EDCS-1529839

RF Exposure Study - Engineering Analysis per

**FCC 2.1091**

**Industry Canada RSS-102**

# AIR-CAP1532E-B-K9

**FCC ID: LDK102089P**

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**1.0: Attestation Statement of Compliance**

The Cisco AIR-CAP1532E-B-K9, 802.11N radio has been evaluated for Maximum Permissible Exposure in compliance with 47 Code of Federal Regulations 2.1093. The evaluation was in accordance with methodology as referenced in FCC Bulletin OET 65C (rev 01-01). This report serves as the additional technical analysis of the Cisco radio modules

This study addresses the addition of an additional pair of transmitters using the data derived in the afore mentioned report #
2.4GHz DTS 13dBi report EDCS#- 1324627
5GHz 14dBi UNII-1 report EDCS-1518109
5GHz 14dBi UNII-2 report EDCS-1324630
5GHz 14dBi UNII-2ext reports EDCS-1518110
5GHz 14dBi UNII-3 report EDCS-1518111

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**.

This analysis also complies with the requirements stated in Industry Canada RSS-102 as well as the applicable Australian and New Zealand regulations.

the following case scenarios were used :
**2.4GHz WLAN**
**5GHz WLAN**

This device must be installed to provide a separation distance of at least 40 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 40cm (16 inches) from the antenna.

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## 2.0 EUT Description.

The AIR-CAP1532E-B-K9 Cisco 802.11N Radio support the following modes of operation. The modes are further defined in the radio Theory of Operation. The modes included in this report represent the worst-case data for all modes.

802.11n - Non HT-20, One Antenna, 6 to 54 Mbps
802.11n - Non HT-20, Two Antennas, 6 to 54 Mbps

802.11n - HT-20, One Antenna, M0 to M7
802.11n - HT-20, Two Antennas, M0 to M7
802.11n - HT-20, Two Antennas, M8 to M15

802.11n - HT-20 Beam Forming, Two Antennas, M0 to M7
802.11n - HT-20 Beam Forming, Two Antennas, M8 to M15

802.11n - HT-20 STBC, Two Antennas, M0 to M7

802.11n - Non HT-40 Duplicate, One Antenna, 6 to 54 Mbps
802.11n - Non HT-40 Duplicate, Two Antennas, 6 to 54 Mbps

802.11n - HT-40, One Antenna, M0 to M7
802.11n - HT-40, Two Antennas, M0 to M7
802.11n - HT-40, Two Antennas, M8 to M15

802.11n - HT-40 Beam Forming, Two Antennas, M0 to M7
802.11n - HT-40 Beam Forming, Two Antennas, M8 to M15

802.11n - HT-40 STBC, Two Antennas, M0 to M7

The following antennas are supported by this product series.
The data included in this report represent the worst case data for all antennas.

| Frequency | Part Number | Antenna Type | Antenna Gain (dBi) | >30 degree 5 GHz Antenna Gain (dBi) |
|---|---|---|---|---|
| **5 GHz** | AIR-ANT5180V-N | Single Band Omni | 8 | -3 |
| | AIR-ANT5114P2M-N | Single Band, Directional Patch | 14 | 5 |
| **2.4/5 GHz** | AIR-ANT2547V-N= | Dual-band Omni | 4 / 7 | -6 |
| | AIR-ANT2547VG-N= | Dual-band Omni, Gray | 4 / 7 | -6 |
| | AIR-ANT2588P3M-N= | Dual-band/Dual Polarized Directional, Patch | 8 / 8 | 1 |

## 3.0 Methodology

All calculations were made in accordance with ANSI C95.1, and FCC OET 65C.

## 4.0 Technical Requirements

### *4.1 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.

## 5.0 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

### 6.0 Results

Equation (1) and the measured peak power are used to calculate the MPE distance. Note that for mobile or fixed location transmitters such as an access point, the minimum separation distance is 40 cm even if the calculations indicate that the MPE distance may be less.

S=1mW/cm^2 maximum. The highest supported antenna gain is 6 dBi (9dBi with beamforming). Using the peak power levels recorded in the test report along with Equation 1 above, the MPE distances are calculated as follows.

**MPE Calculations:**

| Band | Power Density (mW/cm^2) | Peak Transmit Power (dBm) | Antenna Gain (dBi) | MPE Distance (cm) | Limit (cm) | Margin (cm) |
|---|---|---|---|---|---|---|
| 2.4GHz DTS | 1 | 26.9 | 13 | 27.88 | 40 | 12.12 |
| 5GHz UNII-1 | 1 | 20.9 | 14 | 15.68 | 40 | 24.32 |
| 5GHz UNII-2 | 1 | 12.4 | 14 | 5.89 | 40 | 34.11 |
| 5GHz UNII-2e | 1 | 13.7 | 14 | 6.84 | 40 | 33.16 |
| 5GHz UNII-3 | 1 | 25.2 | 14 | 25.72 | 40 | 14.28 |

To maintain compliance, installations will assure a separation distance of at least 40cm.

Using Equation 2, the MPE levels (s) at 40 cm are calculated as follows:

| Band | MPE Distance (cm) | Peak Transmit Power (dBm) | Antenna Gain (dBi) | Power Density (mW/cm^2) | Limit (mW/cm^2) | Margin (mW/cm^2) |
|---|---|---|---|---|---|---|
| 2.4GHz DTS | 40 | 26.9 | 13 | 0.49 | 1 | 0.51 |
| 5GHz UNII-1 | 40 | 20.9 | 14 | 0.15 | 1 | 0.85 |
| 5GHz UNII-2 | 40 | 12.4 | 14 | 0.02 | 1 | 0.98 |
| 5GHz UNII-2e | 40 | 13.7 | 14 | 0.03 | 1 | 0.97 |
| 5GHz UNII-3 | 40 | 25.2 | 14 | 0.41 | 1 | 0.59 |

**Calculations with additional transmitters**

The AIR-CAP1532E-B-K9 Cisco 802.11N Radio support operation with 2.4GHz WLAN & 5GHz WLAN.

Scenerio 1 :
**2.4GHz WLAN ( Highest power)**
**5GHz WLAN (Highest power)**

TX1 + TX6 = % of standard
( 0.49) + (0.41 ) = 0.90

D (estimate) = 40* $\sqrt{\%}$

D = 37.95cm which is less than 40cm recommended

The configuration above co-location calculation is for **General Population/Uncontrolled exposure**. The minimum distance recommended is **20cm (8 inches)** when all antennas are within 20cm of each other.

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**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.

**FCC OET 65C Evaluating Compliance with FCC Guidelines for Human Exposure to RF Fields from 9KHz to 40 Ghz**