

FCC-ID	QHC-I210G24
IC-ID (Industry Canada)	4393B-I210G24



MPE Prediction

Calculations can be made to predict RF field strength and power density levels around typical RF sources using the general equations (3) and (4) on page 19 of the following FCC document:
 “OET Bulletin 65, Edition 97-01 - Evaluating Compliance with FCC Guidelines for Human Exposure to Radio frequency Electromagnetic Fields”.

The table below is excerpted from Table 1B of 47 CFR 1.1310 titled Limits for Maximum Permissible Exposure (MPE), Limits for General Population/Uncontrolled Exposure:

Frequency Range (MHz)	Power density (mW/cm ²)	Averaging time (minutes)
300 – 1500	f (MHz) /1500	30
1500 – 100.000	1.0	30

Based on the above table the limits are:

For 850 MHz frequency band device: 0.57 mW/cm²

For 1900 MHz frequency band device: 1 mW/cm²

Using the equation from page 19 of OET Bulletin 65, Edition 97-01:

$$S = \frac{PG}{4\pi R^2}$$

where: S = power density (in appropriate units, e.g. mW/cm²)

P = power input to the antenna (in appropriate units, e.g., mW)

G = power gain of the antenna in the direction of interest relative to an isotropic radiator

R = distance to the center of radiation of the antenna (appropriate units, e.g., cm)

Note:

This device is to be used only for fixed and mobile applications.

The antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all the persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

§ 2.1091:

The limit for 850 MHz mobile operations where no routine evaluation is required is: 1.5W ERP

The limit for 1700 / 1900 MHz mobile operations where no routine evaluation is required is: 3W EIRP

Max permissive power according to §24.232 : 2W EIRP

Max permissive power according to §§22.913 (a): 7W ERP

FCC-ID	QHC-I210G24
IC-ID (Industry Canada)	4393B-I210G24

For the unit tested by Cetecom Inc., the power density at a distance of 20cm can be deducted as follows-

Operation in cellular band (824-849 MHz)

$$\text{EIRP} = 32.5 + 2.14 = 34.64 \text{ dBm} = 2910.7 \text{ mW}$$

$$\begin{aligned} \text{Power density} &= \text{EIRP} * \text{DutyCycle} / (4\pi R^2) \\ &= 2910.7 * 0.5 / (4 * \pi * 20^2) \\ &= 0.29 \text{ mW/cm}^2 \end{aligned}$$

where duty cycle is 0.5 (worst case) and R is 20cm.

The power density limit for 850 band operation is 0.55 mW/cm^2 . Hence the device is compliant with the rules on RF exposure.

Operation in PCS band (1850-1910 MHz)

$$\text{EIRP} = 30.00 \text{ dBm} = 1000 \text{ mW}$$

$$\begin{aligned} \text{Power density} &= \text{EIRP} * \text{DutyCycle} / (4\pi R^2) \\ &= 1000 * 0.5 / (4 * \pi * 20^2) \\ &= 0.10 \text{ mW/cm}^2 \end{aligned}$$

where duty cycle is 0.5 (worst case) and R is 20cm.

The power density limit for 1900 band operation is 1 mW/cm^2 . Hence the device is compliant with the rules on RF exposure.

Operation in Zigbee mode (2.4GHz)

$$\text{EIRP} = 19.53 \text{ dBm} = 89.74 \text{ mW}$$

$$\begin{aligned} \text{Power density} &= \text{EIRP} / (4\pi R^2) \\ &= 89.74 / (4 * \pi * 20^2) \\ &= 0.018 \text{ mW/cm}^2 \end{aligned}$$

R is 20cm.

The power density limit for 2.4Ghz band operation is 1 mW/cm^2 . Hence the device is compliant with the rules on RF exposure.

FCC-ID	QHC-I210G24
IC-ID (Industry Canada)	4393B-I210G24

Compliance with MPE limits can be guaranteed as the calculation below shows:

850 MHz frequency band

Maximum output power considerations:

Mode	Maximum conducted output power (dBm)	Maximum conducted output power (mW)	Duty cycle	Equivalent conducted output power (Maximum conducted output power x duty cycle) (mW)
GSM	33.03	2009.0	25%	502.27

P	Maximum power input to the antenna:	502.27	mW
R	Distance:	20	cm
S	MPE limit for uncontrolled exposure:	0,57	mW/cm ²

G ₁	Antenna gain (dBi) to comply with MPE limits:	7.47	dB
----------------	---	-------------	-----------

ERP power limit according to §2.1091:	1,5	W ERP
---------------------------------------	-----	-------

G ₂	Antenna gain (dBi) to comply with ERP limits: (ERP = Equivalent conducted output power x Antenna gain / 1,64)	6.90	dB
----------------	--	-------------	-----------

ERP power limit according to §22.913:	7	W ERP
---------------------------------------	---	-------

G ₃	Antenna gain (dBi) to comply with ERP limits: (ERP = Maximum conducted output power x Antenna gain / 1,64)	7.57	dB
----------------	---	-------------	-----------

G _{850 MHz band}	Min (G ₁ , G ₂ , G ₃)	6.90	dB
---------------------------	---	-------------	-----------

Therefore the maximum antenna gain for mobile operation to comply with MPE and ERP limits shall not exceed **6.90 dBi**.

FCC-ID	QHC-I210G24
IC-ID (Industry Canada)	4393B-I210G24

1900 MHz frequency band

Maximum output power considerations:

Mode	Maximum conducted output power (dBm)	Maximum conducted output power (mW)	Duty cycle	Equivalent conducted output power (Maximum conducted output power x duty cycle) (mW)
GSM	30.17	1039.9	25%	259.98

P	Maximum power input to the antenna:	259.98	mW
R	Distance:	20	cm
S	MPE limit for uncontrolled exposure:	1	mW/cm ²

G ₁	Antenna gain (dBi) to comply with MPE limits:	12.85	dBi
----------------	---	--------------	------------

EIRP power limit according to §2.1091:	3	W EIRP
--	---	--------

G ₂	Antenna gain (dBi) to comply with ERP limits: (EIRP = Equivalent conducted output power x Antenna gain)	12.77	dBi
----------------	---	--------------	------------

EIRP power limit according to §24.232:	2	W EIRP
--	---	--------

G ₃	Antenna gain (dBi) to comply with EIRP limits: (EIRP = Maximum conducted output power x Antenna gain)	2.83	dBi
----------------	--	-------------	------------

G _{1900 MHz band}	Min (G ₁ , G ₂ , G ₃)	2.83	dBi
----------------------------	---	-------------	------------

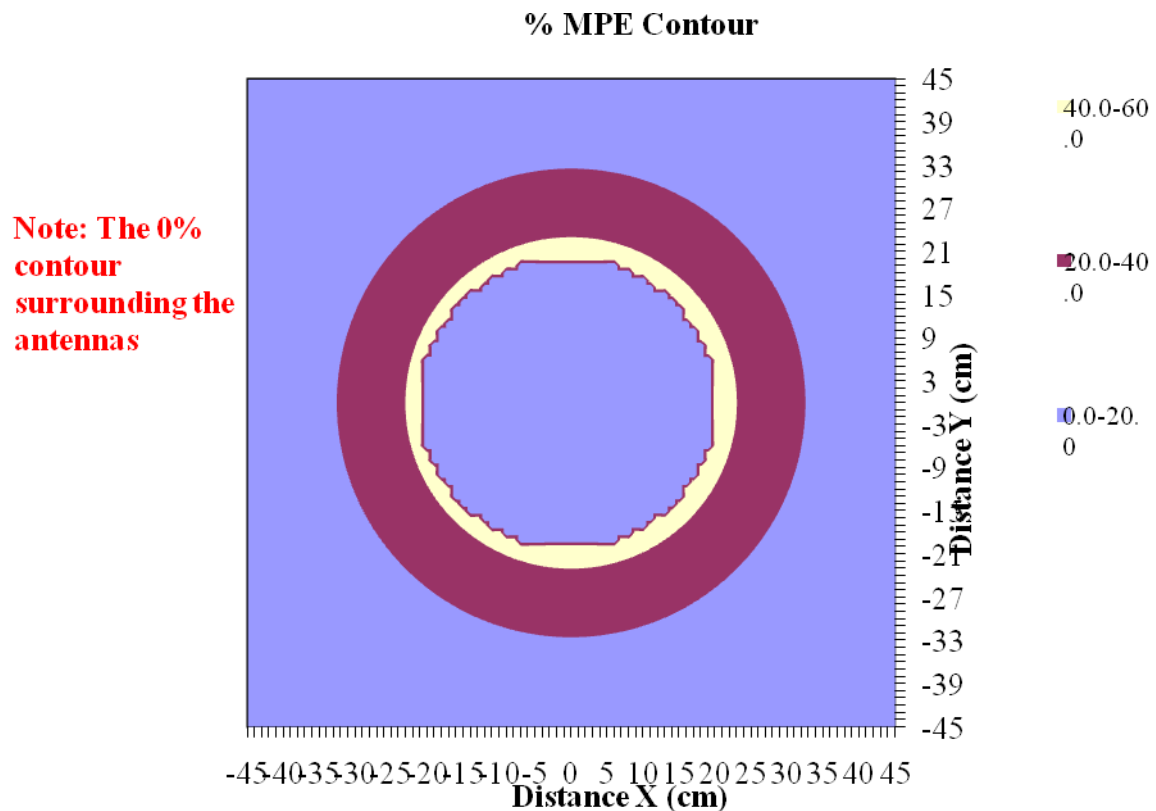
Therefore the maximum antenna gain for mobile operation to comply with MPE and ERP limits shall not exceed **2.83 dBi**.

FCC-ID	QHC-I210G24
IC-ID (Industry Canada)	4393B-I210G24

Prediction for Simultaneous Transmission

The MPE limit was made using a separation distance of 1 cm to represent the worse case.
Output power listed below is for 50% duty cycle in GSM mode.

Antenna No.		Total	1	2
Tx Status			On	On
Frequency	MHz		2440	848.8
MPE Limit	mW/cm ²		1.00	0.57
Max % MPE	%	52.9	1.8	51.2
Power	(W)	1.545	0.090	1.455
Antenna Gain	dBi		0.00	0.00
EIRP	(W)	1.55	0.090	1.455
X	(cm)		-1.0	0.0
Y	(cm)		0.0	0.0
Sector			FALSE	FALSE
Arc			FALSE	FALSE
θ ₁	degs	input	-120	-120
θ ₂			60	60
θ ₁		actual	-120	-120
θ ₂			60	60



FCC-ID	QHC-I210G24
IC-ID (Industry Canada)	4393B-I210G24

Antenna No.		Total	1	2
Tx Status			On	On
Frequency	MHz		2440	1850.2
MPE Limit	mW/cm ²		1.00	1.00
Max % MPE	%	11.7	1.8	9.9
Power	(W)	0.590	0.090	0.500
Antenna Gain	dBi		0.00	0.00
EIRP	(W)	0.59	0.090	0.500
X	(cm)		-1.0	0.0
Y	(cm)		0.0	0.0
Sector			FALSE	FALSE
Arc			FALSE	FALSE
θ ₁	degs	input	-120	-120
θ ₂			60	60
θ ₁		actual	-120	-120
θ ₂			60	60

