Nalloy, LLC

REVISED TEST REPORT TO 104760-44A

YRP0R7

Tested to The Following Standards:

FCC Part 15 Subpart C Section(s)

15.207 & 15.247
(FHSS 902-928MHz)

Report No.: 104760-44B

Date of issue: March 22, 2022

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:

Nalloy, LLC
2301 5th Avenue
Seattle, WA 98108

Representative: Naga Suryadevara
Customer Reference Number: 2D-04568090

REPORT PREPARED BY:

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

Project Number: 104760

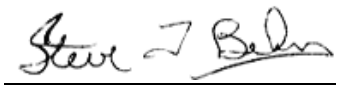
DATE OF EQUIPMENT RECEIPT: May 14, 2021
DATE(S) OF TESTING: May 14 and 21, 2021

Revision History

Original: Testing of the YRP0R7 to FCC Part 15 Subpart C Section(s) 15.207 & 15.247 (FHSS 902-928MHz).
Revision A: To replace the test setup photos to clarify the EUT from peripheral equipment.
Revision A: To replace Conducted Emissions data.

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.
22116 23rd Drive S.E.,
Canyon Park, Bothell, WA 98021

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 (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	NA1
15.247(d)	Radiated Emissions & Band Edge	NA	Pass
15.207	AC Conducted Emissions	NA	Pass

NA = Not Applicable
NA1 = Not applicable because the EUT does not have a conducted port.

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
NA	Nalloy, LLC.	YRP0R7	NA

Support Equipment:

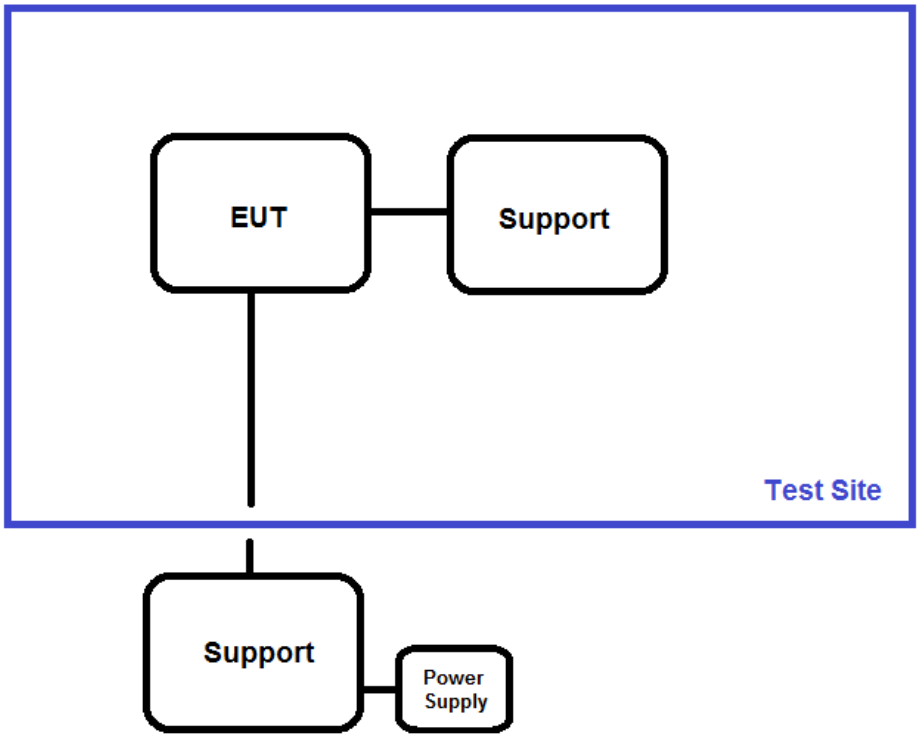
Device	Manufacturer	Model #	S/N
Laptop	Lenovo	T430	PBPXKGW
Laptop PSU	Lenovo	92P1156	11S92P1156Z1ZDXN0AVB44
Power Supply	ZKTeco Co LTD	ZK-MSS-PS	Power Supply

General Product Information:

Product Information	Manufacturer-Provided Details
Equipment Type:	Radio Module
Type of Wideband System:	FHSS
Operating Frequency Range:	902.4-927.6 MHz
Number of Hopping Channels:	64
Receiver Bandwidth and Synchronization:	The manufacturer declares the receiver input bandwidth matches the transmit channel bandwidth and shifts frequencies in synchronization with the transmitter.
Modulation Type(s):	GFSK-2
Maximum Duty Cycle:	Tested at 100%
Number of TX Chains:	1
Antenna Type(s) and Gain:	PCB Antenna / -2 dBi
Beamforming Type:	NA
Antenna Connection Type:	Integral
Nominal Input Voltage:	5-30 VDC
Firmware / Software used for Test:	Railtest_v2.2.0 Realterm 2.0.0.70

Block Diagram of Test Setup(s)

Test Setup Block Diagram



FCC Part 15 Subpart C

15.247(a) Transmitter Characteristics

Test Setup/Conditions			
Test Location:	Bothell Lab C3	Test Engineer:	M. Harrison
Test Method:	ANSI C63.10 (2013)	Test Date(s):	5/21/2021
Configuration:	1		
Test Setup:	Test Mode: Continuously Modulated The spectrum analyzer is connected to a near field probe located near EUT antenna.		

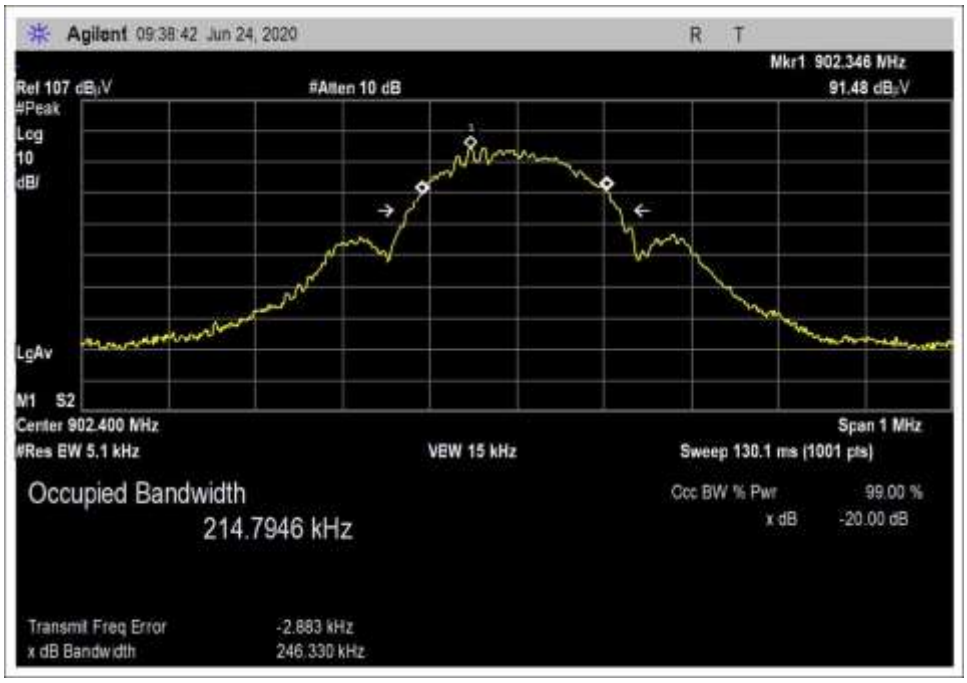
Environmental Conditions			
Temperature (ºC)	23	Relative Humidity (%):	40

Test Equipment					
Asset#	**Description**	**Manufacturer**	**Model**	**Cal Date**	**Cal Due**
2871	Spectrum Analyzer	Agilent	E4440A	3/12/2020	3/12/2022

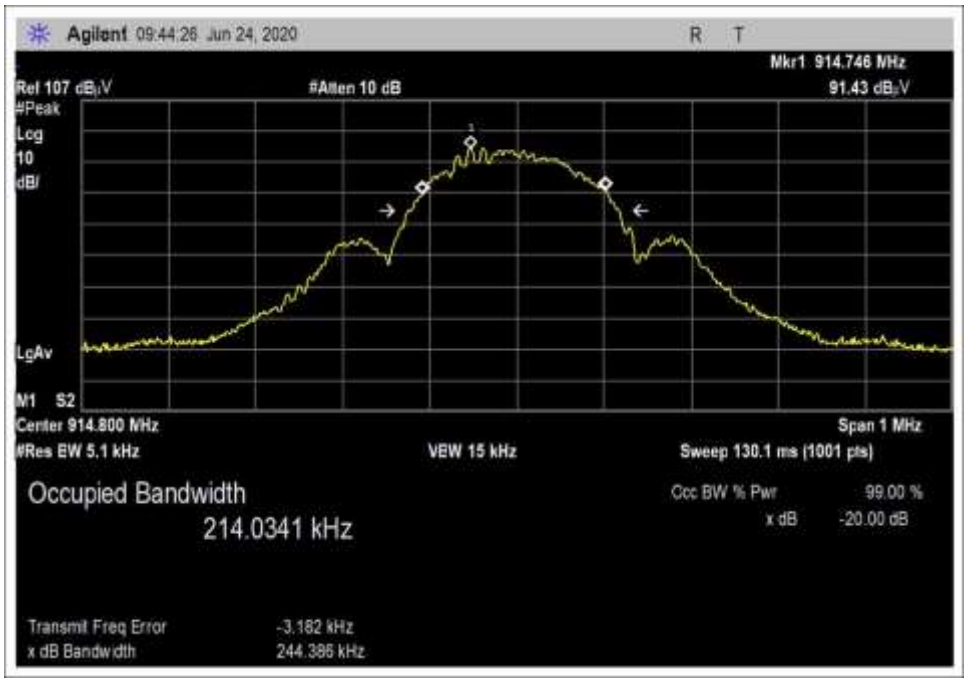
15.247(a)(1) 20 dB Bandwidth

Test Data Summary					
Frequency (MHz)	**Antenna Port**	**Modulation**	**Measured (kHz)**	**Limit (kHz)**	**Results**
902.4	1	GFSK-2	246.3	≤500	Pass
914.8	1	GFSK-2	244.4	≤500	Pass
927.6	1	GFSK-2	243.7	≤500	Pass

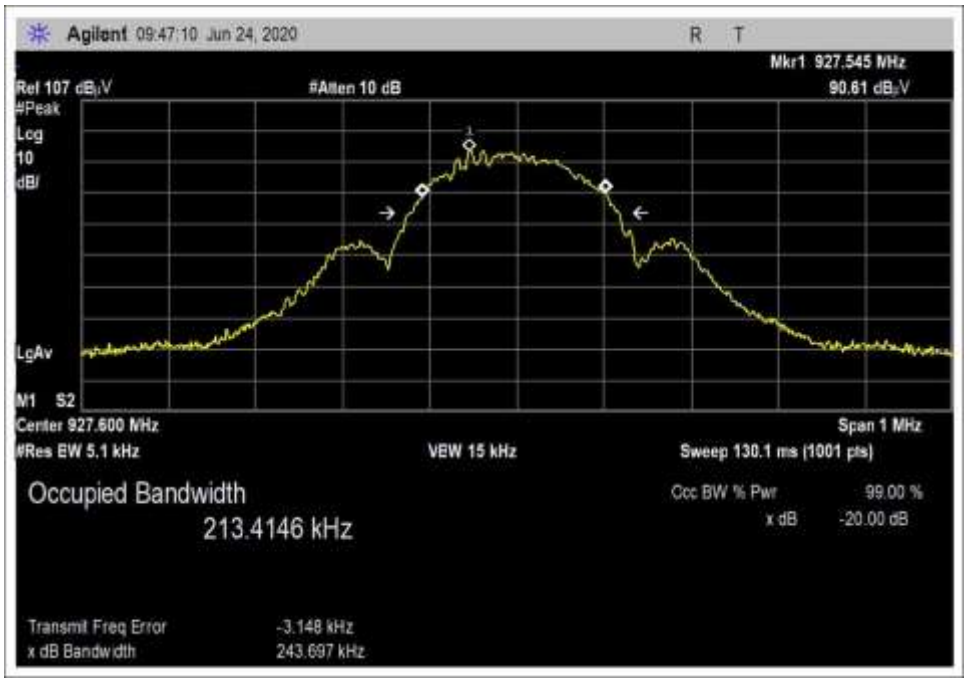
Plot(s)



Low Channel



Middle Channel

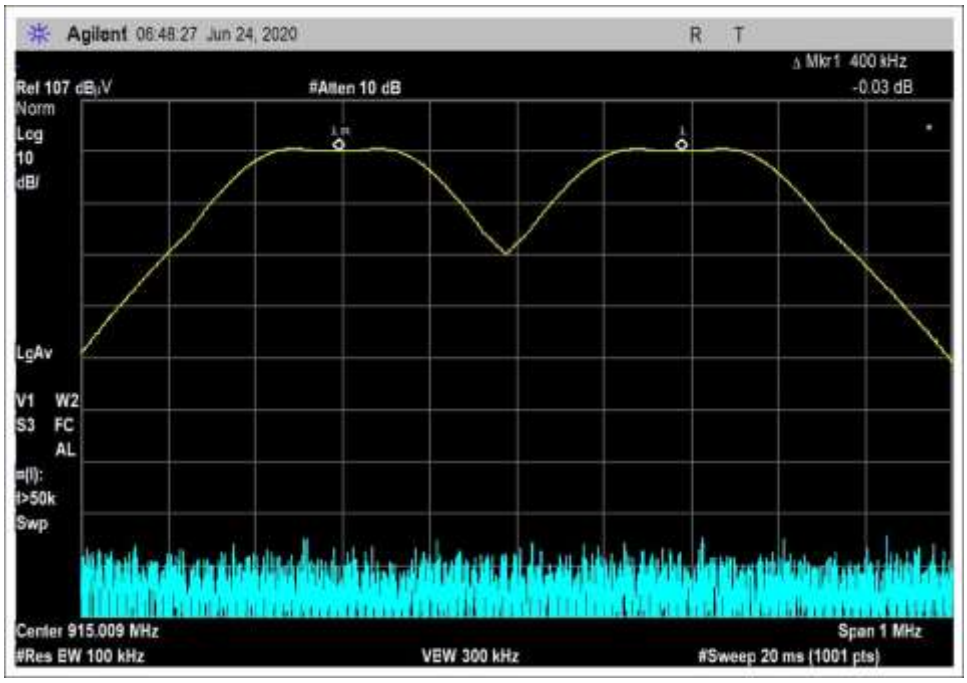


High Channel

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	Transmitting	400	≥ 246.3	Pass

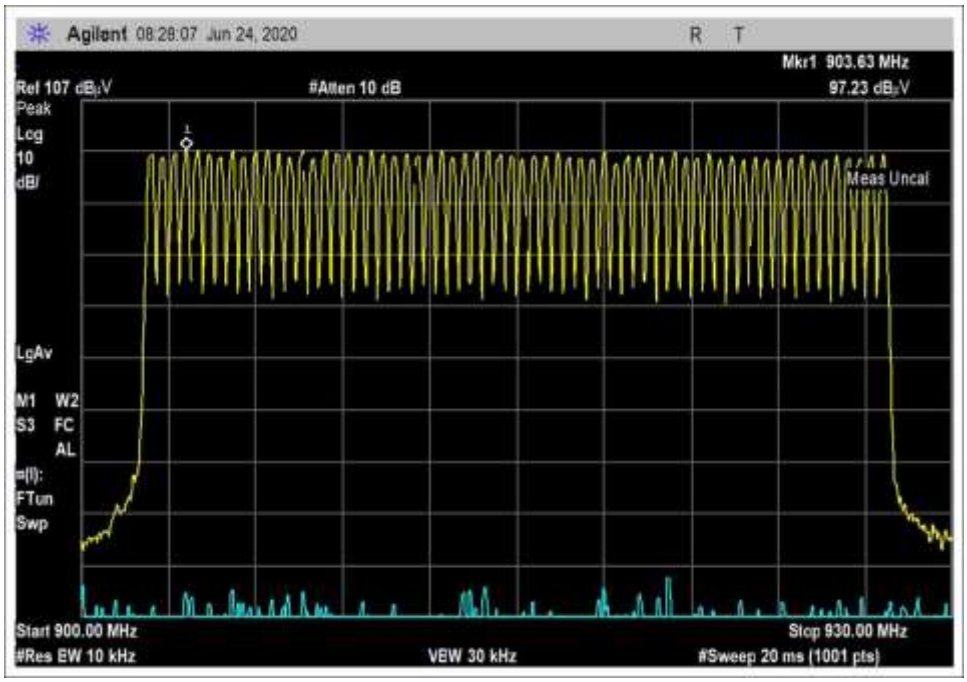
Plot(s)



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

Test Data Summary				
$Limit = \begin{cases} 50\ Channels \mid 20\ dB\ BW < 250kHz \\ 25\ Channels \mid 20\ dB\ BW \geq 250kHz \end{cases}$				
Antenna Port	**Operational Mode**	**Measured (Channels)**	**Limit (Channels)**	**Results**
1	Transmitting	64	≥ 50	Pass

Plot(s)



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

Test Data Summary				
Observation Period, P_{obs} is derived from the following: $P_{Obs} = \begin{cases} 20\ Seconds & 20\ dB\ BW < 250kHz \\ 10\ Seconds & 20\ dB\ BW \geq 250kHz \end{cases}$				
Antenna Port	**Operational Mode**	**Measured (ms)**	**Limit (ms/P_{obs})**	**Results**
1	Hopping	2.87	≤400	Pass

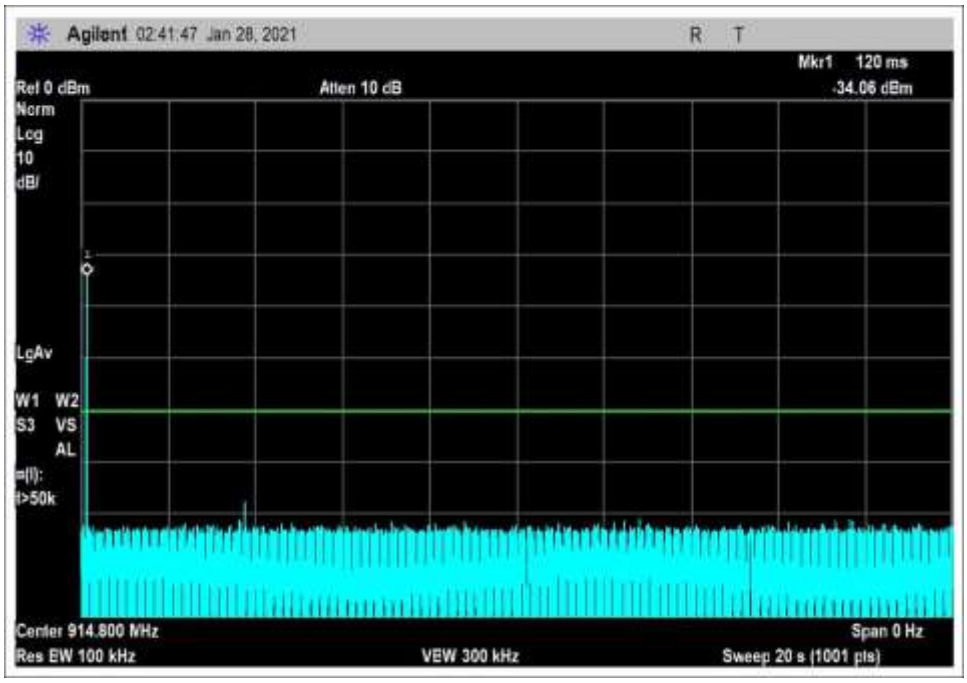
Measured results are calculated as follows:

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

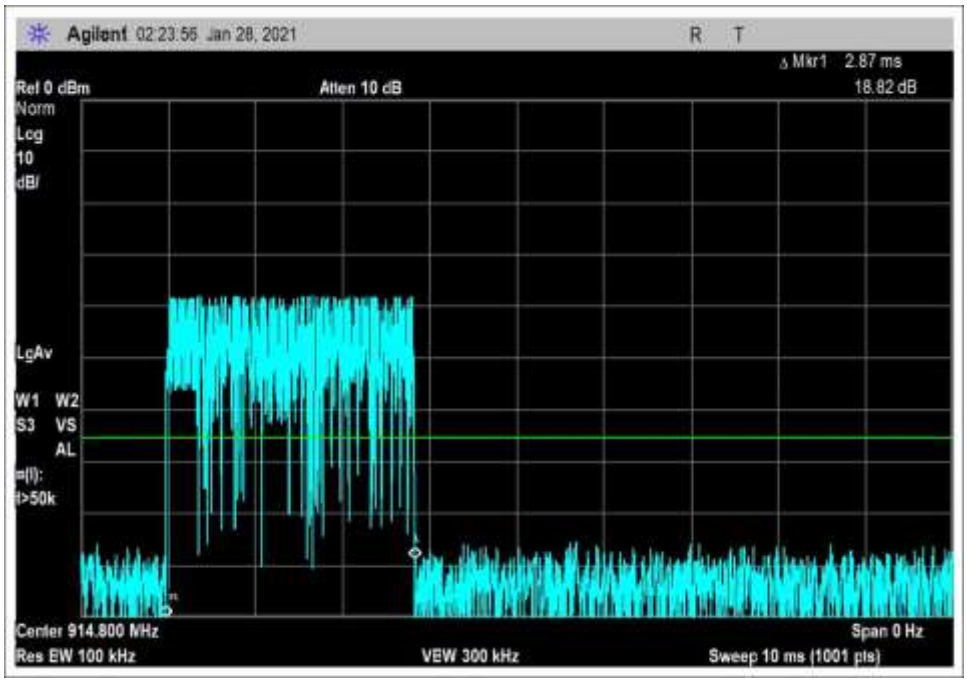
Actual Calculated Values:

Parameter	Value
Observation Period (P_{obs}):	20s
Number of RF Bursts / P_{obs}:	1
On time of RF Burst:	2.87ms
Number of Control or other signals / P_{obs}:	0
On time of Control or other Signals:	0
Total Measured On Time:	2.87

Plot(s)



TOO 20 Seconds



TOO Pulse

Test Setup Photo(s)

15.247(b)(2) Output Power

Test Setup/Conditions			
Test Location:	Bothell Lab C3	Test Engineer:	M. Harrison
Test Method:	ANSI C63.10 (2013)	Test Date(s):	5/14/2021
Configuration:	1		
Test Setup:	Test Mode: Continuously Modulated The EUT is set 1.5 meters high on a Styrofoam table. X, Y and Z axis are investigated with the worst case reported. In order not to mask emissions from the EUT, the power supply was placed at distance of 30cm from the EUT. The peripheral equipment was placed away from each other in order to simulate typical installation.		

Environmental Conditions			
Temperature (ºC)	20	Relative Humidity (%):	33

Test Equipment					
Asset#	**Description**	**Manufacturer**	**Model**	**Cal Date**	**Cal Due**
2871	Spectrum Analyzer	Agilent	E4440A	3/12/2020	3/12/2022
1995	Biconilog Antenna	Chase	CBL6111C	4/14/2020	4/14/2022
02307	Preamp	HP	8447D	1/10/2020	1/10/2022
P05275	Attenuator	Weinschel	1W	3/26/2020	3/26/2022
D06122	Power Supply	Lambda	GEN 125-80	1/18/2021	1/18/2023

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)**
902.4	GFSK-2 / 1	16.3	16.5	16.4	0.2
914.8	GFSK-2 / 1	17.3	17.4	17.3	0.1
927.6	GFSK-2 / 1	15.9	16.1	16	0.2

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

Parameter Definitions:

Measurements performed at input voltage Vnominal ± 15%.

Parameter	Value
$V_{Nominal}$:	5-30 VDC
$V_{Minimum}$:	4. 5 VDC (EUT Shut off below 4.5VDC)
$V_{Maximum}$:	34.5 VDC

Test Data Summary - Radiated Measurement						
$Limit = \begin{cases} 30dBm\ Conducted/36dBm\ EIRP \mid \geq 50\ Channels \\ 24dBm\ Conducted/30dBm\ EIRP \mid < 50\ Channels\ (\min 25) \end{cases}$						
Frequency (MHz)	**Modulation**	**Ant. Type / Gain (dBi)**	**Field Strength (dBuV/m @3m)**	**Calculated (dBm)**	**Limit (dBm)**	**Results**
902.4	GFSK-2	PCB Antenna / -2 dBi	111.7	18.5	≤ 30	Pass
914.8	GFSK-2	PCB Antenna / -2 dBi	112.6	19.4	≤ 30	Pass
927.6	GFSK-2	PCB Antenna / -2 dBi	111.3	18.2	≤ 30	Pass

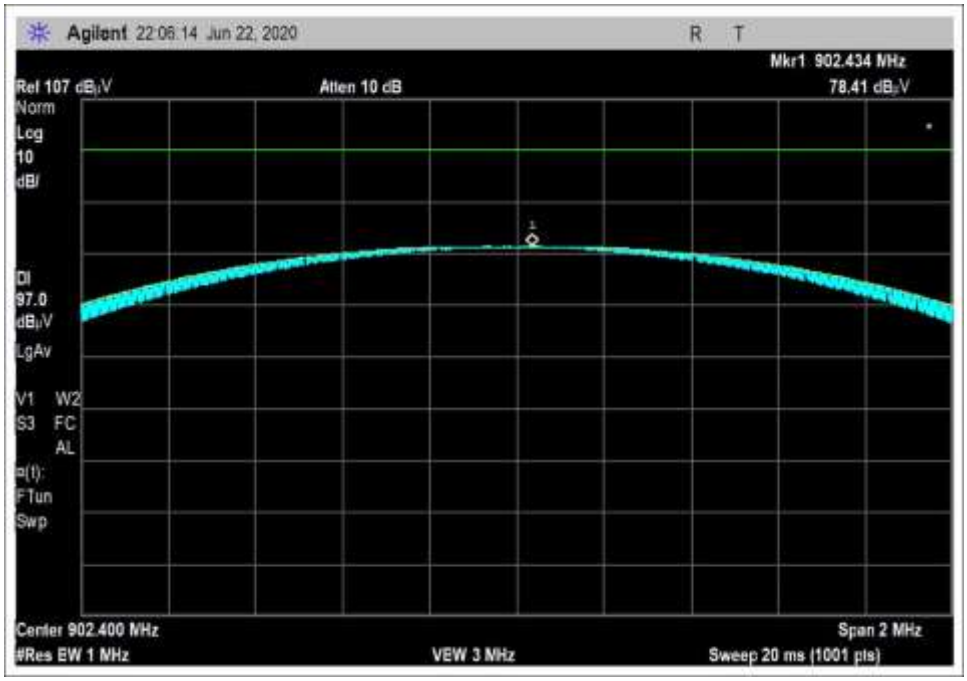
Conducted RF output power calculated in accordance with ANSI C63.10.

$$P(W) = \frac{(E \cdot d)^2}{30\ G}$$

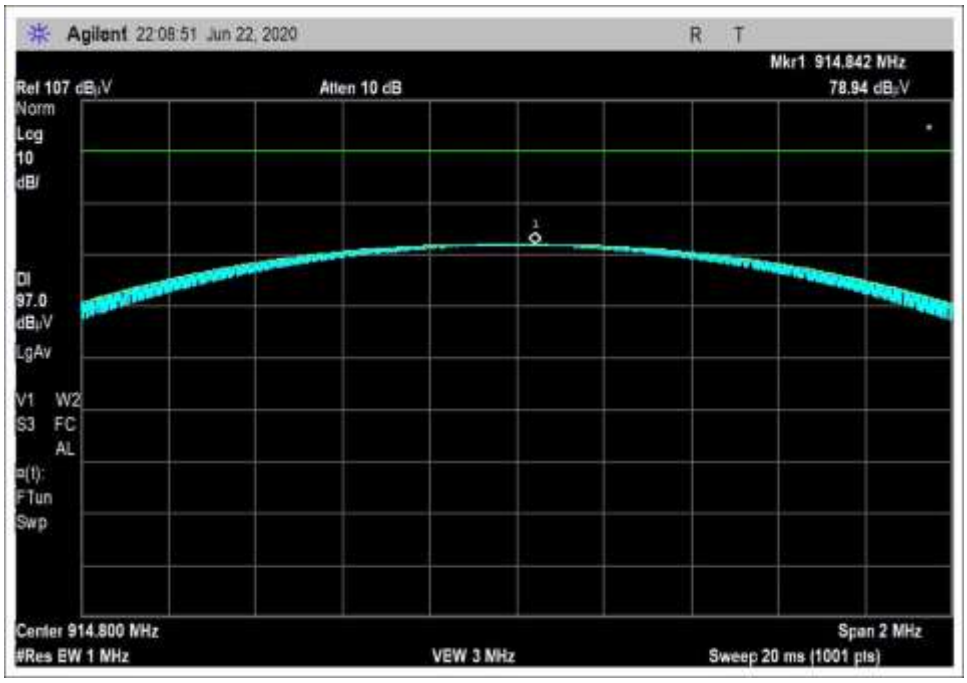
Or equivalently, in logarithmic form:

$$P(dBm) = E(dBuV/m) + 20LOG(d) - G\ - 104.77$$

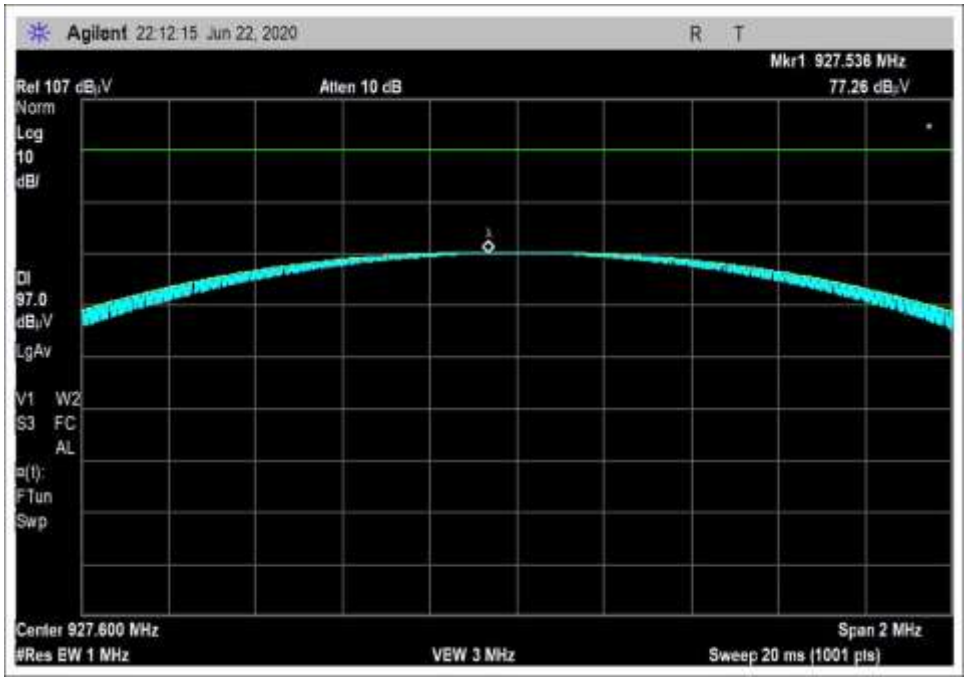
Plots



Low Channel



Middle Channel



High Channel

Test Setup / Conditions / Data

Test Location:	CKC Laboratories, Inc. • 22116 23rd Drive SE, Suite A • Bothell, WA 98021 • 1-800-500-4EMC		
Customer:	**Nalloy, LLC**		
Specification:	**15.247(b) Power Output (902-928 MHz FHSS >50 Channels)**		
Work Order #:	**104760**	Date:	5/14/2021
Test Type:	**Maximized Emissions**	Time:	12:46:41
Tested By:	M. Harrison	Sequence#:	7
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:

Test Environment Conditions:
Temperature: 20°C
Humidity: 33%
Pressure: 102.1kPa

Test Method: ANSI C63.10: 2013

Frequency range: 902.4-927.6 MHz

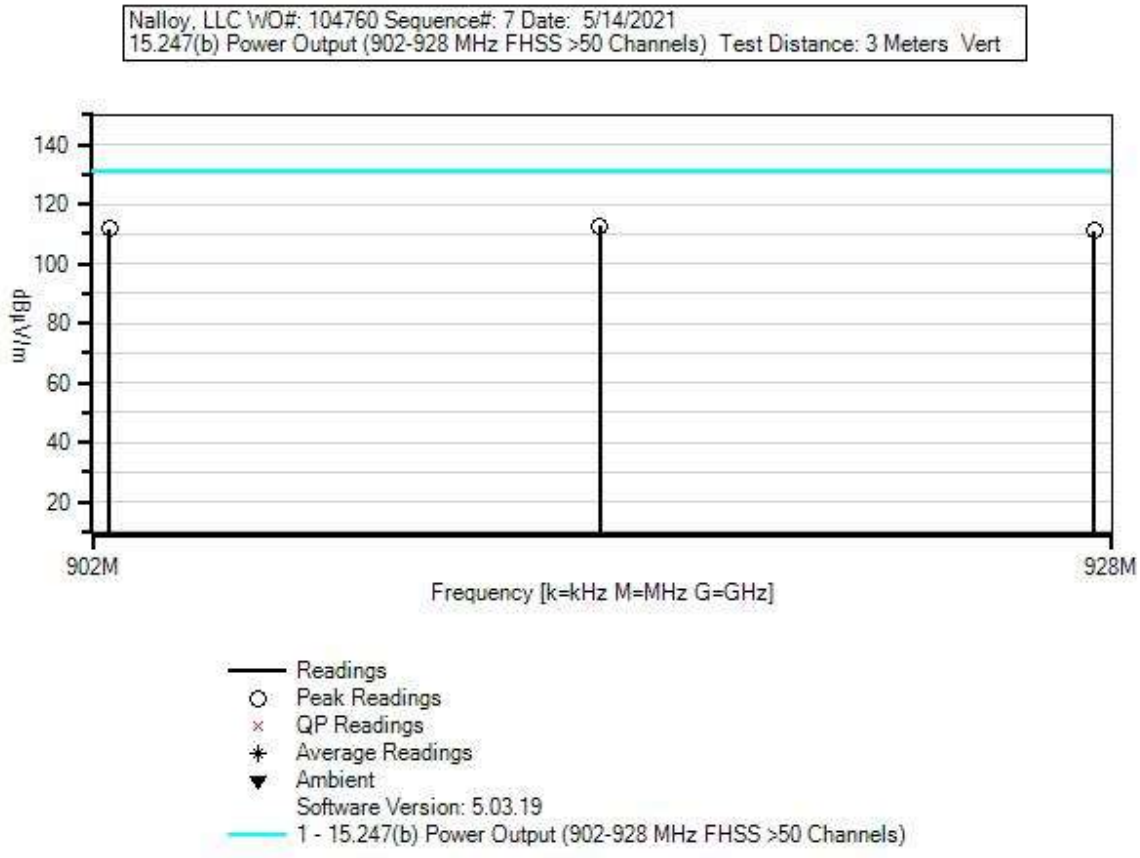
Setup:
AOS V2 Powered Via Delta PSU (24VDC/100W PSU MSS)
Low Channel (0) 902.4 MHz, Mid (31) 914.8MHz, High (63) 927.6MHz
GFSK-2
100% Duty Cycle
PWR Level Setting: 150
PWR Output: 15dBm

Test Mode: Continuously Modulated

The EUT is set 1.5 meters high on a Styrofoam table. X, Y and Z axis are investigated with the worst case reported.

In order not to mask emissions from the EUT, the power supply was placed at distance of 30cm from the EUT.

The peripheral equipment was placed away from each other in order to simulate typical installation.



Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
	AN02871	Spectrum Analyzer	E4440A	3/12/2020	3/12/2022
T1	ANP05305	Cable	ETSI-50T	9/6/2019	9/6/2021
T2	ANP05360	Cable	RG214	2/3/2020	2/3/2022
T3	ANP06540	Cable	Heliax	8/23/2019	8/23/2021
T4	AN01995	Biconilog Antenna	CBL6111C	4/14/2020	4/14/2022
T5	ANP05275	Attenuator	1W	3/26/2020	3/26/2022

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	914.842M	78.9	+1.5 +6.1	+2.1	+0.4	+23.6	+0.0	112.6	131.2	-18.6	Vert
2	902.434M	78.4	+1.4 +6.1	+2.1	+0.3	+23.4	+0.0	111.7	131.2	-19.5	Vert
3	927.536M	77.3	+1.5 +6.1	+2.2	+0.4	+23.8	+0.0	111.3	131.2	-19.9	Vert

Test Setup Photo(s)

Below 1GHz

Below 1GHz


EUT
X-Axis
(Flat)
05 .05 .2021 09 :33

X Axis


Y-Axis
Upright
(2 Cables on top)
05 .08 .2021 08 :34

Y Axis

Z Axis

15.247(d) Radiated Emissions & Band Edge

Test Setup / Conditions / Data

Test Location:	CKC Laboratories, Inc. • 22116 23rd Drive SE, Suite A • Bothell, WA 98021 • 1-800-500-4EMC		
Customer:	**Nalloy, LLC**		
Specification:	**15.247(d) / 15.209 Radiated Spurious Emissions**		
Work Order #:	**104760**	Date:	5/14/2021
Test Type:	**Maximized Emissions**	Time:	10:02:00
Tested By:	M. Harrison	Sequence#:	3
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:

Test Environment Conditions:
Temperature: 20°C
Humidity: 33%
Pressure: 102.1kPa

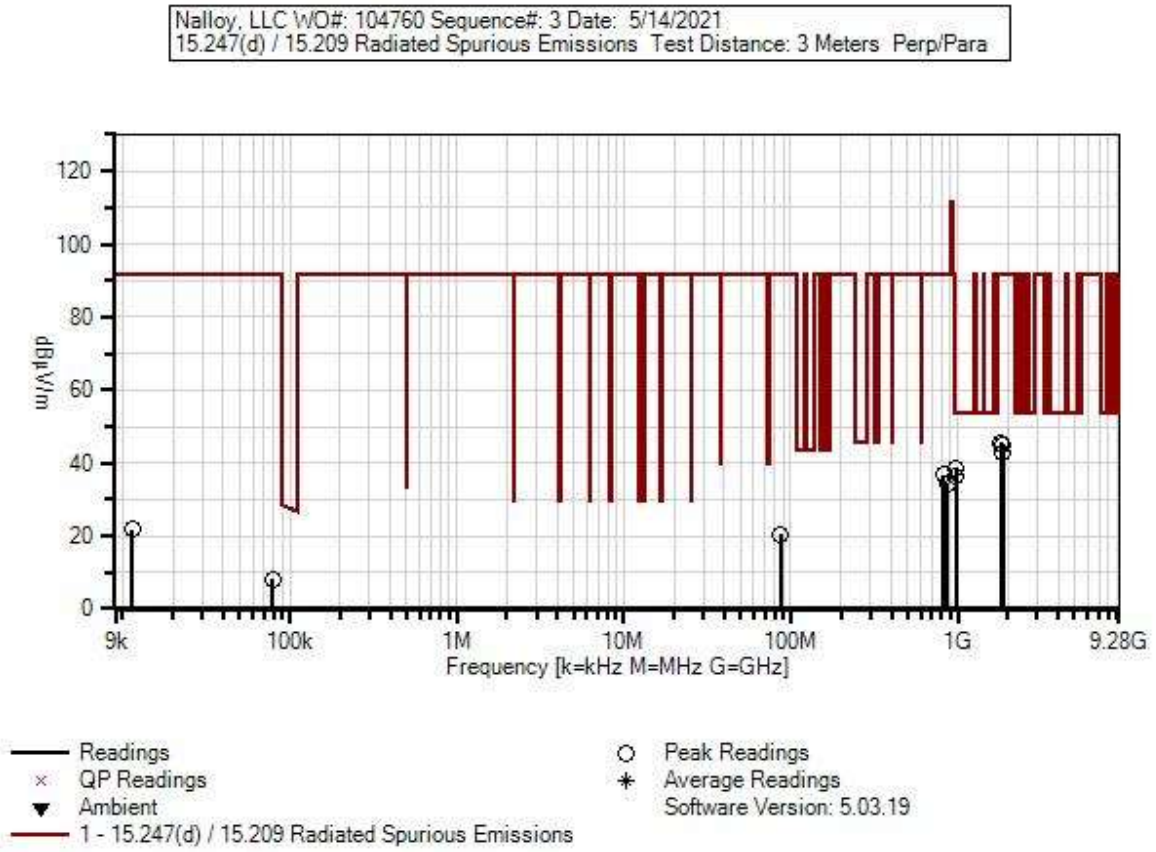
Test Method: ANSI C63.10: 2013

Frequency range: 9k-10GHz (Highest Frequency Generated = 927.6MHz)

Setup:
AOS V2 Powered Via Delta PSU (24VDC/100W PSU MSS)
Low Channel (0) 902.4 MHz, Mid (31) 914.8MHz, High (63) 927.6MHz
GFSK-2
100% Duty Cycle
PWR Level Setting: 150
PWR Output: 15dBm

In order not to mask emissions from the EUT, the power supply was placed at distance of 30cm from the EUT.

The peripheral equipment was placed away from each other in order to simulate typical installation.



Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN02871	Spectrum Analyzer	E4440A	3/12/2020	3/12/2022
T2	AN03540	Preamp	83017A	5/13/2019	5/13/2021
T3	AN01467	Horn Antenna-ANSI C63.5 Calibration	3115	7/5/2019	7/5/2021
T4	ANP06515	Cable	Heliax	7/1/2020	7/1/2022
T5	ANP06540	Cable	Heliax	8/23/2019	8/23/2021
T6	ANP07505	Cable	CLU40-KMKM-02.00F	1/26/2021	1/26/2023
T7	AN03170	High Pass Filter	HM1155-11SS	10/23/2019	10/23/2021
T8	AN02307	Preamp	8447D	1/10/2020	1/10/2022
T9	ANP05305	Cable	ETSI-50T	9/6/2019	9/6/2021
T10	ANP05360	Cable	RG214	2/3/2020	2/3/2022
T11	AN01995	Biconilog Antenna	CBL6111C	4/14/2020	4/14/2022
T12	ANP05275	Attenuator	1W	3/26/2020	3/26/2022
T13	AN00052	Loop Antenna	6502	5/4/2020	5/4/2022

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

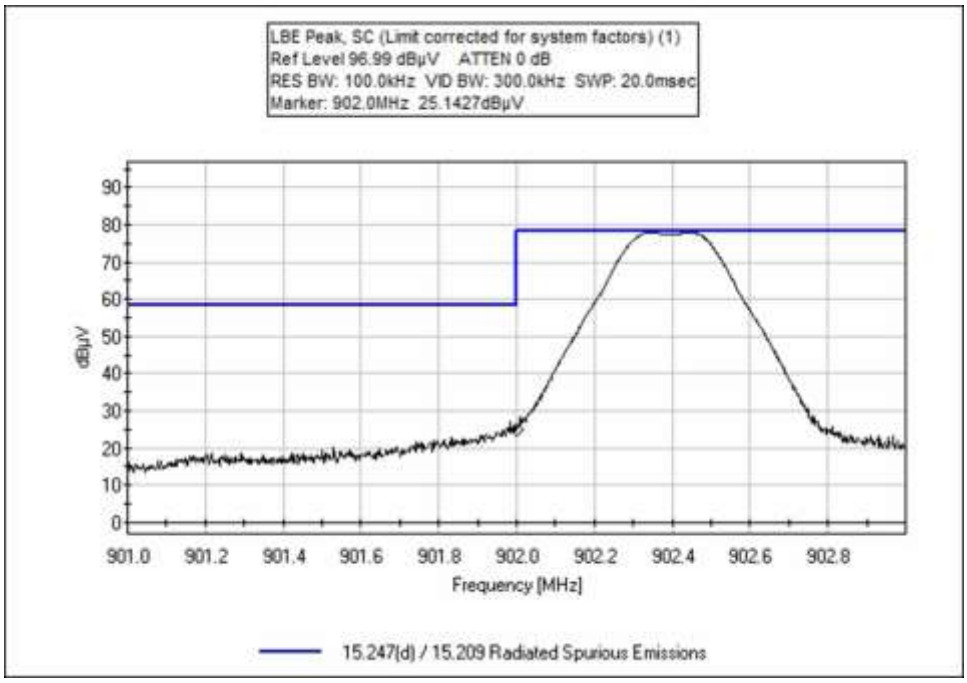
#	Freq	Rdng	T1 T5 T9 T13	T2 T6 T10	T3 T7 T11	T4 T8 T12	Dist	Corr	Spec	Margin	Polar
	MHz	dBµV	dB	dB	dB	dB	Table	dBµV/m	dBµV/m	dB	Ant
1	978.700M	30.8	+0.0 +0.4 +1.5 +0.0	+0.0 +0.0 +2.3	+0.0 +0.0 +24.6	+0.0 -27.1 +6.1	+0.0	38.6	54.0	-15.4	Vert/
2	979.600M	28.8	+0.0 +0.4 +1.5 +0.0	+0.0 +0.0 +2.3	+0.0 +0.0 +24.6	+0.0 -27.1 +6.1	+0.0	36.6	54.0	-17.4	Vert/
3	1805.046M	50.8	+0.0 +0.5 +0.0 +0.0	-34.8 +0.3 +0.0	+26.1 +0.5 +0.0	+2.3 +0.0 +0.0	+0.0	45.7	91.7	-46.0	Vert/
4	1855.170M	49.5	+0.0 +0.5 +0.0 +0.0	-34.7 +0.3 +0.0	+26.5 +0.4 +0.0	+2.4 +0.0 +0.0	+0.0	44.9	91.7	-46.8	Vert/
5	1829.475M	47.5	+0.0 +0.5 +0.0 +0.0	-34.8 +0.3 +0.0	+26.3 +0.4 +0.0	+2.4 +0.0 +0.0	+0.0	42.6	91.7	-49.1	Vert/
6	825.400M	31.9	+0.0 +0.3 +1.4 +0.0	+0.0 +0.0 +1.9	+0.0 +0.0 +22.7	+0.0 -27.6 +6.1	+0.0	36.7	91.7	-55.0	Vert/
7	864.200M	28.9	+0.0 +0.3 +1.4 +0.0	+0.0 +0.0 +2.0	+0.0 +0.0 +23.1	+0.0 -27.5 +6.1	+0.0	34.3	91.7	-57.4	Vert/
8	11.397k	46.8	+0.0 +0.0 +0.0 +15.1	+0.0 +0.0 +0.0	+0.0 +0.0 +0.0	+0.0 +0.0 +0.0	-40.0	21.9	91.7	-69.8	Perp/
9	86.300M	33.0	+0.0 +0.1 +0.4 +0.0	+0.0 +0.0 +0.5	+0.0 +0.0 +8.2	+0.0 -27.8 +6.0	+0.0	20.4	91.7	-71.3	Vert/
10	79.218k	38.5	+0.0 +0.0 +0.0 +9.6	+0.0 +0.0 +0.0	+0.0 +0.0 +0.0	+0.0 +0.0 +0.0	-40.0	8.1	91.7	-83.6	Perp/
11	18.209M	11.5	+0.0 +0.1 +0.0 +8.0	+0.0 +0.0 +0.0	+0.0 +0.0 +0.0	+0.2 +0.0 +0.0	-20.0	-0.2	91.7	-91.9	Perp/

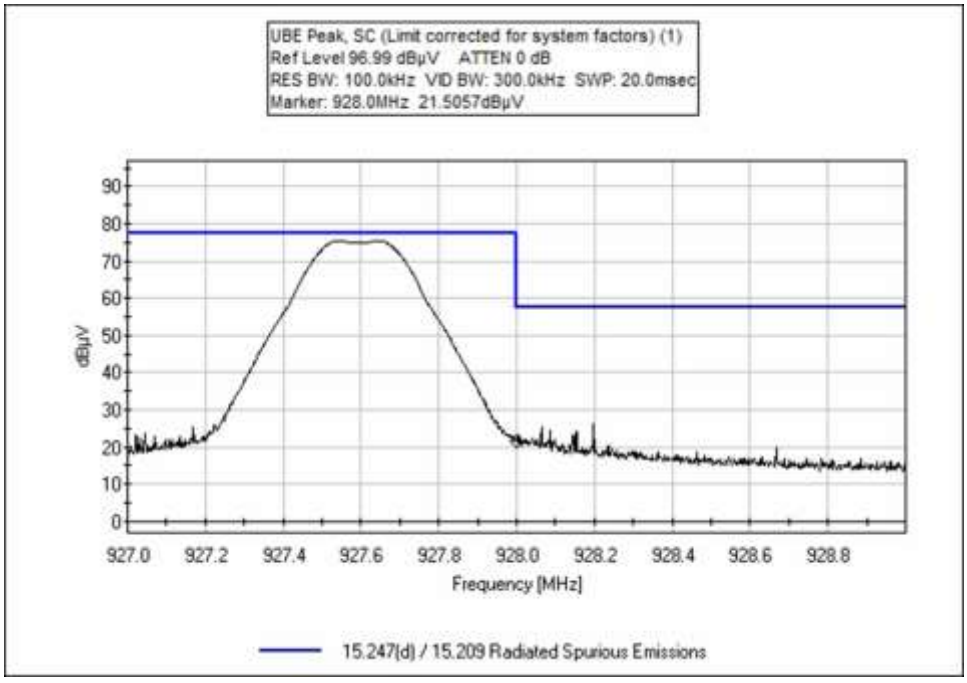
Band Edge

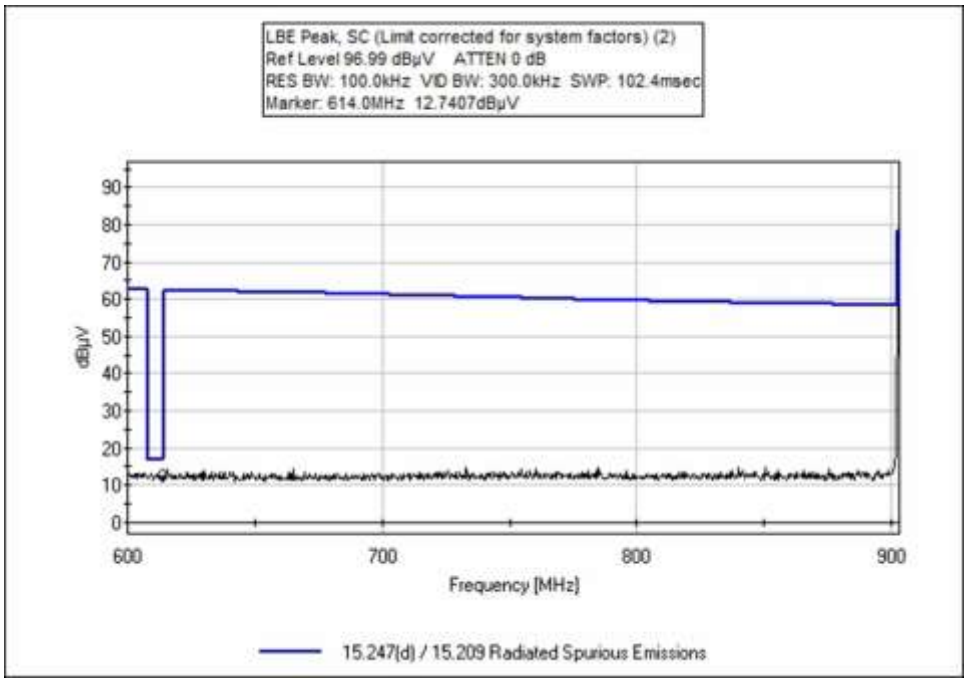
Band Edge Summary					
Operating Mode: Single Channel (Low and High)					
Frequency (MHz)	**Modulation**	**Ant. Type**	**Field Strength (dBuV/m @3m)**	**Limit (dBuV/m @3m)**	**Results**
614	GFSK-2	PCB Antenna	42	< 46	Pass
902	GFSK-2	PCB Antenna	58.4	< 91.7	Pass
928	GFSK-2	PCB Antenna	55.5	< 91.7	Pass
960	GFSK-2	PCB Antenna	44.2	<54	Pass

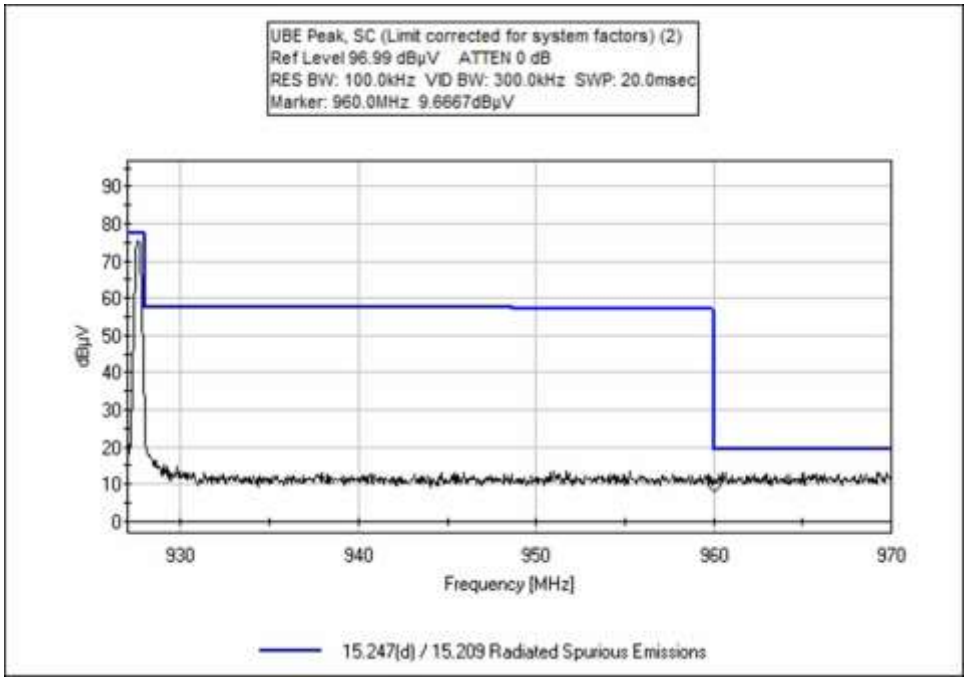
Band Edge Summary					
Operating Mode: Hopping					
Frequency (MHz)	**Modulation**	**Ant. Type**	**Field Strength (dBuV/m @3m)**	**Limit (dBuV/m @3m)**	**Results**
614	GFSK-2	PCB Antenna	41.8	<46	Pass
902	GFSK-2	PCB Antenna	57.5	< 91.7	Pass
928	GFSK-2	PCB Antenna	57.6	< 91.7	Pass
960	GFSK-2	PCB Antenna	47.8	<54	Pass

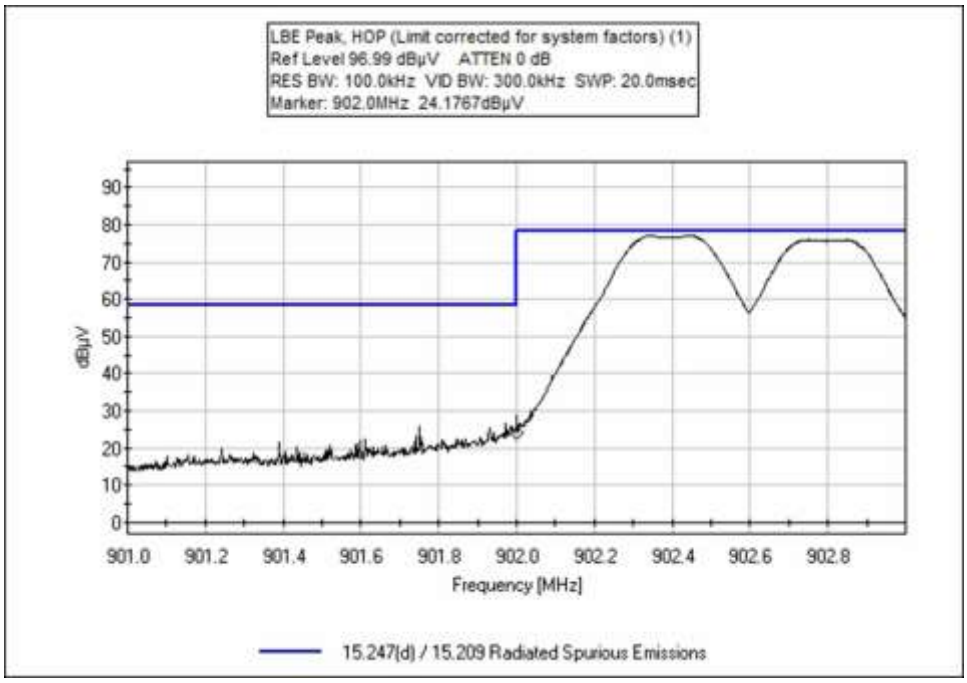
Band Edge Plots

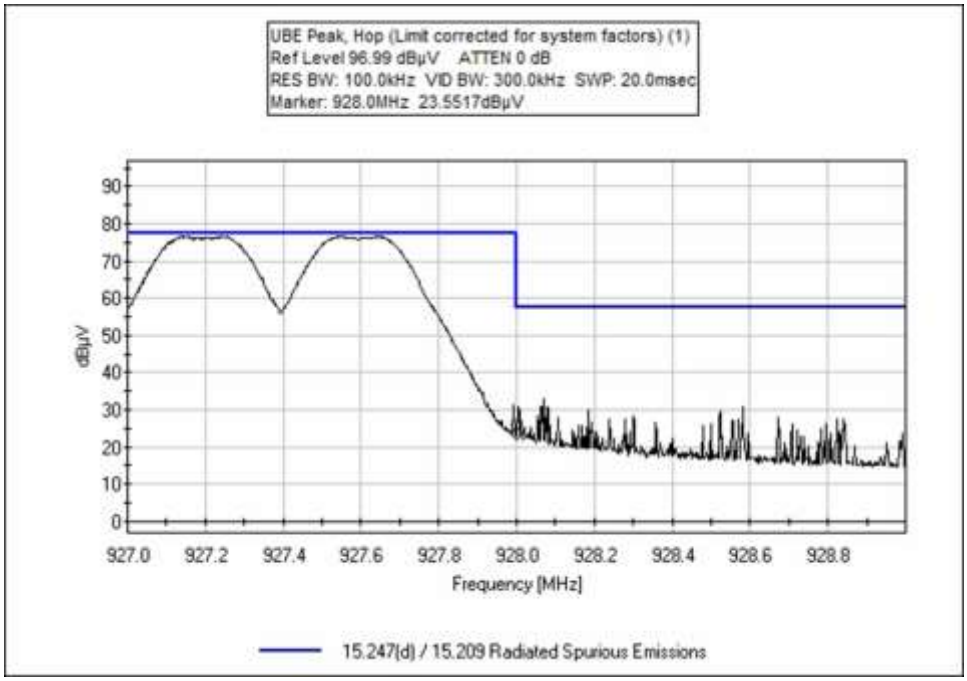


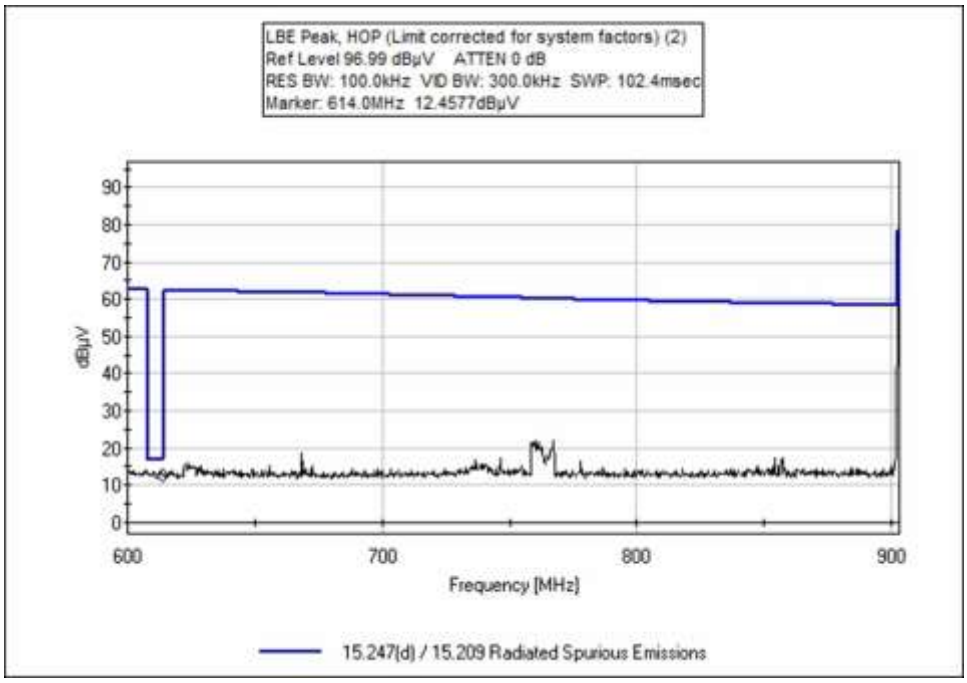


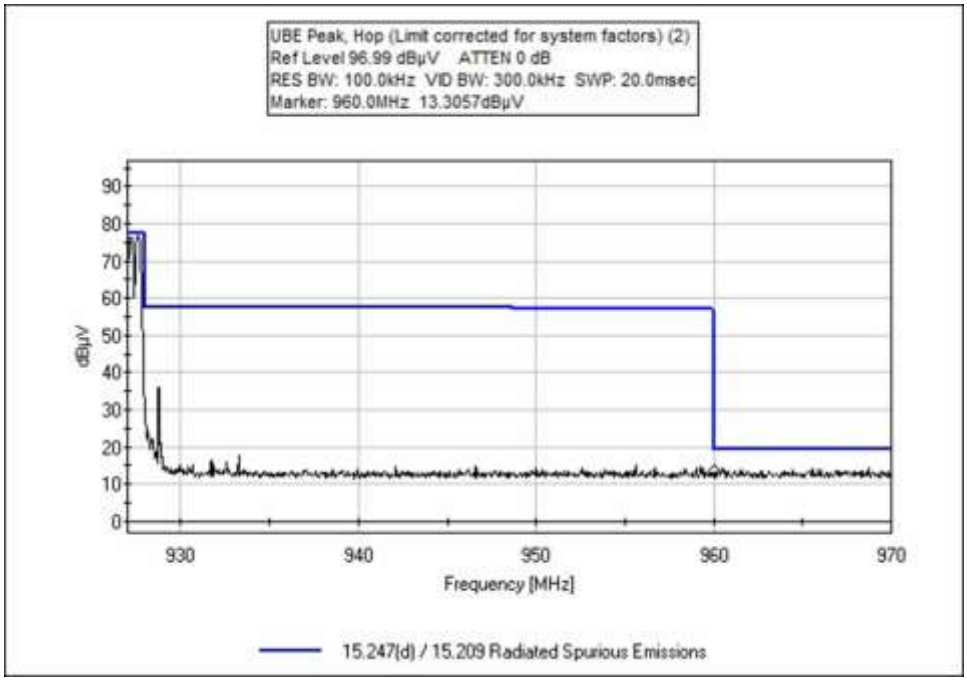

LBE Peak, SC (Limit corrected for system factors) (2)
Ref Level 96.99 dBµV ATTEN 0 dB
RES BW: 100.0kHz VID BW: 300.0kHz SWP: 102.4msec
Marker: 614.0MHz 12.7407dBµV
dBµV
90
80
70
60
50
40
30
20
10
0
600
700
800
900
Frequency [MHz]
15.247(d) / 15.209 Radiated Spurious Emissions


UBE Peak, SC (Limit corrected for system factors) (2)
Ref Level 96.99 dBµV ATTEN 0 dB
RES BW: 100.0kHz VID BW: 300.0kHz SWP: 20.0msec
Marker: 960.0MHz 9.6667dBµV
dBµV
90
80
70
60
50
40
30
20
10
0
930
940
950
960
970
Frequency [MHz]
15.247(d) / 15.209 Radiated Spurious Emissions


LBE Peak, HOP (Limit corrected for system factors) (1)
Ref Level 96.99 dBµV ATTEN 0 dB
RES BW: 100.0kHz VID BW: 300.0kHz SWP: 20.0msec
Marker: 902.0MHz 24.1767dBµV
dBµV
Frequency [MHz]
15.247(d) / 15.209 Radiated Spurious Emissions


UBE Peak, Hop (Limit corrected for system factors) (1)
Ref Level 96.99 dBµV ATTEN 0 dB
RES BW: 100.0kHz VID BW: 300.0kHz SWP: 20.0msec
Marker: 928.0MHz 23.5517dBµV
dBµV
Frequency [MHz]
15.247(d) / 15.209 Radiated Spurious Emissions


LBE Peak, HOP (Limit corrected for system factors) (2)
Ref Level 96.99 dBµV ATTEN 0 dB
RES BW: 100.0kHz VID BW: 300.0kHz SWP: 102.4msec
Marker: 614.0MHz 12.4577dBµV
dBµV
90
80
70
60
50
40
30
20
10
0
600
700
800
900
Frequency [MHz]
15.247(d) / 15.209 Radiated Spurious Emissions


UBE Peak, Hop (Limit corrected for system factors) (2)
Ref Level 96.99 dBµV ATTEN 0 dB
RES BW: 100.0kHz VID BW: 300.0kHz SWP: 20.0msec
Marker: 960.0MHz 13.3057dBµV
dBµV
90
80
70
60
50
40
30
20
10
0
930
940
950
960
970
Frequency [MHz]
15.247(d) / 15.209 Radiated Spurious Emissions

Test Setup / Conditions / Data

Test Location:	CKC Laboratories, Inc. • 22116 23rd Drive SE, Suite A • Bothell, WA 98021 • 1-800-500-4EMC		
Customer:	**Nalloy, LLC**		
Specification:	**15.247(d) / 15.209 Radiated Spurious Emissions**		
Work Order #:	**104760**	Date:	5/14/2021
Test Type:	**Maximized Emissions**	Time:	08:40:47
Tested By:	M. Harrison	Sequence#:	6
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:

Test Environment Conditions:
Temperature: 20°C
Humidity: 33%
Pressure: 102.1kPa

Test Method: ANSI C63.10: 2013

Frequency range: 600-970MHz (Highest Frequency Generated = 927.6MHz)

Setup:
AOS V2 Powered Via Delta PSU (24VDC/100W PSU MSS)
Low Channel (0) 902.4 MHz, Mid (31) 914.8MHz, High (63) 927.6MHz
GFSK-2
100% Duty Cycle
PWR Level Setting: 150
PWR Output: 15dBm

In order not to mask emissions from the EUT, the power supply was placed at distance of 30cm from the EUT.

The peripheral equipment was placed away from each other in order to simulate typical installation.

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN02871	Spectrum Analyzer	E4440A	3/12/2020	3/12/2022
T2	ANP05305	Cable	ETSI-50T	9/6/2019	9/6/2021
T3	ANP05360	Cable	RG214	2/3/2020	2/3/2022
T4	ANP06540	Cable	Heliax	8/23/2019	8/23/2021
T5	AN01995	Biconilog Antenna	CBL6111C	4/14/2020	4/14/2022
T6	ANP05275	Attenuator	1W	3/26/2020	3/26/2022

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	902.345M	78.4	+0.0 +23.4	+1.4 +6.1	+2.1	+0.3	+0.0	111.7	111.7 SC	+0.0	Vert
2	614.000M	12.7	+0.0 +20.0	+1.2 +6.1	+1.7	+0.3	+0.0	42.0	46.0 SC	-4.0	Vert
3	614.000M	12.5	+0.0 +20.0	+1.2 +6.1	+1.7	+0.3	+0.0	41.8	46.0 Hop	-4.2	Vert
4	960.000M	13.3	+0.0 +24.3	+1.5 +6.1	+2.2	+0.4	+0.0	47.8	54.0 Hop	-6.2	Vert
5	960.000M	9.7	+0.0 +24.3	+1.5 +6.1	+2.2	+0.4	+0.0	44.2	54.0 SC	-9.8	Vert
6	902.000M	25.1	+0.0 +23.4	+1.4 +6.1	+2.1	+0.3	+0.0	58.4	91.7 SC	-33.3	Vert
7	928.000M	23.6	+0.0 +23.8	+1.5 +6.1	+2.2	+0.4	+0.0	57.6	91.7 Hop	-34.1	Vert
8	902.000M	24.2	+0.0 +23.4	+1.4 +6.1	+2.1	+0.3	+0.0	57.5	91.7 Hop	-34.2	Vert
9	928.000M	21.5	+0.0 +23.8	+1.5 +6.1	+2.2	+0.4	+0.0	55.5	91.7 SC	-36.2	Vert

Test Setup Photo(s)

Below 1GHz

Below 1GHz

Above 1GHz

Above 1GHz


EUT
X-Axis
(Flat)
05 .05 .2021 09 :33

X Axis


Y-Axis
Upright
(2 Cables on top)
05 .08 .2021 08 :34

Y Axis

Z Axis

15.207 AC Conducted Emissions

Test Setup / Conditions / Data

Test Location:	CKC Laboratories, Inc. • 22116 23rd Drive SE, Suite A • Bothell, WA 98021 • 1-800-500-4EMC		
Customer:	**Nalloy, LLC**		
Specification:	**15.207 AC Mains - Average**		
Work Order #:	**104760**	Date:	5/14/2021
Test Type:	**Conducted Emissions**	Time:	13:58:29
Tested By:	M. Harrison	Sequence#:	8
Software:	EMITest 5.03.19		120V 60Hz

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

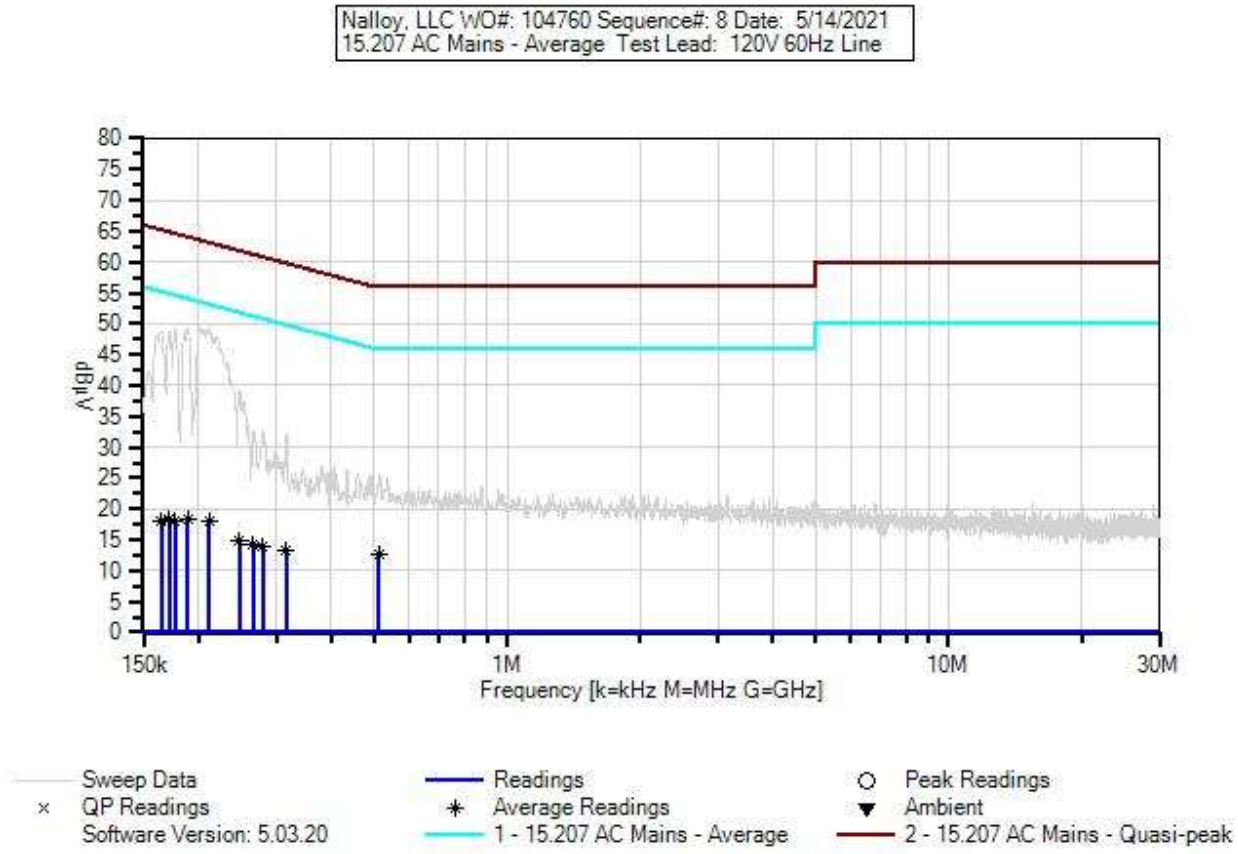
Test Conditions / Notes:

Test Environment Conditions:
Temperature: 20°C
Humidity: 33%
Pressure: 102.1kPa

Test Method: ANSI C63.10: 2013

Frequency range: 150k-30MHz

Setup:
AOS V2 Powered Via Delta PSU (24VDC/100W PSU MSS)
Low Channel (0) 902.4 MHz, Mid (31) 914.8MHz, High (63) 927.6MHz
GFSK-2
100% Duty Cycle
PWR Level Setting: 150
PWR Output: 15dBm



Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	ANP06219	Attenuator	768-10	4/7/2020	4/7/2022
T2	ANP06515	Cable	Heliax	7/1/2020	7/1/2022
T3	ANP06540	Cable	Heliax	8/23/2019	8/23/2021
T4	AN01311	50uH LISN-Line1 (L)	3816/2	2/24/2020	2/24/2022
	AN01311	50uH LISN-Line2 (N)	3816/2	2/24/2020	2/24/2022
	AN02871	Spectrum Analyzer	E4440A	3/12/2020	3/12/2022
T5	AN02611	High Pass Filter	HE9615-150K-50-720B	1/10/2020	1/10/2022

Measurement Data: Reading listed by margin. Test Lead: Line

#	Freq	Rdng	T1 T5	T2	T3	T4	Dist	Corr	Spec	Margin	Polar
	MHz	dBµV	dB	dB	dB	dB	Table	dBµV	dBµV	dB	Ant
1	512.876k	2.8	+9.1	+0.0	+0.0	-0.4	+0.0	12.5	46.0	-33.5	Line
	Ave		+0.2								
^	512.875k	16.8	+9.1	+0.0	+0.0	-0.4	+0.0	26.5	46.0	-19.5	Line
			+0.2								
3	211.085k	7.4	+9.1	+0.0	+0.0	-1.1	+0.0	17.9	53.2	-35.3	Line
	Ave		+0.3								
^	211.085k	41.1	+9.1	+0.0	+0.0	-1.1	+0.0	51.6	53.2	-1.6	Line
			+0.3								
5	189.269k	7.6	+9.1	+0.0	+0.0	-1.3	+0.0	18.3	54.1	-35.8	Line
	Ave		+0.3								
^	189.269k	41.1	+9.1	+0.0	+0.0	-1.3	+0.0	51.8	54.1	-2.3	Line
			+0.3								
7	316.530k	3.4	+9.1	+0.0	+0.0	-0.7	+0.0	13.3	49.8	-36.5	Line
	Ave		+0.1								
^	316.530k	23.5	+9.1	+0.0	+0.0	-0.7	+0.0	33.4	49.8	-16.4	Line
			+0.1								
9	176.907k	7.0	+9.1	+0.0	+0.0	-1.4	+0.0	17.9	54.6	-36.7	Line
	Ave		+0.4								
^	176.906k	41.0	+9.1	+0.0	+0.0	-1.4	+0.0	51.9	54.6	-2.7	Line
			+0.4								
11	171.816k	7.2	+9.1	+0.0	+0.0	-1.5	+0.0	18.2	54.9	-36.7	Line
	Ave		+0.4								
^	171.816k	40.8	+9.1	+0.0	+0.0	-1.5	+0.0	51.8	54.9	-3.1	Line
			+0.4								
13	279.443k	3.9	+9.1	+0.0	+0.0	-0.8	+0.0	13.9	50.8	-36.9	Line
	Ave		+0.1								
^	279.442k	24.3	+9.1	+0.0	+0.0	-0.8	+0.0	34.3	50.8	-16.5	Line
			+0.1								
15	266.353k	4.2	+9.1	+0.0	+0.0	-0.8	+0.0	14.3	51.2	-36.9	Line
	Ave		+0.2								
^	266.352k	24.3	+9.1	+0.0	+0.0	-0.8	+0.0	34.4	51.2	-16.8	Line
			+0.2								
17	164.544k	6.9	+9.1	+0.0	+0.0	-1.6	+0.0	18.1	55.2	-37.1	Line
	Ave		+0.5								
^	164.544k	40.8	+9.1	+0.0	+0.0	-1.6	+0.0	52.0	55.2	-3.2	Line
			+0.5								
19	247.446k	4.5	+9.1	+0.0	+0.0	-0.9	+0.0	14.7	51.8	-37.1	Line
	Ave		+0.2								
^	247.445k	30.9	+9.1	+0.0	+0.0	-0.9	+0.0	41.1	51.8	-10.7	Line
			+0.2								

Test Location:	CKC Laboratories, Inc. • 22116 23rd Drive SE, Suite A • Bothell, WA 98021 • 1-800-500-4EMC		
Customer:	**Nalloy, LLC**		
Specification:	**15.207 AC Mains - Average**		
Work Order #:	**104760**	Date:	5/14/2021
Test Type:	**Conducted Emissions**	Time:	14:10:26
Tested By:	M. Harrison	Sequence#:	9
Software:	EMITest 5.03.19		120V 60Hz

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

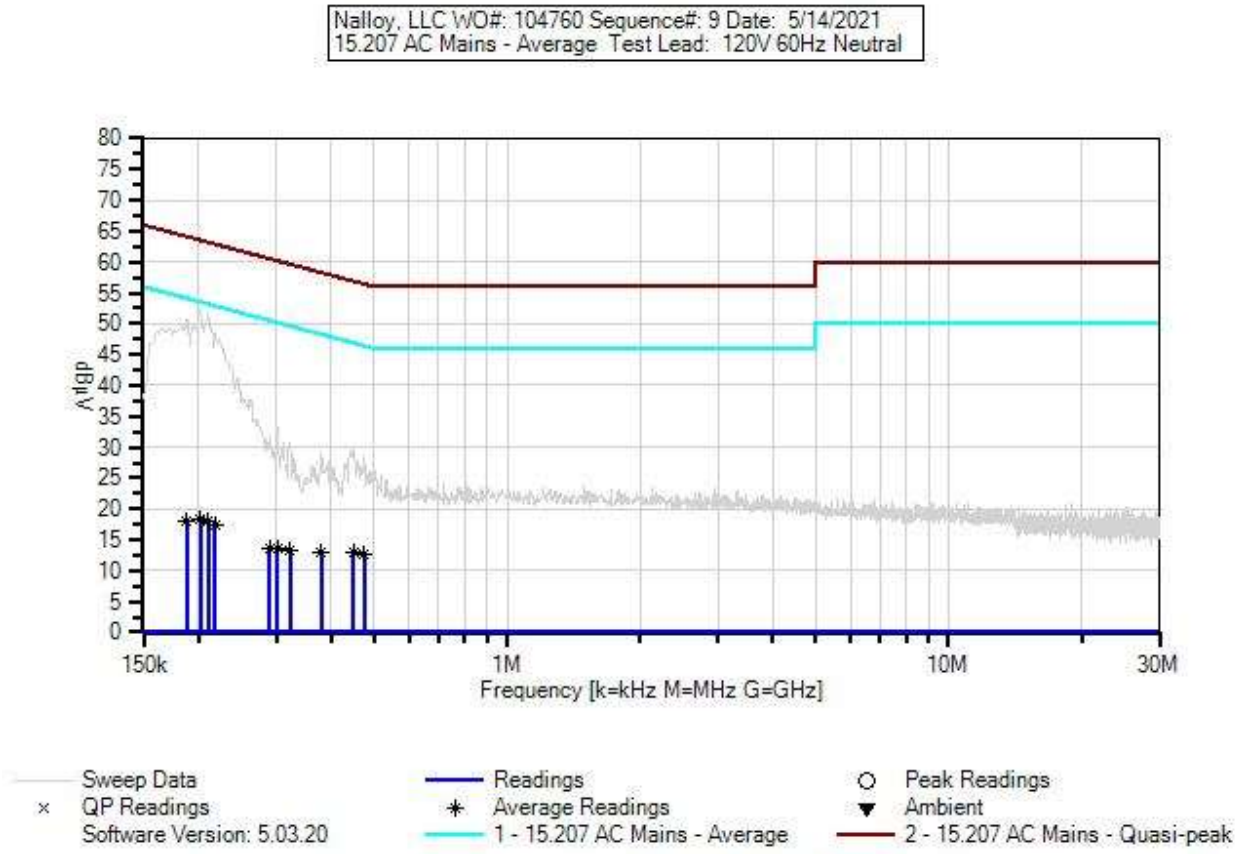
Test Conditions / Notes:

Test Environment Conditions:
Temperature: 20°C
Humidity: 33%
Pressure: 102.1kPa

Test Method: ANSI C63.10: 2013

Frequency range: 150k-30MHz

Setup:
AOS V2 Powered Via Delta PSU (24VDC/100W PSU MSS)
Low Channel (0) 902.4 MHz, Mid (31) 914.8MHz, High (63) 927.6MHz
GFSK-2
100% Duty Cycle
PWR Level Setting: 150
PWR Output: 15dBm



Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	ANP06219	Attenuator	768-10	4/7/2020	4/7/2022
T2	ANP06515	Cable	Heliax	7/1/2020	7/1/2022
T3	ANP06540	Cable	Heliax	8/23/2019	8/23/2021
	AN01311	50uH LISN-Line1 (L)	3816/2	2/24/2020	2/24/2022
T4	AN01311	50uH LISN-Line2 (N)	3816/2	2/24/2020	2/24/2022
	AN02871	Spectrum Analyzer	E4440A	3/12/2020	3/12/2022
T5	AN02611	High Pass Filter	HE9615-150K-50-720B	1/10/2020	1/10/2022

Measurement Data: Reading listed by margin. Test Lead: Neutral

#	Freq	Rdng	T1 T5	T2	T3	T4	Dist	Corr	Spec	Margin	Polar
	MHz	dBµV	dB	dB	dB	dB	Table	dBµV	dBµV	dB	Ant
1	473.607k	3.0	+9.1	+0.0	+0.0	-0.4	+0.0	12.7	46.5	-33.8	Neutr
	Ave		+0.2								
^	473.606k	19.5	+9.1	+0.0	+0.0	-0.4	+0.0	29.2	46.5	-17.3	Neutr
			+0.2								
3	448.882k	3.1	+9.1	+0.0	+0.0	-0.5	+0.0	12.9	46.9	-34.0	Neutr
	Ave		+0.2								
^	448.881k	20.9	+9.1	+0.0	+0.0	-0.5	+0.0	30.7	46.9	-16.2	Neutr
			+0.2								
5	210.358k	7.7	+9.1	+0.0	+0.0	-1.1	+0.0	18.2	53.2	-35.0	Neutr
	Ave		+0.3								
^	210.358k	43.2	+9.1	+0.0	+0.0	-1.1	+0.0	53.7	53.2	+0.5	Neutr
			+0.3								
7	201.632k	7.9	+9.1	+0.0	+0.0	-1.2	+0.0	18.4	53.5	-35.1	Neutr
	Ave		+0.2								
^	201.631k	44.1	+9.1	+0.0	+0.0	-1.2	+0.0	54.6	53.5	+1.1	Neutr
			+0.2								
9	379.070k	3.2	+9.1	+0.0	+0.0	-0.5	+0.0	13.0	48.3	-35.3	Neutr
	Ave		+0.2								
^	379.069k	20.4	+9.1	+0.0	+0.0	-0.5	+0.0	30.2	48.3	-18.1	Neutr
			+0.2								
11	218.357k	7.0	+9.1	+0.0	+0.0	-1.1	+0.0	17.5	52.9	-35.4	Neutr
	Ave		+0.3								
^	218.357k	40.1	+9.1	+0.0	+0.0	-1.1	+0.0	50.6	52.9	-2.3	Neutr
			+0.3								
13	188.542k	7.5	+9.1	+0.0	+0.0	-1.3	+0.0	18.2	54.1	-35.9	Neutr
	Ave		+0.3								
^	188.541k	42.8	+9.1	+0.0	+0.0	-1.3	+0.0	53.5	54.1	-0.6	Neutr
			+0.3								
15	321.621k	3.3	+9.1	+0.0	+0.0	-0.6	+0.0	13.1	49.7	-36.6	Neutr
	Ave		+0.1								
^	321.620k	22.1	+9.1	+0.0	+0.0	-0.6	+0.0	31.9	49.7	-17.8	Neutr
			+0.1								
17	301.259k	3.6	+9.1	+0.0	+0.0	-0.7	+0.0	13.5	50.2	-36.7	Neutr
	Ave		+0.1								
^	301.258k	24.7	+9.1	+0.0	+0.0	-0.7	+0.0	34.6	50.2	-15.6	Neutr
			+0.1								
19	290.351k	3.7	+9.1	+0.0	+0.0	-0.7	+0.0	13.6	50.5	-36.9	Neutr
	Ave		+0.1								
^	290.350k	23.1	+9.1	+0.0	+0.0	-0.7	+0.0	33.0	50.5	-17.5	Neutr
			+0.1								

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 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.