

Muehlau, 07.05.2019

1 RF Exposure and Transmitter Power Considerations for the ARU 3570

FCC ID: WJ9-ARU3560

The transmitter operation for the ARU 3570 covers the 902 – 928MHz operating band (RF ID). The ARU 3570 supports one internal antenna and up to three external antennas but operates on only one antenna at a time.

In addition, the ARU 3570 contains a Cellular module (FCC: WJ9-KSPHS8P) that operates in GSM850 and GSM1900 frequency bands.

The RF ID internal antenna and the Cellular module antenna are in close proximity to each other.

The GSM850 and GSM1900 do not transmit simultaneously

The RF ID and Cellular module can transmit simultaneously.

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

MAXIMUM TRANSMITTER POWER CONSIDERATIONS

Conducted power values are maximum average tune up with tolerance:

RFID 915MHz:

Transmitter power:

(Ref 15.247 (b)(4) – Antennas with gains >6dBi)

- 1) For external 13dBi gain antenna use, 30dBm max. power is reduced by 7dB (13dBi – 6dB)
 $EIRP_{max} = +23dBm + 13dBi \text{ antenna gain} = +36dBm (3.98W)$
- 2) For external 10dBi gain antenna use, 30dBm max. power is reduced by 4dB (10dBi – 6dB)
 $EIRP_{max} = +26dBm + 10dBi \text{ antenna gain} = +36dBm (3.98W)$
- 3) For external 8dBi gain antenna use, 30dBm max. power is reduced by 2dB (8dBi – 6dB)
 $EIRP_{max} = +28dBm + 8dBi \text{ antenna gain} = +36dBm (3.98W)$
- 4) For internal +7dBi gain antenna use, 30dBm max. power is reduced by 1dB (7dBi – 6dB)
 $EIRP_{max} = +29dBm + 7dBi \text{ antenna gain} = +36dBm (3.98W)$

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- 5) For external 6dBi gain antenna use

$$\text{EIRP}_{\text{max}} = +30\text{dBm} + 6\text{dBi antenna gain} = +36\text{dBm} (3.98\text{W})$$

Cellular GSM850:

Power conducted = 33.5dBm (2.24W)

Antenna Gain: 3.9dBi

EIRP = 37.4dBm = 5495.4mW

Cellular GSM1900:

Power conducted = 30.5dBm (1.12W)

Antenna Gain: 2.5dBi

EIRP = 33.0dBm = 1995.3mW

MPE CALCULATIONS

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

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

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)

RFID

Power Density Requirement

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

$$S_{\text{req1}} = f_{\text{MHz}} / 1500 \text{ mW/cm}^2 = 902 / 1500 = 0.6 \text{ mW/cm}^2$$

Calculation:

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

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

$$R = \sqrt{3981 / (4 \pi \times 0.6)}$$

$$R = \sqrt{3981 / (7.54)}$$

$$R = \sqrt{527.98}$$

$$R = 23\text{cm}$$

Cellular: GSM850 (824MHz to 849MHz)**Power Density Requirement**

From table 1 (b) - Limits for General Population/ Uncontrolled Exposure of FCC Rule Part 1.1310 for GSM850

$$S_{\text{req2}} = f_{\text{MHz}}/1500 \text{ mW/cm}^2 = 824/1500 = 0.55 \text{ mW/cm}^2$$

Calculation:

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

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

$$R = \sqrt{5495.1 / (4 \pi \times 0.55)}$$

$$R = \sqrt{5495.1 / (6.91)}$$

$$R = \sqrt{795.24}$$

$$R = 28.2\text{cm}$$

Cellular: GSM1900 (1850MHz to 1910MHz)**Power Density Requirement**

From table 1 (b) - Limits for General Population/ Uncontrolled Exposure of FCC Rule Part 1.1310 for GSM1900

$$S_{\text{req3}} = 1.0 \text{ mW/cm}^2$$

Calculation:

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

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

$$R = \sqrt{1995.3 / (4 \pi \times 1)}$$

$$R = \sqrt{1995.3 / (12.57)}$$

$$R = \sqrt{158.74}$$

$$R = 12.6\text{cm}$$

Therefore at a distance of 20cm, the power density of the GSM1900 transmission will be <1.

KDB 447498 D01 Section 7.2: SIMULTANEOUS TRANSMISSION CONSIDERATIONS

For mobile exposure host platform devices to qualify for simultaneous transmission MPE test exclusion, all transmitters and antennas in the host must qualify for the standalone MPE test exclusion in KDB 447498 D01, section 7.1.

From KDB 447498 D01, section 7.1:

"When a device qualifies for the categorical exclusion provision of § 2.1091(c), the minimum test separation distance may be estimated, when applicable, by simple calculations according to plane-wave equivalent conditions, to ensure the transmitter and its antenna(s) can operate in manners that meet or exceed the estimated distance.⁶³ The source-based time-averaged maximum radiated power, according to the maximum antenna gain, must be applied to calculate the field strength and power density required to establish the minimum test separation distance."

⁶³ The type of calculations used to estimate minimum test separation distance for MPE compliance must be appropriate for the type of antenna(s) and exposure conditions evaluated "

Therefore, a minimum test separation distance needs to be such that as per KDB 447498, the summation of calculated MPE ratios for RFID + cellular is <1.

Using an iterative process, 37cm is found to be the optimum minimum separation distance that provides ΣMPE ratios <1.0

For RFID

Calculation:

$$S = 3981/4 \pi R^2$$

$$S = 3981/(12.56 \times 37^2)$$

$$S = 3981/(7238)$$

$$S_1 = 0.231 \text{ mW/cm}^2$$

For Cellular: GSM850 (824MHz to 849MHz)

Calculation:

$$S = 5495 / 4 \pi R^2$$

$$S = 5495 / (12.56 \times 37^2)$$

$$S = 5495 / (17203)$$

$$S_2 = 0.319 \text{ mW/cm}^2$$

Therefore,

$$\begin{aligned}\Sigma \text{MPE}_{\text{ratios}} &= (S_1 / S_{\text{req1}}) + (S_2 / S_{\text{req2}}) \\ &= (0.231/0.6) + (0.319/0.55) \\ &= 0.965\end{aligned}$$

As the Σ of MPE ratios < 1.0 at a distance of 37cm, in accordance with KDB447498 Section 7.2, simultaneous transmission test exclusion applies for the transmitters.

Conclusion

The safe operating distance for the ARU 3570 for General Population/ Uncontrolled Exposure limits is:

- A minimum of 23cm when only the RFID is operational.
- A minimum of 37cm with simultaneous operation of the RFID and Cellular module.

For all antennas specified to be used with the equipment

Signature:  Date: 05/07/2019

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