

RF Test Report

Project Number: 4458635**Proposal Number:** 8652**Report Number:** 4458635EMC01**Revision Level:** 1**Client:** Current Lighting Solutions, LLC**Equipment Under Test:** Wireless People Counting Sensor**Model:** WMZ10**FCC ID:** 2AS3F-WMZ10**IC:** 25008-WMZ10**Applicable Standards:** FCC Part 15 Subpart C, § 15.247

RSS-247, Issue 2

RSS-GEN, Issue 5

ANSI C63.10:2013

Report issued on: 01 July 2019**Test Result:** Compliant

Tested by:

A handwritten signature in blue ink, appearing to read 'Martin Taylor'.

Martin Taylor, Project Engineer

Reviewed by:

A handwritten signature in black ink, appearing to read 'Aaron Froehlich'.

Aaron Froehlich, EMC Test Engineer

Remarks: This report details the results of the testing carried out on one sample, the results contained in this test report do not relate to other samples of the same product. The manufacturer should ensure that all products in series production are in conformity with the product sample detailed in this report.

This document is issued by the Company under its General Conditions of Service accessible at <http://www.sgs.com/en/Terms-and-Conditions.aspx>. Attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein.

Any holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents. Any unauthorized alteration, forgery or falsification of the content or appearance of this document is unlawful and offenders may be prosecuted to the fullest extent of the law.

Table of Contents

1	SUMMARY OF TEST RESULTS.....	4
1.1	MODIFICATIONS REQUIRED FOR COMPLIANCE	4
2	GENERAL INFORMATION.....	5
2.1	CLIENT INFORMATION	5
2.2	TEST LABORATORY	5
2.3	GENERAL INFORMATION OF EUT	5
2.4	OPERATING MODES AND CONDITIONS	5
2.5	EUT CONNECTION BLOCK DIAGRAM – CONDUCTED MEASUREMENTS.....	6
2.6	EUT CONNECTION BLOCK DIAGRAM – RADIATED MEASUREMENTS	6
2.7	SYSTEM CONFIGURATIONS	6
2.8	CABLE LIST	6
3	BANDWIDTH	7
3.1	TEST RESULT.....	7
3.2	TEST METHODS	7
3.3	TEST SITE	7
3.4	TEST EQUIPMENT	7
3.5	TEST DATA – DTS BANDWIDTH (6dB)	8
3.6	TEST DATA – 99% OCCUPIED BANDWIDTH.....	9
4	OUTPUT POWER	10
4.1	TEST RESULT.....	10
4.2	TEST METHOD.....	10
4.3	TEST SITE	10
4.4	TEST EQUIPMENT	10
4.5	TEST DATA.....	10
5	POWER SPECTRAL DENSITY	11
5.1	TEST RESULT.....	11
5.2	TEST METHOD.....	11
5.3	TEST SITE	11
5.4	TEST EQUIPMENT	11
5.5	TEST DATA.....	12
6	CONDUCTED SPURIOUS EMISSIONS / BAND EDGE.....	13
6.1	TEST RESULT.....	13
6.2	TEST METHOD.....	13
6.3	TEST SITE	13
6.4	TEST EQUIPMENT	13
6.5	TEST DATA – DTS BAND EDGE.....	14
6.6	TEST DATA – DTS CONDUCTED SPURIOUS EMISSIONS	15
7	EMISSIONS IN RESTRICTED FREQUENCY BANDS	16
7.1	TEST RESULT.....	16
7.2	TEST METHOD.....	16
7.3	TEST SITE	16
7.4	TEST EQUIPMENT	17
7.5	TEST DATA – ANTENNA-PORT CONDUCTED EMISSIONS	18
7.6	TEST DATA – RADIATED EMISSIONS	20
8	BAND EDGE EMISSIONS IN RESTRICTED FREQUENCY BANDS.....	30
8.1	TEST RESULT.....	30

8.2	TEST METHOD.....	30
8.3	TEST SITE	30
8.4	TEST EQUIPMENT	30
8.5	TEST DATA.....	31
9	AC POWERLINE CONDUCTED EMISSIONS.....	32
9.1	TEST RESULT.....	32
9.2	TEST METHOD.....	32
9.3	TEST SITE	32
9.4	TEST EQUIPMENT	32
9.5	TEST DATA.....	33
10	MEASUREMENT UNCERTAINTY.....	35
11	REVISION HISTORY	36

1 Summary of Test Results

Test Description	Test Specification		Test Result
Bandwidth	15.247(a)(2)	RSS-247 S5.2 (a) RSS-GEN S6.7	Compliant
Output Power	15.247(b)(3)	RSS-247 S5.4 (d)	Compliant
Power Spectral Density	15.247(e)	RSS-247 S5.2 (b)	Compliant
Conducted Spurious Emissions / Band Edge	15.247(d)	RSS-247 S5.5	Compliant
Emissions in Restricted Frequency Bands	15.247(d) 15.205, 15.209	RSS-247 S5.5 RSS-GEN S8.9, S8.10	Compliant
Band Edge Emissions in Restricted Frequency Bands	15.205, 15.209	RSS-GEN S8.9, S8.10	Compliant
AC Powerline Conducted Emissions	15.207	RSS-GEN S8.8	Compliant
Antenna Requirement	15.203	RSS-GEN S6.8	Compliant ⁽¹⁾

(1) Device uses an internal surface-mount antenna which cannot be replaced by the end user.

1.1 Modifications Required for Compliance

A power setting of 34 raw was found to produce the maximum RF output power while remaining in compliance with the required limits for restricted band emissions. This was the power setting used for all channels for the testing in this report.

2 General Information

2.1 Client Information

Name: Current Lighting Solutions, LLC
Address: 1975 Noble Rd
City, State, Zip, Country: East Cleveland, Ohio 44112, USA

2.2 Test Laboratory

Name: SGS North America, Inc.
Address: 620 Old Peachtree Road NW, Suite 100
City, State, Zip, Country: Suwanee, GA 30024, USA

Accrediting Body: A2LA
Type of lab: Testing Laboratory
Certificate Number: 3212.01

2.3 General Information of EUT

Type of Product: Wireless People Counting Sensor
Model: WMZ10
Firmware Version ID Number: Github Repository - Lighting/module-d v1.0.0
Serial Number: Not labeled

FCC ID: 2AS3F-WMZ10
IC: 25008-WMZ10

Frequency Range: 2402 – 2480 MHz
Data Modes: Bluetooth Low Energy
Antenna: Internal Surface-Mount Antenna
(2 suppliers) Johanson Technology (0.5 dBi)
Shenzhen Sunlord Electronics Co., Ltd. (1.5 dBi)

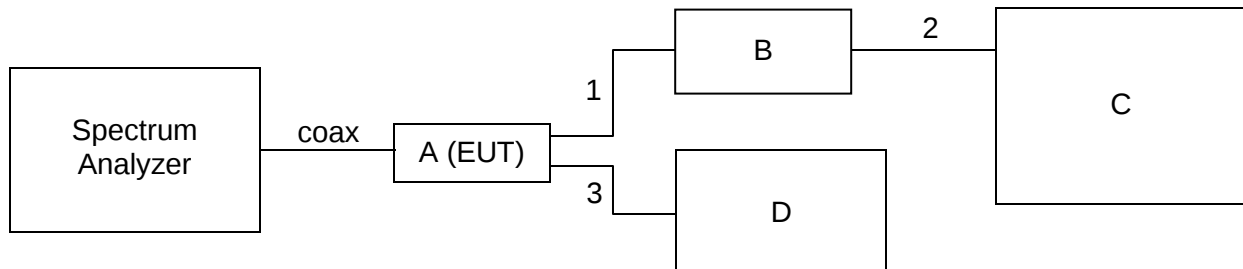
Rated Voltage: 9.5 – 24 Vdc
Test Voltage: 16 Vdc

Sample Received Date: 15 May 2019
Dates of testing: 15 May to 13 June 2019

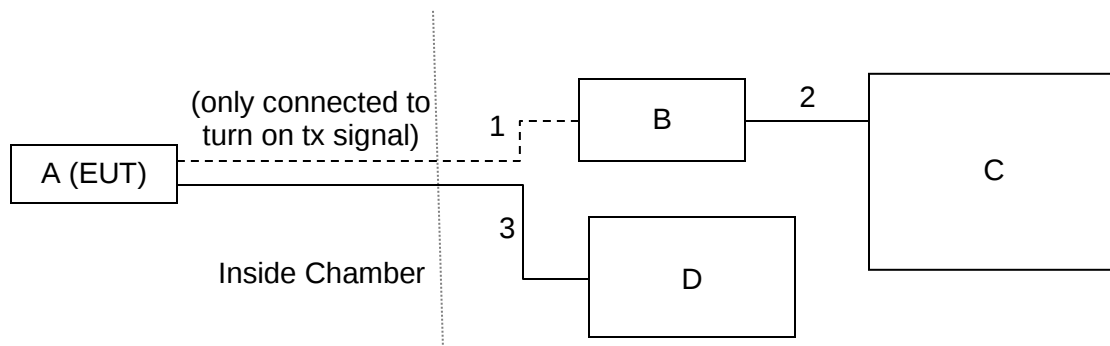
2.4 Operating Modes and Conditions

The EUT was programmed by the manufacturer to transmit at 100% duty cycle on low, middle and high Bluetooth LE channels with the same modulation and bandwidth as is used in normal operation. The client provided a Silicon Labs board to control the radio using a serial communications program on a laptop computer. This was used to set the channel and power and to turn the modulated transmitter signal on and off using test mode commands.

2.5 EUT Connection Block Diagram – Conducted Measurements



2.6 EUT Connection Block Diagram – Radiated Measurements



2.7 System Configurations

Device Reference	Manufacturer	Description	Model Number	Serial Number
A	Current Lighting Solutions, LLC	Wireless People Counting Sensor (EUT)	WMZ10	Not labeled
B	Silicon Labs	Developer Board	WSTK	164624133
C	Lenovo	Laptop Computer	80XV	PF0STB5L
D	Rigol	DC Power Supply	DP711	DP7A202200419

2.8 Cable List

Cable reference	Port Name	Start	End	Cable Length (m)	Ferrite installed?	Shielded?
1	Comm.	EUT	Developer Board	0.15	N	N
2	USB	Laptop	Developer Board	1.0	N	N
3	DC Power	EUT	DC Power Supply	Various	N	N

3 Bandwidth

3.1 Test Result

Test Description	Test Specification		Test Result
DTS Bandwidth (6dB)	15.247(a)(2)	RSS-247 S5.2 (a)	Compliant
Occupied Bandwidth (99%)		RSS-GEN S6.7	Reported

3.2 Test Methods

The DTS 6dB bandwidth measurements were performed using the procedure from ANSI C63.10 clause 11.8.1, and the 99% occupied bandwidth measurements were performed using the procedure from ANSI C63.10 clause 6.9.3.

Limit

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

3.3 Test Site

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature: 23.4 °C

Relative Humidity: 43.6 %

Atmospheric Pressure: 98.0 kPa

3.4 Test Equipment

Test End Date: 16-May-2019

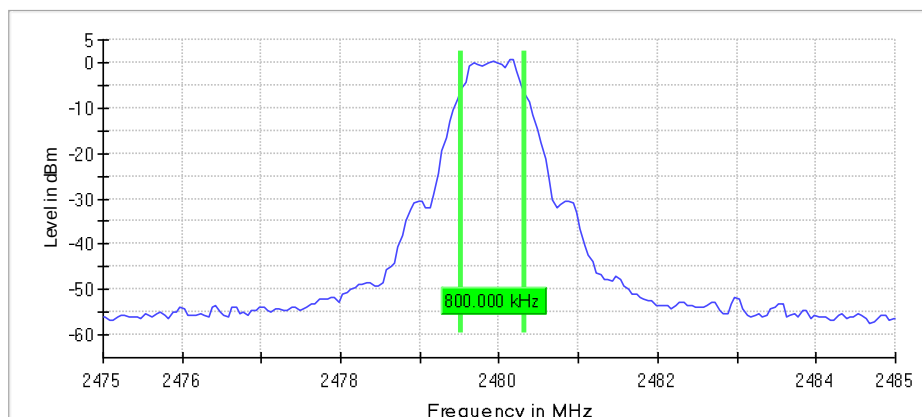
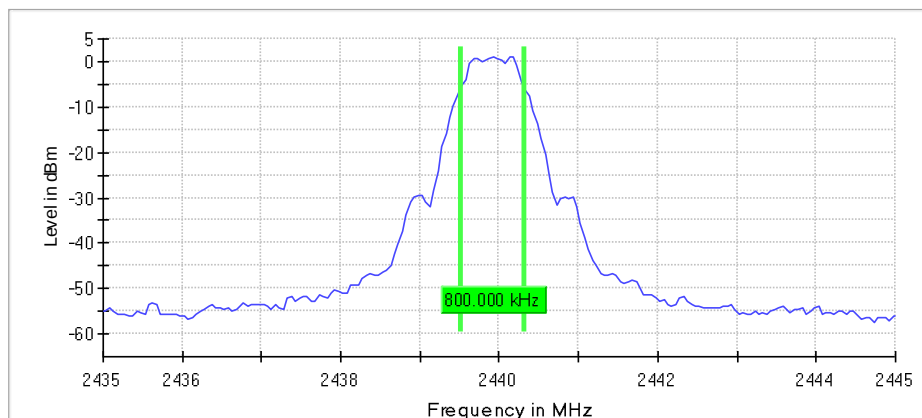
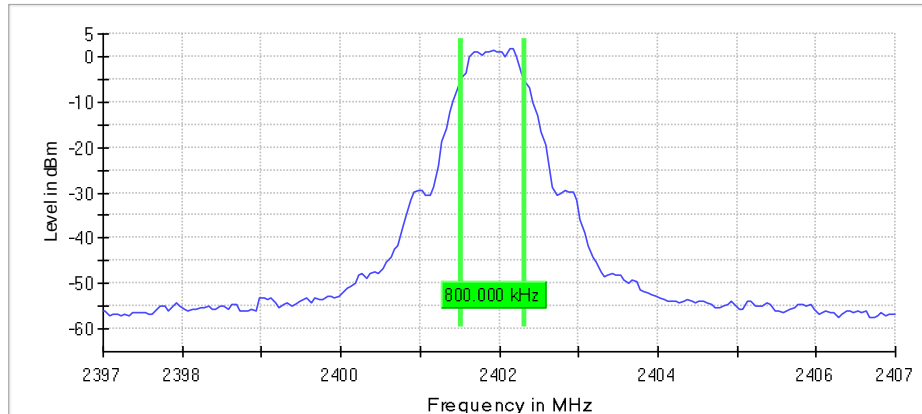
Tester: MT

Equipment	Model	Manufacturer	Asset Number	Cal Due Date
RF CABLE	141	HUBER & SUHNER	B095585	25-Jul-2019
ATTENUATOR, 10DB	10DB	ROHDE & SCHWARZ	B095591	25-Jul-2019
RF SWITCH (TS8997)	OSP	ROHDE & SCHWARZ	15039	15-Dec-2019
POWER METER (TS8997)	OSP-B157	ROHDE & SCHWARZ	15040	15-Dec-2019
SIGNAL ANALYZER (TS8997)	FSV30	ROHDE & SCHWARZ	B085749	1-Nov-2019

Note: The equipment calibration period is 1 year except for the FSV which is on a 2-year cycle.

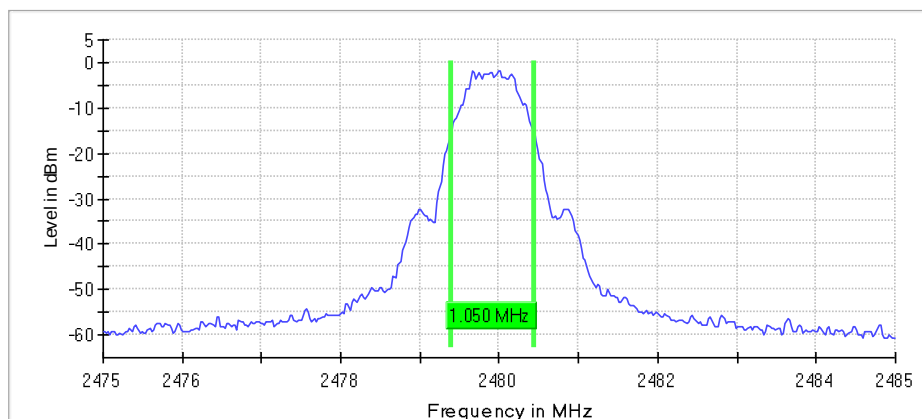
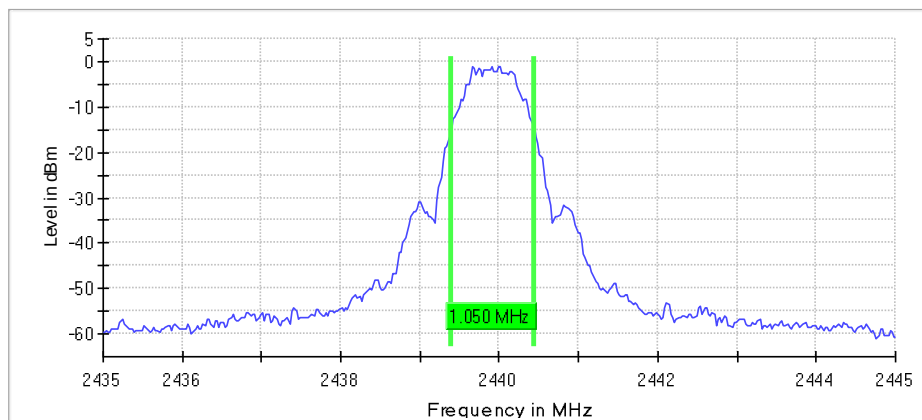
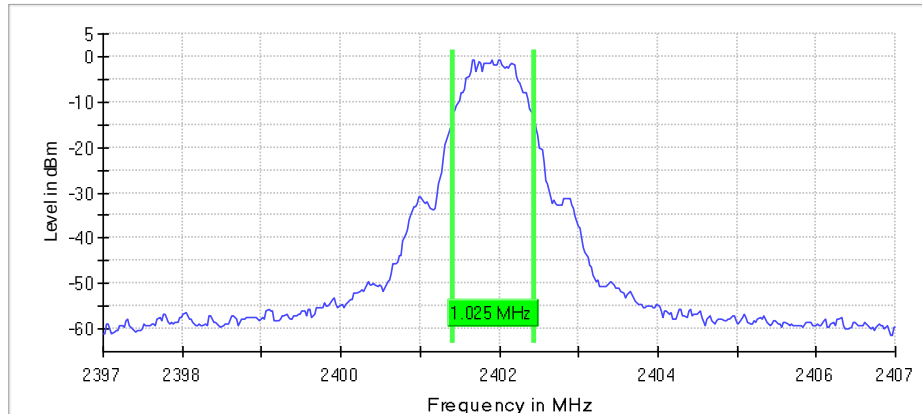
3.5 Test Data – DTS Bandwidth (6dB)

Channel	Frequency (MHz)	6dB Bandwidth (kHz)	Limit Min (kHz)	Result
0	2402	800	500	Pass
19	2440	800	500	Pass
39	2480	800	500	Pass



3.6 Test Data – 99% Occupied Bandwidth

Channel	Frequency (MHz)	99% Bandwidth (kHz)	Result
0	2402	1025	Reported
19	2440	1050	Reported
39	2480	1050	Reported



4 Output Power

4.1 Test Result

Test Description	Test Specification		Test Result
Fundamental Emission Output Power	15.247(b)(3)	RSS-247 S5.4 (d)	Compliant

4.2 Test Method

Fundamental maximum conducted (average) output power measurements were performed using the method described in ANSI C63.10:2013 clause 11.9.2.3.2. This method uses a wideband gated RF power meter with gate parameters adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Because the measurement is made only during the ON time of the transmitter, no duty cycle correction factor is required.

Limit

For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. For using antennas with greater than 6dBi of gain, the limit is reduced in dB by the amount the gain exceeds 6dBi (e.g. for a 7.4dBi antenna, the limit is reduced from 30dBm to 28.6dBm). Also, the e.i.r.p. shall not exceed 4 Watts (36 dBm) based on RSS-247 S5.4 (d).

4.3 Test Site

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature: 23.4 °C
Relative Humidity: 43.6 %
Atmospheric Pressure: 98.0 kPa

4.4 Test Equipment

Test End Date: 16-May-2019

Tester: MT

Equipment	Model	Manufacturer	Asset Number	Cal Due Date
RF CABLE	141	HUBER & SUHNER	B095585	25-Jul-2019
ATTENUATOR, 10DB	10DB	ROHDE & SCHWARZ	B095591	25-Jul-2019
RF SWITCH (TS8997)	OSP	ROHDE & SCHWARZ	15039	15-Dec-2019
POWER METER (TS8997)	OSP-B157	ROHDE & SCHWARZ	15040	15-Dec-2019
SIGNAL ANALYZER (TS8997)	FSV30	ROHDE & SCHWARZ	B085749	1-Nov-2019

Note: The equipment calibration period is 1 year except for the FSV which is on a 2-year cycle.

4.5 Test Data

Channel	Frequency (MHz)	RMS Power (dBm)	Limit Max (dBm)	EIRP (dBm)	Limit Max (dBm)	Result
0	2402	2.6	30	4.1	36	Pass
19	2440	2.1	30	3.6	36	Pass
39	2480	1.5	30	3.0	36	Pass

5 Power Spectral Density

5.1 Test Result

Test Description	Test Specification		Test Result
Power Spectral Density	15.247(e)	RSS-247 S5.2 (b)	Compliant

5.2 Test Method

Power spectral density measurements were performed using the procedures from ANSI C63.10: 2013 clause 11.10.

Limit

The maximum limit is 8 dBm / 3 kHz.

5.3 Test Site

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature: 23.4 °C

Relative Humidity: 43.6 %

Atmospheric Pressure: 98.0 kPa

5.4 Test Equipment

Test End Date: 16-May-2019

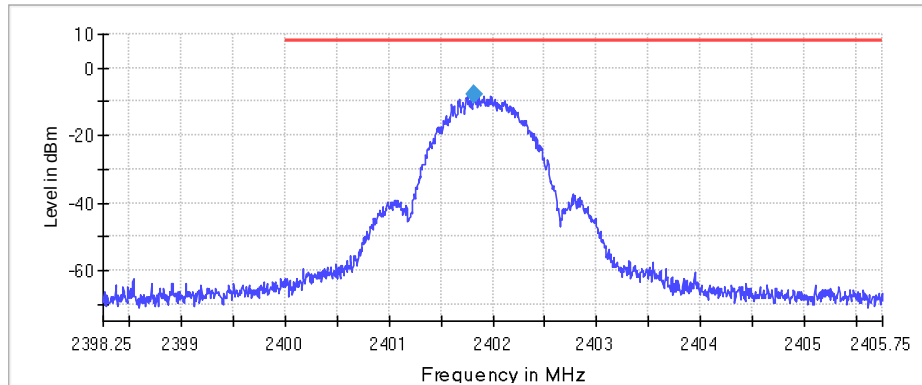
Tester: MT

Equipment	Model	Manufacturer	Asset Number	Cal Due Date
RF CABLE	141	HUBER & SUHNER	B095585	25-Jul-2019
ATTENUATOR, 10DB	10DB	ROHDE & SCHWARZ	B095591	25-Jul-2019
RF SWITCH (TS8997)	OSP	ROHDE & SCHWARZ	15039	15-Dec-2019
POWER METER (TS8997)	OSP-B157	ROHDE & SCHWARZ	15040	15-Dec-2019
SIGNAL ANALYZER (TS8997)	FSV30	ROHDE & SCHWARZ	B085749	1-Nov-2019

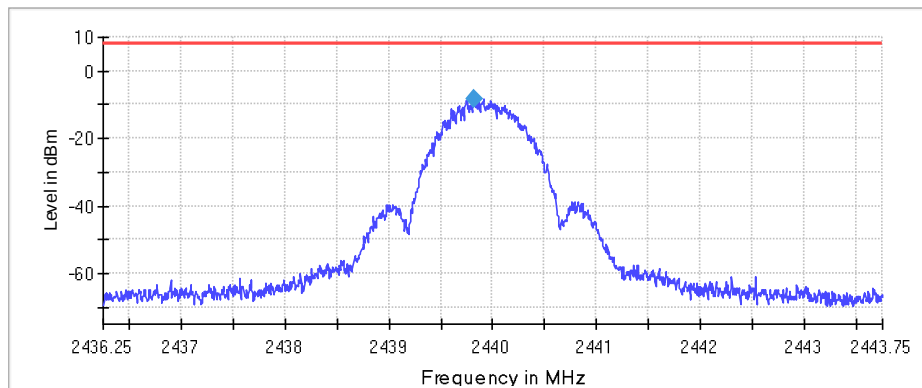
Note: The equipment calibration period is 1 year except for the FSV which is on a 2-year cycle.

5.5 Test Data

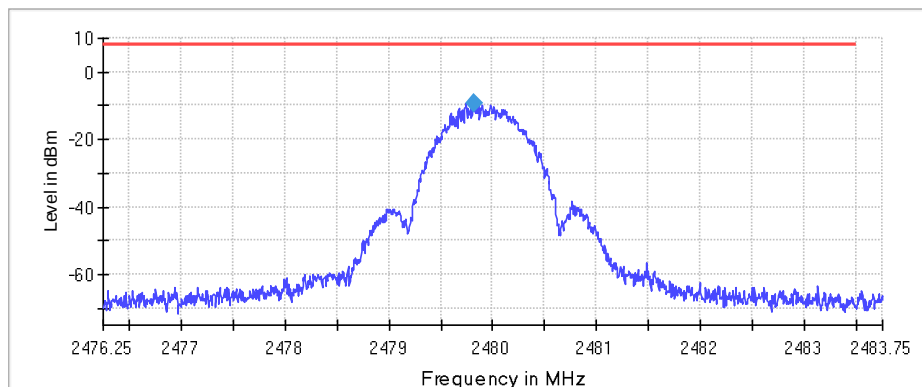
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit Max (dBm/3kHz)	Result
0	2402	-7.9	8	Pass
19	2440	-8.5	8	Pass
39	2480	-9.2	8	Pass



— Limit — Sum Level ◆ PSD



— Limit — Sum Level ◆ PSD



— Limit — Sum Level ◆ PSD

6 Conducted Spurious Emissions / Band Edge

6.1 Test Result

Test Description	Test Specification		Test Result
Conducted Spurious and Band Edge Emissions	15.247(d)	RSS-247 S5.5	Compliant

6.2 Test Method

Conducted band edge and spurious band emissions in non-restricted frequency bands were measured using the method defined in ANSI C63.10 clause 11.11.

Limit

Because the maximum conducted average output power was used to determine compliance with the output power limits, the limit in any 100 kHz band outside of the authorized band is 30 dB below the maximum in-band peak level.

6.3 Test Site

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions	Band Edge Emissions	Conducted Spurious Emissions
Temperature:	23.4 °C	22.8 °C
Relative Humidity:	43.6 %	52.6 %
Atmospheric Pressure:	98.0 kPa	97.6 kPa

6.4 Test Equipment

Band Edge Emissions

Test End Date: 16-May-2019

Tester: MT

Equipment	Model	Manufacturer	Asset Number	Cal Due Date
RF CABLE	141	HUBER & SUHNER	B095585	25-Jul-2019
ATTENUATOR, 10DB	10DB	ROHDE & SCHWARZ	B095591	25-Jul-2019
RF SWITCH (TS8997)	OSP	ROHDE & SCHWARZ	15039	15-Dec-2019
POWER METER (TS8997)	OSP-B157	ROHDE & SCHWARZ	15040	15-Dec-2019
SIGNAL ANALYZER (TS8997)	FSV30	ROHDE & SCHWARZ	B085749	1-Nov-2019

Note: The equipment calibration period is 1 year except for the FSV which is on a 2-year cycle.

Conducted Spurious Emissions

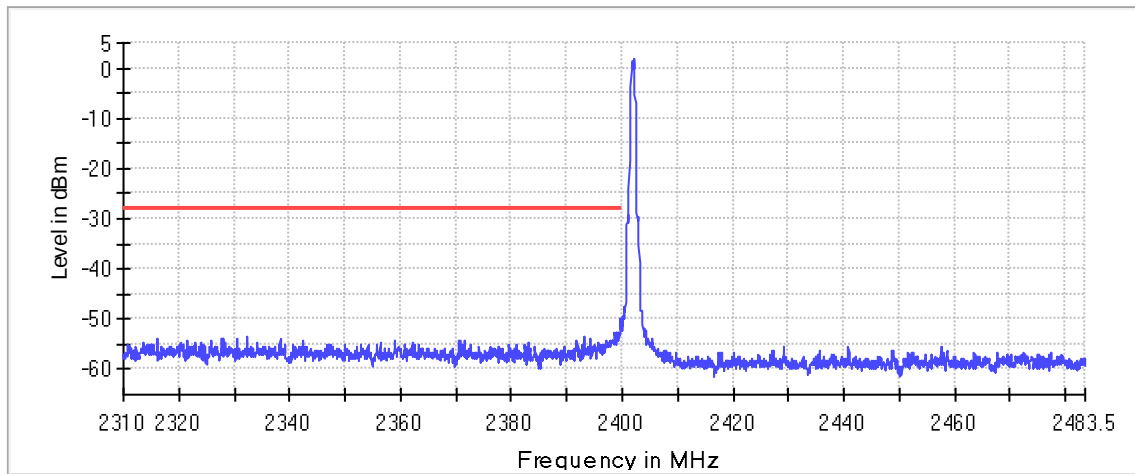
Test End Date: 13-Jun-2019

Tester: MT

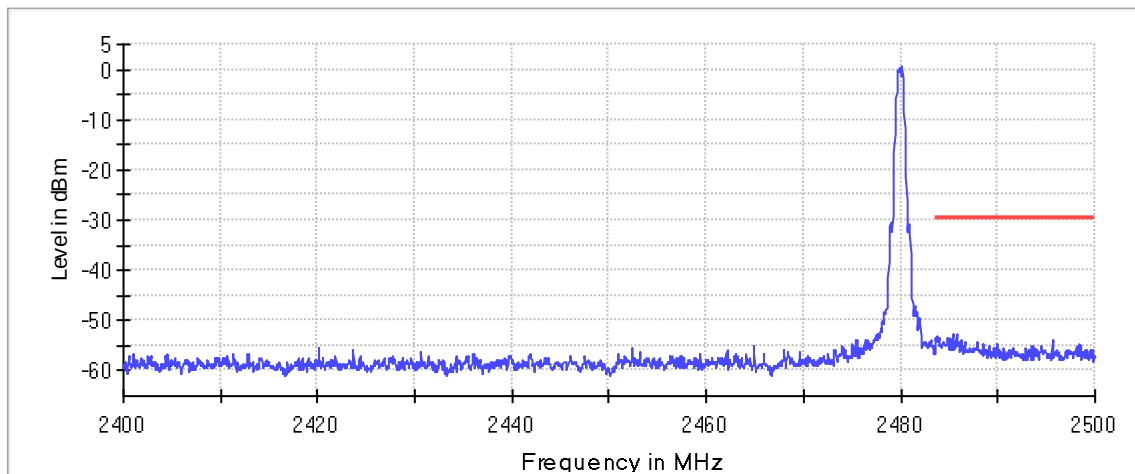
Equipment	Model	Manufacturer	Asset Number	Cal Due Date
EMI TEST RECEIVER	ESU40	ROHDE & SCHWARZ	B079629	2-Jul-2019

6.5 Test Data – DTS Band Edge

BLE - Lower band edge

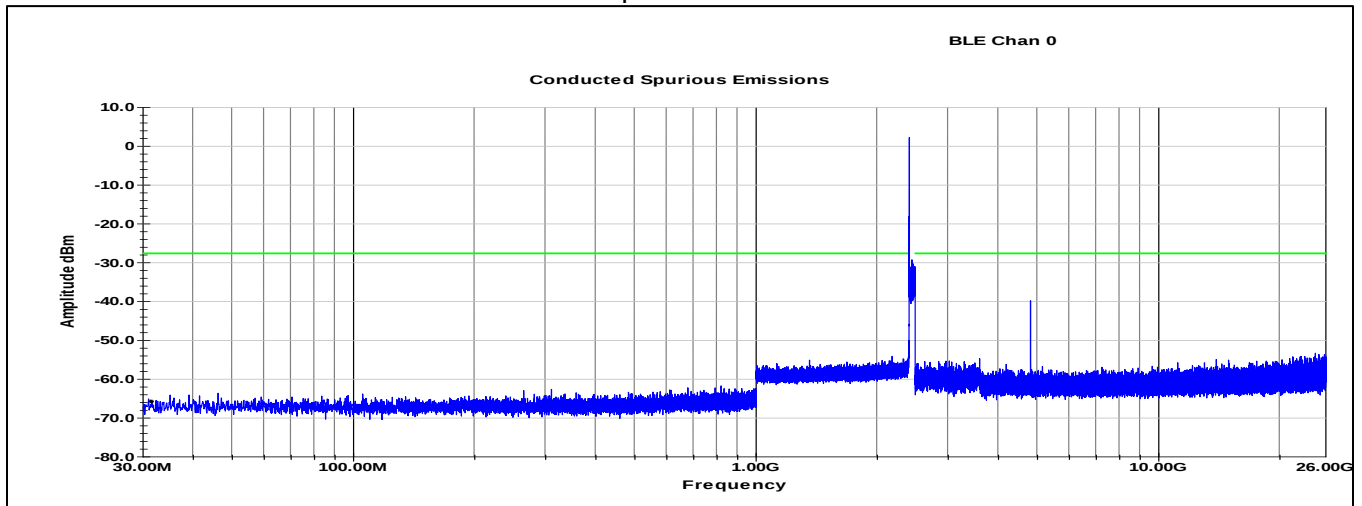


BLE - Upper band edge

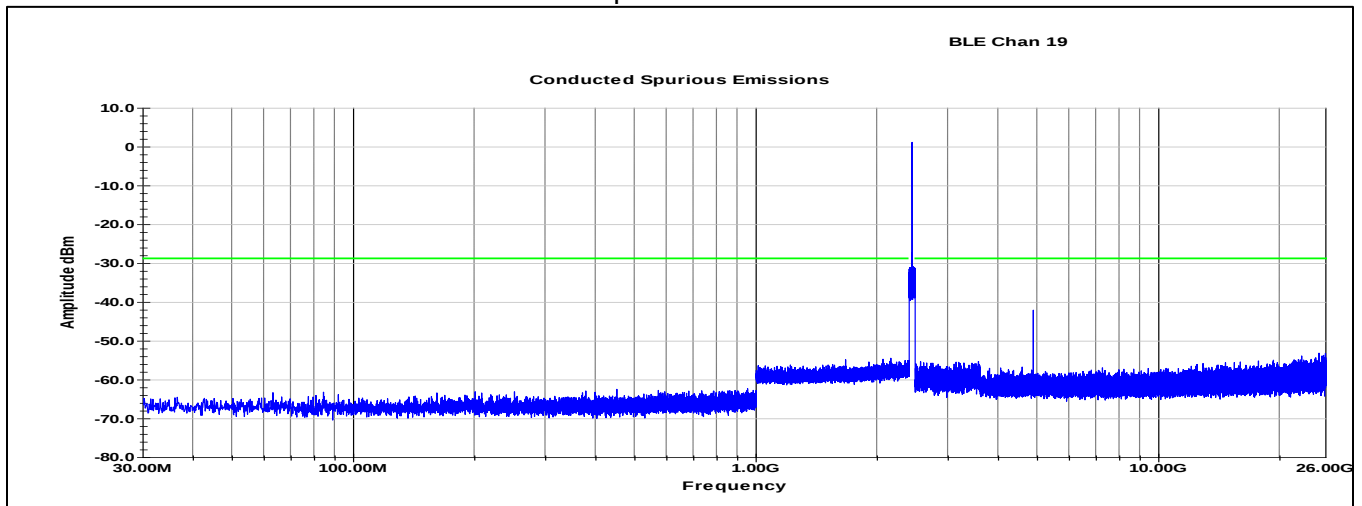


6.6 Test Data – DTS Conducted Spurious Emissions

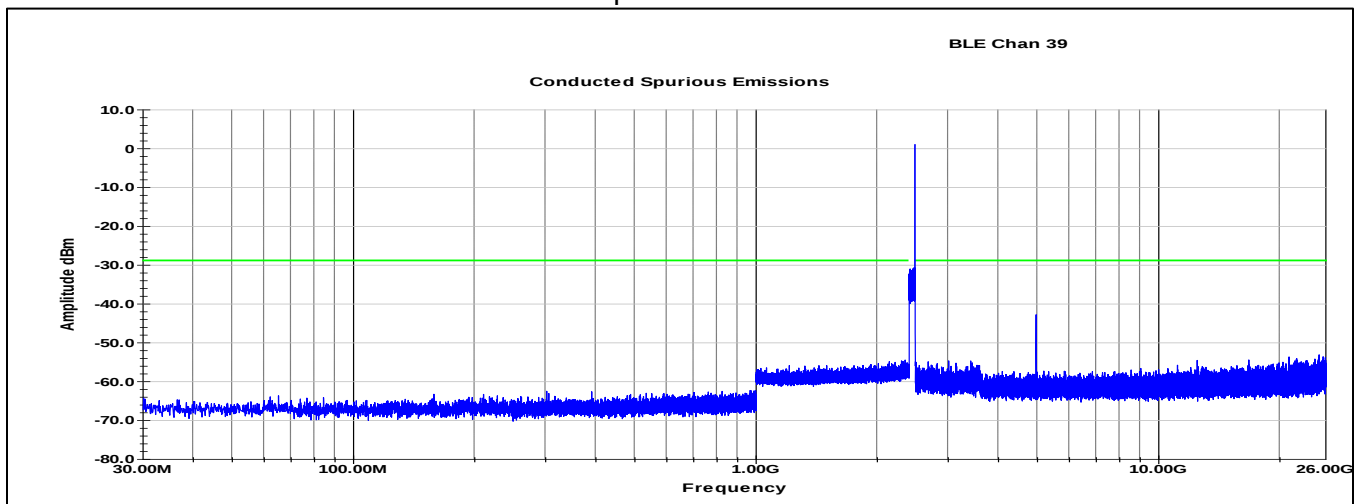
Conducted Spurs – BLE Channel 0



Conducted Spurs – BLE Channel 19



Conducted Spurs – BLE Channel 39



7 Emissions in Restricted Frequency Bands

7.1 Test Result

Test Description	Test Specification		Test Result
Emissions in Restricted Frequency Bands	15.247(d) 15.205, 15.209	RSS-247 S5.5 RSS-GEN S8.9, S8.10	Compliant

7.2 Test Method

Antenna-port conducted and radiated emissions in restricted frequency bands were measured using methods defined in ANSI C63.10 clause 11.12.

Lowest, middle and highest channels were investigated – the device was commanded to continuously transmit on channels 0, 19 and 39 with the antenna port terminated in 50 Ω for the cabinet / case emissions as required per ANSI C63.10 clause 11.12.2.1.

Test distances for radiated tests:

- 9k to 30 MHz – Near field prescan to determine if there were any emissions
- 30 to 1000 MHz - The EUT to measurement antenna distance was 3 meters
- 1 to 18 GHz - The EUT to measurement antenna distance was 3 meters
- 18 to 26 GHz - The EUT to measurement antenna distance was 3 meters

Limits within restricted bands of operation:

Frequency	Limits ⁽¹⁾		Peak Limits dBuV/m
	Microvolts/m	dBuV/m	
30 - 88 MHz	100	40 ⁽²⁾	--
88 - 216 MHz	150	43.5 ⁽²⁾	--
216 - 960 MHz	200	46 ⁽²⁾	--
960 - 1000 MHz	500	54 ⁽²⁾	--
1 - 40 GHz	500	54 ⁽³⁾	74

(1) These limits are applicable to emissions outside of the intentional transmit frequency band.

(2) Quasi-peak limit

(3) Average limit

7.3 Test Site

SGS EMC Laboratory, Suwanee, GA (conducted tests)

10m Absorber Lined Shielded Enclosure (ALSE), Suwanee, GA (radiated tests)

Environmental Conditions	Conducted	Radiated	Radiated	Radiated
	9kHz-26GHz	30-1000MHz	1-18GHz	18-26GHz
Temperature:	23.8 °C	22.4 °C	22.9 °C	23.0 °C
Relative Humidity:	40.5 %	51.1 %	48.6 %	49.5 %
Atmospheric Pressure:	97.9 kPa	97.7 kPa	97.7 kPa	97.7 kPa

7.4 Test Equipment

Conducted Tests

Test End Date: 15-May-2019

Tester: MT

Equipment	Model	Manufacturer	Asset Number	Cal Due Date
SIGNAL ANALYZER (TS8997)	FSV30	ROHDE & SCHWARZ	B085749	1-Nov-2019
RF CABLE (TS8997)	141	HUBER & SUHNER	B095588	25-Jul-2019

Note: The equipment calibration period is 1 year except for the FSV which is on a 2-year cycle.

30-1000MHz Radiated Tests

Test End Date: 17-May-2019

Tester: MT

Equipment	Model	Manufacturer	Asset Number	Cal Due Date
ANTENNA, BILOG	JB6	SUNOL	B079690	11-Dec-2019
RF CABLE	SF106	HUBER & SUHNER	B079712	24-Jul-2019
RF CABLE	SF106	HUBER & SUHNER	B079713	24-Jul-2019
RF CABLE	SF106	HUBER & SUHNER	B079659	23-Jul-2019
RF CABLE	SUCOFLEX 100	HUBER & SUHNER	B108523	24-Jul-2019
LOW NOISE AMPLIFIER	TS-PR18	ROHDE & SCHWARZ	15003	24-Jan-2020
EMI TEST RECEIVER	ESU40	ROHDE & SCHWARZ	B079629	2-Jul-2019

Note: The equipment calibration period is 1 year.

1-18GHz Radiated Tests

Test End Date: 20-May-2019

Tester: MT

Equipment	Model	Manufacturer	Asset Number	Cal Due Date
ANTENNA, DRG HORN (MEDIUM)	3117	ETS LINDGREN	B079699	2-Jul-2020
RF CABLE	SF102	HUBER & SUHNER	B079822	25-Jul-2019
RF CABLE	SUCOFLEX 100	HUBER & SUHNER	B108523	24-Jul-2019
LOW NOISE AMPLIFIER	TS-PR18	ROHDE & SCHWARZ	15003	24-Jan-2020
EMI TEST RECEIVER	ESU40	ROHDE & SCHWARZ	B079629	2-Jul-2019

Note: The equipment calibration period is 1 year.

18-26GHz Radiated Tests

Test End Date: 20-May-2019

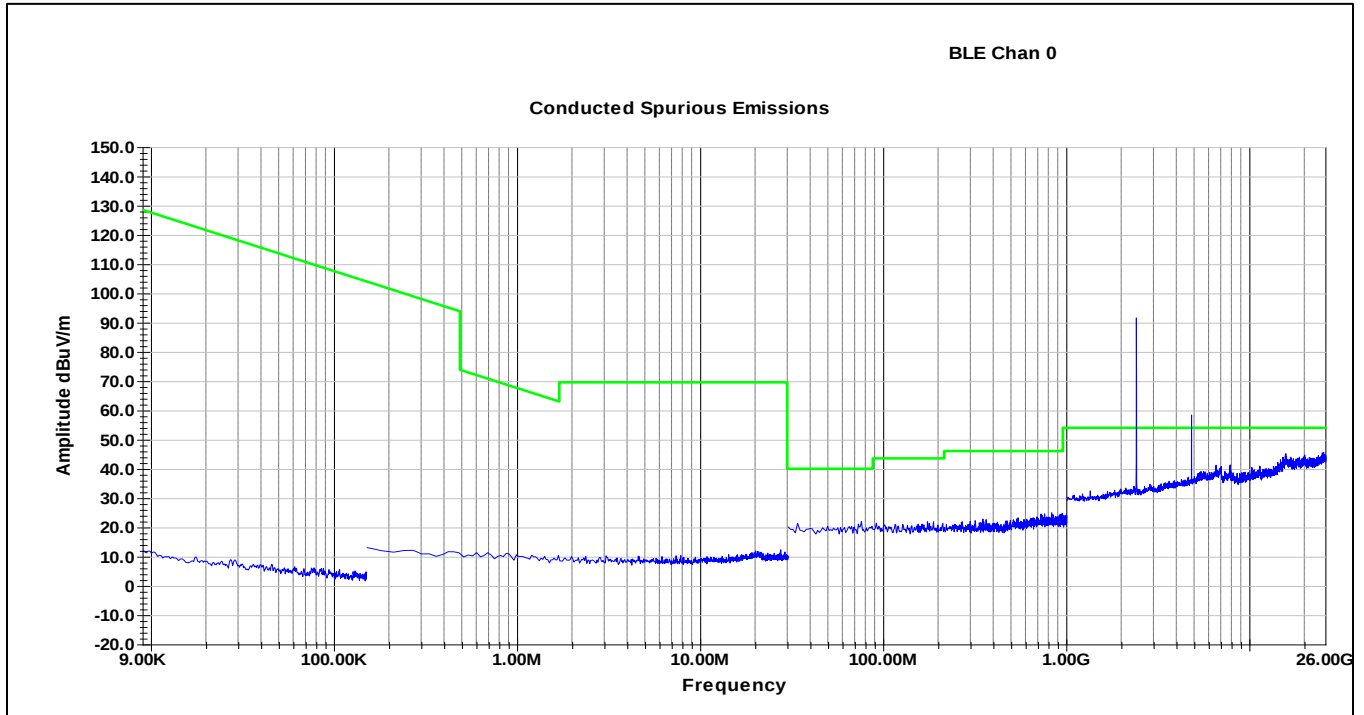
Tester: MT

Equipment	Model	Manufacturer	Asset Number	Cal Due Date
ANTENNA, HORN (SMALL)	LB-180400-20-C-KF	A-INFO	15007	30-Mar-2020
RF CABLE	SF102	HUBER & SUHNER	B079822	25-Jul-2019
RF CABLE	SF102	HUBER & SUHNER	B079823	25-Jul-2019
LOW NOISE AMPLIFIER	NSP1840-HG	MITEQ	B087572	27-Jul-2019
EMI TEST RECEIVER	ESU40	ROHDE & SCHWARZ	B079629	2-Jul-2019

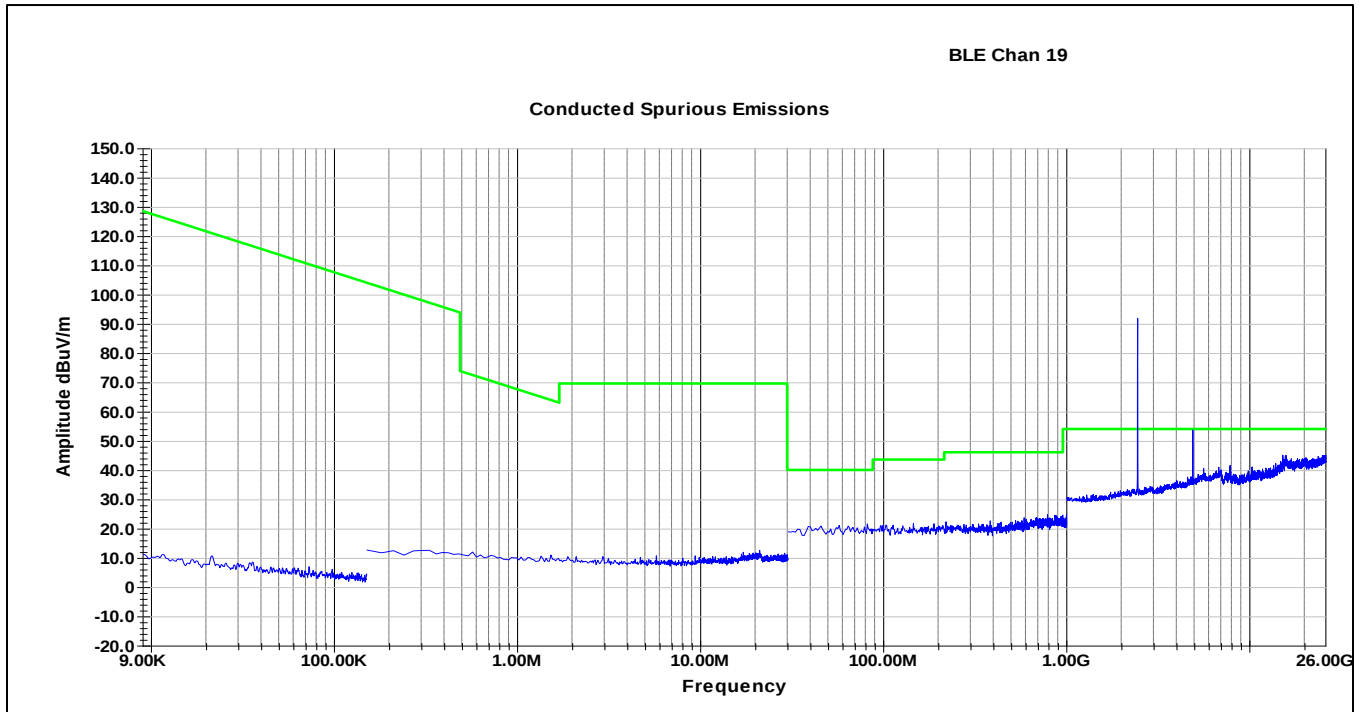
Note: The equipment calibration period is 1 year.

7.5 Test Data – Antenna-Port Conducted Emissions

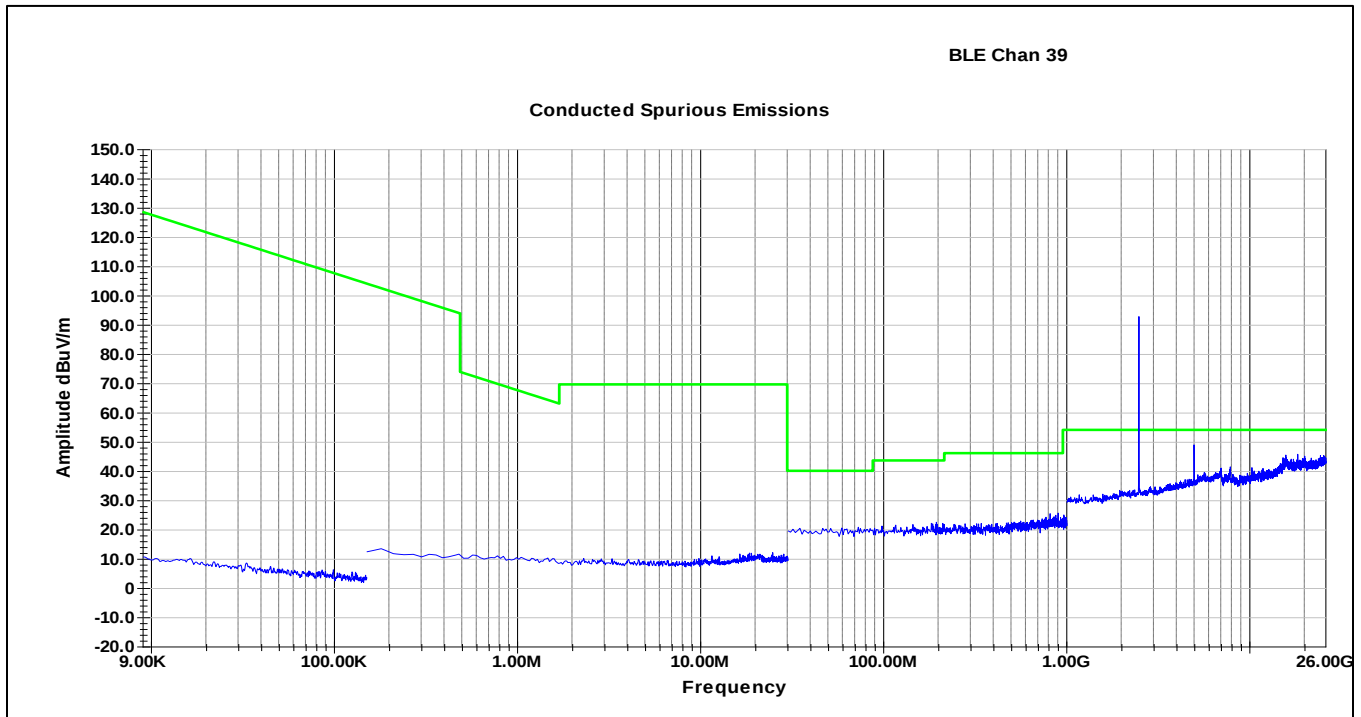
BLE Channel 0 Peak Emissions Plot



BLE Channel 19 Peak Emissions Plot



BLE Channel 39 Peak Emissions Plot



Tabular Data

EUT Channel	Tx Freq (MHz)	Meas Freq (MHz)	Raw Pk Pwr (dBm)	AG (dBi)	CL (dB)	3m FS Conversion	Final Value (dBuV/m)	Pk Limit (dBuV/m)	Margin (dB)
0	2402	4804	-41.5	2.0	2.9	95.2	58.6	74.0	-15.4
19	2440	4880	-46.2	2.0	2.9	95.2	53.9	74.0	-20.1
39	2480	4960	-51.0	2.0	2.9	95.2	49.1	74.0	-24.9

EUT Channel	Tx Freq (MHz)	Meas Freq (MHz)	Raw Avg Pwr (dBm)	AG (dBi)	CL (dB)	3m FS Conversion	Final Value (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)
0	2402	4804	-47.3	2.0	2.9	95.2	52.8	54.0	-1.2
19	2440	4880	-52.8	2.0	2.9	95.2	47.3	54.0	-6.7
39	2480	4960	-56.1	2.0	2.9	95.2	44.0	54.0	-10.0

AG = Antenna Gain (2 dB is minimum antenna gain allowed by test method)

CL = Cable Loss

3m FS Conversion is to convert measured power to Field Strength at 3m distance

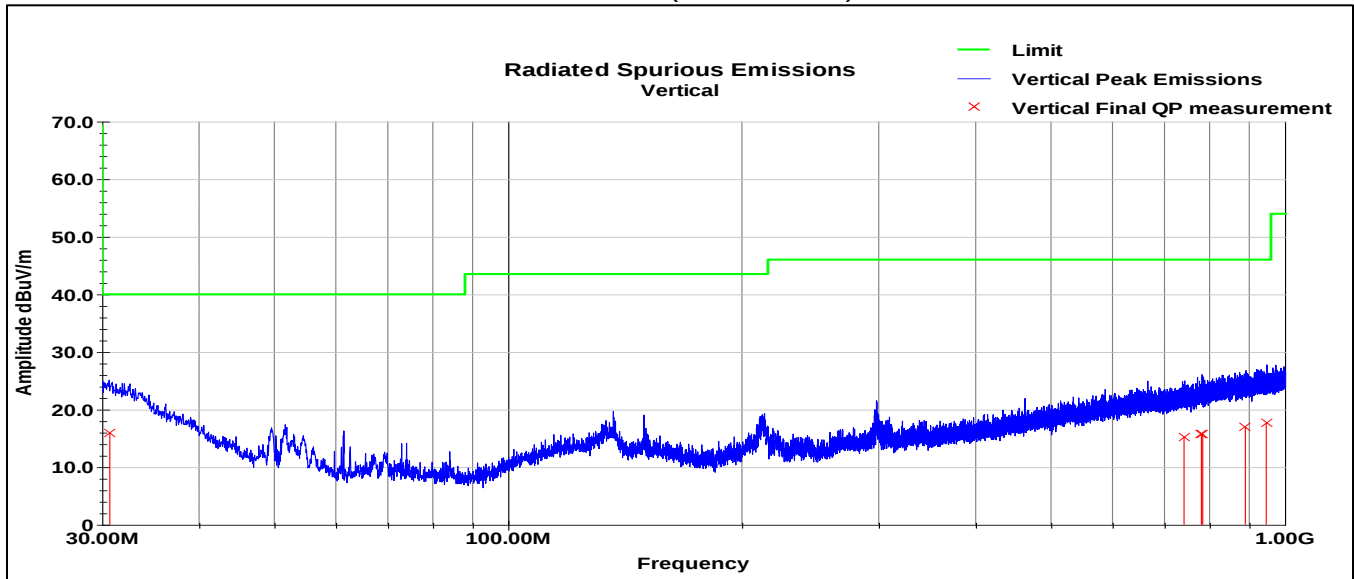
Final Value = Raw Pwr + AG + CL + 3m FS Conversion

Margin = Avg Value - Limit

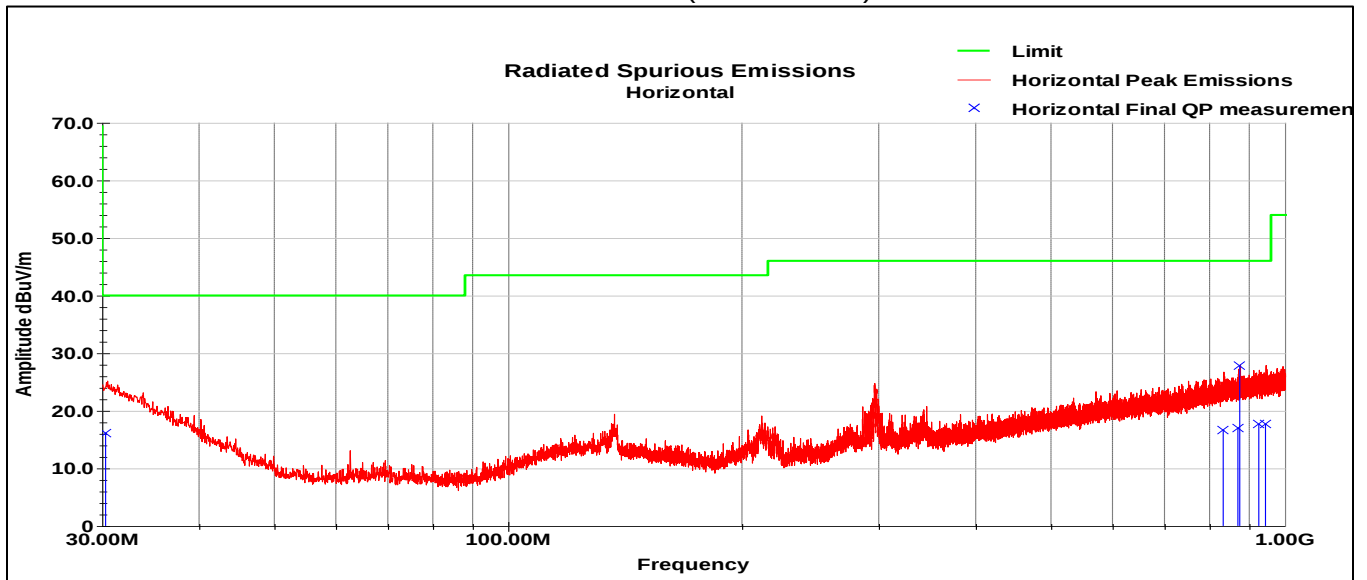
7.6 Test Data – Radiated Emissions

No emissions were detected in the 9kHz to 30MHz frequency range.

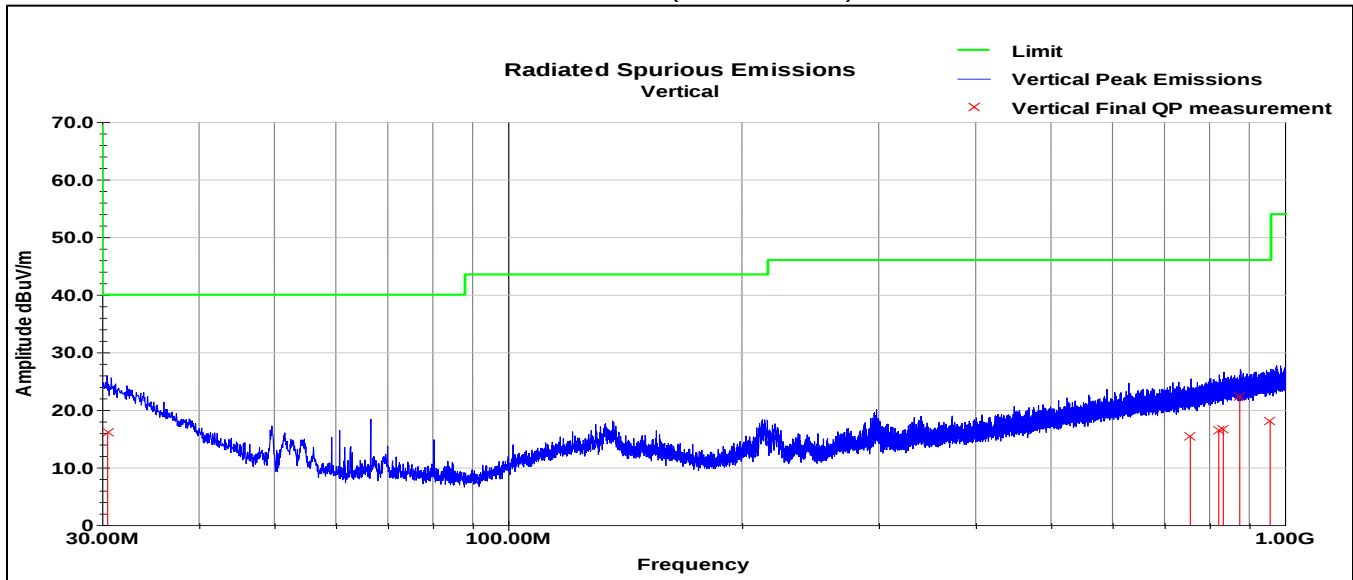
BLE Channel 0
Vertical Plot (30-1000MHz)



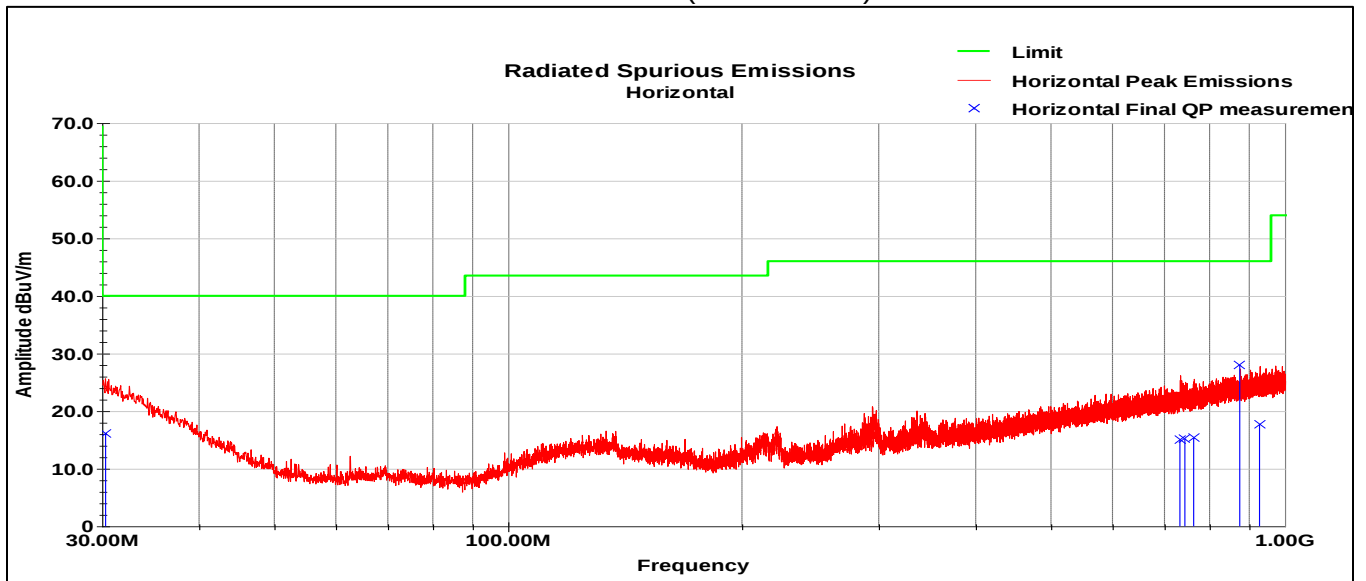
BLE Channel 0
Horizontal Plot (30-1000MHz)



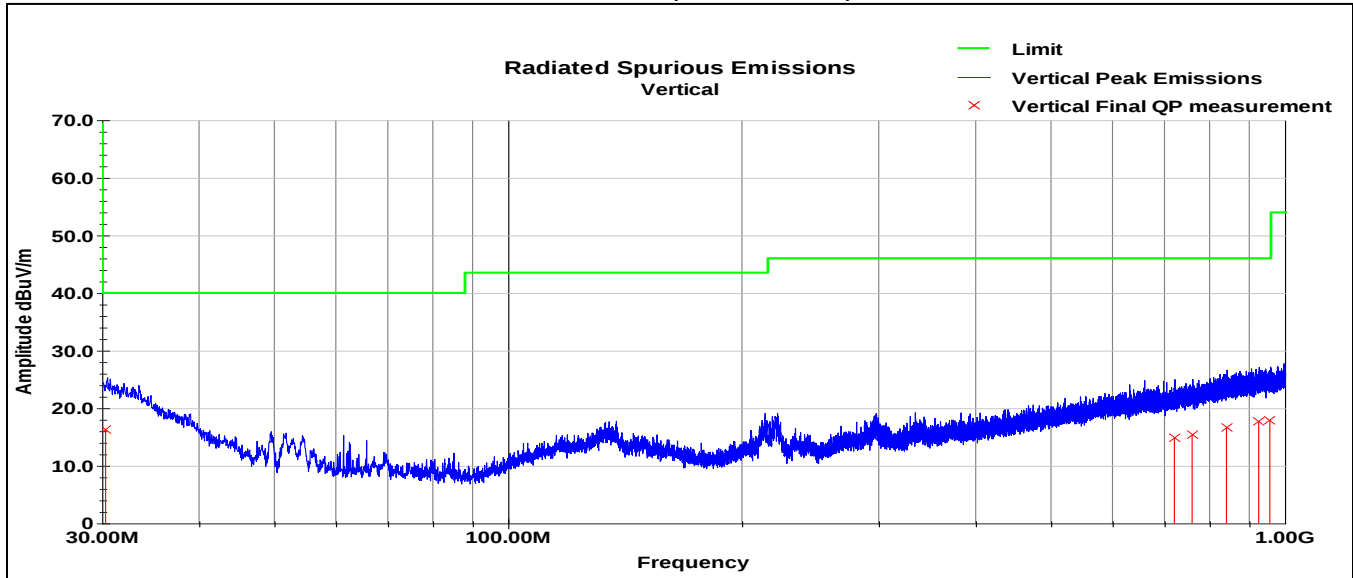
BLE Channel 19 Vertical Plot (30-1000MHz)



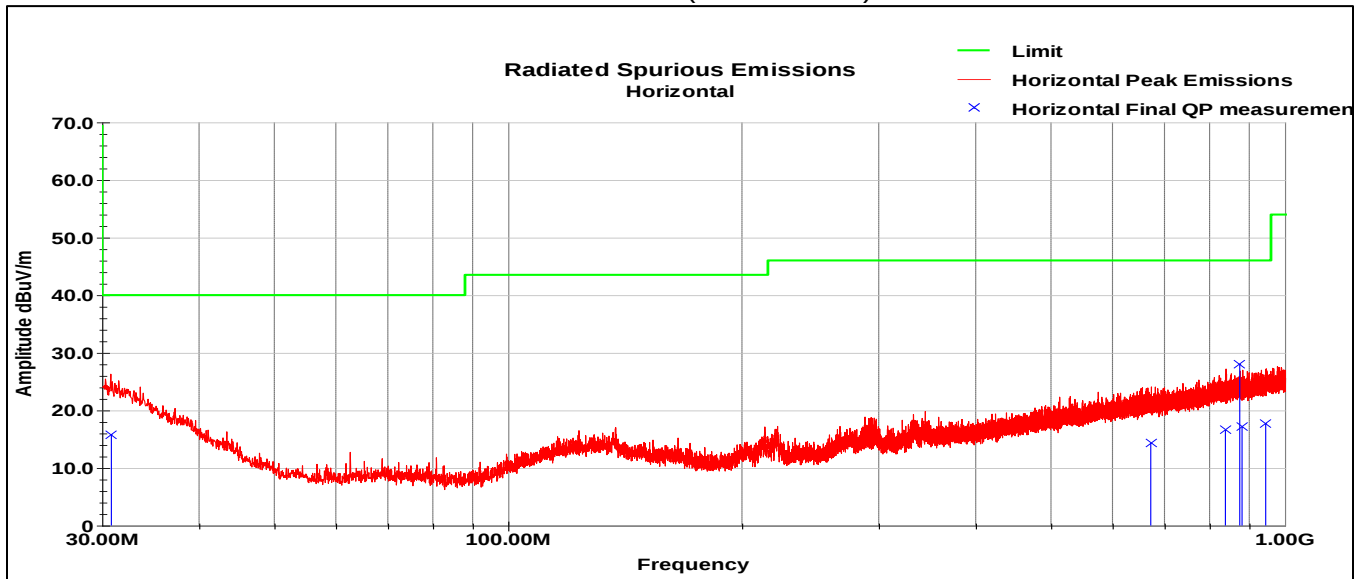
BLE Channel 19 Horizontal Plot (30-1000MHz)



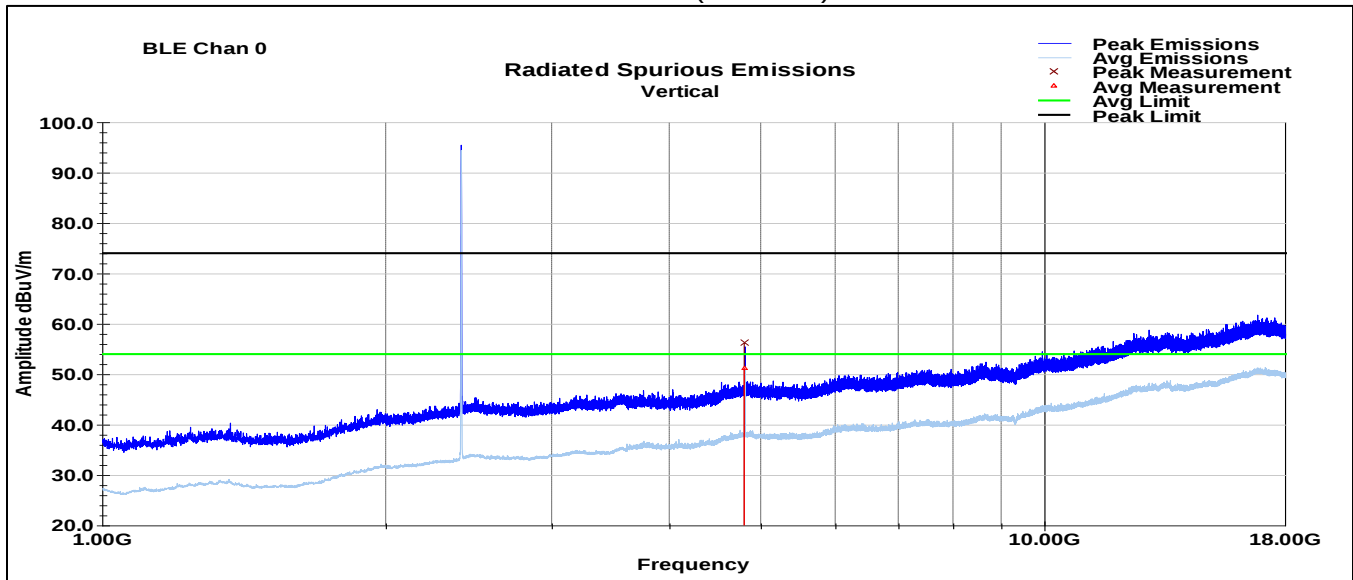
BLE Channel 39 Vertical Plot (30-1000MHz)



BLE Channel 39 Horizontal Plot (30-1000MHz)



BLE Channel 0 Vertical Plot (1-18GHz)

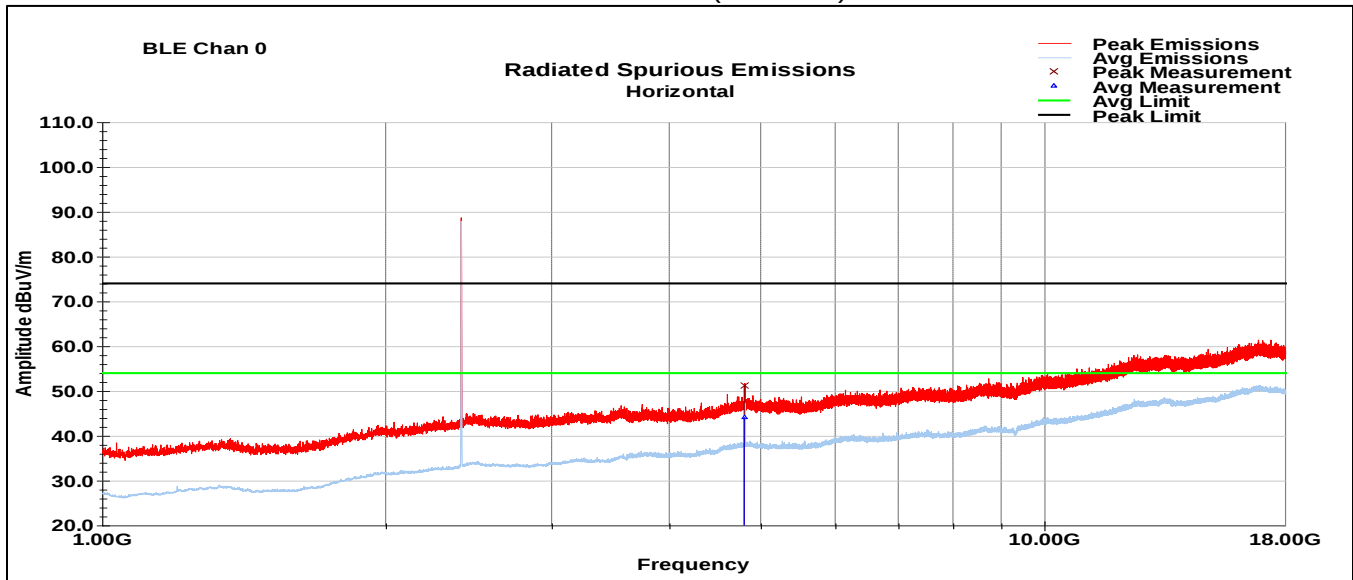


Vertical Data (1-18GHz)

Frequency MHz	Raw Pk dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Final Pk dBuV/m	Limit dBuV/m	Margin dB
4803.52	52.3	V	33.0	227.0	34.7	3.5	34.2	56.2	74.0	-17.8
Pk Value = Level + AF + CL - Amp										
Margin = Pk Value - Limit										

Frequency MHz	Raw Avg dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Final Avg dBuV/m	Limit (dBuV/m)	Margin (dB)
4803.52	47.3	V	33.0	227.0	34.7	3.5	34.2	51.3	54.0	-2.7
Avg Value = Level + AF + CL - Amp										
Margin = Avg Value - Limit										

BLE Channel 0 Horizontal Plot (1-18GHz)

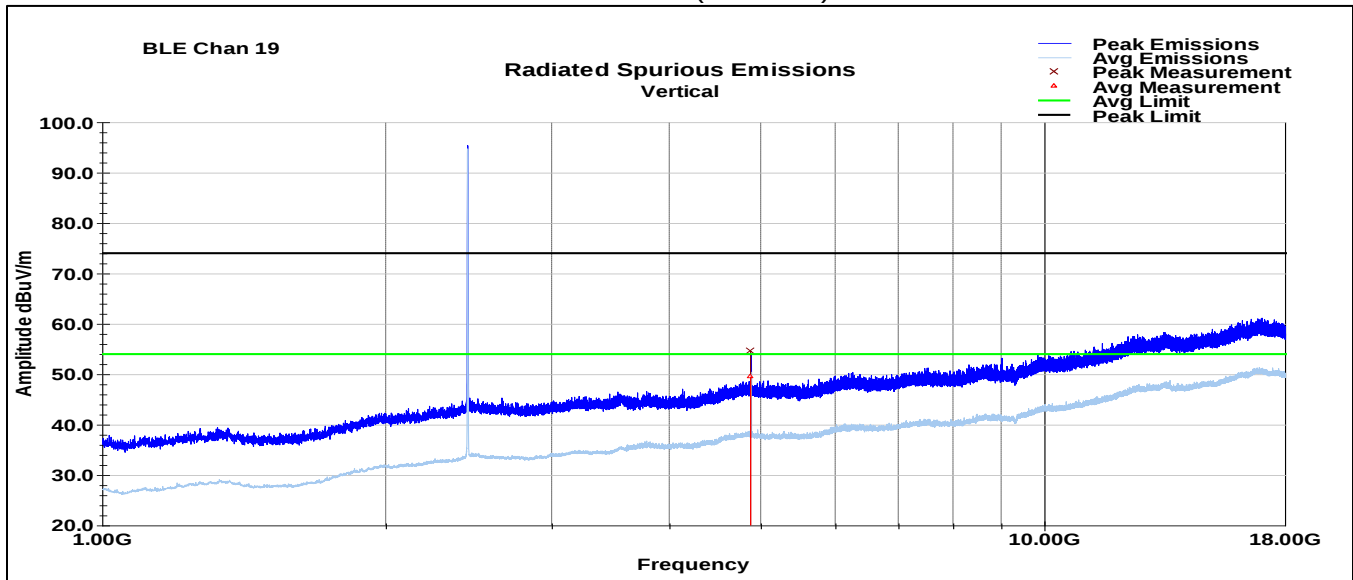


Horizontal Data (1-18GHz)

Frequency MHz	Raw Pk dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Final Pk dBuV/m	Limit dBuV/m	Margin dB
4803.88	47.2	H	67.0	127.0	34.7	3.5	34.2	51.1	74.0	-22.9
Pk Value = Level + AF + CL - Amp										
Margin = Pk Value - Limit										

Frequency MHz	Raw Avg dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Avg Value dBuV/m	Limit (dBuV/m)	Margin (dB)
4803.88	40.2	H	67.0	127.0	34.7	3.5	34.2	44.1	54.0	-9.8
Avg Value = Level + AF + CL - Amp										
Margin = Avg Value - Limit										

BLE Channel 19 Vertical Plot (1-18GHz)

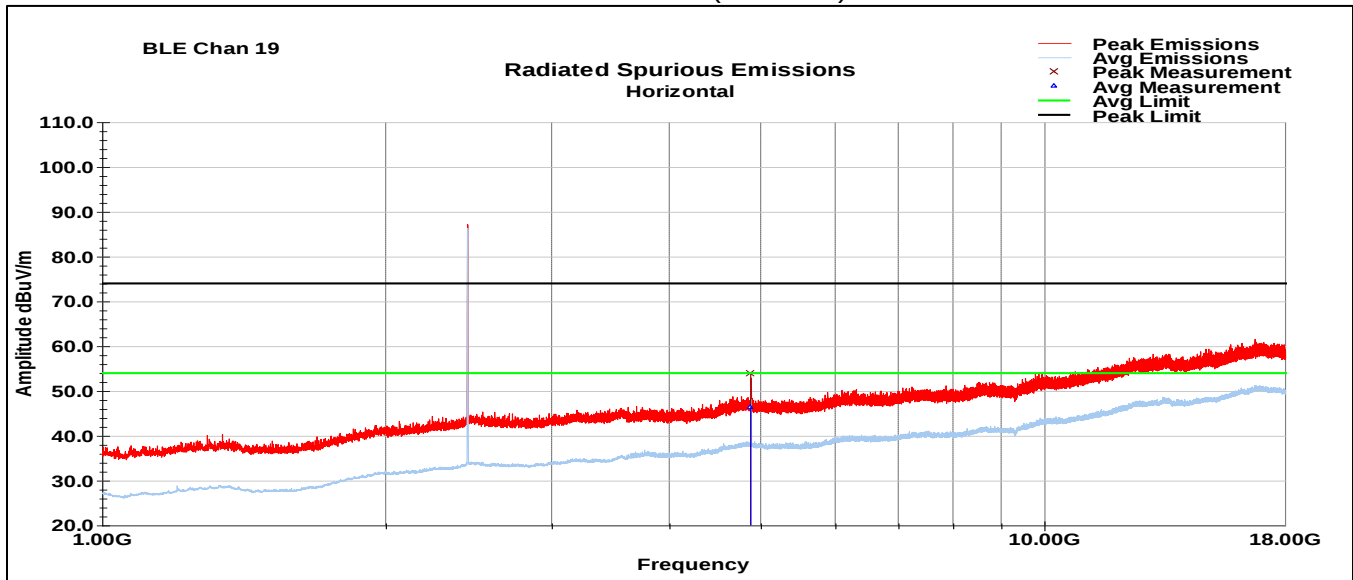


Vertical Data (1-18GHz)

Frequency MHz	Raw Pk dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Final Pk dBuV/m	Limit dBuV/m	Margin dB
4879.68	50.7	V	37.0	202.0	34.5	3.5	34.2	54.6	74.0	-19.4
Pk Value = Level + AF + CL - Amp										
Margin = Pk Value - Limit										

Frequency MHz	Raw Avg dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Final Avg dBuV/m	Limit (dBuV/m)	Margin (dB)
4879.68	45.6	V	37.0	202.0	34.5	3.5	34.2	49.5	54.0	-4.5
Avg Value = Level + AF + CL - Amp										
Margin = Avg Value - Limit										

BLE Channel 19 Horizontal Plot (1-18GHz)

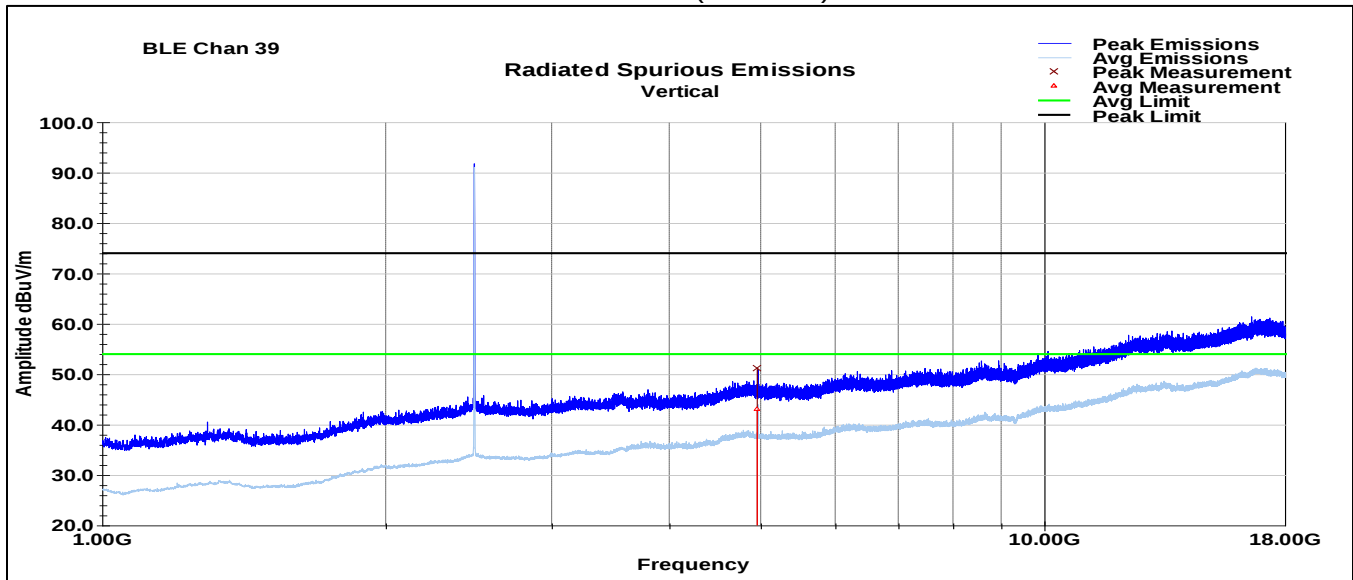


Horizontal Data (1-18GHz)

Frequency MHz	Raw Pk dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Final Pk dBuV/m	Limit dBuV/m	Margin dB
4880.28	50.1	H	191.0	112.0	34.5	3.5	34.2	54.0	74.0	-20.0
Pk Value = Level + AF + CL - Amp										
Margin = Pk Value - Limit										

Frequency MHz	Raw Avg dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Avg Value dBuV/m	Limit (dBuV/m)	Margin (dB)
4880.28	42.7	H	191.0	112.0	34.5	3.5	34.2	46.5	54.0	-7.5
Avg Value = Level + AF + CL - Amp										
Margin = Avg Value - Limit										

BLE Channel 39 Vertical Plot (1-18GHz)

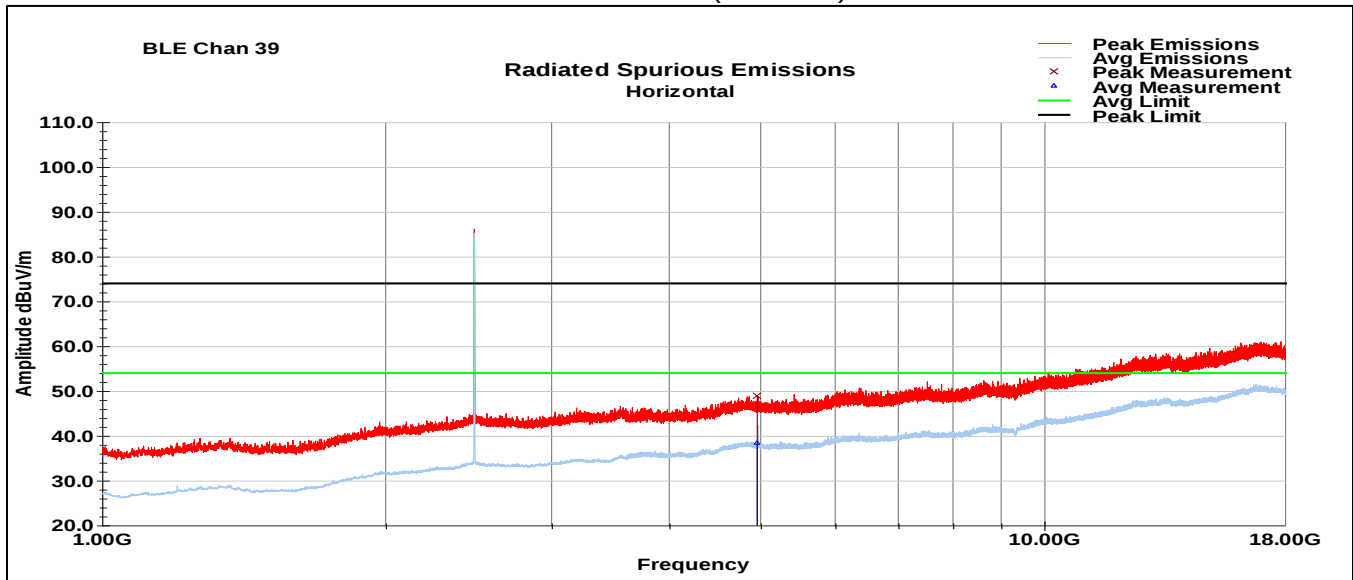


Vertical Data (1-18GHz)

Frequency MHz	Raw Pk dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Final Pk dBuV/m	Limit dBuV/m	Margin dB
4959.44	47.4	V	354.0	208.0	34.4	3.6	34.3	51.1	74.0	-22.9
Pk Value = Level + AF + CL - Amp										
Margin = Pk Value - Limit										

Frequency MHz	Raw Avg dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Final Avg dBuV/m	Limit (dBuV/m)	Margin (dB)
4959.44	39.3	V	354.0	208.0	34.4	3.6	34.3	43.0	54.0	-11.0
Avg Value = Level + AF + CL - Amp										
Margin = Avg Value - Limit										

BLE Channel 39 Horizontal Plot (1-18GHz)

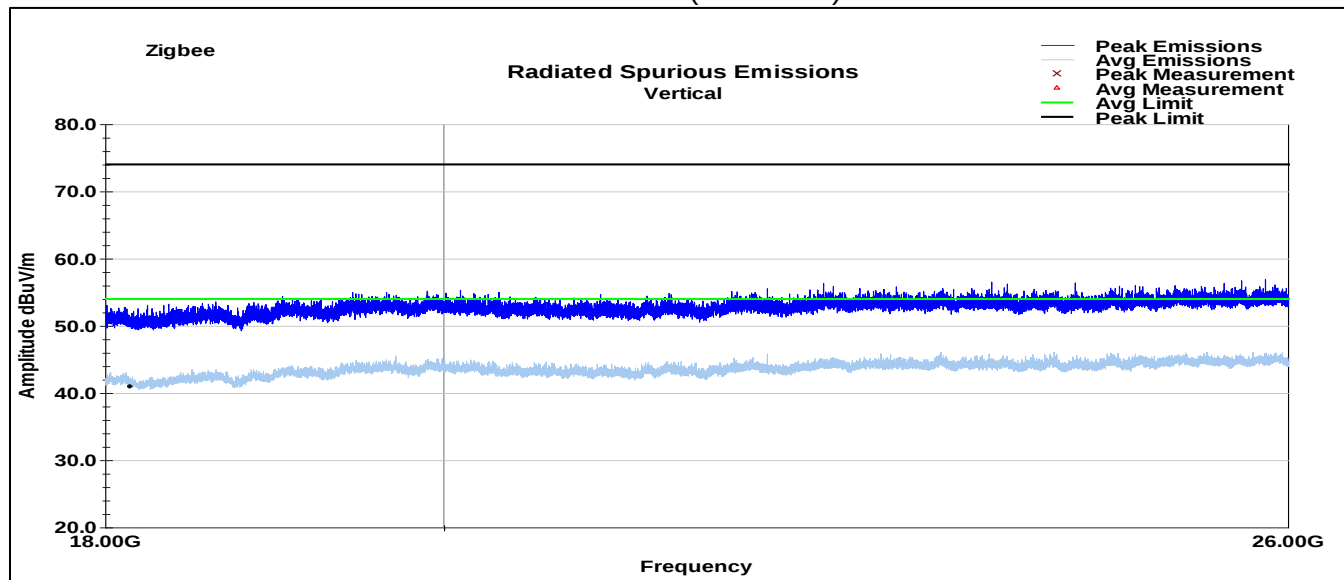


Horizontal Data (1-18GHz)

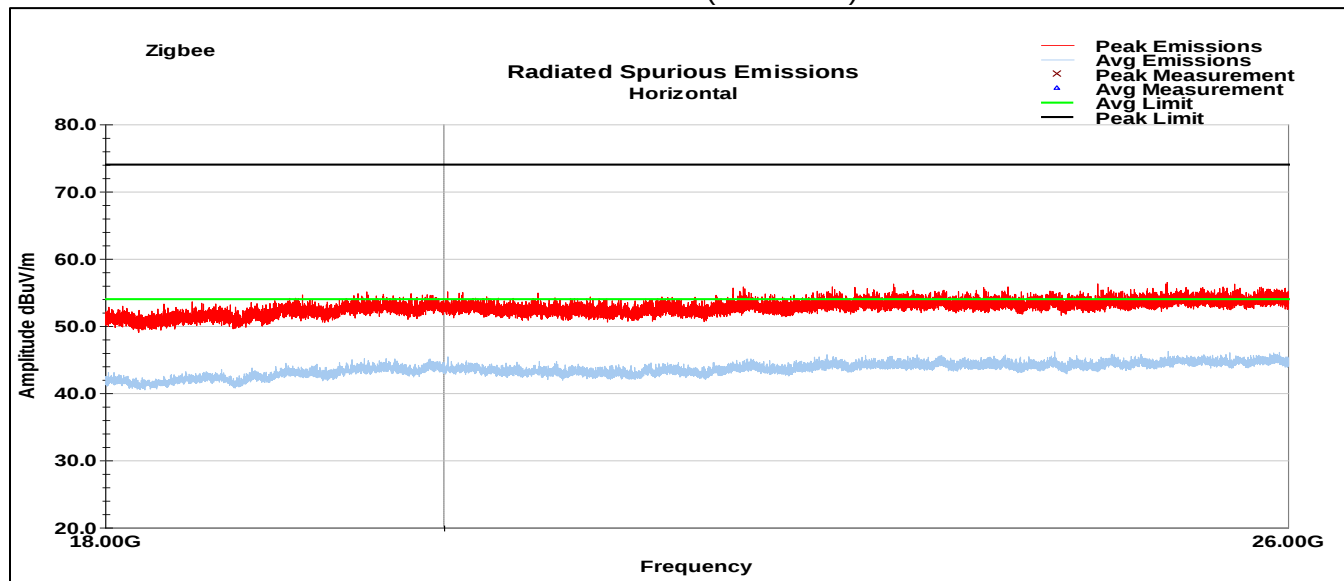
Frequency MHz	Raw Pk dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Final Pk dBuV/m	Limit dBuV/m	Margin dB
4959.44	45.2	H	26.0	107.0	34.4	3.6	34.3	48.9	74.0	-25.1
Pk Value = Level + AF + CL - Amp										
Margin = Pk Value - Limit										

Frequency MHz	Raw Avg dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Avg Value dBuV/m	Limit (dBuV/m)	Margin (dB)
4959.44	34.9	H	26.0	107.0	34.4	3.6	34.3	38.5	54.0	-15.4
Avg Value = Level + AF + CL - Amp										
Margin = Avg Value - Limit										

BLE (Channels 0, 19 & 39 all similar)
Vertical Plot (18-26GHz)



BLE (Channels 0, 19 & 39 all similar)
Horizontal Plot (18-26GHz)



8 Band Edge Emissions in Restricted Frequency Bands

8.1 Test Result

Test Description	Test Specification		Test Result
Band Edge Emissions in Restricted Frequency Bands	15.205, 15.209	RSS-GEN S8.9, 8.10	Compliant

8.2 Test Method

Field strength measurements were performed at the restricted band edges of 2390MHz and 2483.5MHz. Measurements were made using the conducted methods defined in ANSI C63.10: 2013 clause 11.12.2. The measurements were converted to a radiated field strength equivalent using the equations defined in that section. Both peak and average measurements were performed at the antenna port.

Offset Calculations:

A reference level offset was applied to the spectrum analyzer so that conducted measurements in dBμV represent field strength measurements in dBμV/m.

$$\text{Offset} = -20\text{Log}(D) + 104.8 - 107 + \text{CL} + \text{DC} + \text{AG}$$

$$\text{Offset}_{3\text{m}} = -11.7 + \text{CL} + \text{DC} + \text{AG}$$

Where:

D = 3m	Distance
CL = 1.3 dB	Cable Loss (including Murata MXHQ87WJ3000 measurement probe)
DC = 0 dB (100%)	Duty Cycle Correction Factor [10Log(1/Duty Cycle)]
AG = 2 dB	Antenna Gain [2 dB is the minimum allowed by the test method]

$$\text{Offset} = -8.4 \text{ dB}$$

8.3 Test Site

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature:	23.7 °C
Relative Humidity:	40.7 %
Atmospheric Pressure:	97.9 kPa

8.4 Test Equipment

Test End Date: 15-May-2019

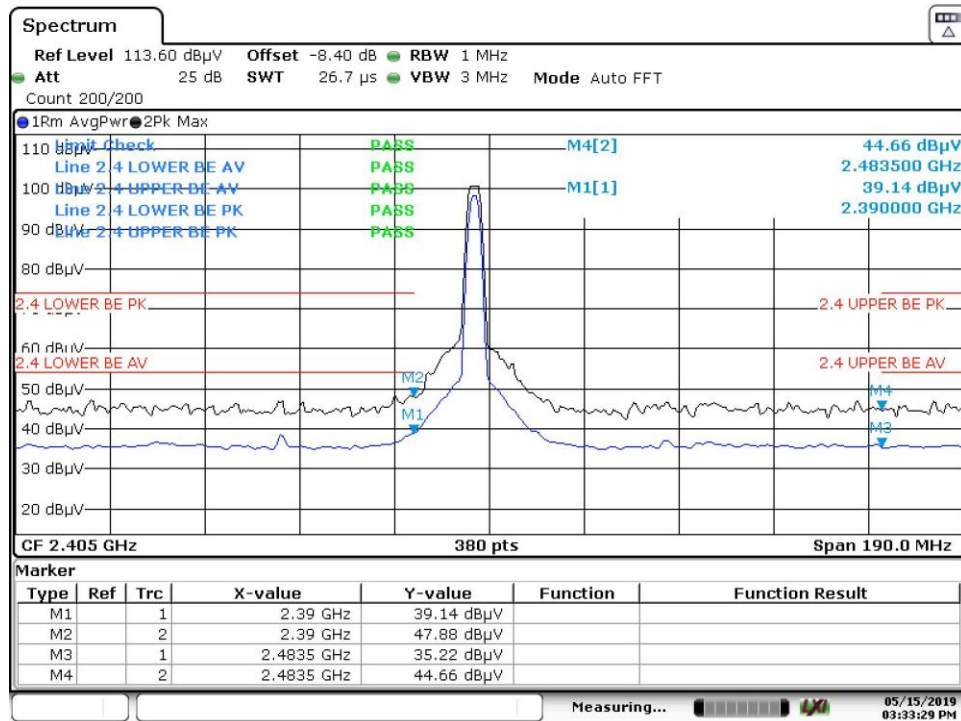
Tester: MT

Equipment	Model	Manufacturer	Asset Number	Cal Due Date
RF CABLE	141	HUBER & SUHNER	B095588	25-Jul-2019
SIGNAL ANALYZER (TS8997)	FSV30	ROHDE & SCHWARZ	B085749	1-Nov-2019

Note: The equipment calibration period is 1 year except for the FSV which is on a 2-year cycle.

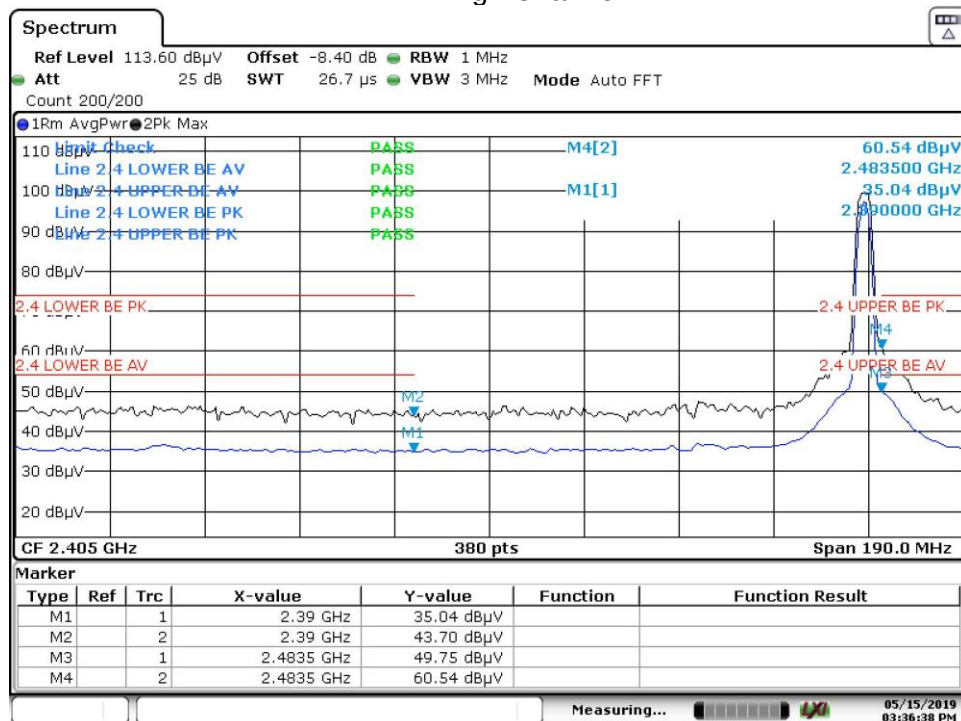
8.5 Test Data

BLE – Low Channel



Date: 15.MAY.2019 15:33:29

BLE – High Channel



Date: 15.MAY.2019 15:36:38

9 AC Powerline Conducted Emissions

9.1 Test Result

Test Description	Test Specification		Test Result
AC Powerline Conducted Emissions	15.207	RSS-GEN S8.8	Compliant

9.2 Test Method

With the receiver's resolution bandwidth was set to 9 kHz, exploratory scans were performed over the measuring frequency range (0.15 MHz to 30 MHz) using a max hold mode incorporating a Peak detector and Average detector and using the TILE! software. The final test data was measured using a Quasi-Peak detector and Average detector and compared against the limits indicated in the table below.

Frequency Range	Limits (dBuV)
0.15 to 0.5 MHz	Avg 56 to 46 QP 66 to 56
0.5 to 5 MHz	Avg 46 Pk 56
5 to 30 MHz	Avg 50 Pk 60

9.3 Test Site

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions:

Temperature: 22.5 °C

Relative Humidity: 51.4 %

Atmospheric Pressure 97.7 kPa

9.4 Test Equipment

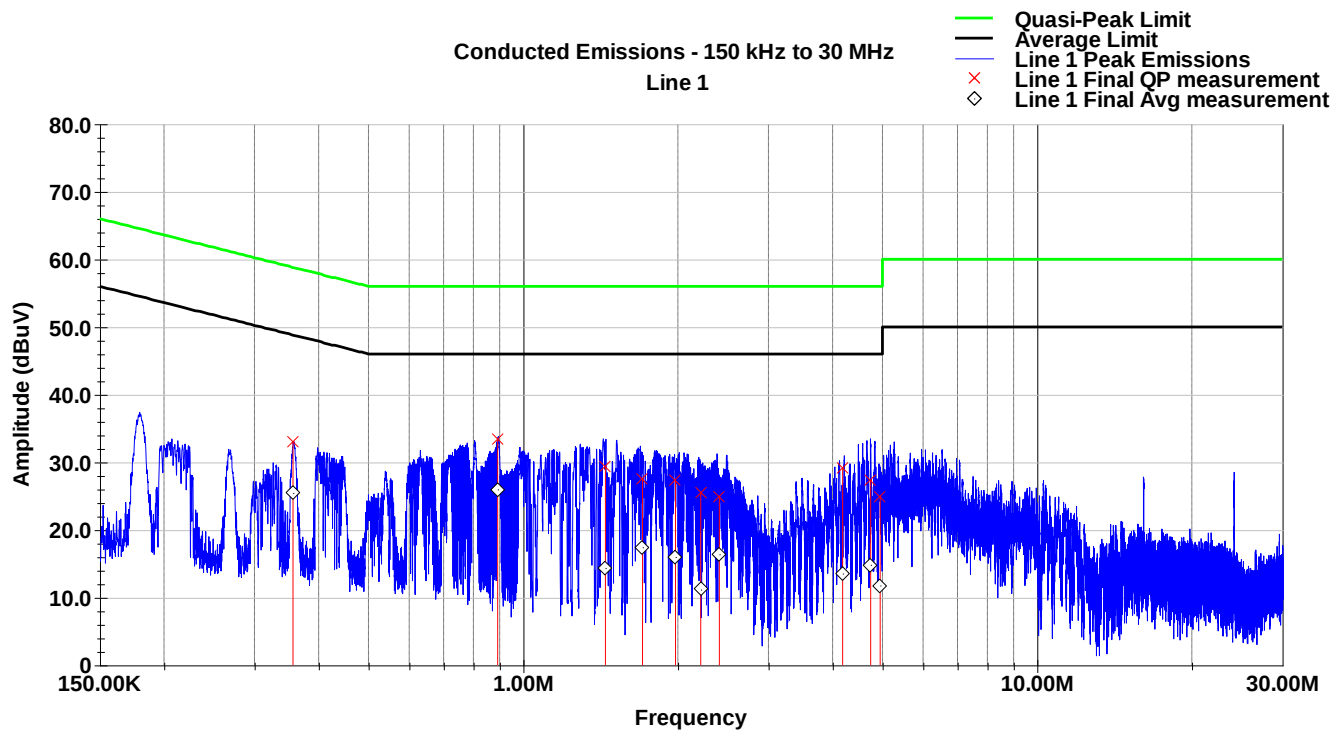
Test End Date: 13-Jun-2019

Tester: MT

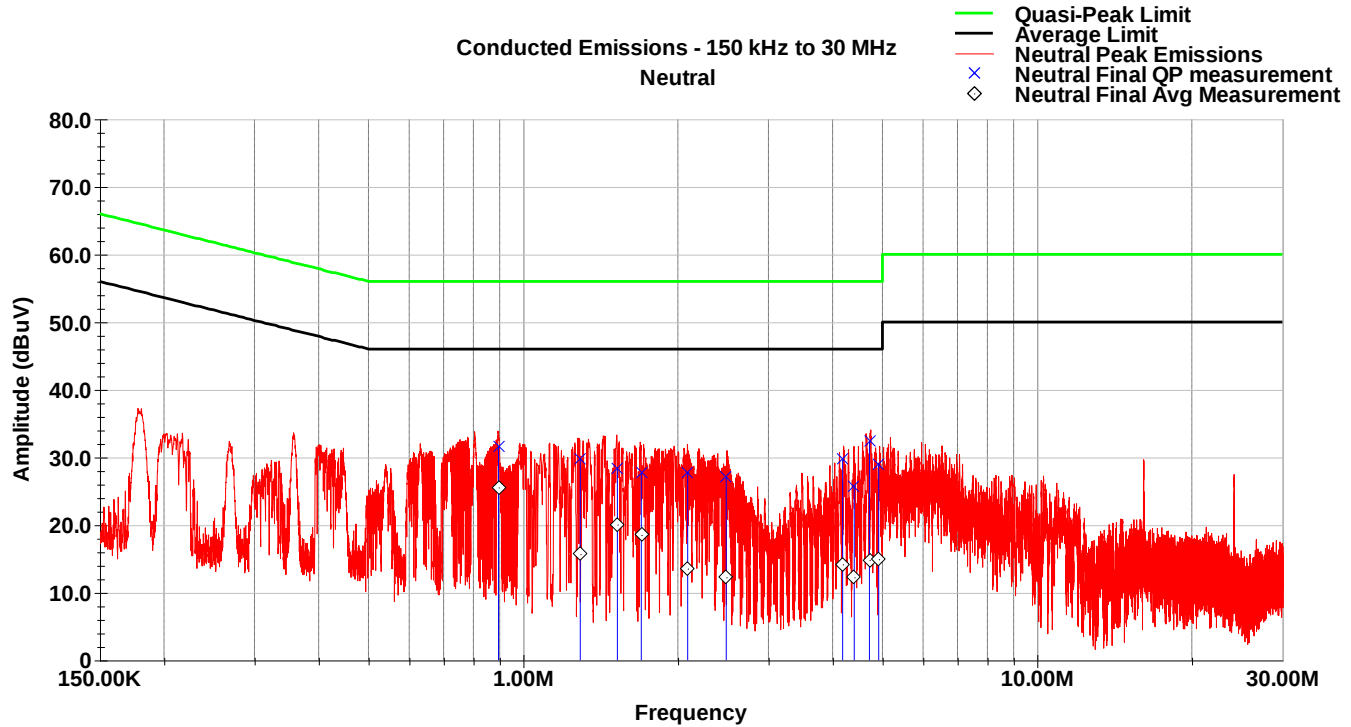
Equipment	Model	Manufacturer	Asset Number	Cal Due Date
LINE IMPEDANCE STABILIZATION NETWORK	NNB 51	TESEQ	B087573	3-Dec-2019
RF CABLE	UC-N-MM-78	MAURY MICROWAVE	17017	24-Jul-2019
EMI TEST RECEIVER	ESU40	ROHDE & SCHWARZ	B079629	2-Jul-2019

Software: "181112 Conducted Emissions TILE7" TILE! profile dated 12 Nov 2018

9.5 Test Data



Frequency MHz	QP Value dBUV	QP Limit dBUV	QP Margin dB	Avg Value dBUV	Avg Limit dBUV	Avg Margin dB
0.356	33.1	58.8	-25.6	25.5	48.8	-23.3
0.892	33.4	56.0	-22.6	26.0	46.0	-20.0
1.445	29.4	56.0	-26.6	14.4	46.0	-31.6
1.707	27.6	56.0	-28.4	17.5	46.0	-28.5
1.978	27.2	56.0	-28.8	16.0	46.0	-30.0
2.216	25.4	56.0	-30.6	11.2	46.0	-34.8
2.408	24.9	56.0	-31.1	16.4	46.0	-29.6
4.184	29.2	56.0	-26.8	13.6	46.0	-32.4
4.743	27.4	56.0	-28.6	14.9	46.0	-31.1
4.950	25.0	56.0	-31.0	11.8	46.0	-34.2



Frequency MHz	QP Value dBuV	QP Limit dBuV	QP Margin dB	Avg Value dBuV	Avg Limit dBuV	Avg Margin dB
0.895	31.5	56.0	-24.5	25.6	46.0	-20.4
1.292	29.7	56.0	-26.3	15.7	46.0	-30.3
1.525	28.3	56.0	-27.7	20.1	46.0	-25.9
1.698	27.7	56.0	-28.3	18.5	46.0	-27.5
2.090	27.8	56.0	-28.2	13.6	46.0	-32.4
2.484	27.1	56.0	-28.9	12.3	46.0	-33.7
4.183	29.7	56.0	-26.3	14.2	46.0	-31.8
4.406	25.8	56.0	-30.2	12.3	46.0	-33.7
4.717	32.3	56.0	-23.7	14.9	46.0	-31.1
4.918	29.0	56.0	-27.0	15.0	46.0	-31.0

10 Measurement Uncertainty

The measurement uncertainty figures are calculated in accordance with TR 100 028-1 [2] and correspond to an expansion factor (coverage factor) $k = 2$ (which provides confidence levels of 95.45 % in the case where the distributions characterizing the actual measurement uncertainties are normal (Gaussian)).

Parameter	Expanded Uncertainty for Normal k factor equal to 2	
	Required	Laboratory Actual
Radio Frequency	$\pm 1 \times 10^{-5}$	$\pm 9.8 \times 10^{-8}$
total RF power, conducted	± 1.5 dB	± 1.2 dB
RF power density, conducted	± 3 dB	± 0.7 dB
spurious emissions, conducted	± 3 dB	± 2.1 dB
all emissions, radiated	± 6 dB	± 4.8 dB
temperature	$\pm 1^{\circ}\text{C}$	$\pm 0.5^{\circ}\text{C}$
humidity	± 5 %	$\pm 3.5\%$
DC and low frequency voltages	± 3 %	$\pm 0.4\%$
Conducted disturbance at mains port using AMN	± 3.4 dB	± 2.5 dB

11 Revision History

Revision Level	Description of changes	Revision Date
0	Initial release	20 June 2019
1	- Added information of two antenna suppliers (section 2.3) - Updated EIRP values based on max antenna gain (section 4.5)	01 July 2019