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Penumbra Inc. SAR EXCLUSION REPORT

SCOPE OF WORK

SAR EXCLUSION CALCULATION
ON THE REAL IMMERSIVE SYSTEM

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SAR EXCLUSION TEST REPORT

Report Number: 105326998LEX-001.2

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Product Name: Real Immersive System
Model Xavier 1 / Xavier 2

Standards: FCC Part 2.1093
RSS-102 Issue 5

Tested by:
Intertek Testing Services NA, Inc.
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Lexington, KY 40510
USA

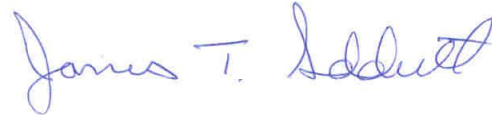
Client:
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1 Introduction and Conclusion

SAR exclusion calculations were performed on the product constructed as described in section 4. Information provided by the client including maximum output power, antenna gain(s), and minimum separation distance(s) was used to determine if the product under evaluation was exempt from SAR. Any change in these stated values may invalidate these results. No additions, deviations, or exclusions have been made from the standard(s) unless specifically noted.

The device is a wireless virtual reality headset with the addition of two (2) Bluetooth transmitters. The headset by itself is a pre-approved device manufactured by HTC Corporation, model number 2Q9R100. The FCC ID for the headset is NM82QR100 and the ISED certificate number is 4115A-2Q9R100. The data was extracted from the report dated September 10, 2020, report number FA073116-02.

This analysis report takes the original SAR data from the FCC filing under FCCID N82Q9R100 and ISED certificate number 411A-2Q9R100. This report shows the compliance of adding two (2) Bluetooth transmitters to the headset. The simultaneous evaluation is calculated and shown to comply within this report.

Based on the results of our investigation, we have concluded the product under evaluation is **exempt** from SAR requirements for each of the standard(s) indicated. The results obtained in this test report pertain only to the item(s) evaluated. Intertek does not make any claims of compliance for samples or variants which were not evaluated.

2 Test Summary

Requirement	Simultaneous 1-g SAR (W/kg)	1-g SAR Limit (W/kg)	Simultaneous 10-g SAR (W/kg)	10-g SAR Limit (W/kg)	Result
FCC Part 2.1093	1.1	1.6	1.2	4.0	Exempt from SAR
RSS-102 Issue 5	1.1	1.6	1.2	4.0	Exempt from SAR



3 Client Information

This product was tested at the request of the following:

Client Information	
Client Name:	Penumbra Inc.
Address:	One Penumbra Place Alameda, CA 94502-6592 USA
Contact:	Puneet Goyal
Telephone:	+1 (510) 748-3200
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Manufacturer Information	
Manufacturer Name:	Penumbra Inc.
Manufacturer Address:	One Penumbra Place Alameda, CA 94502-6592 USA



4 Description of Equipment under Test and Variant Models

Equipment Under Test	
Product Name	Real Immersive System
Model Number	Xavier 1 / Xavier 2
FCC Identifier	2AQU7-REAL02
IC Identifier	24199-REAL02
Type of Transmission	Digital Transmission System (DTS), 2x Radios
Rated RF Output Power	7.88 dBm
Antenna(s) and Gain	Internal Antenna, Peak Gain: 1.3 dBi
Frequency Range	2402 MHz – 2479 MHz
Type of Modulation / Data Rate	Gaussian Frequency Shift Keying (GFSK) / 1 Mbit/s
Number of Channel(s)	77
Description of Equipment Under Test (provided by client)	
<p>Xavier is a digital hardware and software medical device platform utilizing virtual reality technology designed for use in healthcare and focusing on physical, neurorehabilitation and/or wellness needs. Xavier 1 is intended to be used in a clinical environment, or any other facility that may facilitate rehabilitation by healthcare providers who have received appropriate training in rehabilitation therapy. Xavier 2 is intended to be used in a residential environment, or any other facility that may facilitate rehabilitation individuals with physical, neurorehabilitation and/or wellness needs. A caregiver may be optionally present to help the user operate the system. The mode to test is in functional mode when the device is completely removed from the charging station and strapped to a patient/user.</p> <p>Xavier is composed of:</p> <ul style="list-style-type: none"> • All-In-One Head Mounted Display (HMD) • HMD Controller • Wireless Sensor Modules (WSM) • Wireless Transmitter Module (WTM) • Sensor Charger (charging station) • Tablet (Xavier 1 configuration only) 	

4.1 Variant Models:

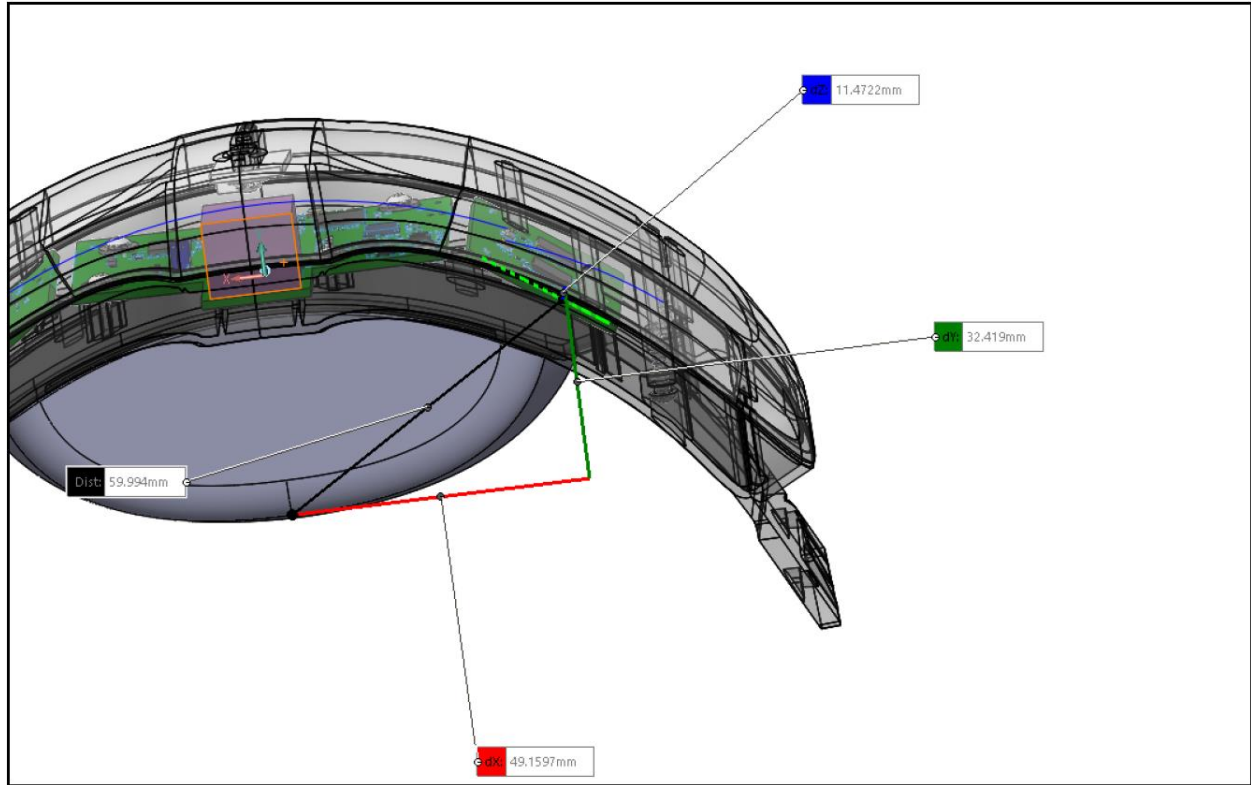
There were no variant models covered by this evaluation.



4.2 Antenna Separation

The following information was provided by Penumbra Inc. and may affect compliance. Intertek does not make any claims of compliance for values other than those shown below.

The minimum antenna separation from the antenna to the user was taken to be 11.4722mm, rounded down to 11mm, as shown in the diagram below:





5 FCC Part 2.1093 SAR Exclusion Criteria

5.1 Standalone SAR Exemption Calculation

Per KDB 447498 D01 General RF Exposure Guidance v06 § 4.3.1(a), the 1-g extremity SAR exclusion threshold is:

$$\left(\frac{(\text{max. power of channel, including tune - up tolerance, mW})}{(\text{min. test separation distance, mm})} \right) \cdot \left(\sqrt{f_{(\text{GHz})}} \right) \leq 3.0$$

The maximum output power was taken from Intertek report 105041185MPK-001. The antenna separation distance was provided by the client as shown in section 4.2. Deviations from these values may affect compliance.

Device	Frequency (GHz)	Output Power (dBm)	Output Power (mW)	Separation Distance (mm)	Exclusion Threshold	Limit	Exempt from SAR?
Radio 1	2.479	7.88	6.14	11	0.878	3.0	Exempt
Radio 2	2.479	7.88	6.14	11	0.878	3.0	Exempt

5.2 Estimated SAR Calculation

Per KDB 447498 D01 v06 § 4.32(b): When an antenna qualifies for the standalone SAR test exclusion of 4.3.1 and also transmits simultaneously with other antennas, the standalone SAR value must be estimated according to the following to determine the simultaneous transmission SAR test exclusion criteria:

$$SAR_{1g,EST} = \left(\frac{(\text{max. power of channel, including tune - up tolerance, mW})}{(\text{min. test separation distance, mm})} \right) \cdot \left(\frac{\sqrt{f_{(\text{GHz})}}}{7.5} \right)$$

$$SAR_{10g,EST} = \left(\frac{(\text{max. power of channel, including tune - up tolerance, mW})}{(\text{min. test separation distance, mm})} \right) \cdot \left(\frac{\sqrt{f_{(\text{GHz})}}}{18.75} \right)$$

Device	Frequency (GHz)	Output Power (dBm)	Output Power (mW)	Separation Distance (mm)	Estimated 1-g SAR (W/kg)	Estimated 10-g SAR (W/kg)
Radio 1	2.479	7.88	6.14	11	0.12	0.05
Radio 2	2.479	7.88	6.14	11	0.12	0.05

5.3 Simultaneous SAR Exemption Calculation

The following table indicates the maximum SAR values for the VR headset in addition to the new radios. The combined 1-g SAR value of 1.1 W/kg is less than the limit of 1.6 W/kg, and the combined 10-g SAR value of 1.2 W/kg is less than the limit of 4.0 W/kg.

Band	1-g SAR (W/kg)	10-g SAR (W/kg)
VR Headset 2450MHz	0.13	0.46
VR Headset 5 GHz	0.42	0.51
VR Headset Internal Bluetooth	0.24	0.10
Radio 1	0.12	0.05
Radio 2	0.12	0.05
Simultaneous	1.03 ~ 1.1	1.17 ~ 1.2



6 ISED RSS-102 Issue 5 SAR Exemption Calculation

6.1 Standalone SAR Exemption Calculation

RSS-102 Issue 5 § 2.5.1: SAR evaluation is required if the separation distance between the user and/or bystander and the antenna and/or radiating element of the device is less than or equal to 20 cm, except when the device operates at or below the applicable output power level (adjusted for tune-up tolerance) for the specified separation distance defined in Table 1.

Table 1: SAR evaluation — Exemption limits for routine evaluation based on frequency and separation distance^{4,5}

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of ≤5 mm	At separation distance of 10 mm	At separation distance of 15 mm	At separation distance of 20 mm	At separation distance of 25 mm
≤300	71 mW	101 mW	132 mW	162 mW	193 mW
450	52 mW	70 mW	88 mW	106 mW	123 mW
835	17 mW	30 mW	42 mW	55 mW	67 mW
1900	7 mW	10 mW	18 mW	34 mW	60 mW
2450	4 mW	7 mW	15 mW	30 mW	52 mW
3500	2 mW	6 mW	16 mW	32 mW	55 mW
5800	1 mW	6 mW	15 mW	27 mW	41 mW

Output power level shall be the higher of the maximum conducted or equivalent isotropically radiated power (e.i.r.p.) source-based, time-averaged output power. For controlled use devices where the 8 W/kg for 1 gram of tissue applies, the exemption limits for routine evaluation in Table 1 are multiplied by a factor of 5. For limb-worn devices where the 10 gram value applies, the exemption limits for routine evaluation in Table 1 are multiplied by a factor of 2.5. If the operating frequency of the device is between two frequencies located in Table 1, linear interpolation shall be applied for the applicable separation distance. For test separation distance less than 5 mm, the exemption limits for a separation distance of 5 mm can be applied to determine if a routine evaluation is required.

Device	Frequency (MHz)	Output Power (dBm)	Antenna Gain (dBi)	EIRP (mW)	Separation Distance (mm)	Limit (mW)	Exempt from SAR?
Radio 1	2450	7.88	1.3	8.28	11	8.6	Exempt
Radio 2	2450	7.88	1.3	8.28	11	8.6	Exempt

6.2 Simultaneous SAR Exemption Calculation

RSS-102 Issue 5 § 3.1.2: Compliance of devices with multiple transmitters capable of simultaneous transmission shall be assessed in accordance with the latest version of IEEE 1528. However, other recognized methods — such as the procedures published by the FCC proven to provide a conservative estimate of the SAR value — can also be used. Applicants shall include in the RF exposure technical brief all information relevant to the exact test methodology used.

Please refer to section 5.3 of this report for the simultaneous SAR exemption calculation.



7 Revision History

Revision Level	Date	Report Number	Prepared By	Reviewed By	Notes
0	2/1/2023	105326998LEX-001	BZ	JTS	Original Issue
1	3/30/2023	105326998LEX-001.1	BZ	JTS	Added antenna separation information. Fixed exclusion limit calculation.
2	4/11/2023	105326998LEX-001.2	BZ	JTS	Updated antenna gain