RF EXPOSURE EVALUATION

According to FCC 1.1310: The criteria listed in the following table shall be used to evaluate the environment impact of human exposure to radio frequency(RF) Radiation as specified in §1.1307(b)

Limits for Maximum Permissible Exposure (MPE)

Frequency Range(MHz)	Electric Field Strength(V/m)	Magnetic Field Strength(A/m)	Power Density(mW/cm^2)	Average Time
(A) Limits for Occupational/Control Exposures				
300-1500	--	--	F/300	6
1500-100000	--	--	5	6
(B) Limits for General Population/Uncontrol Exposures				
300-1500	--	--	F/1500	6
1500-100000	--	--	1	30

11.1 Friis transmission formula: Pd= (Pout*G)\ (4*pi*R^2)

Where
Pd= Power density in mW/cm^2
Pout=output power to antenna in mW
G= Numeric gain of the antenna relative to isotropic antenna
Pi=3.1416
R= distance between observation point and center of the radiator in cm(20cm)
Pd the limit of MPE, 1mW/cm^2. If we know the maximum gain of the antenna and total power input to the antenna, through the calculation, we will know the distance where the MPE limit is reached.
mW=10^(dBm/10)

11.2 Max output power

Operation Frequency: BT 2402-2480MHz,
BLE

BT Antenna=2dBi

	Frequency	Maximum Conducted Output Power(PK)	LIMIT
	(MHz)	(dBm)	dBm
BT BLE	2402	1.02	30
	2440	1.43	30
	2480	2.98	30

Operation Frequency: WIFI 802.11b/g/n HT20: 2412-2462MHz,
WIFI 802.11n HT40: 2422-2452MHz,

WIFI Antenna 1 Gain =2dBi, Antenna 2 Gain =2dBi ,MIMO mode: Directional gain

= 10log(antenna 1 + antenna 2) dbi =5.01dbi in 2.4GHz

Test Channel	Frequenc (MHz)	Conducted Output Power(dBm)		Total Power (dBm)		LIMIT (dBm)	Verdict
		ANT 1	ANT 2	ANT 1	ANT 2		
802.11b							
1	2412	17.24	17.15	-	-	30	PASS
6	2437	17.16	17.03	-	-	30	PASS
11	2462	17.21	17.07	-	-	30	PASS
802.11g							
1	2412	17.29	17.01	-	-	30	PASS
6	2437	17.15	17.33	-	-	30	PASS
11	2462	17.22	17.22	-	-	30	PASS
802.11n HT20							
1	2412	17.16	17.11	20.15		29.97	PASS
6	2437	17.23	17.08	20.17		29.97	PASS
11	2462	17.18	17.24	20.22		29.97	PASS
802.11n HT40							
3	2422	17.36	17.15	20.27		29.97	PASS
6	2437	17.29	17.24	20.28		29.97	PASS
9	2452	17.58	17.36	20.48		29.97	PASS

Operation Frequency: WIFI 5180-5240MHz, 5745-5825MHz

WIFI Antenna 1 Gain =2dBi, Antenna 2 Gain =2dBi ,MIMO mode: Directional gain

= 10log(antenna 1 + antenna 2) dbi =5.01dbi in 5.0GHz

Test Channel	Frequency	Maximum output power. (AV) (dBm)		Total Power (AV)	LIMIT	Result
	(MHz)	ANT 1	ANT 2	dBm	dBm	
TX 802.11a Mode						
CH36	5180	15.72	15.27	–	23.97	Pass
CH40	5200	15.69	15.12	–	23.97	Pass
CH48	5240	15.35	15.18	–	23.97	Pass
TX 802.11 n20M Mode						
CH36	5180	14.570	14.280	17.438	22.35	Pass
CH40	5200	14.760	14.170	17.485	22.35	Pass
CH48	5240	14.080	14.070	17.085	22.35	Pass
TX 802.11 n40M Mode						
CH38	5190	14.870	14.150	17.535	22.35	Pass
CH46	5230	14.570	14.070	17.337	22.35	Pass
TX 802.11 AC20M Mode						
CH36	5180	14.840	14.270	17.575	22.35	Pass
CH40	5200	14.540	14.060	17.317	22.35	Pass
CH48	5240	14.250	14.110	17.191	22.35	Pass
TX 802.11 AC40M Mode						
CH38	5190	14.140	14.010	17.086	22.35	Pass
CH46	5230	14.110	14.100	17.115	22.35	Pass
TX 802.11 AC80M Mode						
CH42	5210	14.530	14.420	17.486	22.35	Pass

Test Channel	Frequency	Maximum output power. (AV) (dBm)		Total (AV)	LIMIT
	(MHz)	ANT 1	ANT 2	dBm	dBm
TX 802.11a Mode					
CH 149	5745	17.15	17.36	–	30
CH 157	5785	17.29	17.11	–	30
CH 165	5825	17.38	17.37	–	30
TX 802.11 n20M Mode					
CH 149	5745	17.31	17.13	20.231	27.96
CH 157	5785	17.37	17.23	20.311	27.96
CH 165	5825	17.22	17.44	20.342	27.96
TX 802.11 n40M Mode					
CH 151	5755	17.28	17.14	20.221	27.96
CH 159	5795	17.16	17.03	20.106	27.96
TX 802.11 AC20M Mode					
CH 149	5745	17.14	17.05	20.106	27.96
CH 157	5785	17.21	17.09	20.161	27.96
CH 165	5825	17.22	17.15	20.195	27.96
TX 802.11 AC40M Mode					
CH 151	5755	17.58	17.25	20.428	27.96
CH 159	5795	17.34	17.28	20.320	27.96
TX 802.11 AC80M Mode					
CH 155	5775	17.02	17.1	20.070	27.96

11.2 Measurement Result

BT max possible output power (PK,conducted)：2±1dbm

Pout=3dBm=2.00mW

BT Antenna=2dBi ,numeric gain result =1.58=G

R=20cm

Pd=(Pout*G)\ (4*pi*R^2)=0.00063（mW/cm²）

2.4G WIFI:

2.4GWIFI max possible output power (PK,conducted)：20±1dbm

Pout=21dBm=125.89mW

2.4G WIFI Antenna 1 Gain =2dBi, Antenna 2 Gain =2dBi ,MIMO mode: Directional gain= 10log(antenna 1 + antenna 2) dbi =5.01dBi in 2.4GHz ,numeric gain result =3.17=G

R=20cm

Pd=(Pout*G)\ (4*pi*R^2)=0.07939（mW/cm²）

5G WIFI:

5GWIFI max possible output power (PK,conducted)：20±1dbm

Pout=21dBm=125.89mW

5G WIFI Antenna 1 Gain =2dBi, Antenna 2 Gain =2dBi ,MIMO mode: Directional gain = 10log(antenna 1 + antenna 2) dbi =5.01dBi in 2.4GHz ,numeric gain result =3.17=G

R=20cm

Pd=(Pout*G)\ (4*pi*R^2)=0.07939（mW/cm²）

Conclusion:
CONCULSION:
Both of the WLAN 5GHz Band and Bluetooth and WLAN 2.4GHz can transmit simultaneously, the formula of calculated the MPE is:
CPD1 / LPD1 + CPD2 / LPD2 + CPD3 / LPD3 ⋯⋯etc. < 1
CPD = Calculation power density
LPD = Limit of power density
Therefore, the worst-case situation is 0.00063/1+ 0.07939/1+0.07939/1=0.09941, which is less than "1".
This confirmed that the device comply with FCC 1.1310 MPE limit.