RF Exposure Evaluation Declaration

FCC ID:	2ABLK-844E-1
APPLICANT:	Calix Inc.
Application Type:	Certification
Product:	WiFi Concurrent 4 Port GE LAN VoIP Ethernet Gateway with USB
Model No.:	844E-1
Trademark:	Calix
FCC Classification:	Digital Transmission System (DTS) Unlicensed National Information Infrastructure (UNII)

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ACCREDITED
TESTING LABORATORY
CERTIFICATE #3628.01

Revision History

Report No.	Version	Description	Issue Date
1501RSU00604	Rev. 01	Initial report	03-21-2015

1. PRODUCT INFORMATION

1.1. Equipment Description

Product Name	WiFi Concurrent 4 Port GE LAN VoIP Ethernet Gateway with USB
Model No.	844E-1
Frequency Range	**For 2.4GHz Band:** 802.11b/g/n-HT20: 2412 ~ 2462MHz 802.11n-HT40: 2422 ~ 2452MHz **For 5GHz Band:** For 802.11a/n-HT20: 5180~5320MHz, 5500~5700MHz, 5745~5825MHz For 802.11ac-VHT20: 5180~5320MHz, 5500~5720MHz, 5745~5825MHz For 802.11n-HT40: 5190~5310MHz, 5510~5670MHz, 5755~5795MHz For 802.11ac-VHT40: 5190~5310MHz, 5510~5710MHz, 5755~5795MHz For 802.11ac-VHT80: 5210MHz, 5290MHz, 5530MHz, 5610MHz, 5690MHz, 5775MHz
Type of Modulation	802.11b: DSSS 802.11g/a/n/ac: OFDM
Maximum Average Output Power	**For 2.4GHz Band:** 802.11b: 22.26dBm 802.11g: 22.37dBm 802.11n-HT20: 26.22dBm 802.11n-HT40: 23.87dBm **For 5GHz Band:** 802.11a: 26.97dBm 802.11n-HT20: 26.83dBm 802.11n-HT40: 27.19dBm 802.11ac-VHT20: 27.20dBm 802.11ac-VHT40: 27.16dBm 802.11ac-VHT80: 24.87dBm

1.2. Antenna Description

Antenna Type	Frequency Band (GHz)	T_X Paths	Directional Gain (dBi)		
			Non Beam Forming	Beam Forming	CDD
PCB Antenna	2.4	2	1.90	--	--
	5.2	4	2.17	8.04	8.04
	5.3	4	2.03	7.78	7.78
	5.6	4	2.55	8.38	8.38
	5.8	4	2.70	8.70	8.70

Note:

1. Transmit at 2.4GHz support two antennas, and support four antennas at 5GHz transmit.
2. The EUT working on Beam Forming mode, and the Beam Forming support 802.11n/ac, not include 802.11a, and 802.11a working on CDD mode.
3. Correlated signals include, but are not limited to, signals transmitted in any of the following modes:
   - Any transmit Beam Forming mode, whether fixed or adaptive (e.g., phased array modes, closed loop MIMO modes, Transmitter Adaptive Antenna modes, Maximum Ratio Transmission (MRT) modes, and Statistical Eigen Beam Forming (EBF) modes).
4. Unequal antenna gains, with equal transmit powers. For antenna gains given by G_1, G_2, …, G_N dBi
   - transmit signals are correlated, then
   - Directional gain = 10 log[$(10^{G1/20} + 10^{G2/20} + \ldots + 10^{GN/20})^2/N_{ANT}$] dBi [Note the “20”s in the denominator of each exponent and the square of the sum of terms; the object is to combine the signal levels coherently.]

2. RF Exposure Evaluation

2.1. Limits

According to FCC 1.1310: The criteria listed in the following table shall be used to evaluate the environment impact of human exposure to radio frequency (RF) radiation as specified in 1.1307(b)

LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Average Time (Minutes)
(A) Limits for Occupational/ Control Exposures				
300-1500	--	--	f/300	6
1500-100,000	--	--	5	6
(B) Limits for General Population/ Uncontrolled Exposures				
300-1500	--	--	f/1500	6
1500-100,000	--	--	1	30

f= Frequency in MHz

Calculation Formula: Pd = (Pout*G)/(4*pi*r2)

Where
Pd = power density in mW/cm2
Pout = output power to antenna in mW
G = gain of antenna in linear scale
Pi = 3.1416
r = distance between observation point and center of the radiator in cm

Pd is the limit of MPE, $1mW/cm^2$. If we know the maximum gain of the antenna and the total power input to the antenna, through the calculation, we will know the distance r where the MPE limit is reached.

2.2. Test Result of RF Exposure Evaluation

Product	WiFi Concurrent 4 Port GE LAN VoIP Ethernet Gateway with USB
Test Item	RF Exposure Evaluation

Antenna Gain: The maximum Gain measured in fully anechoic chamber is 1.90dBi for 2.4GHz, 8.04dBi for 5.2GHz, 7.78dBi for 5.3GHz, 8.38dBi for 5.6GHz and 8.70dBi for 5.80GHz in logarithm scale.

For 2.4GHz ISM Band:

Test Mode	Frequency Band (MHz)	Maximum Average Output Power (dBm)	Power Density at R = 20 cm (mW/cm^2)	Limit (mW/cm^2)
802.11b	2412 ~ 2462	22.26	0.0518	1
802.11g	2412 ~ 2462	22.37	0.0532	1
802.11n-HT20	2412 ~ 2462	26.22	0.1290	1
802.11n-HT40	2422 ~ 2452	23.87	0.0751	1

For 5GHz UNII Band:

Test Mode	Frequency Band (MHz)	Maximum Average Output Power (dBm)	Power Density at R = 20 cm (mW/cm^2)	Limit (mW/cm^2)
802.11a	5180 ~ 5240	23.76	0.3011	1
	5260 ~ 5320	20.87	0.1458	1
	5500 ~ 5700	21.12	0.1773	1
	5725 ~ 5825	26.97	0.7341	1
802.11n-HT20	5180 ~ 5240	23.92	0.3124	1
	5260 ~ 5320	20.88	0.1461	1
	5500 ~ 5700	21.24	0.1823	1
	5725 ~ 5825	26.83	0.7108	1
802.11n-HT40	5190 ~ 5230	24.11	0.3264	1
	5270 ~ 5310	21.13	0.1548	1
	5510 ~ 5670	21.23	0.1819	1
	5755 ~ 5795	27.19	0.7722	1

802.11ac-VHT20	5180 ~ 5240	23.99	0.3175	1
	5260 ~ 5320	21.10	0.1537	1
	5500 ~ 5720	21.16	0.1789	1
	5725 ~ 5825	27.20	0.7740	1
802.11ac-VHT40	5190 ~ 5230	24.31	0.3418	1
	5270 ~ 5310	21.15	0.1555	1
	5510 ~ 5710	21.27	0.1835	1
	5755 ~ 5795	27.16	0.7669	1
802.11ac-VHT80	5210	16.25	0.0534	1
	5290	18.84	0.0914	1
	5530 ~ 5690	21.04	0.1741	1
	5775	24.87	0.4526	1

CONCULISON:

Both of the WLAN 2.4GHz Band and WLAN 5GHz Band can transmit simultaneously. Therefore, the Max Power Density at R (20 cm) = 0.1290mW/cm^2+ 0.7740mW/cm^2 = 0.9030mW/cm^2 < 1mW/cm^2.

So the EUT complies with the requirement.

The End