Electromagnetic Compatibility Test Report

Prepared in accordance with

EN 55022:2006+A1:2007

On

DC DC Converter LTM8033

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.

Auftraggeber: *Client:*	Linear Technology Corporation 1630 McCarthy Blvd. Milpitas, CA 95035	David Ng (408) 432-1900 / (408) 433-0615

Bezeichnung: *Identification:*	DC DC Converter	**Serien-Nr.:** *Serial No.*	Date Code 1011MY
Gegenstand der Prüfung: *Test item:*	LTM8033	**Prüfdatum:** *Date tested:*	April 23 2010

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
Gary Jorgenson **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	
US5251	**NVLAP CODE (100411-0)**	

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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 EN 55022:2006+A1:2007 based on the results of testing performed on April 23, 2010 on the DC DC Converter, Model No. LTM8033, 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**	David Ng
		Fax	(408) 433-0615	**e-mail**	dng@linear.com

Description	DC DC Converter	**Model Number**	LTM8033
Serial Number	Date Code 1011MY	**Test Voltage/Freq.**	3.6 - 36 Vdc
Test Date Completed:	April 23, 2010	**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 MHz - 6000 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 accredited 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.

2.2 Test Facilities

All of the test facilities are located at 1279 Quarry Lane, Pleasanton, California 94566, USA.
(2305 Mission College, Santa Clara, 95054, USA location is 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). The 10 meter semi-anechoic chamber used to collect the radiated data has been verified to comply with the theoretical normalized site attenuation requirements of ANSI C63.4:2003, at test distances of 3 and 10 meters. A report detailing this site can be obtained from TUV Rheinland of North America.

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

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

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	01/20/2010	01/20/2011	RE
EMI Receiver (RF Filter Section)	HP	85460A	3704A00407	01/20/2010	01/20/2011	RE
9 kHz – 1 GHz Ant. Preamplifier	Sonoma	310N	185516	1/20/2010	1/20/2011	RE
Bilog Antenna Emissions	EMCO	3142	9701-1117	5/1/2008	5/1/2010	RE

Note: RE=Radiated Emissions

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

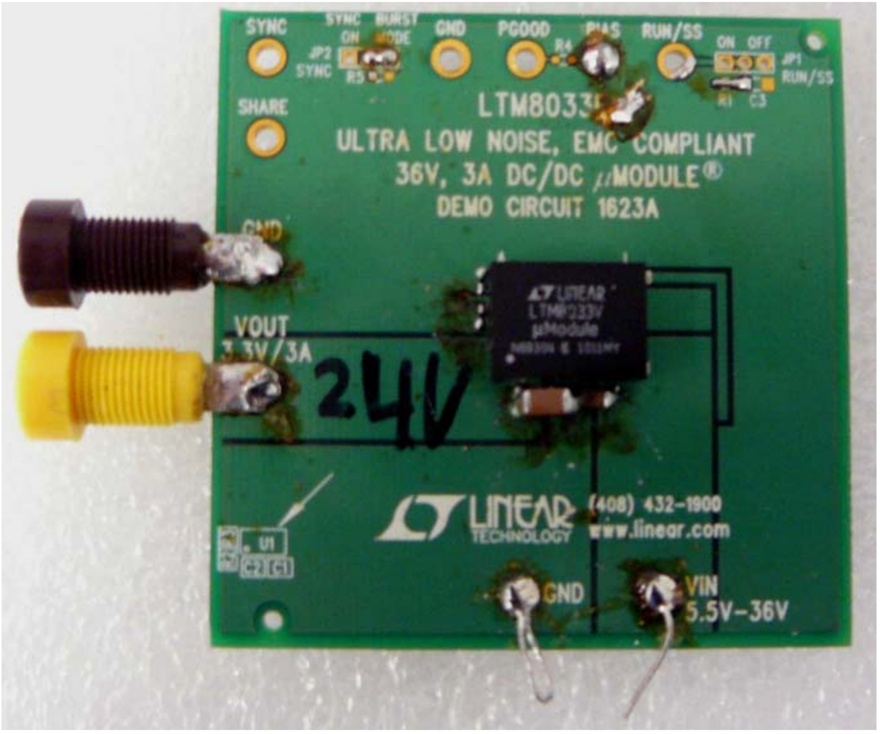


Figure 1 – Photo of EUT & Demo Circuit CFG 1 – Front

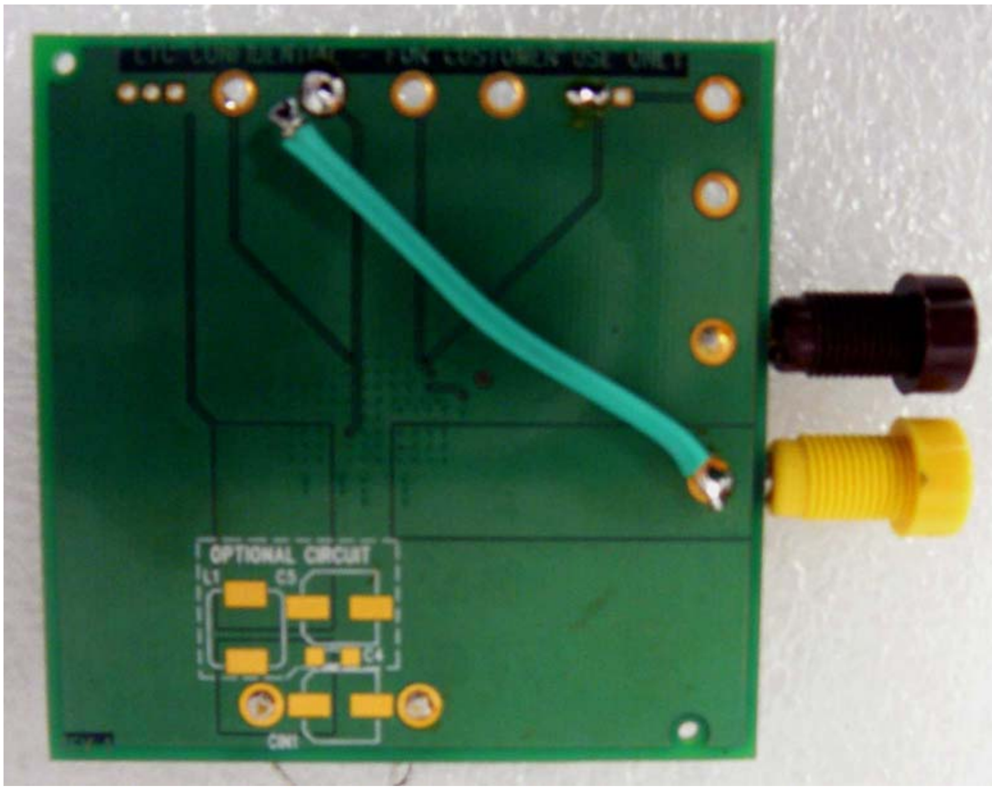


Figure 2 – Photo of EUT & Demo Circuit CFG 1 – Back

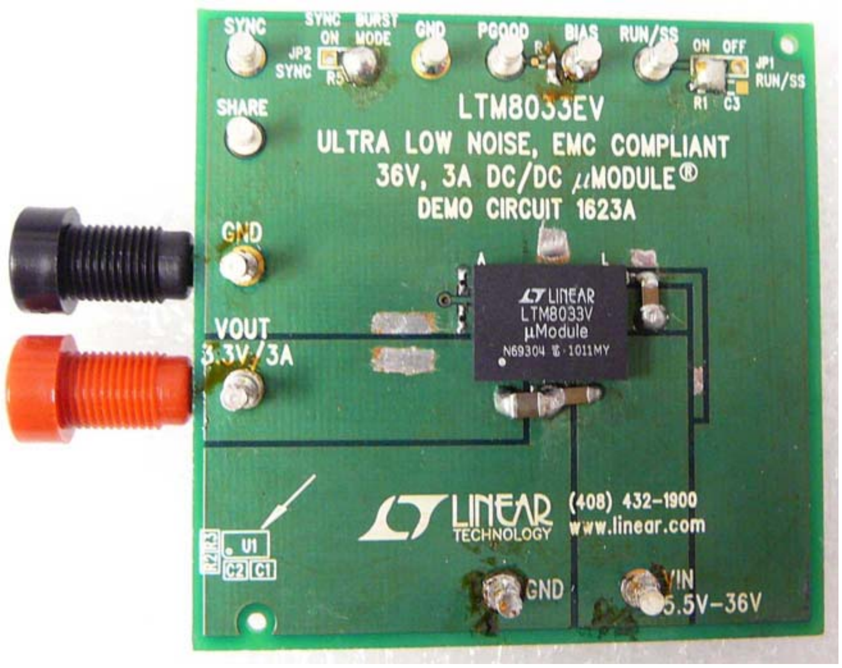


Figure 3 – Photo of EUT & Demo Circuit CFG 2 – Front

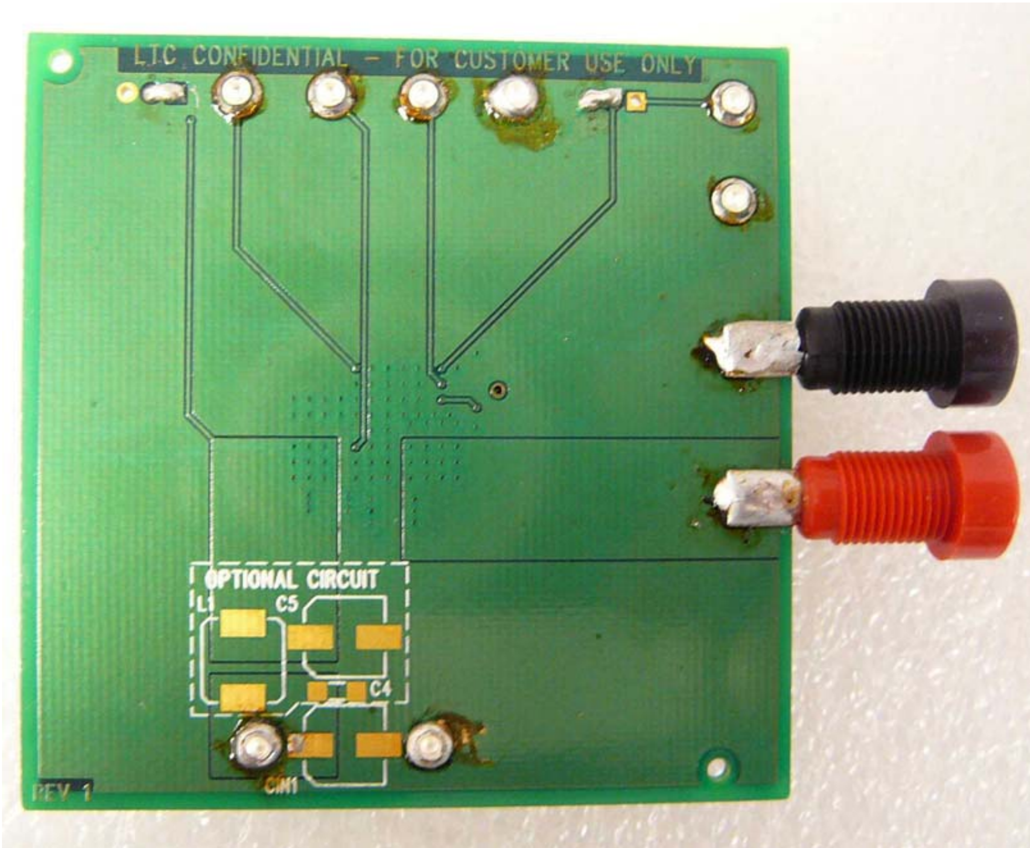


Figure 4 – Photo of EUT & Demo Circuit CFG 2 – Back

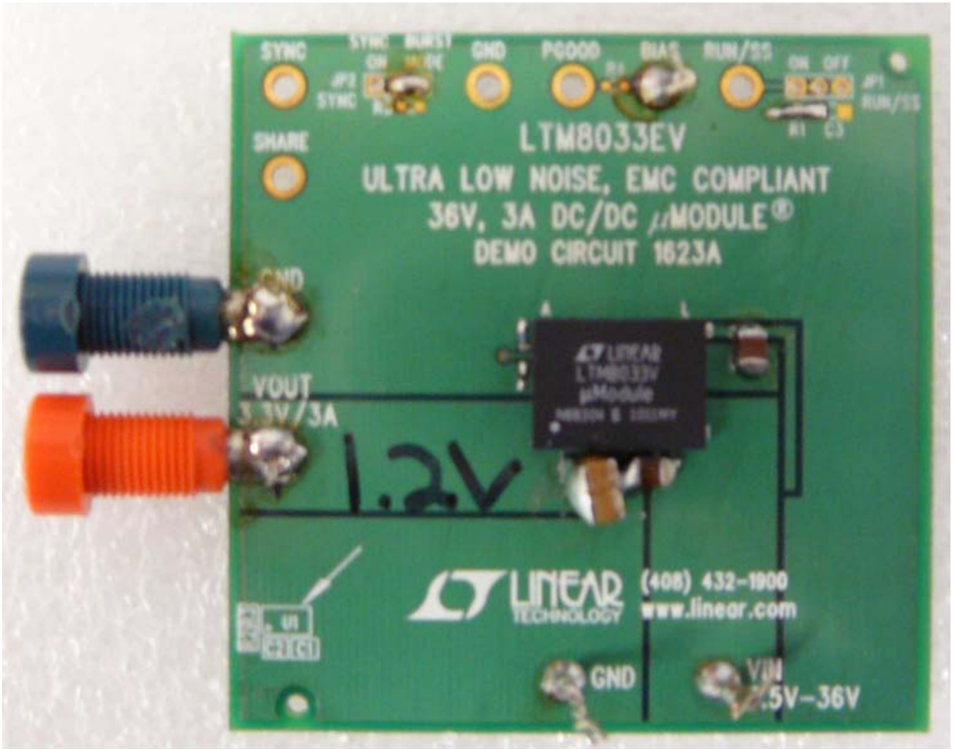


Figure 5 – Photo of EUT & Demo Circuit CFG 3 – Front

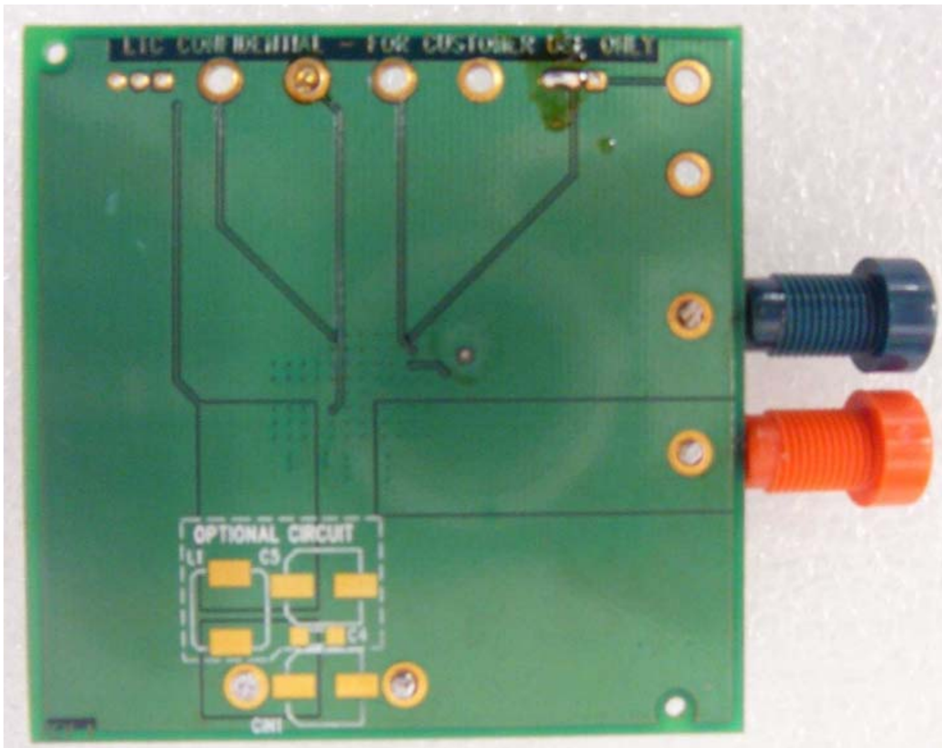


Figure 6 – Photo of EUT & Demo Circuit CFG 3 – Back

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 Over View of Test

Results	**Complies** (as tested per this report)	**Date**	April 23 2010
Standard	EN 55022:2006+A1:2007		
Product Model	LTM8033	**Serial#**	Date Code 1011MY
Configuration	See test plan for details		
Test Set-up	Tested in 10m chamber, placed on turntable, see test plan for details.		
EUT Powered By	3.6 - 36 Vdc		
Frequency Range	30 - 1000 MHz @ 10 meters, 1000 - 6000 MHz @ 3 meters		
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.

The frequency range from 1000 - 6000 MHz was investigated for radiated emissions on only the configuration with the highest emissions in the 30 - 1000 MHz range.

Radiated emission testing was performed at a distance of 10 meters in the semi-anechoic chamber for the frequency range 30 - 1000 MHz and 3 meters for the frequency range 1000 - 6000 MHz.

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

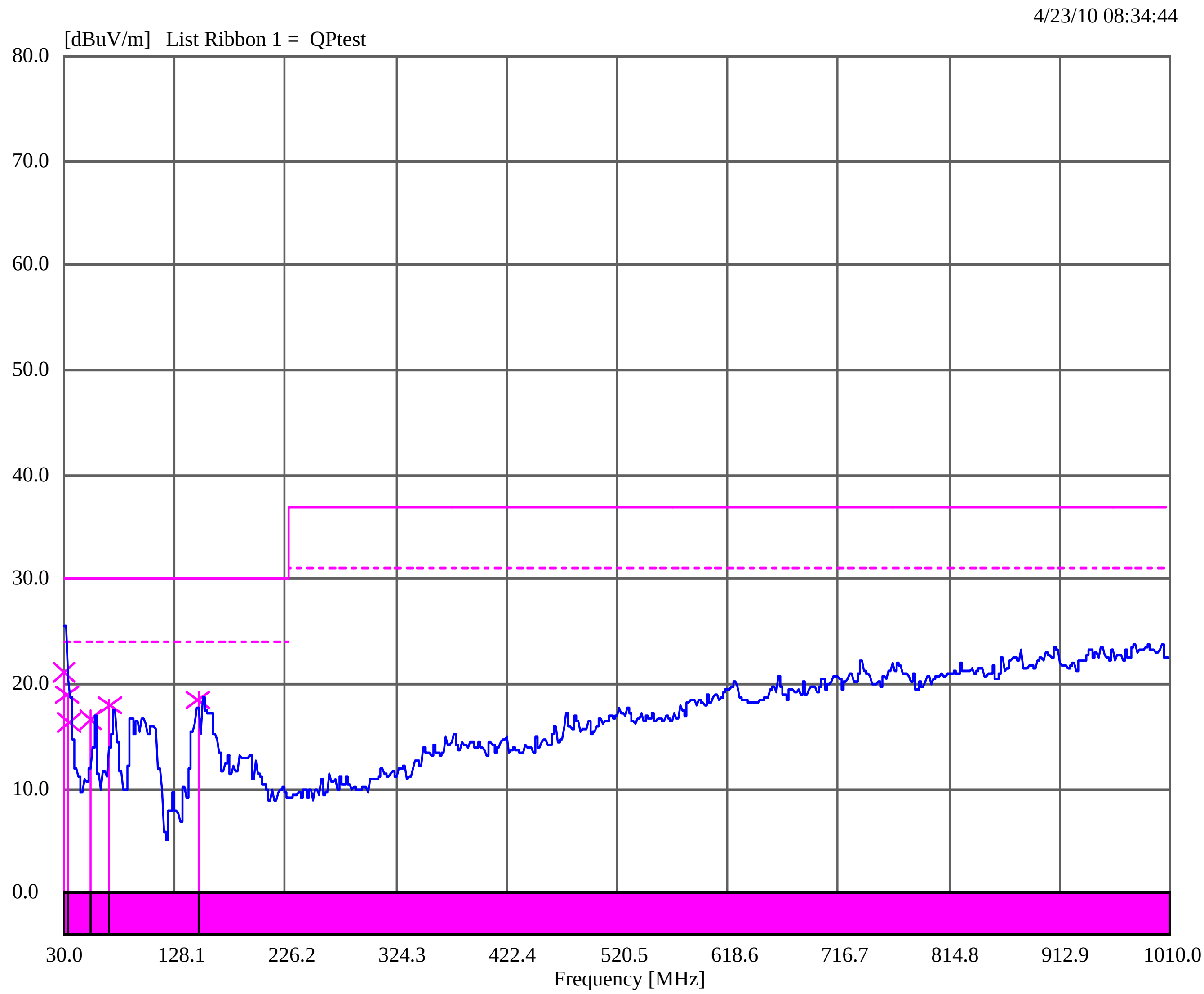
All final radiated emissions measurements were below (in compliance) the limits.

4.1.5 Final Graphs

NOTES: Configuration 1: 24 Vout, 1.5 A, 36 Vin (5V bias)

Radiated Emissions 30 – 1000 MHz

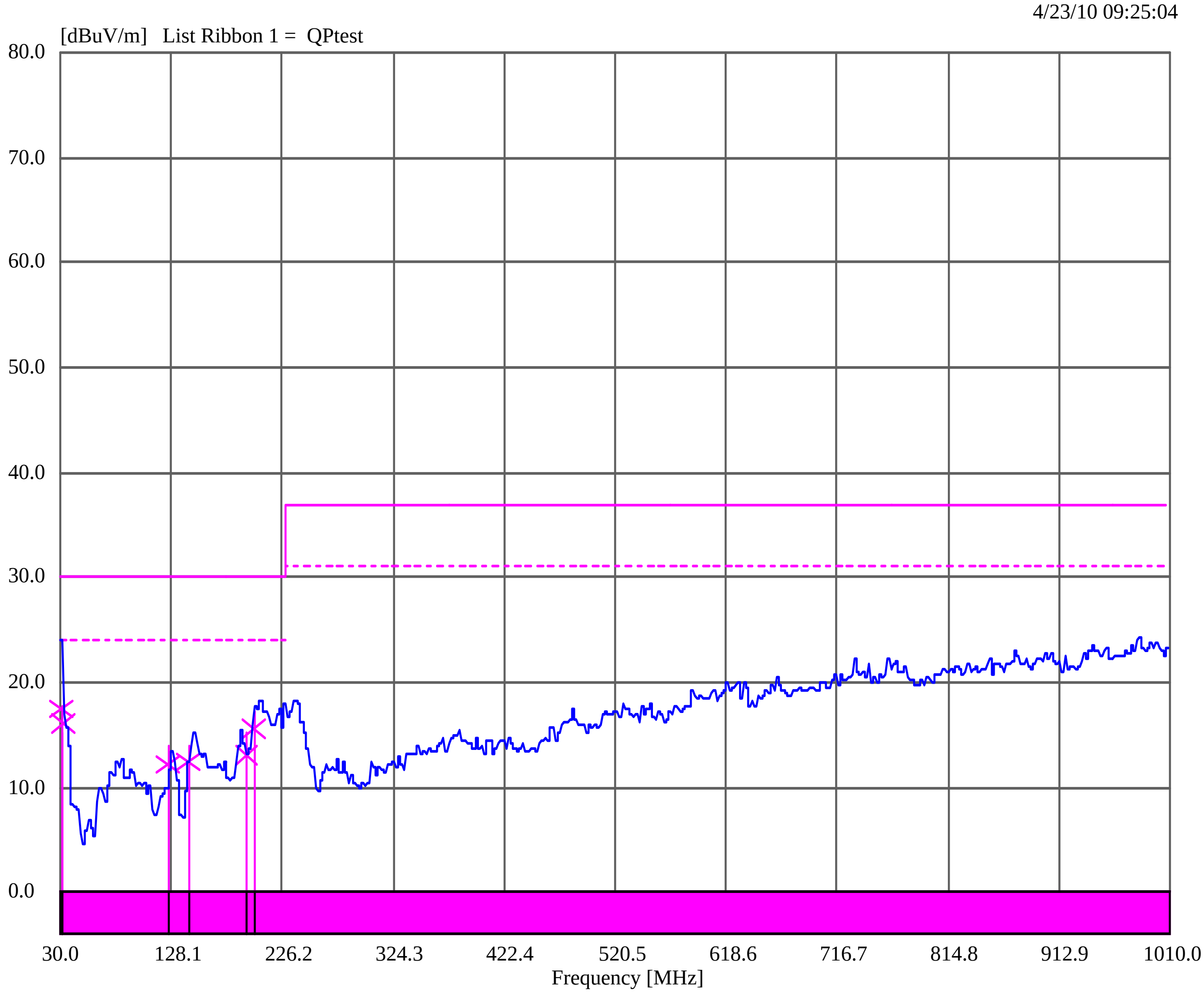
Vertical / Horizontal



NOTES: Configuration 2a: 12 Vout, 3 A, 36 Vin (Vout = bias)

Radiated Emissions 30 – 1000 MHz

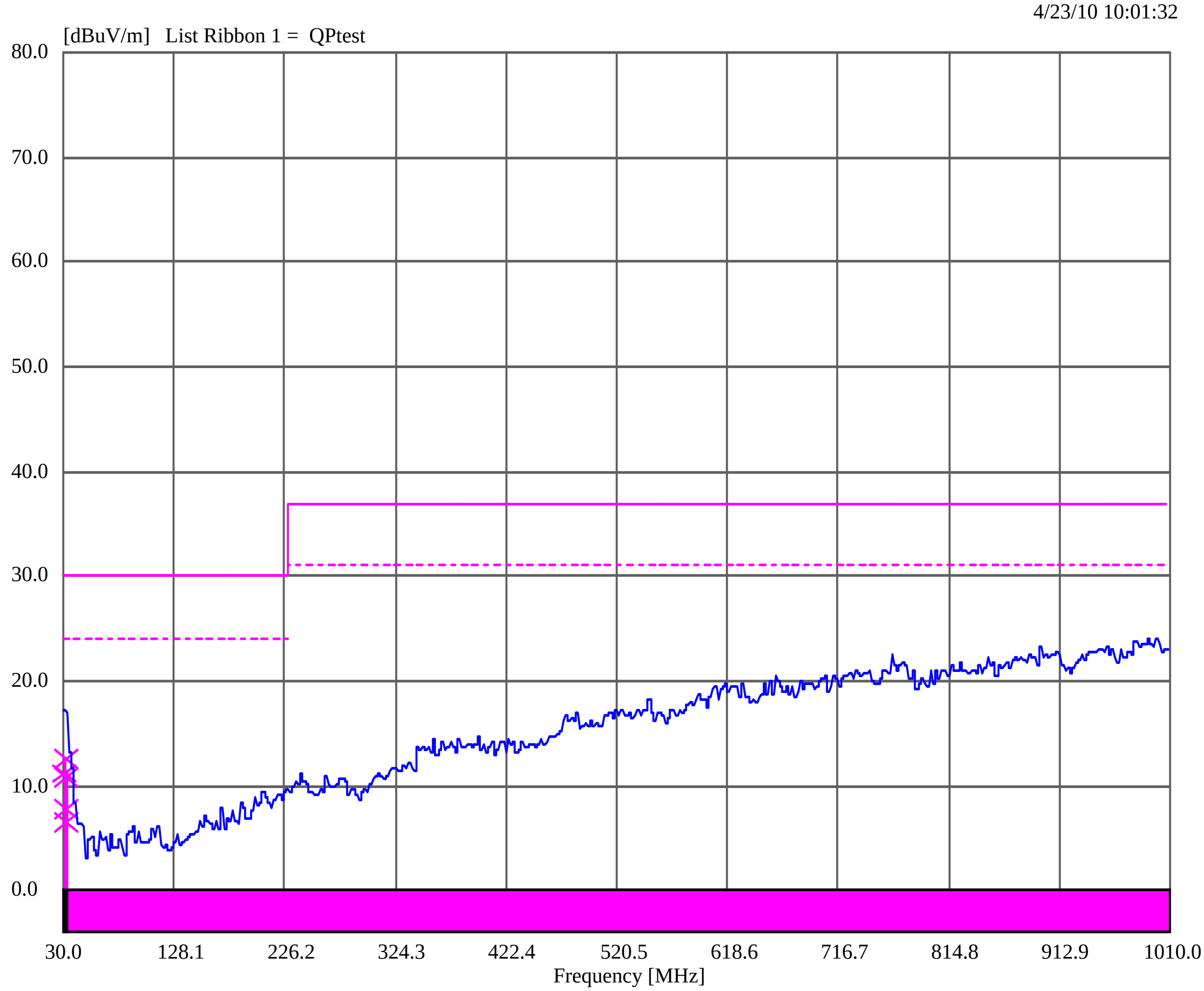
Vertical / Horizontal



NOTES: Configuration 2b: 12 Vout, 3 A, 24 Vin (Vout = bias)

Radiated Emissions 30 – 1000 MHz

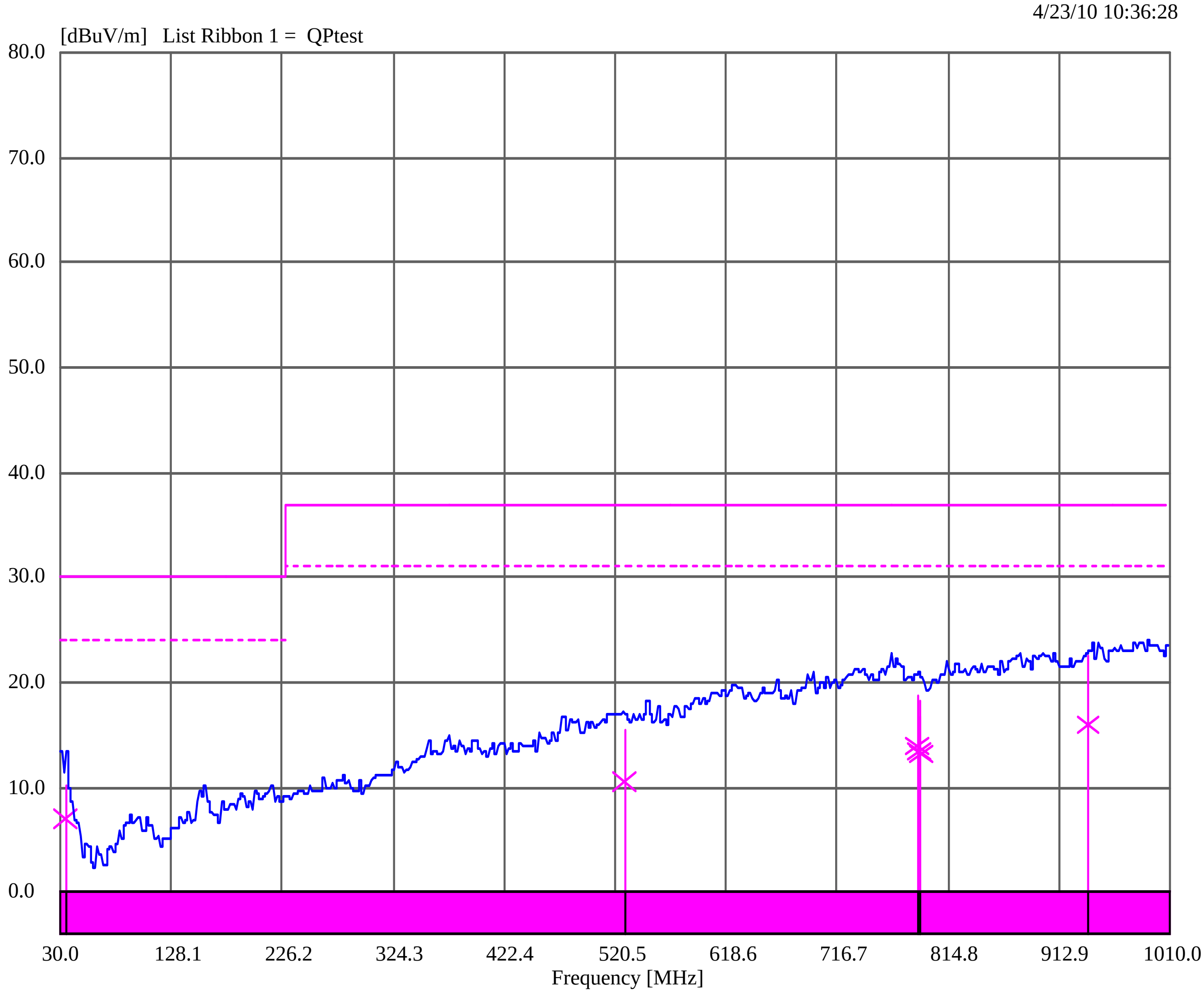
Vertical / Horizontal



NOTES: Configuration 3a: 1.2 Vout, 3 A, 12 Vin (5V = bias)

Radiated Emissions 30 – 1000 MHz

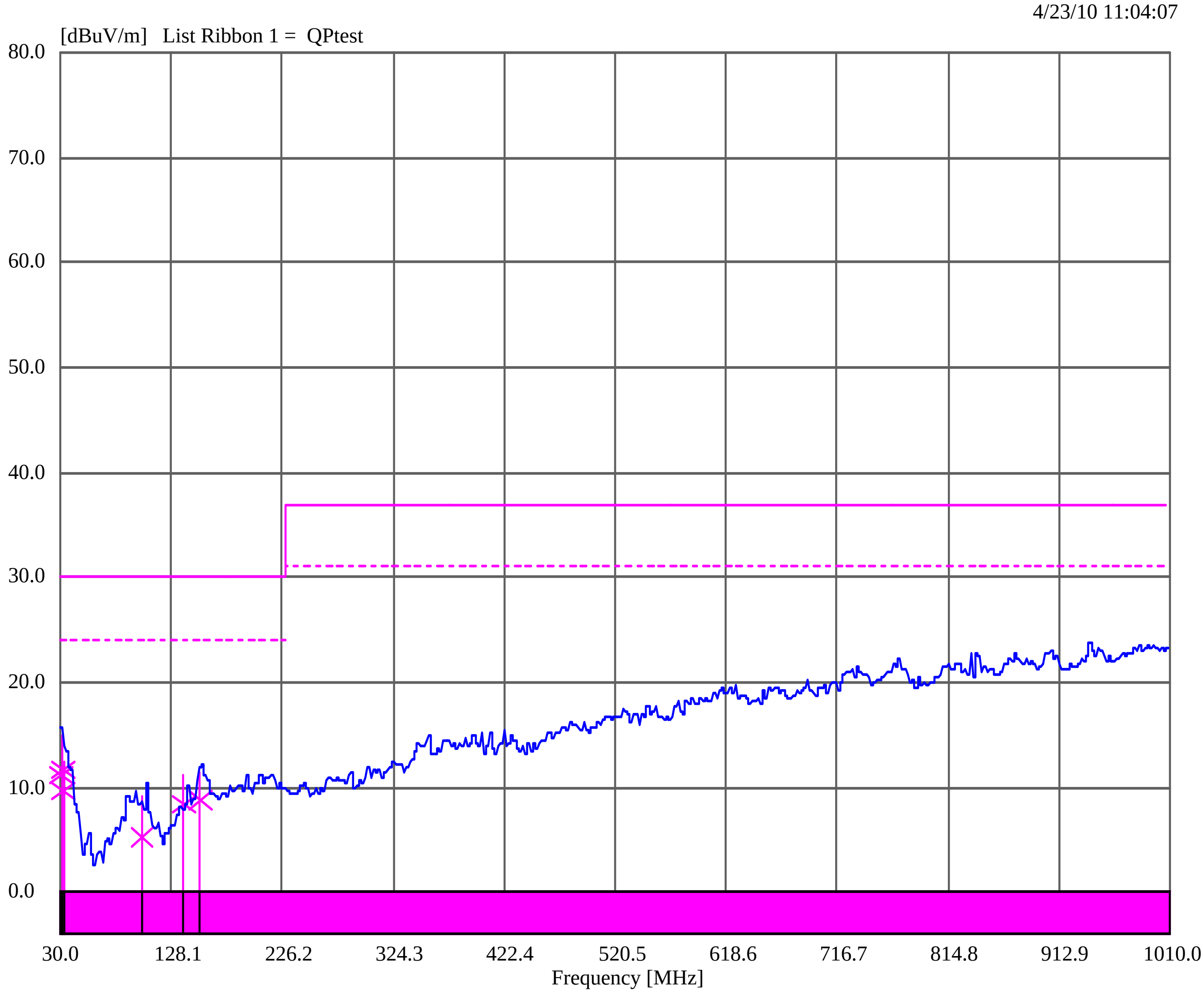
Vertical / Horizontal



NOTES: Configuration 3b: 1.2 Vout, 3 A, 24 Vin (5V = bias)

Radiated Emissions 30 – 1000 MHz

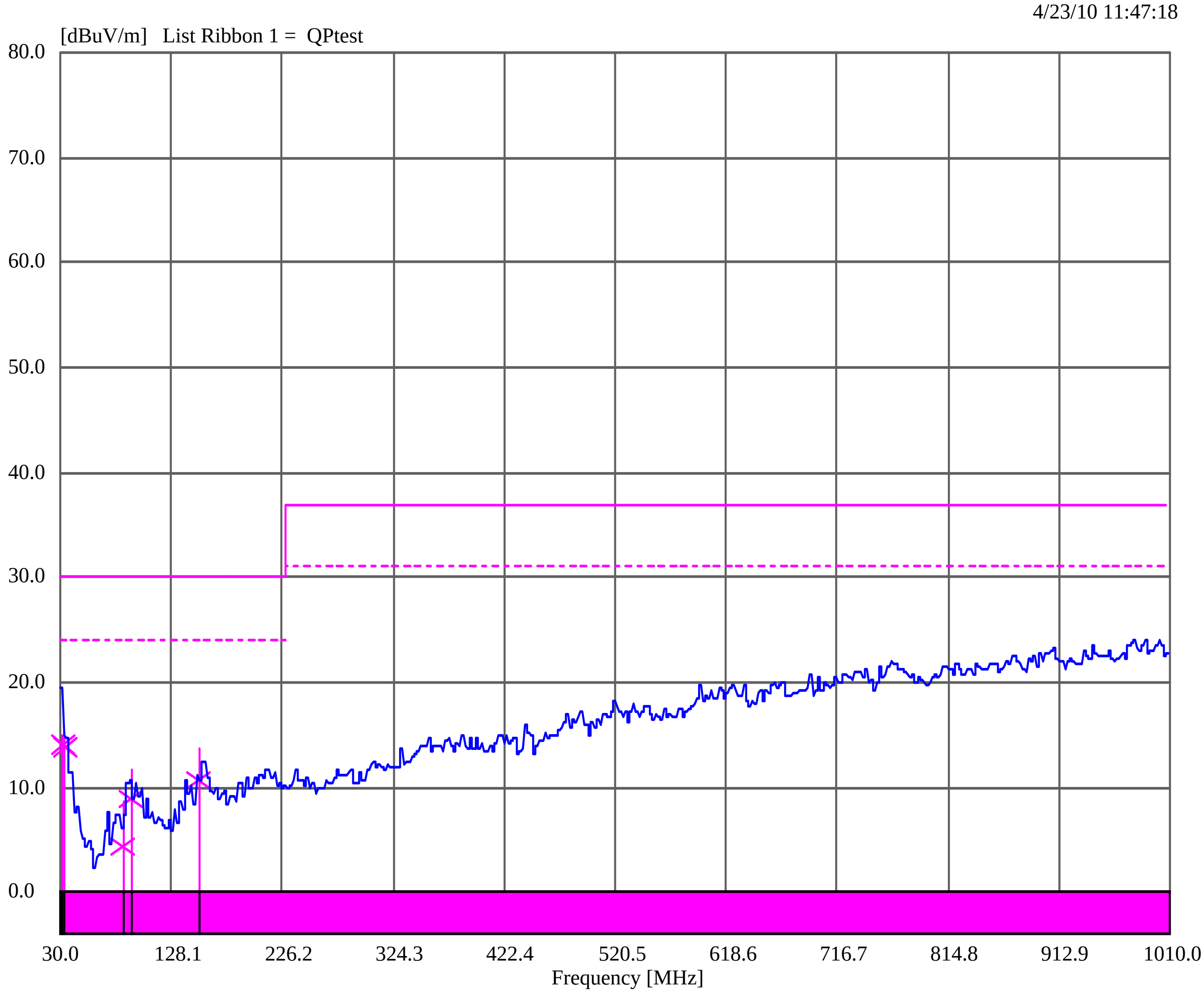
Vertical / Horizontal



NOTES: Configuration 3c: 1.2 Vout, 3 A, 36 Vin (5V = bias)

Radiated Emissions 30 – 1000 MHz

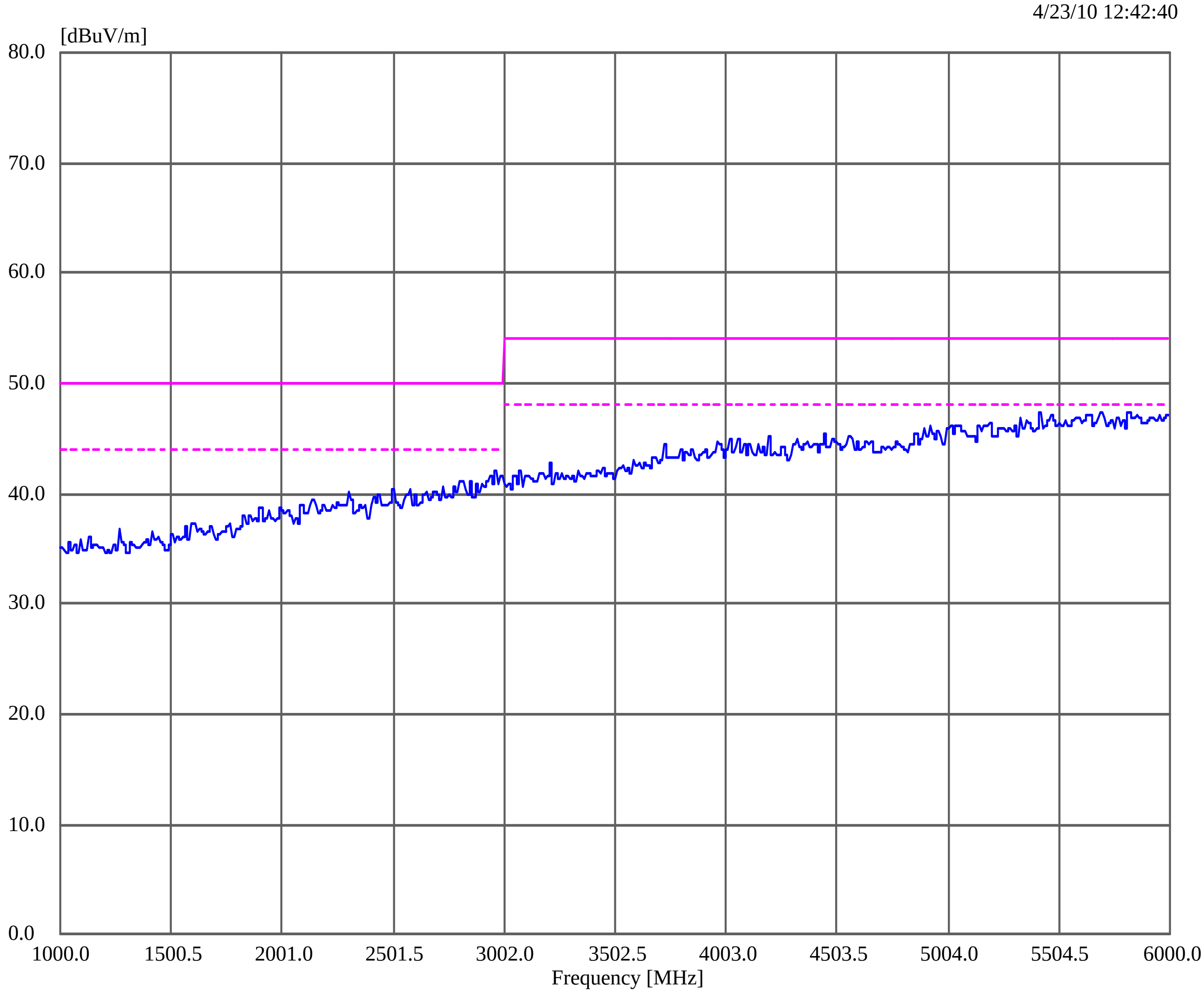
Vertical / Horizontal



NOTES: Configuration 1: 24 Vout, 1.5 A, 36 Vin (5V bias)

Radiated Emissions 1000 – 6000 MHz

Vertical / Horizontal



4.1.6 Radiated Emissions Scan Tabulated Data

Configuration 1: 24 Vout, 1.5 A, 36 Vin (5V bias)

Frequency	Peak	QP	QP Lmt	QP Margin	Angle	Hgt	Pol	Total Correction
MHz	dBuV/m	dBuV/m	dBuV/m	dB	deg	cm		Factor
29.150000	25.68	--.--	--.--	--.--	5	101	Vert	-3.83
30.367739	21.00	21.14	30.00	-8.86	5	101	Vert	-4.41
32.796414	19.08	19.08	30.00	-10.92	5	101	Vert	-5.67
33.998499	17.55	16.34	30.00	-13.66	5	101	Vert	-6.41
53.427663	17.48	16.60	30.00	-13.40	158	102	Vert	-13.86
70.420688	18.63	18.01	30.00	-11.99	224	197	Vert	-14.99
148.102272	19.30	18.50	30.00	-11.50	176	398	Horz	-12.97

Configuration 2a: 12 Vout, 3 A, 36 Vin (Vout = bias)

Frequency	Peak	QP	QP Lmt	QP Margin	Angle	Hgt	Pol	Total Correction
MHz	dBuV/m	dBuV/m	dBuV/m	dB	deg	cm		Factor
29.557500	23.53	--.--	--.--	--.--	75	102	Vert	-4.02
31.234186	17.80	17.46	30.00	-12.54	75	102	Vert	-4.89
32.085923	15.18	16.13*	30.00	-13.87	75	102	Vert	-5.43
124.818925	14.00	12.26	30.00	-17.74	65	398	Horz	-14.50
143.427040	13.93	12.39	30.00	-17.61	154	398	Horz	-13.55
194.843201	15.28	13.11	30.00	-16.89	144	398	Horz	-10.76
201.588416	17.34	15.66	30.00	-14.34	139	401	Horz	-10.77

Configuration 2b: 12 Vout, 3 A, 24 Vin (Vout = bias)

Frequency	Peak	QP	QP Lmt	QP Margin	Angle	Hgt	Pol	Total Correction
MHz	dBuV/m	dBuV/m	dBuV/m	dB	deg	cm		Factor
29.917013	16.32	16.02	--.--	--.--	273	102	Vert	-4.20
30.760753	12.14	11.27	30.00	-18.73	273	102	Vert	-4.60
31.587821	12.75	12.56	30.00	-17.44	273	102	Vert	-5.14
32.379766	10.18	7.78	30.00	-22.22	273	102	Vert	-5.55
32.792573	8.12	6.59	30.00	-23.41	273	102	Vert	-5.67
33.255204	11.43	10.79	30.00	-19.21	273	102	Vert	-5.91

Configuration 3a: 1.2 Vout, 3 A, 12 Vin (5V = bias)

Frequency	Peak	QP	QP Lmt	QP Margin	Angle	Hgt	Pol	Total Correction
MHz	dBuV/m	dBuV/m	dBuV/m	dB	deg	cm		Factor
34.592115	10.21	7.06	30.00	-22.94	357	102	Vert	-6.67
529.092190	15.46	10.58	37.00	-26.42	357	102	Vert	-0.28
787.377489	18.87	13.98	37.00	-23.02	357	102	Vert	2.89
789.631368	18.22	13.44*	37.00	-23.56	357	102	Vert	2.84
790.134767	16.70	13.28	37.00	-23.72	357	102	Vert	2.82
938.677383	22.62	16.01	37.00	-20.99	357	102	Vert	5.94

Configuration 3b:1.2 Vout, 3 A, 24 Vin (5V = bias)

Frequency	Peak	QP	QP Lmt	QP Margin	Angle	Hgt	Pol	Total Correction
MHz	dBuV/m	dBuV/m	dBuV/m	dB	deg	cm		Factor
28.100000	16.95	--.--	--.--	--.--	357	101	Vert	-3.13
31.459058	12.54	11.17	30.00	-18.83	357	101	Vert	-5.05
32.239513	14.94	11.69	30.00	-18.31	357	101	Vert	-5.47
32.785518	12.54	9.63	30.00	-20.37	357	101	Vert	-5.66
102.372058	9.19	5.27	30.00	-24.73	172	194	Vert	-13.44
139.224631	11.10	8.38	30.00	-21.62	139	398	Horz	-13.86
153.166604	11.39	8.79	30.00	-21.21	351	401	Horz	-12.19

Configuration 3c: 1.2 Vout, 3 A, 36 Vin (5V = bias)

Frequency	Peak	QP	QP Lmt	QP Margin	Angle	Hgt	Pol	Total Correction
MHz	dBuV/m	dBuV/m	dBuV/m	dB	deg	cm		Factor
27.597360	20.34	20.24	--.--	--.--	357	102	Vert	-2.79
28.113243	19.97	20.18	--.--	--.--	357	102	Vert	-3.13
31.732881	15.03	14.12	30.00	-15.88	357	102	Vert	-5.21
33.798383	15.17	13.84	30.00	-16.16	357	102	Vert	-6.28
85.894414	8.69	4.45	30.00	-25.55	355	103	Vert	-14.76
92.601720	11.60	8.92	30.00	-21.08	165	100	Vert	-14.03
152.173316	13.63	10.74	30.00	-19.26	1	297	Horz	-12.35

4.1.7 Photos

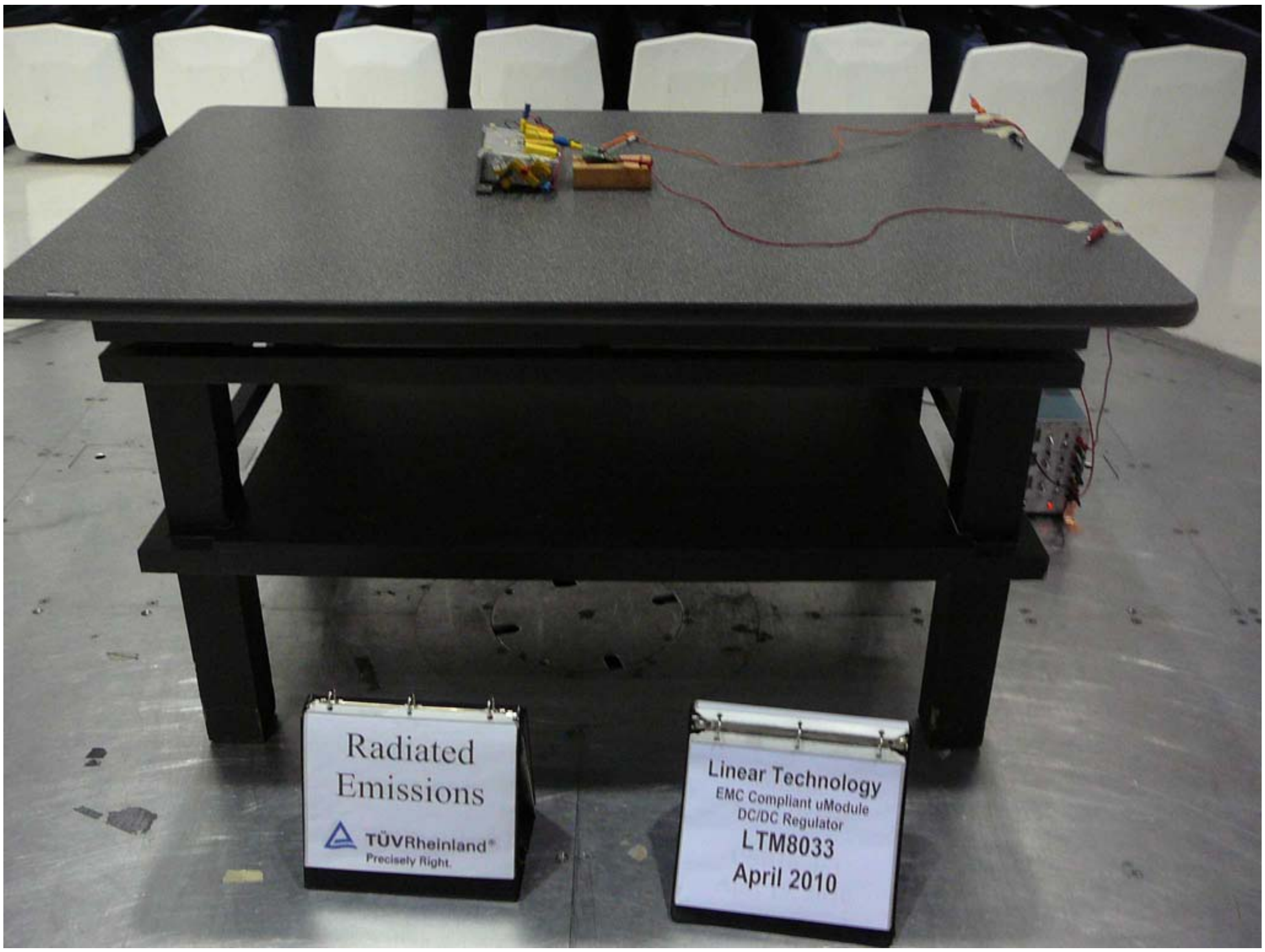


Figure 7 – Radiated Emissions CFG1 Test Setup – Front

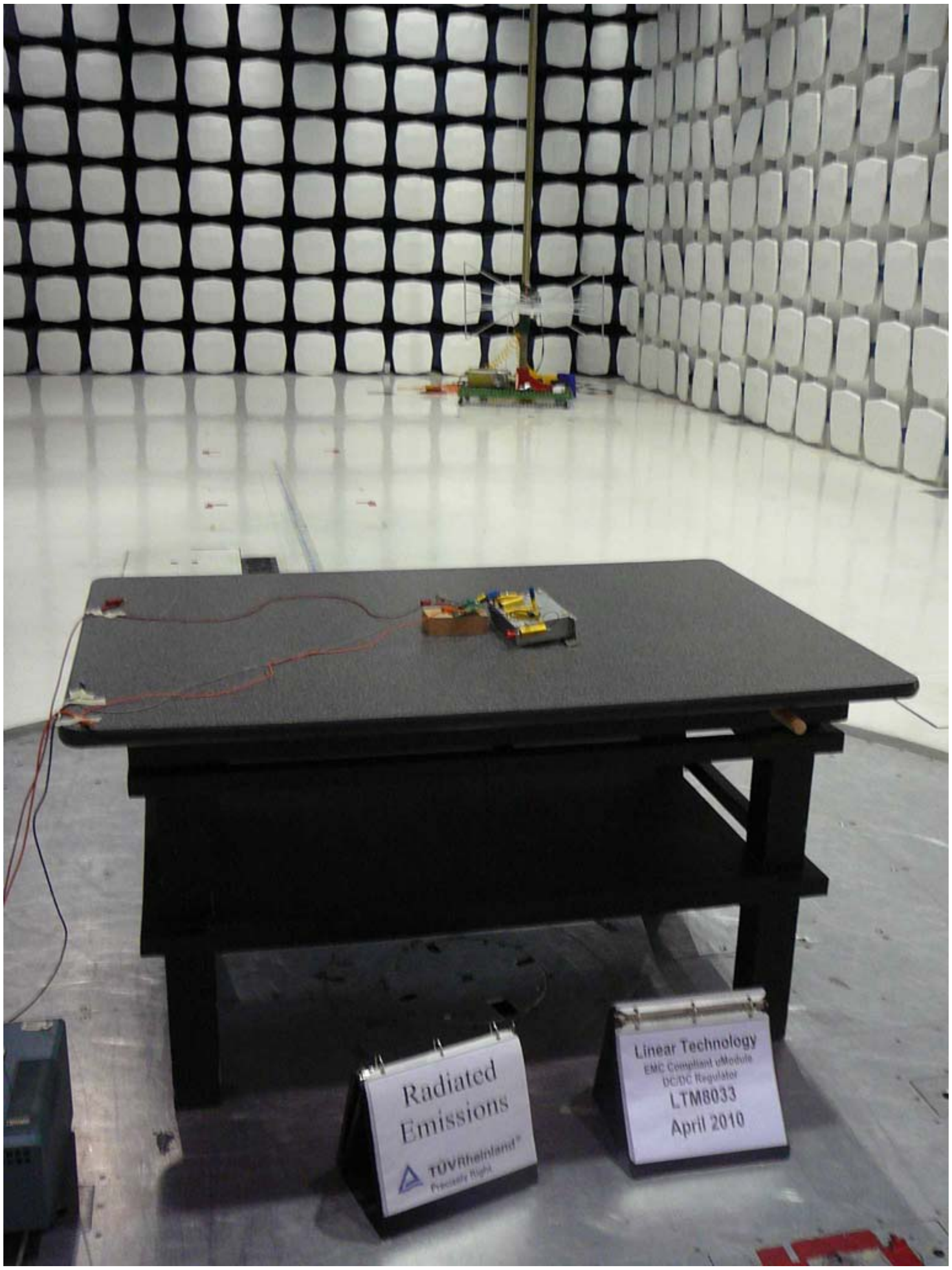


Figure 8 – Radiated Emissions 30 - 1000 MHz CFG1 Test Setup – Back

Figure 9 – Radiated Emissions 1000 - 6000 MHz CFG1 Test Setup – Back

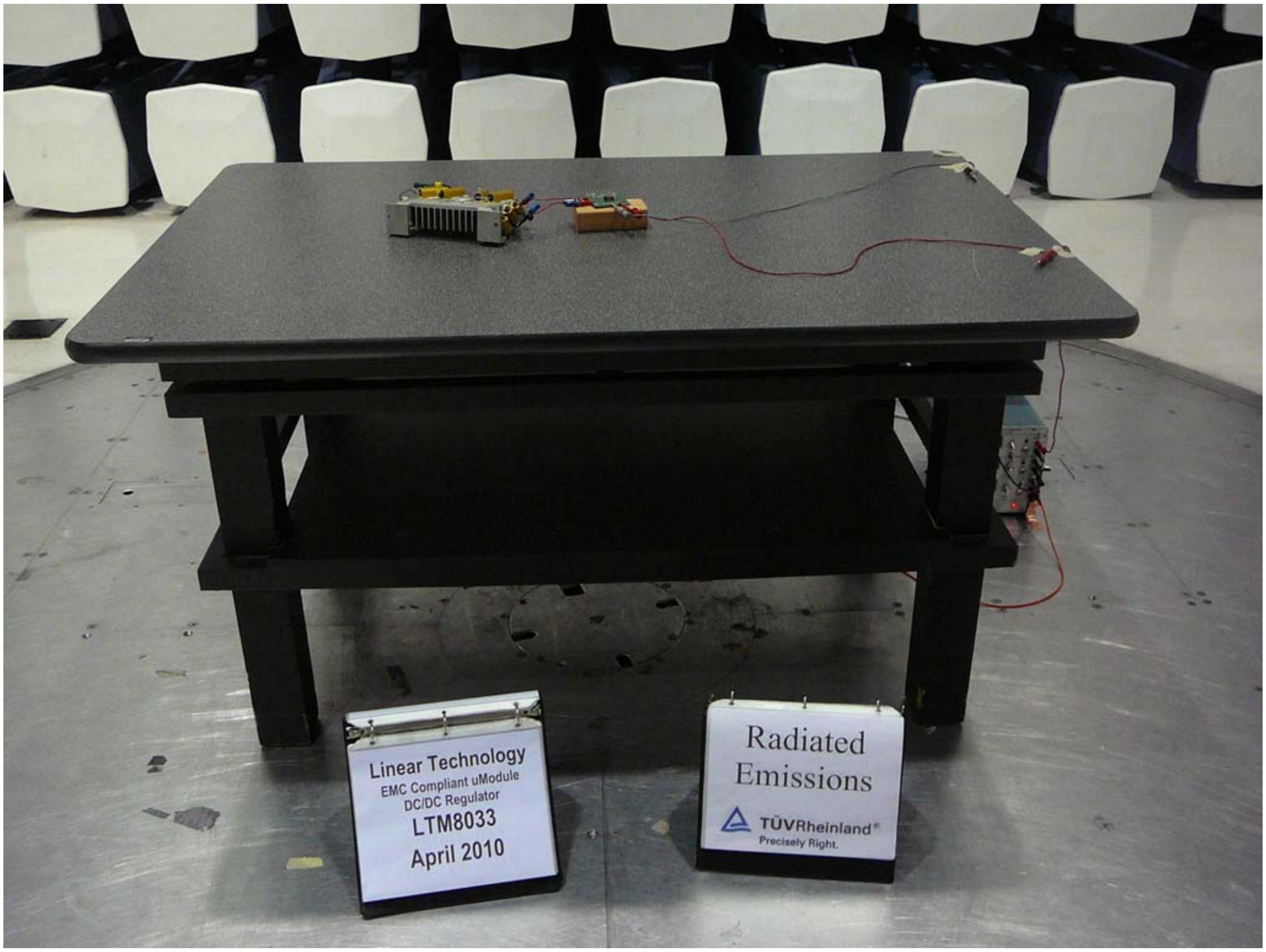


Figure 10 – Radiated Emissions CFG2 Test Setup – Front

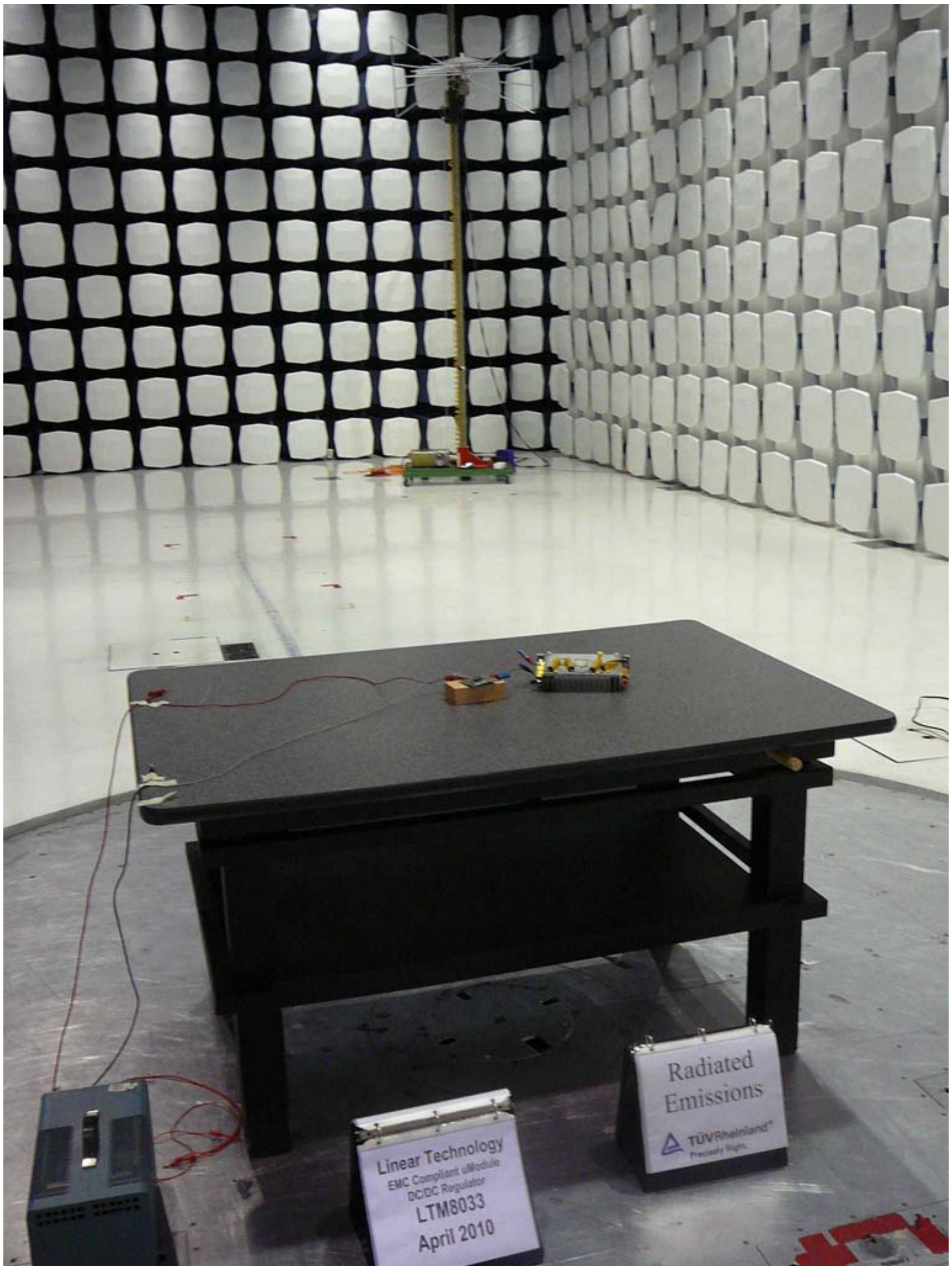


Figure 11 – Radiated Emissions 30 - 1000 MHz CFG2 Test Setup – Back

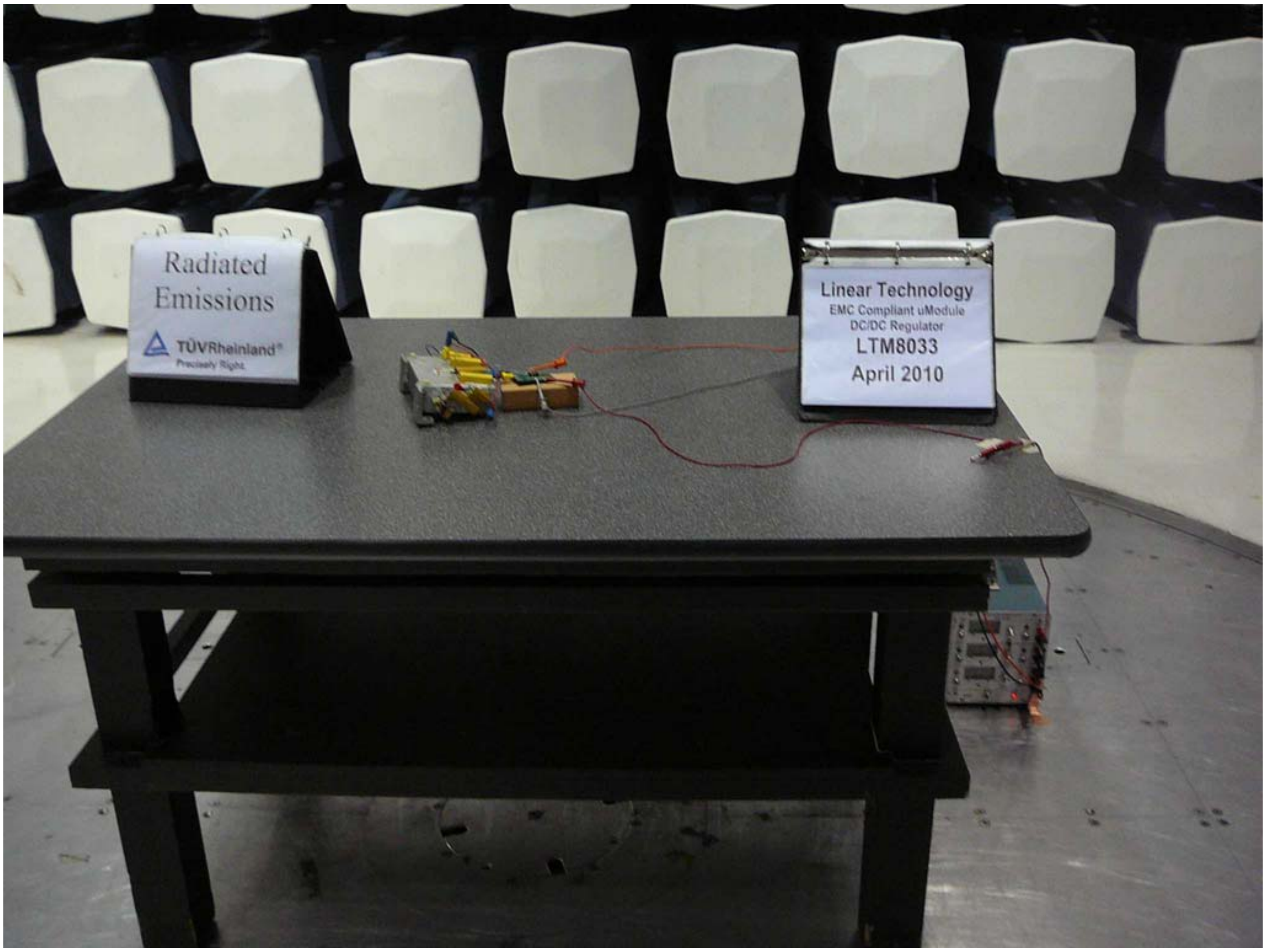


Figure 12 – Radiated Emissions CFG3 Test Setup – Front

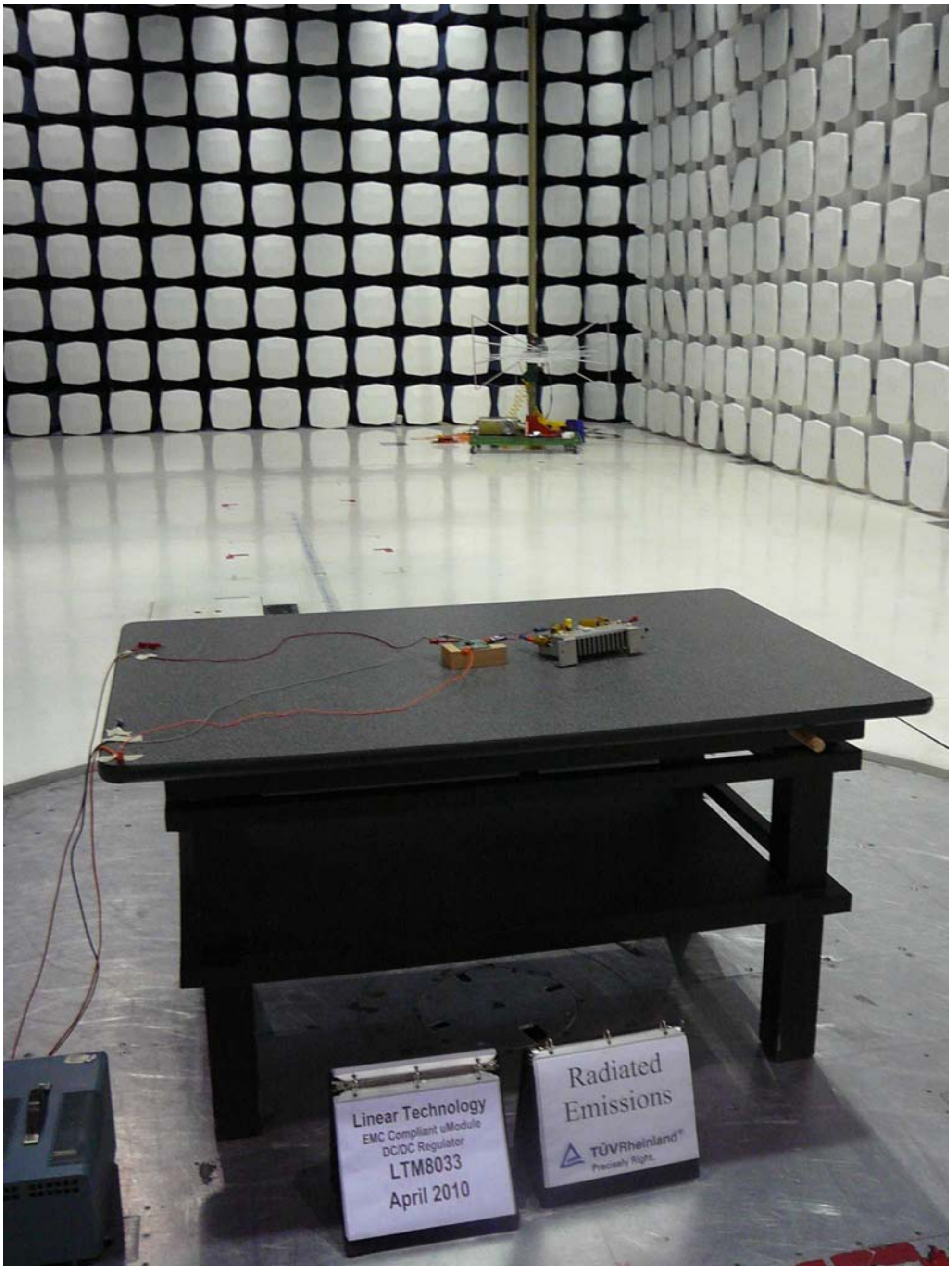


Figure 13 – Radiated Emissions 30 - 1000 MHz CFG3 Test Setup – Back

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	David Ng
Telephone	(408) 432-1900
Fax	(408) 433-0615
e-mail	dng@linear.com

5.2 Model(s) Name

LTM8033

5.3 Type of Product

DC DC Converter

5.4 Equipment Under Test (EUT) Description

The LTM8033 is an electromagnetic compatible (EMC) 36V, 3A DC/DC µModule buck converter designed to meet the radiated emissions requirements of EN55022 class B. Included in the package are the switching controller, power switches, inductor, filters and all support components. Operating over an input voltage range of 3.6V to 36V, the LTM8033 supports an output voltage range of 0.8V to 25V, and a switching frequency range of 200kHz to 2.4MHz, each set by a single resistor.

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** 3.6 to 36 V	☐	**Batteries**	☐	**Host -**

5.9.2 Electrical Power Information

Name	Type	Voltage		Frequency	Current	Notes
		min	max			
DC Input	DC	3.6	36	N/A	Load Dependent	
DC Output	DC	0.8	25	N/A	3 A max	
Notes						

5.10 *EUT Modes of Operation*

Configuration 1: 24 Vout, 1.5 A, 36 Vin (5 V bias)
Configuration 2a: 12 Vout, 3 A, 36 Vin (Vout = bias)
Configuration 2b: 12 Vout, 3 A, 24 Vin (Vout = bias)
Configuration 3a: 1.2 Vout, 3 A, 12 Vin (5 V = bias)
Configuration 3b:1.2 Vout, 3 A, 24 Vin (5 V = bias)
Configuration 3c: 1.2 Vout, 3 A, 36 Vin (5 V = bias)
.

5.11 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**

5.12 Electrical Support Equipment

Type	Manufacture	Model	Connected To
Power Supply	Power Designs Inc.	TP343B	EUT Input
Load Resistors	N/A	N/A	EUT Output

5.13 EUT Equipment/Cabling Information

EUT Port	Connected To	Location	Cable Type		
			Length	Shielded	Bead
VIN	Power Supply	Inside Chamber	1.8 meters	No	No
BIAS	Power Supply	Inside Chamber	1.8 meters	No	No
VOUT	Resistive load	Inside Chamber	.15 meters	No	No

5.14 EUT Test Program

None

5.15 Monitoring of EUT during Testing

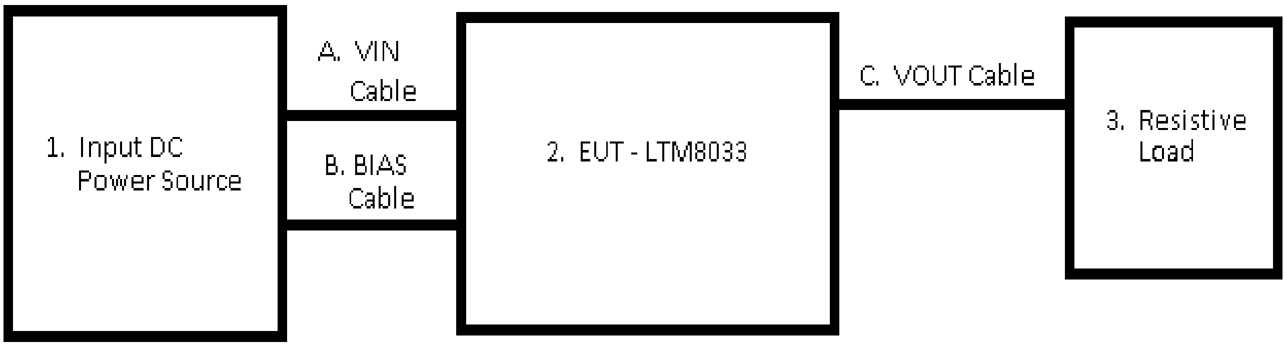
For Emissions testing the EUT output voltage is checked during the test.

5.16 EUT Configuration

5.16.1 Description

Configuration	Description
Configuration 1	Installed on 24 Vout demo circuit board
Configuration 2	Installed on 12 Vout demo circuit board
Configuration 3	Installed on 1.2 Vout demo circuit board
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 Final Radiated Emissions Test Set-up

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,
Frequency Range	1000 – 6000 MHz	**Ant Dist**	3m	**Det**	Avg. 1000 – 6000 MHz,
Scan #1	Configuration 1 (30 – 1000 MHz)				
Scan #2	Configuration 2a (30 – 1000 MHz)				
Scan #3	Configuration 2b (30 – 1000 MHz)				
Scan #4	Configuration 3a (30 – 1000 MHz)				
Scan #5	Configuration 2b (30 – 1000 MHz)				
Scan #6	Configuration 3c (30 – 1000 MHz)				
Scan #7	Configuration with highest emissions for Scans 1-6 (1000 - 6000MHz)				
Configuration	See section 5.16				
Notes	Only worst case configuration (Based on 30-1000MHz results) tested from 1000-6000MHz				