# TEST REPORT

**Report Number: 103930307MPK-003**
**Project Number: G103930307**
**August 20, 2019**

**Testing performed on**
**Connected AC Android Control Module**
**Model: AP6255**

**FCC ID: 2AHLA-SP01500243**
**IC: 4811A-SP01500243**
**to**

**FCC Part 15 Subpart C (15.247)**
**Industry Canada RSS-247 Issue 2**

**For**

**Bosch Automotive Service Solutions, Inc.**

| Test Performed by: | Test Authorized by: |
|---|---|
| Intertek | Bosch Automotive Service Solutions, Inc |
| 1365 Adams Court | 655 Eisenhower Dr |
| Menlo Park, CA 94025 USA | Owatonna, MN 55060 USA |

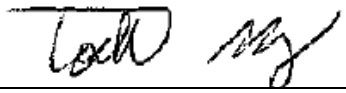
Prepared by: _____ **Date:** August 20, 2019
Todd Moy

Reviewed by: _____ **Date:** August 20, 2019
Krishna K Vemuri

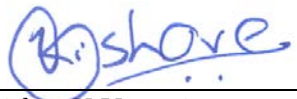
*This report is for the exclusive use of Intertek's Client and is provided pursuant to the agreement between Intertek and its Client. Intertek's responsibility and liability are limited to the terms and conditions of the agreement. Intertek assumes no liability to any party, other than to the Client in accordance with the agreement, for any loss, expense or damage occasioned by the use of this report. Only the Client is authorized to copy or distribute this report and then only in its entirety. Any use of the Intertek name or one of its marks for the sale or advertisement of the tested material, product or service must first be approved in writing by Intertek. The observations and test results in this report are relevant only to the sample tested. This report by itself does not imply that the material, product, or service is or has ever been under an Intertek certification program. This report must not be used to claim product endorsement by A2LA, NIST nor any other agency of the U.S. Government.*

| Report No. 103930307MPK-003 | |
|---|---|
| **Equipment Under Test:** | Connected AC Android Control Module |
| **Trade Name:** | Bosch Automotive Service Solutions, Inc |
| **Model Number:** | AP6255 |
| **Part Number:** | CBA-G19-UBS2 |
| **Applicant:** | Bosch Automotive Service Solutions, Inc |
| **Contact:** | Bill Brown |
| **Address:** | Bosch Automotive Service Solutions, Inc<br>655 Eisenhower Dr<br>Owatonna, MN 55060 USA |
| **Country:** | USA |
| **Tel. Number:** | (507) 455-8312 |
| **Email:** | bill.brown2@us.bosch.com |
| **Applicable Regulation:** | FCC Part 15 Subpart C (15.247)<br>Industry Canada RSS-247 Issue 2 |
| **Date of Test:** | June 24-July 25, 2019 |

***We attest to the accuracy of this report:***



Todd Moy
Project Engineer



Krishna K Vemuri
Engineering Team Lead

# TABLE OF CONTENTS

## 1.0 Summary of Tests

| Test | Reference FCC | Reference Industry Canada | Result |
|---|---|---|---|
| **RF Output Power** | 15.247(b)(3) | RSS-247, 5.4.d) | Complies |
| **6 dB Bandwidth** | 15.247(a)(2) | RSS-247, 5.2.a) | Complies |
| **Power Density** | 15.247(e) | RSS-247, 5.2.b) | Complies |
| **Out of Band Antenna Conducted Emission** | 15.247(d) | RSS-247, 5.5 | Complies |
| **Transmitter Radiated Emissions** | 15.247(d), 15.209, 15.205 | RSS-247, 5.5 | Complies |
| **AC Line Conducted Emission** | 15.207 | RSS-GEN | Complies |
| **Antenna Requirement** | 15.203 | RSS-GEN | Complies (Unique Antenna Attachment) |

**EUT receive date:** June 24, 2019

**EUT receive condition:** The pre-production version of the EUT was received in good condition with no apparent damage. As declared by the Applicant, it is identical to the production units.

**Test start date:** Jun 24, 2019

**Test completion date:** July 25, 2019

The test results in this report pertain only to the item tested.

`

## 2.0 General Information

### 2.1 Product Description

Bosch Automotive Service Solutions, Inc. supplied the following description of the EUT:

The module is a single board computer with Rockchip ARM Cortex-A17 CPU, Quad core processor.

Features:

- On Board DDR3L 935MHz, 2GB
- Wi-Fi, IEEE 802.11a/b/g/n/ac dual-band radio with virtual-simultaneous dual-band operation
- Bluetooth, V4.2+EDR with integrated PA for Class 1.5 and Low Energy (BLE)
- On Board eMMC, 64GB
- 1 xmicro-SD
- 1 RS232
- 2 2W speaker outputs
- 2 USB 2.0 Host, 1 USB OTG 2.0
- 1 LVDS Output
- 1 Capacitive touchscreen input

For more information, refer to the following product specification, declared by the manufacturer.

Information about the 2.4 GHz radio is presented below:

| | |
|---|---|
| **Applicant** | Bosch Automotive Service Solutions, Inc. |
| **Model No.** | AP6255 |
| **FCC Identifier** | 2AHLA-SP01500243 |
| **IC Identifier** | 4811A-SP01500243 |
| **Type of transmission** | Digital Transmission System (DTS) |
| **Rated RF Output** | 3.62 dBm |
| **Antenna(s) & Gain** | Antenna with Unique Connector, Peak Gain: 5 dBi |
| **Frequency Range** | 2402 – 2480 MHz |
| **Type of modulation/data rate** | GFSK 1MB/s |
| **Number of Channel(s)** | 40, Channel 0-39 |
| **Applicant Name & Address** | Bosch Automotive Service Solutions, Inc<br>655 Eisenhower Dr.<br>Owatonna, MN 55060<br>USA |

## 2.2 Related Submittal(s) Grants

None.

## 2.3 Test Facility

The test site used to collect the radiated data is site 1 (10-m semi-anechoic chamber). This test facility and site measurement data have been fully placed on file with the FCC, IC and A2LA accredited.

## 2.4 Test Methodology

Antenna conducted measurements were performed according to the FCC documents "Guidance for Performing Compliance Measurement on Digital Transmission Systems (DTS) Operating under §15.247" (KDB 558074 D01 DTS Meas Guidance v05r02), and RSS-247 Issue 2, RSS-GEN Issue 5.

Radiated emissions and AC mains conducted emissions measurements were performed according to the procedures in ANSI C63.10: 2013. Radiated tests were performed at an antenna to EUT distance of 3 meters, unless stated otherwise in the "Data Sheet" of this report.

## 2.5 Measurement Uncertainty

Compliance with the limits was based on the results of the measurements and doesn't take into account the measurement uncertainty.

Estimated Measurement Uncertainty

| Measurement | Expanded Uncertainty (k=2) | | |
|---|---|---|---|
| | 0.15 MHz – 1 GHz | 1 GHz – 2.5 GHz | > 2.5 GHz |
| RF Power and Power Density – antenna conducted | - | 0.7 dB | - |
| Unwanted emissions - antenna conducted | 1.1 dB | 1.3 dB | 1.9 dB |
| Bandwidth – antenna conducted | - | 30 Hz | - |

| Measurement | Expanded Uncertainty (k=2) | | | |
|---|---|---|---|---|
| | 0.15 MHz – 30MHz | 30 – 200 MHz | 200 MHz – 1 GHz | 1 GHz – 18 GHz |
| Radiated emissions | - | 4.7 | 4.6 | 5.1 dB |
| AC mains conducted emissions | 2.1 dB | - | - | - |

## 3.0 System Test Configuration

### 3.1 Support Equipment

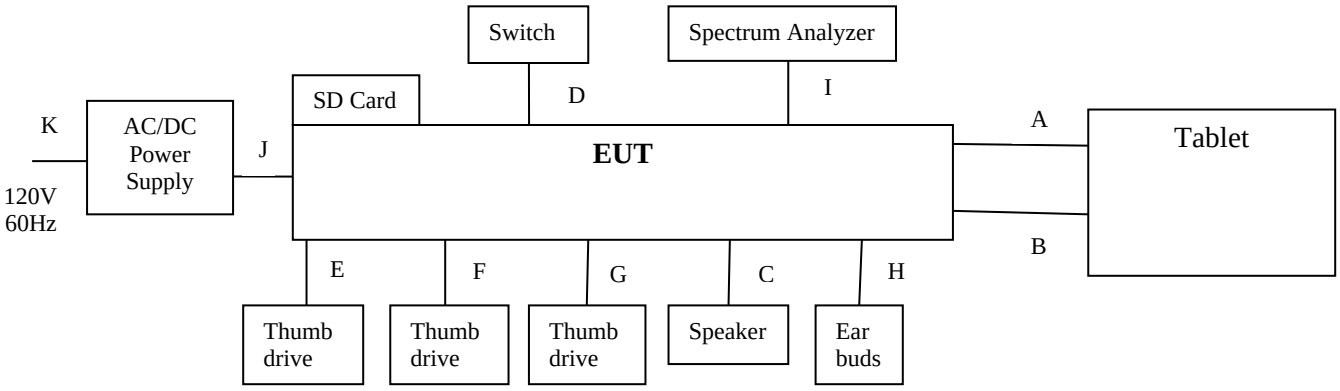
| Support Equipment | | |
|---|---|---|
| **Description** | **Manufacturer** | **Model Number** |
| Tablet | OSD DISPLAYS | OSD101T3990-81TS |
| Power Supply | XP POWER LLC | ECS130US12-XE1141 |
| Thumb drive | Freescale | - |
| Thumb drive | HP | - |
| Thumb drive | Kingston | - |
| Speaker | Visaton | FR 58 |
| Earbuds | - | - |
| Switch | - | - |
| SD Memory Card | - | - |

| Cables | | | | | |
|---|---|---|---|---|---|
| **ID** | **Description** | **Length (m)** | **Shielding** | **Ferrites** | **Termination** |
| A | Ribbon Cable | 0.1 | No | No | Tablet |
| B | Ribbon Cable | 0.1 | No | No | Tablet |
| C | Power Cable | 0.6 | No | No | Speaker |
| D | Power Cable | 0.6 | No | No | Switch |
| E | Micro-USB to USB | 0.6 | Yes | No | Thumb drive |
| F | USB Extender | 0.6 | Yes | No | Thumb drive |
| G | USB Extender | 0.6 | Yes | No | Thumb drive |
| H | Headphone Extender | 0.4 | No | No | Earbuds |
| I | SMA Cable | 0.2 | Yes | No | EUT |
| J | DC Power Cable | 0.5 | No | No | Power Supply |
| K | AC Power Cable | 2.0 | No | No | Power Supply |

## 3.2 Block Diagram of Test Setup

| Equipment Under Test | | | |
|---|---|---|---|
| **Description** | **Manufacturer** | **Part Number** | **Serial Number (LOT Number)** |
| Connected AC Android Control Module | Bosch Automotive Service Solutions, Inc | CBA-G19-UBS2 | 209498-1-010 |

Antenna was removed and co-axial connector with a cable was installed for Conducted Measurements.



## 3.3 Justification

For radiated emission measurements the EUT is placed on a non-conductive table.

## 3.4 Software Exercise Program

The software “Ampak RFTestTool, VER 5.7” was used to exercise the EUT. The software was provided by Bosch Automotive Service Solutions, Inc.

## 3.5 Mode of Operation during Test

During transmitter testing, the transmitter was setup to transmit continuously using the maximum RF power setting provided by the manufacturers via test scripts. The corresponding output power in dBm can be found in section 4.2 of this report.

## 3.6 Modifications Required for Compliance

No modifications were made by the manufacturer or Intertek to the EUT in order to bring the EUT into compliance.

## 3.7 Additions, Deviations and Exclusions from Standards

No additions, deviations or exclusions from the standard were made.

## 4.0 Measurement Results

4.1 6-dB Bandwidth and 99% Occupied Bandwidth
FCC Rule: 15.247(a)(2); RSS-247, 5.2.a) and RSS-GEN;

4.1.1 Requirement

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

4.1.2 Procedure

A spectrum analyzer was connected to the antenna port of the transmitter.

For FCC 6dB Channel Bandwidth the Procedure described in the FCC Publication KDB 558074 D01 Meas Guidance v05r02 was used to determine the DTS occupied bandwidth. Section 11.8.1 Option 1 of ANSI 63.10 was used.

1. Set RBW = 100 kHz.
2. Set the video bandwidth (VBW) ≥ 3 x RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. 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.

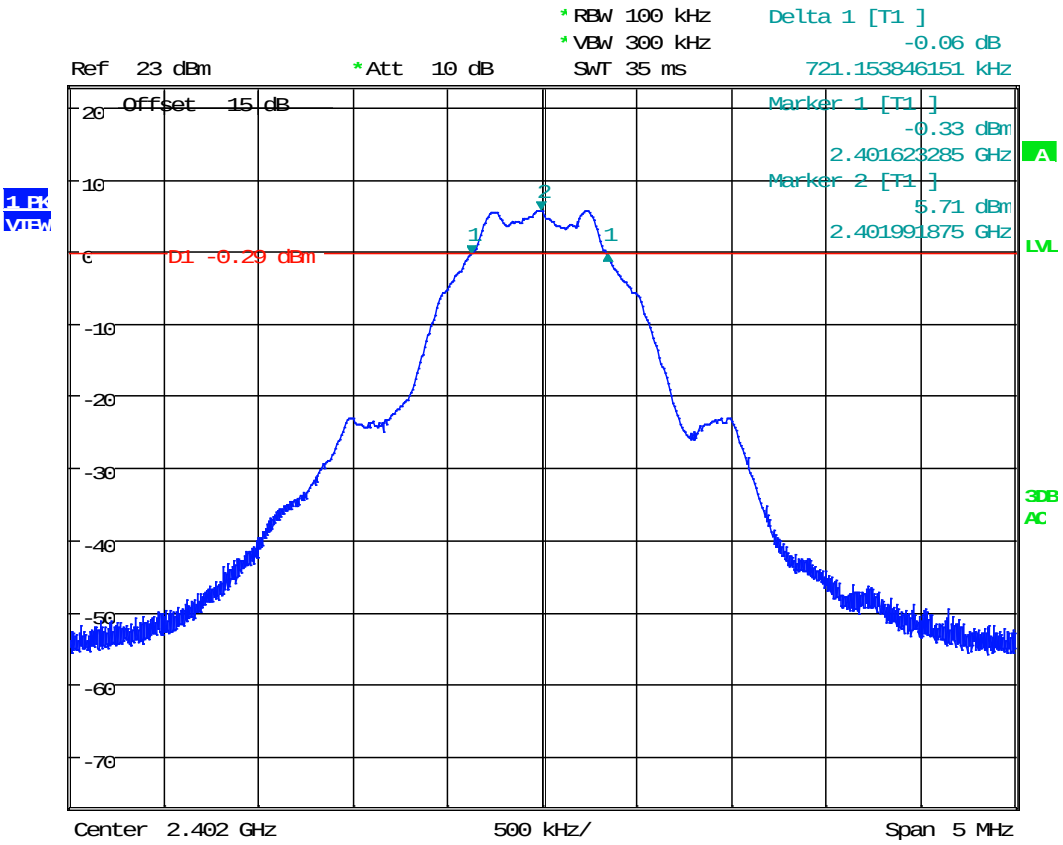
For 99% power bandwidth measurement, the bandwidth was determined by using the built-in 99% occupied bandwidth function of the spectrum analyzer. The resolution bandwidth is set to 1% of the selected span as is without being below 1%. The video bandwidth shall be set to 3 times the resolution bandwidth.

4.1.3 Test Result

| Frequency (MHz) | 6-dB bandwidth FCC 15.247 & RSS-GEN | Occupied bandwidth, RSS-GEN | Plot |
|---|---|---|---|
| MHz | kHz | MHz | |
| 2402 | 721.154 | -- | 1.1 |
| | -- | 1.0556 | 1.4 |
| 2440 | 703.526 | -- | 1.2 |
| | -- | 1.0568 | 1.5 |
| 2480 | 713.846 | -- | 1.3 |
| | -- | 1.0525 | 1.6 |

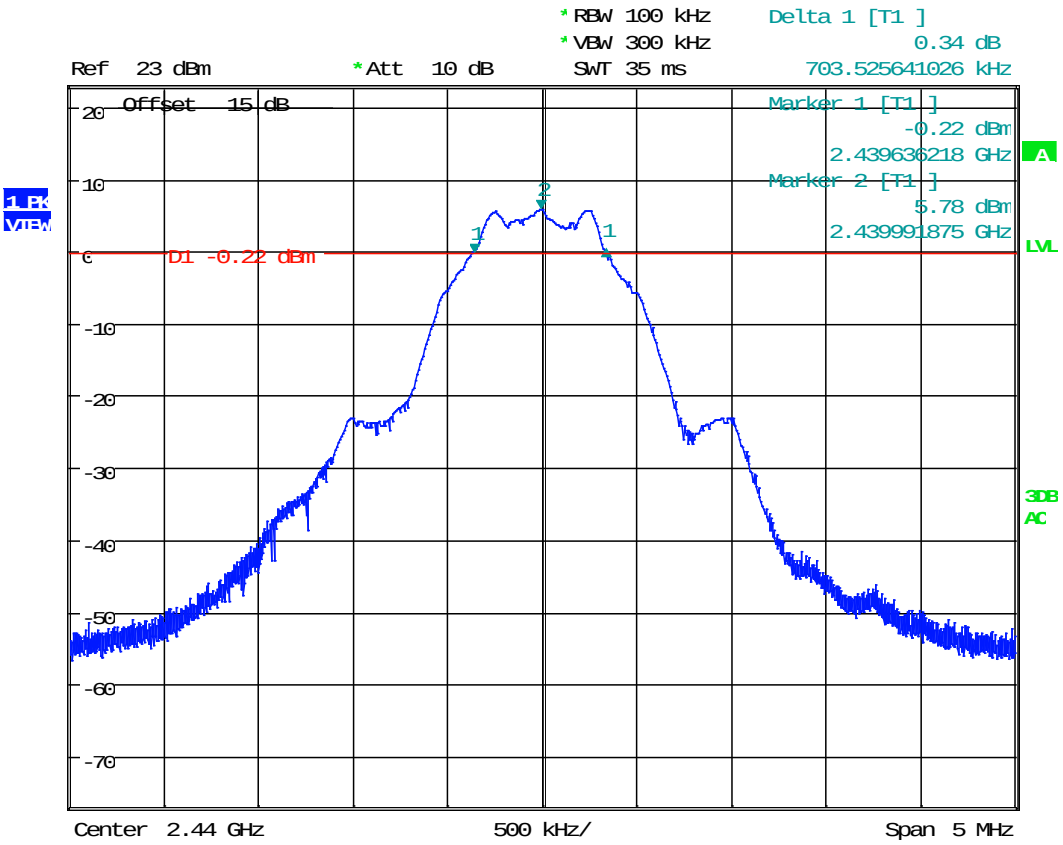
| Tested By | Test Date |
|---|---|
| Todd Moy | June 24, 2019 |

Plot 1. 1



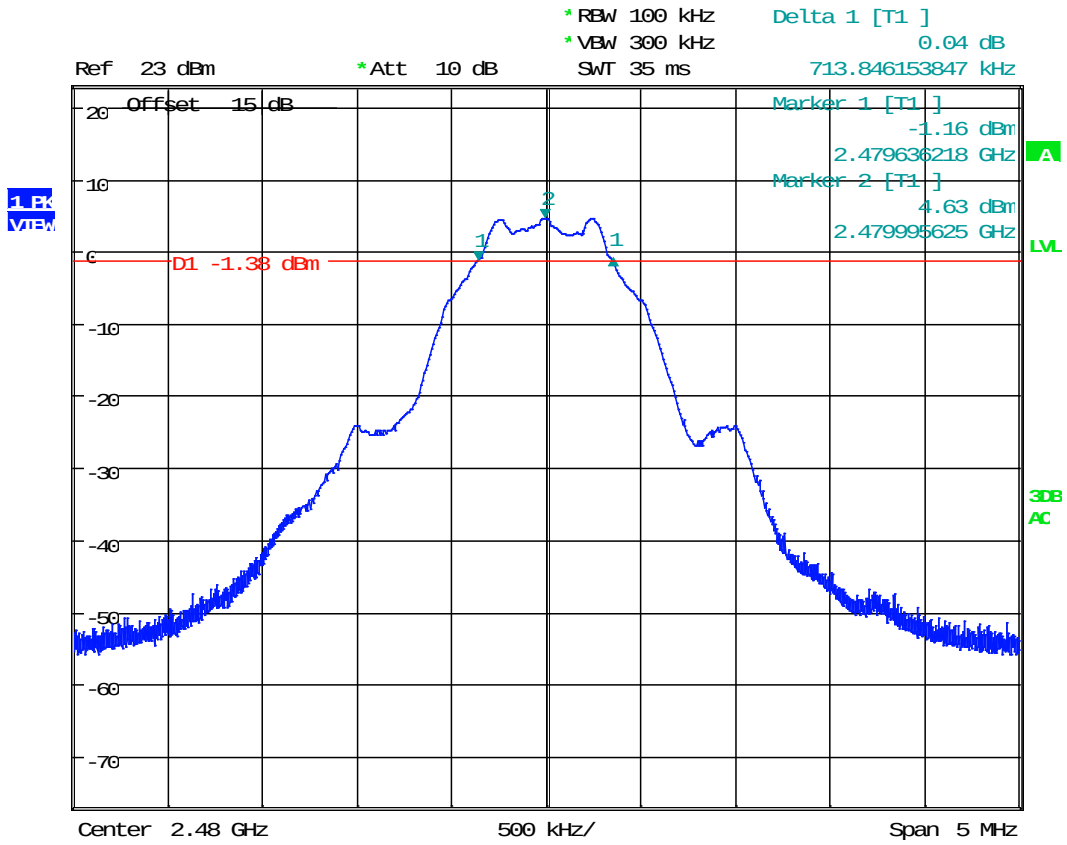

Date: 24.JUN.2019 13:55:20

Plot 1. 2



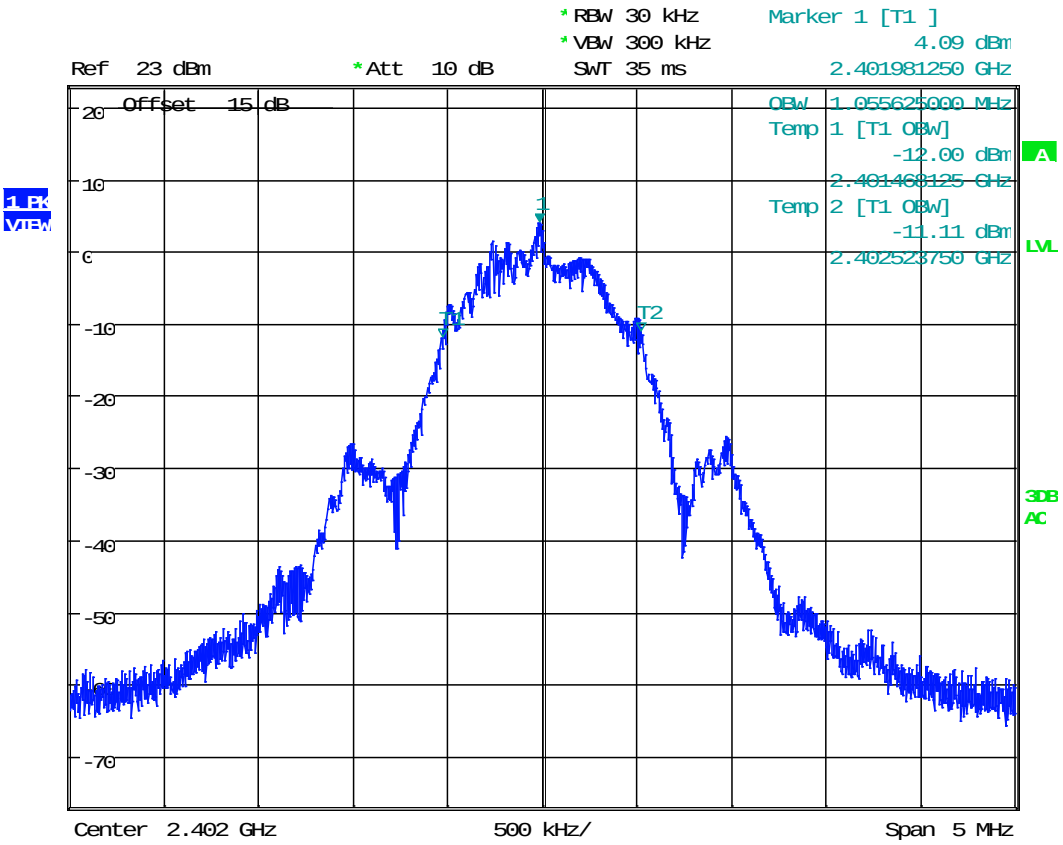

Date: 24.JUN.2019 14:00:47

Plot 1. 3



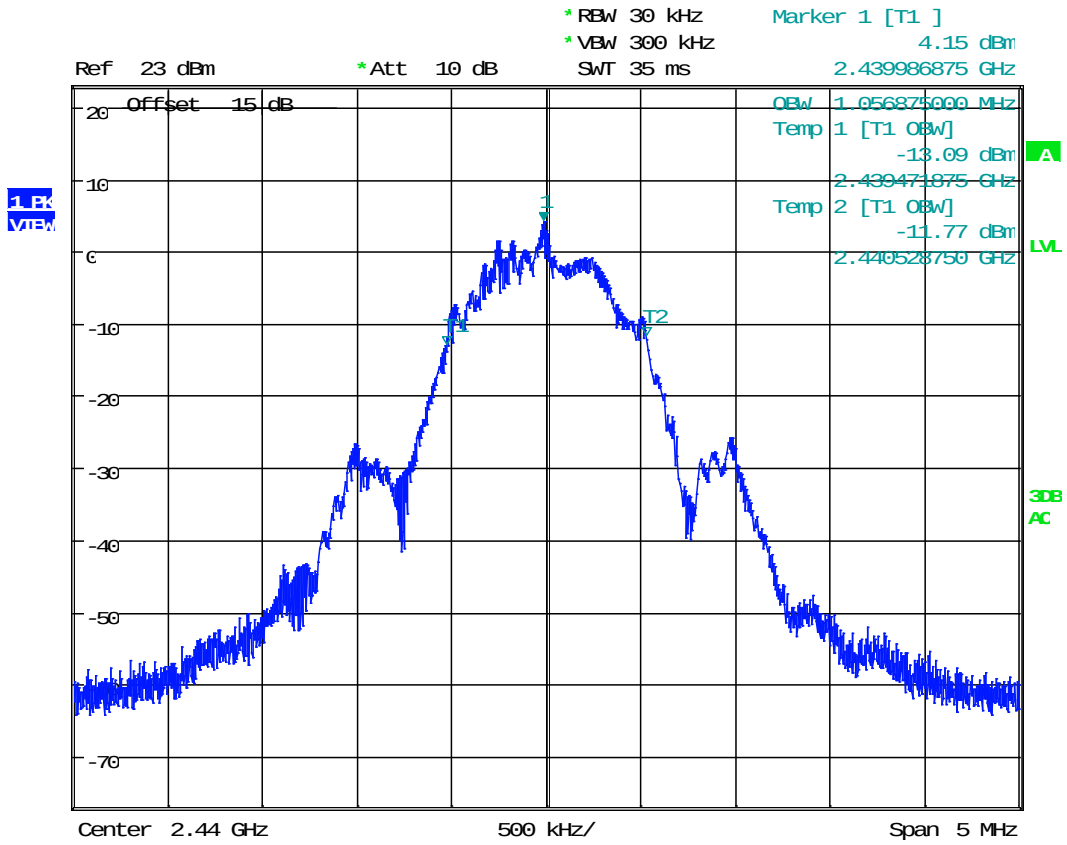

Date: 24.JUN.2019 14:07:14

Plot 1. 4



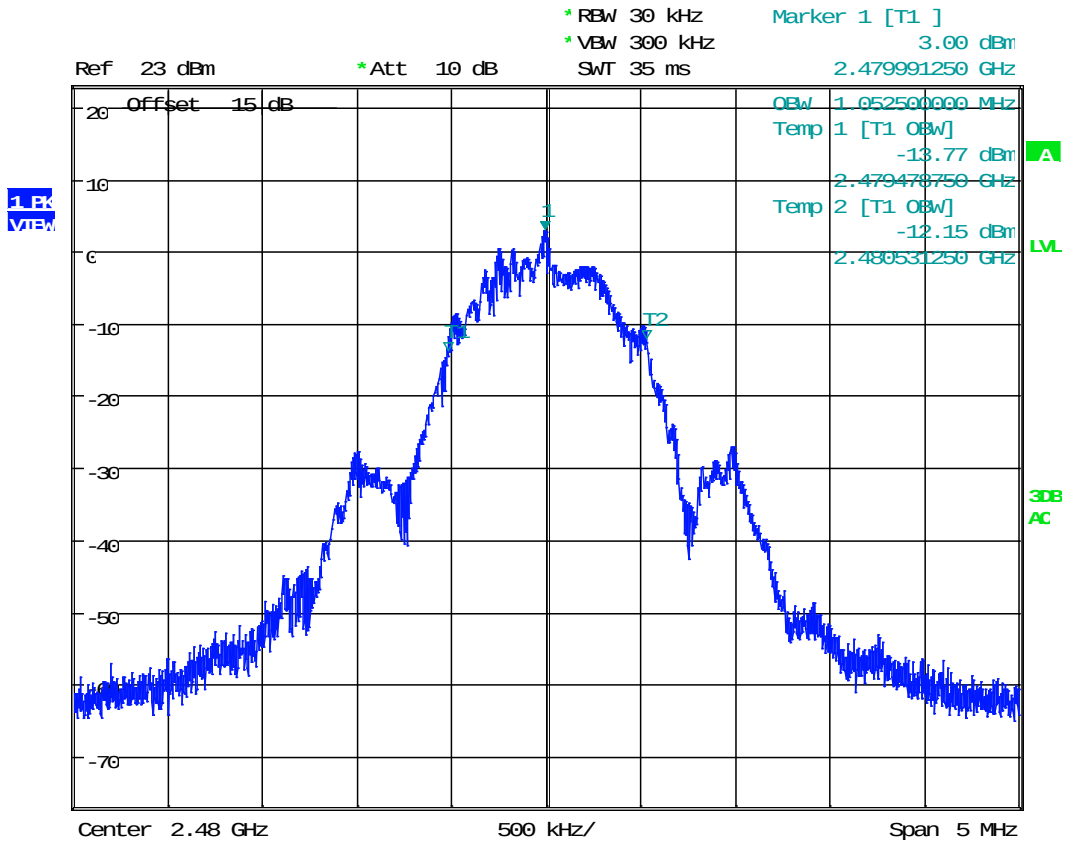

Date: 24.JUN.2019 14:13:13

Plot 1.5




Date: 24.JUN.2019 14:12:28

Plot 1.6




Date: 24.JUN.2019 14:11:30

## 4.2 Maximum Peak Conducted Output Power at Antenna Terminals
FCC Rule: 15.247(b)(3); RSS-247, 5.4.d);

### 4.2.1 Requirement

For antennas with gains of 6 dBi or less, maximum allowed transmitter output is 1 watt or 30 dBm.
For antennas with gains greater than 6 dBi, transmitter output level must be decreased appropriately, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

### 4.2.2 Procedure

The procedure described in FCC Publication KDB 558074 D01 Meas Guidance v05r02 was used. Specifically, section 11.9.1.1 RBW ≥ DTS bandwidth in ANSI 63.10.

1. Set the RBW ≥ DTS Bandwidth
2. Set the VBW ≥ 3 x RBW
3. Set the span ≥ 3 x RBW
4. Detector = Peak
5. Sweep time = Auto couple
6. Trace mode = Max Hold
7. Allow trace to fully stabilize
8. Use peak marker function to determine the peak amplitude level.

A spectrum analyzer was connected to the antenna port of the transmitter.

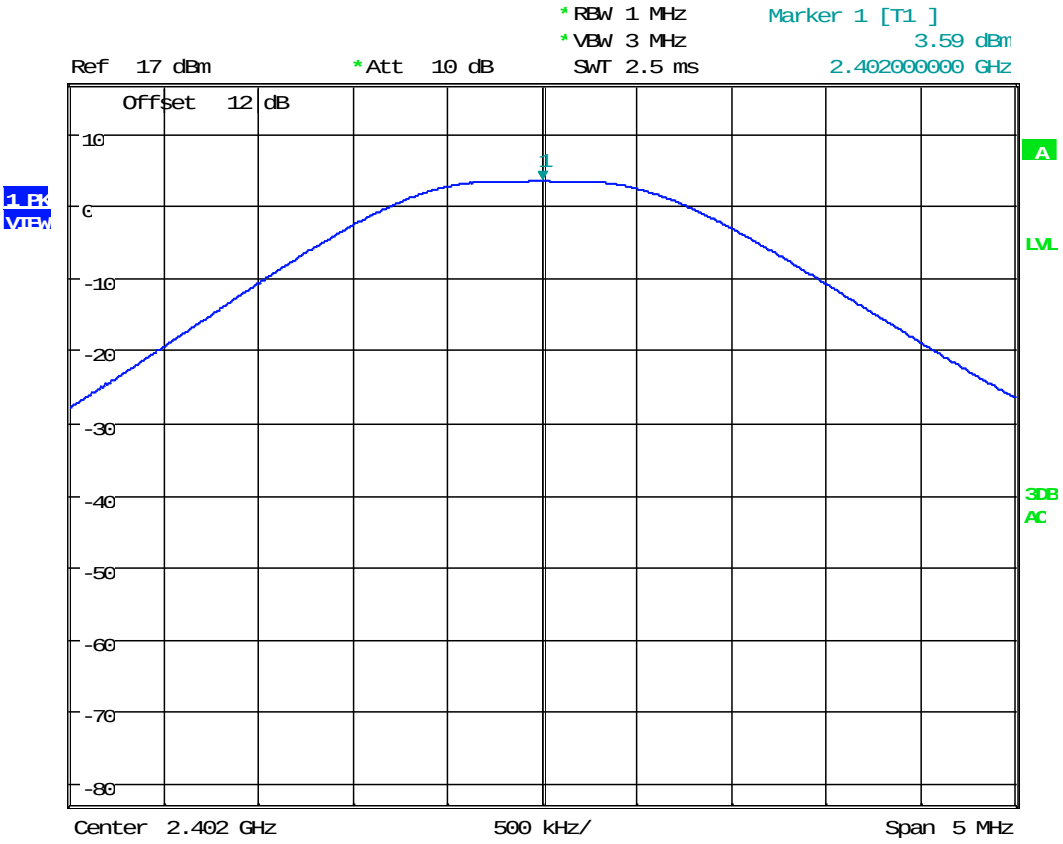
### 4.2.3 Test Result

Refer to the following plots 2.1 – 2.3 for the test details.

| **Frequency** | **Conducted Power (peak)** | | **Plot** |
|---|---|---|---|
| MHz | dBm | mW | |
| 2402 | 3.59 | 2.286 | 2.1 |
| 2440 | 3.62 | 2.301 | 2.2 |
| 2480 | 2.46 | 1.762 | 2.3 |

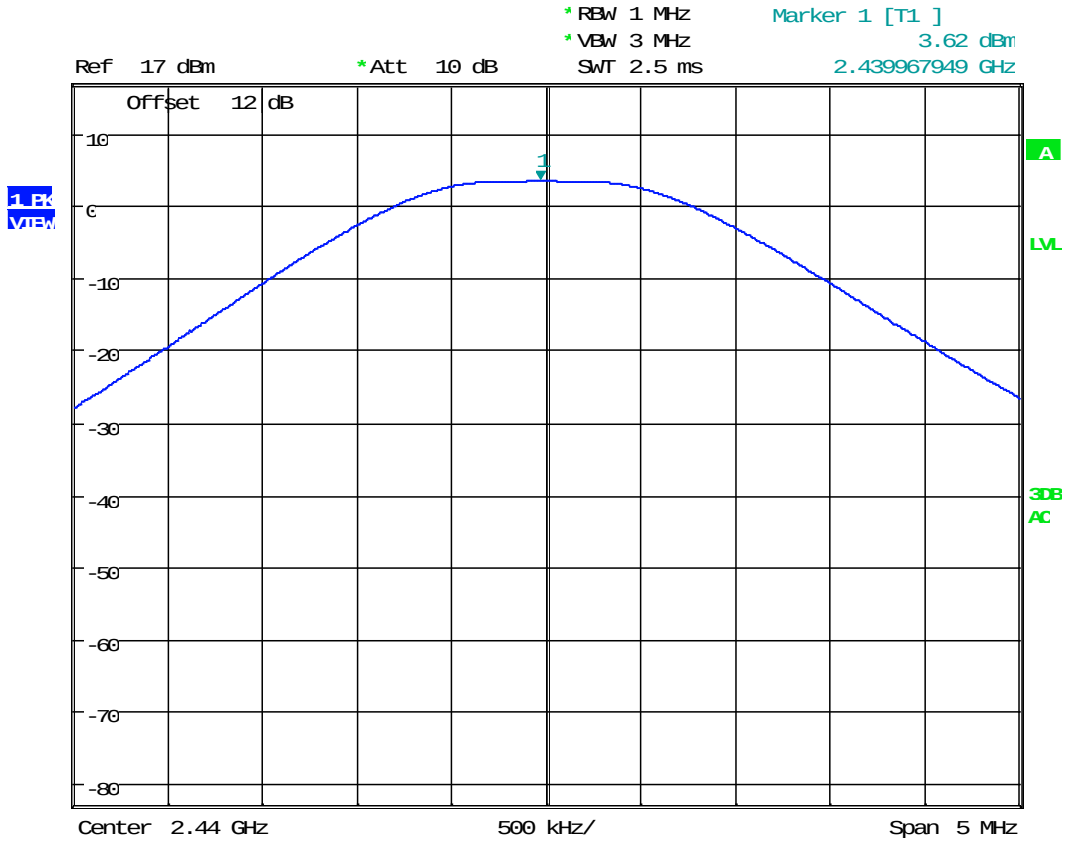
| **Tested By** | **Test Date** |
|---|---|
| Todd Moy | June 24, 2019 |

Plot 2. 1



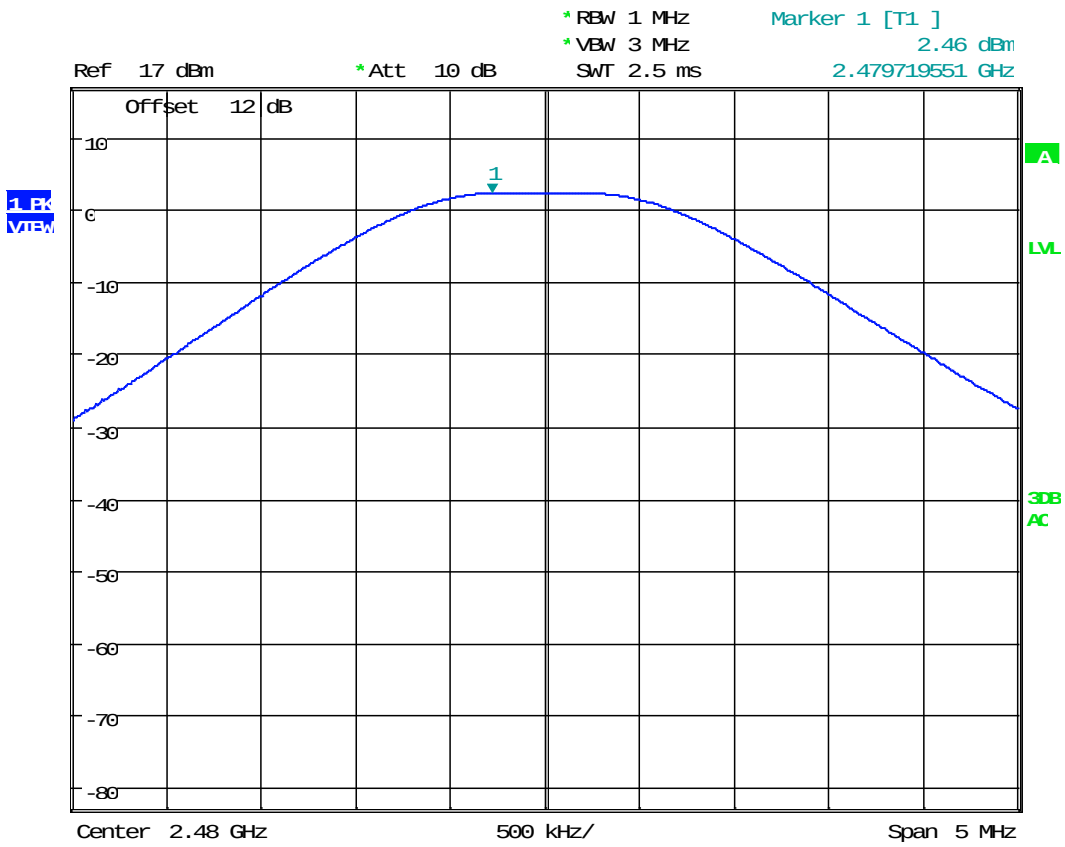

Date: 24.JUN.2019 14:19:59

Plot 2. 2




Date: 24.JUN.2019 14:20:41

Plot 2. 3




Date: 24.JUN.2019 14:21:20

## 4.3 Maximum Power Spectral Density
FCC: 15.247 (e); RSS-247, 5.2.b);

### 4.3.1 Requirement

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna should not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

### 4.3.2 Procedure

A spectrum analyzer was connected to the antenna port of the transmitter.

The procedure described in FCC Publication KDB 558074 D01 Meas Guidance v05r02, specifically section 11.10.2 Method PKPSD (peak PSD) of ANSI 63.10.

1. Set analyzer center frequency to DTS channel center frequency.
2. Set the span to 1.5 times the *DTS bandwidth*.
3. Set the RBW to: 3 kHz ≤ RBW ≤ 100 kHz.
4. Set the VBW ≥ 3 x RBW.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level within the RBW.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

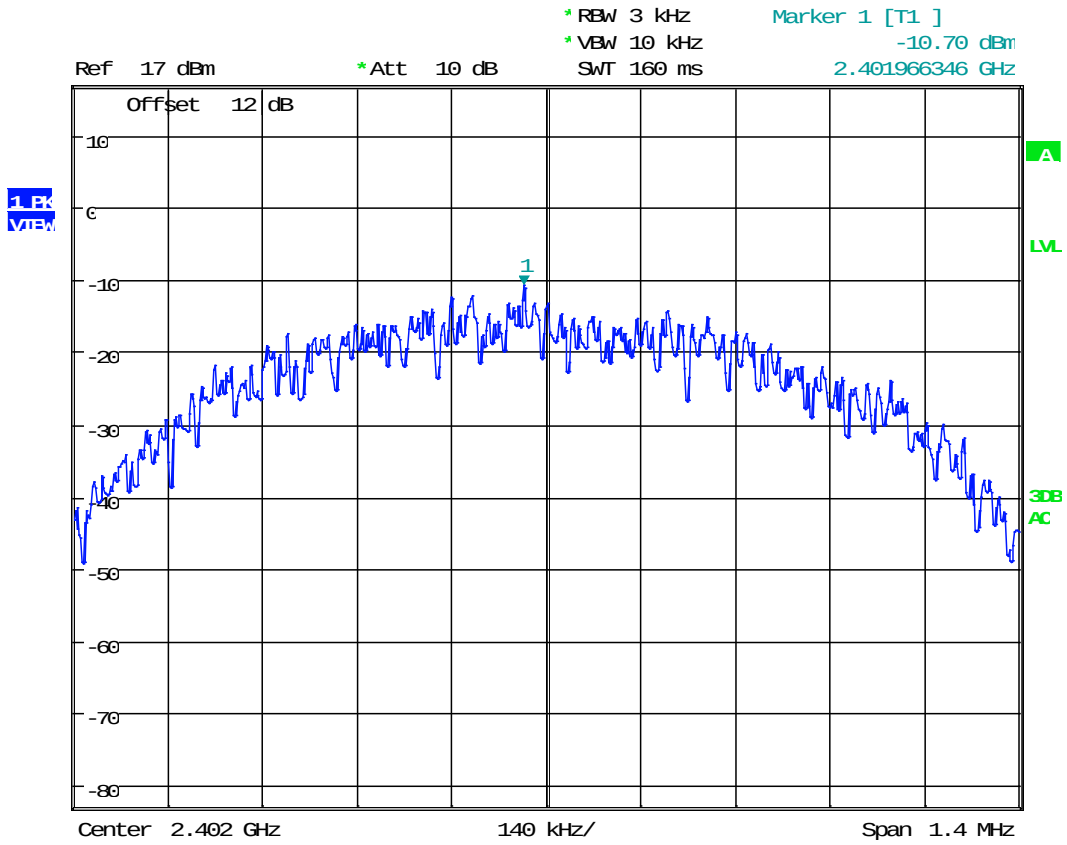
### 4.3.3 Test Result

Refer to the following plots for the test result

| Frequency, | Maximum Power Spectral Density | Maximum Power Spectral Density Limit | Margin | Plot |
|---|---|---|---|---|
| MHz | dBm | dBm | dB | |
| 2402 | -10.70 | 8.0 | -18.7 | 3.1 |
| 2440 | -10.73 | 8.0 | -18.73 | 3.2 |
| 2480 | -11.92 | 8.0 | -19.92 | 3.3 |

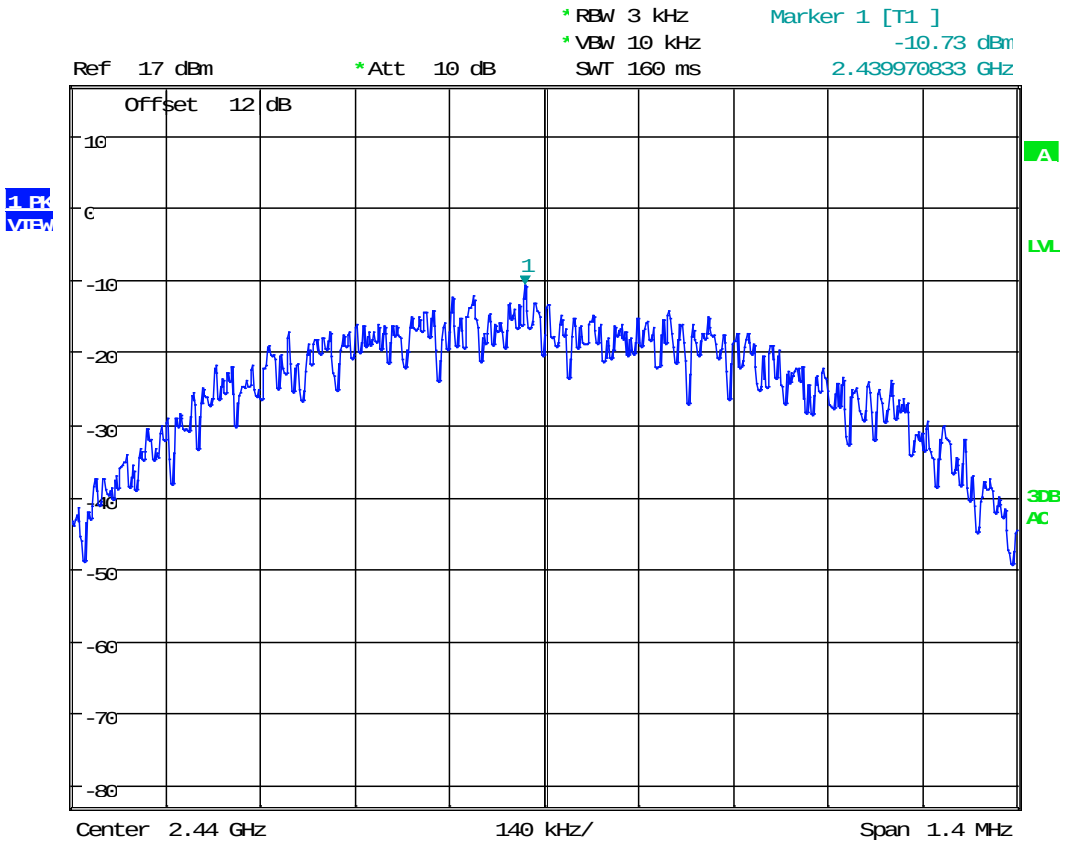
| Tested By | Test Date |
|---|---|
| Todd Moy | June 24, 2019 |

Plot 3. 1



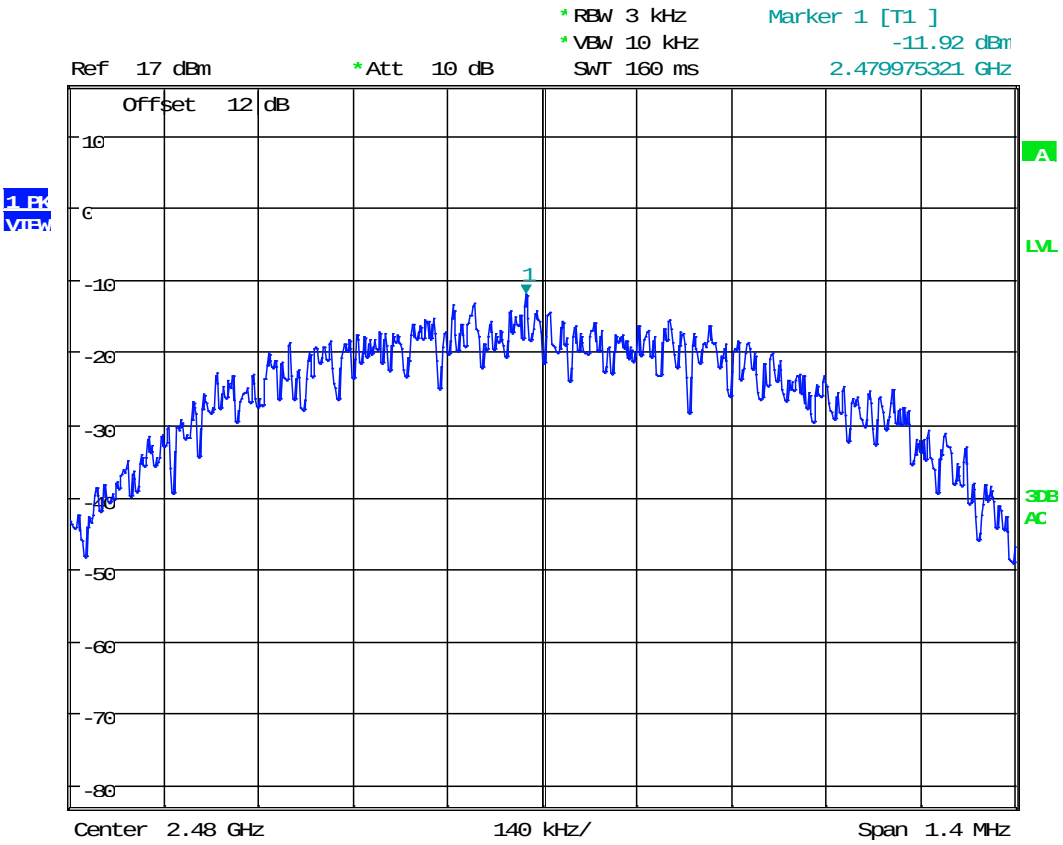

Date: 24.JUN.2019 14:26:52

Plot 3. 2




Date: 24.JUN.2019 14:26:12

Plot 3. 3




Date: 24.JUN.2019 14:25:29

## 4.4 Out of Band Antenna Conducted Emission
FCC: 15.247(d); RSS-247, 5.5;

### 4.4.1 Requirement

In any 100 kHz bandwidth outside the EUT pass-band, the RF power shall be below the maximum in-band 100 kHz emissions by at least 20 dB (if peak power of in-band emission is measured) or 30 dB (if average power of in-band emission is measured).

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)

### 4.4.2 Procedure

The procedure described in FCC Publication KDB 558074 D01 Meas Guidance v05r02, specifically section 11.11 DTS Emissions in non-restricted frequency bands of ANSI 63.10.

A spectrum analyzer was connected to the antenna port of the transmitter.

1. Set the RBW = 100 kHz.
2. Set the VBW ≥ 3 x RBW.
3. Detector = peak.
4. Sweep time = auto couple.
5. Trace mode = max hold.
6. Allow trace to fully stabilize.
7. Use the peak marker function to determine the maximum amplitude level.

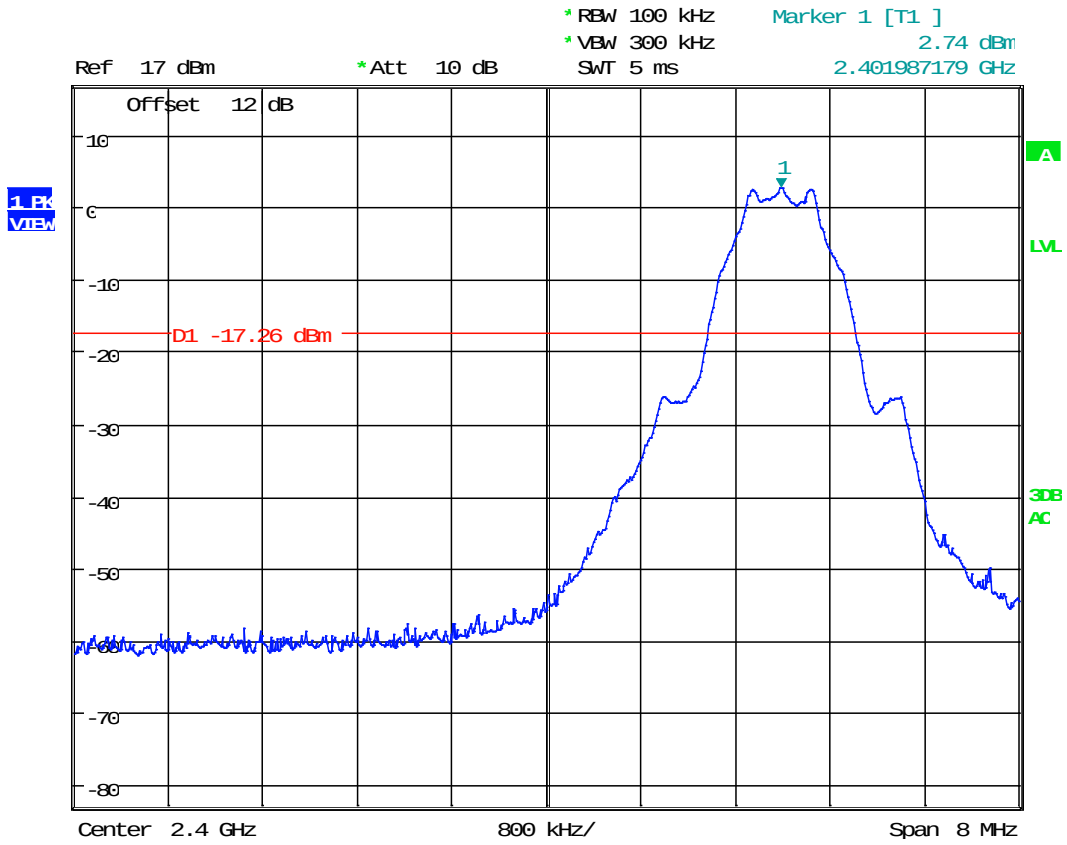
The unwanted emissions were measured from 30 MHz to 25 GHz. Plots below are corrected for cable loss and then compared to the limits.

### 4.4.3 Test Result

Refer to the following plots 4.1 – 4.5 for unwanted conducted emissions. The plot shows -20dB attenuation limit line.

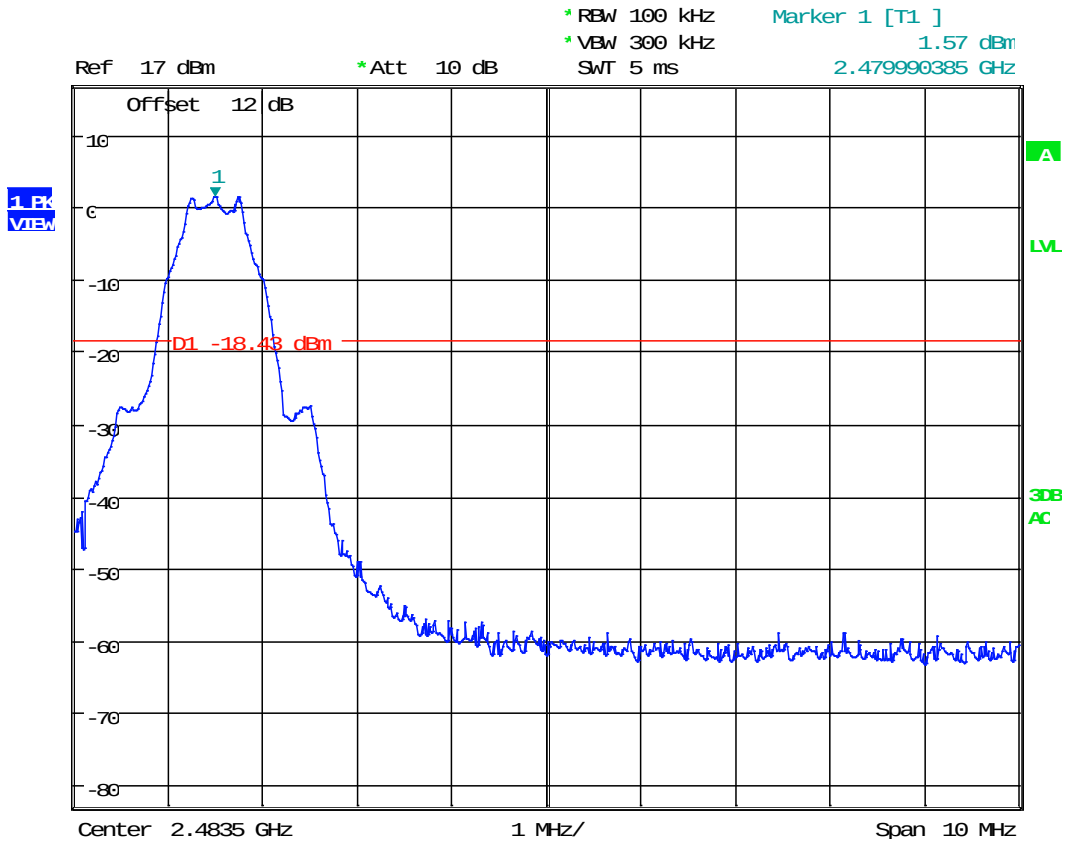
| Tested By | Test Date |
|---|---|
| Todd Moy | June 24, 2019 |

Tx @ Low Channel, 2400 MHz Band Edge
Plot 4.1



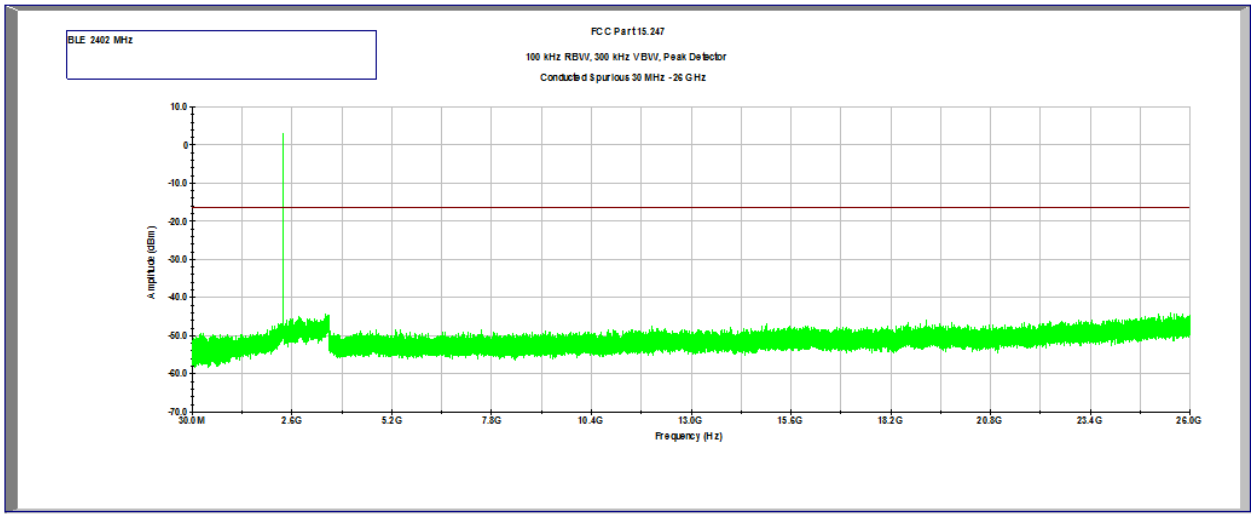

Date: 24.JUN.2019 14:28:41

Tx @ Low Channel, 2483.5 MHz Band Edge
Plot 4.2

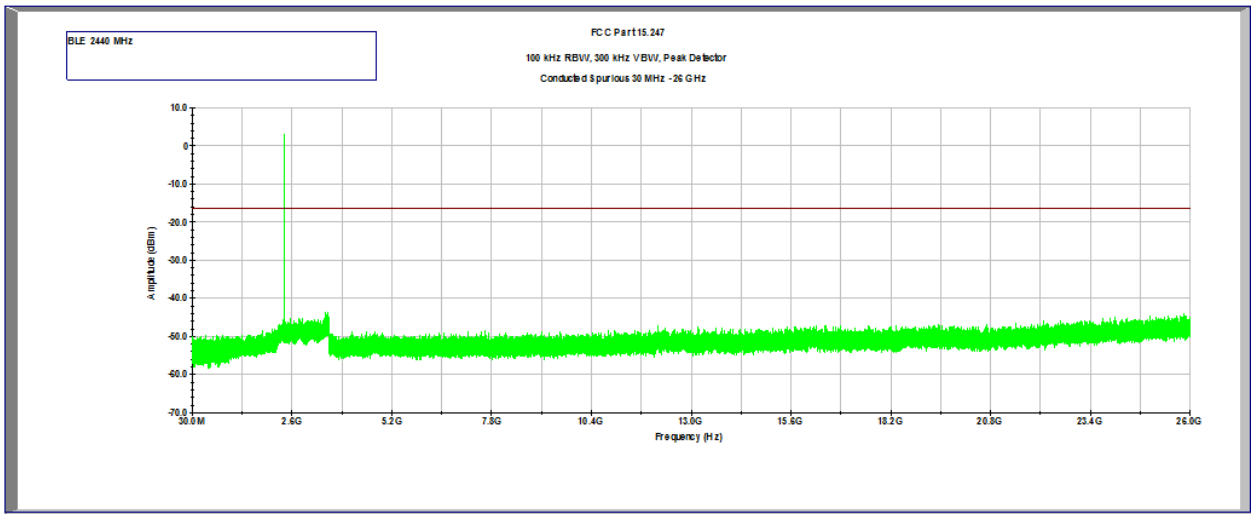



Date: 24.JUN.2019 14:29:49

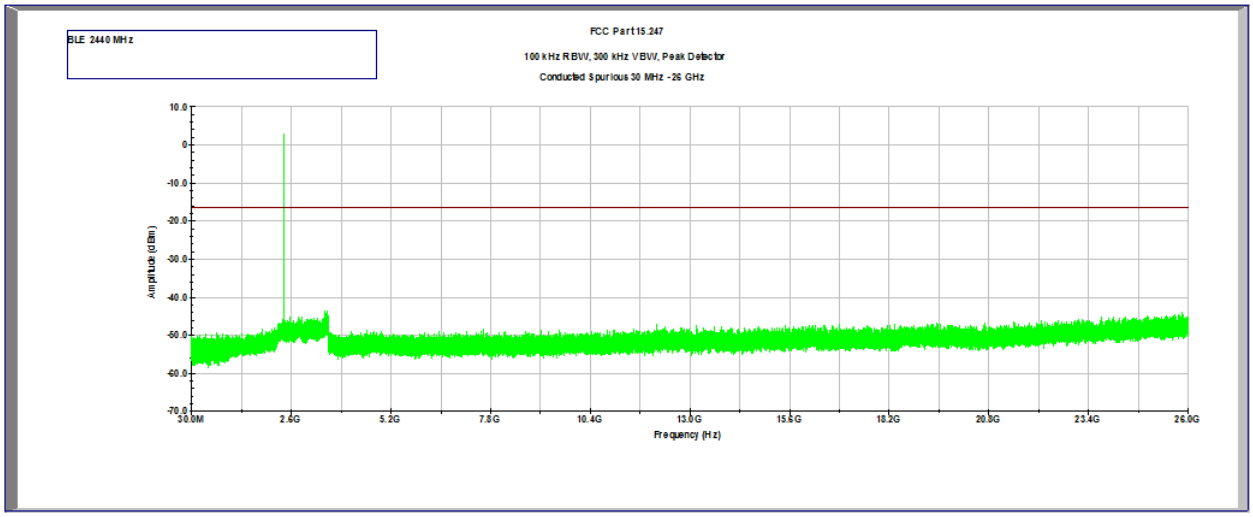
Tx @ Low Channel, 2402 MHz
30MHz -26GHz Conducted Spurious
Plot 4.3




Tx @ Mid Channel, 2440 MHz
30MHz -26GHz Conducted Spurious
Plot 4.4



Tx @ High Channel, 2480 MHz
30MHz -26GHz Conducted Spurious
Plot 4.5



## 4.5 Transmitter Radiated Emissions
FCC Rules: 15.247(d), 15.209, 15.205; RSS-247, 5.5;

### 4.5.1 Requirement

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)).

For out of band radiated emissions (except for frequencies in restricted bands), in any 100 kHz bandwidths outside the EUT pass-band, the RF power shall be at least 20dB (peak) or 30 dB (average) below that of the maximum in-band 100 kHz emissions.

### 4.5.2 Procedure

Radiated emission measurements were performed from 30 MHz to 25 GHz according to the procedure described in ANSI C63.10: 2013. Spectrum Analyzer Resolution Bandwidth is 100 kHz or greater for frequencies 30 MHz to 1000 MHz, 1 MHz for frequencies above 1000 MHz. Above 1000 MHz Peak and Average measurements were performed.

The EUT is placed on a plastic turntable that is 80 cm in height for below 1000MHz and 1.5m in height for above 1GHz. If the EUT attaches to peripherals, they are connected and operational (as typical as possible). During testing, all cables were manipulated to produce worst-case emissions. The signal is maximized through rotation. The antenna height and polarization are varied during the search for maximum signal level. The antenna height is varied from 1 to 4 meters.

Radiated emissions are taken at 3 meters for frequencies above 1 GHz and at 10 meters for frequencies below 1 GHz.

Measurements made from 1 GHz to 18GHz had a 2.4-2.5GHz notch filter in place. A preamp was used from 30MHz to 26GHz.

All measurements were made with a Peak Detector and compared to QP limits for 30MHz – 1GHz and Average limits for 1GHz – 26GHz.

Radiated measurements were performed on the X, Y and Z orientation of the EUT. Data is presented with the worst-case configuration (the configuration which resulted in the highest emission levels).

### 4.5.3 Field Strength Calculation

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF – AG; if measurement is performed at a distance other than specified in the rule, a Distance Correction Factor (DCF) shall be added.

Where FS = Field Strength in dB(μV/m)
RA = Receiver Amplitude (including preamplifier) in dB(μV); AF = Antenna Factor in dB(1/m)
CF = Cable Attenuation Factor in dB; AG = Amplifier Gain in dB

Assume a receiver reading of 52.0 dB(μV) is obtained. The antennas factor of 7.4 dB(1/m) and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving field strength of 32 dB(μV/m). This value in dB(μV/m) was converted to its corresponding level in μV/m.
RA = 52.0 dB(μV)
AF = 7.4 dB(1/m)
CF = 1.6 dB
AG = 29.0 dB
FS = 52.0+7.4+1.6-29.0 = 32 dB(μV/m).
Level in μV/m = Common Antilogarithm [(32 dBμV/m)/20] = 39.8 μV/m.

### 4.5.4 Antenna-port conducted measurements

Antenna-port conducted measurements may also be used as an alternative to radiated measurements for demonstrating compliance in the restricted frequency bands. If conducted measurements are performed, then proper impedance matching must be ensured and an additional radiated test for cabinet/case spurious emissions is required.

### 4.5.5 General Procedure for conducted measurements in restricted bands

a) Measure the conducted output power (in dBm) using the detector specified for determining quasi-peak, peak, and average conducted output power, respectively.

b) Add the maximum transmit antenna gain (in dBi) to the measured output power level to determine the EIRP level (see 12.2.5 for guidance on determining the applicable antenna gain)

c) Add the appropriate maximum ground reflection factor to the EIRP level (6 dB for frequencies ≤ 30 MHz, 4.7 dB for frequencies between 30 MHz and 1000 MHz, inclusive and 0 dB for frequencies > 1000 MHz).

d) For devices with multiple antenna-ports, measure the power of each individual chain and sum the EIRP of all chains in linear terms (*e.g.*, Watts, mW).

e) Convert the resultant EIRP level to an equivalent electric field strength using the following relationship:
E = EIRP – 20log D + 104.8+DCF (DCF for Average measurements)
where:
E = electric field strength in dBμV/m,
EIRP = equivalent isotropic radiated power in dBm
D = specified measurement distance in meters.
DCF = Duty Cycle Correction Factor
f) Compare the resultant electric field strength level to the applicable limit.
g) Perform radiated spurious emission test

### 4.5.6 Test Results

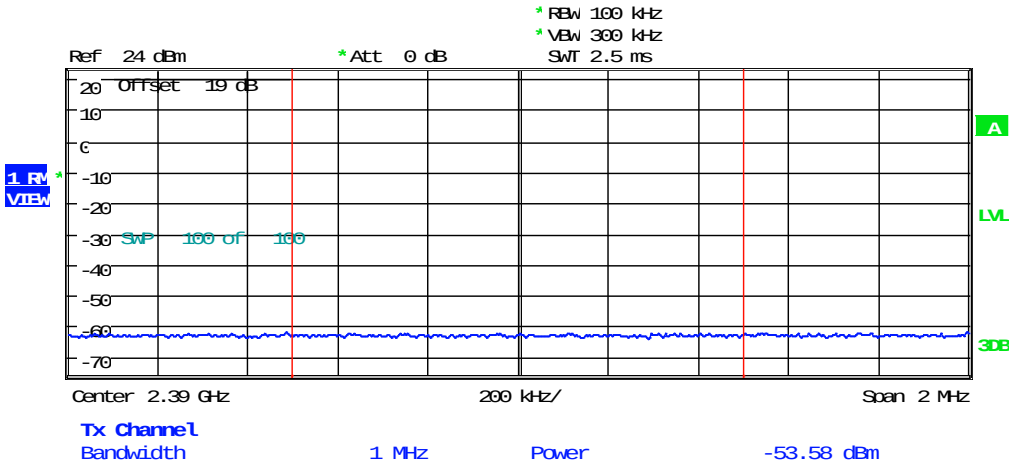
The data on the following pages list the significant emission frequencies, the limit and the margin of compliance.

Conducted Out-of-Band Spurious Emissions at the Band Edge were made with the consideration of cable loss and the addition of a 5dBi Antenna.

| Tested By | Test Date |
|---|---|
| Todd Moy | June 25 – July 23, 2019 |

**Test Results: 15.209/15.205 Restricted Band Emissions at Antenna Port**

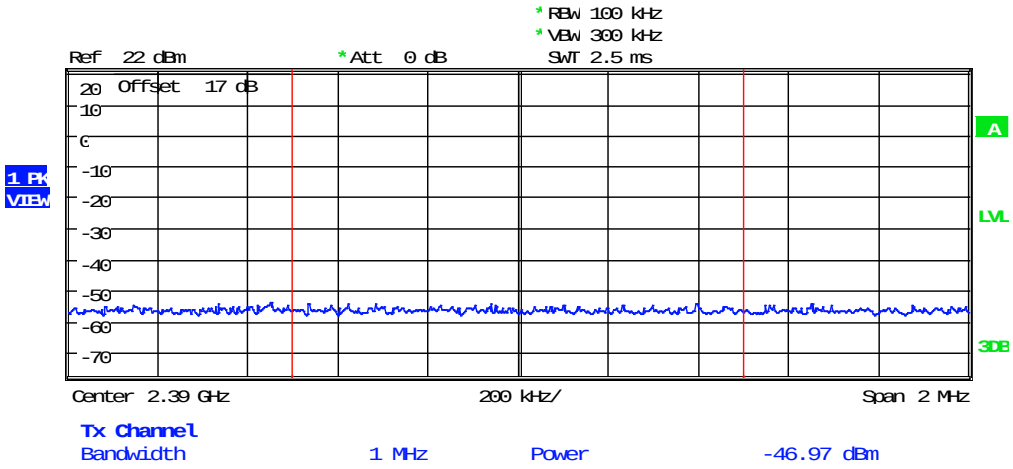
Conducted Out-of-Band Spurious Emissions at the Band Edge – Tx @ 2402 MHz, Average




| Frequency | Corrected Amplitude | Corrected Amplitude | Limit | Margin | Detector | Results |
|---|---|---|---|---|---|---|
| GHz | dBm | dB(µV/m) | dB(µV/m) | dB | | |
| 2.390 | -53.58 | 41.68 | 54 | -12.32 | RMS | Pass |

E = Corrected Amplitude – 20log D + 104.8
Corrected Amplitude = EIRP+ δ
D = 3 (meters)
Section 11.13.3.4 “Trace averaging across on- and off-times of the EUT transmissions followed by duty cycle correction” of ANSI 63.10 was utilized per KDB 558074 D01 DTS Meas Guidance v05r02

Conducted Out-of-Band Spurious Emissions at the Band Edge – Tx @ 2402 MHz, Peak

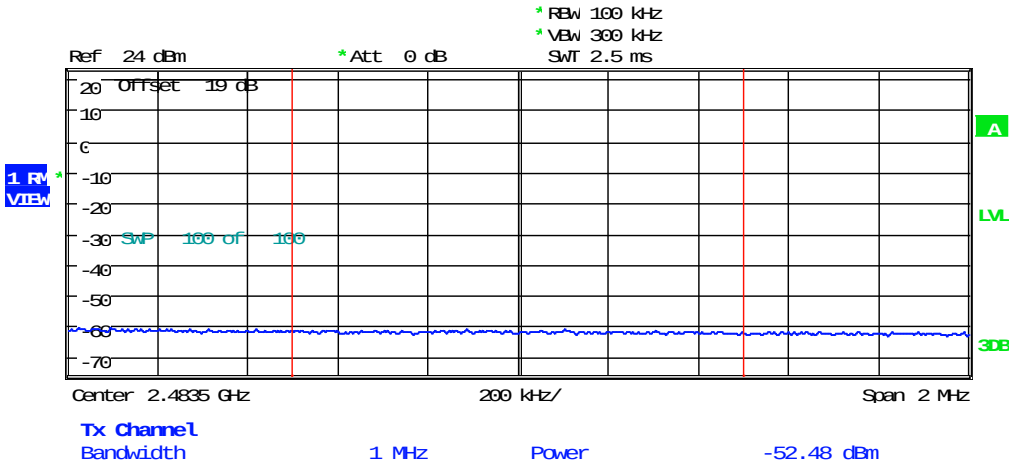



Date: 25.JUN.2019 10:31:16

| Frequency | Corrected Amplitude | Corrected Amplitude | Limit | Margin | Detector | Results |
|---|---|---|---|---|---|---|
| GHz | dBm | dB(µV/m) | dB(µV/m) | dB | | |
| 2.390 | -46.97 | 48.29 | 74 | -25.71 | Peak | Pass |

E = Corrected Amplitude – 20log D + 104.8
Corrected Amplitude = EIRP
D = 3 (meters)
Section 11.13.3.2 “Peak detection” of ANSI 63.10 was utilized per KDB 558074 D01 DTS Meas Guidance v05r02

Conducted Out-of-Band Spurious Emissions at the Band Edge – Tx @ 2480 MHz, Average

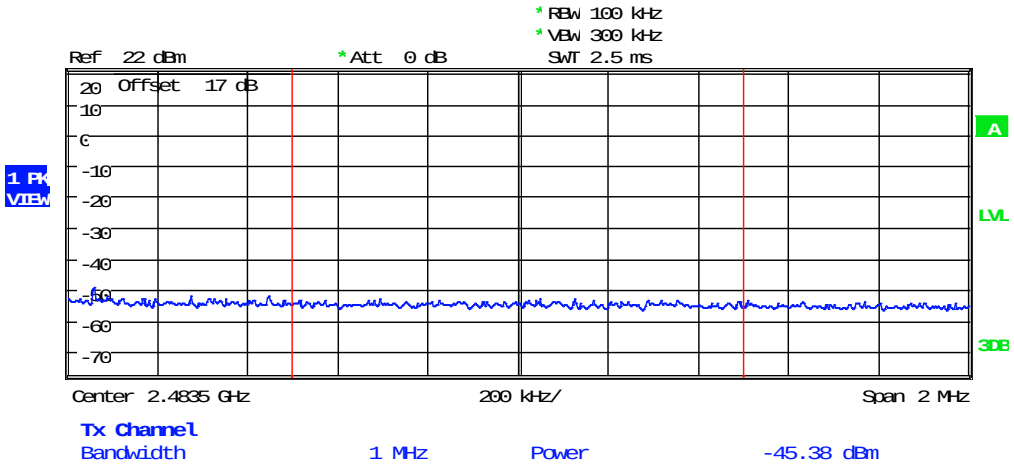



Date: 25.JUN.2019 10:23:33

| Frequency | Corrected Amplitude | Corrected Amplitude | Limit | Margin | Detector | Results |
|---|---|---|---|---|---|---|
| GHz | dBm | dB(µV/m) | dB(µV/m) | dB | | |
| 2.4835 | -52.48 | 42.78 | 54 | -11.22 | RMS | Pass |

E = Corrected Amplitude – 20log D + 104.8
Corrected Amplitude = EIRP+ δ
D = 3 (meters)
Section 11.13.3.4 “Trace averaging across on- and off-times of the EUT transmissions followed by duty cycle correction” of ANSI 63.10 was utilized per KDB 558074 D01 DTS Meas Guidance v05r02

Conducted Out-of-Band Spurious Emissions at the Band Edge – Tx @ 2480 MHz, Peak



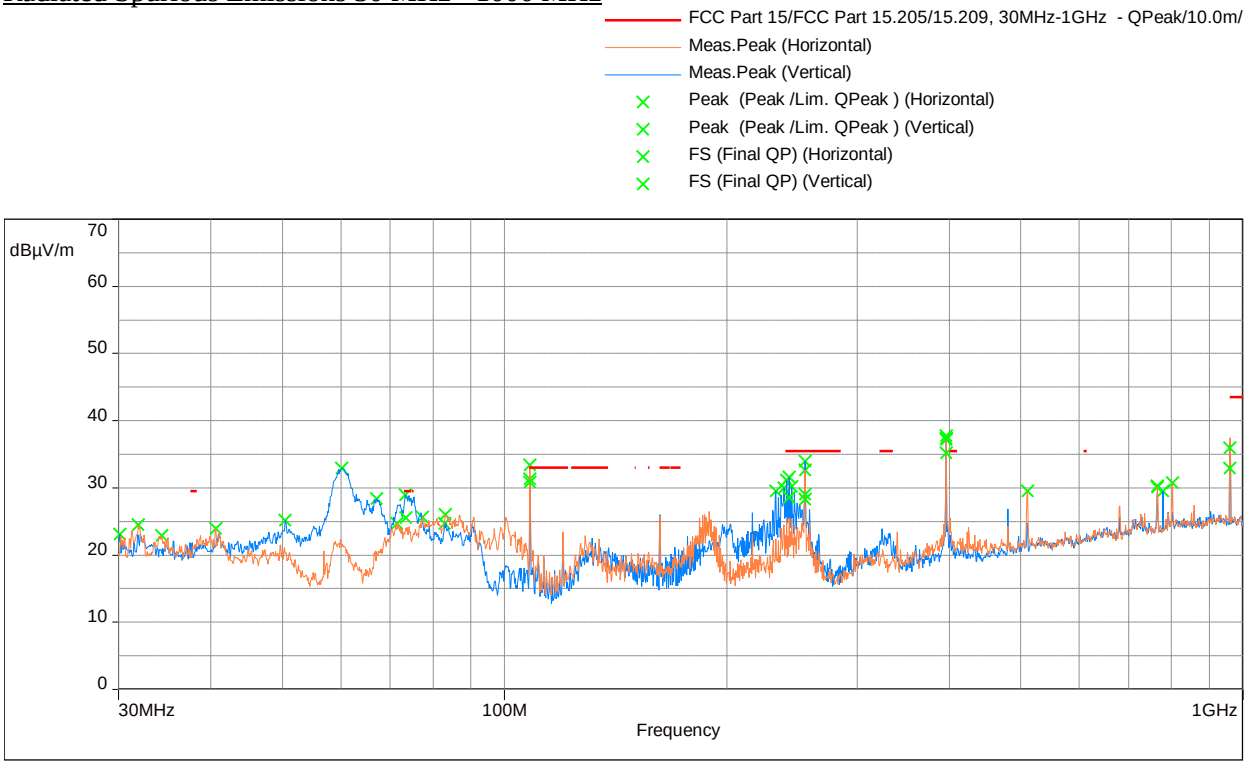

| Frequency | Corrected Amplitude | Corrected Amplitude | Limit | Margin | Detector | Results |
|---|---|---|---|---|---|---|
| GHz | dBm | dB(µV/m) | dB(µV/m) | dB | | |
| 2.4835 | -45.38 | 49.88 | 74 | -24.12 | Peak | Pass |

E = Corrected Amplitude – 20log D + 104.8
Corrected Amplitude = EIRP
D = 3 (meters)
Section 11.13.3.2 “Peak detection” of ANSI 63.10 was utilized per KDB 558074 D01 DTS Meas Guidance v05r02

## Out-of-Band Radiated Spurious Emissions

Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 2402MHz

Radiated Spurious Emissions 30 MHz - 1000 MHz

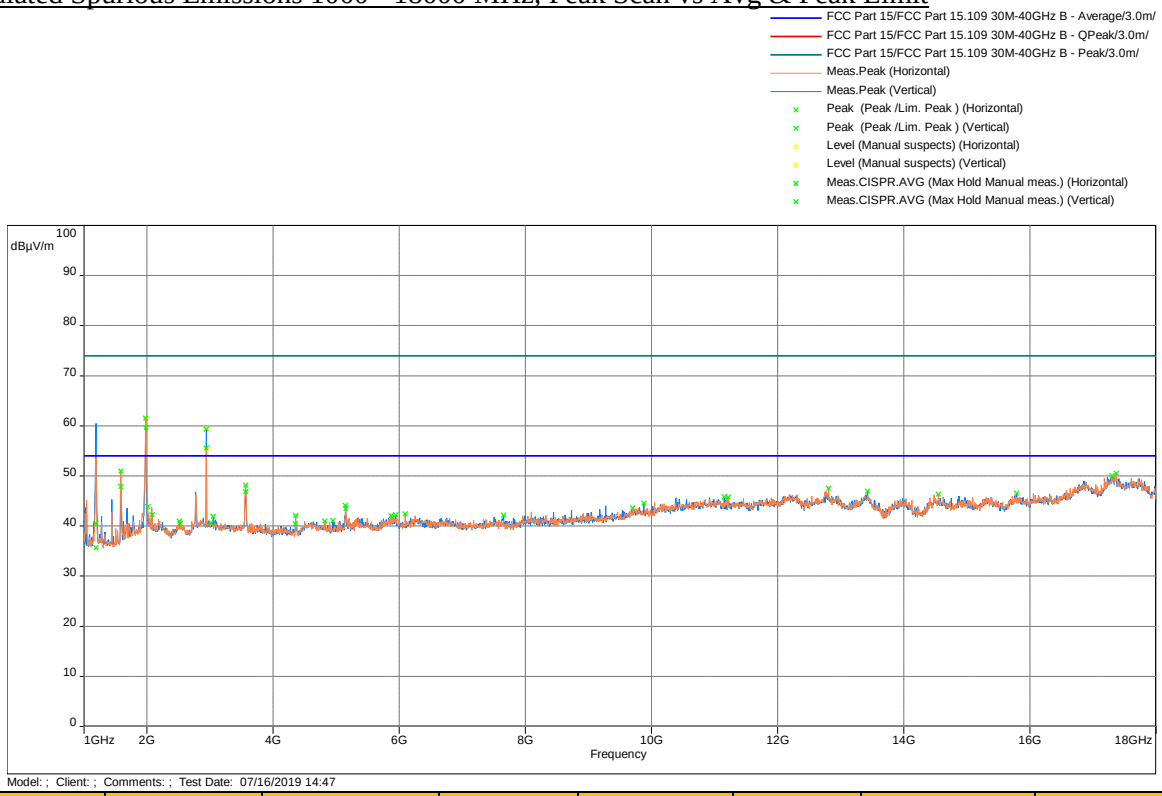



Model: ; Client: ; Comments: ; Test Date: 07/17/2019 11:39

| Frequency | QP@10m | Limit@10m | Margin | Height | Angle | Polarization | Correction |
|---|---|---|---|---|---|---|---|
| MHz | dB(µV/m) | dB(µV/m) | (dB) | (m) | (°) | | (dB) |
| 60.102 | 33.0 | 68.4* | -35.4 | 3 | 289.75 | Vertical | -15.3 |
| 73.419 | 25.5 | 29.5 | -4.0 | 2.79 | 82.25 | Vertical | -18.2 |
| 108.192 | 30.9 | 33.0 | -2.1 | 4 | 307.25 | Horizontal | -14.3 |
| 242.849 | 28.6 | 35.5 | -6.9 | 1.12 | 316.5 | Vertical | -11.4 |
| 255.065 | 28.3 | 35.5 | -7.2 | 1 | 229 | Vertical | -11.6 |
| 255.077 | 29.1 | 35.5 | -6.4 | 2.84 | 185.75 | Horizontal | -11.6 |
| 396.110 | 37.2 | 68.4* | -31.2 | 3 | 101 | Vertical | -7.6 |
| 396.110 | 37.8 | 68.4* | -30.6 | 2.98 | 132.5 | Horizontal | -7.6 |
| 960.013 | 33.0 | 43.5 | -10.6 | 2.99 | 237.25 | Vertical | -0.1 |
| 960.269 | 35.9 | 43.5 | -7.6 | 1 | 43.75 | Horizontal | -0.1 |

*Note: The following frequencies do not fall into the restricted band of FCC PT 15. 205, the limits for these frequencies are subject to FCC PT 15.247(d).

Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Avg & Peak Limit




| Freq. MHz | Ave@3m dB(uV/m) | Ave Limit@3m dB(µV/m) | Margin dB | Azimuth deg | Height m | Polarity | Correction dB |
|---|---|---|---|---|---|---|---|
| 1188.414 | 40.5 | 54 | -13.5 | 171 | 1.66 | Vertical | -16.1 |
| 1188.350 | 35.7 | 54 | -18.3 | 35.25 | 3.24 | Horizontal | -16.1 |

Note: Final average measurements were performed using section 11.12.2.5.2 of ANSI 63.10; when utilizing 11.12.2.5.2, the Trace mode was set to Max Hold and the measurement correction factor in 11.12.2.5.2 i) is not added (reference KDB 558074 D01 DTS Meas Guidance v05r02; FAQ #3(b)).

| Freq. MHz | Peak@3m dB(uV/m) | Peak Limit@3m dB(µV/m) | Margin dB | Azimuth deg | Height m | Polarity | Correction dB |
|---|---|---|---|---|---|---|---|
| 1977.500 | 61.5 | 78.9* | -17.4 | 27 | 1.26 | Horizontal | -13.5 |
| 1980.333 | 59.7 | 78.9* | -19.2 | 16.5 | 1.26 | Vertical | -13.5 |
| 2938.567 | 59.3 | 78.9* | -19.6 | 238.75 | 1.26 | Vertical | -12.4 |
| 2938.567 | 55.6 | 78.9* | -23.3 | 351 | 3.23 | Horizontal | -12.4 |

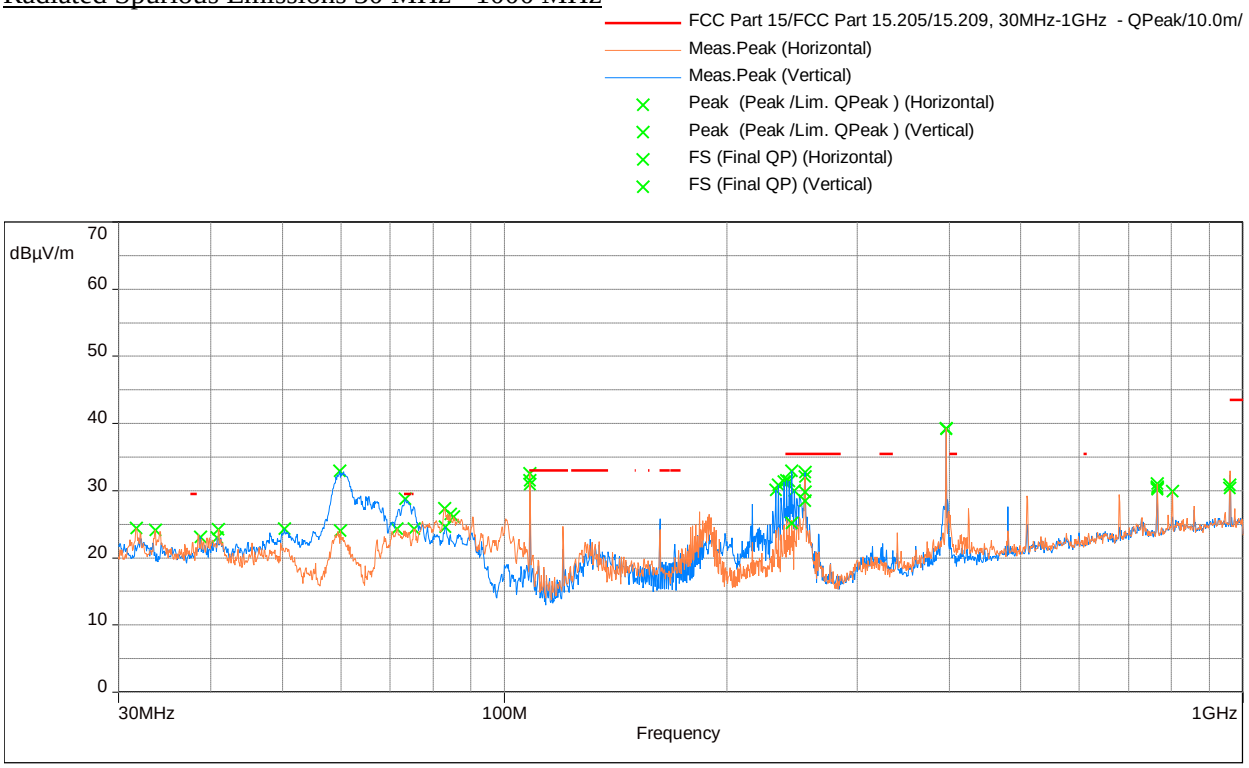
*Note: The following frequencies do not fall into the restricted band of FCC PT 15. 205, the limits for these frequencies are subject to FCC PT 15.247(d).

Note: Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz.

Note: FS@3m = RA + Correction
Correction = AF + CF – Preamp

| Results | Complies |
|---|---|

Radiated Spurious Emissions 30 MHz - 1000 MHz

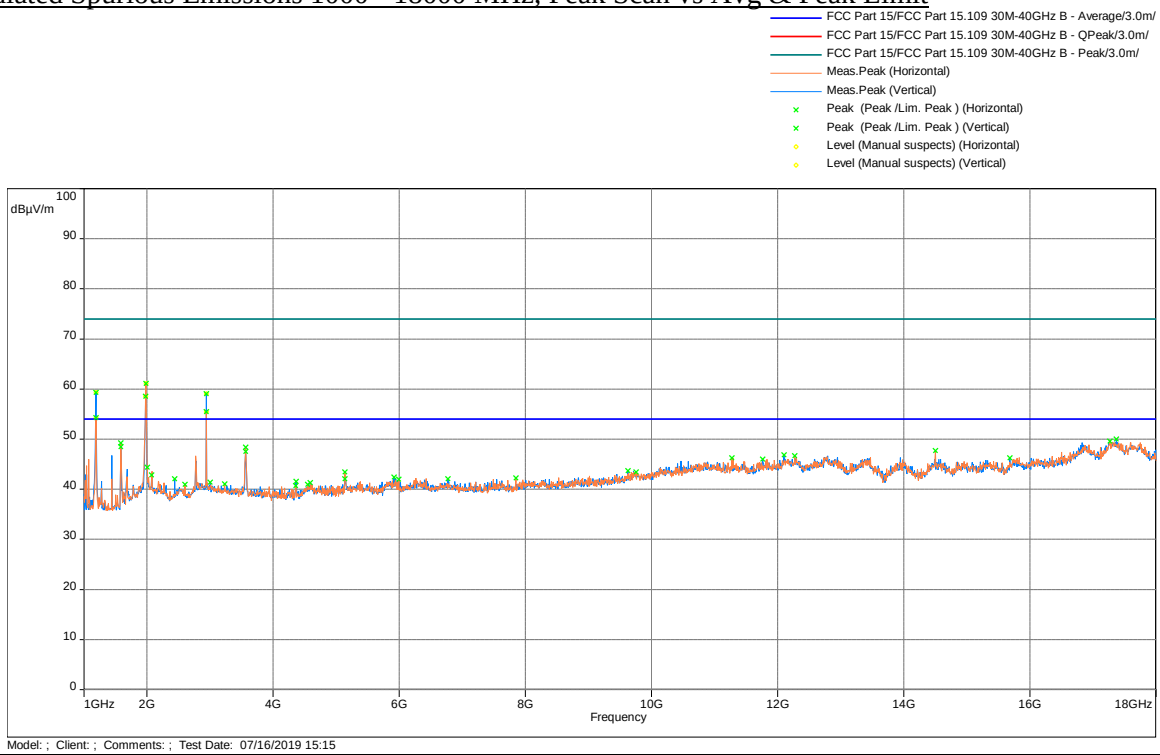



Model: ; Client: ; Comments: ; Test Date: 07/17/2019 12:11

| Frequency | QP@10m | Limit@10m | Margin | Height | Angle | Polarization | Correction |
|---|---|---|---|---|---|---|---|
| MHz | dB(µV/m) | dB(µV/m) | (dB) | (m) | (°) | | (dB) |
| 59.811 | 32.9 | 68.4* | -35.5 | 289.75 | 2 | Vertical | -15.2 |
| 108.217 | 31.5 | 33.0 | -1.5 | 297.25 | 3.96 | Horizontal | -14.3 |
| 244.937 | 25.2 | 35.5 | -10.3 | 332.25 | 1 | Vertical | -11.6 |
| 255.022 | 29.8 | 35.5 | -5.7 | 359 | 3.31 | Horizontal | -11.6 |
| 255.083 | 28.5 | 35.5 | -7.1 | 127.75 | 1.04 | Vertical | -11.6 |
| 396.110 | 39.2 | 68.4* | -29.2 | 85.25 | 1 | Vertical | -7.6 |
| 396.110 | 39.3 | 68.4* | -29.2 | 107 | 1.98 | Horizontal | -7.6 |
| 960.183 | 30.8 | 43.5 | -12.7 | 299.5 | 1.93 | Vertical | -0.1 |
| 960.274 | 30.4 | 43.5 | -13.1 | 298.25 | 1 | Horizontal | -0.1 |

*Note: The following frequencies do not fall into the restricted band of FCC PT 15. 205, the limits for these frequencies are subject to FCC PT 15.247(d).

Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Avg & Peak Limit




| Freq. MHz | Ave@3m dB(uV/m) | Ave Limit@3m dB(µV/m) | Margin dB | Azimuth deg | Height m | Polarity | Correction dB |
|---|---|---|---|---|---|---|---|
| 1188.294 | 37.3 | 54 | -16.7 | 21.25 | 3.24 | Vertical | -16.1 |
| 1188.294 | 36.3 | 54 | -17.7 | 37.5 | 1.4 | Horizontal | -16.1 |

Note: Final average measurements were performed using section 11.12.2.5.2 of ANSI 63.10; when utilizing 11.12.2.5.2, the Trace mode was set to Max Hold and the measurement correction factor in 11.12.2.5.2 i) is not added (reference KDB 558074 D01 DTS Meas Guidance v05r02; FAQ #3(b)).

| Freq. MHz | Peak@3m dB(uV/m) | Peak Limit@3m dB(µV/m) | Margin dB | Azimuth deg | Height m | Polarity | Correction dB |
|---|---|---|---|---|---|---|---|
| 1979.767 | 58.6 | 78.9* | -20.3 | 342.5 | 3.3 | Vertical | -13.5 |
| 1980.900 | 61.1 | 78.9* | -17.8 | 26 | 1.3 | Horizontal | -13.5 |
| 2938.000 | 55.5 | 78.9* | -23.4 | 359.5 | 3.3 | Horizontal | -12.4 |
| 2938.567 | 59.0 | 78.9* | -19.9 | 231.75 | 1.26 | Vertical | -12.4 |

*Note: The following frequencies do not fall into the restricted band of FCC PT 15. 205, the limits for these frequencies are subject to FCC PT 15.247(d).

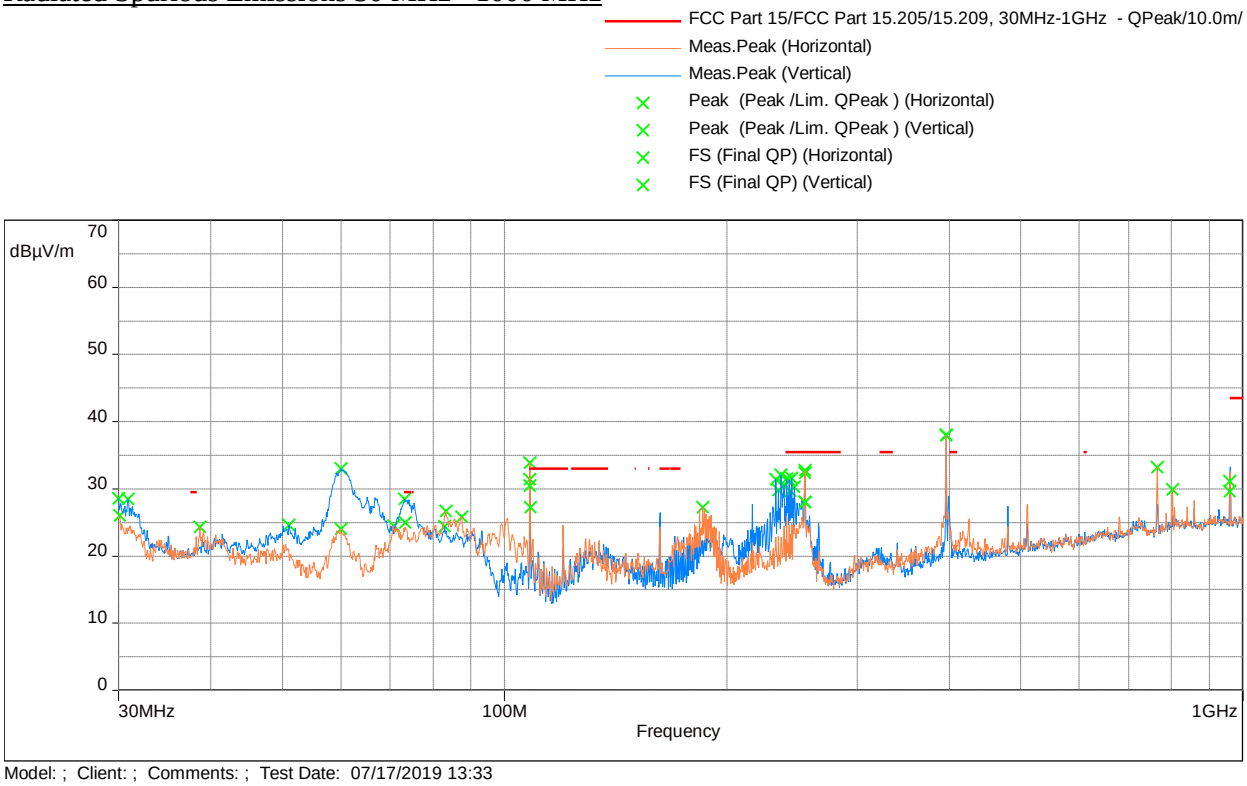
Note: Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz

Note: FS@3m = RA + Correction
Correction = AF + CF – Preamp

| Results | Complies |
|---|---|

Test Results: 15.209 Radiated Spurious Emissions High Channel, Tx at 2480MHz

Radiated Spurious Emissions 30 MHz - 1000 MHz

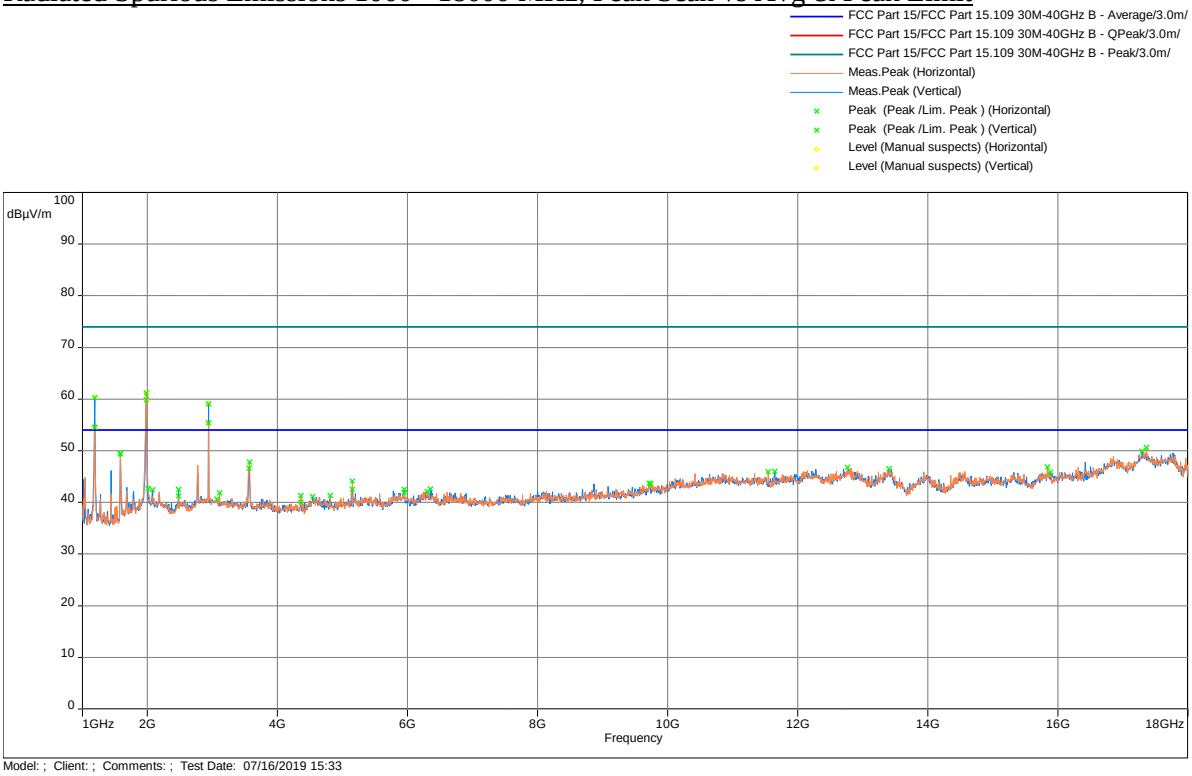



Model: ; Client: ; Comments: ; Test Date: 07/17/2019 13:33

| Frequency | QP@10m | Limit@10m | Margin | Height | Angle | Polarization | Correction |
|---|---|---|---|---|---|---|---|
| MHz | dB(µV/m) | dB(µV/m) | (dB) | (m) | (°) | | (dB) |
| 60.005 | 33.1 | 67.3* | -34.2 | 288.5 | 2.98 | Vertical | -15.3 |
| 73.339 | 25.0 | 29.5 | -4.5 | 91 | 2.69 | Vertical | -18.2 |
| 108.173 | 30.5 | 33.0 | -2.5 | 137.75 | 4 | Horizontal | -14.3 |
| 108.305 | 27.3 | 33.0 | -5.7 | 228.5 | 1.61 | Vertical | -14.3 |
| 255.011 | 28.0 | 35.5 | -7.5 | 16.25 | 3.91 | Horizontal | -11.6 |
| 255.021 | 28.0 | 35.5 | -7.5 | 138.25 | 1 | Vertical | -11.6 |
| 396.110 | 38.1 | 67.3* | -29.2 | 318.5 | 1.02 | Horizontal | -7.6 |
| 396.110 | 37.9 | 67.3* | -29.3 | 86.5 | 1 | Vertical | -7.6 |
| 960.062 | 29.6 | 43.5 | -13.9 | 44 | 1 | Horizontal | -0.1 |
| 960.209 | 31.1 | 43.5 | -12.4 | 299 | 1.97 | Vertical | -0.1 |

*Note: The following frequencies do not fall into the restricted band of FCC PT 15. 205, the limits for these frequencies are subject to FCC PT 15.247(d).

Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Avg & Peak Limit




| Freq. MHz | Ave@3m dB(uV/m) | Ave Limit@3m dB(µV/m) | Margin dB | Azimuth deg | Height m | Polarity | Correction dB |
|---|---|---|---|---|---|---|---|
| 1188.352 | 35.7 | 54 | -18.3 | 34.75 | 3.24 | Horizontal | -16.1 |
| 1188.476 | 40.3 | 54 | -13.7 | 170.75 | 1.66 | Vertical | -16.1 |

Note: Final average measurements were performed using section 11.12.2.5.2 of ANSI 63.10; when utilizing 11.12.2.5.2, the Trace mode was set to Max Hold and the measurement correction factor in 11.12.2.5.2 i) is not added (reference KDB 558074 D01 DTS Meas Guidance v05r02; FAQ #3(b)).

| Freq. MHz | Peak@3m dB(uV/m) | Peak Limit@3m dB(µV/m) | Margin dB | Azimuth deg | Height m | Polarity | Correction dB |
|---|---|---|---|---|---|---|---|
| 1980.333 | 59.9 | 77.7* | -17.9 | 343.3 | 3.24 | Vertical | -13.5 |
| 1980.900 | 61.2 | 77.7* | -16.5 | 26.5 | 1.25 | Horizontal | -13.5 |
| 2938.567 | 59.1 | 77.7* | -18.6 | 239.25 | 1.25 | Vertical | -12.4 |
| 2938.567 | 55.4 | 77.7* | -22.3 | 359.5 | 3.23 | Horizontal | -12.4 |

*Note: The following frequencies do not fall into the restricted band of FCC PT 15. 205, the limits for these frequencies are subject to FCC PT 15.247(d).

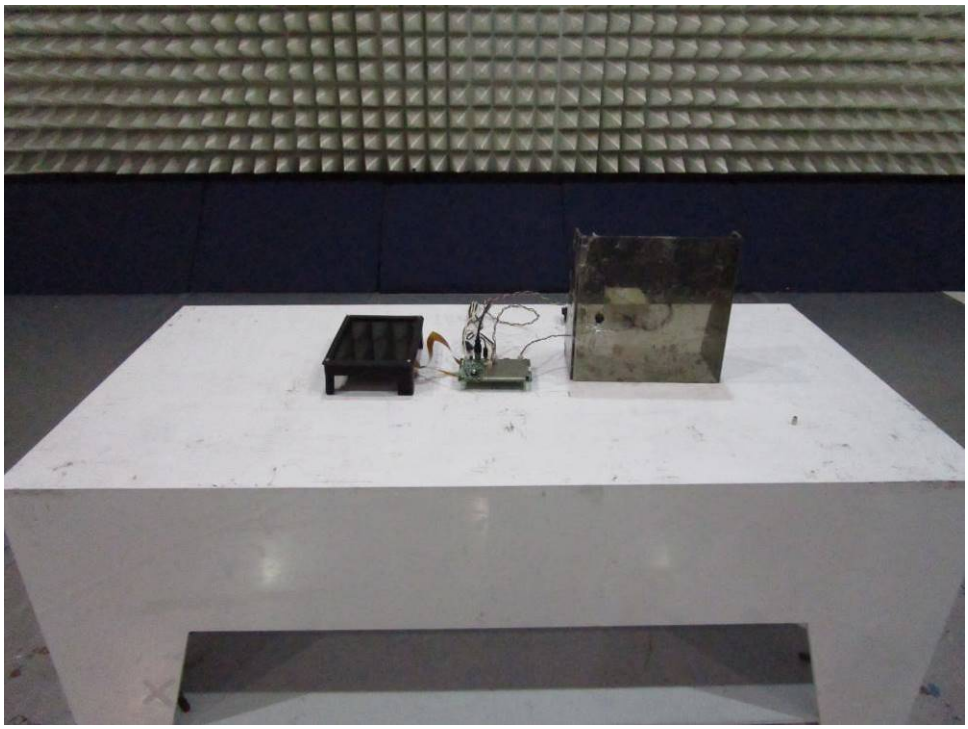
Note: Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz

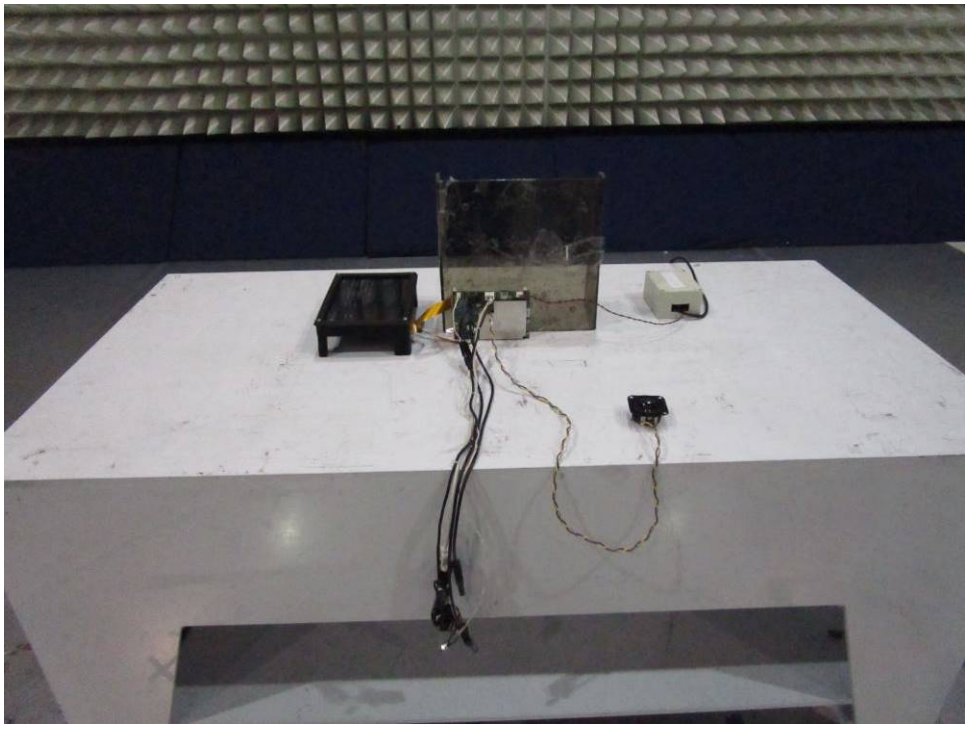
Note: FS@3m = RA + Correction
Correction = AF + CF – Preamp

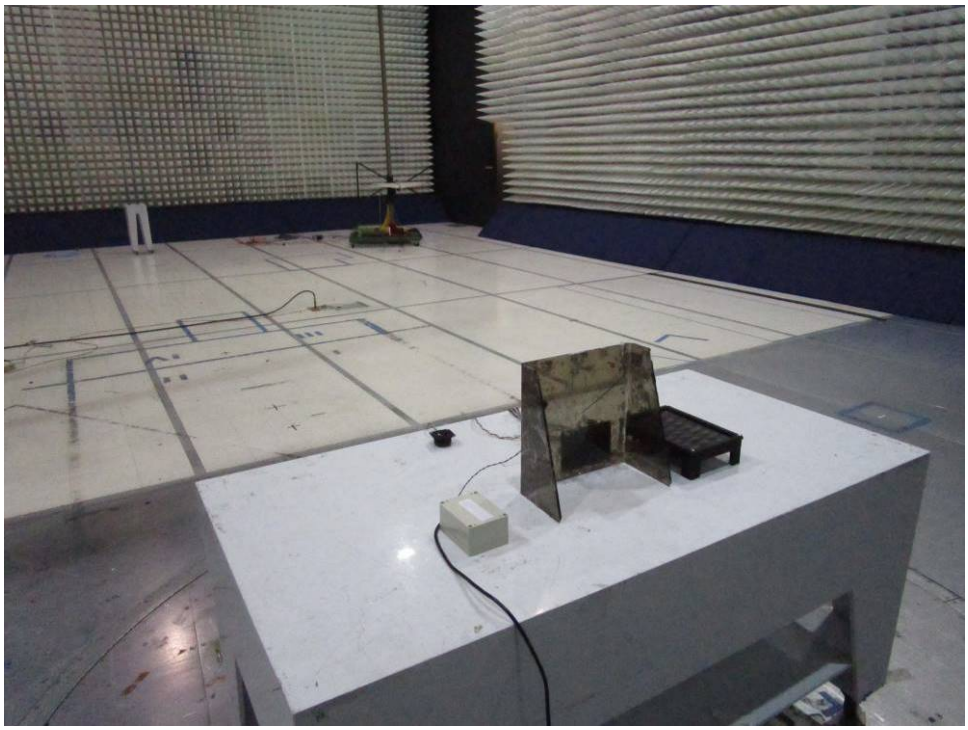
| Results | Complies |
|---|---|

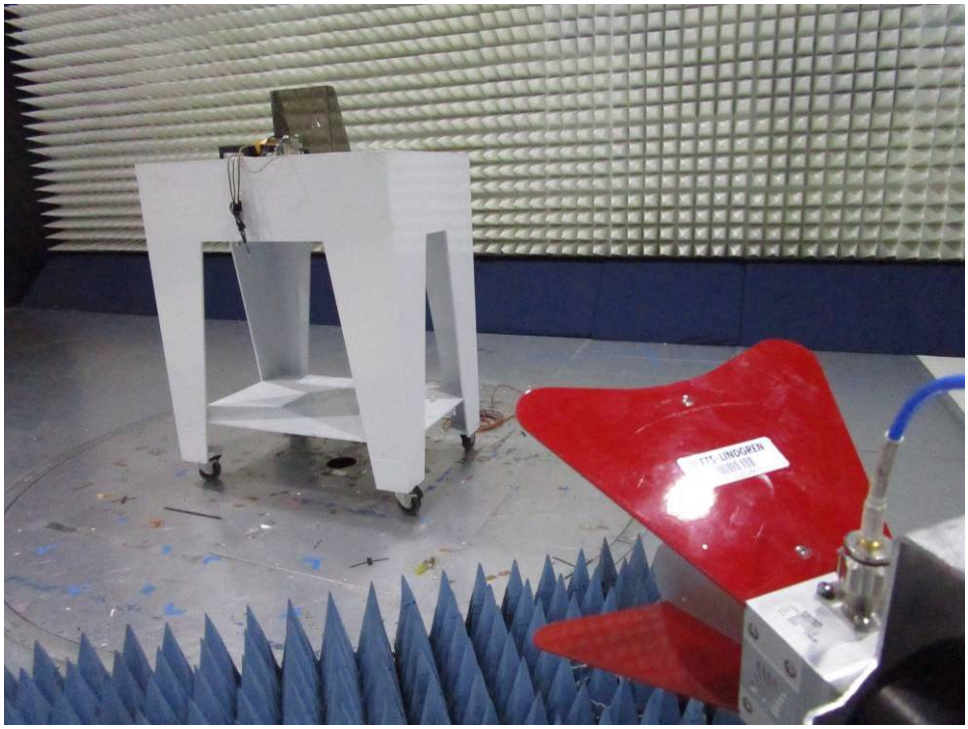
4.3.7 Test setup

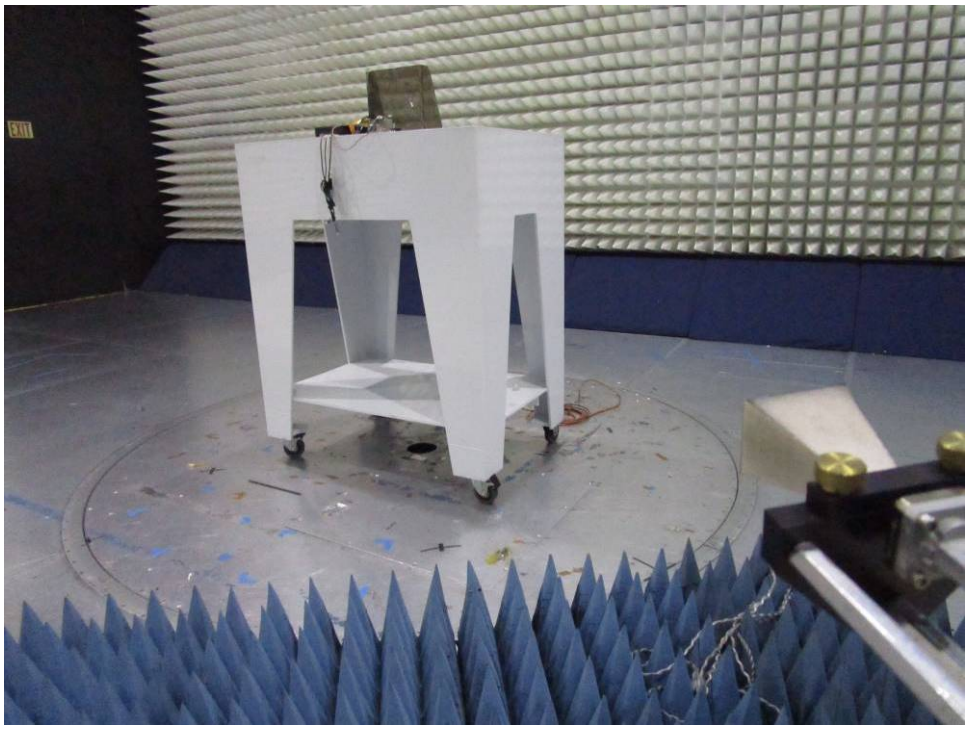
**The following photographs show the testing configurations used.**











## 4.4 AC Line Conducted Emission
FCC: 15.207; RSS-GEN

### 4.4.1 Requirement

| Frequency Band MHz | FCC Part 15.207 Limits | |
|---|---|---|
| | Quasi-Peak | Average |
| 0.15-0.50 | 66 to 56 * | 56 to 46 * |
| 0.50-5.00 | 56 | 46 |
| 5.00-30.00 | 60 | 50 |

*Note: *Decreases linearly with the logarithm of the frequency*
*At the transition frequency the lower limit applies.*

### 4.4.2 Procedure

Measurements are carried out using quasi-peak and average detector receivers in accordance with CISPR 16. An AMN is required to provide a defined impedance at high frequencies across the power feed at the point of measurement of terminal voltage and also to provide isolation of the circuit under test from the ambient noise on the power lines. An AMN as defined in CISPR 16 shall be used.

The EUT is located so that the distance between the boundary of the EUT and the closest surface of the AMN is 0.8m.

Where a flexible mains cord is provided by the manufacturer, this shall be 1m long or if in excess of 1m, the excess cable is folded back and forth as far as possible so as to form a bundle not exceeding 0.4m in length.

The EUT is arranged and connected with cables terminated in accordance with the product specification.

Conducted disturbance is measured between the phase lead and the reference ground, and between the neutral lead and the reference ground. Both measured values are reported.

The EUT, where intended for tabletop use, is placed on a table whose top is 0.8m above the ground plane. A vertical, metal reference plane is placed 0.4m from the EUT. The vertical metal reference-plane is at least 2m by 2m. The EUT shall be kept at least 0.8m from any other metal surface or other ground plane not being part of the EUT. The table is constructed of non-conductive materials. Its dimensions are 1m by 1.5m, but may be extended for larger EUT.

Floor standing EUT are placed on a horizontal metal ground plane and isolated from the ground plane by resting on an insulating material. The metal ground plane extends at least 0.5m beyond the boundaries of the EUT and has minimum dimensions of 2m by 2m.

Equipment setup for conducted disturbance tests followed the guidelines of ANSI C63.4:2014.

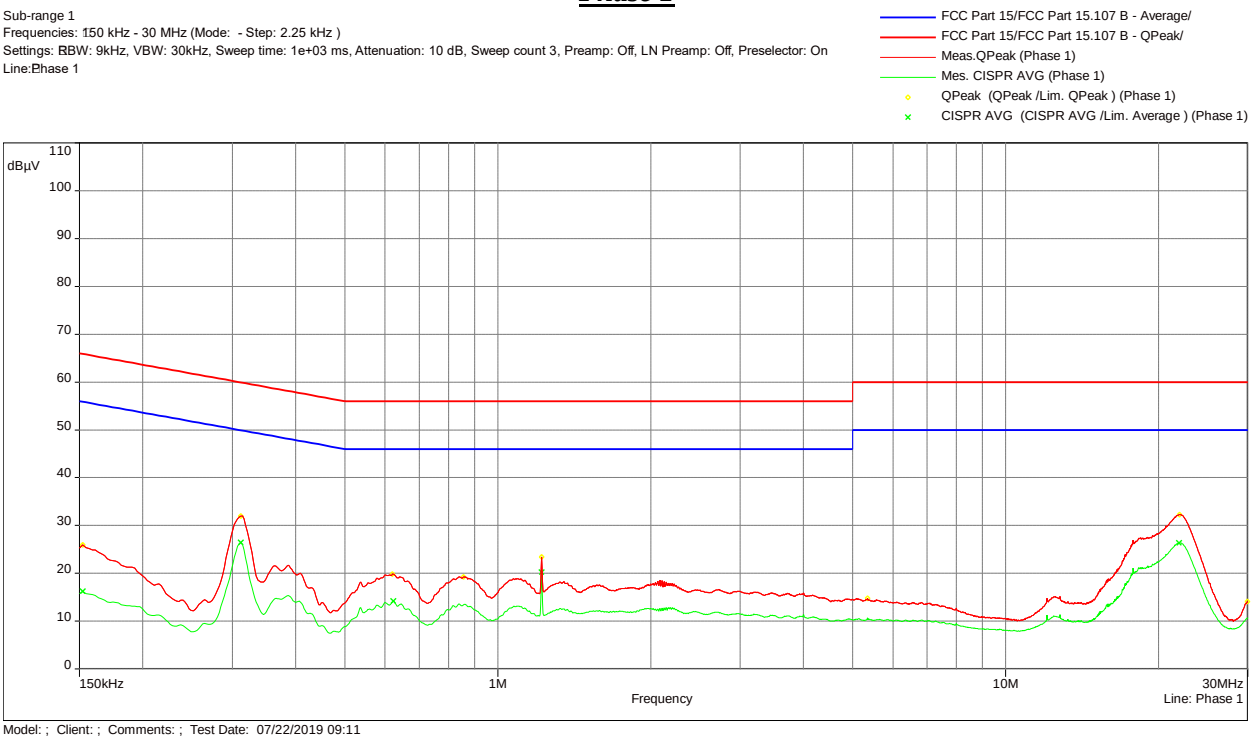
| Tested By | Test Date |
|---|---|
| Todd Moy | July 22, 2019 |

### 4.4.3 Test Results

## 15.207: Conducted Emissions 120VAC 60Hz

***Phase 1***

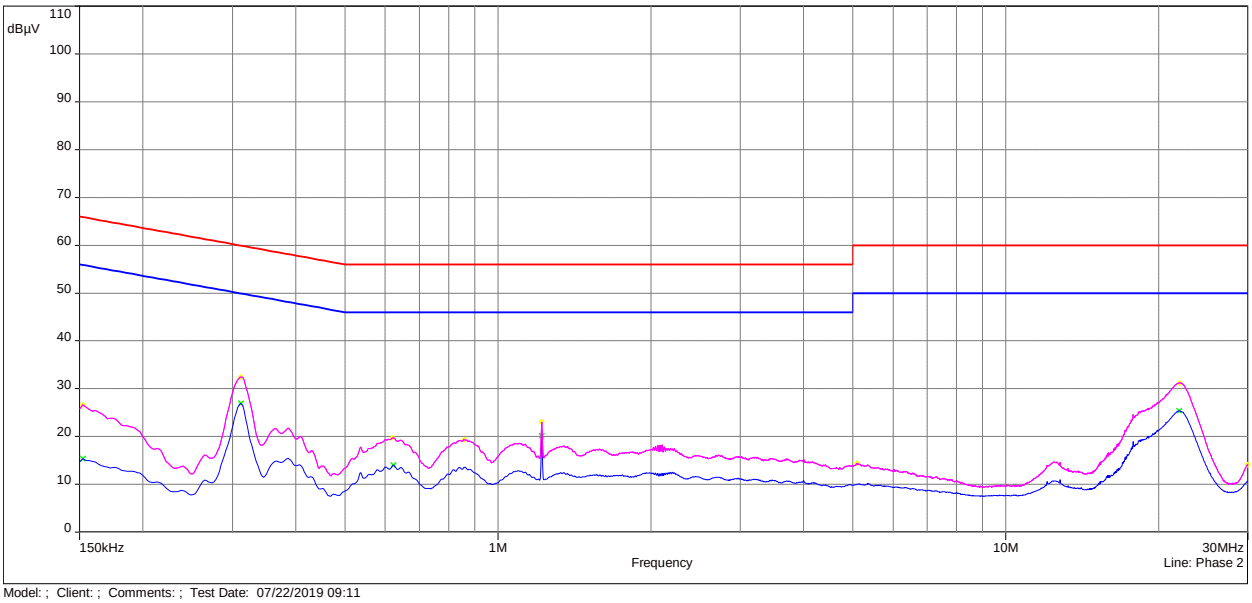
Sub-range 1
Frequencies: 150 kHz - 30 MHz (Mode: - Step: 2.25 kHz )
Settings: RBW: 9kHz, VBW: 30kHz, Sweep time: 1e+03 ms, Attenuation: 10 dB, Sweep count 3, Preamp: Off, LN Preamp: Off, Preselector: On
Line:Phase 1




Model: ; Client: ; Comments: ; Test Date: 07/22/2019 09:11

***Phase 2***

Sub-range 2
Frequencies: 150 kHz - 30 MHz (Mode: - Step: 2.25 kHz )
Settings: RBW: 9kHz, VBW: 30kHz, Sweep time: 1e+03 ms, Attenuation: 10 dB, Sweep count 1, Preamp: Off, LN Preamp: Off, Preselector: On
Line:Phase 2




Model: ; Client: ; Comments: ; Test Date: 07/22/2019 09:11

4.4.3 Test Results (Continued)

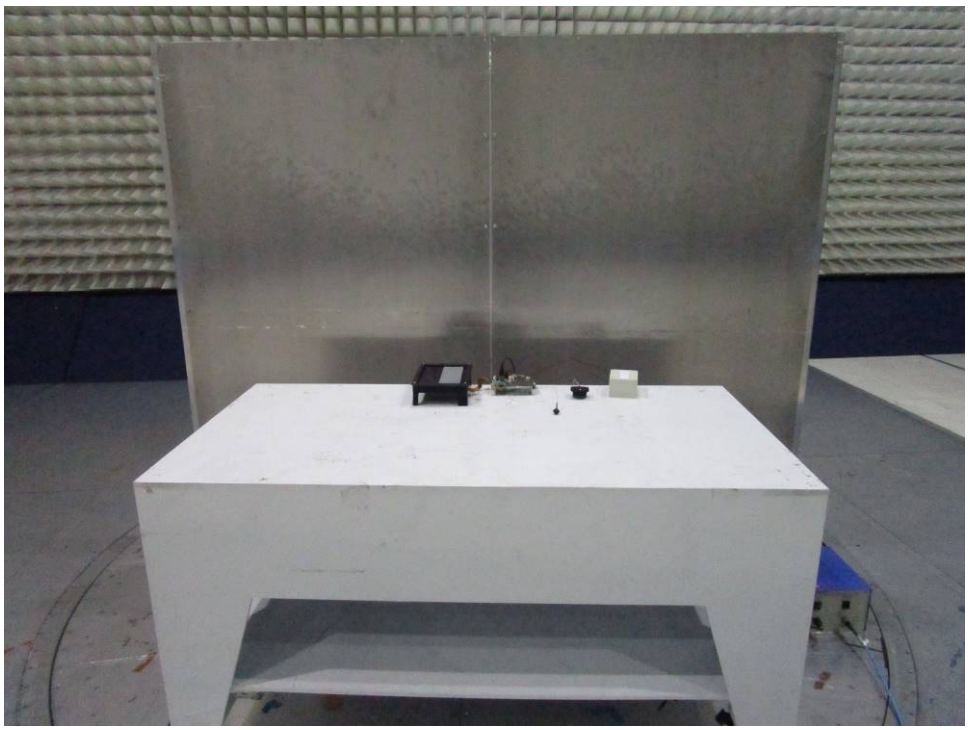
| Quasi Peak Table | | | | | |
|---|---|---|---|---|---|
| Frequency (MHz) | QPeak (dBµV) | Lim. QPeak (dBµV) | QPeak-Lim (dB) | Phase | Correction (dB) |
| 0.152 | 26.0 | 65.9 | -39.9 | Phase 1 | 11.3 |
| 0.152 | 26.7 | 65.9 | -39.2 | Phase 2 | 11.3 |
| 0.312 | 32.0 | 59.9 | -27.9 | Phase 1 | 11.0 |
| 0.312 | 32.4 | 59.9 | -27.5 | Phase 2 | 11.0 |
| 0.620 | 19.9 | 56 | -36.1 | Phase 1 | 10.9 |
| 0.620 | 19.8 | 56 | -36.3 | Phase 2 | 10.9 |
| 0.857 | 19.3 | 56 | -36.7 | Phase 1 | 10.9 |
| 0.859 | 19.3 | 56 | -36.7 | Phase 2 | 10.9 |
| 1.221 | 23.4 | 56 | -32.6 | Phase 1 | 10.9 |
| 1.221 | 23.0 | 56 | -33.0 | Phase 2 | 10.9 |
| 5.091 | 14.4 | 60 | -45.6 | Phase 2 | 11.1 |
| 5.348 | 14.8 | 60 | -45.2 | Phase 1 | 11.1 |
| 21.995 | 31.2 | 60 | -28.8 | Phase 2 | 11.3 |
| 22.000 | 32.2 | 60 | -27.8 | Phase 1 | 11.3 |
| 29.956 | 14.1 | 60 | -45.9 | Phase 2 | 11.2 |
| 29.960 | 14.1 | 60 | -45.9 | Phase 1 | 11.2 |

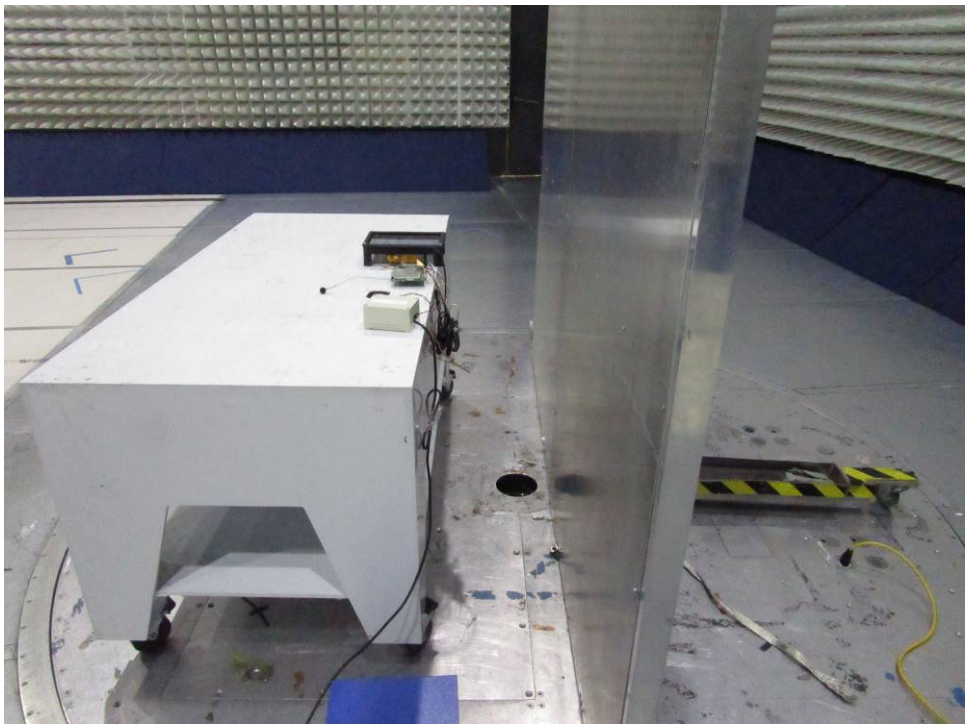
4.4.3 Test Results (Continued)

| Average Table | | | | | |
|---|---|---|---|---|---|
| Frequency (MHz) | AVG (dBµV) | Lim. Average (dBµV) | AVG-Lim (dB) | Phase | Correction (dB) |
| 0.152 | 16.2 | 55.9 | -39.6 | Phase 1 | 11.3 |
| 0.152 | 15.3 | 55.9 | -40.6 | Phase 2 | 11.3 |
| 0.312 | 26.9 | 49.9 | -23.0 | Phase 2 | 11.0 |
| 0.312 | 26.4 | 49.9 | -23.5 | Phase 1 | 11.0 |
| 0.623 | 14.0 | 46 | -32.0 | Phase 2 | 10.9 |
| 0.623 | 14.2 | 46 | -31.8 | Phase 1 | 10.9 |
| 1.221 | 20.1 | 46 | -25.9 | Phase 2 | 10.9 |
| 1.221 | 20.2 | 46 | -25.8 | Phase 1 | 10.9 |
| 21.955 | 26.4 | 50 | -23.6 | Phase 1 | 11.3 |
| 21.968 | 25.4 | 50 | -24.6 | Phase 2 | 11.3 |
| 0.152 | 16.2 | 55.9 | -39.6 | Phase 1 | 11.3 |
| 0.152 | 15.3 | 55.9 | -40.6 | Phase 2 | 11.3 |
| 0.312 | 26.9 | 49.9 | -23.0 | Phase 2 | 11.0 |
| 0.312 | 26.4 | 49.9 | -23.5 | Phase 1 | 11.0 |
| 0.623 | 14.0 | 46 | -32.0 | Phase 2 | 10.9 |
| 0.623 | 14.2 | 46 | -31.8 | Phase 1 | 10.9 |
| 1.221 | 20.1 | 46 | -25.9 | Phase 2 | 10.9 |
| 1.221 | 20.2 | 46 | -25.8 | Phase 1 | 10.9 |
| 21.955 | 26.4 | 50 | -23.6 | Phase 1 | 11.3 |
| 21.968 | 25.4 | 50 | -24.6 | Phase 2 | 11.3 |

**Results:** **Complies** by 23.0 dB

4.4.4 Test setup





## 5.0 List of Test Equipment

Measurement equipment used for emission compliance testing utilized the equipment on the following list:

| Equipment | Manufacturer | Model/Type | Asset # | Cal Int | Cal Due |
|---|---|---|---|---|---|
| Spectrum Analyzer | Rohde and Schwarz | FSU | ITS 00913 | 12 | 03/26/20 |
| EMI Receiver | Rohde and Schwarz | ESR7 | ITS 01607 | 12 | 10/23/19 |
| Pre-Amplifier (18-40GHz) | Miteq | TTA1840-35-S-M | ITS 01393 | 12 | 02/08/20 |
| Active Horn Antenna | ETS-Lindgren | 3117-PA | ITS 01636 | 12 | 01/17/20 |
| Horn Antenna (10-40 GHz) | ETS-Lindgren1376 | 3116C | ITS 01376 | 12 | 04/15/20 |
| Bi-Log Antenna | Antenna Research | LPB-2513 | ITS 00355 | 12 | 04/24/20 |
| Pre-Amplifier | Sonoma Instrument | 310N | ITS 00415 | 12 | 04/17/20 |
| RE Cable | TRU Corporation | TRU CORE 300 | ITS 01462 | 12 | 09/17/19 |
| RE Cable | TRU Corporation | TRU CORE 300 | ITS 01465 | 12 | 09/17/19 |
| RE Cable | TRU Corporation | TRU CORE 300 | ITS 01470 | 12 | 09/17/19 |
| RF Cable | TRU Corporation | TRU CORE 300 | ITS 01342 | 12 | 12/05/19 |
| LISN | Com-Power | LIN-115A | ITS 01283 | 12 | 10/03/19 |
| Transient Limiter | Com-Power | LIT-153A | ITS 01457 | 12 | 09/20/19 |
| Notch Filter | MICRO-TRONICS | BRM50702 | ITS 01166 | 12 | 05/14/20 |
| RF Cable | Mega Phase | EMC1-K1K1-236 | ITS 01537 | 12 | 02/20/20 |
| 10 dB Attenuator | Mini Circuits | BW-S10W5+ | ITS 01582 | 12 | 10/07/19 |
| RF Cable | Mega Phase | TM40-K1K1-59 | ITS 01156 | 12 | 02/20/20 |

# No Calibration required

Software used for emission compliance testing utilized the following:

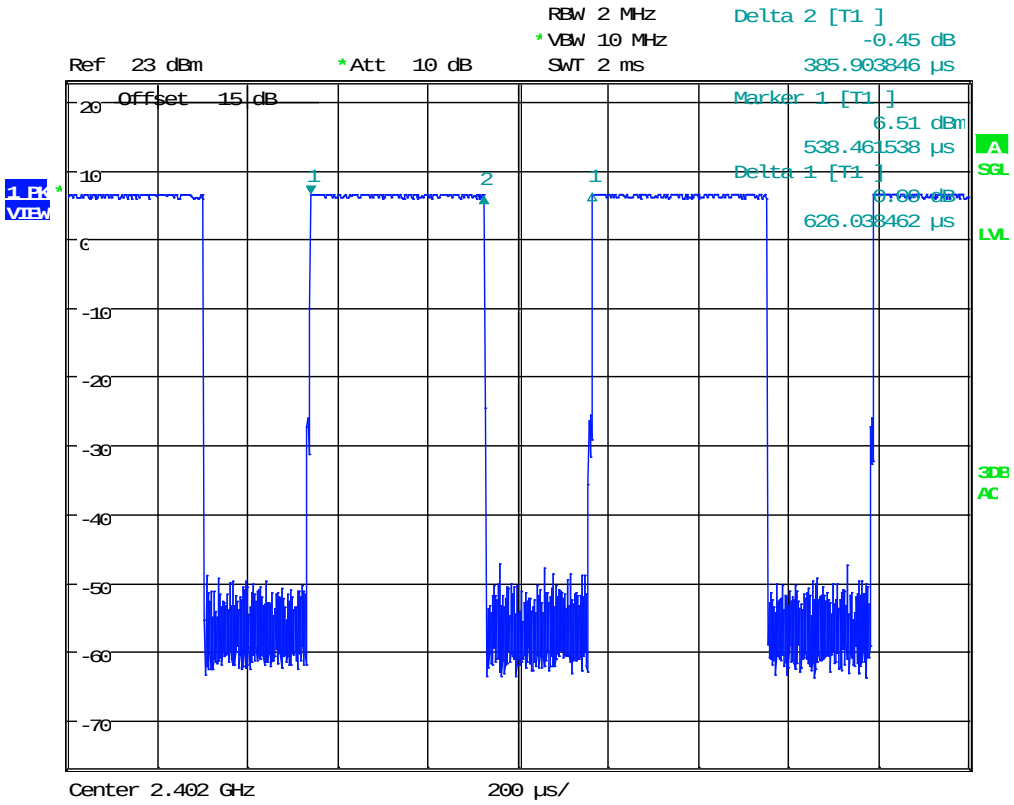
| Name | Manufacturer | Version | Template/Profile |
|---|---|---|---|
| Tile | Quantum Change | 3.4.K.22 | Conducted Spurious_30M-26GHz |
| BAT-EMC | Nexio | 3.17.0.10 | Bosch July 15, 2019 |
| BAT-EMC | Nexio | 3.17.0.10 | Bosch July 17, 2019 |
| RS Commander | Rohde Schwarz | 1.6.4 | Not Applicable (Screen grabber) |

## 6.0 Document History

| Revision/ Job Number | Writer Initials | Reviewers Initials | Date | Change |
|---|---|---|---|---|
| 1.0 / G103930307 | TM | KV | August 20, 2019 | Original document |

## Annex A – Duty Cycle Measurement

Plot A.1 – BLE duty cycle




Duty Cycle = DC= On Time / Period = 385 ms/ 626 ms = 0.6150

Duty Cycle Correction Factor (DCF) δ (dB):
DCF Power Averaging = 10 log (1/DC) = 2.11 dB
DCF Linear Voltage Averaging = 20 log (1/DC) = 4.22 dB