TEST REPORT

Report Number. : 14262501-E3V2

Applicant	:	ENERGOUS CORPORATION 3590 NORTH FIRST STREET, SUITE 210, SAN JOSE, CA 95134, U.S.A.
Model	:	VN55
Brand	:	ENERGOUS
FCC ID	:	2ADNG-VN55
IC	:	23686-VN55
EUT Description	:	WIRELESS CHARGER
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:
May 04, 2022

Prepared by:
UL VERIFICATION SERVICES
47173 Benicia Street
Fremont, CA 94538 U.S.A.
TEL: (510) 319-4000
FAX: (510) 661-0888

ACCREDITED
CERT #0751.05

REPORT REVISION HISTORY

Rev.	Issue Date	Revisions	Revised By
V1	4/25/2022	Initial Issue	--
V2	5/4/2022	Updated report to address TCB's questions	Tina Chu

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: ENERGOUS CORPORATION
3590 NORTH FIRST STREET,
SUITE 210,
SAN JOSE, CA 95134, U.S.A.

EUT DESCRIPTION: WIRELESS CHARGER

MODEL: VN55

BRAND: ENERGOUS

SERIAL NUMBER: 5072 (CONDUCTED); AEFEC0B3 (RADIATED)

SAMPLE RECEIPT DATE: MARCH 31, 2022

DATE TESTED: APRIL 04, 2022 – APRIL 14, 2022

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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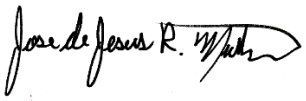
Approved & Released For
UL Verification Services Inc. By:

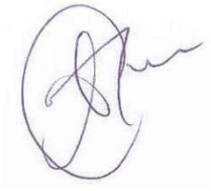
DAN CORONIA
OPERATIONS LEADER
UL Verification Services Inc.

Prepared By:



JOSE MARTINEZ
TEST ENGINEER
UL Verification Services Inc.

Reviewed By:



TINA CHU
SENIOR PROJECT ENGINEER
UL Verification Services Inc.

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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.

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

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, and RSS-GEN Issue 5 + A1 + A2, and RSS-247 Issue 2.

4. FACILITIES AND ACCREDITATION

UL LLC is accredited by A2LA, certification #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, USA	US0104	2324A	550739
☐	Building 2: 47266 Benicia Street, Fremont, CA 94538, USA	US0104	22541	550739
☒	Building 4: 47658 Kato Rd, Fremont, CA 94538, USA	US0104	2324B	550739

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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	2.84 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 a stand-alone wireless charger with BLE and Zigbee 802.15.4 that is mounted on a ceiling or a wall. The wireless charger transmits power via a frequency hopping signal between 917.2MHz to 918.8MHz and a DTS Zigbee 802.15.4 signal between 2402MHz and 2480MHz, and charges multiple receivers at a time.

This report documents test results of the Zigbee 802.15.4 radio portion (only supports 250kbps) of the wireless charger.

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	Zigbee 802.15.4	21.27	133.97

6.3. DESCRIPTION OF AVAILABLE ANTENNAS

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

The radio utilizes two embedded internal antennas, with a maximum gain of 2.5 dBi as total.

6.4. SOFTWARE AND FIRMWARE

The EUT firmware installed during testing was 3.5.9_engz

The test utility software used during testing was 3.5.9_engz

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6.5. WORST-CASE CONFIGURATION AND MODE

Radiated band edge were performed with the EUT was set to transmit at the Low /2475MHz/High channels measured power.

Radiated harmonics, and spurious emissions from 1 GHz to 18GHz were performed with the EUT was set to transmit at the Low/Mid/High channels with highest output power as worst-case scenario.

Radiated emission below 30MHz, below 1GHz, above 18GHz, and power line conducted emission were performed with the EUT was set to transmit at the channel with highest output power as worst-case scenario.

The EUT is a wall or ceiling mounted device and it has one USB type C port for power only. The fundamental of the EUT was investigated in four orthogonal orientations X,Y,Z1, Z2, it was determined that X orientation was worst-case orientation; therefore, all final radiated testing was performed with the EUT in X orientation.

Worst-case data rate as provided by the client was:
Zigbee 802.15.4: 250 kbps.

The EUT only supports Zigbee 802.15.4 2 Tx (MIMO) at the same time, it does not support 1 Tx (SISO). All radiated tests are performed on 2 Tx (MIMO) only.

WPT band and 2.4G Zigbee 802.15.4 transmit simultaneously, simultaneous operation result of the radiated emissions is documented in UL document 14262501-E1 WPT report.

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6.6. DESCRIPTION OF TEST SETUP

SUPPORT TEST EQUIPMENT				
Description	**Manufacturer**	**Model**	**Serial Number**	**FCC ID/ DoC**
Laptop	Dell	Precision M3800	1N80562	DoC
Laptop AC/DC adapter	Dell	HA130PM130	CN-0V363H-CH200-732-03L8-A00	DoC
AC/DC Switching Adapter	CUI Inc.	HDP-QB05010U	-	DoC

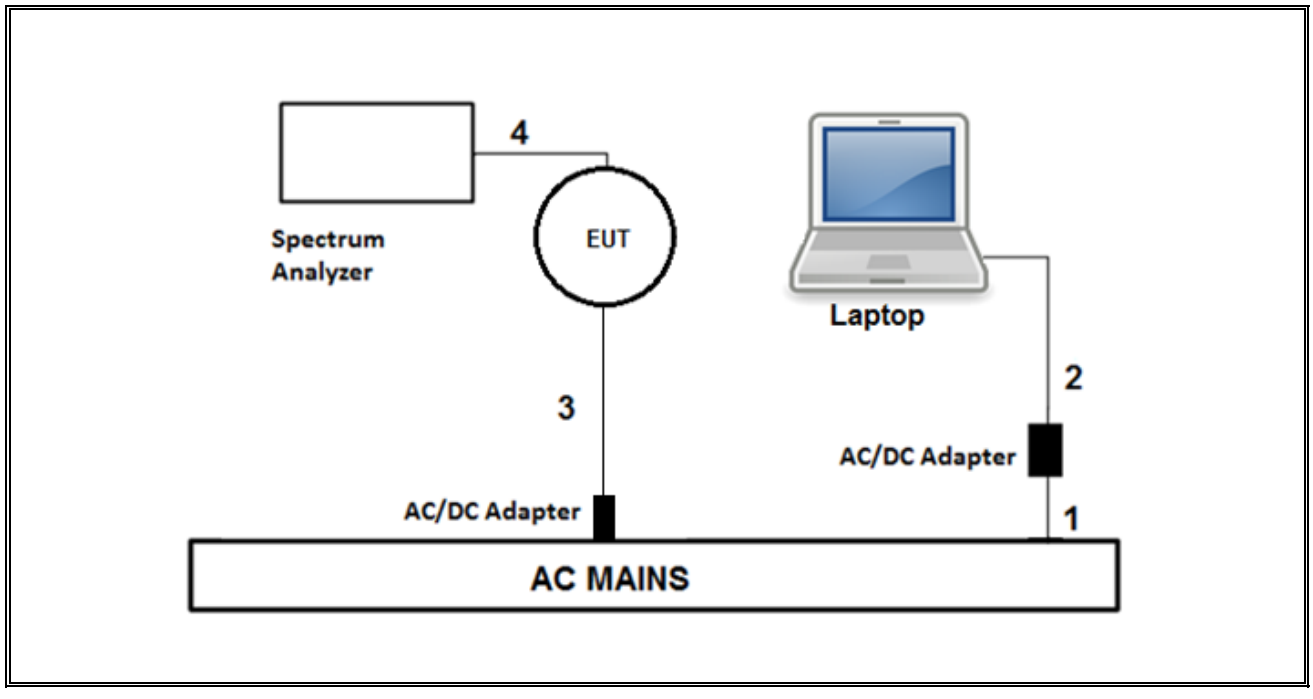
I/O CABLES (RF CONDUCTED TEST)						
Cable No.	**Port**	**# of Identical Ports**	**Connector Type**	**Cable Type**	**Cable Length (m)**	**Remarks**
1	AC	1	AC	Un-shielded	1	AC Mains to AC/DC Adapter
2	DC	1	DC	Un-shielded	1.5	AC/DC Adapter to Laptop
3	USB	1	USB Type C	Shielded	1	EUT to AC/DC adapter
4	Antenna	1	SMA	Un-shielded	0.3	To spectrum analyzer

I/O CABLES (RF RADIATED TEST/AC LINE CONDUCTED TEST)						
Cable No.	**Port**	**# of Identical Ports**	**Connector Type**	**Cable Type**	**Cable Length (m)**	**Remarks**
1	USB	1	USB Type C	Shielded	1	

TEST SETUP-RF CONDUCTED TEST

The EUT was powered by AC/DC adapter via USB cable. Test software exercised the EUT.

SETUP DIAGRAMS



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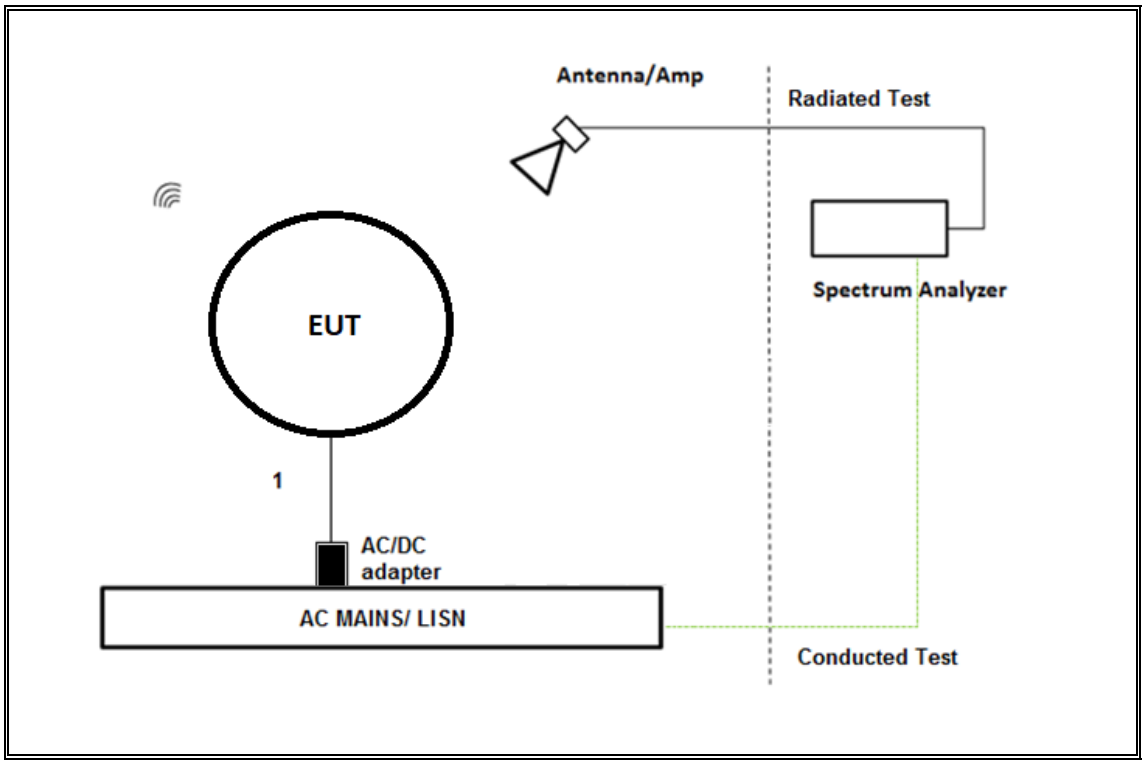
TEST SETUP- RADIATED TEST / AC LINE CONDUCTED TEST

The EUT was powered by AC/DC adapter via USB cable. Test software exercised the EUT. Laptop was removed after test setup.

SETUP DIAGRAM



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7. MEASUREMENT METHOD

6 dB BW: ANSI C63.10 Subclause -11.8.1 RBW ≥ DTS BW

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

Output Power: ANSI C63.10 Subclause -11.9.1.3 Method PKPM1 Peak-reading power meter

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

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

Radiated emissions non-restricted frequency bands: ANSI C63.10 Subclause -11.11

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

Conducted emissions in restricted frequency bands: ANSI C63.10 Subclause -11.12.2

Band-edge: ANSI C63.10 Subclause -11.13.3.4 Integration method -Trace averaging across ON and OFF times DC correction

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

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

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8. 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, Passive Loop 30Hz - 1MHz	ELECTRO METRICS	EM-6871	PRE0179466 (170014)	06/08/2022	06/08/2021
Antenna, Passive Loop 100KHz - 30MHz	ELECTRO METRICS	EM-6872	PRE0179468 (170016)	06/08/2022	06/08/2021
Antenna, Broadband Hybrid, 30MHz to 2000MHz	Sunol Sciences Corp.	JB1	82258	10/01/2022	10/01/2021
Amplifier, 9KHz to 1GHz, 32dB	SONOMA INSTRUMENT	310	175953	02/08/2023	02/08/2022
Thermometer	Control Company	14-650-118	160656	03/30/2023	03/30/2022
EMI TEST RECEIVER	Rohde & Schwarz	ESW44	PRE0179367	02/16/2023	02/16/2022
Antenna, Horn 1-18GHz	ETS-Lindgren (Cedar Park, Texas)	3117	79834	05/07/2022	05/07/2021
Amplifier, 100MHz-18GHz	MITEQ	AFS42-00101800-25-S-42	150755	03/09/2023	03/092022
Thermometer - Digital	Control Company	14-650-118	175731	02/03/2023	02/03/2022
EMI TEST RECEIVER, with B8 option	Rohde & Schwarz	ESW44	169937	02/20/2023	02/20/2022
Antenna, Horn 18 to 26.5GHz	ARA	MWH-1826/B	81139	05/25/2022	05/25/2021
Rf Amplifier, 18-26.5GHz, 60dB gain	AMPLICAL	AMP18G26.5-60	171590	05/21/2022	05/21/2021
Spectrum Analyzer, PSA, 3Hz to 26.5GHz	Keysight Technologies Inc	E4440A	81311	02/02/2023	02/02/2022
Power Meter, P-series single channel	Keysight Technologies Inc	N1911A	90719	01/24/2023	01/24/2022
Power Sensor, P - series, 50MHz to 18GHz, Wideband	Keysight Technologies Inc	N1921A	90391	02/03/2023	02/03/2022
AC Line Conducted					
LISN	Fischer Custom Communications, Inc	FCC-LISN-50/250-25-2-01-480V	175765	01/26/2023	01/26/2022
EMI TEST RECEIVER	Rohde & Schwarz	ESR	93091	02/21/2023	02/21/2022
Transient Limiter	TE	TBFL1	207996	06/01/2022	06/01/2021
UL TEST SOFTWARE LIST					
Radiated Software	UL	UL EMC	Rev 9.5, Jan 03, 2020		
Antenna Port Software	UL	UL RF	Ver 2021.08.27		
AC Line Conducted Software	UL	UL EMC	Rev 9.5, 07 Jul 2020		

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9. ANTENNA PORT TEST RESULTS

9.1. ON TIME AND DUTY CYCLE

LIMITS

None; for reporting purposes only.

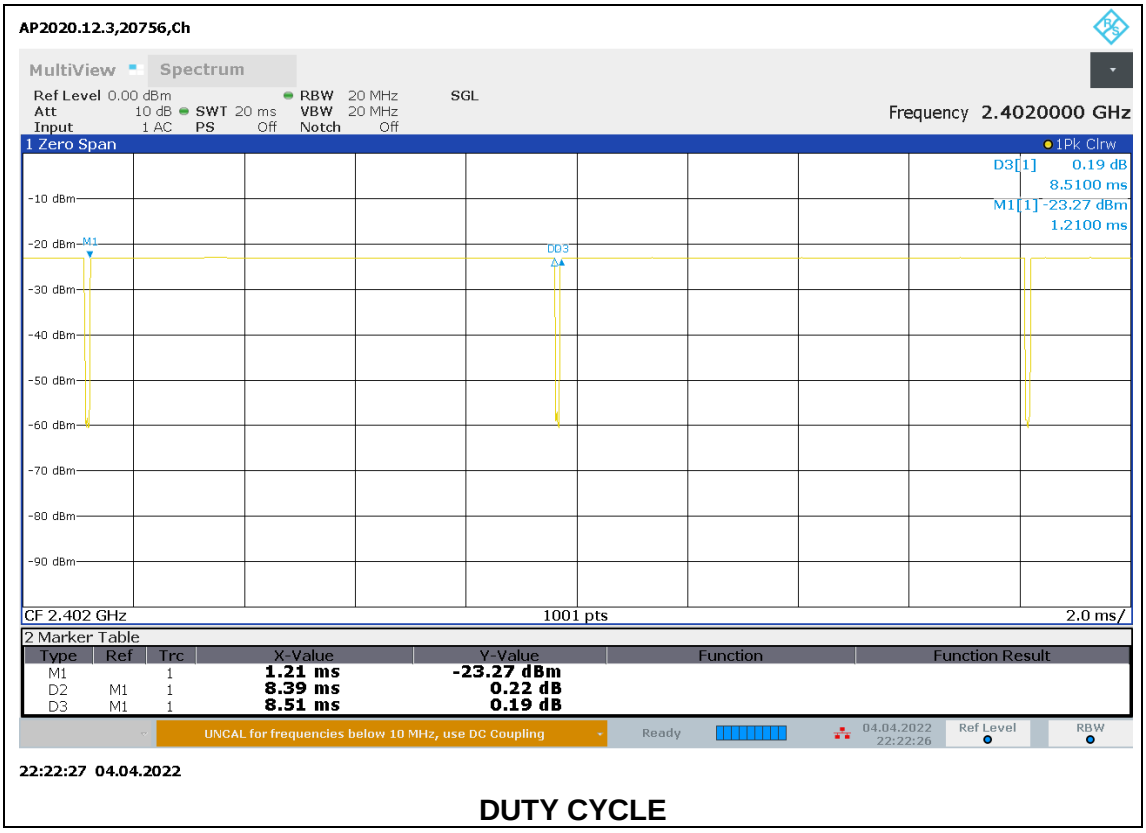
PROCEDURE

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

ON TIME AND DUTY CYCLE RESULTS

	B (msec)	(msec)	x (linear)	Cycle (%)	Correction Factor (dB)	Minimum VBW (kHz)
2.4GHz Band						
Zigbee 802.15.4	8.39	8.51	0.986	98.59	0.00	0.010

Test Engineer	20756 CW



DUTY CYCLE

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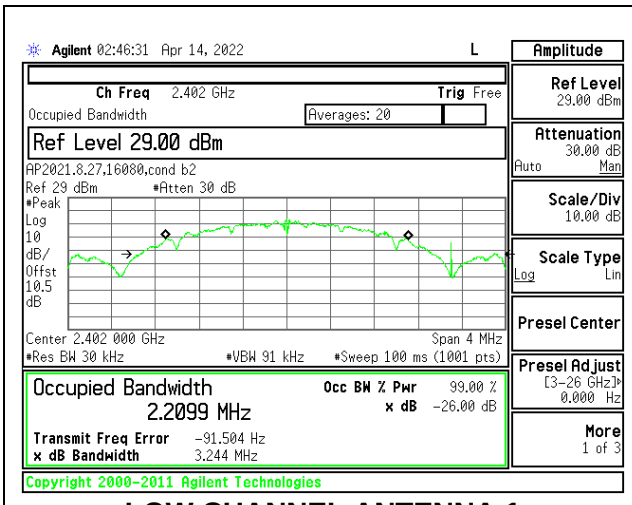
9.2. 99% BANDWIDTH

LIMITS

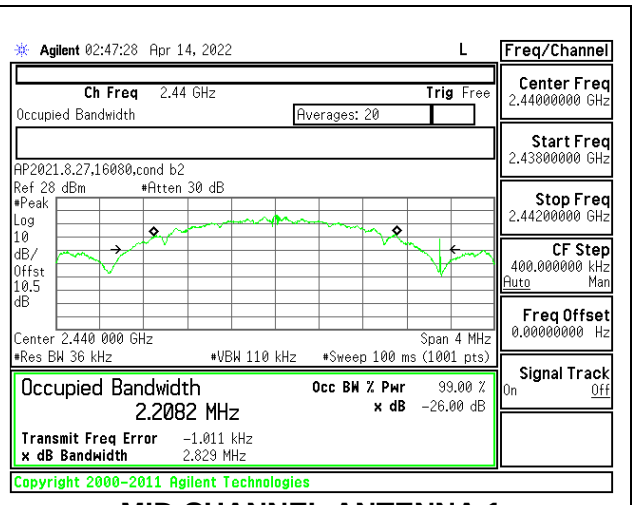
None; for reporting purposes only.

RESULTS

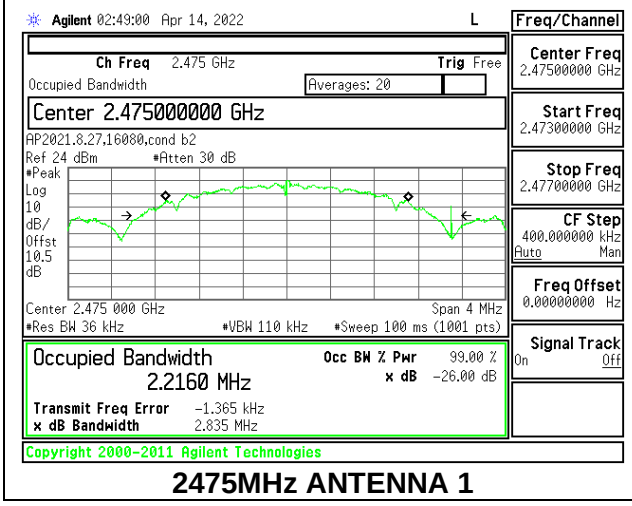
Channel	Frequency (MHz)	99% Bandwidth (MHz) Antenna 1	99% Bandwidth (MHz) Antenna 2
Low	2402	2.2099	2.2072
Middle	2440	2.2082	2.2186
Inner	2475	2.2160	2.2198
High	2480	2.2142	2.2123



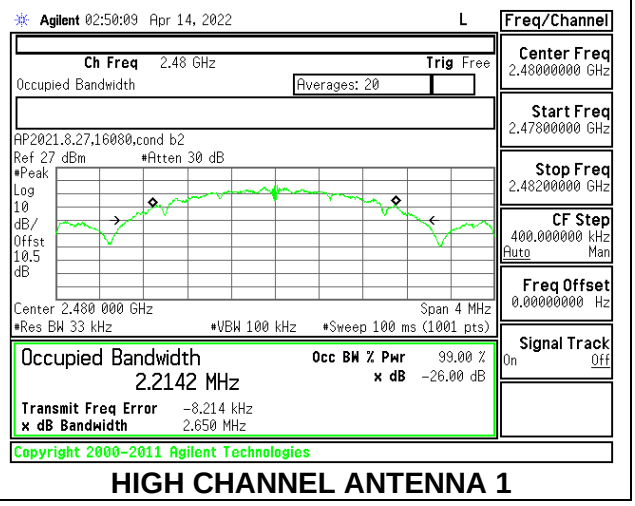
LOW CHANNEL ANTENNA 1



MID CHANNEL ANTENNA 1



2475MHz ANTENNA 1



HIGH CHANNEL ANTENNA 1

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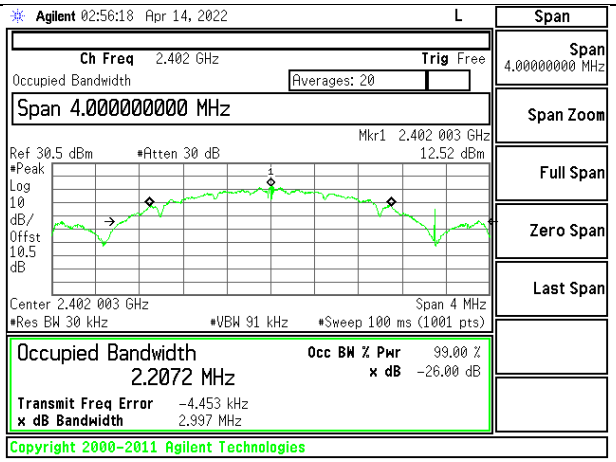
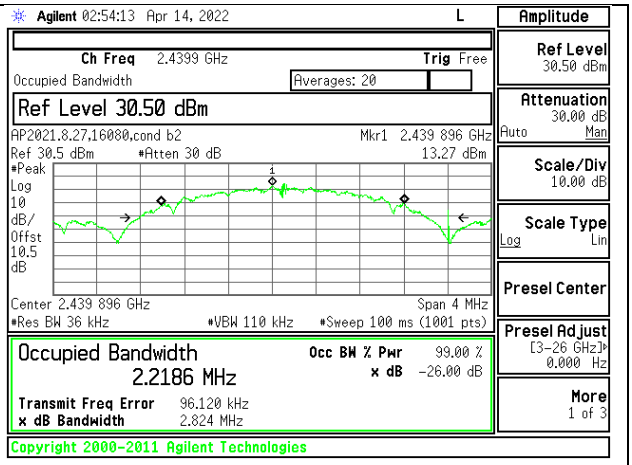
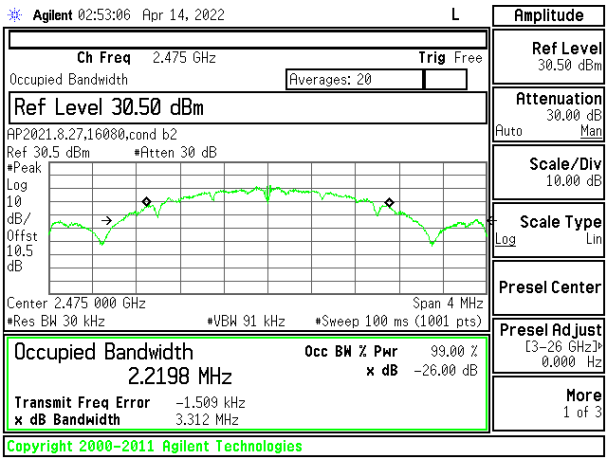


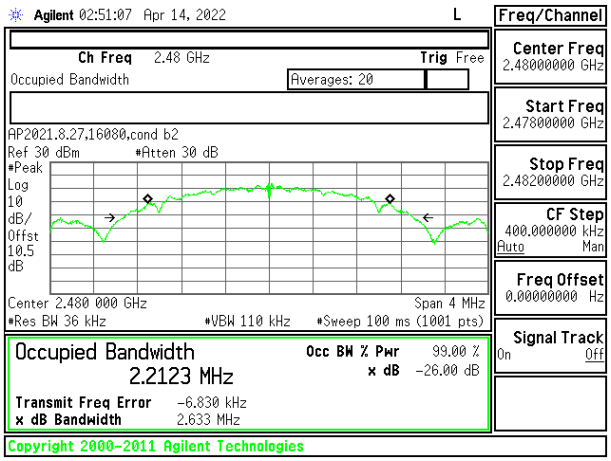
LOW CHANNEL ANTENNA 2



MID CHANNEL ANTENNA 2



2475MHz ANTENNA 2



HIGH CHANNEL ANTENNA 2

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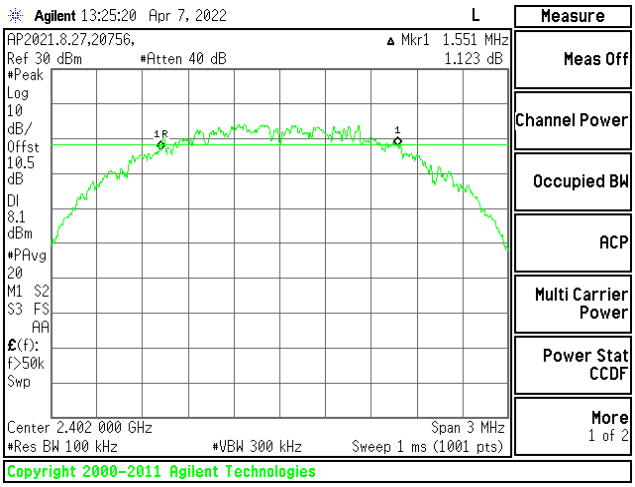
9.3. 6 dB BANDWIDTH

LIMITS

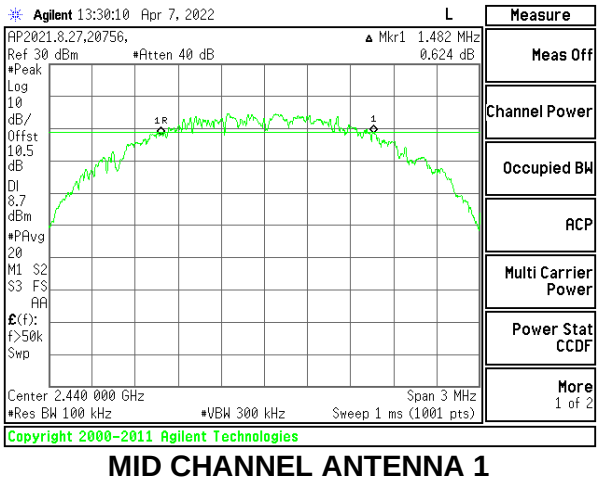
FCC §15.247 (a) (2)
RSS-247 5.2 (a)
The minimum 6 dB bandwidth shall be at least 500 kHz.

RESULTS

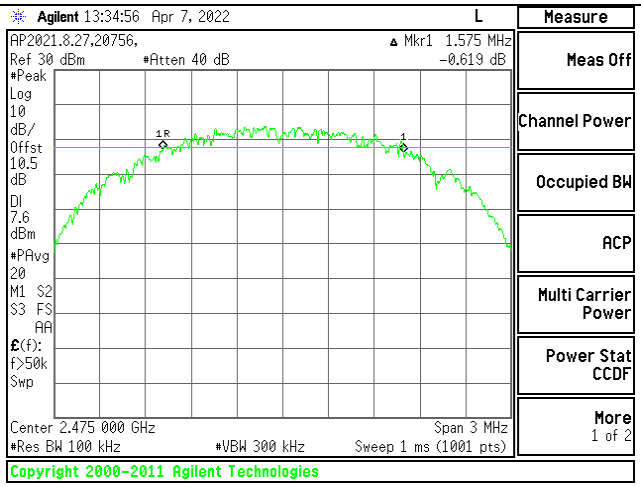
Channel	Frequency (MHz)	6 dB Bandwidth (MHz) Antenna 1	6 dB Bandwidth (MHz) Antenna 2	Minimum Limit (MHz)
Low	2402	1.551	1.572	0.5
Middle	2440	1.482	1.419	0.5
Inner	2475	1.575	1.557	0.5
High	2480	1.509	1.488	0.5



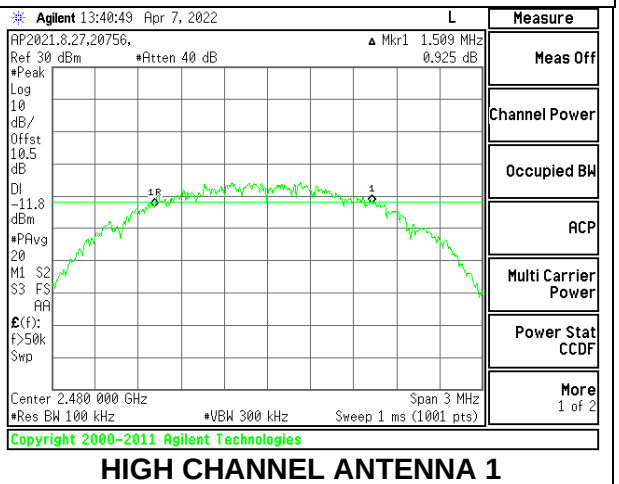
LOW CHANNEL ANTENNA 1



MID CHANNEL ANTENNA 1



2475MHz ANTENNA 1



HIGH CHANNEL ANTENNA 1

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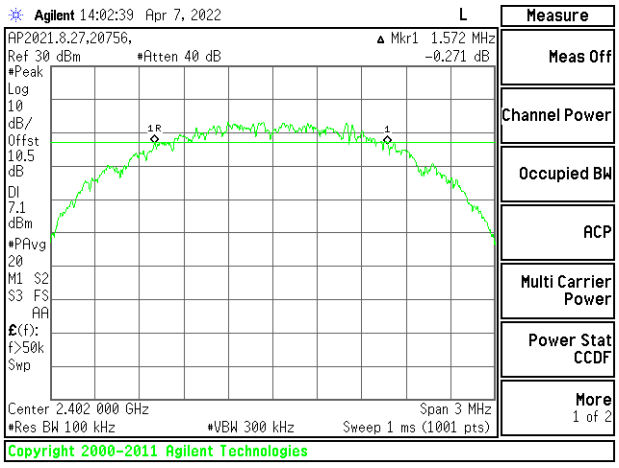
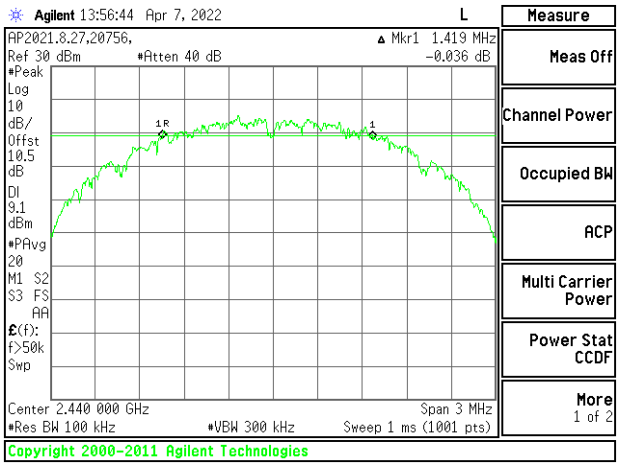
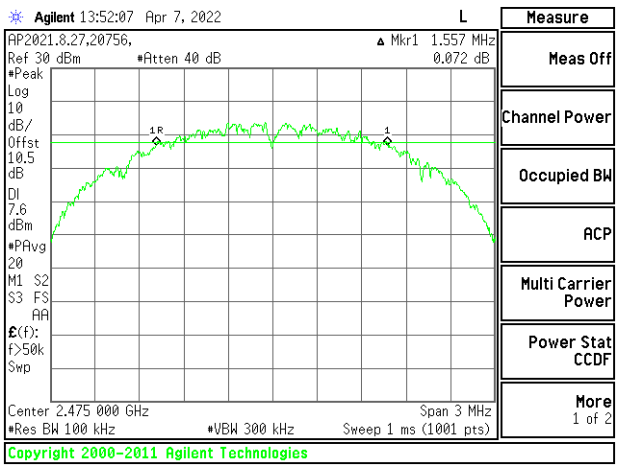


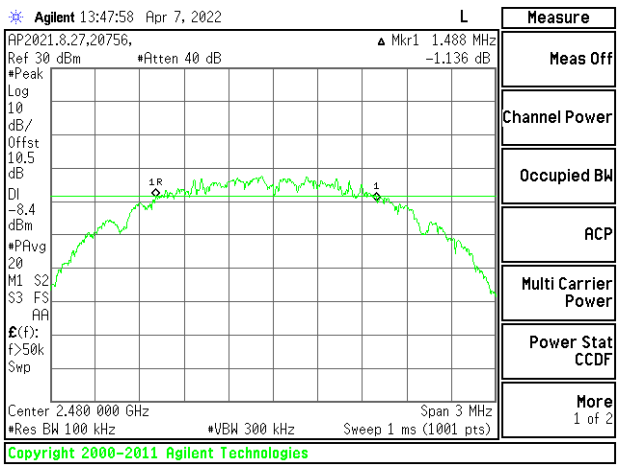
LOW CHANNEL ANTENNA 2



MID CHANNEL ANTENNA 2



2475MHz ANTENNA 2



HIGH CHANNEL ANTENNA 2

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9.4. OUTPUT POWER

LIMITS

FCC §15.247 (b) (3)
RSS-247 5.4 (d)

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

TEST PROCEDURE

The transmitter output is connected to a power meter.

The 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

Tested By:	20756
Date:	4/7/2022

Channel	Frequency (MHz)	Output Power Antenna 1 (dBm)	Output Power Antenna 2 (dBm)	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	17.77	17.07	20.44	30	-9.56
Middle	2440	18.38	18.14	21.27	30	-8.73
Inner	2475	17.71	17.27	20.51	30	-9.49
High	2480	-1.6	1.5	3.23	30	-26.77

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9.5. 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

Tested By:	20756
Date:	4/7/2022

Channel	Frequency (MHz)	Average Power Antenna 1 (dBm)	Average Power Antenna 2 (dBm)	Total Power (dBm)
Low	2402	17.66	16.88	20.30
Middle	2440	18.29	18.03	21.17
Inner	2475	17.54	17.13	20.35
High	2480	-2.18	1.10	2.77

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9.6. POWER SPECTRAL DENSITY

LIMITS

FCC §15.247 (e)
RSS-247 (5.2) (b)

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

RESULTS

Channel	Frequency (MHz)	Antenna 1 Meas (dBm/ 3kHz)	Antenna 2 Meas (dBm/ 3kHz)	Total Corr'd PSD (dBm/ 3kHz)	Limit (dBm/ 3kHz)	Margin (dB)
Low	2402	3.520	4.012	6.78	8.0	-1.2
Mid	2440	4.015	4.900	7.49	8.0	-0.5
Inner	2475	3.059	4.303	6.74	8.0	-1.3
High	2480	-16.519	-13.228	-11.56	8.0	-19.6

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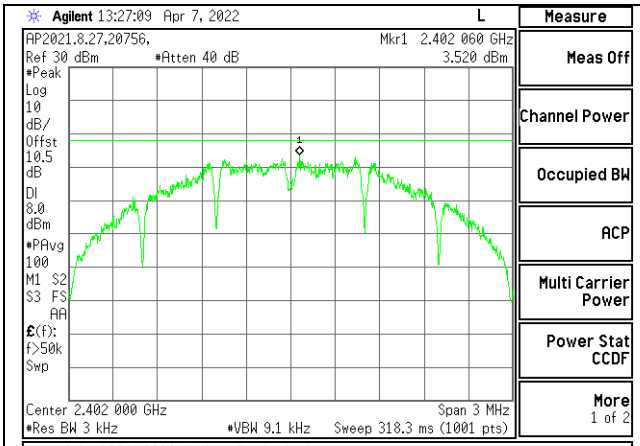
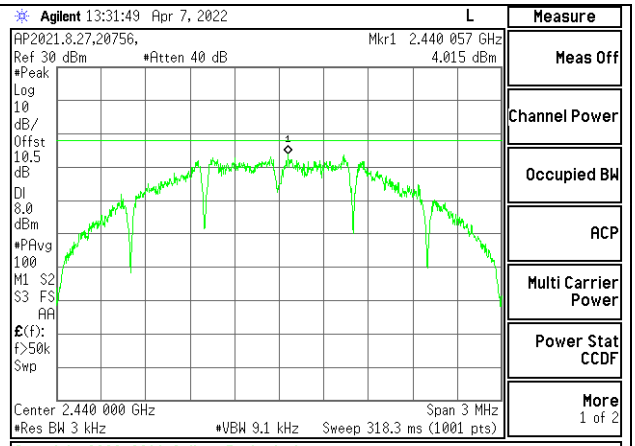
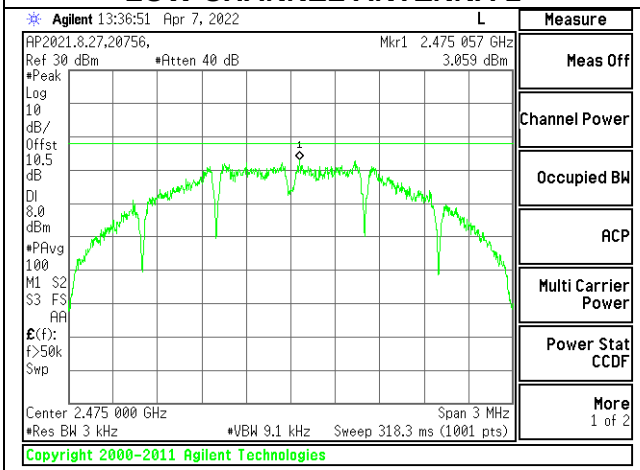


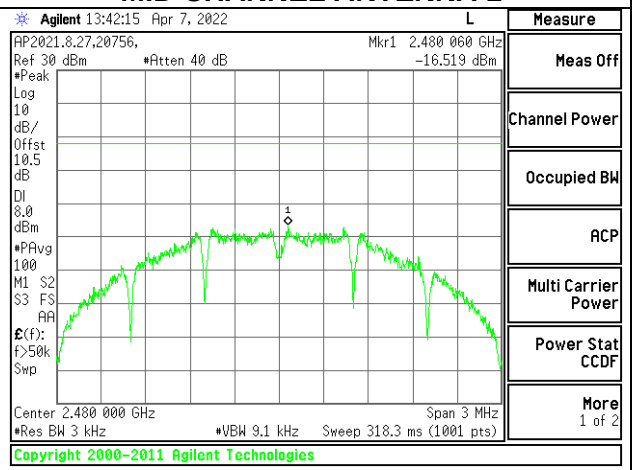
LOW CHANNEL ANTENNA 1



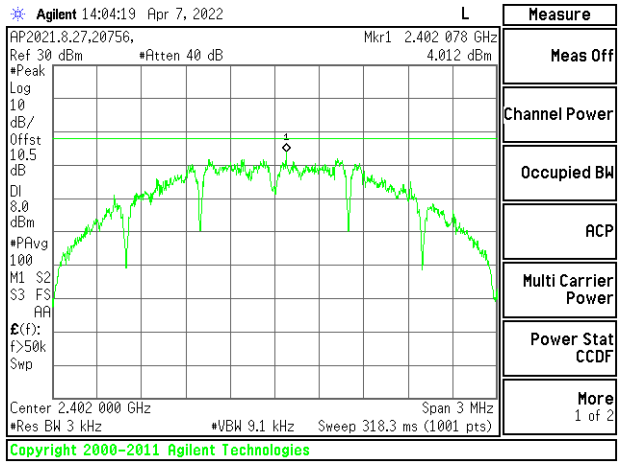
MID CHANNEL ANTENNA 1



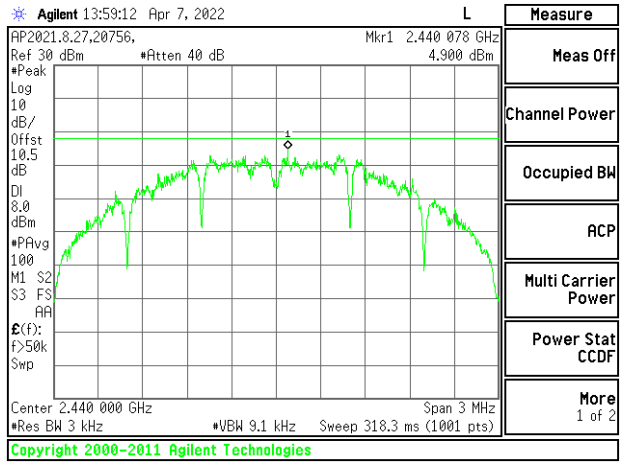
2475MHz ANTENNA 1



HIGH CHANNEL ANTENNA 1

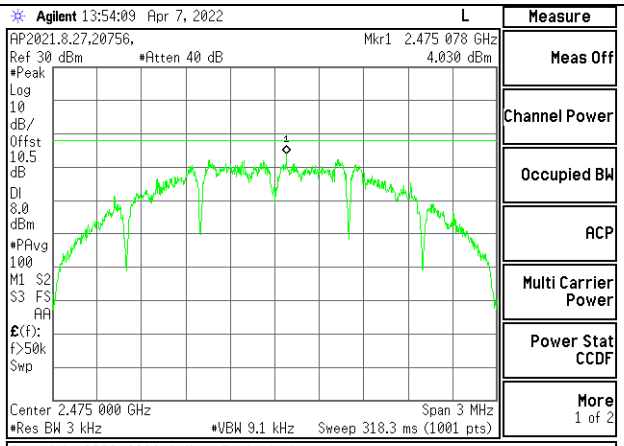


LOW CHANNEL ANTENNA 2

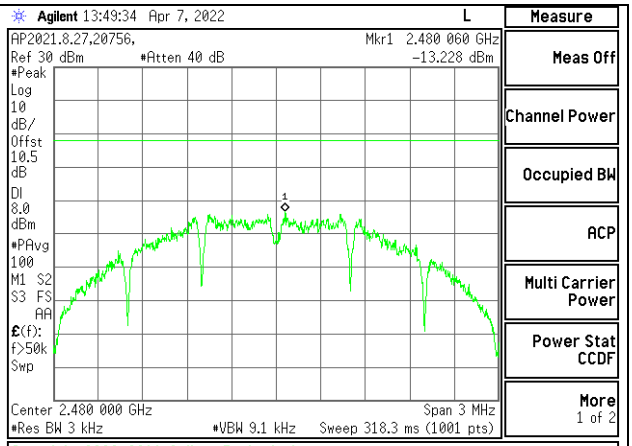


MID CHANNEL ANTENNA 2

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



2475MHz ANTENNA 2



HIGH CHANNEL ANTENNA 2

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9.7. CONDUCTED SPURIOUS EMISSIONS

LIMITS

FCC §15.247 (d)
RSS-247 5.5

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

RESULTS

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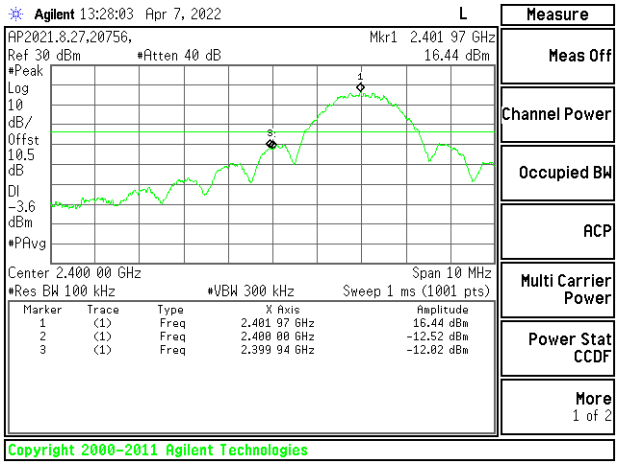
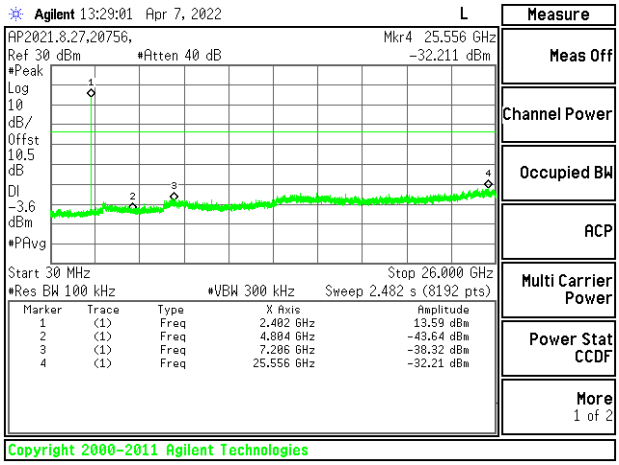
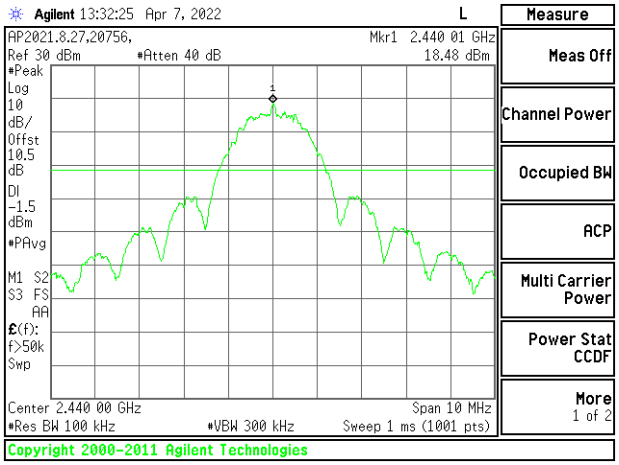


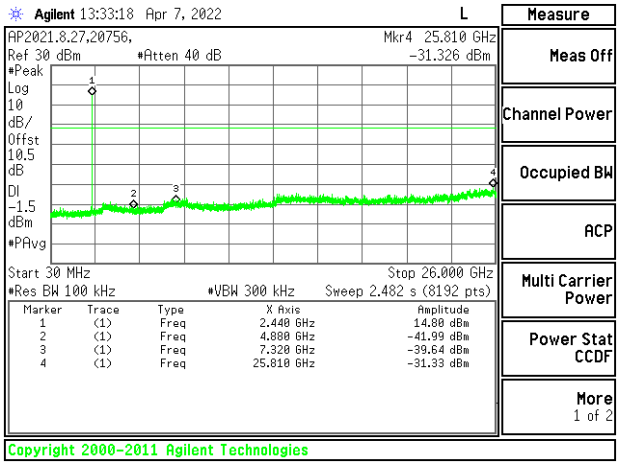
LOW CHANNEL BANDEDGE ANTENNA 1



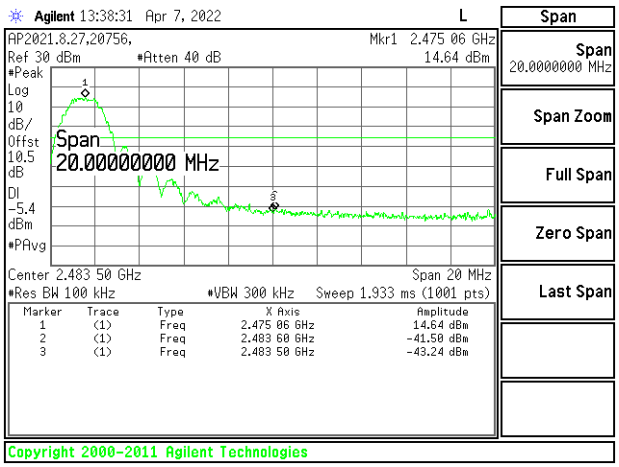
OUT-OF-BAND LOW CHANNEL ANTENNA 1



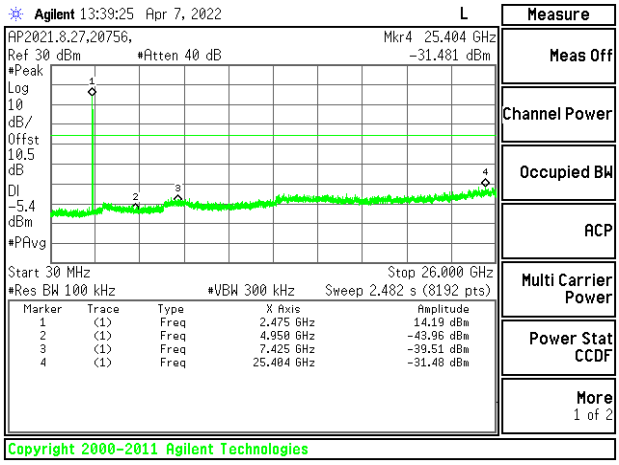
IN-BAND REFERENCE LEVEL ANTENNA 1



OUT-OF-BAND MID CHANNEL ANTENNA 1



2475MHz BANDEDGE ANTENNA 1



OUT-OF-BAND 2475MHz ANTENNA 1

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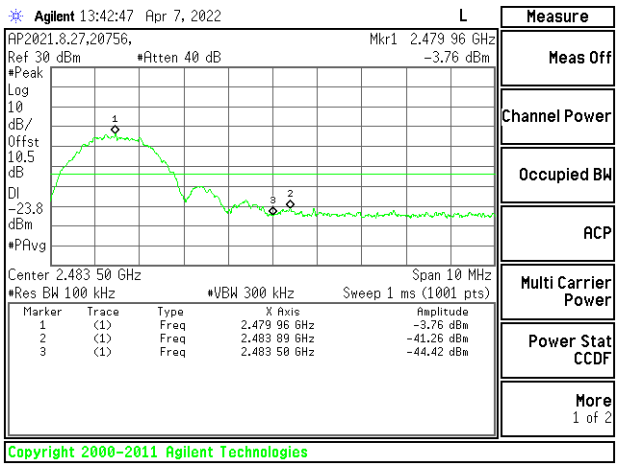
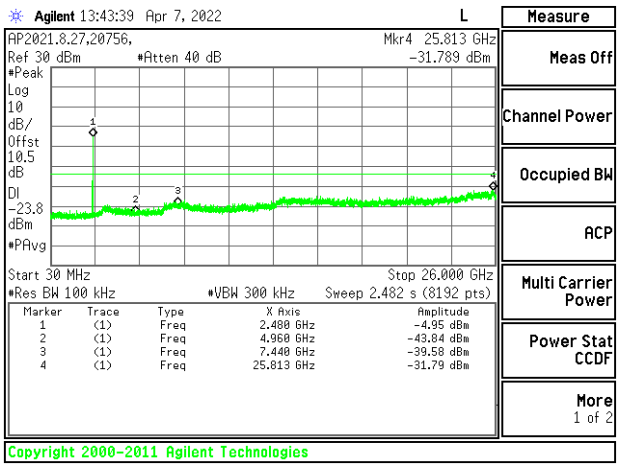


HIGH CHANNEL BANDEDGE ANTENNA 1



OUT-OF-BAND HIGH CHANNEL ANTENNA 1

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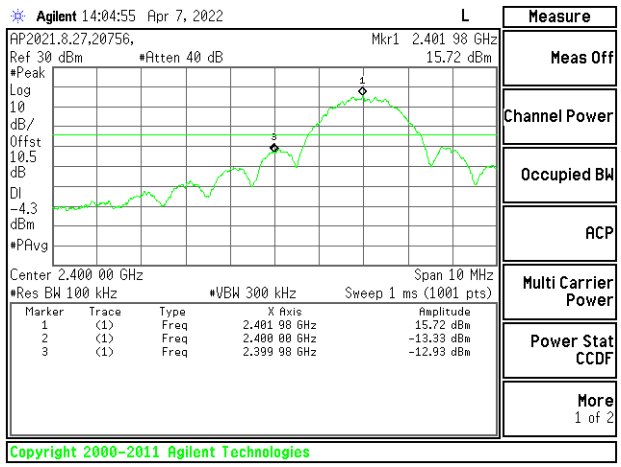
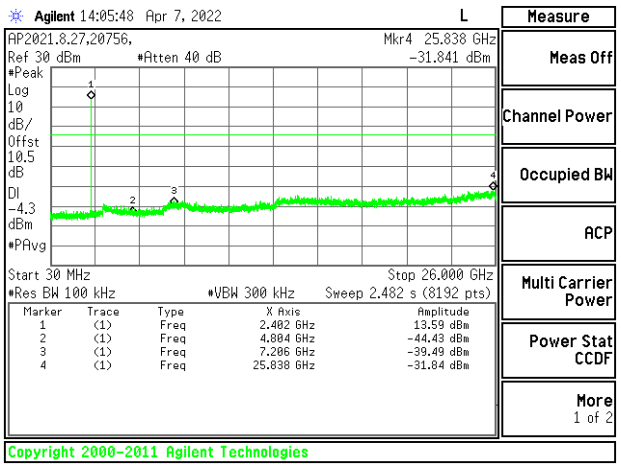
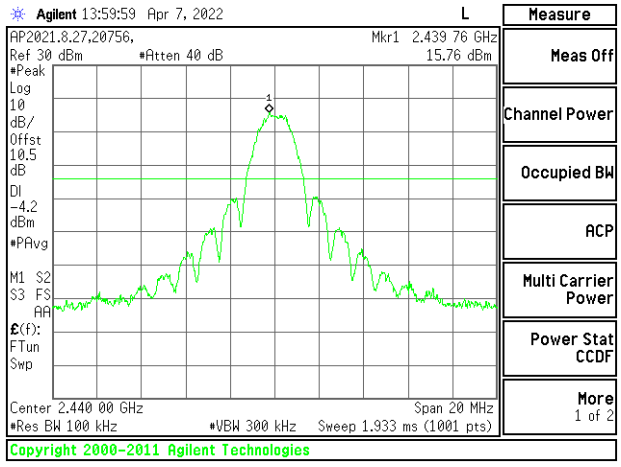


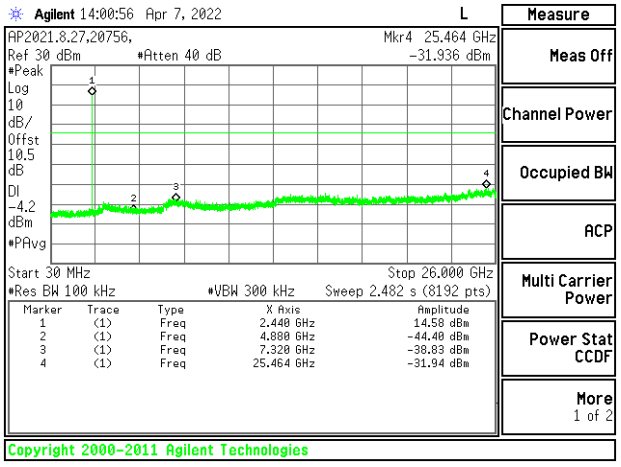
LOW CHANNEL BANDEDGE ANTENNA 2



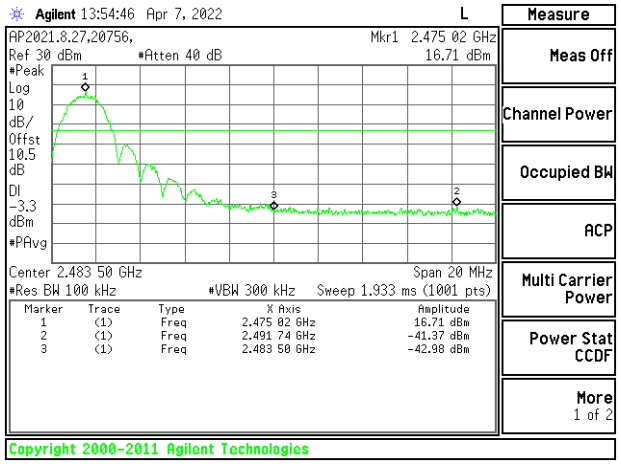
OUT-OF-BAND LOW CHANNEL ANTENNA 2



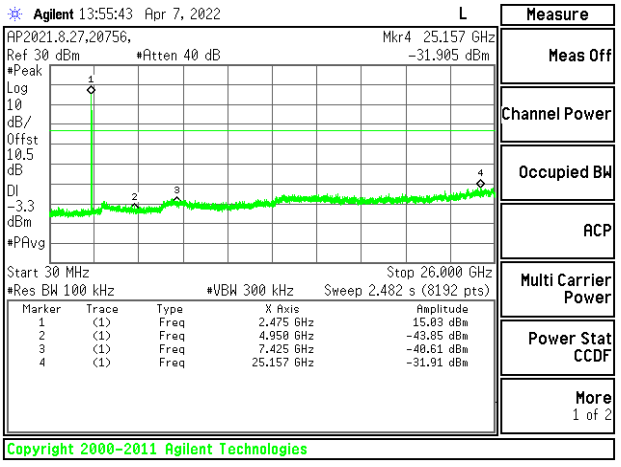
IN-BAND REFERENCE LEVEL ANTENNA 2



OUT-OF-BAND MID CHANNEL ANTENNA 2



2475MHz BANDEDGE ANTENNA 2



OUT-OF-BAND 2475MHz ANTENNA 2

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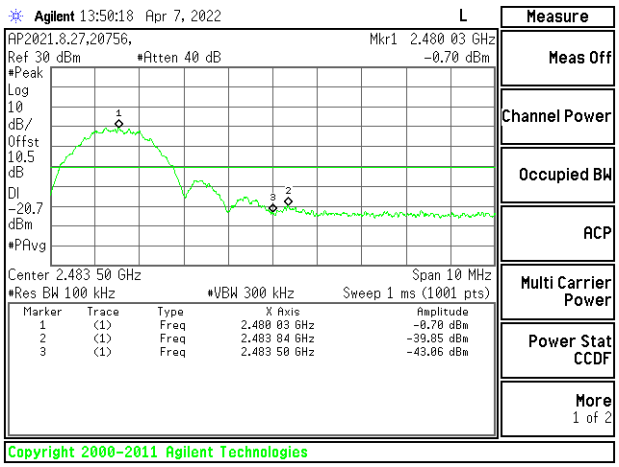
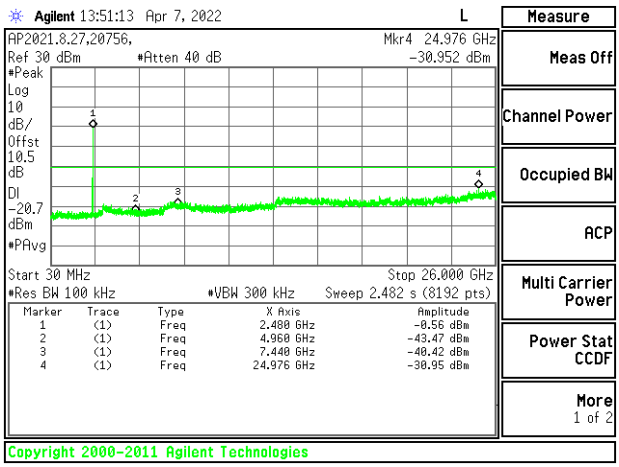


HIGH CHANNEL BANDEDGE ANTENNA 2



OUT-OF-BAND HIGH CHANNEL ANTENNA 2

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10. RADIATED TEST RESULTS

10.1. LIMITS AND PROCEDURE

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 as applicable 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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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. Blue color trace on plots: Parallel orientation. Green color trace on plots: Perpendicular orientation.

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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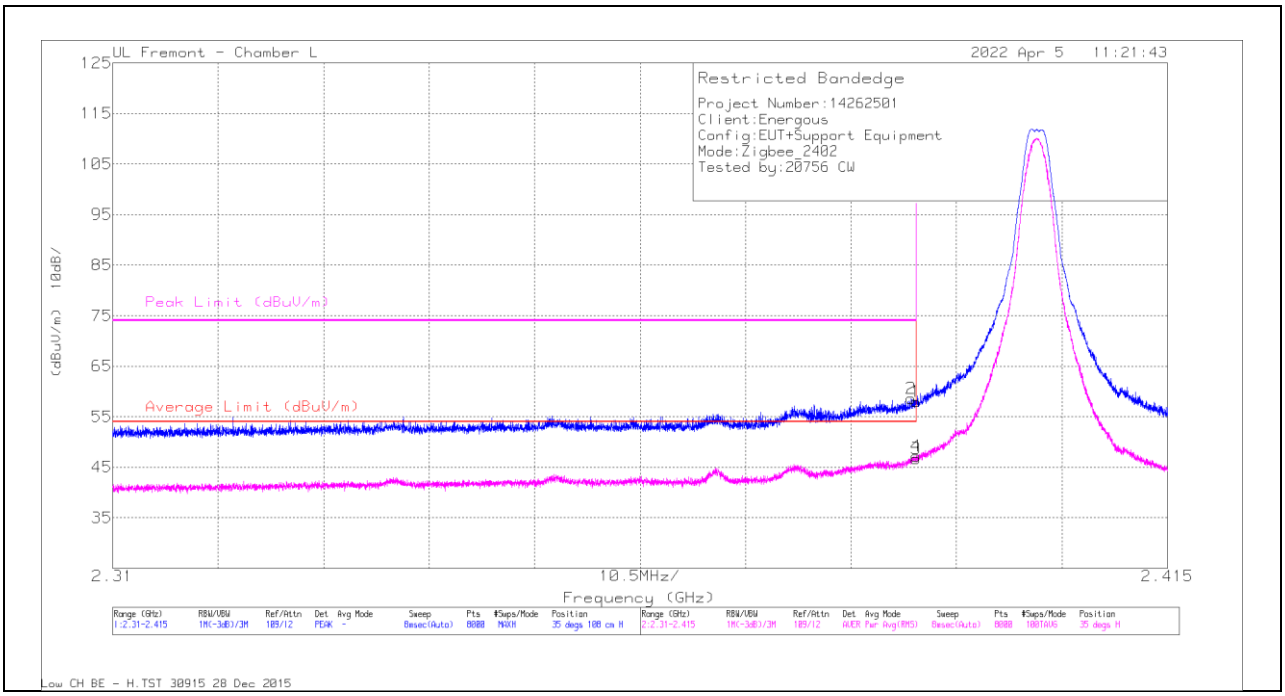
10.2. TRANSMITTER ABOVE 1 GHz

BANDEDGE (LOW CHANNEL)

HORIZONTAL RESULT



Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF 79834 (dB/m)	Amp/Cbl/Fltr/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	* 2.39	37.48	Pk	32	-11.5	57.98	-	-	74	-16.02	35	108	H
2	* 2.389484	38.06	Pk	32	-11.5	58.56	-	-	74	-15.44	35	108	H
3	* 2.39	26.21	RMS	32	-11.5	46.71	54	-7.29	-	-	35	108	H
4	* 2.389983	26.64	RMS	32	-11.5	47.14	54	-6.86	-	-	35	108	H

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

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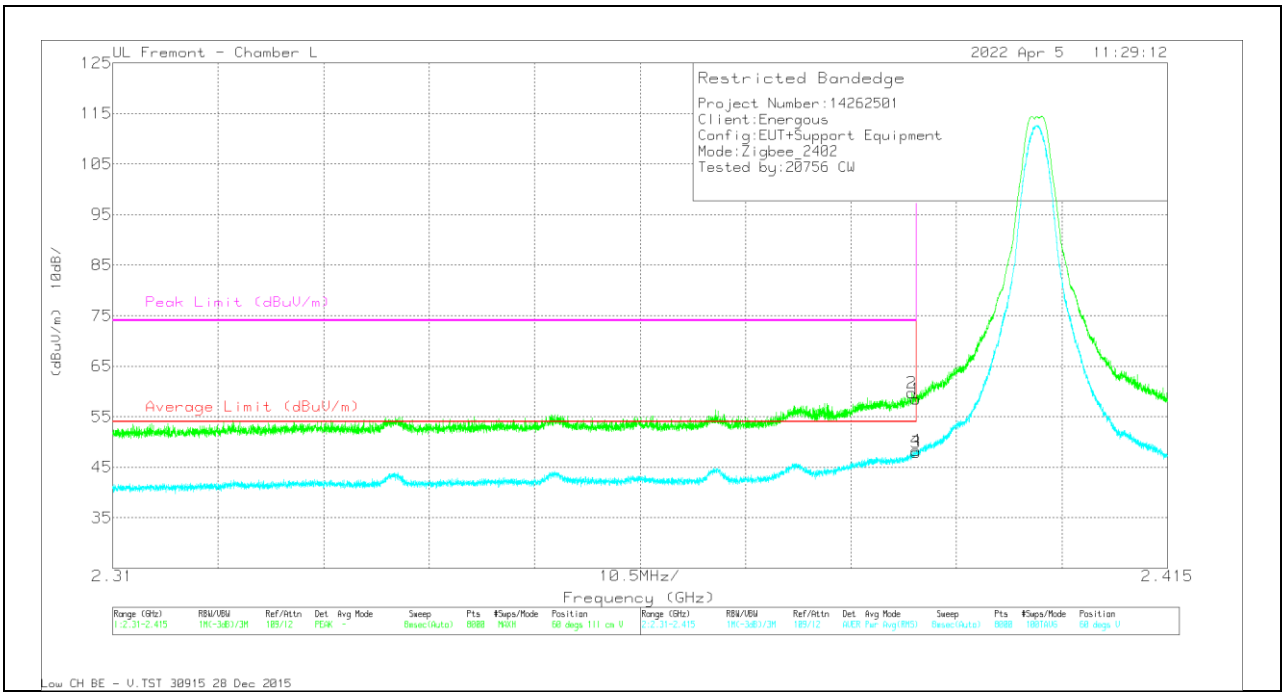
VERTICAL RESULT



Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF 79834 (dB/m)	Amp/Cbl/Fltr/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	* 2.39	37.96	Pk	32	-11.5	58.46	-	-	74	-15.54	60	111	V
2	* 2.389563	39.19	Pk	32	-11.5	59.69	-	-	74	-14.31	60	111	V
3	* 2.39	27.48	RMS	32	-11.5	47.98	54	-6.02	-	-	60	111	V
4	* 2.38997	27.8	RMS	32	-11.5	48.3	54	-5.7	-	-	60	111	V

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

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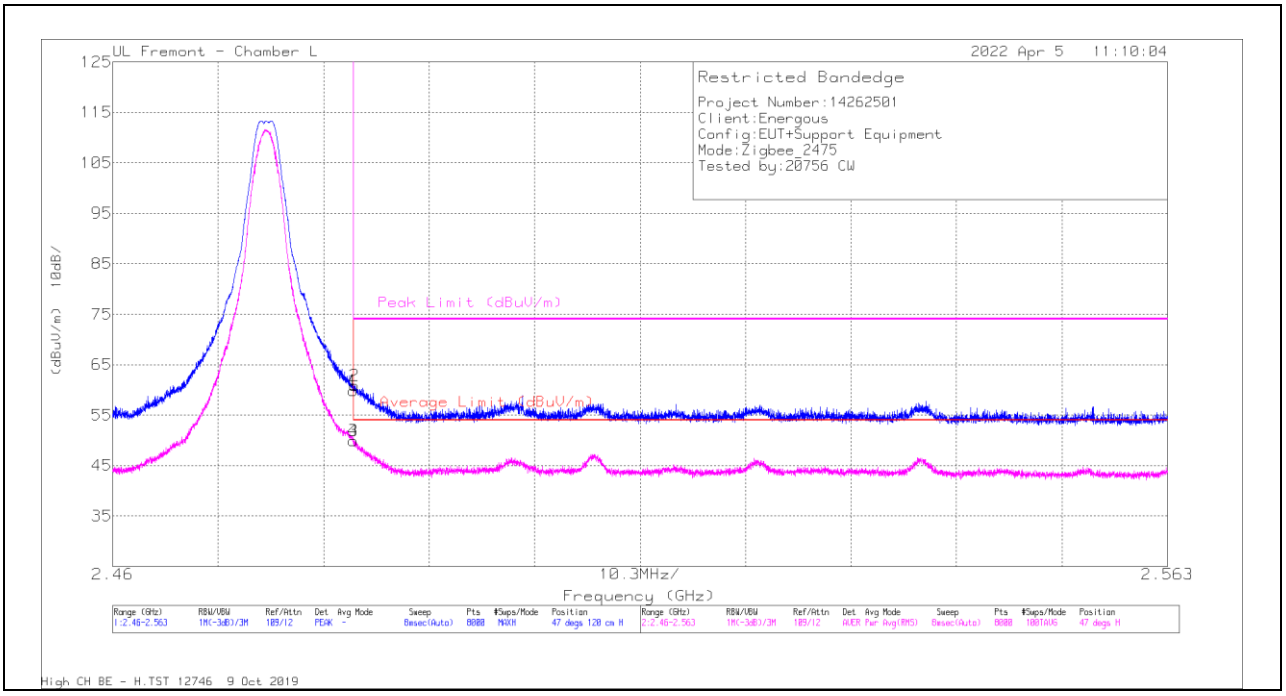
BANDEDGE (2475 MHz)

HORIZONTAL RESULT



Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF 79834 (dB/m)	Amp/Cbl/Fltr/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	* 2.4835	38.67	Pk	32.3	-11.1	59.87	-	-	74	-14.13	47	120	H
2	* 2.483616	39.69	Pk	32.3	-11.1	60.89	-	-	74	-13.11	47	120	H
3	* 2.4835	28.69	RMS	32.3	-11.1	49.89	54	-4.11	-	-	47	120	H
4	* 2.483501	28.68	RMS	32.3	-11.1	49.88	54	-4.12	-	-	47	120	H

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

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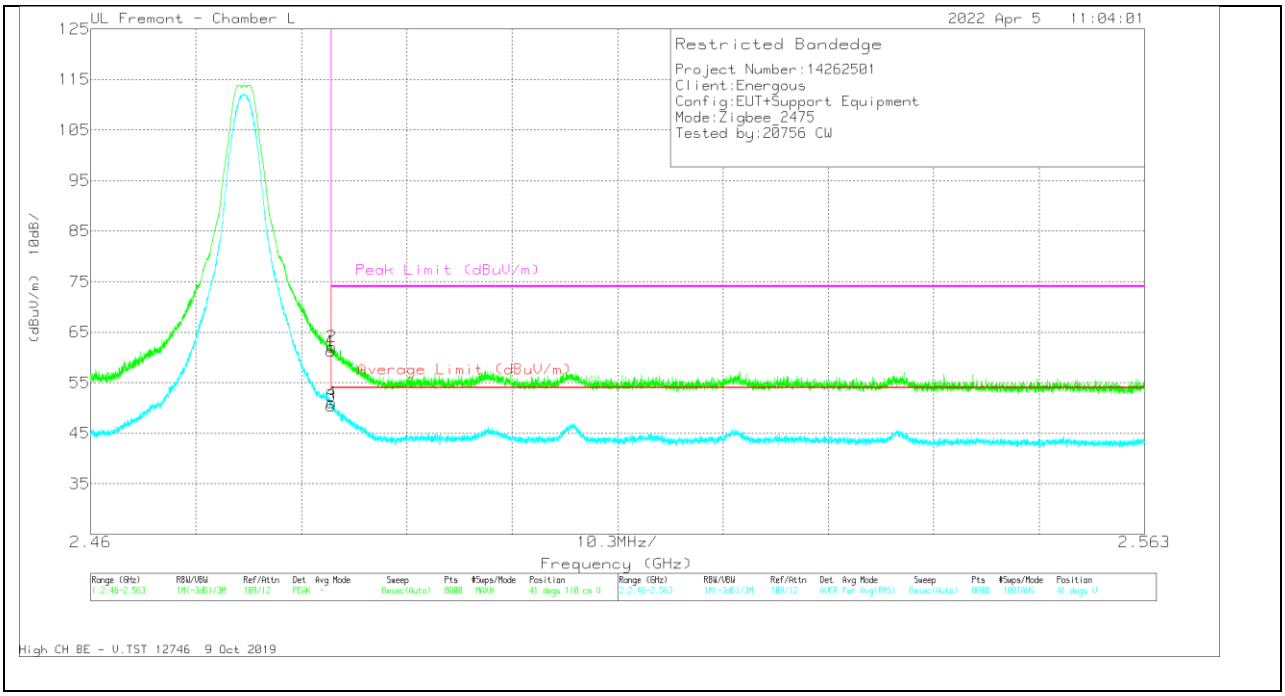
VERTICAL RESULT



Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF 79834 (dB/m)	Amp/Cbl/Fltr/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	* 2.4835	39.98	Pk	32.3	-11.1	61.18	-	-	74	-12.82	41	110	V
2	* 2.483565	40.88	Pk	32.3	-11.1	62.08	-	-	74	-11.92	41	110	V
3	* 2.4835	29.24	RMS	32.3	-11.1	50.44	54	-3.56	-	-	41	110	V
4	* 2.483552	29.81	RMS	32.3	-11.1	51.01	54	-2.99	-	-	41	110	V

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

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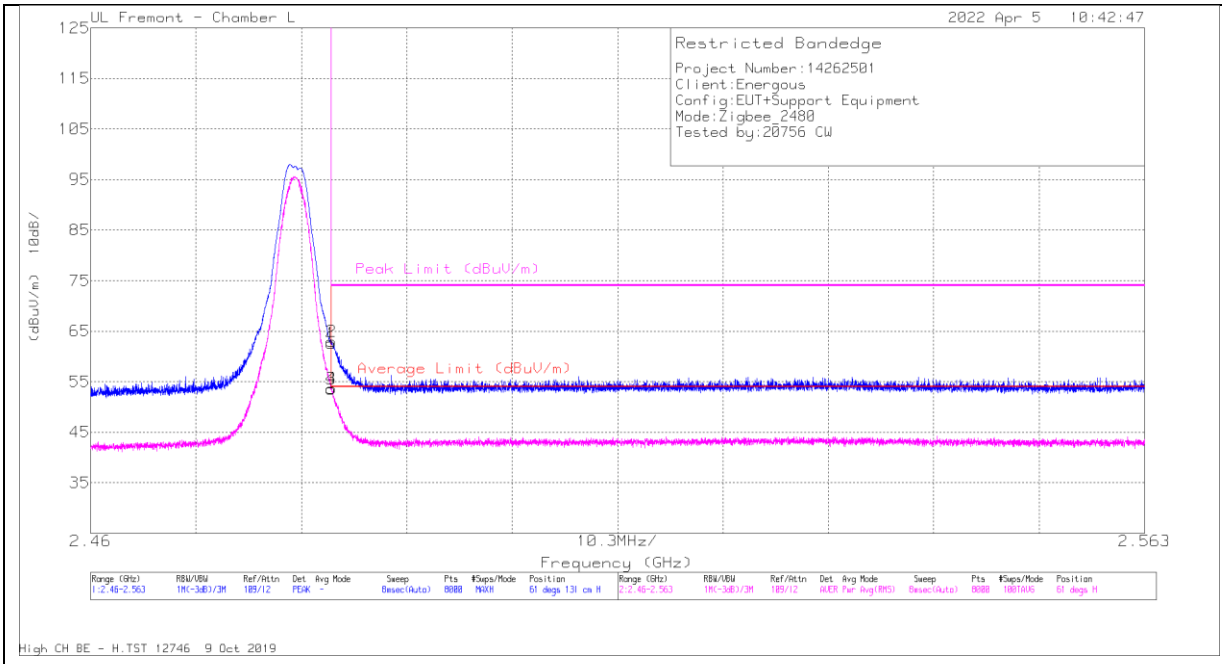
BANDEDGE (HIGH CHANNEL)

HORIZONTAL RESULT



Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF 79834 (dB/m)	Amp/Cbl/Fltr/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	* 2.4835	41.35	Pk	32.3	-11.1	62.55	-	-	74	-11.45	61	131	H
2	* 2.483526	41.79	Pk	32.3	-11.1	62.99	-	-	74	-11.01	61	131	H
3	* 2.4835	32.38	RMS	32.3	-11.1	53.58	54	-.42	-	-	61	131	H
4	* 2.483526	32.46	RMS	32.3	-11.1	53.66	54	-.34	-	-	61	131	H

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

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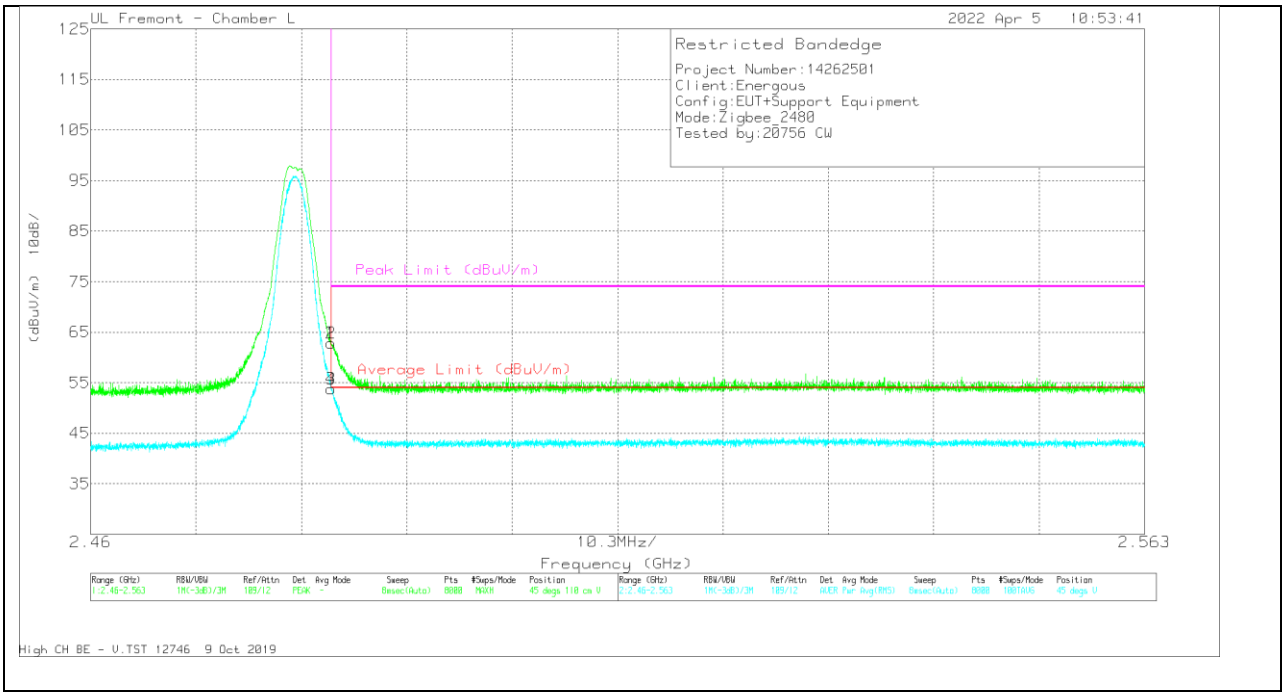
VERTICAL RESULT



Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF 79834 (dB/m)	Amp/Cbl/Fltr/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	* 2.4835	41.64	Pk	32.3	-11.1	62.84	-	-	74	-11.16	45	110	V
2	* 2.483501	41.64	Pk	32.3	-11.1	62.84	-	-	74	-11.16	45	110	V
3	* 2.4835	32.62	RMS	32.3	-11.1	53.82	54	-.18	-	-	45	110	V
4	* 2.483501	32.62	RMS	32.3	-11.1	53.82	54	-.18	-	-	45	110	V

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

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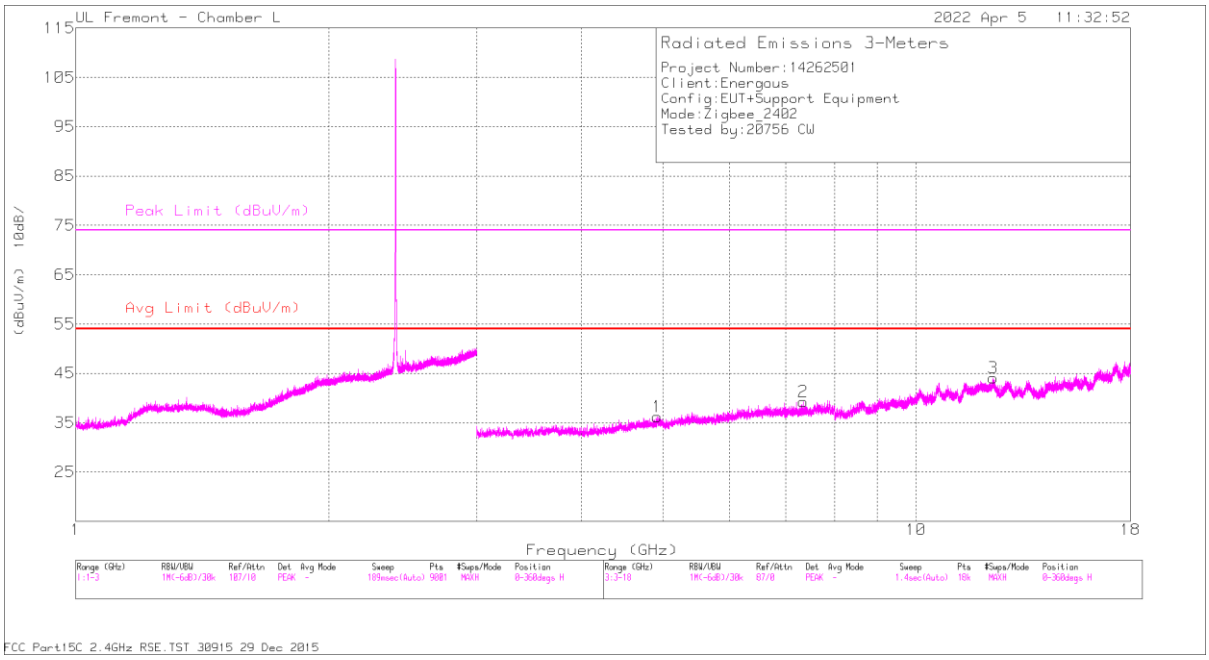
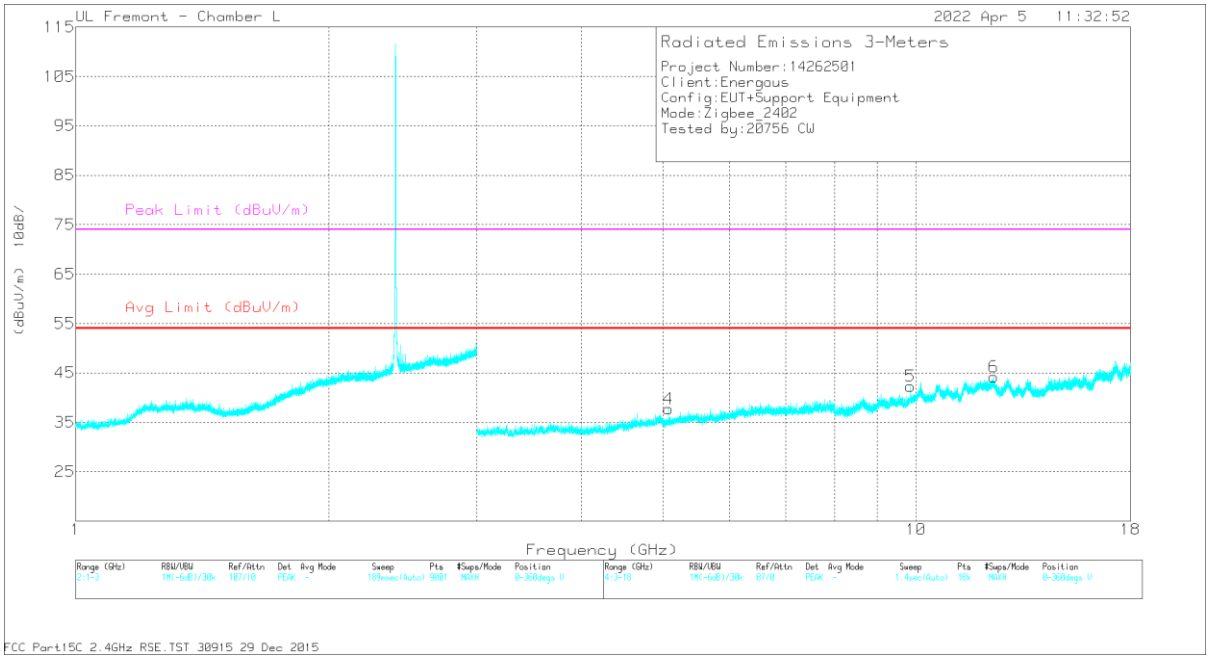
HARMONICS AND SPURIOUS EMISSIONS

LOW CHANNEL RESULTS



HORIZONTAL



VERTICAL

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RADIATED EMISSIONS

Radiated Emissions

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF 79834 (dB/m)	Amp/Cbl/Fltr/ Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 4.924532	34.96	PK2	34.2	-23.6	45.56	-	-	74	-28.44	349	103	H
	* 4.926518	23.82	MAv1	34.2	-23.5	34.52	54	-19.48	-	-	349	103	H
2	* 7.347951	33.14	PK2	35.6	-19.7	49.04	-	-	74	-24.96	81	115	H
	* 7.34692	21.41	MAv1	35.6	-19.7	37.31	54	-16.69	-	-	81	115	H
3	* 12.349623	30.95	PK2	39.1	-16.1	53.95	-	-	74	-20.05	150	117	H
	* 12.351613	19.19	MAv1	39.1	-16.1	42.19	54	-11.81	-	-	150	117	H
4	* 5.074921	36.25	PK2	34.4	-24.2	46.45	-	-	74	-27.55	142	115	V
	* 5.076999	24.72	MAv1	34.4	-24.2	34.92	54	-19.08	-	-	142	115	V
5	9.847602	28.14	PK2	37	-15.5	49.64	-	-	-	-	128	103	V
	9.848857	16.8	MAv1	37	-15.5	38.3	-	-	-	-	128	103	V
6	* 12.372809	29.3	PK2	39.1	-16.1	52.3	-	-	74	-21.7	225	173	V
	* 12.37354	18.07	MAv1	39.1	-16.1	41.07	54	-12.93	-	-	225	173	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
PK2 - KDB558074 Method: Maximum Peak
MAv1 - KDB558074 Option 1 Maximum RMS Average

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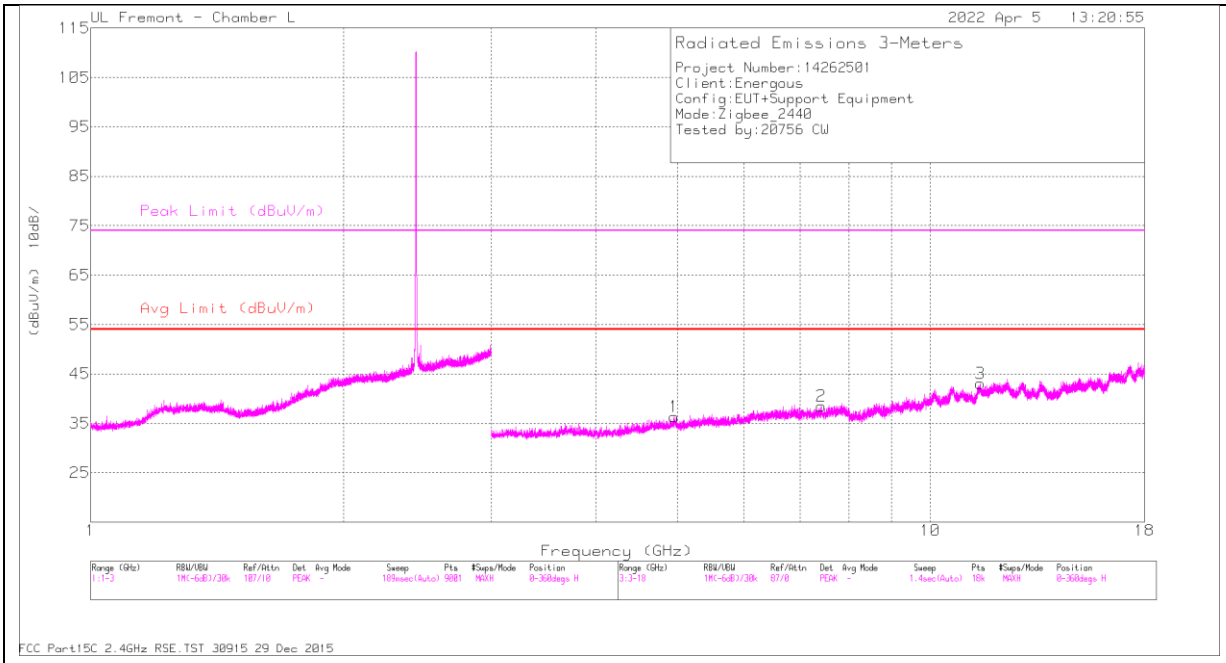
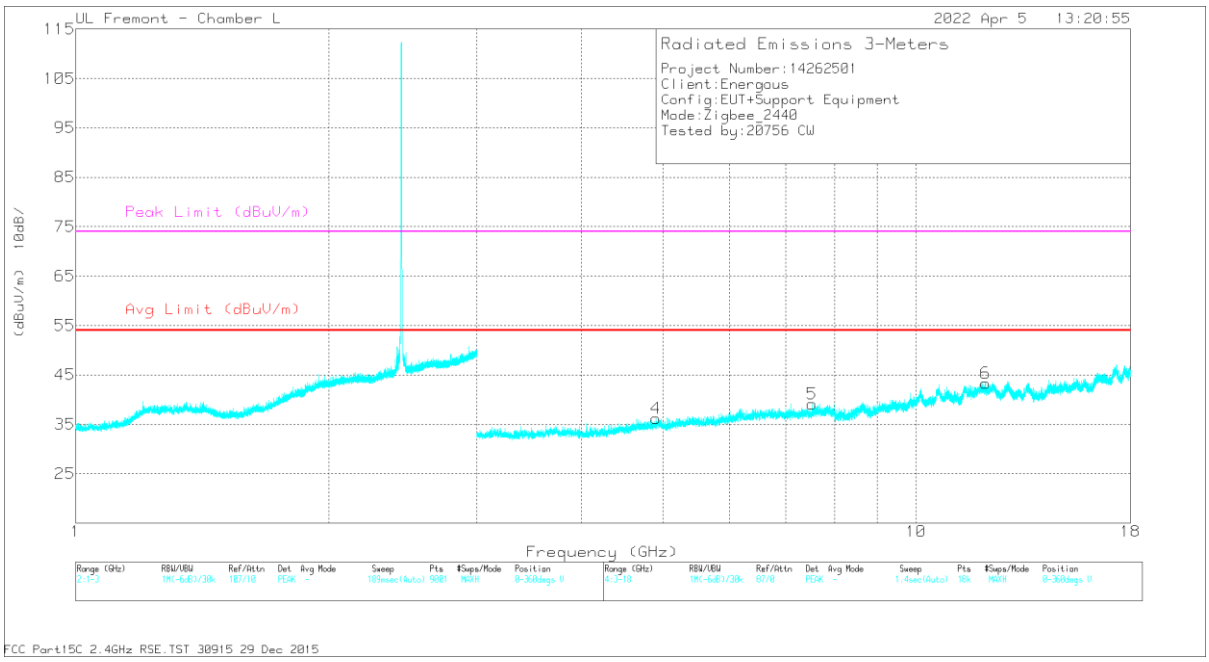
MID CHANNEL RESULTS



HORIZONTAL



VERTICAL

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Radiated Emissions

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF 79834 (dB/m)	Amp/Cbl/Fltr/ Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 4.957158	35.62	PK2	34.2	-23.2	46.62	-	-	74	-27.38	47	116	H
	* 4.954384	24.15	MAv1	34.2	-23.1	35.25	54	-18.75	-	-	47	116	H
2	* 7.423097	33.57	PK2	35.7	-19.6	49.67	-	-	74	-24.33	336	112	H
	* 7.421778	21.93	MAv1	35.7	-19.6	38.03	54	-15.97	-	-	336	112	H
3	* 11.472343	29.87	PK2	38.5	-15.6	52.77	-	-	74	-21.23	330	103	H
	* 11.471472	17.7	MAv1	38.5	-15.6	40.6	54	-13.4	-	-	330	103	H
4	* 4.909623	35.37	PK2	34.1	-23.9	45.57	-	-	74	-28.43	209	388	V
	* 4.908612	23.63	MAv1	34.1	-24	33.73	54	-20.27	-	-	209	388	V
5	* 7.517789	32.78	PK2	35.7	-20	48.48	-	-	74	-25.52	272	120	V
	* 7.519259	20.95	MAv1	35.7	-20	36.65	54	-17.35	-	-	272	120	V
6	* 12.110592	29.16	PK2	39.1	-16.3	51.96	-	-	74	-22.04	167	105	V
	* 12.109753	17.49	MAv1	39.1	-16.3	40.29	54	-13.71	-	-	167	105	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
PK2 - KDB558074 Method: Maximum Peak
MAv1 - KDB558074 Option 1 Maximum RMS Average

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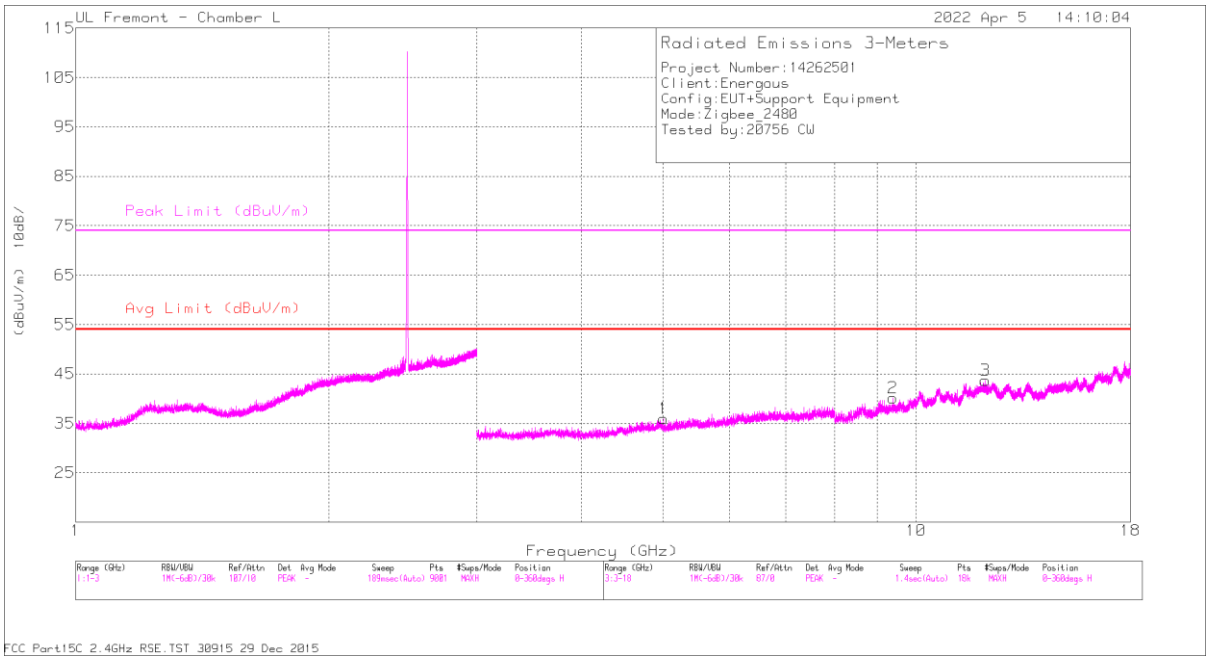
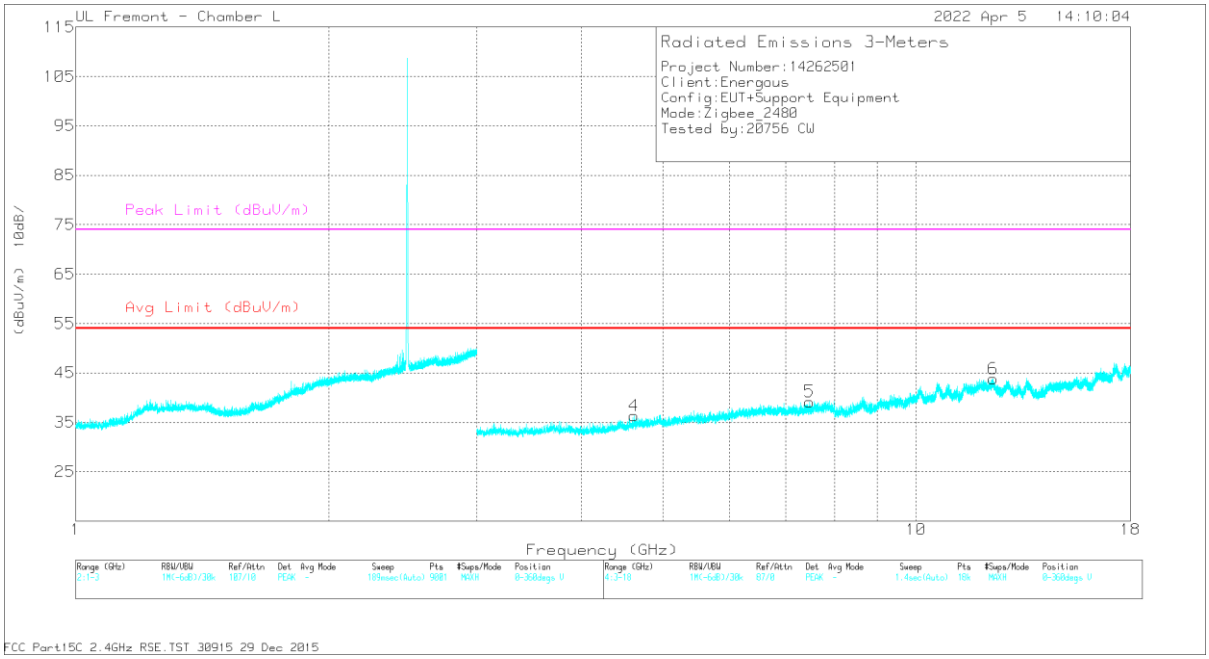
HIGH CHANNEL RESULTS



HORIZONTAL



VERTICAL

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RADIATED EMISSIONS

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF 79834 (dB/m)	Amp/Cbl/Fltr/ Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 5.004515	35.94	PK2	34.2	-24.1	46.04	-	-	74	-27.96	163	102	H
	* 5.003372	24.59	MAv1	34.2	-24	34.79	54	-19.21	-	-	163	102	H
2	* 9.385589	30.17	PK2	36.5	-16.8	49.87	-	-	74	-24.13	128	105	H
	* 9.382176	19.03	MAv1	36.5	-16.8	38.73	54	-15.27	-	-	128	105	H
3	* 12.093135	28.9	PK2	39.1	-16.3	51.7	-	-	74	-22.3	123	140	H
	* 12.095109	17.74	MAv1	39.1	-16.3	40.54	54	-13.46	-	-	123	140	H
4	* 4.614907	35.99	PK2	34	-25.1	44.89	-	-	74	-29.11	183	324	V
	* 4.615654	24.27	MAv1	34	-25.1	33.17	54	-20.83	-	-	183	324	V
5	* 7.468639	30.42	PK2	35.7	-19.9	46.22	-	-	74	-27.78	62	105	V
	* 7.470514	19.15	MAv1	35.7	-19.9	34.95	54	-19.05	-	-	62	105	V
6	* 12.36074	29.61	PK2	39.2	-16.1	52.71	-	-	74	-21.29	101	146	V
	* 12.360085	18.43	MAv1	39.2	-16.1	41.53	54	-12.47	-	-	101	146	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
PK2 - KDB558074 Method: Maximum Peak
MAv1 - KDB558074 Option 1 Maximum RMS Average

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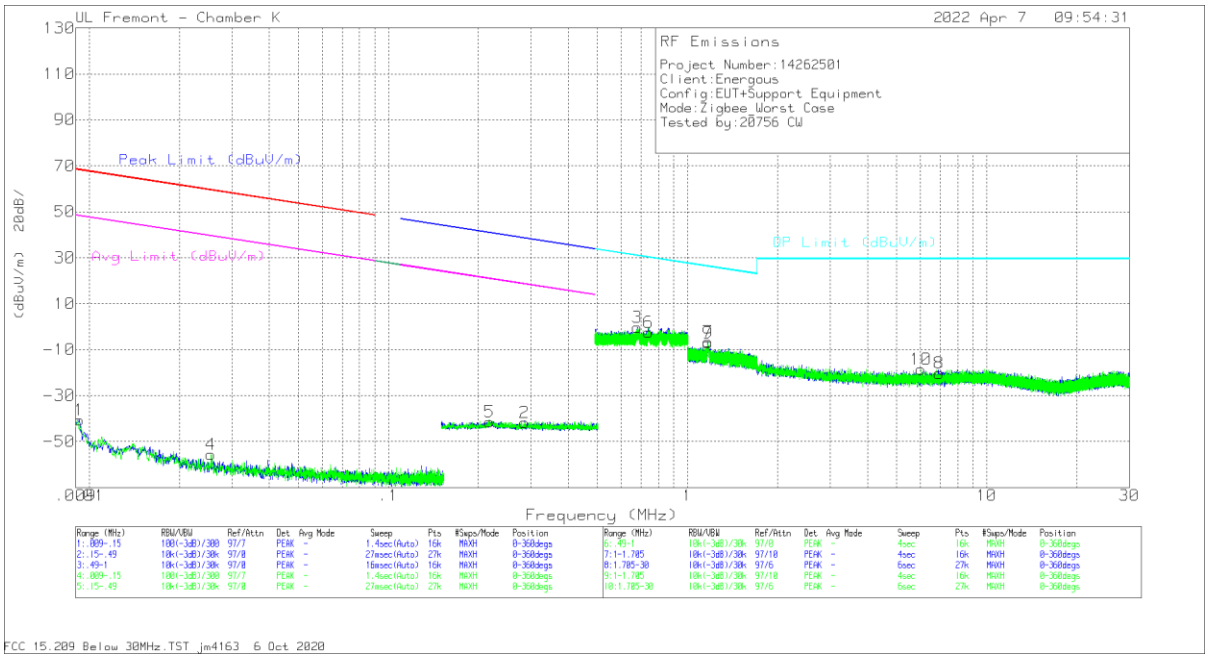
10.3. WORST CASE BELOW 30MHZ

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 (dBuV/m)	Peak Limit (dBuV/m)	Margin (dB)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	Margin (dB)	Avg Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
1	.0093	8.98	Pk	61	-30.6	-80	-40.62	68.26	-108.88	48.26	-88.88	-	-	-	-	0-360
2	.2849	14.21	Pk	56.2	-32.2	-80	-41.79	-	-	-	-	38.52	-80.31	18.52	-60.31	0-360
4	.0255	-1.94	Pk	58.4	-32	-80	-55.54	59.44	-114.98	39.44	-94.98	-	-	-	-	0-360
5	.2174	14.43	Pk	56.3	-32.2	-80	-41.47	-	-	-	-	40.87	-82.34	20.87	-62.34	0-360

Pk - Peak detector

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna (E ACF)	Amp/Cbl (dB)	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
3	.6789	15.48	Pk	56.2	-32.1	-40	-.42	30.98	-31.4	0-360
6	.7409	13.49	Pk	56.2	-32.1	-40	-2.41	30.22	-32.63	0-360
7	1.1708	19.83	Pk	45.8	-32.1	-40	-6.47	26.26	-32.73	0-360
8	6.9188	16.67	Pk	34.8	-31.8	-40	-20.33	29.5	-49.83	0-360
9	1.17	19.28	Pk	45.8	-32.1	-40	-7.02	26.26	-33.28	0-360
10	6.0301	18.27	Pk	35.2	-31.9	-40	-18.43	29.5	-47.93	0-360

Pk - Peak detector

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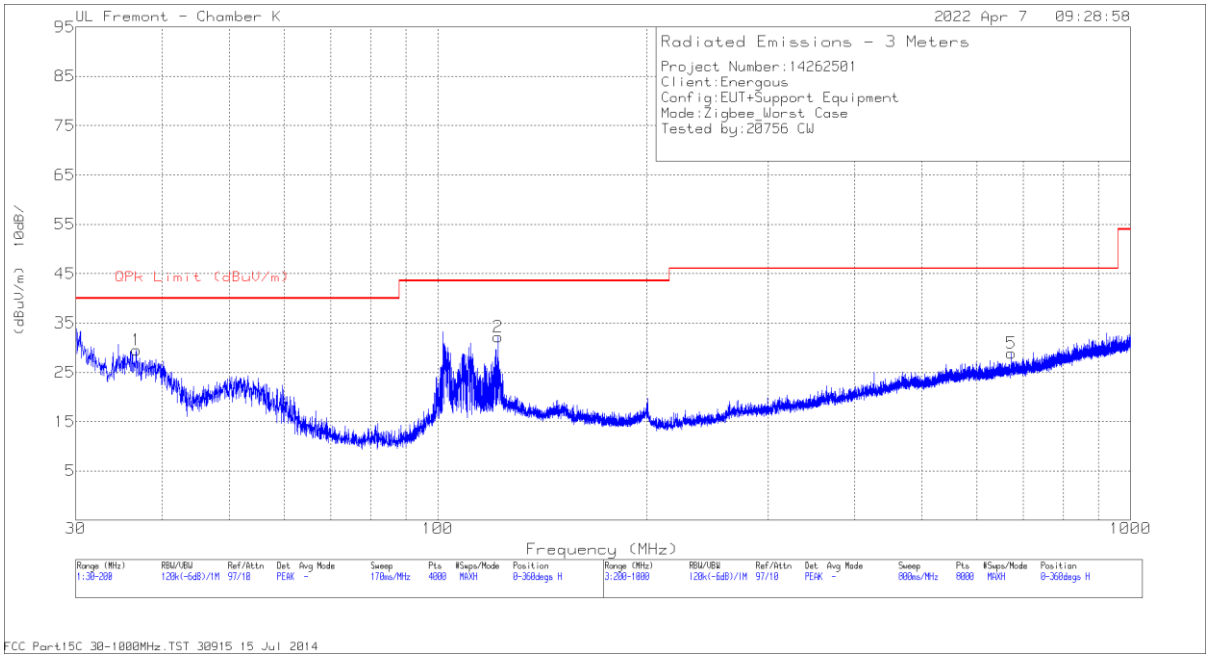
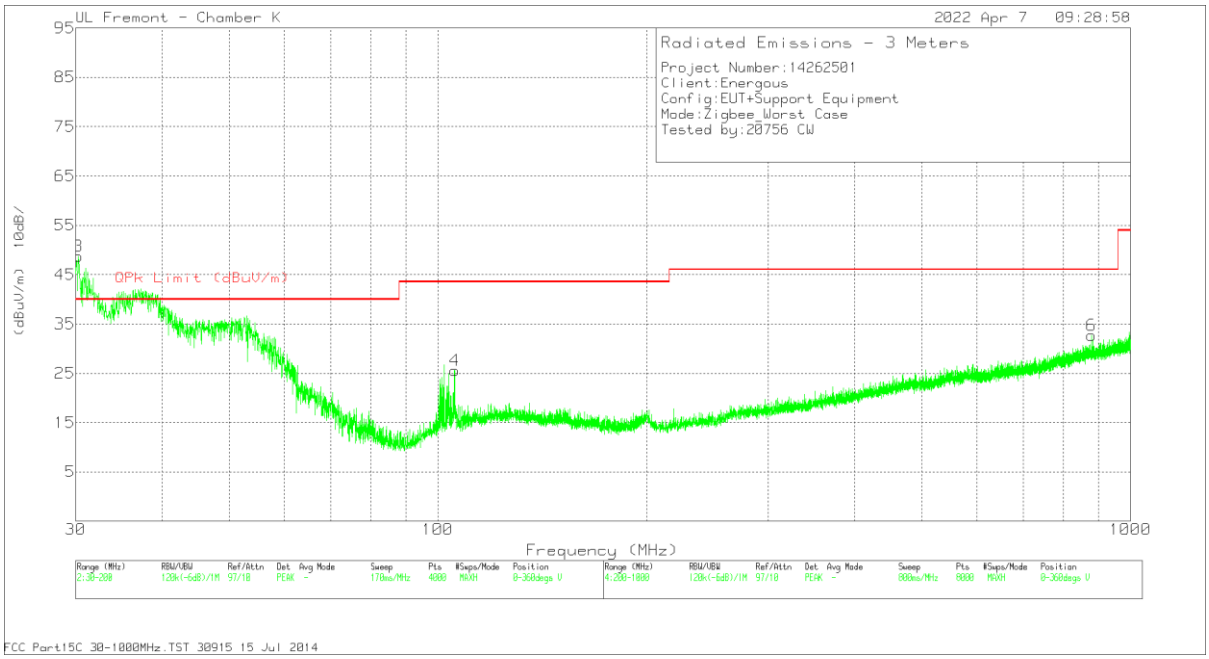
10.4. WORST CASE BELOW 1 GHZ

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	82258 ACF (dB)	Amp/Cbl (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	36.7167	38.33	Pk	22.7	-31.5	29.53	40	-10.47	0-360	393	H
2	* 122.249	42.69	Pk	20.2	-30.7	32.19	43.52	-11.33	0-360	295	H
3	30.0061	41.99	Qp	27.9	-31.5	38.39	40	-1.61	169	126	V
4	105.733	38.38	Pk	18.1	-30.9	25.58	43.52	-17.94	0-360	101	V
5	673.662	30.91	Pk	26.3	-28.3	28.91	46.02	-17.11	0-360	101	H
6	878.188	31.51	Pk	28.4	-27.2	32.71	46.02	-13.31	0-360	101	V

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

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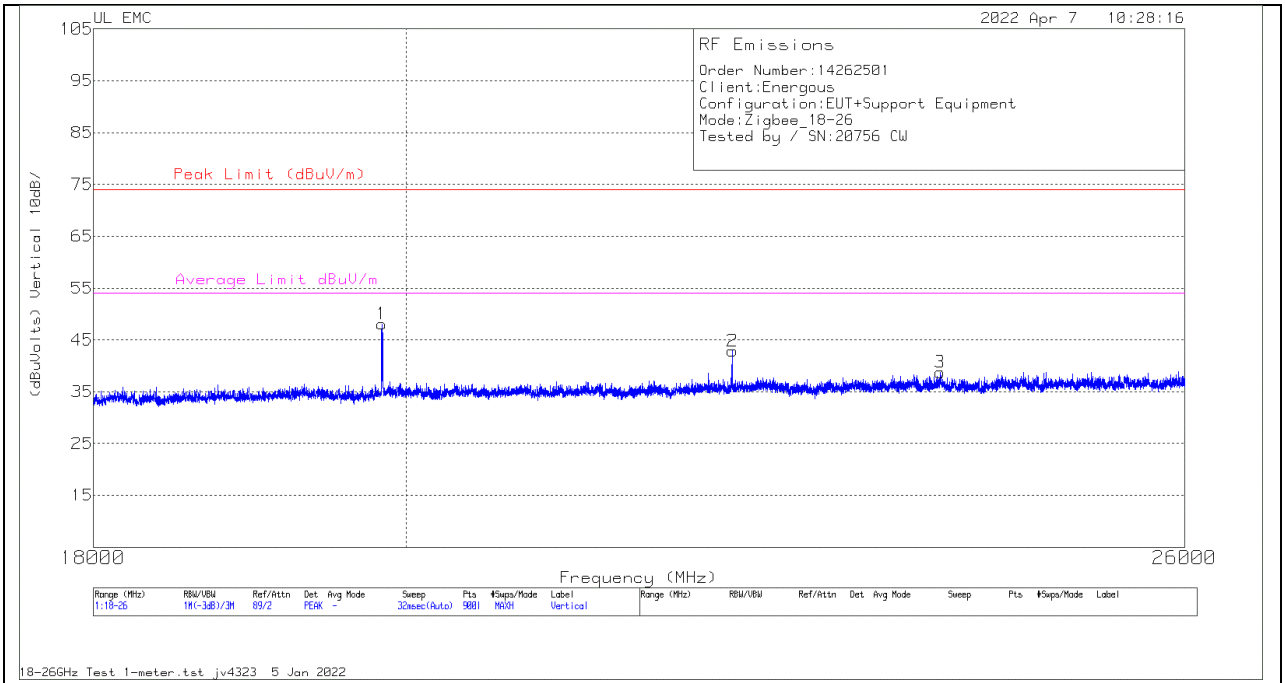
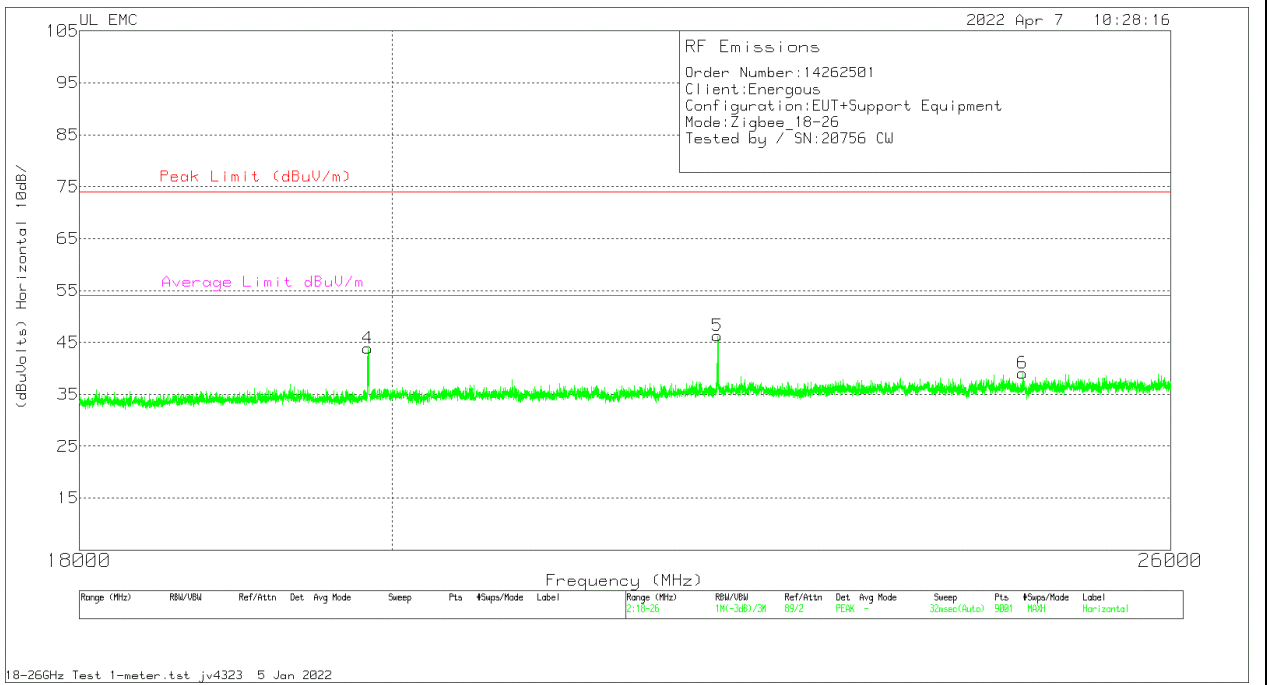
10.5. WORST CASE 18-26 GHZ

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



HORIZONTAL



VERTICAL

UL VERIFICATION SERVICES
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18 – 26GHz DATA

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AF 81139 (dB/m)	Amp/Cbl (dB)	Dist Corr (dB)	Corrected Reading (dBuVolts)	Peak Limit (dBuV/m)	PK Margin (dB)	Average Limit dBuV/m	Margin (dB)
1	19835.897	80.42	Pk	33.6	-57.1	-9.5	47.42	74	-26.58	54	-6.58
	19835.897	75.19	RMS	33.6	-57.1	-9.5	42.19	-	-	54	-11.81
2	22324.445	75.87	Pk	34.3	-57.8	-9.5	42.87	74	-31.13	54	-11.13
3	23943.112	70.51	Pk	34.5	-56.8	-9.5	38.71	74	-35.29	54	-15.29
4	19836.445	76.9	Pk	33.6	-57.1	-9.5	43.9	74	-30.1	54	-10.1
5	22315.556	79.3	Pk	34.3	-57.8	-9.5	46.3	74	-27.7	54	-7.7
6	24733.334	69.08	Pk	34.9	-55.4	-9.5	39.08	74	-34.92	54	-14.92

Pk - Peak detector
RMS - RMS detection

UL VERIFICATION SERVICES
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11. AC POWER LINE CONDUCTED EMISSIONS

LIMITS

FCC §15.207 (a)
RSS-Gen 8.8

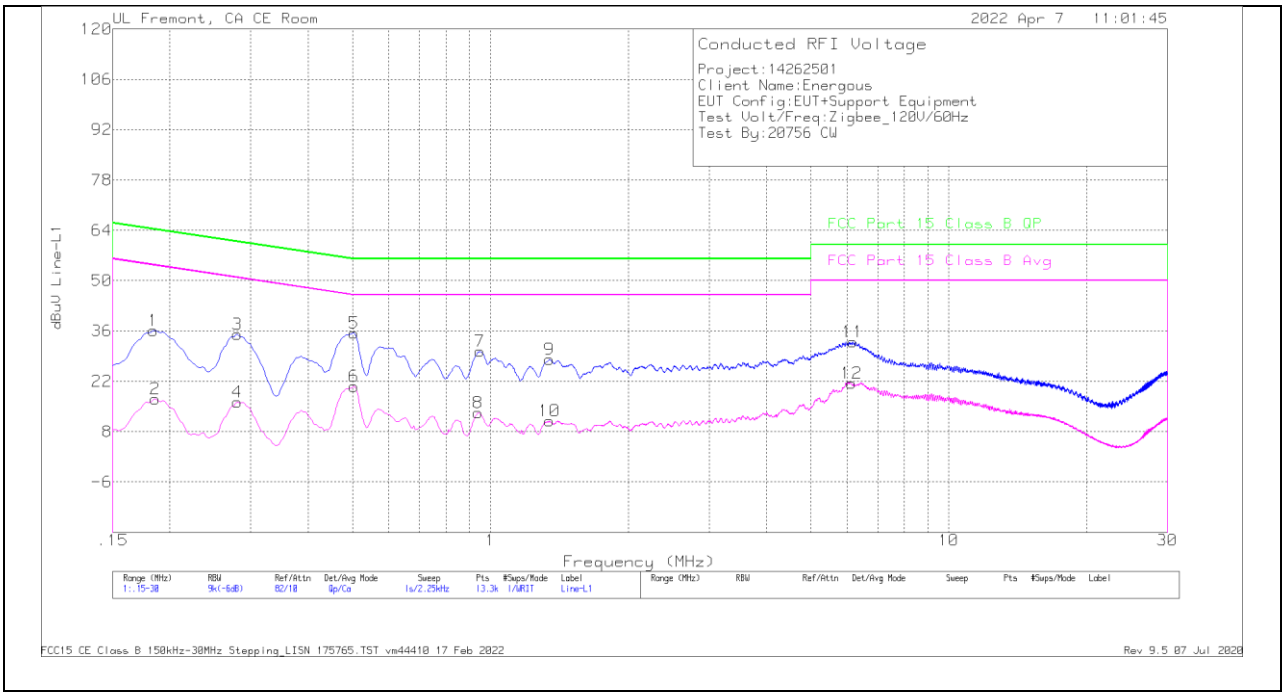
Frequency of Emission (MHz)	Conducted Limit (dBµV)	
	Quasi-peak	Average
0.15-0.5	66 to 56 *	56 to 46 *
0.5-5	56	46
5-30	60	50

*Decreases with the logarithm of the frequency.

RESULTS

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

LINE 1 RESULTS



Range 1: Line-L1 .15 - 30MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	175765 LISN L1	C1&C3 cable	TekBox Limiter TBFL1 Model 207	Corrected Reading dBuV	FCC Part 15 Class B QP	QP Margin (dB)	FCC Part 15 Class B Avg	Av(CISPR)Margin (dB)
2	.186	7.65	Ca	.1	0	9.4	17.15	-	-	54.21	-37.06
4	.2805	6.96	Ca	0	0	9.3	16.26	-	-	50.8	-34.54
6	.50325	11.28	Ca	0	0	9.3	20.58	-	-	46	-25.42
8	.93975	3.81	Ca	0	.1	9.3	13.21	-	-	46	-32.79
10	1.347	1.53	Ca	0	.1	9.3	10.93	-	-	46	-35.07
12	6.135	12.02	Ca	0	.1	9.3	21.42	-	-	50	-28.58
1	.18375	26.7	Qp	.1	0	9.4	36.2	64.31	-28.11	-	-
3	.2805	25.84	Qp	0	0	9.3	35.14	60.8	-25.66	-	-
5	.50325	26.14	Qp	0	0	9.3	35.44	56	-20.56	-	-
7	.94875	20.92	Qp	0	.1	9.3	30.32	56	-25.68	-	-
9	1.347	18.63	Qp	0	.1	9.3	28.03	56	-27.97	-	-
11	6.16875	23.64	Qp	0	.1	9.3	33.04	60	-26.96	-	-

Qp - Quasi-Peak detector
Ca - CISPR average detection

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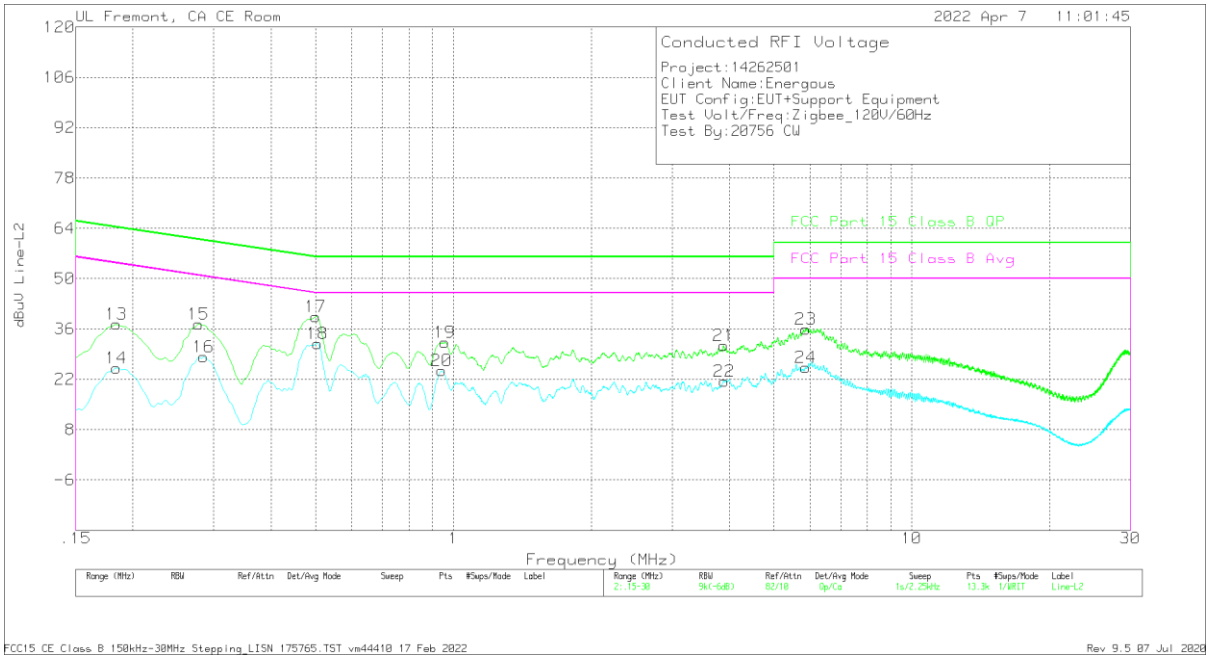
LINE 2 RESULTS



Range 2: Line-L2 .15 - 30MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	175765 LISN L2	C2&C3 cable	TekBox Limiter TBFL1 Model 207	Corrected Reading dBuV	FCC Part 15 Class B QP	QP Margin (dB)	FCC Part 15 Class B Avg	Av(CISPR)Margin (dB)
14	.18375	15.68	Ca	.1	0	9.4	25.18	-	-	54.31	-29.13
16	.285	18.92	Ca	0	0	9.3	28.22	-	-	50.67	-22.45
18	.5055	22.71	Ca	0	0	9.3	32.01	-	-	46	-13.99
20	.942	14.97	Ca	0	.1	9.3	24.37	-	-	46	-21.63
22	3.89625	12.05	Ca	0	.1	9.3	21.45	-	-	46	-24.55
24	5.8695	15.83	Ca	0	.1	9.3	25.23	-	-	50	-24.77
13	.18375	27.83	Qp	.1	0	9.4	37.33	64.31	-26.98	-	-
15	.27825	28.11	Qp	0	0	9.3	37.41	60.87	-23.46	-	-
17	.501	30.19	Qp	0	0	9.3	39.49	56	-16.51	-	-
19	.95775	22.88	Qp	0	.1	9.3	32.28	56	-23.72	-	-
21	3.885	21.96	Qp	0	.1	9.3	31.36	56	-24.64	-	-
23	5.87175	26.48	Qp	0	.1	9.3	35.88	60	-24.12	-	-

Qp - Quasi-Peak detector
Ca - CISPR average detection

UL VERIFICATION SERVICES
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