TEST REPORT

Report Number.: 14093504-E1V2

Applicant	:	SONOS INC. 614 CHAPALA ST. SANTA BARBARA, CA, 93101, U.S.A.
Model	:	S39
Brand	:	SONOS
FCC ID	:	SBVRM039
IC	:	5373A-RM039
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:
2022-10-03

Prepared by:
UL VERIFICATION SERVICES
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CERT #0751.05

REPORT REVISION HISTORY

Rev.	Issue Date	Revisions	Revised By
V1	2022-09-22	Initial Issue	---
V2	2022-10-03	Updated Section 3 and 6.3	K.Kedida

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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:	S39
BRAND:	SONOS
SERIAL NUMBER:	Radiated Sample: A100 2207CP F0-F6-C1-A0-0D-80:1 and A100 2207CP F0-F6-C1-A0-0D-CC:9 Conducted Sample: 7885B
SAMPLE RECEIPT DATE:	2022-07-25
DATE TESTED:	2022-07-25 to 08-23

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
CFR 47 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. This report must not be used by the client to claim product certification, approval, or endorsement by A2LA, NIST, any agency of the Federal Government, or any agency of the U.S. government.

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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 CFR 47 Part 2, FCC CFR 47 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	208313
☐	Building 2: 47266 Benicia Street Fremont, CA 94538, U.S.A	US0104	22541	208313
☒	Building 4: 47658 Kato Rd Fremont, CA 94538, U.S.A	US0104	2324B	208313

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}
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

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 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	12.51	17.82
2402 - 2480	Enhanced DQPSK	12.44	17.54
2402 - 2480	Enhanced 8PSK	12.44	17.54

6.3. DESCRIPTION OF AVAILABLE ANTENNAS

The antenna gain and type as provided by the manufacturer are as follows:

The radio utilizes a PCB antenna, with maximum gain of 1.2 dBi.

6.4. SOFTWARE AND FIRMWARE

The EUT software used during testing was 70.1-29190-diag.

The test utility software used during testing was GUI_V8.

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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
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 EUT/Spectrum Analyzer/AC/DC Adapter
2	DC	1	DC	Un-shielded	1	AC/DC Adapter to Laptop
3	Ethernet	1	RJ45	Un-shielded	1.5	Laptop to USB Ethernet Adapter
4	USB-A	1	USB-A	Shielded	0.05	USB Ethernet Adapter to USB
5	USB-C	1	USB-C	Shielded	0.05	EUT to USB-C/USB-A Female Adapter
6	SMA Cable	1	SMA	Un-Shielded	0.1	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 EUT/Spectrum Analyzer/AC/DC Adapter
2	DC	1	DC	Un-shielded	1	AC/DC Adapter to Laptop
3	Ethernet	1	RJ45	Un-shielded	10	Laptop to USB Ethernet Adapter
4	USB-A	1	USB-A	Shielded	0.05	USB Ethernet Adapter to USB
5	USB-C	1	USB-C	Shielded	0.05	EUT to USB-C/USB-A Female Adapter
6	SMA Cable	1	SMA	Un-Shielded	10	EUT to Horn Antenna

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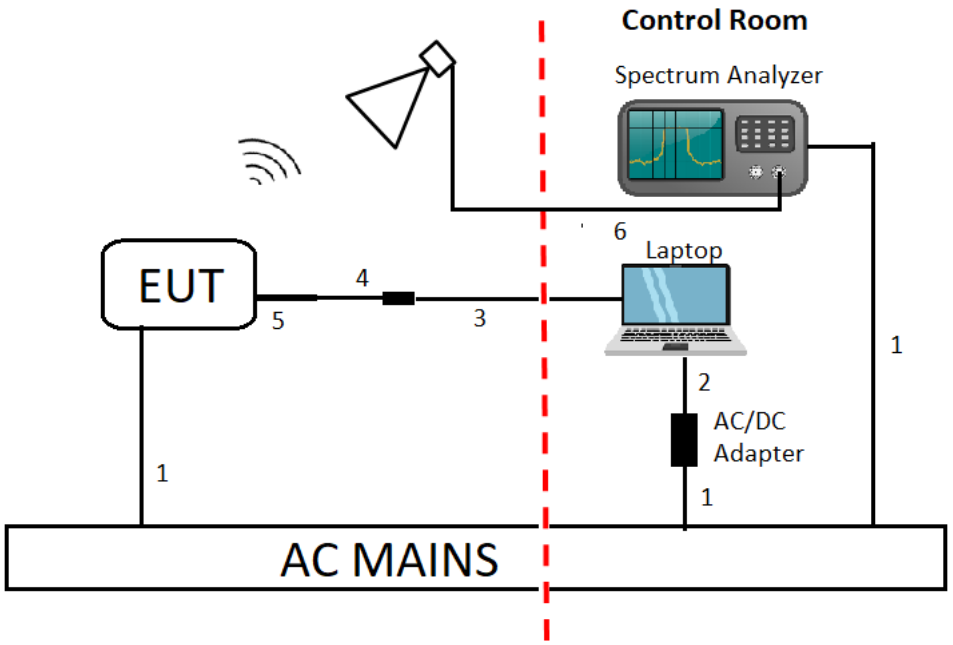
TEST SETUP

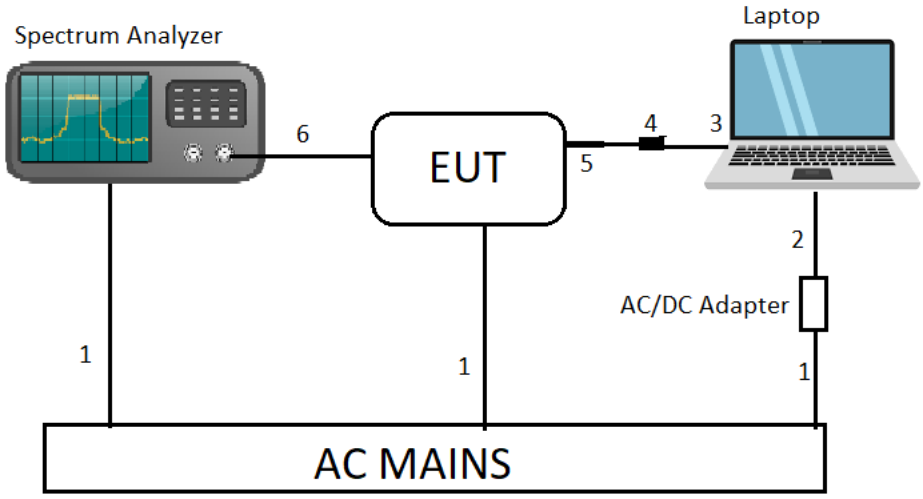
The EUT is a stand-alone unit, and the radio is exercised remotely by Sonos Compliance GUI test utility software via ethernet.

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 3GHz	Sunol Sciences Corp.	JB3	171862	2022-09-28	2021-09-28
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	80402	2023-07-05	2022-07-05
Amplifier, 100MHz-18GHz	AMPLICAL	AMP0.1G18-47-20	185686	2023-04-19	2022-04-19
EMI TEST RECEIVER, with B8 option	Rohde & Schwarz	ESW44	169937	2023-02-20	2022-02-20
EMI TEST RECEIVER	Rohde & Schwarz	ESW44	169927	2023-02-13	2022-02-13
Antenna, Horn 18 to 26.5GHz	ARA	MWH-1826/B	81138	2022-10-13	2021-10-13
Amplifier 18-26.5GHz, +5Vdc, 60dB min	AMPLICAL	AMP18G26.5-60	215705	2023-02-26	2022-02-26
Antenna, Passive Loop 30Hz - 1MHz	ELECTRO METRICS	EM-6871	219909	2023-05-10	2022-05-10
Antenna, Passive Loop 100KHz - 30MHz	ELECTRO METRICS	EM-6872	219911	2023-05-10	2022-05-10
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent Technologies	N9030A	80396	2023-01-02	2022-01-02
Power Meter, P-series single channel	Keysight Technologies Inc	N1911A	T1268	2023-02-03	2022-02-03
Power Sensor, P - series, 50MHz to 18GHz, Wideband	Keysight Technologies Inc	N1921A	90419	2023-03-02	2022-03-02
AC Line Conducted					
LISN	Fischer Custom Communications, Inc	FCC-LISN-50/250-25-2-01-480V	175765	2023-01-25	2022-01-25
EMI TEST RECEIVER	Rohde & Schwarz	ESR	93091	2023-02-21	2022-02-21
Transient Limiter	Com-Power	LIT-930	127455	2023-02-02	2022-02-02
UL TEST SOFTWARE LIST					
Radiated Software	UL	UL EMC	Ver 2022-07-06		
Antenna Port Software	UL	UL RF	Ver 2022.5.31		
AC Line Conducted Software	UL	UL EMC	Rev 9.5, 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, 6.5

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

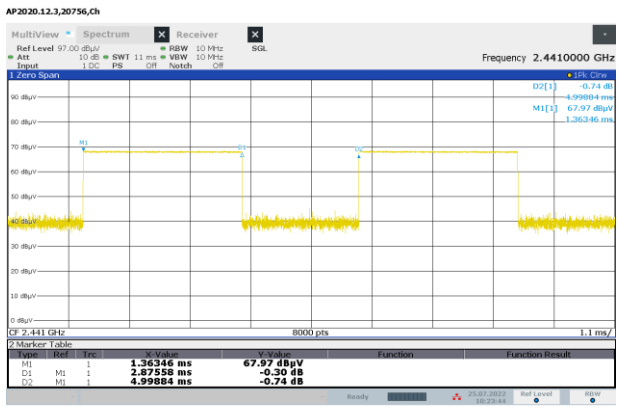
PROCEDURE

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

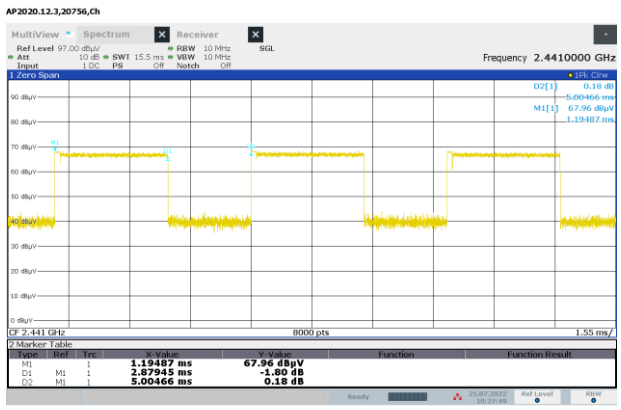
ON TIME AND DUTY CYCLE RESULTS

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	2.876	4.999	0.575	57.5249	2.40	0.348
Bluetooth 8PSK	2.879	5.005	0.575	57.5354	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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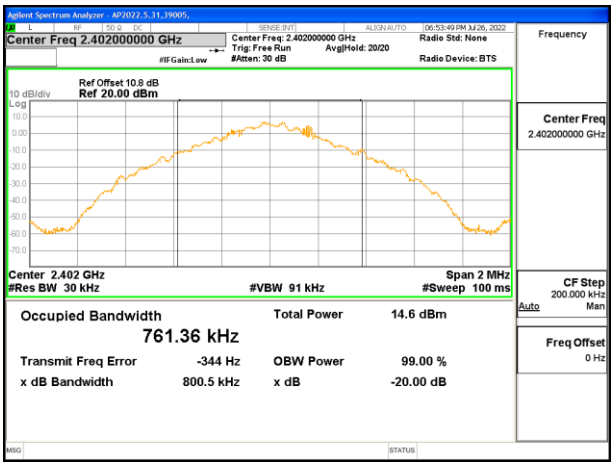
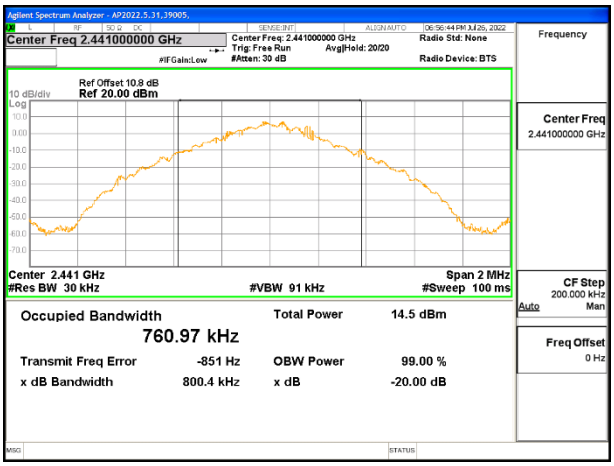
9.2.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

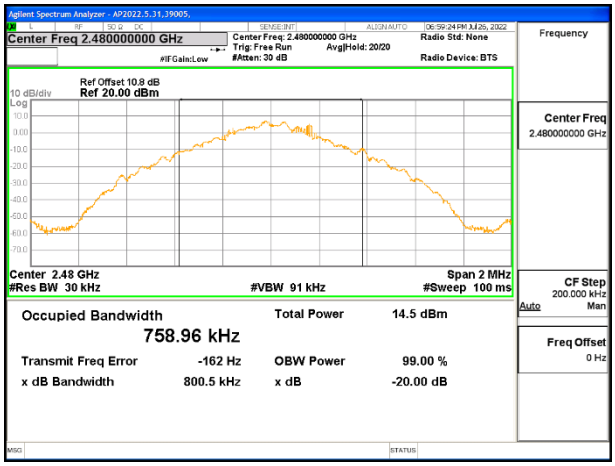
Channel	Frequency (MHz)	20dB Bandwidth (kHz)	99% Bandwidth (kHz)
Low	2402	800.5	761.36
Mid	2441	800.4	760.97
High	2480	800.5	758.96



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

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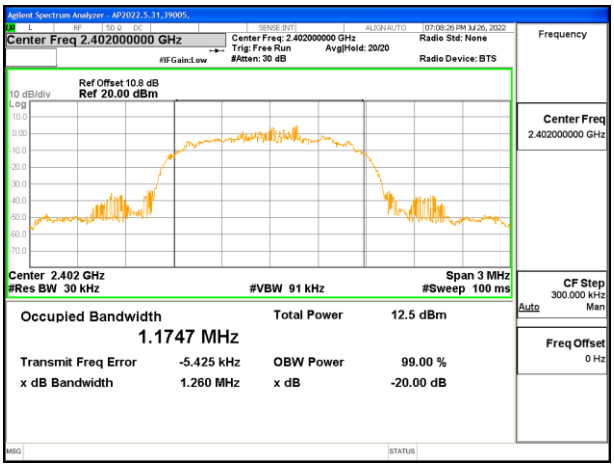
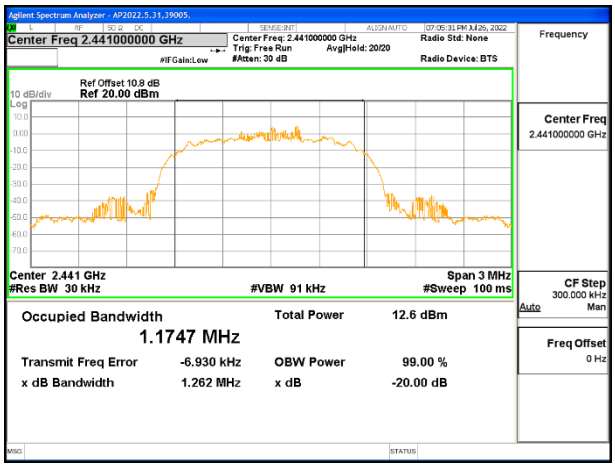
9.2.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

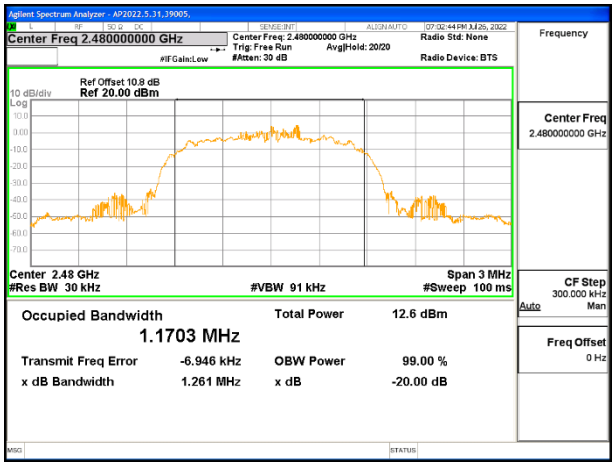
Channel	Frequency (MHz)	20dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	2402	1.260	1.1747
Mid	2441	1.262	1.1747
High	2480	1.261	1.1703



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.

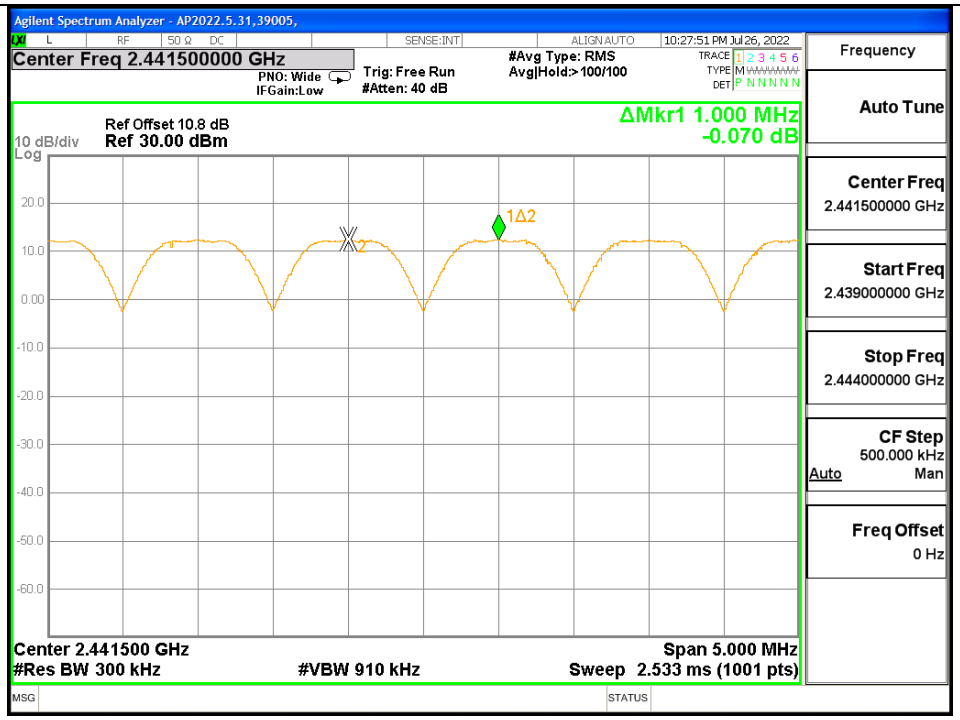
TEST PROCEDURE

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

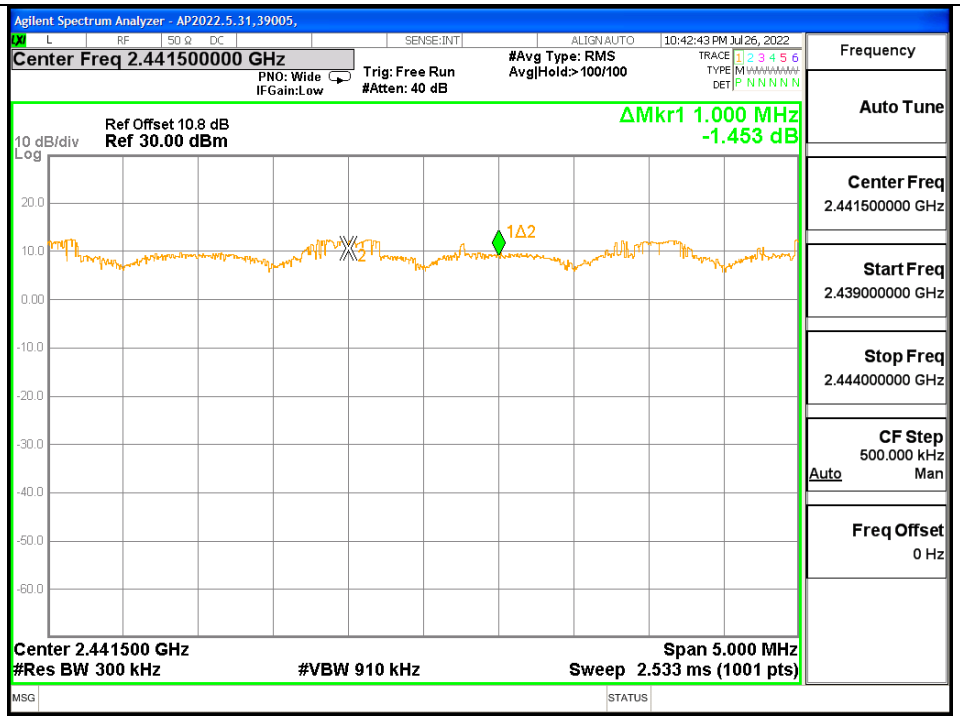
UL VERIFICATION SERVICES
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

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

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

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

UL VERIFICATION SERVICES
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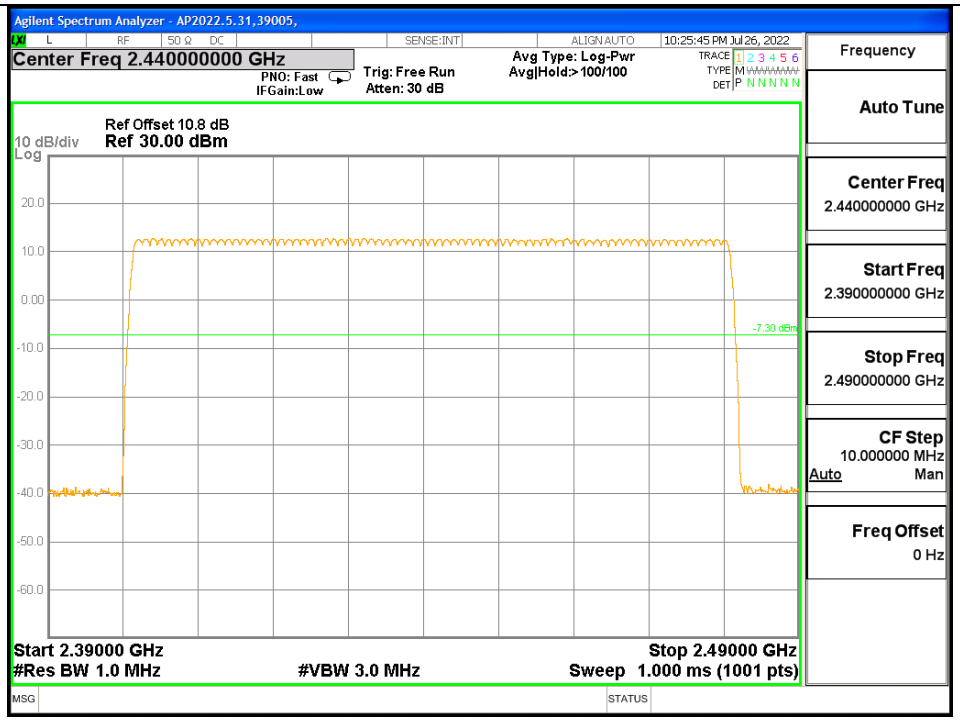
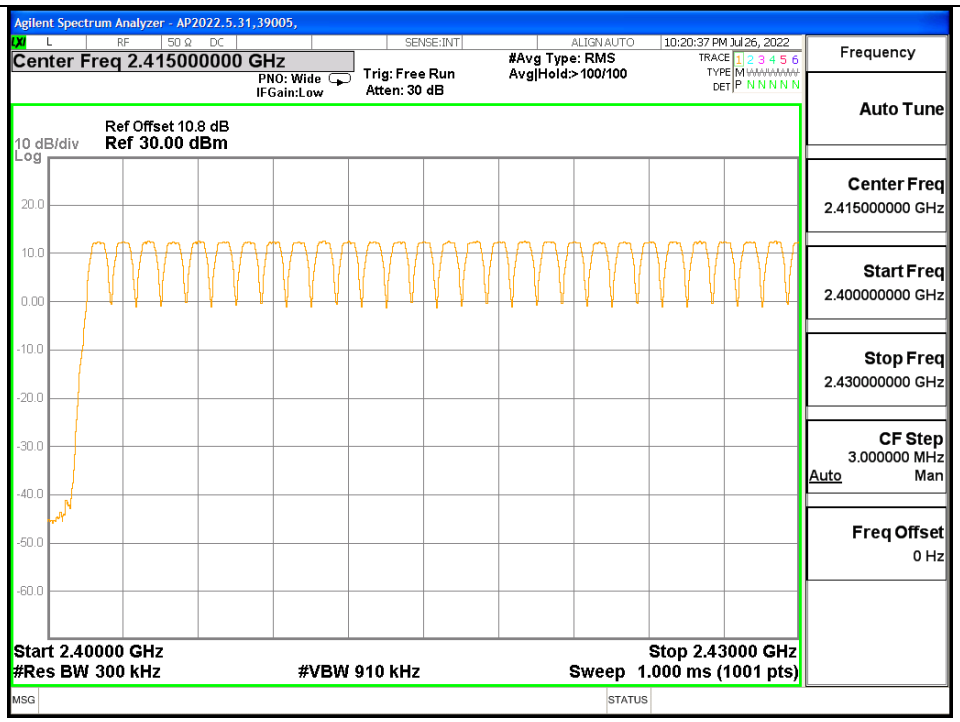
9.4.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

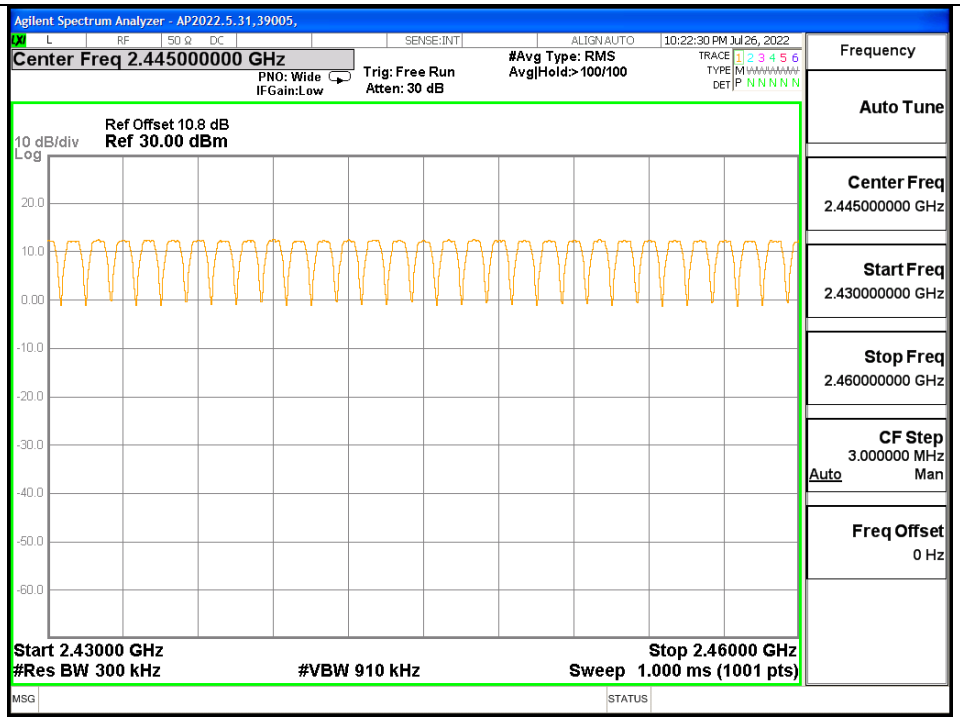


100MHz SPAN

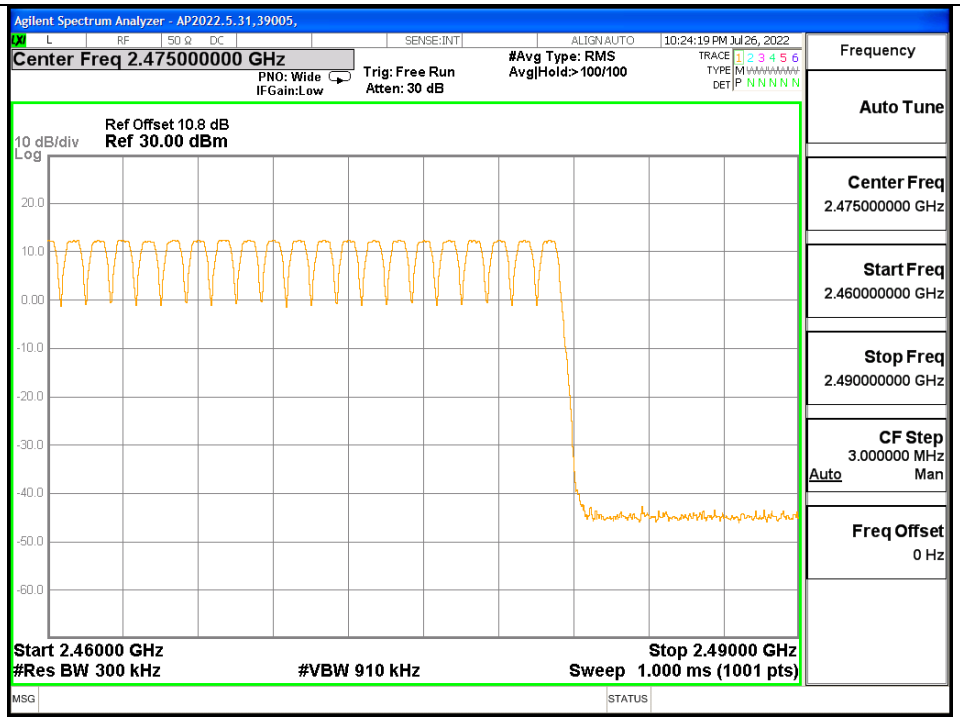


30MHz SPAN, SEGMENT 1 OF 3

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



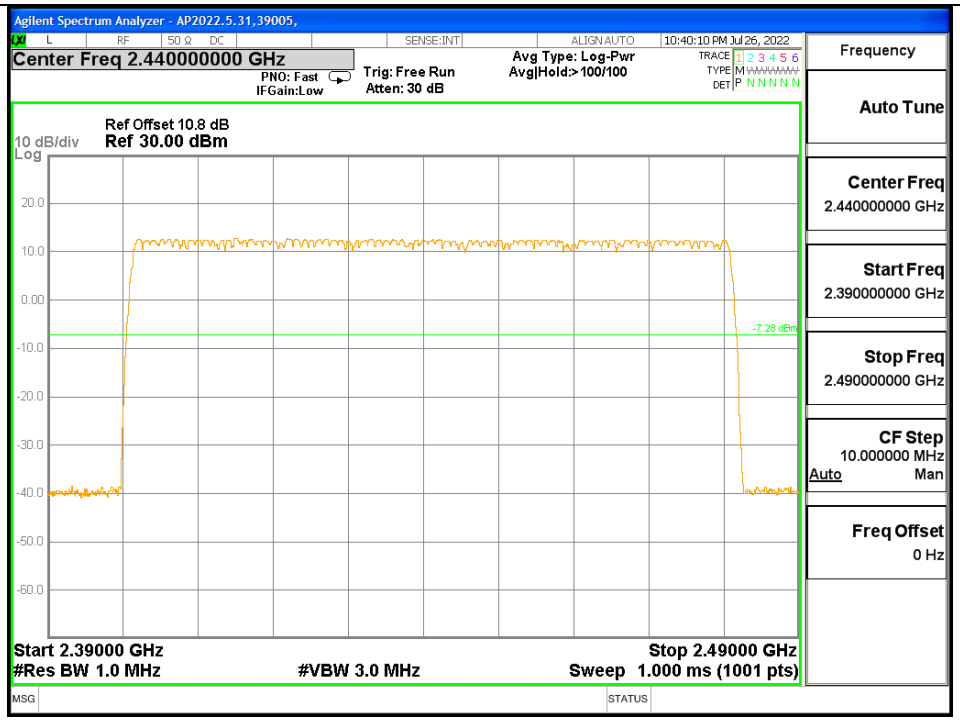
30MHz SPAN, SEGMENT 2 OF 3



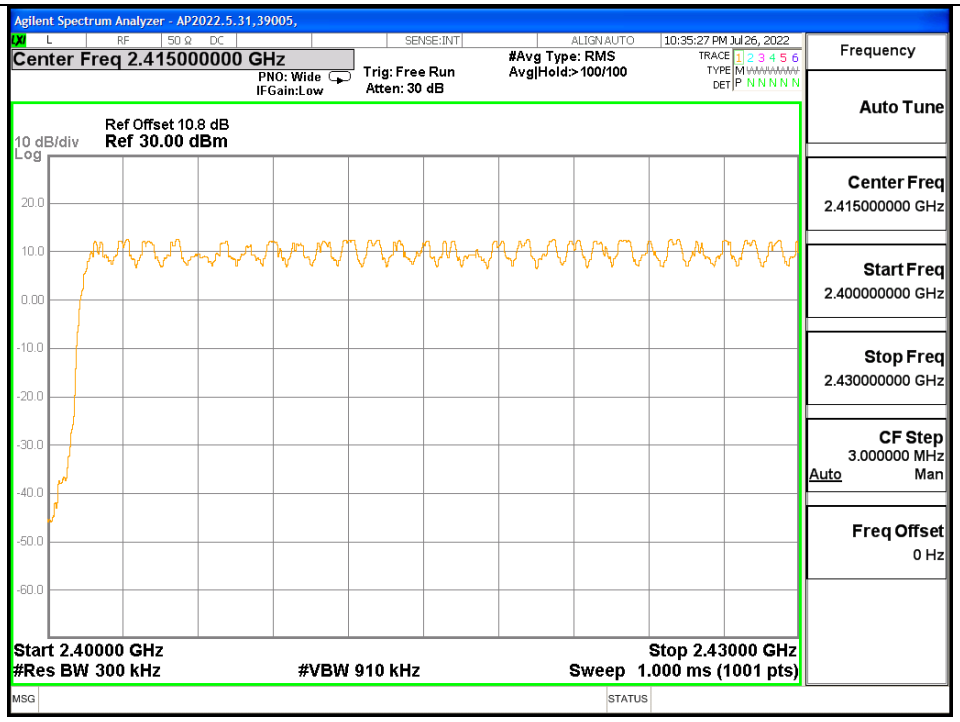
30MHz SPAN, SEGMENT 3 OF 3

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

9.4.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

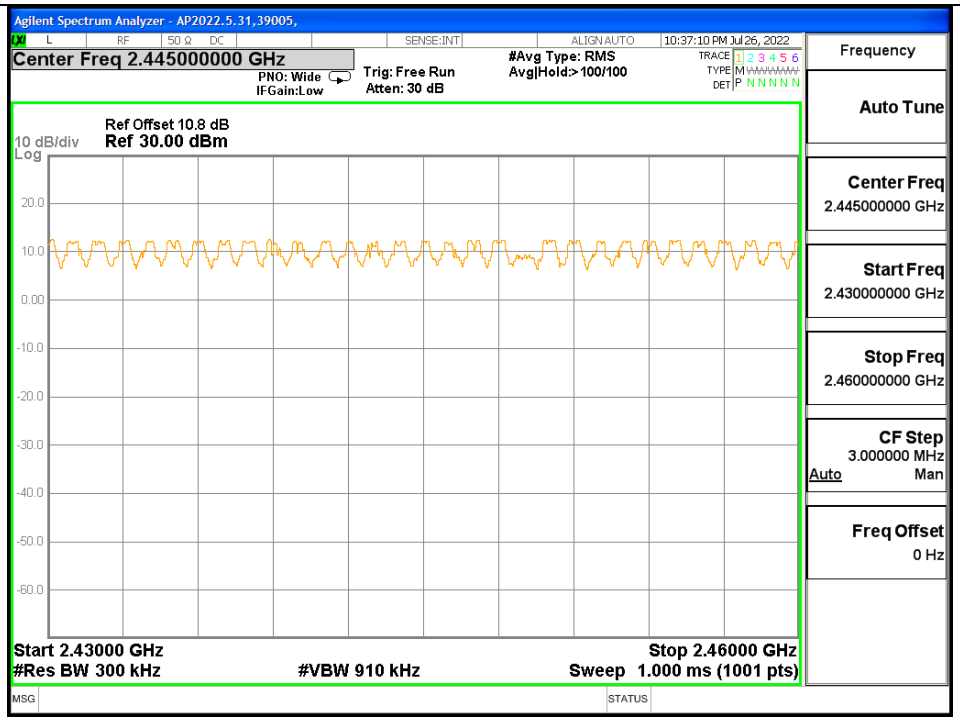


100MHz SPAN

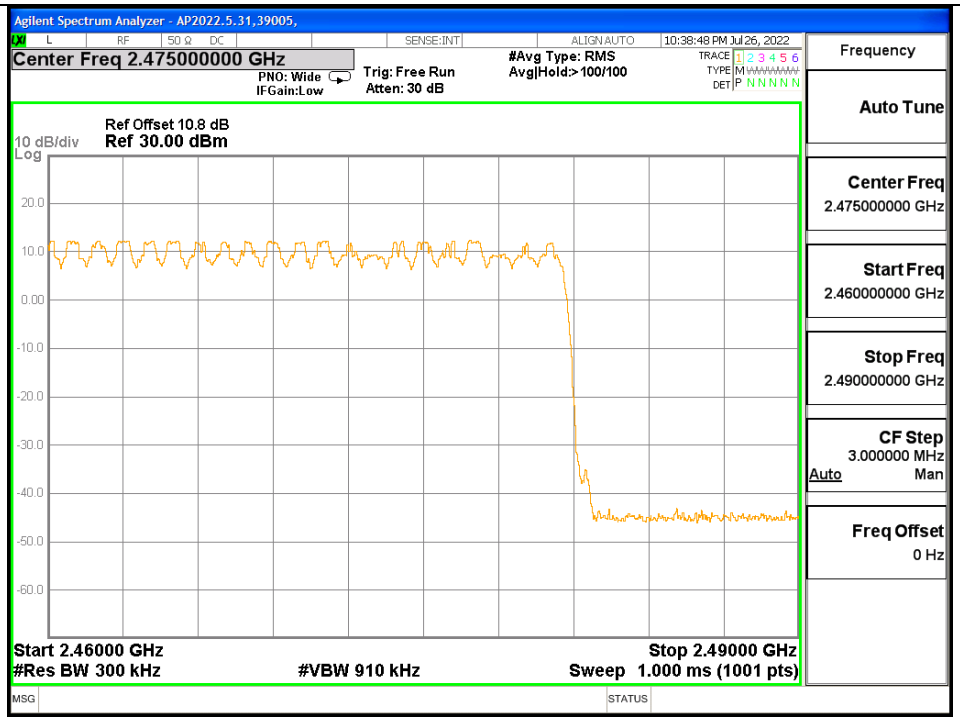


30MHz SPAN, SEGMENT 1 OF 3

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

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

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

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	0.369	14	0.0517	0.4	-0.3483
DH3	1.622	13	0.2109	0.4	-0.1891
DH5	2.868	8	0.2294	0.4	-0.1706
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	0.369	3.5	0.01292	0.4	-0.3871
DH3	1.622	3.25	0.05272	0.4	-0.3473
DH5	2.868	2	0.05736	0.4	-0.3426

UL VERIFICATION SERVICES
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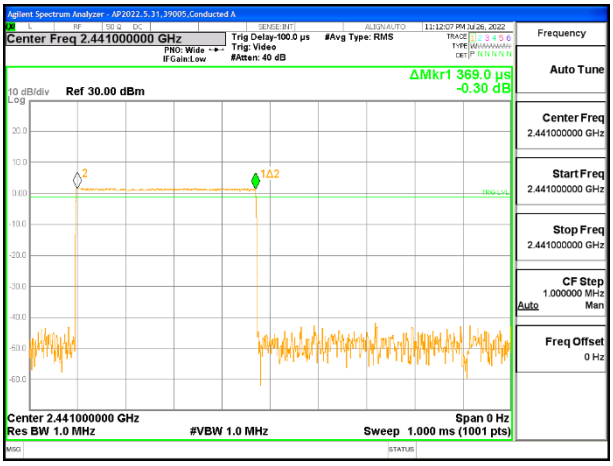
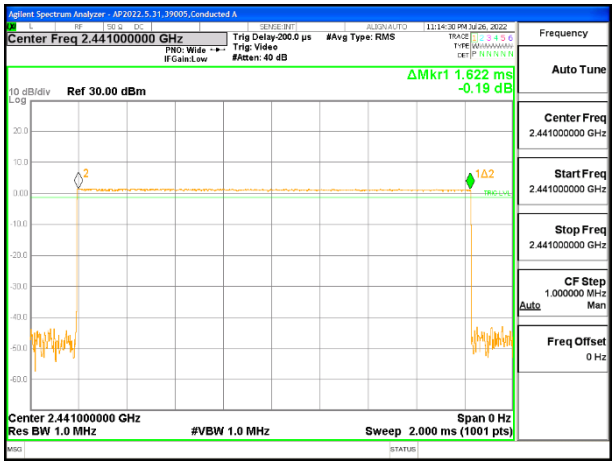
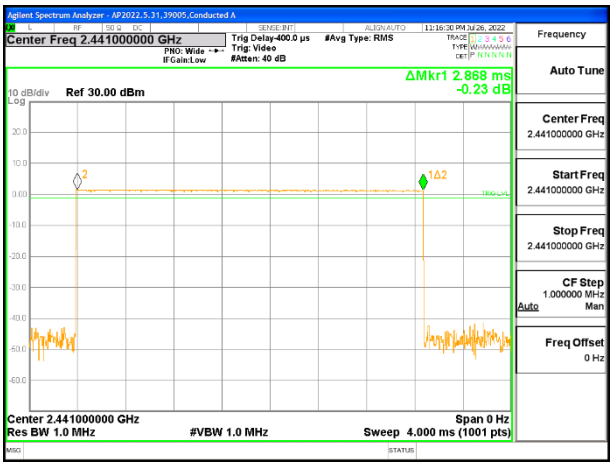


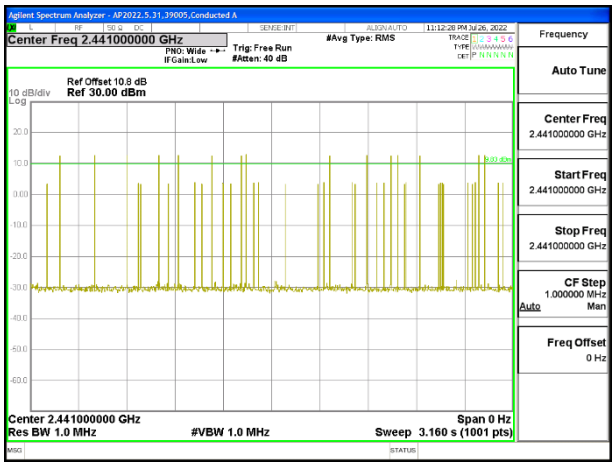
PULSE WIDTH – DH1



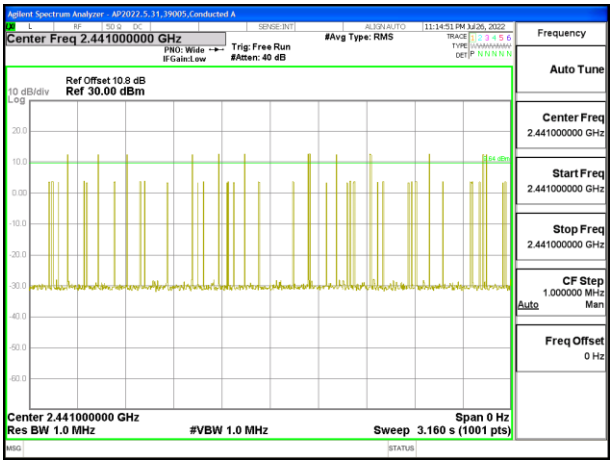
PULSE WIDTH – DH3



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

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	14	0.0777	0.4	-0.3223
3DH3	1.8	7	0.126	0.4	-0.274
3DH5	2.868	5	0.1434	0.4	-0.2566

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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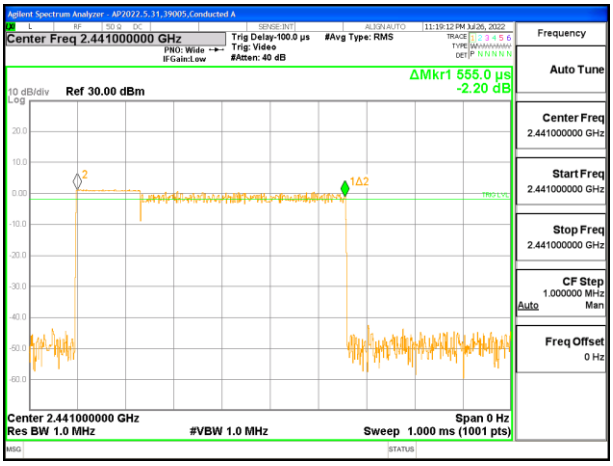
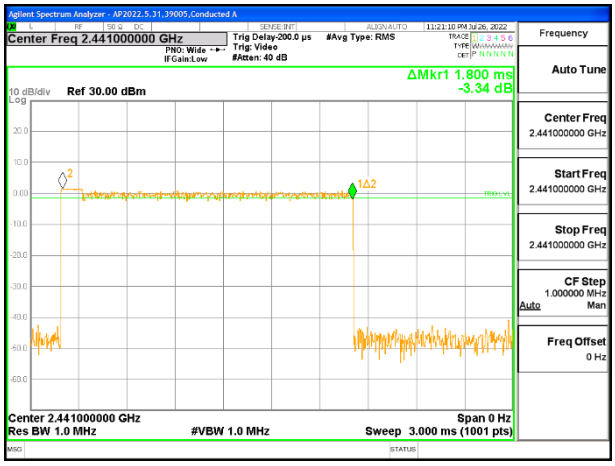
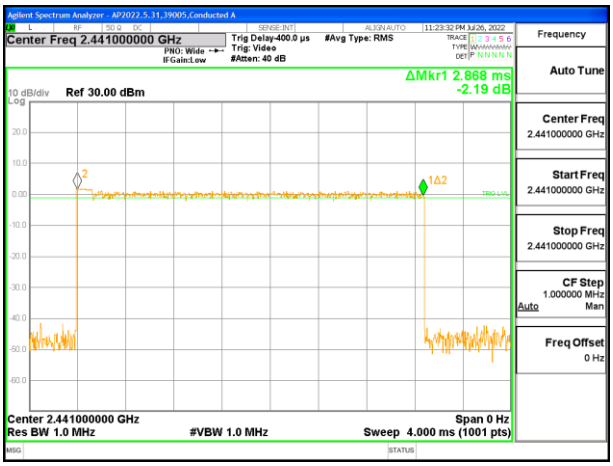


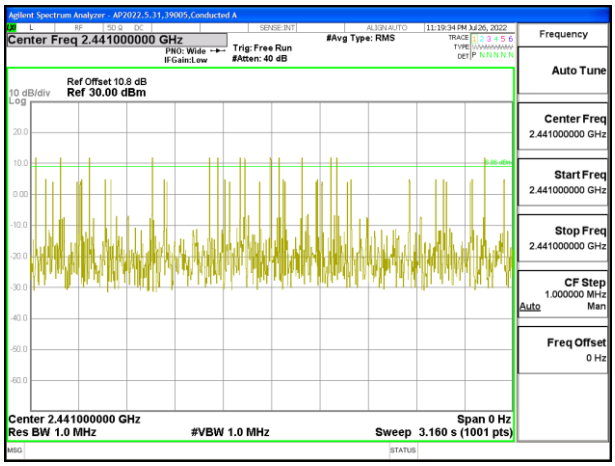
PULSE WIDTH – 3DH1



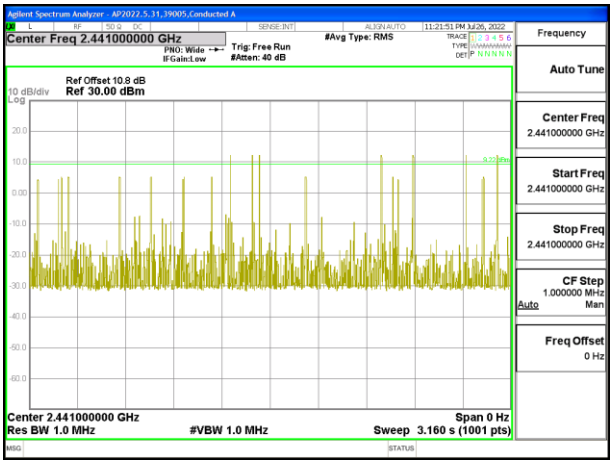
PULSE WIDTH – 3DH3



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

The transmitter output is connected to a 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:	RA 39005
Date:	2022-07-28

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	12.50	21	-8.5
Middle	2441	12.51	21	-8.49
High	2480	12.50	21	-8.5

9.6.2. BLUETOOTH ENHANCED DATA RATE DQPSK MODULATION

Tested By:	RA 39005
Date:	2022-07-28

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	12.44	21	-8.56
Middle	2441	12.43	21	-8.57
High	2480	12.44	21	-8.56

9.6.3. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

Tested By:	RA 39005
Date:	2022-07-28

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	12.44	21	-8.56
Middle	2441	12.44	21	-8.56
High	2480	12.44	21	-8.56

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

9.7. AVERAGE POWER

LIMITS

None; for reporting purposes only

TEST PROCEDURE

The transmitter output is connected to a 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
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

9.7.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

Tested By:	RA 39005
Date	2022-07-28

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	12.18
Middle	2441	12.06
High	2480	12.02

9.7.2. BLUETOOTH ENHANCED DATA RATE DQPSK MODULATION

Tested By:	RA 39005
Date	2022-07-28

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	9.38
Middle	2441	9.34
High	2480	9.35

9.7.3. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

Tested By:	RA 39005
Date	2022-07-28

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	9.38
Middle	2441	9.36
High	2480	9.38

UL VERIFICATION SERVICES
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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.

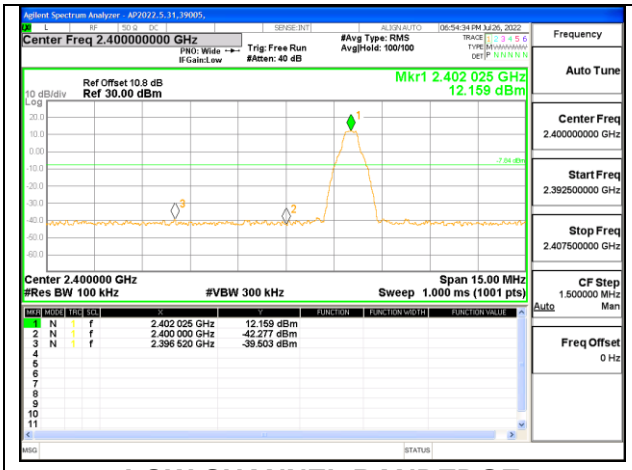
The bandedges at 2.4 and 2.4835 GHz are investigated with the transmitter set to the normal hopping mode.

RESULTS

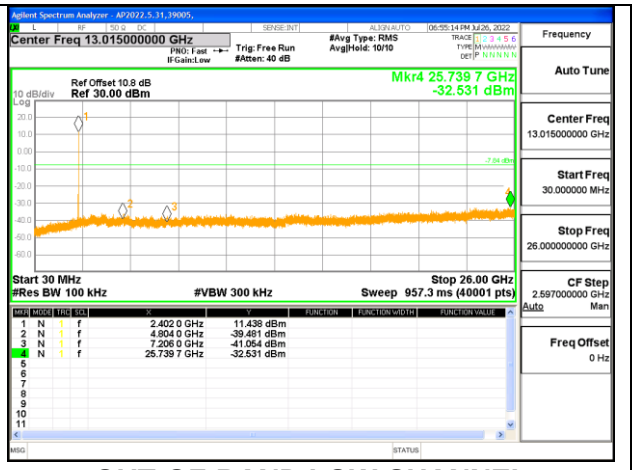
UL VERIFICATION SERVICES
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

9.8.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

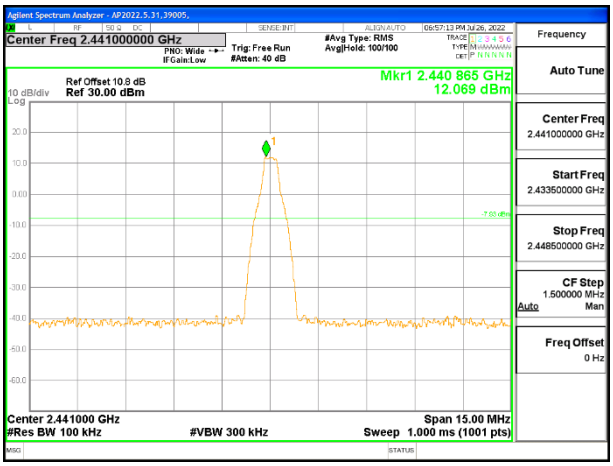
Antenna 1 SPURIOUS EMISSIONS, NON-HOPPING



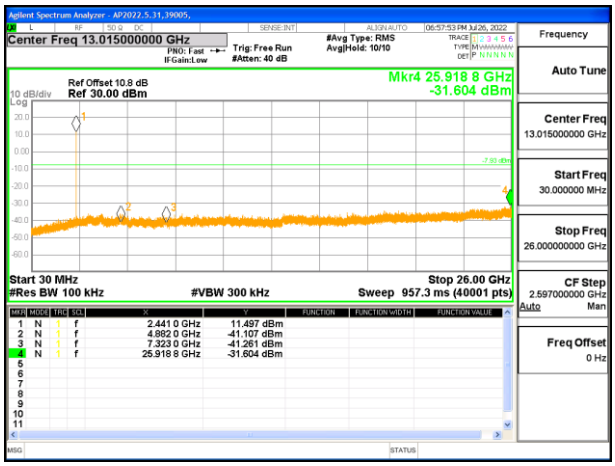
LOW CHANNEL BANDEDGE



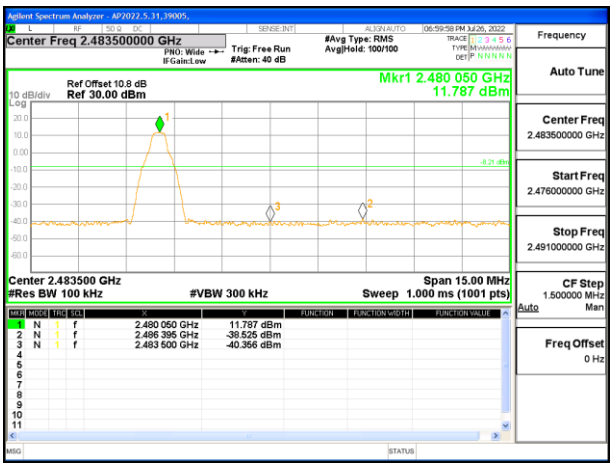
OUT-OF-BAND LOW CHANNEL



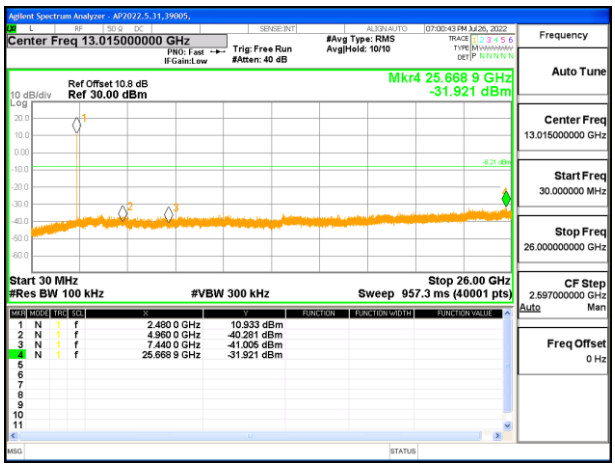
IN-BAND REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL



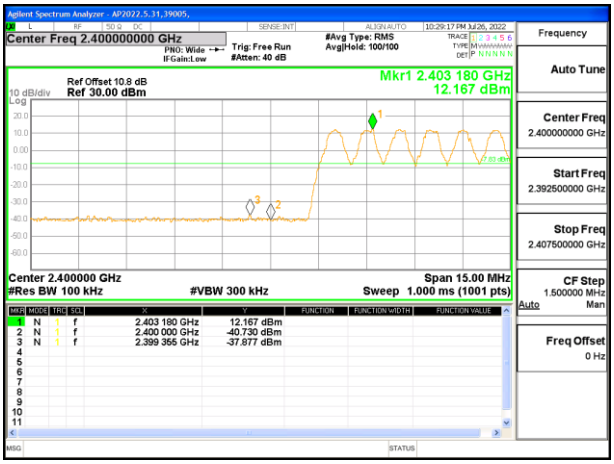
HIGH CHANNEL BANDEDGE



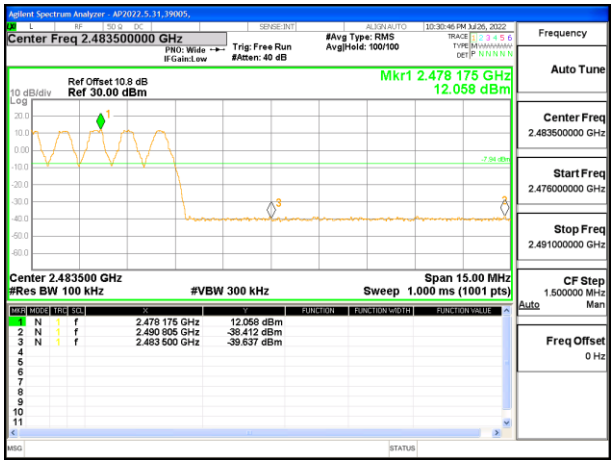
OUT-OF-BAND HIGH CHANNEL

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

Antenna 1 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON



LOW BANDEDGE

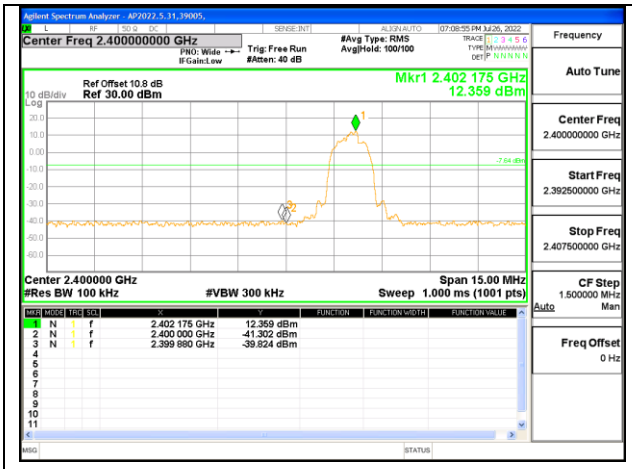


HIGH BANDEDGE

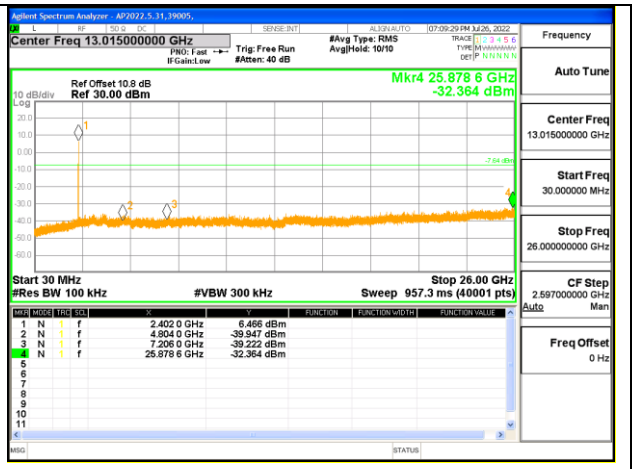
UL VERIFICATION SERVICES
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

9.8.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

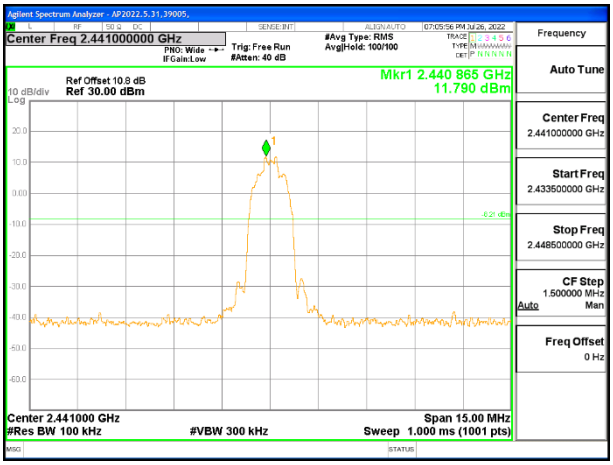
Antenna 1 SPURIOUS EMISSIONS, NON-HOPPING



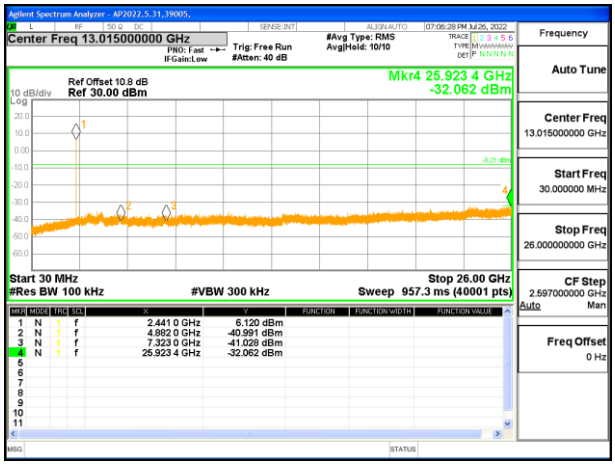
LOW CHANNEL BANDEDGE



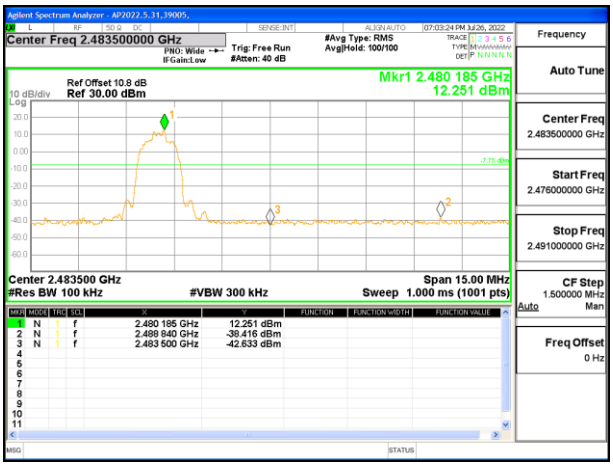
OUT-OF-BAND LOW CHANNEL



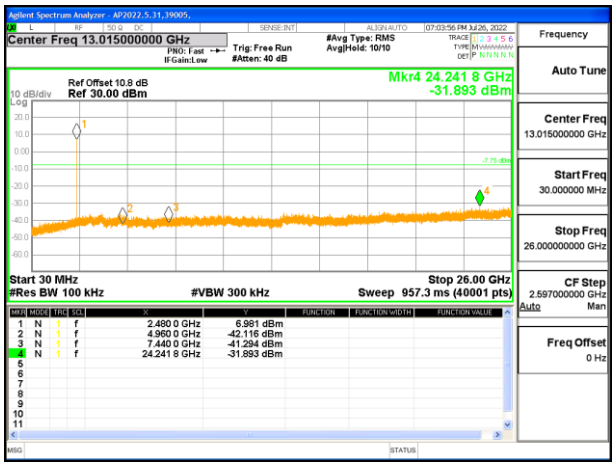
IN-BAND REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL



HIGH CHANNEL BANDEDGE



OUT-OF-BAND HIGH CHANNEL

UL VERIFICATION SERVICES
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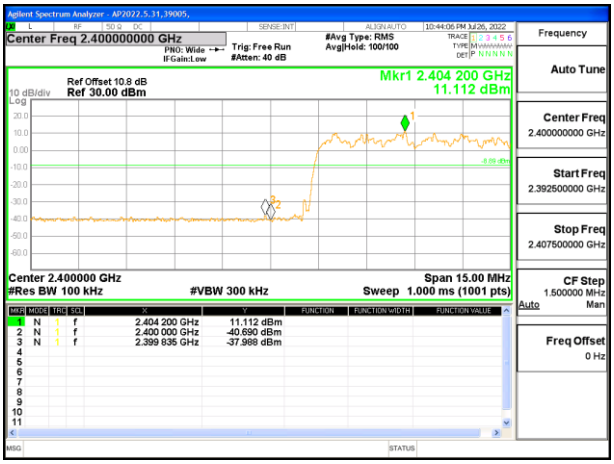
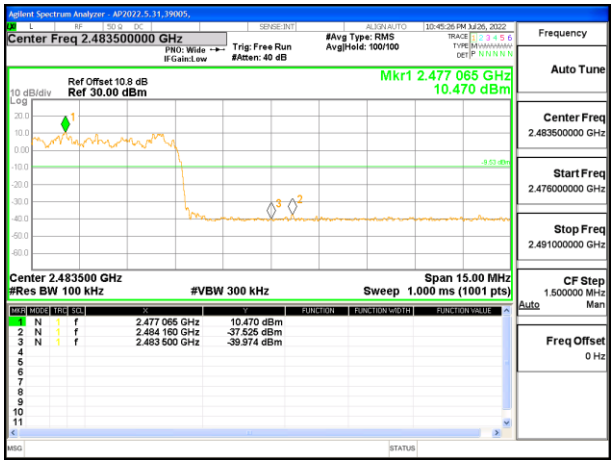
Antenna 1 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON



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.

Note: The limits in CFR 47, Part 15, Subpart C, paragraph 15.209(a), are identical to those in RSS-Gen section 8.9, Table 6, since the measurements are performed in terms of magnetic field strength and converted to electric field strength levels (as reported in the table), using the free space impedance of 377 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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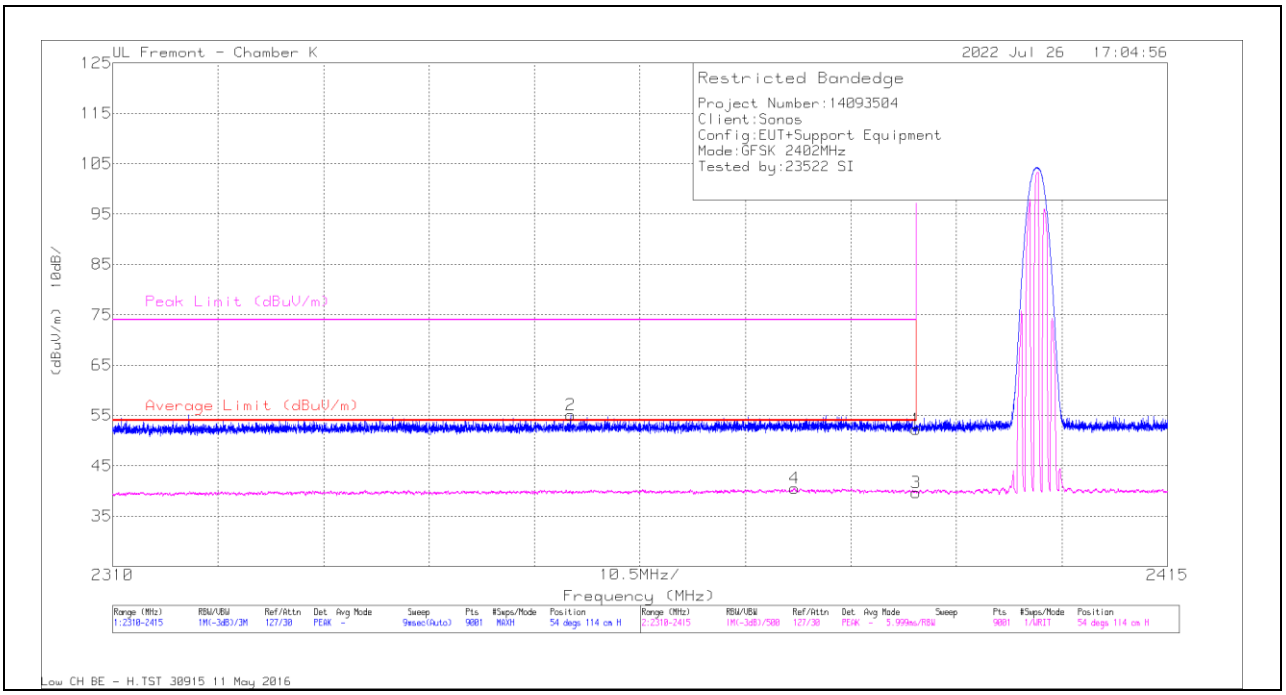
10.1. TRANSMITTER ABOVE 1 GHz

10.1.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

BANDEDGE (LOW CHANNEL)

HORIZONTAL RESULT



Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF 80404 (dB/m)	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	55.08	Pk	32.1	-34.9	52.28	-	-	74	-21.72	54	114	H
2	* 2355.618	58.17	Pk	32	-35	55.17	-	-	74	-18.83	54	114	H
3	* 2390	42.48	VA1T	32.1	-34.9	39.68	54	-14.32	-	-	54	114	H
4	* 2377.902	43.32	VA1T	32.1	-34.9	40.52	54	-13.48	-	-	54	114	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 transmitted duration

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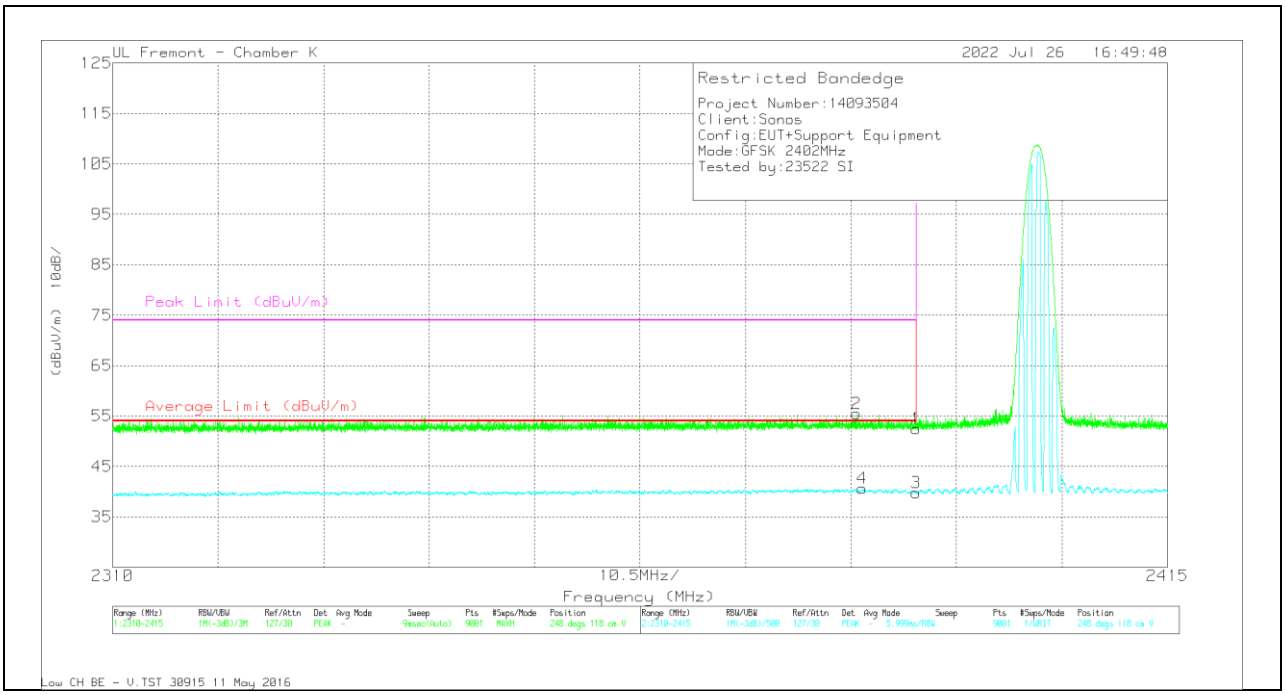
VERTICAL RESULT



Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF 80404 (dB/m)	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	55.34	Pk	32.1	-34.9	52.54	-	-	74	-21.46	248	118	V
2	* 2384.062	58.13	Pk	32.2	-34.8	55.53	-	-	74	-18.47	248	118	V
3	* 2390	42.57	VA1T	32.1	-34.9	39.77	54	-14.23	-	-	248	118	V
4	* 2384.622	43.25	VA1T	32.2	-34.8	40.65	54	-13.35	-	-	248	118	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 transmitted duration

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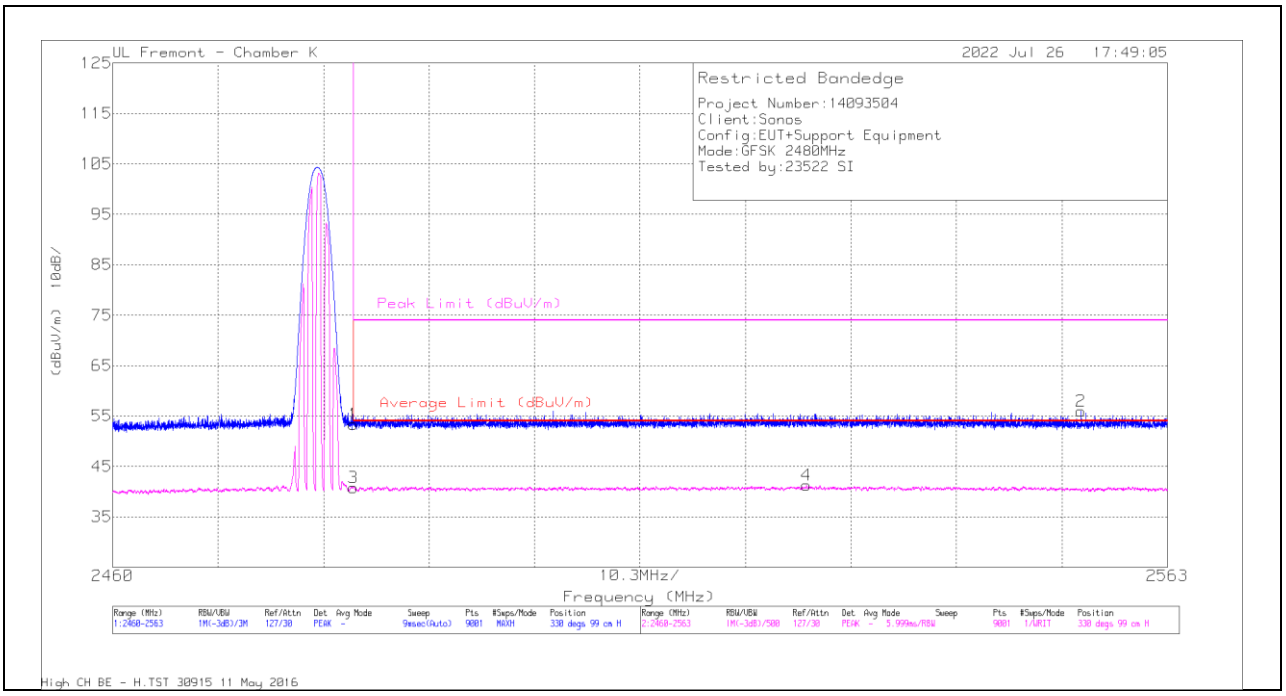
BANDEDGE (HIGH CHANNEL)

HORIZONTAL RESULT



Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF 80404 (dB/m)	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	32.7	-34.5	53.37	-	-	74	-20.63	330	99	H
2	2554.573	57.77	Pk	32.5	-34.3	55.97	-	-	74	-18.03	330	99	H
3	* 2483.5	42.66	VA1T	32.7	-34.5	40.86	54	-13.14	-	-	330	99	H
4	2527.76	42.76	VA1T	32.8	-34.3	41.26	54	-12.74	-	-	330	99	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 transmitted duration

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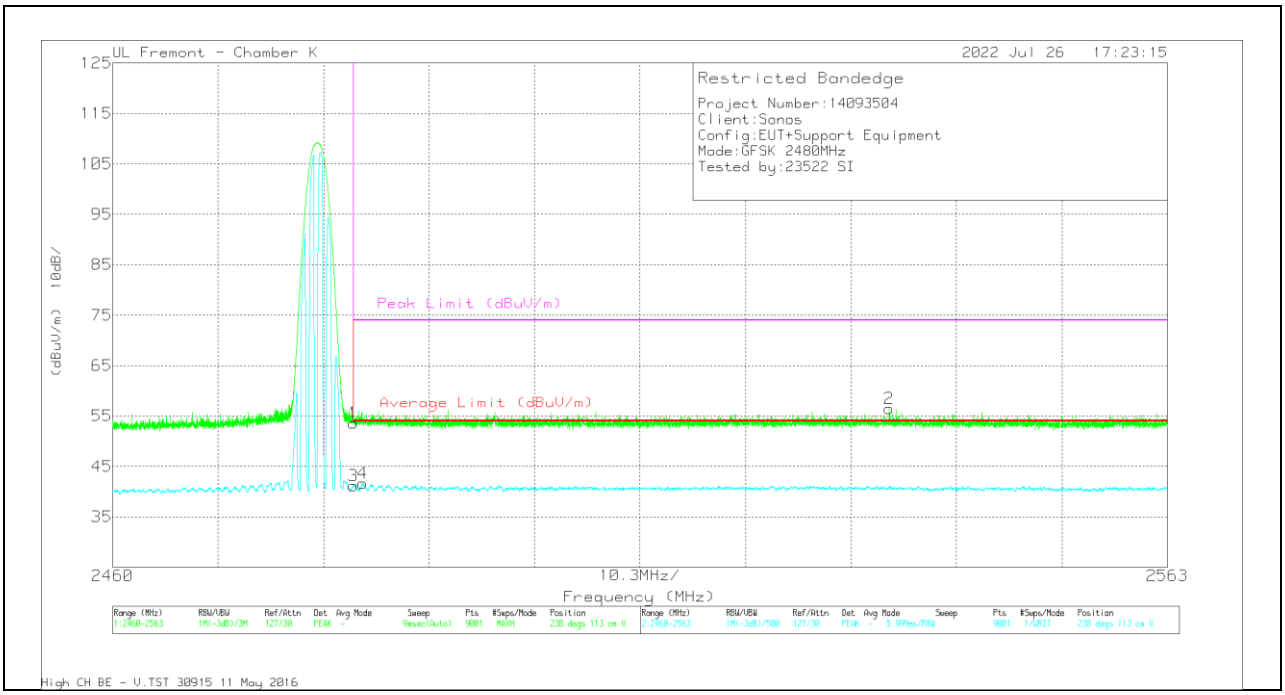
VERTICAL RESULT



Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF 80404 (dB/m)	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	55.37	Pk	32.7	-34.5	53.57	-	-	74	-20.43	238	113	V
2	2535.839	58	Pk	32.7	-34.2	56.5	-	-	74	-17.5	238	113	V
3	* 2483.5	43.02	VA1T	32.7	-34.5	41.22	54	-12.78	-	-	238	113	V
4	* 2484.422	43.44	VA1T	32.7	-34.5	41.64	54	-12.36	-	-	238	113	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 transmitted duration

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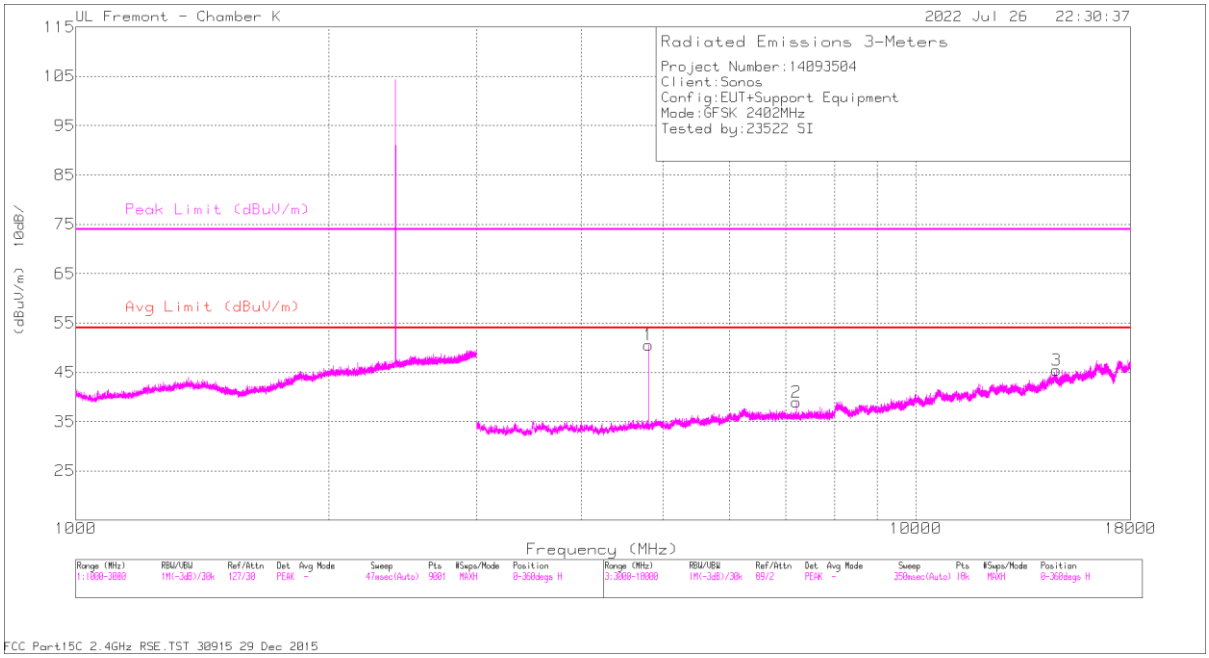
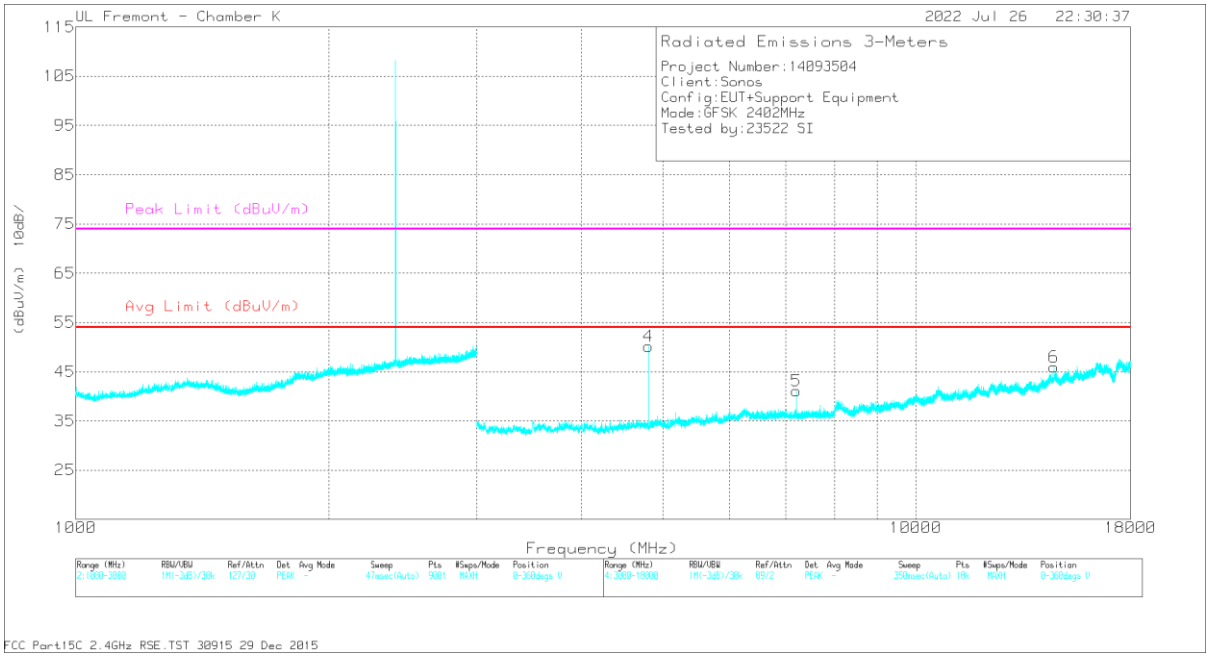
HARMONICS AND SPURIOUS EMISSIONS

LOW CHANNEL RESULTS



HORIZONTAL



VERTICAL

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RADIATED EMISSIONS

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AF 80404 (dB/m)	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	* 4803.71	59.12	PKFH	34.2	-40.6	52.72	-	-	74	-21.28	322	101	H
	* 4803.734	55.4	VA1T	34.2	-40.6	49	54	-5	-	-	322	101	H
2	7205.362	49.17	PKFH	35.9	-38.3	46.77	-	-	-	-	303	129	H
	7205.685	39.63	VA1T	35.9	-38.3	37.23	-	-	-	-	303	129	H
3	14690.9	45.84	PKFH	39.9	-32.8	52.94	-	-	-	-	338	104	H
	14689.446	32.17	VA1T	39.9	-32.8	39.27	-	-	-	-	338	104	H
4	* 4804.054	58.86	PKFH	34.2	-40.6	52.46	-	-	74	-21.54	249	239	V
	* 4804.106	55.59	VA1T	34.2	-40.6	49.19	54	-4.81	-	-	249	239	V
5	7206.177	50.24	PKFH	35.9	-38.3	47.84	-	-	-	-	34	146	V
	7205.833	42.47	VA1T	35.9	-38.3	40.07	-	-	-	-	34	146	V
6	14606.488	46	PKFH	39.8	-33.7	52.1	-	-	-	-	234	388	V
	14606.915	33.19	VA1T	39.8	-33.7	39.29	-	-	-	-	234	388	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 transmitted duration

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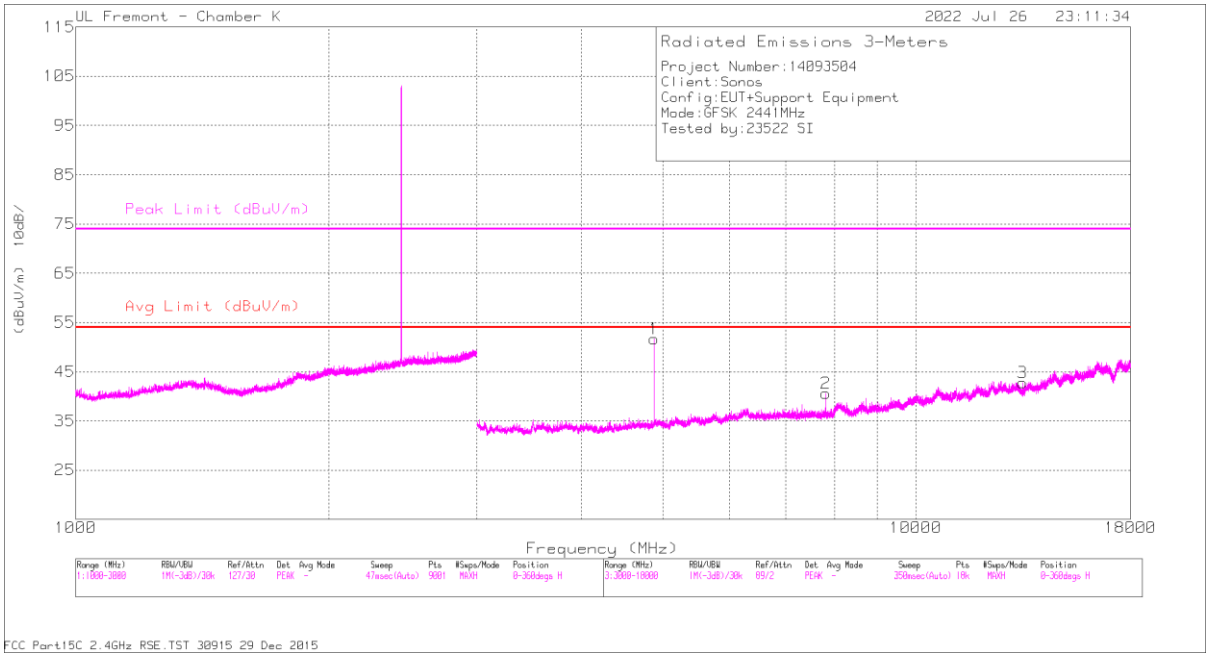
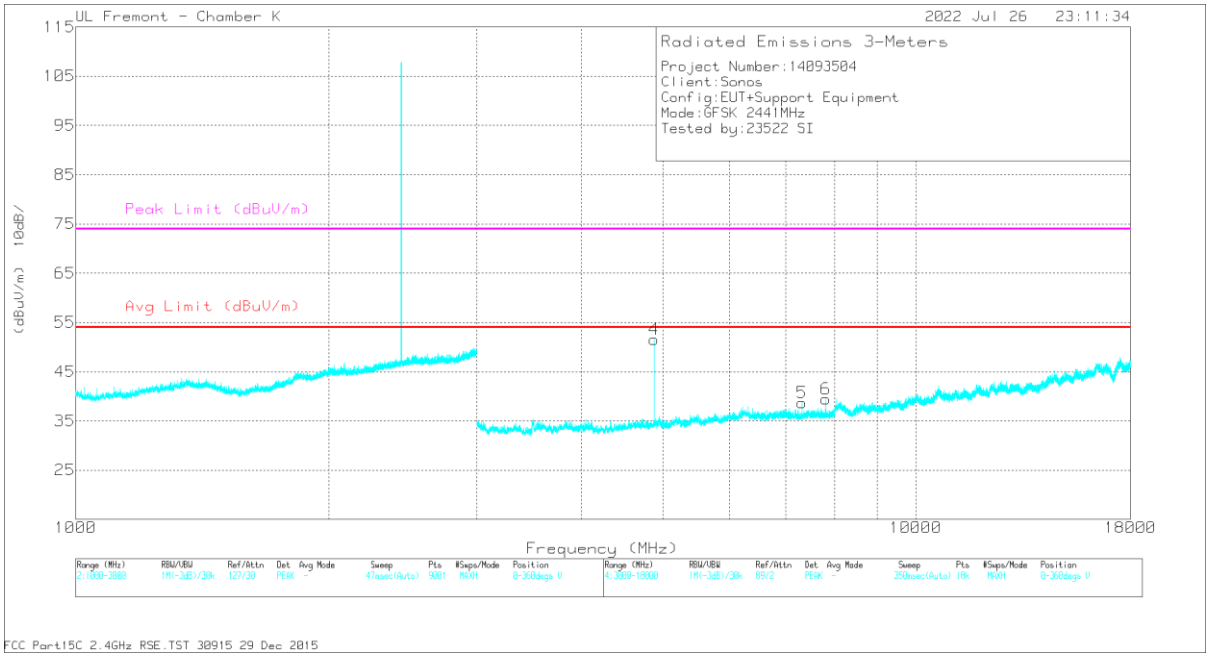
MID CHANNEL RESULTS



HORIZONTAL



VERTICAL

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RADIATED EMISSIONS

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AF 80404 (dB/m)	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	* 4881.824	60.31	PKFH	34.1	-40.3	54.11	-	-	74	-19.89	326	205	H
	* 4882.124	57.68	VA1T	34.1	-40.3	51.48	54	-2.52	-	-	326	205	H
2	7810.963	48.87	PKFH	35.9	-37.5	47.27	-	-	-	-	56	196	H
	7811.143	40.18	VA1T	35.9	-37.5	38.58	-	-	-	-	56	196	H
3	13405.385	46.45	PKFH	39.2	-34.6	51.05	-	-	-	-	300	175	H
	13404.598	31.84	VA1T	39.2	-34.6	36.44	-	-	-	-	300	175	H
4	* 4882.304	60.82	PKFH	34.1	-40.3	54.62	-	-	74	-19.38	244	206	V
	* 4881.684	56.79	VA1T	34.1	-40.3	50.59	54	-3.41	-	-	244	206	V
5	* 7322.666	49.49	PKFH	35.7	-37.9	47.29	-	-	74	-26.71	35	120	V
	* 7322.77	38.84	VA1T	35.7	-37.9	36.64	54	-17.36	-	-	35	120	V
6	7810.963	48.42	PKFH	35.9	-37.5	46.82	-	-	-	-	9	131	V
	7811.311	39.59	VA1T	35.9	-37.5	37.99	-	-	-	-	9	131	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 transmitted duration

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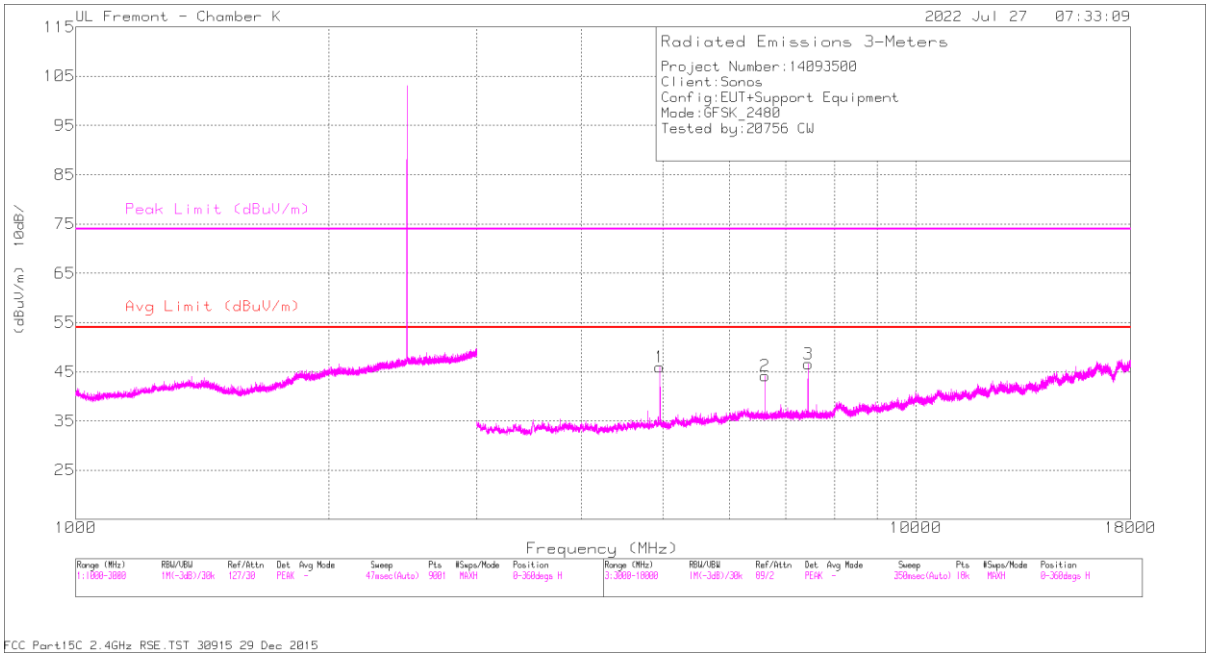
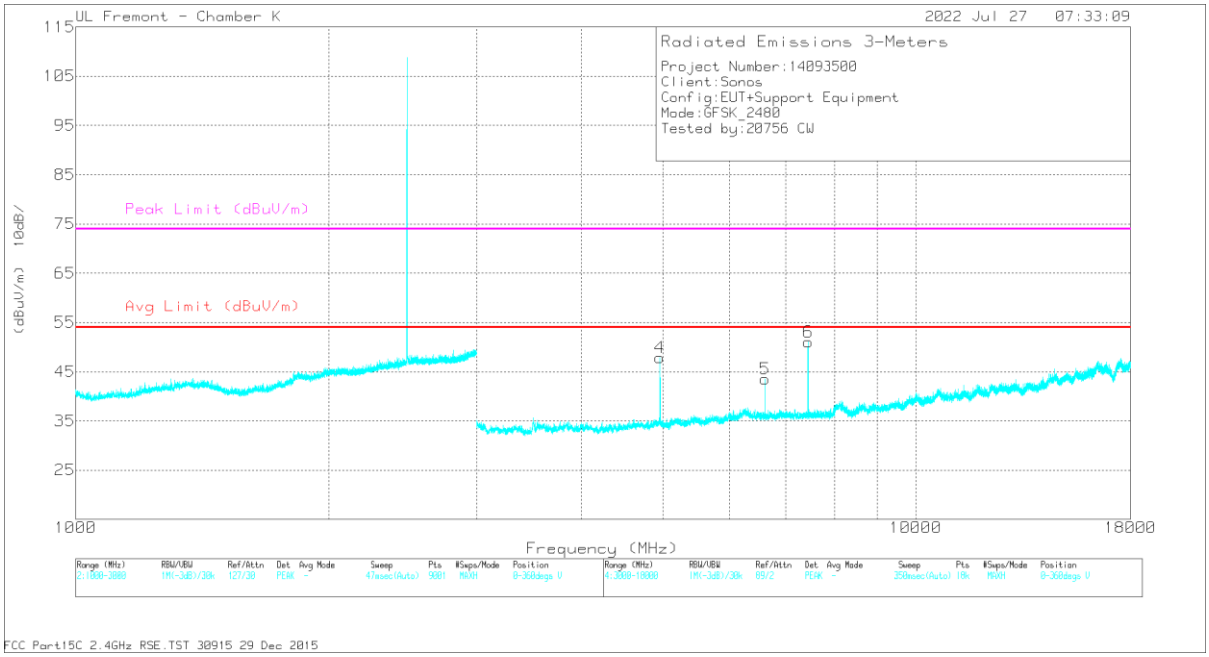
HIGH CHANNEL RESULTS



HORIZONTAL



VERTICAL

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RADIATED EMISSIONS

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AF 80404 (dB/m)	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	* 4959.944	56.97	PKFH	34.1	-40.4	50.67	-	-	74	-23.33	240	103	H
	* 4959.828	51.77	VA1T	34.1	-40.4	45.47	54	-8.53	-	-	240	103	H
2	6612.852	47.67	PKFH	35.8	-38.8	44.67	-	-	-	-	36	110	H
	6612.853	37.75	VA1T	35.8	-38.8	34.75	-	-	-	-	36	110	H
3	* 7440.071	52.95	PKFH	35.8	-37.8	50.95	-	-	74	-23.05	98	202	H
	* 7439.975	47.74	VA1T	35.8	-37.8	45.74	54	-8.26	-	-	98	202	H
4	* 4960.006	57.8	PKFH	34.1	-40.4	51.5	-	-	74	-22.5	34	316	V
	* 4959.982	53.77	VA1T	34.1	-40.4	47.47	54	-6.53	-	-	34	316	V
5	6613.4	52.62	PKFH	35.8	-38.8	49.62	-	-	-	-	19	318	V
	6613.292	47.62	VA1T	35.8	-38.8	44.62	-	-	-	-	19	318	V
6	* 7440.222	55.69	PKFH	35.8	-37.8	53.69	-	-	74	-20.31	308	185	V
	* 7439.963	51.14	VA1T	35.8	-37.8	49.14	54	-4.86	-	-	308	185	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 transmitted duration

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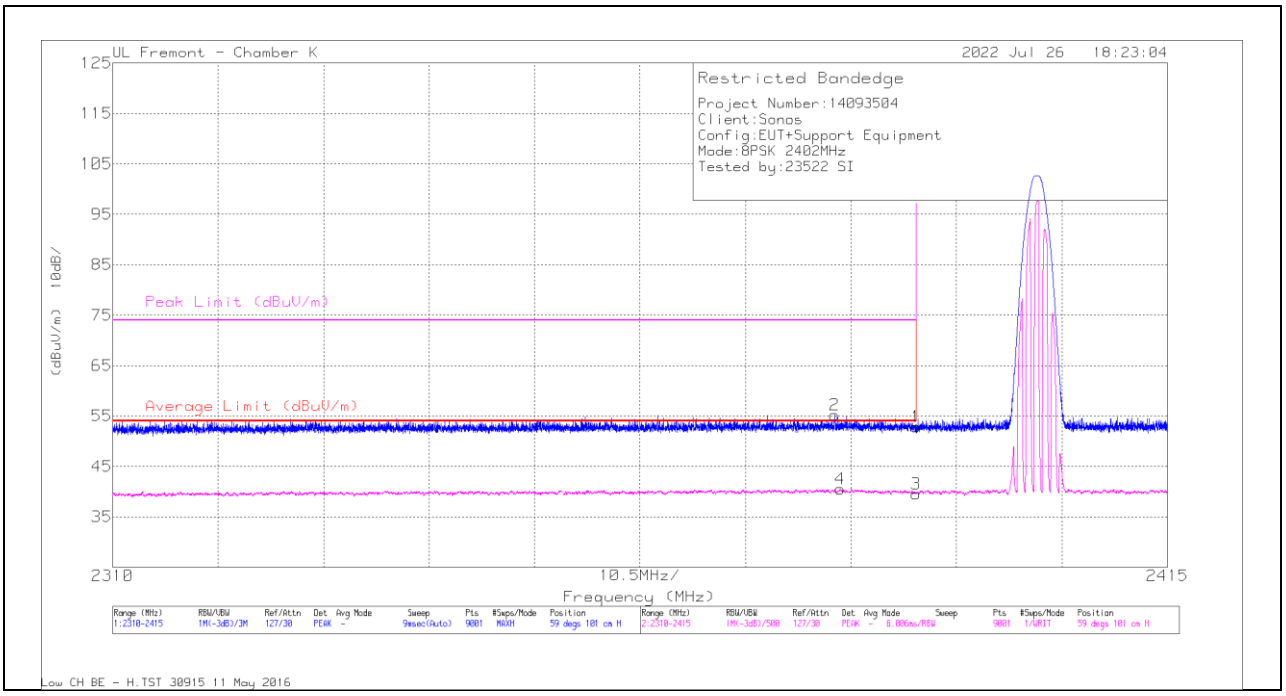
10.1.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

BANDEDGE (LOW CHANNEL)

HORIZONTAL RESULT



Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AF 80404 (dB/m)	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	55.71	Pk	32.1	-34.9	52.91	-	-	74	-21.09	59	101	H
2	* 2381.892	57.93	Pk	32.2	-34.9	55.23	-	-	74	-18.77	59	101	H
3	* 2390	42.39	VA1T	32.1	-34.9	39.59	54	-14.41	-	-	59	101	H
4	* 2382.429	43.16	VA1T	32.2	-34.8	40.56	54	-13.44	-	-	59	101	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 transmitted duration

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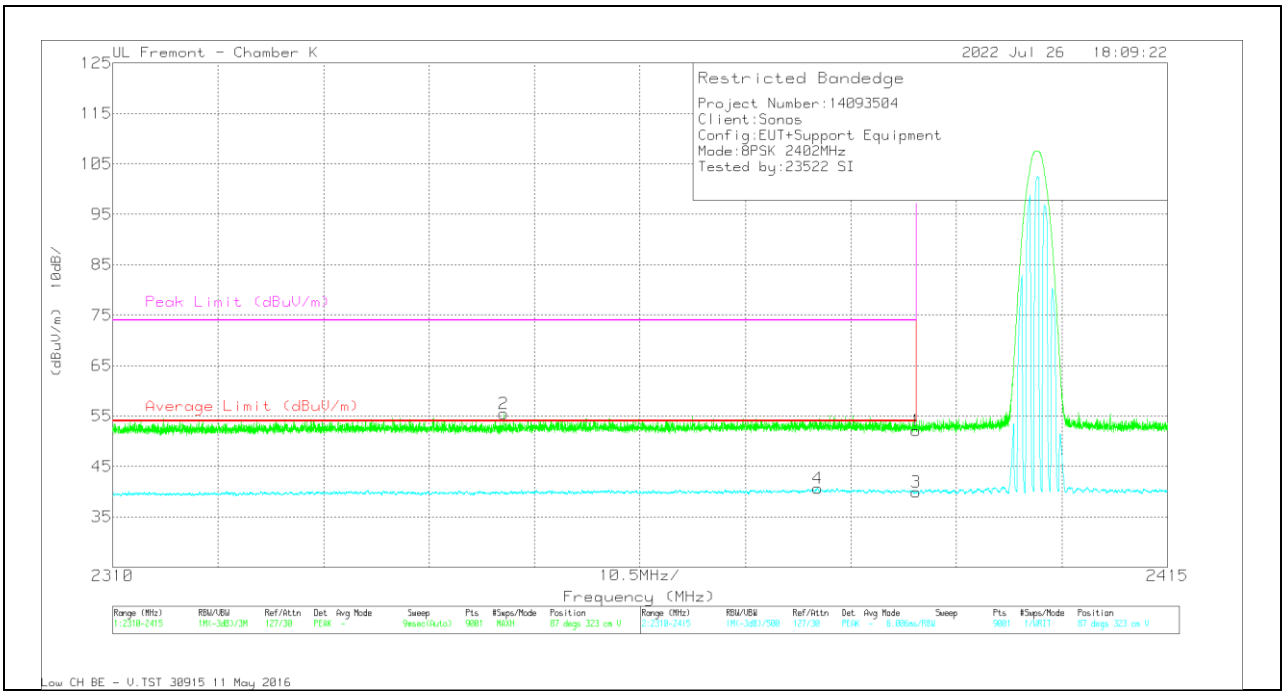
VERTICAL RESULT



Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AF 80404 (dB/m)	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	54.86	Pk	32.1	-34.9	52.06	-	-	74	-21.94	87	323	V
2	* 2348.921	58.48	Pk	32	-35	55.48	-	-	74	-18.52	87	323	V
3	* 2390	42.7	VA1T	32.1	-34.9	39.9	54	-14.1	-	-	87	323	V
4	* 2380.165	43.38	VA1T	32.2	-34.9	40.68	54	-13.32	-	-	87	323	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 transmitted duration

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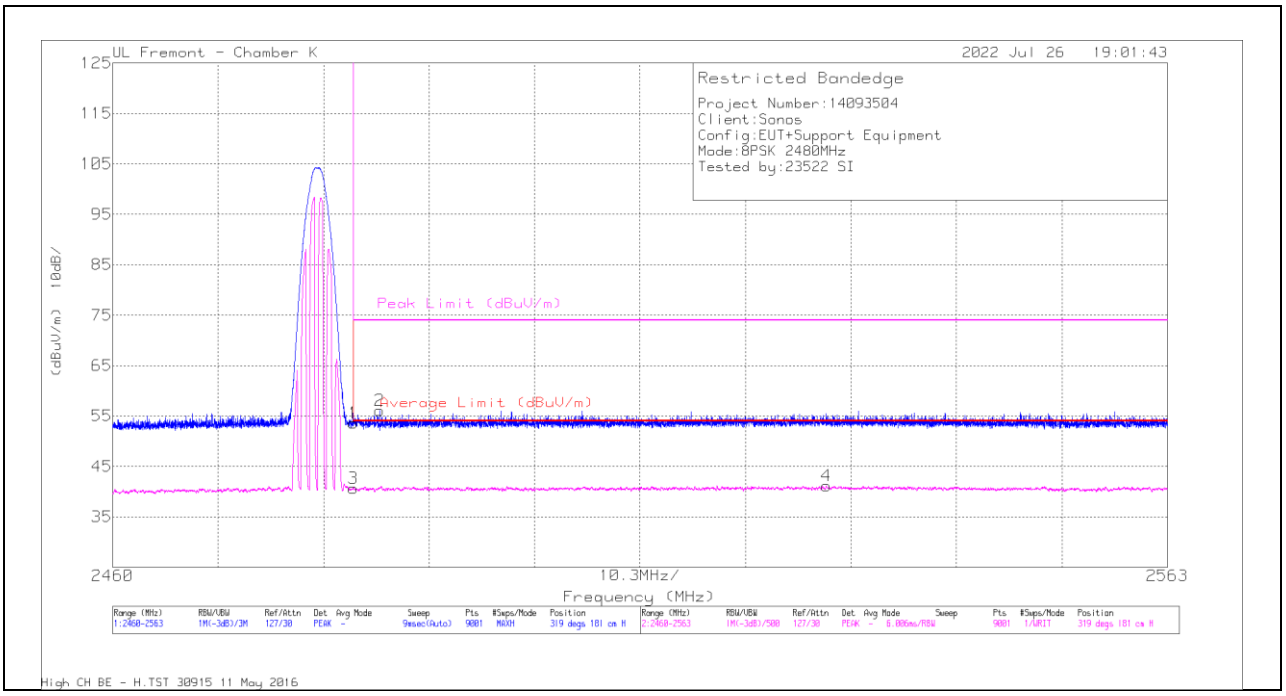
BANDEDGE (HIGH CHANNEL)

HORIZONTAL RESULT



Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AF 80404 (dB/m)	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	55.48	Pk	32.7	-34.5	53.68	-	-	74	-20.32	319	181	H
2	* 2486.092	57.84	Pk	32.8	-34.5	56.14	-	-	74	-17.86	319	181	H
3	* 2483.5	42.52	VA1T	32.7	-34.5	40.72	54	-13.28	-	-	319	181	H
4	2529.683	42.66	VA1T	32.8	-34.3	41.16	54	-12.84	-	-	319	181	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 transmitted duration

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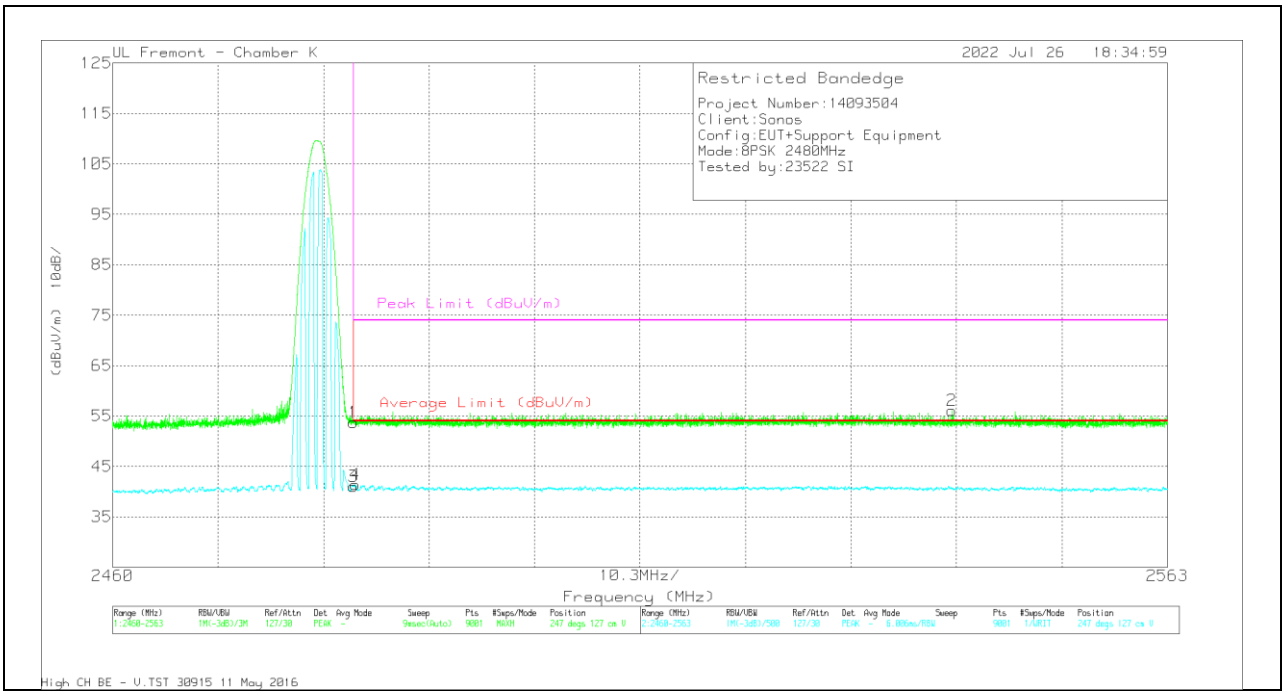
VERTICAL RESULT



Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AF 80404 (dB/m)	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	55.56	Pk	32.7	-34.5	53.76	-	-	74	-20.24	247	127	V
2	2541.939	57.63	Pk	32.7	-34.2	56.13	-	-	74	-17.87	247	127	V
3	* 2483.5	42.87	VA1T	32.7	-34.5	41.07	54	-12.93	-	-	247	127	V
4	* 2483.701	43.19	VA1T	32.7	-34.5	41.39	54	-12.61	-	-	247	127	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 transmitted duration

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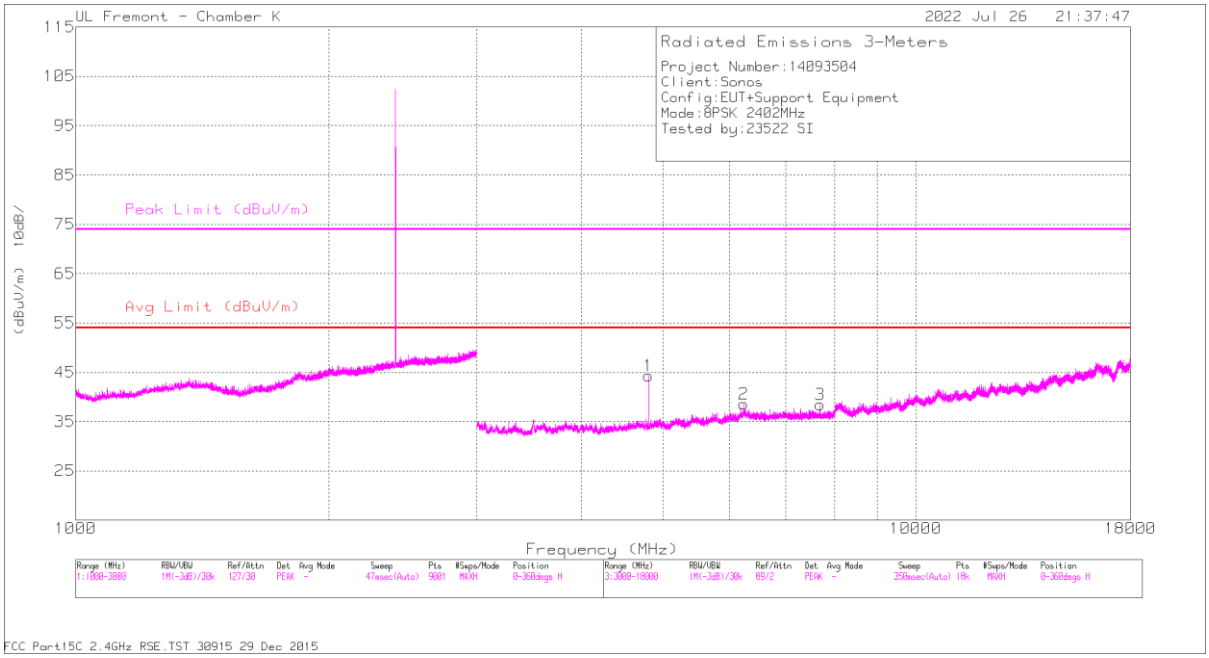
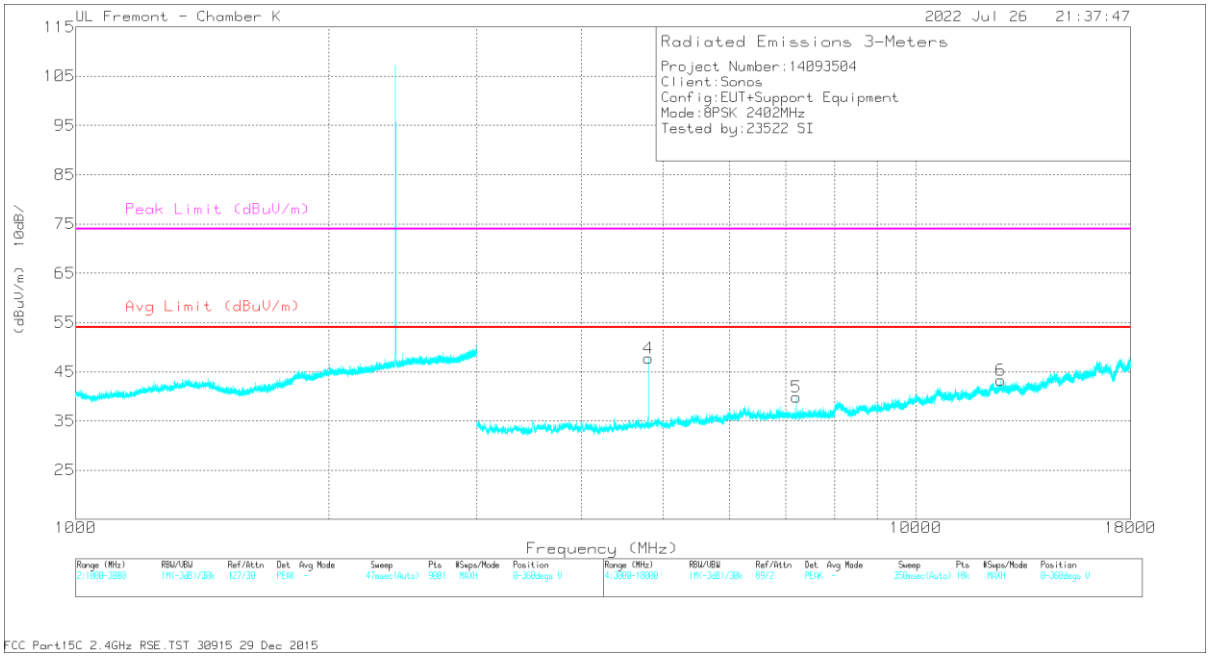
HARMONICS AND SPURIOUS EMISSIONS

LOW CHANNEL RESULTS



HORIZONTAL



VERTICAL

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RADIATED EMISSIONS

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AF 80404 (dB/m)	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	* 4803.688	59.43	PKFH	34.2	-40.6	53.03	-	-	74	-20.97	324	106	H
	* 4804	49.26	VA1T	34.2	-40.6	42.86	54	-11.14	-	-	324	106	H
2	6234.919	48.07	PKFH	35.8	-38.3	45.57	-	-	-	-	315	306	H
	6236.31	35.04	VA1T	35.8	-38.3	32.54	-	-	-	-	315	306	H
3	* 7686.616	48.02	PKFH	35.9	-38	45.92	-	-	74	-28.08	47	191	H
	* 7686.576	38.19	VA1T	35.9	-38	36.09	54	-17.91	-	-	47	191	H
4	* 4804.432	58.31	PKFH	34.2	-40.6	51.91	-	-	74	-22.09	244	234	V
	* 4803.644	47.63	VA1T	34.2	-40.6	41.23	54	-12.77	-	-	244	234	V
5	7206.019	47.78	PKFH	35.9	-38.3	45.38	-	-	-	-	316	114	V
	7206.043	35.73	VA1T	35.9	-38.3	33.33	-	-	-	-	316	114	V
6	* 12624.679	44.91	PKFH	39.2	-33.8	50.31	-	-	74	-23.69	84	131	V
	* 12622.801	31.93	VA1T	39.2	-33.8	37.33	54	-16.67	-	-	84	131	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 transmitted duration

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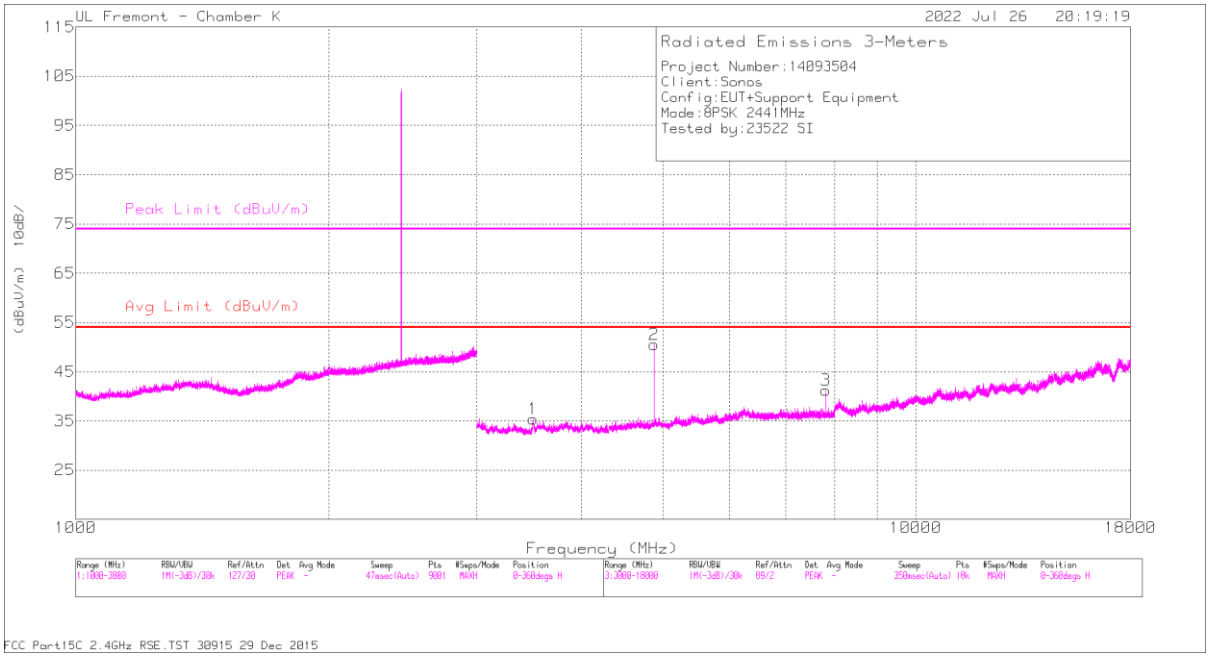
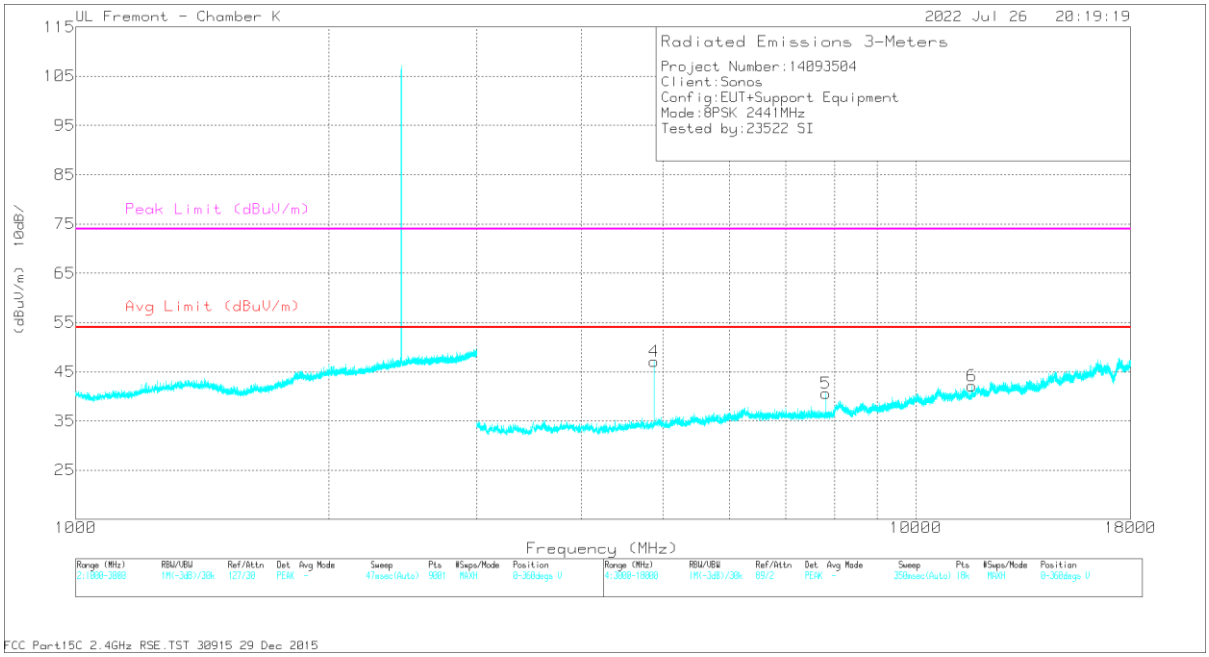
MID CHANNEL RESULTS



HORIZONTAL



VERTICAL

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RADIATED EMISSIONS

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AF 80404 (dB/m)	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	* 3502.284	51.92	PKFH	34.2	-41.8	44.32	-	-	74	-29.68	85	360	H
	* 3502.332	38.57	VA1T	34.2	-41.8	30.97	54	-23.03	-	-	85	360	H
2	* 4881.852	59.92	PKFH	34.1	-40.3	53.72	-	-	74	-20.28	325	206	H
	* 4882.22	50.53	VA1T	34.1	-40.3	44.33	54	-9.67	-	-	325	206	H
3	7810.779	48.92	PKFH	35.9	-37.5	47.32	-	-	-	-	53	171	H
	7811.119	40.98	VA1T	35.9	-37.5	39.38	-	-	-	-	53	171	H
4	* 4881.54	60.17	PKFH	34.1	-40.3	53.97	-	-	74	-20.03	242	219	V
	* 4882.168	50.56	VA1T	34.1	-40.3	44.36	54	-9.64	-	-	242	219	V
5	7811.546	49.44	PKFH	35.9	-37.5	47.84	-	-	-	-	8	132	V
	7811.386	39.28	VA1T	35.9	-37.5	37.68	-	-	-	-	8	132	V
6	* 11655.479	45.33	PKFH	38.5	-35.4	48.43	-	-	74	-25.57	191	283	V
	* 11658.316	32.78	VA1T	38.5	-35.4	35.88	54	-18.12	-	-	191	283	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 transmitted duration

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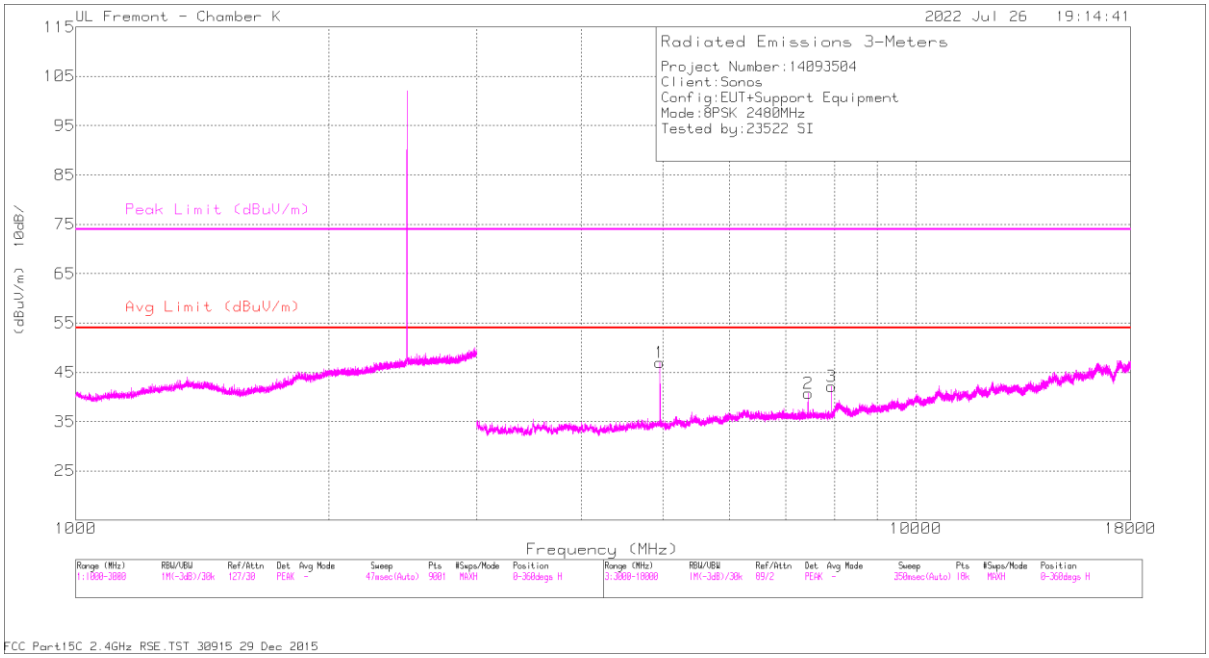
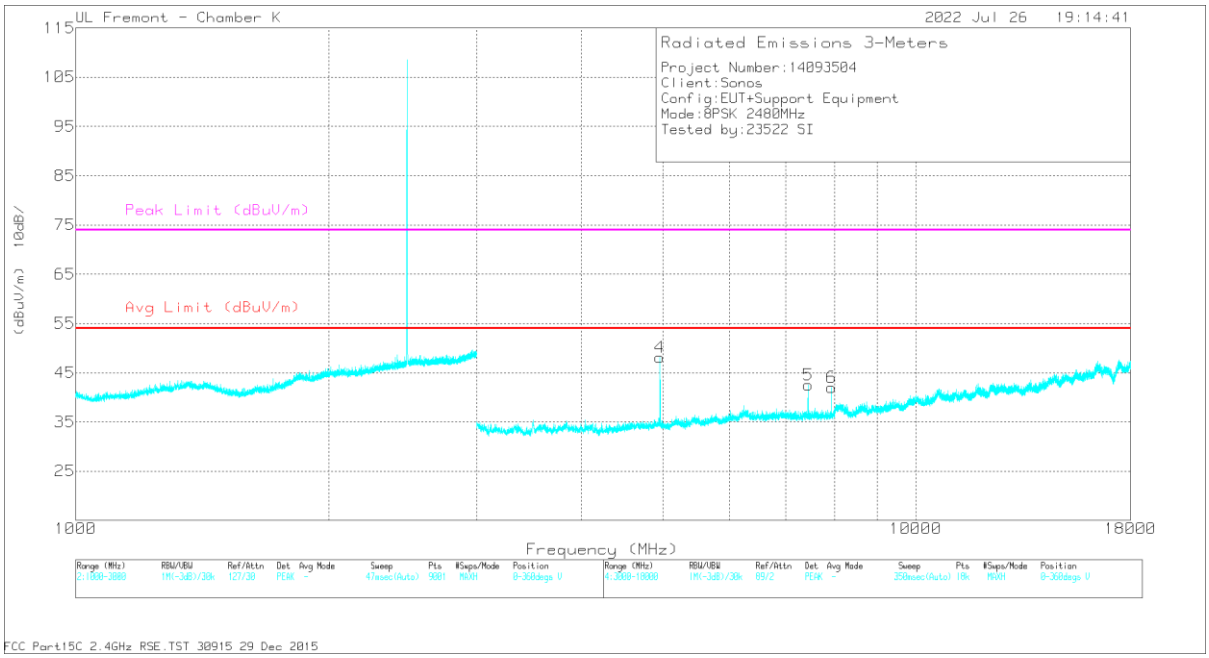
HIGH CHANNEL RESULTS



HORIZONTAL



VERTICAL

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RADIATED EMISSIONS

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AF 80404 (dB/m)	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	* 4959.77	59.51	PKFH	34.1	-40.4	53.21	-	-	74	-20.79	81	156	H
	* 4960.011	47.57	VA1T	34.1	-40.4	41.27	54	-12.73	-	-	81	156	H
2	* 7440.229	50.23	PKFH	35.8	-37.8	48.23	-	-	74	-25.77	43	176	H
	* 7440.213	37.6	VA1T	35.8	-37.8	35.6	54	-18.4	-	-	43	176	H
3	7935.71	50.2	PKFH	35.9	-37.5	48.6	-	-	-	-	58	183	H
	7935.982	43.19	VA1T	35.9	-37.5	41.59	-	-	-	-	58	183	H
4	* 4959.756	59.68	PKFH	34.1	-40.4	53.38	-	-	74	-20.62	356	122	V
	* 4959.736	47.65	VA1T	34.1	-40.4	41.35	54	-12.65	-	-	356	122	V
5	* 7439.579	50.69	PKFH	35.8	-37.8	48.69	-	-	74	-25.31	29	98	V
	* 7440.075	36.76	VA1T	35.8	-37.8	34.76	54	-19.24	-	-	29	98	V
6	7936.298	50.25	PKFH	35.9	-37.5	48.65	-	-	-	-	12	105	V
	7935.898	42.32	VA1T	35.9	-37.5	40.72	-	-	-	-	12	105	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 transmitted duration

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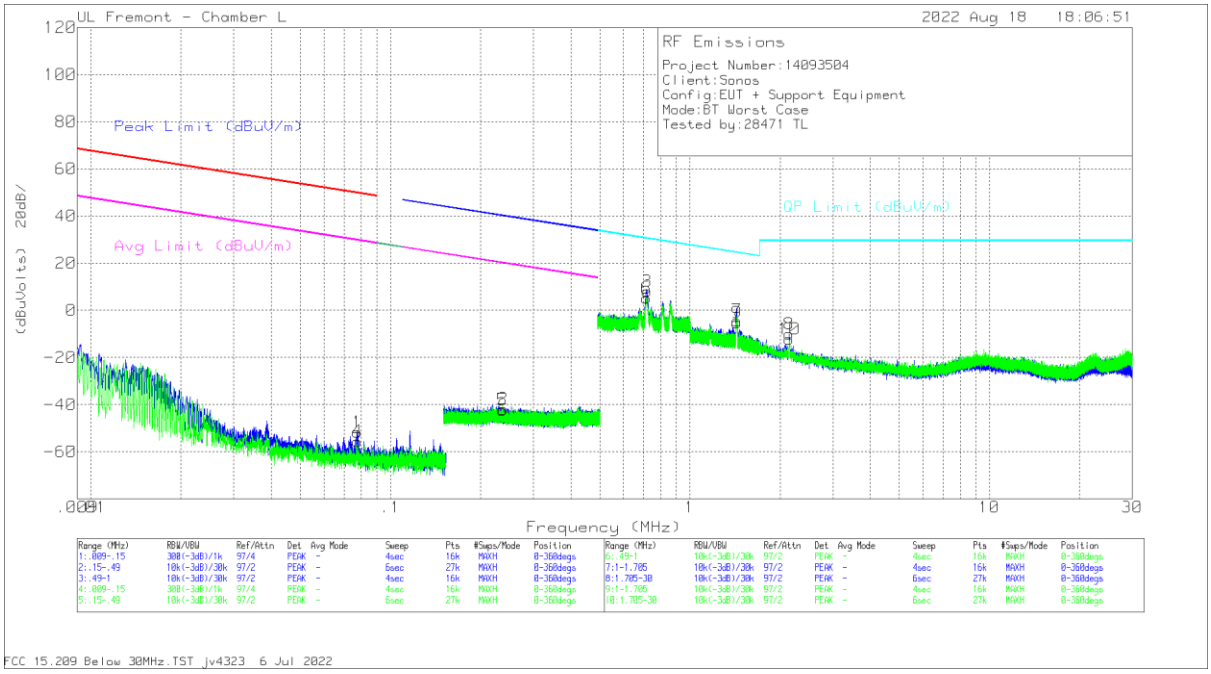
10.2. WORST CASE BELOW 30MHz

SPURIOUS EMISSIONS BELOW 30 MHz (WORST-CASE CONFIGURATION)



ANTENNA- TWO ORIENTATIONS FACE ON/FACE OFF

Below 30MHz Data

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)	QP Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	Margin (dB)	Avg Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
1	.0775	4.56	Pk	55.7	-32	-80	-51.74	49.8	-101.54	29.8	-81.54	-	-	-	-	-	-	0-360
2	.2383	13.87	Pk	56.2	-32	-80	-41.93	-	-	-	-	-	-	40.07	-82	20.07	-62	0-360
4	.0775	.55	Pk	55.8	-32	-80	-55.65	49.8	-105.45	29.8	-85.45	-	-	-	-	-	-	0-360
5	.2368	13.49	Pk	56.2	-32	-80	-42.31	-	-	-	-	-	-	40.13	-82.44	20.13	-62.44	0-360
3	.7195	23.78	Pk	56.2	-31.9	-40	8.08	-	-	-	-	30.47	-22.39	-	-	-	-	0-360
6	.716	20.93	Pk	56.2	-31.9	-40	5.23	-	-	-	-	30.52	-25.29	-	-	-	-	0-360
7	1.4383	23	Pk	44.6	-31.9	-40	-4.3	-	-	-	-	24.47	-28.77	-	-	-	-	0-360
8	2.1462	20.43	Pk	41.3	-31.8	-40	-10.07	-	-	-	-	29.5	-39.57	-	-	-	-	0-360
9	1.4381	22.02	Pk	44.6	-31.9	-40	-5.28	-	-	-	-	24.47	-29.75	-	-	-	-	0-360
10	2.1462	18.33	Pk	41.3	-31.8	-40	-12.17	-	-	-	-	29.5	-41.67	-	-	-	-	0-360

Pk - Peak detector

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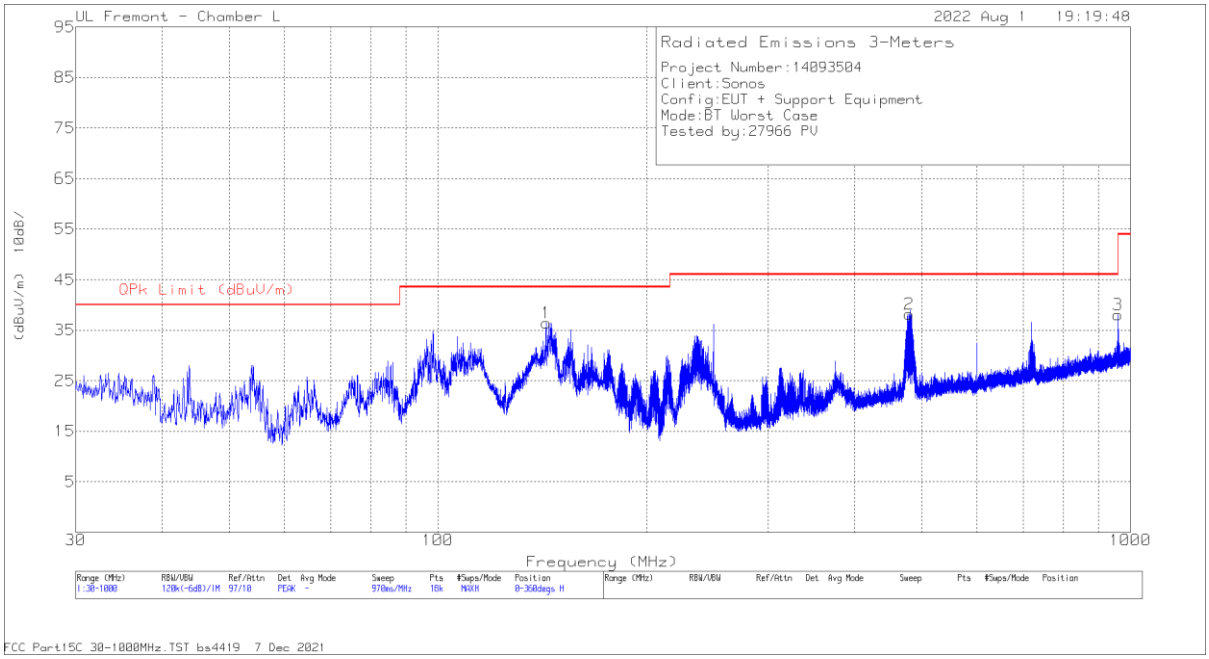
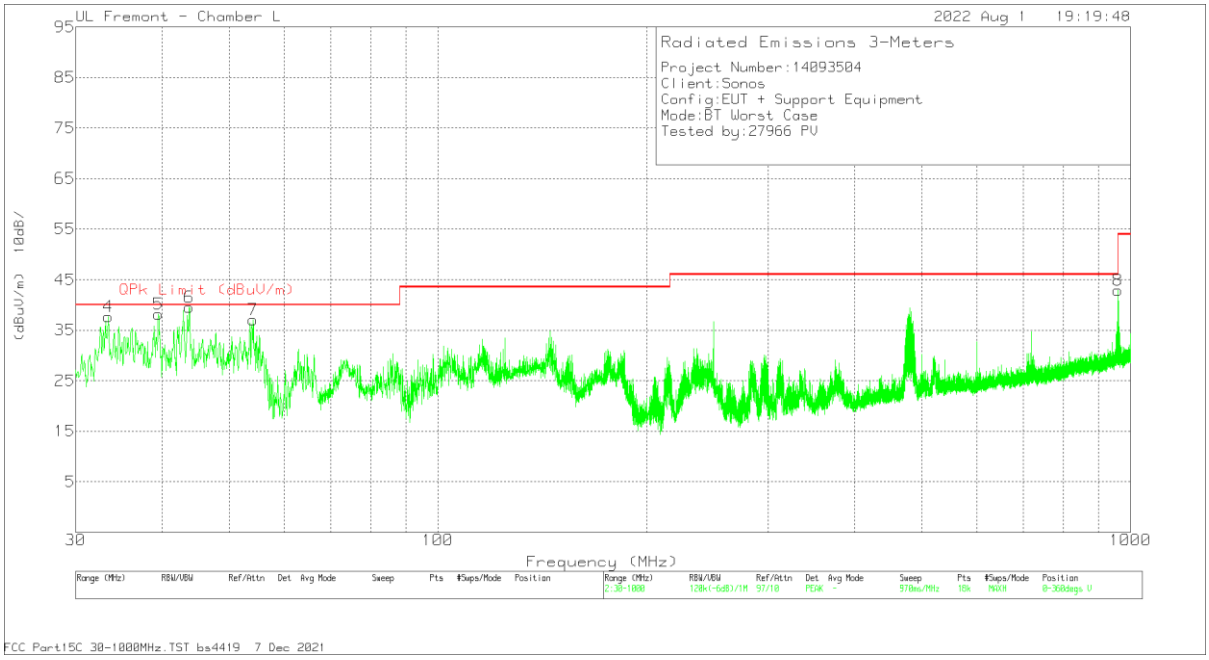
10.3. WORST CASE BELOW 1 GHz

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



HORIZONTAL



VERTICAL

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Below 1GHz Data

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	171862 HYBRID JB3	Amp/Cbl (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	143.275	48.14	Pk	18.6	-30.3	36.44	43.52	-7.08	0-360	199	H
2	479.65	43.52	Pk	23.5	-28.9	38.12	46.02	-7.9	0-360	99	H
3	960.043	36.24	Pk	28.8	-27	38.04	53.97	-15.93	0-360	99	H
4	33.1636	42.84	Qp	24.5	-31.3	36.04	40	-3.96	275	103	V
5	39.5037	46.01	Qp	19.9	-31.3	34.61	40	-5.39	123	143	V
6	43.7849	53.19	Qp	16.9	-31.2	38.89	40	-1.11	115	107	V
7	53.9105	52.4	Qp	13	-31.1	34.3	40	-5.7	317	113	V
8	960.016	41.05	Pk	28.8	-27	42.85	53.97	-11.12	0-360	101	V

Pk - Peak detector
Qp - Quasi-Peak detector

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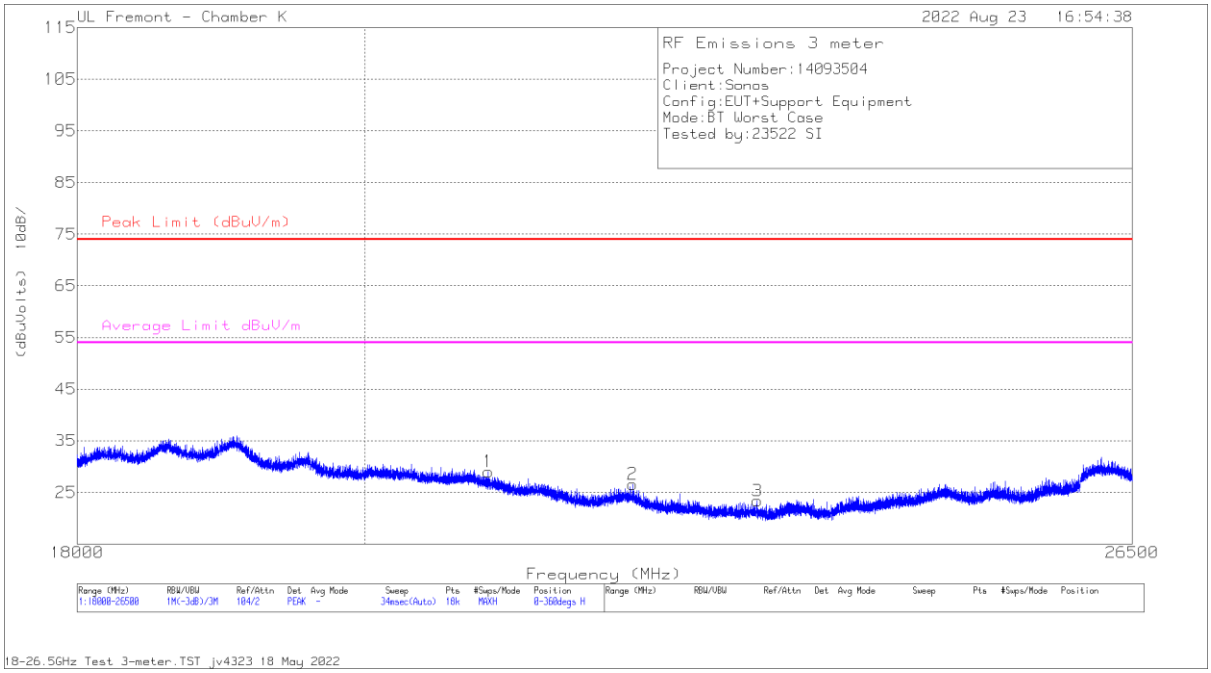
10.4. WORST CASE 18-26 GHz

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



HORIZONTAL

VERTICAL

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18 – 26GHz DATA

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	81138 AF (dB/m)	215705 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	* 20928.249	36.34	Pk	33.2	-59.5	19	29.04	74	-44.96	54	-24.96	0-360	99	H
2	* 22065.831	34.7	Pk	33.4	-60.8	19.3	26.6	74	-47.4	54	-27.4	0-360	200	H
3	* 23096.692	31.07	Pk	33.5	-61	19.8	23.37	74	-50.63	54	-30.63	0-360	99	H
4	* 18159.139	45.72	Pk	32.5	-61	17.7	34.92	74	-39.08	54	-19.08	0-360	100	V
5	* 20406.443	38.61	Pk	33	-59.8	18.6	30.41	74	-43.59	54	-23.59	0-360	200	V
6	* 22546.553	32.44	Pk	33.5	-61	19.6	24.54	74	-49.46	54	-29.46	0-360	200	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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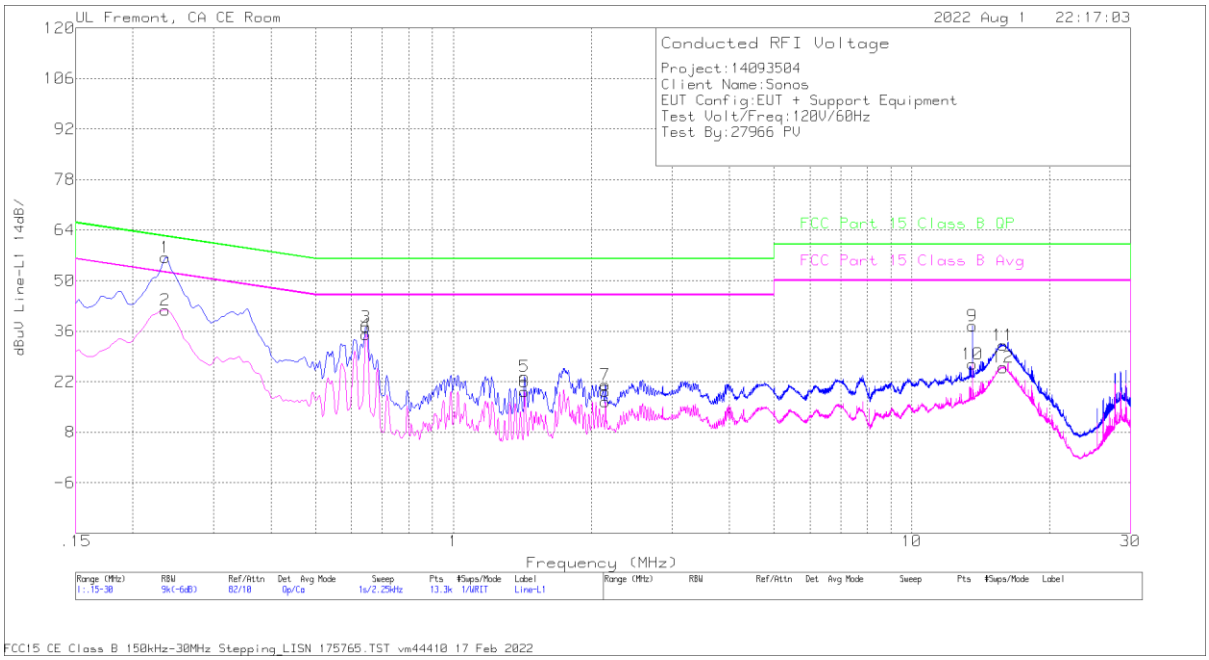
11.1. AC POWER LINE

LINE 1 RESULTS



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	.2355	32.55	Ca	0	0	9.3	41.85	-	-	52.25	-10.4
4	.645	25.66	Ca	0	.1	9.3	35.06	-	-	46	-10.94
6	1.4303	9.78	Ca	0	.1	9.3	19.18	-	-	46	-26.82
8	2.1458	7.04	Ca	0	.1	9.3	16.44	-	-	46	-29.56
10	13.56	17.28	Ca	.1	.2	9.3	26.88	-	-	50	-23.12
12	15.8528	16.33	Ca	.1	.2	9.3	25.93	-	-	50	-24.07
1	.2355	47.16	Qp	0	0	9.3	56.46	62.25	-5.79	-	-
3	.645	27.69	Qp	0	.1	9.3	37.09	56	-18.91	-	-
5	1.4303	13.99	Qp	0	.1	9.3	23.39	56	-32.61	-	-
7	2.1458	11.7	Qp	0	.1	9.3	21.1	56	-34.9	-	-
9	13.56	27.96	Qp	.1	.2	9.3	37.56	60	-22.44	-	-
11	15.8134	22.5	Qp	.1	.2	9.3	32.1	60	-27.9	-	-

Qp - Quasi-Peak detector
Ca - CISPR average detection

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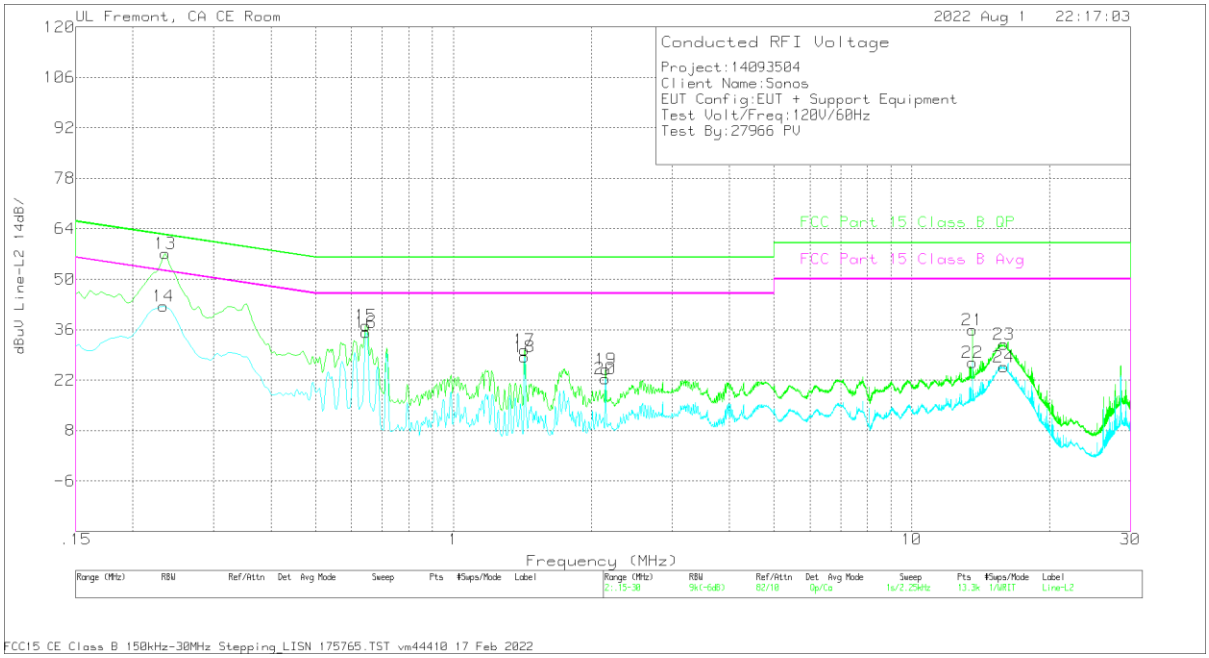
LINE 2 RESULTS



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	.2333	33.19	Ca	0	0	9.3	42.49	-	-	52.33	-9.84
16	.645	25.88	Ca	0	.1	9.3	35.28	-	-	46	-10.72
18	1.4303	19.05	Ca	0	.1	9.3	28.45	-	-	46	-17.55
20	2.1458	13.03	Ca	0	.1	9.3	22.43	-	-	46	-23.57
22	13.56	17.32	Ca	.1	.2	9.3	26.92	-	-	50	-23.08
24	15.8618	16.12	Ca	.1	.2	9.3	25.72	-	-	50	-24.28
13	.2355	47.78	Qp	0	0	9.3	57.08	62.25	-5.17	-	-
15	.645	27.71	Qp	0	.1	9.3	37.11	56	-18.89	-	-
17	1.4303	20.88	Qp	0	.1	9.3	30.28	56	-25.72	-	-
19	2.148	15.56	Qp	0	.1	9.3	24.96	56	-31.04	-	-
21	13.56	26.39	Qp	.1	.2	9.3	35.99	60	-24.01	-	-
23	15.864	22.27	Qp	.1	.2	9.3	31.87	60	-28.13	-	-

Qp - Quasi-Peak detector
Ca - CISPR average detection

UL VERIFICATION SERVICES
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