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1 RF Exposure and Transmitter Power Considerations for the ARU 3560

FCC ID: WJ9-ARU3560

The transmitter operation for the ARU 3560 covers the 902 – 928MHz operating band (RFID). The ARU 3560 supports one internal antenna and up to three external antennas but operates on only one antenna at a time. In addition, the ARU 3560 contains a WLAN module (FCC ID: WJ9-WL1837MOD) that operates in the 2.4 GHz and 5 GHz frequency bands using WLAN 802.11a/b/g/n technologies.

The RFID internal antenna and the WLAN module antenna are in close proximity to each other.

The 2.4GHz, and 5GHz WLAN do not transmit simultaneously

The RF ID and WLAN 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)
 $EIRP_{max} = +28dBm + 8dBi \text{ antenna gain} = +36dBm (3.98W)$

KATHREIN Sachsen GmbH

Lindenstraße 3
09241 Mühlau
Germany

Phone: +49 3722 60 73 10
Fax: +49 3722 60 73 24
info@kathrein-sachsen.de
www.kathrein-sachsen.de

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VAT Reg. No.: DE 140 915 677

Company headquarters: Mühlau
HRB 2398 Chemnitz

Managing director(s): Daniel Schkalda

Bank details:

EUR-Accounts:

Deutsche Bank Chemnitz
IBAN: DE28 8707 0000 0263 7270 00
BIC: DEUTDE8CXXX

Volksbank Chemnitz
IBAN: DE60 8709 6214 0320 0014 47
BIC: GENODEF1CH1

Sparkasse Mittelsachsen
IBAN: DE93 8705 2000 3545 0015 54
BIC: WELADED1FGX

- 4) For internal +7dBi gain antenna use, 30dBm max. power is reduced by 1dB (7dBi – 6dB)

$$\text{EIRP}_{\text{max}} = +29\text{dBm} + 7\text{dBi antenna gain} = +36\text{dBm} (3.98\text{W})$$

- 5) For external 6dBi gain antenna use

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

WLAN 2.4GHz:

Power conducted = 17.5dBm (56.2mW)

Antenna Gain: 3.2dBi

EIRP = 20.7dBm = 117.5 mW

WLAN 5GHz:

Power conducted = 19.5dBm (89.1mW)

Antenna Gain: 4.5dBi

EIRP = 24.0dBm = 251.2 mW

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:

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

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

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

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

$$R = \sqrt{527.98}$$

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

For WLAN 2.4GHzValues:

Transmitter frequency range = 2412 MHz to 2472MHz

EIRP = 117.5 mW

R = 20cm

Power Density Requirement

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

$$S_{\text{req2}} = 1.0 \text{ mW/cm}^2$$

Calculation:

$$S = 117.5 / 4 \pi R^2$$

$$S = 117.5 / (12.56 \times 20^2)$$

$$S = 117.5 / (5024)$$

$$S = 0.023 \text{ mW/cm}^2 (<1.0 \text{ mW/cm}^2)$$

(S = 1 at a distance of 3.1cm)

For WLAN 5GHzValues:

Transmitter frequency range = 5180 MHz to 5825MHz

EIRP = 251.2 mW

R = 20cm

Power Density Requirement

From table 1 (b) - Limits for General Population/ Uncontrolled Exposure of FCC Rule Part 1.1310 for 5GHz

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

Calculation:

$$S = 251.2 / 4 \pi R^2$$

$$S = 251.2 / (12.56 \times 20^2)$$

$$S = 251.2 / (5024)$$

$$S = 0.050 \text{ mW/cm}^2 (<1.0 \text{ mW/cm}^2)$$

(S = 1 at a distance of 4.5cm)

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 RF ID + WLAN 5GHz is <1.

Using an iterative process, 24cm is found to be the optimum minimum separation distance that provides Σ MPE ratios <1.0

For RFID

Calculation:

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

$$S = 3981/(12.56 \times 24^2)$$

$$S = 3981/(7238)$$

$$S_1 = 0.550 \text{ mW/cm}^2$$

For WLAN 5GHz

Calculation:

$$S = 251.2 / 4 \pi R^2$$

$$S = 251.2 / (12.56 \times 24^2)$$

$$S = 251.2 / (7238)$$

$$S_3 = 0.035 \text{ mW/cm}^2$$

Therefore,

$$\Sigma \text{MPE}_{\text{ratios}} = (S_1 / S_{\text{req1}}) + (S_3 / S_{\text{req3}})$$

$$= (0.550/0.6) + (0.035/1.0)$$

$$= 0.952$$

As the Σ of MPE ratios < 1.0 at a distance of 24cm, in accordance with KDB447498 Section 7.2, simultaneous transmission test exclusion applies for the transmitters.

Conclusion

The safe operating distance for the ARU 3560 for General Population/ Uncontrolled Exposure limits is:

- A minimum of 23cm when only the RFID is operational.
- A minimum of 24cm with simultaneous operation of the RFID and WLAN module.

For all antennas specified to be used with the equipment

Signature:  Date: 05/07/2019

Daniel Schkalda

Managing director