5 FCC §15.247(i) §2.1091 & ISED RSS-102 - RF Exposure

5.1 Applicable Standards

According to FCC §2.1091 (Mobile Devices) RF exposure is calculated.

Limits for General Population/Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Averaging Time (minute)
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
30-300	27.5	0.073	0.2	30
300-1500	/	/	f/1500	30
1500-100,000	/	/	1.0	30

Note: f = frequency in MHz
* = Plane-wave equivalent power density

According to ISED RSS-102 Issue 5:

2.5.2 Exemption Limits for Routine Evaluation – RF Exposure Evaluation

RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows:

- below 20 MHz[6] and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1 W (adjusted for tune-up tolerance);
- at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $4.49/f^{0.5}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance);
- at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \times 10^{-2} f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 5 W (adjusted for tune-up tolerance).

In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the e.i.r.p. was derived.

5.2 MPE Prediction

Predication of MPE limit at a given distance, Equation from OET Bulletin 65, Edition 97-01

$$S = PG/4\pi R^2$$

Where: S = power density
P = power input to antenna
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna

5.3 MPE Results

Bluetooth 2.4 GHz Radio (FCC ID: I28MD-FXLAN11AC)

Maximum average output power at antenna input terminal (dBm):	10.27
Maximum average output power at antenna input terminal (mW):	10.641
Prediction distance (cm):	20
Prediction frequency (MHz):	2402
Maximum Antenna Gain, typical (dBi):	0.3
Maximum Antenna Gain (numeric):	1.0715
Power density of prediction frequency at 20.0 cm (mW/cm^2):	0.0023
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.0

WLAN 2.4 GHz Radio (FCC ID: I28MD-FXLAN11AC)

Maximum average output power at antenna input terminal (dBm):	16.77
Maximum average output power at antenna input terminal (mW):	47.534
Prediction distance (cm):	20
Prediction frequency (MHz):	2412
Maximum Antenna Gain, typical (dBi):	0.3
Maximum Antenna Gain (numeric):	1.0715
Power density of prediction frequency at 20.0 cm (mW/cm^2):	0.010
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.0

WLAN 5 GHz Radio (FCC ID: I28MD-FXLAN11AC)

Maximum average output power at antenna input terminal (dBm):	14.76
Maximum average output power at antenna input terminal (mW):	29.923
Prediction distance (cm):	20
Prediction frequency (MHz):	5550
Maximum Antenna Gain, typical (dBi):	4.4
Maximum Antenna Gain (numeric):	2.75
Power density of prediction frequency at 20.0 cm (mW/cm^2):	0.016
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.0

RFID 900 MHz Radio (FCC ID: UZ7RE40)

Maximum average output power at antenna input terminal (dBm):	27.20
Maximum average output power at antenna input terminal (mW):	524.807
Prediction distance (cm):	20
Prediction frequency (MHz):	902.75
Maximum Antenna Gain, typical (dBi):	-30
Maximum Antenna Gain (numeric):	0.001
Power density of prediction frequency at 20.0 cm (mW/cm^2):	0.0001
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	0.602

BT5 2.4 GHz Radio (FCC ID: I28-EYSNSNZWWZ1)

Maximum peak output power at antenna input terminal (dBm):	2.10
Maximum peak output power at antenna input terminal (mW):	1.6218
Prediction distance (cm):	20
Prediction frequency (MHz):	2442
Maximum Antenna Gain, typical (dBi):	-4.00
Maximum Antenna Gain (numeric):	0.398
Power density of prediction frequency at 20.0 cm (mW/cm^2):	0.00013
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1

Radio Co-location

Frequency Band	Max Conducted Power (dBm)	Antenna Gain (dBi)	Evaluated Distance (cm)	Worst-Case MPE (mW/cm^2)	MPE Limit (mW/cm^2)	Worst-Case MPE Ratios	Sum of MPE Ratios	Limit
RFID + 2.4 Wi-Fi								
900 MHz Radio	27.20	-30	20	0.0001	0.602	0.02%	2.32%	100%
2.4 WLAN	16.77	0.3	20	0.023	1.0	2.3%		

Frequency Band	Max Conducted Power (dBm)	Antenna Gain (dBi)	Evaluated Distance (cm)	Worst-Case MPE (mW/cm^2)	MPE Limit (mW/cm^2)	Worst-Case MPE Ratios	Sum of MPE Ratios	Limit
RFID + 5 Wi-Fi								
900 MHz Radio	27.20	-30	20	0.0001	0.602	0.02%	1.62%	100%
5 WLAN	14.76	4.4	20	0.016	1.0	1.6%		

Frequency Band	Max Conducted Power (dBm)	Antenna Gain (dBi)	Evaluated Distance (cm)	Worst-Case MPE (mW/cm^2)	MPE Limit (mW/cm^2)	Worst-Case MPE Ratios	Sum of MPE Ratios	Limit
RFID + Bluetooth								
900 MHz Radio	27.20	-30	20	0.0001	0.602	0.02%	0.43%	100%
Bluetooth	10.27	0.3	20	0.0023	1.0	0.23%		

Frequency Band	Max Conducted Power (dBm)	Antenna Gain (dBi)	Evaluated Distance (cm)	Worst-Case MPE (mW/cm^2)	MPE Limit (mW/cm^2)	Worst-Case MPE Ratios	Sum of MPE Ratios	Limit
RFID + BT5								
900 MHz Radio	27.20	-30	20	0.0001	0.602	0.02%	0.033%	100%
BT5	2.10	-4.00	20	0.00013	1.0	0.013%		

Results

For the different combination of transmitters, a separation distance of 20 cm complies with the MPE simultaneous transmission limit of ≤ 1.0.

5.4 RF exposure evaluation exemption for IC

RFID 902.75 MHz (IC: 109AN-RE40)

27.20 dBm + (-30.0) dBi = -2.8 dBm < $1.31\times10^{-2}f^{0.6834}$ = 1.371 W = 31.370 dBm

BT BR, 2402 MHz (IC: 3798B-FXLANAC)

10.27 dBm + 0.3 dBi = 10.57 dBm < $1.31\times10^{-2}f^{0.6834}$ = 2.676 W = 34.275 dBm

WLAN 802.11b, 2412 MHz (IC: 3798B-FXLANAC)

16.77 dBm + 0.3 dBi = 17.07 dBm < $1.31\times10^{-2}f^{0.6834}$ = 2.684 W = 34.288 dBm

WLAN 802.11n40, 5550 MHz (IC: 3798B-FXLANAC)

14.76 dBm + 4.4 dBi = 19.16 dBm < $1.31\times10^{-2}f^{0.6834}$ = 4.744 W = 36.761 dBm

BT5 1Mbps 2442MHz (IC: 3798B-EYSNSNZWWZ1)

2.10dBm + -4.00 dBi = -1.90 dBm < $1.31\times10^{-2}f^{0.6834}$ = 2.707 W = 34.325 dBm.

Therefore, RF exposure is not required.