EDCS – 21541326

Maximum Permissible Exposure Study - Engineering Analysis

C9124AXI-B, C9124AXD-B

Cisco Catalyst C9124AX Series 802.11ax Access Point

FCC ID: LDK-HTIAK2282

2400-2483.5 MHz, 5150-5250 MHz,

5250-5350 MHz, 5470-5725 MHz, 5725-5850 MHz

Against the following Specifications:
47 Code of Federal Regulations 2.1091

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This report replaces any previously entered test report under EDCS – 21541326. This test report has been electronically authorized and archived using the CISCO Doc Central. Test Report Template EDCS# 11556830.

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Attestation Statement of Compliance

The C9124AXI-B and C9124AXD-B have been evaluated for Maximum Permissible Exposure in compliance with 47 Code of Federal Regulations [Part 1.1307(b) (for fixed devices), Part 2.1091 (for mobile devices), and Part 2.1093 (for portable devices)]. Part 1.1307(b) refers to limits in Part 1.1310 and 2.1093. The evaluation was in accordance with methodology as referenced in KDB 447498 D01 General RF Exposure Guidance v06. This report serves as the additional technical analysis of the Cisco radio modules.

This study addresses the following transmitters using the data derived in these test reports:

- BLE reports EDCS-21541312, EDCS-21606814
- 2.4GHz reports EDCS# EDCS-21574927, EDCS-21541314
- 2.4GHz Auxiliary reports EDCS-21541311, EDCS-21574925
- 5GHz UNII-1 report EDCS-21574910, EDCS-21541322
- 5GHz UNII-2 report EDCS-21574912, EDCS-21541323
- 5GHz UNII-2ext report EDCS-21574913, EDCS-21541324
- 5GHz UNII-3 report EDCS-21574914, EDCS-21541325
- 5GHz UNII-1 Auxiliary reports EDCS-21541303, EDCS-21574899
- 5GHz UNII-2 Auxiliary reports EDCS-21541304, EDCS-21574902
- 5GHz UNII-2ext Auxiliary reports EDCS-21541305, EDCS-21574903
- 5GHz UNII-3 Auxiliary reports EDCS-21541306, EDCS-21574904

The limits used for this evaluation are in line with the recommendations of the World Health Organizations (WHO) International Committee on Non-Ionizing Radiation Protection (ICNIRP) as well as the American National Standards Institute (ANSI) C95.1.

The limits chosen are of General Population/Uncontrolled Exposure.

The following case scenarios were used:

- BLE
- 2.4GHz WLAN
- 5GHz WLAN
- 2.4GHz Auxiliary Radio
- 5GHz Auxiliary Radio

This device must be installed to provide a separation distance of at least 30 cm from all persons. Installers must be provided with antenna installation and transmitter operating conditions for satisfying RF exposure compliance.

Based on the study this case scenario, the General Population/Uncontrolled Exposure and the minimum recommended distance is around 30cm from the antenna.

1.0 EUT Description

The Cisco Catalyst 9124AX Series outdoor access points are next-generation Wi-Fi 6 access points encased in a rugged and robust design that service providers and enterprises can easily deploy.

The C9124AXI-B Supports the following radio modes:

BLE 5.1

2.4GHz Wi-Fi Radio
- 802.11b (1-11Mbps)
- 802.11g (6-54Mbps)
- 802.11n HT20 (MCS0 – MCS31)
- 802.11ax HE20 (MCS0-MCS11, 4SS)

2.4GHz Auxiliary Radio
- 802.11g Non HT20, One Antenna, 6 to 54 Mbps, 1ss

5GHz Wi-Fi Radio:
- 802.11a (6-54Mbps)
- 802.11n HT20 (MCS0 – MCS31)
- 802.11n HT40 (MCS0 – MCS31)
- 802.11ac VHT20 (MCS0-MCS9, 4SS)
- 802.11ac VHT40 (MCS0-MCS9, 4SS)
- 802.11ac VHT80 (MCS0-MCS9, 4SS)
- 802.11ac VHT80+80 (MCS0-MCS9, 2SS Max)
- 802.11ax HE20 (MCS0-MCS11, 4SS)
- 802.11ax HE40 (MCS0-MCS11, 4SS)
- 802.11ax HE80 (MCS0-MCS11, 4SS)
- 802.11ax HE80+80 (MCS0-MCS9, 2SS Max)

5GHz Auxiliary Radio:
802.11a - Non HT20, One Antenna, 6 to 54 Mbps, 1ss

The following antennas are supported by this product series. Please note, the antenna information has been provided by the customer (the Cisco business unit). The data included in this report represent the worst-case data for all antennas.

Ithaca (Internal Antenna) Model C9124AXD-x

Frequency	Antenna Name		Antenna Gain
2.4GHz & 5GHz (Wi-Fi)	Antenna 1	TX/RX: internal	9dBi@2.4GHz 9dBi@5GHz
2.4GHz & 5GHz (Wi-Fi)	Antenna 2	TX/RX: internal	9dBi@2.4GHz 9dBi@5GHz
2.4GHz & 5GHz (Wi-Fi)	Antenna 3	TX/RX: internal	9dBi@2.4GHz 9dBi@5GHz
2.4GHz & 5GHz (Wi-Fi)	Antenna 4	TX/RX: internal	9dBi@2.4GHz 9dBi@5GHz
BLE	Antenna T	TX/RX: internal	4dBi
2.4GHz & 5GHz (Aux)	Antenna A	TX/RX: internal	9dBi@2.4GHz 9dBi@5GHz
2.4GHz & 5GHz (Aux)	Antenna B	RX: internal	9dBi@2.4GHz 9dBi@5GHz

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Ithaca (Internal Antenna) Model C9124AXI-x

Frequency	Antenna Name		Antenna Gain
2.4GHz & 5GHz (Wi-Fi)	Antenna 1	TX/RX: internal	7dBi@2.4GHz 7dBi@5GHz
2.4GHz & 5GHz (Wi-Fi)	Antenna 2	TX/RX: internal	7dBi@2.4GHz 7dBi@5GHz
2.4GHz & 5GHz (Wi-Fi)	Antenna 3	TX/RX: internal	7dBi@2.4GHz 7dBi@5GHz
2.4GHz & 5GHz (Wi-Fi)	Antenna 4	TX/RX: internal	7dBi@2.4GHz 7dBi@5GHz
BLE	Antenna T	TX/RX: internal	5dBi
2.4GHz & 5GHz (Aux)	Antenna A	TX/RX: internal	6dBi@2.4GHz 7dBi@5GHz
2.4GHz & 5GHz (Aux)	Antenna B	RX: internal	6dBi@2.4GHz 7dBi@5GHz

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Methodology

All calculations were made in accordance with ANSI C95.1.

Measurement Uncertainty Values

Parameter	Max MU from standard	Declared MU
Occupied Channel Bandwidth	+/- 5%	+/-2%
RF Output Power, conducted	+/- 1,5dB	+/-1.4dB
Power Spectral Density, conducted	+/- 3dB	+/- 2dB
Unwanted emissions, conducted	+/- 3dB	+/- 2dB
All emissions, radiated	+/- 6dB	+/- 3.2dB
Temperature	+/- 3C	+/- 0.7C
Supply Voltages	+/- 3%	+/- 2.5%
Time	+/- 5%	+/-2%

2.0 Technical Requirements

2.1 Single Band Operation – Limits

FCC Limits for Maximum Permissible Exposure (MPE)

(A) Limits for Occupational/Controlled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm^2)	Averaging Time $\|E\|^2$, $\|H\|^2$ or S (minutes)
0.3-3.0	614	1.63	(100)*	6
3.0-30	1842/f	4.89/f	($900/f^2$)*	6
30-300	61.4	0.163	1.0	6
300-1500	--	--	f/300	6
1500-100,000	--	--	5	6

(B) Limits for General Population/Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm^2)	Averaging Time $\|E\|^2$, $\|H\|^2$ or S (minutes)
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	($180/f^2$)*	30
30-300	27.5	0.073	0.2	30
300-1500	--	--	f/1500	30
1500-100,000	--	--	1.0	30

f = frequency in MHz *Plane-wave equivalent power density

NOTE 1: See Section 1 for discussion of exposure categories.

NOTE 2: The averaging time for General Population/Uncontrolled exposure to fixed transmitters is not applicable for mobile and portable transmitters. See 47 CFR §§2.1091 and 2.1093 on source-based time-averaging requirements for mobile and portable transmitters.

3.0 Calculations

Given

E=√(30*P*G)/d and S=E^2/3770

where

E=Field Strength in Volts/meter
P=Power in Watts
G=Numeric Antenna Gain
d=Distance in meters
S=Power Density in mW/cm^2

Combine equations and rearrange the terms to express the distance as a function of the remaining variables:

d=√((30*P*G)/(3770*S))

Changing to units of power in mW and distance in cm, using:

P(mW)=P(W)/1000 d(cm)=100*d(m)

yields

d=100*√((30*(P/1000)*G)/(3770*S))
d=0.282*√(P*G/S)

where

d=Distance in cm
P=Power in mW
G=Numeric Antenna Gain
S=Power Density in mW/cm^2

Substituting the logarithmic form of power and gain using:

P(mW)=10^(P(dBm)/10) G(numeric)=10^(G(dBi)/10)

yields

d=0.282*10^((P+G)/20)/√S Equation (1)

and

s=((0.282*10^((P+G)/20))/d)^2 Equation (2)

where

d=MPE distance in cm
P=Power in dBm
G=Antenna Gain in dBi
S=Power Density in mW/cm^2

4.0 Results

MPE Calculations:
Equation (1) and the measured peak power can be used to calculate the MPE distance.

Using Equation 2, the power density levels (s) at 30 cm are calculated as follows:

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Radio Interface	Frequency (MHz)	MPE Distance (cm)	Radiated Transmit Power (dBm)	Antenna Gain (dBi)	Power Density (mW/cm^2)	Limit (mW/cm^2)	Margin (mW/cm^2)
BLE	2402	30	0.61	5	0.0003	1	0.9997
2.4GHz	2437	30	28.5	7	0.3135	1	0.6865
2.4GHz Auxiliary	2437	30	24	6	0.0884	1	0.9116
5GHz	5825	30	22.55	13*	0.3518	1	0.6482
5GHz Auxiliary	5220	30	24.2	7	0.1165	1	0.8835

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Radio	Frequency (MHz)	MPE Distance (cm)	Radiated Transmit Power (dBm)	Antenna Gain (dBi)	Power Density (mW/cm^2)	Limit (mW/cm^2)	Margin (mW/cm^2)
BLE	2402	30	0.61	4	0.0003	1	0.9997
2.4GHz	2437	30	26.8	9	0.3359	1	0.6641
2.4GHz Auxiliary	2437	30	24	9	0.1763	1	0.8237
5GHz	5825	30	23.9	12*	0.3438	1	0.6562
5GHz Auxiliary	5825	30	22.2	9	0.1165	1	0.8835

***** Correlated Gain

To maintain compliance, installations will assure a separation distance of at least 30 cm.

Calculations with additional transmitters

The FCC's MPE limits vary with frequency. Therefore, in mixed or broadband RF fields where several sources and frequencies are involved, the fraction of the recommended limit (in terms of power density or square of the electric or magnetic field strength) incurred within each frequency interval should be determined, and the sum of all fractional contributions should not exceed 1.0, or 100% in terms of percentage.

Worst Case Scenario:
BLE (Highest power)
2.4GHz WLAN (Highest power)
5GHz WLAN (Highest power)
2.4GHz Auxiliary (Highest power)
5GHz Auxiliary (Highest power)

Total Power Densities (Percentages) = 2.4GHz Power Density % + 5GHz Power Density % +2.4GHz Auxiliary Power Density % + 5GHz Auxiliary Power Density % + BLE Power Density %

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Total Relative Power Densities (Percentages) = (0.0003/1.0)*100 + (0.3135/1.0)*100 + (0.0884/1.0)*100 + (0.3518/1.0)*100 + (0.1165/1.0)*100
= 87.1%

The limit for this scenario is 100%. The result is passing.

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Total Relative Power Densities (Percentages) = (0.0003/1.0)*100 + (0.3359/1.0)*100 + (0.1763/1.0)*100 + (0.3438/1.0)*100 + (0.1165/1.0)*100
= 97.3%
The limit for this scenario is 100%. The result is passing.

With a separation distance of 30cm the worst-case co-located scenarios meet the General Population/Uncontrolled exposure Power density requirement of 1.0mW/cm^2.

References

American National Standards Institute (ANSI), "Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz," ANSI/IEEE C95.1-1992 (previously issued as IEEE C95.1-1991). Copyright 1992 by the Institute of Electrical and Electronics Engineers, Inc. (IEEE), New York, N.Y. 10017. For copies contact the IEEE: 1-800-678-4333 or 1-908-981-1393.

American National Standards Institute (ANSI), "Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields - RF and Microwave". ANSI/IEEE C95.3-1992. Copyright 1992, The Institute of Electrical and Electronics Engineers, Inc. (IEEE), New York, NY 10017. For copies contact the IEEE: 1-800-678-4333 or 1-908-981-1393.