



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

FCC ID: NEODMINI2107L2017

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).

Antenna gains specified by the manufacturer:

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

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

The transmitter operation of the DIGImini covers the Cellular 700 MHz (Band 12) and AWS 1700 MHz (Band 4) operating bands using W-CDMA and LTE cellular operating technologies in Band 4 and LTE (only) in Band 12.

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 (<1.5GHz, Max Tx = 1.5W ERP. >1.5GHz, Max Tx= <3W ERP)

Part 27.50 (c)(10) – 699 - 716 MHz Uplink

Portable stations (hand-held devices) are limited to 3 watts ERP. (As the device provides a mobile service between the base station and the portable, the output power should be subject to the same limits as a portable unit when transmitting on an uplink channel).

Part 27.50 (c)(3) – 729 - 746 MHz Downlink

Fixed and base stations transmitting a signal with an emission bandwidth greater than 1 MHz must not exceed an ERP of 1000 watts/MHz.

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

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

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

Fixed or base stations operating in the 2110 - 2155 MHz band are limited to 1640 W 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. LTE in Band 12 (700 MHz) and WCDMA in Band 4 (1700 MHz) operation were found to have the highest power levels and therefore these values were used in the following calculations.

Maximum Transmitter Power for DIGImini 2107L-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 was chosen as being representative of the worst case operating condition. In all cases the ERP/EIRP met the appropriate Part 27 limits detailed above.

1. Uplink

ERP – LTE Band 12, 700 MHz

As stated above, the maximum specified antenna gain = 9 dBi with 2 dB cable loss

Max. Conducted Transmitter Power for the DIGImini: P = 21.3 dBm measured at the antenna socket in LTE operating mode.

$$\text{EIRP}_{\text{eff}} = 21.3 + 9 - 2 = 28.3 \text{ dBm}$$

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

$$\text{ERP}_{\text{eff}} = 28.3 - 2.1 = 26.2 \text{ dBm}$$

ie: $\text{ERP}_{\text{eff}} = 0.42 \text{ W}$ (meets 3 W ERP limit)

EIRP – LTE Band 4, 1700 MHz

Max. Conducted Transmitter Power for the DIGImini: P = 20.5 dBm measured at the antenna socket in WCDMA operating mode.

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

ie: $\text{EIRP}_{\text{eff}} = 0.56 \text{ W}$ (meets 1 W EIRP limit)

2. Downlink

ERP – LTE Band 12, 700 MHz

Maximum specified antenna gain = 2.2 dBi with 2 dB cable loss

Max. Conducted Transmitter Power for the DIGImini: P = 20.9 dBm measured at the antenna socket in LTE operating mode.

$$\text{EIRP}_{\text{eff}} = 20.9 + 2.2 - 2 = 21.1 \text{ dBm}$$

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

$$\text{ERP}_{\text{eff}} = 21.1 - 2.1 = 19 \text{ dBm}$$

ie: $\text{ERP}_{\text{eff}} = 0.08 \text{ W}$ (meets 1000 W ERP limit)

EIRP – LTE Band 4, 1700 MHz

Max. Conducted Transmitter Power for the DIGImini: P = 20.3 dBm measured at the antenna socket in LTE operating mode.

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

ie: $\text{EIRP}_{\text{eff}} = 0.11 \text{ W}$ (meets 1640 W EIRP limit)

MPE Calculation for the DIGImini 2107L-2017 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:

700 MHz (LTE Band 12) EIRP: 21.1 dBm

1700 MHz (LTE Band 4) EIRP: 20.5 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 @ LTE Band 12, 700 MHz:

Values:

Transmitter frequency range = 728 MHz to 746 MHz (DL)

P = Power Input to antenna = 18.9 dBm

G = Antenna Gain = 2.2 dBi

Therefore Max. EIRP = 21.1 dBm (0.129 W)

Power Density Requirement

Exposure of From table 1 (b) - Limits for General Population/ Uncontrolled
FCC Rule Part 1.1310 for 700 MHz

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

$$S_{\text{req}} = 728/1500 = 0.49 \text{ mW/cm}^2 \text{ (worst case)}$$

Calculation:

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

$$0.49 = 129/(12.56 \times R^2)$$

$$R^2 = 129/(12.56 \times 0.49)$$

$$R = 4.58 \text{ cm (<20 cm)}$$

DIGImini @ LTE Band 4, 1700 MHz:

Values:

Transmitter frequency range = 2110 MHz to 2155 MHz (DL)

P = Power Input to antenna = 18.3 dBm

G = Antenna Gain = 2.2 dBi

Therefore Max. EIRP = 20.5 dBm (0.112 W)

Power Density Requirement

Exposure of From table 1 (b) - Limits for General Population/ Uncontrolled
FCC Rule Part 1.1310 for 2100 MHz.

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

Calculation:

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

$$1.0 = 112/(12.56 \times R^2)$$

$$R^2 = 112/(12.56 \times 1.0)$$

$$R = 2.99 \text{ cm } (<20 \text{ cm})$$

Conclusion

The required Part 27.50 (c)(10), Part 27.50 (d)(4), 27.50 (c)(3) and 27.50 (d)(2)(B) maximum transmitter power limits will not be exceeded for the DIGImini 2107L-2017 using an external antenna having a maximum gain of 9 dBi with 2 dB minimum cable loss, and an indoor antenna having a maximum gain of 2.2 dBi with 2 dB minimum 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 2107L-2017 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, as required by the responsible FCC Bureau(s).