

National Technical Systems Test Report for Electromagnetic Interference (EMI) Testing of the FVT

Prepared For

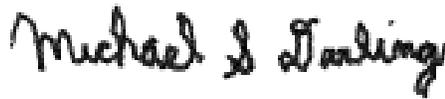
Pro V&V, Inc. | 6705 Odyssey Dr NW Ste C | Huntsville, AL 35806

Prepared By

National Technical Systems | 1736 Vista View Drive | Longmont, CO. 80504 | (303) 776-7249 |

A handwritten signature in black ink, appearing to read "Greg Gagne", written in a cursive style.

Greg Gagne
Technical Writer

A handwritten signature in black ink, appearing to read "Michael S. Darling", written in a cursive style.

Michael Darling
EMI Department Manager



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Revision History

Rev.	Description	Issue Date
0	ETR-PR121029-00	03/23/2021

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1.0 Introduction

This document presents the test procedures used and the results obtained during the performance of an Electromagnetic Interference 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.

- Pro V&V, Inc. Purchase Order(s) 2020-005,2020-007,Signed COS, dated 07/02/2020,10/21/2020,02/11/2021
- National Technical Systems (NTS) Quote(s) OP0565856, dated 10/22/2020
- NTS Corporate Quality Policy Manual, Revision 9, dated 9/20/2018
- ISO/IEC 17025:2017(E) *General Requirements for the Competence of Testing and Calibration Laboratories*, dated 11/1/2017
- Test Specification: FCC Part 15

3.0 Product Selection and Description

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

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

Item	Qty.	Name/Description	Part Number	Serial Number
1	1	FVT	FVT	FVT-BBU-001

3.1 Security Classification

Non-classified

4.0 General Test Requirements

4.1 Test Equipment

NTS-provided equipment is calibrated according to ISO/IEC 17025:2017(E) and calibration is traceable to the National Institute of Standards and Technology (NIST). Calibration records are maintained on file at NTS.

4.2 Measurement Uncertainties

Measurement uncertainty data is available upon request.

4.3 Notice of Deviation

In accordance with NTS' quality procedures, when the EUT is observed to exceed or display susceptibility, a Notice of Deviation (NOD) document is generated by the technician performing the test. This NOD documents the requirement, how the EUT deviated from the requirement, and allows room for resolution of the deviation.

This document is reviewed and approved by the NTS Program Manager or Engineer and the NTS Quality Assurance Representative, and then forwarded to the customer contact. Once mitigated (or passed over), the steps taken to correct the deviation (or simply instruction from the customer to continue testing) are recorded in the NOD and a copy of the NOD is integrated into the body of the report, in the appropriate location.

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, 30 MHz - 1 GHz	FCC Part 15	Longmont	01/19/2020 - 01/19/2020	FVT	FVT-BBU-001	Complied
5.2	Conducted Emissions, 150 kHz - 30 MHz	FCC Part 15	Longmont	01/15/2021 - 01/15/2021	FVT	FVT-BBU-001	Complied

*The decision rule used to state compliance is in accordance with the test specification used for testing. Unless otherwise noted, testing was performed in accordance with the latest published version of test specification at time of test.

5.1 Radiated Emissions, 30 MHz - 1 GHz

Radiated Emissions, FCC Part 15

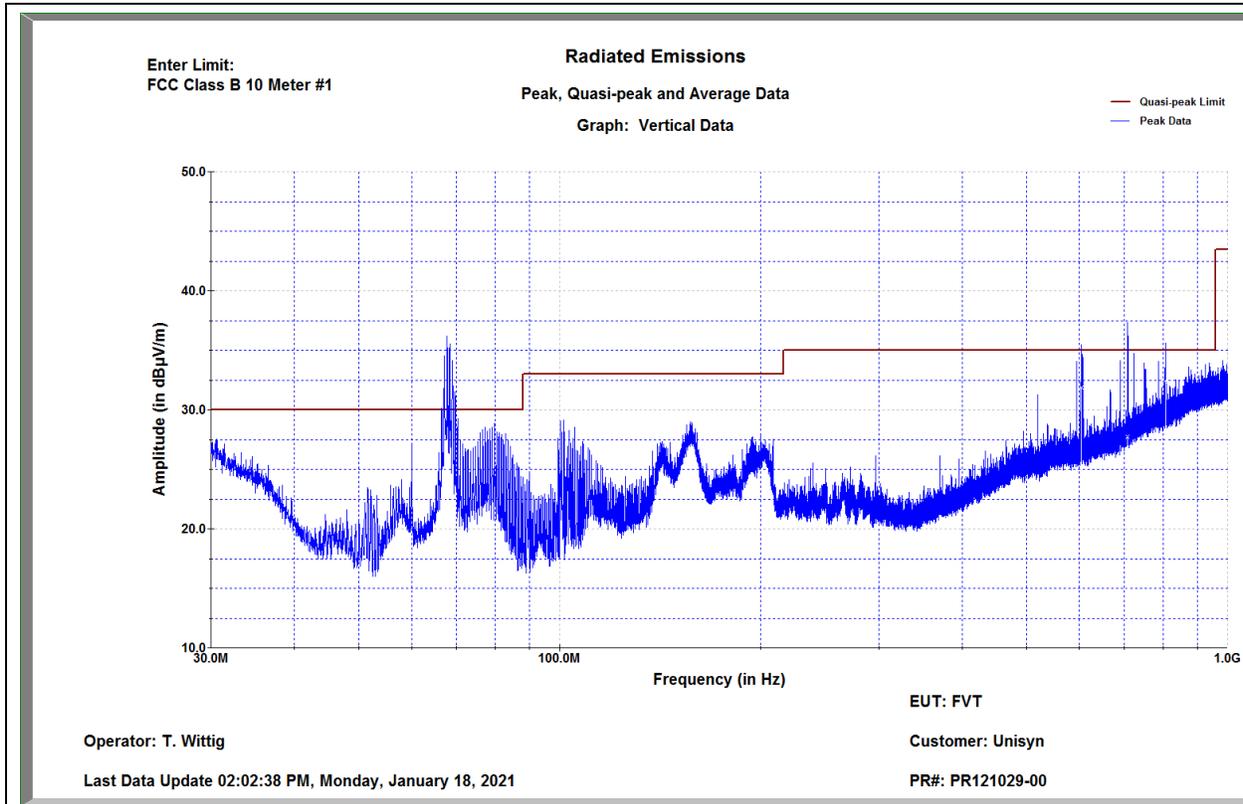
Manufacturer:	Unisyn	Project Number:	PR121029-00/B80802
Customer Representative:	Michael Walker	Test Area:	10m2
Model:	FVT	S/N:	FVT-BBU-001
Standard Referenced:	FCC Part 15	Date:	January 19, 2021
Temperature:	20°C	Humidity:	40%
Input Voltage:	120Vac/60Hz	Pressure:	843mb
Configuration of Unit:	Normal Operating Mode		
Test Engineer:	T. Wittig/Son La		

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The highest emission measured was at **709.00 MHz**, which was **0.2 dB** below the limit.

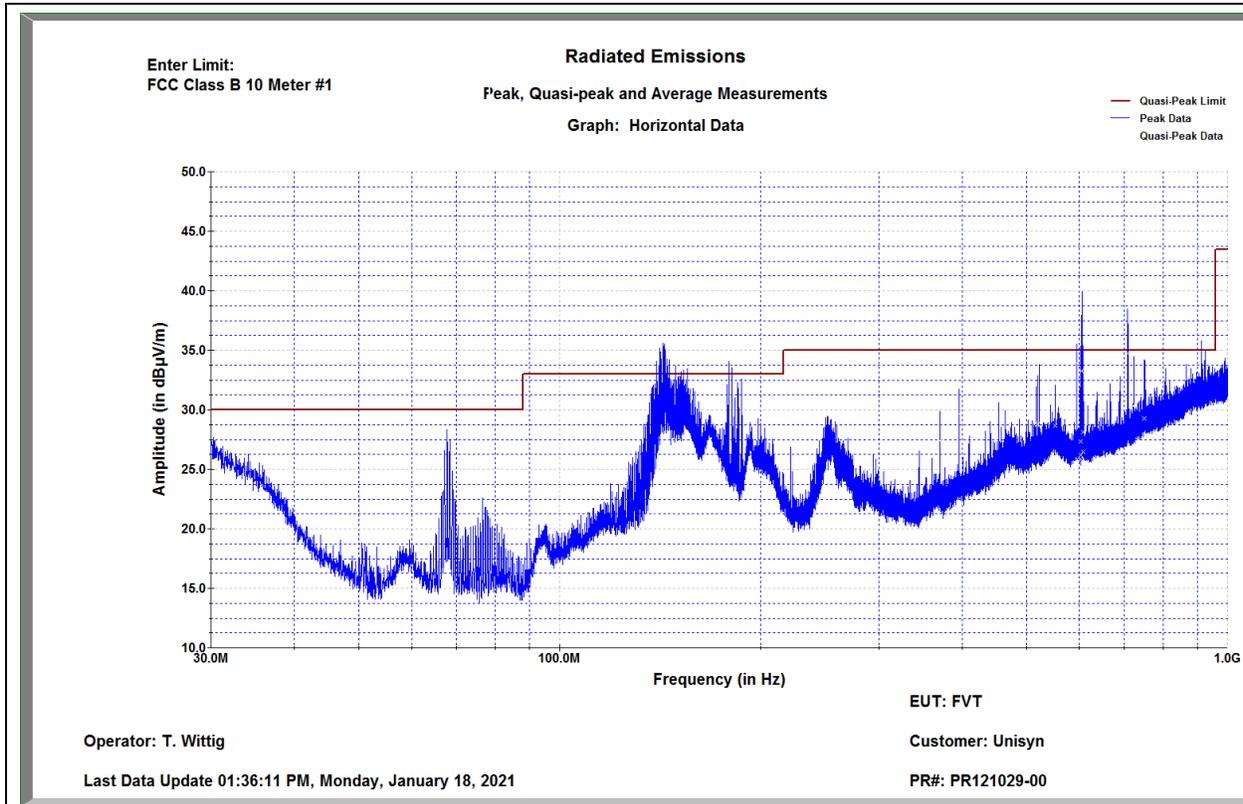
- “Type” refers to the type of measurement performed. The type of measurement made is based on the requirements of the particular standard:
 - PK = Peak Measurement: RBW is 120kHz, VBW is 3 MHz
 - QP = Quasi-Peak Measurement: RBW is 120kHz, VBW is 3 MHz, and QP Detection is ENABLED
 - AV = Video Average 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: $49.6 \text{ dBuV} + 11.4 \text{ dB/m} - 28.8 \text{ dB (CF/AG)} = 32.2 \text{ dBuV/m}$. **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 100 kHz (> 1 GHz)



Radiated Emissions-Quasi-Peak Data Table
Vertical

Frequency (MHz)	Amplitude (in dBµV/m)	Quasi-peak Limit (in dBµV/m)	Delta to Limit (in dB)	EUT Azimuth (in degrees)	Antenna Height (in cm)
67.054	24.8	30.0	-5.2	90	334
67.765	21.9	30.0	-8.1	106	279
68.444	18.9	30.0	-11.1	21	369
604.822	31.9	35.0	-3.1	219	262
708.935	27.7	35.0	-7.3	167	306
806.485	32.4	35.0	-2.6	270	388

Graph 1. Vertical Scan



Radiated Emissions-Quasi-Peak Data Table
Horizontal

Frequency (MHz)	Amplitude (in dBµV/m)	Quasi-peak Limit (in dBµV/m)	Delta to Limit (in dB)	EUT Azimuth (in degrees)	Antenn Height (in cm)
30.291	20.1	30.0	-9.9	30	103
141.873	25.3	33.0	-7.7	135	324
142.520	24.4	33.0	-8.6	97	325
143.231	24.9	33.0	-8.1	114	375
143.846	25.3	33.0	-7.7	116	358
594.055	34.0	35.0	-1.0	356	101
603.238	27.4	35.0	-7.6	353	158
604.919	33.3	35.0	-1.7	6	107
709.000	34.8	35.0	-0.2	15	292
722.903	30.3	35.0	-4.7	116	314

Graph 2. Horizontal Scan

Radiated Emissions, FCC Part 15

Manufacturer:	Unisyn	Project Number:	PR121029-00/B80802
Customer Representative:	Michael Walker	Test Area:	10m2
Model:	FVT	S/N:	FVT-BBU-001
Standard Referenced:	FCC Part 15	Date:	January 19, 2021

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Figure A1. Radiated Emissions Test Setup (Front).



Figure A1. Radiated Emissions Test Setup (Back).



Radiated Emissions, FCC Part 15

Manufacturer:	Unisyn	Project Number:	PR121029-00/B80802
Customer Representative:	Michael Walker	Test Area:	10m2
Model:	FVT	S/N:	FVT-BBU-001
Standard Referenced:	FCC Part 15	Date:	January 19, 2021

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Test Equipment List

ID Number	Manufacturer	Model #	Serial #	Description	Cal Date	Cal Due
1038	Fluke	85	66180455	Multimeter/Frequency Meter	05/26/2020	05/26/2021
1219	Mini-Circuits	ZKL-2	062905	Preamp, 10 - 2000 MHz, 30 dB	05/20/2020	05/20/2021
1232	Sunol Sciences	JB1	A071605-2	Bilog Antenna, 30 MHz to 2.0 GHz	09/25/2019	09/25/2021
1233	Sunol Sciences	SC104V	110305-1	Positioning Controller	NA	NA
1323	Rohde&Schwarz	SMT03	100204	Signal Generator, 5 kHz to 3 GHz	05/05/2020	05/05/2021
1584	IFR	2023B	202303/034	Signal Generator 9 kHz - 2.05 GHz (WC059597)	09/24/2020	09/24/2021
1901	EXTECH	445703	0617	Hygrometer-Thermometer (WC059899)	06/29/2020	06/29/2021
1945	ROHDE & SCHWARZ	ESW26	101441	EMI Test Receiver (WC076849)	11/18/2020	11/18/2021



5.2 Conducted Emissions, 150 kHz - 30 MHz

Conducted Emissions, FCC PART 15, CLASS B

Manufacturer:	Unisyn	Project Number:	PR121029-00 B80802
Customer Representative:	Michael Walker	Test Area:	GP #10m1
Model:	FVT	S/N:	FVT-BBU-001
Standard Referenced:	FCC PART 15	Date:	January 15, 2021
Temperature:	19.01°C	Humidity:	22%
Input Voltage:	120Vac/60Hz	Pressure:	840mb
Configuration of Unit:	Normal Operating Mode		
Test Engineer:	Son La		

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Conducted Emissions-Quasi-Peak/ Average Data Table L1					
Frequency	Amplitude (dBµV)	Quasi-peak Limit (dBµV)	Delta to Quasi-peak Limit (dB)	Average Limit (dBµV)	Delta to Average Limit (dB)
244.65 KHz	30.16	63.30	-33.13	53.30	-23.13
250.95 KHz	28.22	63.12	-34.90	53.12	-24.90
254.41 KHz	29.31	63.02	-33.70	53.02	-23.70
256.76 KHz	29.88	62.95	-33.07	52.95	-23.07
257.32 KHz	24.16	62.93	-38.77	52.93	-28.77
258.18 KHz	28.82	62.91	-34.09	52.91	-24.09

Conducted Emissions-Quasi-Peak/ Average Data Table L2					
Frequency	Amplitude (dBµV)	Quasi-peak Limit (dBµV)	Delta to Quasi-peak Limit (dB)	Average Limit (dBµV)	Delta to Average Limit (dB)
227.18 KHz	52.77	63.79	-11.03	53.79	-1.03
226.74 KHz	52.45	63.81	-11.36	53.81	-1.36
227.05 KHz	52.07	63.80	-11.73	53.80	-1.73
227.43 KHz	52.05	63.79	-11.73	53.79	-1.73
225.85 KHz	51.97	63.83	-11.87	53.83	-1.87
227.00 KHz	51.84	63.80	-11.96	53.80	-1.96

The highest emission measured was at **0.227 MHz**, which was **1.03 dB** below the limit.

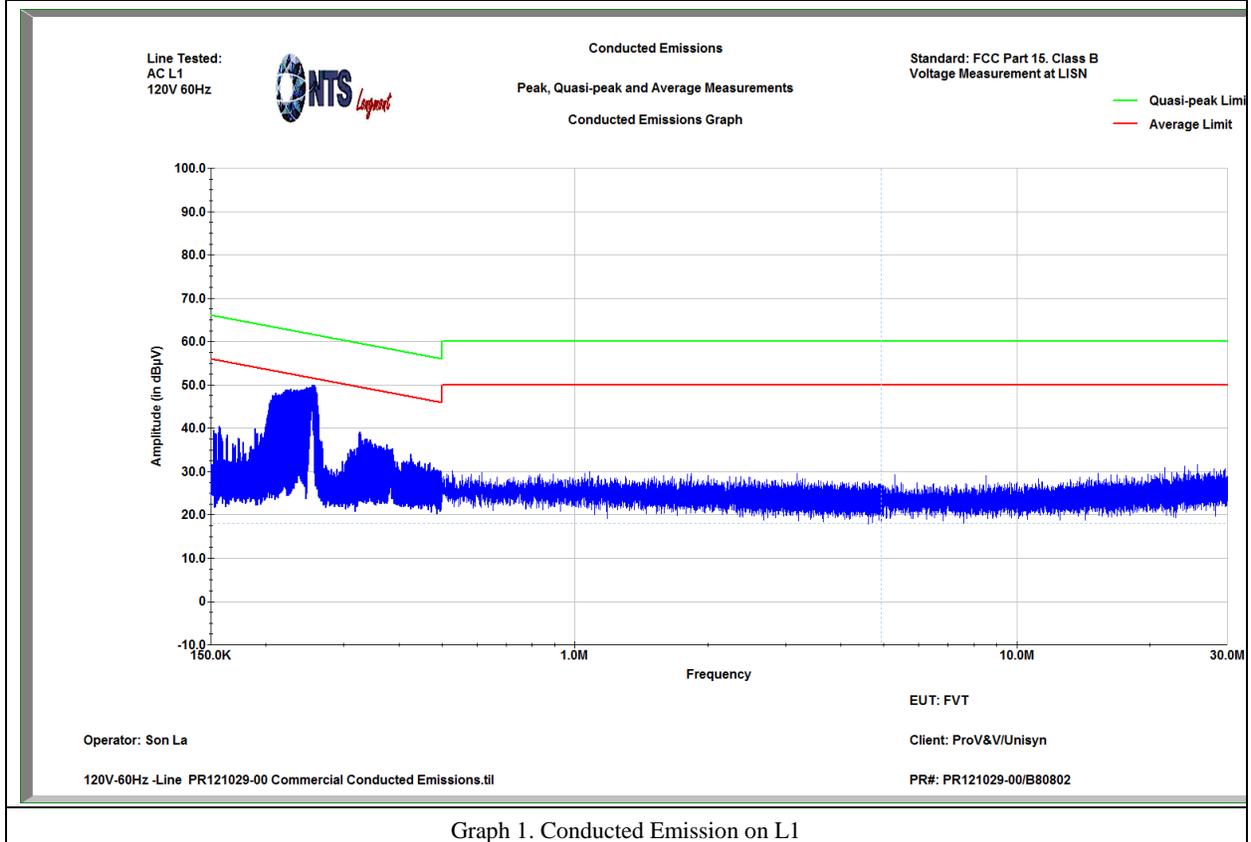
- “Type” refers to the type of measurement performed. The type of measurement made is based on the requirements of the particular standard:
 - PK = Peak Measurement: RBW is 9 kHz, VBW is 3 MHz
 - QP = Quasi-Peak Measurement: RBW is 9 kHz, VBW is 3 MHz, and QP Detection is ENABLED
 - AV = Video Average Measurement: RBW is 9 kHz, VBW is 10 Hz
- The “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: $49.6 \text{ dBuV} + 11.4 \text{ dB/m} - 28.8 \text{ dB (CF/AG)} = 32.2 \text{ dBuV/m}$. **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.
- The PRESCAN is a peak measurement and is performed with the RBW set to 9 kHz, and the VBW set to 3 MHz

Conducted Emissions, FCC PART 15, CLASS B

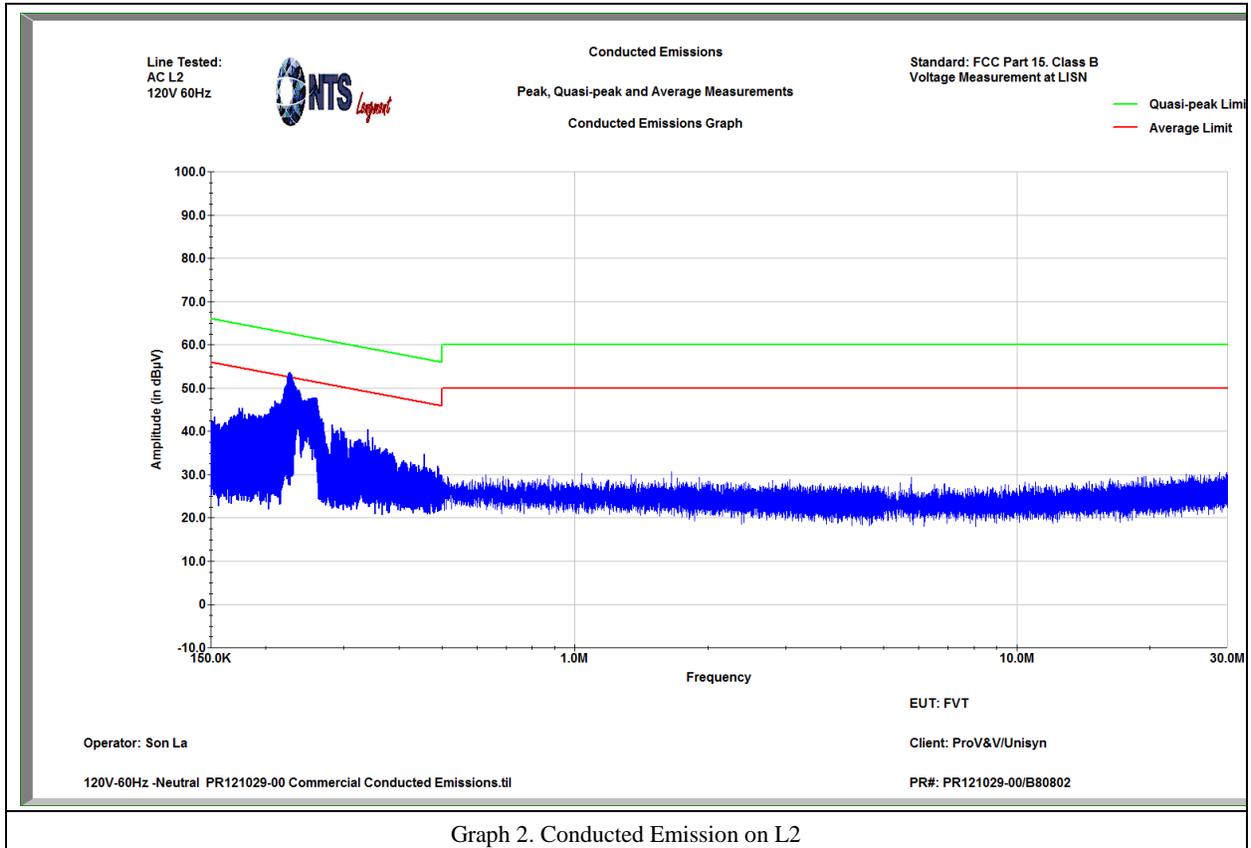
Manufacturer:	Unisyn	Project Number:	PR121029-00 B80802
Customer Representative:	Michael Walker	Test Area:	GP #10m1
Model:	FVT	S/N:	FVT-BBU-001
Standard Referenced:	FCC PART 15	Date:	January 15, 2021

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Graph 1. Conducted Emission on L1



Graph 2. Conducted Emission on L2

Conducted Emissions, FCC PART 15, CLASS B

Manufacturer:	Unisyn	Project Number:	PR121029-00 B80802
Customer Representative:	Michael Walker	Test Area:	GP #10m1
Model:	FVT	S/N:	FVT-BBU-001
Standard Referenced:	FCC PART 15	Date:	January 15, 2021

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Figure A1. Conducted Emissions Test Setup.



Figure A2. Conducted Emissions Test Setup.

Conducted Emissions, FCC PART 15, CLASS B

Manufacturer:	Unisyn	Project Number:	PR121029-00 B80802
Customer Representative:	Michael Walker	Test Area:	GP #10m1
Model:	FVT	S/N:	FVT-BBU-001
Standard Referenced:	FCC PART 15	Date:	January 15, 2021

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Figure A3. Conducted Emissions Test Setup.



Conducted Emissions, FCC PART 15, CLASS B

Manufacturer:	Unisyn	Project Number:	PR121029-00 B80802
Customer Representative:	Michael Walker	Test Area:	GP #10m1
Model:	FVT	S/N:	FVT-BBU-001
Standard Referenced:	FCC PART 15	Date:	January 15, 2021

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Test Equipment List

ID Number	Manufacturer	Model #	Serial #	Description	Cal Date	Cal Due
1017	Pacific Power	TMX 140	0256	4 kVA, 50 Hz Power Source	NA	NA
1038	Fluke	85	66180455	Multimeter/Frequency Meter	05/26/2020	05/26/2021
1200	Agilent Technology	11947A	3107A03807	Transient Limiter, 9 kHz to 200 MHz	04/24/2020	04/24/2021
1323	Rohde&Schwarz	SMT03	100204	Signal Generator, 5 kHz to 3 GHz	05/05/2020	05/05/2021
1901	EXTECH	445703	0617	Hygrometer-Thermometer (WC059899)	06/29/2020	06/29/2021
1938	SOLAR ELECTRONICS	8012-50-R-25-BNC	SN221373-1A	150kHz to 30MHz LISN	11/10/2020	11/10/2021
1945	ROHDE & SCHWARZ	ESW26	101441	EMI Test Receiver (WC076849)	11/18/2020	11/18/2021



6.0 Test Log

EMI Test Log

Manufacturer:	Unisyn	Project Number:	PR121029-00
			B80802
Model:	FVT	S/N:	FVT-BBU-001
			FVT-BBU-002
Customer Representative:	Michael Walker		
Standard Referenced:	FCC		

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10m Emissions

Test	Test Code	Date	Event	O T	Time (hrs)	Result	Initials
RE		September 15, 2020 0800-0900	Test#1: 30MHz – 1GHz, 8 rads, 4 heights, 3 second dwell, ref level = 80dBu, 10 meter distance. 120Vac/60Hz Unit failing at 239.9MHz by 4.6dB Added Wurth ferrite 742-711-31 to controller cable. Unit passing by 1.1dB Client has a firmware fix that should be available 9-16-2020.		1.0	Fail	KJ
RE		September 16, 2020 0800-0830	Waiting on client to get UUT updated ATI was swapped out with one with updated firmware		0.5	Complete	KJ/TW
RE		0830-0900	Test#2: 30MHz – 1GHz, 8 rads, 4 heights, 3 second dwell, ref level = 80dBu, 10 meter distance. 120Vac/60Hz Unit failing at 239.9MHz by 6.29dB		0.5	Fail	KJ/TW
RE		0900-1200	RE Troubleshooting		3.0	Complete	KJ/TW
RE		January 18, 2021	Begin pre-test verification/cable loss measurements in 10 meter #1		---	---	TW

10m Emissions

Test	Test Code	Date	Event	O T	Time (hrs)	Result	Initials
			Cable Loss Measurements At 0dBm 30 MHz -36.6 dBm 100 MHz -36.1 dBm 250 MHz -36.4 dBm 500 MHz -38.9 dBm 800 MHz -41.1 dBm 900 MHz -41.6 dBm 1 GHz -42.9 dBm Cable Loss Measurements At -20 dBm 30 MHz +26 dBm 100 MHz +26.4 dBm 250 MHz +25.7 dBm 500 MHz +25.1 dBm 800 MHz +24 dBm 900 MHz +23.5 dBm 1 GHz +23.5 dBm		---	---	TW

Ground Planes / CALC

Test	Test Code	Date	Event	O T	Time (hrs)	Result	Initials
CE		January 15, 2021	Conducted emissions 150KHz -30MHz FCC Part 15. Class B, 120V, 60Hz			-	-
CE		11:30	FCC Part 15. Class B, Line - LISN			Pass	SL
CE		12:00	FCC Part 15. Class B, Neutral - LISN			Pass	SL
RE		January 19, 2021 8:00 -11:00	Radiated emissions 30MHz -1000MHz FCC Part 15. Class B, 120V, 60Hz			Pass	SL



End of Report