NTS Labs, LLC Test Report for EMI Emissions Testing of the ExpressVote® Universal Voting System Hardware 3.0

Prepared For
Pro V&V, Inc. | 6705 Odyssey Drive, Suite C | Huntsville, AL 35806

Performed By
NTS Labs, LLC | 1736 Vista View Drive | Longmont, CO 80504-5242 | 303-776-7249 | www.nts.com

Jessica Bedard
Preparer

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Program Manager

Revision History

Rev.	Description	Issue Date
0	Initial Release	09/08/2023
1	• Corrected unit name and address on cover page • Added OH test data to Section 5.3	10/09/2023

Table of Contents

List of Tables

1.0 Introduction

This document presents the test procedures used and the results obtained during the performance of an Electromagnetic Interference (EMI) test program. The test program was conducted to assess the ability of the specified Equipment Under Test (EUT) to successfully satisfy the requirements listed in Section 2.0.

2.0 References

The following references listed below form a part of this document to the extent specified herein.

- Test Specification: FCC Part 15 Class B
- Pro V&V, Inc Purchase Order(s) 2023-011, dated 04/24/2023
- NTS Labs, LLC (NTS) Quote(s) OP0638253, dated 04/19/2023
- ISO/IEC 17025:2017(E) *General Requirements for the Competence of Testing and Calibration Laboratories*, dated 11/1/2017

3.0 Product Selection and Description

Pro V&V, Inc selected and provided the following test sample(s) to be used as the Equipment Under Test:

Table 3.0-1: Product Identification - Equipment Under Test (EUT)

Item	Qty.	Name/Description	Part Number	Serial Number
1	1	ExpressVote3 Universal Voting System Hardware 3.0	ExpressVote3	EV032334P026

3.1 Security Classification

Non-classified

4.0 General Test Requirements

4.1 Test Equipment

The instrumentation used in the performance of these tests is periodically calibrated and standardized within manufacturer's rated accuracies and are traceable to the National Institute of Standards and Technology. The calibration procedures and practices are in accordance with ISO 17025:2017. Certification of calibration is on file subject to inspection by authorized personnel.

4.2 Measurement Uncertainties

ISO/IEC 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below were calculated using the approach described in CISPR 16-4-2:2003 using a coverage factor of k=2, which gives a level of confidence of approximately 95%. The levels were found to be below levels of CISPR and therefore no adjustment of the data for measurement uncertainty is required.

Table 4.2-1: Measurement Uncertainties

Measurement Type	Measurement Units	Frequency Range	Expanded Uncertainty
Conducted Emissions	dBuA	150kHz to 30MHz	+/- 3.75 dB
Radiated Emissions	dBuV/m	30MHz to 1GHz	+/- 6.32 dB
		1GHz to 6GHz	+/- 9.59 dB
		6GHz to 18GHz	+/- 7.58 dB
		18GHz to 40GHz	+/- 6.08 dB

5.0 Test Descriptions and Results

Table 5.0-1: Summary of Test Information & Results

Section	Test	Specification	Test Facility	Test Date	Part #	Serial #	Test Result
5.1	Radiated Emissions	FCC Part 15 Class B	Longmont	08/17/2023	ExpressVote3	EV032334P026	Passed
5.2	Conducted Emissions	FCC Part 15 Class B	Longmont	08/17/2023	ExpressVote3	EV032334P026	Passed
5.3	Radiated Emissions - OH Lower & Upper Levels	N/A	Longmont	8/22/2023	ExpressVote3	EV032334P026	Passed

The decision rule for Test Results was based on the Test Specification used for testing.

5.1 Radiated Emissions

5.1.1 Test Procedure

FCC Part 15 Class B

5.1.2 Test Result

Passed

5.1.3 Test Datasheets

National Technical Systems

Radiated Emissions, FCC Part 15, Class B

Standard Referenced:	FCC Part 15, Class B	Date:	8/17/2023
Temperature:	25˚C Humidity: 43%	Pressure:	843 mb
Input Voltage:	120Vac/60Hz	Pretest & Linearity Check:	Pass
Configuration of Unit:	Shoe-shine mode	Sweep Time Check:	Ok
Test Engineer / Technician:	T. Wittig		

Date	Time	Log Entries	Initials	Result
8/17/2023	1300	Setup pre-test verification and ambient scans	TW	---
	1305	Begin Radiated Emissions, 30 MHz - 1 GHz. FCC Part 15. Class BHz (4.1.2.9) Meanwell Power Supply PN: EPP-200-24	TW	---
	1445	Completed RE testing	TW	Pass

"Type" refers to the type of measurement performed. The type of measurement made is based on the requirements of the particular standard:

PK = Peak Measurement: RBW is 120kHz, VBW is 3 MHz
QP = Quasi-Peak Measurement: RBW is 120kHz, VBW is 3 MHz, and QP Detection is ENABLED
AV = Video Average Measurement: RBW is 1 MHz, VBW is 10 Hz

The "field strength" (FS) emissions level is attained by adding the received amplitude measured (RA), Antenna factor (AF), and cable factor (CF) minus the amplifier gain (AG). FS = RA + AF + CF – AG .Final measurements are made with the Azimuth, Polarity, Height, and EUT Cables positioned for maximum radiation. If applicable, cables positions are noted in the test log.
(Sample Calculation: 49.6 dBuV + 11.4 dB/m – 28.8 dB (CF/AG) = 32.2 dBuV/m. Important Note: This is a sample calculation only for the purpose of demonstration, and does not reflect data in this report.)

The "Azm/Pol/Hgt" indicates the turn-table azimuth, the antenna polarity, and the antenna height where the maximum emissions level was measured.

The "Margin" is with reference to the emissions limit. A positive number indicates that the emission measurement is below the limit. A negative number indicates that the emission measurement exceeds the limit.

The PRESCAN is a peak measurement and is performed with the RBW set to 120 kHz, VBW set to 3 MHz (30 MHz to 1 GHz), and the RBW set to 1 MHz, VBW set to 3MHz (> 1 GHz)

The Antenna setup for >1GHz should match the setup that was used to meet SVSWR requirements. Refer to the SVSWR report storred in the calibration records for the chamber being used.

5.1.4 Test Photographs

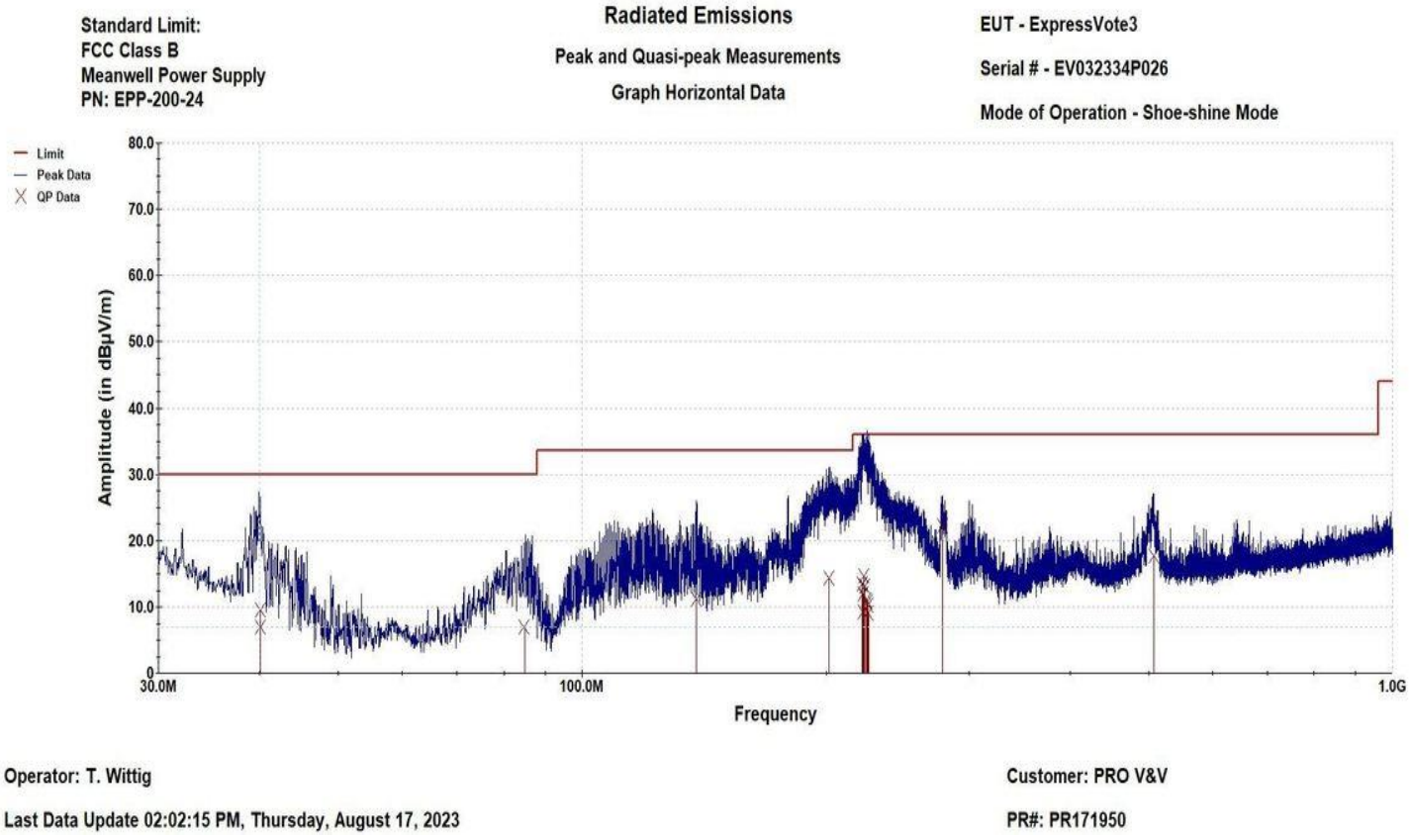
Radiated Emissions Test Setup Photo-Front Side

Radiated Emissions Test Setup Photo-Left Side

Radiated Emissions Test Setup Photo-Right Side

Radiated Emissions Test Setup Photo-Back Side

5.1.5 Test Data



Radiated Emissions
Table: Horizontal Quasi-Peaks below 1 GHz

Operator:

EUT: ExpressVote3
PR#: PR171950
Customer: PRO V&V

Frequency (MHz)	QP (in dBuV)	Delta QP to Limit (in dBuV)	Height (in cm)	Azimuth (in Degrees)
40.030 MHz	6.935	-23.065	194	283
40.110 MHz	9.482	-20.518	350	29
84.850 MHz	6.989	-23.011	317	295
138.450 MHz	11.168	-22.352	148	225
201.850 MHz	14.448	-19.072	400	130
221.410 MHz	13.501	-22.519	400	33
222.130 MHz	11.922	-24.098	243	63
222.290 MHz	9.280	-26.740	352	292
222.650 MHz	14.693	-21.327	387	208
223.210 MHz	13.157	-22.863	240	164
224.150 MHz	11.071	-24.949	292	347
224.590 MHz	10.745	-25.275	249	84
225.130 MHz	10.274	-25.746	291	59
225.470 MHz	9.120	-26.900	288	303
278.530 MHz	22.198	-13.822	324	163
507.850 MHz	17.751	-18.269	147	62

Standard Limit:
FCC Class B
Meanwell Power Supply
PN: EPP-200-24

Standard Limit:
FCC Class B
Meanwell Power Supply
PN: EPP-200-24

Radiated Emissions

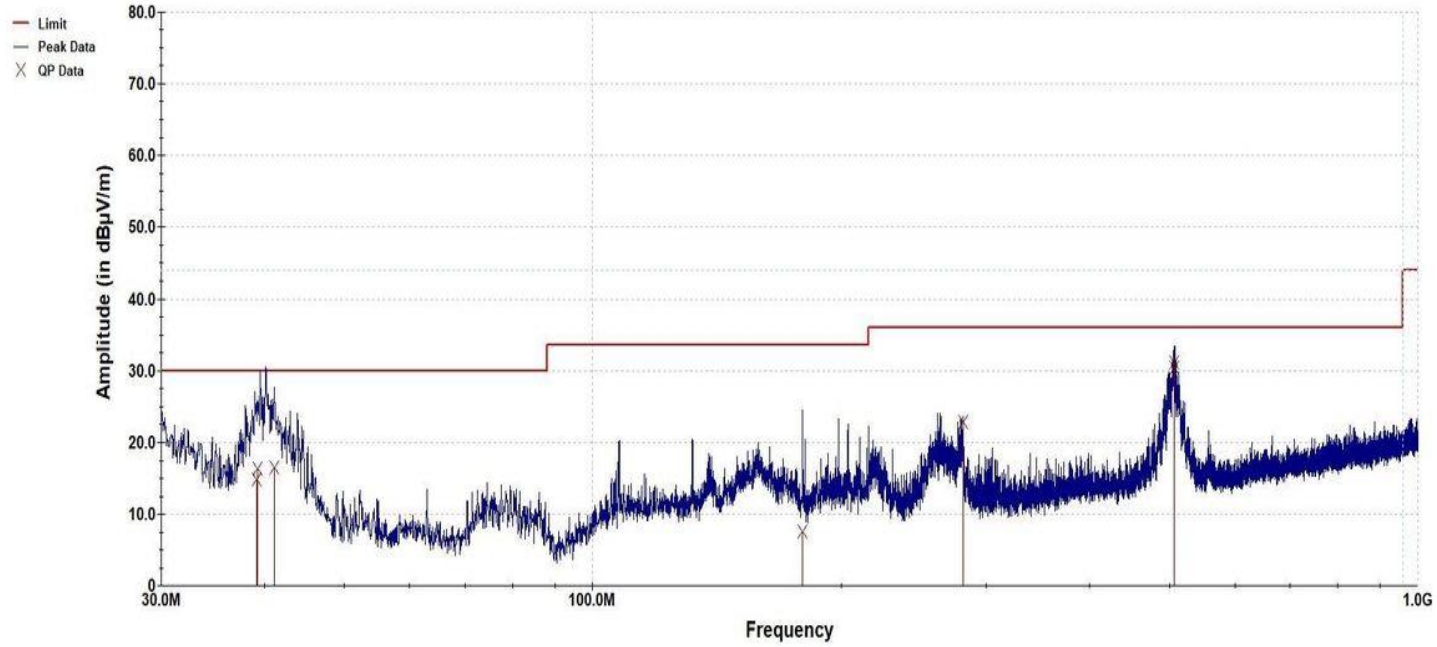
Peak and Quasi-peak Measurements

Graph Vertical Data

EUT - ExpressVote3

Serial # - EV032334P026

Mode of Operation - Shoe-shine Mode



Operator: T. Wittig

Last Data Update 02:33:21 PM, Thursday, August 17, 2023

Customer: PRO V&V

PR#: PR171950

Radiated Emissions
Table: Vertical Quasi-Peaks below 1 GHz

Operator: T. Wittig

EUT: ExpressVote3
PR#: PR171950
Customer: PRO V&V

Frequency (MHz)	QP (in dBuV)	Delta QP to Limit (in dBuV)	Height (in cm)	Azimuth (in Degrees)
39.150 MHz	14.795	-15.205	372	95
39.310 MHz	16.424	-13.576	320	208
41.150 MHz	16.486	-13.514	208	164
179.510 MHz	7.530	-25.990	230	130
280.910 MHz	22.890	-13.130	100	95
506.070 MHz	31.153	-4.867	298	252
507.230 MHz	30.407	-5.613	313	154

Standard Limit:
FCC Class B
Meanwell Power Supply
PN: EPP-200-24

5.1.6 Test Equipment List

Table 5.1-1: Radiated Emissions Test Equipment List

Asset Number	Asset Type	Manufacturer	Model	Calibrated	Due
WC059715	Chamber (EMI, Semi-Anechoic)	Rayproof	SR1	07/13/2015	NCR
WC059692	Meter (Digital Multimeter)	Fluke	83-3	09/12/2022	09/12/2023
WC059745	Power Supply (AC)	California Instruments	MX15-1	NCR	NCR
WC059748	Controller (System)	Sunol Sciences	SC104V	NCR	NCR
WC059822	Receiver	Keysight Technologies	N9038A	09/21/2022	09/21/2023
WC070276	Antenna (Biconical)	Sunol Sciences	JB1	09/21/2021	09/21/2023
WC076938	Cable (Test)	N/A	RF Coax Cable	09/16/2022	09/16/2023
WC078465	Amplifier (Pre/RF/Low Noise)	Pasternack Enterprises	PE15A1013	09/06/2022	09/06/2023
WC078470	Software	ETS-Lindgren	C47213	NCR	NCR
WC078488	Meter (Hydrometer)	Extech Instruments	Datalogger 42270	02/15/2023	02/15/2024

Calibration Abbreviations
CAL: Calibration
NCR: No Calibration Required

5.2 Conducted Emissions

5.2.1 Test Procedure

FCC Part 15 Class B

5.2.2 Test Result

Passed

5.2.3 Test Datasheets

National Technical Systems

Conducted Emissions, FCC Part 15, Class B

Standard Referenced:	FCC Part 15, Class B	Date:	8/17/2023
Temperature:	24˚C Humidity: 51%	Pressure:	843 mb
Input Voltage:	120Vac/60Hz	LISN Bonding:	1.8 miliohms
Configuration of Unit:	Shoe-shine Mode	Sweep Time Check:	Yes
Test Engineer:	T. Wittig		

Date	Time	Log Entries	Initials	Result
8/17/2023		Perormed CE pre-test verification and ambient runs	TW	Complete
	1130	Setup EUT in 10 meter #1 groundplane	TW	Complete
	1135	Begin Conducted Emissions, 150 kHz - 30 MHz. FCC Part 15. Class B.(4.1.2.9) Meanwell Power Supply PN: EPP-200-24	TW	---
	1230	Completed CE testing	TW	Pass

"Type" refers to the type of measurement performed. The type of measurement made is based on the requirements of the particular standard:

PK = Peak Measurement: RBW is 9 kHz, VBW is 3 MHz
QP = Quasi-Peak Measurement: RBW is 9 kHz, VBW is 3 MHz, and QP Detection is ENABLED
AV = Video Average Measurement: RBW is 9 kHz, VBW is 10 Hz

The "CE Level" is attained by adding the conducted amplitude measured (CA), Attenuation Cal factor (ACF), cable factor (CF) plus the LISN Cal Factor (LCF). CE Level = CA + ACF + CF + LCF . If applicable, cables positions are noted in the test log. (Sample Calculation: -7.5 dBuV + 20.2 dB + 1.5 dB + 23.8 dB= 38 dBuV. **Important Note:** This is a sample calculation only for the purpose of demonstration, and does not reflect data in this report.)

The "TestPoint" indicates which AC or DC input power line or which I/O cable the measurement was made on.

The "Margin" is with reference to the emissions limit. A positive number indicates that the emission measurement is below the limit. A negative number indicates that the emission measurement exceeds the limit.

5.2.4 Test Photographs

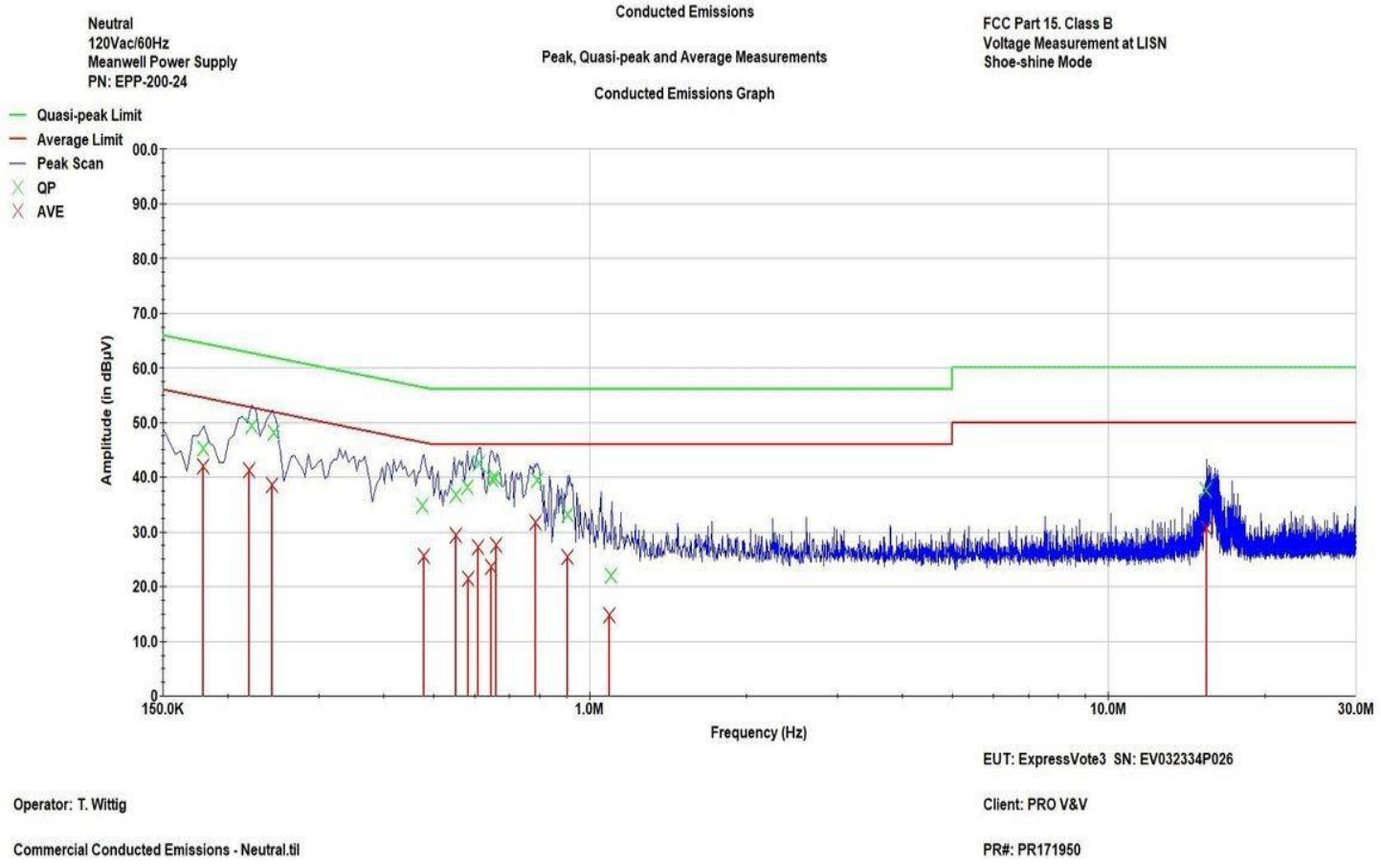
CE Test Setup - Front

CE Test Setup - Left

CE Test Setup - Right

CE Test Setup - Back

5.2.5 Test Data



Conducted Emissions
Quasi-Peak Data Table

Operator: T. Wittig
11:18:42 AM, Thursday, August 17, 2023

EUT: ExpressVote3 SN: EV032334P026
PR#: PR171950
Client: PRO V&V

Frequency (MHz)	Amplitude (in dBµV)	Quasi-peak Limit (in dBµV)	Delta to Quasi-peak Limit (in dB)
179.79 KHz	45.26	65.15	-19.89
222.39 KHz	49.40	63.93	-14.53
245.86 KHz	48.05	63.26	-15.21
475.77 KHz	34.69	56.69	-22.00
551.01 KHz	36.80	56.00	-19.20
580.59 KHz	38.11	56.00	-17.89
610.92 KHz	42.52	56.00	-13.48
647.15 KHz	39.59	56.00	-16.41
657.35 KHz	39.80	56.00	-16.20
789.58 KHz	39.45	56.00	-16.55
906.44 KHz	33.06	56.00	-22.94
1.10 MHz	21.99	56.00	-34.01
15.40 MHz	37.57	60.00	-22.43
Neutral			
120Vac/60Hz			
Meanwell Power Supply			
PN: EPP-200-24			

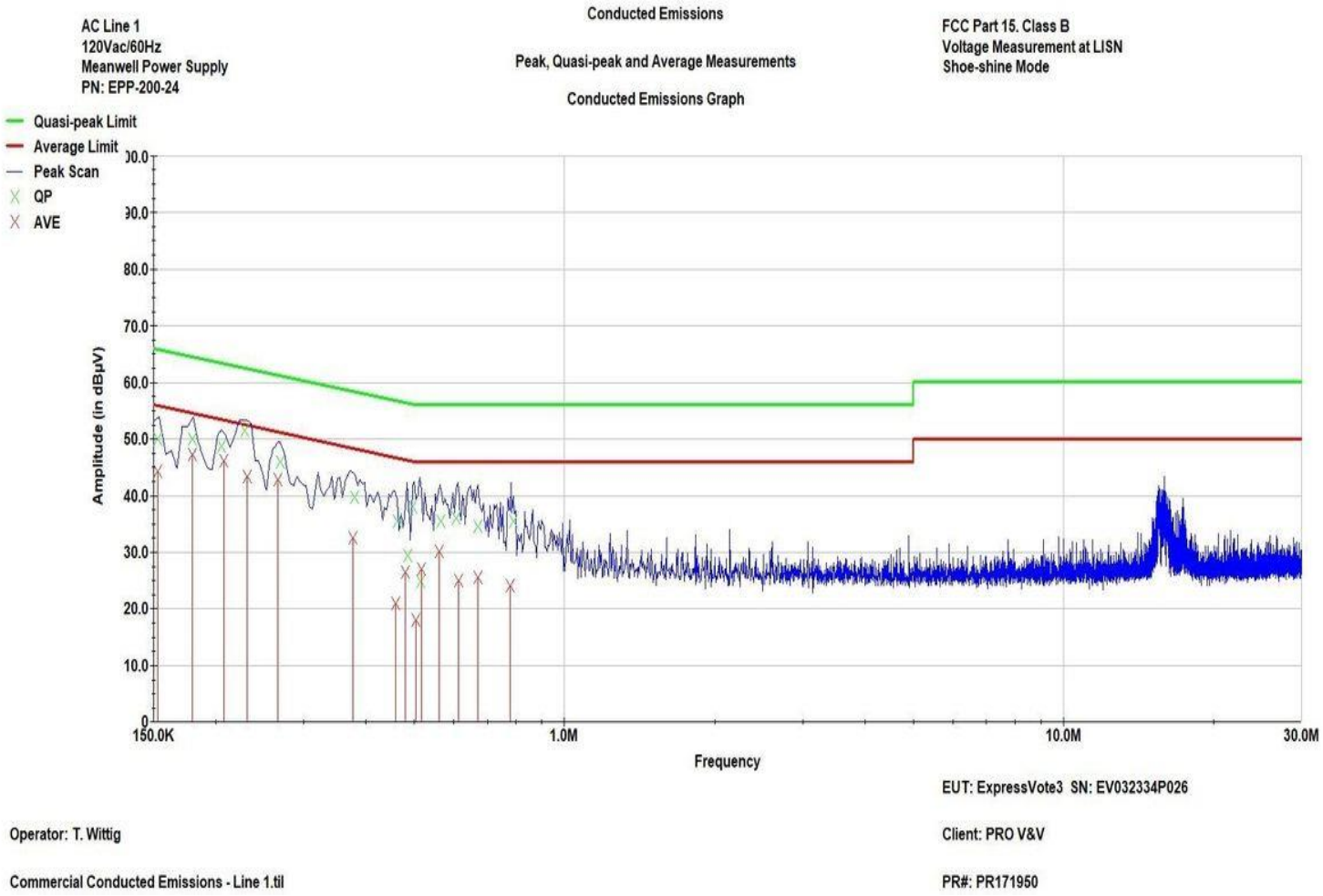
Conducted Emissions
Average Data Table

Operator: T. Wittig
11:22:18 AM, Thursday, August 17, 2023

EUT: ExpressVote3 SN: EV032334P026
PR#: PR171950
Client: PRO V&V

Frequency (MHz)	Amplitude (in dBµV)	Average Limit (in dBµV)	Delta to Average Limit (in dB)
179.79 KHz	41.94	55.15	-13.21
220.18 KHz	41.18	53.99	-12.82
243.62 KHz	38.54	53.33	-14.78
478.02 KHz	25.56	46.63	-21.06
550.99 KHz	29.28	46.00	-16.72
581.54 KHz	21.52	46.00	-24.48
608.67 KHz	27.25	46.00	-18.75
644.90 KHz	23.59	46.00	-22.41
659.59 KHz	27.60	46.00	-18.40
786.22 KHz	31.66	46.00	-14.34
904.19 KHz	25.40	46.00	-20.60
1.09 MHz	14.81	46.00	-31.19
15.48 MHz	30.65	50.00	-19.35

Neutral
120Vac/60Hz
Meanwell Power Supply
PN: EPP-200-24


Conducted Emissions
AC Line 1
120Vac/60Hz
Meanwell Power Supply
PN: EPP-200-24
Peak, Quasi-peak and Average Measurements
Conducted Emissions Graph
FCC Part 15. Class B
Voltage Measurement at LISN
Shoe-shine Mode
Quasi-peak Limit
Average Limit
Peak Scan
QP
AVE
Amplitude (in dBµV)
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
150.0K
1.0M
10.0M
30.0M
Frequency
EUT: ExpressVote3 SN: EV032334P026
Operator: T. Wittig
Client: PRO V&V
Commercial Conducted Emissions - Line 1.til
PR#: PR171950

Conducted Emissions
Quasi-Peak Data Table

Operator: T. Wittig
11:03:05 AM, Thursday, August 17, 2023

EUT: ExpressVote3 SN: EV032334P026
PR#: PR171950
Client: PRO V&V

Frequency (MHz)	Amplitude (in dBµV)	Quasi-peak Limit (in dBµV)	Delta to Quasi-peak Limit (in dB)
152.66 KHz	49.95	65.92	-15.97
179.79 KHz	49.94	65.15	-15.21
205.39 KHz	48.63	64.42	-15.79
228.99 KHz	51.39	63.74	-12.35
269.09 KHz	45.98	62.60	-16.62
379.77 KHz	39.65	59.44	-19.79
461.58 KHz	35.49	57.10	-21.61
484.56 KHz	29.36	56.44	-27.09
496.86 KHz	38.07	56.09	-18.02
514.65 KHz	24.92	56.00	-31.08
564.72 KHz	35.40	56.00	-20.60
606.66 KHz	36.02	56.00	-19.98
670.25 KHz	34.56	56.00	-21.44
788.93 KHz	35.44	56.00	-20.56
AC Line 1			
120Vac/60Hz			
Meanwell Power Supply			
PN: EPP-200-24			

Conducted Emissions
Average Data Table

Operator: T. Wittig
11:06:43 AM, Thursday, August 17, 2023

EUT: ExpressVote3 SN: EV032334P026
PR#: PR171950
Client: PRO V&V

Frequency (MHz)	Amplitude (in dBµV)	Average Limit (in dBµV)	Delta to Average Limit (in dB)
152.66 KHz	44.34	55.92	-11.58
179.79 KHz	47.19	55.15	-7.96
207.46 KHz	46.12	54.36	-8.24
231.24 KHz	43.37	53.68	-10.31
266.42 KHz	42.90	52.67	-9.77
375.99 KHz	32.46	49.54	-17.08
459.17 KHz	21.03	47.17	-26.14
480.08 KHz	26.43	46.57	-20.14
503.59 KHz	18.04	46.00	-27.96
516.91 KHz	27.01	46.00	-18.99
560.23 KHz	30.09	46.00	-15.91
613.39 KHz	24.97	46.00	-21.03
670.18 KHz	25.51	46.00	-20.49
777.81 KHz	24.17	46.00	-21.83
AC Line 1			
120Vac/60Hz			
Meanwell Power Supply			
PN: EPP-200-24			

5.2.6 Test Equipment List

Table 5.2-1: Conducted Emissions Test Equipment List

Asset Number	Asset Type	Manufacturer	Model	Calibrated	Due
WC059715	Chamber (EMI, Semi-Anechoic)	Rayproof	SR1	07/13/2015	NCR
WC059589	Meter (Milliohm)	Hewlett Packard	4328A	11/08/2022	04/10/2024
WC059692	Meter (Digital Multimeter)	Fluke	83-3	09/12/2022	09/12/2023
WC059729	Power Supply (AC)	Pacific Power Source	TMX 140	NCR	NCR
WC059822	Receiver	Keysight Technologies	N9038A	09/21/2022	09/21/2023
WC076848	Network (LISN)	Solar Electronics	8012-50-R-25-BNC	02/15/2023	02/15/2024
WC078470	Software	ETS-Lindgren	C47213	NCR	NCR
WC078471	Cable (Test)	N/A	BNC Coaxial Cable	NCR	NCR
WC078488	Meter (Hydrometer)	Extech Instruments	Datalogger 42270	02/15/2023	02/15/2024

Calibration Abbreviations
CAL: Calibration
NCR: No Calibration Required

5.3 Radiated Emissions - OH Lower & Upper Levels

5.3.1 Test Procedure

Per customer request: 120-140 kHz, 2-90 MHz, and 300 MHz-6 GHz

5.3.2 Test Result

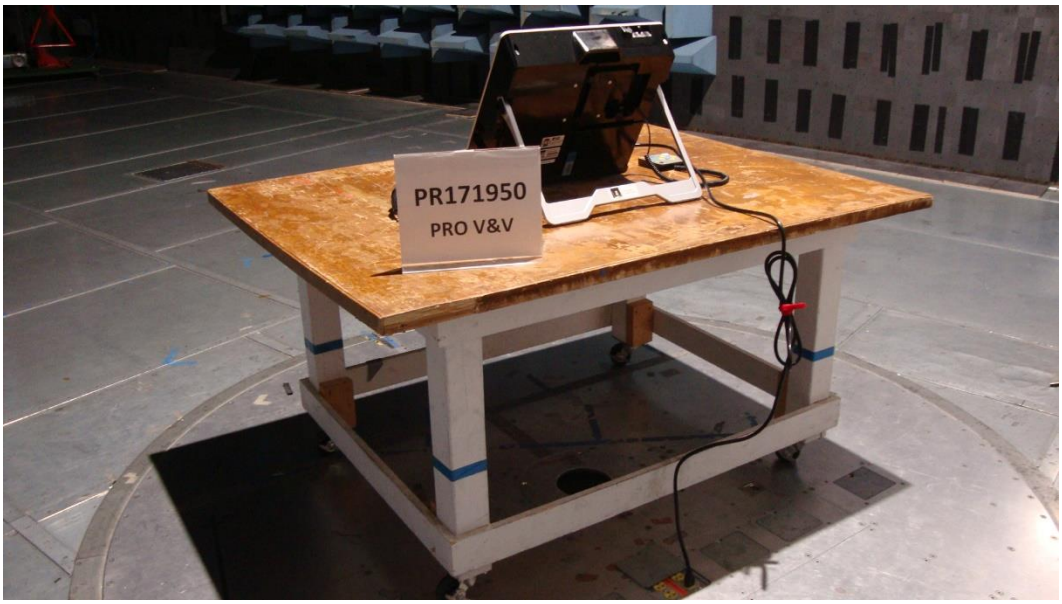
Passed

5.3.3 Test Photographs

Ohio Test Setup – Front

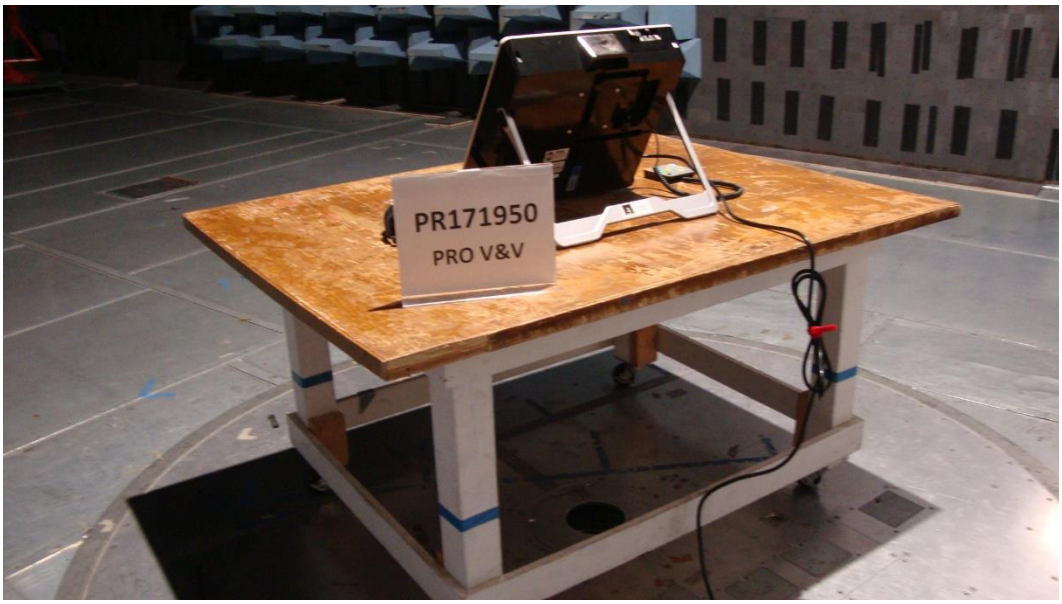
Ohio Test Setup - Left

Ohio Test Setup - Right

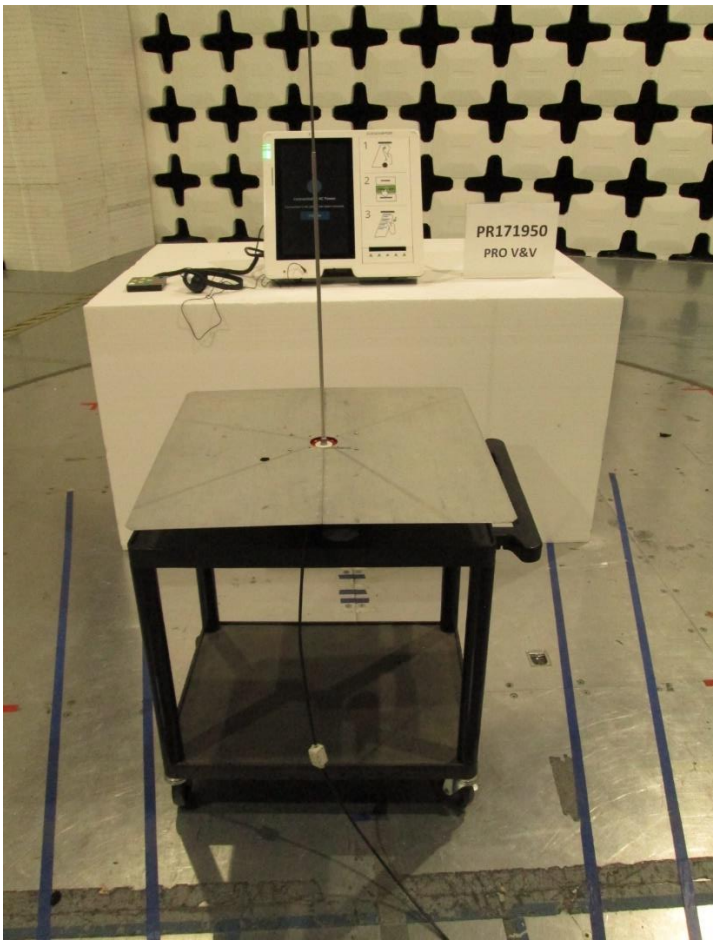


Ohio Test Setup - Back

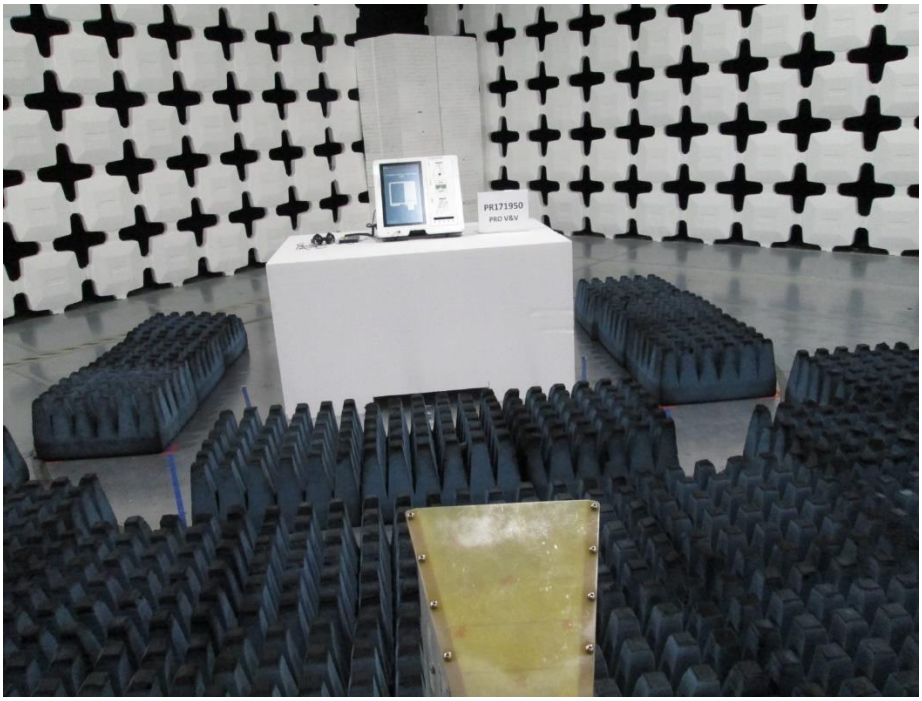
Ohio Test Setup - 001



Ohio Test Setup - 004

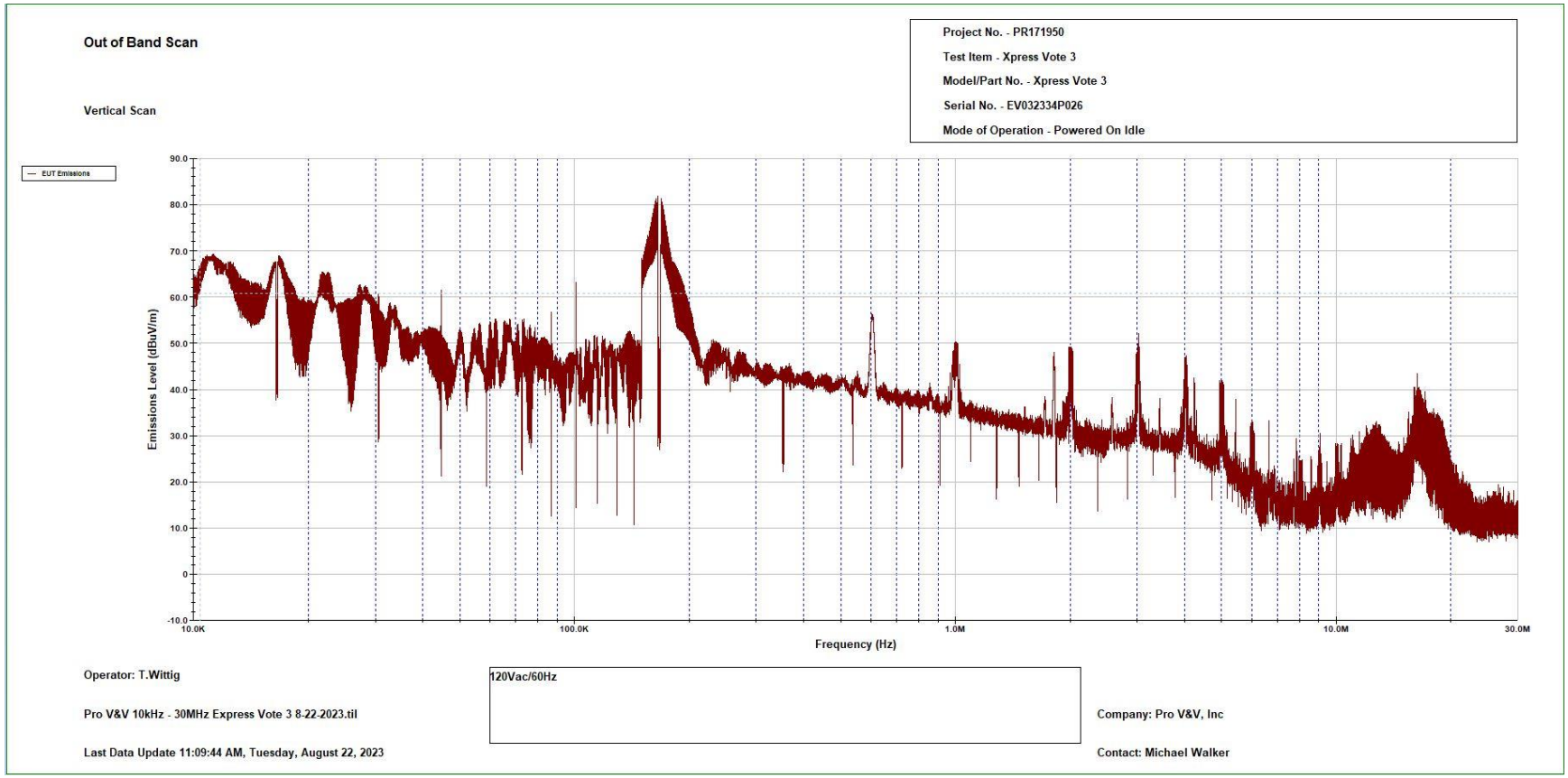


RE Ohio 10kHz-30MHz



RE Ohio 1GHz_6GHz

5.3.4 Test Data



Standard Limit:
FCC Class B
Meanwell Power Supply
PN: EPP-200-24

Radiated Emissions

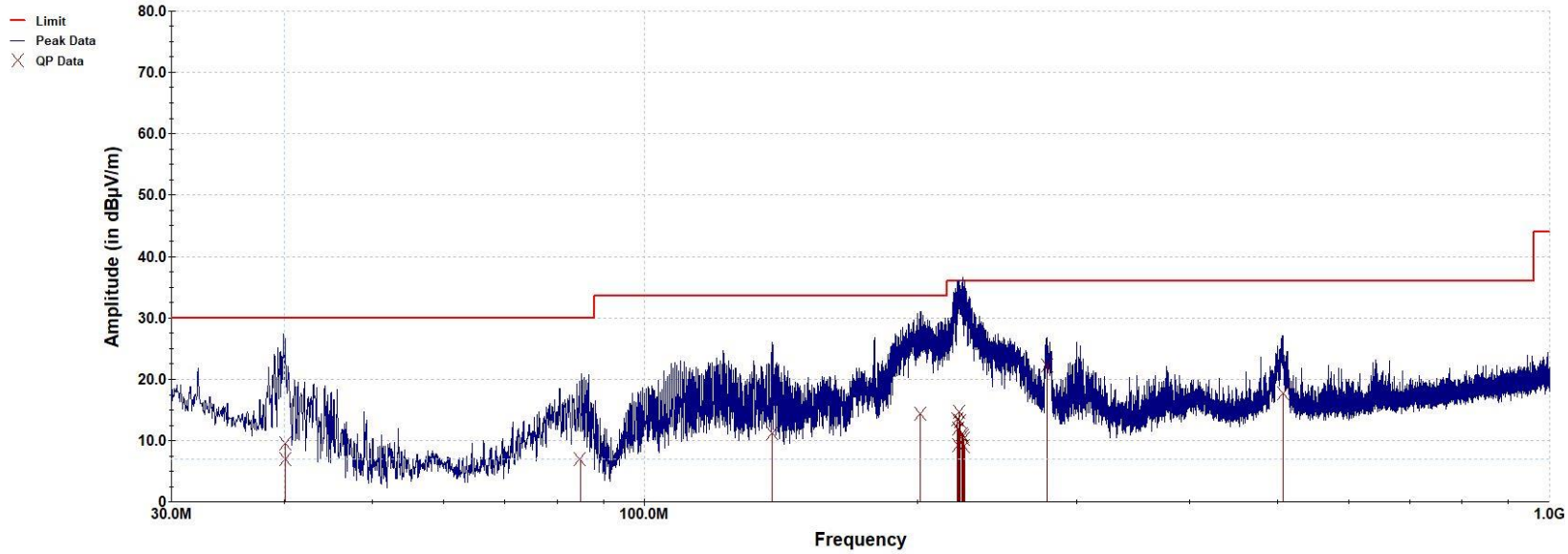
Peak and Quasi-peak Measurements

Graph Horizontal Data

EUT - ExpressVote3

Serial # - EV032334P026

Mode of Operation - Shoe-shine Mode



Operator: T. Wittig

Last Data Update 02:02:15 PM, Thursday, August 17, 2023

Customer: PRO V&V

PR#: PR171950

Standard Limit:
FCC Class B
Meanwell Power Supply
PN: EPP-200-24

Radiated Emissions

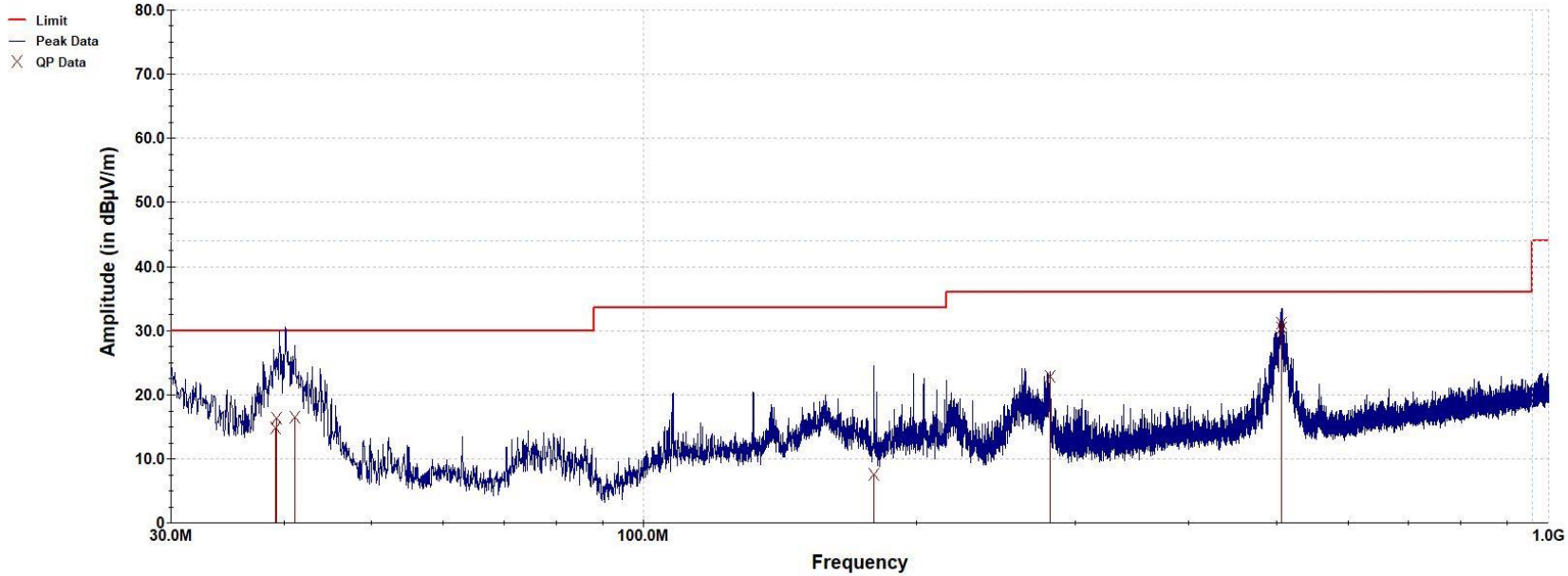
Peak and Quasi-peak Measurements

Graph Vertical Data

EUT - ExpressVote3

Serial # - EV032334P026

Mode of Operation - Shoe-shine Mode

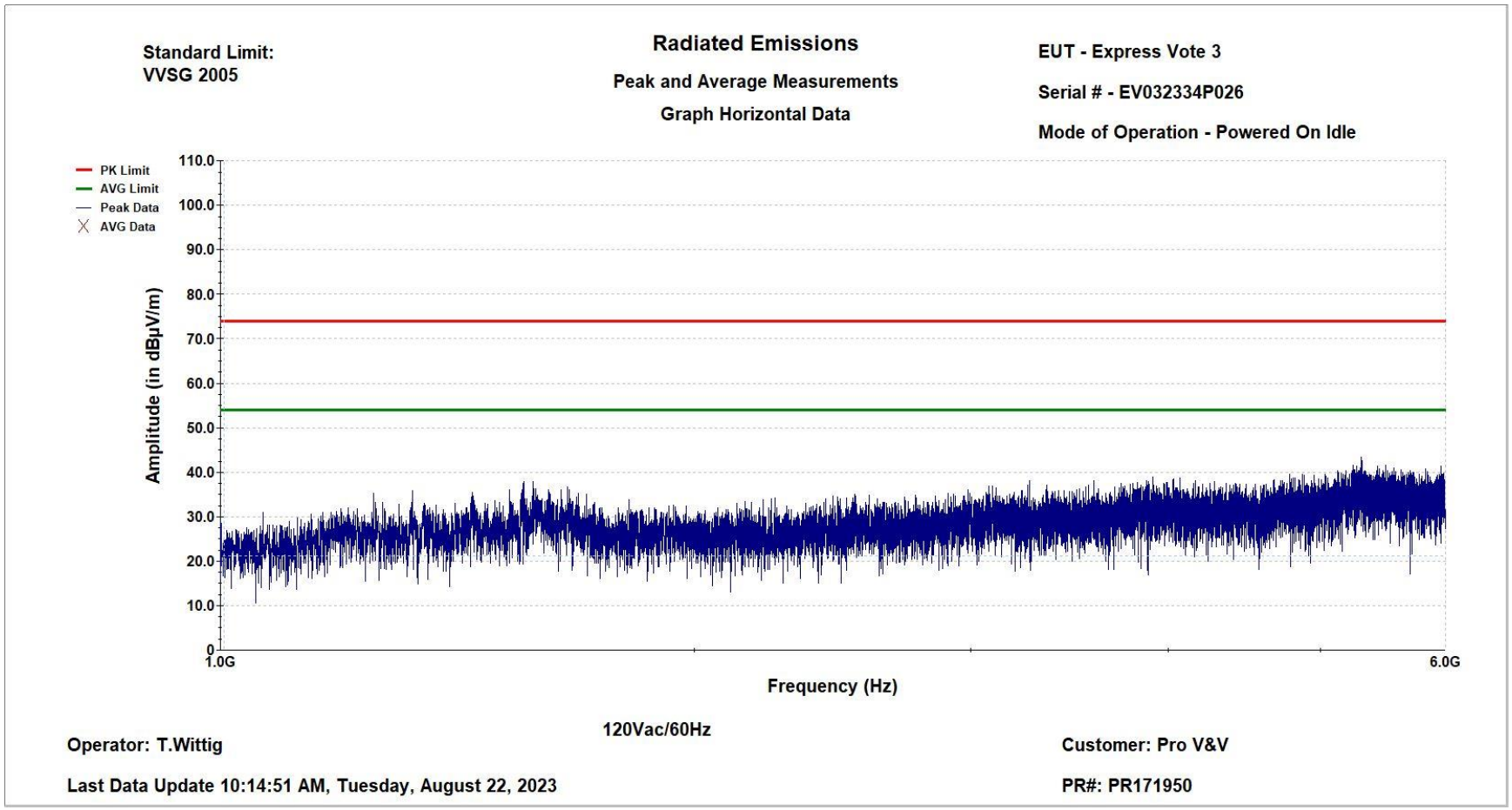


Operator: T. Wittig

Last Data Update 02:33:21 PM, Thursday, August 17, 2023

Customer: PRO V&V

PR#: PR171950


Standard Limit:
VVSG 2005
Radiated Emissions
Peak and Average Measurements
Graph Horizontal Data
EUT - Express Vote 3
Serial # - EV032334P026
Mode of Operation - Powered On Idle
PK Limit
AVG Limit
Peak Data
AVG Data
Amplitude (in dBµV/m)
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
1.0G
6.0G
Frequency (Hz)
120Vac/60Hz
Operator: T.Wittig
Customer: Pro V&V
Last Data Update 10:14:51 AM, Tuesday, August 22, 2023
PR#: PR171950

Standard Limit:
VVSG 2005

Radiated Emissions

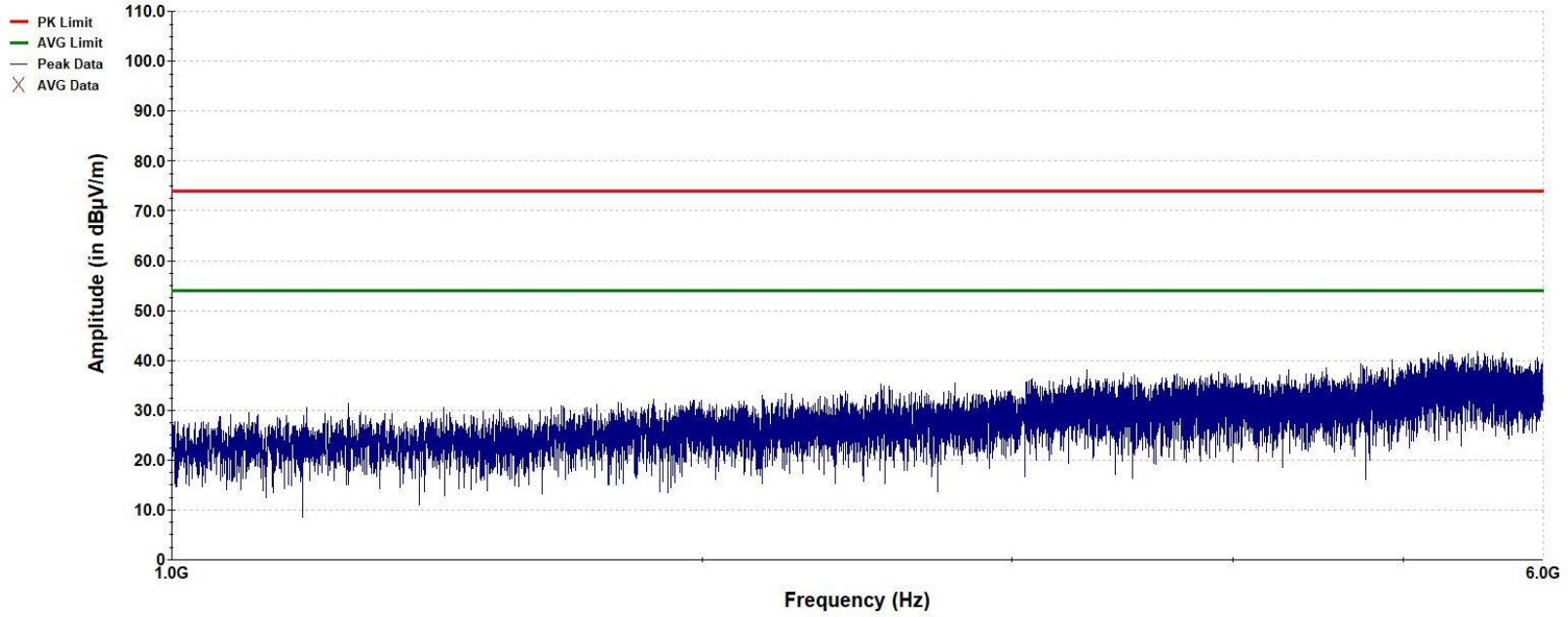
Peak and Average Measurements

Graph Vertical Data

EUT - Express Vote 3

Serial # - EV032334P026

Mode of Operation - Powered On Idle



120Vac/60Hz

Operator: T.Wittig

Customer: Pro V&V

Last Data Update 10:15:10 AM, Tuesday, August 22, 2023

PR#: PR171950

5.3.5 Test Equipment List

Table 5.3-1: Radiated Emissions - OH Lower & Upper Levels Test Equipment List

Asset Number	Asset Type	Manufacturer	Model	Calibrated	Due
WC059431	Controller (System)	Sunol Sciences	SC110V	NCR	NCR
WC059550	Amplifier (Pre/RF/Low Noise)	Ciao Wireless	1-18 GHZ	06/01/2023	06/01/2024
WC059551	Amplifier (Pre/RF/Low Noise)	Pasternack Enterprises	EMCI-LNA-30-1000M	07/05/2023	07/05/2024
WC059584	Antenna (Active Monopole)	ETS-Lindgren	3301B	04/14/2022	04/14/2024
WC059623	Chamber (EMI, Semi-Anechoic)	Rayproof	SR2	NCR	NCR
WC059692	Meter (Digital Multimeter)	Fluke	83-3	09/12/2022	09/12/2023
WC059739	Antenna (Biconilog)	Sunol Sciences	JB1	05/18/2021	05/11/2024
WC059742	Antenna (Double Ridge Guide)	EMCO	3115	09/22/2021	02/03/2024
WC076859	Receiver	Rohde & Schwarz	ESW44	01/25/2023	01/25/2024
WC076870	Cable (Test)	Pasternack Enterprises	RF Coaxial Cable (20 meters)	08/22/2023	08/22/2024
WC076925	Cable (Test)	Teledyne-taber	3 M RF Coax Cable	06/01/2023	06/01/2024
WC078470	Software	ETS-Lindgren	C47213	NCR	NCR
WC078490	Meter (Hydrometer)	Extech Instruments	Datalogger 42270	02/15/2023	02/15/2024

Calibration Abbreviations
CAL: Calibration
NCR: No Calibration Required

End of Test Report