



# **CERTIFICATION TEST REPORT**

**Report Number. : 12681939-E5V3 (Right)**

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

**Model :** A2083

**FCC ID :** BCG-A2083

**IC :** 579C-A2083

**EUT Description :** Bluetooth Earbud

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

**Date Of Issue:**  
October 10, 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	9/19/2019	Initial Issue	Chin Pang
V2	10/04/2019	Address TCB Questions	Francisco Guarnero
V3	10/08/2019	Add BR DM1 mode	Chin Pang

## TABLE OF CONTENTS

<b>REPORT REVISION HISTORY .....</b>	<b>2</b>
<b>TABLE OF CONTENTS .....</b>	<b>3</b>
<b>1. ATTESTATION OF TEST RESULTS .....</b>	<b>5</b>
<b>2. TEST METHODOLOGY .....</b>	<b>6</b>
<b>3. FACILITIES AND ACCREDITATION .....</b>	<b>6</b>
<b>4. CALIBRATION AND UNCERTAINTY .....</b>	<b>6</b>
4.1. <i>MEASURING INSTRUMENT CALIBRATION</i> .....	6
4.2. <i>SAMPLE CALCULATION</i> .....	6
4.3. <i>MEASUREMENT UNCERTAINTY</i> .....	7
<b>5. EQUIPMENT UNDER TEST .....</b>	<b>8</b>
5.1. <i>EUT DESCRIPTION</i> .....	8
5.2. <i>MAXIMUM OUTPUT POWER</i> .....	8
5.3. <i>DESCRIPTION OF AVAILABLE ANTENNAS</i> .....	8
5.4. <i>SOFTWARE AND FIRMWARE</i> .....	8
5.5. <i>WORST-CASE CONFIGURATION AND MODE</i> .....	9
5.6. <i>DESCRIPTION OF TEST SETUP</i> .....	10
<b>6. TEST AND MEASUREMENT EQUIPMENT .....</b>	<b>15</b>
<b>7. MEASUREMENT METHODS .....</b>	<b>16</b>
<b>8. ANTENNA PORT TEST RESULTS .....</b>	<b>17</b>
8.1. <i>ON TIME AND DUTY CYCLE</i> .....	17
8.2. <i>20 dB AND 99% BANDWIDTH</i> .....	19
8.2.1. <i>BLUETOOTH BASIC DATA RATE GFSK DM1 MODULATION</i> .....	20
8.2.2. <i>BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION</i> .....	21
8.3. <i>HOPPING FREQUENCY SEPARATION</i> .....	22
8.4. <i>NUMBER OF HOPPING CHANNELS</i> .....	23
8.4.1. <i>BLUETOOTH BASIC DATA RATE GFSK DM1 MODULATION</i> .....	24
8.4.2. <i>BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION</i> .....	25
8.5. <i>AVERAGE TIME OF OCCUPANCY</i> .....	26
8.5.1. <i>BLUETOOTH BASIC DATA RATE GFSK DM1 MODULATION</i> .....	27
8.5.2. <i>BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION</i> .....	28
8.6. <i>OUTPUT POWER</i> .....	30
8.6.1. <i>BLUETOOTH BASIC DATA RATE GFSK DM1 MODULATION</i> .....	31
8.6.2. <i>BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION</i> .....	31
8.6.3. <i>BLUETOOTH ENHANCED DATA RATE DQPSK MODULATION</i> .....	31
8.7. <i>AVERAGE POWER</i> .....	32

8.7.1. BLUETOOTH BASIC DATA RATE GFSK DM1 MODULATION .....	33
8.7.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION .....	33
8.7.3. BLUETOOTH ENHANCED DATA RATE DQPSK MODULATION .....	33
8.8. CONDUCTED SPURIOUS EMISSIONS .....	34
8.8.1. BLUETOOTH BASIC DATA RATE GFSK DM1 MODULATION .....	35
8.8.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION .....	37
<b>9. RADIATED TEST RESULTS .....</b>	<b>39</b>
9.1. TRANSMITTER ABOVE 1 GHz .....	41
9.1.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION .....	41
9.1.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION .....	51
9.2. WORST CASE BELOW 1 GHz .....	61
9.3. WORST CASE 18-26 GHz .....	63
9.4. WORST CASE BELOW 30MHz .....	65
<b>10. AC POWER LINE CONDUCTED EMISSIONS .....</b>	<b>66</b>
10.1.1. AC Power Line Host .....	67
10.1.2. AC Power Line Norm .....	69
<b>11. SETUP PHOTOS .....</b>	<b>71</b>

## 1. ATTESTATION OF TEST RESULTS

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

**EUT DESCRIPTION:** Bluetooth Earbud

**MODEL:** A2083

**SERIAL NUMBER:** Radiated - DLC9326002DJQH32N, DLC9326000ZJQH328  
Conducted - DLC9326001NJQH32G

**DATE TESTED:** AUGUST 30 - SEPTEMBER 04, 2019 & OCTOBER 04-08, 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.

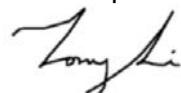
Approved & Released By:



---

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, KDB 558074 D01 15.247 Meas Guidance v05r02, KDB 414788 D02 v01r01, RSS-GEN Issue 5, 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 (IC:2324B-1)	<input checked="" type="checkbox"/> Chamber D (IC:22541-1)	<input type="checkbox"/> Chamber I (IC: 2324A-5)
<input type="checkbox"/> Chamber B (IC:2324B-2)	<input type="checkbox"/> Chamber E (IC:22541-2)	<input type="checkbox"/> Chamber J (IC: 2324A-6)
<input type="checkbox"/> Chamber C (IC:2324B-3)	<input type="checkbox"/> Chamber F (IC:22541-3)	<input type="checkbox"/> Chamber K (IC: 2324A-1)
	<input checked="" type="checkbox"/> Chamber G (IC:22541-4)	<input type="checkbox"/> Chamber L (IC: 2324A-3)
	<input type="checkbox"/> Chamber H (IC: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 (dB<sub>UV</sub>/m) = Measured Voltage (dB<sub>UV</sub>) + Antenna Factor (dB/m) + Cable Loss (dB) – Preamp Gain (dB)

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

#### MAINS CONDUCTED EMISSIONS

Where relevant, the following sample calculation is provided:

Final Voltage (dB<sub>UV</sub>) = Measured Voltage (dB<sub>UV</sub>) + Cable Loss (dB) + Limiter Factor (dB) + LISN Insertion Loss.

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

#### 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

The EUT, model A2083 is a Bluetooth earbud for the right ear. It has an integral battery, microphone and antenna. It can charge via bottom contacts with charging case. It is designed to work in conjunction with left earbud, A2084

### 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 DM1	12.51	17.82
2402 - 2480	Enhanced DQPSK	12.74	18.79
2402 - 2480	Enhanced 8PSK	12.83	19.19

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

The radio utilizes an LDS antenna, with a maximum gain of -2.8 dBi.

### 5.4. SOFTWARE AND FIRMWARE

The EUT firmware installed during testing was version 2A628200.

## 5.5. WORST-CASE CONFIGURATION AND MODE

Radiated emissions below 1GHz, above 18GHz, and power line conducted emission were performed with the EUT set to transmit at the channel with highest output power as worst-case scenario.

Band edge and radiated emissions between 1GHz and 18GHz were performed with the EUT set to transmit at the highest power on low, middle and 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

For AC line conducted emission, test was investigated with AC power adapter and with laptop.

The fundamental of the EUT was investigated in three orthogonal orientations X,Y,Z, it was determined that X (Flatbed) orientation was worst-case orientation; therefore, all final radiated testing was performed with the EUT in X (Flatbed) orientation.

Radiated emissions were tested at worst case on 100% duty cycle.

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

GFSK mode: DM1

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
EUT AC Adapter	Apple	A1385	D292365CDYADHLHC3	NA
Charger Case	Apple	A1602	DLCYX1FZLKKT	NA

### I/O CABLES (CONDUCTED TEST)

I/O Cable List						
Cable No	Port	# of identical ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1	Antenna	1	SMA	Un-Shielded	0.2	To spectrum Analyzer
2	USB	1	USB	Shielded	1	N/A
3	AC	1	AC	Un-shielded	2	N/A

### 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						

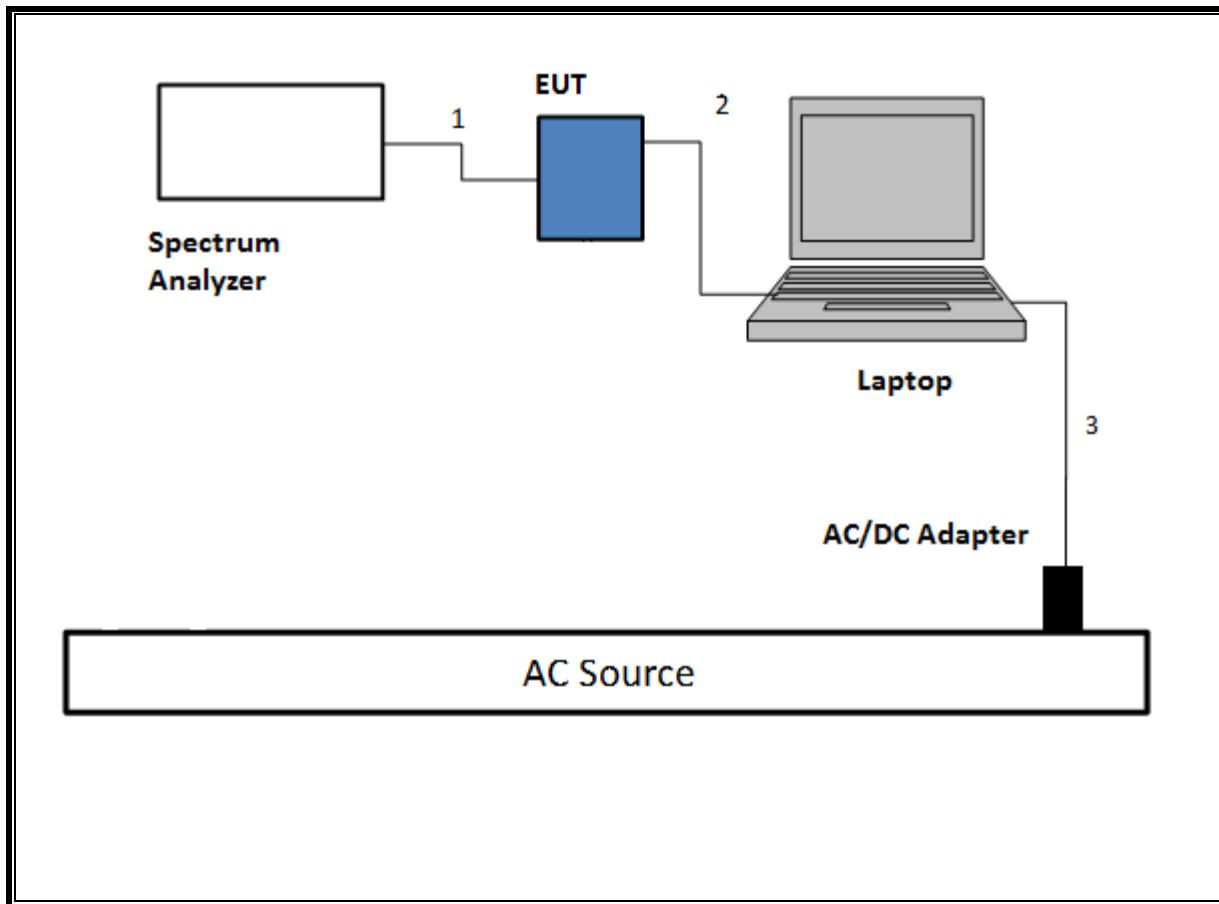
### I/O CABLES (BELOW 1GHz AND AC POWER LINE TEST WITH ADAPTER AND LAPTOP)

I/O Cable List						
Cable No	Port	# of identical	Connector Type	Cable Type	Cable Length (m)	Remarks
1	AC	1	AC	Un-shielded	2	N/A
2	USB	1	USB	Un-shielded	1	N/A

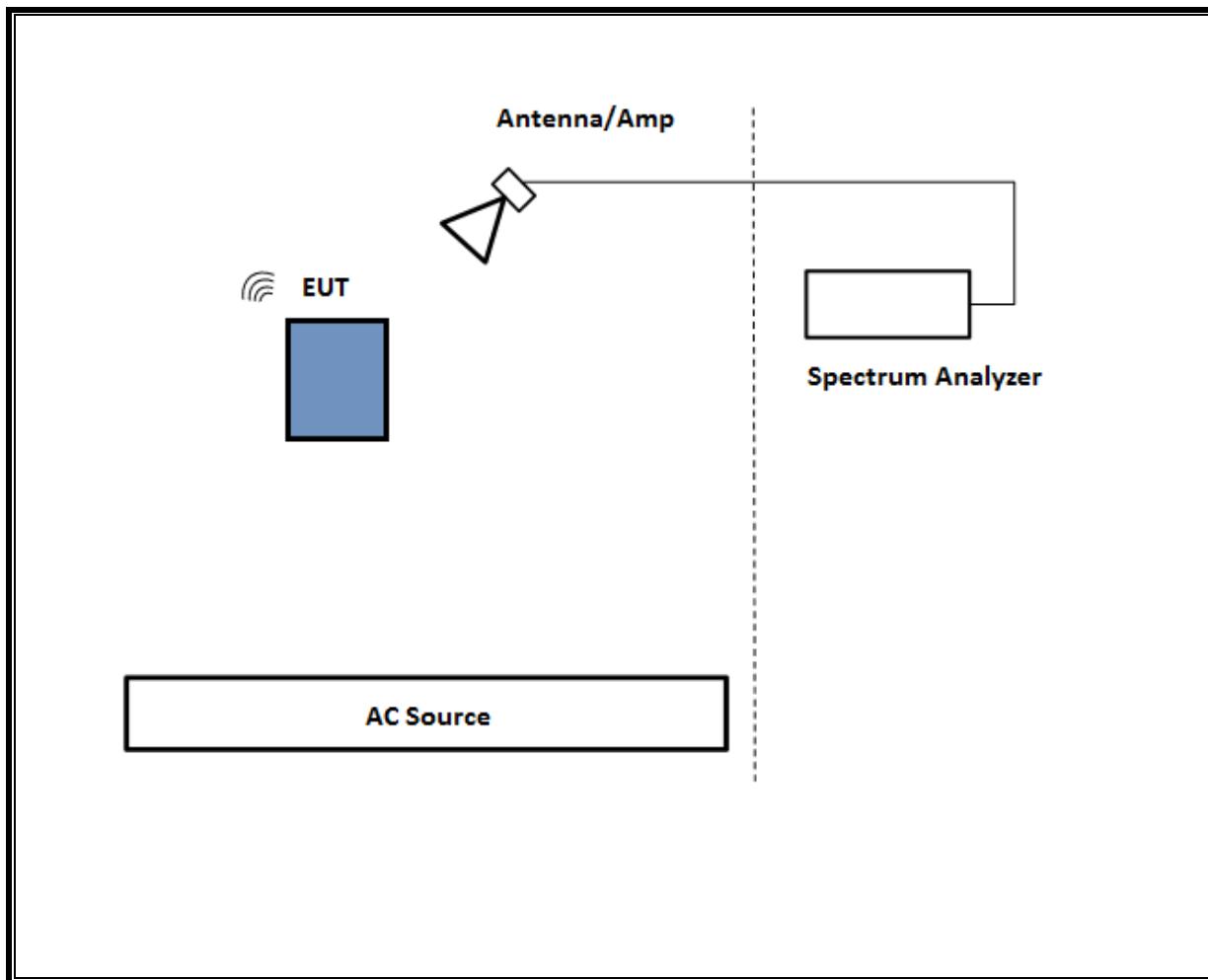
### TEST SETUP

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

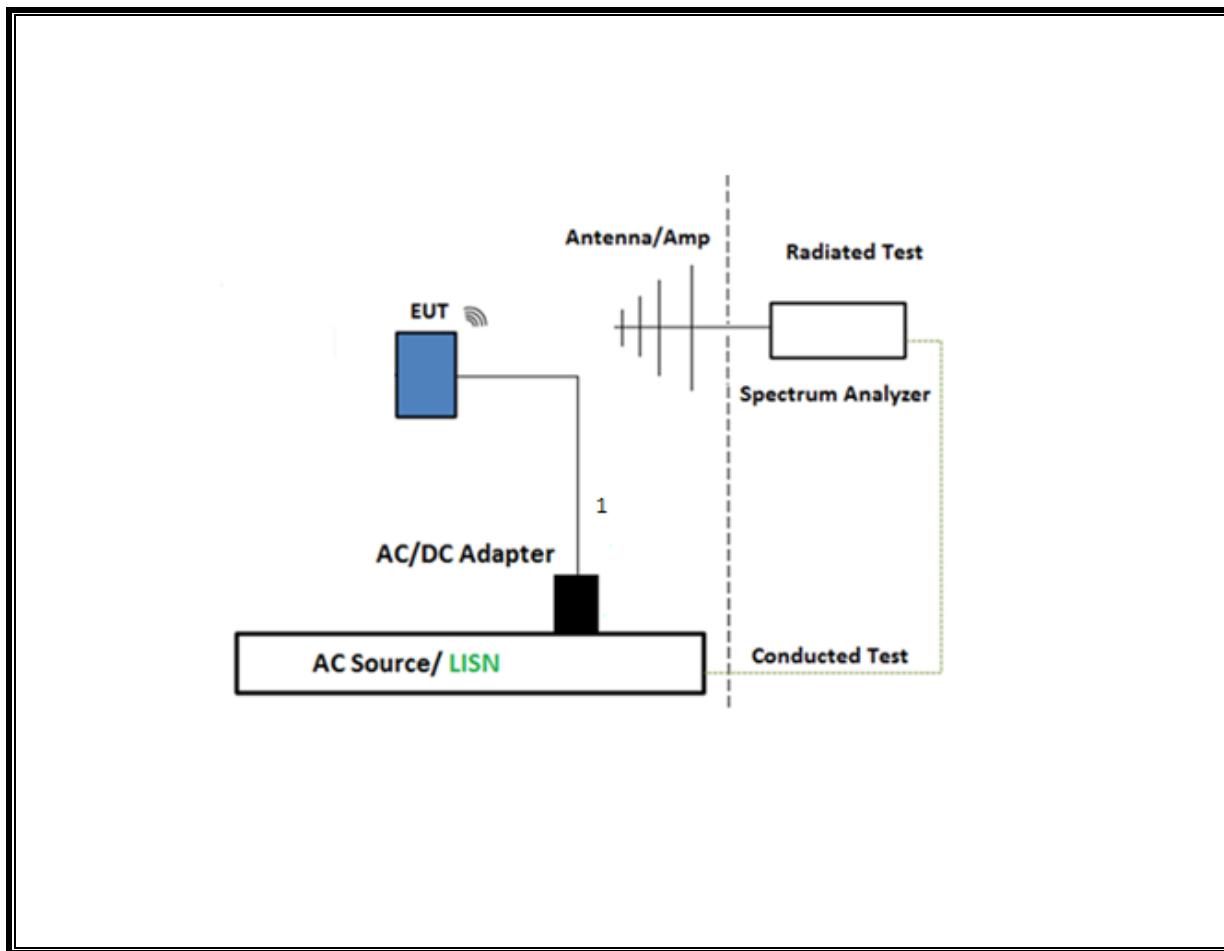
**SETUP DIAGRAM FOR CONDUCTED TESTS**



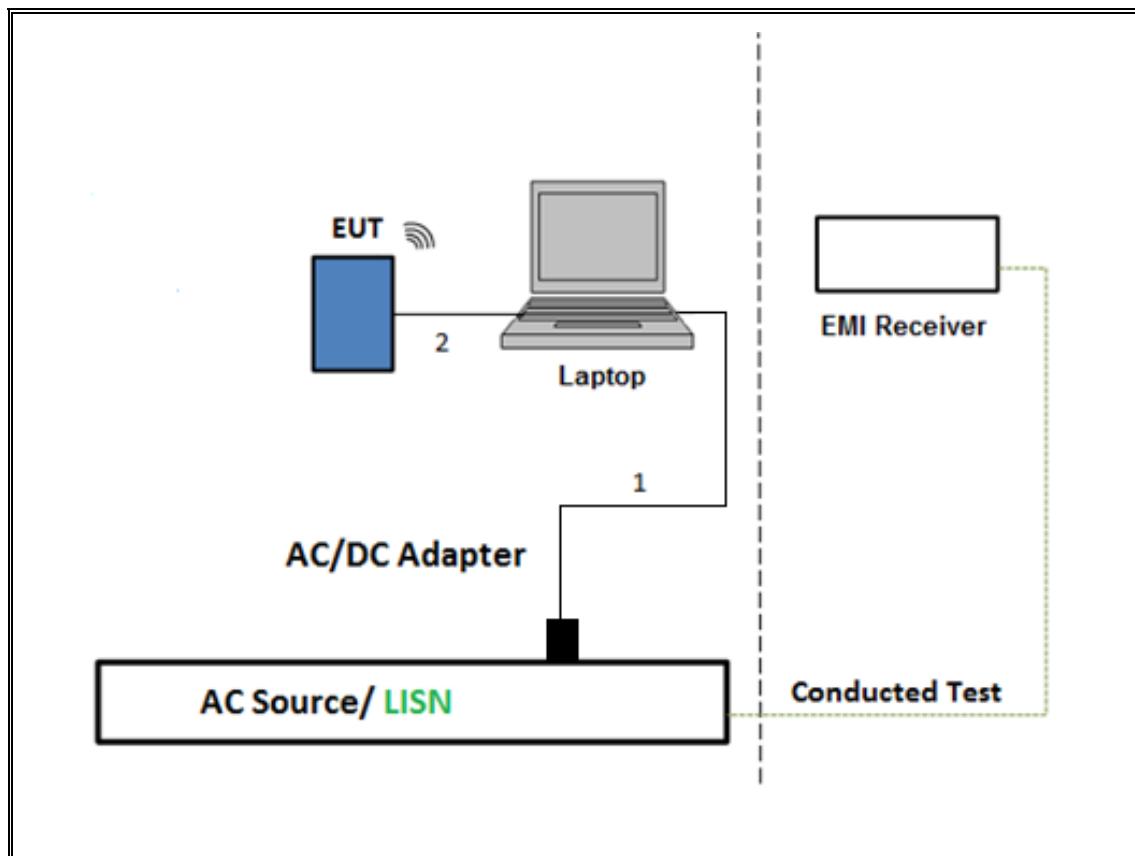
**SETUP DIAGRAM FOR RADIATED TESTS ABOVE 1GHz**



**SETUP DIAGRAM FOR BELOW 1GHz and AC LINE CONDUCTED TEST**



**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	Last Cal
Amplifier, 1 to 18GHz, 35dB	AMPLICAL	AMP1G18-35	138301	08/03/2020	08/03/2019
Amplifier, 10kHz to 1GHz, 32dB	Sonoma Instrument Co.	310N	T286	07/31/2020	07/31/2019
Amplifier, 1-18GHz	MITEQ	AFS42-00101800-25-S-42	T742	07/21/2020	07/21/2019
Antenna, Active Loop 9KHz to 30MHz	ETS-Lindgren	6502	T1683	02/21/2020	02/21/2019
Antenna, Broadband Hybrid, 30MHz to 2000MHz	Sunol Sciences Corp.	JB1	T185	06/06/2020	06/06/2019
Antenna, Horn 1-18GHz	ETS-Lindgren	3117	T712	02/26/2020	02/26/2019
Antenna, Horn 1-18GHz	ETS-Lindgren	3117	T119	03/22/2020	03/22/2019
Antenna Horn, 18 to 26GHz	ARA	MWH-1826	T447	08/13/2020	08/13/2019
Power Meter, P-series single channel	Agilent (Keysight) Technologies	N1911A	T227	10/29/2019	10/29/2018
Power Sensor	Agilent (Keysight) Technologies	N1921A	T1226	02/06/2020	02/06/2019
Pre-Amp 18-26GHz	Agilent (Keysight) Technologies	8449B	T404	03/23/2020	03/23/2019
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent (Keysight) Technologies	N9030A	T906	01/22/2020	01/22/2019
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent (Keysight) Technologies	N9030A	T1466	01/23/2020	01/23/2019
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent (Keysight) Technologies	N9030A	T905	01/24/2020	01/24/2019
Thermometer - Digital	Control Company	14-650-118	PRE0177862	02/22/2020	02/22/2019

AC Line Conducted					
Description	Manufacturer	Model	ID Num	Cal Due	Last Cal
EMI Test Receiver 9Khz-7GHz	Rohde & Schwarz	ESCI7	T1436	02/14/2020	02/14/2019
Power Cable, Line Conducted Emissions	UL	PG1	T861	10/19/2019	10/19/20189
LISN for Conducted Emissions CISPR-16	Fischer	50/250-25-2-01	T1310	01/24/2020	01/24/2019

UL AUTOMATION SOFTWARE					
Software Type	Manufacturer	Model	Software Version		
Radiated Software	UL	UL EMC	Ver 9.5, April 26, 2016		
Conducted Software	UL	UL EMC	Ver 10.1, August 27, 2019		
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. ON TIME AND DUTY CYCLE

#### LIMITS

None; for reporting purposes only.

#### PROCEDURE

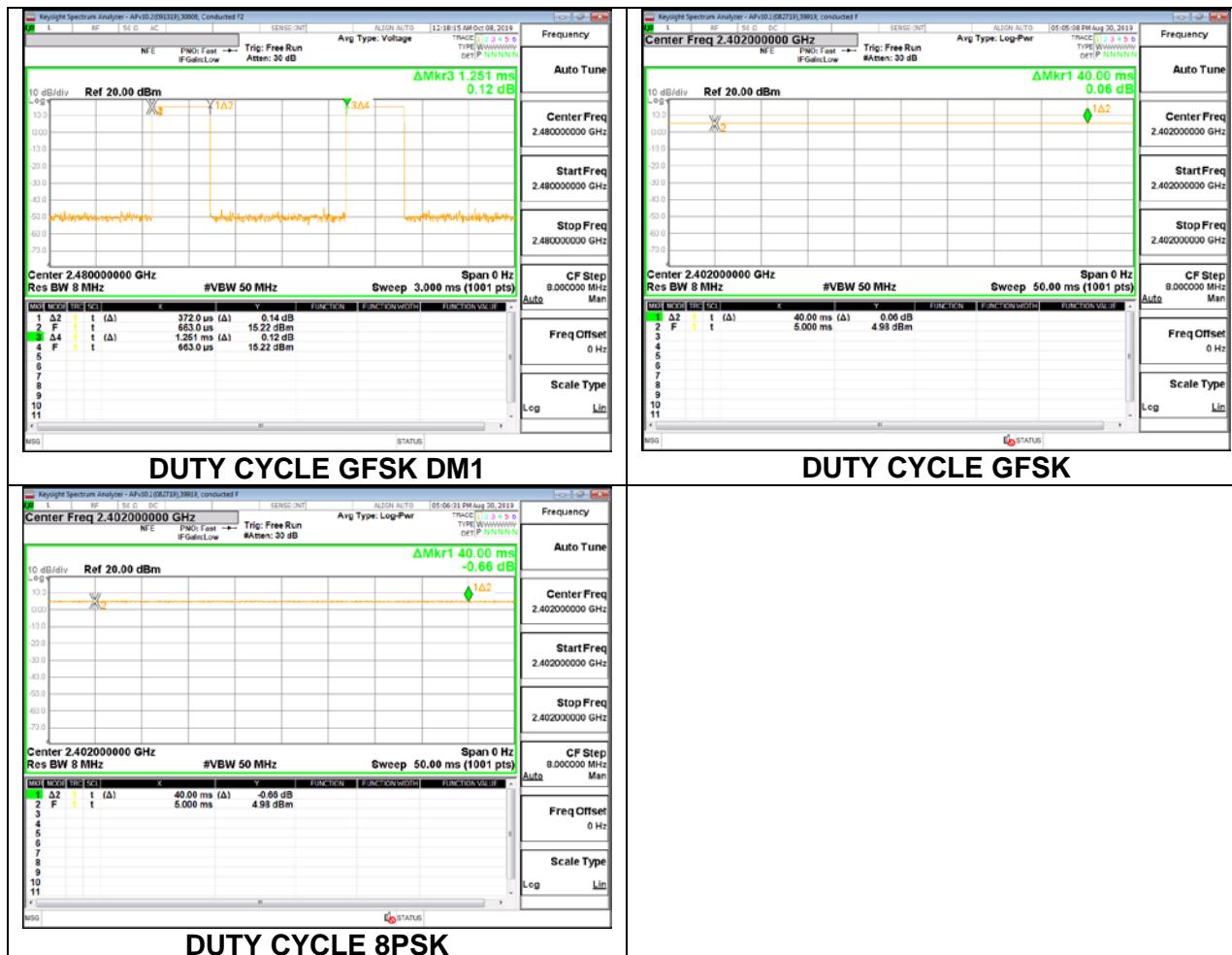
ANSI C63.10, Section 11.6 : Zero-Span Spectrum Analyzer Method.

#### ON TIME AND DUTY CYCLE RESULTS

Mode	ON Time B (msec)	Period (msec)	Duty Cycle x (linear)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)	1/T Minimum VBW (kHz)
Bluetooth GFSK, DM1	0.37	1.25	0.297	29.7%	5.27	2.688
Bluetooth GFSK	40.00	40.00	1.000	100.0%	0.00	0.010
Bluetooth 8PSK	40.00	40.00	1.000	100.0%	0.00	0.010

Note: During radiated emission testing, the device was programmed to transmit at 100% duty cycle as shown in the plot below. Under normal use the device would operate with a maximum duty cycle of 29.7% therefore radiated emission data in this report is considered to be worst case.

DUTY CYCLE PLOTS



## 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

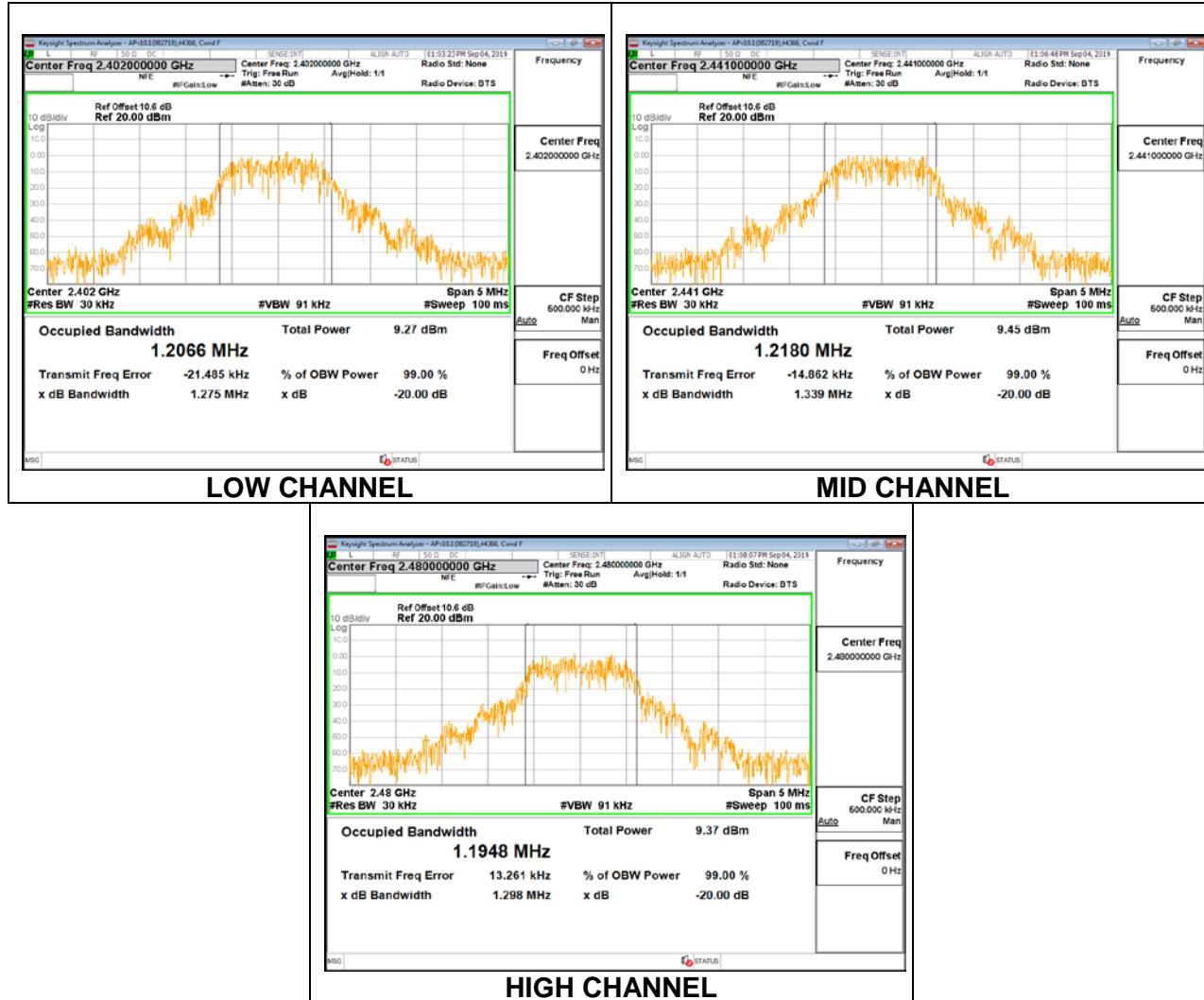
## 8.2.1. BLUETOOTH BASIC DATA RATE GFSK DM1 MODULATION

Channel	Frequency (MHz)	20dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	2402	0.897	0.823
Mid	2441	0.892	0.818
High	2480	0.894	0.822



## 8.2.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

Channel	Frequency (MHz)	20dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	2402	1.2750	1.2066
Mid	2441	1.3390	1.2180
High	2480	1.2980	1.1948



### 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 910KHz. The sweep time is coupled.

#### RESULTS

##### GFSK DM1 AND 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.

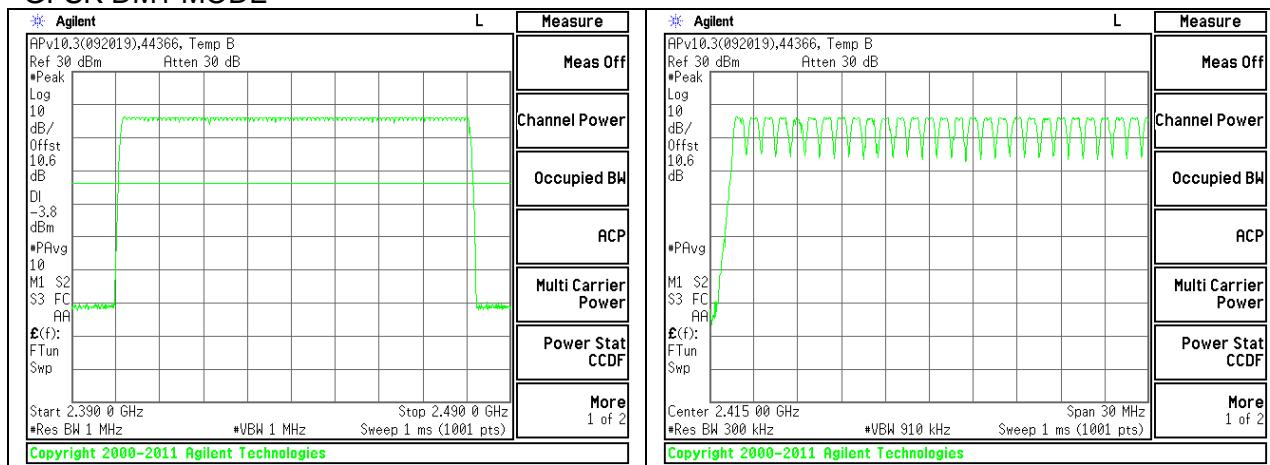
### RESULTS

Normal Mode: 79 Channels Observed

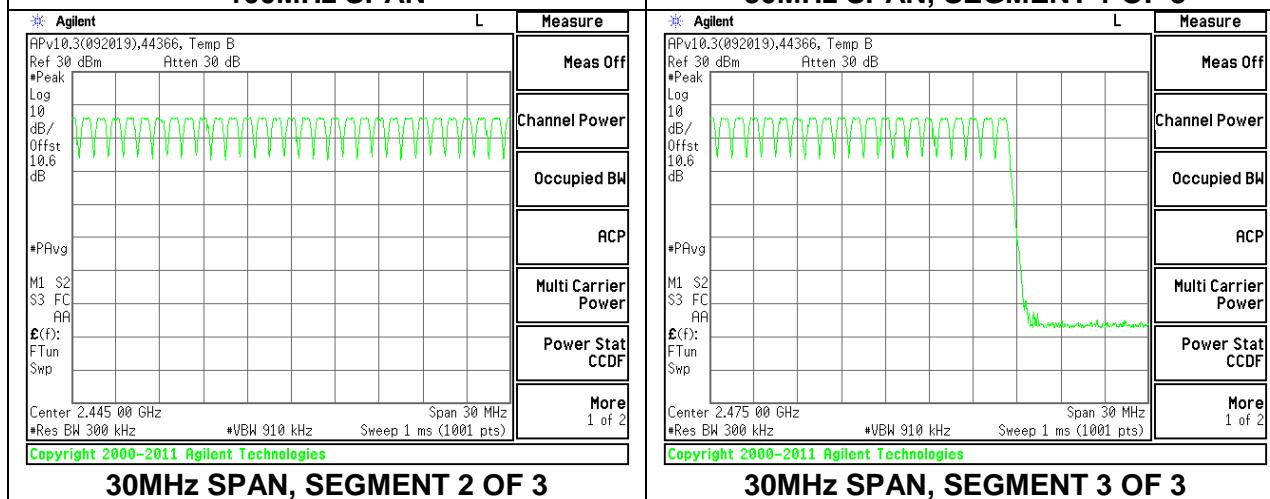
### 8.4.1. BLUETOOTH BASIC DATA RATE GFSK DM1 MODULATION

<b>ID:</b>	44366	<b>Date:</b>	10/07/2019
------------	-------	--------------	------------

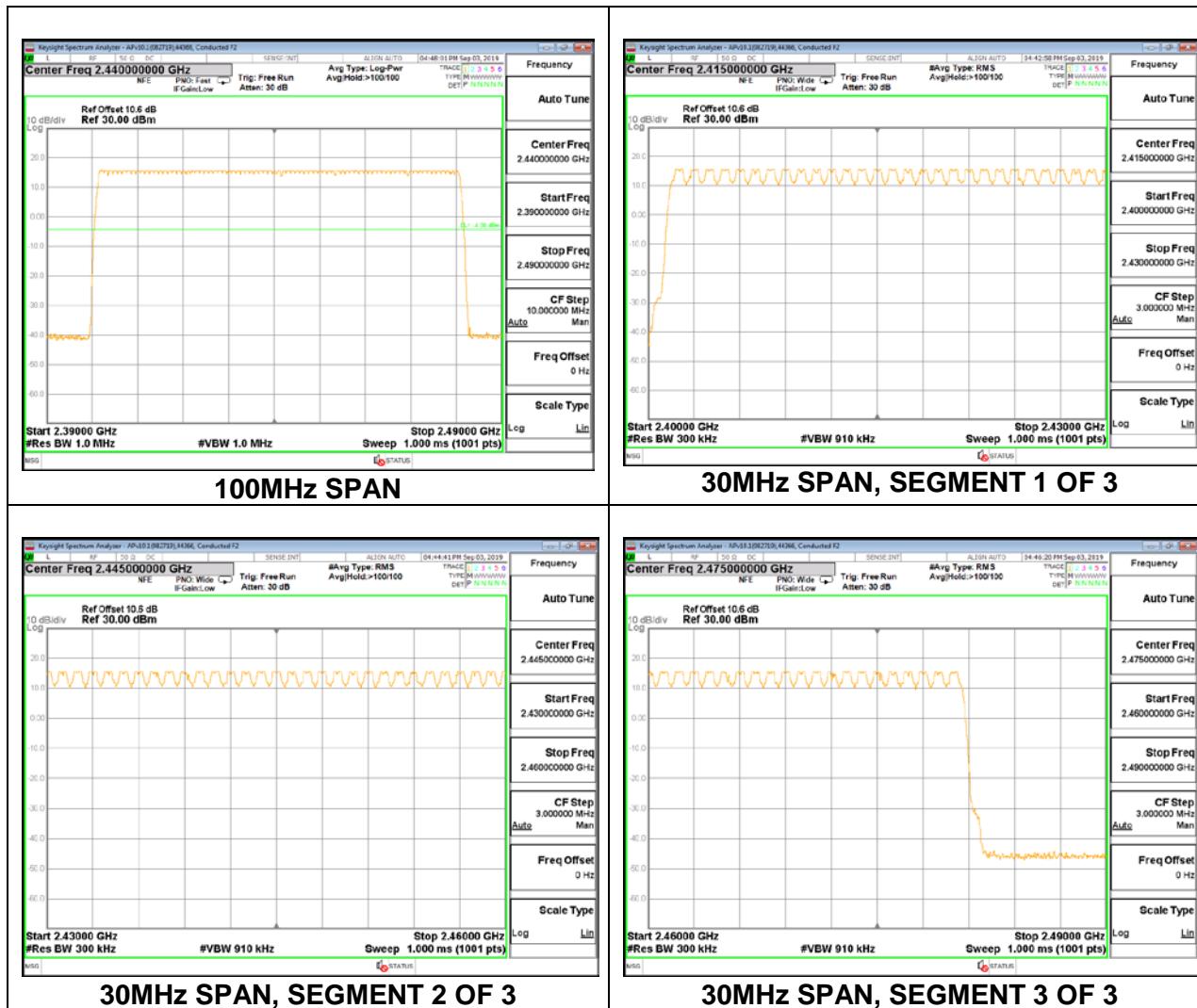
#### GFSK DM1 MODE



#### 100MHz SPAN



## 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  $10 * (\# \text{ of pulses in } 3.16 \text{ s}) * \text{pulse width}$ .

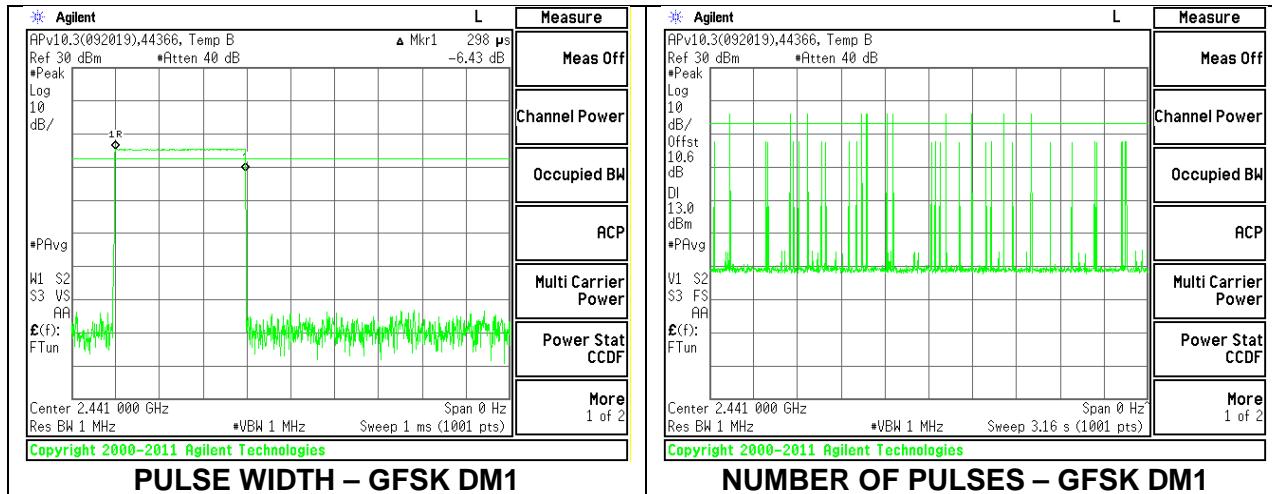
For AFH mode, the average time of occupancy in the specified 8 second period (20 channels \* 0.4 seconds) is equal to  $10 * (\# \text{ of pulses in } 0.8 \text{ s}) * \text{pulse width}$ .

### RESULTS

### 8.5.1. BLUETOOTH BASIC DATA RATE GFSK DM1 MODULATION

DH Packet	Pulse Width (msec)	Number of Pulses in 3.16 seconds	Average Time of Occupancy (sec)	Limit (sec)	Margin (sec)
<b>GFSK Normal Mode</b>					
DM1	0.298	11	0.0328	0.4	-0.3672
<b>GFSK AFH Mode</b>					
DM1	0.298	2.75	0.00820	0.4	-0.3918

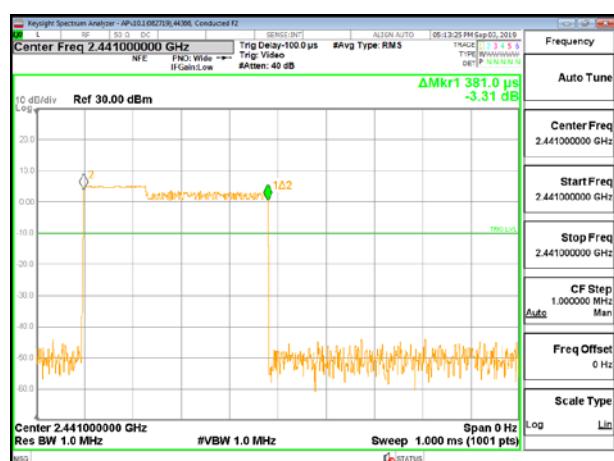
**ID:** 44366 **Date:** 10/07/2019



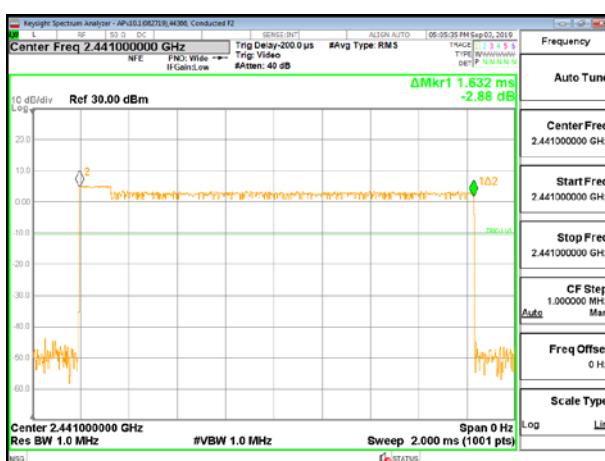
### 8.5.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

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	0.381	31	0.11811	0.4	-0.28189
3DH3	1.632	17	0.27744	0.4	-0.12256
3DH5	2.880	12	0.3456	0.4	-0.0544

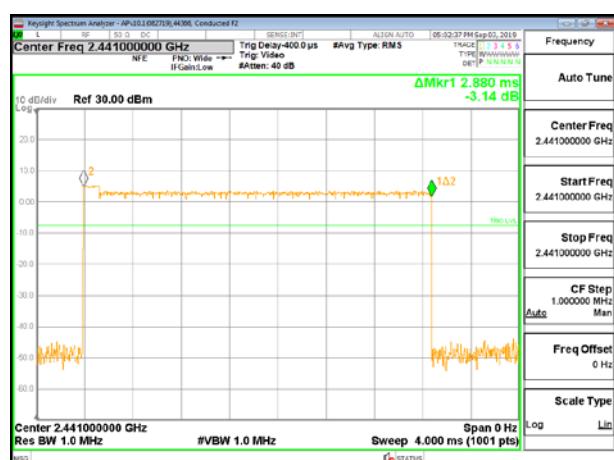
Note: for AFH(8PSK) mode, please refer to the results of AFH(GFSK) mode; the channel selection and hopping rate are the same for both EDR and Basic Rate operation, data for Basic Rate demonstrates compliance with channel occupancy when AFH is employed.



## PULSE WIDTH – 3DH1



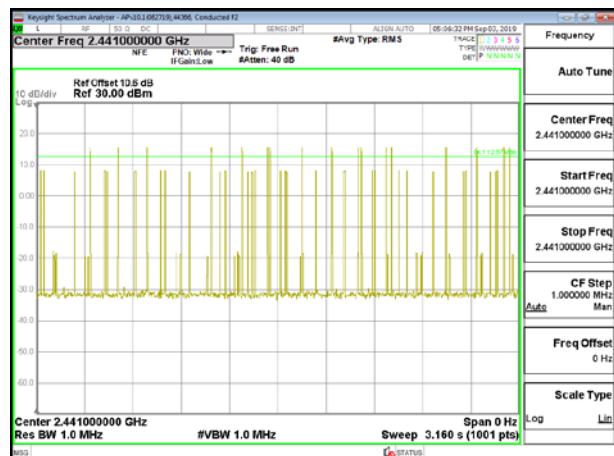
## PULSE WIDTH – 3DH3



## PULSE WIDTH – 3DH5



## NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – 3DH1



## NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – 3DH3



## NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – 3DH5

## 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.

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts

### TEST PROCEDURE

Measurements perform using a wideband gated RF power meter.

The cable assembly insertion loss of 10.6 dB (including 10 dB pad and 0.6 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 DM1 MODULATION

Tested By:	44366
Date:	10/8/2019

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	12.51	21	-8.49
Middle	2441	12.34	21	-8.66
High	2480	12.25	21	-8.75

### 8.6.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

Tested By:	44366
Date:	9/4/2019

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	12.83	21	-8.17
Middle	2441	12.65	21	-8.35
High	2480	12.59	21	-8.41

### 8.6.3. BLUETOOTH ENHANCED DATA RATE DQPSK MODULATION

Tested By:	44366
Date:	9/4/2019

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	12.74	21	-8.26
Middle	2441	12.57	21	-8.43
High	2480	12.50	21	-8.5

## 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 10.6 dB (including 10 dB pad and 0.6 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 DM1 MODULATION

Tested By:	44366
Date	10/8/2019

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	12.39
Middle	2441	12.23
High	2480	12.13

### 8.7.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

Tested By:	44366
Date	9/4/2019

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	9.44
Middle	2441	9.28
High	2480	9.2

### 8.7.3. BLUETOOTH ENHANCED DATA RATE DQPSK MODULATION

Tested By:	44366
Date	9/4/2019

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	9.37
Middle	2441	9.21
High	2480	9.14

## 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.

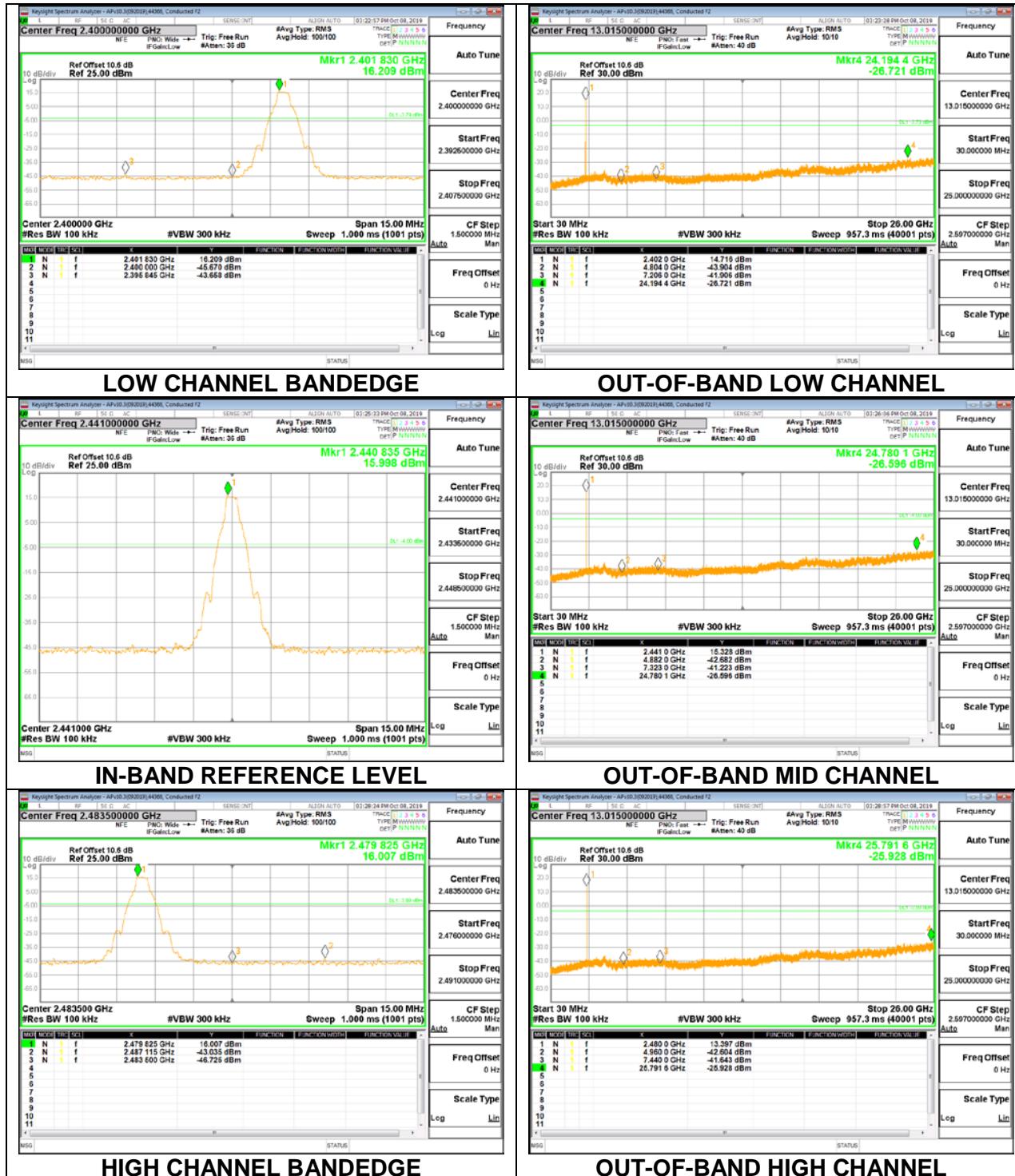
The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

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

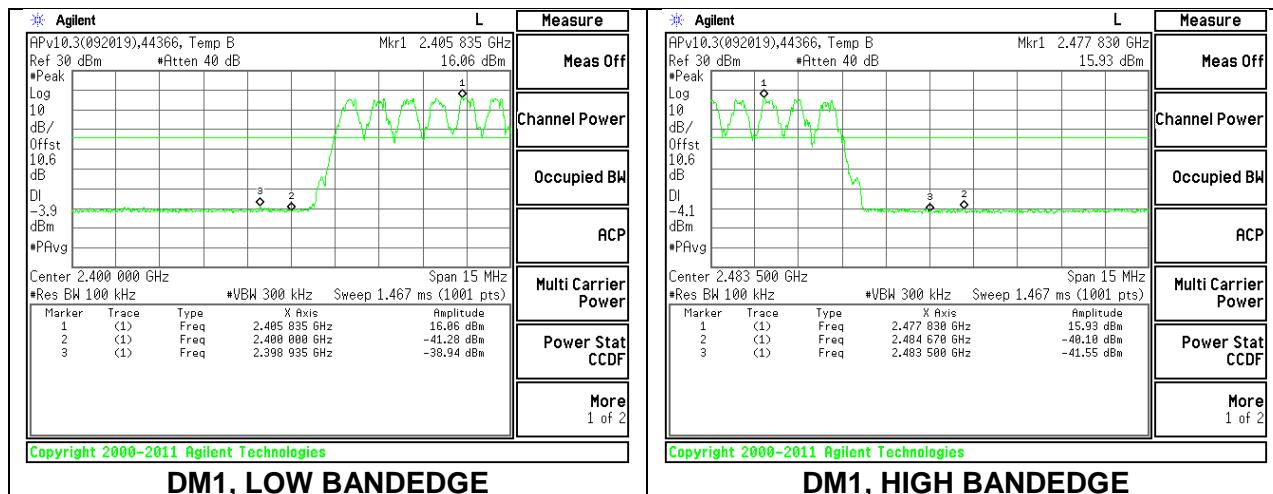
### RESULTS

## 8.8.1. BLUETOOTH BASIC DATA RATE GFSK DM1 MODULATION

### SPURIOUS EMISSIONS, NON-HOPPING

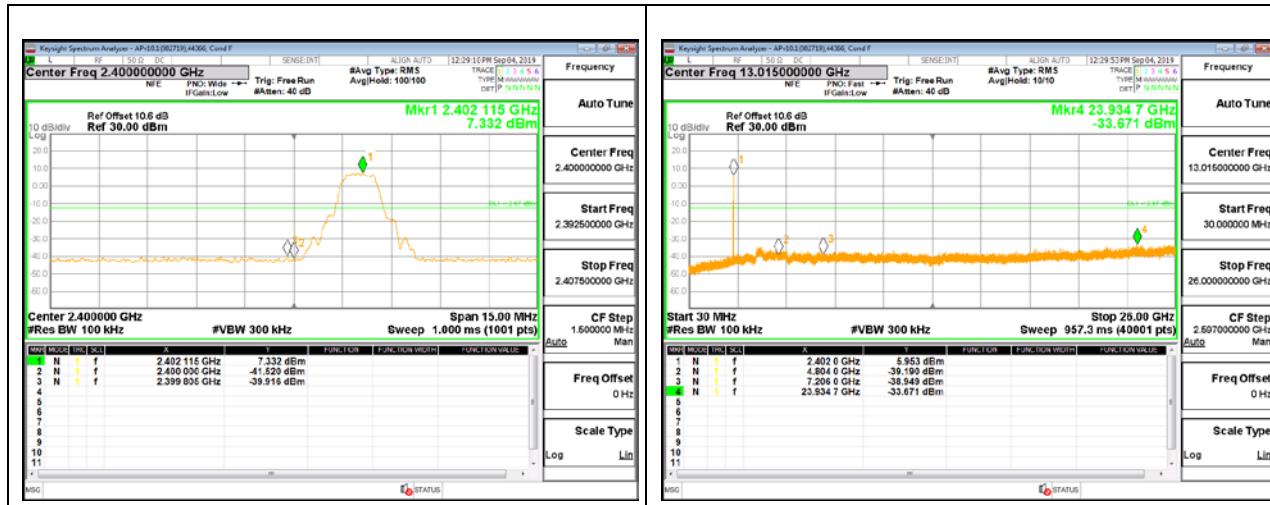


ID:	44366	Date:	10/08/2019
-----	-------	-------	------------



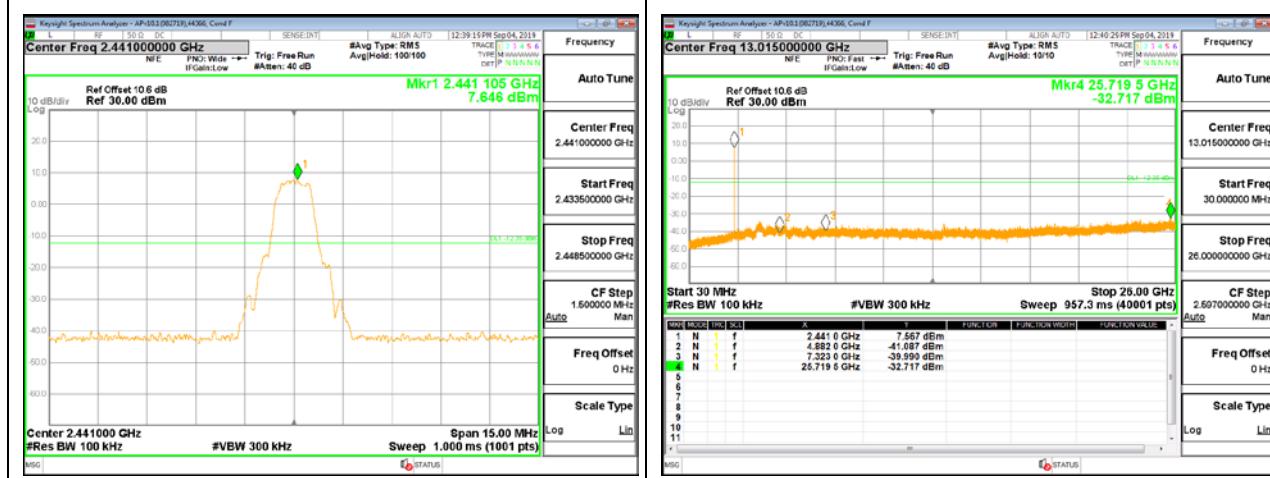
## 8.8.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

## SPURIOUS EMISSIONS, NON-HOPPING



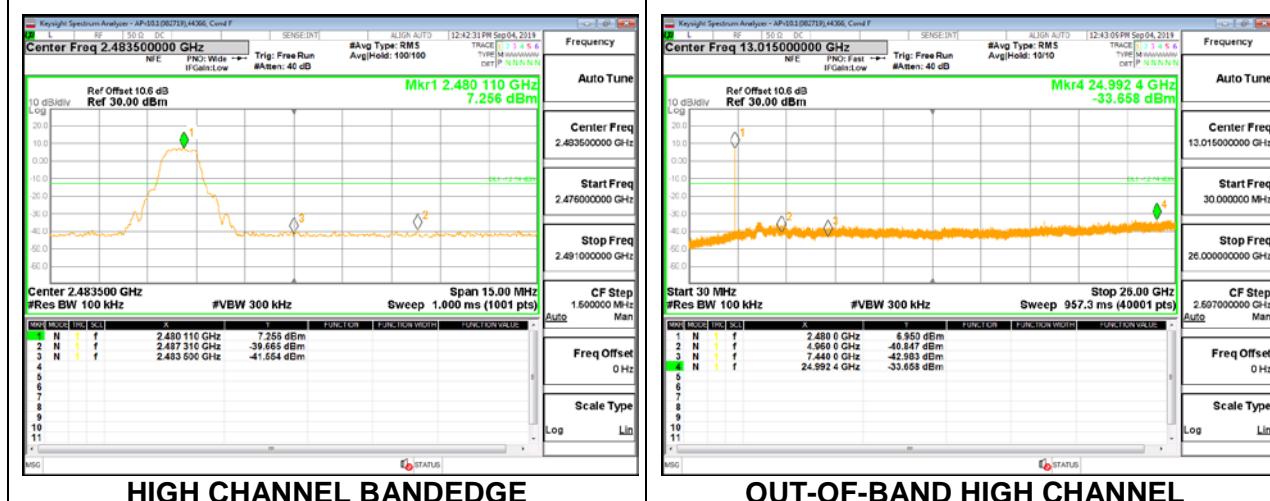
## LOW CHANNEL BANDEDGE

## OUT-OF-BAND LOW CHANNEL



## IN-BAND REFERENCE LEVEL

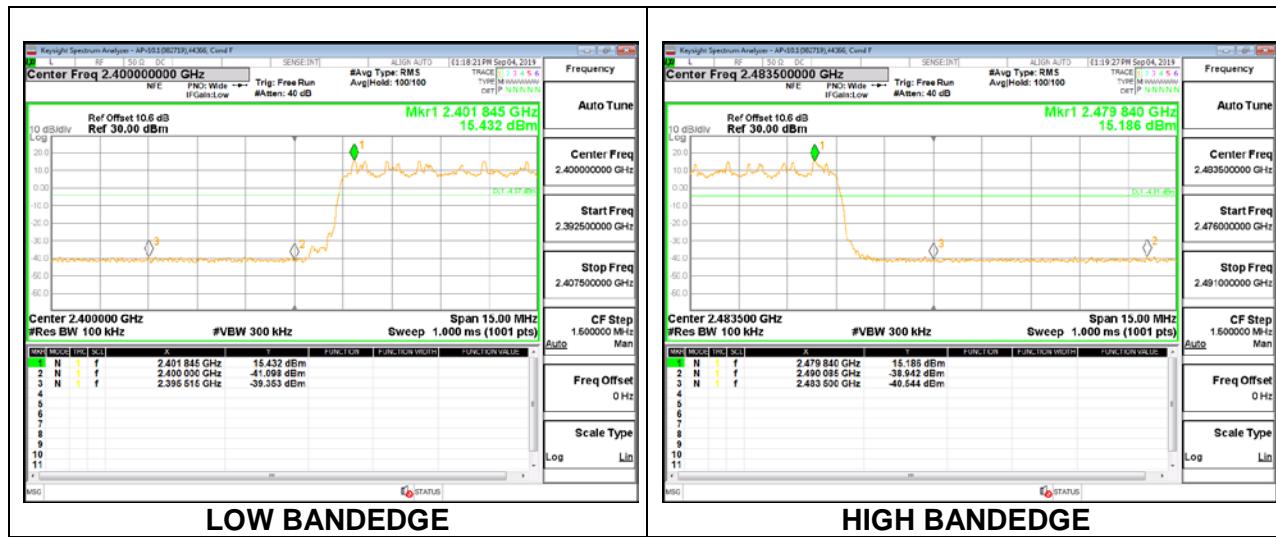
## OUT-OF-BAND MID CHANNEL



## HIGH CHANNEL BANDEDGE

## OUT-OF-BAND HIGH CHANNEL

**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 and 1 MHz resolution bandwidth with 1/T video bandwidth with peak detector for average measurements.

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 v05r02**

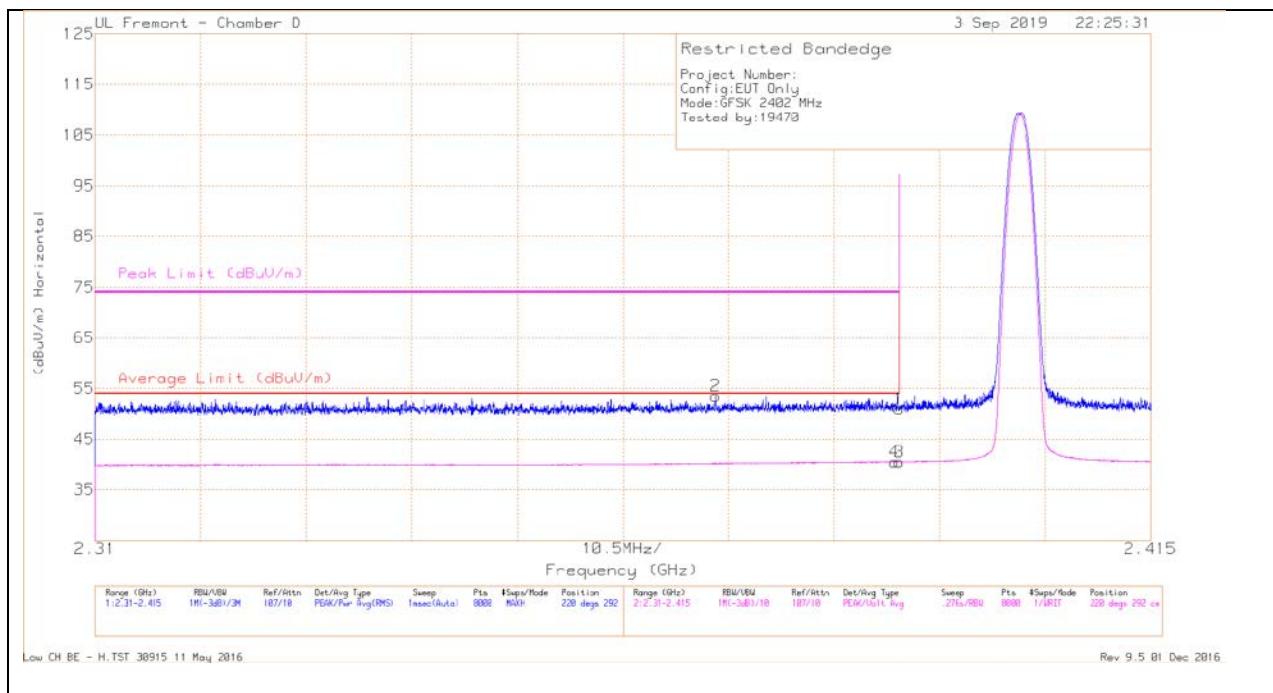
Use of a duty cycle correction factor (DCCF) is permitted for calculating average radiated field strength emission levels for an FHSS device in 15.247. This DCCF can be applied when the field strength limit (e.g., within a Government Restricted band) and the conditions specified in Section 15.35(c) can 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



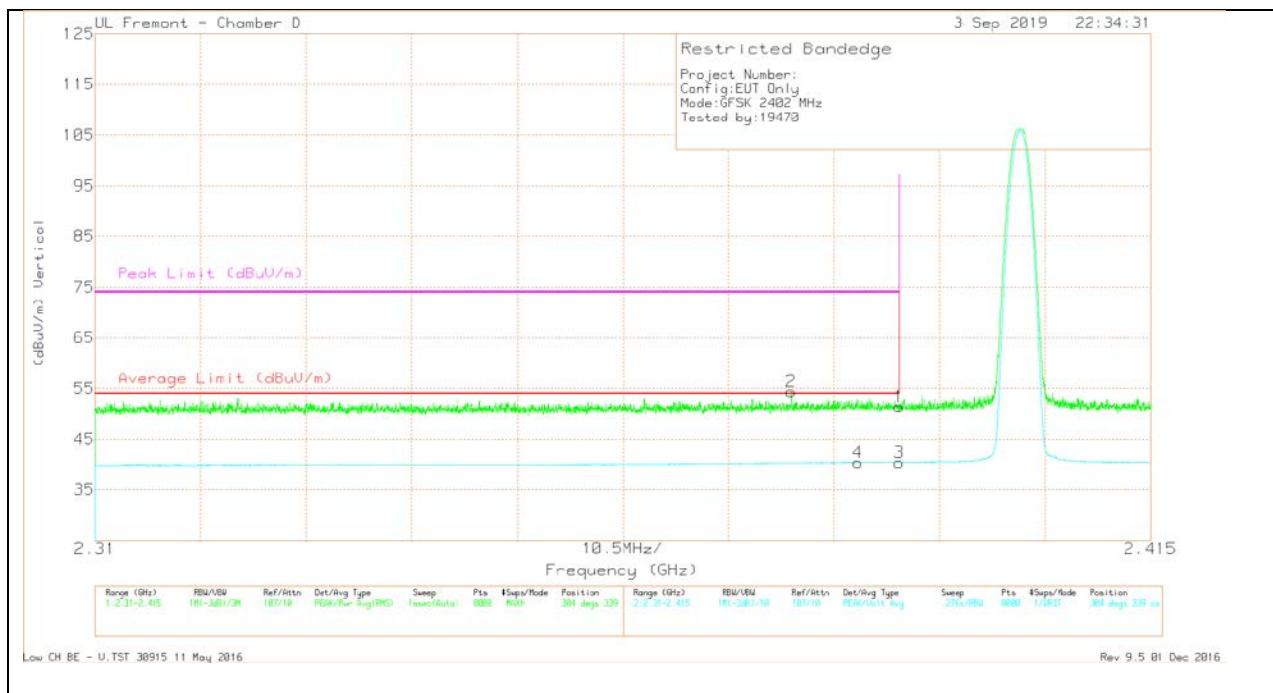
Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T712 (dB/m)	Amp/Cbl/Fltr/P ad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
2	* 2.372	42.21	Pk	31.9	-20.6	53.51	-	-	74	-20.49	220	292	H
4	* 2.389	29	VA1T	32	-20.5	40.5	54	-13.5	-	-	220	292	H
1	* 2.39	39.4	Pk	32	-20.5	50.9	-	-	74	-23.1	220	292	H
3	* 2.39	28.98	VA1T	32	-20.5	40.48	54	-13.52	-	-	220	292	H

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

Pk - Peak detector

VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

## VERTICAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T712 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
2	* 2.379	42.97	Pk	31.9	-20.5	54.37	-	-	74	-19.63	304	339	V
4	* 2.386	29	VA1T	32	-20.6	40.4	54	-13.6	-	-	304	339	V
1	* 2.39	39.95	Pk	32	-20.5	51.45	-	-	74	-22.55	304	339	V
3	* 2.39	28.85	VA1T	32	-20.5	40.35	54	-13.65	-	-	304	339	V

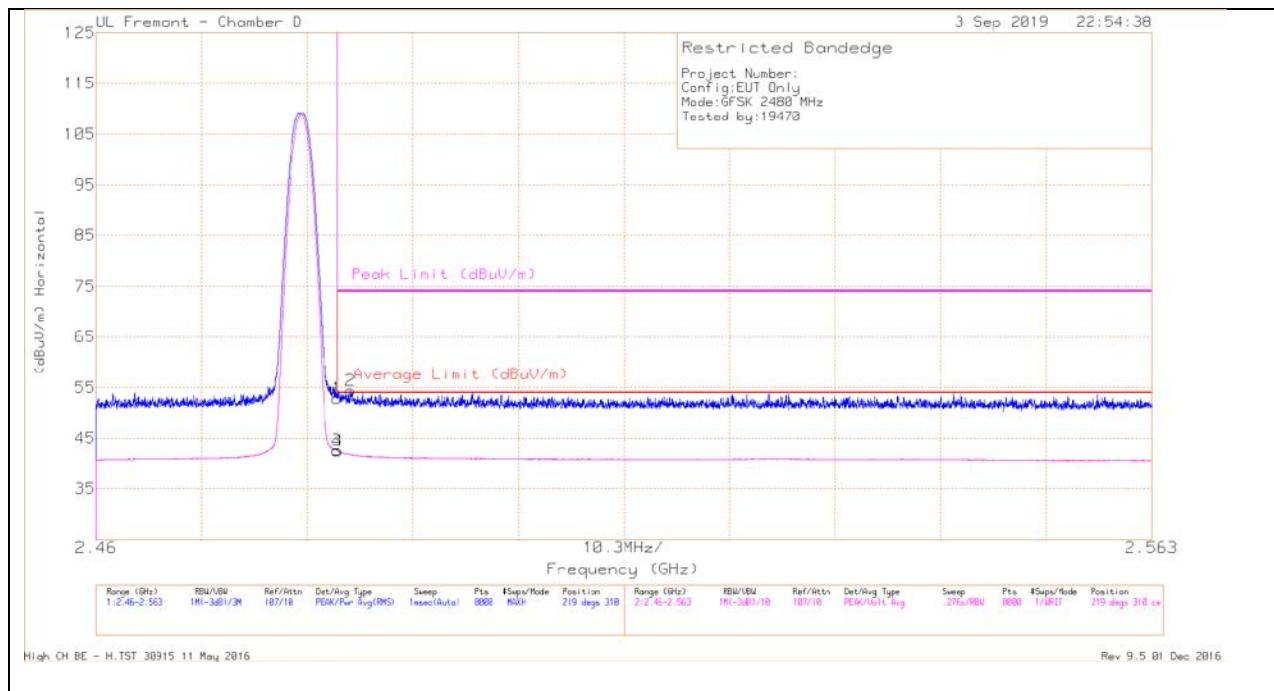
\* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

Pk - Peak detector

VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

## BANDEDGE (HIGH CHANNEL)

### HORIZONTAL RESULT



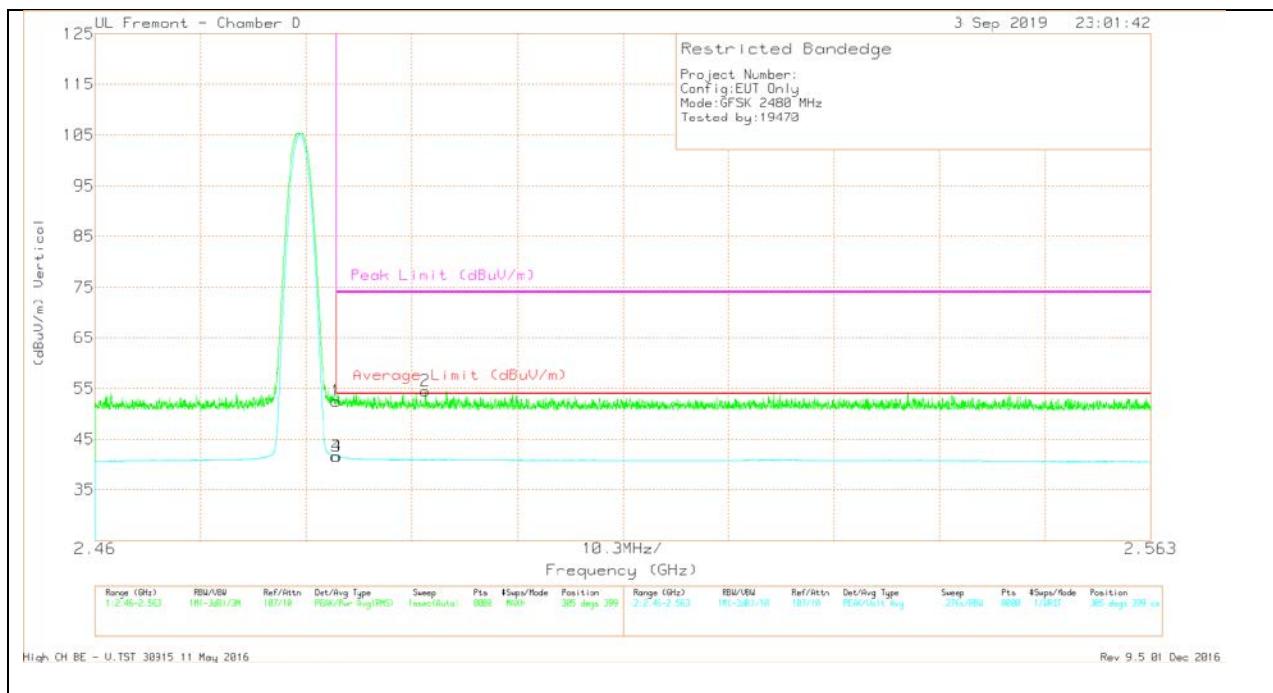
Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T712 (dB/m)	Amp/Cbl/Filt/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.484	40.95	Pk	32.4	-20.5	52.85	-	-	74	-21.15	219	310	H
3	* 2.484	30.64	VA1T	32.4	-20.5	42.54	54	-11.46	-	-	219	310	H
4	* 2.484	30.58	VA1T	32.4	-20.5	42.48	54	-11.52	-	-	219	310	H
2	* 2.485	42.59	Pk	32.3	-20.5	54.39	-	-	74	-19.61	219	310	H

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

Pk - Peak detector

VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

## VERTICAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBm)	Det	AF T712 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	Corrected Reading (dBm)	Average Limit (dBm/m)	Margin (dB)	Peak Limit (dBm/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.484	40.63	Pk	32.4	-20.5	52.53	-	-	74	-21.47	305	399	V
3	* 2.484	29.71	VA1T	32.4	-20.5	41.61	54	-12.39	-	-	305	399	V
4	* 2.484	29.66	VA1T	32.4	-20.5	41.56	54	-12.44	-	-	305	399	V
2	* 2.492	42.55	Pk	32.4	-20.4	54.55	-	-	74	-19.45	305	399	V

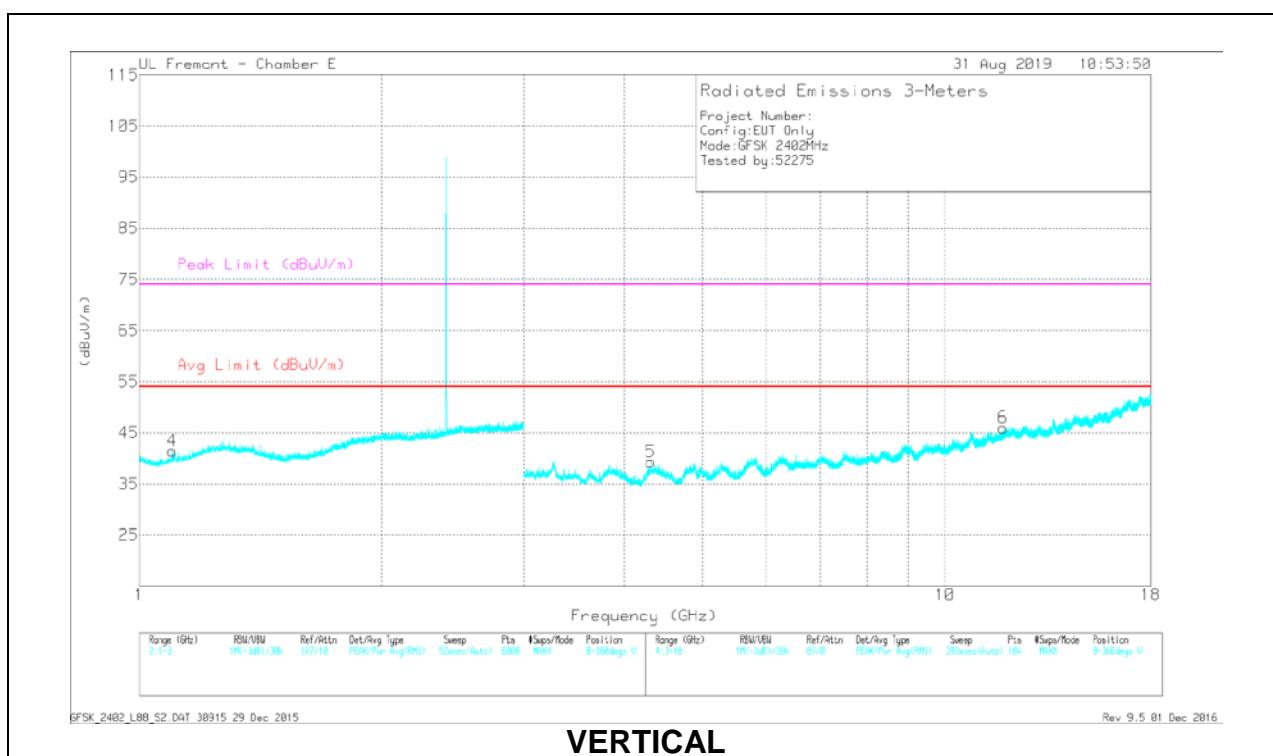
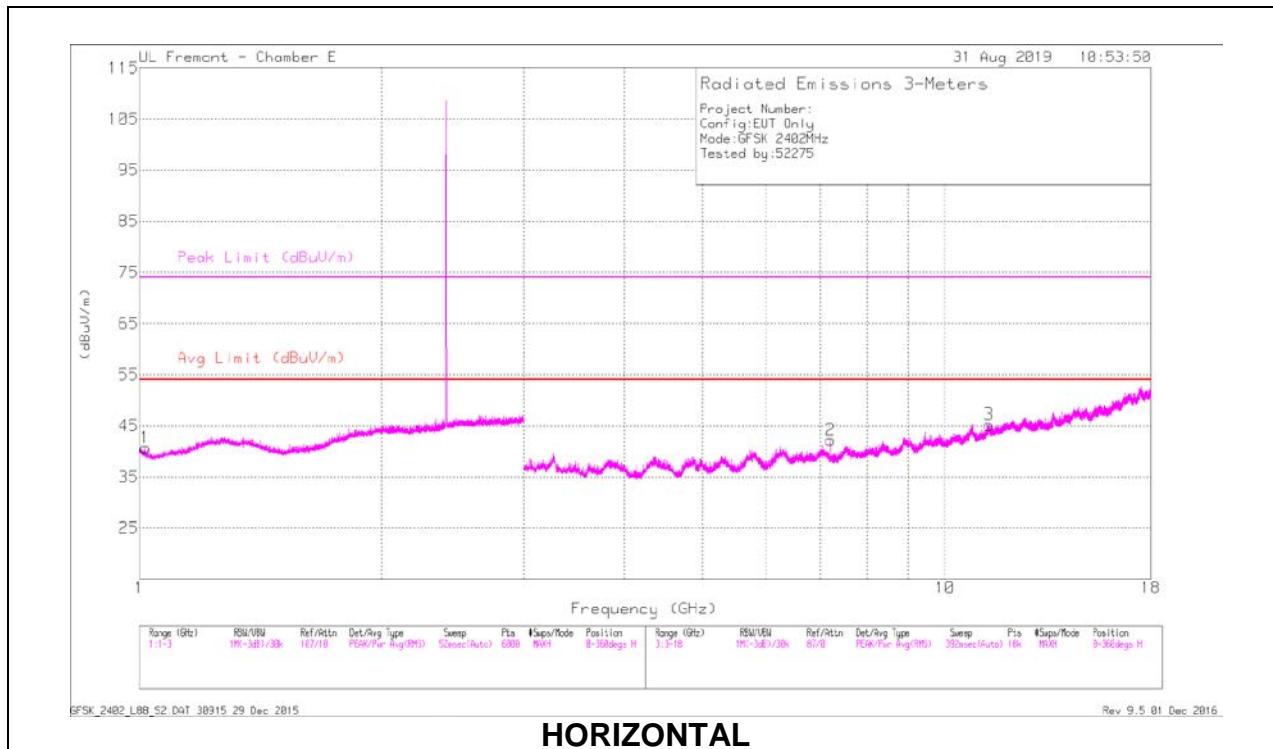
\* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

Pk - Peak detector

VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

## HARMONICS AND SPURIOUS EMISSIONS

### LOW CHANNEL RESULTS



## RADIATED EMISSIONS

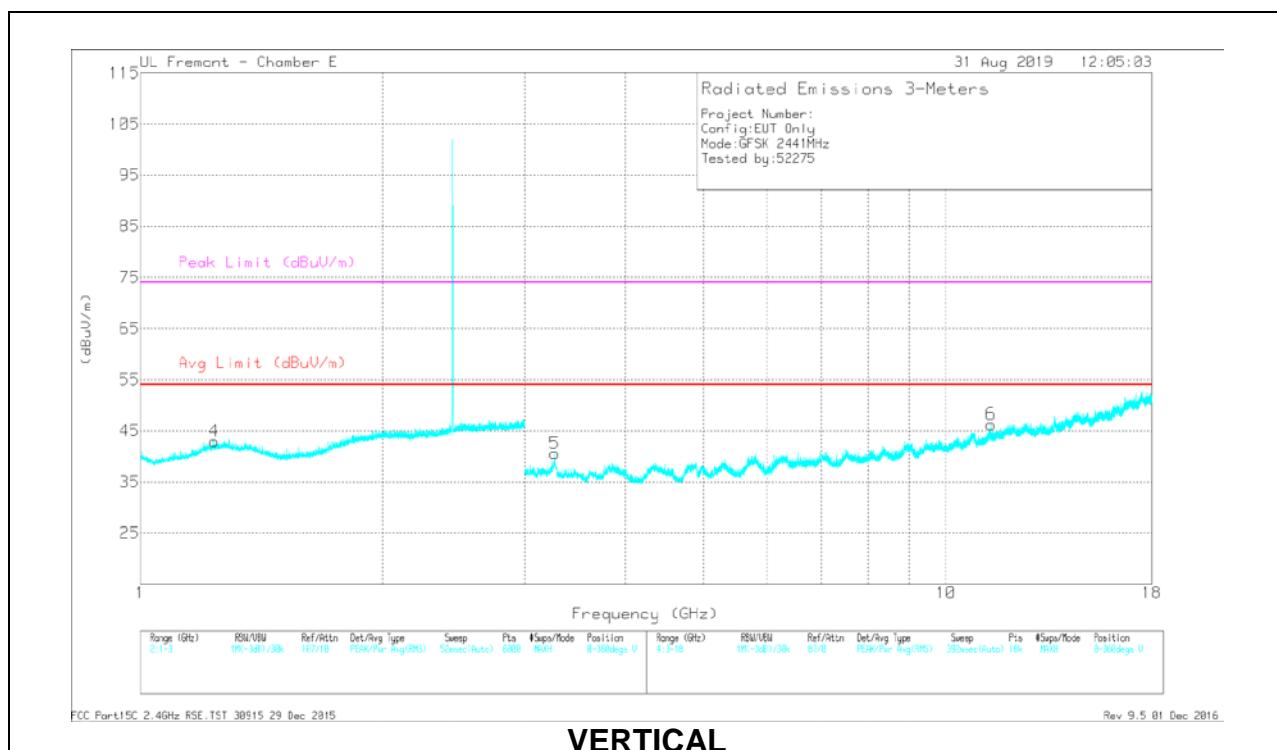
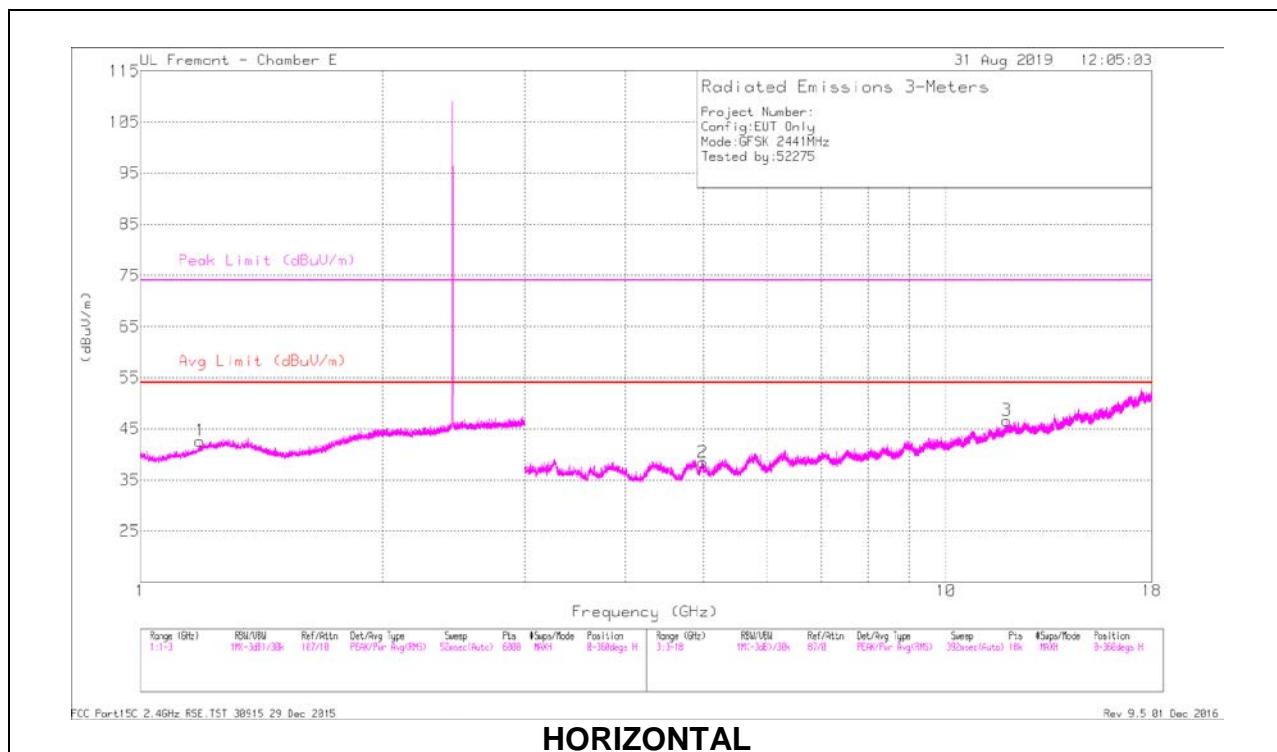
Markers	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T119 (dB/m)	Amp/Cpl/Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 1.018	43.8	PKFH	27.5	-25.7	45.6	-	-	74	-28.4	140	190	H
	* 1.02	32.13	VA1T	27.4	-25.7	33.83	54	-20.17	-	-	140	190	H
2	7.205	38.19	PKFH	35.6	-28.1	45.69	-	-	-	-	300	102	H
3	* 11.33	35.66	PKFH	38.1	-22.2	51.56	-	-	74	-22.44	245	214	H
	* 11.326	23	VA1T	38.1	-22.2	38.9	54	-15.1	-	-	245	214	H
4	* 1.101	44.93	PKFH	27.8	-25.9	46.83	-	-	74	-27.17	255	315	V
	* 1.101	32.38	VA1T	27.8	-25.9	34.28	54	-19.72	-	-	255	315	V
5	* 4.312	41.36	PKFH	33.7	-30.3	44.76	-	-	74	-29.24	360	261	V
	* 4.312	29.46	VA1T	33.6	-30.3	32.76	54	-21.24	-	-	360	261	V
6	* 11.815	34.43	PKFH	38.9	-22.3	51.03	-	-	74	-22.97	152	347	V
	* 11.816	22.88	VA1T	38.9	-22.3	39.48	54	-14.52	-	-	152	347	V

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

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

VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

## MID CHANNEL RESULTS



## RADIATED EMISSIONS

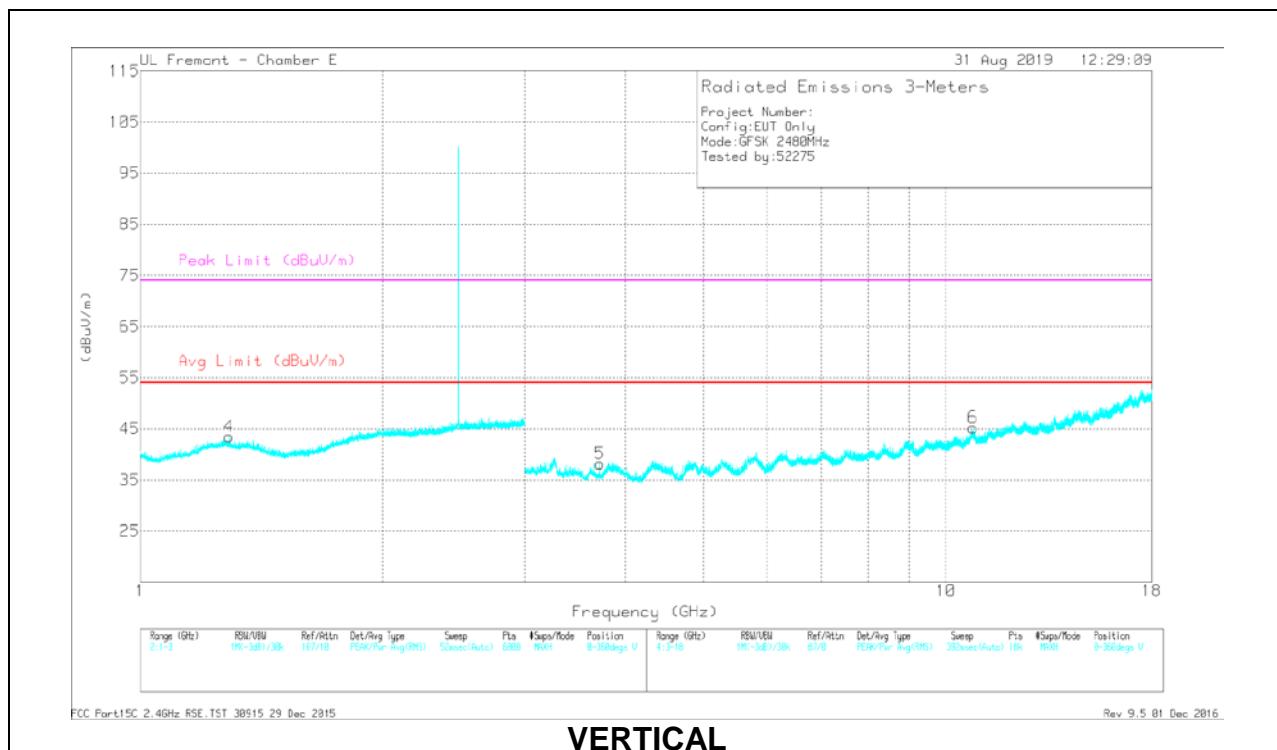
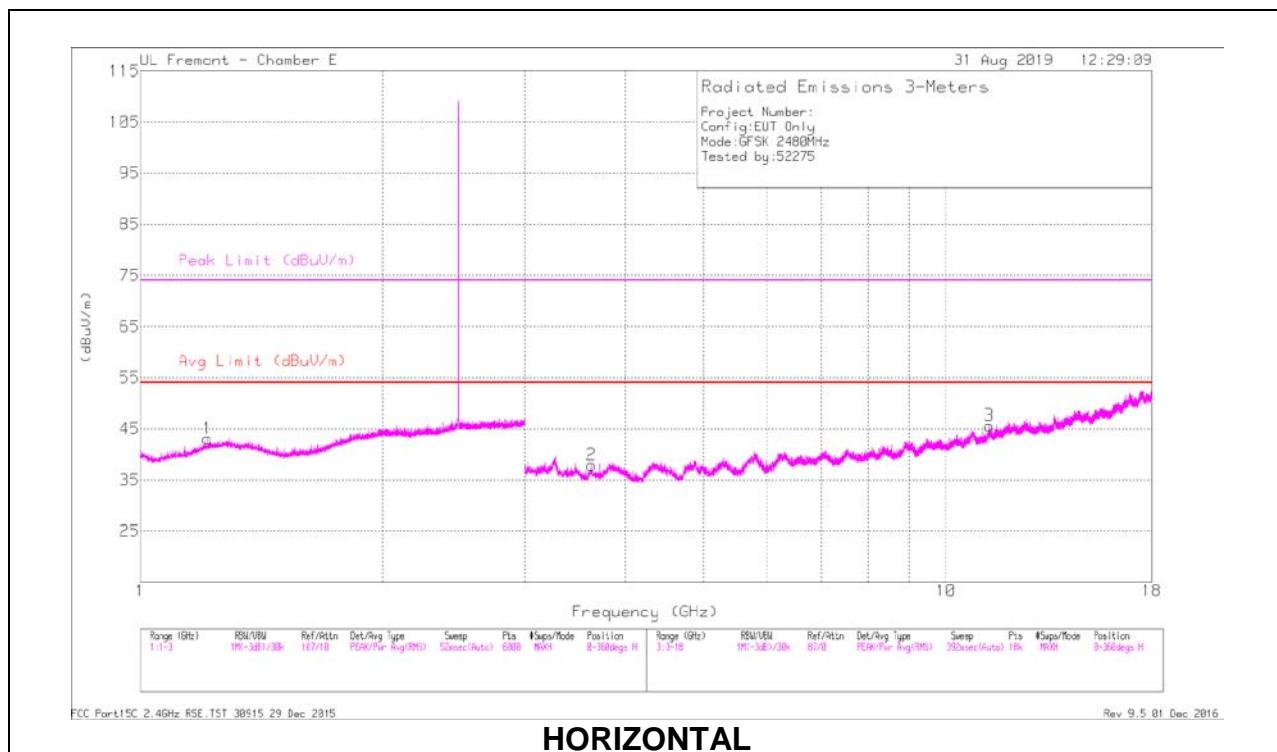
Markers	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T119 (dB/m)	Amp/Cbl/Fltr/ Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 1.188	44.84	PKFH	29.1	-26	47.94	-	-	74	-26.06	260	160	H
	* 1.186	32.53	VA1T	29.1	-26.1	35.53	54	-18.47	-	-	260	160	H
4	* 1.236	44.7	PKFH	29.9	-26.1	48.5	-	-	74	-25.5	331	237	V
	* 1.237	32.61	VA1T	29.9	-26.1	36.41	54	-17.59	-	-	331	237	V
2	* 4.988	41.35	PKFH	34.1	-30.5	44.95	-	-	74	-29.05	139	355	H
	* 4.988	29.17	VA1T	34.1	-30.5	32.77	54	-21.23	-	-	139	355	H
3	* 11.894	35.34	PKFH	39	-22.3	52.04	-	-	74	-21.96	288	298	H
	* 11.896	23.08	VA1T	39	-22.3	39.78	54	-14.22	-	-	288	298	H
6	* 11.375	35.27	PKFH	38.2	-22.8	50.67	-	-	74	-23.33	268	114	V
	* 11.371	23.41	VA1T	38.2	-22.7	38.91	54	-15.09	-	-	268	114	V
5	3.272	43.58	PKFH	34.7	-33.2	45.08	-	-	-	-	287	105	V

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

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

VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

## HIGH CHANNEL RESULTS



## RADIATED EMISSIONS

Markers	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T119 (dB/m)	Amp/Cbl/Fltr/ Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 1.211	44.09	PKFH	29.6	-26.1	47.59	-	-	74	-26.41	245	320	H
	* 1.211	32.51	VA1T	29.6	-26.1	36.01	54	-17.99	-	-	245	320	H
4	* 1.287	44.02	PKFH	30	-26.2	47.82	-	-	74	-26.18	194	174	V
	* 1.29	32.67	VA1T	30	-26.2	36.47	54	-17.53	-	-	194	174	V
2	* 3.632	42.23	PKFH	33.5	-33	42.73	-	-	74	-31.27	121	268	H
	* 3.631	30.41	VA1T	33.6	-33	31.01	54	-22.99	-	-	121	268	H
3	* 11.318	35.37	PKFH	38.1	-22.1	51.37	-	-	74	-22.63	342	140	H
	* 11.319	22.98	VA1T	38.1	-22.1	38.98	54	-15.02	-	-	342	140	H
5	* 3.72	44.08	PKFH	33.1	-33	44.18	-	-	74	-29.82	322	342	V
	* 3.72	33.88	VA1T	33.1	-33	33.98	54	-20.02	-	-	322	342	V
6	* 10.794	35.48	PKFH	37.9	-23	50.38	-	-	74	-23.62	272	301	V
	* 10.793	24.03	VA1T	37.9	-23	38.93	54	-15.07	-	-	272	301	V

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

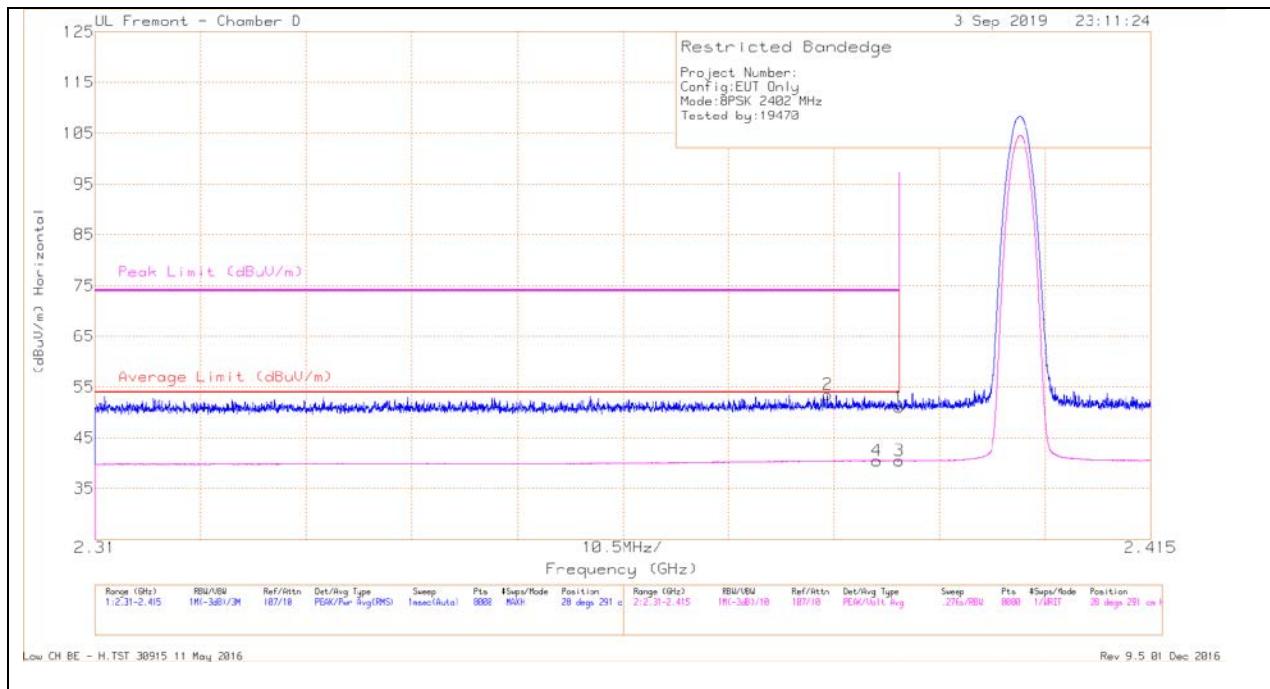
PKFH - FHSS: RB=100k/1MHz VB=3 x RB, Peak

VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

## 9.1.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

### BANDEDGE (LOW CHANNEL)

#### HORIZONTAL RESULT



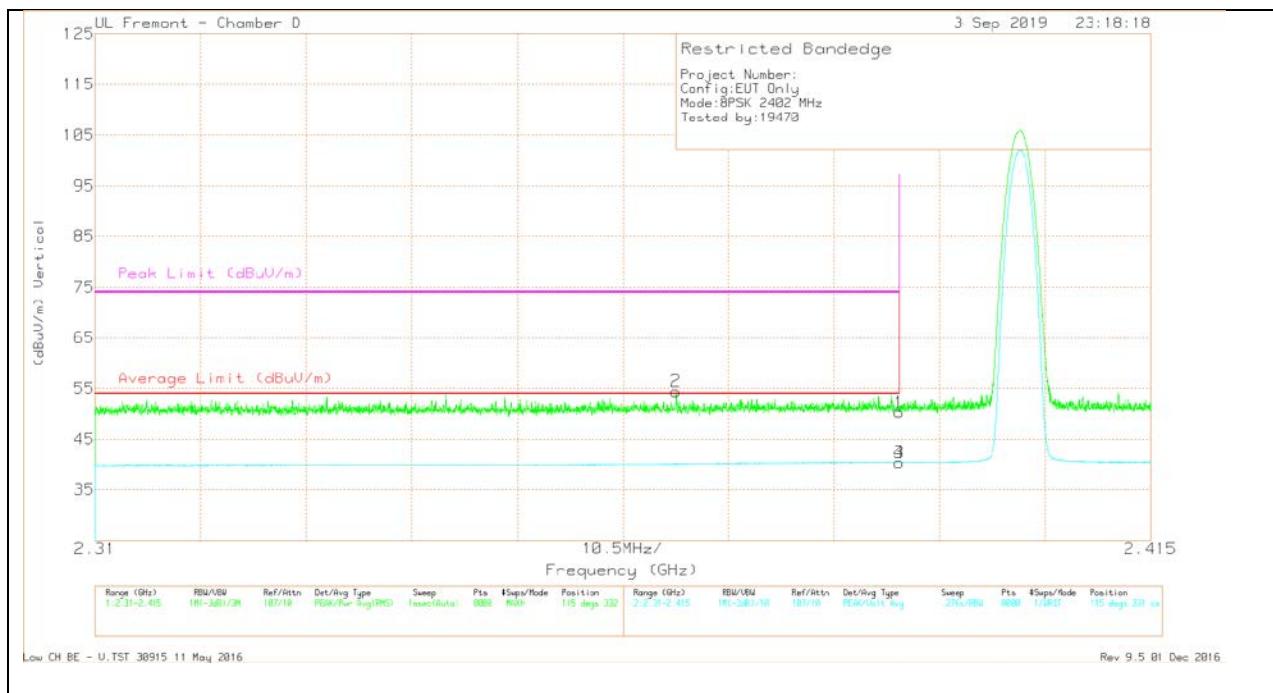
Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T712 (dBm)	Amp/Cbl/Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
2	* 2.383	42.16	Pk	32	-20.6	53.56	-	-	74	-20.44	28	291	H
4	* 2.388	29.11	VA1T	32	-20.6	40.51	54	-13.49	-	-	28	291	H
1	* 2.39	39.55	Pk	32	-20.5	51.05	-	-	74	-22.95	28	291	H
3	* 2.39	28.96	VA1T	32	-20.5	40.46	54	-13.54	-	-	28	291	H

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

Pk - Peak detector

VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

## VERTICAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T712 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
2	* 2.368	43.25	Pk	31.8	-20.6	54.45	-	-	74	-19.55	115	332	V
1	* 2.39	38.77	Pk	32	-20.5	50.27	-	-	74	-23.73	115	332	V
3	* 2.39	28.87	VA1T	32	-20.5	40.37	54	-13.63	-	-	115	331	V
4	* 2.39	28.88	VA1T	32	-20.5	40.38	54	-13.62	-	-	115	331	V

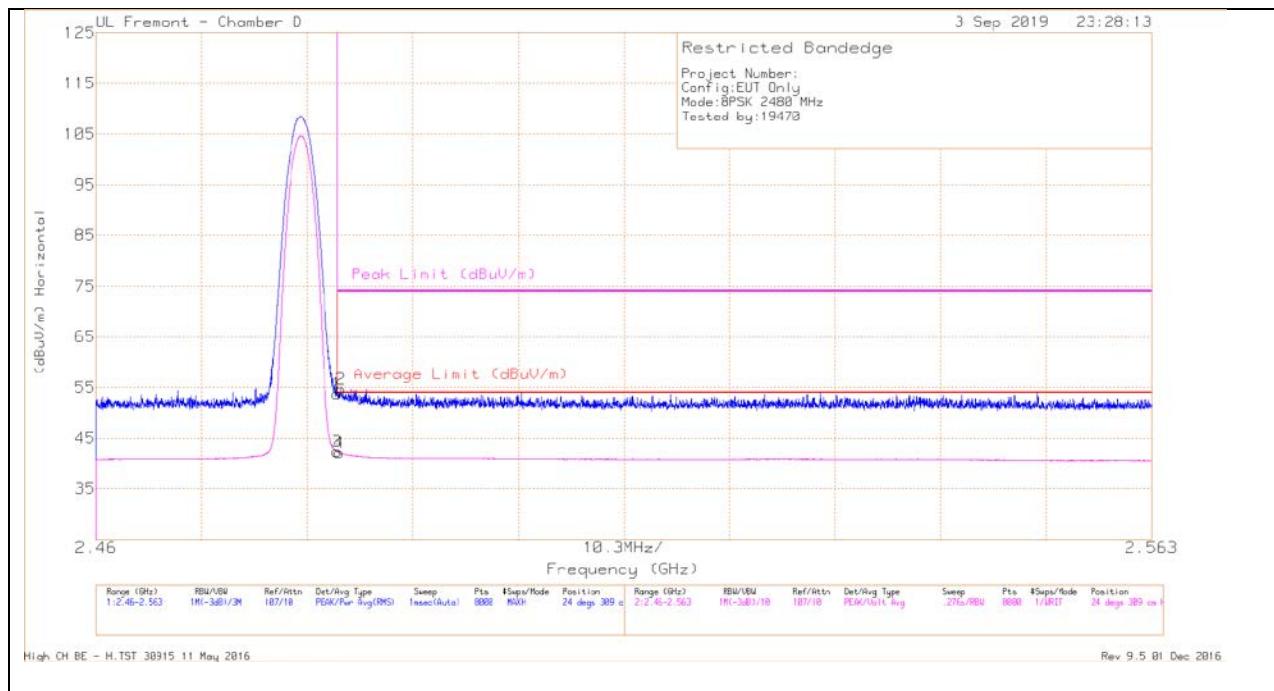
\* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

Pk - Peak detector

VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

## BANDEDGE (HIGH CHANNEL)

### HORIZONTAL RESULT



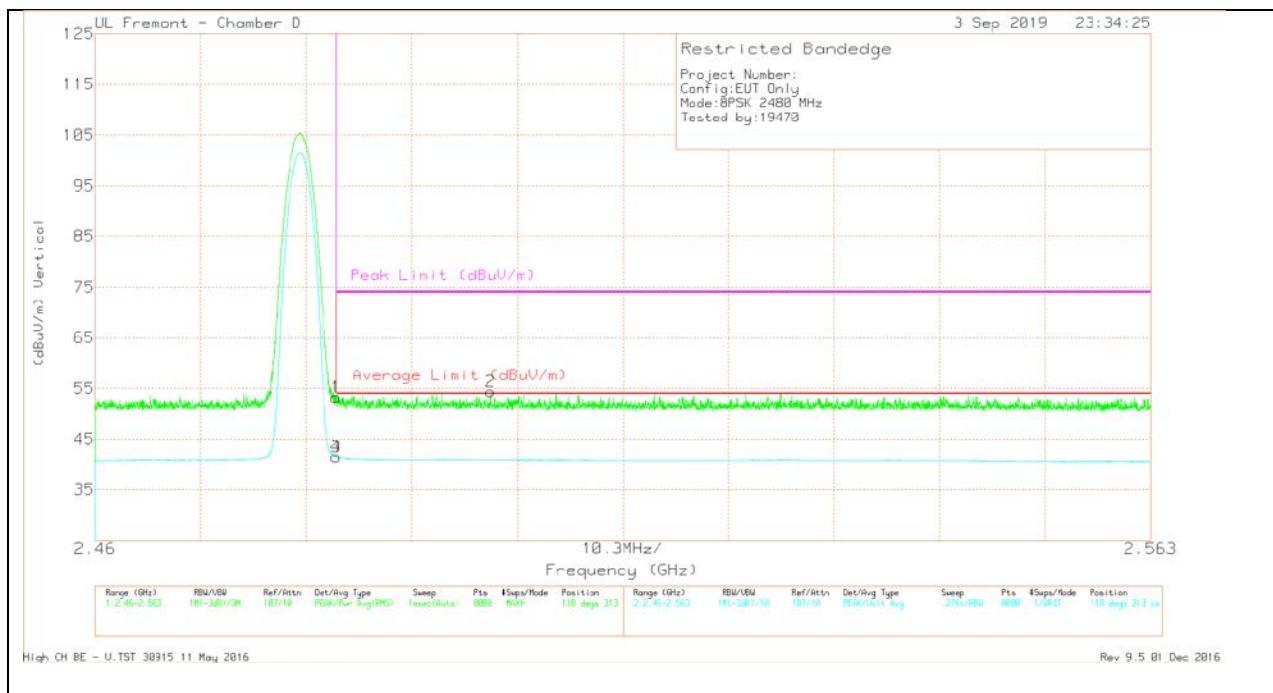
Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T712 (dB/m)	Amp/Cbl/Filt/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.484	41.87	Pk	32.4	-20.5	53.77	-	-	74	-20.23	24	309	H
2	* 2.484	42.86	Pk	32.3	-20.5	54.66	-	-	74	-19.34	24	309	H
3	* 2.484	30.41	VA1T	32.4	-20.5	42.31	54	-11.69	-	-	24	309	H
4	* 2.484	30.22	VA1T	32.4	-20.5	42.12	54	-11.88	-	-	24	309	H

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

Pk - Peak detector

VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

## VERTICAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T712 (dB/m)	Amp/Cbl/Fltr/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	* 2.484	41.36	Pk	32.4	-20.5	53.26	-	-	74	-20.74	118	313	V
3	* 2.484	29.61	VA1T	32.4	-20.5	41.51	54	-12.49	-	-	118	313	V
4	* 2.484	29.61	VA1T	32.4	-20.5	41.51	54	-12.49	-	-	118	313	V
2	* 2.499	42.49	Pk	32.3	-20.4	54.39	-	-	74	-19.61	118	313	V

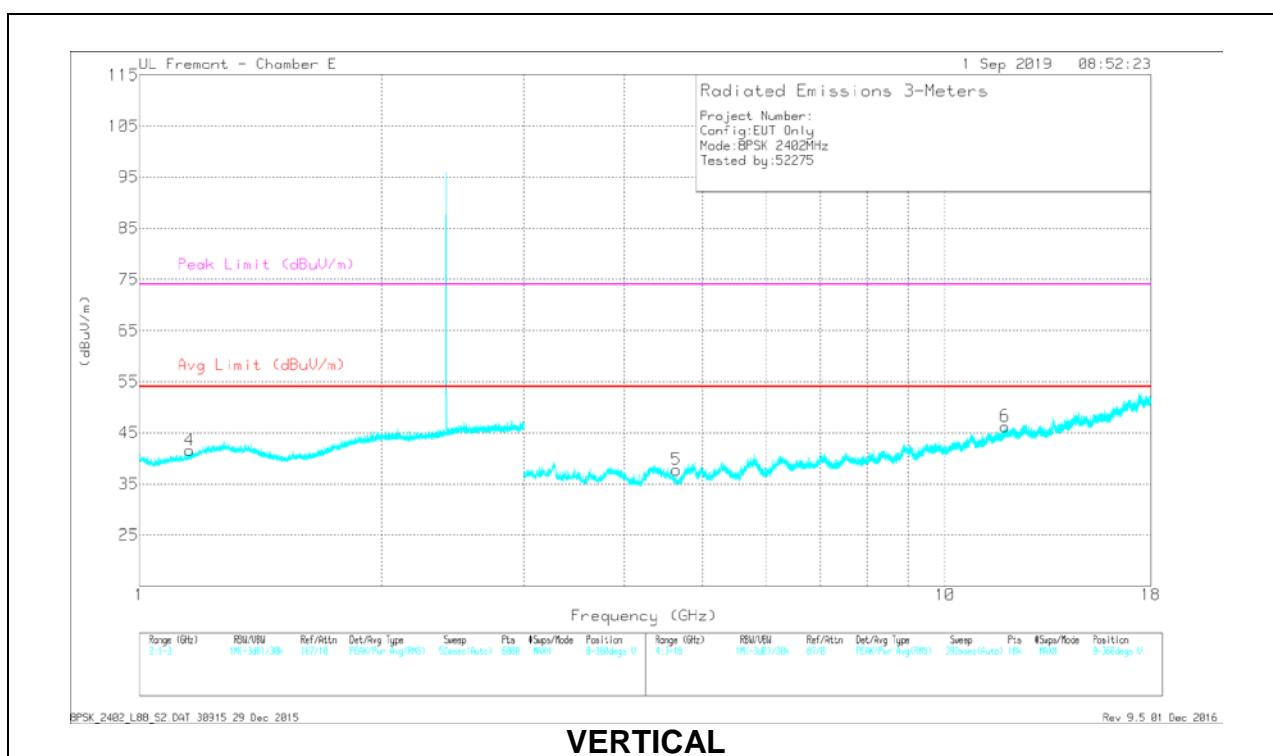
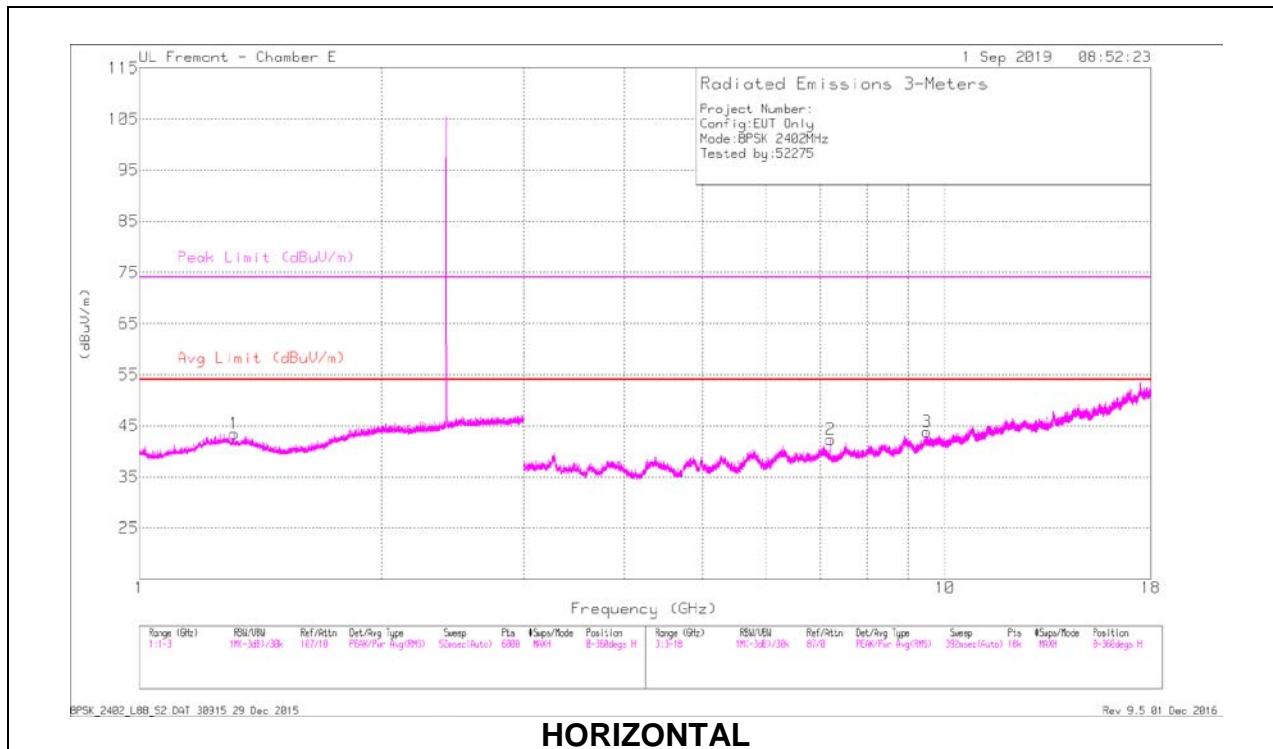
\* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

Pk - Peak detector

VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

## HARMONICS AND SPURIOUS EMISSIONS

### LOW CHANNEL RESULTS



## RADIATED EMISSIONS

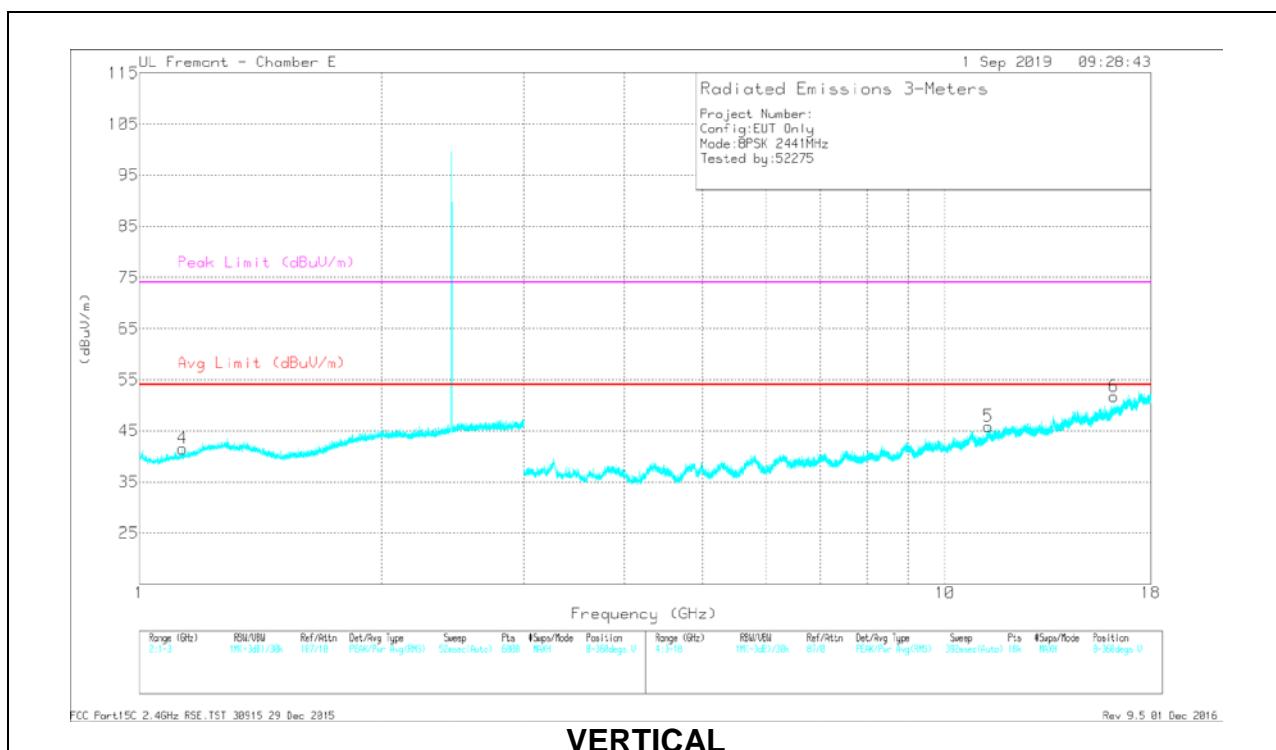
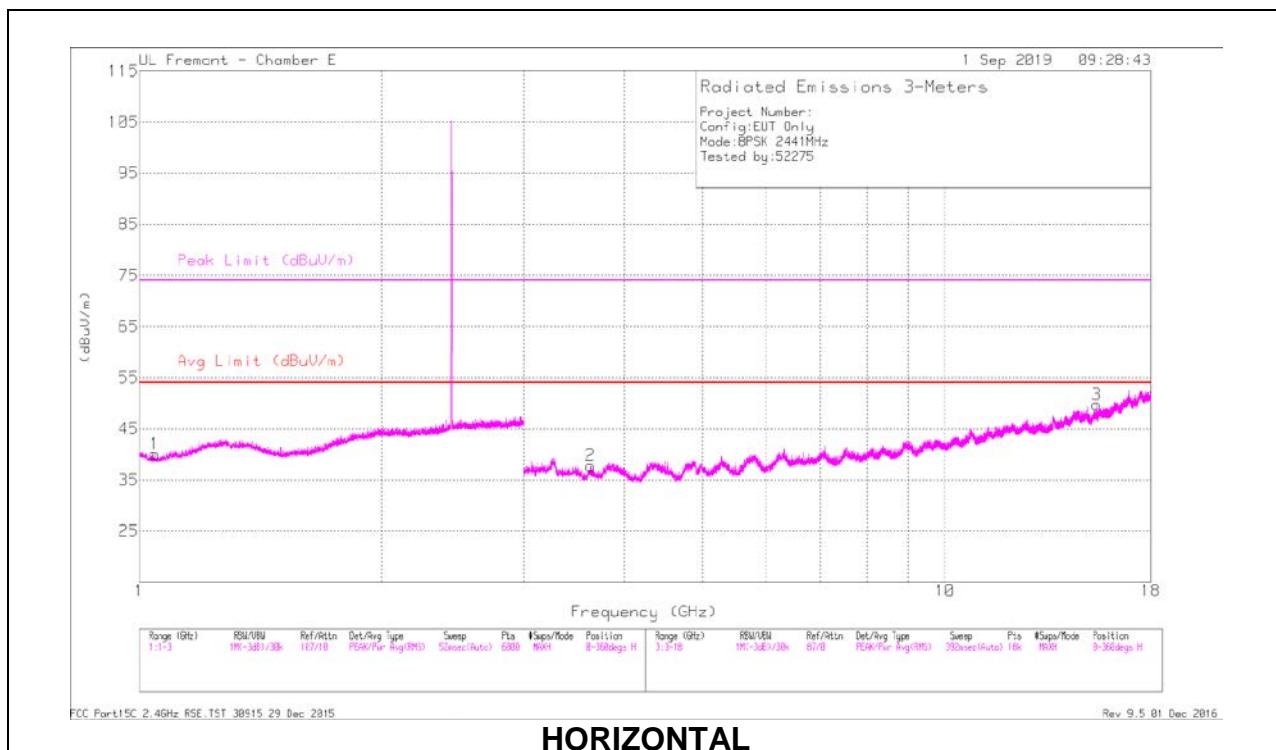
Markers	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T119 (dB/m)	Amp/Cbl/Fltr/ Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 1.311	44.67	PKFH	29.7	-26.2	48.17	-	-	74	-25.83	265	304	H
	* 1.312	32.79	VA1T	29.7	-26.2	36.29	54	-17.71	-	-	265	304	H
2	7.206	39.66	PKFH	35.6	-28.1	47.16	-	-	-	-	294	101	H
3	* 9.484	36.1	PKFH	36.7	-24.1	48.7	-	-	74	-25.3	107	288	H
	* 9.484	24	VA1T	36.7	-24.1	36.6	54	-17.4	-	-	107	288	H
4	* 1.156	44.54	PKFH	28.3	-26	46.84	-	-	74	-27.16	303	177	V
	* 1.157	32.51	VA1T	28.4	-26	34.91	54	-19.09	-	-	303	177	V
5	* 4.643	41.53	PKFH	34.2	-31.9	43.83	-	-	74	-30.17	318	217	V
	* 4.641	28.28	VA1T	34.2	-31.9	30.58	54	-23.42	-	-	318	217	V
6	* 11.864	35.55	PKFH	39	-22.2	52.35	-	-	74	-21.65	120	328	V
	* 11.862	22.93	VA1T	38.9	-22.2	39.63	54	-14.37	-	-	120	328	V

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

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

VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

## MID CHANNEL RESULTS



## RADIATED EMISSIONS

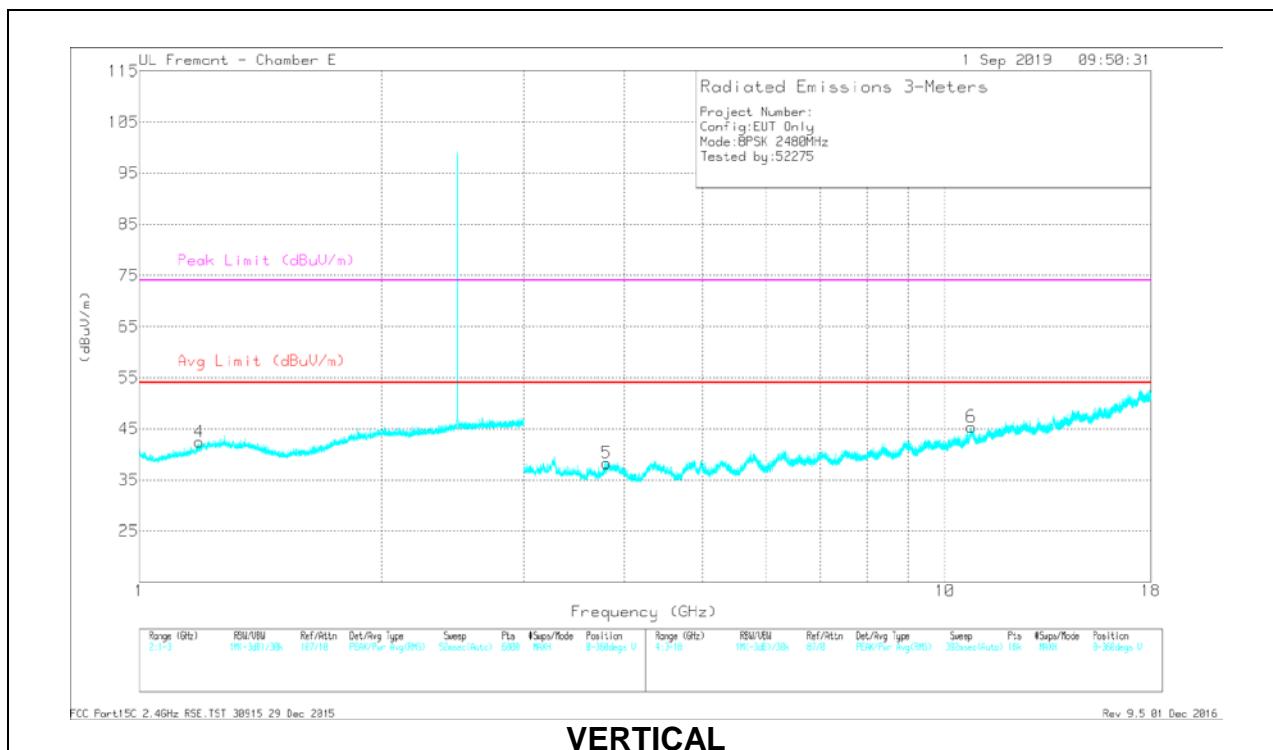
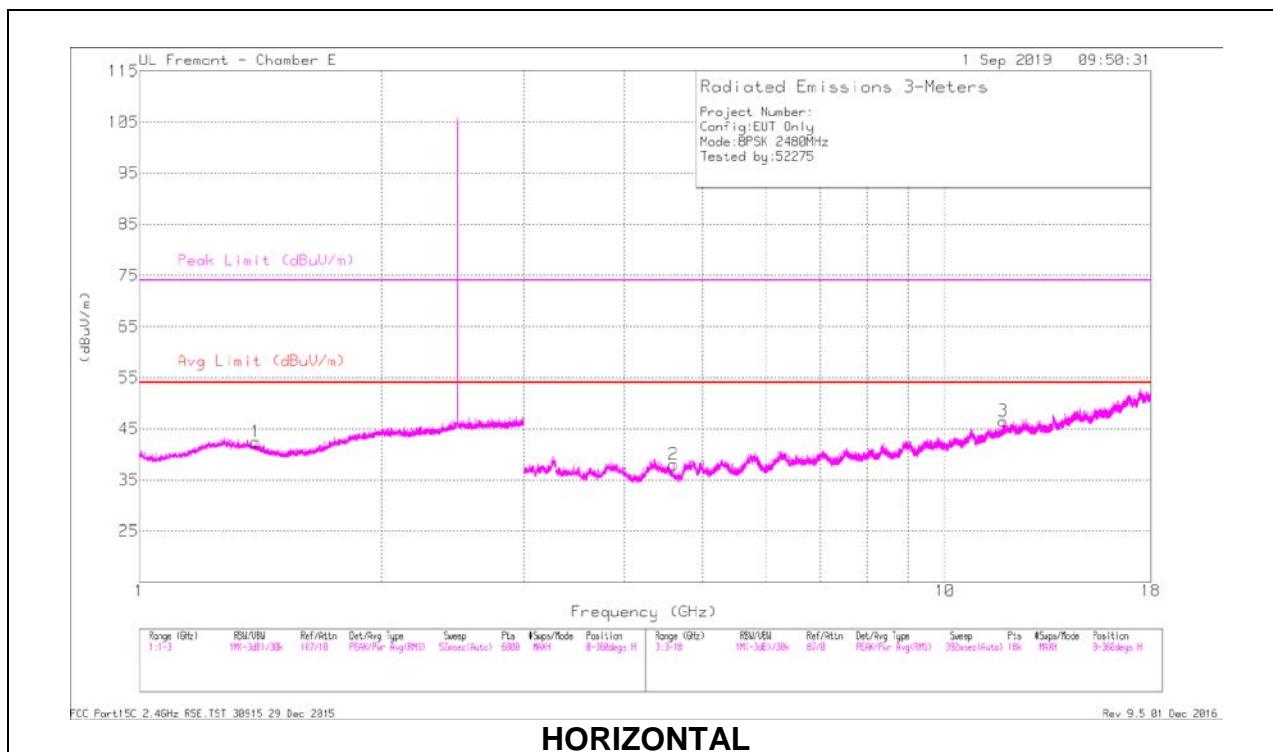
Markers	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T119 (dB/m)	Amp/Cbl/Fltr/ Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 1.047	44.23	PKFH	27.1	-25.8	45.53	-	-	74	-28.47	177	223	H
	* 1.044	32.27	VA1T	27	-25.8	33.47	54	-20.53	-	-	177	223	H
2	* 3.632	42.37	PKFH	33.5	-33	42.87	-	-	74	-31.13	348	172	H
	* 3.633	30.4	VA1T	33.5	-33	30.9	54	-23.1	-	-	348	172	H
3	* 15.418	34.97	PKFH	40.2	-20.1	55.07	-	-	74	-18.93	250	348	H
	* 15.418	22.52	VA1T	40.2	-20.1	42.62	54	-11.38	-	-	250	348	H
4	* 1.133	44.42	PKFH	28	-26	46.42	-	-	74	-27.58	370	117	V
	* 1.133	32.47	VA1T	28	-26	34.47	54	-19.53	-	-	370	117	V
5	* 11.302	35.34	PKFH	38.1	-22.4	51.04	-	-	74	-22.96	132	193	V
	* 11.304	23.14	VA1T	38.1	-22.3	38.94	54	-15.06	-	-	132	193	V
6	16.209	34.41	PKFH	40.5	-19.2	55.71	-	-	-	-	322	245	V

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

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

VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

## HIGH CHANNEL RESULTS



## RADIATED EMISSIONS

Markers	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T119 (dB/m)	Amp/Cbl/Fltr/ Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 1.397	44.62	PKFH	29.2	-26.2	47.62	-	-	74	-26.38	221	281	H
	* 1.398	32.9	VA1T	29.2	-26.2	35.9	54	-18.1	-	-	221	281	H
2	* 4.601	40.56	PKFH	34.2	-31.9	42.86	-	-	74	-31.14	346	247	H
	* 4.601	28.7	VA1T	34.2	-31.9	31	54	-23	-	-	346	247	H
3	* 11.812	34.22	PKFH	38.9	-22.3	50.82	-	-	74	-23.18	371	148	H
	* 11.81	22.96	VA1T	38.9	-22.3	39.56	54	-14.44	-	-	371	148	H
4	* 1.186	44.29	PKFH	29.1	-26	47.39	-	-	74	-26.61	139	193	V
	* 1.188	32.53	VA1T	29.1	-26	35.63	54	-18.37	-	-	139	193	V
5	* 3.802	42.39	PKFH	33.4	-31.7	44.09	-	-	74	-29.91	342	133	V
	* 3.805	30.35	VA1T	33.3	-31.4	32.25	54	-21.75	-	-	342	133	V
6	* 10.78	35.9	PKFH	37.9	-23.1	50.7	-	-	74	-23.3	360	302	V
	* 10.776	24.11	VA1T	37.9	-23.1	38.91	54	-15.09	-	-	360	302	V

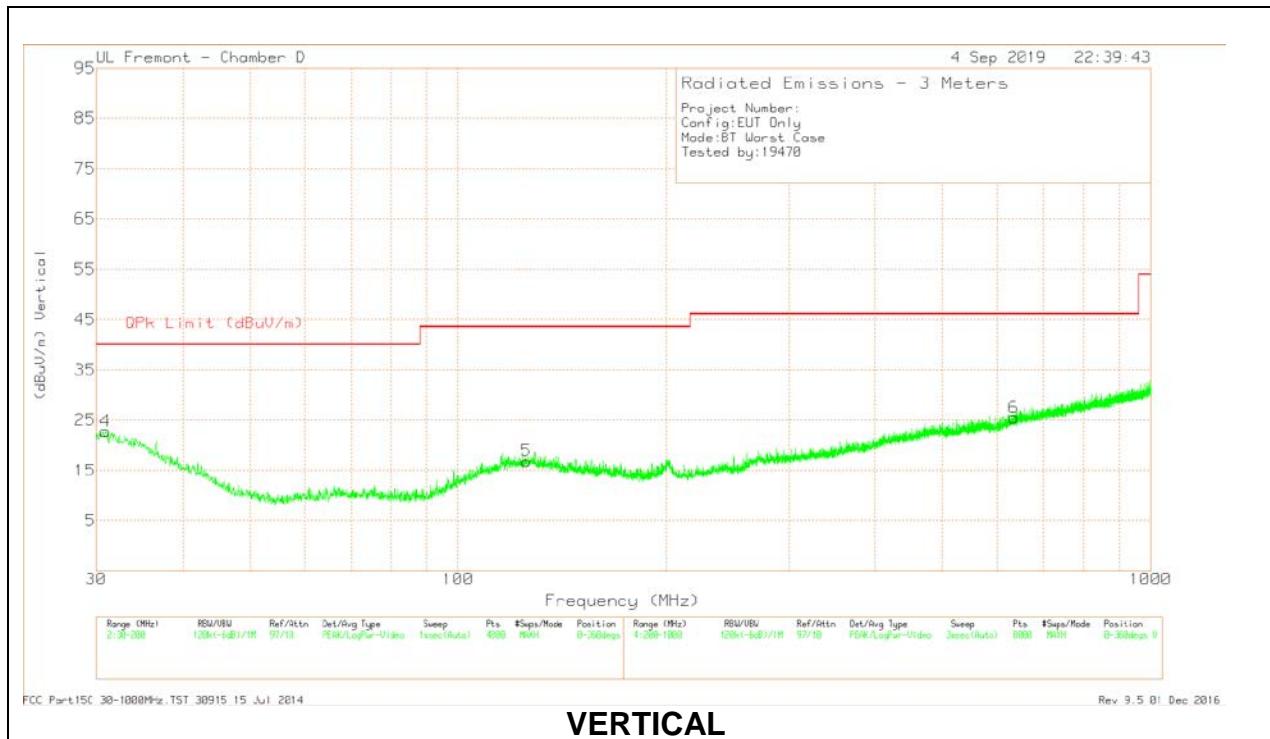
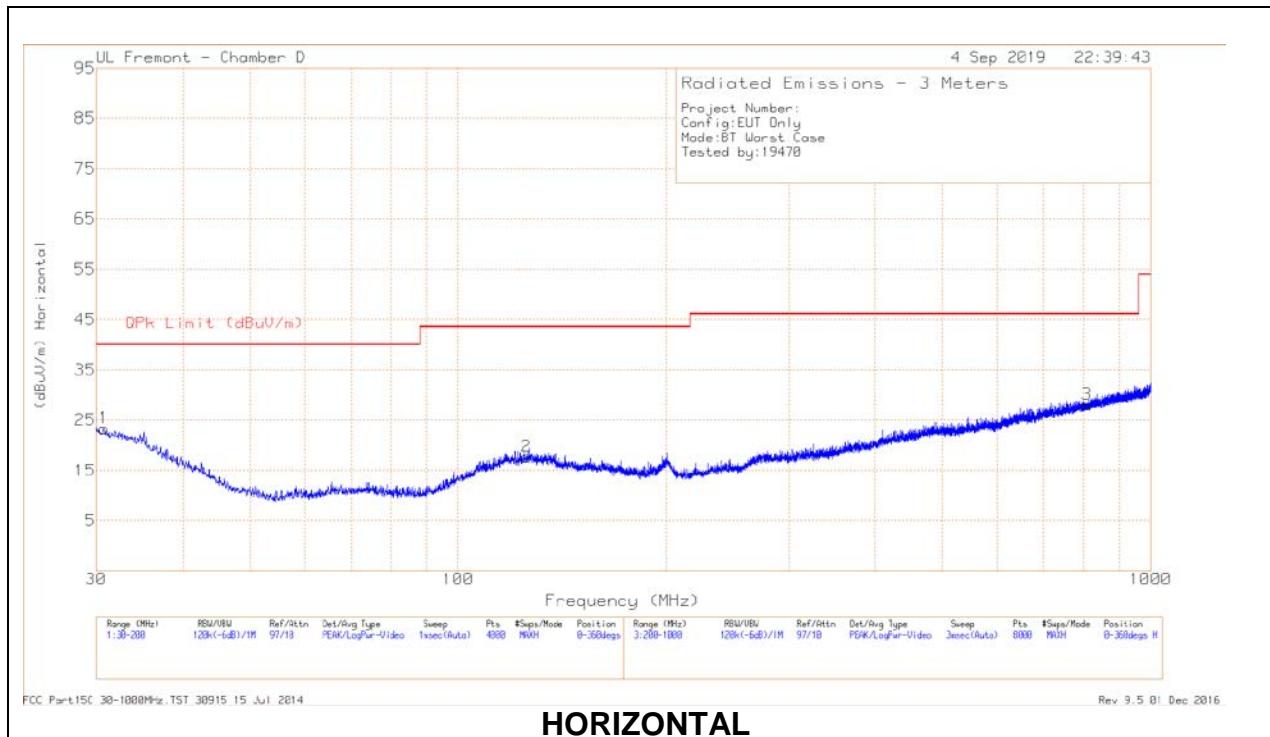
\* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

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

VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

## 9.2. WORST CASE BELOW 1 GHz

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



### Below 1GHz Data

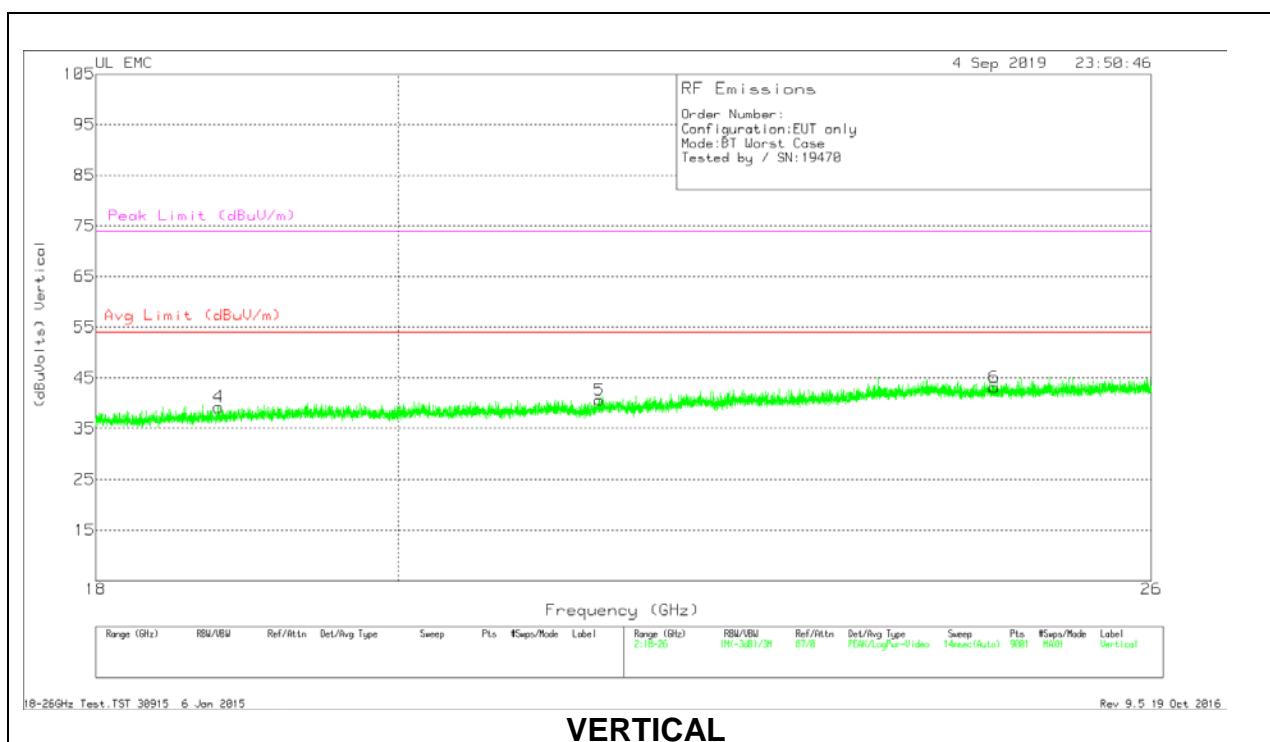
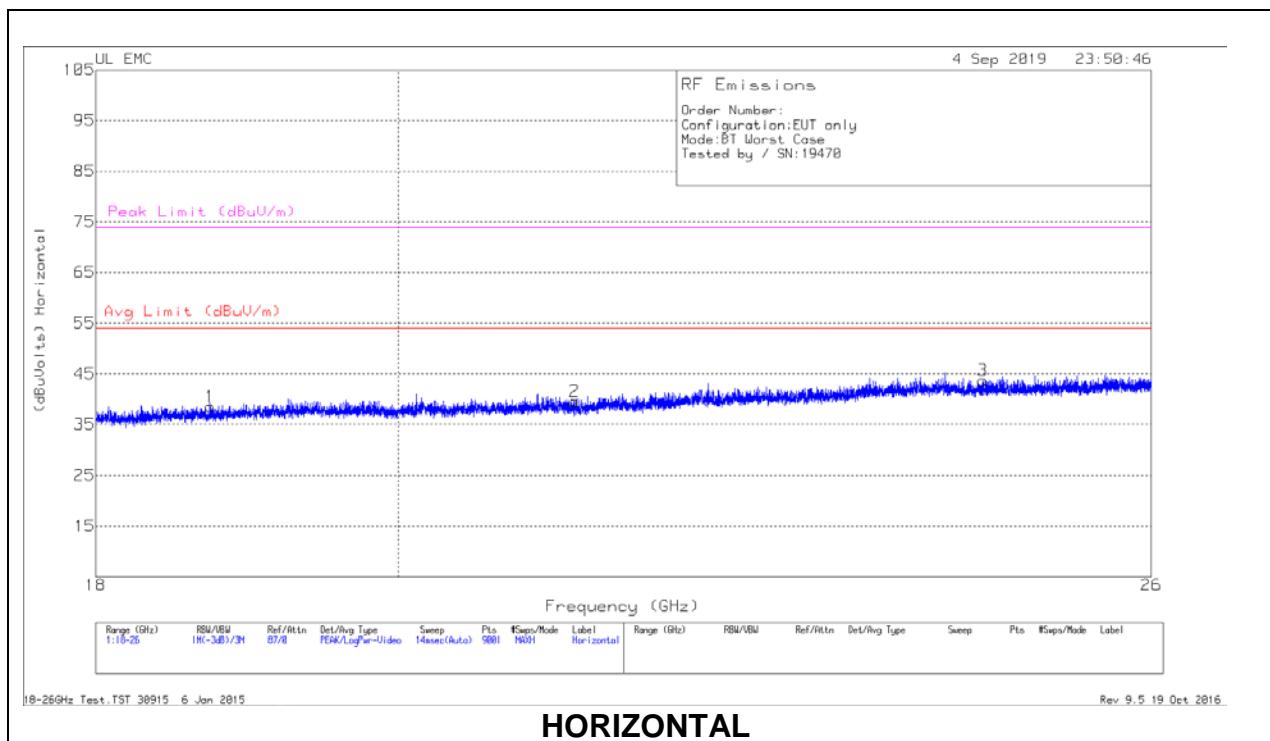
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AF T185 (dB/m)	Amp/Cbl (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	30.7407	21.26	Qp	26.1	-31.7	15.66	40	-24.34	65	124	H
2	* 125.428	21.43	Qp	19.9	-30.8	10.53	43.52	-32.99	154	181	H
4	30.7221	21.3	Qp	26.1	-31.7	15.7	40	-24.3	251	230	V
5	* 125.4245	21.39	Qp	19.9	-30.8	10.49	43.52	-33.03	28	112	V
6	807.6908	20.09	Qp	27.2	-27.6	19.69	46.02	-26.33	72	315	H
3	634.3483	20.31	Qp	25.4	-28.3	17.41	46.02	-28.61	305	331	V

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

Qp - Quasi-Peak detector

### 9.3. WORST CASE 18-26 GHz

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



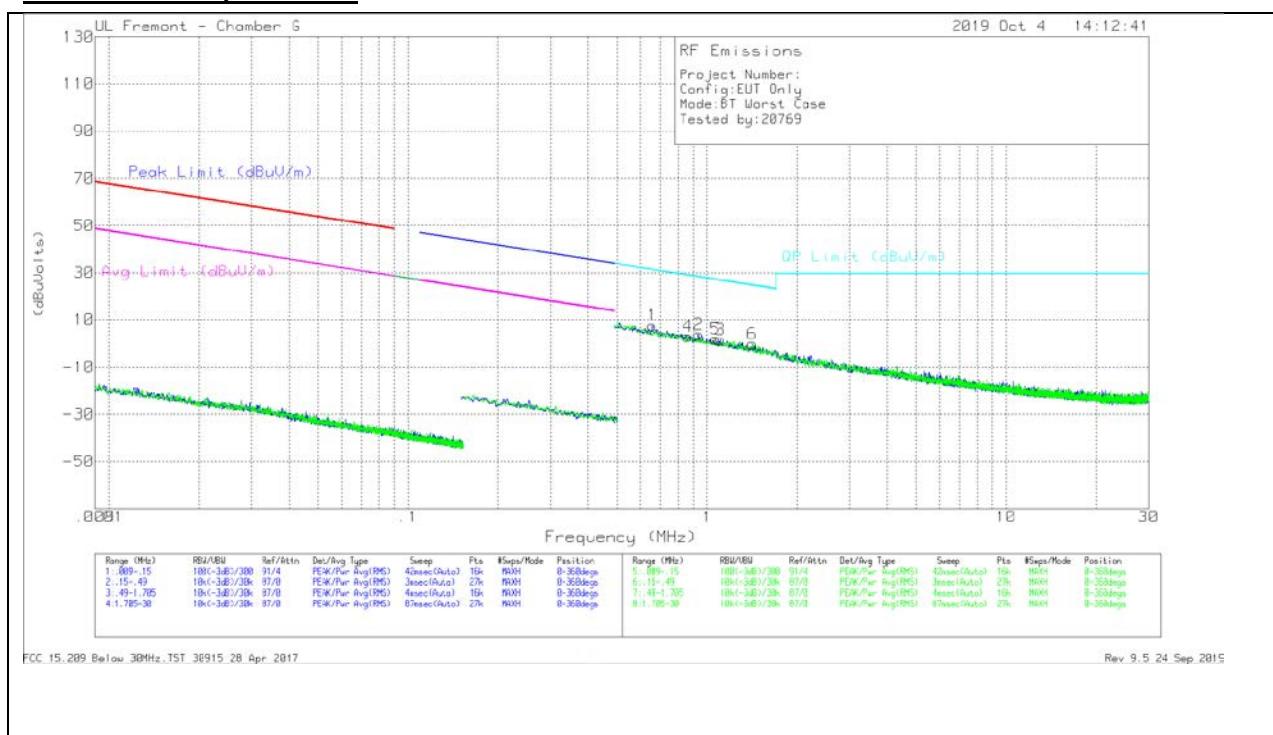
## 18 – 26GHz DATA

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	T447 AF (dB/m)	Amp/Cbl (dB)	Dist Corr (dB)	Corrected Reading (dBuVolts)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)
1	18.732	37.46	Pk	32.4	-21.8	-9.5	38.56	54	-15.44	74	-35.44
2	21.268	37.51	Pk	33	-21.4	-9.5	39.61	54	-14.39	74	-34.39
3	24.517	38.4	Pk	34.4	-19.6	-9.5	43.7	54	-10.3	74	-30.3
4	18.787	38.27	Pk	32.4	-21.9	-9.5	39.27	54	-14.73	74	-34.73
5	21.454	38.26	Pk	33.1	-21.2	-9.5	40.66	54	-13.34	74	-33.34
6	24.616	37.57	Pk	34.4	-19.3	-9.5	43.17	54	-10.83	74	-30.83

Pk - Peak detector

## 9.4. WORST CASE BELOW 30MHz

### Parallel and Perpendicular



### Data

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna (dBm)	Cables (dB)	Dist Corr 30m	Corrected Reading (dBuVolts)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
1	.65716	36.59	Pk	11	.1	-40	7.69	31.26	-23.57	0-360
4	.86202	31.75	Pk	11.1	.1	-40	2.95	28.91	-25.96	0-360
2	.93585	32.64	Pk	11.2	.1	-40	3.94	28.2	-24.26	0-360
5	1.06551	30.52	Pk	11.3	.1	-40	1.92	27.07	-25.15	0-360
3	1.10951	30.26	Pk	11.3	.1	-40	1.66	26.72	-25.06	0-360
6	1.41895	28.36	Pk	11.3	.1	-40	-.24	24.59	-24.83	0-360

Pk - Peak detector

FCC 15.209 Below 30MHz.TST 30915 28 Apr 2017  
 Rev 9.5 24 Sep 2019

## 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 <sup>*</sup>	56 to 46 <sup>*</sup>
0.5-5	56	46
5-30	60	50

<sup>\*</sup> 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

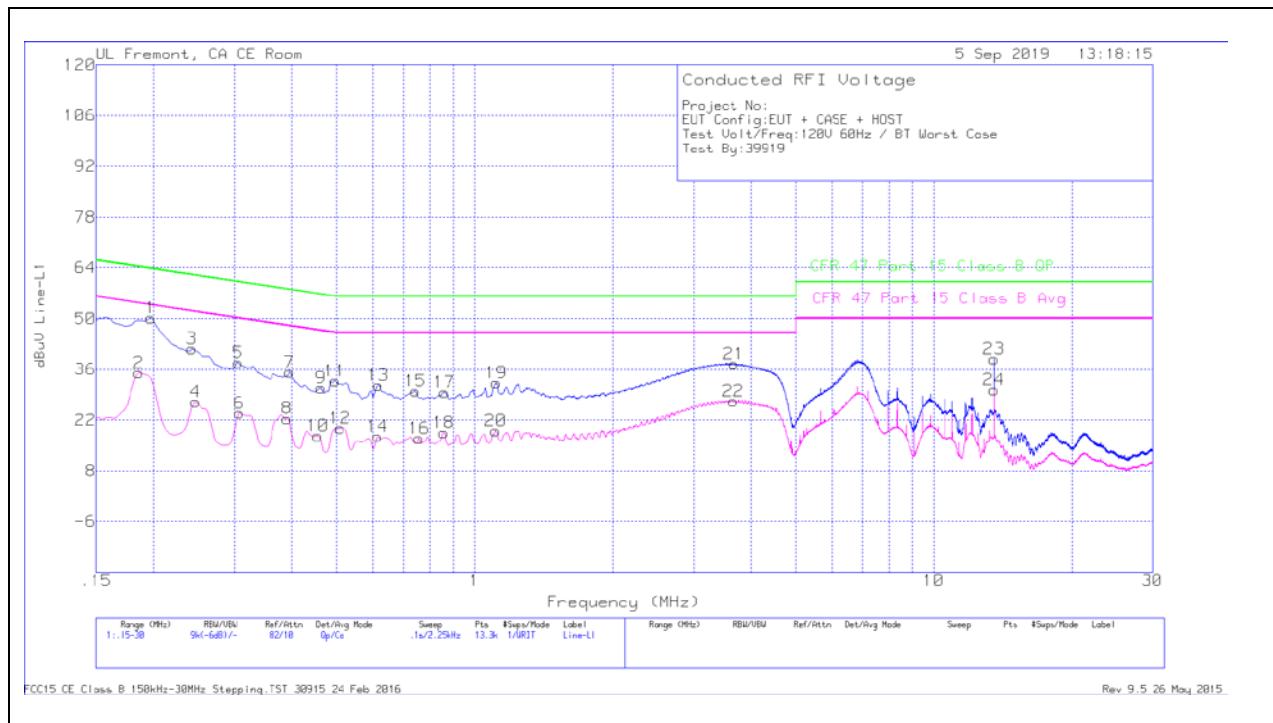
The receiver is set to a resolution bandwidth of 9 kHz. Peak detection is used unless otherwise noted as quasi-peak or average.

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

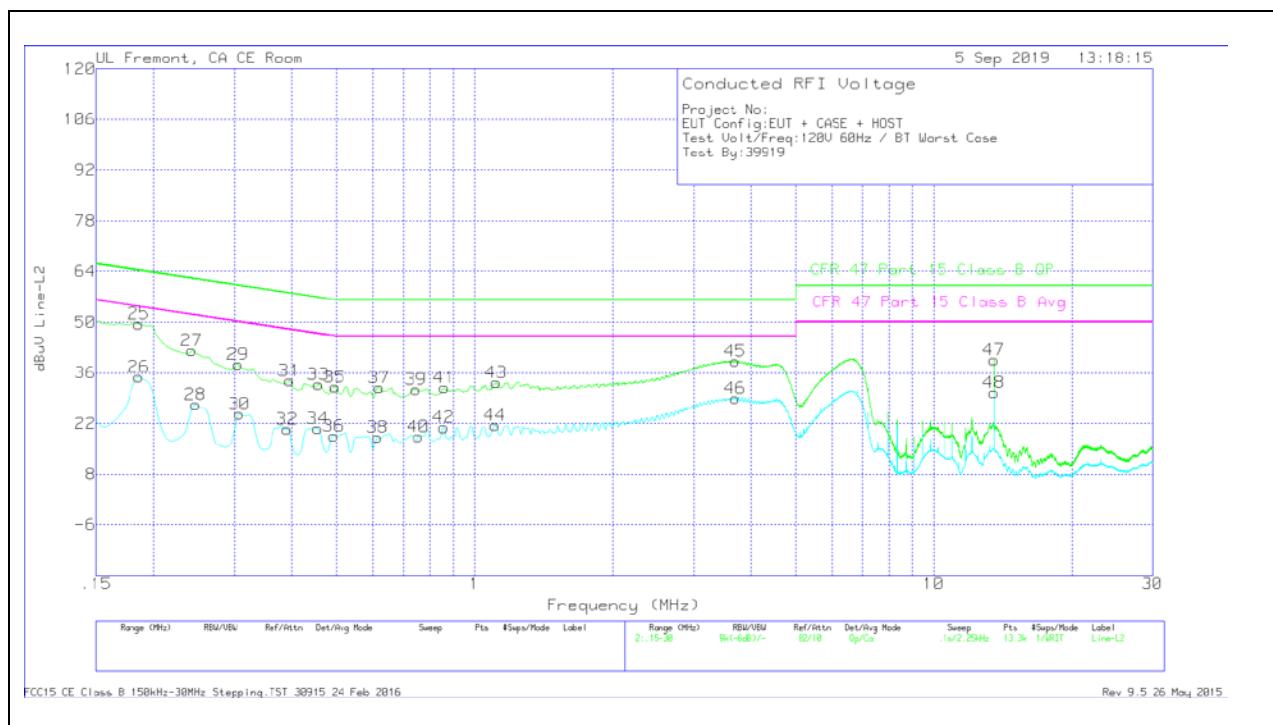
### RESULTS

## 10.1.1. AC Power Line Host

### LINE 1 RESULTS



### LINE 2 RESULTS



## AC LINE DATA

### Range 1: Line-L1 .15 - 30MHz

Marker	Frequenc y (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	.19725	40.15	Qp	0	0	10.1	50.25	63.73	-13.48	-	-
2	.186	24.91	Ca	0	0	10.1	35.01	-	-	54.21	-19.2
3	.24225	31.64	Qp	0	0	10.1	41.74	62.02	-20.28	-	-
4	.24675	16.96	Ca	0	0	10.1	27.06	-	-	51.87	-24.81
5	.30525	27.73	Qp	0	0	10.1	37.83	60.1	-22.27	-	-
6	.3075	13.77	Ca	0	0	10.1	23.87	-	-	50.04	-26.17
7	.39525	25.13	Qp	0	0	10.1	35.23	57.95	-22.72	-	-
8	.39075	12.35	Ca	0	0	10.1	22.45	-	-	48.05	-25.6
9	.46275	20.7	Qp	0	0	10.1	30.8	56.64	-25.84	-	-
10	.456	7.61	Ca	0	0	10.1	17.71	-	-	46.77	-29.06
11	.4965	22.63	Qp	0	0	10.1	32.73	56.06	-23.33	-	-
12	.51	9.66	Ca	0	0	10.1	19.76	-	-	46	-26.24
13	.618	21.53	Qp	0	0	10.1	31.63	56	-24.37	-	-
14	.61575	7.37	Ca	0	0	10.1	17.47	-	-	46	-28.53
15	.744	19.89	Qp	0	0	10.1	29.99	56	-26.01	-	-
16	.7575	6.85	Ca	0	0	10.1	16.95	-	-	46	-29.05
17	.85875	19.64	Qp	0	0	10.1	29.74	56	-26.26	-	-
18	.8565	8.4	Ca	0	0	10.1	18.5	-	-	46	-27.5
19	1.1175	22.03	Qp	0	.1	10.1	32.23	56	-23.77	-	-
20	1.113	8.82	Ca	0	.1	10.1	19.02	-	-	46	-26.98
21	3.67913	27.22	Qp	0	.1	10.1	37.42	56	-18.58	-	-
22	3.66675	16.97	Ca	0	.1	10.1	27.17	-	-	46	-18.83
23	13.56	28.36	Qp	.1	.2	10.2	38.86	60	-21.14	-	-
24	13.56	19.8	Ca	.1	.2	10.2	30.3	-	-	50	-19.7

### Range 2: Line-L2 .15 - 30MHz

Marker	Frequenc y (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)
25	.186	39.46	Qp	0	0	10.1	49.56	64.21	-14.65	-	-
26	.186	24.77	Ca	0	0	10.1	34.87	-	-	54.21	-19.34
27	.24225	32.09	Qp	0	0	10.1	42.19	62.02	-19.83	-	-
28	.24675	17.08	Ca	0	0	10.1	27.18	-	-	51.87	-24.69
29	.30525	28.23	Qp	0	0	10.1	38.33	60.1	-21.77	-	-
30	.3075	14.58	Ca	0	0	10.1	24.68	-	-	50.04	-25.36
31	.39525	23.77	Qp	0	0	10.1	33.87	57.95	-24.08	-	-
32	.39075	10.39	Ca	0	0	10.1	20.49	-	-	48.05	-27.56
33	.45825	22.75	Qp	0	0	10.1	32.85	56.72	-23.87	-	-
34	.456	10.52	Ca	0	0	10.1	20.62	-	-	46.77	-26.15
35	.4965	22.03	Qp	0	0	10.1	32.13	56.06	-23.93	-	-
36	.49425	8.47	Ca	0	0	10.1	18.57	-	-	46.1	-27.53
37	.62025	21.76	Qp	0	0	10.1	31.86	56	-24.14	-	-
38	.61575	8.14	Ca	0	0	10.1	18.24	-	-	46	-27.76
39	.74625	21.26	Qp	0	0	10.1	31.36	56	-24.64	-	-
40	.75525	8.21	Ca	0	0	10.1	18.31	-	-	46	-27.69
41	.85875	21.77	Qp	0	0	10.1	31.87	56	-24.13	-	-
42	.8565	10.79	Ca	0	0	10.1	20.89	-	-	46	-25.11
43	1.1175	23.07	Qp	0	.1	10.1	33.27	56	-22.73	-	-
44	1.11075	11.22	Ca	0	.1	10.1	21.42	-	-	46	-24.58
45	3.69375	29.02	Qp	0	.1	10.1	39.22	56	-16.78	-	-
46	3.69375	18.77	Ca	0	.1	10.1	28.97	-	-	46	-17.03
47	13.56	29.02	Qp	.1	.2	10.2	39.52	60	-20.48	-	-
48	13.56	20.04	Ca	.1	.2	10.2	30.54	-	-	50	-19.46

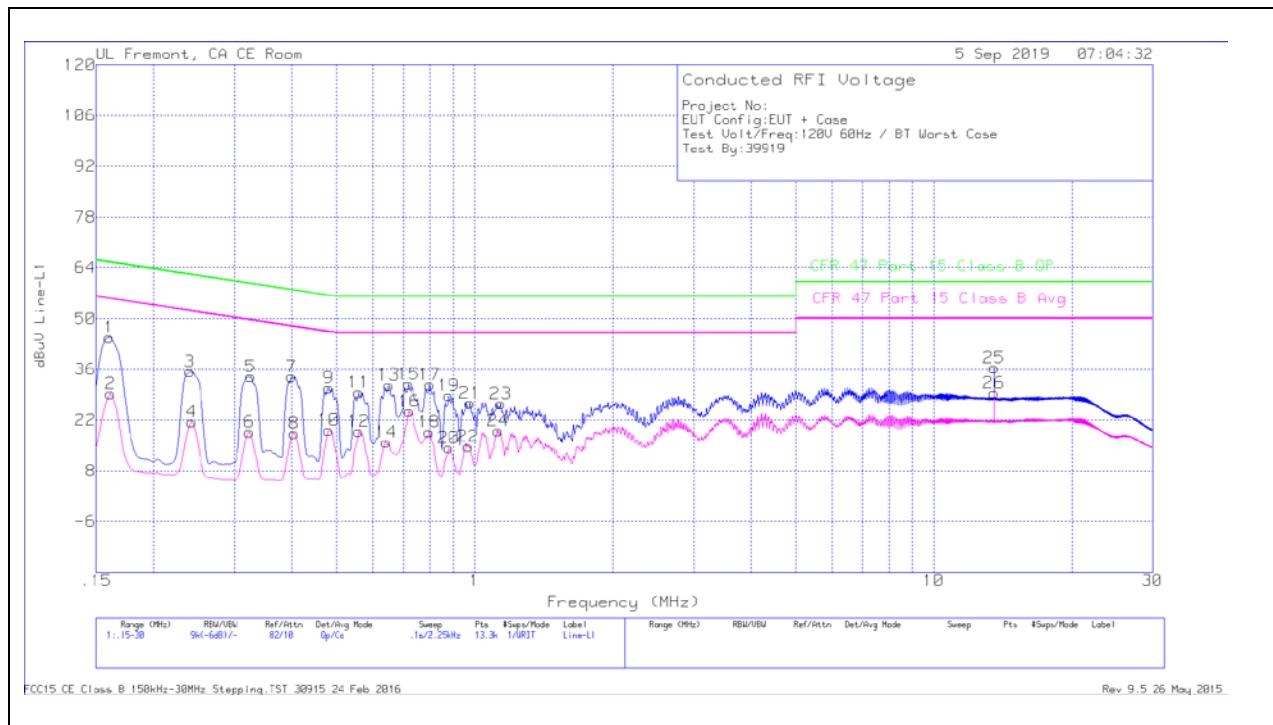
Qp - Quasi-Peak detector

Ca - CISPR average detection

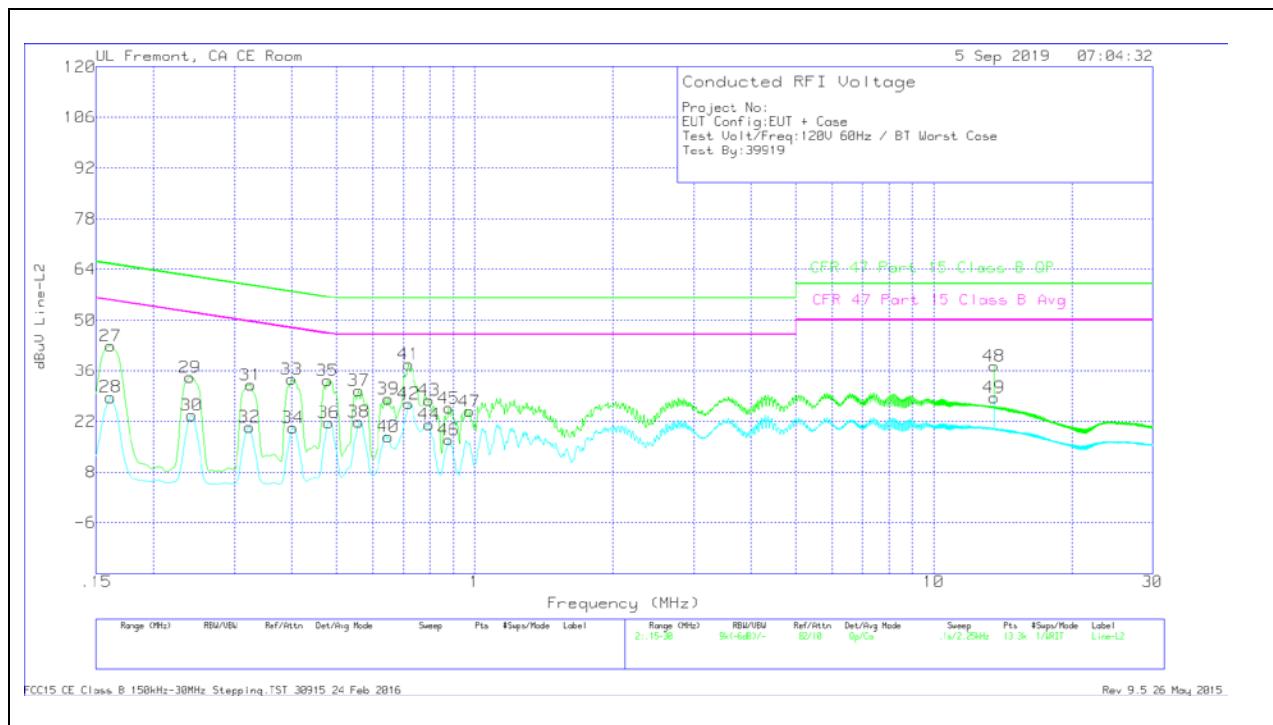
\*Indicates UL RFID signal. Not from device

## 10.1.2. AC Power Line Norm

### LINE 1 RESULTS



### LINE 2 RESULTS



### AC LINE DATA

#### 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	.16013	34.66	Qp	.1	0	10.1	44.86	65.46	-20.6	-	-
2	.16125	19.06	Ca	.1	0	10.1	29.26	-	-	55.4	-26.14
3	.24	25.31	Qp	0	0	10.1	35.41	62.1	-26.69	-	-
4	.24225	11.32	Ca	0	0	10.1	21.42	-	-	52.02	-30.6
5	.3255	23.93	Qp	0	0	10.1	34.03	59.57	-25.54	-	-
6	.32325	8.6	Ca	0	0	10.1	18.7	-	-	49.62	-30.92
7	.39975	23.88	Qp	0	0	10.1	33.98	57.86	-23.88	-	-
8	.40425	8.31	Ca	0	0	10.1	18.41	-	-	47.77	-29.36
9	.48075	20.8	Qp	0	0	10.1	30.9	56.33	-25.43	-	-
10	.48075	9.08	Ca	0	0	10.1	19.18	-	-	46.33	-27.15
11	.5595	19.54	Qp	0	0	10.1	29.64	56	-26.36	-	-
12	.5595	8.85	Ca	0	0	10.1	18.95	-	-	46	-27.05
13	.65175	21.56	Qp	0	0	10.1	31.66	56	-24.34	-	-
14	.64275	5.76	Ca	0	0	10.1	15.86	-	-	46	-30.14
15	.71925	21.76	Qp	0	0	10.1	31.86	56	-24.14	-	-
16	.7215	14.28	Ca	0	0	10.1	24.38	-	-	46	-21.62
17	.80025	21.62	Qp	0	0	10.1	31.72	56	-24.28	-	-
18	.798	8.59	Ca	0	0	10.1	18.69	-	-	46	-27.31
19	.879	18.77	Qp	0	0	10.1	28.87	56	-27.13	-	-
20	.879	4.25	Ca	0	0	10.1	14.35	-	-	46	-31.65
21	.978	16.46	Qp	0	.1	10.1	26.66	56	-29.34	-	-
22	.969	4.53	Ca	0	.1	10.1	14.73	-	-	46	-31.27
23	1.14	16.31	Qp	0	.1	10.1	26.51	56	-29.49	-	-
24	1.12875	8.85	Ca	0	.1	10.1	19.05	-	-	46	-26.95
*25	13.56	25.94	Qp	.1	.2	10.2	36.44	60	-23.56	-	-
*26	13.56	18.95	Ca	.1	.2	10.2	29.45	-	-	50	-20.55

#### 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)
27	.16125	32.7	Qp	.1	0	10.1	42.9	65.4	-22.5	-	-
28	.16125	18.51	Ca	.1	0	10.1	28.71	-	-	55.4	-26.69
29	.24	24.05	Qp	0	0	10.1	34.15	62.1	-27.95	-	-
30	.24225	13.57	Ca	0	0	10.1	23.67	-	-	52.02	-28.35
31	.3255	22.01	Qp	0	0	10.1	32.11	59.57	-27.46	-	-
32	.32325	10.42	Ca	0	0	10.1	20.52	-	-	49.62	-29.1
33	.39975	23.5	Qp	0	0	10.1	33.6	57.86	-24.26	-	-
34	.402	10.13	Ca	0	0	10.1	20.23	-	-	47.81	-27.58
35	.4785	23.24	Qp	0	0	10.1	33.34	56.37	-23.03	-	-
36	.48075	11.55	Ca	0	0	10.1	21.65	-	-	46.33	-24.68
37	.5595	20.37	Qp	0	0	10.1	30.47	56	-25.53	-	-
38	.5595	11.82	Ca	0	0	10.1	21.92	-	-	46	-24.08
39	.6495	18.16	Qp	0	0	10.1	28.26	56	-27.74	-	-
40	.6495	7.8	Ca	0	0	10.1	17.9	-	-	46	-28.1
41	.71925	27.68	Qp	0	0	10.1	37.78	56	-18.22	-	-
42	.71925	16.86	Ca	0	0	10.1	26.96	-	-	46	-19.04
43	.798	17.82	Qp	0	0	10.1	27.92	56	-28.08	-	-
44	.798	11.12	Ca	0	0	10.1	21.22	-	-	46	-24.78
45	.879	15.53	Qp	0	0	10.1	25.63	56	-30.37	-	-
46	.879	6.88	Ca	0	0	10.1	16.98	-	-	46	-29.02
47	.97575	14.62	Qp	0	.1	10.1	24.82	56	-31.18	-	-
*48	13.56	26.84	Qp	.1	.2	10.2	37.34	60	-22.66	-	-
*49	13.56	18.07	Ca	.1	.2	10.2	28.57	-	-	50	-21.43

Qp - Quasi-Peak detector

Ca - CISPR average detection

\*Indicates UL RFID signal. Not from device.

## 11. SETUP PHOTOS

Please refer to 12681939-EP1V1 for setup photos

**END OF TEST REPORT**