EMC TEST REPORT

NVLAP Lab Code:200033-0

Standard(s):

47 CFR FCC Part 15.247
RSS 247, Issue 3, 2023

FCC ID:Y9ZMRX21A1WS7
IC:4406A-MRX21A1WS7

Product: WS™ ALERT™ XPV Headset (BLE)

Model(s): MRX21A1WS7-NA

Company Name:
3M Svenska AB

3M Division: PSD

Address:
Box 2341, Malmstensgatan 19
SE-33102 Värnamo, Sweden

Report Number: HRE202303408-4
Report Issue Date: September 12, 2024

Report Prepared by:

Signature: 
Yuriy Litvinov
Lead EMC Engineer

Tested by:
3M Company, Hardgoods Regulatory Engineering Laboratory
410 E. Fillmore Avenue, Building 76
St. Paul, Minnesota 55107-1208, USA

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1.0 Test Summary

Based on the results of our investigation, we have concluded the product tested **comply** with the requirements of the standard(s) indicated. The results obtained in this test report pertain only to the item(s) tested.

	Requirement – Test	Test Description	Result	Comments
4.1	FCC Part 15.247(a)(2)/ RSS-247(5.2(a))/RSS-Gen (6.7)	DTS Bandwidth	**pass**	
4.2	FCC Part 15.247(b)(3)/ RSS-247(5.4(d))	Maximum Peak Conducted Output Power	**pass**	
4.3	FCC Part 15.247(e)/ RSS-247(5.2(b))	Maximum Power Spectral Density level	**pass**	
4.4	FCC Part 15.209 RSS-Gen, 8.9	Radiated Emissions in restricted band	**pass**	
4.5	FCC Part 15.247(d)/ RSS-247(5.5)	Radiated Emissions in non-restricted band	**pass**	
4.6	FCC Part 15.247(d)(1)/ RSS-247(5.5)	DTS Band-edge Emissions Measurements	**pass**	
4.7	FCC Part 15.207/ RSS-Gen (8.8)	Conducted Emissions	**pass**	
4.8	FCC Part 15.247(i)/ RSS 102 Issue 5	RF Exposure Compliance	**pass**	

Note:	

1.1 Measurement Uncertainty

The measured value related to the corresponding limit will be used to decide whether the equipment meets the requirements. The measurement uncertainty figures were calculated and correspond to a coverage factor of k=2, providing a confidence level of respectively 95.45 % in the case where the distributions characterizing the actual measurement uncertainties are normal (Gaussian).

Radiated emissions 30MHz to 1000MHz	4.9 dB
Radiated emissions 1GHz to 18GHz	4.6 dB
Conducted emissions 150KHz to 30MHz (AMN)	2.7 dB
Conducted emissions 150KHz to 30MHz (AAN)	1.92 dB
RF frequency	$\pm 3 \times 10^{-8}$
RF power, conducted	1.4 dB
RF Power Spectral Density	0.96 dB

1.2 Test Facility

Test Facility Accreditations:	ISO/IEC 17025:2017, NVLAP LAB CODE: 200033-0
	FCC US502
	ISED Canada CAB identifier: US0012

2.0 Equipment Description

2.1	Equipment Under Test			
Description:	WS ALERT XPV Headset helps protect against hazardous noise, has Bluetooth wireless communication, noise-cancelling boom microphone, and level-dependent function for ambient listening.			
Model(s):	MRX21A1WS7-NA			
Serial number:	128837-2			
3M Division:	Personal Safety			
Modifications and Special Measures:	none			
Frequency Range:	2402.0-2480.0 MHz			
Channel No.:	39			
Modulation Type:	GFSK			
FCC Classification:	Digital Transmission System (DTS)			
Output Power EIRP:	3.7dBm (2.3mW), (1dBm Conducted RF Power)			
Antenna Type and Antenna Assembly Gain:	☐ External	☒ Integral PCB Antenna	☐ Dedicated	
	☒ 2.7dBi	☐ Declared by the Manufacturer	☒ Measured	
Test Deviations or Exclusions	☐ Yes	☒ No		
Rated Power:	**Voltage:**	☒ 120VAC	☐ 230VAC	☒ 3VDC
	Phase:	☐ 1ph	☐ 3ph	☒ USB-C
	Frequency:	☐ 50Hz	☒ 60Hz	
	Current:	N/A		
Test Dates:	02/05-02/13/2024			
Received Date:	01/15/2024			
Received Conditions:	☐ Poor	☒ Good		
	☒ Prototype	☐ Production		

3.0 EUT Configuration

3.1 System Configuration

No.	Product Type	Manufacturer	Model	Comments
1	EUT	3M	MRX21A1WS7	
2	USB Charger	Apple	M1385	Support Equipment
3	Programming interface	Qualcomm	TRBI200	Support Equipment

3.2 Input/Output Ports of EUT

No.	Description	Type	Comments
1	DC Power	USB-C	
2			

3.3 Cables

No.	Description	Type	Length	Shielding	Comments
1	USB-C	USB 2.0	1m	Yes	
2					

3.4 Measurement Arrangements of EUT

	Intended Operational Arrangement(s)	Comments
☒	Table-top only	
☐	Floor-standing only	
☐	Floor-standing or table-top	
☒	Other	Body-worn

3.5 Primary function(s) of EUT

No.	List of Essential Functions
1	Voice communications and audio listing over Bluetooth.
2	

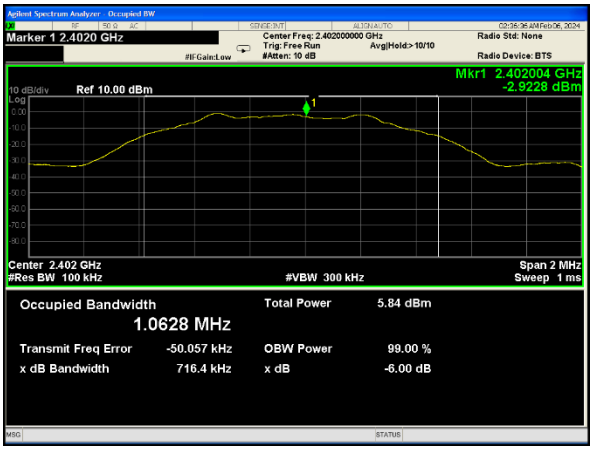
3.6 Exercising of EUT and Interfaces

No.	Mode of Operation
1	Transmitting at lowest (0), middle (19) and highest (39) channels of operation with unmodulated CW carrier
2	Continuous transmission of modulated signal at lowest (0), middle (19) and highest (39) channels
3	Device programming using Qualcomm Bluesuit WIN.3.3 software for continuous transmission of modulated carrier at maximum rated RF output power and Duty Cycle.

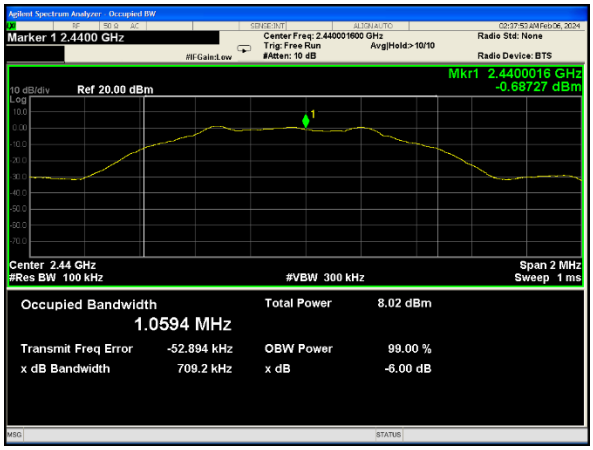
4.0 Test Conditions and Results

4.1	DTS Bandwidth	
	Laboratory Ambient Temperature:	23°C
	Relative Humidity:	48%
	Atmospheric Pressure:	1011 mbars
Reference Standard(s):	☒ ANSI C63.10:2020, Section 11.8.2 ☒ FCC Part 15.247/RSS 247 ☒ KDB 558074	**Measurement Point** ☒ Conducted ☐ Radiated
Frequency Range:	☒ 2402.0-2480.0 MHz	RBW = 100KHz VBW ≥ 3 x RBW
Nominal Voltage:	☐ 120VAC ☒ 3.0VDC	
Test Personnel:	Yuriy Litvinov	**Date:** 02/06/2024

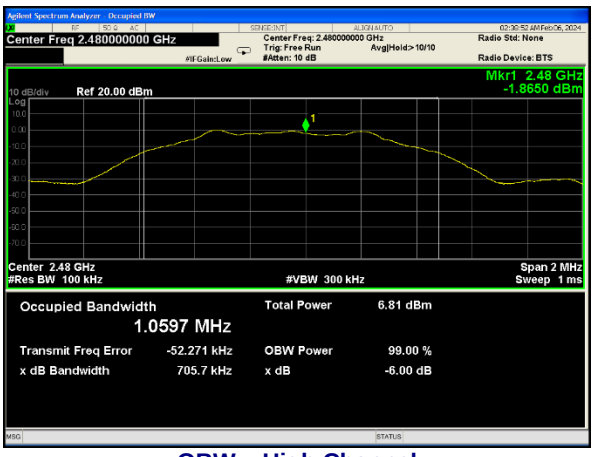
Frequency (MHz)	Data Rate	99% dB Bandwidth (KHz)	6 dB Bandwidth (KHz)	6dB OBW Limit (KHz)	Results
2402	1 Mbps	1.0628	716.4	**> 500**	**pass**
2440	1 Mbps	1.0594	709.2	**> 500**	**pass**
2480	1 Mbps	1.0597	705.7	**> 500**	**pass**



OBW – Low Channel



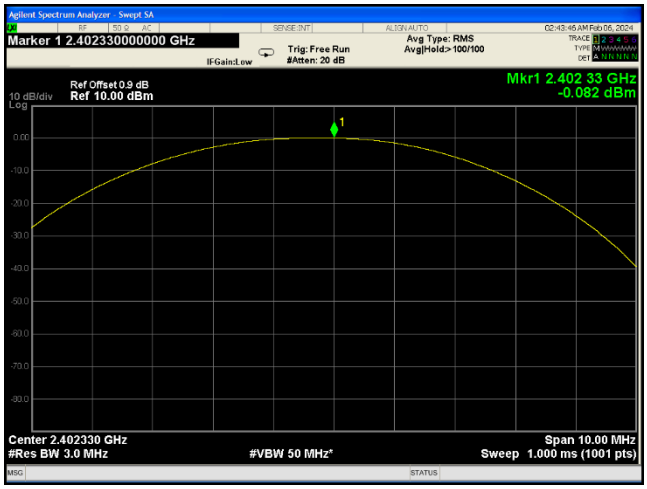
OBW – Mid Channel



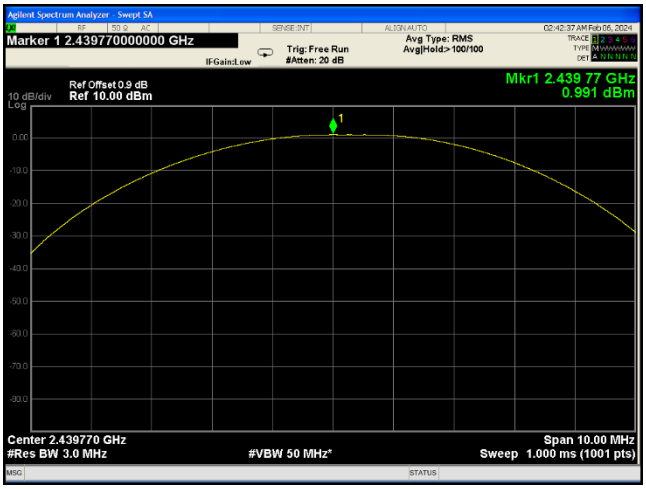
OBW – High Channel

4.2	**Maximum Output Power**	
Method:	Measurements was performed with CW carrier at the highest power level at which the transmitter is intended to operate. The analyzer offset was adjusted to compensate for the attenuator and other losses.	
	Laboratory Ambient Temperature:	23°C
	Relative Humidity:	48%
	Atmospheric Pressure:	1011 mbars
Reference Standard(s):	☒ ANSI C63.10:2020, Section 11.9 ☒ FCC Part 15.247/RSS 247 ☒ KDB 558074	**Measurement Point** ☒ Conducted ☐ Radiated
Frequency Range:	☒ 2402.0 – 2480.0 MHz	
Antenna Gain:	2.7dBi	**Maximum Power (EIRP):**
Limit:	30 dBm	3.7dBm (2.3mW)
Nominal Voltage:	☐ 120VAC ☒ 3.0VDC	
Test Personnel:	Yuriy Litvinov	**Date:** 02/06/2024

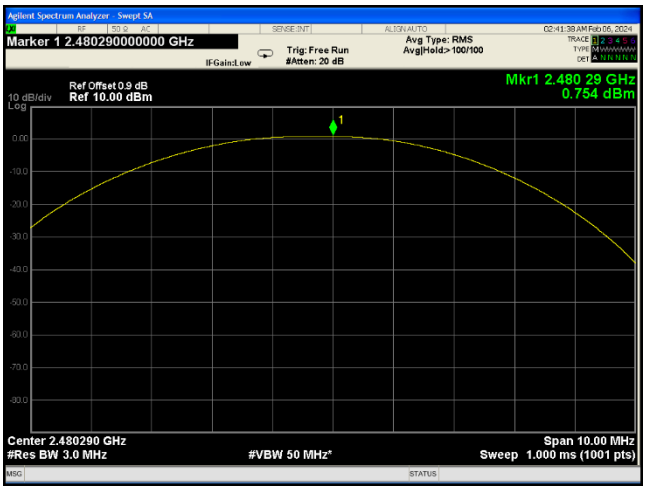
Note:	EIRP (dBm) = Conducted Power (dBm) +Antenna Gain (dBi)= 1.0+2.7= 3.7dBm



Low Channel

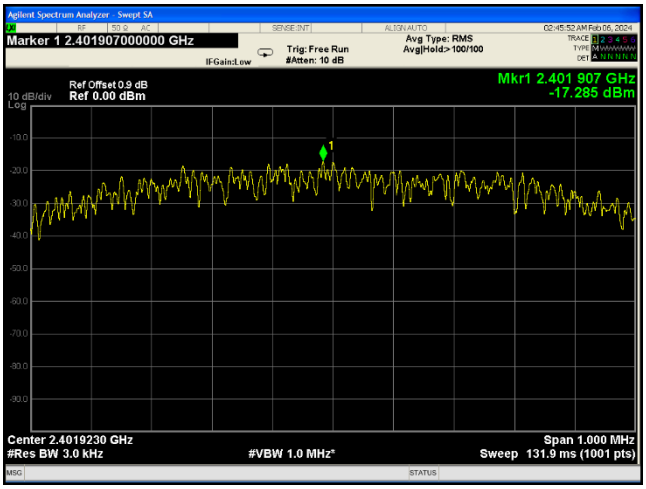


Mid Channel

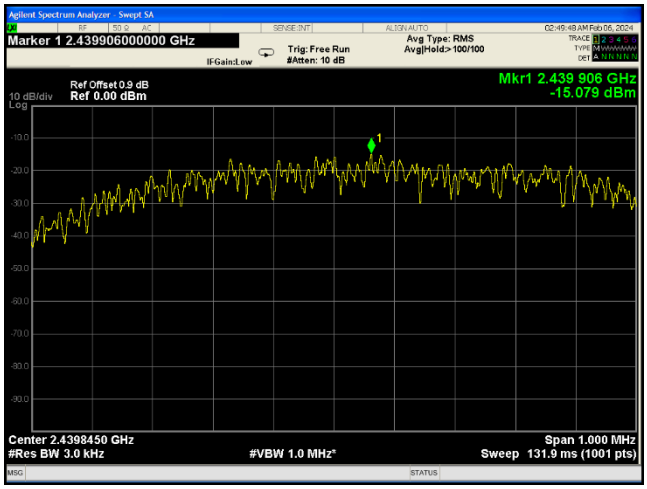


High Channel

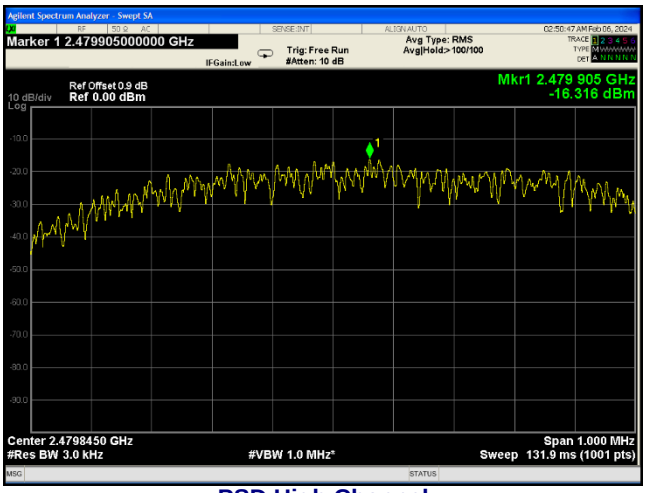
4.3	**Maximum Power Spectral Density level**	
Method:	Measurements was performed with modulated carrier at the highest power level at which the transmitter is intended to operate. The analyzer offset was adjusted to compensate for the attenuator and other losses.	
	Laboratory Ambient Temperature:	23°C
	Relative Humidity:	48%
	Atmospheric Pressure:	1011 mbars
Reference Standard(s):	☒ ANSI C63.10:2020, Section 11.10.2 ☒ FCC Part 15.247/RSS 247 ☒ KDB 558074	**Measurement Point** ☒ Conducted ☐ Radiated
Frequency Range:	☒ 2402.0 – 2480.0 MHz	**PSD Results**
PSD Limit:	8 dBm in any 3KHz band	-15.1dBm
Nominal Voltage:	☐ 120VAC ☒ 3.0VDC	
Test Personnel:	Yuriy Litvinov	**Date:** 02/06/2024



PSD Low Channel



PSD Mid Channel



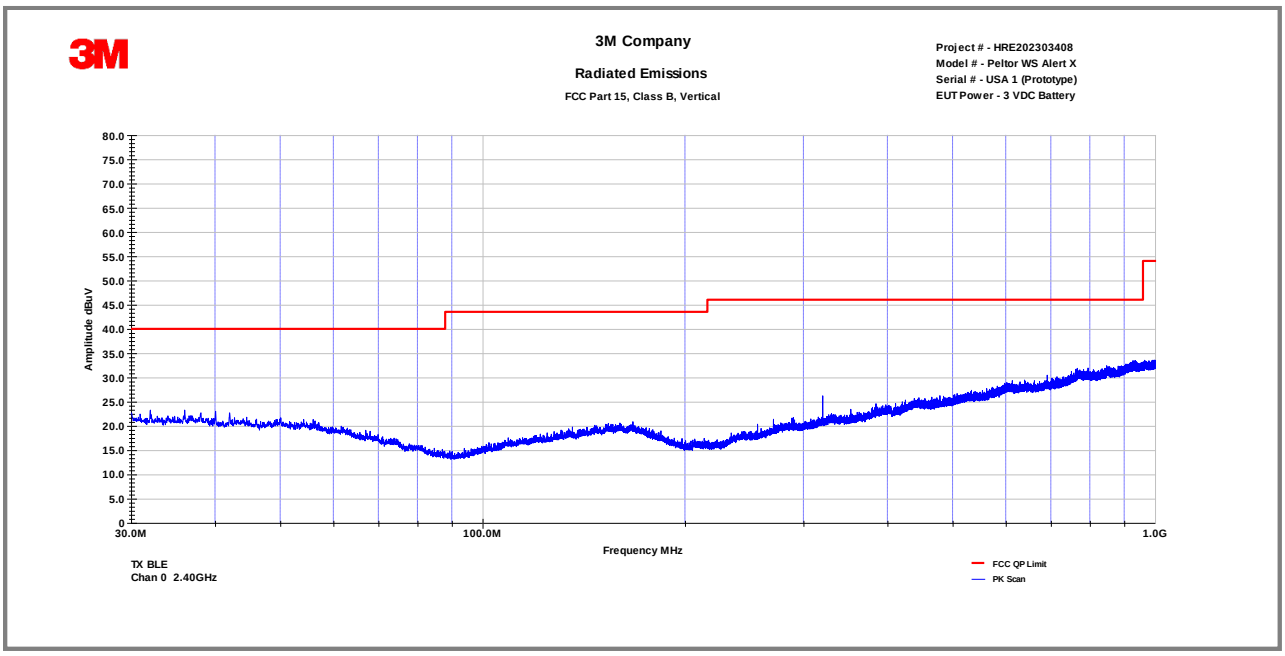
PSD High Channel

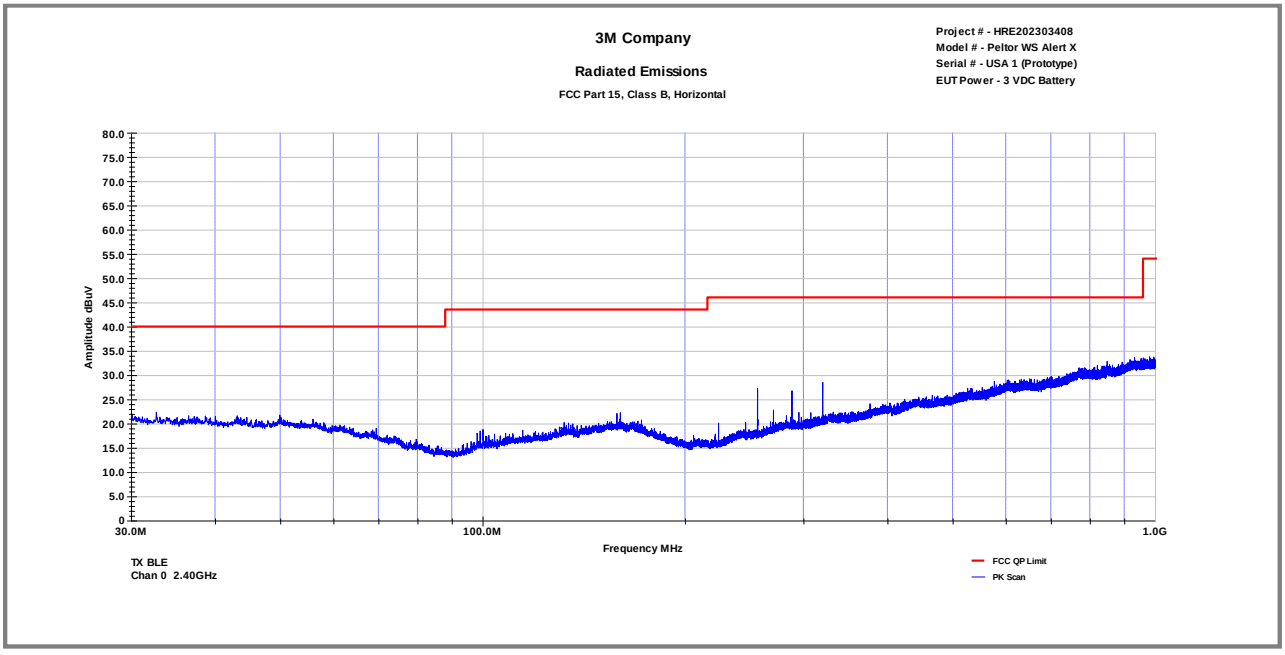
4.4	**Radiated Emissions in restricted band**		
Method:	Measurements were made in a 3-meter semi-anechoic chamber that complies to CISPR 16/ANSI C63.4 standards. EUT was rotated through three orthogonal axes to determine which attitude (orientation) and arrangement produces the highest emission relative to the limit; the attitude and device arrangement that produces the highest emission relative to the limit was used in making final radiated emission measurements. Spurious Radiated emissions measurements ware performed with external preamp and a high pass filter. Final measurements were then performed by rotating the EUT 360° and adjusting the receive antenna height from 1 to 4 m. All frequencies were investigated in both horizontal and vertical antenna polarity, where applicable.		
Test Verification: ☒	Laboratory Ambient Temperature:	23°C	
	Relative Humidity:	55%	
	Atmospheric Pressure:	1011 mbars	
Reference Standard(s):	☒ ANSI C63.10:2020, Section 11.12.1 ☒ FCC Part 15.205/15.209/RSS Gen (8.9) ☒ KDB 558074	**Measurement Distance**	
		☒ 3 Meters ☐	
Frequency Range:	☒ 30 MHz to 1 GHz	RBW = 100KHz, VBW ≥ 3 x RBW	
	☒ 1 GHz to 25 GHz	RBW = 1MHz, VBW ≥ 3 x RBW	
Nominal Voltage:	☐ 120VAC ☒ 3.0VDC		
Test Personnel:	Keith Schwartz KS	**Date:** 02/08/2024	

Limits –15.209 and RSS Gen

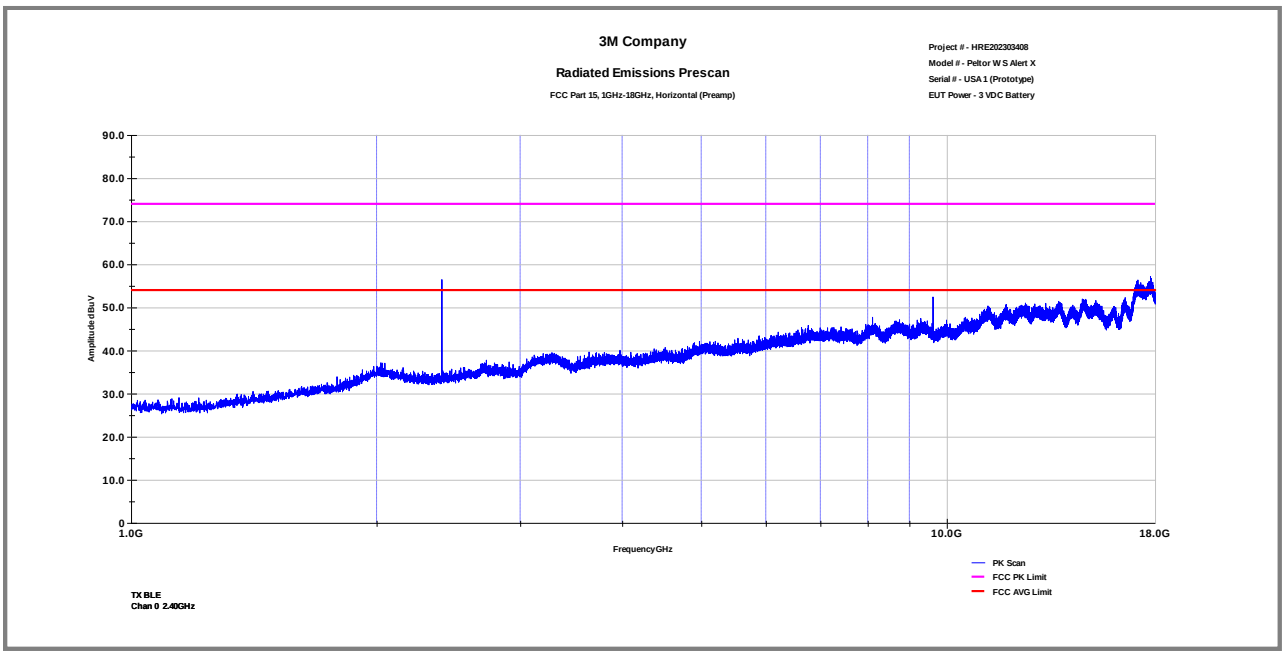
Frequency (MHz)	Limit dB (µV/m)				
	Quasi-Peak	Average	Peak	Distance	Results
0.009-0.490		2400/F(KHz)		300	**N/A**
0.490-1.705	24000/F(KHz)			30	**N/A**
1.705-30	30			30	**N/A**
30 to 88	40			3	**pass**
88 to 216	43.5			3	**pass**
216 to 960	46			3	**pass**
Above 960		54	74	3	**pass**

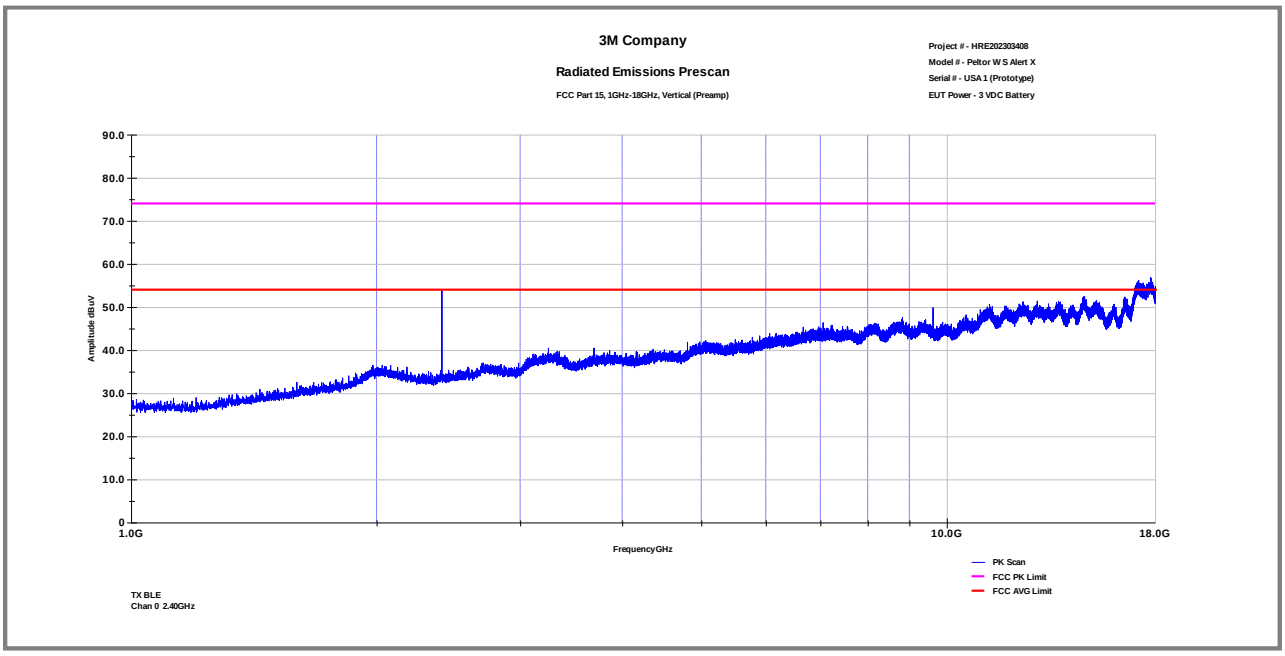
Modifications:	
Note:	The lower limit applies at the transition frequency. An inverse proportionality factor of 20 dB per decade has been used to normalize the measured data to the specified distance for determining compliance For emission in the restricted bands, the limit of 15.209 was used. There are no emissions were detected in the 15.205 restricted band within 30dB below 15.209 limit adjacent or nearby to 2400-2483.5MHz frequency band during operation at the high channel. No radiated spurious emissions were detected above 18GHz



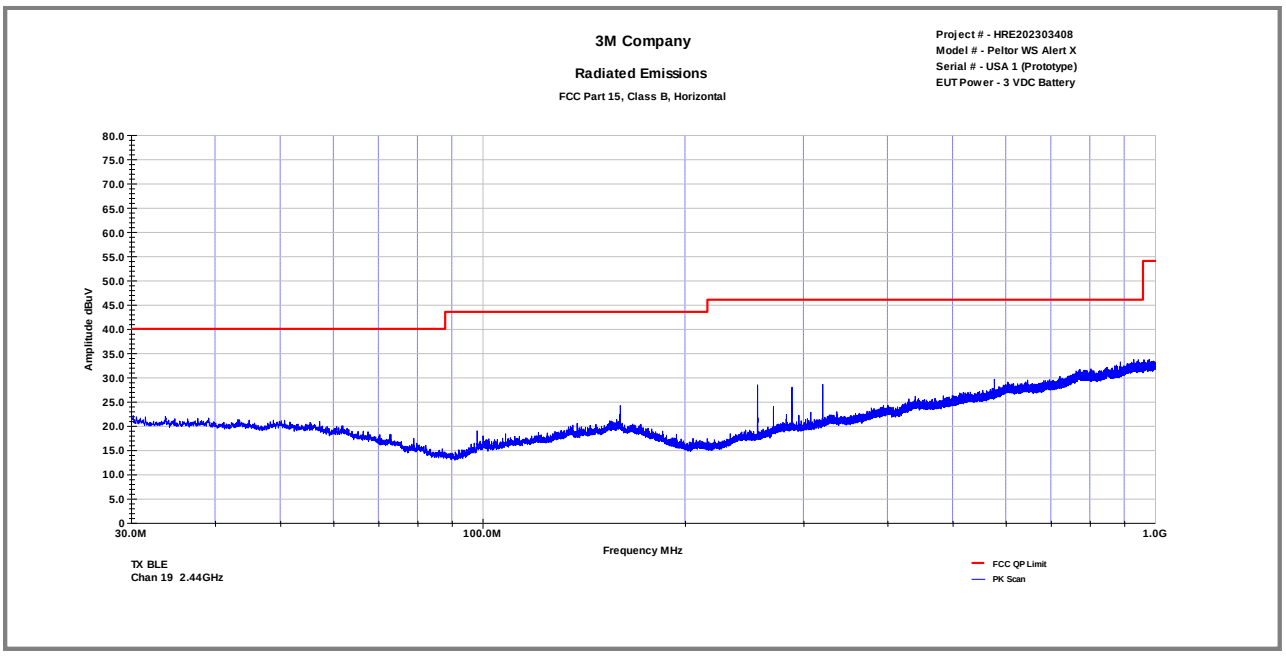


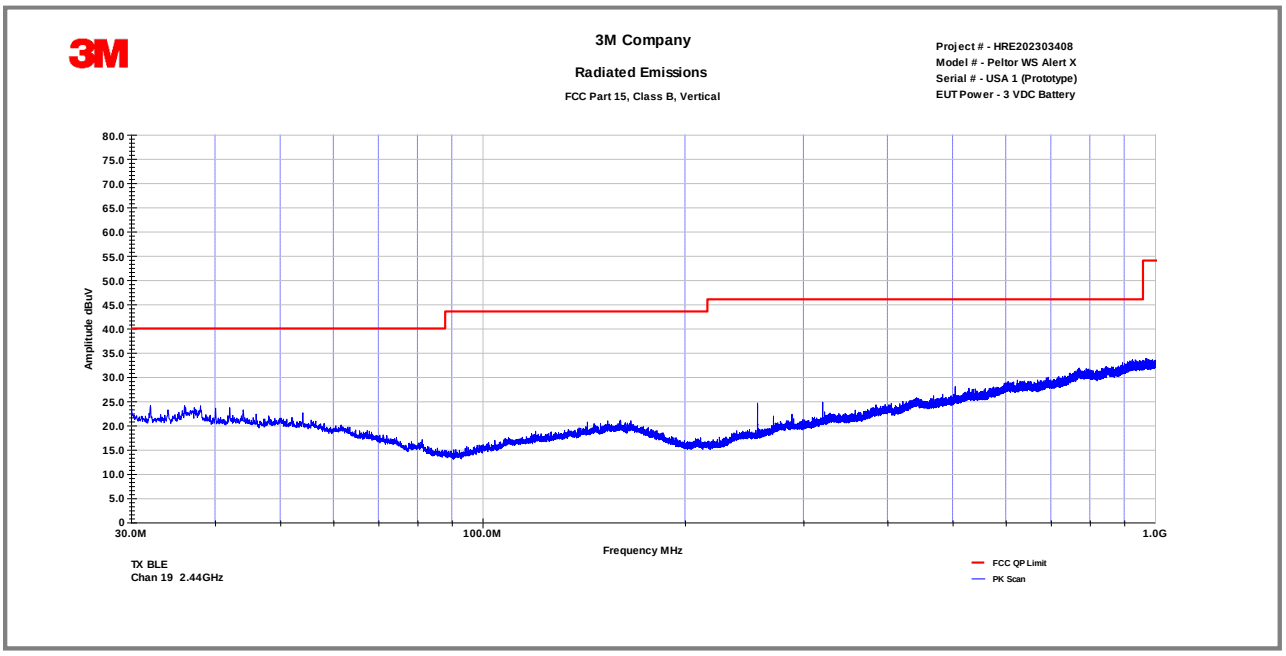
FCC Part 15.209 Radiated Emissions in restricted band – Low Channel



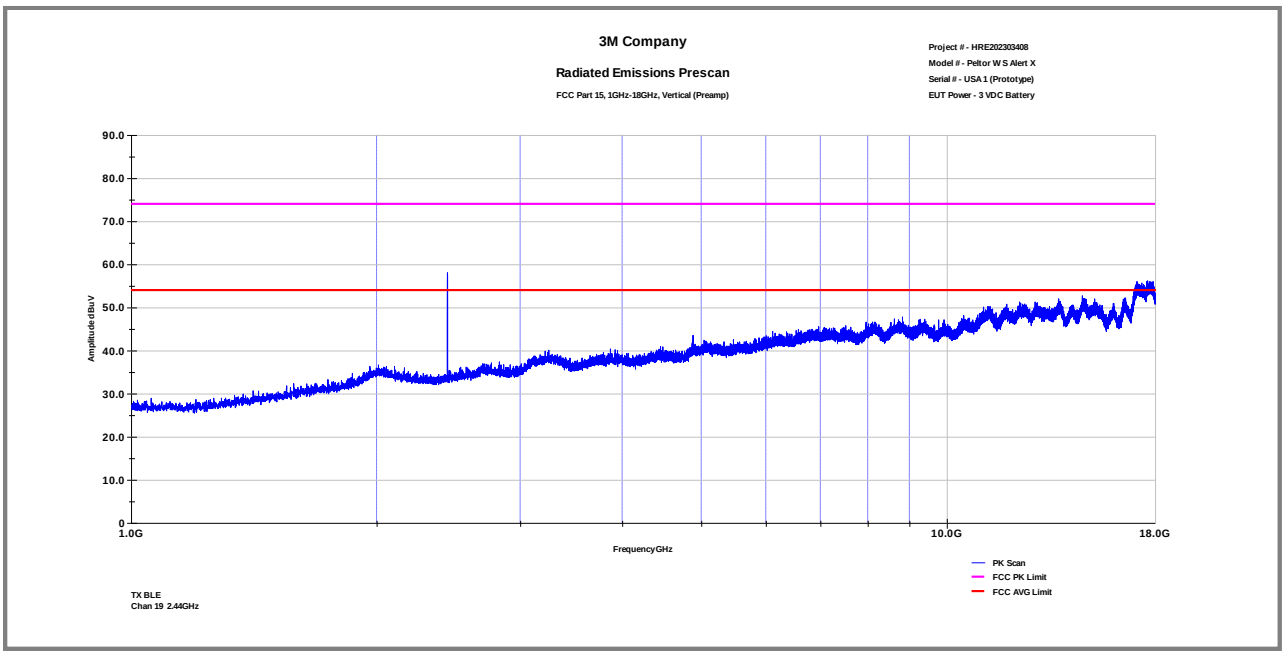


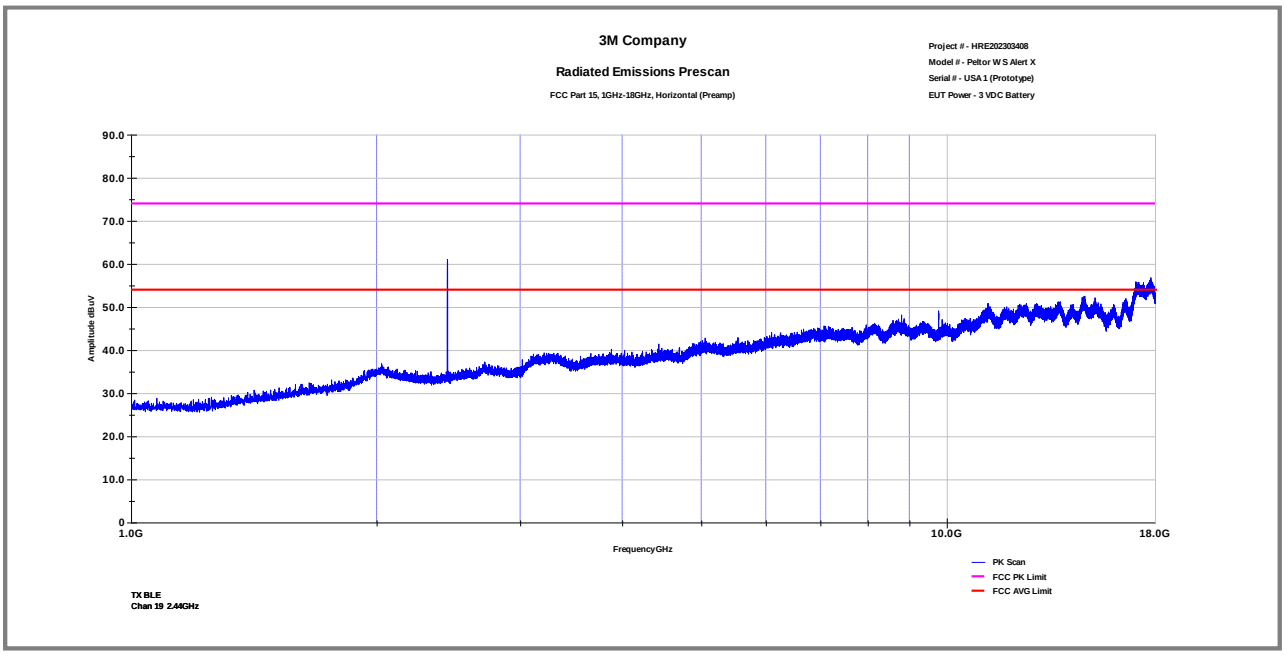
FCC Part 15.209 Radiated Emissions in restricted band – Low Channel



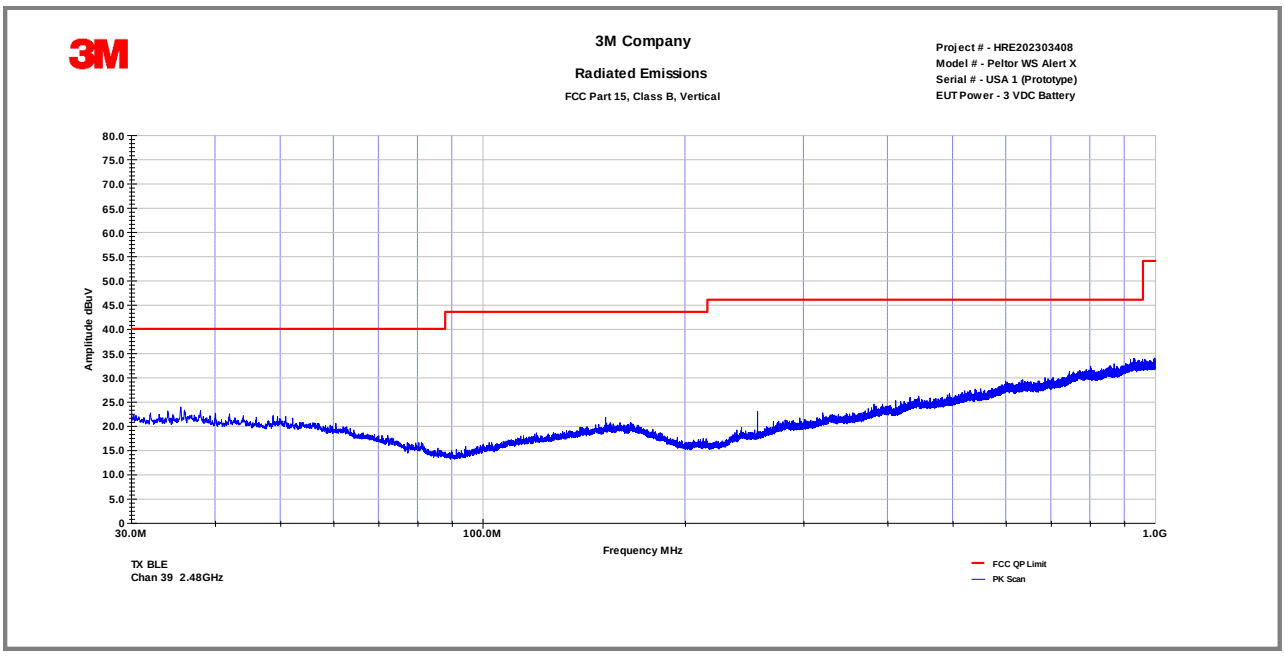


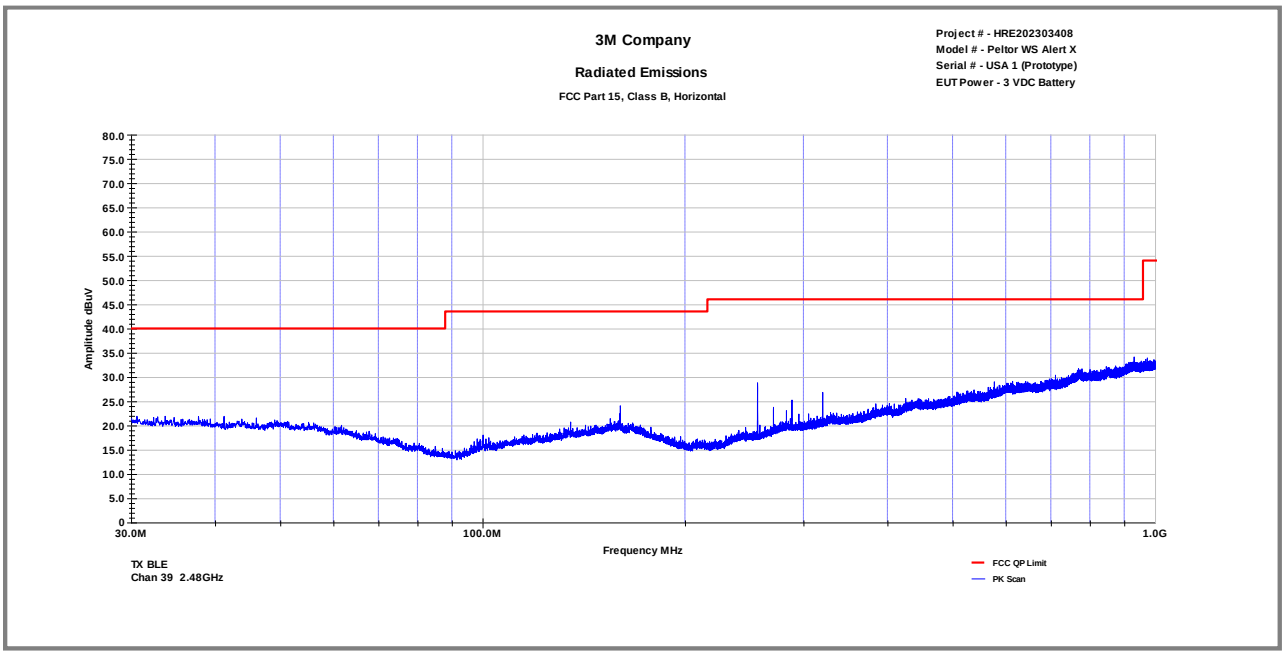
FCC Part 15.209 Radiated Emissions in restricted band – Mid Channel



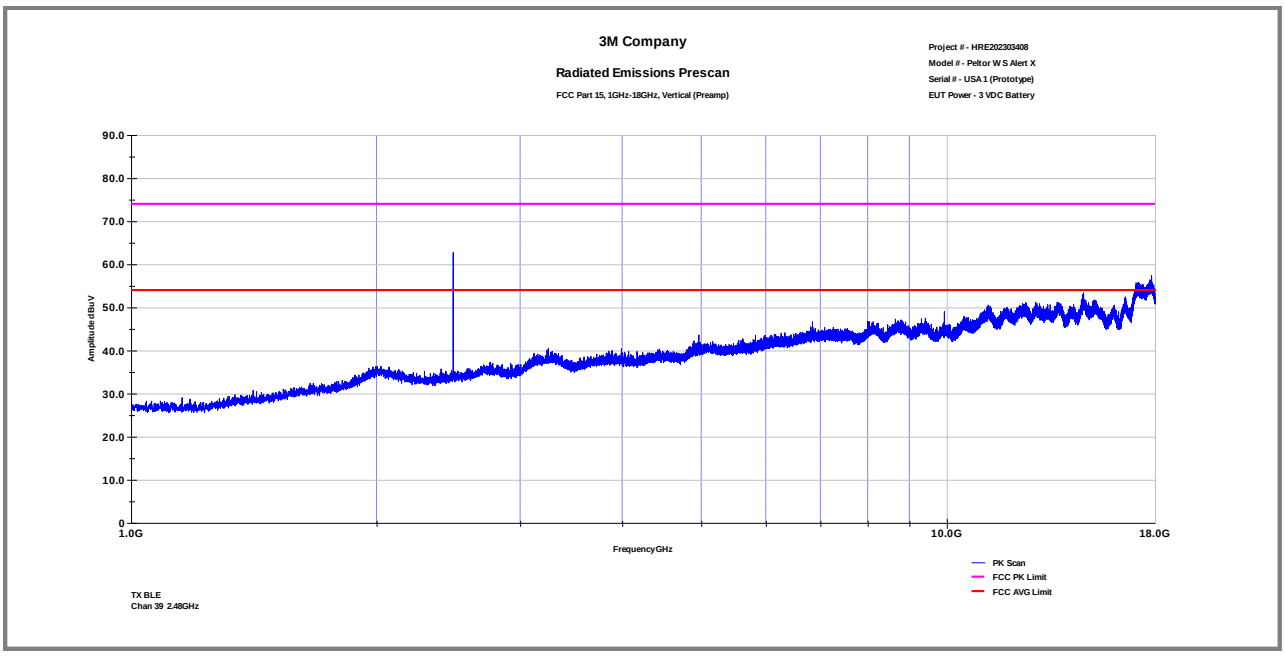


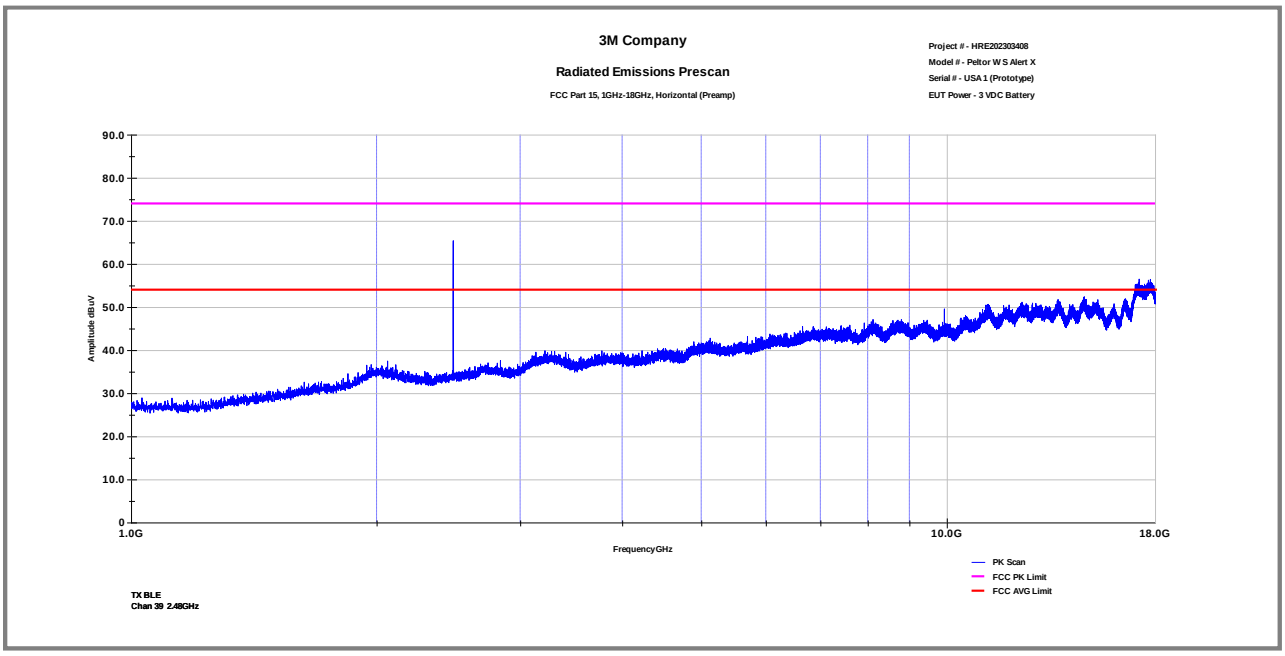
FCC Part 15.209 Radiated Emissions in restricted band – Mid Channel





FCC Part 15.209 Radiated Emissions in restricted band – High Channel





FCC Part 15.209 Radiated Emissions in restricted band – High Channel

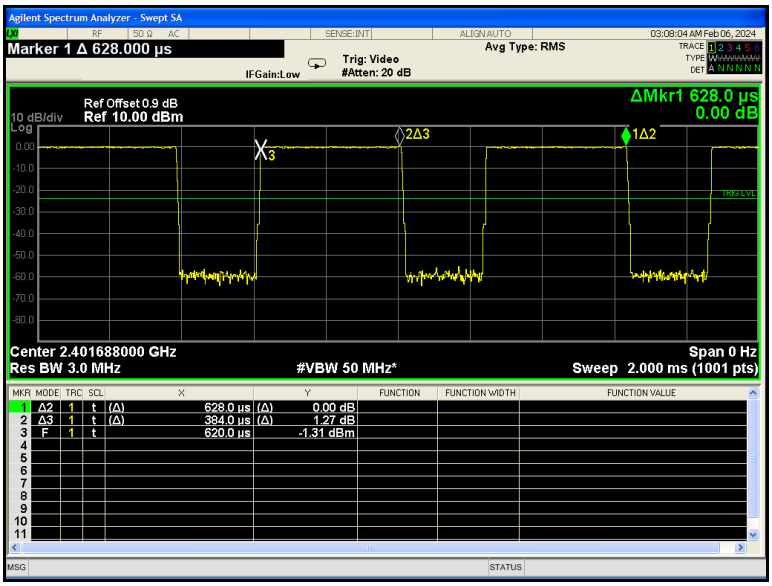
Tables - Radiated Emissions in restricted band

Pol	Frequency (MHz)	Peak dBµV/m	AVG dBµV/m	Total CF dB	Net Peak dBµV/m	Net AVG dBµV/m	PK Limit dBµV/m	AVGLimit dBµV/m	PK Margin dB	AVG Margin dB
V	4803.50	50.45	42.2	-6.36	44.09	35.86	74.00	54.00	-29.91	-18.14
H	4803.50	49.93	40.6	-6.36	43.57	34.25	74.00	54.00	-30.43	-19.75
V	8099.70	48.13	36.3	-3.69	-0.08	32.65	74.00	54.00	-74.08	-21.35
H	8099.70	47.79	36.4	-3.69	-0.08	32.71	74.00	54.00	-74.08	-21.29
V	9607.00	53.13	46.5	-1.60	-0.22	44.86	74.00	54.00	-74.22	-9.14
H	9607.00	54.98	49.2	-1.60	-0.22	47.59	74.00	54.00	-74.22	-6.41
Notes:		Net Reading (dBuV) = Reading (dBµV) + (Antenna with amp CF(dB)+Cable CF(dB)) AVG VBW>1/T=3KHz								
		Low Channel								

Pol	Frequency (MHz)	Peak dBµV/m	AVG dBµV/m	Total CF dB	Net Peak dBµV/m	Net AVG dBµV/m	PK Limit dBµV/m	AVGLimit dBµV/m	PK Margin dB	AVG Margin dB
V	4880.00	51.79	44.1	-5.30	46.49	38.75	74.00	54.00	-27.51	-15.25
H	4880.00	50.26	41.6	-5.30	44.96	36.28	74.00	54.00	-29.04	-17.72
V	7320.00	49.02	37.6	-2.01	47.01	35.54	74.00	54.00	-26.99	-18.46
H	7320.00	48.79	38.1	-2.01	46.78	36.08	74.00	54.00	-27.22	-17.92
V	12200.00	45.77	34.6	4.97	50.74	39.53	74.00	54.00	-23.26	-14.47
H	12200.00	45.49	34.8	4.97	50.46	39.72	74.00	54.00	-23.54	-14.28
Notes:		Net Reading (dBuV) = Reading (dBµV) + (Antenna with amp CF(dB)+Cable CF(dB)) AVG VBW>1/T=3KHz								
		Mid Channel								

Pol	Frequency (MHz)	Peak dBµV/m	AVG dBµV/m	Total CF dB	Net Peak dBµV/m	Net AVG dBµV/m	PK Limit dBµV/m	AVGLimit dBµV/m	PK Margin dB	AVG Margin dB
V	2700.00	51.05	40.6	-12.21	38.84	28.38	74.00	54.00	-35.16	-25.62
H	2700.00	51.55	40.5	-12.21	39.34	28.24	74.00	54.00	-34.66	-25.76
V	4959.86	51.38	43.7	-5.17	46.21	38.57	74.00	54.00	-27.79	-15.43
H	4959.86	49.76	40.5	-5.17	44.59	35.37	74.00	54.00	-29.41	-18.63
V	7439.40	48.58	37.8	-1.69	46.89	36.10	74.00	54.00	-27.11	-17.90
H	7439.40	48.72	38.5	-1.69	47.03	36.76	74.00	54.00	-26.97	-17.24
V	14649.00	44.87	33.3	8.22	53.09	41.54	74.00	54.00	-20.91	-12.46
H	14649.00	44.62	33.3	8.22	52.84	41.54	74.00	54.00	-21.16	-12.46
Notes:		Net AVG VBW>1/T=2KHz Reading (dBuV) = Reading (dBµV) + (Antenna with amp CF(dB)+Cable CF(dB)) AVG VBW>1/T=3KHz								
		High Channel								

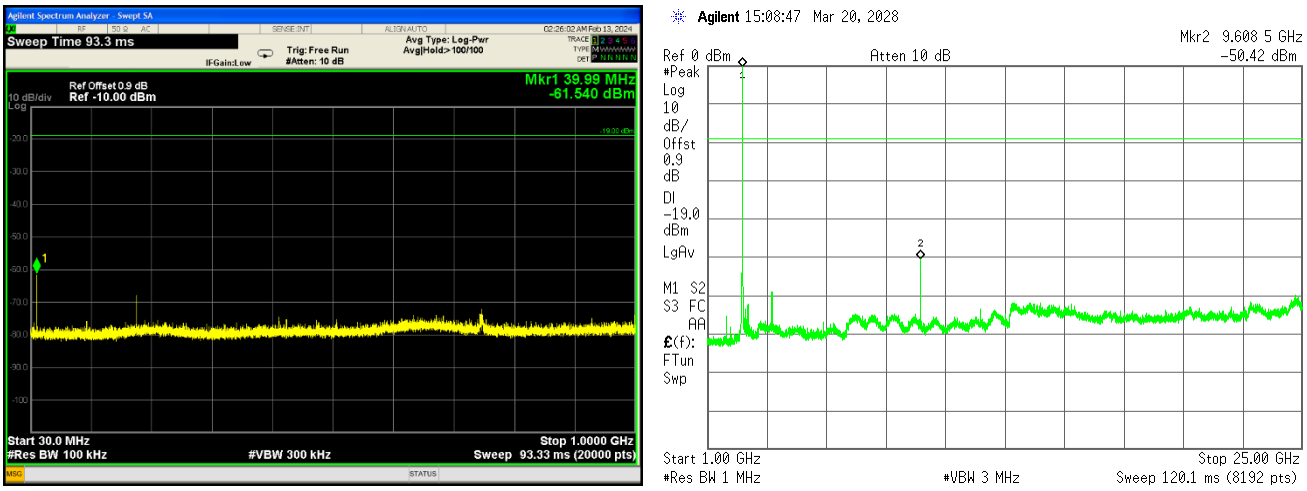
Duty Cycle Correction factor



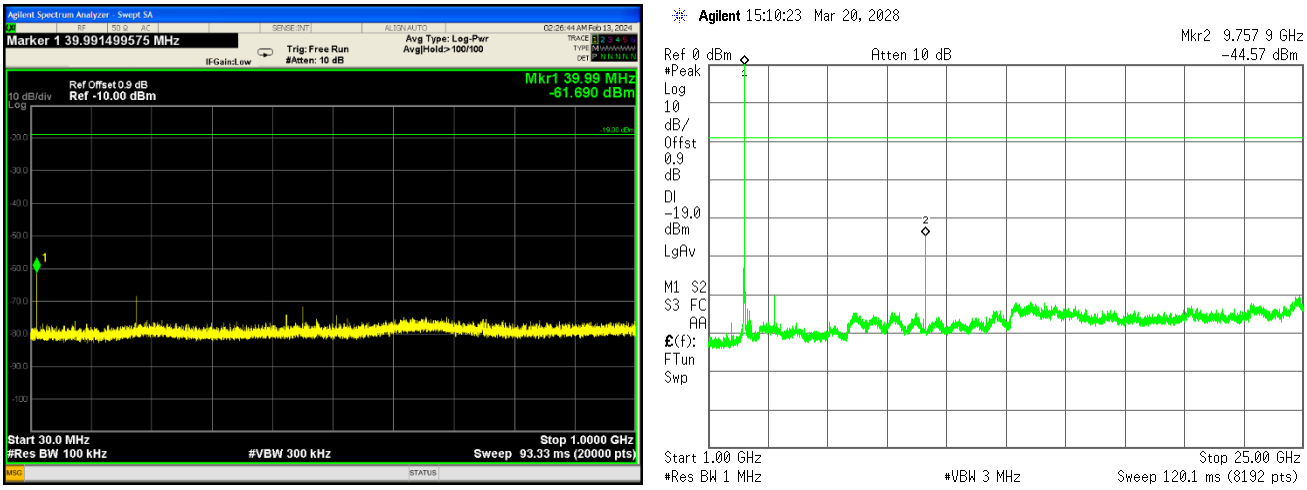
The total number of pulses over 100ms/0.628ms= 159
Transmission On time per burst = 0.384ms
Total on time over 100 ms = 0.385ms x 159 = 61.1ms
Duty Cycle Correction Factor = 20 log (61.1ms/100ms) = -4.3dB
VBW = 3KHz > 1/T

4.5	**Radiated Emissions in non-restricted band**		
Method:	The measurements were made with transmitter set to transmit continuously low, medium and high channels.		
		Laboratory Ambient Temperature:	23°C
		Relative Humidity:	48%
		Atmospheric Pressure:	1011 mbars
Reference Standard(s):		☒ ANSI C63.10:2020, Section 11.11 ☒ FCC Part 15.247/RSS 247 ☒ KDB 558074	**Measurement Point** ☒ Conducted ☐ Radiated
Frequency Range:		☒ 2402.0-2480.0 MHz	
In-band power in 100KHz:		☒ 1.00dBm	**Results:**
Limit:		☒ -29.0dBm (30dBc below in-band power)	>43dBc
Nominal Voltage:		☐ 120VAC ☒ 3.0VDC	
Test Personnel:		Yuriy Litvinov	**Date:** 02/13/2024

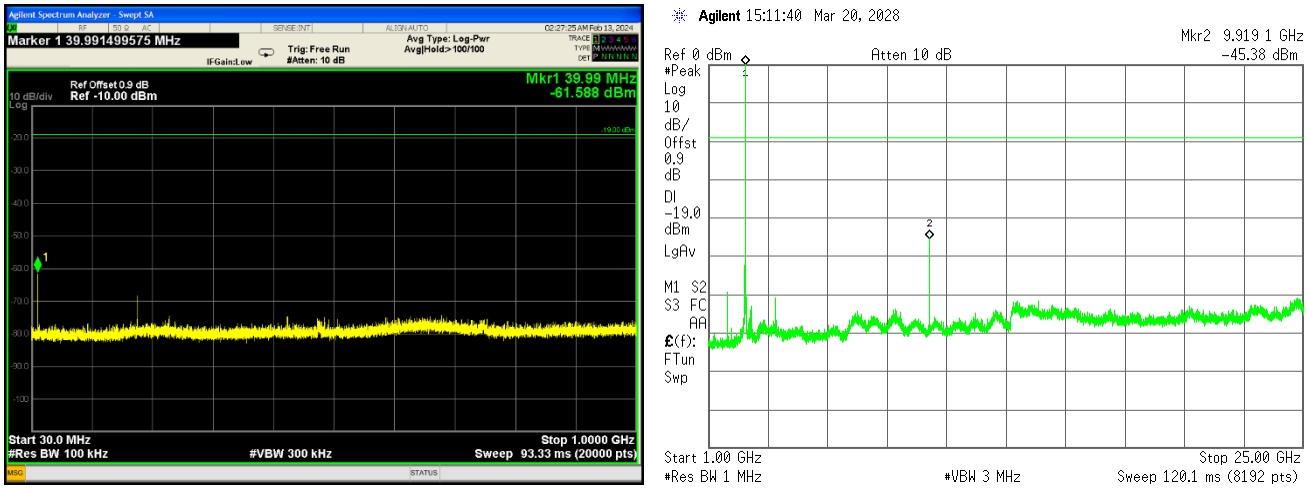
Note:	



Conducted Spurious - Low Channel



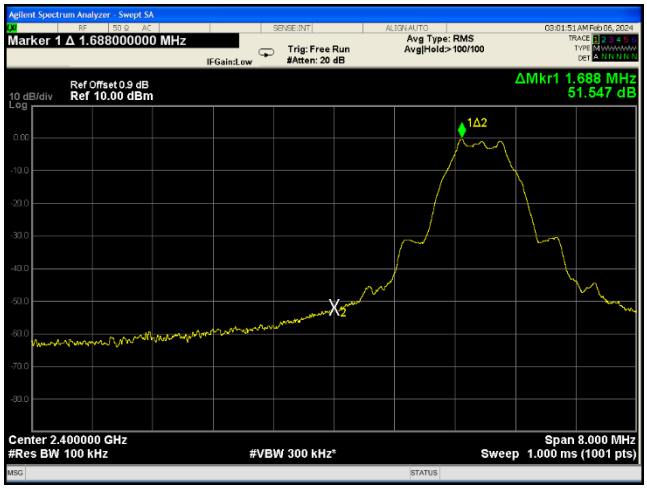
Conducted Spurious – Mid Channel



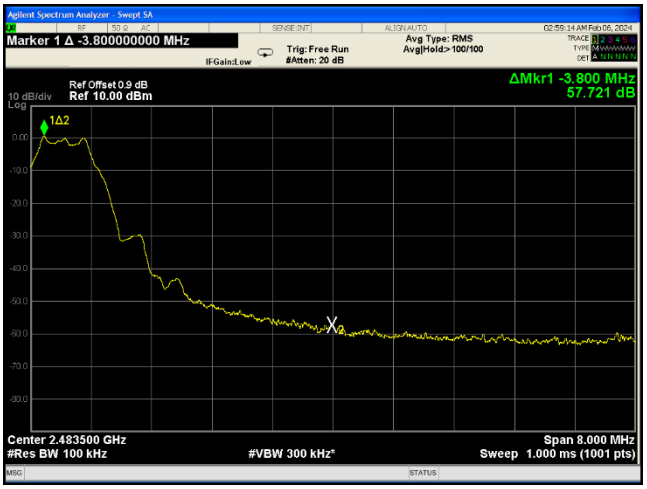
Conducted Spurious – High Channel

4.6	**Band-Edge Compliance**	
Method:	The measurements were made with transmitter set to transmit continuously with modulated signal at low and high channels.	
	Laboratory Ambient Temperature:	23°C
	Relative Humidity:	48%
	Atmospheric Pressure:	1011 mbars
Reference Standard(s):	☒ ANSI C63.10:2020, Section 11.13.2 ☒ FCC Part 15.247/RSS 247 ☒ KDB 558074	**Measurement Point** ☒ Conducted ☐ Radiated
Frequency Range:	☒ 2402.0-2480.0 MHz	**Results**
Limit:	☒ >30dBc	Low Ch., 2402 MHz > 51dBc High Ch., 2480 MHz > 57dBc
Nominal Voltage:	☐ 120VAC ☒ 3.0VDC	
Test Personnel:	Yuriy Litvinov	**Date:** 02/06/2024

Note:	



Band Edge - Low Channel
Center Freq. 2.400GHz



Band Edge - High Channel
Center Freq. 2.4835GHz

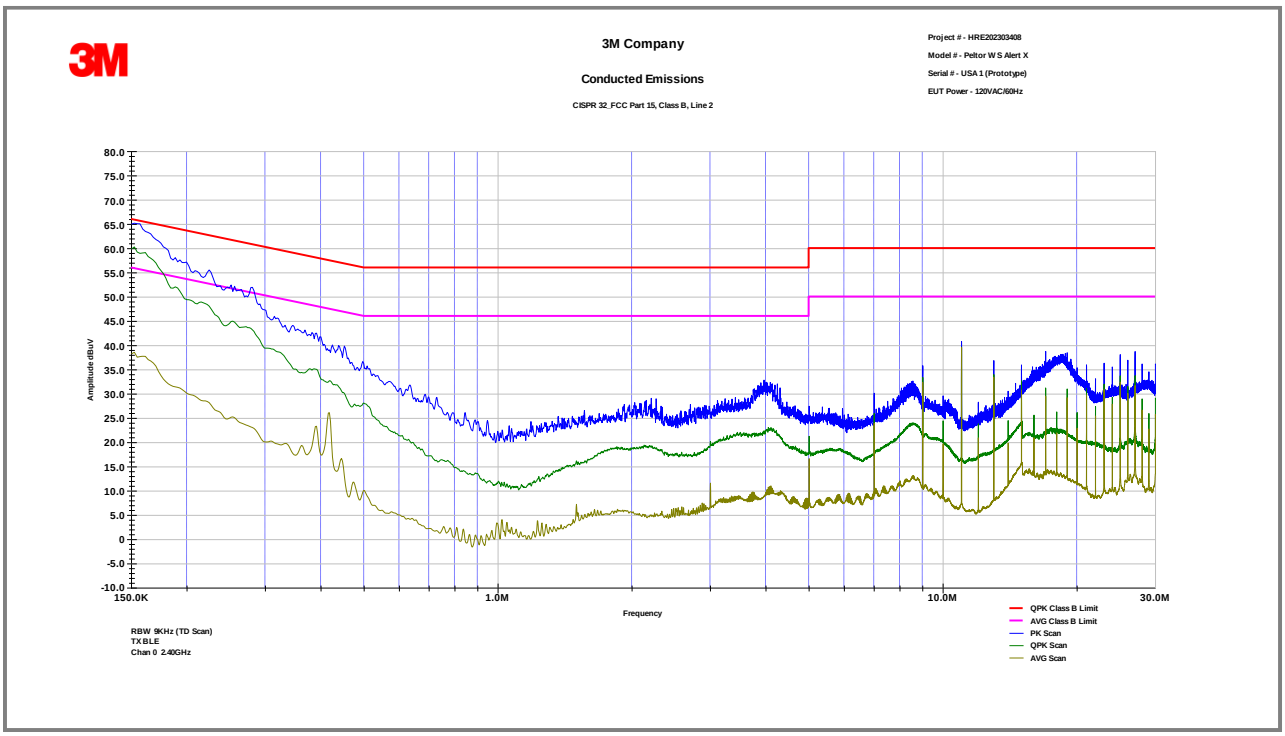
4.7	**Conducted Emissions Data**
Method:	The AMN was placed 0.8 m from the boundary of the unit under test and bonded to a ground reference plane. This distance was between the closest points of the AMN and the EUT. All other units of the EUT and associated equipment was at least 0.8 m from the AMN. All power was connected to the system through Artificial Mains Network (AMN). Conducted voltage measurements on mains lines were made at the output of the AMN.
	All power was connected to the system through Artificial Mains Network (AMN). All tested telecommunications lines were connected to an Asymmetric Artificial Network (AAN) and conducted voltage measurements on telecommunications lines were made at the output of the ISN. Where an AAN was not appropriate or available measurements were made using a Capacitive Voltage Probe.

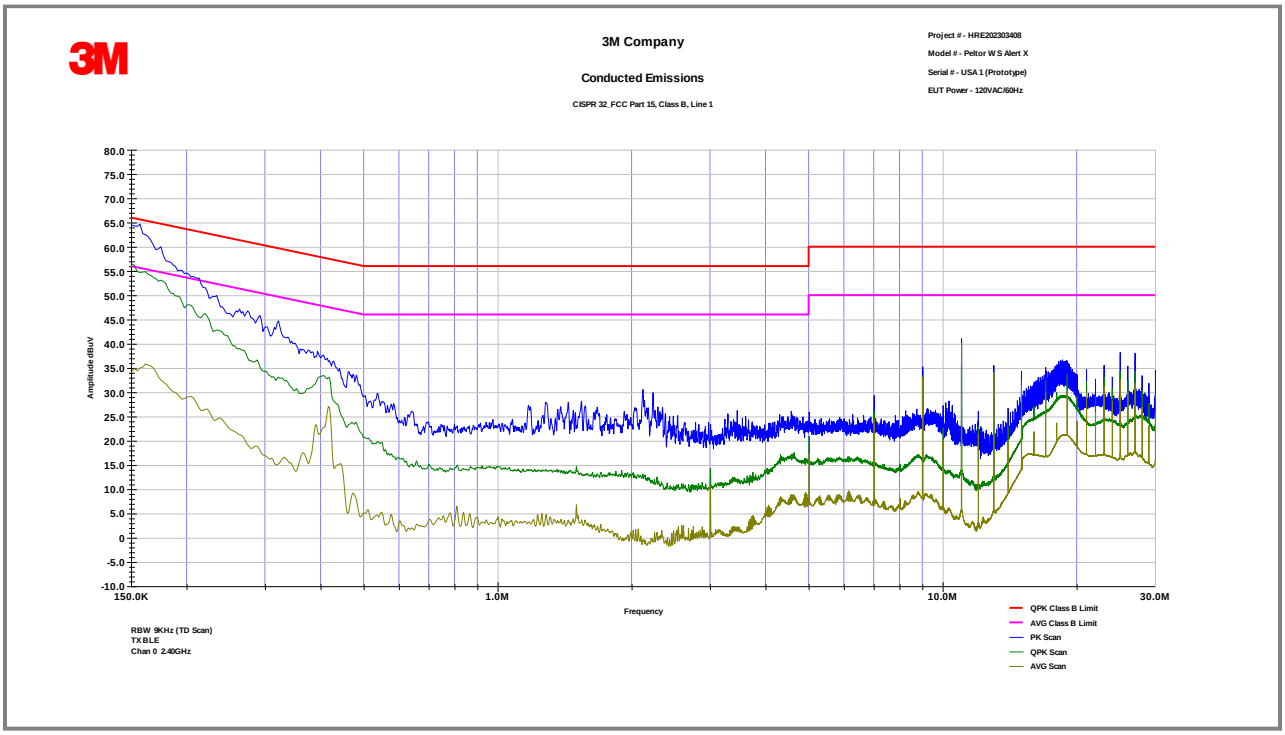
Test Verification: ☒	Laboratory Ambient Temperature:	23°C
	Relative Humidity:	48%
	Atmospheric Pressure:	1011 mbars
Reference Standard(s):	☒ RSS Gen/FCC 15.207 ☐ ANSI C63.4:2014 ☒ ANSI C63.10:2020	**Measurement Point** ☒ Mains ☐ Telecommunication ports ☐
Nominal Voltage:	☒ 120VAC ☐ 230VAC ☐ 3.0VDC	
Test Personnel:	Keith Schwartz KS	**Date:** 02/08/2024

Limits – Part 15.207/RSS Gen – AC Mains

Frequency (MHz)	Limit dB (µV)			
	Quasi-Peak	Average	Result	Comments
0.15 to 0.50	66 to 56	56 to 46	**pass**	Time Domain Scan
0.50 to 5	56	46	**pass**	Time Domain Scan
5 to 30	60	50	**pass**	Time Domain Scan

Modifications:	
Note:	Tested while charging over USB-C port using USB Charger


3M Company
Conducted Emissions
CISPR 32_FCC Part 15, Class B, Line 2
Project # - HRE202303408
Model # - Peltor W S Alert X
Serial # - USA 1 (Prototype)
EUT Power - 120VAC/60Hz
Amplitude dBuV
80.0
75.0
70.0
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0
-5.0
-10.0
150.0K
1.0M
10.0M
30.0M
Frequency
RBW 9KHz (TD Scan)
TX BLE
Chan 0 2.40GHz
QPK Class B Limit
AVG Class B Limit
PK Scan
QPK Scan
AVG Scan


3M Company
Conducted Emissions
CISPR 32_FCC Part 15, Class B, Line 1
Project # - HRE202303408
Model # - Peltor W S Alert X
Serial # - USA 1 (Prototype)
EUT Power - 120VAC/60Hz
Amplitude dBuV
80.0
75.0
70.0
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0
-5.0
-10.0
150.0K
1.0M
10.0M
30.0M
Frequency
RBW 9KHz (TD Scan)
TX BLE
Chan 0 2.40GHz
QPK Class B Limit
AVG Class B Limit
PK Scan
QPK Scan
AVG Scan

4.8	RF Exposure Evaluation	
Reference Standard(s):	☒ KDB 447498 RF Exposure Guidance v06 ☐ KDB 447498 Interim RF Exposure Guidance v01 ☒ RSS 102, Issue 5 ☐	☐ MPE ☐ SAR Evaluation ☒ SAR Test Exclusion
Frequency Range(s):	☐ 911-918.5MHz ☒ 2402-2480.0MHz ☐	

Antenna Separation Distance:	>40mm
RF Exposure Conditions:	Portable (Body-worn)
2.4GHz Antenna Gain:	2.7dBi
BT EDR the source-based conducted output power:	3.0mW(4.8dBm)*0.7(FHSS worst case duty cycle)= 2.1mW(3.2dBm)
BT EDR EIRP/ERP output power:	**EIRP**=3.2dBm + 2.7dBi=5.9dBm, **ERP**=5.9dBm - 2.15dB=3.75dBm(2.4mW)
BLE the source-based conducted output power:	1.3mW(1dBm)*0.85(worst case duty cycle)=1.1mW(0.4dBm)
BLE EIRP/ERP output power:	**EIRP**=0.4dBm + 2.7dBi=3.1dBm, **ERP**=3.1dBm - 2.15dB= 0.95dBm(1.2mW)
The SAR Exclusion Threshold Level	
FCC Part 2.1093	77mW<40mm @2.45GHz
RSS 102, Issue 5	173mW>40mm @2.45GHz

Note:	

5.0	Test Equipment				
Test Equipment Used					
Description	**Manufacturer**	**Model**	**Identifier**	**Last Cal. Date**	**Check**
Biconilog Antenna	Schwarzbeck	VULB 9168	9168-1070	10/20/2023	☒
Horn Antenna	A.H. Systems	SAS 571	1010	10/20/2023	☒
Loop Antenna	A.H. Systems	EHA-51B	1213E	10/20/2023	☐
EMI Receiver	Rohde & Schwarz	ESW26	101412	10/20/2023	☒
Signal Analyzer	Agilent	N9000A	MY53031040	10/20/2023	☒
EMI Receiver	Agilent	E4448A	1530975	10/20/2023	☒
LISN	TESEQ	NNB51	1130	10/20/2023	☒
Coaxial Cable	Insulated Wire	2803	CBL2039	10/20/2023	☒
EMC Software	ETS-Lindgren	TILE 7		N/A	☒
Equipment Calibration Interval:		☒ 12 months		☐ 24 months	

6.0	Report revision history		
Revision Level	**Date**	**Report Number**	**Notes**
0	09/12/2024	HRE202303408-4	Original Issue