EDCS – 11757932

Maximum Permissible Exposure Study - Engineering Analysis

AIR-RM-VBLE2-K9=

Cisco BLE Beacon Point Module

FCC ID: LDK825321596

2400-2483.5 MHz

Against the following Specifications:
47 Code of Federal Regulations 2.1091

Cisco Systems
170 West Tasman Drive
San Jose, CA 95134

This report replaces any previously entered test report under EDCS – 11757932. This test report has been electronically authorized and archived using the CISCO Doc Central. Test Report Template EDCS# 11556830.

EDCS – 11757932

Attestation Statement of Compliance

The **AIR-RM-VBLE2-K9=** radio has been evaluated for Maximum Permissible Exposure in compliance with 47 Code of Federal Regulations 2.1091. The evaluation was in accordance with methodology as referenced in FCC Bulletin OET 65C (rev 01-01) along with KDB 447498 D01 General RF Exposure Guidance. 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 #
Bluetooth Low Energy report: EDCS-11757914.

Additionally, this study considers colocation of the AIR-RM-VBLE2-K9= on host APs:
AIR-AP3802I-B-K9 & AIR-AP3802I-UX-K9 (FCC ID: LDK102100)
AIR-AP3802E-B-K9 & AIR-AP3802E-UX-K9 (FCC ID: LDK102099)
These have the following radio transmitters, covered in these MPE reports: EDCS-1152007 & 1150850.
2.4GHz DTS, 5GHz UNII-1, 5GHz UNII-2, 5GHz UNII-2ext, 5GHz UNII-3.

(These APs also contain a XOR radio that is not active on implementations with the AIR-RM-VBLE2-K9=.)
Evaluation of the aforementioned host APs required a separation distance of 30cm, so that is carried through this evaluation.

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:

Bluetooth LE + 2.4GHz WLAN + 5GHz WLAN

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 (12 inches) from the antenna.

Test Engineer: Chris Blair
Cisco Systems Inc
Corporate Compliance and Certifications
125 West Tasman Drive
San Jose, CA 95134
Email: cblair@cisco.com

1.0 EUT Description

EDCS – 11757932

The AIR-RM-VBLE2-K9= is a project for launching the Virtual BLE Module for the Cisco Aironet AP 3800. The vBLE module is intended to provide highly accurate indoor location delivered in real time, without the site survey or deployment of battery-operated physical BLE beacons on site. Vulcano snugly fits around the AP and helps deliver an integrated solution to customers that is cohesive, easy to deploy & maintain over the duration of its lifetime.

Vulcano top use cases

1. Indoor navigation with turn-by-turn guidance
2. Proximity messaging and engagement

Info taken from PRD: EDCS-11499611

Radio Modes

BLE (GFSK), 1 antenna on at a time (12 located around periphery)

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)
2.4 GHz BLE (GFSK)	XKAA-N29	Integrated, patch	5.8

2.0 Methodology

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

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%

3.0 Technical Requirements

3.1 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.

4.0 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

5.0 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 30 cm even if the calculations indicate that the MPE distance may be less.

S=1mW/cm^2 maximum. Using the peak power levels recorded in the test report along with Equation 1 above, the MPE distances are calculated as follows.

MPE Calculations:

Frequency (MHz)	Power Density (mW/cm^2)	Radiated Transmit Power (dBm)	Antenna Gain (dBi)	MPE Distance (cm)	Limit (cm)	Margin (cm)
BLE (2442)	0.001	1.81	5.8	0.68	30	29.32

The UUT does not stand alone, and is only mounted on a Cisco AIR-AP3802I-B-K9, AIR-AP3802I-UX-K9, AIR-AP3802E-B-K9, AIR-AP3802E-UX-K9, AIR-AP3802P-B-K9, or AIR-AP3802P-UX-K9, all of which contain a dual-band 2.4GHz/5GHz wifi radio. These APs are already approved. To maintain compliance, installations will assure a separation distance of at least 30 cm.

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

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 (2442)	30	1.81	5.8	0.001	1.0	0.999

EDCS – 11757932

Calculations with additional transmitters

Bluetooth Low Energy (Highest power) from AIR-RM-VBLE2-K9=
2.4GHz WLAN (Highest power) from host AP:
5GHz WLAN (Highest power) from host AP:

TX1 + TX2 + TX3 = % of standard
(0.001) + (0.34) + (0.23) = 0.571

D (estimate) = $30^* \sqrt{\%}$

D = 22.67 cm which is less than 30 cm recommended.

The configuration above co-location calculation is for **General Population/Uncontrolled exposure**. The minimum distance recommended is **30 cm (12 inches)** when all antennas are within 30 cm of each other.

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