# Australian Communications and Media Authority

# EMC Test Report

## Regarding Emissions Compliance of the

## LulzBot TAZ 5 3D Printer

## For Aleph Objects, Inc.

## In Accordance with the Emissions Standards

## AS/NZS CISPR 22:2009 + A1:2010

## Class A

### Revision History

| Release | Date | Description |
|---|---|---|
| 1.0 | 2 December 2015 | Initial release |
| 1.1 | 14 December 2015 | Corrected Res BW for RE |

## Description of Equipment Under Test (EUT)

| | | |
|---|---|---|
| Test Item | : | LulzBot TAZ 5 – 3D Printer |
| Manufacturer | : | Aleph Objects, Inc. |
| Receipt date | : | 20 November 2015 |

## Manufacturer's information

| | | |
|---|---|---|
| Manufacturers Representative | : | Eric Kuzmenko |
| Company | : | Aleph Objects, Inc. |
| Address | : | 626 West 66th Street<br>Loveland, Colorado 80538<br>U.S.A. |
| Website | : | https://www.alephobjects.com/index.html |

## Tests Performed at

| | | |
|---|---|---|
| Address | : | EMI Test Lab LLC<br>1822 Skyway Drive Unit J<br>Longmont, Colorado 80504<br>U.S.A |
| Website | : | http://www.emitestlab.com/ |

| | | |
|---|---|---|
| **Test Specifications** | : | AS/NZS CISPR 22:2009 + A1:2010 |
| Tests completed | : | 20 November 2015 |

**Result of Testing : The EUT is in Compliance with AS/NZS CISPR 22:2009 + A1:2010, Class A for commercial use**

| | | |
|---|---|---|
| Senior EMC Engineer | : | Dennis King |
| Report written by | : | Dennis King – EMI Test Lab |
| Test Plan | : | Dennis King for Aleph Objects |
| Report date | : | 20 November 2015 |

***These test results relate only to the specific unit that was tested. A periodic production audit to verify continued compliance is recommended.***

## Table of Contents

# 1 General

## 1.1 Applied Standards

The LulzBot TAZ 5 3D Printer, made by Aleph Objects, Inc., was evaluated for emissions using AS/NZS CISPR 22:2009 + A1:2010 to show compliance regarding the Australian and New Zealand EMC requirements (Electro Magnetic Compatibility).

The Australian Communications and Media Authority (the ACMA) is responsible for regulating telecommunications, broadcasting, radiocommunications and the internet. The ACMA has responsibility under the *Radiocommunications Act 1992* for the regulation of electromagnetic compatibility (EMC).

The ACMA regulates EMC through the Radiocommunications Labelling (Electromagnetic Compatibility) Notice 2008 as amended (the EMC Labelling Notice) and the Radiocommunications (Electromagnetic Compatibility) Standard 2008 (the EMC Standard). The EMC Standard specifies the technical standards that apply to devices. The EMC Labelling Notice identifies the compliance, labelling and document-keeping requirements that apply to specific devices. It applies certain document-keeping requirements based on the risk of interference from a non-compliant device.

The Trans-Tasman Mutual Recognition Arrangement applies to EMC regulation in Australia and New Zealand. As a result, the EMC arrangements within the two countries comprise a common set of technical standards and regulatory processes for products supplied to the Australian and New Zealand markets. The aim of this is to allow free trade of devices between Australia and New Zealand without the need for additional regulatory approval in the importing country. The New Zealand Radiocommunications (Compliance) Notice is available on the Radio Spectrum Management (RSM) website

### 1.2 Detailed description of the test configuration, input and output ports

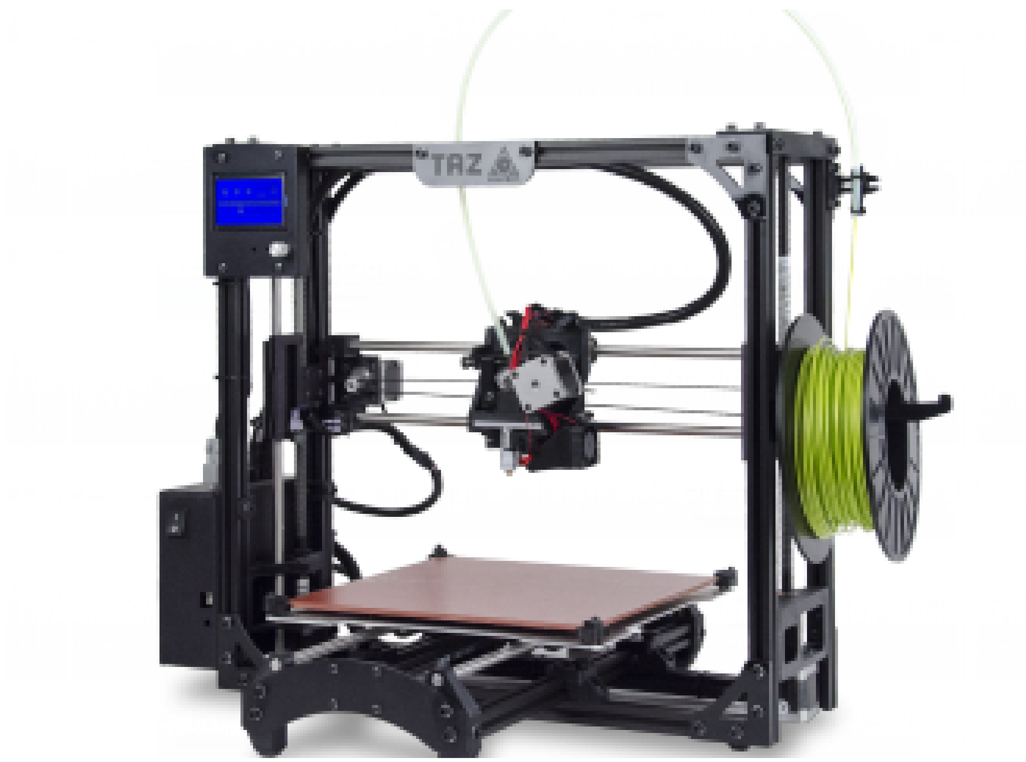
The 3D Printer was tested while printing a 3D image. The printer was connected to a laptop through the usb port on the printer and was also tested while printing from an SD card. The software was installed on the laptop by Aleph Objects and represents typical software currently used by the end user.

For all test configurations the equipment under test (EUT) is powered by nominal Australian AC power: 240VAC/50Hz. All I/O cables are less than 3 meters.

**LulzBot TAZ 5 Software:**

The default software for the LulzBot TAZ 5 3D printer is called Cura LulzBot Edition. Cura is a Free Software program that both prepares your files for printing (by converting your model into GCODE), and also allows you to control the operation of your LulzBot 3D printer. The revision used during the testing was 14.09.

Firmware loaded on the TAZ 5 was Marlin 2015Q1




https://www.lulzbot.com/products/lulzbot-taz-5-3d-printer

### 1.2.1 Description of test configuration

| | | |
|---|---|---|
| EUT | : | LulzBot TAZ 5 3D Printer |
| Manufacturer | : | Aleph Objects, Inc. |
| System model name | : | TAZ 5 |
| Serial Number | : | KT-PR0036NA-12245 |
| Test Voltage | : | 240 VAC 50 Hz |

### 1.2.2. Description of tested input and output ports and power supply information

| Number of cable type | Type of Cable | From | To | Shielded? | Remarks - length |
|---|---|---|---|---|---|
| 1 | USB | Test Laptop | LulzBot TAZ5 | Yes | Typical 6 ft. usb cable, no ferrites |

| Power supply location | Manufacturer | Model | Serial number | Shielded | Remarks |
|---|---|---|---|---|---|
| External AC supply | Mean Well in a housing designed by Aleph Objects | RSP-500-24 | KT-PR0036NA-12245 | Yes, metal enclosure | CE mark – Output; 24V 21A Tested with Steward ferrite P/N 28B0672-000. |
| | | | | | |

### 1.2.2 Operation modes

During preliminary testing for emissions it was determined that the following configurations are worst case for emissions. All further testing was done in these modes.

The system is operating in a typical mode as used by the end user.

The 3D Printer was tested while printing a 3D image. The printer was connected to a laptop through the usb port on the printer, the 3D printer was also tested while running from an on board SD card, no laptop attached. The software was installed on the laptop by Aleph Objects and represents typical software currently used by the end user.

## 2 Emissions

The EUT (equipment under test) has been tested to determine conformity with the relevant emissions parts of AS/NZS CISPR 22:2009 +A1:2010, Class A for commercial use.

AC Power line conducted and radiated field strength measurements concerning the emission of radiated and conducted electromagnetic disturbances were made.

## 2.1 AC Mains Power Input Ports

The disturbance voltage emissions levels at the AC mains power port of the EUT were measured in conformity with and according to the criteria as stated below.

| | | |
|---|---|---|
| Basic standard | : | AS/NZS CISPR 22:2009 + A1:2010 |
| Frequency range 1 | : | 0.15 – 0.5 MHz |
| Limit | : | 79.0 dBuV quasi peak, 66 dBuV average |
| Frequency range 2 | : | 0.5 – 30 MHz |
| Limit | : | 73 dBuV quasi peak, 60 dBuV average |

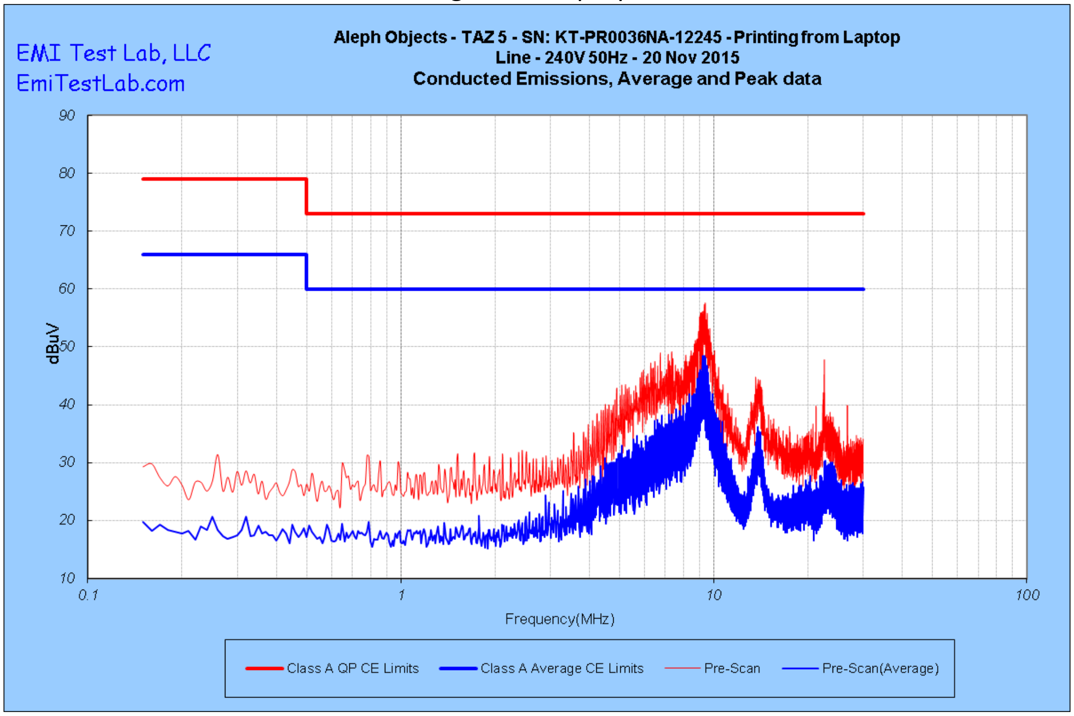
| | |
|---|---|
| Results of the measurements concerning the emissions of voltage levels at the AC mains input port of the EUT. | **PASS Class A** |
| Name of Test Engineer:<br>Signature:<br>Date: | Dennis King<br><br>20 November 2015 |

Remarks. The configuration was tested at 240VAC 50Hz.

**Conducted Emission Summary:**

**The unit was printing during all conducted emissions tests.** **PASS**

Printing from a laptop - Line



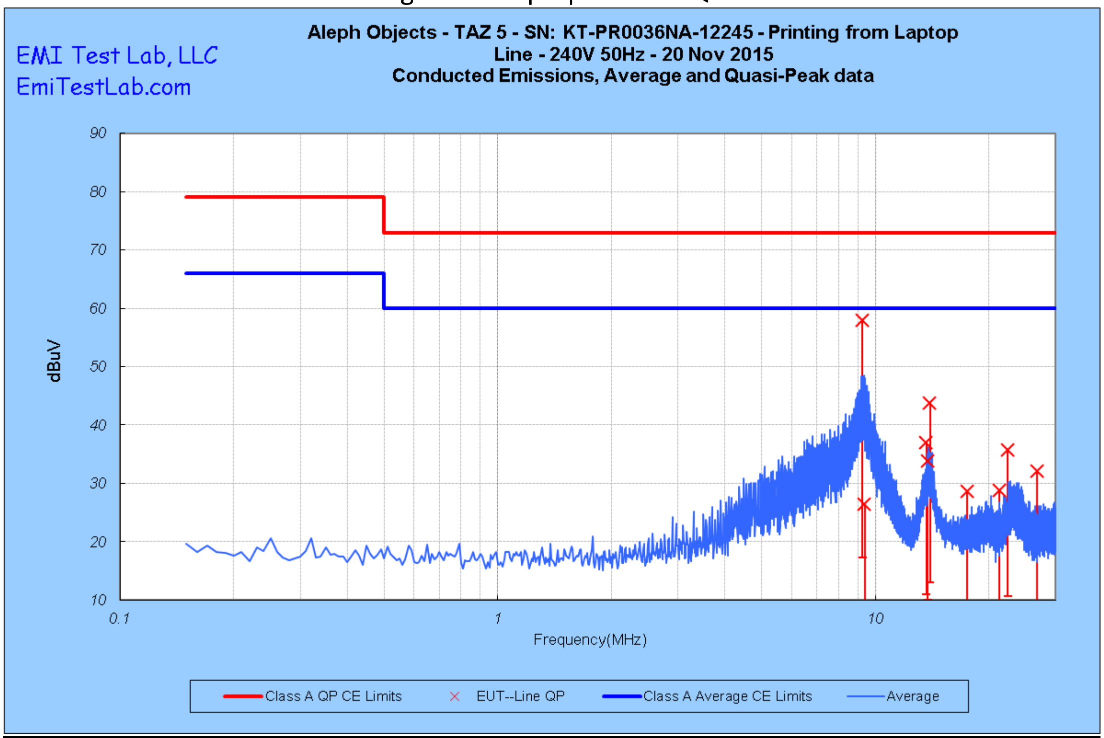

**240 VAC 50 Hz Line**

**Peak passes the Quasi Peak (upper) and Average (lower) limits**

**Red is peak and blue is average**

**The above chart is corrected data;**
**Spectrum Analyzer reading + Cable loss + Lisn insertion loss + transient limiter**
**10 kHz Spectrum Analyzer resolution bandwidth**

Printing from a laptop – Line – QP data




**240 VAC 50 Hz Line**

**Quasi Peak passes the Quasi Peak (upper) and Average (lower) limits**

**Red is peak and blue is average**

**The above chart is corrected data;**
**Spectrum Analyzer reading + Cable loss + Lisn insertion loss + transient limiter**
**10 kHz Spectrum Analyzer resolution bandwidth**

Printing from a laptop – Line – Tabular Data

| Frequency (MHz) | QP Disturbance (dBuV) | QP Limit | Margin QP (dB) | Tranducer Connection | Correction Factor (dB) |
|---|---|---|---|---|---|
| 9.250 | 57.91 | 73.00 | 15.09 | AMN | 1.18 |
| 9.380 | 26.45 | 73.00 | 46.55 | AMN | 1.18 |
| 13.640 | 36.95 | 73.00 | 36.05 | AMN | 1.25 |
| 13.770 | 33.76 | 73.00 | 39.24 | AMN | 1.26 |
| 13.960 | 43.71 | 73.00 | 29.29 | AMN | 1.26 |
| 17.510 | 28.61 | 73.00 | 44.39 | AMN | 1.31 |
| 21.310 | 28.67 | 73.00 | 44.33 | AMN | 1.37 |
| 22.430 | 35.61 | 73.00 | 37.39 | AMN | 1.39 |
| 26.820 | 32.04 | 73.00 | 40.96 | AMN | 1.45 |

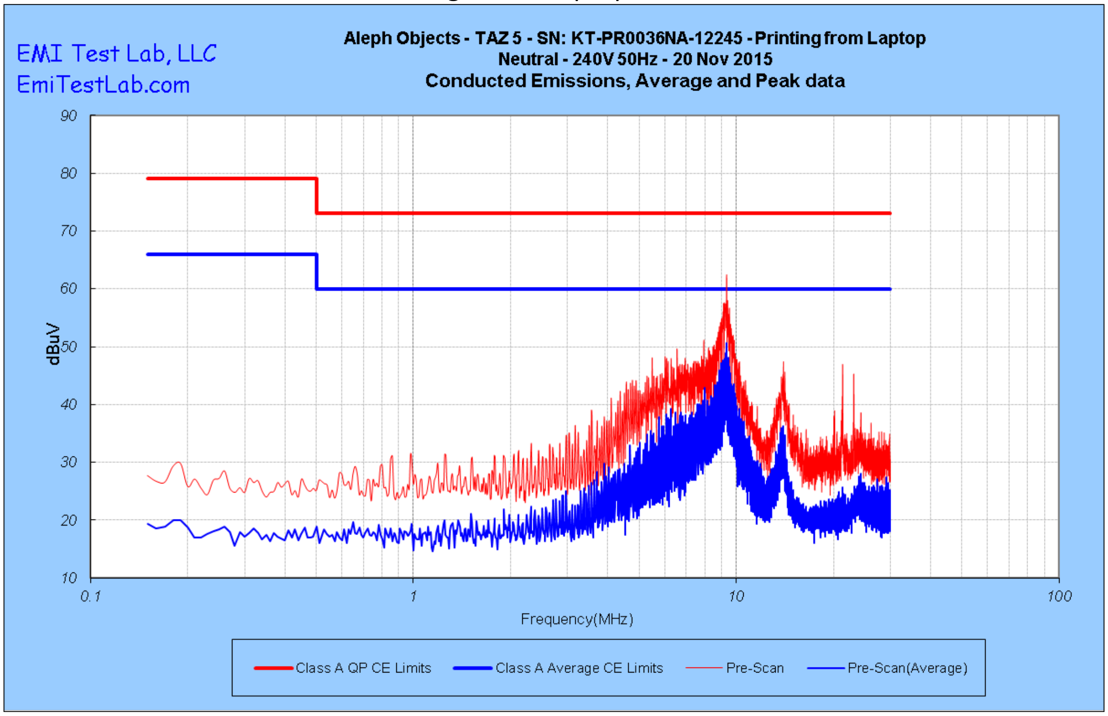
**240 VAC 50 Hz Line**

**Quasi Peak passes the Quasi Peak (upper) and Average (lower) limits**

**Red is peak and blue is average**

**The above chart is corrected data;**
**Spectrum Analyzer reading + Cable loss + Lisn insertion loss + transient limiter**
**10 kHz Spectrum Analyzer resolution bandwidth**

Printing from a laptop - Neutral



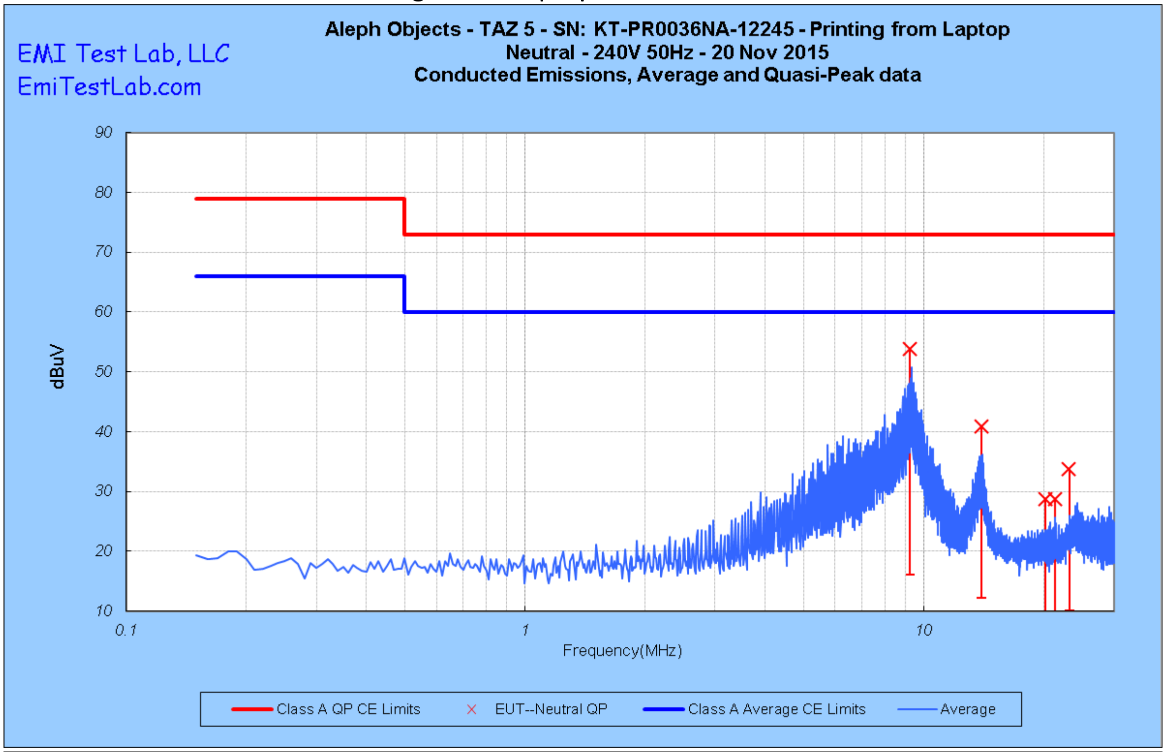

**240 VAC 50 Hz Line**

**Peak passes the Quasi Peak (upper) and Average (lower) limits**

**Red is peak and blue is average**

**The above chart is corrected data;**
**Spectrum Analyzer reading + Cable loss + Lisn insertion loss + transient limiter**
**10 kHz Spectrum Analyzer resolution bandwidth**

Printing from a laptop – Neutral – QP data




**240 VAC 50 Hz Line**

**Quasi Peak passes the Quasi Peak (upper) and Average (lower) limits**

**Red is peak and blue is average**

**The above chart is corrected data;**
**Spectrum Analyzer reading + Cable loss + Lisn insertion loss + transient limiter**
**10 kHz Spectrum Analyzer resolution bandwidth**

Printing from a laptop – Neutral – Tabular Data

| *Frequency (MHz)* | *QP Disturbance (dBuV)* | *QP Limit* | *Margin QP (dB)* | *Tranducer Connection* | *Correction Factor (dB)* |
|---|---|---|---|---|---|
| 9.240 | 33.07 | 73.00 | 39.93 | AMN | 1.17 |
| 9.240 | 53.79 | 73.00 | 19.21 | AMN | 1.17 |
| 13.970 | 37.76 | 73.00 | 35.24 | AMN | 1.26 |
| 13.970 | 40.86 | 73.00 | 32.14 | AMN | 1.26 |
| 20.190 | 28.65 | 73.00 | 44.35 | AMN | 1.35 |
| 21.360 | 28.67 | 73.00 | 44.33 | AMN | 1.37 |
| 23.210 | 33.73 | 73.00 | 39.27 | AMN | 1.40 |

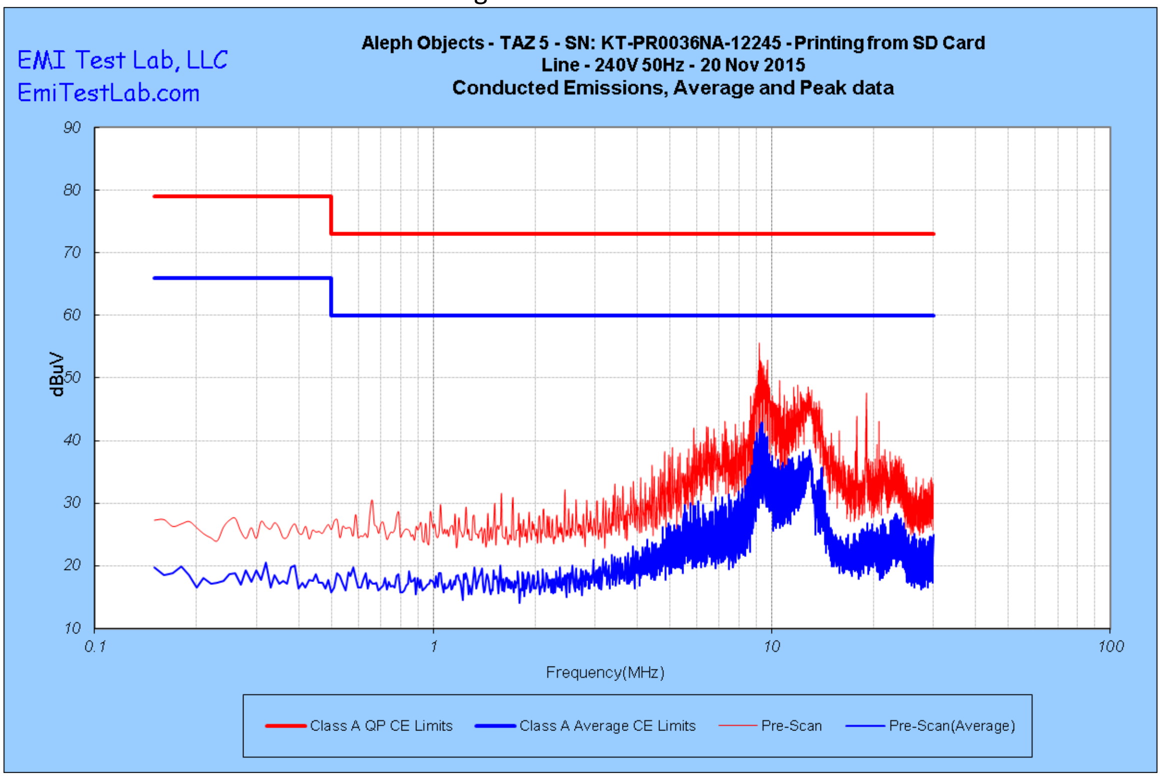
**240 VAC 50 Hz Line**

**Quasi Peak passes the Quasi Peak (upper) and Average (lower) limits**

**Red is peak and blue is average**

**The above chart is corrected data;**
**Spectrum Analyzer reading + Cable loss + Lisn insertion loss + transient limiter**
**10 kHz Spectrum Analyzer resolution bandwidth**

Printing from an SD Card - Line



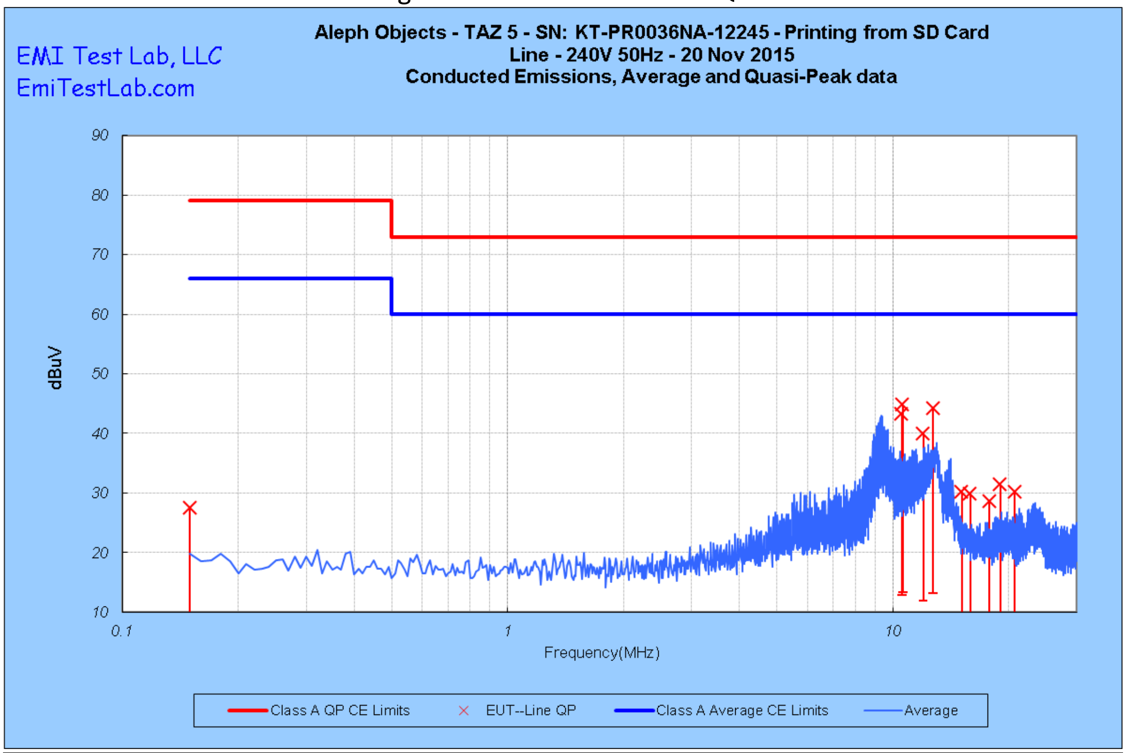

**240 VAC 50 Hz Line**

**Peak passes the Quasi Peak (upper) and Average (lower) limits**

**Red is peak and blue is average**

**The above chart is corrected data;**
**Spectrum Analyzer reading + Cable loss + Lisn insertion loss + transient limiter**
**10 kHz Spectrum Analyzer resolution bandwidth**

Printing from an SD card – Line – QP data




**<u>240 VAC 50 Hz Line</u>**

**<u>Quasi Peak passes the Quasi Peak (upper) and Average (lower) limits</u>**

**<u>Red is peak and blue is average</u>**

**The above chart is corrected data;**
**Spectrum Analyzer reading + Cable loss + Lisn insertion loss + transient limiter**
**10 kHz Spectrum Analyzer resolution bandwidth**

Printing from an SD Card – Line – Tabular Data

| Frequency (MHz) | QP Disturbance (dBuV) | QP Limit | Margin QP (dB) | Tranducer Connection | Correction Factor (dB) |
|---|---|---|---|---|---|
| 0.150 | 32.00 | 79.00 | 47.00 | AMN | 0.20 |
| 0.150 | 27.50 | 79.00 | 51.50 | AMN | 0.20 |
| 10.620 | 44.74 | 73.00 | 28.26 | AMN | 1.21 |
| 10.560 | 43.21 | 73.00 | 29.79 | AMN | 1.21 |
| 12.000 | 39.93 | 73.00 | 33.07 | AMN | 1.23 |
| 12.720 | 44.22 | 73.00 | 28.78 | AMN | 1.24 |
| 15.090 | 30.18 | 73.00 | 42.82 | AMN | 1.28 |
| 15.890 | 29.89 | 73.00 | 43.11 | AMN | 1.29 |
| 17.800 | 28.62 | 73.00 | 44.38 | AMN | 1.32 |
| 19.020 | 31.34 | 73.00 | 41.66 | AMN | 1.34 |
| 20.740 | 30.16 | 73.00 | 42.84 | AMN | 1.36 |

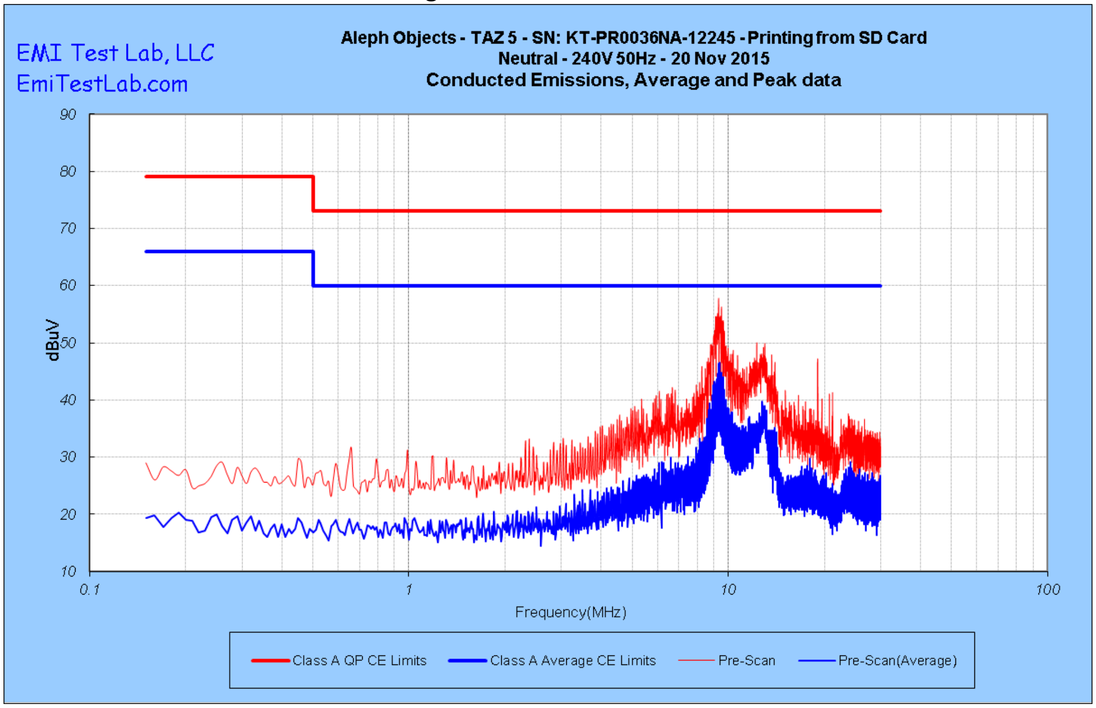
**240 VAC 50 Hz Line**

**Quasi Peak passes the Quasi Peak (upper) and Average (lower) limits**

**Red is peak and blue is average**

**The above chart is corrected data;**
**Spectrum Analyzer reading + Cable loss + Lisn insertion loss + transient limiter**
**10 kHz Spectrum Analyzer resolution bandwidth**

Printing from an SD Card - Neutral



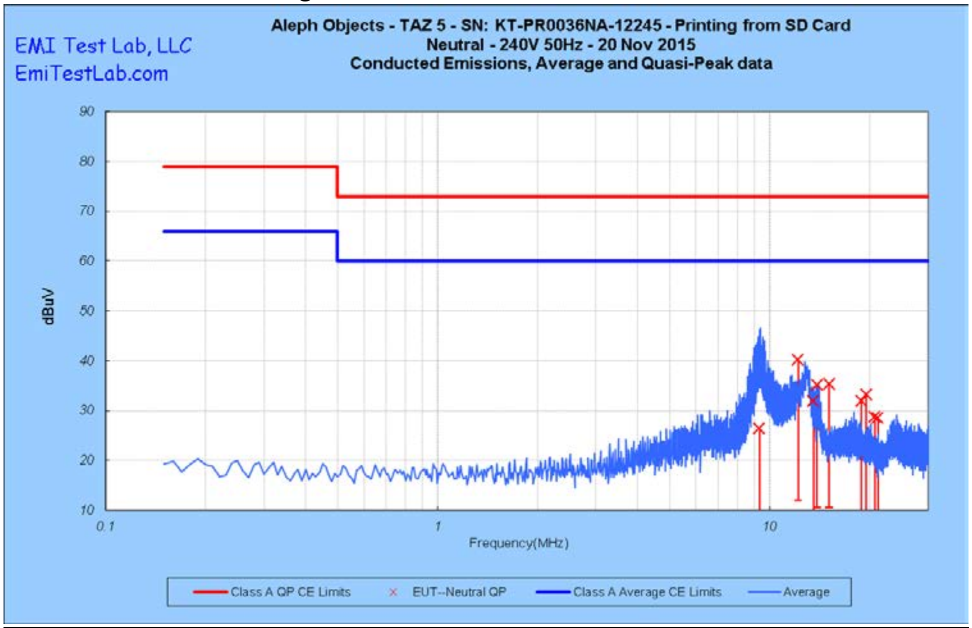

**240 VAC 50 Hz Line**

**Peak passes the Quasi Peak (upper) and Average (lower) limits**

**Red is peak and blue is average**

**The above chart is corrected data;**
**Spectrum Analyzer reading + Cable loss + Lisn insertion loss + transient limiter**
**10 kHz Spectrum Analyzer resolution bandwidth**

Printing from an SD Card – Neutral – QP data




**240 VAC 50 Hz Line**

**Quasi Peak passes the Quasi Peak (upper) and Average (lower) limits**

**Red is peak and blue is average**

**The above chart is corrected data;**
**Spectrum Analyzer reading + Cable loss + Lisn insertion loss + transient limiter**
**10 kHz Spectrum Analyzer resolution bandwidth**

Printing from an SD card – Neutral – Tabular Data

| Frequency (MHz) | QP Disturbance (dBuV) | QP Limit | Margin QP (dB) | Tranducer Connection | Correction Factor (dB) |
|---|---|---|---|---|---|
| 9.310 | 26.43 | 73.00 | 46.57 | AMN | 1.18 |
| 12.190 | 40.13 | 73.00 | 32.87 | AMN | 1.23 |
| 13.570 | 31.85 | 73.00 | 41.15 | AMN | 1.25 |
| 13.900 | 35.16 | 73.00 | 37.84 | AMN | 1.26 |
| 15.100 | 35.30 | 73.00 | 37.70 | AMN | 1.28 |
| 18.910 | 31.90 | 73.00 | 41.10 | AMN | 1.33 |
| 19.550 | 33.19 | 73.00 | 39.81 | AMN | 1.34 |
| 20.750 | 28.57 | 73.00 | 44.43 | AMN | 1.36 |
| 21.220 | 28.52 | 73.00 | 44.48 | AMN | 1.37 |

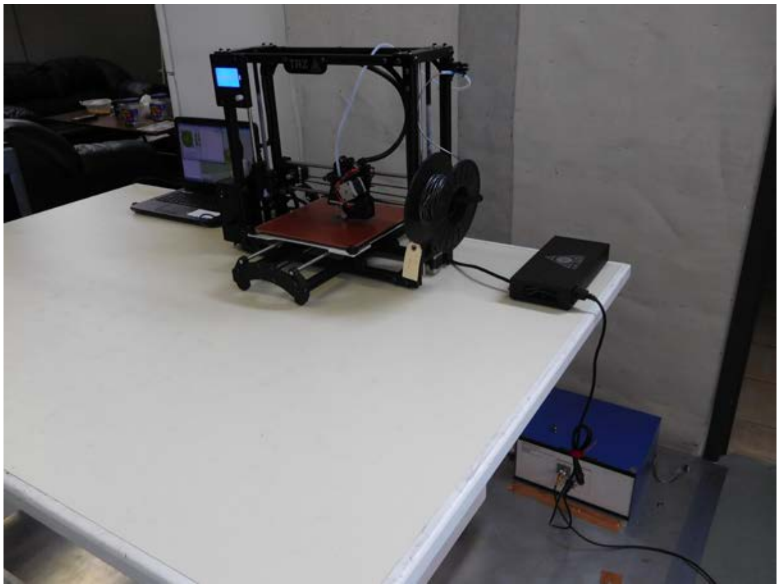
**240 VAC 50 Hz Line**

**Quasi Peak passes the Quasi Peak (upper) and Average (lower) limits**

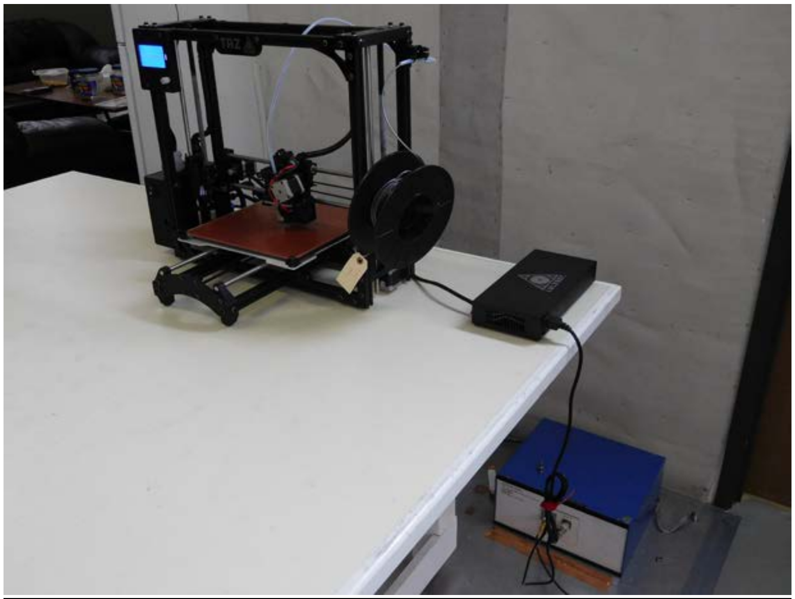
**Red is peak and blue is average**

**The above chart is corrected data;**
**Spectrum Analyzer reading + Cable loss + Lisn insertion loss + transient limiter**
**10 kHz Spectrum Analyzer resolution bandwidth**

**Printing from an SD Card**



**Printing from a laptop**



**Conducted emissions test setup**

## 2.2 Enclosure

### 2.2.1 30-1,000 MHz

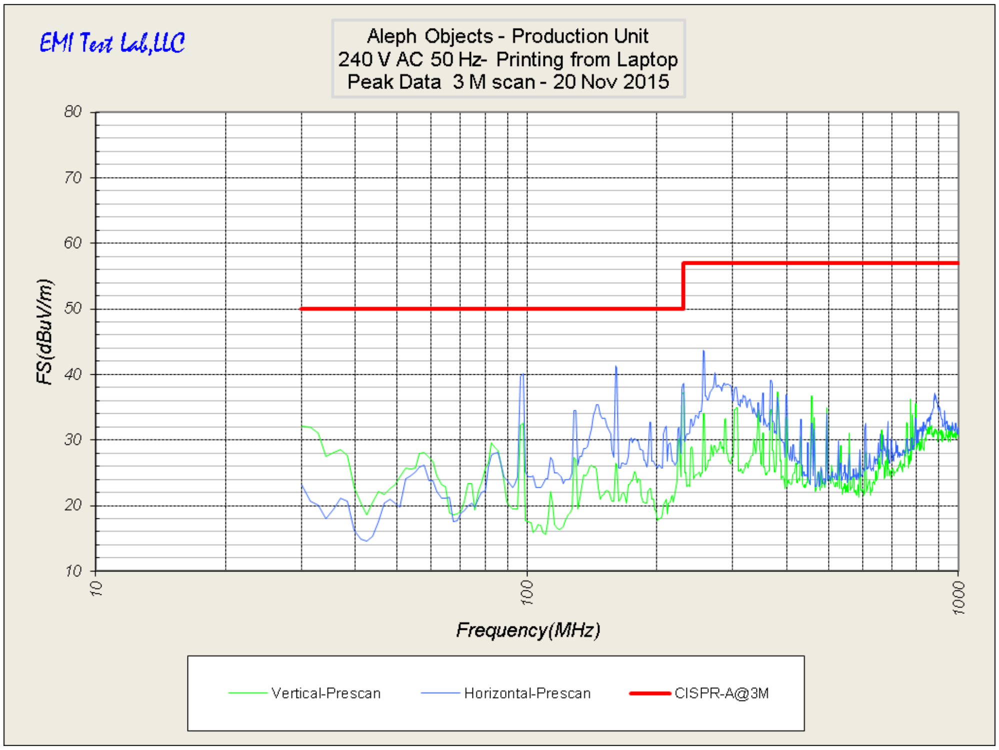
The radiated field strength levels (electric component) have been measured in conformity with and according to the criteria as stated below.

| | | |
|---|---|---|
| Basic standard | : | AS/NZS CISPR 22:2009 + A1:2010 |
| Limit distance | : | 3 meters |
| Frequency range 1 | : | 30 -230 MHz |
| Limits | : | 50 dBuV/m |
| Frequency range 2 | : | 230 – 1,000 MHz |
| Limits | : | 57 dBuV/m |

| | |
|---|---|
| Results of the measurements concerning radiated electromagnetic fields (electric component) emitted by the EUT, enclosure, as a tested system | **PASS Class A** |
| Name of Test Engineer:<br>Signature:<br>Date: | Dennis King<br>[signature]<br>20 November 2015 |
| Remarks: The configuration was tested at 240 VAC 50 Hz<br>**Radiated Emissions Summary:**<br>**The unit was tested printing from a laptop and printing from an SD card. 120 kHz SA res bw. Both configurations PASS with no modifications.** | |

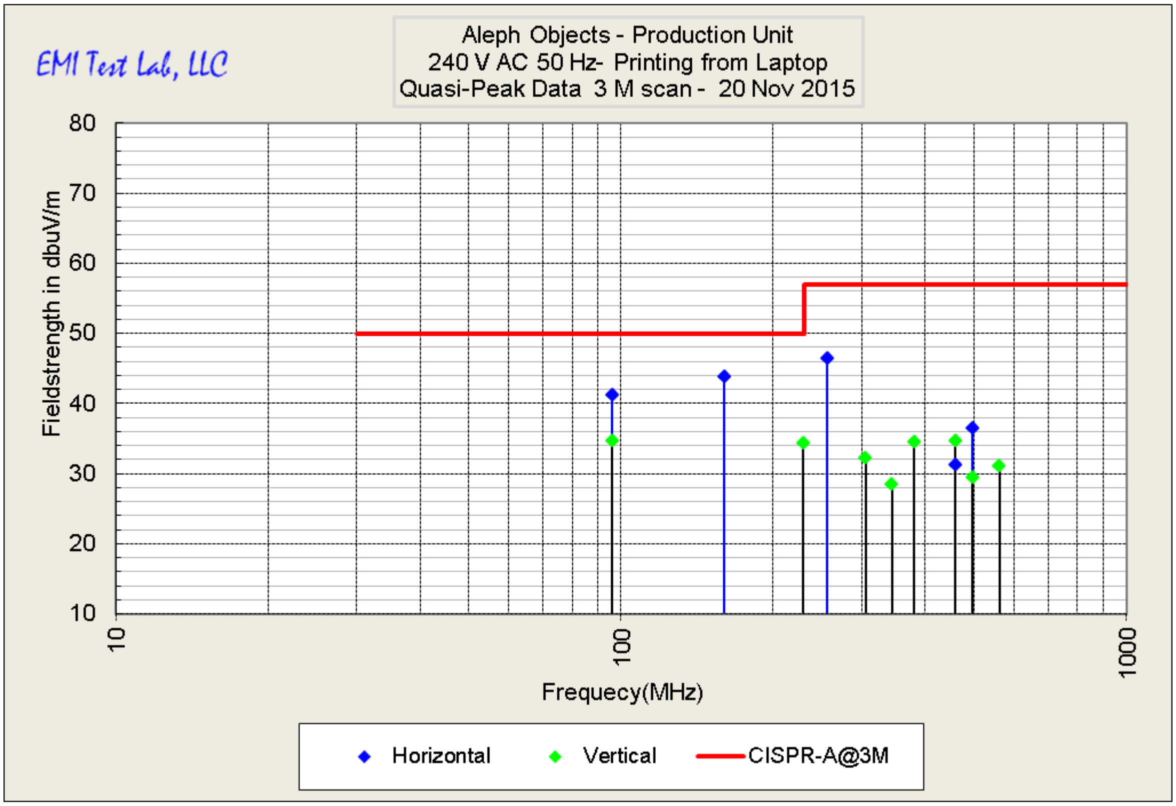
**The chart below is peak data compared to a quasi-peak limit**

**Printing from a laptop**



**The chart below is quasi peak data compared to a quasi-peak limit**

**Printing from a laptop**

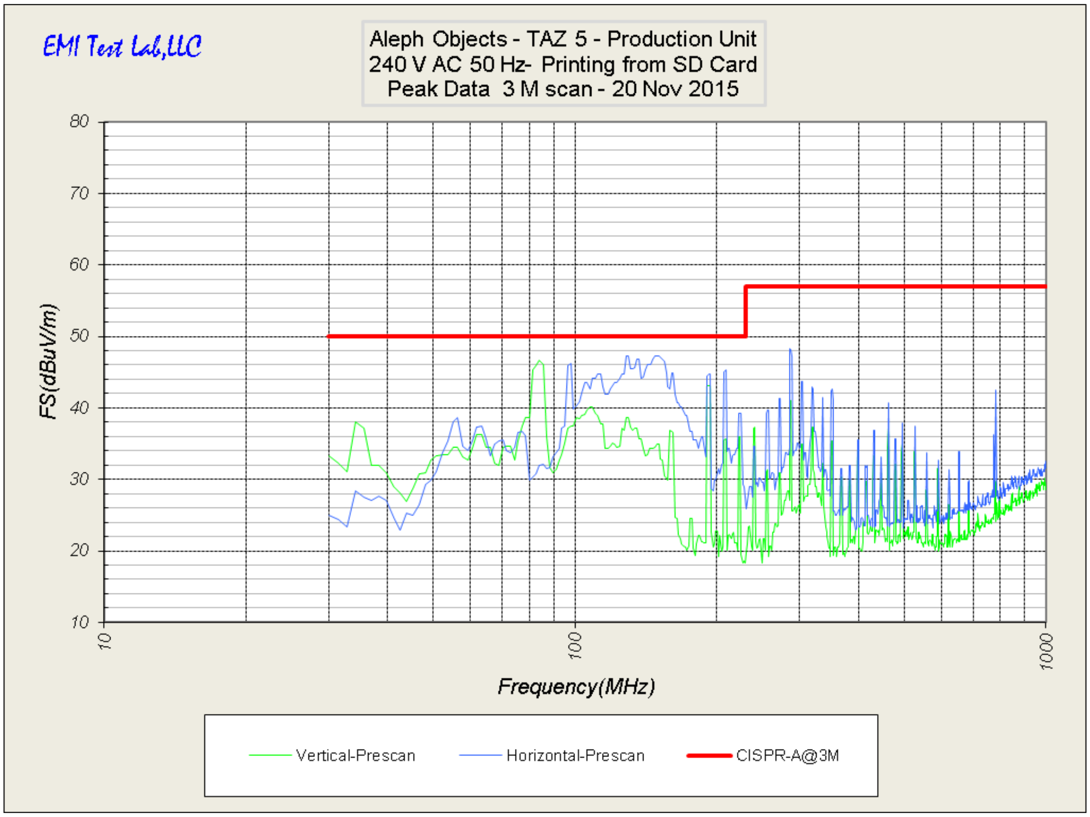


## Printing from a laptop – quasi peak tabular data

| EMI Test Lab | | | | | | Sheet4 |
|---|---|---|---|---|---|---|
| 1822 Skyway Drive, Unit J, Longmont Co<br>Dennis King dennis@emitestlab.com , Cell 303-746-0611 | | | | | | |
| **Frequency** | **F.S. EUT** | **Limit** | **Azimuth** | **Height** | **Antenna Polarization** | **Limit delta** |
| *(MHz)* | *(dBuV/m)* | *(dBuV/m)* | *Degrees* | *Meters* | *H or V* | *dBuV* |
| 380.54 | 34.55 | 57 | 8.0 | 1 | V | -22.5 |
| 559.98 | 31.05 | 57 | 40.0 | 1 | V | -26.0 |
| 495.99 | 29.37 | 57 | 60.0 | 1 | V | -27.6 |
| 229.21 | 34.30 | 50 | 92.0 | 1 | V | -15.7 |
| 96.01 | 34.67 | 50 | 172.0 | 1 | V | -15.3 |
| 304.42 | 32.20 | 57 | 312.0 | 1 | V | -24.8 |
| 343.27 | 28.47 | 57 | 348.0 | 1 | V | -28.5 |
| 458.40 | 34.65 | 57 | 348.0 | 1 | V | -22.4 |
| 495.98 | 36.45 | 57 | 12.0 | 1 | H | -20.6 |
| 255.99 | 46.42 | 57 | 140.0 | 1 | H | -10.6 |
| 95.99 | 41.17 | 50 | 172.0 | 1 | H | -8.8 |
| 159.98 | 43.82 | 50 | 208.0 | 1 | H | -6.2 |
| 458.36 | 31.32 | 57 | 348.0 | 1 | H | -25.7 |

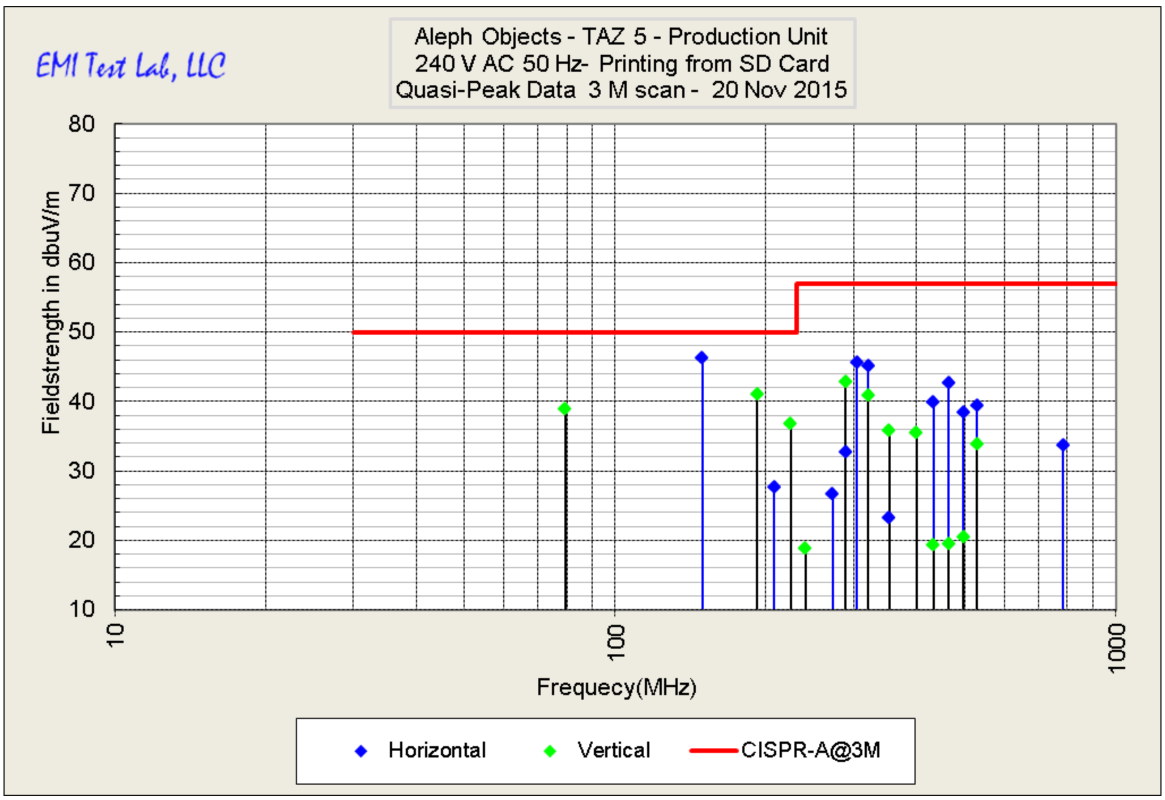
**The chart below is peak data compared to a quasi-peak limit**

**Printing from an SD Card**



**The chart below is quasi peak data compared to a quasi-peak limit**

**Printing from an SD Card**



**Printing from an SD Card – quasi peak tabular data**

| EMI Test Lab | | | | | | Sheet4 |
|---|---|---|---|---|---|---|
| 1822 Skyway Drive, Unit J, Longmont Co<br>Dennis King dennis@emitestlab.com , Cell 303-746-0611 | | | | | | |
| **Frequency** | **F.S. EUT** | **Limit** | **Azimuth** | **Height** | **Antenna Polarization** | **Limit delta** |
| *(MHz)* | *(dBuV/m)* | *(dBuV/m)* | *Degrees* | *Meters* | *H or V* | *dBuV* |
| 495.45 | 20.47 | 57 | 0.0 | 1 | V | -36.5 |
| 463.98 | 19.45 | 57 | 4.0 | 1 | V | -37.6 |
| 351.99 | 35.77 | 57 | 8.0 | 1 | V | -21.2 |
| 224.00 | 36.82 | 50 | 16.0 | 1 | V | -13.2 |
| 79.43 | 38.92 | 50 | 116.0 | 1 | V | -11.1 |
| 527.97 | 33.80 | 57 | 128.0 | 1 | V | -23.2 |
| 191.98 | 40.97 | 50 | 136.0 | 1 | V | -9.0 |
| 431.98 | 19.40 | 57 | 168.0 | 1 | V | -37.6 |
| 240.00 | 18.85 | 57 | 192.0 | 1 | V | -38.2 |
| 399.98 | 35.47 | 57 | 196.0 | 1 | V | -21.5 |
| 319.99 | 40.85 | 57 | 336.0 | 1 | V | -16.2 |
| 287.99 | 42.92 | 57 | 336.0 | 1 | V | -14.1 |
| 320.00 | 45.07 | 57 | 0.0 | 1 | H | -11.9 |
| 463.98 | 42.65 | 57 | 20.0 | 1 | H | -14.4 |
| 431.99 | 39.90 | 57 | 164.0 | 1 | H | -17.1 |
| 527.98 | 39.42 | 57 | 176.0 | 1 | H | -17.6 |
| 271.97 | 26.75 | 57 | 224.0 | 1 | H | -30.3 |
| 149.35 | 46.30 | 50 | 232.0 | 1 | H | -3.7 |
| 303.99 | 45.65 | 57 | 240.0 | 1 | H | -11.4 |
| 352.19 | 23.20 | 57 | 328.0 | 1 | H | -33.8 |
| 784.60 | 33.62 | 57 | 340.0 | 1 | H | -23.4 |
| 495.81 | 38.40 | 57 | 344.0 | 1 | H | -18.6 |
| 207.81 | 27.67 | 50 | 356.0 | 1 | H | -22.3 |
| 288.37 | 32.70 | 57 | 356.0 | 1 | H | -24.3 |

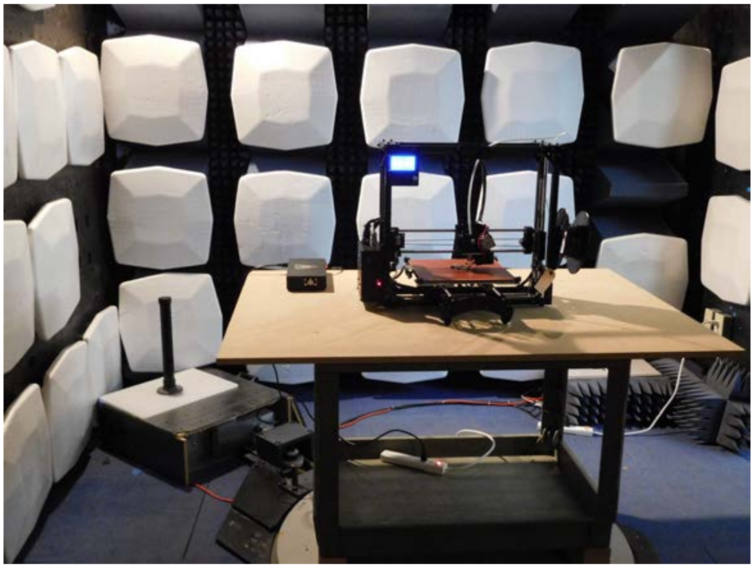
### 2.2.2 1-6 GHz

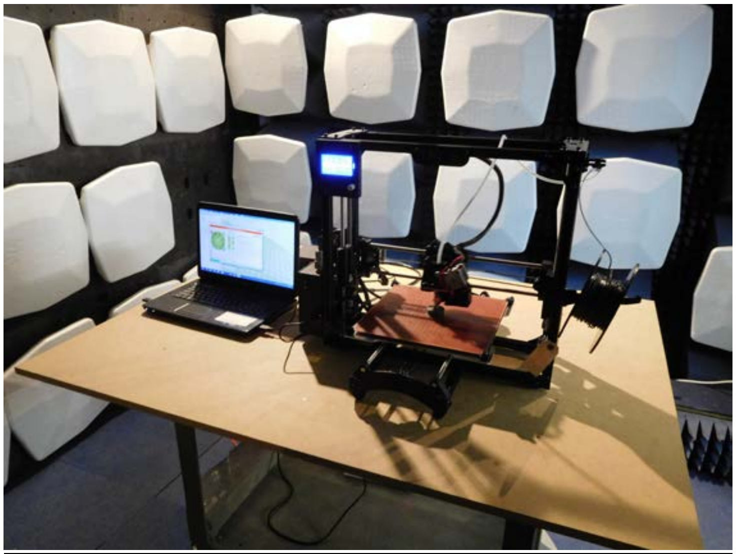
The radiated field strength levels (electric component) have been measured in conformity with and according to the criteria as stated below.

| | | |
|---|---|---|
| Basic standard | : | FCC Part 15, Subpart B, ICES-003 Issue 5 |
| Test method | : | ANSI C63.4, CAN/CSA – CISPR 22-10 |
| Limit distance | : | 3 meters |
| Frequency range 1 | : | 1-3 GHz |
| Limits | : | Average 50 dBuV/m, Peak 70 dBuV/m |
| Frequency range 2 | : | 3-6 GHz |
| Limits | : | Average 54 dBuV/m, Peak 74 dBuV/m |

| | |
|---|---|
| Results of the measurements concerning radiated electromagnetic fields (electric component) emitted by the EUT, enclosure, as a tested system | **Not applicable- no clock frequency higher than 108 MHz** |
| Name of Test Engineer:<br>Signature:<br>Date: | Dennis King<br>[signature]<br>2 December 2015 |
| Remarks:<br>**Not applicable , all clocks under 108 MHz.** | |

## Radiated Emissions Setup


**Radiated emissions test setup – printing from SD Card**


**Radiated emissions test setup – printing from a laptop**

## 3.0 Modifications

**No modifications were made during the testing.**

## 4.0 User Guide Statements – Labels

**From CISPR 22 the following statement should be placed in the user guide:**

**4.2 Class A ITE**

Class A ITE is a category of all other ITE which satisfies the class A ITE limits but not the class B ITE limits. Such equipment should not be restricted in its sale but the following warning shall be included in the instructions for use:

> **Warning**
> This is a class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

**Information from the ACMA regarding the RCM Mark:**

**Note: The ACMA is amending the communications regulatory arrangements to introduce a consolidated mark (the Regulatory Compliance Mark—'RCM') for devices and equipment subject to the ACMA's telecommunications, radiocommunications, EMC and EMR/EME compliance and labelling requirements. The new arrangements will commence on 1 March 2013 with a three-year transition period. This booklet, and information published on the ACMA website, will be updated at that time. Further information about the RCM and transitional arrangements is available on the ACMA website.**

**What is the RCM?**

The Regulatory Compliance Mark (RCM) is a trademark owned by Australian and New Zealand regulators. The design and use of the RCM is legally protected by registration in Australia and New Zealand. The RCM is used to indicate compliance with all sections of AS/NZS 4417 that are applicable to the device. These are:

AS/NZS 4417.1—general rules for use of the mark

AS/NZS 4417.2—specific requirements for electrical safety regulatory applications

AS/NZS 4417.3—specific requirements for electromagnetic compatibility regulatory applications

AS/NZS 4417.4—specific requirements for radio apparatus regulatory applications.

A new version of AS/NZS 4417 is currently being prepared. In the case of radiocommunications, EMC and EME, the draft revised version of AS/NZS 4417 will only refer to the ACMA's regulatory arrangements and will not purport to describe the rules for the use of the mark for the purposes of complying with ACMA requirements.

**Can I use the RCM?**

The RCM may be used to indicate EMC compliance. If the RCM is used as a replacement for the C-Tick compliance mark, the device must comply with the other applicable regulations—such as electrical safety—that are covered by the RCM Standard AS/NZS 4417. The various parts of this standard specify the conditions for using the RCM for the different regulatory regimes. The RCM Standard is available from the SAI Global website.

More information about the conditions of use of the RCM is in the RCM Standard AS/NZS 4417. Suppliers who intend to use the RCM must register with the RCM Registrar. Where the RCM is used to indicate compliance with EMC regulations, the supplier must advise the ACMA of their intention to use the RCM and the supplier identification information to be used.

## 5.0 Test equipment and Environmental Conditions

All tests were conducted within parameters specified for each test, for example >30% humidity for ESD. The lab temperature during all testing was between 70-72 degrees F.
All equipment used for testing has been calibrated or verified for cal using NIST traceable standards. Each piece of test equipment has a cal verification procedure that is conducted before and after each test.

## Table of Test Equipment

| Equipment | Description and Test | Model number | Serial number | Next cal due |
|---|---|---|---|---|
| HP Spectrum Analyzer | Used for Radiated and Conducted Emissions | 8566B | 2607A02760 | 3 June 2016 |
| HP Quasi-Peak Adapter | Used for Radiated and Conducted Emissions | 85650A | 8574A00233 | 3 June 2016 |
| Advantest Spectrum Analyzer | Used for Radiated and Conducted Emissions | R3361A | 01730556 | 20 October 2016 |
| Com-Power transient Limiter | Conducted Emissions | HZ560 | 001 | 3 June 2016 |
| RF Bay Pre-Amp | Radiated emissions – 100kHz to 10 GHz | LPA-10-20 | 0643 | 12 Dec 2015 |
| GTEM | Radiated Emissions and Radiated Immunity | 5317 | 9703-1209 | 25 April 2016 – Field Uniformity Cal per IEC 61000-4-20 |
| 3 Meter FAR – Fully Anechoic Room | Radiated Immunity and Emissions | N/A | FAR #1 | 15 October 2016 Field Uniformity per IEC/EN 61000-4-3 and Correlation data to GTEM |
| ComPower Horn Antenna | 1-18 GHz – Radiated Immunity and Emissions | AH 118 | 071040 | 20 March 2016 |
| Chase BiLog Antenna | Radiated Emissions and Immunity | CBL6111 | 1121 | 20 March 2016 |
| Marconi Instruments – Signal Generator 10kHz – 2.7 GHz | Radiated Immunity | 2031 | 1196061031 | 20 October 2016 |
| HP Signal Generator | Radiated Immunity | 8657A | STD0578 | 3 May 2016 |

| | | | | |
|---|---|---|---|---|
| HP Synthesized Sweep Generator .01-20 GHz | Radiated Immunity<br><br>1 GHz to 2.7 GHz | 83752B | 34462 | 3 May 2016 |
| Amplifier Research .800 – 4.2 GHz Amp | Radiated Immunity – 1 GHz to 2.7 GHz | 10S1G4 | 34516 | 4 May 2016 |
| Antenna Research Associates – 100 Watt amplifier w/controller | Radiated Immunity – 80-1000 MHz in the FAR | ARAPS/PC757LC<br>ARA757LC-CE | 587V7<br>587V7 | 20 October 2016 |
| Kalmus Power Amplifier | Radiated Immunity 150kHz – 1 GHz – in the GTEM | 747LC-CE | 7894-1 | 12 May 2016 |
| Amplifier Research E- Field Probe | Radiated Immunity | FP 2000 | 12845 | 12 May 2016 |
| Com-Power LISN | Conducted emissions | LI-115 | 241010 | 17 May 2016 |
| Com-Power LISN | Conducted emissions | LI-115 | 241011 | 17 May 2016 |
| California Instruments 1000 VA Power Source | Emissions and Immunity - used as a 100/120/230/240-VAC 50/60 Hz AC source | 1001WP | L04788 | 4 June 2016 |
| EMI Labs CDN | Conducted Immunity | EMICDN | 001 | 9 Dec 2015 |
| Schaffner ESD Gun | Electro Static Discharge | NSG435 | 54711 | 11 Dec 2015 |
| KeyTek ECAT | Fast transients / Burst | E412 | 32612 | 5 June 2016 |
| FCC Inc. RF Current Probe | Monitor Conducted Immunity signal | F-33-1 | 423 | 9 Dec 2015 |
| EMI Labs Mag Loop | Magnetic Loop Antenna | Mag100 | 80162 | 12 Dec 2015 |
| Thermo Keytek CE Master | Surge/ AC Dips and Interrupts | CE Master | 0405277 | 15 Dec 2015 |
| | | | | |

All equipment used for testing has been calibrated or verified for cal using NIST traceable standards. Each piece of test equipment has a cal verification procedure that is conducted before and after each test.

## 6.0 *Measurement Uncertainty* - Radiated Emissions example;

| Table of Uncertainty Calculation | | | | | |
|---|---|---|---|---|---|
| √ | **Contribution** | **Designation** | **Probability Distribution** | **k** | **Uncertainty (dB)** |
| | Equipment Under Test Uncertainties | $U_{EUT}$ | | | Note 1 |
| √ | Measuring Receiver Amplitude Accuracy | $U_{RXaccuracy}$ | rectangular | $\sqrt{3}$ | ± 0.9 |
| √ | GTEM Uniformity | $U_{Uniformity}$ | rectangular | $\sqrt{3}$ | ± 4.0 |
| √ | Secondary Field Components | $U_{Secondary}$ | | | Excluded by Test Method |
| √ | Mismatch Uncertainty-GTEM to Pre-Amplifier | $U_{Mismatch}$ | U-shaped | $\sqrt{2}$ | +0.63 and -0.65 |
| √ | Mismatch Uncertainty-Pre-Amplifier to Spectrum Analyzer | $U_{Mismatch}$ | U-shaped | $\sqrt{2}$ | +0.92 and -1.03 |
| √ | System Sensitivity Error | $U_{Sensitivity}$ | rectangular | $\sqrt{3}$ | 0.28 |
| √ | GTEM Electric-Field Frequency Response | $U_{E-Field}$ | rectangular | $\sqrt{3}$ | ± 1.6 |
| | Ambient Signal Uncertainty | $U_{Abient}$ | | | Not Significant |
| √ | GTEM to OATS Correlation | $U_{Corr}$ | rectangular | $\sqrt{3}$ | ±1.2 |
| √ | Septum Height Variation | $U_{Septum}$ | normal | 2 | +0.72 and -0.82 |
| | Coaxial Cable Temperature Variations | $U_{CableTemperature}$ | | | Not Significant |
| √ | Coaxial Cable Calibration | $U_{CableCalibration}$ | rectangular | $\sqrt{3}$ | ±0.05 |
| √ | Pre-amplifier Calibration Uncertainty | $U_{Pre-Amp}$ | rectangular | $\sqrt{3}$ | ±0.05 |
| | Combined Uncertainty(dB) Positive Terms | | | | 2.77 |
| | Combined Uncertainty(dB) Negative Terms | | | | -2.75 |
| | Expanded Uncertainty Positive Terms | | Normal | 2 | 5.54 |
| | Expanded Uncertainty Negative Terms | | Normal | 2 | -5.50 |

## Typical Measurement Uncertainty for the following Tests:

| |
|---|
| The estimated combined standard uncertainty for Conducted Emissions, CISPR 22 is ± 1.2dB |
| The estimated combined standard uncertainty for Radiated Immunity, EN 61000-4-3 is ± 2.7dB |
| The estimated combined standard uncertainty for EFT/Burst, EN 61000-4-4 is ± 5.8% |
| The estimated combined standard uncertainty for Surge, EN 61000-4-5 is ± 8% |
| The estimated combined standard uncertainty for Conducted Immunity, EN 61000-4-6 is ± 1.5 dB |
| The estimated combined standard uncertainty for Magnetic Fields, EN 61000-4-8 is ± 0.6% |
| The estimated combined standard uncertainty for Voltage Dips and Interrupts, EN 61000-4-11 is ± 4.3% |
| The estimated combined standard uncertainty for Harmonic current and flicker is ± 11.6% |
| The estimated combined standard uncertainty for ESD testing, EN 61000-4-2 is ± 4% |

# 7.0 Test Plan

**Testing required**

The LulzBot TAZ 5 3D Printer will be tested for Class A Radiated and Conducted Emissions per AS/NZS CISPR 22:2009 + A1:2010. The test voltage will be 240 VAC 50 Hz.

**Test Setup**

The LulzBot TAZ 5 will be operating in a typical use mode, printing an object during all the testing.

Two modes will be tested:

1. Printing from a laptop
2. Printing from an internal SD card.

The user software is installed on a laptop and is controlling the 3D printer. There are no other I/O cables on the 3D Printer.

Typical software that the end user would use will be used during the testing.

**I/O cables**

The unit has only one I/O cable, the USB cable that is used to control the printer from software installed on the host computer. There are no I/O cables on the unit.

**Status of the test unit**

Production level.

## 8.0 Conclusion

**The Aleph Objects – LulzBot TAZ 5 3D Printer complies with;**

**AS/NZS CISPR 22:2009 + A1:2010, Class A for commercial use**

**in the configurations and operating modes as stated in this test report.**

**End of Report**