5 FCC §2.1091, §1.1310(d) (3) & ISED RSS-102 - RF Exposure

5.1 Applicable Standards

As per FCC §1.1310(d) (3), At operating frequencies above 6 GHz, the MPE limits listed in Table 1 in paragraph (e)(1) of this section shall be used in all cases to evaluate the environmental impact of human exposure to RF radiation as specified in §1.1307(b) of this part.

TABLE 1 TO §1.1310(E)(1)—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(i) Limits for Occupational/Controlled Exposure				
0.3-3.0	614	1.63	*(100)	≤6
3.0-30	1842/f	4.89/f	*($900/f^2$)	<6
30-300	61.4	0.163	1.0	<6
300-1,500			f/300	<6
1,500-100,000			5	<6
(ii) 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
300-1,500			f/1500	<30
1,500-100,000			1.0	<30

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

According to ISED RSS-102 Issue 5 Section 3, devices operating above 6 GHz regardless of the separation distance shall undergo an RF exposure evaluation.

Table 4: RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)				
Frequency Range (MHz)	**Electric Field (V/m rms)**	**Magnetic Field (A/m rms)**	**Power Density (W/m^2)**	**Reference Period (minutes)**
0.003-10	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	$3.142 f^{0.3417}$	$0.008335 f^{0.3417}$	$0.02619 f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	$616000/f^{1.2}$
150000-300000	$0.158 f^{0.5}$	$4.21 \times 10^{-4} f^{0.5}$	$6.67 \times 10^{-5} f$	$616000/f^{1.2}$

Note: f is frequency in MHz.
* Based on nerve stimulation (NS).
** Based on specific absorption rate (SAR).

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 MH 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

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

Where: S = power density
EIRP = Effective Isotropic Radiated Power
R = distance to the center of radiation of the antenna

5.3 MPE Results for FCC

Note: maximum EIRP determined from worst-case peak UWB limit of 0dBm/50MHz.

UWB Standalone

Maximum EIRP (dBm):	0
Maximum EIRP (mW):	1
Prediction distance (cm):	20
Prediction frequency (MHz):	6489.6
Power density of prediction frequency at 20 cm (mW/cm^2):	0.0002
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.0
Power density of prediction frequency at 20 cm (W/m^2):	0.002
IC MPE limit for uncontrolled exposure at prediction frequency (W/m^2):	10

Radio Co-location

Simultaneous transmission among 2.4 GHz Wi-Fi, DECT, and UWB.

Worst Case Co-location MPE Calculation: 2.4 GHz Wi-Fi + DECT + UWB

Radio	Max EIRP (dBm)	Evaluated Distance (cm)	Worst-Case Exposure (mW/cm^2)	Limit (mW)	Worst-Case Ratios	Sum of Ratios	Limit
Worst Case							
2.4 GHz Wi-Fi	20.22	20	0.0209	1	0.6967%	2.6%	100%
DECT	20	20	0.019	1	1.9%		
UWB	0	20	0.0002	1	0.02%		

Simultaneous transmission among BT, DECT, and UWB.

Worst Case Co-location MPE Calculation: BT + DECT + UWB

Radio	Max EIRP (dBm)	Evaluated Distance (cm)	Worst-Case Exposure (mW/cm^2)	Limit (mW/cm^2)	Worst-Case Ratios	Sum of Ratios	Limit
Worst Case							
BLE	10.53	20	0.00225	1	0.075%	2.0%	100%
DECT	20	20	0.019	1	1.9%		
UWB	0	20	0.0002	1	0.02%		

.

Simultaneous transmission among 5 GHz Wi-Fi, DECT, and UWB.

Worst Case Co-location MPE Calculation: 5 GHz Wi-Fi + DECT + UWB

Radio	Max EIRP (dBm)	Evaluated Distance (cm)	Worst-Case Exposure (mW/cm^2)	Limit (mW)	Worst-Case Ratios	Sum of Ratios	Limit
Worst Case							
5 GHz Wi-Fi	17.58	20	0.0114	1	0.38%	2.3%	100%
DECT	20	20	0.019	1	1.9%		
UWB	0	20	0.0002	1	0.02%		

Note: 2.4 GHz Wi-Fi, 5 GHz Wi-Fi, Bluetooth transmit from the same module and cannot transmit at the same time.
Note: DECT "Max EIRP" is actually Maximum Output Power since antenna gain results in lower EIRP.

5.4 RF Exposure Evaluation Exemption for IC

UWB:
The e.i.r.p of this device is 0 dBm (1 mW), which is less than the exemption threshold, i.e., 5 W. Therefore, the RF exposure evaluation is exempt.

Wifi/BT(worst-case):
The e.i.r.p of this device is 20.22 dBm (105.2 mW), which is less than the exemption threshold, i.e., 1.31x10^-2*f^0.6834W = 2.68W. Therefore, the RF exposure evaluation is exempt.

DECT:
The e.i.r.p of this device is 20 dBm (100 mW), which is less than the exemption threshold, i.e., 1.31x10^-2*f^0.6834W = 2.30W. Therefore, the RF exposure evaluation is exempt.

Worst Case Co-location:

0.001/5 + 0.1052/2.68 + 0.1/2.3 = 0.1 < 1