RF Exposure Exhibit

EUT Name: Subpac (Wearable)

Model No.: M2X

CFR Part 1.1310 and RSS 102

Prepared for:

Subpac
380 Portage Avenue
Palo Alto, CA 94306
Tel: (415) 936-4133

Prepared by:

TUV Rheinland of North America, Inc.

1279 Quarry Lane
Pleasanton, CA 94566
Tel: (925) 249-9123
Fax: (925) 249-9124
http://www.tuv.com/

Report/Issue Date: January 01, 2017
Report Number: 31663775.001 Appendix A

Contents

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)**
$0.003\text{-}10^{21}$	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	$3.142\,f^{0.3417}$	$0.008335\,f^{0.3417}$	$0.02619f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	$616000/f^{1.2}$
150000-300000	$0.158\,f^{0.5}$	$4.21 \times 10^{-4}\,f^{0.5}$	$6.67 \times 10^{-5}\,f$	$616000/f^{1.2}$

Note: f is frequency in MHz.
*Based on nerve stimulation (NS).
** Based on specific absorption rate (SAR).

1.2 EUT Operating Condition

The Model M2X, is a wearable form factor, vibrotactile membrances to enable full experiential sound for music, gaming and virtual reality entertainment. The M2X operates in the 2.4 GHz, Bluetooth.

1.3 MPE calculation

1.3.1 Antenna Gain

Integrated Antenna peak gain: 0 dBi or 1 (numeric).

1.3.2 Conducted Output Power

2.441 GHz, max power: 3.11 dBm (2.046 mW)

1.3.3 Output Power into Antenna & RF Exposure value at distance 0.6cm

Calculations for this report are based on highest power measurement, therefore 2.441 GHz.

Corrected (including cal factors) Measurment:	3.11	dBm	
The Gain of the antenna:	0.00	dBi	
Type of Measurment:	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:	0.002046445	Watts
or:	2.04644	mW
or:	2046.44	µW
or:	3.11	dBm

Frequency range from 10 MHz to 40 GHz:

Frequency:	2.44	GHz

Power output with DC and antenna Gain (EiRP):

Power (dBm):	3.11
Power (mW):	2.046
Power (W):	0.002046

R = distance in	0.6	cm

FCC:		
Controlled Exposures - Limit =	5	mW/cm^2
Uncontrolled Exposures - Limit =	1	mW/cm^2
Pd =	0.4523636	mW/cm^2
Controlled Margin to Limit =	4.5476	mW/cm^2
Uncontrolled Margin to Limit =	0.5476	mW/cm^2

Note: * = Plane-wave equivalent power density

IC:		
Controlled Exposures to Limit =	31.88534789	W/m^2
Uncontrolled Exposures Limit =	5.408510856	W/m^2
Pd =	4.523636	W/m^2
Controlled Margin to Limit =	27.3617	W/m^2
Uncontrolled Margin to Limit =	0.8849	W/m^2

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

1.3.4 Sample Calculation

The Friss 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 = 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).