

KE2 Therm Solutions

TEST REPORT FOR

**SmartEdge Portable Access Point
Model: KE2 Connect**

Tested to The Following Standards:

FCC Part 15 Subpart C Section(s)

**15.207 & 15.247
(DTS 2400-2483.5 MHz)**

Report No.: 99529-18

Date of issue: June 7, 2019



Test Certificate # 803.01

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

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

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ADMINISTRATIVE INFORMATION

Test Report Information

REPORT PREPARED FOR:

KE2 Therm Solutions
209 Lang Dr.
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Representative: Steve Roberts

REPORT PREPARED BY:

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CKC Laboratories, Inc.
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Project Number: 99529

DATE OF EQUIPMENT RECEIPT:

February 4, 2019

DATE(S) OF TESTING:

February 4 and May 16, 2019

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.

A handwritten signature in black ink, reading "Steve Behm", is written over a horizontal line.

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

Test Facility Information



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

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

Software Versions

CKC Laboratories Proprietary Software	Version
EMITest Emissions	5.03.12

Site Registration & Accreditation Information

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

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

SUMMARY OF RESULTS

Standard / Specification: FCC Part 15 Subpart C - 15.247 (DTS)

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

NA = Not Applicable

NP = CKC Laboratories was not contracted to perform test.

* Bandedge is the non-compliant item as determined from surveillance testing. Radiated spurious emission was evaluated during surveillance testing and found to maintain compliance.

** Power Spectral Density from original testing under original grantee FCID: 2AFIW-AR300M indicate margin of 13dB or better, hence not selected for reevaluation as compared to the amount of non-compliance margin during surveillance testing.

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

Report prepared for PC II equipment authorization. 802.11n40 with reduced firmware power setting from 14dBm to 10dBm.

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
5V DC Power Supply	CUI Inc.	SW15-5-N-138	NA
SmartEdge Portable Access Point	KE2 Connect	KE2 Connect	NA

Support Equipment:

Device	Manufacturer	Model #	S/N
Laptop	Lenovo	Thinkpad	NA

General Product Information:

Product Information	Manufacturer-Provided Details
Equipment Type:	Stand-Alone Equipment
Type of Wideband System:	802.11n40 (for this report)
Operating Frequency Range:	2422-2452MHz
Modulation Type(s):	OFDM
Maximum Duty Cycle:	99%
Number of TX Chains:	2
Antenna Type(s) and Gain:	External 2dBi
Beamforming Type:	NA
Antenna Connection Type:	External Connector
Nominal Input Voltage:	5Vdc
Firmware / Software used for Test:	Atheros Radio test (ART2-GUI) version 2.3

FCC Part 15 Subpart C

15.247(b)(3) Output Power

Test Setup / Conditions			
Test Location:	Brea Lab A	Test Engineer:	E. Wong
Test Method:	ANSI C63.10 (2013), KDB 558074 v05r02 April 2, 2019	Test Date(s):	5/16/2019
Configuration:	1		
Test Setup:	The EUT seeking PCII equipment authorization is place on test bench LAN is connected to remote laptop for configuration of continuous transmit test mode. Changes from original certification: Depopulation of 5745-5825MHz radio. Metal enclosure and two external antennae. Antenna gain 2 dBi. 802.11 n40 2422MHz, 2437MHz, 2452MHz Note: The software setting on support laptop is adjusted by 10MHz to set the measured center frequency. Test software setting Max TX power set: 10dBm (reduced from original testing of 14 dBm to 10dBm to maintain continuous compliance.) 802.11n40: 10 , 10 Gain set: not selected. Frequency range of measurement = Fundamental Simultaneous transmission from Chain1 and Chain2. Site A ANSI C63.10-2013		

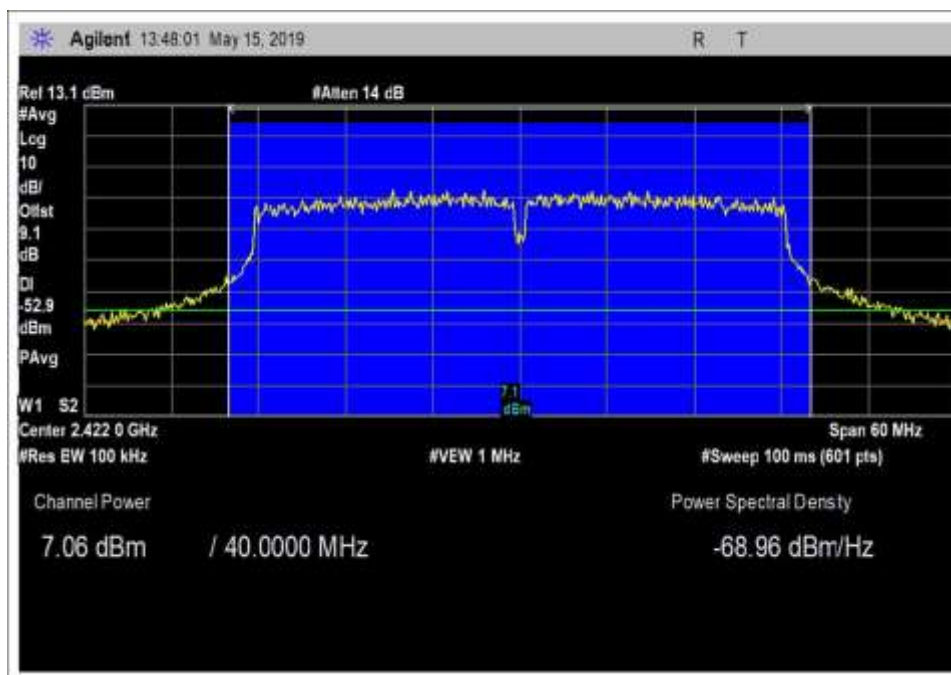
Environmental Conditions			
Temperature (°C)	24	Relative Humidity (%):	55

Test Equipment					
Asset#	Description	Manufacturer	Model	Cal Date	Cal Due
02672	Spectrum Analyzer	Agilent	E4446A	3/13/2019	3/13/2021
AN03430	Attenuator	Aeroflex/Weinschel	75A-10-12	12/19/2017	12/19/2019
P07244	Cable	H&S	32022-29094K-29094K-24TC	7/5/2018	7/5/2020

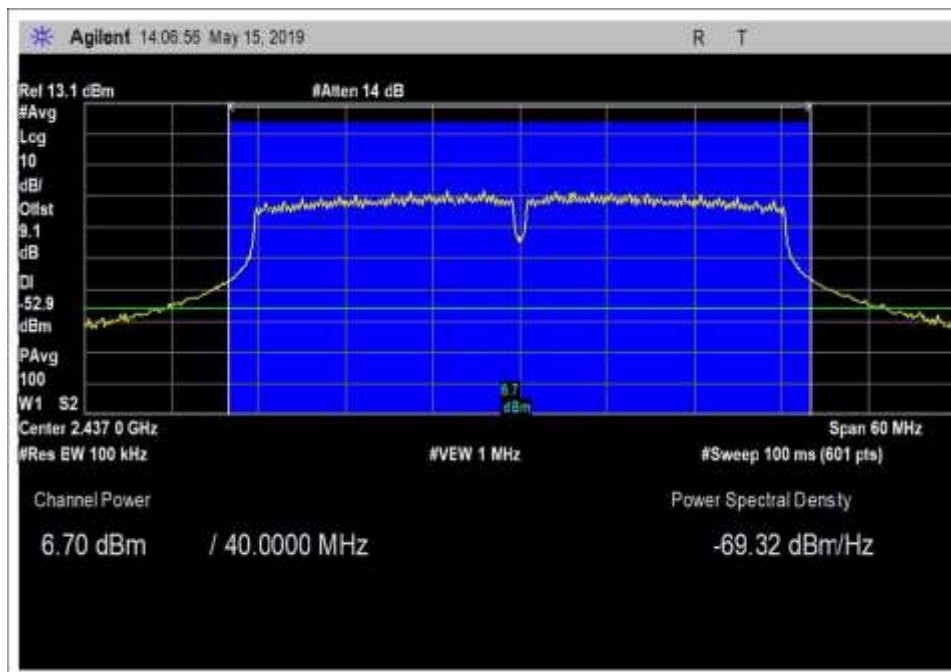
Test Data Summary - RF Conducted Measurement					
Measurement Option: AVGSA-1					
Frequency (MHz)	Modulation	Ant. Type / Gain (dBi)	Measured (dBm)	Limit (dBm)	Results
Chain 1					
2422	802.11n40	External 2dBi	7.06	≤ 30	Pass
2437	802.11n40	External 2dBi	6.70	≤ 30	Pass
2452	802.11n40	External 2dBi	6.22	≤ 30	Pass
Chain 2					
2422	802.11n40	External 2dBi	7.67	≤ 30	Pass
2437	802.11n40	External 2dBi	7.59	≤ 30	Pass
2452	802.11n40	External 2dBi	7.16	≤ 30	Pass
Chain 1 + Chain2					
2422	802.11n40	External 2dBi	10.39*	≤ 30	Pass
2437	802.11n40	External 2dBi	10.18*	≤ 30	Pass
2452	802.11n40	External 2dBi	9.73*	≤ 30	Pass

* Linearly summed Firmware power setting =10dBm

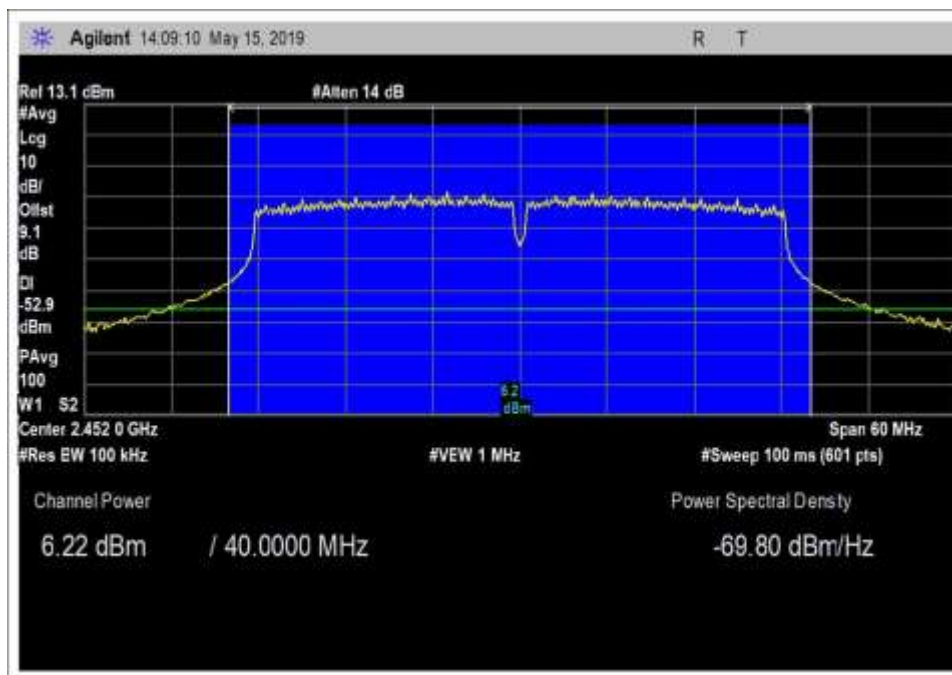
Plots



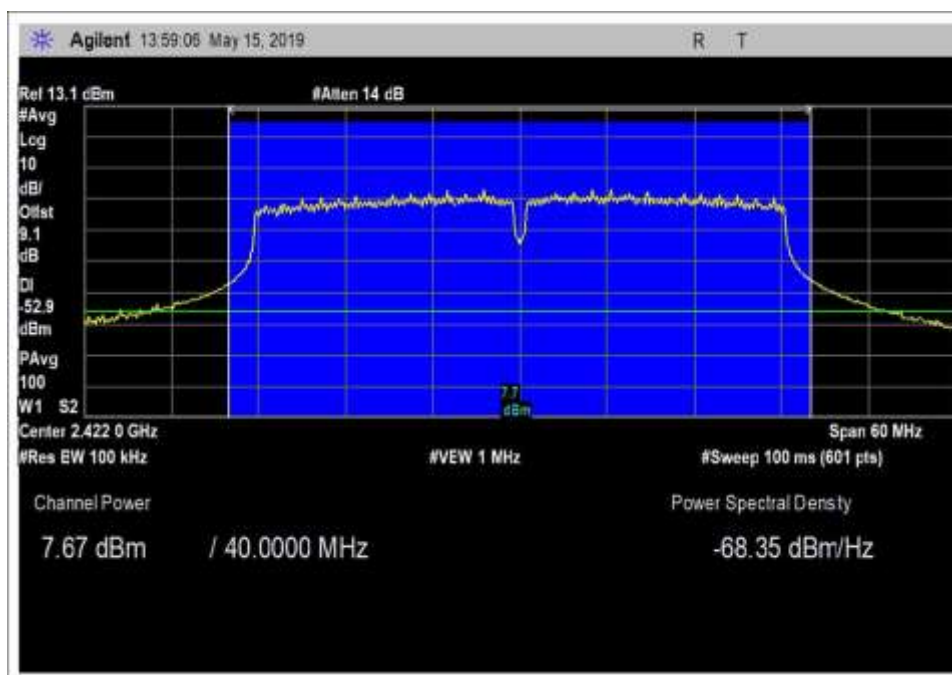
Chain 1, Pset 10dBm



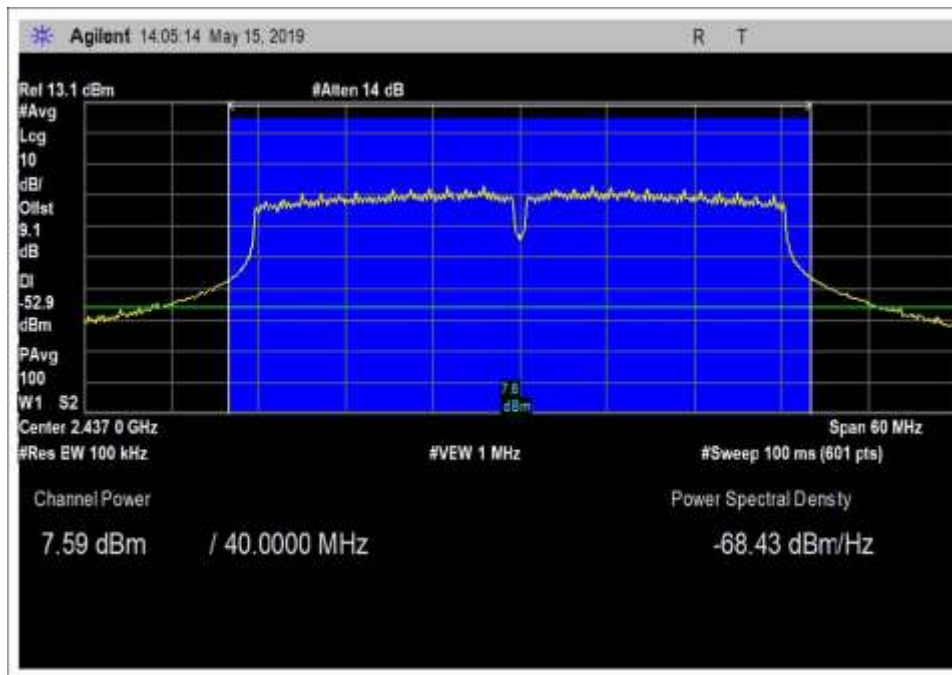
Chain 1, Pset 10dBm



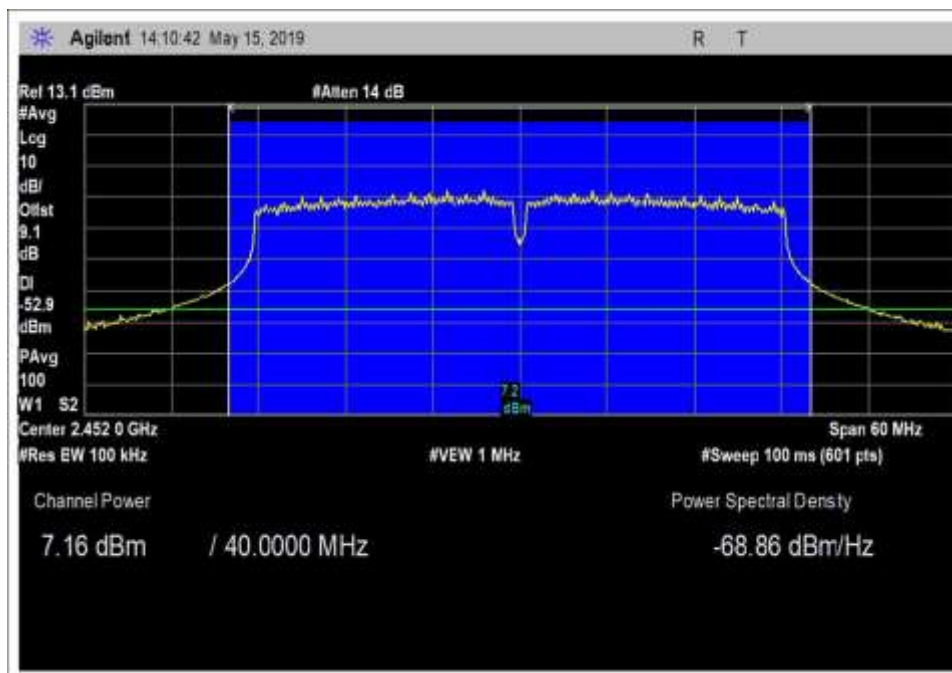
Chain 1, Pset 10dBm



Chain 2, Pset 10dBm



Chain 2, Pset 10dBm



Chain 2, Pset 10dBm

Test Setup Photo(s)



15.247(d) Radiated Emissions & Band Edge

Test Setup/Conditions

Test Location:	Brea Lab A	Test Engineer:	E .Wong
Test Method:	ANSI C63.10 (2013), KDB 558074	Test Date(s):	2/4/2019
Configuration:	1		
Declaration:	Spurious emission was evaluated during surveillance testing and found to be in compliant.		

Environmental Conditions

Temperature (°C)	24	Relative Humidity (%):	55
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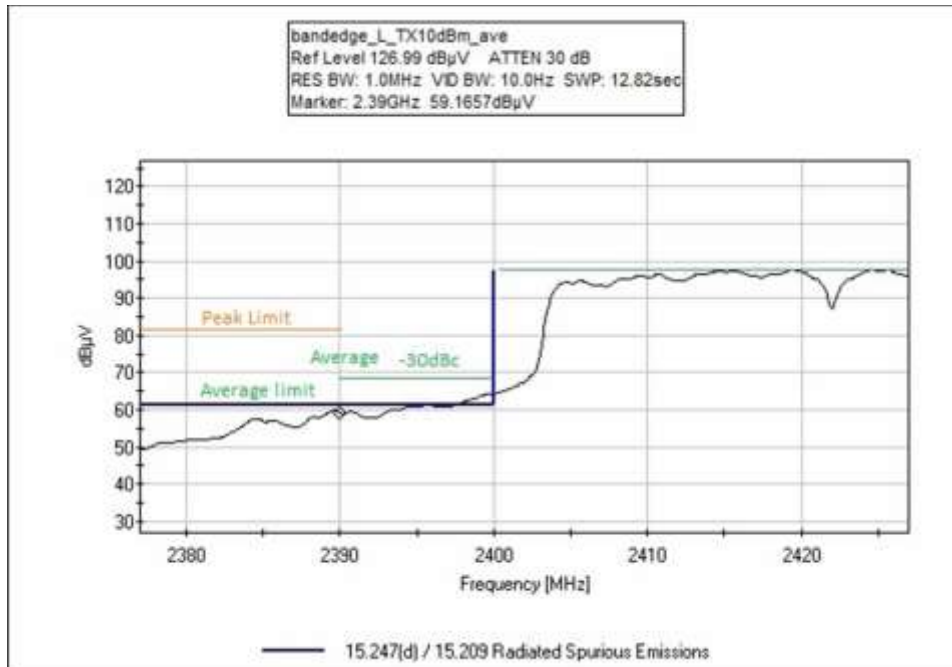
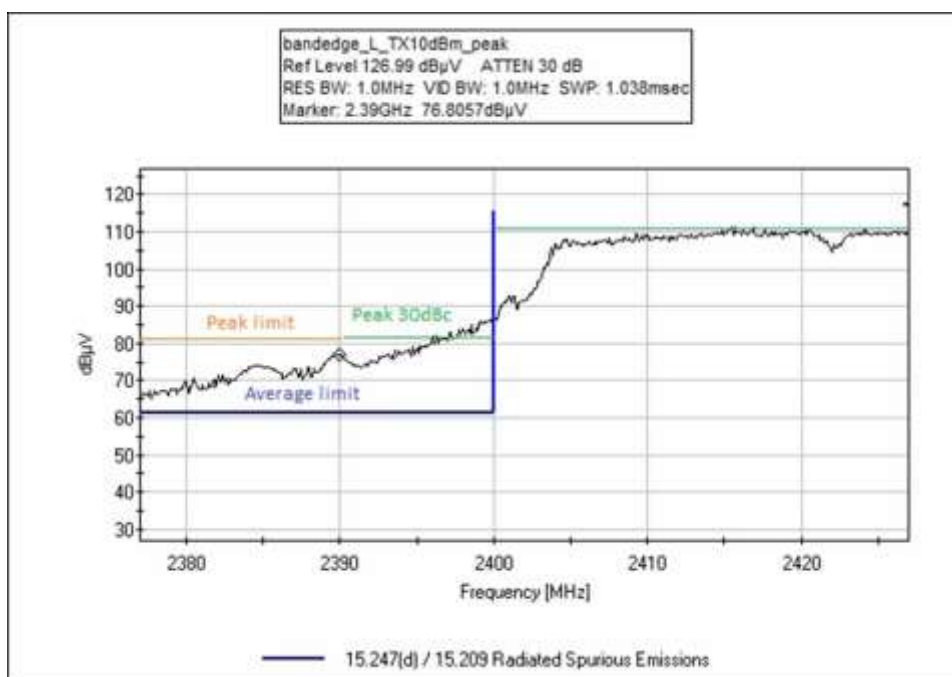
Band Edge

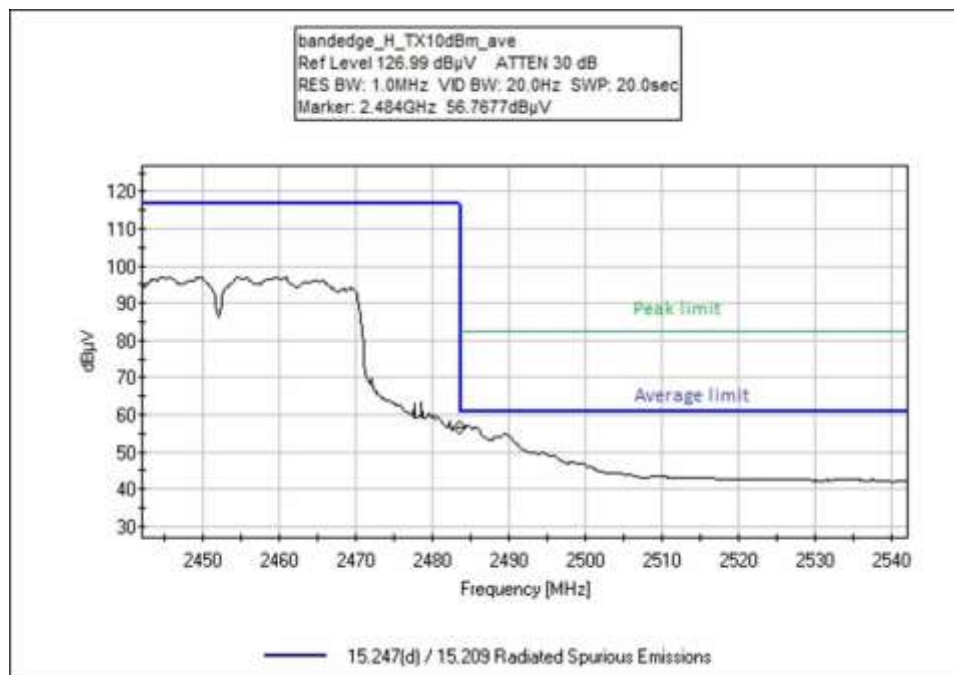
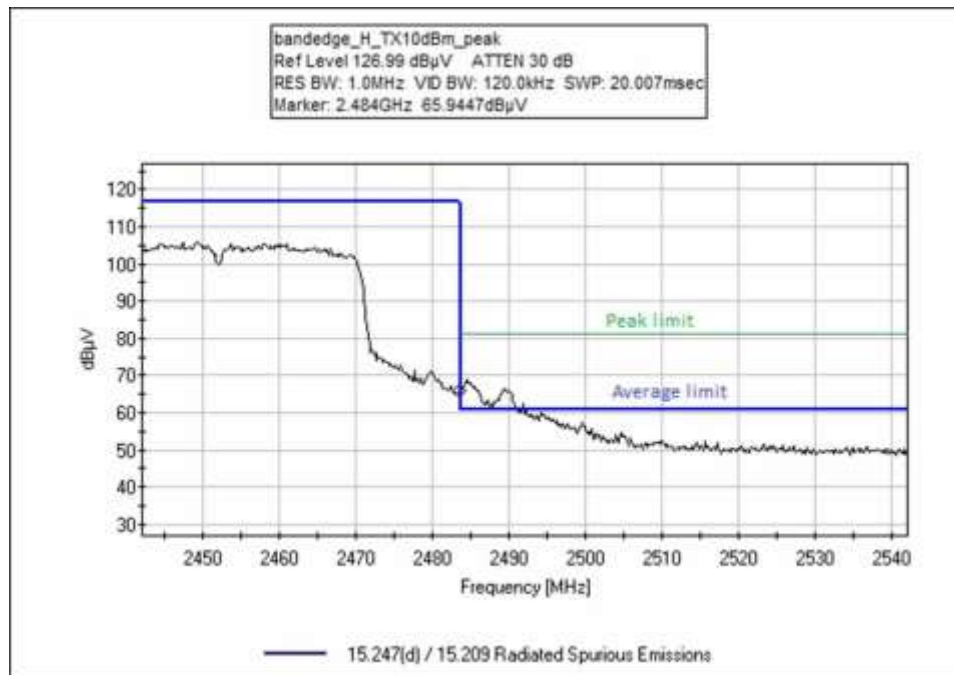
Band Edge Summary

Frequency (MHz)	Modulation	Ant. Type	Field Strength (dBuV/m @3m)	Limit (dBuV/m @3m)	Results
2390.0	802.11n40	External 2dBi	52.2	<54	Pass
2483.5	802.11n40	External 2dBi	50.2	<54	Pass

Worst case emission as evaluated during surveillance testing.

Band Edge Plots





Test Setup / Conditions / Data

Test Location: CKC Laboratories, Inc. • 110 N. Olinda Place • Brea, CA 92821 • 714 993 6112
 Customer: **KE2 Connect**
 Specification: **15.247(d) / 15.209 Radiated Spurious Emissions**
 Work Order #: **99529** Date: 3/4/2019
 Test Type: **Radiated Scan** Time: 19:07:00
 Tested By: E. Wong Sequence#: 5
 Software: EMITest 5.03.12

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

Test Conditions / Notes:

The EUT seeking PCII equipment authorization is placed on Styrofoam block. Antennas set in vertical position as intended.

WAN, USB, RS485 are connected to section of cable.
 LAN is connected to remote laptop for configuration of continuous transmit test mode.

Changes from original certification:
 Depopulation of 5745-5825MHz radio.
 Metal enclosure and two external antennae.
 Antenna gain 2 dBi.

802.11 n40
 2422MHz, 2452MHz
 Note: The software setting on support laptop is adjusted by 10MHz to set the measured center frequency. (set to 2442 MHz to transmit at 2452MHz)

Test software setting
 Max TX power set reduced from original testing at 14 dBm to 10dBm to maintain bandedge compliance.

802.11n40: 10 , 10
 Gain set: not selected.

Frequency range of measurement = 1-18GHz base on preliminary test data.
 1000 MHz-18000 MHz; RBW=1 MHz,VBW=1 MHz.

Test environment conditions:
 Temperature: 24°C, Relative Humidity: 55 %, Pressure: 100kPa

Site A
 ANSI C63.10-2013
 Surveillance testing. The test data represents worst case emissions for the investigated operational modes. All other protocols was evaluated separately with power setting unchanged and reported in Surveillance testing report.

KE2 Connect W/O#: 99529 Sequence#: 5 Date: 3/4/2019
15.247(d) / 15.209 Radiated Spurious Emissions Test Distance: 3 Meters Vert



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

○ Peak Readings
* Average Readings
Software Version: 5.03.12

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
	AN02869	Spectrum Analyzer	E4440A	8/10/2018	8/10/2019
T1	AN00849	Horn Antenna	3115	3/14/2018	3/14/2020
T2	ANP07246	Cable	32022-29094K-29094K-24TC	7/5/2018	7/5/2020
T3	AN00786	Preamplifier	83017A	5/12/2018	5/12/2020
T4	ANP07139	Cable	ANDL1-PNMNM-48	3/4/2019	3/4/2021

Measurement Data:

Reading listed by margin.

Test Distance: 3 Meters

#	Freq MHz	Rdng dBμV	T1 dB	T2 dB	T3 dB	T4 dB	Dist Table	Corr dBμV/m	Spec dBμV/m	Margin dB	Polar Ant
1	2390.000M Ave	59.2	+28.3	+0.3	-38.7	+3.1	+0.0	52.2	54.0 banedge_802.11n40_L_MCS11_10dBm	-1.8	Vert
^	2390.000M	76.7	+28.3	+0.3	-38.7	+3.1	+0.0	69.7	54.0 banedge_802.11n40_L_MCS11_10dBm	+15.7	Vert
3	2483.500M Ave	56.9	+28.5	+0.3	-38.7	+3.2	+0.0	50.2	54.0 banedge_802.11n40_H_MCS11_10dBm	-3.8	Vert
^	2483.500M	65.4	+28.5	+0.3	-38.7	+3.2	+0.0	58.7	54.0 banedge_802.11n40_H_MCS11_10dBm	+4.7	Vert

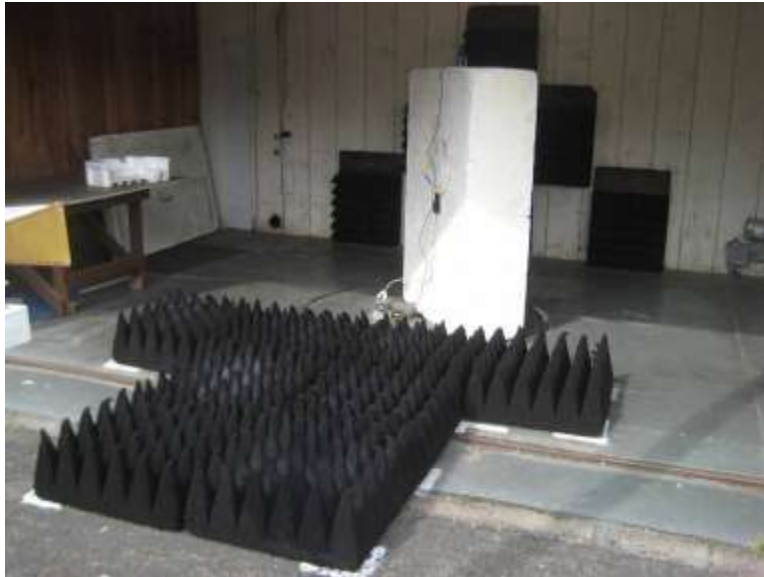
Test Setup Photo(s)



Below 1 GHz



Below 1 GHz



Above 1 GHz



Above 1GHz

SUPPLEMENTAL INFORMATION

Measurement Uncertainty

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

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

Emissions Test Details

TESTING PARAMETERS

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

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

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

CORRECTION FACTORS

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

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

TEST INSTRUMENTATION AND ANALYZER SETTINGS

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

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

SPECTRUM ANALYZER/RECEIVER DETECTOR FUNCTIONS

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

Peak

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

Quasi-Peak

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

Average

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