4.2 Antenna Description

The antennas used by the EUT are permanent attached antennas.

Radio	Antenna	Manufacturer/PN	Frequency Range (MHz)	Antenna Type	Maximum Antenna Gain (dBi)
Bluetooth	Single Antenna	N/A	2400-2500	PCB	2.3
Wi-Fi 2 2.4 GHz	Ant A	WC0D-15/GSD	2400-2500	PIFA	4
	Ant B	WC0D-15/GSD	2400-2500	PIFA	4
Wi-Fi 2 5 GHz	Ant A	WC0D-15/GSD	5150-5850	PIFA	4.5
	Ant B	WC0D-15/GSD	5150-5850	PIFA	4.5
Wi-Fi 1 2.4 GHz	Single Antenna	WC0D-15/GSD	2400-2500	PIFA	4
Wi-Fi 1 5 GHz	Single Antenna	WC0D-15/GSD	5150-5850	PIFA	4.5

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

5.1 Applicable Standards

According to FCC §15.247(i) and §1.1307(b)(1), systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

According to KDB 447 498 Section (7.2), "simultaneous transmission of MPE test exclusion applies when the sum of the MPE ratios for all simultaneous transmitting antennas incorporated in a host device, based on calculated or measured field strengths or power density, is ≤ 1.0. The MPE ratio of each antenna is determined at the minimum *test separation distance* required by the operating configurations and exposure conditions of the host device, according to the ratio of field strengths or power density to MPE limit, at the test frequency.

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 (minutes)
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

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

Before equipment certification is granted, the procedure of IC RSS-102 must be followed concerning the exposure of humans to RF field.

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

BT Radio

Worst Case: GFSK, Mid Channel 2441 MHz

Maximum peak output power at antenna input terminal (dBm):	11.81
Maximum peak output power at antenna input terminal (mW):	15.17
Prediction distance (cm):	20
Prediction frequency (MHz):	2441
Maximum Antenna Gain, typical (dBi):	2.3
Maximum Antenna Gain (numeric):	1.6982
Power density of prediction frequency at 20.0 cm (mW/cm^2):	0.0051
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.0
MPE Ratio (numeric):	0.0051

The device is compliant with the requirement MPE limit for uncontrolled exposure. The maximum power density at the distance of 20 cm is 0.0051 mW/cm^2. Limit is 1.0 mW/cm^2.

Radio Co-location

The device supports the following radio co-location configurations.

	Wi-Fi Radio 2 2.4G	Wi-Fi Radio 2 UNII-1	Wi-Fi Radio 2 UNII-3
BT	X	X	X
Wi-Fi Radio 1 2.4G		X	X
Wi-Fi Radio 1 UNII-1	X		X
Wi-Fi Radio 1 UNII-3	X	X	

Worst Case Colocation 2.4 GHz Classic Bluetooth and 2.4 GHz Wi-Fi Radio 2 (MIMO):

Frequency Band	Max Conducted Power(dBm)	Evaluated Distance (cm)	Worst-Case MPE (mW/cm^2)	MPE Limit (mW/cm^2)	Worst-Case MPE Ratios	Sum of MPE Ratios	Limit
Worst Case							
2.4 GHz Classic Bluetooth	11.81	20	0.0051	1.0	0.51%	42.36%	100%
2.4 Wi-Fi Radio 2	26.23	20	0.4185	1.0	41.85%		

Worst Case Colocation 2.4 GHz Classic Bluetooth and 5.8 GHz Wi-Fi Radio 2 (MIMO):

Frequency Band	Max Conducted Power(dBm)	Evaluated Distance (cm)	Worst-Case MPE (mW/cm^2)	MPE Limit (mW/cm^2)	Worst-Case MPE Ratios	Sum of MPE Ratios	Limit
Worst Case							
2.4 GHz Classic Bluetooth	11.81	20	0.0051	1.0	0.51%	22.95%	100%
5.8 GHz Wi-Fi Radio 2	23.02	20	0.2244	1.0	22.44%		

5.4 RF exposure evaluation exemption for IC

BT Radio

Worst Case: GFSK, Mid Channel 2441 MHz

Maximum EIRP power = 11.81dBm + 2.3 dBi = 14.11 dBm which is less than $1.31\times10^{-2}f^{0.6834}$ = 2.71 W = 34.33 dBm