RF Exposure

Purpose

The purpose of this test is to ensure that the RF energy intentionally transmitted, in terms of power density emitted from the EUT at a stated operating distance does not exceed the limits listed below as defined in the applicable test standard, as calculated based upon readings obtained during testing. This helps protect human exposure to excessive RF fields.

Limit(s) and Method

The limits, as defined FCC 1.1310 Table 1 (B) limits for general public exposure was applied. The limits for the frequency ranges 300 MHz to 1.5 GHz and 1.5 GHz to 100 GHz was applied. The limits are f/1500 mW/cm^2 and 1.0 mW/cm^2 respectively.

As per FCC KDB 447498, Clause 4.3.1 b), the 1-g SAR exclusion threshold for 200 mm test distance is 1597 mW (see below for calculations).

For RSS 102 the RF exposure exemption limit for a 2400 MHz transmitter is 1.31×10^{-2} $f^{0.6834}$ W which is 2.65 W.

The distance used for calculations was 20 cm, as this is the minimum distance an operator will be from the EUT during normal operation, as stated by the manufacturer.

Results

The EUT meets the requirements.

The EUT passed the requirements. The worst case calculated power density was 0.061 mW/cm^2, this is significantly under the 1.0 mW/cm^2 requirement.

For FCC SAR exemption, the maximum power the WIFI transmits is 160 mW which is less than 1597mW; therefore, the EUT meets individual SAR testing exclusion requirements.

For FCC SAR exemption, the maximum power the Zigbee transmits is 88 mW which is less than 1597mW; therefore, the EUT meets individual SAR testing exclusion requirements.

As per FCC KDB 447498, Clause 4.3.2 b), a standalone SAR value of 0.4 W/kg is used as the estimated 1-g SAR. The sum of the SAR value for both transmitters is 0.8 W/kg which is less than the 1.6 W/kg limit.

For RSS 102, the E.I.R.P of the Zigbee is 19.43 dBm + 5 dBi = 24.43 dBm (0.277 W) which is significantly less than the 2.65 W RF Exposure exemption limit.

For RSS 102, the E.I.R.P of the WIFI is 22.05 dBm + 2.8 dBi = 24.85 dBm (0.205 W) which is significantly less than the 2.65 W RF Exposure exemption limit.

Calculations – Power Density

Zigbee

Method 1 (conducted power)

$P_d = (P_t*G) / (4*pi*R^2)$
Where Pt = 19.43 dBm or 87.70 mW as per Peak power conducted output
Where G = 5 dBi, or numerically 3.16
Where R = 20 cm

$P_d = (87.79\ mW * 3.16) / (4 * pi * 20cm^2)$
$P_d = 277.33\ mW / 5026\ cm^2$
$P_d = 0.055\ mW/cm^2$

WIFI

Method 1 (conducted power)

$P_d = (P_t*G) / (4*pi*R^2)$
Where Pt = 22.05 dBm or 160.32 mW as per Peak power conducted output
Where G =2.8 dBi, or numerically 1.90
Where R = 20 cm

$P_d = (160.32\ mW * 1.90) / (4 * pi * 20cm^2)$
$P_d = 205.49\ mW / 5026\ cm^2$
$P_d = 0.061\ mW/cm^2$

Antenna Co-location

The MPE requirement for collocated antennas are that the sum of ratios should be less than 1.

The sum of ratios (P_d / Limit) for each transmitter is
(P_d(WIFI)/Limit(WIFI)) + (P_d(Zigbee)/Limit (Zigbee))

(0.061/1.0) + (0.055/1.0) = 0.116 < 1

The EUT meets the antenna collocation MPE requirements.

Calculations – SAR Exclusion Limit

According to FCC KDB 447498, Clause 4.3.1 a) the exclusion power for up to 50 mm is

Power @ 50 mm= (3 * distance)/ $\sqrt{f(GHz)}$
Power @ 50 mm= (3 * 50)/ $\sqrt{}$ (2.4)
Power @ 50 mm= 97 mW

According to FCC KDB 447498, Clause 4.3.1 b), the test exclusion power for above 50 mm is

Power @ 50 mm + $(\text{dist} - 50\ \text{mm}) \times 10$

The exclusion power for 200 mm is therefore

97 mW + ((200 mm – 50 mm)*10) = 1597 mW