



Compliance Testing, LLC

Previously Flom Test Lab

EMI, EMC, RF Testing Experts Since 1963

toll-free: (866) 311-3268

fax: (480) 926-3598

<http://www.ComplianceTesting.com>

info@ComplianceTesting.com

Test Report

Prepared for: Robert Bosch, LLC

Model: CLN-ILB Ballast

Description: 2.4 GHz Transmitter

To

FCC Part(s) 15.247 DTS

Date of Issue: September 13, 2013

On the behalf of the applicant:

**Robert Bosch, LLC
15000 North Haggerty Road
Plymouth, MI 48170**

Attention of:

**Steven Gladstein, Engineering Manager
Ph: (734) 979-3035
E-mail: steve.gladstein@us.bosch.com**

**Prepared By
Compliance Testing, LLC
3356 N San Marcos Pl, Suite 107
Chandler, AZ 85225-7176
(866) 311-3268 phone / (480) 926-3598 fax
www.compliancetesting.com
Project No: p1310002**

**Alex Macon
Project Test Engineer**

This report may not be reproduced, except in full, without written permission from Compliance Testing
All results contained herein relate only to the sample tested



Test Report Revision History

Revision	Date	Revised By	Reason for Revision
1.0	September 13, 2013	Alex Macon	Original Document



Table of Contents

<u>Description</u>	<u>Page</u>
Standard Test Conditions Engineering Practices	6
Peak Output Power	9
Conducted Spurious Emission	10
Radiated Spurious Emissions	21
Emissions at Band Edges	24
Occupied Bandwidth	26
Transmitter Power Spectral Density (PSD)	29
A/C Powerline Conducted Emission	31
Receiver Spurious Emissions	35
Test Equipment Utilized	38



ILAC / A2LA

Compliance Testing, LLC, has been accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer joint ISO-ILAC-IAF Communiqué dated January 2009)

The tests results contained within this test report all fall within our scope of accreditation, unless noted below.

Please refer to <http://www.compliancetesting.com/labscope.html> for current scope of accreditation.

Testing Certificate Number: **2152.01**



FCC OATS Reg, #933597

IC Reg. #2044A-1

Non-accredited tests contained in this report:

N/A



The applicant has been cautioned as to the following

15.21 - Information to User

The user's manual or instruction manual for an intentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

15.27(a) - Special Accessories

Equipment marked to a consumer must be capable of complying with the necessary regulations in the configuration in which the equipment is marketed. Where special accessories, such as shielded cables and/or special connectors are required to enable an unintentional or intentional radiator to comply with the emission limits in this part, the equipment must be marketed with, i.e. shipped and sold with, those special accessories. However, in lieu of shipping or packaging the special accessories with the unintentional or intentional radiator, the responsible party may employ other methods of ensuring that the special accessories are provided to the consumer without an additional charge.

Information detailing any alternative method used to supply the special accessories for a grant of equipment authorization or retained in the verification records, as appropriate. The party responsible for the equipment, as detailed in § 2.909 of this chapter, shall ensure that these special accessories are provided with the equipment. The instruction manual for such devices shall include appropriate instructions on the first page of text concerned with the installation of the device that these special accessories must be used with the device. It is the responsibility of the user to use the needed special accessories supplied with the equipment.



Standard Test Conditions Engineering Practices

Except as noted herein, the following conditions and procedures were observed during the testing.

In accordance with ANSI C63.10-2009 and unless otherwise indicated in the specific measurement results, the ambient temperature of the actual EUT was maintained within the range of 10° to 40°C (50° to 104°F) unless the particular equipment requirements specify testing over a different temperature range. Also, unless otherwise indicated, the humidity levels were in the range of 10% to 90% relative humidity.

Measurement results, unless otherwise noted, are worst-case measurements.

Environmental Conditions		
Temperature (°C)	Humidity (%)	Pressure (mbar)
25.4 - 27.5	39.7 - 49.3	962.3 – 967.9

EUT Description

Model: CLN-ILB Ballast

Description: 2.4 GHz Transmitter

Additional Information:

The manufacturer provided 3 different devices tuned to low, medium and high channels. The high channel's power was decreased in order to pass the high end restricted band specification. The manufacturer declares the duty cycle of the transmitter to be 3% in normal operation.

EUT Operation during Tests

EUT is set into a continuous transmit mode and powered by a DC power supply for transmitter tests. For AC Conducted emissions a power chord was hardwired into the device and a load lamp was connected to the EUT.



Accessories:

Qty	Description	Mfg	Model	S/N
1	High Intensity Lamp	N/A	N/A	N/A

Cables: None

Modifications:

1	Power on the high channel was decreased in order to pass the 2483.5 MHz restricted band.
---	--

15.203: Antenna Requirement:

- ☐ The antenna is permanently attached to the EUT
- ☒ The antenna uses a unique coupling
- ☐ The EUT must be professionally installed
- ☐ The antenna requirement does not apply



Test Reports Summary

Specification	Test Name	Pass, Fail, N/A	Comments
15.247(b)	Peak Output Power	Pass	
15.247(d)	Conducted Spurious Emissions	Pass	
15.247(d), 15.209(a), 15.205	Radiated Spurious Emissions	Pass	
15.247(d), 15.209(a), 15.205	Emissions At Band Edges	Pass	
15.247(a)(2)	Occupied Bandwidth	Pass	
15.247(e)	Transmitter Power Spectral Density	Pass	
15.207	A/C Powerline Conducted Emissions	Pass	
RSS-Gen 6(b)	Receiver Spurious Emission Limits	Pass	



Peak Output Power

Name of Test:

Peak Output Power

Engineer: Alex Macon

Test Equipment Utilized:

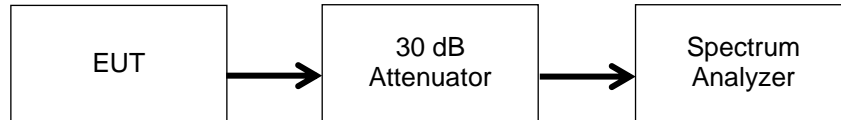
i00379

Test Date: 9/12/13

Test Procedure

The EUT was connected directly to a spectrum analyzer. The peak readings were taken and the result was then compared to the limit.

Test Setup



Transmitter Peak Output Power

Tuned Frequency (MHz)	Measured Value (dBm)	Specification Limit	Result
2405.50	15.97	1 W (30 dBm)	Pass
2440.50	15.90	1 W (30 dBm)	Pass
2480.35	1.04	1 W (30 dBm)	Pass



Conducted Spurious Emission

Name of Test:

Conducted Spurious Emissions

Engineer: Alex Macon

Test Equipment Utilized:

i00379

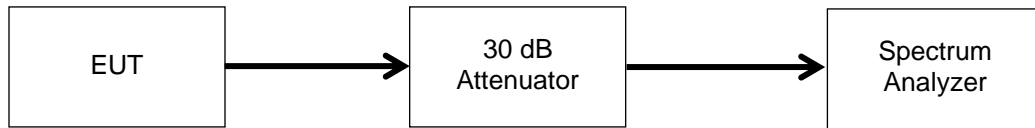
Test Date: 9/13/13

Test Procedure

The EUT was connected to a spectrum analyzer to verify that the EUT met the requirements for spurious emissions. The frequency range from 30 MHz to the 10th harmonic of the fundamental transmitter was observed. Only detectable spurious emissions were recorded and plotted. The peak output power is subtracted from the recorded measurement to provide the corrected spurious level dBc.

Only the worst case is recorded in the Conducted Spurious Emissions Summary Test Table.

Test Setup



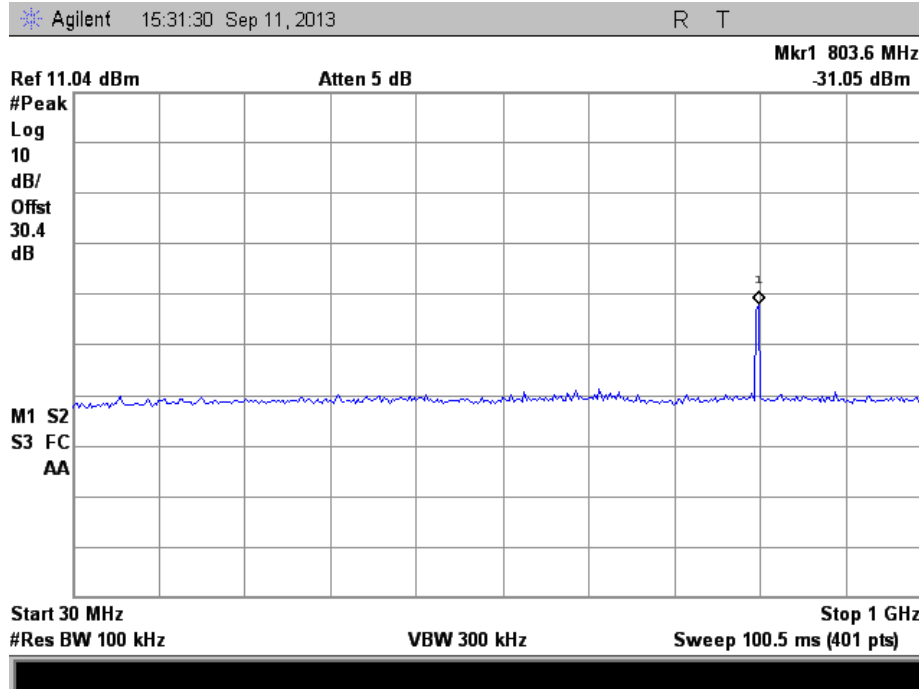
Conducted Spurious Emissions Summary Test Table

Tuned Frequency (MHz)	Emission Frequency (MHz)	Measured Value (dBm)	Reference Level (dBm)	Corrected Measurement (dBc)	Specification Limit (dBc)	Result
2405.50	1605.0	-30.87	15.97	-46.84	-20	Pass
2440.50	1567.5	-32.19	15.90	-48.09	-20	Pass
2480.35	21310.0	-47.25	1.04	-48.29	-20	Pass

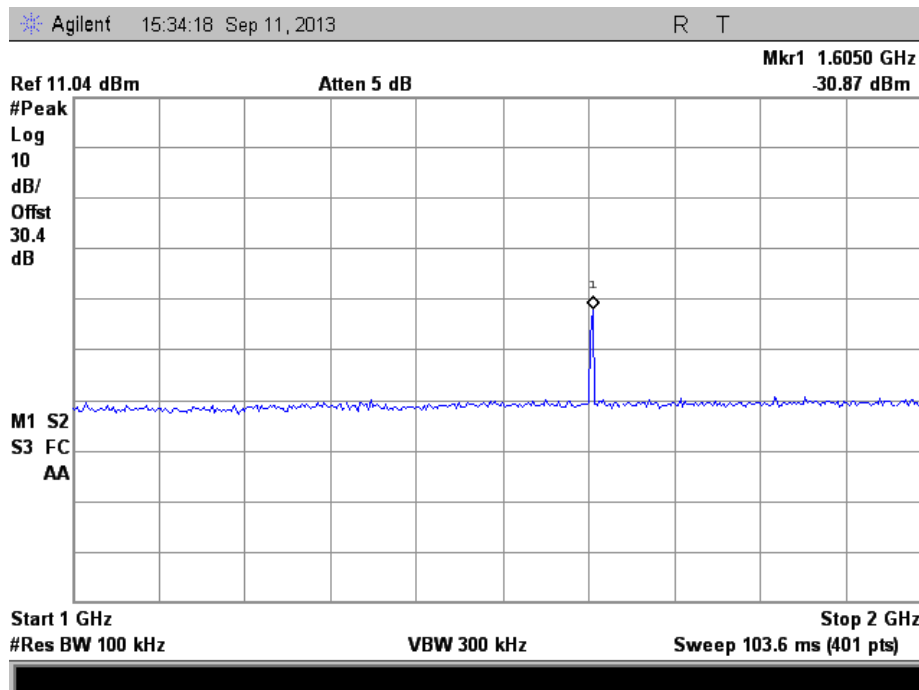


Conducted Spurious Emissions Tuned Frequency=2405.5 MHz

30MHz – 1000MHz

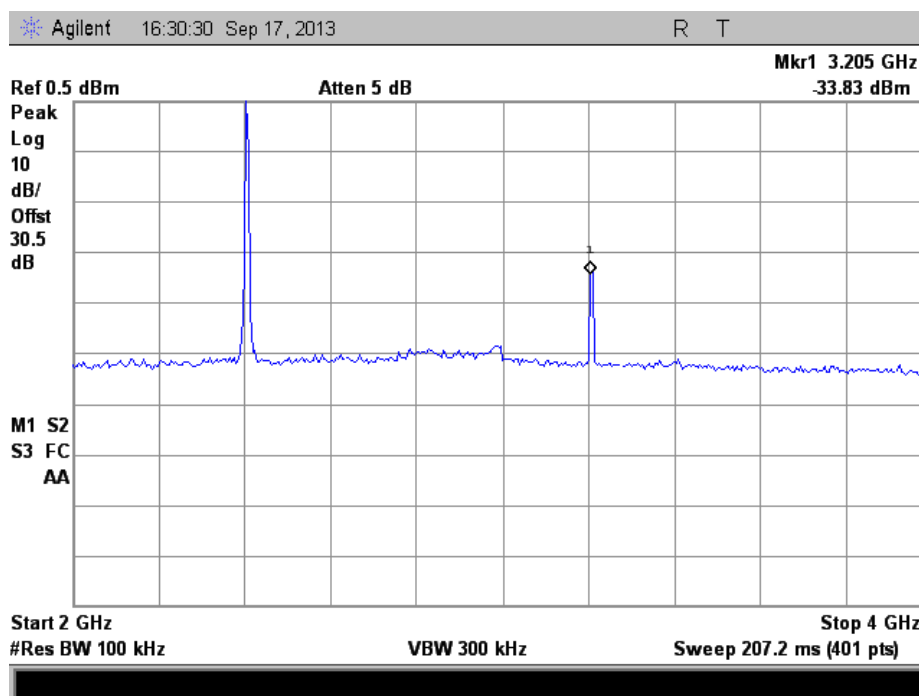


1GHz – 2 GHz



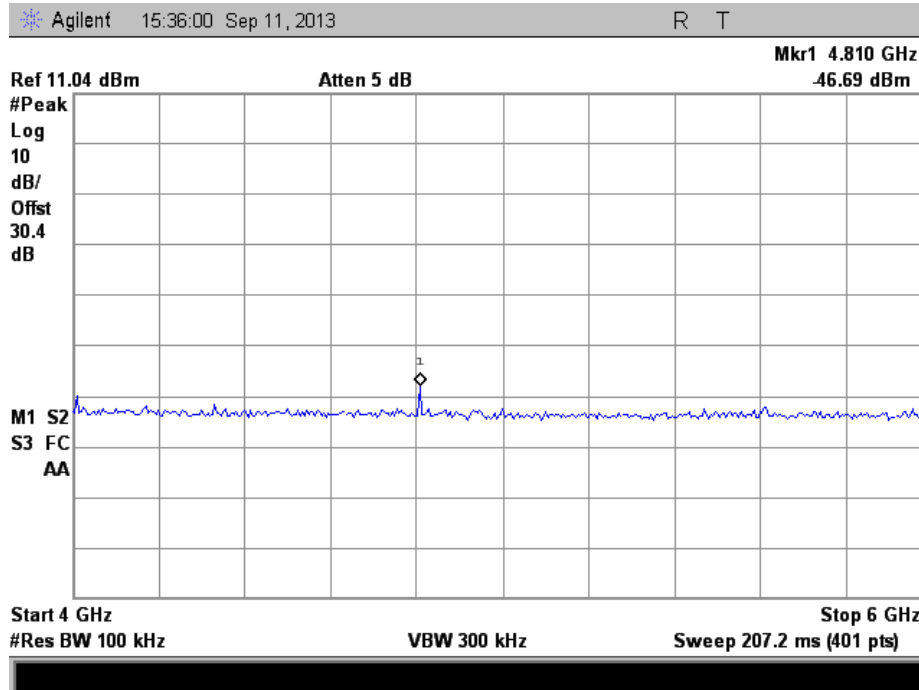


2GHz – 4GHz

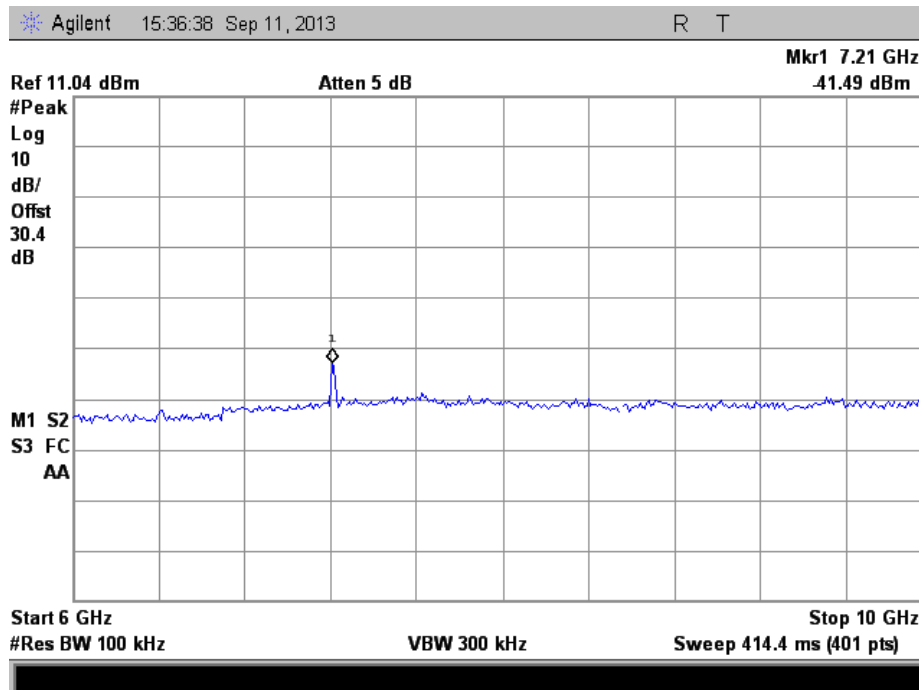




4GHz – 6GHz

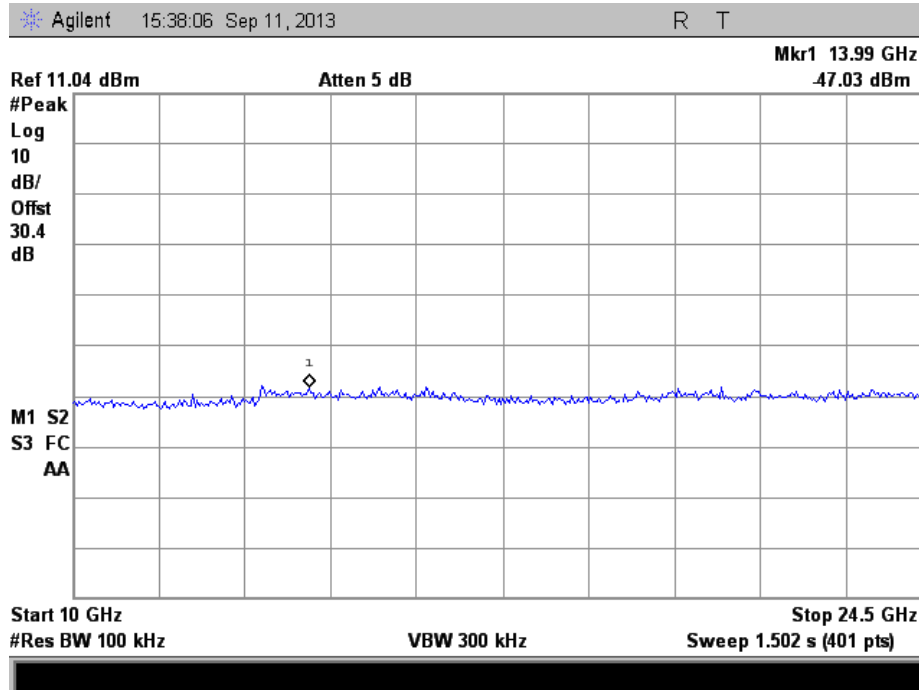


6GHz – 10GHz



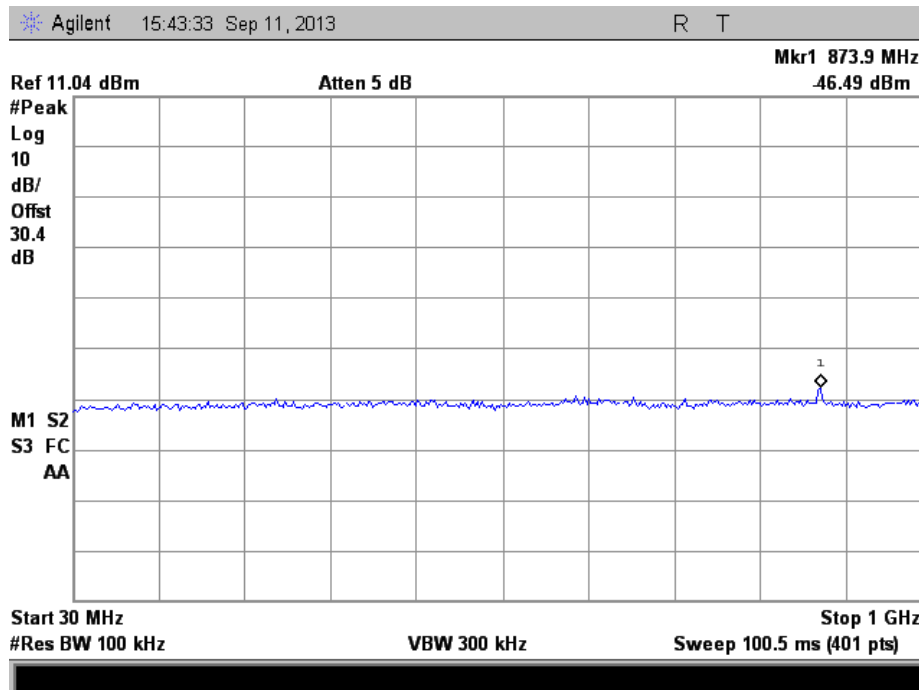


10GHz – 24.5GHz



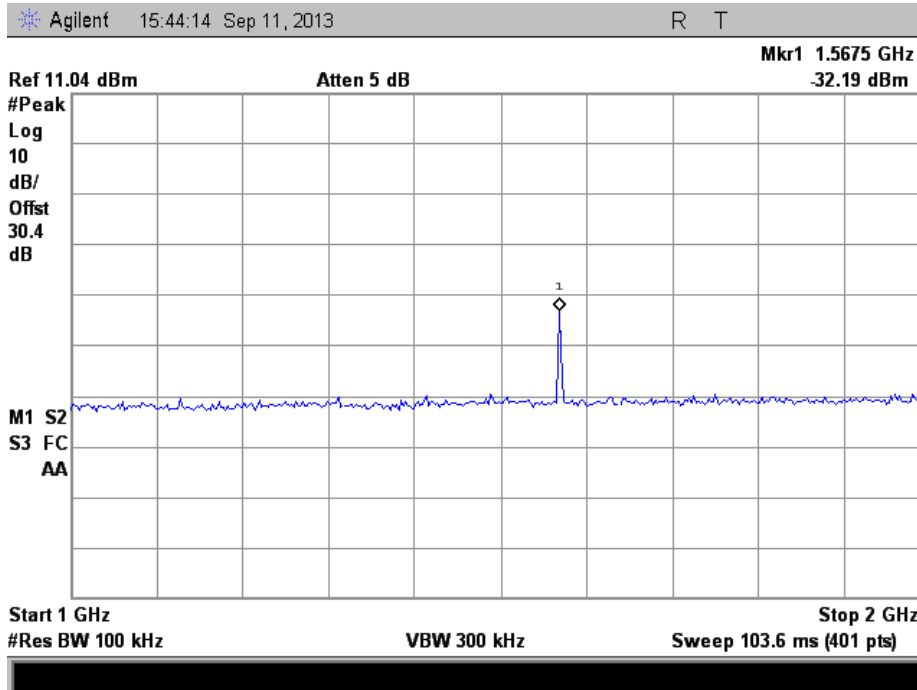
Conducted Spurious Emissions Tuned Frequency=2440.5 MHz

30MHz – 1000MHz

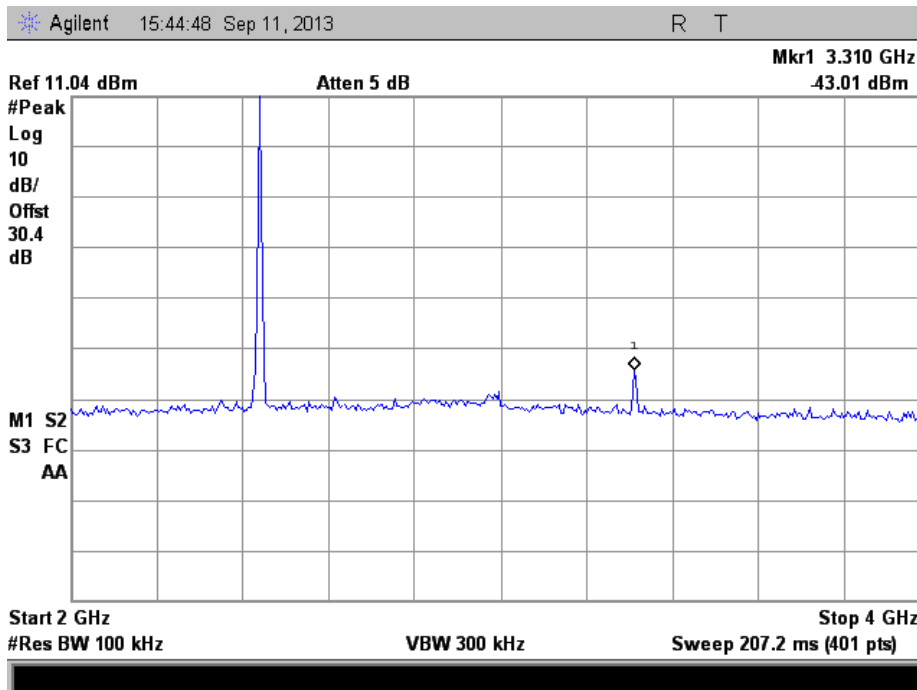




1GHz – 2GHz

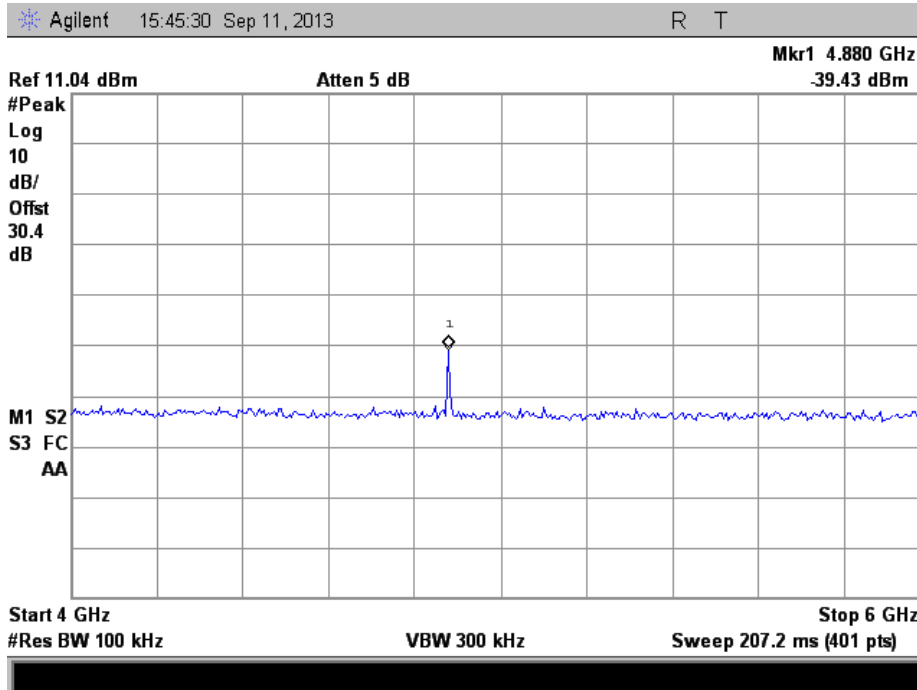


2GHz – 4GHz

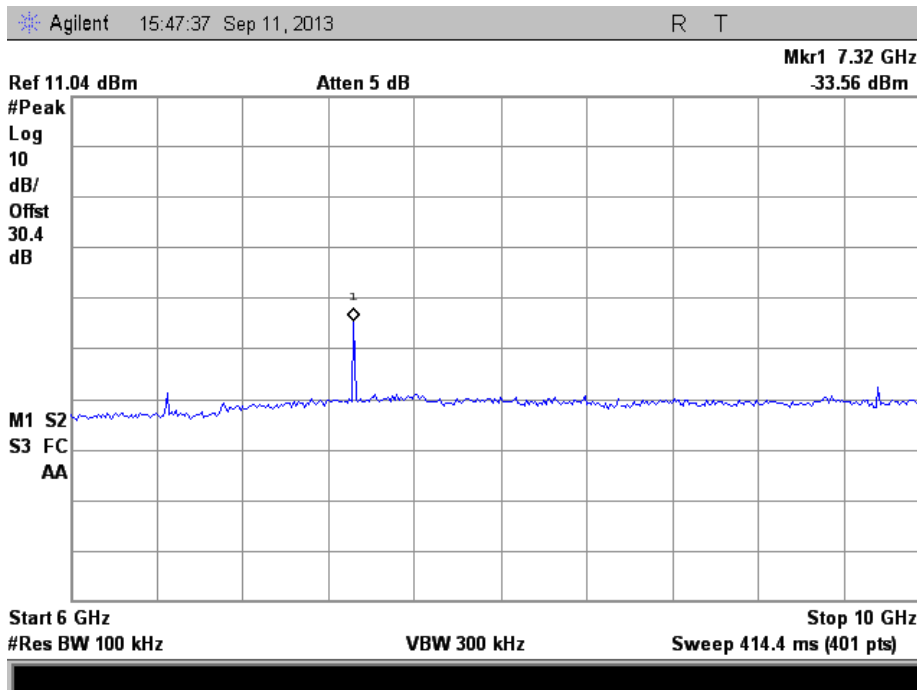




4GHz – 6GHz

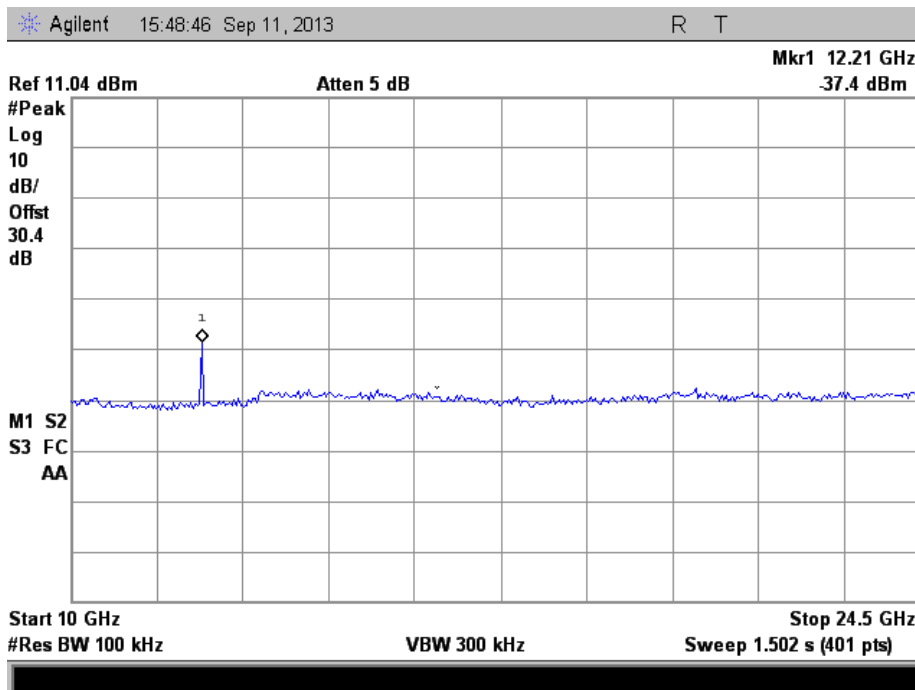


6GHz – 10GHz



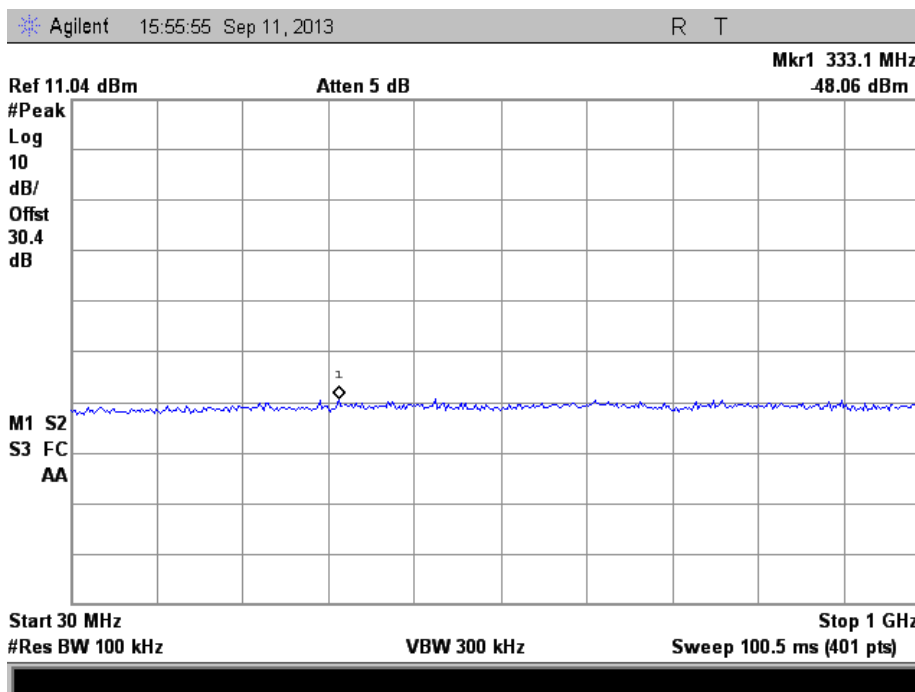


10GHz – 24.5GHz



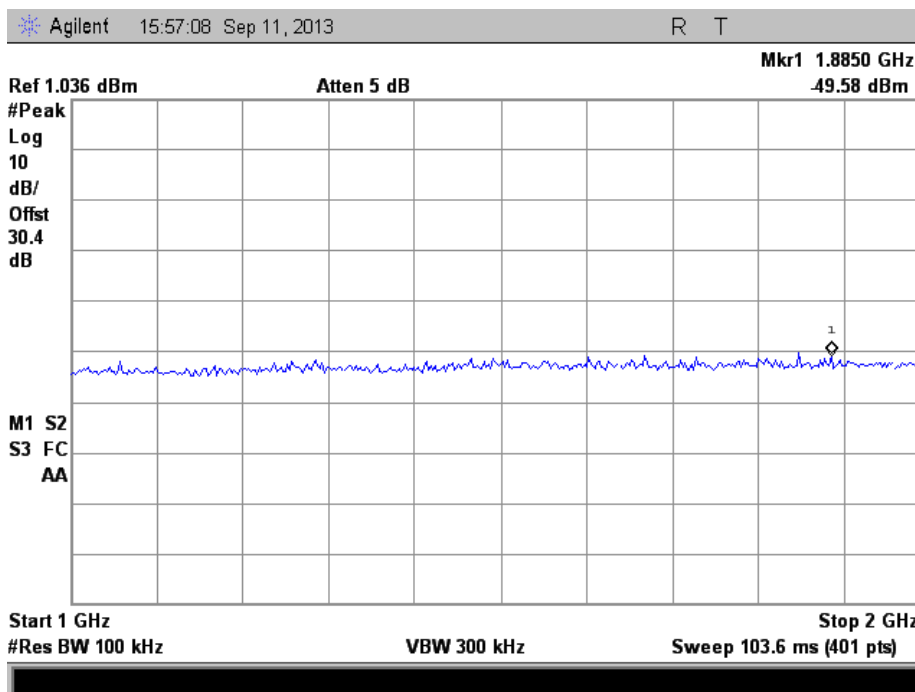
Conducted Spurious Emissions Tuned Frequency=2480.35 MHz

30MHz – 1000MHz

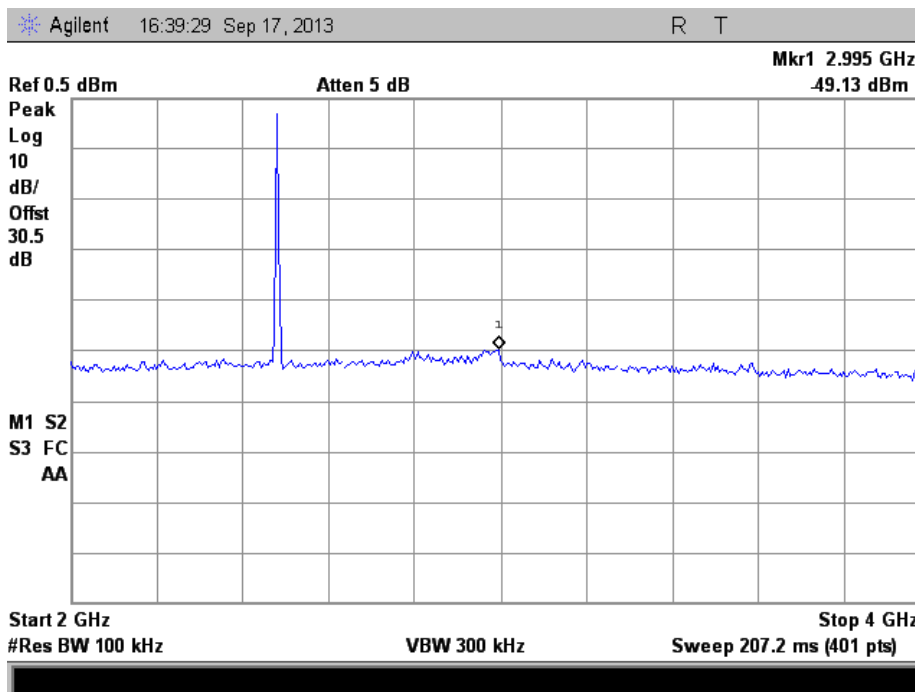




1GHz – 2GHz

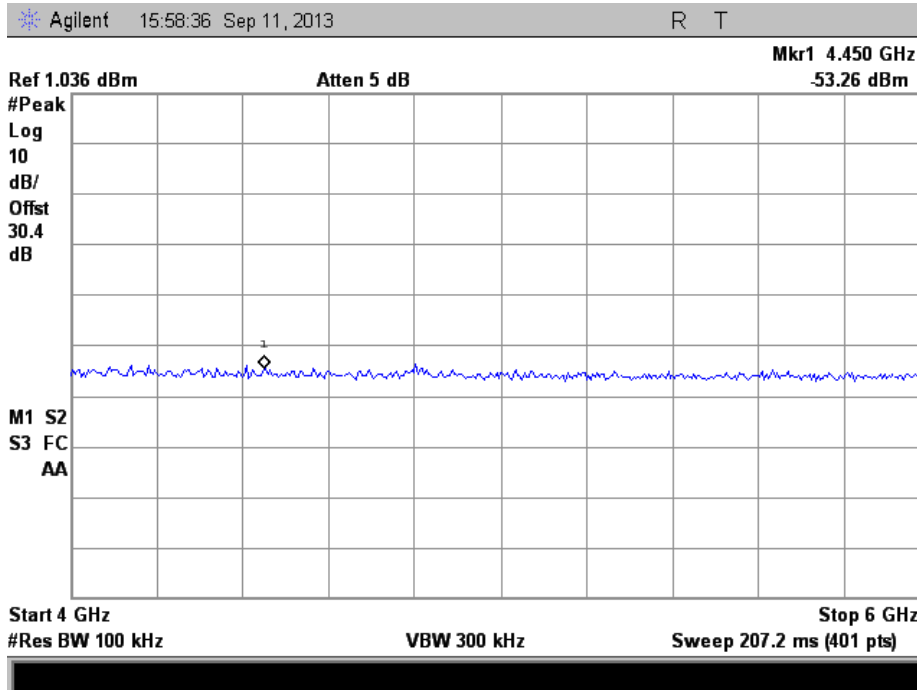


2GHz – 4GHz

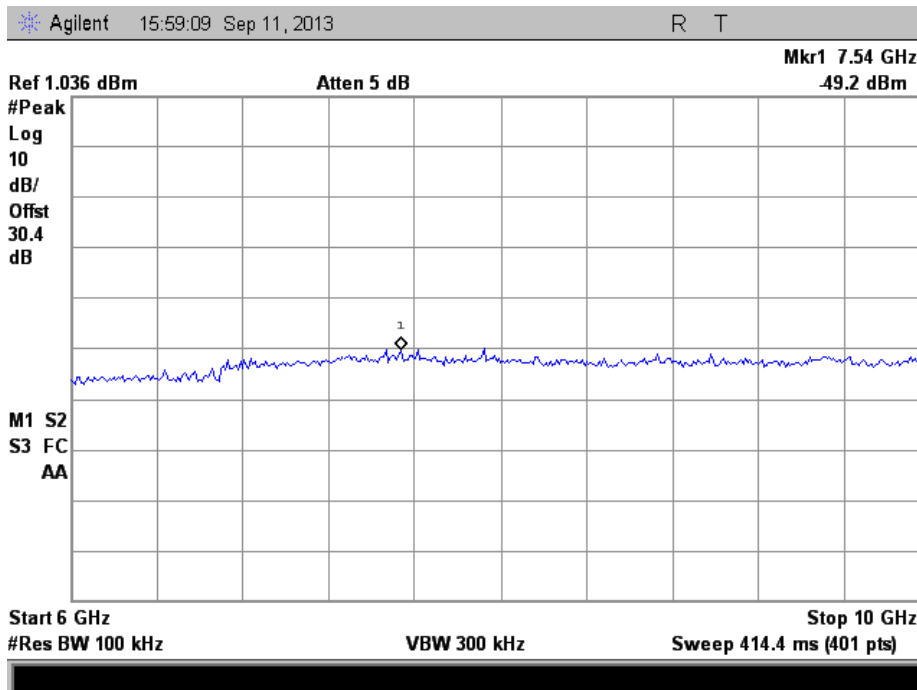




4GHz – 6GHz

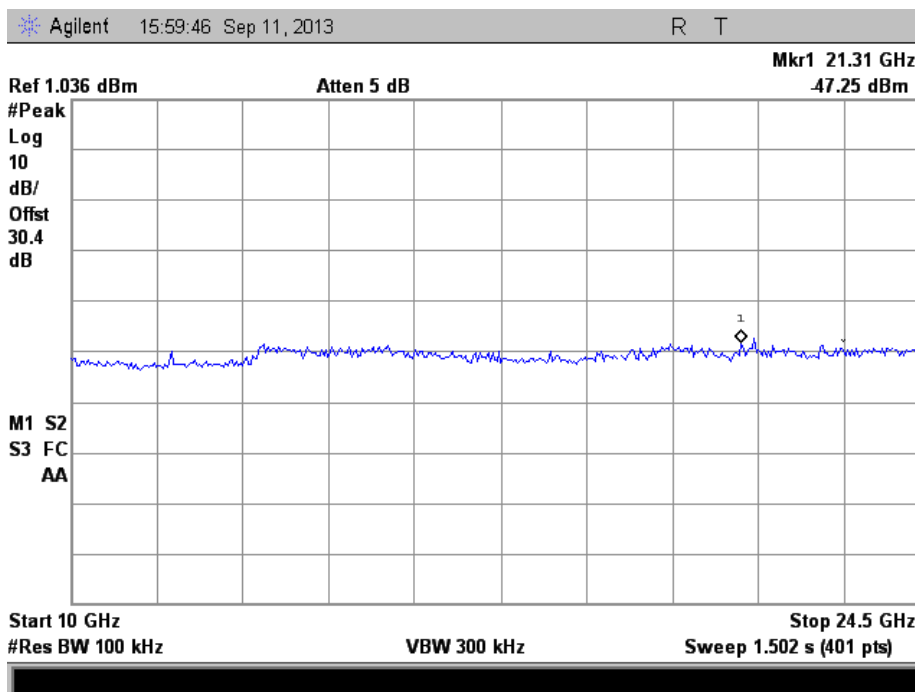


6GHz – 10GHz





10GHz – 24.5GHz





Radiated Spurious Emissions

Name of Test: Radiated Spurious Emissions **Engineer:** Alex Macon
Test Equipment Utilized: I00033, i00177, i00267, i00271, i00379 **Test Date:** 9/13/13

Test Procedure Radiated Spurious Emissions: 30 – 1000 MHz

The EUT was tested in an Open Area Test Site (OATS) set 3m from the receiving antenna. A spectrum analyzer was used to verify that the EUT met the requirements for Radiated Emissions. The EUT was tested by rotating it 360° with the antennas in both the vertical and horizontal orientation and was raised from 1 to 4 meters to ensure the TX signal levels were maximized. All emissions from 30 MHz to 1 GHz were examined.

Measured Level includes antenna and receiver cable correction factors.

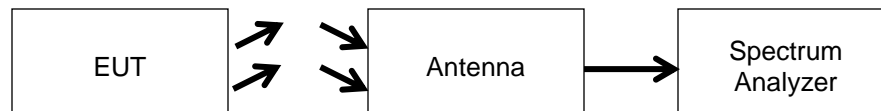
Correction factors were input into the spectrum analyzer before recording "Measured Level".

RBW = 100 KHz

VBW = 300 KHz

Detector –Peak

Test Setup



Radiated Spurious Emissions Test Data: 30 MHz – 1000 MHz

Note: worst case Reference Output Power = 1.04 dBm or 108 dBuV

Emission Frequency (MHz)	Measured Value (dBuV)	Reference Level (dBuV)	Corrected Measurement (dBc)	Specification Limit (dBc)	Result
30.316	30.176	108	-77.824	-20	Pass
43.789	27.475	108	-80.525	-20	Pass
134.736	27.882	108	-80.118	-20	Pass
215.577	32.445	108	-75.555	-20	Pass
223.579	35.383	108	-72.617	-20	Pass
393.471	22.715	108	-85.285	-20	Pass
760.650	13.908	108	-94.092	-20	Pass



Test Procedure for Radiated Spurious Emissions above 1 GHz

The EUT was tested on an Outdoor Area Test Site (OATS) set 3m from the receiving antenna. A spectrum analyzer was used to verify that the EUT met the requirements for Radiated Spurious Emissions. The antenna, high pass filter, amplifier and cable correction factors were input into the spectrum analyzer before recording the Measured Level to ensure accurate readings. The spectrum for each tuned frequency was examined to the 10th harmonic.

Test Setup



Detector Settings	RBW	VBW	Span
Peak	1 MHz	3 MHz	As Necessary
Average	1 MHz	3 MHz	As Necessary

Radiated Spurious Emissions

Tuned Freq (MHz)	Emission Freq (GHz)	Measured Value (dBuV)	Reference Level (dBuV)	Corrected Measurement (dBc)	Specification Limit (dBc)	Result
2405.50	4.810	51.27	123	-71.73	-20	Pass
2405.50	7.216	49.03	123	-73.97	-20	Pass
2405.50	9.621	52.75	123	-70.25	-20	Pass
2405.50	12.027	51.19	123	-71.81	-20	Pass

Tuned Freq (MHz)	Emission Freq (GHz)	Measured Value (dBuV)	Reference Level (dBuV)	Corrected Measurement (dBc)	Specification Limit (dBc)	Result
2440.50	4.881	51.28	123	-71.72	-20	Pass
2440.50	7.318	60.41	123	-62.59	-20	Pass
2440.50	9.761	57.41	123	-65.59	-20	Pass
2440.50	12.202	63.47	123	-59.53	-20	Pass

Tuned Freq (MHz)	Emission Freq (GHz)	Measured Value (dBuV)	Reference Level (dBuV)	Corrected Measurement (dBc)	Specification Limit (dBc)	Result
2480.35	4.958	37.08	108	-70.92	-20	Pass

No other emissions were detectable. All emissions were lower than -20 dBc.



Radiated Spurious Emissions in the Restricted Bands

*Note: The Manufacturer declares a transmitter duty cycle of 3%

Tuned Frequency (MHz)	Emission Frequency (MHz)	Peak Measured Value (dBuV/m)	Peak Limit (dBuV/m)	Average Measured Value (dBuV/m)	Average Limit (dBuV/m)	Result
2405.50	4810.89	51.27	74.0	49.63	54.0	Pass
2405.50	12027.32	51.19	74.0	50.73	54.0	Pass

Tuned Frequency (MHz)	Emission Frequency (MHz)	Peak Measured Value (dBuV/m)	Peak Limit (dBuV/m)	Average Measured Value (dBuV/m)	Average Limit (dBuV/m)	Result
2440.50	4881.05	51.28	74.0	37.41	54.0	Pass
2440.50	7318.42	60.41	74.0	39.52	54.0	Pass
2440.50	12202.55	63.47	74.0	45.44	54.0	Pass

Tuned Frequency (MHz)	Emission Frequency (MHz)	Peak Measured Value (dBuV/m)	Peak Limit (dBuV/m)	Average Measured Value (dBuV/m)	Average Limit (dBuV/m)	Result
2480.35	4.958	37.08	74.0	36.20	54.0	Pass



Emissions at Band Edges

Name of Test:

Emissions at Band Edges

Engineer: Alex Macon

Test Equipment Utilized:

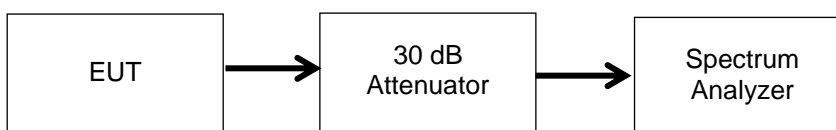
i00379

Test Date: 9/12/13

Test Procedure

The EUT was connected as shown. A spectrum analyzer was used to verify that the EUT met the requirements for band edge. The cable and antenna correction factors were input into the analyzer as a reference level offset to ensure accurate readings were obtained

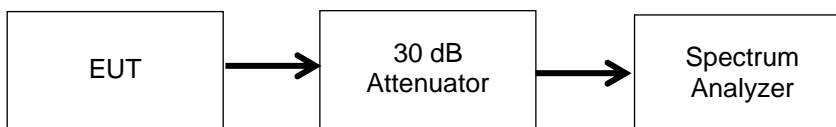
Band Edge Test Setup



Band Edge Emissions Summary

Tuned Frequency (MHz)	Emission Frequency (MHz)	Measured Value (dBc)	Detector	Limit (dBc)	Result
2405.50	2400.0	-52.98	Peak	-20 dBc	Pass
2480.35	2483.5	-32.42	Peak	-20dBc	Pass

Restricted Band Test Setup

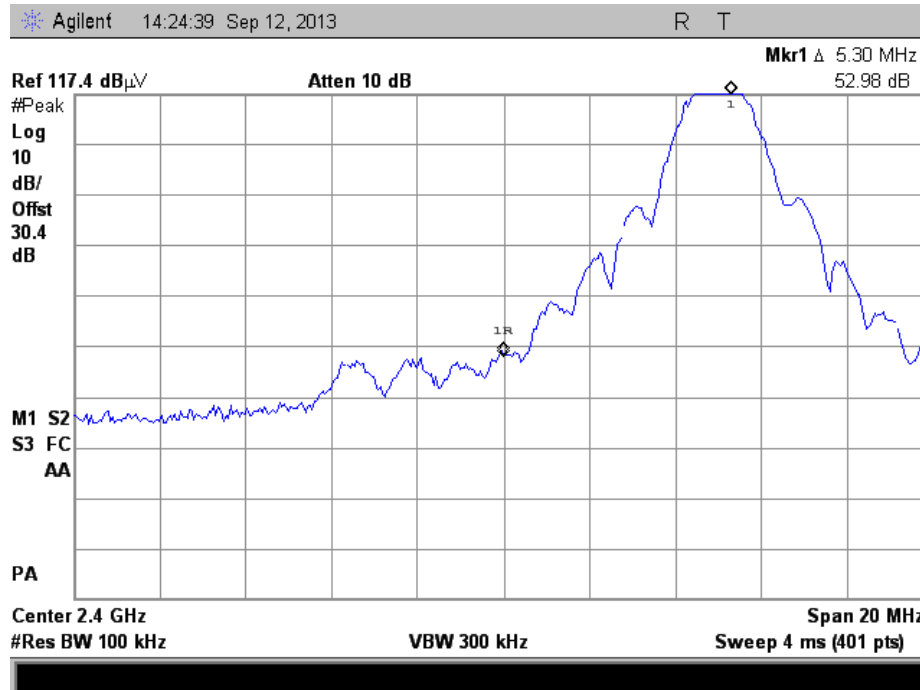


Restricted Band Emissions Summary

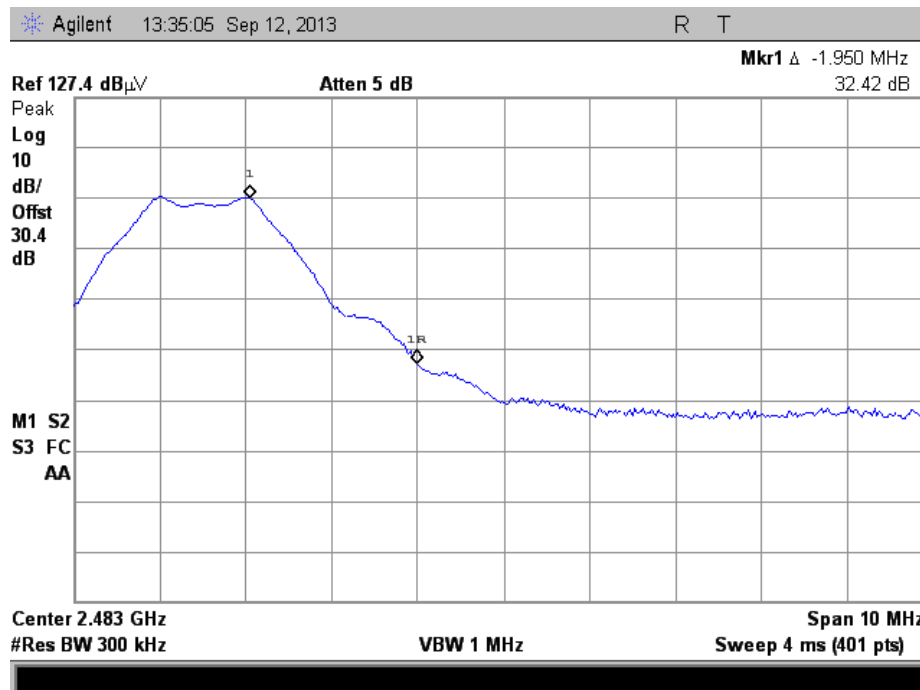
Restricted Band (MHz)	Tuned Frequency (MHz)	Emission Frequency (MHz)	Measured Value (dBuV/m)	Detector	Limit (dBuV/m)	Result
2300 – 2390	2405.5	2388.4	62.4	Peak	74	Pass
2300 – 2390	2405.5	2388.91	45.8	Average	54	Pass
2483.5 - 2500	2483.35	2483.5	70.6	Peak	74	Pass
2483.5 - 2500	2483.35	2483.5	46.6	Average	54	Pass



Band Edge 2400 MHz
Tuned Frequency = 2405.5 MHz



Band Edge 2483.5 MHz
Tuned Frequency = 2480.35 MHz





Occupied Bandwidth

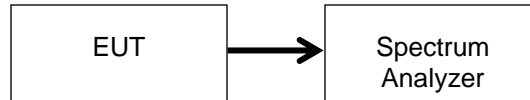
Name of Test: Occupied Bandwidth
Test Equipment Utilized: i00379

Engineer: Alex Macon
Test Date: 9/16/13

Test Procedure

The EUT was connected directly to a spectrum analyzer. The Span was set wide enough to capture the entire transmit spectrum and the resolution bandwidth was set to at least 1% of the span. The analyzer was set to max hold and when the entire spectrum was captured the 6dB and 99% bandwidths were measured to verify the bandwidth met the specification.

Test Setup



6 dB Occupied Bandwidth Summary

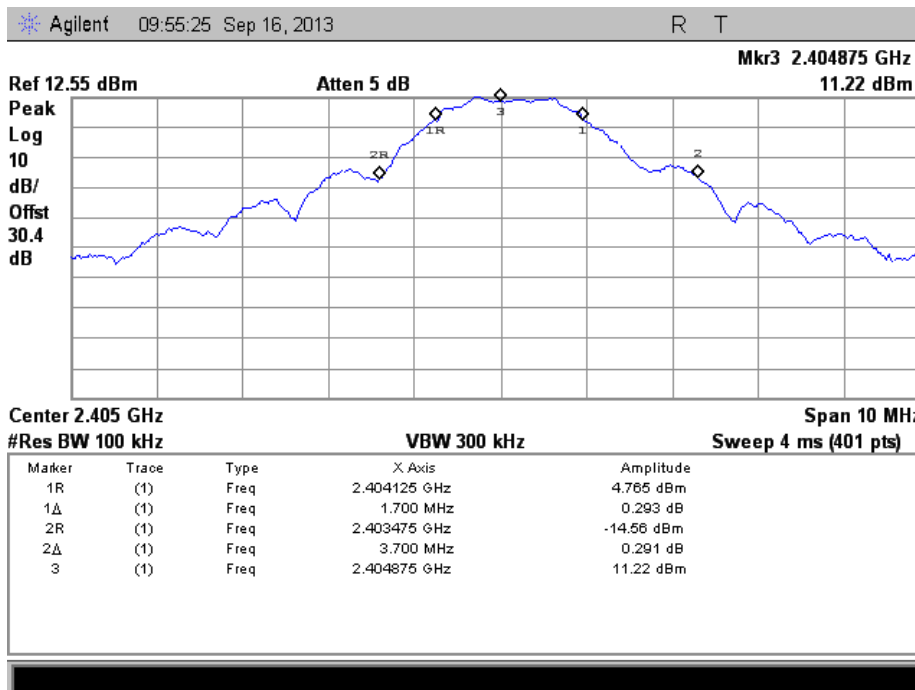
Frequency (MHz)	Measured Bandwidth (kHz)	Specification Limit (kHz)	Result
2405.50	1700	≥ 500	Pass
2440.50	1825	≥ 500	Pass
2480.35	1750	≥ 500	Pass

99% Bandwidth Summary

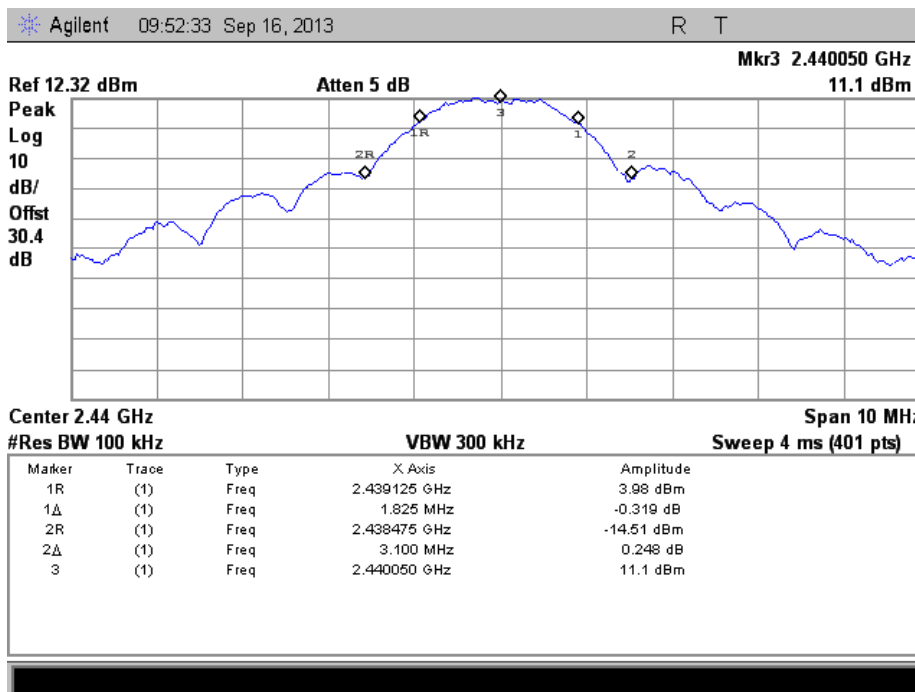
Frequency (MHz)	Measured Bandwidth (kHz)	Result
2405.50	3700	Pass
2440.50	3100	Pass
2480.35	2925	Pass



6dB and 99% Bandwidth 2405.5 MHz

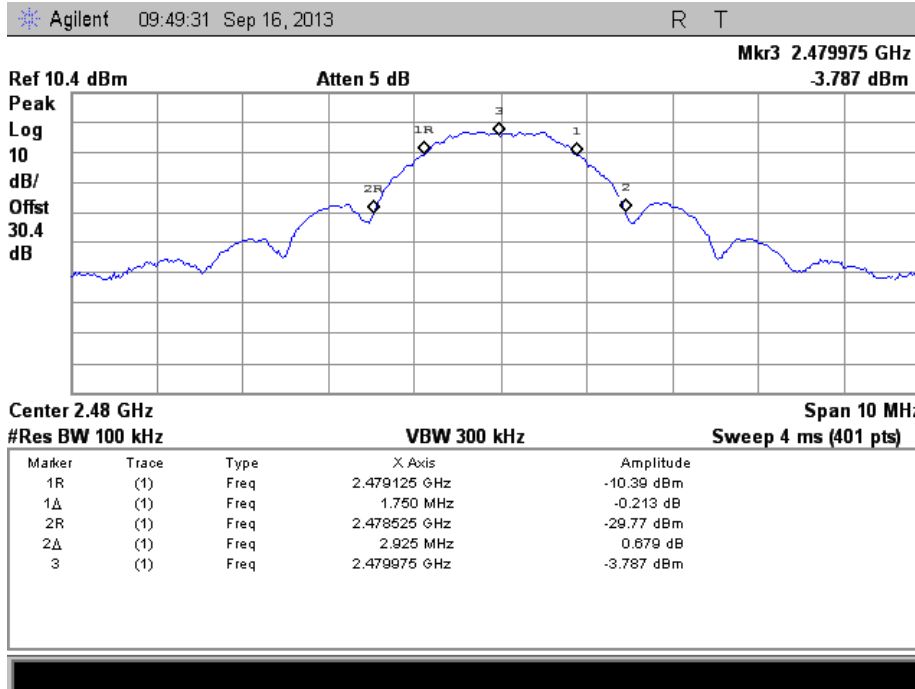


6dB and 99% Bandwidth 2440.5 MHz





6dB and 99% Bandwidth 2480.35 MHz





Transmitter Power Spectral Density (PSD)

Name of Test: Transmitter Power Spectral Density (PSD)
Test Equipment Utilized: i00379

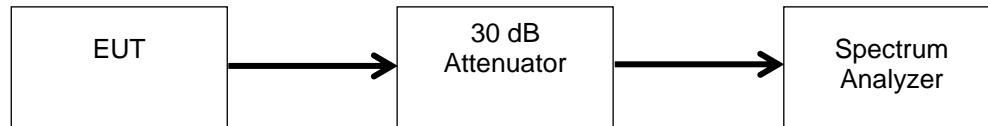
Engineer: Alex Macon

Test Date: 9/11/13

Test Procedure

The EUT was connected directly to a spectrum analyzer. The test was performed per section 6.11.2.3 of C63.10 - 2009 "Procedure for determining PSD for DTS devices".

Test Setup



PSD Summary

Frequency (MHz)	Measured Data (dBm)	Specification Limit (dBm)	Result
2405.50	.333	8	Pass
2440.50	.760	8	Pass
2480.35	-15.19	8	Pass

PSD 2405.5 MHz





PSD 2440.5 MHz



PSD 2480.35 MHz





A/C Powerline Conducted Emission

Name of Test:

A/C Powerline Conducted Emissions

Engineer: Alex Macon

Test Equipment Utilized:

i00033, i00123, i00270

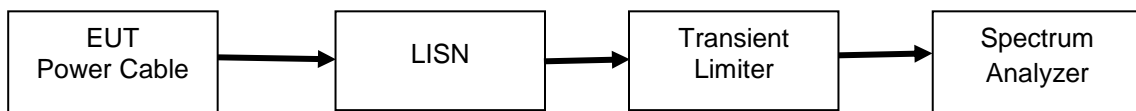
Test Date: 7/29/13

Test Procedure

The EUT power cable was connected to a LISN and the monitored output of the LISN was connected to a transient limiter, which then connected directly to a spectrum analyzer. The conducted emissions from 150 kHz to 30 MHz were measured and compared to the specification limits.

The EUT is a hybrid device. The RF transmitter section of the device is tested to 15.207 limits while the Ballast section is tested to 15.107 Class A limits.

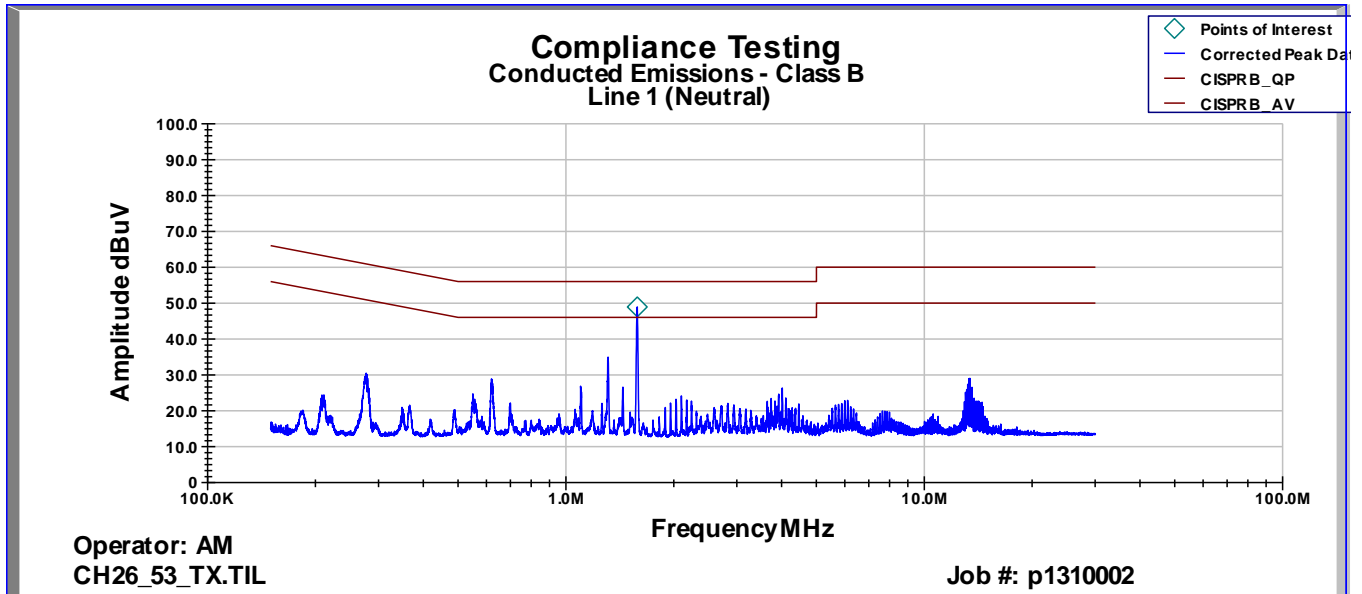
Test Setup



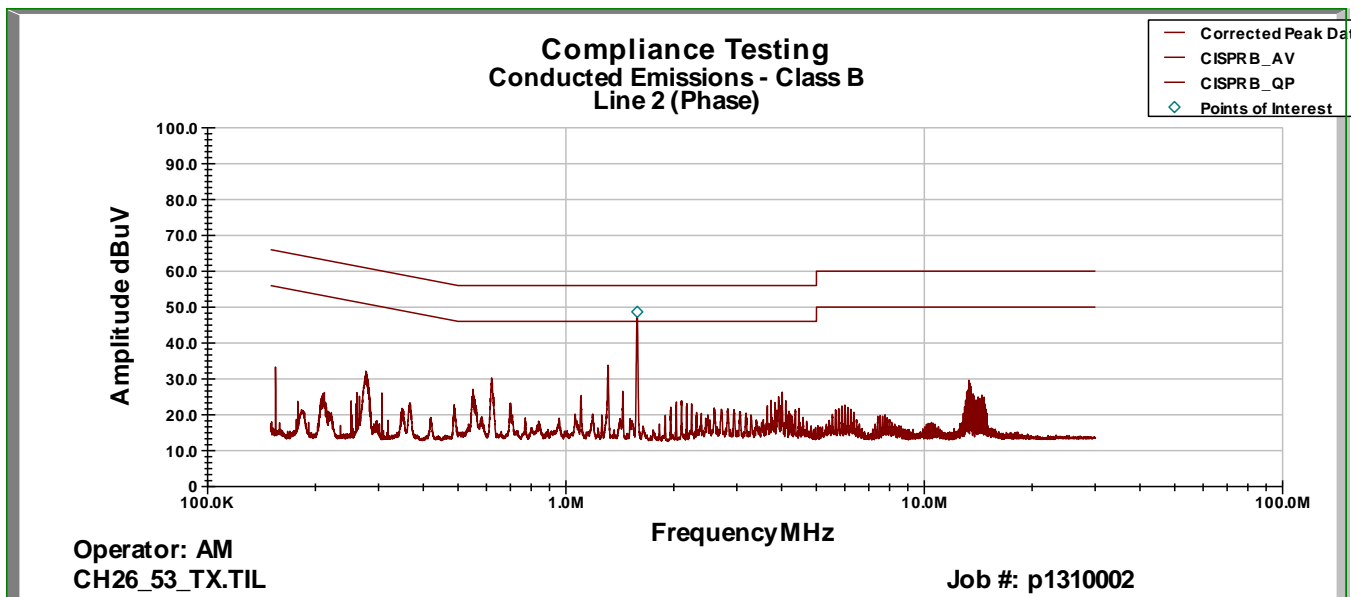


Conducted Emission RF Circuitry Test Results

Line 1 Peak Plot



Line 2 Peak Plot



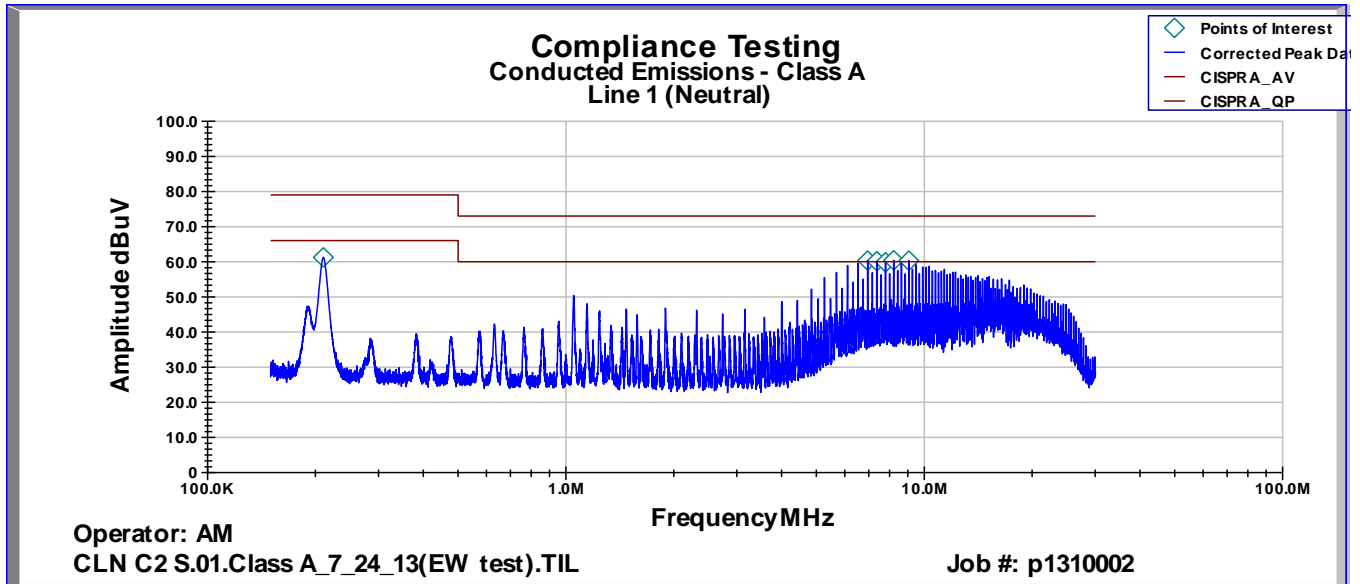
*Note: The 1.58 MHz emission is an ambient signal within the test setup. It is not related to the EUT

All peak emissions are below the Quasi-Peak and average limits.

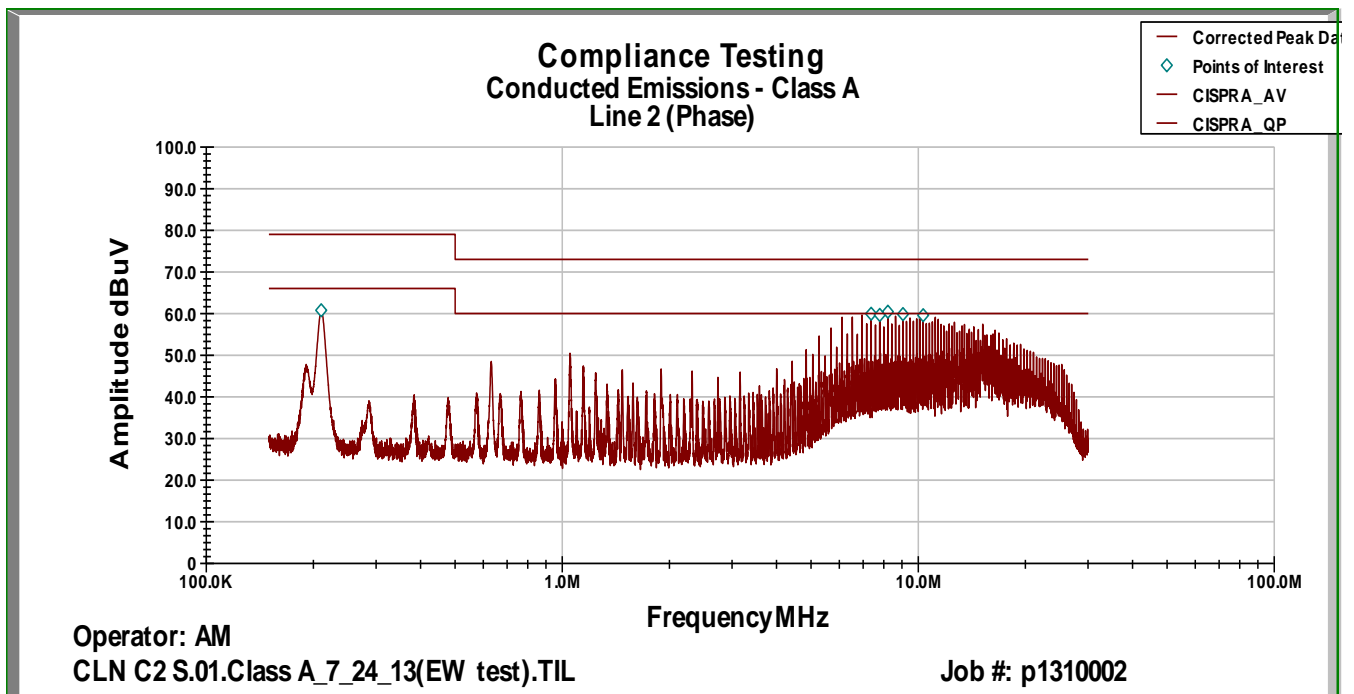


Conducted Emission Ballast Circuitry Test Results

Line 1 Peak Plot



Line 2 Peak Plot





Line 1 Neutral AVG Detector

Frequency	Measured Value (dBuV)	LISN Correction Factor (dB)	Cable Loss (dB)	Transient Limiter (dB)	Final Data (dBuV)	Limit (dBuV)	Avg Margin (dB)
210.79 KHz	50.73	0.19	0.02	10.1	61.04	66	-4.96
6.9475 MHz	49.09	0	0.12	10.2	59.41	60	-0.59
7.3678 MHz	49.07	0	0.13	10.2	59.40	60	-0.60
7.7893 MHz	49.09	0	0.12	10.2	59.41	60	-0.59
8.2101 MHz	48.9	0	0.13	10.2	59.23	60	-0.77
9.0529 MHz	48.33	0	0.15	10.2	58.69	60	-1.32

Line 2 Phase AVG Detector

Frequency	Measured Value (dBuV)	LISN Correction Factor (dB)	Cable Loss (dB)	Transient Limiter (dB)	Final Data (dBuV)	Limit (dBuV)	Avg Margin (dB)
210.35 KHz	50.16	0.19	0.02	10.1	60.47	66	-5.53
7.3682 MHz	49.13	0	0.13	10.2	59.46	60	-0.54
7.7891 MHz	49.00	0	0.12	10.2	59.32	60	-0.68
8.2101 MHz	48.98	0	0.13	10.2	59.31	60	-0.69
9.0529 MHz	48.36	0	0.15	10.2	58.71	60	-1.29
10.316 MHz	47.43	0	0.156	10.2	57.79	60	-2.22

Line 1 Neutral QP Detector

Frequency	Measured Value (dBuV)	LISN Correction Factor (dB)	Cable Loss (dB)	Transient Limiter (dB)	Final Data (dBuV)	Limit (dBuV)	QP Margin (dB)
210.79 KHz	50.58	0.19	0.02	10.1	60.90	79	-18.11
6.9475 MHz	49.1	0	0.12	10.2	59.42	73	-13.58
7.3678 MHz	49.15	0	0.13	10.2	59.48	73	-13.52
7.7893 MHz	49.1	0	0.12	10.2	59.42	73	-13.58
8.2101 MHz	49.14	0	0.13	10.2	59.47	73	-13.53
9.0529 MHz	48.66	0	0.15	10.2	59.01	73	-13.99

Line 2 Phase QP Detector

Frequency	Measured Value (dBuV)	LISN Correction Factor (dB)	Cable Loss (dB)	Transient Limiter (dB)	Final Data (dBuV)	Limit (dBuV)	QP Margin (dB)
210.35 KHz	50.11	0.19	0.02	10.1	60.43	79	-18.57
7.3682 MHz	49.33	0	0.13	10.2	59.66	73	-13.34
7.7891 MHz	49.01	0	0.12	10.2	59.33	73	-13.67
8.2101 MHz	49.44	0	0.13	10.2	59.77	73	-13.23
9.0529 MHz	48.36	0	0.15	10.2	58.71	73	-14.29
10.316 MHz	48.03	0	0.156	10.2	58.39	73	-14.61



Receiver Spurious Emissions

Name of Test:

Receiver Spurious Emissions

Engineer: Alex Macon

Test Equipment Utilized:

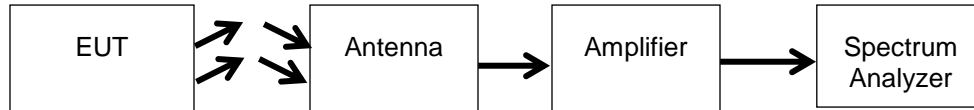
i00103, i00267, i00271, i00379

Test Date: 9/17/13

Test Procedure

The EUT was tested on an Outdoor Area Test Site (OATS) set 3m from the receiving antenna. A spectrum analyzer was used to verify that the EUT met the requirements for Receiver Spurious Emissions. The antenna, amplifier and cable correction factors were input into the spectrum analyzer before recording the Measured Level to ensure accurate readings

Test Setup



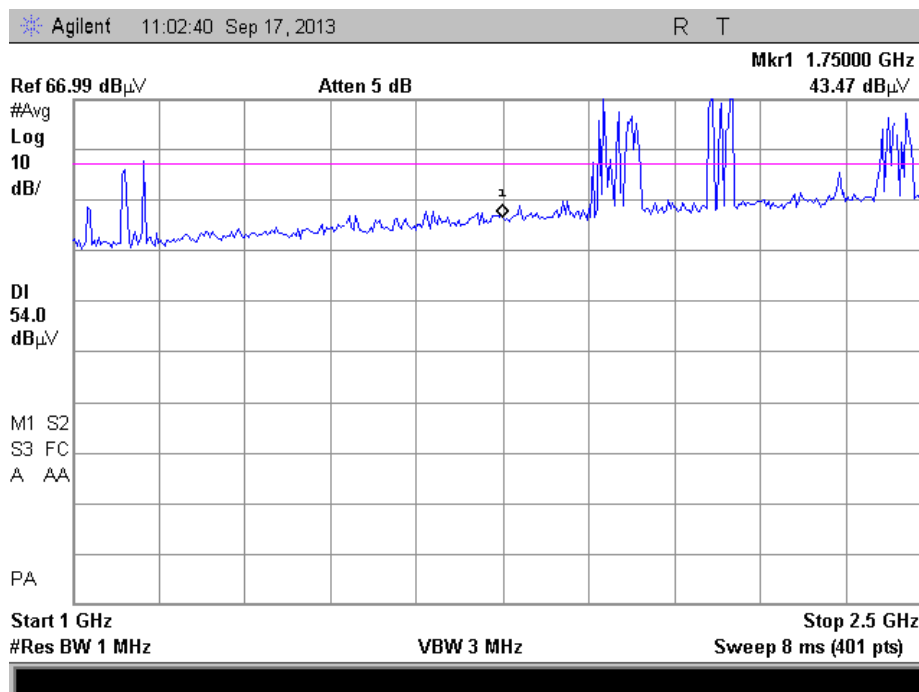
Receiver Spurious Emissions Summary

Frequency Range (MHz)	Recorded Measurement (dBuV)	Specification Limit (dBuV)	Result
30 – 88	30.17	40.0	Pass
88-216	32.44	43.5	Pass
216-960	35.38	46.0	Pass
1000 - 8000	42.26	54.0	Pass

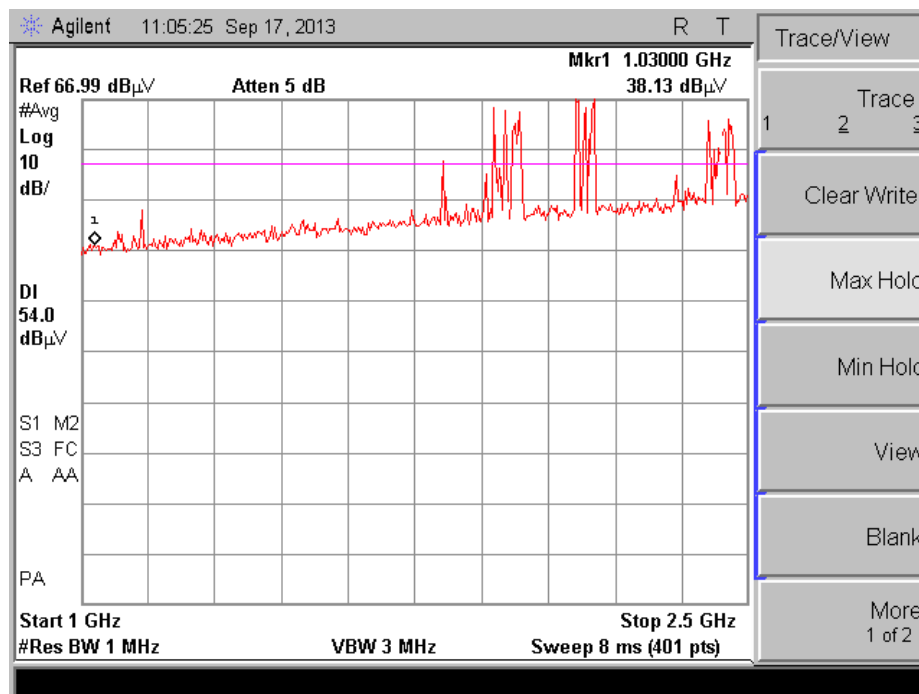


Receiver Spurious Emissions 1GHz MHz – 2.5 GHz

EUT turned off



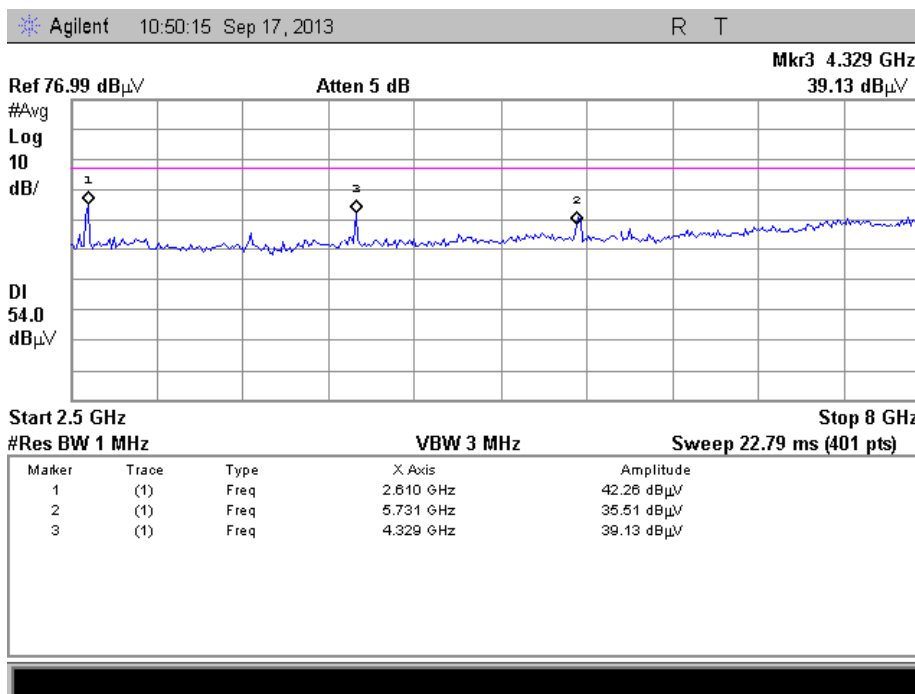
EUT powered on



*Note: The signals seen in the OATS plots above are ambient signals. This was confirmed using a compact semi-anechoic chamber and a spectrum analyzer.



Receiver Spurious Emissions 2.5 GHz – 8 GHz





Test Equipment Utilized

Description	Manufacturer	Model #	CT Asset #	Last Cal Date	Cal Due Date
EMI Receiver	HP	8546A	i00033	12/27/12	12/27/13
Transient Limiter	Com-Power	LIT-153	i00123	Verified on:7/24/13	
High Pass Filter	Trilithic	4HX3400-3-XX	i00177	Verified on: 9/13/13	
Bilog Antenna	Schaffner	CBL6111C	i00267	12/19/11	12/19/13
LISN	FCC	FCC LISN 50-32-2-01	i00270	10/5/12	10/5/14
Horn Antenna, Amplified	ARA	DRG-118/A	i00271	4/19/12	4/19/14
Humidity / Temp Meter	Newport	IBTHX-W-5	i00282	12/4/12	12/4/13
Transformer	Jefferson Electric	211-091-120	i00338	Verified on:7/17/13	
AC Power Source	Behlman	BL 6000	i00362	Verified on:7/24/13	
EMI Analyzer	Agilent	E7405A	i00379	11/21/12	11/21/13
Labview Software	National Instruments	FCC_PART15AB_R2	i00395	Compiled on: 06/11	
Thermo Hygrometer	Omega	RH81	i00408	4/15/13	4/15/15

In addition to the above listed equipment standard RF connectors and cables were utilized in the testing of the described equipment. Prior to testing these components were tested to verify proper operation.

END OF TEST REPORT