



Maximum Permissible Exposure Study - Engineering Analysis

IW9165E-B
IW9165E-A

Cisco Industrial Wireless Access Point

FCC ID: LDKIW9165E
IC: 2461A-IW9165E

**2400-2483.5 MHz, 4.9GHz 5150-5250 MHz,
5250-5350 MHz, 5470-5725 MHz, 5725-5850 MHz**

**Against the following Specifications:
47 Code of Federal Regulations 2.1091
RSS-102 Issue 5**

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

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Summary of Test Result

| Report Clause | Ref Std. Clause | Test Items | Result (PASS/FAIL) | Remark |
|---------------|-----------------|---------------------|--------------------|--------|
| 2 | - | Exposure evaluation | PASS | - |

Declaration of Conformity:

1. The test results with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers. It's means measurement values may risk exceeding the limit of regulation standards, if measurement uncertainty is include in test results.
2. The measurement uncertainty please refer to report" Measurement Uncertainty".

1 General Description

1.1 EUT General Information

| RF General Information | | | |
|------------------------|--|--|--|
| Evaluation Mode | Frequency Range (MHz) | Operating Frequency (MHz) | Modulation Type |
| 5GHz WLAN | 5150-5250 5250-5350 5470-5725 5725-5850 | 5180-5250 5250-5320 5500-5720 5745-5825 | 802.11a/n: OFDM (BPSK, QPSK, 16QAM, 64QAM) 802.11ac: OFDM (BPSK, QPSK, 16QAM, 64QAM, 256QAM) 802.11ax: OFDMA (BPSK, QPSK, 16QAM, 64QAM, 256QAM, 1024QAM) |
| 4.9GHz WLAN | 4940-4990 | 4945-4985 | OFDM (BPSK, QPSK, 16QAM, 64QAM) |
| Bluetooth | 2400-2483.5 | 2402-2480 | LE: GFSK |

1.2 Antenna Information

| Product ID | Family | Description | Supported by IW9165DHD? | Supported by IW9165E? | Peak Gain 2.4 GHz (dBi) | Peak Gain 4.9 GHz (dBi) | Peak Gain 5 GHz (dBi) | Gain > 30° Elevation UNII-1 (dBi) | Peak Gain 6 GHz (dBi) | Gain > 30° Elevation UNII-5 & 7 | 5 GHz Fixed Point-to-Point? | 5 GHz Point-to-Multipoint? |
|--------------------|--------|--|-------------------------|-----------------------|-------------------------|-------------------------|-----------------------|-----------------------------------|-----------------------|---------------------------------|-----------------------------|----------------------------|
| IW-ANT-OMM-53-N= | Legacy | 5 GHz 3 dBi Omnidirectional Antenna, Multi-polarized, N Female Connector | No | Yes | N/A | 3 | 3 | 0 | N/A | N/A | No | Yes |
| AIR-ANT5180V-N= | Legacy | 5 GHz 8 dBi Omnidirectional Colinear Array Antenna, N Male Connector | Yes | Yes | N/A | 8 | 8 | -3 | N/A | N/A | No | Yes |
| IW-ANT-PNL-59-N= | Legacy | 5 GHz 9 dBi 2-Element Patch Array Antenna, Slant ±45 Polarized, N Female Connectors | Yes | Yes | N/A | N/A | 10 | 7 | N/A | N/A | Yes | Yes |
| AIR-ANT5114P2M-N= | Legacy | 5 GHz 13 dBi 2-Element Patch Array Antenna, N Male Connectors | Yes | Yes | N/A | N/A | 13 | 4 | N/A | N/A | Yes | Yes |
| AIR-ANT5114P2M-NS= | SIA | | Yes | Yes | N/A | N/A | 13 | 3 | N/A | N/A | Yes | Yes |
| IW-ANT-SKD-513-Q= | Legacy | 5 GHz 14 dBi 2-Element Shark Antenna, Slant ±45 Polarized, QMA Female Connectors | No | Yes | N/A | 13 | 13 | 8 | N/A | N/A | No | Yes |
| IW-ANT-SKS-514-Q= | Legacy | 5 GHz 14 dBi 2-Element Shark Antenna, Slant ±45 Polarized, QMA Female Connectors | No | Yes | N/A | 13 | 13 | 8 | N/A | N/A | No | Yes |
| AIR-ANT2547V-N= | Legacy | 2.4 GHz 4 dBi / 5 GHz 7 dBi Omnidirectional Colinear Array Antenna, N male connector | Yes | Yes | 4 | N/A | 7 | -3 | N/A | N/A | No | Yes |
| AIR-ANT2547VG-N= | Legacy | 2.4 GHz 4 dBi / 5 GHz 7 dBi Omnidirectional Colinear Array | Yes | Yes | 4 | N/A | 7 | -3 | N/A | N/A | No | Yes |
| AIR-ANT2547VG-NS= | SIA | | Yes | Yes | 4 | N/A | 7 | -3 | N/A | N/A | No | Yes |
| AIR-ANT2568VG-N= | Legacy | 2.4 GHz 6 dBi / 5 GHz 8 dBi Omnidirectional Antenna, N Male | Yes | Yes | 6 | N/A | 8 | 3 | N/A | N/A | No | Yes |
| AIR-ANT2568VG-NS= | SIA | | Yes | Yes | 6 | N/A | 8 | 3 | N/A | N/A | No | Yes |
| AIR-ANT2588P4M-NS= | SIA | 2.4 GHz 8 dBi / 5 GHz 8 dBi 4-Element Dual-Polarized Patch Antenna, N | No | Yes | 8 | N/A | 8 | -2 | N/A | N/A | No | Yes |
| AIR-ANT2513P4M-N= | Legacy | 2.4 GHz 13 dBi / 5 GHz 13 dBi Polarization Diverse Patch Array | No | Yes | 13 | N/A | 13 | 1 | N/A | N/A | Yes | Yes |
| AIR-ANT2513P4M-NS= | SIA | | No | Yes | 13 | N/A | 13 | 1 | N/A | N/A | Yes | Yes |
| IW-ANT-OMV-2567-N | SIA | Tri-band 2.4 GHz 4 dBi, 5/6 GHz 7 dBi Omnidirectional Colinear Array Antenna, Vertically Polarized, N Male Connector | Yes | Yes | 4 | 7 | 7 | -7 | 7 | -6 | No | Yes |
| IW-ANT-OMH-2567-N | SIA | Tri-band 2.4 GHz 4 dBi, 5/6 GHz 7 dBi Omnidirectional Colinear Array Antenna, Horizontally Polarized, N Male Connector | Yes | Yes | 4 | 7 | 7 | -6 | 7 | -4 | No | Yes |
| IW-ANT-PNL-515-N= | SIA | Tri-band 5 GHz 15dBi Panel Antenna | Yes | Yes | | 15 | 15 | 3 | | | Yes | Yes |

1.3 Table for EUT support function

| Function | Support Band |
|----------|-------------------|
| AP | BLE, 5GHz, 4.9GHz |
| P2P/P2MP | BLE, 5GHz, 4.9GHz |

Note1: For above table list, only AP mode was tested and recorded in this test.

Note2: The above information was declared by manufacturer.

1.4 Table for Radio function

| Radio (R) | 5GHz UNII 1~UNII 3 | 4.9 GHz | BLE | GPS |
|-----------|---|---------|-----|-----|
| R1 | V (AP: 20/40/80) (P2P/P2MP: 20/40/80) | V | V | - |
| R2 | V (AP: 20/40/80/160) (P2P/P2MP: 20/40/80/160) | V | - | - |
| R3 | - | - | - | V |

Note: The above information was declared by manufacturer.

1.5 Applicable Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- 47 CFR Part 2.1091
- KDB 447498 D04 Interim General RF Exposure Guidance v01

The following reference test guidance is not within the scope of accreditation of TAF.

- 47 CFR Part 1.1307
- 47 CFR Part 1.1310
- RSS – 102 Issue 5

RSS – 102: IEEE C95.3-2002: *IEEE recommended practice for measurements and computations of radio frequency electromagnetic fields with respect to human exposure to such fields, 100 kHz-300 GHz.*

A device requiring an RF exposure evaluation shall be made in accordance with the latest version of IEEE C95.3

2 Maximum Permissible Exposure

2.1 MPE Exemption - FCC

Option (A): 1.1307(b)(3)(i)(A): Available maximum time-averaged power is < 1 mW.

Option (B): 1.1307(b)(3)(i)(B): Device operates between 300 MHz and 6 GHz and the maximum time-averaged power or effective radiated power (ERP), whichever is greater, <= Pth.

$$P_{th} \text{ (mW)} = \begin{cases} ERP_{20 \text{ cm}} (d/20 \text{ cm})^x & d \leq 20 \text{ cm} \\ ERP_{20 \text{ cm}} & 20 \text{ cm} < d \leq 40 \text{ cm} \end{cases}$$

Where

$$x = -\log_{10} \left(\frac{60}{ERP_{20 \text{ cm}} \sqrt{f}} \right) \text{ and } f \text{ is in GHz};$$

and

$$ERP_{20 \text{ cm}} \text{ (mW)} = \begin{cases} 2040f & 0.3 \text{ GHz} \leq f < 1.5 \text{ GHz} \\ 3060 & 1.5 \text{ GHz} \leq f \leq 6 \text{ GHz} \end{cases}$$

d = the separation distance (cm);

Option (C): 1.1307(b)(3)(i)(C): ERP is below a threshold calculated based on the distance R between the person and the antenna / radiating structure, where $R > \lambda / 2$.

| Single RF Sources Subject to Routine Environmental Evaluation | |
|---|--|
| RF Source frequency (MHz) | Threshold ERP (watts) |
| 0.3-1.34 | 1,920 R ² . |
| 1.34-30 | 3,450 R ² /f ² . |
| 30-300 | 3.83 R ² . |
| 300-1,500 | 0.0128 R ² f. |
| 1,500-100,000 | 19.2R ² . |
| Note: R is in meters, f is in MHz. | |

Exemption Limits for Routine Evaluation - ISED RSS 102

RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows:

- below 20 MHz⁶ and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1 W (adjusted for tune-up tolerance);
- at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $4.49/f^{0.5}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance);
- at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \times 10^{-2} f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 5 W (adjusted for tune-up tolerance).

2.2 RF exposure evaluation exemption for FCC

Radio 1: 15dBi antenna gain

| | |
|--------------------------------|-------------------------------|
| Prediction frequency (MHz) | 5745 |
| Maximum Output Power (dBm) | 19dBm |
| Maximum ERP (dBm) | 31.86 |
| Maximum ERP (W) | 1.534 |
| Prediction distance (cm) | 40 |
| 1500 MHz $\leq f <$ 100000 MHz | MPE-based Exemption Threshold |
| | P_{th} (W) |
| | 19.2R ² = 3.072W |

Radio 2: 15dBi antenna gain

| | |
|--------------------------------|-------------------------------|
| Prediction frequency (MHz) | 5745MHz |
| Maximum Output Power (dBm) | 19dBm |
| Maximum ERP (dBm) | 32.86 |
| Maximum ERP (W) | 1.931 |
| Prediction distance (cm) | 40 |
| 1500 MHz $\leq f <$ 100000 MHz | MPE-based Exemption Threshold |
| | P_{th} (W) |
| | 19.2R ² = 3.072W |

2.3 RF exposure evaluation exemption for ISED

Radio 1: 15dBi antenna gain

| | |
|----------------------------|--|
| Prediction frequency (MHz) | 5745MHz |
| Maximum Output Power (dBm) | 19dBm |
| Max. Antenna gain | 15dBi |
| Tolerances | 0.50dB |
| Maximum EIRP (dBm) | 34.50dBm |
| Maximum EIRP (W) | 2.819 |
| $300MHz \leq f < 6GHz$ | Exemption Limits for Routine Evaluation |
| | (W) |
| | $1.31 \times 10^{-2} f^{0.6834} W = 4.857 \text{ watt.}$ |

The routine evaluation is exempted because $2.819 < 4.857 \text{ watt.}$

Radio 2: 15dBi antenna gain

| | |
|----------------------------|--|
| Prediction frequency (MHz) | 5745MHz |
| Maximum Output Power (dBm) | 20dBm |
| Max. Antenna gain | 15dBi |
| Tolerances | 0.50dB |
| Maximum EIRP (dBm) | 35.50dBm |
| Maximum EIRP (W) | 3.548 |
| $300MHz \leq f < 6GHz$ | Exemption Limits for Routine Evaluation |
| | (W) |
| | $1.31 \times 10^{-2} f^{0.6834} W = 4.857 \text{ watt.}$ |

The routine evaluation is exempted because $3.548 < 4.857 \text{ watt.}$

2.4 Limit of Maximum Permissible Exposure

(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 |

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

RSS-102 limits

| Frequency Range (MHz) | Electric Field (V/m rms) | Magnetic Field (A/m rms) | Power Density (W/m ²) | Reference Period (minutes) |
|------------------------|---------------------------|--|-----------------------------------|----------------------------|
| 0.003-10 ²¹ | 83 | 90 | - | Instantaneous* |
| 0.1-10 | - | 0.73/ f | - | 6** |
| 1.1-10 | 87/ f ^{0.5} | - | - | 6** |
| 10-20 | 27.46 | 0.0728 | 2 | 6 |
| 20-48 | 58.07/ f ^{0.25} | 0.1540/ f ^{0.25} | 8.944/ f ^{0.5} | 6 |
| 48-300 | 22.06 | 0.05852 | 1.291 | 6 |
| 300-6000 | 3.142 f ^{0.3417} | 0.008335 f ^{0.3417} | 0.02619 f ^{0.6834} | 6 |
| 6000-15000 | 61.4 | 0.163 | 10 | 6 |
| 15000-150000 | 61.4 | 0.163 | 10 | 616000/ f ^{1.2} |
| 150000-300000 | 0.158 f ^{0.5} | 4.21 x 10 ⁻⁴ f ^{0.5} | 6.67 x 10 ⁻⁵ f | 616000/f ^{1.2} |

Note: f is frequency in MHz.

* Based on nerve stimulation (NS).

** Based on specific absorption rate (SAR).

2.5 MPE Calculation Method

The MPE was calculated at 100 cm to show compliance with the power density limit.

The following formula was used to calculate the Power Density:

$$E \text{ (V/m)} = \frac{\sqrt{30 \xi P \xi G}}{d} \qquad \text{Power Density: } Pd \text{ (W/m}^2\text{)} = \frac{E^2}{377}$$

E = Electric field (V/m)

P = RF output power (W)

G = EUT Antenna numeric gain (numeric)

d = Separation distance between radiator and human body (m)

The formula can be changed to

$$Pd = \frac{30 \xi P \xi G}{377 \xi d^2}$$

2.6 Calculated Result and Limit

Exposure Environment: General Population / Uncontrolled Exposure

For Radio 1

For Antenna set 1 – 3dBi.

| Frequency | DG (dBi) | Power (dBm) | EIRP (dBm) | Tolerance (dB) | Tune-up EIRP (dBm) | Tune-up EIRP (W) | Distance (cm) | S (mW/cm ²) | S Limit (mW/cm ²) |
|-----------------|------------|-------------|-------------|----------------|--------------------|------------------|---------------|-------------------------|-------------------------------|
| 5220 MHz | 3.0 | 20.9 | 23.9 | 0.50 | 24.40 | 0.275 | 40 | 0.014 | 1.00000 |
| 5270 MHz | 3.0 | 24.0 | 27.0 | 0.50 | 27.50 | 0.562 | 40 | 0.028 | 1.00000 |
| 5500 MHz | 3.0 | 24.0 | 27.0 | 0.50 | 27.50 | 0.562 | 40 | 0.028 | 1.00000 |
| 5755 MHz | 3.0 | 24.6 | 27.6 | 0.50 | 28.10 | 0.645 | 40 | 0.032 | 1.00000 |
| 4980 MHz | 3.0 | 15.0 | 18.0 | 0.50 | 18.50 | 0.0707 | 40 | 0.004 | 1.00000 |

For Radio 1

For Antenna set 2 – 15 dBi.

| Frequency | DG (dBi) | Power (dBm) | EIRP (dBm) | Tolerance (dB) | Tune-up EIRP (dBm) | Tune-up EIRP (W) | Distance (cm) | S (mW/cm ²) | S Limit (mW/cm ²) |
|-----------------|-------------|-------------|-------------|----------------|--------------------|------------------|---------------|-------------------------|-------------------------------|
| 5220 MHz | 15.0 | 17.0 | 32.0 | 0.50 | 32.50 | 1.22 | 40 | 0.088 | 1.00000 |
| 5320 MHz | 15.0 | 12.0 | 27.0 | 0.50 | 27.50 | 0.562 | 40 | 0.028 | 1.00000 |
| 5660 MHz | 15.0 | 12.0 | 27.0 | 0.50 | 27.50 | 0.562 | 40 | 0.028 | 1.00000 |
| 5745 MHz | 15.0 | 19.0 | 34.0 | 0.50 | 34.50 | 2.818 | 40 | 0.140 | 1.00000 |
| 4950 MHz | 15.0 | 15.0 | 30 | 0.50 | 30.50 | 1.22 | 40 | 0.056 | 1.00000 |

For Radio 1 - BLE

For Antenna – 8dBi

| Frequency | DG (dBi) | Power (dBm) | EIRP (dBm) | Tolerance (dB) | Tune-up EIRP (dBm) | Tune-up EIRP (W) | Distance (cm) | S (mW/cm ²) | S Limit (mW/cm ²) |
|-----------|----------|-------------|------------|----------------|--------------------|------------------|---------------|-------------------------|-------------------------------|
| 2437 MHz | 8 | 4.5 | 12.5 | 0.50 | 13.0 | 0.020 | 40 | 0.001 | 1.00000 |

For Radio 2

For Antenna set 1 – 3dBi

| Frequency | DG (dBi) | Power (dBm) | EIRP (dBm) | Tolerance (dB) | Tune-up EIRP (dBm) | Tune-up EIRP (W) | Distance (cm) | S (mW/cm ²) | S Limit (mW/cm ²) |
|-------------------|----------|-------------|------------|----------------|--------------------|------------------|---------------|-------------------------|-------------------------------|
| 5240MHz – BF 2T1S | 6.01 | 20.9 | 26.91 | 0.50 | 27.41 | 0.551 | 40 | 0.027 | 1.00000 |
| 5320 MHz | 3.0 | 19.9 | 22.9 | 0.50 | 23.40 | 0.219 | 40 | 0.011 | 1.00000 |
| 5690 MHz | 3.0 | 21.6 | 24.6 | 0.50 | 25.10 | 0.320 | 40 | 0.016 | 1.00000 |
| 5745 MHz | 3.0 | 21.5 | 24.5 | 0.50 | 25.0 | 0.397 | 40 | 0.016 | 1.00000 |
| 4980 MHz | 3.0 | 20.0 | 23 | 0.50 | 23.50 | 0.210 | 40 | 0.011 | 1.00000 |

For Radio 2

For Antenna set 2 – 15 dBi

| Frequency | DG (dBi) | Power (dBm) | EIRP (dBm) | Tolerance (dB) | Tune-up EIRP (dBm) | Tune-up EIRP (W) | Distance (cm) | S (mW/cm ²) | S Limit (mW/cm ²) |
|-----------------|-------------|-------------|-------------|----------------|--------------------|------------------|---------------|-------------------------|-------------------------------|
| 5220 MHz | 15.0 | 17.0 | 32.0 | 0.50 | 32.50 | 1.22 | 40 | 0.088 | 1.00000 |
| 5320 MHz | 15.0 | 12.0 | 27.0 | 0.50 | 27.50 | 0.562 | 40 | 0.028 | 1.00000 |
| 5660 MHz | 15.0 | 12.0 | 27.0 | 0.50 | 27.50 | 0.562 | 40 | 0.028 | 1.00000 |
| 5745 MHz | 18.0 | 17.0 | 35.0 | 0.50 | 35.50 | 0.562 | 40 | 0.176 | 1.00000 |
| 4950 MHz | 15.0 | 15.0 | 30 | 0.50 | 30.50 | 1.22 | 40 | 0.056 | 1.00000 |

2.7 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) – 13dBm

5GHz Radio 1 – 34.50dBm

5GHz Radio 2 – 35.50dBm

Total Power Densities (Percentages) = 5GHz Radio 1 Power Density % + 5GHz Radio 2 Power Density % +

BLE Power Density % + 4.9GHz Radio 1

Total Relative Power Densities (Percentages) = $(0.140/1.0) * 100 + (0.176/1.0) * 100 + (0.001/1) * 100 +$
 $(0.056/1.0) * 100 =$
 $= 14 \% + 17.6 \% + 1\% + 5.6 \%$
 $= 38.2\%$

-----THE END-----