, K-Type	16 Nov 2016	16 Nov 2017	
51802	Huber+Suhner Sucoflex101PE	40 GHz Cable, K-Type	16 Nov 2016	16 Nov 2017	
6335	Lufft 5063-33W	Dial Hygrometer	16 Aug 2017	16 Aug 2018	
20490	Keysight 8710-1765	PRESET TORQUE WRENCH, 8lb-in	06 Feb 2017	06 Feb 2018	
33041	Fluke 175	True RMS DMM	01 Jun 2017	01 Jun 2018	
55191	York EMC Series CGE03C	Comb Generator	NA	NA	
49516	Keysight N9030A-550	PXA Signal Analyzer, 3Hz to 50GHz	02 Nov 2016	02 Nov 2017	
6324	Lufft 5063-33W	Dial Hygrometer	02 Nov 2016	02 Nov 2017	
54058	Aeroflex 40AH2W-20	SMA Attenuator, 20 dB 40GHz	21 Apr 2017	21 Apr 2018	

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: Photographs of Test Setups

Appendix G: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

Appendix H: 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

Appendix I: Test Assessment Plan

Compliance Test Plan (Excel) EDCS# 11670323
Target Power Tables: NA. UUT only has 1 power setting

Appendix J: Worst Case Justification

The UUT is BLE, and only has 1 mode (BLE, GFSK), and 1 power setting for all domains.
The power is set in radio firmware, and is not accessible to the user.

The duty cycle was 62.4% for conducted measurements, but was increased to 87.5% for RSE.

At the time of conducted tests, 62.4% was the only duty cycle that was available to the test engineer (0x25 HCI).
A correction factor (+2.05dB) corresponding to the actual duty cycle (62.4%) was used in calculations for conducted tests.

Radiated tests were performed subsequently, and 87.5% duty cycle was the highest available (0x7D HCI), and was used for those tests.

Although 2 duty cycles were used, [1] RSE testing was done at the highest duty cycle available, and [2] conducted tests were compensated by duty cycle correction factor.

Both of these scenarios exceed the expected use of the transmitter, as the UUT is intended to receive 90-95% of the time.