HxGN MineDiscovery CoreHP and CoreLP

FCC Maximum Permissible Exposure (MPE) Calculations

Reference: FCC document 'Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields '

From herein this document will be referred to as the 'FCC Guideline to MPE' document.

1.1 CoreHP and CoreLP Intentional Radiators

The CoreHP and CoreLP units comprise the following RF intentional radiators

1.1.1   WiFi

Radio: DoodleLabs ACM-DB-2, Max Power 27dBm (500mW)

Antenna: MobileMark OD6-2400MOD2-BLK-SP-35, 6dBi, 2400GHz to 2500MHz.

Reference documents: -

https://www.doodlelabs.com/products/wi-fi-band-radio-transceivers/data-sheet-acm-db-2/

MobileMark OD6 data sheet, 'antenna-spec-140-od-2400.pdf'.

1.1.2   4G

Radio: Sierra Wireless EM7565 M.2, LTE and UMTS module, Max Power 23dBm (200mW)

Antenna: RMM-UMB-DN-BLK; antenna gain 3dBi, 750MHz to 1250MHz, 2.1GHz to 2.7GHz, and 5dBi, 1.65GHz to 2GHz.

Refer documents AirPrime EM7565 Product Technical Specification and RM-WLF Antenna Specification for further information.

1.2 MPE Calculations

1.2.1   MPE Formula

The FCC Guide to MPE document section 3 'Methods of Predicting Human Exposure' page 17, advises to use the following formula

$S = P.G / 4.\pi.R^2$

$\Rightarrow R = (P.G / 4.\pi.S)^{0.5}$

Where

S = Power Density (MPE) mW/cm^2

P = Power input to antenna (power output from radio) (mW)

G = Power gain of antenna relative to isotropic radiator (converted from dBi)

R = Distance from antenna (cm)

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1.2.2   WiFi MPE Calculations

Referring to The FCC Guide to MPE document, Appendix A, Table 1 (B) Limits for General Population/Uncontrolled exposure (1.5GHz to 100GHz).

S = 1.0 mW/cm2

P = 27dBm = 500mW (ref ACM-DB-2 data sheet)

G = 6dBi = 4 (ref MobileMark OD6-2400MOD2-BLK-SP-35 data sheet)

⇨ $R = (P.G\ /\ 4.\pi.S\ )^{0.5}$

⇨ $R = (500 \times 4\ /\ 4.\pi\ .\ 1)^{0.5}$

⇨   R = 12.62 cm

1.2.3   GSM (LTE 4G) MPE Calculations

The EM7565 transmits at different power levels dependent on its transmit frequency. The calculations shown here are for the worst case scenario (Maximum required R)

1.2.3.1   GSM 300 to 1500MHz

Referring to The FCC Guide to MPE document, Appendix A, Table 1 (B) Limits for General Population/Uncontrolled exposure (300MHz to 1500MHz).

S = f/1500 = 750/1500 = 0.5 mW/cm^2

P = 23dBm = 200mW (ref EM7565 data sheet, Table 4-6 Conducted Tx power tolerances.)

G = 3dBi = 2 (ref RMM-UMB-DN-BLK data sheet, 3dBi @750-1250MHz)

⇨ $R = (P.G\ /\ 4.\pi.S\ )^{0.5}$

⇨ $R = (200 \times 2\ /\ 4.\pi.\ 0.5\ )^{0.5}$

⇨   R = 7.98 cm

1.2.3.2   GSM 1.5GHz to 100GHz

Referring to The FCC Guide to MPE document, Appendix A, Table 1 (B) Limits for General Population/Uncontrolled exposure (1.5GHz to 100GHz).

S = 1.0 mW/cm2

P = 23dBm = 200mW (ref EM7565 data sheet, Table 4-6 Conducted Tx power tolerances.)

G = 5dBi = 3.162 (ref RMM-UMB-DN-BLK data sheet, 5dBi @ 1650-2000MHz)

⇨ $R = (P.G\ /\ 4.\pi.S\ )^{0.5}$

⇨ $R = (200 \times 3.162\ /\ 4.\pi\ .1)^{0.5}$

⇨   R = 7.09 cm

1.2.4 Simultaneous Transmission (WLAN and GSM) MPE Calculations

MPE, $S_{TOT} <= 1.0$ mW/cm^2 at R = 20cm

Where $S_{TOT} = S_{WLAN} + S_{GSM}$

Using formula $S = P.G\ /\ 4.\pi.R^2$

$S_{WLAN} = P.G\ /\ 4.\pi.R^2 = (500 \times 4)\ /\ (4.\ \pi.\ 20^2) = 0.398$ mW/cm^2

$S_{GSM\ (300to1500MHz)} = P.G\ /\ 4.\pi.R^2 = (200 \times 2)\ /\ (4.\ \pi.\ 20^2) = 0.0796$ mW/cm^2

$S_{GSM\ (1.5to100GHz)} = P.G\ /\ 4.\pi.R^2 = (200 \times 3.162)\ /\ (4.\ \pi.\ 20^2) = 0.126$ mW/cm^2

⇨ $S_{TOT} = 0.398 + 0.126 = 0.524$ mW/cm^2

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