Electromagnetic Compatibility Test Report

Prepared in accordance with

EN 55022: 2006, +A1: 2007

On

DC DC uModule Regulator LTM4613

For

Linear Technology Corporation
1630 McCarthy Blvd.
Milpitas, CA 95035
U.S.A.

Prepared by:

TUV Rheinland of North America, Inc.
2305 Mission College Blvd., Suite 105
Santa Clara, CA 95054
U.S.A.

Revisions

Revision No.	Date	Reason for Change	Author
0	3/14/2011	Original Document	N/A

Auftraggeber: *Client:*	Linear Technology Corporation 1630 McCarthy Blvd. Milpitas, CA 95035	Richard Ying Main (408) 432-1900 Ext. 3007 Fax (408)-434-0507 Rying@linear.com	
Bezeichnung: *Identification:*	DC DC uModule Regulator	**Serien-Nr.:** *Serial No.*	None
Gegenstand der Prüfung: *Test item:*	LTM4613	**Prüfdatum:** *Date tested:*	March 10, 2011
Prüfort: *Testing location:*	TUV Rheinland of North America 2305 Mission College Blvd., Suite 105 Santa Clara, CA 95054 U.S.A.	Tel: (925) 249-9123 Fax: (925) 249-9124	
Prüfgrundlage: *Test specification:*	Emissions: EN 55022:2006+A1:2007		
Prüfergebnis: *Test Result:*	**Der vorstehend beschriebene Prüfgegenstand wurde geprüft und entspricht oben genannter Prüfgrundlage. The above product was found to be Compliant to the above test standard(s)**		

geprüft / *tested by:* Gary Jorgenson			**kontrolliert** / *reviewed by:* Conan Boyle		
March 11, 2011			March 14, 2011		
Datum *Date*	**Name** *Name*	**Unterschrift** *Signature*	**Datum** *Date*	**Name** *Name*	**Unterschrift** *Signature*

Sonstiges : *Other Aspects:*	**None**

Abkürzungen:	OK, Pass, Compliant, Complies = entspricht Prüfgrundlage Fail, Not Compliant, Does not Comply = entspricht nicht Prüfgrundlage N/A = nicht anwendbar
Abbreviations:	OK, Pass, Compliant, Complies = passed Fail, Not Compliant, Does Not Comply = failed N/A = not applicable

FC	NVLAP® NVLAP LAB CODE 100411-0	Industry Canada Industrie Canada	VCCI
US5251		**2932D-1**	**1097**

TABLE OF CONTENTS

1 General Information

1.1 Scope

This report is intended to document the status of conformance with the requirements of the EN 55022: 2006, +A1: 2007 based on the results of testing performed on March 10, 2011 on the DC DC uModule Regulator, Model No. LTM4613, manufactured by Linear Technology Corporation. This report only applies to the specific samples tested under the stated test conditions. It is the responsibility of the manufacturer to assure that additional production units of this model are manufactured with identical or EMI equivalent electrical and mechanical components. This report is further intended to document changes and modifications to the EUT throughout its life cycle. All documentation will be included as a supplement.

1.2 Purpose

Testing was performed to evaluate the EMC performance of the EUT (Equipment Under Test) in accordance with the applicable requirements, procedures, and criteria defined in the application of regulations and application of standards listed in this report.

1.3 *Summary of Test Results*

Applicant	Linear Technology Corporation 1630 McCarthy Blvd. Milpitas, CA 95035	**Tel**	(408) 432-1900	**Contact**	Richard Ying
		Fax	(408)-434-0507	**e-mail**	Rying@linear.com

Description	DC DC uModule Regulator	**Model Number**	LTM4613
Serial Number	None	**Test Voltage/Freq.**	12 - 36 Vdc
Test Date Completed:	March 10, 2011	**Test Engineer**	Gary Jorgenson

Standards	Description	Severity Level or Limit	Criteria	Test Result
EN 55022:2006+A1:2007 Product Family Standard Emissions	Information Technology Equipment – Radio Disturbance	See called out basic standards below	See Below	Complies
EN 55022:2006+A1:2007	Radiated Emissions	Class B, 30 - 1000 MHz	Limit	Complies

2 Laboratory Information

2.1 Accreditations & Endorsements

2.1.1 US Federal Communications Commission

TUV Rheinland of North America located at 2305 Mission College Blvd, Suite 105, Santa Clara, CA 95054, is recognized by the commission for performing testing services for the general public on a fee basis. This laboratory test facilities have been fully described in reports submitted to and accepted by the FCC (Registration No US5251). The laboratory scope of accreditation includes: Title 47 CFR Parts 15 and 18. The accreditation is updated every 3 years.

2.1.2 NIST / NVLAP

TUV Rheinland of North America is accredited by the National Voluntary Laboratory Accreditation Program, which is administered under the auspices of the National Institute of Standards and Technology. The laboratory has been assessed and accredited in accordance with ISO Standard 17025:2005 (Lab Code: 100411-0). The scope of laboratory accreditation includes emission and immunity testing. The accreditation is updated annually.

2.1.3 Industry Canada

Industry Canada Industrie Canada Registration No.: 2932D-1. The 10 meter Semi-Anechoic Chamber has been accepted by Industry Canada to perform testing to 3 and 10 meters based on the test procedures described in ANSI C63.4-2003.

2.1.4 Japan – VCCI

The Voluntary Control Council for Interference by Information Technology Equipment (VCCI) is a group that consists of Information Technology Equipment (ITE) manufacturers and EMC test laboratories. The purpose of the Council is to take voluntary control measures against electromagnetic interference from Information Technology Equipment, and thereby contribute to the development of a socially beneficial and responsible state of affairs in the realm of Information Technology Equipment in Japan. TUV Rheinland of North America at 1279 Quarry Ln, Pleasanton, CA 94566 has been assessed and approved in accordance with the Regulations for Voluntary Control Measures. (Registration Nos. R-2366, C-2585, C-2586, T-1635).

2.1.5 Acceptance by Mutual Recognition Arrangement

The United States has an established agreement with specific countries under the Asia Pacific Laboratory Accreditation Corporation (APLAC) Mutual Recognition Arrangement. Under this agreement, all TUV Rheinland at 1279 Quarry Lane, Pleasanton, CA 94566 test results and test reports within the scope of the laboratory NIST / NVLAP accreditation will be accepted by each member country.

2.2 Test Facilities

Test facilities are located at 1279 Quarry Lane, Pleasanton, California 94566, U.S.A. and 2305 Mission College, Santa Clara, 95054, U.S.A. (Santa Clara is the Pleasanton Annex).

Emission Test Facility

The Semi-Anechoic chamber and AC Line Conducted measurement facility used to collect the radiated and conducted data has been constructed in accordance with ANSI C63.7:1992. The site has been measured in accordance with and verified to comply with the theoretical normalized site attenuation requirements of ANSI C63.4:2003, at test distances of 3 and 10 meters. This site has been described in reports dated November 1st, 2006, submitted to the FCC, and accepted by letter dated November 28, 2006. The site is listed with the FCC and accredited by NVLAP (Lab Code 100411-0).

Immunity Test Facility

ESD, EFT, Surge, PQF: These tests are performed in an environmentally controlled room with a 3.7m x 3.7m x 3.175mm thick aluminum floor connected to PE ground. For ESD testing, tabletop equipment is placed on an insulated mat with a surface resistivity of 10^9 Ohms/square on a 1.6m x 0.8m x 0.8m high non-conductive table with a 3.175mm aluminum top (Horizontal Coupling Plane). The HCP is connected to the main ground plane via a low impedance ground strap through two 470 kΩ resistors. The Vertical Coupling Plane consists of an aluminum plate 50cm x 50cm x 3.175mm thick. The VCP is connected to the main ground plane via a low impedance ground strap through two 470 kΩ resistors. For each of the other tests, the HCP is removed.

RF Field Immunity testing is performed in a 10m semi-anechoic chamber with absorber added to floor.

RF Conducted and Magnetic Field Immunity testing is performed on a 4.9m x 3.7m x 3.175mm thick aluminum ground plane which is connected to one end of the anechoic chamber.

All test areas allow a minimum distance of 1 meter from the EUT to walls or conducting objects

2.3 Measurement Uncertainty

Two types of measurement uncertainty are expressed in this report, per *ISO Guide To The Expression Of Uncertainty In Measurement*, 1st Edition, 1995.

The Combined Standard Uncertainty is the standard uncertainty of the result of a measurement when that result is obtained from the values of a number of other quantities, equal to the positive square root of a sum of terms, the terms being the variances or co-variances of these other quantities weighted according to how the measurement result varies with changes in these quantities. The term standard uncertainty is the result of a measurement expressed as a standard deviation.

The Expanded Uncertainty defines an interval about the result of a measurement that may be expected to encompass a large fraction of the distribution of values that could reasonably be attributed to the measurand. The fraction may be viewed as the coverage probability or level of confidence of the interval.

Sample Calculation – radiated & conducted emissions

The field strength is calculated by subtracting the Amplifier Gain and adding the Cable Loss and Antenna Correction Factor to the measured reading. The basic equation is as follows:

Field Strength (dBμV/m) = RAW - AMP + CBL + ACF

Where: RAW = Measured level before correction (dBμV)

AMP = Amplifier Gain (dB)

CBL = Cable Loss (dB)

ACF = Antenna Correction Factor (dB/m)

$$\mu V/m = 10^{\frac{dB\mu V/m}{20}}$$

Sample radiated emissions calculation @ 30 MHz

Measurement +Antenna Factor–Amplifier Gain+Cable loss=Radiated Emissions (dBuV/m)

25 dBuV/m + 17.5 dB – 20 dB + 1.0 dB = 23.5 dBuV/m

Table 1: Summary of Uncertainties - Emissions

	U_{lab}	U_{cispr}
Radiated Disturbance @ 10m		
30 MHz – 1,000 MHz	3.2 dB	5.2 dB

Table 2: Measurement Uncertainty Immunity

The estimated combined standard uncertainty for ESD immunity measurements is ± 4.1%.
The estimated combined standard uncertainty for radiated immunity measurements is ± 2.05 dB.

The expanded uncertainty at a level of 95% confidence is obtained by multiplying the combined standard uncertainty by a coverage factor of 2. Compliance criteria are not based on measurement uncertainty.

2.4 Calibration Traceability

All measurement instrumentation is traceable to the National Institute of Standards and Technology (NIST). Measurement method complies with ANSI/NCSL Z540-1-1994 and ISO Standard 17025:2005. Equipment calibration records are kept on file at the test facility.

2.5 Measurement Equipment Used

Equipment	Manufacturer	Model #	Serial/Inst #	Last Cal dd/mm/yy	Next Cal dd/mm/yy	Test
EMI Receiver (Receiver Section)	HP	85462A	3807A00445	12/03/2010	12/03/2011	RE
EMI Receiver (RF Filter Section)	HP	85460A	3704A00407	12/03/2010	12/03/2011	RE
9 kHz – 1 GHz Ant. Preamplifier	HP	8447D	2944A07486	1/17/2011	1/17/2012	RE
Bilog Antenna Emissions	EMCO	3142	9701-1117	07/14/2010	07/14/2011	RE

Notes: CE = Conducted Emissions, CI= Conducted Immunity, DP=Disturbance Power, EFT=Electrical Fast Transients, ESD = Electrostatic Discharge, FLI=Flicker, HAR=Harmonics, MF=Magnetic Field Immunity, RE=Radiated Emissions, RI=Radiated Immunity, SI=Surge Immunity, VDSI=Voltage Dips and Short Interruptions

3 Product Information

3.1 Product Description

See Section 6.4.

3.2 Equipment Modifications and Test Setup

None.

3.3 Test Plan

The EUT product information, test configuration, mode of operation, test types, test procedures, test levels, pass/failure criteria, in this report were carried out per the product test plan located in Appendix A of this report.

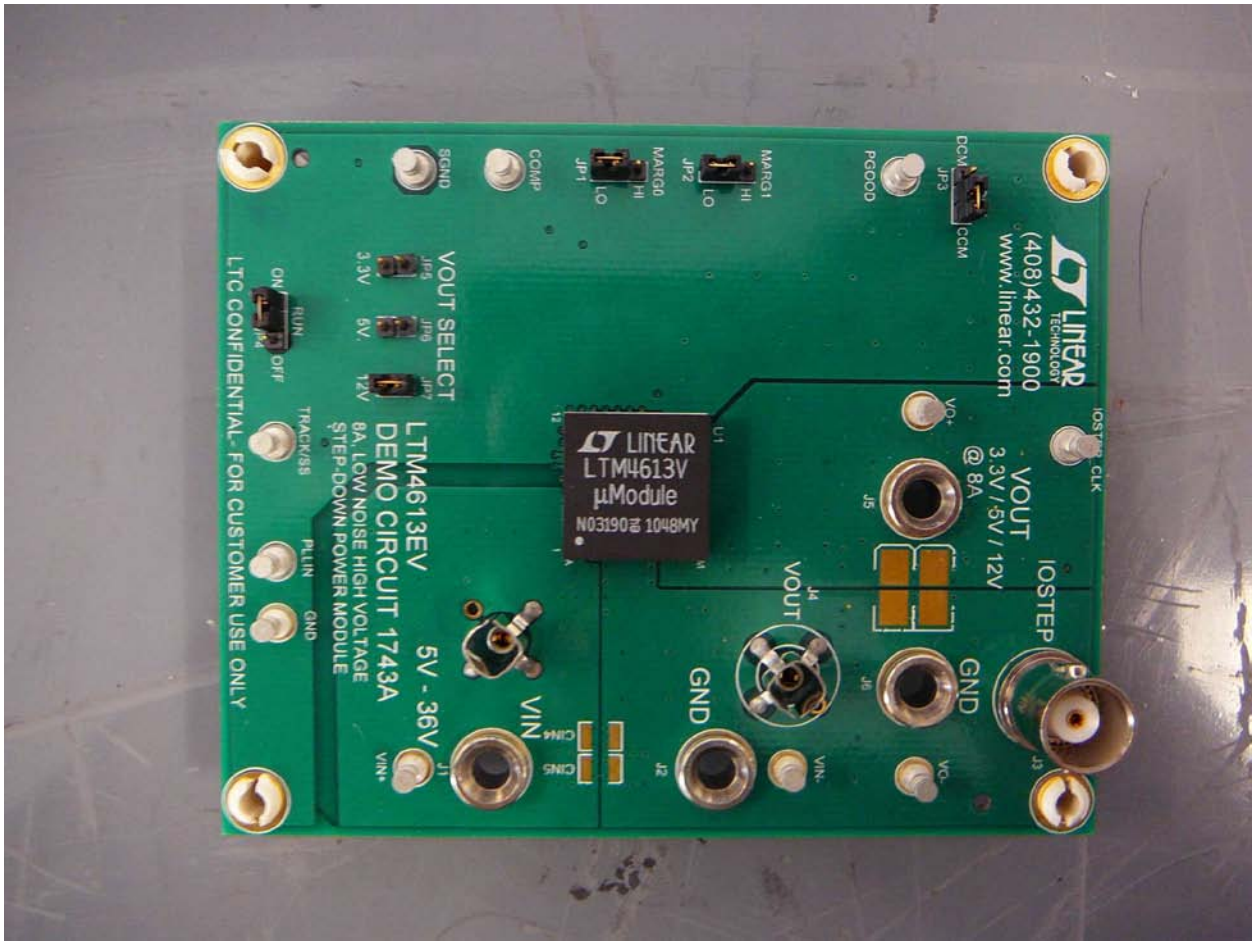


Figure 1 – Photo of EUT with fixture - Front

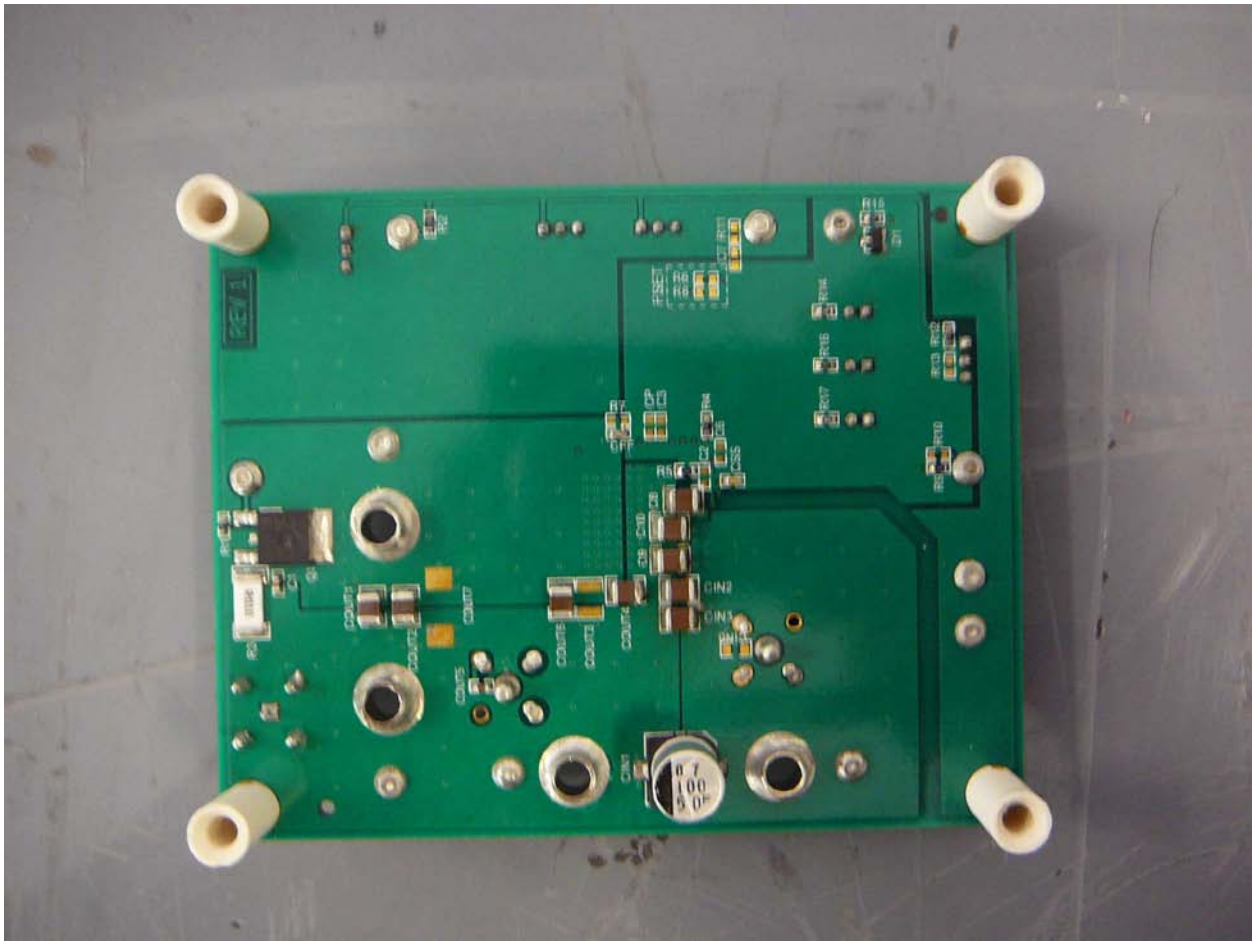


Figure 2 – Photo of EUT with fixture Back

4 Emissions

4.1 Radiated Emissions

This test measures the electromagnetic levels of spurious signals generated by the EUT that radiated from the EUT and may affect the performance of other nearby electronic equipment.

4.1.1 Overview of Test

Results	**Complies** (as tested per this report)	**Date**	March 10, 2011
Standard	EN 55022:2006+A1:2007		
Product Model	LTM4613	**Serial#**	None
Configuration	See test plan for details.		
Test Setup	Tested in 10m chamber, placed on turntable, see test plan for details.		
EUT Powered By	12 – 36 Vdc		
Frequency Range	30 – 1000 MHz @ 10m		
Perf. Criteria	Class B (Below Limit)	**Perf. Verification**	Readings Under Limit
Mod. to EUT	None	**Test Performed By**	Gary Jorgenson

4.1.2 Test Procedure

Radiated emissions tests were performed using the procedures of ANSI C63.4 including methods for signal maximizations and EUT configuration. The photos included with the report show the EUT in its maximized configuration.

The frequency range from 30 – 1000 MHz was investigated for radiated emissions on all configurations.

4.1.3 Deviations

There were no deviations from the test methodology listed in the test plan for the radiated emission test.

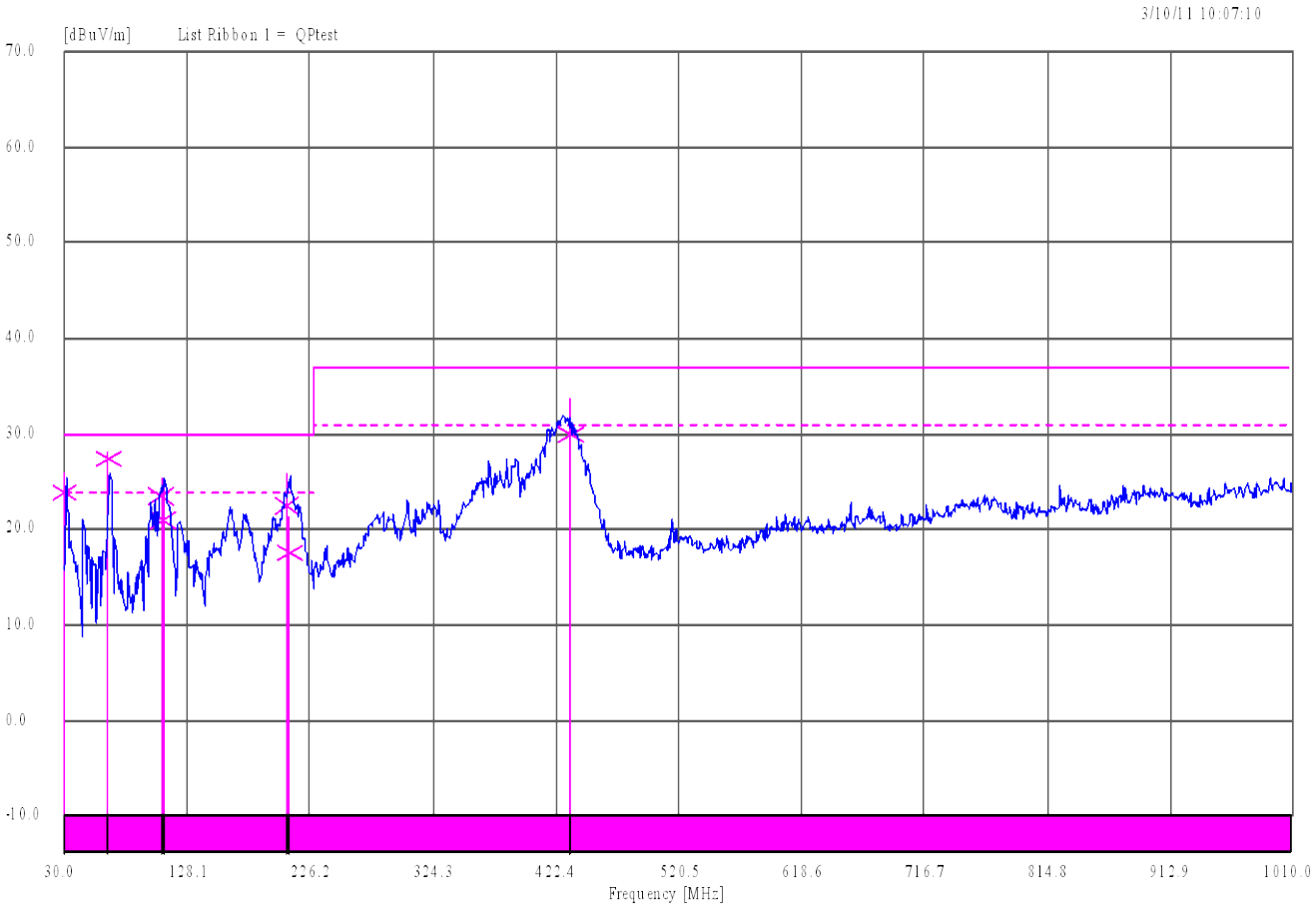
4.1.4 Final Test

All final radiated emissions measurements were below (in compliance) the limits.

4.1.5 Final Graphs

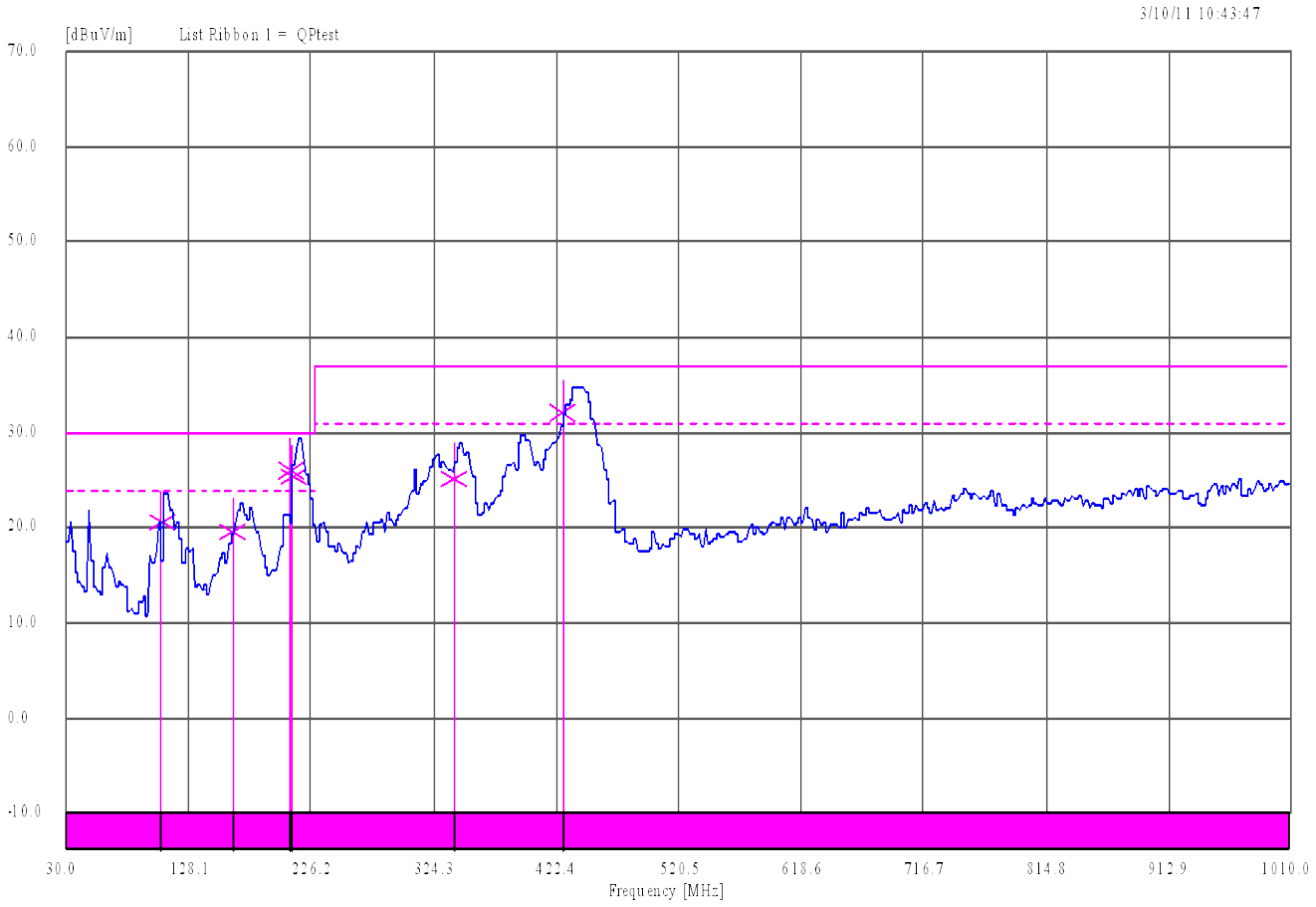
NOTES: 24V Input, 12V output @ 8A

Radiated Emissions 30 – 1000 MHz
Vertical / Horizontal



NOTES: 36V Input, 12V output @ 5A

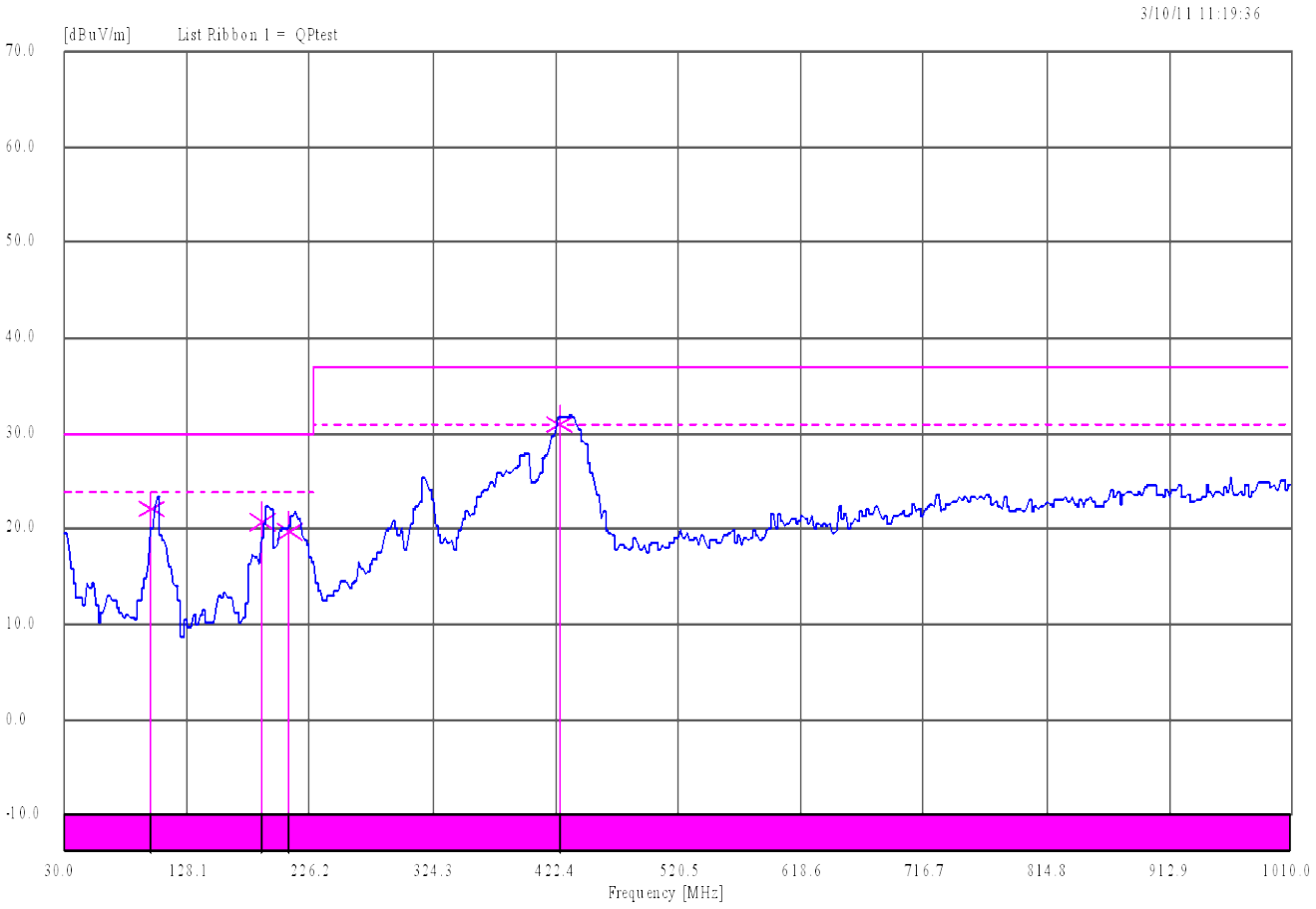
Radiated Emissions 30 – 1000 MHz
Vertical / Horizontal



NOTES: : 36V Input, 5V output @ 8A

Radiated Emissions 30 – 1000 MHz

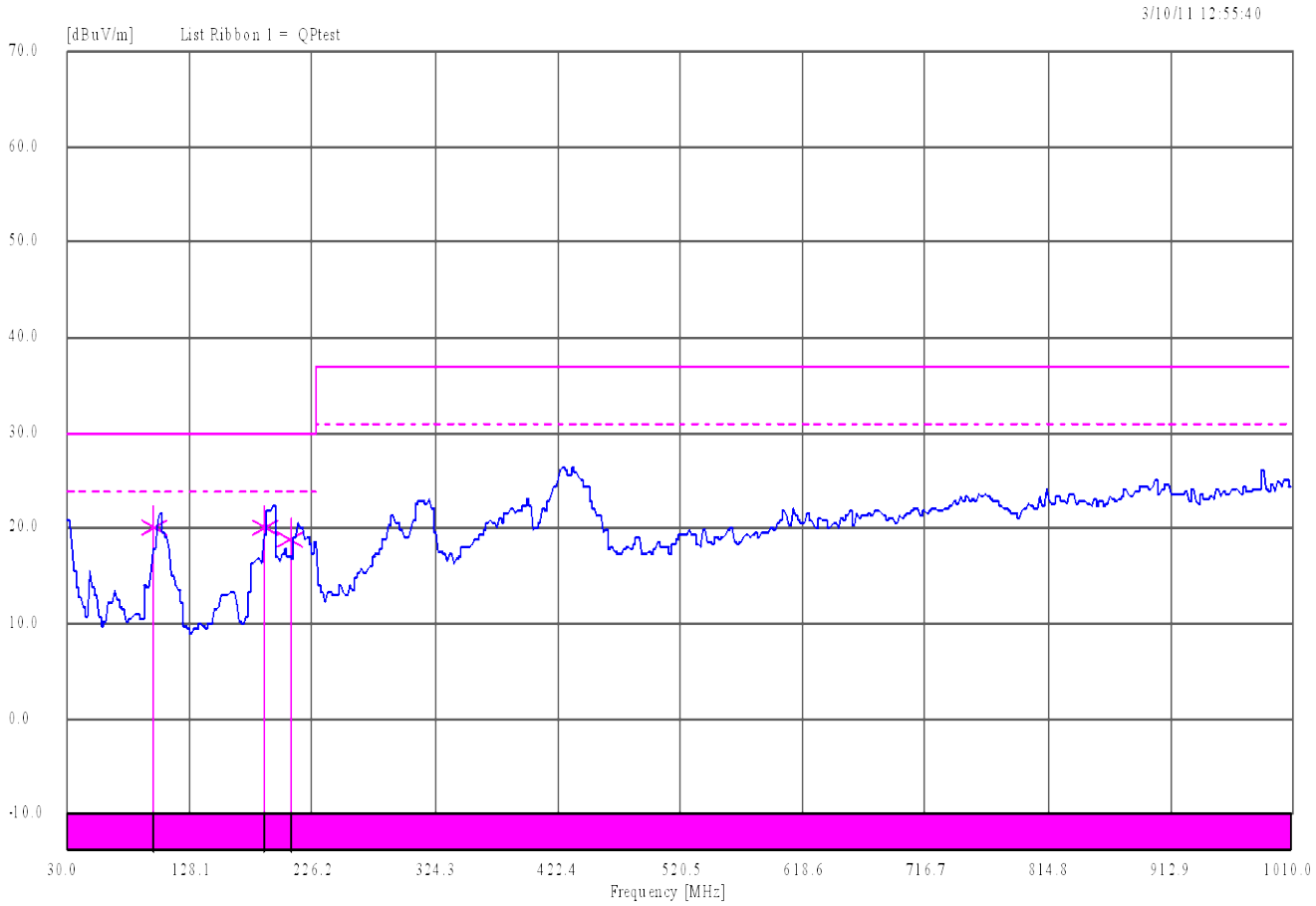
Vertical / Horizontal



NOTES: 24V Input, 5V output @ 8A

Radiated Emissions 30 – 1000 MHz

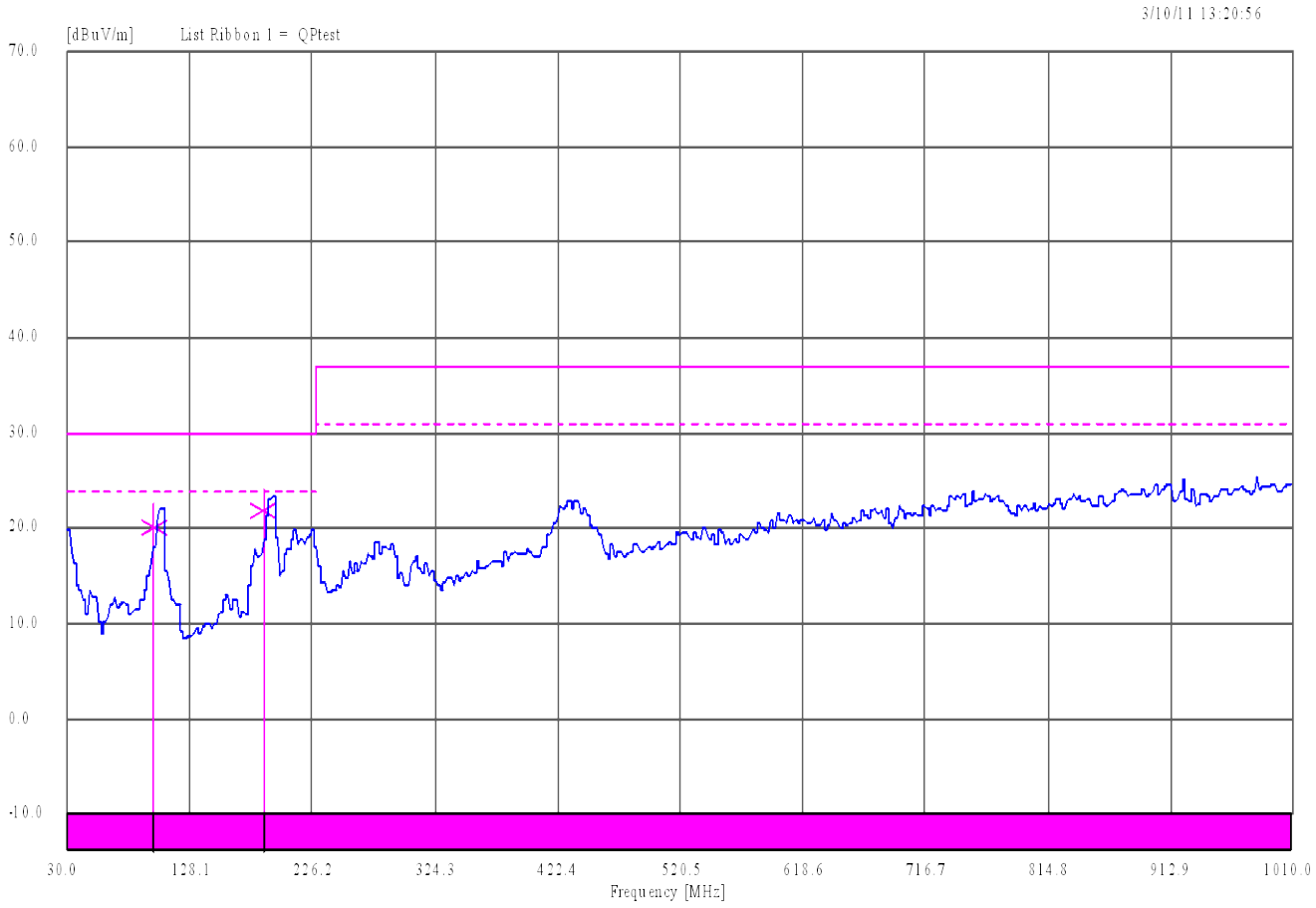
Vertical / Horizontal



NOTES: 12V Input, 5V output @ 8A

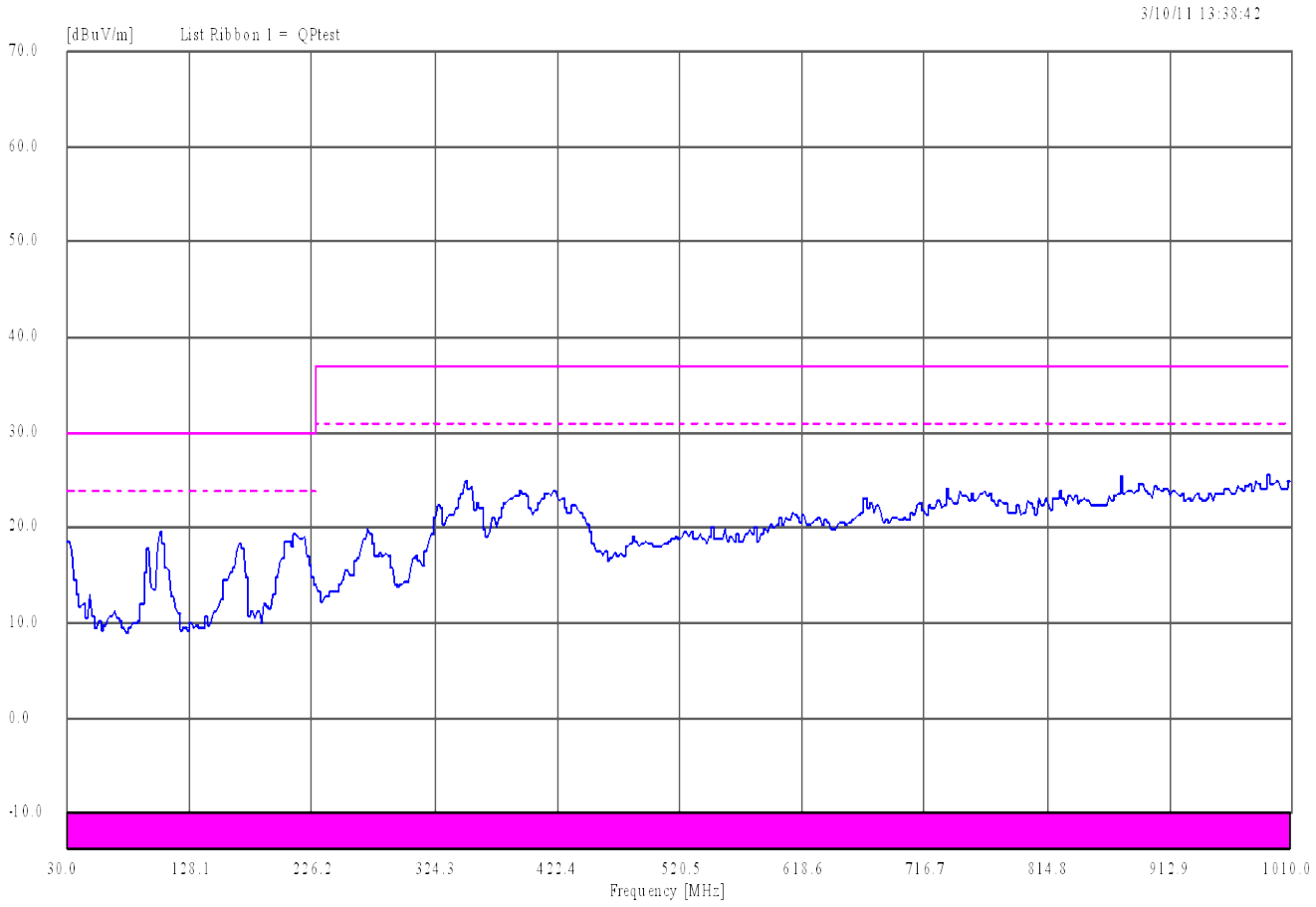
Radiated Emissions 30 – 1000 MHz

Vertical / Horizontal



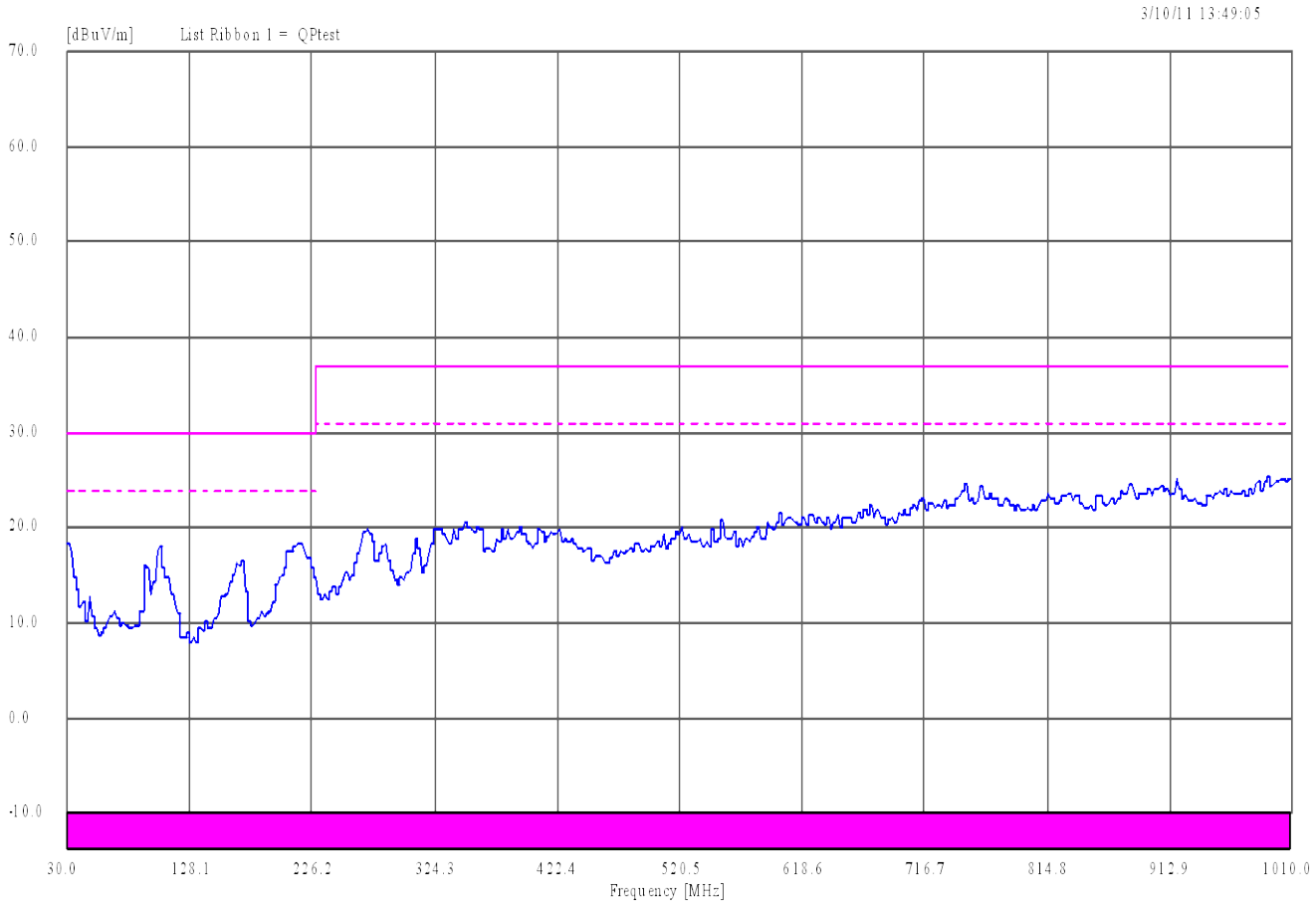
NOTES: 36V Input, 3.3V output @ 8A

Radiated Emissions 30 – 1000 MHz
Vertical / Horizontal



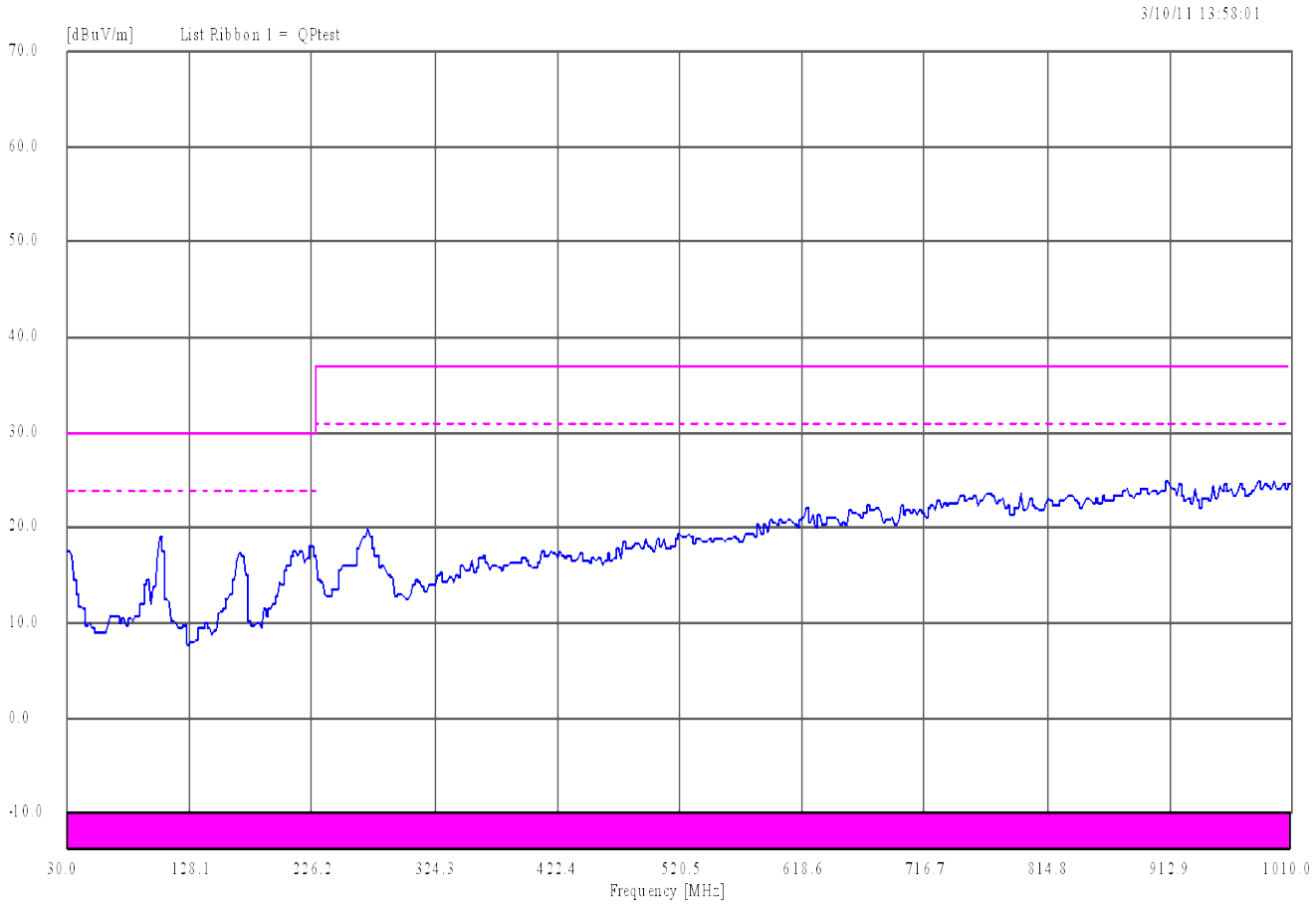
NOTES: 24V Input, 3.3V output @ 8A

Radiated Emissions 30 – 1000 MHz
Vertical / Horizontal



NOTES: 12V Input, 3.3V output @ 8A

Radiated Emissions 30 – 1000 MHz
Vertical / Horizontal



4.1.6 Radiated Emissions Scan Tabulated Data

24V Input, 12V output @ 8A

Frequency	Peak	QP	QP Lmt	QP Margin	Angle	Hgt	Pol	Total Correction Factor
MHz	dBuV/m	dBuV/m	dBuV/m	dB	deg	cm		
30.086189	25.97	23.89	30.00	-6.11	203	104	Vert	-8.71
65.405432	28.25	27.49	30.00	-2.51	252	394	Vert	-19.09
107.264962	25.35	23.50	30.00	-6.50	244	101	Vert	-17.81
109.785640	25.33	20.99	30.00	-9.01	262	300	Vert	-18.03
207.358060	25.82	22.55	30.00	-7.45	97	99	Vert	-14.08
209.722867	21.42	17.62	30.00	-12.38	0	300	Horz	-14.05
433.722782	33.80	29.94	37.00	-7.06	76	220	Horz	-7.58

36V Input, 12V output @ 5A

Frequency	Peak	QP	QP Lmt	QP Margin	Angle	Hgt	Pol	Total Correction Factor
MHz	dBuV/m	dBuV/m	dBuV/m	dB	deg	cm		
106.123575	23.97	20.68	30.00	-9.32	243	103	Vert	-17.69
162.802935	23.07	19.66	30.00	-10.34	335	396	Horz	-15.78
209.497167	29.41	26.01	30.00	-3.99	62	329	Horz	-14.05
211.234677	28.73	25.45	30.00	-4.55	67	307	Horz	-14.00
340.562845	28.87	25.12	37.00	-11.88	45	188	Horz	-9.20
428.255616	35.55	32.12	37.00	-4.88	85	243	Horz	-7.58

36V Input, 5V output @ 8A

Frequency	Peak	QP	QP Lmt	QP Margin	Angle	Hgt	Pol	Total Correction
MHz	dBuV/m	dBuV/m	dBuV/m	dB	deg	cm		Factor
99.938319	23.98	22.08	30.00	-7.92	244	102	Vert	-17.61
187.507117	22.76	20.70	30.00	-9.30	355	395	Horz	-14.75
209.645189	21.92	19.71	30.00	-10.29	113	90	Vert	-14.05
425.934827	33.01	30.98	37.00	-6.02	58	182	Horz	-7.61

24V Input, 5V output @ 8A

Frequency	Peak	QP	QP Lmt	QP Margin	Angle	Hgt	Pol	Total Correction
MHz	dBuV/m	dBuV/m	dBuV/m	dB	deg	cm		Factor
99.764967	22.31	20.05	30.00	-9.95	238	99	Vert	-17.61
187.795394	22.33	20.17	30.00	-9.83	2	344	Horz	-14.74
208.352861	21.09	18.85	30.00	-11.15	113	102	Vert	-14.06

12V Input, 5V output @ 8A

Frequency	Peak	QP	QP Lmt	QP Margin	Angle	Hgt	Pol	Total Correction
MHz	dBuV/m	dBuV/m	dBuV/m	dB	deg	cm		Factor
100.018677	22.75	20.12	30.00	-9.88	235	249	Vert	-17.60
187.217869	24.13	21.94	30.00	-8.06	28	393	Horz	-14.75

36 V Input, 3.3 V output @ 8 A
Note: No Emissions found within 10 dB of the Class B Limit

24 V Input, 3.3 V output @ 8 A
Note: No emissions within 10 dB of Class B Margin

12 V Input, 3.3 V output @ 8 A
Note: No emissions within 10 dB of Class B Margin

4.1.7 Photos

Figure 3 – Radiated Emissions Test Setup – Front

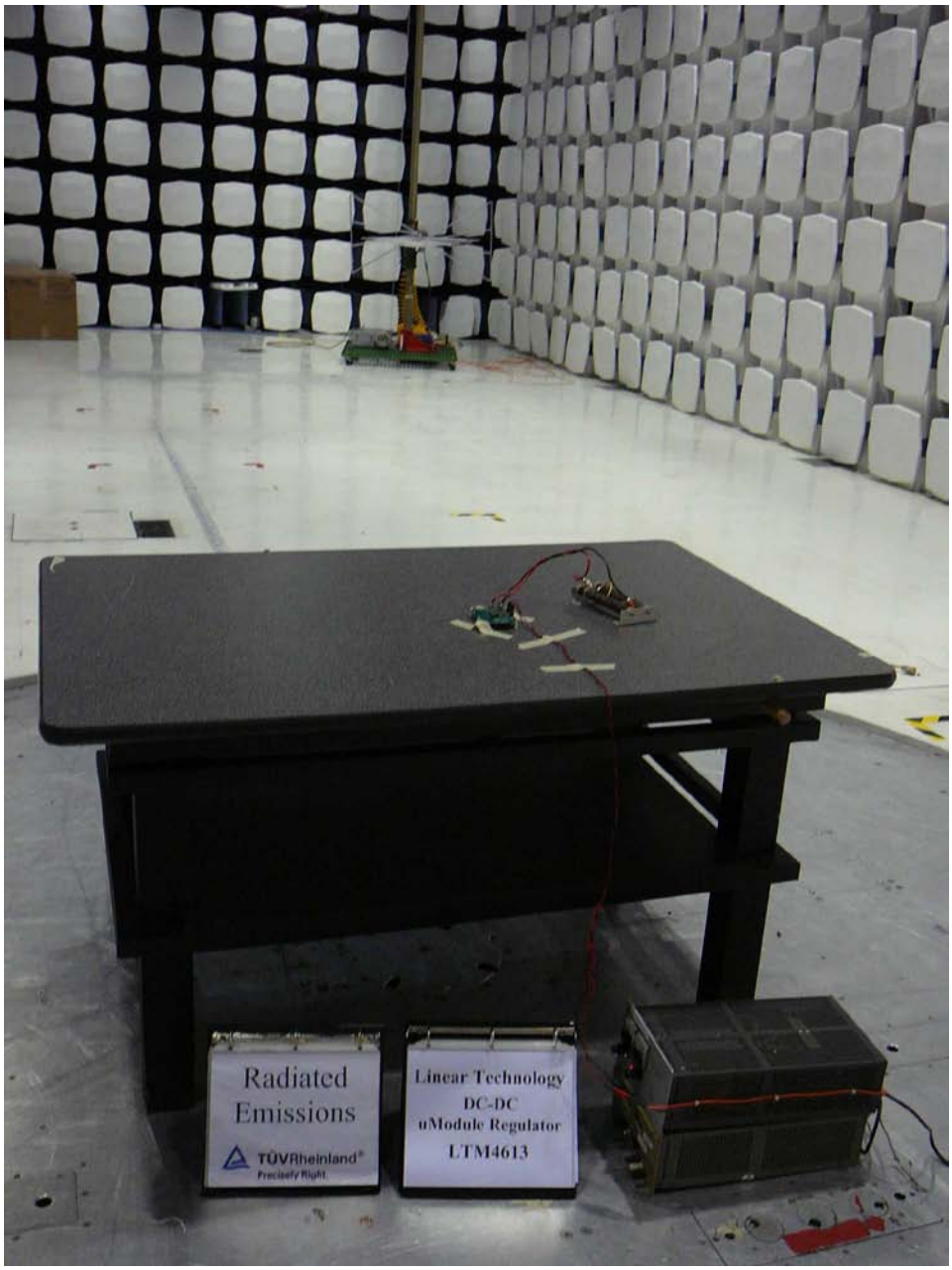


Figure 4 – Radiated Emissions 30 - 1000 MHz Test Setup – Back

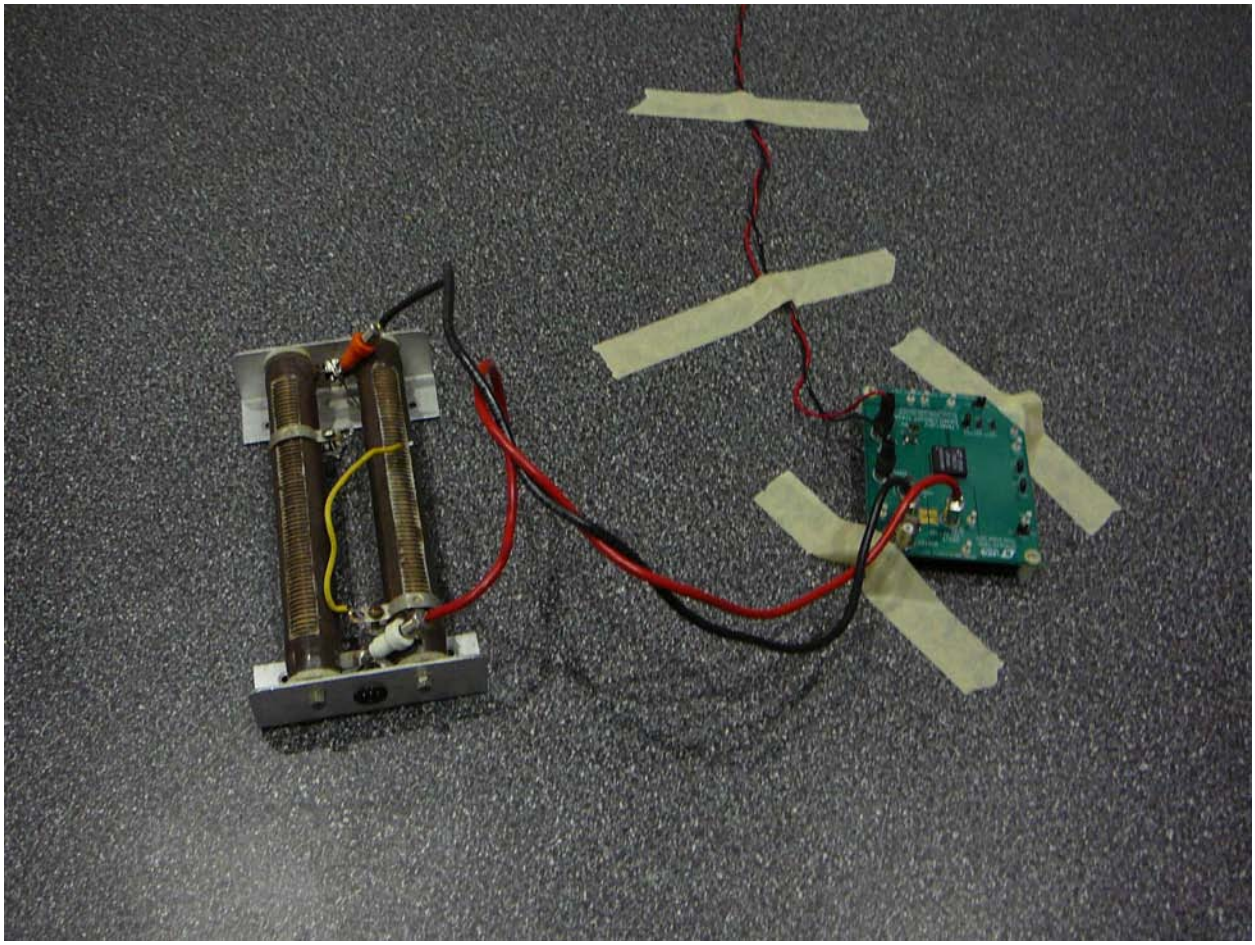


Figure 5 – Radiated Emissions 30 - 1000 MHz Test Setup – Load 1

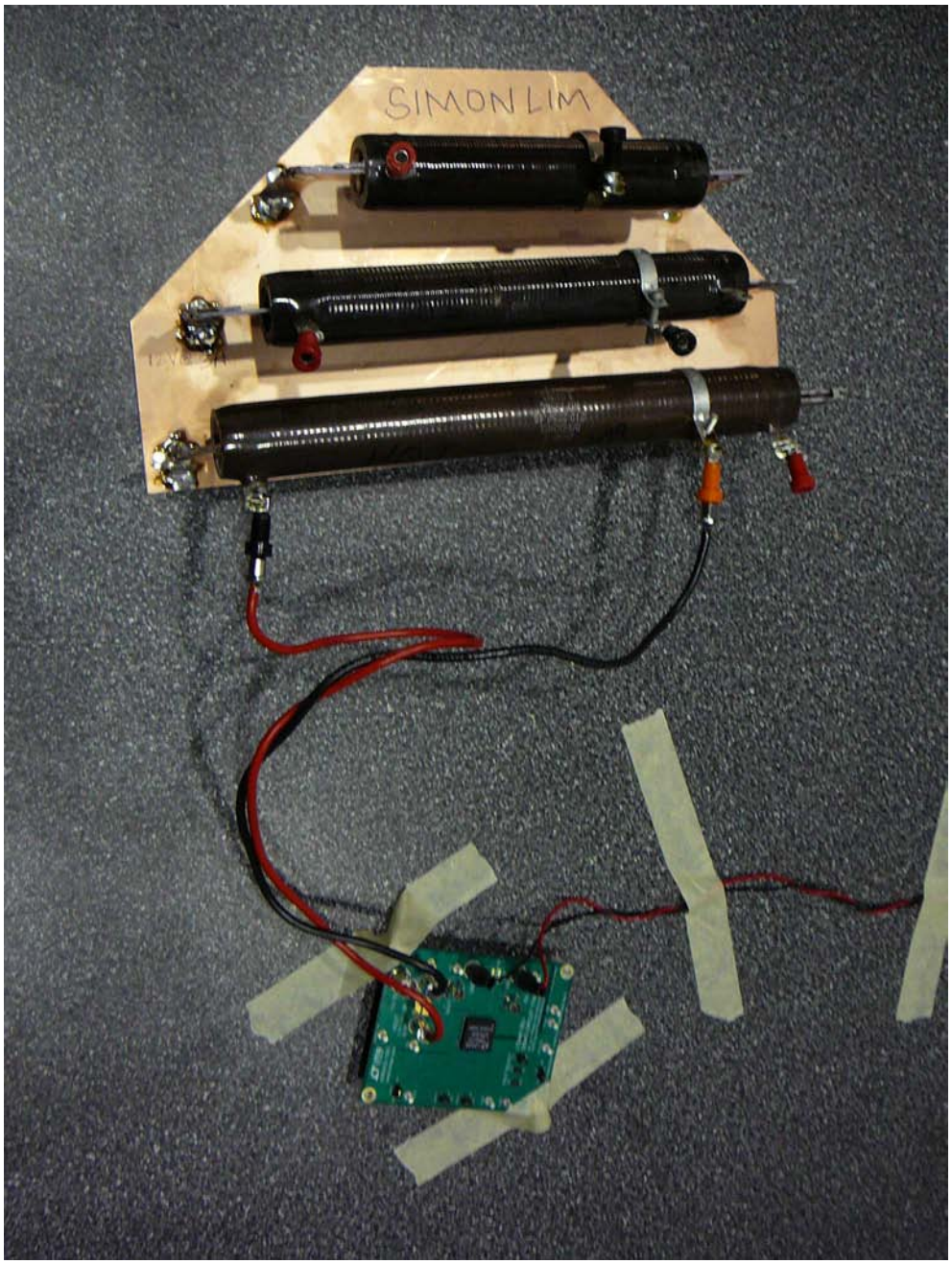


Figure 6 – Radiated Emissions 30 - 1000 MHz Test Setup – Load 2

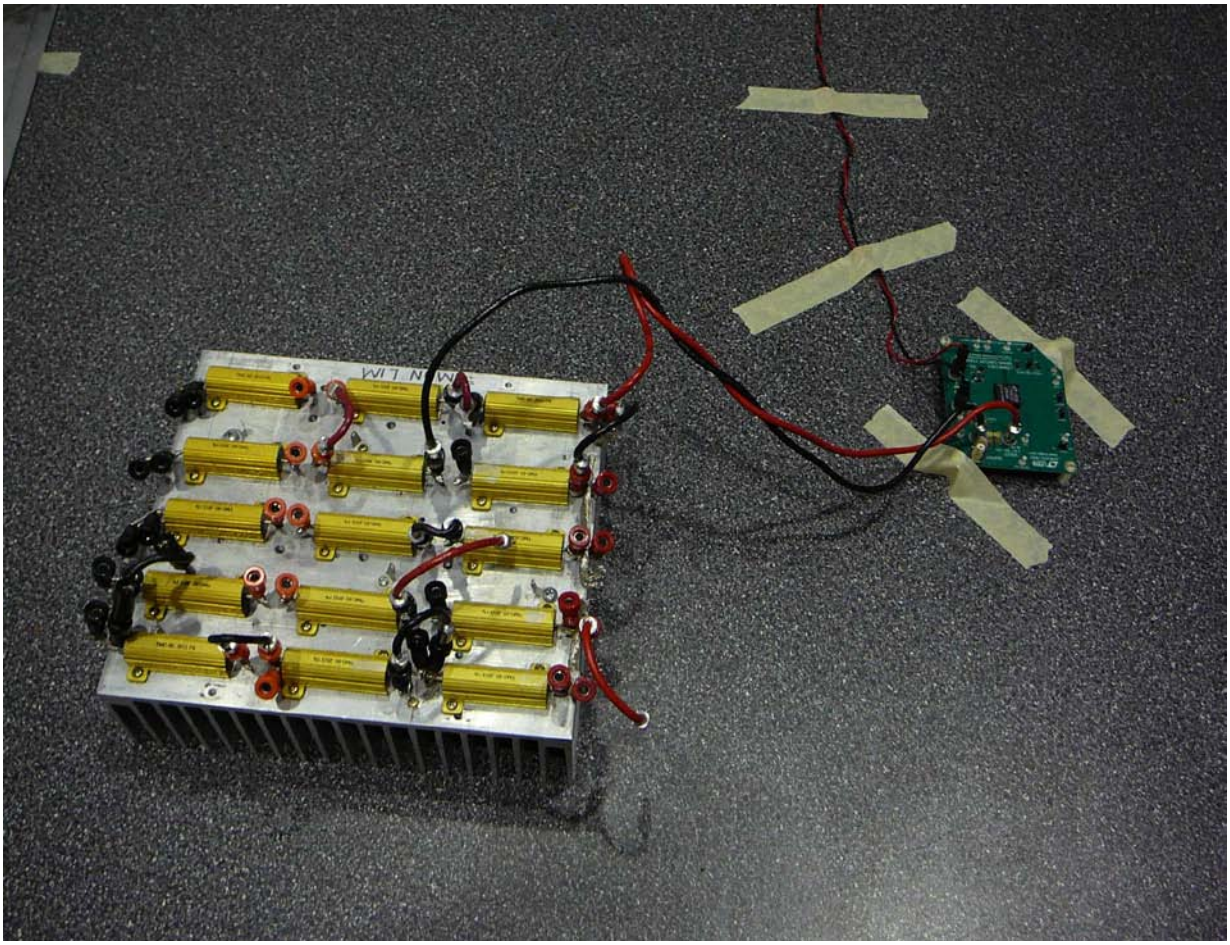


Figure 7 – Radiated Emissions 30 - 1000 MHz Test Setup – Load 3

Appendix A

5 Test Plan

This test report is intended to follow this test plan outlined here in unless other wise stated in this here report. The following test plan will give details on product information, standards to be used, test set ups and refer to TUV test procedures. The test procedures will give the steps to be taken when performing the stated test. The product information below came via client, product manual, product itself and or the internet.

5.1 General Information

Client	Linear Technology Corporation.
Address	1630 McCarthy Blvd.
Address	Milpitas, CA 95035
Contact Person	Richard Ying
Telephone	(408) 432-1900 Extension 3318
Fax	(408)-434-0507
e-mail	Rying@linear.com

5.2 Model(s) Name

LTM4613

5.3 Type of Product

DC DC uModule Regulator

5.4 Equipment Under Test (EUT) Description

The LTM®4613 is an ultra low noise, high voltage, 8 A switching mode DC/DC power supply. The onboard input filter and noise cancellation circuits achieve low noise operation, thus effectively reducing electromagnetic interference (EMI).

5.5 Modifications

None

5.6 Product Environment

☒	**Residential**	☐	**Hospital**
☒	**Light Industrial**	☐	**Small Clinic**
☒	**Industrial**	☐	**Doctor's office**
☐	**Other**		

*Check all that apply

5.7 Countries

☒	**USA**
☐	**Taiwan**
☐	**Japan**
☒	**Europe**

*Check all that apply

5.8 Applicable Documents

Standards	Description
EN 55022:2006+A1:2007	Radiated Emissions

5.9 EUT Electrical Powered Information

5.9.1 Electrical Power Type

☐	**AC**	☒	**DC**	☐	**Batteries**	☐	**Host -**

5.9.2 Electrical Power Information

Name	**Type**	**Voltage**		**Frequency**	**Current**	**Notes**
		min	**max**			
DC Input	DC	4.5V	36.0V	600 kHz	Load Dependant	
DC Output	DC	3.3V	16V	600 kHz	8 A Max	
Notes	None					

5.9.3 EUT Modes of Operation

- 24V Input, 12V output @ 8A
- 36V Input, 12V output @ 5A
- 36V Input, 5V output @ 8A
- 24V Input, 5V output @ 8A
- 12V Input, 5V output @ 8A
- 36V Input, 3.3V output @ 8A
- 24V Input, 3.3V output @ 8A
- 12V Input, 3.3V output @ 8A

5.10 EUT Clock/Oscillator Frequencies

☒	**Less than 108 MHz**	**FCC – scan up to 1 GHz**
☐	**Less than 500 MHz**	**FCC – scan up to 2 GHz**
☐	**Less than 1000 MHz**	**FCC – scan up to 5 GHz**
☐	**Greater then 1000 MHz**	**FCC – scan up to 5th Harmonic or 40 GHz**

5.11 Electrical Support Equipment

Type	Manufacture	Model	Connected To
Power Supply	Lambda	LP532-FM	EUT input
Load Resistors	N/A	N/A	EUT Output

5.12 EUT Equipment/Cabling Information

EUT Port	Connected To	Location	Cable Type		
			Length	Shielded	Bead
VIN	Power Supply	Inside Chamber	1 meter	No	No
VOUT	Resistive load	Inside Chamber	0.2 meters	No	No

5.13 EUT Test Program

None

5.14 Monitoring of EUT during Testing

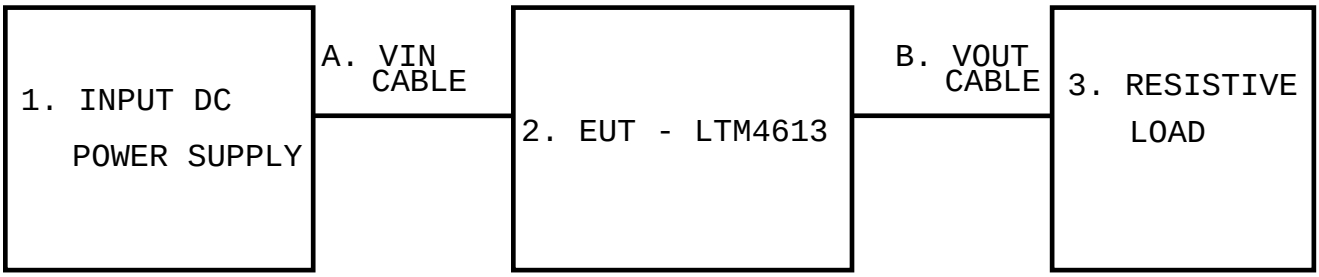
For Emissions testing the EUT output voltage is checked during the test.

5.15 EUT Configuration

5.15.1 Description

Configuration	Description
One Only	LTM4613 installed on demo board 1743A
Notes	All configurations tested with a resistive load

5.15.2 Block Diagram



5.16 Emissions

5.16.1 Radiated Emissions

5.16.1.1 Final Radiated Emissions Test Setup

Standard	EN 55022:2006 +A1:2007			**TUV Test Procedure**	QP093006
Limit	Class B	**Emissions Verification**			Emissions Under Limit
Frequency Range	30 – 1000 MHz	**Ant Dist**	10m	**Det**	QP 30 – 1000 MHz,
Scan #1	(30 – 1000 MHz) 24V Input, 12V output @ 8A				
Scan #2	(30 – 1000 MHz) 36V Input, 12V output @ 5A				
Scan #3	(30 – 1000 MHz) 36V Input, 5V output @ 8A				
Scan #4	(30 – 1000 MHz) 24V Input, 5V output @ 8A				
Scan #5	(30 – 1000 MHz) 12V Input, 5V output @ 8A				
Scan #6	(30 – 1000 MHz) 36V Input, 3.3V output @ 8A				
Scan #7	(30 – 1000 MHz) 24V Input, 3.3V output @ 8A				
Scan #8	(30 – 1000 MHz) 12V Input, 3.3V output @ 8A				
Configuration	See section 5.16				

END OF REPORT