



TEST REPORT

Report Number: R13510374-E1

Applicant : Sonos
614 Chapala Street
Santa Barbara, CA 93101
USA

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:

April 14, 2021

Prepared by:

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REPORT REVISION HISTORY

Rev.	Issue Date	Revisions	Revised By
V1	2021-03-30	Initial Issue	Cristian Melara
V2	2021-04-05	Updated EUT description to Wireless Smart Speaker	Cristian Melara
V3	2021-04-14	Added Conducted Data. Added Max output power table. Minor revisions	Noah Bennett
V4	2021-04-20	Revised antenna type. Removed "Host" from AC Power line header.	Noah Bennett

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: Sonos 614 Chapala Street
Santa Barbara, CA 93101
USA

EUT DESCRIPTION: Wireless Smart Speaker

MODEL: S38

SERIAL NUMBER: 00:0E:58:71:72:5D
00:0E:58:21:EF:54

SAMPLE RECEIPT DATE: 2021-03-15

DATE TESTED: 2021-03-15 to 2021-04-13

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 + Amendment 1: 2019	Complies

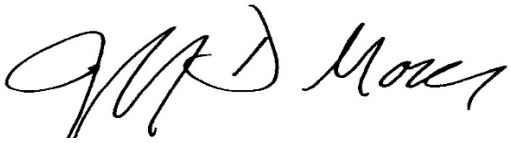
UL LLC tested the above equipment in accordance with the requirements set forth in the above standards. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

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 Kiewra/Jeff Moser
Project Engineer/Operations Manager
Consumer Technology Division
UL LLC.



Cristian Melara
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	Complies	ANSI C63.10 Section 6.9.3.
15.247 (a) (2)	RSS-247 5.2 (a)	6dB BW		None.
15.247 (b) (3)	RSS-247 5.4 (d)	Output Power		None.
See Comment		Average power	-	Per ANSI C63.10, Section 11.9.2.3.2.
15.247 (e)	RSS-247 5.2 (b)	PSD	Complies	None.
15.247 (d)	RSS-247 5.5	Conducted Spurious Emissions		None.
15.209, 15.205	RSS-GEN 8.9, 8.10	Radiated Emissions		None.
15.207	RSS-Gen 8.8	AC Mains Conducted Emissions		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: 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, USA and 2800 Perimeter Park Dr., Suite B, Morrisville, North Carolina, 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.

	Address	ISED CABID	ISED Company Number	FCC Registration
☐	Building: 12 Laboratory Dr RTP, NC 27709, U.S.A	US0067	2180C	703469
☒	Building: 2800 Perimeter Park Dr., Suite B Morrisville, NC, 27560 U.S.A			

UL LLC (RTP), CABID US00067, 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	1.22%
RF output power, conducted	1.3 dB (PK) 0.45 dB (AV)
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:

Field Strength (dBuV/m) = Measured Voltage (dBuV) + Antenna Factor (dB/m) + Cable

Loss (dB) – Preamp Gain (dB)

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

MAINS CONDUCTED EMISSIONS

Where relevant, the following sample calculation is provided:

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

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

6. EQUIPMENT UNDER TEST

6.1. EUT DESCRIPTION

The EUT is a wireless speaker with a BLE radio and 2.4GHz/5GHz WLAN radio. This report covers the BLE radio only.

6.2. MAXIMUM OUTPUT POWER

Channel	Frequency (MHz)	Peak Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	-0.36	30	-30.36
Mid	2440	-0.40	30	-30.40
High	2480	-0.55	30	-30.55

6.3. DESCRIPTION OF AVAILABLE ANTENNAS

The antenna(s) gain and type, as provided by the manufacturer, are as follows:
The radio utilizes an etched IFA antenna, with a maximum gain of 1.4dBi.

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 at the channel with highest output power and PSD 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, high channel.

The EUT is intended to operate in only one orientation, therefore all tests were performed in its intended orientation.

6.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	Manufacturer/Brand	Model	Serial Number	FCC ID
Laptop	Lenovo	T440P	PB0294NN	NA

I/O CABLES

I/O Cable List						
Cable No	Port	# of identical ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1	1	1	AC Mains	I/O	<3m	Powers EUT
2	1	1	Ethernet	I/O	<3m	Communications Port

SETUP DIAGRAMS

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

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.

8. TEST AND MEASUREMENT EQUIPMENT

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

Test Equipment Used – AC Mains Conducted Emissions Measurement Equipment

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
Conducted Room 1					
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
PS214	AC Power Source	Elgar	CW2501M (s/n 1523A02396)	NA	NA
ATA222	Transient Limiter, 0.009-100MHz	Electro-Metrics	EM-7600	2020-03-26	2021-03-26
SOFTEMI	EMI Software	UL	Version 9.5 2015-08-20	NA	NA

Test Equipment Used – Conducted Emissions Measurement Equipment (Morrisville – Conducted 2)

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
SA0027	Spectrum Analyzer	Keysight	N9030A	2020-06-10	2021-06-10
PWM004 (PRE0137346)	RF Power Meter	Keysight Technologies	N1911A	2020-07-31	2021-07-31
PWS002	Peak and Avg Power Sensor, 50MHz to 18GHz	Keysight Technologies	N1921A	2020-09-10	2021-09-10
HI0090	Environmental Meter	Fisher Scientific	15-077-963	2020-06-26	2021-06-26
EMISoftware	Antenna Port Software	UL LLC	AP Version 2021.03.09, 2021.4.9	NA	NA

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

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
	0.009-30MHz	(Loop Ant.)			
AT0079	Active Loop Antenna	ETS-Lindgren	6502	2020-08-20	2021-08-20
	30-1000 MHz				
AT0074	Hybrid Broadband Antenna	Sunol Sciences Corp.	JB3	2020-07-27	2021-07-27
	1-18 GHz				
AT0072	Double-Ridged Waveguide Horn Antenna, 1 to 18 GHz	ETS Lindgren	3117	2020-04-27	2021-04-27
	18-40 GHz				
AT0063	Horn Antenna, 18-26.5GHz	ARA	MWH-1826/B	2020-10-30	2021-10-30
	Gain-Loss Chains				
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
N-SAC04	Gain-loss string: 18-40GHz	Various	Various	2020-08-07	2021-08-07
	Receiver & Software				
SA0026	Spectrum Analyzer	Agilent	N9030A	2020-07-16	2021-07-16
SOFTEMI	EMI Software	UL	Version 9.5 2020-08-19	NA	NA
	Additional Equipment Used				
HI0094	Environmental Meter	Fisher Scientific	06-662-4 11725843	2020-01-21	2022-01-21

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

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
	1-18 GHz				
AT0067	Double-Ridged Waveguide Horn Antenna, 1 to 18 GHz	ETS Lindgren	3117	2020-04-28	2021-04-28
	18-40 GHz				
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
	Gain-Loss Chains				
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
	Receiver & Software				
197954	Spectrum Analyzer	Rohde & Schwarz	ESW44	2020-03-27	2021-03-27
197955	Spectrum Analyzer	Rohde & Schwarz	ESW44	2020-03-11	2021-03-11
SA0025	Spectrum Analyzer	Agilent	N9030A	2020-03-17	2021-03-17
SOFTEMI	EMI Software	UL	Version 9.5 2020-08-19	NA	NA
	Additional Equipment used				
s/n 181474409	Environmental Meter	Fisher Scientific	15-077-963	2020-08-06	2021-08-06

9. ANTENNA PORT TEST RESULTS

9.1. ON TIME AND DUTY CYCLE

LIMITS

None; for reporting purposes only.

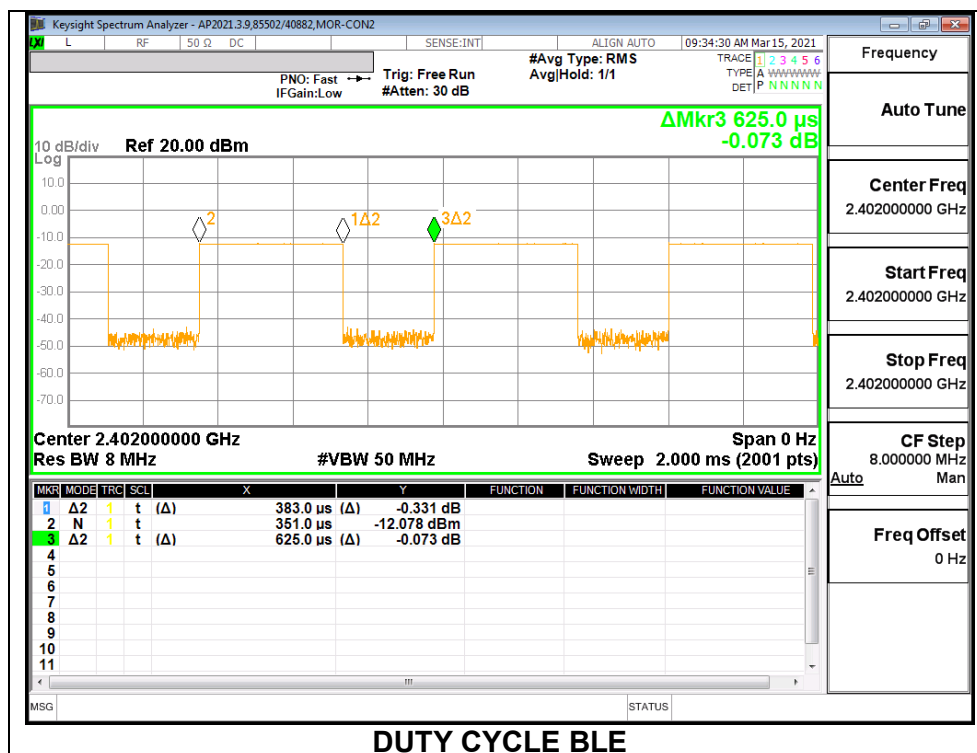
PROCEDURE

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)
2.4GHz Band						
BLE	0.383	0.625	0.613	61.28%	4.25	2.611

DUTY CYCLE PLOTS



9.2 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

RESULTS

9.1.1. BLE (1Mbps)

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	1.0497
Middle	2440	1.0477
High	2480	1.0492



9.3 6 dB BANDWIDTH

LIMITS

FCC §15.247 (a) (2)

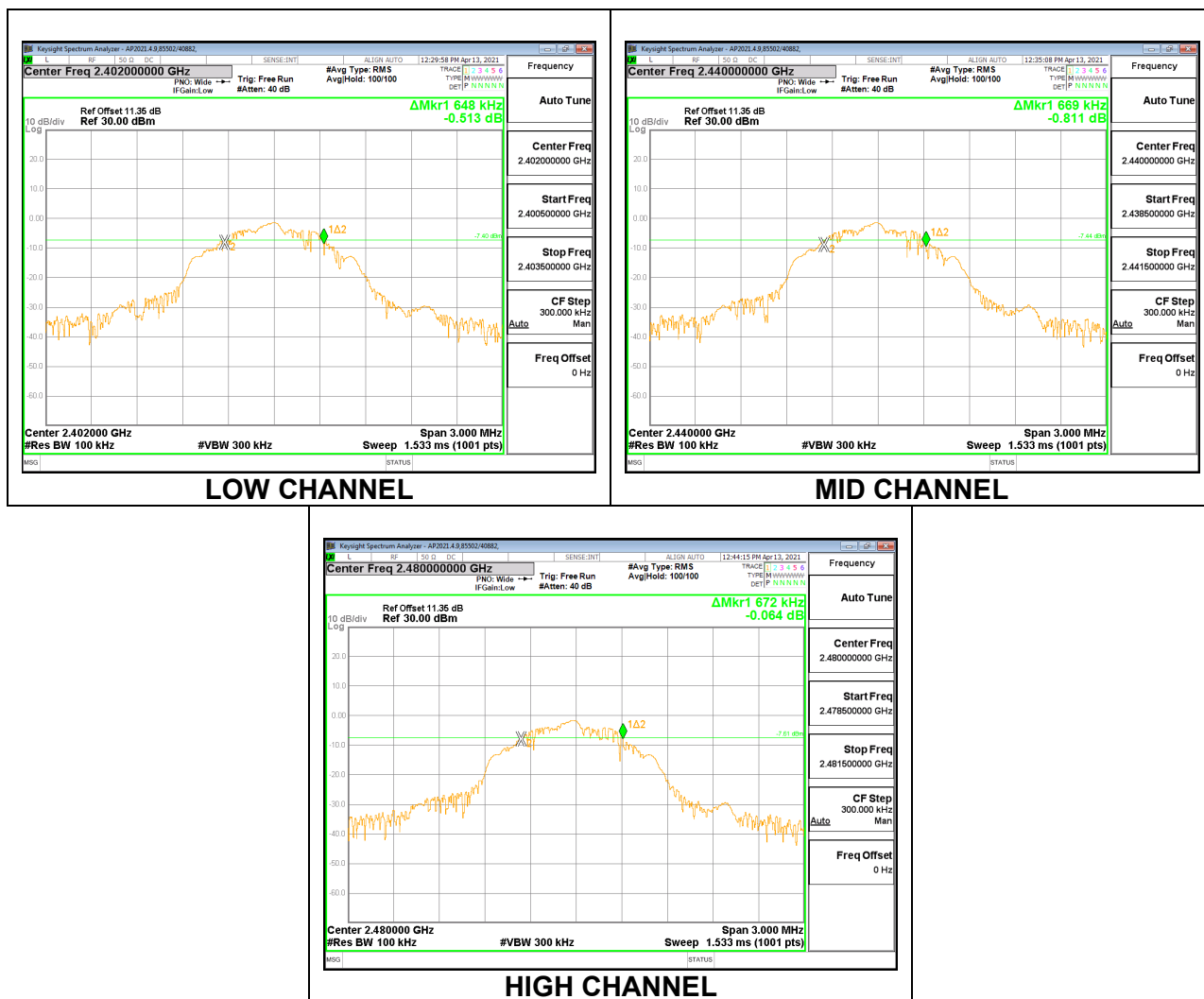
RSS-247 5.2 (a)

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

RESULTS

9.3.1 BLE (1Mbps)

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	0.6480	0.5
Middle	2440	0.6690	0.5
High	2480	0.6720	0.5



9.4 OUTPUT POWER

LIMITS

FCC §15.247 (b) (3)

RSS-247 5.4 (d)

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

TEST PROCEDURE

The transmitter output is connected to a power meter.

The cable assembly insertion loss of 11.95 dB was entered as an offset in the power meter to allow for a peak reading of power.

RESULTS

9.4.1 BLE (1Mbps)

Tested By:	85502/40882
Date:	2021-03-15

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	-0.380	30	-30.380
Middle	2440	-0.450	30	-30.450
High	2480	-0.780	30	-30.780

9.5 AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

The cable assembly insertion loss of 11.95 dB was entered as an offset in the power meter to allow for an average gated reading of power.

RESULTS

9.5.1 BLE (1Mbps)

Tested By:	85502/40882
Date:	2021-03-15

Channel	Frequency (MHz)	Average Power Reading (dBm)
Low	2402	-1.520
Middle	2440	-1.500
High	2480	-1.490

9.6 POWER SPECTRAL DENSITY

LIMITS

FCC §15.247 (e)

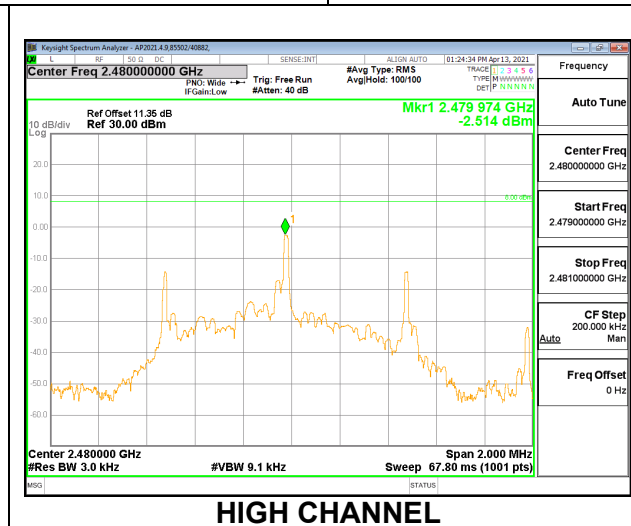
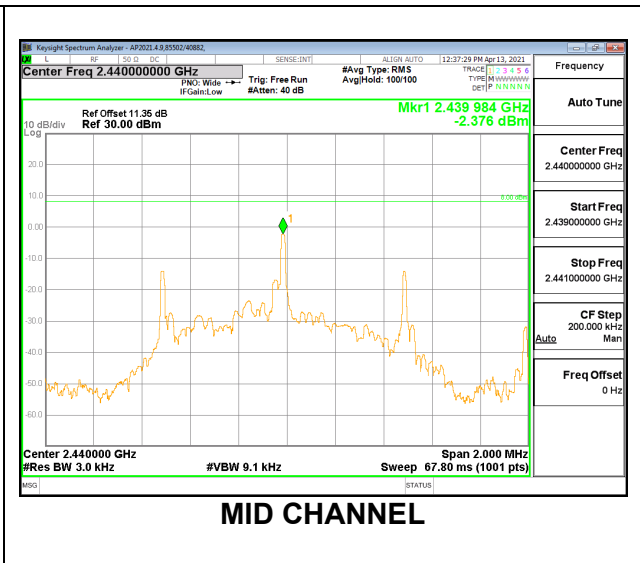
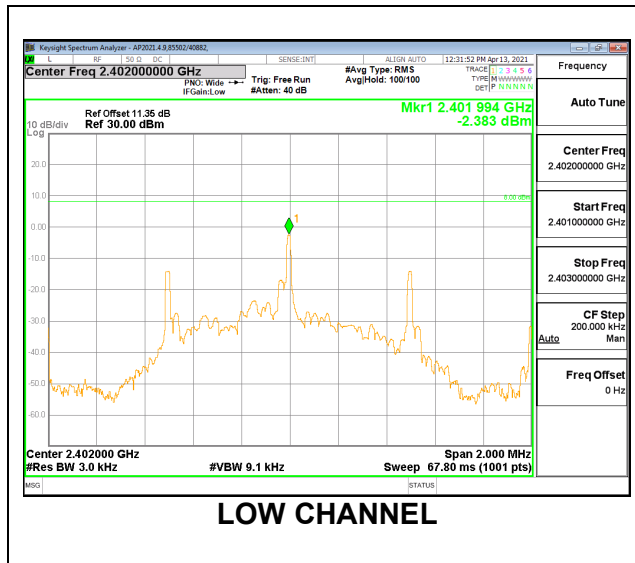
RSS-247 (5.2) (b)

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 BLE (1Mbps)

Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2402	-2.38	8	-10.38
Middle	2440	-2.38	8	-10.38
High	2480	-2.51	8	-10.51



9.7 CONDUCTED SPURIOUS EMISSIONS

LIMITS

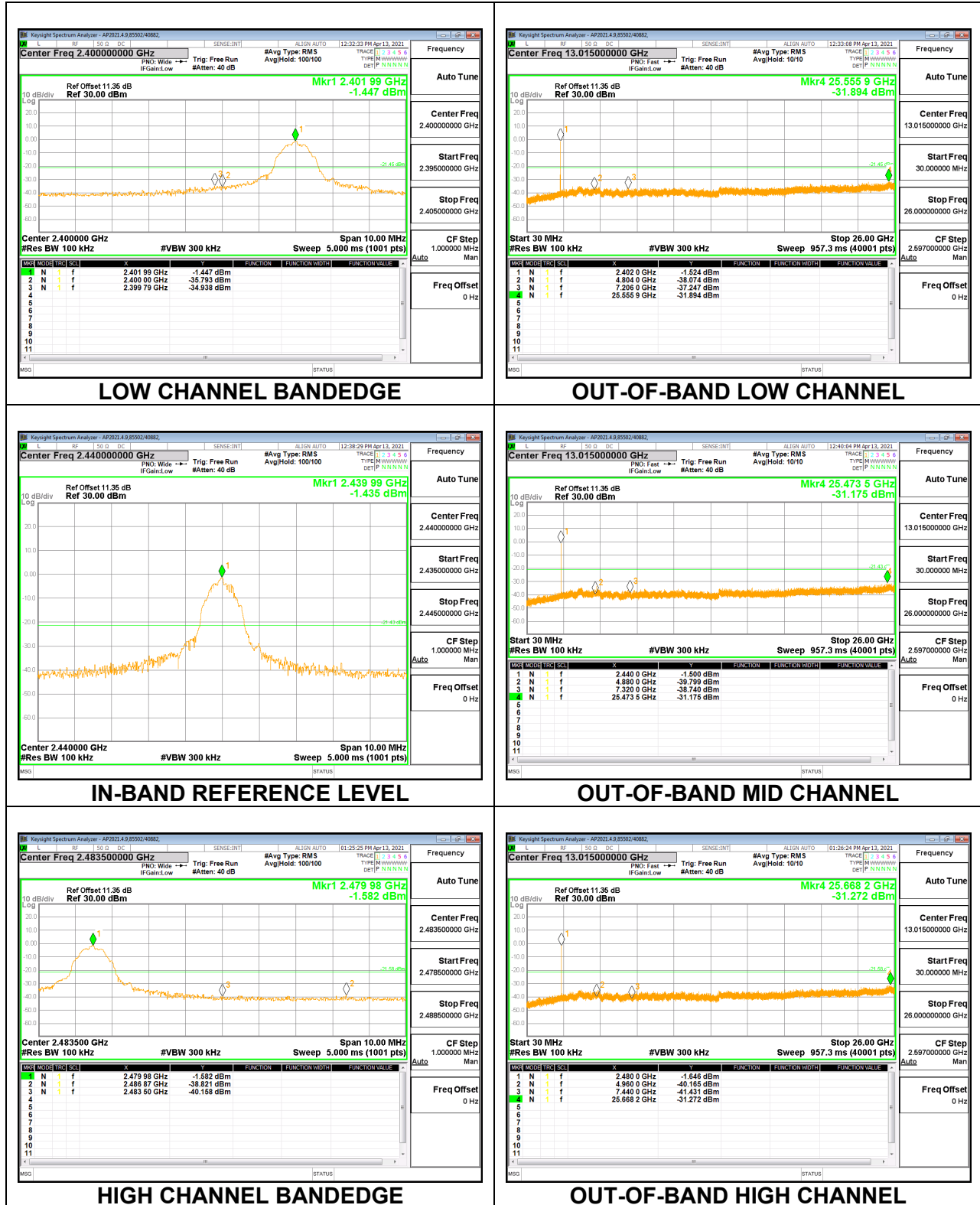
FCC §15.247 (d)

RSS-247 5.5

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

RESULTS

9.7.1 BLE (1Mbps)



10 RADIATED TEST RESULTS

10.2 LIMITS AND PROCEDURE

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	-

Frequency Range (MHz)	Field Strength Limit (uV/m) at 3 m	Field Strength Limit (dBuV/m) at 3 m
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.

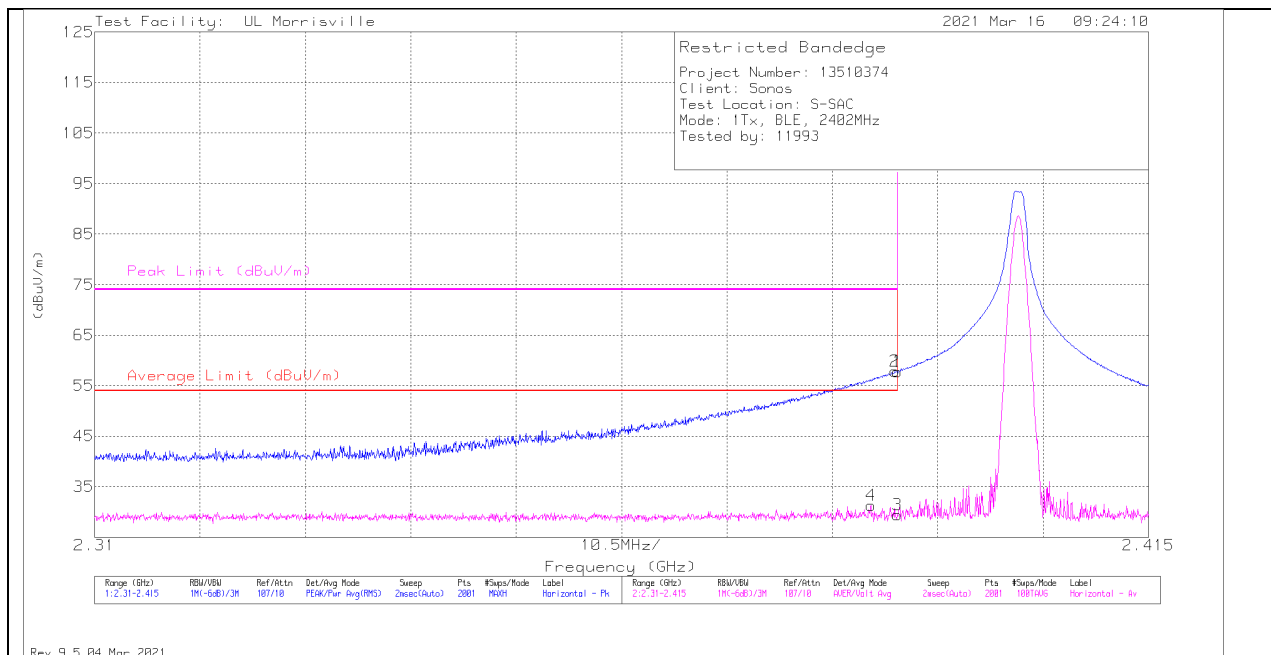
10.3 TRANSMITTER ABOVE 1 GHz

10.3.1 BLE (1Mbps)

Antenna 1

BANDEDGE (LOW CHANNEL)

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	49.7	Pk	32.1	-24	0	57.8	-	-	74	-16.2	97	296	H
2	* ** 2.38975	49.75	Pk	32.1	-24	0	57.85	-	-	74	-16.15	97	296	H
3	* ** 2.38996	17.13	ADV	32.1	-24	4.25	29.48	54	-24.52	-	-	97	296	H
4	* ** 2.38733	18.82	ADV	32.2	-24	4.25	31.27	54	-22.73	-	-	97	296	H

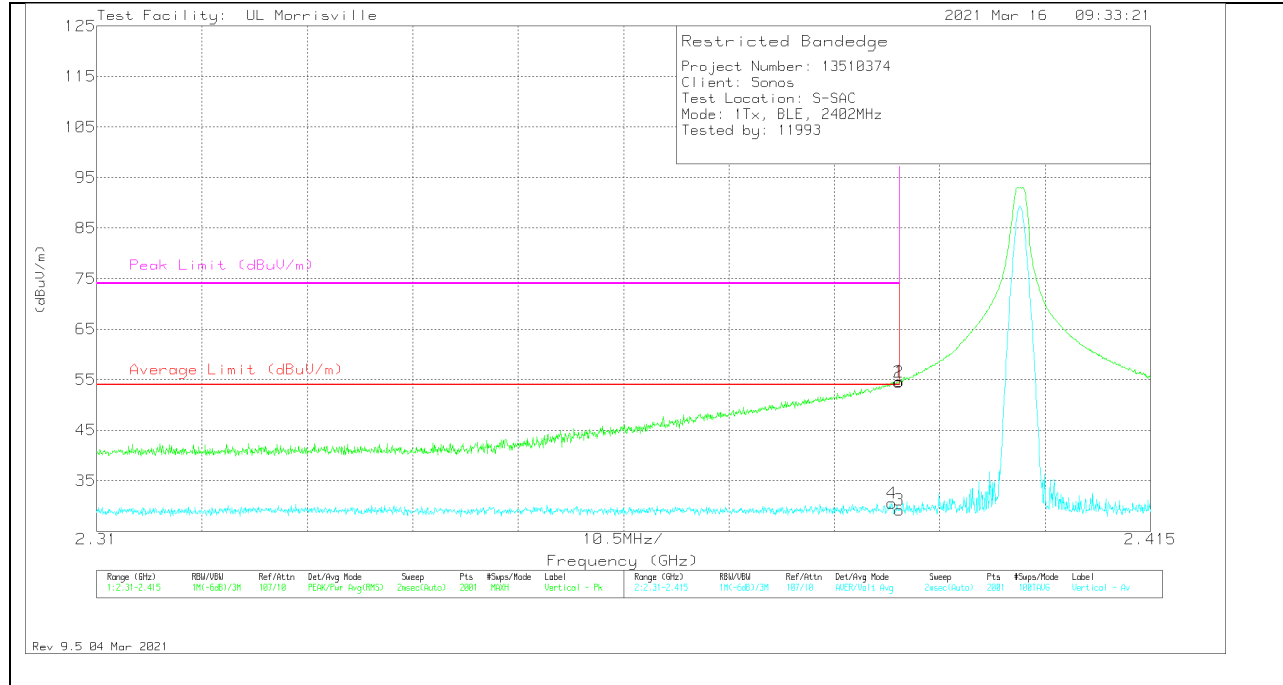
* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

** - 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	46.49	Pk	32.1	-24	0	54.59	-	-	74	-19.41	288	375	V
2	* ** 2.38991	46.4	Pk	32.1	-24	0	54.5	-	-	74	-19.5	288	375	V
3	* ** 2.38996	16.8	ADV	32.1	-24	4.25	29.15	54	-24.85	-	-	288	375	V
4	* ** 2.38922	18.23	ADV	32.1	-24	4.25	30.58	54	-23.42	-	-	288	375	V

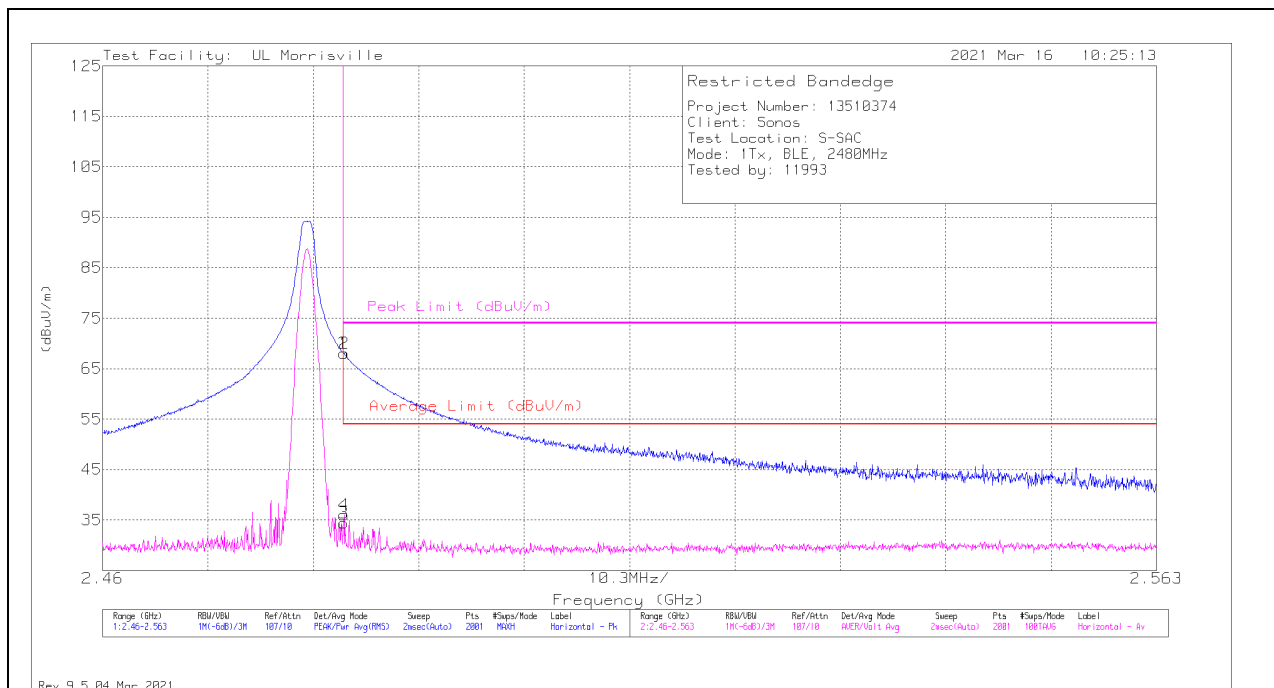
* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

** - indicates frequency in Taiwan NCC LP0002 Restricted Band

Pk - Peak detector

BANDEDGE (HIGH CHANNEL)

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	* ** 2.48354	60.04	Pk	32.4	-24.4	0	68.04	-	-	74	-5.96	95	389	H
2	* ** 2.48359	60.04	Pk	32.4	-24.4	0	68.04	-	-	74	-5.96	95	389	H
3	* ** 2.48354	22.2	ADV	32.4	-24.4	4.25	34.45	54	-19.55	-	-	95	388	H
4	* ** 2.48359	23.73	ADV	32.4	-24.4	4.25	35.98	54	-18.02	-	-	95	388	H

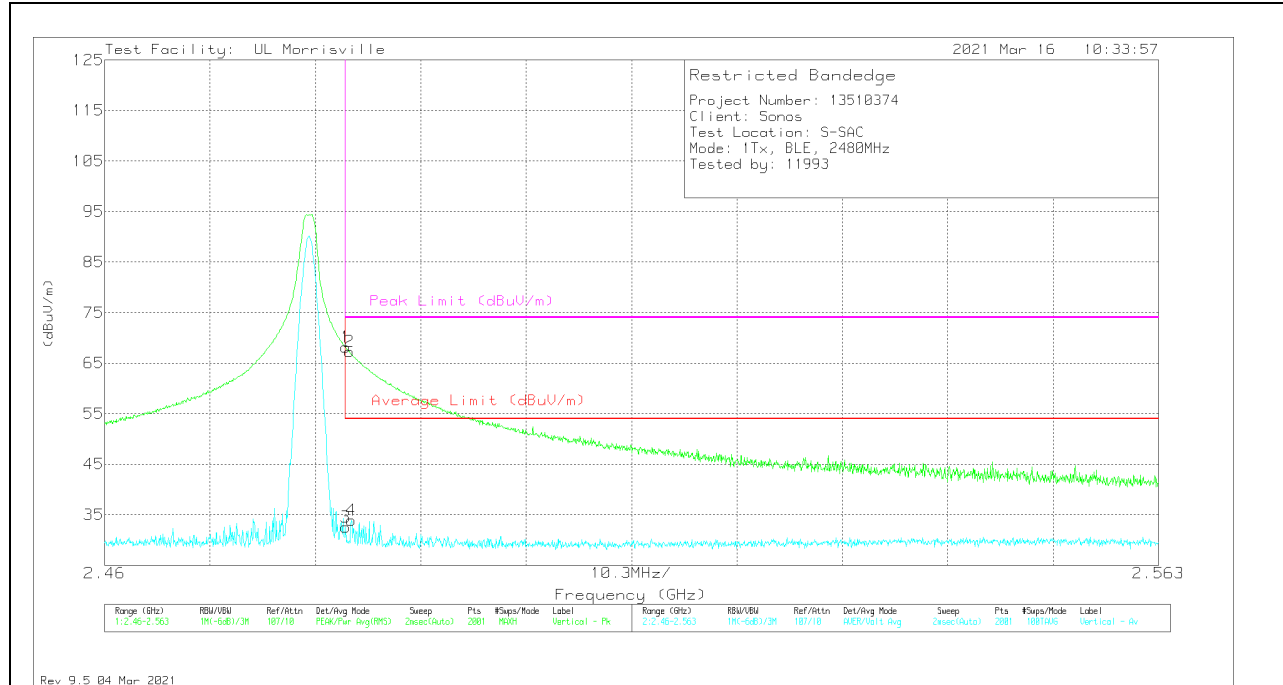
* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

** - 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	* ** 2.48354	60.15	Pk	32.4	-24.4	0	68.15	-	-	74	-5.85	281	376	V
2	* ** 2.48395	59.28	Pk	32.4	-24.4	0	67.28	-	-	74	-6.72	281	376	V
3	* ** 2.48354	20.3	ADV	32.4	-24.4	4.25	32.55	54	-21.45	-	-	281	376	V
4	* ** 2.4841	21.64	ADV	32.4	-24.4	4.25	33.89	54	-20.11	-	-	281	376	V

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

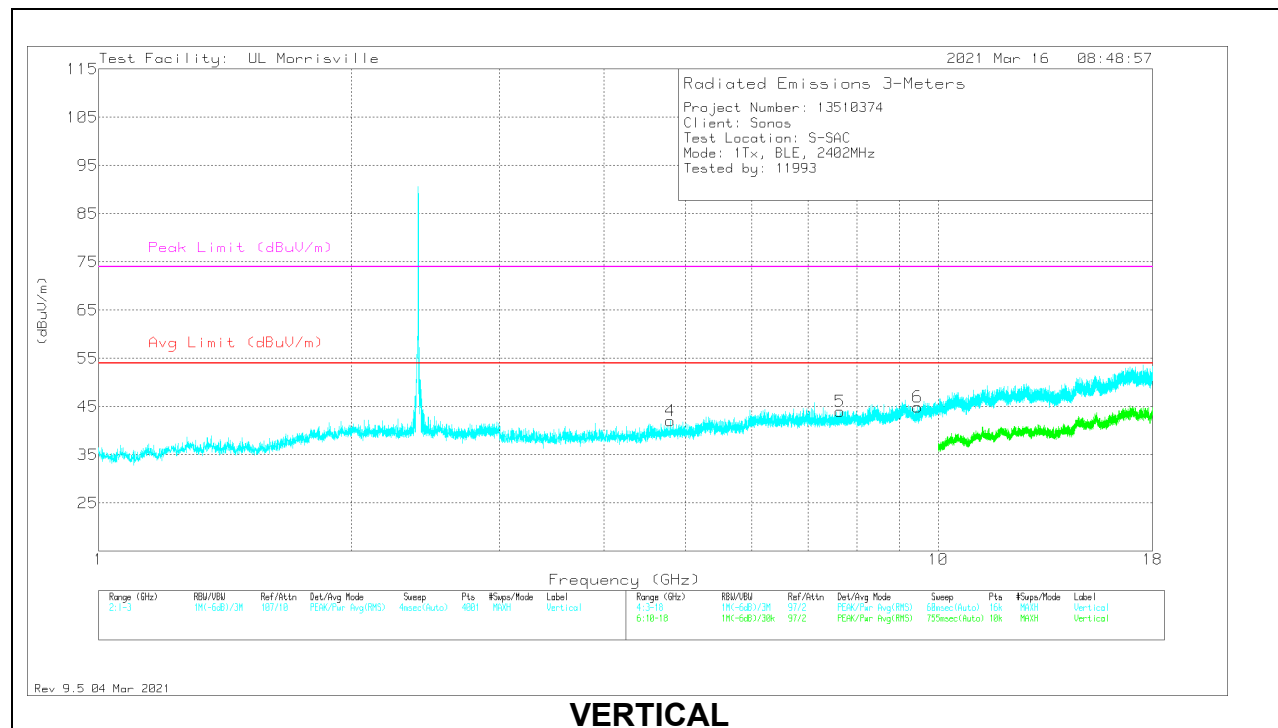
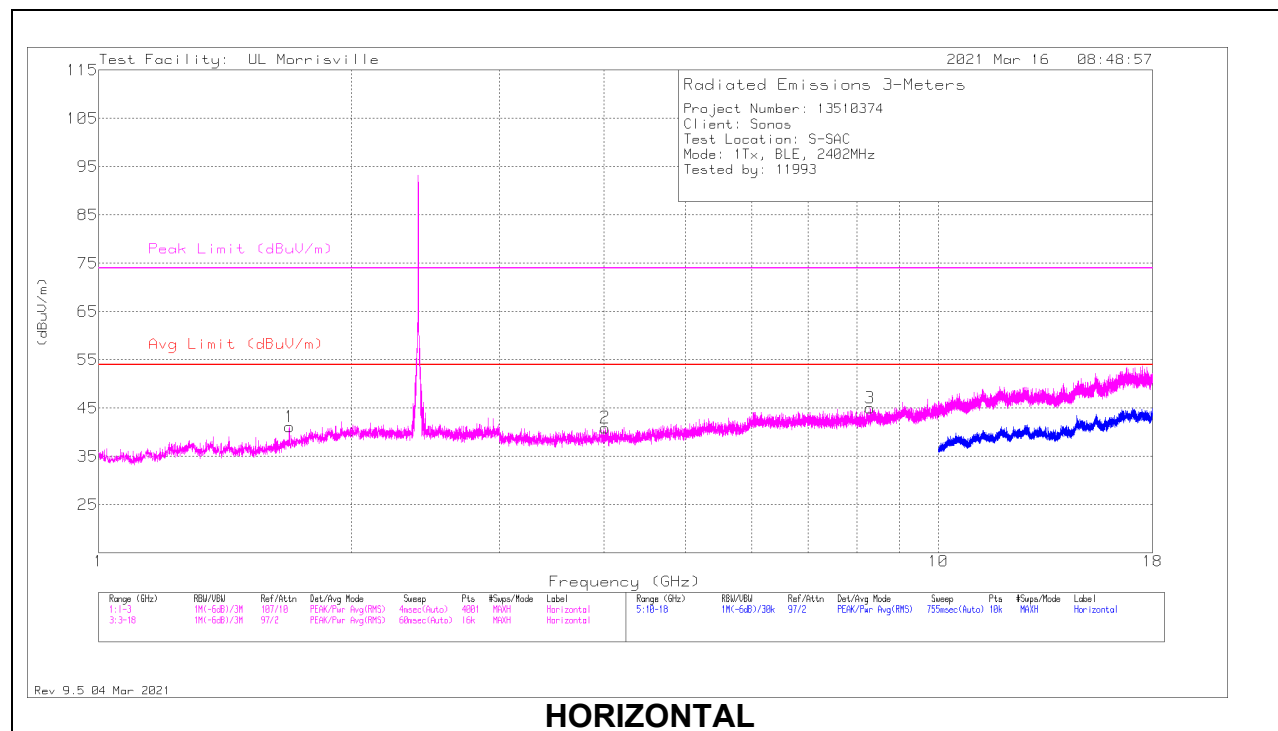
** - indicates frequency in Taiwan NCC LP0002 Restricted Band

Pk - Peak detector

ADV - Linear Voltage Average

HARMONICS AND SPURIOUS EMISSIONS

LOW CHANNEL RESULTS



RADIATED EMISSIONS

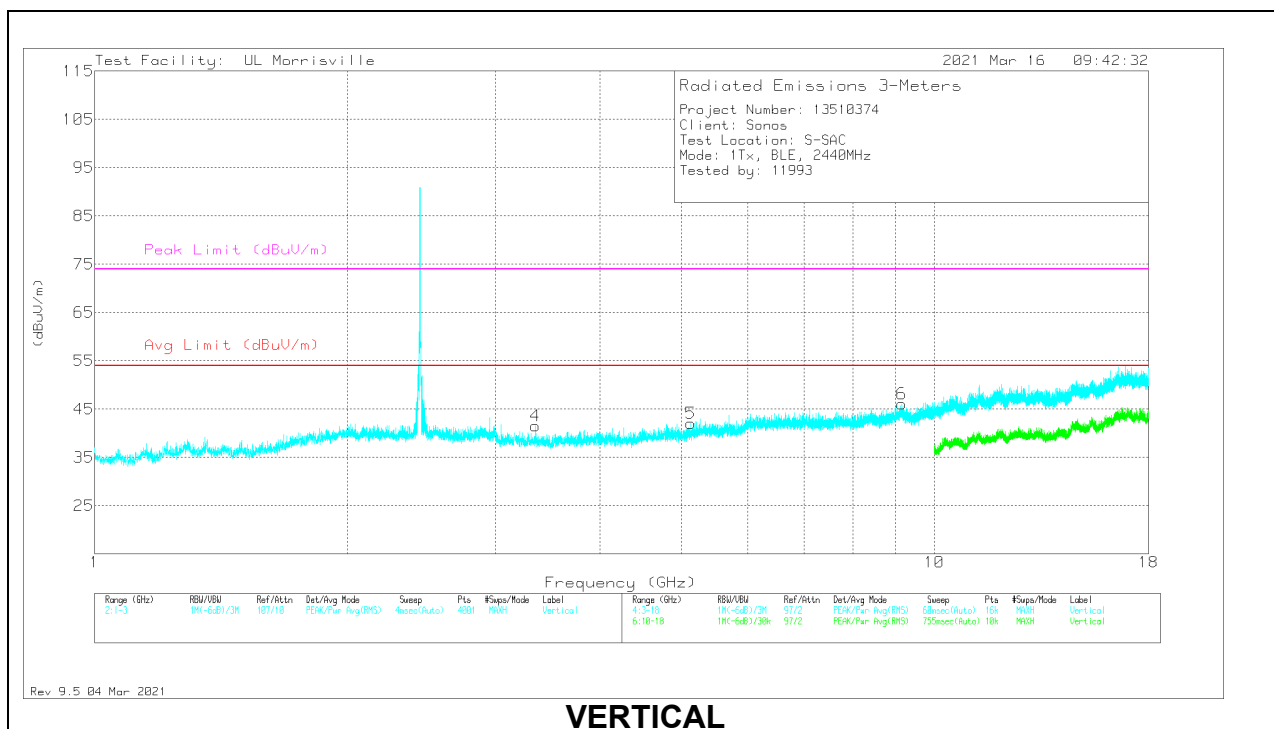
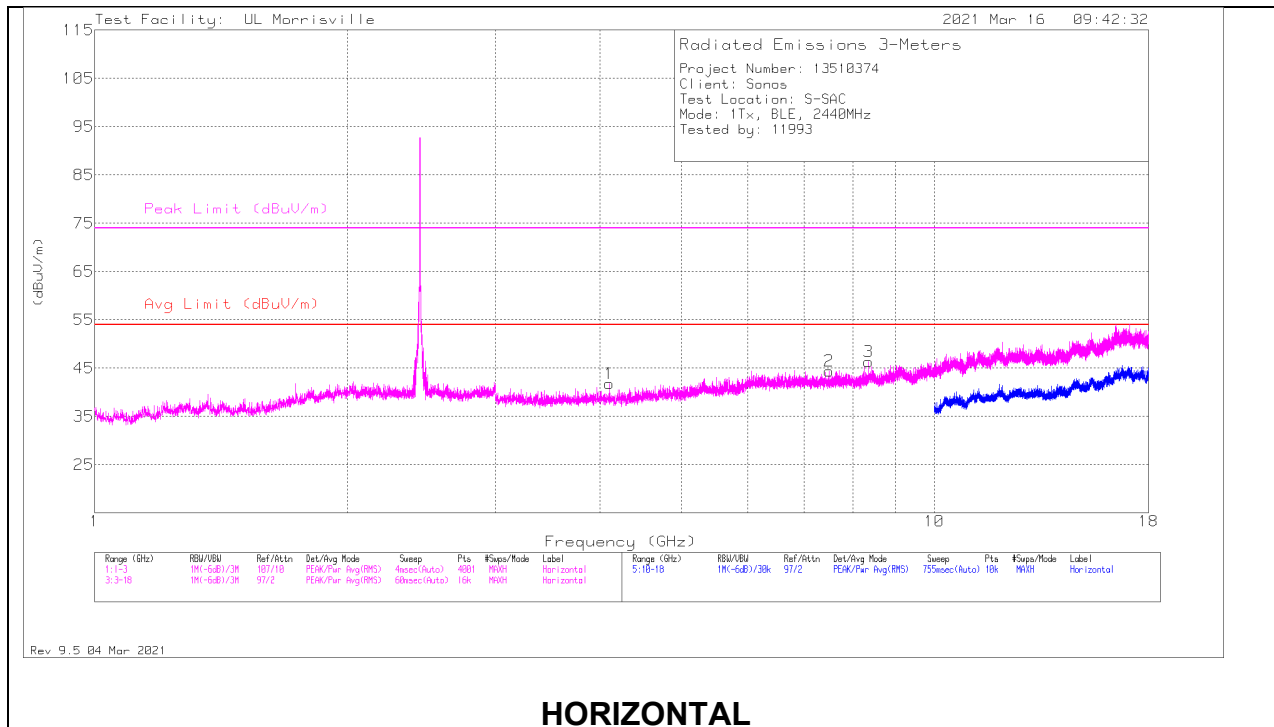
Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0067 (dB/m)	Amp/Cbl/Filtr/Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 1.687	34.01	Pk	29.3	-22.2	41.11	54	-12.89	74	-32.89	0-360	101	H
2	* ** 4.01438	39.66	Pk	33.4	-32.1	40.96	54	-13.04	74	-33.04	0-360	200	H
3	* ** 8.29125	36.75	Pk	35.8	-27.5	45.05	54	-8.95	74	-28.95	0-360	200	H
4	* ** 4.79719	38.95	Pk	34	-30.9	42.05	54	-11.95	74	-31.95	0-360	101	V
5	* ** 7.64156	35.72	Pk	35.7	-27.4	44.02	54	-9.98	74	-29.98	0-360	101	V
6	* ** 9.44906	34.97	Pk	36.4	-26.5	44.87	54	-9.13	74	-29.13	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 RESULTS



RADIATED EMISSIONS

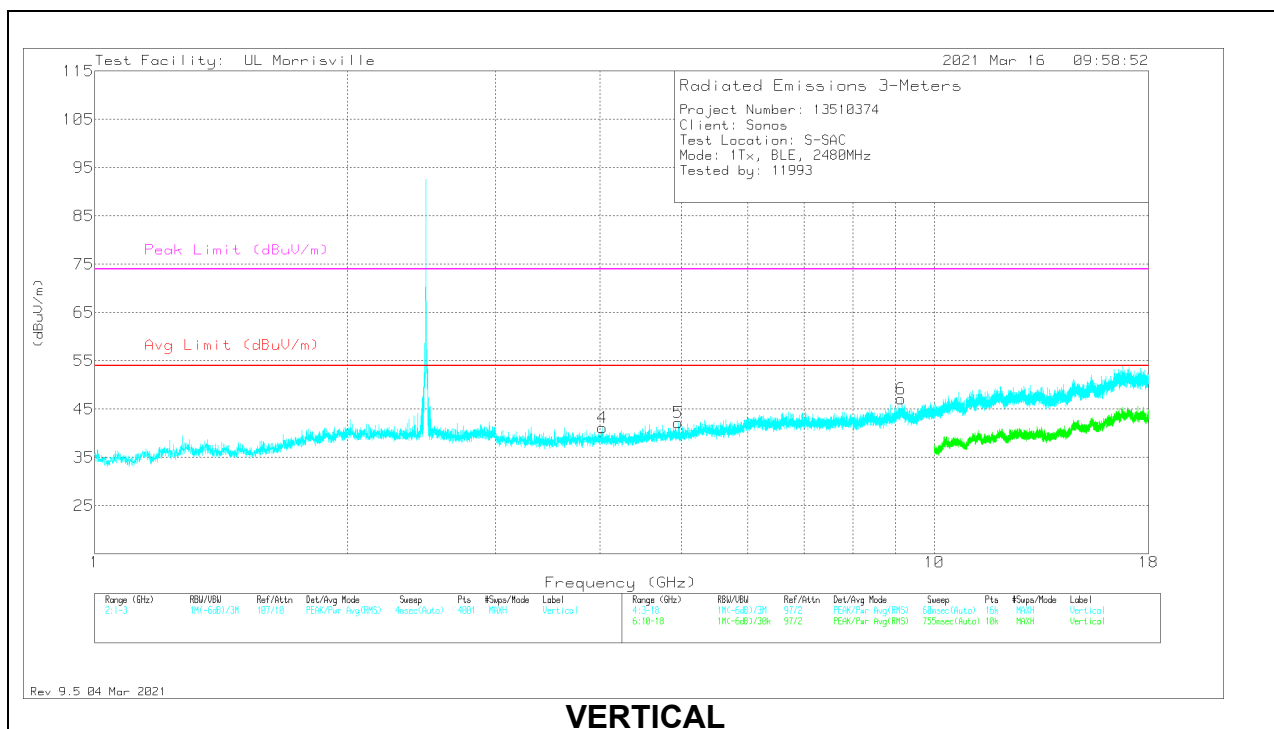
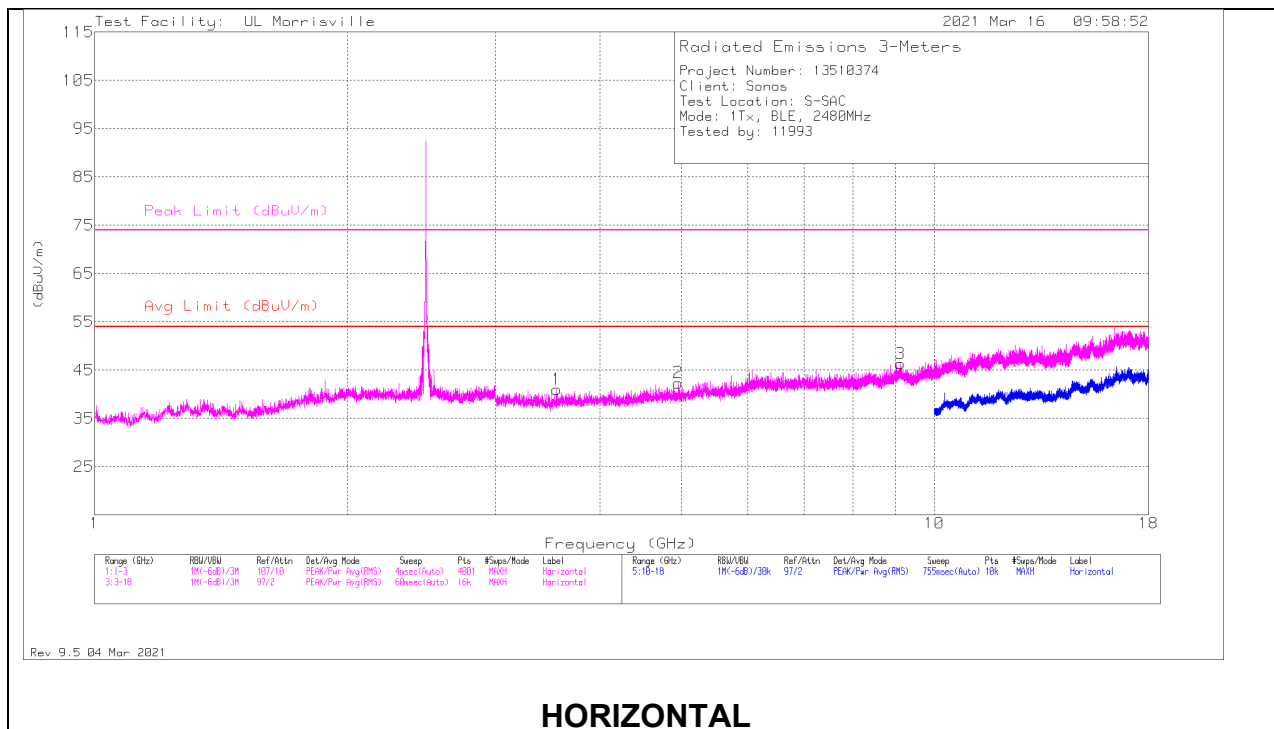
Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0067 (dB/m)	Amp/Cbl/Filtr/Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 4.10531	40.5	Pk	33.4	-32.1	41.8	54	-12.2	74	-32.2	0-360	101	H
2	* ** 7.49344	36.67	Pk	35.6	-27.9	44.37	54	-9.63	74	-29.63	0-360	200	H
3	* ** 8.355	37.71	Pk	35.8	-27.2	46.31	54	-7.69	74	-27.69	0-360	101	H
4	* ** 3.3525	41.13	Pk	32.9	-32.5	41.53	54	-12.47	74	-32.47	0-360	101	V
5	* ** 5.13	39.06	Pk	34.1	-31.1	42.06	54	-11.94	74	-31.94	0-360	101	V
6	* ** 9.14719	35.86	Pk	36.3	-26.1	46.06	54	-7.94	74	-27.94	0-360	101	V

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

** - indicates frequency in Taiwan NCC LP0002 Restricted Band

Pk - Peak detector

HIGH CHANNEL RESULTS



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	* ** 3.55313	40.39	Pk	32.9	-32.3	40.99	54	-13.01	74	-33.01	0-360	101	H
2	* ** 4.95938	39.49	Pk	33.9	-31	42.39	54	-11.61	74	-31.61	0-360	199	H
3	* ** 9.11344	36	Pk	36.3	-26	46.3	54	-7.7	74	-27.7	0-360	101	H
4	* ** 4.02469	40.03	Pk	33.4	-32.3	41.13	54	-12.87	74	-32.87	0-360	101	V
5	* ** 4.95938	39.31	Pk	33.9	-31	42.21	54	-11.79	74	-31.79	0-360	199	V
6	* ** 9.1275	36.74	Pk	36.3	-25.9	47.14	54	-6.86	74	-26.86	0-360	199	V

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

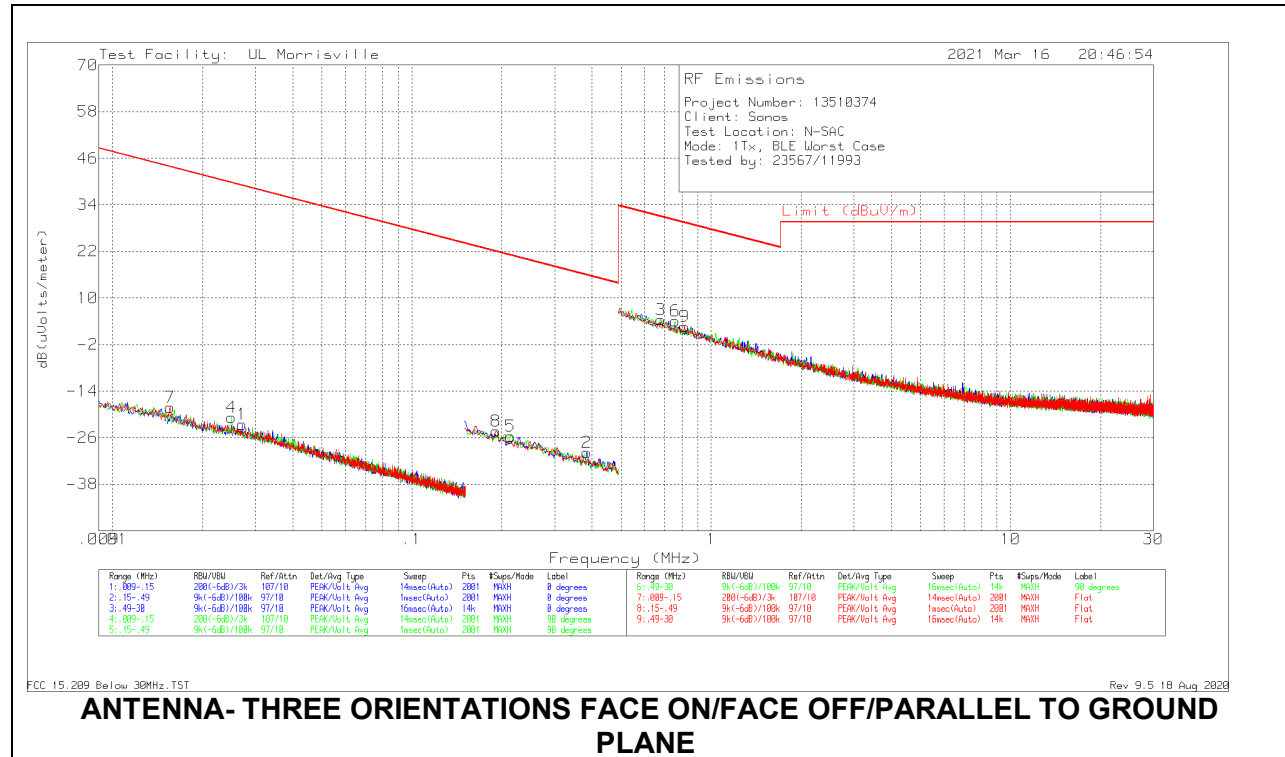
** - indicates frequency in Taiwan NCC LP0002 Restricted Band

Pk - Peak detector

10.4 WORST CASE BELOW 30MHZ

Note: All measurements were made at a test distance of 3 m. The measured data was extrapolated from the test distance (3m) to the specification distance (300 m from 9-490 kHz and 30 m from 490 kHz – 30 MHz) 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*Log (test distance / specification distance).

E-FIELD SPURIOUS EMISSIONS BELOW 30 MHz (WORST-CASE CONFIGURATION)



Below 30MHz Data

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AT0079 (dB/m)	Cbl (dB)	Dist. Corr. Factor (dB)	Corrected Reading dB(uVolts/meter)	FCC 15.209 Qp/Avg Limit (dBuV/m)	FCC 15.209 Pk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Antenna Position
7	.0156	46.23	Pk	15.5	.1	-80	-18.17	43.74	63.74	-61.91	0-360	Flat
4	.02498	45.56	Pk	13.5	.1	-80	-20.84	39.65	59.65	-60.49	0-360	Face Off
1	.02718	43.86	Pk	13.4	.1	-80	-22.64	38.92	58.92	-61.56	0-360	Face On
8	.1914	44.82	Pk	10.8	.1	-80	-24.28	21.97	41.97	-46.25	0-360	Flat
5	.21324	43.39	Pk	10.8	.1	-80	-25.71	21.03	41.03	-46.74	0-360	Face Off
2	.38435	39.43	Pk	10.6	.1	-80	-29.87	15.91	35.91	-45.78	0-360	Face On
3	.67972	33.37	Pk	10.8	.2	-40	4.37	30.96	-	-26.59	0-360	Face On
6	.75772	33.07	Pk	10.8	.2	-40	4.07	30.01	-	-25.94	0-360	Face off
9	.81463	31.6	Pk	10.8	.2	-40	2.6	29.38	-	-26.78	0-360	Flat

Pk - Peak detector

Test Facility: UL Morrisville

Date/Time: 2021 Mar 16 20:46:54

RF Emissions

Project Number: 13510374
 Client: Sonos
 Test Location: N-SAC
 Mode: 1Tx, BLE Worst Case
 Tested by: 23567/11993

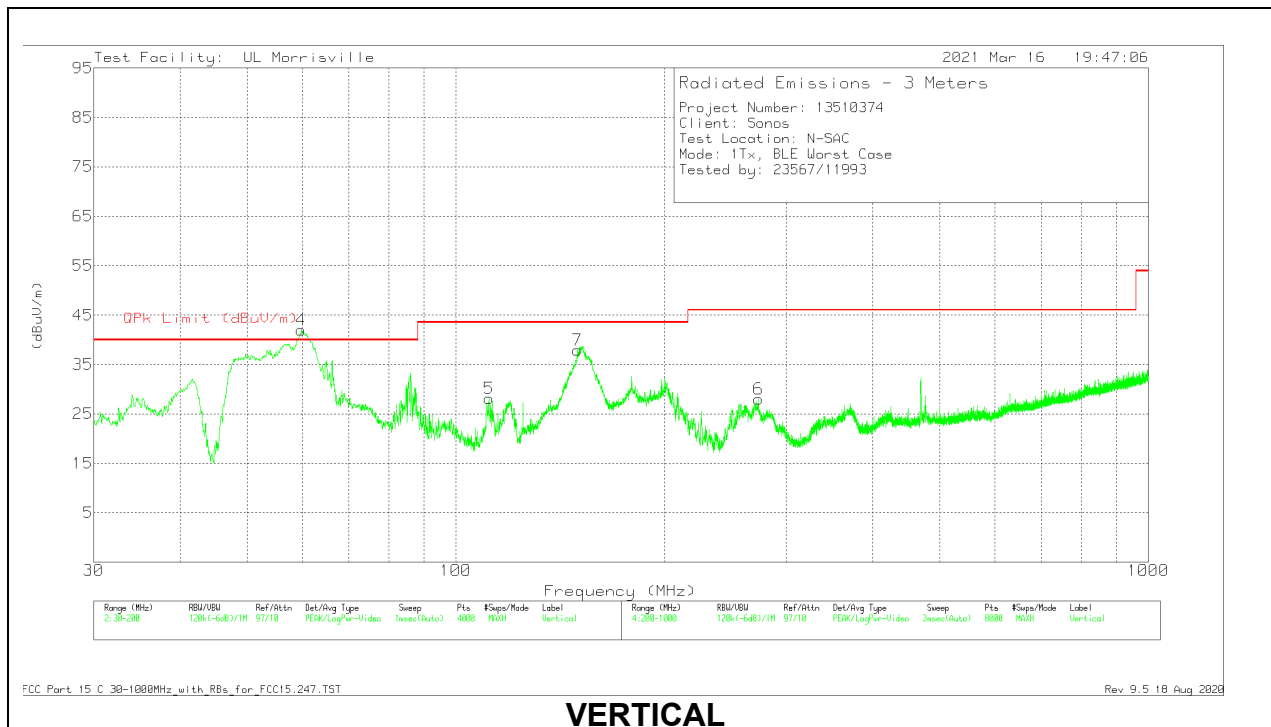
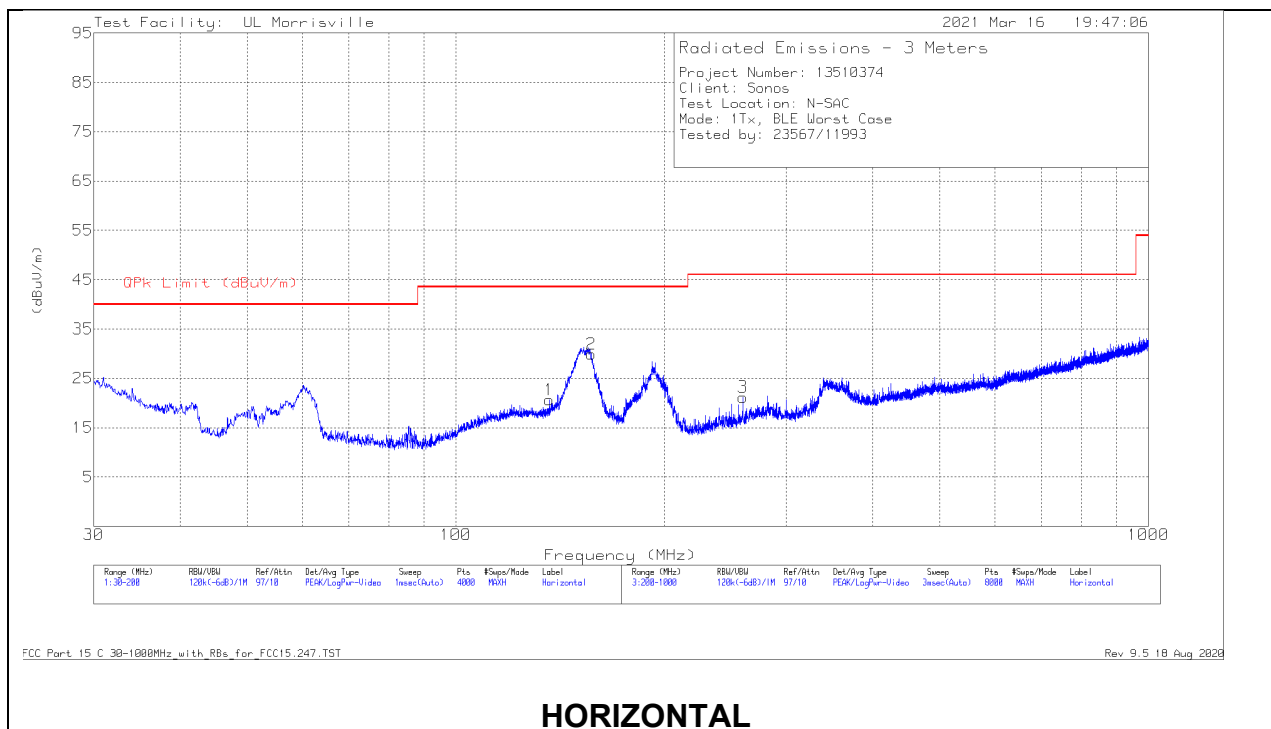
Range (MHz)	RBU/VBW	Ref/Antn	Det/Avg Type	Sweep	Pts	#Sups/Mode	Label
1: .009-15	5k(-6dB)/3k	107/10	PEAK/Volt Avg	14msec(Auto)	2001	NH/N	9 degrees
2: .15-49	5k(-6dB)/100k	97/10	PEAK/Volt Avg	14msec(Auto)	2001	NH/N	9 degrees
3: 49-30	5k(-6dB)/100k	97/10	PEAK/Volt Avg	14msec(Auto)	14k	NH/N	9 degrees
4: .009-15	200(-6dB)/3k	107/10	PEAK/Volt Avg	14msec(Auto)	2001	NH/N	30 degrees
5: .15-49	5k(-6dB)/100k	97/10	PEAK/Volt Avg	14msec(Auto)	2001	NH/N	30 degrees

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AT0079 (dB/m)	Cbl (dB)	Dist. Corr. Factor (dB)	Corrected Reading dB(uAmps/meter)	FCC 15.209 Qp/Avg Limit (dBuA/m)	FCC 15.209 Pk Limit (dBuA/m)	Margin (dB)	Azimuth (Degs)	Antenna Position
7	.0156	46.23	Pk	-87.5	.1	-80	-121.17	-59.26	-39.26	-61.91	0-360	Flat
4	.02498	45.56	Pk	-89.5	.1	-80	-123.84	-63.35	-43.35	-60.49	0-360	Face Off
1	.02718	43.86	Pk	-89.6	.1	-80	-125.64	-64.08	-44.08	-61.56	0-360	Face On
8	.1914	44.82	Pk	-92.2	.1	-80	-127.28	-81.03	-61.03	-46.25	0-360	Flat
5	.21324	43.39	Pk	-92.2	.1	-80	-128.71	-81.97	-61.97	-46.74	0-360	Face Off
2	.38435	39.43	Pk	-92.4	.1	-80	-132.87	-87.09	-67.09	-45.78	0-360	Face On
3	.67972	33.37	Pk	-92.2	.2	-40	-98.63	-72.04	-	-26.59	0-360	Face On
6	.75772	33.07	Pk	-92.2	.2	-40	-98.93	-72.99	-	-25.94	0-360	Face off
9	.81463	31.6	Pk	-92.2	.2	-40	-100.4	-73.62	-	-26.78	0-360	Flat

This report shall not be reproduced except in full, without the written approval of UL LLC.

10.5 WORST CASE BELOW 1 GHZ

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



Below 1GHz Data

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AT0074 (dB/m)	Amp/Cbl (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 136.4901	31.24	Pk	19.4	-30	20.64	43.52	-22.88	0-360	200	H
2	* ** 156.7678	41.15	Pk	18.6	-29.8	29.95	43.52	-13.57	0-360	200	H
5	* ** 111.6211	39.49	Pk	18.9	-30.3	28.09	43.52	-15.43	0-360	100	V
7	* ** 149.9737	44.83	Qp	18.7	-29.9	33.63	43.52	-9.89	14	100	V
3	* ** 259.7078	31.92	Pk	18.2	-28.9	21.22	46.02	-24.8	0-360	98	H
6	* ** 273.6096	37.47	Pk	19.4	-28.8	28.07	46.02	-17.95	0-360	100	V
4	59.8002	59.38	Pk	13.5	-30.9	41.98	-	-	0-360	100	V

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

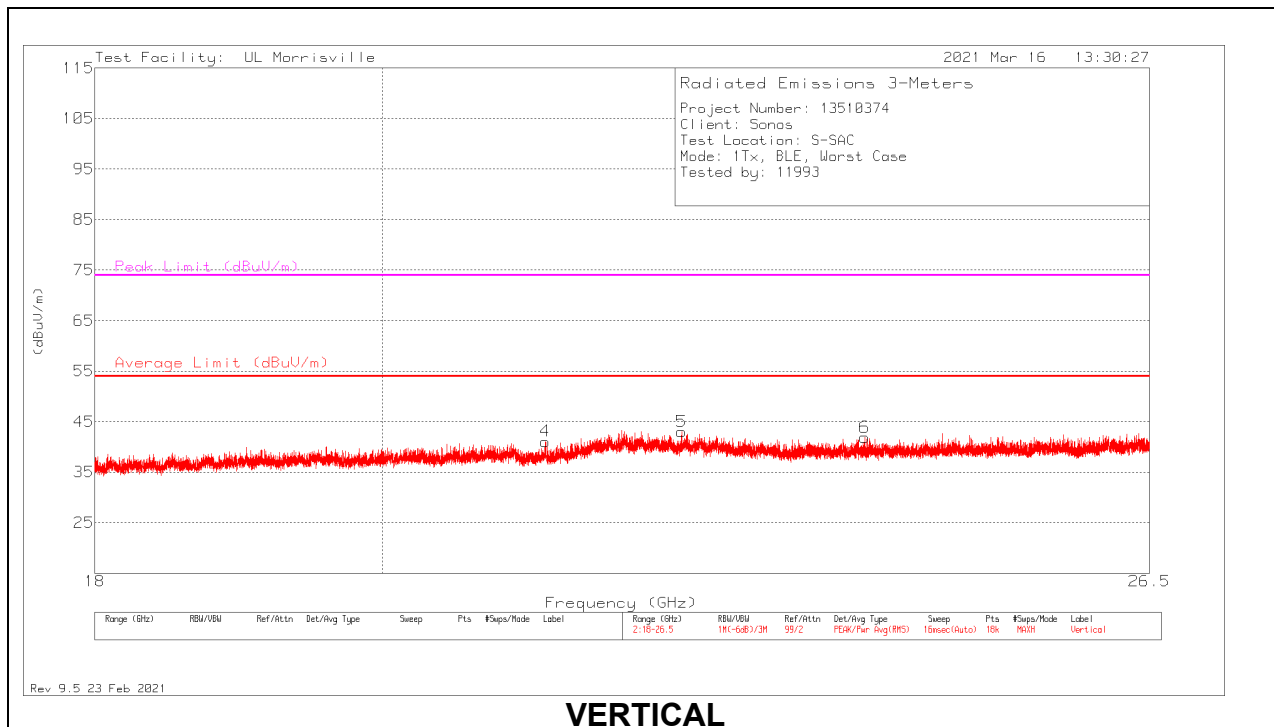
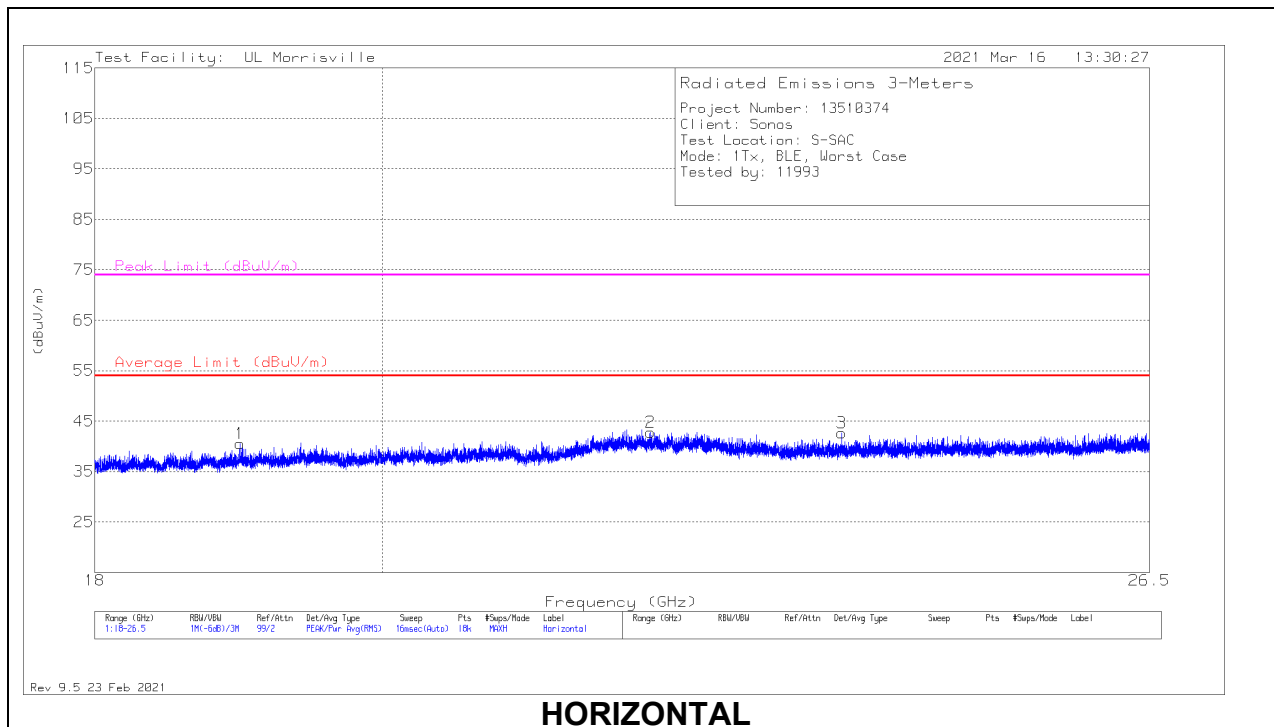
** - indicates frequency in Taiwan NCC LP0002 Restricted Band

Pk - Peak detector

Qp - Quasi-Peak detector

10.6 WORST CASE 18-26 GHZ

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



18 – 26GHz DATA

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0063 AF (dB/m)	Amp/Cbl (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 18.98322	46.25	Pk	33.3	-39	40.55	54	-13.45	74	-33.45	0-360	199	H
2	* ** 22.06936	45.42	Pk	36.8	-39.4	42.82	54	-11.18	74	-31.18	0-360	149	H
3	* ** 23.67075	46.11	Pk	34.9	-38.4	42.61	54	-11.39	74	-31.39	0-360	149	H
4	* ** 21.23159	45.9	Pk	34.4	-39.2	41.1	54	-12.9	74	-32.9	0-360	101	V
5	* ** 22.32201	45.98	Pk	36.5	-39.5	42.98	54	-11.02	74	-31.02	0-360	150	V
6	* ** 23.87146	45.56	Pk	34.9	-38.5	41.96	54	-12.04	74	-32.04	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

11 AC POWER LINE CONDUCTED EMISSIONS

LIMITS

FCC §15.207 (a)

RSS-Gen 8.8

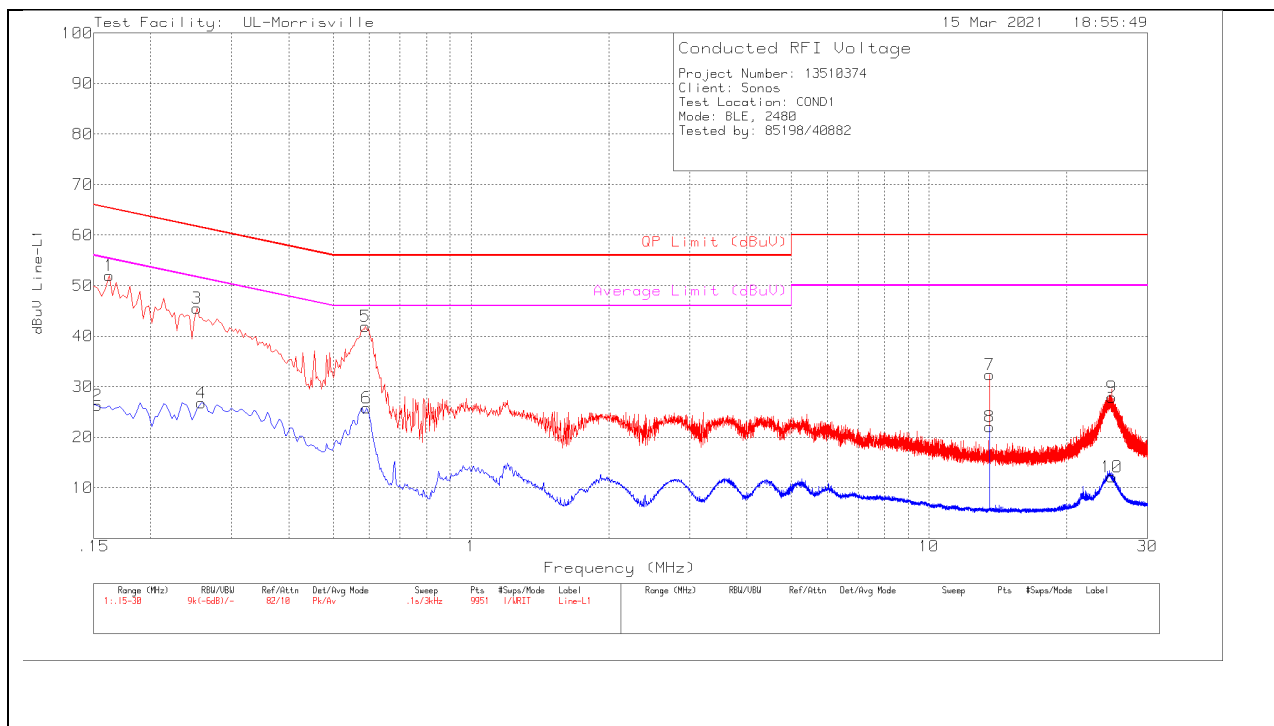
Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	Quasi-peak	Average
0.15-0.5	66 to 56 *	56 to 46 *
0.5-5	56	46
5-30	60	50

* Decreases with the logarithm of the frequency.

RESULTS

11.2.1 AC Power Line

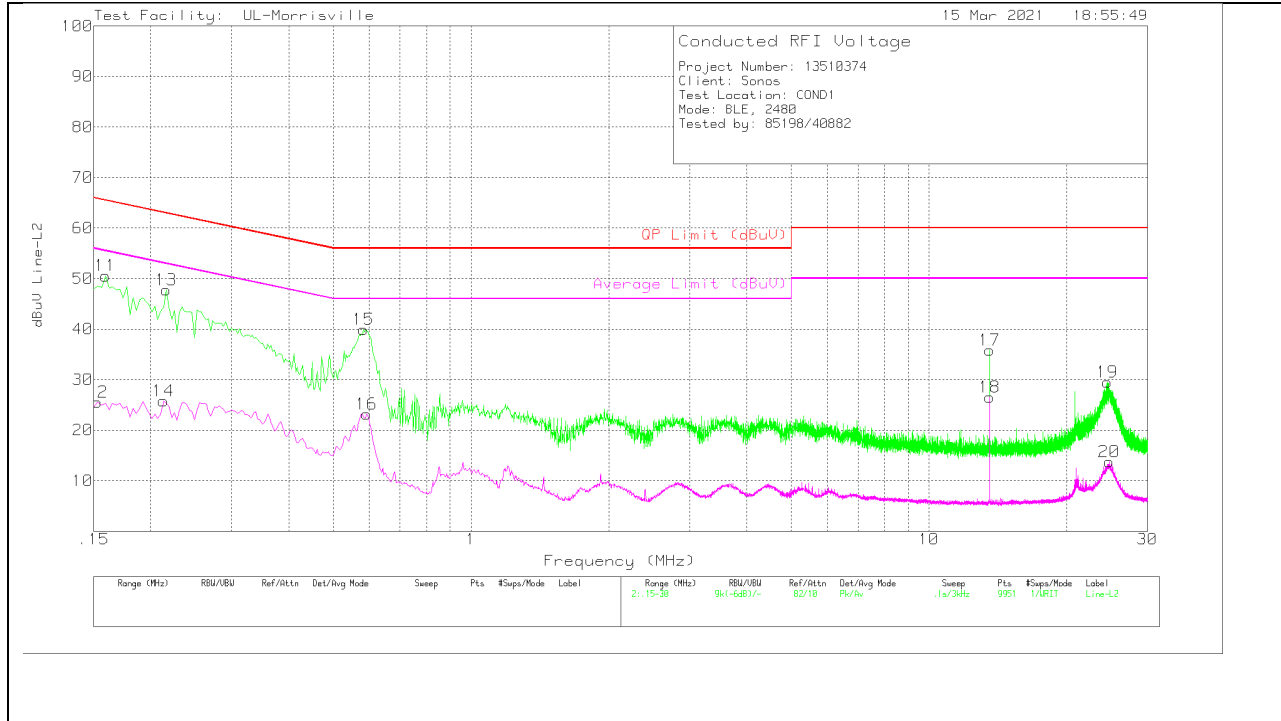
LINE 1 RESULTS



Range 1: Line-L1 .15 - 30MHz										
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	LISN VCF (dB)	Cbl/Limiter (dB)	Corrected Reading dBuV	QP Limit (dBuV)	Margin (dB)	Average Limit (dBuV)	Margin (dB)
1	.162	42.09	Pk	.2	9.7	51.99	65.36	-13.37	-	-
2	.153	16.33	Av	.2	9.7	26.23	-	-	55.84	-29.61
3	.252	35.76	Pk	.1	9.7	45.56	61.69	-16.13	-	-
4	.258	17.03	Av	.1	9.7	26.83	-	-	51.5	-24.67
5	.588	32.17	Pk	0	9.8	41.97	56	-14.03	-	-
6	.591	15.94	Av	0	9.8	25.74	-	-	46	-20.26
7	13.56	22.24	Pk	.1	10	32.34	60	-27.66	-	-
8	13.56	11.97	Av	.1	10	22.07	-	-	50	-27.93
9	25.083	17.45	Pk	.3	10.2	27.95	60	-32.05	-	-
10	25.083	1.68	Av	.3	10.2	12.18	-	-	50	-37.82

Pk - Peak detector
Av - Average detection

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 (dBUV)	Margin (dB)	Average Limit (dBUV)	Margin (dB)
11	.159	40.66	Pk	.2	9.7	50.56	65.52	-14.96	-	-
12	.153	15.62	Av	.2	9.7	25.52	-	-	55.84	-30.32
13	.216	37.97	Pk	.1	9.7	47.77	62.97	-15.2	-	-
14	.213	16.01	Av	.1	9.7	25.81	-	-	53.09	-27.28
15	.582	30.18	Pk	0	9.8	39.98	56	-16.02	-	-
16	.591	13.37	Av	0	9.8	23.17	-	-	46	-22.83
17	13.56	25.71	Pk	.1	10	35.81	60	-24.19	-	-
18	13.56	16.47	Av	.1	10	26.57	-	-	50	-23.43
19	24.51	19.07	Pk	.2	10.2	29.47	60	-30.53	-	-
20	24.753	3.34	Av	.2	10.2	13.74	-	-	50	-36.26

Pk - Peak detector
Av - Average detection

12 SETUP PHOTOS

Please refer to R13510374-EP1 for setup photos

END OF TEST REPORT