Electromagnetic Compatibility Test Report

Prepared in accordance with

EN 55022 Radiated Emissions

On

DC DC uModule Regulator LTM4623

Prepared for:

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

Prepared by:

TUV Rheinland of North America, Inc.
1279 Quarry Lane, Ste. A
Pleasanton, CA 94566
U.S.A.

Revisions

Revision No.	Date	Reason for Change	Author
0	January 21, 2014	Original Document	N/A

Note: Latest revision report will replace all previous reports.

ATTESTATION OF TEST RESULTS

Client:	Linear Technology Corporation 1630 McCarthy Blvd. Milpitas, CA 95035 U.S.A.	Richard Ying Tel. (408) 432-1900 Extension 3318 Rying@linear.com	
Model Name	LTM4623	***Serial Number(s):***	N/A (ENG.1)
Model Number(s)	LTM4623	***Date(s) Tested:***	November 4, 2013
Test Location(s):	TUV Rheinland of North America 2305 Mission College Blvd., Ste. 105 Santa Clara, CA 95054 U.S.A. Tel. (925) 249-9123		
Test Specifications:	Emissions:	EN 55022:2010, CISPR 22:2008	
Test Result:	**The above product was found to be Compliant to the above test standard(s)**		

Tested by: Gary Jorgenson	***Reviewed by:*** Conan Boyle
December 18, 2013 ***Date Name Signature***	Digitally signed by Conan Boyle DN: cn=Conan Boyle, o=TUV Rheinland of North America, ou=SFR EMC, email=cboyle@us.tuv.com, c=US Date: 2014.01.21 18:21:48 -08'00' January 21, 2014 ***Date Name Signature***
Other aspects:	**None**

SANTA CLARA

FC	ilac-MRA A2LA ACCREDITED	**INDUSTRY CANADA**	VCCI
US5251	**Testing Cert #3331.02**	**2932D-1**	**1097 (A-0032)**

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1 General Information

1.1 Scope

This report is intended to document the status of conformance with the requirements of the listed standards based on the results of testing performed on November 4, 2013 on the DC DC uModule Regulator, Model No. LTM4623, 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 Extension 3318
		Contact	Richard Ying
Description	DC DC uModule Regulator	**E-mail**	Rying@linear.com
Model Name	LTM4623	**Input Power**	4.0 Vdc - 20 Vdc
Model Number(s)	LTM4623	**Serial Number(s)**	N/A (ENG.1)
Test Date(s)	November 4, 2013	**Test Engineer**	Gary Jorgenson

Standards	Description	Severity Level or Limit	Criteria	Test Result
EN 55022:2010, CISPR 22:2008 Product Family Standard Emissions	Information Technology Equipment – Radio Disturbance	See called out basic standards below	See Below	Complies
EN 55022:2010, CISPR 22:2008	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 EMC test facilities located at 1279 Quarry Lane, Ste. A, Pleasanton, CA, 94566, and 2305 Mission College Blvd, Ste. 105, Santa Clara, CA 95054, are recognized by the Commission for performing testing services for the general public on a fee basis. These laboratory test facilities have been fully described in reports submitted to and accepted by the FCC (Pleasanton Registration No. US5254, Santa Clara Registration No. US5251). The laboratory Scopes of Accreditation include Title 47 CFR Parts 15, 18 and 90. The accreditations are updated every three years.

2.1.2 A2LA

TUV Rheinland of North America EMC test facilities are accredited by the American Association for Laboratory Accreditation (A2LA). The laboratories have been assessed and accredited by A2LA in accordance with ISO Standard 17025:2005 (Testing Certificate #3331.02). The Scope of Laboratory Accreditation includes emission and immunity testing. The accreditations are updated annually.

2.1.3 Industry Canada

The Pleasanton 5-meter Semi-Anechoic Chamber, Registration No. 2932M-1, has been accepted by Industry Canada to perform testing to 3 and 5 meters based on the test procedures described in ANSI C63.4-2009. The Santa Clara 10-meter Semi-Anechoic Chamber, Registration No. 2932D-1, has been accepted by Industry Canada to perform testing to 3 and 10 meters based on the test procedures described in ANSI C63.4-2009.

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 EMC test facilities located at 1279 Quarry Lane, Ste. A, Pleasanton, CA, 94566, and 2305 Mission College Blvd, Ste. 105, Santa Clara, CA 95054, have been assessed and approved in accordance with the Regulations for Voluntary Control Measures.

VCCI Registration No. for Pleasanton: A-0031

VCCI Registration No. for Santa Clara: A-0032

2.2 Test Facilities and EMC Software

Test facilities are located at 1279 Quarry Lane, Ste. A, Pleasanton, California 94566, U.S.A. and 2305 Mission College Blvd., Ste. 105, Santa Clara, 95054, U.S.A. (Santa Clara is the Pleasanton Annex).

2.2.1 Emission Test Facility

The Semi-Anechoic Chambers and AC Line Conducted measurement facilities used to collect radiated and conducted emissions data have been constructed in accordance with ANSI C63.7:1992. The Santa Clara 10 meter semi-anechoic chamber has been measured in accordance with and verified to comply with the theoretical volumetric normalized site attenuation of ANSI C63.4:2009 and SVSWR requirements of CISPR 16-1-4 Consol. Ed. 3.0 (2010-04), 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 A2LA (Testing Certificate #3331.02). The Pleasanton 5 meter semi-anechoic chamber has been verified to comply with the theoretical volumetric normalized site attenuation of ANSI C63.4:2009 and SVSWR requirements of CISPR 16-1-4 Consol. Ed. 3.0 (2010-04) at a test distance of 3 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 A2LA (Testing Certificate #3331.02).

2.2.2 Immunity Test Facility

ESD, EFT, Surge, PQF: These tests are performed in an environmentally controlled room with a 3.7 m x 3.7 m x 3.175 mm 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 1.6 m x 0.8 m x 0.8 m high non-conductive table with a 3.175 mm 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 50 cm x 50 cm x 3.175 mm 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 4.9 m x 3.7 m x 3.175 mm 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.

2.2.3 EMC Software - Santa Clara

Manufacturer	Name	Version	Test Type
Hewlett-Packard	HP85876B	A.01.00 970825	Radiated & Conducted Emissions
EMISoft	Vasona	5.0	Radiated & Conducted Emissions
ETS-Lindgren	TILE	4.2.A	Radiated Emissions > 1 GHz
ETS-Lindgren	TILE	V.3.4.K.22	Radiated & Conducted Immunity

Manufacturer	Name	Version	Test Type
Haefely	WinFEAT	1.6.3	Surge
Thermo Electron - Keytek	CEWare32	3.0	EFT/Surge/Voltage Dips & Interrupt
Voltech	IEC61000-3	1.15.07RC	Harmonic & Flicker

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.

2.3.1 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

2.3.2 Measurement Uncertainty Emissions

Per CISPR 16-4-2	**U_{lab}**	**U_{cispr}**
Radiated Disturbance @ 10 meters		
30 – 1,000 MHz	2.25 dB	4.51 dB
Radiated Disturbance @ 3 meters		
30 – 1,000 MHz	2.26 dB	4.52 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 mm/dd/yy	Next Cal mm/dd/yy	Test
EMI Receiver	Agilent	MXE	MY51210195	1/19/2013	1/19/2014	RE
100 kHz – 1 GHz Preamplifier	HP	8447D	2944A07486	1/17/2013	1/17/2014	RE
Bilog Antenna Emissions	Sunol Sciences	JB3	A020502	04/12/2013	04/12/2015	RE

Note: CE=Conducted Emissions, CI=Conducted Immunity, DP=Disturbance Power, EFT=Electrical Fast Transients, ESD=Electrostatic Discharge, FLI=Flicker, HAR=Harmonics, MF=Magnetic Field Immunity, NCR=No Calibration Required, 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

Added 47uF Capacitor to input.

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.

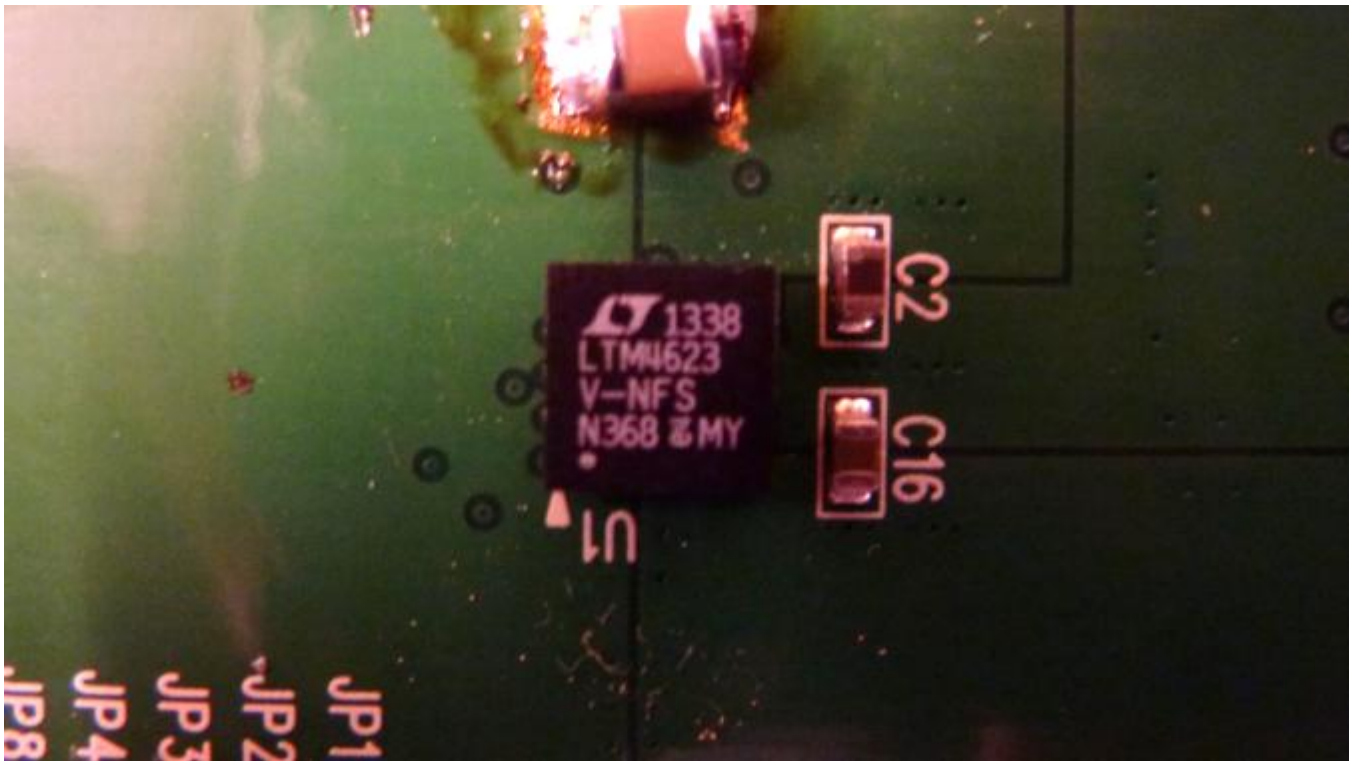


Figure 1 - External Photo of EUT

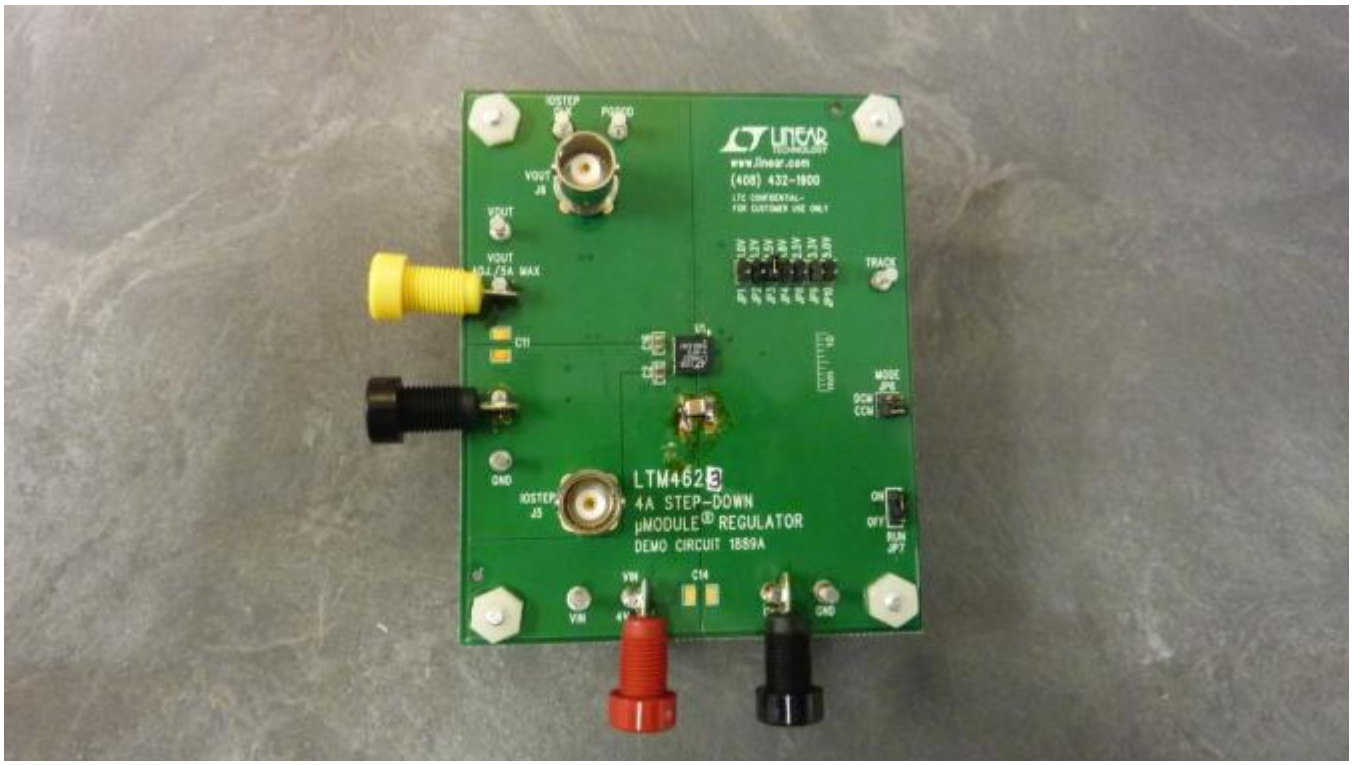


Figure 2 - External Photo of EUT Demo Board

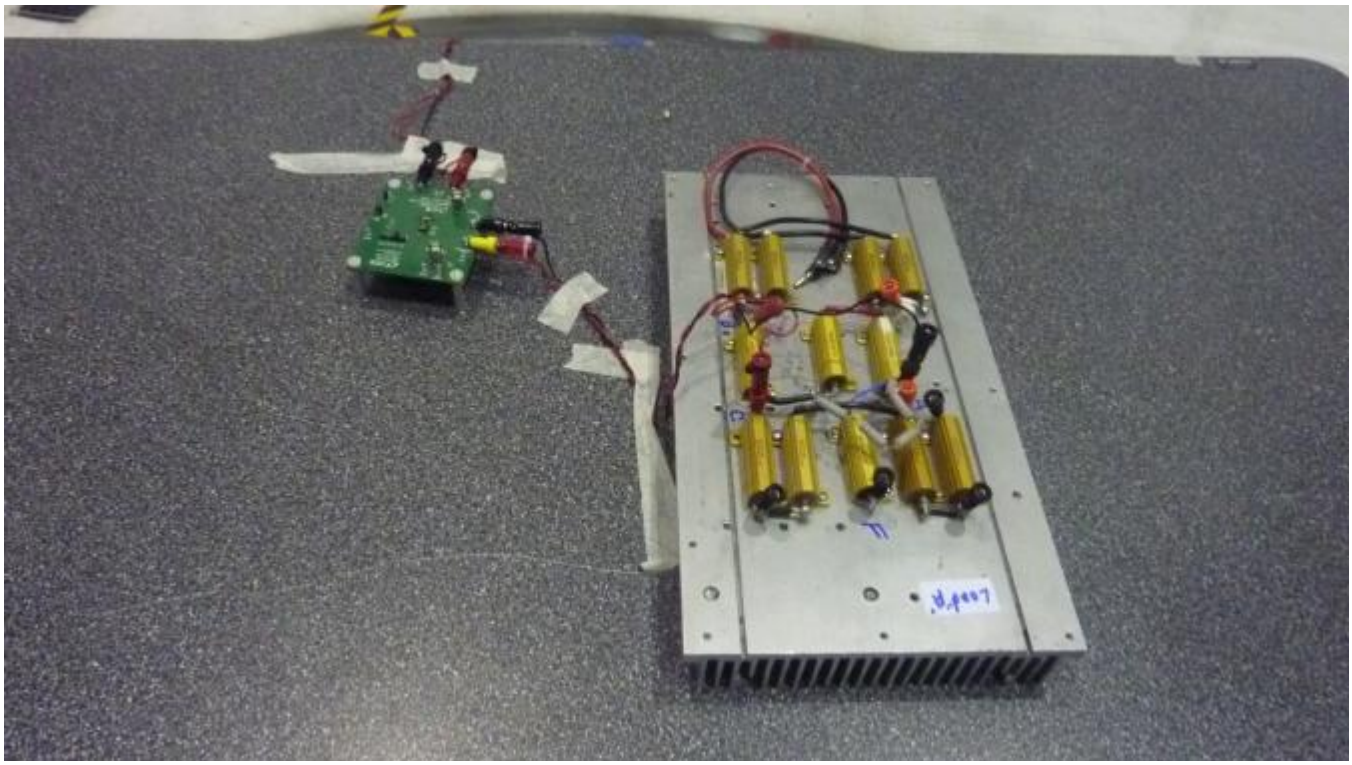


Figure 3 - Photo of EUT Load

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)			**Test Date(s)**		November 4, 2013	
Standard	EN 55022:2010, CISPR 22:2008						
Model Number	LTM4623			**Serial #**		N/A (ENG.1)	
Configuration	See test plan for details.						
Test Setup	Tested in the 10-meter chamber, placed on turntable: see test plan for details.						
EUT Powered By	DC Power supply						
Environmental Conditions	November 4, 2013	**Temp**	21º C	**Humidity**	42%	**Pressure**	1017 mbar
Frequency Range	30 - 1000 MHz						
Perf. Criteria	Class B			**Perf. Verification**		Readings Under Limit	
Mod. to EUT	Added 47uF capacitor to input			**Test Performed By**		Gary Jorgenson	

4.1.2 Test Procedure

Radiated emissions tests were performed using the procedures of ANSI C63.4:2009 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.

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

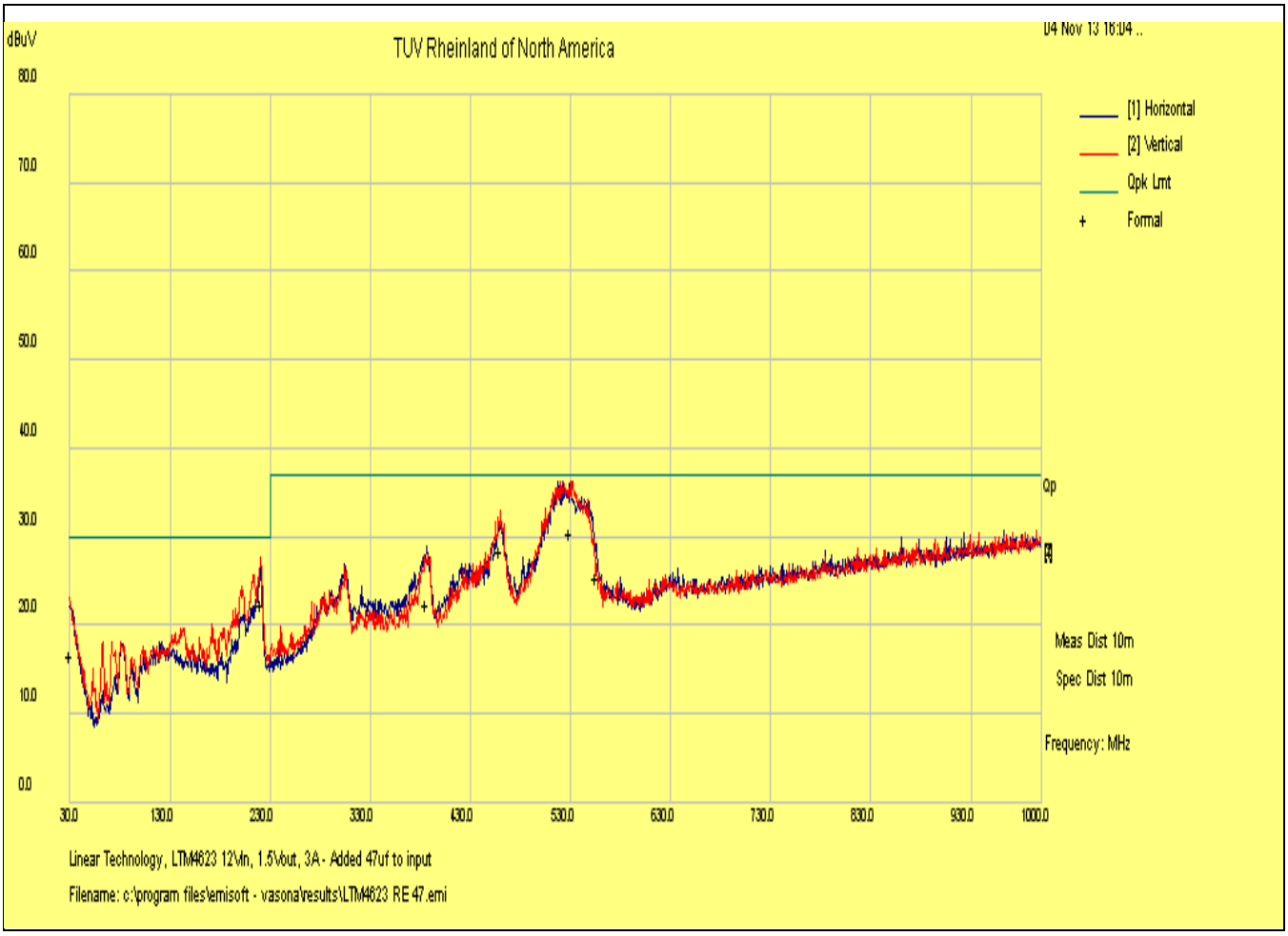
All final radiated emissions measurements were below the specification limits.

4.1.5 Plots

NOTES: 12Vdc in, 1.5Vdc out, 3A (Added 47uF Cap. To input)

Radiated Emissions Pre-Scan

Vertical / Horizontal



4.1.6 Final Peak Data – 30 - 1000 MHz

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV	Measurement Type	Pol	Hgt cm	Azt Deg	QP Limit dBuV	Margin dB
529.55	43.01	3.38	-10.15	36.24	Peak [Scan]	V	300	149	37	-0.76
220.9688	41.26	2.45	-16.14	27.57	Peak [Scan]	V	100	169	30	-2.43
460.4375	40.37	3.19	-10.79	32.78	Peak [Scan]	V	400	147	37	-4.23
995.7563	30.11	4.35	-3.78	30.68	Peak [Scan]	V	400	353	37	-6.32
30	28.31	1.47	-6.8	22.99	Peak [Scan]	V	400	275	30	-7.01
555.6188	35.46	3.45	-9.87	29.04	Peak [Scan]	H	200	314	37	-7.96
386.475	38.13	2.99	-12.29	28.83	Peak [Scan]	H	300	1	37	-8.17
304.025	37.4	2.75	-13.29	26.86	Peak [Scan]	H	300	264	37	-10.14
80.925	36.51	1.81	-20.14	18.18	Peak [Scan]	V	400	68	30	-11.82
62.7375	36.38	1.71	-20.14	17.95	Peak [Scan]	V	100	241	30	-12.05
39.7	29.12	1.55	-13.96	16.71	Peak [Scan]	V	300	203	30	-13.29
529.55	43.01	3.38	-10.15	36.24	Peak [Scan]	V	300	149	37	-0.76

4.1.7 Final Quasi Peak Data – 30 - 1000 MHz

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV	Measurement Type	Pol	Hgt cm	Azt Deg	QP Limit dBuV	Margin dB
386.0956	33.02	2.99	-12.3	23.72	Quasi Peak	H	214	248	37	-13.29
460.2013	36.03	3.19	-10.8	28.42	Quasi Max	V	306	144	37	-8.58
529.5631	37.17	3.38	-10.15	30.4	Quasi Max	V	323	144	37	-6.6
220.5606	38.26	2.45	-16.16	24.55	Quasi Peak	V	104	192	30	-5.45
30	21.94	1.47	-6.8	16.61	Quasi Max	V	127	273	30	-13.39
555.4644	31.75	3.45	-9.87	25.33	Quasi Max	H	183	312	37	-11.67

4.1.8 Photos

Figure 4 - Radiated Emissions Test Setup 30 - 1000 MHz - Front

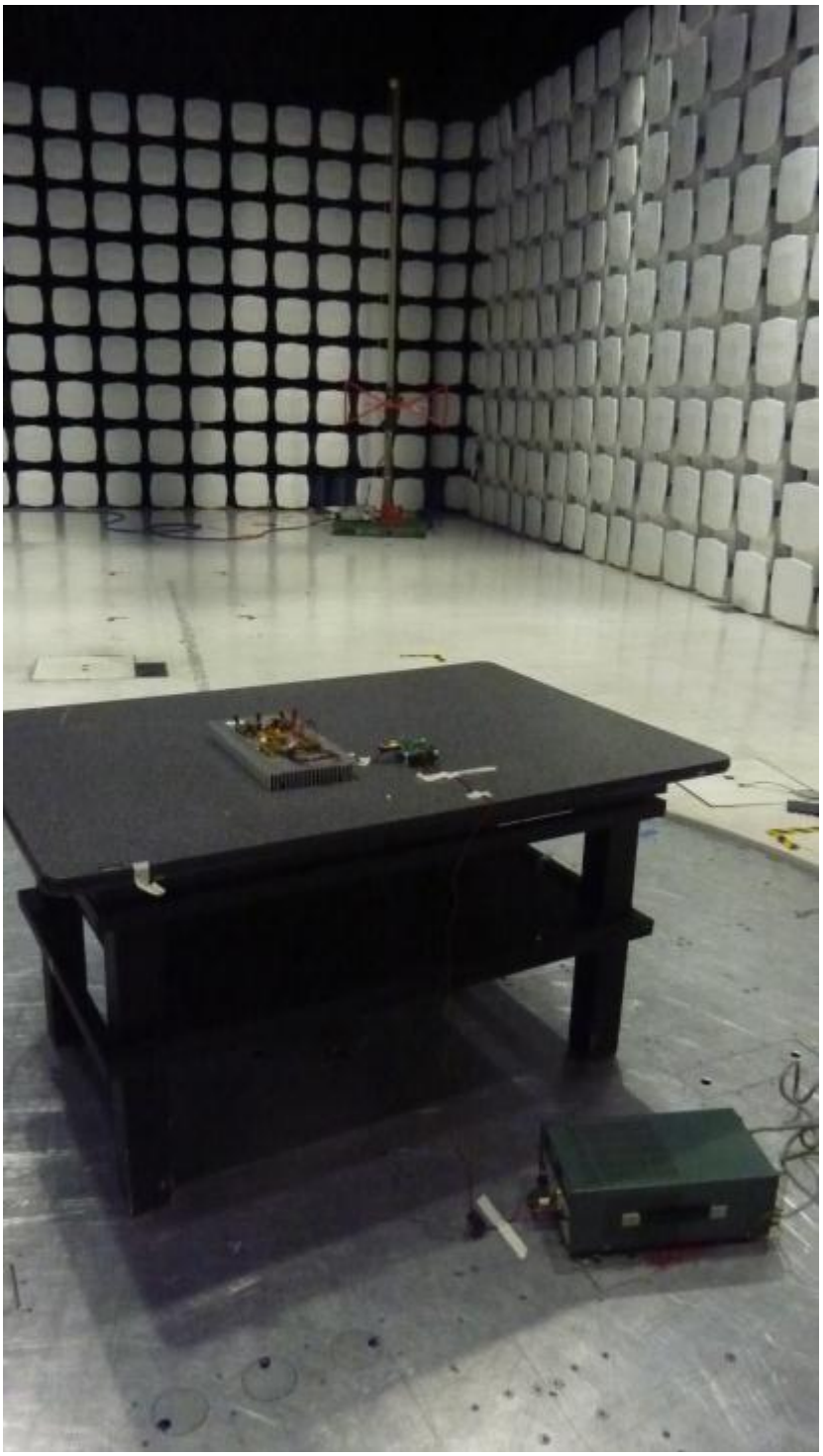


Figure 5 - Radiated Emissions Test Setup 30 - 1000 MHz - Back

Appendix A

5 Test Plan

This test report is intended to follow this test plan outlined here in unless otherwise 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 1	1630 McCarthy Blvd.
	Milpitas, CA 95035
Contact Person	Richard Ying
Telephone	(408) 432-1900 Extension 3318
e-mail	Rying@linear.com

5.2 EUT Designation

Model Name	LTM4623
Model Number(s)	LTM4623

5.3 EUT Description

DC DC uModule Regulator

5.4 Equipment Under Test (EUT) Description

The LTM®4623 is a complete 3A step-down switching mode uModule® regulator in a tiny 6.25mm×6.25mm×1.82mm LGA package. The LTM4623 operates from a 4V to 20V input supply, delivering a regulated output adjustable between 0.6V to 5.5V, ideal for applications in communications, storage, industrial and medical systems.

5.5 Product Environment

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

*Check all that apply

5.6 Countries

☒	**USA**
☒	**Europe**

*Check all that apply

5.7 Applicable Documents

Standards	Description
EN 55022:2010, CISPR 22:2008 Standard Emissions	Information Technology Equipment – Radio Disturbance
EN 55022:2010, CISPR 22:2008	Radiated Emissions

5.8 EUT Electrical Power Information

Name	# of Phases	Type	Output Voltage		AC Voltage Frequency	Current Max.
			Min	Max		
DC Input	1 ☐ 3 ☐ None ☒	AC ☐ DC ☒ Host ☐ Batteries ☐	4.0 V	20 V	1 MHz or 1.5 MHz	Load Dependent
DC Output	1 ☐ 3 ☐ None ☒	AC ☐ DC ☒ Host ☐ Batteries ☐	0.6 V	5.5 V	1 MHz or 1.5 MHz	3 A Max
Notes						

5.9 EUT Clock/Oscillator Frequencies

Reference Designation	Speed (MHz)	Type
		☐ Oscillator ☐ Microprocessor

5.9.1 Radiated Emissions, Upper Frequency

☒	**Less than 108 MHz**	**Scan to 1 GHz**
☐	**Less than 500 MHz**	**Scan to 2 GHz**
☐	**Less than 1000 MHz**	**Scan to 5 GHz**
☐	**Greater than 1000 MHz**	**Scan to 5th Harmonic or 40 GHz (whichever is lower)**

5.10 Electrical Support Equipment

Reference Designation	Manufacturer	Model	Serial Number
Power Supply	Kikusui	PAD 16-30L	--
Load Resistors	N/A	N/A	--

5.11 Non - Electrical Support Equipment

Reference Designation	Manufacturer	Model	Serial Number or Description (e.g., Type of Gas or Liquid)
None			

5.12 EUT Equipment/Cabling Information

EUT Port	Connected To	Cable Type				
		Length (Meters)	Shielded Yes / No		Bead Yes / No	
VIN	Power Supply	1 meter	☐	☒	☐	☒
VOUT	Resistive Load	0.2 meters	☐	☒	☐	☒

5.13 EUT Test Program

None

5.14 EUT Modes of Operation

- 12 V Input, 1.5 V output @ 3 A

5.15 Monitoring of EUT during Testing

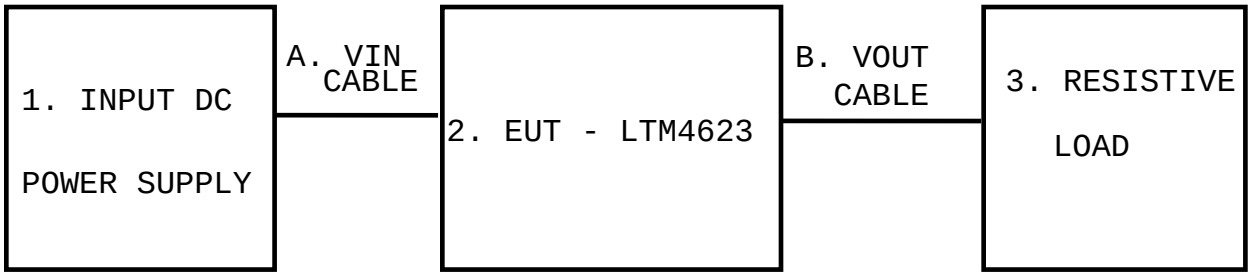
For Emissions testing the EUT output voltage is checked during the test.

5.16 EUT Configuration

5.16.1 Description

Configuration	Description
One Only	LTM4623 installed on demo board DC1889A
Notes	All configurations tested with a resistive load

5.16.2 Block Diagram



5.17 Emissions

5.17.1 Radiated Emissions

5.17.1.1 Preliminary Radiated Emissions Test Setup

Standard	EN 55022:2010, CISPR 22:2008			**TUV Test Procedure**	MS-0005192
Limit	Class B	**Emissions Verification**		Emissions Under Limit	
Frequency Range	30 - 1000 MHz				
Scan #1	Pre-scan 30 – 1000 MHz	**Antenna Distance**	10m	**Detector**	Peak
Configuration	See Section 5.16				
Notes	None				

5.17.1.2 Final Radiated Emissions Test Setup

Standard	EN 55022:2010, CISPR 22:2008			**TUV Test Procedure**	MS-0005192
Limit	Class B	**Emissions Verification**		Emissions Under Limit	
Frequency Range	30 - 1000 MHz				
Scan #1	Final Scan 30 – 1000 MHz 12 V Input, 1.5 V Output @ 3 A	**Antenna Distance**	10m	**Detector**	Quasi Peak
Configuration	See Section 5.16				
Notes	None				

END OF REPORT