Tonal

TEST REPORT FOR

Bar Control
Model: 110-0017

Tested to The Following Standards:

FCC Part 15 Subpart C Section(s)

15.247
(DTS 2400-2483.5 MHz)

Report No.: 106246-13

Date of issue: January 24, 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

Testing the Future
CKC LABORATORIES, INC.

TABLE OF CONTENTS

ADMINISTRATIVE INFORMATION

Test Report Information

REPORT PREPARED FOR:

Tonal
617 Bryant Street
San Francisco, CA 94107

Representative: Nate Pickslay

REPORT PREPARED BY:

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

Project Number: 106246

DATE OF EQUIPMENT RECEIPT: December 9, 2021
DATE(S) OF TESTING: December 9-10, 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.
1120 Fulton Place
Fremont, CA 94539

Software Versions

CKC Laboratories Proprietary Software	Version
EMITest Emissions	5.03.20

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)

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

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
The Test Setup Photos are incorporated by reference 106246-13_Test Setup_Photos.

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 3

***Equipment Under Test* (* = EUT):**

Device Name	Manufacturer	Model #	S/N
Bar Control	Tonal	110-0017	0011

Support Devices:

Device Name	Manufacturer	Model #	S/N
Laptop	Apple	MacBook Pro A1278	C1MMF2KDDV30
Laptop Power Supply	Apple	ADP-60AD T	E131881

Configuration 4

***Equipment Under Test* (* = EUT):**

Device Name	Manufacturer	Model #	S/N
Bar Control	Tonal	110-0017	0014

Support Devices:

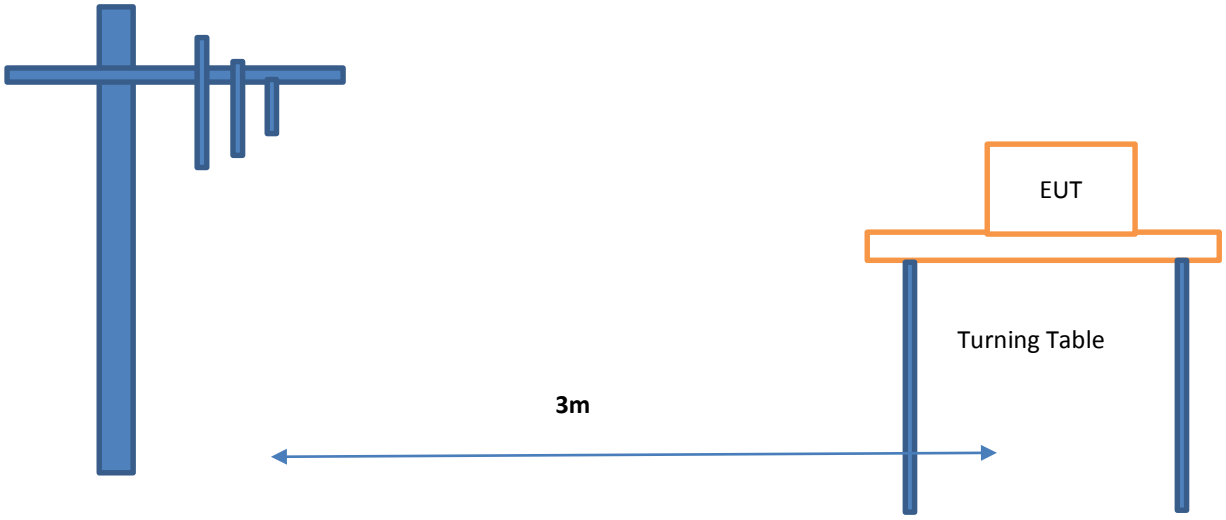
Device Name	Manufacturer	Model #	S/N
Laptop	Apple	MacBook Pro A1278	C1MMF2KDDV30
Laptop Power Supply	Apple	ADP-60AD T	E131881

General Product Information:

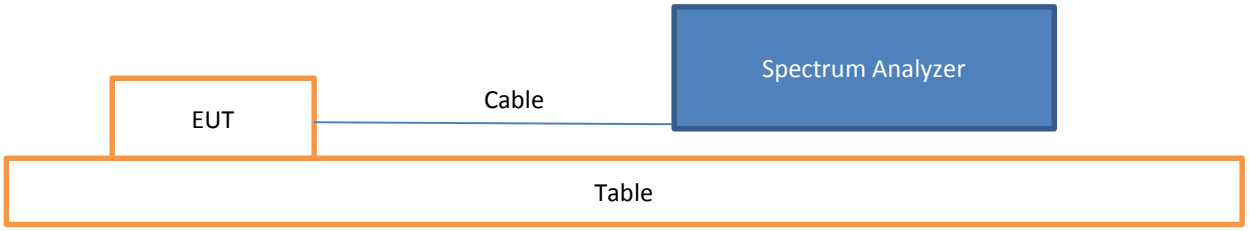
Product Information	Manufacturer-Provided Details
Equipment Type:	Stand-Alone Equipment
Type of Wideband System:	Bluetooth
Operating Frequency Range:	2402-2480MHz
Modulation Type(s):	GFSK
Maximum Duty Cycle:	100%
Number of TX Chains:	1
Antenna Type(s) and Gain:	Integral 3.31dBi
Beamforming Type:	NA
Antenna Connection Type:	Integral
Nominal Input Voltage:	1.5VDC Battery
Software used for Test:	Putty version 0.74
The validity of results is dependent on the stated product details, the accuracy of which the manufacturer assumes full responsibility.	

Block Diagram of Test Setup(s)

Radiated Method Setup



Conducted Method Setup



FCC Part 15 Subpart C

15.247(a)(2) 6dB Bandwidth

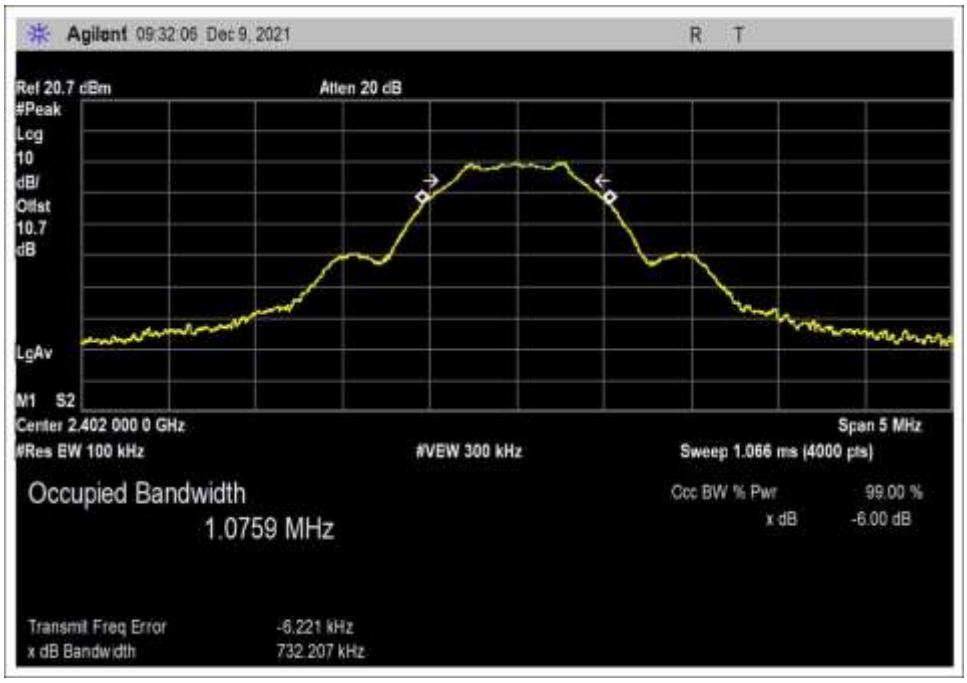
Test Setup/Conditions			
Test Location:	Fremont Lab C3	Test Engineer:	Hieu Song Nguyenpham
Test Method:	ANSI C63.10 (2013), KDB 558074 D01 15.247 Meas Guidance v05r02	Test Date(s):	12/9/2021
Configuration:	3		
Test Setup:	The EUT is placed non-conducted table. The EUT is operated as intended. The EUT is connected straight to a Spectrum Analyzer.		

Environmental Conditions			
Temperature (ºC)	22.5	Relative Humidity (%):	45

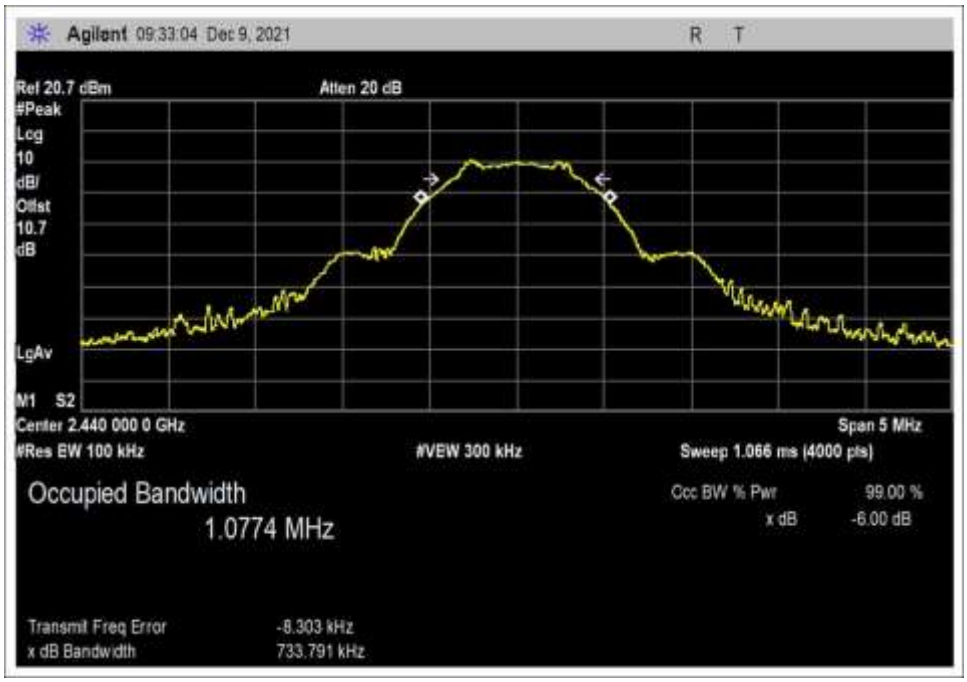
Test Equipment					
Asset#	**Description**	**Manufacturer**	**Model**	**Cal Date**	**Cal Due**
02660	Spectrum Analyzer	Agilent	E4446A	12/4/2020	12/4/2022
03013	Cable	Astrolab	32022-2-2909K-36TC	3/25/2020	3/25/2022
P06239	Attenuator	Weinschel	54A-10	6/17/2020	6/17/2022

Test Data Summary					
Frequency (MHz)	**Antenna Port**	**Modulation**	**Measured (kHz)**	**Limit (kHz)**	**Results**
2402	1	GFSK	732.207	≥500	Pass
2442	1	GFSK	733.791	≥500	Pass
2480	1	GFSK	747.155	≥500	Pass

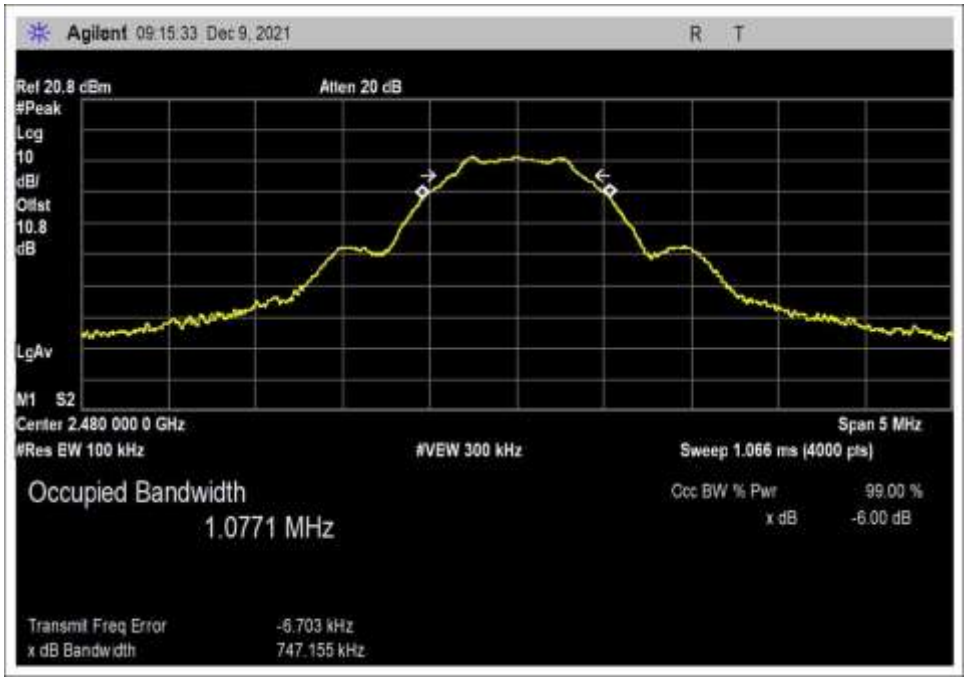
Plot(s)



Low Channel



Middle Channel



High Channel

15.247(b)(3) Output Power

Test Setup / Conditions			
Test Location:	Fremont Lab C3	Test Engineer:	Hieu Song Nguyenpham
Test Method:	ANSI C63.10 (2013), KDB 558074 D01 15.247 Meas Guidance v05r02	Test Date(s):	12/9/2021
Configuration:	3		
Test Setup:	The EUT is placed non-conducted table. The EUT is operated as intended. The EUT is connected straight to a Spectrum Analyzer.		

Environmental Conditions			
Temperature (ºC)	22.8	Relative Humidity (%):	43

Test Equipment					
Asset#	**Description**	**Manufacturer**	**Model**	**Cal Date**	**Cal Due**
02660	Spectrum Analyzer	Agilent	E4446A	12/4/2020	12/4/2022
03013	Cable	Astrolab	32022-2-2909K-36TC	3/25/2020	3/25/2022
P06239	Attenuator	Weinschel	54A-10	6/17/2020	6/17/2022

Test Data Summary - Voltage Variations

This equipment is battery powered. Power output tests were performed using a fresh battery.

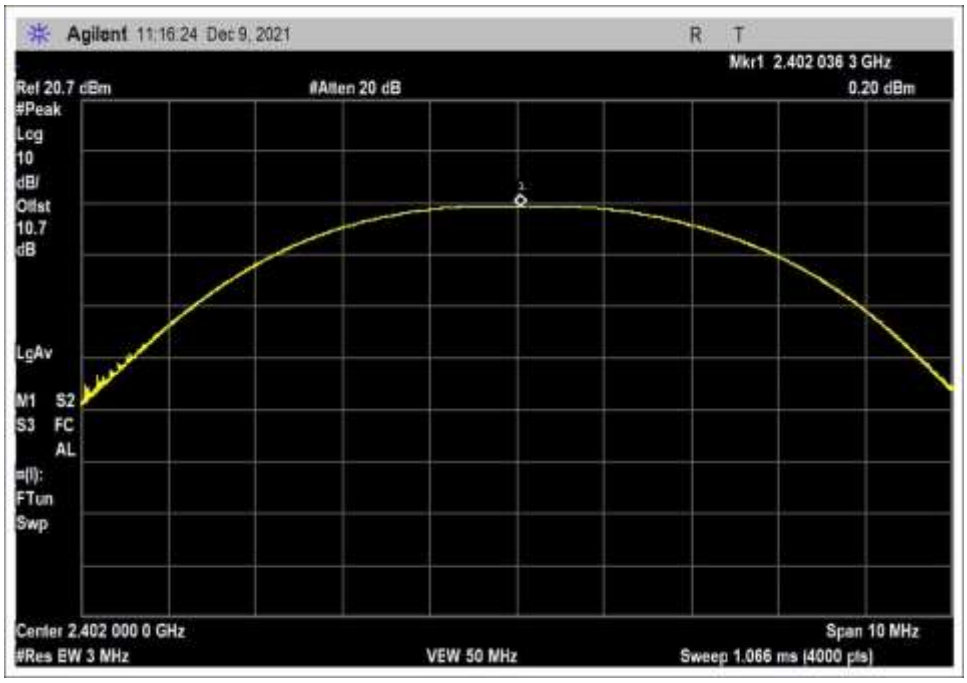
Power Output Test Data Summary - RF Conducted Measurement					
Measurement Option: RBW > DTS Bandwidth					
Frequency (MHz)	**Modulation**	**Ant. Type / Gain (dBi)**	**Measured (dBm)**	**Limit (dBm)**	**Results**
2402	GFSK	Integral/3.31	0.20	≤30	Pass
2442	GFSK	Integral/3.31	0.99	≤30	Pass
2480	GFSK	Integral/3.31	2.06	≤30	Pass

For fixed point-to-point antennas, the limit is calculated in accordance with 15.247(c)(1):

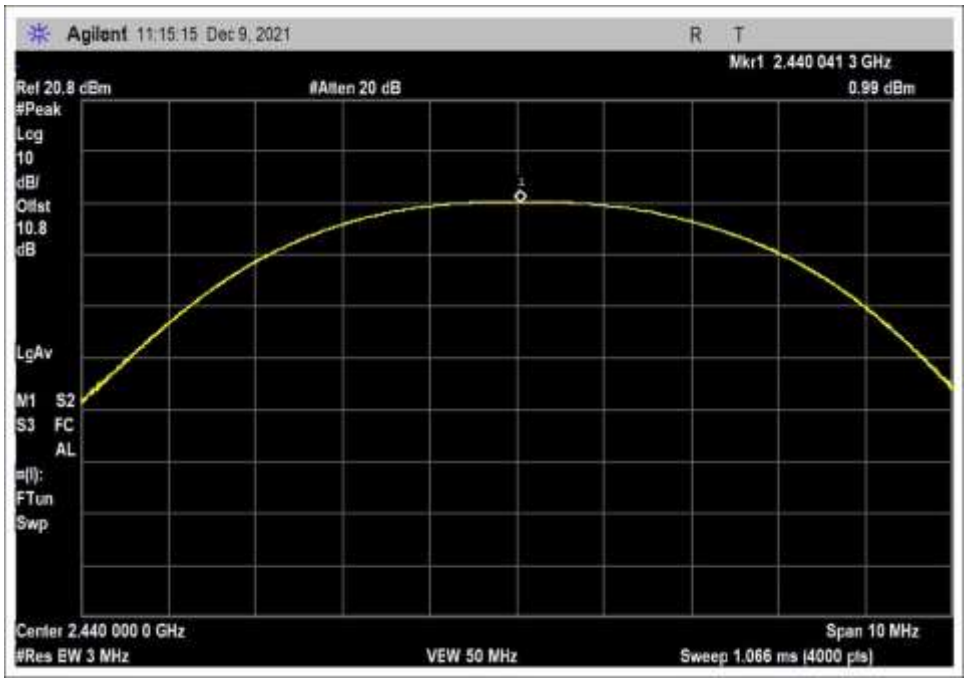
$$Limit = 30 - Roundup\left(\frac{G-6}{3}\right)$$

For directional beamforming antennas, the limit is calculated in accordance with 15.247(c)(2) and KDB 662911.

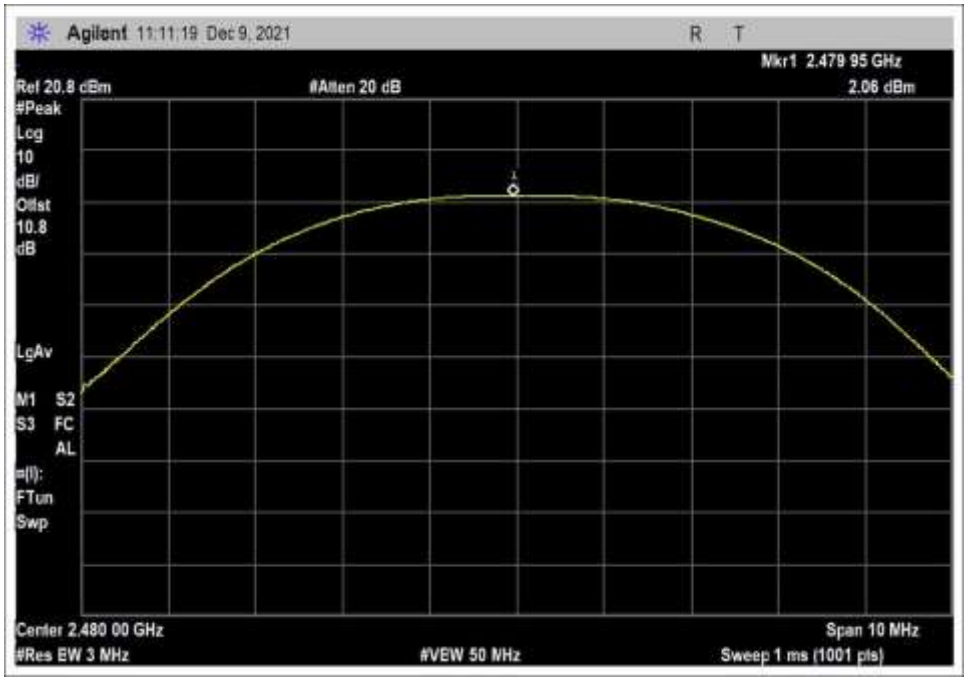
Plots



Low Channel



Middle Channel



High Channel

15.247(d) RF Conducted Emissions & Band Edge

Test Setup / Conditions / Data

Test Location:	CKC Laboratories, Inc. • 1120 Fulton Place • Fremont CA 94539 • 510-249-1170		
Customer:	**Tonal**		
Specification:	**15.247(d) Conducted Spurious Emissions**		
Work Order #:	**106246**	Date:	12/9/2021
Test Type:	**Radiated Scan**	Time:	10:22:11 AM
Tested By:	Hieu Song Nguyenpham	Sequence#:	1
Software:	EMITest 5.03.20		

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 3			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 3			

Test Conditions / Notes:

Conducted Spurious Emission

Frequency Range: 9kHz to 25GHz

Environmental Conditions:
Temperature: 23.1°C
Humidity: 43%
Atmospheric Pressure: 101.4kPa

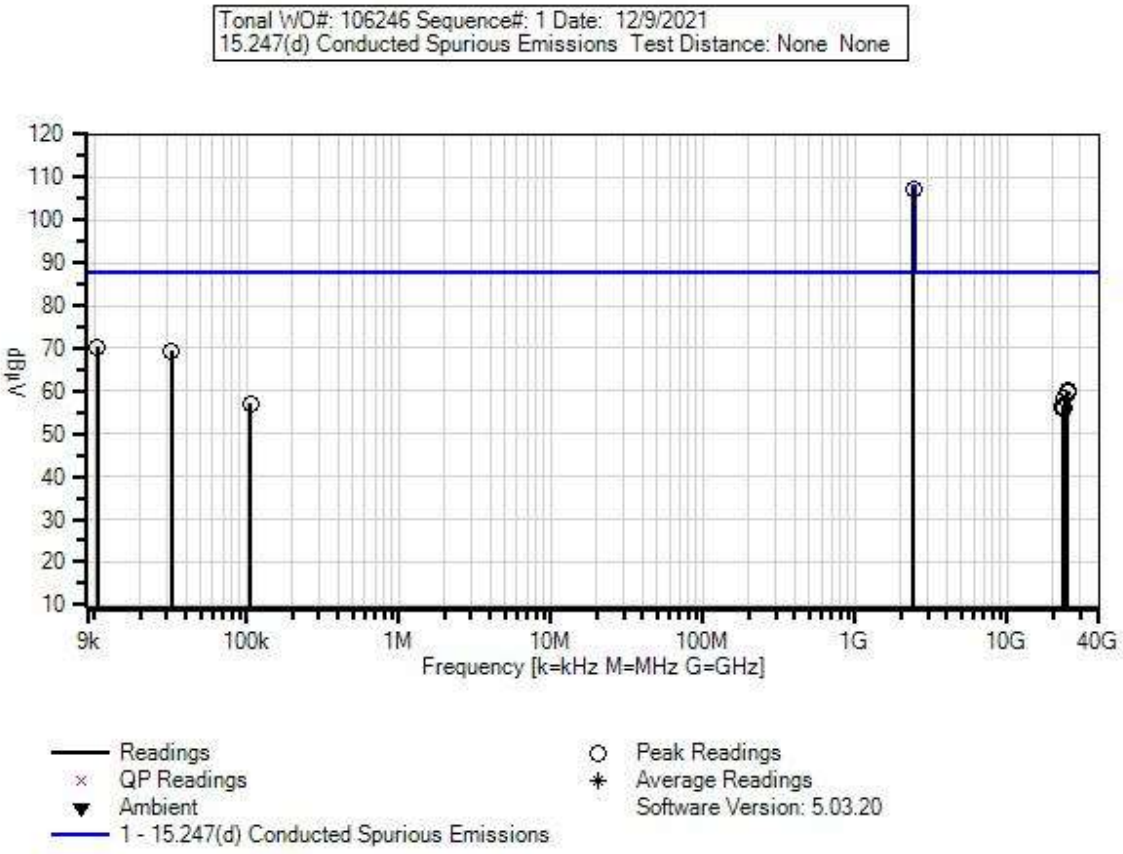
Software: Putty version 0.74

Highest Generated Frequency: 2.48GHz

Method: ANSI C63.10 2013

The EUT is placed non-conducted table.
It is operated as intended.
It is connected straight to a Spectrum Analyzer.
A laptop is used to send the command to the EUT.

Note: Low Channel



Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
	AN02660	Spectrum Analyzer	E4446A	12/4/2020	12/4/2022
T1	ANP06239	Attenuator	54A-10	6/17/2020	6/17/2022
T2	AN03013	Cable	32022-2-2909K-36TC	3/25/2020	3/25/2022

Measurement Data: Reading listed by margin. Test Distance: None

#	Freq MHz	Rdng dBµV	T1 dB	T2 dB	dB	dB	Dist Table	Corr dBµV	Spec dBµV	Margin dB	Polar Ant
1	2400.765M	96.6	+9.9	+0.8			+0.0	107.3	108.0	-0.7	None
2	10.539k	60.5	+9.8	+0.0			+0.0	70.3	87.9	-17.6	None
3	32.277k	59.6	+9.8	+0.0			+0.0	69.4	87.9	-18.5	None
4	24727.545 M	47.0	+10.3	+2.7			+0.0	60.0	87.9	-27.9	None
5	24790.419 M	46.5	+10.3	+2.7			+0.0	59.5	87.9	-28.4	None
6	23826.347 M	45.9	+10.1	+2.5			+0.0	58.5	87.9	-29.4	None
7	106.967k	47.3	+9.8	+0.0			+0.0	57.1	87.9	-30.8	None
8	23029.940 M	43.5	+10.2	+2.6			+0.0	56.3	87.9	-31.6	None
9	23145.209 M	43.2	+10.2	+2.6			+0.0	56.0	87.9	-31.9	None
10	23260.479 M	43.3	+10.1	+2.5			+0.0	55.9	87.9	-32.0	None

Test Location:	CKC Laboratories, Inc. • 1120 Fulton Place • Fremont CA 94539 • 510-249-1170		
Customer:	**Tonal**		
Specification:	**15.247(d) Conducted Spurious Emissions**		
Work Order #:	**106246**	Date:	12/9/2021
Test Type:	**Radiated Scan**	Time:	10:35:45 AM
Tested By:	Hieu Song Nguyenpham	Sequence#:	2
Software:	EMITest 5.03.20		

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 3			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 3			

Test Conditions / Notes:

Conducted Spurious Emission

Frequency Range: 9kHz to 25GHz

Environmental Conditions:
Temperature: 23.1°C
Humidity: 43%
Atmospheric Pressure: 101.4kPa

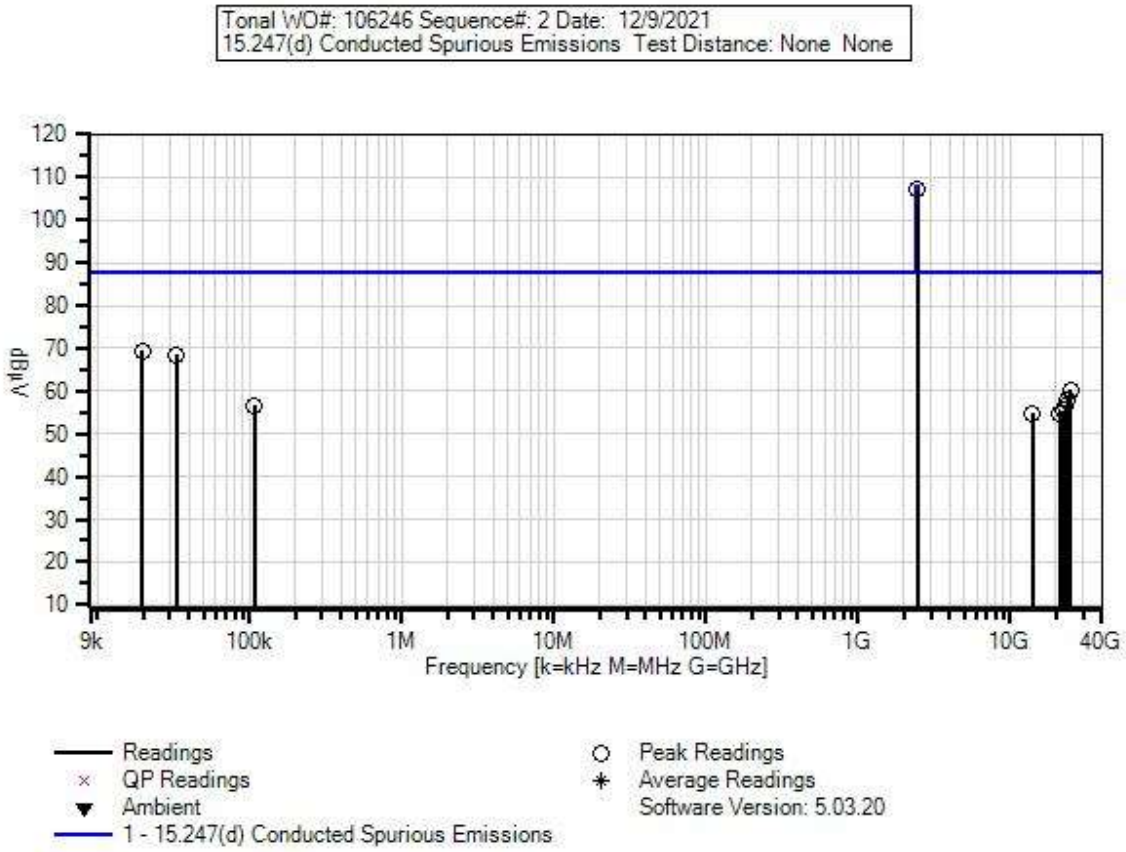
Software: Putty version 0.74

Highest Generated Frequency: 2.48GHz

Method: ANSI C63.10 2013

The EUT is placed non-conducted table.
It is operated as intended.
It is connected straight to a Spectrum Analyzer.
A laptop is used to send the command to the EUT.

Note: Middle Channel



Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
	AN02660	Spectrum Analyzer	E4446A	12/4/2020	12/4/2022
T1	ANP06239	Attenuator	54A-10	6/17/2020	6/17/2022
T2	AN03013	Cable	32022-2-2909K-36TC	3/25/2020	3/25/2022

Measurement Data: Reading listed by margin. Test Distance: None

#	Freq MHz	Rdng dBµV	T1 dB	T2 dB	dB	dB	Dist Table	Corr dBµV	Spec dBµV	Margin dB	Polar Ant
1	2439.667M	96.3	+9.9	+0.9			+0.0	107.1	108.0	-0.9	None
2	19.819k	59.6	+9.8	+0.0			+0.0	69.4	87.9	-18.5	None
3	32.958k	58.7	+9.8	+0.0			+0.0	68.5	87.9	-19.4	None
4	24821.856 M	47.3	+10.3	+2.7			+0.0	60.3	87.9	-27.6	None
5	23815.868 M	45.5	+10.1	+2.5			+0.0	58.1	87.9	-29.8	None
6	107.228k	46.9	+9.8	+0.0			+0.0	56.7	87.9	-31.2	None
7	23103.293 M	43.8	+10.2	+2.6			+0.0	56.6	87.9	-31.3	None
8	21898.203 M	42.8	+10.2	+2.4			+0.0	55.4	87.9	-32.5	None
9	21196.107 M	42.1	+10.2	+2.5			+0.0	54.8	87.9	-33.1	None
10	13882.121 M	42.9	+9.9	+1.9			+0.0	54.7	87.9	-33.2	None

Test Location:	CKC Laboratories, Inc. • 1120 Fulton Place • Fremont CA 94539 • 510-249-1170		
Customer:	**Tonal**		
Specification:	**15.247(d) Conducted Spurious Emissions**		
Work Order #:	**106246**	Date:	12/9/2021
Test Type:	**Radiated Scan**	Time:	10:46:52 AM
Tested By:	Hieu Song Nguyenpham	Sequence#:	3
Software:	EMITest 5.03.20		

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 3			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 3			

Test Conditions / Notes:

Conducted Spurious Emission

Frequency Range: 9kHz to 25GHz

Environmental Conditions:
Temperature: 23.1°C
Humidity: 43%
Atmospheric Pressure: 101.4kPa

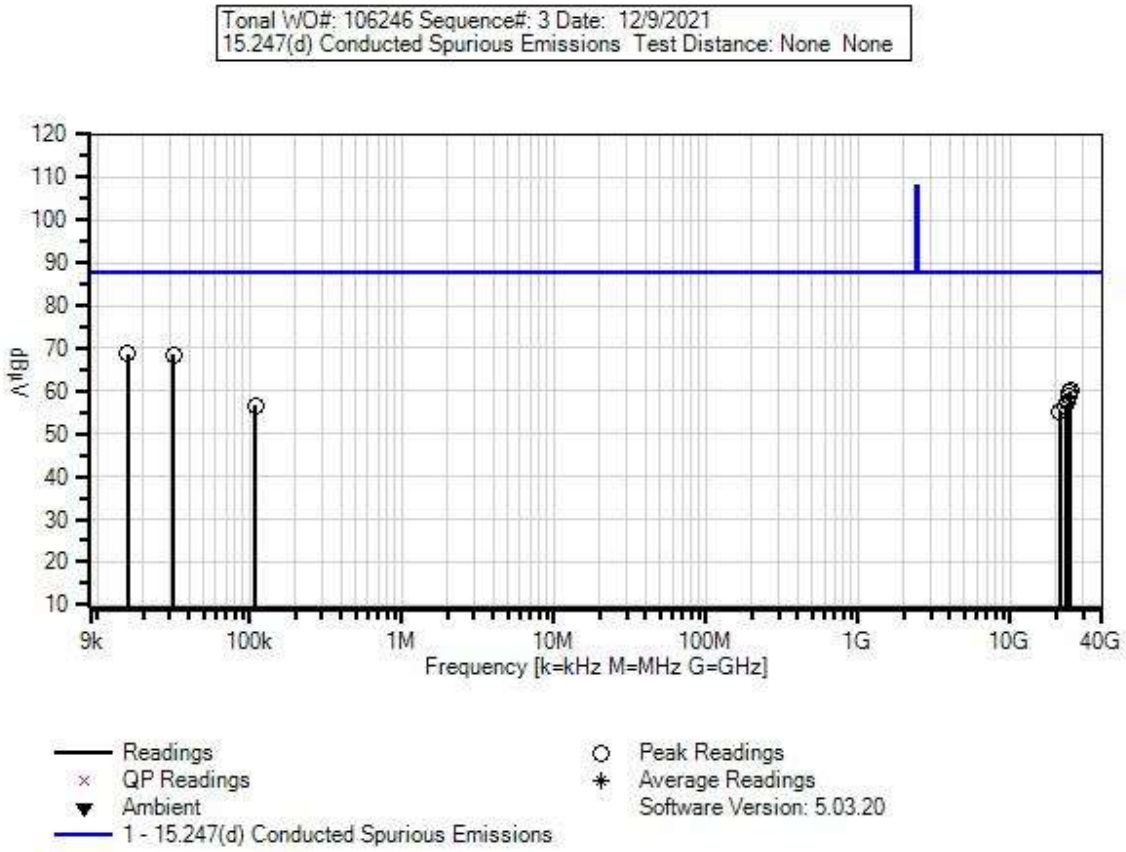
Software: Putty version 0.74

Highest Generated Frequency: 2.48GHz

Method: ANSI C63.10 2013

The EUT is placed non-conducted table.
It is operated as intended.
It is connected straight to a Spectrum Analyzer.
A laptop is used to send the command to the EUT.

Note: Middle Channel



Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
	AN02660	Spectrum Analyzer	E4446A	12/4/2020	12/4/2022
T1	ANP06239	Attenuator	54A-10	6/17/2020	6/17/2022
T2	AN03013	Cable	32022-2-2909K-36TC	3/25/2020	3/25/2022

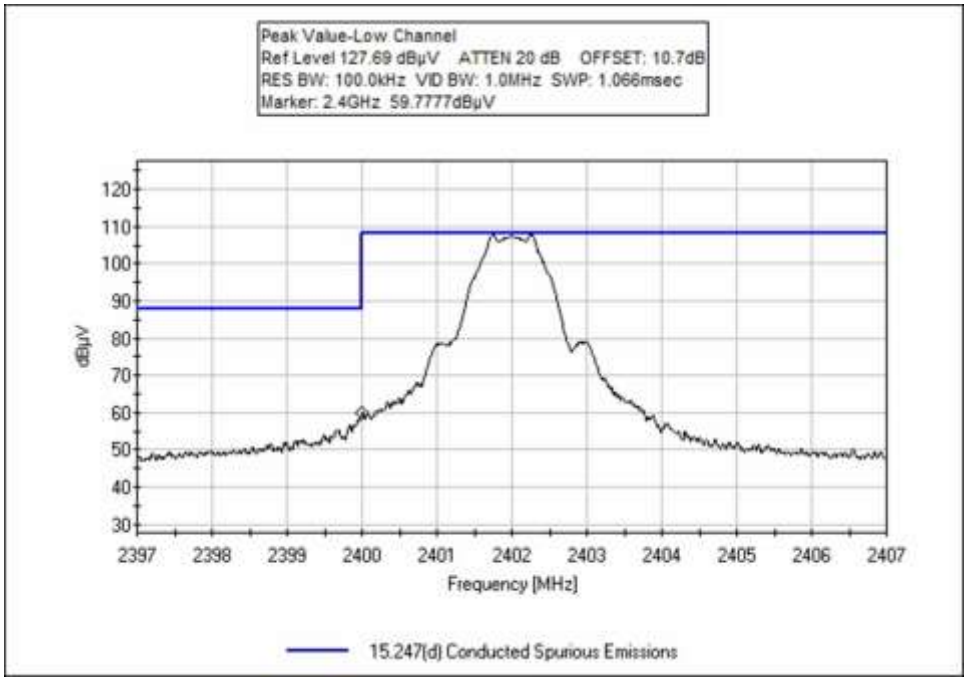
Measurement Data: Reading listed by margin. Test Distance: None

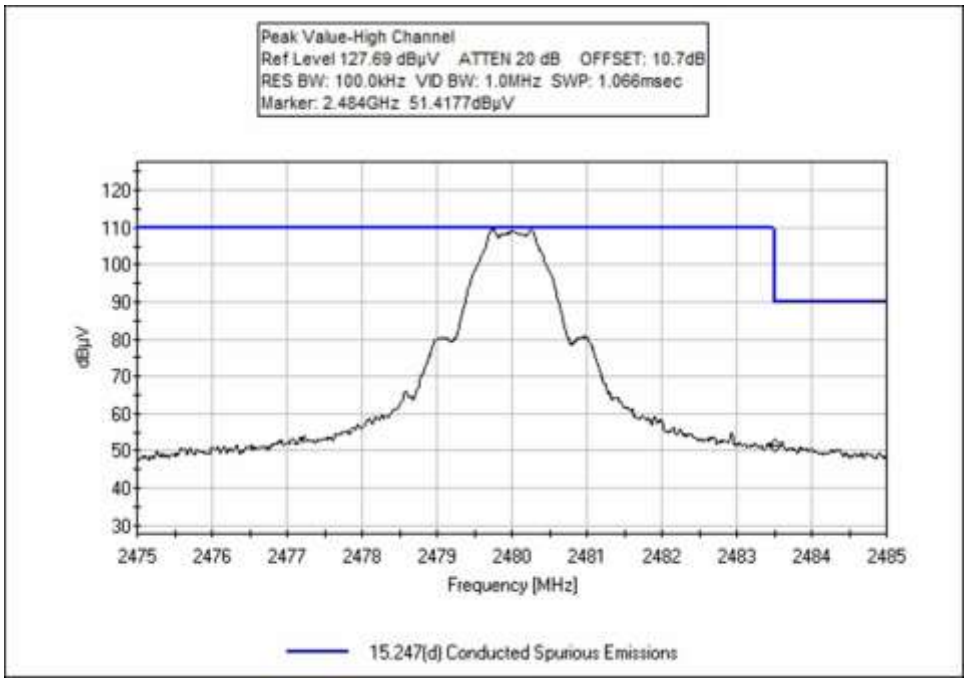
#	Freq MHz	Rdng dBµV	T1 dB	T2 dB	dB	dB	Dist Table	Corr dBµV	Spec dBµV	Margin dB	Polar Ant
1	15.860k	59.0	+9.8	+0.0			+0.0	68.8	87.9	-19.1	None
2	31.595k	58.6	+9.8	+0.0			+0.0	68.4	87.9	-19.5	None
3	24779.940 M	47.1	+10.3	+2.7			+0.0	60.1	87.9	-27.8	None
4	24517.964 M	46.6	+10.2	+2.7			+0.0	59.5	87.9	-28.4	None
5	24559.880 M	45.9	+10.2	+2.7			+0.0	58.8	87.9	-29.1	None
6	23826.347 M	44.6	+10.1	+2.5			+0.0	57.2	87.9	-30.7	None
7	109.574k	46.8	+9.8	+0.0			+0.0	56.6	87.9	-31.3	None
8	23050.898 M	43.5	+10.2	+2.6			+0.0	56.3	87.9	-31.6	None
9	21164.670 M	42.4	+10.2	+2.5			+0.0	55.1	87.9	-32.8	None

Band Edge

Band Edge Summary				
Limit applied: Max Power/100kHz - 20dB.				
Frequency (MHz)	**Modulation**	**Measured (dBuV)**	**Limit (dBuV)**	**Results**
2400.0	GFSK	59.7777	<87.2	Pass
2483.5	GFSK	51.4177	<89.1	Pass

Band Edge Plots





15.247(d) Radiated Emissions & Band Edge

Test Setup / Conditions / Data

Test Location:	CKC Laboratories, Inc. • 1120 Fulton Place • Fremont CA 94539 • 510-249-1170		
Customer:	**Tonal**		
Specification:	**15.247(d) / 15.209 Radiated Spurious Emissions**		
Work Order #:	**106246**	Date:	12/10/2021
Test Type:	**Radiated Scan**	Time:	13:55:01
Tested By:	Hieu Song Nguyenpham	Sequence#:	23
Software:	EMITest 5.03.20		

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 4			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 4			

Test Conditions / Notes:

Radiated Spurious Emission

Frequency Range: 9kHz to 1GHz

Environmental Conditions:
Temperature: 22.7°C
Humidity: 45%
Atmospheric Pressure: 101.6kPa

Highest Generated Frequency: 2.48GHz

Method: ANSI C63.10 2013

The EUT is set up as intended.
It is continuously transmitting or receiving during testing.
The EUT is set up in the worst orthogonal.

Note: Low Channel

No emission has been found from the EUT from 9kHz to 30MHz

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	ANP07508	Preamp	310N	7/9/2020	7/9/2022
T2	AN00852	Biconilog Antenna	CBL 6111C	4/14/2020	4/14/2022
T3	ANP06049	Attenuator	PE7002-6	5/11/2020	5/11/2022
T4	ANP01187	Cable	CNT-195	7/6/2020	7/6/2022
T5	ANP06691	Cable	PE3062-180	3/25/2020	3/25/2022
T6	ANP06694	Cable	PE3062-480	3/25/2020	3/25/2022
	AN02660	Spectrum Analyzer	E4446A	12/4/2020	12/4/2022
	AN00432	Loop Antenna	6502	7/19/2021	7/19/2023

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	947.469M	28.6	-30.9 +1.3	+23.8 +3.3	+5.9	+0.7	+0.0	32.7	46.0	-13.3	Horiz
2	878.890M	30.1	-31.5 +1.2	+23.1 +3.2	+5.9	+0.7	+0.0	32.7	46.0	-13.3	Horiz
3	866.158M	29.7	-31.6 +1.2	+23.0 +3.2	+5.9	+0.7	+0.0	32.1	46.0	-13.9	Vert
4	736.188M	30.0	-32.0 +1.1	+21.6 +2.8	+6.0	+0.6	+0.0	30.1	46.0	-15.9	Horiz
5	742.915M	29.0	-32.0 +1.1	+21.7 +2.8	+6.0	+0.6	+0.0	29.2	46.0	-16.8	Vert
6	30.732M	28.5	-32.1 +0.2	+18.4 +0.4	+5.9	+0.0	+0.0	21.3	40.0	-18.7	Vert
7	495.588M	29.3	-31.9 +0.8	+18.1 +2.2	+5.9	+0.5	+0.0	24.9	46.0	-21.1	Vert
8	43.110M	29.9	-32.1 +0.2	+12.0 +0.5	+5.9	+0.0	+0.0	16.4	40.0	-23.6	Vert

Test Location:	CKC Laboratories, Inc. • 1120 Fulton Place • Fremont CA 94539 • 510-249-1170		
Customer:	**Tonal**		
Specification:	**15.247(d) / 15.209 Radiated Spurious Emissions**		
Work Order #:	**106246**	Date:	12/9/2021
Test Type:	**Radiated Scan**	Time:	17:00:41
Tested By:	Hieu Song Nguyenpham	Sequence#:	14
Software:	EMITest 5.03.20		

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 4			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 4			

Test Conditions / Notes:

Radiated Spurious Emission

Frequency Range: 1GHz to 25GHz

Environmental Conditions:
Temperature: 22.7°C
Humidity: 45%
Atmospheric Pressure: 101.6kPa

Highest Generated Frequency: 2.48GHz

Method: ANSI C63.10 2013

The EUT is set up as intended.
It is continuously transmitting or receiving during testing.
The EUT is set up in the worst orthogonal.

Note: Low Channel

Tonal WO#: 106246 Sequence#: 14 Date: 12/9/2021
15.247(d) / 15.209 Radiated Spurious Emissions Test Distance: 3 Meters

Readings
QP Readings
Ambient
1 - 15.247(d) / 15.209 Radiated Spurious Emissions
Peak Readings
Average Readings
Software Version: 5.03.20

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN03302	Cable	32026-29094K-29094K-72TC	1/9/2020	1/9/2022
T2	ANP01210	Cable	FSJ1P-50A-4A	11/2/2020	11/2/2022
T3	ANP06902	Cable	32022-29094K-29094K-36TC	8/13/2020	8/13/2022
T4	AN03386	High Pass Filter	11SH10-3000/T10000-O/O	4/6/2020	4/6/2022
T5	AN03713	Preamp	01001800-221055-202525	5/24/2021	5/24/2023
	AN02660	Spectrum Analyzer	E4446A	12/4/2020	12/4/2022
	AN03619	Cable	OKOCQoCQ177.2	9/17/2021	9/17/2023
	ANP00928	Cable	various	1/9/2020	1/9/2022
	ANP00929	Cable	various	1/9/2020	1/9/2022
	ANP07699	Cable	32022-29094K-29094K-72TC	10/5/2020	10/5/2022
T6	AN02113	Horn Antenna-ANSI C63.5	3115	3/11/2021	3/11/2023
	AN02694	Horn Antenna	AMFW-5F-18002650-20-10P	10/26/2021	10/26/2023
	AN02693	Active Horn Antenna	AMFW-5F-12001800-20-10P	10/26/2021	10/26/2023

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	4803.370M	63.0	+1.8 -56.1	+3.7 +32.2	+1.2	+0.4	+0.0	46.2	54.0	-7.8	Horiz
2	9607.880M	55.7	+2.6 -57.0	+5.3 +36.5	+1.7	+0.4	+0.0	45.2	54.0	-8.8	Horiz
3	8450.487M	56.8	+2.5 -57.4	+5.0 +35.4	+1.6	+0.5	+0.0	44.4	54.0	-9.6	Vert
4	7206.790M	57.7	+2.3 -57.1	+4.5 +34.6	+1.5	+0.4	+0.0	43.9	54.0	-10.1	Horiz
5	3816.500M	57.2	+1.6 -56.2	+3.3 +31.5	+1.0	+0.5	+0.0	38.9	54.0	-15.1	Horiz

Test Location:	CKC Laboratories, Inc. • 1120 Fulton Place • Fremont CA 94539 • 510-249-1170		
Customer:	**Tonal**		
Specification:	**15.247(d) / 15.209 Radiated Spurious Emissions**		
Work Order #:	**106246**	Date:	12/10/2021
Test Type:	**Radiated Scan**	Time:	14:14:33
Tested By:	Hieu Song Nguyenpham	Sequence#:	26
Software:	EMITest 5.03.20		

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 4			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 4			

Test Conditions / Notes:

Radiated Spurious Emission

Frequency Range: 9kHz to 1GHz

Environmental Conditions:
Temperature: 22.7°C
Humidity: 45%
Atmospheric Pressure: 101.6kPa

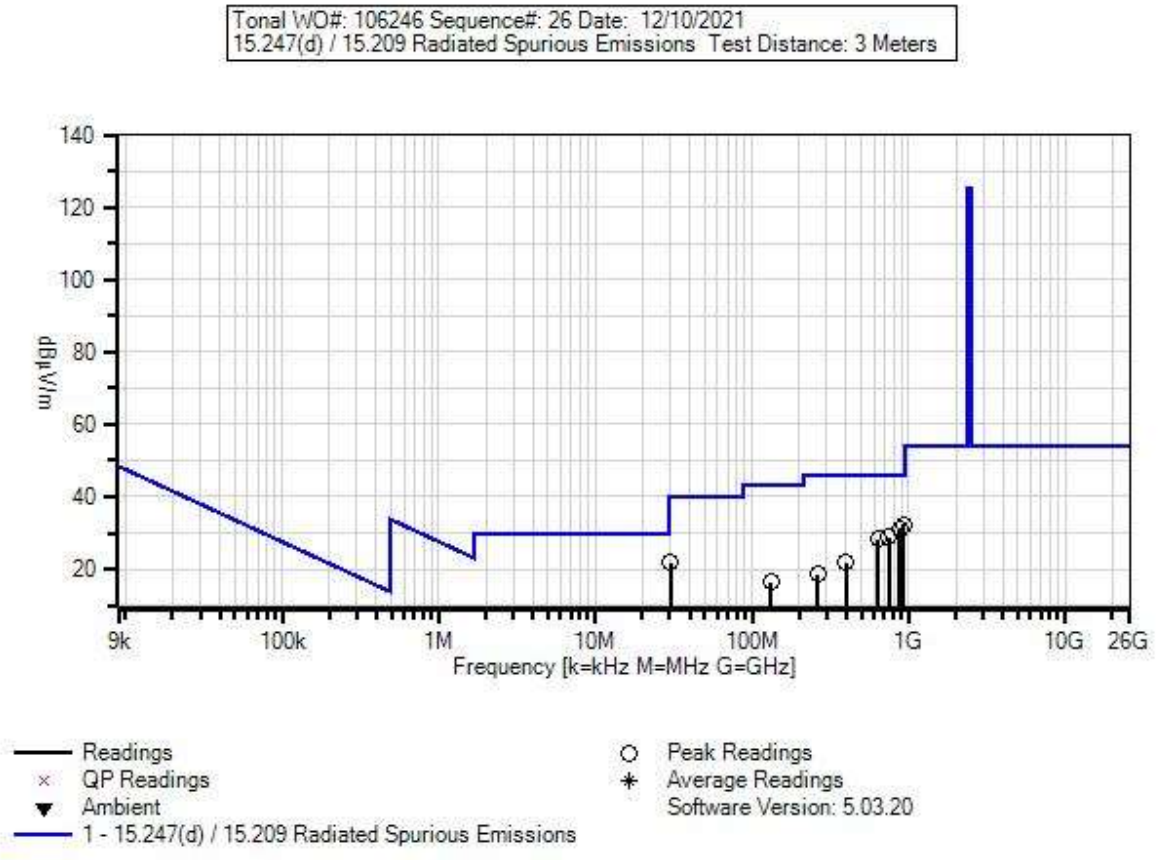
Highest Generated Frequency: 2.48GHz

Method: ANSI C63.10 2013

The EUT is set up as intended.
It is continuously transmitting or receiving during testing.
The EUT is set up in the worst orthogonal.

Note: Middle Channel

No emission has been found from the EUT from 9kHz to 30MHz



Test Equipment:

ID	Asset #/Serial #	Description	Model	Calibration Date	Cal Due Date
T1	ANP07508	Preamp	310N	7/9/2020	7/9/2022
T2	AN00852	Biconilog Antenna	CBL 6111C	4/14/2020	4/14/2022
T3	ANP06049	Attenuator	PE7002-6	5/11/2020	5/11/2022
T4	ANP01187	Cable	CNT-195	7/6/2020	7/6/2022
T5	ANP06691	Cable	PE3062-180	3/25/2020	3/25/2022
T6	ANP06694	Cable	PE3062-480	3/25/2020	3/25/2022
	AN02660	Spectrum Analyzer	E4446A	12/4/2020	12/4/2022
	AN00432	Loop Antenna	6502	7/19/2021	7/19/2023

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	928.190M	28.6	-31.1 +1.3	+23.6 +3.3	+5.9	+0.7	+0.0	32.3	46.0	-13.7	Vert
2	877.981M	28.6	-31.5 +1.2	+23.1 +3.2	+5.9	+0.7	+0.0	31.2	46.0	-14.8	Horiz
3	748.373M	28.4	-32.0 +1.1	+21.8 +2.8	+6.0	+0.6	+0.0	28.7	46.0	-17.3	Horiz
4	641.534M	30.0	-32.0 +1.0	+20.2 +2.6	+5.9	+0.6	+0.0	28.3	46.0	-17.7	Vert
5	30.379M	28.9	-32.1 +0.2	+18.5 +0.4	+5.9	+0.0	+0.0	21.8	40.0	-18.2	Horiz
6	397.956M	28.9	-31.9 +0.7	+15.7 +1.9	+6.0	+0.5	+0.0	21.8	46.0	-24.2	Vert
7	131.543M	29.3	-32.0 +0.4	+11.8 +1.0	+5.9	+0.1	+0.0	16.5	43.5	-27.0	Vert
8	261.648M	29.5	-31.9 +0.6	+12.7 +1.5	+6.0	+0.3	+0.0	18.7	46.0	-27.3	Horiz

Test Location:	CKC Laboratories, Inc. • 1120 Fulton Place • Fremont CA 94539 • 510-249-1170		
Customer:	**Tonal**		
Specification:	**15.247(d) / 15.209 Radiated Spurious Emissions**		
Work Order #:	**106246**	Date:	12/9/2021
Test Type:	**Radiated Scan**	Time:	16:40:28
Tested By:	Hieu Song Nguyenpham	Sequence#:	11
Software:	EMITest 5.03.20		

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 4			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 4			

Test Conditions / Notes:

Radiated Spurious Emission

Frequency Range: 1GHz to 25GHz

Environmental Conditions:
Temperature: 22.7°C
Humidity: 45%
Atmospheric Pressure: 101.6kPa

Highest Generated Frequency: 2.48GHz

Method: ANSI C63.10 2013

The EUT is set up as intended.
It is continuously transmitting or receiving during testing.
The EUT is set up in the worst orthogonal.

Note: Middle Channel

Tonal WO#: 106246 Sequence#: 11 Date: 12/9/2021
15.247(d) / 15.209 Radiated Spurious Emissions Test Distance: 3 Meters

Readings
QP Readings
Ambient
1 - 15.247(d) / 15.209 Radiated Spurious Emissions
Peak Readings
Average Readings
Software Version: 5.03.20

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN03302	Cable	32026-29094K-29094K-72TC	1/9/2020	1/9/2022
T2	ANP01210	Cable	FSJ1P-50A-4A	11/2/2020	11/2/2022
T3	ANP06902	Cable	32022-29094K-29094K-36TC	8/13/2020	8/13/2022
T4	AN03386	High Pass Filter	11SH10-3000/T10000-O/O	4/6/2020	4/6/2022
T5	AN03713	Preamp	01001800-221055-202525	5/24/2021	5/24/2023
	AN02660	Spectrum Analyzer	E4446A	12/4/2020	12/4/2022
	AN03619	Cable	OKOCQoCQ177.2	9/17/2021	9/17/2023
	ANP00928	Cable	various	1/9/2020	1/9/2022
	ANP00929	Cable	various	1/9/2020	1/9/2022
	ANP07699	Cable	32022-29094K-29094K-72TC	10/5/2020	10/5/2022
T6	AN02113	Horn Antenna-ANSI C63.5	3115	3/11/2021	3/11/2023
	AN02694	Horn Antenna	AMFW-5F-18002650-20-10P	10/26/2021	10/26/2023
	AN02693	Active Horn Antenna	AMFW-5F-12001800-20-10P	10/26/2021	10/26/2023

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	4879.630M	63.9	+1.8 -56.1	+3.7 +32.4	+1.2	+0.4	+0.0	47.3	54.0	-6.7	Horiz
2	8415.693M	57.6	+2.5 -57.4	+5.0 +35.4	+1.6	+0.5	+0.0	45.2	54.0	-8.8	Vert
3	7320.690M	57.6	+2.3 -57.2	+4.6 +34.9	+1.5	+0.4	+0.0	44.1	54.0	-9.9	Horiz
4	9759.680M	54.2	+2.6 -57.0	+5.3 +36.6	+1.7	+0.4	+0.0	43.8	54.0	-10.2	Horiz

Test Location:	CKC Laboratories, Inc. • 1120 Fulton Place • Fremont CA 94539 • 510-249-1170		
Customer:	**Tonal**		
Specification:	**15.247(d) / 15.209 Radiated Spurious Emissions**		
Work Order #:	**106246**	Date:	12/10/2021
Test Type:	**Radiated Scan**	Time:	14:42:17
Tested By:	Hieu Song Nguyenpham	Sequence#:	29
Software:	EMITest 5.03.20		

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 4			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 4			

Test Conditions / Notes:

Radiated Spurious Emission

Frequency Range: 9kHz to 1GHz

Environmental Conditions:
Temperature: 22.7°C
Humidity: 45%
Atmospheric Pressure: 101.6kPa

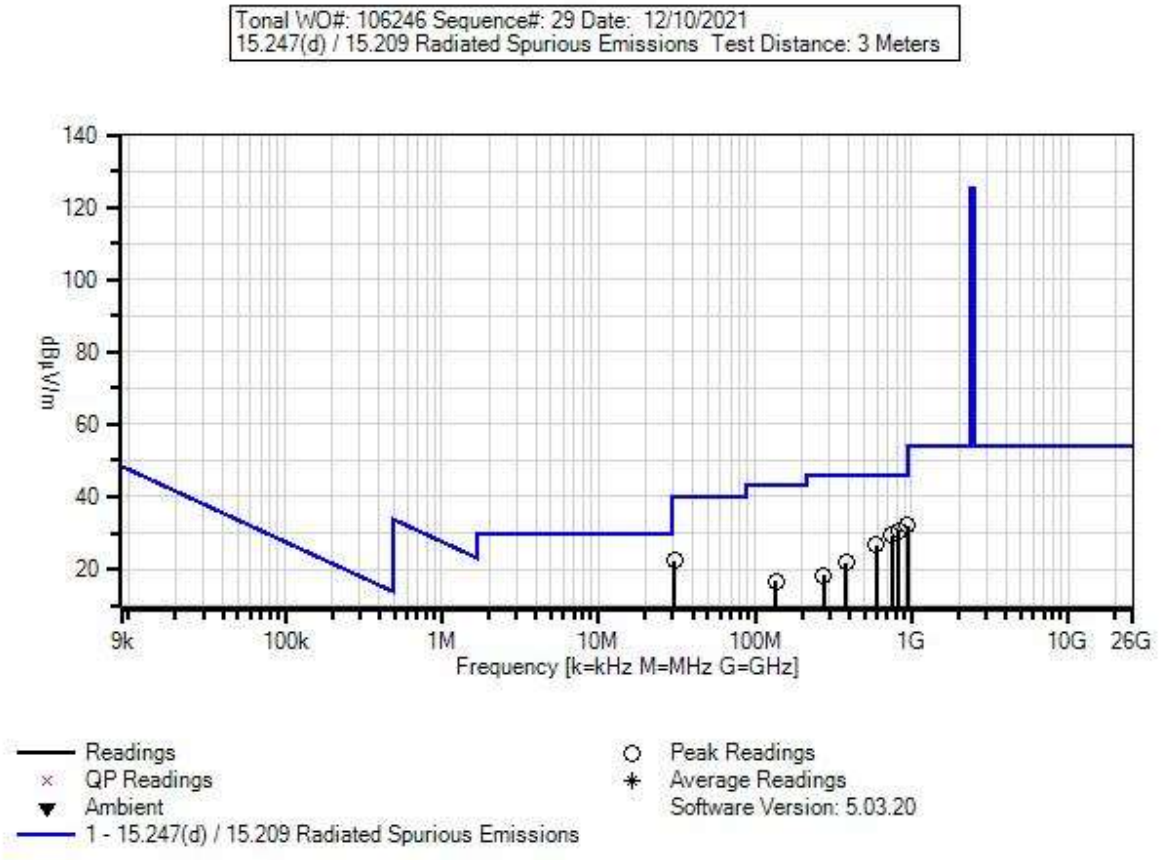
Highest Generated Frequency: 2.48GHz

Method: ANSI C63.10 2013

The EUT is set up as intended.
It is continuously transmitting or receiving during testing.
The EUT is set up in the worst orthogonal.

Note: High Channel

No emission has been found from the EUT from 9kHz to 30MHz



Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	ANP07508	Preamp	310N	7/9/2020	7/9/2022
T2	AN00852	Biconilog Antenna	CBL 6111C	4/14/2020	4/14/2022
T3	ANP06049	Attenuator	PE7002-6	5/11/2020	5/11/2022
T4	ANP01187	Cable	CNT-195	7/6/2020	7/6/2022
T5	ANP06691	Cable	PE3062-180	3/25/2020	3/25/2022
T6	ANP06694	Cable	PE3062-480	3/25/2020	3/25/2022
	AN02660	Spectrum Analyzer	E4446A	12/4/2020	12/4/2022
	AN00432	Loop Antenna	6502	7/19/2021	7/19/2023

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	940.450M	28.1	-31.0 +1.3	+23.7 +3.3	+5.9	+0.7	+0.0	32.0	46.0	-14.0	Vert
2	828.940M	28.8	-31.8 +1.2	+22.7 +3.1	+5.9	+0.7	+0.0	30.6	46.0	-15.4	Horiz
3	745.454M	29.1	-32.0 +1.1	+21.7 +2.8	+6.0	+0.6	+0.0	29.3	46.0	-16.7	Horiz
4	30.547M	29.5	-32.1 +0.2	+18.5 +0.4	+5.9	+0.0	+0.0	22.4	40.0	-17.6	Vert
5	591.909M	29.2	-32.0 +0.9	+19.5 +2.5	+5.9	+0.6	+0.0	26.6	46.0	-19.4	Vert
6	380.219M	29.3	-31.9 +0.7	+15.3 +1.9	+6.0	+0.4	+0.0	21.7	46.0	-24.3	Horiz
7	136.599M	29.4	-32.0 +0.4	+11.7 +1.0	+5.9	+0.2	+0.0	16.6	43.5	-26.9	Horiz
8	274.039M	28.8	-31.9 +0.6	+12.9 +1.6	+6.0	+0.3	+0.0	18.3	46.0	-27.7	Vert

Test Location:	CKC Laboratories, Inc. • 1120 Fulton Place • Fremont CA 94539 • 510-249-1170		
Customer:	**Tonal**		
Specification:	**RSS-247 5.5 / RSS-GEN 8.9 Radiated Spurious Emissions**		
Work Order #:	**106246**	Date:	12/9/2021
Test Type:	**Radiated Scan**	Time:	16:08:33
Tested By:	Hieu Song Nguyenpham	Sequence#:	8
Software:	EMITest 5.03.20		

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 4			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 4			

Test Conditions / Notes:

Radiated Spurious Emission

Frequency Range: 1GHz to 25GHz

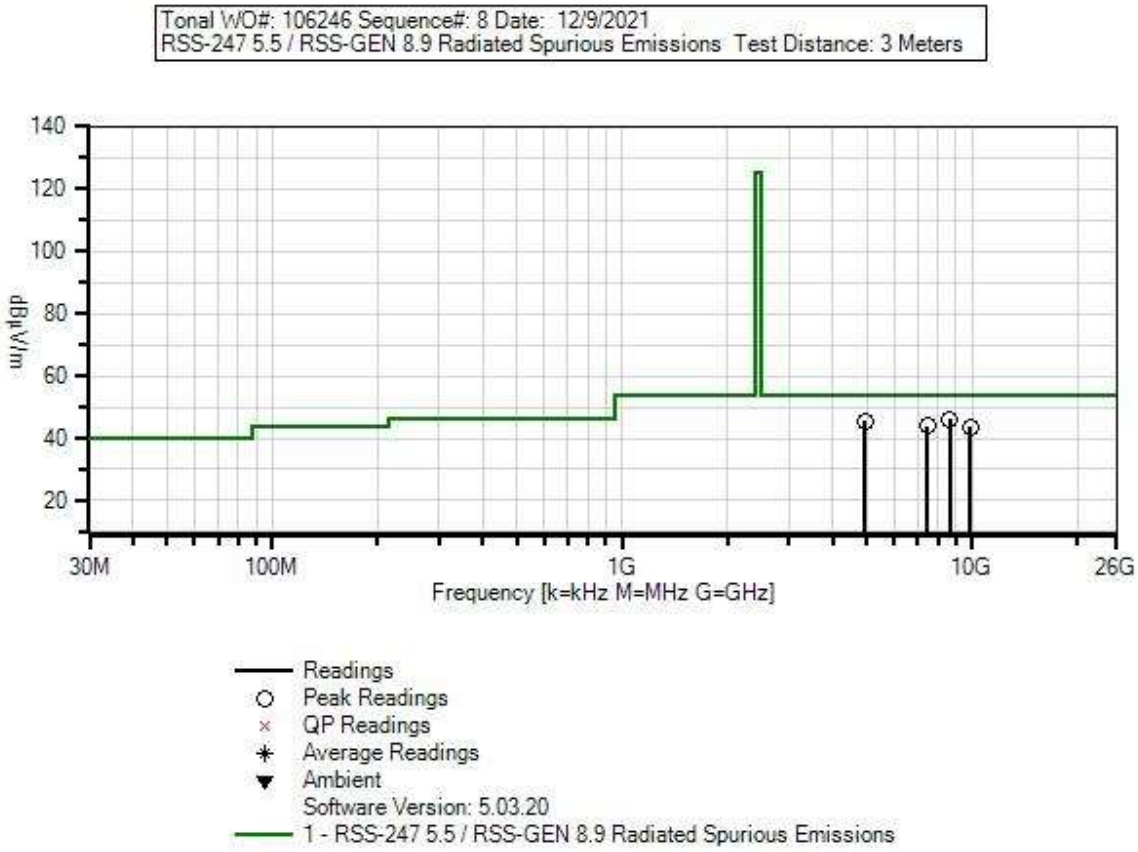
Environmental Conditions:
Temperature: 22.7°C
Humidity: 45%
Atmospheric Pressure: 101.6kPa

Highest Generated Frequency: 2.48GHz

Method: ANSI C63.10 2013

The EUT is set up as intended.
It is continuously transmitting or receiving during testing.
The EUT is set up in the worst orthogonal.

Note: High Channel


Tonal WO#: 106246 Sequence#: 8 Date: 12/9/2021
RSS-247 5.5 / RSS-GEN 8.9 Radiated Spurious Emissions Test Distance: 3 Meters
140
120
100
80
60
40
20
dBµV/m
30M
100M
1G
10G
26G
Frequency [k=kHz M=MHz G=GHz]
Readings
Peak Readings
QP Readings
Average Readings
Ambient
Software Version: 5.03.20
1 - RSS-247 5.5 / RSS-GEN 8.9 Radiated Spurious Emissions

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN03302	Cable	32026-29094K-29094K-72TC	1/9/2020	1/9/2022
T2	ANP01210	Cable	FSJ1P-50A-4A	11/2/2020	11/2/2022
T3	ANP06902	Cable	32022-29094K-29094K-36TC	8/13/2020	8/13/2022
T4	AN03386	High Pass Filter	11SH10-3000/T10000-O/O	4/6/2020	4/6/2022
T5	AN03713	Preamp	01001800-221055-202525	5/24/2021	5/24/2023
	AN02660	Spectrum Analyzer	E4446A	12/4/2020	12/4/2022
	AN03619	Cable	OKOCQoCQ177.2	9/17/2021	9/17/2023
	ANP00928	Cable	various	1/9/2020	1/9/2022
	ANP00929	Cable	various	1/9/2020	1/9/2022
	ANP07699	Cable	32022-29094K-29094K-72TC	10/5/2020	10/5/2022
T6	AN02113	Horn Antenna-ANSI C63.5	3115	3/11/2021	3/11/2023
	AN02694	Horn Antenna	AMFW-5F-18002650-20-10P	10/26/2021	10/26/2023
	AN02693	Active Horn Antenna	AMFW-5F-12001800-20-10P	10/26/2021	10/26/2023

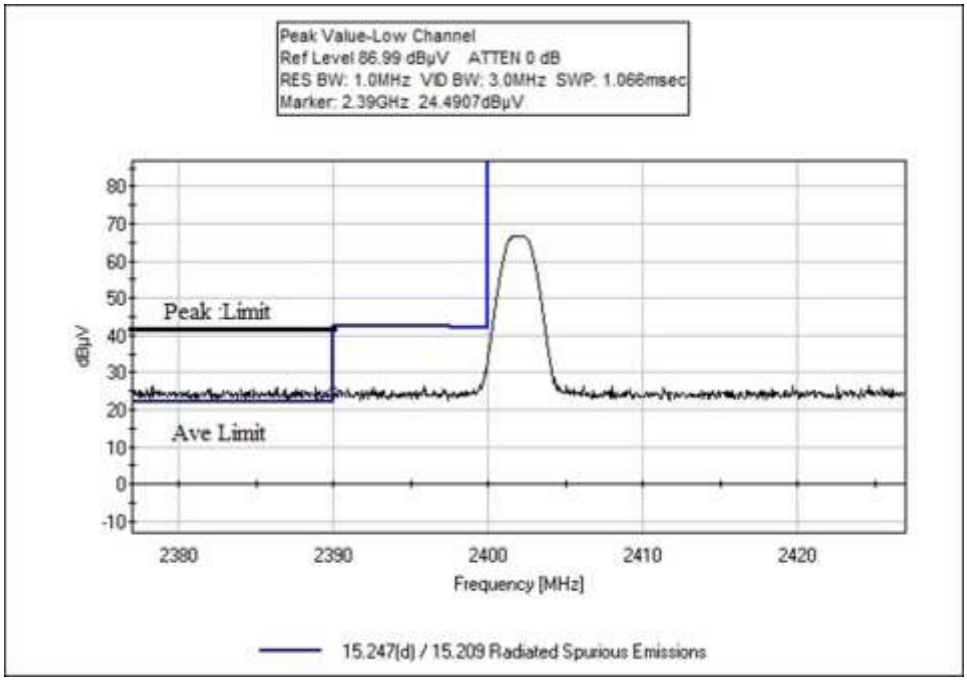
Measurement Data: Reading listed by margin. Test Distance: 3 Meters

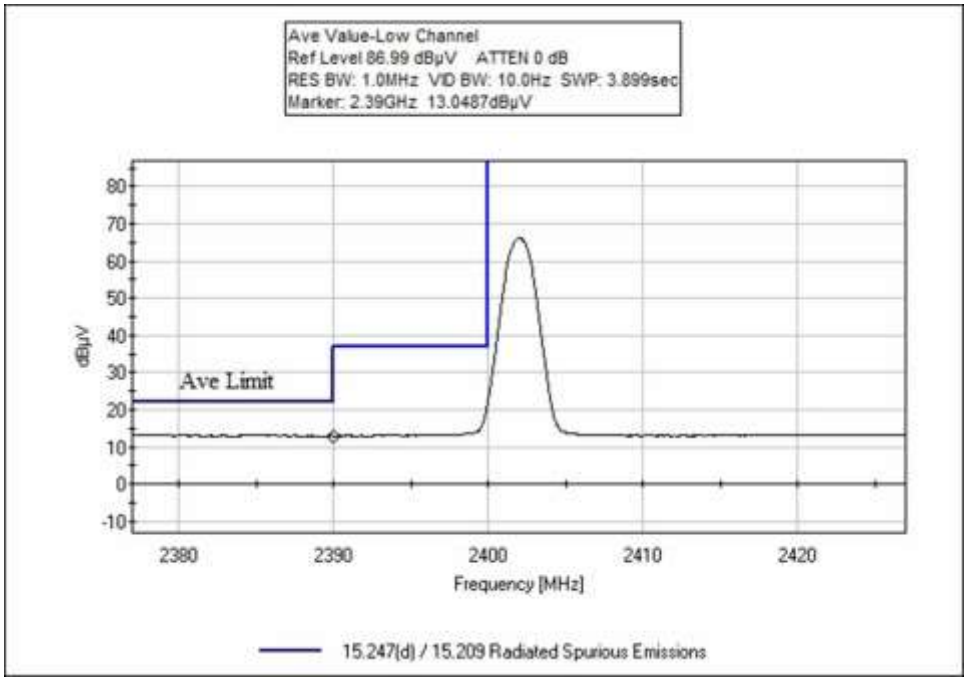
#	Freq	Rdng	T1 T5	T2 T6	T3	T4	Dist	Corr	Spec	Margin	Polar
	MHz	dBµV	dB	dB	dB	dB	Table	dBµV/m	dBµV/m	dB	Ant
1	8652.647M	58.1	+2.5 -57.4	+5.1 +35.6	+1.6	+0.5	+0.0	46.0	54.0	-8.0	Horiz
2	4959.958M	61.8	+1.8 -56.1	+3.8 +32.6	+1.2	+0.4	+0.0	45.5	54.0	-8.5	Horiz
3	7440.720M	57.0	+2.3 -57.3	+4.6 +35.3	+1.5	+0.5	+0.0	43.9	54.0	-10.1	Horiz
4	9920.340M	53.3	+2.7 -56.7	+5.4 +36.7	+1.7	+0.5	+0.0	43.6	54.0	-10.4	Horiz

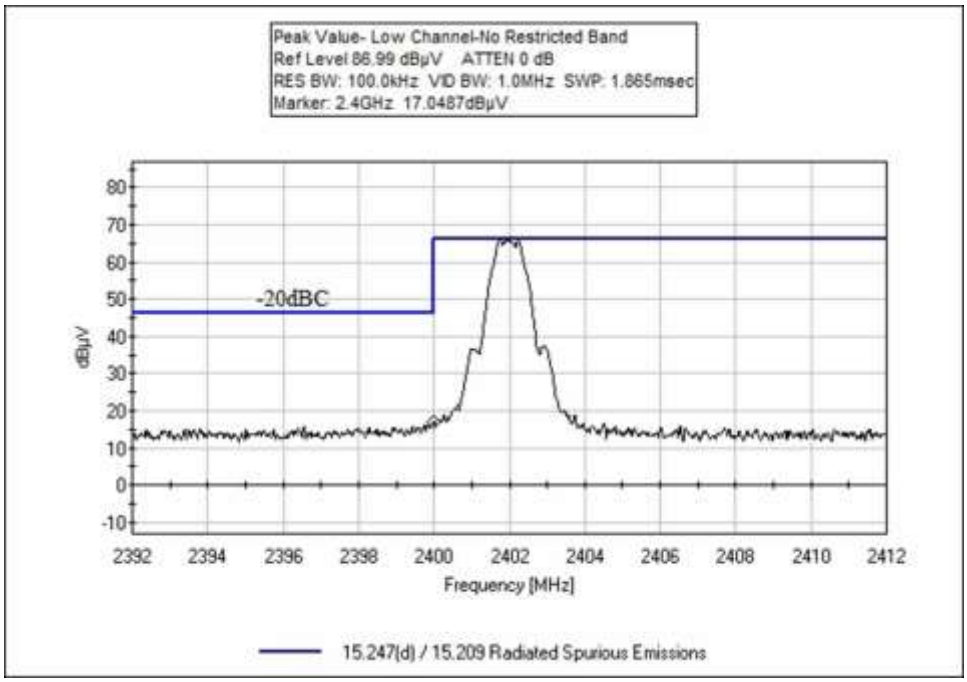
Band Edge

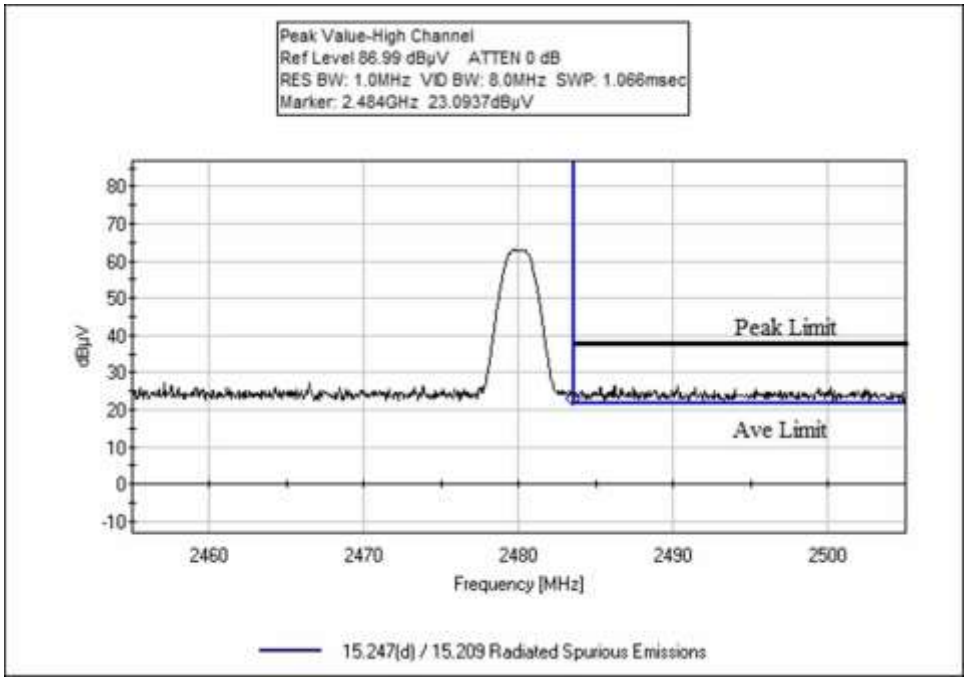
Band Edge Summary					
Frequency (MHz)	Modulation	Ant. Type	Field Strength (dBuV/m @3m)	Limit (dBuV/m @3m)	Results
2390.0	GFSK	Integral	44.8	<54	Pass
2400.0	GFSK	Integral	48.8	<78	Pass
2483.5	GFSK	Integral	45.5	<54	Pass

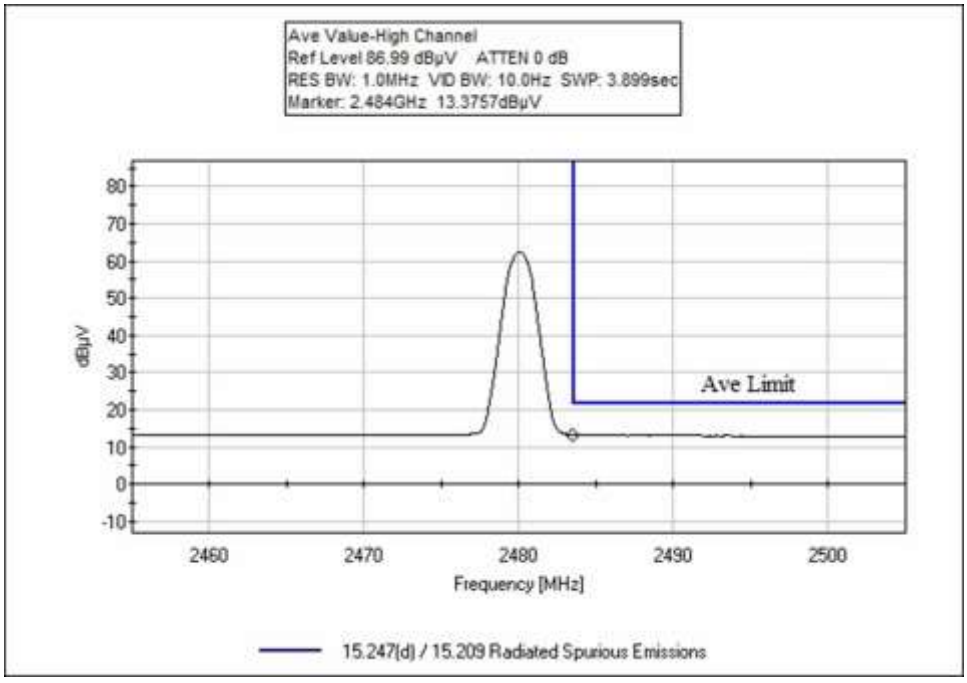
Band Edge Plots




Ave Value-Low Channel
Ref Level 86.99 dBµV ATTEN 0 dB
RES BW: 1.0MHz VID BW: 10.0Hz SWP: 3.899sec
Marker: 2.39GHz 13.0487dBµV
dBµV
Ave Limit
Frequency [MHz]
15.247(d) / 15.209 Radiated Spurious Emissions


Peak Value- Low Channel-No Restricted Band
Ref Level 86.99 dBµV ATTEN 0 dB
RES BW: 100.0kHz VID BW: 1.0MHz SWP: 1.865msec
Marker: 2.4GHz 17.0487dBµV
dBµV
-20dBC
Frequency [MHz]
15.247(d) / 15.209 Radiated Spurious Emissions


Peak Value-High Channel
Ref Level 86.99 dBµV ATTEN 0 dB
RES BW: 1.0MHz VID BW: 8.0MHz SWP: 1.066msec
Marker: 2.484GHz 23.0937dBµV
Peak Limit
Ave Limit
dBµV
Frequency [MHz]
15.247(d) / 15.209 Radiated Spurious Emissions


Ave Value-High Channel
Ref Level 86.99 dBµV ATTEN 0 dB
RES BW: 1.0MHz VID BW: 10.0Hz SWP: 3.899sec
Marker: 2.484GHz 13.3757dBµV
Ave Limit
dBµV
Frequency [MHz]
15.247(d) / 15.209 Radiated Spurious Emissions

Test Setup / Conditions / Data

Test Location:	CKC Laboratories, Inc. • 1120 Fulton Place • Fremont CA 94539 • 510-249-1170		
Customer:	**Tonal**		
Specification:	**Band Edge**		
Work Order #:	**106246**	Date:	12/09/2021
Test Type:	**Radiated Emission**	Time:	
Tested By:	Hieu Song Nguyenpham	Sequence#:	
Software:	EMITest 5.03.19		

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 4			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 4			

Test Conditions / Notes:

Band edge

Environmental Conditions:
Temperature: 22.9°C
Humidity: 43%
Atmospheric Pressure: 101.5kPa

Software: Putty version 0.74

Highest Generated Frequency: 2.48GHz

Method: ANSI C63.10 2013

The EUT is set up as intended.
The EUT is set up in the worst orthogonal.

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
	AN02660	Spectrum Analyzer	E4446A	12/4/2020	12/4/2022
T1	AN03302	Cable	32026-29094K-29094K-72TC	1/9/2020	1/9/2022
T2	ANP01210	Cable	FSJ1P-50A-4A	11/2/2020	11/2/2022
T3	AN01273	Horn Antenna	3115	11/24/2020	11/24/2022

15.247(e) Power Spectral Density

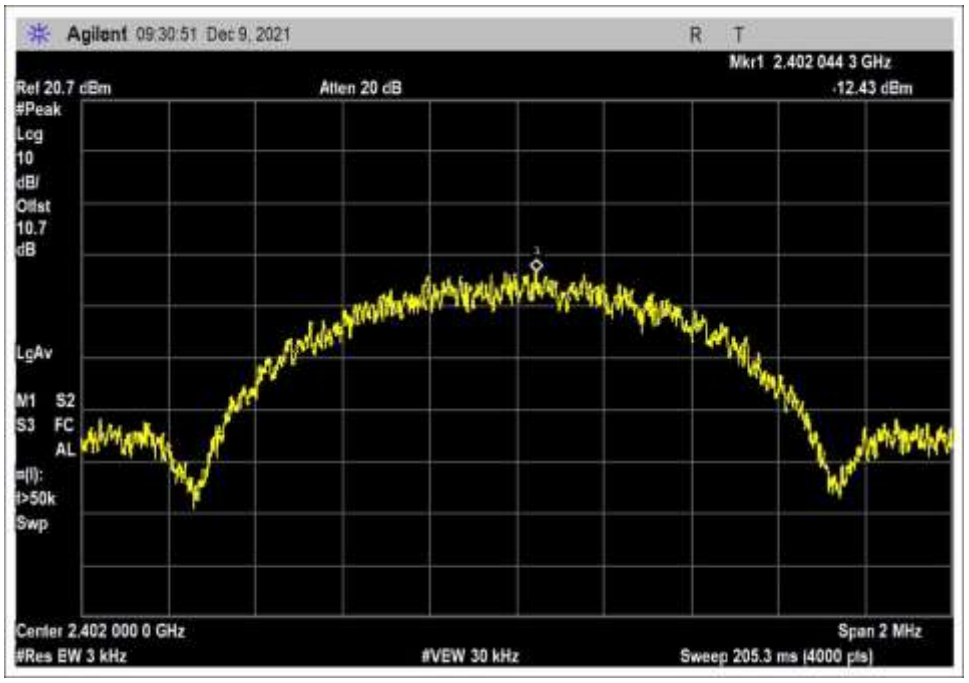
Test Setup / Conditions / Data			
Test Location:	Fremont Lab C3	Test Engineer:	Hieu Song Nguyenpham
Test Method:	ANSI C63.10 (2013), KDB 558074 D01 15.247 Meas Guidance v05r02	Test Date(s):	12/9/2021
Configuration:	3		
Test Setup:	The EUT is placed non-conducted table. The EUT is operated as intended. The EUT is connected straight to a Spectrum Analyzer.		

Environmental Conditions			
Temperature (ºC)	22.3	Relative Humidity (%):	45

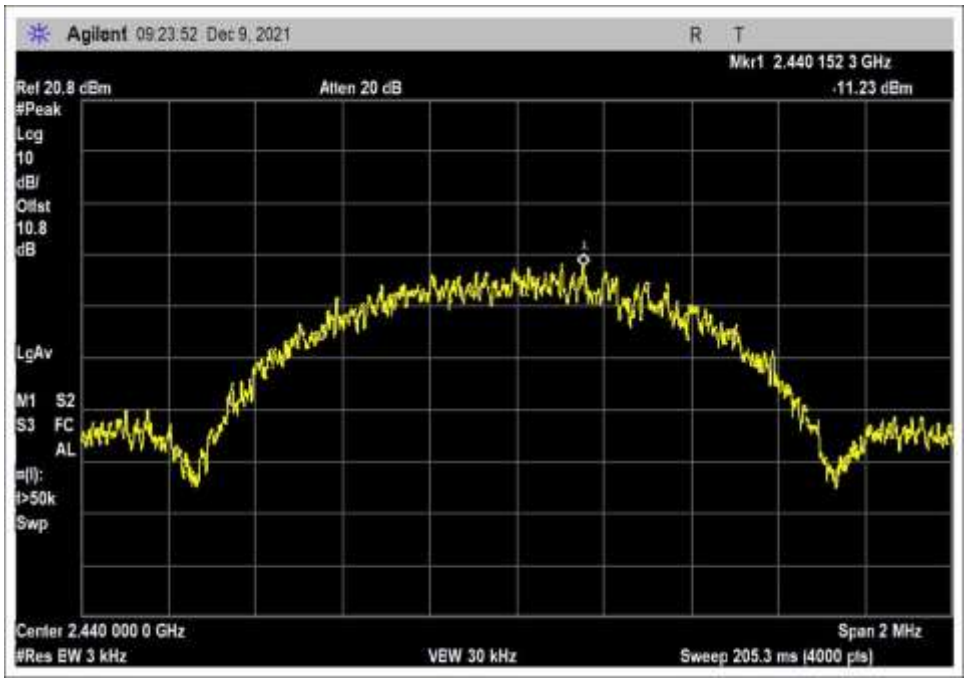
Test Equipment					
Asset#	**Description**	**Manufacturer**	**Model**	**Cal Date**	**Cal Due**
02660	Spectrum Analyzer	Agilent	E4446A	12/4/2020	12/4/2022
03013	Cable	Astrolab	32022-2-2909K-36TC	3/25/2020	3/25/2022
P06239	Attenuator	Weinschel	54A-10	6/17/2020	6/17/2022

PSD Test Data Summary - RF Conducted Measurement				
Measurement Method: PKPSD				
Frequency (MHz)	**Modulation**	**Measured (dBm/3kHz)**	**Limit (dBm/3kHz)**	**Results**
2402	GFSK	-12.43	≤8	Pass
2442	GFSK	-11.23	≤8	Pass
2480	GFSK	-10.36	≤8	Pass

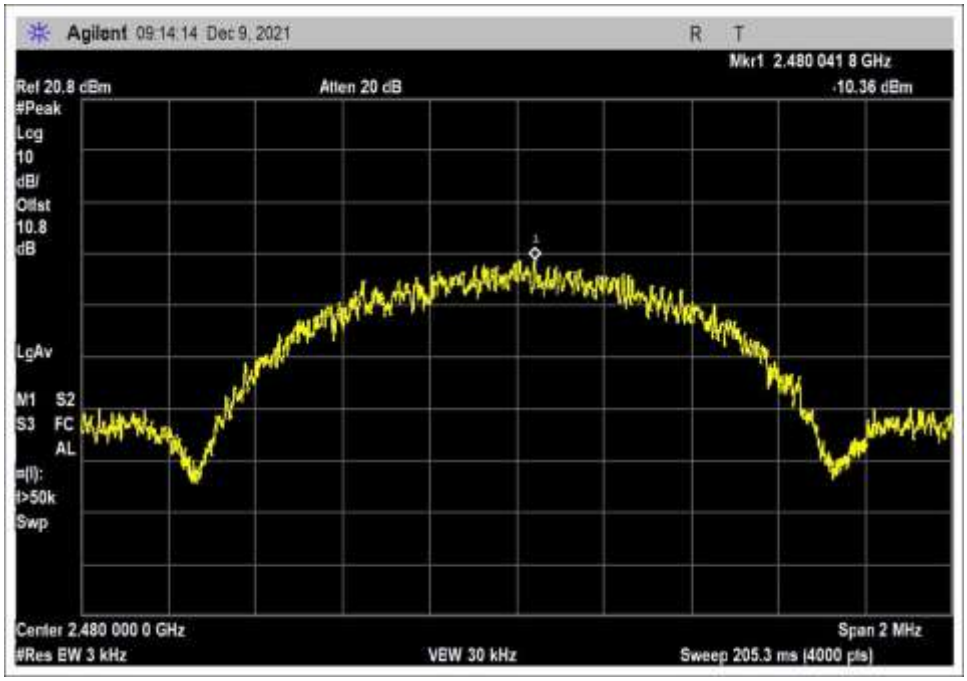
Plots



Low Channel



Middle Channel



High Channel

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.