



CERTIFICATION TEST REPORT

Report Number. : 12742033-E1V3

Applicant : APPLE, INC.
1 APPLE PARK WAY
CUPERTINO, CA 95014, U.S.A.

Model : A2047

FCC ID : BCGA2047

IC : 579C-A2047

EUT Description : LEFT EARBUD

Test Standard(s) : FCC 47 CFR PART 15 SUBPART C
ISED RSS-247 ISSUE 2
ISED RSS-GEN ISSUE 5

Date Of Issue:

April 16, 2019

Prepared by:

UL Verification Services Inc.
47173 Benicia Street
Fremont, CA 94538 U.S.A.
TEL: (510) 319-4000
FAX: (510) 661-0888

REPORT REVISION HISTORY

| Rev. | Issue Date | Revisions | Revised By |
|------|------------|-------------------------|------------|
| V1 | 4/10/2019 | Initial Issue | Tony Li |
| V2 | 4/11/2019 | Fixed FCC ID | Chin Pang |
| V3 | 4/16/19 | Addressed TCB Questions | Tony Li |

TABLE OF CONTENTS

| | |
|--|-----------|
| REPORT REVISION HISTORY | 2 |
| TABLE OF CONTENTS | 3 |
| 1. ATTESTATION OF TEST RESULTS | 5 |
| 2. TEST METHODOLOGY | 6 |
| 3. FACILITIES AND ACCREDITATION | 6 |
| 4. CALIBRATION AND UNCERTAINTY | 7 |
| 4.1. <i>MEASURING INSTRUMENT CALIBRATION</i> | <i>7</i> |
| 4.2. <i>SAMPLE CALCULATION</i> | <i>7</i> |
| 4.3. <i>MEASUREMENT UNCERTAINTY</i> | <i>7</i> |
| 5. EQUIPMENT UNDER TEST | 8 |
| 5.1. <i>EUT DESCRIPTION</i> | <i>8</i> |
| 5.2. <i>MAXIMUM OUTPUT POWER</i> | <i>8</i> |
| 5.3. <i>DESCRIPTION OF AVAILABLE ANTENNAS</i> | <i>8</i> |
| 5.4. <i>SOFTWARE AND FIRMWARE</i> | <i>8</i> |
| 5.5. <i>WORST-CASE CONFIGURATIONS</i> | <i>8</i> |
| 5.6. <i>DESCRIPTION OF TEST SETUP</i> | <i>9</i> |
| 6. TEST AND MEASUREMENT EQUIPMENT | 16 |
| 7. MEASUREMENT METHODS | 17 |
| 8. ANTENNA PORT TEST RESULTS | 18 |
| 8.1. <i>DUTY CYCLE</i> | <i>18</i> |
| 8.2. <i>20 dB AND 99% BANDWIDTH</i> | <i>19</i> |
| 8.2.1. <i>BLUETOOTH BASIC DATA RATE GFSK MODULATION</i> | <i>20</i> |
| 8.2.2. <i>BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION</i> | <i>21</i> |
| 8.3. <i>HOPPING FREQUENCY SEPARATION</i> | <i>22</i> |
| 8.3.1. <i>BLUETOOTH BASIC DATA RATE GFSK MODULATION</i> | <i>23</i> |
| 8.3.2. <i>BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION</i> | <i>23</i> |
| 8.4. <i>NUMBER OF HOPPING CHANNELS</i> | <i>24</i> |
| 8.4.1. <i>BLUETOOTH BASIC DATA RATE GFSK MODULATION</i> | <i>25</i> |
| 8.4.2. <i>BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION</i> | <i>27</i> |
| 8.5. <i>AVERAGE TIME OF OCCUPANCY</i> | <i>29</i> |
| 8.5.1. <i>BLUETOOTH BASIC DATA RATE GFSK MODULATION</i> | <i>29</i> |
| 8.5.2. <i>BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION</i> | <i>31</i> |
| 8.6. <i>OUTPUT POWER</i> | <i>33</i> |
| 8.6.1. <i>BLUETOOTH BASIC DATA RATE GFSK MODULATION</i> | <i>34</i> |
| 8.6.2. <i>BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION</i> | <i>34</i> |

| | |
|--|-----------|
| 8.6.3. BLUETOOTH ENHANCED DATA RATE DQPSK MODULATION | 34 |
| 8.7. AVERAGE POWER..... | 35 |
| 8.7.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION | 36 |
| 8.7.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION..... | 36 |
| 8.7.3. BLUETOOTH ENHANCED DATA RATE DQPSK MODULATION | 36 |
| 8.8. CONDUCTED SPURIOUS EMISSIONS..... | 37 |
| 8.8.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION | 38 |
| 8.8.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION..... | 40 |
| 9. RADIATED TEST RESULTS..... | 42 |
| 9.1. TRANSMITTER ABOVE 1 GHz | 44 |
| 9.1.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION | 44 |
| 9.1.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION..... | 54 |
| 9.2. WORST CASE BELOW 1 GHZ..... | 64 |
| 9.3. WORST CASE 18-26 GHz..... | 66 |
| 10. AC POWER LINE CONDUCTED EMISSIONS | 68 |
| 10.1.1. AC Power Line Host..... | 69 |
| 10.1.2. AC Power Line Norm..... | 71 |
| 11. SETUP PHOTOS | 73 |

1. ATTESTATION OF TEST RESULTS

COMPANY NAME: APPLE INC.
1 APPLE PARK WAY
CUPERTINO, CA 95014, U.S.A.

EUT DESCRIPTION: Left Earbud

MODEL: A2047

SERIAL NUMBER: CC2YC06CLYY4 (Conducted), CC2YC0B7LYY4 (Radiated)

DATE TESTED: MARCH 22 – APRIL 4, 2019

| APPLICABLE STANDARDS | |
|--------------------------|--------------|
| STANDARD | TEST RESULTS |
| CFR 47 Part 15 Subpart C | Complies |
| ISED RSS-247 Issue 2 | Complies |
| ISED RSS-GEN Issue 5 | Complies |

UL Verification Services Inc. tested the above equipment in accordance with the requirements set forth in the above standards. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. All samples tested were in good operating condition throughout the entire test program. Measurement Uncertainties are published for informational purposes only and were not taken into account unless noted otherwise.

This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of the U.S. government.

Approved & Released For
UL Verification Services Inc. By:



Chin Pang
Senior Engineer
Consumer Technology Division
UL Verification Services Inc.

Prepared By:



Tony Li
Test Engineer
Consumer Technology Division
UL Verification Services Inc.

2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC CFR 47 Part 2, FCC CFR 47 Part 15, ANSI C63.10-2013, RSS-GEN Issue 5, KDB558074 D01v05r02 and RSS-247 Issue 2.

3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 47173 and 47266 Benicia Street, and 47658 Kato Road, Fremont, California, USA. Line conducted emissions are measured only at the 47173 address. The following table identifies which facilities were utilized for radiated emission measurements documented in this report. Specific facilities are also identified in the test results sections.

| 47173 Benicia Street | 47266 Benicia Street | 47658 Kato Rd |
|---|--|---|
| <input type="checkbox"/> Chamber A (ISED:2324B-1) | <input type="checkbox"/> Chamber D (ISED:22541-1) | <input type="checkbox"/> Chamber I (ISED:2324A-5) |
| <input type="checkbox"/> Chamber B (ISED:2324B-2) | <input type="checkbox"/> Chamber E (ISED:22541-2) | <input type="checkbox"/> Chamber J (ISED:2324A-6) |
| <input type="checkbox"/> Chamber C (ISED:2324B-3) | <input type="checkbox"/> Chamber F (ISED:22541-3) | <input type="checkbox"/> Chamber K (ISED:2324A-1) |
| | <input checked="" type="checkbox"/> Chamber G (ISED:22541-4) | <input type="checkbox"/> Chamber L (ISED:2324A-3) |
| | <input checked="" type="checkbox"/> Chamber H (ISED:22541-5) | |

The above test sites and facilities are covered under FCC Test Firm Registration # 208313. Chambers above are covered under Industry Canada company address and respective code

UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0

4. CALIBRATION AND UNCERTAINTY

4.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

4.2. SAMPLE CALCULATION

RADIATED EMISSIONS

Where relevant, the following sample calculation is provided:

Field Strength (dBuV/m) = Measured Voltage (dBuV) + Antenna Factor (dB/m) + Cable Loss (dB) – Preamp Gain (dB)

$$36.5 \text{ dBuV} + 18.7 \text{ dB/m} + 0.6 \text{ dB} - 26.9 \text{ dB} = 28.9 \text{ dBuV/m}$$

MAINS CONDUCTED EMISSIONS

Where relevant, the following sample calculation is provided:

Final Voltage (dBuV) = Measured Voltage (dBuV) + Cable Loss (dB) + Limiter Factor (dB) + LISN Insertion Loss.

$$36.5 \text{ dBuV} + 0 \text{ dB} + 10.1 \text{ dB} + 0 \text{ dB} = 46.6 \text{ dBuV}$$

4.3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

| PARAMETER | UNCERTAINTY |
|---|-------------|
| Worst Case Conducted Disturbance, 9KHz to 0.15 MHz | 3.84 dB |
| Worst Case Conducted Disturbance, 0.15 to 30 MHz | 3.65 dB |
| Worst Case Radiated Disturbance, 9KHz to 30 MHz | 2.52 dB |
| Worst Case Radiated Disturbance, 30 to 1000 MHz | 4.88 dB |
| Worst Case Radiated Disturbance, 1000 to 18000 MHz | 4.24 dB |
| Worst Case Radiated Disturbance, 18000 to 26000 MHz | 4.37 dB |
| Worst Case Radiated Disturbance, 26000 to 40000 MHz | 5.17 dB |

Uncertainty figures are valid to a confidence level of 95%.

5. EQUIPMENT UNDER TEST

5.1. EUT DESCRIPTION

A2047 is a Bluetooth earbud for the left ear. It has an integral battery, microphone and antenna. It can charge via bottom contacts with charging case.

5.2. MAXIMUM OUTPUT POWER

The transmitter has a maximum peak conducted output power as follows:

| Frequency Range (MHz) | Mode | Output Power (dBm) | Output Power (mW) |
|-----------------------|----------------|--------------------|-------------------|
| 2402 - 2480 | Basic GFSK | 12.72 | 18.71 |
| 2402 - 2480 | Enhanced DQPSK | 12.51 | 17.82 |
| 2402 - 2480 | Enhanced 8PSK | 13.26 | 21.18 |

Note: GFSK, DQPSK, 8PSK average Power are all investigated, The GFSK & 8PSK Power are the worst case. Testing is based on these modes to showing compliance. For average power data please refer to section 8.7.

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

| Frequency Band (GHz) | Antenna Gain (dBi) |
|----------------------|--------------------|
| 2.4 | -5.40 |

5.4. SOFTWARE AND FIRMWARE

The EUT firmware installed during testing was 1A610

5.5. WORST-CASE CONFIGURATIONS

Radiated band edge, harmonic, and spurious emissions from 1GHz to 18GHz were performed with the EUT was set to transmit at highest power on Low/Middle/High channels.

Radiated emissions below 30MHz, below 1GHz, 18-26GHz and power line conducted emissions were performed with the EUT transmits at the channel with the highest output power as worst-case scenario

The fundamental of the EUT was investigated in three orthogonal orientations X,Y,Z, it was determined that Z (Portrait) orientation was worst-case orientation; therefore, all final radiated testing was performed with the EUT in Z (Portrait) orientation. There were no emissions found below 30MHz within 20dB of the limit.

Worst-case data rates as provided by the client were:

GFSK mode: DH5

8PSK mode: 3-DH5

5.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

| Support Equipment List | | | | |
|------------------------|-------------------|-------------|-------------------|------------|
| Description | Manufacturer | Model | Serial Number | FCC ID |
| Laptop | Apple | Macbook Pro | C02P41RZG086 | FCC DoC |
| Laptop AC/DC adapter | Liteon Technology | PA-1450-BA1 | B123 | NA |
| Charger Case | Apple | A2078 | CC2909500NDLYY13N | 579C-A2078 |
| 10dB Fixed Attenuator | Pasternack | PE7087-10 | Label ID: 178584 | N/A |

I/O CABLES (CONDUCTED TEST)

| I/O Cable List | | | | | | |
|----------------|---------|----------------------|----------------|-------------|------------------|------------------------------------|
| Cable No | Port | # of identical ports | Connector Type | Cable Type | Cable Length (m) | Remarks |
| 1 | AC | 1 | AC | Un-shielded | 2 | N/A |
| 2 | USB | 1 | Lightning | Shielded | 1 | N/A |
| 3 | Antenna | 1 | SMA | Un-Shielded | 0.3 | To spectrum Analyzer / Power Meter |

I/O CABLES (RADIATED ABOVE 1 GHZ)

| I/O Cable List | | | | | | |
|----------------|------|----------------------|----------------|------------|------------------|---------|
| Cable No | Port | # of identical ports | Connector Type | Cable Type | Cable Length (m) | Remarks |
| NA | | | | | | |

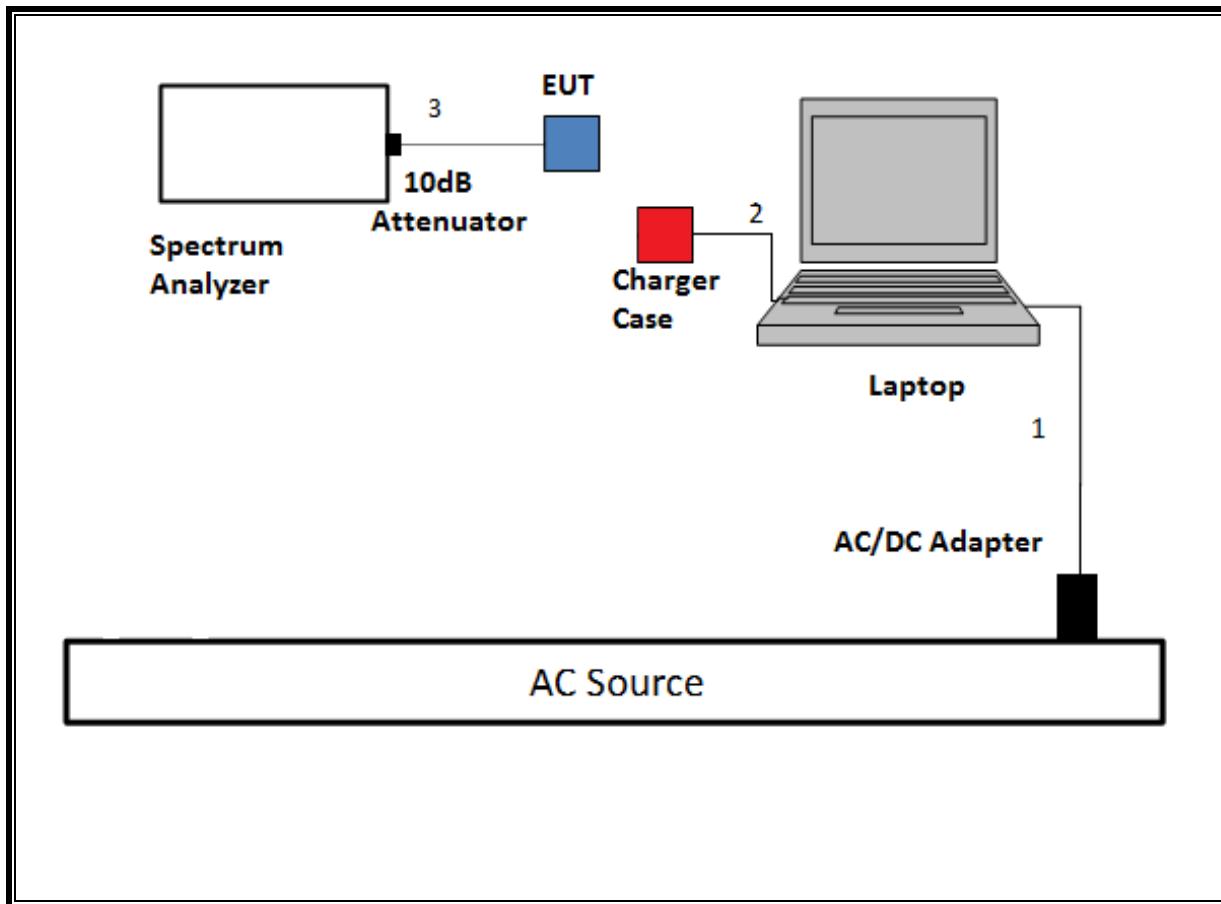
I/O CABLES (BELOW 1GHz AND AC POWER LINE TEST WITH ADAPTER AND LAPTOP)

| Cable No | Port | # of identical | Connector Type | Cable Type | Cable Length (m) | Remarks |
|----------|------|----------------|----------------|-------------|------------------|---------|
| 1 | AC | 1 | AC | Un-shielded | 1 | N/A |
| 2 | USB | 1 | Lightning | Shielded | 1 | N/A |

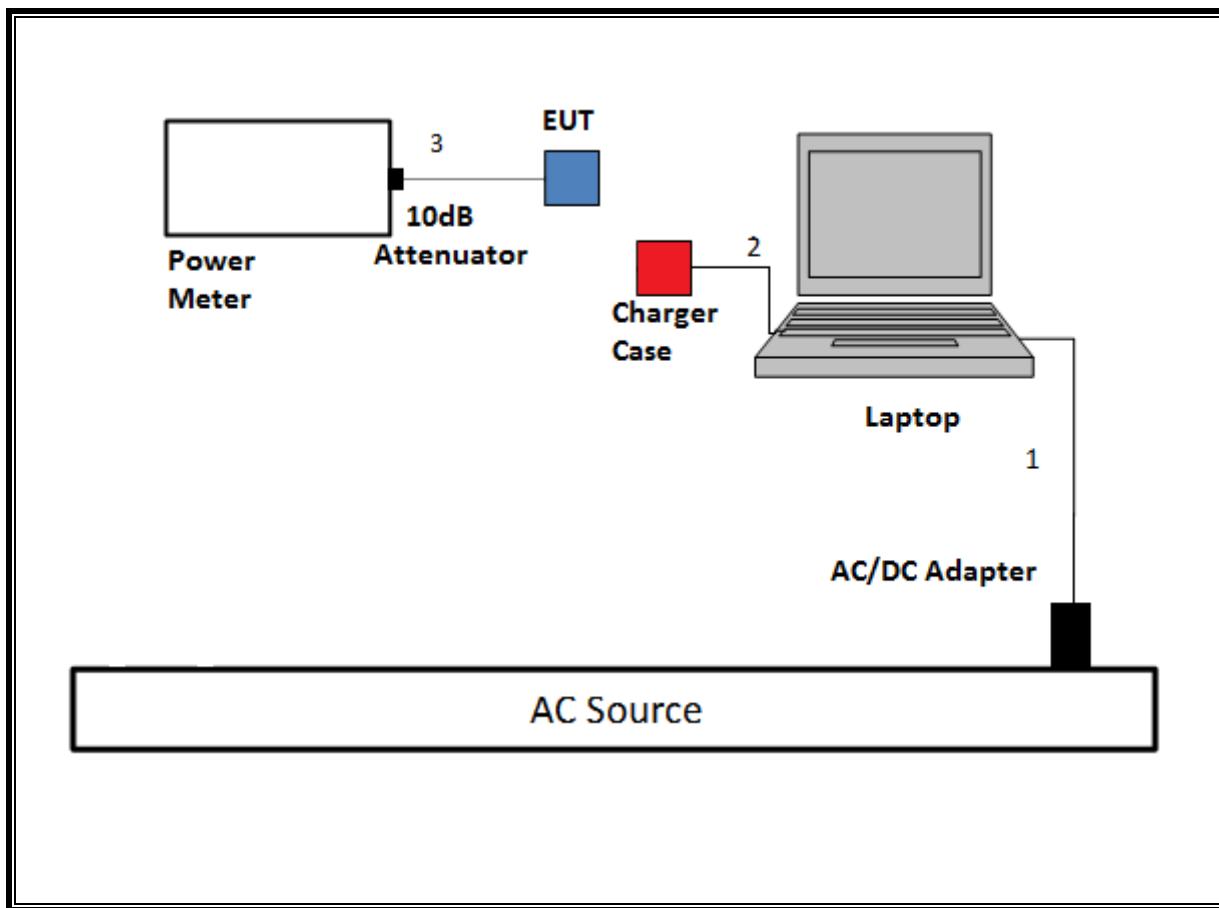
TEST SETUP

The EUT is connected to a test laptop during the tests. Test software exercised the radio card.

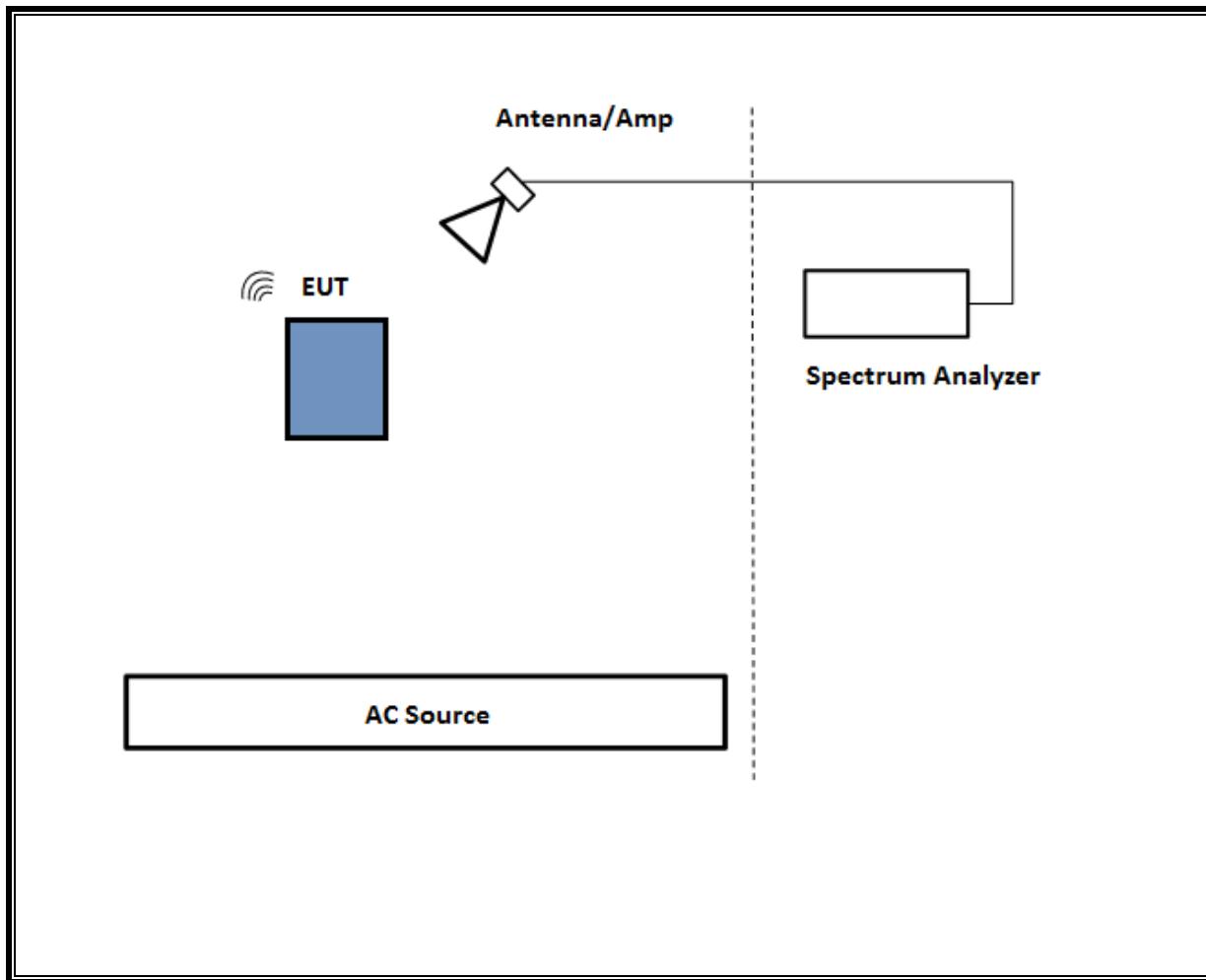
SETUP DIAGRAM FOR CONDUCTED TESTS



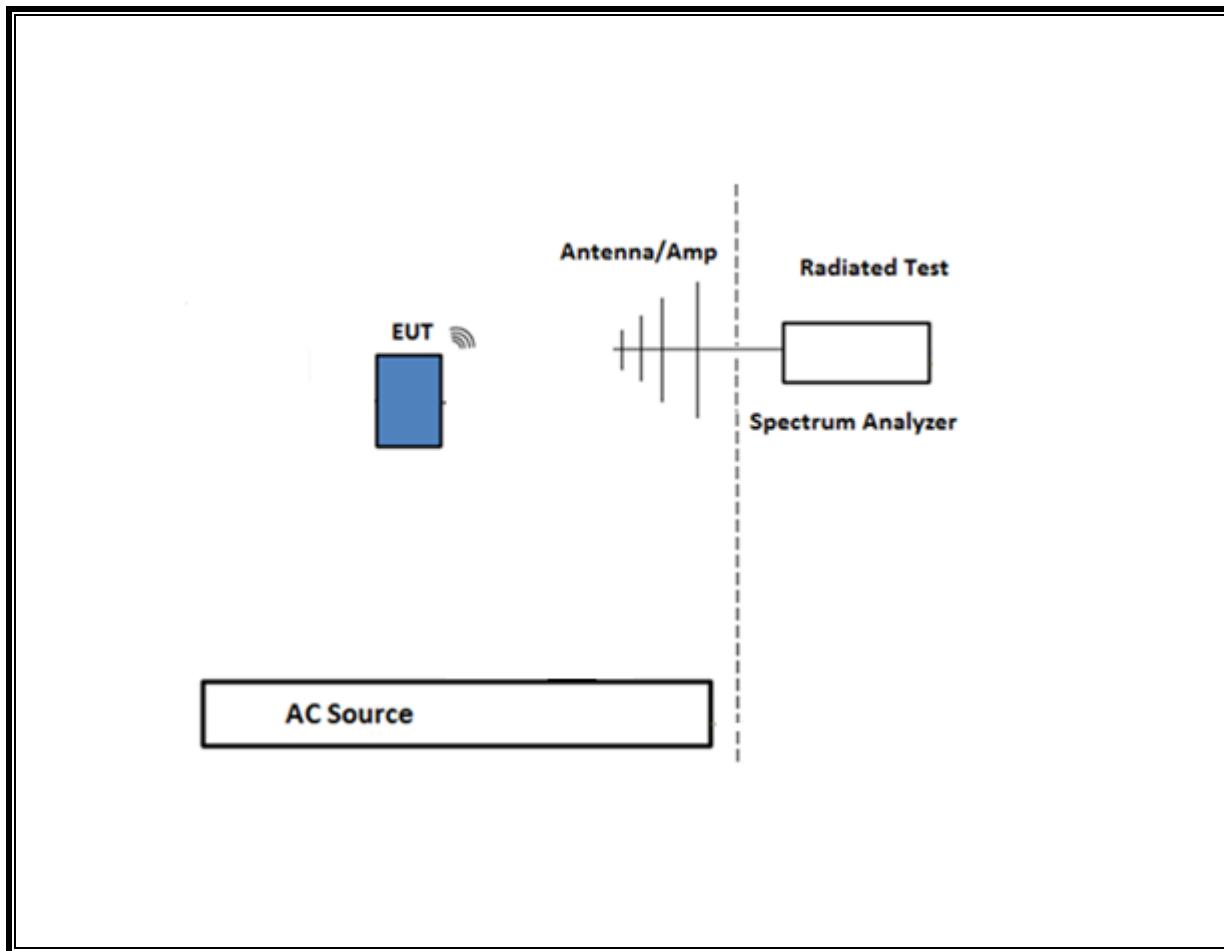
SETUP DIAGRAM FOR CONDUCTED TESTS: POWER METER CONFIGURATION



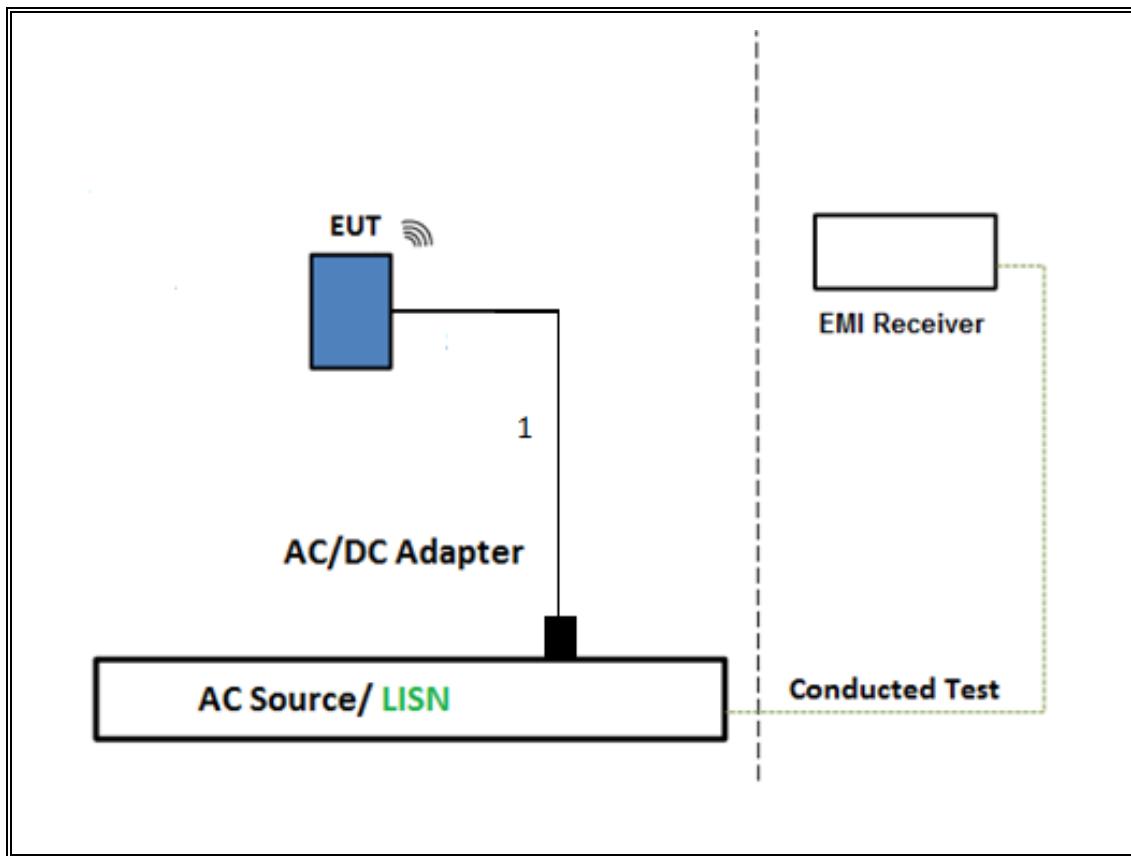
SETUP DIAGRAM FOR RADIATED TESTS ABOVE 1GHz



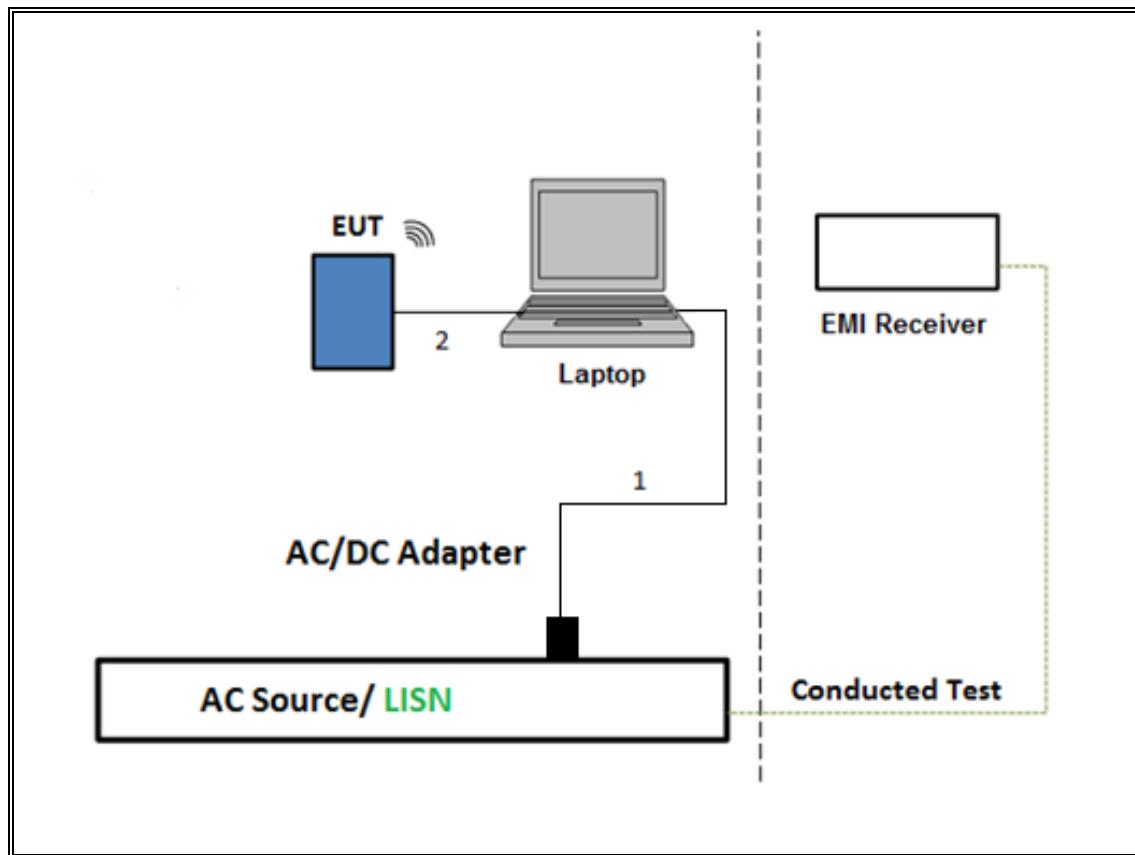
SETUP DIAGRAM FOR BELOW 1GHz



TEST SETUP- AC LINE CONDUCTED: CHARGER CONFIGURATION



TEST SETUP- AC LINE CONDUCTED: LAPTOP CONFIGURATION



6. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the tests documented in this report:

| TEST EQUIPMENT LIST | | | | |
|---|---------------------------------|------------------------|--------|------------|
| Description | Manufacturer | Model | ID Num | Cal Due |
| Amplifier, 1 – 18GHz | MITEQ | AFS42-00101800-25-S-42 | T491 | 05/19/2019 |
| Amplifier, 1 - 18GHz | MITEQ | AFS42-00101800-25-S-42 | T1567 | 01/26/2020 |
| Antenna, Active Loop 9KHz to 30MHz | ETS-Lindgren | 6502 | T1616 | 10/18/2019 |
| Antenna, Broadband Hybrid, 30MHz to 2000MHz | Sunol Sciences Corp. | JB1 | T185 | 04/19/2019 |
| Antenna, Horn 1-18GHz | ETS-Lindgren | 3117 | T120 | 07/02/2019 |
| Filter, HPF 3.0GHz | MICRO-TRONICS | HPM17543 | T898 | 05/19/2019 |
| Amplifier, 10KHz to 1GHz, 32dB | Sonoma Instrument Co. | 310N | T834 | 06/04/2019 |
| Antenna, Horn 1-18GHz | ETS-Lindgren | 3117 | T136 | 07/02/2019 |
| Pre-Amp 18-26GHz | Agilent Technology | 8449B | T404 | 03/23/2020 |
| Antenna, Horn 18 to 26.5GHz | ARA | MWH-1826/B | T447 | 06/16/2019 |
| Power Meter, P-series single channel | Agilent (Keysight) Technologies | N1911A | T227 | 10/29/2019 |
| Power Sensor | Power Sensor | Keysight | T1226 | 02/06/2020 |
| Spectrum Analyzer, PXA, 3Hz to 44GHz | Agilent (Keysight) Technologies | N9030A | T340 | 01/22/2020 |
| Spectrum Analyzer, PXA, 3Hz to 44GHz | Agilent (Keysight) Technologies | N9030A-544 | T1113 | 01/22/2020 |
| Thermometer | Control Company | 14-650-118, 15557603 | T1817 | 05/01/2019 |

| AC Line Conducted | | | | |
|---------------------------------------|-----------------|----------------|---------------------------|------------|
| EMI Test Receiver 9Khz-7GHz | Rohde & Schwarz | ESCI7 | T1436 | 02/23/2020 |
| Power Cable, Line Conducted Emissions | UL | PG1 | T861 | 08/31/2019 |
| LISN for Conducted Emissions CISPR-16 | Fischer | 50/250-25-2-01 | T1310 | 06/19/2019 |
| UL AUTOMATION SOFTWARE | | | | |
| Radiated Software | UL | UL EMC | Ver 9.5, April 26, 2016 | |
| Conducted Software | UL | UL EMC | Ver 5.4, October 13, 2016 | |
| AC Line Conducted Software | UL | UL EMC | Ver 9.5, May 26, 2015 | |

7. MEASUREMENT METHODS

On Time and Duty Cycle: ANSI C63.10-2013 Section 11.6

Occupied BW (20dB): ANSI C63.10-2013 Section 6.9.2

Occupied BW (99%): ANSI C63.10-2013 Section 6.9.3

Carrier Frequency Separation: ANSI C63.10-2013 Section 7.8.2

Number of Hopping Frequencies: ANSI C63.10-2013 Section 7.8.3

Time of Occupancy (Dwell Time): ANSI C63.10-2013 Section 7.8.4

Peak Output Power: ANSI C63.10-2013 Section 7.8.5

Conducted Spurious Emissions: ANSI C63.10-2013 Section 7.8.8

Conducted Band-Edge: ANSI C63.10-2013 Section 6.10.4

Radiated Spurious Emissions Below 30MHz: ANSI C63.10-2013 Section 6.4

Radiated Spurious Emissions 30-1000MHz: ANSI C63.10-2013 Section 6.3 and 6.5

Radiated Spurious Emissions above 1GHz: ANSI C63.10-2013 Section 6.3 and 6.6

Radiated Band-edge: ANSI C63.10-2013 Section 6.10.5

AC Power-line conducted emissions: ANSI C63.10-2013, Section 6.2.

8. ANTENNA PORT TEST RESULTS

8.1. DUTY CYCLE

PROCEDURE

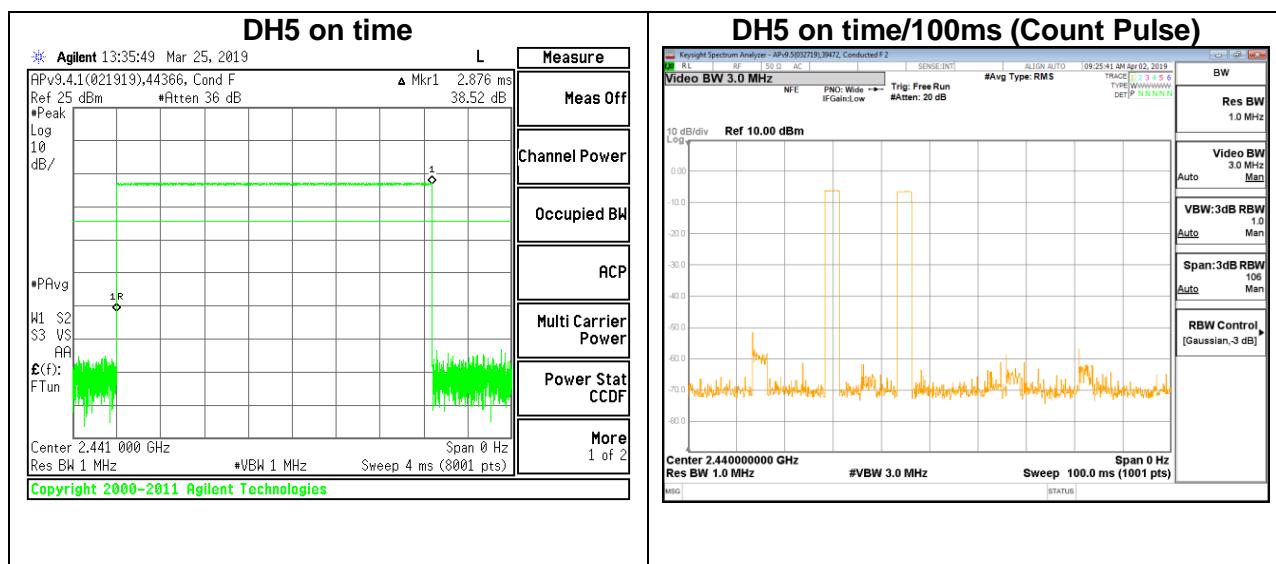
FCC Public Notice DA 00-705 measurement guidelines.

ON TIME AND DUTY CYCLE RESULTS

Duty cycle correction factor(dB) = $20\log(\text{duty cycle})$

Duty cycle=on time/100 milliseconds

On time = dwell time * hopping number in 100ms



Note: Duty Cycle = on time/100 milliseconds = $2*2.876 / 100 = 5.752\%$
Duty cycle correction factor = $20*\log(\text{Duty cycle}) = -24.80 \text{ dB}$

8.2. 20 dB AND 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer. The RBW is set to $\geq 1\%$ of the 20 dB bandwidth. The VBW is set to \geq RBW. The sweep time is coupled.

RESULTS

8.2.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

| Channel | Frequency (MHz) | 20dB Bandwidth (MHz) | 99% Bandwidth (MHz) |
|---------|-----------------|----------------------|---------------------|
| Low | 2402 | 0.934 | 0.875 |
| Mid | 2441 | 0.936 | 0.876 |
| High | 2480 | 0.937 | 0.877 |



8.2.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

| Channel | Frequency (MHz) | 20dB Bandwidth (MHz) | 99% Bandwidth (MHz) |
|---------|-----------------|----------------------|---------------------|
| Low | 2402 | 1.355 | 1.211 |
| Mid | 2441 | 1.356 | 1.213 |
| High | 2480 | 1.356 | 1.212 |



8.3. HOPPING FREQUENCY SEPARATION

LIMITS

FCC §15.247 (a) (1)

RSS-247 (5.1) (b)

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

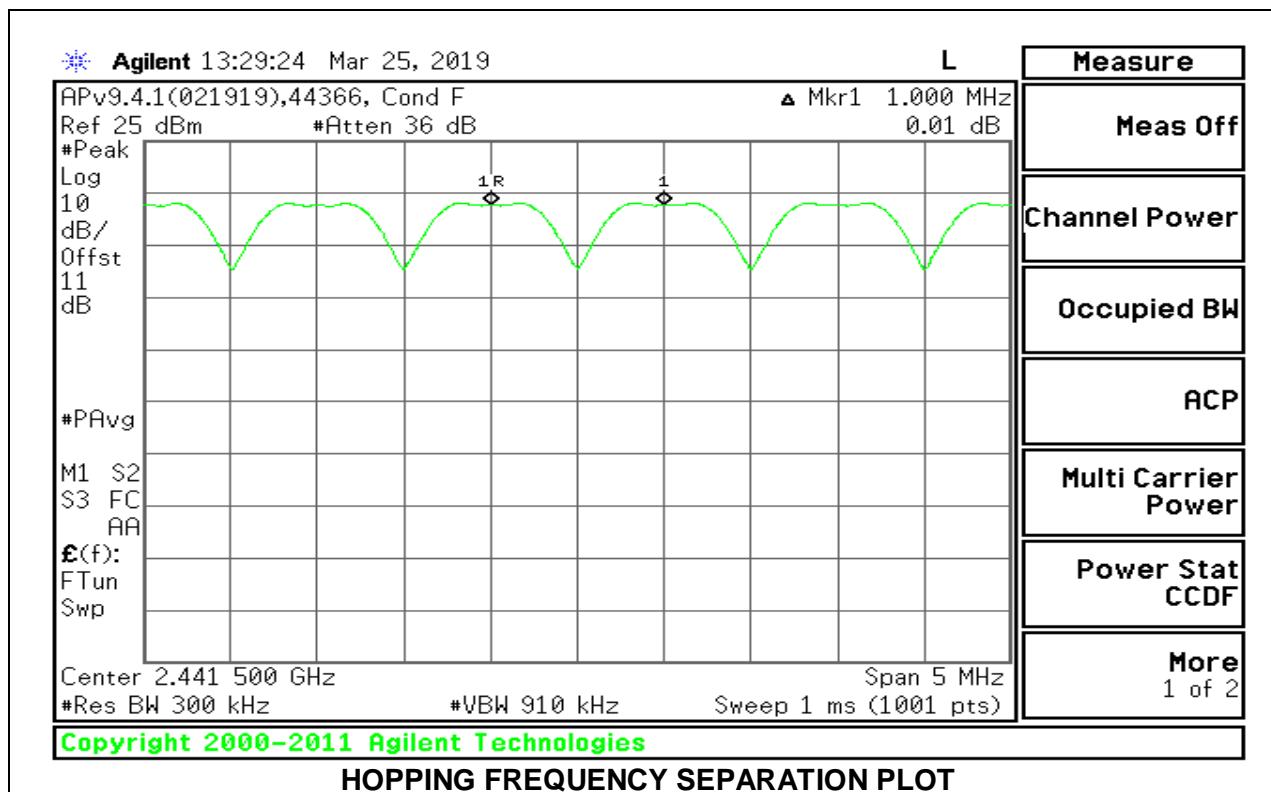
Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

TEST PROCEDURE

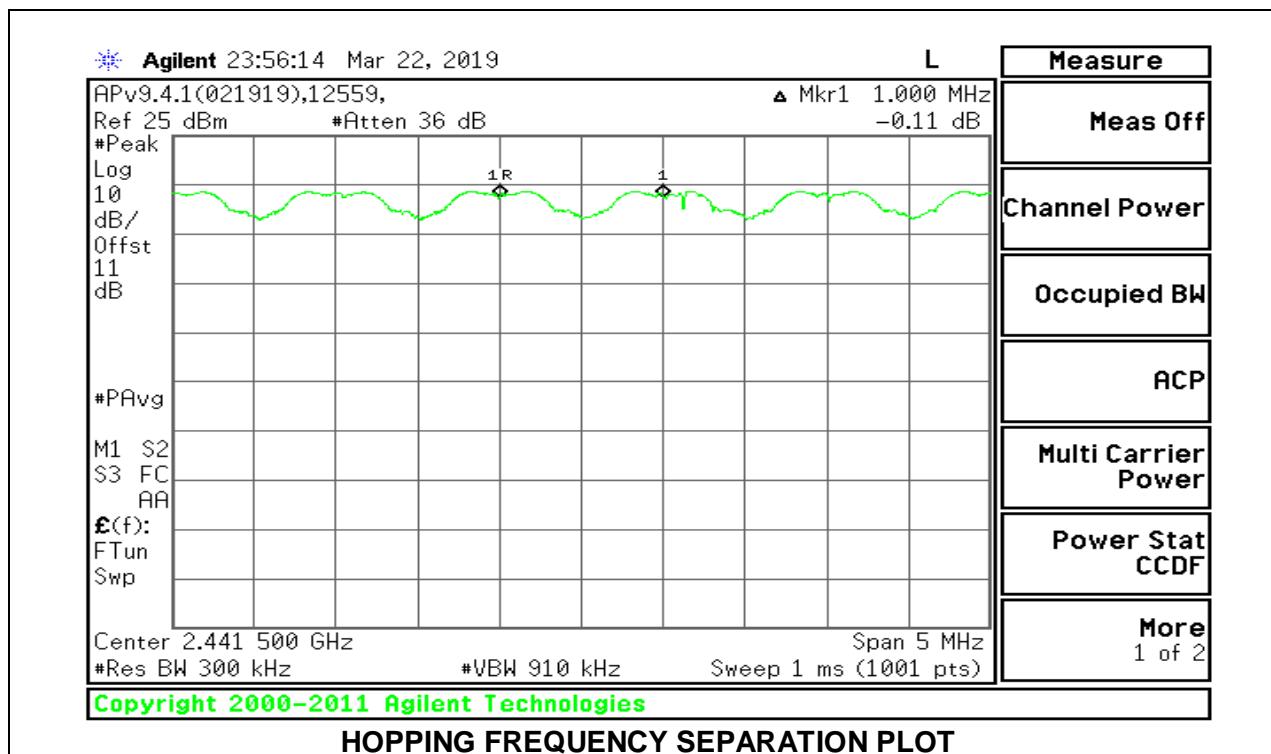
The transmitter output is connected to a spectrum analyzer. The RBW is set to 300 kHz and the VBW is set to 3x RBW. The sweep time is coupled.

RESULTS

8.3.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION



8.3.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION



8.4. NUMBER OF HOPPING CHANNELS

LIMITS

FCC §15.247 (a) (1) (iii)

RSS-247 (5.1) (d)

Frequency hopping systems in the 2400 – 2483.5 MHz band shall use at least 15 non-overlapping channels.

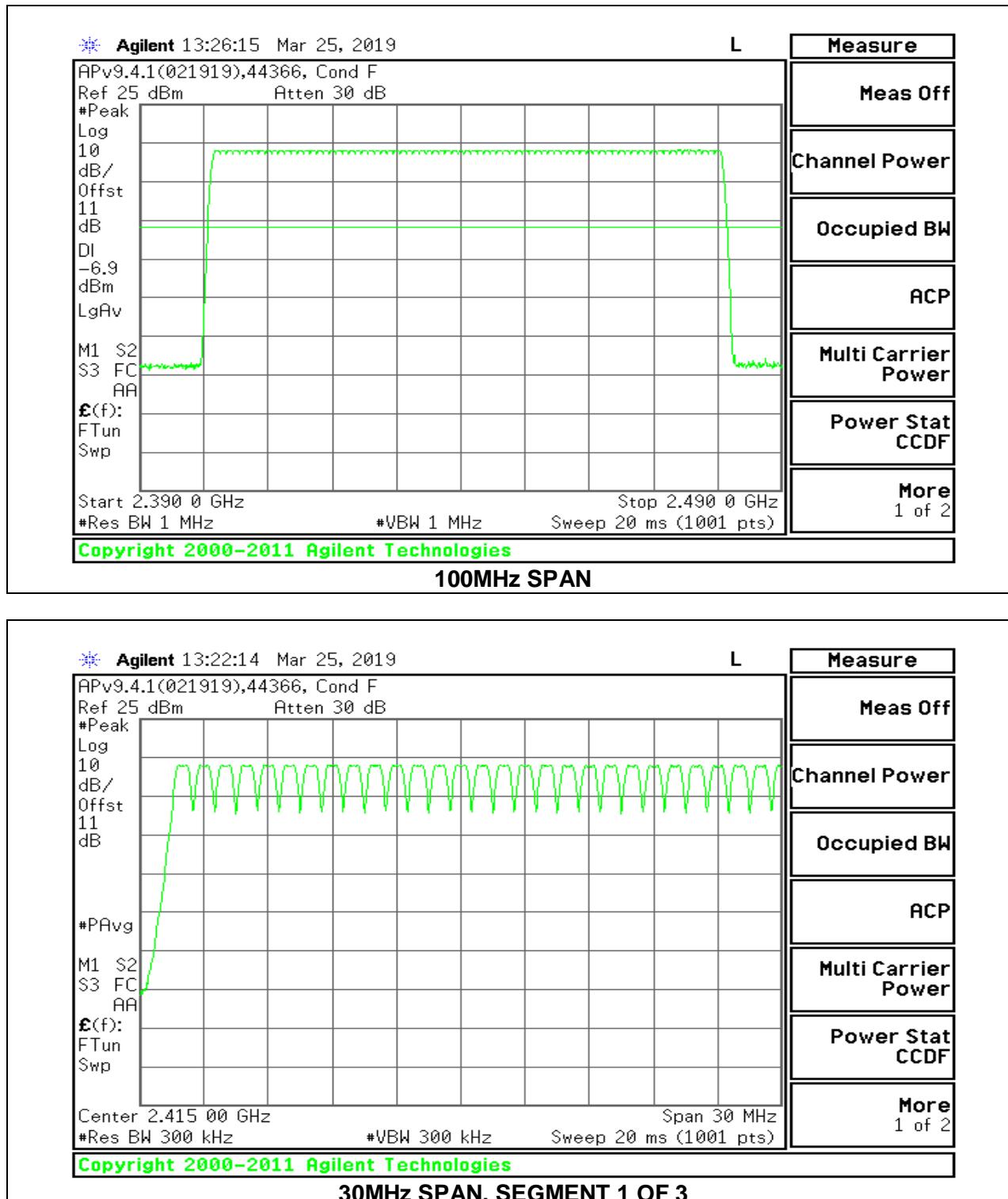
TEST PROCEDURE

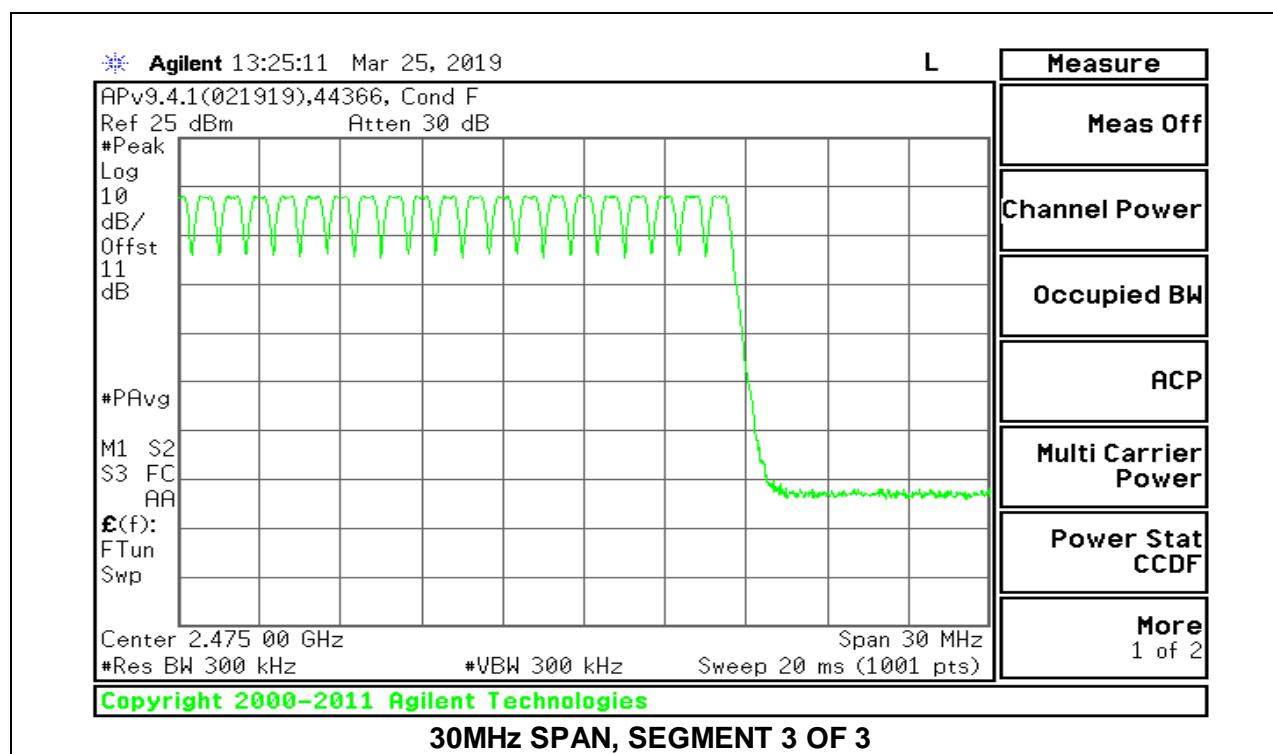
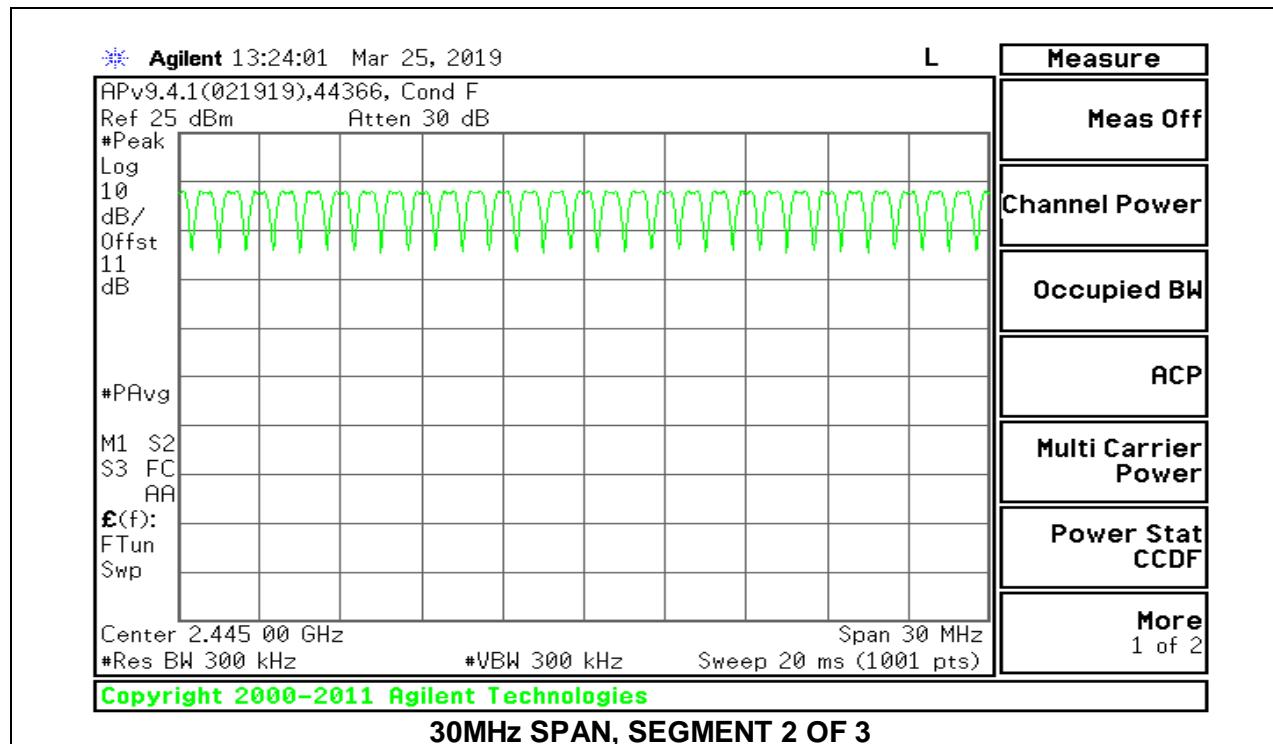
The transmitter output is connected to a spectrum analyzer. The span is set to cover the entire authorized band, in either a single sweep or in multiple contiguous sweeps. The RBW is set to a maximum of 1 % of the span. The analyzer is set to Max Hold.

RESULTS

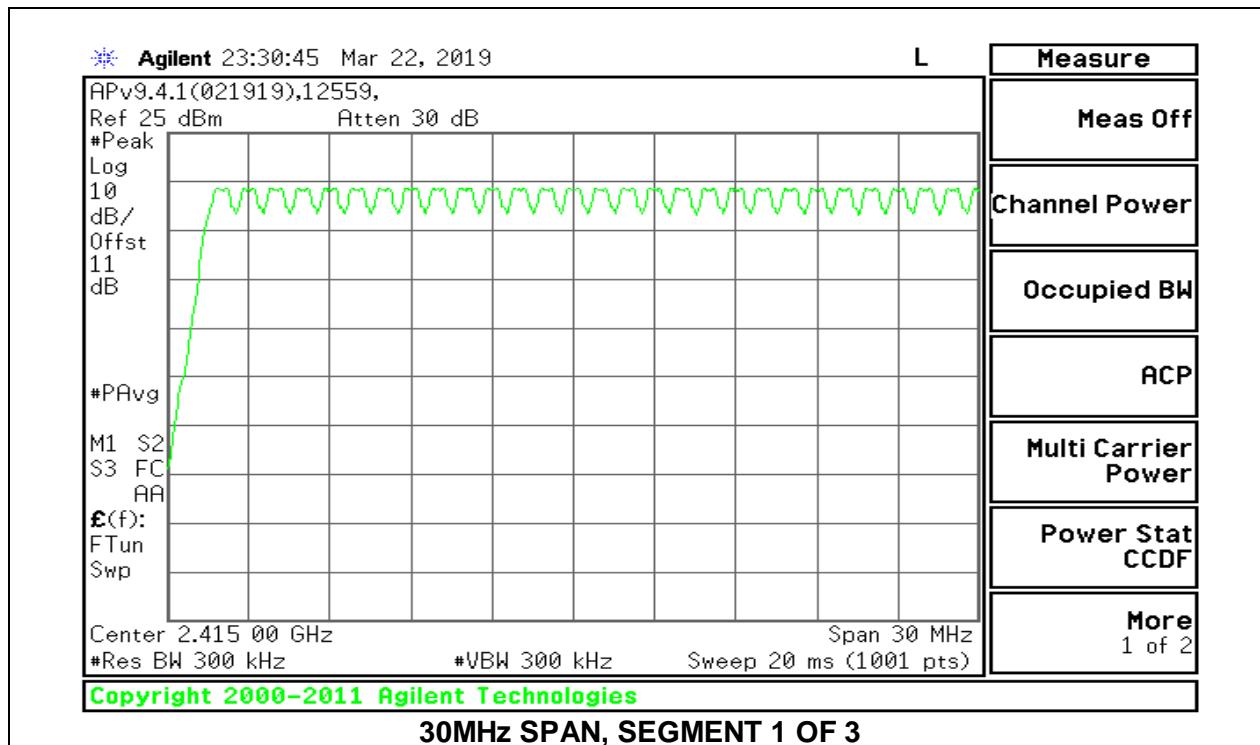
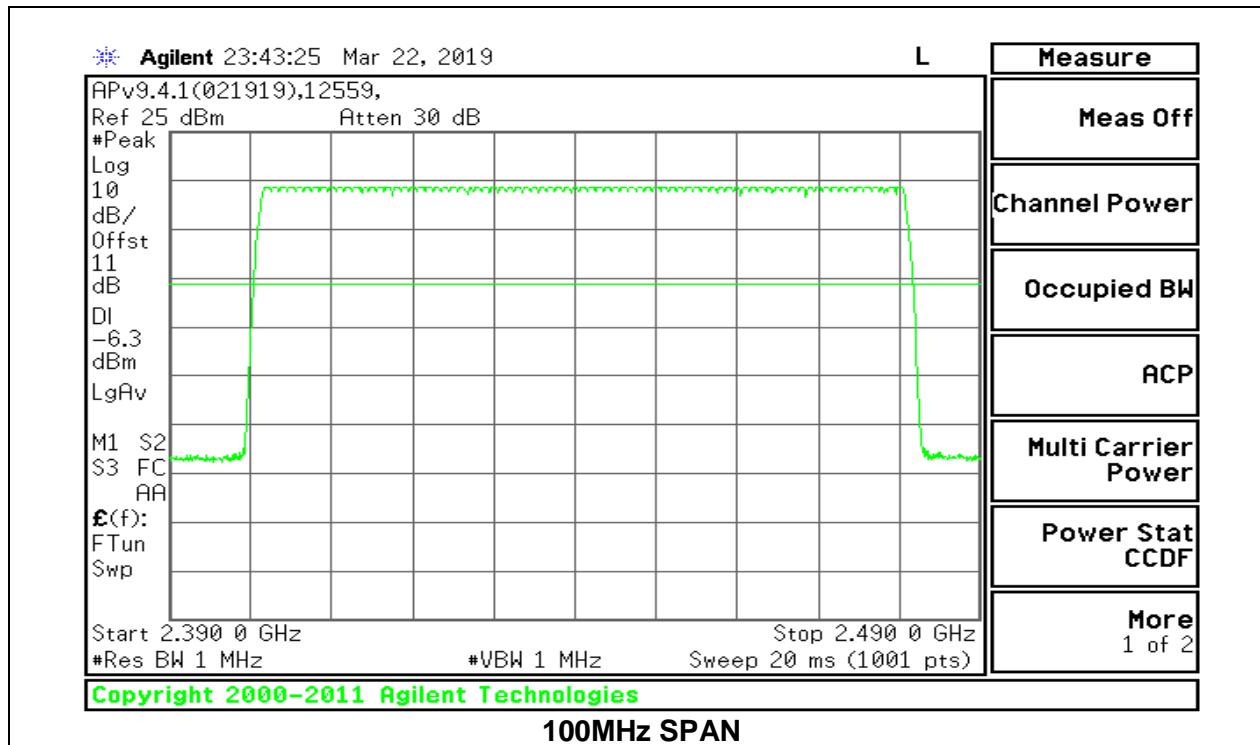
Normal Mode: 79 Channels Observed

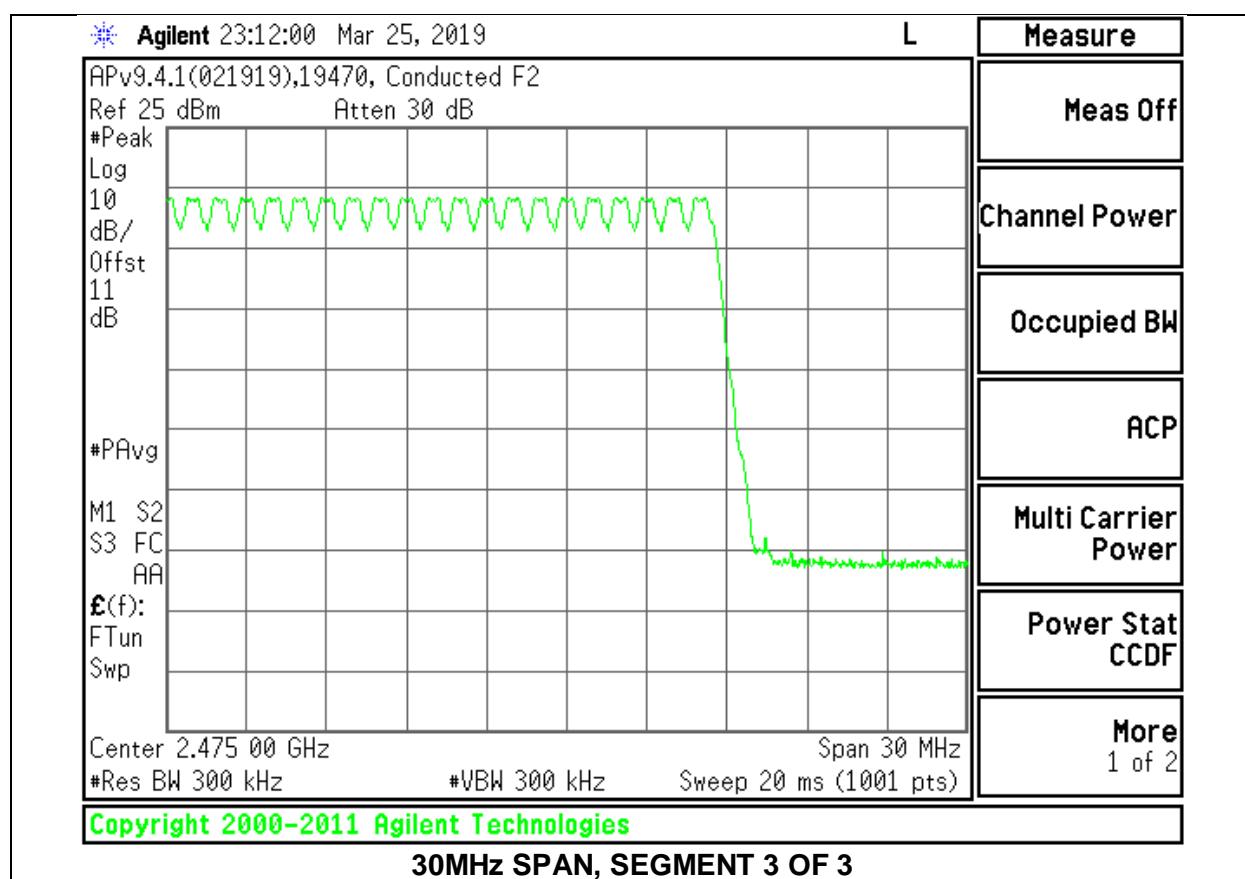
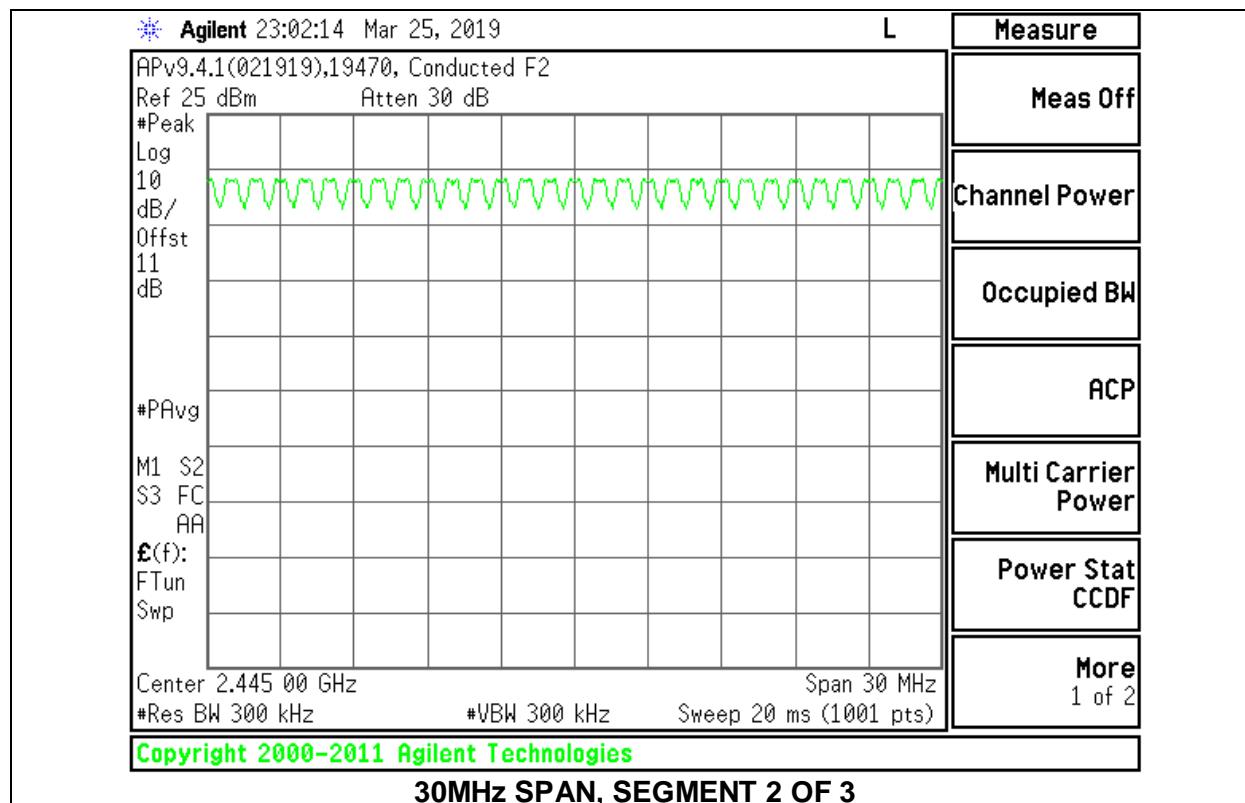
8.4.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION





8.4.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION





8.5. AVERAGE TIME OF OCCUPANCY

LIMITS

FCC §15.247 (a) (1) (iii)

RSS-247 (5.1) (d)

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer. The span is set to 0 Hz, centered on a single, selected hopping channel. The width of a single pulse is measured in a fast scan. The number of pulses is measured in a 3.16 second scan, to enable resolution of each occurrence.

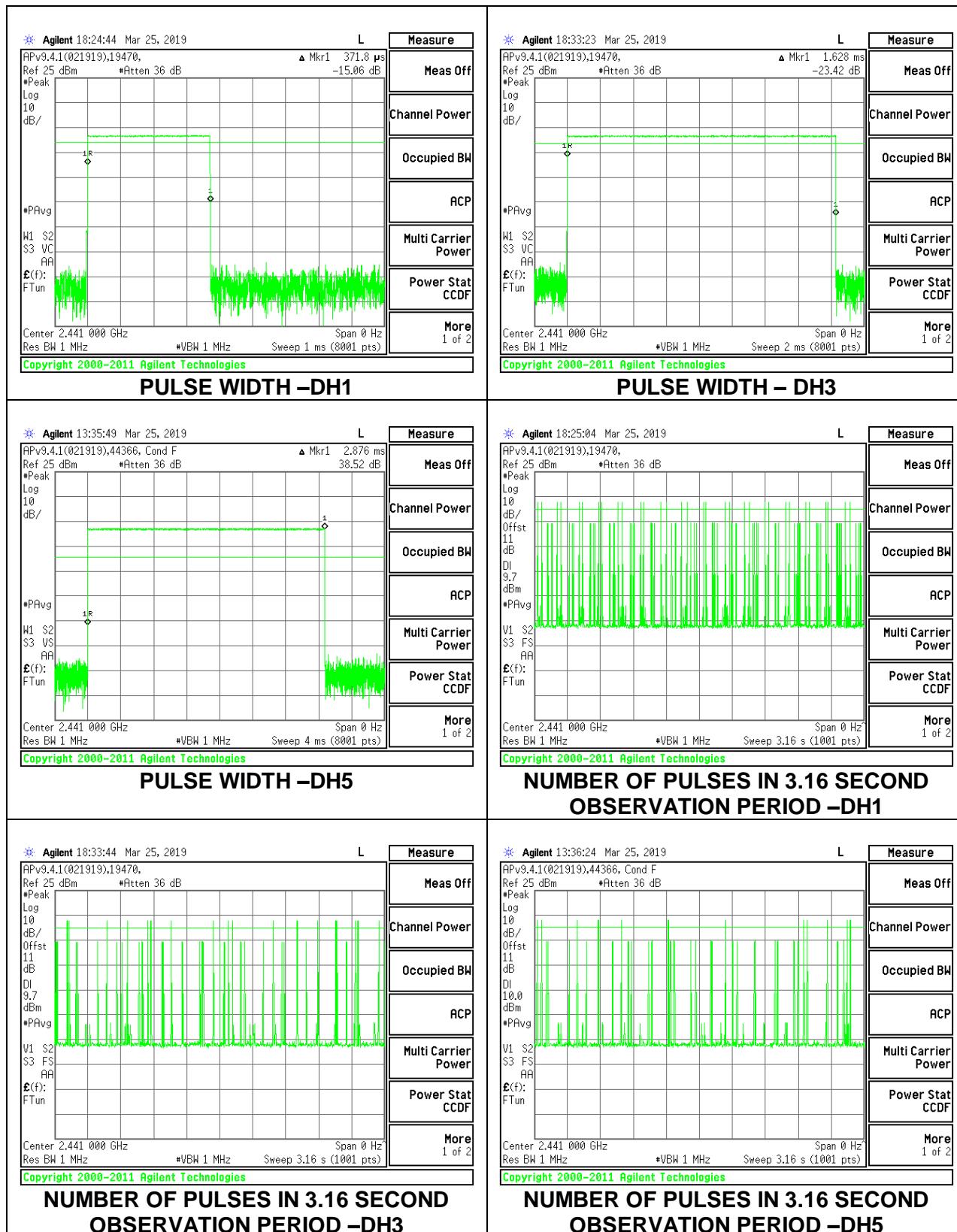
The average time of occupancy in the specified 3.16 second period (79 channels * 0.4 s) is equal to $10 * (\# \text{ of pulses in } 3.16 \text{ s}) * \text{pulse width}$.

For AFH mode, the average time of occupancy in the specified 8 second period (20 channels * 0.4 seconds) is equal to $10 * (\# \text{ of pulses in } 0.8 \text{ s}) * \text{pulse width}$.

RESULTS

8.5.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

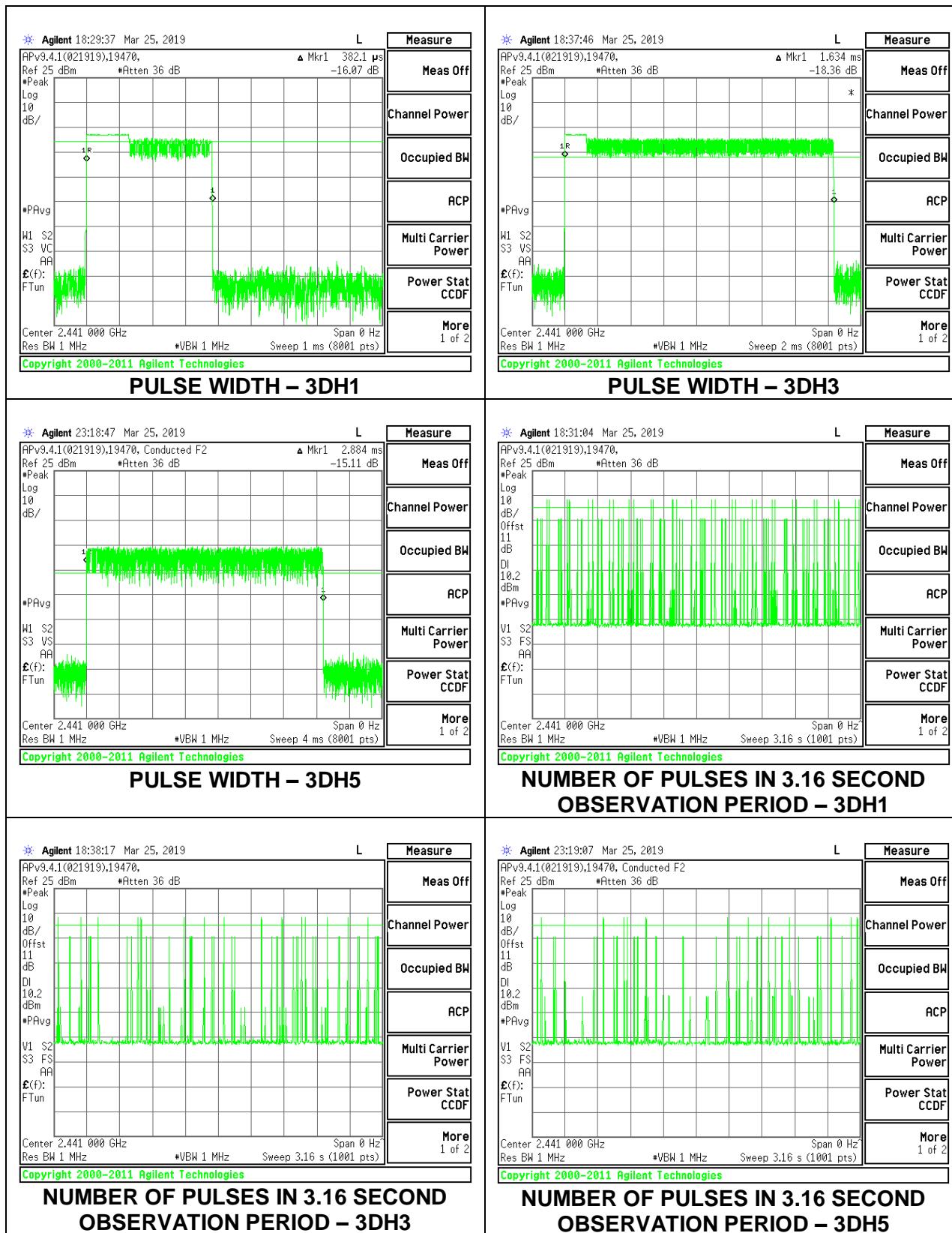
| DH Packet | Pulse Width (msec) | Number of Pulses in 3.16 seconds | Average Time of Occupancy (sec) | Limit (sec) | Margin (sec) |
|-------------------------|--------------------|----------------------------------|---------------------------------|-------------|--------------|
| GFSK Normal Mode | | | | | |
| DH1 | 0.371 | 32 | 0.1187 | 0.4 | -0.2813 |
| DH3 | 1.628 | 18 | 0.2930 | 0.4 | -0.1070 |
| DH5 | 2.876 | 12 | 0.3451 | 0.4 | -0.0549 |
| DH Packet | Pulse Width (sec) | Number of Pulses in 0.8 seconds | Average Time of Occupancy (sec) | Limit (sec) | Margin (sec) |
| GFSK AFH Mode | | | | | |
| DH1 | 0.371 | 8 | 0.02968 | 0.4 | -0.3703 |
| DH3 | 1.628 | 4.5 | 0.07326 | 0.4 | -0.3267 |
| DH5 | 2.876 | 3 | 0.08628 | 0.4 | -0.3137 |



8.5.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

| DH Packet | Pulse Width (msec) | Number of Pulses in 3.16 seconds | Average Time of Occupancy (sec) | Limit (sec) | Margin (sec) |
|-------------------------|--------------------|----------------------------------|---------------------------------|-------------|--------------|
| 8PSK Normal Mode | | | | | |
| 3DH1 | 0.3821 | 32 | 0.122272 | 0.4 | -0.27773 |
| 3DH3 | 1.634 | 15 | 0.2451 | 0.4 | -0.1549 |
| 3DH5 | 2.884 | 13 | 0.37492 | 0.4 | -0.02508 |

Note: for AFH(8PSK) mode, please refer to the results of AFH(GFSK) mode; the channel selection and hopping rate are the same for both EDR and Basic Rate operation, data for Basic Rate demonstrates compliance with channel occupancy when AFH is employed.



8.6. OUTPUT POWER

LIMITS

§15.247 (b) (1)

RSS-247 (5.4) (b)

The maximum antenna gain is less than 6 dBi, therefore the limit is 30 dBm. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

TEST PROCEDURE

Measurements perform using a wideband gated RF power meter.

The cable assembly insertion loss of 10.5 dB (including 10 dB pad and 1 dB cable) was entered as an offset in the power meter to allow for a gated peak reading of power.

RESULTS

8.6.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

| | |
|------------|-----------|
| Tested By: | 44366 |
| Date: | 3/26/2019 |

| Channel | Frequency (MHz) | Output Power (dBm) | Limit (dBm) | Margin (dB) |
|---------|--------------------|-----------------------|----------------|----------------|
| Low | 2402 | 12.72 | 30 | -17.28 |
| Middle | 2441 | 12.58 | 30 | -17.42 |
| High | 2480 | 12.65 | 30 | -17.35 |

8.6.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

| | |
|------------|-----------|
| Tested By: | 44366 |
| Date: | 3/26/2019 |

| Channel | Frequency (MHz) | Output Power (dBm) | Limit (dBm) | Margin (dB) |
|---------|--------------------|-----------------------|----------------|----------------|
| Low | 2402 | 13.26 | 21 | -7.74 |
| Middle | 2441 | 13.14 | 21 | -7.86 |
| High | 2480 | 13.1 | 21 | -7.9 |

8.6.3. BLUETOOTH ENHANCED DATA RATE DQPSK MODULATION

| | |
|------------|----------|
| Tested By: | 44366 |
| Date: | 4/4/2019 |

| Channel | Frequency (MHz) | Output Power (dBm) | Limit (dBm) | Margin (dB) |
|---------|--------------------|-----------------------|----------------|----------------|
| Low | 2402 | 12.51 | 21 | -8.49 |
| Middle | 2441 | 12.23 | 21 | -8.77 |
| High | 2480 | 12.13 | 21 | -8.87 |

8.7. AVERAGE POWER

LIMITS

None; for reporting purposes only

TEST PROCEDURE

Measurements perform using a wideband gated RF power meter.

The cable assembly insertion loss of 11 dB (including 10 dB pad and 1 dB cable) was entered as an offset in the power meter to allow for a gated average reading of power.

RESULTS

8.7.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

| | |
|------------|-----------|
| Tested By: | 44366 |
| Date | 3/26/2019 |

| Channel | Frequency (MHz) | Average Power (dBm) |
|---------|--------------------|------------------------|
| Low | 2402 | 12.48 |
| Middle | 2441 | 12.37 |
| High | 2480 | 12.47 |

8.7.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

| | |
|------------|-----------|
| Tested By: | 44366 |
| Date | 3/26/2019 |

| Channel | Frequency (MHz) | Average Power (dBm) |
|---------|--------------------|------------------------|
| Low | 2402 | 9.95 |
| Middle | 2441 | 9.86 |
| High | 2480 | 9.84 |

8.7.3. BLUETOOTH ENHANCED DATA RATE DQPSK MODULATION

| | |
|------------|----------|
| Tested By: | 44366 |
| Date | 4/4/2019 |

| Channel | Frequency (MHz) | Average Power (dBm) |
|---------|--------------------|------------------------|
| Low | 2402 | 9.69 |
| Middle | 2441 | 9.53 |
| High | 2480 | 9.46 |

8.8. CONDUCTED SPURIOUS EMISSIONS

LIMITS

FCC §15.247 (d)

RSS-247 5.5

Limit = -20 dBc

TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.

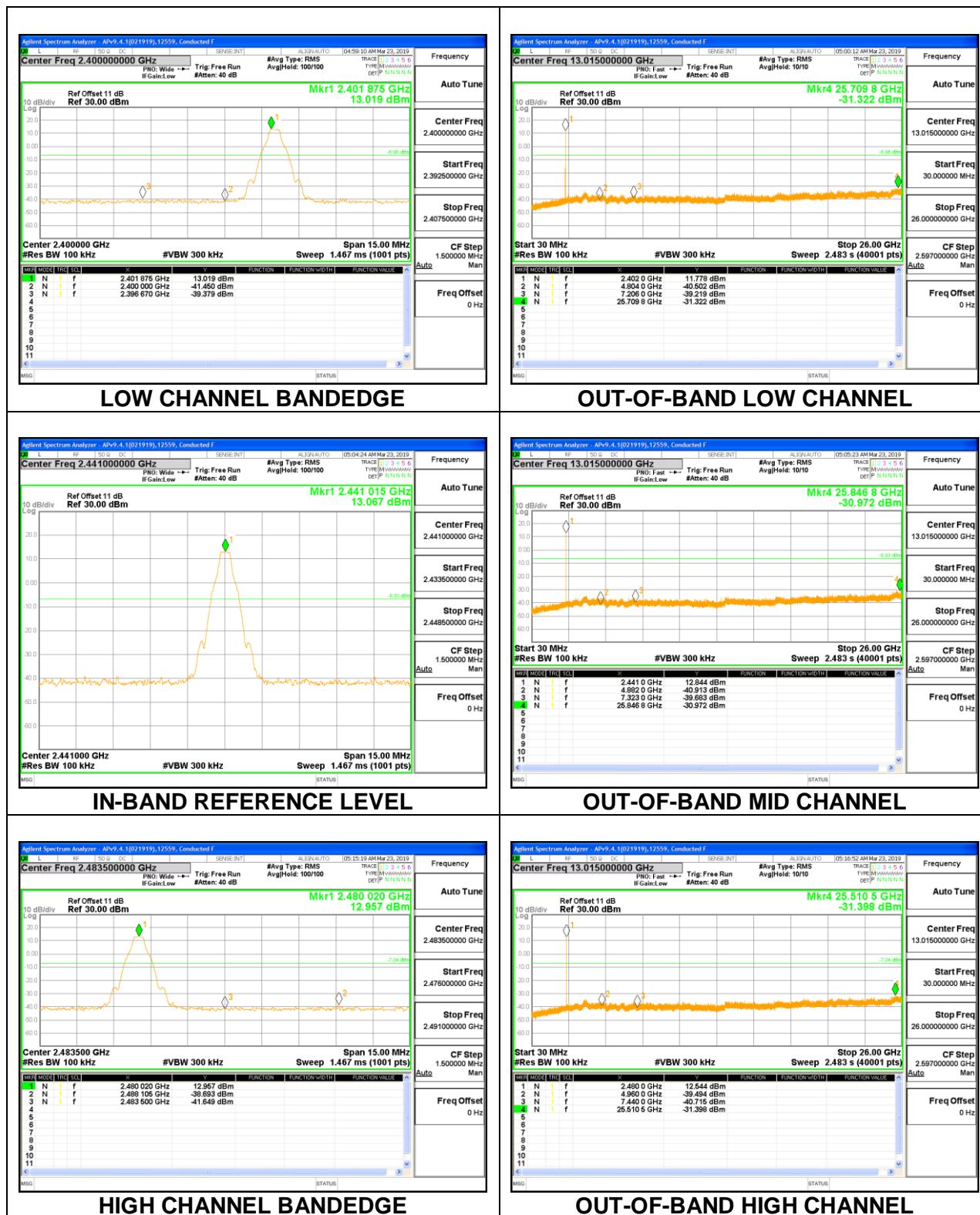
The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

The bandedges at 2.4 and 2.4835 GHz are investigated with the transmitter set to the normal hopping mode.

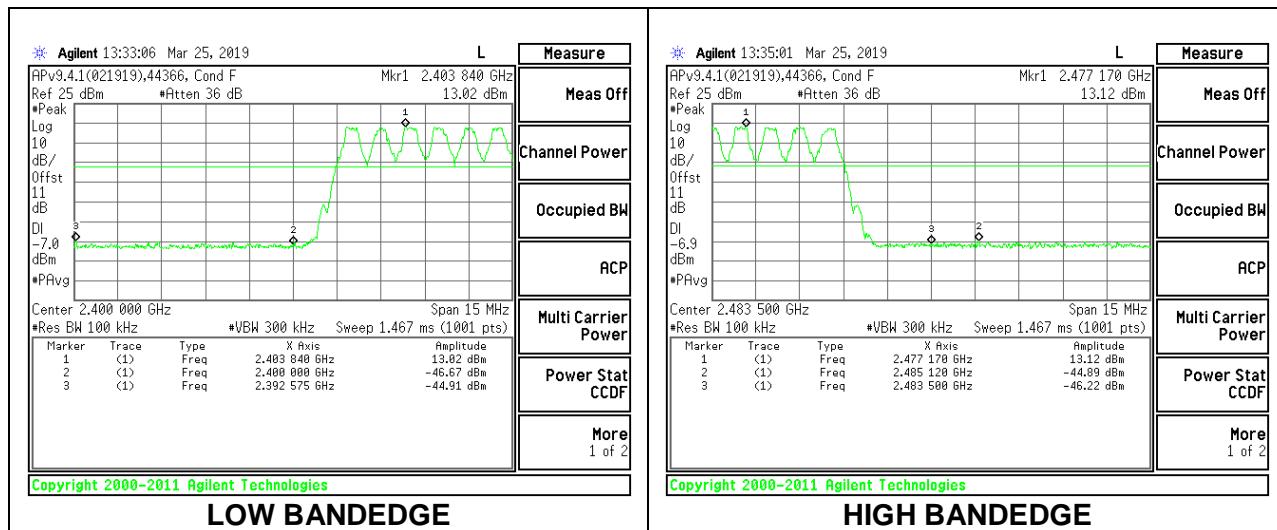
RESULTS

8.8.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

Antenna 1 SPURIOUS EMISSIONS, NON-HOPPING

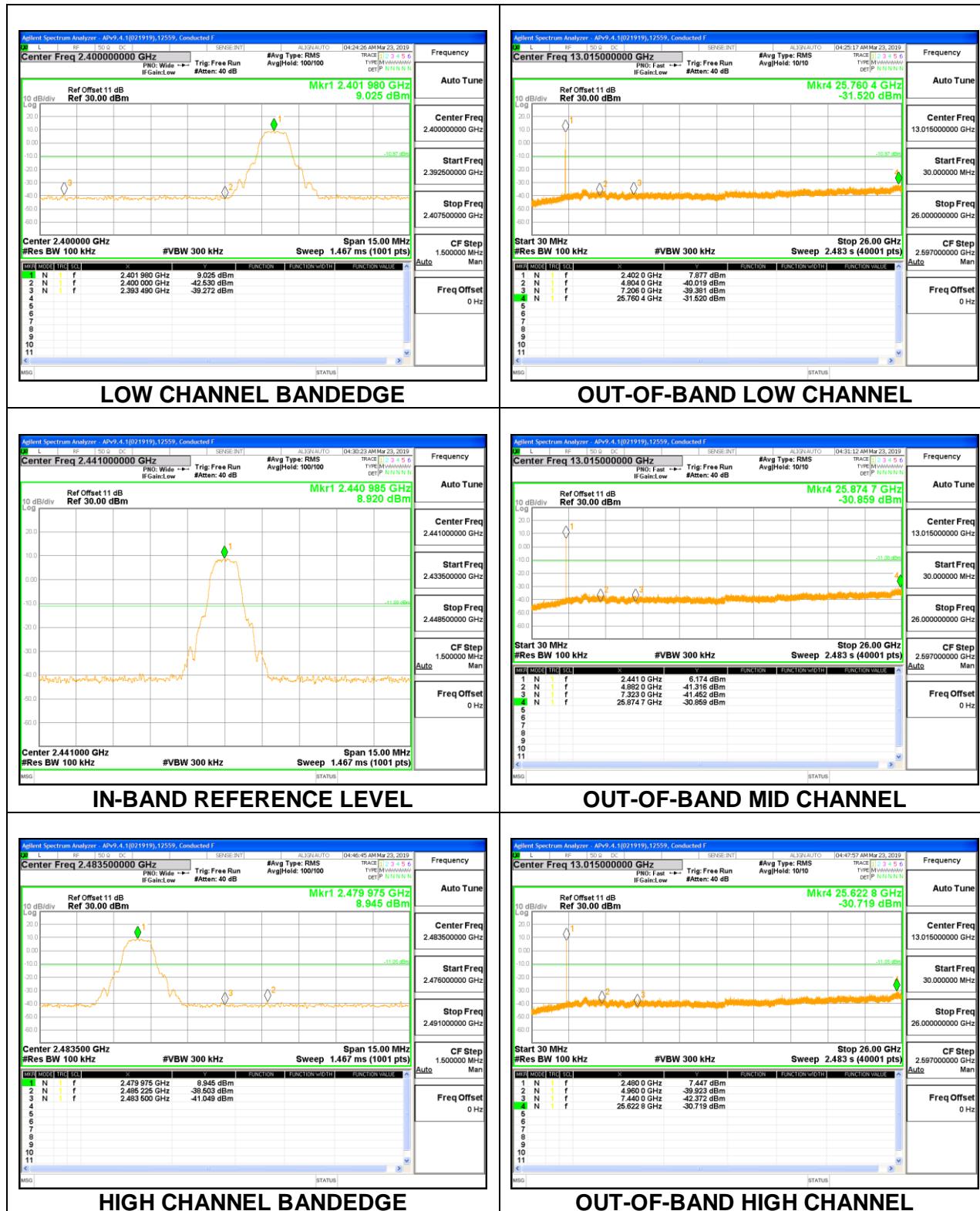


Antenna 1 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON

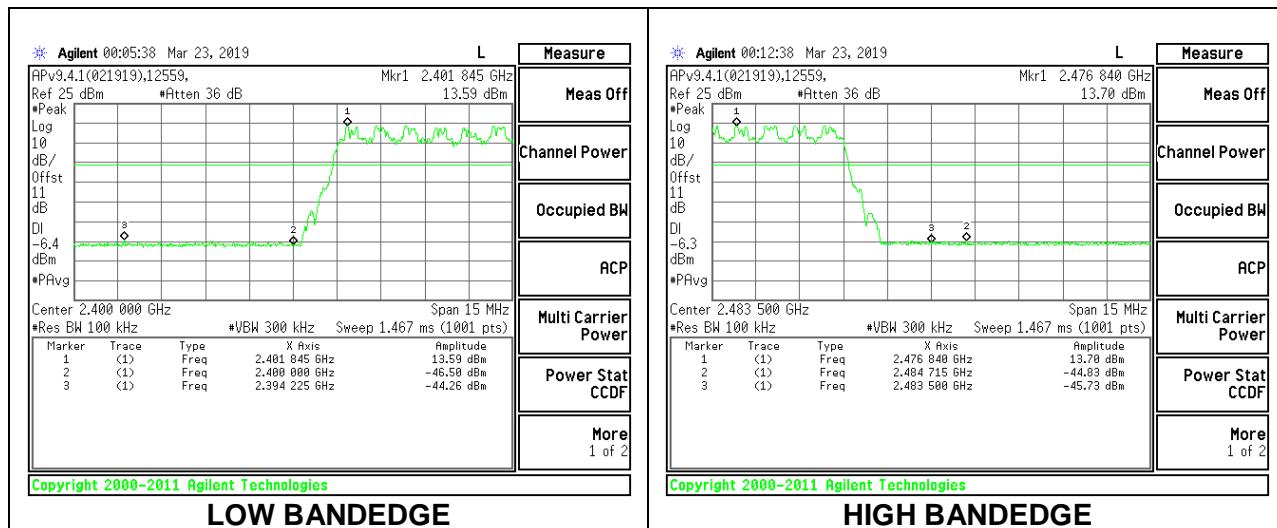


8.8.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

Antenna 1 SPURIOUS EMISSIONS, NON-HOPPING



Antenna 1 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON



9. RADIATED TEST RESULTS

LIMITS

FCC §15.205 and §15.209

RSS-GEN, Section 8.9 and 8.10.

| Frequency Range (MHz) | Field Strength Limit (uV/m) at 3 m | Field Strength Limit (dBuV/m) at 3 m |
|-----------------------|------------------------------------|--------------------------------------|
| 0.009-0.490 | 2400/F(kHz) @ 300 m | - |
| 0.490-1.705 | 24000/F(kHz) @ 30 m | - |
| 1.705 - 30 | 30 @ 30m | - |
| 30 - 88 | 100 | 40 |
| 88 - 216 | 150 | 43.5 |
| 216 - 960 | 200 | 46 |
| Above 960 | 500 | 54 |

TEST PROCEDURE

The EUT is placed on a non-conducting table 80 cm above the ground plane for measurement below 1GHz; 1.5 m above the ground plane for measurement above 1GHz. The antenna to EUT distance is 3 meters. The EUT is configured in accordance with ANSI C63.10. The EUT is set to transmit in a continuous mode.

For measurements below 1 GHz the resolution bandwidth is set to 100 kHz for peak detection measurements or 120 kHz for quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak.

For pre-scans above 1 GHz the resolution bandwidth is set to 1 MHz; the video bandwidth is set to 30 KHz for peak measurements.

For final measurements above 1 GHz the resolution bandwidth is set to 1 MHz; the video bandwidth is set to 3 MHz for peak measurements.

For the final measurements above 1GHz radiated spurious harmonics and band edge measurement, there is no need for the average reading since the peak reading passed with the peak limit. The average reading = peak reading – duty cycle Correction Factor (DCCF) which is $20 \log (\text{ON time}/100 \text{ milliseconds})$ and greater than 20dB.

The spectrum from 1 GHz to 18 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in each applicable band. Below 1GHz and above 18GHz emissions, the channel with the highest output power was tested.

The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized in both the vertical and the horizontal positions.

For below 30MHz testing, investigation was done on three antenna orientations (parallel, perpendicular, and ground-parallel), parallel and perpendicular are the worst orientations, therefore testing was performed on these two orientations only.

KDB 414788 Open Field Site(OFS) and Chamber Correlation Justification

Base on FCC 15.31 (f) (2): measurements may be performed at a distance closer than that specified in the regulations; however, an attempt should be made to avoid making measurements in the near field.

OFS and chamber correlation testing had been performed and chamber measured test result is the worst case test result.

KDB 558074 D01 15.247 Meas Guidance v05r01

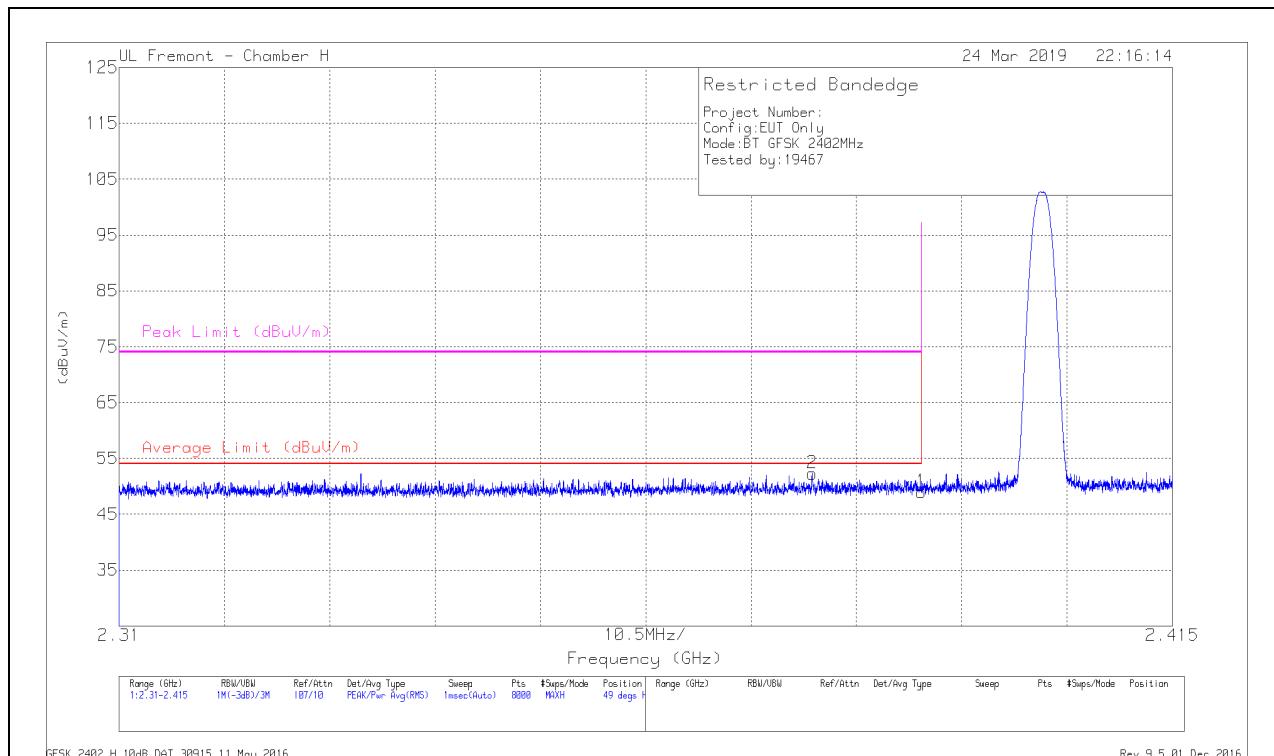
Use of a duty cycle correction factor (DCCF) is permitted for calculating average radiated field strength emission levels for an FHSS device in 15.247. This DCCF can be applied when the field strength limit (e.g., within a Government Restricted band) and the conditions specified in Section 15.35(c) can be satisfied. The average radiated field strength is calculated by subtracting the DCCF from the maximum radiated field strength level as determined through measurement. The maximum radiated field strength level represents the worst-case (maximum amplitude) RMS measurement of the emission(s) during continuous transmission (i.e., not including any time intervals during which the transmitter is off or is transmitting at a reduced power level). It is also acceptable to apply the DCCF to a measurement performed with a peak detector instead of the specified RMS power averaging detector. Note that Section 15.35(c) specifies that the DCCF shall represent the worst-case (greatest duty cycle) over any 100 msec transmission period.

9.1. TRANSMITTER ABOVE 1 GHz

9.1.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

BANDEDGE (LOW CHANNEL)

HORIZONTAL RESULT

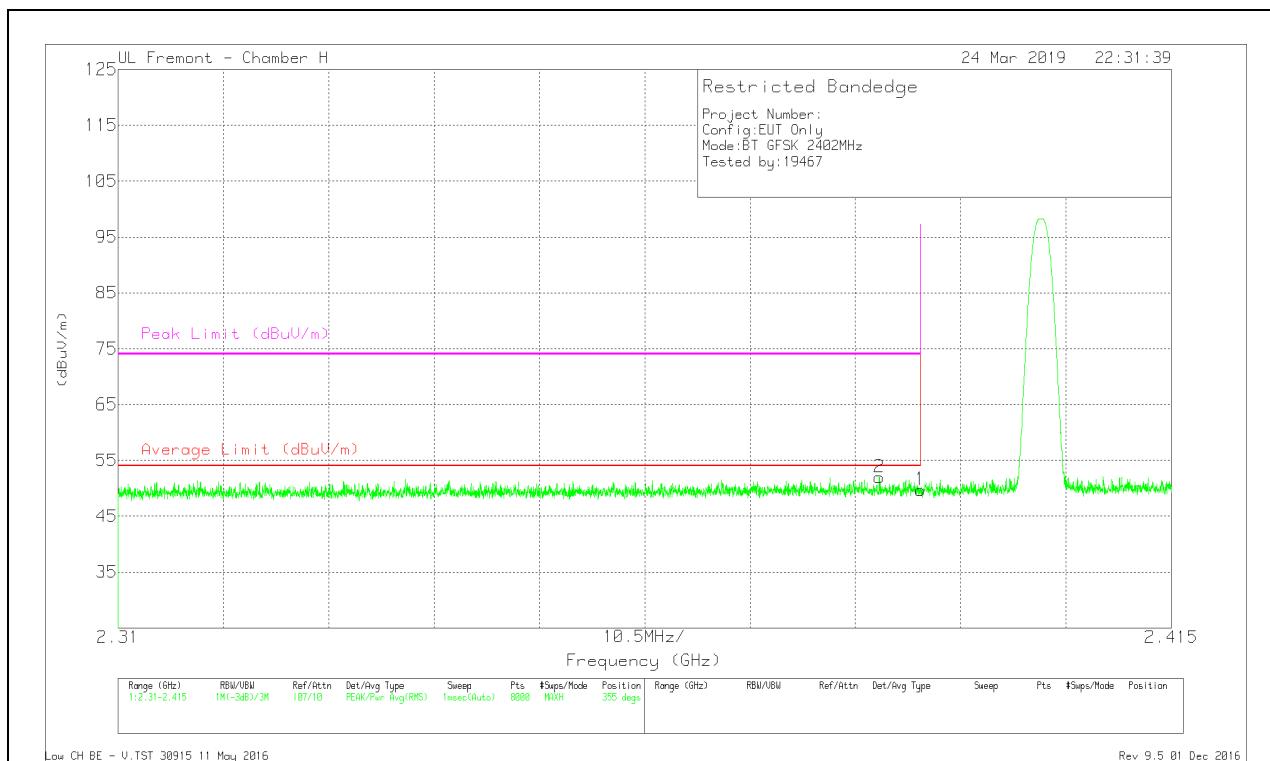


| Marker | Frequency (GHz) | Meter Reading (dBm) | Det | AF T136 (dB/m) | Amp/Cbl/Fltr/Pad (dB) | Corrected Reading (dBm) | Peak Limit (dBm) | PK Margin (dB) | Azimuth (Degs) | Height (cm) | Polarity |
|--------|-----------------|---------------------|-----|----------------|-----------------------|-------------------------|------------------|----------------|----------------|-------------|----------|
| 1 | * 2.39 | 40.88 | Pk | 31.6 | -23.5 | 48.98 | 74 | -25.02 | 49 | 111 | H |
| 2 | * 2.379 | 44.21 | Pk | 31.6 | -23.5 | 52.31 | 74 | -21.69 | 49 | 111 | H |

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

Pk - Peak detector

VERTICAL RESULT

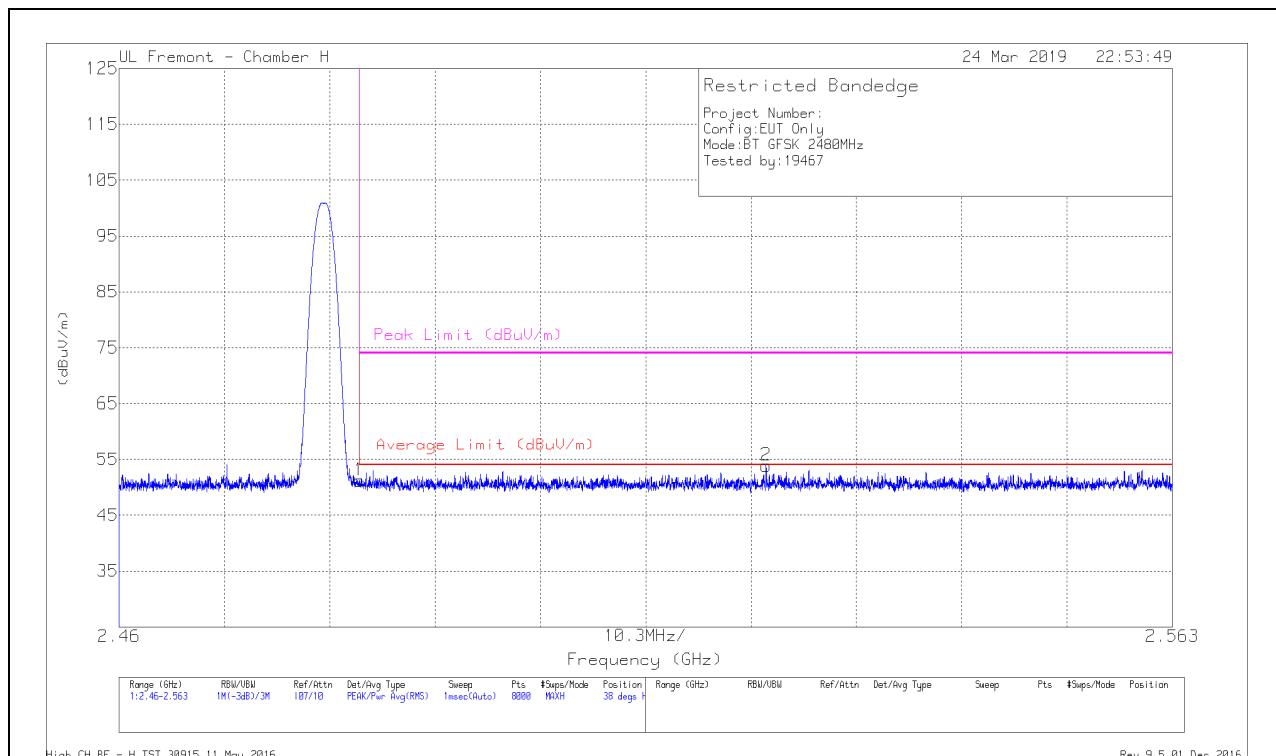


| Marker | Frequency (GHz) | Meter Reading (dBuV) | Det | AF T136 (dB/m) | Amp/Cbl/Filt/Pad (dB) | Corrected Reading (dBuV/m) | Peak Limit (dBuV/m) | PK Margin (dB) | Azimuth (Degs) | Height (cm) | Polarity |
|--------|-----------------|----------------------|-----|----------------|-----------------------|----------------------------|---------------------|----------------|----------------|-------------|----------|
| 1 | *2.39 | 41.58 | Pk | 31.6 | -23.5 | 49.68 | 74 | -24.32 | 355 | 117 | V |
| 2 | *2.386 | 43.86 | Pk | 31.6 | -23.5 | 51.96 | 74 | -22.04 | 355 | 117 | V |

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
 Pk - Peak detector

BANDEDGE (HIGH CHANNEL)

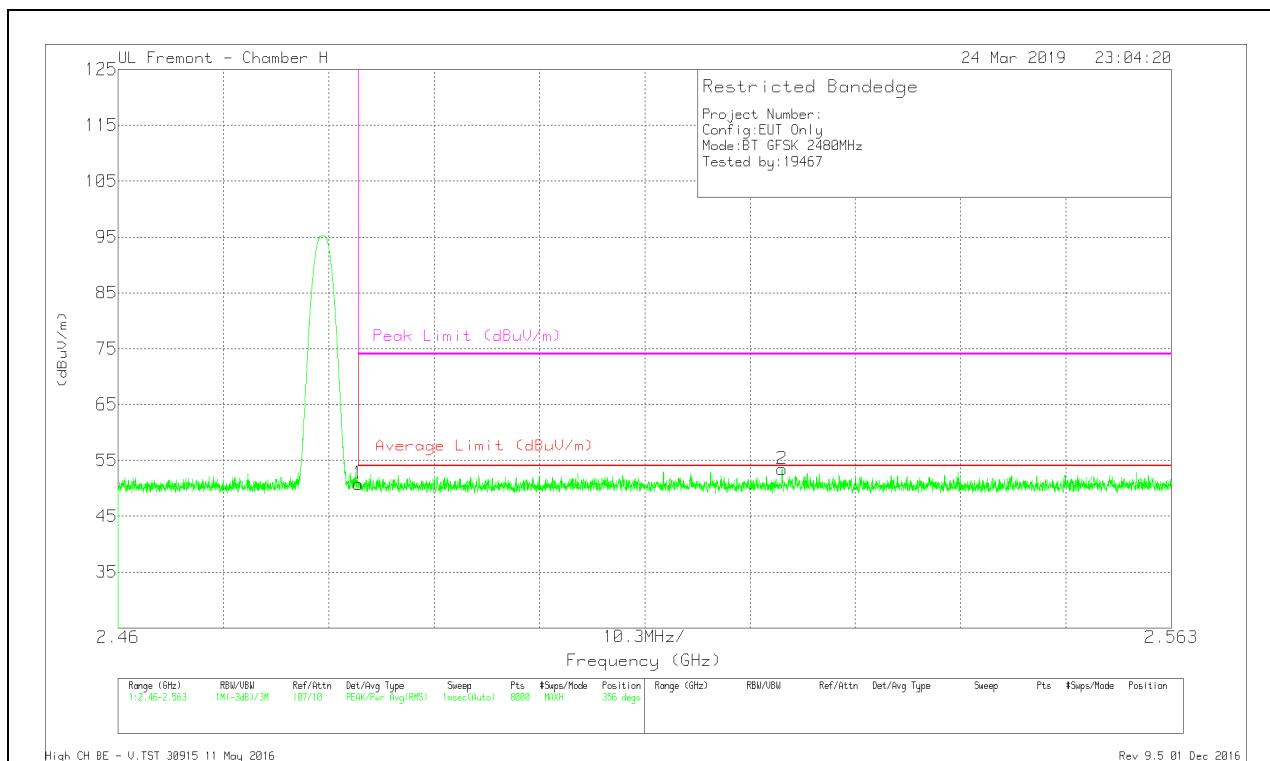
HORIZONTAL RESULT



| Marker | Frequency (GHz) | Meter Reading (dBuV) | Det | AF T136 (dB/m) | Amp/Cbl/Fltr/Pad (dB) | Corrected Reading (dBuV/m) | Peak Limit (dBuV/m) | PK Margin (dB) | Azimuth (Degs) | Height (cm) | Polarity |
|--------|-----------------|----------------------|-----|----------------|-----------------------|----------------------------|---------------------|----------------|----------------|-------------|----------|
| 1 | * 2.484 | 42.2 | Pk | 32.3 | -23.3 | 51.2 | 74 | -22.8 | 38 | 106 | H |
| 2 | 2.523 | 44.69 | Pk | 32.4 | -23.2 | 53.89 | 74 | -20.11 | 38 | 106 | H |

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
 Pk - Peak detector

VERTICAL RESULT

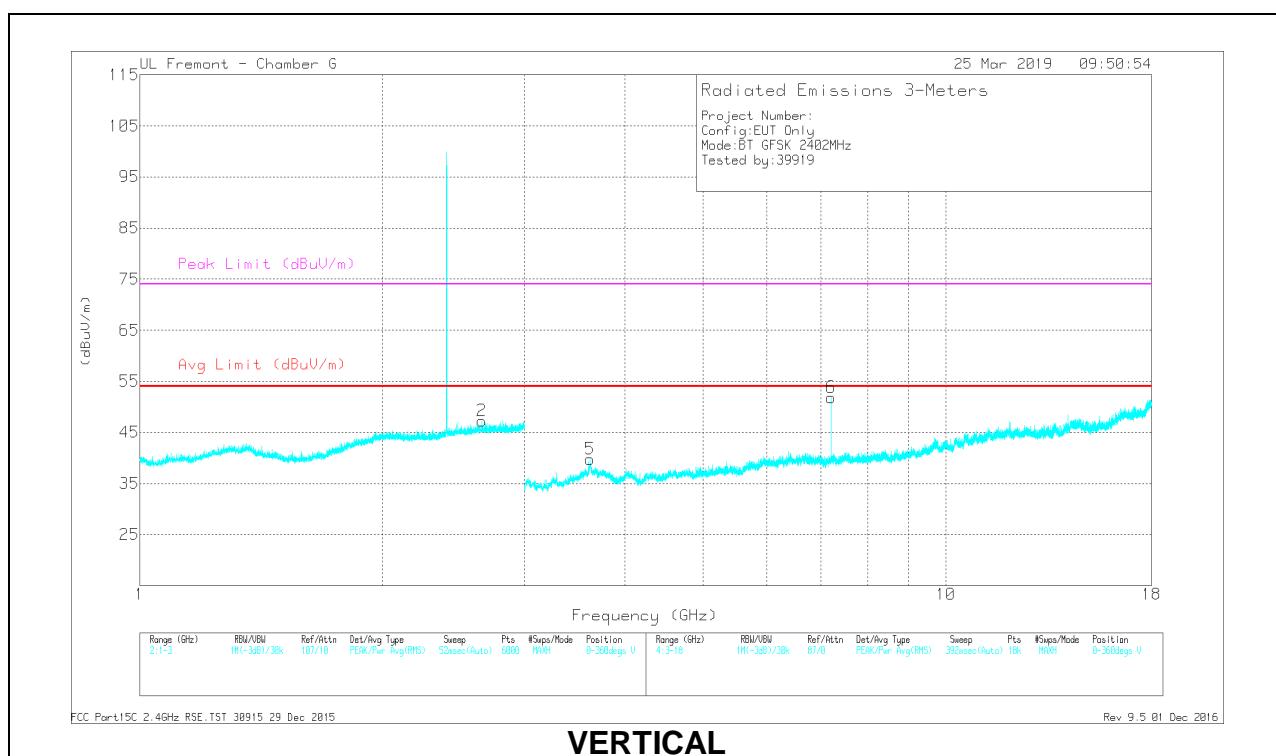
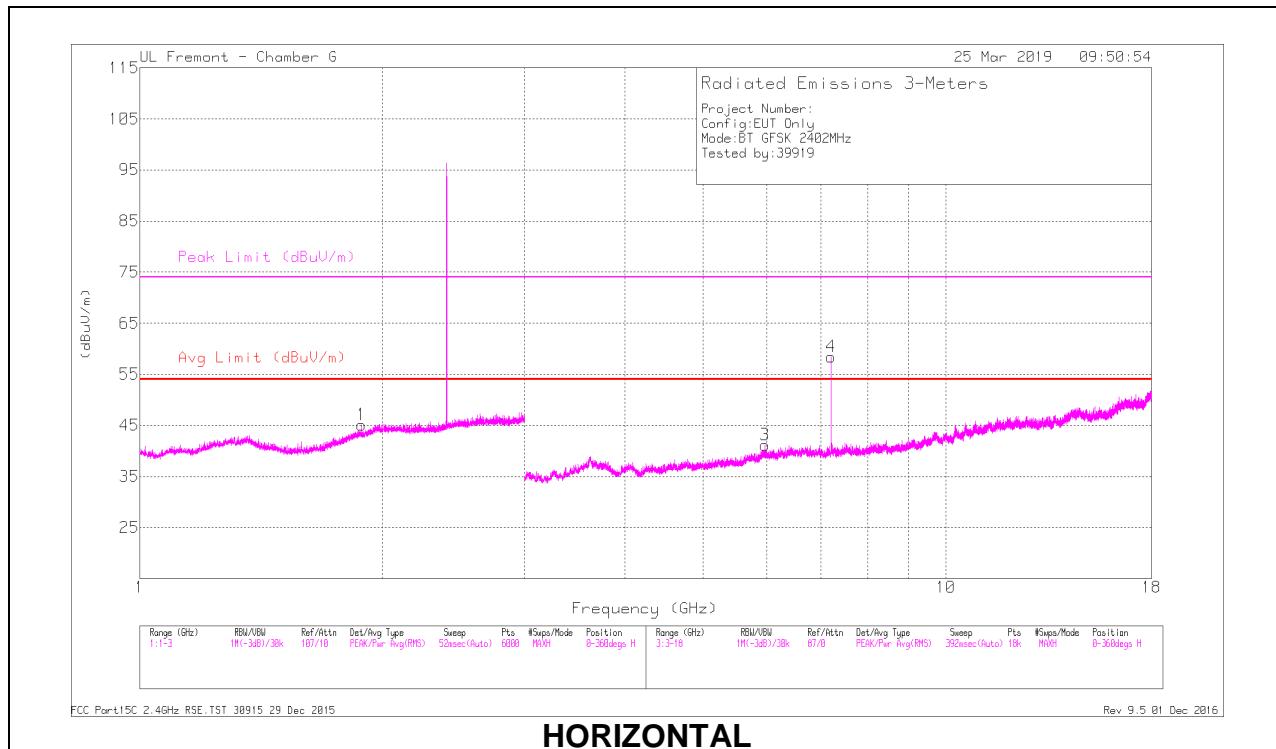


| Marker | Frequency (GHz) | Meter Reading (dBuV) | Det | AF T136 (dB/m) | Amp/Cbl/Filt/Pad (dB) | Corrected Reading (dBuV/m) | Peak Limit (dBuV/m) | PK Margin (dB) | Azimuth (Degs) | Height (cm) | Polarity |
|--------|-----------------|----------------------|-----|----------------|-----------------------|----------------------------|---------------------|----------------|----------------|-------------|----------|
| 1 | * 2.484 | 41.78 | Pk | 32.3 | -23.3 | 50.78 | 74 | -23.22 | 356 | 132 | V |
| 2 | 2.525 | 44.12 | Pk | 32.4 | -23.1 | 53.42 | 74 | -20.58 | 356 | 132 | V |

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector

HARMONICS AND SPURIOUS EMISSIONS

LOW CHANNEL RESULTS



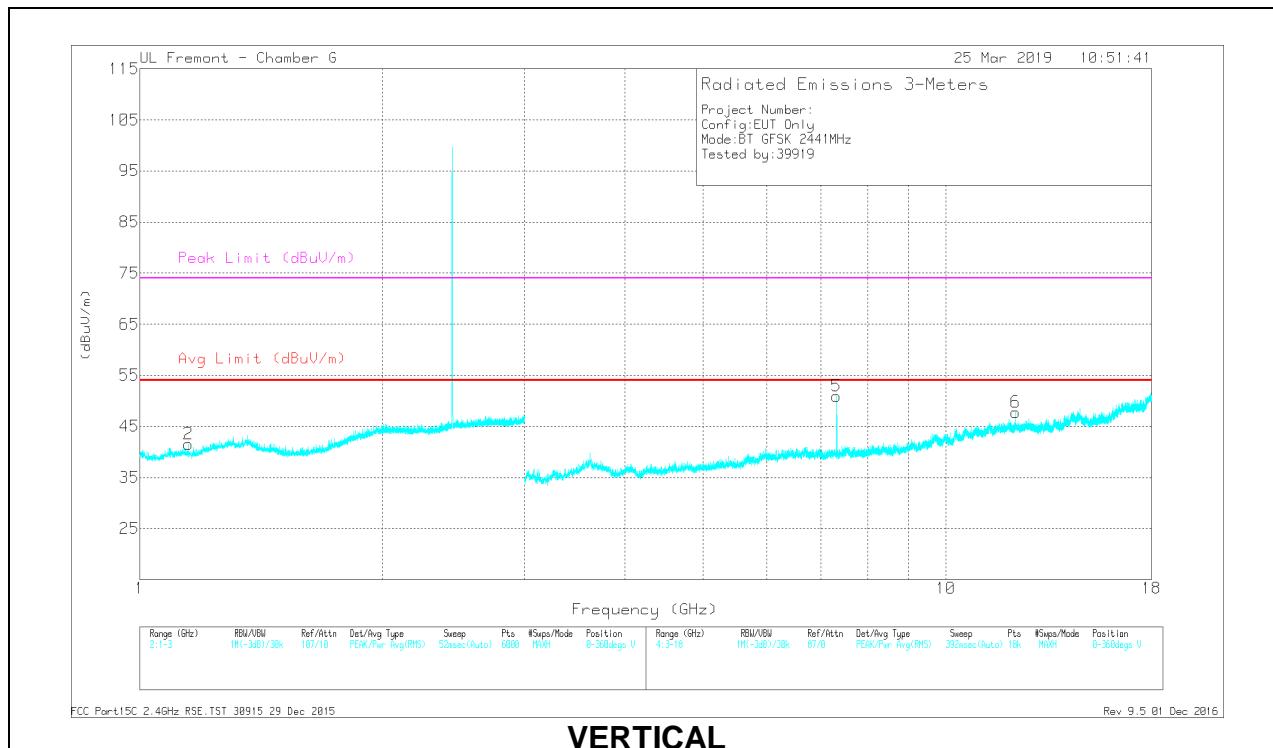
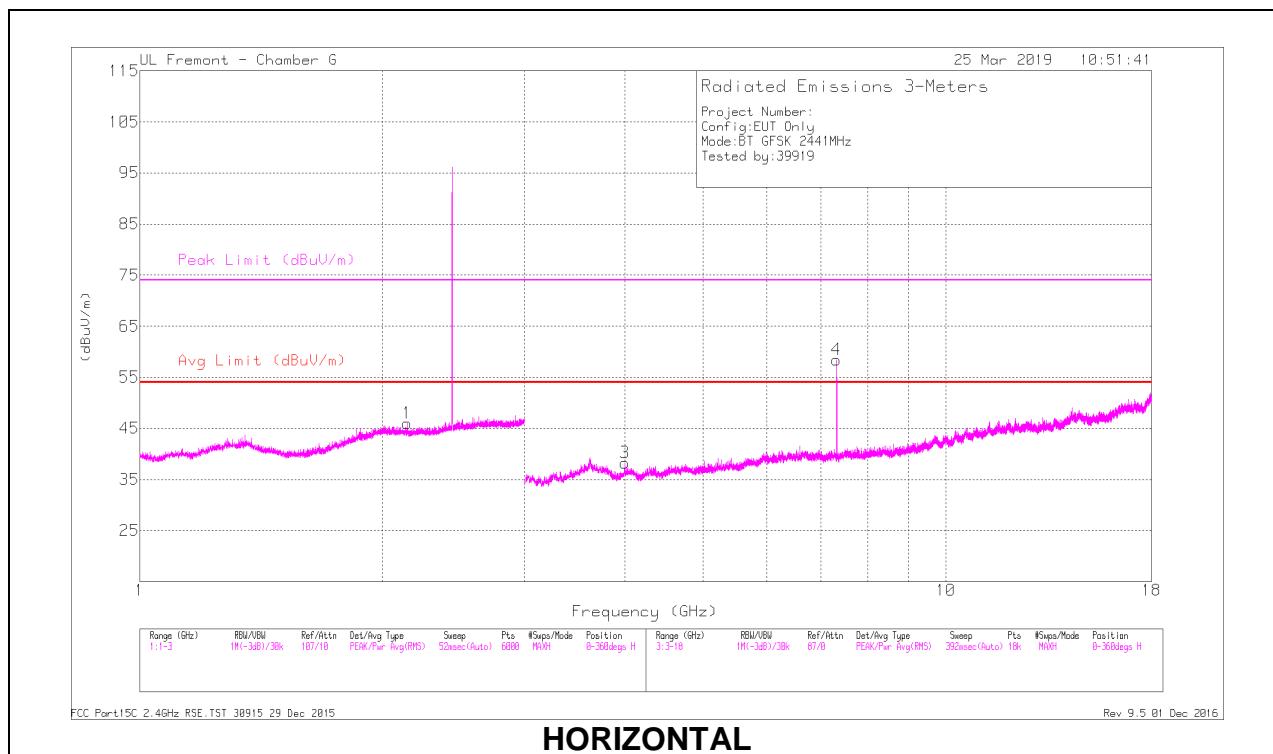
RADIATED EMISSIONS

| Marker | Frequency (GHz) | Meter Reading (dBuV) | Det | AF T120 (dB/m) | Amp/Cbl/Fltr/Pad (dB) | Corrected Reading (dBuV/m) | Peak Limit (dBuV/m) | PK Margin (dB) | Azimuth (Degs) | Height (cm) | Polarity |
|--------|-----------------|----------------------|------|----------------|-----------------------|----------------------------|---------------------|----------------|----------------|-------------|----------|
| 1 | 2.933 | 43.05 | PKFH | 32.6 | -21.7 | 53.95 | 74 | -20.05 | 183 | 227 | V |
| 2 | * 3.619 | 39.96 | PKFH | 35.7 | -30.2 | 45.46 | 74 | -28.54 | 43 | 224 | V |
| 3 | 5.968 | 38.46 | PKFH | 35.5 | -28.1 | 45.86 | 74 | -28.14 | 109 | 136 | H |
| 4 | 7.206 | 51.96 | PKFH | 35.8 | -27.8 | 59.96 | 74 | -14.04 | 274 | 101 | H |
| 5 | 1.886 | 42.21 | PKFH | 31.3 | -23 | 50.51 | 74 | -23.49 | 334 | 111 | H |
| 6 | 7.207 | 46.89 | PKFH | 35.8 | -27.8 | 54.89 | 74 | -19.11 | 145 | 177 | V |

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

PKFH - FHSS: RB=100k/1MHz VB=3 x RB, Peak

MID CHANNEL RESULTS



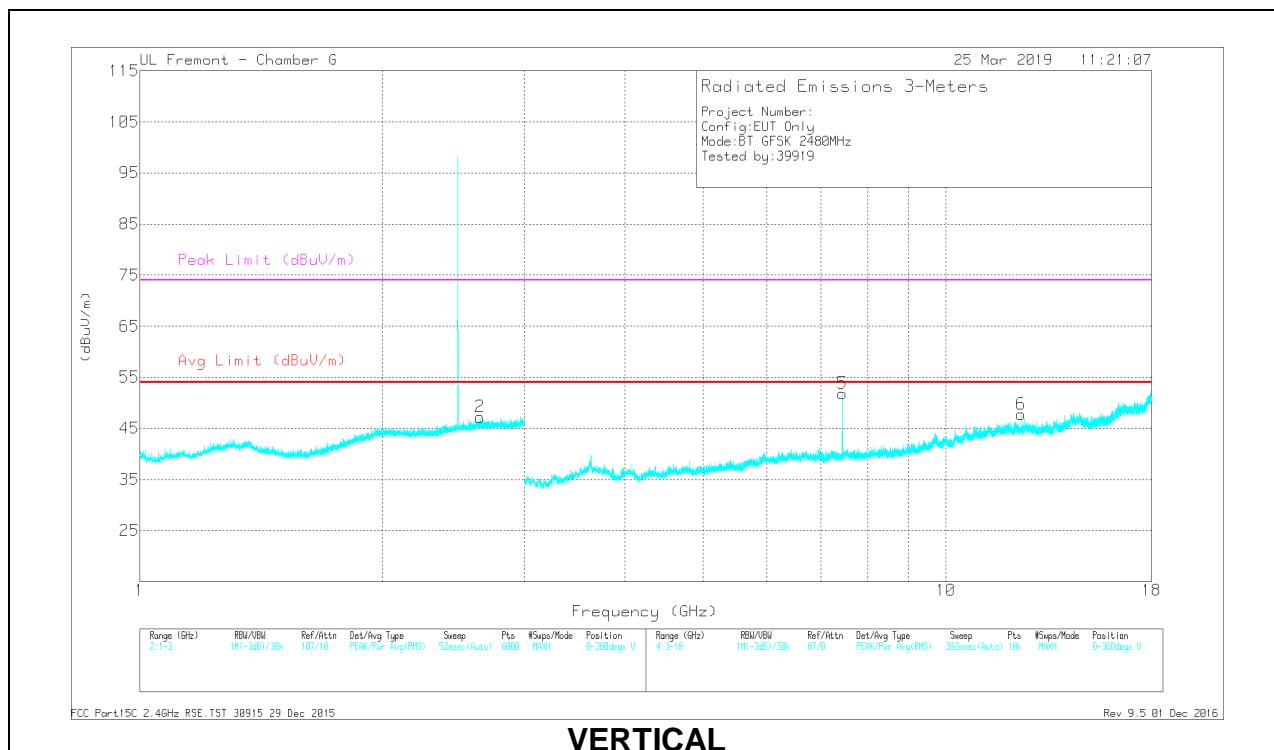
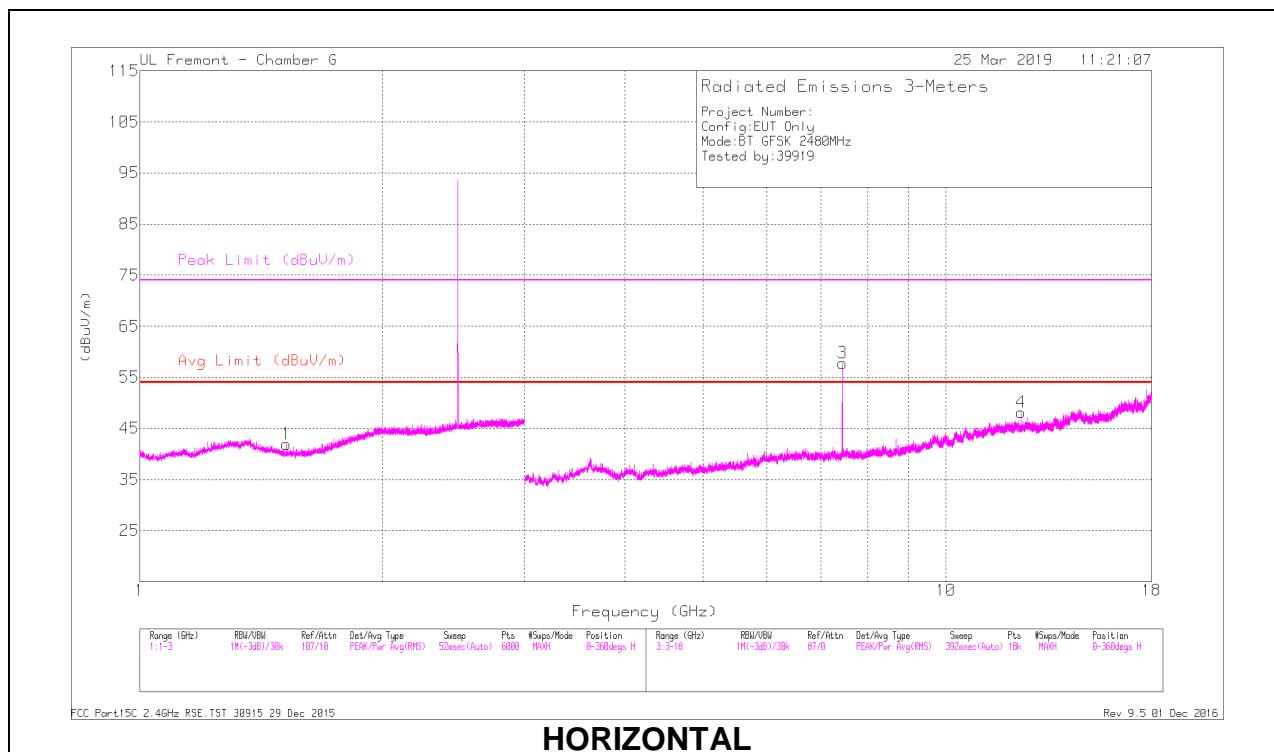
RADIATED EMISSIONS

| Marker | Frequency (GHz) | Meter Reading (dBuV) | Det | AF T120 (dB/m) | Amp/Cb/Fltr/P ad (dB) | Corrected Reading (dBuV/m) | Peak Limit (dBuV/m) | PK Margin (dB) | Azimuth (Degs) | Height (cm) | Polarity |
|--------|-----------------|----------------------|------|----------------|-----------------------|----------------------------|---------------------|----------------|----------------|-------------|----------|
| 1 | 2.147 | 41.58 | PKFH | 31.7 | -22.6 | 50.68 | 74 | -23.32 | 359 | 202 | H |
| 2 | * 1.149 | 42.57 | PKFH | 27.8 | -23.9 | 46.47 | 74 | -27.53 | 254 | 127 | V |
| 3 | * 3.999 | 38.81 | PKFH | 33.6 | -29.6 | 42.81 | 74 | -31.19 | 192 | 225 | H |
| 4 | * 7.323 | 51.73 | PKFH | 35.9 | -27.6 | 60.03 | 74 | -13.97 | 272 | 101 | H |
| 5 | * 7.323 | 45.98 | PKFH | 35.9 | -27.6 | 54.28 | 74 | -19.72 | 152 | 182 | V |
| 6 | * 12.206 | 36.37 | PKFH | 39.5 | -22.8 | 53.07 | 74 | -20.93 | 272 | 197 | V |

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

PKFH - FHSS: RB=100k/1MHz VB=3 x RB, Peak

HIGH CHANNEL RESULTS



RADIATED EMISSIONS

| Marker | Frequency (GHz) | Meter Reading (dBuV) | Det | AF T120 (dB/m) | Amp/Cbl/Fltr/Pad (dB) | Corrected Reading (dBuV/m) | Peak Limit (dBuV/m) | PK Margin (dB) | Azimuth (Degs) | Height (cm) | Polarity |
|--------|-----------------|----------------------|------|----------------|-----------------------|----------------------------|---------------------|----------------|----------------|-------------|----------|
| 1 | * 1.521 | 41.96 | PKFH | 27.7 | -23.3 | 46.36 | 74 | -27.64 | 212 | 152 | H |
| 2 | 2.644 | 41.12 | PKFH | 32.6 | -22.1 | 51.62 | 74 | -22.38 | 174 | 184 | V |
| 3 | * 7.44 | 51.88 | PKFH | 36 | -27.9 | 59.98 | 74 | -14.02 | 274 | 105 | H |
| 4 | * 12.4 | 35.6 | PKFH | 39.5 | -23.6 | 51.5 | 74 | -22.5 | 320 | 114 | H |
| 5 | * 7.44 | 45.83 | PKFH | 36 | -27.9 | 53.93 | 74 | -20.07 | 134 | 212 | V |
| 6 | * 12.401 | 37.71 | PKFH | 39.5 | -23.6 | 53.61 | 74 | -20.39 | 151 | 198 | V |

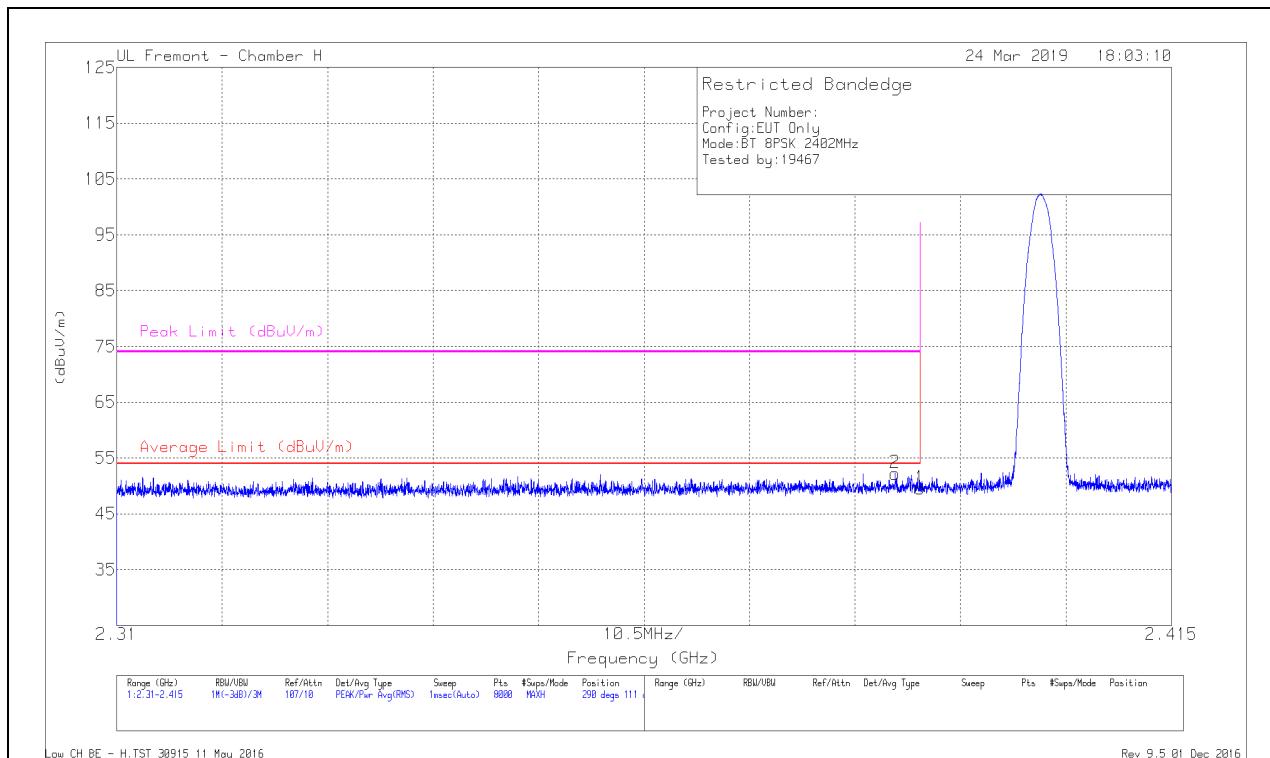
* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

PKFH - FHSS: RB=100k/1MHz VB=3 x RB, Peak

9.1.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

BANDEDGE (LOW CHANNEL)

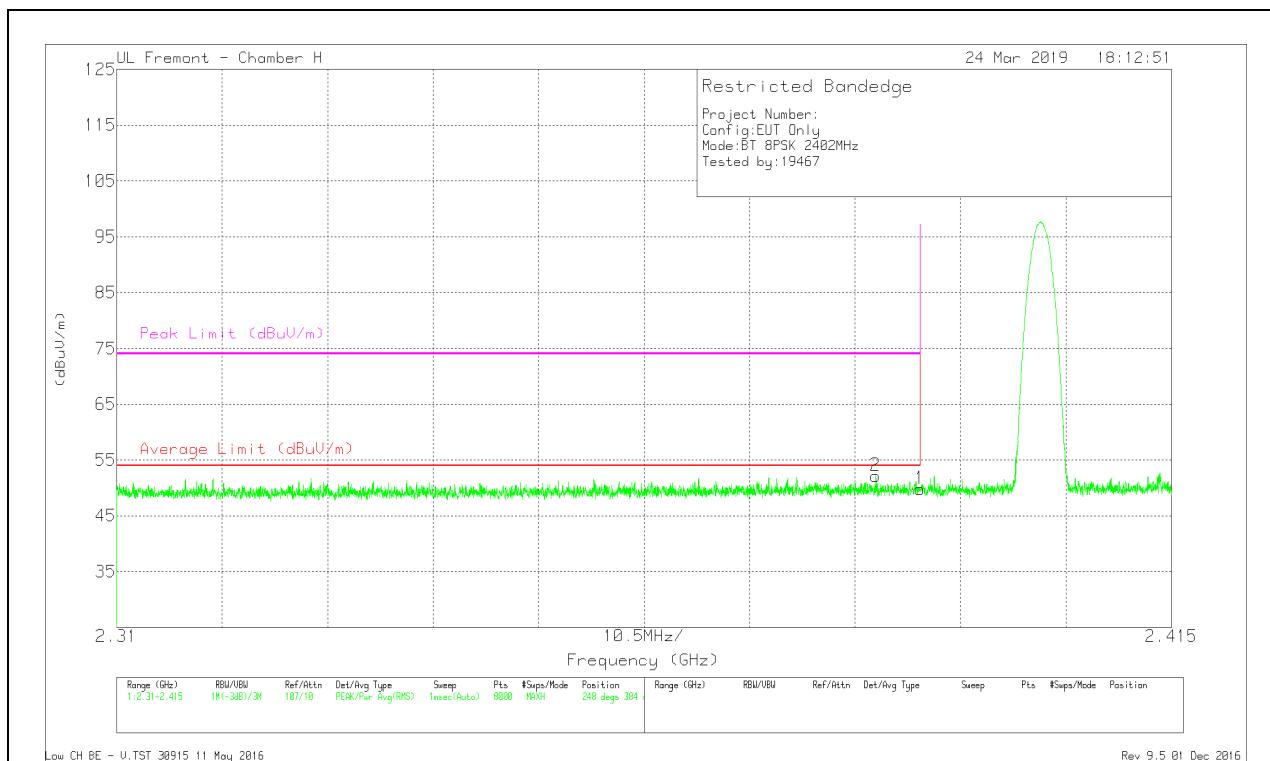
HORIZONTAL RESULT



| Marker | Frequency (GHz) | Meter Reading (dBuV) | Det | AF T136 (dB/m) | Amp/Cbl/Fltr/Pad (dB) | Corrected Reading (dBuV/m) | Peak Limit (dBuV/m) | PK Margin (dB) | Azimuth (Degs) | Height (cm) | Polarity |
|--------|-----------------|----------------------|-----|----------------|-----------------------|----------------------------|---------------------|----------------|----------------|-------------|----------|
| 1 | * 2.39 | 41.49 | Pk | 31.6 | -23.5 | 49.59 | 74 | -24.41 | 290 | 111 | H |
| 2 | * 2.387 | 44.12 | Pk | 31.6 | -23.5 | 52.22 | 74 | -21.78 | 290 | 111 | H |

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector

VERTICAL RESULT

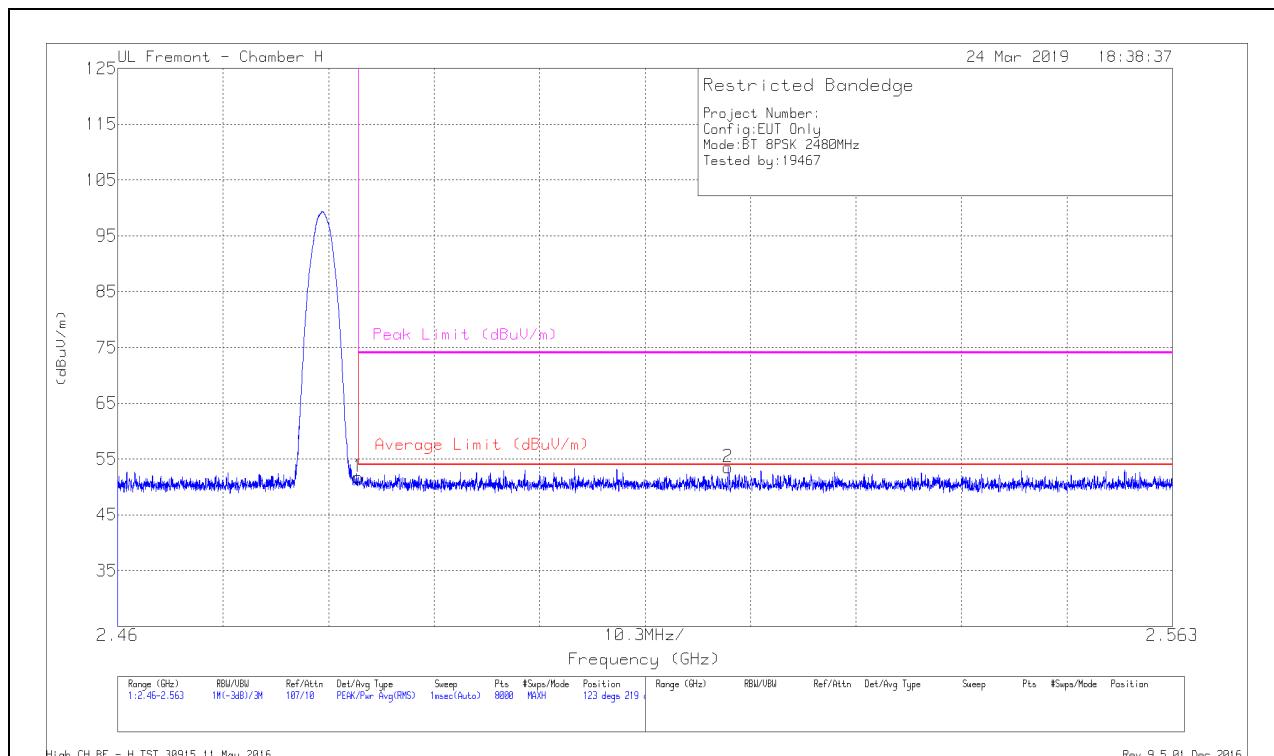


* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector

| Marker | Frequency (GHz) | Meter Reading (dBuV) | Det | AF T136 (dB/m) | Amp/Cbl/Filt /Pad (dB) | Corrected Reading (dBuV/m) | Average Limit (dBuV/m) | Margin (dB) | Peak Limit (dBuV/m) | PK Margin (dB) | Azimuth (Degs) | Height (cm) | Polarity |
|--------|-----------------|----------------------|-----|----------------|------------------------|----------------------------|------------------------|-------------|---------------------|----------------|----------------|-------------|----------|
| 1 | * 2.39 | 41.65 | Pk | 31.6 | -23.5 | 49.75 | - | - | 74 | -24.25 | 248 | 384 | V |
| 2 | * 2.386 | 44.08 | Pk | 31.6 | -23.5 | 52.18 | - | - | 74 | -21.82 | 248 | 384 | V |

BANDEDGE (HIGH CHANNEL)

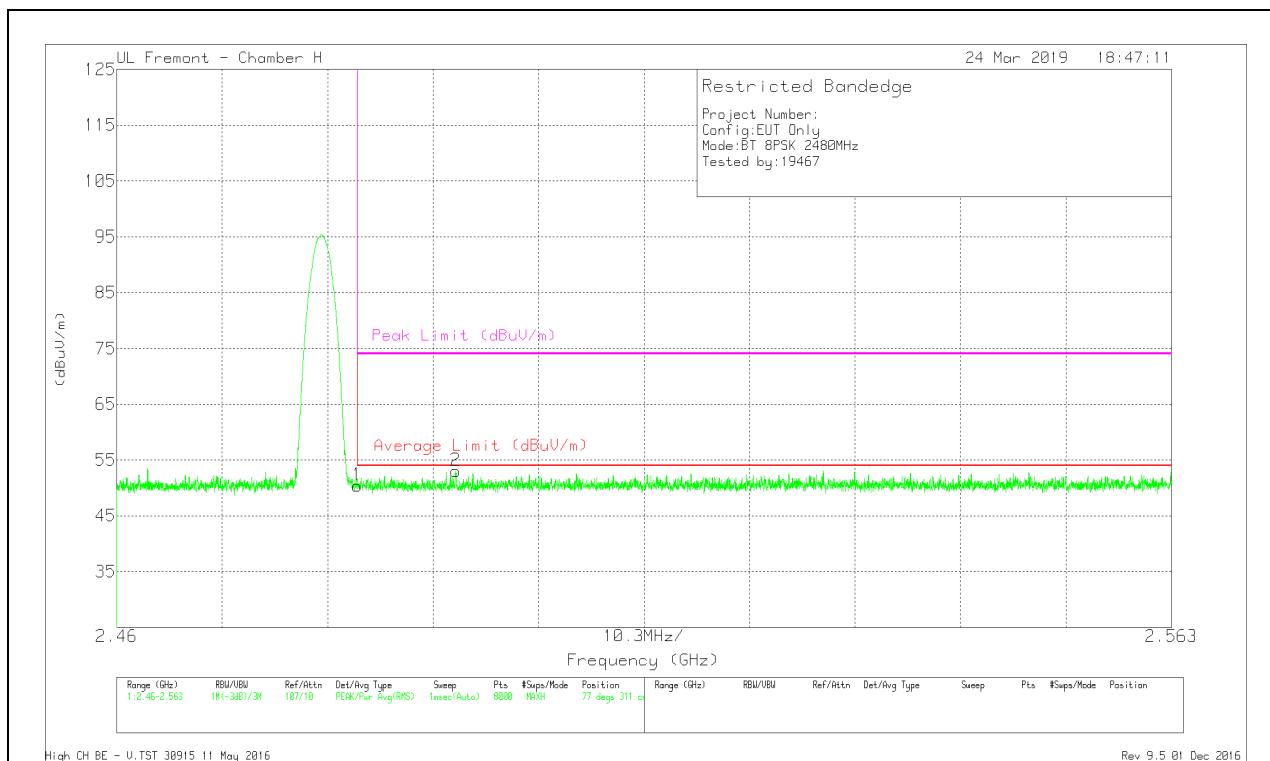
HORIZONTAL RESULT



| Marker | Frequency (GHz) | Meter Reading (dBuV) | Det | AF T136 (dB/m) | Amp/Cbl/Filtr/Pad (dB) | Corrected Reading (dBuV/m) | Peak Limit (dBuV/m) | PK Margin (dB) | Azimuth (Degs) | Height (cm) | Polarity |
|--------|-----------------|----------------------|-----|----------------|------------------------|----------------------------|---------------------|----------------|----------------|-------------|----------|
| 1 | * 2.484 | 42.77 | Pk | 32.3 | -23.3 | 51.77 | 74 | -22.23 | 123 | 219 | H |
| 2 | 2.52 | 44.38 | Pk | 32.3 | -23.2 | 53.48 | 74 | -20.52 | 123 | 219 | H |

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
 Pk - Peak detector

VERTICAL RESULT

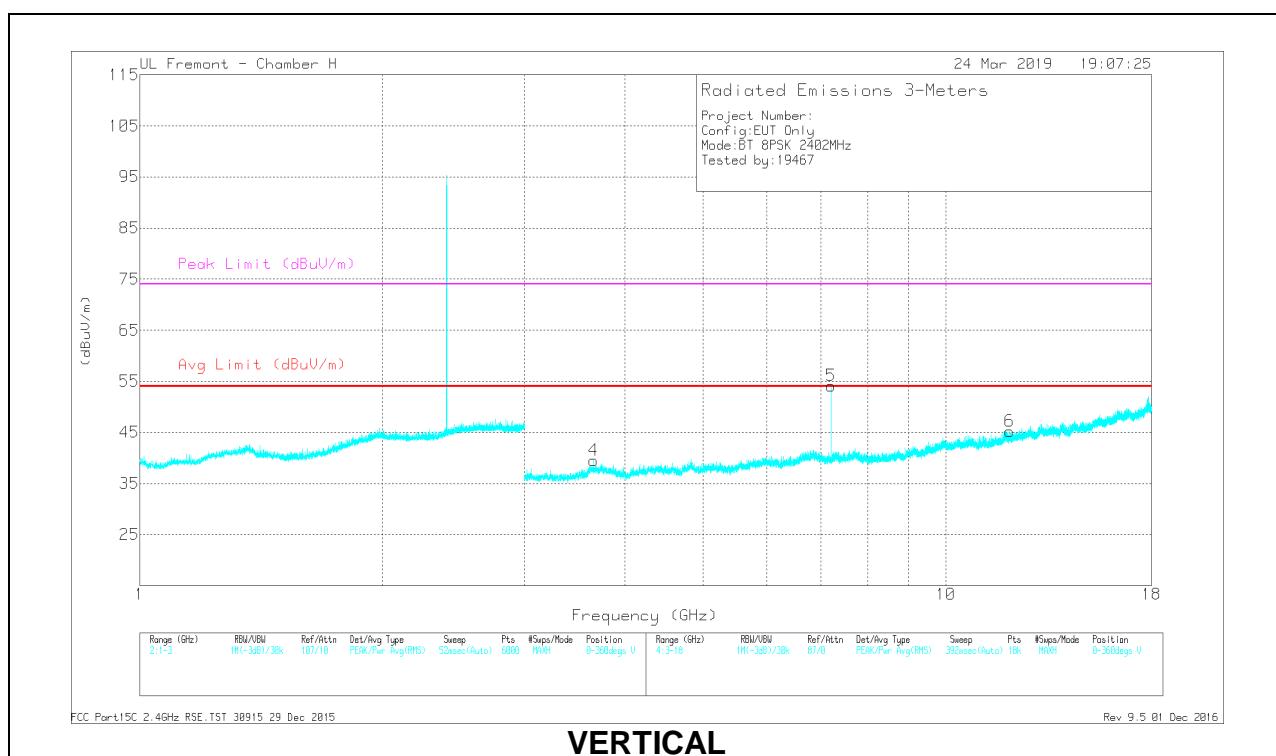
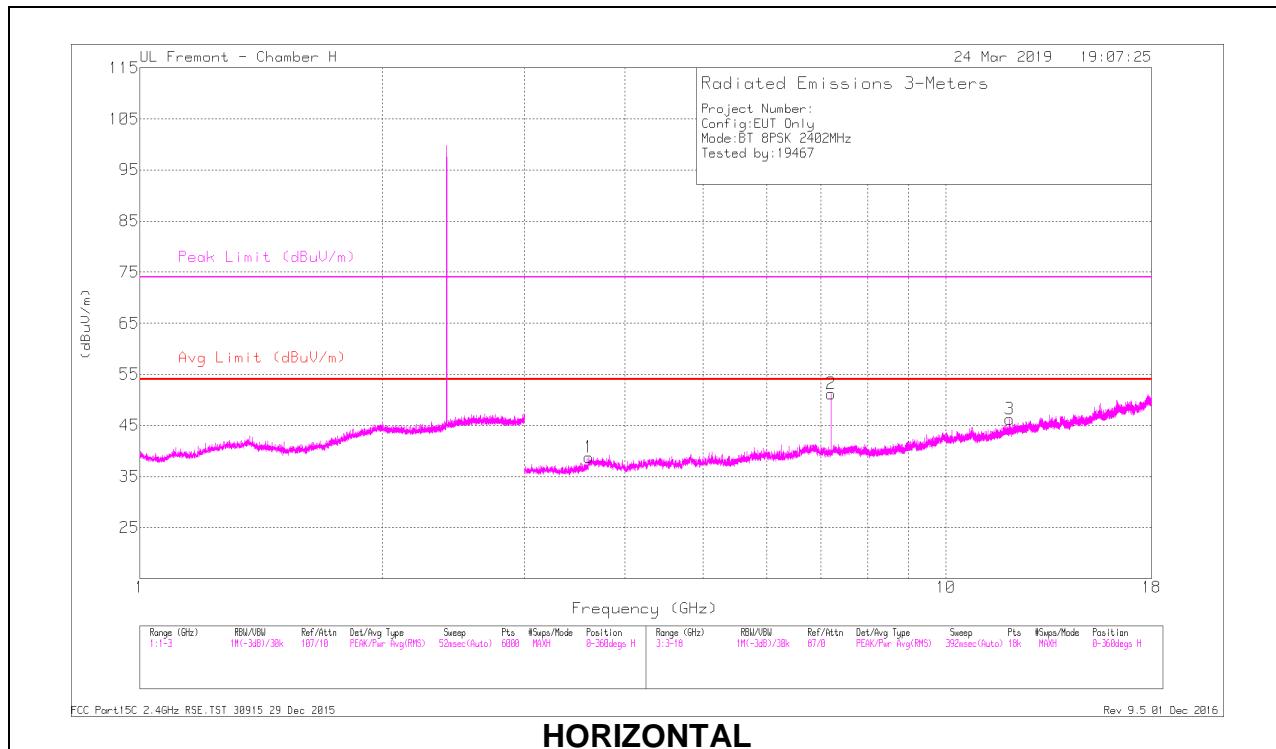


* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
 Pk - Peak detector

| Marker | Frequency (GHz) | Meter Reading (dBuV) | Det | AF T136 (dB/m) | Amp/Cbl/Fltr/P ad (dB) | Corrected Reading (dBuV/m) | Peak Limit (dBuV/m) | PK Margin (dB) | Azimuth (Degs) | Height (cm) | Polarity |
|--------|-----------------|----------------------|-----|----------------|------------------------|----------------------------|---------------------|----------------|----------------|-------------|----------|
| 1 | *2.484 | 41.43 | Pk | 32.3 | -23.3 | 50.43 | 74 | -23.57 | 77 | 311 | V |
| 2 | *2.493 | 44.02 | Pk | 32.3 | -23.3 | 53.02 | 74 | -20.98 | 77 | 311 | V |

HARMONICS AND SPURIOUS EMISSIONS

LOW CHANNEL RESULTS

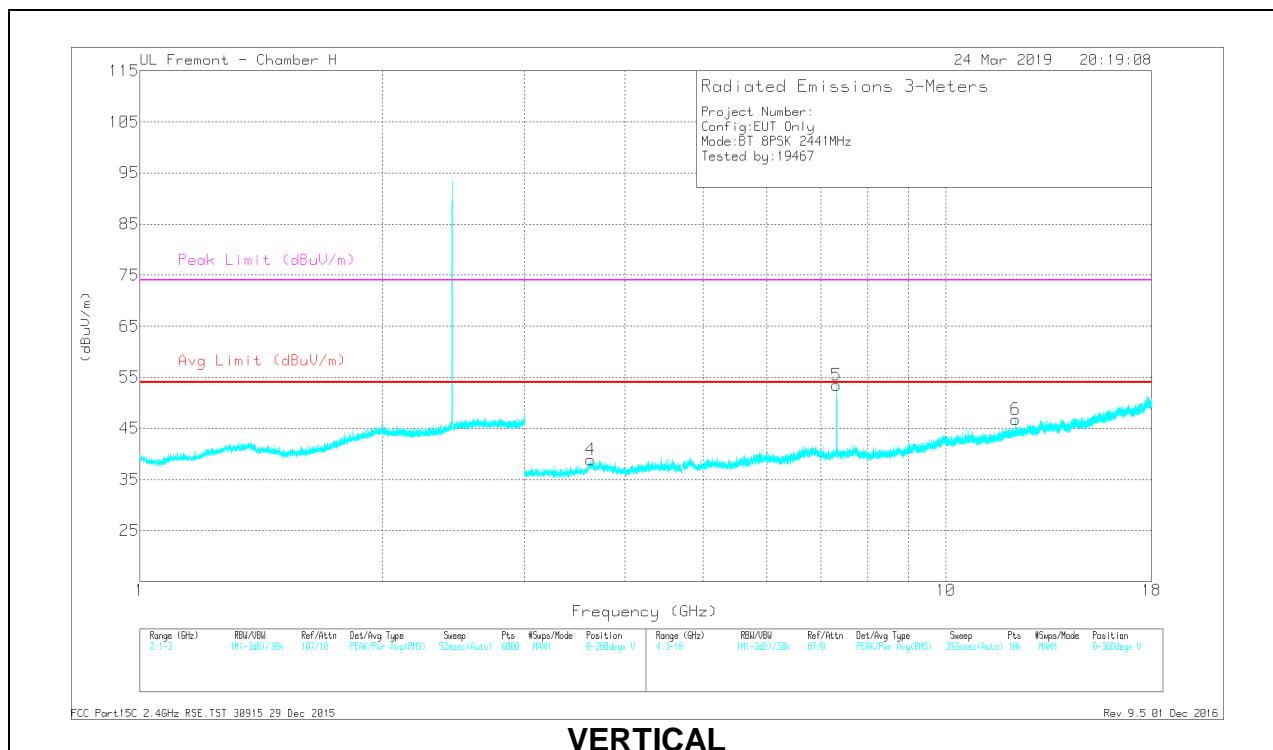
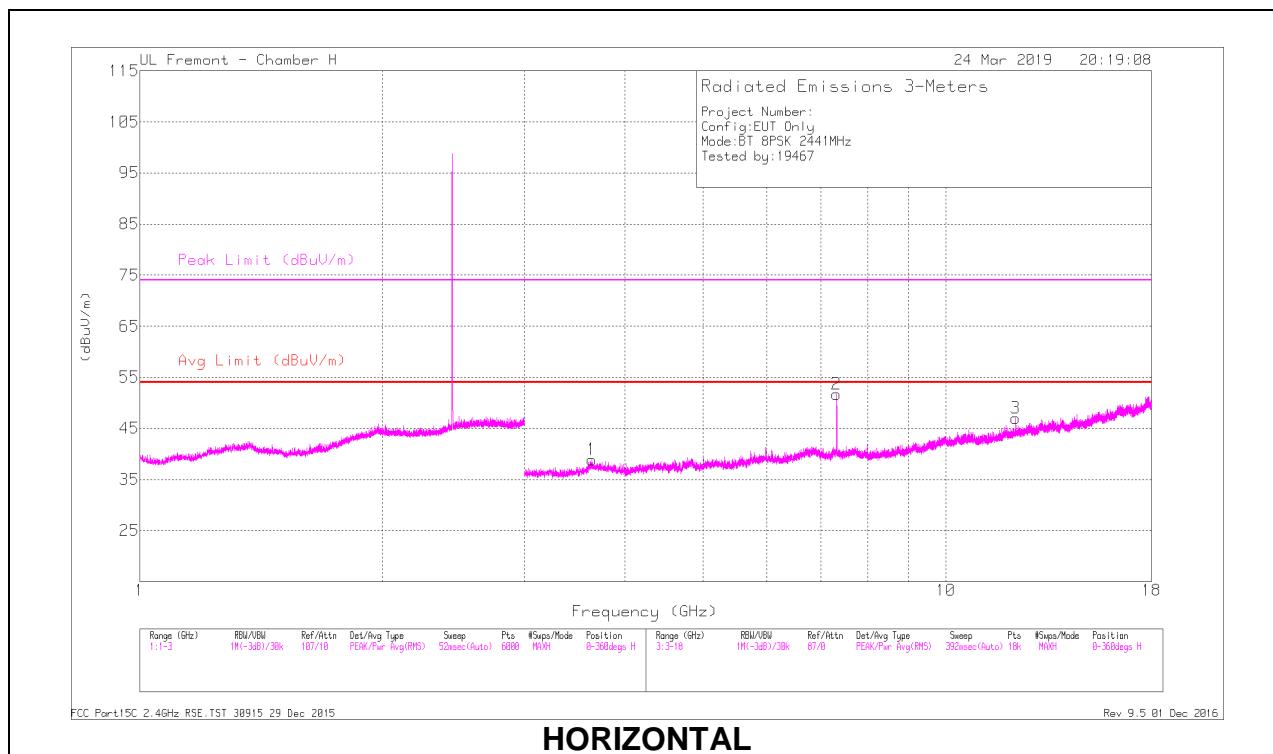


RADIATED EMISSIONS

| Marker | Frequency (GHz) | Meter Reading (dBuV) | Det | AF T136 (dB/m) | Amp/Cbl/Fltr/Pad (dB) | Corrected Reading (dBuV/m) | Peak Limit (dBuV/m) | PK Margin (dB) | Azimuth (Degs) | Height (cm) | Polarity |
|--------|-----------------|----------------------|------|----------------|-----------------------|----------------------------|---------------------|----------------|----------------|-------------|----------|
| 1 | * 3.607 | 39.59 | PKFH | 33.1 | -29.8 | 42.89 | 74 | -31.11 | 303 | 117 | H |
| 2 | 7.206 | 47.73 | PKFH | 36.3 | -28 | 56.03 | - | - | 74 | 103 | H |
| 3 | * 12.009 | 36.57 | PKFH | 38.8 | -23.2 | 52.17 | 74 | -21.83 | 289 | 100 | H |
| 4 | * 3.659 | 40.05 | PKFH | 33.1 | -29.6 | 43.55 | 74 | -30.45 | 258 | 304 | V |
| 5 | 7.206 | 51.04 | PKFH | 36.3 | -28 | 59.34 | - | - | 260 | 244 | V |
| 6 | * 12.011 | 37.9 | PKFH | 38.9 | -23.2 | 53.6 | 74 | -20.4 | 327 | 117 | V |

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
PKFH - FHSS: RB=100k/1MHz VB=3 x RB, Peak

MID CHANNEL RESULTS



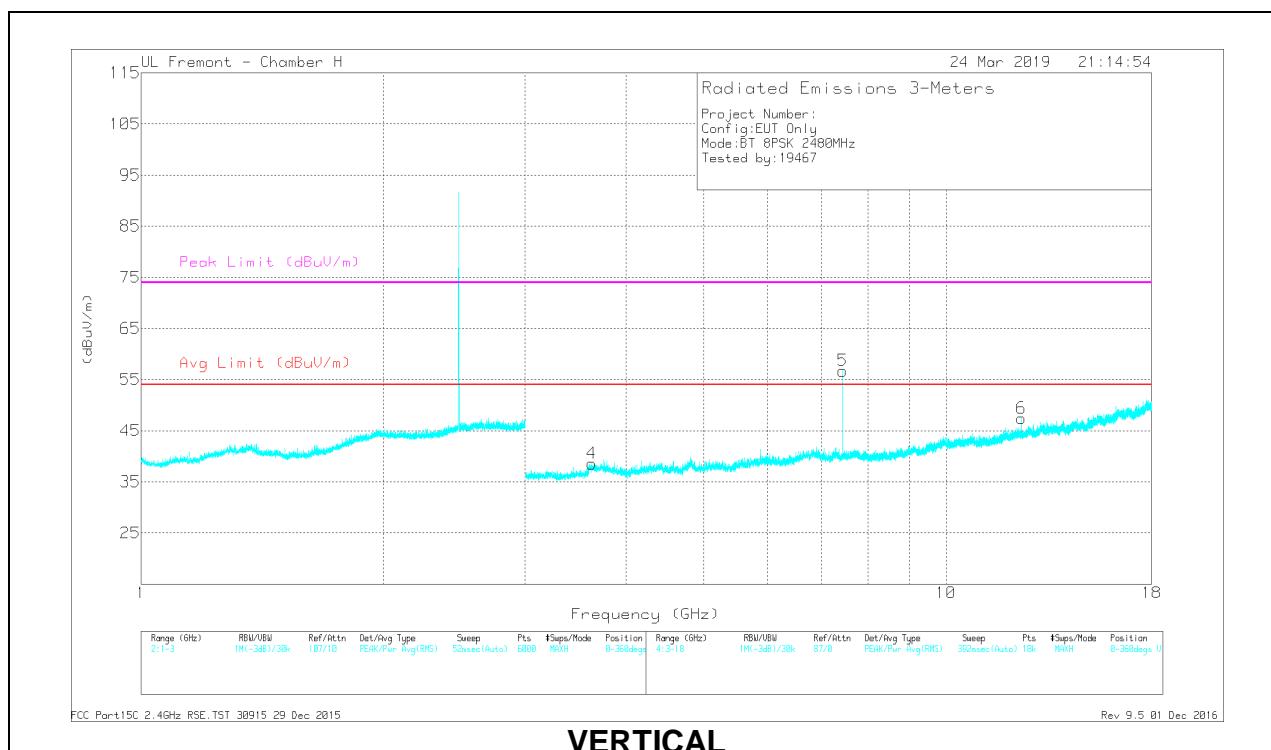
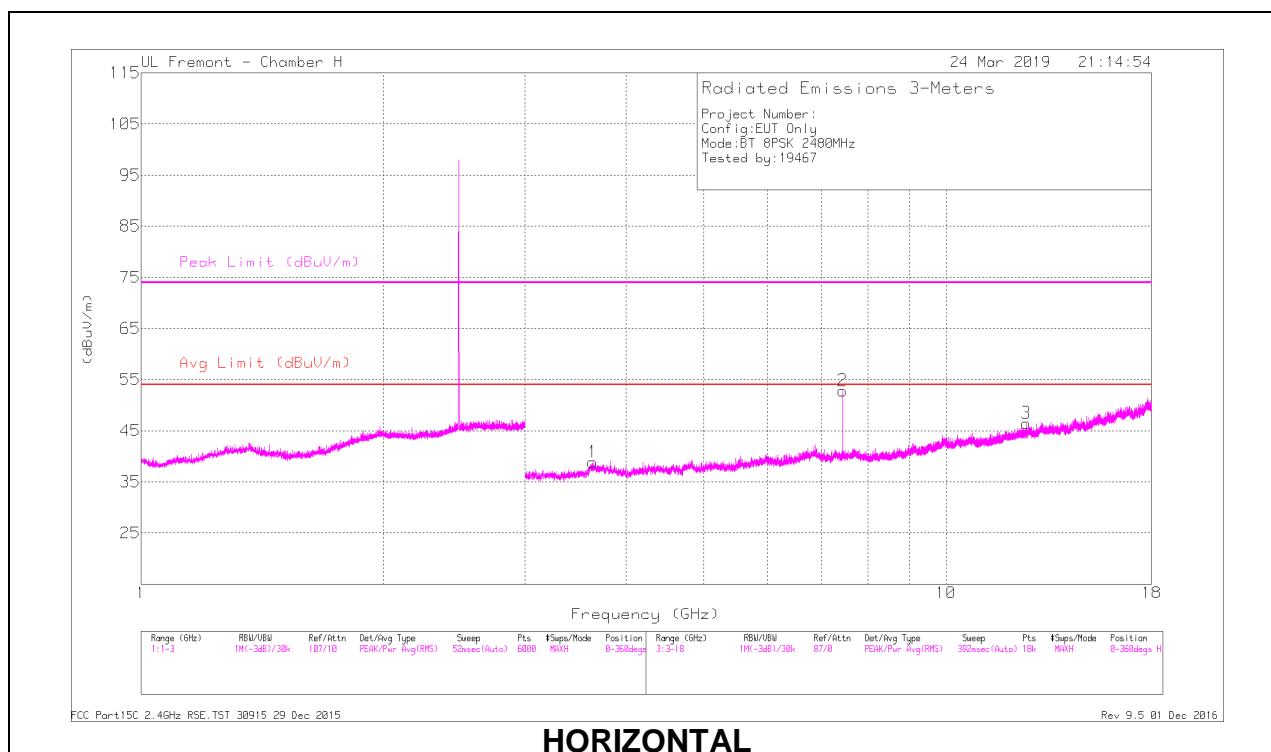
RADIATED EMISSIONS

| Marker | Frequency (GHz) | Meter Reading (dBuV) | Det | AF T136 (dB/m) | Amp/Cbl/Fltr/Pad (dB) | Corrected Reading (dBuV/m) | Peak Limit (dBuV/m) | PK Margin (dB) | Azimuth (Degs) | Height (cm) | Polarity |
|--------|-----------------|----------------------|------|----------------|-----------------------|----------------------------|---------------------|----------------|----------------|-------------|----------|
| 1 | * 3.635 | 40.3 | PKFH | 33.1 | -29.5 | 43.9 | 74 | -30.1 | 314 | 382 | H |
| 2 | * 7.323 | 46.8 | PKFH | 36.4 | -26.6 | 56.6 | 74 | -17.4 | 151 | 101 | H |
| 3 | * 12.204 | 37.64 | PKFH | 39.1 | -23 | 53.74 | 74 | -20.26 | 44 | 111 | H |
| 4 | * 3.629 | 40.24 | PKFH | 33.1 | -29.7 | 43.64 | 74 | -30.36 | 269 | 373 | V |
| 5 | * 7.323 | 48.26 | PKFH | 36.4 | -26.6 | 58.06 | 74 | -15.94 | 146 | 101 | V |
| 6 | * 12.205 | 37.22 | PKFH | 39.1 | -23 | 53.32 | 74 | -20.68 | 54 | 103 | V |

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

PKFH - FHSS: RB=100k/1MHz VB=3 x RB, Peak

HIGH CHANNEL RESULTS



RADIATED EMISSIONS

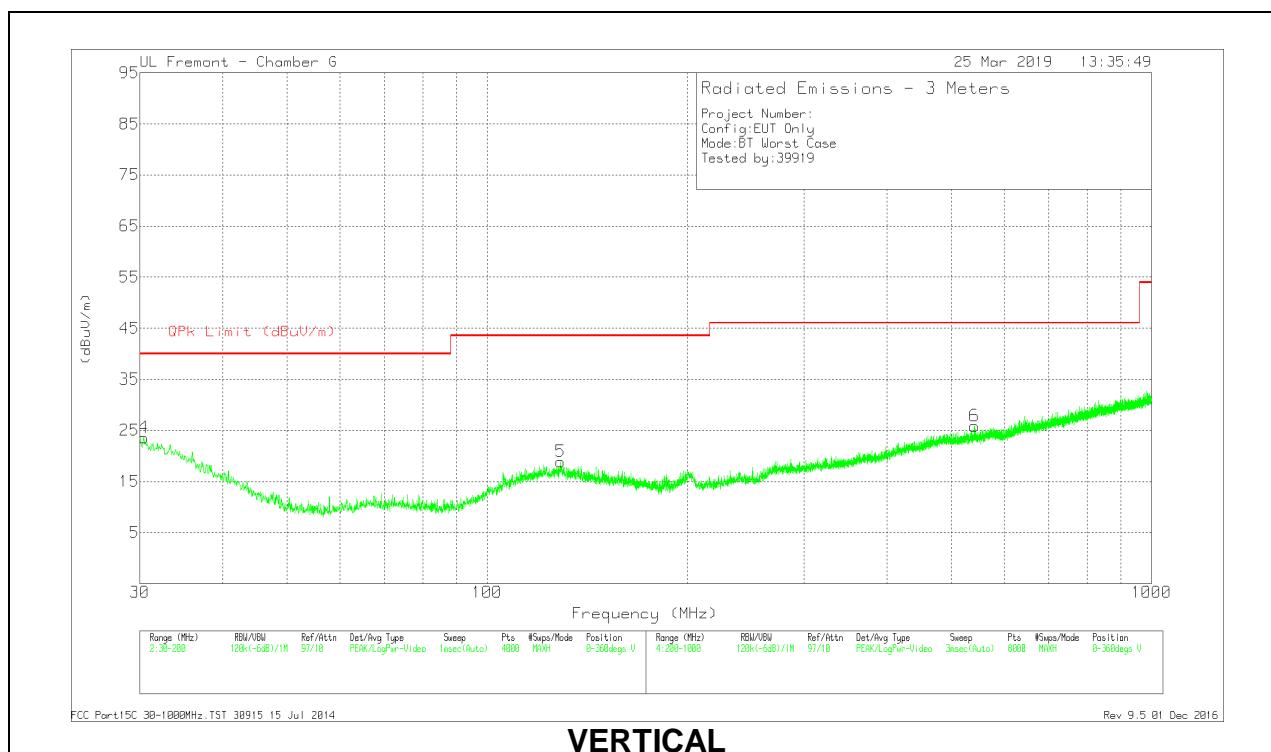
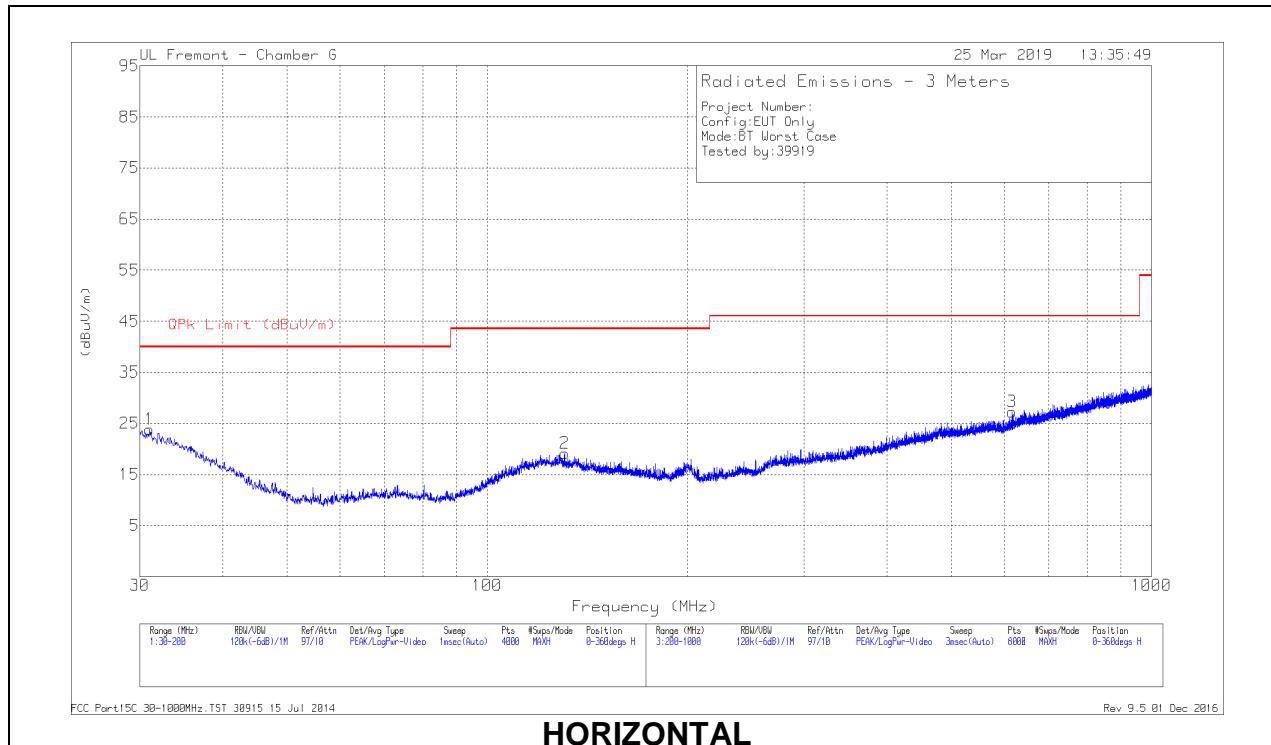
| Marker | Frequency (GHz) | Meter Reading (dBuV) | Det | AF T136 (dB/m) | Amp/Cbl/Fltr/Pad (dB) | Corrected Reading (dBuV/m) | Peak Limit (dBuV/m) | PK Margin (dB) | Azimuth (Degs) | Height (cm) | Polarity |
|--------|-----------------|----------------------|------|----------------|-----------------------|----------------------------|---------------------|----------------|----------------|-------------|----------|
| 1 | * 3.639 | 40.63 | PKFH | 33.1 | -29.5 | 44.23 | 74 | -29.77 | 172 | 244 | H |
| 2 | * 7.44 | 47.88 | PKFH | 36.5 | -27.3 | 57.08 | 74 | -16.92 | 229 | 103 | H |
| 3 | * 12.581 | 35.22 | PKFH | 39.2 | -22.8 | 51.62 | 74 | -22.38 | 180 | 354 | H |
| 4 | * 3.63 | 39.45 | PKFH | 33.1 | -29.6 | 42.95 | 74 | -31.05 | 189 | 330 | V |
| 5 | * 7.44 | 52.15 | PKFH | 36.5 | -27.3 | 61.35 | 74 | -12.65 | 175 | 248 | V |
| 6 | * 12.399 | 38.45 | PKFH | 39.1 | -23.2 | 54.35 | 74 | -19.65 | 254 | 108 | V |

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

PKFH - FHSS: RB=100k/1MHz VB=3 x RB, Peak

9.2. WORST CASE BELOW 1 GHZ

SPURIOUS EMISSIONS 30 TO 1000 MHz (WORST-CASE CONFIGURATION)

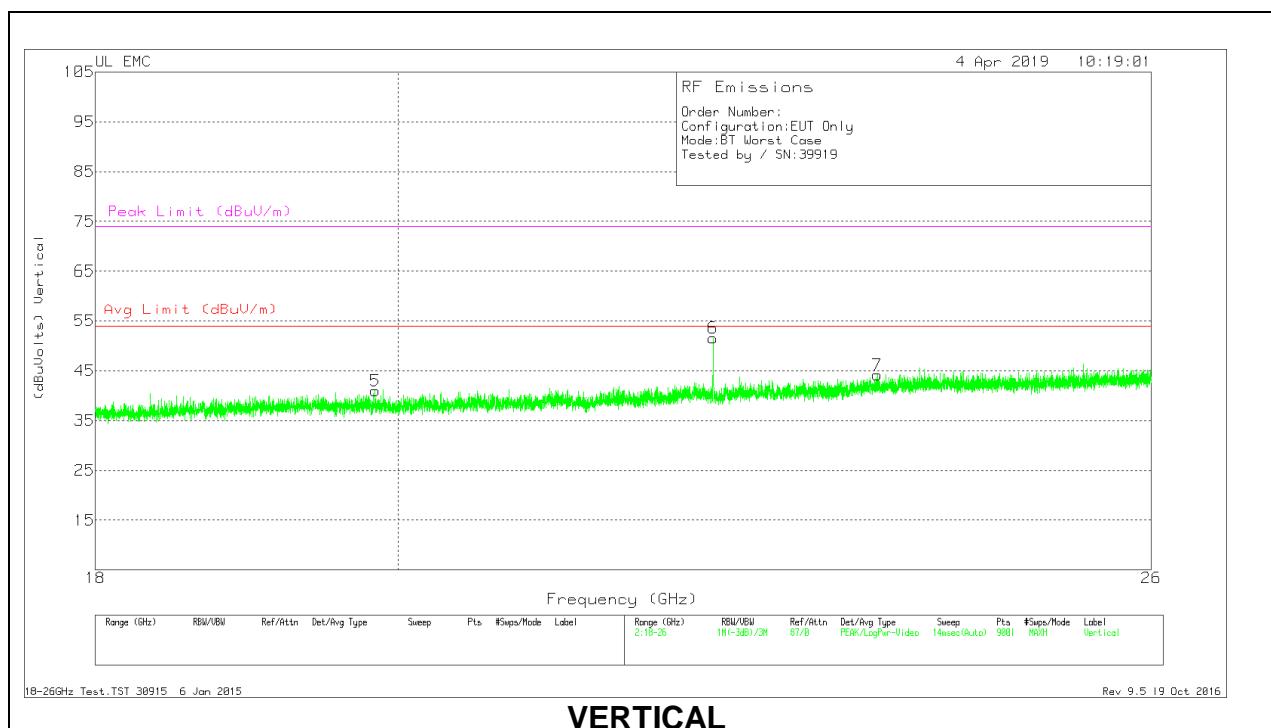
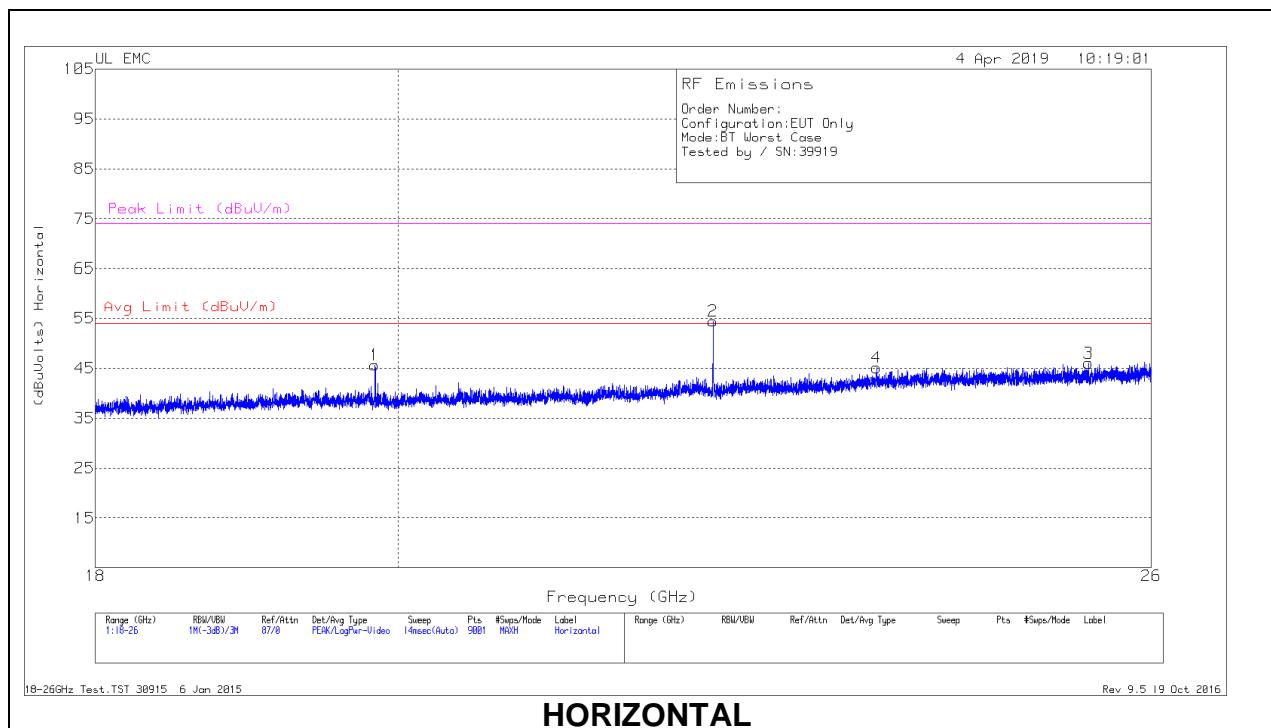


Below 1GHz Data

| Marker | Frequency (MHz) | Meter Reading (dBuV) | Det | AF T185 (dB/m) | Amp Cbl (dB) | Corrected Reading (dBuV/m) | QPk Limit (dBuV/m) | Margin (dB) | Azimuth (Degs) | Height (cm) | Polarity |
|--------|-----------------|----------------------|-----|----------------|--------------|----------------------------|--------------------|-------------|----------------|-------------|----------|
| 1 | 31.0203 | 29.08 | Pk | 26 | -31.2 | 23.88 | 40 | -16.12 | 0-360 | 300 | H |
| 2 | * 130.7511 | 29.43 | Pk | 19.8 | -30.1 | 19.13 | 43.52 | -24.39 | 0-360 | 400 | H |
| 3 | 617.1542 | 29.83 | Pk | 24.8 | -27.4 | 27.23 | 46.02 | -18.79 | 0-360 | 400 | H |
| 4 | 30.4039 | 28.22 | Pk | 26.6 | -31.2 | 23.62 | 40 | -16.38 | 0-360 | 100 | V |
| 5 | * 128.8806 | 29.21 | Pk | 19.9 | -30.2 | 18.91 | 43.52 | -24.61 | 0-360 | 100 | V |
| 6 | 541.3444 | 29.48 | Pk | 24.1 | -27.7 | 25.88 | 46.02 | -20.14 | 0-360 | 100 | V |

9.3. WORST CASE 18-26 GHz

SPURIOUS EMISSIONS 18-26 GHz (WORST-CASE CONFIGURATION)



18 – 26GHz DATA

| Marker | Frequency (GHz) | Meter Reading (dBuV) | Det | T447 AF (dB/m) | Amp/Cbl (dB) | Dist Corr (dB) | Corrected Reading (dBuVolts) | Peak Limit (dBuV/m) | PK Margin (dB) |
|--------|-----------------|----------------------|-----|----------------|--------------|----------------|------------------------------|---------------------|----------------|
| 1 | 19.839 | 43.92 | Pk | 32.7 | -21.5 | -9.5 | 45.62 | 74 | -28.38 |
| 2 | 22.319 | 50.85 | Pk | 33.5 | -20.4 | -9.5 | 54.45 | 74 | -19.55 |
| 3 | 25.437 | 40.93 | Pk | 34.5 | -19.9 | -9.5 | 46.03 | 74 | -27.97 |
| 4 | 23.626 | 40.43 | Pk | 34.1 | -19.9 | -9.5 | 45.13 | 74 | -28.87 |
| 5 | 19.842 | 39.27 | Pk | 32.7 | -21.5 | -9.5 | 40.97 | 74 | -33.03 |
| 6 | 22.319 | 47.99 | Pk | 33.5 | -20.4 | -9.5 | 51.59 | 74 | -22.41 |
| 7 | 23.632 | 39.39 | Pk | 34.1 | -19.8 | -9.5 | 44.19 | 74 | -29.81 |

Pk - Peak detector

10. AC POWER LINE CONDUCTED EMISSIONS

LIMITS

FCC §15.207 (a)

RSS-Gen 8.8

| Frequency of Emission (MHz) | Conducted Limit (dBuV) | |
|-----------------------------|------------------------|-----------------------|
| | Quasi-peak | Average |
| 0.15-0.5 | 66 to 56 [*] | 56 to 46 [*] |
| 0.5-5 | 56 | 46 |
| 5-30 | 60 | 50 |

^{*} Decreases with the logarithm of the frequency.

TEST PROCEDURE

The EUT is placed on a non-conducting table 40 cm from the vertical ground plane and 80 cm above the horizontal ground plane. The EUT is configured in accordance with ANSI C63.10

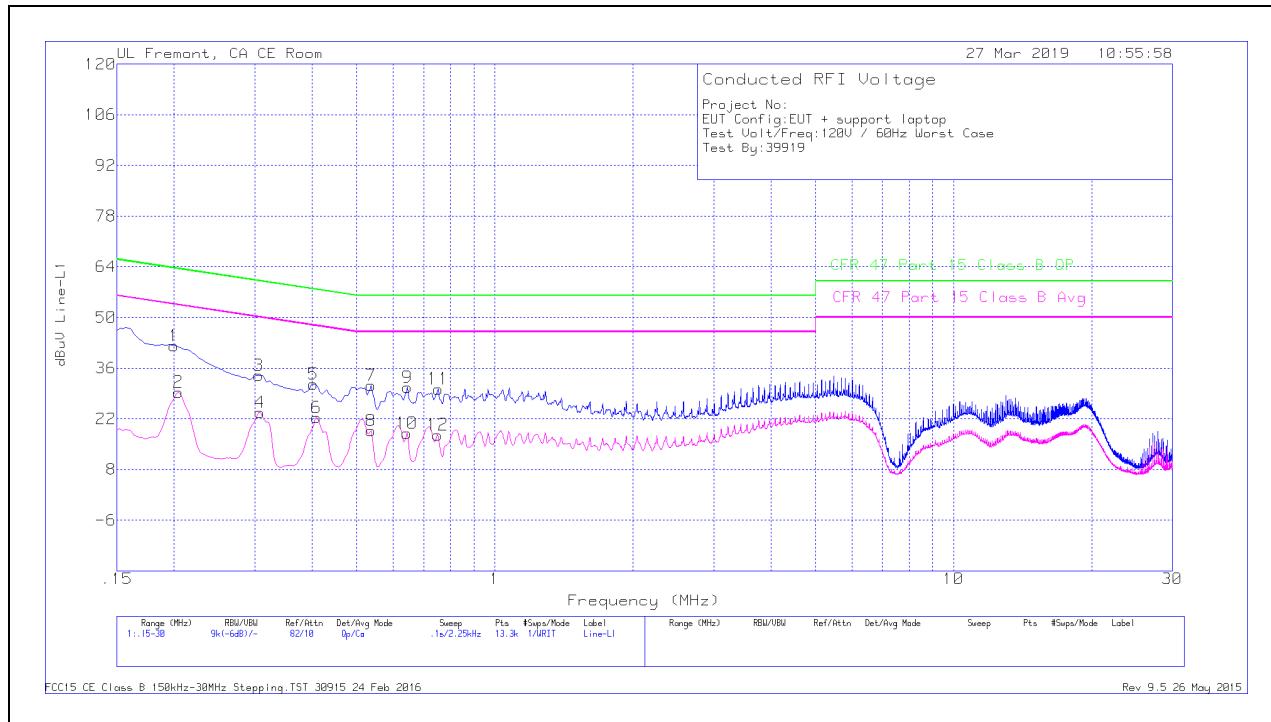
The receiver is set to a resolution bandwidth of 9 kHz. Peak detection is used unless otherwise noted as quasi-peak or average.

Line conducted data is recorded for both NEUTRAL and HOT lines.

RESULTS

10.1.1. AC Power Line Host

LINE 1 RESULTS



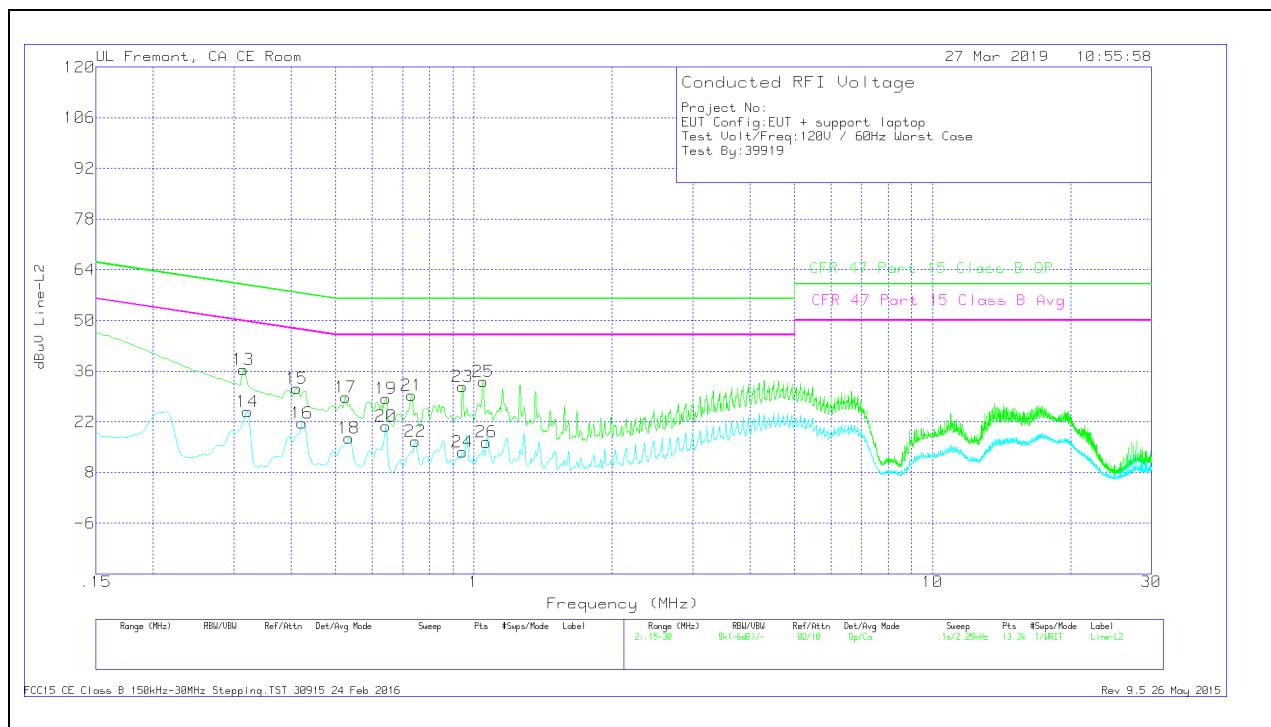
Range 1: Line-L1 .15 - 30MHz

| Marker | Frequency (MHz) | Meter Reading (dBuV) | Det | LISN L1 | LC Cables C1&C3 | Limiter (dB) | Corrected Reading dBuV | CFR 47 Part 15 Class B QP | QP Margin (dB) | CFR 47 Part 15 Class B Avg | Av(CISPR) Margin (dB) |
|--------|-----------------|----------------------|-----|---------|-----------------|--------------|------------------------|---------------------------|----------------|----------------------------|-----------------------|
| 1 | .1995 | 32.13 | Qp | 0 | 0 | 10.1 | 42.23 | 63.63 | -21.4 | - | - |
| 2 | .204 | 19.3 | Ca | 0 | 0 | 10.1 | 29.4 | - | - | 53.45 | -24.05 |
| 3 | .30525 | 23.89 | Qp | 0 | 0 | 10.1 | 33.99 | 60.1 | -26.11 | - | - |
| 4 | .3075 | 13.72 | Ca | 0 | 0 | 10.1 | 23.82 | - | - | 50.04 | -26.22 |
| 5 | .402 | 21.55 | Qp | 0 | 0 | 10.1 | 31.65 | 57.81 | -26.16 | - | - |
| 6 | .40875 | 12.19 | Ca | 0 | 0 | 10.1 | 22.29 | - | - | 47.67 | -25.38 |
| 7 | .537 | 21.07 | Qp | 0 | 0 | 10.1 | 31.17 | 56 | -24.83 | - | - |
| 8 | .537 | 8.54 | Ca | 0 | 0 | 10.1 | 18.64 | - | - | 46 | -27.36 |
| 9 | .645 | 20.59 | Qp | 0 | 0 | 10.1 | 30.69 | 56 | -25.31 | - | - |
| 10 | .64275 | 7.92 | Ca | 0 | 0 | 10.1 | 18.02 | - | - | 46 | -27.98 |
| 11 | .753 | 20.17 | Qp | 0 | 0 | 10.1 | 30.27 | 56 | -25.73 | - | - |
| 12 | .75075 | 7.48 | Ca | 0 | 0 | 10.1 | 17.58 | - | - | 46 | -28.42 |

Qp - Quasi-Peak detector

Ca - CISPR average detection

LINE 2 RESULTS



Range 2: Line-L2 .15 - 30MHz

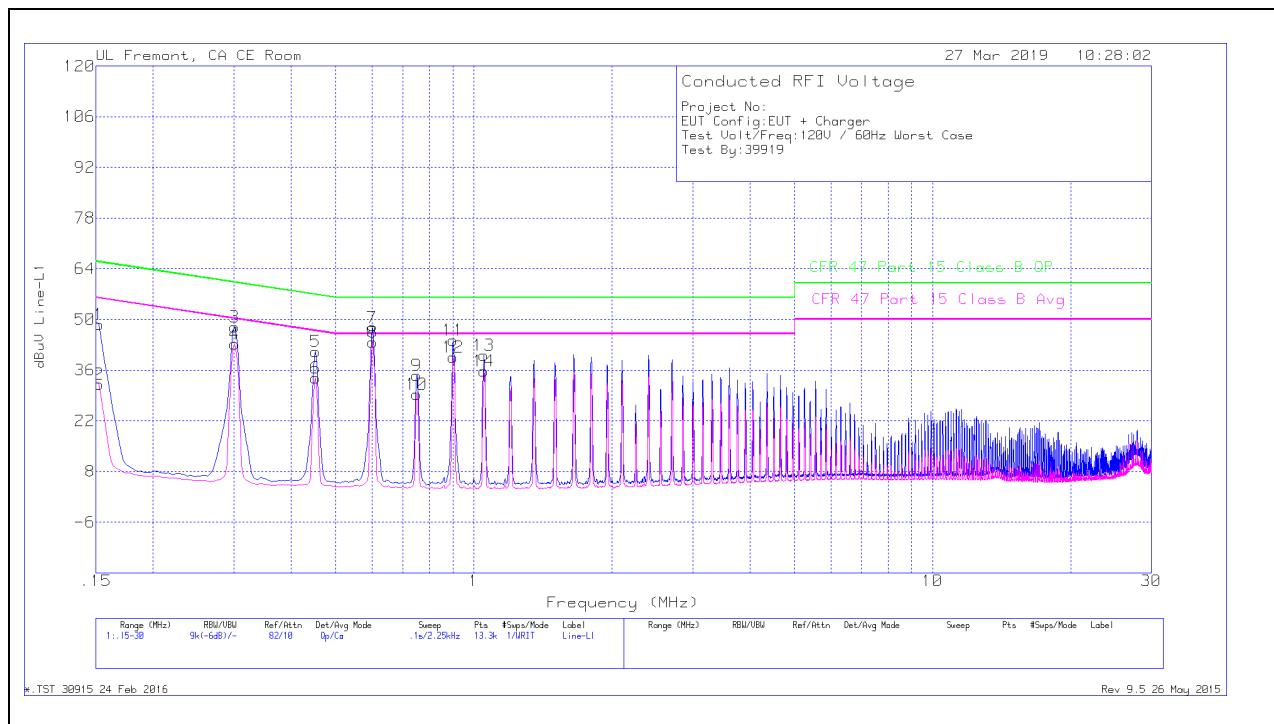
| Marker | Frequency (MHz) | Meter Reading (dBuV) | Det | LISN L2 | LC Cables C2&C3 | Limiter (dB) | Corrected Reading dBuV | CFR 47 Part 15 Class B QP | QP Margin (dB) | CFR 47 Part 15 Class B Avg | Av(CISPR) Margin (dB) |
|--------|-----------------|----------------------|-----|---------|-----------------|--------------|------------------------|---------------------------|----------------|----------------------------|-----------------------|
| 13 | .31425 | 26.41 | Qp | 0 | 0 | 10.1 | 36.51 | 59.86 | -23.35 | - | - |
| 14 | .321 | 14.62 | Ca | 0 | 0 | 10.1 | 24.72 | - | - | 49.68 | -24.96 |
| 15 | .411 | 21.11 | Qp | 0 | 0 | 10.1 | 31.21 | 57.63 | -26.42 | - | - |
| 16 | .42225 | 11.54 | Ca | 0 | 0 | 10.1 | 21.64 | - | - | 47.4 | -25.76 |
| 17 | .52575 | 18.76 | Qp | 0 | 0 | 10.1 | 28.86 | 56 | -27.14 | - | - |
| 18 | .53475 | 7.39 | Ca | 0 | 0 | 10.1 | 17.49 | - | - | 46 | -28.51 |
| 19 | .64275 | 18.37 | Qp | 0 | 0 | 10.1 | 28.47 | 56 | -27.53 | - | - |
| 20 | .64275 | 10.73 | Ca | 0 | 0 | 10.1 | 20.83 | - | - | 46 | -25.17 |
| 21 | .73275 | 19.24 | Qp | 0 | 0 | 10.1 | 29.34 | 56 | -26.66 | - | - |
| 22 | .74625 | 6.6 | Ca | 0 | 0 | 10.1 | 16.7 | - | - | 46 | -29.3 |
| 23 | .94425 | 21.58 | Qp | 0 | .1 | 10.1 | 31.78 | 56 | -24.22 | - | - |
| 24 | .94425 | 3.41 | Ca | 0 | .1 | 10.1 | 13.61 | - | - | 46 | -32.39 |
| 25 | 1.04775 | 22.9 | Qp | 0 | .1 | 10.1 | 33.1 | 56 | -22.9 | - | - |
| 26 | 1.0635 | 6.17 | Ca | 0 | .1 | 10.1 | 16.37 | - | - | 46 | -29.63 |

Qp - Quasi-Peak detector

Ca - CISPR average detection

10.1.2. AC Power Line Norm

LINE 1 RESULTS



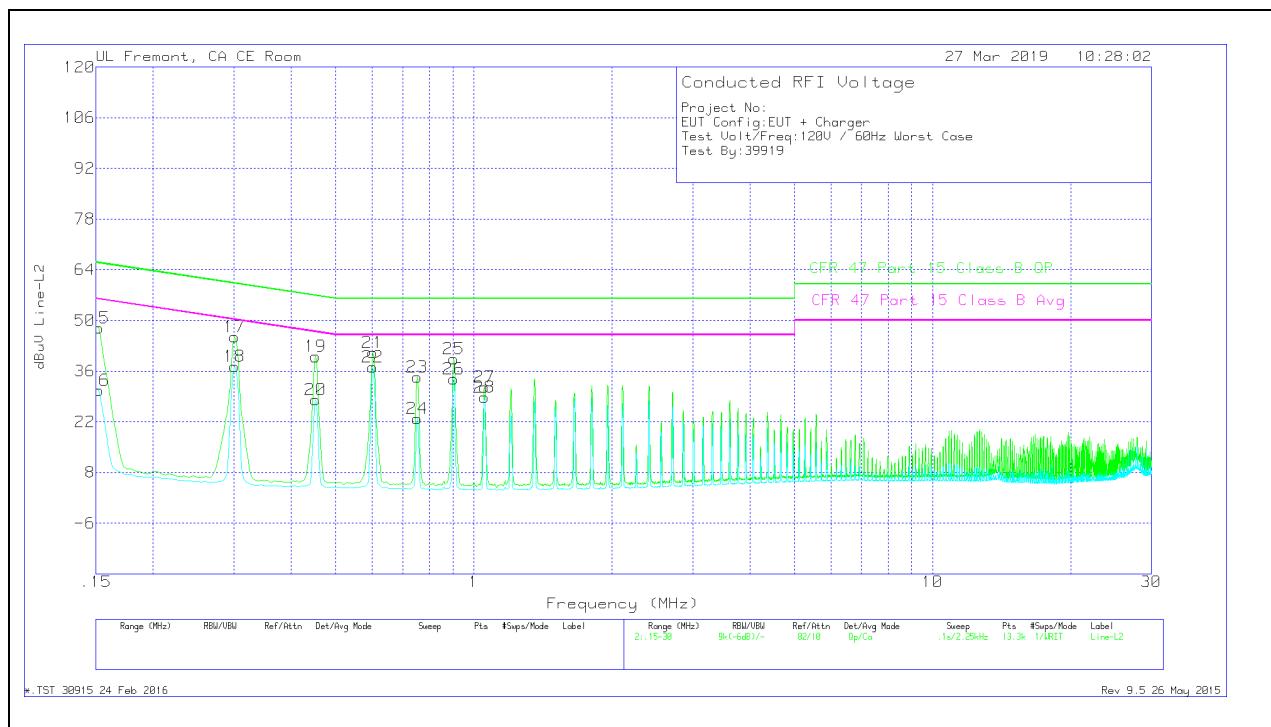
Range 1: Line-L1 .15 - 30MHz

| Marker | Frequency (MHz) | Meter Reading (dBuV) | Det | LISN L1 | LC Cables C1&C3 | Limiter (dB) | Corrected Reading dBuV | CFR 47 Part 15 Class B QP | QP Margin (dB) | CFR 47 Part 15 Class B Avg | Av(CISPR) Margin (dB) |
|--------|-----------------|----------------------|-----|---------|-----------------|--------------|------------------------|---------------------------|----------------|----------------------------|-----------------------|
| 1 | .15225 | 38.4 | Qp | .1 | 0 | 10.1 | 48.6 | 65.88 | -17.28 | - | - |
| 2 | .15225 | 21.93 | Ca | .1 | 0 | 10.1 | 32.13 | - | - | 55.88 | -23.75 |
| 3 | .30075 | 37.79 | Qp | 0 | 0 | 10.1 | 47.89 | 60.22 | -12.33 | - | - |
| 4 | .30075 | 33.2 | Ca | 0 | 0 | 10.1 | 43.3 | - | - | 50.22 | -6.92 |
| 5 | .4515 | 31.06 | Qp | 0 | 0 | 10.1 | 41.16 | 56.85 | -15.69 | - | - |
| 6 | .4515 | 23.66 | Ca | 0 | 0 | 10.1 | 33.76 | - | - | 46.85 | -13.09 |
| 7 | .6 | 37.71 | Qp | 0 | 0 | 10.1 | 47.81 | 56 | -8.19 | - | - |
| 8 | .60225 | 33.59 | Ca | 0 | 0 | 10.1 | 43.69 | - | - | 46 | -2.31 |
| 9 | .75075 | 24.47 | Qp | 0 | 0 | 10.1 | 34.57 | 56 | -21.43 | - | - |
| 10 | .75075 | 19.21 | Ca | 0 | 0 | 10.1 | 29.31 | - | - | 46 | -16.69 |
| 11 | .9015 | 34.1 | Qp | 0 | 0 | 10.1 | 44.2 | 56 | -11.8 | - | - |
| 12 | .9015 | 29.49 | Ca | 0 | 0 | 10.1 | 39.59 | - | - | 46 | -6.41 |
| 13 | 1.05225 | 29.91 | Qp | 0 | .1 | 10.1 | 40.11 | 56 | -15.89 | - | - |
| 14 | 1.05225 | 25.53 | Ca | 0 | .1 | 10.1 | 35.73 | - | - | 46 | -10.27 |

Qp - Quasi-Peak detector

Ca - CISPR average detection

LINE 2 RESULTS



Range 2: Line-L2 .15 - 30MHz

| Marker | Frequency (MHz) | Meter Reading (dBuV) | Det | LISN L2 | LC Cables C2&C3 | Limiter (dB) | Corrected Reading dBuV | CFR 47 Part 15 Class B QP | QP Margin (dB) | CFR 47 Part 15 Class B Avg | Av(CISPR) Margin (dB) |
|--------|-----------------|----------------------|-----|---------|-----------------|--------------|------------------------|---------------------------|----------------|----------------------------|-----------------------|
| 15 | .15225 | 37.71 | Qp | .1 | 0 | 10.1 | 47.91 | 65.88 | -17.97 | - | - |
| 16 | .15225 | 20.49 | Ca | .1 | 0 | 10.1 | 30.69 | - | - | 55.88 | -25.19 |
| 17 | .30075 | 35.42 | Qp | 0 | 0 | 10.1 | 45.52 | 60.22 | -14.7 | - | - |
| 18 | .30075 | 27.14 | Ca | 0 | 0 | 10.1 | 37.24 | - | - | 50.22 | -12.98 |
| 19 | .4515 | 29.91 | Qp | 0 | 0 | 10.1 | 40.01 | 56.85 | -16.84 | - | - |
| 20 | .4515 | 17.95 | Ca | 0 | 0 | 10.1 | 28.05 | - | - | 46.85 | -18.8 |
| 21 | .60225 | 31.02 | Qp | 0 | 0 | 10.1 | 41.12 | 56 | -14.88 | - | - |
| 22 | .60225 | 26.98 | Ca | 0 | 0 | 10.1 | 37.08 | - | - | 46 | -8.92 |
| 23 | .753 | 24.27 | Qp | 0 | 0 | 10.1 | 34.37 | 56 | -21.63 | - | - |
| 24 | .753 | 12.72 | Ca | 0 | 0 | 10.1 | 22.82 | - | - | 46 | -23.18 |
| 25 | .90375 | 29.22 | Qp | 0 | 0 | 10.1 | 39.32 | 56 | -16.68 | - | - |
| 26 | .90375 | 23.66 | Ca | 0 | 0 | 10.1 | 33.76 | - | - | 46 | -12.24 |
| 27 | 1.0545 | 21.44 | Qp | 0 | .1 | 10.1 | 31.64 | 56 | -24.36 | - | - |
| 28 | 1.0545 | 18.54 | Ca | 0 | .1 | 10.1 | 28.74 | - | - | 46 | -17.26 |

Qp - Quasi-Peak detector

Ca - CISPR average detection

11. SETUP PHOTOS

Please refer to 12742033-EP1V1 for setup photos

END OF TEST REPORT