

# RF Test Report

**Project Number:** 4455847**Proposal Number:** 8670**Report Number:** 4455847EMC01**Revision Level:** 1**Client:** Vitls, Inc.**Equipment Under Test:** Vital Signs Monitoring Device**Model Name:** Tego VSS Sensor**Model Number:** VT-F-010**FCC ID:** 2ASYD-VT-F-010**Applicable Standards:** FCC Part 15 Subpart C, § 15.247

RSS-247, Issue 2

RSS-GEN, Issue 5

ANSI C63.10:2013

**Report issued on:** 10 May 2019**Test Result:** Compliant

Tested by:



Martin Taylor, RF/EMC Engineer

Reviewed by:



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.

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## 1 Summary of Test Results

| Test Description                            | Test Specification          |                                     | Test Result              |
|---------------------------------------------|-----------------------------|-------------------------------------|--------------------------|
| Bandwidth                                   | 15.247(a)(2)                | RSS-247 S5.2 (a)<br>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<br>/ Band Edge | 15.247(d)                   | RSS-247 S5.5                        | Compliant                |
| Field Strength of Spurious<br>Radiation     | 15.247(d)<br>15.205, 15.209 | RSS-247 S5.5<br>RSS-GEN S8.9, S8.10 | Compliant                |
| Emissions in Restricted<br>Frequency Bands  | 15.205, 15.209              | RSS-GEN S8.9, S8.10                 | Compliant                |
| Antenna Requirement                         | 15.203                      | RSS-GEN S6.8                        | Compliant <sup>(1)</sup> |
| AC Powerline Conducted<br>Emissions         | 15.207                      | RSS-GEN S8.8                        | NA <sup>(2)</sup>        |

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

(2) Device does not connect to the AC Mains.

### 1.1 Modifications Required for Compliance

None

## 2 General Information

### 2.1 Client Information

Name: Vitls, Inc.  
Address: 2450 Holcombe Blvd., Ste. X  
City, State, Zip, Country: Houston, TX 77021, 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: Vital Signs Monitoring Device  
Model Name: Tego VSS Sensor  
Model Number: VT-F-010  
Serial Number: Not labeled

FCC ID: 2ASYD-VT-F-010

Frequency Range: 2402 – 2480 MHz  
Data Modes: Bluetooth Low Energy  
Antenna: Internal Surface-Mount Antenna

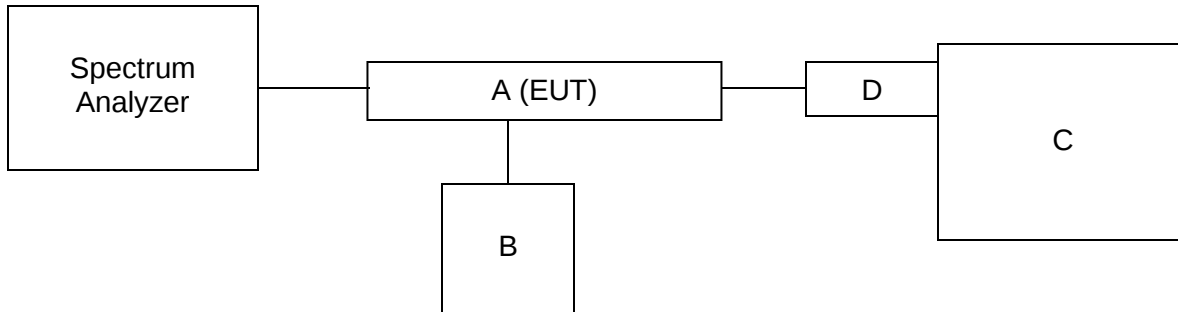
Rated Voltage: 3.7 Vdc  
Test Voltage: 3.7 Vdc

Sample Received Date: 15 January 2019  
Dates of testing: 28 February to 15 April 2019

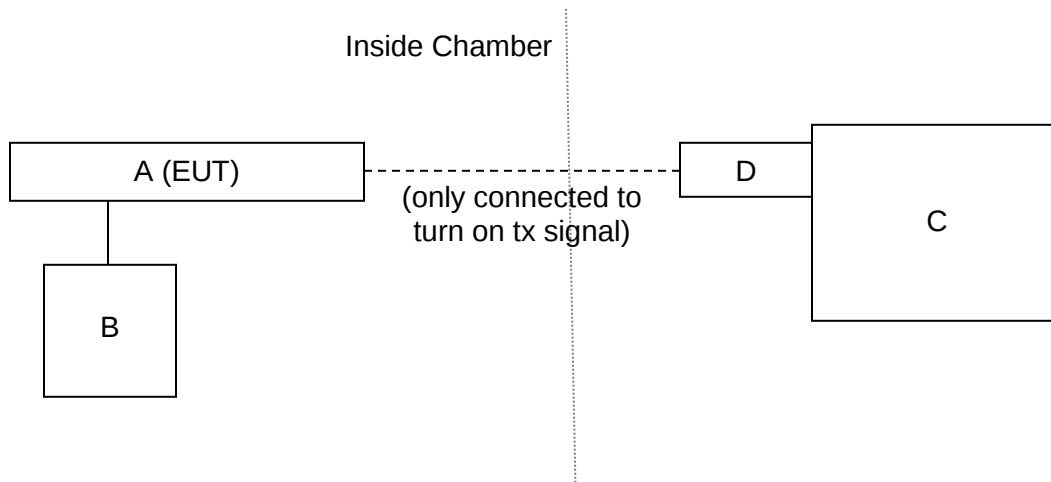
### 2.4 Operating Modes and Conditions

The EUT was programmed by the manufacturer to transmit on low, mid and high channels in all necessary modulation and modes of operation. Continuous traffic was generated using test commands controlled by software provided by the client.

## 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                | Vitls Inc.   | Tego VSS Sensor (EUT)   | VT-F-010     | Not labeled   |
| B                | SHLB Co.     | 3.7V Li-polymer Battery | PL652533     | Not labeled   |
| C                | Lenovo       | Laptop (w/ control SW)  | 80XV         | PF0STB5L      |
| D                | (unknown)    | USB to TTL Converter    | Not labeled  | Not labeled   |

### 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: 49.8 %

Atmospheric Pressure: 96.9 kPa

#### 3.4 Test Equipment

Test End Date: 9-Apr-2019

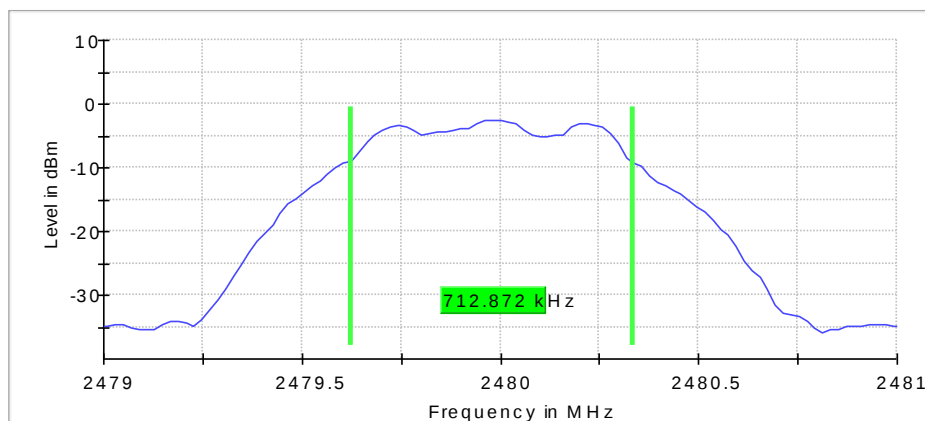
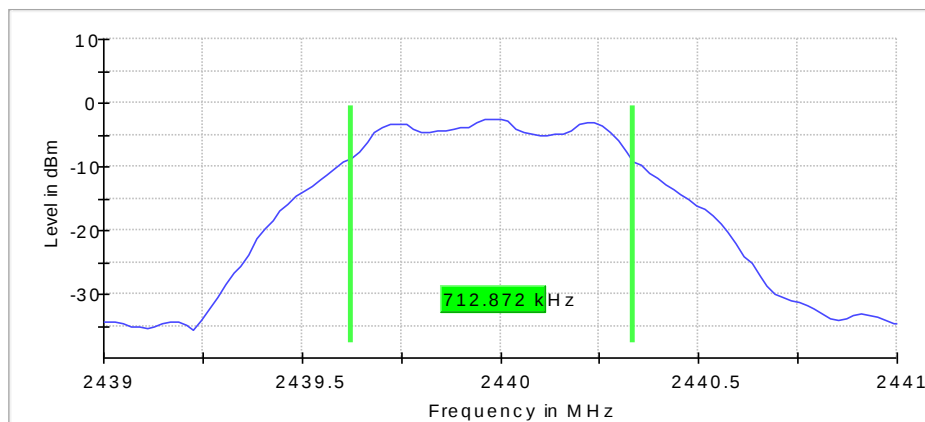
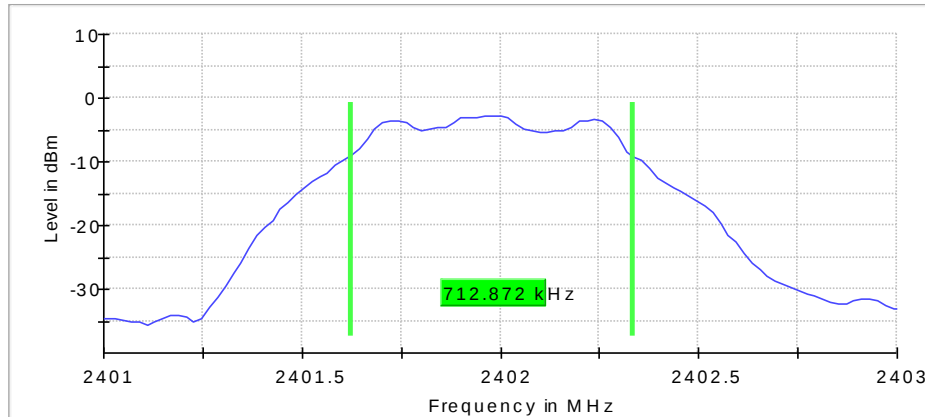
Tester: ASF

| Equipment                 | Model | Manufacturer    | Asset Number | Cal Due Date |
|---------------------------|-------|-----------------|--------------|--------------|
| RF CABLE (TS8997)         | 141   | HUBER & SUHNER  | B095585      | 25-Jul-2019  |
| ATTENUATOR, 10DB (TS8997) | 10DB  | ROHDE & SCHWARZ | B095591      | 25-Jul-2019  |
| RF SWITCH (TS8997)        | OSP   | ROHDE & SCHWARZ | 15039        | 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.

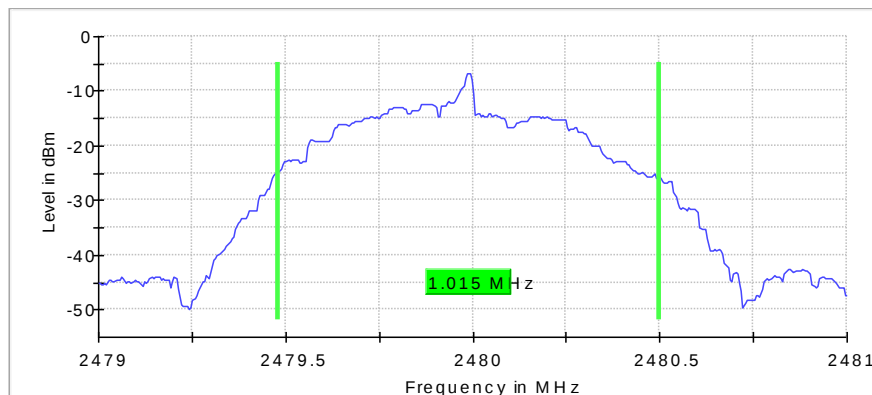
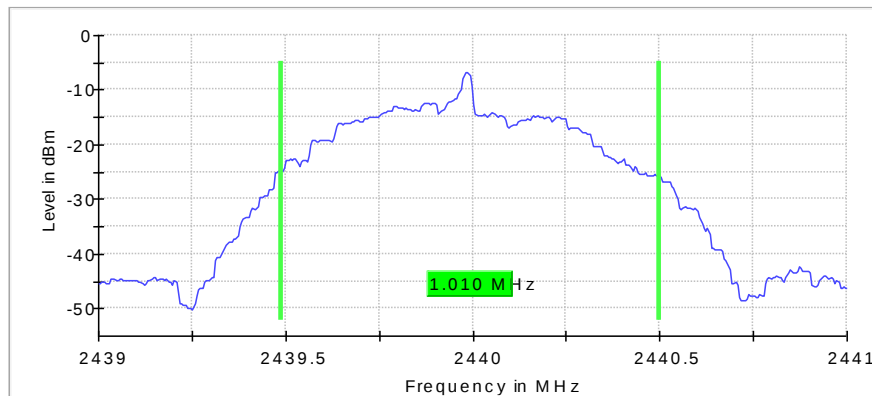
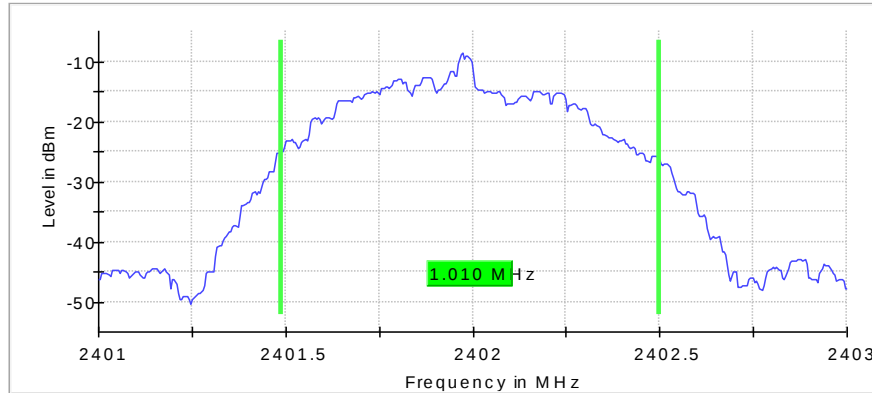
### 3.5 Test Data – DTS Bandwidth (6dB)

| Channel | Frequency (MHz) | 6dB Bandwidth (kHz) | Limit Min (kHz) | Result |
|---------|-----------------|---------------------|-----------------|--------|
| 0       | 2402            | 712.9               | 500             | Pass   |
| 19      | 2440            | 712.9               | 500             | Pass   |
| 39      | 2480            | 712.9               | 500             | Pass   |



### 3.6 Test Data – 99% Occupied Bandwidth

| Channel | Frequency (MHz) | 99% Bandwidth (kHz) | Result   |
|---------|-----------------|---------------------|----------|
| 0       | 2402            | 1010                | Reported |
| 19      | 2440            | 1010                | Reported |
| 39      | 2480            | 1015                | 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).

### 4.3 Test Site

SGS EMC Laboratory, Suwanee, GA

#### Environmental Conditions

Temperature: 23.4 °C

Relative Humidity: 49.8 %

Atmospheric Pressure: 96.9 kPa

### 4.4 Test Equipment

Test End Date: 9-Apr-2019

Tester: ASF

| Equipment                 | Model    | Manufacturer    | Asset Number | Cal Due Date |
|---------------------------|----------|-----------------|--------------|--------------|
| RF CABLE (TS8997)         | 141      | HUBER & SUHNER  | B095585      | 25-Jul-2019  |
| ATTENUATOR, 10DB (TS8997) | 10DB     | ROHDE & SCHWARZ | B095591      | 25-Jul-2019  |
| RF SWITCH (TS8997)        | OSP      | ROHDE & SCHWARZ | 15039        | 15-Dec-2019  |
| SIGNAL ANALYZER (TS8997)  | FSV30    | ROHDE & SCHWARZ | B085749      | 1-Nov-2019   |
| POWER METER (TS8997)      | OSP-B157 | ROHDE & SCHWARZ | 15040        | 15-Dec-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) | Result |
|---------|-----------------|-----------------|-----------------|--------|
| 0       | 2402            | -3.0            | 30              | Pass   |
| 19      | 2440            | -2.8            | 30              | Pass   |
| 39      | 2480            | -2.7            | 30              | 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: 49.8 %

Atmospheric Pressure: 96.9 kPa

### 5.4 Test Equipment

Test End Date: 9-Apr-2019

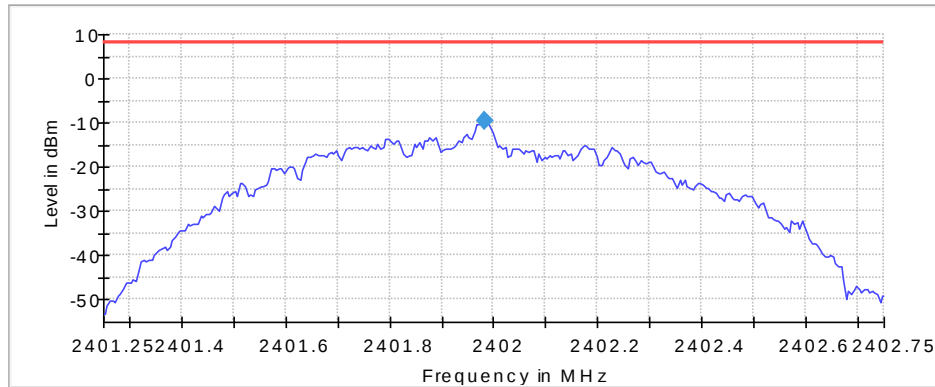
Tester: ASF

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

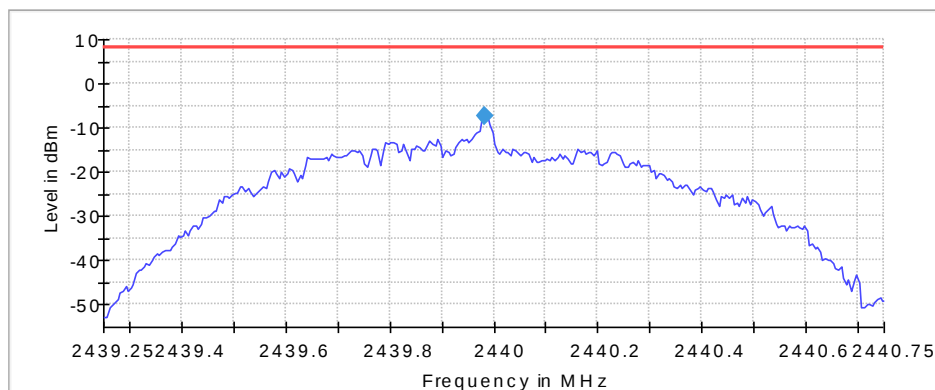
Note: The equipment calibration period is 1 year except for the FSV which is on a 2-year cycle.

## 5.5 Test Data

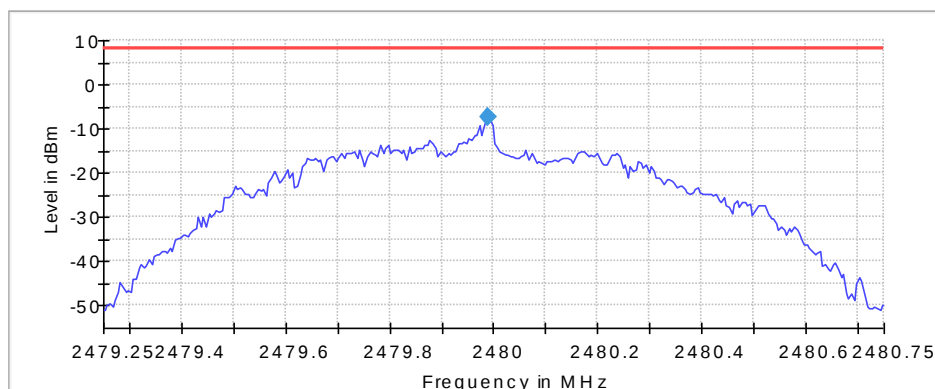
| Channel | Frequency (MHz) | PSD (dBm/3kHz) | Limit Max (dBm/3kHz) | Result |
|---------|-----------------|----------------|----------------------|--------|
| 0       | 2402            | -9.64          | 8                    | Pass   |
| 19      | 2440            | -7.37          | 8                    | Pass   |
| 39      | 2480            | -7.46          | 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 Band Edge Emissions | 15.247(d)          | RSS-247 S5.5 | Compliant   |

### 6.2 Test Method

Conducted band edge 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

Temperature: 23.4 °C

Relative Humidity: 49.8 %

Atmospheric Pressure: 96.9 kPa

### 6.4 Test Equipment

Test End Date: 9-Apr-2019

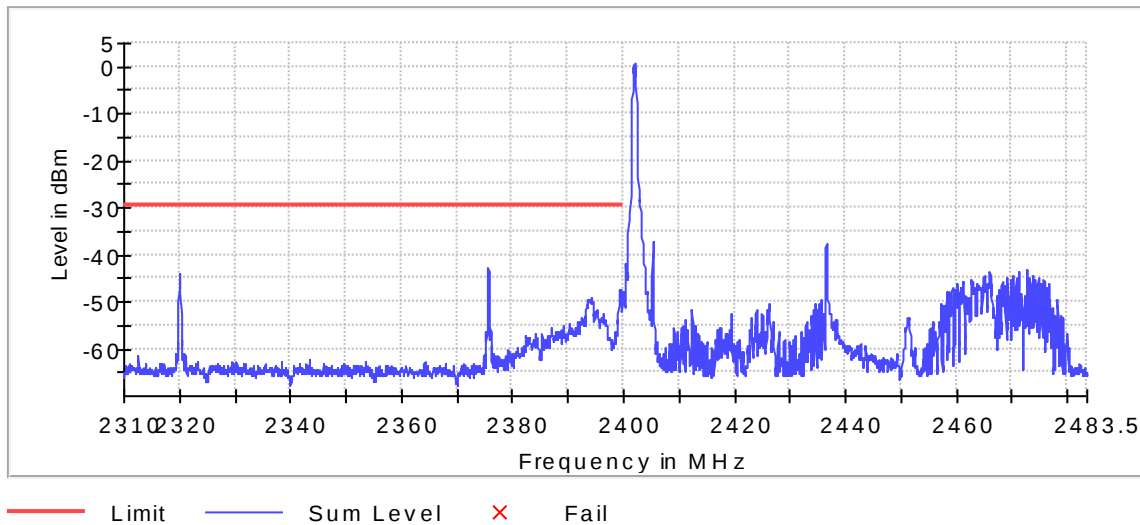
Tester: ASF

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

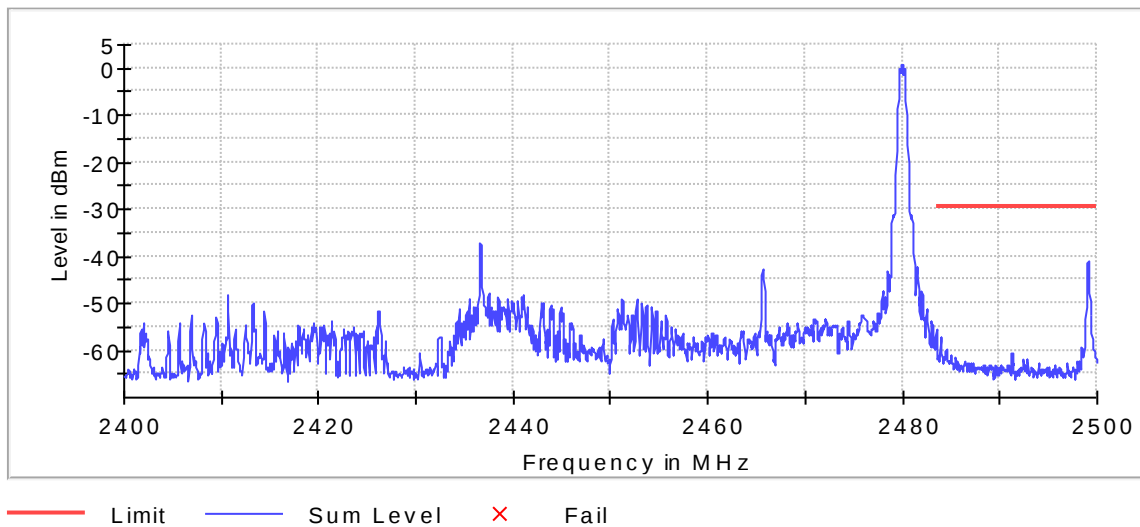
Note: The equipment calibration period is 1 year except for the FSV which is on a 2-year cycle.

## 6.5 Test Data – DTS Band Edge

BLE - Lower band edge:



BLE - Upper band edge:



## 6.6 Test Data – Conducted Spurious Emissions

Emissions in the spurious domain were measured in a radiated test setup with the EUT antenna installed. This requirement is covered by the results in section 7 of this report.

## 7 Field Strength of Spurious Radiation

### 7.1 Test Result

| Test Description            | Test Specification          |                                     | Test Result |
|-----------------------------|-----------------------------|-------------------------------------|-------------|
| Radiated Spurious Emissions | 15.247(d)<br>15.205, 15.209 | RSS-247 S5.5<br>RSS-GEN S8.9, S8.10 | Compliant   |

### 7.2 Test Method

The radiated measurement methods defined in ANSI C63.10 and KDB 558074 D01 15.247 Meas Guidance v05r02 were used.

Lowest, middle and highest channels were investigated – the device was commanded to continuously transmit on channels 0, 19 and 39.

Test distance:

- 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 <sup>(1)</sup> |                     | Peak Limits<br>dBuV/m |
|----------------|-----------------------|---------------------|-----------------------|
|                | Microvolts/m          | dBuV/m              |                       |
| 30 - 88 MHz    | 100                   | 40 <sup>(2)</sup>   | --                    |
| 88 - 216 MHz   | 150                   | 43.5 <sup>(2)</sup> | --                    |
| 216 - 960 MHz  | 200                   | 46 <sup>(2)</sup>   | --                    |
| 960 - 1000 MHz | 500                   | 54 <sup>(2)</sup>   | --                    |
| 1 - 40 GHz     | 500                   | 54 <sup>(3)</sup>   | 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

Absorber Lined Shielded Enclosure (ALSE), Suwanee, GA

#### Environmental Conditions

##### Mid Channel Tests

|                       |            |             |             |
|-----------------------|------------|-------------|-------------|
|                       | 30-1000MHz | 1-18GHz     | 18-26GHz    |
| Enclosure:            | 3m Chamber | 10m Chamber | 10m Chamber |
| Temperature:          | 21.4 °C    | 22.7 °C     | 22.7 °C     |
| Relative Humidity:    | 48.4 %     | 48.2 %      | 52.8 %      |
| Atmospheric Pressure: | 97.7 kPa   | 97.8 kPa    | 97.6 kPa    |

##### Low & High Channel Tests

|                       |             |            |            |
|-----------------------|-------------|------------|------------|
|                       | 30-1000MHz  | 1-18GHz    | 18-26GHz   |
| Enclosure:            | 10m Chamber | 3m Chamber | 3m Chamber |
| Temperature:          | 21.3 °C     | 22.3 °C    | 21.9 °C    |
| Relative Humidity:    | 55.7 %      | 32.5 %     | 34.0 %     |
| Atmospheric Pressure: | 97.8 kPa    | 98.0 kPa   | 97.9 kPa   |

## 7.4 Test Equipment

### Mid Channel Tests

30-1000MHz

Test End Date: 28-Feb-2019

Tester: CO

| Equipment           | Model             | Manufacturer    | Asset Number | Cal Due Date |
|---------------------|-------------------|-----------------|--------------|--------------|
| ANTENNA, BILOG      | JB6               | SUNOL           | B079689      | 30-Oct-2019  |
| RF CABLE            | NFS-290-78.7-NFS  | FLORIDA RF LABS | B095019      | 24-Jul-2019  |
| RF CABLE            | NMS-290-236.2-NMS | FLORIDA RF LABS | B095020      | 23-Jul-2019  |
| RF CABLE            | SF106             | HUBER & SUHNER  | B079659      | 23-Jul-2019  |
| RF CABLE            | 104PE             | HUBER & SUHNER  | B079793      | 24-Jul-2019  |
| LOW NOISE AMPLIFIER | TS-PR18           | ROHDE & SCHWARZ | 15003        | 24-Jan-2020  |
| EMI TEST RECEIVER   | ESU8              | ROHDE & SCHWARZ | B085759      | 17-Aug-2019  |

1-18GHz

Test End Date: 1-Mar-2019

Tester: MT

| Equipment                  | Model   | Manufacturer    | Asset Number | Cal Due Date |
|----------------------------|---------|-----------------|--------------|--------------|
| ANTENNA, DRG HORN (MEDIUM) | 3117    | ETS LINDGREN    | B079691      | 10-Aug-2019  |
| RF CABLE                   | SF102   | HUBER & SUHNER  | B079822      | 25-Jul-2019  |
| RF CABLE                   | 104PE   | HUBER & SUHNER  | B079793      | 24-Jul-2019  |
| LOW NOISE AMPLIFIER        | TS-PR18 | ROHDE & SCHWARZ | 15003        | 24-Jan-2020  |
| EMI TEST RECEIVER          | ESU40   | ROHDE & SCHWARZ | B079629      | 2-Jul-2019   |

18-26GHz

Test End Date: 1-Mar-2019

Tester: MT

| Equipment             | Model             | Manufacturer    | Asset Number | Cal Due Date |
|-----------------------|-------------------|-----------------|--------------|--------------|
| ANTENNA, HORN (SMALL) | LB-180400-20-C-KF | A-INFO          | 15007        | 30-Mar-2019  |
| 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.

# Low & High Channel Tests

30-1000MHz

Test End Date: 12-Apr-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  | B079661      | 23-Jul-2019  |
| RF CABLE            | 104PE  | HUBER & SUHNER  | B079793      | 24-Jul-2019  |
| LOW NOISE AMPLIFIER | ZKL-2+ | MINI-CIRCUITS   | B079800      | 27-Jul-2019  |
| EMI TEST RECEIVER   | ESU8   | ROHDE & SCHWARZ | B085759      | 17-Aug-2019  |

1-18GHz

Test End Date: 15-Apr-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   |

18-26GHz

Test End Date: 15-Apr-2019

Tester: MT

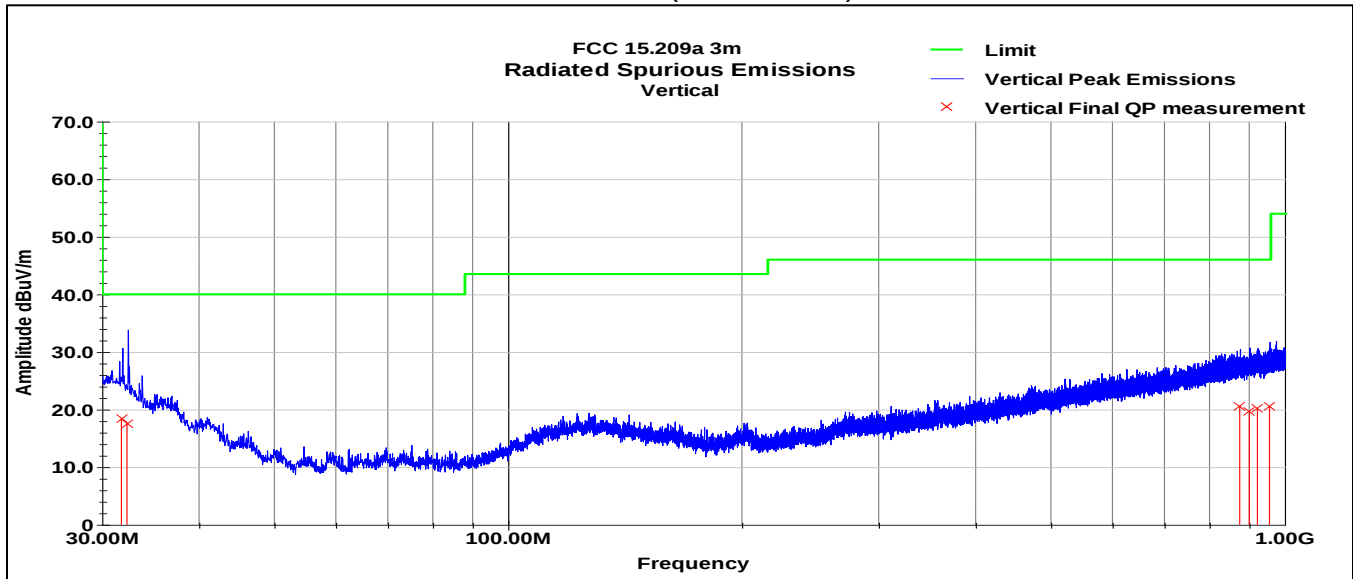
| Equipment             | Model             | Manufacturer    | Asset Number | Cal Due Date |
|-----------------------|-------------------|-----------------|--------------|--------------|
| ANTENNA, HORN (SMALL) | LB-180400-20-C-KF | A-INFO          | 15007        | 30-Mar-2020  |
| RF CABLE              | 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.

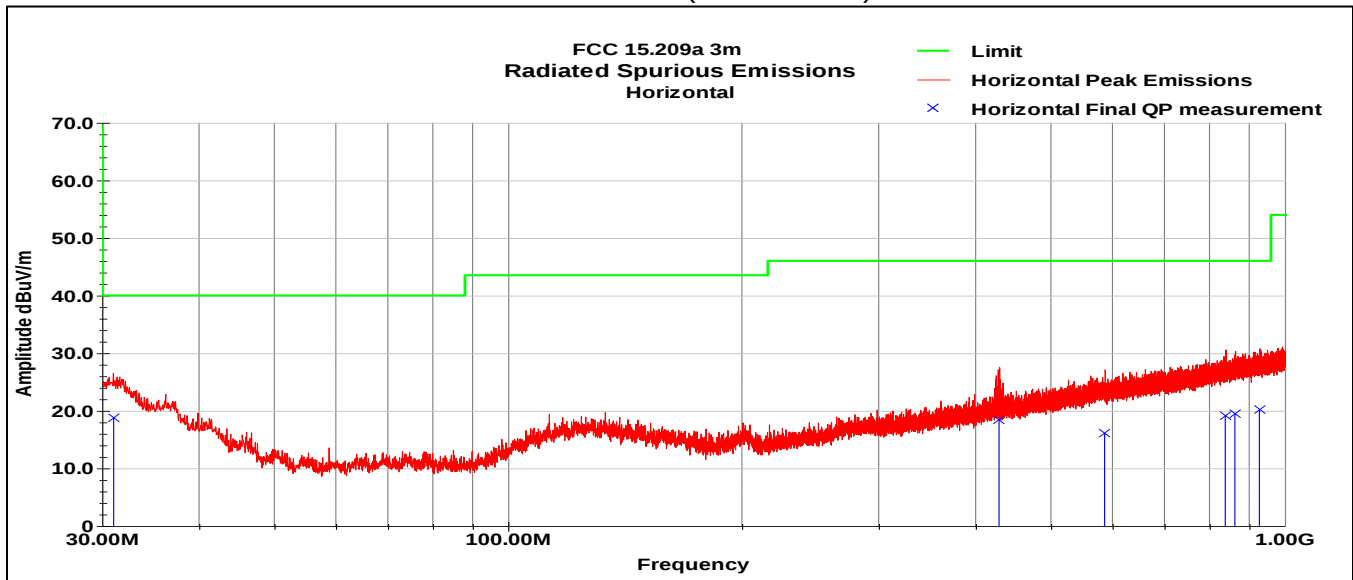
## 7.5 Test Data

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

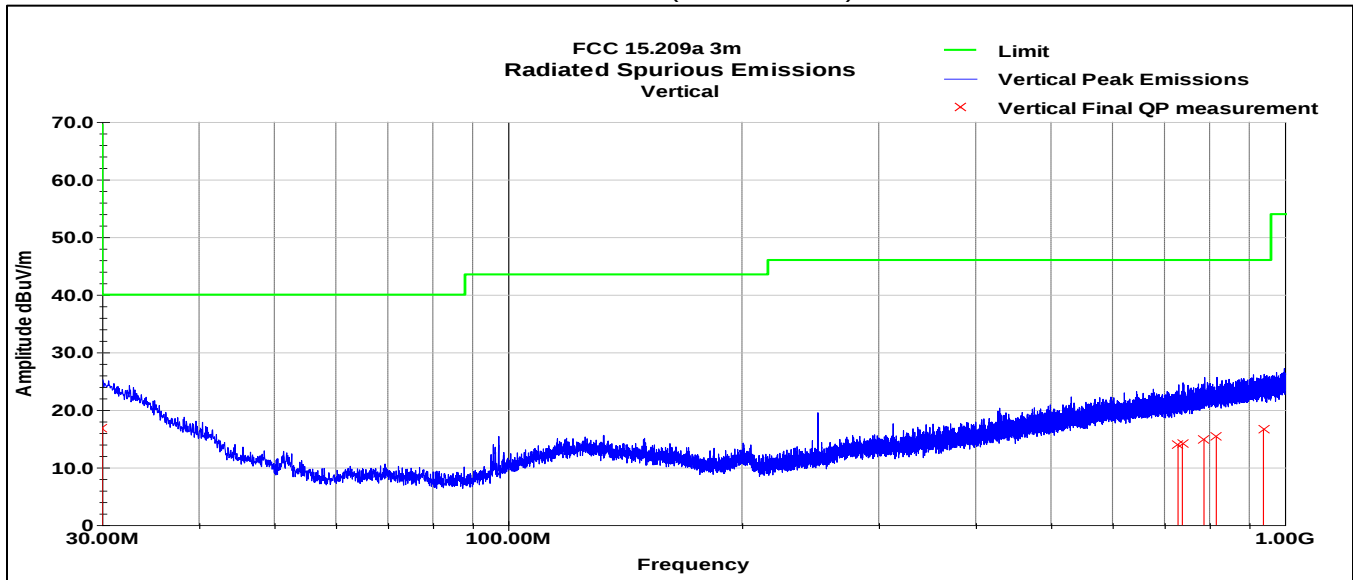
BLE Channel 0  
Vertical Plot (30-1000MHz)



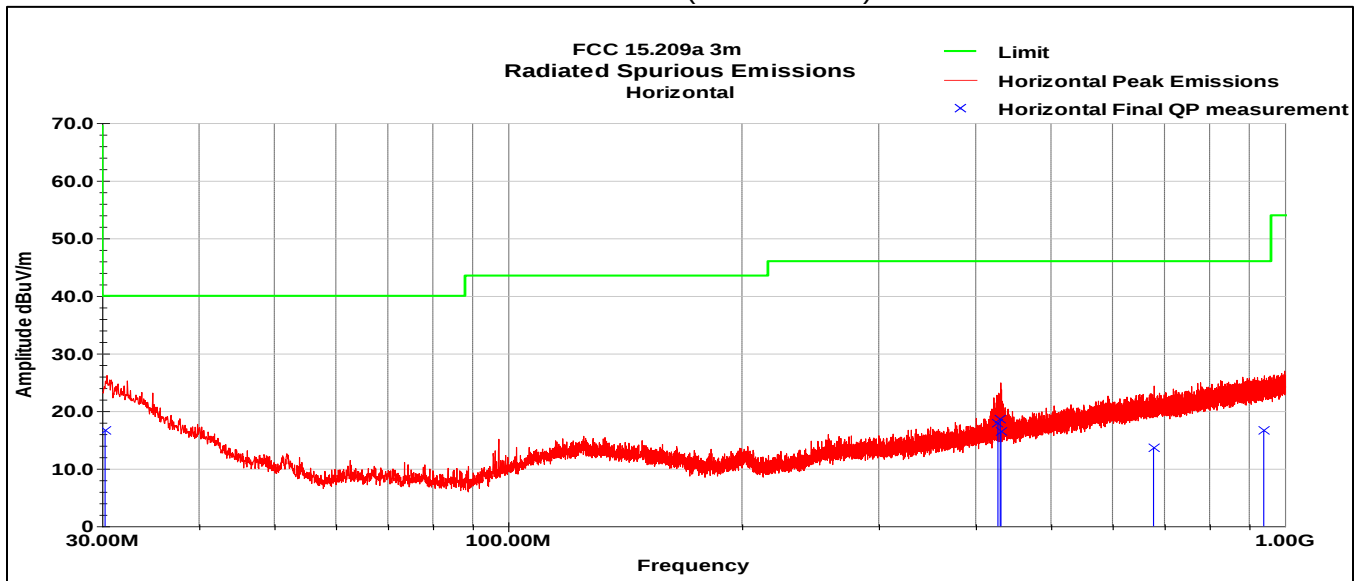
BLE Channel 0  
Horizontal Plot (30-1000MHz)



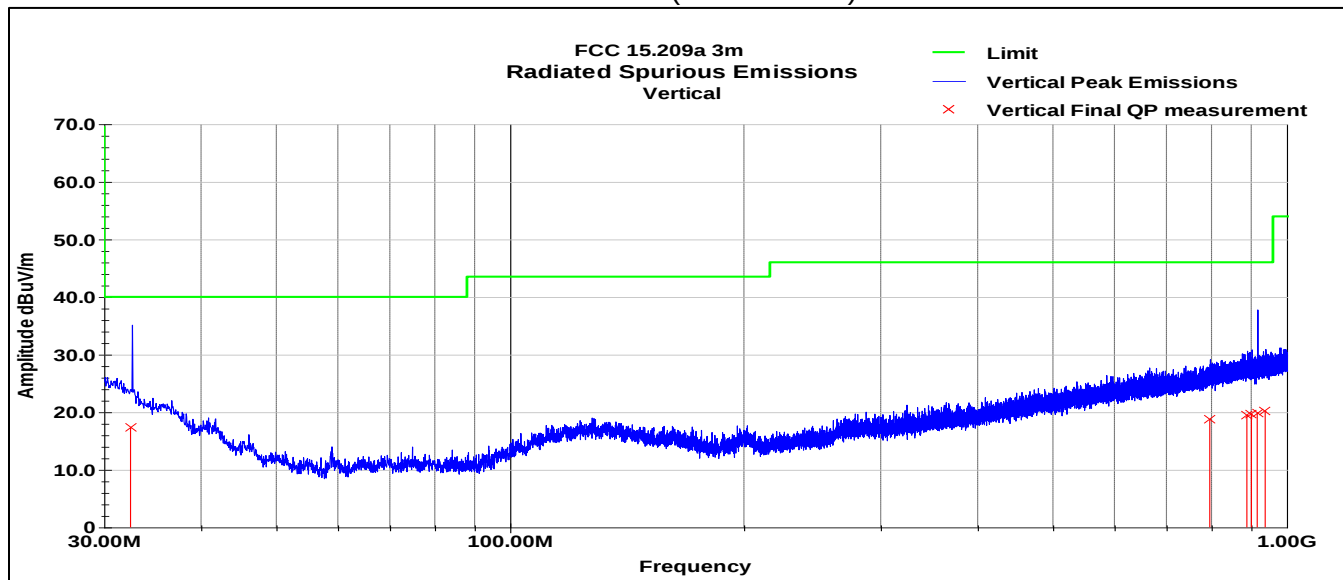
## BLE Channel 19 Vertical Plot (30-1000MHz)



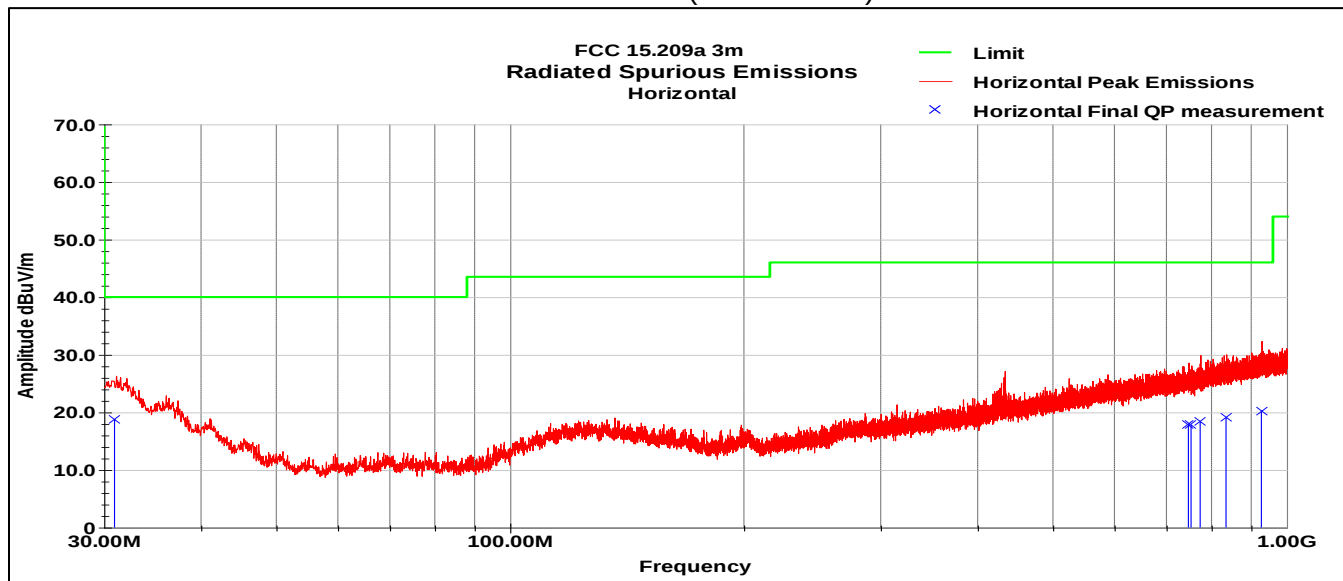
## BLE Channel 19 Horizontal Plot (30-1000MHz)



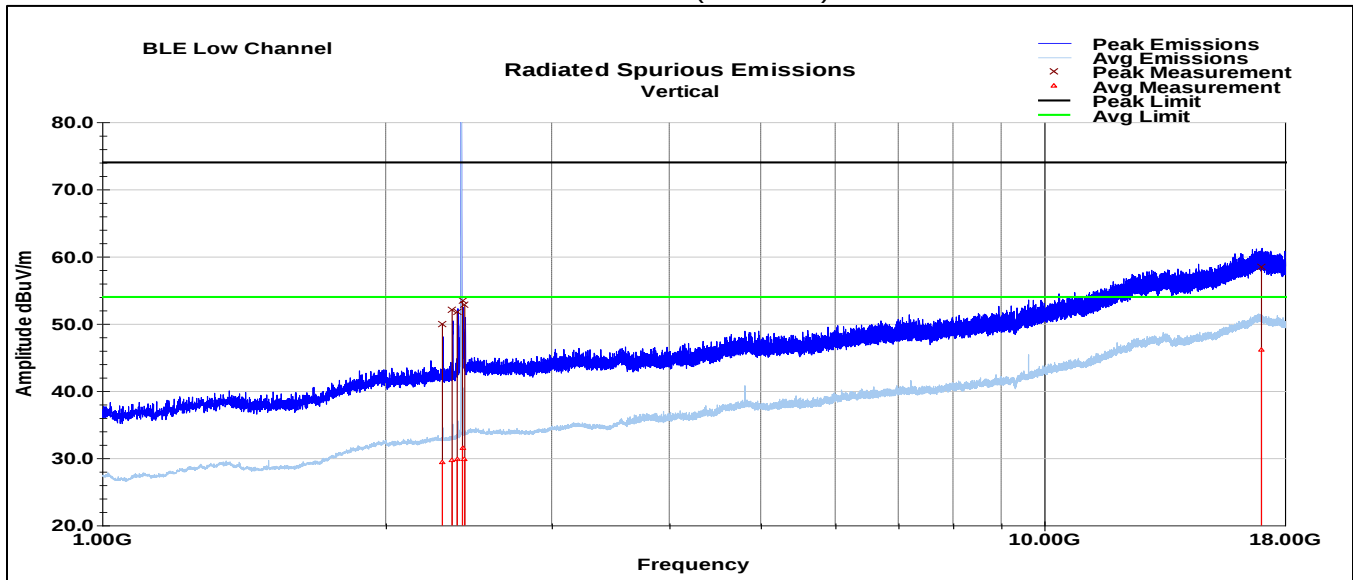
### BLE Channel 39 Vertical Plot (30-1000MHz)



### BLE Channel 39 Horizontal Plot (30-1000MHz)



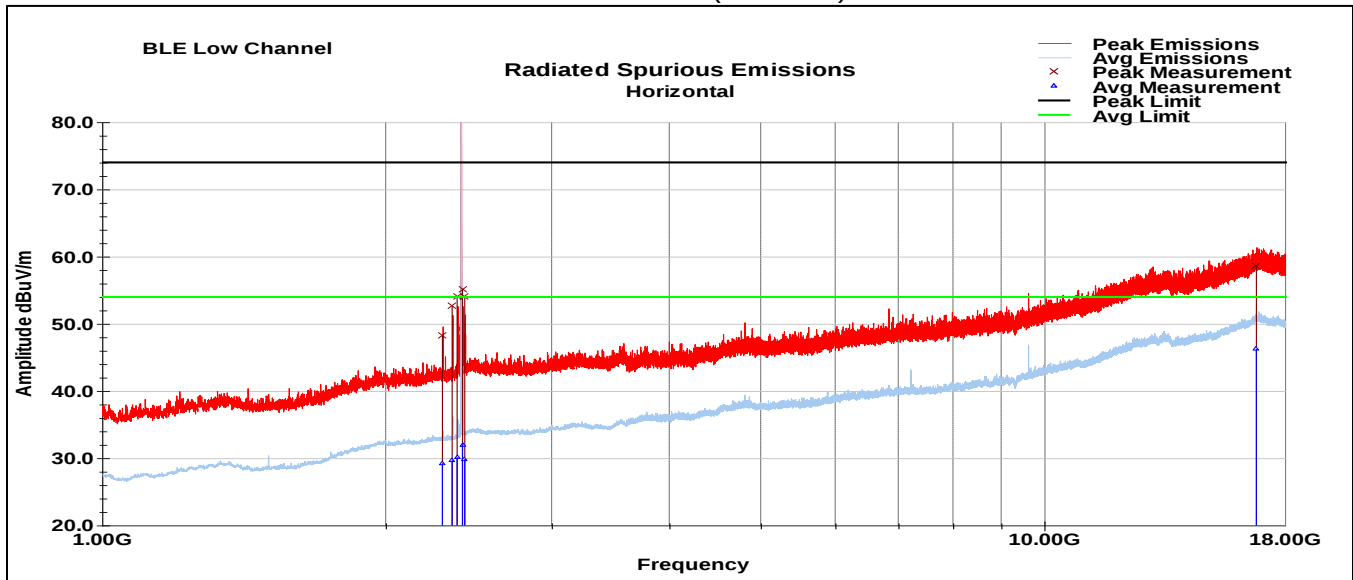
### BLE Channel 0 Vertical Plot (1-18GHz)



### Vertical Average Data (1-18GHz)

| Frequency<br>MHz                 | Raw Avg<br>dBuV | Polarity<br>(V/H) | Azimuth<br>(degrees) | Height<br>(cm) | AF<br>(dB/m) | Loss<br>(dB) | Amp<br>(dB) | Final Avg<br>dBuV/m | Limit<br>(dBuV/m) | Margin<br>(dB) |
|----------------------------------|-----------------|-------------------|----------------------|----------------|--------------|--------------|-------------|---------------------|-------------------|----------------|
| 2297.80                          | 29.8            | V                 | 244.0                | 172.0          | 31.7         | 2.4          | 34.5        | 29.4                | 54.0              | -24.6          |
| 2352.80                          | 30.0            | V                 | 257.0                | 121.0          | 31.7         | 2.4          | 34.4        | 29.7                | 54.0              | -24.3          |
| 2382.04                          | 30.0            | V                 | 265.0                | 110.0          | 31.9         | 2.4          | 34.4        | 29.9                | 54.0              | -24.1          |
| 2412.92                          | 31.5            | V                 | 262.0                | 118.0          | 32.1         | 2.4          | 34.4        | 31.6                | 54.0              | -22.4          |
| 2426.28                          | 29.6            | V                 | 258.0                | 146.0          | 32.2         | 2.4          | 34.4        | 29.8                | 54.0              | -24.1          |
| 17002.88                         | 28.6            | V                 | 223.0                | 137.0          | 41.5         | 6.9          | 30.8        | 46.2                | 54.0              | -7.8           |
|                                  |                 |                   |                      |                |              |              |             |                     |                   |                |
| QP Value = Level + AF + CL - Amp |                 |                   |                      |                |              |              |             |                     |                   |                |
| Margin = QP Value - Limit        |                 |                   |                      |                |              |              |             |                     |                   |                |

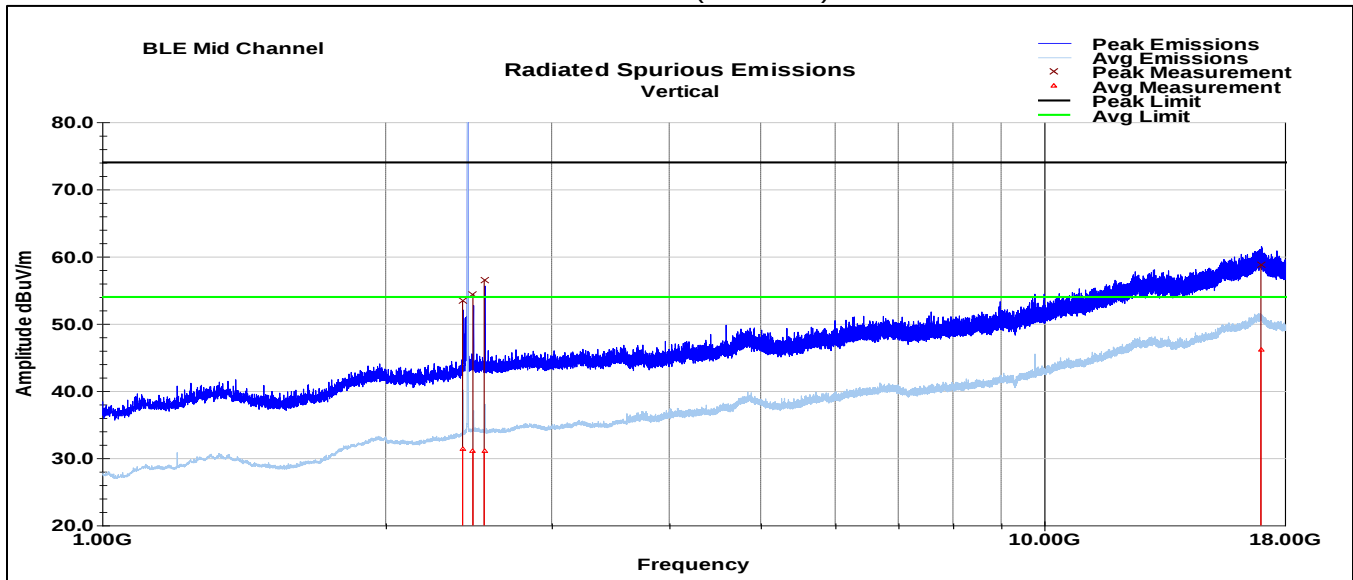
### BLE Channel 0 Horizontal Plot (1-18GHz)



### Horizontal Average Data (1-18GHz)

| Frequency<br>MHz                 | Raw Avg<br>dBuV | Polarity<br>(V/H) | Azimuth<br>(degrees) | Height<br>(cm) | AF<br>(dB/m) | Loss<br>(dB) | Amp<br>(dB) | Avg Value<br>dBuV/m | Limit<br>(dBuV/m) | Margin<br>(dB) |
|----------------------------------|-----------------|-------------------|----------------------|----------------|--------------|--------------|-------------|---------------------|-------------------|----------------|
| 2297.68                          | 29.6            | H                 | 55.0                 | 186.0          | 31.7         | 2.4          | 34.5        | 29.2                | 54.0              | -24.7          |
| 2352.80                          | 30.0            | H                 | 128.0                | 199.0          | 31.7         | 2.4          | 34.4        | 29.7                | 54.0              | -24.3          |
| 2381.80                          | 30.3            | H                 | 126.0                | 188.0          | 31.9         | 2.4          | 34.4        | 30.1                | 54.0              | -23.9          |
| 2412.80                          | 31.9            | H                 | 125.0                | 208.0          | 32.1         | 2.4          | 34.4        | 32.0                | 54.0              | -21.9          |
| 2426.40                          | 29.6            | H                 | 120.0                | 209.0          | 32.2         | 2.4          | 34.4        | 29.9                | 54.0              | -24.1          |
| 16792.76                         | 28.6            | H                 | 329.0                | 250.0          | 41.6         | 6.8          | 30.8        | 46.3                | 54.0              | -7.7           |
|                                  |                 |                   |                      |                |              |              |             |                     |                   |                |
| QP Value = Level + AF + CL - Amp |                 |                   |                      |                |              |              |             |                     |                   |                |
| Margin = QP Value - Limit        |                 |                   |                      |                |              |              |             |                     |                   |                |

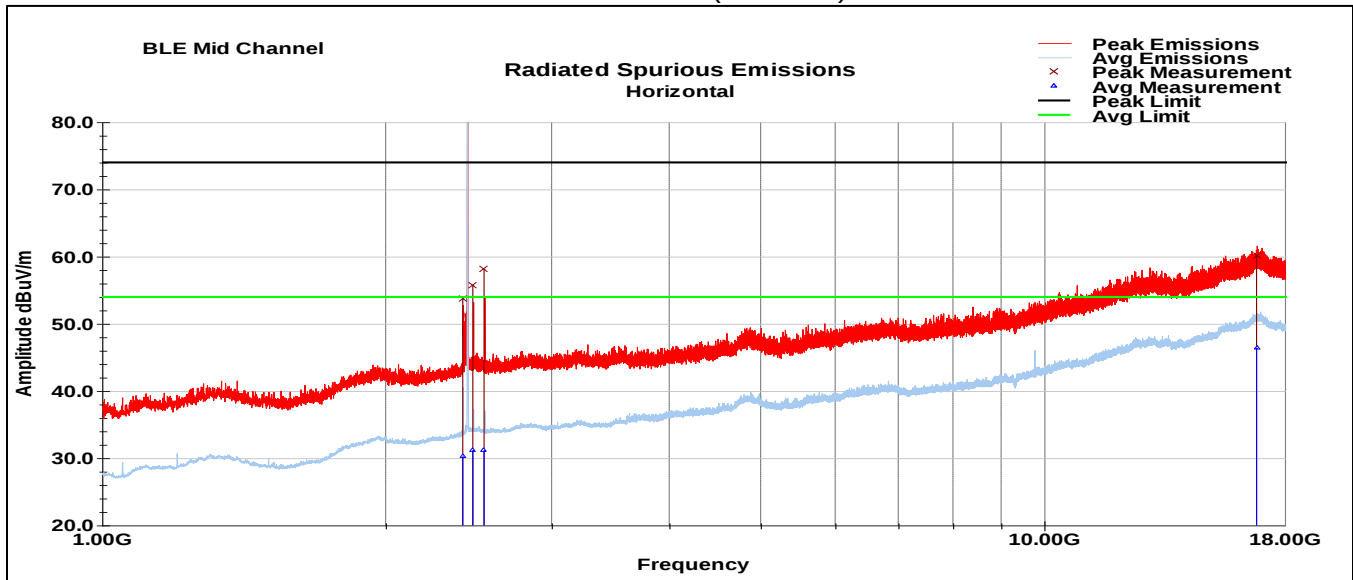
## BLE Channel 19 Vertical Plot (1-18GHz)



## Vertical Average Data (1-18GHz)

| 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) |
|----------------------------------|--------------|----------------|-------------------|-------------|-----------|-----------|----------|------------------|----------------|-------------|
| 2413.68                          | 31.1         | V              | 235.0             | 239.0       | 32.2      | 2.5       | 34.4     | 31.3             | 54.0           | -22.6       |
| 2475.16                          | 30.4         | V              | 237.0             | 221.0       | 32.5      | 2.5       | 34.4     | 31.1             | 54.0           | -22.9       |
| 2544.20                          | 30.4         | V              | 238.0             | 234.0       | 32.5      | 2.6       | 34.5     | 31.0             | 54.0           | -23.0       |
| 16983.76                         | 28.3         | V              | 182.0             | 236.0       | 41.6      | 7.0       | 30.8     | 46.2             | 54.0           | -7.8        |
|                                  |              |                |                   |             |           |           |          |                  |                |             |
| QP Value = Level + AF + CL - Amp |              |                |                   |             |           |           |          |                  |                |             |
| Margin = QP Value - Limit        |              |                |                   |             |           |           |          |                  |                |             |

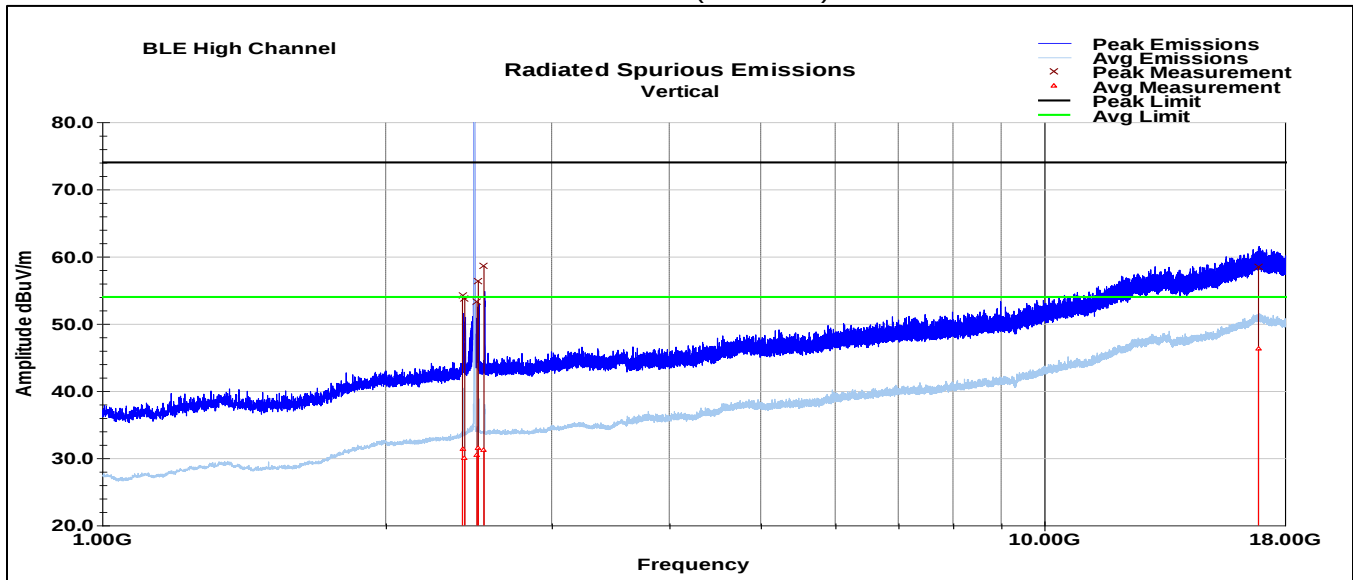
## BLE Channel 19 Horizontal Plot (1-18GHz)



## Horizontal Average Data (1-18GHz)

| Frequency<br>MHz                 | Raw Avg<br>dBuV | Polarity<br>(V/H) | Azimuth<br>(degrees) | Height<br>(cm) | AF<br>(dB/m) | Loss<br>(dB) | Amp<br>(dB) | Avg Value<br>dBuV/m | Limit<br>(dBuV/m) | Margin<br>(dB) |
|----------------------------------|-----------------|-------------------|----------------------|----------------|--------------|--------------|-------------|---------------------|-------------------|----------------|
| 2414.88                          | 30.0            | H                 | 132.0                | 228.0          | 32.2         | 2.5          | 34.4        | 30.2                | 54.0              | -23.7          |
| 2475.04                          | 30.5            | H                 | 131.0                | 222.0          | 32.5         | 2.5          | 34.4        | 31.2                | 54.0              | -22.8          |
| 2544.16                          | 30.6            | H                 | 127.0                | 234.0          | 32.5         | 2.6          | 34.5        | 31.2                | 54.0              | -22.8          |
| 16804.12                         | 28.5            | H                 | 296.0                | 214.0          | 41.8         | 6.9          | 30.8        | 46.4                | 54.0              | -7.6           |
|                                  |                 |                   |                      |                |              |              |             |                     |                   |                |
| QP Value = Level + AF + CL - Amp |                 |                   |                      |                |              |              |             |                     |                   |                |
| Margin = QP Value - Limit        |                 |                   |                      |                |              |              |             |                     |                   |                |

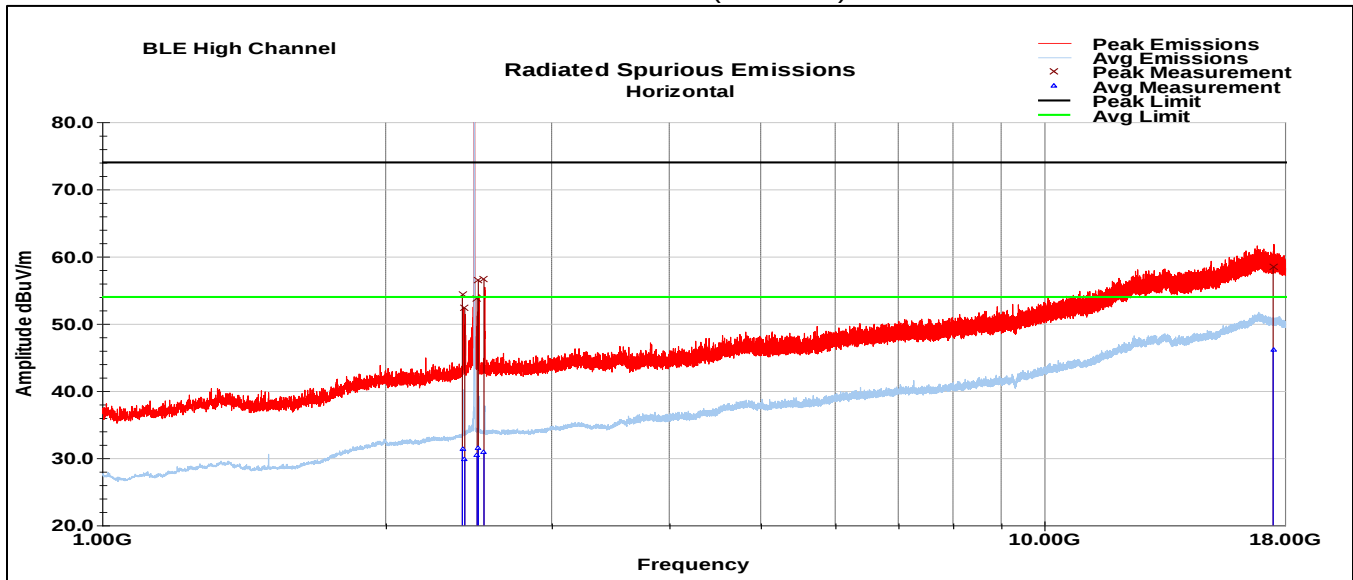
## BLE Channel 39 Vertical Plot (1-18GHz)



## Vertical Average Data (1-18GHz)

| 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) |
|----------------------------------|--------------|----------------|-------------------|-------------|-----------|-----------|----------|------------------|----------------|-------------|
| 2412.80                          | 31.3         | V              | 241.0             | 169.0       | 32.1      | 2.4       | 34.4     | 31.4             | 54.0           | -22.6       |
| 2426.28                          | 29.7         | V              | 243.0             | 204.0       | 32.2      | 2.4       | 34.4     | 29.9             | 54.0           | -24.0       |
| 2500.76                          | 29.9         | V              | 253.0             | 209.0       | 32.5      | 2.5       | 34.4     | 30.5             | 54.0           | -23.5       |
| 2507.92                          | 31.0         | V              | 252.0             | 215.0       | 32.4      | 2.5       | 34.4     | 31.5             | 54.0           | -22.5       |
| 2543.52                          | 30.8         | V              | 261.0             | 231.0       | 32.3      | 2.5       | 34.5     | 31.1             | 54.0           | -22.8       |
| 16878.84                         | 28.7         | V              | 241.0             | 191.0       | 41.6      | 6.8       | 30.8     | 46.2             | 54.0           | -7.7        |
|                                  |              |                |                   |             |           |           |          |                  |                |             |
| QP Value = Level + AF + CL - Amp |              |                |                   |             |           |           |          |                  |                |             |
| Margin = QP Value - Limit        |              |                |                   |             |           |           |          |                  |                |             |

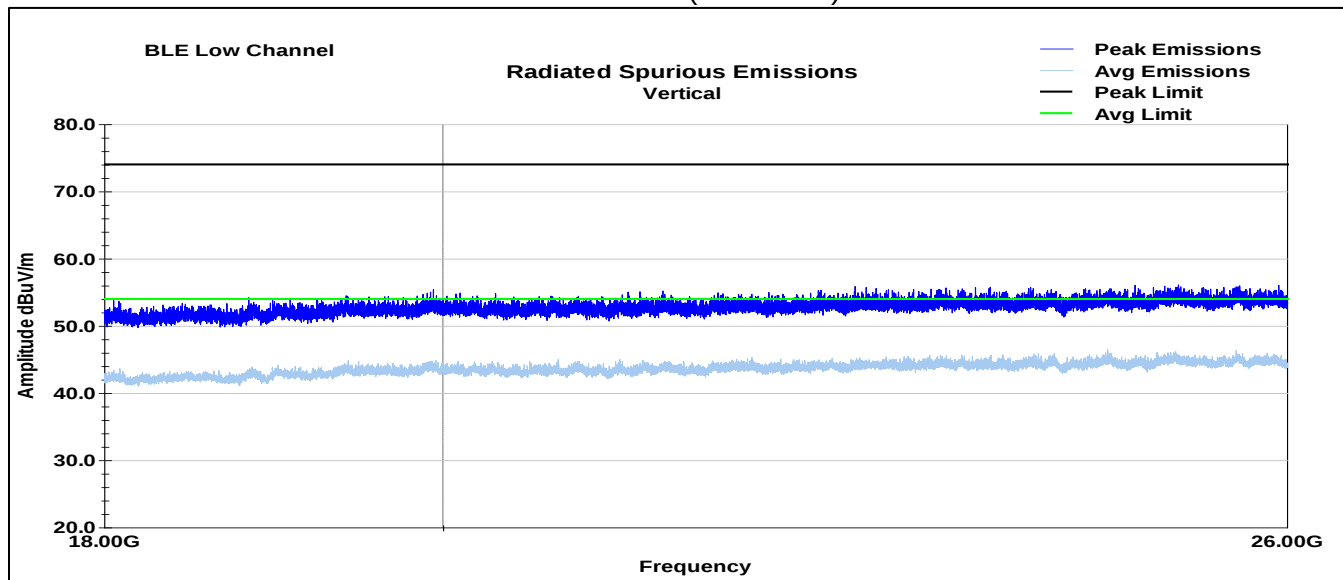
### BLE Channel 39 Horizontal Plot (1-18GHz)



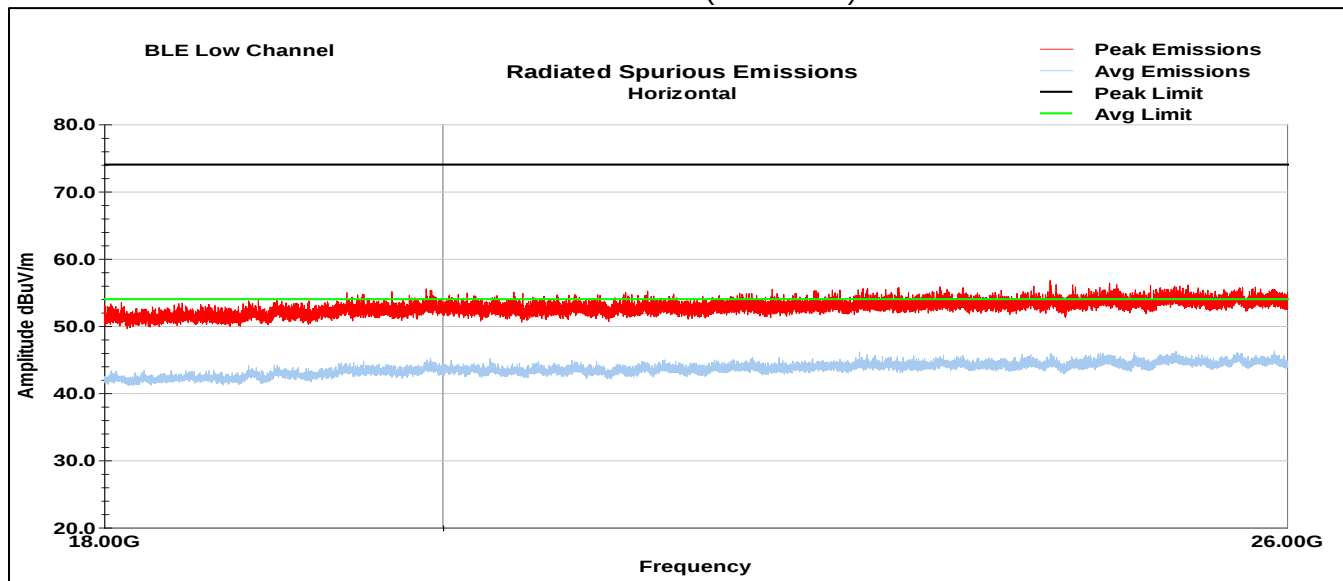
### Horizontal Average Data (1-18GHz)

| Frequency<br>MHz                 | Raw Avg<br>dBuV | Polarity<br>(V/H) | Azimuth<br>(degrees) | Height<br>(cm) | AF<br>(dB/m) | Loss<br>(dB) | Amp<br>(dB) | Avg Value<br>dBuV/m | Limit<br>(dBuV/m) | Margin<br>(dB) |
|----------------------------------|-----------------|-------------------|----------------------|----------------|--------------|--------------|-------------|---------------------|-------------------|----------------|
| 2412.44                          | 31.2            | H                 | 136.0                | 208.0          | 32.1         | 2.4          | 34.4        | 31.3                | 54.0              | -22.6          |
| 2426.28                          | 29.6            | H                 | 132.0                | 197.0          | 32.2         | 2.4          | 34.4        | 29.8                | 54.0              | -24.1          |
| 2501.20                          | 29.9            | H                 | 112.0                | 225.0          | 32.5         | 2.5          | 34.4        | 30.4                | 54.0              | -23.6          |
| 2507.92                          | 31.0            | H                 | 125.0                | 199.0          | 32.4         | 2.5          | 34.4        | 31.5                | 54.0              | -22.5          |
| 2543.44                          | 30.5            | H                 | 123.0                | 178.0          | 32.3         | 2.5          | 34.5        | 30.8                | 54.0              | -23.1          |
| 17496.92                         | 29.2            | H                 | 124.0                | 172.0          | 41.1         | 6.9          | 31.1        | 46.2                | 54.0              | -7.8           |
|                                  |                 |                   |                      |                |              |              |             |                     |                   |                |
| QP Value = Level + AF + CL - Amp |                 |                   |                      |                |              |              |             |                     |                   |                |
| Margin = QP Value - Limit        |                 |                   |                      |                |              |              |             |                     |                   |                |

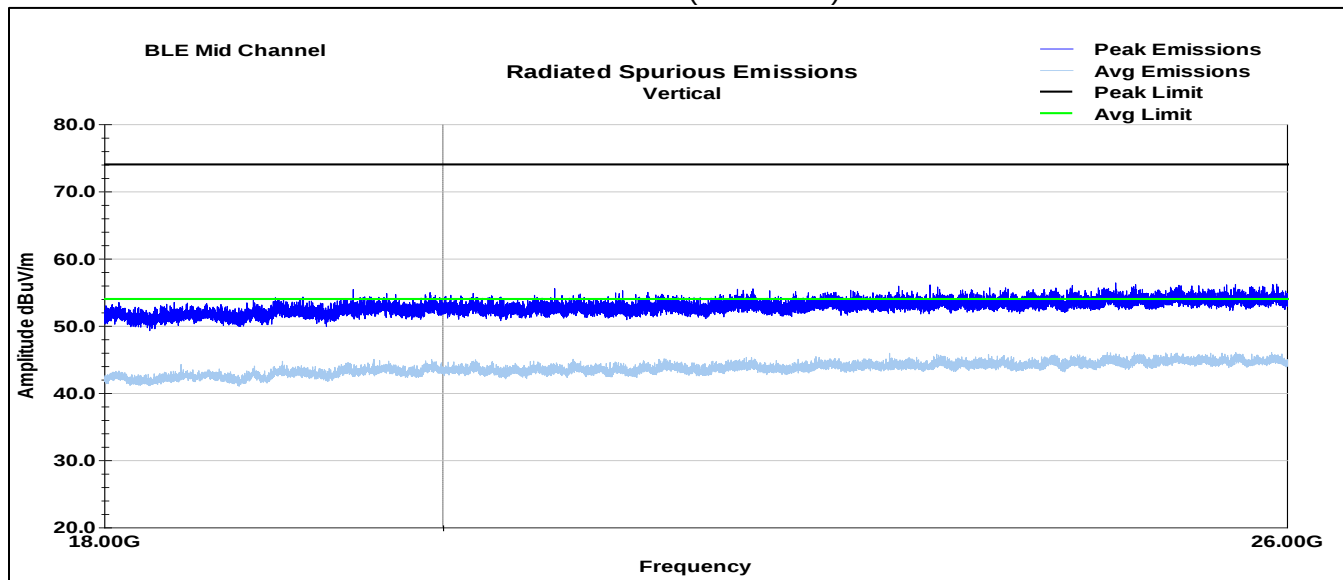
BLE Channel 0  
Vertical Plot (18-26GHz)



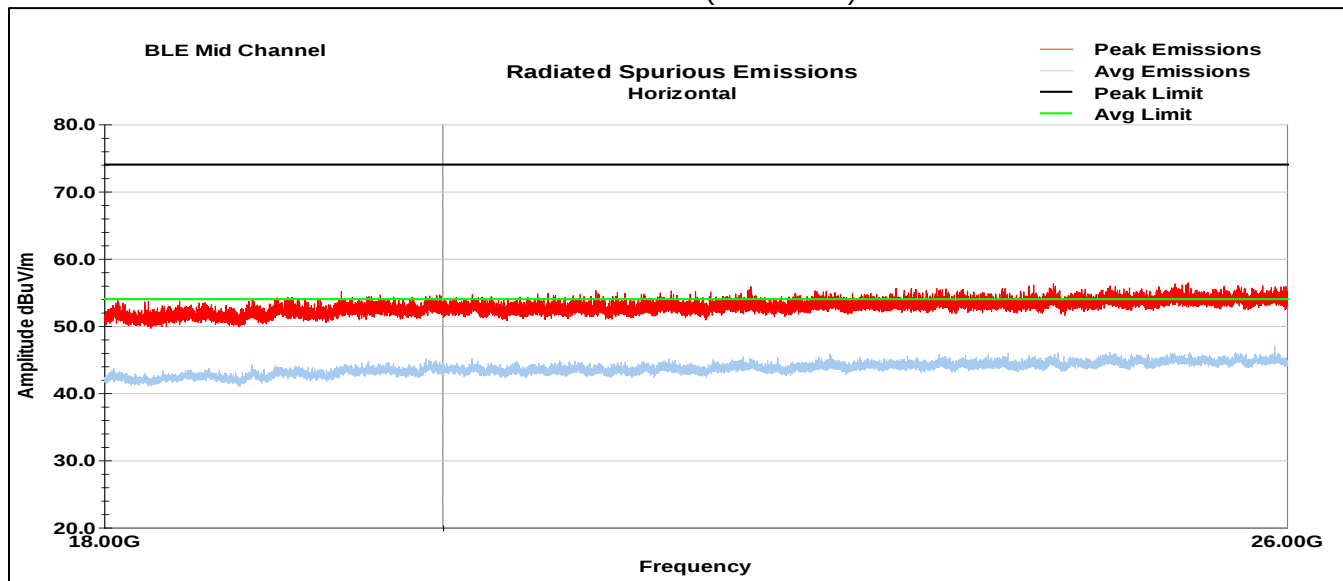
BLE Channel 0  
Horizontal Plot (18-26GHz)



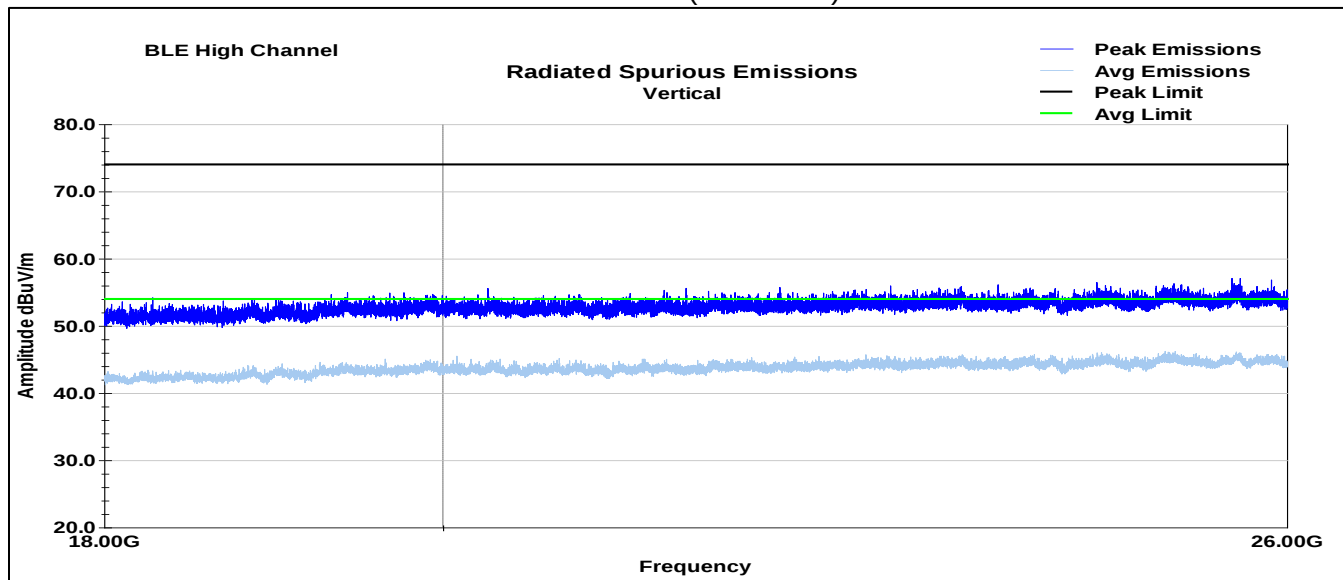
BLE Channel 19  
Vertical Plot (18-26GHz)



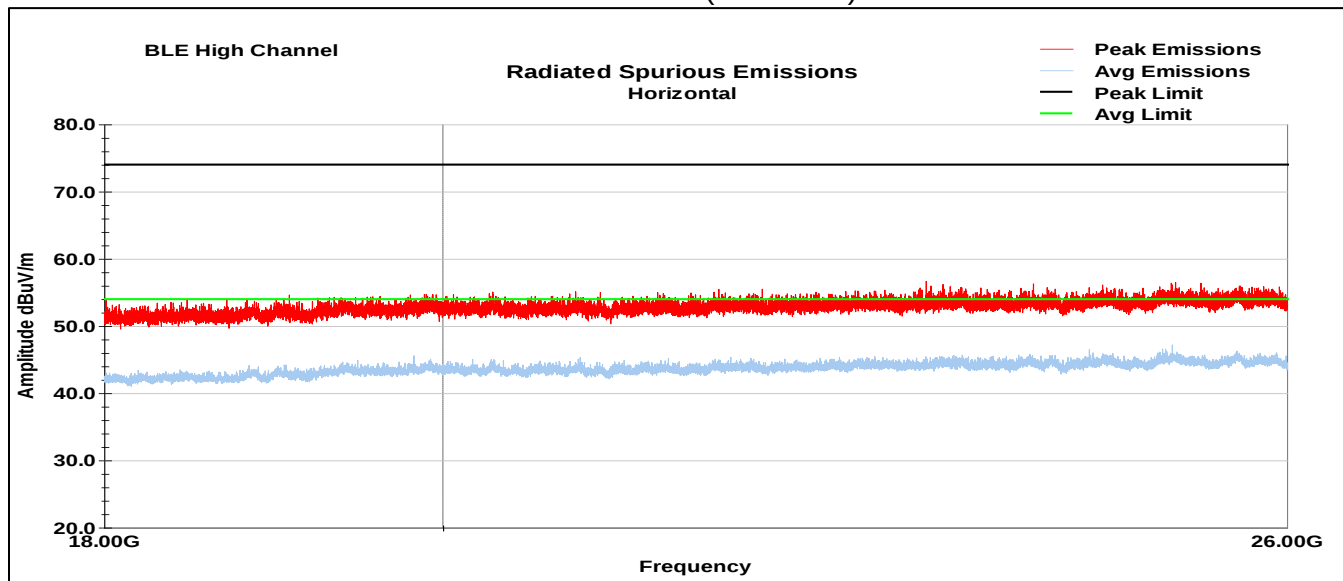
BLE Channel 19  
Horizontal Plot (18-26GHz)



BLE Channel 39  
Vertical Plot (18-26GHz)



BLE Channel 39  
Horizontal Plot (18-26GHz)



## 8 Emissions in Restricted Frequency Bands

### 8.1 Test Result

| Test Description                        | Test Specification |                    | Test Result |
|-----------------------------------------|--------------------|--------------------|-------------|
| 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.

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

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

Where:

|                      |                                                               |
|----------------------|---------------------------------------------------------------|
| D = 3m               | Distance                                                      |
| CL = 11.0 dB         | Cable Loss                                                    |
| DC = 1.34 dB (73.5%) | Duty Cycle Correction Factor [10Log(1/Duty Cycle)]            |
| AG = 3.3 dB          | Antenna Gain [2 dB is the minimum allowed by the test method] |

$$\text{Offset} = 3.94 \text{ dB}$$

### 8.3 Test Site

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

|                       |          |
|-----------------------|----------|
| Temperature:          | 23.4 °C  |
| Relative Humidity:    | 49.8 %   |
| Atmospheric Pressure: | 96.9 kPa |

### 8.4 Test Equipment

Test End Date: 9-Apr-2019

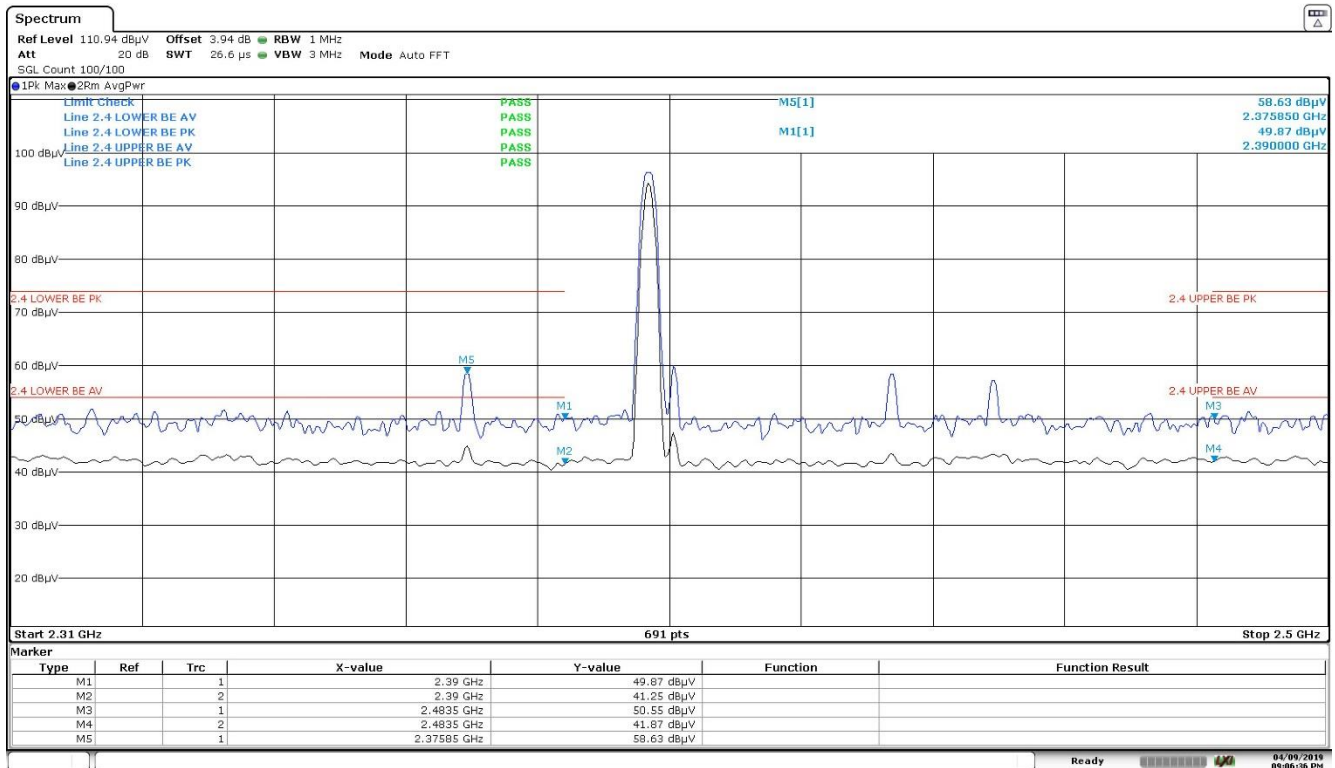
Tester: ASF

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

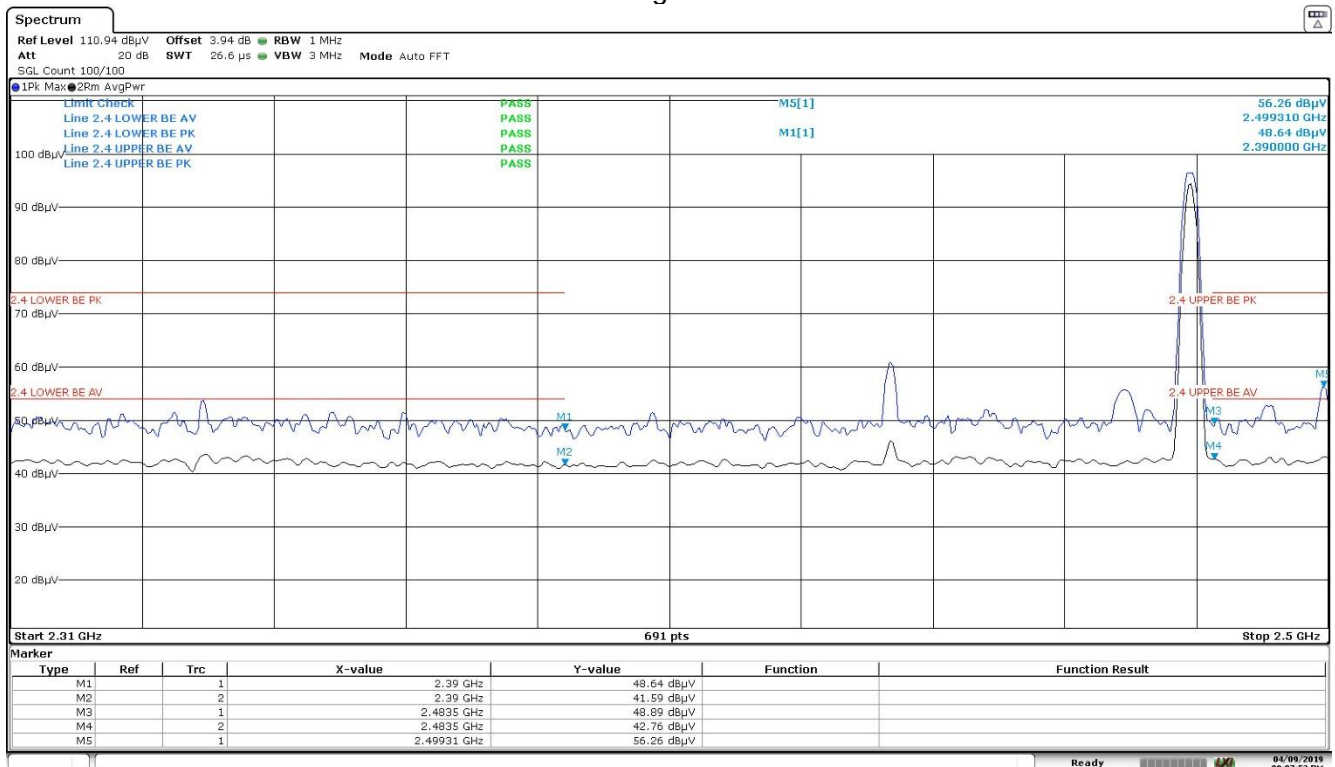
Note: The equipment calibration period is 1 year except for the FSV30 which is on a 2-year cycle.

## 8.5 Test Data – Restricted Band Edge

### BLE – Low Channel



### BLE – High Channel



## 9 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                     | $\pm 1.5$ dB                                        | $\pm 1.2$ dB              |
| RF power density, conducted                   | $\pm 3$ dB                                          | $\pm 0.7$ dB              |
| spurious emissions, conducted                 | $\pm 3$ dB                                          | $\pm 2.1$ dB              |
| all emissions, radiated                       | $\pm 6$ dB                                          | $\pm 4.8$ dB              |
| temperature                                   | $\pm 1^{\circ}\text{C}$                             | $\pm 0.5^{\circ}\text{C}$ |
| humidity                                      | $\pm 5$ %                                           | $\pm 3.5\%$               |
| DC and low frequency voltages                 | $\pm 3$ %                                           | $\pm 0.4\%$               |
| Conducted disturbance at mains port using AMN | $\pm 3.4$ dB                                        | $\pm 2.5$ dB              |

## 10 Revision History

| Revision Level | Description of changes                                 | Revision Date |
|----------------|--------------------------------------------------------|---------------|
| 0              | Initial release                                        | 22 April 2019 |
| 1              | Updated KDB reference to latest version in section 7.2 | 10 May 2019   |
|                |                                                        |               |
|                |                                                        |               |
|                |                                                        |               |
|                |                                                        |               |
|                |                                                        |               |
|                |                                                        |               |
|                |                                                        |               |
|                |                                                        |               |