

1. MAXIMUM PERMISSIBLE EXPOSURE (MPE)

1.1. Standard Applicable

According to §1.1307(b)(1), systems operating under the provisions of this section shall be operated in a manner that ensure that the public is not exposed to radio frequency energy level in excess of the Commission’s guideline.

This is a Mobile device, the MPE is required.

According to §1.1310 and §2.1093 RF exposure is calculated.

Limits for Maximum Permissive Exposure (MPE)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Averaging Time (minute)
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
1500-15000	/	/	1.0	30

F = frequency in MHz

* = Plane-wave equipment power density

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1.2. Maximum Permissible Exposure (MPE) Evaluation (Worst Case)

			Manufacturing Max Power [dBm]		
			BR	EDR	BLE
2400~2485MHz	Low	Time averaged	7.75	5.87	4.61
		Calculated to 100% duty	8.88	7.00	5.31
	Mid	Time averaged	8.25	6.87	5.49
		Calculated to 100% duty	9.38	8.00	6.19
	High	Time averaged	6.05	3.87	2.72
		Calculated to 100% duty	7.18	5.00	3.42

MPE Prediction (BT-BR)

Prediction of MPE limit at a given distance

Equation from page 18 of 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

Max. output power including tune-up tolerancel:	9.38	(dBm)
Max. output power including tune-up tolerancel:	8.6696188	(mW)
Duty cycle:	100	(%)
Maximum Pav :	8.6696188	(mW)
Peak Antenna gain (Maximum):	2.1	(dBi)
Peak Antenna gain (linear):	1.6218101	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	2441	(MHz)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm ²)
Power density at predication frequency at 20 (cm)	0.003	(mW/cm ²)

Measurement Result

The predicted power density level at 20 cm is 0.003 mW/cm².

This is below the uncontrolled exposure limit of 1 mW/cm² at 2441MHz.

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MPE Prediction (BLE)

Prediction of MPE limit at a given distance

Equation from page 18 of 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

Max. output power including tune-up tolerancel:	6.19	(dBm)
Max. output power including tune-up tolerancel:	4.1591061	(mW)
Duty cycle:	100	(%)
Maximum Pav :	4.1591061	(mW)
Peak Antenna gain (Maximum):	2.1	(dBi)
Peak Antenna gain (linear):	1.6218101	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	2440	(MHz)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm2)
Power density at predication frequency at 20 (cm)	0.001	(mW/cm2)
Measurement Result		
The predicted power density level at 20 cm is 0.001 mW/cm2.		
This is below the uncontrolled exposure limit of 1 mW/cm2 at 2440MHz.		

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11b		Manufacturing Max Power [dBm]	
Band	channel	1Mbps	11Mbps
2400~2485MHz	1-11	17.3	17.3

MPE Prediction (WLAN-802.11 b)

Prediction of MPE limit at a given distance

Equation from page 18 of 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

Max. output power including tune-up tolerancel:	17.30	(dBm)
Max. output power including tune-up tolerancel:	53.70318	(mW)
Duty cycle:	100	(%)
Maximum Pav :	53.70318	(mW)
Peak Antenna gain (Maximum):	2.1	(dBi)
Peak Antenna gain (linear):	1.6218101	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	2462	(MHz)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm ²)
Power density at predication frequency at 20 (cm)	0.017	(mW/cm ²)

Measurement Result

The predicted power density level at 20 cm is 0.017 mW/cm².

This is below the uncontrolled exposure limit of 1 mW/cm² at 2462MHz.

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11a		Manufacturing Max Power [dBm]	
Band	channel	6Mbps	54Mbps
5150~5250MHz	All	16.0	15.0
5250~5350MHz	All	16.0	15.0
5470~5725MHz	All	16.5	15.0
5725~5850MHz	All	13.5	13.5

MPE Prediction (WLAN-802.11 a)

Prediction of MPE limit at a given distance

Equation from page 18 of 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

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5150~5250MHz

Max. output power including tune-up tolerancel:	16.00	(dBm)
Max. output power including tune-up tolerancel:	39.810717	(mW)
Duty cycle:	100	(%)
Maximum Pav :	39.810717	(mW)
Peak Antenna gain (Maximum):	2	(dBi)
Peak Antenna gain (linear):	1.5848932	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	5240	(MHz)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm ²)
Power density at predication frequency at 20 (cm)	0.013	(mW/cm ²)
Measurement Result		
The predicted power density level at 20 cm is 0.013 mW/cm ² .		
This is below the uncontrolled exposure limit of 1 mW/cm ² at 5240MHz.		

5250~5350MHz

Max. output power including tune-up tolerancel:	16.00	(dBm)
Max. output power including tune-up tolerancel:	39.810717	(mW)
Duty cycle:	100	(%)
Maximum Pav :	39.810717	(mW)
Peak Antenna gain (Maximum):	2	(dBi)
Peak Antenna gain (linear):	1.5848932	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	5300	(MHz)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm ²)
Power density at predication frequency at 20 (cm)	0.013	(mW/cm ²)
Measurement Result		
The predicted power density level at 20 cm is 0.013 mW/cm ² .		
This is below the uncontrolled exposure limit of 1 mW/cm ² at 5300MHz.		

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5470~5725MHz

Max. output power including tune-up tolerancel:	16.50	(dBm)
Max. output power including tune-up tolerancel:	44.668359	(mW)
Duty cycle:	100	(%)
Maximum Pav :	44.668359	(mW)
Peak Antenna gain (Maximum):	1	(dBi)
Peak Antenna gain (linear):	1.2589254	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	5580	(MHz)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm2)
Power density at predication frequency at 20 (cm)	0.011	(mW/cm2)
Measurement Result		
The predicted power density level at 20 cm is 0.011 mW/cm2.		
This is below the uncontrolled exposure limit of 1 mW/cm2 at 5580MHz.		

5725~5850MHz

Max. output power including tune-up tolerancel:	13.50	(dBm)
Max. output power including tune-up tolerancel:	22.387211	(mW)
Duty cycle:	100	(%)
Maximum Pav :	22.387211	(mW)
Peak Antenna gain (Maximum):	0.4	(dBi)
Peak Antenna gain (linear):	1.0964782	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	5745	(MHz)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm2)
Power density at predication frequency at 20 (cm)	0.005	(mW/cm2)
Measurement Result		
The predicted power density level at 20 cm is 0.005 mW/cm2.		
This is below the uncontrolled exposure limit of 1 mW/cm2 at 5745MHz.		

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2. COLLOCATED MPE ANALYSIS

The modem may transmit simultaneously with other collocated radio transmitters within a host device, provided the following conditions are met:

- Each collocated radio transmitter has been certified by FCC for mobile application (that will be met since SQNS module will have its own FCC ID and host device will have its own FCC ID)
- At least 20 cm separation distance between the antennas of the collocated transmitters and the user's body must be maintained at all times (host installation should taking care of that)

The output power and antenna gain in a collocated configuration must not exceed the limits and configurations stipulated in the following table 1. The power density calculations for the individual transmitters per wireless technology at an exposure minimum separation distance of 20cm.

Exclusion of test condition:

Simultaneous transmission 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 .

$$MPE\ ratio1 + MPE\ ratio2 + MPE\ ration \leq 1.0$$

The spreadsheet as FCC deduces, and releases is employed to conduct the measurement:

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Table 1: Collocated MPE Calculation (Worst Case Table)

Technology	Frequency (MHz)	Max Conducted Power (dBm)	Max Gain (dBi)	Duty Cycle	FCC Power Density @20cm (mW/cm ²)	FCC MPE Limit (mW/cm ²)
BT-BR	2441	9.38	2.1	100	0.003	1.000
WLAN 5G	5580	16.50	1.0	100	0.011	1.000

Scenario 1:							
BT-BR+WLAN 5G							
BT-BR (mW/cm ²)	FCC MPE limit (mW/cm ²)	BT-BR / MPE limit	WLAN 5G (mW/cm ²)	FCC MPE limit (mW/cm ²)	WLAN 5G / MPE limit	BT-BR+WLAN 5G	FCC Limit (mW/cm ²)
0.00280	1	0.00280	0.01119	1	0.01119	0.01399	1

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