



# TEST REPORT

**Report Number. :** R13510374-E2

**Applicant :** Sonos Inc.  
614 Chapala St.  
Santa Barbara, CA 93101, U.S.A

**Model :** S38

**FCC ID :** SBVRM038

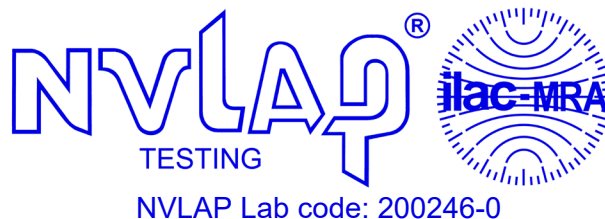
**IC :** 5373A-RM038

**EUT Description :** Wireless Smart Speaker

**Test Standard(s) :** FCC 47 CFR PART 15 SUBPART C: 2021  
ISED RSS-247 ISSUE 2: 2017  
ISED RSS-GEN ISSUE 5 + A1: 2019

**Date Of Issue:**  
2021-03-30

**Prepared by:**  
UL LLC  
12 Laboratory Dr.  
Research Triangle Park, NC 27709 U.S.A.  
TEL: (919) 549-1400



NVLAP Lab code: 200246-0

## REPORT REVISION HISTORY

Rev.	Issue Date	Revisions	Revised By
V1	2021-03-30	Initial Issue	Haley Ackun
V2	2021-04-20	Updated antenna gain info	Haley Ackun

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# 1. ATTESTATION OF TEST RESULTS

**COMPANY NAME:** Sonos Inc.  
614 Chapala St.  
Santa Barbara, CA 93101, U.S.A

**EUT DESCRIPTION:** Wireless Smart Speaker

**MODEL:** S38

**SERIAL NUMBER:** Radiated Samples: 00:0E:58:71:72:5D & 00:0E:58:21:EF:54  
Conducted Sample: 00:0E:58:96:2E:87

**SAMPLE RECEIPT DATE:** 2021-03-12

**DATE TESTED:** 2021-03-15 to 2021-03-19

APPLICABLE STANDARDS	
STANDARD	TEST RESULTS
CFR 47 Part 15 Subpart C: 2021	Complies
ISED RSS-247 Issue 2: 2017	Complies
ISED RSS-GEN Issue 5 + A1: 2019	Complies

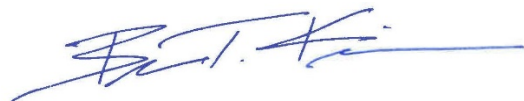
UL LLC tested the above equipment in accordance with the requirements set forth in the above standards. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

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 taken into account 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:

Prepared By:



Brian T. Kiewra  
Project Engineer/Operations Leader  
Consumer Technology Division  
UL LLC.

Haley Ackun  
Laboratory Engineer  
Consumer Technology Division  
UL LLC.

## 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	Complies	None.
15.247 (b) (3)	RSS-247 5.4 (d)	Output Power	Complies	None.
15.247 (e)	RSS-247 5.2 (b)	PSD	Complies	None.
15.247 (d)	RSS-247 5.5	Conducted Spurious Emissions	Complies	None.
15.209, 15.205	RSS-GEN 8.9, 8.10	Radiated Emissions	Complies	None.
15.207	RSS-Gen 8.8	AC Mains Conducted Emissions	Complies	None.

This report contains data provided by the applicant which can impact the validity of results. UL LLC is only responsible for the validity of results after the integration of the data provided by the customer.

### 3. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC CFR 47 Part 2, FCC CFR 47 Part 15: 2021, ANSI C63.10-2013, KDB 662911 D01 Multiple Transmitter Output v02r01, KDB 558074 D01 15.247 Meas Guidance v05r02, KDB 414788 D01 Radiated Test Site v01r01, RSS-GEN Issue 5 + A1: 2019, and RSS-247 Issue 2: 2017.

### 4. FACILITIES AND ACCREDITATION

UL LLC is accredited by NVLAP, Laboratory Code 200246-0, for all testing performed within the scope of this report. Testing was performed at the locations noted below.

	Address	ISED CABID	ISED Company Number	FCC Registration
<input type="checkbox"/>	Building: 12 Laboratory Dr RTP, NC 27709, U.S.A	US0067	2180C	703469
<input checked="" type="checkbox"/>	Building: 2800 Perimeter Park Dr. Suite B Morrisville, NC 27560, U.S.A			

## 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	1.22%
RF output power, conducted	1.3 dB (PK) 0.45 dB (AV)
RF output power, radiated (SAC) < 180 MHz	6.18 dB
RF output power, radiated (SAC) >=180 MHz	3.23 dB
Power Spectral Density, conducted	2.47 dB
Unwanted Emissions, conducted	1.94 dB
All emissions, radiated	6.01 dB
Conducted Emissions (0.150-30MHz) - LISN	3.40 dB
Temperature	0.57°C
Humidity	3.39%
DC Supply voltages	1.70%
Time	3.39%

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

### 5.4. 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:

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

36.5 dBuV + 0 dB + 10.1 dB + 0 dB = 46.6 dBuV

## 6. EQUIPMENT UNDER TEST

### 6.1. EUT DESCRIPTION

The EUT is a wireless smart speaker that supports BLE, 2.4 GHz WLAN, and 5 GHz WLAN. This reports only covers 2.4 GHz WLAN.

### 6.2. MAXIMUM OUTPUT POWER

The transmitter has a maximum conducted output power as follows:

Frequency Range (MHz)	Mode	Output Power Chain 0 (dBm)	Output Power Chain 0 (mW)	Output Power Chain 1 (dBm)	Output Power Chain 1 (mW)	Total Output Power (dBm)	Total Output Power (mW)
2412 - 2462	802.11b	21.35	136.46	21.10	128.82	22.30	169.82
2412 - 2462	802.11g	25.43	349.14	25.10	323.59	21.13	129.72
2412 - 2462	802.11n HT20	25.33	341.19	25.32	340.41	21.65	146.22

### 6.3. DESCRIPTION OF AVAILABLE ANTENNAS

The EUT supports 2 antennas. The antenna gain and type, as provided by the manufacturer, are as follows:

The radio utilizes 2 Monopole FPC antennas, chain 0 with a maximum gain of 1.5 dBi and chain 1 with a maximum gain of 2.3 dBi.

### 6.4. SOFTWARE AND FIRMWARE

The EUT firmware installed during testing was Sonos S2 V13.2.

The test utility software used during testing was JPerf 2.0.2

### 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 in MIMO at the channel with highest output power as worst-case scenario.

Radiated emissions between 1GHz and 18GHz were performed with the EUT set to transmit in MIMO at the highest power on low, middle and high channels. Band edge emissions between 1 GHz and 18 GHz were performed with the EUT set to transmit in MIMO on the following channels, for each modulation, based on the final power settings. Note: power stepping was performed to include the highest power setting.

802.11b mode: Channels 1 & 11  
802.11g mode: Channels 1, 2, 3, 10 & 11  
802.11nHT20 mode: Channels 1, 2, 3, 9, 10 & 11

The EUT only operates in 1 orientation; Therefore all final radiated emissions were performed with the EUT in X orientation.

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

802.11b mode: 1 Mbps  
802.11g mode: 6 Mbps  
802.11n HT20mode: MCS0

## 6.6. DESCRIPTION OF TEST SETUP

### SUPPORT EQUIPMENT

Support Equipment List				
Description	Manufacturer	Model	Serial Number	FCC ID
Laptop	Lenovo	T440P	PB0294NN	-

### I/O CABLES

I/O Cable List						
Cable No.	Port	# of Identical Ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1	1	1	I/O	AC Mains	<3m	Connected to AC Mains
2	1	1	I/O	Ethernet	<3m	None.

### TEST SETUP

Test software exercised the radio card.

### SETUP DIAGRAM

Please refer to R13510374-EP1 for setup diagrams.

## 7. MEASUREMENT METHOD

Duty Cycle: ANSI C63.10 Subclause 11.6

6 dB BW: ANSI C63.10 Subclause -11.8.1

Output Power: ANSI C63.10 Subclause -11.9.1.3 Method PKPM1 Peak-reading power meter  
Output Power: ANSI C63.10 Subclause -11.9.2.3.2 Method AVGPM-G (Measurement using a gated RF average-reading power meter)

PSD: ANSI C63.10 Subclause -11.10.2 Method PKPSD (peak PSD)

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

Emissions non-restricted frequency bands: ANSI C63.10 Subclause -11.11 and 6.10.4

Emissions restricted frequency bands: ANSI C63.10 Subclause -11.12.1 and 6.10.5

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

KDB 558074 D01 15.247 Meas Guidance v05r02 FAQ #3

## 8. TEST AND MEASUREMENT EQUIPMENT

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

Test Equipment Used – Antenna Port – RF Conducted (Morrisville – Conducted 2)

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
SA0027	Spectrum Analyzer	Keysight	N9030A	2020-06-10	2021-06-10
PWM001	Power Meter	Keysight	N1912A	2020-07-17	2021-07-17
PWM002	Power Meter	Keysight	N1912A	2020-07-31	2021-07-31
PWM005	Power Meter	Keysight	N1912A	2020-07-14	2021-07-14
PWS001	Power Sensor	Keysight	N1921A	2020-05-27	2021-05-27
PWS006	Power Sensor	Keysight	N1921A	2020-11-25	2021-11-25
PWS005	Power Sensor	Keysight	N1921A	2020-05-26	2021-05-26
PWS002	Power Sensor	Keysight	N1921A	2020-09-10	2021-09-10
HI0090	Environmental Meter	Fisher Scientific	15-077-963	2020-06-26	2021-06-26
HI0091	Environmental Meter	Fisher Scientific	15-077-963	2020-06-26	2021-06-26
	<b>Miscellaneous (if needed)</b>				
EMISoftware	Antenna Port Software	UL LLC	AP Version 2021-02-02, 2021-02-16, 2021-03-09		

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	2020-03-26	2021-03-26
HI0091	Environmental Meter	Fisher Scientific	14-650-118	2020-06-26	2021-06-26
LISN003	LISN, 50-ohm/50-uH, 2-conductor, 25A	Fischer Custom Com.	FCC-LISN-50-25-2-01-550V	2020-08-18	2021-08-18
75141	EMI Test Receiver 9kHz-7GHz	Rohde & Schwarz	ESCI 7	2020-08-18	2021-08-18
72822	Spectrum Analyzer	Keysight Technologies	E4446A	2020-01-02	2021-01-02
ATA222	Transient Limiter, 0.009-100MHz	Electro-Metrics	EM-7600	2020-03-26	2021-03-26
PS214	AC Power Source	Elgar	CW2501M (s/n 1523A02396)	NA	NA
SOFTEMI	EMI Software	UL	Version 9.5 (2015-08-20)		
	<b>Miscellaneous (if needed)</b>				
CDECABLE001	ANSI C63.4 1m extension cable.	UL	Per Annex B of ANSI C63.4	2020-08-08	2021-08-08

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

Equip. ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
	<b>1-18 GHz</b>				
AT0067	Double-Ridged Waveguide Horn Antenna, 1 to 18 GHz	ETS Lindgren	3117	2020-04-28	2021-04-28
	<b>18-40 GHz</b>				
AT0063	Horn Antenna, 18-26.5GHz	ARA	MWH-1826/B	2020-10-30	2021-10-30
AT0061	Horn Antenna, 26-40GHz	ARA	MWH-2640/B	2020-10-30	2021-10-30
	<b>Gain-Loss Chains</b>				
S-SAC03	Gain-loss string: 1-18GHz	Various	Various	2020-07-06	2020-07-06
S-SAC04	Gain-loss string: 18-40GHz	Various	Various	2020-07-07	2021-07-07
	<b>Receiver &amp; Software</b>				
197954	Spectrum Analyzer	Rohde & Schwarz	ESW44	2020-03-27	2021-03-27
SA0025	Spectrum Analyzer	Agilent	N9030A	2020-03-17	2021-03-17
SOFTEMI	EMI Software	UL	Version 9.5 (2021-03-04)		
	<b>Additional Equipment used</b>				
s/n 181474409	Environmental Meter	Fisher Scientific	15-077-963	2020-08-06	2021-08-06

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

Equip. ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
	<b>0.009-30MHz</b>	<b>(Loop Ant.)</b>			
AT0079	Active Loop Antenna	ETS-Lindgren	6502	2020-08-20	2021-08-20
	<b>30-1000 MHz</b>				
AT0074	Hybrid Broadband Antenna	Sunol Sciences Corp.	JB3	2020-07-27	2021-07-27
	<b>1-18 GHz</b>				
AT0072	Double-Ridged Waveguide Horn Antenna, 1 to 18 GHz	ETS Lindgren	3117	2020-04-27	2021-04-27
	<b>Gain-Loss Chains</b>				
N-SAC01	Gain-loss string: 0.009-30MHz	Various	Various	2020-08-07	2021-08-07
N-SAC02	Gain-loss string: 25-1000MHz	Various	Various	2020-08-07	2021-08-07
N-SAC03	Gain-loss string: 1-18GHz	Various	Various	2020-08-07	2021-08-07
	<b>Receiver &amp; Software</b>				
SA0026	Spectrum Analyzer	Agilent	N9030A	2020-07-16	2021-07-16
SOFTEMI	EMI Software	UL	Version 9.5 (2020-08-19)		
	<b>Additional Equipment Used</b>				
HI0094	Environmental Meter	Fisher Scientific	06-662-4 11725843	2020-01-21	2022-01-21



## 9. ANTENNA PORT TEST RESULTS

### 9.1. ON TIME AND DUTY CYCLE

#### LIMITS

None; for reporting purposes only.

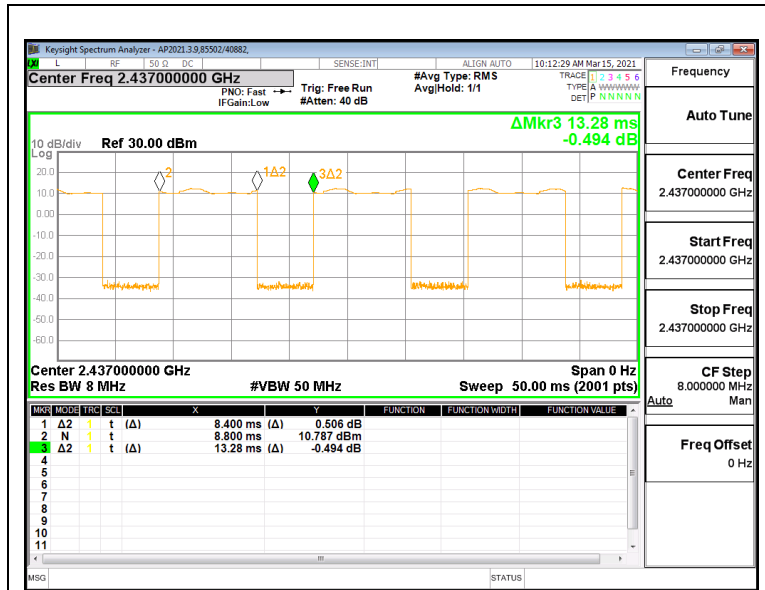
#### PROCEDURE

KDB 558074 Zero-Span Spectrum Analyzer Method.

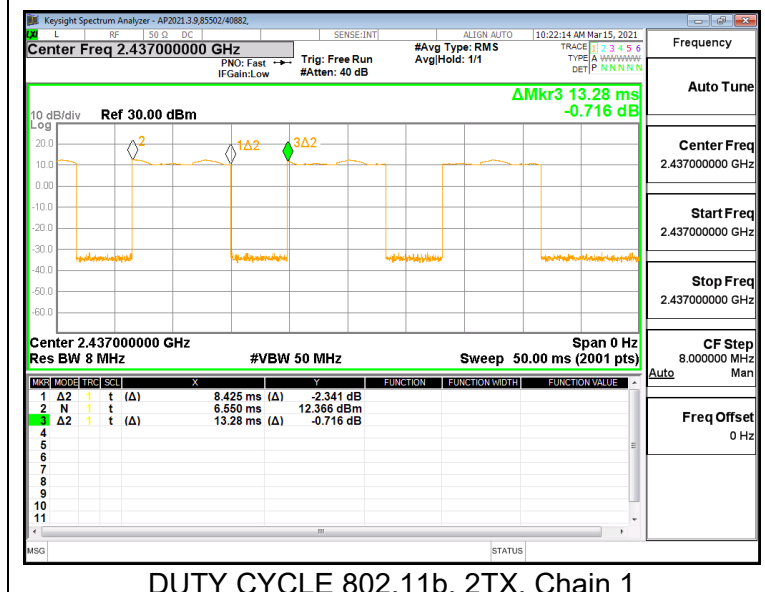
#### ON TIME AND DUTY CYCLE RESULTS

Mode	ON Time B (msec)	Period (msec)	Duty Cycle x (linear)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)	1/B Minimum VBW (kHz)
<b>2.4GHz Band</b>						
802.11b 2TX, Chain 0	8.400	13.28	0.633	63.25%	3.98	0.119
802.11b 2TX, Chain 1	8.425	13.28	0.634	63.44%	3.95	0.119
802.11g 2TX, Chain 0	1.395	2.810	0.496	49.64%	6.08	0.717
802.11g 2TX, Chain 1	1.395	2.810	0.496	49.64%	6.08	0.717
802.11n HT20 2TX, Chain 0	1.300	2.516	0.517	51.67%	5.74	0.769
802.11n HT20 2TX, Chain 1	1.307	2.513	0.520	52.01%	5.68	0.765

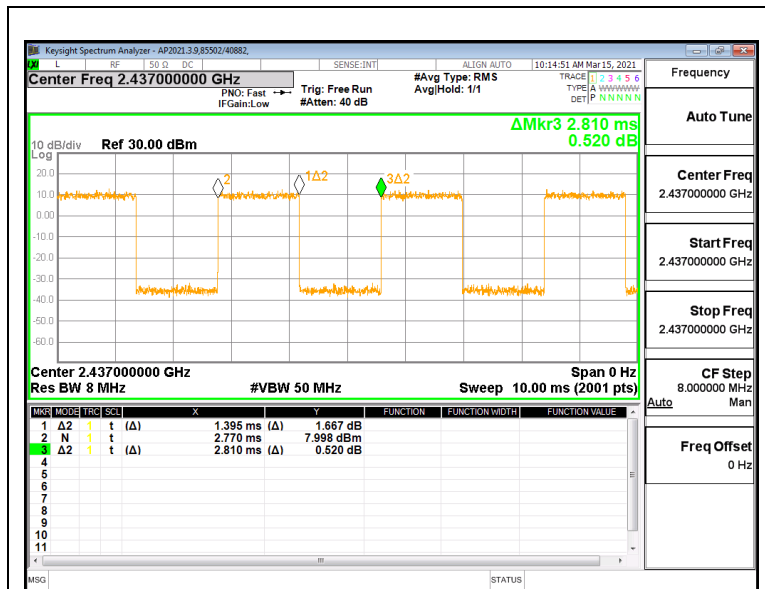
DUTY CYCLE PLOTS



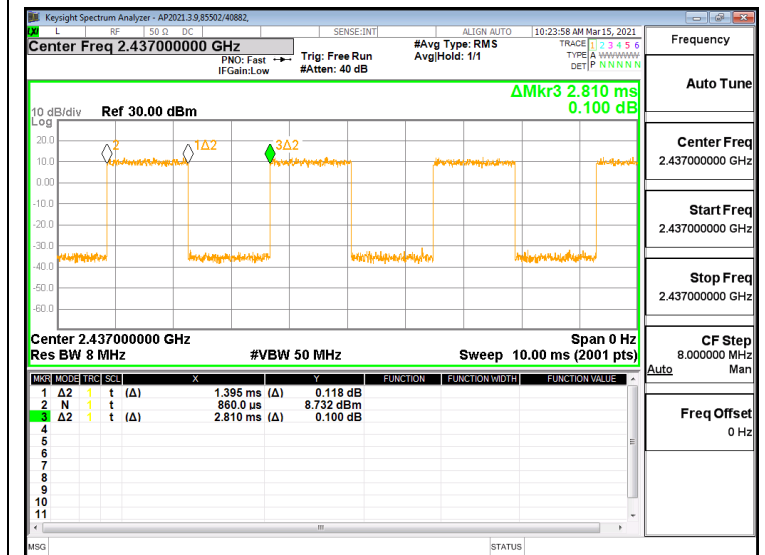
DUTY CYCLE 802.11b, 2TX, Chain 0



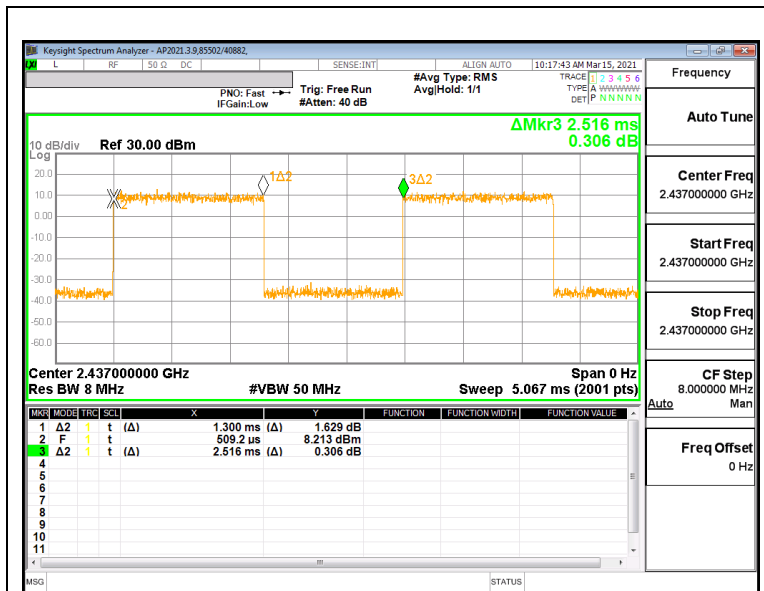
DUTY CYCLE 802.11b, 2TX, Chain 1



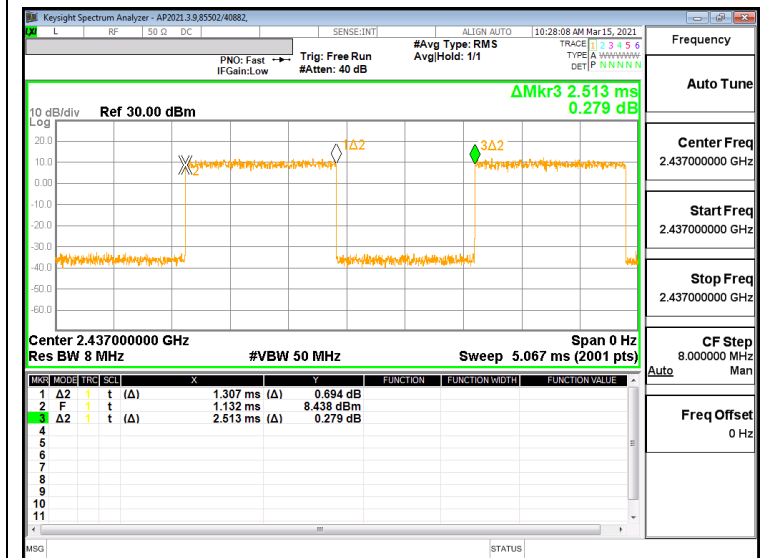
DUTY CYCLE 802.11g, 2TX, Chain 0



DUTY CYCLE 802.11g, 2TX, Chain 1



DUTY CYCLE 802.11nHT20, 2TX, Chain 0



DUTY CYCLE 802.11nHT20, 2TX, Chain 1

## **9.2. 99% BANDWIDTH**

### **LIMITS**

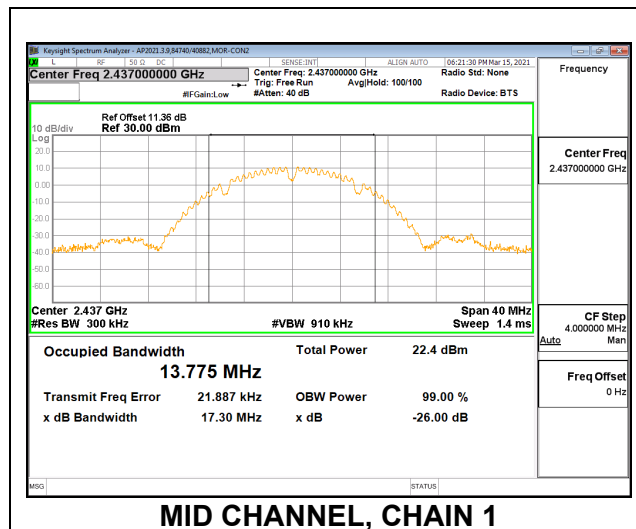
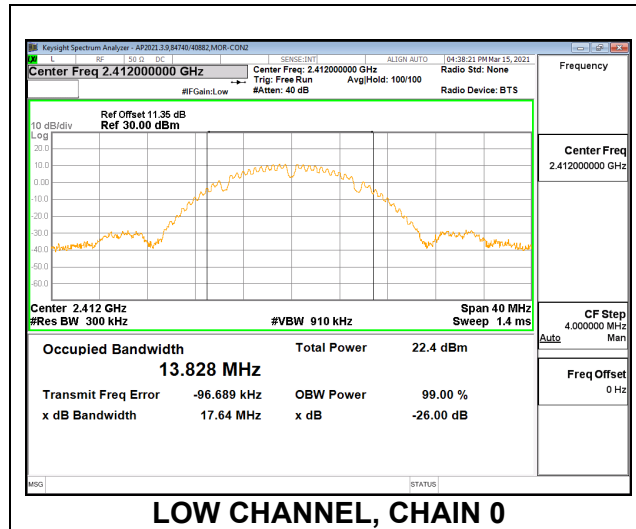
None; for reporting purposes only.

### **RESULTS**

### 9.2.1. 802.11b MODE

#### 2TX Chain 0 + Chain 1 CDD MODE

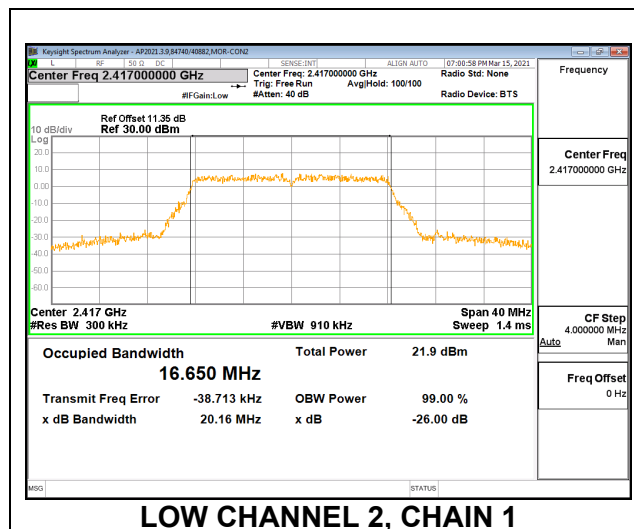
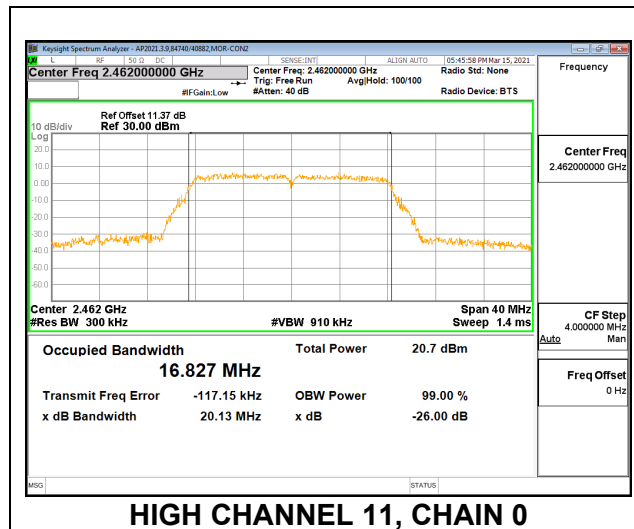
Channel	Frequency (MHz)	99% Bandwidth Chain 0 (MHz)	99% Bandwidth Chain 1 (MHz)
Low 1	2412	13.828	13.619
Mid 6	2437	13.551	13.775
High 11	2462	13.689	13.744



### 9.2.2. 802.11g MODE

#### 2TX Chain 0 + Chain 1 CDD MODE

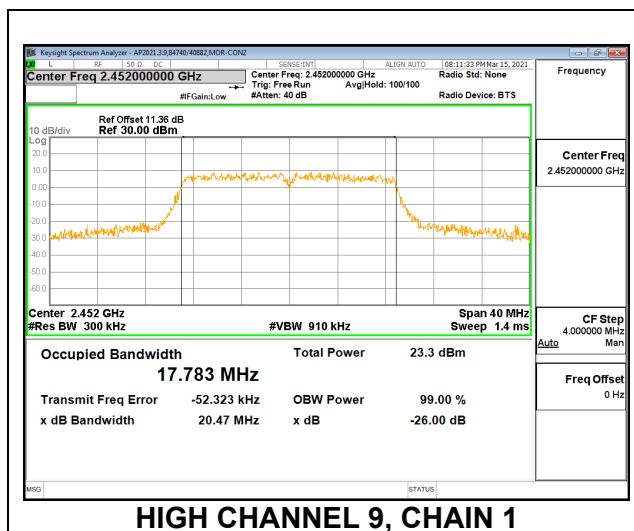
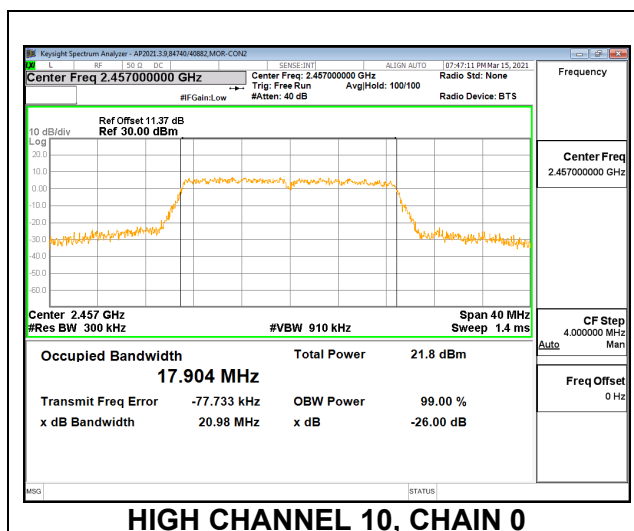
Channel	Frequency (MHz)	99% Bandwidth Chain 0 (MHz)	99% Bandwidth Chain 1 (MHz)
Low 1	2412	16.715	16.597
Low 2	2417	16.826	16.650
Low 3	2422	16.800	16.638
Mid 6	2437	16.764	16.614
High 10	2457	16.794	16.625
High 11	2462	16.827	16.630



### 9.2.3. 802.11n HT20 MODE

#### 2TX Chain 0 + Chain 1 CDD MODE

Channel	Frequency (MHz)	99% Bandwidth Chain 0 (MHz)	99% Bandwidth Chain 1 (MHz)
Low 1	2412	17.796	17.682
Low 2	2417	17.847	17.726
Low 3	2422	17.897	17.708
Mid 6	2437	17.843	17.692
High 9	2452	17.826	17.783
High 10	2457	17.904	17.719
High 11	2462	17.822	17.738





### **9.3. 6 dB BANDWIDTH**

#### **LIMITS**

FCC §15.247 (a) (2)

RSS-247 5.2 (a)

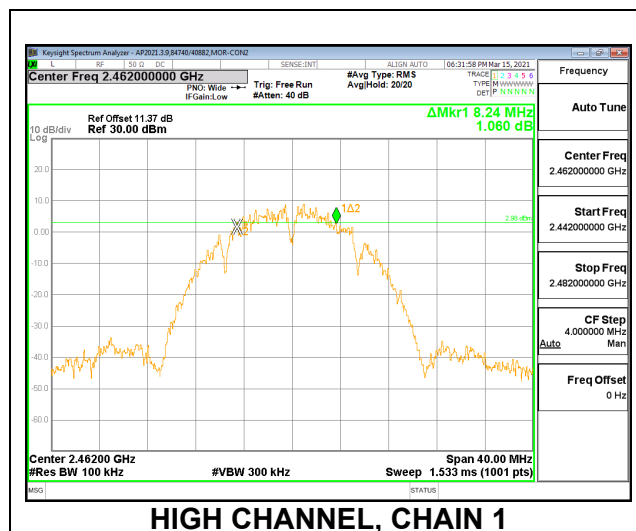
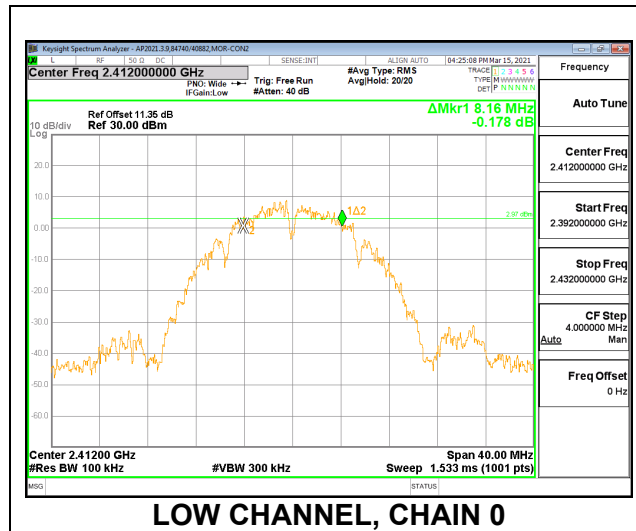
The minimum 6 dB bandwidth shall be at least 500 kHz.

#### **RESULTS**

### 9.3.1. 802.11b MODE

#### 2TX Chain 0 + Chain 1 CDD MODE

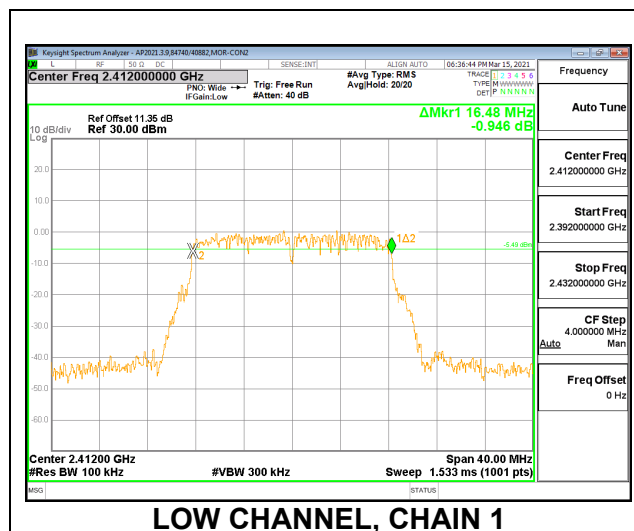
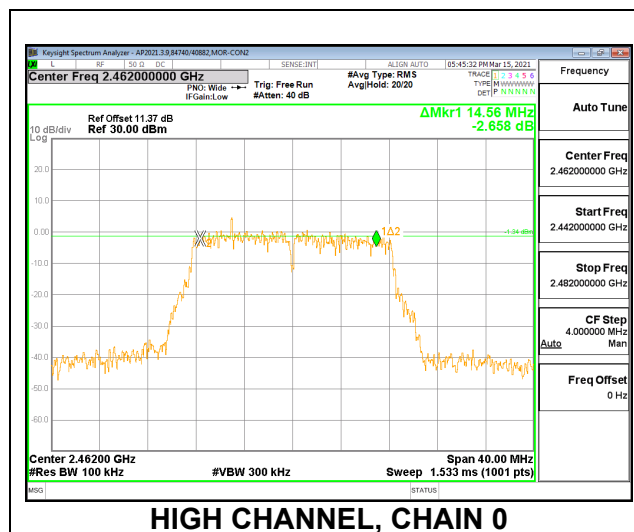
Channel	Frequency (MHz)	6 dB BW Chain 0 (MHz)	6 dB BW Chain 1 (MHz)	Minimum Limit (MHz)
Low 1	2412	8.16	8.48	0.5
Mid 6	2437	8.56	9.20	0.5
High 11	2462	8.16	8.24	0.5



### 9.3.2. 802.11g MODE

#### 2TX Chain 0 + Chain 1 CDD MODE

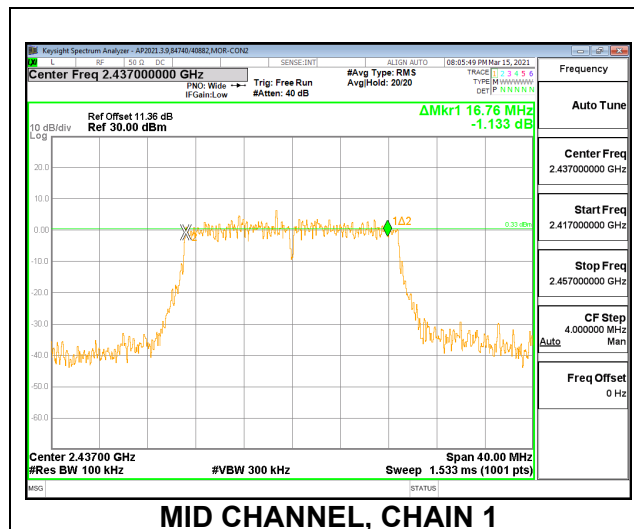
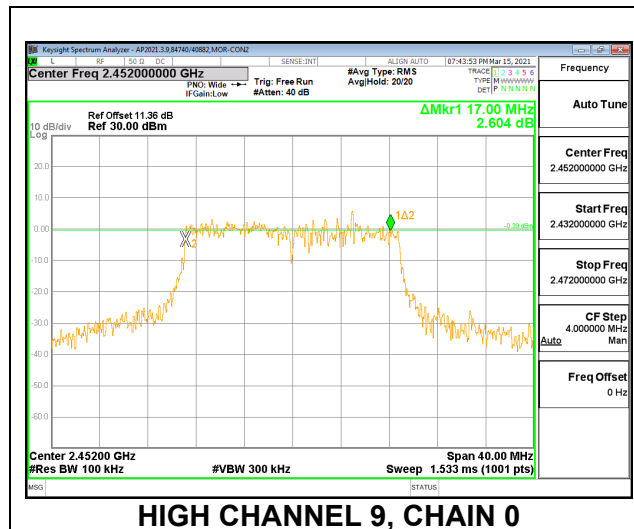
Channel	Frequency (MHz)	6 dB BW Chain 0 (MHz)	6 dB BW Chain 1 (MHz)	Minimum Limit (MHz)
Low 1	2412	16.48	16.48	0.5
Low 2	2417	15.72	16.48	0.5
Low 3	2422	16.44	16.48	0.5
Mid 6	2437	16.56	16.52	0.5
High 10	2457	16.52	16.48	0.5
High 11	2462	14.56	16.48	0.5



### 9.3.3. 802.11n HT20 MODE

#### 2TX Chain 0 + Chain 1 CDD MODE

Channel	Frequency (MHz)	6 dB BW Chain 0 (MHz)	6 dB BW Chain 1 (MHz)	Minimum Limit (MHz)
Low 1	2412	17.80	17.72	0.5
Low 2	2417	17.76	17.72	0.5
Low 3	2422	17.68	17.72	0.5
Mid 6	2437	17.76	16.76	0.5
High 9	2452	17.00	17.60	0.5
High 10	2457	17.36	17.76	0.5
High 11	2462	17.72	17.68	0.5



## 9.4. OUTPUT POWER

### LIMITS

FCC §15.247 (b) (3)

RSS-247 5.4 (d)

For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt, based on the use of antennas with directional gains that do not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

### TEST PROCEDURE

The transmitter output is connected to a RF peak power meter.

The cable assembly insertion loss of 11.35 dB (including 10.15 dB pad, 0.80 dB EUT cable, and 0.40 dB test cable) was entered as an offset in the power meter.

**DIRECTIONAL ANTENNA GAIN**

Tx chains are uncorrelated for power and correlated for PSD due to the device supporting CDD in all MIMO modes. The directional gains are as follows:

<b>Band (GHz)</b>	<b>Chain 0 Antenna Gain (dBi)</b>	<b>Chain 1 Antenna Gain (dBi)</b>	<b>Uncorrelated Chains Directional Gain (dBi)</b>	<b>Correlated Chains Directional Gain (dBi)</b>
2.4	1.50	2.30	1.92	4.92

**RESULTS**

**9.4.1. 802.11b MODE**

**2TX Chain 0 + Chain 1 CDD MODE**

<b>Test Engineer:</b>	85502/40882
<b>Test Date:</b>	2021-03-19

**Limits**

Channel	Frequency (MHz)	Directional Gain (dBi)	FCC/ISED Power Limit (dBm)	ISED EIRP Limit (dBm)	Max Power (dBm)
Low 1	2412	1.92	30.00	36	30.00
Mid 6	2437	1.92	30.00	36	30.00
High 11	2462	1.92	30.00	36	30.00

**Results**

Channel	Frequency (MHz)	Chain 0 Meas Power (dBm)	Chain 1 Meas Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Margin (dB)
Low 1	2412	21.26	20.56	23.93	30.00	-6.07
Mid 6	2437	21.35	20.96	24.17	30.00	-5.83
High 11	2462	21.23	21.10	24.18	30.00	-5.82

### 9.4.2. 802.11g MODE

#### 2TX Chain 0 + Chain 1 CDD MODE

<b>Test Engineer:</b>	85502/40882
<b>Test Date:</b>	2021-03-19

#### Limits

Channel	Frequency (MHz)	Directional Gain (dBi)	FCC/ISED Power Limit (dBm)	ISED EIRP Limit (dBm)	Max Power (dBm)
Low 1	2412	1.92	30.00	36	30.00
Low 2	2417	1.92	30.00	36	30.00
Low 3	2422	1.92	30.00	36	30.00
Mid 6	2437	1.92	30.00	36	30.00
High 10	2457	1.92	30.00	36	30.00
High 11	2462	1.92	30.00	36	30.00

#### Results

Channel	Frequency (MHz)	Antenna 1 Meas Power (dBm)	Antenna 2 Meas Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Margin (dB)
Low 1	2412	23.48	23.26	26.38	30.00	-3.62
Low 2	2417	24.75	24.71	27.74	30.00	-2.26
Low 3	2422	25.37	25.10	28.25	30.00	-1.75
Mid 6	2437	25.43	25.08	28.27	30.00	-1.73
High 10	2457	24.64	24.98	27.82	30.00	-2.18
High 11	2462	24.00	24.27	27.15	30.00	-2.85



### 9.4.3. 802.11n HT20 MODE

#### 2TX Chain 0 + Chain 1 CDD MODE

<b>Test Engineer:</b>	85502/40882
<b>Test Date:</b>	2021-03-19

#### Limits

Channel	Frequency (MHz)	Directional Gain (dBi)	FCC/ISED Power Limit (dBm)	ISED EIRP Limit (dBm)	Max Power (dBm)
Low 1	2412	1.92	30.00	36	30.00
Low 2	2417	1.92	30.00	36	30.00
Low 3	2422	1.92	30.00	36	30.00
Mid 6	2437	1.92	30.00	36	30.00
High 9	2452	1.92	30.00	36	30.00
High 10	2457	1.92	30.00	36	30.00
High 11	2462	1.92	30.00	36	30.00

#### Results

Channel	Frequency (MHz)	Chain 0 Meas Power (dBm)	Chain 1 Meas Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Margin (dB)
Low 1	2412	22.94	22.72	25.84	30.00	-4.16
Low 2	2417	25.01	24.88	27.96	30.00	-2.04
Low 3	2422	25.33	25.32	28.34	30.00	-1.66
Mid 6	2437	25.13	25.26	28.21	30.00	-1.79
High 9	2452	24.91	25.22	28.08	30.00	-1.92
High 10	2457	24.37	24.74	27.57	30.00	-2.43
High 11	2462	23.92	24.22	27.08	30.00	-2.92

## **9.5. AVERAGE POWER**

### **LIMITS**

None; for reporting purposes only

### **TEST PROCEDURE**

The transmitter output is connected to a RF gated average power meter.

The cable assembly insertion loss of 11.35 dB (including 10.15 dB pad, 0.80 dB EUT cable, and 0.40 dB test cable) was entered as an offset in the power meter.

### **RESULTS**

### 9.5.1. 802.11b MODE

#### 2TX Chain 0 + Chain 1 CDD MODE

<b>Test Engineer:</b>	85502/40882
<b>Test Date:</b>	2021-03-15

Channel	Frequency (MHz)	Chain 0 Power (dBm)	Chain 1 Power (dBm)	Total Power (dBm)
Low 1	2412	19.42	18.88	22.17
Mid 6	2437	19.29	19.29	22.30
High 11	2462	19.20	19.18	22.20

### 9.5.2. 802.11g MODE

#### 2TX Chain 0 + Chain 1 CDD MODE

<b>Test Engineer:</b>	85502/40882
<b>Test Date:</b>	2021-03-15

Channel	Frequency (MHz)	Chain 0 Power (dBm)	Chain 1 Power (dBm)	Total Power (dBm)
Low 1	2412	15.97	15.54	18.77
Low 2	2417	17.89	17.36	20.64
Low 3	2422	18.21	18.02	21.13
Mid 6	2437	18.02	17.97	21.01
High 10	2457	17.73	17.58	20.67
High 11	2462	16.04	16.10	19.08

### 9.5.3. 802.11nHT20 MODE

#### 2TX Chain 0 + Chain 1 CDD MODE

<b>Test Engineer:</b>	85502/40882
<b>Test Date:</b>	2021-03-15

Channel	Frequency (MHz)	Chain 0 Power (dBm)	Chain 1 Power (dBm)	Total Power (dBm)
Low 1	2412	14.87	14.56	17.73
Low 2	2417	17.72	17.45	20.60
Low 3	2422	18.63	18.65	21.65
Mid 6	2437	18.20	18.55	21.39
High 9	2452	18.17	18.53	21.36
High 10	2457	17.12	17.47	20.31
High 11	2462	15.48	15.83	18.67

## **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.

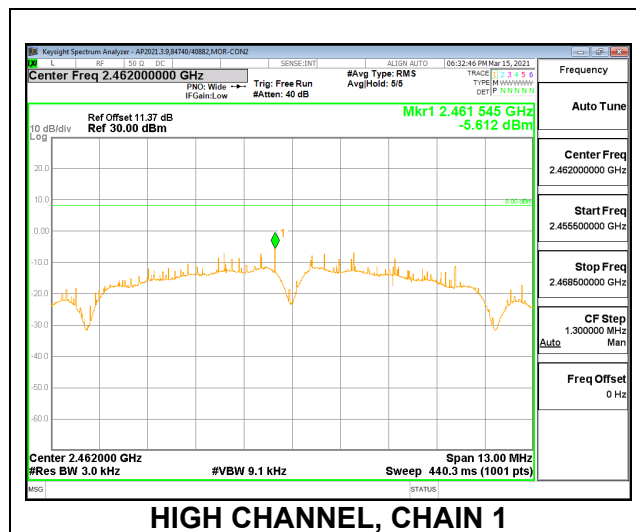
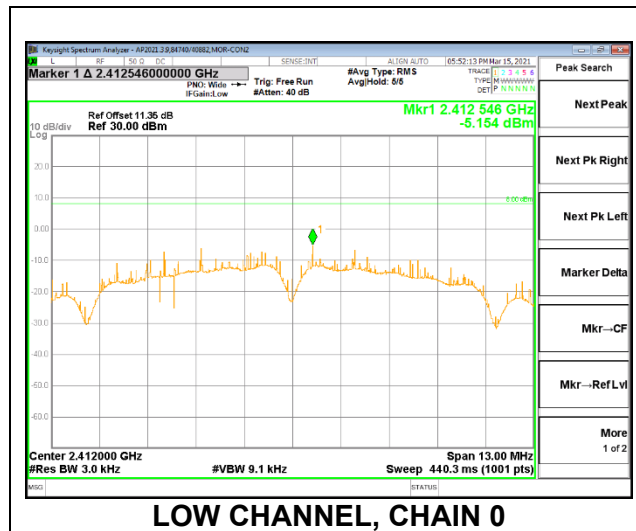
### **RESULTS**

### 9.6.1. 802.11b MODE

#### 2TX Chain 0 + Chain 1 CDD MODE

##### PSD Results

Channel	Frequency (MHz)	Chain 0 Meas (dBm/ 3kHz)	Chain 1 Meas (dBm/ 3kHz)	Total Corr'd PSD (dBm/ 3kHz)	Limit (dBm/ 3kHz)	Margin (dB)
Low 1	2412	-5.154	-6.912	-2.93	8.0	-10.9
Mid 6	2437	-7.453	-5.654	-3.45	8.0	-11.5
High 11	2462	-6.974	-5.612	-3.23	8.0	-11.2

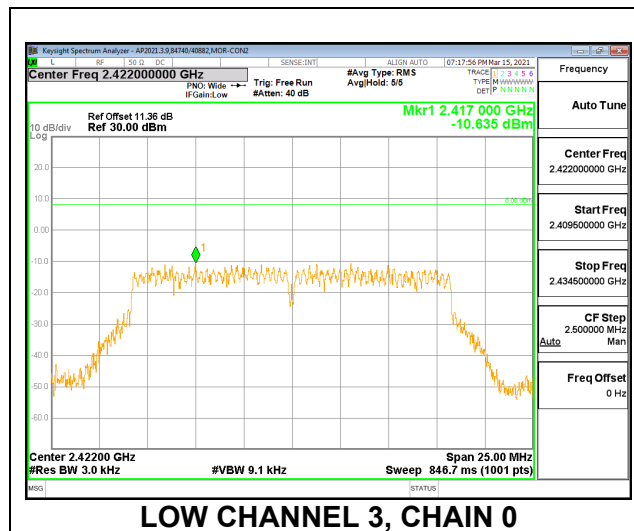


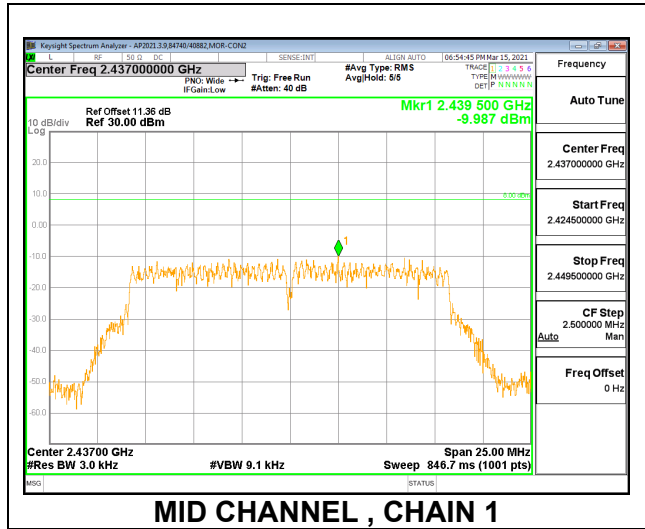
### 9.6.2. 802.11g MODE

#### 2TX Chain 0 + Chain 1 CDD MODE

##### PSD Results

Channel	Frequency (MHz)	Chain 0 Meas (dBm/ 3kHz)	Chain 1 Meas (dBm/ 3kHz)	Total Corr'd PSD (dBm/ 3kHz)	Limit (dBm/ 3kHz)	Margin (dB)
Low 1	2412	-12.714	-12.607	-9.65	8.0	-17.6
Low 2	2417	-11.150	-11.741	-8.43	8.0	-16.4
Low 3	2422	-10.635	-11.256	-7.92	8.0	-15.9
Mid 6	2437	-10.849	-9.987	-7.39	8.0	-15.4
High 10	2457	-11.366	-11.256	-8.30	8.0	-16.3
High 11	2462	-12.920	-11.894	-9.37	8.0	-17.4





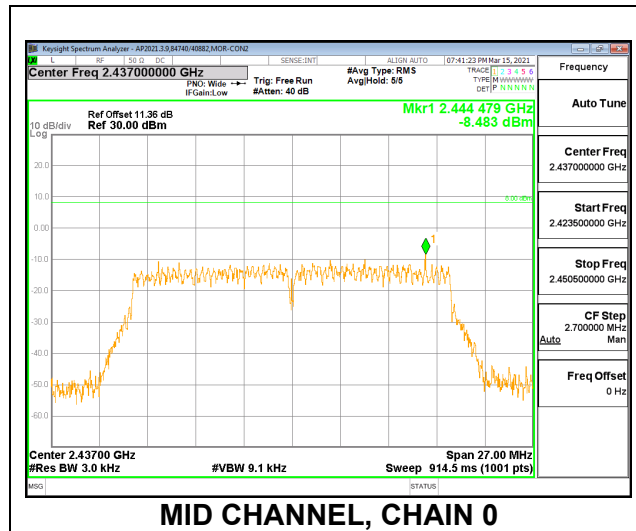


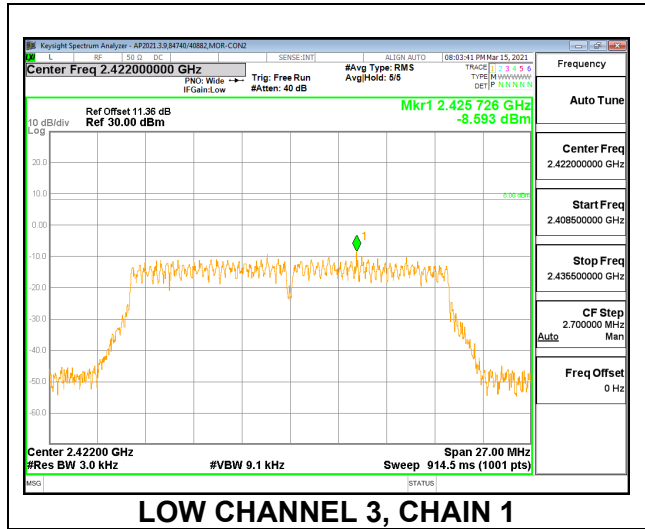
### 9.6.3. 802.11n HT20 MODE

#### 2TX Chain 0 + Chain 1 CDD MODE

##### PSD Results

Channel	Frequency (MHz)	Chain 0 Meas (dBm/3kHz)	Chain 1 Meas (dBm/3kHz)	Total Corr'd PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low 1	2412	-12.667	-13.301	-9.96	8.0	-18.0
Low 2	2417	-8.872	-10.812	-6.72	8.0	-14.7
Low 3	2422	-9.289	-8.593	-5.92	8.0	-13.9
Mid 6	2437	-8.483	-8.624	-5.54	8.0	-13.5
High 9	2452	-10.190	-9.025	-6.56	8.0	-14.6
High 10	2457	-9.788	-9.970	-6.87	8.0	-14.9
High 11	2462	-11.834	-11.354	-8.58	8.0	-16.6





## **9.7. CONDUCTED SPURIOUS EMISSIONS**

### **LIMITS**

FCC §15.247 (d)

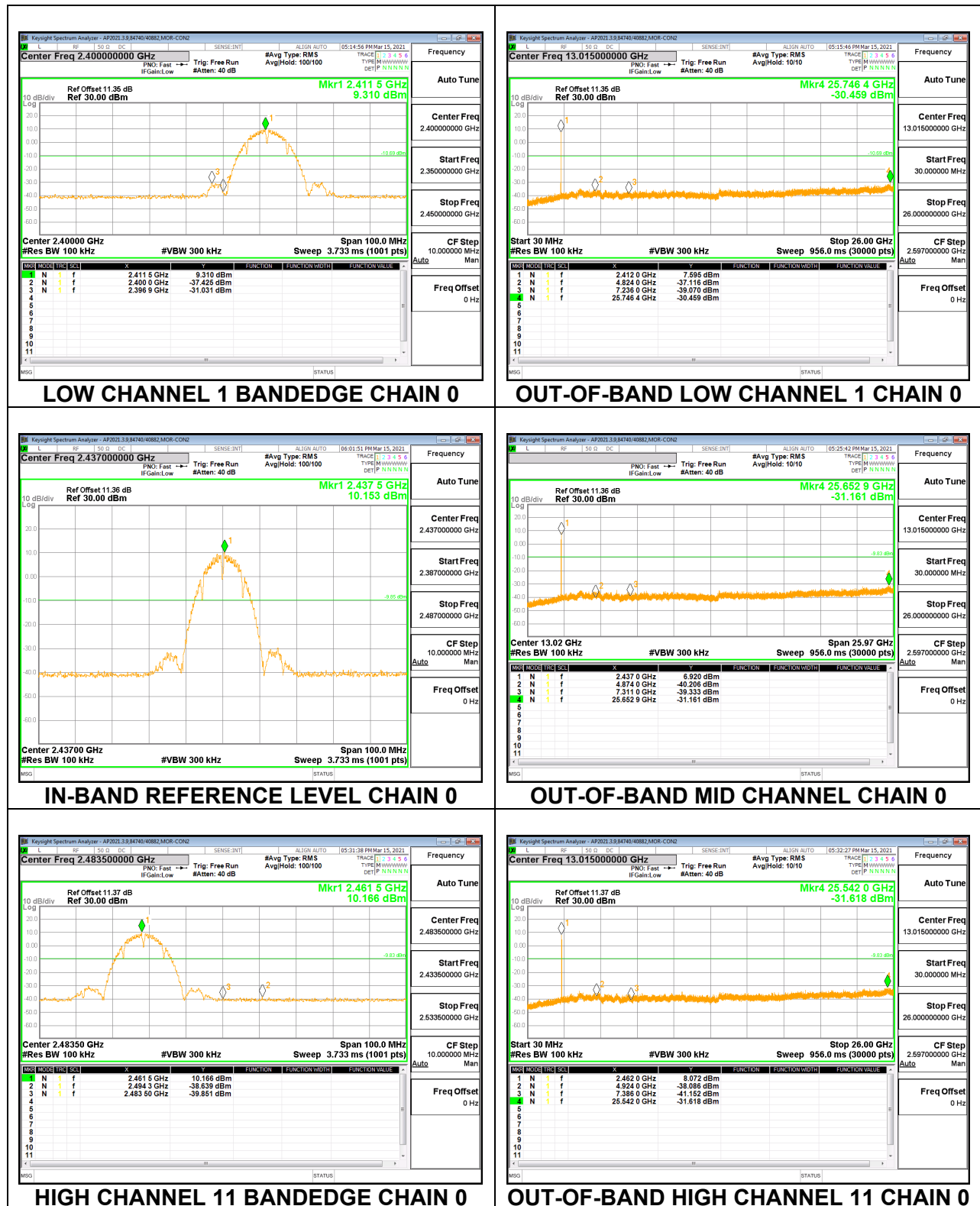
RSS-247 5.5

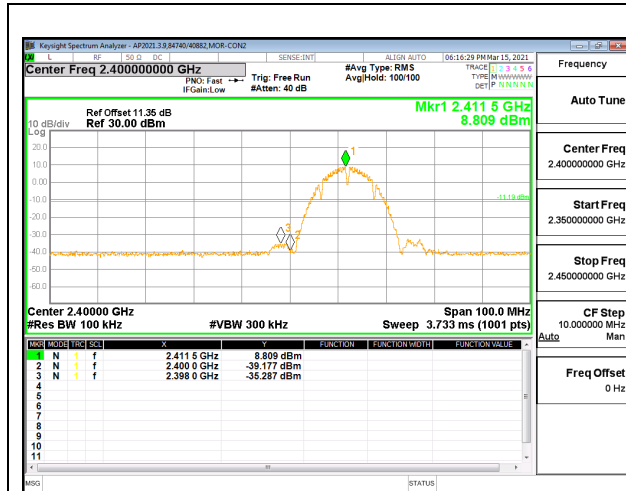
Output power was measured based on the use of an peak measurement, therefore the required attenuation is -20 dBc.

### **RESULTS**

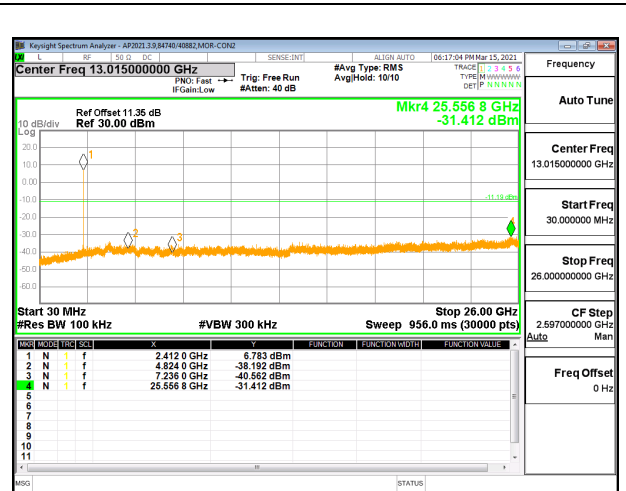
### 9.7.1. 802.11b MODE

#### 2TX Chain 0 + Chain 1 CDD MODE

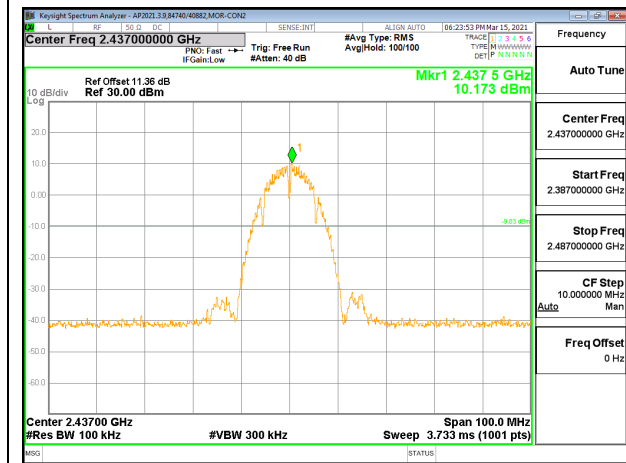




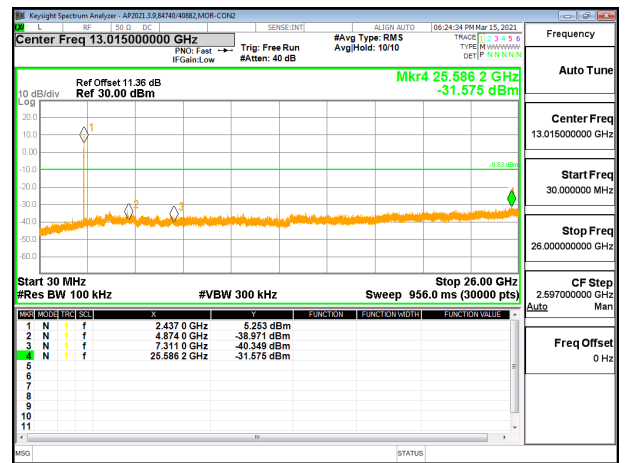
LOW CHANNEL 1 BANDEDGE CHAIN 1



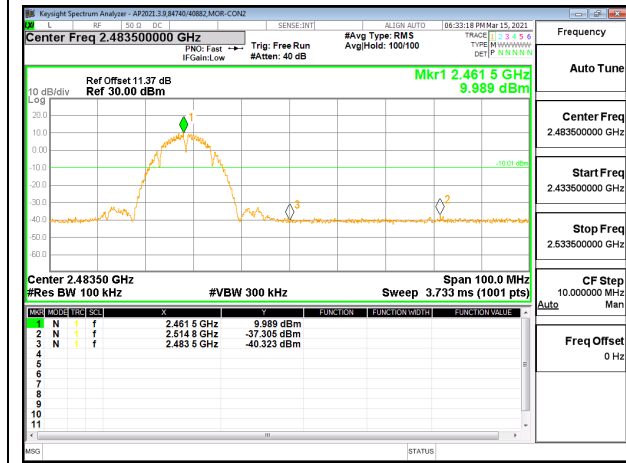
OUT-OF-BAND LOW CHANNEL 1 CHAIN 1



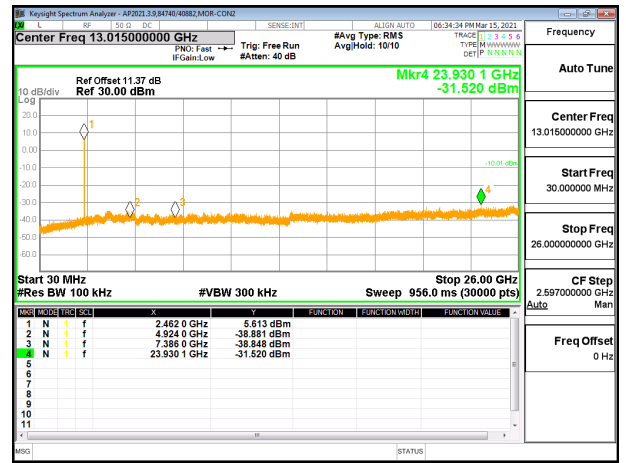
IN-BAND REFERENCE LEVEL CHAIN 1



OUT-OF-BAND MID CHANNEL CHAIN 1



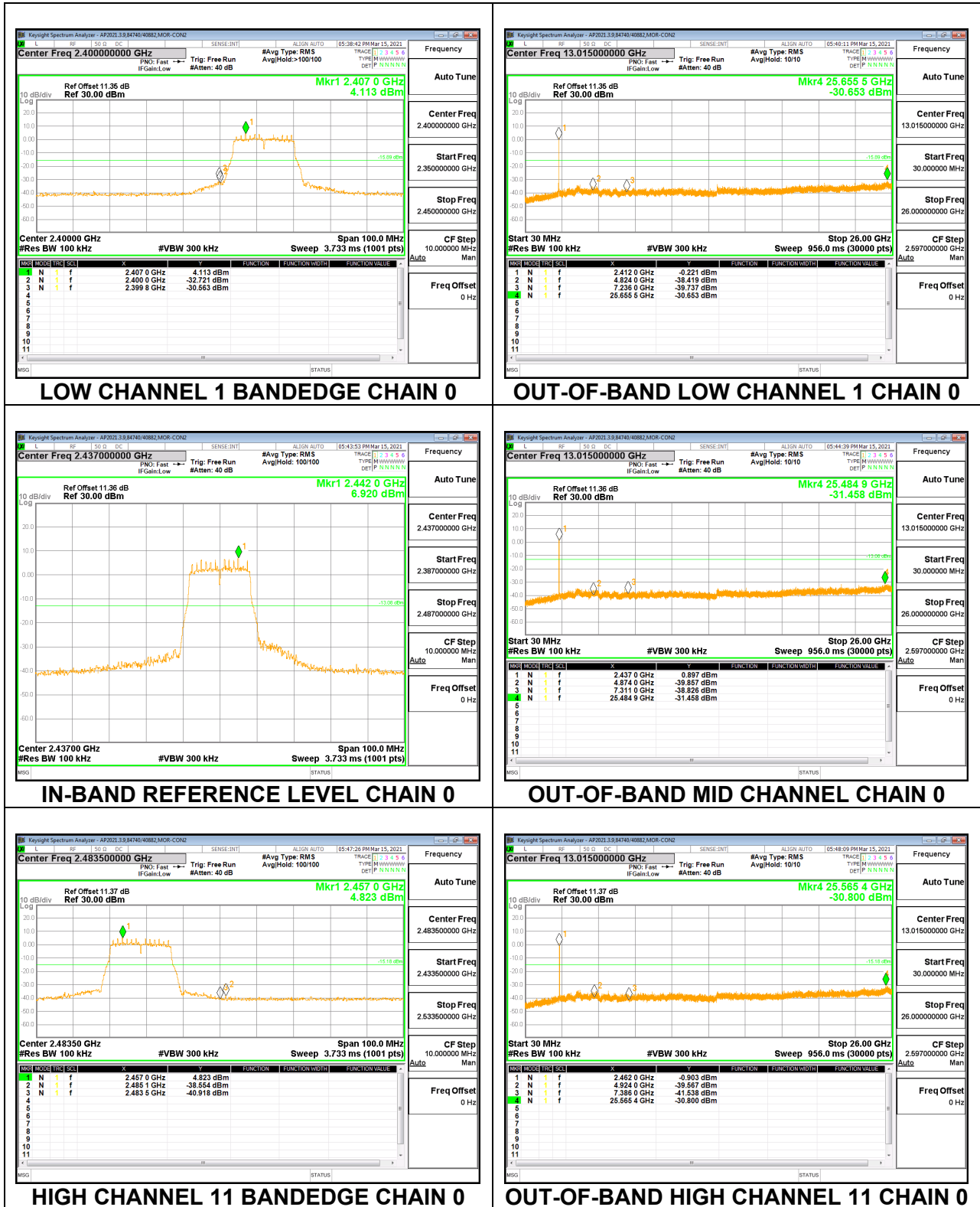
HIGH CHANNEL 11 BANDEDGE CHAIN 1

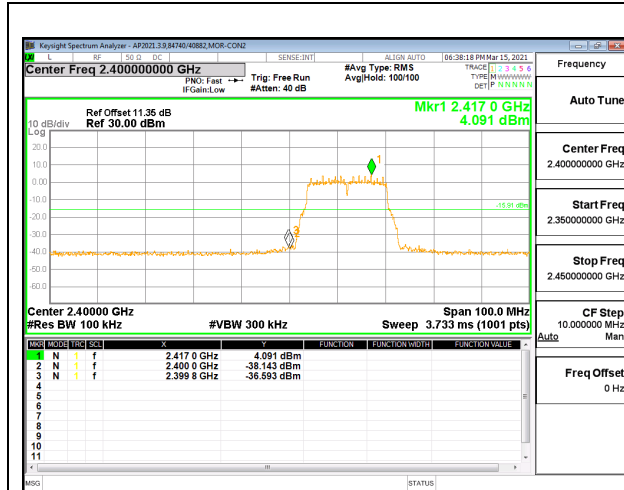


OUT-OF-BAND HIGH CHANNEL 11 CHAIN 1

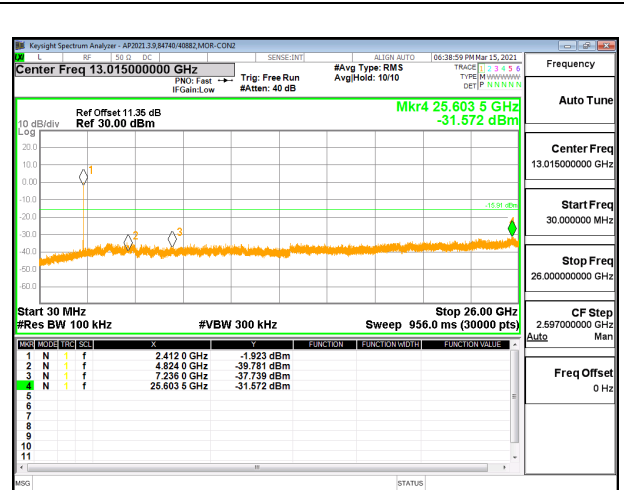
### 9.7.2. 802.11g MODE

#### 2TX Chain 0 + Chain 1 CDD MODE

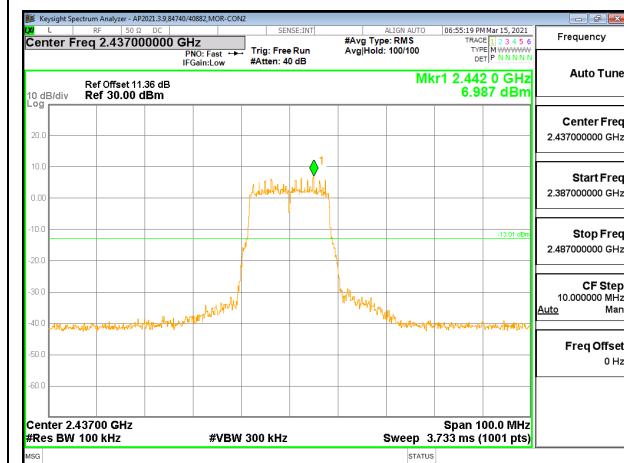




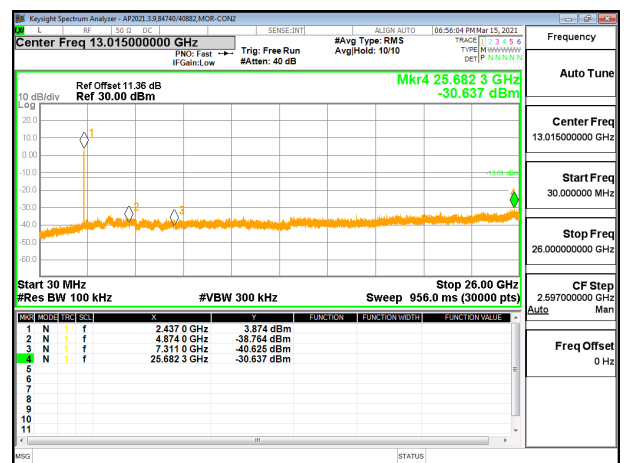
LOW CHANNEL 1 BANDEDGE CHAIN 1



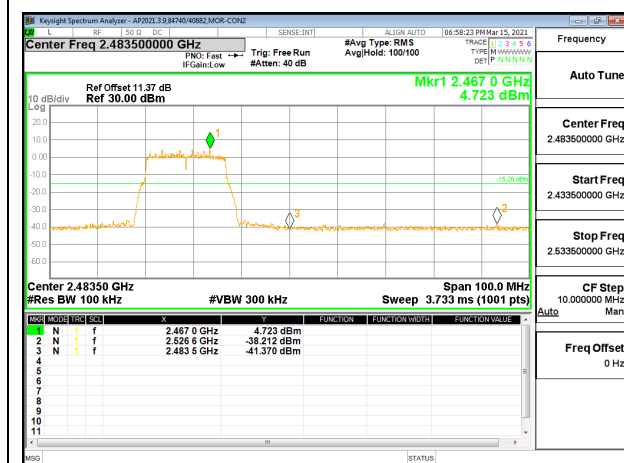
OUT-OF-BAND LOW CHANNEL 1 CHAIN 1



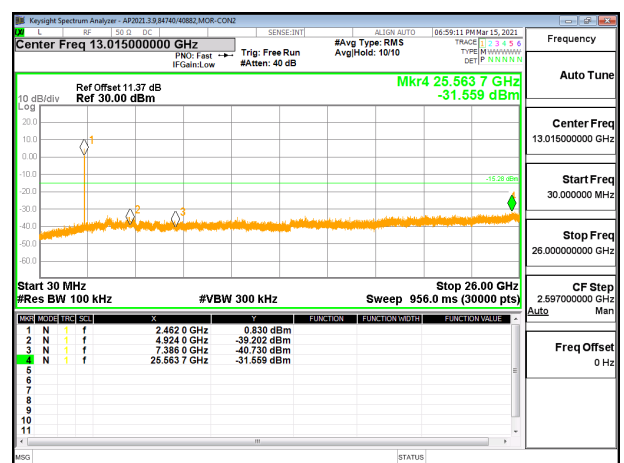
IN-BAND REFERENCE LEVEL CHAIN 1



OUT-OF-BAND MID CHANNEL CHAIN 1



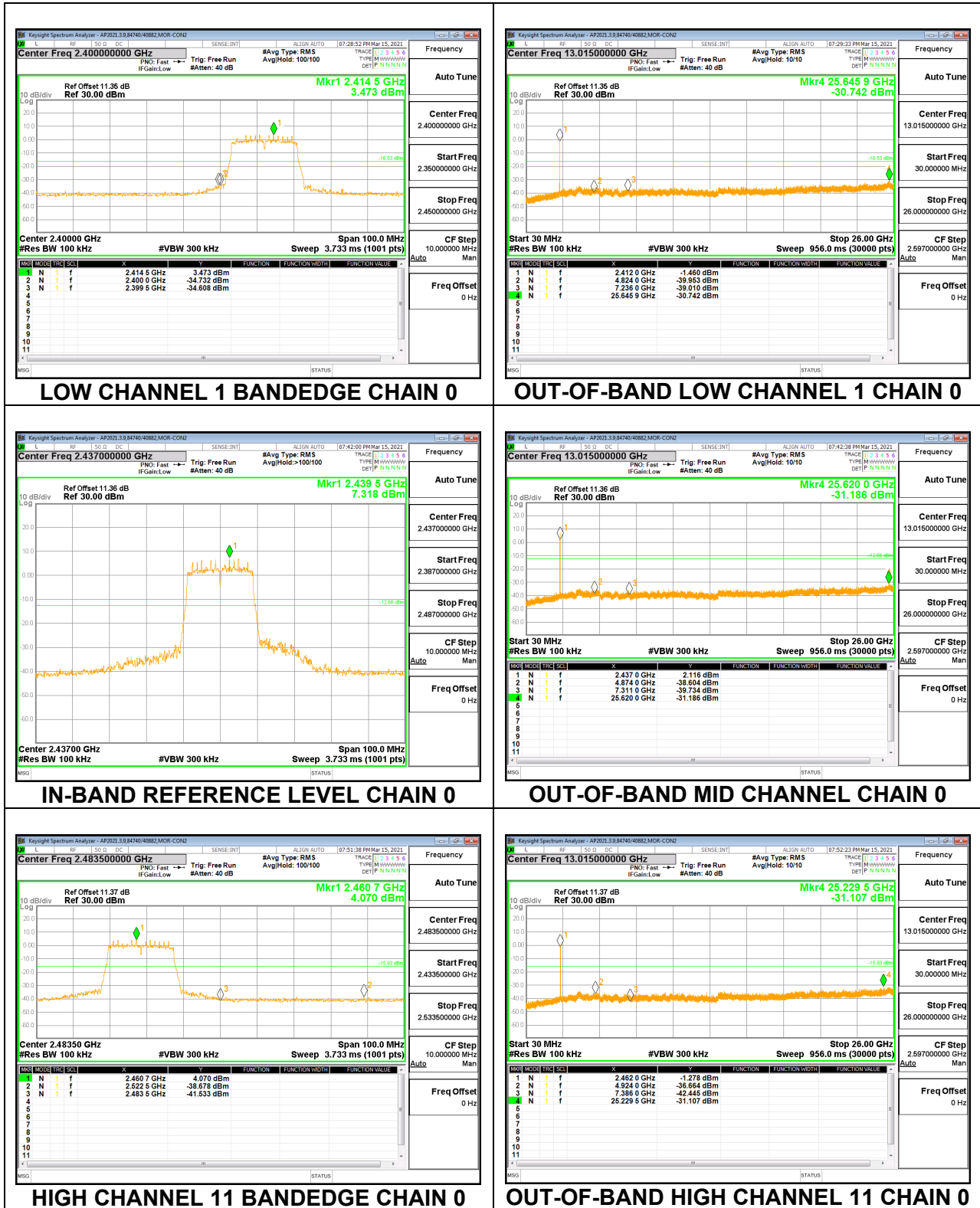
HIGH CHANNEL 11 BANDEDGE CHAIN 1



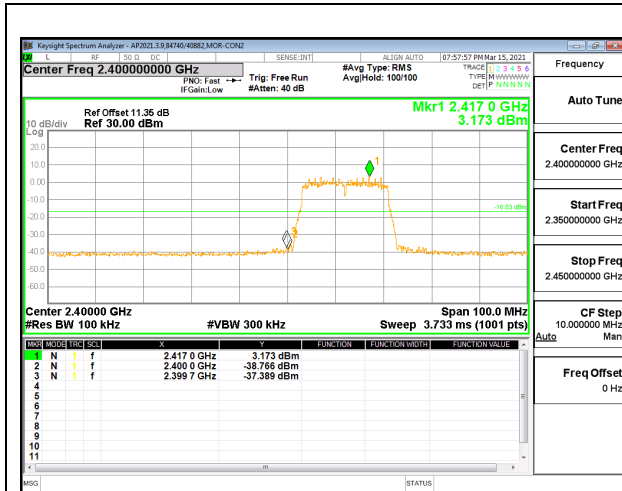
OUT-OF-BAND HIGH CHANNEL 11 CHAIN 1

### 9.7.3. 802.11n HT20 MODE

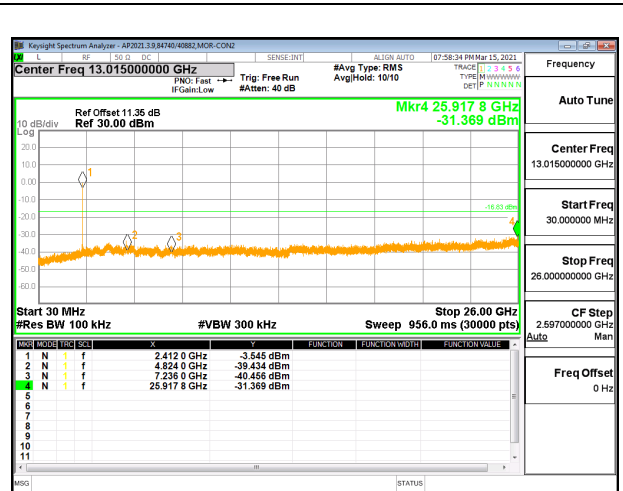
#### 2TX Chain 0 + Chain 1 CDD MODE



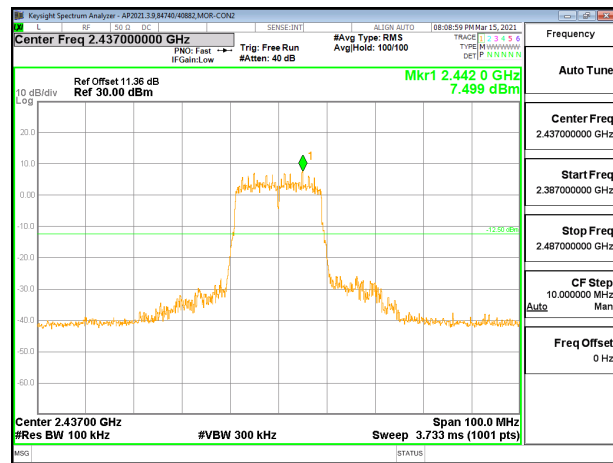




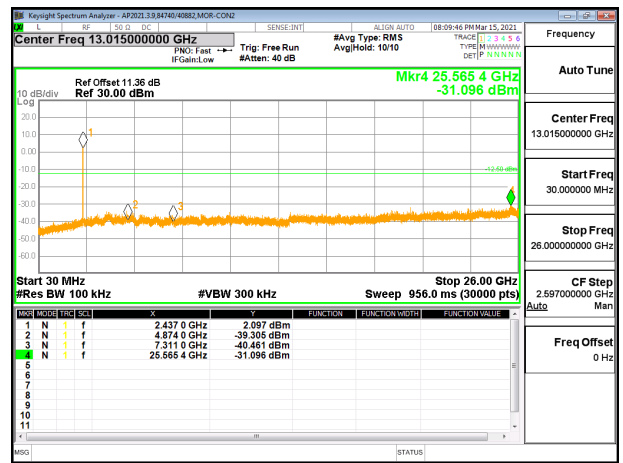
LOW CHANNEL 1 BANDEDGE CHAIN 1



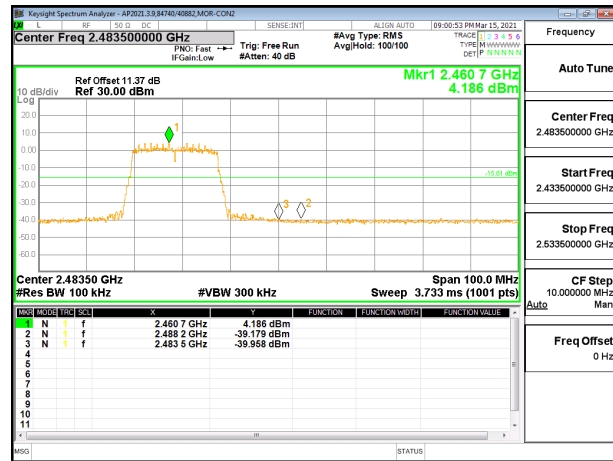
OUT-OF-BAND LOW CHANNEL 1 CHAIN 1



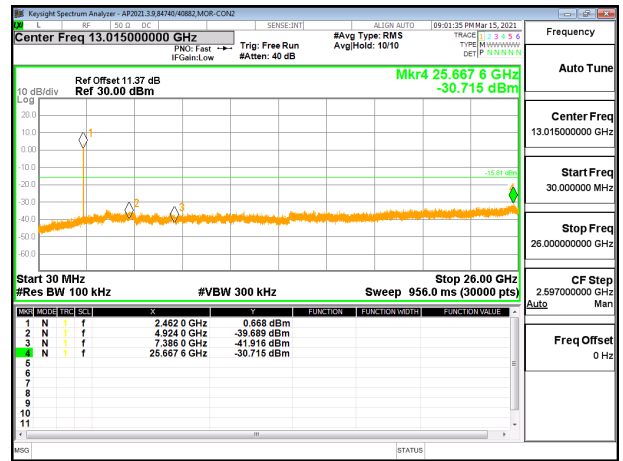
IN-BAND REFERENCE LEVEL CHAIN 1



OUT-OF-BAND MID CHANNEL CHAIN 1



HIGH CHANNEL 11 BANDEDGE CHAIN 1



OUT-OF-BAND HIGH CHANNEL 11 CHAIN 1

## 10. RADIATED TEST RESULTS

### LIMITS

FCC §15.205 and §15.209

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

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 in the 30-1000MHz range, 9kHz for peak and/or quasi-peak detection measurements in the 0.15-30MHz range and 200Hz for peak and/or quasi-peak detection measurements in the 9 to 150kHz range. Peak detection is used unless otherwise noted as quasi-peak or average (9-90kHz and 110-490kHz).

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 as applicable for linear voltage averaging 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.

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.

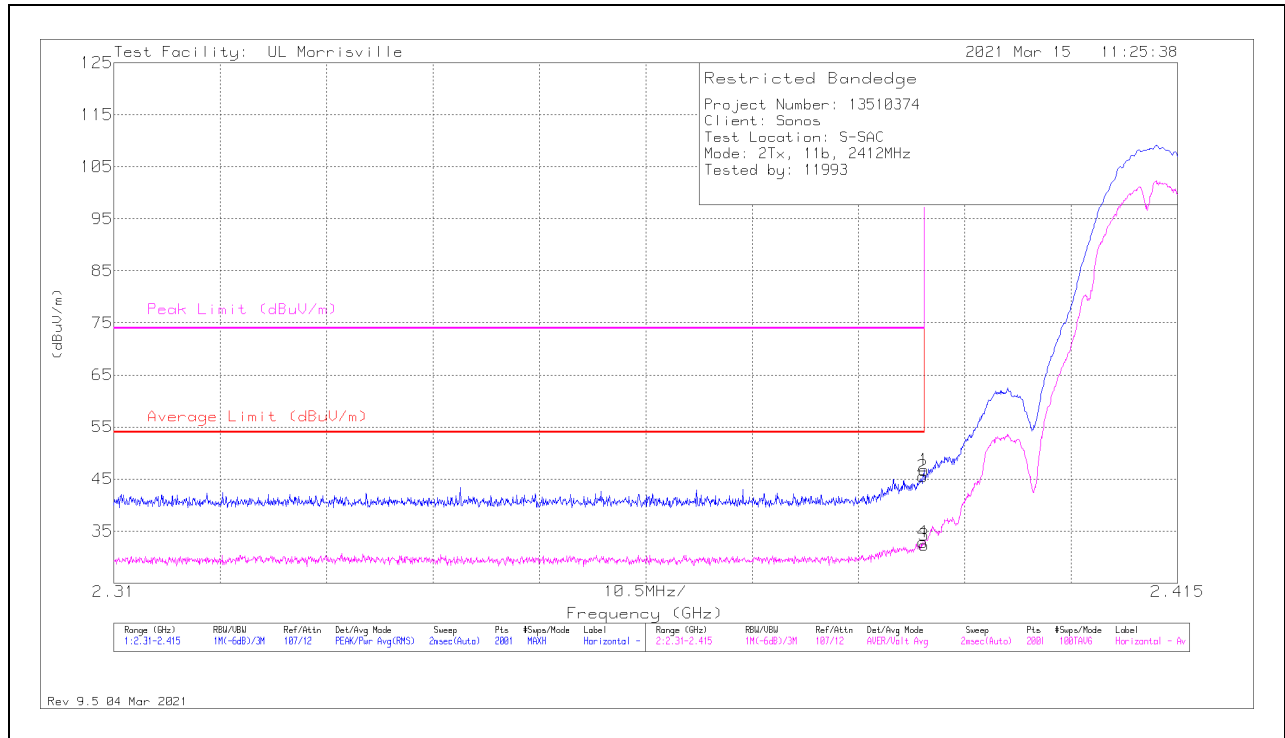
## 10.1. TRANSMITTER ABOVE 1 GHz

### 10.1.1. TX ABOVE 1 GHz 802.11b MODE IN THE 2.4 GHz BAND

#### 2TX Chain 0 + Chain 1 CDD MODE

#### BANDEDGE (LOW CHANNEL, CH 1)

#### HORIZONTAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0067 (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	*** 2.38996	38.64	Pk	32.1	-24	0	46.74	-	-	74	-27.26	238	102	H
2	*** 2.38985	37.42	Pk	32.1	-24	0	45.52	-	-	74	-28.48	238	102	H
3	*** 2.38996	20.21	ADV	32.1	-24	3.98	32.29	54	-21.71	-	-	238	102	H
4	*** 2.38985	20.77	ADV	32.1	-24	3.98	32.85	54	-21.15	-	-	238	102	H

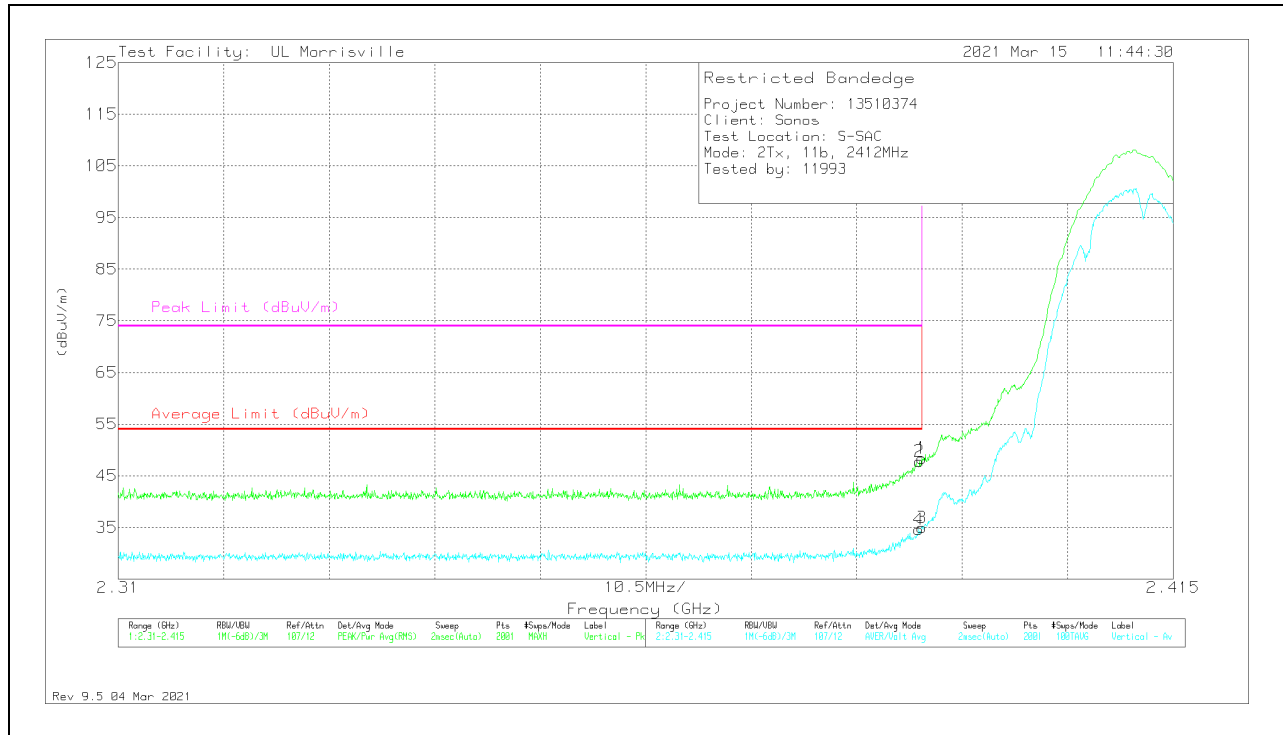
\* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

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

Pk - Peak detector

ADV - Linear Voltage Average

### VERTICAL RESULT

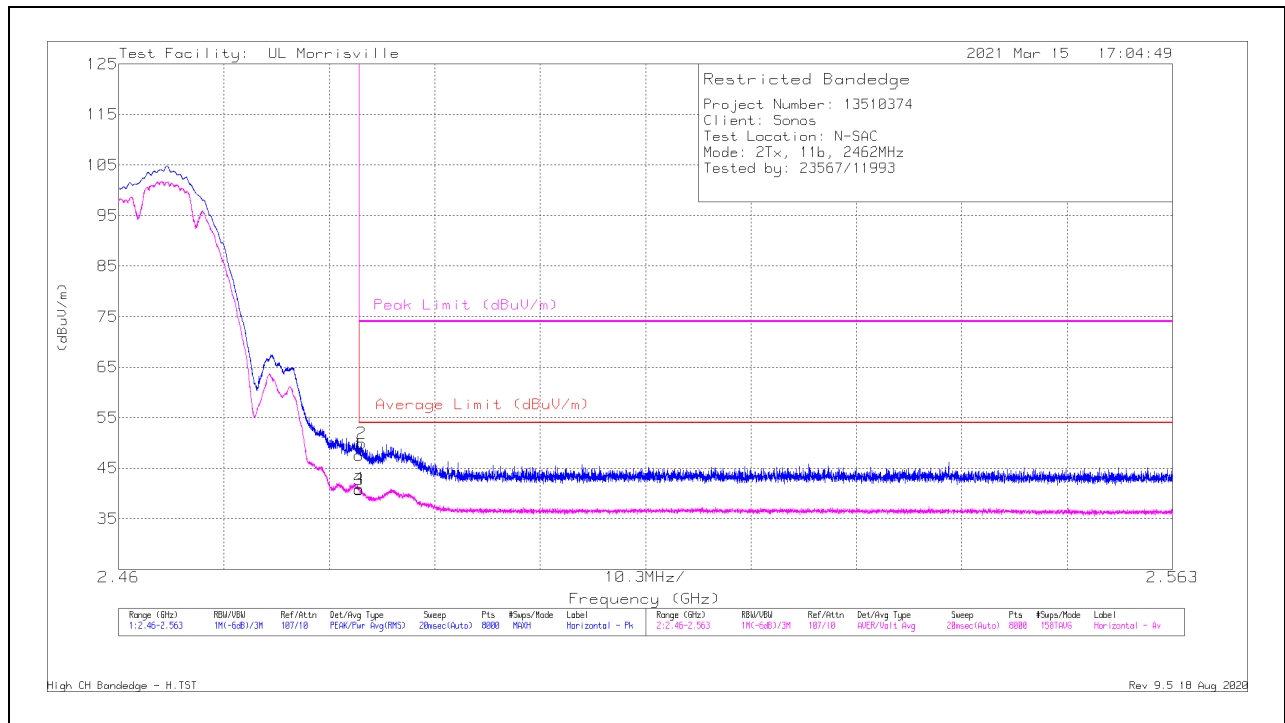


Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0067 (dB/m)	Amp/Cbl/Filtr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	*** 2.38996	40.29	Pk	32.1	-24	0	48.39	-	-	74	-25.61	112	238	V
2	*** 2.38975	39.67	Pk	32.1	-24	0	47.77	-	-	74	-26.23	112	238	V
3	*** 2.38996	22.89	ADV	32.1	-24	3.98	34.97	54	-19.03	-	-	112	238	V
4	*** 2.38964	22.51	ADV	32.1	-24	3.98	34.59	54	-19.41	-	-	112	238	V

\* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band  
 \*\* - indicates frequency in Taiwan NCC LP0002 Restricted Band  
 Pk - Peak detector  
 ADV - Linear Voltage Average

**BANDEDGE (HIGH CHANNEL, CH 11)**

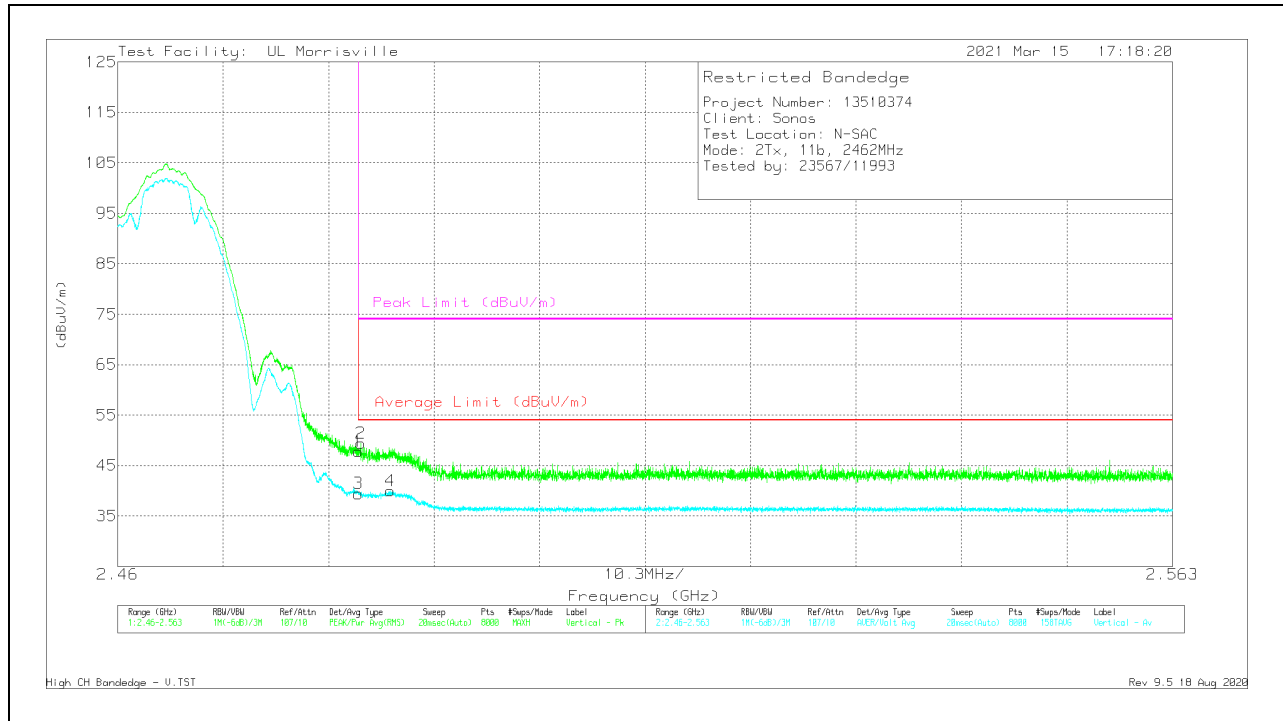
**HORIZONTAL RESULT**



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (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	*** 2.4835	39.5	Pk	32.4	-24.3	0	47.6	-	-	74	-26.4	204	359	H
2	*** 2.48373	41.77	Pk	32.4	-24.3	0	49.87	-	-	74	-24.13	204	359	H
3	** 2.4835	28.7	ADV	32.4	-24.3	3.98	40.78	54	-13.22	-	-	204	359	H
4	** 2.48351	28.84	ADV	32.4	-24.3	3.98	40.92	54	-13.08	-	-	204	359	H

\* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band  
 \*\* - indicates frequency in Taiwan NCC LP0002 Restricted Band  
 Pk - Peak detector  
 ADV - Linear Voltage Average

### VERTICAL RESULT

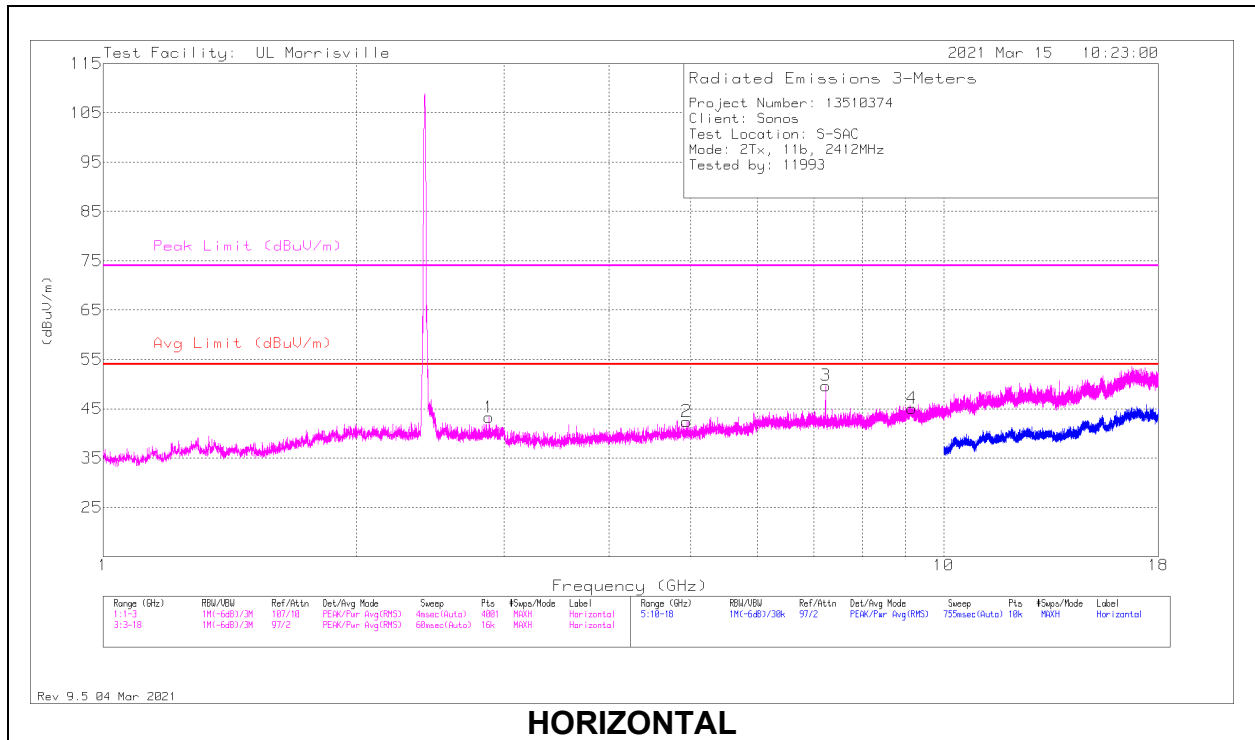


Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (dB/m)	Amp/Cbl/Filtr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	*** 2.4835	39.7	Pk	32.4	-24.3	0	47.8	-	-	74	-26.2	126	232	V
2	*** 2.48375	41.34	Pk	32.4	-24.3	0	49.44	-	-	74	-24.56	126	232	V
3	*** 2.4835	27.35	ADV	32.4	-24.3	3.98	39.43	54	-14.57	-	-	126	232	V
4	*** 2.48659	27.76	ADV	32.5	-24.3	3.98	39.94	54	-14.06	-	-	126	232	V

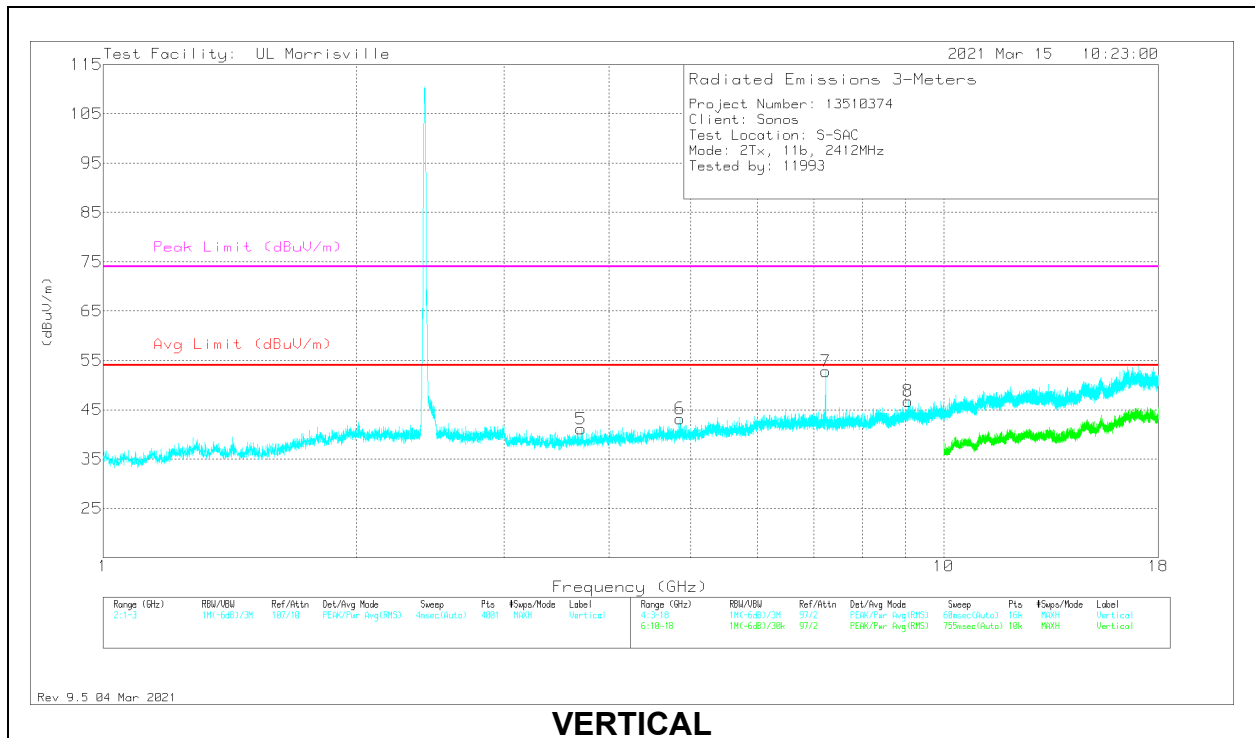
\* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band  
 \*\* - indicates frequency in Taiwan NCC LP0002 Restricted Band  
 Pk - Peak detector  
 ADV - Linear Voltage Average

# HARMONICS AND SPURIOUS EMISSIONS

## LOW CHANNEL, CH 1 RESULTS



**HORIZONTAL**



**VERTICAL**



**RADIATED EMISSIONS**

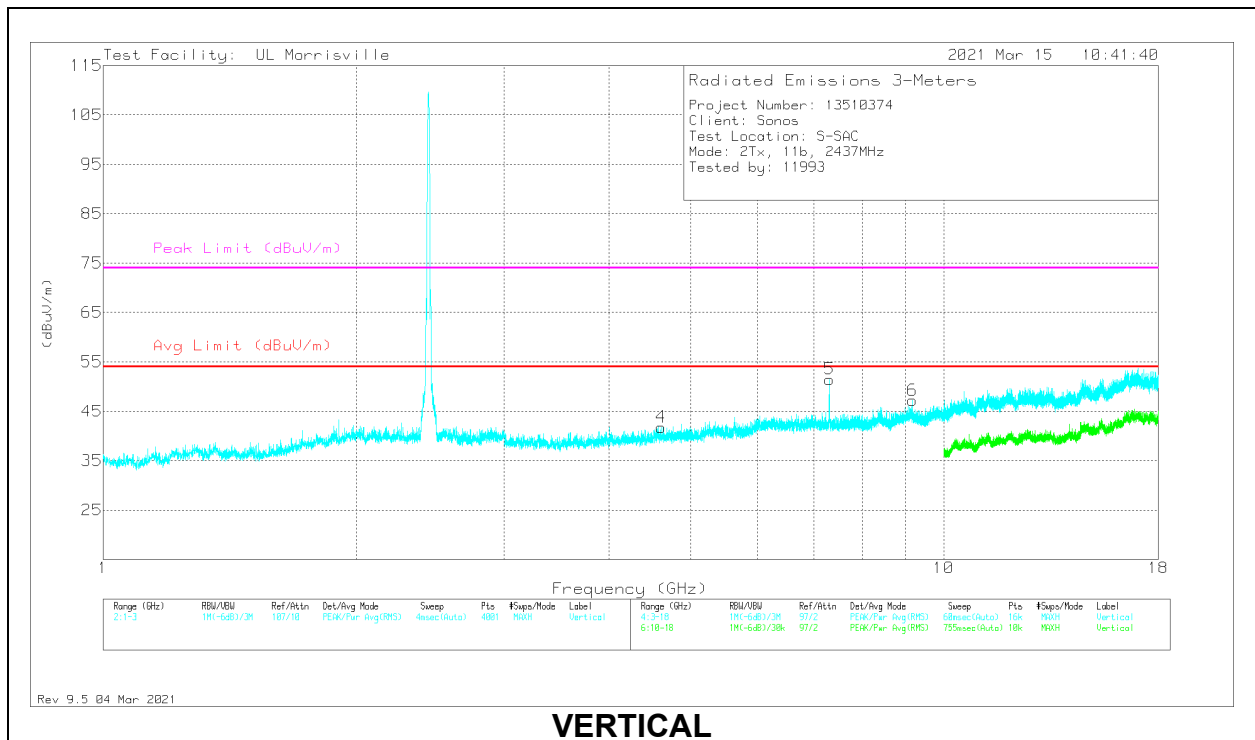
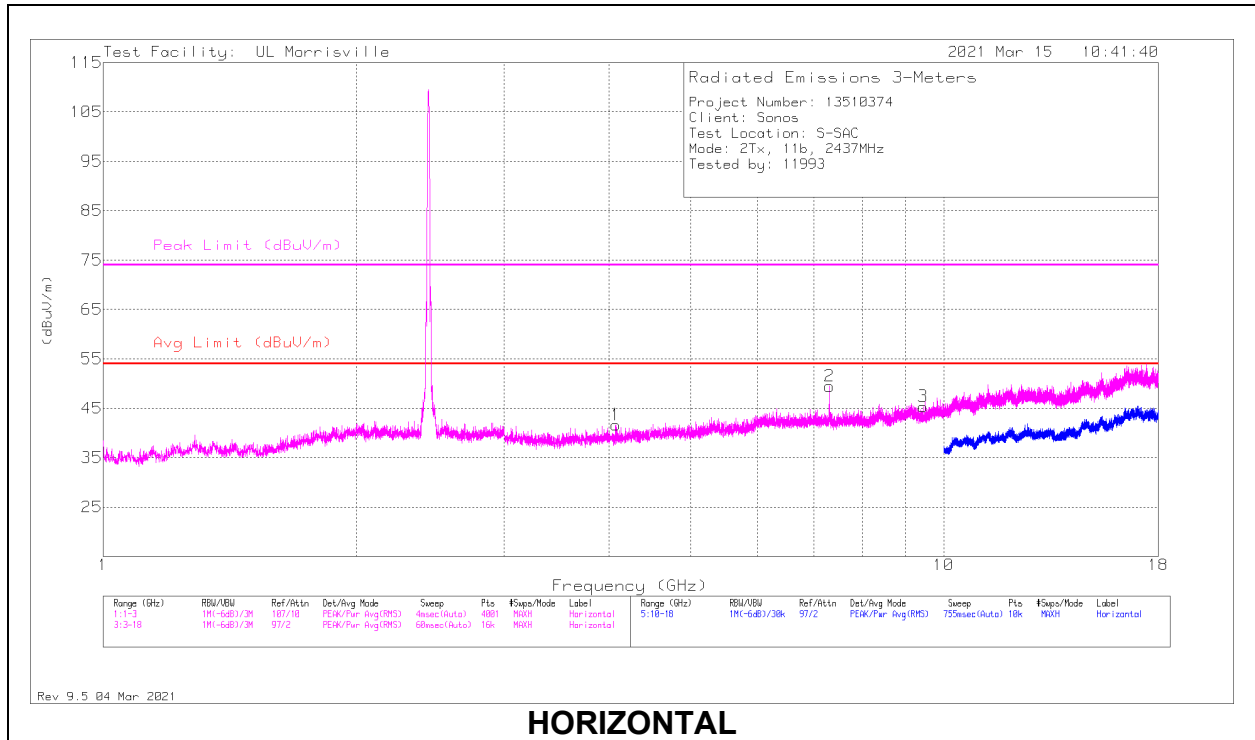
Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0067 (dB/m)	Amp/Cbl/Filtr/Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	*** 2.878	36.47	Pk	32.6	-25.8	43.27	54	-10.73	74	-30.73	0-360	101	H
2	*** 4.94438	39.43	Pk	33.9	-30.9	42.43	54	-11.57	74	-31.57	0-360	101	H
4	*** 9.165	34.96	Pk	36.3	-26.2	45.06	54	-8.94	74	-28.94	0-360	101	H
5	*** 3.70219	40.39	Pk	33.1	-32.4	41.09	54	-12.91	74	-32.91	0-360	200	V
6	*** 4.85344	39.96	Pk	34	-30.8	43.16	54	-10.84	74	-30.84	0-360	200	V
8	*** 9.06844	36.84	Pk	36.2	-26.3	46.74	54	-7.26	74	-27.26	0-360	101	V
3	7.23563	41.9	Pk	35.6	-27.8	49.7	-	-	-	-	0-360	200	H
7	7.23563	44.99	Pk	35.6	-27.8	52.79	-	-	-	-	0-360	200	V

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

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

Pk - Peak detector

### MID CHANNEL, CH 6 RESULTS



**RADIATED EMISSIONS**

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0067 (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	* ** 4.0725	40.83	Pk	33.4	-32.6	0	41.63	54	-12.37	74	-32.37	0-360	200	H
2	* ** 7.31184	44.85	PK2	35.6	-27.4	0	53.05	-	-	74	-20.95	202	185	H
	* ** 7.31174	34.56	ADV	35.6	-27.5	3.98	46.64	54	-7.36	-	-	202	185	H
3	* ** 9.44719	35.44	Pk	36.4	-26.5	0	45.34	54	-8.66	74	-28.66	0-360	101	H
4	* ** 4.61063	39.49	Pk	34.1	-31.8	0	41.79	54	-12.21	74	-32.21	0-360	200	V
5	* ** 7.31152	46.33	PK2	35.6	-27.5	0	54.43	-	-	74	-19.57	253	134	V
	* ** 7.31167	36.65	ADV	35.6	-27.5	3.98	48.73	54	-5.27	-	-	253	134	V
6	* ** 9.18094	37.09	Pk	36.3	-26.2	0	47.19	54	-6.81	74	-26.81	0-360	200	V

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

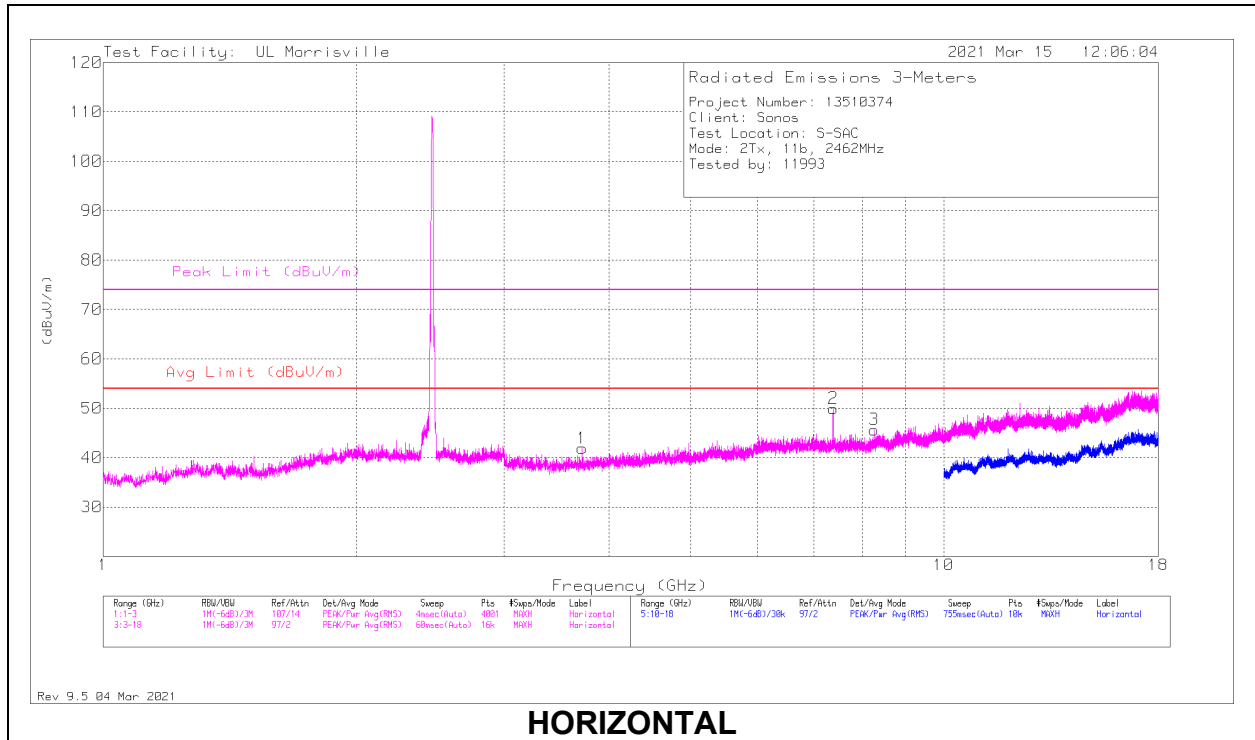
\*\* - indicates frequency in Taiwan NCC LP0002 Restricted Band

PK2 -: Maximum Peak

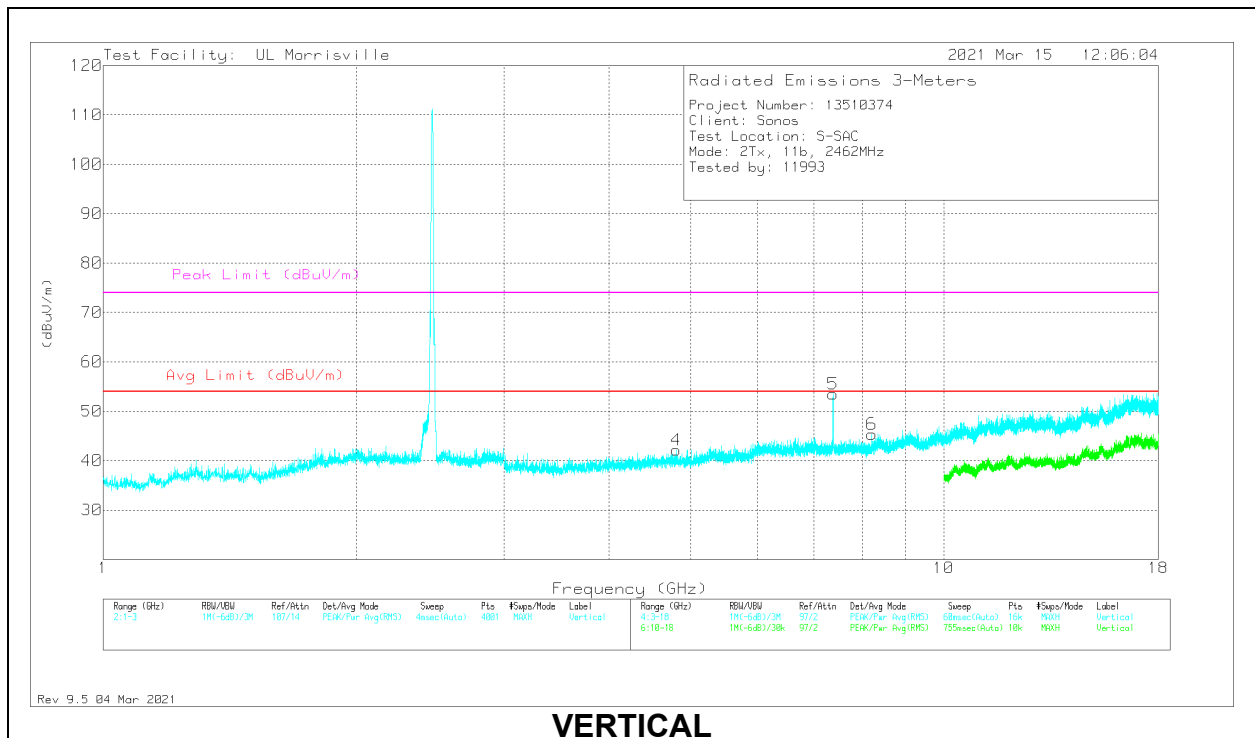
ADV - Linear Voltage Average

Pk - Peak detector

### HIGH CHANNEL, CH 11 RESULTS



**HORIZONTAL**



**VERTICAL**

**RADIATED EMISSIONS**

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0067 (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	*** 3.71438	41.28	Pk	33.2	-32.6	0	41.88	54	-12.12	74	-32.12	0-360	101	H
2	*** 7.38506	44.55	PK2	35.6	-27.5	0	52.65	-	-	74	-21.35	53	181	H
	*** 7.38503	35.55	ADV	35.6	-27.5	3.98	47.63	54	-6.37	-	-	53	181	H
3	*** 8.26594	37.35	Pk	35.8	-27.5	0	45.65	54	-8.35	74	-28.35	0-360	200	H
4	*** 4.80656	39.03	Pk	34	-30.9	0	42.13	54	-11.87	74	-31.87	0-360	200	V
5	*** 7.38544	46.86	PK2	35.6	-27.5	0	54.96	-	-	74	-19.04	254	197	V
	*** 7.38505	38.21	ADV	35.6	-27.5	3.98	50.29	54	-3.71	-	-	254	197	V
6	*** 8.21438	36.86	Pk	35.8	-27.3	0	45.36	54	-8.64	74	-28.64	0-360	200	V

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

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

Pk - Peak detector

PK2 - Maximum Peak

ADV - Linear Voltage Average