



# TEST REPORT

**Report Number. :** R12239019-E4

**Applicant :** Johnson Controls, Inc.  
507 East Michigan Street  
Milwaukee, WI 53202, USA

**Model :** WVS-1000

**FCC ID :** OEJ-WVS100

**IC :** 279A-WVS100

**EUT Description :** Vibration Sensor

**Test Standard(s) :** FCC 47 CFR PART 15 SUBPART C  
ISED RSS-247 ISSUE 2  
ISED RSS-GEN ISSUE 5+A1

**Date of Issue:**  
2021-02-05

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## REPORT REVISION HISTORY

Ver.	Issue Date	Revisions	Revised By
1	2018-12-19	Initial Issue	Brian T. Kiewra
2	2019-06-26	Corrected IC ID	Lariah Ijames
3	2019-07-11	Updated section 9.3 and EUT description	Niklas Haydon
4	2020-12-10	Updated standard references. Updated to current report format.	Brian T. Kiewra
5	2021-02-05	Revised Section 4 to include CABID	Brian T. Kiewra

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# 1. ATTESTATION OF TEST RESULTS

**COMPANY NAME:** Johnson Controls, Inc.  
507 East Michigan Street  
Milwaukee, WI 53202, USA

**EUT DESCRIPTION:** Vibration Sensor

**MODEL:** WVS-1000

**SERIAL NUMBER:** Radiated: 1811-002D3, 1811-002CA  
Conducted: 1811-002B5, 1811-002CE

**DATE TESTED:** 2018-10-23 to 2018-11-08

APPLICABLE STANDARDS	
STANDARD	TEST RESULTS
CFR 47 Part 15 Subpart C	Compliant
ISED RSS-247 Issue 2	Compliant
ISED RSS-GEN Issue 5+A1	Compliant

UL LLC 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 considered unless noted otherwise.

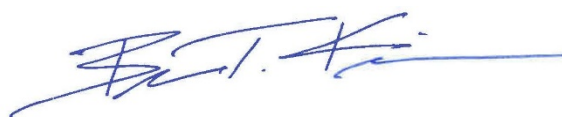
This document may not be altered or revised in any way unless done so by UL LLC and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL LLC will constitute fraud and shall nullify the document. This report must not be used by the client to claim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

Approved & Released  
For UL LLC by:



Jeffrey Moser  
Operations Leader  
UL – Consumer Technology Division

Prepared By:



Brian T. Kiewra  
Project Engineer  
UL – Consumer Technology Division

## 2. TEST RESULTS SUMMARY

FCC Clause	ISED Clause	Requirement	Result	Comment
See Comment		Duty Cycle	Reporting purposes only	ANSI C63.10 Section 11.6.
-	RSS-GEN 6.7	99% OBW	Reporting purposes only	ANSI C63.10 Section 6.9.3.
15.247 (a) (2)	RSS-247 5.2 (a)	6dB BW	Compliant	None.
15.247 (b) (3)	RSS-247 5.4 (d)	Output Power	Compliant	None.
See Comment		Average power	Reporting purposes only	Per ANSI C63.10, Section 11.9.2.3.2.
15.247 (e)	RSS-247 5.2 (b)	PSD	Compliant	None.
15.247 (d)	RSS-247 5.5	Conducted Spurious Emissions	Compliant	None.
15.209, 15.205	RSS-GEN 8.9, 8.10	Radiated Emissions	Compliant	None.
15.207	RSS-Gen 8.8	AC Mains Conducted Emissions	Compliant	None.

## 3. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC CFR 47 Part 2, FCC CFR 47 Part 15: 2020, ANSI C63.10-2013, KDB 558074 D01 15.247 Meas Guidance v05r02, KDB 414788 D01 Radiated Test Site v01r01, RSS-GEN Issue 5 + Amendment 1: 2019, and RSS-247 Issue 2:2017.

## 4. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 12 Laboratory Drive, Research Triangle Park, North Carolina 27709, USA and 2800 Perimeter Park Dr., Suite B, Morrisville, North Carolina 27560, USA. 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.

12 Laboratory Dr.	2800 Perimeter Park Dr.
<b>Site Code: 2180C</b>	
<input type="checkbox"/> Chamber A RTP	<input checked="" type="checkbox"/> North Chamber
<input type="checkbox"/> Chamber C RTP	<input type="checkbox"/> South Chamber

The above test sites and facilities are covered under FCC Test Firm Registration # 703469. Chambers above are covered under Industry Canada company address and respective code.

UL LLC (RTP), CABID 0067, is accredited by NVLAP, Laboratory Code 200246-0

## 5. DECISION RULES AND MEASUREMENT UNCERTAINTY

### 5.1. METROLOGICAL TRACEABILITY

All test and measuring equipment utilized to perform the tests documented in this report are calibrated on a regular basis, with a maximum time between calibrations of one year or the manufacturers' recommendation, whichever is less, and where applicable is traceable to recognized national standards.

### 5.2. DECISION RULES

The Decision Rule is based on Simple Acceptance in accordance with ISO Guide 98-4:2012 Clause 8.2. (Measurement uncertainty is not taken into account when stating conformity with a specified requirement.)

### 5.3. MEASUREMENT UNCERTAINTY

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

PARAMETER	UNCERTAINTY
Radio Frequency (Spectrum Analyzer)	141.2 Hz
Occupied Channel Bandwidth	2.00%
RF output power, conducted	1.3 dB (PK) 0.45 dB (AV)
RF output power, radiated (SAC)	4.52 dB
Power Spectral Density, conducted	2.47 dB
Unwanted Emissions, conducted	3.05 dB
All emissions, radiated	4.88 dB
Temperature	2.26°C
Humidity	6.79%
DC Supply voltages	1.70%
Time	3.39%

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

### 5.1. SAMPLE CALCULATION

#### **RADIATED EMISSIONS**

Where relevant, the following sample calculation is provided:

$$\text{Field Strength (dBuV/m)} = \text{Measured Voltage (dBuV)} + \text{Antenna Factor (dB/m)} + \text{Cable Loss (dB)} - \text{Preamp Gain (dB)}$$

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

#### **MAINS CONDUCTED EMISSIONS**

Where relevant, the following sample calculation is provided:

$$\text{Final Voltage (dBuV)} = \text{Measured Voltage (dBuV)} + \text{Cable Loss (dB)} + \text{Limiter Factor (dB)} + \text{LISN Insertion Loss.}$$

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

## 6. EQUIPMENT UNDER TEST

### 6.1. EUT DESCRIPTION

The EUT is a device to collect vibration data via vibration sensor and save the captured data to computer or send it to cloud by WiFi or cellphone. BLE connection used to configure device and network.

### 6.2. 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	BLE	3.57	2.28

### 6.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes an PCB antenna, with a maximum gain of 0.5 dBi.

### 6.4. SOFTWARE AND FIRMWARE

The EUT firmware installed during testing was v0.0.13.  
The test utility software used during testing was OS vB43

### 6.5. 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 and PSD as worst-case scenario.

Radiated emissions between 1GHz and 18GHz were performed with the EUT set to transmit at the highest power on low, middle and high channels.

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

## 6.6. DESCRIPTION OF TEST SETUP

### SUPPORT EQUIPMENT

Support Equipment List				
Description	Manufacturer	Model	Serial Number	FCC ID
Laptop	Lenovo	T470	PF0ZV66P	NA
Vibration Sensor	CTC	ACC199-149	1027	NA

### I/O CABLES

I/O Cable List						
Cable No.	Port	# of Identical Ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1	USB	1	USB c	USB	<3m	Data and charging
2	Audio	1	3.5mm Audio	Audio	<3m	None
3	Sensor	1	5pin barrel	Proprietary	<3m	Connects to vibration sensor

### TEST SETUP

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

### SETUP DIAGRAMS

Please refer to R12239019-EP4 for setup diagrams



## 7. MEASUREMENT METHOD

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

6 dB BW: ANSI C63.10 Subclause -11.8.1

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

Output Power: ANSI C63.10 Subclause -11.9.1.3 (PKPM1)

PSD: ANSI C63.10 Subclause -11.10.2 (Peak PSD)

Emissions in non-restricted frequency bands: ANSI C63.10 Subclause -11.11

Radiated emissions restricted frequency bands: ANSI C63.10 Subclause -11.12.1

General Radiated Emissions: ANSI C63.10:2013 Sections 6.3 – 6.6

AC Power Line Conducted Emissions: ANSI C63.10-2013, Section 6.2.

## 8. TEST AND MEASUREMENT EQUIPMENT

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

Test Equipment Used - Radiated Disturbance Emissions Test Equipment (Morrisville - North Chamber)

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
<b>0.009-30MHz (Loop Ant.)</b>					
AT0079	Active Loop Antenna	ETS-Lindgren	6502	2018-01-02	2019-01-02
<b>30-1000 MHz</b>					
AT0073	Hybrid Broadband Antenna	Sunol Sciences Corp.	JB3	2018-08-06	2019-08-06
<b>1-18 GHz</b>					
AT0072	Double-Ridged Waveguide Horn Antenna, 1 to 18 GHz	ETS Lindgren	3117	2018-04-30	2019-04-30
<b>18-40 GHz</b>					
AT0076	Horn Antenna, 18-26.5GHz	ARA	MWH-1826/B	2017-10-10	2018-10-31
<b>Gain-Loss Chains</b>					
N-SAC01	Gain-loss string: 0.009-30MHz	Various	Various	2018-09-06	2019-09-06
N-SAC02	Gain-loss string: 25-1000MHz	Various	Various	2018-05-20	2019-05-20
N-SAC03	Gain-loss string: 1-18GHz	Various	Various	2018-03-23	2019-03-23
N-SAC04	Gain-loss string: 18-40GHz	Various	Various	2018-09-30	2019-03-31
<b>Receiver &amp; Software</b>					
SA0027	Spectrum Analyzer	Agilent	N9030A	2018-04-04	2019-04-04
SOFTEMI	EMI Software	UL	Version 9.5	NA	NA
<b>Additional Equipment used</b>					
s/n 161024690	Environmental Meter	Fisher Scientific	15-077-963	2016-12-21	2018-12-21

Note - All Radiated testing performed prior to 2018-10-31.

Test Equipment Used - Wireless Conducted Measurement Equipment

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
<b>Conducted Room 1</b>					
T177 (PRE0079253)	Spectrum Analyzer	Agilent Technologies	E4446A	2018-04-12	2019-04-12
PWM001	RF Power Meter	Keysight Technologies	N1912A	2018-05-30	2019-07-30
PWS007	Peak and Avg Power Sensor, 50MHz to 6GHz	Keysight Technologies	E9323A	2018-05-30	2019-05-31
SN 161024885	Environmental Meter	Fisher Scientific	15-077-963	2016-12-23	2018-12-23

Test Equipment Used - Line-Conducted Emissions – Voltage (Morrisville – Conducted 1)

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
CBL087	Coax cable, RG223, N-male to BNC-male, 20-ft.	Pasternack	PE3W06143-240	2018-06-19	2019-06-19
s/n 160938893	Environmental Meter	Fisher Scientific	14-650-118	2016-11-02	2018-11-02
LISN003	LISN, 50-ohm/50-uH, 2-conductor, 25A	Fischer Custom Com.	FCC-LISN-50-25-2-01-550V	2018-08-21	2019-08-21
PRE0101521 (75141)	EMI Test Receiver 9kHz-7GHz	Rohde & Schwarz	ESCI 7	2018-08-22	2019-08-22
TL001	Transient Limiter, 0.009-30MHz	Com-Power	LIT-930A	2018-06-13	2019-06-13
PS215	AC Power Source	Elgar	CW2501M (s/n 1523A02397)	NA	NA
SOFTEMI	EMI Software	UL	Version 9.5	NA	NA

Note: Line Conducted testing performed prior to 2018-11-02.

## 9. ANTENNA PORT TEST RESULTS

### 9.1. ON TIME AND DUTY CYCLE

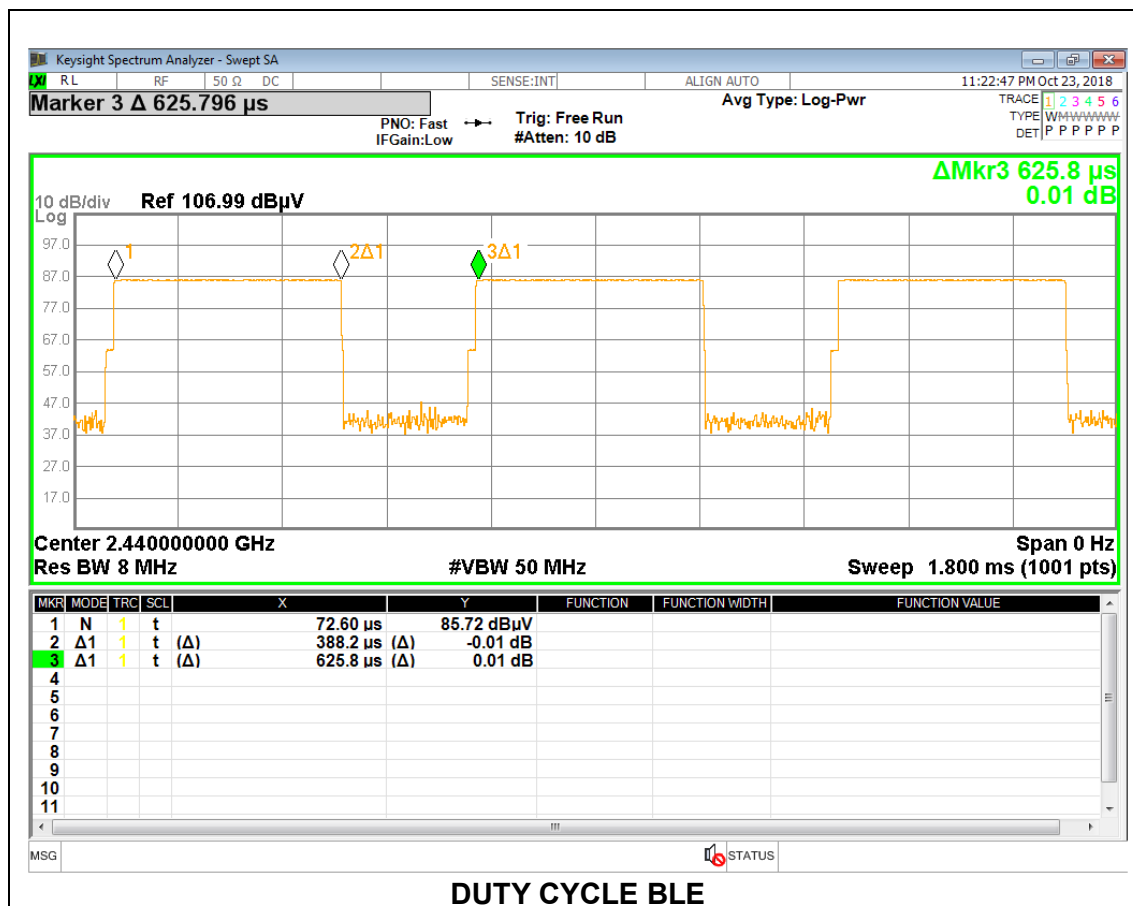
#### LIMITS

None; for reporting purposes only.

#### 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/B Minimum VBW (kHz)
BLE	0.388	0.626	0.620	62.03%	2.07	2.576

#### DUTY CYCLE PLOTS



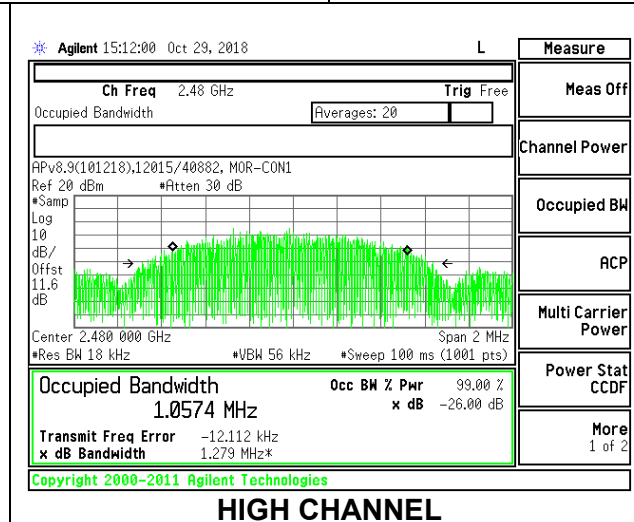
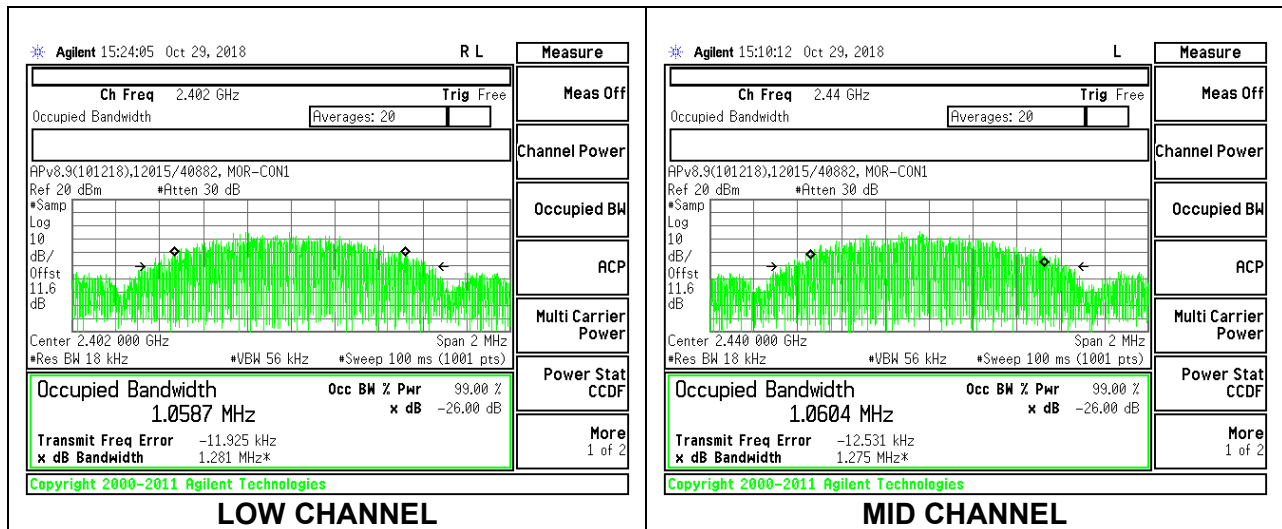
## 9.2. 99% BANDWIDTH

### LIMITS

None; for reporting purposes only.

### RESULTS

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	1.0587
Middle	2440	1.0604
High	2480	1.0574



### 9.3. 6 dB BANDWIDTH

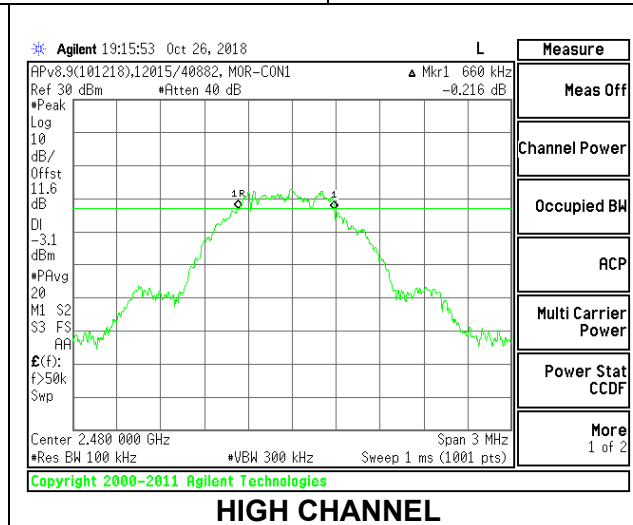
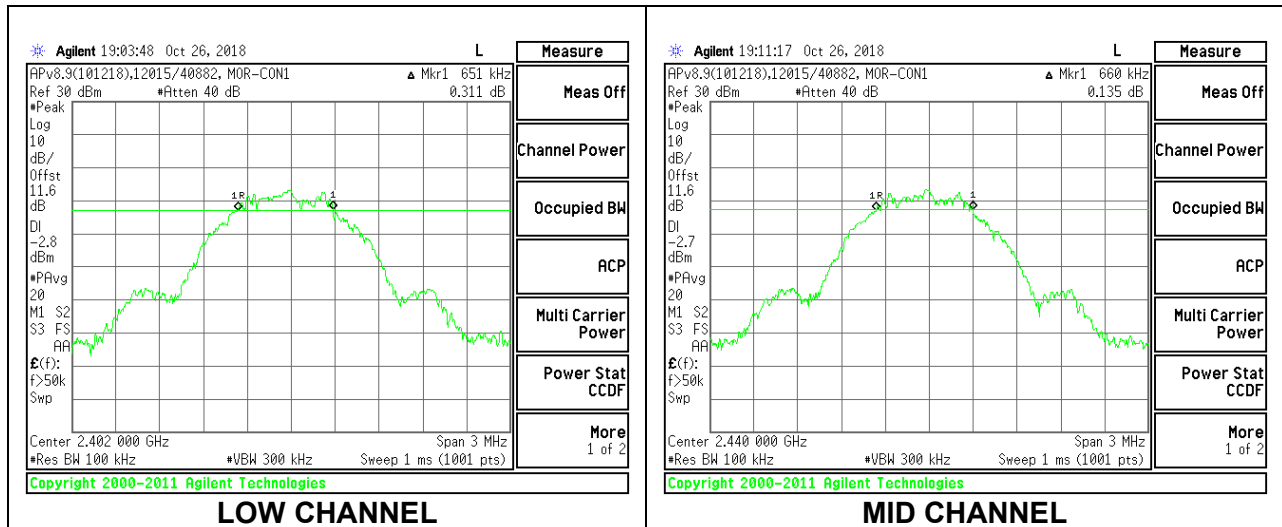
#### LIMITS

FCC §15.247 (a)(2)  
 RSS-247 5.2 (a)

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

#### RESULTS

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	0.6510	0.5
Middle	2440	0.6600	0.5
High	2480	0.6600	0.5



## 9.4. OUTPUT POWER

### LIMITS

FCC §15.247 (b) (3)

IC RSS-247 5.4 (d)

The maximum antenna gain is less than or equal to 6 dBi, therefore the limit is 30 dBm.

### RESULTS

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	3.02	30	-26.980
Middle	2440	3.57	30	-26.430
High	2480	3.50	30	-26.500

### TEST INFORMATION

Test Date: 2018-10-25

Project No: 12239019

Tested By: 40882

## 9.5. AVERAGE POWER

### LIMITS

None; for reporting purposes only.

### RESULTS

The cable assembly insertion loss of 11.6 dB (including 10 dB pad and 1.6 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

Channel	Frequency (MHz)	AV power (dBm)
Low	2402	2.69
Middle	2440	2.86
High	2480	2.94

### TEST INFORMATION

Test Date: 2018-10-25  
Project No: 12239019  
Tested By: 40882



### 9.6. POWER SPECTRAL DENSITY LIMITS

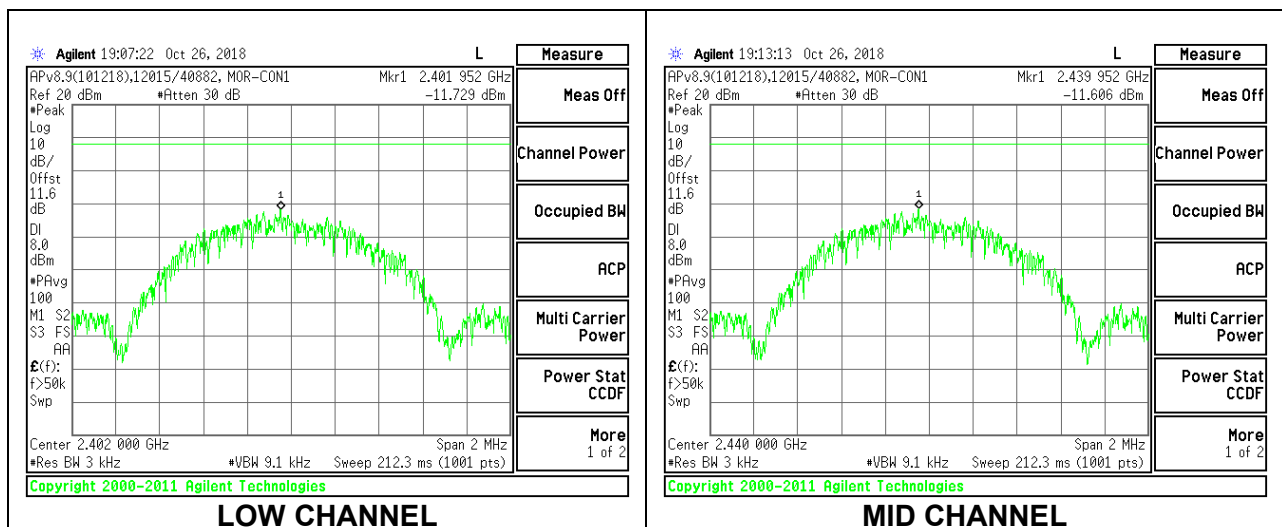
FCC §15.247 (e)

RSS-247 (5.2) (b)

The power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

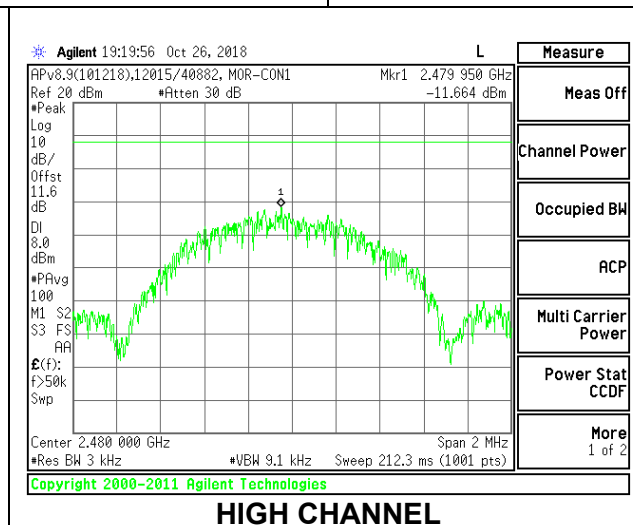
### RESULTS

Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2402	-11.729	8	-19.73
Middle	2440	-11.606	8	-19.61
High	2480	-11.664	8	-19.66



LOW CHANNEL

MID CHANNEL



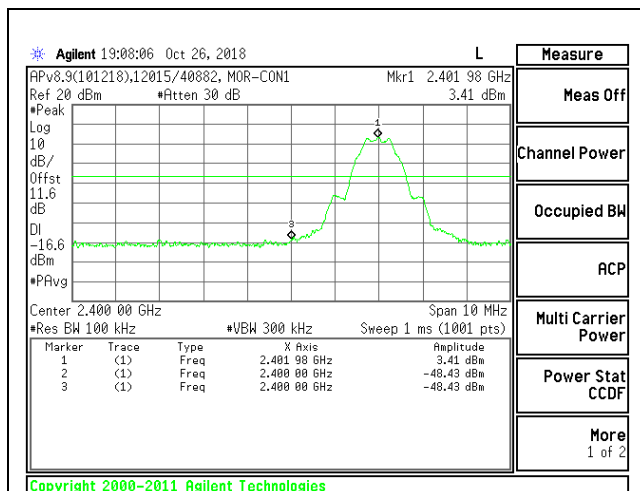
HIGH CHANNEL

## 9.7. CONDUCTED SPURIOUS EMISSIONS LIMITS

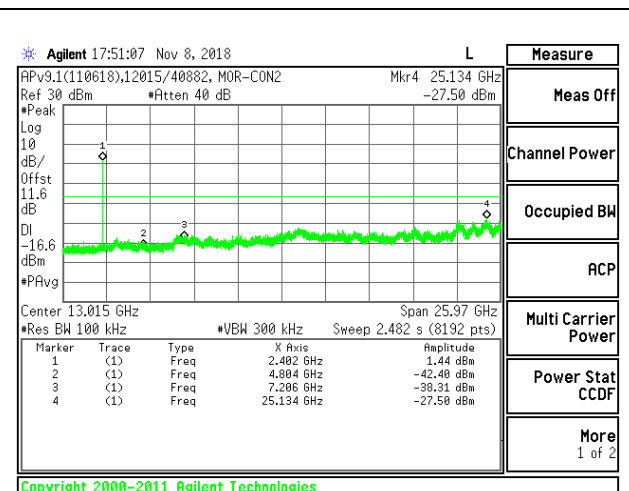
FCC §15.247 (d)  
 RSS-247 5.5

Output power was measured based on the use of a peak measurement, therefore the required attenuation is 20 dB.

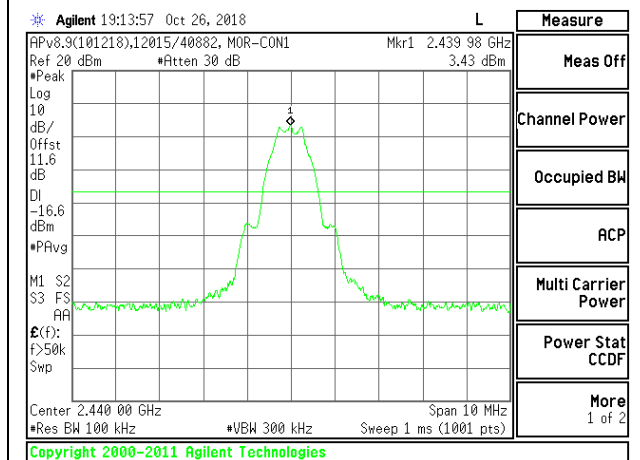
### RESULTS



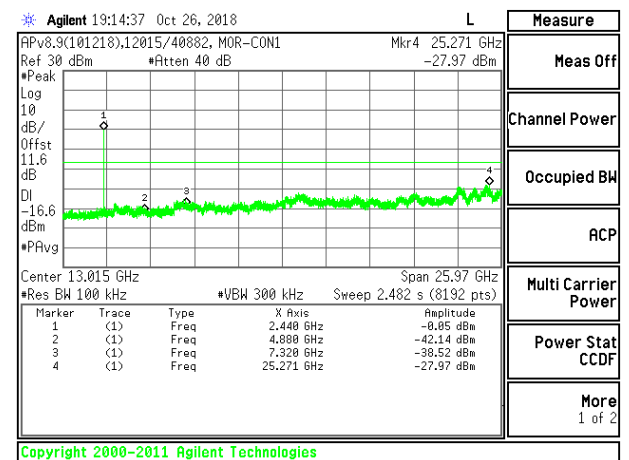
**LOW CHANNEL BANDEDGE**



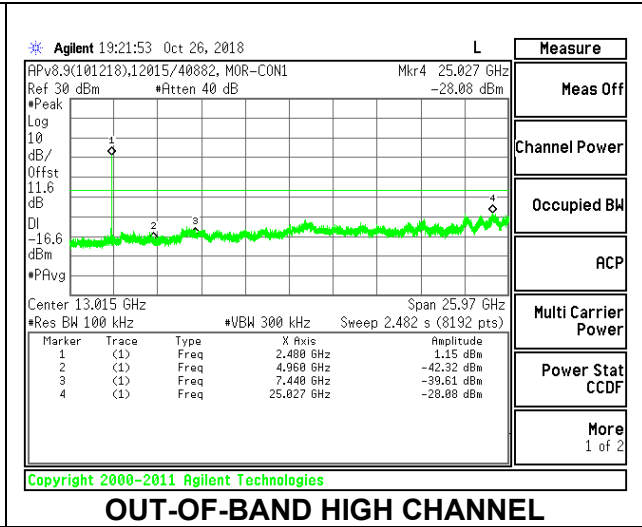
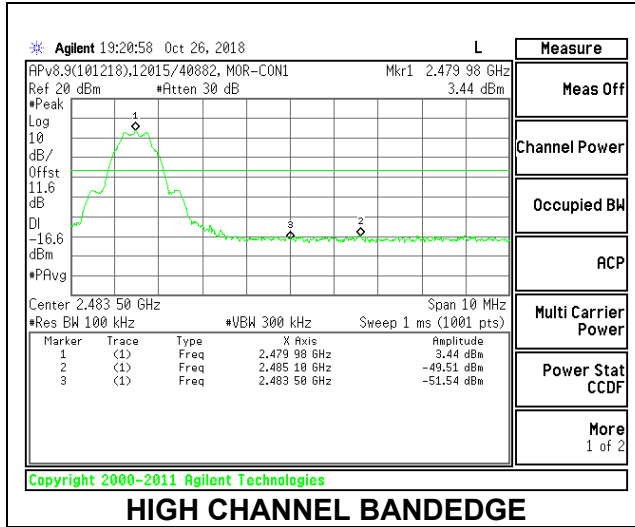
**OUT-OF-BAND LOW CHANNEL**



**IN-BAND REFERENCE LEVEL**



**OUT-OF-BAND MID CHANNEL**



## 10. 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 for the 30-1000 MHz range, 9 kHz for peak detection measurements or 9 kHz for quasi-peak detection measurements for the 0.15-30 MHz range and 200 Hz for peak detection measurements or 200 Hz for quasi-peak detection measurements for the 9 to 150 kHz range. 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 average measurements above 1GHz, the resolution bandwidth and video bandwidth are set as described in ANSI C63.10:2013 for the applicable measurement. The particular averaging method used for this test program was RMS.

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 and PSD 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.

3D antenna use - For below 30MHz testing, investigation was done on three antenna orientations (parallel, perpendicular, and ground-parallel).

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.

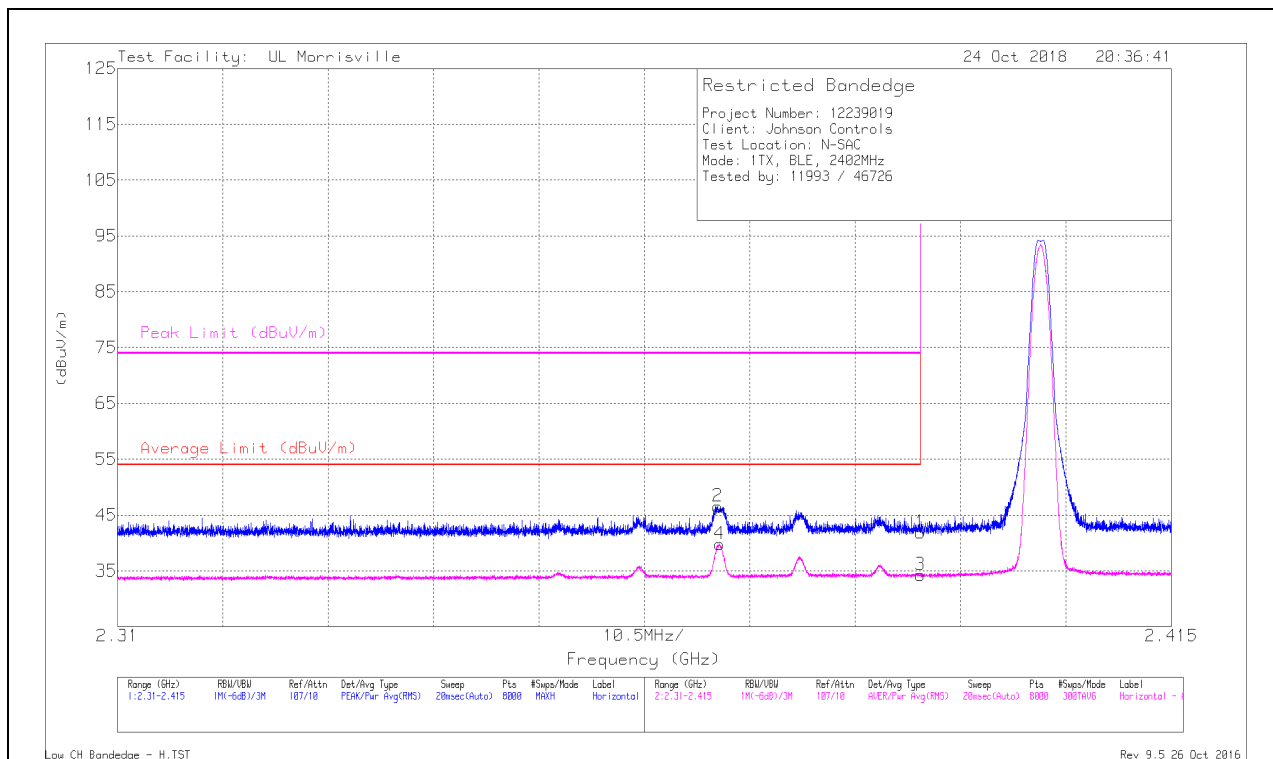
### **KDB 414788 Open Field Site(OFS) and Chamber Correlation Justification**

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

### 10.1. TRANSMITTER ABOVE 1 GHz

#### BANDEDGE (LOW CHANNEL)

#### HORIZONTAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 AF (dB/m)	Amp/Cbl/Filtr/Pad (dB)	DC Corr (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	34.39	Pk	32	-24.5	0	41.89	-	-	74	-32.11	124	150	H
2	*** 2.37	39.2	Pk	31.8	-24.5	0	46.5	-	-	74	-27.5	124	150	H
3	*** 2.39	24.67	RMS	32	-24.5	2.07	34.24	54	-19.76	-	-	124	150	H
4	*** 2.37	30.39	RMS	31.8	-24.5	2.07	39.76	54	-14.24	-	-	124	150	H

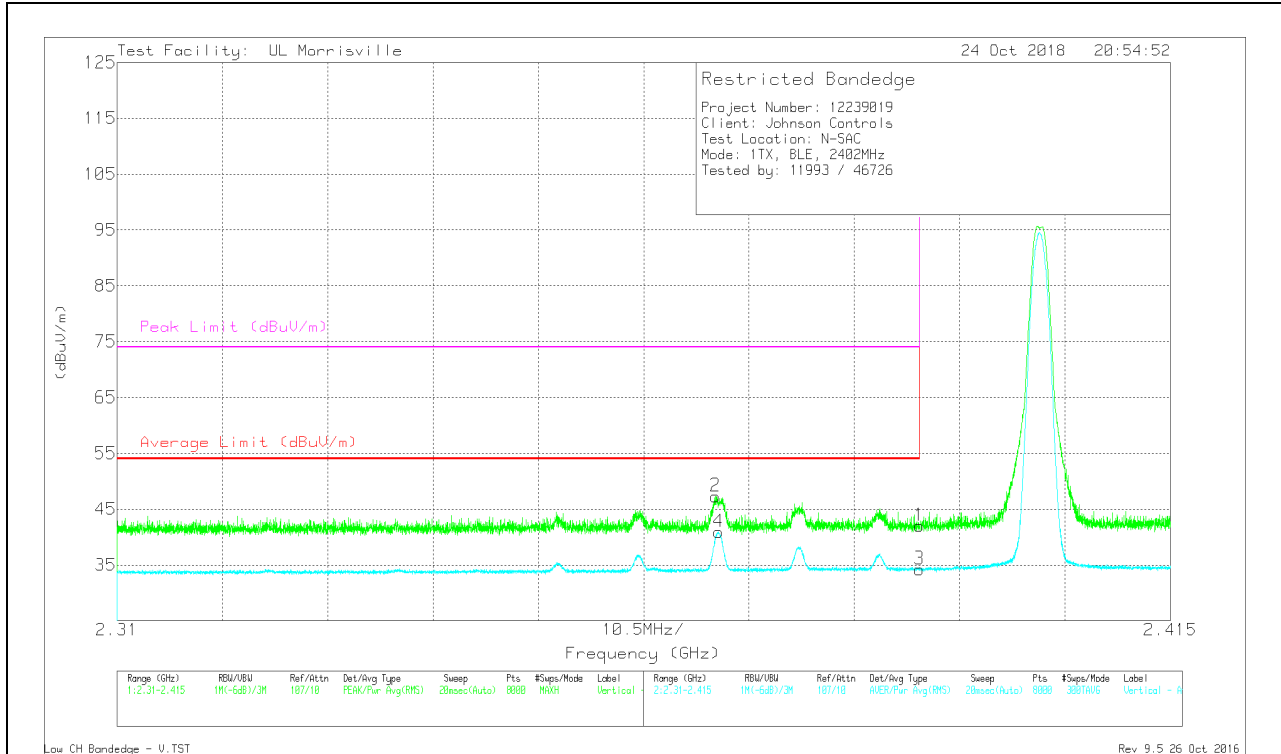
\* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

\*\* - indicates frequency in Taiwan NCC LP0002 Restricted Band

Pk - Peak detector

RMS - RMS detection

### VERTICAL RESULT

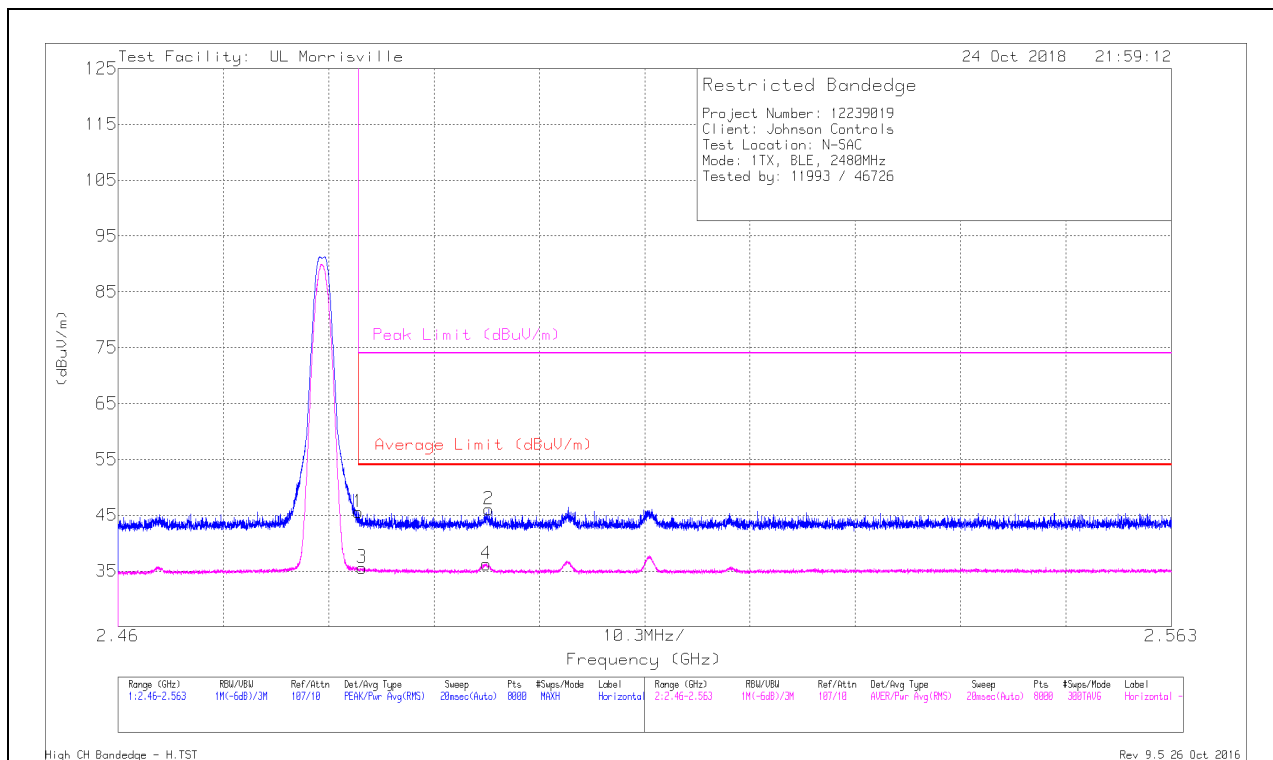


Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 AF (dB/m)	Amp/Cbl/Filtr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	*** 2.39	34.53	Pk	32	-24.5	0	42.03	-	-	74	-31.97	162	204	V
2	*** 2.37	40	Pk	31.8	-24.5	0	47.3	-	-	74	-26.7	162	204	V
3	*** 2.39	24.65	RMS	32	-24.5	2.07	34.22	54	-19.78	-	-	162	204	V
4	*** 2.37	31.53	RMS	31.8	-24.5	2.07	40.9	54	-13.1	-	-	162	204	V

\* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band  
 \*\* - indicates frequency in Taiwan NCC LP0002 Restricted Band  
 Pk - Peak detector  
 RMS - RMS detection

**BANEDGE (HIGH CHANNEL)**

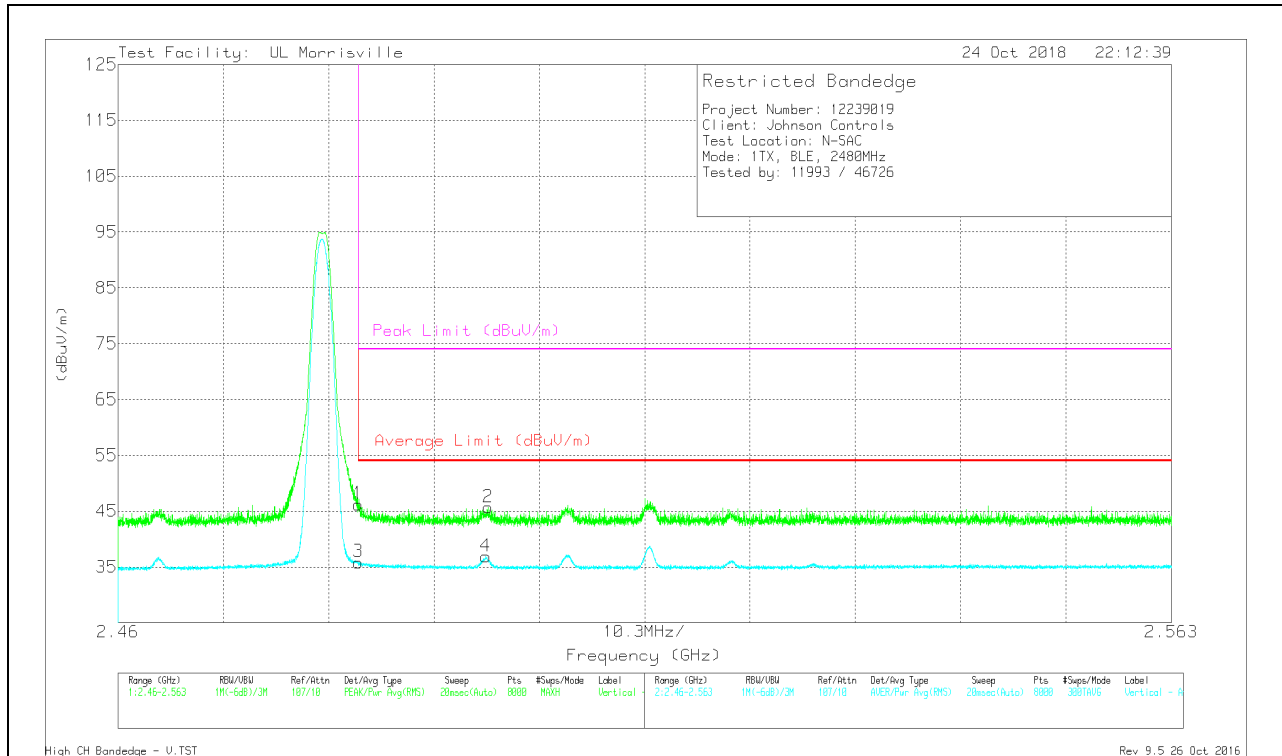
**HORIZONTAL RESULT**



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 AF (dB/m)	Amp/Cbl/Filtr/Pad (dB)	DC Corr (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	37.54	Pk	32.4	-24.4	0	45.54	-	-	74	-28.46	133	105	H
2	*** 2.496	38.14	Pk	32.3	-24.4	0	46.04	-	-	74	-27.96	133	105	H
3	* ** 2.484	25.52	RMS	32.4	-24.4	2.07	35.59	54	-18.41	-	-	133	105	H
4	* ** 2.496	26.27	RMS	32.3	-24.4	2.07	36.24	54	-17.76	-	-	133	105	H

\* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band  
 \*\* - indicates frequency in Taiwan NCC LP0002 Restricted Band  
 Pk - Peak detector  
 RMS - RMS detection

### VERTICAL RESULT



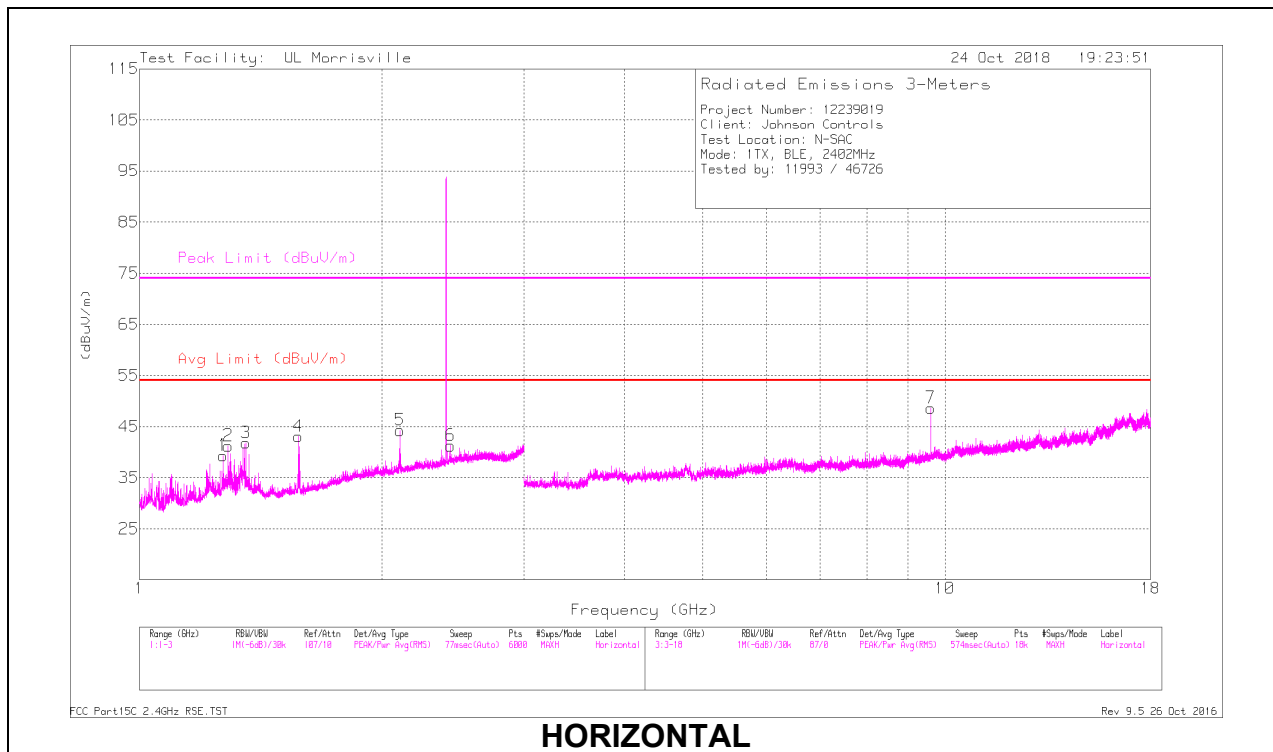
Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 AF (dB/m)	Amp/Cbl/Filtr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 2.484	38.23	Pk	32.4	-24.4	0	46.23	-	-	74	-27.77	287	124	V
2	* ** 2.496	37.77	Pk	32.3	-24.4	0	45.67	-	-	74	-28.33	287	124	V
3	* ** 2.484	25.78	RMS	32.4	-24.4	2.07	35.85	54	-18.15	-	-	287	124	V
4	* ** 2.496	26.91	RMS	32.3	-24.4	2.07	36.88	54	-17.12	-	-	287	124	V

\* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band  
 \*\* - indicates frequency in Taiwan NCC LP0002 Restricted Band  
 Pk - Peak detector  
 RMS - RMS detection

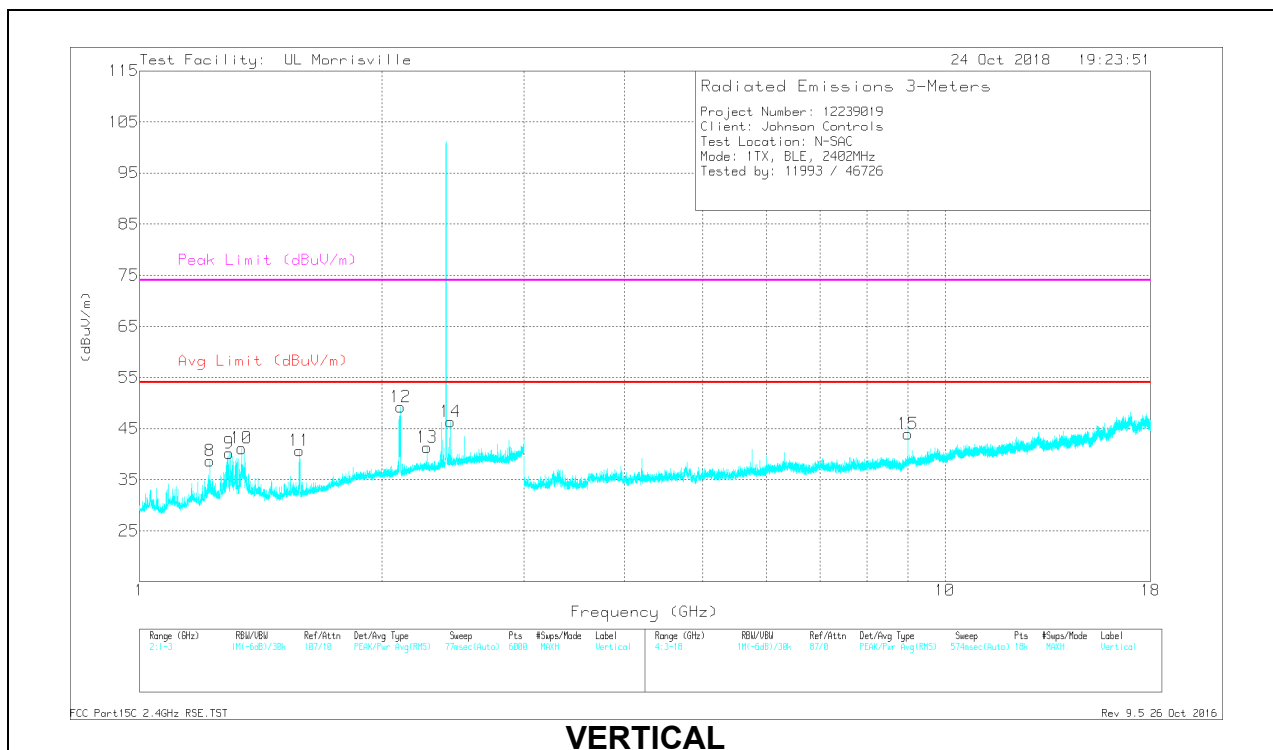


# HARMONICS AND SPURIOUS EMISSIONS

## LOW CHANNEL RESULTS



**HORIZONTAL**



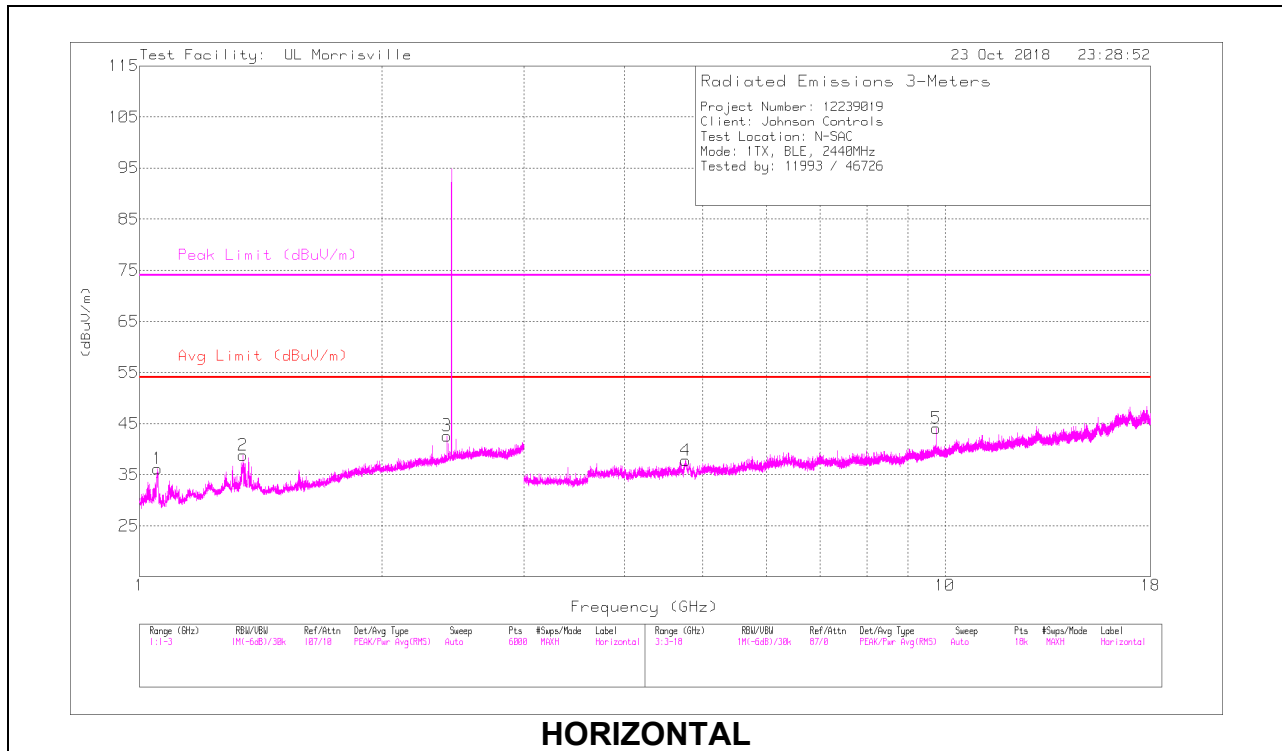
**VERTICAL**

**RADIATED EMISSIONS**

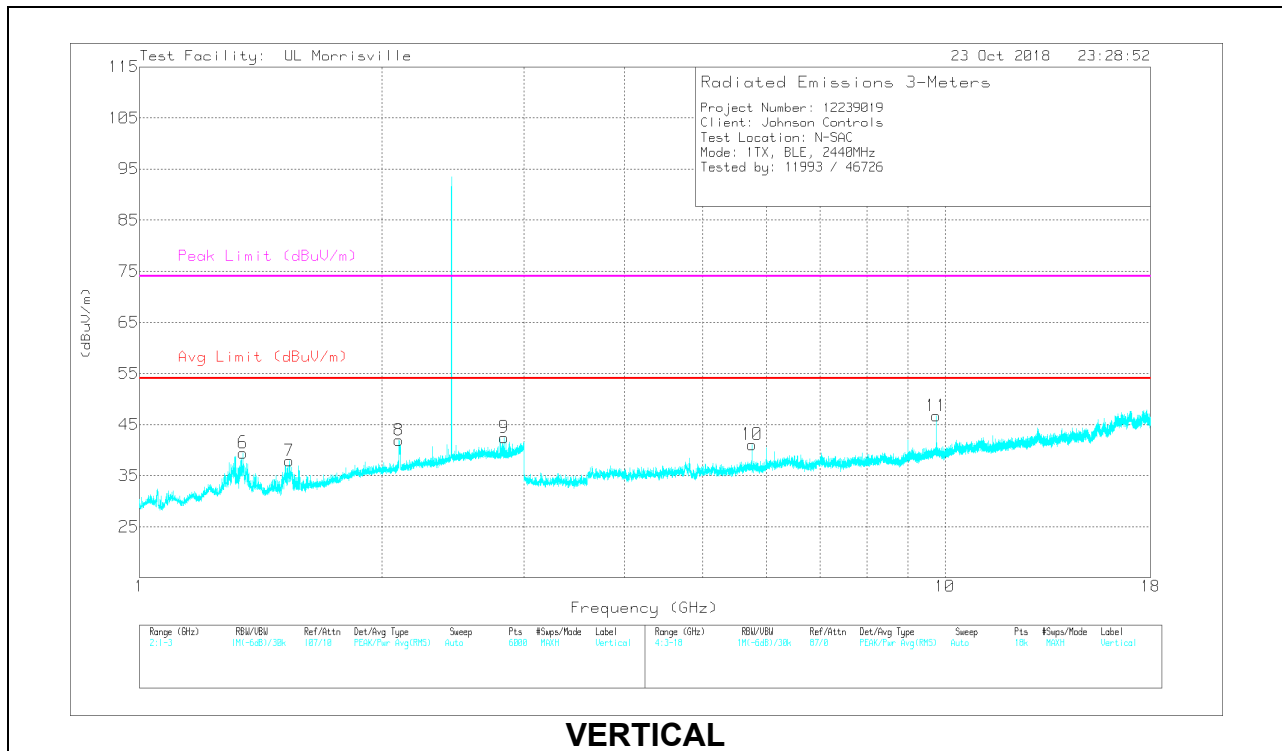
Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 AF (dB/m)	Amp/Cbl/Filtr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 1.272	42.8	PK2	29.2	-25.9	0	46.1	-	-	74	-27.9	171	231	H
	* 1.272	25.1	MAv1	29.2	-25.9	2.07	30.47	54	-23.53	-	-	171	231	H
2	* 1.287	46.25	PK2	29.3	-25.8	0	49.75	-	-	74	-24.25	177	259	H
	* 1.287	26.23	MAv1	29.3	-25.8	2.07	31.8	54	-22.2	-	-	177	259	H
3	*** 1.354	47.16	PK2	29.3	-25.5	0	50.96	-	-	74	-23.04	177	313	H
	*** 1.353	25.95	MAv1	29.3	-25.5	2.07	31.82	54	-22.18	-	-	177	313	H
4	*** 1.577	49.28	PK2	27.9	-24.7	0	52.48	-	-	74	-21.52	100	245	H
	*** 1.576	24.53	MAv1	27.9	-24.7	2.07	29.8	54	-24.2	-	-	100	245	H
5	2.104	37.77	Pk	31.1	-24.6	0	44.27	-	-	-	-	0-360	102	H
6	2.434	33.46	Pk	32.3	-24.5	0	41.26	-	-	-	-	0-360	102	H
7	9.607	39.74	Pk	36.9	-28	0	48.64	-	-	-	-	0-360	199	H
8	*** 1.224	41.15	PK2	28.9	-26.1	0	43.95	-	-	74	-30.05	220	282	V
	*** 1.222	25.35	MAv1	28.9	-26.1	2.07	30.22	54	-23.78	-	-	220	282	V
9	* 1.291	39.89	PK2	29.2	-25.8	0	43.29	-	-	74	-30.71	240	128	V
	* 1.289	25.17	MAv1	29.3	-25.8	2.07	30.74	54	-23.26	-	-	240	128	V
10	*** 1.34	43.58	PK2	29.3	-25.6	0	47.28	-	-	74	-26.72	228	262	V
	*** 1.338	25.84	MAv1	29.2	-25.6	2.07	31.51	54	-22.49	-	-	228	262	V
11	*** 1.578	45.49	PK2	27.8	-24.7	0	48.59	-	-	74	-25.41	111	208	V
	*** 1.578	24.75	MAv1	27.8	-24.7	2.07	29.92	54	-24.08	-	-	111	208	V
13	*** 2.274	39.43	PK2	31.7	-24.5	0	46.63	-	-	74	-27.37	205	220	V
	*** 2.274	30	MAv1	31.7	-24.5	2.07	39.27	54	-14.73	-	-	205	220	V
15	9	40.52	PK2	36.2	-28.6	0	48.12	-	-	-	-	265	155	V
	9	30.38	MAv1	36.2	-28.6	2.07	40.05	-	-	-	-	265	155	V
12	2.109	42.51	Pk	31.2	-24.5	0	49.21	-	-	-	-	0-360	199	V
14	2.434	38.55	Pk	32.3	-24.5	0	46.35	-	-	-	-	0-360	199	V

\* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band  
 \*\* - indicates frequency in Taiwan NCC LP0002 Restricted Band  
 PK2 - Maximum Peak  
 MAv1 - Maximum RMS Average

### MID CHANNEL RESULTS



**HORIZONTAL**



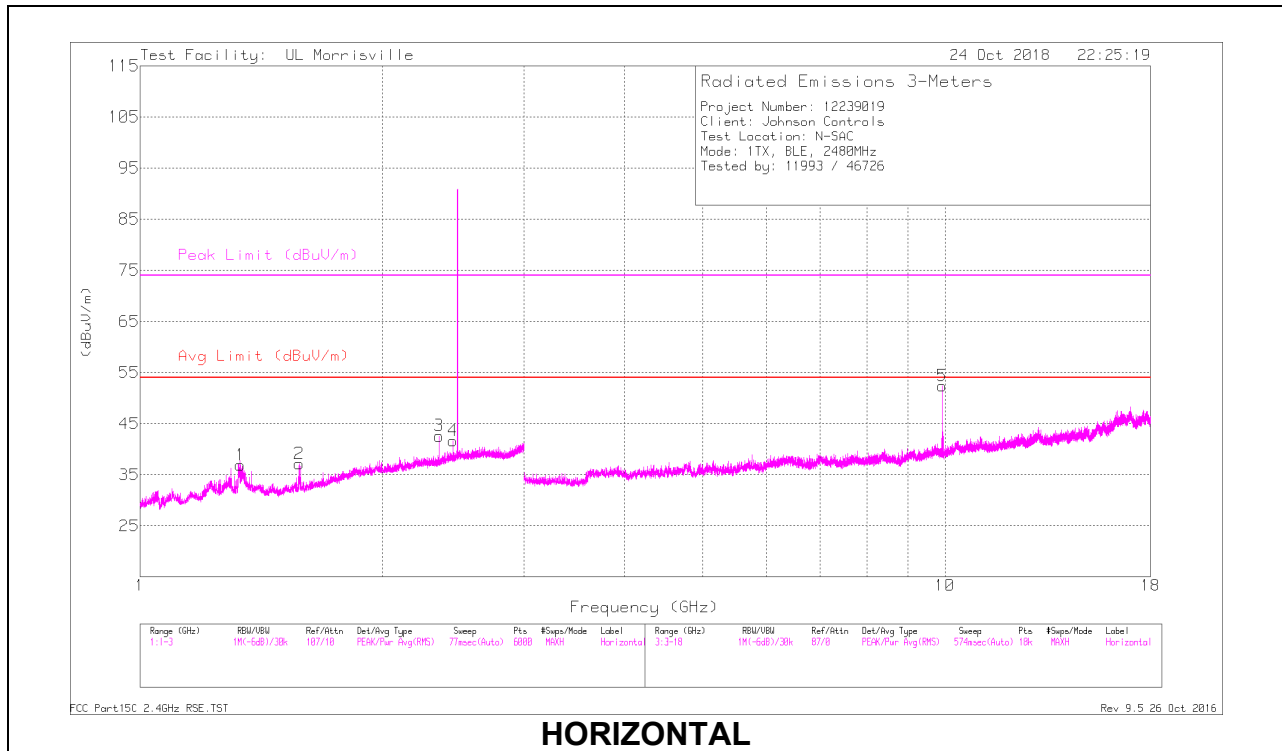
**VERTICAL**

**RADIATED EMISSIONS**

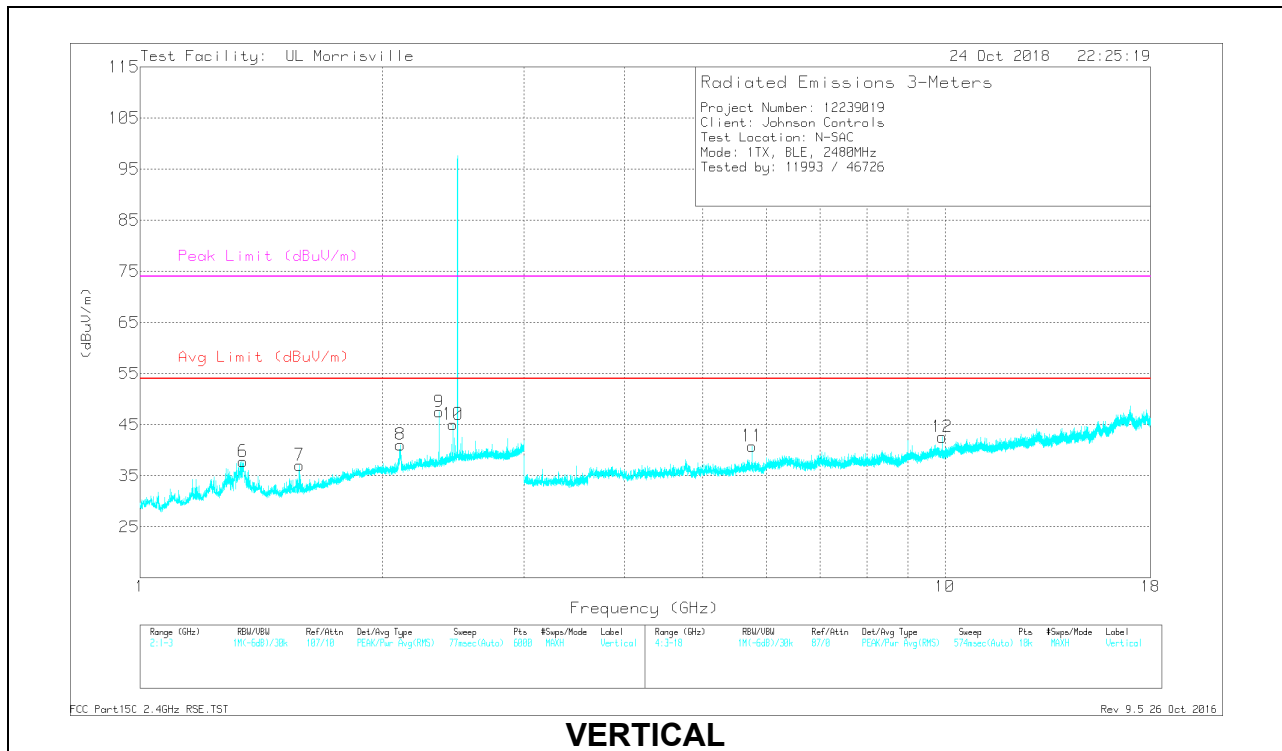
Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 AF (dB/m)	Amp/Cbl/Filtr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	*** 1.051	48.32	PK2	27.1	-27.2	0	48.22	-	-	74	-25.78	180	137	H
	*** 1.05	25.98	MAv1	27.1	-27.2	2.07	27.95	54	-26.05	-	-	180	137	H
2	*** 1.345	47.77	PK2	29.3	-25.6	0	51.47	-	-	74	-22.53	179	197	H
	*** 1.344	26.7	MAv1	29.3	-25.6	2.07	32.47	54	-21.53	-	-	179	197	H
4	*** 4.763	42.25	PK2	34.1	-32.1	0	44.25	-	-	74	-29.75	105	330	H
	*** 4.764	30.35	MAv1	34.1	-32.1	2.07	34.42	54	-19.58	-	-	105	330	H
3	2.408	35.1	PK	32	-24.5	0	42.6	-	-	-	-	0-360	102	H
	9.76	34.38	PK	37	-27.3	0	44.08	-	-	-	-	0-360	199	H
6	*** 1.346	44.61	PK2	29.3	-25.5	0	48.41	-	-	74	-25.59	159	180	V
	*** 1.344	26.23	MAv1	29.3	-25.6	2.07	32	54	-22	-	-	159	180	V
7	*** 1.534	42.74	PK2	27.9	-24.9	0	45.74	-	-	74	-28.26	163	227	V
	*** 1.536	24.77	MAv1	28	-24.9	2.07	29.94	54	-24.06	-	-	163	227	V
9	*** 2.835	40.11	PK2	32	-23.8	0	48.31	-	-	74	-25.69	173	251	V
	*** 2.835	25.17	MAv1	32	-23.8	2.07	35.44	54	-18.56	-	-	173	251	V
10	5.76	37.91	PK	34.7	-31.5	0	41.11	-	-	-	-	0-360	199	V
11	9.76	37.01	PK	37	-27.3	0	46.71	-	-	-	-	0-360	102	V

\* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band  
 \*\* - indicates frequency in Taiwan NCC LP0002 Restricted Band  
 PK2 - Maximum Peak  
 MAv1 - Maximum RMS Average

### HIGH CHANNEL RESULTS



### HORIZONTAL



### VERTICAL

**RADIATED EMISSIONS**

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 AF (dB/m)	Amp/Cbl/Filtr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
2	*** 1.578	46.59	PK2	27.8	-24.7	0	49.69	-	-	74	-24.31	108	236	H
	*** 1.579	25.14	MAv1	27.8	-24.7	2.07	30.31	54	-23.69	-	-	108	236	H
3	*** 2.352	40.17	PK2	31.7	-24.5	0	47.37	-	-	74	-26.63	350	106	H
	*** 2.352	32.53	MAv1	31.7	-24.5	2.07	41.8	54	-12.2	-	-	350	106	H
1	*** 1.334	43.81	PK2	29.1	-25.6	0	47.31	-	-	74	-26.69	177	276	H
	*** 1.335	25.49	MAv1	29.1	-25.6	2.07	31.06	54	-22.94	-	-	177	276	H
6	*** 1.344	44.89	PK2	29.3	-25.6	0	48.59	-	-	74	-25.41	224	252	V
	*** 1.345	25.71	MAv1	29.3	-25.6	2.07	31.48	54	-22.52	-	-	224	252	V
7	*** 1.575	46.12	PK2	27.9	-24.7	0	49.32	-	-	74	-24.68	113	289	V
	*** 1.577	24.51	MAv1	27.9	-24.7	2.07	29.78	54	-24.22	-	-	113	289	V
9	*** 2.352	43.87	PK2	31.7	-24.5	0	51.07	-	-	74	-22.93	203	207	V
	*** 2.352	39.06	MAv1	31.7	-24.5	2.07	48.33	54	-5.67	-	-	203	207	V
8	2.106	34.59	Pk	31.1	-24.6	0	41.09	-	-	-	-	0-360	199	V
4	2.448	33.92	Pk	32.2	-24.5	0	41.62	-	-	-	-	0-360	103	H
10	2.448	37.38	Pk	32.2	-24.5	0	45.08	-	-	-	-	0-360	199	V
11	5.76	37.61	Pk	34.7	-31.5	0	40.81	-	-	-	-	0-360	199	V
5	9.92	43.09	Pk	37.1	-27.8	0	52.39	-	-	-	-	0-360	102	H
12	9.92	33.31	Pk	37.1	-27.8	0	42.61	-	-	-	-	0-360	199	V

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

\*\* - indicates frequency in Taiwan NCC LP0002 Restricted Band

PK2 - Maximum Peak

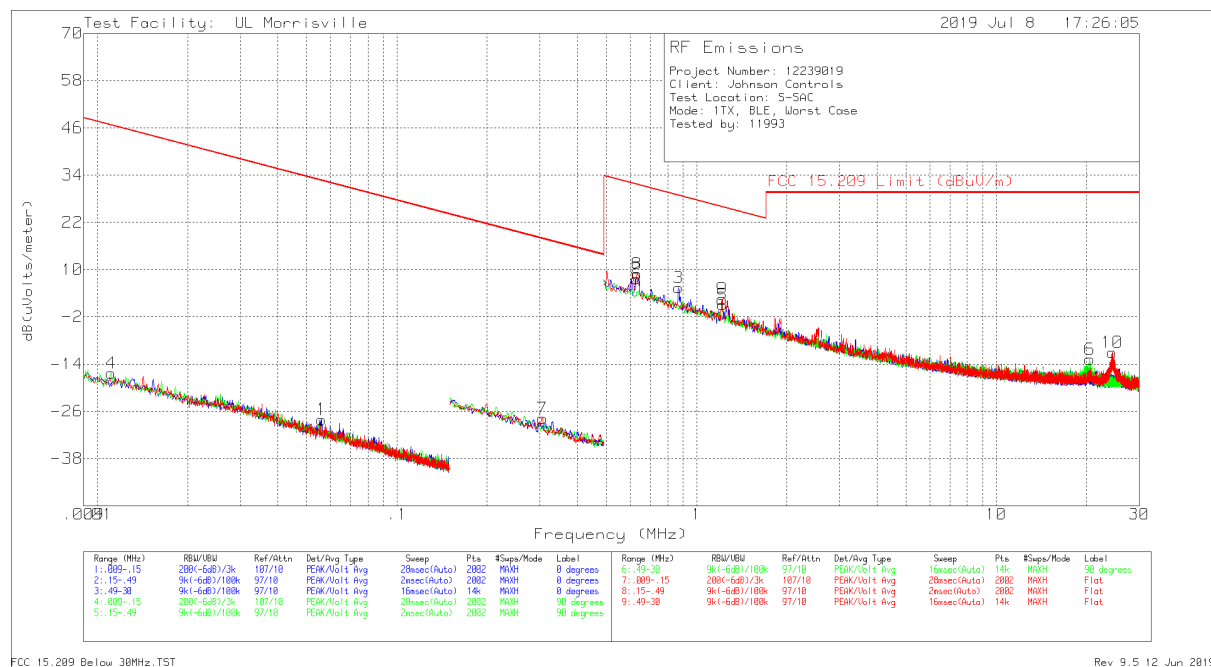
MAv1 - Maximum RMS Average

## 10.2. WORST CASE BELOW 1 GHz

### SPURIOUS EMISSIONS 0.009 to 30 MHz (WORST-CASE CONFIGURATION)

Note: All measurements were made at a test distance of 3 m. The limits in the plots and tabular data are the FCC/IC limits extrapolated from the specification distance (300 m from 9-490 kHz and 30 m from 490 kHz – 30 MHz) to the measurement distance to clearly show the relative levels of fundamental and spurious emissions and demonstrate compliance with the requirement that the level of any spurious emissions be below the level of the intentionally transmitted signal. The extrapolation factor for the limits were  $40 \cdot \log(\text{specification distance} / \text{test distance})$ .

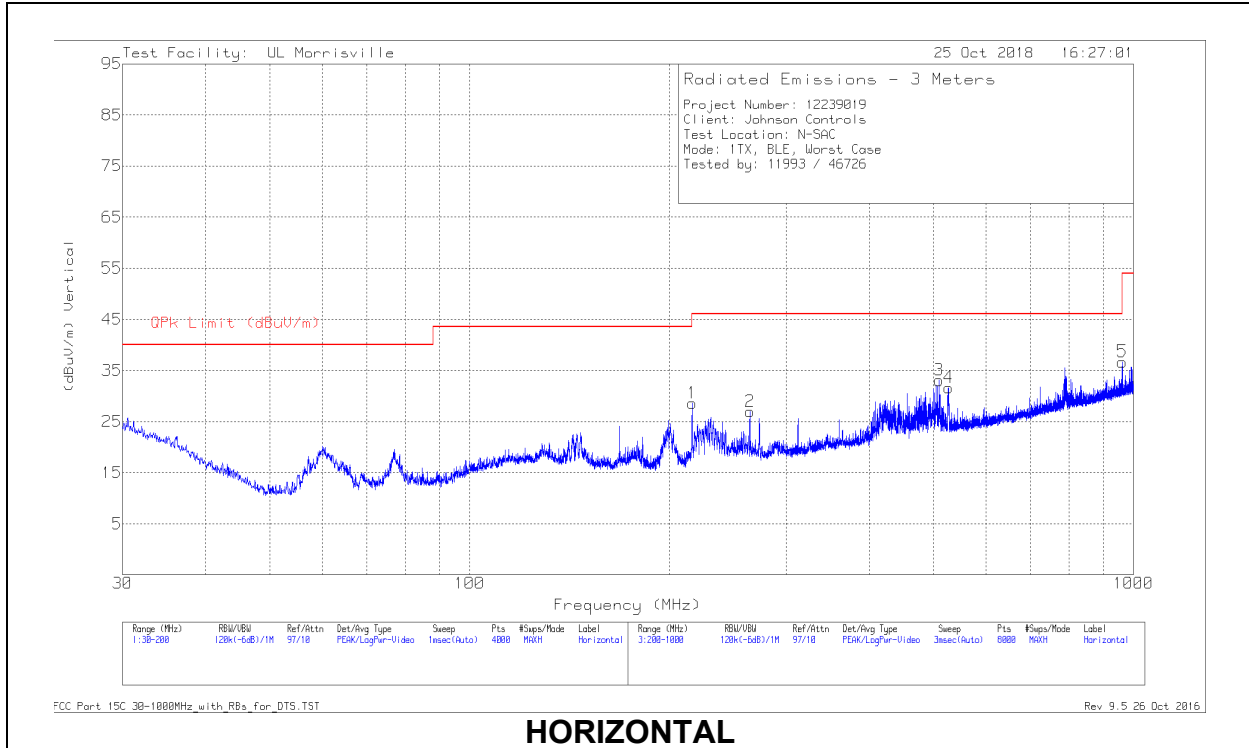
The below 30 MHz limits in CFR 47, Part 15, Subpart C, paragraph 15.209 (a), are identical to those in RSS-GEN Section 8.9, Table 6, since the measurements are performed in terms of magnetic field strength and converted to electric field strength levels (as reported in the table) using the free space impedance of  $377\Omega$ . For example, the measurement frequency 11.1 kHz resulted in a level of -16.33 dBuV/m, which is equivalent to  $-16.33 - 51.5 = -67.83$  dBuA/m, which has the same margin, -63.03 dB, to the corresponding RSS-GEN Table 6 limit as it has to be 15.209(a) limit.



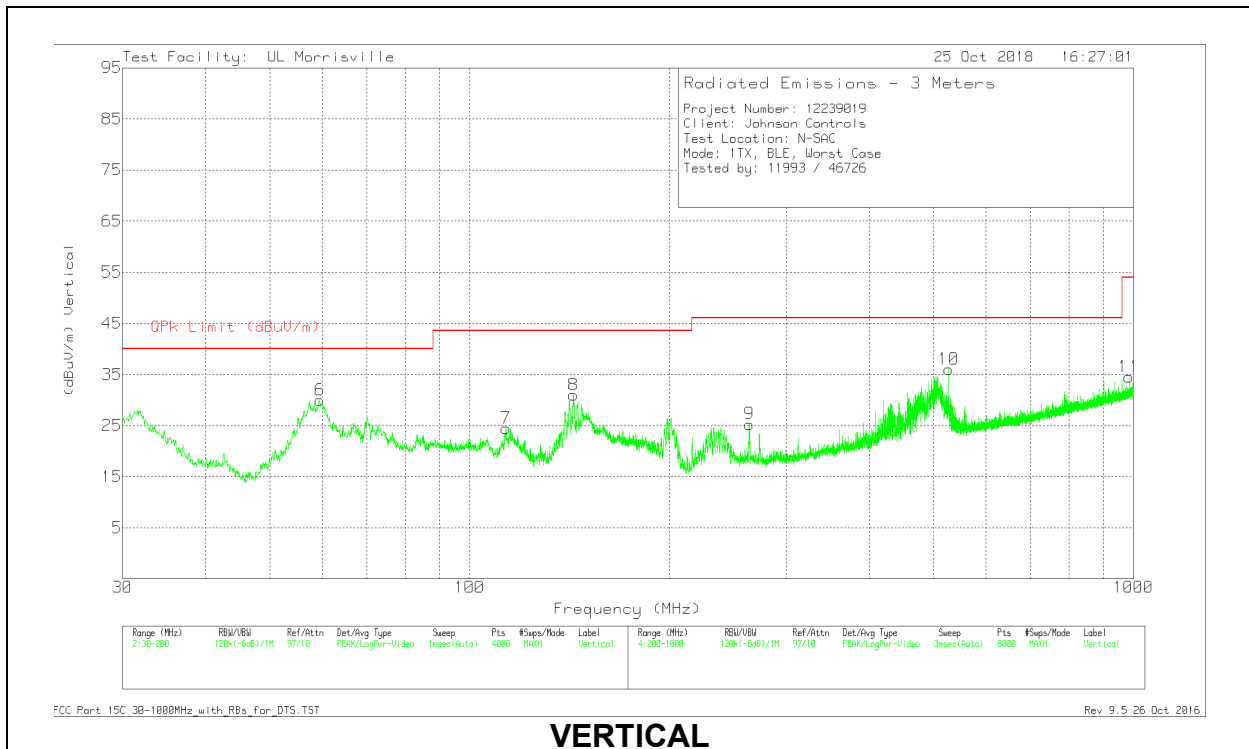
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AT0079 AF (dB/m)	Cbl (dB)	Dist. Corr. Factor (dB)	Corrected Reading dB(uVolts/meter)	QP/AVG FCC 15.209 Limit (dBuV/m)	PK FCC 15.209 Limit (dBuV/m)	Worst-case Margin (dB)	Azimuth (Degs)	Antenna Face
4	.0111	45.77	Pk	17.8	.1	-80	-16.33	46.7	66.7	-63.03	0-360	Off
1	.05604	40.32	Pk	11.5	.1	-80	-28.08	32.63	52.63	-60.71	0-360	On
7	.30589	41.49	Pk	10.6	.1	-80	-27.81	17.89	37.89	-45.7	0-360	Flat
2	.62913	36.82	Pk	10.8	.1	-40	7.72	31.63	-	-23.91	0-360	On
8	.63334	37.99	Pk	10.8	.1	-40	8.89	31.57	-	-22.68	0-360	Flat
3	.87155	34.52	Pk	10.8	.1	-40	5.42	28.8	-	-23.38	0-360	On
9	1.21726	31.27	Pk	11	.2	-40	2.47	25.9	-	-23.43	0-360	Flat
5	1.21831	29.89	Pk	11	.2	-40	1.09	25.89	-	-24.8	0-360	Off
6	20.51811	16.56	Pk	9.8	.8	-40	-12.84	29.54	-	-42.38	0-360	Off
10	24.36205	18.99	Pk	9.2	.8	-40	-11.01	29.54	-	-40.55	0-360	Flat

Pk - Peak detector

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



**HORIZONTAL**



**VERTICAL**



Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AT0073 ACF (dB/m)	Amp/Cbl (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
2	* ** 264.3084	37.39	Pk	19.3	-29.7	26.99	46.02	-19.03	0-360	102	H
5	* ** 961.899	32.8	Pk	29.5	-25.6	36.7	53.97	-17.27	0-360	198	H
1	216.3021	41.16	Pk	17.4	-30	28.56	46.02	-17.46	0-360	102	H
3	509.0402	37.48	Pk	24.1	-28.5	33.08	46.02	-12.94	0-360	198	H
4	526.9925	35.45	Pk	24.4	-28.2	31.65	46.02	-14.37	0-360	198	H
7	* ** 113.4491	35.77	Pk	19.4	-30.7	24.47	43.52	-19.05	0-360	102	V
9	* ** 263.8083	35.67	Pk	19.3	-29.7	25.27	46.02	-20.75	0-360	199	V
11	* ** 984.3019	30.1	Pk	29.7	-25.3	34.5	53.97	-19.47	0-360	199	V
6	59.4389	47.44	Pk	13.8	-31.3	29.94	40	-10.06	0-360	102	V
8	143.3343	42.25	Pk	19.3	-30.6	30.95	43.52	-12.57	0-360	102	V
10	526.5424	39.81	Pk	24.4	-28.2	36.01	46.02	-10.01	0-360	102	V

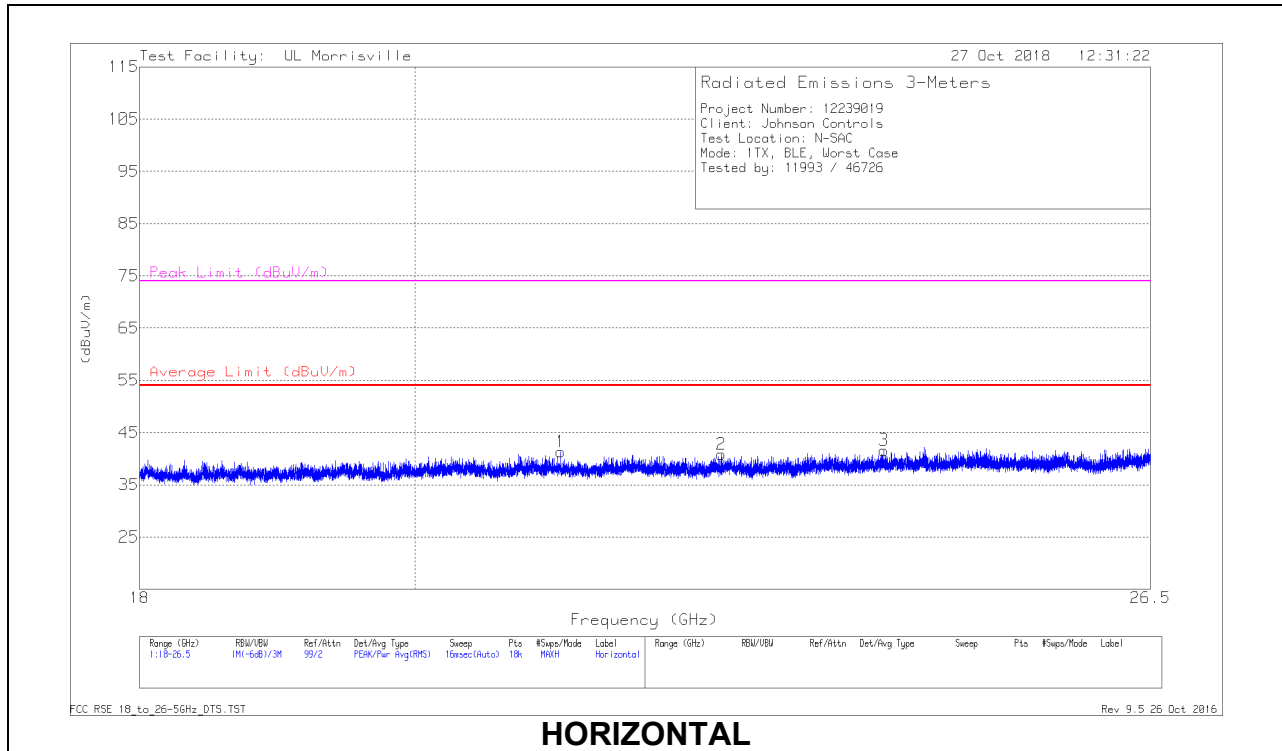
\* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

\*\* - indicates frequency in Taiwan NCC LP0002 Restricted Band

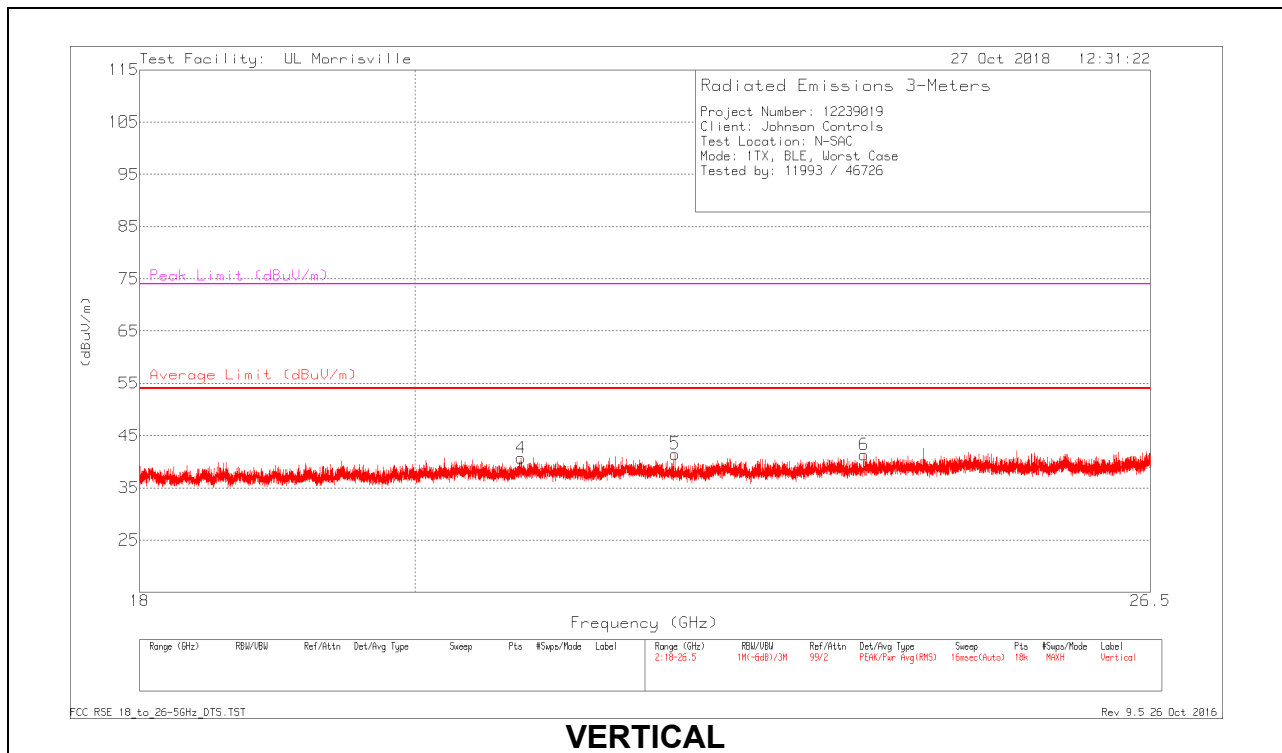
PK - Peak

### 10.3. WORST-CASE 18-26 GHz

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



**HORIZONTAL**



**VERTICAL**

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0076 AF (dB/m)	Amp/Cbl (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 21.148	48.15	Pk	33	-39.8	0	41.35	54	-12.65	74	-32.65	0-360	199	H
2	* ** 22.487	46.36	Pk	33.7	-39.2	0	40.86	54	-13.14	74	-33.14	0-360	102	H
3	* ** 23.93	46.51	Pk	34	-38.9	0	41.61	54	-12.39	74	-32.39	0-360	102	H
4	* ** 20.826	47.39	Pk	33.1	-39.8	0	40.69	54	-13.31	74	-33.31	0-360	102	V
5	* ** 22.093	47	Pk	33.8	-39.3	0	41.5	54	-12.5	74	-32.5	0-360	202	V
6	* ** 23.749	46.35	Pk	34	-39	0	41.35	54	-12.65	74	-32.65	0-360	300	V

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

\*\* - indicates frequency in Taiwan NCC LP0002 Restricted Band

PK - Peak

## 11. AC POWER LINE CONDUCTED EMISSIONS

### LIMITS

FCC §15.207 (a)  
RSS-Gen 8.8

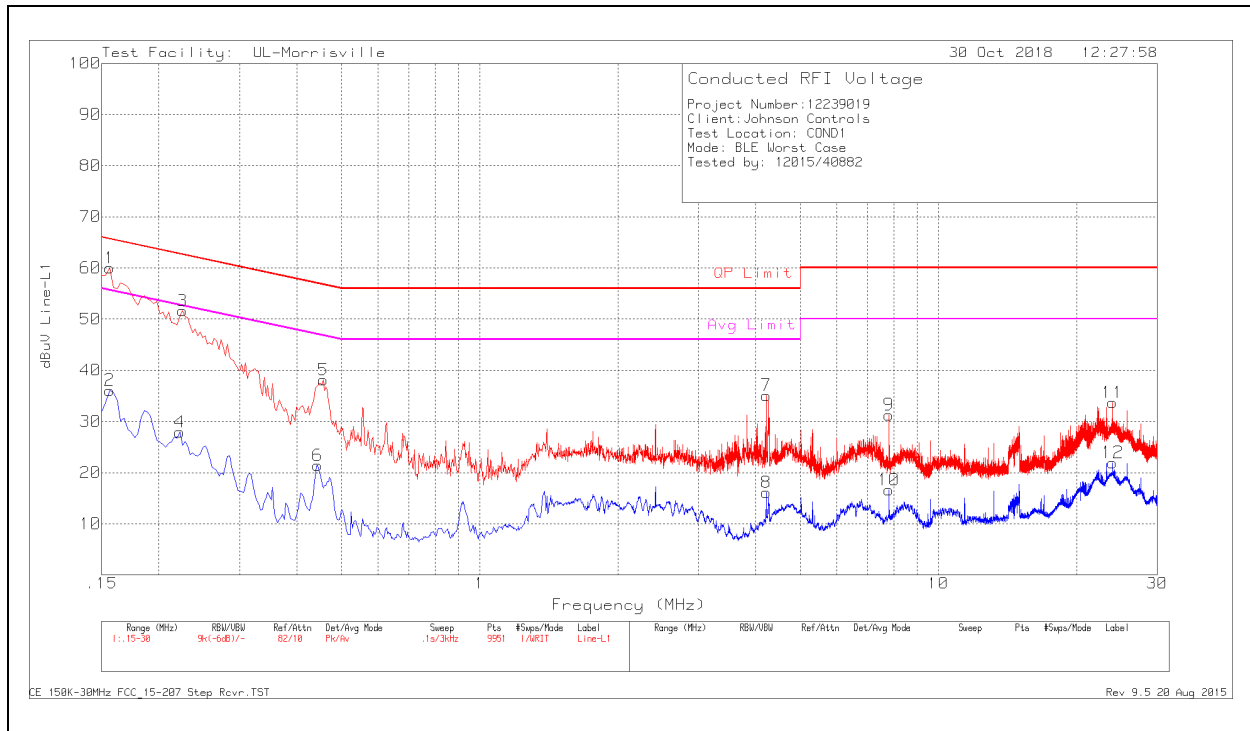
Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

\*Decreases with the logarithm of the frequency.

### RESULTS

### 11.1.1. AC POWER LINE HOST

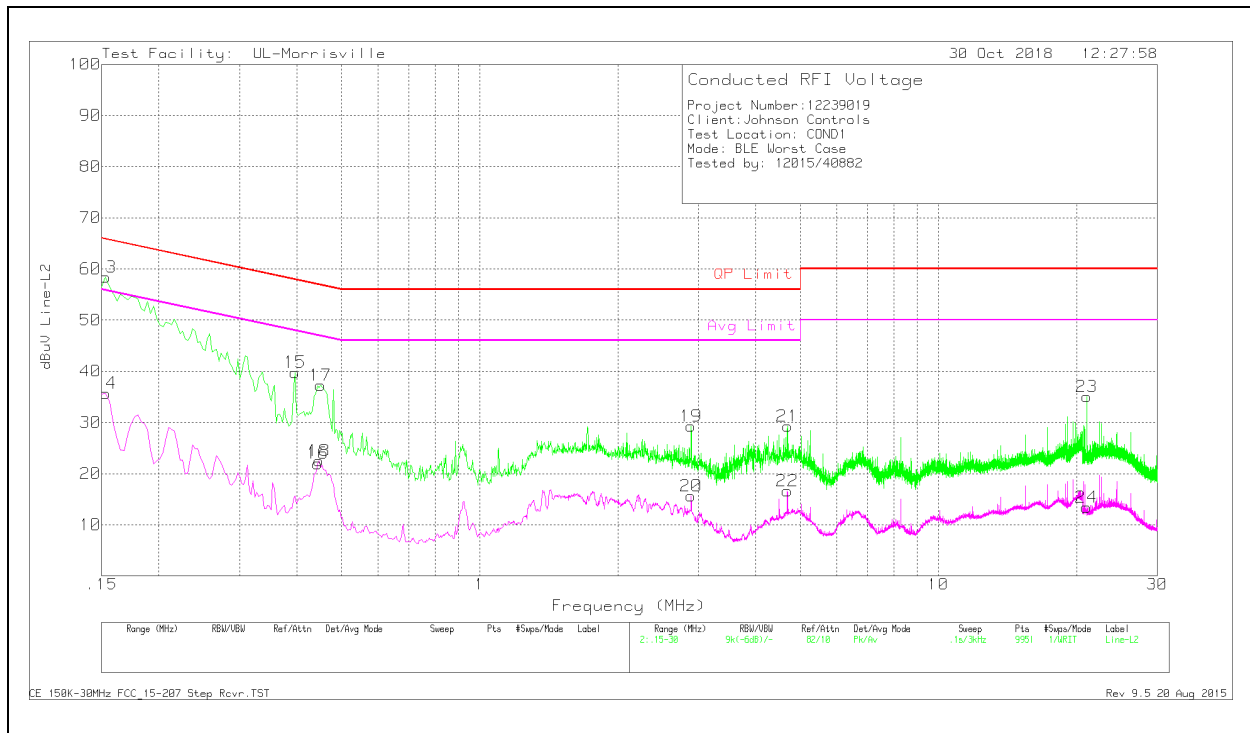
### LINE 1 RESULTS



Range 1: Line-L1 .15 - 30MHz										
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	LISN VCF (dB)	Cbl/Limiter (dB)	Corrected Reading dBuV	QP Limit	Margin (dB)	Avg Limit	Margin (dB)
1	.15533	36.38	Qp	.2	10	46.58	65.71	-19.13	-	-
2	.156	25.89	Av	.2	10	36.09	-	-	55.67	-19.58
3	.225	41.57	Pk	.1	10	51.67	62.63	-10.96	-	-
4	.222	17.83	Av	.1	10	27.93	-	-	52.74	-24.81
5	.456	28.1	Pk	0	10	38.1	56.77	-18.67	-	-
6	.444	11.3	Av	.1	10	21.4	-	-	46.99	-25.59
7	4.212	25.01	Pk	0	10.1	35.11	56	-20.89	-	-
8	4.215	6.04	Av	0	10.1	16.14	-	-	46	-29.86
9	7.806	20.99	Pk	.1	10.2	31.29	60	-28.71	-	-
10	7.806	6.32	Av	.1	10.2	16.62	-	-	50	-33.38
11	23.997	22.89	Pk	.2	10.6	33.69	60	-26.31	-	-
12	23.997	11.15	Av	.2	10.6	21.95	-	-	50	-28.05

PK - Peak detector  
 Av - Average detection  
 Qp - Quasi-Peak detector

### LINE 2 RESULTS



Range 2: Line-L2 .15 - 30MHz										
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	LISN VCF (dB)	Cbl/Limiter (dB)	Corrected Reading dBuV	QP Limit	Margin (dB)	Avg Limit	Margin (dB)
13	.153	48.21	Pk	.2	10	58.41	65.84	-7.43	-	-
14	.153	25.5	Av	.2	10	35.7	-	-	55.84	-20.14
15	.396	29.67	Pk	.1	10	39.77	57.94	-18.17	-	-
16	.444	11.87	Av	.1	10	21.97	-	-	46.99	-25.02
17	.45	27.18	Pk	.1	10	37.28	56.88	-19.6	-	-
18	.447	12.39	Av	.1	10	22.49	-	-	46.93	-24.44
19	2.892	19.19	Pk	0	10.1	29.29	56	-26.71	-	-
20	2.892	5.56	Av	0	10.1	15.66	-	-	46	-30.34
21	4.689	19.17	Pk	0	10.1	29.27	56	-26.73	-	-
22	4.686	6.54	Av	0	10.1	16.64	-	-	46	-29.36
23	21.06	24.28	Pk	.2	10.6	35.08	60	-24.92	-	-
24	21.03	2.58	Av	.2	10.6	13.38	-	-	50	-36.62

Pk - Peak detector  
 Av - Average detection

## 12. SETUP PHOTOS

Please refer to R12239019-EP4 for setup photos

**END OF TEST REPORT**