Venstar, Inc.

TEST REPORT FOR

Subgig Temperature Humidity Sensor
Model: VENnet Sensor

Tested to The Following Standards:

FCC Part 15 Subpart C Section(s)

15.247
(DTS 902-928MHz)

Report No.: 105151-10

Date of issue: April 2, 2021

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 # 803.01

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ADMINISTRATIVE INFORMATION

Test Report Information

REPORT PREPARED FOR:

Venstar, Inc.
9250 Owensmouth Avenue
Chatsworth, CA 91311

Representative: Alex Garashin

DATE OF EQUIPMENT RECEIPT:
DATE(S) OF TESTING:

REPORT PREPARED BY:

Kim Romero
CKC Laboratories, Inc.
5046 Sierra Pines Drive
Mariposa, CA 95338

Project Number: 105151

March 8, 2021
March 8, 10, 15, 17, and 22, 2021

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	5.03.19

Site Registration & Accreditation Information

Location	*NIST CB #	FCC	Canada	Japan
Canyon Park, Bothell, WA	US0103	US1024	3082C	A-0136
Brea, CA	US0103	US1024	3082D	A-0136
Fremont, CA	US0103	US1024	3082B	A-0136
Mariposa, CA	US0103	US1024	3082A	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 - 15.247 (DTS 902-928MHz)

Test Procedure	Description	Modifications	Results
15.247(a)(2)	6dB Bandwidth	NA	PASS
15.247(b)(3)	Output Power	NA	PASS
15.247(d)	RF Conducted Emissions & Band Edge	NA	PASS
15.247(d)	Radiated Emissions & Band Edge	NA	PASS
15.247(e)	Power Spectral Density	NA	PASS
15.207	AC Conducted Emissions	NA	NA1

NA = Not Applicable

NA1 = Not applicable because the manufacturer declares the EUT is battery powered.

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
Subgig Temperature Humidity Sensor	Venstar, Inc.	VENnet Sensor	NA

Support Equipment:

Device	Manufacturer	Model #	S/N
Development Kit	Texas Instruments	CC1352R1	NA
Laptop Computer	Lenovo	ThinkPad T500	L3B3906

General Product Information:

Product Information	Manufacturer-Provided Details
Equipment Type:	Stand-Alone Equipment
Type of Wideband System:	915MHz
Operating Frequency Range:	915MHz
Modulation Type(s):	2-GFSK
Maximum Duty Cycle:	100%
Number of TX Chains:	1
Antenna Type(s) and Gain:	Surface Mount -1dBi
Beamforming Type:	NA
Antenna Connection Type:	Integral
Nominal Input Voltage:	One 3V CR2450 Battery
Firmware / Software used for Test:	915MHz WB-DSSS 60 kbps, 2-GFSK, 195 kHz deviation, 4x spreading.
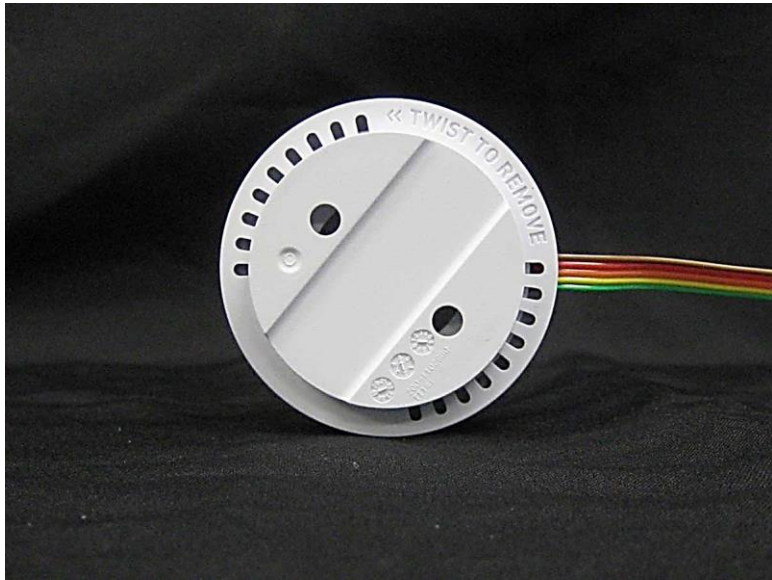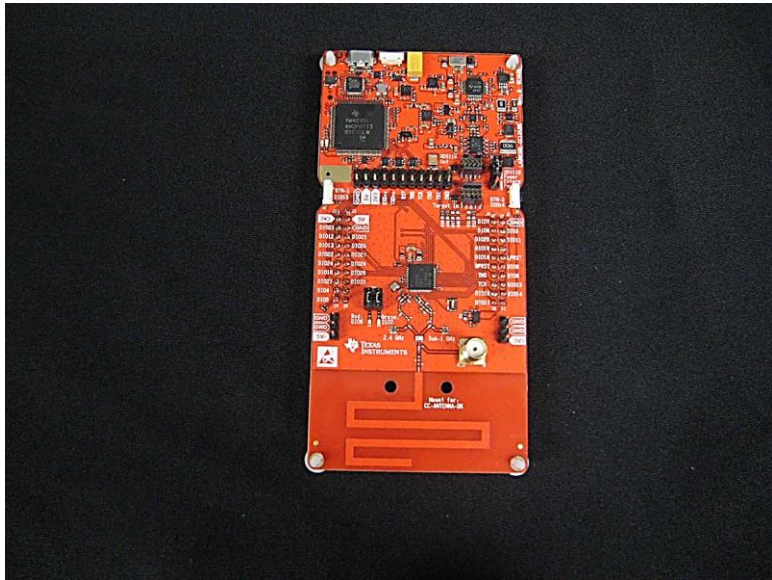
Development Kit

Laptop

Test Setup Block Diagram

FCC Part 15 Subpart C

15.247(a)(2) 6dB Bandwidth

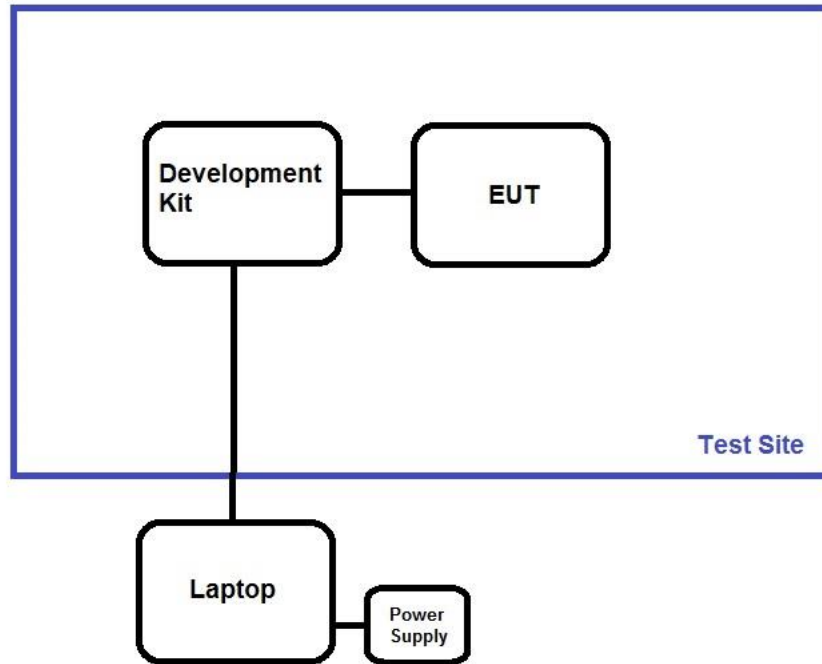| Test Setup/Conditions			
Test Location:	Brea Lab D	Test Engineer:	S. Yamamoto
Test Method:	ANSI C63.10 (2013), KDB 558074 v05r02: 04/02/2019	Test Date(s):	3/10/2021
Configuration:	1		
Test Setup:	The equipment under test (EUT) and support equipment are located together on the tabletop. The EUT is connected to the Texas Instruments CC1352R1 development board. The board is connected to the support laptop via USB cable. The board is providing 3.3Vdc to the EUT. The support laptop is running Texas Instruments SmartRF Studio 7 software to enable settings of the EUT. Software setting: RF Designed Based On: LAUNCHXL-CC1352R1 Setting Selection: WB-DSSS 60kbps, 2-GFSK, 195 kHz deviation, 4x spreading Frequency: 915.00MHz Symbol Rate: 480.00031 Modulation: 2-GFSK Deviation: 195kHz Mode: Continuous TX/ Modulated TX Power Setting: 14dBm		

Environmental Conditions			
Temperature (ºC)	20	Relative Humidity (%):	40

Test Equipment					
Asset#	Description	Manufacturer	Model	Cal Date	Cal Due
02869	Spectrum Analyzer	Agilent	E4440A	8/3/2020	8/3/2021
03432	Attenuator	Aeroflex/Weinschel	90-30-34	10/22/2019	10/22/2021
P07657	Cable	Astrolab, Inc.	32022-29094K-29094K-24TC	7/30/2020	7/30/2022

Test Data Summary					
Frequency (MHz)	Antenna Port	Modulation	Measured (kHz)	Limit (kHz)	Results
915	1	2-GFSK	570	≥500	Pass

Plot(s)

Test Setup Photo(s)
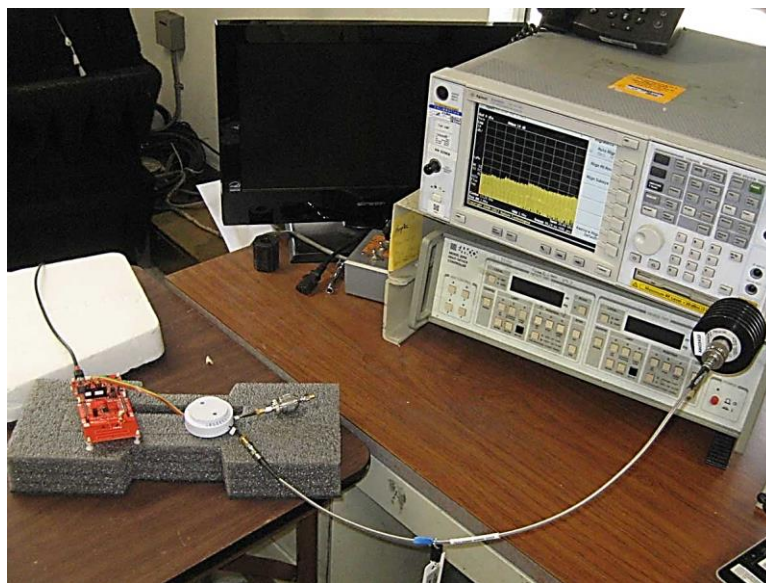
15.247(b)(3) Output Power
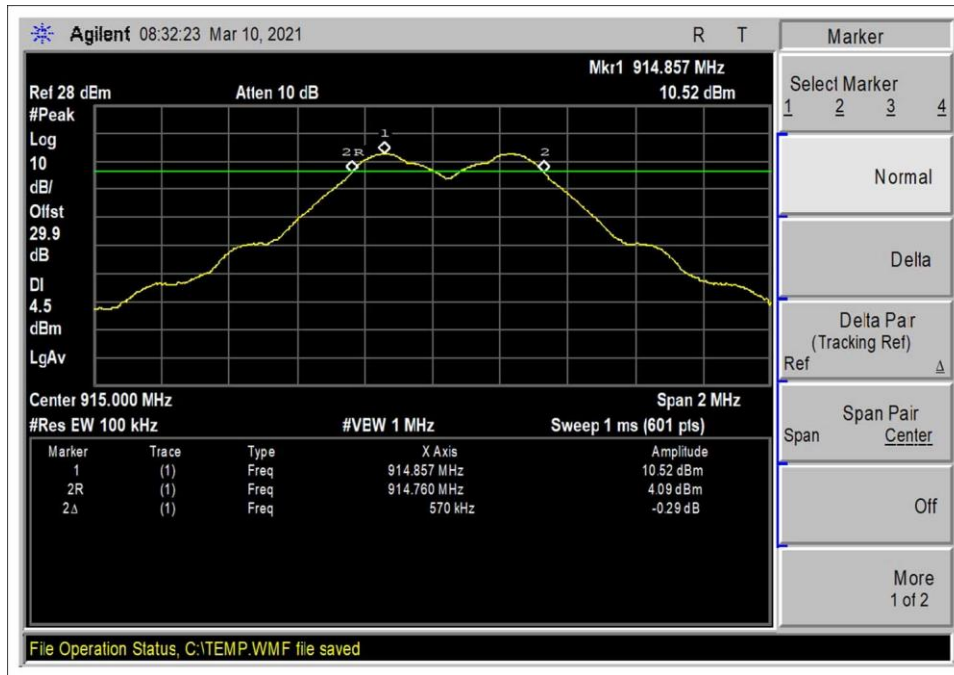
Test Setup/Conditions			
Test Location:	Brea Lab D	Test Engineer:	S. Yamamoto
Test Method:	ANSI C63.10 (2013), KDB 558074 v05r02: 04/02/2019	Test Date(s):	3/8/2021
Configuration:	1		
Test Setup:	The equipment under test (EUT) and support equipment are located together on the tabletop. The EUT is connected to the Texas Instruments CC1352R1 development board. The board is connected to the support laptop via USB cable. The board is providing 3.3Vdc to the EUT. The support laptop is running Texas Instruments SmartRF Studio 7 software to enable settings of the EUT. Software setting: RF Designed Based On: LAUNCHXL-CC1352R1 Setting Selection: WB-DSSS 60kbps, 2-GFSK, 195 kHz deviation, 4x spreading Frequency: 915.00MHz Symbol Rate: 480.00031 Modulation: 2-GFSK Deviation: 195kHz Mode: Continuous TX/ Modulated TX Power Setting: 14dBm		

Environmental Conditions			
Temperature (ºC)	20	Relative Humidity (%):	41

Test Equipment					
Asset#	Description	Manufacturer	Model	Cal Date	Cal Due
02869	Spectrum Analyzer	Agilent	E4440A	8/3/2020	8/3/2021
03432	Attenuator	Aeroflex/Weinschel	90-30-34	10/22/2019	10/22/2021
P07657	Cable	Astrolab, Inc.	32022-29094K-29094K-24TC	7/30/2020	7/30/2022

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)
915	2-GFSK / 1	NA	11.45	NA	NA

Note: The EUT is normally powered by one 3V CR2450 battery. The test was performed with an input voltage equivalent to a brand new fresh CR2450 battery.

Test Data Summary - Voltage Variations

This equipment is battery powered. Power output tests were performed using an input voltage equivalent to a fresh battery.

Test Data Summary - RF Conducted Measurement

Measurement Option: RBW > DTS Bandwidth

Frequency (MHz)	Modulation	Ant. Type / Gain (dBi)	Measured (dBm)	Limit (dBm)	Results
915	2-GFSK	Integral / -1.0	11.45	≤30	Pass

Plot(s)
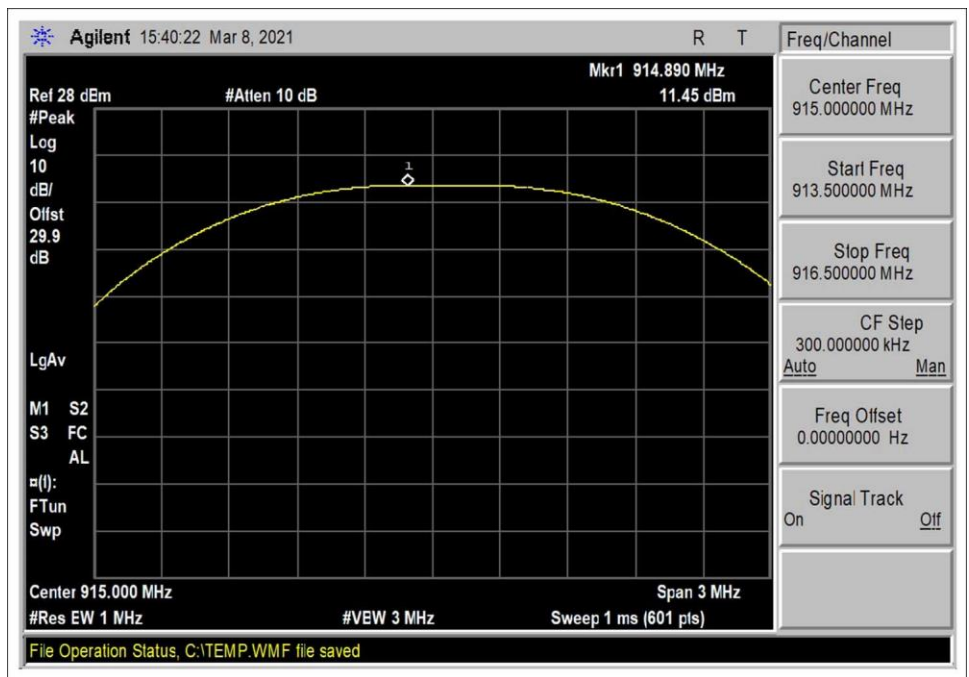
Test Setup / Conditions / Data

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 DTS)**
Work Order #:   **105151**   Date: 3/22/2021
Test Type: **Conducted Emissions**   Time: 14:24:55
Tested By: S. Yamamoto   Sequence#: 0
Software: EMITest 5.03.19   3.3Vdc

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) and support equipment are located together on the table top.
The EUT is connected to the Texas Instruments CC1352R1 development board. The board is connected to the support laptop via USB cable. The board is providing 3.3Vdc to the EUT.
The EUT is normally powered by one CR2450 3V battery.

The support laptop is running Texas Instruments SmartRF Studio 7 software to enable settings of the EUT.

Software Setting:
RF Designed Based On: LAUNCHXL-CC1352R1
Setting Selection: WB-DSSS 60kbps, 2-GFSK, 195 kHz deviation, 4x spreading
Frequency: 915.00MHz
Symbol Rate: 480.00031
Modulation: 2-GFSK
Deviation: 195kHz
Mode: Continuous TX/ Modulated
TX Power Setting: 14dBm

Test Environment Conditions:
Temperature: 20°C
Relative Humidity: 41%
Pressure: 99kPa

Site D

Test Method ANSI C63.10 (2013) KDB 558074 v05r02: 04/02/2019

Venstar, Inc. WO#: 105151 Sequence#: 0 Date: 3/22/2021
15.247(b) Power Output (902-928 MHz DTS) Test Lead: 3.3Vdc 915MHz Port

Legend:
- Sweep Data
- 1 – 15.247(b) Power Output (902-928 MHz DTS)
- Measure List
- Readings
- × Peak Readings
- Software Version: 5.03.19

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN02869	Spectrum Analyzer	E4440A	8/3/2020	8/3/2021
T2	AN03432	Attenuator	90-30-34	10/22/2019	10/22/2021
T3	ANP07657	Cable	32022-29094K-29094K-24TC	7/30/2020	7/30/2022

Measurement Data: Reading listed by margin.   Test Lead: 915MHz Port

#	Freq MHz	Rdng dBμV	T1 dB	T2 dB	T3 dB	dB	Dist Table	Corr dBμV	Spec dBμV	Margin dB	Polar Ant
1	914.890M	88.6	+0.0	+29.6	+0.3		+0.0	118.5	137.0	-18.6	915MH
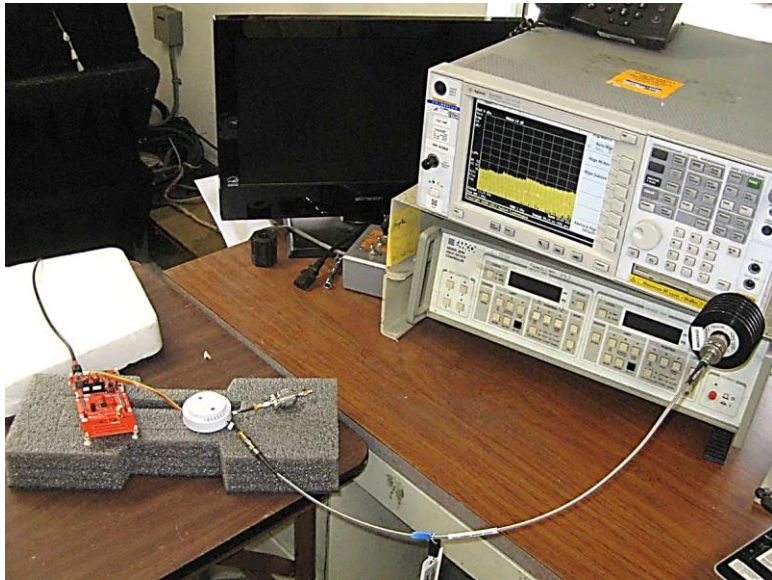
15.247(d) RF Conducted Emissions & Band Edge

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) Conducted Spurious Emissions**
Work Order #: **105151** Date: 3/8/2021
Test Type: **Conducted Emissions** Time: 16:13:52
Tested By: S. Yamamoto Sequence#: 1
Software: EMITest 5.03.19 3.3Vdc

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) and support equipment are located together on the table top.
The EUT is connected to the Texas Instruments CC1352R1 development board. The board is connected to the support laptop via USB cable. The board is providing 3.3Vdc to the EUT.

The support laptop is running Texas Instruments SmartRF Studio 7 software to enable settings of the EUT.

Software Setting:
RF Designed Based On: LAUNCHXL-CC1352R1
Setting Selection: WB-DSSS 60kbps, 2-GFSK, 195 kHz deviation, 4x spreading
Frequency: 915.00MHz
Symbol Rate: 480.00031
Modulation: 2-GFSK
Deviation: 195kHz
Mode: Continuous TX/ Modulated
TX Power Setting: 14dBm

Frequency of Measurement: 9kHz-10GHz
RBW=100kHz, VBW=300kHz

Test Environment Conditions:
Temperature: 20°C
Relative Humidity: 41%
Pressure: 99kPa

Site D

Test Method ANSI C63.10 (2013) KDB 558074 v05r02: 04/02/2019

Venstar, Inc. WO#: 105151 Sequence#: 1 Date: 3/8/2021
15.247(d) Conducted Spurious Emissions Test Lead: 3.3Vdc 915MHz Port
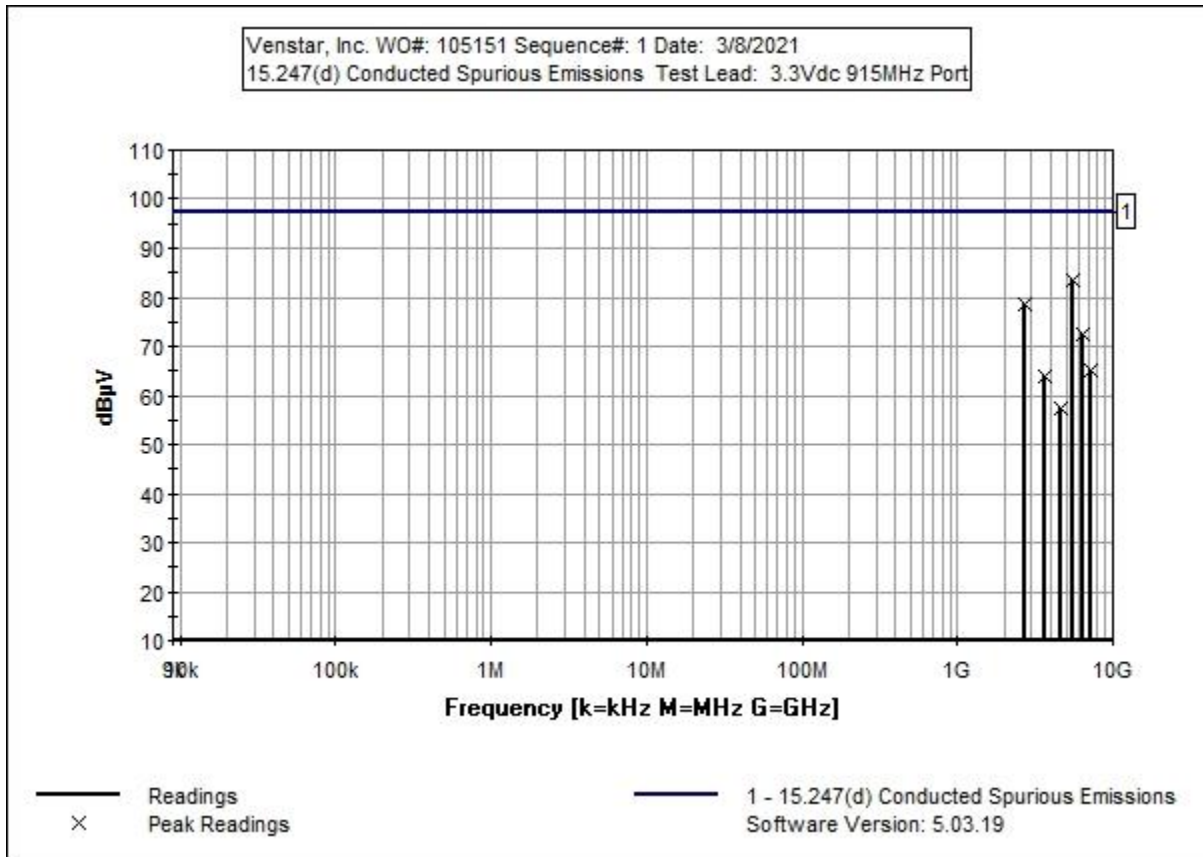
Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
	AN02869	Spectrum Analyzer	E4440A	8/3/2020	8/3/2021
T1	AN03432	Attenuator	90-30-34	10/22/2019	10/22/2021
T2	ANP07657	Cable	32022-29094K-29094K-24TC	7/30/2020	7/30/2022

Measurement Data: Reading listed by margin. Test Lead: 915MHz Port

| #	Freq MHz	Rdng dBµV	T1 dB	T2 dB	dB	dB	Dist Table	Corr dBµV	Spec dBµV	Margin dB	Polar Ant
1	5491.417M	52.7	+29.9	+0.8			+0.0	83.4	97.4	-14.0	915MH
2	2744.567M	48.2	+29.7	+0.5			+0.0	78.4	97.4	-19.0	915MH
3	6404.000M	42.0	+29.5	+0.8			+0.0	72.3	97.4	-25.1	915MH
4	7321.867M	35.0	+29.4	+0.8			+0.0	65.2	97.4	-32.2	915MH
5	3660.917M	33.5	+29.8	+0.6			+0.0	63.9	97.4	-33.5	915MH
6	4576.200M	27.2	+29.7	+0.6			+0.0	57.5	97.4	-39.9	915MH

Band Edge

Band Edge Summary

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

Frequency (MHz)	Modulation	Measured (dBm)	Limit (dBm)	Results
902	2-GFSK	-58.29	<-9.5	Pass
928	2-GFSK	-59.26	<-9.5	Pass

Band Edge Plots
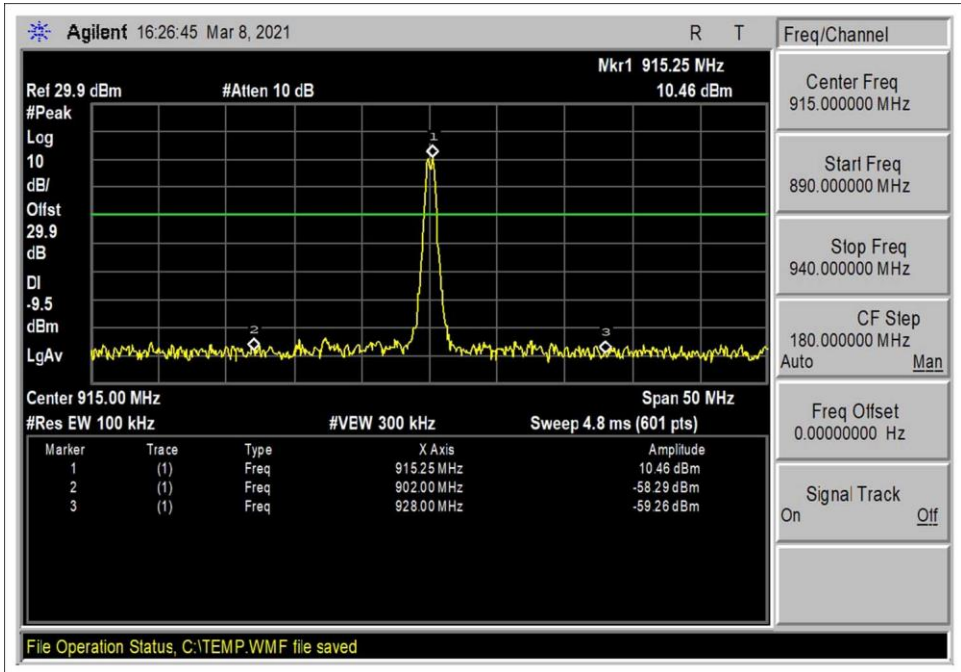
Test Location: CKC Laboratories, Inc. • 110 N Olinda Pl • Brea CA 92823 • 714-993-6112
Customer: **Venstar, Inc.**
Specification: **15.247(d) Conducted Spurious Emissions**
Work Order #: **105151**   Date: 3/22/2021
Test Type: **Conducted Emissions**   Time: 16:15:40
Tested By: S. Yamamoto   Sequence#: 0
Software: EMITest 5.03.19   3.3Vdc

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) and support equipment are located together on the table top.
The EUT is connected to the Texas Instruments CC1352R1 development board. The board is connected to the support laptop via USB cable. The board is providing 3.3Vdc to the EUT.

The support laptop is running Texas Instruments SmartRF Studio 7 software to enable settings of the EUT.

Software Setting:
RF Designed Based On: LAUNCHXL-CC1352R1
Setting Selection: WB-DSSS 60kbps, 2-GFSK, 195 kHz deviation, 4x spreading
Frequency: 915.00MHz
Symbol Rate: 480.00031
Modulation: 2-GFSK
Deviation: 195kHz
Mode: Continuous TX/ Modulated
TX Power Setting: 14dBm

Test Environment Conditions:
Temperature: 20°C
Relative Humidity: 41%
Pressure: 99kPa

Site D

Test Method ANSI C63.10 (2013) KDB 558074 v05r02: 04/02/2019

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN02869	Spectrum Analyzer	E4440A	8/3/2020	8/3/2021
T2	AN03432	Attenuator	90-30-34	10/22/2019	10/22/2021
T3	ANP07657	Cable	32022-29094K-29094K-24TC	7/30/2020	7/30/2022

Measurement Data: Reading listed by margin.   Test Lead: 915MHz Port

#	Freq MHz	Rdng dBµV	T1 dB	T2 dB	T3 dB	dB	Dist Table	Corr dBµV	Spec dBµV	Margin dB	Polar Ant
1	902.000M	18.8	+0.0	+29.6	+0.3		+0.0	48.7	97.5	-48.8	915MH
2	928.000M	17.8	+0.0	+29.6	+0.3		+0.0	47.7	97.5	-49.8	915MH

Test Setup Photo(s)
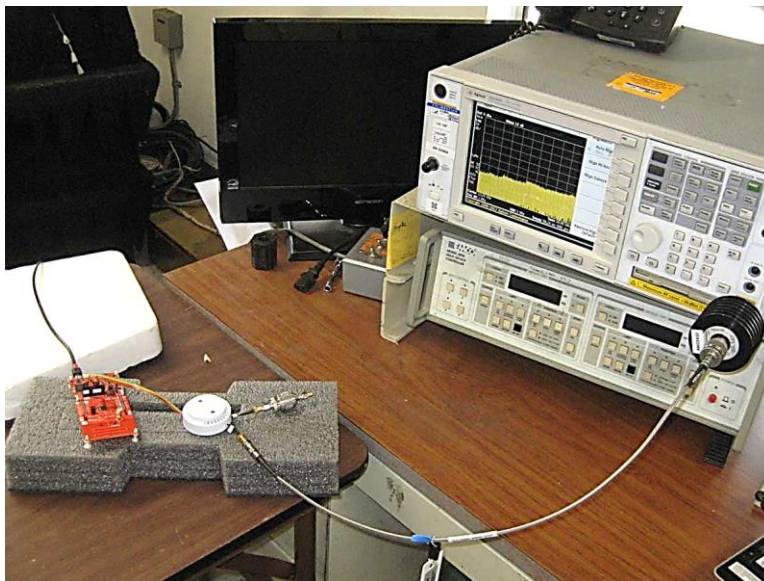
15.247(d) Radiated Emissions & Band Edge

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 #:   **105151**   Date: 3/15/2021
Test Type: **Maximized Emissions**   Time: 15:53:47
Tested By: S. Yamamoto   Sequence#: 5
Software: EMITest 5.03.19

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 located stand alone on the Styrofoam table top.
The EUT is connected to the Texas Instruments CC1352R1 development board via unshielded ribbon cable.
The development board is connected to the support laptop via USB cable. The board is providing 3.3Vdc to the EUT.

The support laptop is running Texas Instruments SmartRF Studio 7 software to enable settings of the EUT.

Software Setting:
RF Designed Based On: LAUNCHXL-CC1352R1
Setting Selection: WB-DSSS 60kbps, 2-GFSK, 195 kHz deviation, 4x spreading
Frequency: 915.00MHz
Symbol Rate: 480.00031
Modulation: 2-GFSK
Deviation: 195kHz
Mode: Continuous TX/ Modulated
TX Power Setting: 14dBm

Frequency of Measurement: 9kHz-10GHz

Frequency of Datasheet: 9kHz to 10GHz
1GHz to 10GHz, RBW= 1MHz, VBW=3MHz

Test Environment Conditions:
Temperature: 18°C
Relative Humidity: 40%
Pressure: 99kPa

Site D

Test Method ANSI C63.10 (2013) KDB 558074 v05r02: 04/02/2019

Venstar, Inc. WO#: 105151 Sequence#: 5 Date: 3/15/2021
15.247(d) / 15.209 Radiated Spurious Emissions Test Distance: 3 Meters Horiz
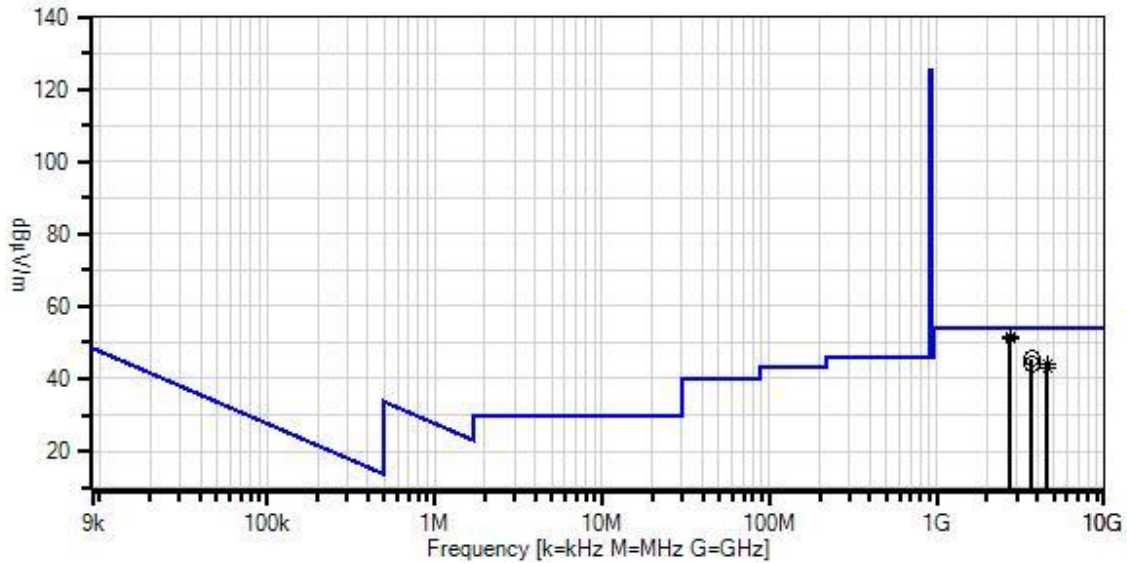
Readings
× QP Readings
▼ Ambient
—— 1 - 15.247(d) / 15.209 Radiated Spurious Emissions

○ Peak Readings
✳ Average Readings
Software Version: 5.03.19

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
	AN02869	Spectrum Analyzer	E4440A	8/3/2020	8/3/2021
T1	ANP04382	Cable	LDF-50	5/15/2020	5/15/2022
T2	ANP07692	Cable	LDF1-50	8/20/2020	8/20/2022
T3	AN00787	Preamp	83017A	5/31/2019	5/31/2021
T4	ANP07656	Cable	32022-29094K-29094K-24TC	7/30/2020	7/30/2022
T5	AN01646	Horn Antenna	3115	3/17/2020	3/17/2022
T6	AN03169	High Pass Filter	HM1155-11SS	5/8/2019	5/8/2021
	ANP05569	Cable-Amplitude +15C to +45C (dB)	RG-214/U	12/14/2020	12/14/2022
	ANP06978	Cable	Sucoflex 104A	3/26/2020	3/26/2022
	AN00010	Preamp	8447D	1/2/2020	1/2/2022
	ANP05283	Attenuator	ATT-0218-06-NNN-02	3/26/2020	3/26/2022
	AN01994	Biconilog Antenna	CBL6111C	4/14/2020	4/14/2022
	AN00314	Loop Antenna	6502	4/13/2020	4/13/2022

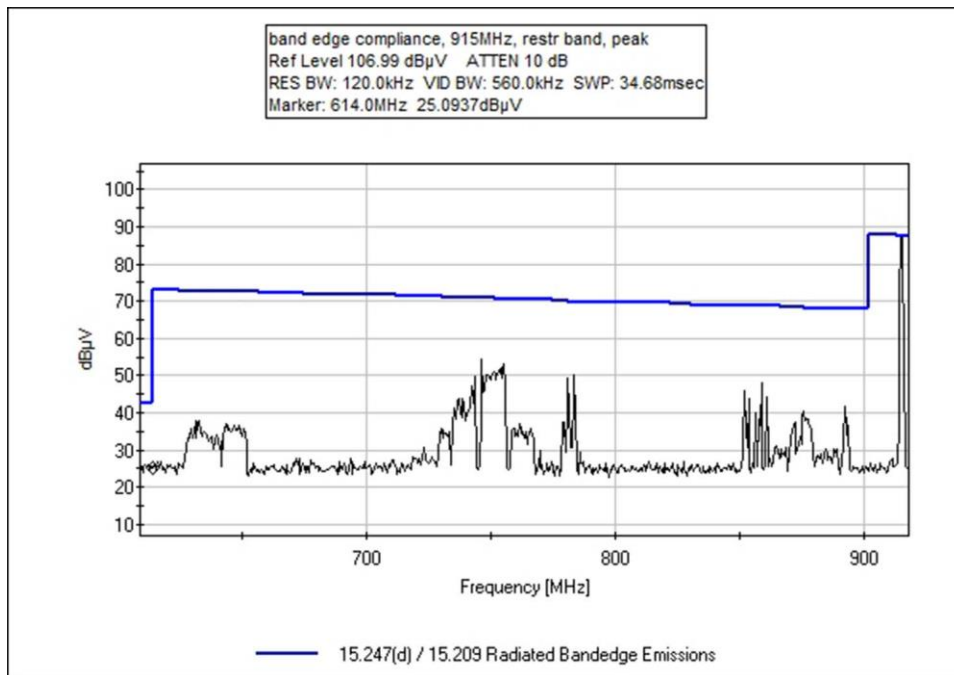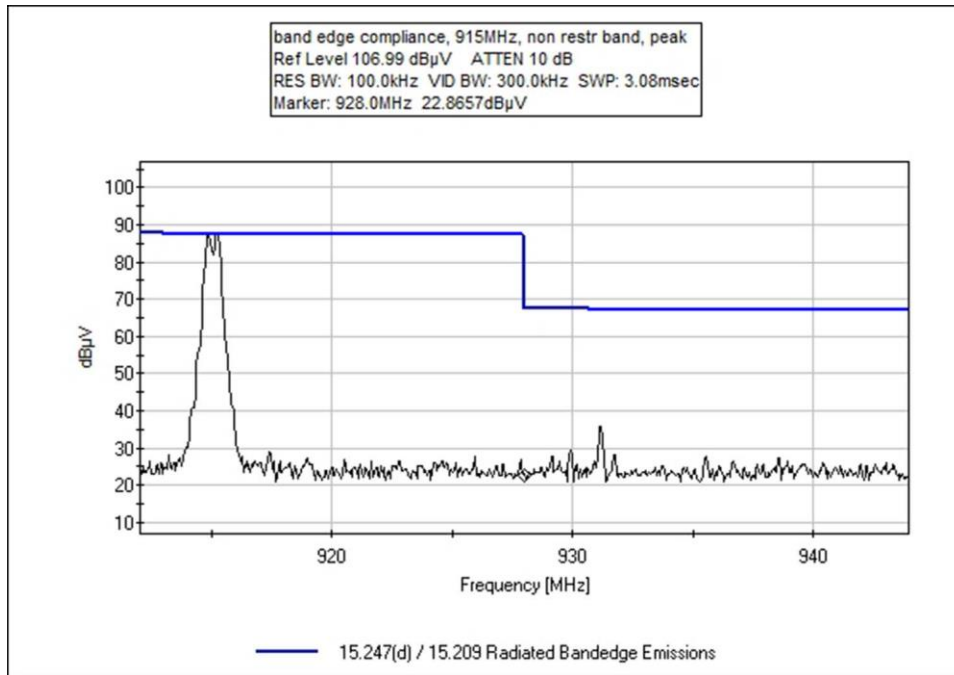**Measurement Data:** Reading listed by margin. Test Distance: 3 Meters

#	Freq	Rdng	T1 T5	T2 T6	T3	T4	Dist	Corr	Spec	Margin	Polar
	MHz	dBμV	dB	dB	dB	dB	Table	dBμV/m	dBμV/m	dB	Ant
1	2744.539M Ave	51.1	+6.0 +29.3	+4.5 +0.2	-40.0	+0.5	+0.0	51.6	54.0	-2.4	Vert
^	2744.539M	57.9	+6.0 +29.3	+4.5 +0.2	-40.0	+0.5	+0.0	58.4	54.0	+4.4	Vert
3	2744.556M Ave	50.6	+6.0 +29.3	+4.5 +0.2	-40.0	+0.5	+0.0	51.1	54.0	-2.9	Horiz
^	2744.556M	57.7	+6.0 +29.3	+4.5 +0.2	-40.0	+0.5	+0.0	58.2	54.0	+4.2	Horiz
5	3661.297M	39.6	+7.4 +32.4	+5.3 +0.2	-40.0	+0.5	+0.0	45.4	54.0	-8.6	Horiz
6	4574.221M Ave	36.3	+8.2 +32.8	+5.9 +0.2	-39.8	+0.6	+0.0	44.2	54.0	-9.8	Vert
^	4574.221M	44.6	+8.2 +32.8	+5.9 +0.2	-39.8	+0.6	+0.0	52.5	54.0	-1.5	Vert
8	3659.647M	38.3	+7.4 +32.4	+5.3 +0.2	-40.0	+0.5	+0.0	44.1	54.0	-9.9	Vert
9	4574.179M Ave	35.0	+8.2 +32.8	+5.9 +0.2	-39.8	+0.6	+0.0	42.9	54.0	-11.1	Horiz
^	4574.179M	43.4	+8.2 +32.8	+5.9 +0.2	-39.8	+0.6	+0.0	51.3	54.0	-2.7	Horiz

Band Edge

Band Edge Summary

Frequency (MHz)	Modulation	Ant. Type	Field Strength (dBuV/m @3m)	Limit (dBuV/m @3m)	Results
902	2-GFSK	Integral	24.8	<76.5	Pass
928	2-GFSK	Integral	32.0	<76.5	Pass
614	2-GFSK	Integral	28.6	<46	Pass
960	2-GFSK	Integral	25.7	<54	Pass

Band Edge Plots

band edge compliance, 915MHz, non restr band, peak
Ref Level 106.99 dBµV   ATTEN 10 dB
RES BW: 100.0kHz VID BW: 300.0kHz SWP: 3.08msec
Marker: 928.0MHz 22.8657dBµV

15.247(d) / 15.209 Radiated Bandedge Emissions

band edge compliance, 915MHz, restr band, peak
Ref Level 106.99 dBµV   ATTEN 10 dB
RES BW: 120.0kHz VID BW: 560.0kHz SWP: 34.68msec
Marker: 614.0MHz 25.0937dBµV

15.247(d) / 15.209 Radiated Bandedge Emissions

band edge compliance, 915MHz, restr band, peak
Ref Level 106.99 dBμV   ATTEN 10 dB
RES BW: 120.0kHz VID BW: 560.0kHz SWP: 11.44msec
Marker: 960.0MHz 25.7457dBμV

15.247(d) / 15.209 Radiated Bandedge Emissions

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 Bandedge Emissions**
Work Order #: **105151**   Date: 3/17/2021
Test Type: **Maximized Emissions**   Time: 12:25:47
Tested By: S. Yamamoto   Sequence#: 8
Software: EMITest 5.03.19

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 located stand alone on the Styrofoam table top.
The EUT is connected to the Texas Instruments CC1352R1 development board via unshielded ribbon cable.
The development board is connected to the support laptop via USB cable. The board is providing 3.3Vdc to the EUT.

The support laptop is running Texas Instruments SmartRF Studio 7 software to enable settings of the EUT.

Software Setting:
RF Designed Based On: LAUNCHXL-CC1352R1
Setting Selection: WB-DSSS 60kbps, 2-GFSK, 195 kHz deviation, 4x spreading
Frequency: 915.00MHz
Symbol Rate: 480.00031
Modulation: 2-GFSK
Deviation: 195kHz
Mode: Continuous TX/ Modulated
TX Power Setting: 14dBm

Test Environment Conditions:
Temperature: 19°C
Relative Humidity: 40%
Pressure: 99kPa

Site D

Test Method ANSI C63.10 (2013) KDB 558074 v05r02: 04/02/2019

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN02869	Spectrum Analyzer	E4440A	8/3/2020	8/3/2021
T2	ANP06978	Cable	Sucoflex 104A	3/26/2020	3/26/2022
T3	AN00010	Preamp	8447D	1/2/2020	1/2/2022
T4	ANP04382	Cable	LDF-50	5/15/2020	5/15/2022
T5	ANP05569	Cable-Amplitude +15C to +45C (dB)	RG-214/U	12/14/2020	12/14/2022
T6	ANP05283	Attenuator	ATT-0218-06-NNN-02	3/26/2020	3/26/2022
T7	AN01994	Biconilog Antenna	CBL6111C	4/14/2020	4/14/2022

Measurement Data: Reading listed by margin. Test Distance: 3 Meters

#	Freq	Rdng	T1 T5	T2 T6	T3 T7	T4	Dist	Corr	Spec	Margin	Polar
	MHz	dBµV	dB	dB	dB	dB	Table	dBµV/m	dBµV/m	dB	Ant
1	614.000M	25.1	+0.0 +2.8	+0.2 +5.8	-28.0 +19.9	+2.8	+0.0	28.6	46.0	-17.4	Horiz
2	960.000M	25.7	+0.0 +3.7	+0.3 +5.9	-27.4 +23.6	+3.5	+0.0	35.3	54.0	-18.7	Horiz
3	902.000M	24.8	+0.0 +3.5	+0.3 +5.9	-27.5 +22.9	+3.4	+0.0	33.3	76.5	-43.2	Horiz
4	928.000M	22.9	+0.0 +3.6	+0.3 +5.9	-27.4 +23.2	+3.5	+0.0	32.0	76.5	-44.5	Horiz

Test Setup Photo(s)


Below 1GHz, View 1
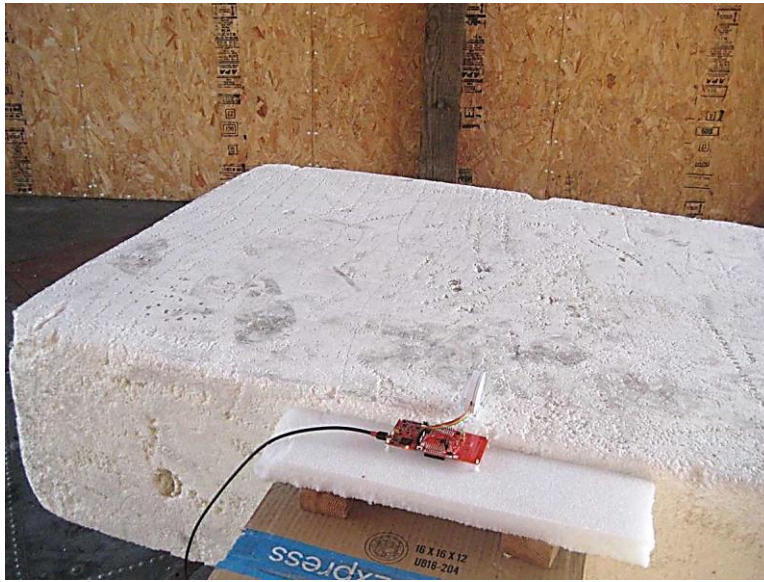
Below 1GHz, View 2

Above 1GHz

15.247(e) Power Spectral Density

Test Setup/Conditions			
Test Location:	Brea Lab D	Test Engineer:	S. Yamamoto
Test Method:	ANSI C63.10 (2013), KDB 558074 v05r02: 04/02/2019	Test Date(s):	3/8/2021
Configuration:	1		
Test Setup:	The equipment under test (EUT) and support equipment are located together on the tabletop. The EUT is connected to the Texas Instruments CC1352R1 development board. The board is connected to the support laptop via USB cable. The board is providing 3.3Vdc to the EUT. The support laptop is running Texas Instruments SmartRF Studio 7 software to enable settings of the EUT. Software setting: RF Designed Based On: LAUNCHXL-CC1352R1 Setting Selection: WB-DSSS 60kbps, 2-GFSK, 195 kHz deviation, 4x spreading Frequency: 915.00MHz Symbol Rate: 480.00031 Modulation: 2-GFSK Deviation: 195kHz Mode: Continuous TX/ Modulated TX Power Setting: 14dBm		

Environmental Conditions			
Temperature (ºC)	20	Relative Humidity (%):	41

Test Data Summary - RF Conducted Measurement				
Measurement Method: PKPSD				
Frequency (MHz)	Modulation	Measured (dBm/3kHz)	Limit (dBm/3kHz)	Results
915	2-GFSK	5.02	≤8	Pass
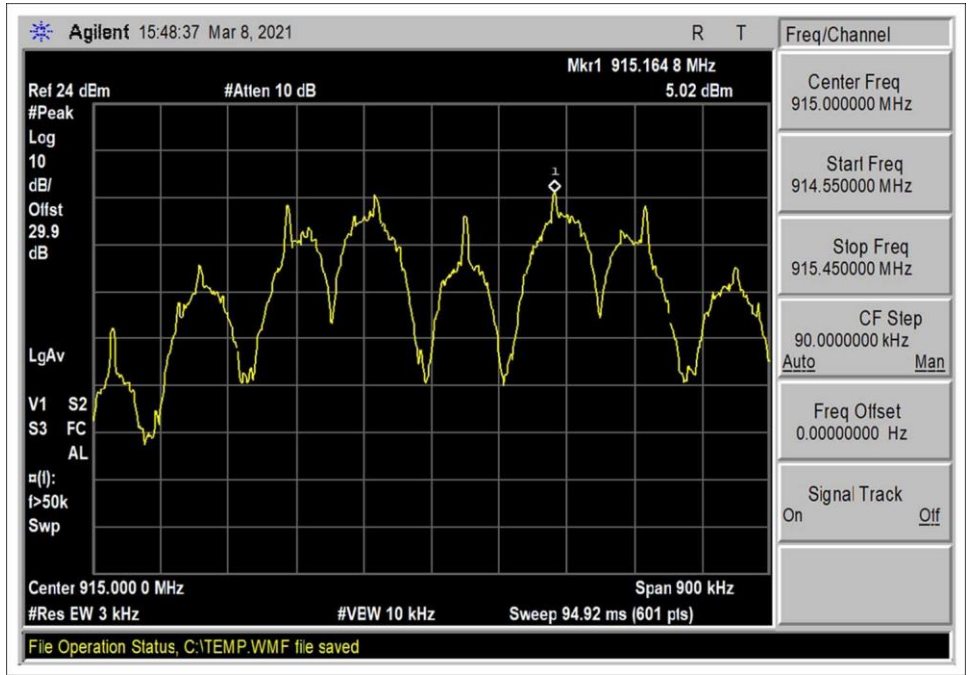
Report No.: 105151-10

Test Location: CKC Laboratories, Inc. • 110 N Olinda Pl • Brea CA 92823 • 714-993-6112
Customer: **Venstar, Inc.**
Specification: **15.247(e) Peak Power Spectral Density (902-928 MHz DTS)**
Work Order #: **105151**   Date: 3/22/2021
Test Type: **Conducted Emissions**   Time: 14:24:55
Tested By: S. Yamamoto   Sequence#: 0
Software: EMITest 5.03.19   3.3Vdc

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) and support equipment are located together on the table top.
The EUT is connected to the Texas Instruments CC1352R1 development board. The board is connected to the support laptop via USB cable. The board is providing 3.3Vdc to the EUT.

The support laptop is running Texas Instruments SmartRF Studio 7 software to enable settings of the EUT.

Software Setting:
RF Designed Based On: LAUNCHXL-CC1352R1
Setting Selection: WB-DSSS 60kbps, 2-GFSK, 195 kHz deviation, 4x spreading
Frequency: 915.00MHz
Symbol Rate: 480.00031
Modulation: 2-GFSK
Deviation: 195kHz
Mode: Continuous TX/ Modulated
TX Power Setting: 14dBm

Test Environment Conditions:
Temperature: 20°C
Relative Humidity: 41%
Pressure: 99kPa

Site D

Test Method ANSI C63.10 (2013) KDB 558074 v05r02: 04/02/2019

Venstar, Inc. WO#: 105151 Sequence#: 0 Date: 3/22/2021
15.247(e) Peak Power Spectral Density (902-928 MHz DTS) Test Lead: 3.3Vdc 915MHz Port
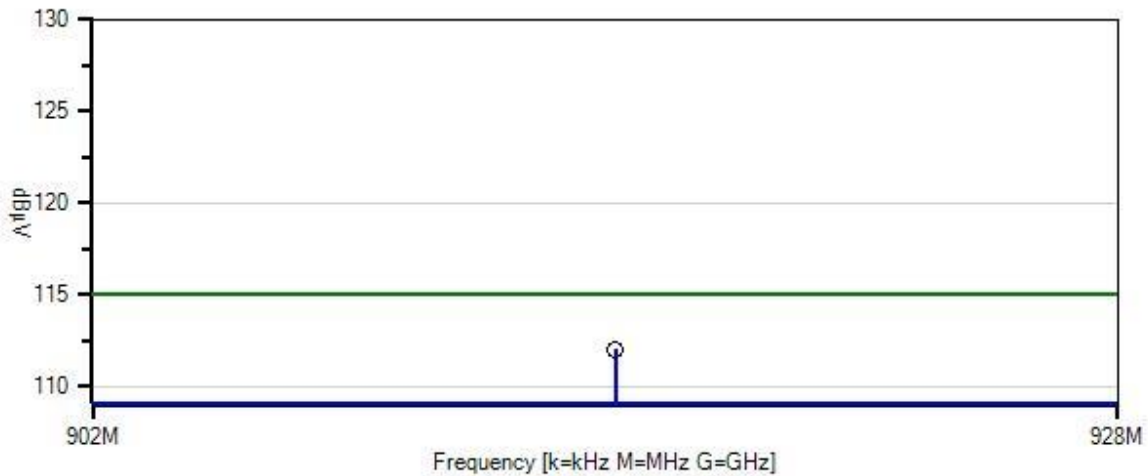
Sweep Data
Readings
O Peak Readings
× QP Readings
* Average Readings
▼ Ambient
Software Version: 5.03.19
1 - 15.247(e) Peak Power Spectral Density (902-928 MHz DTS)

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN02869	Spectrum Analyzer	E4440A	8/3/2020	8/3/2021
T2	AN03432	Attenuator	90-30-34	10/22/2019	10/22/2021
T3	ANP07657	Cable	32022-29094K-29094K-24TC	7/30/2020	7/30/2022

Measurement Data: Reading listed by margin.   Test Lead: 915MHz Port

#	Freq MHz	Rdng dBµV	T1 dB	T2 dB	T3 dB	dB	Dist Table	Corr dBµV	Spec dBµV	Margin dB	Polar Ant
1	915.165M	82.1	+0.0	+29.6	+0.3		+0.0	112.0	115.0	-3.0	915MH
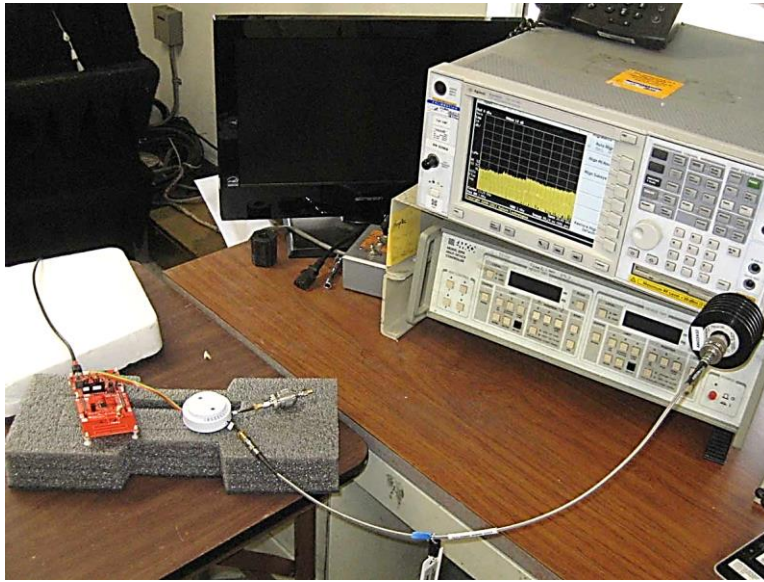
SUPPLEMENTAL INFORMATION

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 dBµV/m, the spectrum analyzer reading in dBµV 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	(dBµV)
+	Antenna Factor	(dB/m)
+	Cable Loss	(dB)
-	Distance Correction	(dB)
-	Preamplifier Gain	(dB)
=	Corrected Reading	(dBµV/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.