APPENDIX C - RF EXPOSURE EVALUATION

Maximum Permissible Exposure (MPE)

Applicable Standard

According to subpart §1.1310, 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.

Limits for Maximum Permissible Exposure (MPE) (§1.1310, §2.1091)

(B) 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)**
0.3–1.34	614	1.63	*(100)	30
1.34–30	824/f	2.19/f	*(180/f²)	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;

According to §1.1310 and §2.1091 RF exposure is calculated.

Calculation formula:

Prediction of power density at the distance of the applicable MPE limit
$S = PG/4\pi R^2$ = power density (in appropriate units, e.g. mW/cm^2);
P = power input to the antenna (in appropriate units, e.g., mW);
G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain;
R = distance to the center of radiation of the antenna (appropriate units, e.g., cm);

For simultaneously transmit system, the calculated power density should comply with:

$$\sum_i \frac{S_i}{S_{Limit,i}} \leq 1$$

Calculated Data:

Operation Modes	Frequency (MHz)	Antenna Gain		Conducted output power including Tune-up Tolerance		Evaluation Distance (cm)	Power Density (mW/cm^2)	MPE Limit (mW/cm^2)
		(dBi)	(numeric)	(dBm)	(mW)			
WiFi 2.4G	2412-2462	5.73	3.74	24	251.18864	20.00	0.1870	1.0
WiFi 5.2G	5150-5250	4.21	2.64	13	19.95	20.00	0.0105	1.0
WiFi 5.3G	5250-5350	4.21	2.64	12	15.85	20.00	0.0083	1.0
WiFi 5.6G	5470-5725	6.45	4.42	12	15.85	20.00	0.0139	1.0
WiFi 5.8G	5725-5850	5.65	3.67	13	19.95	20.00	0.0146	1.0
Bluetooth	2402-2480	5.73	3.74	9	7.94	20.00	0.0059	1.0
BLE	2402-2480	5.73	3.74	9	7.94	20.00	0.0059	1.0
NFC	13.56	/	/	-44.28	0.00004	20.00	<<0.0001	0.98
NFC field strength is 50.92BμV/m @ 3m = -44.28 dBm(0.00004mW) EIRP. That equal to antenna gain is 0dBi and used the EIRP value as conducted power.								

Note: The Conducted output power including Tune-up Tolerance provided by manufacturer

Simultaneous transmission:

BT, BLE, WiFi can't transmit simultaneously.WiFi/BLE/Bluetooth and NFC can transmit simultaneously:

$S_{BLE}/S_{limit\text{-}BLE} + S_{NFC}/S_{limit\text{-}NFC}$

=0.187/1+0.0001/0.98
=0.187
< 1.0

Result: The device meet FCC MPE at 20 cm distance