ALEPH OBJECTS INC.
TEST REPORT

SCOPE OF WORK
EMC TESTING ON LULZBOT MINI 2 3D PRINTER, MODEL(S): LULZBOT MINI 2

REPORT NUMBER
103436795LAX--003

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EMC TEST REPORT

(FULL COMPLIANCE)

Report Number: 103436795LAX-003
Project Number: G103436795

Report Issue Date: 22-March-2018

Model(s) Tested: LulzBot Mini 2

Standards: EN 55032:2015
Electromagnetic Compatibility Of Multimedia Equipment – Emission Requirements

EN 55024:2010 +A1:2015
Information Technology Equipment – Immunity Characteristics Limits and Methods of Measurement

EN 61000-3-2:2014
EN 61000-3-3:2013

Tested by:
Intertek Testing Services NA, Inc.
25800 Commercentre Drive
Lake Forest, CA 92630
USA

Client:
Aleph Objects Inc.
626 W 66th St.
Loveland, CO 80538
USA

Report prepared by:

Melvin Sanchez
EMC Project Engineer

Report reviewed by

Meak Nget
EMC Engineering Supervisor

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1 Introduction and Conclusion

The tests indicated in section 2.0 were performed on the product constructed as described in section 4.0. The remaining test sections are the verbatim text from the actual data sheets used during the investigation. These test sections include the test name, the specified test Method, a list of the actual Test Equipment Used, documentation Photos, Results and raw Data. No additions, deviations, or exclusions have been made from the standard(s) unless specifically noted.

Based on the results of our investigation, we have concluded the product tested **complies** with the requirements of the standard(s) indicated. The results obtained in this test report pertain only to the item(s) tested. Intertek does not make any claims of compliance for samples or variants which were not tested.

2 Test Summary

Section	Test full name	Result
6	Radiated Emissions (EN 55032:2015, Class B)	Complies
7	AC Mains Conducted Emissions (EN 55032:2015, Class B))	Complies
8	Harmonics (EN 61000-3-2:2014)	Complies
9	Flicker (EN 61000-3-3:2013)	Complies
10	Electro-Static Discharge Immunity Test (EN 61000-4-2:2009)	Complies
11	Radiated, Radio-Frequency, Electromagnetic Immunity (EN 61000-4-3:2006 +A2:2010)	Complies
12	Electrical Fast Transient/Burst Immunity Test (EN 61000-4-4:2012)	Complies
13	Immunity to Surges (EN 61000-4-5:2014 +A1:2017)	Complies
14	Conducted, Radio-Frequency, Electromagnetic Immunity Test (EN 61000-4-6:2014)	Complies
15	Power Frequency Magnetic Field Immunity Test (EN 61000-4-8:2010)	Complies
16	Voltage Dips/Interruptions Immunity Test (EN 61000-4-11:2004 + A1:2017)	Complies
17	Revision History	--

3 Client Information

This EUT was tested at the request of:

Client: Aleph Objects Inc.
626 W 66th St.
Loveland, CO 80538
USA

Contact: Steven Abadie
Telephone: 970-377-1111 Ext 611

Email: steven@alephobjects.com

4 Description of Equipment Under Test and Variant Models

Manufacturer: Aleph Objects Inc.
626 W 66th St.
Loveland, CO 80538
USA

Equipment Under Test			
Description	Manufacturer	Model Number	Serial Number
3D Printer	Aleph Objects Inc.	LulzBot Mini 2	KT-PR0047-0004

Receive Date:	03/09/2018
Received Condition:	Good
Type:	Production

Description of Equipment Under Test (provided by client)

The LulzBot Mini 3D printer is a 3D printer that extrudes plastic to form 3D objects. It is high performance machine that makes 3D printing easy, for everyone. For more details refer to manufacturer's operating manual.

Equipment Under Test Power Configuration			
Rated Voltage	Rated Current	Rated Frequency	Number of Phases
100-240 VAC	3.2 A.	50-60 Hz	Single

Operating modes of the EUT:

No.	Descriptions of EUT Exercising
1	The EUT was set to run Print from SD card.

Software used by the EUT:

No.	Descriptions of EUT Exercising
1	Mini 2 Aerostruder V2

Variant Models:

The following variant models were not tested as part of this evaluation, but have been identified by the manufacturer as being electrically identical models, depopulated models, or with reasonable similarity to the model(s) tested. Intertek does not make any claims of compliance for samples or variants which were not tested.

- None

5 System Setup and Method

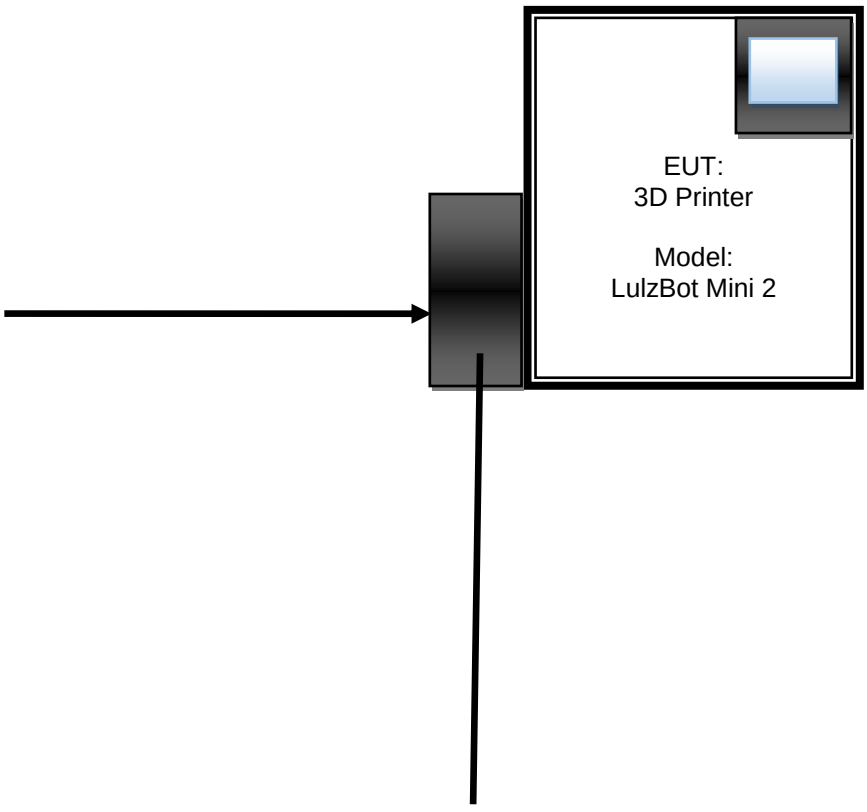
Cables					
ID	Description	Length (m)	Shielding	Ferrites	Termination
1	Mains AC Cable	1.5	None	None	AC Source - EUT
2	USB Cable	2.0	None	Yes	None

Support Equipment			
Description	Manufacturer	Model Number	Serial Number
None	N/A	N/A	N/A

5.1 Method:

Configuration as required by EN 55032 & EN 55024.

5.2 EUT Block Diagram:



5.3 EUT Performance Criteria and Monitoring:

Performance as required by Clause 7 of EN 55024.

General performance criteria

The manufacturer has the obligation to express the performance criteria in terms which relate to the performance of his specific product when used as intended.

Performance criterion A
During and after the test the EUT shall continue to operate as intended without operator intervention. No degradation of performance or loss of function is allowed below a minimum performance level specified by the manufacturer when the EUT is used as intended. The performance level may be replaced by a permissible loss of performance. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, then either of these may be derived from the product description and documentation, and by what the user may reasonably expect from the EUT if used as intended.

Performance criterion B
After the test, the EUT shall continue to operate as intended without operator intervention. No degradation of performance or loss of function is allowed, after the application of the phenomena below a performance level specified by the manufacturer, when the EUT is used as intended. The performance level may be replaced by a permissible loss of performance. During the test, degradation of performance is allowed. However, no change of operating state or stored data is allowed to persist after the test. If the minimum performance level (or the permissible performance loss) is not specified by the manufacturer, then either of these may be derived from the product description and documentation, and by what the user may reasonably expect from the EUT if used as intended.

Performance criterion C
During and after testing, a temporary loss of function is allowed, provided the function is self-recoverable, or can be restored by the operation of the controls or cycling of the power to the EUT by the user in accordance with the manufacturer's instructions. Functions, and/or information stored in non-volatile memory, or protected by a battery backup, shall not be lost.

Particular performance criteria
The particular performance criteria which are specified in the normative annexes take precedence over the corresponding parts of the general performance criteria. Where particular performance criteria for specific functions are not given, then the general performance criteria shall apply.

Product Specific Performance:

No.	Description
1	The LulzBot Mini 3D printer is a 3D printer that extrudes plastic to form 3D objects.
2	During testing printers shall maintain the specified printing quality and normal operation.

Description of how performance was observed during testing:

No.	Description
1	Visually monitored the display for any degradation of performance.
2	Visually monitored the movements of each axis.

6 Radiated Emissions

6.1 Method

Tests are performed in accordance with EN 55032 & CISPR 16-2-3:2010.

TEST SITE: 3m ALSE

The test facility is located at 25791 Commercentre Dr., Lake Forest, CA 92630.

Radiated emission measurements are performed in a 3 meter Semi-Anechoic Chamber. The chamber is a shielded enclosure used to control and maintain a predictable EMI environment within the test region. A lining of RF absorbing material (Absorber) and other anechoic materials are installed over all interior wall and ceiling surfaces as to completely shroud exposed metallic components and disrupt reflective properties. The ground plane is an exposed RF reflective surface. The turntable is flush mounted, 2 meters in diameter, and remotely controlled. The antenna mast can be positioned at 3 meters away from the turntable. The antenna mast is remote controlled and can lower/raise an antenna between 1 – 4 meters. The antenna mast can also rotate between horizontal and vertical polarizations.

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
Radiated Emissions, 3m	30-1000 MHz	4.5 dB	6.3 dB
Radiated Emissions, 3m	1-6 GHz	4.7 dB	5.2 dB

As shown in the table above our radiated emissions U_{lab} is less than the corresponding U_{CISPR} reference value in CISPR 16-4-2 Table 1, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required, based on CISPR 22 and CISPR 11 (for 2006 and later revisions) Clause 11.

Sample Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF - AG
Where FS = Field Strength in dBμV/m
RA = Receiver Amplitude (including preamplifier) in dBμV
CF = Cable Attenuation Factor in dB
AF = Antenna Factor in dB
AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 dBμV is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dBμV/m. This value in dBμV/m was converted to its corresponding level in μV/m.

RA = 52.0 dBμV

AF = 7.4 dB/m
CF = 1.6 dB
AG = 29.0 dB
FS = 32 dBμV/m

To convert from dBμV to μV or mV the following was used:

UF = $10^{(NF / 20)}$ where UF = Net Reading in μV
NF = Net Reading in dBμV

Example:

FS = RA + AF + CF – AG = 52.0 + 7.4 + 1.6 – 29.0 = 32.0
UF = $10^{(32\ dB\mu V / 20)}$ = 39.8 μV/m

6.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
001140	EMI Test Receiver	Rohde & Schwarz	ESCI7	100825	02/28/2018	02/28/2019
001147	Bilog Antenna	TESEQ Gmbh	CBL 6112D	32852	11/16/2017	11/16/2018
001576	Preamplifier 100kHz - 1 Ghz	Rhode & Schwarz	TS-PR1	102068	06/20/2017	06/20/2018
001556	Preamplifier 1 - 18GHz	Rhode & Schwarz	TS-PR18	102144	07/29/2017	07/29/2018
000692	Double-Ridged Horn for frequency 1-18 GHz	ETS Lindgren	3115	00031626	07/25/2017	07/25/2018
000690	Spectrum Analyzer, 9 KHz - 40 GHz	Rohde & Schwarz	FSP40	100027	02/28/2018	02/28/2019
001517	RF Cable 30Mhz - 18Ghz	Rohde & Schwarz	TSPR-B7	101528	07/13/2017	07/13/2018
001518	RF Cable 30Mhz - 18Ghz	Rohde & Schwarz	TSPR-B7	101529	07/13/2017	07/13/2018
000637	EMC Emissions	Panashield	3m Chamber	250831-D-2	12/21/2015	12/21/2018
001014	Lab Monitor	Omega	iBTHX-W	0480395	12/20/2017	12/20/2018

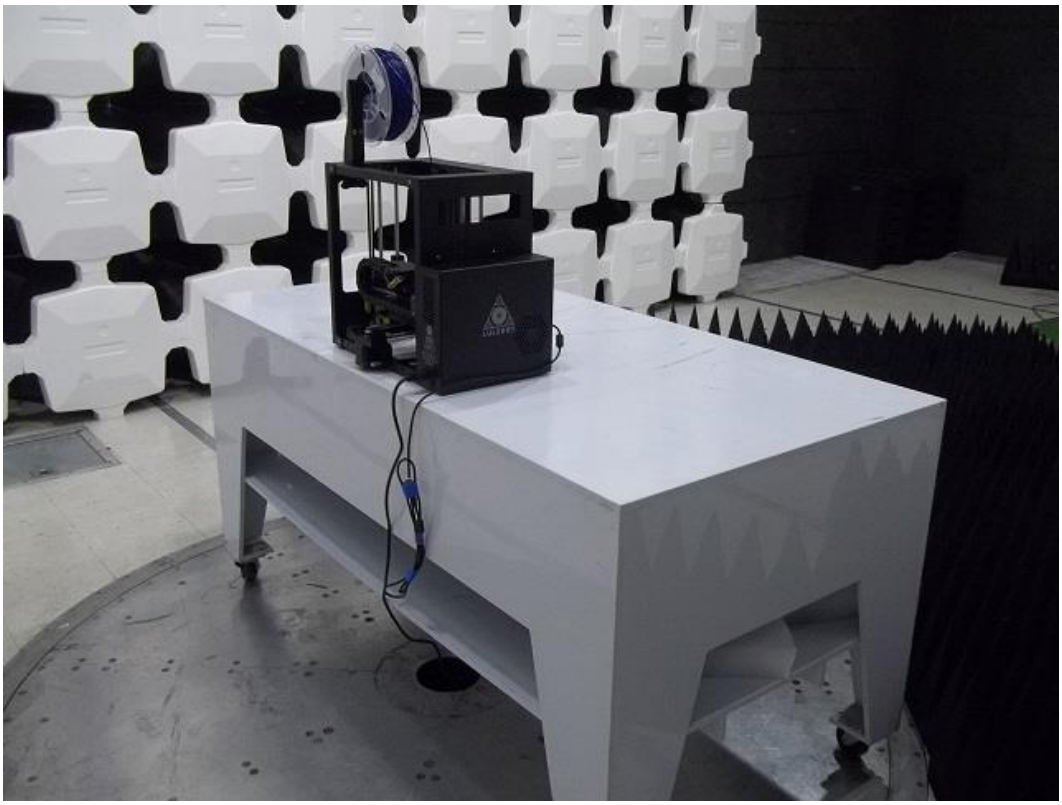
Software Utilized:

Name	Manufacturer	Version
Tile	Quantum Change	4.1
Tile	Quantum Change	3.4.k.29

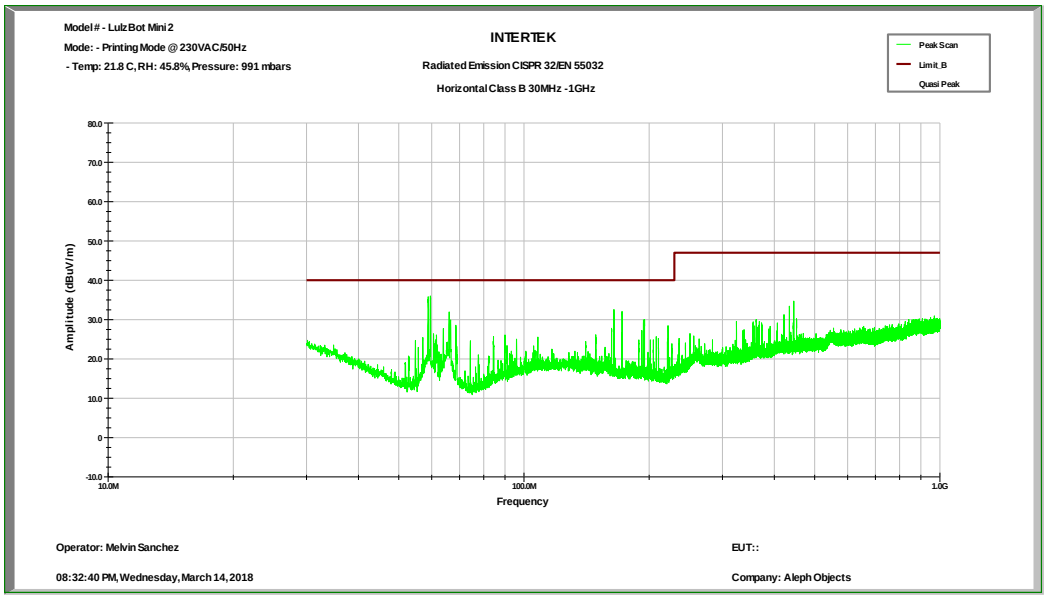
6.3 Results:

The sample tested was found to Comply.

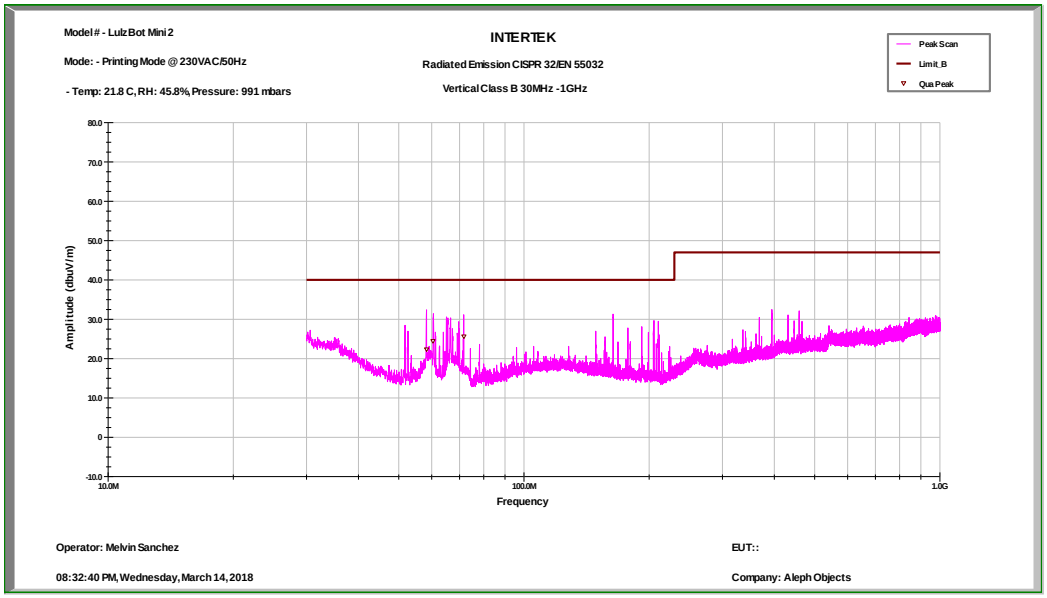
6.4 Setup Photographs:



6.5 Plots:

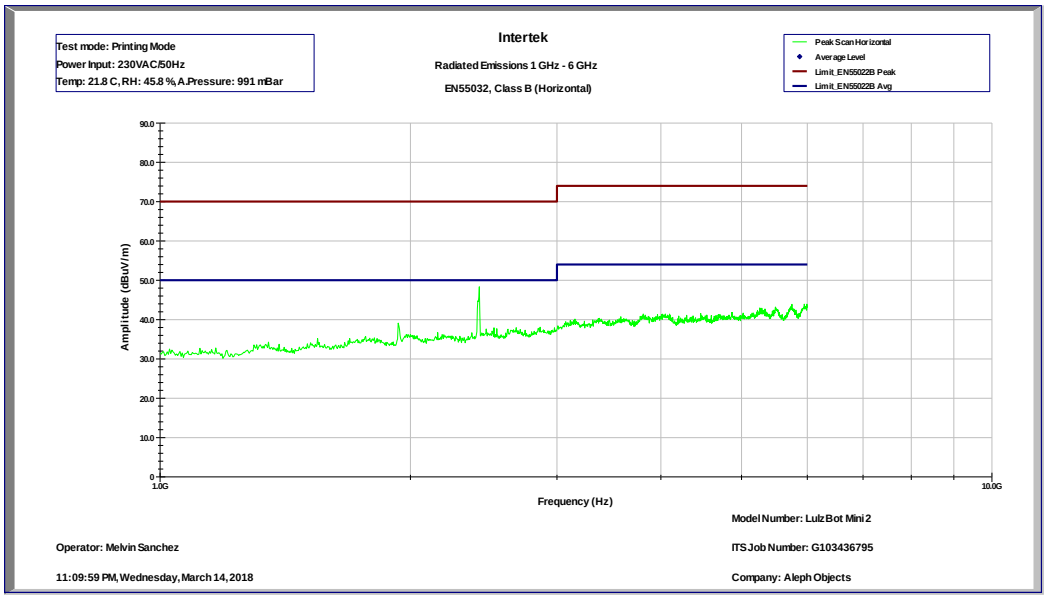


EN 55032 - Radiated Emissions, Peak Scan Horizontal Polarization @ 230VAC/50Hz

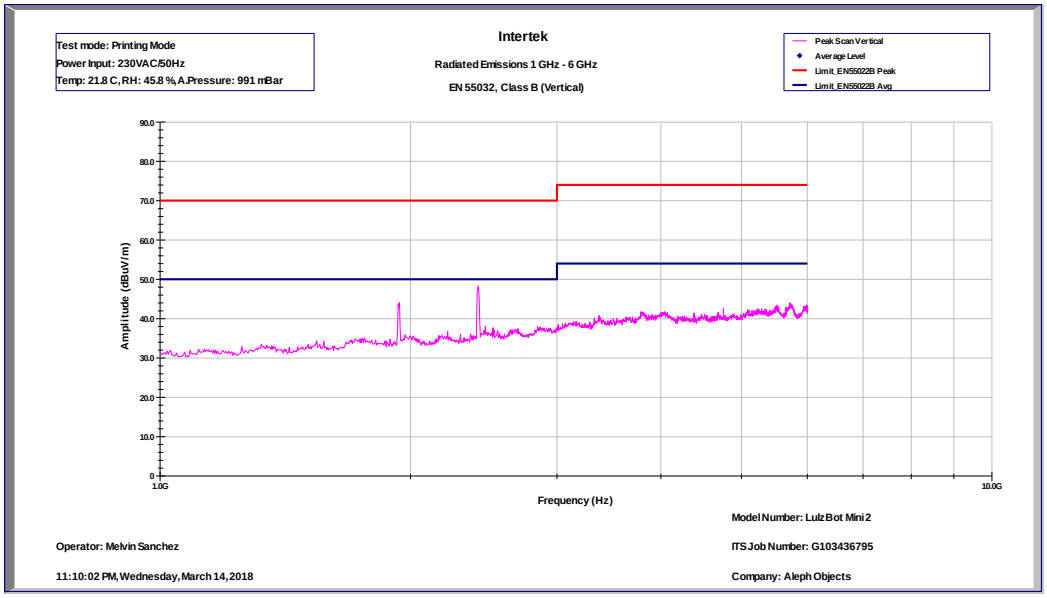


EN 55032 - Radiated Emissions, Peak Scan Vertical Polarization @ 230VAC/50Hz

6.6 Plots:



EN 55032 - Radiated Emissions, Peak Scan Horizontal Polarization @ 230VAC/50Hz
Above 1GHz



EN 55032 - Radiated Emissions, Peak Scan Vertical Polarization @ 230VAC/50Hz
Above 1GHz

6.7 Data:

Test Personnel:	Melvin Sanchez	Test Date:	03/14/2018
Supervising/Reviewing Engineer: (Where Applicable)	Meak Nget		
Product Standard:	EN 55032	Limit Applied:	Class B
Input Voltage:	230VAC/50Hz		
Pretest Verification w/ Ambient Signals or BB Source:	**Yes**	Ambient Temperature:	21.8 ºC
		Relative Humidity:	45.8 %
		Atmospheric Pressure:	991 mbars

EN 55032, Radiated Emissions, Class B (Quasi-Peak Horizontal)							
Frequency MHz	QP FS (dBuV)	Limit @ 3m dB(dBuV)	Margin (dB)	RA (dBuV)	AG dB	AF dB(1/m)	CF dB
58.852	22.542	40	-17.458	38.935	30.495	12.2	1.903
*59.555	25.773	40	-14.227	42.207	30.48	12.144	1.902
66.073	19.061	40	-20.939	35.48	30.411	12.1	1.892
164.535	14.521	40	-25.479	26.051	29.745	15.946	2.268
Detectors/Bandwidths (Det/RBW/VBW)= 120/300kHz							

EN 55032, Radiated Emissions, Class B (Quasi-Peak Vertical)							
Frequency MHz	QP FS (dBuV)	Limit @ 3m dB(dBuV)	Margin (dB)	RA (dBuV)	AG dB	AF dB(1/m)	CF dB
58.338	22.34	40	-17.66	38.743	30.507	12.2	1.903
60.407	24.451	40	-15.549	40.957	30.466	12.059	1.9
71.689	25.619	40	-14.381	41.717	30.35	12.369	1.883
Detectors/Bandwidths (Det/RBW/VBW)= 120/300kHz							

QP FS – Quasi-Peak Field Strength
RA – Receiver (Q-peak) Amplitude
AG – Preamp Gain
AF – Antenna Factor
CF – Cable Factor

Test Result: (*)The **EUT PASSED** Radiated Emission test with – 14.227 dB margin at 59.555 MHz

Deviations, Additions, or Exclusions: None

6.8 Data:

Test Personnel:	Melvin Sanchez	Test Date:	03/14/2018
Supervising/Reviewing Engineer: (Where Applicable)	Meak Nget		
Product Standard:	EN 55032	Limit Applied:	Class B
Input Voltage:	230VAC/50Hz		
Pretest Verification w/ Ambient Signals or BB Source:	**Yes**	Ambient Temperature:	21.8 ºC
		Relative Humidity:	45.8 %
		Atmospheric Pressure:	991 mbars

EN 55032, Radiated Emissions, Class B (Average Peak Horizontal)							
Frequency MHz	**Av Level (dB)**	**Limit@3m (dBuV/m)**	**Av Margin (dB)**	**Raw (dBuV)**	**Cable (dB)**	**Preamp (dB)**	**AF dB(1/m)**
1932.950	24.2	50	-25.8	43.2	3.4	50	27.6
2419.970	22.3	50	-27.7	39.9	3.8	49.8	28.4
*5991.880	29.2	54	-24.8	37.4	6.2	49.7	35.3
Detectors/Bandwidths (Det/RBW/VBW)= 1MHz/3MHz							

EN 55032, Radiated Emissions, Class B (Average Peak Vertical)							
Frequency MHz	**Av Level (dB)**	**Limit@3m (dBuV/m)**	**Av Margin (dB)**	**Raw (dBuV)**	**Cable (dB)**	**Preamp (dB)**	**AF dB(1/m)**
1940.260	13.8	50	-36.2	33.1	3.4	50	27.3
2413.090	15.1	50	-34.9	33	3.8	49.8	28.1
5725.960	22.3	54	-31.7	31.4	6.1	49.7	34.5
Detectors/Bandwidths (Det/RBW/VBW)= 1MHz/3MHz							

Avg Peak FS – (Final) Avg Peak Field Strength
RA – Receiver (quasi peak) Amplitude
AG – Preamp Gain
AF – Antenna Factor
CF – Cable Factor

Test Result: (*)The EUT PASSED Radiated Emission test with -24.8 dB margin at 5991.88 MHz

Deviations, Additions, or Exclusions: None

7 AC Mains Conducted Emissions

7.1 Method

Tests are performed in accordance with EN 55032 & CISPR 16-2-1:2008.

TEST SITE: 3m Emission Chamber

The test is performed in the 3 meter semi-anechoic chamber located at 25791 Commercentre Drive, Lake Forest, CA 92630. This site meets the requirements of CISPR 16-1.

TEST SETUP
The EUT shall be located so that the distance between the boundary of the EUT and the closest surface of the AMN is 0.8m.

If a flexible mains cord is provided by the manufacturer that is in excess of 1m, the excess cable shall be folded back and forth as far as possible to form a bundle not exceeding 0.4m in length.

The EUT shall be arranged and connected with cables terminated in accordance with the product specification. Conducted disturbance shall be measured between each current carrying conductor and the reference ground. Each measured values shall be reported.

If EUT is intended for tabletop use, the EUT shall be placed on a table whose top is 0.8m above the ground plane. A vertical, metal reference plane is being placed 0.4m from the EUT. The vertical metal reference-plane is at least 2m by 2m. The EUT shall be kept at least 0.8m from any other metal surface or other ground plane not being part of the EUT. The table shall be constructed of non-conductive materials. Its dimensions are at least 1m by 1.5m, but may be extended for larger EUT.

If EUT is floor standing, the floor standing EUT shall be placed on a horizontal metal ground plane and isolated from the ground plane by up to 12 mm of insulating material. The metal ground plane shall extend at least 0.5m beyond the boundaries of the EUT and had minimum dimensions of 2m by 2m.

Equipment setup for conducted disturbance tests shall follow the guidelines of CISPR 16.

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
AC Line Conducted Emissions	150 kHz - 30 MHz	2.6 dB	3.4dB
Telco Port Emissions	150 kHz - 30 MHz	2.6 dB	5.0dB

As shown in the table above our conducted emissions U_{lab} is less than the corresponding U_{CISPR} reference value in CISPR 16-4-2 Table 1, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required, based on CISPR 22 and CISPR 11 (for 2006 and later revisions) Clause 11.

Sample Calculations

The following is how net line-conducted readings were determined:

NF = RF + LF + CF + AF
Where NF = Net Reading in dBμV
RF = Reading from receiver in dBμV
LF = LISN or ISN Correction Factor in dB
CF = Cable Correction Factor in dB
AF = Attenuator Loss Factor in dB

To convert from dBμV to μV or mV the following was used:

UF = $10^{(NF / 20)}$ where UF = Net Reading in μV
NF = Net Reading in dBμV

Example:

NF = RF + LF + CF + AF = 28.5 + 0.2 + 0.4 + 20.0 = 49.1 dBμV
UF = $10^{(49.1\ dB\mu V / 20)}$ = 285.1 μV/m

7.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
001140	EMI Test Receiver	Rohde & Schwarz	ESCI7	100825	02/28/2018	02/28/2019
000667	LISN	TESEQ	NNB 51	36060	12/26/2017	12/26/2018
001470	RF Cable	Megaphase	TM18-N1N1-600	none	06/16/2017	06/16/2018
001314	Portable Vertical Ground Plane	Intertek	ANSI C63.4 Sec 5.2.2	none	VBU 03/15/2018	VBU 03/15/2018
001014	Lab Monitor	Omega	iBTHX-W	0480395	12/20/2017	12/20/2018

VBU=Verified Before Used

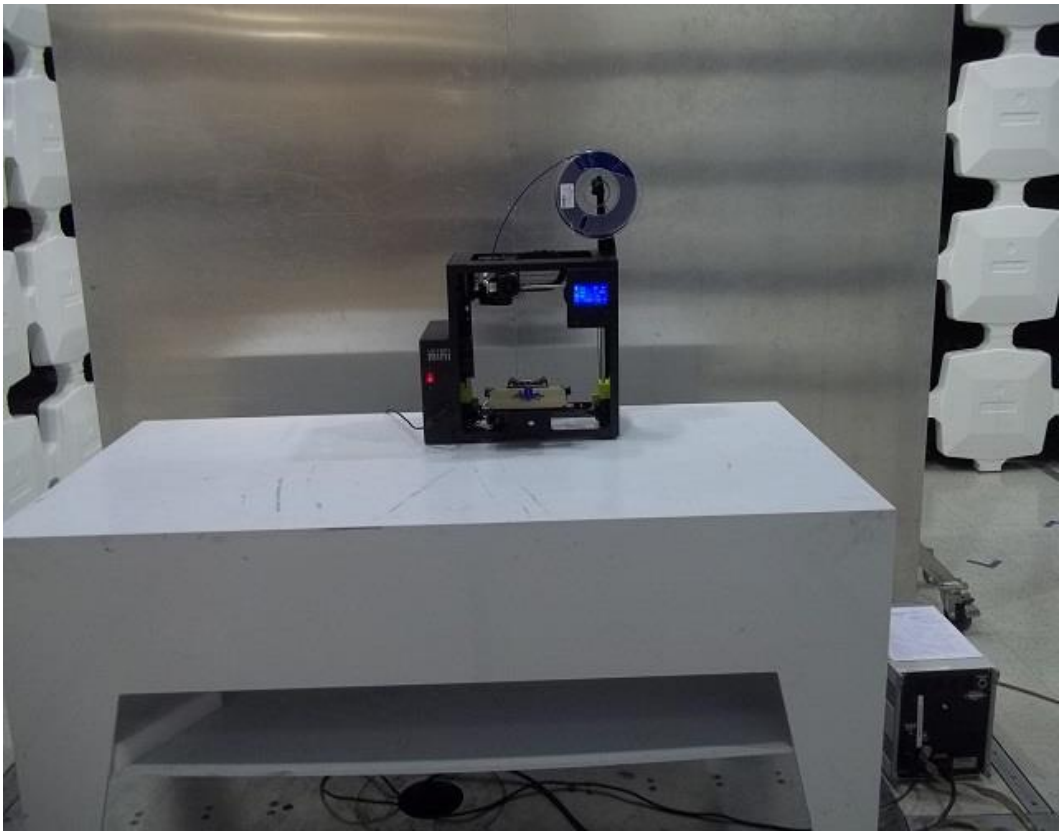
Software Utilized:

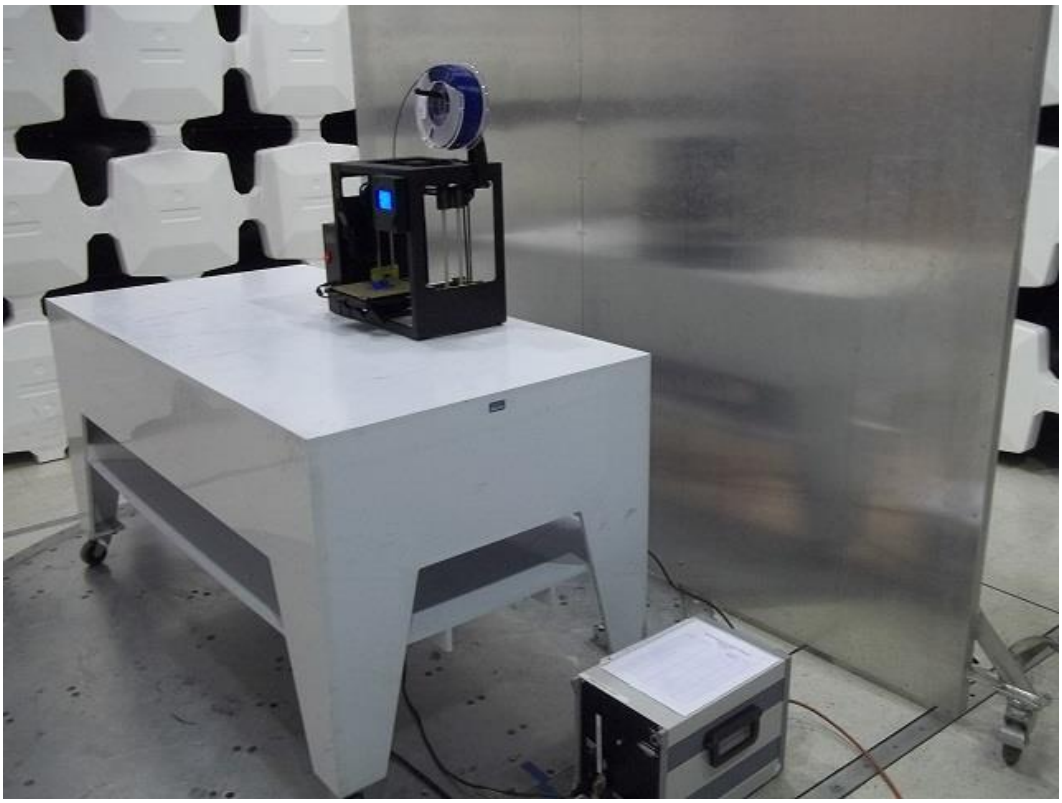
Name	Manufacturer	Version
Tile	Quantum Change	4.1

7.3 Results:

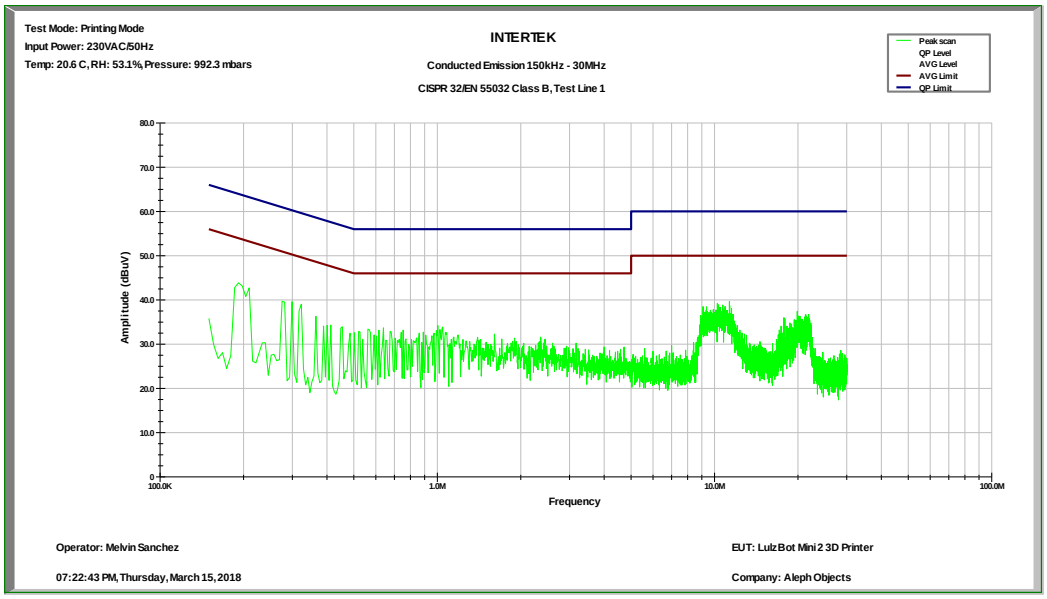
The sample tested was found to Comply.

7.4 Setup Photographs:

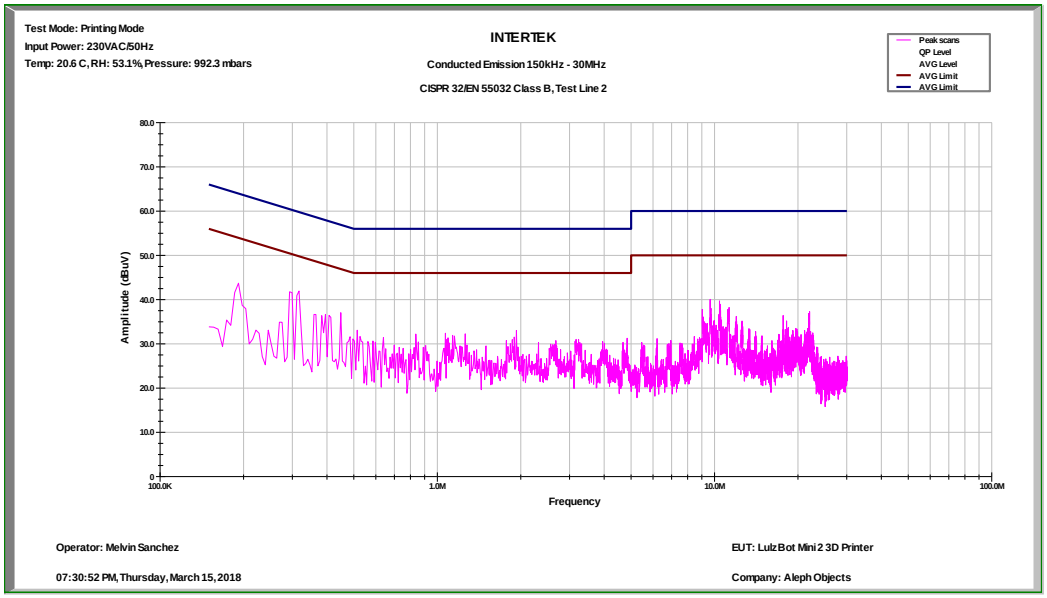




7.5 Plots:



EN 55032 - Conducted Emissions Peak Scan - Line 1 @ 230VAC/50Hz



EN 55032 - Conducted Emissions Peak Scan - Line 2 @ 230VAC/50Hz

7.6 Data:

Test Personnel:	Melvin Sanchez	Test Date:	03/15/2018
Supervising/Reviewing Engineer: (Where Applicable)	Meak Nget		
Product Standard:	EN 55032	Limit Applied:	Class B
Input Voltage:	230VAC/50Hz		
Pretest Verification w/ Ambient Signals or BB Source:	**Yes**	Ambient Temperature:	20.6 ºC
		Relative Humidity:	53.1 %
		Atmospheric Pressure:	992.3 mbars

EN 55032, Conducted Emissions, Class B (Line 1)						
Frequency MHz	**Av Level (dBuV)**	**QP Level (dBuV)**	**Av Limit (dBuV)**	**QP Limit (dBuV)**	**Av Margin (dB)**	**QP Margin (dB)**
0.193	30.47	42.62	54.751	64.751	-24.281	-22.131
0.275	24.659	37.683	52.409	62.409	-27.749	-24.726
0.298	23.027	37.093	51.771	61.771	-28.744	-24.679
0.320	23.645	37.351	51.12	61.12	-27.475	-23.768
10.168	25.089	33.787	50	60	-24.911	-26.213
11.353	26.728	34.398	50	60	-23.272	-25.602
Detectors/Bandwidths (Det/RBW/VBW)= 9/30kHz						

EN 55032, Conducted Emissions, Class B (Line 2)						
Frequency MHz	**Av Level (dBuV)**	**QP Level (dBuV)**	**Av Limit (dBuV)**	**QP Limit (dBuV)**	**Av Margin (dB)**	**QP Margin (dB)**
*0.193	34.012	45.348	54.751	64.751	-20.739	-19.403
0.292	25.757	39.043	51.93	61.93	-26.172	-22.886
0.318	27.232	38.796	51.173	61.173	-23.941	-22.377
0.450	17.876	31.664	47.424	57.424	-29.548	-25.76
9.639	26.125	32.818	50	60	-23.875	-27.182
10.491	26.005	32.78	50	60	-23.995	-27.22
Detectors/Bandwidths (Det/RBW/VBW)= 9/30kHz						

Test Result: (*) The EUT **PASSED** Conducted Emission test with –19.403 dB margin at 0.193 MHz

Deviations, Additions, or Exclusions: None

8 Harmonics

8.1 Method

Tests are performed in accordance with EN 61000-3-2.

TEST SITE: Lake Forest EMC Lab

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 380, and 440 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

Measurement Uncertainty

Measurement	Parameter	Expanded Uncertainty (k=2)	Permitted Error
Harmonics	Current	0.34 %	±5.0%

As shown in the table above our Expanded Measurement Uncertainty for harmonic current U_{lab} is less than the corresponding measurement error allowed by IEC61000-3-2 and IEC61000-4-7, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required. There are currently no U_{CISPR} reference values in CISPR 16 for Harmonics.

8.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
000898	Power Source	TESEQ	5001IX-CTS-208-411-	1337A01349 (1)	12/26/2017	12/26/2018
000899	Power Conditioner	TESEQ	CTS (CCN-1000-1)	1337A01349 (2)	12/26/2017	12/26/2018
001014	Lab Monitor	Omega	iBTHX-W	0480395	12/20/2017	12/20/2018

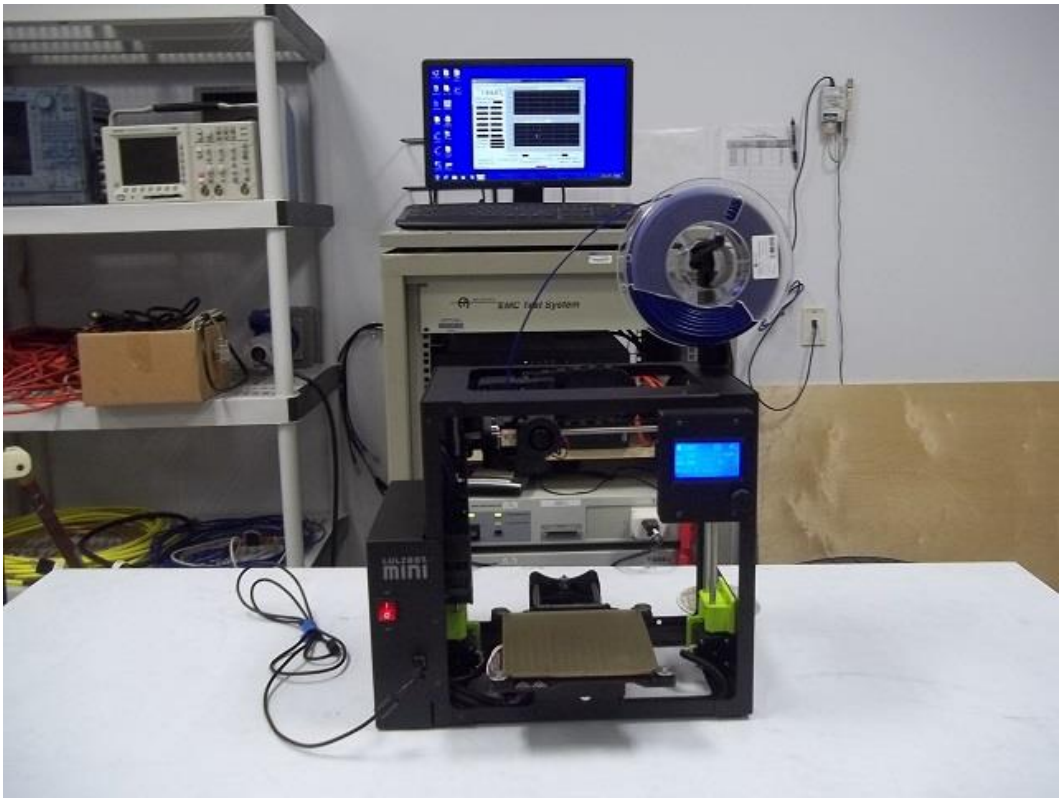
Software Utilized:

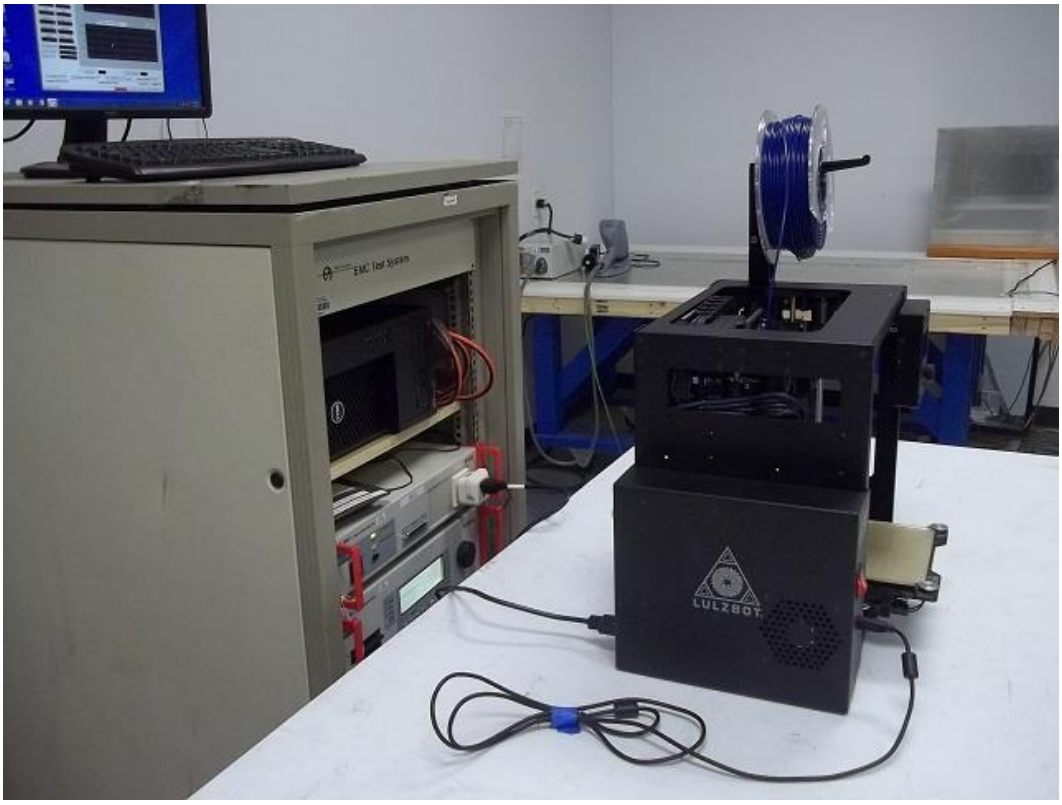
Name	Manufacturer	Version
WIN2100	TESEQ	4.9.0

8.3 Results:

The sample tested was found to Comply.

8.4 Setup Photographs:





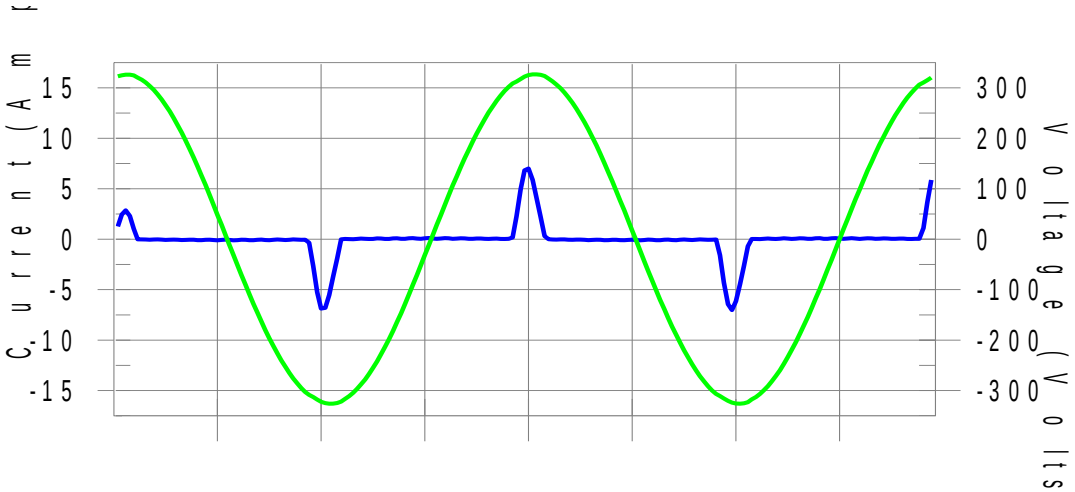
8.5 Plots/Data:

Harmonics – Class-A per Ed. 4.0 (2014)(Run time)

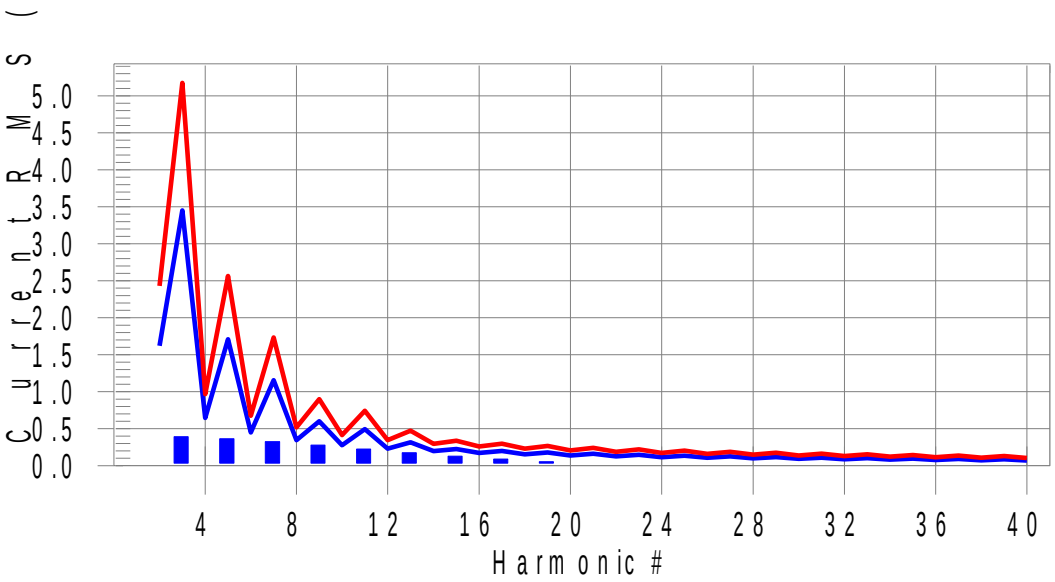
EUT: LulzBot Mini 2 3D Printer **Tested by: Melvin Sanchez**
Test category: Class-A per Ed. 4.0 (2014) (European limits) **Test Margin: 150**
Test date: 3/12/2018 **Start time: 6:46:47 PM** **End time: 6:57:08 PM**
Test duration (min): 10 **Data file name: H-000026.cts_data**
Comment: Printing Mode
Customer: Aleph Objects

Test Result: Pass **Source qualification: Normal**

Current & voltage waveforms



Harmonics and Class A limit line **European Limits**



Test result: Pass Worst harmonic was #15 with 61.5% of the limit.

Current Test Result Summary (Run time)

EUT: LulzBot Mini 2 3D Printer **Tested by: Melvin Sanchez**
Test category: Class-A per Ed. 4.0 (2014) (European limits) **Test Margin: 150**
Test date: 3/12/2018 **Start time: 6:46:47 PM** **End time: 6:57:08 PM**
Test duration (min): 10 **Data file name: H-000026.cts_data**
Comment: Printing Mode
Customer: Aleph Objects

Test Result: Pass **Source qualification: Normal**
THC(A): 0.762 **I-THD(%): 185.0** **POHC(A): 0.052** **POHC Limit(A): 0.377**

Highest parameter values during test:

V_RMS (Volts):	**230.43**	**Frequency(Hz):**	**50.00**
I_Peak (Amps):	**7.151**	**I_RMS (Amps):**	**1.361**
I_Fund (Amps):	**0.615**	**Crest Factor:**	**12.733**
Power (Watts):	**140.4**	**Power Factor:**	**0.466**

Harm#	Harms(avg)	100%Limit	%of Limit	Harms(max)	150%Limit	%of Limit	Status
2	0.013	1.620	0.8	0.024	2.430	1.0	Pass
3	0.392	3.450	11.4	0.590	5.175	11.4	Pass
4	0.013	0.645	2.0	0.023	0.968	2.3	Pass
5	0.363	1.710	21.2	0.551	2.565	21.5	Pass
6	0.012	0.450	2.6	0.021	0.675	3.1	Pass
7	0.324	1.155	28.1	0.497	1.733	28.7	Pass
8	0.010	0.345	3.0	0.018	0.518	3.5	Pass
9	0.278	0.600	46.3	0.430	0.900	47.8	Pass
10	0.009	0.276	3.2	0.017	0.414	4.1	Pass
11	0.227	0.495	45.9	0.357	0.743	48.0	Pass
12	0.007	0.230	3.3	0.015	0.344	4.5	Pass
13	0.176	0.315	56.0	0.281	0.473	59.4	Pass
14	0.006	0.197	N/A	0.014	0.295	N/A	Pass
15	0.129	0.225	57.3	0.207	0.338	61.5	Pass
16	0.005	0.173	N/A	0.012	0.259	N/A	Pass
17	0.088	0.198	44.2	0.140	0.297	47.3	Pass
18	0.004	0.153	N/A	0.009	0.230	N/A	Pass
19	0.054	0.178	30.7	0.083	0.266	31.3	Pass
20	0.003	0.138	N/A	0.008	0.207	N/A	Pass
21	0.031	0.161	19.5	0.039	0.241	16.3	Pass
22	0.002	0.125	N/A	0.006	0.188	N/A	Pass
23	0.019	0.147	13.2	0.030	0.220	13.5	Pass
24	0.002	0.115	N/A	0.006	0.172	N/A	Pass
25	0.017	0.135	12.9	0.026	0.203	12.9	Pass
26	0.002	0.107	N/A	0.005	0.160	N/A	Pass
27	0.017	0.125	13.9	0.034	0.187	18.1	Pass
28	0.001	0.099	N/A	0.005	0.149	N/A	Pass
29	0.016	0.116	13.5	0.033	0.175	19.1	Pass
30	0.001	0.092	N/A	0.004	0.138	N/A	Pass
31	0.013	0.109	11.5	0.028	0.163	17.3	Pass
32	0.001	0.086	N/A	0.004	0.129	N/A	Pass
33	0.010	0.102	9.4	0.020	0.153	13.1	Pass
34	0.001	0.081	N/A	0.004	0.122	N/A	Pass
35	0.009	0.096	9.2	0.015	0.145	10.5	Pass
36	0.001	0.077	N/A	0.003	0.115	N/A	Pass
37	0.009	0.091	9.7	0.013	0.137	9.7	Pass
38	0.001	0.073	N/A	0.003	0.109	N/A	Pass
39	0.009	0.087	10.7	0.012	0.130	9.3	Pass
40	0.001	0.069	N/A	0.003	0.104	N/A	Pass

Voltage Source Verification Data (Run time)

EUT: LulzBot Mini 2 3D Printer **Tested by: Melvin Sanchez**
Test category: Class-A per Ed. 4.0 (2014) (European limits) **Test Margin: 150**
Test date: 3/12/2018 **Start time: 6:46:47 PM** **End time: 6:57:08 PM**
Test duration (min): 10 **Data file name: H-000026.cts_data**
Comment: Printing Mode
Customer: Aleph Objects

Test Result: Pass **Source qualification: Normal**

Highest parameter values during test:

Voltage (Vrms):	**230.43**	**Frequency(Hz):**	**50.00**
I_Peak (Amps):	**7.151**	**I_RMS (Amps):**	**1.361**
I_Fund (Amps):	**0.615**	**Crest Factor:**	**12.733**
Power (Watts):	**140.4**	**Power Factor:**	**0.466**

Harm#	Harmonics V-rms	Limit V-rms	% of Limit	Status
2	0.028	0.461	6.11	OK
3	0.583	2.073	28.13	OK
4	0.019	0.461	4.08	OK
5	0.118	0.922	12.81	OK
6	0.055	0.461	11.91	OK
7	0.156	0.691	22.62	OK
8	0.017	0.461	3.61	OK
9	0.196	0.461	42.51	OK
10	0.013	0.461	2.92	OK
11	0.189	0.230	81.89	OK
12	0.010	0.230	4.49	OK
13	0.174	0.230	75.31	OK
14	0.007	0.230	3.12	OK
15	0.137	0.230	59.38	OK
16	0.009	0.230	4.03	OK
17	0.103	0.230	44.90	OK
18	0.008	0.230	3.56	OK
19	0.066	0.230	28.54	OK
20	0.011	0.230	4.98	OK
21	0.038	0.230	16.47	OK
22	0.007	0.230	3.14	OK
23	0.035	0.230	15.27	OK
24	0.007	0.230	2.96	OK
25	0.043	0.230	18.82	OK
26	0.005	0.230	2.07	OK
27	0.057	0.230	24.82	OK
28	0.005	0.230	1.99	OK
29	0.056	0.230	24.35	OK
30	0.004	0.230	1.75	OK
31	0.051	0.230	22.14	OK
32	0.004	0.230	1.63	OK
33	0.040	0.230	17.57	OK
34	0.004	0.230	1.60	OK
35	0.027	0.230	11.83	OK
36	0.004	0.230	1.52	OK
37	0.024	0.230	10.62	OK
38	0.003	0.230	1.32	OK
39	0.025	0.230	10.89	OK
40	0.007	0.230	2.96	OK

9 Flicker

9.1 Method

Tests are performed in accordance with EN 61000-3-3.

TEST SITE: Lake Forest EMC Lab

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 380, and 440 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

Measurement Uncertainty

Measurement	Parameter	Expanded Uncertainty (k=2)	Permitted Error
Flicker	Pst	1.6 %	±8.0%
Flicker	dc	0.59 %	±8.0%

As shown in the table above our Expanded Measurement Uncertainty for Pst and dc U_{lab} is less than the corresponding measurement error allowed by IEC 61000-3-3, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required. There are currently no U_{CISPR} reference values in CISPR 16 for Flicker.

9.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
000898	Power Source	TESEQ	5001IX-CTS-208-411-	1337A01349 (1)	12/26/2017	12/26/2018
000899	Power Conditioner	TESEQ	CTS (CCN-1000-1)	1337A01349 (2)	12/26/2017	12/26/2018
001014	Lab Monitor	Omega	iBTHX-W	0480395	12/20/2017	12/20/2018

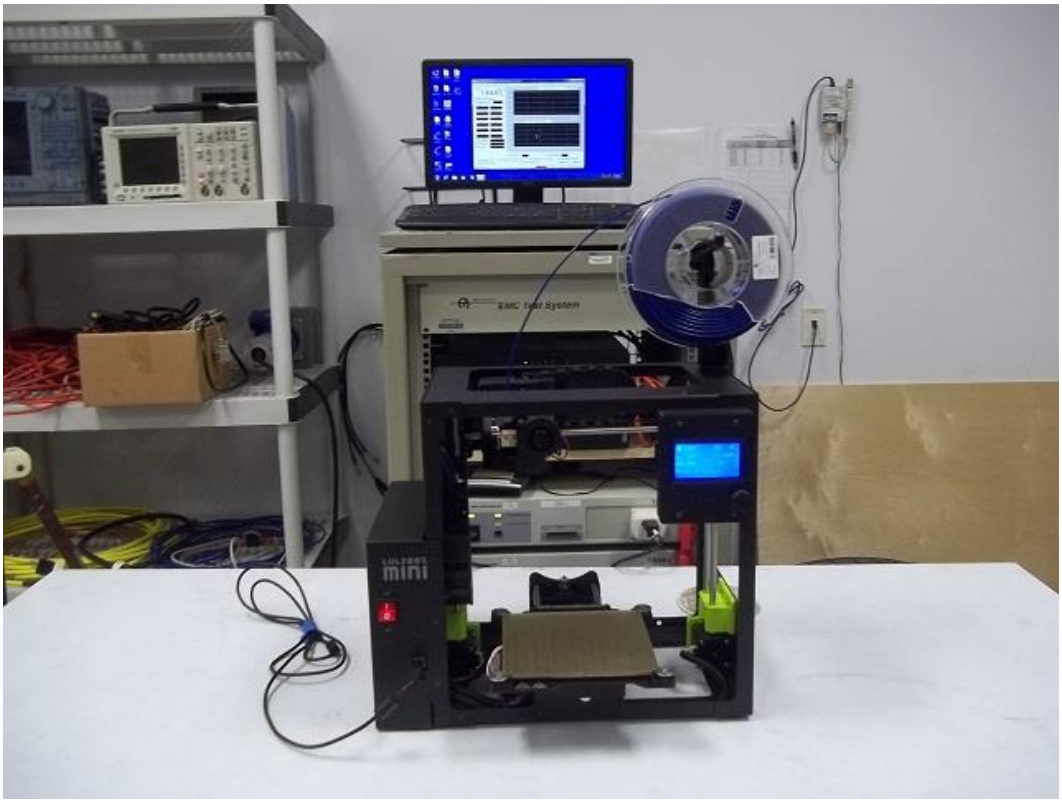
Software Utilized:

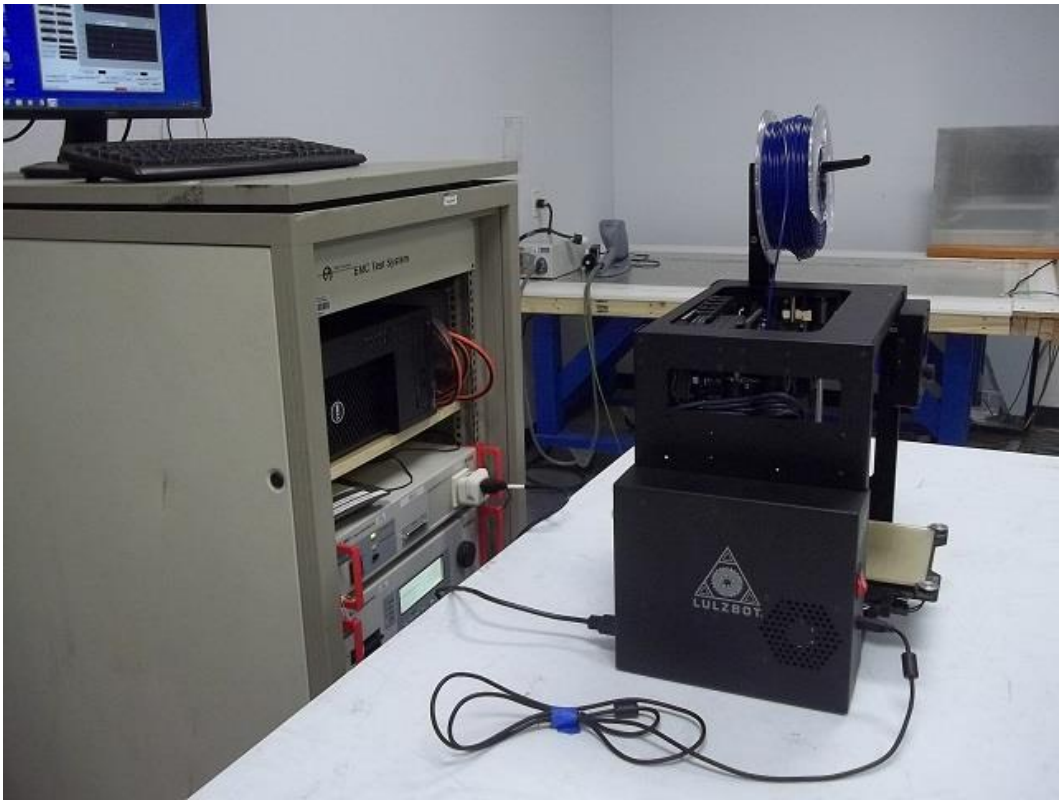
Name	Manufacturer	Version
WIN2100	TESEQ	4.9.0

9.3 Results:

The sample tested was found to Comply.

9.4 Setup Photographs:





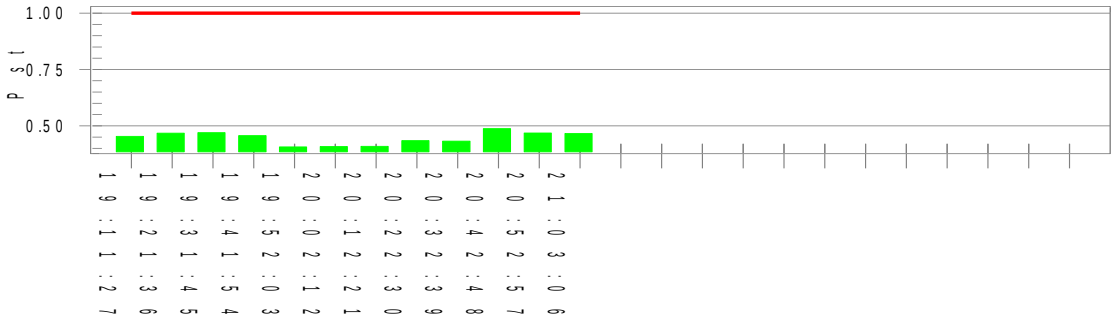
9.5 Plots/Data:

Flicker Test Summary per EN/IEC61000-3-3 Ed. 3.0 (2013) (Run time)

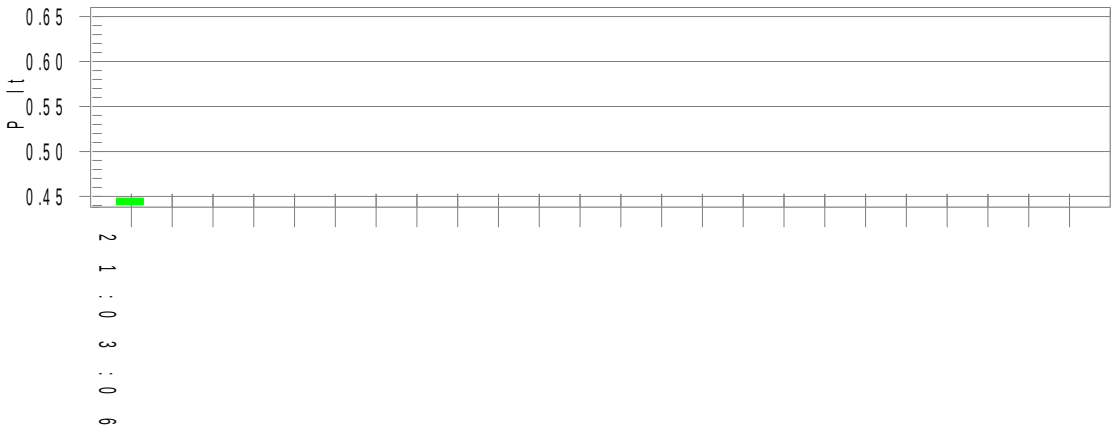
EUT: LulzBot Mini 2 3D Printer **Tested by: Melvin Sanchez**
Test category: All parameters (European limits) **Test Margin: 100**
Test date: 3/12/2018 **Start time: 7:00:57 PM** **End time: 9:03:07 PM**
Test duration (min): 120 **Data file name: F-000027.cts_data**
Comment: Printing Mode
Customer: Aleph Objects

Test Result: Pass **Status: Test Completed**

Pst_i and limit line **European Limits**



Plt and limit line



Parameter values recorded during the test:

Vrms at the end of test (Volt):	**230.01**			
Highest dt (%):	**0.00**	**Test limit (%):**	**N/A**	**N/A**
T-max (mS):	**0**	**Test limit (mS):**	**500.0**	**Pass**
Highest dc (%):	**0.00**	**Test limit (%):**	**3.30**	**Pass**
Highest dmax (%):	**0.15**	**Test limit (%):**	**4.00**	**Pass**
Highest Pst (10 min. period):	**0.488**	**Test limit:**	**1.000**	**Pass**
Highest Plt (2 hr. period):	**0.448**	**Test limit:**	**0.650**	**Pass**

10 Electrostatic Discharge Immunity Test

10.1 Method

Tests are performed in accordance with EN 61000-4-2.

TEST SITE: Lake Forest EMC Lab

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 380, and 440 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

10.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
000898	Power Source	TESEQ	5001IX-CTS-208-411-	1337A01349 (1)	12/26/2017	12/26/2018
000899	Power Conditioner	TESEQ	CTS (CCN-1000-1)	1337A01349 (2)	12/26/2017	12/26/2018
001014	Lab Monitor	Omega	iBTHX-W	0480395	12/20/2017	12/20/2018

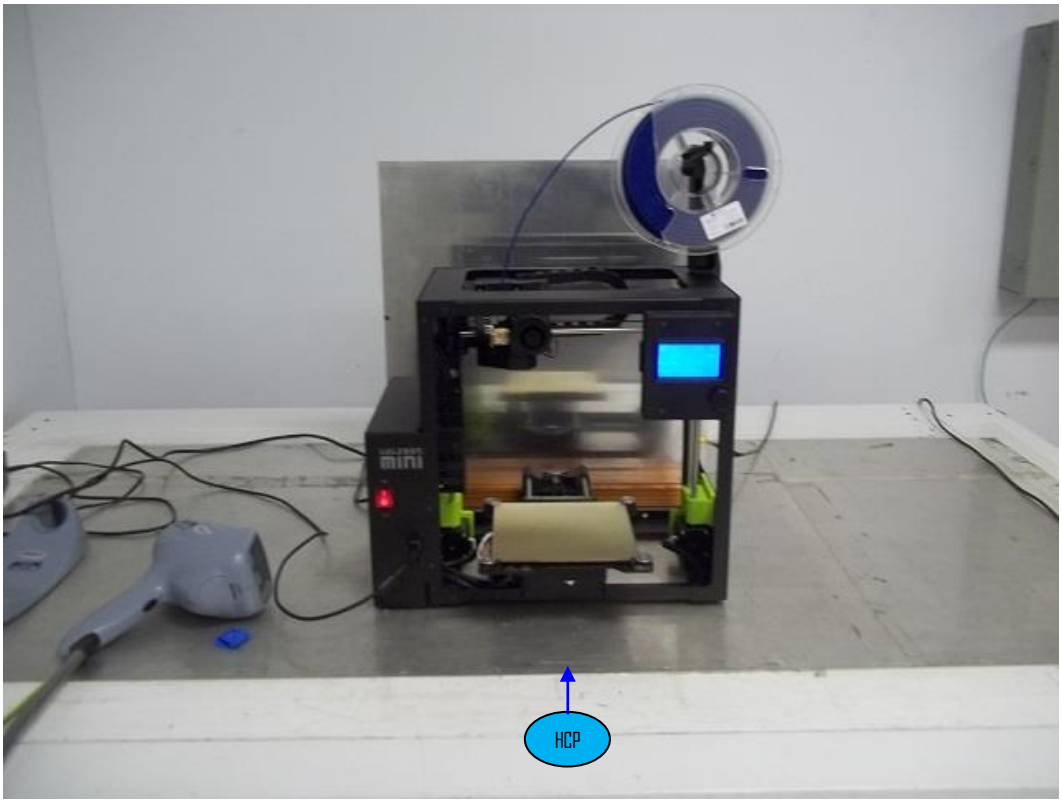
Software Utilized:

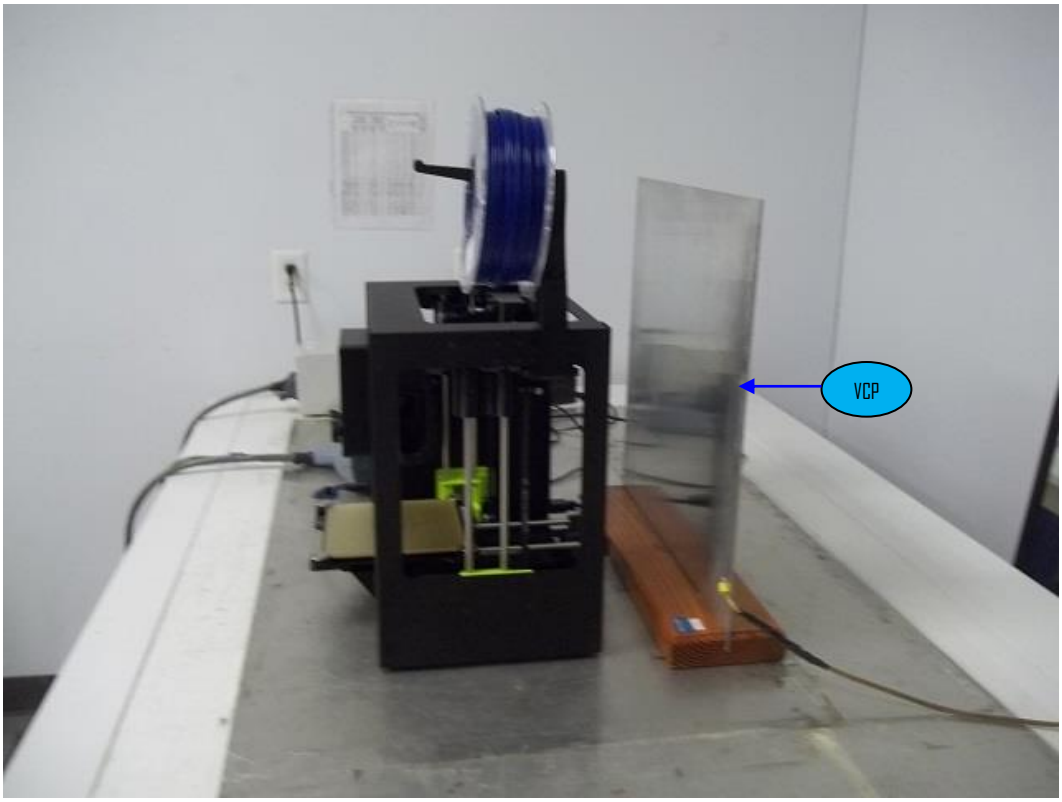
Name	Manufacturer	Version
None	N/A	N/A

10.3 Results:

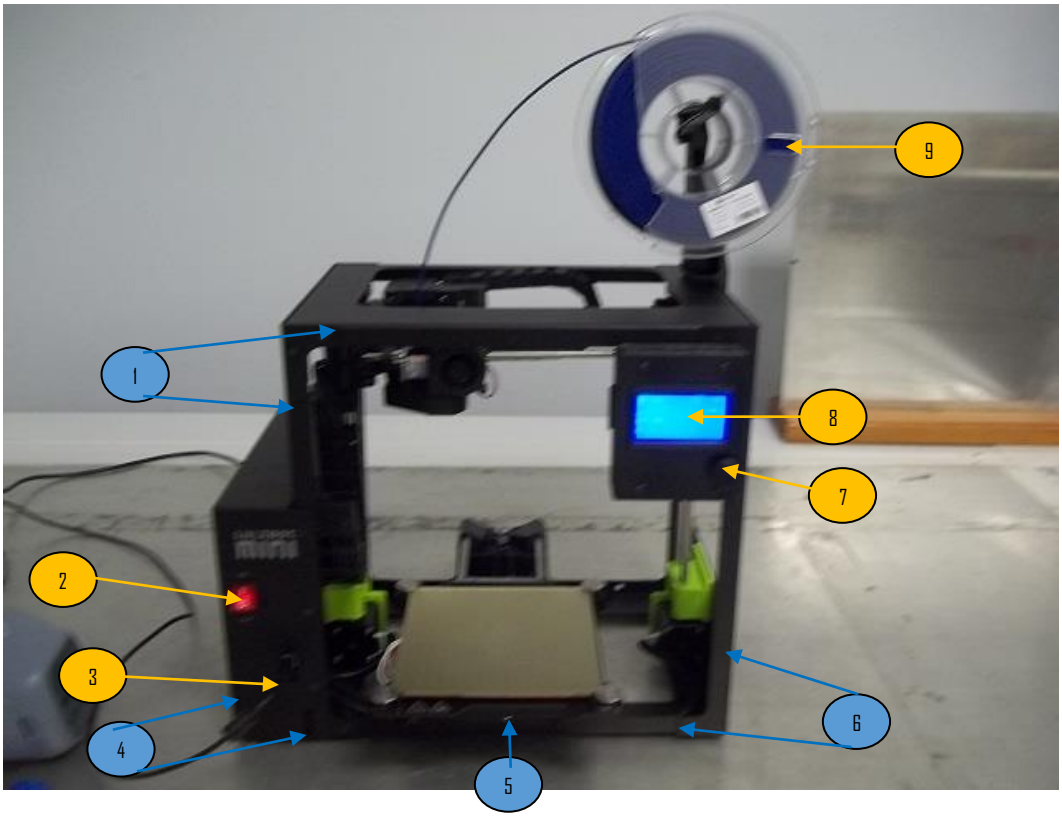
The sample tested was found to Comply.

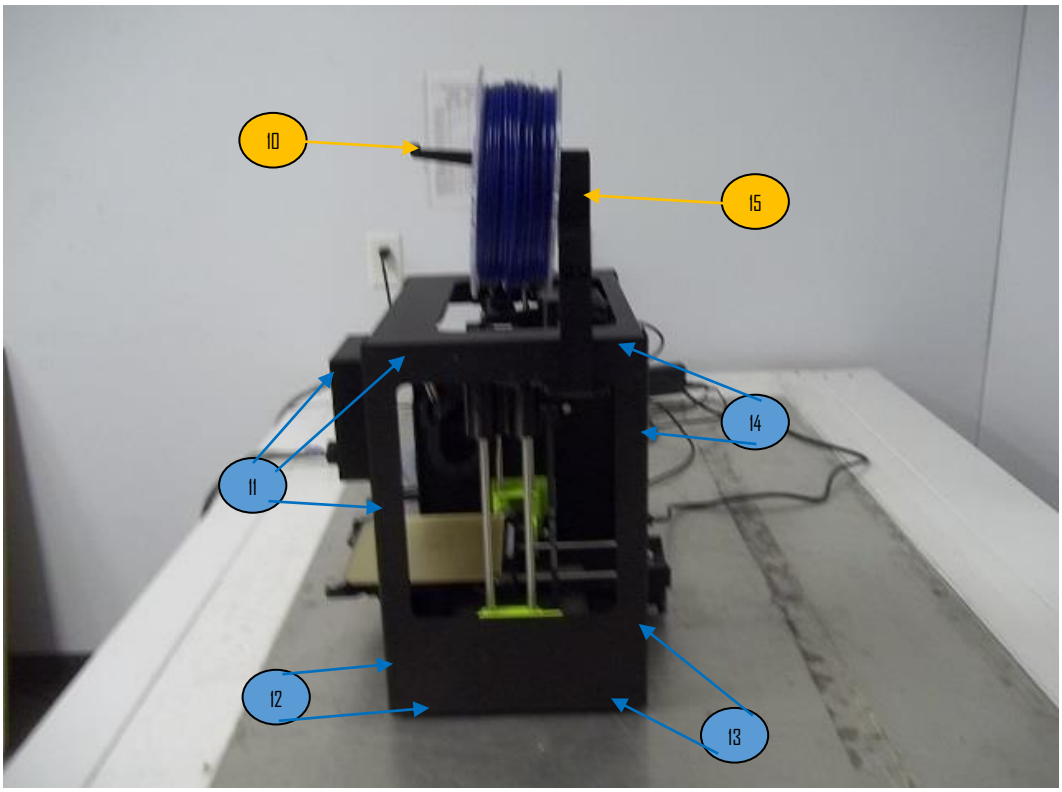
10.4 Setup Photographs:



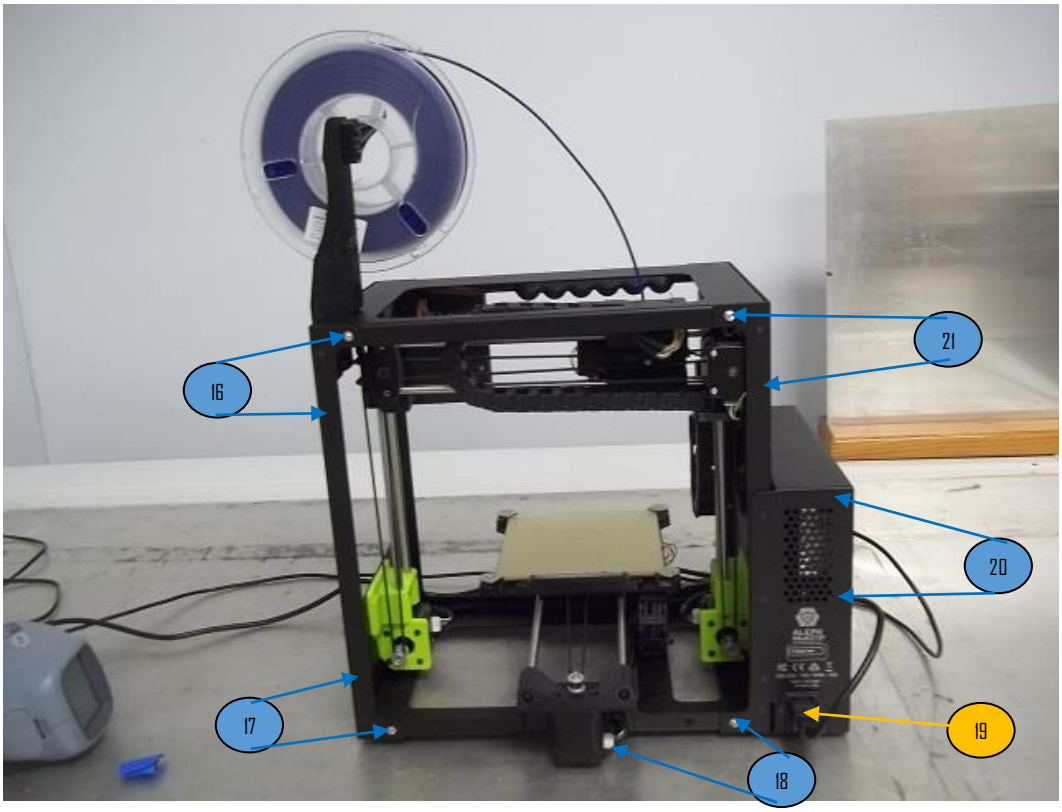


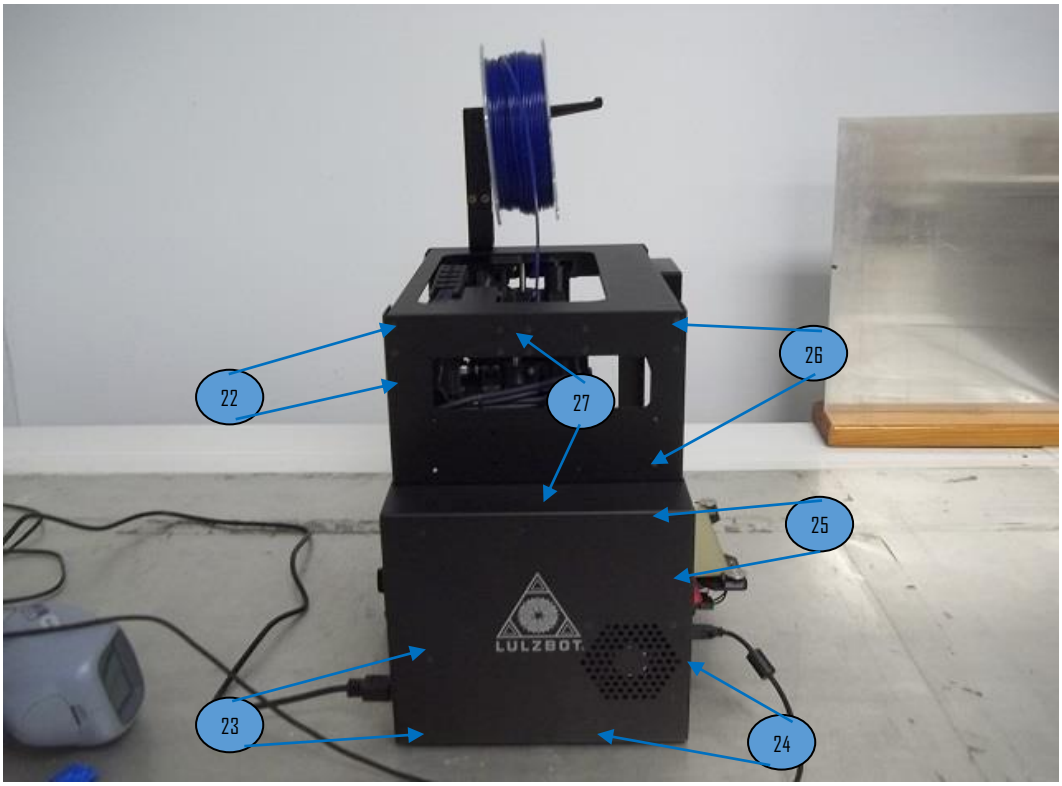
10.5 ESD Test Points:



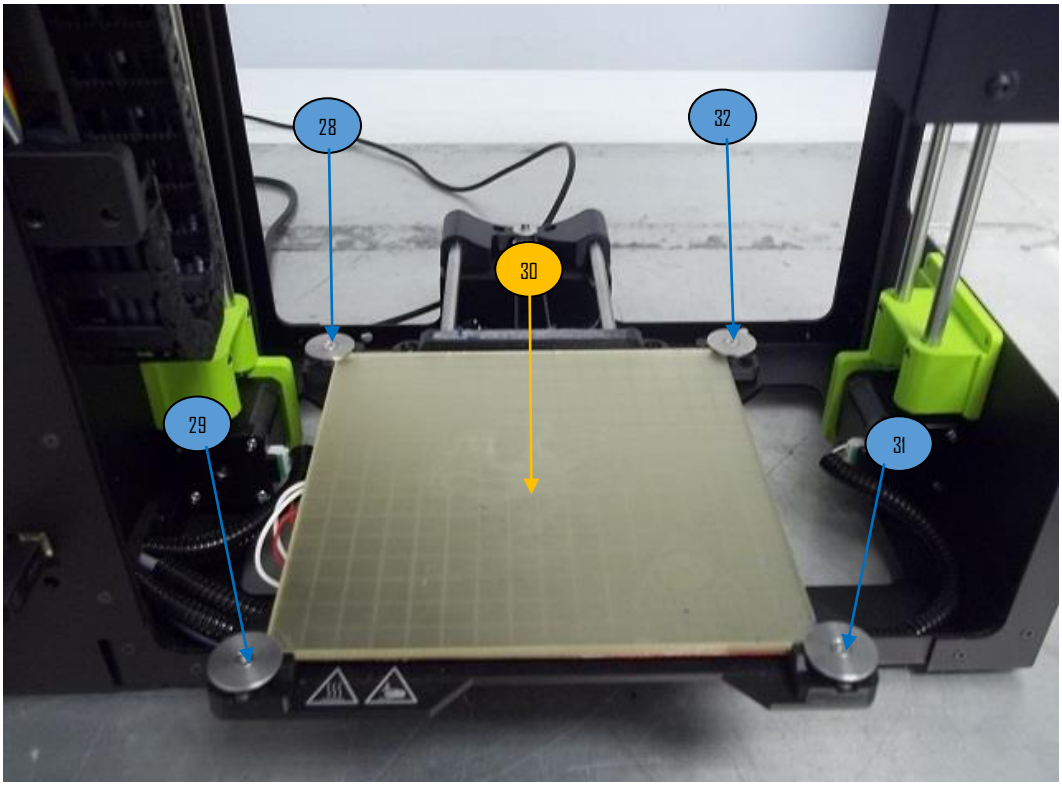


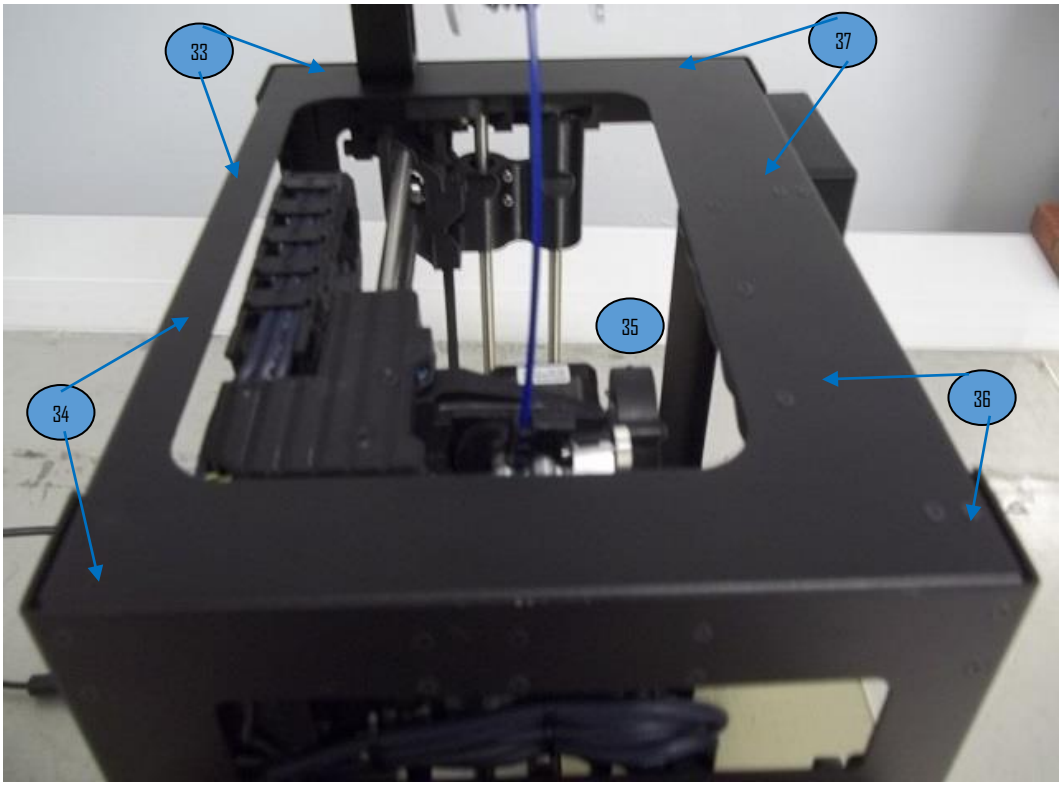
10.6 ESD Test Points:





10.7 ESD Test Points:





10.8 Data:

Test Personnel:	Melvin Sanchez	Test Date:	03/20/2018
Supervising/Reviewing Engineer: (Where Applicable)	Meak Nget	Required Performance:	B
Product Standard:	EN 55024	Test Levels:	See Table Below
Input Voltage:	230VAC/50Hz		
		Ambient Temperature:	20.6 ºC
Waveform Verified on Oscilloscope:	**No**	Relative Humidity:	53 %
470k x 2 Strap(s) Verified:	940kΩ	Atmospheric Pressure:	992 mbars

Test Point	Discharge Voltage Type	Test Voltages, Polarities and Result Classification												
		2 kV		4 kV		6 kV		8 kV			15 kV		__ kV	
		Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg		Pos	Neg	Pos	Neg
HCP	Contact			(A)	(A)									
VCP	Contact			(A)	(A)									
1	Contact			(A)	(A)									
2	Air	(A)	(A)	(A)	(A)			(A)	(A)					
3	Air	(A)	(A)	(A)	(A)			(A)	(A)					
4	Contact			(A)	(A)									
5	Contact			(A)	(A)									
6	Contact			(A)	(A)									
7	Air	(A)	(A)	(A)	(A)			(A)	(A)					
8	Air	(A)	(A)	(A)	(A)			(A)	(A)					
9	Air	(A)	(A)	(A)	(A)			(A)	(A)					
10	Air	(A)	(A)	(A)	(A)			(A)	(A)					
11	Contact			(A)	(A)									
12	Contact			(A)	(A)									
13	Contact			(A)	(A)									
14	Contact			(A)	(A)									
15	Air	(A)	(A)	(A)	(A)			(A)	(A)					
16	Contact			(A)	(A)									
17	Contact			(A)	(A)									
18	Contact			(A)	(A)									
19	Air	(A)	(A)	(A)	(A)			(A)	(A)					
20	Contact			(A)	(A)									
21	Contact			(A)	(A)									
22	Contact			(A)	(A)									
23	Contact			(A)	(A)									
24	Contact			(A)	(A)									
25	Contact			(A)	(A)									
26	Contact			(A)	(A)									
27	Contact			(A)	(A)									
28	Contact			(A)	(A)									
29	Contact			(A)	(A)									
30	Air	(A)	(A)	(A)	(A)			(A)	(A)					
31	Contact			(A)	(A)									
32	Contact			(A)	(A)									
33	Contact			(A)	(A)									
34	Contact			(A)	(A)									
35	Contact			(A)	(A)									
36	Contact			(A)	(A)									
37	Contact			(A)	(A)									

Air Discharges only above 8 kV

Note 1: (A) The EUT met the requirements without any degradation of performance.

Criteria	*During Test*	*After Test*
A	➢ Shall operate as intended ➢ May show degradation of performance (Note 1) ➢ Shall be no loss of function ➢ Shall be no unintentional transmissions	➢ Shall operate as intended ➢ Shall be no degradation of performance (Note 1) ➢ Shall be no loss function ➢ Shall be no loss of stored data or user programmable functions
B	➢ May show loss of function (one or more) ➢ May show degradation of performance (Note 1) ➢ No unintentional transmissions	➢ Functions shall be self-recoverable ➢ Shall operate as intended after recovering ➢ Shall be no loss of stored data or user programmable functions
C	➢ May show loss of function (one or more)	➢ Functions shall be recoverable by the operator ➢ Shall operate as intended after recovering ➢ Shall be no degradation of performance (Note 1)
Note 1: *Degradation of performance during the test is understood as degradation to a level not below a minimum performance level specified by the manufacturer.*		

Deviations, Additions, or Exclusions: None

11 Radiated, radio-frequency, electromagnetic field immunity test

11.1 Method

Tests are performed in accordance with EN 61000-4-3.

TEST SITE: Lake Forest EMC Lab

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 380, and 440 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

11.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
001561	Laser Probe Interface	Amplifier Research	FL7000	0343710	VBU 03/15/2018	VBU 03/15/2018
001091	High Frequency Antenna	AR	ATR80M6G	0337665	VBU 03/15/2018	VBU 03/15/2018
001155	Power Meter	Agilent	E4418B	MY45104449	03/31/2017	03/31/2018
000702	Single Channel Peak Power Meter.	Agilent	E4416A	GB41292577	01/03/2017	01/03/2018
001573	Power Meter Dual Channel	Frankonia	PMS_1084	1081298/2015	10/11/2017	10/11/2018
000721	50 Ohm, 50 W termination	Weinschel	F1426	BJ3475	VBU 03/15/2018	VBU 03/15/2018
001571	Dual Directional Coupler 80 -1000Mhz	Werlatone	C3908-22	107868	11/02/2017	11/02/2018
001570	Amplifier 80 - 1000Mhz	Ophir	5200525	1001/1539	VBU 03/15/2018	VBU 03/15/2018
001519	Signal Generator 9Khz - 6Ghz	Rohde & Schwarz	SMA 100A	100593	09/19/2017	09/19/2018
001010	Field Monitor	ETS Lindgren	FM 5004	00128845	VBU 03/15/2018	VBU 03/15/2018
001092	Tripod	AR	TP1000B	0336437	VBU 03/15/2018	VBU 03/15/2018
001575	7/16 Din Cable	Fairview Microwave	FMC0115400-96	none	VBU 03/15/2018	VBU 03/15/2018
001560	Field Probe 2Mhz - 40Ghz	Amplifier Research	FL7040	0343339	09/08/2017	09/08/2018
001513	Immunity Cable	Megaphase	TM8-N1N1-72-2	15023801002	VBU 03/15/2018	VBU 03/15/2018
001574	7/16 Din Cable Male - Male	Fairview Microwave	FMC1515405-36	None	VBU 03/15/2018	VBU 03/15/2018
001014	Lab Monitor	Omega	iBTHX-W	0480395	12/20/2017	12/20/2018

VBU= Verified Before Used

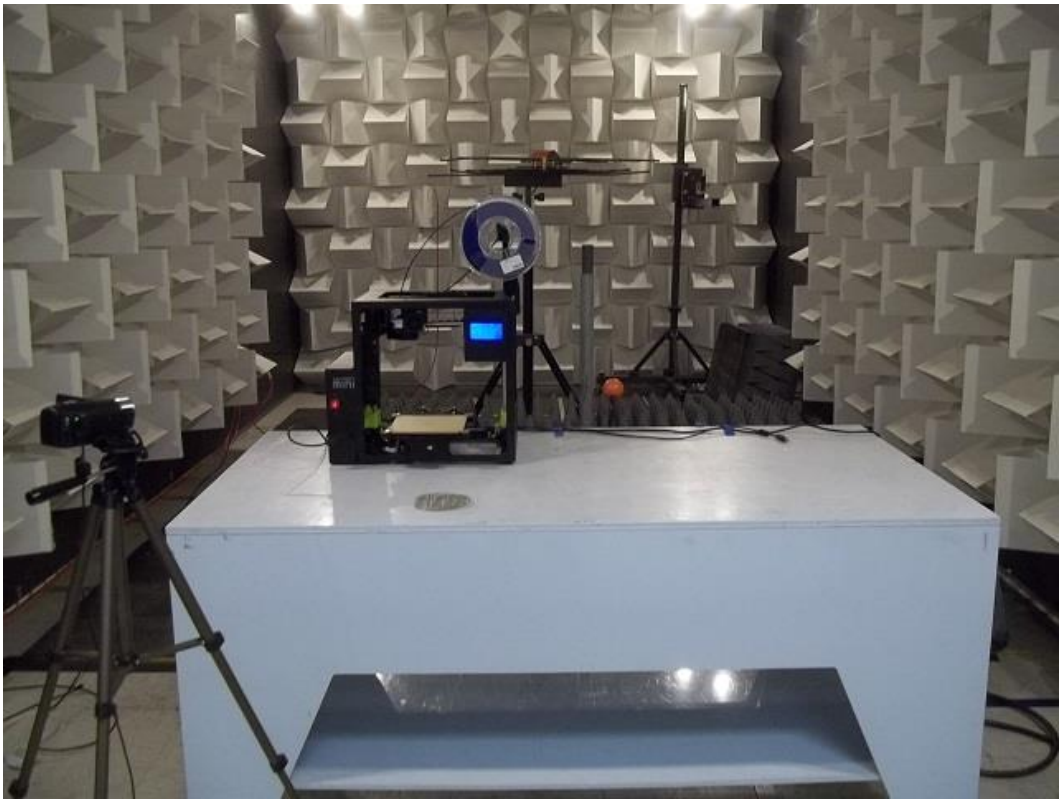
Software Utilized:

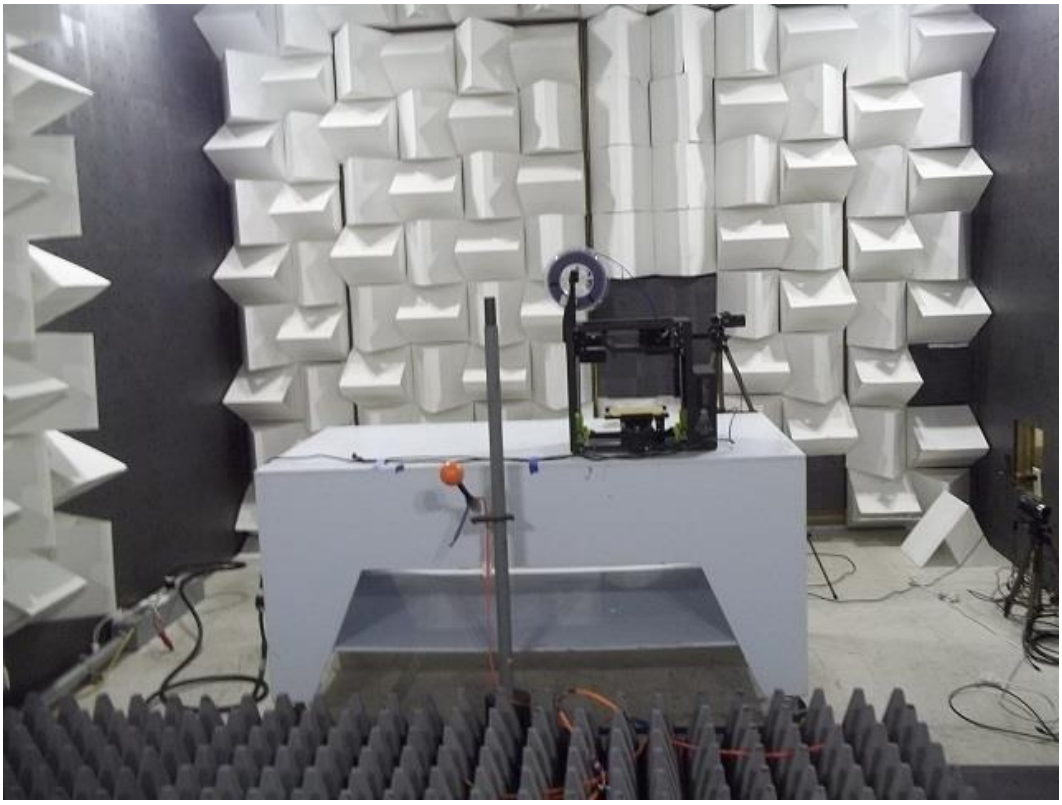
Name	Manufacturer	Version
Tile	Quantum Change	3.4.k.29

11.3 Results:

The sample tested was found to Comply.

11.4 Setup Photographs:





11.5 Data:

Test Personnel:	Melvin Sanchez	Test Date:	03/15/2018
Supervising/Reviewing Engineer: (Where Applicable)	Meak Nget	Modulation:	80% AM @ 1KHz Sine Wave, 1% Step Size, 3s Dwell Time
Product Standard:	EN 55024	Required Performance:	A
Input Voltage:	230VAC/50Hz	Test Levels:	See Table Below
		Ambient Temperature:	20.6 ºC
Field Level Monitored:	**3 V/m**	Relative Humidity:	53.1 %
		Atmospheric Pressure:	X992.3 mbars

Field Level (V/m)	Frequency Range MHz	Antenna Polarity, Azimuths and Result Classification							
		Vertical				Horizontal			
		0	90	180	270	0	90	180	270
3	80-1000	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)
3	80, 120, 160, 230, 434, 460, 600, 863, 900	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)

Note 1: (A) The EUT met the requirements without any degradation of performance.

Criteria	*During Test*	*After Test*
A	➢ Shall operate as intended ➢ May show degradation of performance (Note 1) ➢ Shall be no loss of function ➢ Shall be no unintentional transmissions	➢ Shall operate as intended ➢ Shall be no degradation of performance (Note 1) ➢ Shall be no loss function ➢ Shall be no loss of stored data or user programmable functions
B	➢ May show loss of function (one or more) ➢ May show degradation of performance (Note 1) ➢ No unintentional transmissions	➢ Functions shall be self-recoverable ➢ Shall operate as intended after recovering ➢ Shall be no loss of stored data or user programmable functions
C	➢ May show loss of function (one or more)	➢ Functions shall be recoverable by the operator ➢ Shall operate as intended after recovering ➢ Shall be no degradation of performance (Note 1)
Note 1: *Degradation of performance during the test is understood as degradation to a level not below a minimum performance level specified by the manufacturer.*		

Deviations, Additions, or Exclusions: None

12 Electrical Fast Transient/Burst Immunity Test

12.1 Method

Tests are performed in accordance with EN 61000-4-4.

TEST SITE: Lake Forest EMC Lab

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 380, and 440 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

12.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
001145	EFT Coupler / De-Coupler	ThermoFischer	CM-3CD-EFT	1112263	06/01/2017	06/01/2018
001315	EFT/Surge Generator	Thermo KeyTek	EMC Pro-Plus	1303285	06/01/2017	06/01/2018
001014	Lab Monitor	Omega	iBTHX-W	0480395	12/20/2017	12/20/2018

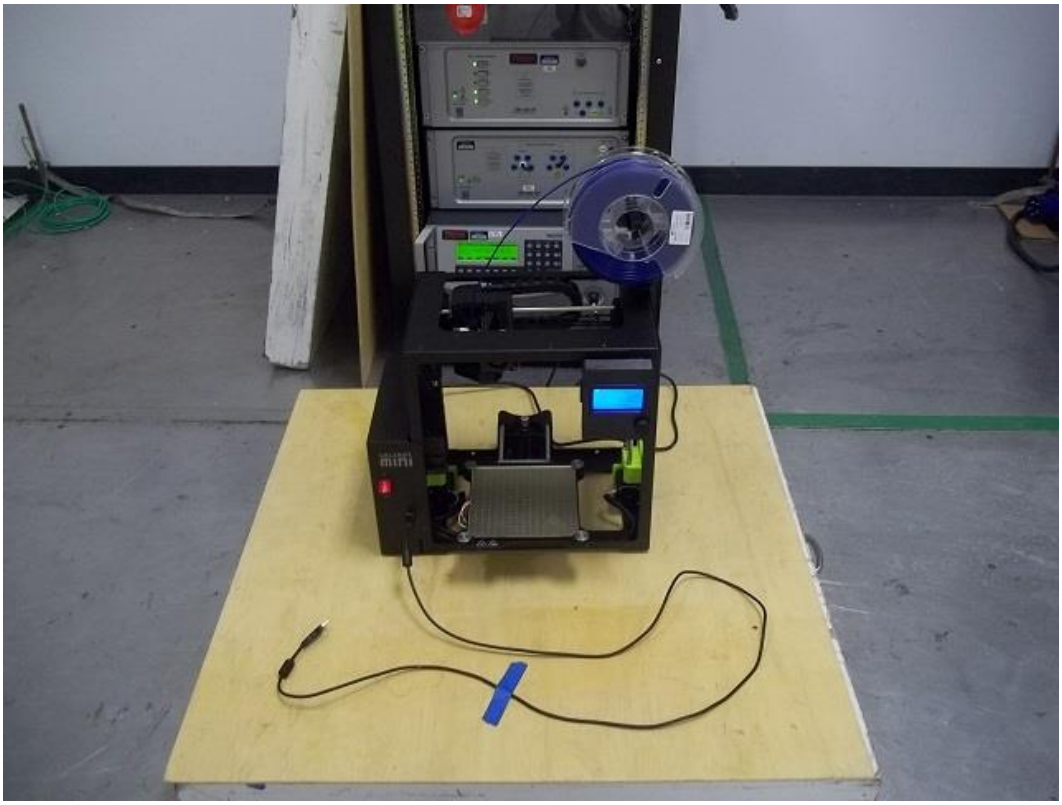
Software Utilized:

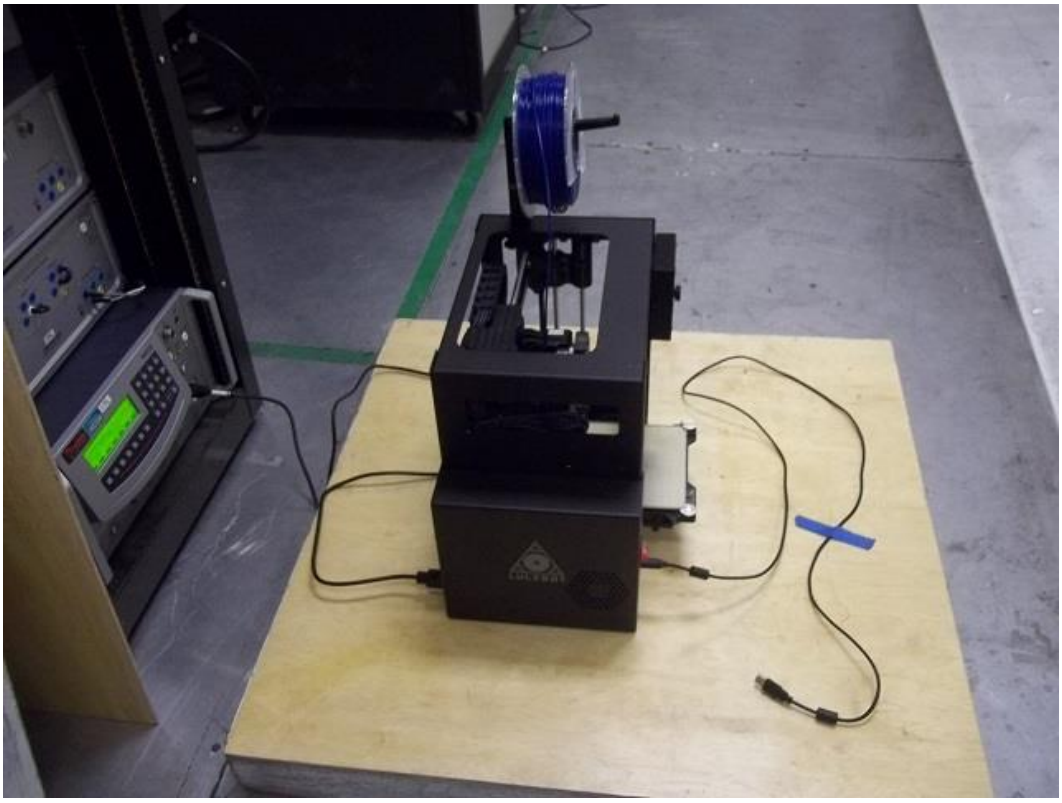
Name	Manufacturer	Version
None	N/A	N/A

12.3 Results:

The sample tested was found to Comply.

12.4 Setup Photographs:





12.5 Test Data:

Test Personnel:	Melvin Sanchez	Test Date:	03/16/2018
Supervising/Reviewing Engineer: (Where Applicable)	Meak Nget	Pulse Repetition Frequency:	5 kHz
		Required Performance:	B
Product Standard:	EN 55024	Test Levels:	See Table Below
Input Voltage:	230VAC/50Hz	Ambient Temperature:	20.7 ºC
Waveform Verified on Oscilloscope:	**No**	Relative Humidity:	53.1 %
		Atmospheric Pressure:	992.3 mbars

Test Point	Coupling Method	Test Voltages, Polarities, and Result Classification									
		0.25kV		0.5kV		1 kV		2 kV		4 kV	
		pos	neg	pos	neg	pos	neg	pos	neg	pos	neg
Power L1	Direct			(A)	(A)	(A)	(A)				
Power L2	Direct			(A)	(A)	(A)	(A)				
Power PE	Direct			(A)	(A)	(A)	(A)				

Note 1: (A) The EUT met the requirements without any degradation of performance.

Criteria	***During Test***	***After Test***
A	➢ Shall operate as intended ➢ May show degradation of performance (Note 1) ➢ Shall be no loss of function ➢ Shall be no unintentional transmissions	➢ Shall operate as intended ➢ Shall be no degradation of performance (Note 1) ➢ Shall be no loss function ➢ Shall be no loss of stored data or user programmable functions
B	➢ May show loss of function (one or more) ➢ May show degradation of performance (Note 1) ➢ No unintentional transmissions	➢ Functions shall be self-recoverable ➢ Shall operate as intended after recovering ➢ Shall be no loss of stored data or user programmable functions
C	➢ May show loss of function (one or more)	➢ Functions shall be recoverable by the operator ➢ Shall operate as intended after recovering ➢ Shall be no degradation of performance (Note 1)
Note 1: *Degradation of performance during the test is understood as degradation to a level not below a minimum performance level specified by the manufacturer.*		

Deviations, Additions, or Exclusions: None

13 Immunity to Surge

13.1 Method

Tests are performed in accordance with EN 61000-4-5.

TEST SITE: Lake Forest EMC Lab

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 380, and 440 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

13.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
001145	EFT Coupler / De-Coupler	ThermoFischer	CM-3CD-EFT	1112263	06/01/2017	06/01/2018
001315	EFT/Surge Generator	Thermo KeyTek	EMC Pro-Plus	1303285	06/01/2017	06/01/2018
001014	Lab Monitor	Omega	iBTHX-W	0480395	12/20/2017	12/20/2018

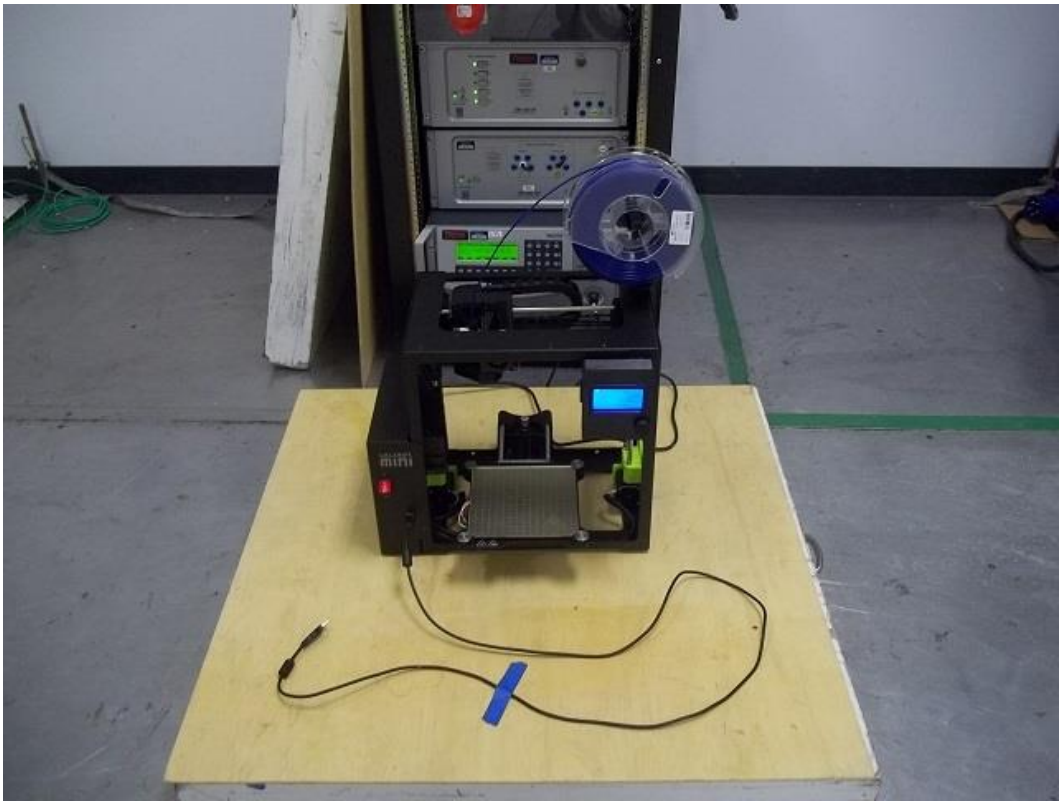
Software Utilized:

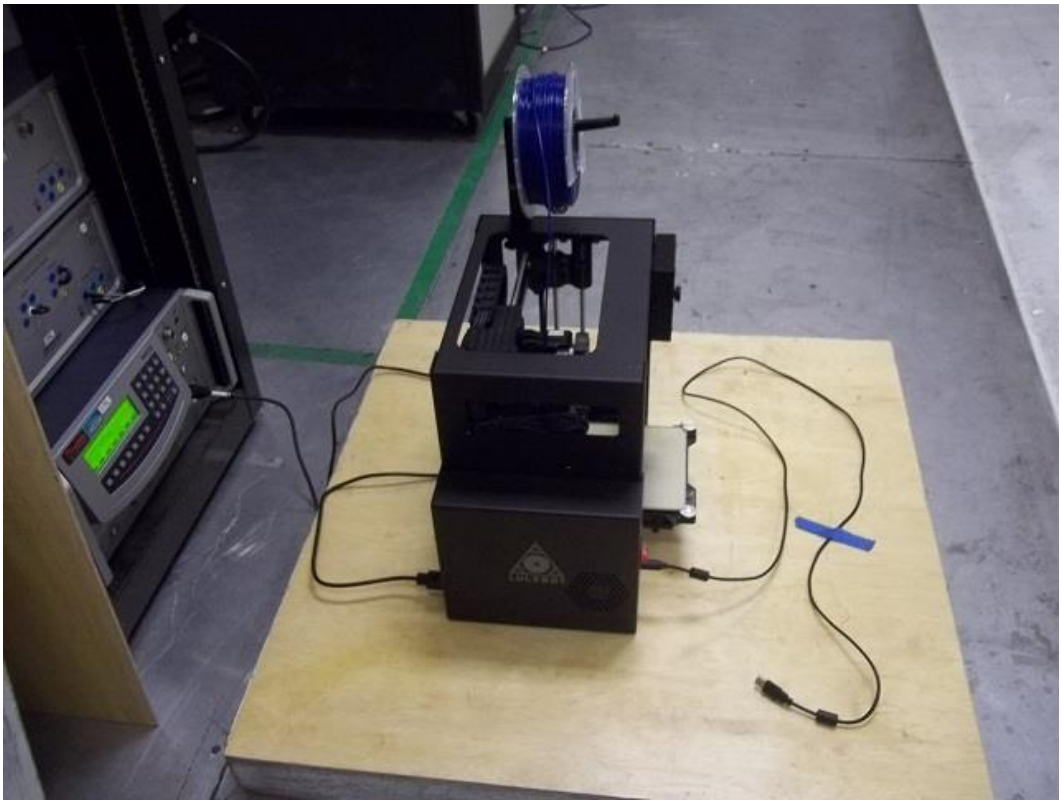
Name	Manufacturer	Version
None	N/A	N/A

13.3 Results:

The sample tested was found to Comply.

13.4 Setup Photographs:





13.5 Test Data:

Test Personnel:	Melvin Sanchez	Test Date:	03/16/2018
Supervising/Reviewing Engineer: (Where Applicable)	Meak Nget	Required Performance:	B
Product Standard:	EN 55024	Test Levels:	See Table Below
Input Voltage:	230VAC/50Hz	Ambient Temperature:	20.7 ºC
Waveform Verified on Oscilloscope:	**No**	Relative Humidity:	53.1 %
		Atmospheric Pressure:	992.3 mbars

	Test Voltages, Polarities, and Result Classification							
	0.5kV		1kV		2kV		4kV	
Test	pos	neg	pos	neg	pos	neg	pos	neg
L1-PE, at 0 deg	(A)	(A)	(A)	(A)	(A)	(A)		
L1-PE, at 90 deg	(A)	(A)	(A)	(A)	(A)	(A)		
L1-PE, at 180 deg	(A)	(A)	(A)	(A)	(A)	(A)		
L1-PE, at 270 deg	(A)	(A)	(A)	(A)	(A)	(A)		
N-PE, at 0 deg	(A)	(A)	(A)	(A)	(A)	(A)		
N-PE, at 90 deg	(A)	(A)	(A)	(A)	(A)	(A)		
N-PE, at 180 deg	(A)	(A)	(A)	(A)	(A)	(A)		
N-PE, at 270 deg	(A)	(A)	(A)	(A)	(A)	(A)		
L1-N, at 0 deg	(A)	(A)	(A)	(A)				
L1-N, at 90 deg	(A)	(A)	(A)	(A)				
L1-N, at 180 deg	(A)	(A)	(A)	(A)				
L1-N, at 270 deg	(A)	(A)	(A)	(A)				

Note 1: (A) The EUT met the requirements without any degradation of performance.

Criteria	***During Test***	***After Test***
A	➢ Shall operate as intended ➢ May show degradation of performance (Note 1) ➢ Shall be no loss of function ➢ Shall be no unintentional transmissions	➢ Shall operate as intended ➢ Shall be no degradation of performance (Note 1) ➢ Shall be no loss function ➢ Shall be no loss of stored data or user programmable functions
B	➢ May show loss of function (one or more) ➢ May show degradation of performance (Note 1) ➢ No unintentional transmissions	➢ Functions shall be self-recoverable ➢ Shall operate as intended after recovering ➢ Shall be no loss of stored data or user programmable functions
C	➢ May show loss of function (one or more)	➢ Functions shall be recoverable by the operator ➢ Shall operate as intended after recovering ➢ Shall be no degradation of performance (Note 1)
Note 1: *Degradation of performance during the test is understood as degradation to a level not below a minimum performance level specified by the manufacturer.*		

Deviations, Additions, or Exclusions: None

14 Conducted, radio-frequency, electromagnetic field immunity test

14.1 Method

Tests are performed in accordance with EN 61000-4-6.

TEST SITE: Lake Forest EMC Lab

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 380, and 440 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

14.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
000512	RF Power Amp	IFI	SMX100	D302081	VBU 03/19/2018	VBU 03/19/2018
001668	Signal Generator 9KHz - 6GHz	Rhode & Schwarz	SMA100A	113777	09/21/2017	09/21/2018
001512	Conducted Immunity Cable	Megaphase	TM8-N1N1-72-2	15023801001	VBU 03/19/2018	VBU 03/19/2018
001280	Power Sensor	Boonton Electronics	51013-4E	35910	08/01/2017	08/01/2018
000526	Current Probe	Fischer CC	F-52	9	06/19/2017	06/19/2018
001278	Power Sensor	Boonton Electronics	51013-4E	35846	08/01/2017	08/01/2018
001134	Dual Direction Coupler	Werlatone	C5571-10	96659	05/25/2017	05/25/2018
001469	Attenuator	Pasternack	PE7021-6	none	VBU 03/19/2018	VBU 03/19/2018
000528	Coup.Decoup.Network	Fischer CC	FCC-801-M3-25	99	06/20/2017	06/20/2018
001514	Immunity cable	Megaphase	TM8-N1N1-102-2	15023802001	VBU 03/19/2018	VBU 03/19/2018
001510	Radiated Immunity RF Cable	Megaphase	TM8-N1N1-120-2	15015302001	VBU 03/19/2018	VBU 03/19/2018
001014	Lab Monitor	Omega	iBTHX-W	0480395	12/20/2017	12/20/2018

VBU=Verified Before Used

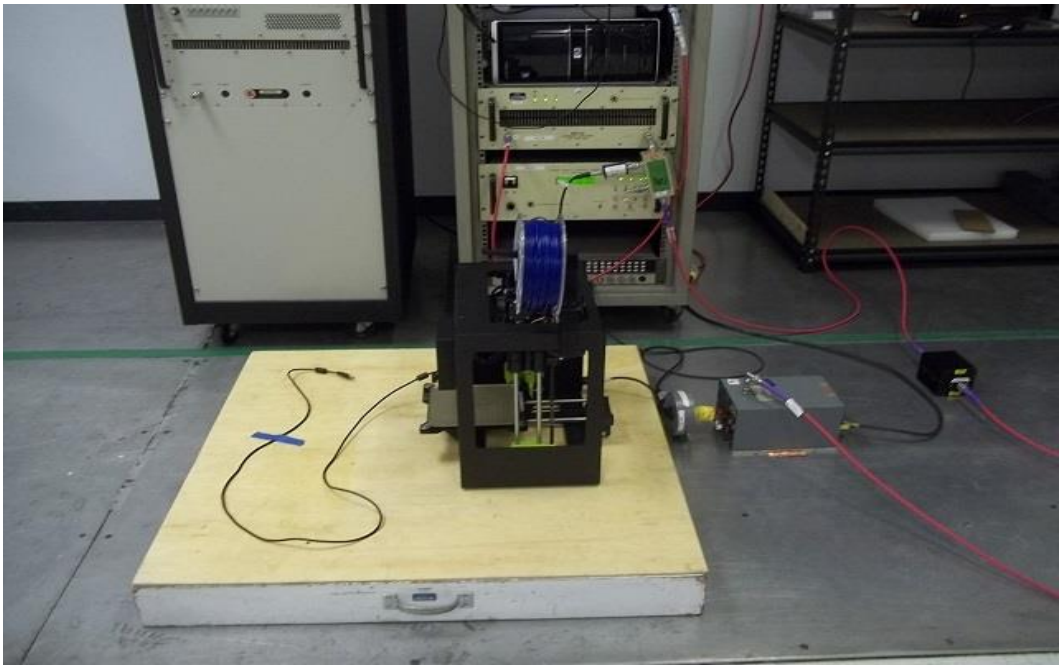
Software Utilized:

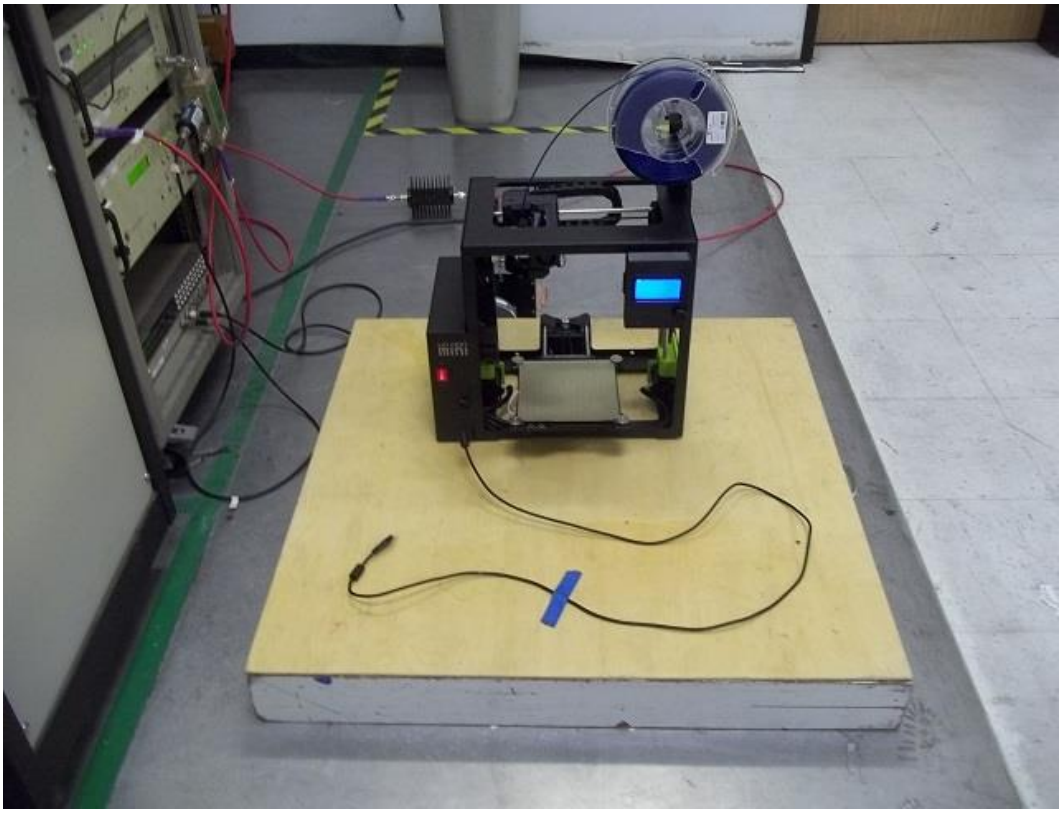
Name	Manufacturer	Version
Tile	Quantum Change	3.4.k.29

14.3 Results:

The sample tested was found to Comply.

14.4 Setup Photographs:





14.5 Test Data:

Test Personnel:	Melvin Sanchez	Test Date:	03/19/2018
Supervising/Reviewing Engineer: (Where Applicable)	Meak Nget	Modulation:	80% AM @ 1KHz Sine Wave, 1% Step Size, 3s Dwell Time
Product Standard:	EN 55024	Required Performance:	A
Input Voltage:	230VAC/50Hz	Test Levels:	See Table Below
Test Level Verification Performed:	**No**	Ambient Temperature:	20.7 ºC
		Relative Humidity:	53 %
		Atmospheric Pressure:	992.3 mbars

Injection Device Type	Frequency Range (MHz)	Port Description	Test Level (Vrms)	Result Classification
CDN	0.15-80	Mains AC Cable	3	(A)
CDN	0.2, 1, 7.1, 13.56, 21, 27.12, 40.68	Mains AC Cable	3	(A)

Notes: (A) The EUT met the requirements without any degradation of performance.

Criteria	*During Test*	*After Test*
A	➢ Shall operate as intended ➢ May show degradation of performance (Note 1) ➢ Shall be no loss of function ➢ Shall be no unintentional transmissions	➢ Shall operate as intended ➢ Shall be no degradation of performance (Note 1) ➢ Shall be no loss function ➢ Shall be no loss of stored data or user programmable functions
B	➢ May show loss of function (one or more) ➢ May show degradation of performance (Note 1) ➢ No unintentional transmissions	➢ Functions shall be self-recoverable ➢ Shall operate as intended after recovering ➢ Shall be no loss of stored data or user programmable functions
C	➢ May show loss of function (one or more)	➢ Functions shall be recoverable by the operator ➢ Shall operate as intended after recovering ➢ Shall be no degradation of performance (Note 1)
Note 1: *Degradation of performance during the test is understood as degradation to a level not below a minimum performance level specified by the manufacturer.*		

Deviations, Additions, or Exclusions: None

15 Power Frequency Magnetic Field Immunity Test

15.1 Method

Tests are performed in accordance with EN 61000-4-8.

TEST SITE: Lake Forest EMC Lab

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 380, and 440 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

15.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
000630	AC Current Clamp	Fluke	i200	none	02/28/2018	02/28/2019
001106	True RMS Multimeter	Fluke	179	18390472	04/27/2017	04/27/2018
000566	Stepdown X-former	GE	9T51B0410	none	VBU 03/19/2018	VBU 03/19/2018
000559	Immunity Loop	Fischer CC	F-1000-4-8/9/10-L-M	4	VBU 03/19/2018	VBU 03/19/2018
000899	Power Conditioner	TESEQ	CTS (CCN-1000-1)	1337A01349 (2)	12/26/2017	12/26/2018
000898	Power Source	TESEQ	5001IX-CTS-208-411-	1337A01349 (1)	12/26/2017	12/26/2018
001132	Exposure Level Tester	Narda	ELT-400	N-0010	05/01/2017	05/01/2018
001133	B-Field Probe 100 cm2	Narda	2300/90.10	M-0446	05/01/2017	05/01/2018
001014	Lab Monitor	Omega	iBTHX-W	0480395	12/20/2017	12/20/2018

VBU=Verified Before Used

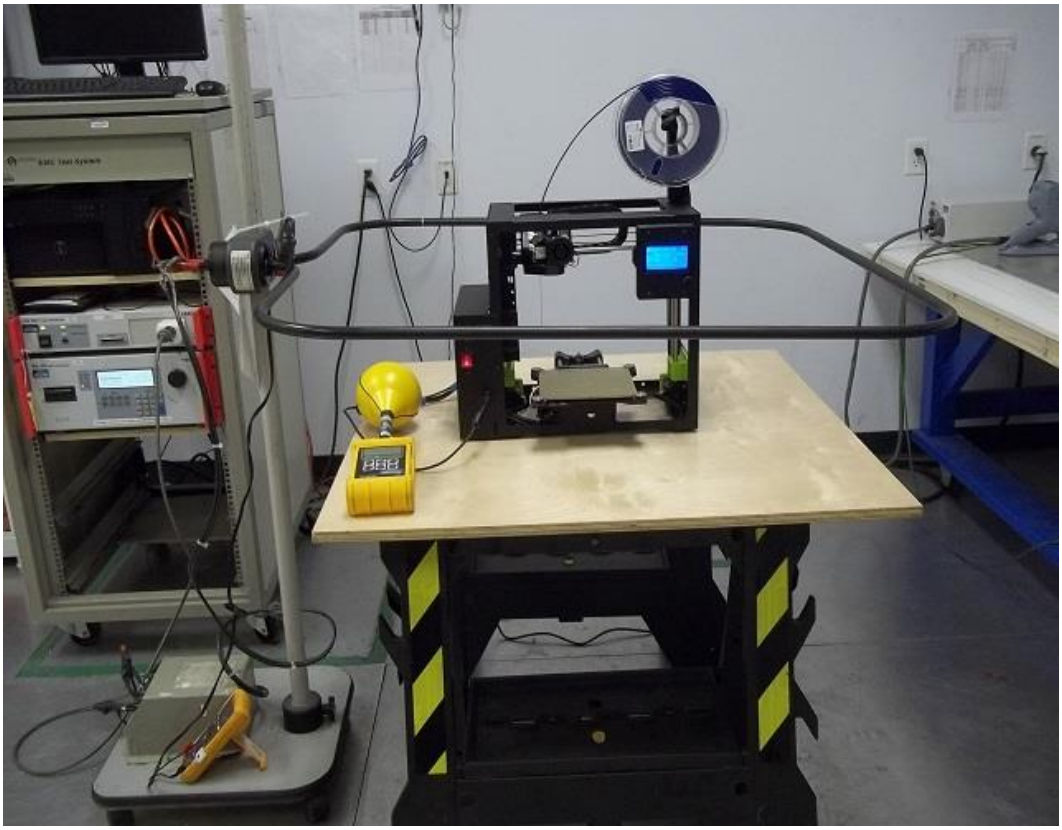
Software Utilized:

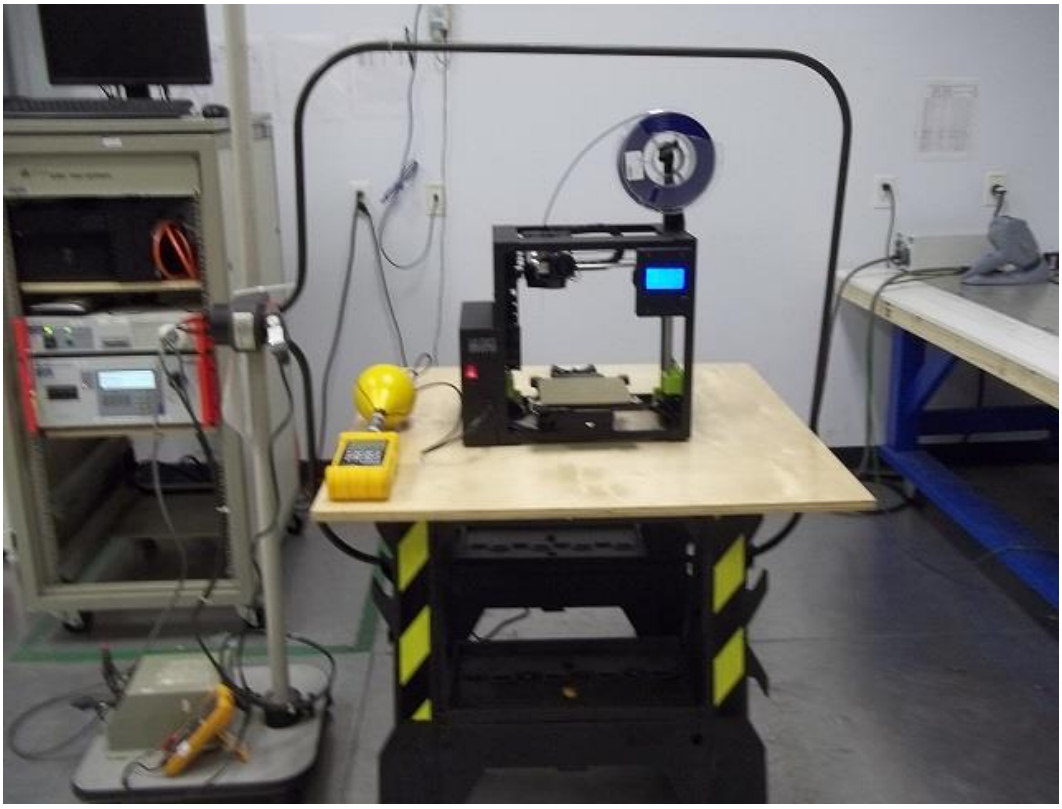
Name	Manufacturer	Version
None	N/A	N/A

15.3 Results:

The sample tested was found to Comply.

15.4 Setup Photographs:





15.5 Test Data:

Test Personnel:	Melvin Sanchez	Test Date:	03/19/2018
Supervising/Reviewing Engineer: (Where Applicable)	Meak Nget	Required Performance:	A
Product Standard:	EN 55024	Test Levels:	See Table Below
Input Voltage:	230VAC/50Hz	Ambient Temperature:	20.7 ºC
Ambient Field Level:	0.277 µT	Relative Humidity:	53 %
Test Field Level Verified:	3.5 µT	Atmospheric Pressure:	992.3 mbars

Test Location/ Mode/ EUT AC Input	Test Level (A/m)	Frequency (Hz)	Result Classification		
			X – Axis	Y – Axis	Z – Axis
Enclosure/Printing Mode/230VAC	1	50	(A)	(A)	(A)

Notes: (A) The EUT met the requirements without any degradation of performance.

Criteria	*During Test*	*After Test*
A	➢ Shall operate as intended ➢ May show degradation of performance (Note 1) ➢ Shall be no loss of function ➢ Shall be no unintentional transmissions	➢ Shall operate as intended ➢ Shall be no degradation of performance (Note 1) ➢ Shall be no loss function ➢ Shall be no loss of stored data or user programmable functions
B	➢ May show loss of function (one or more) ➢ May show degradation of performance (Note 1) ➢ No unintentional transmissions	➢ Functions shall be self-recoverable ➢ Shall operate as intended after recovering ➢ Shall be no loss of stored data or user programmable functions
C	➢ May show loss of function (one or more)	➢ Functions shall be recoverable by the operator ➢ Shall operate as intended after recovering ➢ Shall be no degradation of performance (Note 1)
Note 1: *Degradation of performance during the test is understood as degradation to a level not below a minimum performance level specified by the manufacturer.*		

Deviations, Additions, or Exclusions: None

16 Voltage Dips / Interruptions Immunity Tests

16.1 Method

Tests are performed in accordance with EN 61000-4-11.

TEST SITE: Lake Forest EMC Lab

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 380, and 440 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

16.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
000899	Power Conditioner	TESEQ	CTS (CCN-1000-1)	1337A01349 (2)	12/26/2017	12/26/2018
000898	Power Source	TESEQ	5001IX-CTS-208-411-	1337A01349 (1)	12/26/2017	12/26/2018
001014	Lab Monitor	Omega	iBTHX-W	0480395	12/20/2017	12/20/2018

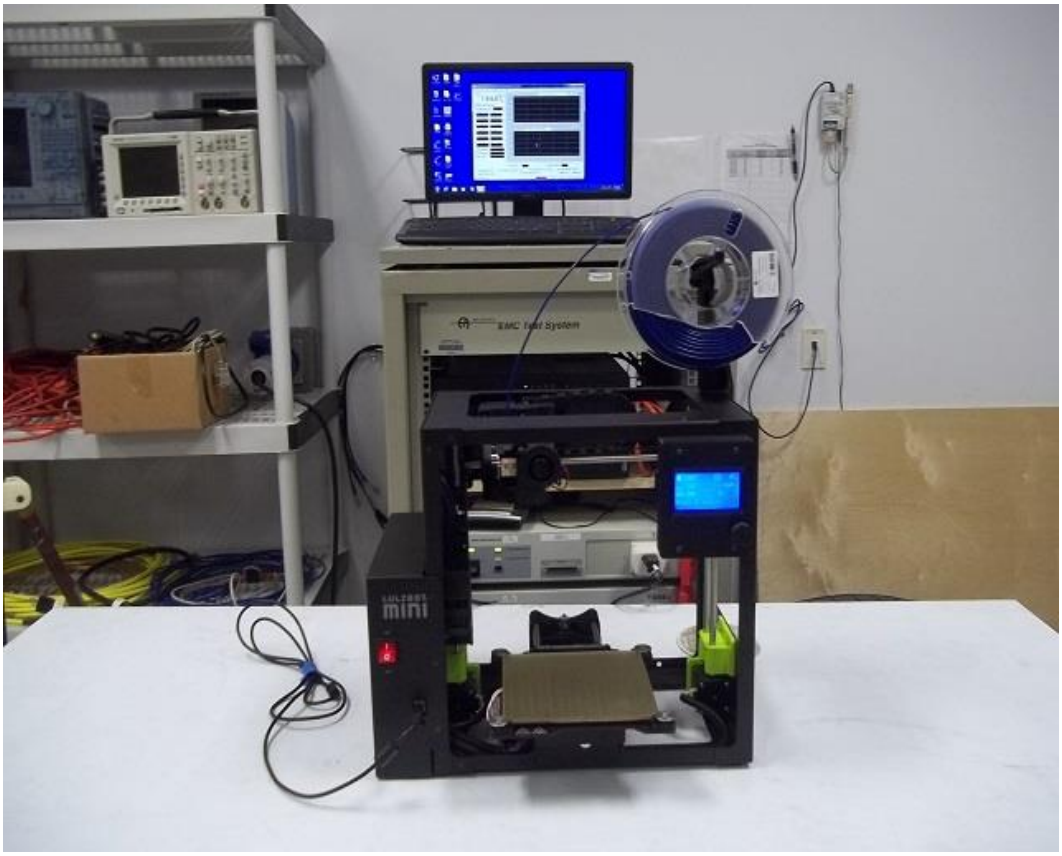
Software Utilized:

Name	Manufacturer	Version
WIN2100	TESEQ	SII

16.3 Results:

The sample tested was found to Comply.

16.4 Setup Photographs:



16.5 Test Data:

Test Personnel:	Melvin Sanchez	Test Date:	03/12/2018
Supervising/Reviewing Engineer: (Where Applicable)	Meak Nget	Required Performance:	B/B/C
Product Standard:	EN 55024	Test Levels:	See Table Below
Input Voltage:	230VAC/50Hz	Ambient Temperature:	22.7 ºC
Waveform Verified on Oscilloscope:	**No**	Relative Humidity:	56 %
		Atmospheric Pressure:	992.5 mbars

Specification	Rated Voltage (Vac)	Frequency (Hz)	Voltage Test Level (%)	Voltage Dip (%)	Test Voltage (Vac)	Duration (Periods)	Result Classification	
							0 deg	180 deg
Test Specification #1	230	50	0	100	0	0.5	(A)	(A)
Test Specification #2	230	50	30	70	69	25	(A)	(A)
Test Specification #3	230	50	0	100	0	250	(C)	(C)

Note 1: (A) The EUT met the requirements without any degradation of performance.

N**ote 2:** (B) The EUT met the requirements with acceptable degradation of performance.

Note 3: (C) The EUT met the requirements with acceptable degradation of performance. During the interruptions the EUT shuts-off. It needs user intervention to recover its function.

Criteria	***During Test***	***After Test***
A	➢ Shall operate as intended ➢ May show degradation of performance (Note 1) ➢ Shall be no loss of function ➢ Shall be no unintentional transmissions	➢ Shall operate as intended ➢ Shall be no degradation of performance (Note 1) ➢ Shall be no loss function ➢ Shall be no loss of stored data or user programmable functions
B	➢ May show loss of function (one or more) ➢ May show degradation of performance (Note 1) ➢ No unintentional transmissions	➢ Functions shall be self-recoverable ➢ Shall operate as intended after recovering ➢ Shall be no loss of stored data or user programmable functions
C	➢ May show loss of function (one or more)	➢ Functions shall be recoverable by the operator ➢ Shall operate as intended after recovering ➢ Shall be no degradation of performance (Note 1)
Note 1: *Degradation of performance during the test is understood as degradation to a level not below a minimum performance level specified by the manufacturer.*		

Deviations, Additions, or Exclusions: None

17 Revision History

Revision Level	Date	Report Number	Prepared By	Reviewed By	Notes
0	03/22/2018	103436795LAX-003	MS	MN	Original Issue