



MPE Evaluation for MC7700 Module

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1. Introduction

This Maximum Permissive Exposure (MPE) report demonstrates compliance for MC7700 module with FCC CFR 47 §2.1091 and IC RSS-102 for collocated simultaneous transmission in mobile exposure conditions. The MPE analysis is limited for Canada / US bands only.

The general population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure.

A separation distance of 20cm or more shall be maintained between the end user and each WWAN, WiMAX, WLAN and Bluetooth transmitting antenna.

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.

2. RF Exposure Limits and Equations

FCC RULES:

According to FCC OET Bulletin 65 Supplement C, 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) Limits for General Population/Uncontrolled Exposure

| Frequency Range (MHz) | Electric Field Strength (E) (V/m) | Magnetic Field Strength (H) (A/m) | Power Density (S) (mW/cm ²) | Averaging Time E ² , H ² or S (minutes) |
|-----------------------|-----------------------------------|-----------------------------------|---|---|
| 0.3-1.34 | 614 | 1.63 | (100)* | 30 |
| 1.34-30 | 824/f | 2.19/f | (180/f ²)* | 30 |
| 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

Table 1 : Limits for Maximum Permissible Exposure (MPE)

IC RULES:

IC has adopted the RF field strength limits established in Health Canada's RF exposure guideline. The limits are shown in Table 2 below per RSS-102.

| Frequency Range (MHz) | Electric Field (V/m rms) | Magnetic Field (A/m rms) | Power Density (W/m ²) | Averaging Time (minutes) |
|-----------------------|--------------------------|--|-----------------------------------|--------------------------|
| 0.003-1 | 280 | 2.19 | - | 6 |
| 1-10 | 280/f | 2.19/f | - | 6 |
| 10-30 | 28 | 2.19/f | - | 6 |
| 30-300 | 28 | 0.073 | 2* | 6 |
| 300-1500 | 1.585 f ^{0.5} | 0.0042 f ^{0.5} | f/150 | 6 |
| 1500-15000 | 61.4 | 0.163 | 10 | 6 |
| 15000-150000 | 61.4 | 0.163 | 10 | 616000/f ^{1.2} |
| 150000-300000 | 0.158 f ^{0.5} | 4.21 x 10 ⁻⁴ f ^{0.5} | 6.67 x 10 ⁻⁵ f | 616000/f ^{1.2} |

Note: f is frequency in MHz.

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

Table 2 : RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)

EQUATIONS:

Power density is given by :

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

where

S = Power density (mW/cm²)

EIRP = Equivalent Isotropic Radiated Power (mW)

D = Separation distance (cm)

3. Product Declarations

| Mode | Equipment Category | Max Transmitter Duty Cycle | Transmitter Range (MHz) | Maximum Conducted Power | | Max Antenna Gain (dBi) |
|------|--------------------|----------------------------|-------------------------|-------------------------|------|------------------------|
| | | | | (dBm) | (W) | |
| GPRS | Class 10 | 25% | 824 - 849 | 33.0 | 2.00 | 5.0 |
| | | | 1850 - 1910 | 30.0 | 1.00 | 3.0 |
| EDGE | Class 10 | 25% | 824 - 849 | 28.0 | 0.63 | 5.0 |
| | | | 1850 - 1910 | 27.0 | 0.50 | 3.0 |
| EDGE | Class 11 | 37.5% | 824 - 849 | 26.2 | 0.42 | 5.0 |
| | | | 1850 - 1910 | 25.2 | 0.33 | 3.0 |
| EDGE | Class 12 | 50.0% | 824 - 849 | 25.0 | 0.32 | 5.0 |
| | | | 1850 - 1910 | 24.0 | 0.25 | 3.0 |
| UMTS | HSDPA HSUPA | 100% | 824 - 849 | 25.0 | 0.32 | 5.0 |
| | | | 1850 - 1910 | 25.0 | 0.32 | 3.0 |
| LTE | Band 17 Band 4 | 100% | 704 - 716 | 25.0 | 0.32 | 6.0 |
| | | | 1710 - 1755 | 25.0 | 0.32 | 5.5 |

Table 3: WWAN Transmitter Declarations

This MPE analysis is applicable to any collocated transmitters with transmit power less than or equal to 28.0dBm for WLAN, less than or equal to 27.0dBm for WiMAX, and less than or equal to 13.0dBm for BT. Specific FCC IDs for those devices are not necessary or identified in this analysis providing they are classified as mobile transmitters. A 100% duty cycle is used for calculations to present a worse-case analysis.

4. MPE Calculations

The WiMAX, WLAN, and BT transmit power and antenna gain parameters represent a maximum transmit power for a given frequency band.

Integration of a WiMAX, WLAN, and BT module that exceeds the parameters requires a new FCC authorization or permissive change application. A maximum antenna gain of 5dBi has been assumed for all collocated antennas.

Table 3 summarizes transmitter parameters associated with this analysis.

4.1. Individual Transmitter Calculations

The power density calculations for the individual transmitters per wireless technology at an exposure separation distance of 20cm are shown in Table 4.

For frequency dependent limit, the lowest transmitter frequency was used to represent the lowest MPE limit in this analysis (eg. 824MHz = 0.549mW/cm²)

The WiMAX, WLAN, and BT power levels listed represent the worse-case scenario for corresponding frequency ranges given.

| Technology | Frequency (MHz) | Maximum Conducted Power (dBm) | Maximum Conducted Power (W) | Maximum Antenna Gain (dBi) | Duty Cycle | Average EIRP (dBm) | Average EIRP (mW) | Power Density @ 20cm (mW/cm ²) | FCC MPE Limit (mW/cm ²) |
|------------------|-----------------|-------------------------------|-----------------------------|----------------------------|------------|--------------------|-------------------|--|-------------------------------------|
| GPRS 2 UL | 824 - 849 | 33 | 2.00 | 5.0 | 0.250 | 31.98 | 1577.393 | 0.314 | 0.549 |
| UMTS | 824 - 849 | 25 | 0.32 | 5.0 | 1.000 | 30.00 | 1000.000 | 0.199 | 0.549 |
| GPRS 2 UL | 1850 - 1910 | 30 | 1.00 | 3.0 | 0.250 | 26.98 | 498.816 | 0.099 | 1.000 |
| EDGE 2 UL | 1850 - 1910 | 27.0 | 0.50 | 3.0 | 0.250 | 23.98 | 250.000 | 0.050 | 1.000 |
| EDGE 3 UL | 1850 - 1910 | 25.2 | 0.33 | 3.0 | 0.375 | 23.94 | 247.760 | 0.049 | 1.000 |
| EDGE 4 UL | 1850 - 1910 | 24.0 | 0.25 | 3.0 | 0.500 | 23.99 | 250.594 | 0.050 | 1.000 |
| UMTS | 1850 - 1910 | 25 | 0.32 | 3.0 | 1.000 | 28.00 | 630.957 | 0.126 | 1.000 |
| LTE | 704 - 716 | 25 | 0.32 | 6.0 | 1.000 | 31.00 | 1258.925 | 0.250 | 0.469 |
| LTE | 1710 - 1755 | 25.0 | 0.32 | 5.5 | 1.000 | 30.50 | 1122.018 | 0.223 | 1.000 |
| WLAN | 2400 - 2500 | 29 | 0.794 | 4.0 | 1.000 | 33.00 | 1995.262 | 0.397 | 1.000 |
| WLAN | 5150 - 5850 | 29 | 0.794 | 4.0 | 1.000 | 33.00 | 1995.262 | 0.397 | 1.000 |
| WiMAX | 2300 - 2400 | 27 | 0.50 | 5.0 | 1.000 | 32.00 | 1584.893 | 0.315 | 1.000 |
| WiMAX | 2500 - 2700 | 27 | 0.50 | 5.0 | 1.000 | 32.00 | 1584.893 | 0.315 | 1.000 |
| WiMAX | 3300 - 3800 | 27 | 0.50 | 5.0 | 1.000 | 32.00 | 1584.893 | 0.315 | 1.000 |
| BT | 2400 - 2500 | 15 | 0.032 | 5.0 | 1.000 | 18.00 | 63.096 | 0.020 | 1.000 |

Table 4: WWAN, WiMAX, WLAN, and BT Individual MPE Calculation

4.2. Collocated MPE Calculation

Per OET Bulletin 65, when RF sources have difference frequencies, the fraction of the FCC power density limit shall be determined and the sum of all fractional components shall be less than 1.

| WLAN/WiMAX Band (GHz) | WLAN/WiMAX Pd (mW/cm ²) | BT Pd (mW/cm ²) | WLAN/WiMAX + BT Pd (mW/cm ²) | Limit |
|-----------------------|-------------------------------------|-----------------------------|--|-------|
| 2.3 - 2.4 | 0.315 | 0.020 | 0.335 | 1.000 |
| 2.4 - 2.5 | 0.397 | | 0.417 | 1.000 |
| 2.5 - 2.7 | 0.315 | | 0.335 | 1.000 |
| 3.3 3.8 | 0.315 | | 0.335 | 1.000 |
| 5.15 - 5.85 | 0.397 | | 0.417 | 1.000 |

Table 5: WLAN/WiMAX + BT Collocated MPE Calculation

| WLAN / WiMAX Band (GHz) | WLAN / WiMAX + BT Pd (mW/cm ²) | FCC MPE Limit (mW/cm ²) | (WLAN / WiMAX + BT Pd) / (MPE Limit) | 850 MHz WWAN Pd (mW/cm ²) | FCC MPE Limit (mW/cm ²) | (WWAN 850 MHz) / MPE Limit) | (850 MHz WWAN + WLAN / WiMAX + BT fraction) | Limit | Pass/Fail |
|-------------------------|--|-------------------------------------|--------------------------------------|---------------------------------------|-------------------------------------|-----------------------------|---|-------|-----------|
| 2.3 - 2.4 | 0.335 | 1.000 | 0.335 | 0.314 | 0.549 | 0.571 | 0.906 | 1.000 | Pass |
| 2.4 - 2.5 | 0.417 | 1.000 | 0.417 | | | | 0.988 | | Pass |
| 2.5 - 2.7 | 0.335 | 1.000 | 0.335 | | | | 0.906 | | Pass |
| 3.3 - 3.8 | 0.335 | 1.000 | 0.335 | | | | 0.906 | | Pass |
| 5.15 - 5.85 | 0.417 | 1.000 | 0.417 | | | | 0.988 | | Pass |

Table 6: WWAN 850MHz + WLAN / WiMAX + BT Collocated MPE Calculation

| WLAN / WiMAX Band (GHz) | WLAN / WiMAX + BT Pd (mW/cm ²) | FCC MPE Limit (mW/cm ²) | (WLAN / WiMAX + BT Pd) / (MPE Limit) | 1900 MHz WWAN Pd (mW/cm ²) | FCC MPE Limit (mW/cm ²) | (WWAN 1900 MHz) / MPE Limit | (1900 MHz WWAN + WLAN / WiMAX + BT fraction) | Limit | Pass/Fail |
|-------------------------|--|-------------------------------------|--------------------------------------|--|-------------------------------------|-----------------------------|--|-------|-----------|
| 2.3 - 2.4 | 0.335 | 1.000 | 0.335 | 0.126 | 1.000 | 0.126 | 0.461 | 1.000 | Pass |
| 2.4 - 2.5 | 0.417 | 1.000 | 0.417 | | | | 0.542 | | Pass |
| 2.5 - 2.7 | 0.335 | 1.000 | 0.335 | | | | 0.461 | | Pass |
| 3.3 - 3.8 | 0.335 | 1.000 | 0.335 | | | | 0.461 | | Pass |
| 5.15 - 5.85 | 0.417 | 1.000 | 0.417 | | | | 0.542 | | Pass |

Table 7: WWAN 1900MHz + WLAN / WiMAX + BT Collocated MPE Calculation

| WLAN / WiMAX Band (GHz) | WLAN / WiMAX + BT Pd (mW/cm ²) | FCC MPE Limit (mW/cm ²) | (WLAN / WiMAX + BT Pd) / (MPE Limit) | 700 MHz WWAN Pd (mW/cm ²) | FCC MPE Limit (mW/cm ²) | (WWAN 700 MHz) / MPE Limit | (700 MHz WWAN + WLAN / WiMAX + BT fraction) | Limit | Pass/Fail |
|-------------------------|--|-------------------------------------|--------------------------------------|---------------------------------------|-------------------------------------|----------------------------|---|-------|-----------|
| 2.3 - 2.4 | 0.335 | 1.000 | 0.335 | 0.250 | 0.469 | 0.534 | 0.869 | 1.000 | Pass |
| 2.4 - 2.5 | 0.417 | 1.000 | 0.417 | | | | 0.950 | | Pass |
| 2.5 - 2.7 | 0.335 | 1.000 | 0.335 | | | | 0.869 | | Pass |
| 3.3 - 3.8 | 0.335 | 1.000 | 0.335 | | | | 0.869 | | Pass |
| 5.15 - 5.85 | 0.417 | 1.000 | 0.417 | | | | 0.950 | | Pass |

Table 8: WWAN 700MHz + WLAN / WiMAX + BT Collocated MPE Calculation

| WLAN / WIMAX Band (GHz) | WLAN / WiMAX + BT Pd (mW/cm ²) | FCC MPE Limit (mW/cm ²) | (WLAN / WIMAX + BT Pd) / (MPE Limit) | 1700 MHz WWAN Pd (mW/cm ²) | FCC MPE Limit (mW/cm ²) | (WWAN 1700 MHz) / MPE Limit | (1700 MHz WWAN + WLAN / WiMAX + BT fraction) | Limit | Pass/Fail |
|-------------------------|--|-------------------------------------|--------------------------------------|--|-------------------------------------|-----------------------------|--|-------|-----------|
| 2.3 - 2.4 | 0.335 | 1.000 | 0.335 | 0.223 | 1.000 | 0.223 | 0.558 | 1.000 | Pass |
| 2.4 - 2.5 | 0.417 | 1.000 | 0.417 | | | | 0.640 | | Pass |
| 2.5 - 2.7 | 0.335 | 1.000 | 0.335 | | | | 0.558 | | Pass |
| 3.3 - 3.8 | 0.335 | 1.000 | 0.335 | | | | 0.558 | | Pass |
| 5.15 - 5.85 | 0.417 | 1.000 | 0.417 | | | | 0.640 | | Pass |

Table 9: WWAN 1700MHz + WLAN / WiMAX + BT Collocated MPE Calculation

5. Conclusion

The analysis concludes that the MC7700 module, when transmitting simultaneously with other co-located radio transmitters within a host device, is compliant with the FCC/IC RF exposure requirements in mobile-only exposure condition, provided the conducted power and antenna gain do not exceed the limits in Table 10 for each given frequency band per wireless technology.

| Technology | Frequency (MHz) | Maximum Conducted Power (dBm) | Maximum Antenna Gain (dBi) |
|------------|-----------------|-------------------------------|----------------------------|
| GPRS/EDGE | 824 - 849 | 33 | 5.0 |
| UMTS | 824 - 849 | 25 | 5.0 |
| GPRS/EDGE | 1850 - 1910 | 30 | 3.0 |
| UMTS | 1850 - 1910 | 25 | 3.0 |
| LTE | 704 - 716 | 25 | 6.0 |
| LTE | 1710 - 1755 | 25 | 5.5 |
| WLAN | 2400 - 2500 | 29 | 4.0 |
| WLAN | 5150 - 5850 | 29 | 4.0 |
| WiMAX | 2300 - 2400 | 27 | 5.0 |
| WiMAX | 2500 - 2700 | 27 | 5.0 |
| WiMAX | 3300 - 3800 | 27 | 5.0 |
| BT | 2400 - 2500 | 15 | 5.0 |

Table 10: Summary of Maximum Conducted Power and Antenna Gain