

RF Exposure and Transmitter Power Considerations for the DIGImini 2107U-2017

FCC ID: NEODMINI2107U2017

The FCC requires that the calculated MPE (Maximum Permissible Exposure) be equal to or less than a given limit dependent on frequency at a distance of 20cm 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).

The transmitter operation of the DIGImini covers the Cellular 700 MHz (Band 13) and AWS 1700 MHz (Band 4) operating bands using W-CDMA and LTE cellular operating technologies in Band 4 and LTE (only) in Band 13.

Antenna gains specified by the manufacturer:

Outdoor antenna gain (uplink): 9dBi (max) with 2dB cable loss (minimum)

Indoor antenna gain (downlink): 2.2dBi (max) with 2dB cable loss (minimum)

The following FCC Rule Parts are applicable:

Part 1.1310 – Radiofrequency radiation exposure limits

Part 2.1091(b); 2.1091(c) – Radiofrequency radiation exposure evaluation: mobile devices (<1.5GHz, Max Tx = 1.5W ERP. >1.5GHz, Max Tx= 3W ERP)

Part 27.50(b)(10): 777-787MHz Uplink

Portable stations (hand-held devices) transmitting in the 746-757MHz, 758-763MHz, 776-793MHz and 805-806MHz bands are limited to 3W ERP

Part 27.50(b)(4): 746-756MHz Downlink

The ERP of fixed and base stations transmitting a signal in the 746-757MHz, 758-763MHz, 776-787MHz and 788-793MHz bands with an emission bandwidth > 1MHz must not exceed an ERP of 1000 Watts/MHz.

Part 27.50(d)(4): 1710-1755MHz Uplink

Fixed, mobile and portable (hand-held) stations operating in the 1710-1750MHz band are limited to 1W EIRP.

Part 27.50(d)(2)(B): 2110-2155MHz Downlink

Fixed or base stations operating in the 2110 - 2155 MHz band are limited to 1640W EIRP.

CALCULATIONS

The highest measured conducted output power per operating band, combined with the highest applicable antenna gain (irrespective of operating technology) was chosen as representative of the worst case operating condition.

Maximum Transmitter Power for DIGImini 2107U-2017

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 along with the cable loss was chosen as being representative of the worst case operating condition.

Uplink

The maximum specified antenna gain = 9dBi. Cable loss = 2dB

ERP – Uplink (777-787MHz)

Max. Conducted Transmitter Power for the DIGImini 700U/1700 = 21.8dBm (151mW) at antenna socket (*measured*).

$$\text{EIRP}_{\text{eff}} = 21.8 + 9 - 2 = 28.8\text{dBm}$$

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

$$\text{ERP}_{\text{eff}} = 28.8 - 2.1 = 26.7\text{dBm}$$

$$\text{i.e.: ERP}_{\text{eff}} = 0.468\text{W (meets 3W limit)}$$

EIRP – Uplink (1710-1755MHz)

Max. Conducted Transmitter Power for the DIGImini 700U/1700 = 20.5dBm (112mW) at antenna socket (*measured*).

$$\text{EIRP}_{\text{eff}} = 20.5 + 9 - 2 = 27.5\text{dBm}$$

$$\text{i.e.: ERP}_{\text{eff}} = 0.562\text{W (meets 1W limit)}$$

Downlink

The maximum specified antenna gain = 2.2dBi. Cable loss = 2dB

ERP – Downlink (746-756MHz)

Max. Conducted Transmitter Power for the DIGImini 700U/1700 = 21.7dBm (148mW) at antenna socket (*measured*).

$$\text{EIRP}_{\text{eff}} = 21.7 + 2.2 - 2 = 21.9\text{dBm}$$

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

$$\text{ERP}_{\text{eff}} = 21.9 - 2.1 = 19.8\text{dBm}$$

i.e.: $\text{ERP}_{\text{eff}} = 0.095\text{W}$ (meets 1000W limit)

EIRP – Downlink (2110-2155MHz)

Max. Conducted Transmitter Power for the DIGImini 700U/1700 = 20.3dBm (151mW) at antenna socket (*measured*).

$$\text{EIRP}_{\text{eff}} = 20.3 + 2.2 - 2 = 20.5\text{dBm}$$

i.e.: $\text{EIRP}_{\text{eff}} = 0.112\text{W}$ (meets 1640W limit)

MPE Calculation for the DIGImini 2107U-2017

This calculation addresses the RF exposure compliance of the indoor antenna only using the following maximum downlink transmitter powers calculated above:

- 700MHz (LTE band 13) EIRP: 21.9dBm (155mW)
- 1700MHz (LTE band 4) EIRP: 20.5dBm (112mW)

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

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

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)

Downlink LTE band 13 (746-756MHz)

Power Density Requirement

Exposure of From table 1 (b) - Limit for General Population/ Uncontrolled
 1500MHz FCC Rule Part 1.1310 for frequencies between 300MHz and

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

$$S_{\text{req}} = 746/1500 = 0.50 \text{ mW/cm}^2 \text{ (worst case)}$$

Calculation:

$$S = \text{EIRP}/4 \pi R^2$$
$$0.50 = 155/(12.56 \times R^2)$$
$$R^2 = 155/(12.56 \times 0.50)$$

$$R = 5.0\text{cm} (<20\text{cm})$$

Downlink LTE band 4 (2110-2155MHz)

Power Density Requirement

From table 1 (b) - Limit for General Population/ Uncontrolled

Exposure of

FCC Rule Part 1.1310 for frequencies above 1500MHz

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

Calculation:

$$S = \text{EIRP}/4 \pi R^2$$
$$1.0 = 112/(12.56 \times R^2)$$
$$R^2 = 112/(12.56 \times 1.0)$$

$$R = 3.0\text{cm} (<20\text{cm})$$

Conclusion

The required Part 27.50(b)(10), Part 27.50(b)(4), 27.50(d)(4) and 27.50 d)(2)(B) maximum transmitter power limits will not be exceeded for the DIGImini 2107U-2017 using an external antenna having a maximum gain of 9dBi with 2dB minimum cable loss, and an indoor antenna having a maximum gain of 2.2dBi with a 2dB cable loss.

The required 20 cm RF exposure limits for General Population/ Uncontrolled Exposure FCC Rule Part 2.1091 will not be exceeded for the DIGImini 2107U-2017 using an indoor antenna having a maximum gain of 2.2 dBi with an associated cable loss of 2dB.

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