

# Venstar, Inc.

## REVISED TEST REPORT TO 102105-7

**Wifi Thermostat  
Model: OnePlus**

**Tested to The Following Standards:**

**FCC Part 15 Subpart C Section(s)**

**15.207 & 15.247  
(FHSS 902-928 MHz)**

**Report No.: 102105-7A**

**Date of issue: June 28, 2019**



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.

**Test Certificate # 803.02**

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## 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: 102105

**DATE OF EQUIPMENT RECEIPT:**

February 22, 2019

**DATE(S) OF TESTING:**

February 22-25, 2019

### Revision History

**Original:** Testing of the Wifi Thermostat, Model: OnePlus to FCC Part 15 Subpart C Section(s) 15.207 & 15.247 (FHSS 902-928 MHz).

**Revision A:** To correct the RBW used in the frequency range of measurement 9kHz to 9.28GHz on the data in Section 15.247(d) Radiated Emissions & Band Edge.

### 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	5.03.11

## Site Registration & Accreditation Information

Location	*NIST CB #	FCC	JAPAN
Brea D, CA	US0060	US1025	A-0147

\*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 - 15.247 (FHSS 902-928MHz)

Test Procedure	Description	Modifications	Results
15.247(a)(1)(i)	Occupied Bandwidth	NA	Pass
15.247(a)(1)	Carrier Separation	NA	Pass
15.247(a)(1)(i)	Number of Hopping Channels	NA	Pass
15.247(a)(1)(i)	Average Time of Occupancy	NA	Pass
15.247(b)(2)	Output Power	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 Thermostat	Venstar, Inc.	OnePlus	23

#### *Support Equipment:*

Device	Manufacturer	Model #	S/N
AC/AC Adaptor	NA	MKA-412400200	NA

### Configuration 2

#### *Equipment Tested:*

Device	Manufacturer	Model #	S/N
Wifi Thermostat	Venstar, Inc.	OnePlus	24

#### *Support Equipment:*

Device	Manufacturer	Model #	S/N
AC/AC Adaptor	NA	MKA-412400200	NA

## General Product Information:

Product Information	Manufacturer-Provided Details
Equipment Type:	Stand-Alone Equipment
Type of Wideband System:	FHSS
Operating Frequency Range:	902.2MHz to 927.8MHz
Number of Hopping Channels:	129
Modulation Type(s):	GFSK
Maximum Duty Cycle:	98%
Number of TX Chains:	1
Antenna Type(s) and Gain:	Integral IFA -1.58dBi
Beamforming Type:	N/A
Antenna Connection Type:	Integral
Nominal Input Voltage:	24Vac
Firmware / Software used for Test:	1.1.0

## FCC Part 15 Subpart C

### 15.247(a) Transmitter Characteristics

#### Test Setup/Conditions

Test Location:	Brea Lab D	Test Engineer:	S. Yamamoto
Test Method:	ANSI C63.10 (2013)	Test Date(s):	2/22/2019
Configuration:	1 and 2		
Test Setup:	The equipment under test (EUT) is placed on the wooden table top. The antenna cable is connected to the spectrum analyzer using a coaxial cable and attenuator.		

#### Environmental Conditions

Temperature (°C)	21	Relative Humidity (%):	35
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#### Test Equipment

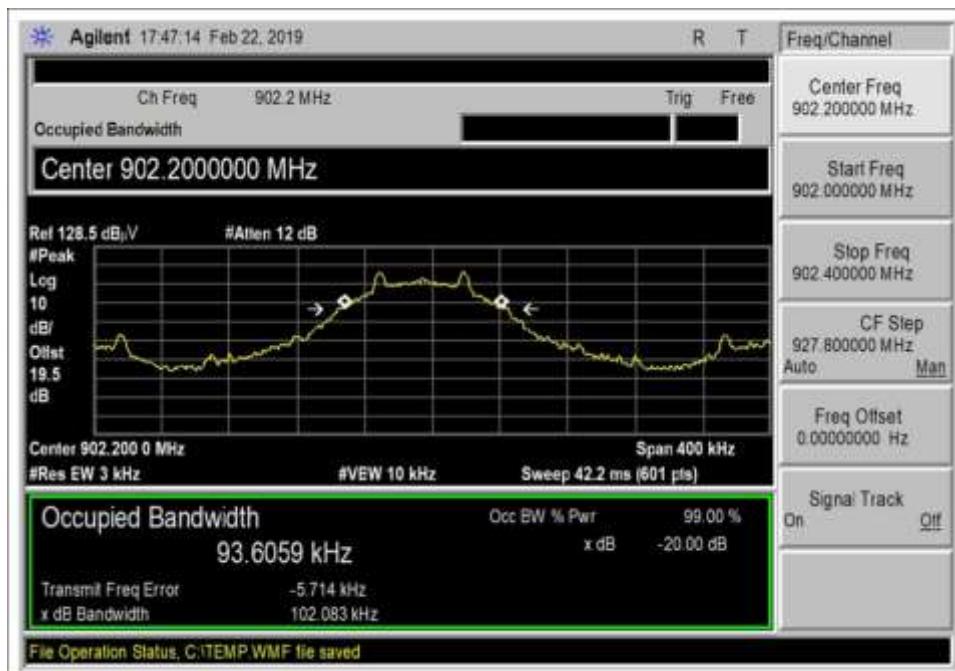
Asset#	Description	Manufacturer	Model	Cal Date	Cal Due
02672	Spectrum Analyzer	Agilent	E4446A	3/2/2017	3/2/2019
03431	Attenuator	Aeroflex/Weinschel	89-20-21	12/19/2017	12/19/2019
P07244	Cable	H&S	32022-29094K-29094K-24TC	7/5/2018	7/5/2020

## 15.247(a)(1) 20 dB Bandwidth

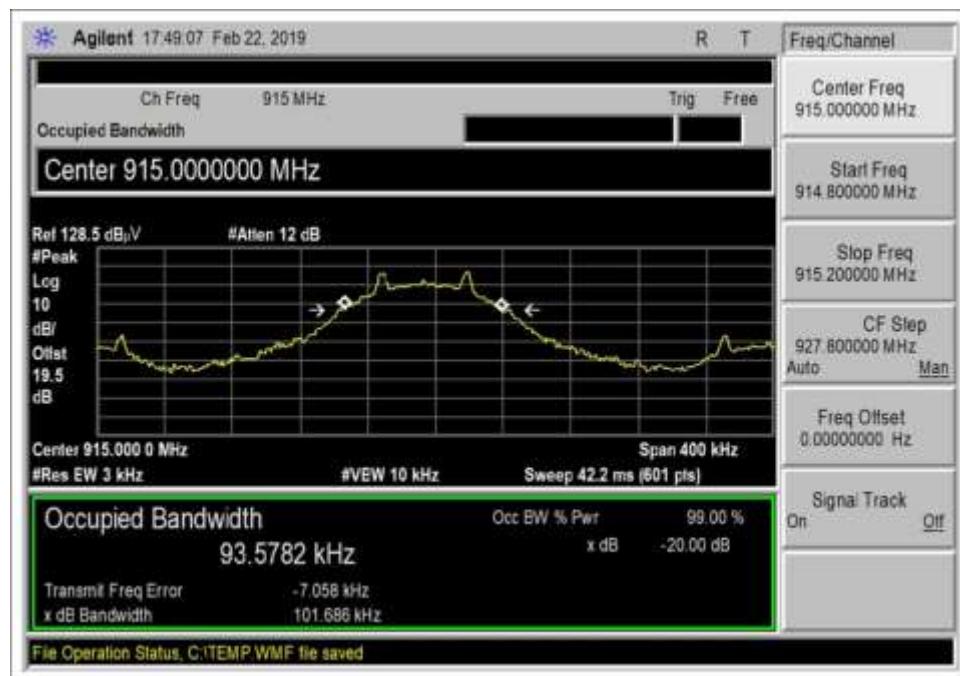
### Test Data Summary

Frequency (MHz)	Antenna Port	Modulation	Measured (kHz)	Limit (kHz)	Results
902.2	1	GFSK	102.1	≤500	Pass
915.0	1	GFSK	101.7	≤500	Pass
927.8	1	GFSK	101.6	≤500	Pass

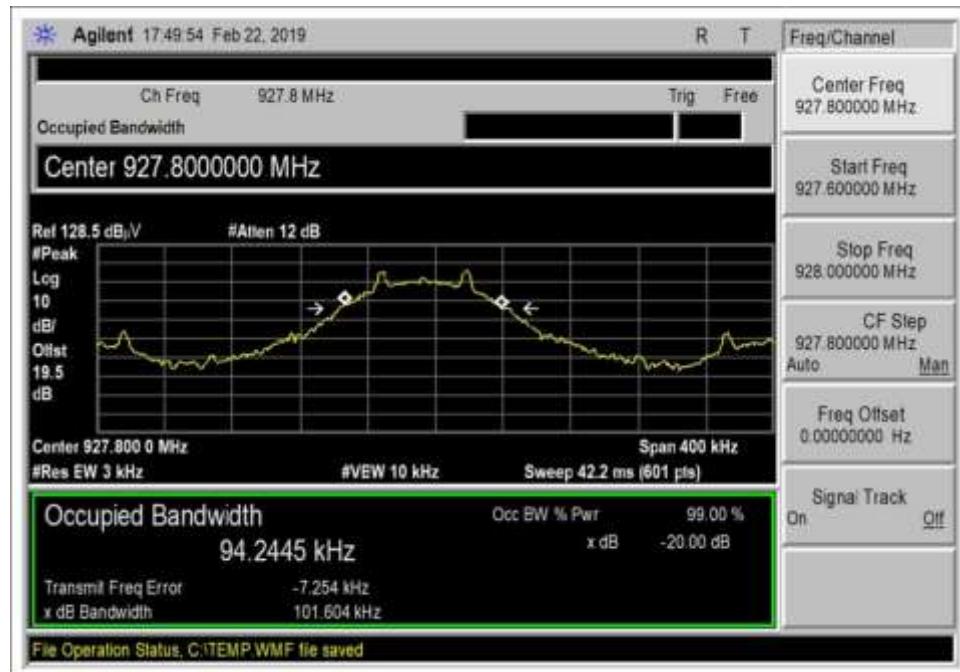
### Plot(s)



Low Channel



Middle Channel



High Channel

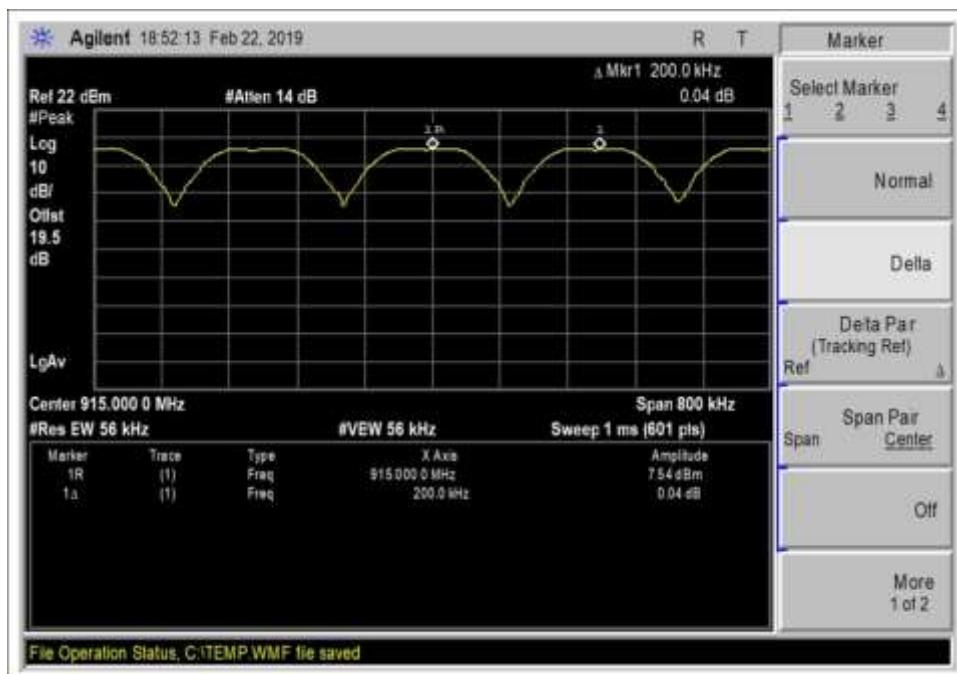
## 15.247(a)(1) Carrier Separation

### Test Data Summary

Limit applied: 20dB bandwidth of the hopping channel.

Antenna Port	Operational Mode	Measured (kHz)	Limit (kHz)	Results
1	hopping	200kHz	>102.1	Pass

### Plot(s)



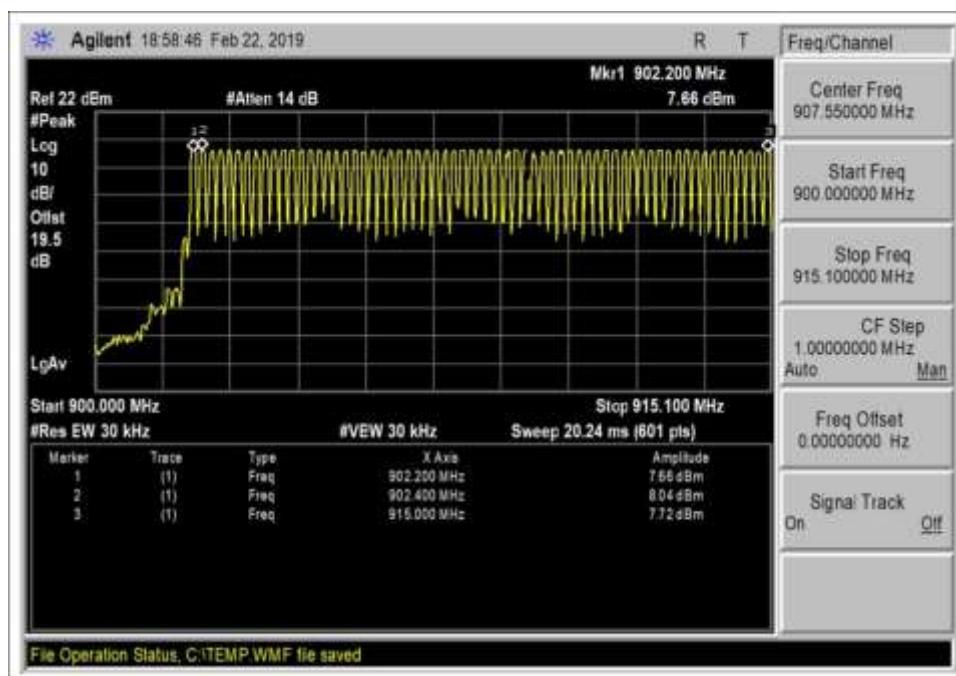
### 15.247(a)(1)(i) Number of Hopping Channels

#### Test Data Summary

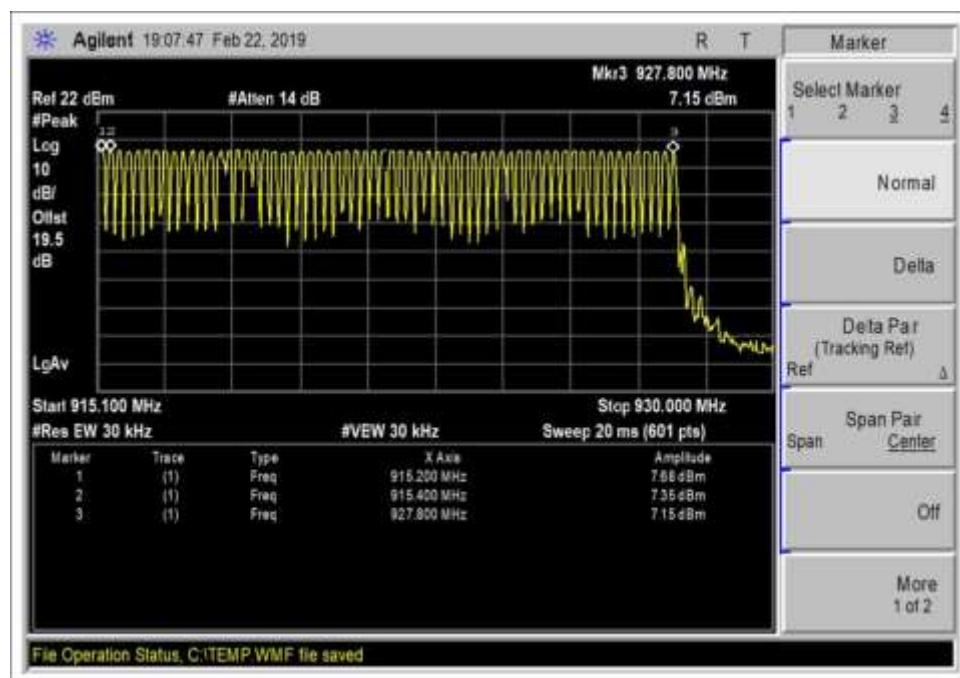
Limit =  $\begin{cases} 50 \text{ Channels} | 20 \text{ dB BW} < 250 \text{ kHz} \\ 25 \text{ Channels} | 20 \text{ dB BW} \geq 250 \text{ kHz} \end{cases}$

Antenna Port	Operational Mode	Measured (Channels)	Limit (Channels)	Results
1	hopping	129	≥50	Pass

#### Plot(s)



Frequency Lower Half



Frequency Higher Half

## 15.247(a)(1)(i) Time of Occupancy

### Test Data Summary

Observation Period,  $P_{obs}$  is derived from the following:

$$P_{obs} = \begin{cases} 20 \text{ Seconds} & | 20 \text{ dB BW} < 250 \text{ kHz} \\ 10 \text{ Seconds} & | 20 \text{ dB BW} \geq 250 \text{ kHz} \end{cases}$$

Antenna Port	Operational Mode	Measured (ms)	Limit (ms/ $P_{obs}$ )	Results
1	hopping	57.75	≤400	Pass

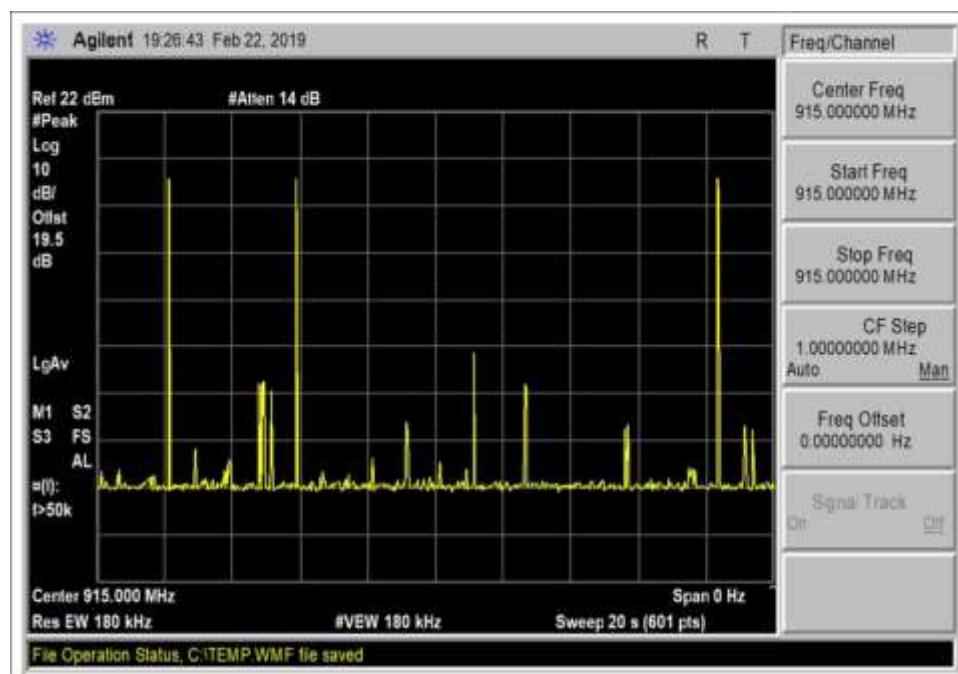
Measured results are calculated as follows:

$$Dwell \text{ time} = \left( \sum_{Bursts} RF \text{ Burst On Time} + \sum_{Control} Control \text{ Signal On time} \right) \Big|_{P_{obs}}$$

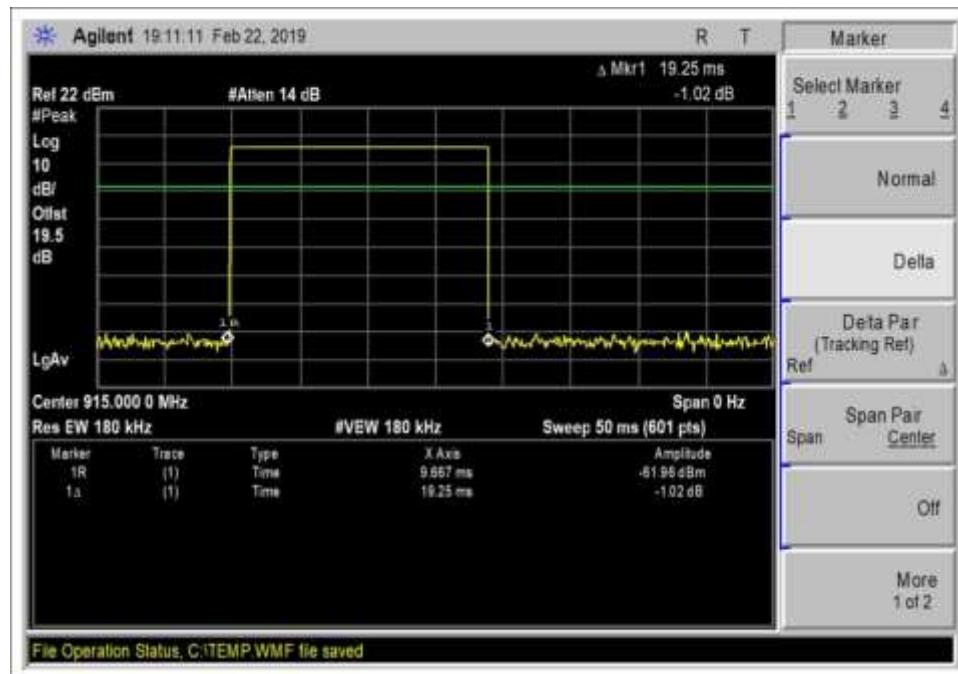
Actual Calculated Values:

Parameter	Value
Observation Period ( $P_{obs}$ ):	20s
Number of RF Bursts / $P_{obs}$ :	3
On time of RF Burst:	19.25ms
Number of Control or other signals / $P_{obs}$ :	0
On time of Control or other Signals:	0
Total Measured On Time:	57.75ms

## Plot(s)



20sec\_3peaks



Single Time\_19.25ms

**Test Setup Photo(s)**



## 15.247(b)(1) Output Power

### Test Data Summary - Voltage Variations

Frequency (MHz)	Modulation / Ant Port	V <sub>Minimum</sub> (dBm)	V <sub>Nominal</sub> (dBm)	V <sub>Maximum</sub> (dBm)	Max Deviation from V <sub>Nominal</sub> (dB)
902.2	GFSK / 1	9.1	9.1	9.1	0.0
915.0	GFSK / 1	8.9	8.9	8.9	0.0
927.8	GFSK / 1	8.7	8.7	8.7	0.0

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

#### **Parameter Definitions:**

Measurements performed at input voltage V<sub>Nominal</sub> ± 15%.

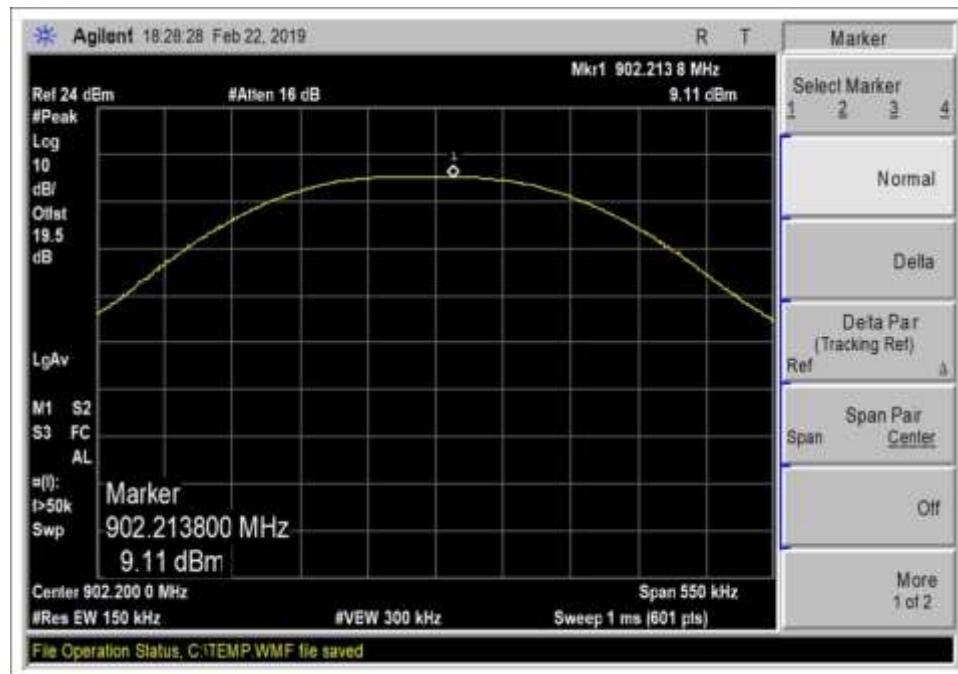
Parameter	Value
V <sub>Nominal</sub> :	24.0
V <sub>Minimum</sub> :	20.4
V <sub>Maximum</sub> :	27.6

### Test Data Summary - RF Conducted Measurement

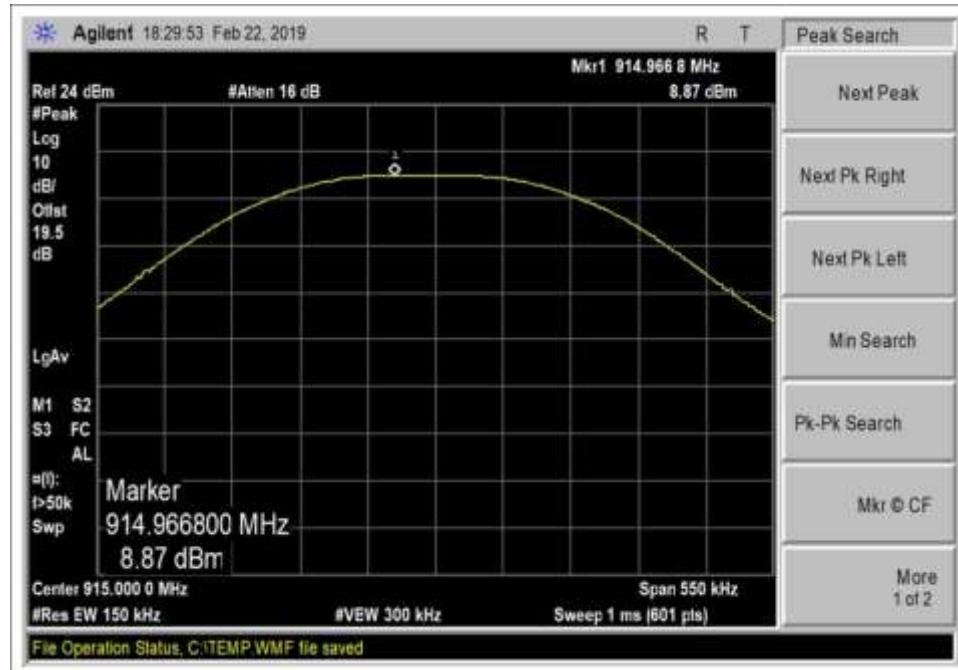
*Limit = {30dBm Conducted/36dBm EIRP | ≥ 50 Channels  
 24dBm Conducted/30dBm EIRP | < 50 Channels (min 25)}*

Frequency (MHz)	Modulation	Ant. Type / Gain (dBi)	Measured (dBm)	Limit (dBm)	Results
902.2	GFSK	Integral IFA / -1.58	9.1	≤30	Pass
915.0	GFSK	Integral IFA / -1.58	8.9	≤30	Pass
927.8	GFSK	Integral IFA / -1.58	8.7	≤30	Pass

## Plots



Low Channel



Middle Channel



High Channel

## Test Setup / Conditions / Data

Test Location: CKC Laboratories Inc. • 110 N Olinda Pl • Brea CA 92823 • 714 993-6112  
 Customer: **Venstar, Inc.**  
 Specification: **15.247(b) Power Output (902-928 MHz FHSS >50 Channels)**  
 Work Order #: **102105** Date: 2/22/2019  
 Test Type: **Conducted Emissions** Time: 17:28:16  
 Tested By: S. Yamamoto Sequence#: 2  
 Software: EMITest 5.03.11 24Vac

***Equipment Tested:***

Device	Manufacturer	Model #	S/N
Configuration 2			

***Support Equipment:***

Device	Manufacturer	Model #	S/N
Configuration 2			

***Test Conditions / Notes:***

The equipment under test (EUT) is placed on the wooden table top. The antenna cable is connected to the spectrum analyzer using a coaxial cable and attenuator.

Frequencies of test: 902.2MHz, 915.0MHz, and 927.8MHz, GFSK, pl=7. EUT firmware is 1.1.0. Antenna is integral IFA. Antenna gain -1.58dBi. Max duty cycle 98%.

Frequency range of measurement = Fundamental emissions for LMH. RBW=150kHz, VBW=300kHz.

Test environment conditions:

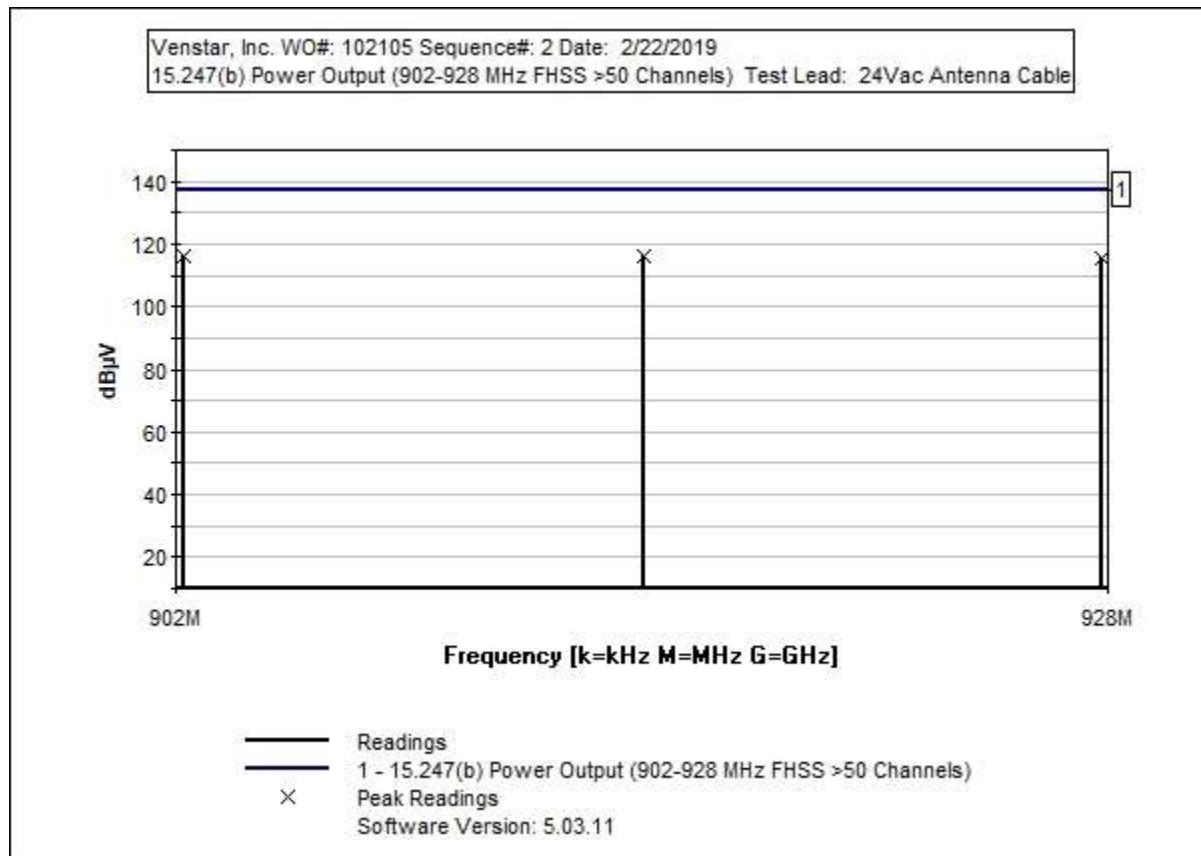
Temperature: 20°C

Relative Humidity: 35%

Pressure: 99kPa

Site D

ANSI C63.10-2013


**Test Equipment:**

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN02672	Spectrum Analyzer	E4446A	3/2/2017	3/2/2019
T2	ANP07244	Cable	32022-29094K- 29094K-24TC	7/5/2018	7/5/2020
T3	AN03431	Attenuator	89-20-21	12/19/2017	12/19/2019

**Measurement Data:**

#	Freq MHz	Rdng dB $\mu$ V	Reading listed by margin.			Dist Table	Corr dB $\mu$ V	Spec dB $\mu$ V	Margin dB	Polar Ant
			T1 dB	T2 dB	T3 dB					
1	902.214M	96.6	+0.0	+0.2	+19.3	+0.0	116.1	137.0	-20.9	Anten
2	914.967M	96.4	+0.0	+0.2	+19.3	+0.0	115.9	137.0	-21.1	Anten
3	927.806M	96.2	+0.0	+0.2	+19.3	+0.0	115.7	137.0	-21.3	Anten

**Test Setup Photo(s)**



## 15.247(d) RF Conducted Emissions & Band Edge

### Test Setup / Conditions / Data

Test Location: CKC Laboratories Inc. • 110 N Olinda Pl • Brea CA 92823 • 7149936112  
 Customer: **Venstar, Inc.**  
 Specification: **15.247(d) Conducted Spurious Emissions**  
 Work Order #: **102105** Date: 2/22/2019  
 Test Type: **Conducted Emissions** Time: 17:28:16  
 Tested By: S. Yamamoto Sequence#: 2  
 Software: EMITest 5.03.11 24Vac

***Equipment Tested:***

Device	Manufacturer	Model #	S/N
Configuration 2			

***Support Equipment:***

Device	Manufacturer	Model #	S/N
Configuration 2			

***Test Conditions / Notes:***

The equipment under test (EUT) is placed on the wooden table top. The antenna cable is connected to the spectrum analyzer using a coaxial cable and attenuator.

Frequencies of test: 902.2MHz, 915.0MHz and 927.8MHz. GFSK, pl=7. EUT firmware is 1.1.0. Antenna is integral IFA. Antenna gain -1.58dBi. Max duty cycle 98%.

Frequency range of measurement = 9kHz to 9.28GHz. RBW=100kHz, VBW=300kHz.

Test environment conditions:

Temperature: 20°C

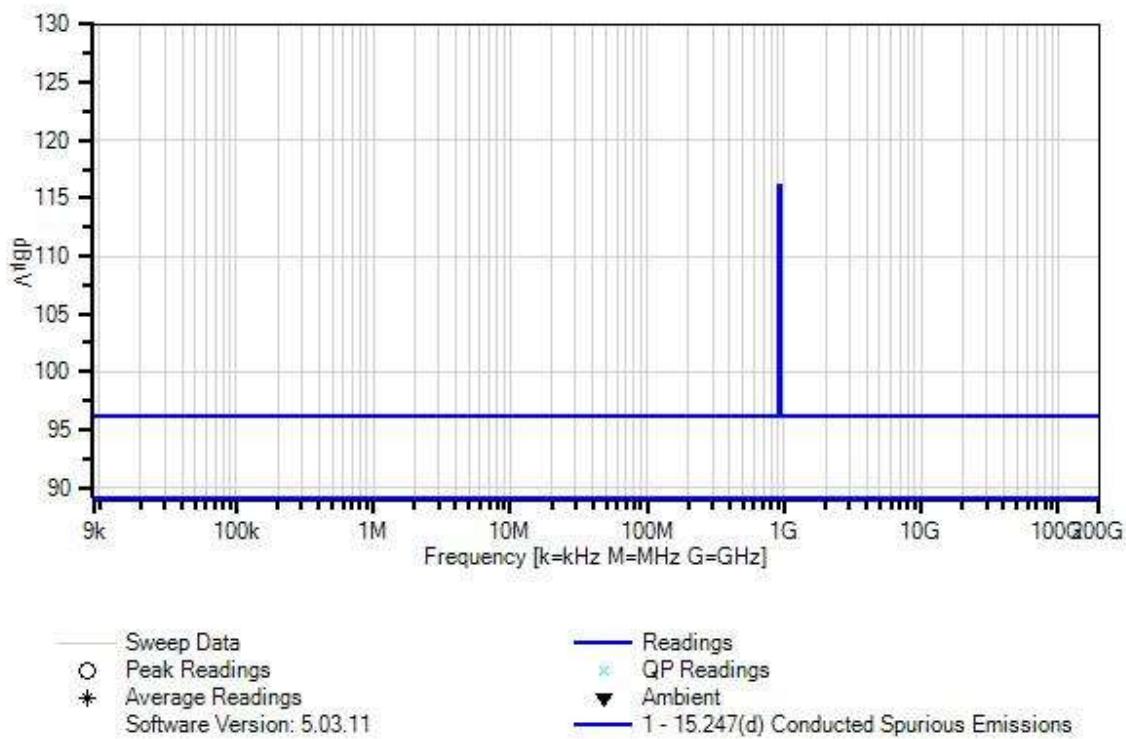
Relative Humidity: 35%

Pressure: 99kPa.

Site D

ANSI C63.10-2013

Venstar, Inc. WO#: 102105 Sequence#: 2 Date: 2/22/2019  
15.247(d) Conducted Spurious Emissions Test Lead: 24\vac Antenna Cable



**Test Equipment:**

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
	AN02672	Spectrum Analyzer	E4446A	3/2/2017	3/2/2019
T1	ANP07244	Cable	32022-29094K- 29094K-24TC	7/5/2018	7/5/2020
T2	AN03431	Attenuator	89-20-21	12/19/2017	12/19/2019

**Measurement Data:**

Reading listed by margin.

Test Lead: Antenna Cable

#	Freq MHz	Rdng dB $\mu$ V	T1 dB	T2 dB	dB	Dist Table	Corr dB $\mu$ V	Spec dB $\mu$ V	Margin dB	Polar Ant
1	2706.504M	52.7	+0.4	+19.3		+0.0	72.4	96.1	-23.7	Anten
2	2744.905M	51.3	+0.4	+19.3		+0.0	71.0	96.1	-25.1	Anten
3	2783.302M	50.7	+0.4	+19.3		+0.0	70.4	96.1	-25.7	Anten
4	1804.333M	47.1	+0.2	+19.3		+0.0	66.6	96.1	-29.5	Anten
5	1830.029M	45.1	+0.2	+19.3		+0.0	64.6	96.1	-31.5	Anten
6	4510.854M	43.1	+0.7	+19.5		+0.0	63.3	96.1	-32.8	Anten
7	1855.637M	43.0	+0.2	+19.3		+0.0	62.5	96.1	-33.6	Anten
8	3711.085M	42.0	+0.5	+19.3		+0.0	61.8	96.1	-34.3	Anten
9	4574.836M	41.0	+0.7	+19.5		+0.0	61.2	96.1	-34.9	Anten
10	3660.074M	41.2	+0.5	+19.3		+0.0	61.0	96.1	-35.1	Anten
11	3608.886M	40.5	+0.6	+19.3		+0.0	60.4	96.1	-35.7	Anten
12	4639.103M	39.1	+0.6	+19.5		+0.0	59.2	96.1	-36.9	Anten

## Band Edge

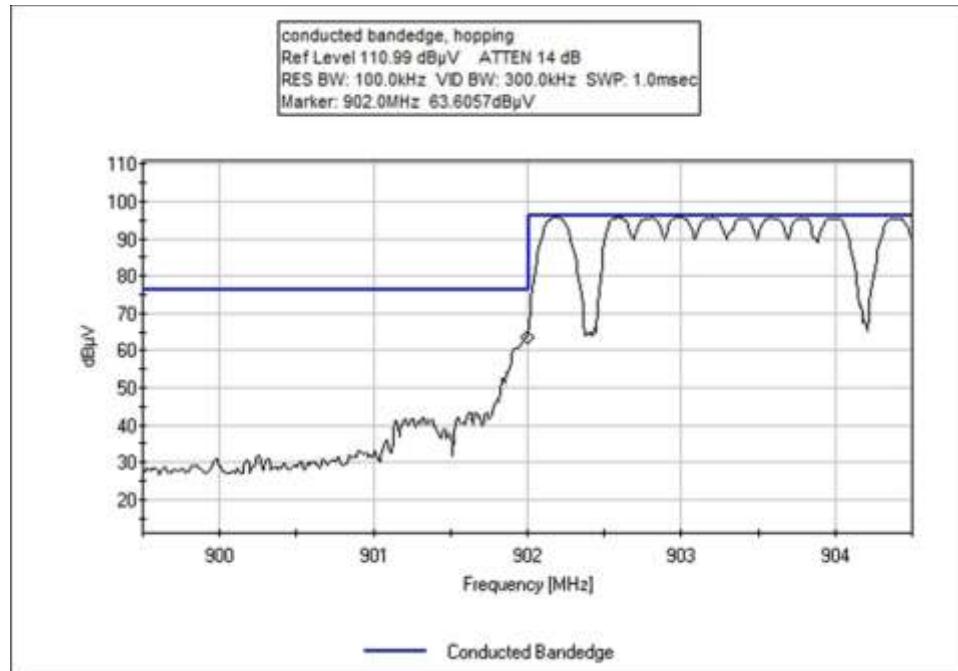
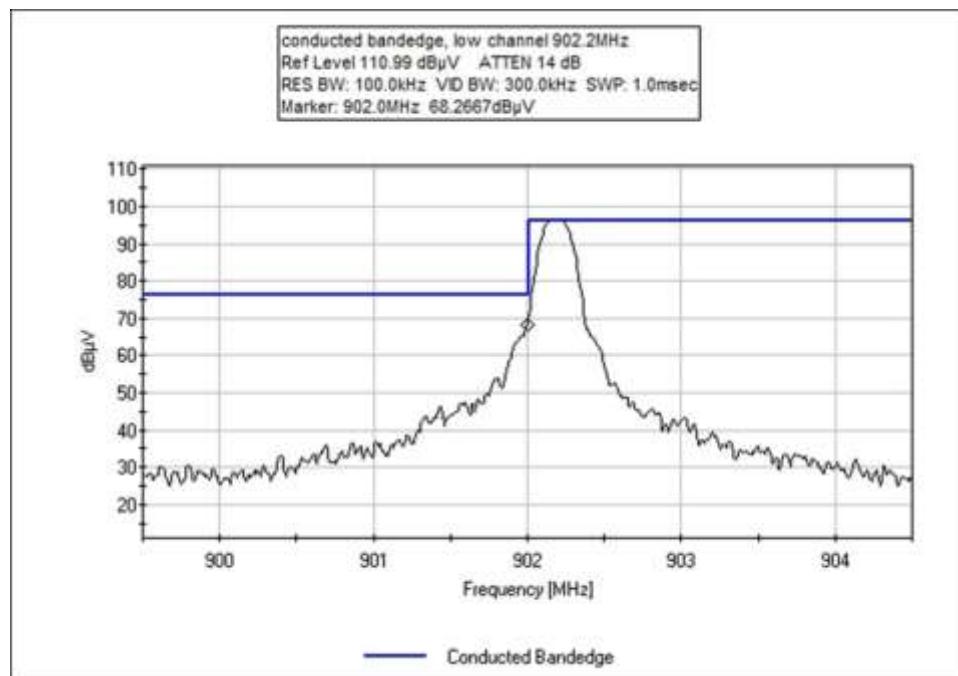
### Band Edge Summary

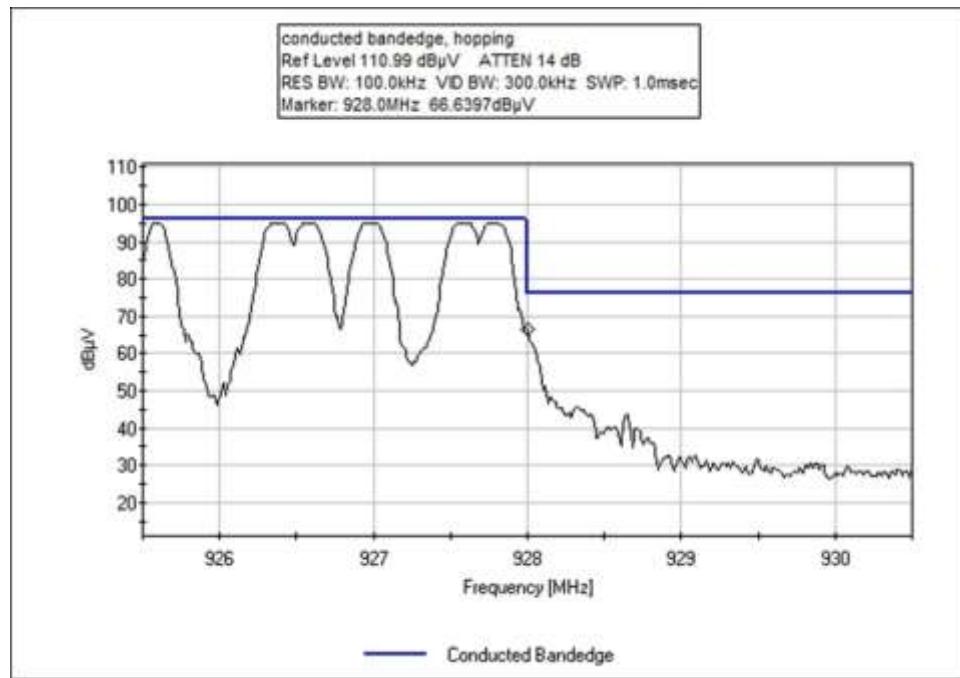
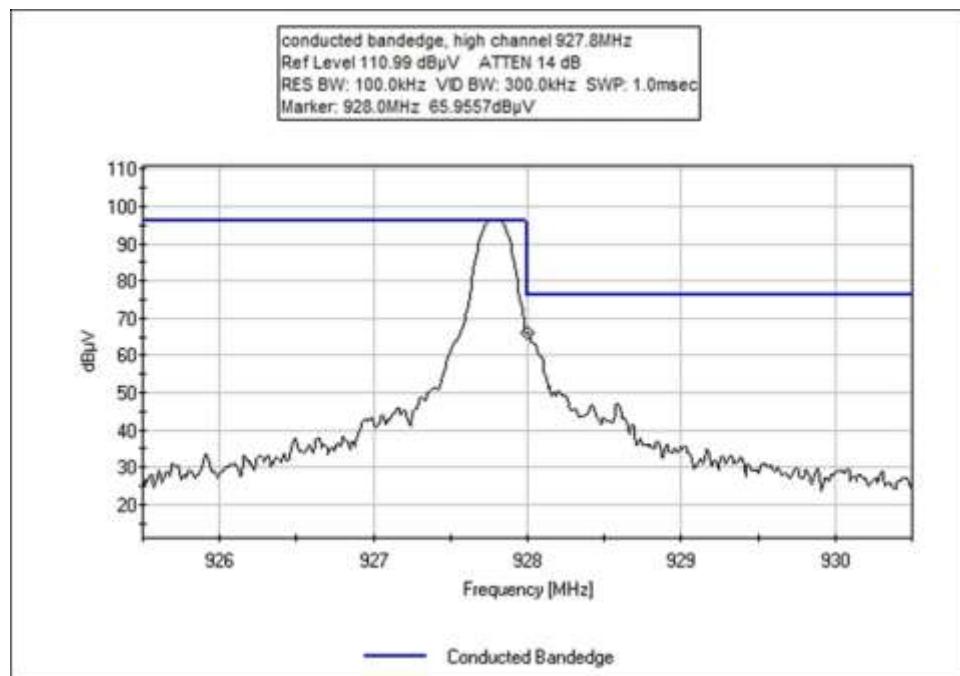
Limit applied: Max Power/100kHz - 20dB.

Frequency (MHz)	Modulation	Measured (dBm)	Limit (dBm)	Results
902	GFSK	-19.2	<-10.9	Pass
928	GFSK	-20.9*	<-10.9	Pass
902	GFSK	-23.9*	<-10.9	Pass
928	GFSK	-21.5	<-10.9	Pass

\*hopping

## Band Edge Plots





## Test Setup / Conditions / Data

Test Location: CKC Laboratories Inc. • 110 N Olinda Pl • Brea CA 92823 • 714 993-6112  
 Customer: **Venstar, Inc.**  
 Specification: **Conducted Bandedge**  
 Work Order #: **102105** Date: 2/22/2019  
 Test Type: **Conducted Emissions** Time: 18:16:03  
 Tested By: S. Yamamoto Sequence#: 1  
 Software: EMITest 5.03.11 24Vac

***Equipment Tested:***

Device	Manufacturer	Model #	S/N
Configuration 1			
Configuration 2			

***Support Equipment:***

Device	Manufacturer	Model #	S/N
Configuration 1			
Configuration 2			

***Test Conditions / Notes:***

The equipment under test (EUT) is placed on the wooden table top. The antenna cable is connected to the spectrum analyzer using a coaxial cable and attenuator.

Frequencies of test: 902.2MHz, and 927.8MHz.

Test performed with both single channel and hopping. GFSK, pl=7. EUT firmware is 1.1.0. Antenna is integral IFA.

Antenna gain -1.58dBi. Max duty cycle 98%.

Frequency range of measurement = 899MHz to 931MHz. RBW=100kHz, VBW=300kHz.

Test environment conditions:

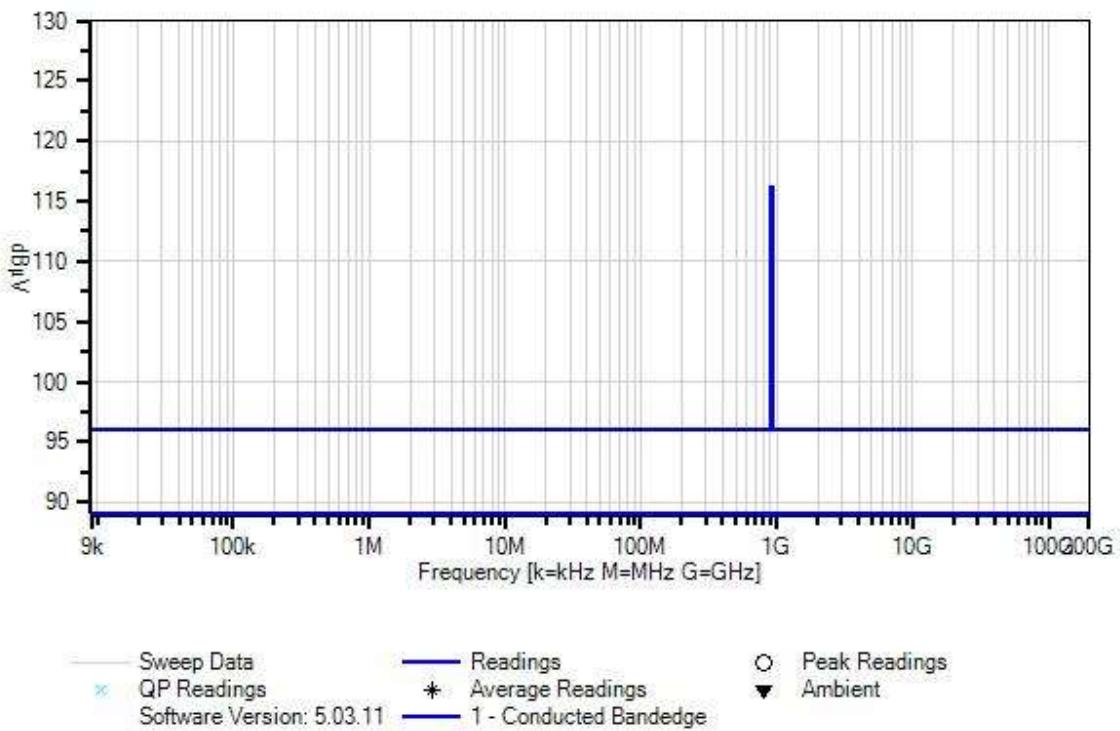
Temperature: 20C

Relative Humidity: 35%

Pressure: 99kPa

Site D

ANSI C63.10-2013

Venstar, Inc. WO#: 102105 Sequence#: 1 Date: 2/22/2019  
 Conducted Bandedge Test Lead: 24Vac Antenna Cable

**Test Equipment:**

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN02672	Spectrum Analyzer	E4446A	3/2/2017	3/2/2019
T2	ANP07244	Cable	32022-29094K-29094K-24TC	7/5/2018	7/5/2020
T3	AN03431	Attenuator	89-20-21	12/19/2017	12/19/2019

**Measurement Data:**

Reading listed by margin.							Test Lead: Antenna Cable			
#	Freq MHz	Rdng dB $\mu$ V	T1 dB	T2 dB	T3 dB	Dist Table	Corr dB $\mu$ V	Spec dB $\mu$ V	Margin dB	Polar Ant
1	902.000M	68.3	+0.0	+0.2	+19.3	+0.0	87.8	96.1	-8.3	Anten low channel 902.2MHz
2	928.000M	66.6	+0.0	+0.2	+19.3	+0.0	86.1	96.1	-10.0	Anten hopping
3	928.000M	66.0	+0.0	+0.2	+19.3	+0.0	85.5	96.1	-10.6	Anten high channel 927.8MHz
4	902.000M	63.6	+0.0	+0.2	+19.3	+0.0	83.1	96.1	-13.0	Anten hopping

**Test Setup Photo(s)**



## 15.247(d) Radiated Emissions & Band Edge

### Test Setup / Conditions / Data

Test Location: CKC Laboratories Inc. • 110 N Olinda Pl • Brea CA 92823 • 714 993-6112  
 Customer: **Venstar, Inc.**  
 Specification: **15.247(d) / 15.209 Radiated Spurious Emissions**  
 Work Order #: **102105** Date: 2/22/2019  
 Test Type: **Maximized Emissions** Time: 14:49:28  
 Tested By: S. Yamamoto Sequence#: 4  
 Software: EMITest 5.03.11

***Equipment Tested:***

Device	Manufacturer	Model #	S/N
Configuration 2			

***Support Equipment:***

Device	Manufacturer	Model #	S/N
Configuration 2			

***Test Conditions / Notes:***

The equipment under test (EUT) is placed on the wooden table top.

Frequencies of test: 902.2MHz, 915.0MHz and 927.8MHz.

GFSK, pl=7. EUT firmware is 1.1.0. Antenna is integral IFA. Antenna gain -1.58dBi. Max duty cycle 98%.

Frequency range of measurement = 9kHz to 9.28GHz.

9kHz to 150kHz, RBW=0.20kHz, VBW=1kHz.

150kHz to 30MHz, RBW=9kHz, VBW=30kHz.

30MHz to 1000MHz, RBW=120kHz, VBW=1.2MHz.

1GHz to 9.28GHz, RBW=1MHz, VBW=3MHz

Test environment conditions:

Temperature: 18°C

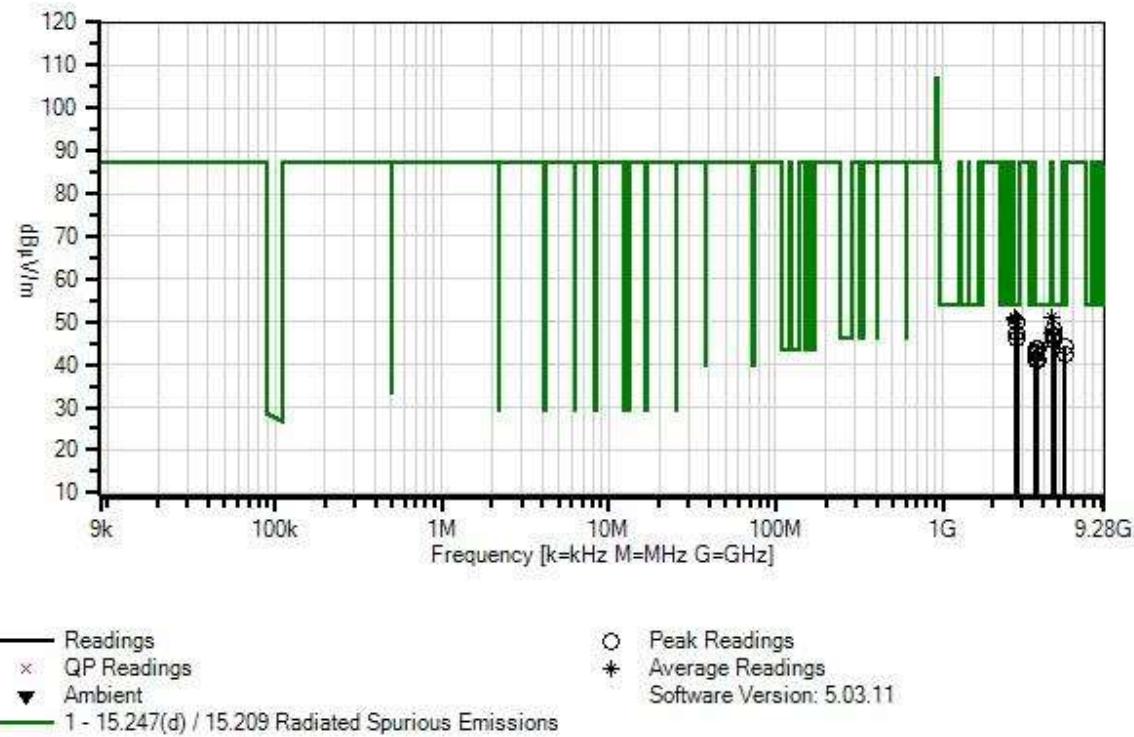
Relative Humidity: 45%

Pressure: 99kPa

Site D

ANSI C63.10-2013

Venstar, Inc. WO#: 102105 Sequence#: 4 Date: 2/22/2019  
15.247(d) / 15.209 Radiated Spurious Emissions Test Distance: 3 Meters Vert



**Test Equipment:**

ID	Asset #/	Description	Model	Calibration Date	Cal Due Date
	AN02672	Spectrum Analyzer	E4446A	3/2/2017	3/2/2019
T1	ANP04382	Cable	LDF-50	6/2/2018	6/2/2020
T2	ANP07138	Cable	ANDL1- PNMNM-60	3/1/2017	3/1/2019
T3	AN00787	Preamp	83017A	6/9/2017	6/9/2019
T4	ANP07243	Cable	32022-29094K- 29094K-24TC	7/5/2018	7/5/2020
T5	AN03169	High Pass Filter	HM1155-11SS	6/15/2017	6/15/2019
T6	AN01646	Horn Antenna	3115	3/14/2018	3/14/2020
	AN00010	Preamp	8447D	2/19/2018	2/19/2020
	AN01994	Biconilog Antenna	CBL6111C	4/23/2018	4/23/2020
	ANP05283	Attenuator	ATT-0218-06- NNN-02	4/5/2018	4/5/2020
	ANP05569	Cable-Amplitude +15C to +45C (dB)	RG-214/U	12/24/2018	12/24/2020
	ANP06978	Cable	Sucoflex 104A	3/31/2018	3/31/2020
	AN00314	Loop Antenna	6502	5/13/2018	5/13/2020

**Measurement Data:**

Reading listed by margin.

Test Distance: 3 Meters

#	Freq MHz	Rdng dB $\mu$ V	T1 dB	T2 dB	T3 dB	T4 dB	Dist Table	Corr dB $\mu$ V/m	Spec dB $\mu$ V/m	Margin dB	Polar
			T5 dB	T6 dB							Ant
1	4511.000M Ave	44.4 +0.1	+7.7 +32.8	+5.6	-40.2	+0.5	+0.0	50.9	54.0	-3.1	Horiz
^	4511.000M	46.4	+7.7 +0.1	+5.6 +32.8	-40.2	+0.5	+0.0	52.9	54.0	-1.1	Horiz
3	2706.600M Ave	51.8 +0.2	+5.7 +28.9	+4.3	-40.3	+0.3	+0.0	50.9	54.0	-3.1	Horiz
^	2706.600M	54.1	+5.7 +0.2	+4.3 +28.9	-40.3	+0.3	+0.0	53.2	54.0	-0.8	Horiz
5	2706.600M Ave	51.5 +0.2	+5.7 +28.9	+4.3	-40.3	+0.3	+0.0	50.6	54.0	-3.4	Vert
^	2706.600M	53.2	+5.7 +0.2	+4.3 +28.9	-40.3	+0.3	+0.0	52.3	54.0	-1.7	Vert
7	2783.403M Ave	50.9 +0.2	+5.8 +29.1	+4.4	-40.3	+0.3	+0.0	50.4	54.0	-3.6	Horiz
^	2783.403M	52.6	+5.8 +0.2	+4.4 +29.1	-40.3	+0.3	+0.0	52.1	54.0	-1.9	Horiz
9	2772.007M	50.3	+5.8 +0.2	+4.4 +29.0	-40.3	+0.3	+0.0	49.7	54.0	-4.3	Horiz
10	2783.400M	50.2	+5.8 +0.2	+4.4 +29.1	-40.3	+0.3	+0.0	49.7	54.0	-4.3	Vert
11	4574.993M	42.2	+7.7 +0.1	+5.8 +32.7	-40.5	+0.5	+0.0	48.5	54.0	-5.5	Horiz
12	2744.997M	48.4	+5.7 +0.2	+4.3 +29.0	-40.3	+0.3	+0.0	47.6	54.0	-6.4	Horiz

13	4511.000M	40.9	+7.7	+5.6	-40.2	+0.5	+0.0	47.4	54.0	-6.6	Vert
	Ave		+0.1	+32.8							
^	4511.000M	44.3	+7.7	+5.6	-40.2	+0.5	+0.0	50.8	54.0	-3.2	Vert
			+0.1	+32.8							
15	4639.003M	40.7	+7.8	+5.9	-40.7	+0.5	+0.0	47.0	54.0	-7.0	Horiz
			+0.2	+32.6							
16	4574.883M	39.9	+7.7	+5.8	-40.5	+0.5	+0.0	46.3	54.0	-7.7	Vert
			+0.1	+32.8							
17	2772.067M	46.6	+5.8	+4.4	-40.3	+0.3	+0.0	46.0	54.0	-8.0	Vert
			+0.2	+29.0							
18	2744.970M	46.6	+5.7	+4.3	-40.3	+0.3	+0.0	45.8	54.0	-8.2	Vert
			+0.2	+29.0							
19	4639.017M	39.1	+7.8	+5.9	-40.7	+0.5	+0.0	45.4	54.0	-8.6	Vert
			+0.2	+32.6							
20	5413.207M	34.3	+8.9	+6.4	-39.7	+0.3	+0.0	44.1	54.0	-9.9	Horiz
			+0.1	+33.8							
21	3711.203M	39.0	+7.1	+5.2	-40.2	+0.5	+0.0	43.9	54.0	-10.1	Horiz
			+0.2	+32.1							
22	3608.783M	39.9	+7.0	+5.1	-40.4	+0.4	+0.0	43.5	54.0	-10.5	Horiz
			+0.2	+31.3							
23	3608.810M	39.3	+7.0	+5.1	-40.4	+0.4	+0.0	42.9	54.0	-11.1	Vert
			+0.2	+31.3							
24	5413.190M	32.7	+8.9	+6.4	-39.7	+0.3	+0.0	42.5	54.0	-11.5	Vert
			+0.1	+33.8							
25	3660.020M	37.9	+7.1	+5.2	-40.3	+0.5	+0.0	42.4	54.0	-11.6	Horiz
			+0.2	+31.8							
26	3660.007M	36.6	+7.1	+5.2	-40.3	+0.5	+0.0	41.1	54.0	-12.9	Vert
			+0.2	+31.8							
27	3711.203M	36.1	+7.1	+5.2	-40.2	+0.5	+0.0	41.0	54.0	-13.0	Vert
			+0.2	+32.1							

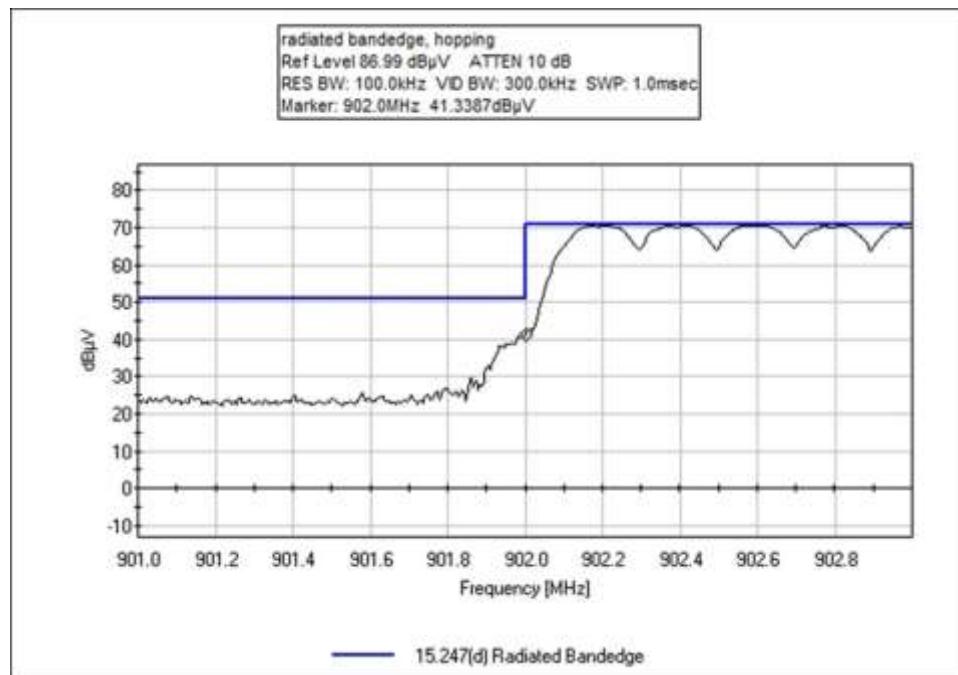
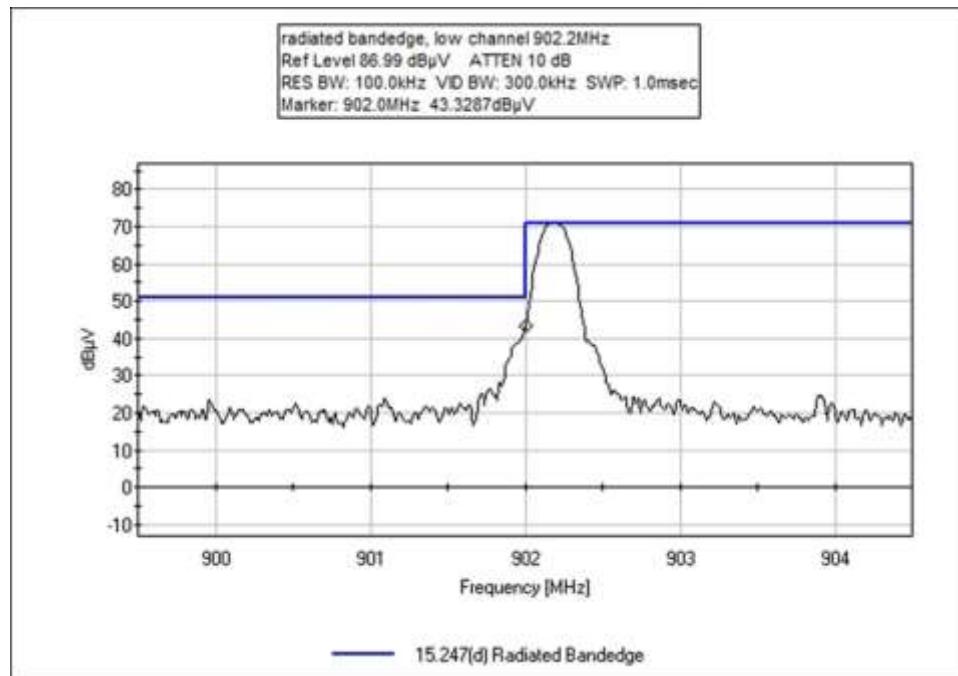
## Band Edge

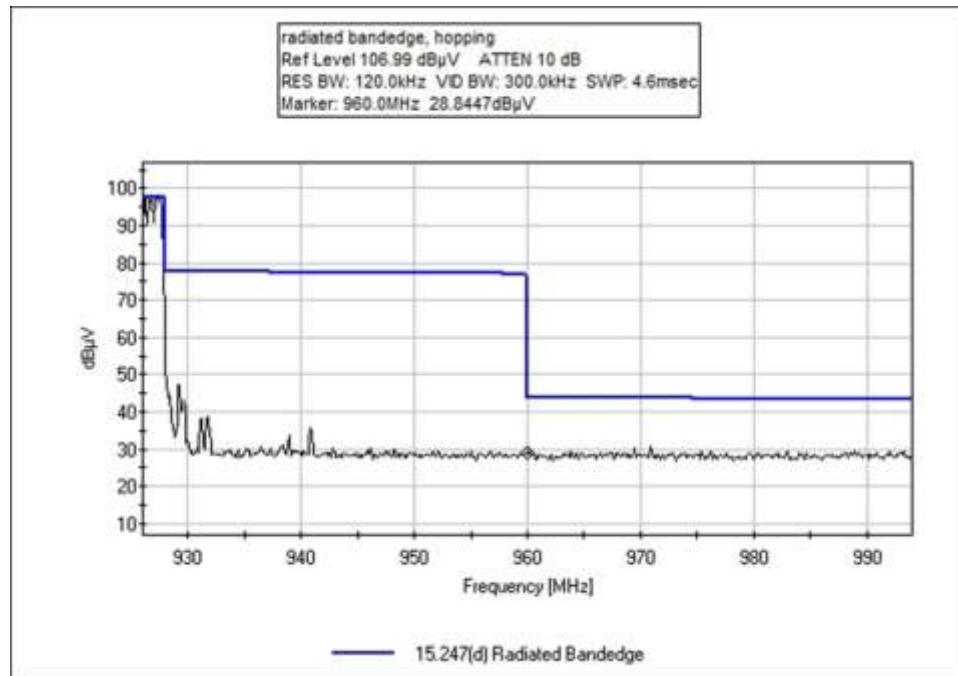
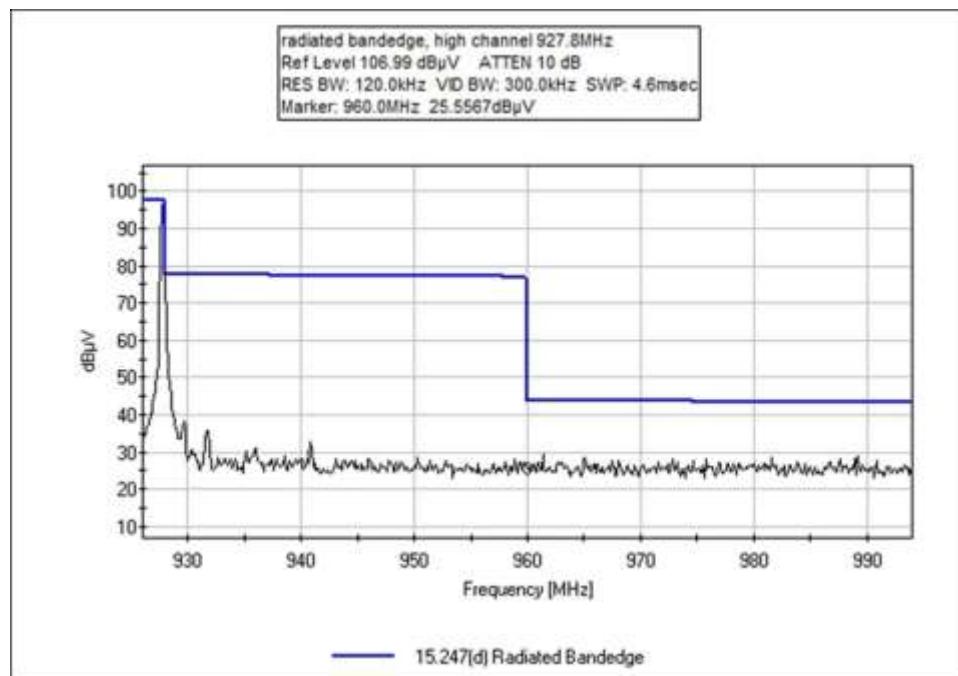
### Band Edge Summary

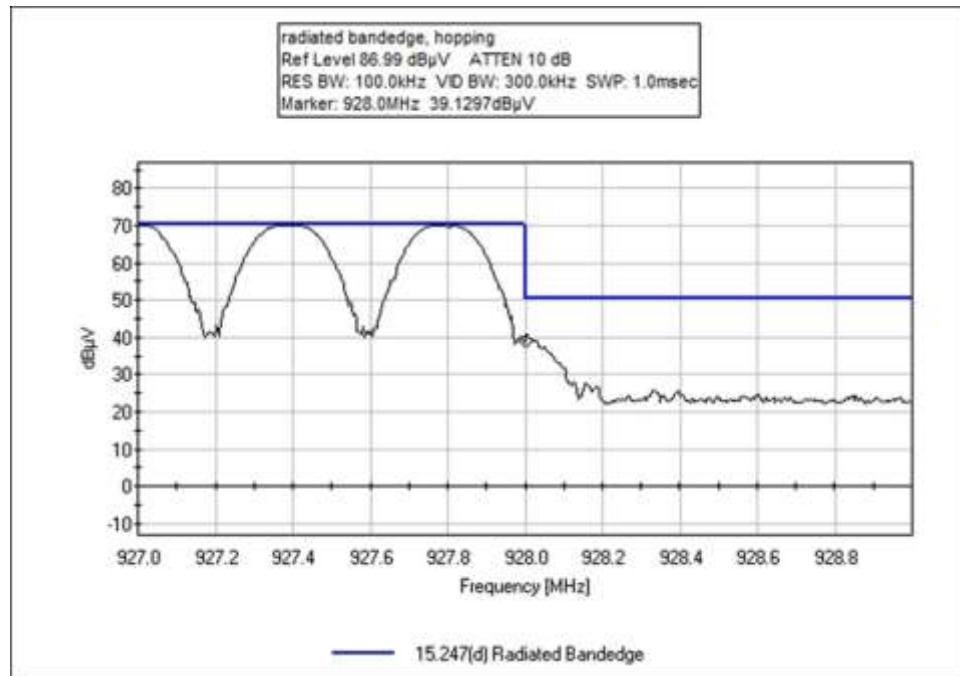
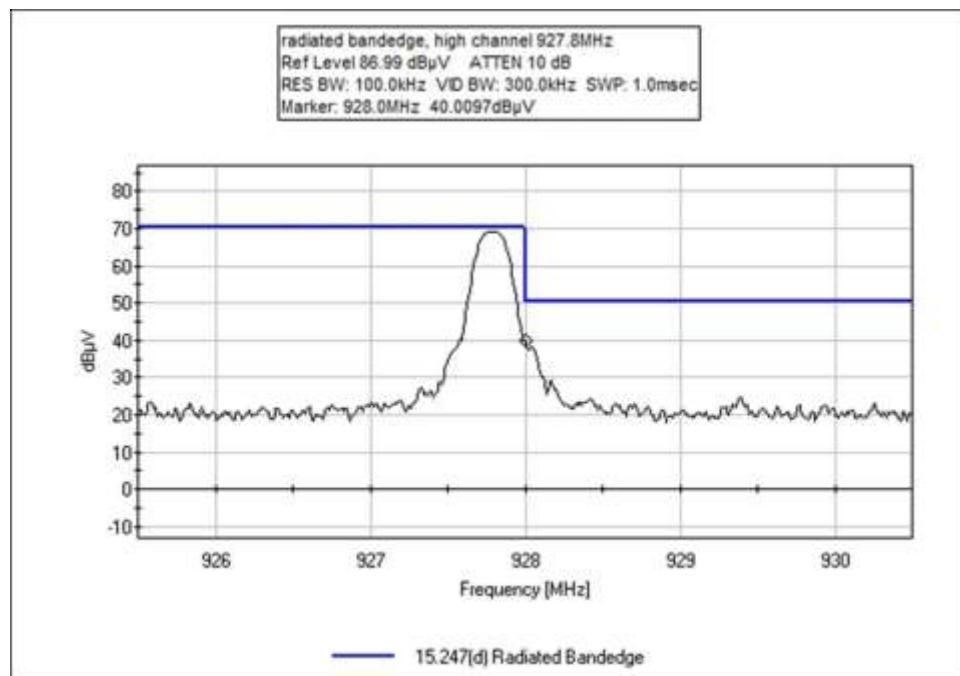
Frequency (MHz)	Modulation	Ant. Type	Field Strength (dBuV/m @3m)	Limit (dBuV/m @3m)	Results
614	GFSK	Integral IFA	27.9	<46	Pass
902	GFSK	Integral IFA	79.4	<87.2	Pass
928	GFSK	Integral IFA	76.6	<87.2	Pass
960	GFSK	Integral IFA	35.7	<54	Pass
614	GFSK	Integral IFA	29.3*	<46	Pass
902	GFSK	Integral IFA	77.4*	<87.2	Pass
928	GFSK	Integral IFA	75.7*	<87.2	Pass
960	GFSK	Integral IFA	38.9*	<54	Pass

\*hopping

## Band Edge Plots







## Test Setup / Conditions / Data

Test Location: CKC Laboratories Inc. • 110 N Olinda Pl • Brea CA 92823 • 714 993-6112  
 Customer: **Venstar, Inc.**  
 Specification: **15.247(d) Radiated Bandedge**  
 Work Order #: **102105** Date: 2/22/2019  
 Test Type: **Maximized Emissions** Time: 16:49:27  
 Tested By: S. Yamamoto Sequence#: 4  
 Software: EMITest 5.03.11

***Equipment Tested:***

Device	Manufacturer	Model #	S/N
Configuration 1			
Configuration 2			

***Support Equipment:***

Device	Manufacturer	Model #	S/N
Configuration 1			
Configuration 2			

***Test Conditions / Notes:***

The equipment under test (EUT) is placed on the wooden table top.

Frequencies of test: 902.2MHz, and 927.8MHz. Test performed with both single channel and hopping.

GFSK, pl=7. EUT firmware is 1.1.0. Antenna is integral IFA. Antenna gain -1.58dBi. Max duty cycle 98%.

Frequency range of measurement = 614MHz to 999MHz. RBW=100kHz or 120kHz (restricted band), VBW=300kHz.

Test environment conditions:

Temperature: 18°C

Relative Humidity: 45%

Pressure: 99kPa

Site D

ANSI C63.10-2013

**Test Equipment:**

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN02672	Spectrum Analyzer	E4446A	3/2/2017	3/2/2019
T2	ANP04382	Cable	LDF-50	6/2/2018	6/2/2020
T3	ANP05569	Cable-Amplitude +15C to +45C (dB)	RG-214/U	12/24/2018	12/24/2020
T4	ANP05283	Attenuator	ATT-0218-06- NNN-02	4/5/2018	4/5/2020
T5	AN01994	Biconilog Antenna	CBL6111C	4/23/2018	4/23/2020
T6	AN00010	Preamp	8447D	2/19/2018	2/19/2020
T7	ANP06978	Cable	Sucoflex 104A	3/31/2018	3/31/2020

**Measurement Data:**

Reading listed by margin.

Test Distance: 3 Meters

#	Freq	Rdng	T1	T2	T3	T4	Dist	Corr	Spec	Margin	Polar
			T5	T6	T7		Table	dB $\mu$ V/m	dB $\mu$ V/m		
	MHz	dB $\mu$ V	dB	dB	dB	dB				dB	Ant
1	902.000M	43.3	+0.0	+3.2	+3.6	+5.9	+0.0	79.4	87.2	-7.8	Horiz
			+23.4	+0.0	+0.0						
2	902.000M	41.3	+0.0	+3.2	+3.6	+5.9	+0.0	77.4	87.2	-9.8	Horiz
			+23.4	+0.0	+0.0						hopping
3	928.000M	40.0	+0.0	+3.3	+3.7	+5.9	+0.0	76.6	87.2	-10.6	Horiz
			+23.7	+0.0	+0.0						
4	928.000M	39.1	+0.0	+3.3	+3.7	+5.9	+0.0	75.7	87.2	-11.5	Horiz
			+23.7	+0.0	+0.0						hopping
5	960.000M	28.8	+0.0	+3.4	+3.8	+5.9	+0.0	38.9	54.0	-15.1	Horiz
			+24.1	-27.4	+0.3						hopping
6	614.000M	25.4	+0.0	+2.6	+2.9	+5.8	+0.0	29.3	46.0	-16.7	Horiz
			+20.4	-28.0	+0.2						hopping
7	614.000M	24.0	+0.0	+2.6	+2.9	+5.8	+0.0	27.9	46.0	-18.1	Horiz
			+20.4	-28.0	+0.2						
8	960.000M	25.6	+0.0	+3.4	+3.8	+5.9	+0.0	35.7	54.0	-18.3	Horiz
			+24.1	-27.4	+0.3						

**Test Setup Photo(s)**



Below 1GHz



Below 1GHz



Above 1GHz, Cone placement

## 15.207 AC Conducted Emissions

### Test Setup / Conditions / Data

Test Location: CKC Laboratories, Inc. • 110 N. Olinda Place • Brea, CA 92821 • 714 993- 6112  
 Customer: **Venstar, Inc.**  
 Specification: **15.207 AC Mains - Average**  
 Work Order #: **102105** Date: 2/25/2019  
 Test Type: **Conducted Emissions** Time: 9:07:19 AM  
 Tested By: S. Yamamoto Sequence#: 5  
 Software: EMITest 5.03.11 120V 60Hz

***Equipment Tested:***

Device	Manufacturer	Model #	S/N
Configuration 2			

***Support Equipment:***

Device	Manufacturer	Model #	S/N
Configuration 2			

***Test Conditions / Notes:***

The equipment under test (EUT) is placed on the wooden table top, orientated per intended installation; all data and Aux port are connected to section of unterminated cable.

The EUT has a 2.4 GHz Limited Modular Approved radio and 900MHz radio installed.

Frequency: 2437MHz Modulation:802.11b 1 mbps pl=12.

Frequency: 915MHz, GFSK pl=7.

EUT firmware is 1.1.0. Antenna are integral IFA. 2.4GHz antenna -0.97dBi.

900MHz band antenna -1.58dBi. Max duty cycle 98%.

Frequency range of measurement = 150kHz to 30MHz. RBW=9kHz,VBW=9.1kHz.

Test environment conditions:

Temperature: 20°C

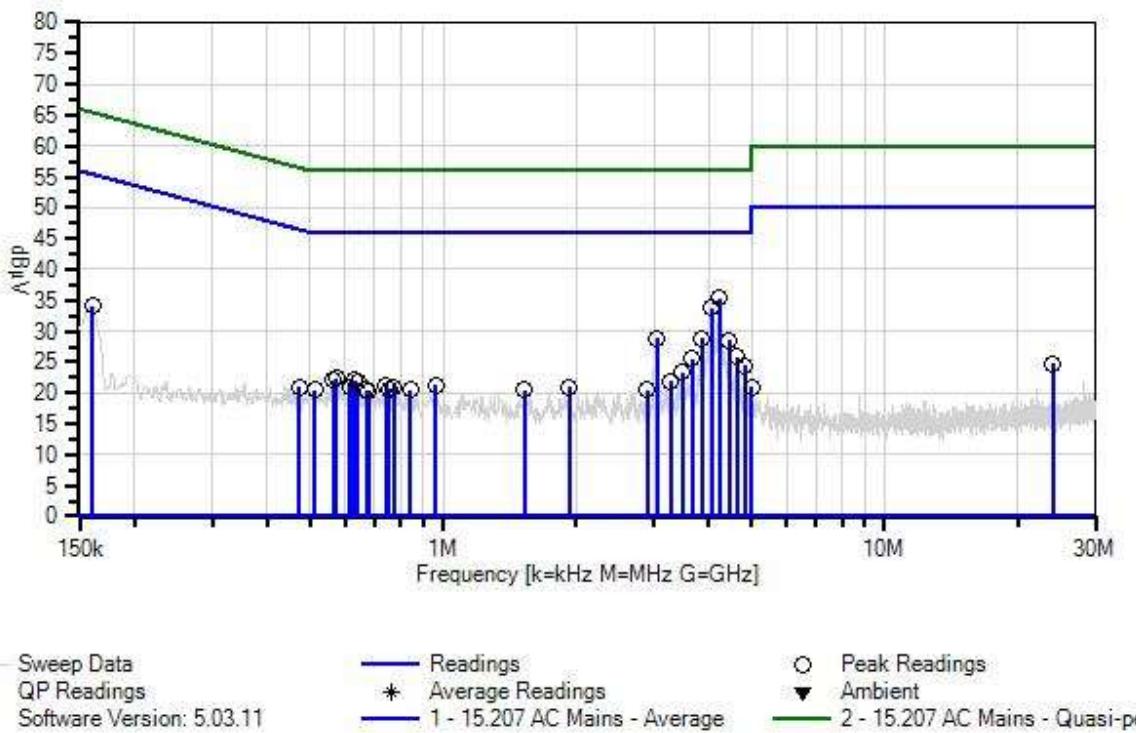
Relative Humidity: 35%

Pressure: 99kPa

Site D

ANSI C63.10-2013

Venstar, Inc. WO#: 102105 Sequence#: 5 Date: 2/25/2019  
15.207 AC Mains - Average Test Lead: 120V 60Hz Line



**Test Equipment:**

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
	AN02672	Spectrum Analyzer	E4446A	3/2/2017	3/2/2019
T1	AN02343	High Pass Filter	HE9615-150K-50-720B	12/24/2018	12/24/2020
T2	ANP01910	Cable	RG-142	10/25/2017	10/25/2019
T3	ANP06085	Attenuator	SA18N10W-09	11/15/2018	11/15/2020
T4	AN00847.1	50uH LISN-Line 1	3816/2NM	3/12/2018	3/12/2019
	AN00847.1	50uH LISN-Line 2	3816/2NM	3/12/2018	3/12/2019

**Measurement Data:**

Reading listed by margin.

Test Lead: Line

#	Freq MHz	Rdng dB $\mu$ V	T1 dB	T2 dB	T3 dB	T4 dB	Dist Table	Corr dB $\mu$ V	Spec dB $\mu$ V	Margin dB	Polar Ant
1	4.224M	28.9	+0.2	+0.2	+5.8	+0.2	+0.0	35.3	46.0	-10.7	Line
2	4.054M	27.4	+0.2	+0.2	+5.8	+0.2	+0.0	33.8	46.0	-12.2	Line
3	3.050M	22.6	+0.2	+0.1	+5.8	+0.2	+0.0	28.9	46.0	-17.1	Line
4	3.858M	22.5	+0.2	+0.2	+5.8	+0.2	+0.0	28.9	46.0	-17.1	Line
5	4.445M	22.1	+0.2	+0.2	+5.8	+0.2	+0.0	28.5	46.0	-17.5	Line
6	4.632M	19.5	+0.1	+0.2	+5.8	+0.2	+0.0	25.8	46.0	-20.2	Line
7	3.671M	19.2	+0.2	+0.1	+5.8	+0.2	+0.0	25.5	46.0	-20.5	Line
8	160.908k	27.7	+0.4	+0.1	+5.8	+0.1	+0.0	34.1	55.4	-21.3	Line
9	4.832M	18.1	+0.1	+0.2	+5.8	+0.2	+0.0	24.4	46.0	-21.6	Line
10	3.476M	17.0	+0.2	+0.1	+5.8	+0.2	+0.0	23.3	46.0	-22.7	Line
11	573.961k	16.0	+0.3	+0.1	+5.8	+0.1	+0.0	22.3	46.0	-23.7	Line
12	565.234k	15.8	+0.3	+0.1	+5.8	+0.1	+0.0	22.1	46.0	-23.9	Line
13	628.501k	15.7	+0.3	+0.1	+5.8	+0.1	+0.0	22.0	46.0	-24.0	Line
14	3.280M	15.6	+0.2	+0.1	+5.8	+0.2	+0.0	21.9	46.0	-24.1	Line
15	640.136k	15.4	+0.3	+0.1	+5.8	+0.1	+0.0	21.7	46.0	-24.3	Line
16	742.672k	15.0	+0.3	+0.1	+5.8	+0.1	+0.0	21.3	46.0	-24.7	Line
17	962.259k	15.1	+0.2	+0.1	+5.8	+0.1	+0.0	21.3	46.0	-24.7	Line
18	613.957k	14.7	+0.3	+0.1	+5.8	+0.1	+0.0	21.0	46.0	-25.0	Line

19	774.669k	14.6	+0.3	+0.1	+5.8	+0.1	+0.0	20.9	46.0	-25.1	Line
20	1.932M	14.7	+0.2	+0.1	+5.8	+0.1	+0.0	20.9	46.0	-25.1	Line
21	4.994M	14.6	+0.1	+0.2	+5.8	+0.2	+0.0	20.9	46.0	-25.1	Line
22	23.998M	17.5	+0.2	+0.4	+5.8	+0.8	+0.0	24.7	50.0	-25.3	Line
23	752.126k	14.3	+0.3	+0.1	+5.8	+0.1	+0.0	20.6	46.0	-25.4	Line
24	512.875k	14.2	+0.3	+0.1	+5.8	+0.1	+0.0	20.5	46.0	-25.5	Line
25	472.879k	14.7	+0.3	+0.1	+5.8	+0.1	+0.0	21.0	46.5	-25.5	Line
26	669.952k	14.2	+0.3	+0.1	+5.8	+0.1	+0.0	20.5	46.0	-25.5	Line
27	2.893M	14.3	+0.2	+0.1	+5.8	+0.1	+0.0	20.5	46.0	-25.5	Line
28	843.027k	14.2	+0.3	+0.1	+5.8	+0.1	+0.0	20.5	46.0	-25.5	Line
29	1.528M	14.2	+0.2	+0.1	+5.8	+0.1	+0.0	20.4	46.0	-25.6	Line
30	675.769k	14.0	+0.3	+0.1	+5.8	+0.1	+0.0	20.3	46.0	-25.7	Line



Test Location: CKC Laboratories, Inc. • 110 N. Olinda Place • Brea, CA 92821 • 714 993- 6112  
Customer: **Venstar, Inc.**  
Specification: **15.207 AC Mains - Average**  
Work Order #: **102105** Date: 2/25/2019  
Test Type: **Conducted Emissions** Time: 9:10:26 AM  
Tested By: S. Yamamoto Sequence#: 6  
Software: EMITest 5.03.11 120V 60Hz

***Equipment Tested:***

Device	Manufacturer	Model #	S/N
Configuration 2			

***Support Equipment:***

Device	Manufacturer	Model #	S/N
Configuration 2			

***Test Conditions / Notes:***

The equipment under test (EUT) is placed on the wooden table top, orientated per intended installation; all data and Aux port are connected to section of unterminated cable.  
The EUT has a 2.4 GHz Limited Modular Approved radio and 900MHz radio installed.

Frequency; 2437MHz Modulation:802.11b 1 mbps pl=12.

Frequency: 915MHz

GFSK pl=7. EUT firmware is 1.1.0. Antenna are integral IFA. 2.4GHz antenna -0.97dBi.  
900MHz band antenna -1.58dBi. Max duty cycle 98%.

Frequency range of measurement = 150kHz to 30MHz. RBW=9kHz,VBW=9.1kHz.

Test environment conditions:

Temperature: 20°C

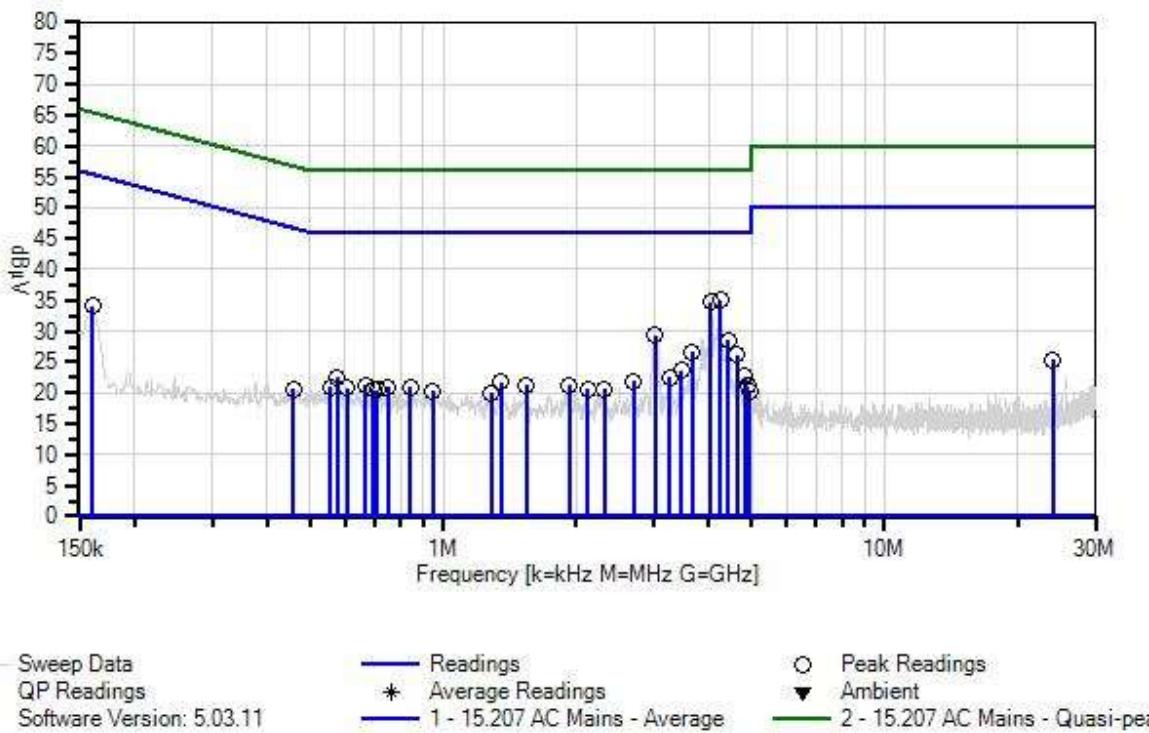
Relative Humidity: 35%

Pressure: 99kPa

Site D

ANSI C63.10-2013

Venstar, Inc. WO#: 102105 Sequence#: 6 Date: 2/25/2019  
15.207 AC Mains - Average Test Lead: 120V 60Hz Neutral



Sweep Data  
QP Readings  
Software Version: 5.03.11

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
	AN02672	Spectrum Analyzer	E4446A	3/2/2017	3/2/2019
T1	AN02343	High Pass Filter	HE9615-150K-50-720B	12/24/2018	12/24/2020
T2	ANP01910	Cable	RG-142	10/25/2017	10/25/2019
T3	ANP06085	Attenuator	SA18N10W-09	11/15/2018	11/15/2020
	AN00847.1	50uH LISN-Line 1	3816/2NM	3/12/2018	3/12/2019
T4	AN00847.1	50uH LISN-Line 2	3816/2NM	3/12/2018	3/12/2019

**Measurement Data:**

Reading listed by margin.

Test Lead: Neutral

#	Freq MHz	Rdng dB $\mu$ V	T1 dB	T2 dB	T3 dB	T4 dB	Dist Table	Corr dB $\mu$ V	Spec dB $\mu$ V	Margin dB	Polar Ant
1	4.245M	28.7	+0.2	+0.2	+5.8	+0.1	+0.0	35.0	46.0	-11.0	Neutr
2	4.045M	28.4	+0.2	+0.2	+5.8	+0.1	+0.0	34.7	46.0	-11.3	Neutr
3	3.016M	23.2	+0.2	+0.1	+5.8	+0.1	+0.0	29.4	46.0	-16.6	Neutr
4	4.432M	22.2	+0.2	+0.2	+5.8	+0.1	+0.0	28.5	46.0	-17.5	Neutr
5	3.667M	20.5	+0.2	+0.1	+5.8	+0.1	+0.0	26.7	46.0	-19.3	Neutr
6	4.628M	20.0	+0.1	+0.2	+5.8	+0.1	+0.0	26.2	46.0	-19.8	Neutr
7	160.908k	27.8	+0.4	+0.1	+5.8	+0.0	+0.0	34.1	55.4	-21.3	Neutr
8	3.471M	17.4	+0.2	+0.1	+5.8	+0.1	+0.0	23.6	46.0	-22.4	Neutr
9	4.824M	16.5	+0.1	+0.2	+5.8	+0.1	+0.0	22.7	46.0	-23.3	Neutr
10	3.254M	16.4	+0.2	+0.1	+5.8	+0.1	+0.0	22.6	46.0	-23.4	Neutr
11	576.142k	16.3	+0.3	+0.1	+5.8	+0.0	+0.0	22.5	46.0	-23.5	Neutr
12	2.702M	15.7	+0.2	+0.1	+5.8	+0.1	+0.0	21.9	46.0	-24.1	Neutr
13	1.349M	15.6	+0.2	+0.1	+5.8	+0.0	+0.0	21.7	46.0	-24.3	Neutr
14	23.998M	18.3	+0.2	+0.4	+5.8	+0.7	+0.0	25.4	50.0	-24.6	Neutr
15	1.932M	15.1	+0.2	+0.1	+5.8	+0.1	+0.0	21.3	46.0	-24.7	Neutr
16	666.316k	15.0	+0.3	+0.1	+5.8	+0.0	+0.0	21.2	46.0	-24.8	Neutr
17	1.541M	15.0	+0.2	+0.1	+5.8	+0.1	+0.0	21.2	46.0	-24.8	Neutr
18	4.909M	14.9	+0.1	+0.2	+5.8	+0.1	+0.0	21.1	46.0	-24.9	Neutr

19	555.053k	14.8	+0.3	+0.1	+5.8	+0.0	+0.0	21.0	46.0	-25.0	Neutr
20	749.944k	14.8	+0.3	+0.1	+5.8	+0.0	+0.0	21.0	46.0	-25.0	Neutr
21	840.845k	14.7	+0.3	+0.1	+5.8	+0.0	+0.0	20.9	46.0	-25.1	Neutr
22	604.503k	14.6	+0.3	+0.1	+5.8	+0.0	+0.0	20.8	46.0	-25.2	Neutr
23	2.123M	14.5	+0.2	+0.1	+5.8	+0.1	+0.0	20.7	46.0	-25.3	Neutr
24	2.319M	14.4	+0.2	+0.1	+5.8	+0.1	+0.0	20.6	46.0	-25.4	Neutr
25	696.131k	14.3	+0.3	+0.1	+5.8	+0.0	+0.0	20.5	46.0	-25.5	Neutr
26	710.675k	14.2	+0.3	+0.1	+5.8	+0.0	+0.0	20.4	46.0	-25.6	Neutr
27	945.248k	14.2	+0.2	+0.1	+5.8	+0.0	+0.0	20.3	46.0	-25.7	Neutr
28	4.956M	14.1	+0.1	+0.2	+5.8	+0.1	+0.0	20.3	46.0	-25.7	Neutr
29	458.335k	14.5	+0.3	+0.1	+5.8	+0.0	+0.0	20.7	46.7	-26.0	Neutr
30	1.285M	13.9	+0.2	+0.1	+5.8	+0.0	+0.0	20.0	46.0	-26.0	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 dB $\mu$ V/m, the spectrum analyzer reading in dB $\mu$ 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	(dB $\mu$ V)
+ Antenna Factor	(dB/m)
+ Cable Loss	(dB)
- Distance Correction	(dB)
- Preamplifier Gain	(dB)
= Corrected Reading	(dB $\mu$ V/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.