



MPE Evaluation for EM7345 Radio Module

September 24, 2014

1. Introduction

In this application we seek modular approval to the EM7345 radio module for use in standalone and collocated simultaneous transmission under mobile configuration. This Maximum Permissible Exposure (MPE) report demonstrates compliance analysis for EM7345 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. A separation distance of 20cm or more shall be maintained between the end user and each WWAN, WiMAX or WLAN, and Bluetooth transmitting antenna.

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.

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)

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/ <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
300-1500	1.585 <i>f</i> ^{0.5}	0.0042 <i>f</i> ^{0.5}	<i>f</i> /150	6
1500-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	616000/ <i>f</i> ^{1.2}
150000-300000	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>	616000/ <i>f</i> ^{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 :

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

where

S = Power density (mW/cm²)

EIRP = Equivalent Isotropic Radiated Power (mW)

D = Separation distance (cm)

3. Product Declarations

The EM7345 radio module supports multiple bands / modes operation. Table 2 lists the output power levels of all the bands / modes supported by the product and permitted in Canada/USA. The operating mode with the highest time-averaged power level for each frequency band is marked in red.

Mode	Equipment Category	Max Transmitter Duty Cycle	Transmitter Frequency (MHz)	Maximum Conducted Power	
				(dBm)	(W)
GPRS	Class 11	37.5%	824-849	33.0	2.00
			1850-1910	30.0	1.00
	Class 12	50%	824-849	32.0	1.58
			1850-1910	29.0	0.79
EDGE	Class 10	25%	824-849	28.0	0.63
			1850-1910	27.0	0.50
	Class 11	37.5%	824-849	27.0	0.50
			1850-1910	26.0	0.40
	Class 12	50%	824-849	26.0	0.40
			1850-1910	25.0	0.32
UMTS	Band 5 Band 4 Band 2	100%	824 - 849	24.5	0.28
			1710-1755	24.5	0.28
			1850 - 1910	24.5	0.28
LTE	Band 17 Band 13 Band 5 Band 4 Band 2 Band 7	100%	704 - 716	24.0	0.25
			777 - 787	24.0	0.25
			824 - 849	24.0	0.25
			1710 - 1755	24.0	0.25
			1850 - 1910	24.0	0.25
			2500 - 2570	24.0	0.25

Table 2: EM7345 Output Powers

4. MPE Calculations

The WWAN MPE calculations are based on conservative conducted transmit power exceeding those listed in the FCC ID N7NEM7345 and IC number 2417C-EM7345 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, 4, and 5 summarize transmitter parameters associated with this analysis.

4.1. Individual Transmitter Calculations

4.1.1. Maximum Output Power

The radiated power calculations for EM7345 per wireless technology are shown in Table 3 and the resulted EIRP/ERP are all within the limits.

	Technology	Frequency (MHz)	Max Conducted Power (dBm)	Max Antenna Gain (dBi)	Max EIRP (dBm)	Max EIRP (W)	Max ERP (dBm)	Max ERP (W)	Max output power limit
EM7345 module (Standalone)	GPRS / EDGE	824-849	33	5	38	6.31	35.85	3.85	7 W ERP
	GPRS / EDGE	1850-1910	30	3	33	2.00	30.86	1.22	2 W EIRP
	UMTS	824 - 849	24.5	5	29.5	0.89	28.36	0.69	7 W ERP
	UMTS	1710 -1755	24.5	5	29.5	0.89	27.86	0.61	1 W EIRP
	UMTS	1850 -1910	24.5	3	27.5	0.56	24.86	0.31	2 W EIRP
	LTE	704 - 716	24	9	33	2.00	30.86	1.22	3 W ERP
	LTE	777 - 787	24	9	33	2.00	30.86	1.22	3 W ERP
	LTE	824 - 849	24	5	29	0.79	28.36	0.69	7 W ERP
	LTE	1710 - 1755	24	5	29	0.79	27.86	0.61	1 W EIRP
	LTE	1850 - 1910	24	3	27	0.50	24.86	0.31	2 W EIRP
	LTE	2500 - 2570	24	9	33	2.00	30.86	1.22	2 W EIRP

Table 3: EM7345 Radiated Power Calculation

4.1.2. Standalone Power Density Calculations

The power density calculations for the individual transmitter at a separation distance of 20 cm are shown in Table 4. For each frequency band, only the mode with the highest time-averaged power is assessed.

For frequency-dependent limit, the lowest transmitter frequency was used to represent the lowest MPE limit in this analysis.

Operating Mode	Lowest TX Freq (MHz)	Max Conducted Power (dBm)	Max Conducted Power (W)	Max Antenna Gain (dBi)	Duty Cycle	Power Density @20 cm (mW/cm ²)	FCC/IC MPE Limit (mW/cm ²)
GPRS 4UL (Cellular)	824	32	1.58	5	50%	0.50	0.55
GPRS 4UL (PCS)	1850	29	0.79	3	50%	0.16	1.00
UMTS (Band 4)	1710	24.5	0.28	5	100%	0.18	1.00
LTE (Band 17)	704	24	0.25	9	100%	0.40	0.47
LTE (Band 13)	777	24	0.25	9	100%	0.40	0.52
LTE (Band 7)	2500	24	0.25	9	100%	0.40	1.00

Table 4: EM7345 Standalone MPE Calculation

4.2. Collocated MPE Calculation

Table 5 below shows the MPE calculation when the EM7345 module is transmitting simultaneously with collocated WiMAX, WLAN, and BT transmitters. The power levels listed represent the worse-case scenario for corresponding frequency ranges given.

	Technology	Frequency (MHz)	Maximum Conducted Power (dBm)	Maximum Antenna Gain (dBi)	Duty Cycle	Power Density @ 20cm (mW/cm ²)	FCC MPE Limit (mW/cm ²)	Power Density to MPE Ratio
EM7345 Module (Collocated)	GPRS 4 UL	824-849	32	3	50%	0.31	0.549	0.57
	GPRS 4 UL	1850-1910	29	3	50%	0.16	1.000	0.16
	UMTS (Band 4)	1710-1755	24.5	5	100%	0.11	1.000	0.11
	LTE (Band 17)	704 - 716	24	6	100%	0.20	0.469	0.42
	LTE (Band 13)	777 - 787	24	6	100%	0.20	0.518	0.38
	LTE (Band 7)	2500-2570	24	9	100%	0.40	1.000	0.40
Other Collocated Transmitters	WLAN	2400 - 2500	28	5	1.000	0.40	1.000	0.40
	WLAN	5150 - 5850	28	5	1.000	0.40	1.000	0.40
	WiMax	2300 - 2400	28	5	1.000	0.40	1.000	0.40
	WiMax	2500 - 2700	28	5	1.000	0.40	1.000	0.40
	WiMax	3300 - 3800	28	5	1.000	0.40	1.000	0.40
	BT	2400 - 2500	15.0	5	1.000	0.02	1.000	0.02

Table 5: EM7345 Collocated MPE Calculation

Adding the highest MPE ratios of WWAN, WiMAX/WLAN and BT transmitters, the max MPE ratio sum is as follows:

$$\text{Max MPE ratio sum} = 0.57 + 0.40 + 0.02 = 0.99 < 1.0$$

5. Conclusion

The analysis above concludes that the EM7345 wireless 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 6 for each given frequency band per wireless technology.

Device	Technology		Frequency (MHz)	Maximum Conducted Power (dBm)	Maximum Antenna Gain (dBi)	
					Standalone	Collocated
EM7345	GPRS		824 - 849	33	5.0	3.0
			1850 - 1910	30	3.0	3.0
	EDGE		824 - 849	28	5.0	3.0
			1850 - 1910	27	3.0	3.0
	UMTS		824 - 849	24.5	5.0	3.0
			1710 - 1755	24.5	5.0	6.0
			1850 - 1910	24.5	3.0	3.0
	LTE		704 - 716	24	9.0	6.0
			777 - 787	24	9.0	6.0
			824 - 849	24	5.0	3.0
			1710 - 1755	24	5.0	3.0
			1850 - 1910	24	3.0	3.0
		2500 - 2570	24	9.0	9.0	
Collocated Transmitters	WLAN		2400 - 2500	28	/	5.0
	WLAN		5150 - 5850	28		5.0
		WiMAX	2300 - 2400	28		5.0
		WiMAX	2500 - 2700	28		5.0
		WiMAX	3300 - 3800	28		5.0
	BT	BT		2400 - 2500		15

Table 6: Summary of Maximum Conducted Power and Antenna Gain