

RF Exposure Exhibit

EUT Name: eero 6 and eero 6 Extender

Model No.: N010001 and Q010001

CFR Part 1.1310 and RSS 102

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1 Test Methodology

In this document, we evaluate the RF Exposure to human body due the intentional transmission from the transmitter (EUT). The limit for Maximum Permissible Exposure (MPE) specified in FCC 1.1310 is followed. Through the Friis transmission formula and the maximum gain of the antenna, we can calculate the distance, away from the product, where the limit of MPE is reached.

Although the Friis transmission formula is a far field assumption, the calculated result of that is an over-prediction for near field power density. We will take that as the worst case to specify the safety range.

1.1 RF Exposure Limit

According to FCC 1.1310 table 1: The criteria listed in the following table shall be used to evaluate the environmental 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 (minutes)
(A)Limits For Occupational / Control Exposures				
0.3-1.34	614	1.63	*(100)	6
1.34-30	1842/f	4.89/f	*(900/f ²)	6
30-300	61.4	0.163	1.0	6
30-1500	...	...	F/300	6
1500-100000	...	...	1.0	6
(B)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
30-1500	...	...	F(MHz)/1500MHz	30
1500-100000	...	...	1.0	30

F = Frequency in MHz

*=Plane wave equivalent density

According to RSS-102 Issue 5: The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation

**RF FIELD STRENGTH LIMITS FOR DEVICES USED BY THE GENERAL PUBLIC
(UNCONTROLLED ENVIRONMENT)**

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m ²)	Reference Period (minutes)
0.003-10 ²¹	83	90	-	Instantaneous*
0.1-10	-	0.73/ f	-	6**
1.1-10	87/ $f^{0.5}$	-	-	6**
10-20	27.46	0.0728	2	6
20-48	58.07/ $f^{0.25}$	0.1540/ $f^{0.25}$	8.944/ $f^{0.5}$	6
48-300	22.06	0.05852	1.291	6
300-6000	3.142 $f^{0.3417}$	0.008335 $f^{0.3417}$	0.02619 $f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	616000/ $f^{1.2}$
150000-300000	0.158 $f^{0.5}$	4.21 x 10 ⁻⁴ $f^{0.5}$	6.67 x 10 ⁻⁵ f	616000/ $f^{1.2}$
Note: f is frequency in MHz. *Based on nerve stimulation (NS). ** Based on specific absorption rate (SAR).				

1.2 EUT Operating Condition

The Model N010001 and Q010001, is a 2x2 home Wi-Fi router. It is intended to operate as a dual band (2.4GHz and 5GHz) wireless router over 20 MHz, 40 MHz and 80 MHz channels.

1.3 MPE calculation

1.3.1 Antenna Gain

1. Bluetooth LE / Zigbee 2.4 GHz Stamped Metal Antenna peak gain: +3.46 dBi or 2.22 (numeric).
2. Wifi 2.4 GHz Flex PCB Antenna peak gain: +3.72 dBi or 2.36 (numeric). Total directional gain: 6.50 dBi
3. Wifi 5.15-5.25 GHz Flex PCB Antenna peak gain: +3.42 dBi or 2.20 (numeric). Total directional gain: 5.99 dBi
4. Wifi 5.25-5.35 GHz Flex PCB Antenna peak gain: +2.37 dBi or 1.73 (numeric). Total directional gain: 5.05 dBi
5. Wifi 5.470-5.725 GHz Flex PCB Antenna peak gain: +3.57 dBi or 2.28 (numeric). Total directional gain: 6.17 dBi
6. Wifi 5.725-5.850 GHz Flex PCB Antenna peak gain: +4.17 dBi or 2.61 (numeric). Total directional gain: 7.12 dBi

1.3.2 Conducted Output Power

1. Bluetooth LE 2.402 GHz, TUV Test Report 32062470.001, max power: 19.55 dBm (90.16 mW)
2. Zigbee 2.475 GHz, TUV Test Report 32062471.001, max power: 17.32 dBm (53.95 mW)
3. Wifi 2.437 GHz, TUV Test Report 32062994.001, max power for non-beamforming: 23.36 dBm (216.77 mW) and for beamforming: 25.45 dBm (350.75 mW)
4. Wifi 5.24 GHz, TUV Test Report 32062991.001, max power for FCC: 22.85 dBm (192.75 mW) and for beamforming: 25.18 dBm (329.61 mW)
5. Wifi 5.23 GHz, TUV Test Report 32062991.001, max power for RSS: 19.36 dBm (192.75 mW) and for beamforming: 16.56 dBm (45.29 mW) at 5210 MHz
6. Wifi 5.785 GHz, TUV Test Report 32062991.001, max power: 22.48 dBm (177.01 mW) and for beamforming: 24.56 dBm (285.76 mW) at 5795 MHz

1.3.3 Output Power into Antenna & RF Exposure value (Non-Beamforming Mode)

Calculations for this report are based on highest power measurement and its antenna gain, therefore 2.437 GHz. Result below is Non-Beamforming Mode.

FCC:

Corrected (including cal factors) Measurement:	23.36	dBm	
The Gain of the antenna:	3.72	dBi	
Type of Measurement:	Conducted		Direct measurement at Antenna Port
Impedance:	50.00	Ω	
Measuring Distance:	0.00	m	
Time weighted Duty Cycle:	100.00	%	

The Power Out would be: 0.216770410 Watts
or: 216.77041 mW
or: 216770.41 μ W
or: 23.36 dBm

Frequency range from 10 MHz to 40 GHz:

Frequency:	2.437	GHz
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Power output with DC and antenna Gain (EIRP):

Power (dBm):	27.08
Power (mW):	510.505
Power (W):	0.510505

R = distance in	20	cm
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FCC:

Controlled Exposures - Limit =	5	mW/cm ²
Uncontrolled Exposures - Limit =	1	mW/cm ²
Pd =	0.1015617	mW/cm ²
Controlled Margin to Limit =	4.8984	mW/cm ²
Uncontrolled Margin to Limit =	0.8984	mW/cm ²

ISED:

Corrected (including cal factors) Measurement:	23.36	dBm
The Gain of the antenna:	3.72	dBi
Type of Measurement:	Conducted	Direct measurement at Antenna Port
Impedance:	50.00	Ω
Measuring Distance:	0.00	m
Time weighted Duty Cycle:	100.00	%

The Power Out would be: 0.216770410 Watts
or: 216.77041 mW
or: 216770.41 μ W
or: 23.36 dBm

Frequency range from 10 MHz to 40 GHz:

Frequency: 2.437 GHz

Power output with DC and antenna Gain (EIRP):

Power (dBm):	27.08
Power (mW):	510.505
Power (W):	0.510505

R = distance in 20 cm

IC:

Controlled Exposures to Limit =	31.86574021	W/m ²
Uncontrolled Exposures Limit =	5.403965492	W/m ²
Pd =	1.015617	W/m ²
Controlled Margin to Limit =	30.8501	W/m ²
Uncontrolled Margin to Limit =	4.3883	W/m ²

Calculations for this report are based on highest power measurement and its antenna gain, therefore 5.24 GHz. Result below is Non-Beamforming Mode.

FCC:

Corrected (including cal factors) Measurement:	22.85	dBm
The Gain of the antenna:	3.42	dBi
Type of Measurement:	Conducted	Direct measurement at Antenna Port
Impedance:	50.00	Ω
Measuring Distance:	0.00	m
Time weighted Duty Cycle:	100.00	%

The Power Out would be: 0.192752491 Watts
or: 192.75249 mW
or: 192752.49 μ W
or: 22.85 dBm

Frequency range from 10 MHz to 40 GHz:

Frequency:	5.24	GHz
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Power output with DC and antenna Gain (EIRP):

Power (dBm):	26.27
Power (mW):	423.643
Power (W):	0.423643

R = distance in	20	cm
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FCC:

Controlled Exposures - Limit =	5	mW/cm ²
Uncontrolled Exposures - Limit =	1	mW/cm ²
Pd =	0.0842811	mW/cm ²
Controlled Margin to Limit =	4.9157	mW/cm ²
Uncontrolled Margin to Limit =	0.9157	mW/cm ²

ISED:

Corrected (including cal factors) Measurement:	19.36	dBm
The Gain of the antenna:	3.42	dBi
Type of Measurement:	Conducted	Direct measurement at Antenna Port
Impedance:	50.00	Ω
Measuring Distance:	0.00	m
Time weighted Duty Cycle:	100.00	%

The Power Out would be: 0.086297855 Watts
or: 86.29785 mW
or: 86297.85 μ W
or: 19.36 dBm

Frequency range from 10 MHz to 40 GHz:

Frequency: 5.23 GHz

Power output with DC and antenna Gain (EIRP):

Power (dBm):	22.78
Power (mW):	189.671
Power (W):	0.189671

R = distance in 20 cm

IC:

Controlled Exposures to Limit =	46.68174598	W/m ²
Uncontrolled Exposures Limit =	9.106669022	W/m ²
Pd =	0.377338	W/m ²
Controlled Margin to Limit =	46.3044	W/m ²
Uncontrolled Margin to Limit =	8.7293	W/m ²

Calculations for this report are based on highest power measurement and its antenna gain, therefore 5.785 GHz. Result below is Non-Beamforming Mode.

FCC:

Corrected (including cal factors) Measurement:	22.48	dBm
The Gain of the antenna:	4.17	dBi
Type of Measurement:	Conducted	Direct measurement at Antenna Port
Impedance:	50.00	Ω
Measuring Distance:	0.00	m
Time weighted Duty Cycle:	100.00	%

The Power Out would be: 0.177010896 Watts
or: 177.01090 mW
or: 177010.90 μ W
or: 22.48 dBm

Frequency range from 10 MHz to 40 GHz:

Frequency:	5.785	GHz
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Power output with DC and antenna Gain (EIRP):

Power (dBm):	26.65
Power (mW):	462.381
Power (W):	0.462381

R = distance in	20	cm
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FCC:

Controlled Exposures - Limit =	5	mW/cm ²
Uncontrolled Exposures - Limit =	1	mW/cm ²
Pd =	0.0919878	mW/cm ²
Controlled Margin to Limit =	4.9080	mW/cm ²
Uncontrolled Margin to Limit =	0.9080	mW/cm ²

ISED:

Corrected (including cal factors) Measurement:	22.48	dBm
The Gain of the antenna:	4.17	dBi
Type of Measurement:	Conducted	Direct measurement at Antenna Port
Impedance:	50.00	Ω
Measuring Distance:	0.00	m
Time weighted Duty Cycle:	100.00	%

The Power Out would be: 0.177010896 Watts
or: 177.01090 mW
or: 177010.90 μ W
or: 22.48 dBm

Frequency range from 10 MHz to 40 GHz:

Frequency:	5.785	GHz
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Power output with DC and antenna Gain (EiRP):

Power (dBm):	26.65
Power (mW):	462.381
Power (W):	0.462381

R = distance in	20	cm
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IC:

Controlled Exposures to Limit =	49.09620552	W/m ²
Uncontrolled Exposures Limit =	9.756490295	W/m ²
Pd =	0.919878	W/m ²
Controlled Margin to Limit =	48.1763	W/m ²
Uncontrolled Margin to Limit =	8.8366	W/m ²

1.3.4 RF Exposure value when 3 radios operating simultaneously (Non-Beamforming Mode)

Non-Beamforming Exposure result (FCC)

Operating Frequency (MHz)	Power Density (mW/cm ²)	
2437	0.1016	
5240	0.0843	
5785	0.0920	
	0.2778	Total Power Density (mW/cm ²)
	1.0000	Uncontrolled Exposure Limit (mW/cm ²)
	-0.7222	Margin (mW/cm ²)
Note: Result were calculated at a distance from the user is 20 cm		

Non-Beamforming Exposure result (ISED)

Operating Frequency (MHz)	Power Density (W/cm ²)	Limit (W/cm ²)	Ratio	
2437	1.0156	5.4040	0.1879	
5230	0.3773	9.1067	0.0414	
5785	0.9199	9.7565	0.0943	
			0.3237	Σ ratio
Note: 1. The MPE calculation for simultaneous transmission is less than 1. 2. Result were calculated at a distance from the user is 20 cm				

1.3.5 Output Power into Antenna & RF Exposure value (Beamforming Mode)

Calculations for this report are based on highest power measurement (summed 2 chains) and its antenna gain, therefore 2.437 GHz. Result below is Beamforming Mode.

FCC:

Corrected (including cal factors) Measurement:	25.45	dBm	
The Gain of the antenna:	6.50	dBi	
Type of Measurement:	Conducted		Direct measurement at Antenna Port
Impedance:	50.00	Ω	
Measuring Distance:	0.00	m	
Time weighted Duty Cycle:	100.00	%	

The Power Out would be: 0.350751874 Watts
or: 350.75187 mW
or: 350751.87 μ W
or: 25.45 dBm

Frequency range from 10 MHz to 40 GHz:

Frequency: 2.437 GHz

Power output with DC and antenna Gain (EiRP):

Power (dBm):	31.95
Power (mW):	1566.751
Power (W):	1.566751

R = distance in 20 cm

FCC:

Controlled Exposures - Limit =	5	mW/cm ²
Uncontrolled Exposures - Limit =	1	mW/cm ²
Pd =	0.3116952	mW/cm ²
Controlled Margin to Limit =	4.6883	mW/cm ²
Uncontrolled Margin to Limit =	0.6883	mW/cm ²

ISED:

Corrected (including cal factors) Measurement:	25.45	dBm
The Gain of the antenna:	6.50	dBi
Type of Measurement:	Conducted	Direct measurement at Antenna Port
Impedance:	50.00	Ω
Measuring Distance:	0.00	m
Time weighted Duty Cycle:	100.00	%

The Power Out would be: 0.350751874 Watts
or: 350.75187 mW
or: 350751.87 μ W
or: 25.45 dBm

Frequency range from 10 MHz to 40 GHz:

Frequency: 2.437 GHz

Power output with DC and antenna Gain (EIRP):

Power (dBm):	31.95
Power (mW):	1566.751
Power (W):	1.566751

R = distance in 20 cm

IC:

Controlled Exposures to Limit =	31.86574021	W/m ²
Uncontrolled Exposures Limit =	5.403965492	W/m ²
Pd =	3.116952	W/m ²
Controlled Margin to Limit =	28.7488	W/m ²
Uncontrolled Margin to Limit =	2.2870	W/m ²

Calculations for this report are based on highest power measurement (summed 2 chains) and its antenna gain, therefore 5.24 GHz. Result below is Beamforming Mode.

FCC:

Corrected (including cal factors) Measurement:	25.18	dBm
The Gain of the antenna:	5.99	dBi
Type of Measurement:	Conducted	Direct measurement at Antenna Port
Impedance:	50.00	Ω
Measuring Distance:	0.00	m
Time weighted Duty Cycle:	100.00	%

The Power Out would be: 0.329609712 Watts
or: 329.60971 mW
or: 329609.71 μ W
or: 25.18 dBm

Frequency range from 10 MHz to 40 GHz:

Frequency: 5.24 GHz

Power output with DC and antenna Gain (EIRP):

Power (dBm):	31.17
Power (mW):	1309.182
Power (W):	1.309182

R = distance in 20 cm

FCC:

Controlled Exposures - Limit =	5	mW/cm ²
Uncontrolled Exposures - Limit =	1	mW/cm ²
Pd =	0.2604535	mW/cm ²
Controlled Margin to Limit =	4.7395	mW/cm ²
Uncontrolled Margin to Limit =	0.7395	mW/cm ²

ISED:

Corrected (including cal factors) Measurement:	16.56	dBm
The Gain of the antenna:	5.99	dBi
Type of Measurement:	Conducted	Direct measurement at Antenna Port
Impedance:	50.00	Ω
Measuring Distance:	0.00	m
Time weighted Duty Cycle:	100.00	%

The Power Out would be: 0.045289758 Watts
or: 45.28976 mW
or: 45289.76 μ W
or: 16.56 dBm

Frequency range from 10 MHz to 40 GHz:

Frequency:	5.21	GHz
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Power output with DC and antenna Gain (EiRP):

Power (dBm):	22.55
Power (mW):	179.887
Power (W):	0.179887

R = distance in	20	cm
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IC:

Controlled Exposures to Limit =	46.59240284	W/m ²
Uncontrolled Exposures Limit =	9.082855364	W/m ²
Pd =	0.357874	W/m ²
Controlled Margin to Limit =	46.2345	W/m ²
Uncontrolled Margin to Limit =	8.7250	W/m ²

Calculations for this report are based on highest power measurement (summed 2 chains) and its antenna gain, therefore 5.795 GHz. Result below is Beamforming Mode.

FCC:

Corrected (including cal factors) Measurement:	24.56	dBm
The Gain of the antenna:	7.12	dBi
Type of Measurement:	Conducted	Direct measurement at Antenna Port
Impedance:	50.00	Ω
Measuring Distance:	0.00	m
Time weighted Duty Cycle:	100.00	%

The Power Out would be: 0.285759054 Watts
or: 285.75905 mW
or: 285759.05 μ W
or: 24.56 dBm

Frequency range from 10 MHz to 40 GHz:

Frequency:	5.795	GHz
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Power output with DC and antenna Gain (EIRP):

Power (dBm):	31.68
Power (mW):	1472.313
Power (W):	1.472313

R = distance in	20	cm
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FCC:

Controlled Exposures - Limit =	5	mW/cm ²
Uncontrolled Exposures - Limit =	1	mW/cm ²
Pd =	0.2929073	mW/cm ²
Controlled Margin to Limit =	4.7071	mW/cm ²
Uncontrolled Margin to Limit =	0.7071	mW/cm ²

ISED:

Corrected (including cal factors) Measurement:	24.56	dBm
The Gain of the antenna:	7.12	dBi
Type of Measurement:	Conducted	Direct measurement at Antenna Port
Impedance:	50.00	Ω
Measuring Distance:	0.00	m
Time weighted Duty Cycle:	100.00	%

The Power Out would be: 0.285759054 Watts
or: 285.75905 mW
or: 285759.05 μ W
or: 24.56 dBm

Frequency range from 10 MHz to 40 GHz:

Frequency: 5.795 GHz

Power output with DC and antenna Gain (EiRP):

Power (dBm):	31.68
Power (mW):	1472.313
Power (W):	1.472313

R = distance in 20 cm

IC:

Controlled Exposures to Limit =	49.13862125	W/m ²
Uncontrolled Exposures Limit =	9.768012789	W/m ²
Pd =	2.929073	W/m ²
Controlled Margin to Limit =	46.2095	W/m ²
Uncontrolled Margin to Limit =	6.8389	W/m ²

1.3.6 RF Exposure value when 3 radios operating simultaneously (Beamforming Mode)

Beamforming Mode Exposure result (FCC)

Frequency (MHz)	Power Density (mW/cm ²)	
2437	0.3117	
5240	0.2605	
5795	0.2929	
	0.8651	Total Power Density (mW/cm ²)
	1.0000	Uncontrolled Exposure Limit (mW/cm ²)
	-0.1349	Margin (mW/cm ²)
Note: Result were calculated at a distance from the user is 20 cm		

Beamforming Mode Exposure result (ISED)

Operating Frequency (MHz)	Power Density (W/cm ²)	Limit (W/cm ²)	Ratio	
2437	3.1170	5.4040	0.5768	
5210	0.3579	9.0829	0.0394	
5795	2.9291	9.7680	0.2999	
			0.9161	Σ ratio
Note: 1. The MPE calculation for simultaneous transmission is less than 1. 2. Result were calculated at a distance from the user is 20 cm				

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

FCC and ISED: Result were calculated at a distance from the user is 20 cm.

1.3.7 Sample Calculation

The Friss transmission formula: $P_d = (P_{out} * G) / (4 * \pi * R^2)$

Where;

P_d = power density in mW/cm²

P_{out} = output power to antenna in mW

G = gain of antenna in linear scale

$\pi \approx 3.1416$

R = distance between observation point and center of the radiator in cm

Ref. : David K. Cheng, *Field and Wave Electromagnetics*, Second Edition, Page 640, Eq. (11-133).