MPE Evaluation for EM7700 Module

04/24/2012

1. Introduction

In this application we seek for modular approval to the EM7700 module for use in standalone and collocated simultaneous transmission under mobile configuration. This Maximum Permissive Exposure (MPE) report demonstrates compliance analysis for EM7700 module with FCC CFR 47 §2.1091 for standalone and collocated transmission in mobile exposure conditions. The MPE analysis is limited for 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.

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 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)

EQUATIONS:

Power density is given by :

S = EIRP / (4 * Pi * D^2)

where

S = Power density (mW/cm^2)
EIRP = Equivalent Isotropic Radiated Power (mW)
D = Separation distance (cm)

3. Product Declarations

The EM7700 module can be installed for use in any mobile host as long as the antenna gain of the host antenna does not exceed the gain listed in table 2.

This MPE analysis is applicable to any collocated transmitters with transmit power:

- less than or equal to 29.0dBm for WLAN/WiMAX; and
- less than or equal to 15.0dBm 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 when applicable.

Mode	Equipment Category	Max Transmitter Duty Cycle	Transmitter Range (MHz)	Maximum Conducted Power		Max Antenna Gain (dBi)	
				(dBm)	(W)	Standalone	Collocated
UMTS	HSDPA HSUPA	100%	824 - 849	24.0	0.25	9.5	6.5
			1850 - 1910	24.0	0.25	9.0	9.0
LTE	Band 17 Band 4	100%	704 - 716	24.0	0.25	9.0	6.0
			1710 - 1755	24.0	0.25	6.0	6.0

Table 2: EM7700 Standalone and Collocated Transmission Declarations

4. MPE Calculations

The WWAN MPE calculations are based on conservative conducted transmit power exceeding those listed in the FCC ID N7NEM7700 filing. The higher transmit power levels are used to present a worst case assessment.

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

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

Table 3 and 4 summarize transmitter parameters associated with this analysis.

4.1. Individual Transmitter Calculations

4.1.1. Maximum Output Power

The maximum power calculations for EM7700 per wireless technology are shown in Table 3

	Technology	Frequency (MHz)	Maximum Conducted Power (dBm)	Maximum Conducted Power (W)	Maximum Antenna Gain (dBi)	Duty Cycle	Max EIRP (dBm)	Max EIRP (W)	Max ERP (dBm)	Max ERP (W)	Max output power limit
EM7700 module (Standalone)	**UMTS**	824 - 849	24.0	0.251	9.5	1.000	33.500	2.239	31.360	**1.368**	7 W ERP
	UMTS	1850 - 1910	24.0	0.251	9.0	1.000	33.000	**1.995**	30.860	1.219	2 W EIRP
	LTE	704 - 716	24.0	0.251	9.0	1.000	33.000	**1.995**	30.860	1.219	3 W ERP
	LTE	1710 - 1755	24.0	0.251	6.0	1.000	30.000	**1.000**	27.860	0.611	1 W EIRP

Table 3: EM7700 Maximum Output Power Calculation

According to FCC 2.1091(c), mobile devices that are authorized under subpart H of part 22, 24, and 27, are subject to routine environmental evaluation for RF exposure prior to equipment authorization or use if they operate at frequencies of 1.5GHz or below and their effective radiated power (ERP) is 1.5 watts or more, or if they operate at frequencies above 1.5GHz and their ERP is 3 watts or more. Otherwise, routine environmental evaluation for RF exposure is categorical excluded.

4.1.2. Power Density

The power density calculations for the individual transmitters per wireless technology at an exposure minimum 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/cm^2)

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)
EM7700 Module (Standalone)	UMTS		824 - 849	24.0	0.251	9.5	1.000	33.50	2238.721	**0.445**	0.549
	UMTS		1850 - 1910	24.0	0.251	9.0	1.000	33.00	1995.262	**0.397**	1.000
	LTE		704 - 716	24.0	0.251	9.0	1.000	33.00	1995.262	**0.397**	0.469
	LTE		1710 - 1755	24.0	0.251	6.0	1.000	30.00	1000.000	**0.199**	1.000
EM7700 Module (Collocated)	UMTS	UMTS	824 - 849	24.0	0.251	6.5	1.000	30.50	1122.018	**0.223**	0.549
	UMTS	UMTS	1850 - 1910	24.0	0.251	9.0	1.000	33.00	1995.262	**0.397**	1.000
	LTE	LTE	704 - 716	24.0	0.251	6.0	1.000	30.00	1000.000	**0.199**	0.469
	LTE	LTE	1710 - 1755	24.0	0.251	6.0	1.000	30.00	1000.000	**0.199**	1.000
Other Collocated Transmitters	WLAN		2400 - 2500	29.0	0.794	5.0	1.000	34.00	2511.886	**0.500**	1.000
	WLAN		5150 - 5850	29.0	0.794	5.0	1.000	34.00	2511.886	**0.500**	1.000
		WiMAX	2300 - 2400	29.0	0.794	5.0	1.000	34.00	2511.886	**0.500**	1.000
		WiMAX	2500 - 2700	29.0	0.794	5.0	1.000	34.00	2511.886	**0.500**	1.000
		WiMAX	3300 - 3800	29.0	0.794	5.0	1.000	34.00	2511.886	**0.500**	1.000
	BT	BT	2400 - 2500	15.0	0.032	5.0	1.000	20.00	100.000	**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	0.500	0.020	**0.520**	1.000
2.4 - 2.5				
2.5 - 2.7				
3.3 3.8				
5.15 - 5.85				

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	0.520	1.000	0.520	0.223	0.549	0.406	**0.926**	1.000	Pass
2.4 - 2.5									
2.5 - 2.7									
3.3 - 3.8									
5.15 - 5.85									

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	0.520	1.000	0.520	0.397	1.000	0.397	**0.917**	1.000	Pass
2.4 - 2.5									
2.5 - 2.7									
3.3 - 3.8									
5.15 - 5.85									

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	0.520	1.000	0.520	0.199	0.469	0.424	**0.944**	1.000	Pass
2.4 - 2.5									
2.5 - 2.7									
3.3 - 3.8									
5.15 - 5.85									

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	0.520	1.000	0.520	0.199	1.000	0.199	**0.719**	1.000	Pass
2.4 - 2.5									
2.5 - 2.7									
3.3 - 3.8									
5.15 - 5.85									

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

5. Conclusion

Based on FCC OET Bulletin 65 Supplement C and 47 CFR §2.1091, the analysis concludes that the EM7700 module, when transmitting either in standalone or simultaneously with other co-located radio transmitters within a host device, is compliant with the FCC RF exposure requirements in mobile 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.

Device	Technology		Frequency (MHz)	Maximum Conducted Power (dBm)	Maximum Antenna Gain (dBi)	
					Standalone	Collocated
EM7700	**UMTS**		824 - 849	24	9.5	6.5
	UMTS		1850 - 1910	24	9.0	9.0
	LTE		704 - 716	24	9.0	6.0
	LTE		1710 - 1755	24	6.0	6.0
Collocated Transmitters	**WLAN**		2400 - 2500	29		5.0
	WLAN		5150 - 5850	29		5.0
		WiMAX	2300 - 2400	29		5.0
		WiMAX	2500 - 2700	29		5.0
		WiMAX	3300 - 3800	29		5.0
	BT	**BT**	2400 - 2500	15		5.0

Table 10: Summary of Maximum Conducted Power and Antenna Gain