

RF Exposure and Transmitter Power Considerations for the DIGImini 2108-2019

FCC ID: NEO-DMINI21082019

The FCC requires that the calculated MPE be equal to or less than a given limit dependent on frequency at a distance of 20 cm from a device to the body of a user.

The MPE calculation as given in FCC OET Bulletin 65, page 19 is used to calculate the safe operating distance for the user.

The DIGImini is a cellular repeater which operates using two antennas, an outdoor antenna for cellular base station communication and an indoor antenna for communication with user devices. This MPE calculation is intended to address the RF exposure compliance of the indoor antenna (downlink) only, the outdoor antenna (uplink) RF exposure compliance is addressed at the time of licensing, as required by the responsible FCC Bureau(s).

Outdoor antenna gain: 13 dBi (max) with 2 dB cable loss.

Indoor antenna gain: 2.2 dBi (max).

The transmitter operation of the DIGImini covers the Cellular 850 MHz (Band V) and PCS 1900 MHz (Band II) operating bands using GSM, GPRS, EDGE, CDMA, W-CDMA and LTE cellular operating technologies.

The following FCC Rule Parts are applicable:

Part 1.1307 (b)

Actions that may have a significant environmental effect, for which Environmental Assessments (EAs) must be prepared.

Part 1.1310 – Radiofrequency radiation exposure limits

Part 2.1091 – Radiofrequency radiation exposure evaluation: mobile devices

Part 22.913 (a)(2)

The ERP of mobile transmitters and auxiliary test transmitters must not exceed 7 Watts.

Part 24.232 (b)

Mobile/ Portable stations are limited to 2 Watts EIRP peak power.

CALCULATIONS

Maximum Transmitter Power for DIGImini 2108-2019

The maximum transmitter power for uplink and downlink transmissions on each frequency band is calculated below. The highest measured conducted output power, combined with the highest applicable antenna gain was chosen as being representative of the worst case operating condition. In all cases the ERP/EIRP met the appropriate Part 22 and Part 24 limits detailed above.

1. Uplink

ERP – 850 MHz (Band V)

Maximum specified uplink antenna gain = 13 dBi with 2 dB cable loss

Max. Conducted Transmitter Power for the DIGImini: P = 21.9 dBm measured @ antenna socket in GSM GMSK operating mode.

$$\text{EIRP}_{\text{eff}} = 21.9 + 13 - 2 = 32.9 \text{ dBm}$$

$$\text{ERP}_{\text{eff}} = \text{EIRP}_{\text{eff}} - 2.1 \text{ dB (half wave dipole gain)}$$

$$\text{ERP}_{\text{eff}} = 32.9 - 2.1 = 30.8 \text{ dBm (1.2 W)}$$

ie: $\text{ERP}_{\text{eff}} = 1.2 \text{ W}$ (meets 7 W limit)

EIRP – PCS 1900 MHz (Band II)

Max. Conducted Transmitter Power for the DIGImini: P = 21.2 dBm measured @ antenna socket in GSM 8-PSK operating mode.

$$\text{EIRP}_{\text{eff}} = 21.2 + 13 - 2 = 32.2 \text{ dBm}$$

ie: $\text{EIRP}_{\text{eff}} = 1.66 \text{ W}$ (meets 2 W limit)

2. Downlink

ERP – 850 MHz (Band V)

Maximum specified downlink antenna gain = 2.2 dBi

Max. Conducted Transmitter Power for the DIGImini: P = 21.7 dBm measured @ antenna socket in GSM GMSK operating mode.

$$\text{EIRP}_{\text{eff}} = 21.7 + 2.2 = 23.9 \text{ dBm}$$

$$\text{ERP}_{\text{eff}} = \text{EIRP}_{\text{eff}} - 2.1 \text{ dB (half wave dipole gain)}$$

$$\text{ERP}_{\text{eff}} = 23.9 - 2.1 = 21.8 \text{ dBm (0.15 W)}$$

ie: $\text{ERP}_{\text{eff}} = 0.15 \text{ W}$ (meets 7 W limit)

EIRP – PCS 1900 MHz (Band II)

Max. Conducted Transmitter Power for the DIGImini: P = 21.5 dBm measured @ antenna socket in GSM 8-PSK operating mode.

$$\text{EIRP}_{\text{eff}} = 21.5 + 2.2 = 23.7 \text{ dBm}$$

ie: $\text{EIRP}_{\text{eff}} = 0.23 \text{ W}$ (meets 2 W limit)

MPE Calculation for the DIGImini 2108-2019 Indoor Antenna

The MPE calculation as given in FCC OET Bulletin 65, page 19 is used to calculate the safe operating distance for the user. This calculation addresses the RF exposure compliance of the indoor antenna only using the following maximum downlink transmitter powers calculated above:

850 MHz (Band V) EIRP: 23.9 dBm

PCS 1900 MHz (Band II) EIRP: 23.7 dBm

$$S = \text{EIRP} / 4 \pi R^2$$

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 (safe operating distance)

DIGImini @850 MHz (Band V):

Values:

Transmitter frequency range = 869 MHz to 894 MHz (DL)

P = Power Input to antenna = 21.7 dBm

G = Antenna Gain = 2.2 dBi

Therefore Max. EIRP = 23.9 dBm (0.245 W)

Power Density Requirement

From table 1 (b) - Limits for General Population/ Uncontrolled Exposure of FCC Rule Part 1.1310 for 850 MHz

$$S = f / 1500 \text{ mW/cm}^2 \text{ (f = operating frequency)}$$

$$S_{\text{req}} = 824 / 1500 = 0.55 \text{ mW/cm}^2 \text{ (worst case)}$$

Calculation:

$$S = \text{EIRP} / 4 \pi R^2$$

$$0.55 = 245 / (12.56 \times R^2)$$

$$R^2 = 245 / (12.56 \times 0.55)$$

$$R = 5.96 \text{ cm (<20 cm)}$$

DIGImini @ PCS 1900 MHz (Band II):

Values:

Transmitter frequency range = 1930 MHz to 1990 MHz (DL)

P = Power Input to antenna = 21.5 dBm

G = Antenna Gain = 2.2 dBi

Therefore Max. EIRP = 23.7 dBm (0.234 W)

Power Density Requirement

From table 1 (b) - Limits for General Population/ Uncontrolled Exposure of FCC Rule Part 1.1310 for 1900 MHz

$$S_{\text{req}} = 1.0 \text{ mW/cm}^2$$

Calculation:

$$S = \text{EIRP}/4 \pi R^2$$

$$1.0 = 234 / (12.56 \times R^2)$$

$$R^2 = 234 / (12.56 \times 1.0)$$

$$R = 4.32 \text{ cm (<20 cm)}$$

Conclusion

The required Part 22.913 (a)(2), Part 24.232 (b) maximum transmitter power limits will not be exceeded for the DIGImini 2108-2019 using an external antenna having a maximum gain of 13 dBi with 2 dB minimum cable loss, and an indoor antenna having a maximum gain of 2.2 dBi.

The required 20 cm RF exposure limits for General Population/ Uncontrolled Exposure FCC Rule Part 2.1091 limits will not be exceeded for the DIGImini 2108-2019 using an indoor antenna having a maximum gain of 2.2 dBi.

The outdoor antenna RF exposure compliance is addressed at the time of licensing, in accordance with FCC Rule Part 1.1307 as required by the responsible FCC Bureau(s).