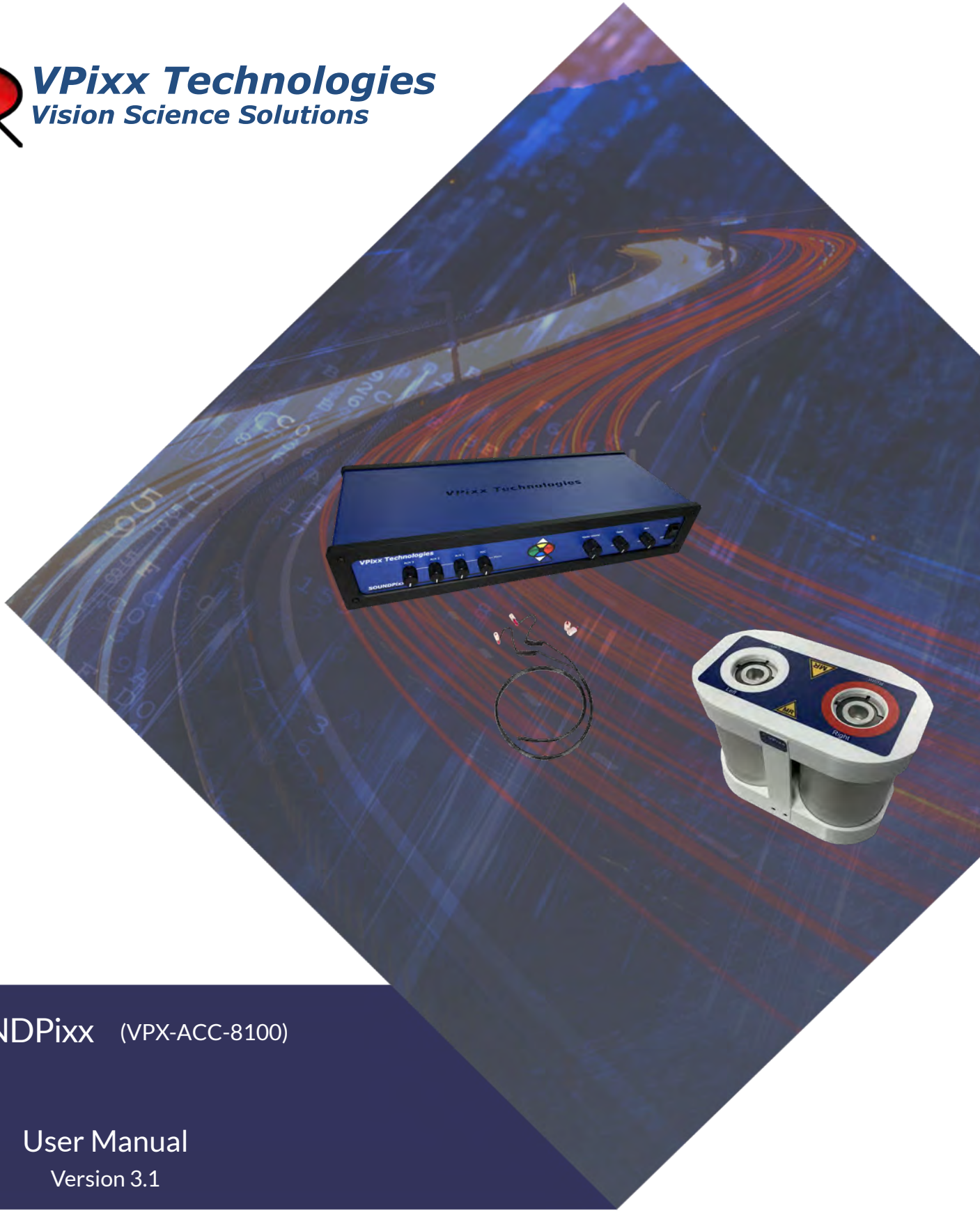
VPixx Technologies
Vision Science Solutions



SOUNDPixx (VPX-ACC-8100)

User Manual

Version 3.1

Phone : (514) 328-7499
1 (844) 488-7499 - Toll Free USA/Canada
EMAIL: support@vpixx.com
www.vpixx.com

IMPORTANT

VPixx Technologies Inc. reserves the right to modify or otherwise update this document without notice as required by a constantly evolving marketplace, client requests or to adapt to new progress or constraints in engineering or manufacturing technology. The information contained in this document may change without prior notice.

For more information about our company and products, visit our website at ***www.vpixx.com***

For information, comments or suggestions, please contact us by e-mail at ***support@vpixx.com***

Our offices are located at:

630 Clairevue West suite 301
Saint-Bruno, Qc
Canada, J3V 6B4

Version History of this document

Version Updated to	Date	Author	Reason
1.0	2015/02/10	P.Kakos	v1.0 release
2.0	2018/05/26	JF Hamelin	V2.0 New transducer
3.0	2019/03/20	P.Kakos	Release of SOUNDPixx v3.0
3.1	2020/04/09	JF Hamelin	Frequency response profile

Document Icons

The use of icons emphasizes helpful, caution or warning notes. Below is a list of the available icons.

Icon	Type	Description
	**Helpful Hint**	*Information to help assembly, installation or usage*
	**Caution Notice**	*Important Information to prevent misuse and/or damage to equipment*
	**Warning**	***Critical information to prevent damage to equipment and/or personnel***

Table of Contents

Table of Figures

Table of Tables

Overview

This manual provides installation, usage and maintenance information for VPixx Technologies Inc.'s SOUNDPixx MRI/EEG stereo audio system kit with pneumatic headsets and transducer.

For technical questions or product support information, do not hesitate to contact the VPixx support team by phone or by sending an E-mail to support@vpixx.com

	*By creating your MyVPixx account on the VPixx Technologies website, you will have access to additional product documentation, demos, source code examples and the latest firmware and software drivers.*

	***WARNINGS AND MARKINGS MUST BE OBSERVED!*** ***Before installing and using your SOUNDPixx audio system, familiarize yourself with the MR room safety symbols found on each component of your SOUNDPixx system. These are explained on the following table***

Table 1 MR room safety symbols

Symbol	*Name*	*Description*
	MR safe	Objects and components that are marked with the green **MR safe** icon present no danger for staff and equipment when operating in the MR room.
	Conditionally MR safe	The yellow **Conditionally MR safe** icon indicates objects and components that are only MR safe in a limited fashion. There are specified safety distances that limit how close the object or component in question may be from the magnet.
	MR unsafe	The red **MR unsafe** icon marks objects or components which are strictly prohibited from entering the MR room.

Product overview

The SOUNDPixx is a complete MRI audio system that includes everything you need to get the benefits of MRI-compatible audio entertainment, while also allowing you to perform cross-modal research when used with our PROPixx or our DATAPixx system. The system will give you microsecond-precise audio stimulation when driven by VPixx hardware.

The SOUNDPixx MRI stereo sound system delivers true stereo music to the subject, which studies have shown to be an important factor in overcoming claustrophobia.

The SOUNDPixx comes equipped with separate audio level adjustments for the subject and for the speakers in the area where the technologist is located. The operator can independently control the sound level in the control room without affecting the subject sound levels.

Included hardware

Immediately after receiving your SOUNDPixx system, verify that no components are missing by consulting the following table:

Table 2 Included hardware

Item	*Name*	*Quantity*	*MR room safety Symbol*
	Amplifier	1	
	Power supply (for amplifier)	1	
	Power cord	1	
	10-foot Molded 3.5mm Male to 2 x RCA Male Audio Cable	3	
	DB9 filter	2	
	70-foot DB9 cable	1	
	30-foot stereo coax cable	1	
	Microphone and speaker package	1	

Item	*Name*	*Quantity*	*MR room safety Symbol*
	Transducer*	1	
	Transducer pneumatic tubing (12-foot)	1	
	MRI coil headset	1	
	Replacement plugs	260 pairs	
	Industrial Velcro	2	

(*): **Conditionally MR safe**, but refer to installation procedure

	***The transducer contains a finite amount of magnetic material and should be kept 3 ft away from the magnet's bore. It can be harnessed underneath the MRI using the supplied industrial Velcro***

General specifications

The SOUNDPixx stereo system kit allows you to stimulate a subject with precise audio waveforms. The system's MRI-compatible transducer has been designed to be introduced into an MRI environment without adversely affecting test data while the system's amplifier (**which is NOT MR Safe**) is installed in, and manipulated from, the operator control room.

SOUNDPixx Amplifier specifications

The SOUNDPixx amplifier is a multi-function 45-Watt auto-mixing amplifier designed for continuous operation in distributed music, paging and audio applications.

- **MR unsafe** component. The amplifier is installed in the operator's control room.
- Aluminum casing
- Width: 37.8 cm (14.88 inches)
- Depth: 16.2 cm (6.38 inches)
- Height: 7.32 cm (2.88 inches)
- Three (3) AUXILIARY inputs for iPod, computer, CD/DVD or DATAPixx subsystems
- One (1) microphone input
- One (1) DB9 output for driving transducer
- One (1) XLR 5-pin Control Room Speaker output
- Low and high frequency equalizer

Figure 1 Amplifier

SOUNDPixx Transducer specifications

- **Conditionally MR safe** component
- Aluminum and plastic casing
- Extra large stereo tubing for greater fidelity
- Vinyl tubing
- 12-foot stereo tubing
- Semi-rigid for durability and consistency
- Universal adapter for use with different pneumatic headphones
- Input impedance: 8 Ohm

Figure 2 Transducer

The SOUNDPixx transducer also includes MRI coil headsets that provide 30 dB NRR tested to ANSI standards, available in standard and mini sizes to accommodate all ear shapes and sizes, including those of children.

Headsets meet and exceed ISO 60601-1-33 specifications. The transducer also includes **250 pairs** of standard size plugs (0.75” X 0.50”) and **10 pairs** of mini size plugs (0.75” X 0.38”).

Figure 3 MRI coil headsets

SOUNDPixx Amplifier rear panel information

The following figure shows the rear panel of the SOUNDPixx amplifier.

Figure 4 Amplifier rear panel

Table 3 Amplifier rear panel information

Connector	Type	description
Control Room Speaker	XLR 5-pin	Audio output for interfacing speakers in the control room
Transducer	DB9	Audio output, 8 Ohm for interfacing with transducer in magnet room using the appropriate cable and filter
MIC	XLR 3-pin	Microphone input
AUX 1	RCA	Audio input
AUX 2	RCA	Audio input
AUX 3	RCA	Audio input
DC OUT +12 V	DC output LEMO	DC power output, +12 VDC, 20 watts MAX
DC IN +12 V	DC input LEMO	DC power input, +12 VDC, 40 watts

Installing your SOUNDPixx

Follow these instructions to install your SOUNDPixx stereo system.

	***Remember to verify MR warning labels on each SOUNDPixx component you intend to bring into the MR room. Failure to do so may result in severe injury or damage to equipment.***

SOUNDPixx Transducer installation

	***The transducer contains a finite amount of magnetic material and should be kept 3 ft away from the magnet's bore. It can be harnessed underneath the MRI using the supplied transducer mount.***

Install the SOUNDPixx transducer on the floor, near the front area of the magnet and 3 ft away from the magnet's bore. Place it in a location where it will not pose a trip hazard when the operator attends to the participant, and keep in mind that the 12-foot air tubing must reach the subject inside the magnet.

Industrial Velcro is supplied to enable you to mount the transducer near the MRI magnet area. Put two strips of Velcro on the bottom side of the transducer box. This will enable you to install the SOUNDPixx Transducer securely in place.

One of the most common areas to mount the transducer is to the front left or right side of the MRI.

You may also remove the lower side panels on the desired placement side of the MRI and secure the transducer using the included mount underneath the magnet.

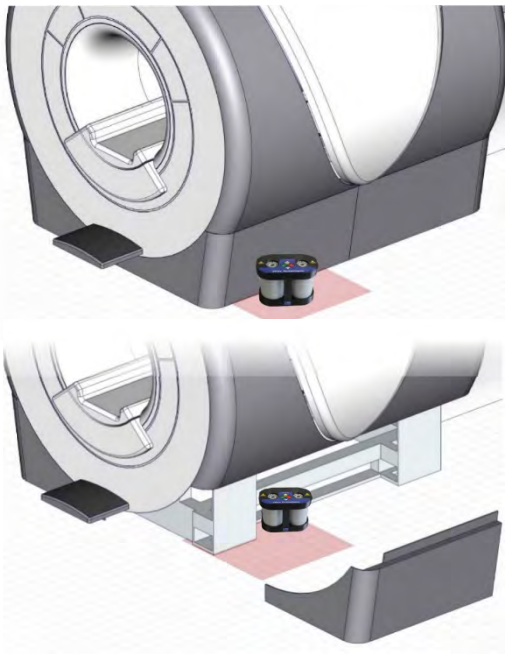


Figure 5 SOUNDPixx transducer in MR room

	Prior to installing the transducer, be sure to clean the floor space with alcohol or another non oil-based cleaner so that the Velcro layers' sticky surfaces have a strong, clean contact with the floor.

After the floor is clean and dry, peel off the protective paper to expose the sticky surface and travel to the location where you have chosen to mount the SOUNDPixx Transducer, holding it securely as you move in the MR room. Carefully place it on the floor and press down firmly to ensure that the sticky Velcro layers have a strong, uniform contact with the floor.

Cable installation

The SOUNDPixx system includes one RFI-filtered DB9 connector. This connector filter allows audio to pass through but filters out any noise. The RFI-filtered DB9 connector should be mounted on the RF penetration panel on the control room side.

Figure 6 RFI-Filtered DB9 connector

As illustrated on figure 8, a 75-foot DB9 cable runs from the SOUNDPixx amplifier to the RF penetration panel connected to the RFI-filtered DB9 connector. Inside the Magnet Room, 30-foot stereo coax cables come from the opposite RFI-filtered DB9 connector and travel along the wall (possibly hidden in a wireway/trough) to the SOUNDPixx transducer installed securely on the floor.

Ensure that there are no coils in the RF-shielded cable. Remove any coils present within the MRI suite by feeding cable slack toward the penetration panel. Once the slack is condensed at the penetration panel, flatten and zip-tie it to aid cable organization. Be sure to leave enough slack to adjust the transducer as needed.

Figure 7 Cable organization

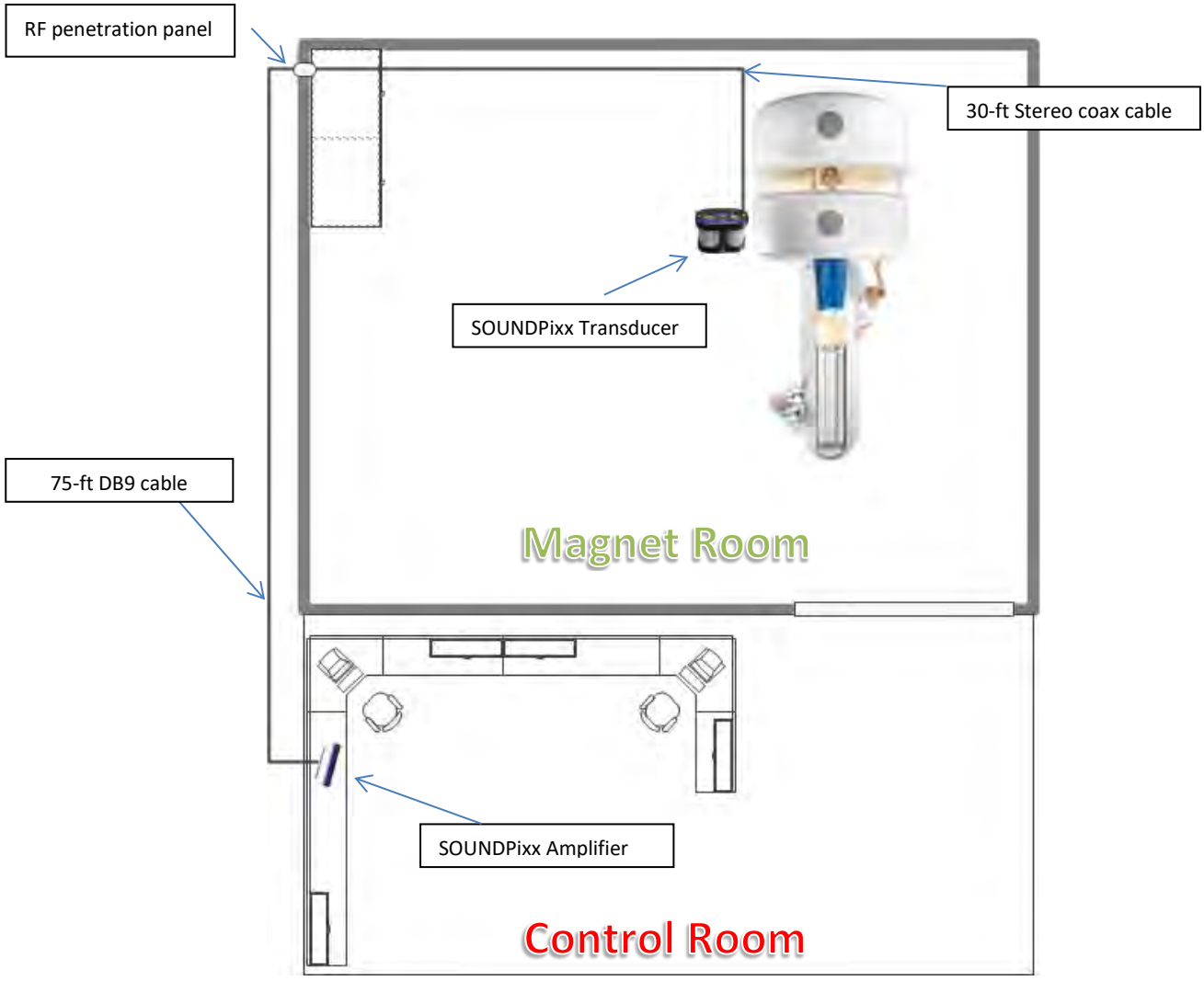


Figure 8 Typical SOUNDPixx setup

Tubing installation

With the transducer securely installed, connect the stereo tubing to the LEFT and RIGHT transducer outlets.

Figure 9 Left and right transducer outlets

Connect the MRI Coil Headsets to the main tubing headset interface.

Main tubing headset interface MRI Coil headset interface

Figure 10 MRI coil headset / main tubing headset interface

SOUNDPixx Amplifier installation

The SOUNDPixx amplifier is not MRI compatible and should be installed in the control room. The SOUNDPixx amplifier works like a regular amplifier, allowing you to connect an audio generator and microphone. A volume control as well as a low and high frequency equalizer are also available.

Figure 11 SOUNDPixx amplifier rear panel

To get the SOUNDPixx amplifier ready for use, follow this procedure:

1. Connect the SOUNDPixx amplifier power cable to the wall outlet and connect the power jack to the amplifier's DC IN +12 V port.

	***Use only the power supply and power cord supplied with the SOUNDPixx system. The power supply and power cord are medical grade and should be used in a medical power outlet.***

2. Connect the microphone to the MIC interface.
3. Connect the Control Room Speaker to the Control Room output.
4. Connect your audio source/generator to an AUX input using the adapter cable supplied with your SOUNDPixx system.
5. Connect the DB9 cable to the DB9 RFI filter on the penetration panel.
6. Test the sound level by putting on the supplied headphones and adjusting the volume to a comfortable level.
7. Your SOUNDPixx system is now ready!

Using your SOUNDPixx

Figure 12 SOUNDPixx amplifier front panel controls

MIC volume control

This control allows you to adjust the volume of the connected microphone. This control only affects the volume heard by the participant. It has no effect on the microphone volume of the speaker located in the control room.

Master Volume control

This control allows you to adjust the volume the participant experiences through his headset. This control only lets you adjust the music output volume from the AUX1, AUX2, AUX3 or MIC inputs.

Bass and Treble controls

These controls allow you to boost or attenuate bass and treble in the participant's headsets. They cannot modify the treble/bass of the speaker in the control room.

AUX1, AUX2, AUX3 and MIC controls

These controls allow you to adjust the volume of their associated auxiliary input like a mixer without amplification.

	*The Master Volume, Bass and Treble controls do not affect the sound of the control room speaker.*

Frequency Response Profile of the SOUNDPixx

Overview

The SOUNDPixx is a pneumatic sound system from VPixx technologies, for use in magnetically sensitive environments such as MEG or MRI testing rooms. The sound system can be used in conjunction with other VPixx devices such as the DATAPixx data synchronization system and the PROPixx DLP projector, or a as a standalone sound system.

The SOUNDPixx is comprised of an amplifier, pneumatic transducer, hollow plastic tubing and headphones. The amplifier receives stereo auxiliary input directly from the test computer, or from the VPixx I/O hub. The amplifier outputs to the pneumatic transducer, which converts the signal into compressed air waves. The waves travel down a length of plastic tubing to either a set of plastic over-ear headphones, or to in-ear headphones positioned in the ear canal.

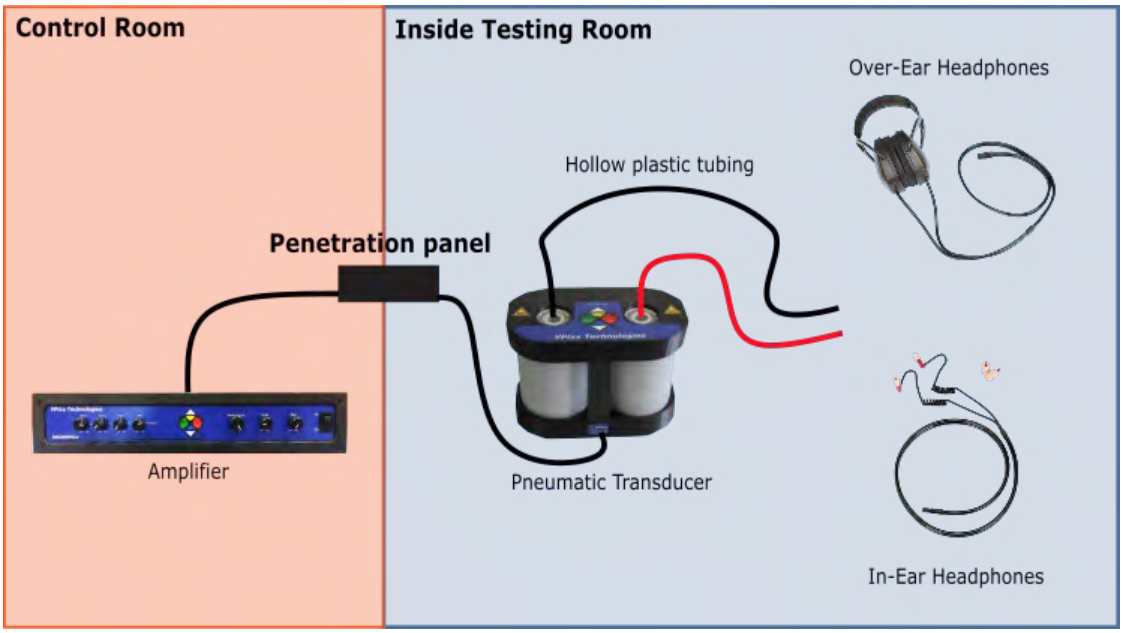


Figure 13 SOUNDPixx components

The purpose of this report is to provide a general sense of the frequency response profile of the SOUNDPixx transducer and to measure the impact of the pneumatic tubing and headphones on this profile. Transduction and transmission of compressed air waves through tubing are particularly prone to attenuating high frequencies, making pneumatic systems more susceptible to intensity drop off in the treble when compared to conventional headphones.

In addition, the SOUNDPixx amplifier includes dials to adjust bass and treble levels. This report also characterizes how adjusting these settings impacts the subsequent frequency response of the headphones.

The aim of this report is to provide researchers with a better understanding of the capabilities of this sound system. These tests **do not** take into account external contributions to sound quality such as magnet noise, air temperature, custom tube lengths and in the case of over-ear headphones, inter-individual differences in the shape of the pinnae. The results reported here should be viewed as a guideline only, and do not necessarily reflect the acoustic properties of the SOUNDPixx in all testing environments.

Introduction to Frequency Response Profiles

The frequency response profile of a sound system shows the relative dB output of different frequencies across the audible range (20Hz to 20 000Hz).

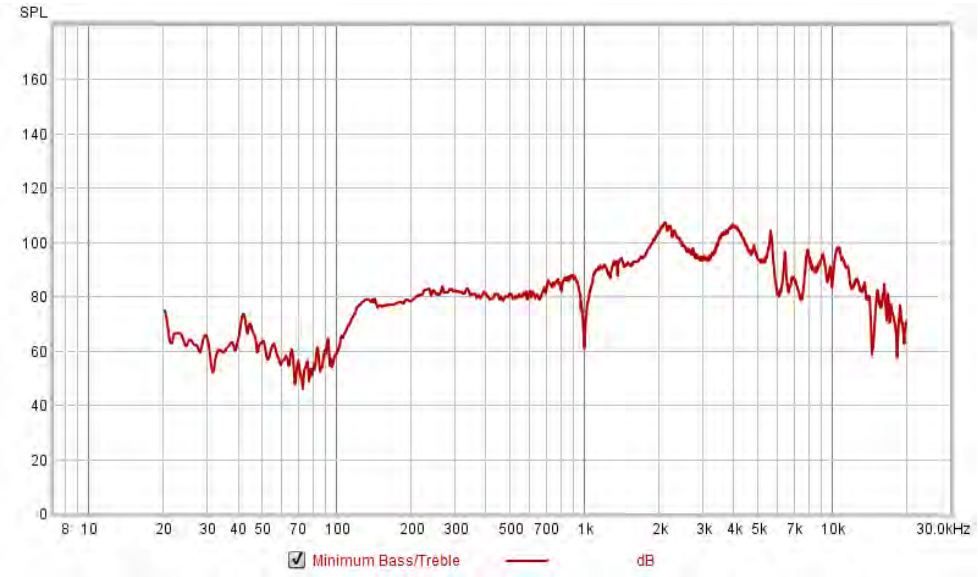


Figure 14 Example frequency response profile

An ideal “neutral” speaker output, measured with an area microphone, resembles a flat line across the entire range. Changing the relative intensity of different ranges of frequencies changes the acoustic quality of the sound. An emphasis on bass can create a booming sound, for example, while an emphasis in the treble can give the audio output a shrill or piercing component. It is a characteristic of most commercial audio systems to amplify base and attenuate frequencies in the high treble to promote a positive listening experience.

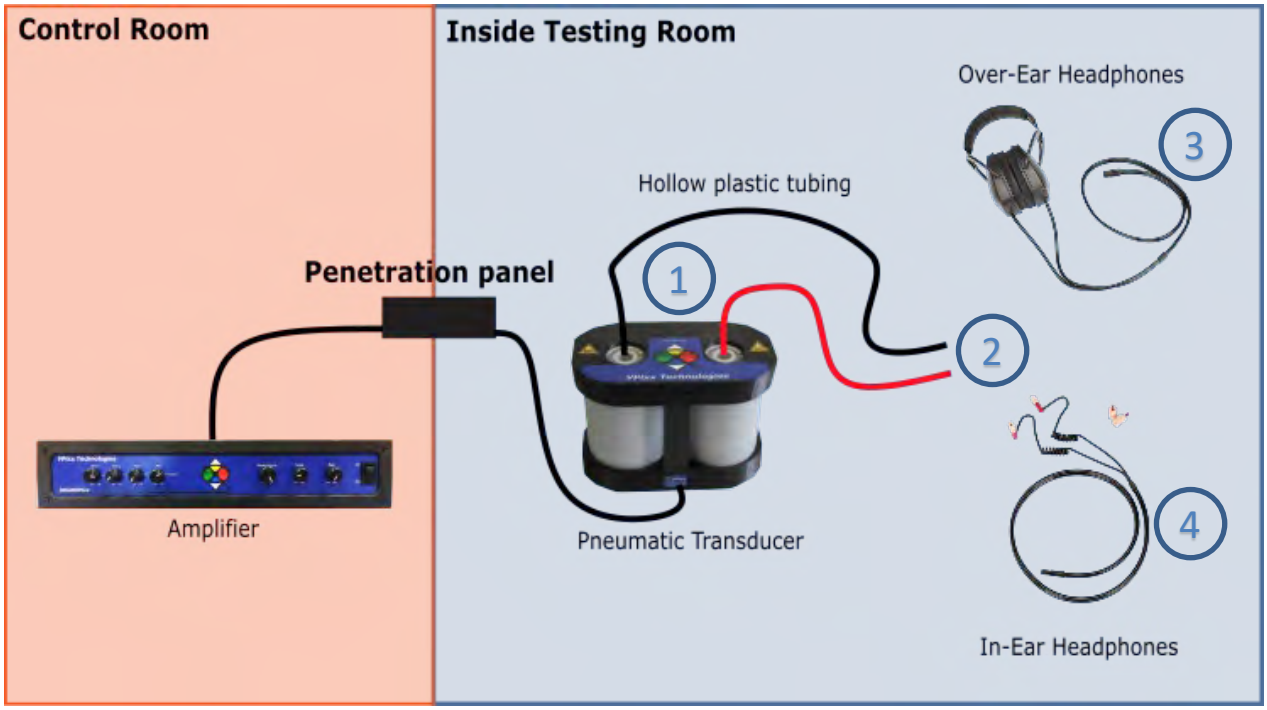
Due to the natural frequency shaping caused by the body and the ear, a “neutral” speaker output with a flat frequency response will no longer be flat by the time it reaches the ear drum. In particular, the pinnae amplify frequencies in the mid range, around 2-5 kHz, and the ear canal muffles very high frequencies. An in-ear microphone will show the result of this shaping, which does not reflect the actual quality of the sound system, but rather the acoustic properties of the ear.

Fortunately, headphone “jigs” with silicone ears and embedded microphones can measure over-ear and in-ear headphones. If the acoustic shaping properties of the jig are known, subsequent recorded data can be filtered to approximate the true frequency response profile of worn headphones without the frequency shaping produced by the ears. This is the approach we have taken to measure the frequency response profile of the SOUNDPixx headphones.

For a more in-depth review of frequency response measurements in headphones and subjective sound quality, see https://www.innerfidelity.com/content/headphone-measurements-explained-frequency-response-part-one

Testing Equipment

Frequency response testing was performed using Room EQ Wizard V5.20 (https://www.roomeqwizard.com/) and an HP Omen laptop running Windows 10 and RealTek Audio sound system. The four SOUNDPixx components found below are tested in terms of their frequency response.



1: Transducer output (no tubes)
2: Air tube opening
3: Over-Ear headphone output
4: In-Ear headphone output

Figure 15 Components tested for frequency response profile

Measurements of transducer and air tube output were recorded with an area microphone, the miniDSP UMIK-1 Measurement Microphone (miniDSP, Hong Kong). Headphone measurements were recorded with a headphone test jig, the miniDSP Earphone Audio Response System or E.A.R.S (miniDSP, Hong Kong).

The microphone manufacturer provided calibration files which characterize the acoustic influence of the jig itself on sound quality. These calibration files are unique to each microphone and serial number. We used the calibration for our specific headphones.

All tests were conducted in a quiet office environment.

Testing Method

Tests consisted of 5 frequency sweeps from 20Hz – 20 000Hz, at a sampling rate of 48 kHz. The settings for measurements were based on the best practices outlined in the microphone manufacturer user manual, located here: https://www.minidsp.com/images/documents/EARS%20User%20Manual.pdf.

For headphone measurements, the right headphone input was measured based on stereo output to the headphones. The transducer and air tube opening were measured with the microphone placed beside the left and right openings. Between each measurement, the position of the microphone/headphones was re-adjusted.

Measurements were made with made with maximum treble, maximum bass, and maximum mid (i.e., treble and bass set to minimum). These levels can be adjusted by turning the dials on the amplifier. The response profiles show the relative effect of amplification in the bass and treble ranges.

Results

Pneumatic transducer (measured with area microphone)

With the air tubes unplugged, the transducer emits pneumatic noise akin to a loudspeaker. Frequency testing shows consistent performance in the upper bass to upper treble range, between ~100 Hz and ~8 kHz. There is a characteristic dip at 1 kHz, which is a product of the changeover from the pneumatic woofer (for low frequencies) and the pneumatic tweeter (for high rangers). Maximum bass and treble produce clear power increases in their respective ranges.

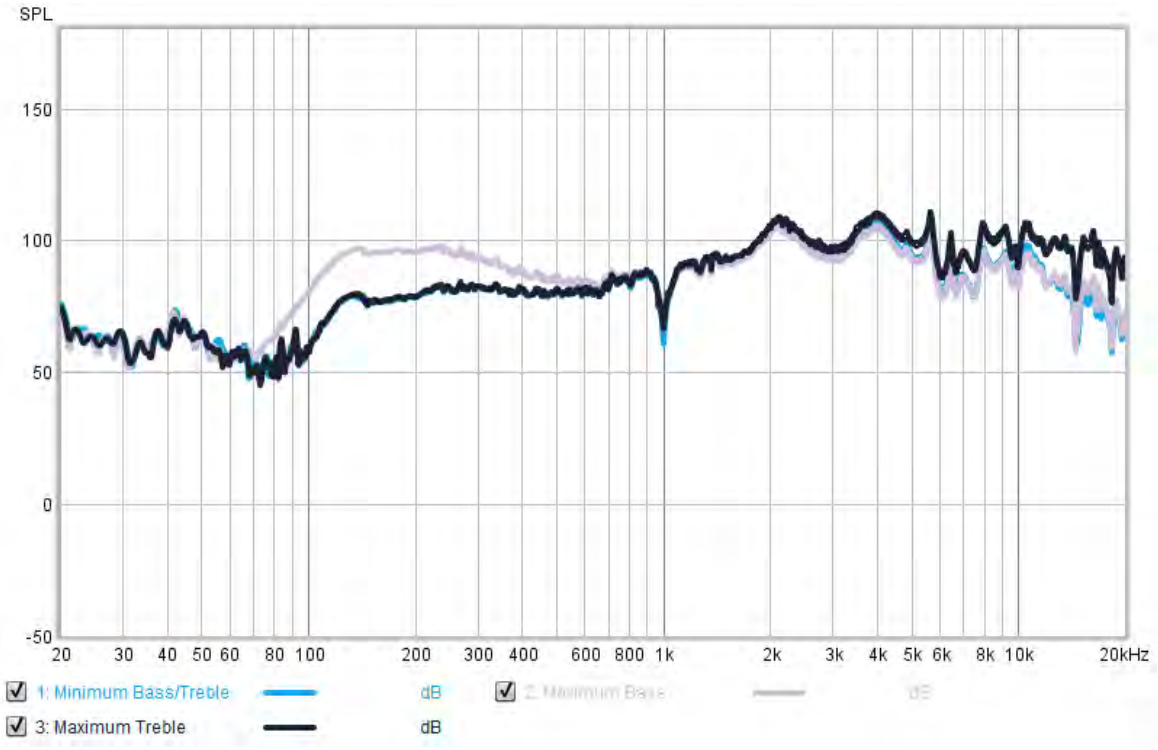


Figure 16 Bass/Treble response VS Frequency profile (pneumatic transducer)

Air tube openings (measured with area microphone)

Muffling of low bass and high treble is an expected consequence of pneumatic sound travelling down a long chamber. Results indicate that the SOUNDPixx maintains power in the low range, but there is some attenuation in treble. One factor which affects the relative muffling of frequencies is the position of the tubes themselves. For the best frequency response possible, **we recommend arranging the tubing so that it is as straight as possible.** Coiling the tubes may produce more muffling while bending the tubes will distort sound quality.

This measurement is difficult to take accurately given the small tubes, and results should be interpreted in the context of our other measurements.

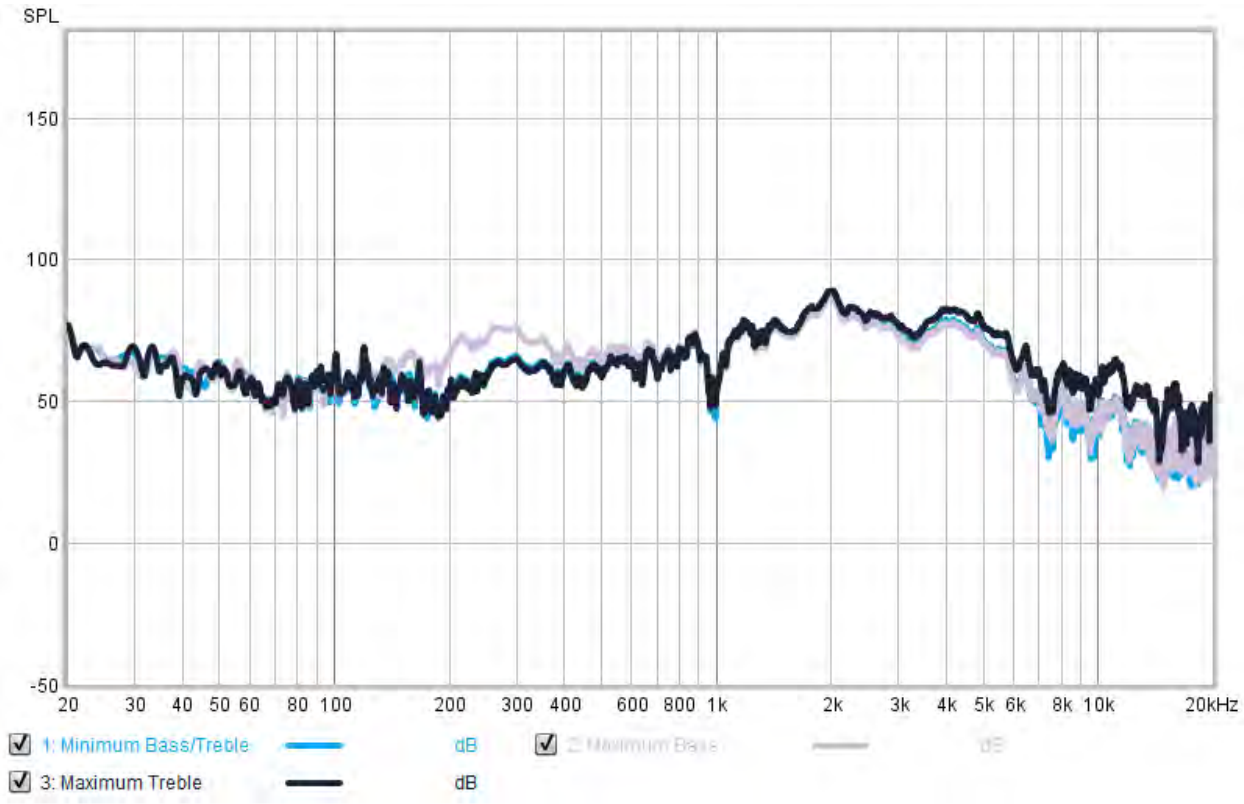


Figure 17 Bass/Treble response VS Frequency profile (air tube openings)

Over-Ear Headphones (right side -- measured with a headphone jig)

Over-ear headphones have a seal, which we adjusted between individual measurements. The quality of the seal does impact frequency response, especially with a noisy background environment. Researchers should ensure a good headphone seal on the participant prior to testing.

As expected, headphones attenuate frequencies in the treble range. Researchers interested in testing in this range may be able to compensate for this effect by equalizing, e.g., selectively raising the volume of higher frequencies to create consistent volume across the frequency range. We recommend performing your own acoustic testing if you pursue this option, as your exact frequency response profile will vary based on your test environment.

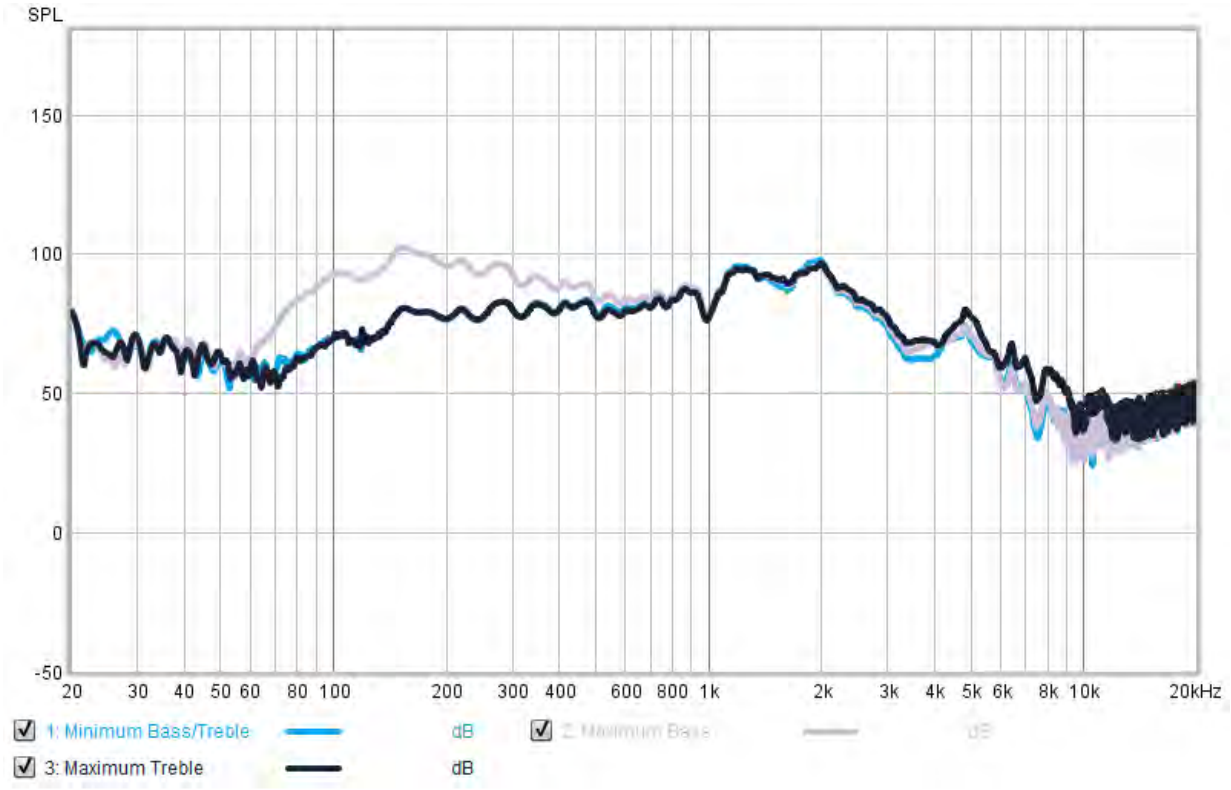


Figure 18 Bass/Treble response VS Frequency profile (over-ear headphones)

In-Ear Headphones (right side -- measured with a headphone jig)

A good seal is also valuable for in-ear headphone performance. The provided foam earplugs should be well-inserted and mold to fill the ear canal. Equalizing may be necessary for testing frequencies above the range of normal speech, i.e., above 5 kHz.

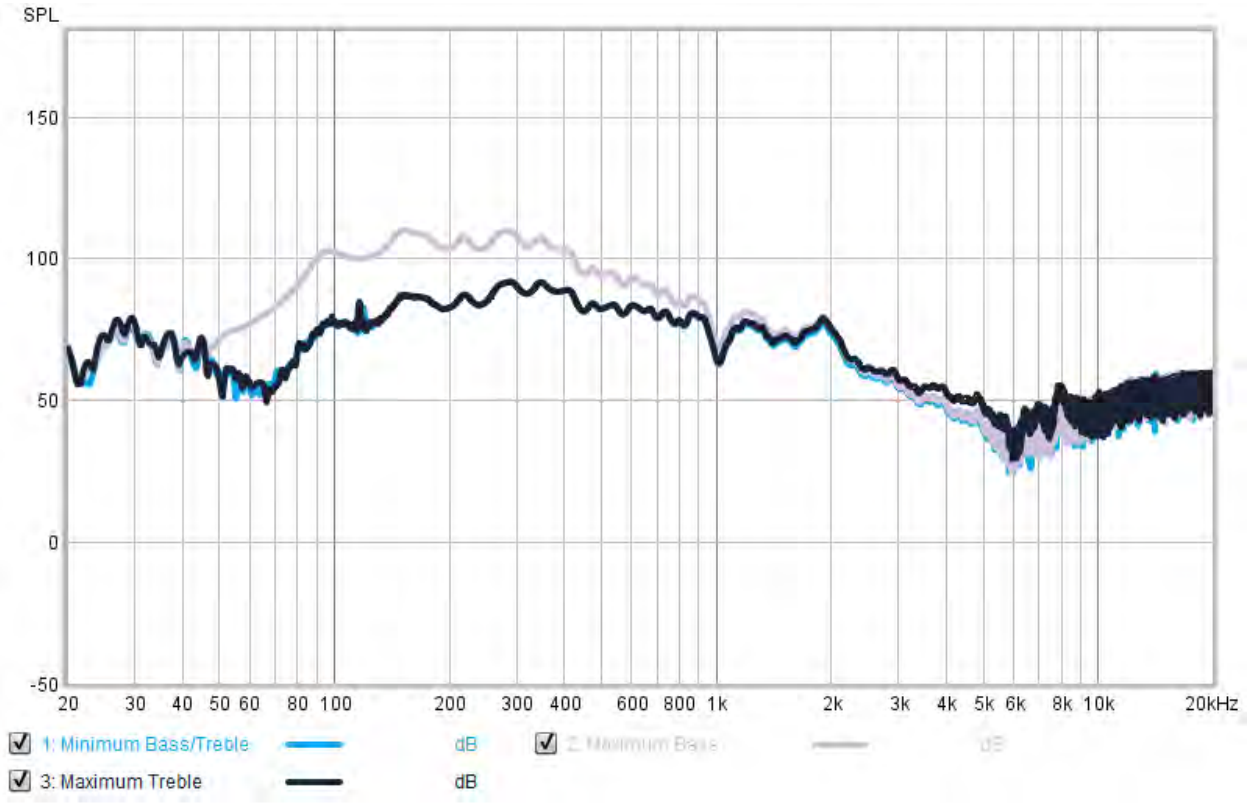


Figure 19 Bass/Treble response VS Frequency profile (in-ear headphones)

Summary

Pneumatic sound systems are effective tools for playing audio in magnetically sensitive environments. The SOUNDPixx shows some characteristic features of pneumatic sound systems, notably a loss of power at high frequencies after the compressed air waves have travelled down a length of thin tubing and headphones. Researchers wishing to test sounds at high frequencies may be able to compensate for this attenuation through equalizing (raising the volume of certain frequencies). Adjusting the bass and treble levels of the amplifier can change the relative power of frequencies as well.

An important note is that there is a characteristic dip at 1 kHz, where output switches between the woofer (for the low range) and tweeter (for the high range). This is a hardware limitation of the pneumatic system, but as the results show this is limited to a small range of frequencies.

This report is intended to provide a general guide to SOUNDPixx performance and what customers can expect from their audio output. It bears repeating that these tests were performed in an office environment, and do not consider background noises common in MRI and MEG testing environments. We encourage interested researchers to perform their own measurements where possible, especially if equalizing is being implemented.

Frequency response charts can be difficult to map to subjective experiences, so we will end with a layman comparison to common audio systems. A common audio experience with limited treble is a high-quality telephone conversation. Researchers planning to play music or movies for their participants may wish to increase the base on the amplifier for an experience similar to standard headphones.

Maintenance

Cleaning the SOUNDPixx

Clean the surface of your SOUNDPixx components as required and depending on usage.

	***Do not use cleaners that contain any petroleum-based materials such as benzene, thinner, or any volatile substance to clean the SOUNDPixx.***

Warranty

The SOUNDPixx is warranted against manufacturing defects in materials and workmanship for two years for parts and labor from the date of purchase.

VPixx Technologies Inc.
630 Clairevue West suite 301
Saint-Bruno, Qc
Canada, J3V 6B4

TEL: (514) 328-7499
FAX: (450) 300-7499
TOLL FREE: (844) 488-7499 (USA/CANADA)
EMAIL: sales@vpixx.com