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RF Exposure Evaluation for the Winnow Vision 3.0

The Winnow Vision 3.0 is a module which contains 2.4GHz and 5GHz WIFI and 2.4GHz Bluetooth (disabled in firmware).

WLAN supports 2x2 MIMO operation with beam forming, and there can be simultaneous transmission between all of the transmitters.

The following FCC Rule Parts and procedures are applicable:

Part 1.1310 – Radiofrequency radiation exposure limits
Part 2.1091 – Radiofrequency radiation exposure evaluation: mobile devices

KDB447498 D01 v06 - Mobile and Portable Devices RF Exposure Procedures and Equipment Authorisation Policies

KDB 662911 D01 v02 r01 – Multiple Transmitter Output

MAXIMUM TRANSMITTER POWER CONSIDERATIONS

From Tune Up tables (conducted power):

WLAN 2.4GHz:

Power (SISO) = 18.4dBm (69.8mW) max

For non-beam forming MIMO, conducted power for each antenna:

Power (2x2MIMO) = 18.24dBm max (66.7mW)

ANTENNA GAINS:

Antenna Gain Ant0: +3.0dBi (x2.0)

Antenna Gain Ant1: +3.0dBi (x2.0)

RADIATED POWER:

EIRP$_{SISO0}$ = 21.40dBm = 138.04 mW

EIRP$_{SISO1}$ = 21.40dBm = 138.04 mW

Power$_{max}$ for non BF 2x2 MIMO operation:

EIRP$_{MIMO}$ = 21.40dBm + 21.40dBm = 138.04 mW + 138.04 mW = 276.08 mW*

*max power to be considered in calculations

<u>WLAN 5GHz:</u>

Power (SISO) = 17.5dBm (56.4mW) max

For non-beam forming MIMO, conducted power for each antenna:

Power (2x2MIMO) = 19.3dBm max (85.3mW)

<u>ANTENNA GAINS:</u>

Antenna Gain Ant0: +5.0dBi (x3.2)

Antenna Gain Ant1: +5.0dBi (x3.2)

<u>RADIATED POWER:</u>

EIRP$_{SISO0}$ = 22.50dBm = 177.83 mW

EIRP$_{SISO1}$ = 22.50dBm = 177.83 mW

Power$_{max}$ for non BF 2x2 MIMO operation:

EIRP$_{MIMO}$ = 22.50dBm + 22.50dBm = 177.83 mW + 177.83 mW = 355.66 mW*

*max power to be considered in calculations

MPE CALCULATIONS

The MPE calculation used to calculate the safe operating distance for the user is.

$$S = EIRP/4 \pi R^2$$

Where S = Power density

EIRP = Effective Isotropic Radiated Power (EIRP = P x G)

P = Conducted Transmitter Power

G = Antenna Gain (relative to an isotropic radiator)

R = distance to the centre of radiation of the antenna (20cm requirement).

For WLAN 2.4GHz

Values:

Transmitter frequency range = 2412 MHz to 2472MHz

Max. $EIRP_{SISO}$ = 138.04 mW

$EIRP_{MIMO}$ = 276.08 mW

R = 20cm

Power Density Requirement

From table 1 (b) - Limits for General Population/ Uncontrolled Exposure of FCC Rule Part 1.1310 for 2.4GHz

S_{req1} = 1.0 mW/cm^2

Calculation:

$S = EIRP_{SISO} /4 \pi R^2$

$S = 138.04/(12.56 \times 20^2)$

$S = 138.04/ (5024)$

$$\textbf{S}_{\textbf{1 SISO}} \textbf{ = 0.03mW/ cm}^2 \, (<1.0 \text{ mW/cm}^2)$$

Similarly for MIMO: $\textbf{S}_{\textbf{1 MIMO}} \textbf{ = 0.05mW/ cm}^2 \, (<1.0 \text{ mW/cm}^2)$

This equates to minimum safe operating distance (2x2 MIMO operation) of 4.7 cm at the RF exposure limit of 1.0 mW/cm²

For WLAN 5GHz

Values:

Transmitter frequency range = 5150 MHz to 5850MHz

Max. $EIRP_{SISO}$ = 177.83 mW

$EIRP_{MIMO}$ = 355.66 mW

R = 20cm

Power Density Requirement

From table 1 (b) - Limits for General Population/ Uncontrolled Exposure of FCC Rule Part 1.1310 for 5GHz

$$\textbf{S}_{\textbf{req2}} \textbf{ = 1.0 mW/cm}^2$$

Calculation:

$$S = EIRP_{SISO} / 4 \, \pi \, R^2$$

$$S = 177.83 / (12.56 \times 20^2)$$

$$S = 177.83 / (5024)$$

$$\textbf{S}_{\textbf{2 SISO}} \textbf{ = 0.04 mW/ cm}^2 \, (<1.0 \text{ mW/cm}^2)$$

Similarly for MIMO: $\textbf{S}_{\textbf{2 MIMO}} \textbf{ = 0.07mW/ cm}^2 \, (<1.0 \text{ mW/cm}^2)$

This equates to minimum safe operating distance (2x2 MIMO operation) of 5.3 cm at the RF exposure limit of 1.0 mW/cm²

Worst case summation of calculated MPE ratios for 2.4GHz and 5GHz WLAN simultaneously transmitting transmitters from each respective antenna is:

$$\textbf{ie: } \Sigma\textbf{MPE}_\textbf{ratios} = \textbf{(S}_\textbf{1 SISO}/ \textbf{ S}_\textbf{req1}\textbf{)} + \textbf{(S}_\textbf{2 SISO}/ \textbf{S}_\textbf{req2}\textbf{)}$$

$$= (0.05/1.0) + (0.07/1.0)$$

$$\textbf{= 0.12}$$

Σ of MPE ratios<1.0, so in accordance with KDB447498 Section 7.2, simultaneous transmission test exclusion applies for the WLAN transmitters.

Conclusion

The required 20cm RF exposure limits for General Population/ Uncontrolled Exposure will not be exceeded for the Winnow Vision 3.0 using antennas as specified.

Best Regards,

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