

MPE Analysis Report

The Equipment Under Test (EUT), is a Thermostat Controller. It contains 2.4GHz Wi-Fi, 5GHz Wi-Fi, Bluetooth BLE and Zigbee features. The EUT is powered by 24VAC.

For Maximum Permissible Exposure (MPE) evaluation of the unit, the maximum power density at 20 cm from this transmitter shall be less than the General Population / Uncontrolled MPE limit in OET Bulletin 65 and meet the requirement listed in KDB447498 D04 v01.

For the RF portions of the unit, the measured powers among all the measured channels were within its production tolerance. The maximum source-based time-averaging duty factor is 100%. From these data and its operating configuration, the exposed power density at a distance (R) of 20 cm from the center of radiation of the antenna can be calculated according to OET Bulletin 65 as follow:

2.4GHz Wi-Fi Portion

Antenna Type: Internal, Integral antenna

Antenna Gain: 0dBi

Operating Mode	Nominal Power	Range of Peak Conducted Power
802.11b	15.23dBm	9dBm to 22dBm
802.11g	13.65dBm	9dBm to 22dBm
802.11n(HT20)	12.22dBm	9dBm to 22dBm

5GHz Wi-Fi Portion

Antenna Type: Internal, Integral antenna

Antenna Gain: 2dBi

Operating Mode	Nominal Power	Range of Peak Conducted Power
802.11a	11.70dBm	9dBm to 22dBm
802.11n(HT20)	9.64dBm	9dBm to 22dBm
802.11n(HT40)	8.85dBm	9dBm to 22dBm

Zigbee Portion

Antenna Type: Internal, Integral antenna

Antenna Gain: 0dBi

Operating Mode	Nominal Power	Range of Peak Conducted Power
Zigbee	9.73dBm	0dBm to 15dBm

Bluetooth BLE Portion

Antenna Type: Internal, Integral antenna

Antenna Gain: 0dBi

Operating Mode	Nominal Power	Range of Peak Conducted Power
Bluetooth BLE (1Mbps)	0.8dBm	-10dBm to 15dBm
Bluetooth BLE (2Mbps)	0.7dBm	-10dBm to 15dBm

For Maximum Permissible Exposure (MPE) evaluation of the EUT, the maximum power density at 20 cm from this mobile transmitter shall be less than the General Population / Uncontrolled MPE limit in OET Bulletin 65.

1) For the 2.4GHz Wi-Fi portion, maximum conducted power was 22dBm. The distance (D) between the antenna and the equipment under test (EUT) was 3 meters. And the maximum source-based time-averaging duty factor is 100%. From these data, the exposed power density at a distance (R) of 20cm from the center of radiation of the antenna can be calculated according to OET Bulletin 65 as follow:

$$\text{The radiated power} = 22\text{dBm} + 0\text{dBi} = 22\text{dBm} (158.49 \text{ mW})$$

$$\begin{aligned}\text{The radiated (EIRP) source-based time-averaging output power} \\ &= (158.49 * 1) \text{ mW} \\ &= 158.49 \text{ mW}\end{aligned}$$

$$\begin{aligned}\text{The power density at 20 cm from the antenna} \\ &= \text{EIRP} / 4\pi R^2 \\ &= 0.031531 \text{ mW cm}^{-2}\end{aligned}$$

2) For the 5GHz Wi-Fi portion, maximum conducted power was 22dBm. The distance (D) between the antenna and the equipment under test (EUT) was 3 meters. And the maximum source-based time-averaging duty factor is 100%. From these data, the exposed power density at a distance (R) of 20cm from the center of radiation of the antenna can be calculated according to OET Bulletin 65 as follow:

$$\text{The radiated power} = 22\text{dBm} + 2\text{dBi} = 24\text{dBm} (251.19 \text{ mW})$$

$$\begin{aligned}\text{The radiated (EIRP) source-based time-averaging output power} \\ &= (251.19 * 1) \text{ mW} \\ &= 251.19 \text{ mW}\end{aligned}$$

$$\begin{aligned}\text{The power density at 20 cm from the antenna} \\ &= \text{EIRP} / 4\pi R^2 \\ &= 0.049973 \text{ mW cm}^{-2}\end{aligned}$$

3) For Zigbee portion, maximum conducted power was 15 dBm. The distance (D) between the antenna and the equipment under test (EUT) was 3 meters. And the maximum source-based time-averaging duty factor is 100%. From these data, the exposed power density at a distance (R) of 20cm from the center of radiation of the antenna can be calculated according to OET Bulletin 65 as follow:

$$\text{The radiated power} = 15\text{dBm} + 0\text{dBi} = 15\text{dBm} (31.62 \text{ mW})$$

$$\begin{aligned}\text{The radiated (EIRP) source-based time-averaging output power} \\ &= (31.62 * 1) \text{ mW} \\ &= 31.62 \text{ mW}\end{aligned}$$

$$\begin{aligned}\text{The power density at 20 cm from the antenna} \\ &= \text{EIRP} / 4\pi R^2 \\ &= 0.006291 \text{ mW cm}^{-2}\end{aligned}$$

4) For Bluetooth BLE portion, maximum conducted power was 15 dBm. The distance (D) between the antenna and the equipment under test (EUT) was 3 meters. And the maximum source-based time-averaging duty factor is 100%. From these data, the exposed power density at a distance (R) of 20cm from the center of radiation of the antenna can be calculated according to OET Bulletin 65 as follow:

The radiated power = 15dBm + 0dBi = 15dBm (31.62 mW)

The radiated (EIRP) source-based time-averaging output power
= (31.62 * 1) mW
= 31.62 mW

The power density at 20 cm from the antenna
= EIRP / $4\pi R^2$
= 0.006291 mW cm⁻²

In the frequency range of 1,500 - 100,000MHz, the MPE limit is 1.0 mWcm⁻² for general population and uncontrolled exposure. As the measured power density at 20cm from the transmitter is lower than the MPE limit, the compliance to the MPE limit can be ensured by indicating the minimum 20cm separation between the transmitter's radiating structures and body of the user or nearby persons. The following RF exposure statement is proposed to be included in the user manual:

“ FCC RF Radiation Exposure Statement

Caution: To maintain compliance with the FCC’s RF exposure guidelines, place the unit at least 20cm from nearby persons.”

In addition, for this product with multiple transmitter and antenna (2.4GHz Wi-Fi portion, Zigbee portion and BLE portion; 5GHz Wi-Fi portion, Zigbee portion and BLE portion), the requirement of Simultaneous Transmission evaluation has also been considered and has complied with the following conditions of the worst case;

$$\text{MPE1/Limit1} + \text{MPE2/Limit2} + \text{MPE3/Limit3} \leq 1$$

Thus,

$$\begin{array}{llllll} 0.031531 / 1 & + & 0.006291 / 1 & + & 0.006291 / 1 & = & 0.044113 \\ \text{2.4GHz Wi-Fi portion} & & \text{Zigbee portion} & & \text{BLE portion} & & \end{array}$$

$$\begin{array}{llllll} 0.049973 / 1 & + & 0.006291 / 1 & + & 0.006291 / 1 & = & 0.062555 \\ \text{5GHz Wi-Fi portion} & & \text{Zigbee portion} & & \text{BLE portion} & & \end{array}$$

It is concluded that no Simultaneous Transmission evaluation is required.