RF Exposure calculation report

FCC ID: 2AFLZRPIRM0
IC: 11880A-RPIRM0
Model/HVIN: Raspberry PI RM0
FVIN: 20210315-3+rpt4

The FCC and ISED require that the calculated MPE be equal to or less than a given limit dependent on frequency at a distance of 20 cm from a device to the body of a user.

The transmitter operation for the Raspberry Pi RMO covers the 2.4 GHz and 5 GHz operating bands.

Simultaneous transmission is not supported between any of the transmitters.

The following FCC/ISED Rule Parts are applicable:
Part 1.1310 — Radiofrequency radiation exposure limits
Part 2.1091(c) — Radiofrequency radiation exposure evaluation: mobile devices
ISED RSS-102 Issue 6, Dec 2023

CALCULATION

The following far field power density equation is applicable:

$$S = EIRP/(4 \pi R^2)$$

Where

S - Power density
EIRP = Effective Isotropically Radiated Power (EIRP = P×G)
P = Conducted Transmitter Power
G = Antenna Gain (relative to an isotropic radiator)
R = distance to the centre of radiation of the antenna (safe operating distance)

Calculation for 2.4GHz BT (BDR/ EDR worst case):

Values:

Transmitter frequency range = 2402–2480 MHz
P = 6.5 dBm
G = 2.6 dBi (x 2.24)
EIRP = 9.1 dBm (8.1 mW)
R = 20 cm

Power Density Requirement
From table 1 (b) - Limits for General Population/ Uncontrolled Exposure of FCC Rule Pan 1.1310 for 2.4 GHz

S_{req1} = 1.0 mW/cm^2

Calculation:

S = EIRP/(4 pi R^2)
= 10 / (12.56 x 20^2)
= 10 / 5024
S_1 = 0.002
(Equivalent to 0.89 cm safe operating distance)

Fundamental transmit (prediction) frequency:	2402	MHz
Maximum measured conducted peak output power:	6.50	dBm
Cable and/or jumper loss:	0	dB
Maximum peak power at antenna input terminal:	6.50	dBm
Duty cycle:	100	%
Maximum calculated average power at antenna input terminal:	4.47	mW
Single Antenna gain (typical):	2.6	dBi
Number of antennae:	1	
Total system gain:	2.60	dBi

	ISED limit:	
MPE limit for uncontrolled exposure at prediction frequency:	**0.535080**	**mW/cm^2**
	5.350805	W/m^2
MPE limit for controlled exposure at prediction frequency:	**3.163609**	**mW/cm^2**
	31.636086	W/m^2
Minimum calculated prediction distance for Uncontrolled compliance:	20	cm
Typical (declared) Uncontrolled distance:	20	cm
Average power density for uncontrolled at prediction frequency:	**0.001617**	**mW/cm^2**
	0.016171	W/m^2
Minimum calculated prediction distance for Controlled compliance:	20	cm
Typical (declared) Controlled distance:	20	cm
Average power density for controlled at prediction frequency:	**0.001617**	**mW/cm^2**
	0.016171	W/m^2
Margin of Compliance for **uncontrolled** envirenment:	**25.20**	**dB**
with Maximum premitted antenna gain:	27.80	dBi
Margin of Compliance for **controlled** envirenment:	**32.91**	**dB**
with Maximum permitted antenna gain:	42.01	dBi

Calculation for 2.4GHz WLAN

Values:

Transmitter frequency range = 2412–2462 MHz

P = 15.4 dBm

G = 2.6 dBi

EIRP= 18.0 dBm (63.1 mW)

Power Density Requirement

From table 1 (b) - Limits for General Population/ Uncontrolled Exposure of FCC Rule Pan 1.1310 for 2.4GHz

S_{req2} = 1.0 mW/cm^2

Calculation:

S = EIRP/(4 pi R^2)

= 77.6 / (12.56 x 20^2)

= 77.6 / 5024

S_2 = 0.0154

(Equivalent to 2.5 cm safe operating distance)

Fundamental transmit (prediction) frequency:	2412	MHz
Maximum measured conducted peak output power:	15.40	dBm
Cable and/or jumper loss:	0	dB
Maximum peak power at antenna input terminal:	15.40	dBm
Duty cycle:	100	%
Maximum calculated average power at antenna input terminal:	34.67	mW
Single Antenna gain (typical):	2.6	dBi
Number of antennae:	1	
Total system gain:	2.60	dBi

	ISED limit:	
MPE limit for uncontrolled exposure at prediction frequency:	**0.536602**	**mW/cm^2**
	5.366018	W/m^2
MPE limit for controlled exposure at prediction frequency:	**3.170187**	**mW/cm^2**
	31.701871	W/m^2
Minimum calculated prediction distance for Uncontrolled compliance:	20	cm
Typical (declared) Uncontrolled distance:	20	cm
Average power density for uncontrolled at prediction frequency:	**0.012552**	**mW/cm^2**
	0.125525	W/m^2
Minimum calculated prediction distance for Controlled compliance:	20	cm
Typical (declared) Controlled distance:	20	cm
Average power density for controlled at prediction frequency:	**0.012552**	**mW/cm^2**
	0.125525	W/m^2
Margin of Compliance for **uncontrolled** envirenment:	**16.31**	**dB**
with Maximum premitted antenna gain:	18.91	dBi
Margin of Compliance for **controlled** envirenment:	**24.02**	**dB**
with Maximum permitted antenna gain:	42.02	dBi

Conclusion

The minimum required 20 cm RF exposure limits for General Population/ Uncontrolled Exposure FCC Rule Part 1.1310 and RSS-102 Issue 6 limits will not be exceeded for the Raspberry RMO using antennas having a maximum gain of 2.6 dBi.