

Venstar, Inc.

TEST REPORT FOR

**WiFi Temperature Sensor
Model: WiFi Sensor Pro**

Tested to The Following Standards:

**FCC Part 15 Subpart C Section(s)
15.207 and 15.247
(DTS 2400-2483.5 MHz)**

Report No.: 103607-6

Date of issue: March 5, 2020



Test Certificate # 803.01

This test report bears the accreditation symbol indicating that the testing performed herein meets the test and reporting requirements of ISO/IEC 17025 under the applicable scope of testing for CKC Laboratories, Inc.

We strive to create long-term, trust based relationships by providing sound, adaptive, customer first testing services. We embrace each of our customers' unique EMC challenges, not as an interruption to set processes, but rather as the reason we are in business.

TABLE OF CONTENTS

Administrative Information	3
Test Report Information	3
Report Authorization	3
Test Facility Information	4
Software Versions	4
Site Registration & Accreditation Information	4
Summary of Results	5
Modifications During Testing	5
Conditions During Testing	5
Equipment Under Test	6
General Product Information	6
FCC Part 15 Subpart C	14
15.247(a)(2) 6dB Bandwidth	14
15.247(b)(3) Output Power	19
15.247(e) Power Spectral Density	25
15.247(d) RF Conducted Emissions & Band Edge	30
15.247(d) Radiated Emissions & Band Edge	35
15.207 AC Conducted Emissions	45
Supplemental Information	54
Measurement Uncertainty	54
Emissions Test Details	54

ADMINISTRATIVE INFORMATION

Test Report Information

REPORT PREPARED FOR:

Venstar, Inc.
9250 Owensmouth Avenue
Chatsworth CA 91311

Representative: Alex Garashin

REPORT PREPARED BY:

Darcy Thompson
CKC Laboratories, Inc.
5046 Sierra Pines Drive
Mariposa, CA 95338

Project Number: 103607

DATE OF EQUIPMENT RECEIPT:

January 14, 2020

DATE(S) OF TESTING:

January 14-19, 2020

Report Authorization

The test data contained in this report documents the observed testing parameters pertaining to and are relevant for only the equipment provided by the client, tested in the agreed upon operational mode(s) and configuration(s) as identified herein. Compliance assessment remains the client's responsibility. This report may not be used to claim product endorsement by A2LA or any government agencies. This test report has been authorized for release under quality control from CKC Laboratories, Inc.



Steve Behm
Director of Quality Assurance & Engineering Services
CKC Laboratories, Inc.

Test Facility Information



Our laboratories are configured to effectively test a wide variety of product types. CKC utilizes first class test equipment, anechoic chambers, data acquisition and information services to create accurate, repeatable and affordable test results.

TEST LOCATION(S):
CKC Laboratories, Inc.
110 Olinda Place
Brea, CA 92823

Software Versions

CKC Laboratories Proprietary Software	Version
EMITest Emissions	5.03.12

Site Registration & Accreditation Information

Location	*NIST CB #	FCC	Japan
Canyon Park, Bothell, WA	US0081	US1022	A-0136
Brea, CA	US0060	US1025	A-0136
Fremont, CA	US0082	US1023	A-0136
Mariposa, CA	US0103	US1024	A-0136

*CKC's list of NIST designated countries can be found at: <https://standards.gov/cabs/designations.html>

SUMMARY OF RESULTS

Standard / Specification: FCC Part 15 Subpart C – 15.207 and 15.247 (DTS)

Test Procedure	Description	Modifications	Results
15.247(a)(2)	6dB Bandwidth	NA	Pass
15.247(b)(3)	Output Power	NA	Pass
15.247(e)	Power Spectral Density	NA	Pass
15.247(d)	RF Conducted Emissions & Band Edge	NA	Pass
15.247(d)	Radiated Emissions & Band Edge	NA	Pass
15.207	AC Conducted Emissions	NA	Pass

NA = Not Applicable

ISO/IEC 17025 Decision Rule

The declaration of pass or fail herein is based upon assessment to the specification(s) listed above, including where applicable, assessment of measurement uncertainties. For performance related tests, equipment was monitored for specified criteria identified in that section of testing.

Modifications During Testing

This list is a summary of the modifications made to the equipment during testing.

Summary of Conditions

No modifications were made during testing.

Modifications listed above must be incorporated into all production units.

Conditions During Testing

This list is a summary of the conditions noted to the equipment during testing.

Summary of Conditions

None

EQUIPMENT UNDER TEST (EUT)

During testing, numerous configurations may have been utilized. The configurations listed below support compliance to the standard(s) listed in the Summary of Results section.

Configuration 1

Equipment Tested:

Device	Manufacturer	Model #	S/N
WiFi Temperature Sensor	Venstar, Inc.	WiFi Sensor Pro	NA

Support Equipment:

Device	Manufacturer	Model #	S/N
120Vac to 24Vac power transformer	SANDAN	AC2400750	NA
Laptop computer	Lenovo	ThinkPad R61 8934	1S8934FAUL3B7192

General Product Information:

Product Information	Manufacturer-Provided Details
Equipment Type:	Stand-Alone Equipment
Type of Wideband System:	802.11n20
Operating Frequency Range:	2412MHz to 2462MHz
Modulation Type(s):	OFDM, BPSK, QPSK, 16-QAM, 64-QAM
Maximum Duty Cycle:	98%
Number of TX Chains:	1
Antenna Type(s) and Gain:	PCB Trace, 2.0dBi
Beamforming Type:	NA
Antenna Connection Type:	Integral
Nominal Input Voltage:	Four 1.5V (AA) batteries or 24Vac
Firmware / Software used for Test:	RLIB-VST02-01-17869-000000 PTIM-VST02-01-20874-000000 RTOS-VST02-01-20904-000000

EUT and Accessory Photo(s)

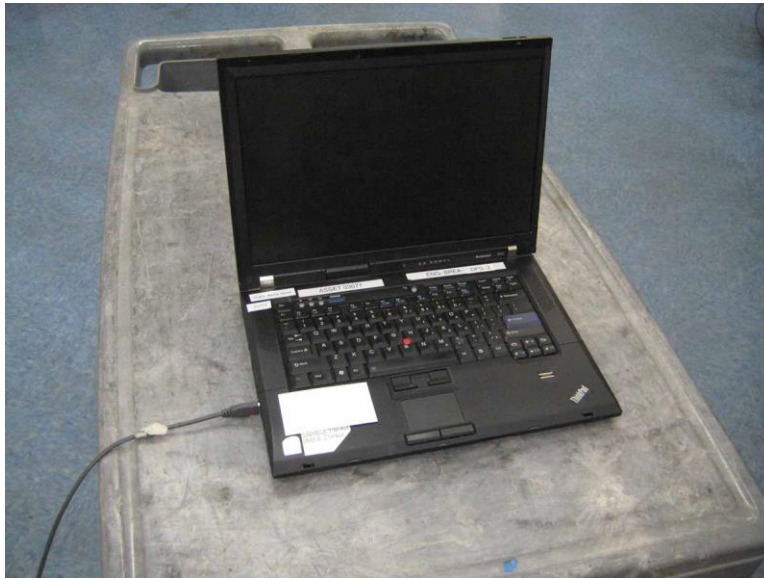






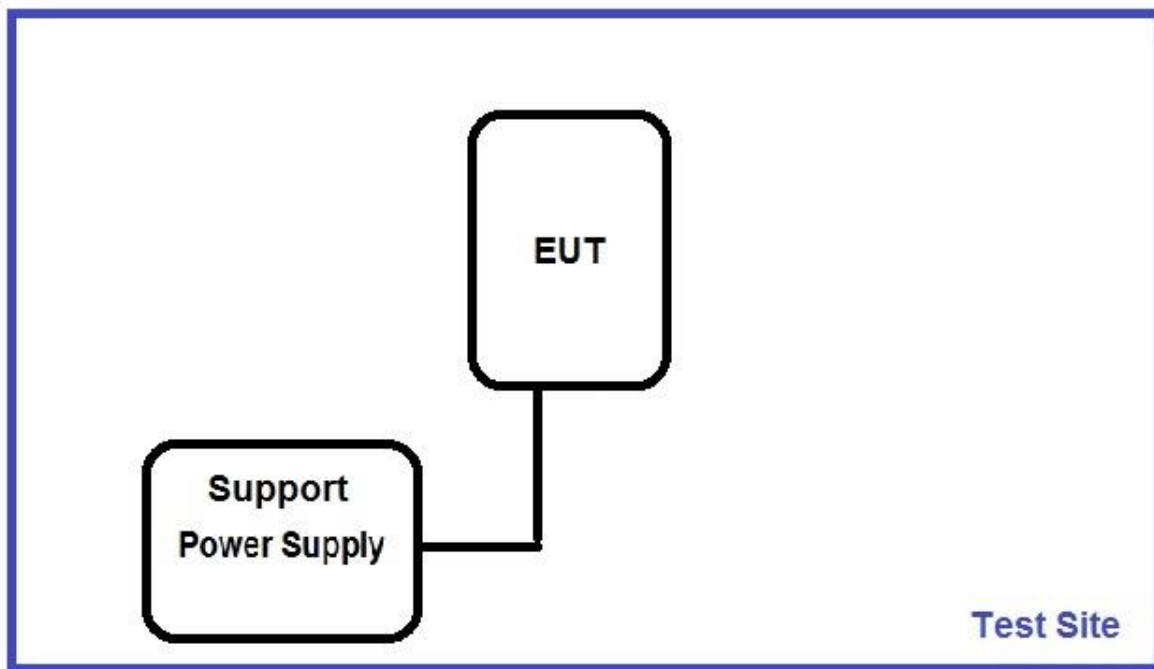


Support Equipment Photo(s)

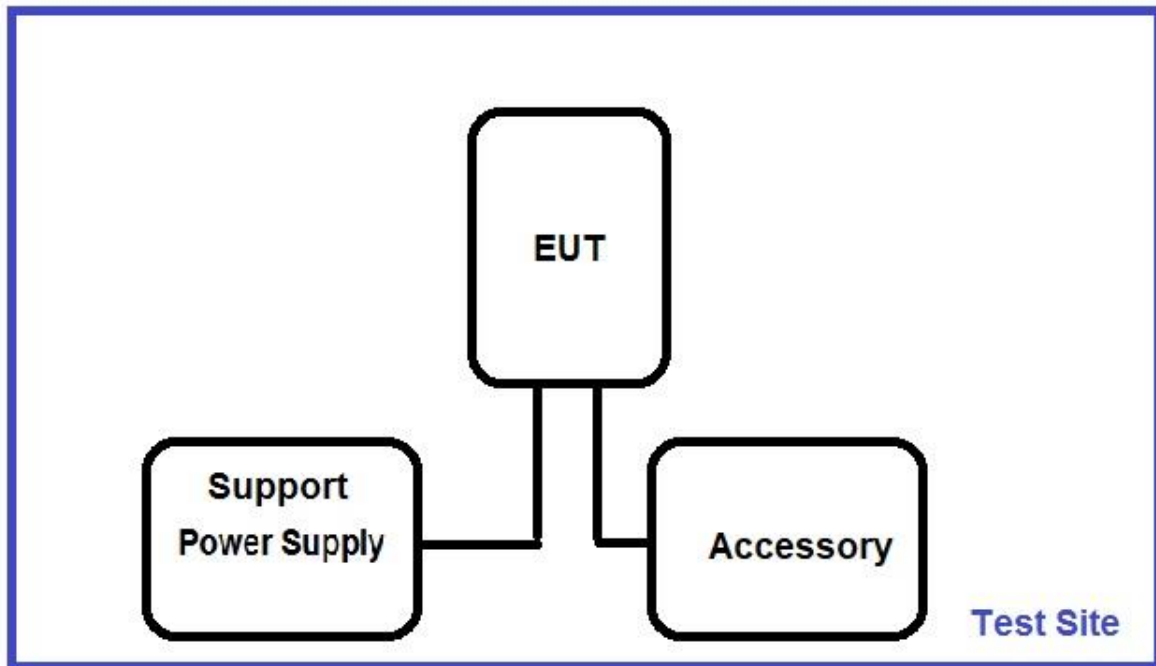


Block Diagram of Test Setup(s)

Test Setup Block Diagram



Test Setup Block Diagram



FCC Part 15 Subpart C

15.247(a)(2) 6dB Bandwidth

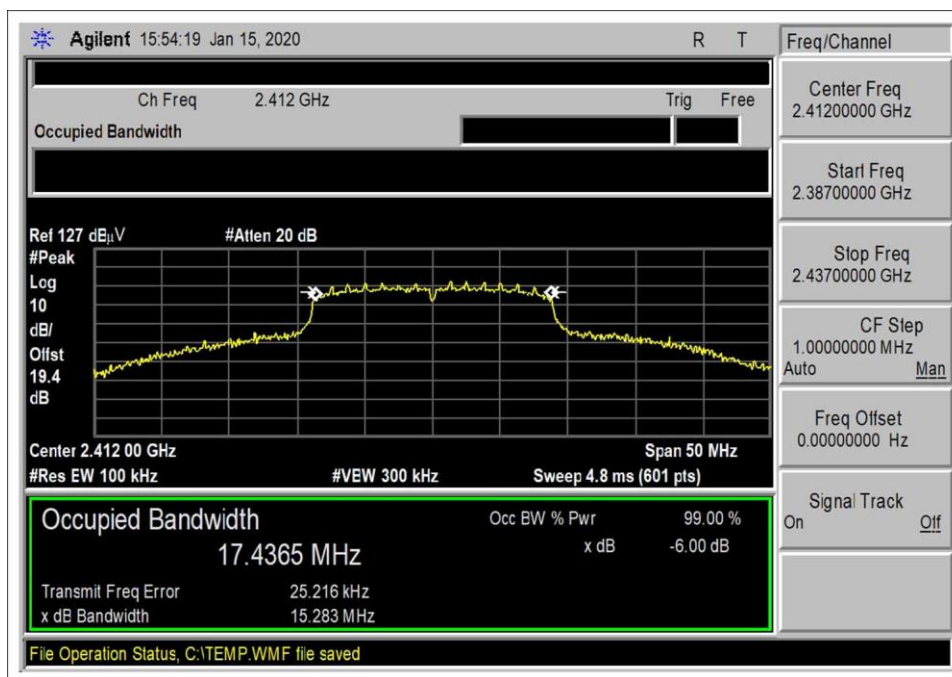
Test Setup/Conditions			
Test Location:	Brea Lab A	Test Engineer:	S. Yamamoto
Test Method:	ANSI C63.10 (2013), KDB 558074 D01 15.247 Meas Guidance v05r02 April 2, 2019	Test Date(s):	1/15/2020
Configuration:	1		
Test Setup:	The EUT is connected to the spectrum analyzer using an attenuator and coaxial cable. Transmitting frequencies: 2412MHz (CH1), 2437MHz (CH6), 2462MHz (CH11) Modulation/Mode: 802.11n20 MCS0 MCS7 duty cycle 98% Measurement frequencies: Low (2412MHz), Middle (2437MHz), High (2462MHz)		

Environmental Conditions			
Temperature (°C)	20	Relative Humidity (%):	48

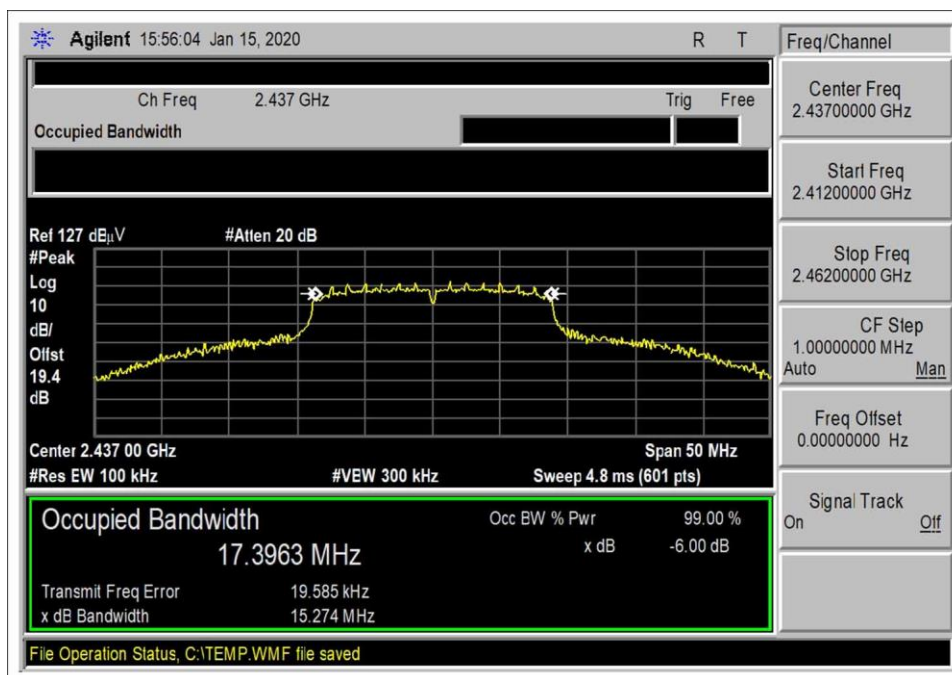
Test Equipment					
Asset#	Description	Manufacturer	Model	Cal Date	Cal Due
02869	Spectrum Analyzer	Agilent	E4440A	7/25/2019	7/25/2020
03431	Attenuator	Aeroflex/Weinschel	89-20-21	12/20/2019	12/20/2021
P07243	Cable	H&S	32022-29094K-29094K-24TC	7/5/2018	7/5/2020

Test Data Summary					
Frequency (MHz)	Antenna Port	Modulation	Measured (kHz)	Limit (kHz)	Results
2412	1	802.11n20 MCS0	15283	≥500	Pass
2437	1	802.11n20 MCS0	15274	≥500	Pass
2462	1	802.11n20 MCS0	15271	≥500	Pass
2412	1	802.11n20 MCS7	17607	≥500	Pass
2437	1	802.11n20 MCS7	17610	≥500	Pass
2462	1	802.11n20 MCS7	17597	≥500	Pass

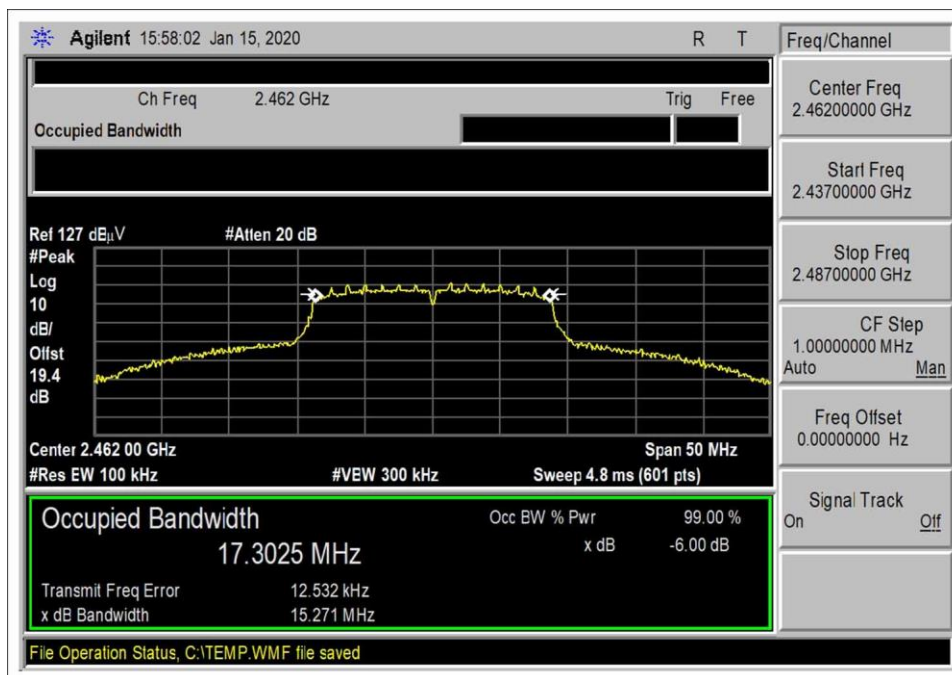
Plot(s)



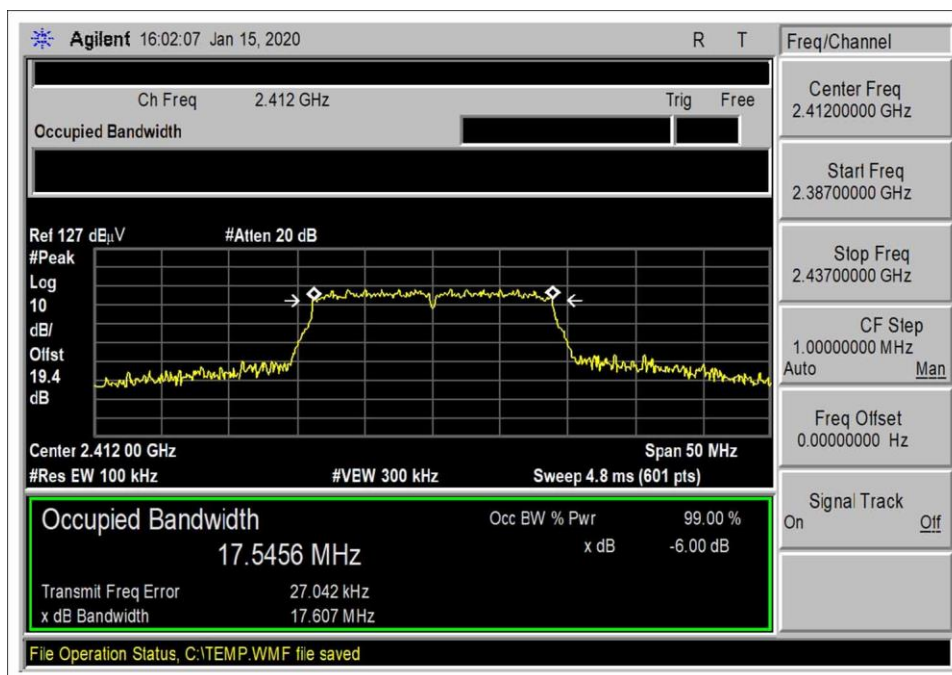
MCS0 Low Channel



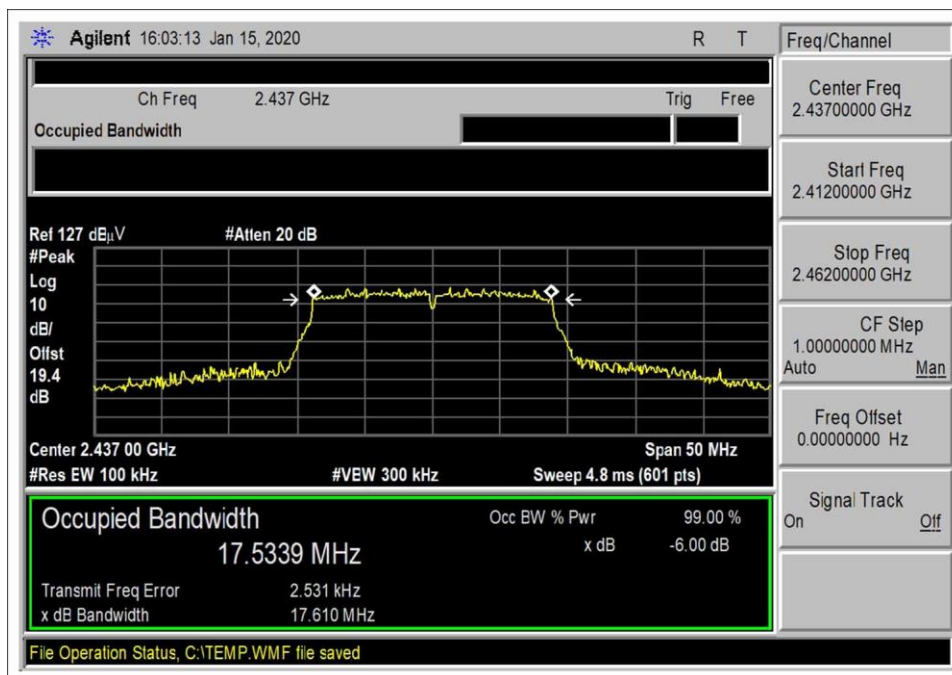
MCS0 Middle Channel



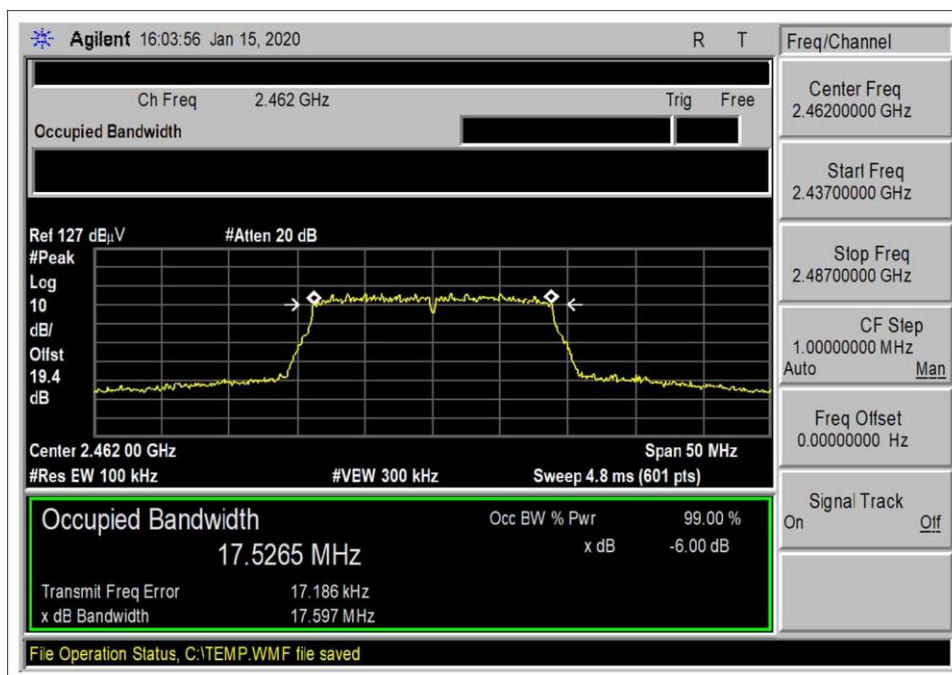
MCS0 High Channel



MCS7 Low Channel

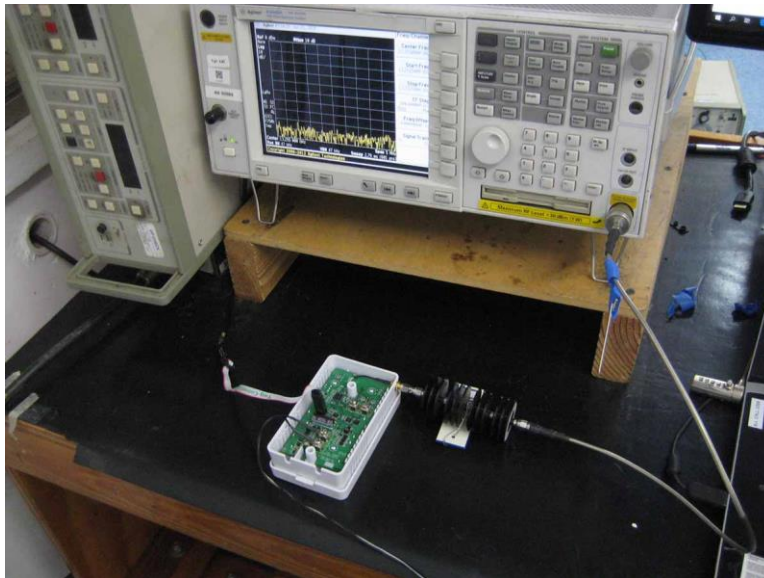


MCS7 Middle Channel



MCS7 High Channel

Test Setup Photo(s)



15.247(b)(3) Output Power

Test Setup / Conditions			
Test Location:	Brea Lab A	Test Engineer:	S. Yamamoto
Test Method:	ANSI C63.10 (2013), KDB 558074 D01 15.247 Meas Guidance v05r02 April 2, 2019	Test Date(s):	1/18/2020
Configuration:	1		
Test Setup:	The EUT is connected to the spectrum analyzer using an attenuator and coaxial cable. Transmitting frequencies: 2412MHz (CH1), 2437MHz (CH6), 2462MHz (CH11) Modulation/Mode: 802.11n20 MCS0 MCS7 duty cycle 98% Measurement frequencies: Low (2412MHz), Middle (2437MHz), High (2462MHz) Measurement power level setting: Low 5, Middle 0, High 5		

Environmental Conditions			
Temperature (°C)	21	Relative Humidity (%):	35

Test Equipment					
Asset#	Description	Manufacturer	Model	Cal Date	Cal Due
02869	Spectrum Analyzer	Agilent	E4440A	7/25/2019	7/25/2020
03431	Attenuator	Aeroflex/Weinschel	89-20-21	12/20/2019	12/20/2021
P07243	Cable	H&S	32022-29094K-29094K-24TC	7/5/2018	7/5/2020
02476	AC Power Supply	California Instruments	1251WP	3/18/2019	3/18/2021
P07164	Multimeter	Fluke	8845A/G	7/30/2019	7/30/2021
01379	Variac	Superior Electric	1256D	12/12/2019	12/12/2020

Test Data Summary - Voltage Variations					
Frequency (MHz)	Modulation / Ant Port	V _{Minimum} (dBm)	V _{Nominal} (dBm)	V _{Maximum} (dBm)	Max Deviation from V _{Nominal} (dB)
2412	802.11n20 MCS0/1	10.8	10.8	10.8	0.0
2437	802.11n20 MCS0/1	14.5	14.5	14.5	0.0
2462	802.11n20 MCS0/1	10.4	10.4	10.4	0.0
2412	802.11n20 MCS7/1	7.3	7.3	7.3	0.0
2437	802.11n20 MCS7/1	11.3	11.3	11.3	0.0
2462	802.11n20 MCS7/1	7.3	7.3	7.3	0.0

Test performed using operational mode with the highest output power, representing worst case.

Parameter Definitions:

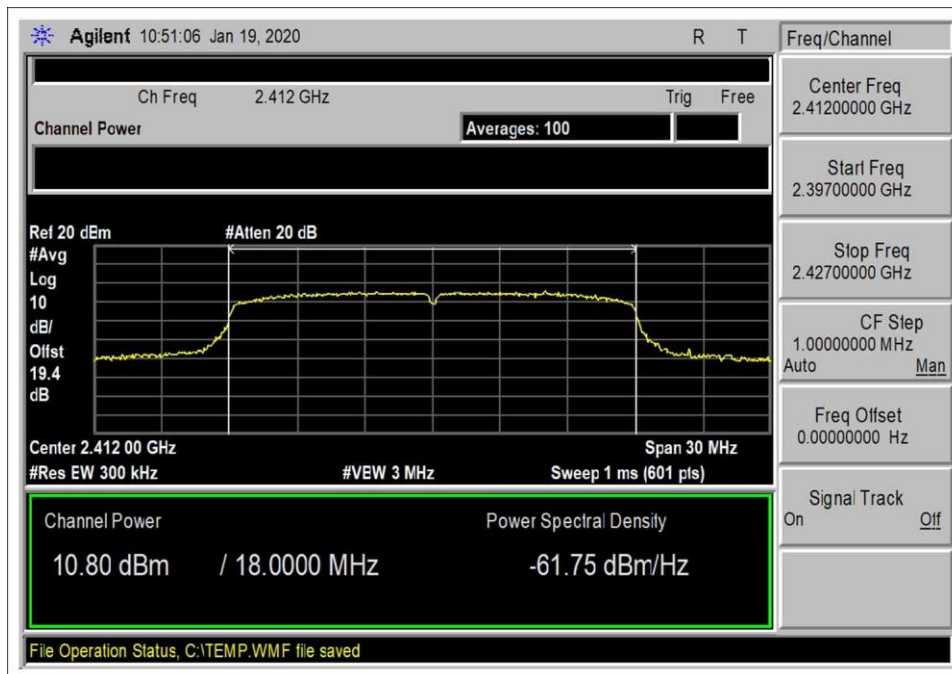
Measurements performed at input voltage V_{Nominal} ± 15%.

Parameter	Value
V _{Nominal} :	24Vac
V _{Minimum} :	20.4Vac
V _{Maximum} :	27.6Vac

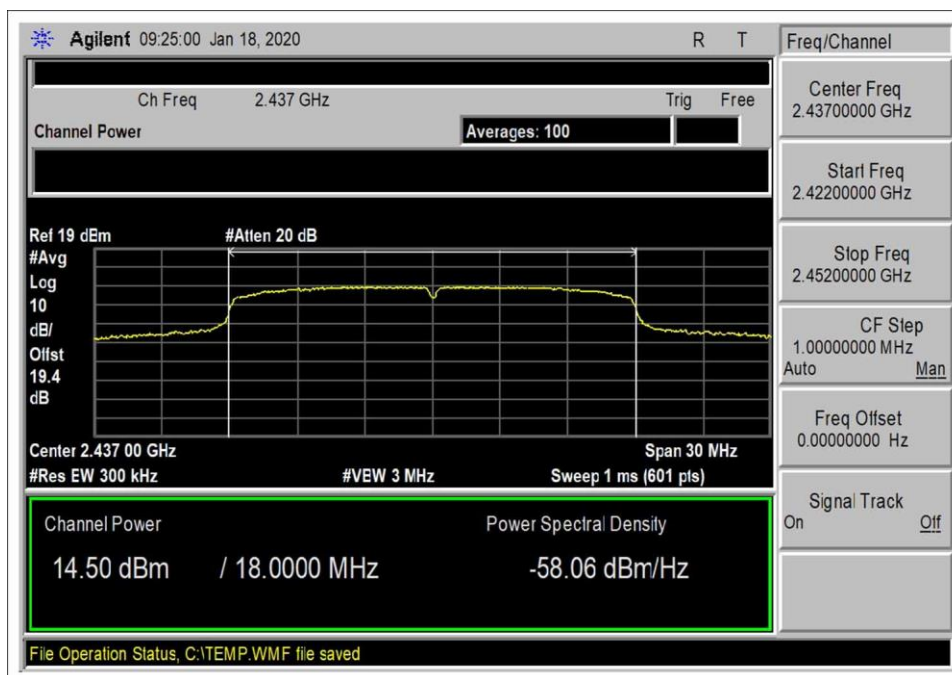
Power Output Test Data Summary - RF Conducted Measurement					
Measurement Option: AVGSA-1					
Frequency (MHz)	Modulation	Ant. Type / Gain (dBi)	Measured (dBm)	Limit (dBm)	Results
2412	802.11n20 MCS0	PCB Trace/2.0dBi	10.8	≤30	Pass
2437	802.11n20 MCS0	PCB Trace/2.0dBi	14.5	≤30	Pass
2462	802.11n20 MCS0	PCB Trace/2.0dBi	10.4	≤30	Pass
2412	802.11n20 MCS7	PCB Trace/2.0dBi	7.3	≤30	Pass
2437	802.11n20 MCS7	PCB Trace/2.0dBi	11.3	≤30	Pass
2462	802.11n20 MCS7	PCB Trace/2.0dBi	7.3	≤30	Pass

This equipment can be either AC powered or battery powered. Power output tests were performed using AC input. Note that using a fresh battery yielded the same results.

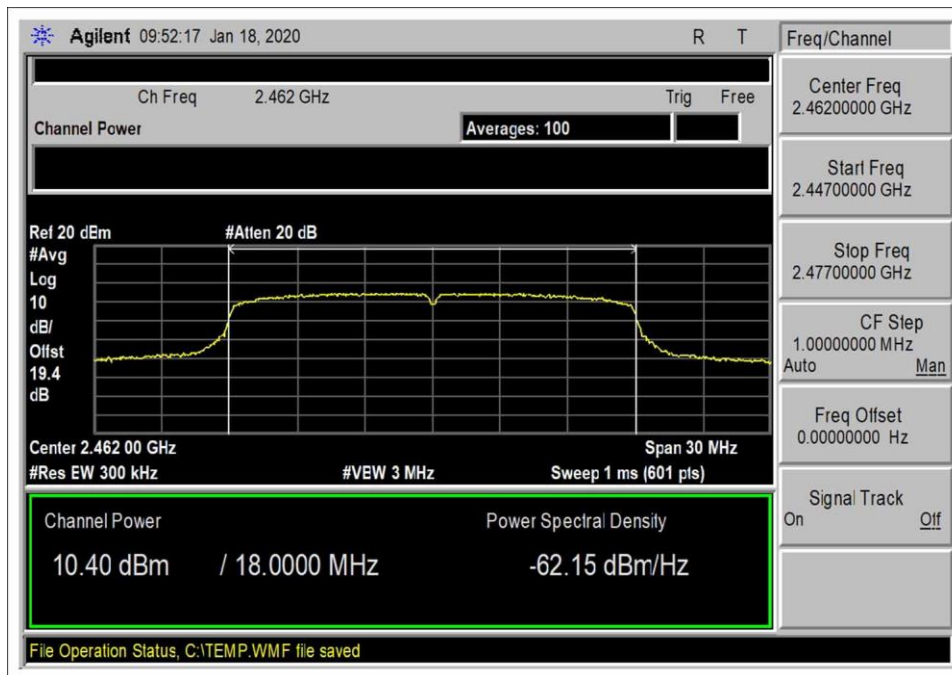
Plots



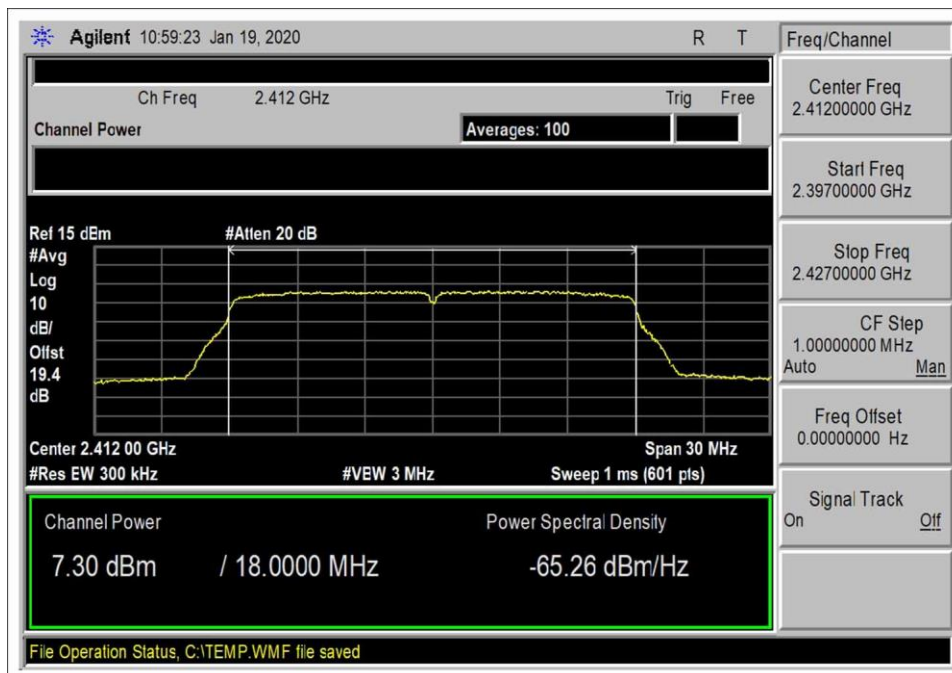
MCS0 Low Channel Power Level 5



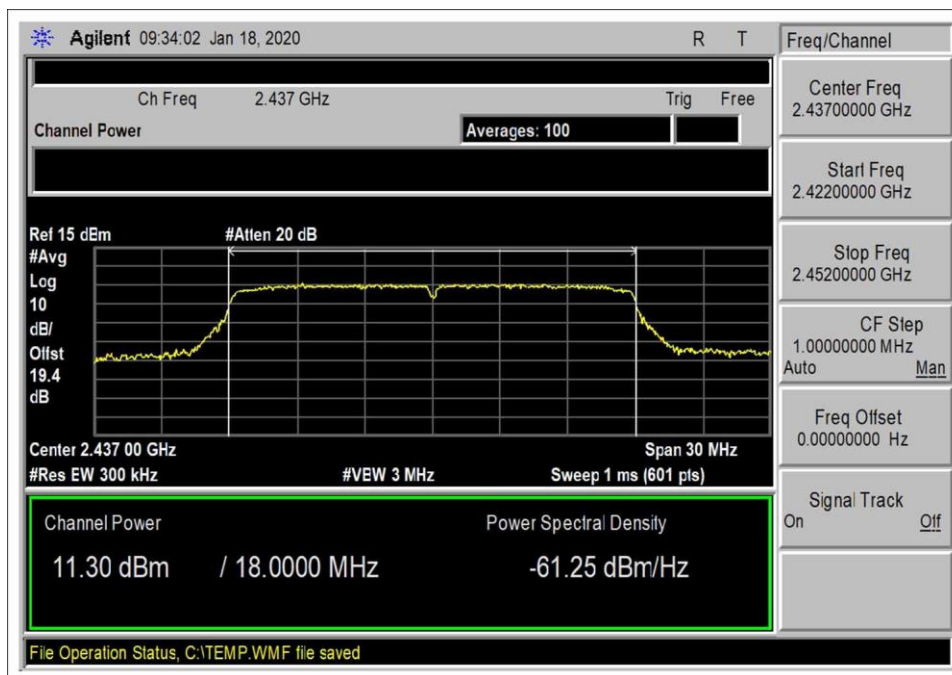
MCS0 Middle Channel Power Level 0



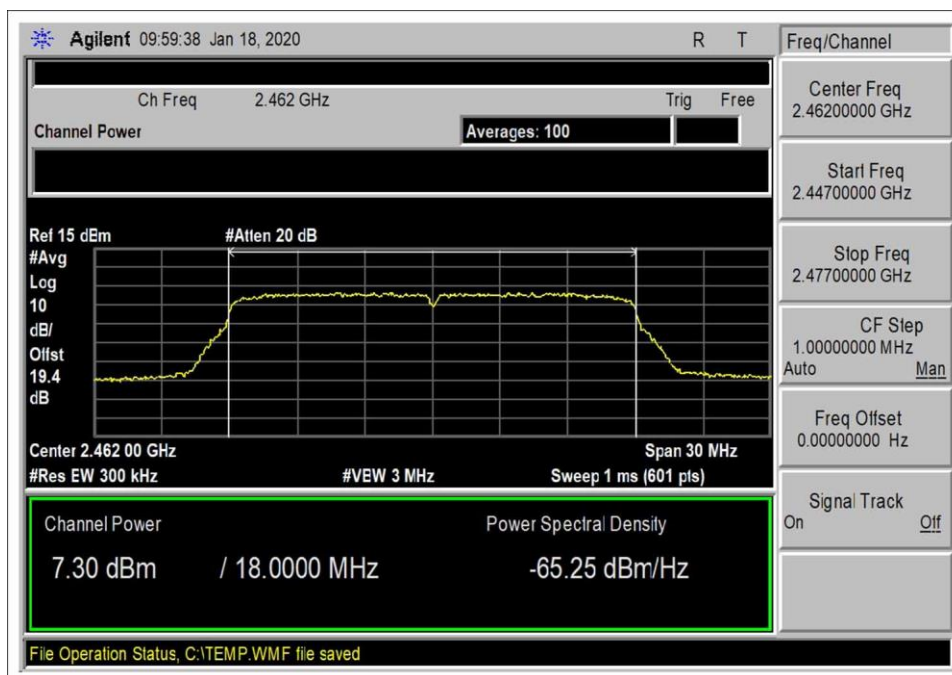
MCS0 High Channel Power Level 5



MCS7 Low Channel Power Level 5

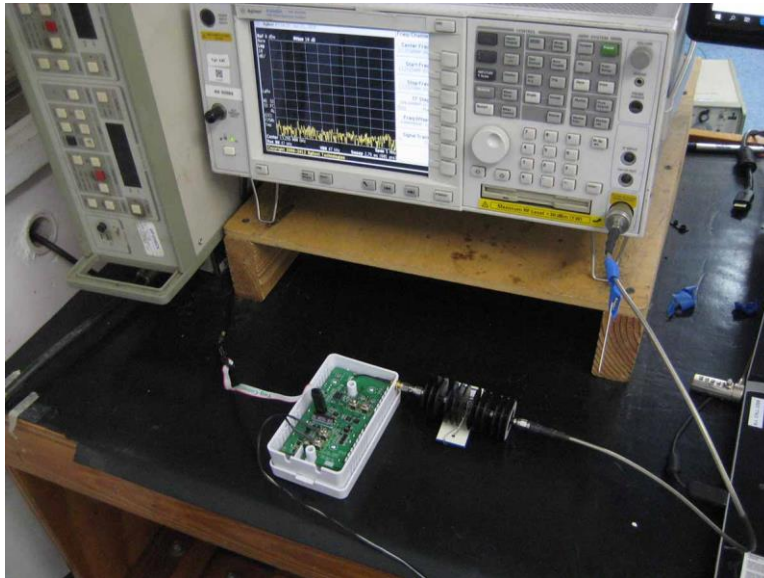


MCS7 Middle Channel Power Level 0



MCS7 High Channel Power Level 5

Test Setup Photo(s)



15.247(e) Power Spectral Density

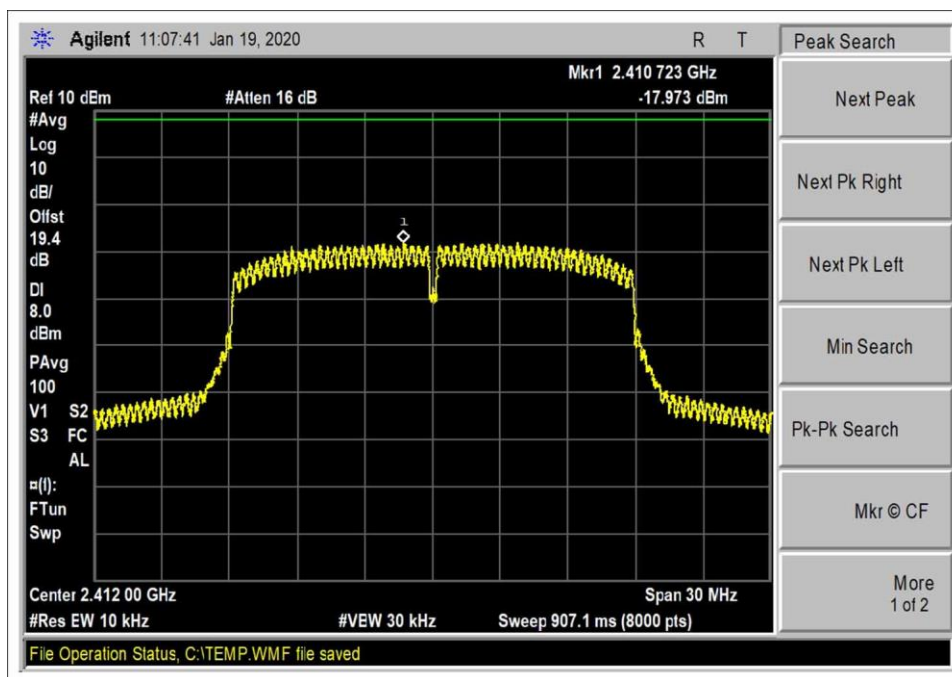
Test Setup / Conditions / Data			
Test Location:	Brea Lab A	Test Engineer:	S. Yamamoto
Test Method:	ANSI C63.10 (2013), KDB 558074 D01 15.247 Meas Guidance v05r02 April 2, 2019	Test Date(s):	1/18/2020
Configuration:	1		
Test Setup:	The EUT is connected to the spectrum analyzer using an attenuator and coaxial cable. Transmitting frequencies: 2412MHz (CH1), 2437MHz (CH6), 2462MHz (CH11) Modulation/Mode: 802.11n20 MCS0 MCS7 duty cycle 98% Measurement frequencies: Low (2412MHz), Middle (2437MHz), High (2462MHz) Measurement power level setting: Low 5, Middle 0, High 5		

Environmental Conditions			
Temperature (°C)	21	Relative Humidity (%):	35

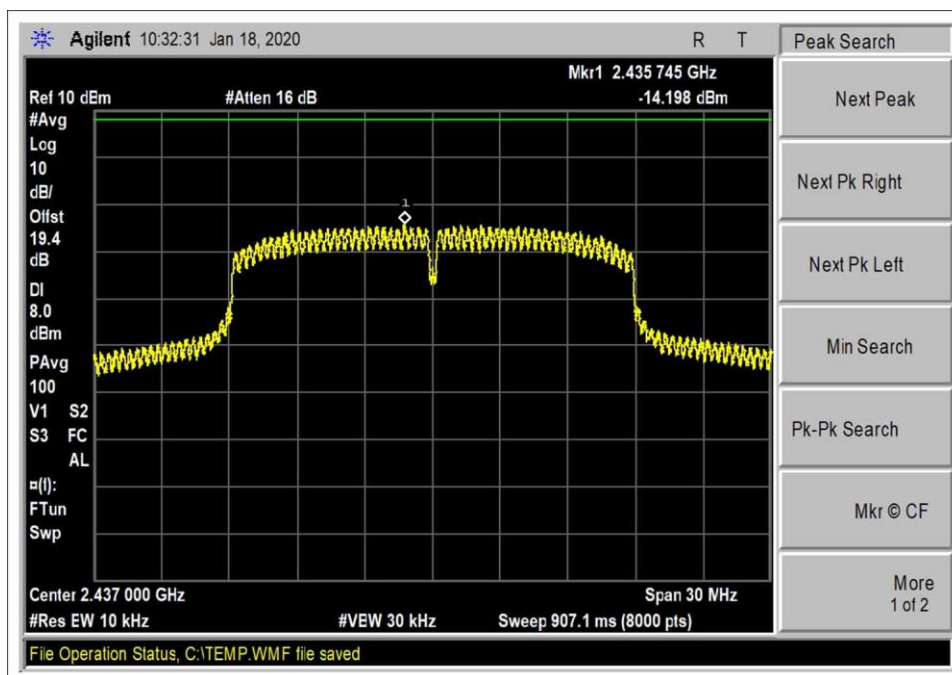
Test Equipment					
Asset#	Description	Manufacturer	Model	Cal Date	Cal Due
02869	Spectrum Analyzer	Agilent	E4440A	7/25/2019	7/25/2020
03431	Attenuator	Aeroflex/Weinschel	89-20-21	12/20/2019	12/20/2021
P07243	Cable	H&S	32022-29094K-29094K-24TC	7/5/2018	7/5/2020

PSD Test Data Summary - RF Conducted Measurement				
Measurement Method: AVGPSD-1				
Frequency (MHz)	Modulation	Measured (dBm/3kHz)	Limit (dBm/3kHz)	Results
2412	802.11n20 MCS0	-17.973	≤8	Pass
2437	802.11n20 MCS0	-14.198	≤8	Pass
2462	802.11n20 MCS0	-17.815	≤8	Pass
2412	802.11n20 MCS7	-21.783	≤8	Pass
2437	802.11n20 MCS7	-18.960	≤8	Pass
2462	802.11n20 MCS7	-22.280	≤8	Pass

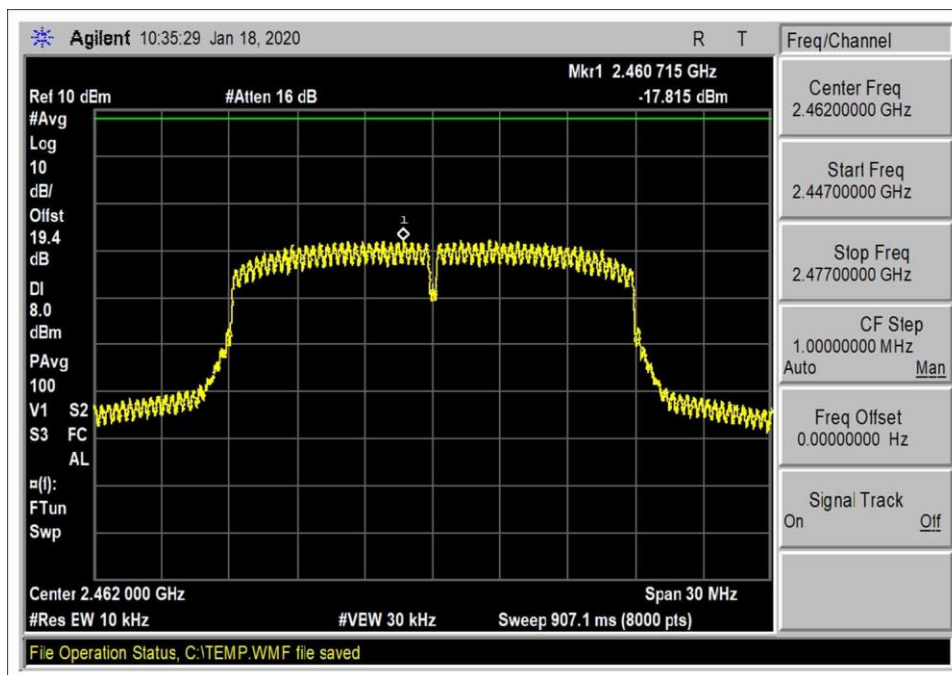
Plots



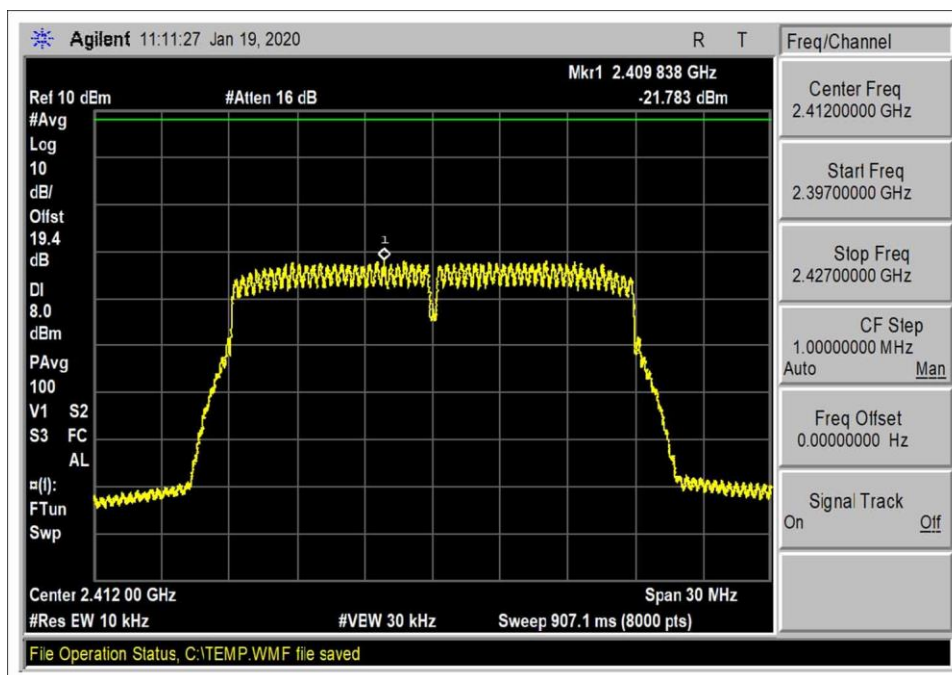
MCS0 Low Channel Power Level 5



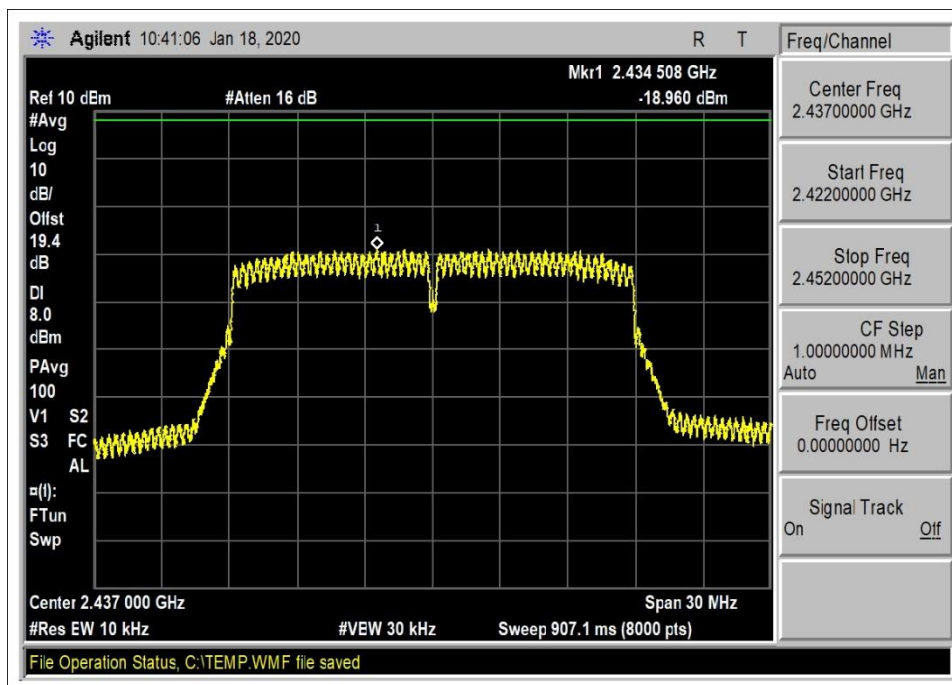
MCS0 Middle Channel Power Level 0



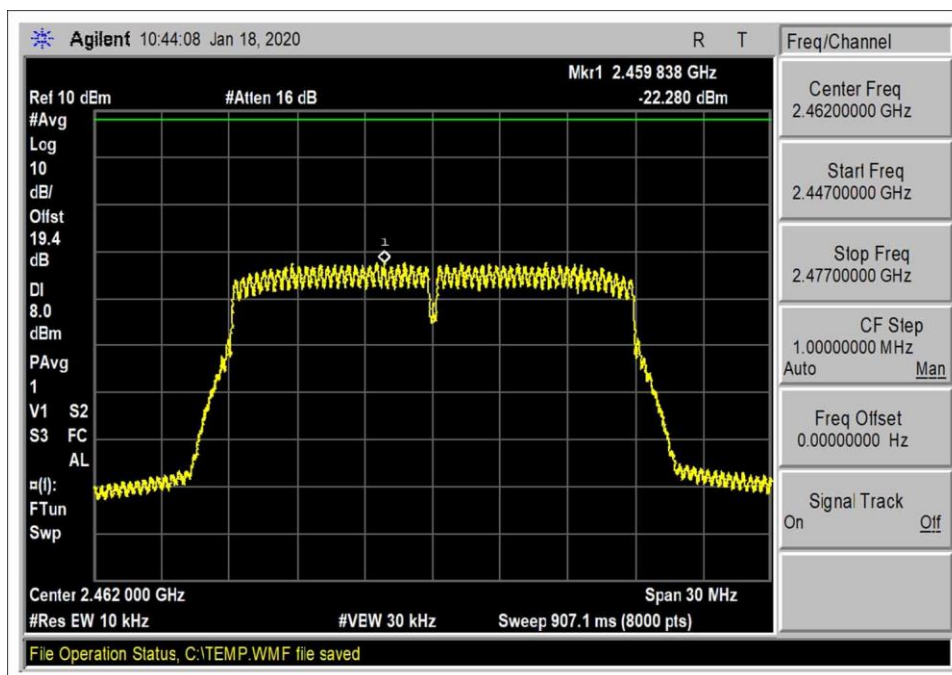
MCS0 High Channel Power Level 5



MCS7 Low Channel Power Level 5

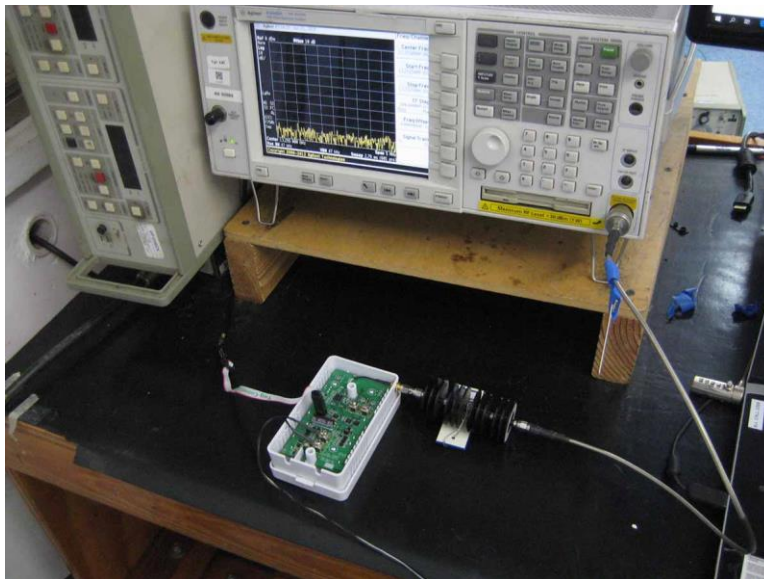


MCS7 Middle Channel Power Level 0



MCS7 High Channel Power Level 5

Test Setup Photo(s)



15.247(d) RF Conducted Emissions & Band Edge

Test Setup / Conditions / Data

Test Location: CKC Laboratories, Inc. • 110 N. Olinda Place • Brea, CA 92823 • 714-993-6112
 Customer: **Venstar, Inc.**
 Specification: **15.247(d) Conducted Spurious Emissions**
 Work Order #: **103607** Date: 1/15/2020
 Test Type: **Conducted Emissions** Time: 08:42:50
 Tested By: S. Yamamoto Sequence#: 0
 Software: EMITest 5.03.12 24Vac

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

Test Conditions / Notes:

The EUT is connected to the spectrum analyzer using an attenuator and coaxial cable.
Transmitting frequencies: 2412MHz (CH1), 2437MHz (CH6), 2462MHz (CH11)
Modulation/Mode: 802.11n20 MCS0 duty cycle 98%
KDB558074 D01 15.247 Meas Guidance v05r02 April 2, 2019
ANSI C63.10 2013
Measurement power level setting: Low 5, Middle 0, High 5
MCS0 is the worst case setting for this test.
Frequency range of data sheet 9kHz to 25GHz
RBW=100kHz, VBW=300kHz
Temperature: 21°C
Humidity: 35%
Pressure: 100kPa
Site A
No emissions found within 25dB of the limit line.

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
	AN02869	Spectrum Analyzer	E4440A	7/25/2019	7/25/2020
	AN03431	Attenuator	89-20-21	12/20/2019	12/20/2021
	ANP07243	Cable	32022-29094K-29094K-24TC	7/5/2018	7/5/2020

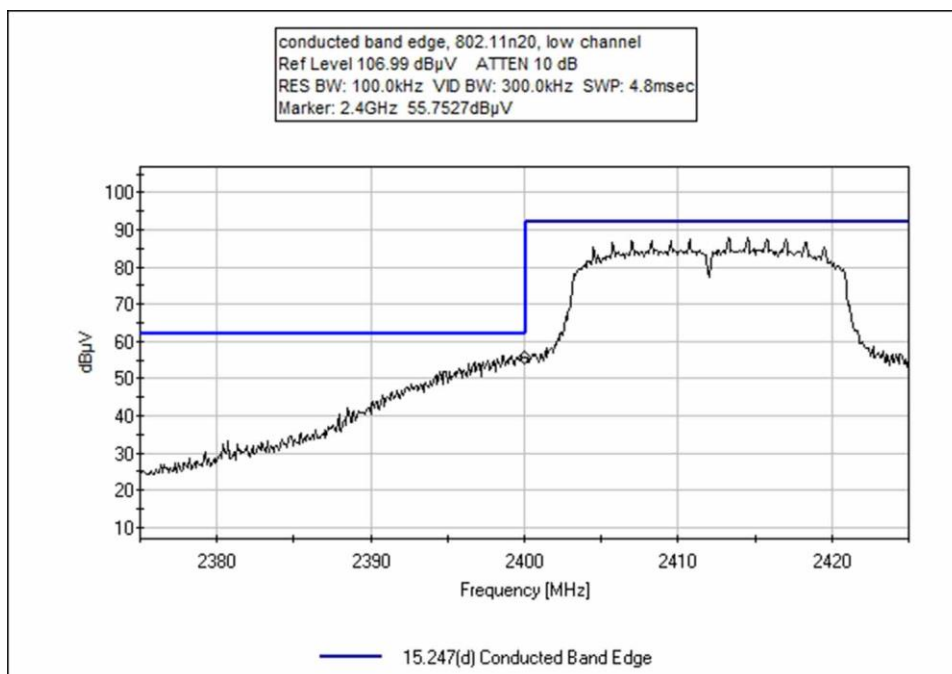
Band Edge

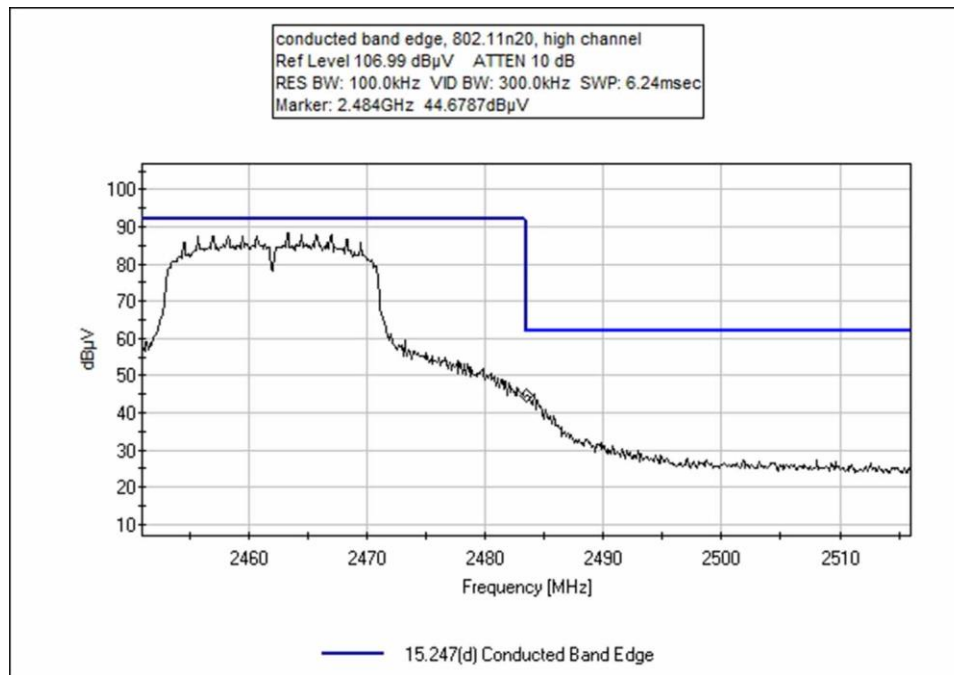
Band Edge Summary

Limit applied: Max Power/100kHz - 30dB (When average power limit is applied).

Frequency (MHz)	Modulation	Measured (dBm)	Limit (dBm)	Results
2400.0	802.11n20 MCS0	-31.8	<-25.6	Pass
2483.5	802.11n20 MCS0	-43.3	<-25.6	Pass

Band Edge Plots





Test Setup / Conditions / Data

Test Location: CKC Laboratories, Inc. • 110 N. Olinda Place • Brea, CA 92823 • 714-993-6112
 Customer: **Venstar, Inc.**
 Specification: **15.247(d) Conducted Band Edge**
 Work Order #: **103607** Date: 1/19/2020
 Test Type: **Conducted Emissions** Time: 11:19:38
 Tested By: S. Yamamoto Sequence#: 0
 Software: EMITest 5.03.12 24Vac

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

Test Conditions / Notes:

The EUT is connected to the spectrum analyzer using an attenuator and coaxial cable.

 Transmitting frequencies: 2412MHz (CH1), 2462MHz (CH11)

 Modulation/Mode: 802.11n20 MCS0 duty cycle 98%
 558074 D01 15.247 Meas Guidance v05r02 April 2, 2019
 ANSI C63.10 2013

 Measurement power level setting: Low 5, High 5
 MCS0 is the worst case setting for this test.

 Temperature: 21°C
 Humidity: 35%
 Pressure: 100kPa

 Frequency range investigated is 2375MHz to 2516MHz.

 Site A

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
	AN02869	Spectrum Analyzer	E4440A	7/25/2019	7/25/2020
T1	AN03431	Attenuator	89-20-21	12/20/2019	12/20/2021
T2	ANP07243	Cable	32022-29094K-29094K-24TC	7/5/2018	7/5/2020

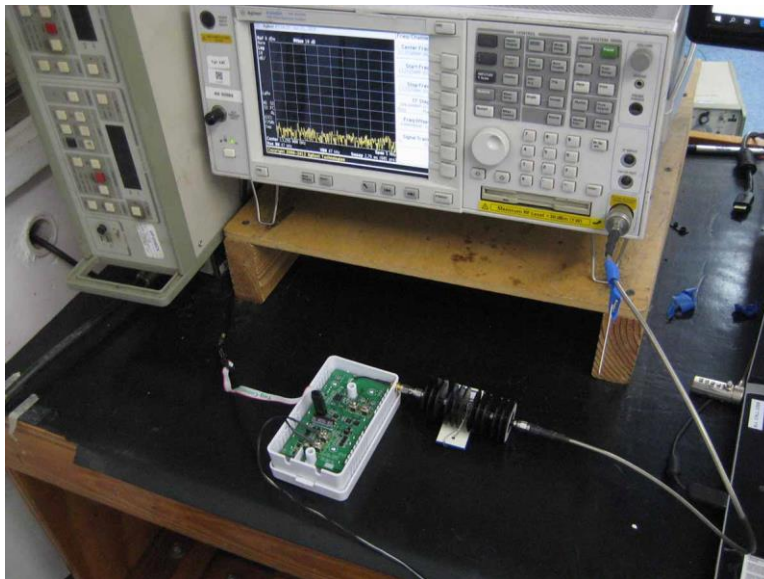
Measurement Data:

Reading listed by margin.

Test Lead: Antenna Port Connector

#	Freq MHz	Rdng dBμV	T1 dB	T2 dB	Dist dB	Corr dBμV	Spec dBμV	Margin dB	Polar Ant
1	2400.000M	55.8	+19.1	+0.3	+0.0	75.2	81.4	-6.2	Anten
2	2483.500M	44.3	+19.1	+0.3	+0.0	63.7	81.4	-17.7	Anten

Test Setup Photo(s)



15.247(d) Radiated Emissions & Band Edge

Test Setup / Conditions / Data

Test Location: CKC Laboratories, Inc. • 110 N. Olinda Place • Brea, CA 92823 • 714-993-6112
 Customer: **Venstar, Inc.**
 Specification: **15.247(d) / 15.209 Radiated Spurious Emissions**
 Work Order #: **103607** Date: 1/15/2020
 Test Type: **Maximized Emissions** Time: 08:42:50
 Tested By: S. Yamamoto Sequence#: 0
 Software: EMITest 5.03.12

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

Test Conditions / Notes:

The equipment under test (EUT) is placed on Styrofoam.

Transmitting frequencies: 2412MHz (CH1), 2437MHz (CH6), 2462MHz (CH11)
 EUT is transmitting continuously at greater than or equal to 98% duty cycle.

Modulation/Mode: 802.11n20 MCS0
 KDB558074 D01 15.247 Meas Guidance v05r02 April 2, 2019
 ANSI C63.10 2013

Measurement power level setting: Low 5, Middle 0, High 5

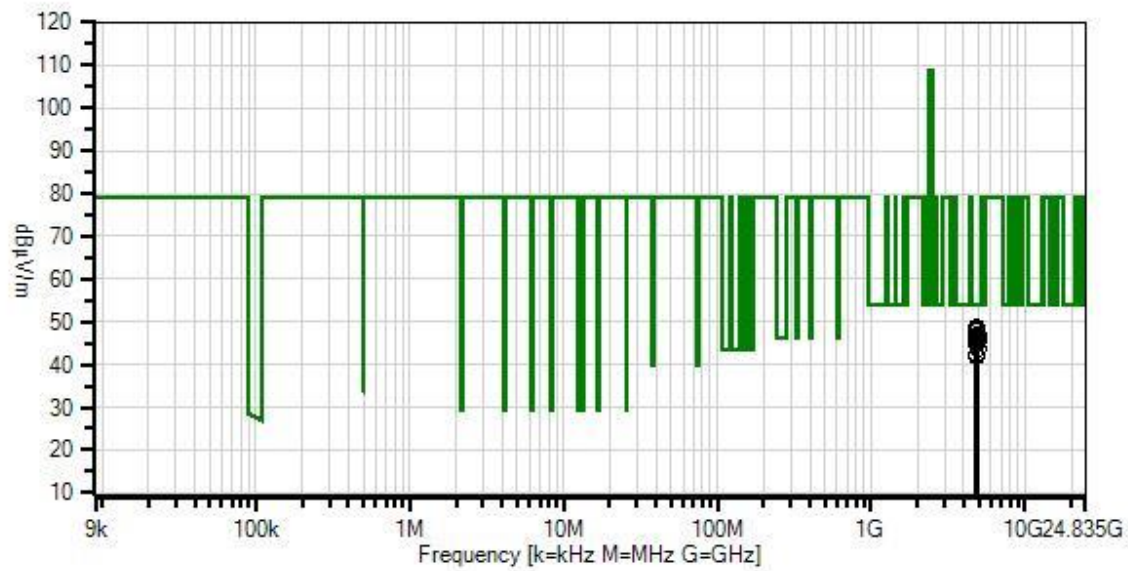
Temperature: 21°C
 Humidity: 35%
 Pressure: 100kPa

Site A

The data presented is the worst case with the EUT tested in each of the three axis system.

Measurement of radiated spurious emissions in the range of 9kHz to 24.835GHz.
 RBW=100kHz, VBW=300kHz (-30dBc limit)
 RBW=200Hz, VBW=2kHz, 9kHz to 150kHz. RBW=9kHz, VBW=91kHz, 150kHz to 30MHz. RBW=120kHz, VBW=1.2MHz, 30MHz to 1000MHz. RBW=1MHz, VBW=8MHz, 1GHz to 25GHz. (15.209 limit)

Venstar, Inc. WO#: 103607 Sequence#: 0 Date: 1/15/2020
 15.247(d) / 15.209 Radiated Spurious Emissions Test Distance: 3 Meters Vert



— Readings
 × QP Readings
 ▼ Ambient
 — 1 - 15.247(d) / 15.209 Radiated Spurious Emissions

○ Peak Readings
 * Average Readings
 Software Version: 5.03.12

Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
	AN02869	Spectrum Analyzer	E4440A	7/25/2019	7/25/2020
T1	ANP07139	Cable	ANDL1-PNMNM-48	3/4/2019	3/4/2021
T2	AN00849	Horn Antenna	3115	3/14/2018	3/14/2020
T3	AN00786	Preamp	83017A	5/12/2018	5/12/2020
T4	ANP07243	Cable	32022-29094K-29094K-24TC	7/5/2018	7/5/2020
T5	AN03385	High Pass Filter	11SH10-3000/T10000-O/O	5/13/2019	5/13/2021
	AN03367	Horn Antenna	62-GH-62-25.	8/1/2019	8/1/2021
	AN01413	Horn Antenna-ANSI C63.5 (dB/m)	84125-80008	10/17/2018	10/17/2020
	AN00309	Preamp	8447D	12/24/2019	12/24/2021
	AN00314	Loop Antenna	6502	5/13/2018	5/13/2020
	AN01995	Biconilog Antenna	CBL6111C	4/23/2018	4/23/2020
	ANP05275	Attenuator	1W	4/5/2018	4/5/2020
	ANP05050	Cable	RG223/U	12/24/2018	12/24/2020
	ANP05198	Cable-Amplitude +15C to +45C (dB)	8268	12/4/2018	12/4/2020

Measurement Data:

Reading listed by margin.

Test Distance: 3 Meters

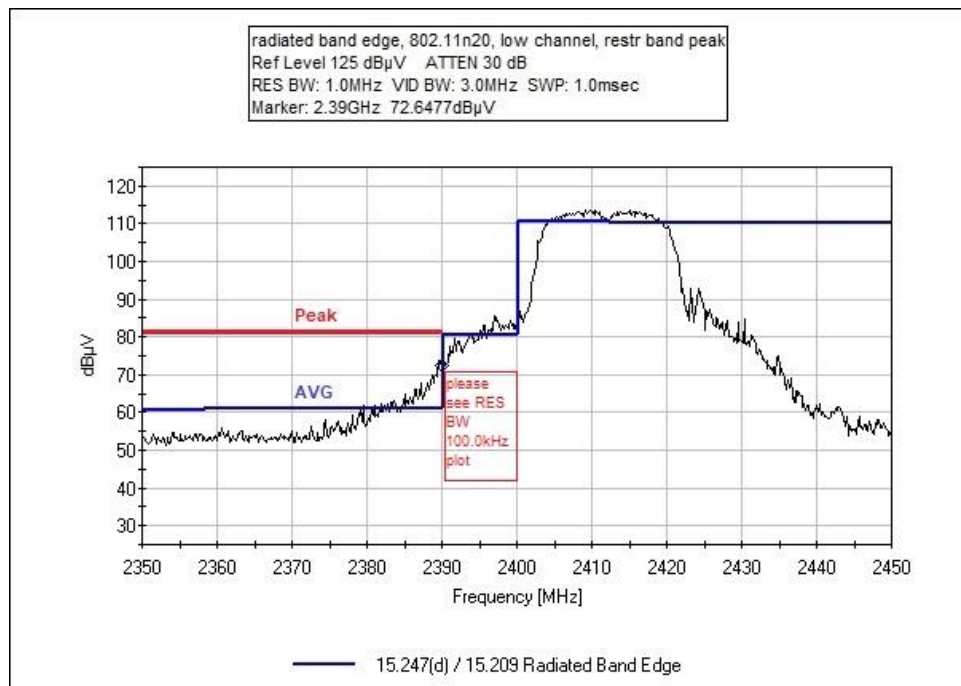
#	Freq	Rdng	T1 T5	T2	T3	T4	Dist	Corr	Spec	Margin	Polar
	MHz	dBμV	dB	dB	dB	dB	Table	dBμV/m	dBμV/m	dB	Ant
1	4874.011M	47.5	+4.8 +0.3	+33.5	-37.6	+0.4	+0.0	48.9	54.0	-5.1	Horiz
2	4874.007M	47.1	+4.8 +0.3	+33.5	-37.6	+0.4	+0.0	48.5	54.0	-5.5	Vert
3	4924.009M	45.5	+4.8 +0.3	+33.6	-37.6	+0.4	+0.0	47.0	54.0	-7.0	Vert
4	4924.000M	45.5	+4.8 +0.3	+33.6	-37.6	+0.4	+0.0	47.0	54.0	-7.0	Horiz
5	4824.044M	44.1	+4.8 +0.3	+33.4	-37.6	+0.5	+0.0	45.5	54.0	-8.5	Horiz
6	4824.000M	43.8	+4.8 +0.3	+33.4	-37.6	+0.5	+0.0	45.2	54.0	-8.8	Vert

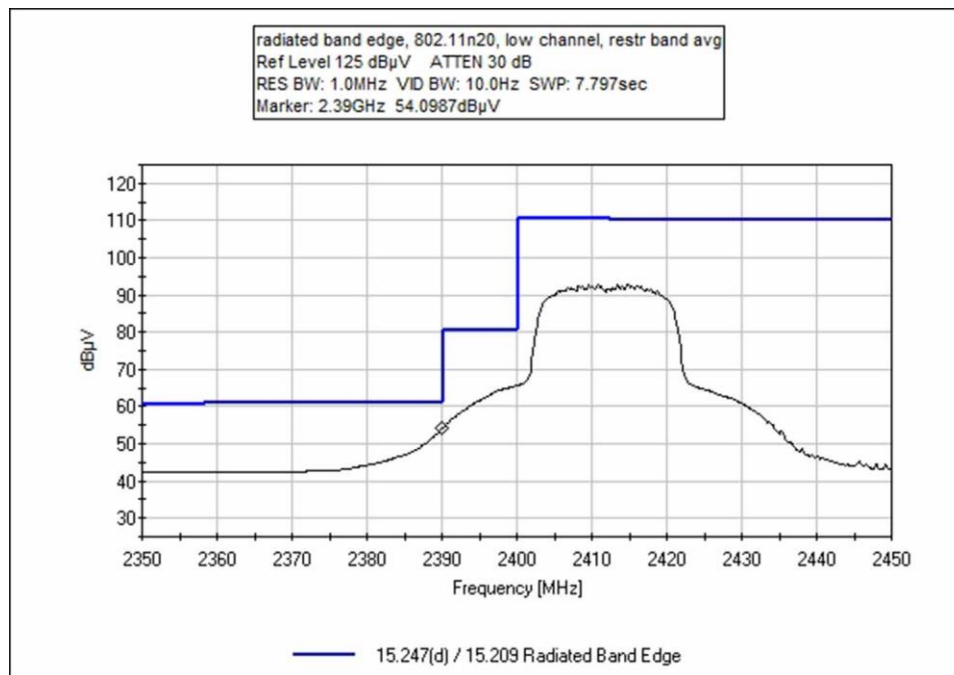
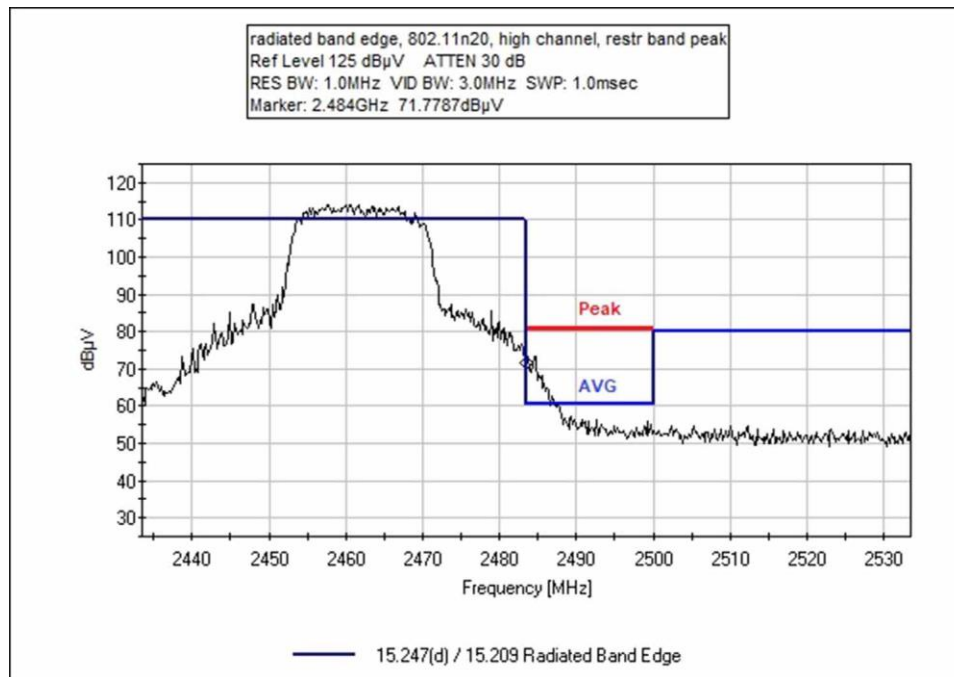
Band Edge

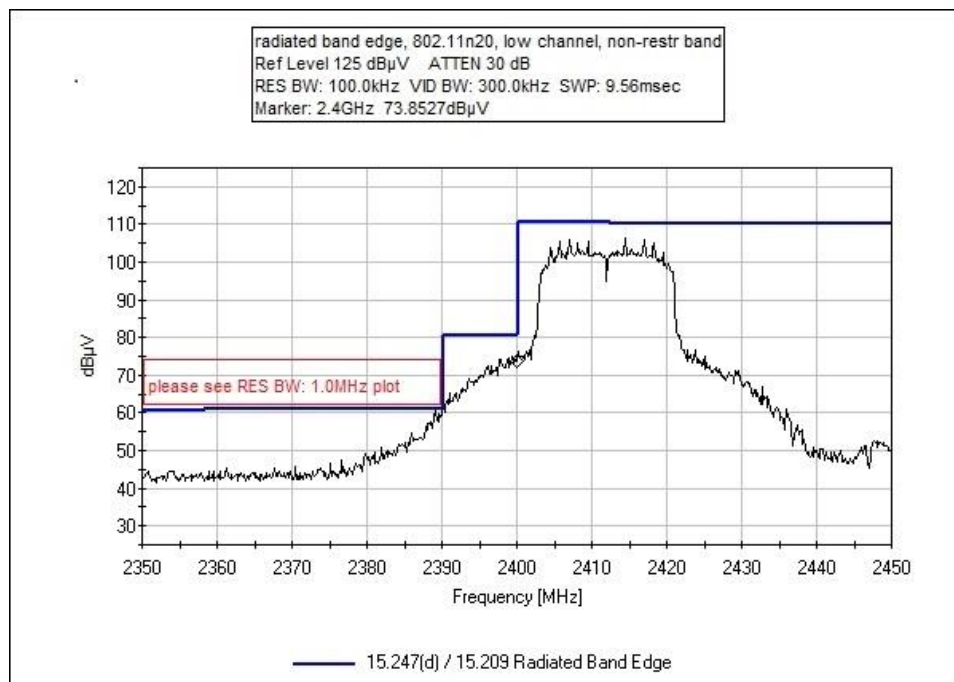
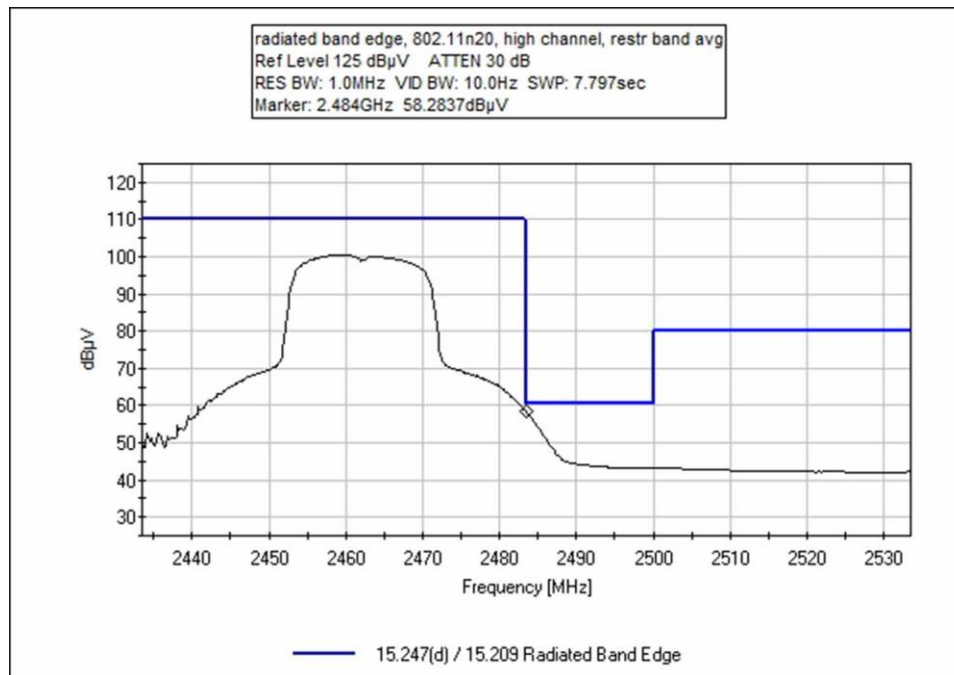
Band Edge Summary

Frequency (MHz)	Modulation	Ant. Type	Field Strength (dBuV/m @3m)	Limit (dBuV/m @3m)	Results
2390.0	802.11n20 MCS0	PCB Trace	47.1	<54	Pass
2400.0	802.11n20 MCS0	PCB Trace	66.8	<73.3	Pass
2483.5	802.11n20 MCS0	PCB Trace	51.6	<54	Pass

Band Edge Plots







Test Setup / Conditions / Data

Test Location: CKC Laboratories, Inc. • 110 N. Olinda Place • Brea, CA 92823 • 714-993-6112
 Customer: **Venstar, Inc.**
 Specification: **15.247(d) / 15.209 Radiated Band Edge**
 Work Order #: **102204** Date: 1/19/2020
 Test Type: **Maximized Emissions** Time: 09:58:10
 Tested By: S. Yamamoto Sequence#: 1
 Software: EMITest 5.03.12

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

Test Conditions / Notes:

The equipment under test (EUT) is placed on Styrofoam.
 Transmitting frequencies: 2412MHz (CH1), 2462MHz (CH11)

 EUT is transmitting continuously at greater than or equal to 98% duty cycle.

 Modulation/Mode: 802.11n20 MCS0
 558074 D01 15.247 Meas Guidance v05r02 April 2, 2019
 ANSI C63.10 2013
 Measurement power level setting: Low 5, High 5

 Temperature: 21°C
 Humidity: 35%
 Pressure: 100kPa

 Site A

 The data presented is the worst case with the EUT tested in each of the three axis system.
 Frequency range of investigation is 2350MHz to 2535MHz.
 RBW=100kHz, VBW=300kHz (-30dBc limit)
 RBW=1MHz, VBW=3MHz (restricted band)

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
	AN02869	Spectrum Analyzer	E4440A	7/25/2019	7/25/2020
T1	ANP07139	Cable	ANDL1-PNMNM-48	3/4/2019	3/4/2021
T2	AN00849	Horn Antenna	3115	3/14/2018	3/14/2020
T3	ANP07243	Cable	32022-29094K-29094K-24TC	7/5/2018	7/5/2020
T4	AN00786	Preamp	83017A	5/12/2018	5/12/2020

Measurement Data:

Reading listed by margin.

Test Distance: 3 Meters

#	Freq MHz	Rdng dBμV	T1 dB	T2 dB	T3 dB	T4 dB	Dist Table	Corr dBμV/m	Spec dBμV/m	Margin dB	Polar Ant
1	2483.500M Ave	58.3	+3.2	+28.5	+0.3	-38.7	+0.0	51.6	54.0	-2.4	Horiz
^	2483.500M	71.8	+3.2	+28.5	+0.3	-38.7	+0.0	65.1	54.0	+11.1	Horiz
3	2400.000M	73.9	+3.1	+28.2	+0.3	-38.7	+0.0	66.8	73.3	-6.5	Horiz
4	2390.000M Ave	54.1	+3.1	+28.3	+0.3	-38.7	+0.0	47.1	54.0	-6.9	Horiz
^	2390.000M	72.6	+3.1	+28.3	+0.3	-38.7	+0.0	65.6	54.0	+11.6	Horiz
6	2500.000M	43.0	+3.2	+28.5	+0.3	-38.7	+0.0	36.3	54.0	-17.7	Horiz

Test Setup Photo(s)



Below 1GHz



Below 1GHz



Above 1GHz

15.207 AC Conducted Emissions

Test Setup / Conditions / Data

Test Location: CKC Laboratories, Inc. • 110 N. Olinda Place • Brea, CA 92823 • 714-993-6112
 Customer: **Venstar, Inc.**
 Specification: **15.207 AC Mains - Average**
 Work Order #: **103607** Date: 1/18/2020
 Test Type: **Conducted Emissions** Time: 11:34:26
 Tested By: S. Yamamoto Sequence#: 2
 Software: EMITest 5.03.12 120V 60Hz

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

Test Conditions / Notes:

The equipment under test (EUT) is placed on the table top.
 Connected to the EUT is the duct sensor accessory.
 The EUT is powered from the 120Vac to 24Vac power transformer.
 The EUT is set to transmit continuously at greater than or equal to 98% duty cycle on channel 6.

 Protocol: 802.11n20 MCS0 power level 0

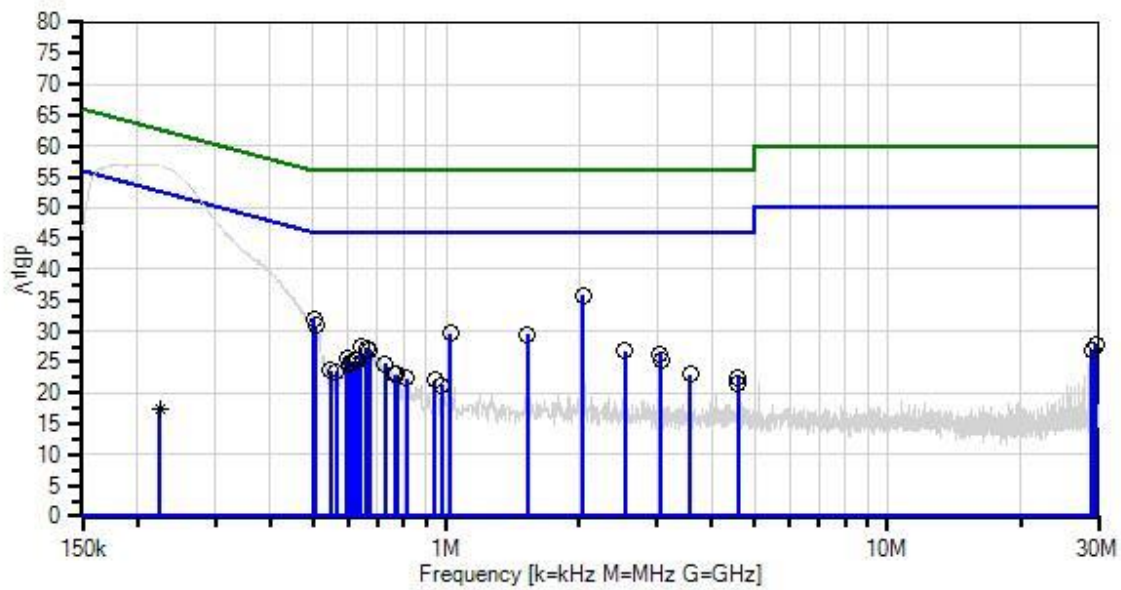
 Frequency range of test: 150kHz to 30MHz
 RBW=9kHz, VBW=30kHz

 Temperature: 21°C
 Humidity: 35%
 Pressure: 100kPa

 Test Method: ANSI C63.10 2013

 Site A

Venstar, Inc. WO#: 103607 Sequence#: 2 Date: 1/18/2020
15.207 AC Mains - Average Test Lead: 120V 60Hz Line



— Sweep Data
× QP Readings
Software Version: 5.03.12
— Readings
* Average Readings
— 1 - 15.207 AC Mains - Average
○ Peak Readings
▼ Ambient
— 2 - 15.207 AC Mains - Quasi-peak

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN02869	Spectrum Analyzer	E4440A	7/25/2019	7/25/2020
T2	AN02610	High Pass Filter	HE9615-150K-50-720B	10/22/2019	10/22/2021
T3	ANP07338	Cable	2249-Y-240	12/24/2019	12/24/2021
T4	ANP07545	Attenuator	SA18N10W-06	1/18/2019	1/18/2021
T5	AN00847.1	50uH LISN-Line 1	3816/2NM	3/11/2019	3/11/2020
	AN00847.1	50uH LISN-Line 2	3816/2NM	3/11/2019	3/11/2020
T6	ANP06986	Cable-Line L1(dB)	90cm-extcord	3/31/2018	3/31/2020
	ANP06986	Cable-Neutral L2(dB)	90cm-extcord	3/31/2018	3/31/2020

Measurement Data:

Reading listed by margin.

Test Lead: Line

#	Freq	Rdng	T1 T5	T2 T6	T3	T4	Dist	Corr	Spec	Margin	Polar
	MHz	dBμV	dB	dB	dB	dB	Table	dBμV	dBμV	dB	Ant
1	2.042M	29.5	+0.0 +0.1	+0.2 +0.1	+0.1	+5.8	+0.0	35.8	46.0	-10.2	Line
2	501.240k	25.8	+0.0 +0.1	+0.3 +0.0	+0.0	+5.8	+0.0	32.0	46.0	-14.0	Line
3	506.330k	24.7	+0.0 +0.1	+0.3 +0.0	+0.0	+5.8	+0.0	30.9	46.0	-15.1	Line
4	1.022M	23.5	+0.0 +0.1	+0.2 +0.0	+0.1	+5.8	+0.0	29.7	46.0	-16.3	Line
5	1.528M	23.2	+0.0 +0.1	+0.2 +0.1	+0.1	+5.8	+0.0	29.5	46.0	-16.5	Line
6	640.864k	21.1	+0.0 +0.1	+0.3 +0.0	+0.1	+5.8	+0.0	27.4	46.0	-18.6	Line
7	661.953k	20.9	+0.0 +0.1	+0.3 +0.0	+0.1	+5.8	+0.0	27.2	46.0	-18.8	Line
8	670.679k	20.6	+0.0 +0.1	+0.3 +0.0	+0.1	+5.8	+0.0	26.9	46.0	-19.1	Line
9	2.544M	20.5	+0.0 +0.1	+0.2 +0.1	+0.1	+5.8	+0.0	26.8	46.0	-19.2	Line
10	3.055M	20.0	+0.0 +0.1	+0.2 +0.1	+0.1	+5.8	+0.0	26.3	46.0	-19.7	Line
11	596.504k	19.2	+0.0 +0.1	+0.3 +0.0	+0.1	+5.8	+0.0	25.5	46.0	-20.5	Line
12	3.063M	19.1	+0.0 +0.1	+0.2 +0.1	+0.1	+5.8	+0.0	25.4	46.0	-20.6	Line
13	622.683k	18.9	+0.0 +0.1	+0.3 +0.0	+0.1	+5.8	+0.0	25.2	46.0	-20.8	Line
14	630.683k	18.9	+0.0 +0.1	+0.3 +0.0	+0.1	+5.8	+0.0	25.2	46.0	-20.8	Line
15	609.594k	18.8	+0.0 +0.1	+0.3 +0.0	+0.1	+5.8	+0.0	25.1	46.0	-20.9	Line
16	728.128k	18.4	+0.0 +0.1	+0.3 +0.0	+0.1	+5.8	+0.0	24.7	46.0	-21.3	Line
17	605.230k	18.3	+0.0 +0.1	+0.3 +0.0	+0.1	+5.8	+0.0	24.6	46.0	-21.4	Line

18	29.582M	19.8	+0.0 +0.5	+0.2 +1.1	+0.5	+5.8	+0.0	27.9	50.0	-22.1	Line
19	547.781k	17.4	+0.0 +0.1	+0.3 +0.0	+0.1	+5.8	+0.0	23.7	46.0	-22.3	Line
20	564.507k	17.1	+0.0 +0.1	+0.3 +0.0	+0.1	+5.8	+0.0	23.4	46.0	-22.6	Line
21	765.943k	16.7	+0.0 +0.1	+0.3 +0.0	+0.1	+5.8	+0.0	23.0	46.0	-23.0	Line
22	771.761k	16.7	+0.0 +0.1	+0.3 +0.0	+0.1	+5.8	+0.0	23.0	46.0	-23.0	Line
23	3.565M	16.8	+0.0 +0.1	+0.1 +0.1	+0.1	+5.8	+0.0	23.0	46.0	-23.0	Line
24	29.075M	18.7	+0.0 +0.5	+0.2 +1.1	+0.5	+5.8	+0.0	26.8	50.0	-23.2	Line
25	4.590M	16.1	+0.0 +0.1	+0.1 +0.2	+0.2	+5.8	+0.0	22.5	46.0	-23.5	Line
26	814.666k	16.1	+0.0 +0.1	+0.3 +0.0	+0.1	+5.8	+0.0	22.4	46.0	-23.6	Line
27	940.995k	15.9	+0.0 +0.1	+0.2 +0.0	+0.1	+5.8	+0.0	22.1	46.0	-23.9	Line
28	4.581M	15.0	+0.0 +0.1	+0.1 +0.2	+0.2	+5.8	+0.0	21.4	46.0	-24.6	Line
29	975.017k	15.0	+0.0 +0.1	+0.2 +0.0	+0.1	+5.8	+0.0	21.2	46.0	-24.8	Line
30	224.902k	11.3	+0.0 +0.1	+0.2 +0.0	+0.0	+5.8	+0.0	17.4	52.6	-35.2	Line
^	224.902k	50.7	+0.0 +0.1	+0.2 +0.0	+0.0	+5.8	+0.0	56.8	52.6 see average data	+4.2	Line

Test Location: CKC Laboratories, Inc. • 110 N. Olinda Place • Brea, CA 92823 • 714-993-6112
 Customer: **Venstar, Inc.**
 Specification: **15.207 AC Mains - Average**
 Work Order #: **103607** Date: 1/18/2020
 Test Type: **Conducted Emissions** Time: 11:40:20
 Tested By: S. Yamamoto Sequence#: 3
 Software: EMITest 5.03.12 120V 60Hz

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

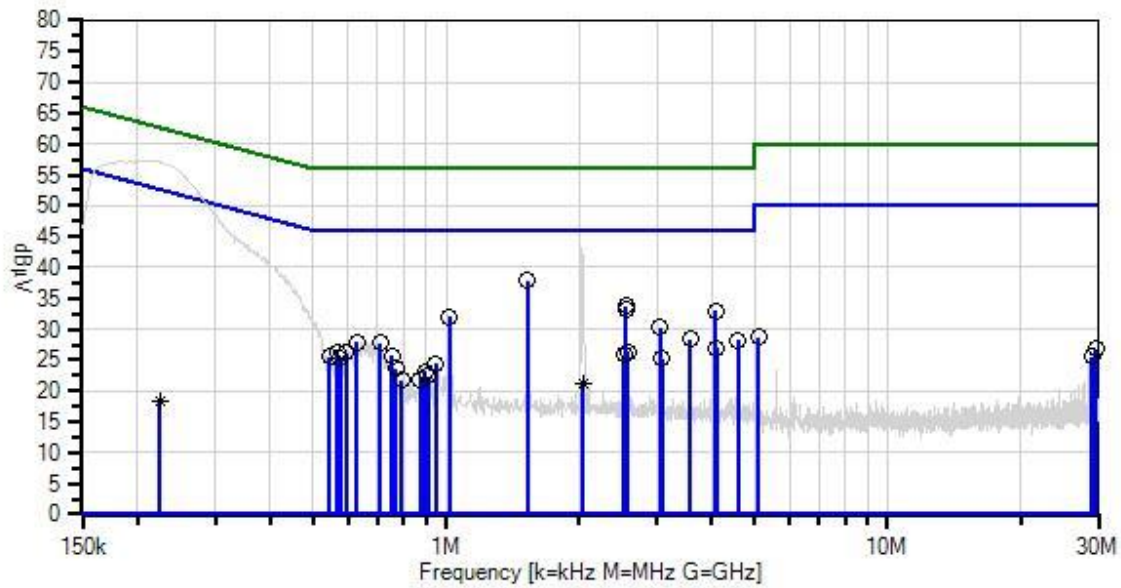
Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

Test Conditions / Notes:

The equipment under test (EUT) is placed on the table top. Connected to the EUT is the duct sensor accessory. The EUT is powered from the 120Vac to 24Vac power transformer. The EUT is set to transmit continuously at greater than or equal to 98% duty cycle on channel 6. Protocol: 802.11n20 MCS0 power level 0 Frequency range of test: 150kHz to 30MHz RBW=9kHz, VBW=30kHz Temperature: 21°C Humidity: 35% Pressure: 100kPa Test Method: ANSI C63.10 2013 Site A

Venstar, Inc. WO#: 103607 Sequence#: 3 Date: 1/18/2020
15.207 AC Mains - Average Test Lead: 120V 60Hz Neutral



— Sweep Data
x QP Readings
Software Version: 5.03.12
— Readings
* Average Readings
— 1 - 15.207 AC Mains - Average
○ Peak Readings
▼ Ambient
— 2 - 15.207 AC Mains - Quasi-peak

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN02869	Spectrum Analyzer	E4440A	7/25/2019	7/25/2020
T2	AN02610	High Pass Filter	HE9615-150K-50-720B	10/22/2019	10/22/2021
T3	ANP07338	Cable	2249-Y-240	12/24/2019	12/24/2021
T4	ANP07545	Attenuator	SA18N10W-06	1/18/2019	1/18/2021
	AN00847.1	50uH LISN-Line 1	3816/2NM	3/11/2019	3/11/2020
T5	AN00847.1	50uH LISN-Line 2	3816/2NM	3/11/2019	3/11/2020
	ANP06986	Cable-Line L1(dB)	90cm-extcord	3/31/2018	3/31/2020
T6	ANP06986	Cable-Neutral L2(dB)	90cm-extcord	3/31/2018	3/31/2020

Measurement Data:

Reading listed by margin.

Test Lead: Neutral

#	Freq	Rdng	T1 T5	T2 T6	T3	T4	Dist	Corr	Spec	Margin	Polar
	MHz	dBμV	dB	dB	dB	dB	Table	dBμV	dBμV	dB	Ant
1	1.528M	31.8	+0.0 +0.0	+0.2 +0.0	+0.1	+5.8	+0.0	37.9	46.0	-8.1	Neutr
2	2.549M	27.4	+0.0 +0.1	+0.2 +0.1	+0.1	+5.8	+0.0	33.7	46.0	-12.3	Neutr
3	2.557M	26.9	+0.0 +0.1	+0.2 +0.1	+0.1	+5.8	+0.0	33.2	46.0	-12.8	Neutr
4	4.071M	26.7	+0.0 +0.1	+0.1 +0.1	+0.2	+5.8	+0.0	33.0	46.0	-13.0	Neutr
5	1.018M	25.9	+0.0 +0.0	+0.2 +0.0	+0.1	+5.8	+0.0	32.0	46.0	-14.0	Neutr
6	3.055M	24.0	+0.0 +0.1	+0.2 +0.1	+0.1	+5.8	+0.0	30.3	46.0	-15.7	Neutr
7	3.565M	22.2	+0.0 +0.1	+0.1 +0.1	+0.1	+5.8	+0.0	28.4	46.0	-17.6	Neutr
8	4.590M	22.0	+0.0 +0.1	+0.1 +0.1	+0.2	+5.8	+0.0	28.3	46.0	-17.7	Neutr
9	628.501k	21.7	+0.0 +0.0	+0.3 +0.0	+0.1	+5.8	+0.0	27.9	46.0	-18.1	Neutr
10	710.675k	21.5	+0.0 +0.0	+0.3 +0.0	+0.1	+5.8	+0.0	27.7	46.0	-18.3	Neutr
11	4.088M	20.7	+0.0 +0.1	+0.1 +0.1	+0.2	+5.8	+0.0	27.0	46.0	-19.0	Neutr
12	566.689k	20.1	+0.0 +0.0	+0.3 +0.0	+0.1	+5.8	+0.0	26.3	46.0	-19.7	Neutr
13	2.574M	20.0	+0.0 +0.1	+0.2 +0.1	+0.1	+5.8	+0.0	26.3	46.0	-19.7	Neutr
14	592.141k	19.9	+0.0 +0.0	+0.3 +0.0	+0.1	+5.8	+0.0	26.1	46.0	-19.9	Neutr
15	2.523M	19.6	+0.0 +0.1	+0.2 +0.1	+0.1	+5.8	+0.0	25.9	46.0	-20.1	Neutr
16	753.580k	19.5	+0.0 +0.0	+0.3 +0.0	+0.1	+5.8	+0.0	25.7	46.0	-20.3	Neutr
17	545.600k	19.4	+0.0 +0.0	+0.3 +0.0	+0.0	+5.8	+0.0	25.5	46.0	-20.5	Neutr

18	576.142k	19.0	+0.0 +0.0	+0.3 +0.0	+0.1	+5.8	+0.0	25.2	46.0	-20.8	Neutr
19	3.076M	18.9	+0.0 +0.1	+0.2 +0.1	+0.1	+5.8	+0.0	25.2	46.0	-20.8	Neutr
20	5.100M	22.4	+0.0 +0.1	+0.1 +0.1	+0.2	+5.8	+0.0	28.7	50.0	-21.3	Neutr
21	949.501k	18.3	+0.0 +0.0	+0.2 +0.0	+0.1	+5.8	+0.0	24.4	46.0	-21.6	Neutr
22	767.397k	17.5	+0.0 +0.0	+0.3 +0.0	+0.1	+5.8	+0.0	23.7	46.0	-22.3	Neutr
23	894.215k	17.0	+0.0 +0.0	+0.3 +0.0	+0.1	+5.8	+0.0	23.2	46.0	-22.8	Neutr
24	29.575M	18.5	+0.0 +0.7	+0.2 +1.1	+0.5	+5.8	+0.0	26.8	50.0	-23.2	Neutr
25	911.226k	16.2	+0.0 +0.0	+0.2 +0.0	+0.1	+5.8	+0.0	22.3	46.0	-23.7	Neutr
26	872.115k	15.7	+0.0 +0.0	+0.3 +0.0	+0.1	+5.8	+0.0	21.9	46.0	-24.1	Neutr
27	795.031k	15.5	+0.0 +0.0	+0.3 +0.0	+0.1	+5.8	+0.0	21.7	46.0	-24.3	Neutr
28	29.061M	17.3	+0.0 +0.7	+0.2 +1.1	+0.5	+5.8	+0.0	25.6	50.0	-24.4	Neutr
29	2.040M	14.9	+0.0 +0.1	+0.2 +0.1	+0.1	+5.8	+0.0	21.2	46.0	-24.8	Neutr
^	2.040M	36.7	+0.0 +0.1	+0.2 +0.1	+0.1	+5.8	+0.0	43.0	46.0 see average data	-3.0	Neutr
31	224.902k	12.5	+0.0 +0.0	+0.2 +0.0	+0.0	+5.8	+0.0	18.5	52.6	-34.1	Neutr
^	224.902k	51.2	+0.0 +0.0	+0.2 +0.0	+0.0	+5.8	+0.0	57.2	52.6 see average data	+4.6	Neutr

Test Setup Photo(s)



SUPPLEMENTAL INFORMATION

Measurement Uncertainty

Uncertainty Value	Parameter
4.73 dB	Radiated Emissions
3.34 dB	Mains Conducted Emissions
3.30 dB	Disturbance Power

Uncertainties reported are worst case for all CKC Laboratories' sites and represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of $k=2$. Compliance is deemed to occur provided measurements are below the specified limits.

Emissions Test Details

TESTING PARAMETERS

Unless otherwise indicated, the following configuration parameters are used for equipment setup: The cables were routed consistent with the typical application by varying the configuration of the test sample. Interface cables were connected to the available ports of the test unit. The effect of varying the position of the cables was investigated to find the configuration that produced maximum emissions. Cables were of the type and length specified in the individual requirements. The length of cable that produced maximum emissions was selected.

The equipment under test (EUT) was set up in a manner that represented its normal use, as shown in the setup photographs. Any special conditions required for the EUT to operate normally are identified in the comments that accompany the emissions tables.

The emissions data was taken with a spectrum analyzer or receiver. Incorporating the applicable correction factors for distance, antenna, cable loss and amplifier gain, the data was reduced as shown in the table below. The corrected data was then compared to the applicable emission limits. Preliminary and final measurements were taken in order to ensure that all emissions from the EUT were found and maximized.

CORRECTION FACTORS

The basic spectrum analyzer reading was converted using correction factors as shown in the highest emissions readings in the tables. For radiated emissions in $\text{dB}\mu\text{V}/\text{m}$, the spectrum analyzer reading in $\text{dB}\mu\text{V}$ was corrected by using the following formula. This reading was then compared to the applicable specification limit. Individual measurements were compared with the displayed limit value in the margin column. The margin was calculated based on subtracting the limit value from the corrected measurement value; a positive margin represents a measurement exceeding the limit, while a negative margin represents a measurement less than the limit.

SAMPLE CALCULATIONS		
	Meter reading	($\text{dB}\mu\text{V}$)
+	Antenna Factor	(dB/m)
+	Cable Loss	(dB)
-	Distance Correction	(dB)
-	Preamplifier Gain	(dB)
=	Corrected Reading	($\text{dB}\mu\text{V}/\text{m}$)

TEST INSTRUMENTATION AND ANALYZER SETTINGS

The test instrumentation and equipment listed were used to collect the emissions data. A spectrum analyzer or receiver was used for all measurements. Unless otherwise specified, the following table shows the measuring equipment bandwidth settings that were used in designated frequency bands. For testing emissions, an appropriate reference level and a vertical scale size of 10 dB per division were used.

MEASURING EQUIPMENT BANDWIDTH SETTINGS PER FREQUENCY RANGE			
TEST	BEGINNING FREQUENCY	ENDING FREQUENCY	BANDWIDTH SETTING
CONDUCTED EMISSIONS	150 kHz	30 MHz	9 kHz
RADIATED EMISSIONS	9 kHz	150 kHz	200 Hz
RADIATED EMISSIONS	150 kHz	30 MHz	9 kHz
RADIATED EMISSIONS	30 MHz	1000 MHz	120 kHz
RADIATED EMISSIONS	1000 MHz	>1 GHz	1 MHz

SPECTRUM ANALYZER/RECEIVER DETECTOR FUNCTIONS

The notes that accompany the measurements contained in the emissions tables indicate the type of detector function used to obtain the given readings. Unless otherwise noted, all readings were made in the "positive peak" detector mode. Whenever a "quasi-peak" or "average" reading was recorded, the measurement was annotated with a "QP" or an "Ave" on the appropriate rows of the data sheets. In cases where quasi-peak or average limits were employed and data exists for multiple measurement types for the same frequency then the peak measurement was retained in the report for reference, however the numbering for the affected row was removed and an arrow or caret ("^") was placed in the far left-hand column indicating that the row above takes precedence for comparison to the limit. The following paragraphs describe in more detail the detector functions and when they were used to obtain the emissions data.

Peak

In this mode, the spectrum analyzer or receiver recorded all emissions at their peak value as the frequency band selected was scanned. By combining this function with another feature called "peak hold," the measurement device had the ability to measure intermittent or low duty cycle transient emission peak levels. In this mode the measuring device made a slow scan across the frequency band selected and measured the peak emission value found at each frequency across the band.

Quasi-Peak

Quasi-peak measurements were taken using the quasi-peak detector when the true peak values exceeded or were within 2 dB of a quasi-peak specification limit. Additional QP measurements may have been taken at the discretion of the operator.

Average

Average measurements were taken using the average detector when the true peak values exceeded or were within 2 dB of an average specification limit. Additional average measurements may have been taken at the discretion of the operator. If the specification or test procedure requires trace averaging, then the averaging was performed using 100 samples or as required by the specification. All other average measurements are performed using video bandwidth averaging. To make these measurements, the test engineer reduces the video bandwidth on the measuring device until the modulation of the signal is filtered out. At this point, the measuring device is set into the linear mode and the scan time is reduced.