B04684 RF Exposure Exhibit

BT BLE (and simultaneous MPE Calculation)

Model: B04684 | Test Number: 230821B

MPE Calculator

RF Exposure uses EIRP for calculation. EIRP is based on TX power added to the antenna gain in dBi.
dBi = dB gain compared to an isotropic radiator.
S = power density in mW/cm^2

Transmitter Output power (dBm)		4.23		
Transmitter Output power (mW)		2.65		
Output Power for % duty Cycle operation (Watts)	100	0.0026	Antenna Gain (dBi)	2.2
Output Power for 100% duty Cycle operation (Watts)		0.003	Antenna Gain (Numeric)	1.66
Tx Frequency (MHz)	2442	Calculation power (Watts) 0.003	dBd + 2.17 = dBi / dBi to dBd	2.17
Calculation power (EIRP mW)		4.40	Antenna Gain (dBd)	0.03
Cable Loss (dB)	0.0	Adjusted Power (dBm) 4.23	Antenna minus cable (dBi)	2.20

Calculated ERP (mw) 2.667
Calculated EIRP (mw) 4.395

EIRP = Po(dBM) + Gain (dB)
Radiated (EIRP) dBm 6.430
ERP = EIRP - 2.17 dB
Radiated (ERP) dBm 4.260

Power density (S) mW/cm² = EIRP / 4 p r^2

r (cm) EIRP (mW)

Occupational Limit		
5	mW/cm²	
50	W/m²	
General Public Limit		
1	mW/cm²	
10	W/m²	

FCC radio frequency radiation exposure limits per 1.1310		
Frequency (MHz)	Occupational Limit (mW/cm²)	Public Limit (mW/cm²)
30-300	1	0.2
300-1,500	f/300	f/1500
1,500-10,000	5	1

Occupational Limit	
$0.6455f^{0.5}$	W/m²
39.7	W/m²
General Public Limit	
$0.02619f^{0.6834}$	W/m²
5.4	W/m²

IC radio frequency radiation exposure limits per RSS-102		
Frequency (MHz)	Occupational Limit (W/m²)	Public Limit (W/m²)
100-6,000	$0.6455f^{0.5}$	
6,000-15,000	50	
48-300		1.291
300-6,000		$0.02619f^{0.6834}$
6,000-15,000	50	10

Definition	Formula	Parameter	Value	Unit
f = Transmit Frequecny (MHz)		f (MHz) =	2442	MHz
P_T = Power Input to Antenna (mW)		P_T (mW) =	2.65	mW
Duty cycle (percentage of operation)		% =	100	%
P_A = Adjusted Power due to Duty cycle or Cable Loss (mW)		P_A (mW) =	2.65	mW
G_N = Numeric Gain of the Antenna		GN (numeric) =	1.66	numeric
S_{20} = Power Density of device at 20cm (mW/m²)	$S_{20}=(P_AG_N)/(4\pi R_{20})^2$	S_{20} (mW/m²) =	0.0009	mW/cm²
S_{20} = Power Density of device at 20cm (W/m²)	$S_{20}=(P_AG_N)/(4\pi R_{20})^2$	S_{20} (W/m²) =	0.0087	W/m²
S_L = Power Density Limit (W/m²)		S_L (W/m²)=	5.412	W/m²
R_C = Minimum distance to the Radiating Element for Compliance (cm)	$R_C=\sqrt{(P_AG_N/4\pi S_L)}$	R_C (cm) =	0.8	cm
S_C = Power Density of the device at the Compliance Distance R_C (W/m²)	$S_C=(P_AG_N)/(4\pi R_C)^2$	S_C (W/m²) =	5.41	W/m²
R_{20} = 20cm		R20=	20	cm

For Complaince with Canada General Population Limits, User Manual must indicate a minimum seperation distance of 0.8 cm
Or in Meters for Complaince with Canada General Population Limits, a minimum seperation distance of 0.01 Meters

Summary: Standalone MPE Calculations and Summary

Band (MHZ)	Tx Duty Cycle (%)	Tx Frequeny (MHz)	Power Total (mW)	Antenna Gain (numeric)	S_L (W/m²)	S_{20} (W/m²)	R_C (cm)	S_C (W/m²)
2402-2480 BLE	100	2442	2.65	1.66	5.412	0.0087	0.8	5.41
2402-2480 WiFi	100	2412	36.90	1.66	5.366	0.1218	0.8	5.41
5150-5250	100	5180	20.89	2.17	9.047	0.0902	2.0	9.05
5725-5850	100	5745	39.81	2.17	9.710	0.1719	2.7	9.71

Simlultaneous MPE Calculation		
	BLE	5.7 G
Tx Frequeny (MHz)	2442	5745
S_{20} (W/m²)	0.0087	0.1719
S_L (W/m²)	5.412	9.710
Power Ratio (S_L / S_{20})	0.002	0.018
Sum of Power Ratios at 20cm (Tx1 + Tx2)		**0.019**
Requirement = Σ of MPE Ratio ≤ 1		

Note: The only possible simultaneous transmit combinations in this design are:
BLE and 5.1G WiFi
BLE and 5.7G WiFi *
* Worst case

BLE and 5.7G WiFi combination still below the limit of 1 for sum of MPE Ratios

2.4GHz

	Model: B04684		Test Number: 230821B					
MPE Calculator	RF Exposure uses EIRP for calculation. EIRP is based on TX power added to the antenna gain in dBi.							
	dBi = dB gain compared to an isotropic radiator.							
	S = power density in mW/cm^2							
		Transmitter Output power (dBm)	15.67					
		Transmitter Output power (mW)	36.90					
Output Power for % duty Cycle operation (Watts)	100		0.0369		Antenna Gain (dBi)	2.2		
		Output Power for 100% duty Cycle operation (Watts)	0.037		Antenna Gain (Numeric)	1.66		
Tx Frequency (MHz)	2412	Calculation power (Watts)	0.037	dBd + 2.17 = dBi	dBi to dBd	2.17		
		Calculation power (EIRP mW)	61.24		Antenna Gain (dBd)	0.03		
Cable Loss (dB)	0.0	Adjusted Power (dBm)	15.67		Antenna minus cable (dBi)	2.20		
	Calculated ERP (mw) 37.154				EIRP = Po(dBM) + Gain (dB)			
	Calculated EIRP (mw) 61.235				Radiated (EIRP) dBm	17.870		
					ERP = EIRP - 2.17 dB			
					Radiated (ERP) dBm	15.700		

Power density (S) mW/cm² = EIRP / 4 p r^2

r (cm) EIRP (mW)

	Occupational Limit	FCC radio frequency radiation exposure limits per 1.1310		
		Frequency (MHz)	Occupational Limit (mW/cm^2)	Public Limit (mW/cm^2)
5	mW/cm^2	30-300	1	0.2
50	W/m^2	300-1,500	f/300	f/1500
	General Public Limit	1,500-10,000	5	1
1	mW/cm^2			
10	W/m^2			

	Occupational Limit	IC radio frequency radiation exposure limits per RSS-102		
$0.6455 f^{0.5}$	W/m^2	Frequency (MHz)	Occupational Limit (W/m^2)	Public Limit (W/m^2)
39.5	W/m^2	100-6,000	$0.6455 f^{0.5}$	
	General Public Limit	6,000-15,000	50	
$0.02619 f^{0.6834}$	W/m^2	48-300		1.291
5.4	W/m^2	300-6,000		$0.02619 f^{0.6834}$
		6,000-15,000	50	10

Definition	Formula	Parameter	Value	Unit
f = Transmit Frequecny (MHz)		f (MHz) =	2412	MHz
P_T = Power Input to Antenna (mW)		P_T (mW) =	36.90	mW
Duty cycle (percentage of operation)		% =	100	%
P_A = Adjusted Power due to Duty cycle or Cable Loss (mW)		P_A (mW) =	36.90	mW
G_N = Numeric Gain of the Antenna		GN (numeric) =	1.66	numeric
S_{20} = Power Density of device at 20cm (mW/m^2)	$S_{20}=(P_A G_N)/(4\pi R_{20})^2$	S_{20} (mW/m^2) =	0.0122	mW/cm^2
S_{20} = Power Density of device at 20cm (W/m^2)	$S_{20}=(P_A G_N)/(4\pi R_{20})^2$	S_{20} (W/m^2) =	0.1218	W/m^2
S_L = Power Density Limit (W/m^2)		S_L (W/m^2)=	5.366	W/m^2
R_C = Minimum distance to the Radiating Element for Compliance (cm)	$R_C=\sqrt{(P_A G_N/4\pi S_L)}$	R_C (cm) =	3.0	cm
S_C = Power Density of the device at the Compliance Distance R_C (W/m^2)	$S_C=(P_A G_N)/(4\pi R_C)^2$	S_C (W/m^2) =	5.37	W/m^2
R_{20} = 20cm		R20=	20	cm

For Complaince with Canada General Population Limits, User Manual must indicate a minimum seperation distance of 3.0 cm

Or in Meters for Complaince with Canada General Population Limits, a minimum seperation distance of 0.03 Meters

Summary: Standalone MPE Calculations and Summary

Band (MHZ)	Tx Duty Cycle (%)	Tx Frequeny (MHz)	Power Total (mW)	Antenna Gain (numeric)	S_L (W/m^2)	S_{20} (W/m^2)	R_C (cm)	S_C (W/m^2)
2402-2480	100	2412	36.90	1.66	5.366	0.1218	3.0	5.37

5.1 GHz

Model: B04684 Test Number: 230821B

MPE Calculator

RF Exposure uses EIRP for calculation. EIRP is based on TX power added to the antenna gain in dBi.

dBi = dB gain compared to an isotropic radiator.

S = power density in mW/cm^2

Transmitter Output power (dBm)	13.20			
Transmitter Output power (mW)	20.89			
Output Power for % duty Cycle operation (Watts) 100	0.0209		Antenna Gain (dBi)	2.8
Output Power for 100% duty Cycle operation (Watts)	0.02		Antenna Gain (Numeric)	1.91
Tx Frequency (MHz) 5180 Calcualtion power (Watts)	0.02	dBd + 2.17 = dBi	dBi to dBd	2.17
Calculation power (EIRP mW)	39.81		Antenna Gain (dBd)	0.63
Cable Loss (dB) 0.0 Adjusted Power (dBm)	13.20		Antenna minus cable (dBi)	2.80
			Antenna Gain (Numeric)	1.91
Calculated ERP (mw) 24.155			EIRP = Po(dBM) + Gain (dB)	1.55
Calculated EIRP (mw) 39.811			Radiated (EIRP) dBm	16.000
			ERP = EIRP - 2.17 dB	
			Radiated (ERP) dBm	13.830

Power density (S) mW/cm² = EIRP / 4 p r^2

r (cm) EIRP (mW)

	Occupational Limit	FCC radio frequency radiation exposure limits per 1.1310		
5	mW/cm^2	Frequency (MHz)	Occupational Limit (mW/cm^2)	Public Limit (mW/cm^2)
50	W/m^2	30-300	1	0.2
	General Public Limit	300-1,500	f/300	f/1500
1	mW/cm^2	1,500-10,000	5	1
10	W/m^2			

	Occupational Limit			
$0.6455f^{0.5}$	W/m^2	IC radio frequency radiation exposure limits per RSS-102		
57.8	W/m^2	Frequency (MHz)	Occupational Limit (W/m^2)	Public Limit (W/m^2)
	General Public Limit	100-6,000	$0.6455f^{0.5}$	
$0.02619f^{0.6834}$	W/m^2	6,000-15,000	50	
9.0	W/m^2	48-300		1.291
		300-6,000		$0.02619f^{0.6834}$
		6,000-15,000	50	10

f = Transmit Frequecny (MHz)		f (MHz) =	5180	MHz
P_T = Power Input to Antenna (mW)		P_T (mW) =	20.8930	mW
Duty cycle (percentage of operation)		% =	100	%
P_A = Adjusted Power due to Duty cycle or Cable Loss (mW)		P_A (mW) =	20.89	mW
G_N = Numeric Gain of the Antenna		GN (numeric) =	2.17	numeric
S_{20} = Power Density of device at 20cm (mW/m^2)	$S_{20}=(P_AG_N)/(4\pi R_{20})^2$	S_{20} (mW/m^2) =	0.0090	mW/cm^2
S_{20} = Power Density of device at 20cm (W/m^2)	$S_{20}=(P_AG_N)/(4\pi R_{20})^2$	S_{20} (W/m^2) =	0.0902	W/m^2
S_L = Power Density Limit (W/m^2)		S_L (W/m^2)=	9.047	W/m^2
R_C = Minimum distance to the Radiating Element for Compliance (cm)	$R_C=\sqrt{(P_AG_N/4\pi S_L)}$	R_C (cm) =	2.0	cm
S_C = Power Density of the device at the Compliance Distance R_C (W/m^2)	$S_C=(P_AG_N)/(4\pi R_C)^2$	S_C (W/m^2) =	9.047	W/m^2
R_{20} = 20cm		R20=	20	cm

For Compliance with Canada General Population Limits, User Manual must indicate a minimum seperation distance of 2.0 cm

Or in Meters for Complaince with Canada General Population Limits, a minimum seperation distance of 0.02 Meters

Summary: Standalone MPE Calculations and Summary

Band (MHZ)	Tx Duty Cycle (%)	Tx Frequeny (MHz)	Power Total (mW)	Antenna Gain (numeric)	S_L (W/m^2)	S_{20} (W/m^2)	R_C (cm)	S_C (W/m^2)
5150-5250	100	5180	20.89	2.17	9.047	0.0902	2.0	9.05

5.7 GHz

	Model: B04684		Test Number: 230821B			
MPE Calculator	RF Exposure uses EIRP for calculation. EIRP is based on TX power added to the antenna gain in dBi.					
	dBi = dB gain compared to an isotropic radiator.					
	S = power density in mW/cm^2					
		Transmitter Output power (dBm)	16.00			
		Transmitter Output power (mW)	39.81			
Output Power for % duty Cycle operation (Watts)		100	0.0398		Antenna Gain (dBi)	2.8
		Output Power for 100% duty Cycle operation (Watts)	0.04		Antenna Gain (Numeric)	1.91
Tx Frequency (MHz)	5745	Calcualtion power (Watts)	0.04	dBd + 2.17 = dBi	dBi to dBd	2.17
		Calculation power (EIRP mW)	75.86		Antenna Gain (dBd)	0.63
Cable Loss (dB)	0.0	Adjusted Power (dBm)	16.00		Antenna minus cable (dBi)	2.80
					Antenna Gain (Numeric)	1.91
	Calculated ERP (mw)	46.026			EIRP = Po(dBM) + Gain (dB)	1.55
	Calculated EIRP (mw)	75.858			Radiated (EIRP) dBm	18.800
					ERP = EIRP - 2.17 dB	
					Radiated (ERP) dBm	16.630

Power density (S) mW/cm² = EIRP / (4 p r^2)

r (cm) EIRP (mW)

	Occupational Limit	FCC radio frequency radiation exposure limits per 1.1310		
5	mW/cm^2	Frequency (MHz)	Occupational Limit (mW/cm^2)	Public Limit (mW/cm^2)
50	W/m^2	30-300	1	0.2
	General Public Limit	300-1,500	f/300	f/1500
1	mW/cm^2	1,500-10,000	5	1
10	W/m^2			

	Occupational Limit	IC radio frequency radiation exposure limits per RSS-102		
$0.6455f^{0.5}$	W/m^2			
60.9	W/m^2	Frequency (MHz)	Occupational Limit (W/m^2)	Public Limit (W/m^2)
	General Public Limit	100-6,000	$0.6455f^{0.5}$	
$0.02619f^{0.6834}$	W/m^2	6,000-15,000	50	
9.7	W/m^2	48-300		1.291
		300-6,000		$0.02619f^{0.6834}$
		6,000-15,000	50	10

f = Transmit Frequecny (MHz)		f (MHz) =	5745	MHz
P_T = Power Input to Antenna (mW)		P_T (mW) =	39.8107	mW
Duty cycle (percentage of operation)		% =	100	%
P_A = Adjusted Power due to Duty cycle or Cable Loss (mW)		P_A (mW) =	39.81	mW
G_N = Numeric Gain of the Antenna		GN (numeric) =	2.17	numeric
S_{20} = Power Density of device at 20cm (mW/m^2)	$S_{20}=(P_AG_N)/(4\pi R_{20})^2$	S_{20} (mW/m^2) =	0.0172	mW/cm^2
S_{20} = Power Density of device at 20cm (W/m^2)	$S_{20}=(P_AG_N)/(4\pi R_{20})^2$	S_{20} (W/m^2) =	0.1719	W/m^2
S_L = Power Density Limit (W/m^2)		S_L (W/m^2)=	9.710	W/m^2
R_C = Minimum distance to the Radiating Element for Compliance (cm)	$R_C=\sqrt{(P_AG_N/4\pi S_L)}$	R_C (cm) =	2.7	cm
S_C = Power Density of the device at the Compliance Distance R_C (W/m^2)	$S_C=(P_AG_N)/(4\pi R_C)^2$	S_C (W/m^2) =	9.710	W/m^2
R_{20} = 20cm		R20=	20	cm

For Compliance with Canada General Population Limits, User Manual must indicate a minimum seperation distance of 2.7 cm

Or in Meters for Complaince with Canada General Population Limits, a minimum seperation distance of 0.03 Meters

Summary: Standalone MPE Calculations and Summary

Band (MHZ)	Tx Duty Cycle (%)	Tx Frequeny (MHz)	Power Total (mW)	Antenna Gain (numeric)	S_L (W/m^2)	S_{20} (W/m^2)	R_C (cm)	S_C (W/m^2)
5725-5850	100	5745	39.81	2.17	9.710	0.1719	2.7	9.71