RF Exposure and Transmitter Power Considerations for the Audiovox Incaar Systems BCU (includes Option GTM681W module)

FCC ID: 2AAKLD189070

Analysis for FCC Mobile use

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 transmitter operation for the Audiovox Incaar Systems BCU covers 850 MHz, 1750 MHz, 1900 MHz and 2.4 GHz operating bands using GSM, CDMA, UMTS, Bluetooth and Wi-Fi technologies.

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

Part 15.247(b)(1) - For frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 watt.

Part 15.247(b)(3) - For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt.

Part 15.247(b)(4) - The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi.

Part 22.913(a)(2)
The ERP of mobile transmitters and auxiliary test transmitters must not exceed 7 Watts.

Part 24.232(c)
Mobile/ Portable stations are limited to 2 Watts EIRP peak power.

Part 27.50(d)(4)
Fixed, mobile, and portable (handheld) stations operating in the 1710–1755 MHz band are limited to 1 watt EIRP.

KDB447498 D01 v05
Mobile and Portable Devices RF Exposure Procedures and Equipment Authorisation Policies

The MPE calculation $S = EIRP/4 \pi R^2$ is used to calculate the safe operating distance for the user.

MAXIMUM TRANSMITTER POWER CONSIDERATIONS

850 MHz Operation

For GSM 850MHz

Transmitter frequency range = 824 MHz to 849 MHz

Conducted power = 33 dBm (2000 mW)

Maximum specified antenna gain = 2.15 dBi

EIRP = 33 + 2.15 dBm = 35.15 dBm = 3273 mW

For Class 10 GPRS/ EGPRS with 2 uplink timeslots, duty cycle = 25%

$EIRP_{eff}$ = 3273/4 = 818 mW

(With consideration of source based time averaging as per KDB 447498 Section 4.1(2))

ERP = 35.15 (EIRP) - 2.2 (dipole gain) = 32.95 dBm = 1972 mW

For Class 10 GPRS/ EGPRS with 2 uplink timeslots, duty cycle = 25%

ERP_{eff} = 1972/4 = 493 mW

For UMTS Band V 850 MHz

Transmitter frequency range = 824 MHz to 849 MHz

Conducted power = 24 dBm (251 mW)

Maximum specified antenna gain = 2.15 dBi

EIRP = 24 + 2.15 dBm = 26.15 dBm = 412 mW

ERP = 26.15 (EIRP) - 2.2 (dipole gain) = 23.95 dBm = 248 mW

ERP = 248 mW

Therefore the Audiovox Incaar Systems BCU meets Part 22.913(a)(2) power limits (ERP 7 Watts).

Also the categorical exclusion provision of FCC Part 2.1091(c) applies as ERP < 1.5W.

1750 MHz Operation

For CDMA 1750 MHz

Transmitter frequency range = 1710 MHz to 1755 MHz

Conducted Power = 24 dBm (251 mW)

Maximum specified antenna gain = 2.15 dBi

EIRP = 24 + 2.15 dBm = 26.15 dBm = 412 mW

EIRP = 412 mW

Therefore the Audiovox Incaar Systems BCU meets 27.50(d)(4) power limits (EIRP 1 Watt).

Also the categorical exclusion provision of FCC Part 2.1091(c) applies as EIRP < 3.0W.

1900 MHz Operation

For PCS 1900 MHz

Transmitter frequency range = 1850 MHz to 1910 MHz

Conducted Power = 30 dBm (1000 mW)

Maximum specified antenna gain = 2.15 dBi

EIRP = 30 + 2.15 dBm = 32.15 dBm = 1641 mW

For Class 10 GPRS with 2 uplink timeslots, duty cycle = 25%

$EIRP_{eff}$ = 1641/4 = 410 mW

(With consideration of source based time averaging as per KDB 447498 Section 4.1(2))

For UMTS Band II 1900 MHz

Transmitter frequency range = 1850 MHz to 1910 MHz

Conducted Power = 24 dBm (251 mW)

Maximum specified antenna gain = 2.15 dBi

EIRP = 24 + 2.15 dBm = 26.15 dBm = 412 mW

EIRP = 412 mW

Therefore the Audiovox Incaar Systems BCU meets 24.232(c) power limits (EIRP 2 Watts).

Also the categorical exclusion provision of FCC Part 2.1091(c) applies as EIRP < 3.0W.

2400 MHz Operation

For WLAN 2450 MHz

Transmitter frequency range = 2412 MHz to 2462 MHz

Max. Conducted Transmitter Power P = 19.96 dBm (99 mW) (specification value + tolerance).

Maximum specified antenna gain = 3.2 dBi

EIRP = 19.96 + 3.2 dBm = 23.16 dBm = 207 mW

For Bluetooth 2450 MHz

Transmitter frequency range = 2402 MHz to 2483.5 MHz

Max. Conducted Transmitter Power P = 5.4 dBm (3.24 mW) (specification value + tolerance).

Maximum specified antenna gain = 3.2 dBi

EIRP = 5.4 + 3.2 dBm = 8.6 dBm = 7.24 mW

Therefore the Audiovox Incaar Systems BCU meets Part 15.247(b)(1), Part 15.247(b)(3) & 15.247(b)(4) conducted power and antenna gain limits (1 W & 6 dBi respectively).

MPE CALCULATIONS

The following MPE calculation is used to calculate the safe operating distance for the highest (worst case) EIRP values in each operating band as stated above.

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

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)

For 850 MHz Operation (worst case GSM 850)

Values:

Transmitter frequency range = 824 MHz to 849 MHz

$EIRP_{eff}$ = 818 mW

R = 20cm

Power Density Requirement

From FCC Rule Part 1.1310 Table 1 - Limits for General Population/ Uncontrolled Exposure for GSM 850 MHz

$S = f/1500$ mW/cm^2 (f = operating frequency)

S_{req1} = 824/1500 = 0.55 mW/cm^2 (worst case)

Calculation:

$S = EIRP_{eff} /4 \pi R^2$

$S = 818/(12.56 \times 20^2)$

$S = 818/(5024)$

S_1 = 0.163 mW/ cm^2 (<0.55 mW/cm^2)

For CDMA 1750 MHz

Values:

Transmitter frequency range = 1710 MHz to 1755 MHz

EIRP = 412 mW

R = 20cm

Power Density Requirement

From FCC Rule Part 1.1310 Table 1 - Limits for General Population/ Uncontrolled Exposure for 1750MHz

S_{req2} = 1.0 mW/cm^2

Calculation:

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

$S = 412/(12.56 \times 20^2)$

$S = 412/(5024)$

S_2 = 0.082 mW/ cm^2 (<1.0 mW/cm^2)

For 1900 MHz Operation (worst case UMTS Band II)

Values:

Transmitter frequency range = 1850MHz to 1910MHz

EIRP = 412 mW

R = 20cm

Power Density Requirement

From FCC Rule Part 1.1310 Table 1 - Limits for General Population/ Uncontrolled Exposure for 1900MHz

S_{req3} = 1.0 mW/cm^2

Calculation:

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

$S = 412/(12.56 \times 20^2)$

$S = 412/(5024)$

S_3 = 0.082 mW/ cm^2 (<1.0 mW/cm^2)

For 2400 MHz Operation (worst case WLAN 802/11g)

Values:

Transmitter frequency range = 2412 MHz to 2462 MHz

EIRP = 207 mW

R = 20cm

Power Density Requirement

From FCC Rule Part 1.1310 Table 1 - Limits for General Population/ Uncontrolled Exposure for 2400MHz

$$S_{req4} = 1.0 \text{ mW/cm}^2$$

Calculation:

$$S = EIRP/4 \pi R^2$$
$$S = 207/(12.56 \times 20^2)$$
$$S = 207/(5024)$$

$$S_4 = 0.041 \text{ mW/ cm}^2 \ (<1.0 \text{ mW/cm}^2)$$

KDB447498 D01 v05 Section 7.2 SIMULTANEOUS TRANSMISSION CONSIDERATIONS

Only one cellular transmitter can be operational at one time in simultaneous operation with WLAN or Bluetooth. The following three worst case scenarios are therefore considered for simultaneous transmission, all other combinations have lower power densities at the applicable frequencies:

Case 1: GSM 850 (GPRS) and WLAN

Case 2: CDMA 1750 and WLAN

Case 3: UMTS Band II and WLAN

Worst case summation of calculated MPE ratios for the above simultaneously transmitting transmitters is calculated below:

Case 1: GSM 850 (GPRS) and WLAN

$$\Sigma\mathbf{MPE_{ratios}} \quad = (S_1/ S_{req1})_+ (S_4/ S_{req4})$$
$$= (0.163/0.55) + (0.036/1.0)$$
$$\mathbf{= 0.296 + 0.036 = 0.332}$$

Case 2: CDMA 1750 and WLAN

$$\Sigma\mathbf{MPE_{ratios}} \quad = (S_2/ S_{req2})_+ (S_4/ S_{req4})$$
$$= (0.082/1.0) + (0.036/1.0)$$
$$\mathbf{= 0.082 + 0.036 = 0.118}$$

Case 3: UMTS Band II and WLAN

$$\Sigma\mathbf{MPE_{ratios}} \quad = (S_3/ S_{req3})_+ (S_4/ S_{req4})$$
$$= (0.082/1.0) + (0.036/1.0)$$
$$\mathbf{= 0.082 + 0.041 = 0.123}$$

Σ of all three scenario MPE ratios <1.0, so in accordance with KDB447498 Section 7.2, simultaneous transmission test exclusion applies for all possible transmitter combinations.

Conclusion

The required 20cm RF exposure limits for General Population/ Uncontrolled Exposure FCC Rule Part 15.247(b)(1), 15.247(b)(4), 22.913(a)(2), 24.232(c) and 27.50(d)(4) maximum transmitter power limits will not be exceeded for the Audiovox Incaar Systems BCU using antennas having a maximum gain of 2.15 dBi (GSM, CDMA, UMTS) and 3.2 dBi (WLAN, Bluetooth) respectively.

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