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TESTING CERT #1255.01

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ENGINEERING TEST REPORT # 314318
LSR Job #: C-2052

Compliance Testing of:
ColorTouch

Test Date(s):
November 14th, December 1st-4th, 2014

Prepared For:
Venstar USA
Attn: Steve Dushane
9250 Owensmouth Avenue
Chatsworth, CA 91311

This Test Report is issued under the Authority of: Shane D. Rismeyer, EMC Engineer

Signature:  Date: 1/27/15

Test Report Reviewed by:
Peter Feilen, EMC Engineer

Signature:  Date: 1/26/15

Report by:
Shane D. Rismeyer, EMC Engineer

Signature:  Date: 1/25/15

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LS Research, LLC in Review

As an EMC Testing Laboratory, our Accreditation and Assessments are recognized through the following:



TESTING CERT #1255.01

A2LA – American Association for Laboratory Accreditation

Accreditation based on ISO/IEC 17025: 2005 with Electrical (EMC) Scope of Accreditation

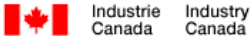
A2LA Certificate Number: 1255.01



Federal Communications Commission (FCC) – USA

Listing of 3 Meter Semi-Anechoic Chamber based on Title 47 CFR – Part 2.948

FCC Registration Number: 90756



Canada

Industry Canada

On file, 3 Meter Semi-Anechoic Chamber based on RSS-212 – Issue 1

File Number: IC 3088-A

On file, 3 and 10 Meter OATS based on RSS-212 – Issue 1

File Number: IC 3088



U. S. Conformity Assessment Body (CAB) Validation

Validated by the European Commission as a U. S. Competent Body operating under the U. S./EU, Mutual Recognition Agreement (MRA) operating under the European Union Electromagnetic Compatibility – Council Directive 2004/108/EC (formerly 89/336/EEC, Article 10.2).

Date of Validation: January 16, 2001

Validated by the European Commission as a U.S. Notified Body operating under the U.S. /EU, Mutual Recognition Agreement (MRA) operating under the European Union Telecommunication Equipment – Council Directive 99/5/EC, Annex V.

Date of Validation: November 20, 2002

Notified Body Identification Number: 1243

Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052

1.0 Summary of Test Report

In November-December 2014 the EUT, Color Touch Thermostat, was tested and MEETS the following requirements:

FCC and IC Paragraph	Test Requirements	Compliance (Yes/No)
FCC:15.247 (a)(2) IC: RSS 210 A8.2 (a)	6 dB Bandwidth of a Digital Modulation System	Yes
FCC : 15.247(b) & 1.1310 IC : RSS 210 A8.4	Maximum Output Power	Yes
FCC:15.247 (d) IC: RSS 210 A8.2 (b)	Power Spectral Density of a Digital Modulation System	Yes
FCC :15.247(d) IC : RSS 210 A8.5	RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
FCC : 15.247(c), 15.209 & 15.205 IC : RSS 210 A8.2(b), section 2.2, 2.6 and 2.7	Transmitter Radiated Emissions	Yes
FCC : 15.109 IC : RSS GEN	Receive Mode (Digital Device) Radiated Emissions	Yes
FCC : 2.1055 (d)	Frequency Stability	Yes
FCC : 15.207 IC : RSS GEN sect. 7.2.2	Power Line Conducted Emissions Measurements	Yes

2.0 Test Facilities

All testing was performed at:

LS Research, LLC
W66 N220 Commerce Court
Cedarburg, Wisconsin, 53012 USA

LS Research, LLC is accredited by A2LA (American Association for Laboratory Accreditation) to the requirements of ISO/IEC 17025, 2005 “General Requirements for the Competence of Calibration and Testing Laboratories”.

LS Research, LLC’s scope of accreditation includes all test methods listed herein, unless otherwise noted.

Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052

3.0 Client Information

Manufacturer Name:	Venstar USA
Address:	9250 Owensmouth Avenue Chatsworth, CA 91311
Contact Person:	Steve Dushane

3.1 Equipment Under Test (EUT) Information

The following information has been supplied by the applicant.

Product Name:	ColorTouch
Model Number:	T8850 T8900 T7850 T7900 THERM-500 THERM-500B
Serial Number:	Eng. Sample
FCC ID	MUH-SKYPORT2
IC Number	12547A-SKYPORT2

3.2 Product Description

Color Touch thermostat is a controller used with HVAC system to regulate temperature and/or humidity. This thermostat incorporates an on-board Wi-Fi transceiver, which allows the user to observe temperature and humidity information using a remote device.

3.3 Modifications Incorporated In the EUT for Compliance Purposes

None noted at time of test

3.4 Deviations & Exclusions from Test Specifications

None noted at time of test

3.5 Additional Information

Low Channel 1(2412 MHz), Middle Channel 6 (2437 MHz), High Channel 11 (2462 MHz). EUT programmed for continuous transmit or receive on selectable channel and data rate (modulation) using the touchscreen interface.

Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
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4.0 Conditions of Test

Environmental:

Temperature: 20-25° C
Relative Humidity: 30-60%
Atmospheric Pressure: 86-106 kPa

Voltage: 24VAC 60Hz

5.0 Test Equipment

All test equipment is calibrated by a calibration laboratory accredited by A2LA to the requirements of ISO 17025. For a complete list of test equipment and calibration dates, see Appendix A. Unless otherwise noted, resolution bandwidth of measuring instrument used during testing for given frequency range, see below.

Frequency Range	Resolution Bandwidth
9 kHz – 150 kHz	200 Hz
150 kHz – 30 MHz	9 kHz
30 MHz – 1000 MHz	120 kHz
Above 1000 MHz	1 MHz

6.0 Conformance Summary

The EUT was found to MEET the requirements as described within the specification of FCC Title 47, CFR Part 15.247, 15.109, Industry Canada RSS-210, Issue 8 (2010), Annex 8, RSS-GEN Issue 4 (2014).

If some emissions are seen to be within 3 dB of their respective limits:

As these levels are within the tolerances of the test equipment and site employed, there is a possibility that this unit, or a similar unit selected out of production may not meet the required limit specification if tested by another agency.

LS Research, LLC certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specifications. The results in this Test Report apply only to the item(s) tested on the above-specified dates. Any modifications made to the EUT subsequent to the indicated test date(s) will invalidate the data herein, and void this certification.

Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052

Appendix A – Test Equipment



Date : 30-Sep-2014

Type Test : Emissions

Job # : C-2052

Prepared By: Shane Rismeyer

Customer : Venstar USA

Quote #: 314318

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	10/19/14	10/19/15	Active Calibration
2	EE 960088	9GHz MXE Spectrum Analyzer	Agilent	N9038A	MY51210138	1/9/15	1/9/16	Active Calibration
3	AA 960078	Log Periodic Antenna	EMCO	93146	9701-4855	1/8/14	1/8/15	Active Calibration
4	AA 960150	Biconical Antenna	ETS	3110B	0003-3346	1/8/14	1/8/15	Active Calibration
5	EE 960146	Std. Gain Horn Ant. w/preamp	Adv. Micro / EMCO	WL622-4 / 3160-09	123001	8/20/14	8/20/15	Active Calibration
6	AA 960137	Standard Gain Horn Ant.	EMCO	3160-10	69259	8/20/14	8/20/15	Active Calibration
7	AA 960158	Double Ridge Horn Antenna	ETS Lindgren	3117	109300	6/20/14	6/20/15	Active Calibration
8	EE 960159	0.8 - 21GHz LNA	Mini-Circuits	ZVA-213X-S+	749411007	6/20/14	6/20/15	Active Calibration
9	AA 960161	Highpass Filter	K&L Microwave	11SH10-8000	2	1/14/14	1/14/15	Active Calibration
10	EE 960084	LISN - 15A	COM-POWER	LJ-215A	191920	5/2/14	5/2/15	Active Calibration

Project Engineer:

Quality Assurance:

Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052

Appendix B – Test Data

B.1 – RF Conducted Emissions

Manufacturer	Venstar
Test Location	LS Research, LLC
Rule Part	FCC Part 15.247 / RSS-210 Annex 8
General Measurement Procedure	FCC KDB 558074 D01 DTS Meas Guidance v03r02 ANSI C63.10-2009 Section 6.7
General Description of Measurement	A direct measurement of the transmitted signal was performed at the antenna port of the EUT via a cable connection to a spectrum analyzer. An attenuator was placed in series with the cable to protect the spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings there by allowing direct measurements, without the need for any further corrections. The EUT was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source.

Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052

B.1.1 – RF Conducted – Fundamental Bandwidth

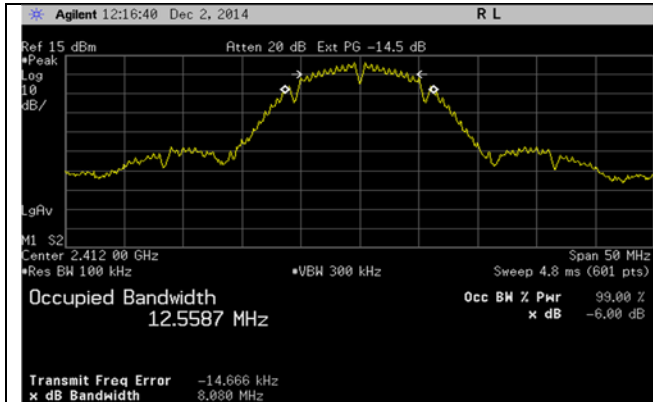
Manufacturer	Venstar
Date	12/2/14
Operator	Shane Rismeyer
Temp. / R.H.	20 - 25° C / 30 - 60% R.H.
Rule Part	FCC Part 15.247 / RSS-210 A8
Specific Measurement Procedure	FCC KDB 558074 Section 8.0 DTS bandwidth ANSI C63.10-2009 Section 6.9 RSS-GEN Section 4.6
Additional Description of Measurement	Peak detector used
Additional Notes	Continuous transmit modulated used for this test.

Table

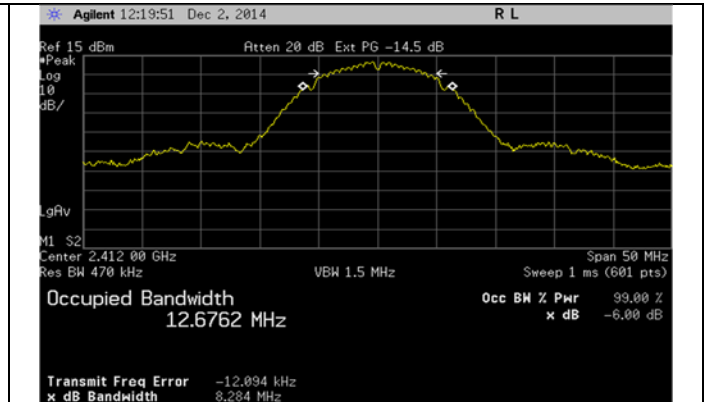
Mode (802.11)	Mode (Mbps)	Frequency (MHz)	99% BW (MHz)	6 dB DTS BW (MHz)
b	1	2412	12.68	8.08
		2437	12.58	8.04
		2462	12.54	8.11
	11	2412	12.30	7.85
		2437	12.23	7.13
		2462	12.28	7.81
g	6	2412	16.47	15.19
		2437	16.51	15.21
		2462	16.43	15.26
	12	2412	16.44	15.51
		2437	16.53	15.80
		2462	16.48	15.46
n	6.5	2412	17.49	15.23
		2437	17.51	15.15
		2462	17.51	15.23
	65	2412	17.54	16.38
		2437	17.54	16.30
		2462	17.53	16.07

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Plots 802.11b – 1 Mbps
Low Channel – 2412 MHz

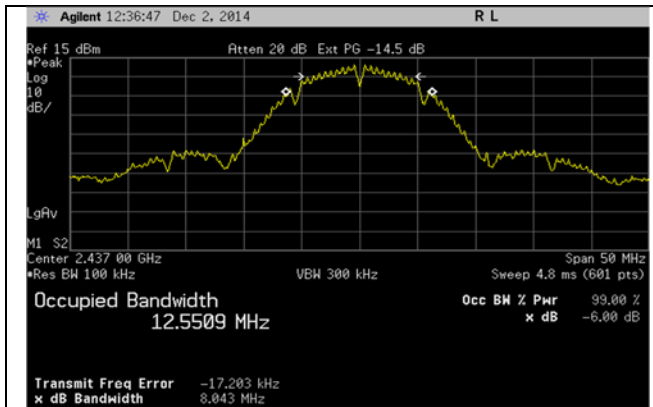


6 dB DTS BW

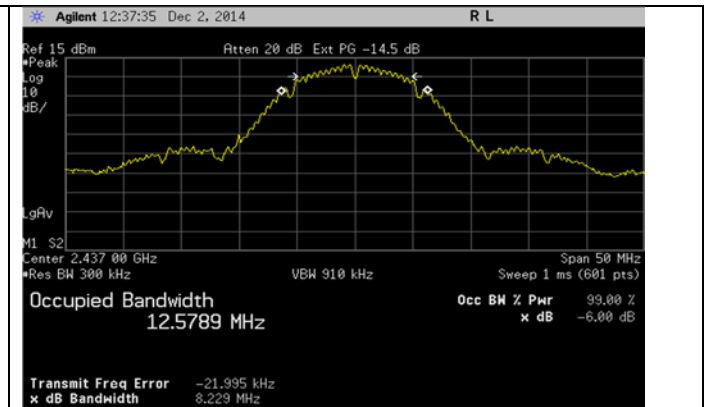


99% BW

Mid Channel – 2437 MHz

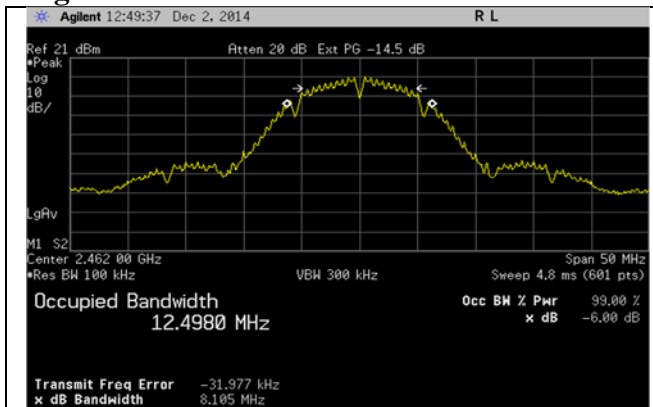


6 dB DTS BW

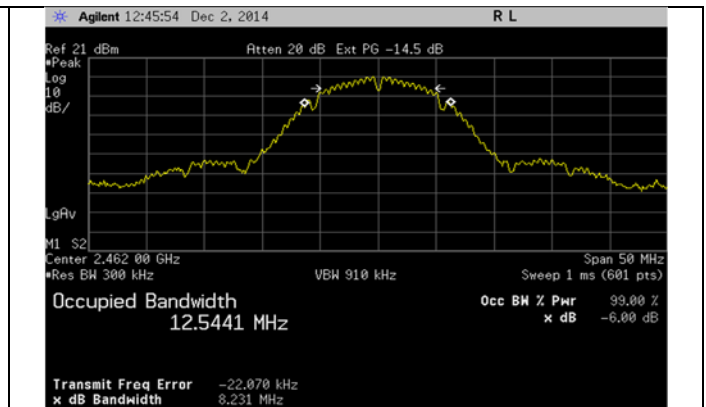


99% BW

High Channel – 2462 MHz



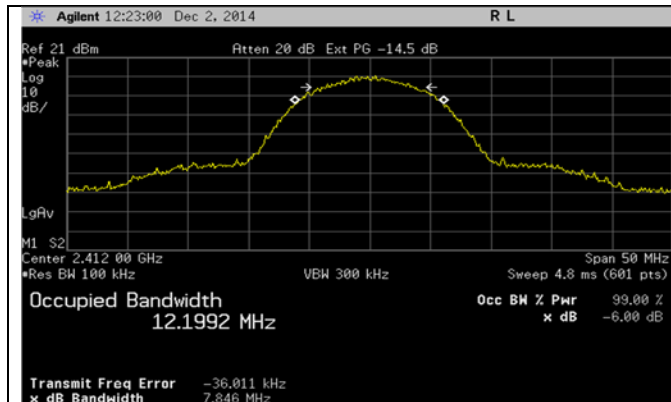
6 dB DTS BW



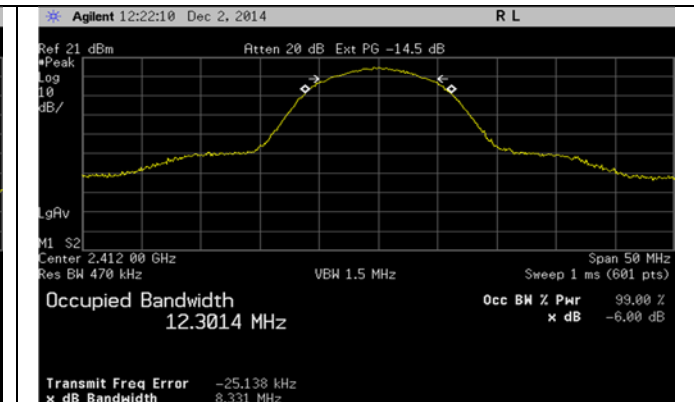
99% BW

Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052

802.11b – 11 Mbps
Low Channel – 2412 MHz

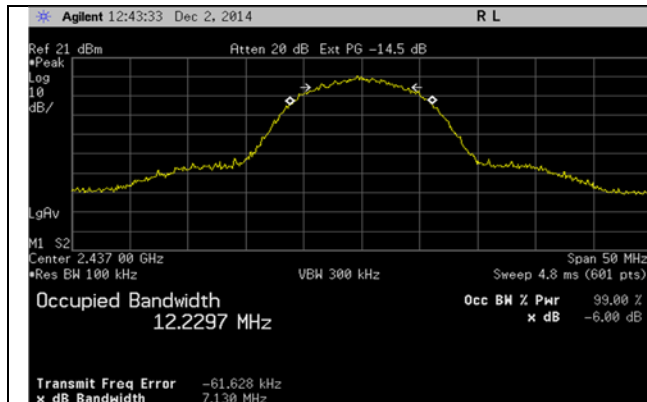


6 dB DTS BW

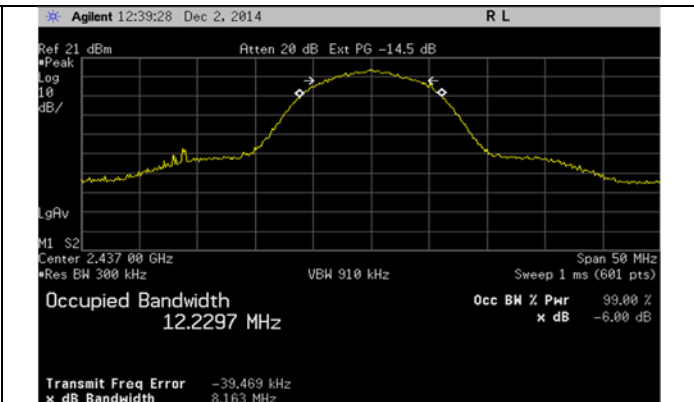


99% BW

Mid Channel – 2437 MHz

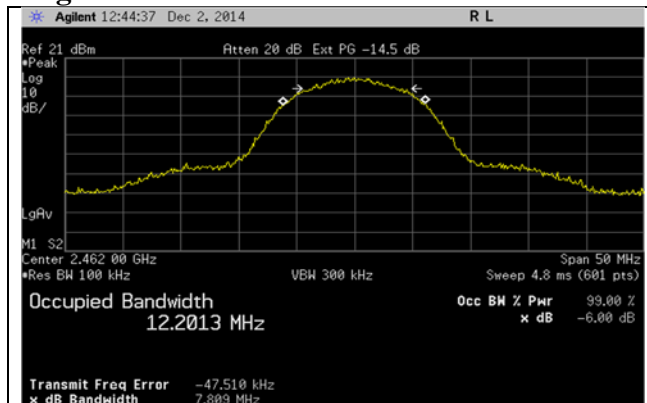


6 dB DTS BW

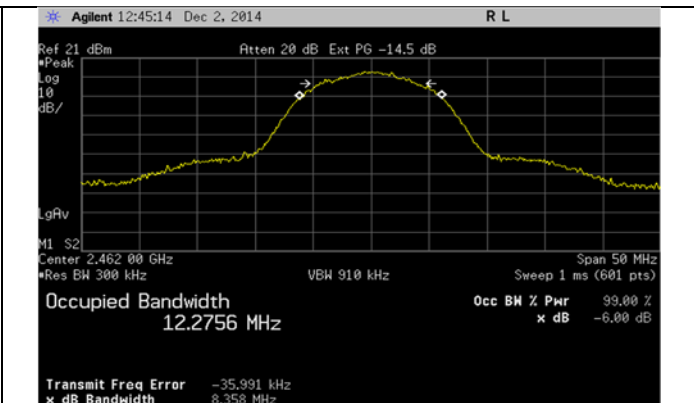


99% BW

High Channel – 2462 MHz



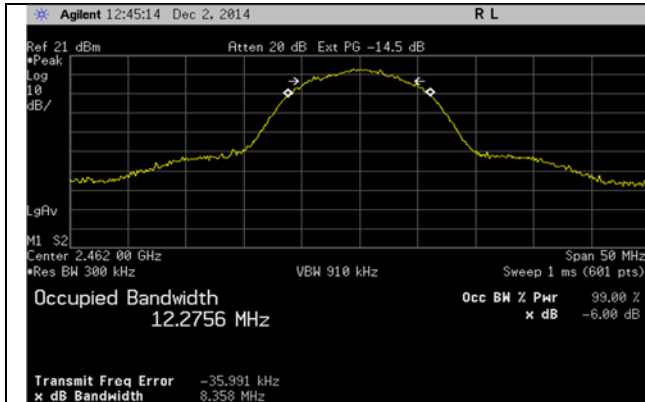
6 dB DTS BW



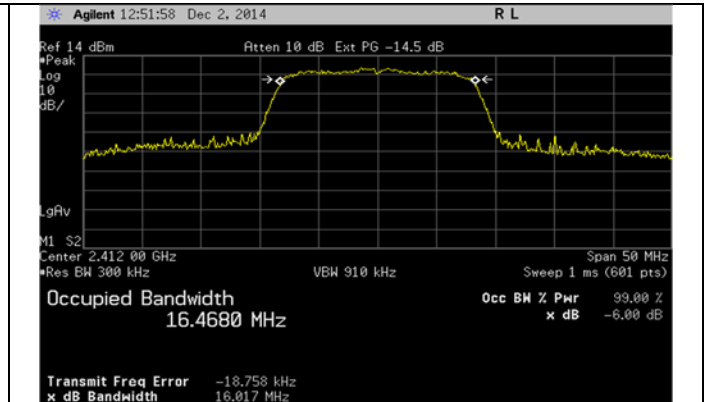
99% BW

Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052

802.11g – 6 Mbps
Low Channel – 2412 MHz

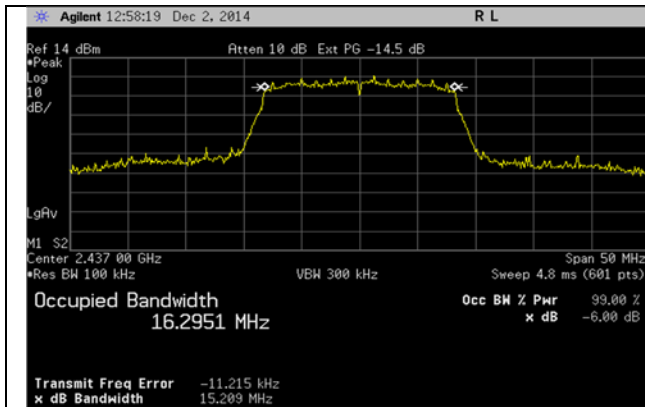


6 dB DTS BW

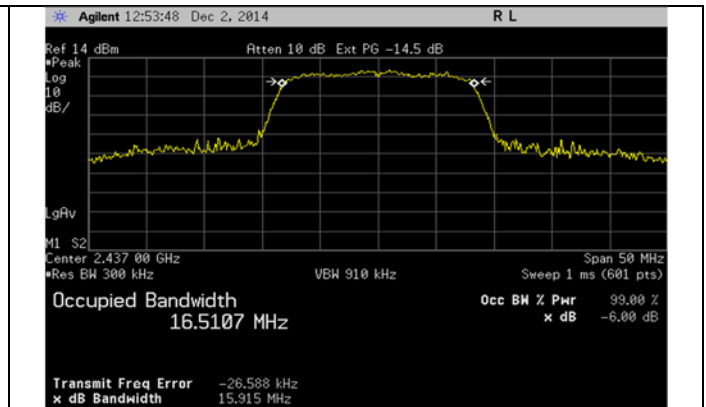


99% BW

Mid Channel – 2437 MHz

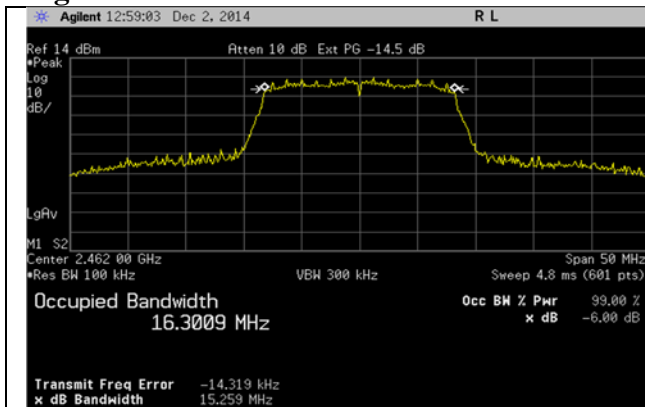


6 dB DTS BW

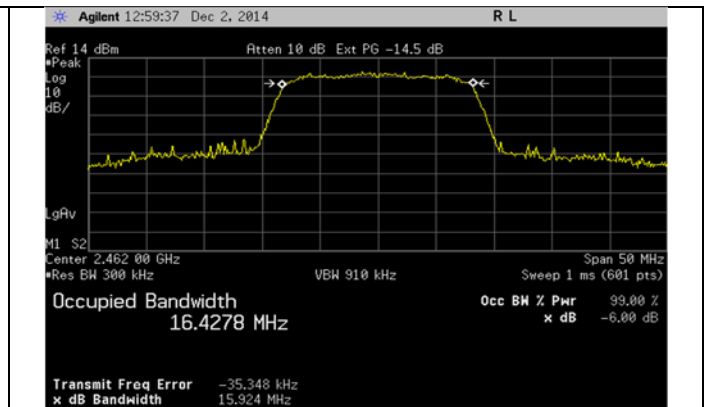


99% BW

High Channel – 2462 MHz



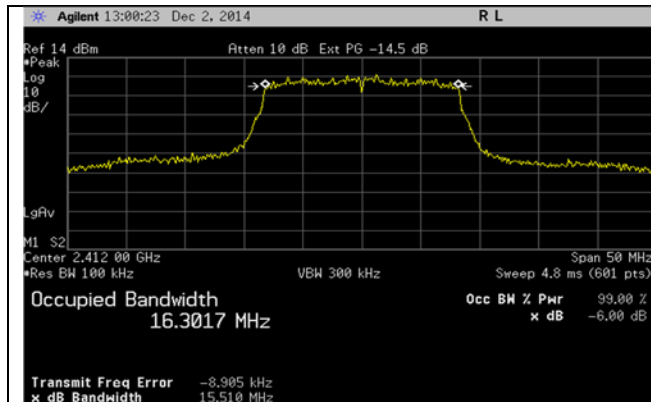
6 dB DTS BW



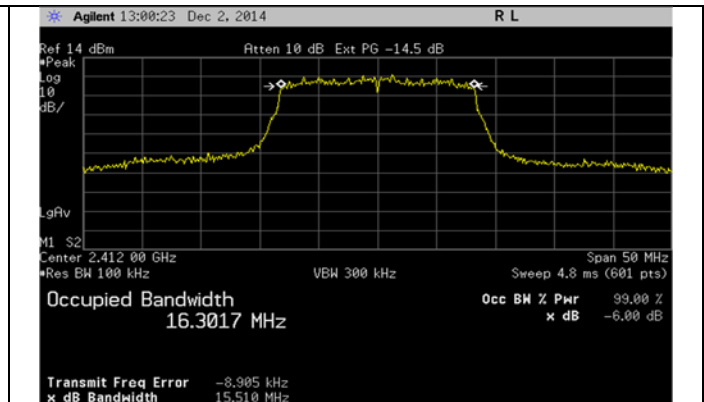
99% BW

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802.11g – 54 Mbps Low Channel – 2412 MHz

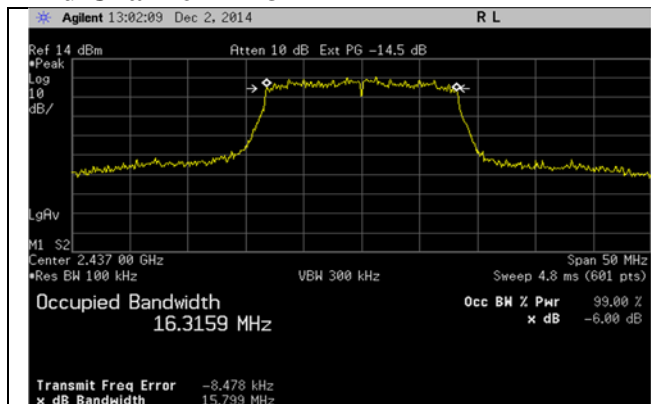


6 dB DTS BW

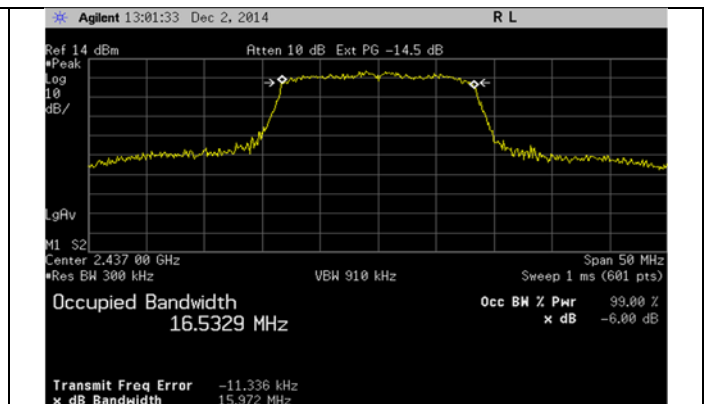


99% BW

Mid Channel – 2437 MHz

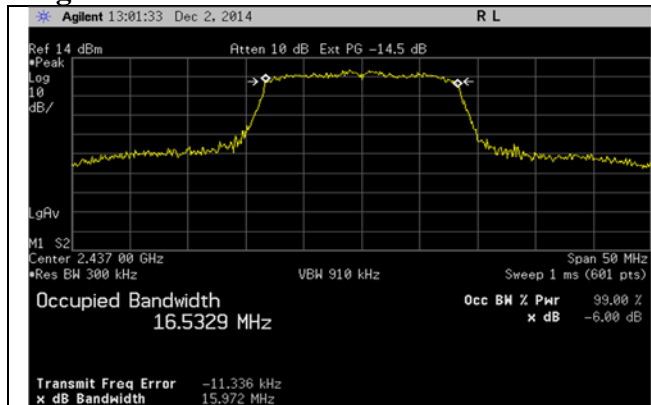


6 dB DTS BW

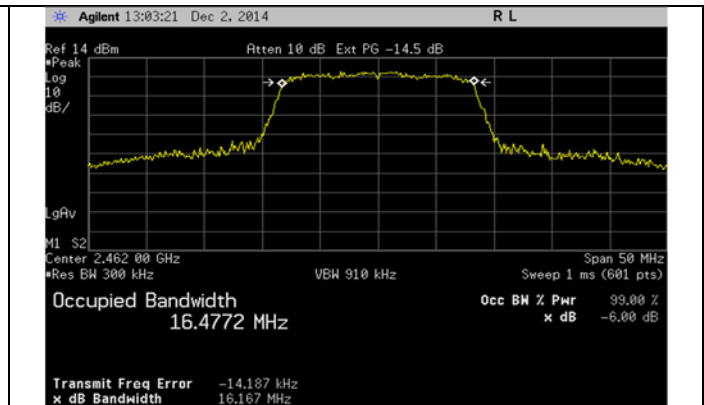


99% BW

High Channel – 2462 MHz



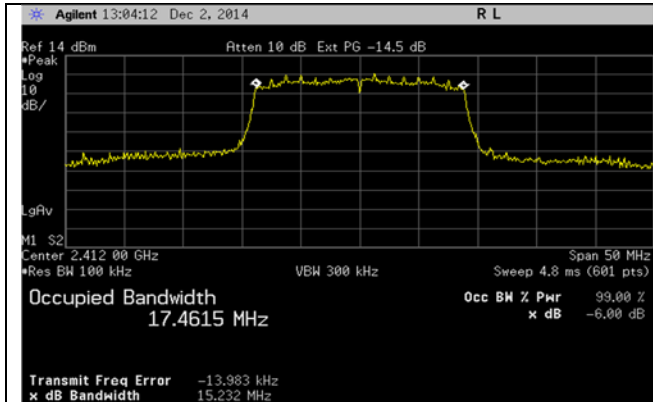
6 dB DTS BW



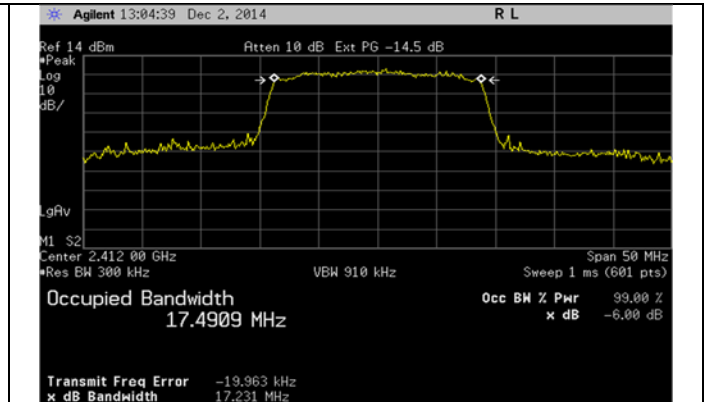
99% BW

Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052

802.11n – 6.5 Mbps
Low Channel – 2412 MHz

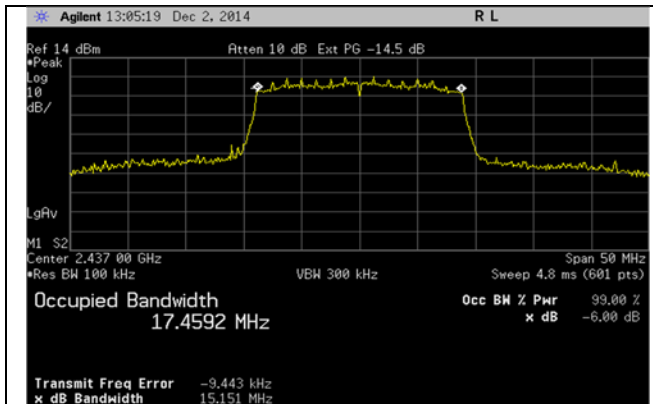


6 dB DTS BW

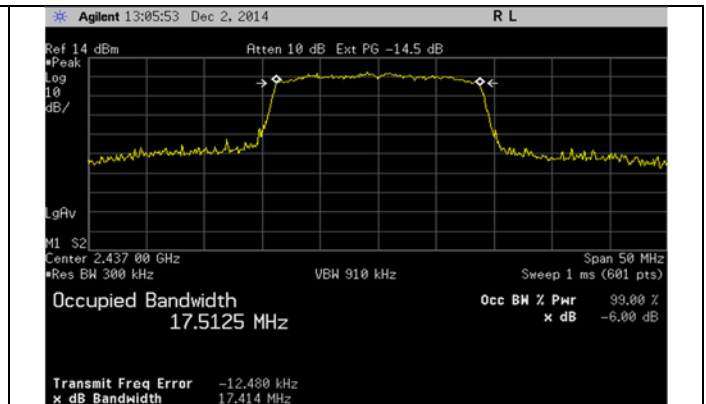


99% BW

Mid Channel – 2437 MHz

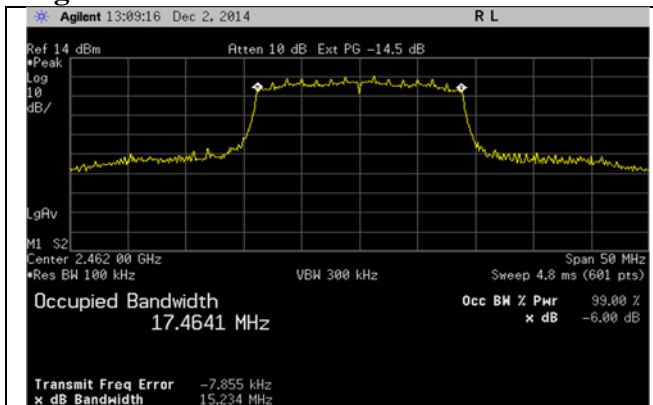


6 dB DTS BW

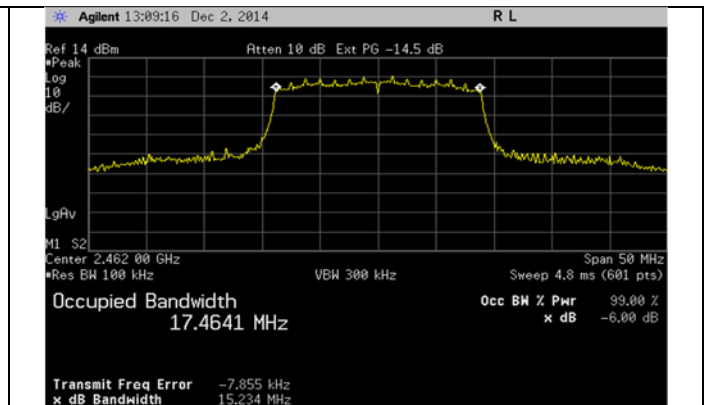


99% BW

High Channel – 2462 MHz



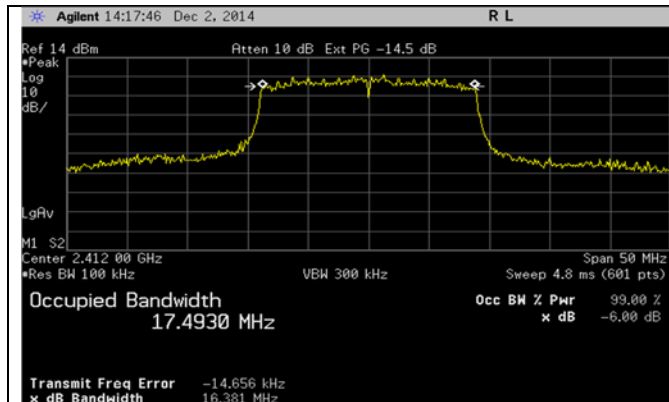
6 dB DTS BW



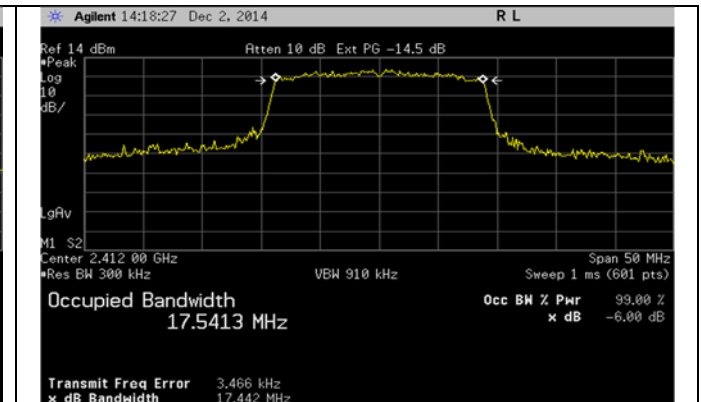
99% BW

Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
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802.11n – 65 Mbps
Low Channel – 2412 MHz

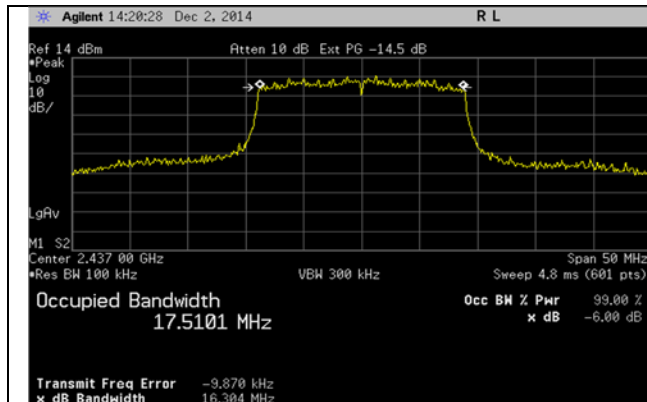


6 dB DTS BW

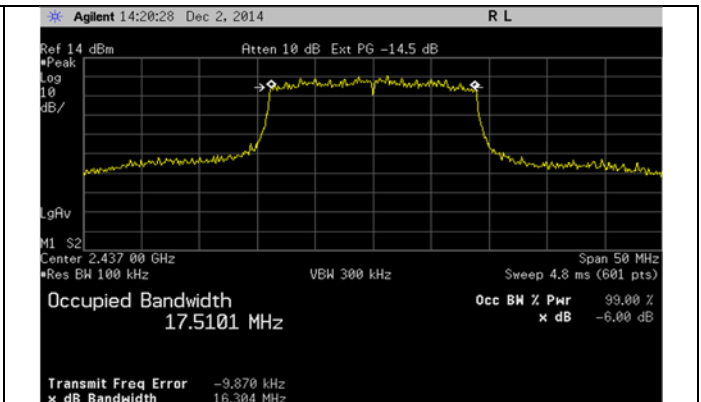


99% BW

Mid Channel – 2437 MHz

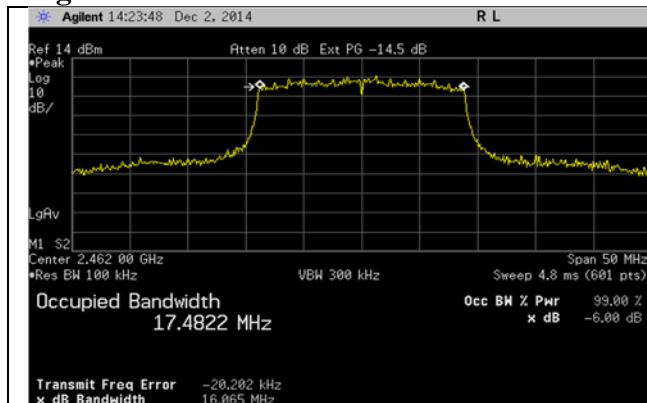


6 dB DTS BW

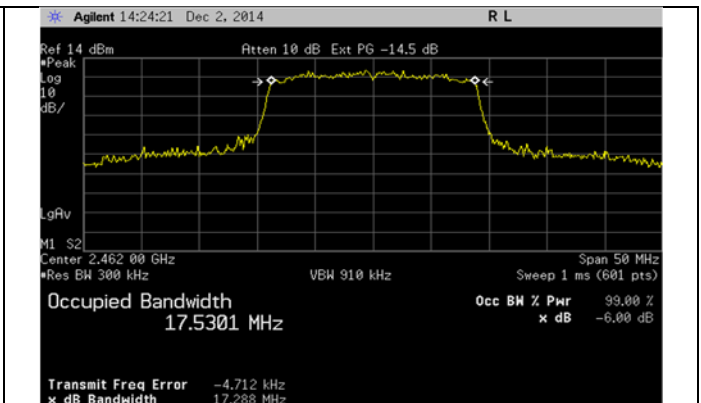


99% BW

High Channel – 2462 MHz



6 dB DTS BW



99% BW

Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052

B.1.2 – RF Conducted – Fundamental Power and Spectral Density

Manufacturer	Venstar
Date	12/2/14
Operator	Shane Rismeyer
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Rule Part	15.247 / RSS-210 A8
Specific Measurement Procedure	FCC KDB 558074 Section 9.2.2.2 FCC KDB 558074 Section 10.3
Additional Description of Measurement	100 kHz resolution bandwidth used for Power Spectral Density measurement
Additional Notes	Continuous transmit modulated used for this test. Sample Calculation: Margin (dB) = Limit – Measured level Average Output power = 18.93 dBm < 30 dBm (limit)

Output Power Table

Mode (802.11)	Mode (Mbps)	Frequency (MHz)	99% BW (MHz)	Power (dBm)	Adj Pwr (dBm)	Limit (dBm)	Margin (dBm)
b	1	2412	12.68	18.60	18.60	30.0	11.4
		2437	12.58	18.43	18.43		11.6
		2462	12.54	18.22	18.22		11.8
	11	2412	12.30	18.93	18.93		11.1
		2437	12.23	18.75	18.75		11.3
		2462	12.28	18.55	18.55		11.5
g	6	2412	16.47	14.82	14.92		15.1
		2437	16.51	14.52	14.62		15.4
		2462	16.43	14.37	14.47		15.5
	12	2412	16.44	14.45	15.45		14.6
		2437	16.53	14.19	15.19		14.8
		2462	16.48	14.12	15.12		14.9
n	6.5	2412	17.49	14.71	14.91	15.1	
		2437	17.51	14.33	14.53	15.5	
		2462	17.51	14.31	14.51	15.5	
	65	2412	17.54	14.31	15.51	14.5	
		2437	17.54	14.03	15.23	14.8	
		2462	17.53	13.99	15.19	14.8	

Note: Adjusted Power reflects the measured value along with the duty cycle correction found in the table below.

Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052

PSD Table

Mode (802.11)	Mode (Mbps)	Frequency (MHz)	Power Spectral Density (dBm)	Adj Pwr (dBm)	Limit (dBm)	Margin (dBm)
b	1	2412	2.307	2.31	8.0	5.69
		2437	2.155	2.16		5.85
		2462	1.927	1.93		6.07
	11	2412	1.934	2.13		5.87
		2437	1.4	1.60		6.40
		2462	1.57	1.77		6.23
g	6	2412	-4.135	-4.04		12.04
		2437	-4.344	-4.24		12.24
		2462	-4.58	-4.48		12.48
	12	2412	-4.103	-3.10		11.10
		2437	-4.524	-3.52		11.52
		2462	-4.613	-3.61		11.61
n	6.5	2412	-4.492	-4.29	12.29	
		2437	-4.636	-4.44	12.44	
		2462	-4.819	-4.62	12.62	
	65	2412	-3.506	-2.31	10.31	
		2437	-4.003	-2.80	10.80	
		2462	-3.825	-2.63	10.63	

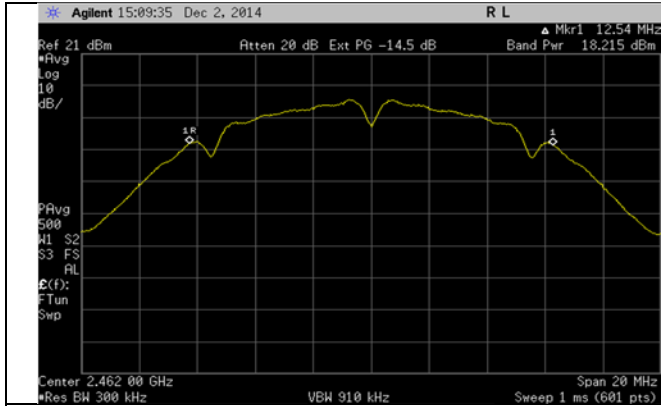
Note: Adjusted Power reflects the measured value along with the duty cycle correction found in the table below.

Duty Cycle Correction

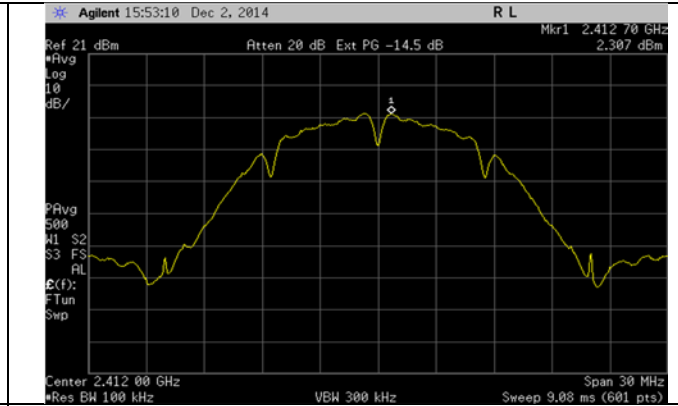
Modulation	803.11 Standard	Data Rate (MBPS)	TX on time (ms)	TX off time (ms)	Duty Cycle	Duty cycle correction factor (dB)
DBPSK	b	1.0	9.989	0.047	1.00	0.0
BPSK	a,g	6.0	1.664	0.052	0.97	0.1
8-QPSK	b	11.0	1.083	0.049	0.96	0.2
QPSK	a,g	12.0	0.843	0.051	0.94	0.3
16-QAM	a,g	24.0	0.430	0.054	0.89	0.5
64-QAM	a,g	54.0	0.204	0.051	0.80	1.0
BPSK	n	MCS0	1.539	0.057	0.96	0.2
64-QAM	n	MCS7	0.174	0.053	0.77	1.2
QPSK	n	MCS1	0.783	0.053	0.94	0.3
64-QAM	n	MCS5	0.215	0.052	0.80	0.9
64-QAM	a,g	48.0	0.226	0.052	0.81	0.9
16-QAM	n	MCS3	0.401	0.052	0.88	0.5

Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052

**Plots - 802.11b - 1 Mbps
Low Channel - 2412 MHz**

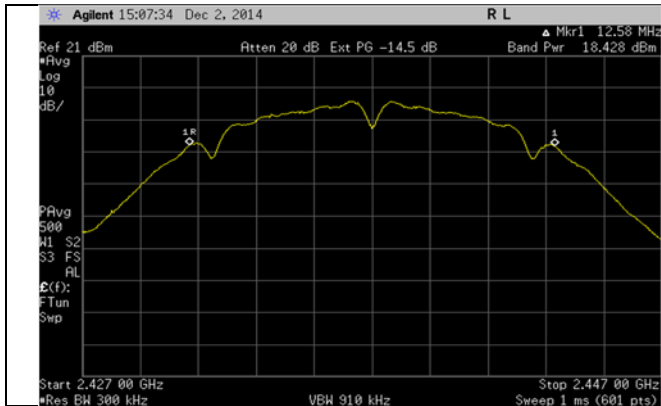


Output Power

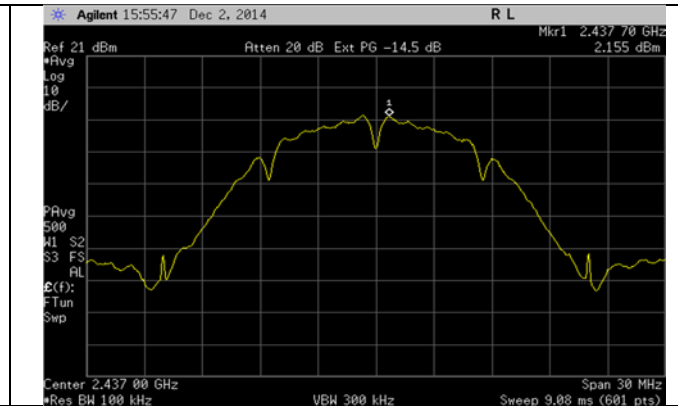


Power Spectral Density

Mid Channel - 2437 MHz

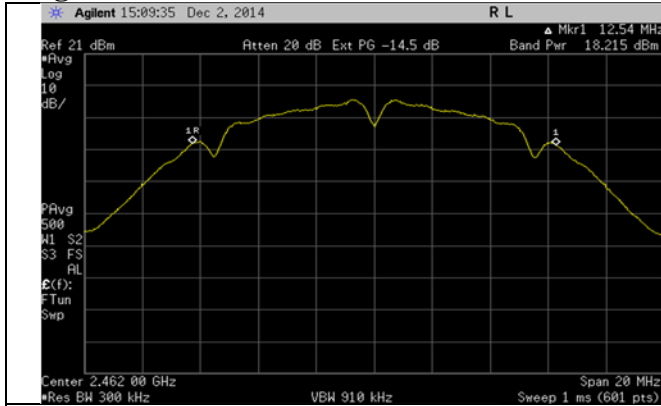


Output Power

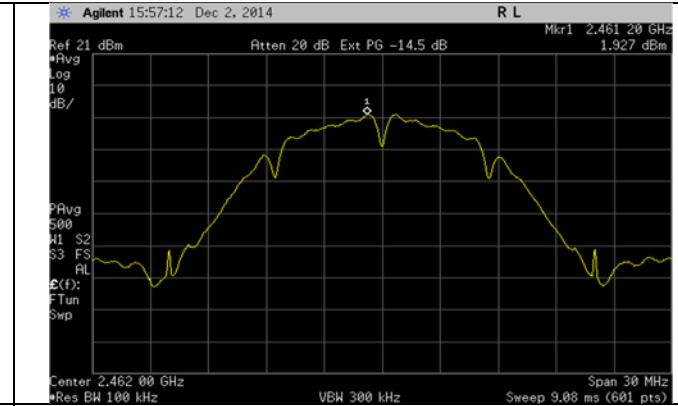


Power Spectral Density

High Channel - 2462 MHz



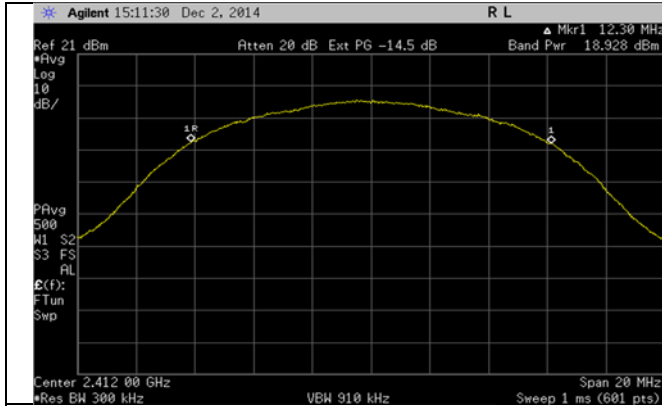
Output Power



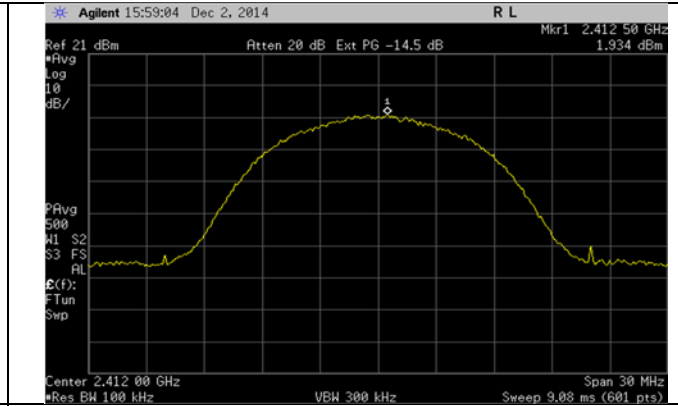
Power Spectral Density

Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052

**802.11b – 11 Mbps
Low Channel – 2412 MHz**



Output Power

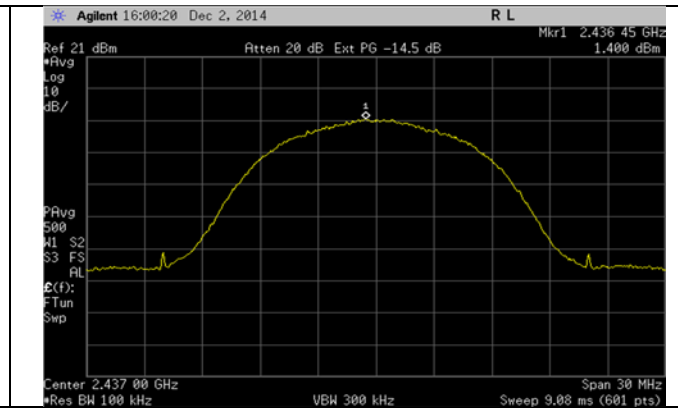


Power Spectral Density

Mid Channel – 2437 MHz

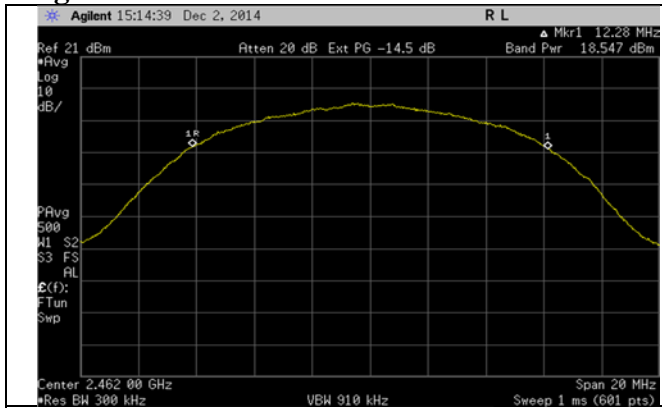


Output Power

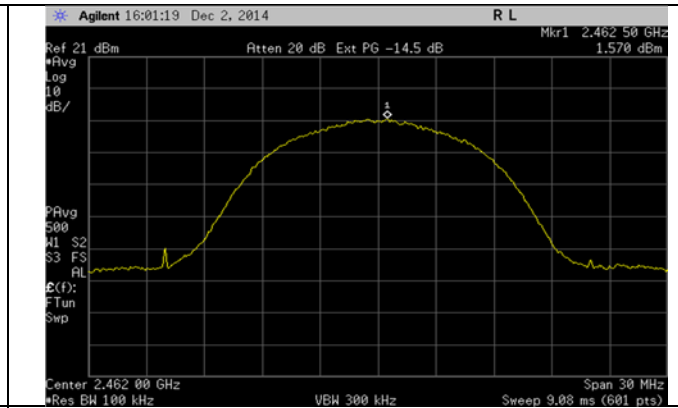


Power Spectral Density

High Channel – 2462 MHz



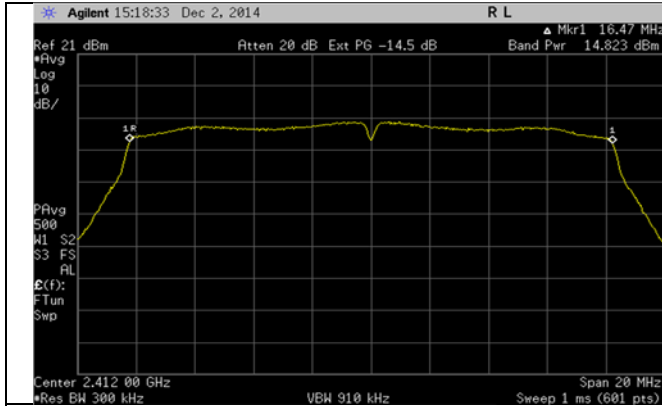
Output Power



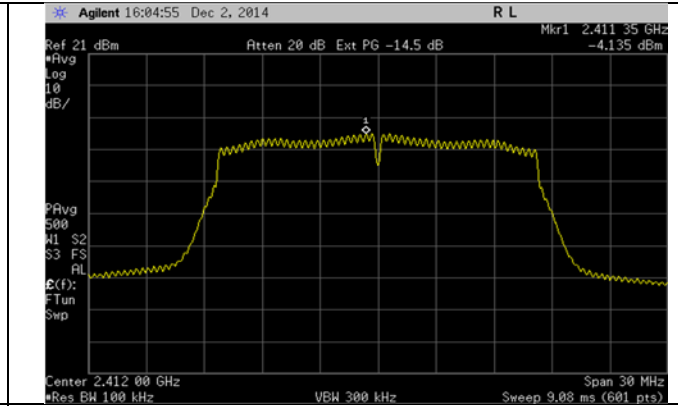
Power Spectral Density

Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052

802.11g – 6 Mbps
Low Channel – 2412 MHz

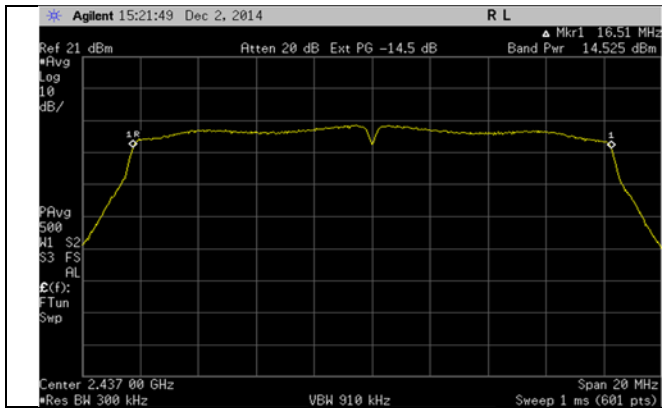


Output Power

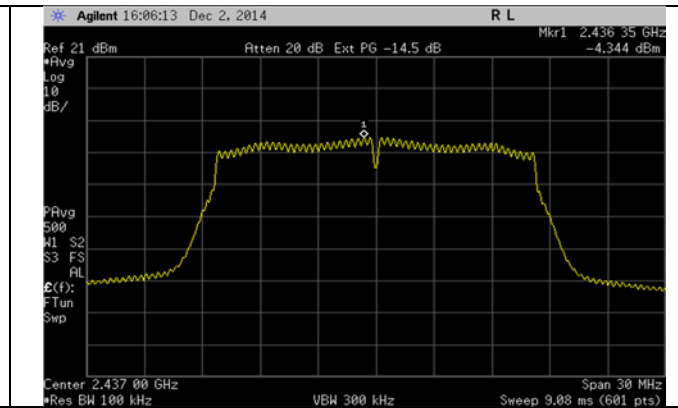


Power Spectral Density

Mid Channel – 2437 MHz

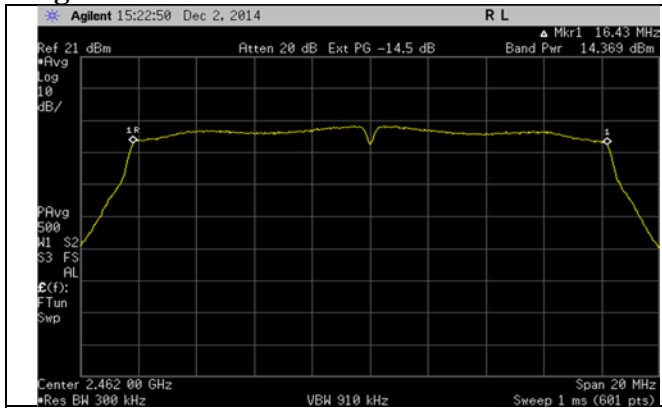


Output Power

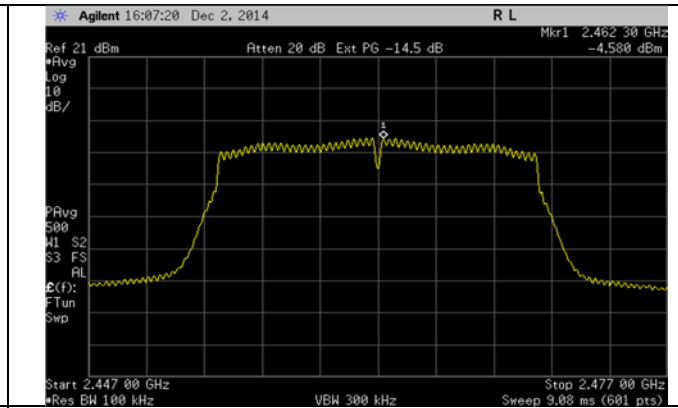


Power Spectral Density

High Channel – 2462 MHz



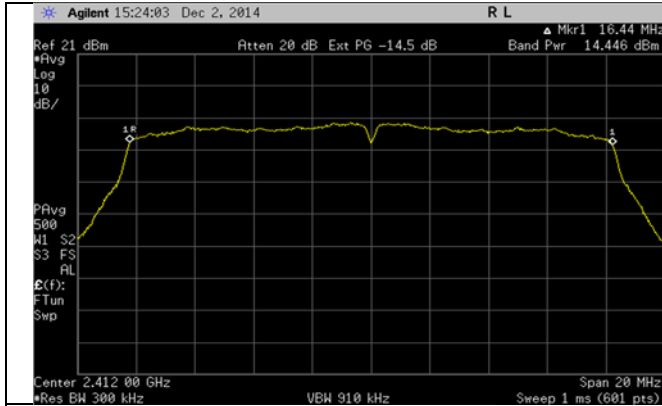
Output Power



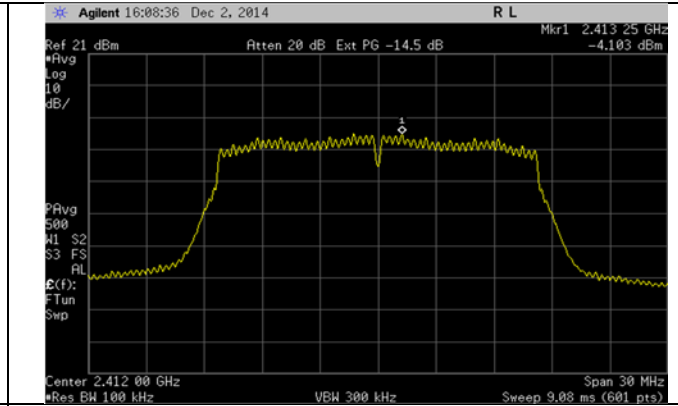
Power Spectral Density

Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052

802.11g – 54 Mbps
Low Channel – 2412 MHz

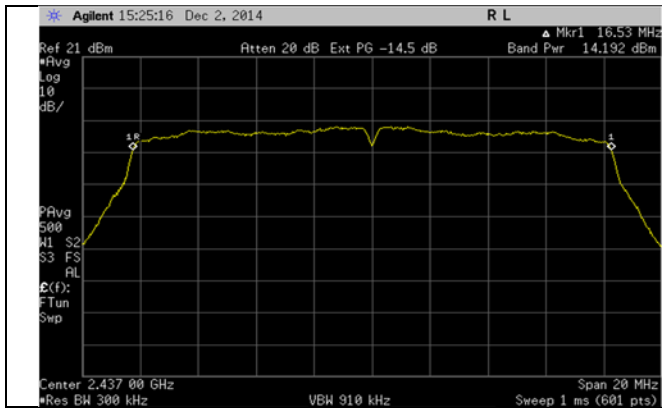


Output Power

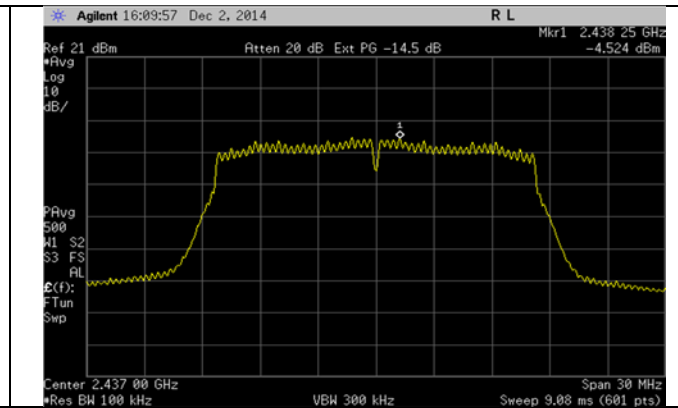


Output Power

Mid Channel – 2437 MHz

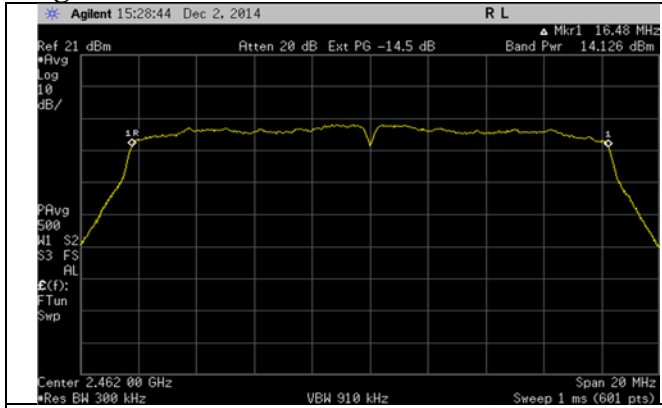


Output Power

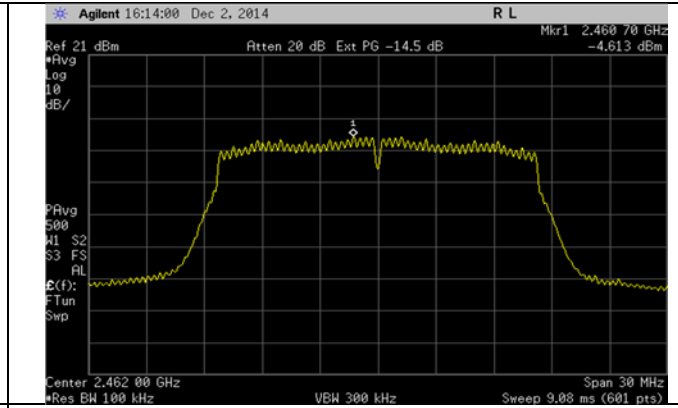


Output Power

High Channel – 2462 MHz



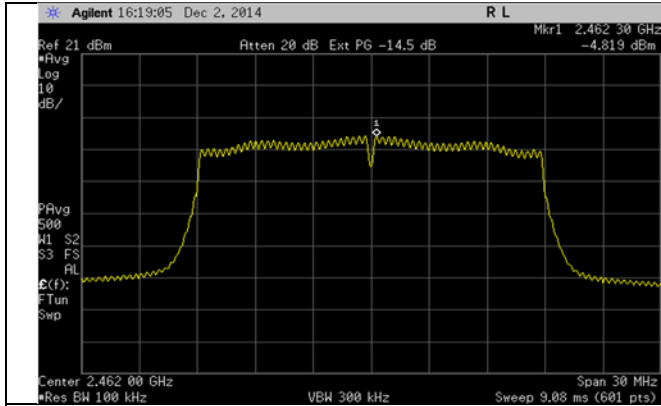
Output Power



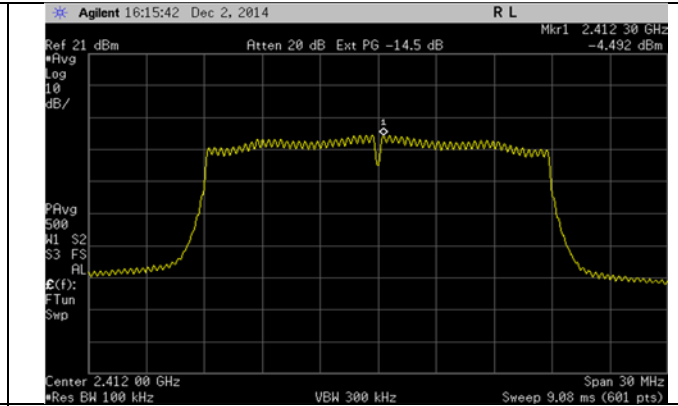
Output Power

Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052

802.11n – 6.5 Mbps
Low Channel – 2412 MHz

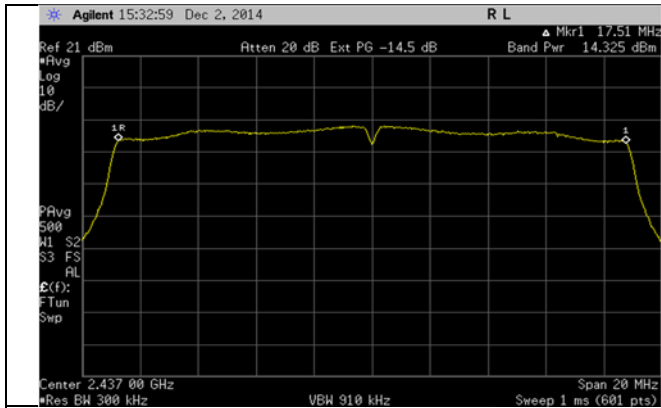


Output Power

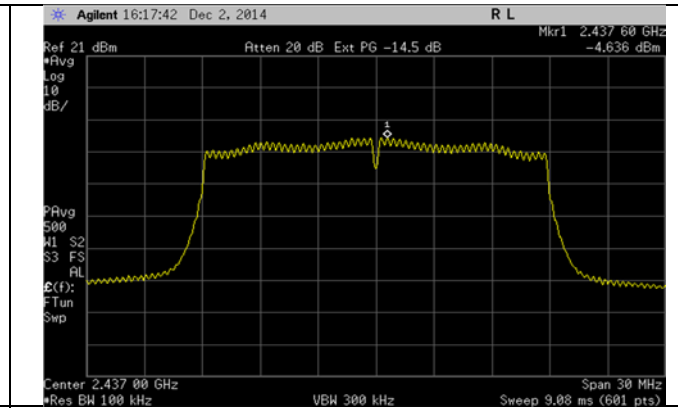


Power Spectral Density

Mid Channel – 2437 MHz

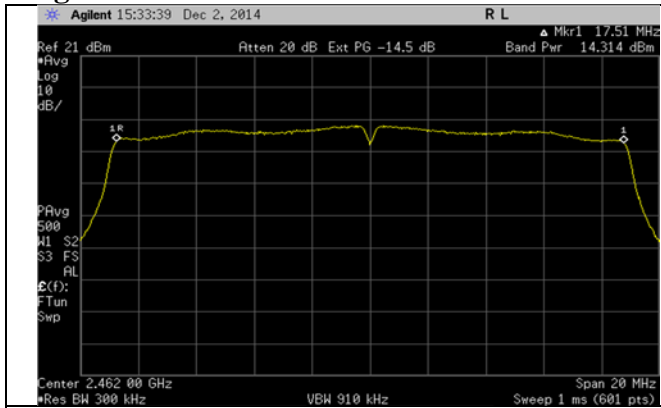


Output Power

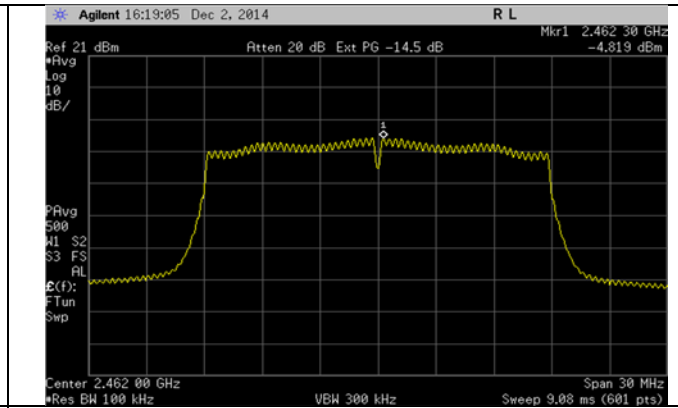


Power Spectral Density

High Channel – 2462 MHz



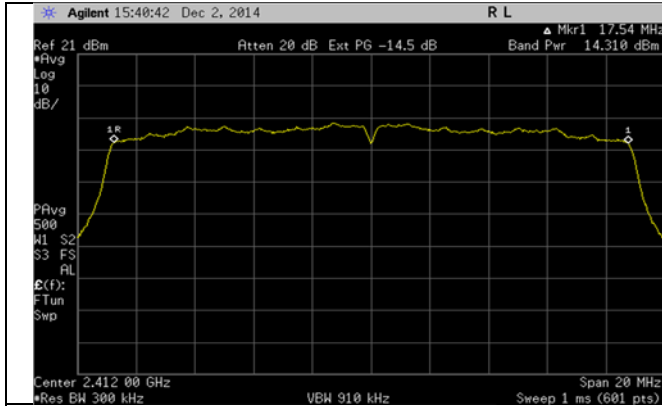
Output Power



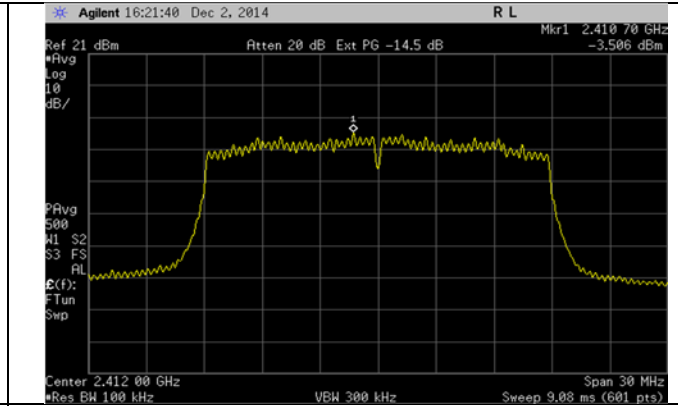
Power Spectral Density

Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052

802.11n – 65 Mbps
Low Channel – 2412 MHz

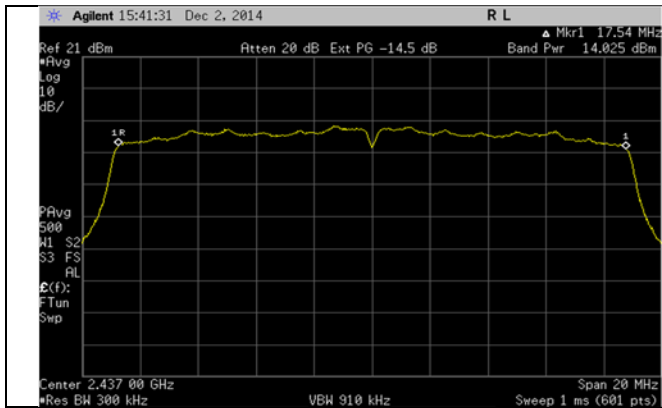


Output Power

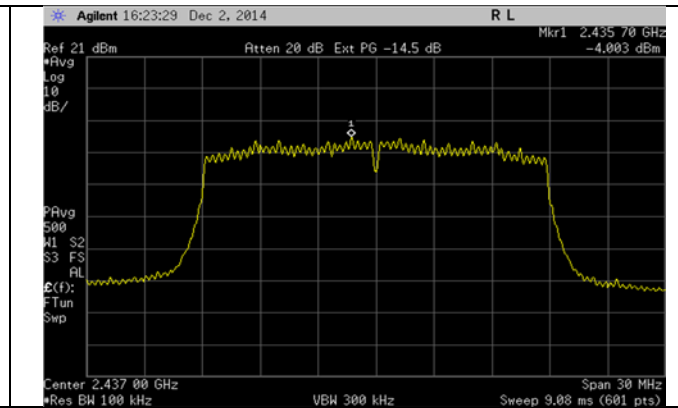


Power Spectral Density

Mid Channel – 2437 MHz

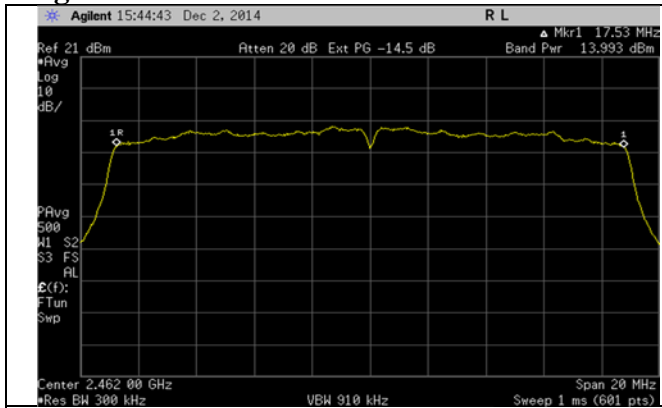


Output Power

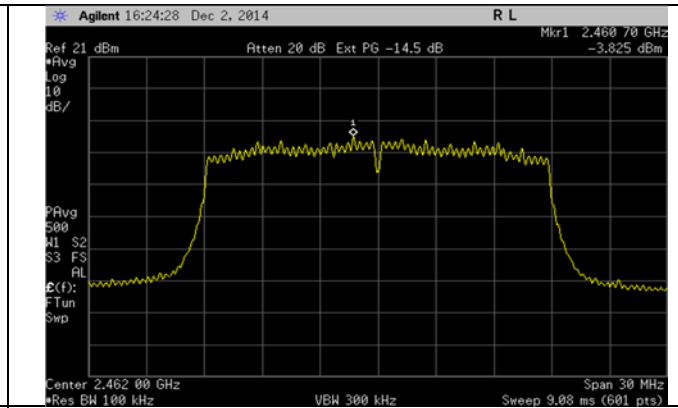


Power Spectral Density

High Channel – 2462 MHz



Output Power



Power Spectral Density

Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052

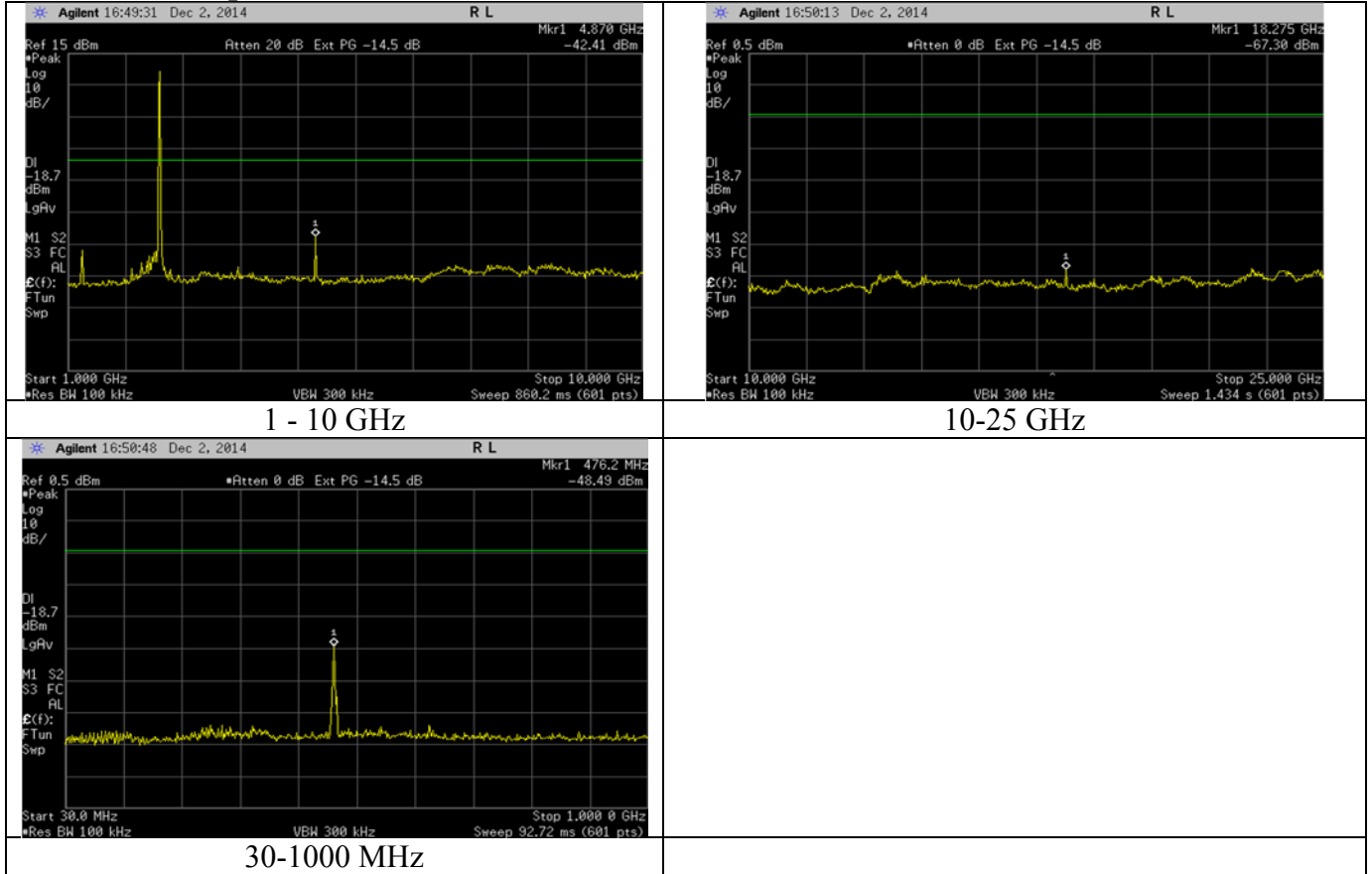
B.1.3 – RF Conducted – Emissions in non-restricted frequency bands

Manufacturer	Venstar
Date	12/2/14
Operator	Shane Rismeyer
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Rule Part	15.247 / RSS-210 A8
Specific Measurement Procedure	FCC KDB 558074 Section 11.0 – Emissions in non-restricted frequency bands
Additional Description of Measurement	RF Conducted Measurement
Additional Notes	No Emissions found to be within 15 dB of limit Continuous transmit modulated used for this test.

Plots start next page

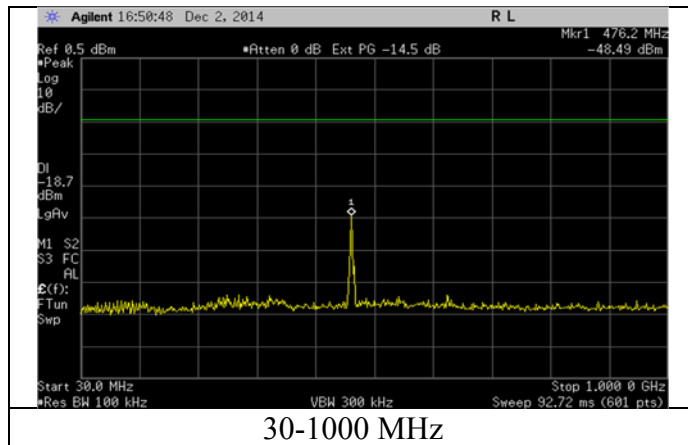
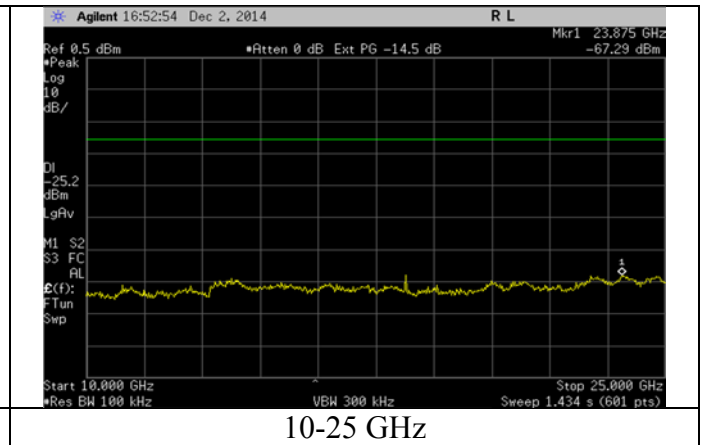
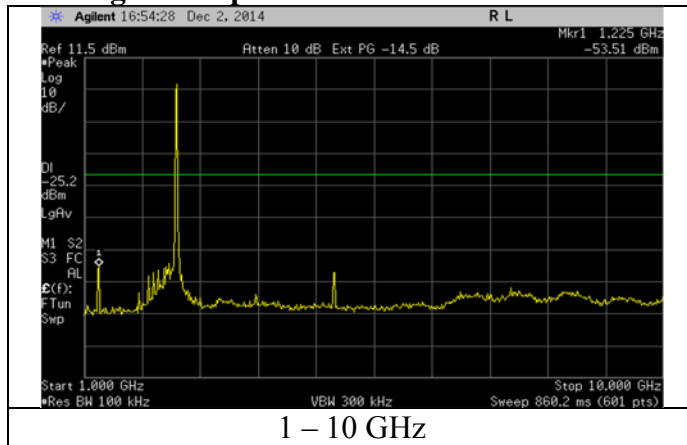
Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052

802.11b - 1 Mbps - Mid Channel - 2437 MHz



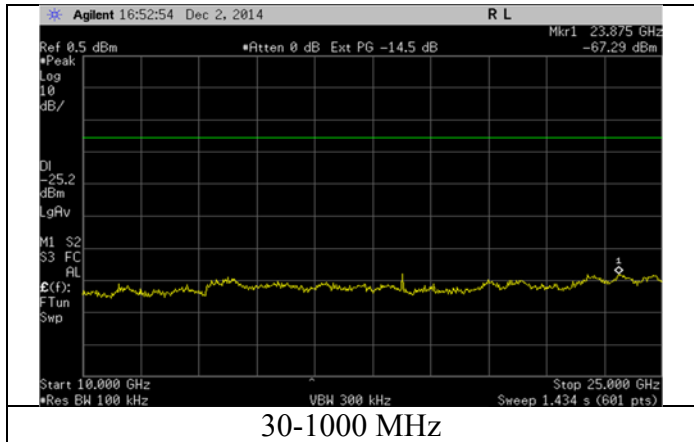
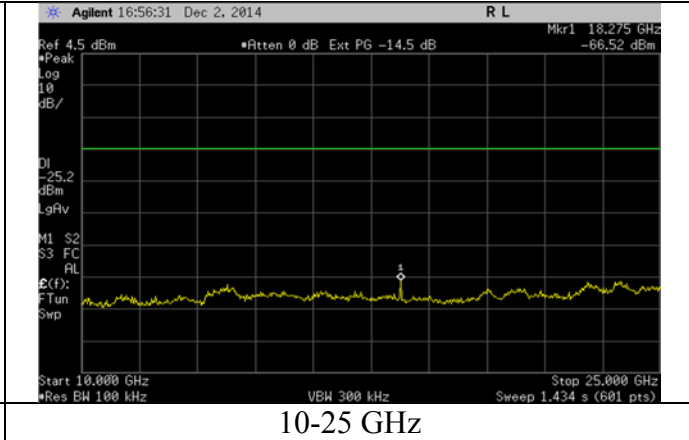
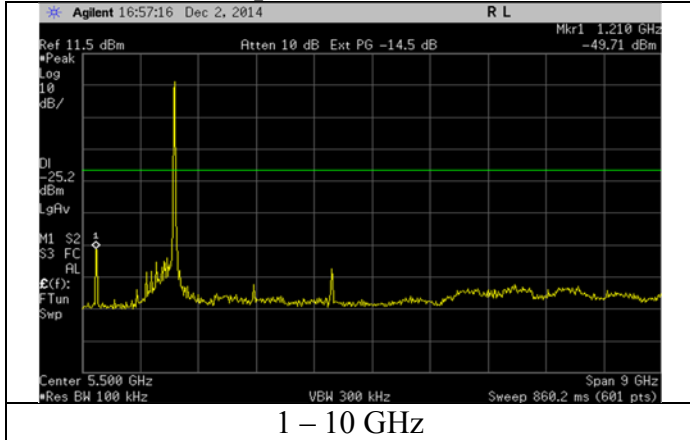
Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052

802.11g – 6 Mbps - Mid Channel – 2437 MHz



Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052

802.11n – 6.5 Mbps - Mid Channel – 2437 MHz



Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052

B.2 – Radiated Emissions

Rule Part(s)	FCC: 15.247 / 15.205 / 15.209 IC: RSS-210 A8 / RSS-210 Section 2.2			
Measurement Procedure	ANSI C63.4 - 2009 ANSI C63.10 – 2009 FCC KDB 558074 D01 DTS Meas Guidance v03r02			
Test Location	LS Research, LLC - FCC Listed 3 meter Semi-Anechoic Chamber			
Test Distance	See data section			
EUT Placement	80 cm height non-conductive table above reference ground plane			
Frequency Range of Measurement	Biconical: 30-300 MHz	Log Periodic Dipole Array: 300-1000 MHz	Double-Ridged Waveguide Horn: 1-18 GHz	Standard Gain Horn: 18-26GHz
Measurement Detectors	30-1000MHz RBW: 120 kHz VBW: At least 300 kHz		1 - 40 GHz: RBW : 1MHz VBW: At least 3 (MHz) Peak 10 Hz Average	
Description of Measurement	<p>1) The antenna, cable, pre-amp, and other necessary measurement system correction factors are loaded onto the EMI receiver / spectrum analyzer when the measurements are preformed. The data is gathered and reported as the corrected values.</p> <p>2) The EUT is placed on a non-conductive pedestal centered on a turn-table in the test location with the antenna at the test distance from the EUT</p> <p>3) Maximum radiated RF emissions are determined by rotation of azimuth and scanning the sense antenna between 1 and 4 meters in height using both horizontal and vertical antenna polarities. Maximized levels are manually noted at degree values of azimuth and at sense antenna height.</p>			
Example Calculations	Reported Measurement data = Raw receiver measurement + Antenna Correction Factor + Cable factor (dB) - amplification factor (when applicable) + Additional factor (when applicable)			

FCC Part 15.209 / IC RSS-210 Section 2.7 Limits:

Frequency (MHz)	3 m Limit ($\mu\text{V/m}$)	3 m Limit ($\text{dB}\mu\text{V/m}$)	Type
30-88	100	40.0	Quasi-Peak
88-216	150	43.5	Quasi-Peak
216-960	200	46.0	Quasi-Peak
Above 960	500	54.0	Average (>1 GHz)

Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052

B.2.1 – Radiated Band-Edge Restricted Bands

Manufacturer	Venstar
Date	12/1/14
Operator	Shane Rismeyer
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Rule Part	15.247/ 15.205 / 15.209
Measurement Procedure	ANSI C63.4 - 2009 ANSI C63.10 - 2009 FCC KDB 558074 v03r02 Section 12.2.7 Radiated spurious emission test
Test Distance	3 meter (1-4 GHz)
EUT Placement	80 cm height non-conductive table centered on turn-table
Detectors	Peak; RBW 1MHz VBW 3 MHz (10Hz VBW for average measurements)
Additional Notes	1) EUT maximized in azimuth and antenna height with maximum results reported.

Example Calculation:

FCC 15.209 Average Limit @ 3 meter (dBµV/m) – Peak Reading (dBµV/m) = Margin

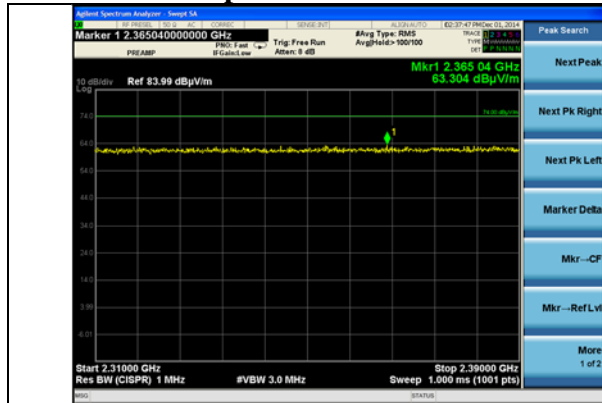
Data Table

Data Rate (Mbps)	Channel	Frequency (MHz)	EUT orientation/ Antenna Polarity	Height (cm)	Azimuth (degree)	Peak Reading (dBµV/m)	Peak Limit (dBµV/m)	Margin (dB)	Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)
1	1	2388.8	Flat Horizontal	105	42	63.3	74.0	10.7	46.8	54.0	7.2
1	11	2483.7	Flat Horizontal	100	125	61.9	74.0	12.1	48.5	54.0	5.5
6	1	2388.8	Flat Horizontal	105	42	63.7	74.0	10.3	48.0	54.0	6.0
6	11	2483.7	Flat Horizontal	100	125	65.2	74.0	8.8	51.8	54.0	2.2
6.5	1	2388.8	Flat Horizontal	105	42	63.3	74.0	10.7	48.0	54.0	6.0
6.5	11	2483.7	Flat Horizontal	100	125	68.3	74.0	5.7	52.1	54.0	1.9
65	1	2388.8	Flat Horizontal	105	42	63.0	74.0	11.0	48.5	54.0	5.5
65	11	2483.7	Flat Horizontal	100	125	67.5	74.0	6.5	51.5	54.0	2.5

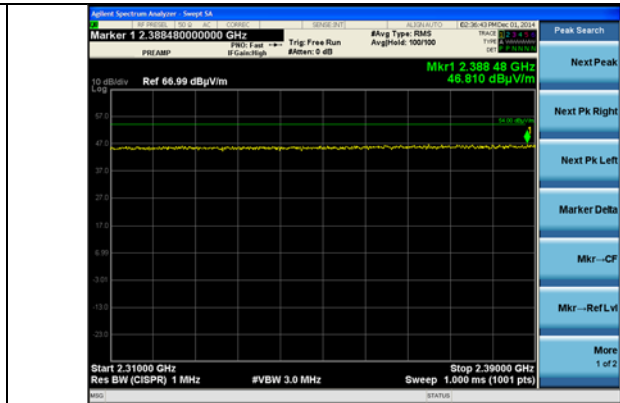
Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052

Plots

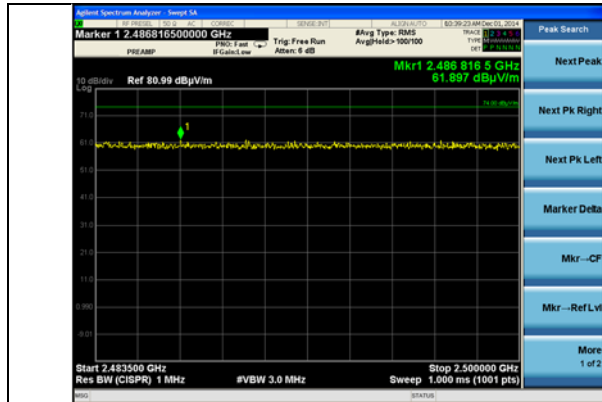
802.11b – 1Mbps



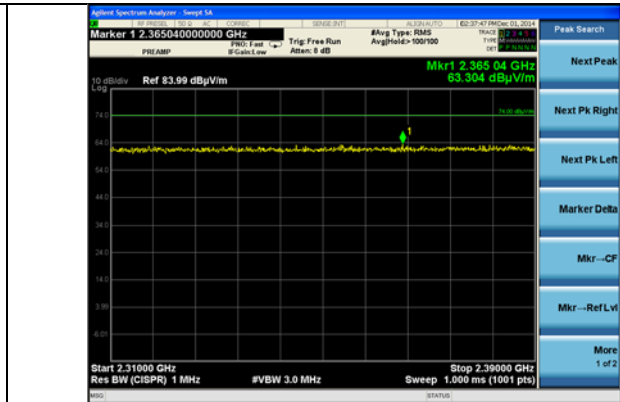
Low Channel (2412 MHz)
 Lower Band-edge (2310-2390 MHz)
Peak



Low Channel (2412 MHz)
 Lower Band-edge (2310-2390 MHz)
Average



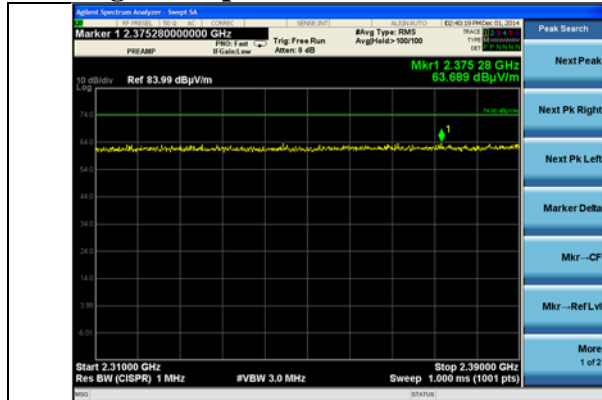
High Channel (2462MHz)
 Upper Band-edge (2483.5-2500 MHz)
Peak



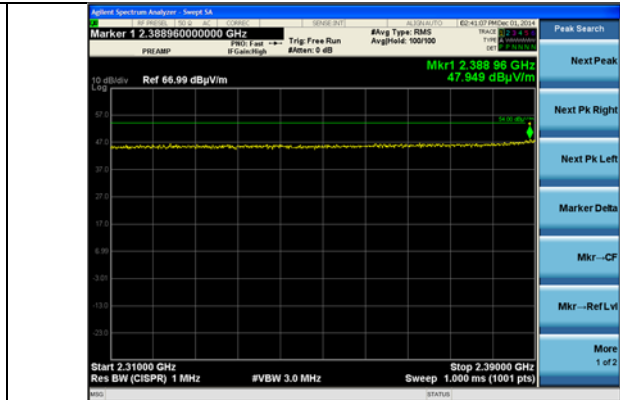
High Channel (2462MHz)
 Upper Band-edge (2483.5-2500 MHz)
Average

Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052

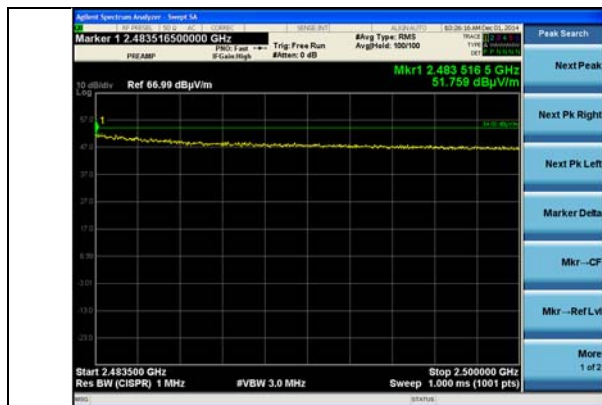
802.11g – 6Mbps



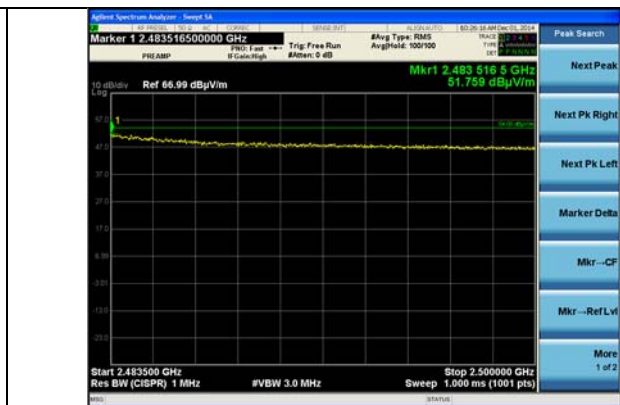
Low Channel (2412 MHz)
Lower Band-edge (2310-2390 MHz)
Peak



Low Channel (2412 MHz)
Lower Band-edge (2310-2390 MHz)
Average



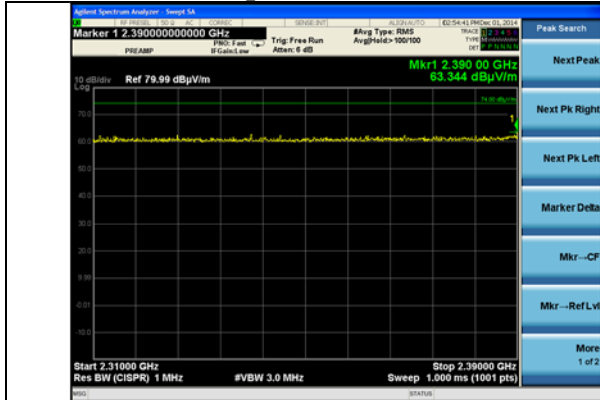
High Channel (2462MHz)
Upper Band-edge (2483.5-2500 MHz)
Peak



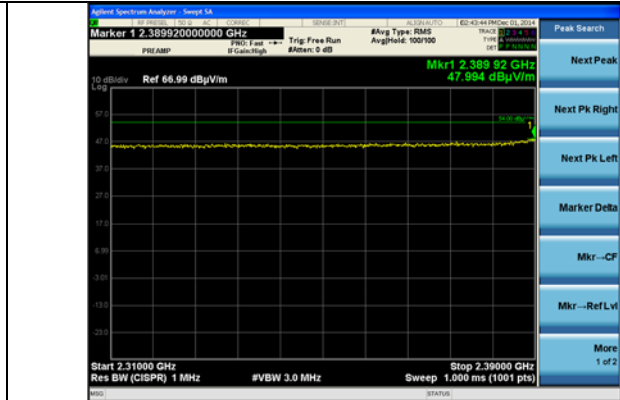
High Channel (2462MHz)
Upper Band-edge (2483.5-2500 MHz)
Average

Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052

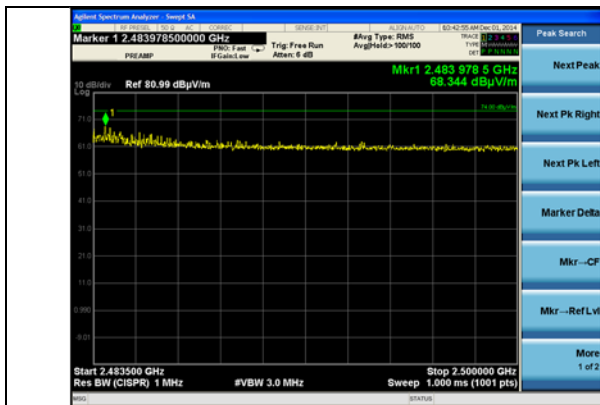
802.11n – 6.5Mbps



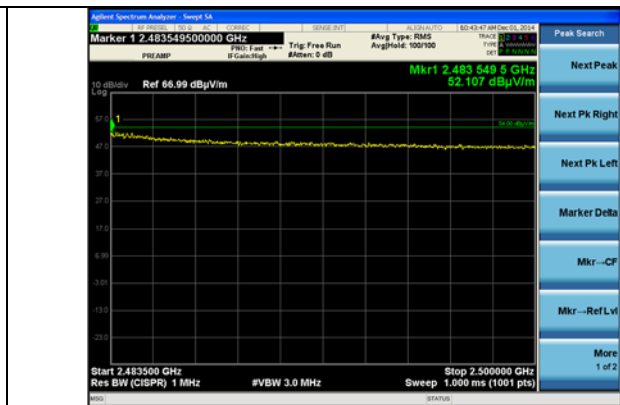
Low Channel (2412 MHz)
 Lower Band-edge (2310-2390 MHz)
Peak



Low Channel (2412 MHz)
 Lower Band-edge (2310-2390 MHz)
Average



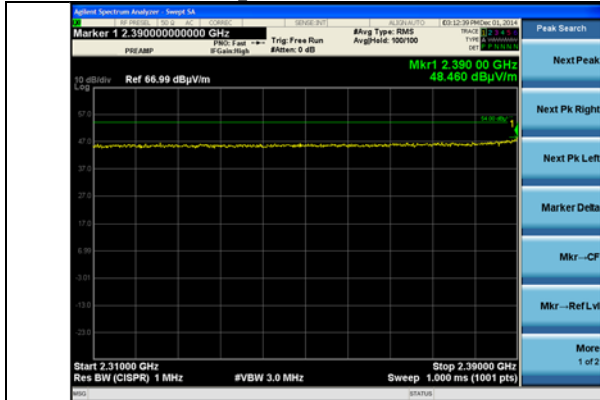
High Channel (2462MHz)
 Upper Band-edge (2483.5-2500 MHz)
Peak



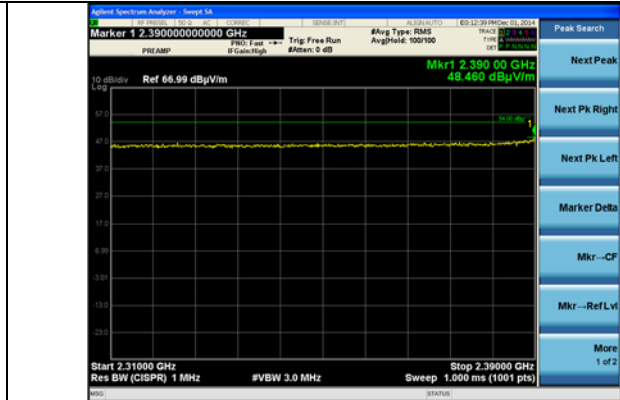
High Channel (2462MHz)
 Upper Band-edge (2483.5-2500 MHz)
Average

Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052

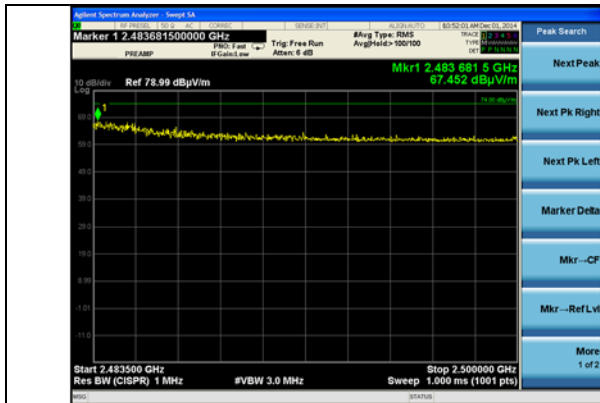
802.11n – 65Mbps



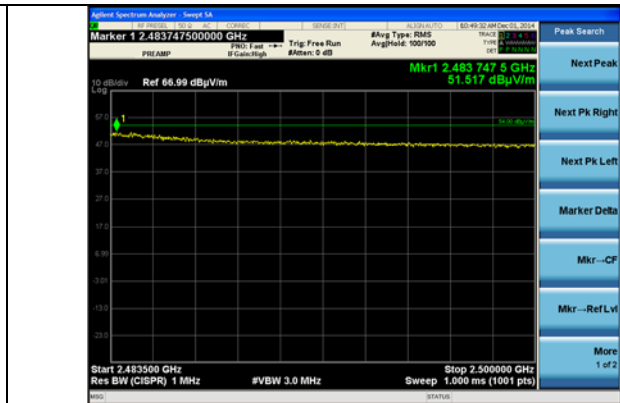
Low Channel (2412 MHz)
 Lower Band-edge (2310-2390 MHz)
Peak



Low Channel (2412 MHz)
 Lower Band-edge (2310-2390 MHz)
Average



High Channel (2462MHz)
 Upper Band-edge (2483.5-2500 MHz)
Peak



High Channel (2462MHz)
 Upper Band-edge (2483.5-2500 MHz)
Average

Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052

B.2.2 – Radiated Harmonics in Restricted Bands

Manufacturer	Venstar
Date	12/4/14
Operator	Shane Rismeyer
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Rule Part	15.247/ 15.205 / 15.209
Measurement Procedure	ANSI C63.4 - 2009 ANSI C63.10 - 2009
Test Distance	3 meters 4-26 GHz
EUT Placement	80 cm height non-conductive table centered on turn-table
Detectors	Peak; RBW 1 MHz Average VBW (10Hz)
Additional Notes	1) Tested in continuous transmit modulated mode with EUT in three orientations at maximum power. (Worst case 1 Mbps)

Example Calculation:

FCC 15.209 Average Limit @ 1 meter (dB μ V/m) – Peak Reading (dB μ V/m) = Margin

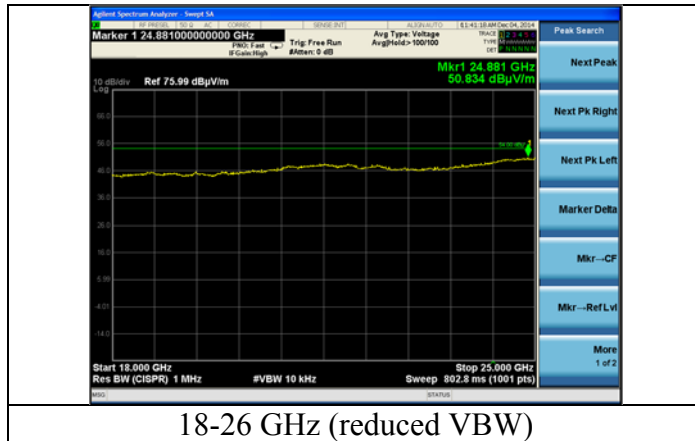
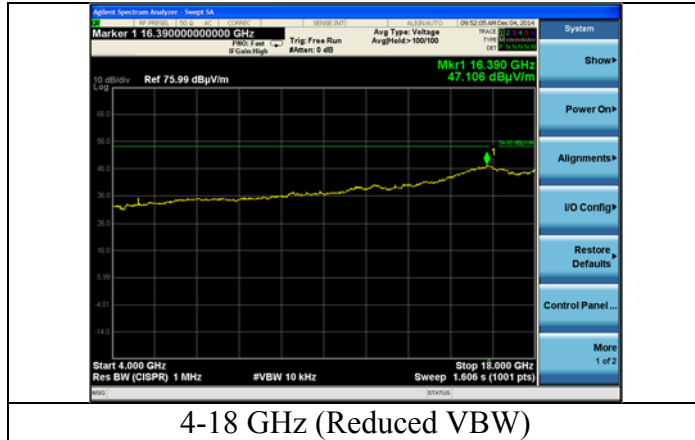
Data Table

Frequency (GHz)	Height (cm)	Azimuth (degree)	Peak Reading (dB μ V/m)	Avg Limit (dB μ V/m)	Margin (dB)	Antenna Polarity	Channel/ Orientation	Note
4.824	111	127	43.8	54.0	10.2	H	Low Ch – Vert Pos	1
4.874	100	131	43.9	54.0	10.1	H	Mid Ch – Vert Pos	1
4.924	201	155	43.6	54.0	10.4	V	High Ch – Side Pos	1

Note 1: Peak measurements below Average limit.

Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052

Plots - Middle Channel



Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052

B.2.3 – Radiated Emissions Transmit Mode

Manufacturer	Venstar
Date	12/4/14
Operator	Shane Rismeyer
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Rule Part	15.247/ 15.205 / 15.209
Measurement Procedure	ANSI C63.4 – 2009 ANSI C63.10 - 2009
Test Distance	3 meter 30-4000 MHz
EUT Placement	80 cm height non-conductive table centered on turn-table
Detectors	Quasi-Peak; 120 kHz and Peak; RBW 1 MHz
Additional Notes	1) Tested in continuous transmit modulated mode with EUT in three orientations at maximum power. 2) Emissions not effected by channel or transmit or receive mode.

Example Calculation:

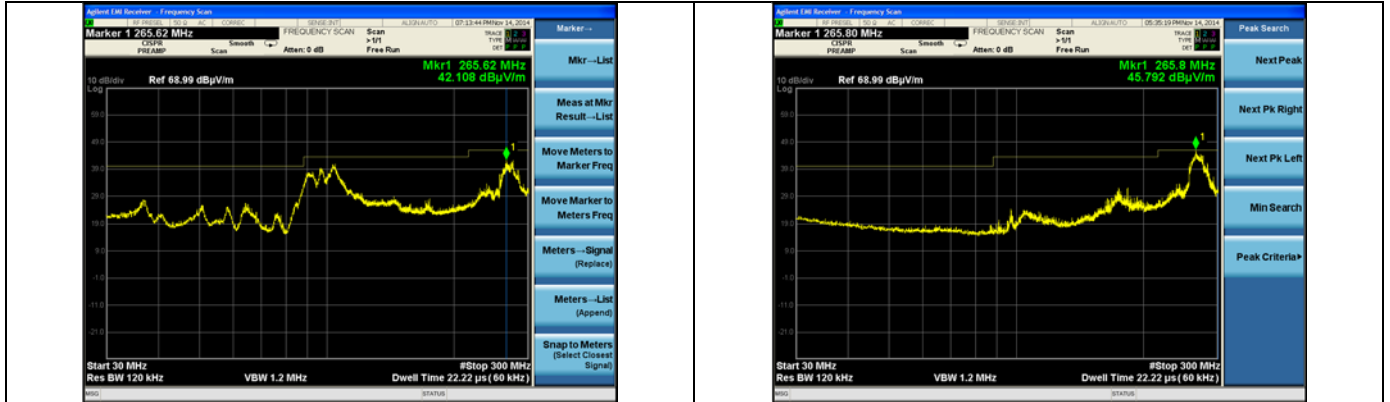
$$\text{Limit (dB}\mu\text{V/m)} - \text{Reading (dB}\mu\text{V/m)} = \text{Margin}$$

Table

Frequency (MHz)	Height (cm)	Azimuth (degree)	Quasi Peak Reading (dBμV/m)	Quasi Peak Limit (dBμV/m)	Margin (dB)	Antenna Polarity	EUT orientation
265.8	1.00	326	40.2	46.0	5.8	H	Vertical
265.6	1.00	296	36.89	46.0	9.1	V	Vertical
104.6	1.00	203	30.18	43.5	13.3	V	Vertical
726.1	1.00	240	38.53	46.0	7.5	H	Vertical
707.5	1.00	0	35.9	46.0	10.1	V	Vertical
265.8	1.00	326	40.2	46.0	5.8	H	Vertical

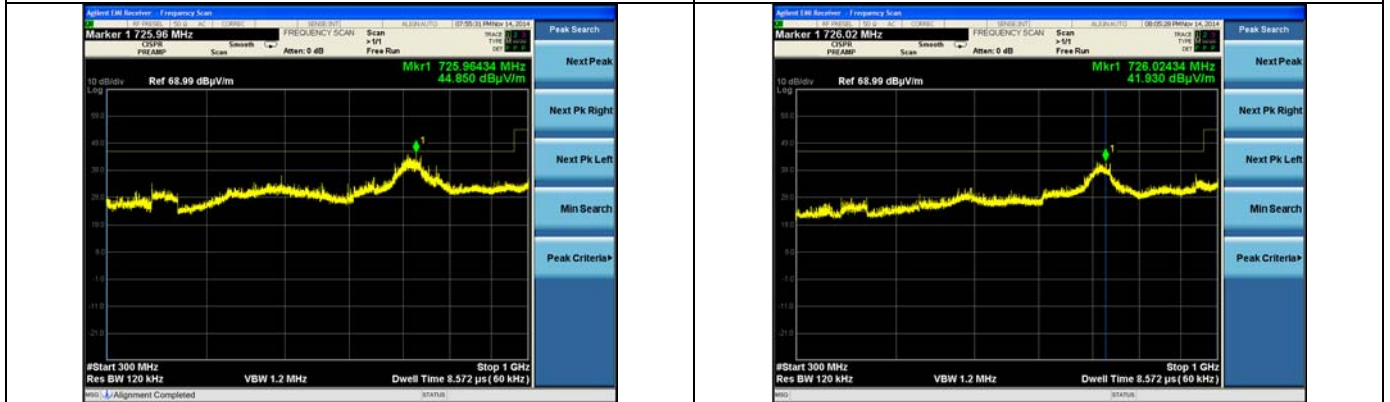
Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052

Plots



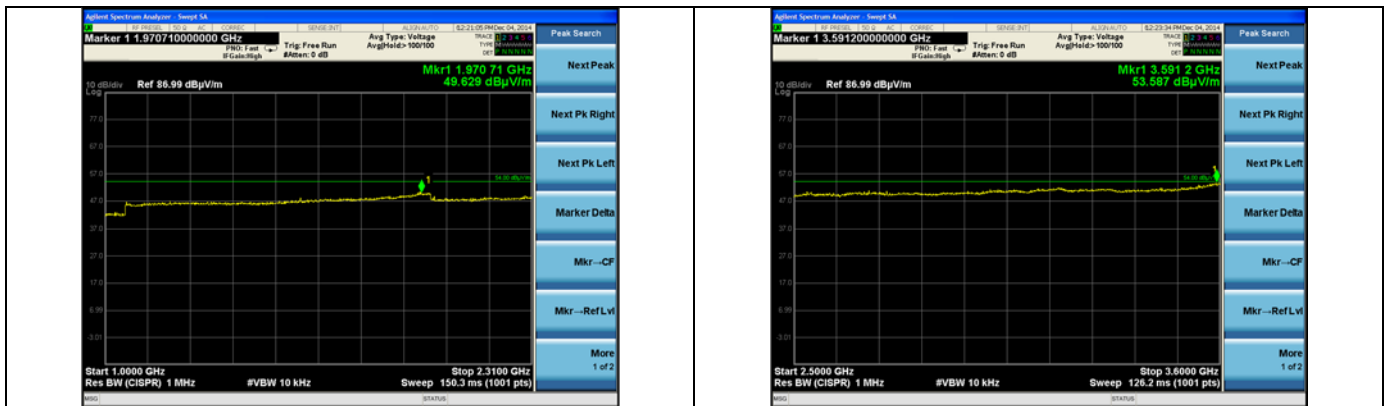
30-300 MHz Vertical

30-300 MHz Horizontal



300-1000 MHz Vertical

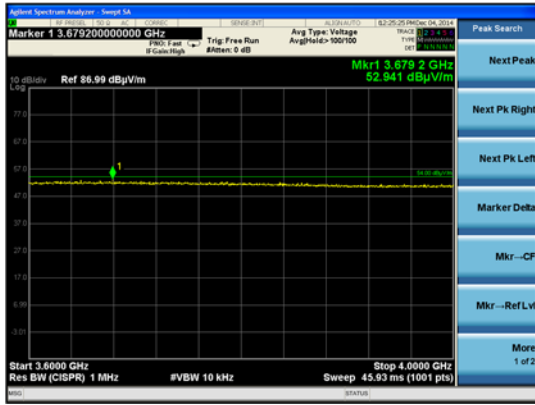
300-1000 MHz Horizontal



1000 - 2310 MHz

2500 - 3600 MHz

Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052



3600-4000 MHz

Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052

B.2.4 – Radiated Emissions Receive Mode

Manufacturer	Venstar
Date	12/4/14
Operator	Shane Rismeyer
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Rule Part	15.109 / RSS-GEN
Measurement Procedure	ANSI C63.4 – 2009 ANSI C63.10 - 2009
Test Distance	3 meter 30-25000MHz
EUT Placement	80 cm height non-conductive table centered on turn-table
Detectors	Quasi-Peak; RBW 120 kHz and Peak; RBW 1 MHz
Additional Notes	<ol style="list-style-type: none"> 1) Tested in continuous transmit modulated mode with EUT in three orientations at maximum power. 2) Maximum results reported 3) Emissions not effected by channel or transmit or receive mode.

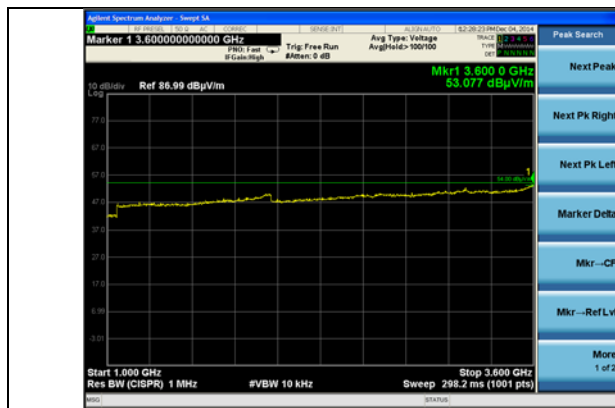
Example Calculation:

$$\text{Limit (dB}\mu\text{V/m)} - \text{Reading (dB}\mu\text{V/m)} = \text{Margin}$$

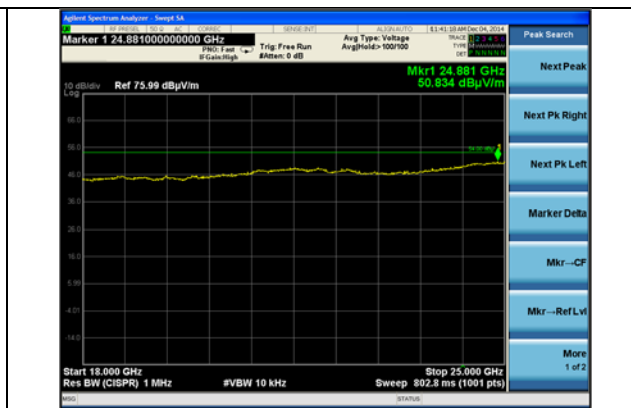
Table

Frequency (MHz)	Height (cm)	Azimuth (degree)	Quasi Peak Reading (dBμV/m)	Quasi Peak Limit (dBμV/m)	Margin (dB)	Antenna Polarity	EUT orientation
265.8	1.00	326	40.2	46.0	5.8	Horizontal	Vertical
265.6	1.00	296	36.9	46.0	9.1	Vertical	Vertical
104.6	1.00	203	30.2	43.5	13.3	Vertical	Vertical
726.1	1.00	240	38.5	46.0	7.5	Horizontal	Vertical
707.5	1.00	0	35.9	46.0	10.1	Vertical	Vertical
265.8	1.00	326	40.2	46.0	5.8	Horizontal	Vertical

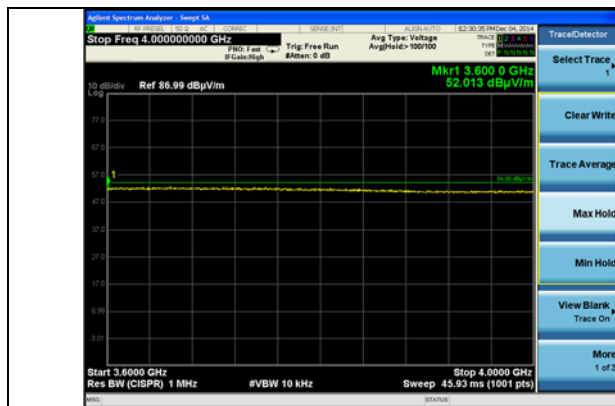
Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052



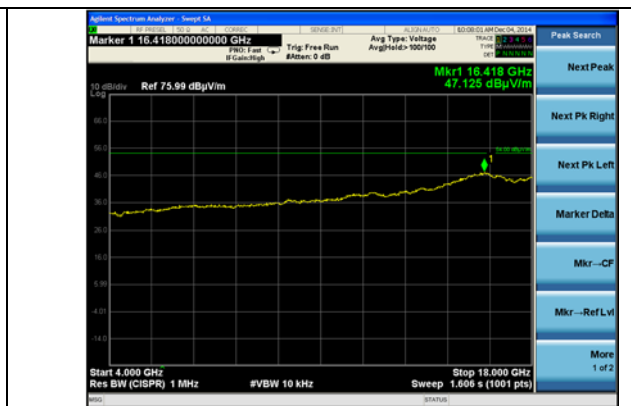
1000 – 3600 MHz (reduced VBW)



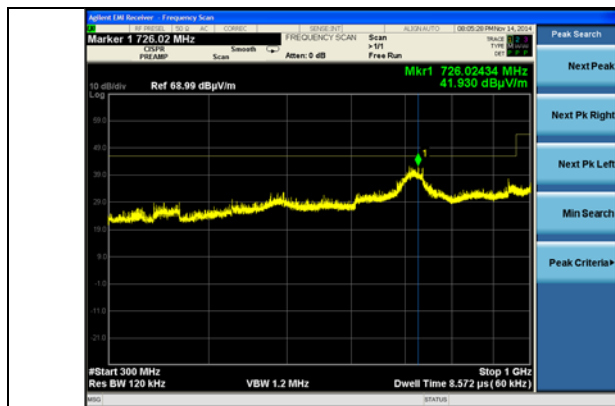
18-26 GHz (reduced VBW)



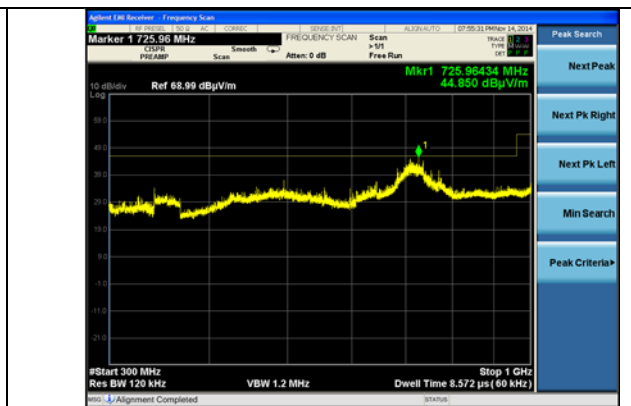
3600-4000 MHz (reduced VBW)



4-18 GHz (reduced VBW)

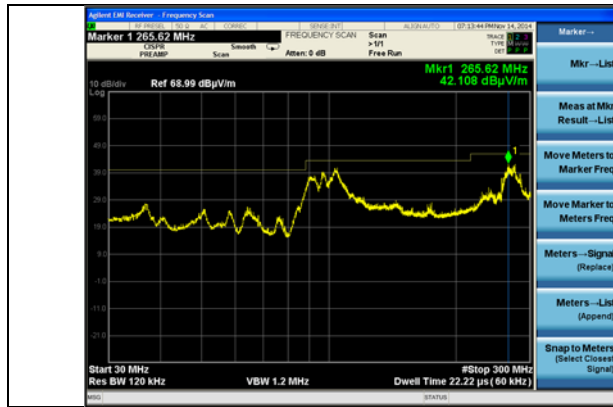


300-1000 MHz Vertical



300-1000 MHz Horizontal

Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052



30-300 MHz Vertical



30-300 MHz Horizontal

Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052

B3 – Frequency Stability

Manufacturer	Venstar
Operator	Shane Rismeyer
Measurement Procedure	ANSI C63.10 - 2009
Additional Notes	<p>The power and frequency stability of the device was examined as a function of the input voltage available to the EUT. A Spectrum Analyzer was used to measure the RF output power and frequency at the appropriate frequency markers. Power was supplied by an external bench-type DC power supply and was varied from the nominal.</p> <p>The power was then cycled On/Off to observe system response. No unusual response was observed, the emission characteristics were well behaved, and the system returned to the same state of operation as before the power cycle.</p> <p>Below is data showing stability of the fundamental frequency.</p> <p>Continuous transmit modulated used for this test.</p>

Channel	Minimum VDC (Hz)	Nominal VDC (Hz)	Maximum VDC (Hz)	freq drift (Hz)
Low (2412 MHz)	2412530000	2412530000	2412530030	30
Mid (2437 MHz)	2436500000	2436500000	2436500010	10
High (2462 MHz)	2462530000	2462530000	2462530032	32

Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052

B4 – AC Mains Conducted Emissions

Test Setup

The test area and setup are in accordance with ANSI C63.4-2009 and with Title 47 CFR, FCC Part 15, Industry Canada RSS-210 and RSS GEN. The EUT was placed on a non-conductive table, with a height of 80 cm above the reference ground plane. The EUT's power cable was plugged into a Line Impedance Stabilization Network (LISN). The AC power supply of 24VAC was provided via an appropriate broadband EMI Filter, and then to the LISN line input. Final readings were then taken and recorded. After the EUT was setup and connected to the LISN, the RF Sampling Port of the LISN was connected to a 10 dB Attenuator-Limiter, and then to the EMI Receiver. The LISN used has the ability to terminate the unused port with a 50Ω (ohm) load when switched to either L1 (line) or L2 (neutral).

Test Procedure

The EUT was investigated in continuous modulated transmit mode for this portion of the testing. The appropriate frequency range and bandwidths were selected on the EMI Receiver, and measurements were made. The bandwidth used for these measurements was as specified for Quasi-Peak and Average detectors in the frequency range of 150 kHz to 30 MHz. Final readings were then taken and recorded.

Limits of Conducted Emissions at the AC Mains Ports

Frequency Range (MHz)	Class B Limits (dBμV)		Measuring Bandwidth
	Quasi-Peak	Average	
0.150 -0.50 *	66-56	56-46	RBW = 9 kHz
0.5 – 5.0	56	46	
5.0 – 30	60	50	
* The limit decreases linearly with the logarithm of the frequency in this range.			

Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052

Test Data

Manufacturer:	Venstar				
Date(s) of Test:	11/14/14				
Test Engineer:	Shane Rismeyer				
Voltage:	24 VAC 60Hz				
Operation Mode:	Continuous transmit modulated used for this test. (No significant difference between transmit or receive or channel selection)				
Environmental Conditions in the Lab:	Temperature: 71° F Relative Humidity: 40%				
Test Location:	X	AC Mains Test area			Chamber
EUT Placed On:	X	40cm from Vertical Ground Plane			10cm Spacers
	X	80cm above Ground Plane			Other:
Measurements:		Pre-Compliance		Preliminary	X Final
Detectors Used:		Peak	X	Quasi-Peak	X Average

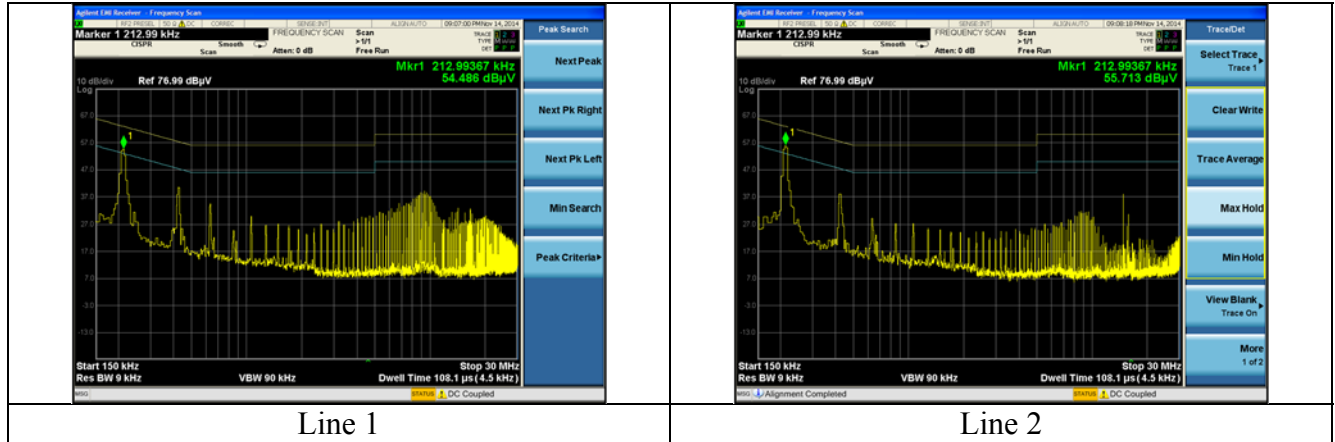
Sample Calculation:

Margin (dB) = Limit (dB μ V) – Reading (dB μ V)

Frequency (MHz)	Line	QP Reading (dB μ V)	QP Limit (dB μ V)	QP Margin (dB)	Average Reading (dB μ V)	Average Limit (dB μ V)	Average Margin (dB)
0.213	L1	53.300	63.088	9.788	44.400	53.088	8.688
0.424	L1	36.500	57.372	20.872	27.500	47.372	19.872
0.209	L2	50.700	63.266	12.566	41.200	53.266	12.066
0.424	L2	40.800	57.372	16.572	37.100	47.372	10.272

Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052

These screen captures represent Peak Emissions. For conducted emission measurements, both a Quasi-Peak detector function and an Average detector function are utilized. The emissions must meet both the Quasi-peak limit and the Average limit as described in 47 CFR 15.207 and RSS GEN 7.2.2 (Table 2).



Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052

Appendix C - Uncertainty Summary

This uncertainty represents an expanded uncertainty expressed at approximately the 95 % confidence level, using a coverage factor of k=2.

Table of Expanded Uncertainty Values, (K=2) for Specified Measurements

Measurement Type	Particular Configuration	Uncertainty Values
Radiated Emissions	3 – Meter chamber, Biconical Antenna	4.82 dB
Radiated Emissions	3-Meter Chamber, Log Periodic Antenna	4.88 dB
Radiated Emissions	3-Meter Chamber, Horn Antenna	4.85 dB
Absolute Conducted Emissions	Agilent PSA/ESA Series	1.38 dB
AC Line Conducted Emissions	Shielded Room/EMCO LISN	3.20 dB
Radiated Immunity	3 Volts/Meter in 3-Meter Chamber	2.05 Volts/Meter
Conducted Immunity	3 Volts level	2.33 V
EFT Burst, Surge, VDI	230 VAC	54.4 V
ESD Immunity	Discharge at 15kV	3200 V
Temperature/Humidity	Thermo-hygrometer	0.64° / 2.88 %RH

Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052

Appendix D - References

Publication	Year	Title
FCC CFR Parts 0-15	2014	Code of Federal Regulations – Telecommunications
ANSI C63.4	2009	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
RSS-210 Annex 8	2010	Low-power License-exempt Radio communication Devices (All Frequency Bands): Category I Equipment
RSS-GEN Issue 4	2014	General Requirements and Information for the Certification of Radio Apparatus
ANSI C63.10	2009	American National Standard for Testing Unlicensed Wireless Devices
FCC KDB 558074 D01 DTS Meas Guidance v03r02	2014	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247

Prepared For: Venstar	Model Number: THERM-500	Report #: 314318
EUT: ColorTouch	Serial Number: Eng Sample	LSR Job #: C-2052