



Test Report

FCC Part 15, Subpart C, Section 15.247 Industry Canada RSS-210, Issue 8

Report Number: CWDHR-Cert

Model: CWDHR

FCC ID: EROCWDHR
IC: 5683C-CWDHR

Date: October 30, 2014 (Revised Nov. 4, 2014)

Prepared by: Grace Lin Date: Oct. 30, 2014
Grace Lin, Sr. Compliance Engineer

Reviewed by: Wayne Owens Date: Oct. 30, 2014
Wayne Owens, Director of Program Management



Table of Contents

1. GENERAL DESCRIPTION.....	3
1.1 PRODUCT DESCRIPTION	3
1.2 TEST METHODOLOGY	3
1.3 TEST FACILITY.....	3
1.4 TEST EQUIPMENT.....	4
1.5 EVALUATION SUMMARY	5
2. SYSTEM TEST CONFIGURATION.....	6
2.1 JUSTIFICATION	6
2.2 BLOCK DIAGRAM.....	6
2.3 EUT EXERCISE SOFTWARE AND MODE(S) OF OPERATION.....	6
2.4 CABLES.....	6
2.5 SPECIAL ACCESSORIES.....	7
2.6 SUPPORT EQUIPMENT	7
2.7 EQUIPMENT MODIFICATIONS	7
3. EVALUATION	8
3.1 ANTENNA REQUIREMENTS.....	8
3.2 DTS BANDWIDTH	9
3.3 99% BANDWIDTH	12
3.4 POWER OUTPUT	14
3.5 BAND EDGE	18
3.6 CONDUCTED SPURIOUS EMISSIONS	20
3.7 POWER SPECTRAL DENSITY	24
3.8 RADIATED SPURIOUS EMISSIONS	27
3.9 TRANSMITTER AC POWER LINE CONDUCTED EMISSIONS.....	29



1. General Description

1.1 Product Description

The equipment under test (EUT) is a Crestron 2.4GHz two-way RF transceiver module, model: CWDHR, serial numbers: CNA8463170 SE (PA07424) and CNA8606559 SE B3 (PA07414).

1.2 Test Methodology

Measurements were performed according to the following procedures and standards:

- 1) ANSI C63.4: 2009
- 2) FCC Publication, "Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating under §15.247", June 5, 2014
- 3) Industry Canada RSS-Gen Issue 3
- 4) Industry Canada RSS-210 Issue 8

All measurements were performed in a 3-meter semi-anechoic chamber and the control room.

1.3 Test Facility

Test data in this report were taken by UL LLC, located at 1285 Walt Whitman Road, Melville, New York 11747.

FCC:
Designation Number: US5155
Test Firm Registration Number: 608404

IC:
Test Site Number: 2180B-1
IC Assigned Company Code:2180B

Duty cycle measurement was performed at the Crestron's 3-meter semi-anechoic chamber facility located at 22 Link Drive, Rockleigh, New Jersey. This test facility has been placed on file with the FCC, Registration Number: 412871, and Industry Canada, Site Number: 5683C-1.



1.4 Test Equipment

Test Equipment Used (UL LLC - Melville, NY)

Description	Manufacturer	Model	Identifier	Cal Date	Cal Due
Spectrum Analyzer	Agilent	E4446A	72823	2014-06-13	2015-06-13
Horn Antenna	EMCO	RGA-180 (50°)	5565	2014-09-17	2015-09-17
Horn Antenna (2-4 GHz)	ETS-Lindgren	3161-02 (22°)**	48107	2007-09-27	See * below
Horn Antenna (4-8 GHz)	ETS-Lindgren	3161-03 (22°)**	48106	2007-09-27	See * below
Horn Antenna (8-12 GHz)	ETS-Lindgren	3160-07 (26°)**	8933	2008-11-24	See * below
Horn Antenna (12-18 GHz)	ETS-Lindgren	3160-08 (26°)**	8932	2007-09-27	See * below
Horn Antenna (18-26.5 GHz)	ETS-Lindgren	3160-09 (27°)**	8947	2007-09-26	See * below
Horn Antenna (26.5-40 GHz)	ETS-Lindgren	3160-10 (27°)**	73004	2007-09-26	See * below
Signal Path Controller	HP	11713A	50250	N/A	N/A
Gain Controller	HP	11713A	50251	N/A	N/A
RF Switch / Preamp Fixture	UL	BOMS1	50249	N/A	N/A
System Controller	UL	BOMS2	50252	N/A	N/A
Measurement Software	UL	Version 9.5	44740	N/A	N/A
<p>* - Note: As allowed by the calibration standard ANSI C63.4 Section 4.4.2, standard gain horns need only a one-time calibration. Only if physical damage occurs will the horn antenna require re-calibration.</p> <p>Gain standard horn antennas (sometimes called standard gain horn antennas) need not be calibrated beyond that which is provided by the manufacturer unless they are damaged or deterioration is suspected, or they are used at a distance closer than $2D^2/\lambda$. Gain standard horn antennas have gains that are fixed by their dimensions and dimensional tolerances.</p> <p>** - Number in parentheses denotes antenna beam width.</p>					

Test Equipment for Duty Cycle Measurement (Crestron)

Description	Model	Serial No.	Frequency Range	Calibration Date
R&S EMI Receiver	ESU40	100076	20 Hz – 40 GHz	Dec. 13, 2013



1.5 Evaluation Summary

Rule Section		Description/Parameters	Results
FCC	IC		
§15.203	N/A	Antenna Requirement	Complies
§15.247(a)(2)	§A8.2(a) of RSS-210	6 dB Bandwidth, 500 kHz	Complies
N/A	§4.6.1 of RSS-Gen	99% Occupied Bandwidth	(for reporting purpose)
§15.247(b)(3)	§A8.4(4) of RSS-210	Power Output, conducted, 1 Watt (30dBm)	Complies
§15.247(d)	§2.1, §A8.5 of RSS-210	Band Edge	Complies
§15.247(d)	§A8.5 of RSS-210	Conducted Spurious Emissions, 20 dBc	Complies
§15.247(e)	§A8.2(b) of RSS-210	Power Spectral Density (PSD), 8 dBm in any 3 kHz band.	Complies
§15.205, §15.209, §15.247(d)	§2.2, §A8.5 of RSS-210	Radiated Spurious Emissions	Complies
§15.207	§7.2.4 of RSS-Gen	Transmitter AC Power Line Conducted Emissions	Not Applicable

Note:

The channels selected for test were 11, 18, and 26.

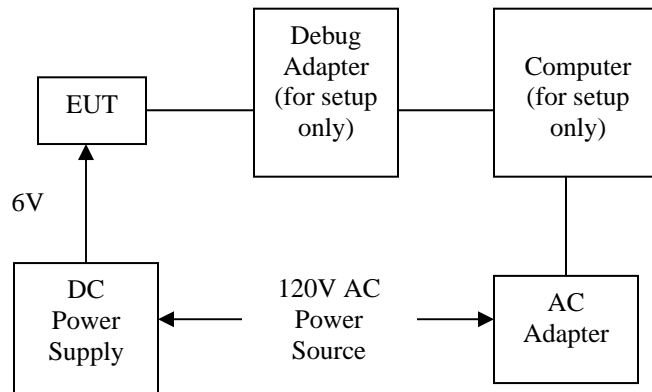
2. System Test Configuration

2.1 Justification

A DC power supply supplied power to the EUT. A computer supplied test commands through a debug adapter.

2.2 Block Diagram

Block diagram is shown below.



2.3 EUT Exercise Software and Mode(s) of Operation

The EUT was configured to transmit continuously with “*em3588-NewFEM_nodetest-with-bootloader.hex*” firmware loaded. Channels 11 (2405 MHz), 18 (2440 MHz), and 26 (2480 MHz) were selected for test.

2.4 Cables

Qty	Description	Length (m)	From - To	Shielded/ Unshielded
1	Cat5 (Crossover)	0.6	Computer – Debug Adapter	Unshielded
1	USB	2.0	Computer – Debug Adapter	Unshielded
1	AWG#18	1.0	DC Power Supply – EUT	Unshielded
1	10-conductor Ribbon Cable	0.3	Debug Adapter – EUT	Unshielded



2.5 *Special Accessories*

There are no special accessories for compliance of this EUT.

2.6 *Support equipment*

No	Description	Manufacturer	Model No	Serial No
1	Computer	DELL	Latitude E6510	F1CQ4Q1 (Service Tag)
2	AC Adapter	DELL	DA90PE3-00	CN-0WTC0V-48661-0AN-9BB4-A00
3	DC Power Supply (owned by UL LLC)	Circuit Specialists Inc.	CSI3005X5	Not Labeled
4	Debug Adapter	Ember	ISA3	EM-ISA3-461

2.7 *Equipment Modifications*

There were no modifications installed during compliance measurements.



3. Evaluation

3.1 *Antenna Requirements*

This module is validated with a SMD antenna. Antenna gain is 2.5 dBi.

The antenna connector of the SMD antenna is unique in the sense of complying with FCC §15.203, §15.204(b), and §15.204(c).

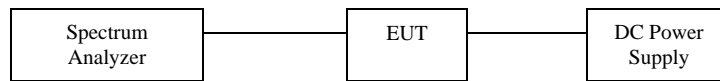


3.2 DTS Bandwidth

Performance Criterion: The minimum DTS bandwidth shall be at least 500 kHz.

Test Results: Complies

Test Details: Refers to the following block diagram, data table, and receiver screen captures. The EUT was tested in a continuous transmit mode at the maximum power level at the boost mode.

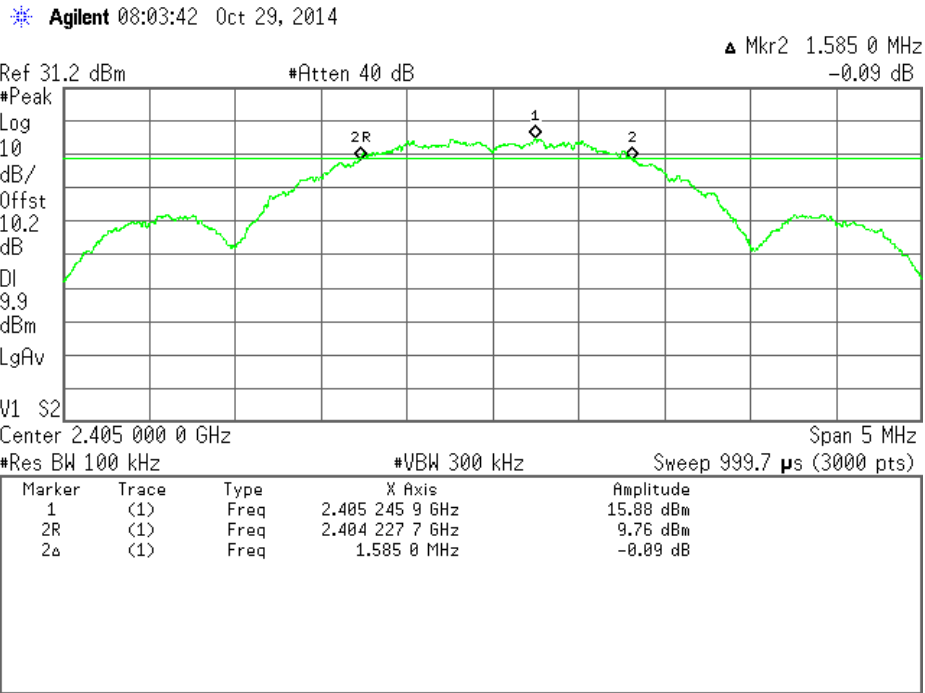


Channel	Frequency (MHz)	6 dB Bandwidth (kHz)
11	2405	1585
18	2440	1610
26	2480	1595

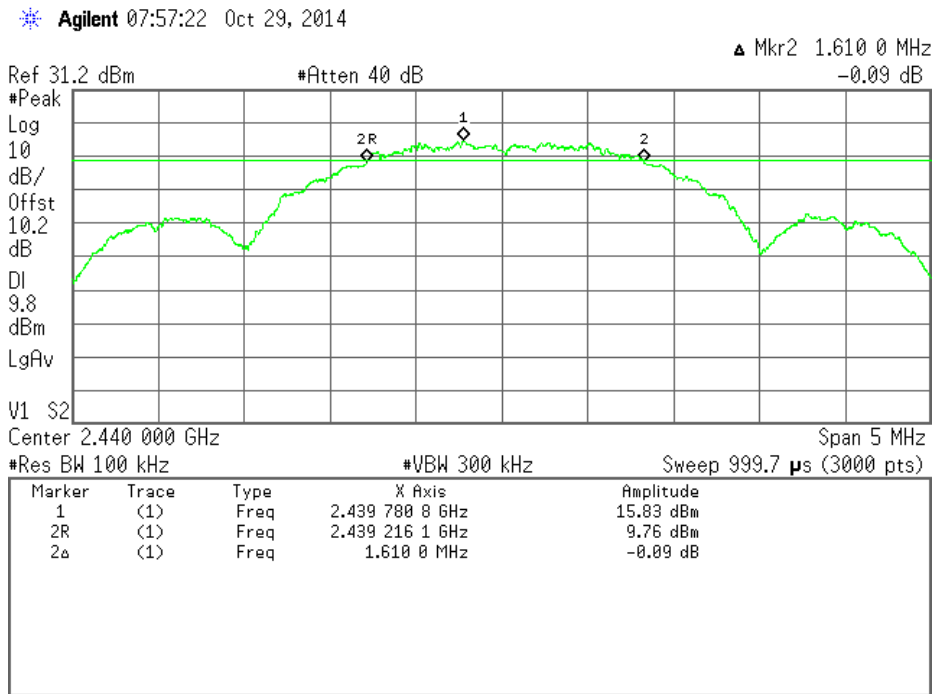
Note: The RF level in the plots is relative and is not the indication of RF output power.



DTS Bandwidth, Channel 11:



DTS Bandwidth, Channel 18:

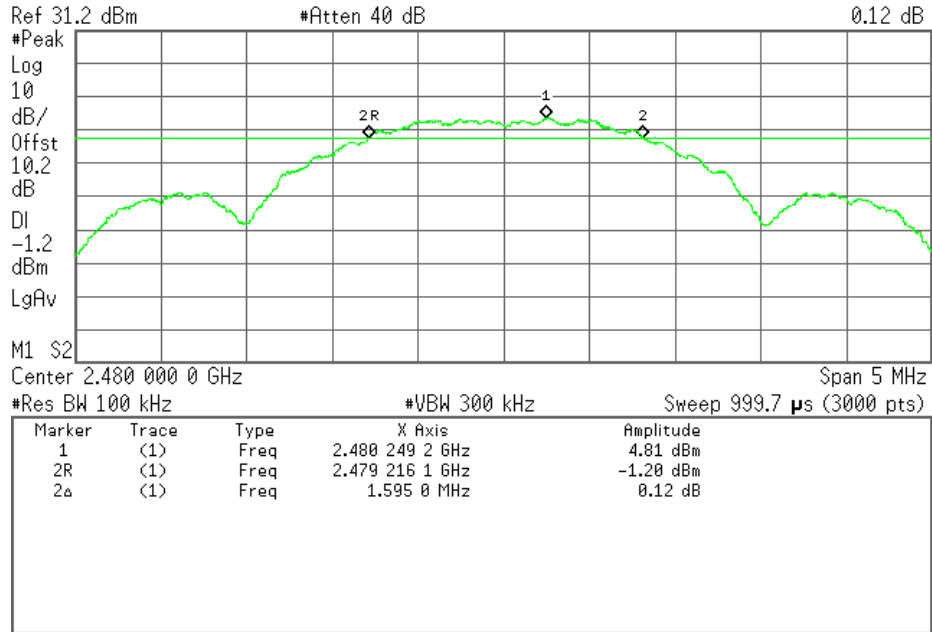




DTS Bandwidth, Channel 26:

Agilent 08:00:56 Oct 29, 2014

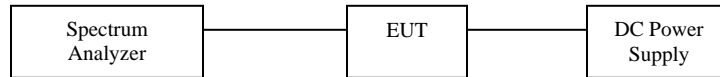
Mkr2 1.595 0 MHz
0.12 dB





3.3 99% Bandwidth

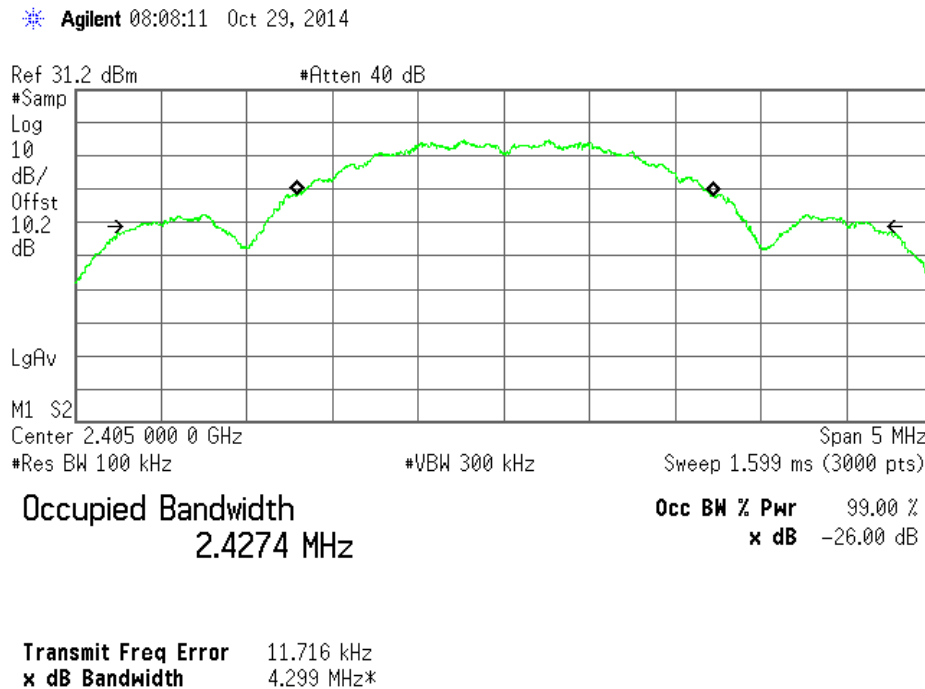
Test Details: Refers to the following block diagram, data table, and receiver screen captures. The EUT was tested in a continuous transmit mode at the maximum power level at the boost mode.



Channel	Frequency (MHz)	99% Bandwidth (MHz)
11	2405	2.427
18	2440	2.439
26	2480	2.415

Note: The RF level in the plots is relative and is not the indication of RF output power.

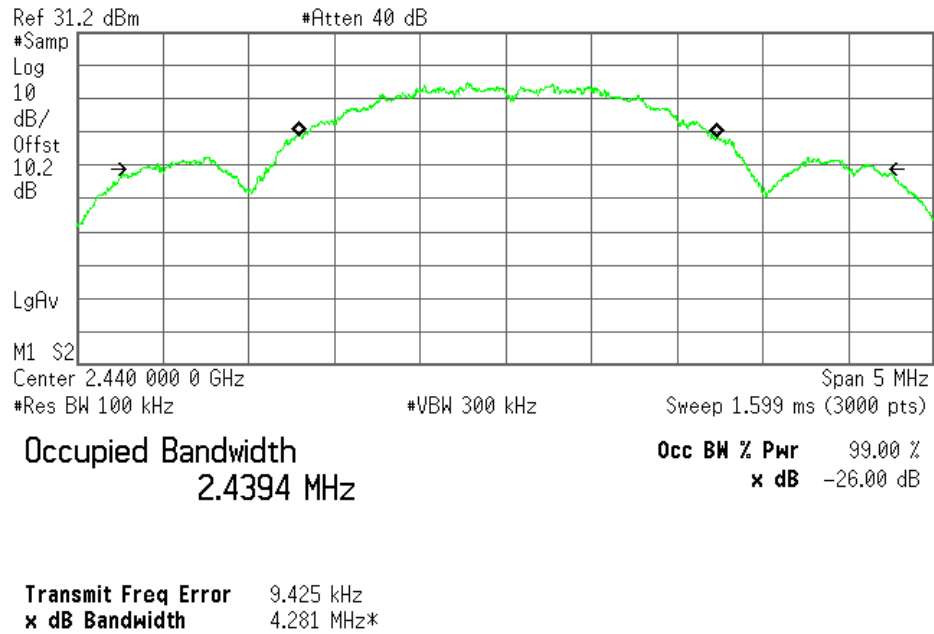
99% Bandwidth, Channel 11:





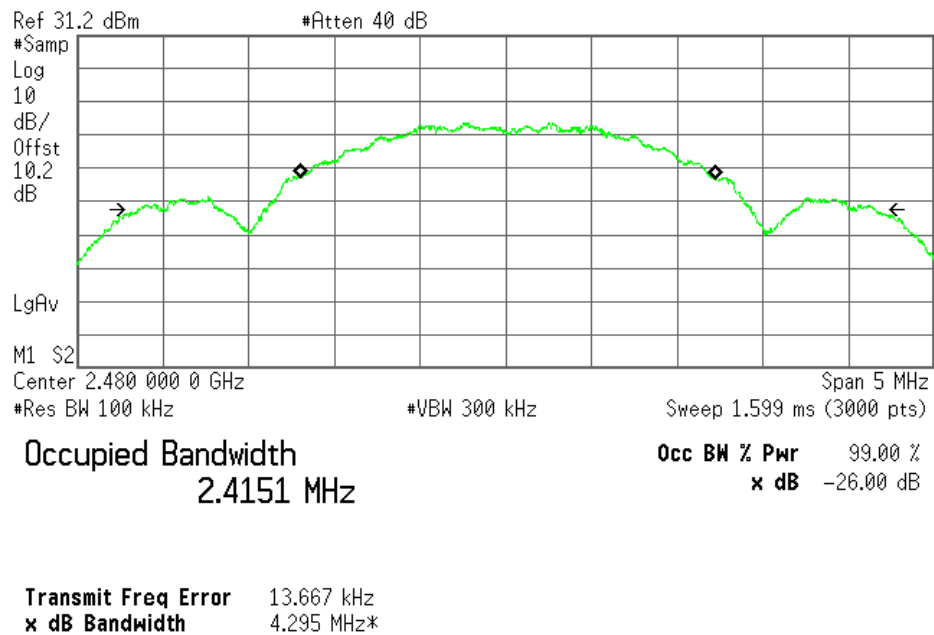
99% Bandwidth, Channel 18:

Agilent 08:12:53 Oct 29, 2014



99% Bandwidth, Channel 26:

Agilent 08:15:01 Oct 29, 2014



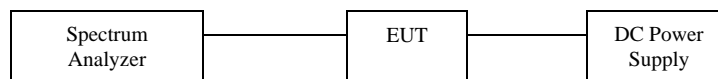


3.4 Power Output

Performance Criterion: The maximum peak conducted output power shall not exceed 1 Watt.

Test Results: Complies

Test Details: The EUT was tested in a continuous transmit mode with maximum power levels at the boost mode. Refers to the following block diagram, data table, and receiver screen captures.



FCC:

Channel	Frequency (MHz)	Power Level	Power	
			dBm	mW
11	2405	0	19.31	85.31
18	2440	0	19.34	85.90
26	2480	-e	8.31	6.78

Industry Canada:

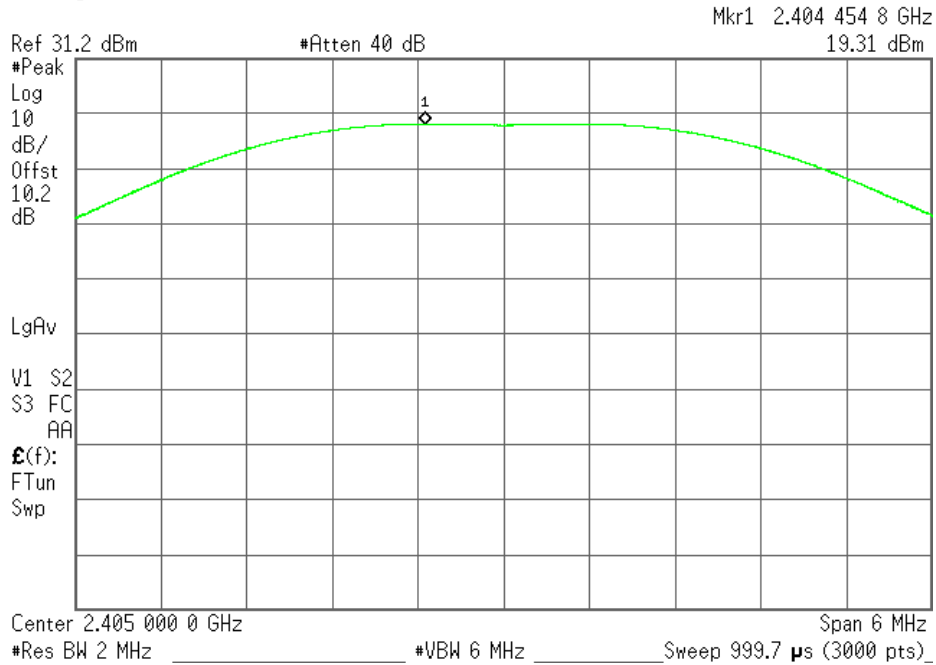
Channel	Frequency (MHz)	Power Level	Power	
			dBm	mW
11	2405	0	19.31	85.31
18	2440	0	19.38	86.70
26	2480	-e	8.31	6.78

Note: The insertion loss was compensated for in the instrument.



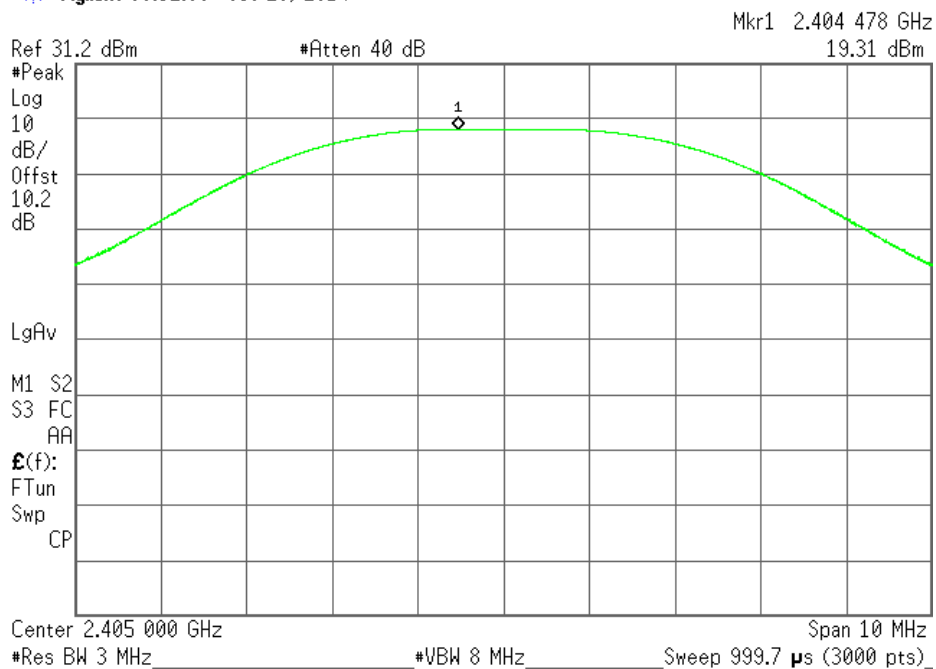
Power Output, Channel 11 (FCC):

Agilent 10:35:42 Oct 29, 2014



Power Output, Channel 11 (Industry Canada):

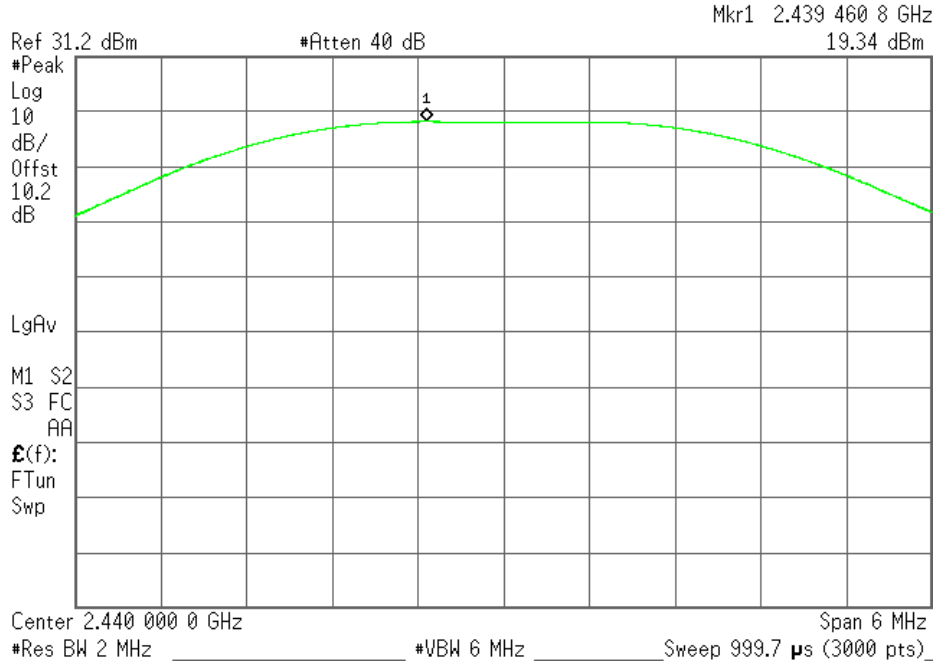
Agilent 08:32:06 Oct 29, 2014





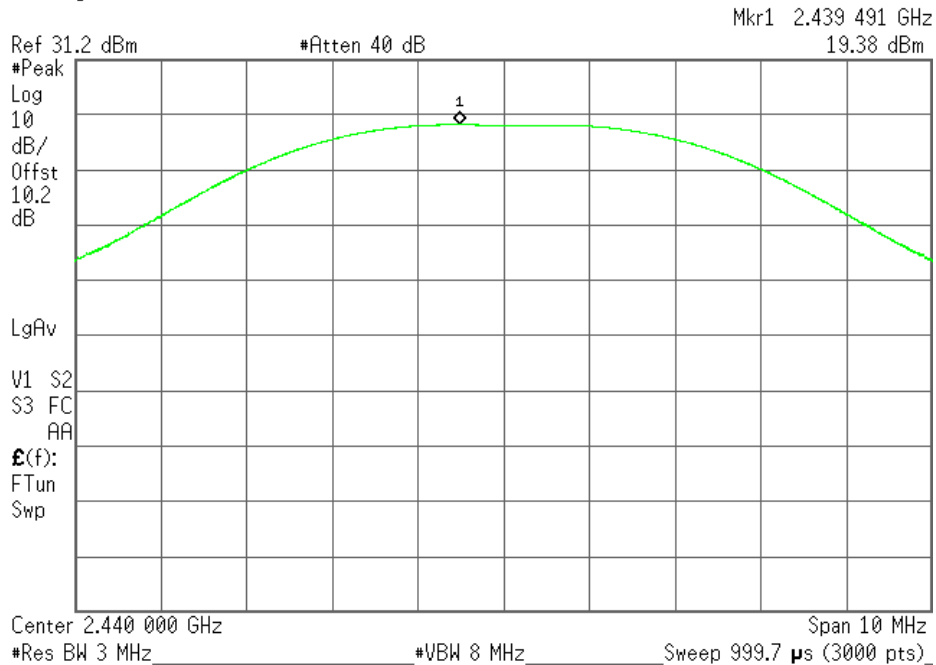
Power Output, Channel 18 (FCC):

Agilent 10:37:20 Oct 29, 2014



Power Output, Channel 18 (Industry Canada):

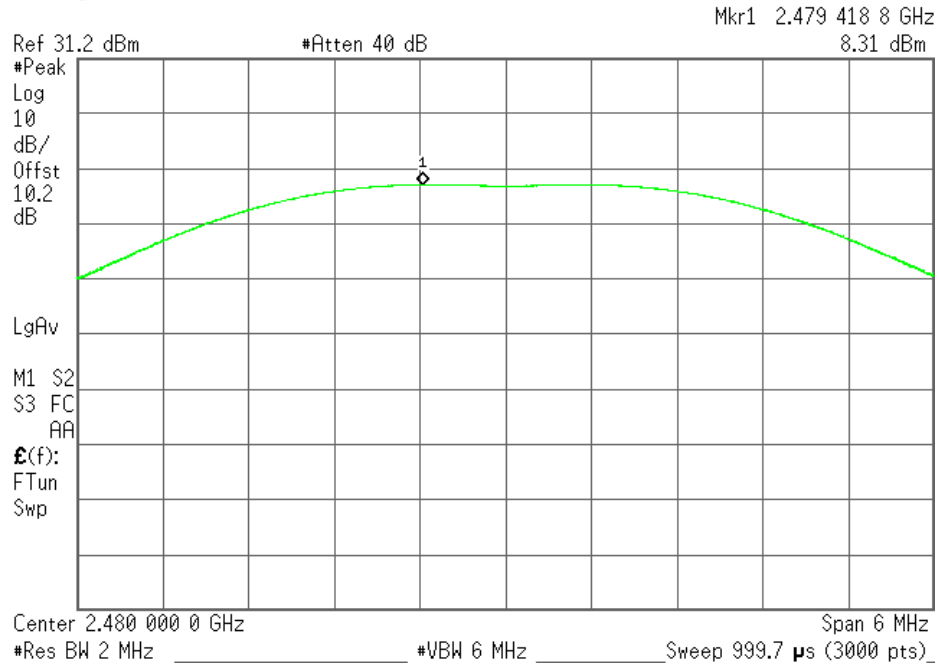
Agilent 08:29:42 Oct 29, 2014





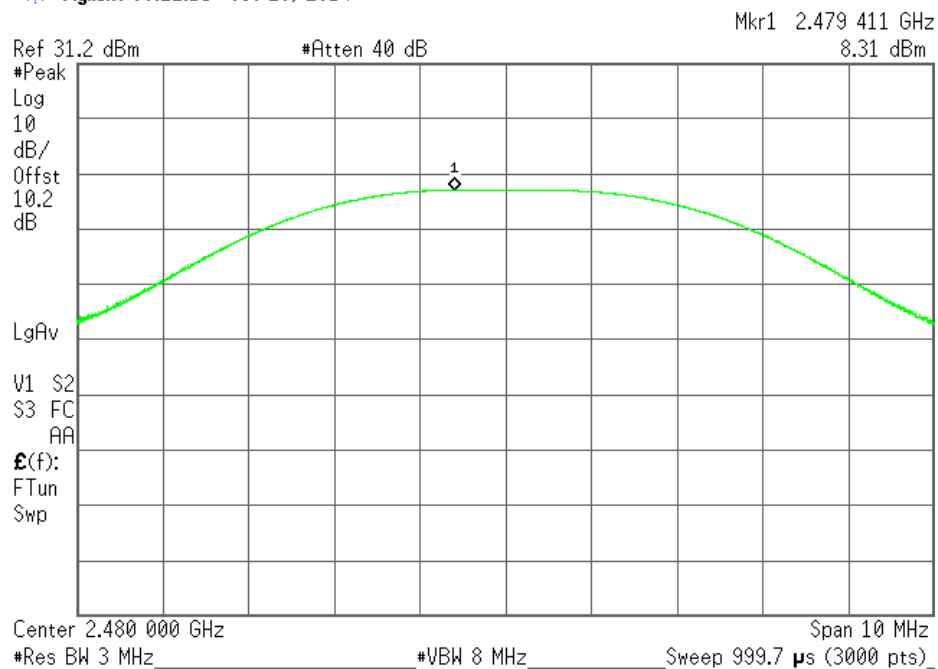
Power Output, Channel 26 (FCC):

Agilent 10:38:29 Oct 29, 2014



Power Output, Channel 26 (Industry Canada):

Agilent 08:22:15 Oct 29, 2014



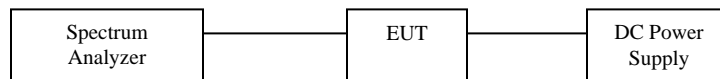


3.5 *Band Edge*

Performance Criterion: In any 100 kHz bandwidth outside the frequency band, the RF power shall be at least 20 dB below that in the 100 kHz bandwidth within the band.

Test Results: Complies

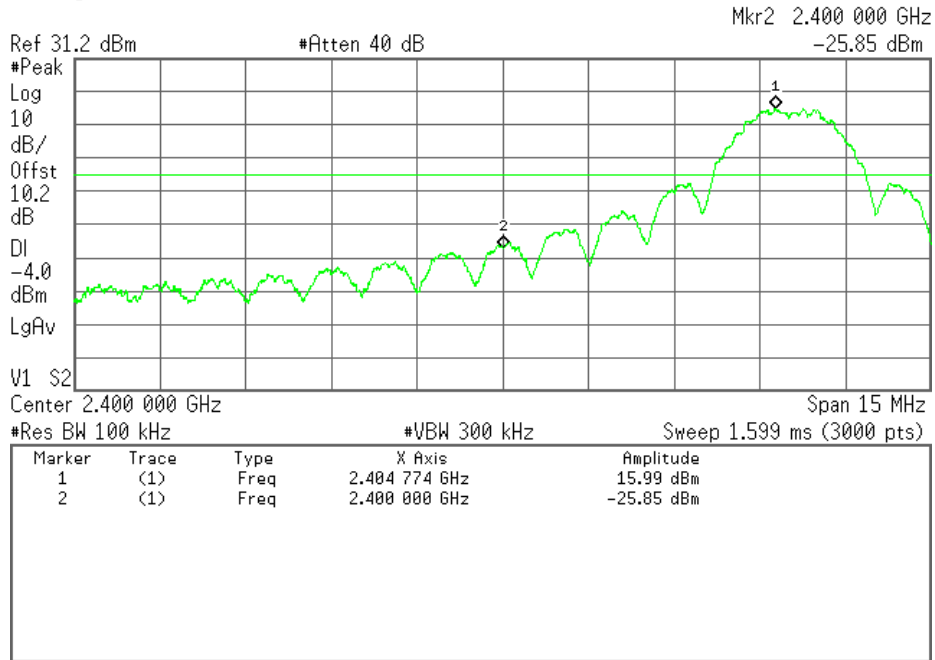
Test Details: Refers to the following block diagram and receiver screen captures



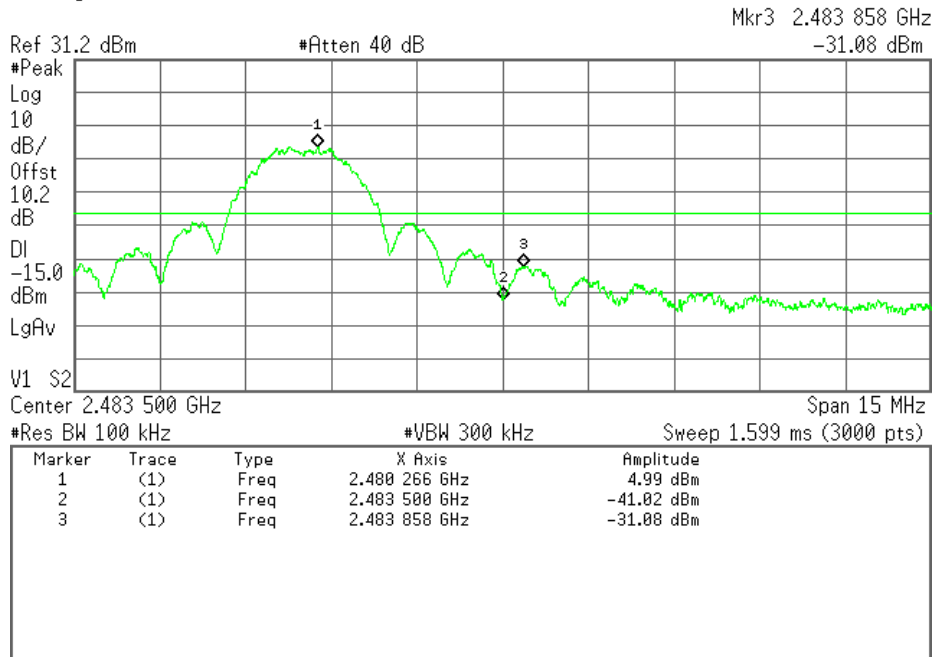


Band Edge:

Agilent 08:37:37 Oct 29, 2014



Agilent 08:45:59 Oct 29, 2014





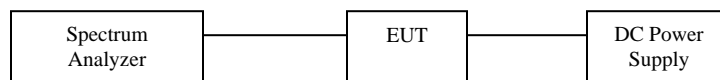
3.6 *Conducted Spurious Emissions*

Performance Criterion: In any 100 kHz bandwidth outside the frequency band, the radio frequency power shall be at least 20 dB below that in the 100 kHz bandwidth within the band.

Test Results: Complies

Test Details: Refers to the following block diagram and receiver screen captures

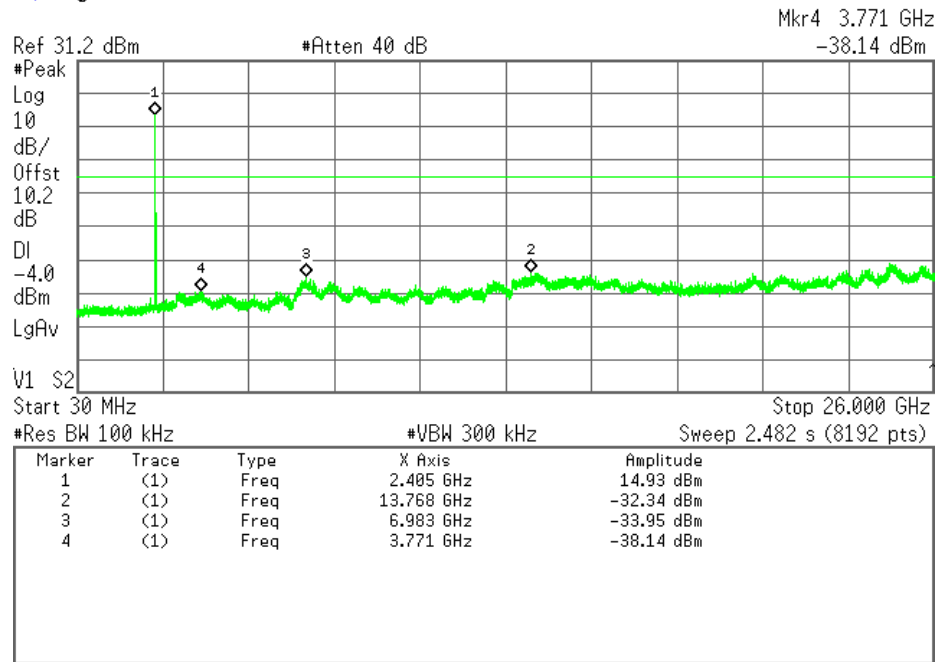
Note: The EUT was tested in a continuous transmit mode at the maximum power level at the boost mode. The RF level in the screen captures is relative and is not the indication of RF output power.





Conducted Spurious Emission – Channel 11

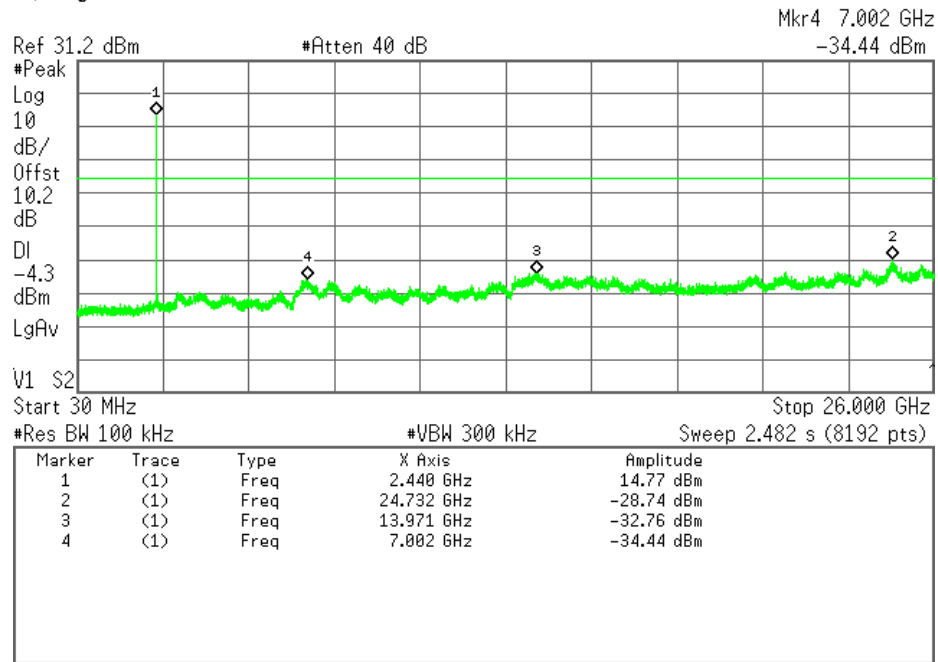
Agilent 09:09:33 Oct 29, 2014





Conducted Spurious Emission – Channel 18

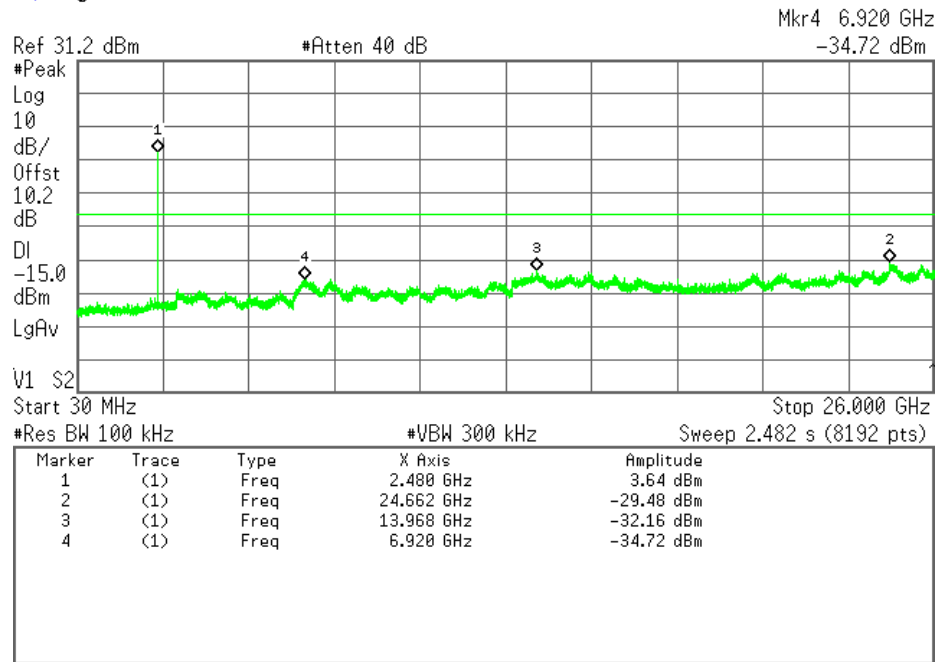
Agilent 09:06:31 Oct 29, 2014





Conducted Spurious Emission – Channel 26

Agilent 08:51:50 Oct 29, 2014



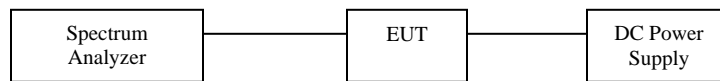


3.7 Power Spectral Density

Performance Criterion: The power spectral density shall not be greater than 8 dBm in any 3 kHz band.

Test Results: Complies

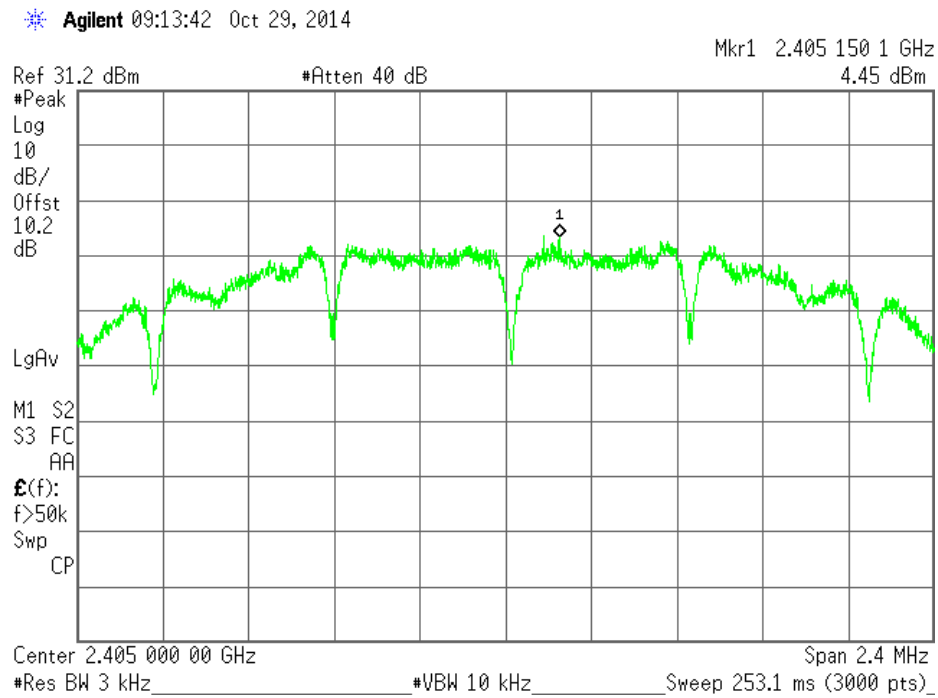
Test Details: The EUT was tested in a continuous transmit mode with maximum power levels. Refers to the following table and receiver screen captures. The insertion loss was compensated for in the instrument.



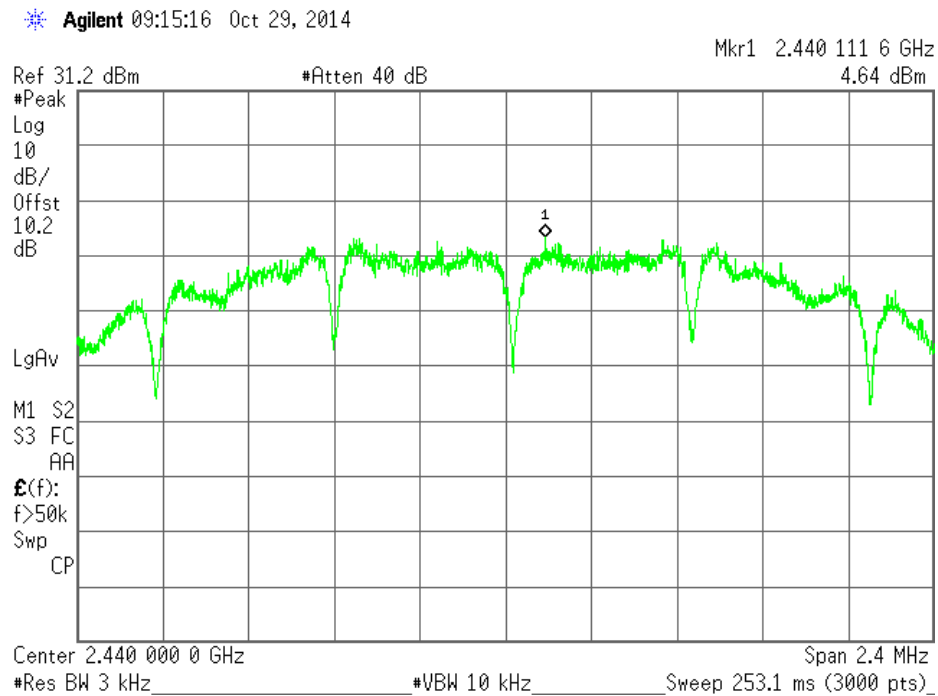
Channel	Frequency (MHz)	Power Spectral Density (dBm)
11	2405	4.45
18	2440	4.64
26	2480	-5.91



Power Spectral Density, Channel 11:



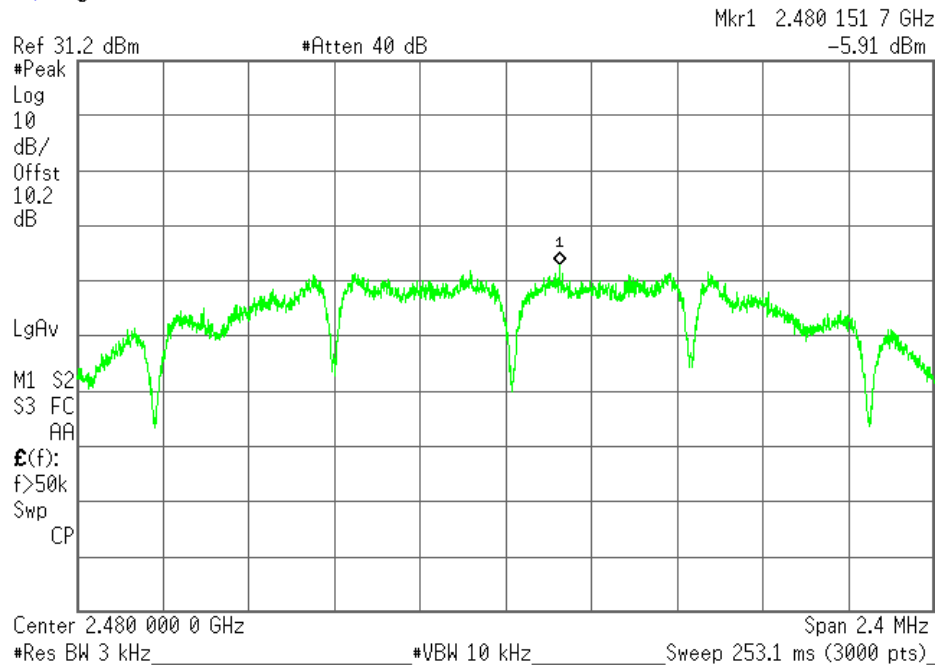
Power Spectral Density, Channel 18:





Power Spectral Density, Channel 26:

Agilent 09:17:08 Oct 29, 2014



3.8 Radiated Spurious Emissions

Performance Criterion: Radiated spurious emissions which fall in the restricted bands must comply with the radiated emission limits specified in FCC § 15.209(a) and Table 2 of IC RSS-Gen.

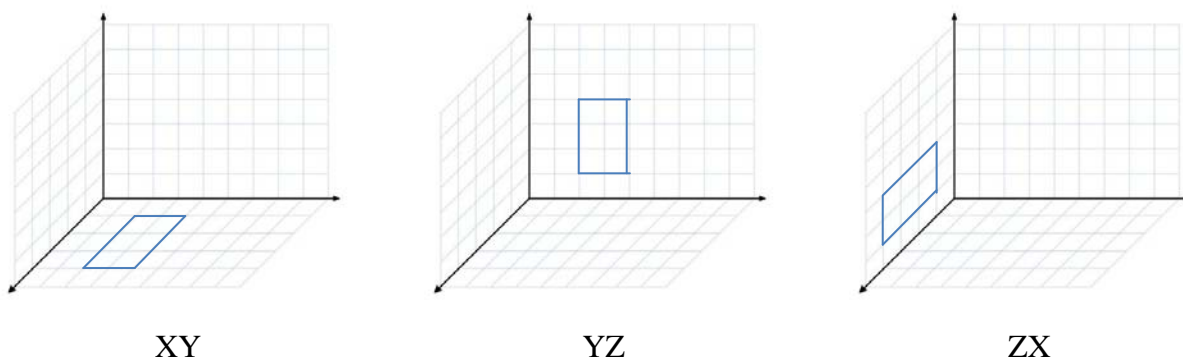
Test Results: Complies

Test Details: Radiated spurious emission was performed from 30 MHz to the tenth harmonics of the carrier. For each scan of radiated emission measurement, the procedures for maximizing emissions were followed. The EUT was rotated and antenna height was varied between 1 m and 4 m in order to maximize the emission. Measurements in both horizontal and vertical polarities were made and the data was recorded. All radiated emission measurements, up to 25 GHz, were performed at 3-meter distance between an antenna and the EUT. All radiated emission measurements, above 18 GHz, were performed at 0.3-meter distance between an antenna and the EUT.

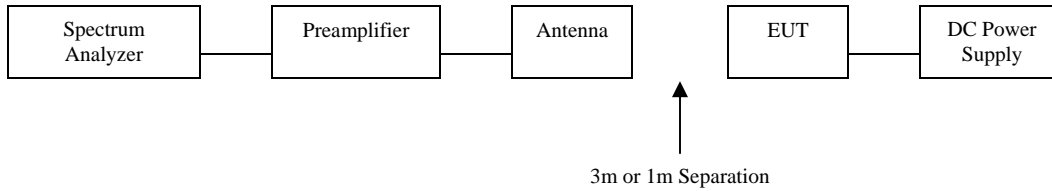
The peak level of radiated emissions above 1 GHz was measured with a resolution bandwidth (RBW) of 1 MHz and a video bandwidth (VBW) of 3 MHz.

For harmonics/spurs that fall in the restricted band, the radiated spurious emissions above 1 GHz were measured with RBW of 1 MHz, VBW of 10 Hz, and Sweep of Auto. The unit was configured for continuous operation.

EUT was tested in three orthogonal orientations (XY, YZ, and ZX planes). Worst-case data taken in XY orientation were recorded.



Refers to the following block diagram and data table for test data. Antenna factor, cable loss, and preamplifier gain were compensated for in the instrument. Calculation of duty cycle correction factor is included in the Theory of Operation.



CWDHR Radiated Spurious Emissions, Boost Mode, Internal Antenna, PA07424												
Antenna Polarization	Frequency (MHz)	Channel No.	Power Setting (Level)	EUT Orientation	Measured Data (dBuV/m)	Duty Cycle Correction Factor (dB)	Corrected Data	Limit (dBuV/m)	Margin (dB)	Antenna Height (cm)	Turntable Degree	Detector
H	2390	11	0	XY	52.2	20	32.20	54	21.80	*	*	AVE
H	2390	11	0	XY	59.48	0	59.48	74	14.52	*	*	PK
H	4810	11	0	XY	46.28	20	26.28	54	27.72	98.0	268.0	AVE
H	4810	11	0	XY	53.03	0	53.03	74	20.97	98.0	268.0	PK
V	12025	11	0	XY	58.43	20	38.43	54	15.57	202.0	201.0	AVE
V	12025	11	0	XY	64.04	0	64.04	74	9.96	202.0	201.0	PK
V	4880	18	0	XY	40.11	20	20.11	54	33.89	138.0	367.0	AVE
V	4880	18	0	XY	48.91	0	48.91	74	25.09	138.0	367.0	PK
H	7320	18	0	XY	51.83	20	31.83	54	22.17	159.0	346.0	AVE
H	7320	18	0	XY	58.00	0	58.00	74	16.00	159.0	346.0	PK
V	12200	18	0	XY	60.74	20	40.74	54	13.26	106.0	305.0	AVE
V	12200	18	0	XY	65.96	0	65.96	74	8.04	106.0	305.0	PK
H	2483.5	26	-e	XY	67.09	20	47.09	54	6.91	*	*	AVE
H	2483.5	26	-e	XY	73.58	0	73.58	74	0.42	*	*	PK
H	2483.5	25	0	XY	62.58	20	42.58	54	11.42	*	*	AVE
H	2483.5	25	0	XY	69.68	0	69.68	74	4.32	*	*	PK
H	4960	26	-e	XY	33.51	20	13.51	54	40.49	176.0	200.0	AVE
H	4960	26	-e	XY	45.93	0	45.93	74	28.07	176.0	200.0	PK
H	7440	26	-e	XY	34.78	20	14.78	54	39.22	230.0	192.0	AVE
H	7440	26	-e	XY	46.88	0	46.88	74	27.12	230.0	192.0	PK
H	12400	26	-e	XY	35.25	20	15.25	54	38.75	193.0	320.0	AVE
H	12400	26	-e	XY	47.09	0	47.09	74	26.91	193.0	320.0	PK

*: based on full maximization search of height and azimuth

Date of Test: October 28, 2014

Tested by: Christopher Locke of UL LLC

CWDHR Radiated Spurious Emissions, Boost Mode, Internal Antenna, PA07414												
Antenna Polarization	Frequency (MHz)	Channel No.	Power Setting (Level)	EUT Orientation	Measured Data (dBuV/m)	Duty Cycle Correction Factor (dB)	Corrected Data	Limit (dBuV/m)	Margin (dB)	Antenna Height (cm)	Turntable Degree	Detector
H	2390	11	0	XY	47.57	20	27.57	54	26.43	*	*	AVE
H	2390	11	0	XY	56.42	0	56.42	74	17.58	*	*	PK
V	4810	11	0	XY	36.72	20	16.72	54	37.28	98.0	285.0	AVE
V	4810	11	0	XY	47.04	0	47.04	74	26.96	98.0	285.0	PK
V	12025	11	0	XY	46.56	20	26.56	54	27.44	100.0	242.0	AVE
V	12025	11	0	XY	55.10	0	55.10	74	18.90	100.0	242.0	PK
H	4880	18	0	XY	32.53	20	12.53	54	41.47	54.0	373.0	AVE
H	4880	18	0	XY	44.44	0	44.44	74	29.56	54.0	373.0	PK
H	7320	18	0	XY	38.75	20	18.75	54	35.25	221.0	198.0	AVE
H	7320	18	0	XY	49.37	0	49.37	74	24.63	221.0	198.0	PK
V	12200	18	0	XY	57.72	20	37.72	54	16.28	104.0	289.0	AVE
V	12200	18	0	XY	63.29	0	63.29	74	10.71	104.0	289.0	PK
H	2483.5	26	-e	XY	66.19	20	46.19	54	7.81	*	*	AVE
H	2483.5	26	-e	XY	72.87	0	72.87	74	1.13	*	*	PK
H	2483.5	25	0	XY	59.58	20	39.58	54	14.42	*	*	AVE
H	2483.5	25	0	XY	66.64	0	66.64	74	7.36	*	*	PK
V	4960	26	-e	XY	32.38	20	12.38	54	41.62	187.0	352.0	AVE
V	4960	26	-e	XY	44.25	0	44.25	74	29.75	187.0	352.0	PK
H	7440	26	-e	XY	34.84	20	14.84	54	39.16	288.0	138.0	AVE
H	7440	26	-e	XY	46.79	0	46.79	74	27.21	288.0	138.0	PK
V	12400	26	-e	XY	35.41	20	15.41	54	38.59	82.0	274.0	AVE
V	12400	26	-e	XY	47.81	0	47.81	74	26.19	82.0	274.0	PK

*: based on full maximization search of height and azimuth

Date of Test: October 28, 2014

Tested by: Ray Mayer of UL LLC



3.9 *Transmitter AC Power Line Conducted Emissions*

Performance Criterion: AC power line conducted emissions shall not exceed the limits specified in FCC § 15.207 and Table 4 of IC RSS-Gen.

Test Results: Not Applicable. EUT is battery powered.