TEST REPORT

Report Number. : 14516849-E1V4

Applicant	:	SONOS INC. 614 CHAPALA ST. SANTA BARBARA, CA, 93101, U.S.A.
Model	:	S44
Brand	:	SONOS
FCC ID	:	SBVRM044
IC	:	5373A-RM044
EUT Description	:	802.11 a/b/g/n/ac/ax 2x2 Client Device with BT and BLE
Test Standard(s)	:	FCC 47 CFR PART 15 SUBPART C ISED RSS-247 ISSUE 2 ISED RSS-GEN ISSUE 5 + A1 + A2

Date Of Issue:
2023-05-25

Prepared by:
UL VERIFICATION SERVICES
47173 Benicia Street
Fremont, CA 94538 U.S.A.
TEL: (510) 319-4000
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CERT #0751.05

REPORT REVISION HISTORY

Rev.	Issue Date	Revisions	Revised By
V1	2023-04-18	Initial Issue	---
V2	2023-05-05	Updated Section 6.6, 9.6, 9.7, 10 and 10.2	Kiya.Kedida
V3	2023-05-17	Updated Section 6.6	Kiya.Kedida
V4	2023-05-25	Section 6.6 updated the setup diagram and the description of test setup cable #3	Glenn Escano

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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:	802.11 a/b/g/n/ac/ax 2x2 Client Device with BT and BLE
MODEL:	S44
BRAND:	Sonos
SERIAL NUMBER:	Radiated Sample: A100 2301WC C4-38-75-00-0F-40-9 Conducted: A100 2301WC C4-38-75-00-0E-7C:0,
SAMPLE RECEIPT DATE:	2023-02-20
DATE TESTED:	2023-02-21 to 2023-04-10

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
FCC 47 CFR Part 15 Subpart C	Complies
ISED RSS-247 Issue 2	Complies
ISED RSS-GEN Issue 5 + A1 + A2	Complies

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

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

This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document.

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2. TEST RESULTS SUMMARY

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

Below is a list of the data provided by the customer:

1. Antenna gain and type (see section 6.3)

FCC Clause	ISED Clause	Requirement	Result	Comment
See Comment		Duty Cycle	Reporting purposes only	Per ANSI C63.10, Section 11.6.
See Comment	RSS-GEN 6.7	20dB BW/99% OBW	Reporting purposes only	ANSI C63.10 Sections 6.9.2 and 6.9.3
15.247 (a)(1)	RSS-247 (5.1) (b)	Hopping Frequency Separation	Compliant	None.
15.247 (a)(1)(iii)	RSS-247 (5.1) (d)	Number of Hopping Channels	Compliant	None.
15.247 (a)(1)(iii)	RSS-247 (5.1) (d)	Average Time of Occupancy	Compliant	None.
15.247 (b)(1)	RSS-247 (5.4) (b)	Output Power	Compliant	None.
See Comment		Average Power	Reporting purposes only	Per ANSI C63.10, Section 11.9.2.3.2.
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.

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3. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC 47 CFR Part 2, FCC 47 CFR Part 15, ANSI C63.10-2013, KDB 558074 D01 15.247 Meas Guidance v05r02, KDB 414788 D01 Radiated Test Site v01r01, RSS-GEN Issue 5 + A1 + A2, and RSS-247 Issue 2.

4. FACILITIES AND ACCREDITATION

UL Verification Services Inc. is accredited by A2LA, Certificate Number 0751.05, 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
☐	Building 1: 47173 Benicia Street Fremont, CA 94538, U.S.A	US0104	2324A	550739
☐	Building 2: 47266 Benicia Street Fremont, CA 94538, U.S.A	US0104	22541	550739
☒	Building 4: 47658 Kato Rd Fremont, CA 94538, U.S.A	US0104	2324B	550739

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	U_{Lab}
Radio Frequency (Spectrum Analyzer)	141.16 Hz
Occupied Bandwidth	1.22%
Power Spectral Density	2.47 dB
RF Power Measurement Direct Method Using Power Meter	1.3 dB (PK) / 0.45 dB (AV)
Unwanted Emissions, Conducted	1.94 dB
Worst Case Conducted Disturbance, 9KHz to 0.15 MHz	3.78 dB
Worst Case Conducted Disturbance, 0.15 to 30 MHz	3.40 dB
Worst Case Radiated Disturbance, 9KHz to 30 MHz	2.87 dB
Worst Case Radiated Disturbance, 30 to 1000 MHz	6.01 dB
Worst Case Radiated Disturbance, 1000 to 18000 MHz	4.73 dB
Worst Case Radiated Disturbance, 18000 to 26000 MHz	4.51 dB
Worst Case Radiated Disturbance, 26000 to 40000 MHz	5.29 dB
Time Domain Measurements	3.39%
Temperature	0.57˚C
Humidity	3.39%
DC Supply Voltages	0.57%

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

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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 dBuV + 18.7 dB/m + 0.6 dB – 26.9 dB = 28.9 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

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6. EQUIPMENT UNDER TEST

6.1. EUT DESCRIPTION

The EUT is an 802.11 a/b/g/n/ac/ax 2x2 Client Device with BT and BLE.

This report covers BT radio

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	Basic GFSK	11.79	15.10
2402 - 2480	Enhanced DQPSK	11.50	14.13
2402 - 2480	Enhanced 8PSK	11.72	14.86

6.3. DESCRIPTION OF AVAILABLE ANTENNAS

The antenna(s) gain and type, as provided by the manufacturer' are as follows:

The radio utilizes a Monopole antenna, with a maximum gain of 1.8 dBi.

6.4. SOFTWARE AND FIRMWARE

The EUT firmware installed during testing was 74.0-39150-1-41.
The test utility software installed during testing was PrimaComplianceGUIInstaller _TESTBUILD3_17Nov22.

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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 as worst-case scenario.

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

The EUT can only be setup in desktop orientation; therefore, all radiated testing was performed with the EUT in desktop orientation.

GFSK, DQPSK, 8PSK average power are all investigated, The GFSK and 8PSK power are the worst case. Testing is based on these modes to showing compliance.

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

GFSK mode: DH5
8PSK mode: 3-DH5

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6.6. DESCRIPTION OF TEST SETUP

SUPPORT TEST EQUIPMENT				
Description	**Manufacturer**	**Model**	**Serial Number**	**FCC ID/ DoC**
Laptop	Lenovo	T460s	PC0JMBF8	Doc
Laptop AC/DC Adapter	Lenovo	ADLX90NLC2A	11S45N0247Z1ZSHH448JEY	Doc
AC Power	Sonos	CPS045180250U	N/A	Doc
Power Supply	Sonos	EC2Y5EB	N/A	Doc
USB-A to Ethernet Adapter	Plugable	USB2-E100	8CAE4CE46AFA	Doc
USB-C to USB-A Female Adapter	Amazon Basics	L6LUC160-CS-R	N/A	Doc

I/O CABLES (CONDUCTED TEST)						
Cable No.	**Port**	**# of Identical Ports**	**Connector Type**	**Cable Type**	**Cable Length (m)**	**Remarks**
1	AC	3	AC	Un-shielded	1.25	AC Mains to Spectrum Analyzer/AC/DC Adapter
2	DC	1	DC	Un-shielded	1	AC/DC Adapter to Laptop
3	USB-C	1	USB-C	Un-shielded	1.5	EUT to AC Power
4	Ethernet	1	RJ45	Un-shielded	1.5	Laptop to USB Ethernet Adapter
5	USB-A	1	USB-A	Shielded	0.05	USB Ethernet Adapter to USB
6	USB-C	1	USB-C	Shielded	0.05	EUT to USB-C/USB-A Female Adapter
7	SMA Cable	1	SMA	Un-Shielded	1.0	EUT to Spectrum Analyzer

I/O CABLES (RADIATED TEST)						
Cable No.	**Port**	**# Of Identical Ports**	**Connector Type**	**Cable Type**	**Cable Length (m)**	**Remarks**
1	AC	3	AC	Un-shielded	1.25	AC Mains to Spectrum Analyzer/AC/DC Adapter
2	DC	1	DC	Un-shielded	1	AC/DC Adapter to Laptop
3	USB-C	1	USB-C	Un-shielded	1.5	EUT to AC Power
4	Ethernet	1	RJ45	Un-shielded	10	Laptop to USB Ethernet Adapter
5	USB-A	1	USB-A	Shielded	0.05	USB Ethernet Adapter to USB
6	USB-C	1	USB-C	Shielded	0.05	EUT to USB-C/USB-A Female Adapter
7	SMA Cable	1	SMA	Un-Shielded	10	EUT to Horn Antenna

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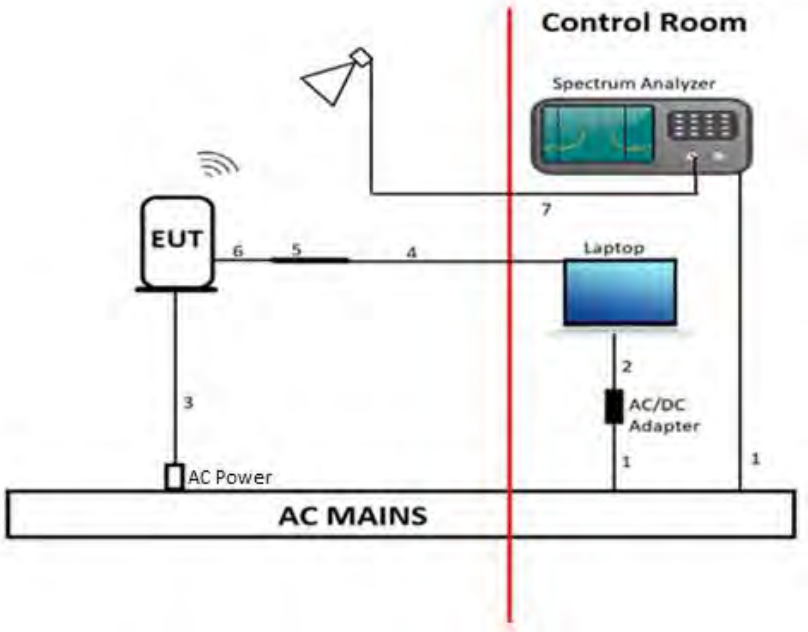
TEST SETUP

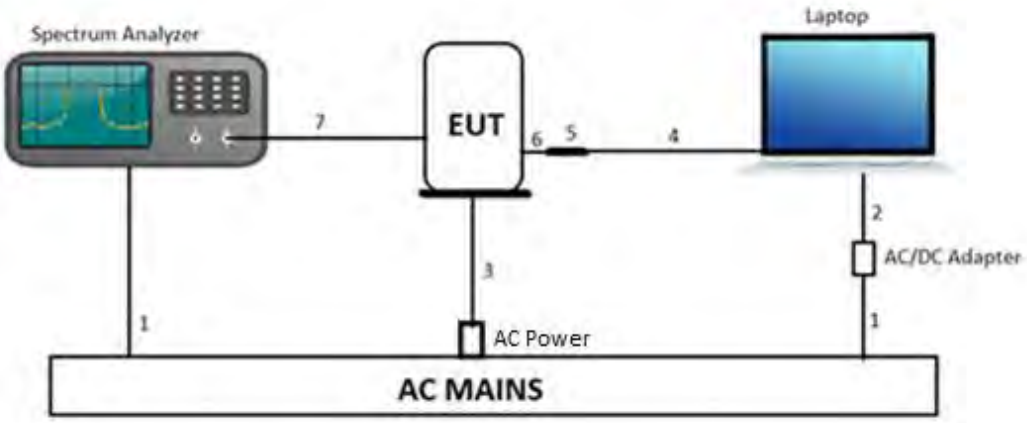
The EUT is a stand-alone unit, and the radio is exercised remotely by Sonos Compliance GUI test utility software via ethernet.

SETUP DIAGRAM

Radiated Configuration



Conducted Configuration



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7. TEST AND MEASUREMENT EQUIPMENT

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

TEST EQUIPMENT LIST					
Description	**Manufacturer**	**Model**	**ID Num**	**Cal Due**	**Last Cal**
Antenna, Broadband Hybrid, 30MHz to 2GHz	Sunol Sciences Corp.	JB1	171862	2023-09-08	2022-09-08
Amplifier, 10KHz to 1GHz, 32dB	SONOMA INSTRUMENT	310N	29654	2023-04-24	2022-04-24
Antenna, Horn 1-18GHz	ETS-Lindgren (Cedar Park, Texas)	3117	80404	2023-10-07	2022-10-07
RF Filter Box, 1-18GHz	FREMONT	SAC-L1	171013	2023-06-24	2022-06-24
EMI TEST RECEIVER, with B8 option	Rohde & Schwarz	ESW44	191429	2024-02-29	2023-02-15
EMI TEST RECEIVER	Rohde & Schwarz	ESW44	225688	2024-02-29	2023-02-14
Antenna, Horn 18 to 26.5GHz	ARA	MWH-1826/B	199659	2023-06-12	2022-06-12
Amplifier 18-26.5GHz, +5Vdc, -54dBm P1dB	AMPLICAL	AMP18G26.5-60	234683	2024-03-29	2023-03-18
Antenna, Passive Loop 30Hz - 1MHz	ELECTRO METRICS	EM-6871	170014	2023-07-19	2022-07-19
Antenna, Passive Loop 100KHz - 30MHz	ELECTRO METRICS	EM-6872	170016	2023-07-19	2022-07-19
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent Technologies	N9030A	80396	2024-01-31	2023-01-27
Power Meter, P-series single channel	Keysight Technologies Inc	N1911A	90719	2024-01-31	2023-01-26
Power Sensor, P - series, 50MHz to 18GHz, Wideband	Keysight Technologies Inc	N1921A	81319	2024-01-31	2023-01-25
10dB Fixed Attenuator	Pasternack Enterprises	PE7087-10	N/A	Verified	Verified
AC Line Conducted					
LISN	Fischer Custom Communications, Inc	FCC-LISN-50/250-25-2-01-480V	175765	2024-01-31	2023-01-31
EMI TEST RECEIVER	Rohde & Schwarz	ESR	171646	2024-02-29	2023-02-29
Transient Limiter	TE	TBFL1	207996	2023-07-15	2022-07-15
UL TEST SOFTWARE LIST					
Radiated Software	UL	UL EMC	Rev 2015-12-29, 2020-04-15 & 2023-01-18		
Antenna Port Software	UL	UL RF	Ver 2022-08-16		
AC Line Conducted Software	UL	UL EMC	Rev 2022-02-17		

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8. MEASUREMENT METHODS

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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9. ANTENNA PORT TEST RESULTS

9.1. ON TIME AND DUTY CYCLE

LIMITS

None; for reporting purposes only.

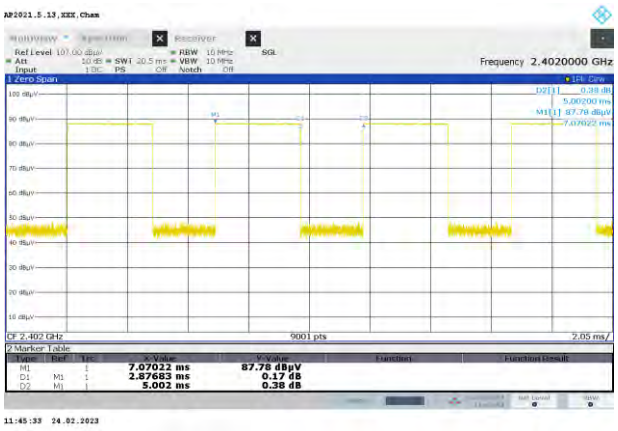
PROCEDURE

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

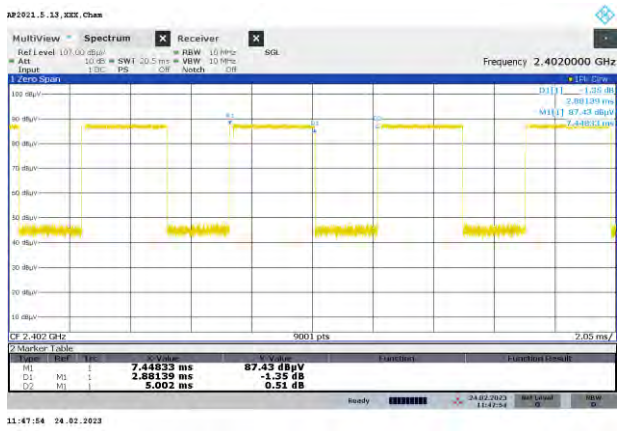
ON TIME AND DUTY CYCLE RESULTS

Mode	ON Time B (msec)	Period (msec)	Duty Cycle x (linear)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)	1/T Minimum VBW (kHz)
Bluetooth GFSK	2.877	5.002	0.575	57.5136	2.40	0.348
Bluetooth 8PSK	2.881	5.002	0.576	57.6048	2.40	0.347

DUTY CYCLE PLOTS



BLUETOOTH GFSK



BLUETOOTH 8PSK

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9.2. 20 dB AND 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

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

RESULTS

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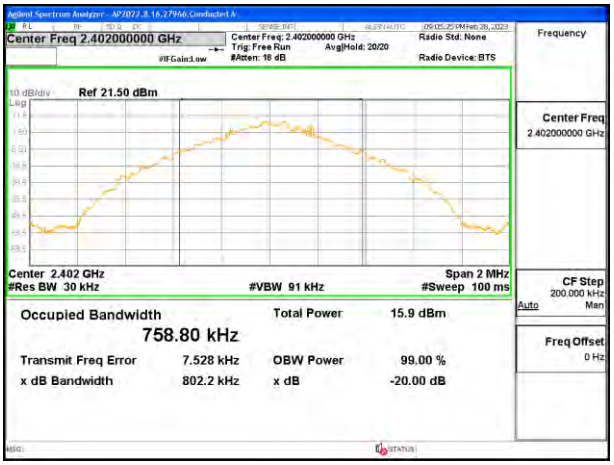
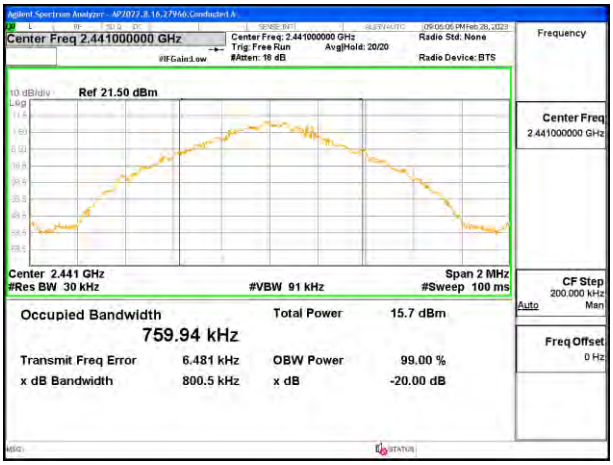
9.2.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

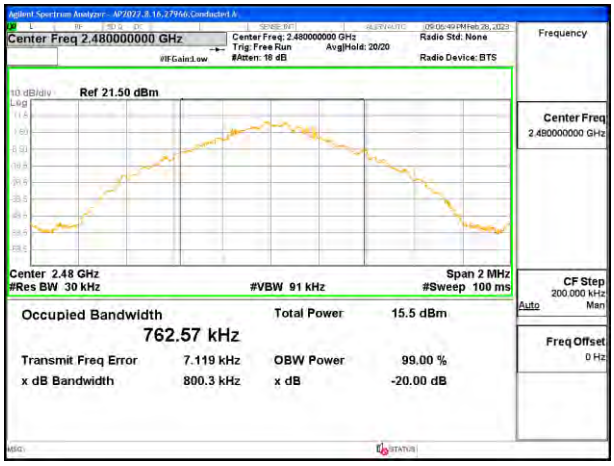
Channel	Frequency (MHz)	20dB Bandwidth (kHz)	99% Bandwidth (kHz)
Low	2402	802.2	758.80
Mid	2441	800.5	759.94
High	2480	800.3	762.57



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

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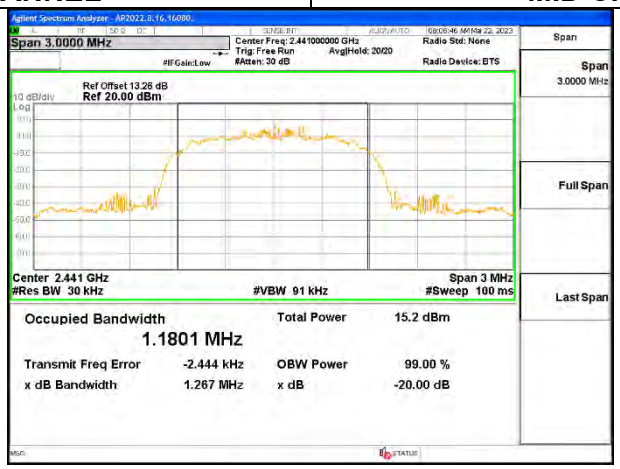
9.2.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

Channel	Frequency (MHz)	20dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	2402	1.268	1.1784
Mid	2441	1.269	1.1747
High	2480	1.267	1.1801

LOW CHANNEL

MID CHANNEL



HIGH CHANNEL

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9.3. HOPPING FREQUENCY SEPARATION

LIMITS

FCC §15.247 (a) (1)

RSS-247 (5.1) (b)

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

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

TEST PROCEDURE

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

RESULTS

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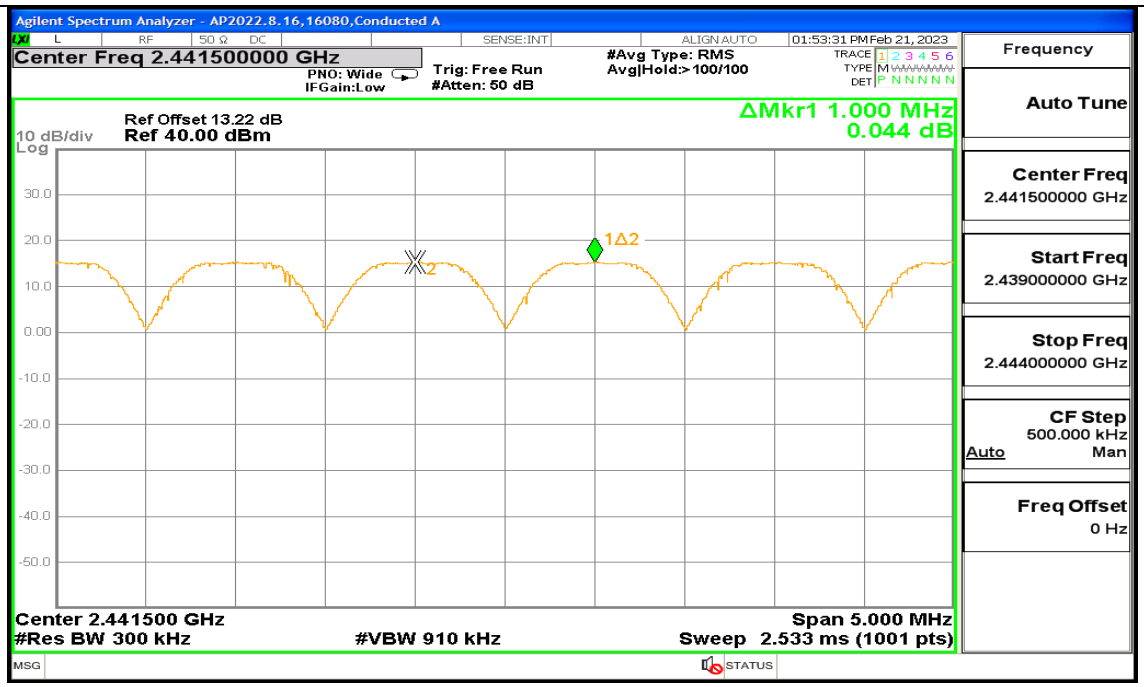
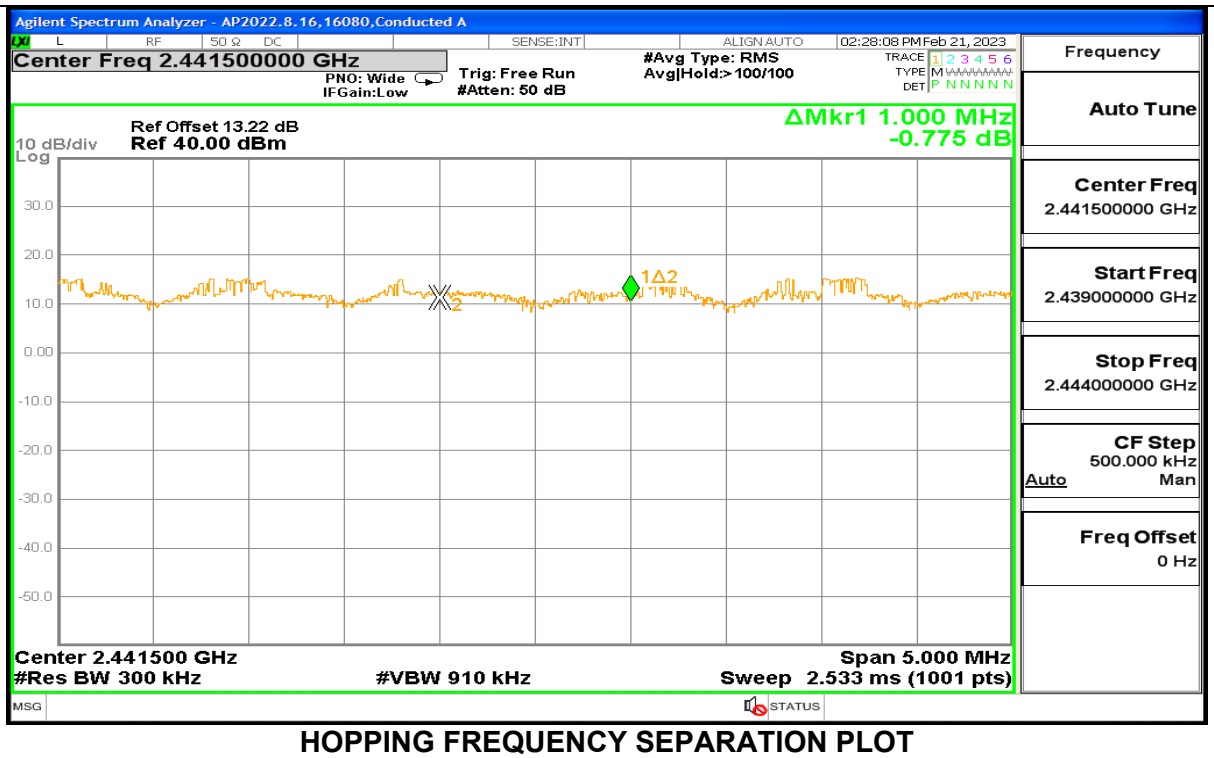
9.3.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION



HOPPING FREQUENCY SEPARATION PLOT

9.3.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION



HOPPING FREQUENCY SEPARATION PLOT

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9.4. NUMBER OF HOPPING CHANNELS

LIMITS

FCC §15.247 (a) (1) (iii)

RSS-247 (5.1) (d)

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

TEST PROCEDURE

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

RESULTS

Normal Mode: 79 Channels Observed

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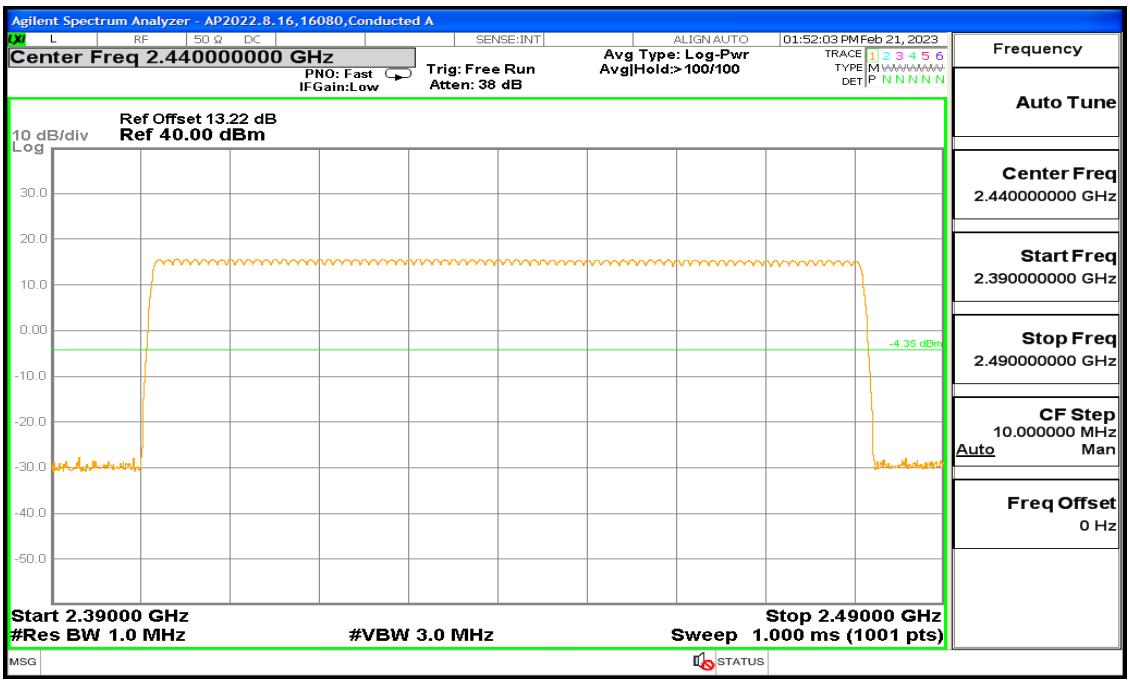
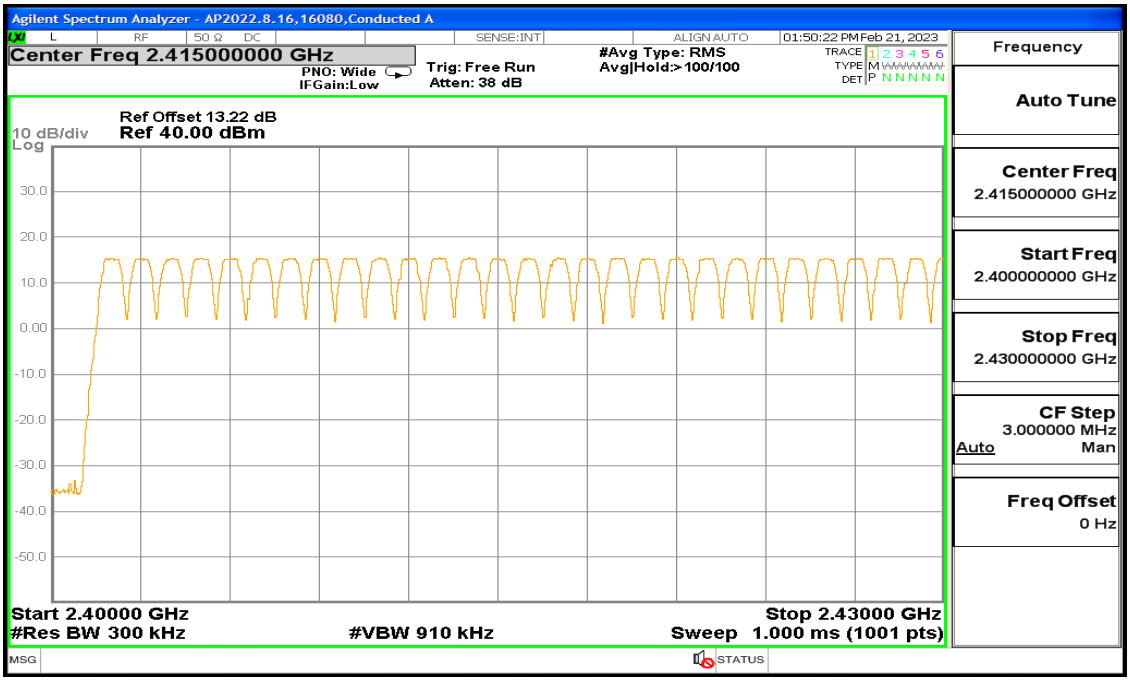
9.4.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION



100MHz SPAN



30MHz SPAN, SEGMENT 1 OF 3

UL VERIFICATION SERVICES
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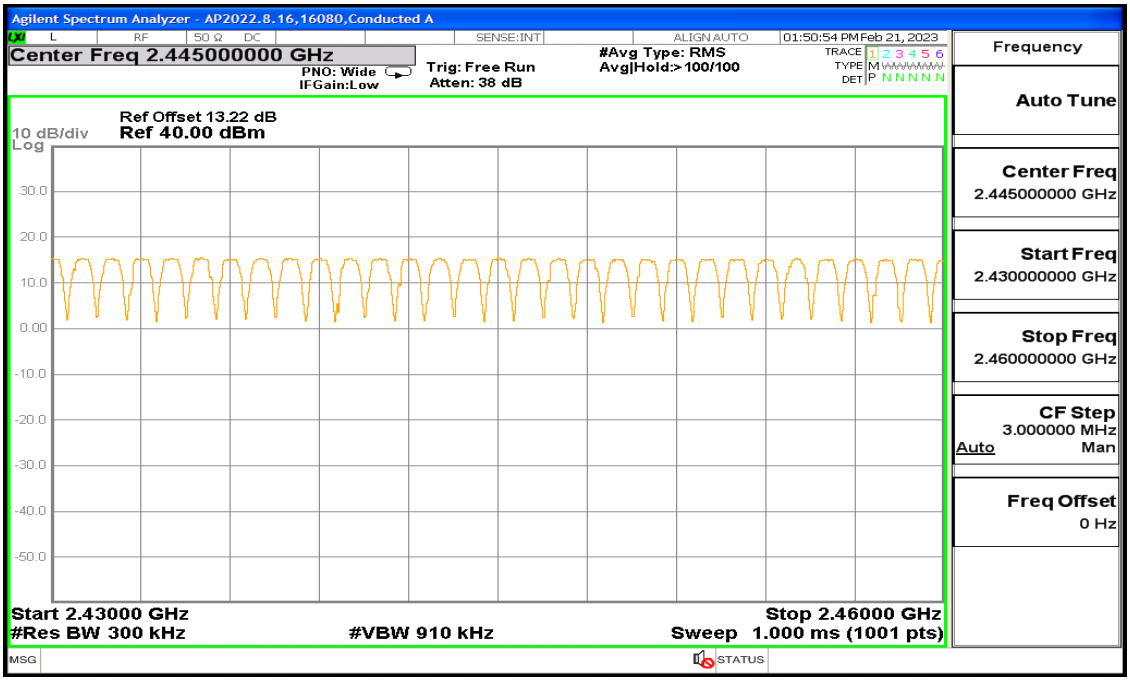
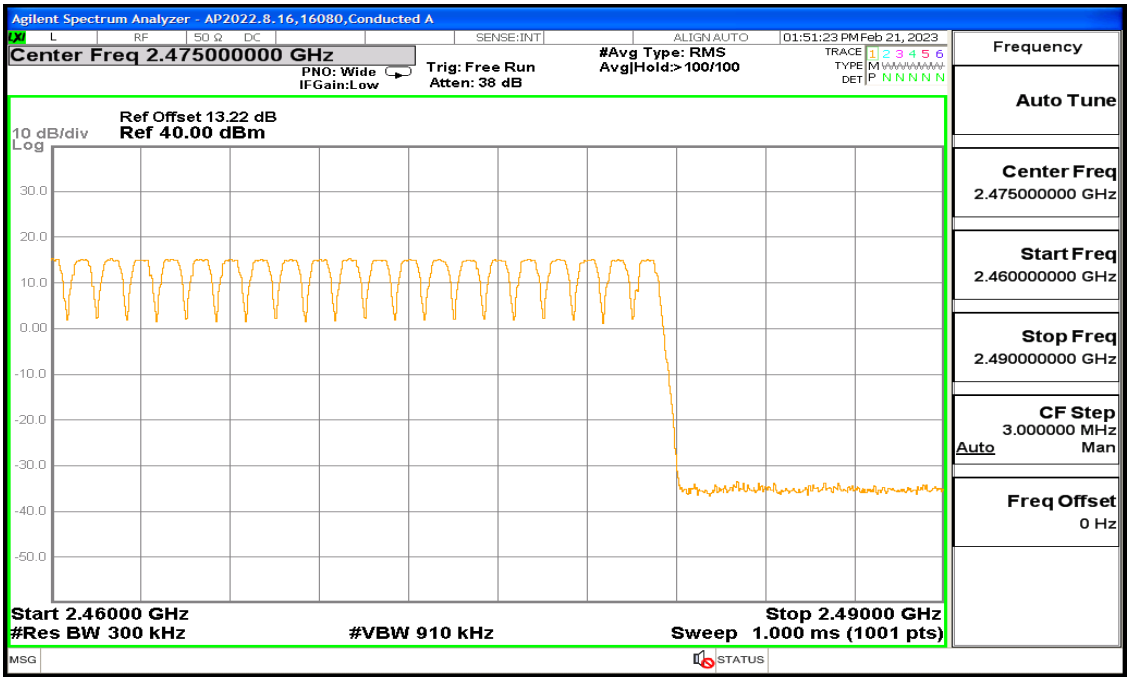


30MHz SPAN, SEGMENT 2 OF 3



30MHz SPAN, SEGMENT 3 OF 3

UL VERIFICATION SERVICES
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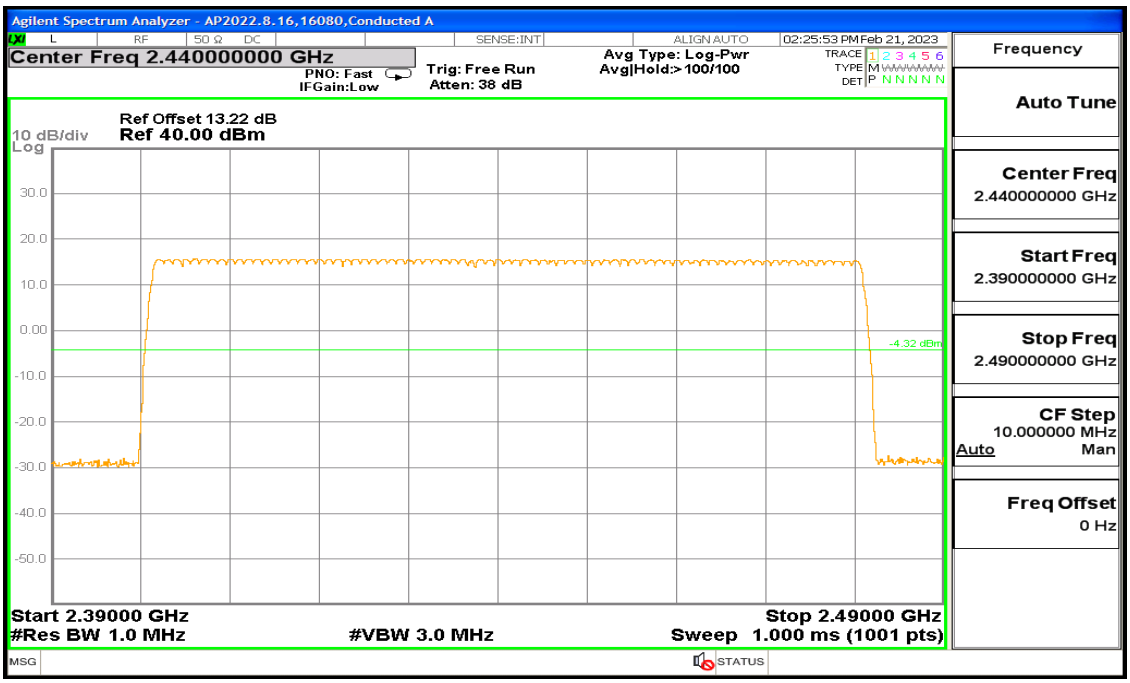
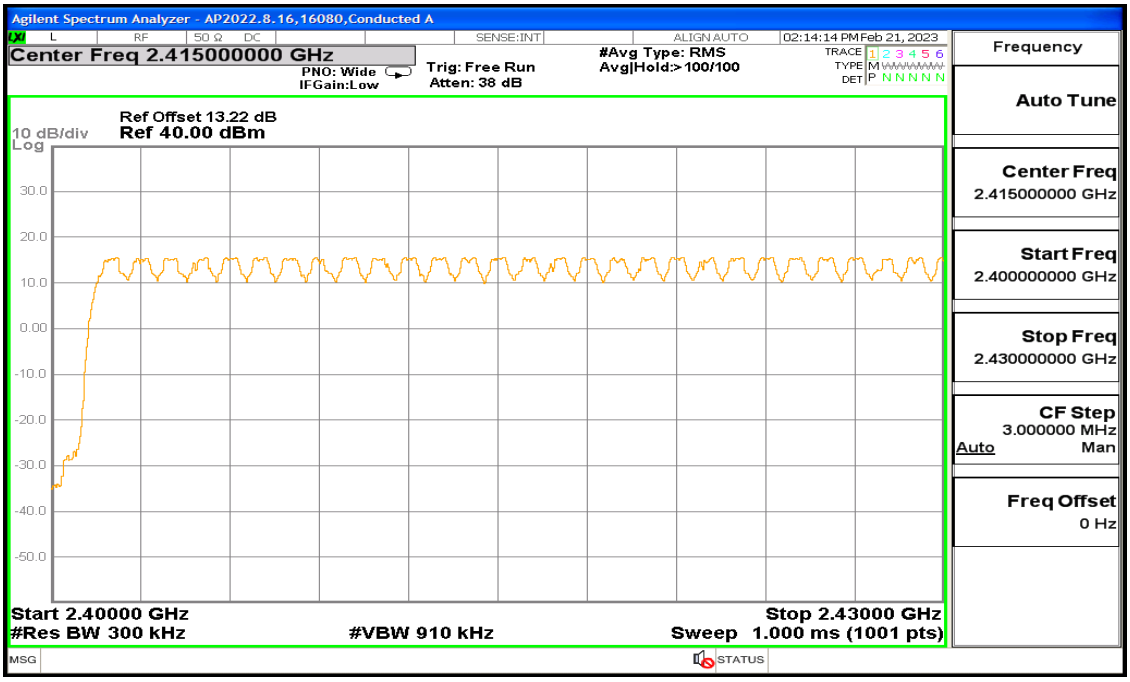
9.4.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

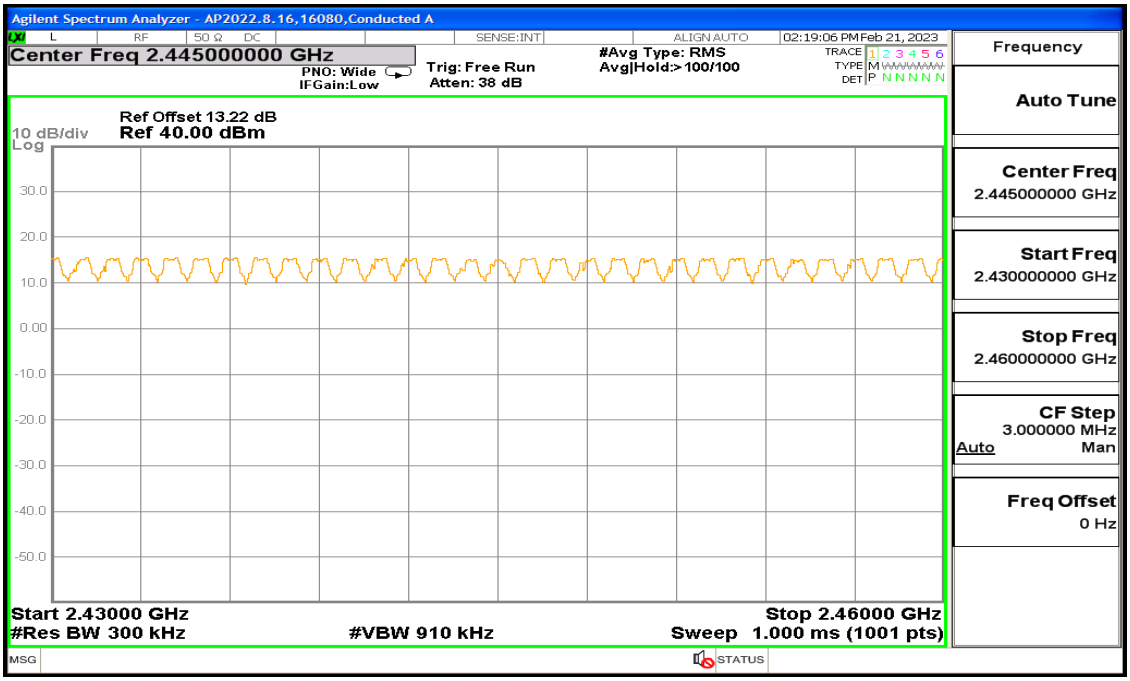


100MHz SPAN

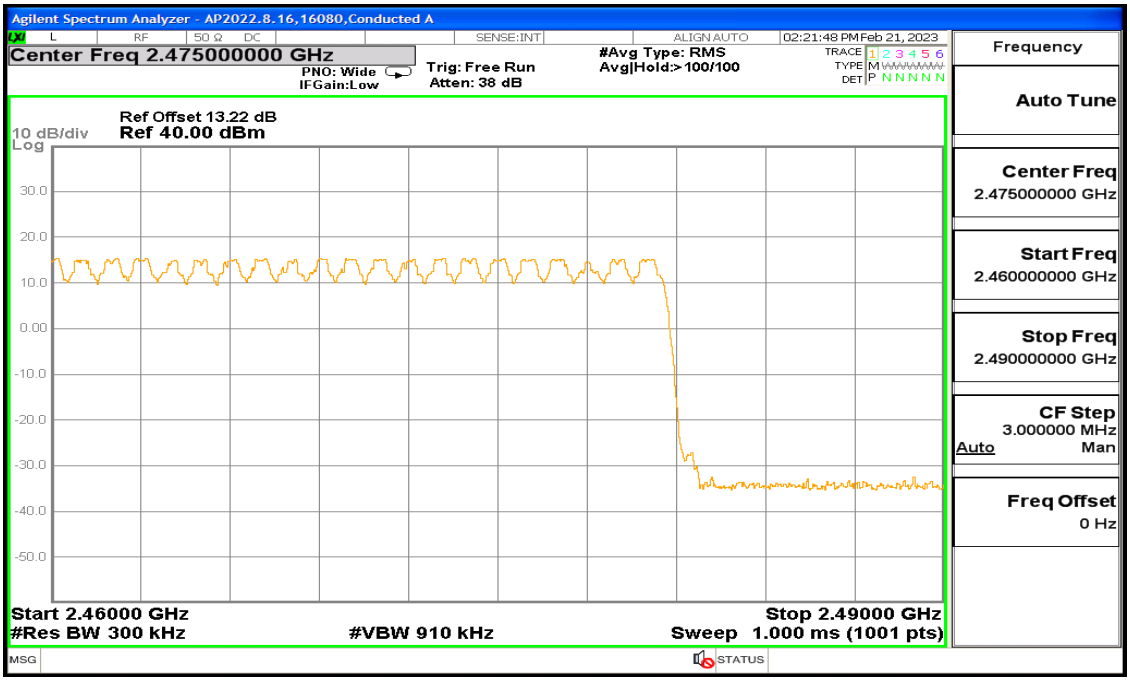


30MHz SPAN, SEGMENT 1 OF 3

UL VERIFICATION SERVICES
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888



30MHz SPAN, SEGMENT 2 OF 3



30MHz SPAN, SEGMENT 3 OF 3

UL VERIFICATION SERVICES
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9.5. AVERAGE TIME OF OCCUPANCY

LIMITS

FCC §15.247 (a) (1) (iii)

RSS-247 (5.1) (d)

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

TEST PROCEDURE

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

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

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

RESULTS

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9.5.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

DH Packet	Pulse Width (msec)	Number of Pulses in 3.16 seconds	Average Time of Occupancy (sec)	Limit (sec)	Margin (sec)
GFSK Normal Mode					
DH1	0.37	15	0.0555	0.4	-0.3445
DH3	1.624	12	0.1949	0.4	-0.2051
DH5	2.864	8	0.2291	0.4	-0.1709
DH Packet	Pulse Width (sec)	Number of Pulses in 0.8 seconds	Average Time of Occupancy (sec)	Limit (sec)	Margin (sec)
GFSK AFH Mode					
DH1	0.37	3.75	0.01388	0.4	-0.3861
DH3	1.624	3	0.04872	0.4	-0.3513
DH5	2.864	2	0.05728	0.4	-0.3427

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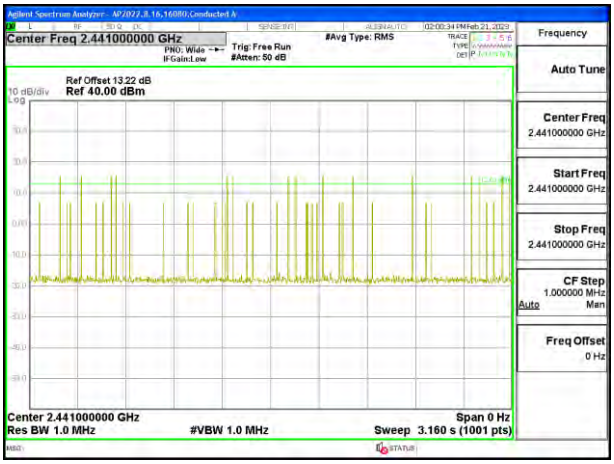
PULSE WIDTH – DH1

PULSE WIDTH – DH3

PULSE WIDTH – DH5



NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH1

NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH3

NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH5

UL VERIFICATION SERVICES
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9.5.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

DH Packet	Pulse Width (msec)	Number of Pulses in 3.16 seconds	Average Time of Occupancy (sec)	Limit (sec)	Margin (sec)
8PSK Normal Mode					
3DH1	0.555	20	0.11100	0.4	-0.289
3DH3	1.796	9	0.16164	0.4	-0.23836
3DH5	2.868	10	0.28680	0.4	-0.1132

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

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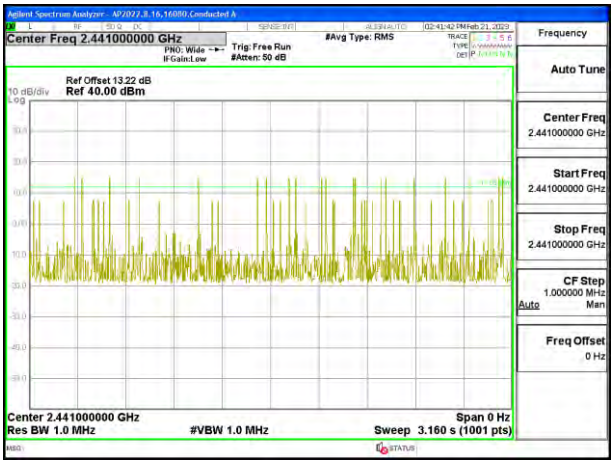
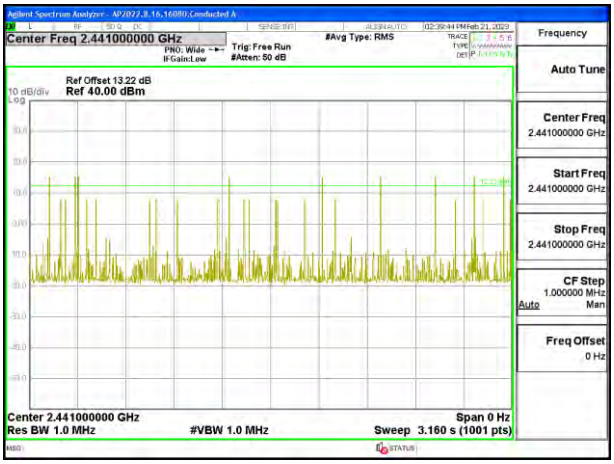
PULSE WIDTH – 3DH1

PULSE WIDTH – 3DH3

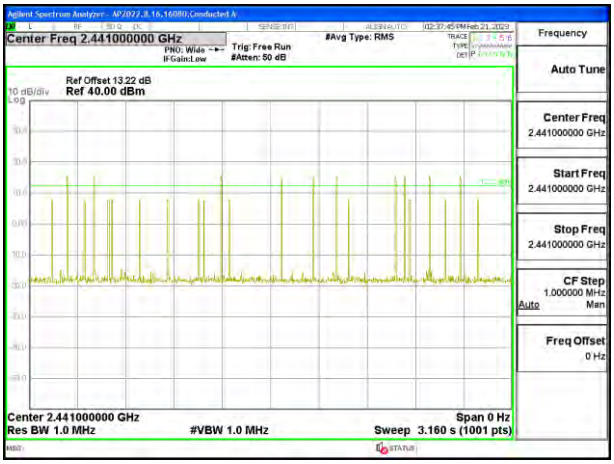
PULSE WIDTH – 3DH5



NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – 3DH1



NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – 3DH3



NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – 3DH5

UL VERIFICATION SERVICES
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9.6. OUTPUT POWER

LIMITS

§15.247 (b) (1)

RSS-247 (5.4) (b)

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

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

TEST PROCEDURE

Measurements perform using a wideband gated RF power meter.

The power output was measured on the EUT antenna port using SMA cable with 10dB attenuator connected to a power meter via wideband power sensor. Peak output power was read directly from power meter.

RESULTS

UL VERIFICATION SERVICES
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

9.6.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

Tested By:	ZS 16080
Date:	2023-04-10

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	11.72	21	-9.28
Middle	2441	11.79	21	-9.21
High	2480	11.60	21	-9.40

9.6.2. BLUETOOTH ENHANCED DATA RATE DQPSK MODULATION

Tested By:	ZS 16080
Date:	2023-04-10

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	11.32	21	-9.68
Middle	2441	11.50	21	-9.50
High	2480	11.36	21	-9.64

9.6.3. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

Tested By:	ZS 16080
Date:	2023-04-10

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	11.64	21	-9.36
Middle	2441	11.72	21	-9.28
High	2480	11.36	21	-9.64

UL VERIFICATION SERVICES
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9.7. AVERAGE POWER

LIMITS

None; for reporting purposes only

TEST PROCEDURE

Measurements perform using a wideband gated RF power meter.

The power output was measured on the EUT antenna port using SMA cable with 10dB attenuator connected to a power meter via wideband power sensor. Gated average output power was read directly from power meter.

RESULTS

UL VERIFICATION SERVICES
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9.7.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

Tested By:	ZS 16080
Date	2023-04-10

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	11.33
Middle	2441	11.32
High	2480	11.11

9.7.2. BLUETOOTH ENHANCED DATA RATE DQPSK MODULATION

Tested By:	ZS 16080
Date	2023-04-10

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	8.44
Middle	2441	8.49
High	2480	8.40

9.7.3. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

Tested By:	ZS 16080
Date	2023-04-10

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	8.52
Middle	2441	8.58
High	2480	8.41

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9.8. CONDUCTED SPURIOUS EMISSIONS

LIMITS

FCC §15.247 (d)

RSS-247 5.5

Limit = -20 dBc

TEST PROCEDURE

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

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

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

RESULTS

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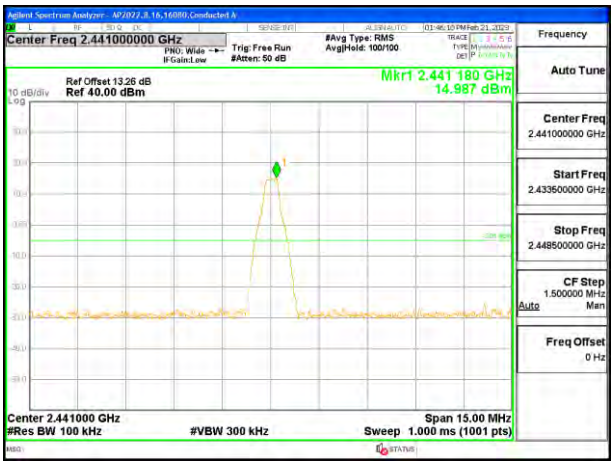
9.8.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

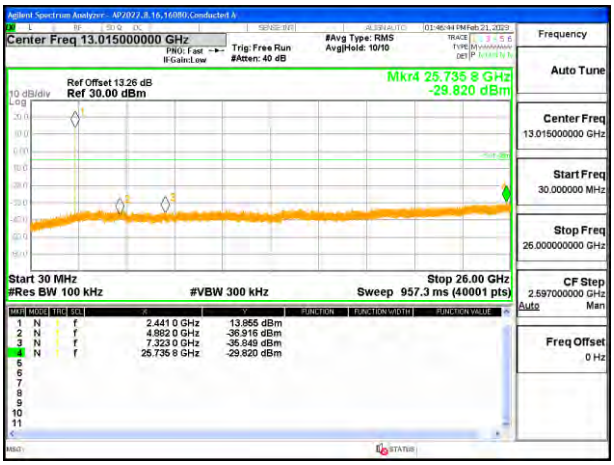
Antenna 1 SPURIOUS EMISSIONS, NON-HOPPING

LOW CHANNEL BANDEDGE

OUT-OF-BAND LOW CHANNEL

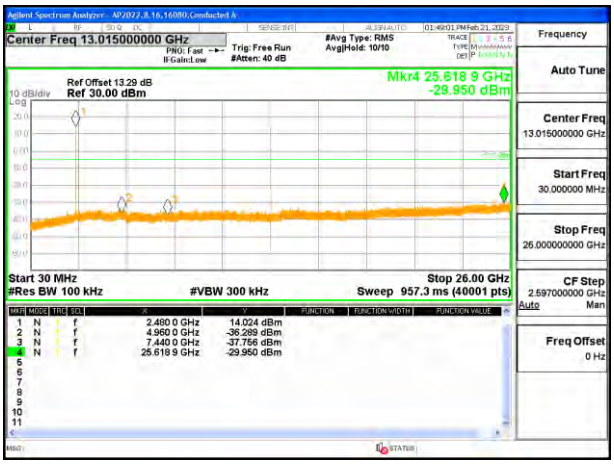


IN-BAND REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL

HIGH CHANNEL BANDEDGE



OUT-OF-BAND HIGH CHANNEL

UL VERIFICATION SERVICES
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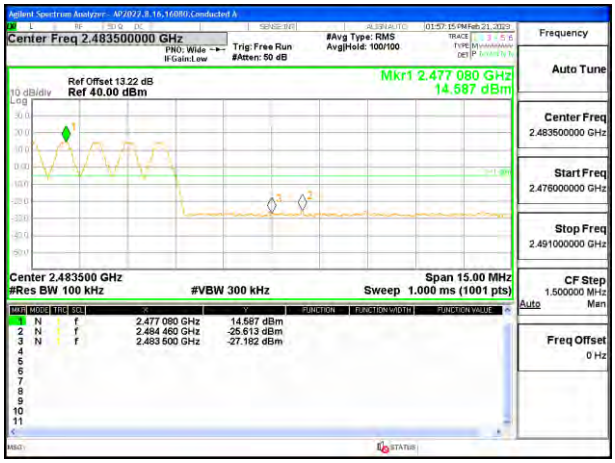
Antenna 1 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON

LOW BANDEDGE



HIGH BANDEDGE

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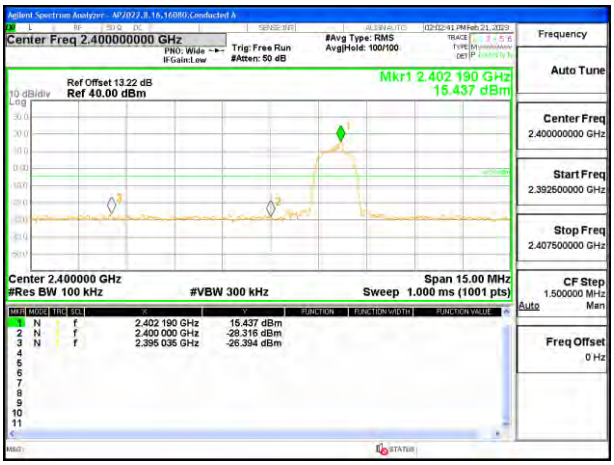
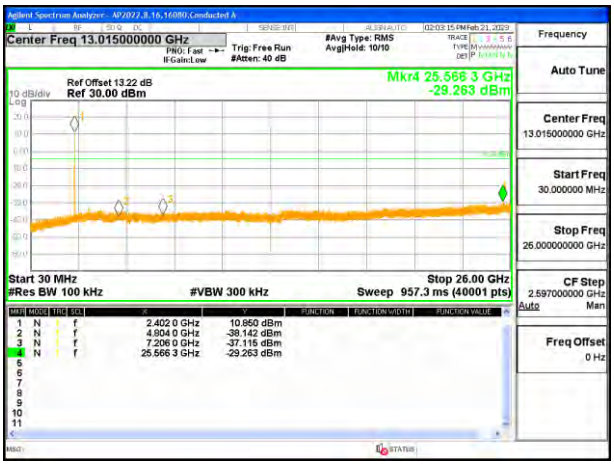
9.8.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

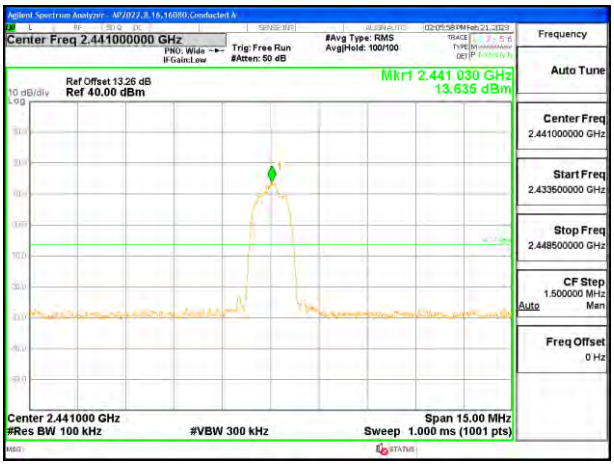
Antenna 1 SPURIOUS EMISSIONS, NON-HOPPING



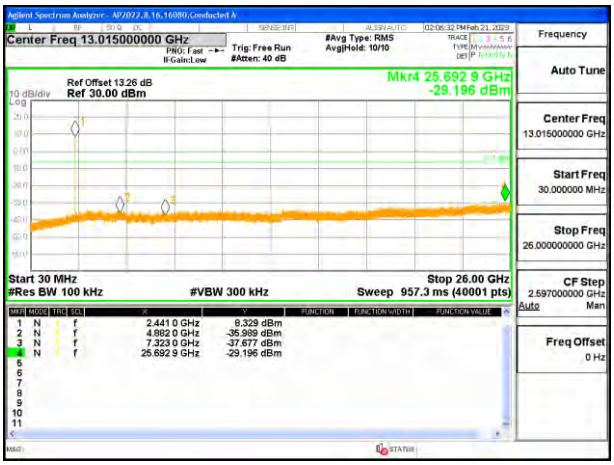
LOW CHANNEL BANDEDGE



OUT-OF-BAND LOW CHANNEL

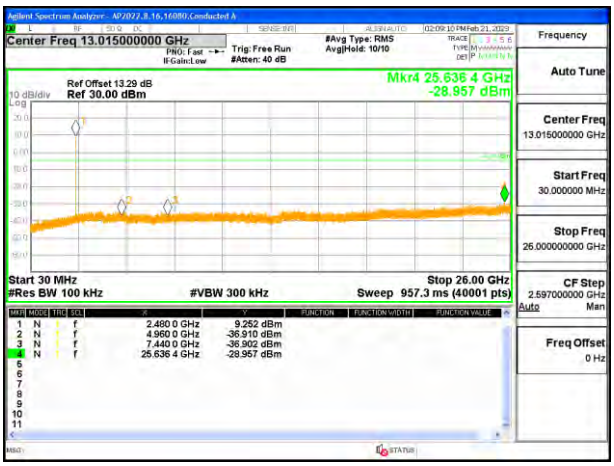


IN-BAND REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL

HIGH CHANNEL BANDEDGE



OUT-OF-BAND HIGH CHANNEL

UL VERIFICATION SERVICES
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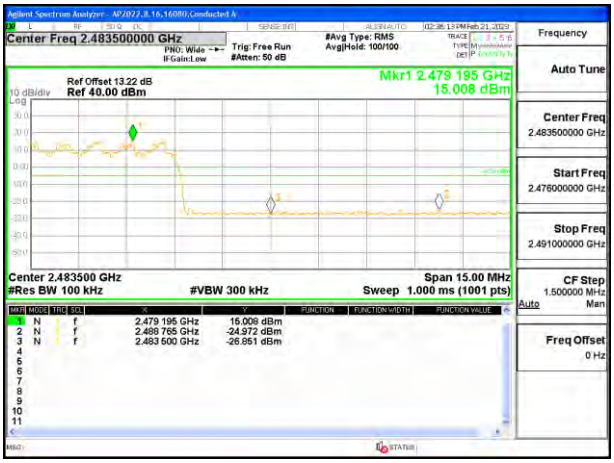
Antenna 1 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON

LOW BANDEDGE



HIGH BANDEDGE

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

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

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

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2D antenna use - For below 30MHz testing, investigation was done on three antenna orientations (parallel, perpendicular, and ground-parallel), parallel and perpendicular are the worst orientations, therefore testing was performed on these two orientations only.

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.

KDB 558074 D01 15.247 Meas Guidance v05r02

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

NOTE: The limits in FCC 47 CFR, 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 Ohms. For example, the measurement at frequency X kHz resulted in a level of Y dBuV/m, which is equivalent to Y – 51.5 = Z dBuA/m, which has the same margin, W dB, to the corresponding RSS-Gen Table 6 limit as it has to 15.209(a) limit.

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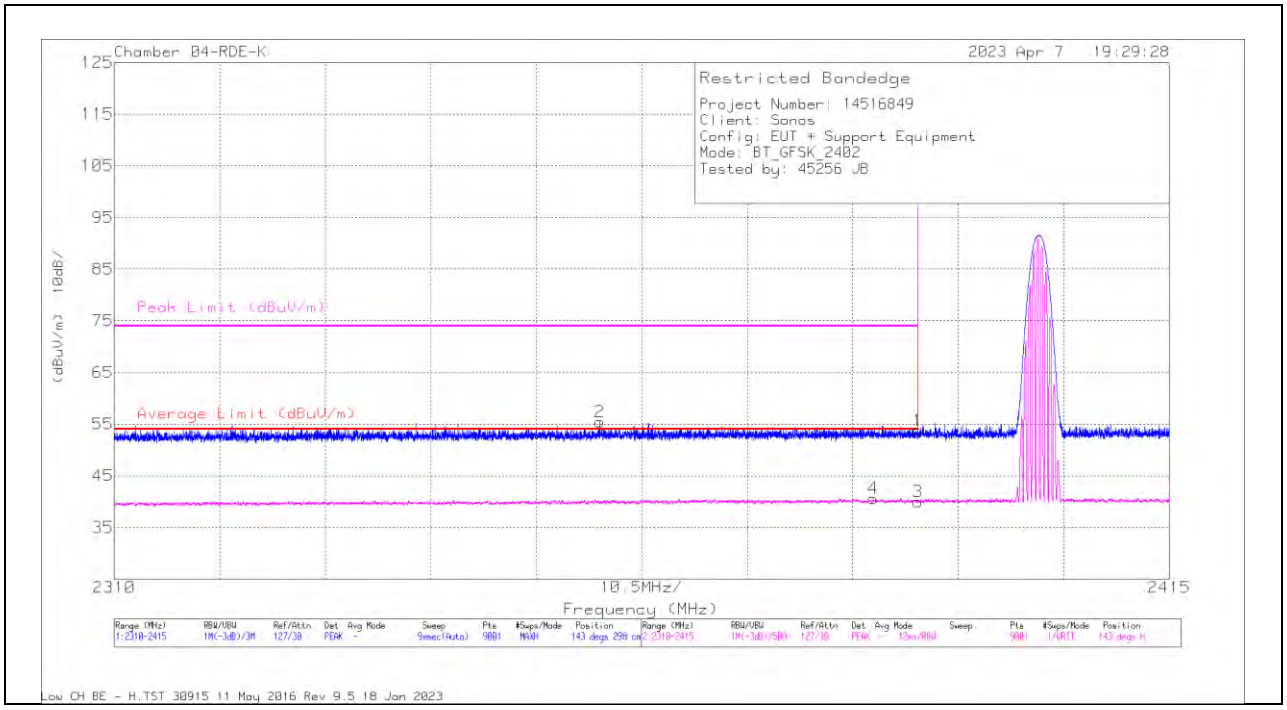
10.1. TRANSMITTER ABOVE 1 GHz

10.1.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

BANDEDGE (LOW CHANNEL)

HORIZONTAL RESULT



Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	223083 ACF (dB) 3mH	Amp/Cbl/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2390	56.8	Pk	31.8	-34.9	53.7	-	-	74	-20.3	143	298	H
2	* 2358.348	58.81	Pk	31.6	-35	55.41	-	-	74	-18.59	143	298	H
3	* 2390	43.04	VA1T	31.8	-34.9	39.94	54	-14.06	-	-	143	298	H
4	* 2385.544	43.68	VA1T	31.8	-34.9	40.58	54	-13.42	-	-	143	298	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmitting duration

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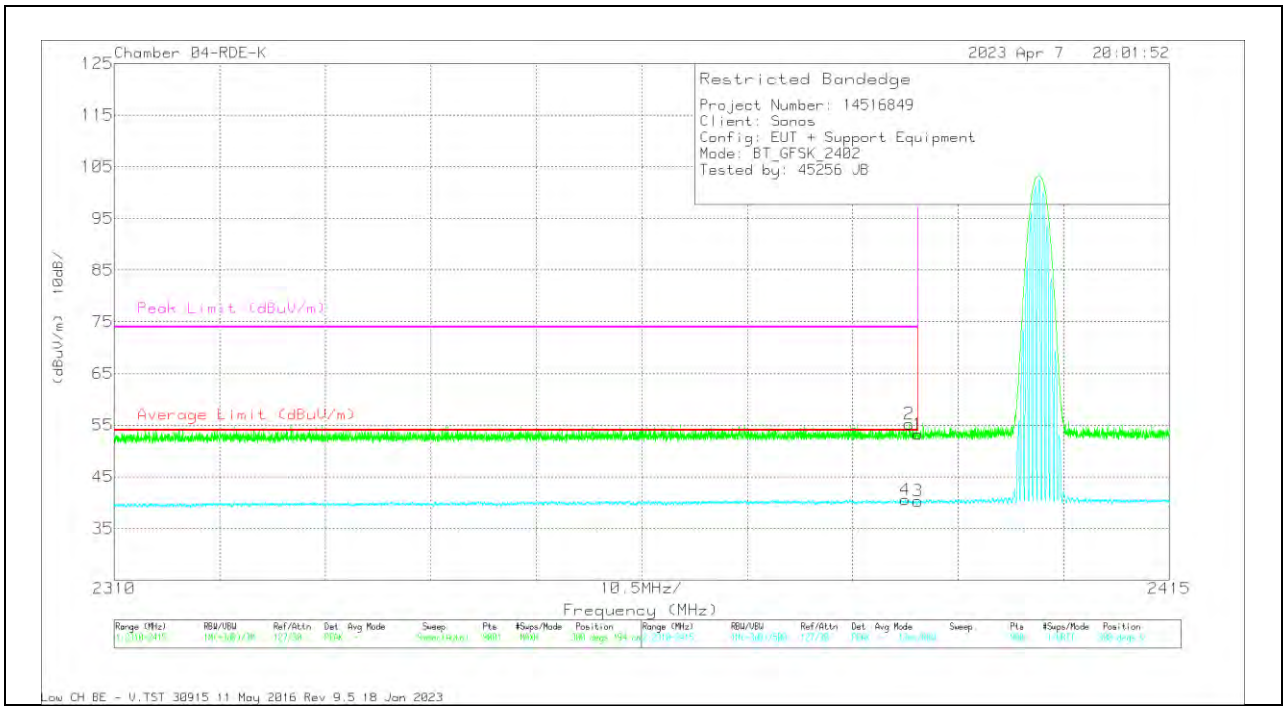
VERTICAL RESULT



Trace Marker

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	223083 ACF (dB) 3mH	Amp/Cbl/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2390	56.33	Pk	31.8	-34.9	53.23	-	-	74	-20.77	300	194	V
2	* 2389.114	58.21	Pk	31.8	-34.8	55.21	-	-	74	-18.79	300	194	V
3	* 2390	43.39	VA1T	31.8	-34.9	40.29	54	-13.71	-	-	300	194	V
4	* 2388.741	43.57	VA1T	31.8	-34.8	40.57	54	-13.43	-	-	300	194	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmitting duration

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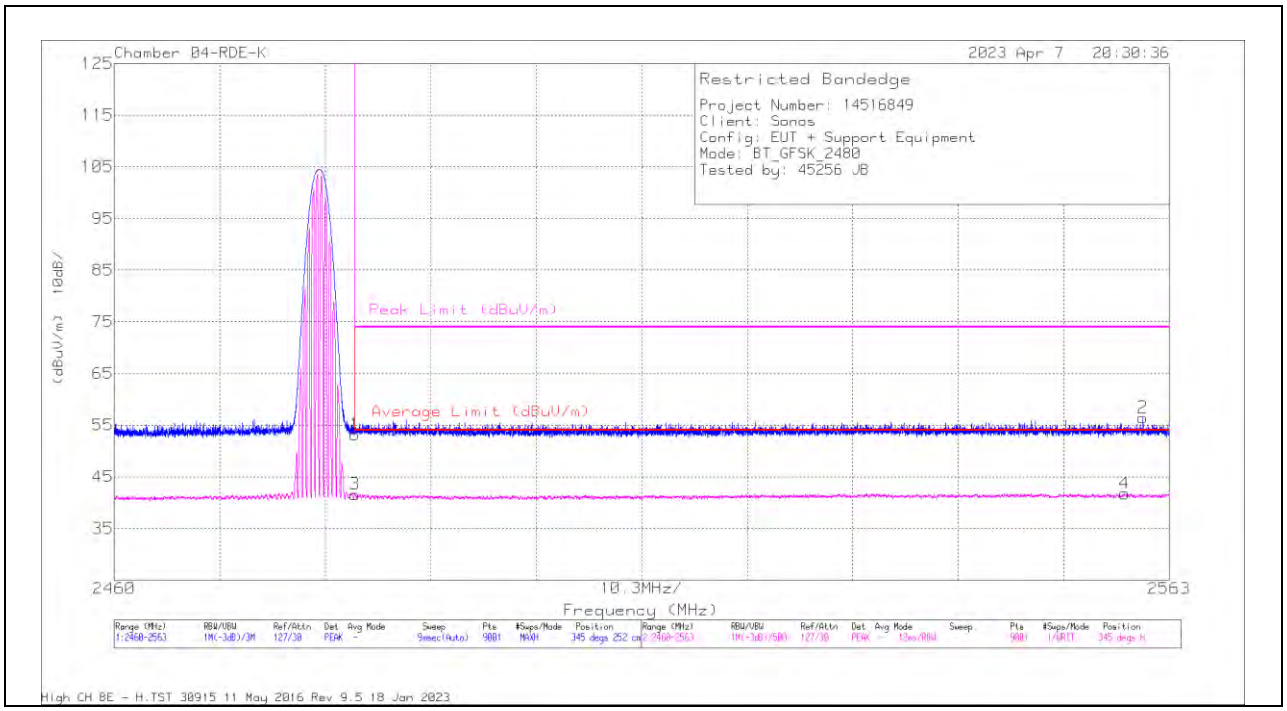
BANDEDGE (HIGH CHANNEL)

HORIZONTAL RESULT



Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	223083 ACF (dB) 3mH	Amp/Cbl/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2483.5	55.47	Pk	32.2	-34.5	53.17	-	-	74	-20.83	345	252	H
2	2560.41	58.52	Pk	32.2	-34.3	56.42	-	-	74	-17.58	345	252	H
3	* 2483.5	43.9	VA1T	32.2	-34.5	41.6	54	-12.4	-	-	345	252	H
4	2558.624	43.75	VA1T	32.2	-34.2	41.75	54	-12.25	-	-	345	252	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmitting duration

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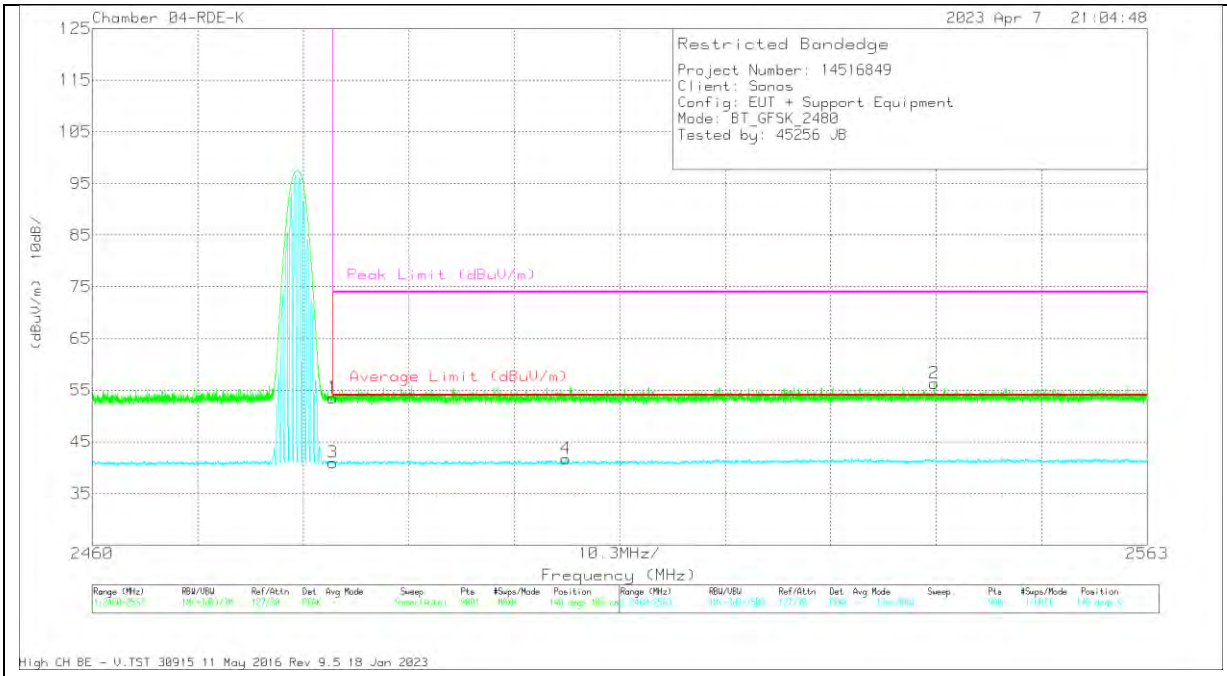
VERTICAL RESULT



Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	223083 ACF (dB) 3mH	Amp/Cbl/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2483.5	55.81	Pk	32.2	-34.5	53.51	-	-	74	-20.49	140	106	V
2	2542.214	58.35	Pk	32.2	-34.2	56.35	-	-	74	-17.65	140	106	V
3	* 2483.5	43.29	VA1T	32.2	-34.5	40.99	54	-13.01	-	-	140	106	V
4	2506.245	43.81	VA1T	32.2	-34.3	41.71	54	-12.29	-	-	140	106	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmitting duration

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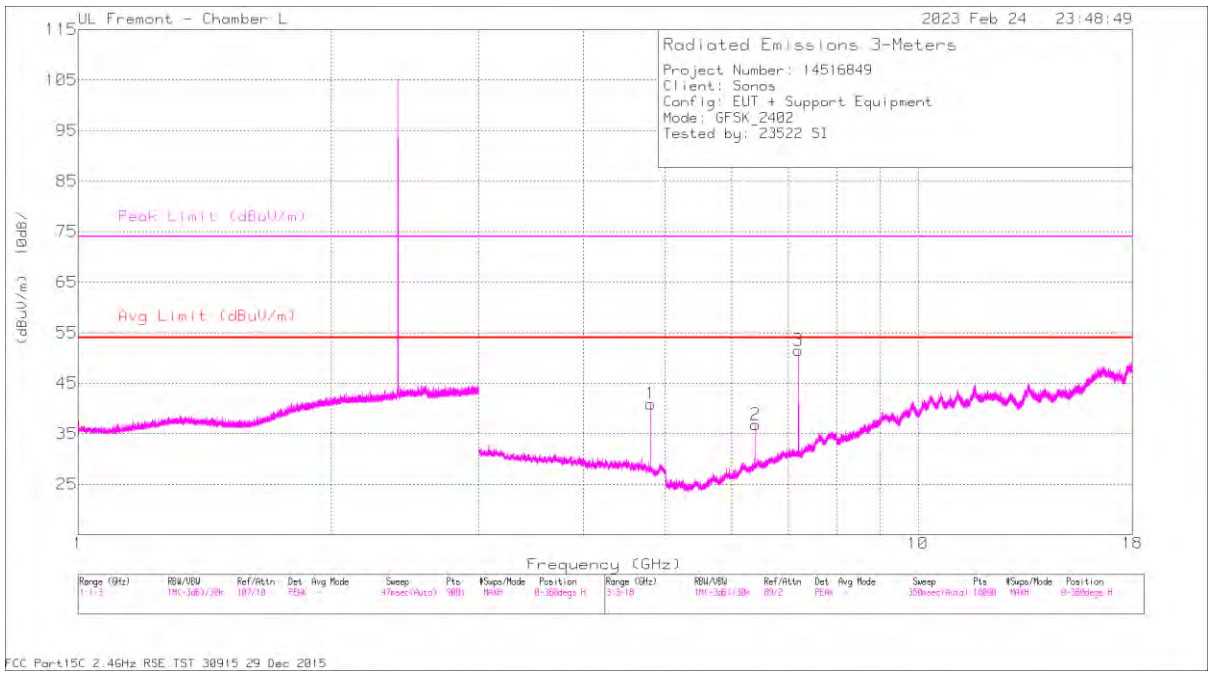
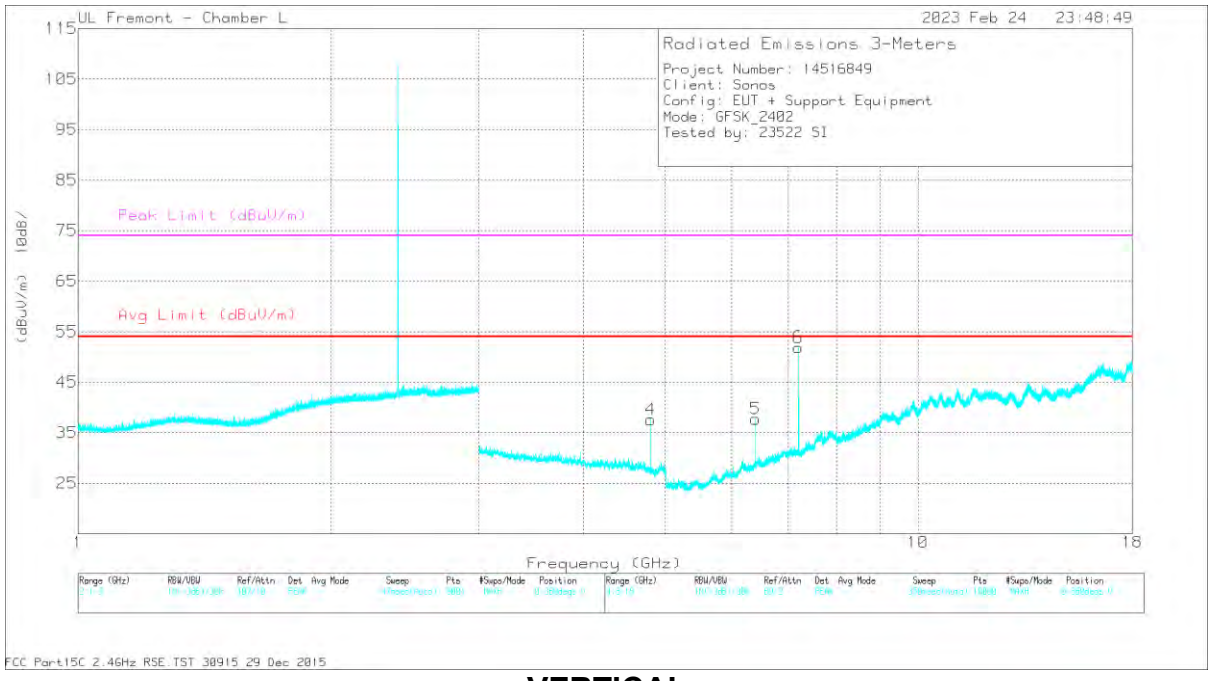
HARMONICS AND SPURIOUS EMISSIONS

LOW CHANNEL RESULTS



HORIZONTAL



VERTICAL

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RADIATED EMISSIONS

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	Horn 1mH	Amp/Cbl/Fltr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 4.804056	39.78	PKFH	34.5	-26.5	47.78	-	-	74	-26.22	228	104	H
	* 4.80402	28.31	VA1T	34.5	-26.5	36.31	54	-17.69	-	-	228	104	H
2	6.405071	28.77	PKFH	35.8	-24	40.57	-	-	-	-	170	105	H
	6.40537	18.43	VA1T	35.8	-24	30.23	-	-	-	-	170	105	H
3	7.205853	43.21	PKFH	35.9	-23	56.11	-	-	-	-	291	211	H
	7.206118	29.58	VA1T	35.9	-23	42.48	-	-	-	-	291	211	H
4	* 4.803667	39.26	PKFH	34.5	-26.5	47.26	-	-	74	-26.74	319	103	V
	* 4.803975	28.4	VA1T	34.5	-26.5	36.4	54	-17.6	-	-	319	103	V
5	6.405551	29.56	PKFH	35.8	-24	41.36	-	-	-	-	238	102	V
	6.405346	19.14	VA1T	35.8	-24	30.94	-	-	-	-	238	102	V
6	7.205773	43.09	PKFH	35.9	-23	55.99	-	-	-	-	222	199	V
	7.20612	29.11	VA1T	35.9	-23	42.01	-	-	-	-	222	199	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
PKFH FHSS/BT RB=100k for Frequencies<1GHz / RB=1MHz for Frequencies>1GHz, VB=3 x RB, Peak
VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmitting duration

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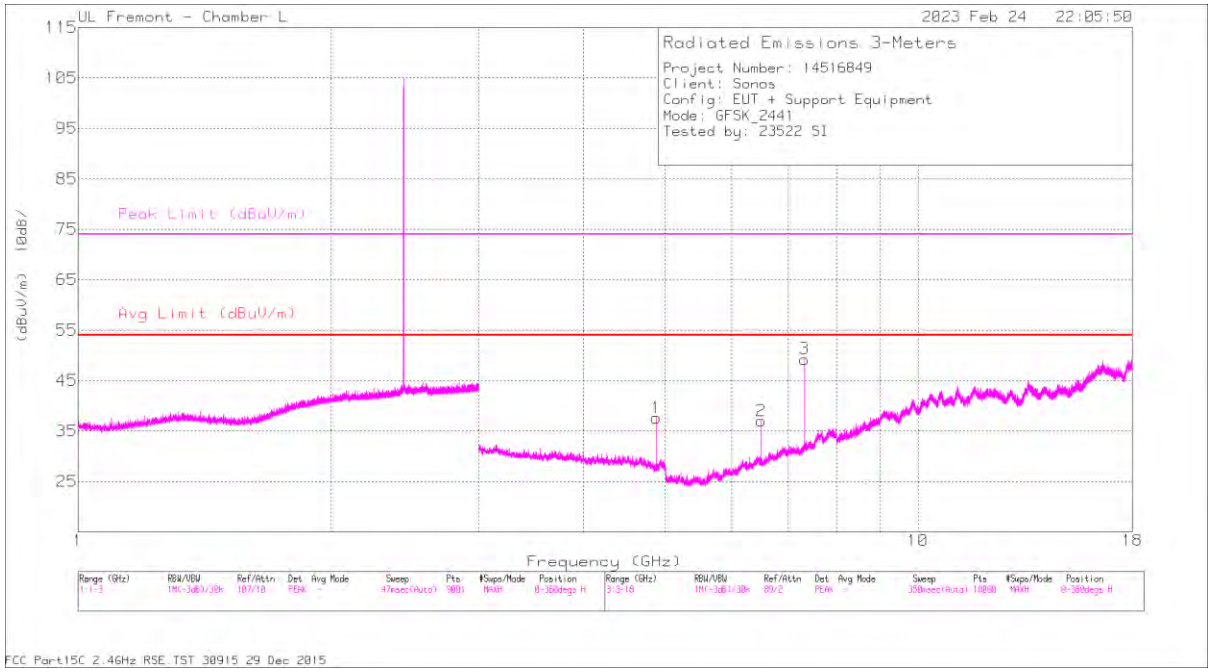
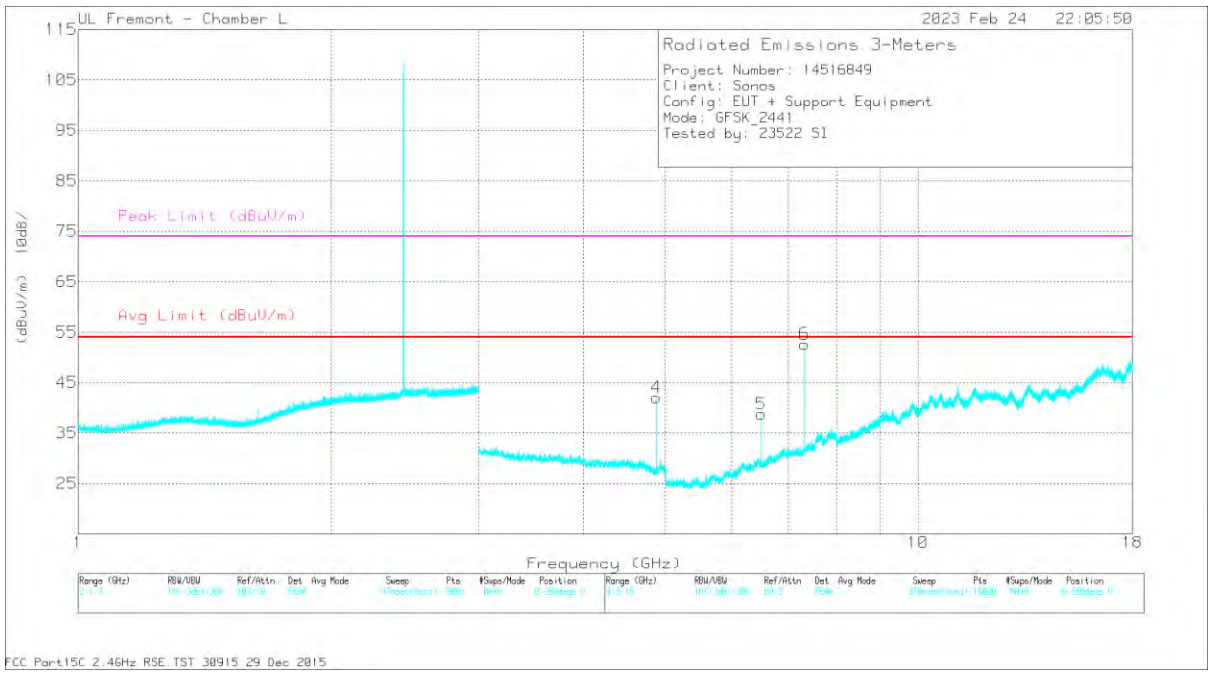
MID CHANNEL RESULTS



HORIZONTAL



VERTICAL

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RADIATED EMISSIONS

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	Horn 1mH	Amp/Cbl/Fltr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 4.882061	38.62	PKFH	34.4	-26.4	46.62	-	-	74	-27.38	29	102	H
	* 4.88208	34.27	VA1T	34.4	-26.4	42.27	54	-11.73	-	-	29	102	H
2	6.509392	29.13	PKFH	35.8	-24.2	40.73	-	-	-	-	179	103	H
	6.509535	21.88	VA1T	35.8	-24.2	33.48	-	-	-	-	179	103	H
3	* 7.322932	40.22	PKFH	35.9	-22.7	53.42	-	-	74	-20.58	320	200	H
	* 7.323054	36.51	VA1T	35.9	-22.7	49.71	54	-4.29	-	-	320	200	H
4	* 4.881982	42.96	PKFH	34.4	-26.4	50.96	-	-	74	-23.04	212	104	V
	* 4.882222	38.02	VA1T	34.4	-26.4	46.02	54	-7.98	-	-	212	104	V
5	6.509183	31.11	PKFH	35.8	-24.2	42.71	-	-	-	-	241	104	V
	6.509379	26.49	VA1T	35.8	-24.2	38.09	-	-	-	-	241	104	V
6	* 7.322968	40.39	PKFH	35.9	-22.7	53.59	-	-	74	-20.41	22	149	V
	* 7.323077	36.75	VA1T	35.9	-22.7	49.95	54	-4.05	-	-	22	149	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
PKFH FHSS/BT RB=100k for Frequencies<1GHz / RB=1MHz for Frequencies>1GHz, VB=3 x RB, Peak
VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmitting duration

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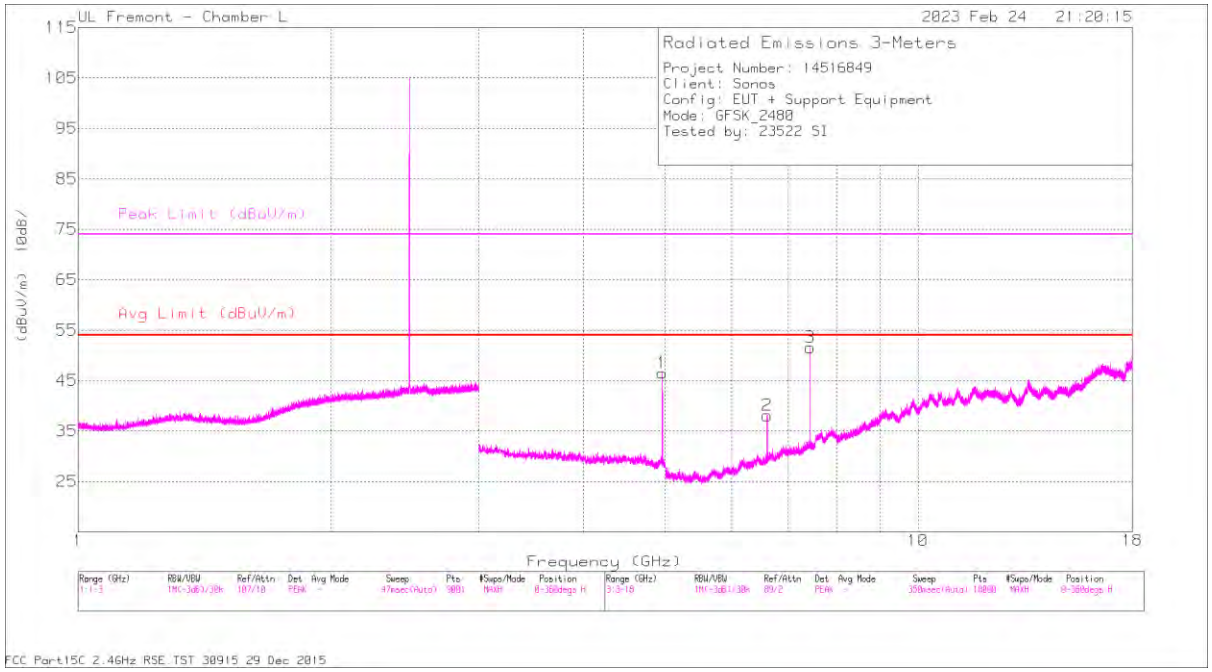
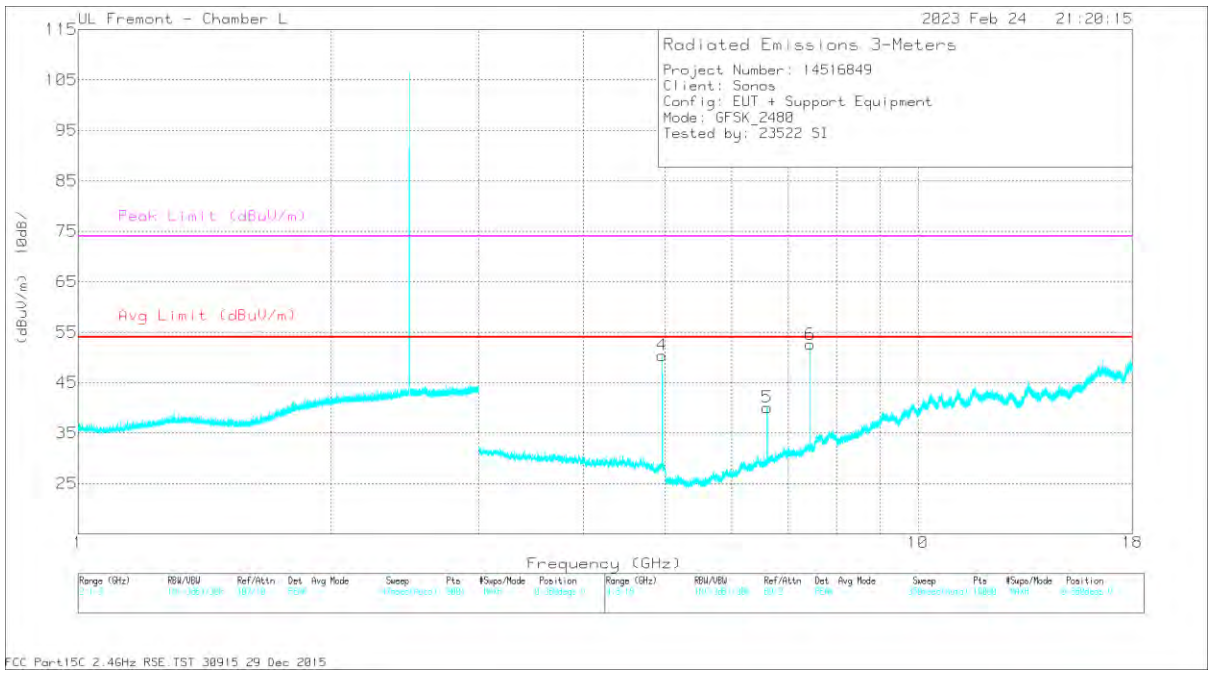
HIGH CHANNEL RESULTS



HORIZONTAL



VERTICAL

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RADIATED EMISSIONS

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	Horn 1mH	Amp/Cbl/Fltr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 4.959703	43.39	PKFH	34.4	-25.4	52.39	-	-	74	-21.61	296	112	H
	* 4.959931	40.7	VA1T	34.4	-25.4	49.7	54	-4.3	-	-	296	112	H
2	6.613222	30.53	PKFH	35.7	-23.7	42.53	-	-	-	-	187	103	H
	6.613411	24.74	VA1T	35.7	-23.7	36.74	-	-	-	-	187	103	H
3	* 7.44018	41.86	PKFH	36	-22.5	55.36	-	-	74	-18.64	205	134	H
	* 7.439811	37.63	VA1T	36	-22.5	51.13	54	-2.87	-	-	205	134	H
4	* 4.960081	41.82	PKFH	34.4	-25.4	50.82	-	-	74	-23.18	219	103	V
	* 4.95999	39.4	VA1T	34.4	-25.4	48.4	54	-5.6	-	-	219	103	V
5	6.613305	33.91	PKFH	35.7	-23.7	45.91	-	-	-	-	241	113	V
	6.613371	29.9	VA1T	35.7	-23.7	41.9	-	-	-	-	241	113	V
6	* 7.43999	41.58	PKFH	36	-22.5	55.08	-	-	74	-18.92	22	145	V
	* 7.440032	37.03	VA1T	36	-22.5	50.53	54	-3.47	-	-	22	145	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
PKFH FHSS/BT RB=100k for Frequencies<1GHz / RB=1MHz for Frequencies>1GHz, VB=3 x RB, Peak
VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmitting duration

UL VERIFICATION SERVICES
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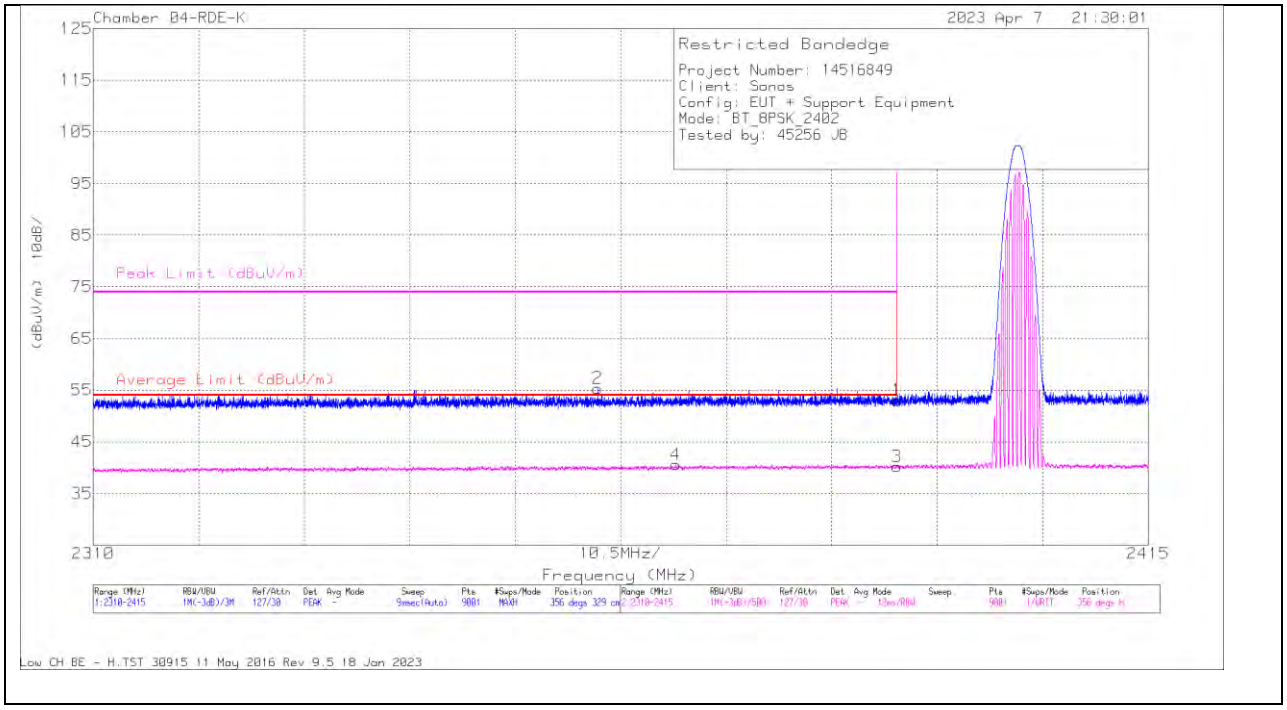
10.1.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

BANDEDGE (LOW CHANNEL)

HORIZONTAL RESULT



Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	223083 ACF (dB) 3mH	Amp/Cbl/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2390	56.15	Pk	31.8	-34.9	53.05	-	-	74	-20.95	356	329	H
2	* 2360.203	58.64	Pk	31.7	-35	55.34	-	-	74	-18.66	356	329	H
3	* 2390	43.3	VA1T	31.8	-34.9	40.2	54	-13.8	-	-	356	329	H
4	* 2367.95	43.75	VA1T	31.7	-34.9	40.55	54	-13.45	-	-	356	329	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmitting duration

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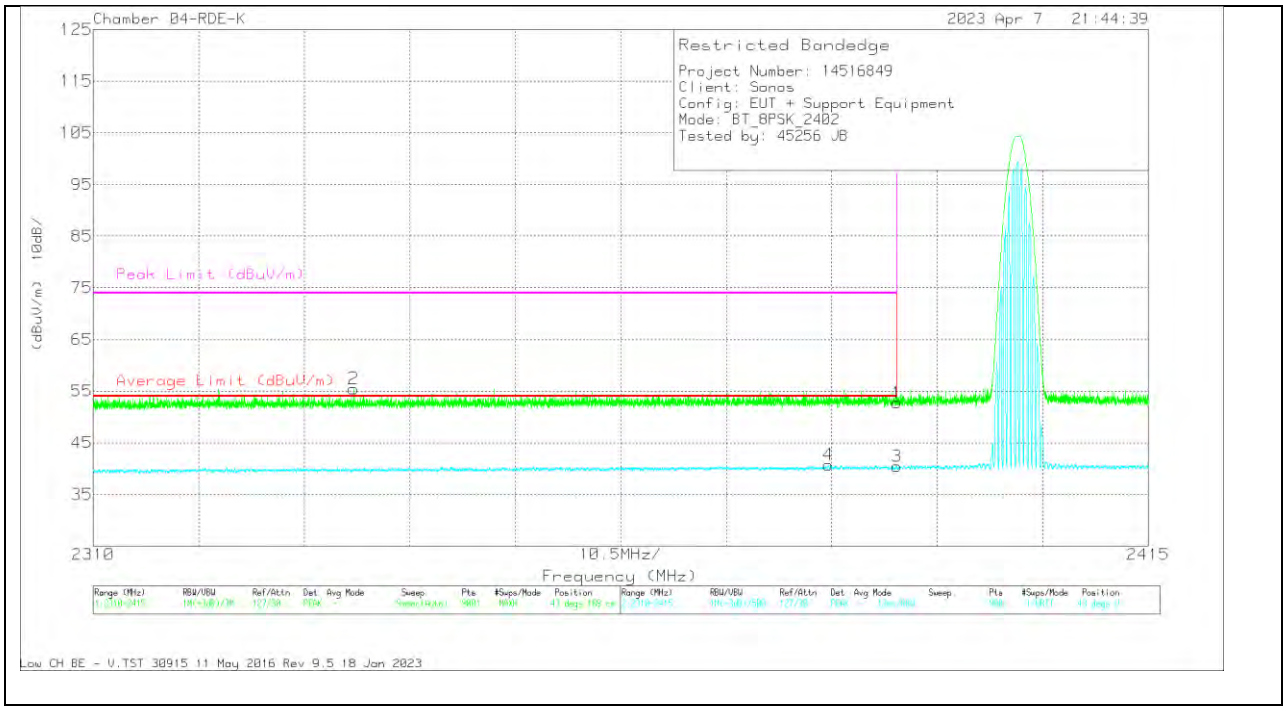
VERTICAL RESULT



Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	223083 ACF (dB) 3mH	Amp/Cbl/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2390	55.86	Pk	31.8	-34.9	52.76	-	-	74	-21.24	43	169	V
2	* 2335.912	59.05	Pk	31.5	-35.1	55.45	-	-	74	-18.55	43	169	V
3	* 2390	43.54	VA1T	31.8	-34.9	40.44	54	-13.56	-	-	43	168	V
4	* 2383.14	43.72	VA1T	31.8	-34.8	40.72	54	-13.28	-	-	43	168	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmitting duration

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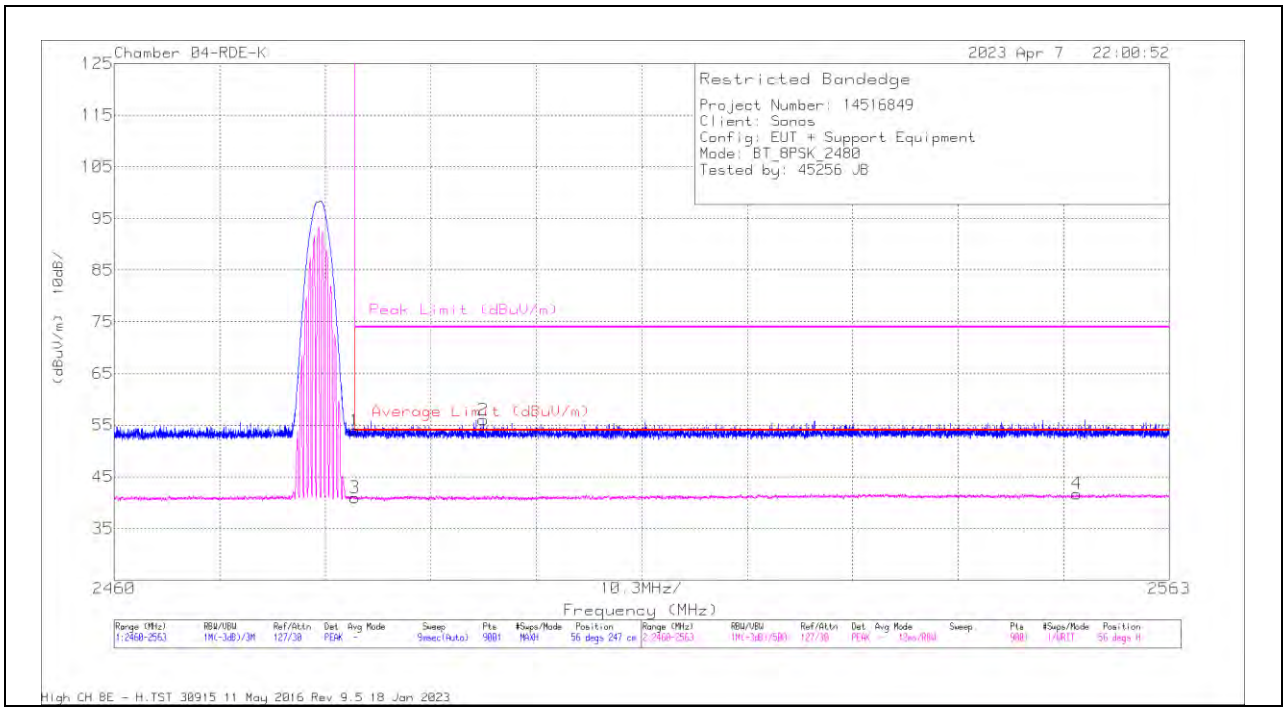
BANDEDGE (HIGH CHANNEL)

HORIZONTAL RESULT



Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	223083 ACF (dB) 3mH	Amp/Cbl/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2483.5	56.26	Pk	32.2	-34.5	53.96	-	-	74	-20.04	56	247	H
2	* 2496.026	58.23	Pk	32.2	-34.4	56.03	-	-	74	-17.97	56	247	H
3	* 2483.5	43.26	VA1T	32.2	-34.5	40.96	54	-13.04	-	-	56	247	H
4	2553.955	43.81	VA1T	32.2	-34.3	41.71	54	-12.29	-	-	56	247	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmitting duration

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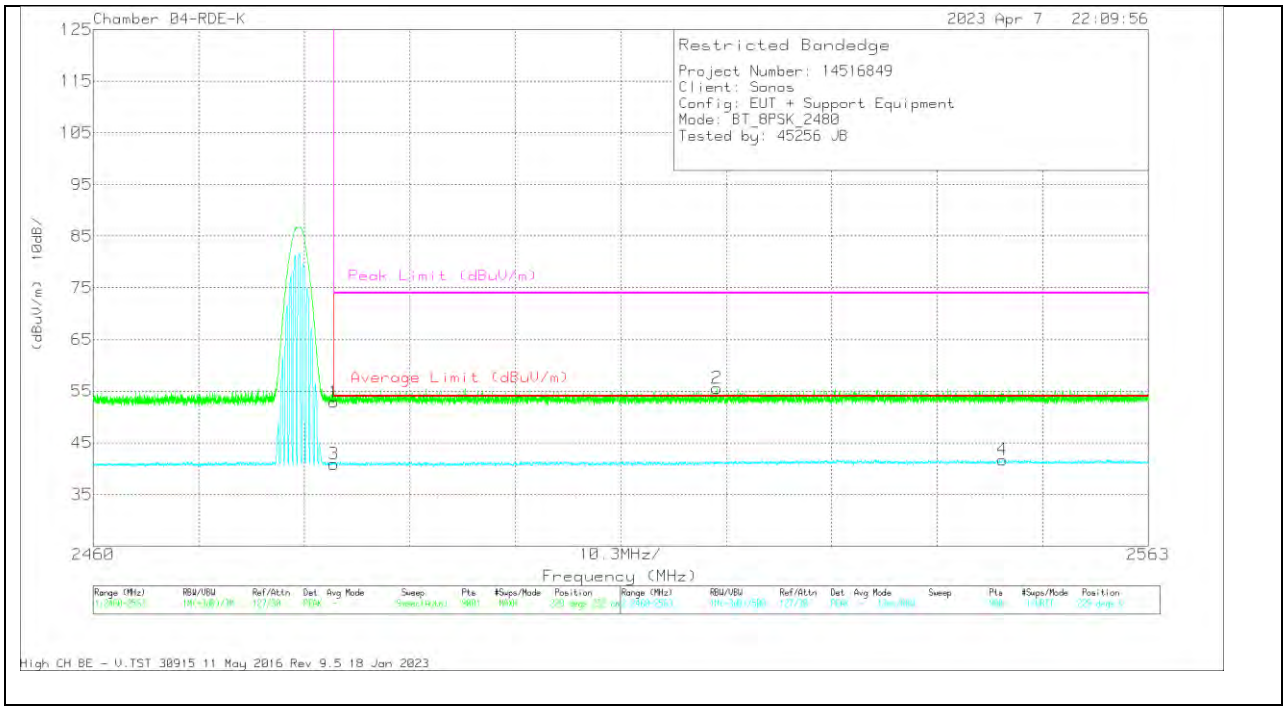
VERTICAL RESULT



Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	223083 ACF (dB) 3mH	Amp/Cbl/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2483.5	55.17	Pk	32.2	-34.5	52.87	-	-	74	-21.13	229	232	V
2	2520.882	57.7	Pk	32.2	-34.3	55.6	-	-	74	-18.4	229	232	V
3	* 2483.5	43.2	VA1T	32.2	-34.5	40.9	54	-13.1	-	-	229	232	V
4	2548.76	43.72	VA1T	32.2	-34.2	41.72	54	-12.28	-	-	229	232	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

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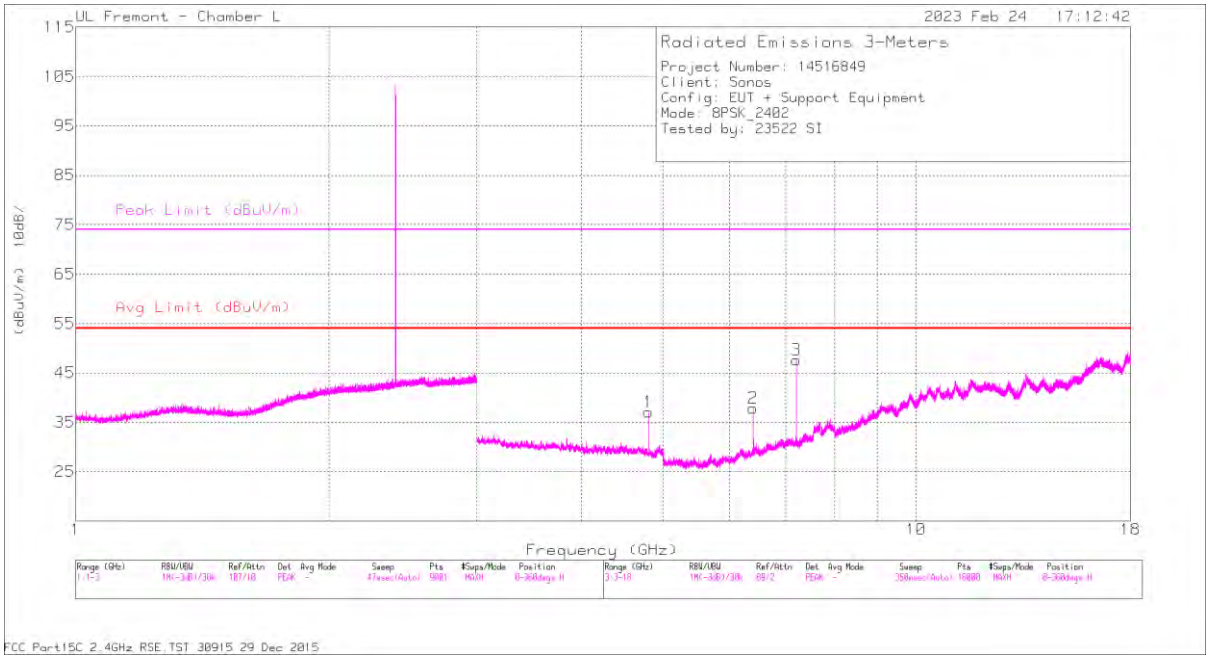
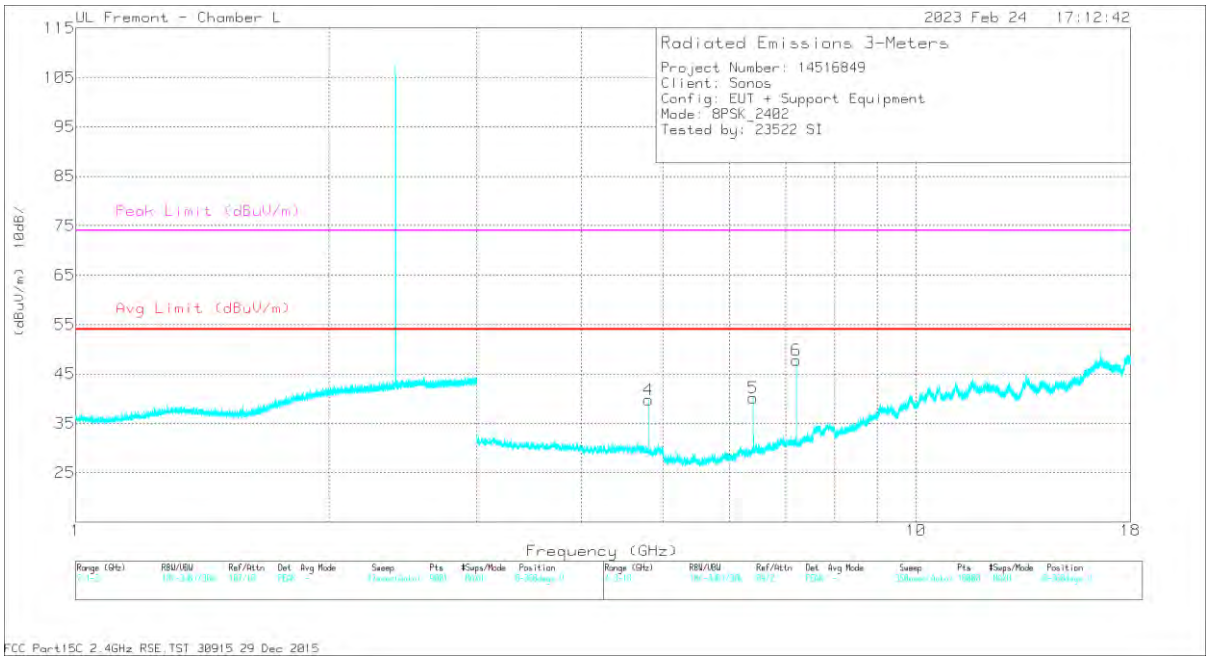
HARMONICS AND SPURIOUS EMISSIONS

LOW CHANNEL RESULTS



HORIZONTAL



VERTICAL

UL VERIFICATION SERVICES
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RADIATED EMISSIONS

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	Horn 1mH	Amp/Cbl/Fltr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 4.804116	36.32	PKFH	34.5	-26.5	44.32	-	-	74	-29.68	26	180	H
	* 4.803785	24.44	VA1T	34.5	-26.5	32.44	54	-21.56	-	-	26	180	H
2	6.405451	31.69	PKFH	35.8	-24	43.49	-	-	-	-	283	331	H
	6.405305	25.58	VA1T	35.8	-24	37.38	-	-	-	-	283	331	H
3	7.205518	38.79	PKFH	35.9	-23	51.69	-	-	-	-	172	332	H
	7.205926	24.41	VA1T	35.9	-23	37.31	-	-	-	-	172	332	H
4	* 4.80418	42.96	PKFH	34.5	-26.5	50.96	-	-	74	-23.04	35	322	V
	* 4.804231	33.13	VA1T	34.5	-26.5	41.13	54	-12.87	-	-	35	322	V
5	6.405453	31.71	PKFH	35.8	-24	43.51	-	-	-	-	75	327	V
	6.405218	27.2	VA1T	35.8	-24	39.0	-	-	-	-	75	327	V
6	7.205986	38.7	PKFH	35.9	-23	51.6	-	-	-	-	221	138	V
	7.206056	24.42	VA1T	35.9	-23	37.32	-	-	-	-	221	138	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
PKFH FHSS/BT RB=100k for Frequencies<1GHz / RB=1MHz for Frequencies>1GHz, VB=3 x RB, Peak
VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmitting duration

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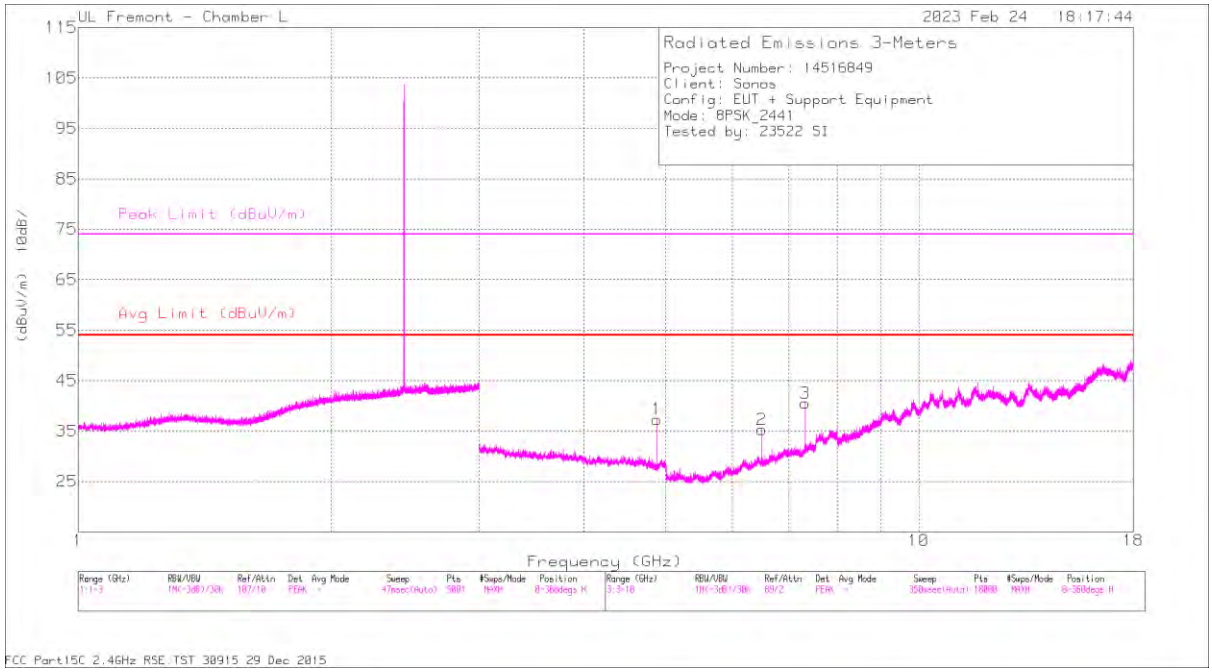
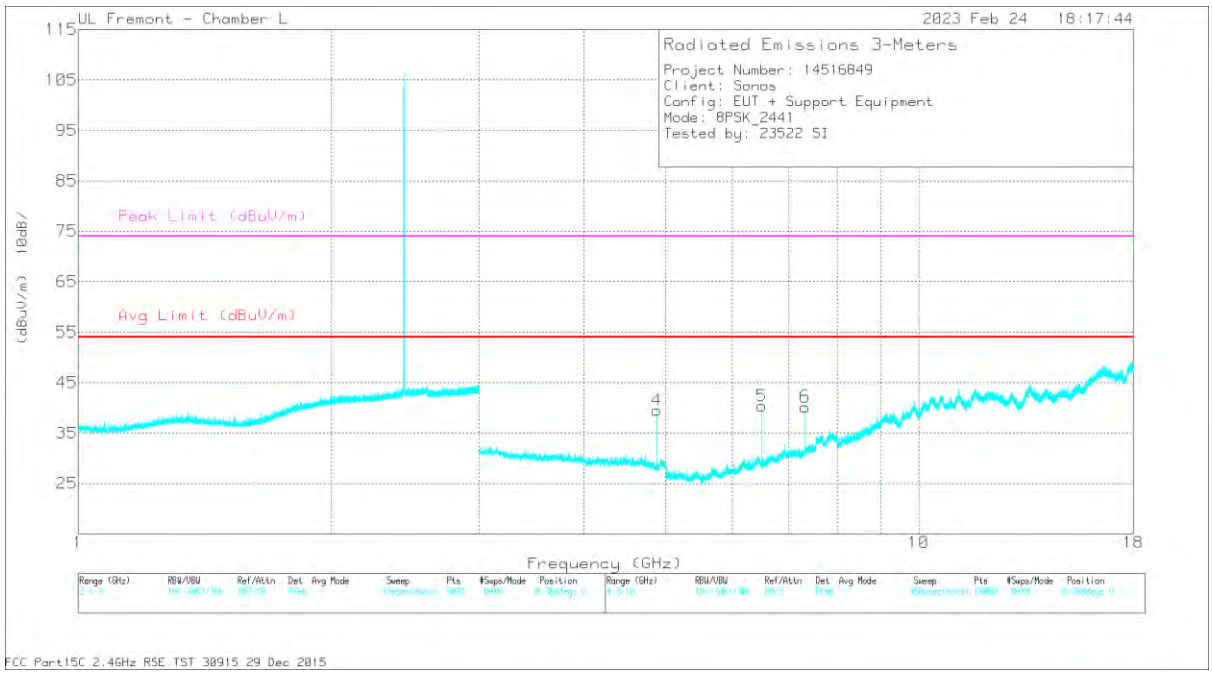
MID CHANNEL RESULTS



HORIZONTAL



VERTICAL

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RADIATED EMISSIONS

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	Horn 1mH	Amp/Cbl/Fltr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 4.881784	41.55	PKFH	34.4	-26.4	49.55	-	-	74	-24.45	332	311	H
	* 4.882314	32.46	VA1T	34.4	-26.4	40.46	54	-13.54	-	-	332	311	H
2	6.509106	30.8	PKFH	35.8	-24.2	42.4	-	-	-	-	182	116	H
	6.509576	24.95	VA1T	35.8	-24.2	36.55	-	-	-	-	182	116	H
3	* 7.323578	38.84	PKFH	35.9	-22.7	52.04	-	-	74	-21.96	348	104	H
	* 7.323149	24.76	VA1T	35.9	-22.7	37.96	54	-16.04	-	-	348	104	H
4	* 4.882051	42.11	PKFH	34.4	-26.4	50.11	-	-	74	-23.89	32	281	V
	* 4.882205	30.9	VA1T	34.4	-26.4	38.9	54	-15.1	-	-	32	281	V
5	6.509342	32.61	PKFH	35.8	-24.2	44.21	-	-	-	-	226	329	V
	6.509189	28.03	VA1T	35.8	-24.2	39.63	-	-	-	-	226	329	V
6	* 7.323032	37.39	PKFH	35.9	-22.7	50.59	-	-	74	-23.41	24	182	V
	* 7.322997	23.5	VA1T	35.9	-22.7	36.7	54	-17.3	-	-	24	182	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
PKFH FHSS/BT RB=100k for Frequencies<1GHz / RB=1MHz for Frequencies>1GHz, VB=3 x RB, Peak
VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmitting duration

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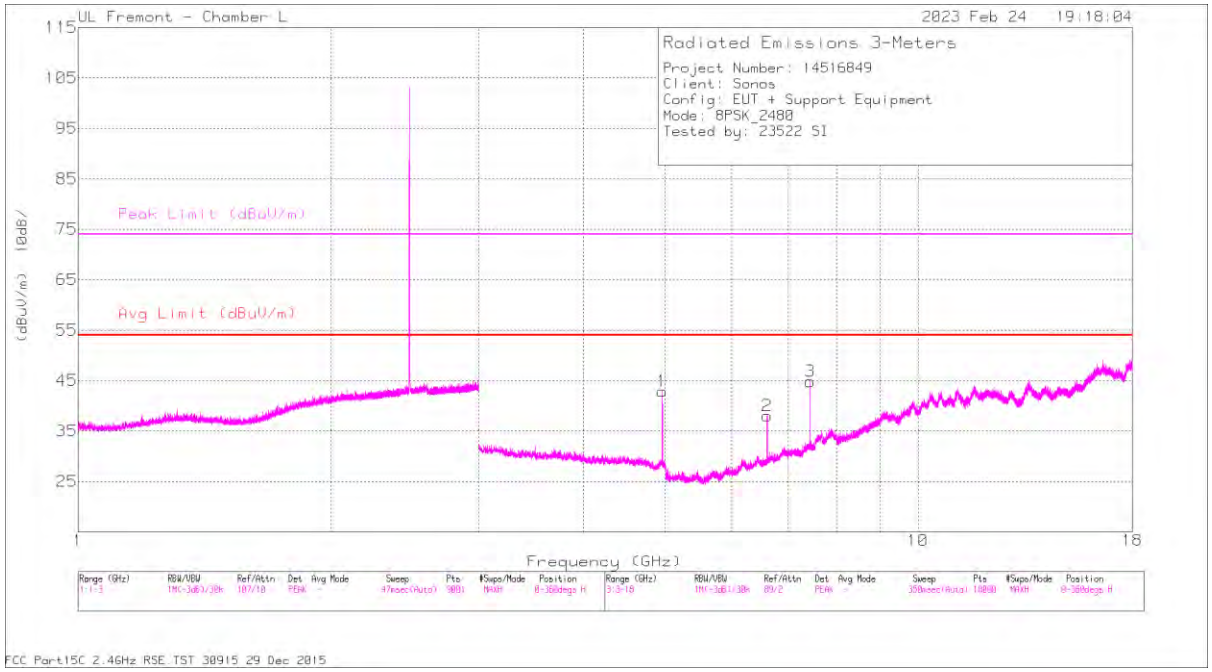
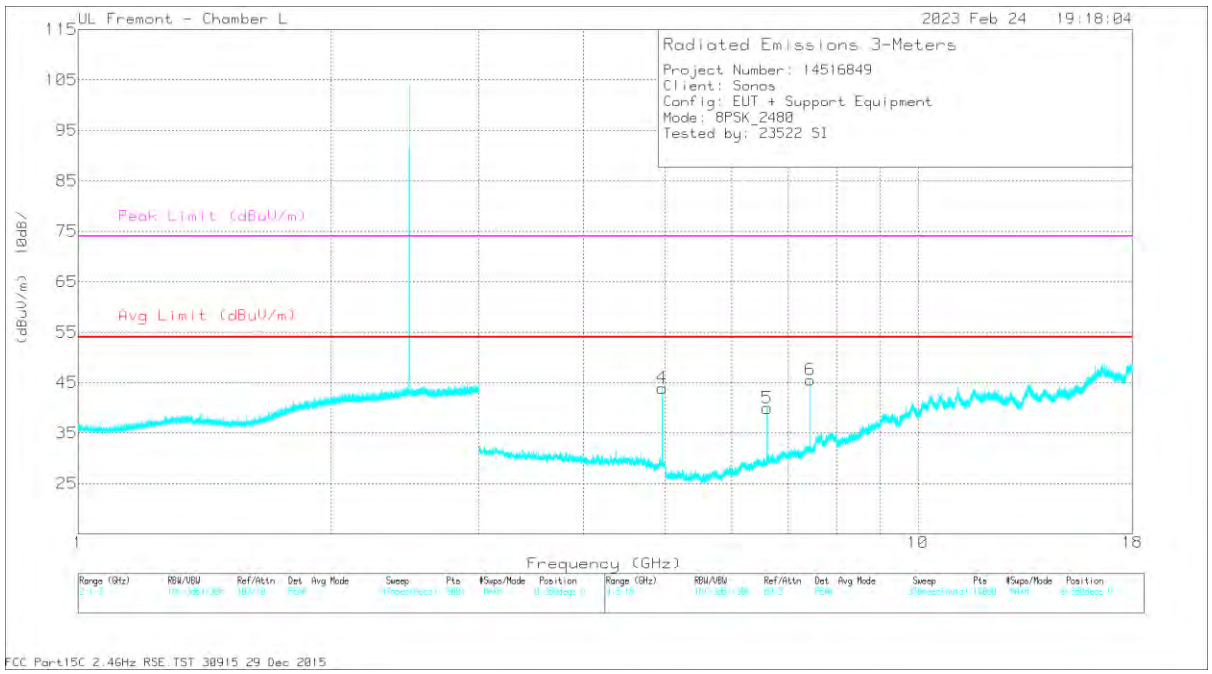
HIGH CHANNEL RESULTS



HORIZONTAL



VERTICAL

UL VERIFICATION SERVICES
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RADIATED EMISSIONS

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	Horn 1mH	Amp/Cbl/Fltr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 4.960304	44.62	PKFH	34.4	-25.4	53.62	-	-	74	-20.38	327	322	H
	* 4.960059	35.05	VA1T	34.4	-25.4	44.05	54	-9.95	-	-	327	322	H
2	6.613676	30.55	PKFH	35.7	-23.7	42.55	-	-	-	-	191	103	H
	6.613587	25.29	VA1T	35.7	-23.7	37.29	-	-	-	-	191	103	H
3	* 7.44046	36.74	PKFH	36	-22.5	50.24	-	-	74	-23.76	290	340	H
	* 7.440168	23.37	VA1T	36	-22.5	36.87	54	-17.13	-	-	290	340	H
4	* 4.960191	45.18	PKFH	34.4	-25.4	54.18	-	-	74	-19.82	39	121	V
	* 4.960108	35.62	VA1T	34.4	-25.4	44.62	54	-9.38	-	-	39	121	V
5	6.613489	31.63	PKFH	35.7	-23.7	43.63	-	-	-	-	220	330	V
	6.613351	26.99	VA1T	35.7	-23.7	38.99	-	-	-	-	220	330	V
6	* 7.439988	40.58	PKFH	36	-22.5	54.08	-	-	74	-19.92	26	191	V
	* 7.440021	27.06	VA1T	36	-22.5	40.56	54	-13.44	-	-	26	191	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
PKFH FHSS/BT RB=100k for Frequencies<1GHz / RB=1MHz for Frequencies>1GHz, VB=3 x RB, Peak
VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmitting duration

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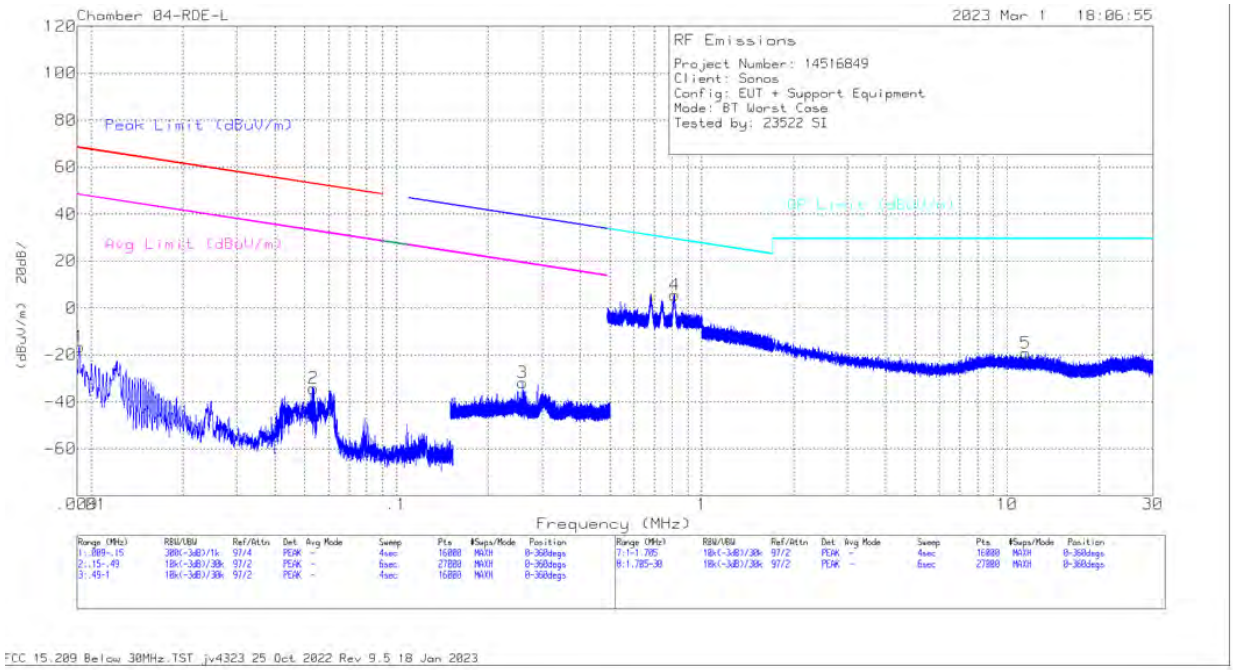
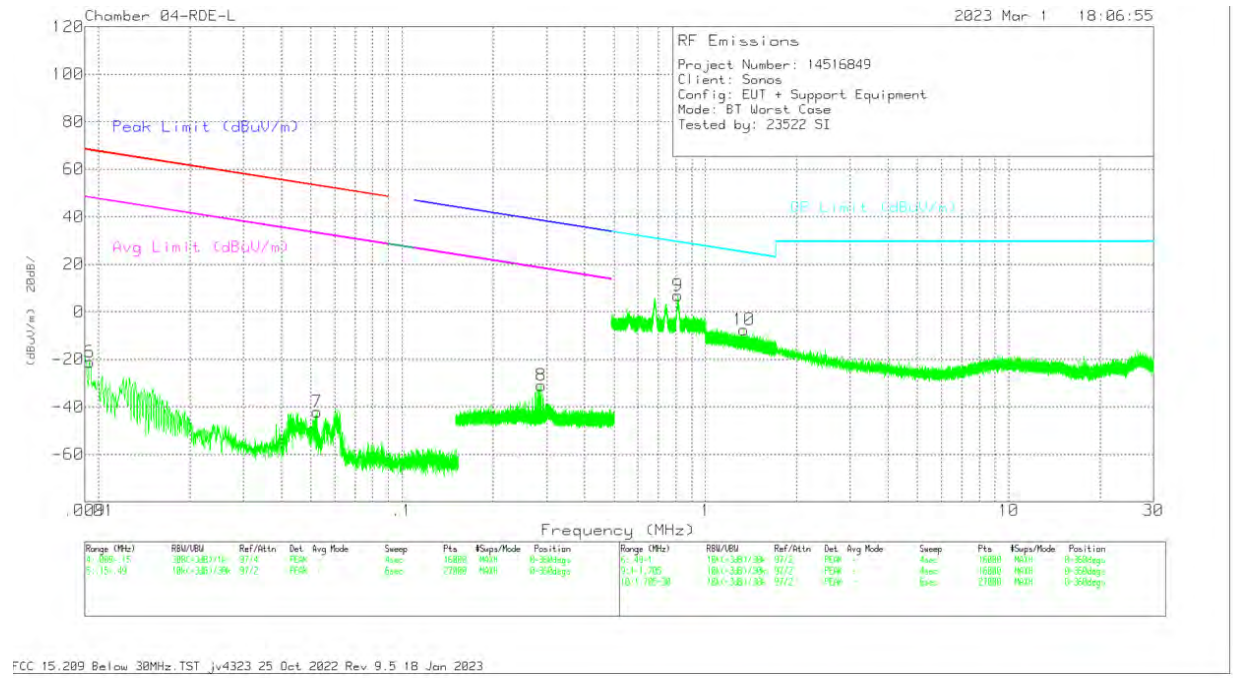
10.2. WORST CASE BELOW 30MHz

SPURIOUS EMISSIONS BELOW 30 MHz (WORST-CASE CONFIGURATION)



ANTENNA - FACE ON



ANTENNA - FACE OFF

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Below 30MHz Data

Range 1: Face On .009 - .15MHz													
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	Amp/Cbl (dB)	Dist Corr 300m	Corrected Reading (dBuVolts)	Peak Limit (dBuV/m)	Margin (dB)	Avg Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Polarity (degs)
1	.0092	31.27	Pk	60.9	-28.7	-80	-16.53	68.35	-84.88	48.35	-64.88	0-360	0-deg
2	.0535	21.07	Pk	56.6	-31.9	-80	-34.23	53.03	-87.26	33.03	-67.26	0-360	0-deg

Range 2: Face On .15 - .49MHz													
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	Amp/Cbl (dB)	Dist Corr 300m	Corrected Reading (dBuVolts)	Peak Limit (dBuV/m)	Margin (dB)	Avg Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Polarity (degs)
3	.2584	24.13	Pk	56	-32	-80	-31.87	39.37	-71.24	19.37	-51.24	0-360	0-deg

Range 3: Face On .49 - 1MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	Amp/Cbl (dB)	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuVolts)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Polarity (degs)
4	.8143	21.29	Pk	56.1	-31.9	-40	5.49	29.4	-23.91	0-360	0-deg

Range 4: Face Off .009 - .15MHz													
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	Amp/Cbl (dB)	Dist Corr 300m	Corrected Reading (dBuVolts)	Peak Limit (dBuV/m)	Margin (dB)	Avg Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Polarity (degs)
6	.0093	26.93	Pk	60.8	-28.8	-80	-21.07	68.18	-89.25	48.18	-69.25	0-360	90-degs
7	.0526	13.14	Pk	56.7	-31.9	-80	-42.06	53.17	-95.23	33.17	-75.23	0-360	90-degs

Range 5: Face Off .15 - .49MHz													
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	Amp/Cbl (dB)	Dist Corr 300m	Corrected Reading (dBuVolts)	Peak Limit (dBuV/m)	Margin (dB)	Avg Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Polarity (degs)
8	.2874	24.93	Pk	56	-32	-80	-31.07	38.44	-69.51	18.44	-49.51	0-360	90-degs

Range 6: Face Off .49 - 1MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	Amp/Cbl (dB)	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuVolts)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Polarity (degs)
9	.8113	22.64	Pk	56.1	-31.9	-40	6.84	29.43	-22.59	0-360	90-degs

Range 8: Face On 1.705 - 30MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E(ACF)	Amp/Cbl (dB)	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuVolts)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Polarity (degs)
5	11.5101	17.81	Pk	34.5	-31.6	-40	-19.29	29.5	-48.79	0-360	0-deg

Range 9: Face Off 1 - 1.705MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E(ACF)	Amp/Cbl (dB)	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuVolts)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Polarity (degs)
10	1.3382	19.28	Pk	45	-31.9	-40	-7.62	25.1	-32.72	0-360	90-degs

Pk - Peak detector

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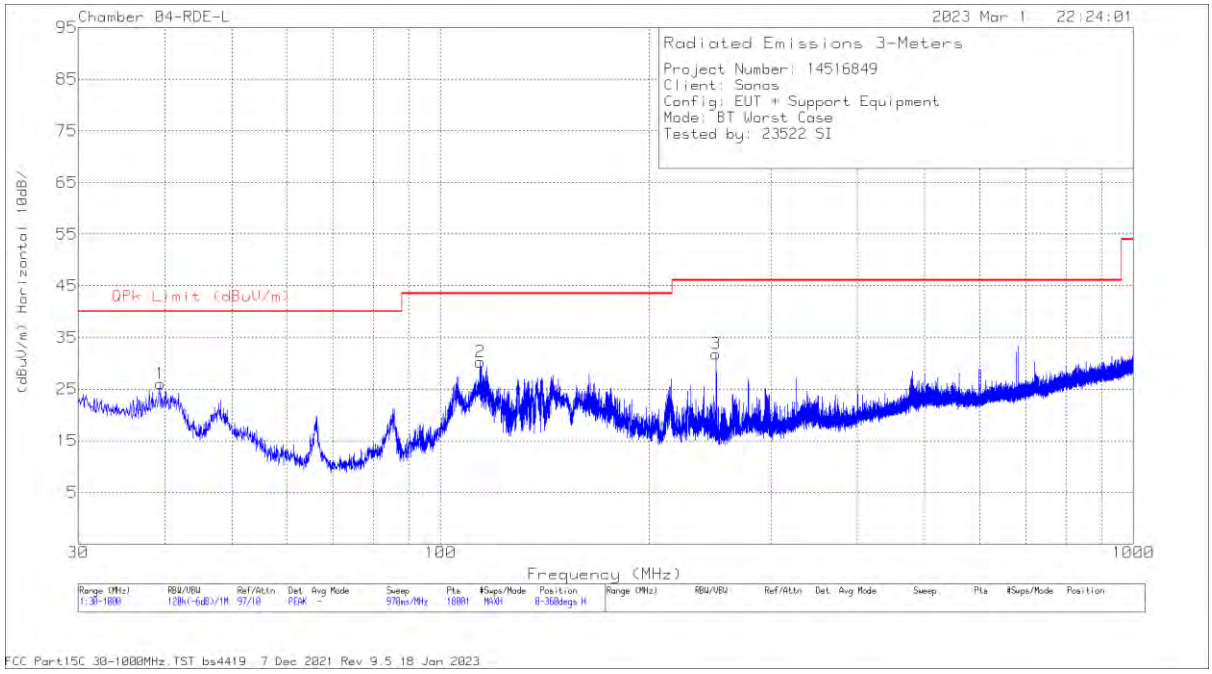
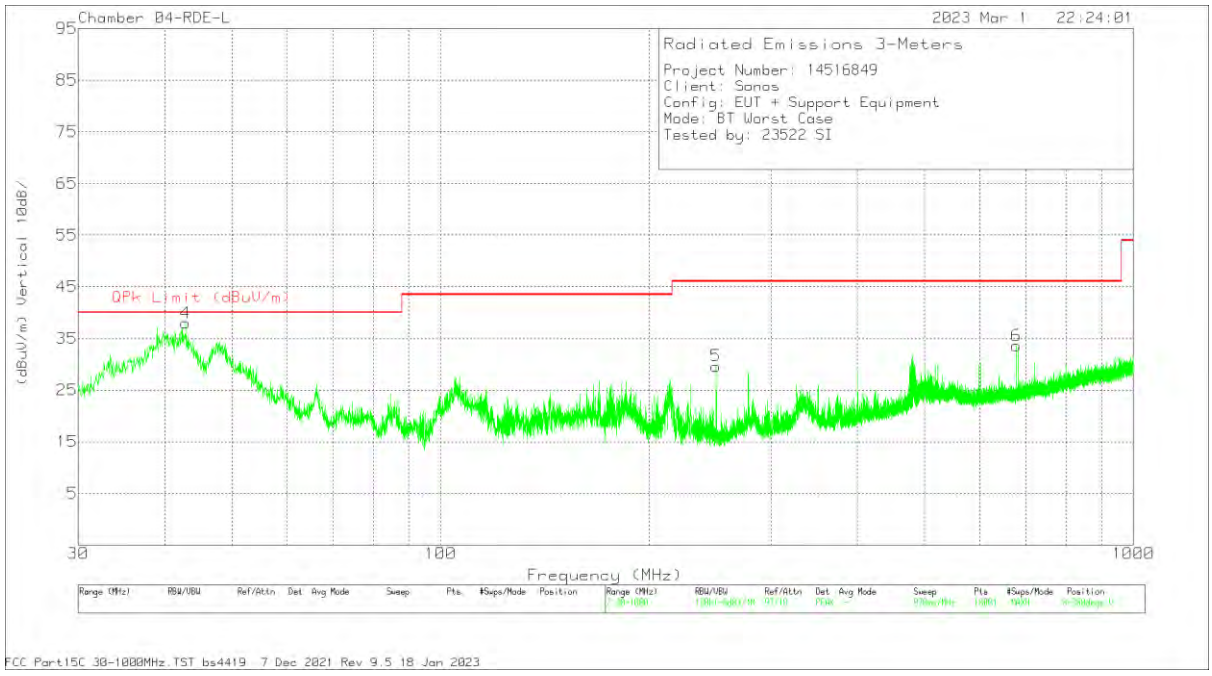
10.3. WORST CASE BELOW 1 GHz

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



HORIZONTAL



VERTICAL

UL VERIFICATION SERVICES
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Below 1GHz Data

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	80293 ACF (dB)	Amp/Cbl (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	39.4306	37.02	Pk	20.2	-31.2	26.02	40	-13.98	0-360	399	H
2	114.229	41.66	Pk	19.2	-30.6	30.26	43.52	-13.26	0-360	299	H
3	249.975	44.33	Pk	17.2	-29.7	31.83	46.02	-14.19	0-360	101	H
4	42.836	52.96	Pk	17.6	-31.2	39.36	40	-.64	104	117	V
	42.836	46.47	Qp	17.6	-31.2	32.87	40	-7.13	104	117	V
5	249.975	42.13	Pk	17.2	-29.7	29.63	46.02	-16.39	0-360	99	V
6	678.123	36.48	Pk	25.4	-28.3	33.58	46.02	-12.44	0-360	99	V

Pk - Peak detector
Qp - Quasi-Peak detector

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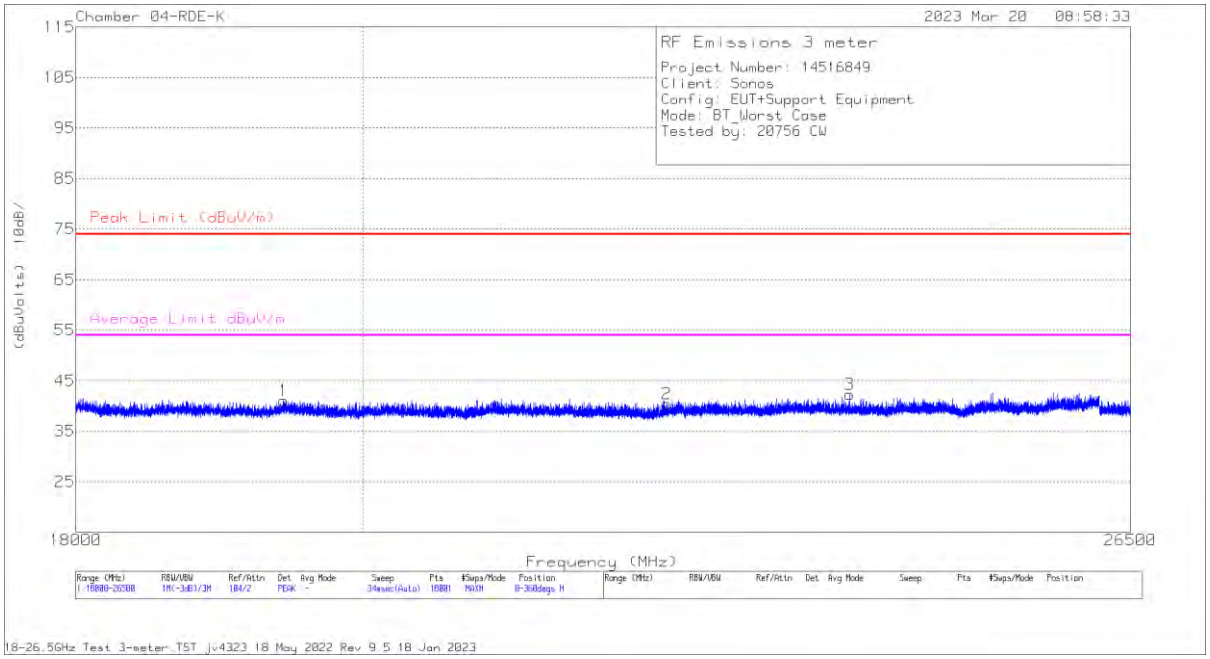
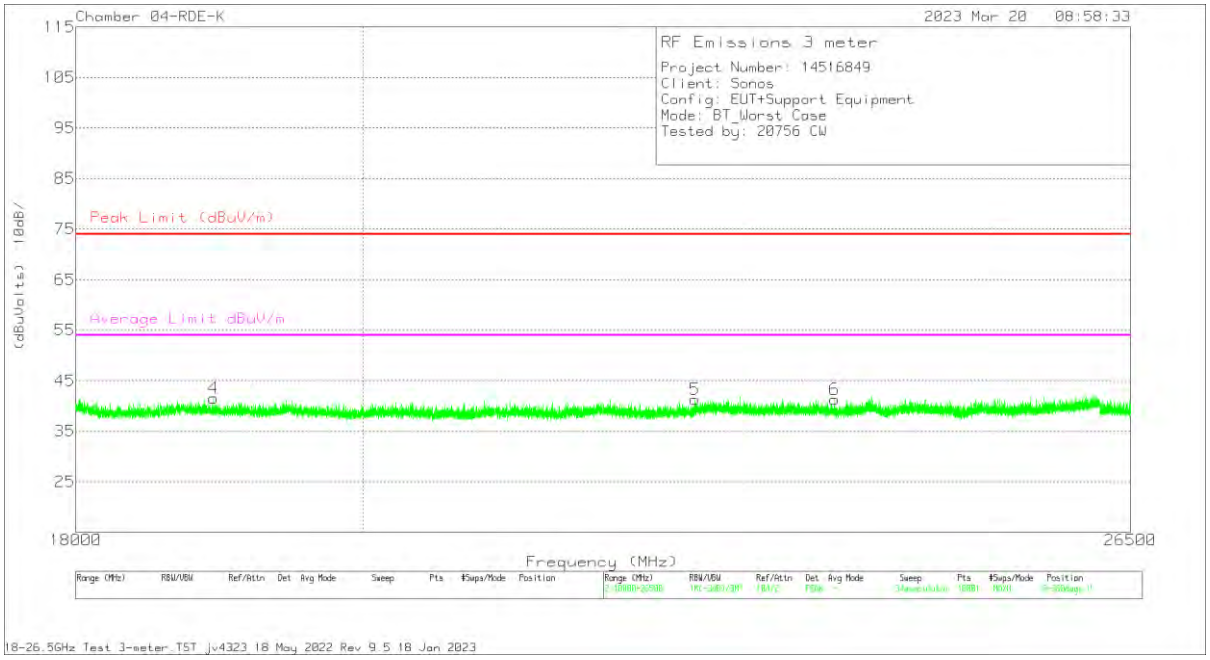
10.4. WORST CASE 18-26 GHz

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



HORIZONTAL



VERTICAL

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18 – 26GHz Data

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	199659 ACF (dB)	234683 Amp/Cbl (dB)	Cables (dB)	Corrected Reading (dBuVolts)	Peak Limit (dBuV/m)	PK Margin (dB)	Average Limit dBuV/m	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 19427.055	51.91	Pk	33.4	-62.8	18.5	41.01	74	-32.99	54	-12.99	0-360	200	H
2	* 22353.415	50.3	Pk	33	-62.6	19.7	40.4	74	-33.6	54	-13.6	0-360	101	H
3	* 23904.664	51.04	Pk	33.3	-62.5	20.4	42.24	74	-31.76	54	-11.76	0-360	200	H
4	* 18933.583	52.21	Pk	33.5	-62.5	18.3	41.51	74	-32.49	54	-12.49	0-360	199	V
5	* 22589.526	51.02	Pk	33.1	-62.7	19.9	41.32	74	-32.68	54	-12.68	0-360	199	V
6	* 23776.692	50.13	Pk	33.3	-62.6	20.4	41.23	74	-32.77	54	-12.77	0-360	199	V

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

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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.

TEST PROCEDURE

The EUT is placed on a non-conducting table 40 cm from the vertical ground plane and 80 cm above the horizontal ground plane. The EUT is configured in accordance with ANSI C63.4.

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

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

RESULTS

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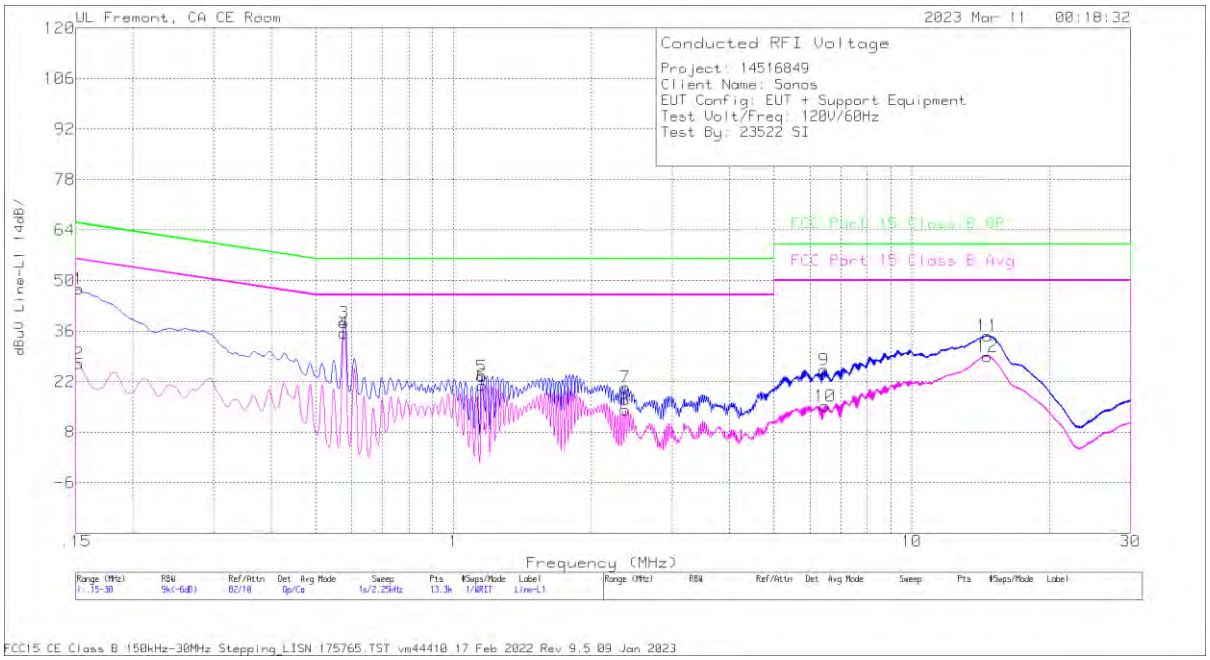
AC Power Line Norm

LINE 1 RESULTS



Trace Markers

Range 1: Line-L1 .15 - 30MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	175765 LISN L1	C1&C3 cable path loss	207996 Limiter with short cabl	Corrected Reading dBuV	FCC Part 15 Class B QP	QP Margin (dB)	FCC Part 15 Class B Avg	Av(CISPR)Margin (dB)
2	.1523	17.62	Ca	.1	0	9.4	27.12	-	-	55.88	-28.76
4	.5775	26.08	Ca	0	.1	9.3	35.48	-	-	46	-10.52
6	1.1558	11.57	Ca	0	.1	9.3	20.97	-	-	46	-25.03
8	2.373	4.76	Ca	0	.1	9.3	14.16	-	-	46	-31.84
10	6.468	5.9	Ca	0	.1	9.3	15.3	-	-	50	-34.7
12	14.649	19.45	Ca	.1	.2	9.3	29.05	-	-	50	-20.95
1	.1523	38.28	Qp	.1	0	9.4	47.78	65.88	-18.1	-	-
3	.5775	28.92	Qp	0	.1	9.3	38.32	56	-17.68	-	-
5	1.1535	14.02	Qp	0	.1	9.3	23.42	56	-32.58	-	-
7	2.3708	11.05	Qp	0	.1	9.3	20.45	56	-35.55	-	-
9	6.4298	15.87	Qp	0	.1	9.3	25.27	60	-34.73	-	-
11	14.6423	25.17	Qp	.1	.2	9.3	34.77	60	-25.23	-	-

Qp - Quasi-Peak detector
Ca - CISPR average detection

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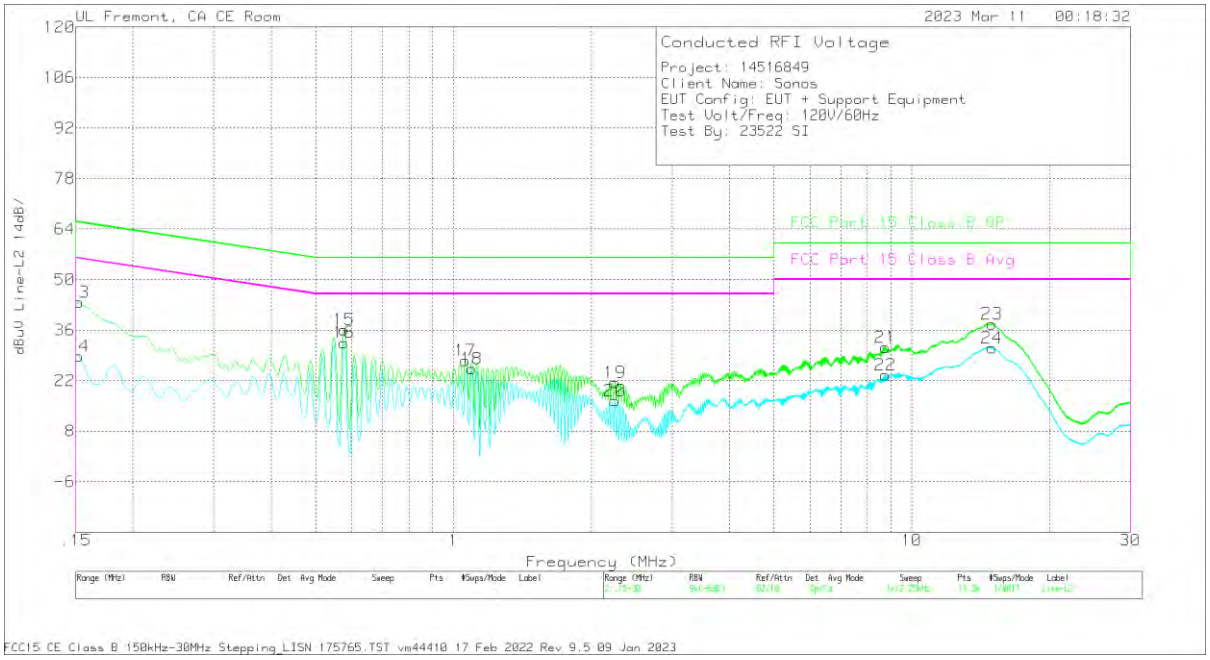
LINE 2 RESULTS



Trace Markers

Range 2: Line-L2 .15 - 30MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	175765 LISN L2	C2&C3 cable path loss	207996 Limiter with short cabl	Corrected Reading dBuV	FCC Part 15 Class B QP	QP Margin (dB)	FCC Part 15 Class B Avg	Av(CISPR)Margin (dB)
14	.1523	19.33	Ca	.1	0	9.4	28.83	-	-	55.88	-27.05
16	.5775	23.13	Ca	0	.1	9.3	32.53	-	-	46	-13.47
18	1.095	15.85	Ca	0	.1	9.3	25.25	-	-	46	-20.75
20	2.2515	7.12	Ca	0	.1	9.3	16.52	-	-	46	-29.48
22	8.754	14.02	Ca	0	.2	9.3	23.52	-	-	50	-26.48
24	14.9618	21.53	Ca	.1	.2	9.3	31.13	-	-	50	-18.87
13	.1523	34.22	Qp	.1	0	9.4	43.72	65.88	-22.16	-	-
15	.5775	26.71	Qp	0	.1	9.3	36.11	56	-19.89	-	-
17	1.0613	18.19	Qp	0	.1	9.3	27.59	56	-28.41	-	-
19	2.2515	12.08	Qp	0	.1	9.3	21.48	56	-34.52	-	-
21	8.754	21.78	Qp	0	.2	9.3	31.28	60	-28.72	-	-
23	14.9775	28.14	Qp	.1	.2	9.3	37.74	60	-22.26	-	-

Qp - Quasi-Peak detector
Ca - CISPR average detection

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