

MAXIMUM PERMISSIBLE EXPOSURE

This Maximum Permissive Exposure (MPE) report demonstrates compliance for MC7700 Module with FCC CFR 47 §1.1310 and 2.1091 and IC Safety Code 6, Section 2.2.1 (a) for standalone and collocated simultaneous transmission in mobile exposure conditions. The MPE analysis is valid for transmitters operating within the parameters defined in Table B used for analysis.

Any collocated transmitter must have a valid FCC ID documenting equivalent or degraded RF Output Power with the collocated parameters calculated in this MPE analysis.

The mobile classification applies when 20 cm or more separation distance is maintained between the end user and WWAN, WLAN and Bluetooth transmission antennas.

Portable user conditions or additional collocated modules not allowed based on this RF exposure analysis require a Class II permissive change and updated MPE or SAR report.

FCC RULES

§1.1310 The criteria listed in Table 1 shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in §1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of §2.1093 of this chapter.

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3–3.0	614	1.63	[*] (100)	6
3.0–30	1842/f	4.89/f	[*] (900/f ²)	6
30–300	61.4	0.163	1.0	6
300–1500 .....	.....	.....	f/300	6
1500–100,000 .....	.....	.....	5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3–1.34	614	1.63	[*] (100)	30
1.34–30	824/f	2.19/f	[*] (180/f ²)	30

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)—Continued

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
30–300	27.5	0.073	0.2	30
300–1500 .....	.....	.....	f/1500	30
1500–100,000 .....	.....	.....	1.0	30

f = frequency in MHz

* = Plane-wave equivalent power density

NOTE 1 TO TABLE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2 TO TABLE 1: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

IC RULES

IC Safety Code 6, Section 2.2.1 (a) A person other than an RF and microwave exposed worker shall not be exposed to electromagnetic radiation in a frequency band listed in Column 1 of Table 5, if the field strength exceeds the value given in Column 2 or 3 of Table 5, when averaged spatially and over time, or if the power density exceeds the value given in Column 4 of Table 5, when averaged spatially and over time.

Table 5
Exposure Limits for Persons Not Classed As RF and Microwave Exposed Workers (Including the General Public)

1 Frequency (MHz)	2 Electric Field Strength; rms (V/m)	3 Magnetic Field Strength; rms (A/m)	4 Power Density (W/m ²)	5 Averaging Time (min)
0.003–1	280	2.19		6
1–10	280/ <i>f</i>	2.19/ <i>f</i>		6
10–30	28	2.19/ <i>f</i>		6
30–300	28	0.073	2*	6
300–1 500	1.585 <i>f</i> ^{0.5}	0.0042 <i>f</i> ^{0.5}	<i>f</i> /150	6
1 500–15 000	61.4	0.163	10	6
15 000–150 000	61.4	0.163	10	616 000 / <i>f</i> ^{1.2}
150 000–300 000	0.158 <i>f</i> ^{0.5}	4.21 x 10 ⁻⁴ <i>f</i> ^{0.5}	6.67 x 10 ⁻⁵ <i>f</i>	616 000 / <i>f</i> ^{1.2}

* Power density limit is applicable at frequencies greater than 100 MHz.

- Notes:**
1. Frequency, *f*, is in MHz.
 2. A power density of 10 W/m² is equivalent to 1 mW/cm².
 3. A magnetic field strength of 1 A/m corresponds to 1.257 microtesla (μT) or 12.57 milligauss (mG).

EQUATIONS

Power density is given by:

$$S = \text{EIRP} / (4 * \text{Pi} * D^2)$$

where

S = Power density in W/m²

EIRP = Equivalent Isotropic Radiated Power in W

D = Separation distance in m

Power density in units of W/m² is converted to units of mW/cm² by dividing by 10.

In the table(s) below, Power and Gain are entered in units of dBm and dBi respectively and conversions to linear forms are used for the calculations.

LIMITS

From FCC §1.1310 Table 1 (B),

the maximum value of

$$S = 0.469 \text{ mW/cm}^2 @ 704\text{MHz}$$

$$S = 0.549 \text{ mW/cm}^2 @ 850\text{MHz}$$

$$S = 1.0 \text{ mW/cm}^2 @ 1710\text{MHz}, 1900\text{MHz}, 2.4\text{GHz} / 5\text{GHz}$$

From IC Safety Code 6, Section 2.2 Table 5 Column 4,

$$S = 4.69 \text{ W/m}^2 @ 704\text{MHz}$$

$$S = 5.49 \text{ W/m}^2 @ 850\text{MHz}$$

$$S = 10 \text{ W/m}^2 @ 1710\text{MHz}, 1900\text{MHz}, 2.4\text{GHz}, 5\text{GHz}$$

Collocated MPE Calculations

From FCC KDB 447498 Section 8, transmitters and modules for use in mobile exposure conditions that allow simultaneous transmission should address the following conditions;

- a) Transmitters and modules certified for mobile or portable exposure conditions and categorically excluded by § 2.1091(c) can be incorporated in mobile host devices without further testing or certification when:
 - i) The closest separation among all simultaneous transmitting antennas is ≥ 20 cm; or
 - ii) The antenna separation distance and MPE compliance boundary requirements that enable all simultaneous transmitting antennas incorporated within the host to comply with MPE limits are specified in the application filing of at least one of the certified transmitters incorporated in the host

device. In addition, when transmitters certified for portable use are incorporated in a mobile host device the antenna(s) must be ≥ 5 cm from all other simultaneous transmitting antennas.

b) All antennas in the final product must be at least 20 cm from users and nearby persons.

1. Stand Alone Transmitter Calculation

RESULTS

Operation in cellular band (824 – 849 MHz)

To meet § 2.1091(c), the antenna gain of GPRS850 is changed from 7.5dBi (original filing) to 1.32dBi.

The maximum conducted output power of MC7700 in Cellular band is 32.5 dBm. Take the worst case as an example, in which an antenna with 3.0 dBi gain is used and 2 slots are used out of 8 slots, hence, Duty cycle factor is 25%. The resulted power density at a distance of 20 cm can be deducted as follows:

$$\text{EIRP} = P_{\text{cond}} + 1.32 - 2.15 = 32.5 + 1.32 - 2.15 = 31.67 \text{ dBm (1.47W)} < 1.5\text{W}$$

The FCC OET Bulletin 65 Supplement C states that mobile devices identified in 47 CFR §2.1091 that operate at frequencies below 1.5 GHz with an ERP of 1.5 watts or more are required to perform routine environmental evaluation for RF exposure prior to equipment authorization or use; otherwise, they are categorically excluded.

Operation in PCS band (1850 – 1910 MHz)

The maximum conducted output power of MC7700 in PCS band is 29.7 dBm. Take the worst case as an example, in which an antenna with 3 dBi gain is used. The resulted ERP can be expressed as follows:

$$\text{ERP} = 29.7 + 3 - 2.15 = 30.55 \text{ dBm (1.14 W)} < 3 \text{ W}$$

The FCC OET Bulletin 65 Supplement C states that mobile devices identified in 47 CFR §2.1091 that operate at frequencies above 1.5 GHz with an ERP of 3.0 watts or more are required to perform routine environmental evaluation for RF exposure prior to equipment authorization or use; otherwise, they are categorically excluded.

Operation in LTE Band 4 (1710 – 1755 MHz)

The maximum conducted output power of MC7700 in PCS band is 24.5 dBm. Take the worst case as an example, in which an antenna with 5.5 dBi gain is used. The resulted ERP can be expressed as follows:

$$\text{ERP} = 24.5 + 5.5 - 2.15 = 27.85 \text{ dBm (0.61 W)} < 3 \text{ W}$$

The FCC OET Bulletin 65 Supplement C states that mobile devices identified in 47 CFR §2.1091 that operate at frequencies above 1.5 GHz with an ERP of 3.0 watts or more are required to perform routine environmental evaluation for RF exposure prior to equipment authorization or use; otherwise, they are categorically excluded.

Operation in LTE Band 17 (704 – 716 MHz)

The maximum conducted output power of MC7700 in Cellular band is 24.2 dBm. Take the worst case as an example, in which an antenna with 3 dBi gain is used. The resulted power density at a distance of 20 cm can be deducted as follows:

$$\text{EIRP} = P_{\text{cond}} + 3 - 2.15 = 25.05 \text{ dBm} (0.32\text{W}) < 1.5\text{W}$$

The FCC OET Bulletin 65 Supplement C states that mobile devices identified in 47 CFR §2.1091 that operate at frequencies below 1.5 GHz with an ERP of 1.5 watts or more are required to perform routine environmental evaluation for RF exposure prior to equipment authorization or use; otherwise, they are categorically excluded.

Table A1: MC7700

Technology	Frequency (MHz)	Output Power (dBm)	Antenna Gain (dBi)	Duty Cycle (%)	Average EIRP (dBm)	Average EIRP (W)	FCC Power Density (mW/cm ²)	FCC MPE Limit (mW/cm ²)
GPRS 850 (2 UL Slots)	824 - 849	32.50	1.32	25	27.82	0.61	0.120	0.549
GPRS 1900 (2 UL Slots)	1850 - 1910	29.70	3.0	25	26.70	0.47	0.093	1.000
LTE Band 4	1710 - 1755	24.50	5.5	100	30.00	1.00	0.199	1.000
LTE Band 17	704 - 716	24.20	3.0	100	27.20	0.52	0.104	0.469

Table A2: WLAN / Bluetooth

Technology	Separation Distance (m)	Output Power (dBm)	Antenna Gain (dBi)	IC Power Density (W/m ²)	FCC Power Density (mW/cm ²)
2412 - 2462	0.20	25.00	6.0	2.51	0.251
5150 - 5250	0.20	17.00	6.0	0.40	0.040
5250 - 5350	0.20	17.00	6.0	0.40	0.040
5470 - 5725	0.20	20.00	6.0	0.79	0.079
5725 - 5850	0.20	25.00	6.0	2.51	0.251
2402 - 2480	0.20	13.00	5.0	0.13	0.013

Table A3: WLAN + Bluetooth

Technology	Separation Distance (m)	WLAN Power Density (mW/cm ²)	BT Power Density (mW/cm ²)	WLAN + BT
2412 - 2462	0.20	0.251	0.013	0.264
5150 - 5250	0.20	0.040	0.013	0.053
5250 - 5350	0.20	0.040	0.013	0.053
5470 - 5725	0.20	0.079	0.013	0.092
5725 - 5850	0.20	0.251	0.013	0.264

2. Collocated MPE Calculations

OET Bulletin 65 “Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields”

Σ [(the highest MPE for each mobile transmitter/antenna included in the simultaneous transmission configuration) / (the corresponding MPE limit)] < 1

Note: This formula is quoted from “KDB616217 D03 Section-Simultaneous Transmission Considerations 4)b)ii”.

RESULTS

Table B1: MC7700 (824-849MHz) + WLAN + Bluetooth

Technology	WLAN+BT FCC Power Density (mW/cm ²)	WLAN+BT FCC Power Density Limit	WLAN+BT /MPE Limit	WWAN FCC Power Density (mW/cm ²)	WWAN FCC Power Density Limit	WWAN/MPE Limit	Sum	Limit
2412 - 2462	0.264	1.000	0.264	0.120	0.549	0.219	0.483	1.000
5150 - 5250	0.053	1.000	0.053	0.120	0.549	0.219	0.272	1.000
5250 - 5350	0.053	1.000	0.053	0.120	0.549	0.219	0.272	1.000
5470 - 5725	0.092	1.000	0.092	0.120	0.549	0.219	0.311	1.000
5725 - 5850	0.264	1.000	0.264	0.120	0.549	0.219	0.483	1.000

Table B2: MC7700 (1850-1910MHz) + WLAN + Bluetooth

Technology	WLAN+BT FCC Power Density (mW/cm ²)	WLAN+BT FCC Power Density Limit	WLAN+BT /MPE Limit	WWAN FCC Power Density (mW/cm ²)	WWAN FCC Power Density Limit	WWAN/MPE Limit	Sum	Limit
2412 - 2462	0.264	1.000	0.264	0.093	1.000	0.093	0.357	1.000
5150 - 5250	0.053	1.000	0.053	0.093	1.000	0.093	0.146	1.000
5250 - 5350	0.053	1.000	0.053	0.093	1.000	0.093	0.146	1.000
5470 - 5725	0.092	1.000	0.092	0.093	1.000	0.093	0.185	1.000
5725 - 5850	0.264	1.000	0.264	0.093	1.000	0.093	0.357	1.000

Table B3: MC7700(1710-1755MHz) + WLAN + Bluetooth

Technology	WLAN+BT FCC Power Density (mW/cm ²)	WLAN+BT FCC Power Density Limit	WLAN+BT /MPE Limit	WWAN FCC Power Density (mW/cm ²)	WWAN FCC Power Density Limit	WWAN/MPE Limit	Sum	Limit
2412 - 2462	0.264	1.000	0.264	0.199	1.000	0.199	0.463	1.000
5150 - 5250	0.053	1.000	0.053	0.199	1.000	0.199	0.252	1.000
5250 - 5350	0.053	1.000	0.053	0.199	1.000	0.199	0.252	1.000
5470 - 5725	0.092	1.000	0.092	0.199	1.000	0.199	0.291	1.000
5725 - 5850	0.264	1.000	0.264	0.199	1.000	0.199	0.463	1.000

Table B4: MC7700(704-716MHz) + WLAN + Bluetooth

Technology	WLAN+BT FCC Power Density (mW/cm ²)	WLAN+BT FCC Power Density Limit	WLAN+BT /MPE Limit	WWAN FCC Power Density (mW/cm ²)	WWAN FCC Power Density Limit	WWAN/MPE Limit	Sum	Limit
2412 - 2462	0.264	1.000	0.264	0.104	0.469	0.222	0.486	1.000
5150 - 5250	0.053	1.000	0.053	0.104	0.469	0.222	0.275	1.000
5250 - 5350	0.053	1.000	0.053	0.104	0.469	0.222	0.275	1.000
5470 - 5725	0.092	1.000	0.092	0.104	0.469	0.222	0.314	1.000
5725 - 5850	0.264	1.000	0.264	0.104	0.469	0.222	0.486	1.000

As shown in the calculations above, when all devices are operational, the worst case combination is within the limit at a distance of 20cm from the device.