

MPE Evaluation for MC7455 Radio Module

September 8, 2015

1. Introduction

In this application we seek modular approval for the MC7455 radio module for use in standalone and collocated simultaneous transmission under mobile configuration. This Maximum Permissible Exposure (MPE) report demonstrates compliance analysis for MC7455 radio module with FCC CFR 47 §2.1091 and IC RSS-102 for standalone and collocated transmission in mobile exposure conditions. The MPE analysis is limited for US / Canada 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.

Any collocated transmitter must have a valid FCC ID documenting equivalent or degraded RF characteristics with the collocated parameters defined in this MPE report. A separation distance of 20cm or more shall be maintained between the end user and each WWAN, WiMAX or WLAN, and Bluetooth transmitting antenna.

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

2. RF Exposure Limits and Equations

FCC Limits:

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 Limits:

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)	Reference Period (minutes)
0.003-10 ²¹	83	90	-	Instantaneous*
0.1-10	-	0.73/ f	-	6**
1.1-10	87/ f ^{0.5}	-	-	6**
10-20	27.46	0.0728	2	6
20-48	58.07/ f ^{0.25}	0.1540/ f ^{0.25}	8.944/ f ^{0.5}	6
48-300	22.06	0.05852	1.291	6
300-6000	3.142 f ^{0.3417}	0.008335 f ^{0.3417}	0.02619f ^{0.6834}	6
6000-15000	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. *Based on nerve stimulation (NS). ** Based on specific absorption rate (SAR).				

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

In the frequency range of 300-6000 MHz, the IC limits are more stringent than the FCC limits. The MPE evaluation in this report will be based on the IC limits, so the deduced output power and antenna gain limits will guarantee compliance with both FCC and IC requirements.

EQUATIONS:

EIRP (dBm) = Conducted Power (dBm) + Antenna Gain (dBi)

Power density is given by :

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

where

S = Power density (mW/cm²)

EIRP = Equivalent Isotropic Radiated Power (mW)

D = Separation distance (cm)

3. Stand-Alone Transmission

When MC7455 module transmits as a stand-alone mobile device, the source-based time-averaged EIRP is calculated by summing up conducted power and antenna gain. A 100% duty cycle is used for calculations to present a worse-case analysis. The antenna gains are chosen so that the resulted radiated power levels are within the limits specified by the FCC rules and IC Radio Standards Specifications (RSS). The IC exemption limits for routine RF exposure evaluation are calculated using the lowest frequency of the operating band presenting the most stringent limits.

As shown in Table 2 below, the resulted EIRP are always below the IC exemption limits for all the operating modes.

Operating Mode	TX Freq Range (MHz)		Max Time-Avg Cond Power (dBm)	Max Time-Avg Cond Power (W)	Max Ant Gain (dBi)	Source-Based Time-Averaged Max EIRP (dBm)	IC Exemption Limit (EIRP) (dBm)	EIRP/ERP Limits
WCDMA Band II LTE Band 2	1850	1910	24	0.25	6	30	33.50	2 W EIRP
WCDMA Band IV LTE Band 4	1710	1755	24	0.25	6	30	33.27	1 W EIRP
WCDMA Band V LTE Band 5	824	849	24	0.25	6	30	31.10	6.3 W ERP
LTE Band 7	2500	2570	23	0.20	9	32	34.39	2 W EIRP
LTE Band 12	699	716	24	0.25	6	30	30.61	3 W ERP
LTE Band 13	777	787	24	0.25	6	30	30.93	3 W ERP
LTE Band 25	1850	1915	24	0.25	6	30	33.50	2 W EIRP
LTE Band 26	814	849	24	0.25	6	30	31.06	7 W ERP
LTE Band 30	2305	2315	23	0.20	1	24	34.15	0.25 W EIRP
LTE Band 41	2496	2690	23	0.20	9	32	34.39	2 W EIRP

Table 2: MC7455 Stand-Alone Transmission

4. Collocated Transmission

When MC7455 module co-transmits with radio transmitter(s) as a mobile device, per KDB 447498 D01, simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneous transmitting antennas incorporated in a host device, based on the calculated/estimated, numerically modeled or measured field strengths or power density, is ≤ 1.0 .

The evaluation here considers a WiMAX or WLAN transmitter, and a Bluetooth transmitter as collocated transmitters. Their radiated output power levels are listed in Table 3 below. The MPE ratio is defined by the ratio of power density to MPE limit. The sum of the MPE ratios is calculated as follows:

$$\begin{aligned} \sum MPE \text{ Ratio} &= \text{Max} (MC7455 \text{ MPE ratio}) + \text{Max} (WLAN/WiMax \text{ MPE ratio}) + BT \\ &\text{MPE Ratio} \\ &= 0.864 + 0.121 + 0.012 = 0.997 < 1.0 \end{aligned}$$

Operating Mode	TX Freq Range (MHz)		Max Time-Avg Cond Power (dBm)	Max Time-Avg Cond Power (W)	Max Ant Gain (dBi)	Source-Based Time-Averaged Max EIRP	Power Density @20 cm (W/m ²)	IC MPE Limit (W/m ²)	IC PwrDensity MPE Ratio
WCDMA Band II LTE Band 2	1850	1910	24	0.25	6	30	1.99	4.48	0.444
WCDMA Band IV LTE Band 4	1710	1755	24	0.25	6	30	1.99	4.24	0.469
WCDMA Band V LTE Band 5	824	849	24	0.25	6	30	1.99	2.58	0.772
LTE Band 7	2500	2570	23	0.20	9	32	3.15	5.50	0.573
LTE Band 12	699	716	24	0.25	6	30	1.99	2.30	0.864
LTE Band 13	777	787	24	0.25	6	30	1.99	2.47	0.804
LTE Band 25	1850	1915	24	0.25	6	30	1.99	4.48	0.444
LTE Band 26	814	849	24	0.25	6	30	1.99	2.55	0.779
LTE Band 30	2305	2315	23	0.20	1	32	0.50	5.20	0.096
LTE Band 41	2496	2690	23	0.20	9	32	3.15	5.49	0.574
WLAN 2.4 GHz	2400	2500				25	0.63	5.35	0.118
WLAN 5 GHz	5150	5850				27	1.00	9.01	0.111
WiMAX	2300	2400				25	0.63	5.19	0.121
	2500	2700				25	0.63	5.50	0.114
	3300	3800				25	0.63	6.65	0.095
BT	2400	2500				15	0.06	5.35	0.012

Table 3: MC7455 Collocated Transmission

5. Conclusion

The analysis presented in this report concludes that the MC7455 radio module, when transmitting either in standalone or simultaneously with other co-located radio transmitters within a host device, is compliant with the FCC/IC RF exposure requirements in mobile exposure condition, provided the conducted power and antenna gain do not exceed the limits in Table 4 for each given frequency band and operating mode.

	Operating Mode	TX Freq Range (MHz)		Max Time-Avg Cond Power (dBm)	Antenna Gain Limits (dBi)	EIRP Limits (dBm)
MC7455	WCDMA Band II LTE Band 2	1850	1910	24	6	30
	WCDMA Band IV LTE Band 4	1710	1755	24	6	30
	WCDMA Band V LTE Band 5	824	849	24	6	30
	LTE Band 7	2500	2570	23	9	32
	LTE Band 12	699	716	24	6	30
	LTE Band 13	777	787	24	6	30
	LTE Band 25	1850	1915	24	6	30
	LTE Band 26	814	849	24	6	30
	LTE Band 30	2305	2315	23	1	32
	LTE Band 41	2496	2690	23	9	32
Collocated Radio Transmitters	WLAN 2.4 GHz	2400	2500			25
	WLAN 5 GHz	5150	5850			27
	WiMAX	2300	2400			25
		2500	2700			25
		3300	3800			25
	BT	2400	2500			15

Table 4: MC7455 RF Exposure Conditions