Naval Submarine Medical Research Laboratory

NSMRL/F1016/TM—2022-1384 February 18, 2022

Impulse Assessment of the SureFire® EP7 Sonic Defenders® Ultra Earplug

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

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1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
18-02-2022	Technical Memorandum	October 2021 - January 2022

4. TITLE AND SUBTITLE

Impulse Assessment of the SureFire® EP7 Sonic Defenders® Ultra Earplug

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

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5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

F1016

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Naval Submarine Medical Research Laboratory
Box 900
Groton, CT 06349-5900

8. PERFORMING ORGANIZATION REPORT NUMBER

NSMRL/F1016/TM--2022-1384

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Bureau of Medicine and Surgery
7700 Arlington Blvd #5113
Falls Church, VA 22042

10. SPONSOR/MONITOR'S ACRONYM(S)

BUMED

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT

DISTRIBUTION A. Approved for public release: distribution unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT

The impulse peak insertion loss (IPIL) is the standard measure of attenuation provided by hearing protection devices (HPDs) in response to an impulsive noise. This technical memorandum describes the IPIL testing conducted and the calculated mean IPIL values for the SureFire® EP7 Sonic Defenders® Ultra Earplug. Testing included two test modes: cap open (i.e., unfiltered) and cap closed (i.e., filtered). Testing was completed in accordance with the ANSI standard S12.42-2010. All device samples were tested at the nominal levels of 150, 160, and 170 decibel peak (dBP, re: 20 µPa). A total of five samples were fitted to an acoustic test fixture two times each for a total of 10 trials per test level in both the cap open and cap closed modes. Results of the testing revealed overall higher mean IPIL values when the EP7 earplug was in the closed mode compared to the open mode at all nominal test levels (i.e., 150, 160, and 170 dBP). These results suggest that, when properly fit and functional, the EP7 can adequately protect (i.e., reduce exposure to less than 140 dBP) against impulses below 173.3 dBP in the cap open mode, and 180.0 dBP in the cap closed mode.

15. SUBJECT TERMS

attenuation, impulse peak insertion loss, IPIL, blast, hearing protection device, HPD, passive HPD, earplug, passive earplug

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			NAVSUBMEDRSCHLAB Commanding Officer
U	U	U	SAR	88	19b. TELEPHONE NUMBER *(Include area code)* 860-694-3263

Reset

Standard Form 298 (Rev. 8/98)
Prescribed by ANSI Std. Z39.18

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This work was supported by the U.S. Navy Bureau of Medicine and Surgery funding work unit F1016. The views expressed in this article are those of the authors and do not necessarily reflect the official policy or position of the Department of the Navy, Department of Defense, nor the U.S. Government. This work was prepared by employees of the U.S. Government as part of their official duties. Title 17 U.S.C. §105 provides that 'Copyright protection under this title is not available for any work of the United States Government.' Title 17 U.S.C. §101 defines a U.S. Government work as a work prepared by a military service member or employee of the U.S. Government as part of that person's official duties.

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Acknowledgements

The authors would like to thank Ms. Rachael Maten for assistance in the collection of resource materials.

CONTENTS

Executive Summary

The impulse peak insertion loss (IPIL) is the standard measure of attenuation provided by hearing protection devices (HPDs) in response to an impulsive noise. This technical memorandum describes the IPIL testing conducted and the calculated mean IPIL values for the SureFire® EP7 Sonic Defenders® Ultra Earplug (EP7; Model: 6498). Testing included two test modes: cap open (i.e., filtered signal) and cap closed (i.e., unfiltered signal). Testing was completed in accordance with the American National Standards Institute (ANSI) standard S12.42-2010, "Methods for the Measurement of Insertion Loss of Hearing Protection Devices in Continuous or Impulsive Noise Using Microphone-in-Real-Ear or Acoustic Test Fixture Procedures." All device samples were tested at the nominal levels of 150, 160, and 170 decibel peak (dBP, re: 20 µPa). A total of five samples were fitted to an acoustic test fixture two times each for a total of 10 trials per test level in both the cap open and cap closed modes. No samples of the HPD were rejected. Results of the testing revealed overall higher mean IPIL values when the EP7 earplug was in the cap closed mode compared to the cap open mode at all nominal test levels. The mean and standard deviation (SD) IPIL values were 26.2 (1.5) dB SPL at 150 dBP, 30.2 (1.1) dB SPL at 160 dBP, and 33.2 (0.7) dB SPL at 170 dBP in the cap open mode, and 41.8 (1.3) dB SPL at 150 dBP, 42.7 (0.9) dB SPL at 160 dBP, and 43.1 (0.8) dB SPL at 170 dBP in the cap closed mode (see Table 1).These results suggest that, when properly fit and functional, the EP7 can adequately protect (i.e., reduce exposure to less than 140 dBP) against impulses below 173.3 dBP in the cap open mode, and 180.0 dBP in the cap closed mode.

Table 1.
EP7 mean (SD) IPIL value (in dB) for all test conditions.

	150 dBP	**160 dBP**	**170 dBP**
Cap Open	26.2 (1.5)	30.2 (1.1)	33.2 (0.7)
Cap Closed	41.8 (1.3)	42.7 (0.9)	43.1 (0.8)

Introduction

The corded SureFire® EP7 Sonic Defenders® Ultra Earplug (EP7; SureFire LLC, Fountain Valley, CA) is a non-linear, foam-tipped earplug that is available in three sizes: small, medium, and large. The EP7 earplugs use foam canal tips composed of hypoallergenic, medical-grade polymer Comply™ material (SureFire LLC, n.d.) and a patented EarLock® within the concha bowl of the ear to maintain earplug retention. EP7 filter caps allow the user to manually select a cap open (i.e., filtered) or cap closed (i.e., unfiltered) mode. Per the manufacturer, when the filter caps are open, the earplug allows conversation to pass through while protecting against noises over 85 dB SureFire LLC, n.d.). When filter caps are closed, additional protection against potentially hazardous impulse noise (e.g. weapon fire) is afforded to the user (SureFire LLC, n.d.). These reusable earplugs last over six months. Comply™ canal tips should be replaced every two to four weeks.

The Department of Defense Instruction 6055.12 (2019) "Hearing Conservation Program (HCP)" limits impulse noise exposure to 140 peak decibels (dBP). Therefore, should an impulse noise meet or exceed 140 dBP, hearing conservation efforts to prevent hearing loss resulting from occupational and operational illness and injury are mandated. One conservation measure used to reduce the user's noise hazard below the 140 dBP limit is the use of hearing protection devices (HPDs; e.g., earplug or earmuff).

In order to calculate whether the issued HPD will reduce the impulse noise exposure below the 140 dBP limit, the impulse peak insertion loss (IPIL) value of the HPD should be subtracted from the impulse noise level (Department of Defense, 2015). The IPIL value is the standard metric (ANSI/ASA S12.42) used to determine the amount of protection afforded by an HPD in response to impulse noise.

Previous testing of the SureFire® EP7 Sonic Defenders® Ultra Earplug by the manufacturer resulted in IPIL values measured at 132, 150 and 168 dBP of 24.5, 29.3 and 32.1 dB, respectively with the filter cap open and 41.8, 45.3 and 44.9 dB with the filter cap closed (SureFire®, n.d.). Additionally, Gallagher et al., (2014) reported that, using Primer RDX 95/5 and C4 to create impulse blasts, the IPIL of the EP7 at 170, 185 and 195 dBP is 27.9, 33.8 and 40.1 dB, respectively, with the filter cap open and 52.9, 52.0 and 51.7 dB, respectively, with the filter cap closed. However, re-testing this product was justifiable for two reasons. First, generating impulses with a shock front at test levels below 150 dBP is generally problematic, and second, higher impulse noise levels are more often encountered occupationally in the military than in industrial occupations. As such, testing at 150, 160, and 170 dBP nominal levels provided more accurate estimates of protection for military impulse noise exposures. The current effort determined the IPIL value for the EP7 earplug using a 4-inch shock tube. This report describes the methods used to determine the IPIL value for the SureFire® EP7 Sonic Defenders® Ultra Earplug in the cap open and cap closed modes and reports the results. Specifically, both an overall device IPIL and ear-specific IPILs are reported for the tested nominal levels.

Methods

Facility

IPIL testing described herein was completed in the Naval Submarine Medical Research Laboratory (NSMRL) 1000 m^3 anechoic chamber in order to minimize any effects of sound reflections.

Equipment

Hardware. NSMRL's 4 inch (in., 10.2 centimeters [cm]) shock tube (B/C Precision, Inc., Greendale, IN) generated all acoustic impulses. The shock tube pressure chamber is approximately 34 in. (86.4 cm) long, with an inner diameter of 4 in. (10.2 cm). A 64 in. (162.6 cm) long catenoidal tube horn consisting of four welded steel flat-projection sheets forming a square cross section was connected to the shock tube using a PVC 4.5 in. (11.4 cm) coupler. An industrial air compressor (ILA#1883054; Industrial Air Corporation, Memphis, TN) supplied pressurized air (900 kilopascal) to the shock tube.

For each trial at 150 dBP, a 7 in. (17.8 cm) by 7 in. (17.8 cm) polyester sheet (SEVA Technical Services, Inc, Newport News, VA) was used as a membrane between the pressurized chamber and the catenoidal tube horn to enable pressurization of the air chamber. Each polyester sheet was 0.001 in. (1.0 mil, 25.4 micrometer [µm]) thick. For each trial at 160 and 170 dBP, a 7 in. (17.8 cm) by 7 in. (17.8 cm) acetate sheet (Grafix Plastic, Maple Heights, OH) was used as a membrane. Each acetate sheet was 0.002 in. (2.0 mil, 50.8 micrometer [µm]) thick.

All waveforms were recorded with an ANSI/ASA S12.42 (2010) compliant GRAS 45CB acoustic test fixture (ATF) with GRAS RA0045-S7 Ear Simulators (GRAS Sound and Vibration, Twinsburg, OH). The ATF was connected to a conditioning amplifier which served as the power supply (GRAS Type 12AA; GRAS Sound and Vibration, Twinsburg, OH). As required by ANSI/ASA S12.42/2010, the ATF was placed to front-face (i.e., nose facing) the catenoidal tube horn at 0° elevation and 0° azimuth.

A reference microphone (Type 378C20; PCB Piezotronics Inc., Depew, NY) was placed 6 in. (15.2 cm) from the ATF left pinna. The reference microphone, the left ATF microphone, and the right ATF microphone were calibrated prior to data collection using a 124 dB sound pressure level (SPL) 250 hertz (Hz) tone generator (Bruel & Kjaer, Marlborough, MA). A diagram depicting the aerial view of the NSMRL 4 in. (10.2 cm) shock tube and test system is presented in Figure 1.

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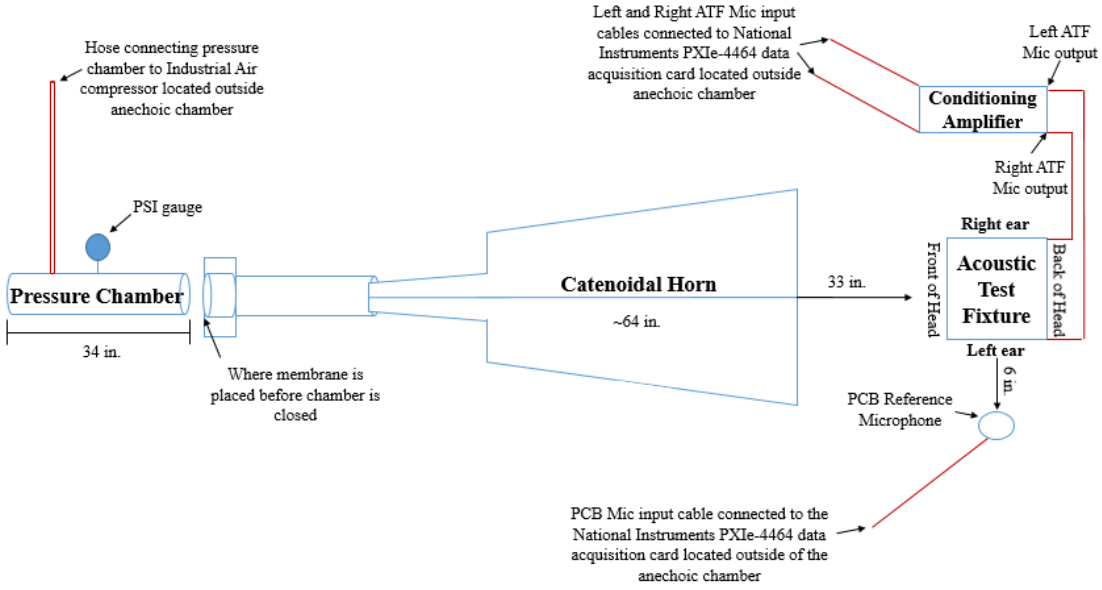
Figure 1.
Diagram of the NSMRL Acoustic Shock Tube and ATF.



Data Acquisition System. The data acquisition system (NI chassis PXIe-1071 with NI PXIe-4460 and NI PXIe-4464; National Instruments Corp., Austin, TX) was controlled by a standalone laptop computer running project specific software (LabVIEW; National Instruments Corp., Austin, TX). In addition, it was connected to the laptop using an MXI cord and host interface card (NI PXIe-8360). The software controlled the acquisition of waveforms from the three source microphones (left ATF, right ATF, reference) at a sampling rate of 204.8 k Samples/second during each impulse recording. Pre-trigger settings were 1024 samples per 0.005 seconds, with a trigger level of 110 dB SPL. Each recording was 0.3 seconds in duration.

Rather than using an ANSI/ASA S12.42-2010 standardized in-line analog external Bessel filter to filter impulses during data acquisition, anti-alias filtering was accomplished by an analog filter and a digital filter. First, an electronic analog anti-aliasing filter (corner frequency of 93.0 kHz [3 dB down]) was applied to all waveforms by the National Instruments data acquisition system during data collection. Then, a second digital Butterworth filter (6^{th} order, low-pass, corner frequency of 20 kHz [3 dB down]) was applied to all recordings by the MATLAB post-processing script. This digital filter was used to mimic the effect of the ANSI/ASA S12.42-2010 standard required anti-aliasing Bessel filter.

The custom-written software program saved all recorded waveforms as files (*.tdms), which were exported and converted to data files using an additional custom software programming script. The script compiled the reference PCB microphone, left ATF microphone, and right ATF microphone channels into a file (*.mat) that saved variables for input to analysis script (MATLAB) similar to the script provided in Annex H of the ANSI/ASA S12.42-2010 standard. Minor alterations were made to the analysis script in order to accept 150, 160, and 170 dBP data (see Data Analysis below).

Hearing Protection Device Samples. Five samples (See Figures 2 and 3 for examples) of the SureFire® EP7 Sonic Defenders® Ultra Earplugs (Manufacturer Product Number: 6498) were tested in accordance with ANSI/ASA S12.42-2010. All samples were medium size. Each sample, consisting of one set of two earplugs, was randomly assigned a number 1 through 5. Each earplug in the sampled set was labeled 'L' for left or 'R' for right to indicate which ATF ear they were to be inserted for all trials.

Figure 2.
Photograph of an EP7 (Cap Open) Earplug Sample.

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Figure 3.
Photograph of an EP7 (Cap Closed) Earplug Sample.

Procedure

Two HPD modes (i.e., cap open [filtered], cap closed [unfiltered]) were tested for each of the five samples of the EP7. Each HPD sample (left and right earplug pair) was fitted to the ATF twice, resulting in two trials (trials A and B) per sample, and 10 total trials per nominal level test condition (150, 160, and 170 dBP) for each HPD mode (i.e., cap open, cap closed). No samples of the HPD were rejected. To achieve an appropriate fit that would provide maximum attenuation, each sample was expertly fitted to the ATF in accordance with instructions on the device packaging. The manufacturer fitting guidelines stated that all samples be inspected for any wear, cracks, or damage prior to use. Once inspected, the cap was placed in the closed or open position and the earplug was inserted into the ATF ear. Foam tips were given at least two minutes to fully expand in the ATF ear canal before impulse testing was performed.

Testing at the 130 dBP nominal level was omitted, and the nominal level of 160 dBP was incorporated as impulses generated with the NSMRL 4 in. (10.2 cm) shock tube at levels below the nominal level of 150 dBP were found to be without a shock front. Measurement of IPIL at 160 dBP was added in order to provide accurate guidance for exposures between 150 and 170 dBP. At the measured levels described herein, all generated impulses had a shock front. As previously stated, the action level for the US Department of Defense (DoD) is 140 dBP for impulse noises. Therefore, IPIL values below 140 dBP are of marginal value to the DoD. Due to non-linear effects of HPDs on IPIL, it is best to use IPIL values measured close to the level of the predicted exposure (Department of Defense, 2015).

Impulse noises were presented to the ATF in occluded (i.e., HPD inserted) and unoccluded (i.e., without the HPD inserted) test configurations. For all occluded measures, the earplugs were fitted on the ATF in accordance with the specifications outlined in ANSI/ASA S12.42-2010. Each HPD sample was exposed to two impulses

at each tested nominal level in each test mode. Adequate pressure for each impulse was determined by increasing pressure (measured in pounds per square inch [psi]) to a point within a pre-specified range necessary for producing either 150 dBP (8.9 to 9.3 psi, 61 to 64 kilopascals [kPa]), 160 dBP (19.5 to 22.1 psi, 134 to 152 kPa), or 170 dBP impulses (28.5 to 29.5 psi, 197 to 203 kPa). The membrane was then punctured using a manual trigger, releasing pressurized air into the catenoidal horn, which created an impulse wave through the catenoidal horn to the ATF. The peak decibel level emitted was dependent upon the amount of air pressure released.

In place of the ANSI/ASA S12.42-2010 standardized calibration impulses at 130 dBP, six total calibration impulses (three pre-, three post-testing) were generated per nominal level (150, 160 dBP) in the unoccluded (i.e., without HPD) test configuration. Calibrations were not completed at the 170 dBP nominal level due to exposure limitations of the ATF microphones.

Data Analysis

MATLAB (Natick, MA) was used to calculate IPIL values at the 150, 160, and 170 dBP nominal levels and to generate all waveform graphs (See Appendices A to R). The mean pressure of each waveform was subtracted from the waveforms to remove any constant offset. The peak levels were then calculated by converting the maximum absolute value of each waveform into dB SPL. The transfer functions of the free-field probe to each ear of the ATF was calculated for the unoccluded waveforms gathered at the 160 dBP nominal levels. The mean transfer function for each ear at each level was then calculated, and the first elements of the transfer functions were set to zero in order to avoid calculations at 0 Hz. The fit of the mean transfer function was tested by applying the mean transfer function for each ear to the free-field probe data gathered in the 150 and 160 dBP nominal level. Then, the difference of the maximum absolute values of the calculated and measured values was determined, converted to dB SPL, and displayed.

The calculated IPIL value (in dB) equaled the mean difference of the maximum absolute value of the waveforms from the ears of the ATF in dB SPL and the maximum absolute value of the estimated values of the unoccluded ears in dB SPL. The estimated values of the unoccluded ears are the waveforms from the free-field probe with the mean transfer function applied to them. These values were calculated for each ear in each trial and condition. The mean values were calculated across both ears and trials, resulting in a mean for each nominal level. Every waveform was plotted with time on the x-axis and pressure on the y-axis. The transfer functions were not plotted.

Results

At all nominal test levels, greater IPILs were obtained when the earplug cap was closed (i.e., unfiltered) compared to when it was open (i.e., filtered). As shown in Table 2, the overall mean (SD) IPIL value in the cap open mode was 26.2 (1.5) dB for the 150 dBP test condition, 30.2 (1.1) dB for the 160 dBP test condition, and 33.2 (0.7) dB for the 170 dBP test condition. The overall mean (SD) IPIL value in the cap closed mode was 41.8 (1.3) dB for the 150 dBP test condition, 42.7 (0.9) dB for the 160 dBP test condition, and 43.1 (0.8) dB for the 170 dBP test condition. Calculated IPIL values for

all individual sample trials in the cap open mode ranged between 22.8 and 28.4 dB at 150 dBP, between 27.6 and 32.1 dB at 160 dBP, and between 31.1 and 34.3 dB at 170 dBP, while all tested sample trials in the cap closed mode ranged between 37.6 and 42.9 dB at 150 dBP, between 40.1 to 43.5 dB at 160 dBP, and between 41.1 to 43.9 dB at 170 dBP.

Table 2.
Mean (SD) IPIL values (in dB) for Tested EP7 Samples.

	150 dBP				**160 dBP**				**170 dBP**			
	Open		***Closed***		***Open***		***Closed***		***Open***		***Closed***	
	Right	*Left*	*Right*	*Left*	*Right*	*Left*	*Right*	*Left*	*Right*	*Left*	*Right*	*Left*
HPD 1, Trial A	22.8	23.7	42.6	41.2	30.0	31.1	43.5	42.1	33.3	34.3	43.7	42.4
HPD 1, Trial B	28.4	27.9	40.2	40.9	31.3	30.7	42.9	42.7	33.6	33.1	43.6	42.3
HPD 2, Trial A	27.3	28.0	42.5	42.6	28.8	29.9	43.4	43.5	33.3	34.3	43.7	43.7
HPD 2, Trial B	25.7	26.5	42.5	42.1	29.1	29.9	43.4	43.0	32.9	33.6	43.7	43.4
HPD 3, Trial A	26.0	26.7	42.5	42.9	31.5	32.1	43.1	43.3	32.8	33.3	43.4	43.6
HPD 3, Trial B	27.6	27.7	42.1	42.7	29.6	29.9	42.9	43.5	33.0	33.2	43.1	43.9
HPD 4, Trial A	27.0	26.4	42.6	37.6	30.1	29.6	43.3	40.1	32.8	32.1	43.7	41.1
HPD 4, Trial B	26.3	23.9	42.1	39.6	29.6	27.6	42.4	40.3	33.3	31.1	42.9	41.2
HPD 5, Trial A	25.3	25.0	42.2	42.3	30.9	30.8	42.7	42.7	33.4	33.5	43.3	43.3
HPD 5, Trial B	25.9	26.0	42.2	42.7	31.0	31.4	42.8	43.1	33.2	33.7	43.2	43.5
Ear Specific Mean (SD)	26.2 (1.5)	26.2 (1.6)	42.2 (0.7)	41.5 (1.7)	30.2 (0.9)	30.3 (1.2)	43.0 (0.4)	42.4 (1.2)	33.2 (0.3)	33.2 (1.0)	43.4 (0.3)	42.8 (1.0)
Level Overall Mean (SD)	**26.2 (1.5)**		**41.8 (1.3)**		**30.2 (1.1)**		**42.7 (0.9)**		**33.2 (0.7)**		**43.1 (0.8)**	

The waveforms for all trials with the EP7 filter cap open are provided in Appendices A to I and are color-coded green. The waveforms for all trials with the EP7 filter cap closed are provided in Appendices J to R and are color-coded orange.

Discussion

Results showed greater IPIL values when the EP7 earplug was in the cap closed mode compared to the cap open mode at all nominal test levels (i.e., 150, 160, and 170 dBP). The overall mean IPIL value for the EP7 in the cap open mode was 26.2 dB at 150 dBP, 30.2 dB at 160 dBP, and 33.2 dB at 170 dBP. The overall mean IPIL value for the EP7 in the cap closed mode was 41.8 dB at 150 dBP, 42.7 dB at 160 dBP, and 43.1 dB at 170 dBP. Across ears, the individual trial mean IPIL values were found to vary as much as 5.6 dB at 150 dBP, 4.5 dB at 160 dBP, and 3.2 dB at 170 dBP in the cap open mode, and 5.3 dB at 150 dBP, 3.4 dB at 160 dBP, and 2.8 dB at 170 dBP in the cap closed mode. This variability may be due to a combination of inherent variance within the impulse system and/or variability in fit as a result of each HPD sample being fitted twice.

It is important to note that these results do not guarantee similar EP7 product performance across all users and environments. Product performance may be impacted by factors such as variability in physical fit of the device and HPD configuration (e.g., single, double- or triple- configuration).

Conclusions

This report described the process for determining the mean impulse peak insertion loss (IPIL) values provided by the SureFire® EP7 Sonic Defenders® Ultra Earplug (EP7) at 150, 160, and 170 dBP nominal levels in both the cap open (i.e., filtered) and cap closed (i.e., unfiltered) modes. The calculated overall mean (SD) IPIL values for the EP7 in the cap open mode were found to be 26.2 (1.5) dB at 150 dBP, 30.2 (1.1) dB at 160 dBP, and 33.2 (0.7) dB at 170 dBP. The calculated overall mean (SD) IPIL values for the EP7 in the cap closed mode were found to be 41.8 (1.3) dB at 150 dBP, 42.7 (0.9) dB at 160 dBP, and 43.1 (0.8) dB at 170 dBP. The results of testing suggest that, when properly fit and functional, the EP7 can adequately protect (i.e., reduce the exposure below 140 dBP) the user from impulse noises below 173.3 dBP in the cap open mode, and 180.0 dBP in the cap closed mode.

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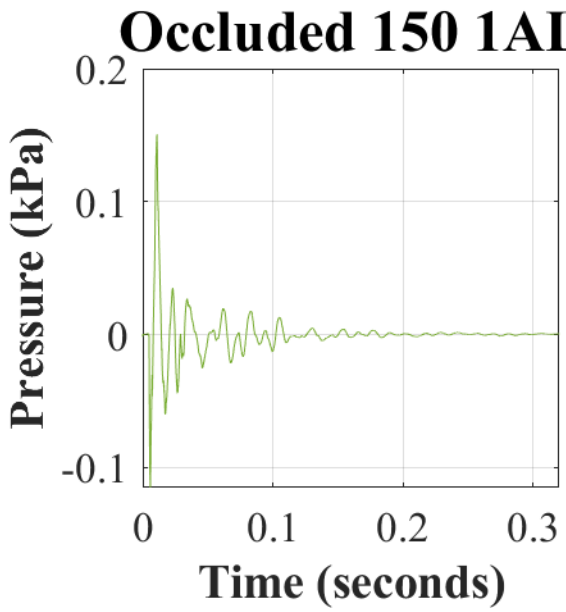
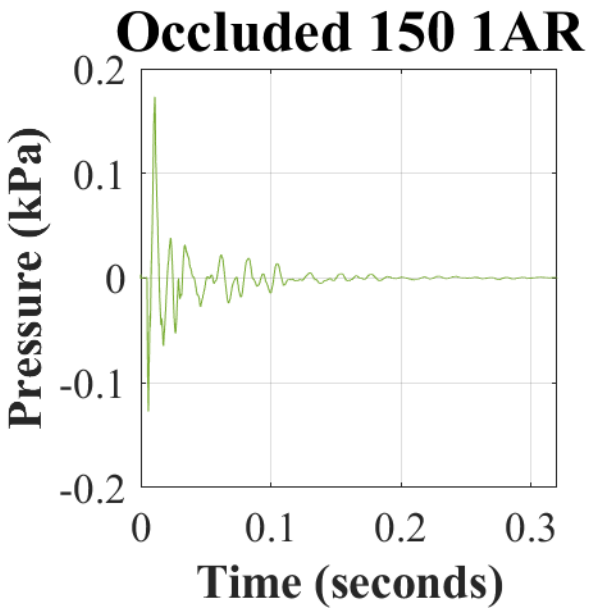
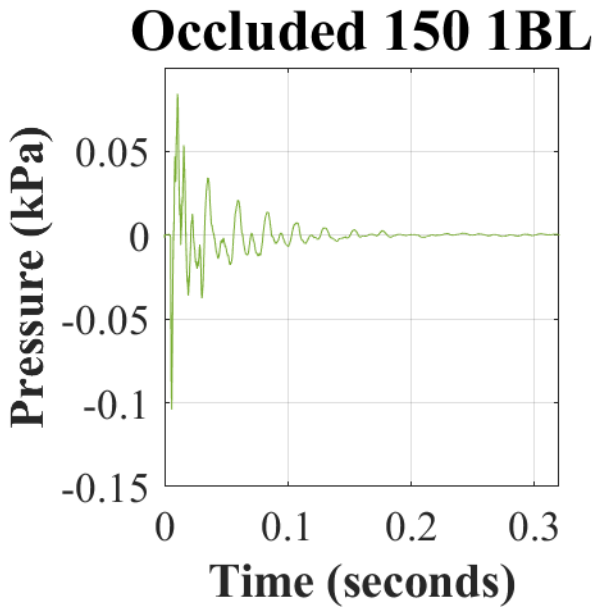
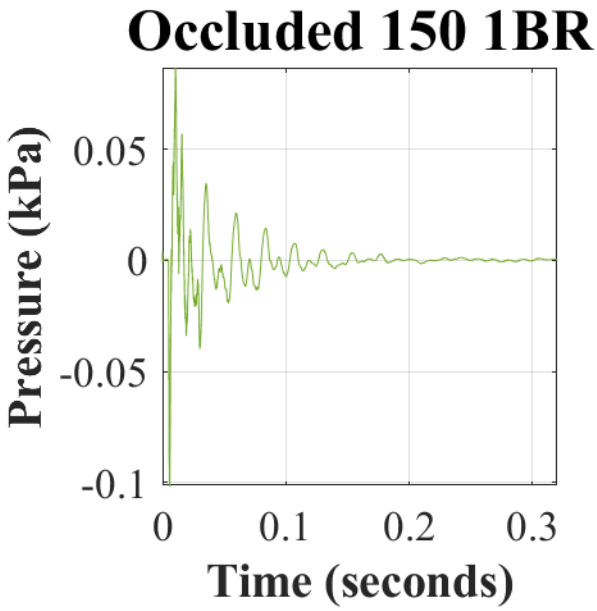
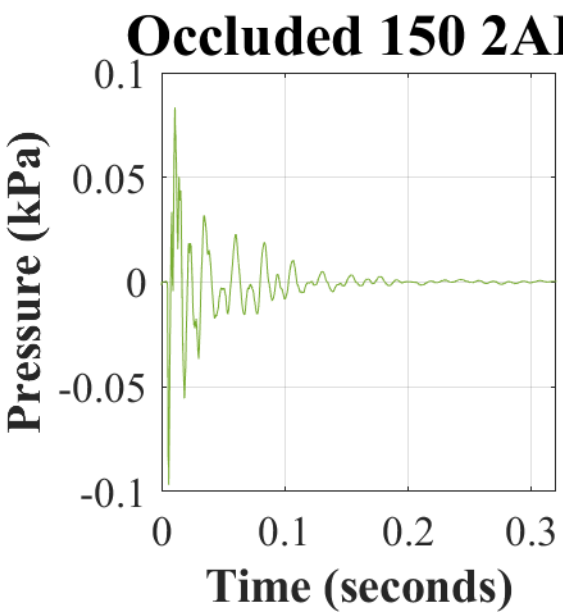
Appendix A. Recorded occluded (closed-ear) waveforms (in kilopascals [kPa]) over time (in seconds [s]) in response to 150 dBP with the EP7 in the cap open mode.

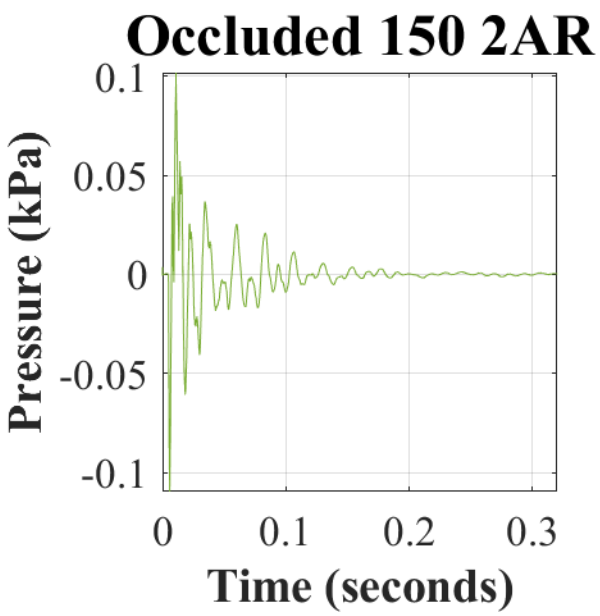


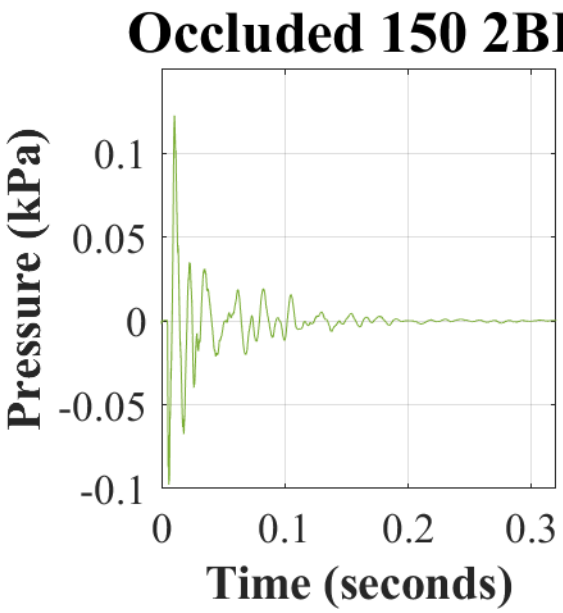


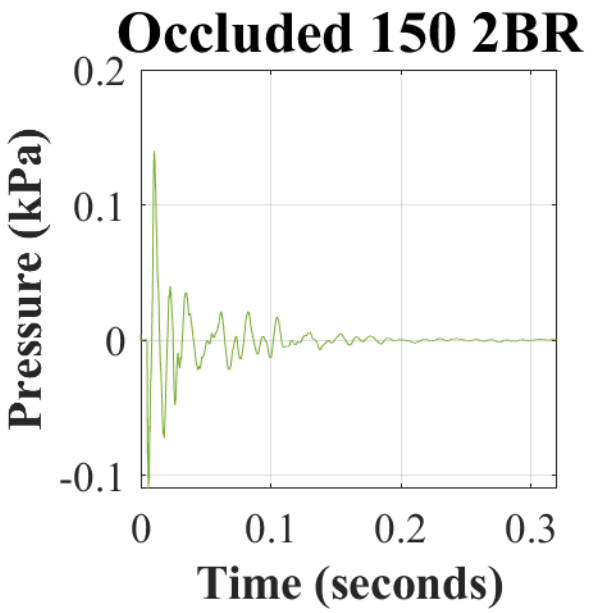


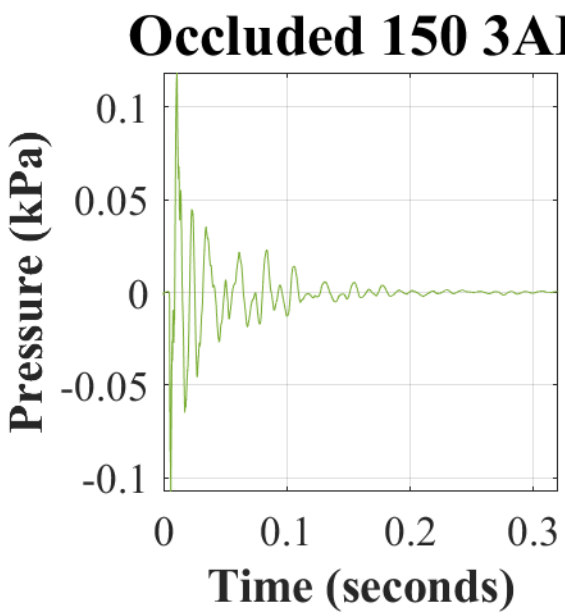


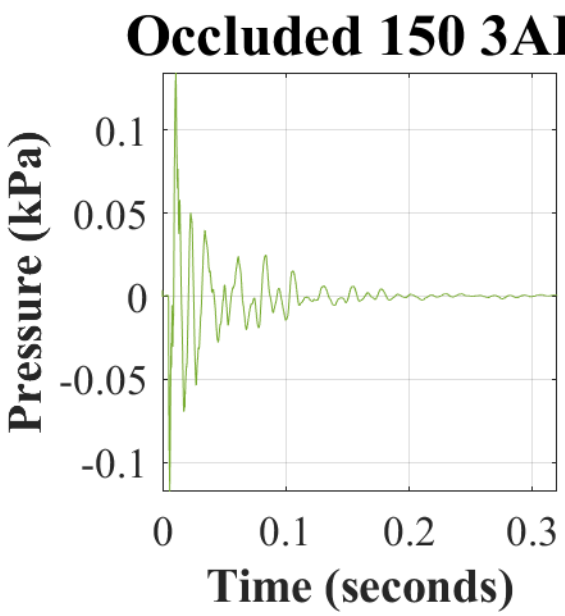

Occluded 150 2AL
Pressure (kPa)
0.1
0.05
0
-0.05
-0.1
0
0.1
0.2
0.3
Time (seconds)

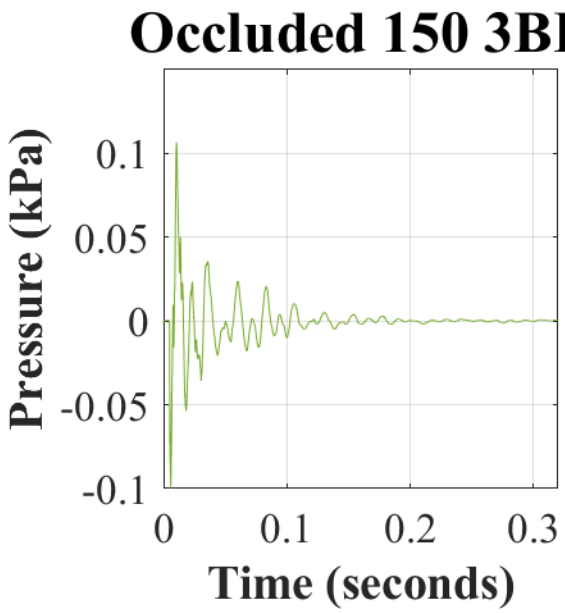

Occluded 150 2AR
Pressure (kPa)
0.1
0.05
0
-0.05
-0.1
0
0.1
0.2
0.3
Time (seconds)

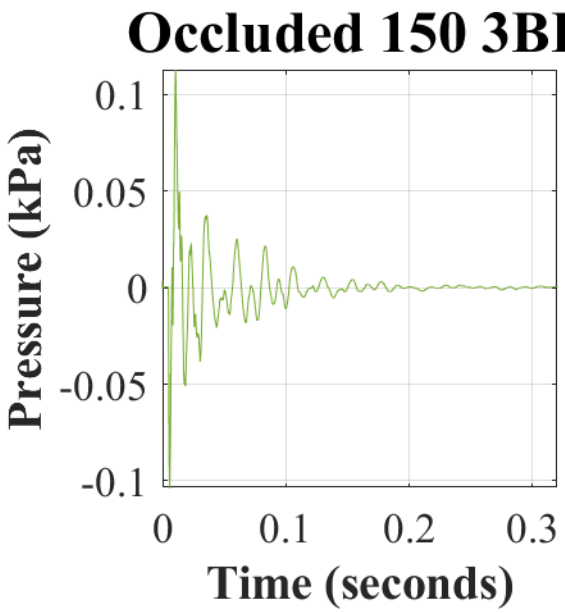

Occluded 150 2BL
Pressure (kPa)
0.1
0.05
0
-0.05
-0.1
0
0.1
0.2
0.3
Time (seconds)

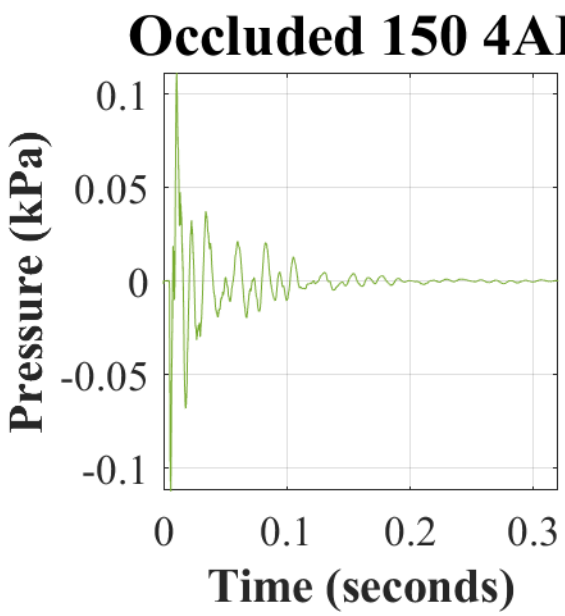

Occluded 150 2BR
Pressure (kPa)
0.2
0.1
0
-0.1
0
0.1
0.2
0.3
Time (seconds)

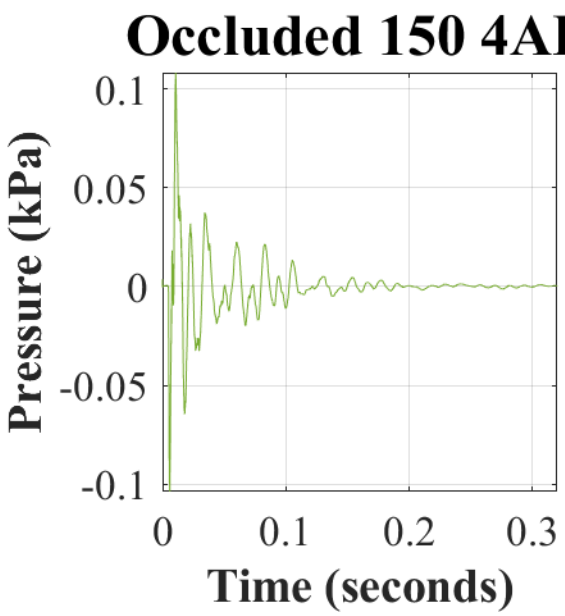

Occluded 150 3AL
Pressure (kPa)
0.1
0.05
0
-0.05
-0.1
0
0.1
0.2
0.3
Time (seconds)

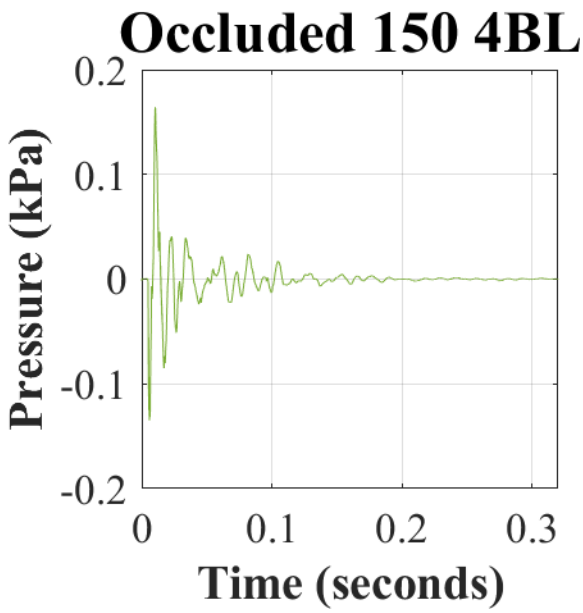

Occluded 150 3AR
Pressure (kPa)
0.1
0.05
0
-0.05
-0.1
0
0.1
0.2
0.3
Time (seconds)

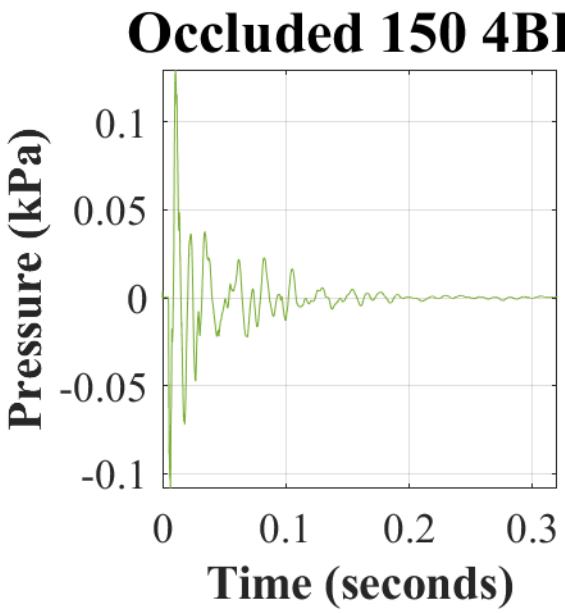

Occluded 150 3BL
Pressure (kPa)
0.1
0.05
0
-0.05
-0.1
0
0.1
0.2
0.3
Time (seconds)

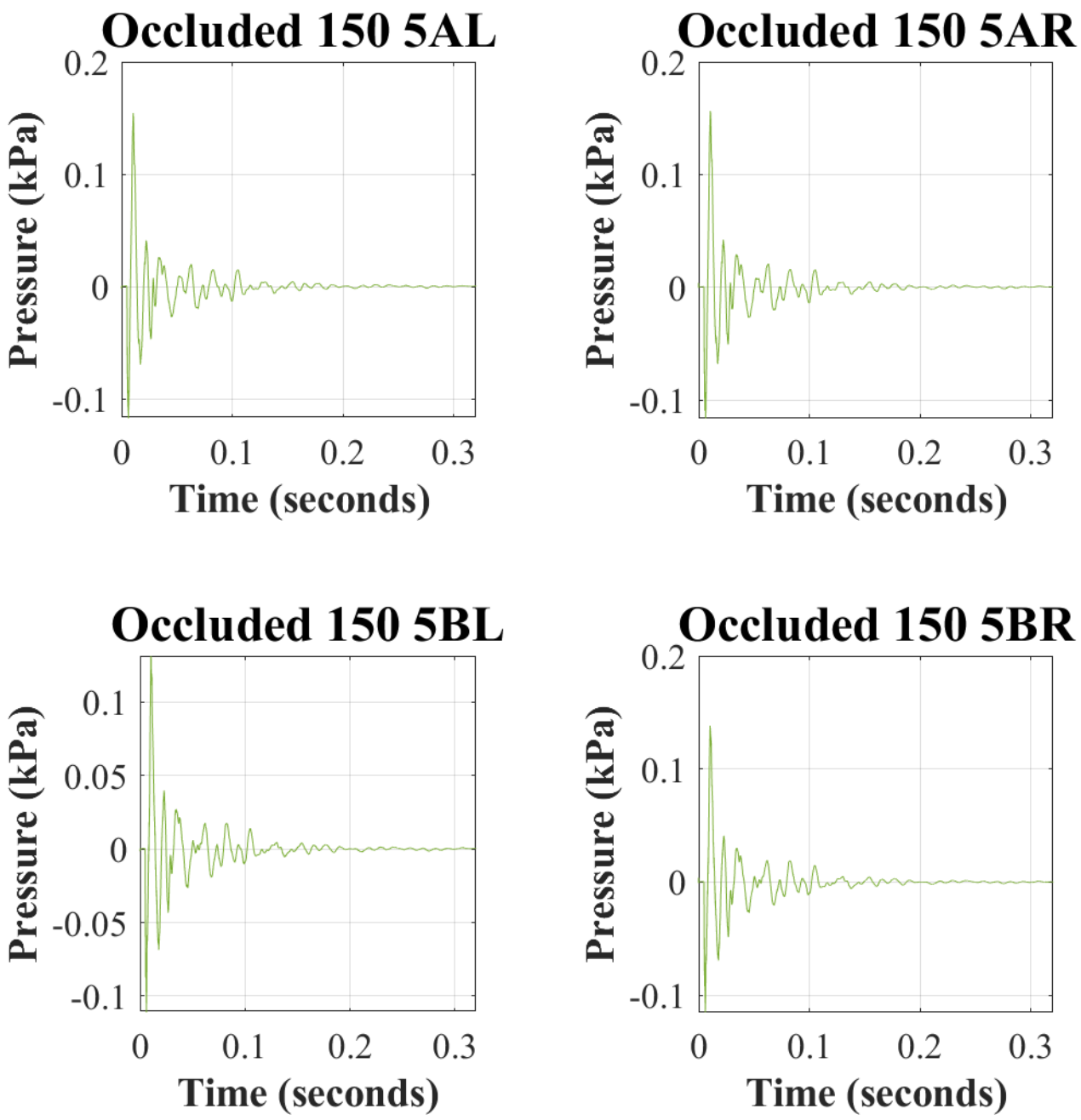

Occluded 150 3BR
Pressure (kPa)
0.1
0.05
0
-0.05
-0.1
0
0.1
0.2
0.3
Time (seconds)


Occluded 150 4AL
Pressure (kPa)
0.1
0.05
0
-0.05
-0.1
0
0.1
0.2
0.3
Time (seconds)


Occluded 150 4AR
Pressure (kPa)
0.1
0.05
0
-0.05
-0.1
0
0.1
0.2
0.3
Time (seconds)

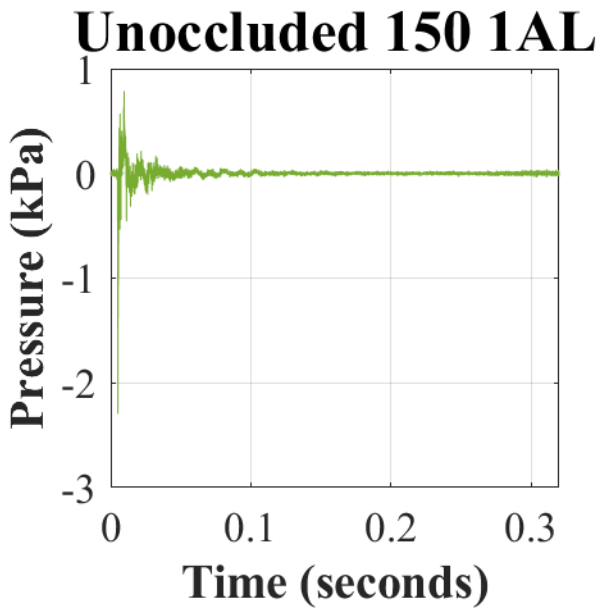

Occluded 150 4BL
Pressure (kPa)
0.2
0.1
0
-0.1
-0.2
0
0.1
0.2
0.3
Time (seconds)

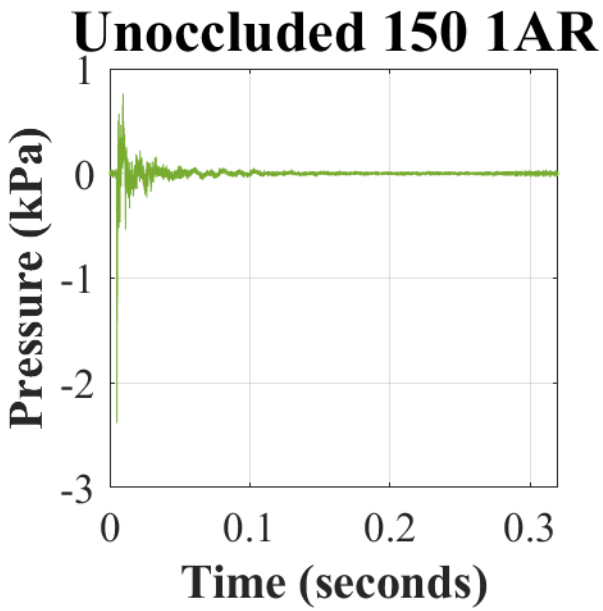

Occluded 150 4BR
Pressure (kPa)
0.1
0.05
0
-0.05
-0.1
0
0.1
0.2
0.3
Time (seconds)

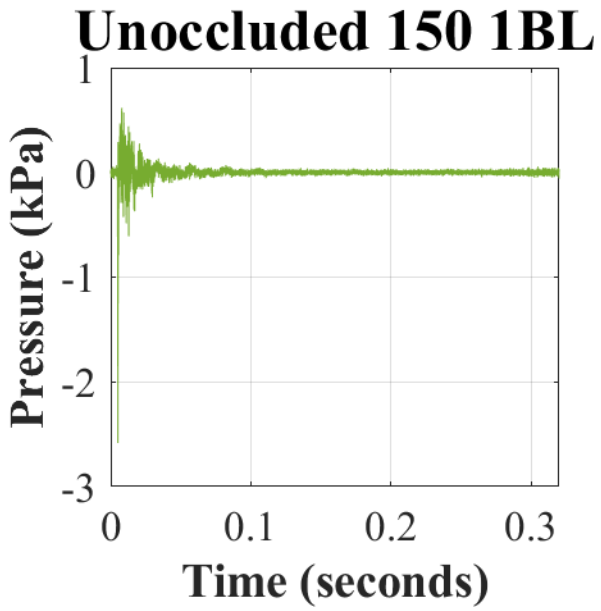


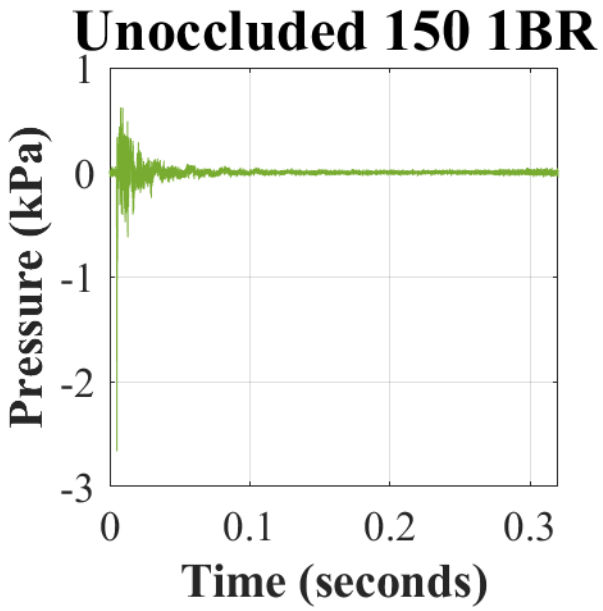
Note. The naming convention for all occluded waveforms is “Occluded LvL NnX”, where ‘Occluded’ is the test condition (i.e., ATF has the HPD donned), ‘LvL’ is the nominal test level (i.e., 150, 160 or 170 dBP), ‘N’ is the sample number (i.e., 1 to 5) of the device tested, ‘n’ is the trial (i.e., A or B) indicating HPD fit (i.e., first or second, respectively), and ‘X’ indicates from what ATF microphone the recording is from (i.e., right [R] or left [L] pinnae).

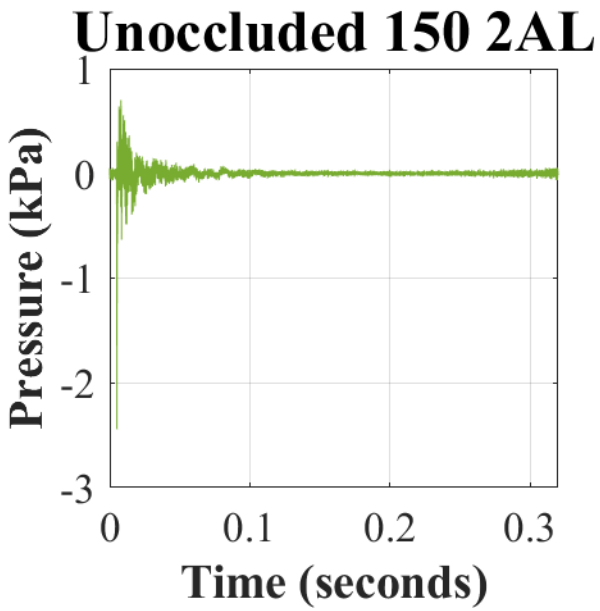
Appendix B. Estimated unoccluded (open-ear) waveforms (in kilopascals [kPa]) over time (in seconds [s]) in response to 150 dBP with the EP7 in the cap open mode.

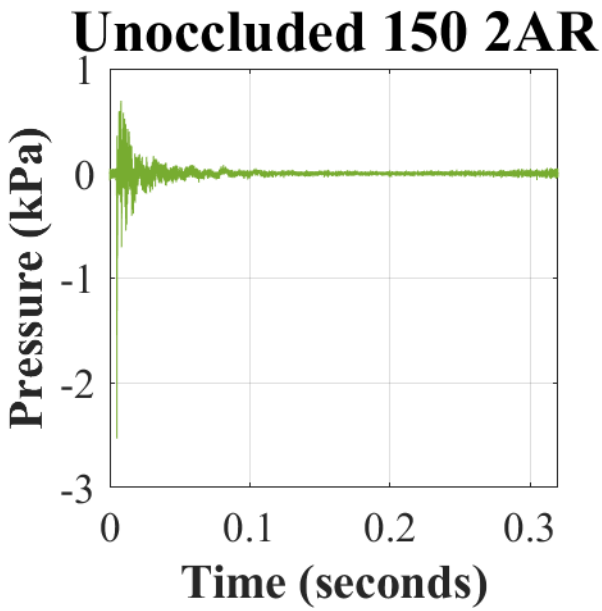


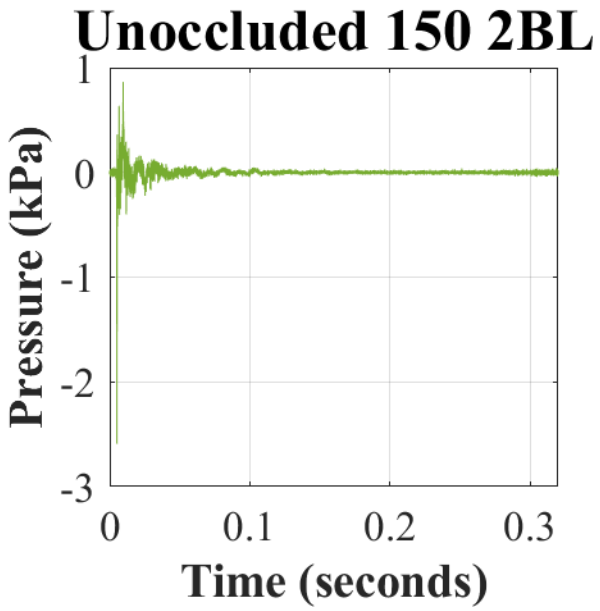


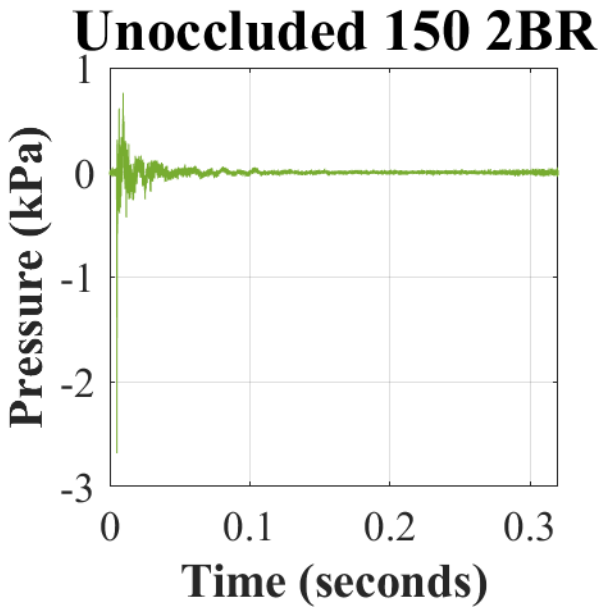


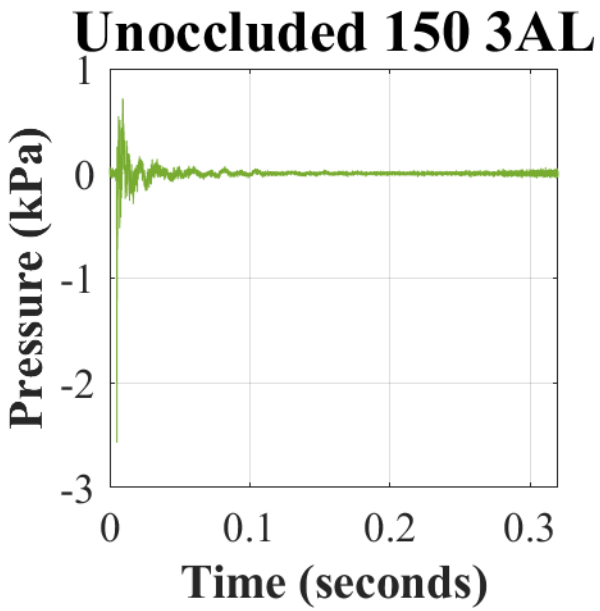


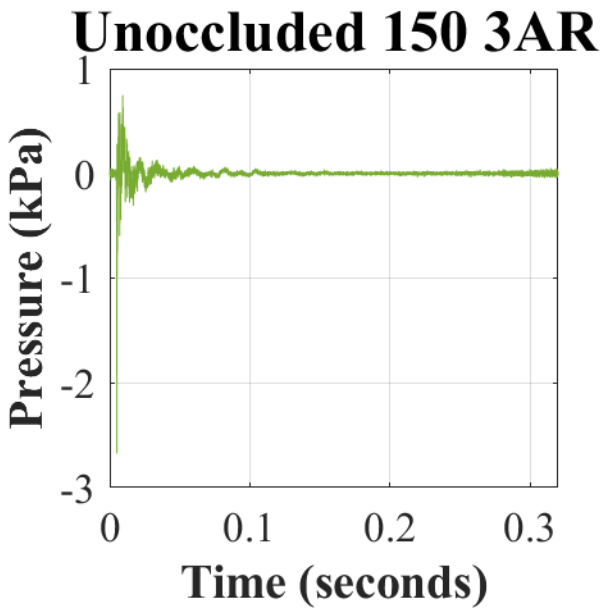

Unoccluded 150 2AL
Pressure (kPa)
1
0
-1
-2
-3
0
0.1
0.2
0.3
Time (seconds)

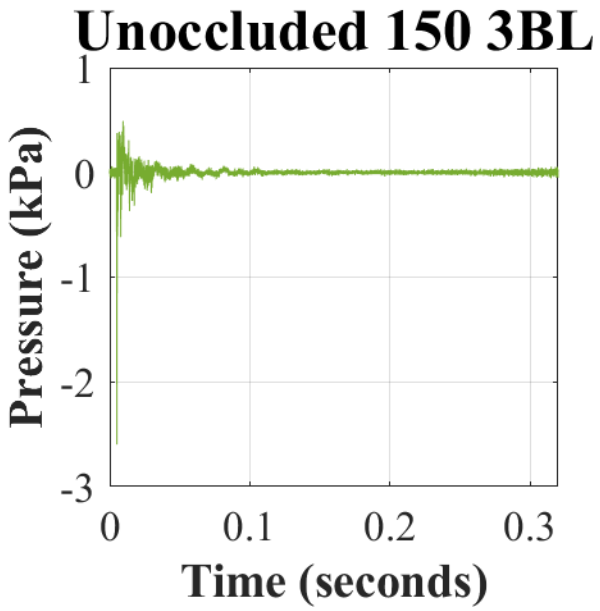

Unoccluded 150 2AR
Pressure (kPa)
1
0
-1
-2
-3
0
0.1
0.2
0.3
Time (seconds)

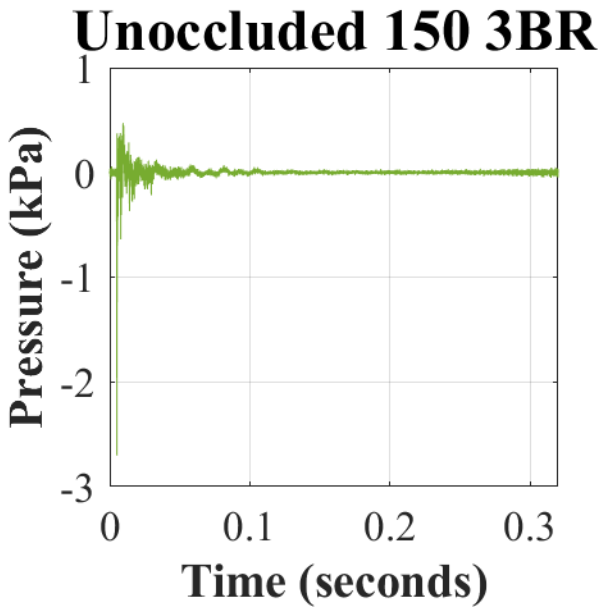

Unoccluded 150 2BL
Pressure (kPa)
1
0
-1
-2
-3
0
0.1
0.2
0.3
Time (seconds)

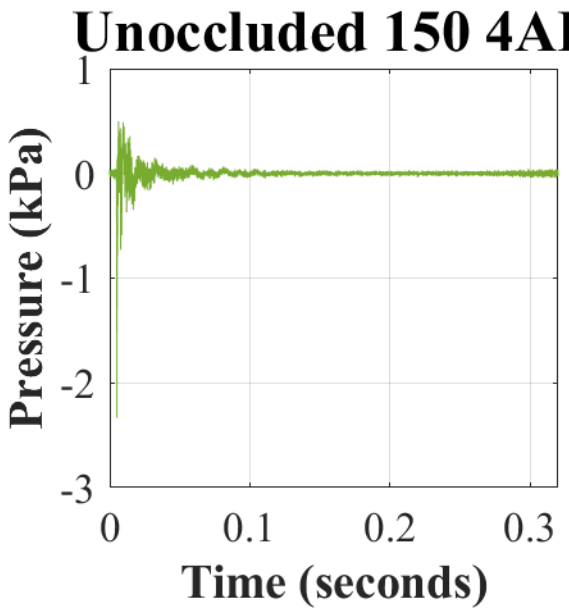

Unoccluded 150 2BR
Pressure (kPa)
1
0
-1
-2
-3
0
0.1
0.2
0.3
Time (seconds)

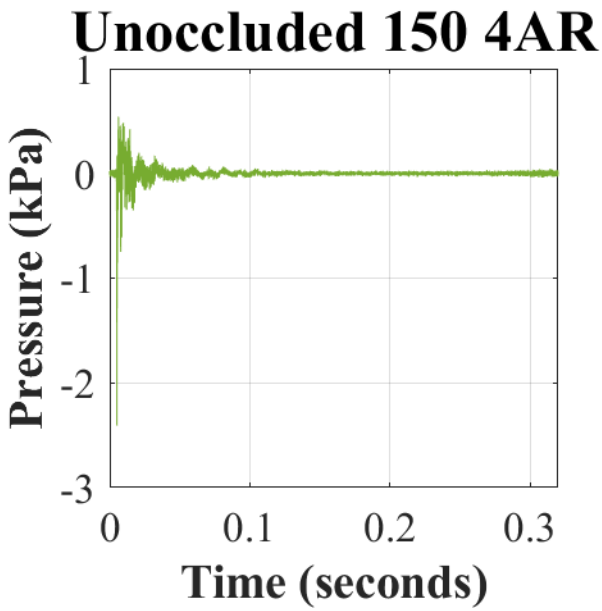

Unoccluded 150 3AL
Pressure (kPa)
1
0
-1
-2
-3
0
0.1
0.2
0.3
Time (seconds)

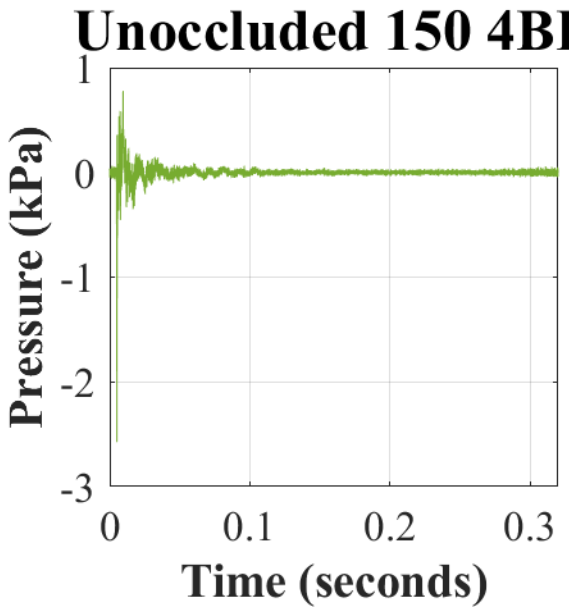

Unoccluded 150 3AR
Pressure (kPa)
1
0
-1
-2
-3
0
0.1
0.2
0.3
Time (seconds)

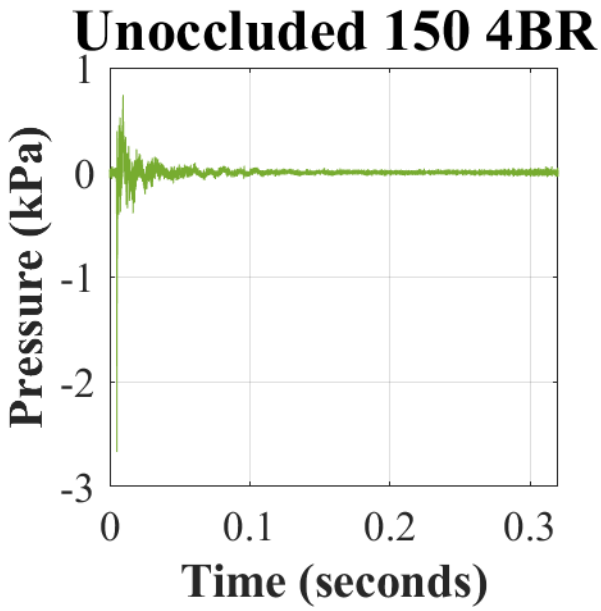

Unoccluded 150 3BL
Pressure (kPa)
1
0
-1
-2
-3
0
0.1
0.2
0.3
Time (seconds)

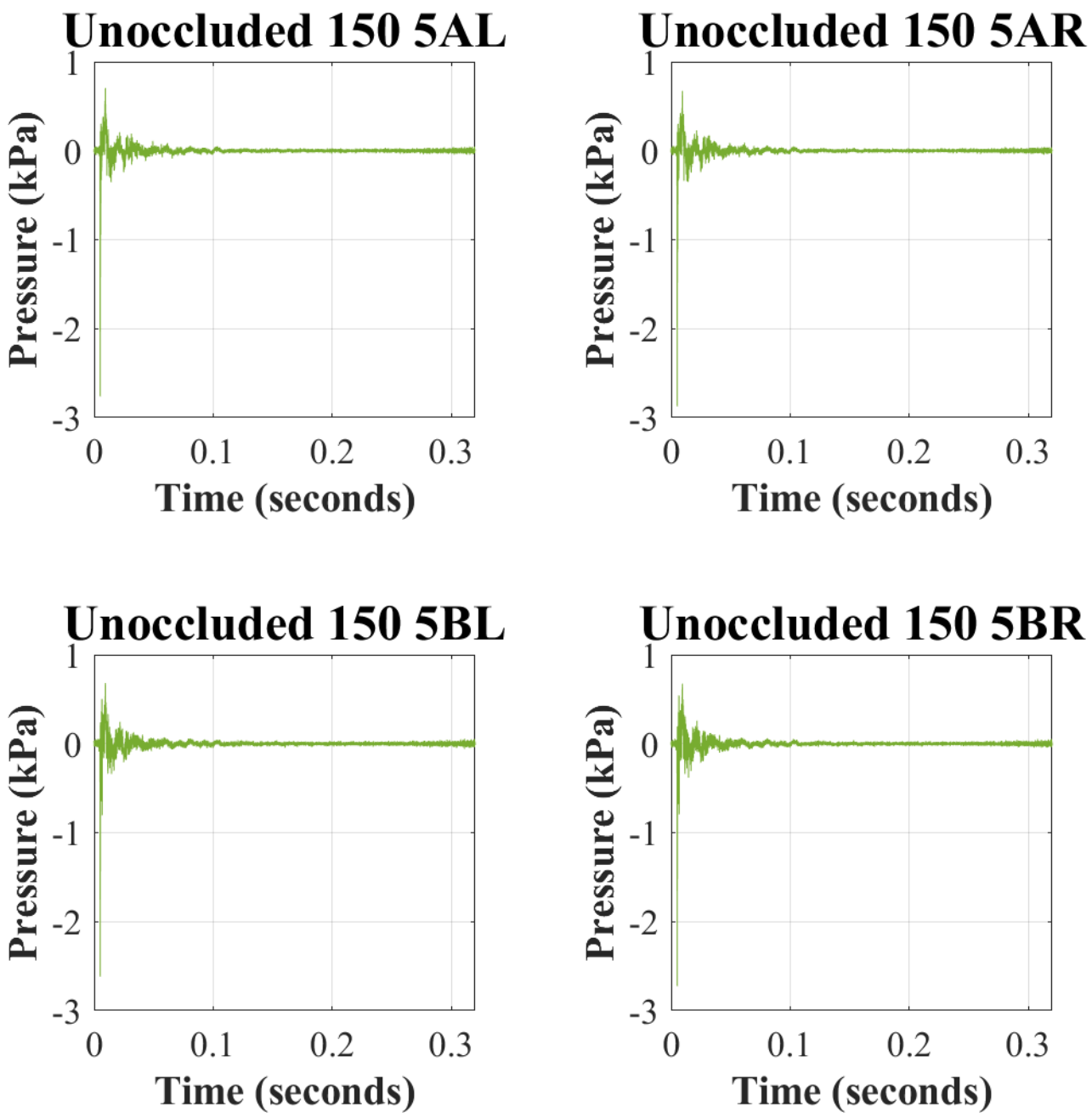

Unoccluded 150 3BR
Pressure (kPa)
1
0
-1
-2
-3
0
0.1
0.2
0.3
Time (seconds)


Unoccluded 150 4AL
Pressure (kPa)
1
0
-1
-2
-3
0
0.1
0.2
0.3
Time (seconds)


Unoccluded 150 4AR
Pressure (kPa)
1
0
-1
-2
-3
0
0.1
0.2
0.3
Time (seconds)

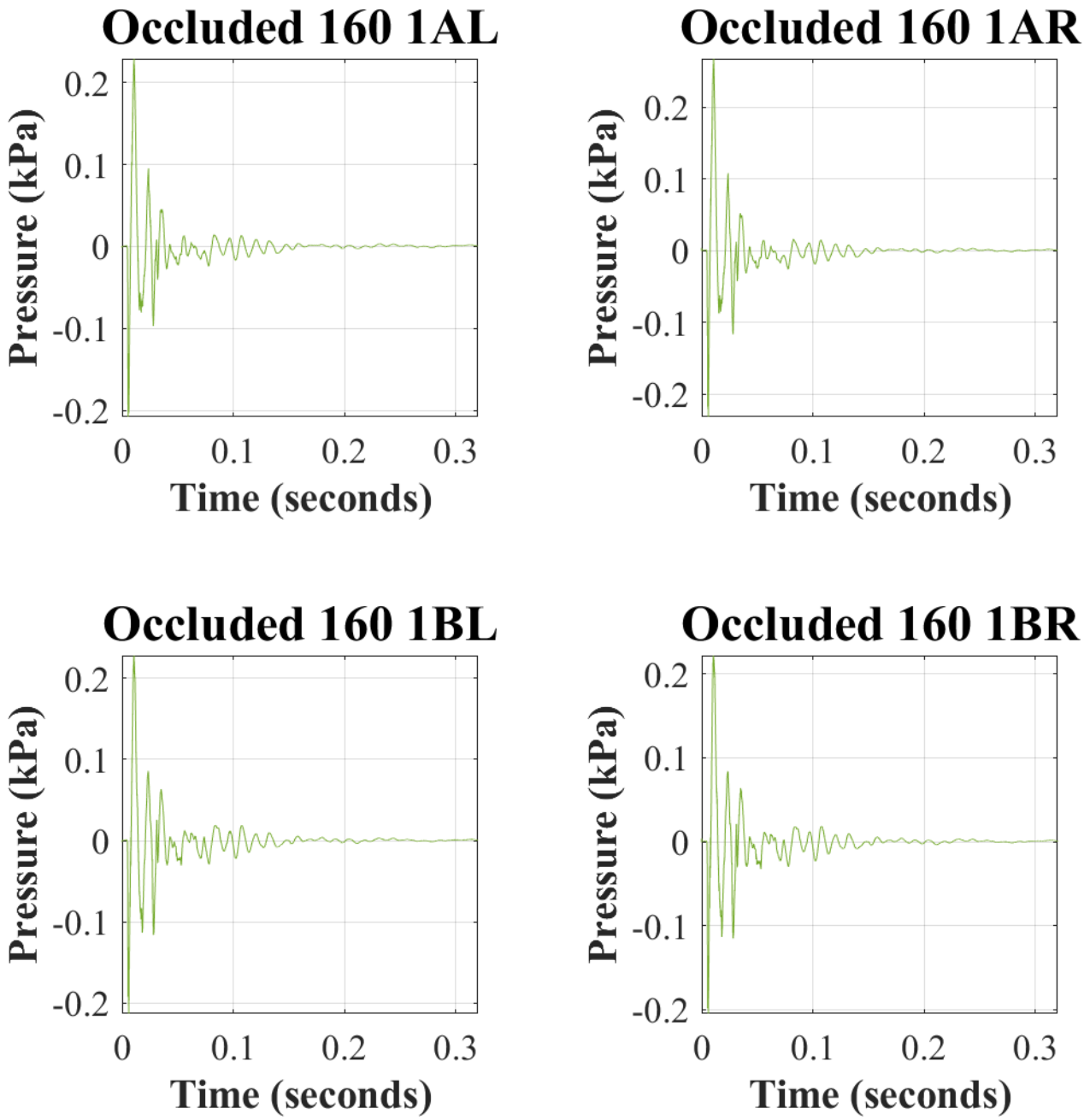

Unoccluded 150 4BL
Pressure (kPa)
1
0
-1
-2
-3
0
0.1
0.2
0.3
Time (seconds)

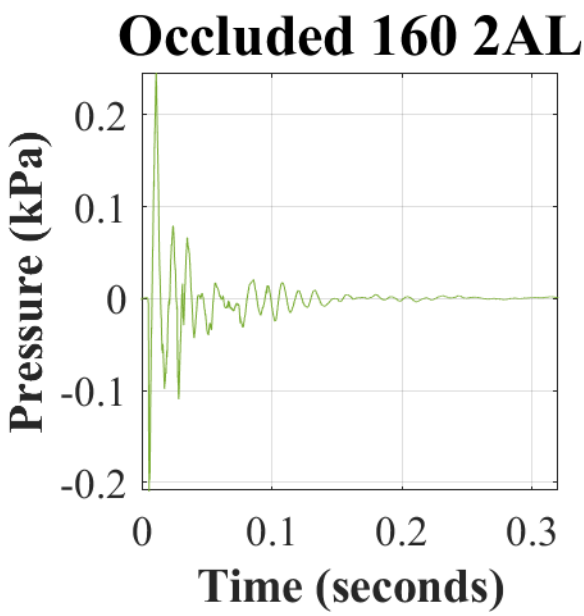

Unoccluded 150 4BR
Pressure (kPa)
1
0
-1
-2
-3
0
0.1
0.2
0.3
Time (seconds)

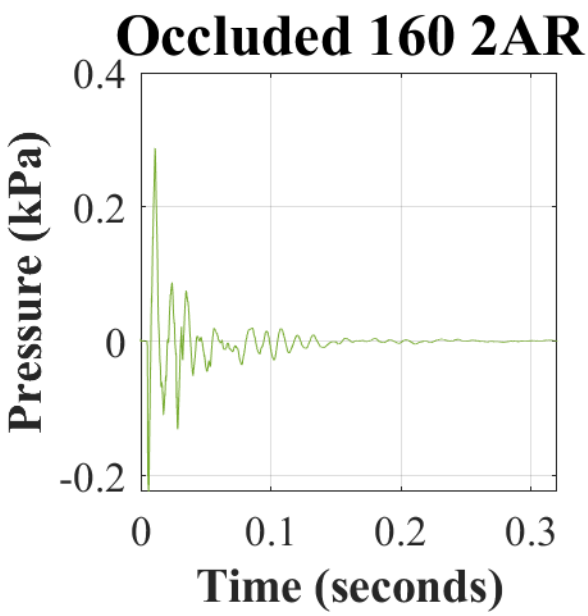


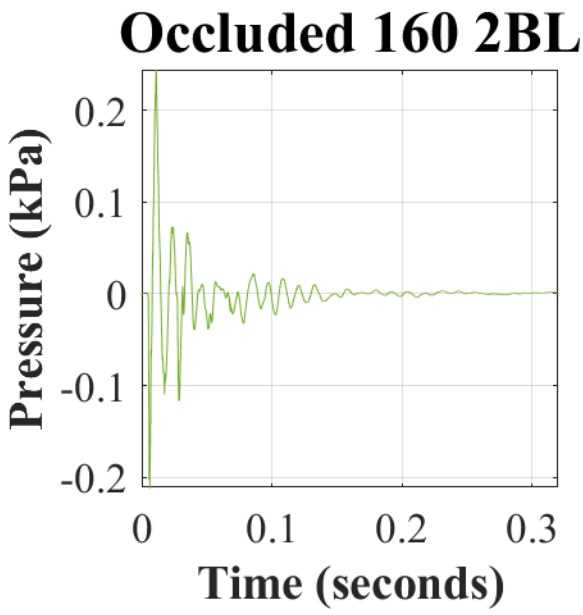
Note. The naming convention for all unoccluded waveforms is "Unoccluded LvL NnX", where 'Unoccluded' is the test condition (i.e., ATF has the HPD doffed), 'LvL' is the nominal test level (i.e., 150, 160 or 170 dBP), 'N' is the sample number (i.e., 1 to 5) of the device tested, 'n' is the trial (i.e., A or B) indicating HPD fit (i.e., first or second, respectively), and 'X' indicates from what ATF microphone the recording is from (i.e., right [R] or left [L] pinnae).

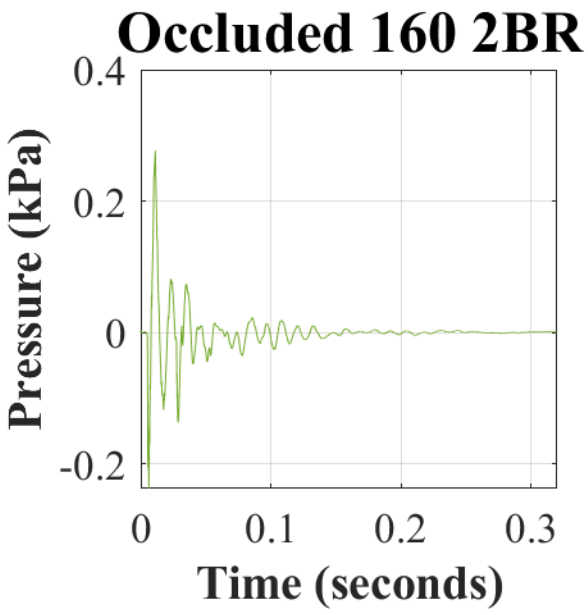
Appendix C. Recorded occluded (closed-ear) waveforms (in kilopascals [kPa]) over time (in seconds [s]) in response to 160 dBP with the EP7 in the cap open mode.

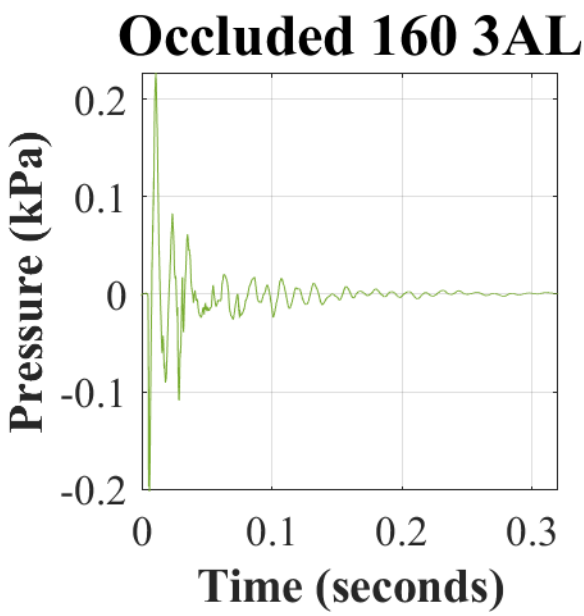


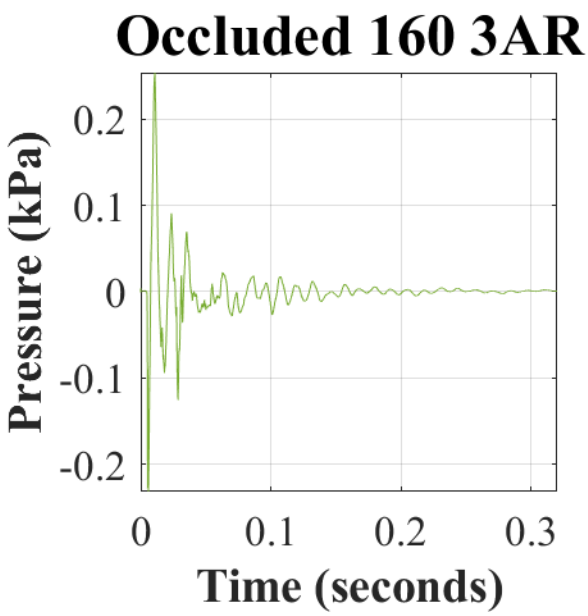

Occluded 160 2AL
Pressure (kPa)
0.2
0.1
0
-0.1
-0.2
0
0.1
0.2
0.3
Time (seconds)

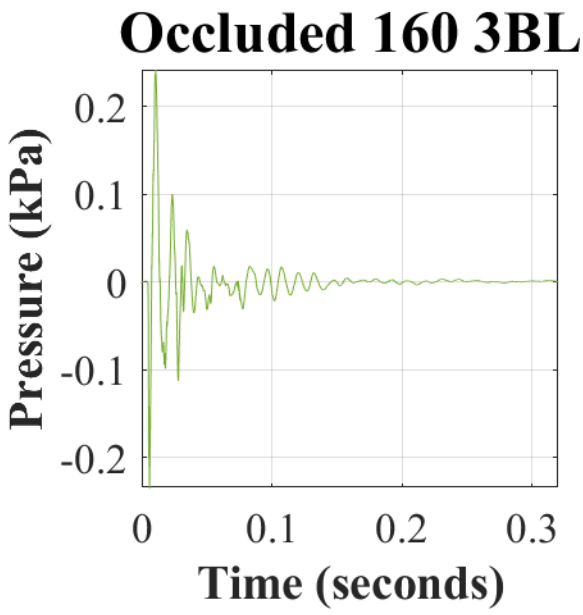

Occluded 160 2AR
Pressure (kPa)
0.4
0.2
0
-0.2
0
0.1
0.2
0.3
Time (seconds)

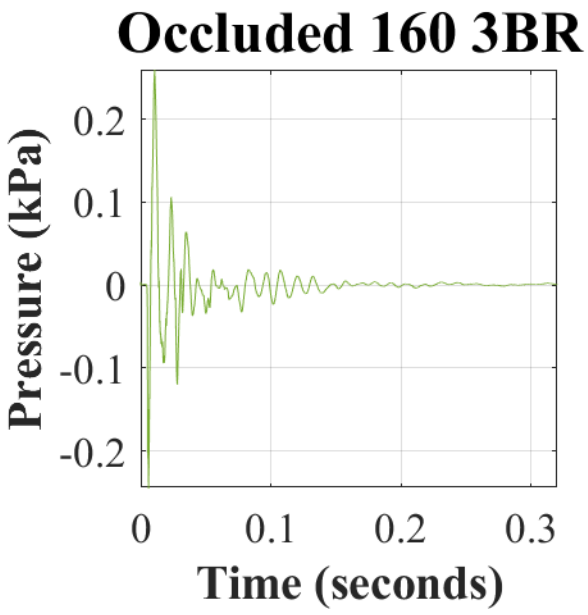

Occluded 160 2BL
Pressure (kPa)
0.2
0.1
0
-0.1
-0.2
0
0.1
0.2
0.3
Time (seconds)

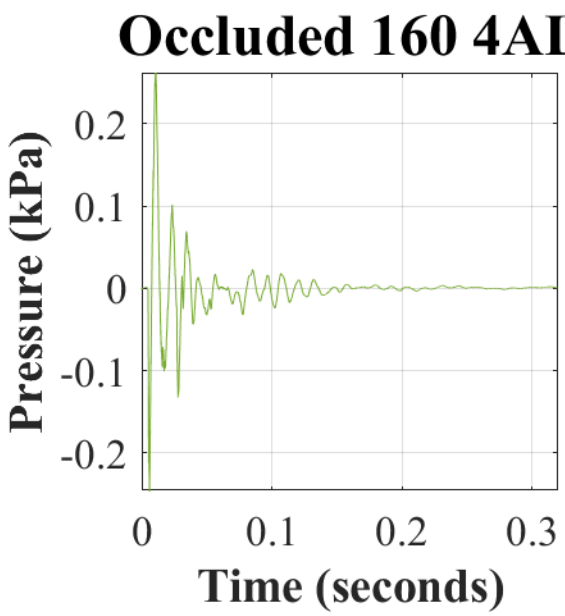

Occluded 160 2BR
Pressure (kPa)
0.4
0.2
0
-0.2
0
0.1
0.2
0.3
Time (seconds)

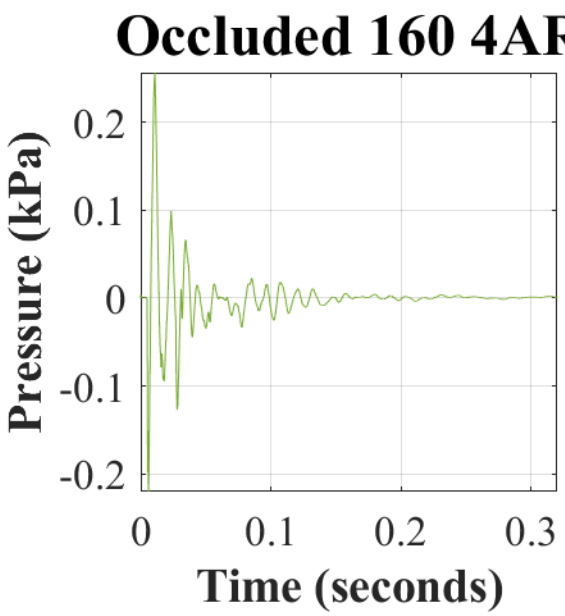

Occluded 160 3AL
Pressure (kPa)
0.2
0.1
0
-0.1
-0.2
0
0.1
0.2
0.3
Time (seconds)

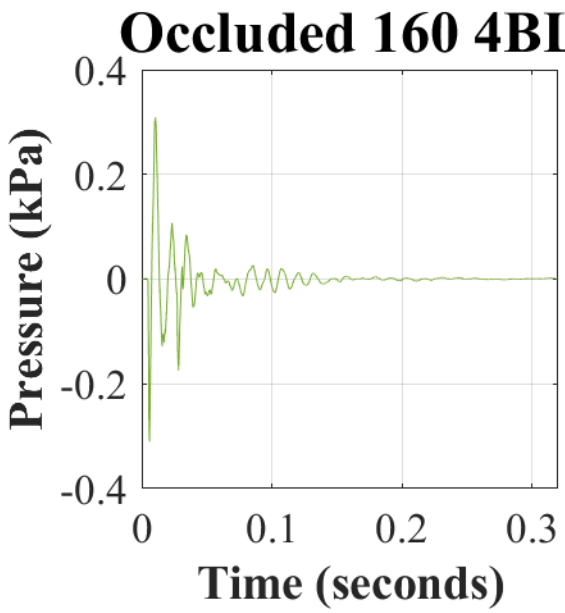

Occluded 160 3AR
Pressure (kPa)
0.2
0.1
0
-0.1
-0.2
0
0.1
0.2
0.3
Time (seconds)

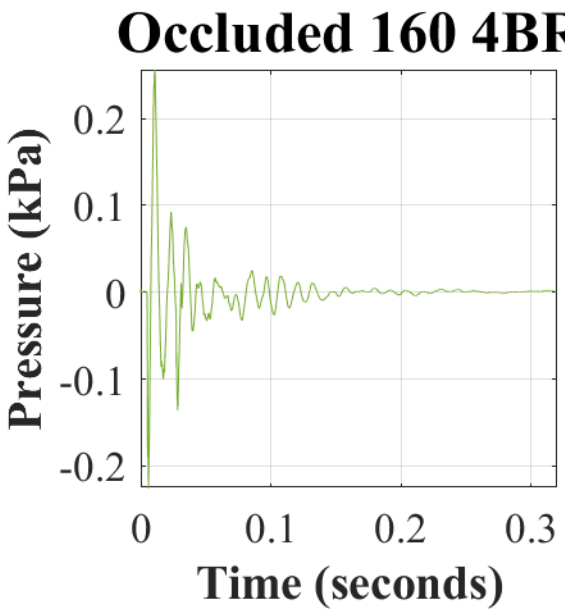

Occluded 160 3BL
Pressure (kPa)
0.2
0.1
0
-0.1
-0.2
0
0.1
0.2
0.3
Time (seconds)

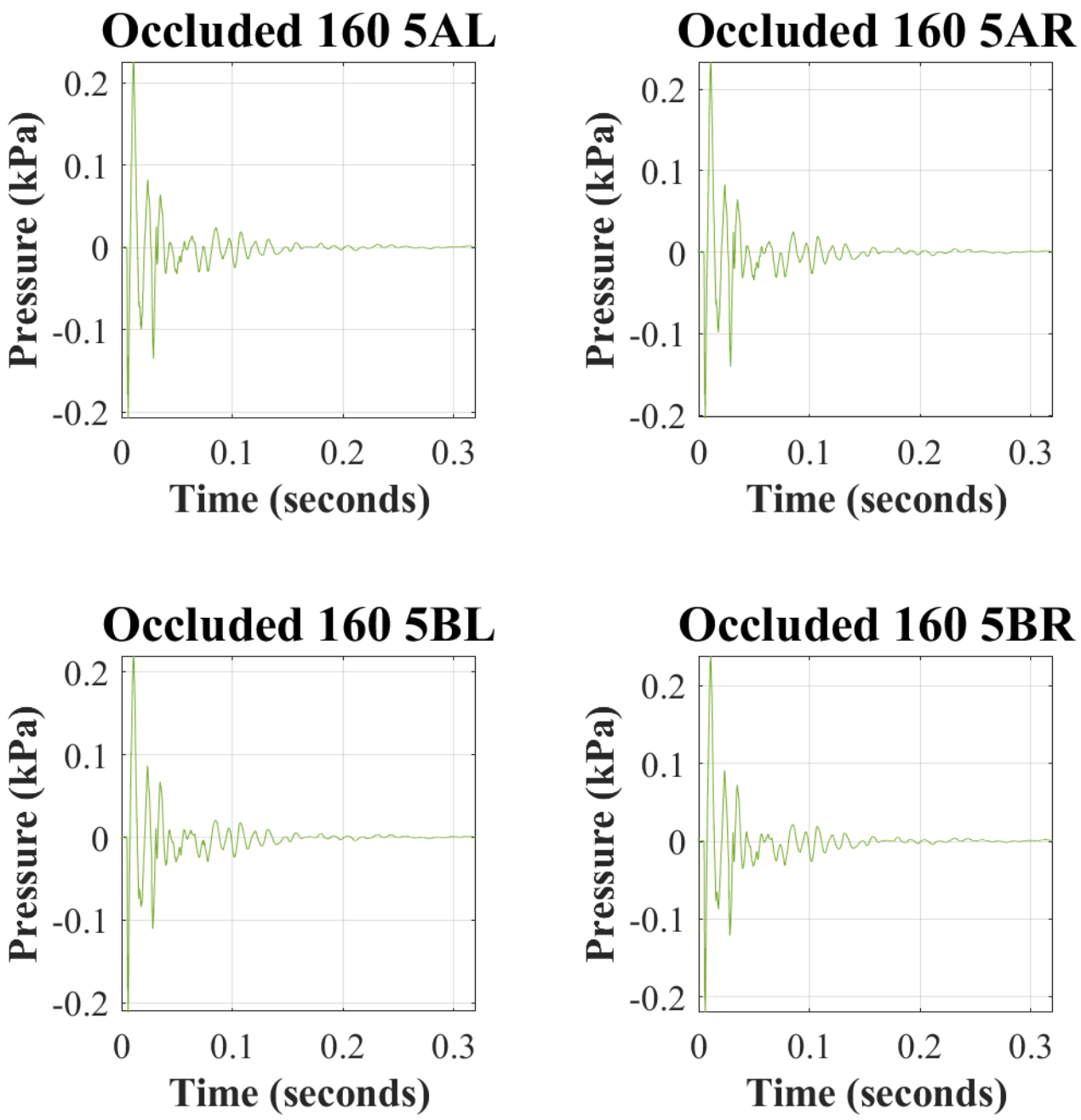

Occluded 160 3BR
Pressure (kPa)
0.2
0.1
0
-0.1
-0.2
0
0.1
0.2
0.3
Time (seconds)


Occluded 160 4AL
Pressure (kPa)
0.2
0.1
0
-0.1
-0.2
0
0.1
0.2
0.3
Time (seconds)


Occluded 160 4AR
Pressure (kPa)
0.2
0.1
0
-0.1
-0.2
0
0.1
0.2
0.3
Time (seconds)

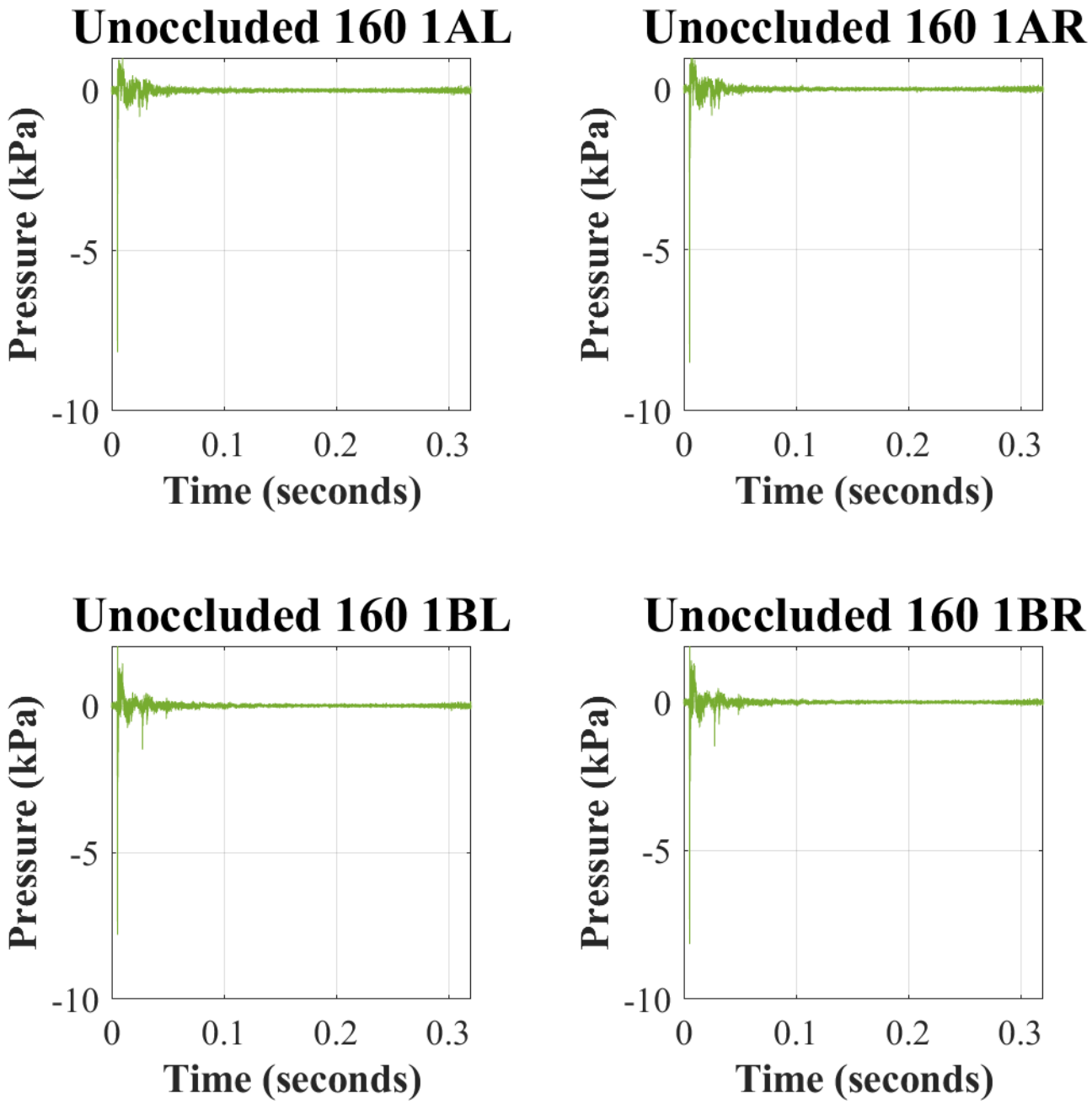

Occluded 160 4BL
Pressure (kPa)
0.4
0.2
0
-0.2
-0.4
0
0.1
0.2
0.3
Time (seconds)

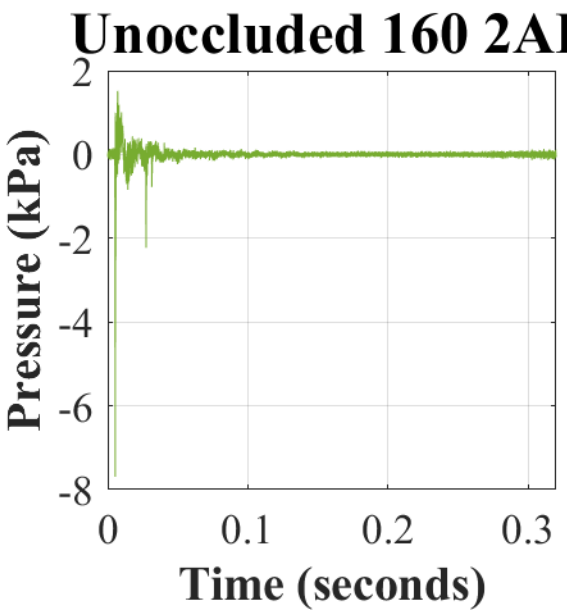

Occluded 160 4BR
Pressure (kPa)
0.2
0.1
0
-0.1
-0.2
0
0.1
0.2
0.3
Time (seconds)

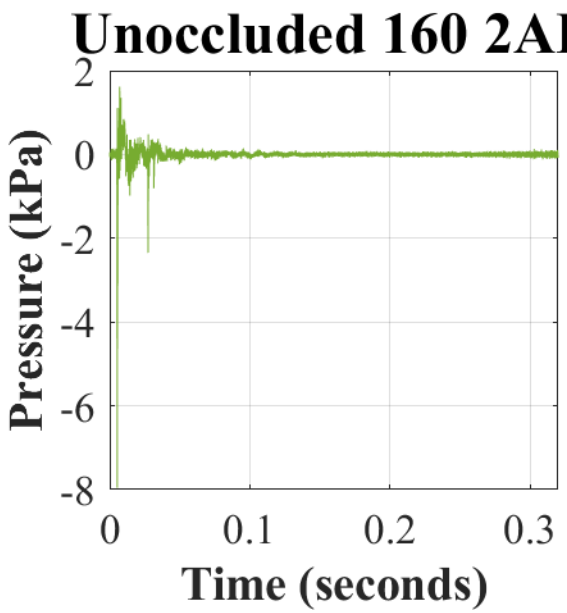


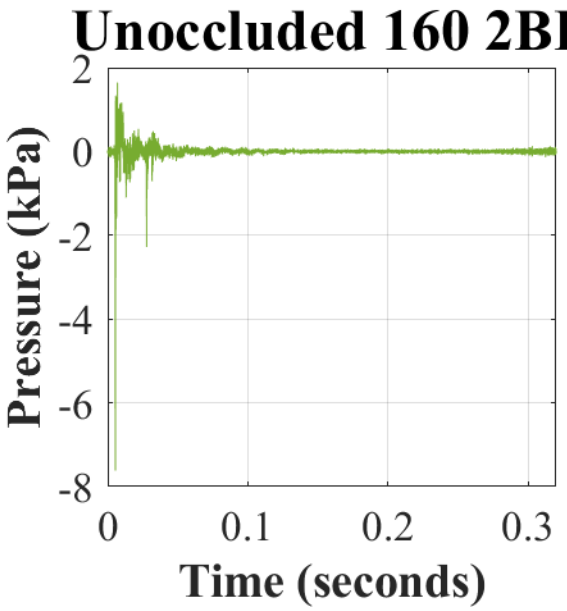
Note. The naming convention for all occluded waveforms is “Occluded LvL NnX”, where ‘Occluded’ is the test condition (i.e., ATF has the HPD donned), ‘LvL’ is the nominal test level (i.e., 150, 160 or 170 dBP), ‘N’ is the sample number (i.e., 1 to 5) of the device tested, ‘n’ is the trial (i.e., A or B) indicating HPD fit (i.e., first or second, respectively), and ‘X’ indicates from what ATF microphone the recording is from (i.e., right [R] or left [L] pinnae).

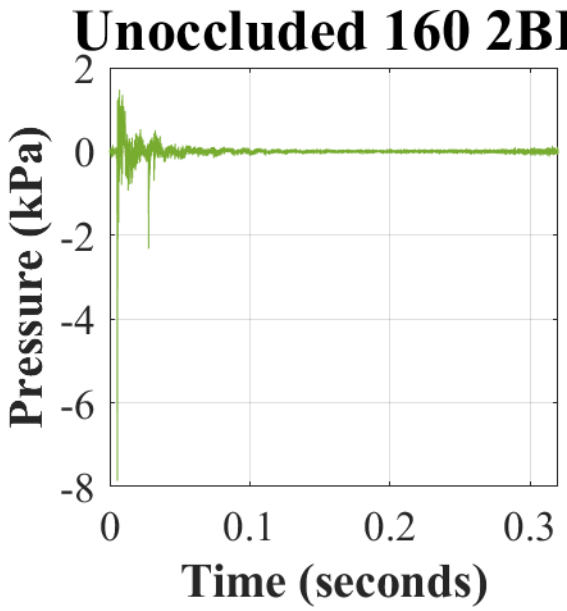
Appendix D. Estimated unoccluded (open-ear) waveforms (in kilopascals [kPa]) over time (in seconds [s]) in response to 160 dBP with the EP7 in the cap open mode.

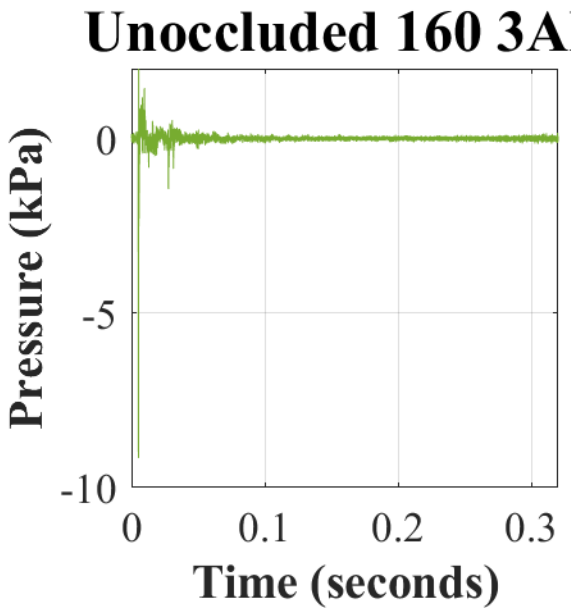


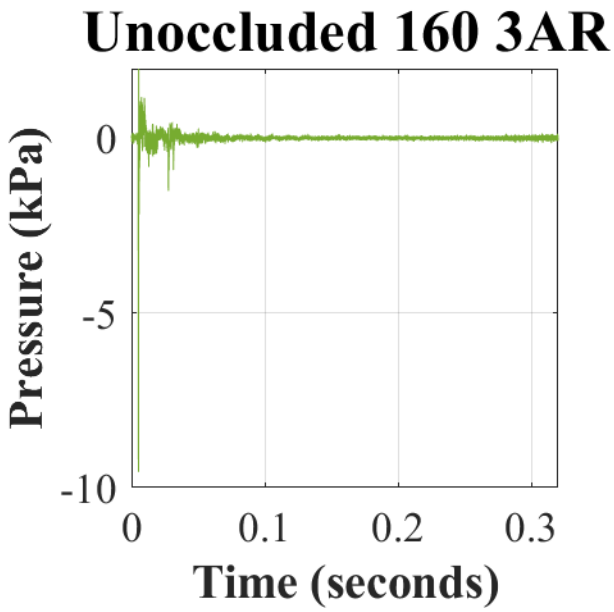

Unoccluded 160 2AL
Pressure (kPa)
2
0
-2
-4
-6
-8
0
0.1
0.2
0.3
Time (seconds)

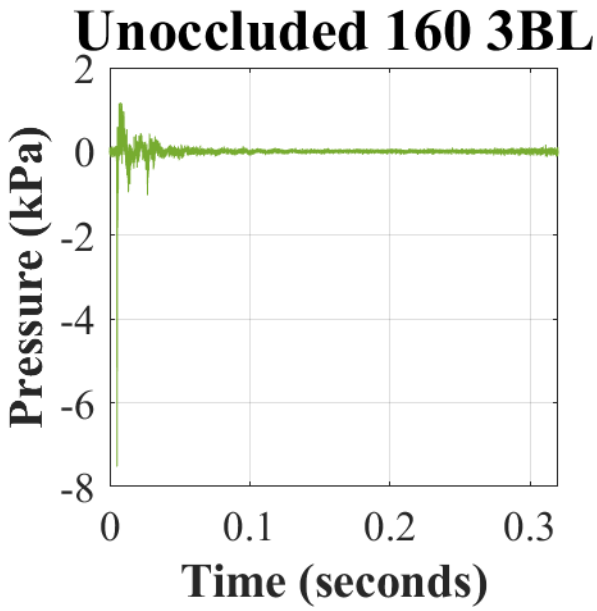

Unoccluded 160 2AR
Pressure (kPa)
2
0
-2
-4
-6
-8
0
0.1
0.2
0.3
Time (seconds)

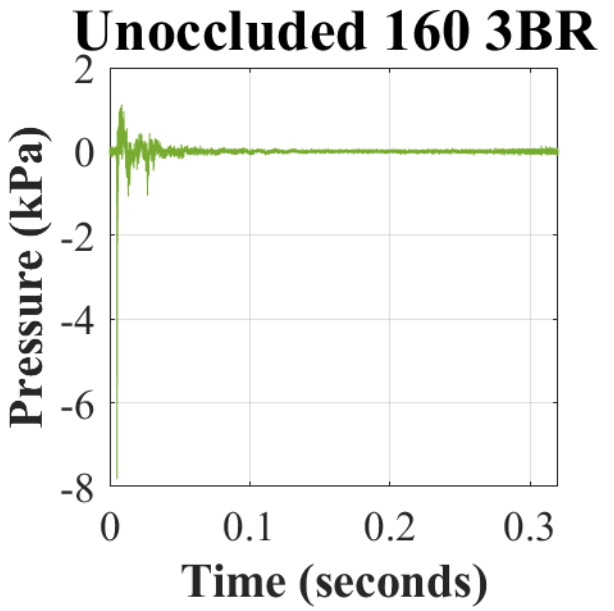

Unoccluded 160 2BL
Pressure (kPa)
2
0
-2
-4
-6
-8
0
0.1
0.2
0.3
Time (seconds)

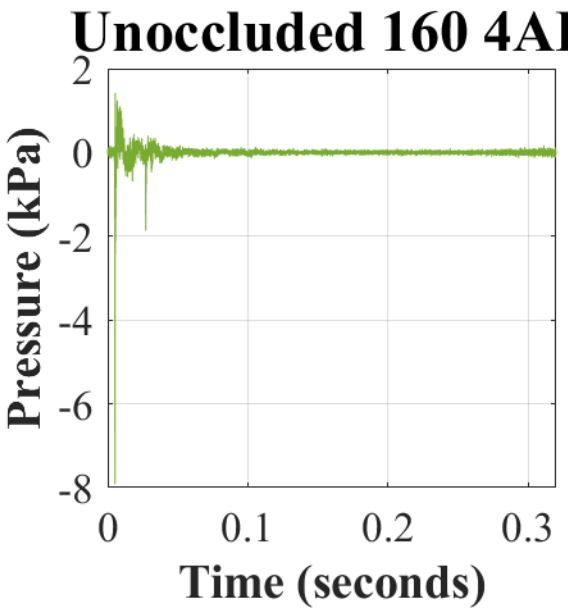

Unoccluded 160 2BR
Pressure (kPa)
2
0
-2
-4
-6
-8
0
0.1
0.2
0.3
Time (seconds)

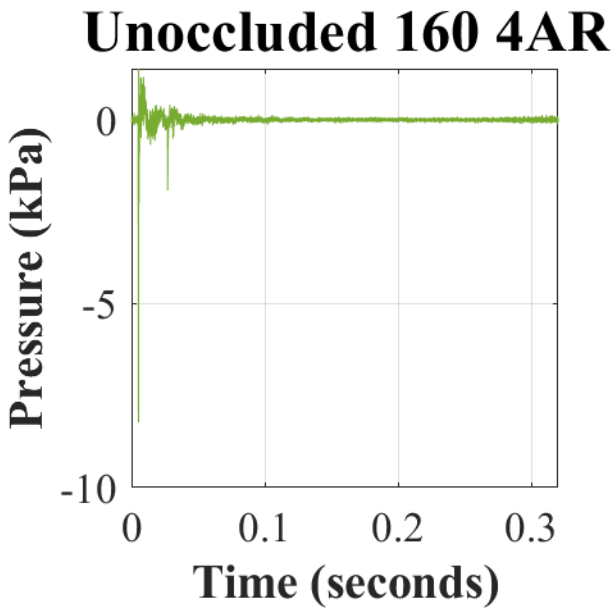

Unoccluded 160 3AL
Pressure (kPa)
0
-5
-10
0
0.1
0.2
0.3
Time (seconds)

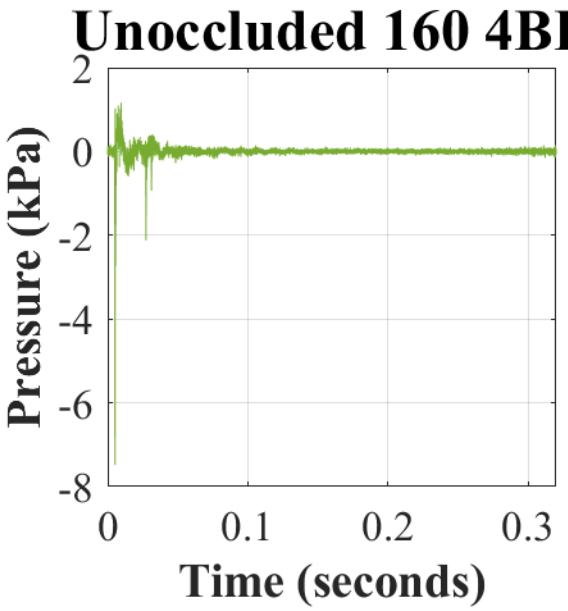

Unoccluded 160 3AR
Pressure (kPa)
0
-5
-10
0
0.1
0.2
0.3
Time (seconds)

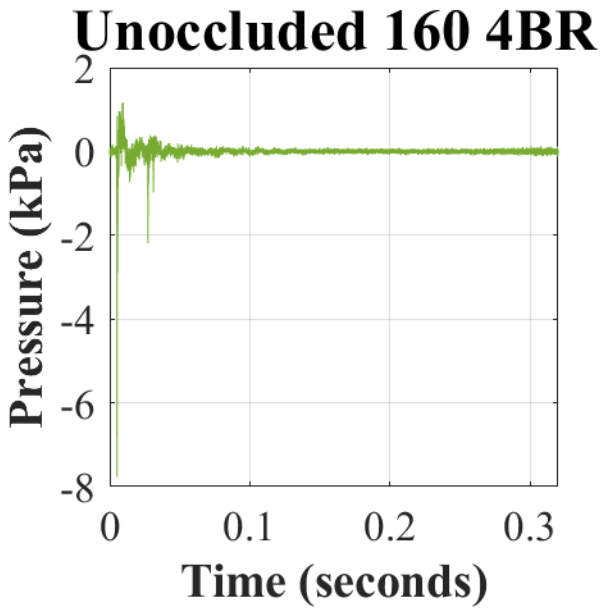

Unoccluded 160 3BL
Pressure (kPa)
2
0
-2
-4
-6
-8
0
0.1
0.2
0.3
Time (seconds)

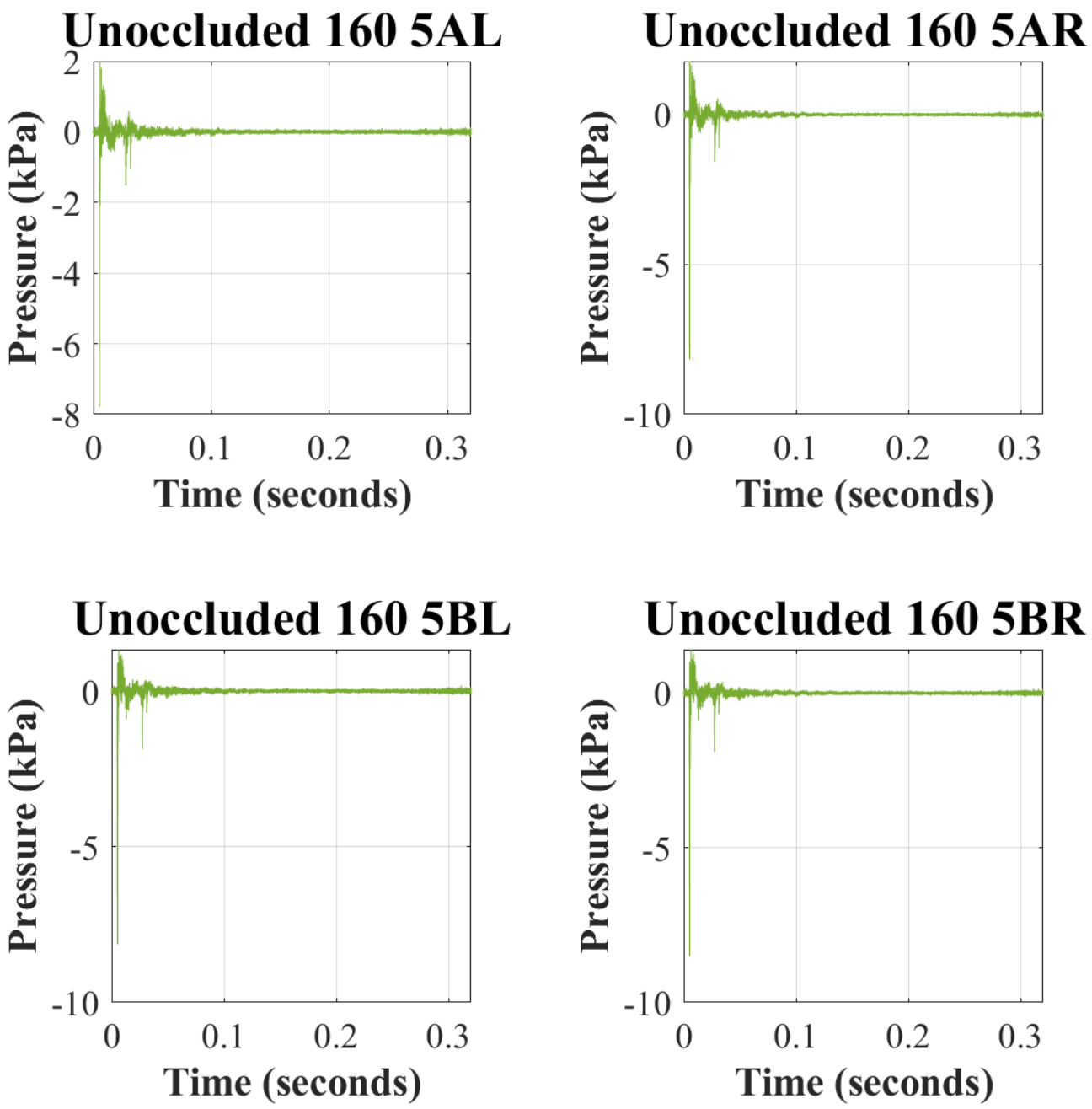

Unoccluded 160 3BR
Pressure (kPa)
2
0
-2
-4
-6
-8
0
0.1
0.2
0.3
Time (seconds)


Unoccluded 160 4AL
Pressure (kPa)
2
0
-2
-4
-6
-8
0
0.1
0.2
0.3
Time (seconds)


Unoccluded 160 4AR
Pressure (kPa)
0
-5
-10
0
0.1
0.2
0.3
Time (seconds)

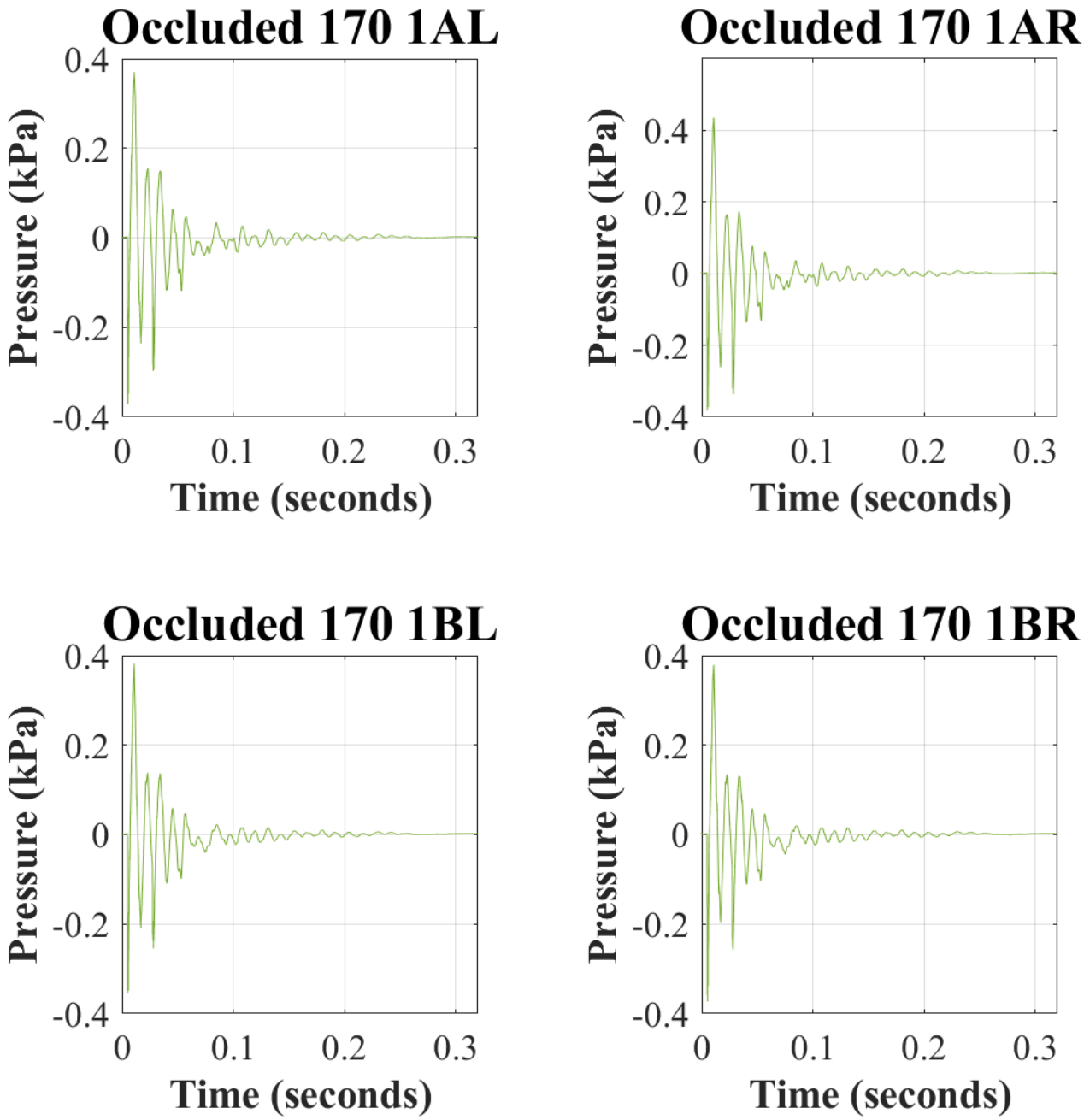

Unoccluded 160 4BL
Pressure (kPa)
2
0
-2
-4
-6
-8
0
0.1
0.2
0.3
Time (seconds)

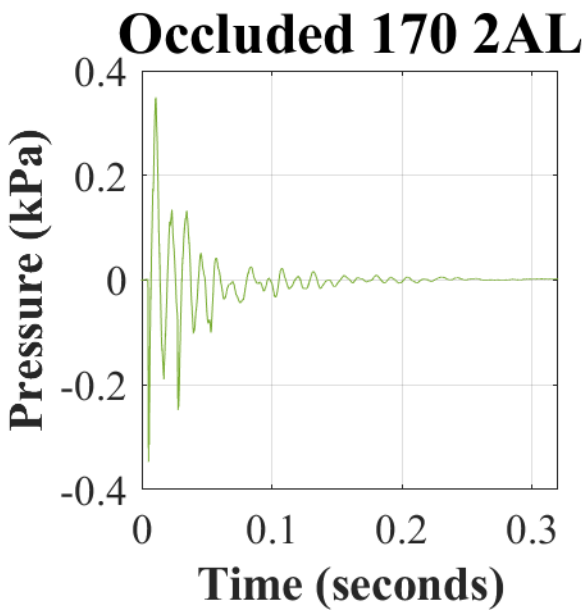

Unoccluded 160 4BR
Pressure (kPa)
2
0
-2
-4
-6
-8
0
0.1
0.2
0.3
Time (seconds)

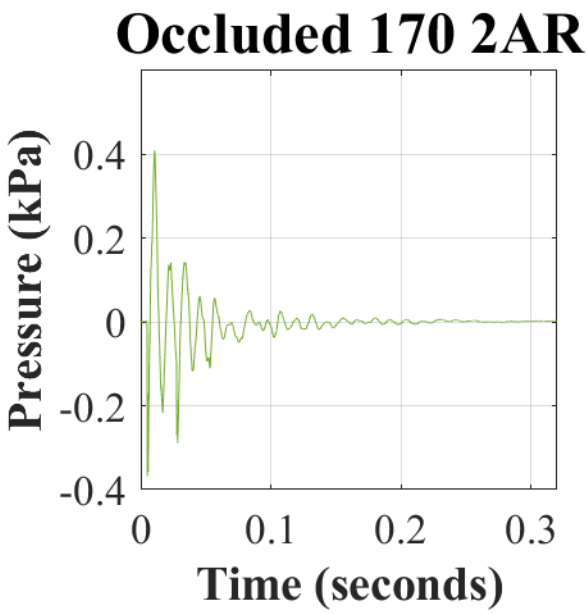


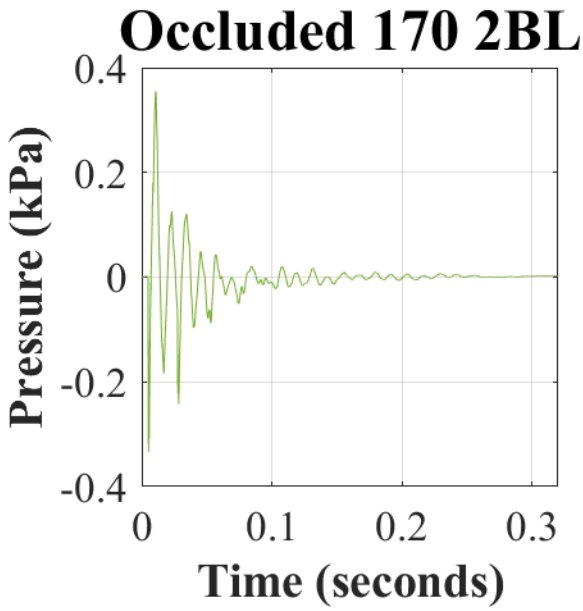
Note. The naming convention for all unoccluded waveforms is "Unoccluded LvL NnX", where 'Unoccluded' is the test condition (i.e., ATF has the HPD doffed), 'LvL' is the nominal test level (i.e., 150, 160 or 170 dBP), 'N' is the sample number (i.e., 1 to 5) of the device tested, 'n' is the trial (i.e., A or B) indicating HPD fit (i.e., first or second, respectively), and 'X' indicates from what ATF microphone the recording is from (i.e., right [R] or left [L] pinnae).

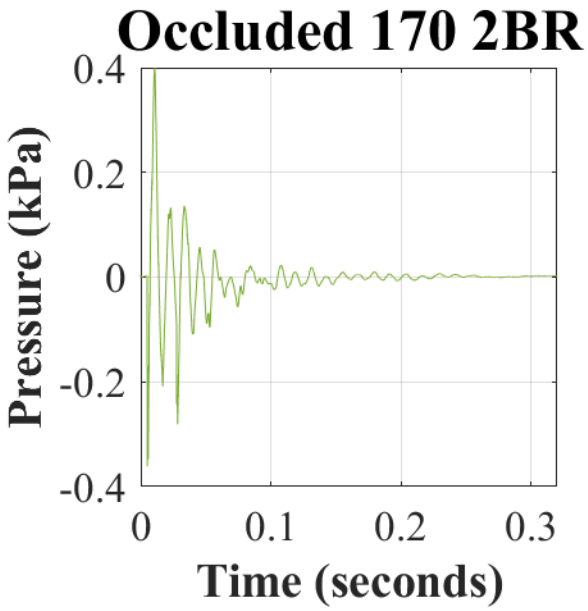
Appendix E. Recorded occluded (closed-ear) waveforms (in kilopascals [kPa]) over time (in seconds [s]) in response to 170 dBP with the EP7 in the cap open mode.

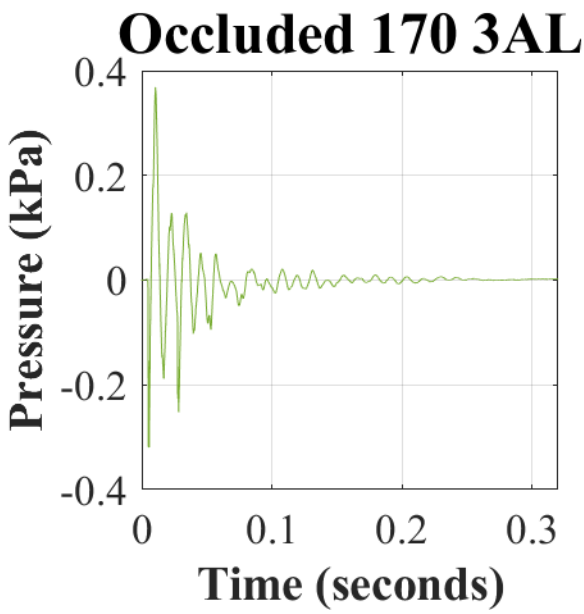


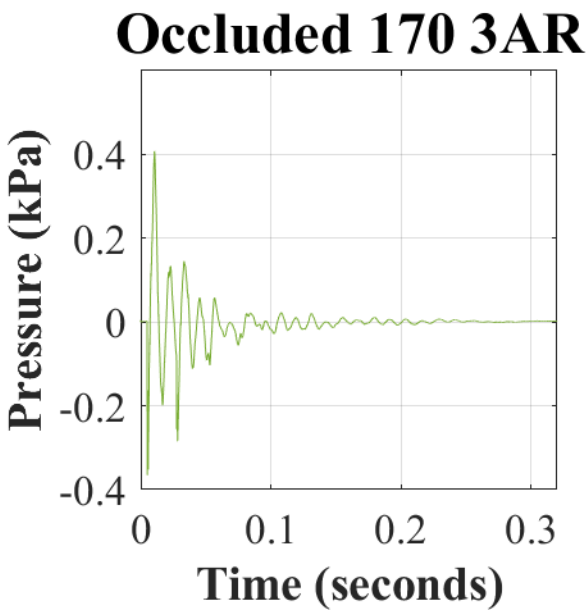

Occluded 170 2AL
Pressure (kPa)
0.4
0.2
0
-0.2
-0.4
0
0.1
0.2
0.3
Time (seconds)

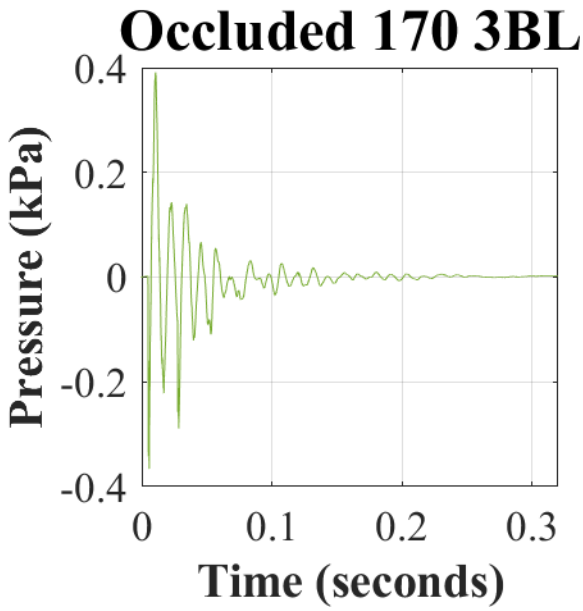

Occluded 170 2AR
Pressure (kPa)
0.4
0.2
0
-0.2
-0.4
0
0.1
0.2
0.3
Time (seconds)

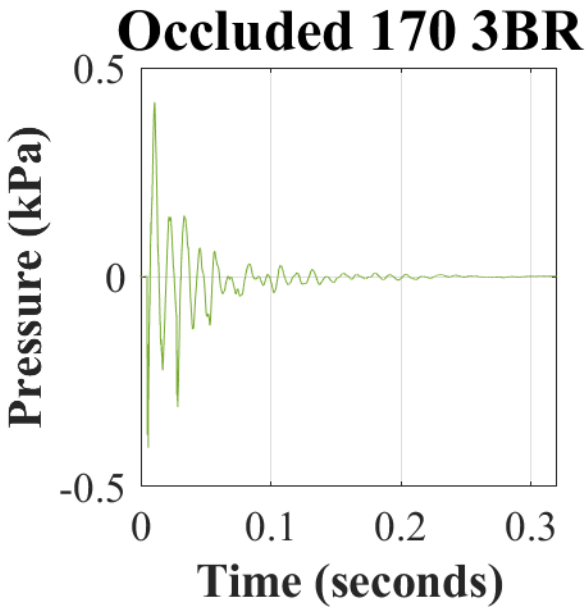

Occluded 170 2BL
Pressure (kPa)
0.4
0.2
0
-0.2
-0.4
0
0.1
0.2
0.3
Time (seconds)

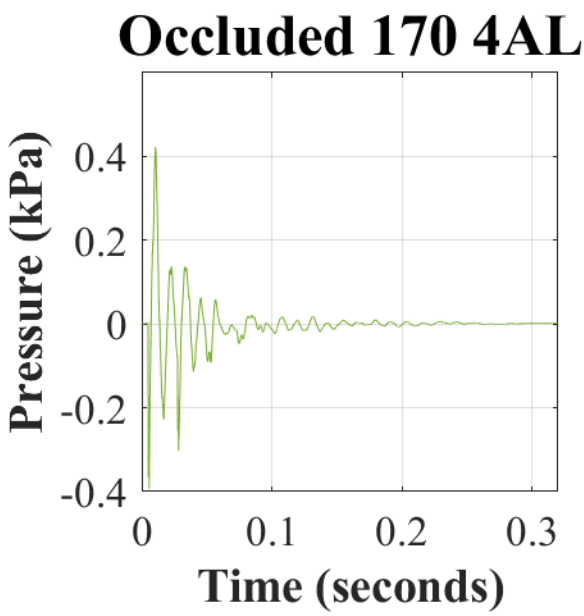

Occluded 170 2BR
Pressure (kPa)
0.4
0.2
0
-0.2
-0.4
0
0.1
0.2
0.3
Time (seconds)

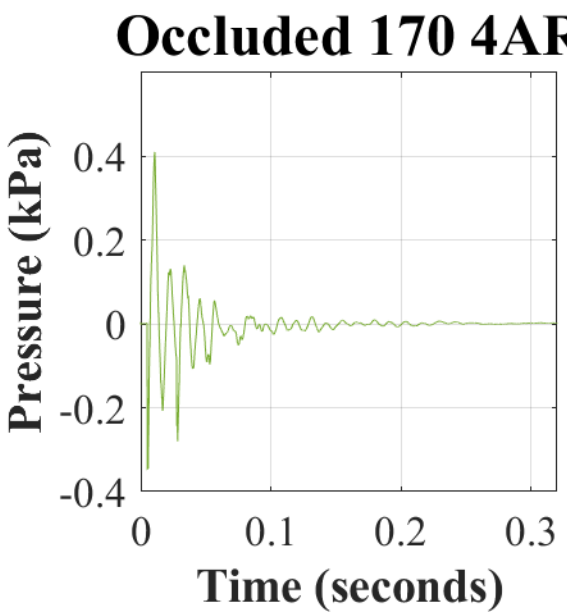

Occluded 170 3AL
Pressure (kPa)
0.4
0.2
0
-0.2
-0.4
0
0.1
0.2
0.3
Time (seconds)

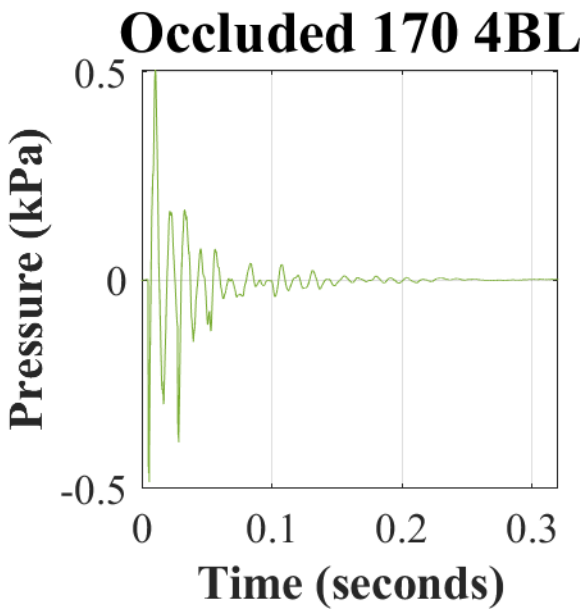

Occluded 170 3AR
Pressure (kPa)
0.4
0.2
0
-0.2
-0.4
0
0.1
0.2
0.3
Time (seconds)

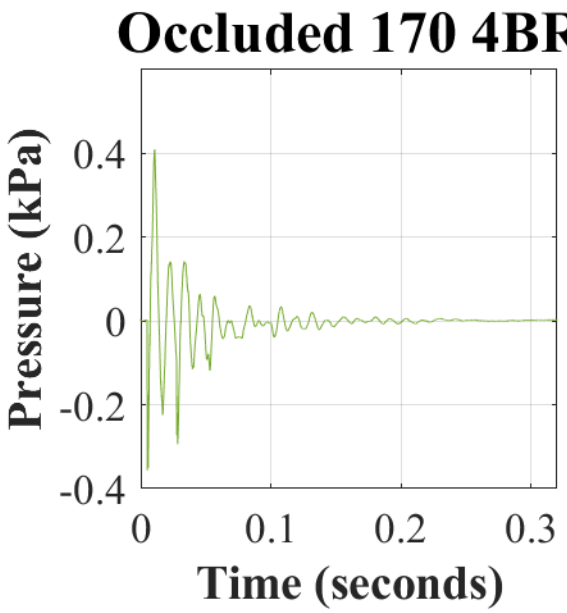

Occluded 170 3BL
Pressure (kPa)
0.4
0.2
0
-0.2
-0.4
0
0.1
0.2
0.3
Time (seconds)

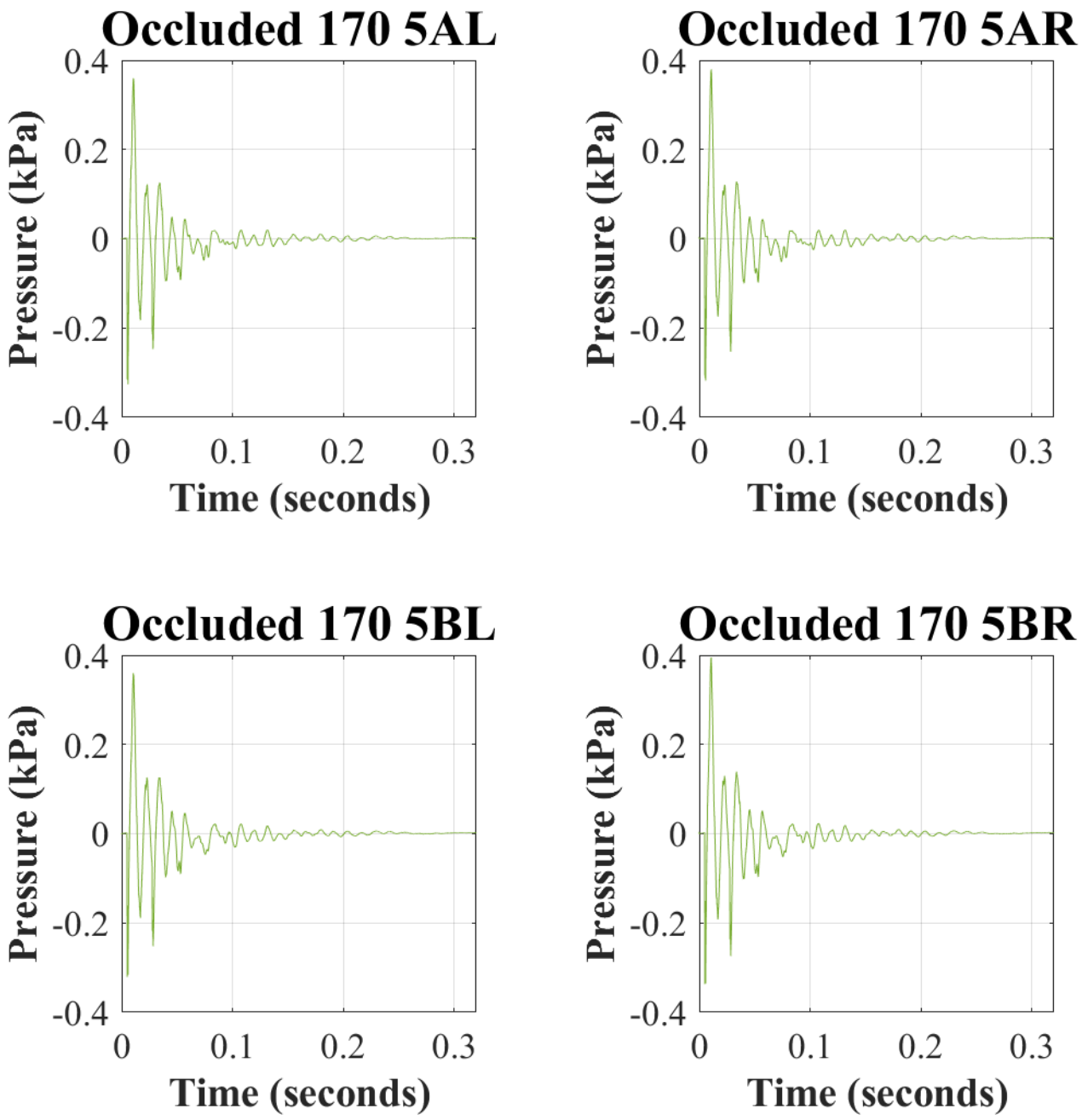

Occluded 170 3BR
Pressure (kPa)
0.5
0
-0.5
0
0.1
0.2
0.3
Time (seconds)


Occluded 170 4AL
Pressure (kPa)
0.4
0.2
0
-0.2
-0.4
0
0.1
0.2
0.3
Time (seconds)


Occluded 170 4AR
Pressure (kPa)
0.4
0.2
0
-0.2
-0.4
0
0.1
0.2
0.3
Time (seconds)

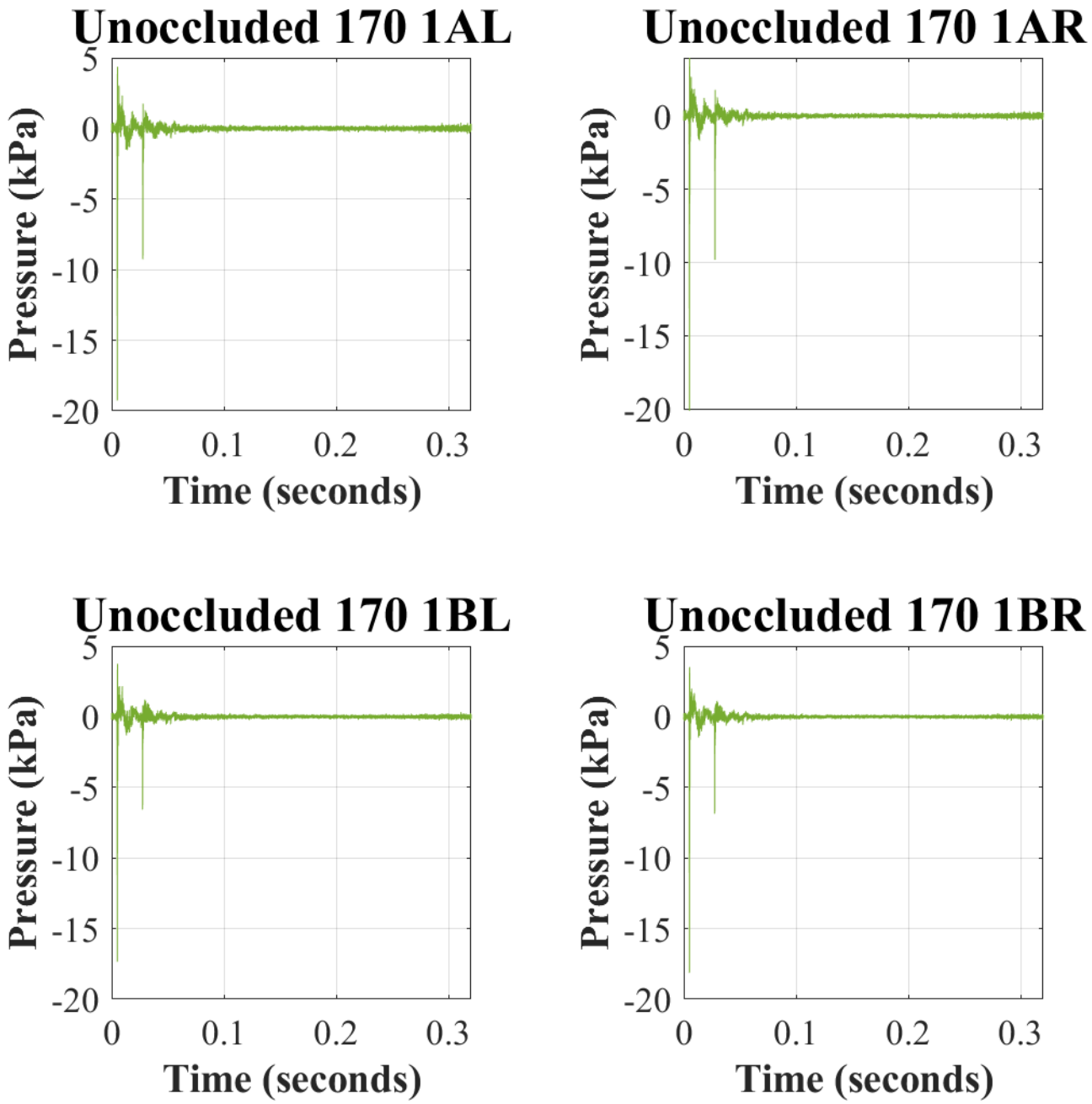

Occluded 170 4BL
Pressure (kPa)
0.5
0
-0.5
0
0.1
0.2
0.3
Time (seconds)

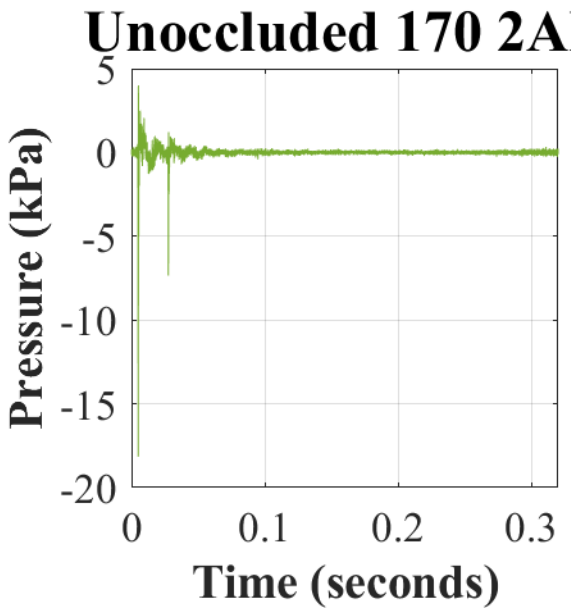

Occluded 170 4BR
Pressure (kPa)
0.4
0.2
0
-0.2
-0.4
0
0.1
0.2
0.3
Time (seconds)

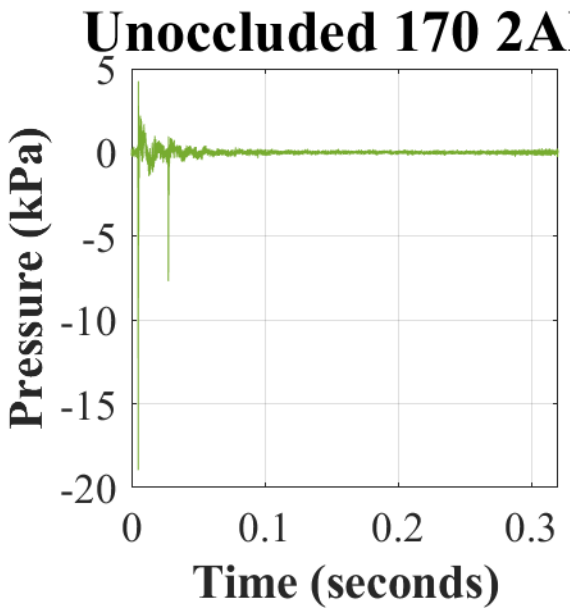


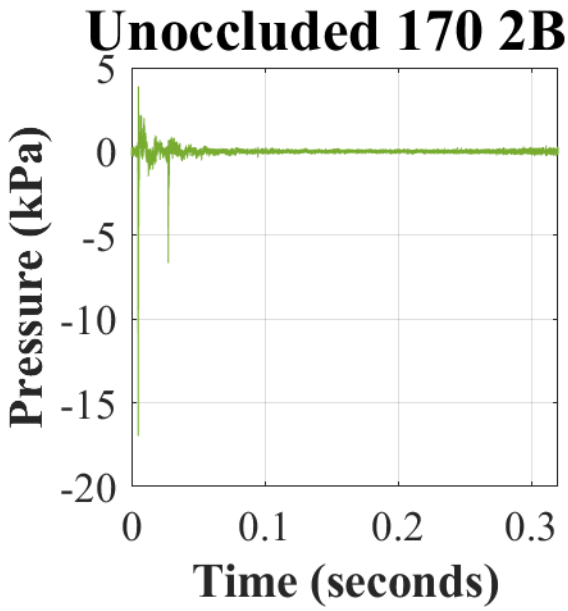
Note. The naming convention for all occluded waveforms is “Occluded LvL NnX”, where ‘Occluded’ is the test condition (i.e., ATF has the HPD donned), ‘LvL’ is the nominal test level (i.e., 150, 160 or 170 dBP), ‘N’ is the sample number (i.e., 1 to 5) of the device tested, ‘n’ is the trial (i.e., A or B) indicating HPD fit (i.e., first or second, respectively), and ‘X’ indicates from what ATF microphone the recording is from (i.e., right [R] or left [L] pinnae).

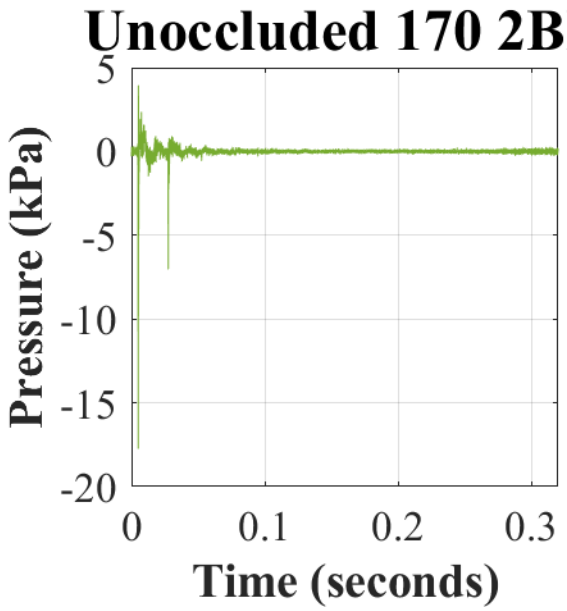
Appendix F. Estimated unoccluded (open-ear) waveforms (in kilopascals [kPa]) over time (in seconds [s]) in response to 170 dBP with the EP7 in the cap open mode.

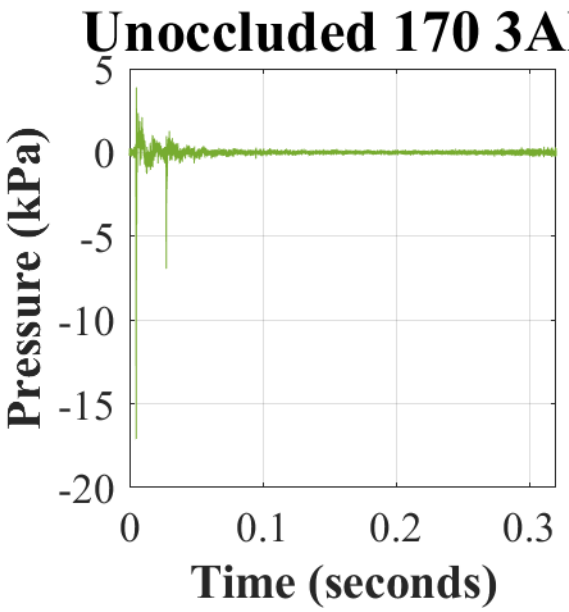


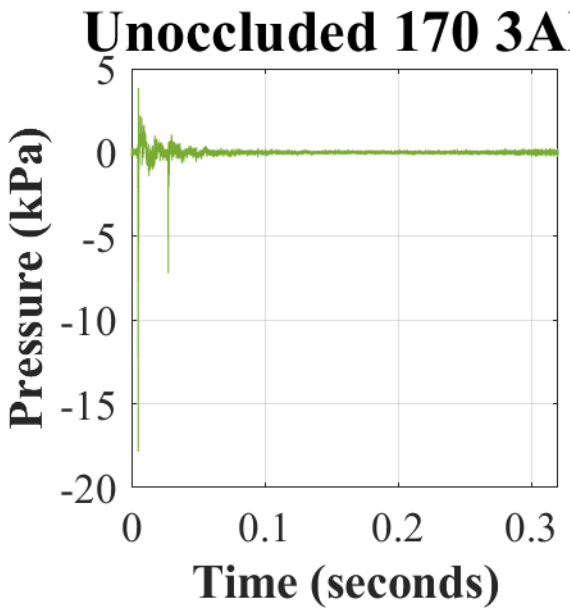

Unoccluded 170 2AL
Pressure (kPa)
5
0
-5
-10
-15
-20
0
0.1
0.2
0.3
Time (seconds)

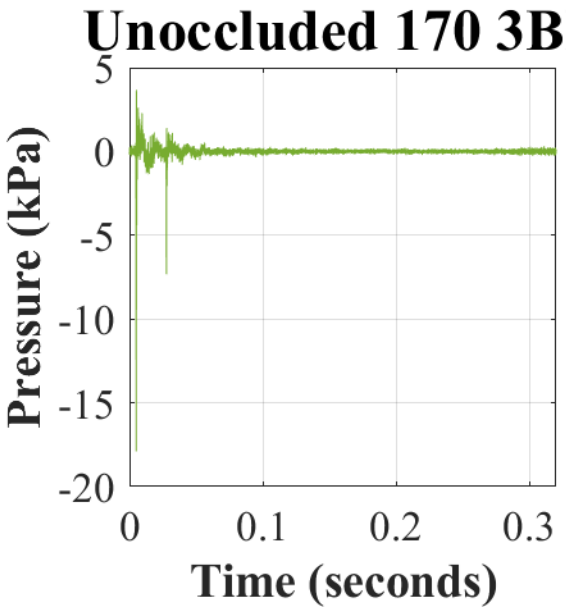

Unoccluded 170 2AR
Pressure (kPa)
5
0
-5
-10
-15
-20
0
0.1
0.2
0.3
Time (seconds)

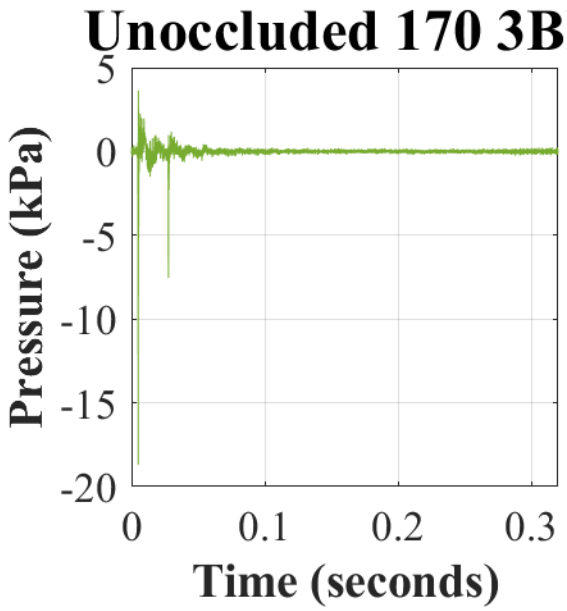

Unoccluded 170 2BL
Pressure (kPa)
5
0
-5
-10
-15
-20
0
0.1
0.2
0.3
Time (seconds)

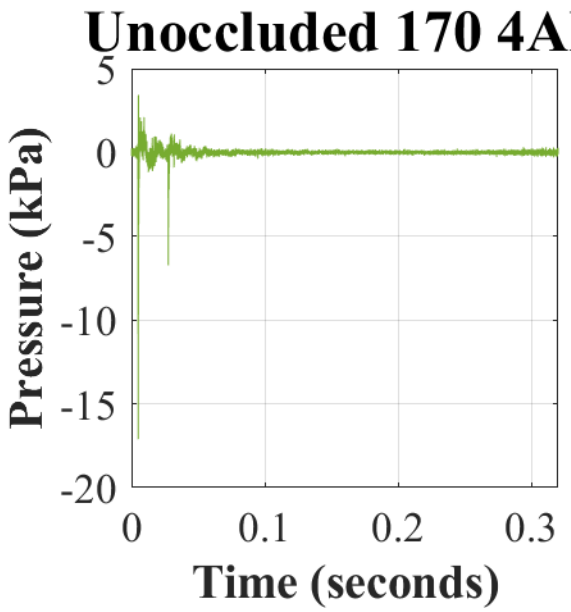

Unoccluded 170 2BR
Pressure (kPa)
5
0
-5
-10
-15
-20
0
0.1
0.2
0.3
Time (seconds)

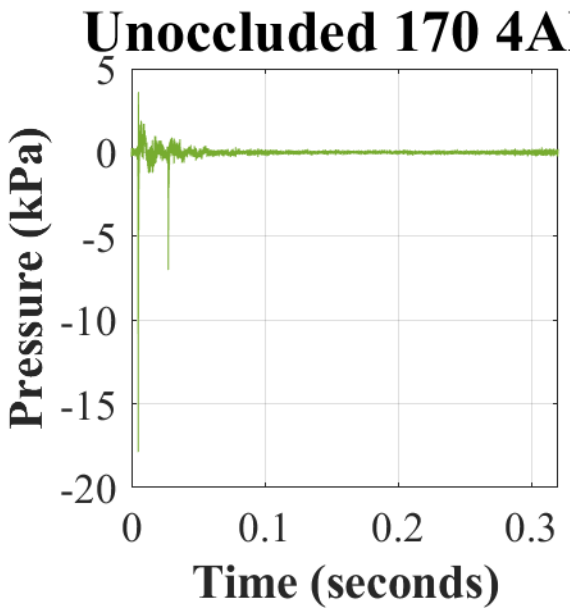

Unoccluded 170 3AL
Pressure (kPa)
5
0
-5
-10
-15
-20
0
0.1
0.2
0.3
Time (seconds)

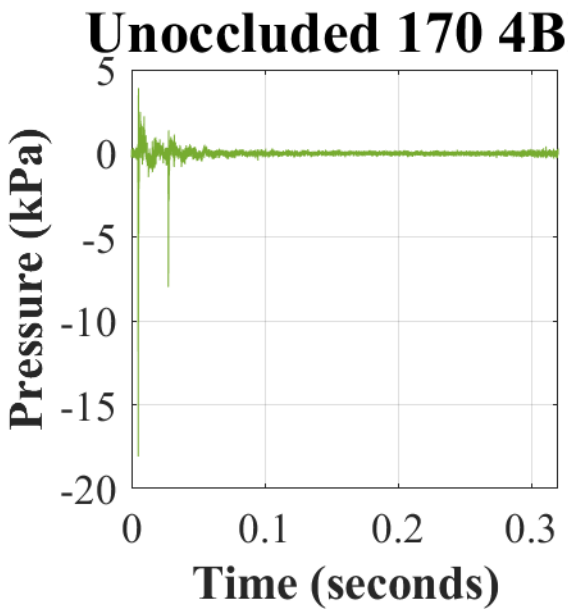

Unoccluded 170 3AR
Pressure (kPa)
5
0
-5
-10
-15
-20
0
0.1
0.2
0.3
Time (seconds)

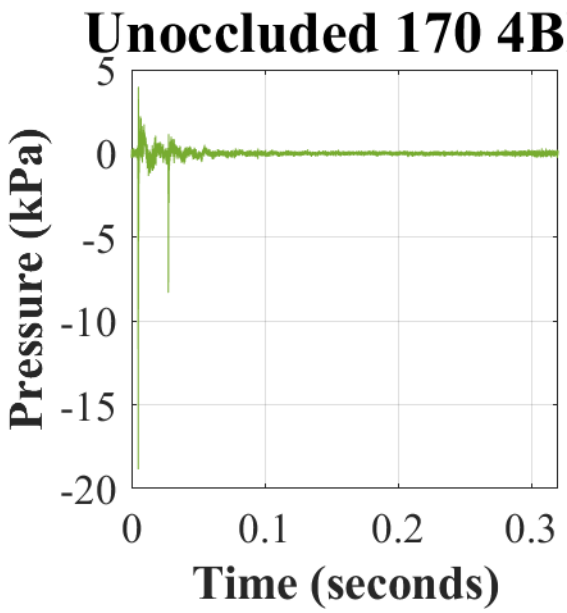

Unoccluded 170 3BL
Pressure (kPa)
5
0
-5
-10
-15
-20
0
0.1
0.2
0.3
Time (seconds)

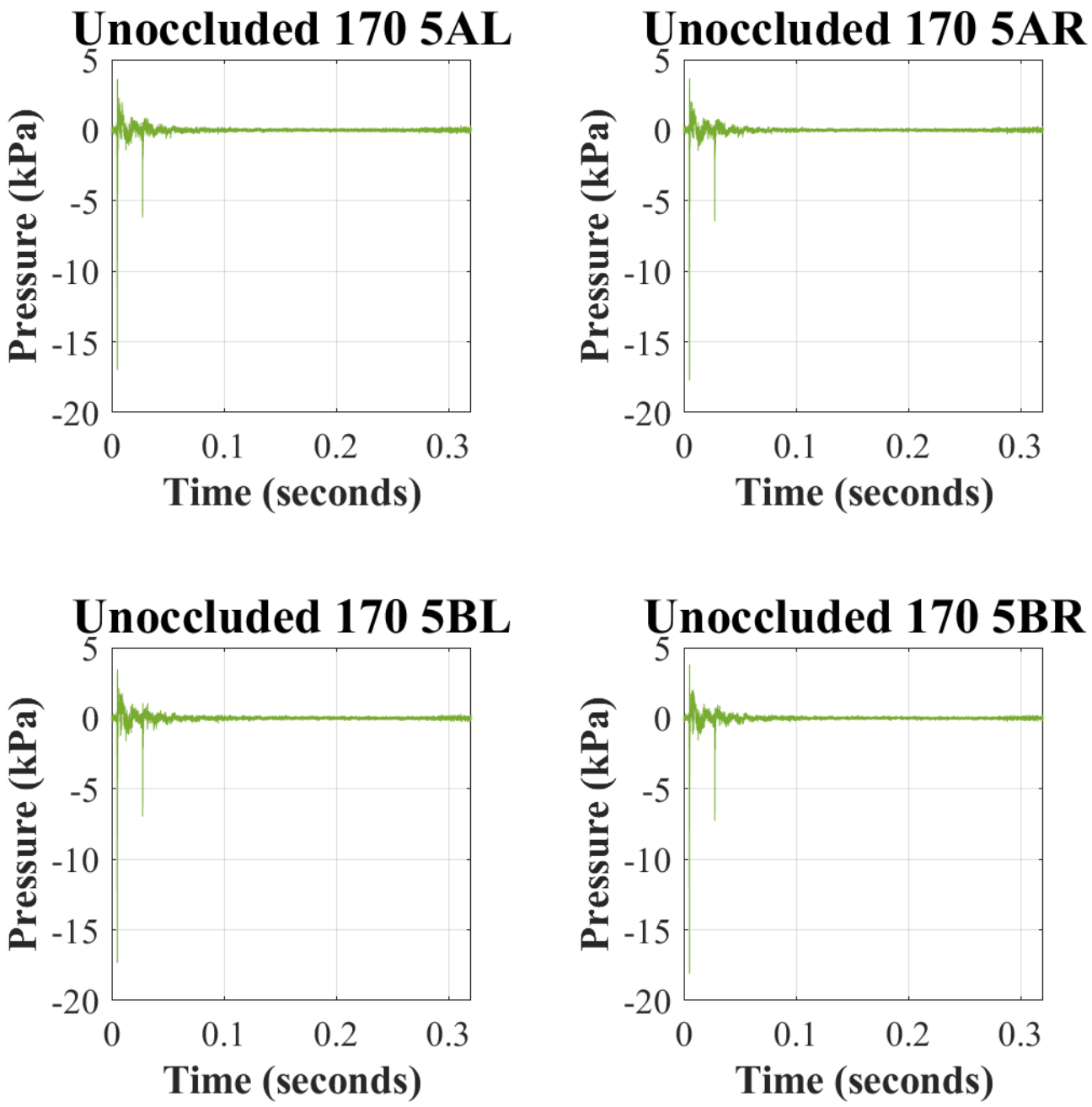

Unoccluded 170 3BR
Pressure (kPa)
5
0
-5
-10
-15
-20
0
0.1
0.2
0.3
Time (seconds)


Unoccluded 170 4AL
Pressure (kPa)
5
0
-5
-10
-15
-20
0
0.1
0.2
0.3
Time (seconds)


Unoccluded 170 4AR
Pressure (kPa)
5
0
-5
-10
-15
-20
0
0.1
0.2
0.3
Time (seconds)

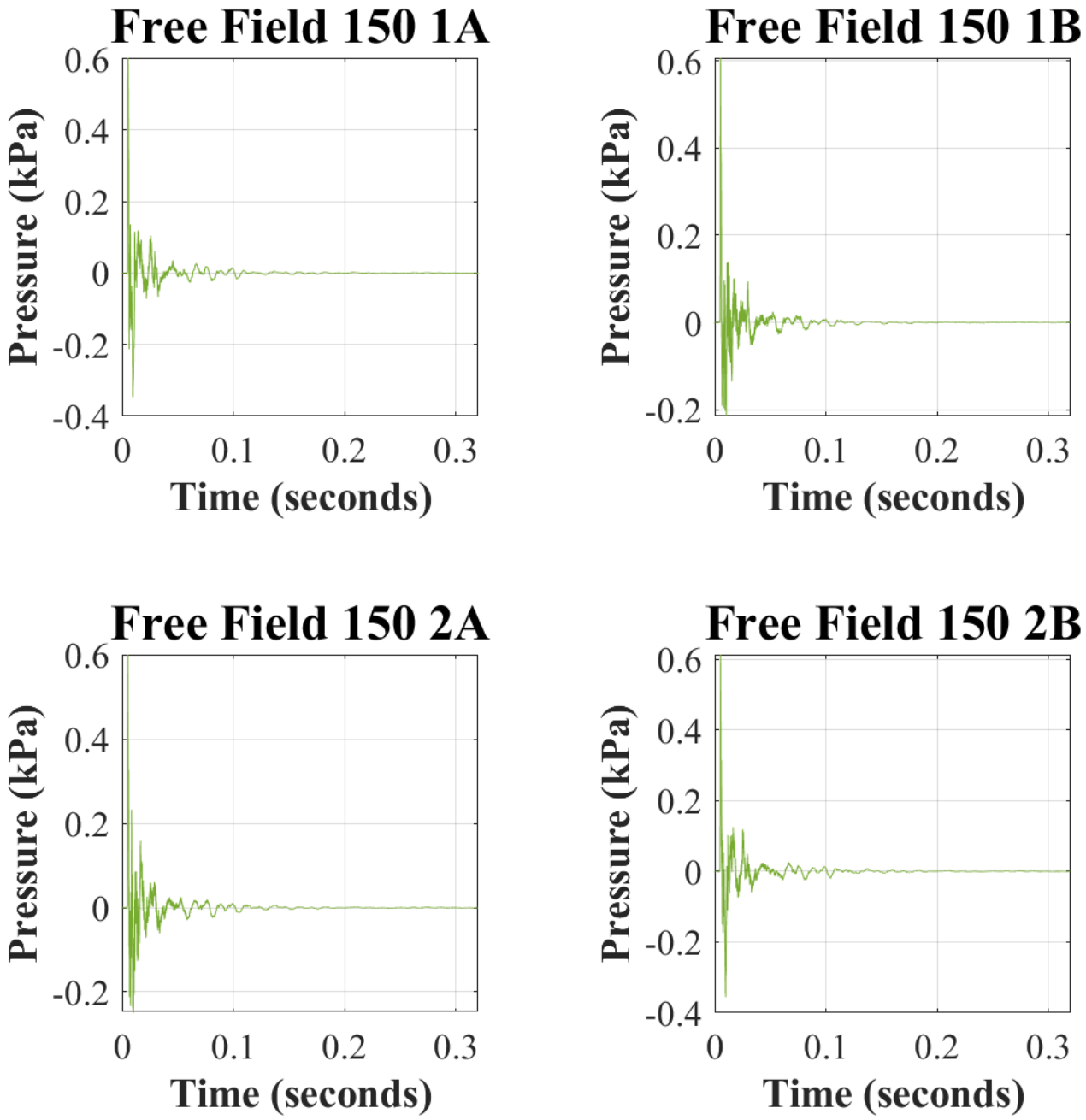

Unoccluded 170 4BL
Pressure (kPa)
5
0
-5
-10
-15
-20
0
0.1
0.2
0.3
Time (seconds)

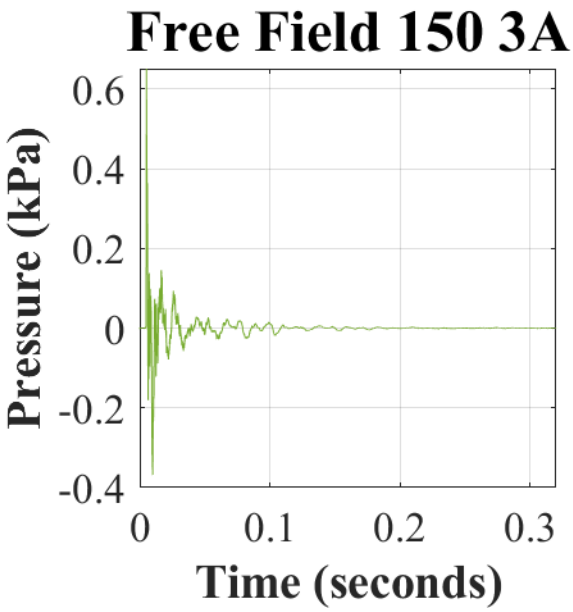

Unoccluded 170 4BR
Pressure (kPa)
5
0
-5
-10
-15
-20
0
0.1
0.2
0.3
Time (seconds)

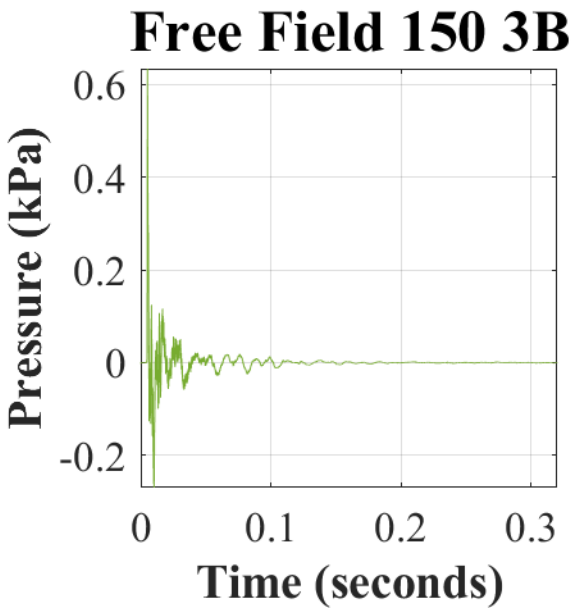


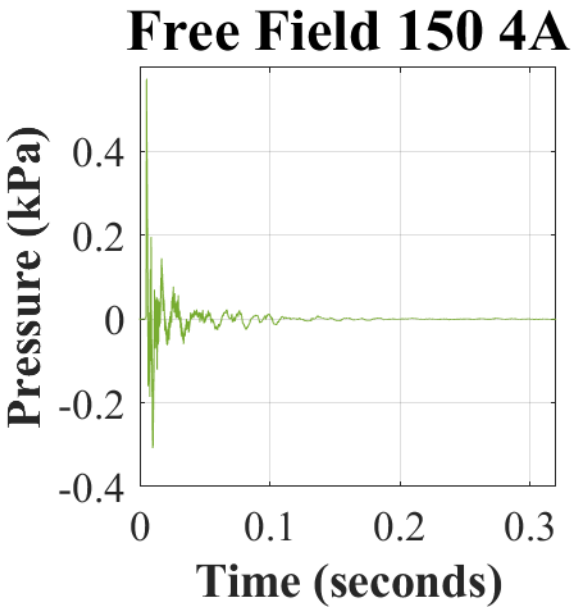
Note. The naming convention for all unoccluded waveforms is "Unoccluded LvL NnX", where 'Unoccluded' is the test condition (i.e., ATF has the HPD doffed), 'LvL' is the nominal test level (i.e., 150, 160 or 170 dBP), 'N' is the sample number (i.e., 1 to 5) of the device tested, 'n' is the trial (i.e., A or B) indicating HPD fit (i.e., first or second, respectively), and 'X' indicates from what ATF microphone the recording is from (i.e., right [R] or left [L] pinnae).

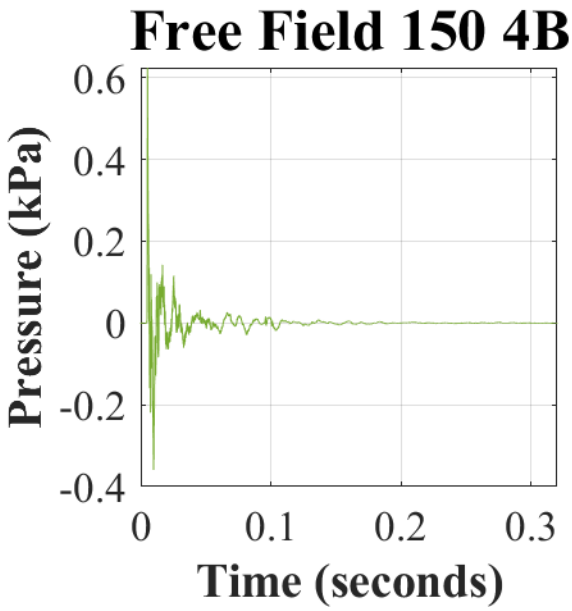
Appendix G. Recorded waveform (in kilopascals [kPa]) over time (in seconds [s]) of the impulse measured with the free-field probe at 150 dBP and the EP7 donned in the cap open mode.

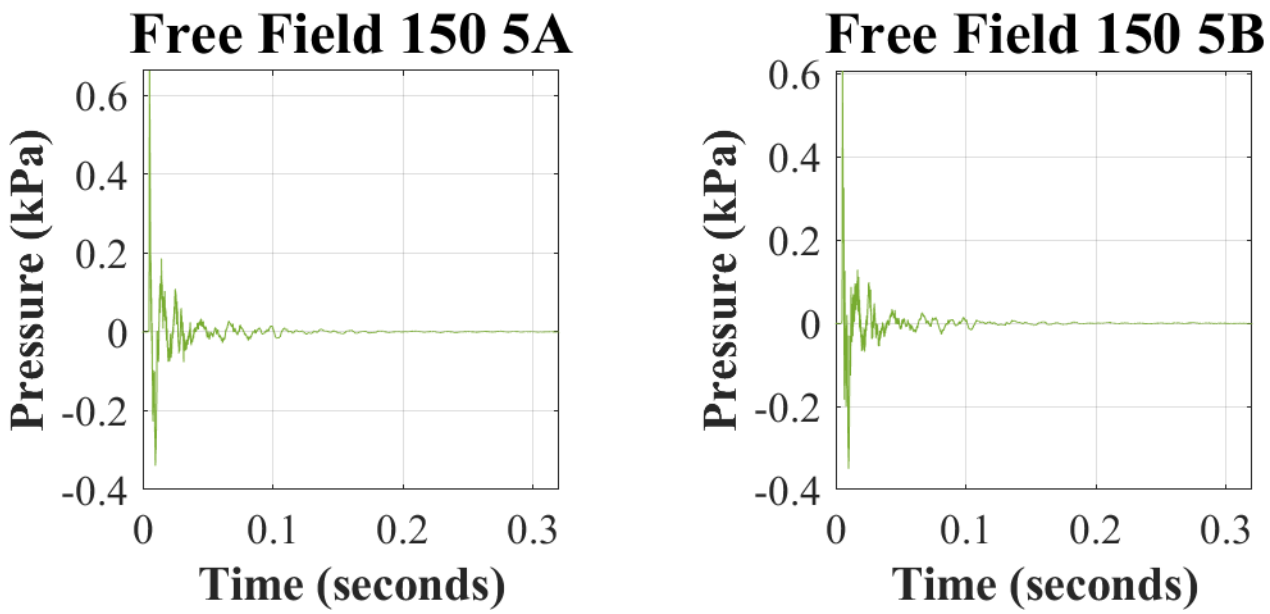



Free Field 150 3A
Pressure (kPa)
0.6
0.4
0.2
0
-0.2
-0.4
0
0.1
0.2
0.3
Time (seconds)


Free Field 150 3B
Pressure (kPa)
0.6
0.4
0.2
0
-0.2
0
0.1
0.2
0.3
Time (seconds)

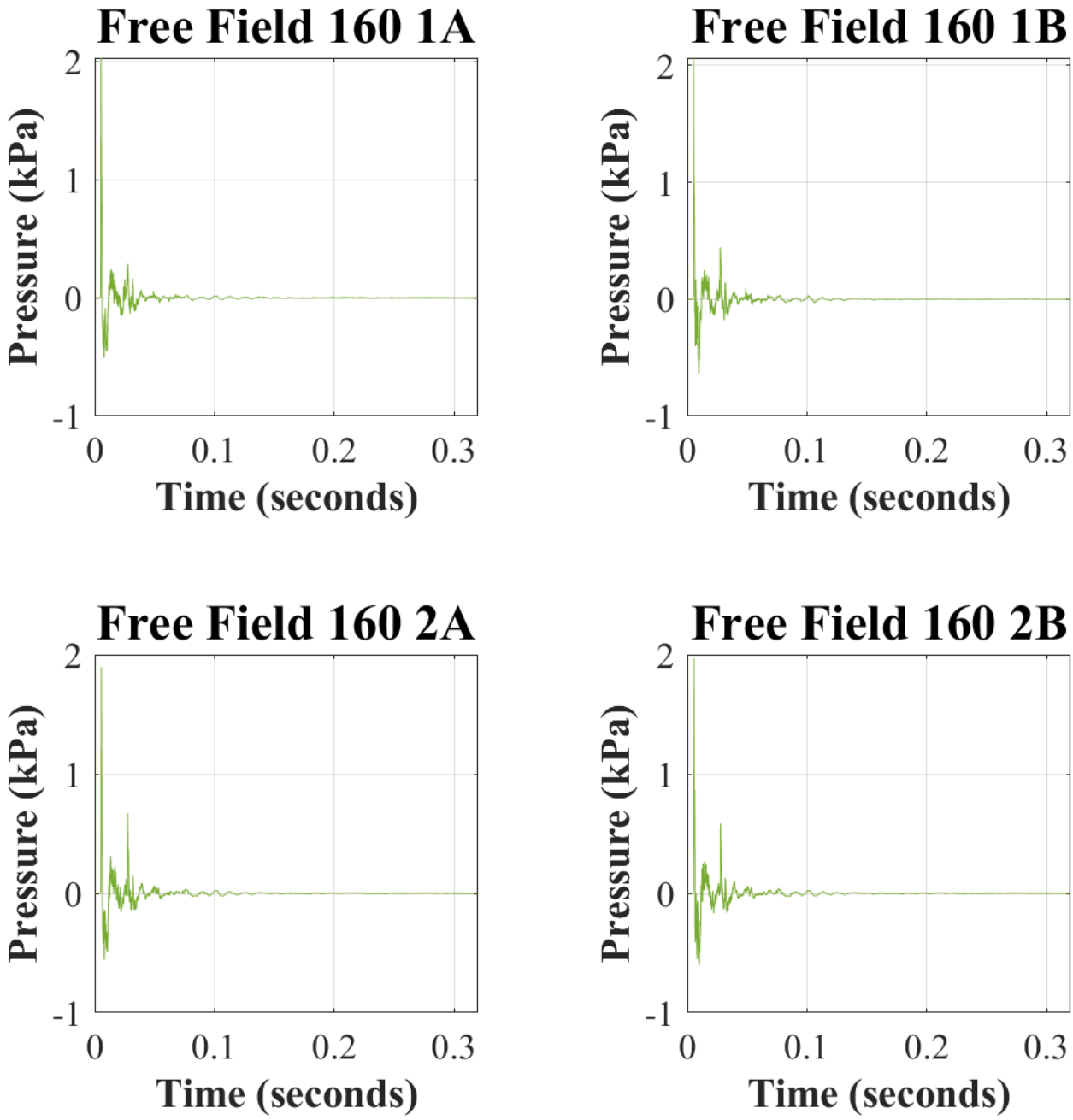

Free Field 150 4A
Pressure (kPa)
0.4
0.2
0
-0.2
-0.4
0
0.1
0.2
0.3
Time (seconds)

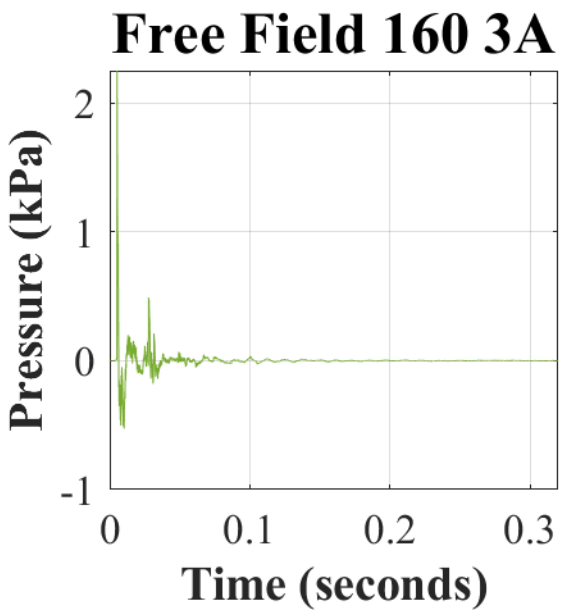

Free Field 150 4B
Pressure (kPa)
0.6
0.4
0.2
0
-0.2
-0.4
0
0.1
0.2
0.3
Time (seconds)

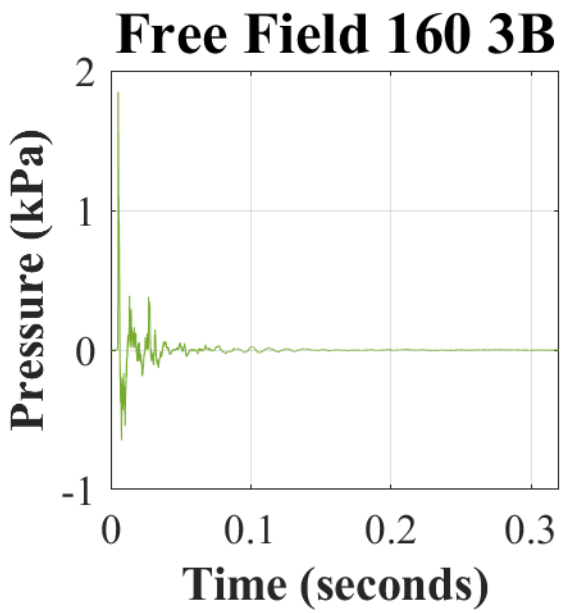


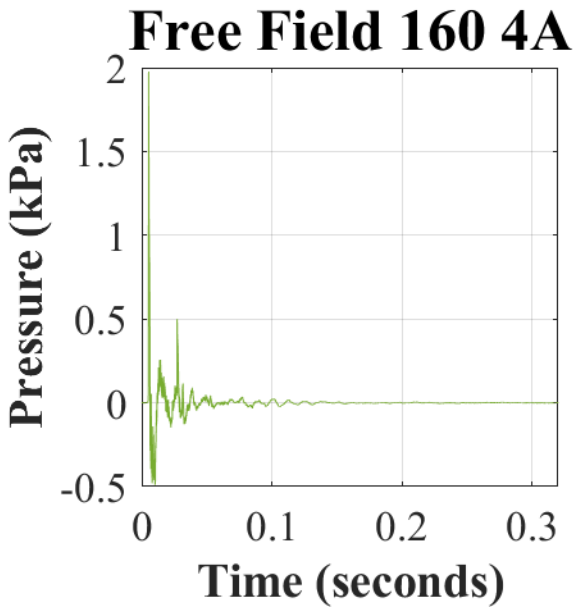
Note. The naming convention for all free-field waveforms is “Free Field LvL Nn”, where ‘Free Field’ indicates that the recording was obtained using the PCB reference microphone, ‘LvL’ is the nominal test level (150 dBP), ‘N’ is the device sample number (1 to 5), and ‘n’ is the device trial (i.e., A or B).

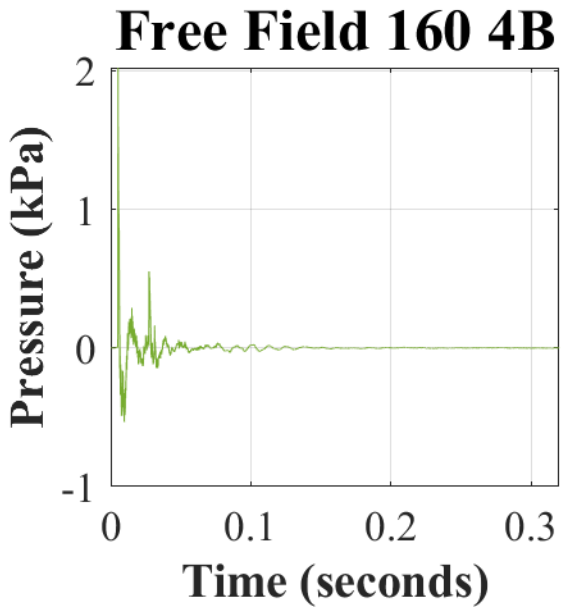
Appendix H. Recorded waveform (in kilopascals [kPa]) over time (in seconds [s]) of the impulse measured with the free-field probe at 160 dBP and the EP7 donned in the cap open mode.

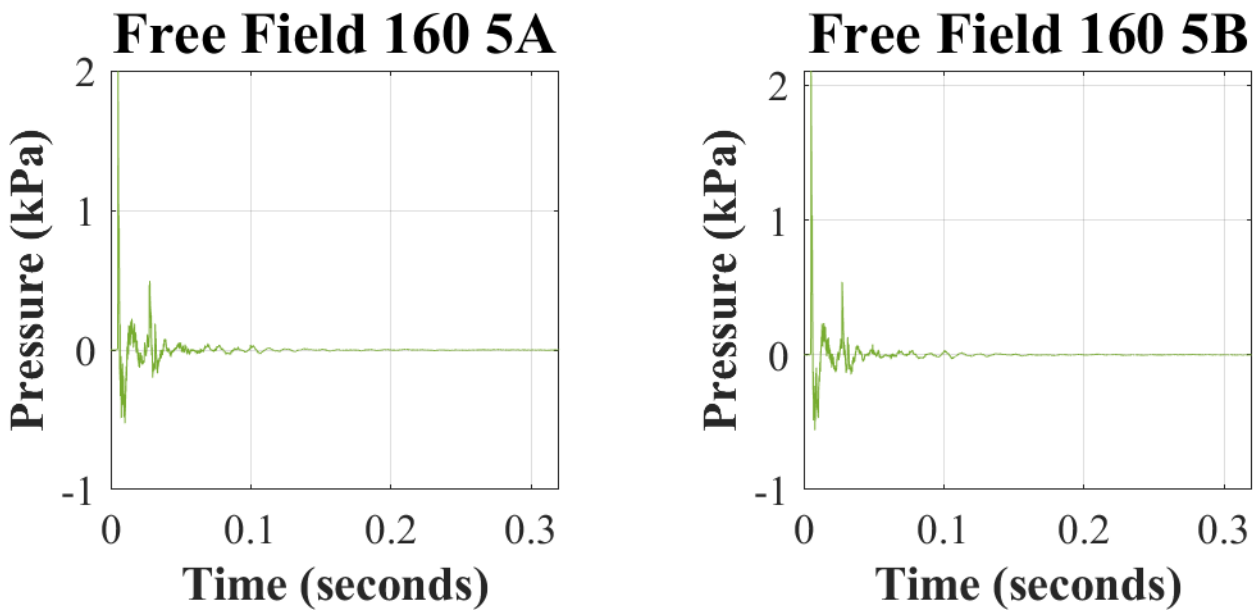



Free Field 160 3A
Pressure (kPa)
2
1
0
-1
0
0.1
0.2
0.3
Time (seconds)


Free Field 160 3B
Pressure (kPa)
2
1
0
-1
0
0.1
0.2
0.3
Time (seconds)

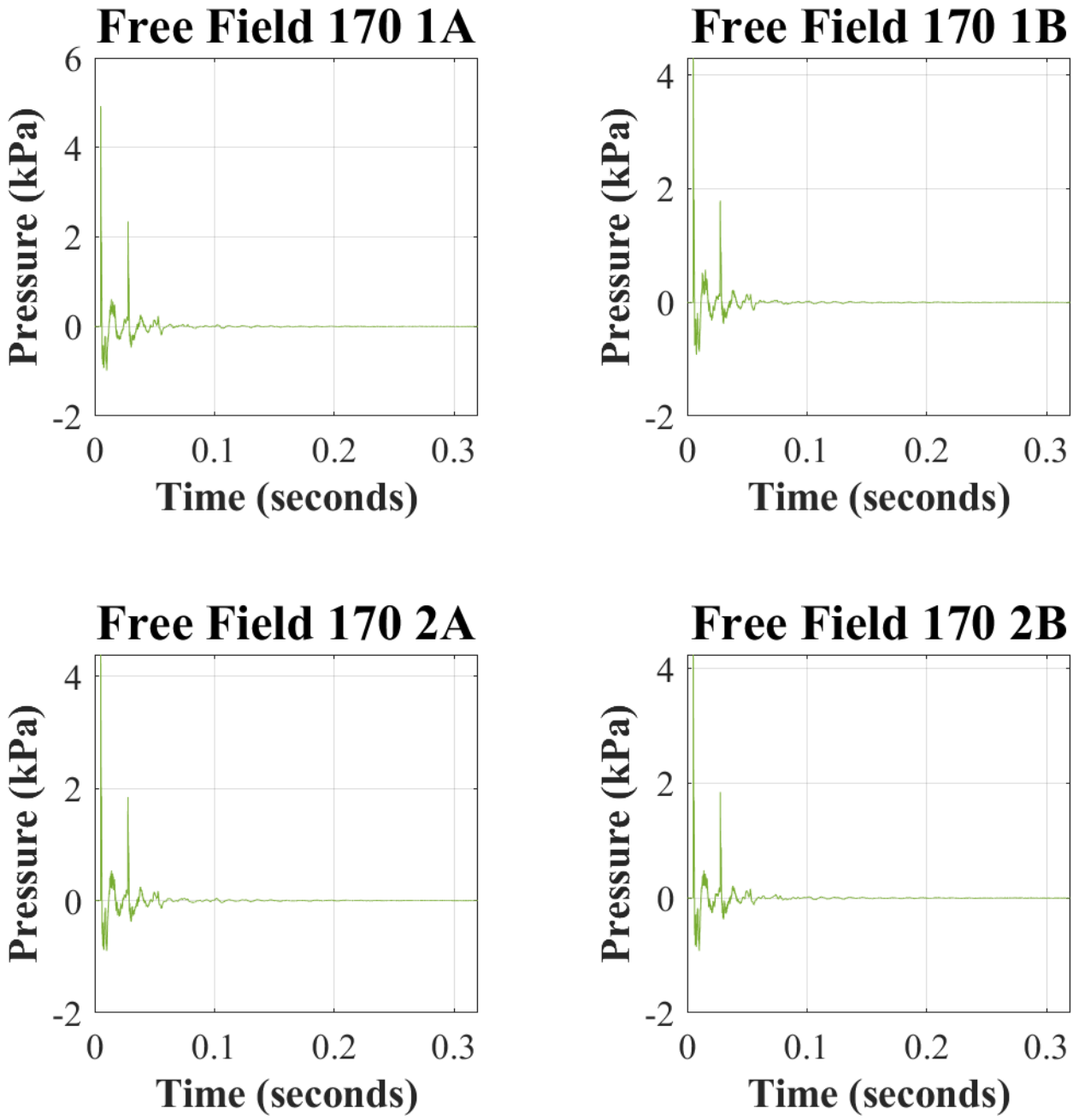

Free Field 160 4A
Pressure (kPa)
2
1.5
1
0.5
0
-0.5
0
0.1
0.2
0.3
Time (seconds)

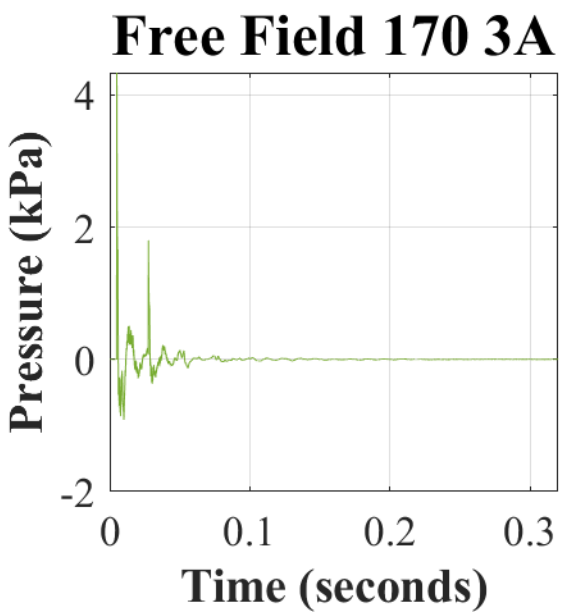

Free Field 160 4B
Pressure (kPa)
2
1
0
-1
0
0.1
0.2
0.3
Time (seconds)

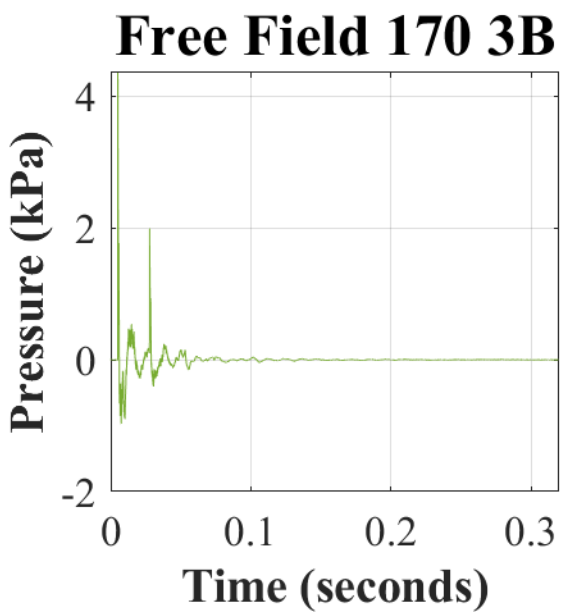


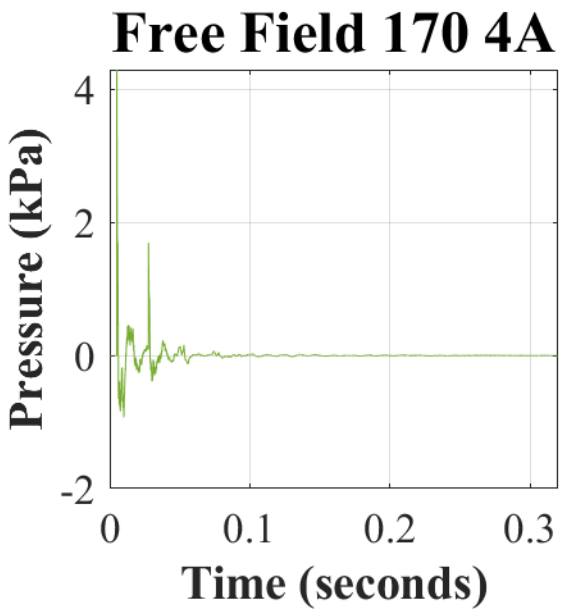
Note. The naming convention for all free-field waveforms is “Free Field LvL Nn”, where ‘Free Field’ indicates that the recording was obtained using the PCB reference microphone, ‘LvL’ is the nominal test level (160 dBP), ‘N’ is the device sample number (1 to 5), and ‘n’ is the device trial (i.e., A or B).

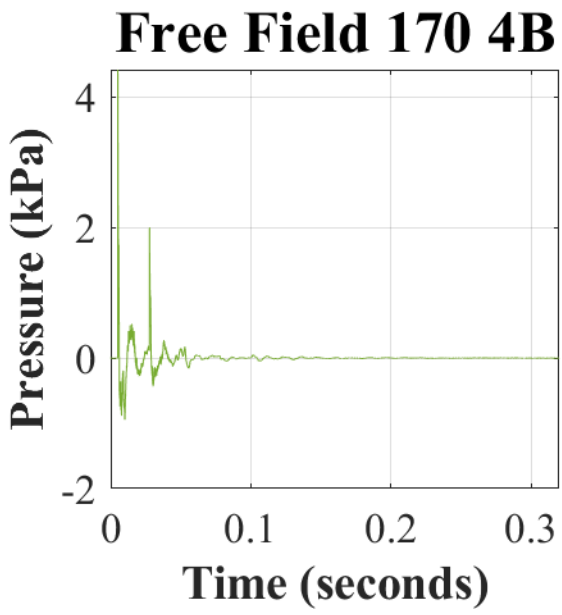
Appendix I. Recorded waveform (in kilopascals [kPa]) over time (in seconds [s]) of the impulse measured with the free-field probe at 170 dBP and the EP7 donned in the cap open mode.

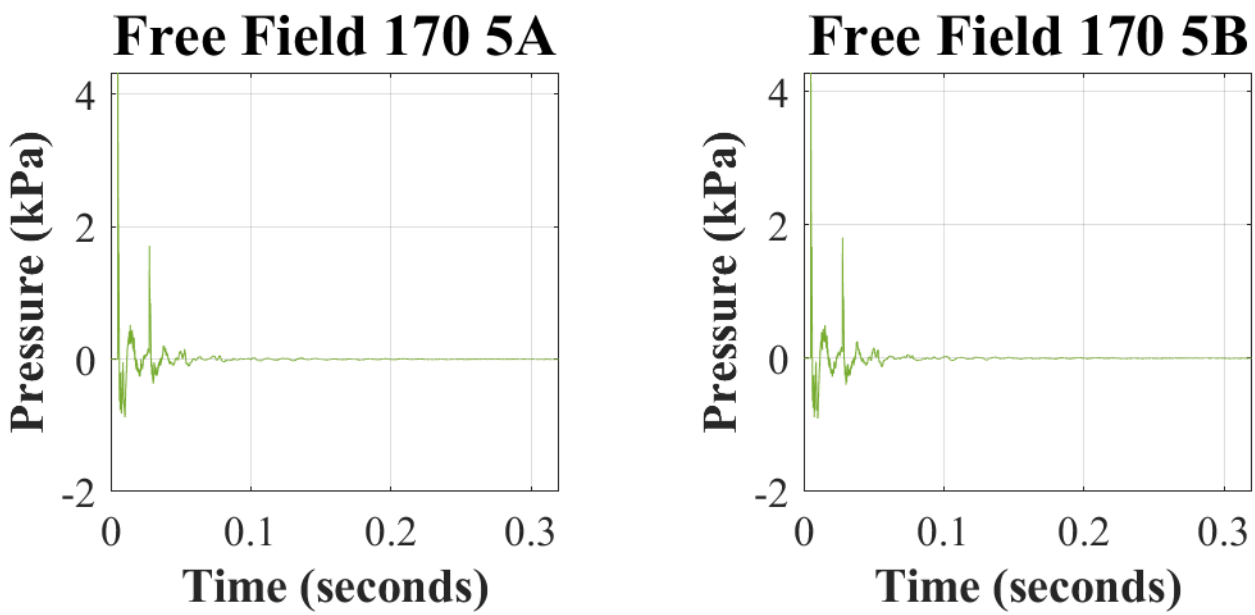



Free Field 170 3A
Pressure (kPa)
4
2
0
-2
0
0.1
0.2
0.3
Time (seconds)


Free Field 170 3B
Pressure (kPa)
4
2
0
-2
0
0.1
0.2
0.3
Time (seconds)

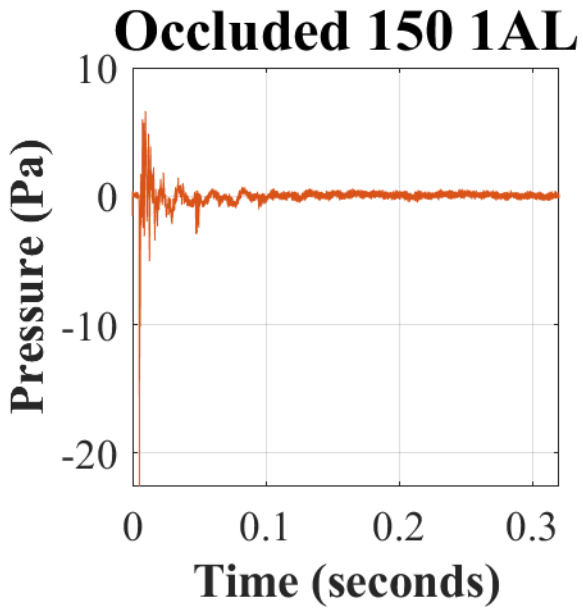

Free Field 170 4A
Pressure (kPa)
4
2
0
-2
0
0.1
0.2
0.3
Time (seconds)

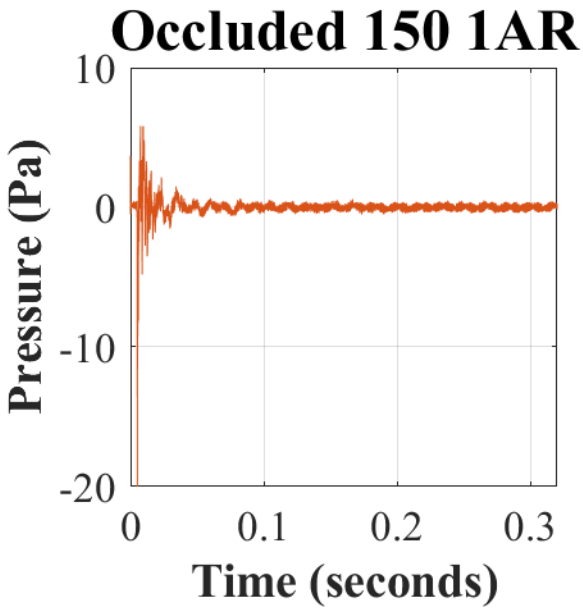

Free Field 170 4B
Pressure (kPa)
4
2
0
-2
0
0.1
0.2
0.3
Time (seconds)

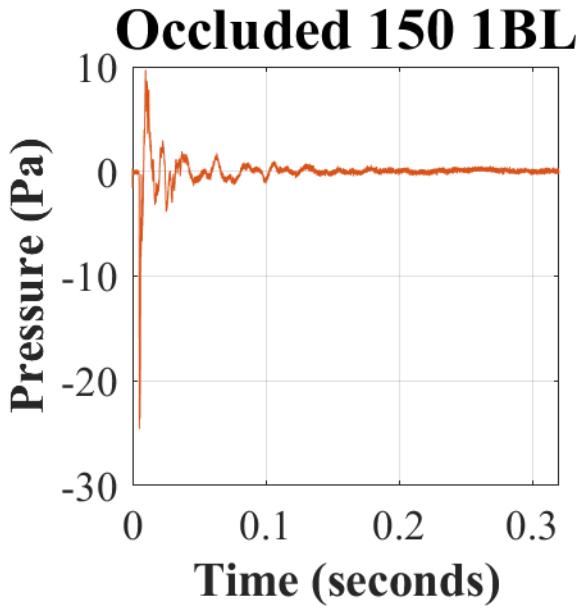


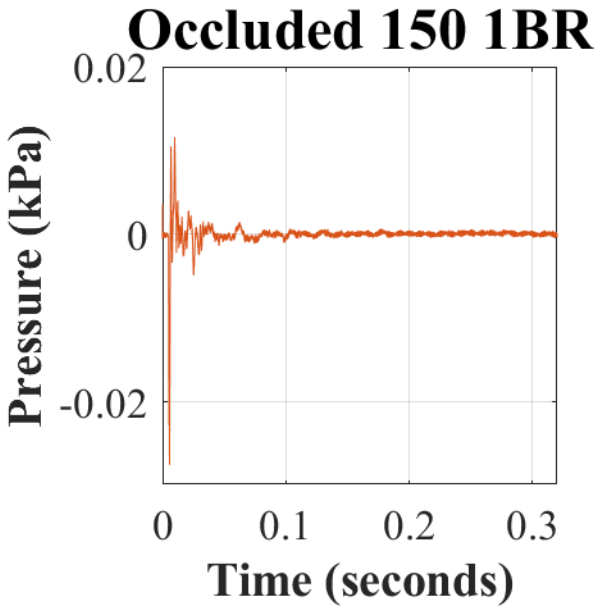
Note. The naming convention for all free-field waveforms is “Free Field LvL Nn”, where ‘Free Field’ indicates that the recording was obtained using the PCB reference microphone, ‘LvL’ is the nominal test level (170 dBP), ‘N’ is the device sample number (1 to 5), and ‘n’ is the device trial (i.e., A or B).

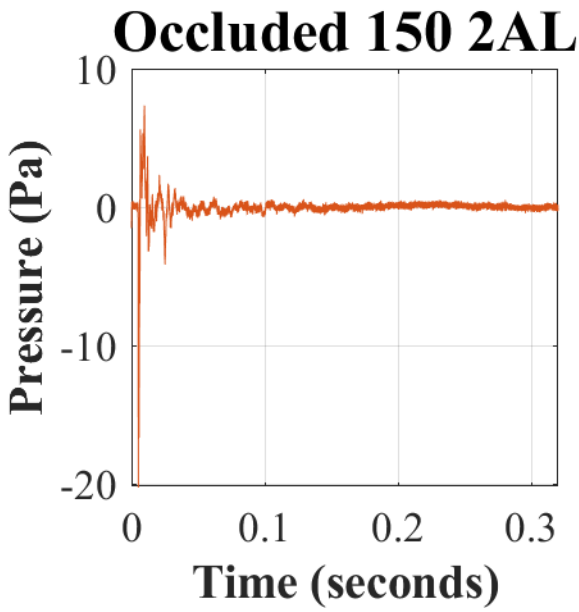
Appendix J. Recorded occluded (closed-ear) waveforms (in pascals [Pa] or kilopascals [kPa]) over time (in seconds [s]) in response to 150 dBP with the EP7 in the cap closed mode.

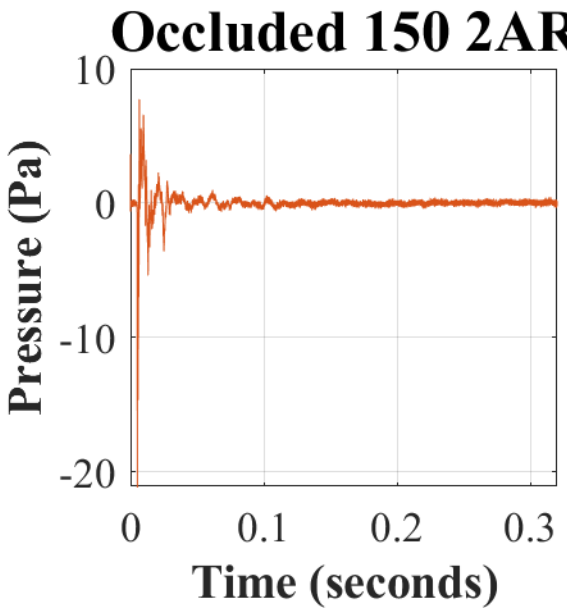


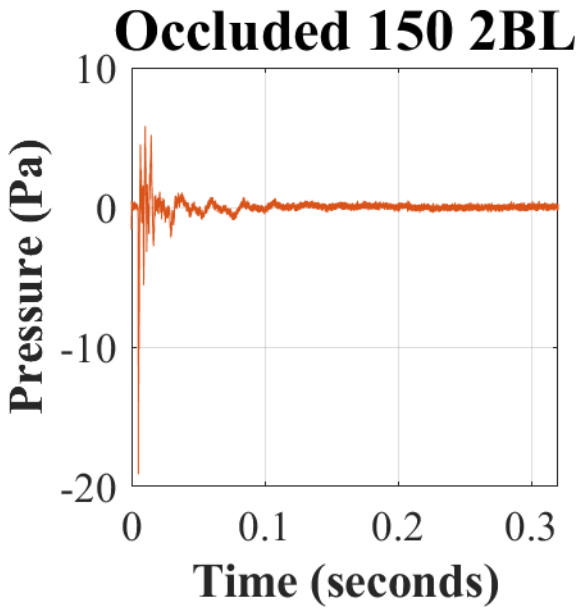


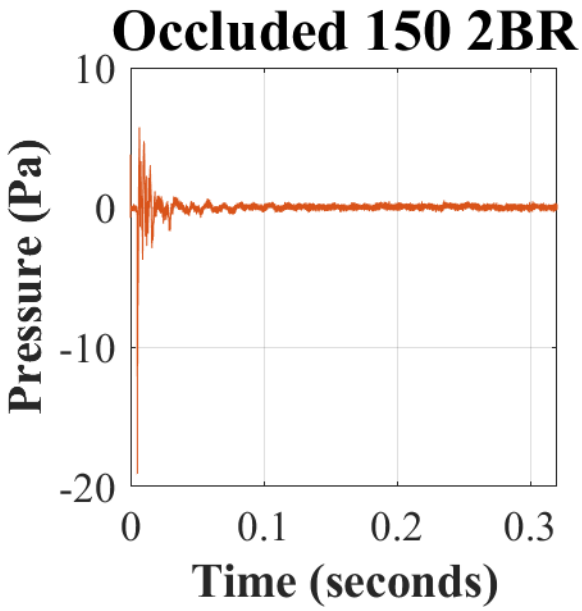


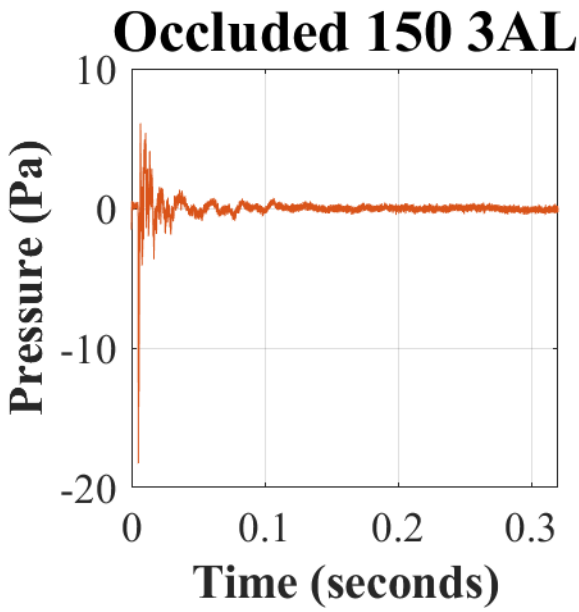


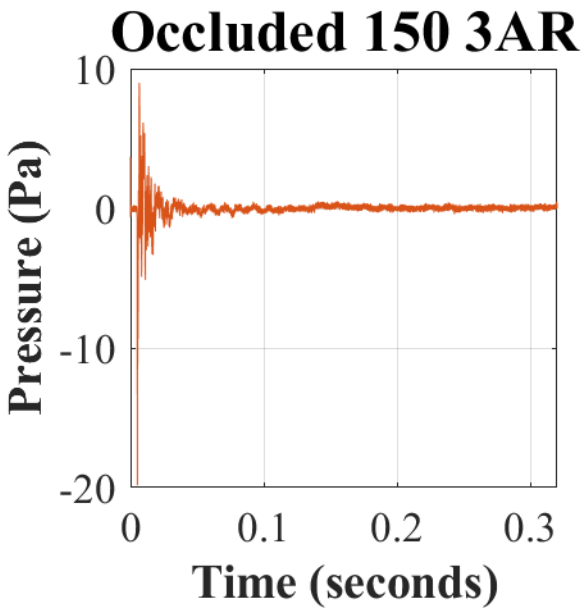

Occluded 150 2AL
Pressure (Pa)
10
0
-10
-20
0
0.1
0.2
0.3
Time (seconds)

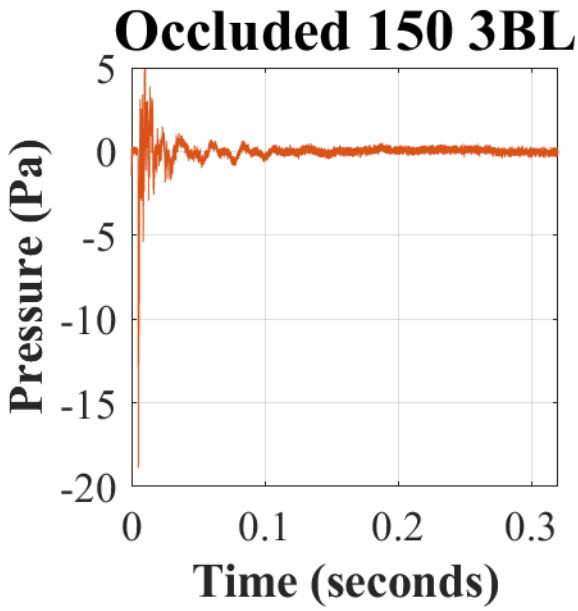

Occluded 150 2AR
Pressure (Pa)
10
0
-10
-20
0
0.1
0.2
0.3
Time (seconds)

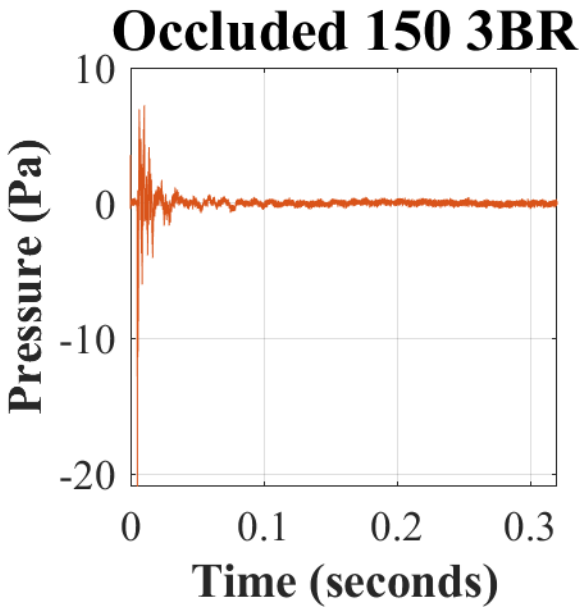

Occluded 150 2BL
Pressure (Pa)
10
0
-10
-20
0
0.1
0.2
0.3
Time (seconds)

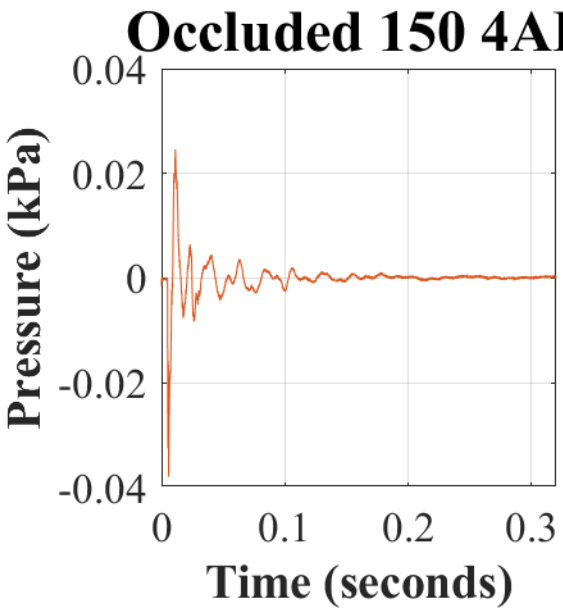

Occluded 150 2BR
Pressure (Pa)
10
0
-10
-20
0
0.1
0.2
0.3
Time (seconds)

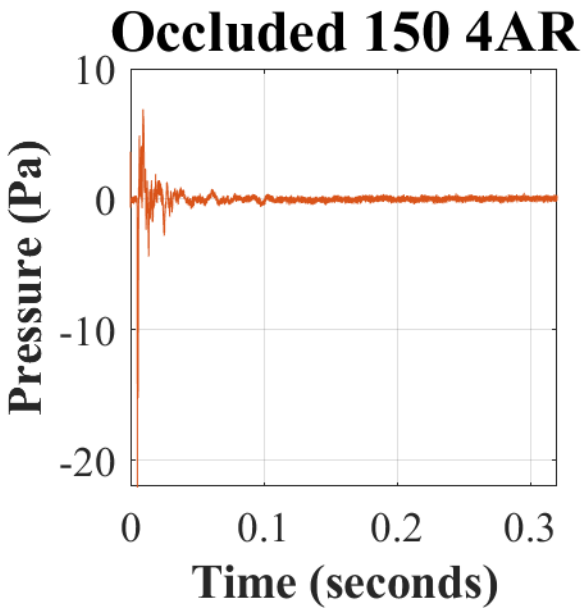

Occluded 150 3AL
Pressure (Pa)
Time (seconds)
10
0
-10
-20
0
0.1
0.2
0.3

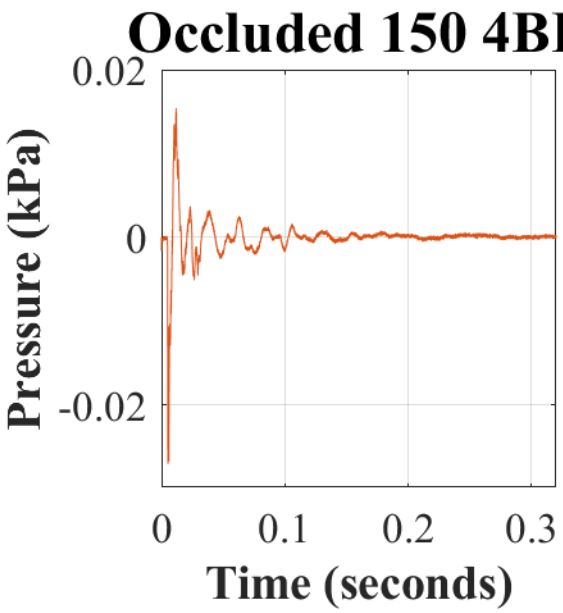

Occluded 150 3AR
Pressure (Pa)
Time (seconds)
10
0
-10
-20
0
0.1
0.2
0.3

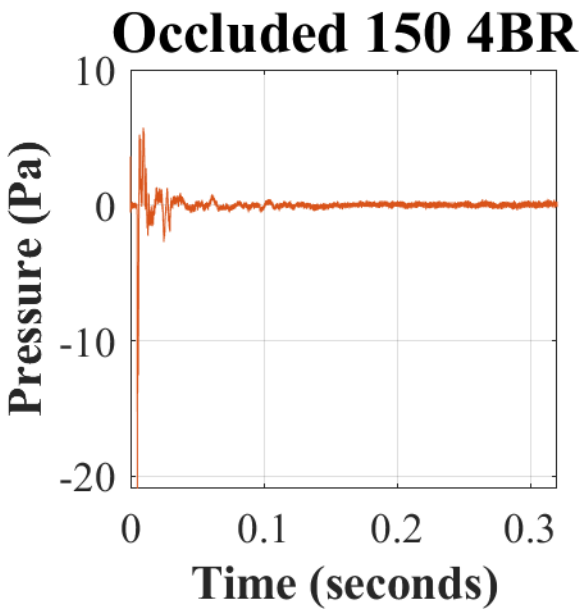

Occluded 150 3BL
Pressure (Pa)
Time (seconds)
5
0
-5
-10
-15
-20
0
0.1
0.2
0.3

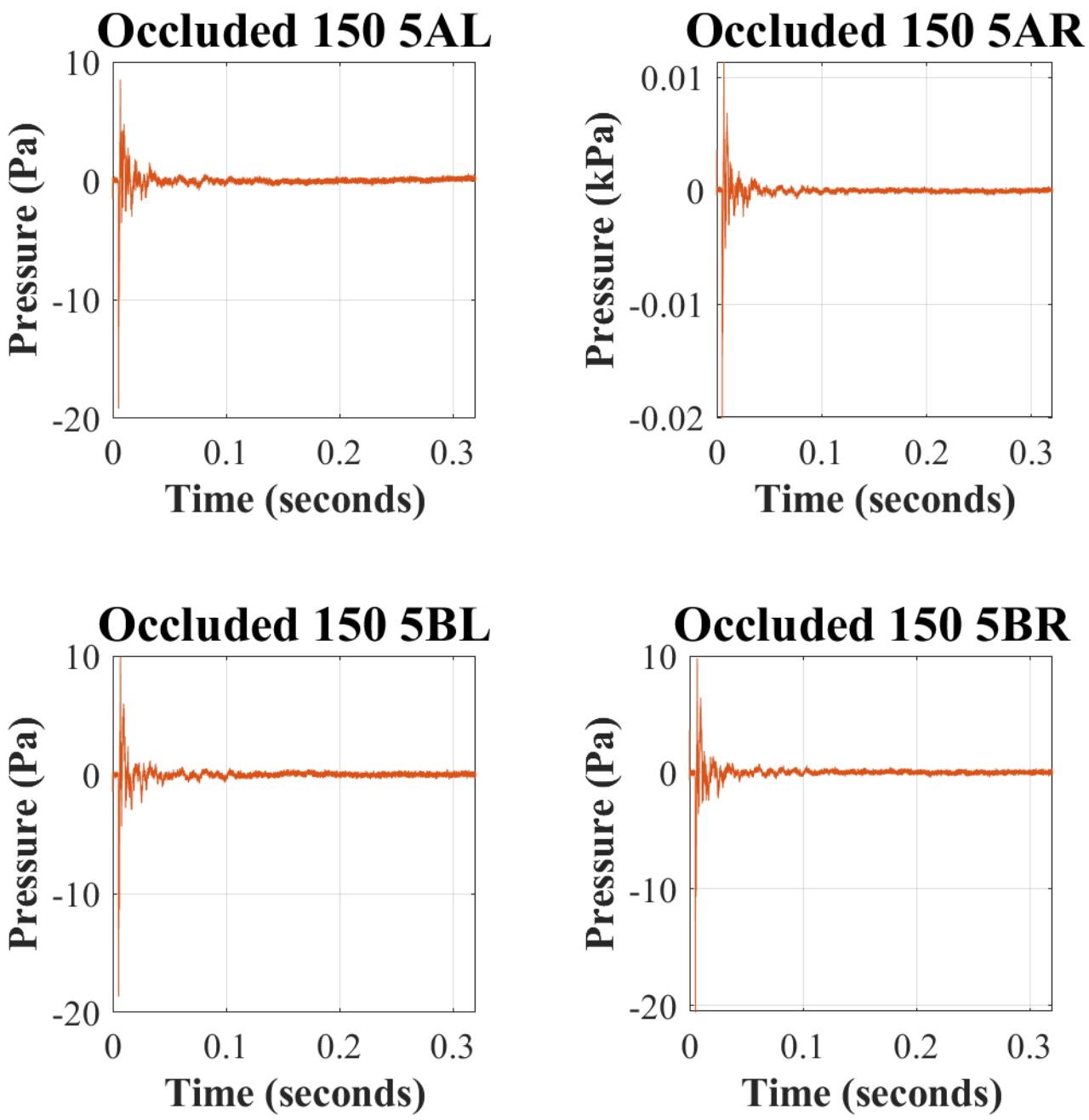

Occluded 150 3BR
Pressure (Pa)
Time (seconds)
10
0
-10
-20
0
0.1
0.2
0.3


Occluded 150 4AL
Pressure (kPa)
0.04
0.02
0
-0.02
-0.04
0
0.1
0.2
0.3
Time (seconds)


Occluded 150 4AR
Pressure (Pa)
10
0
-10
-20
0
0.1
0.2
0.3
Time (seconds)

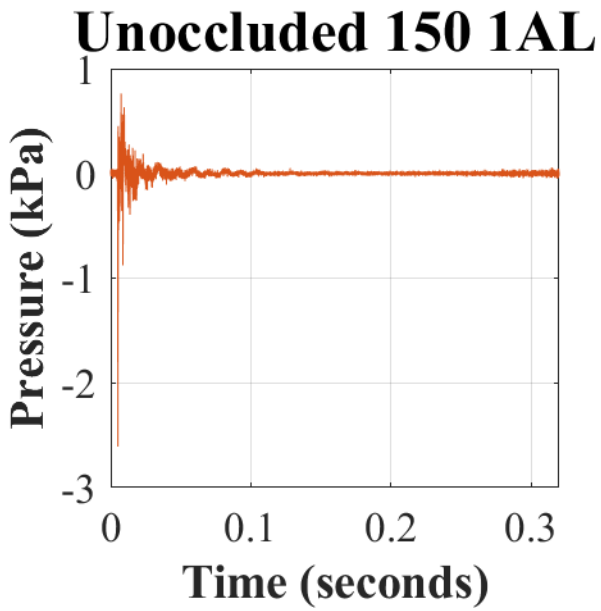

Occluded 150 4BL
Pressure (kPa)
0.02
0
-0.02
0
0.1
0.2
0.3
Time (seconds)

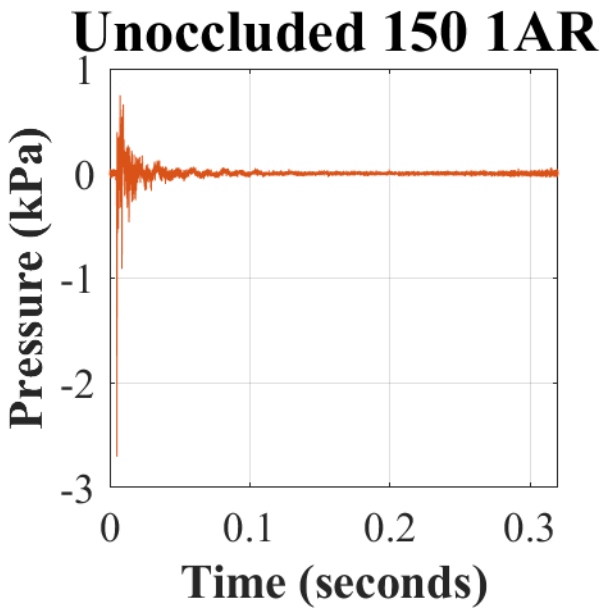

Occluded 150 4BR
Pressure (Pa)
10
0
-10
-20
0
0.1
0.2
0.3
Time (seconds)

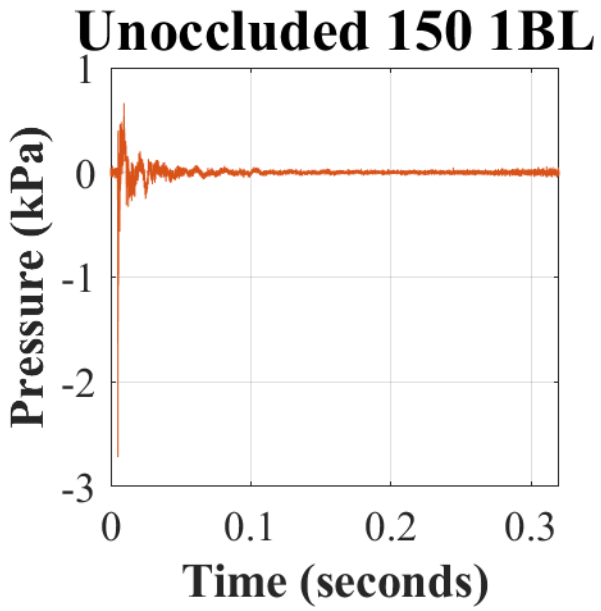


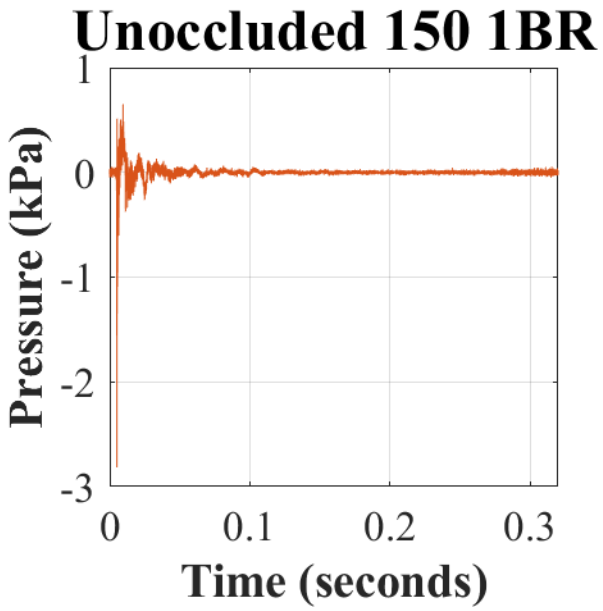
Note. The naming convention for all occluded waveforms is "Occluded LvL NnX", where 'Occluded' is the test condition (i.e., ATF has the HPD donned), 'LvL' is the nominal test level (i.e., 150, 160 or 170 dBP), 'N' is the sample number (i.e., 1 to 5) of the device tested, 'n' is the trial (i.e., A or B) indicating HPD fit (i.e., first or second, respectively), and 'X' indicates from what ATF microphone the recording is from (i.e., right [R] or left [L] pinnae).

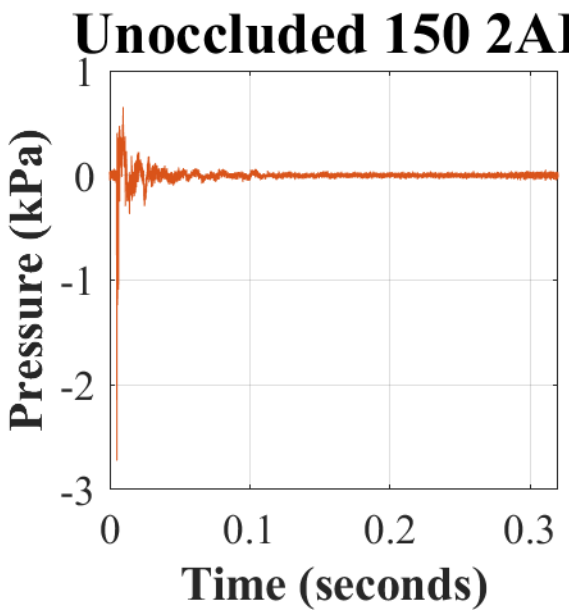
Appendix K. Estimated unoccluded (open-ear) waveforms (in kilopascals [kPa]) over time (in seconds [s]) in response to 150 dBP with the EP7 in the cap closed mode.

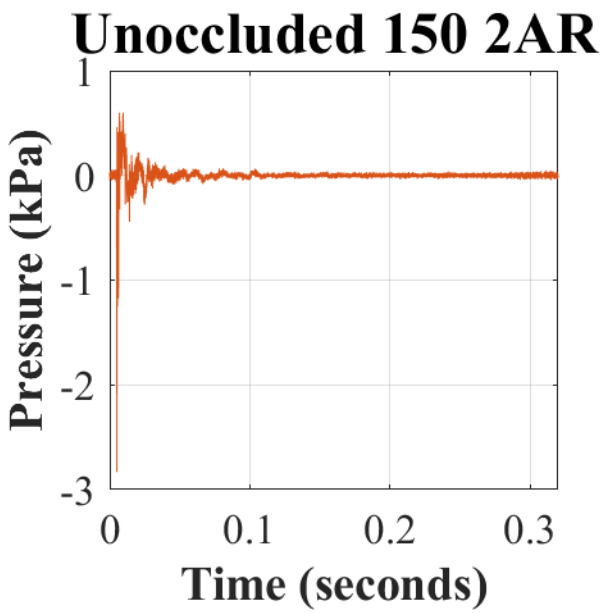


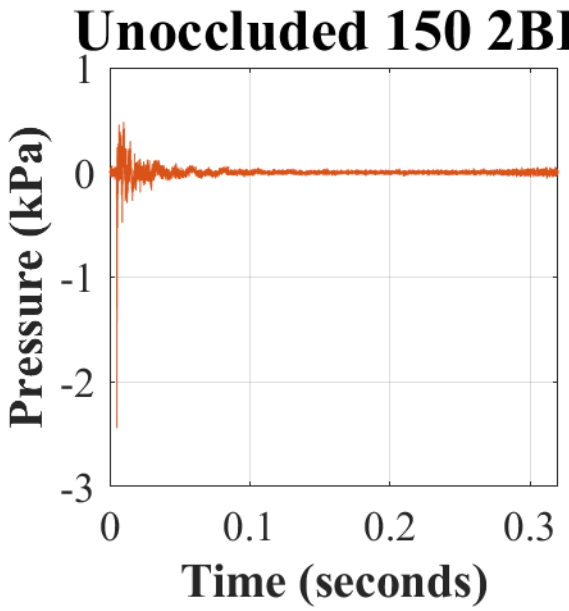


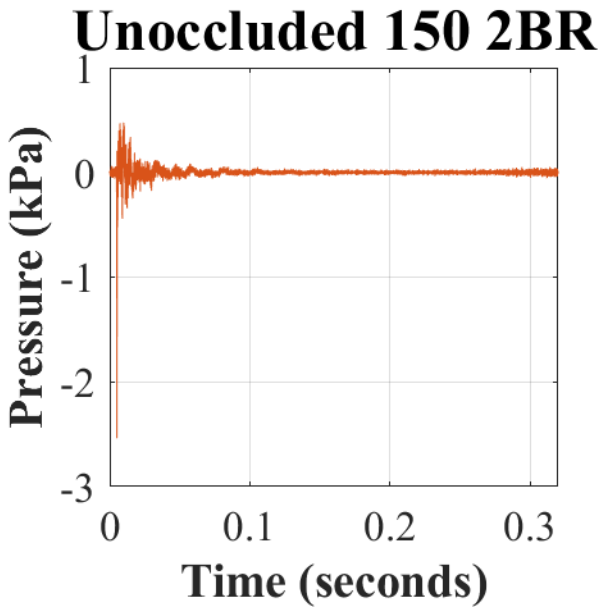


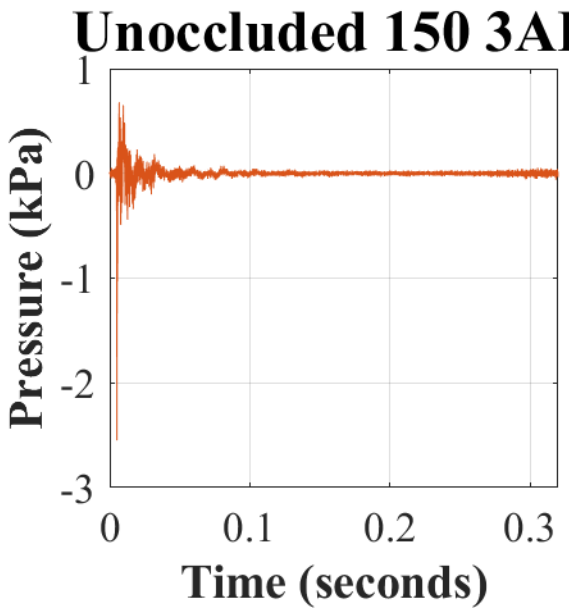


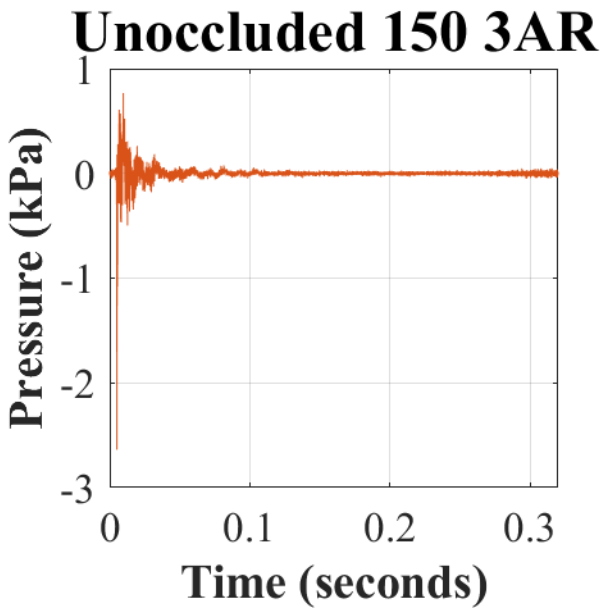

Unoccluded 150 2AL
Pressure (kPa)
1
0
-1
-2
-3
0
0.1
0.2
0.3
Time (seconds)

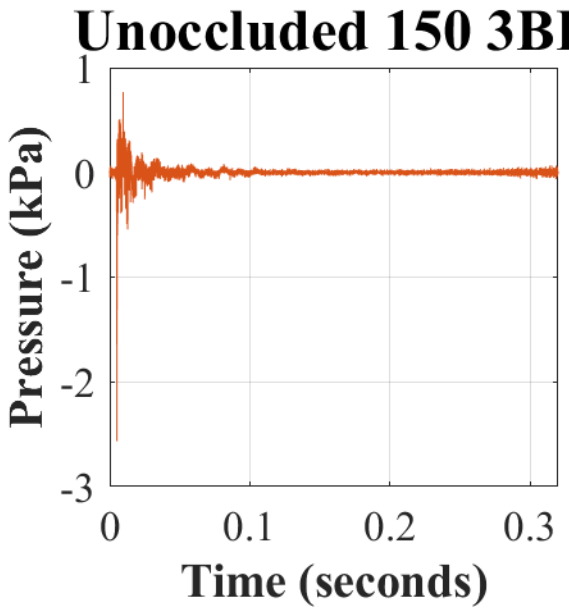

Unoccluded 150 2AR
Pressure (kPa)
1
0
-1
-2
-3
0
0.1
0.2
0.3
Time (seconds)

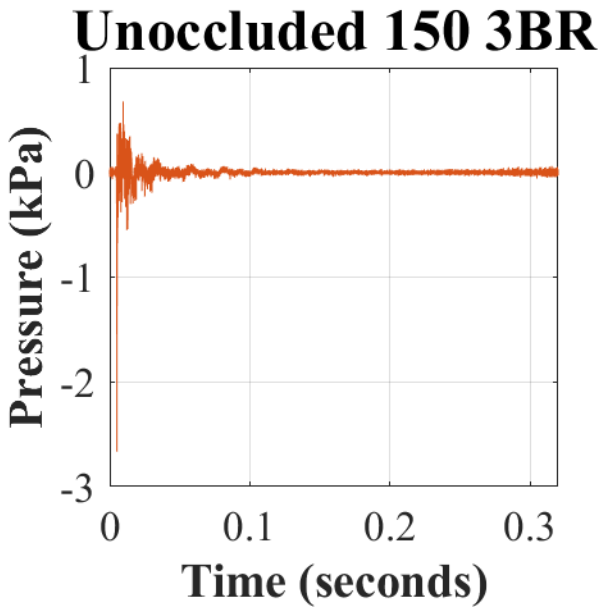

Unoccluded 150 2BL
Pressure (kPa)
1
0
-1
-2
-3
0
0.1
0.2
0.3
Time (seconds)

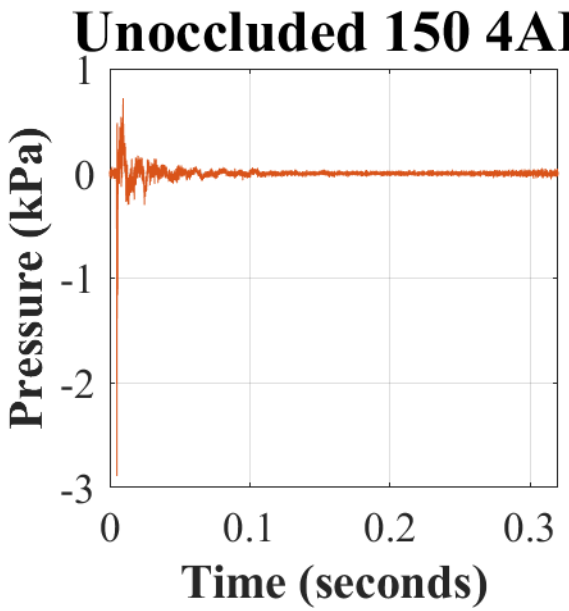

Unoccluded 150 2BR
Pressure (kPa)
1
0
-1
-2
-3
0
0.1
0.2
0.3
Time (seconds)

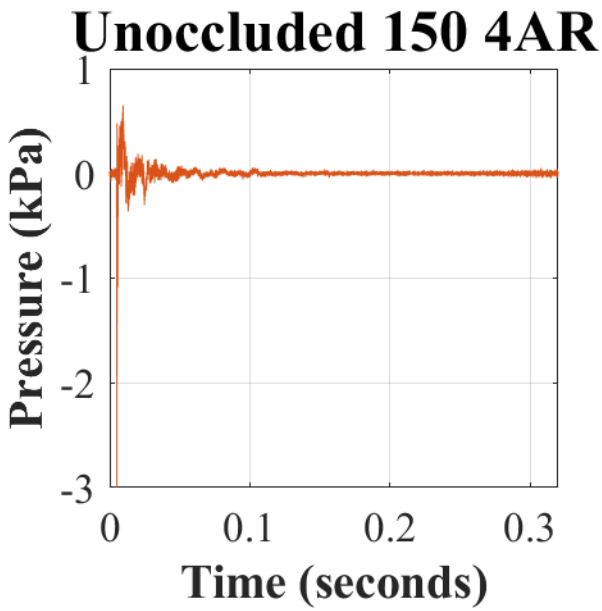

Unoccluded 150 3AL
Pressure (kPa)
1
0
-1
-2
-3
0
0.1
0.2
0.3
Time (seconds)

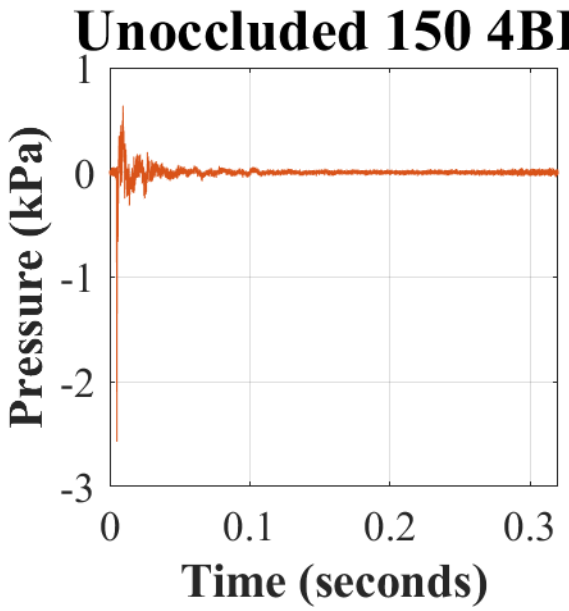

Unoccluded 150 3AR
Pressure (kPa)
1
0
-1
-2
-3
0
0.1
0.2
0.3
Time (seconds)

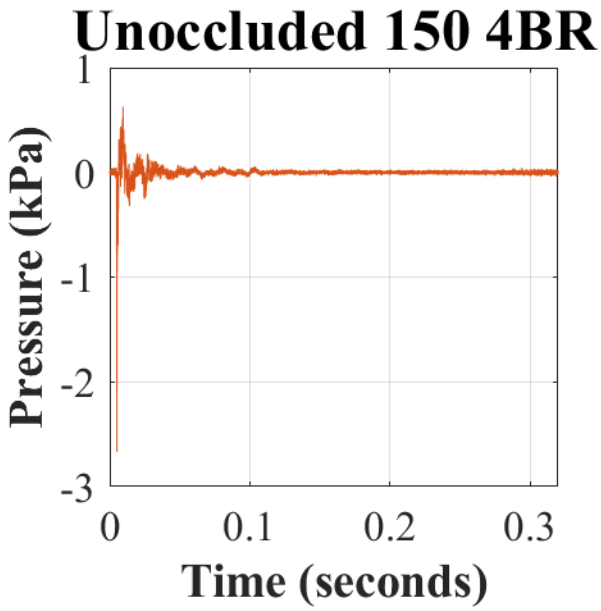

Unoccluded 150 3BL
Pressure (kPa)
1
0
-1
-2
-3
0
0.1
0.2
0.3
Time (seconds)

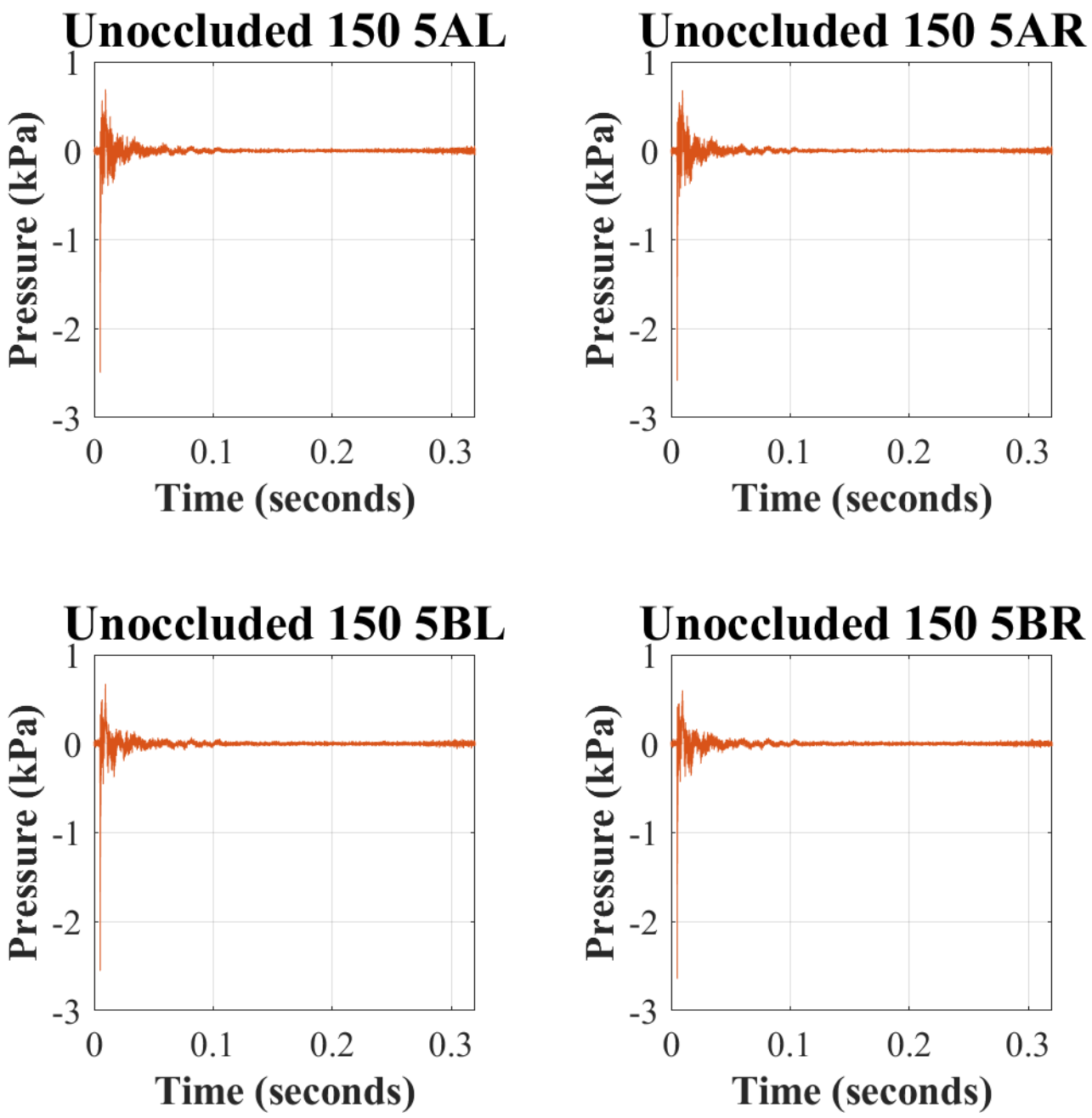

Unoccluded 150 3BR
Pressure (kPa)
1
0
-1
-2
-3
0
0.1
0.2
0.3
Time (seconds)


Unoccluded 150 4AL
Pressure (kPa)
1
0
-1
-2
-3
0
0.1
0.2
0.3
Time (seconds)


Unoccluded 150 4AR
Pressure (kPa)
1
0
-1
-2
-3
0
0.1
0.2
0.3
Time (seconds)

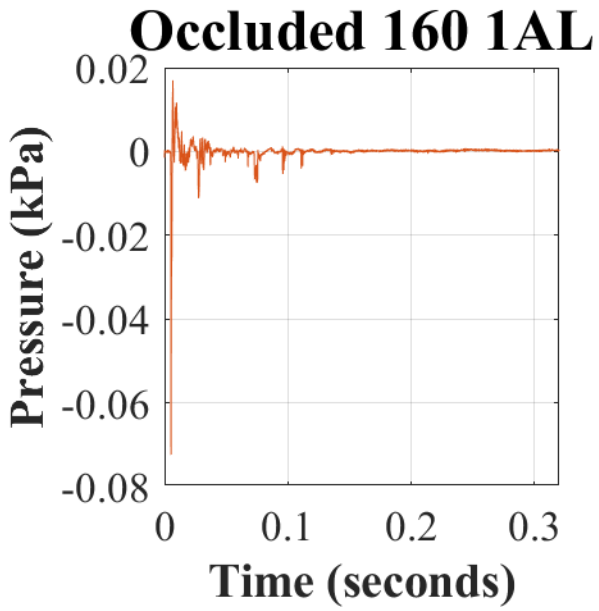

Unoccluded 150 4BL
Pressure (kPa)
1
0
-1
-2
-3
0
0.1
0.2
0.3
Time (seconds)

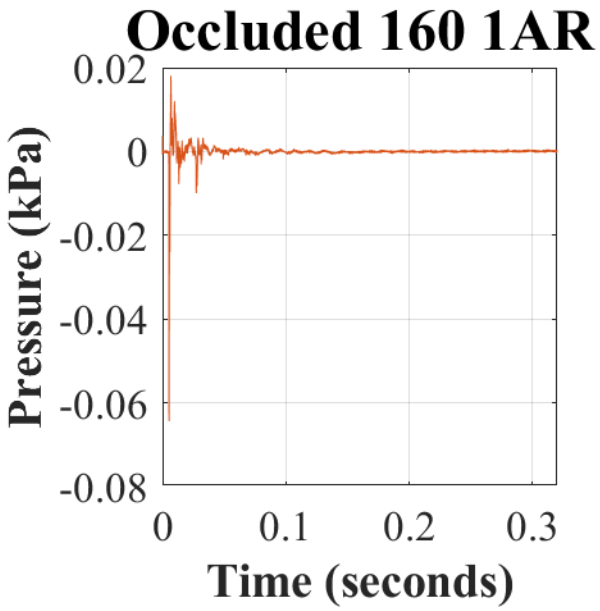

Unoccluded 150 4BR
Pressure (kPa)
1
0
-1
-2
-3
0
0.1
0.2
0.3
Time (seconds)

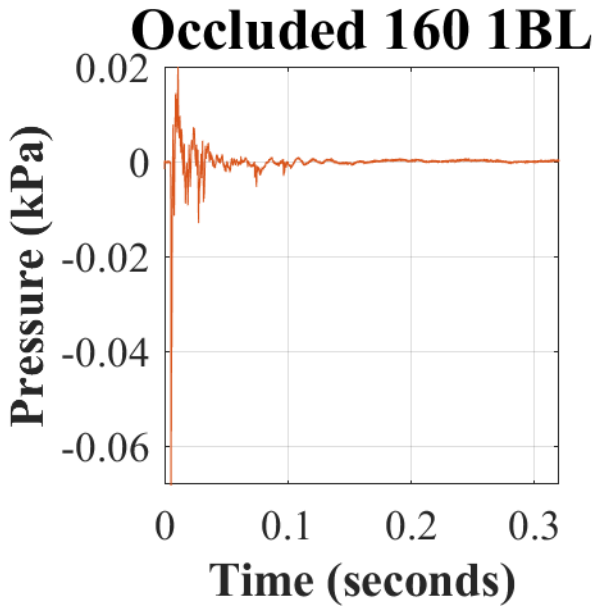


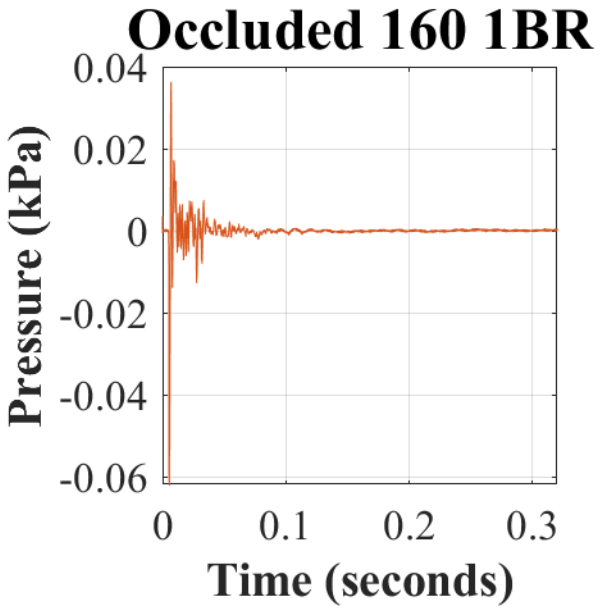
Note. The naming convention for all unoccluded waveforms is "Unoccluded LvL NnX", where 'Unoccluded' is the test condition (i.e., ATF has the HPD doffed), 'LvL' is the nominal test level (i.e., 150, 160 or 170 dBP), 'N' is the sample number (i.e., 1 to 5) of the device tested, 'n' is the trial (i.e., A or B) indicating HPD fit (i.e., first or second, respectively), and 'X' indicates from what ATF microphone the recording is from (i.e., right ([R] or left [L] pinnae).

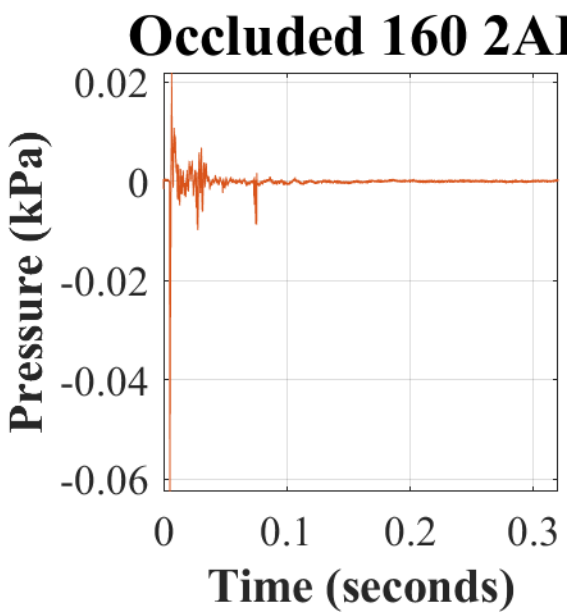
Appendix L. Recorded occluded (closed-ear) waveforms (in pascals [Pa] or kilopascals [kPa]) over time (in seconds [s]) in response to 160 dBP with the EP7 in the cap closed mode.

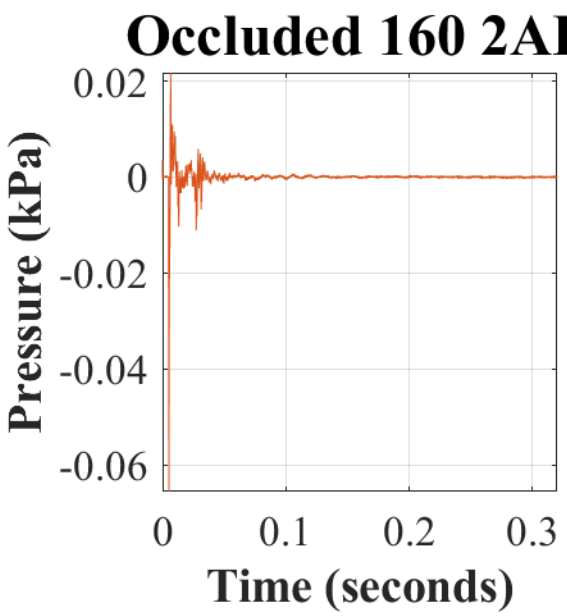


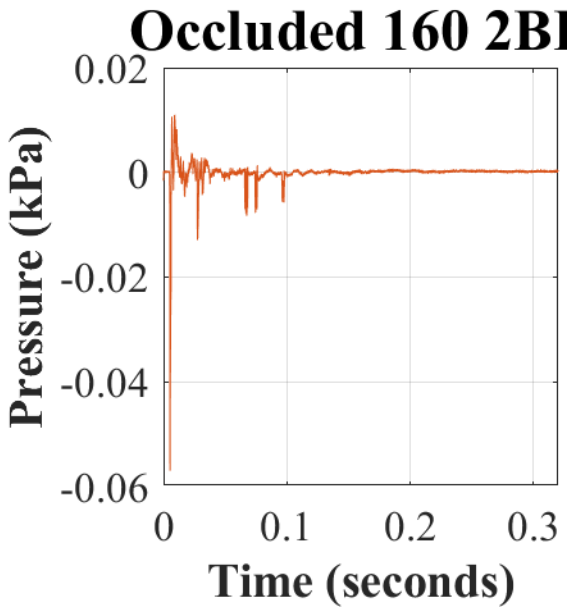


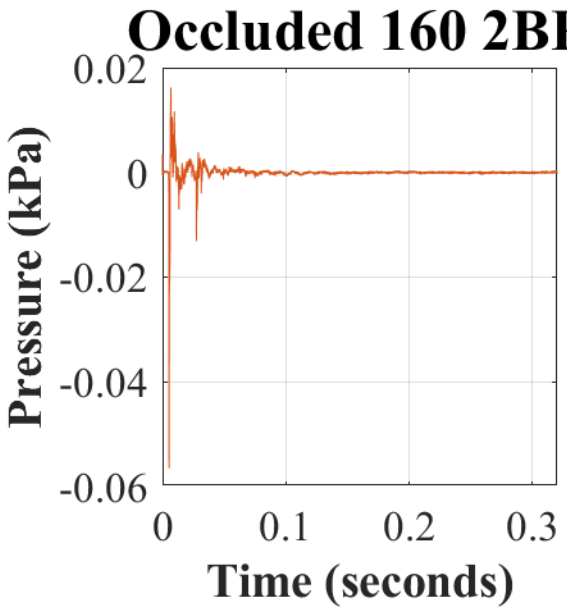


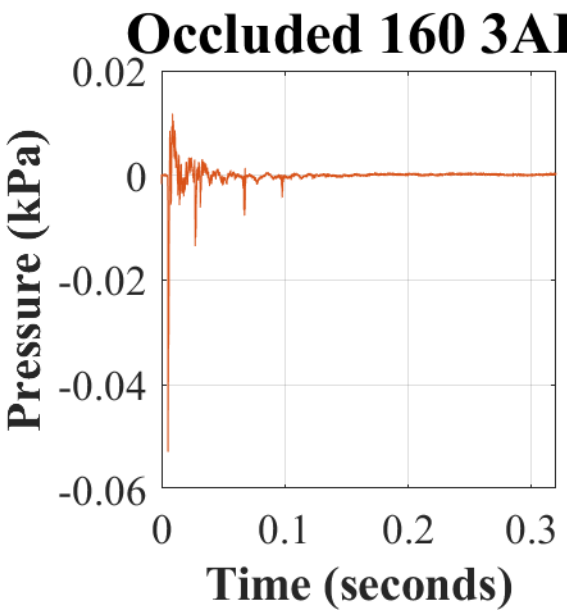


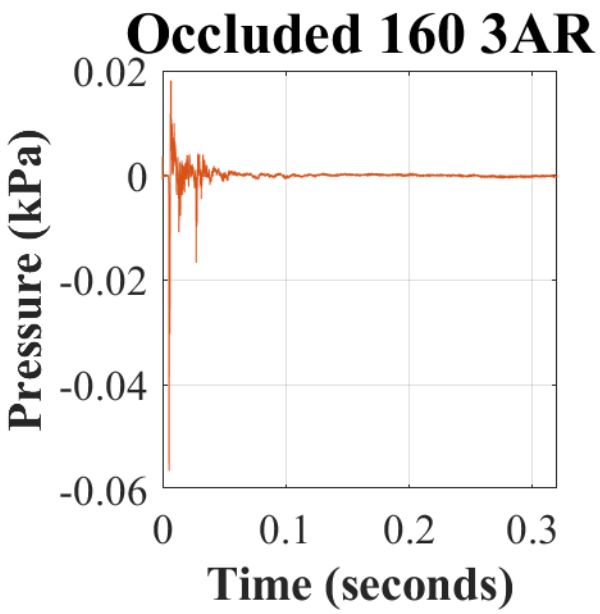

Occluded 160 2AL
Pressure (kPa)
0.02
0
-0.02
-0.04
-0.06
0
0.1
0.2
0.3
Time (seconds)

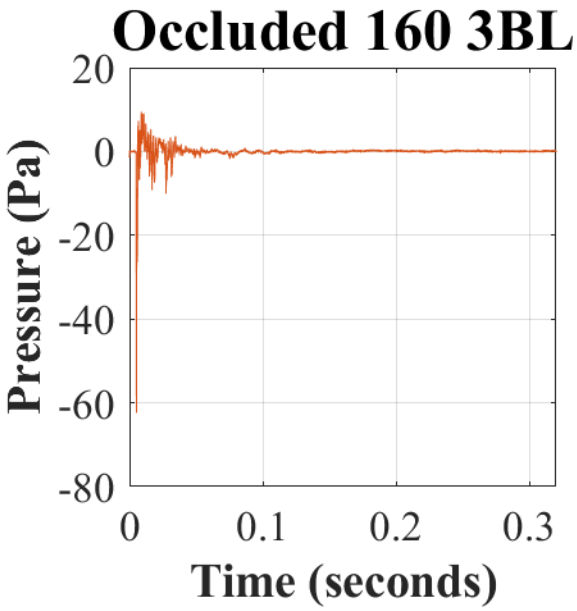

Occluded 160 2AR
Pressure (kPa)
0.02
0
-0.02
-0.04
-0.06
0
0.1
0.2
0.3
Time (seconds)

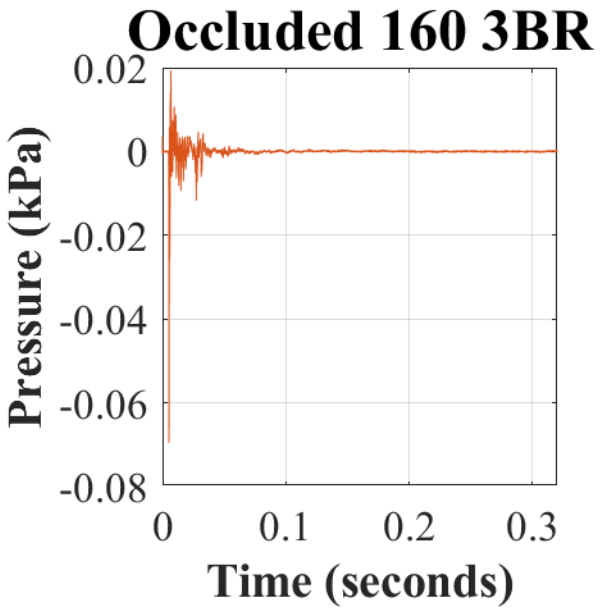

Occluded 160 2BL
Pressure (kPa)
0.02
0
-0.02
-0.04
-0.06
0
0.1
0.2
0.3
Time (seconds)

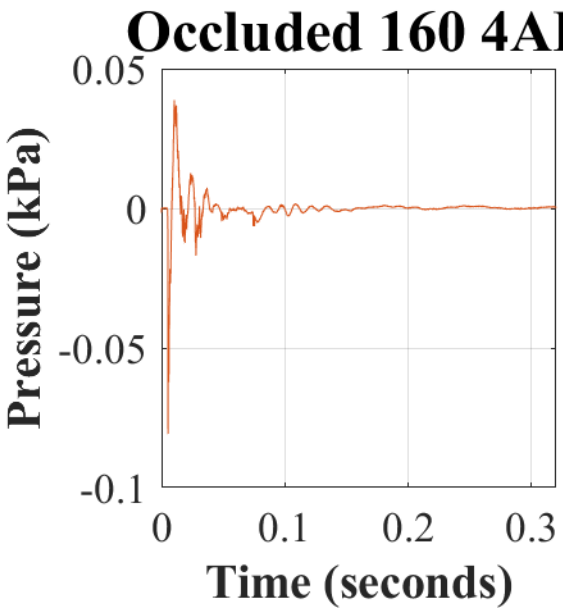

Occluded 160 2BR
Pressure (kPa)
0.02
0
-0.02
-0.04
-0.06
0
0.1
0.2
0.3
Time (seconds)

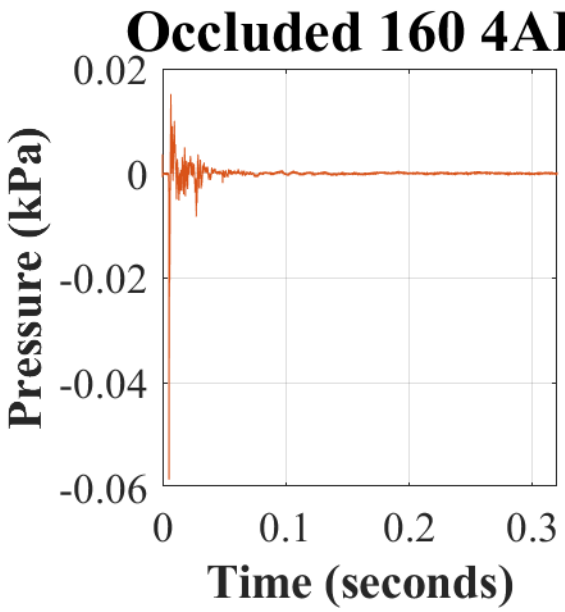

Occluded 160 3AL
Pressure (kPa)
0.02
0
-0.02
-0.04
-0.06
0
0.1
0.2
0.3
Time (seconds)

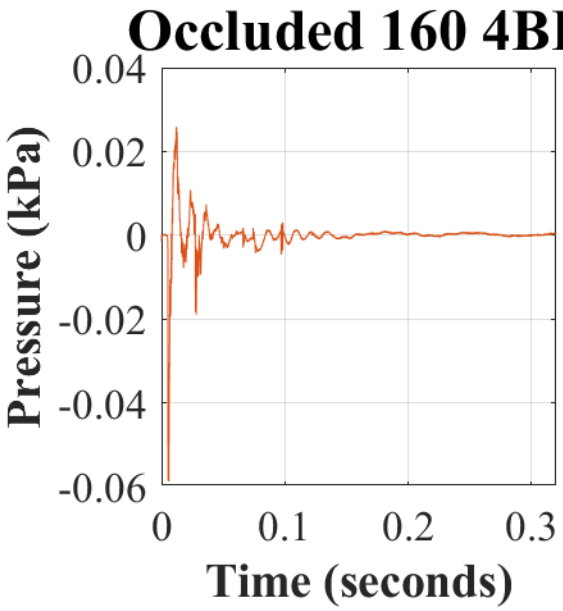

Occluded 160 3AR
Pressure (kPa)
0.02
0
-0.02
-0.04
-0.06
0
0.1
0.2
0.3
Time (seconds)

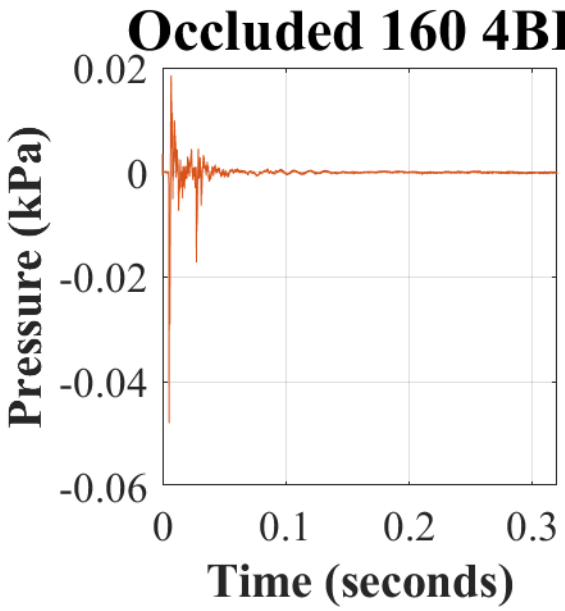

Occluded 160 3BL
Pressure (Pa)
20
0
-20
-40
-60
-80
0
0.1
0.2
0.3
Time (seconds)

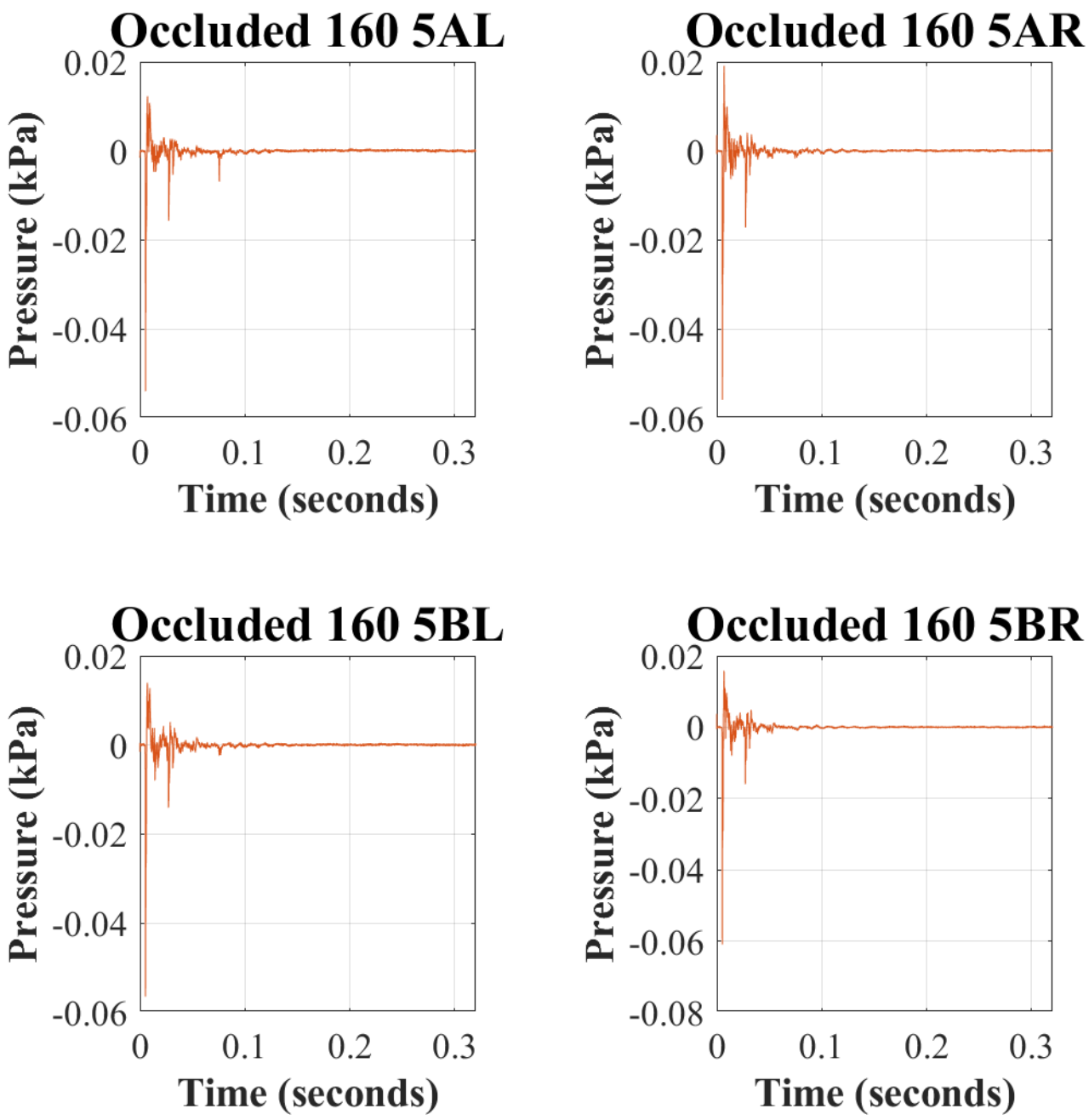

Occluded 160 3BR
Pressure (kPa)
0.02
0
-0.02
-0.04
-0.06
-0.08
0
0.1
0.2
0.3
Time (seconds)


Occluded 160 4AL
Pressure (kPa)
0.05
0
-0.05
-0.1
0
0.1
0.2
0.3
Time (seconds)


Occluded 160 4AR
Pressure (kPa)
0.02
0
-0.02
-0.04
-0.06
0
0.1
0.2
0.3
Time (seconds)

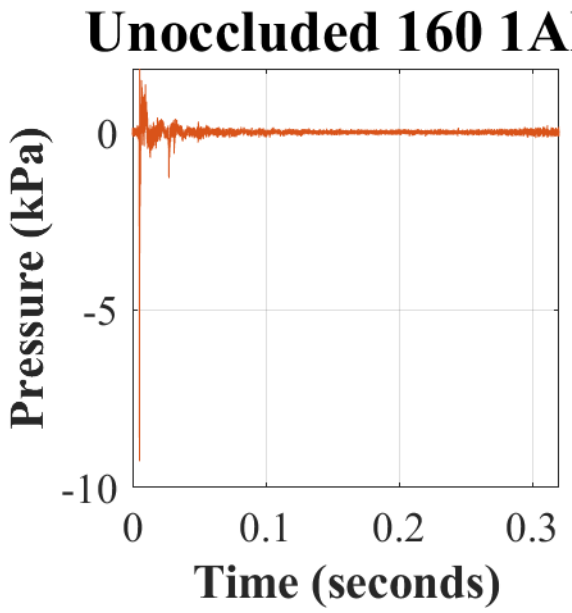

Occluded 160 4BL
Pressure (kPa)
0.04
0.02
0
-0.02
-0.04
-0.06
0
0.1
0.2
0.3
Time (seconds)

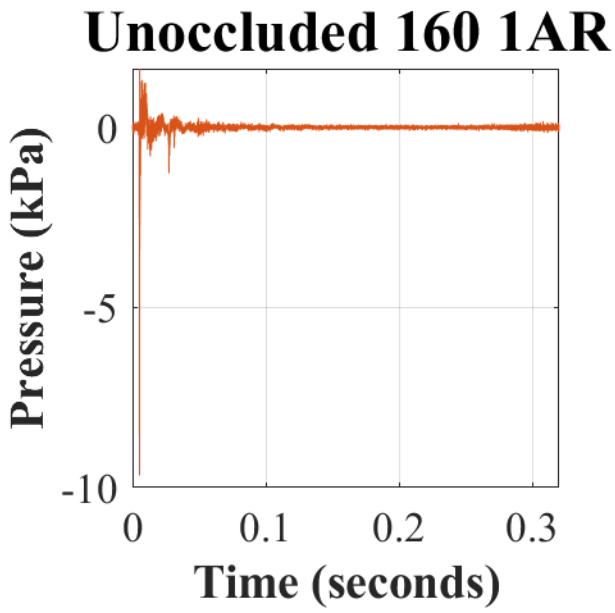

Occluded 160 4BR
Pressure (kPa)
0.02
0
-0.02
-0.04
-0.06
0
0.1
0.2
0.3
Time (seconds)

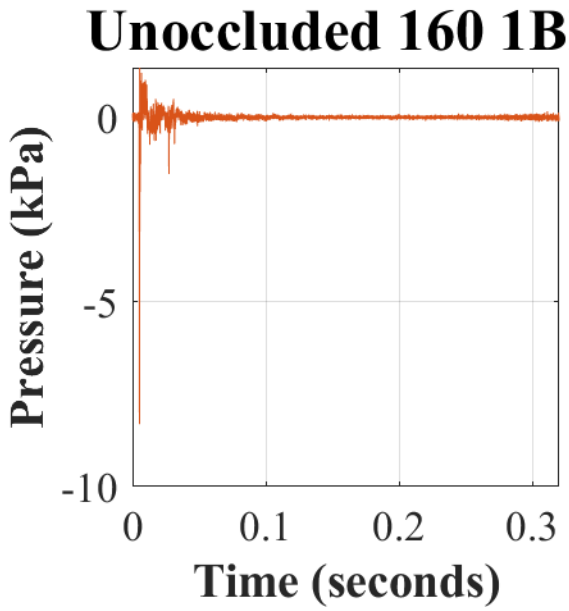


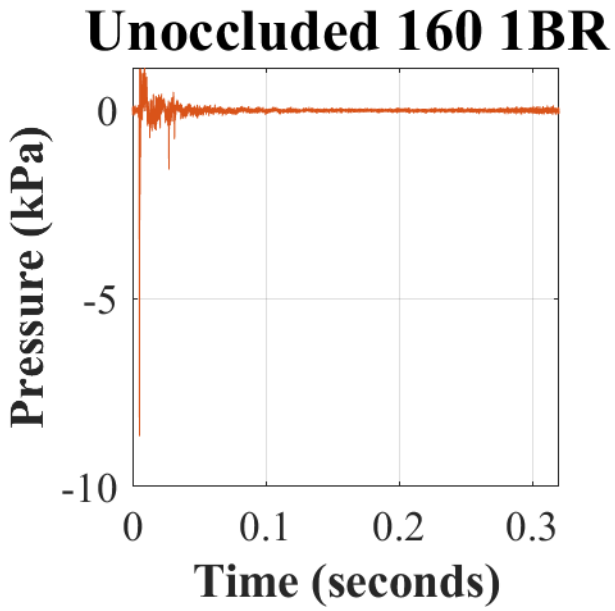
Note. The naming convention for all occluded waveforms is “Occluded LvL NnX”, where ‘Occluded’ is the test condition (i.e., ATF has the HPD donned), ‘LvL’ is the nominal test level (i.e., 150, 160 or 170 dBP), ‘N’ is the sample number (i.e., 1 to 5) of the device tested, ‘n’ is the trial (i.e., A or B) indicating HPD fit (i.e., first or second, respectively), and ‘X’ indicates from what ATF microphone the recording is from (i.e., right [R] or left [L] pinnae).

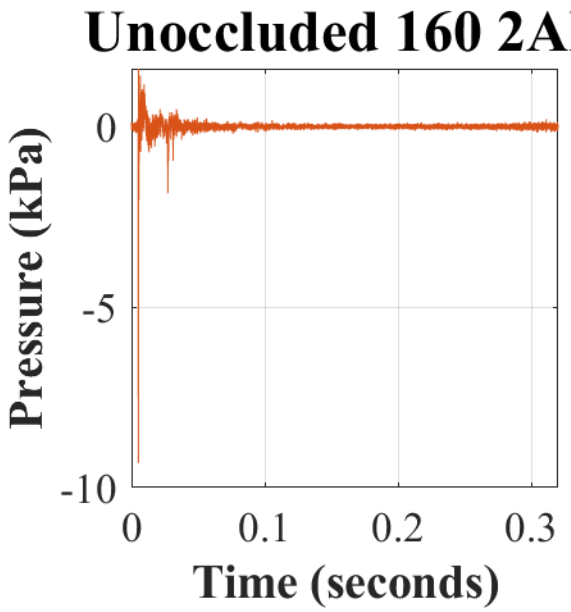
Appendix M. Estimated unoccluded (open-ear) waveforms (in kilopascals [kPa]) over time (in seconds [s]) in response to 160 dBP with the EP7 in the cap closed mode.

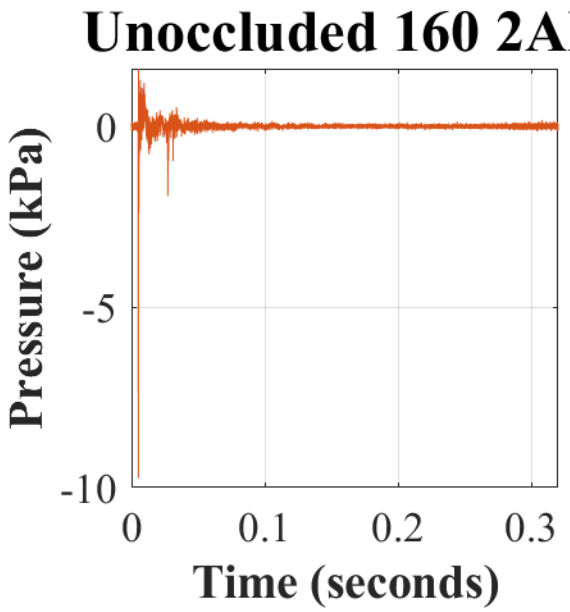


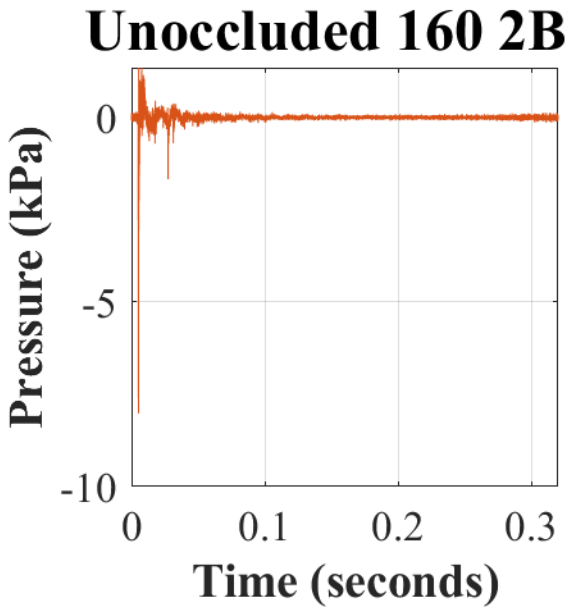


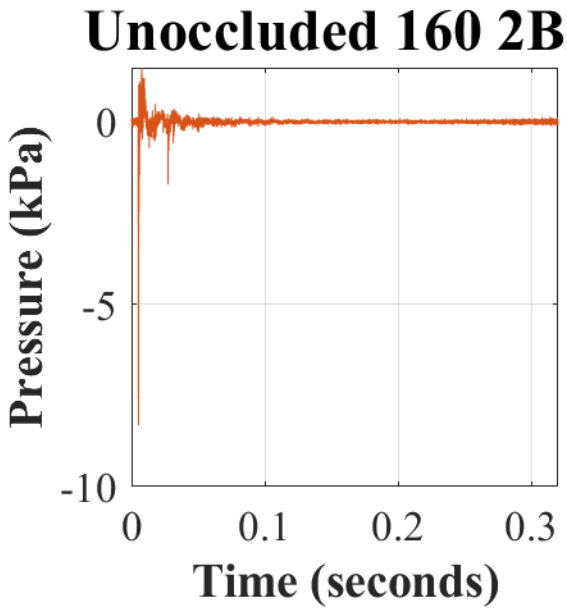


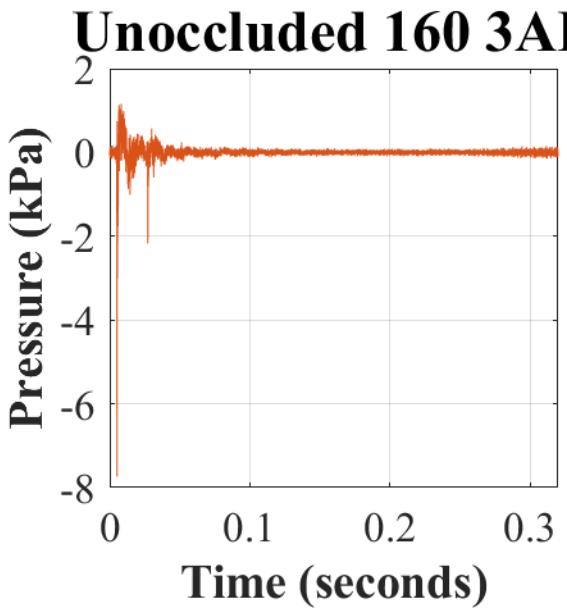


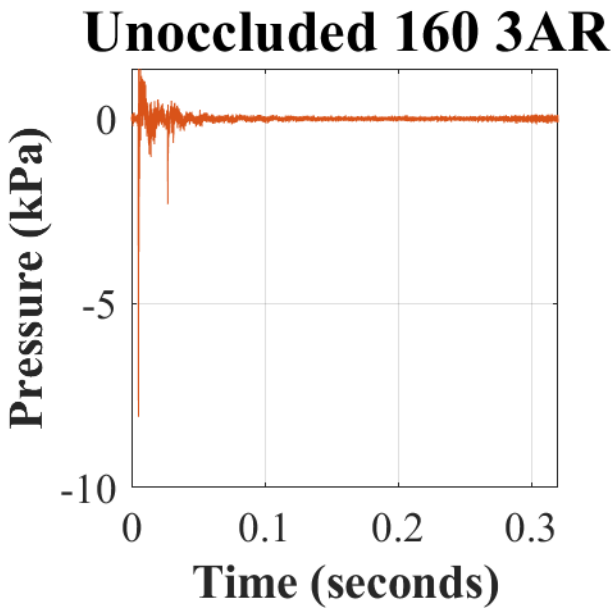

Unoccluded 160 2AL
Pressure (kPa)
0
-5
-10
0
0.1
0.2
0.3
Time (seconds)

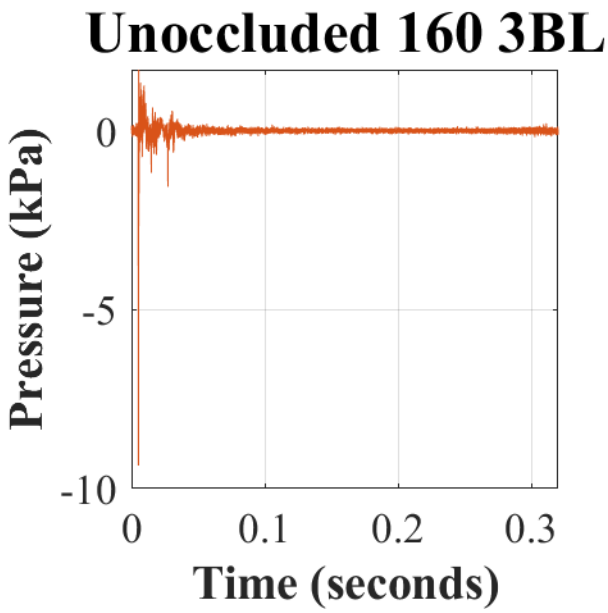

Unoccluded 160 2AR
Pressure (kPa)
0
-5
-10
0
0.1
0.2
0.3
Time (seconds)

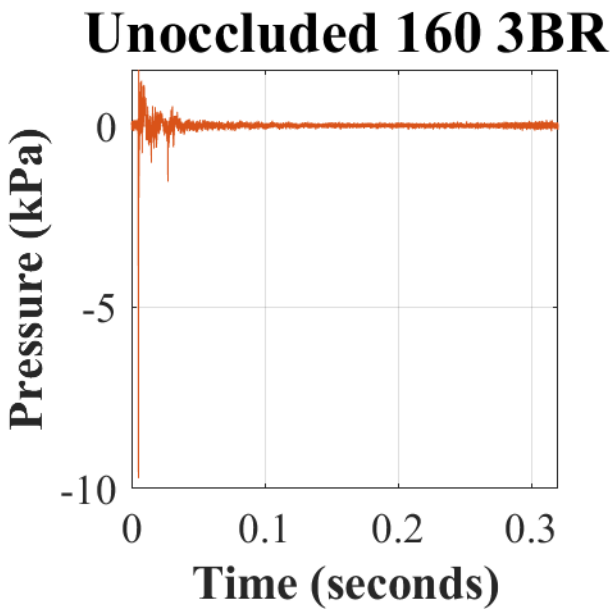

Unoccluded 160 2BL
Pressure (kPa)
0
-5
-10
0
0.1
0.2
0.3
Time (seconds)

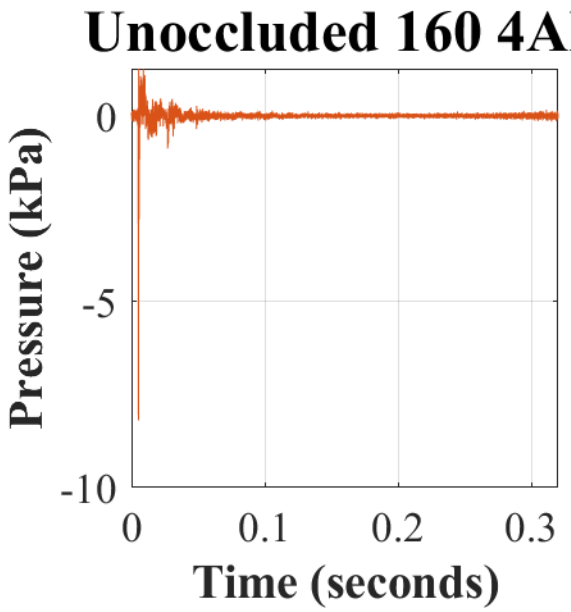

Unoccluded 160 2BR
Pressure (kPa)
0
-5
-10
0
0.1
0.2
0.3
Time (seconds)

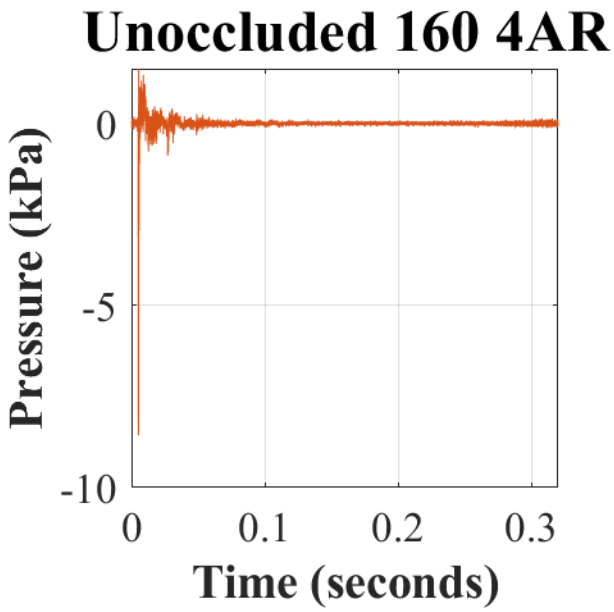

Unoccluded 160 3AL
Pressure (kPa)
2
0
-2
-4
-6
-8
0
0.1
0.2
0.3
Time (seconds)

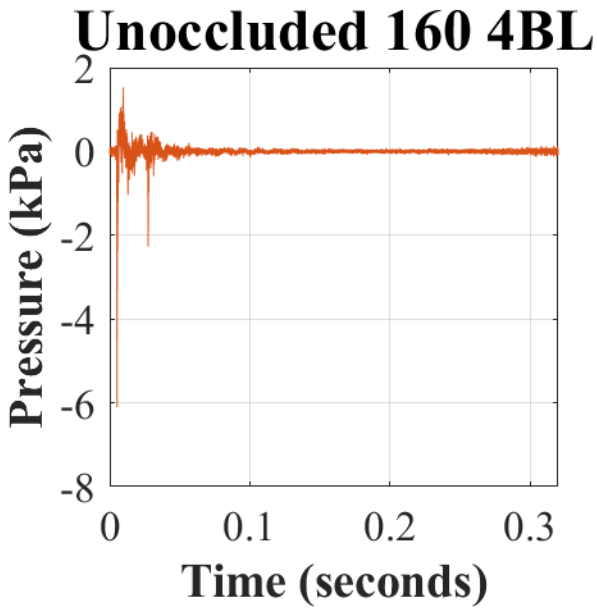

Unoccluded 160 3AR
Pressure (kPa)
0
-5
-10
0
0.1
0.2
0.3
Time (seconds)

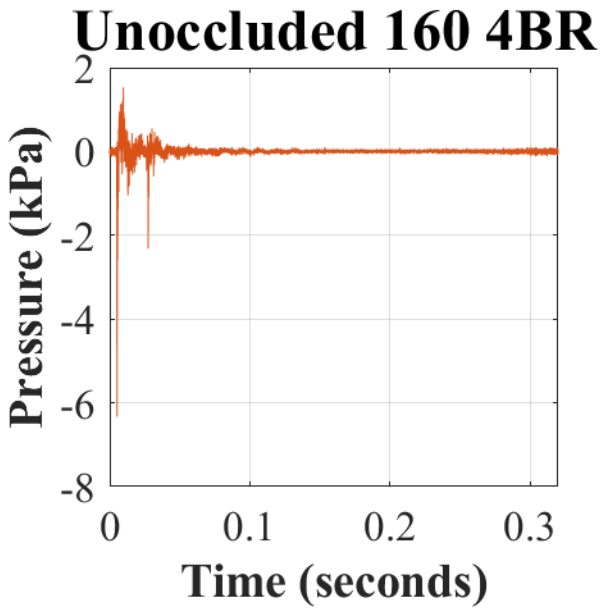

Unoccluded 160 3BL
Pressure (kPa)
0
-5
-10
0
0.1
0.2
0.3
Time (seconds)

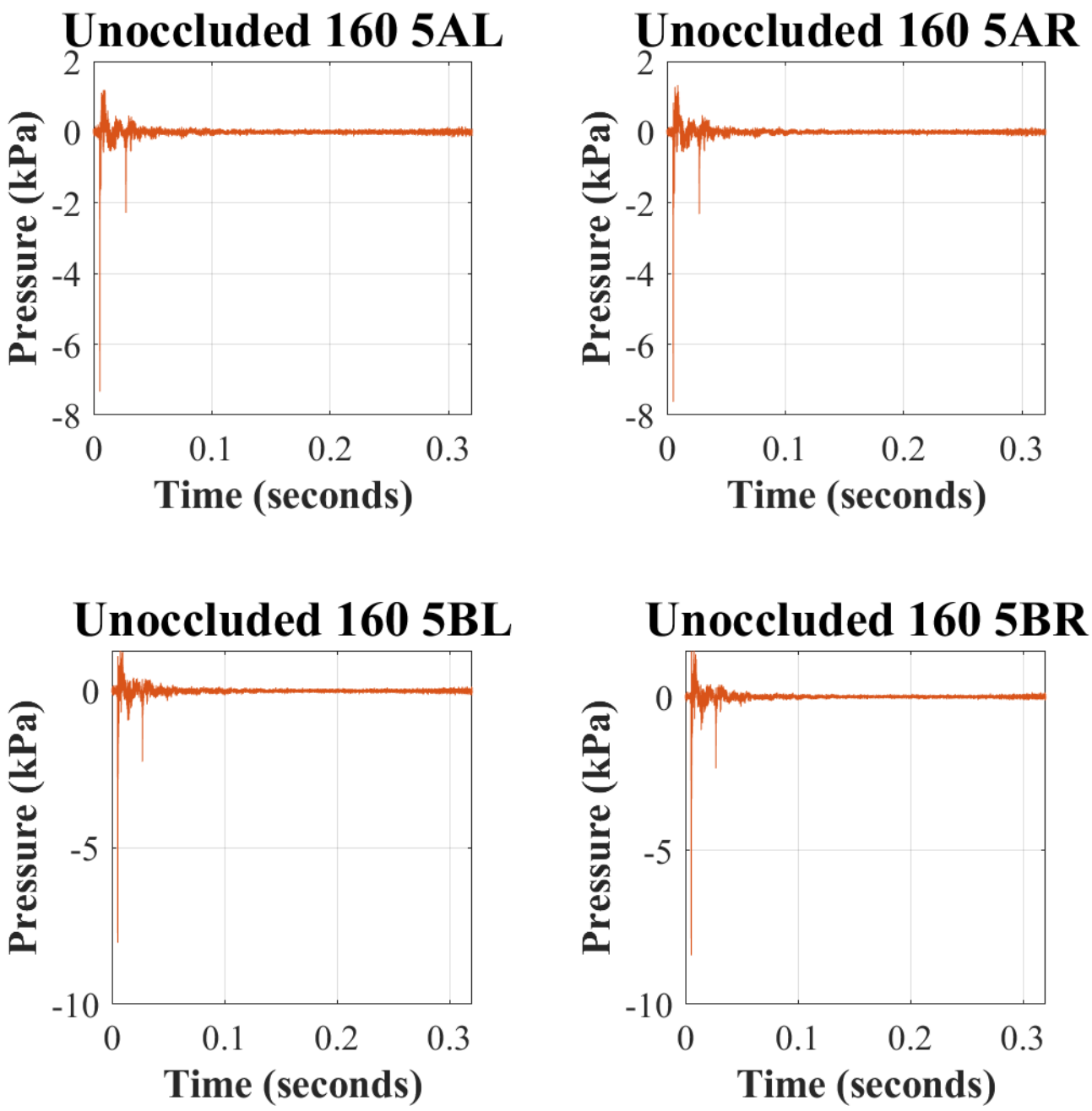

Unoccluded 160 3BR
Pressure (kPa)
0
-5
-10
0
0.1
0.2
0.3
Time (seconds)


Unoccluded 160 4AL
Pressure (kPa)
0
-5
-10
0
0.1
0.2
0.3
Time (seconds)


Unoccluded 160 4AR
Pressure (kPa)
0
-5
-10
0
0.1
0.2
0.3
Time (seconds)

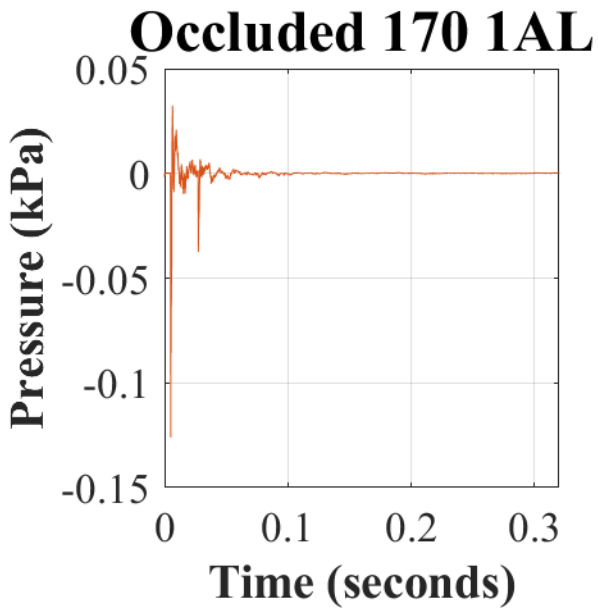

Unoccluded 160 4BL
Pressure (kPa)
2
0
-2
-4
-6
-8
0
0.1
0.2
0.3
Time (seconds)

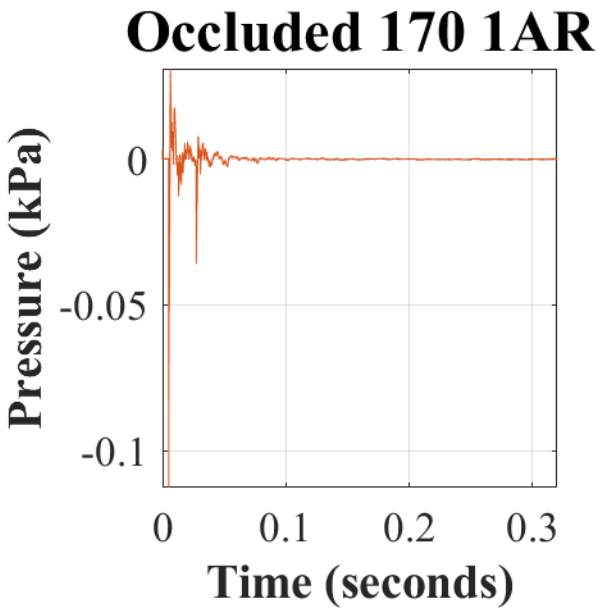

Unoccluded 160 4BR
Pressure (kPa)
2
0
-2
-4
-6
-8
0
0.1
0.2
0.3
Time (seconds)

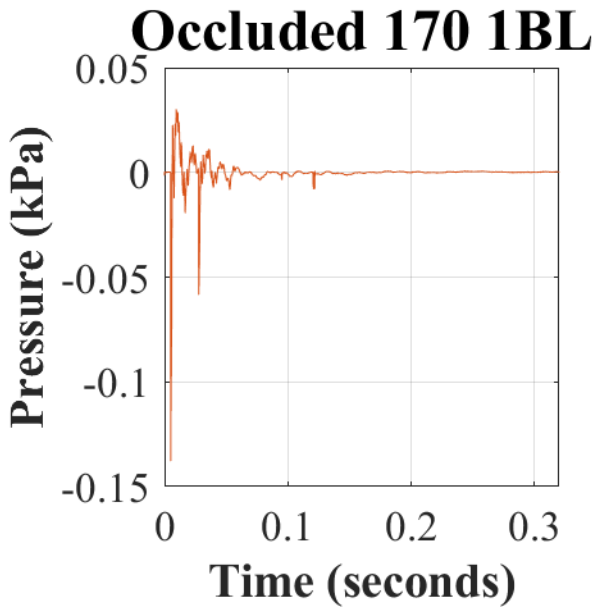


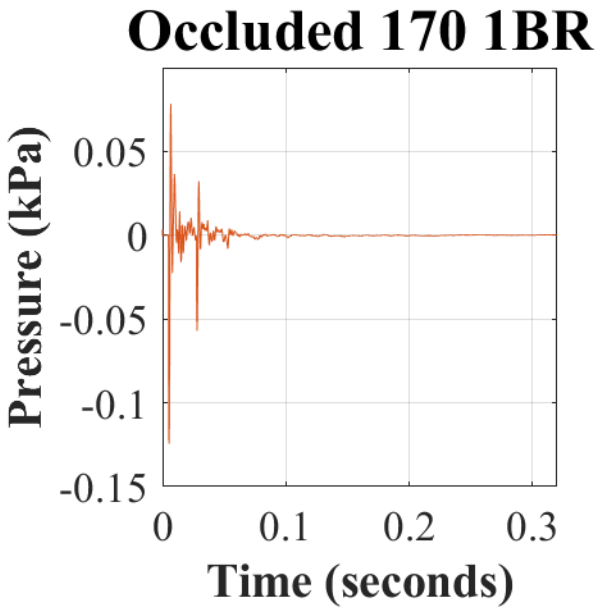
Note. The naming convention for all unoccluded waveforms is "Unoccluded LvL NnX", where 'Unoccluded' is the test condition (i.e., ATF has the HPD doffed), 'LvL' is the nominal test level (i.e., 150, 160 or 170 dBP), 'N' is the sample number (i.e., 1 to 5) of the device tested, 'n' is the trial (i.e., A or B) indicating HPD fit (i.e., first or second, respectively), and 'X' indicates from what ATF microphone the recording is from (i.e., right [R] or left [L] pinnae).

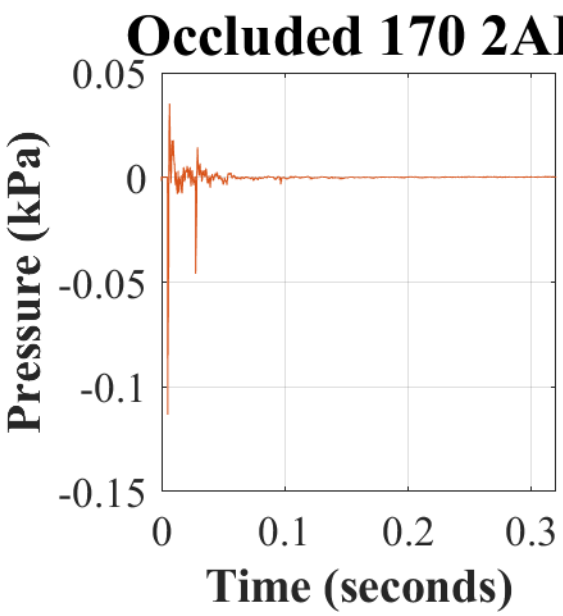
Appendix N. Recorded occluded (closed-ear) waveforms (in kilopascals [kPa]) over time (in seconds [s]) in response to 170 dBP with the EP7 in the cap closed mode.

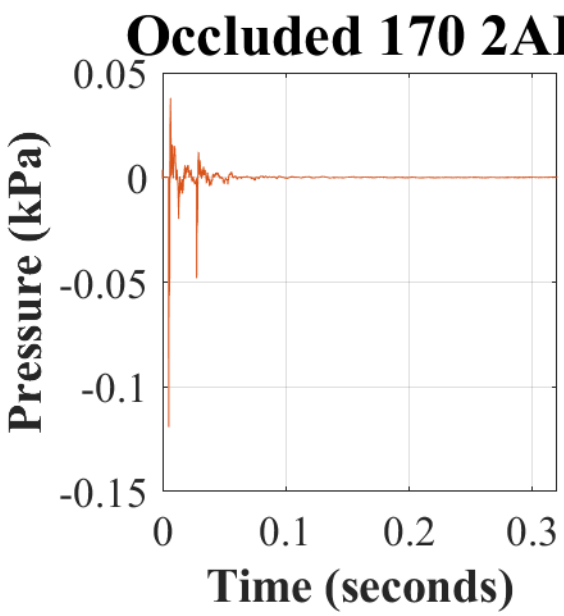


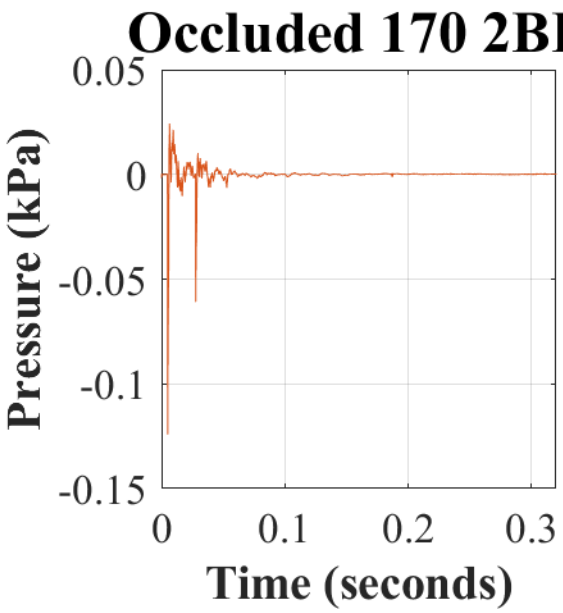


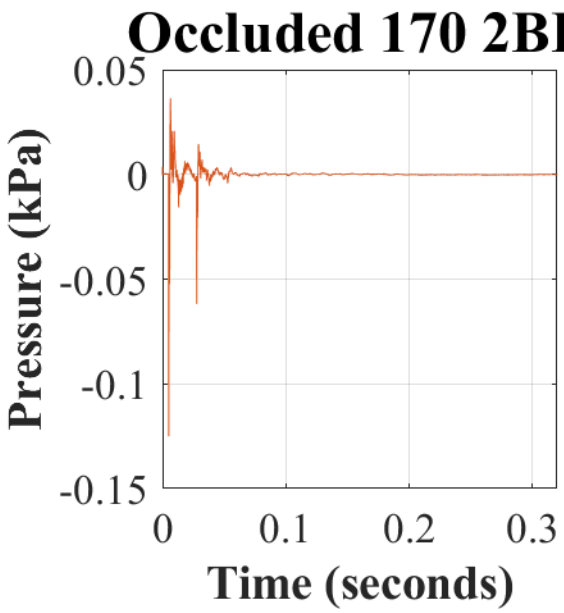


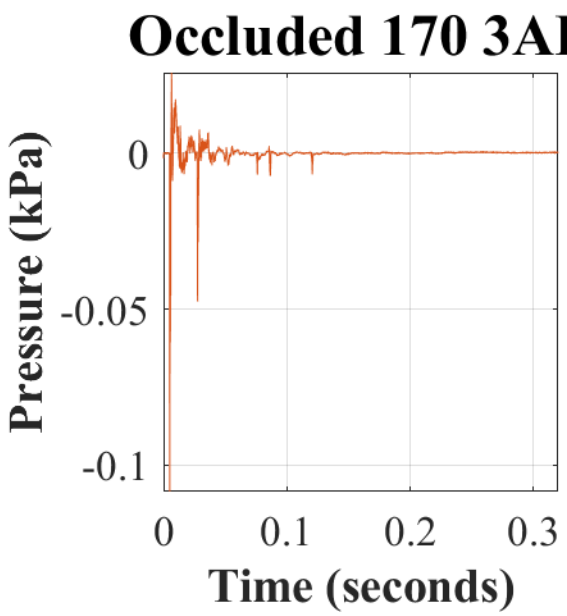


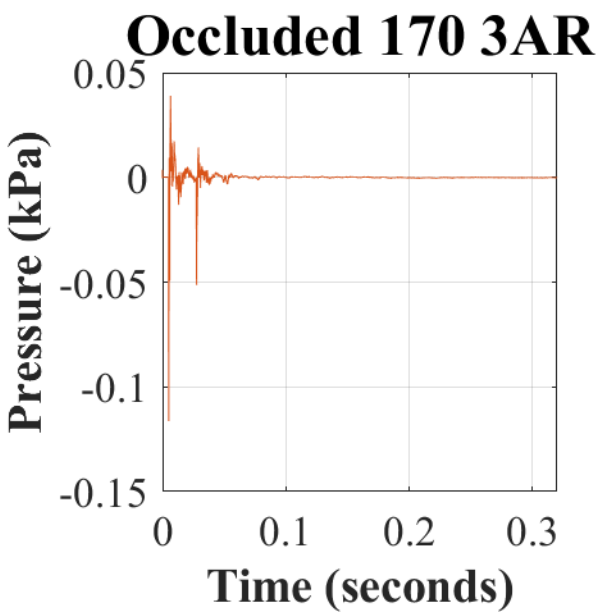

Occluded 170 2AL
Pressure (kPa)
0.05
0
-0.05
-0.1
-0.15
0
0.1
0.2
0.3
Time (seconds)

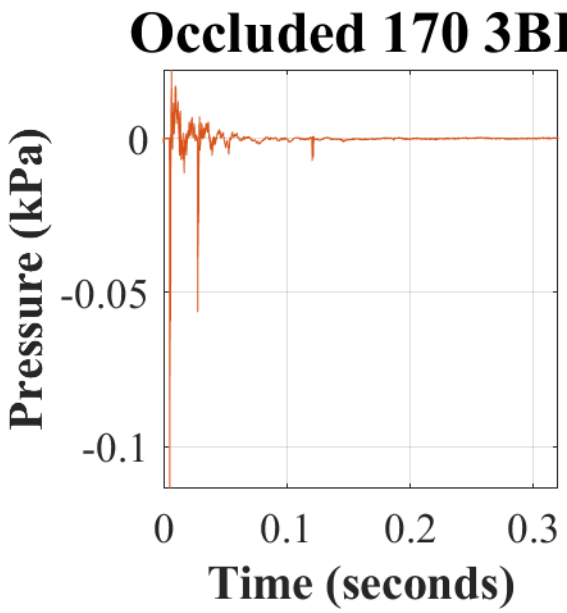

Occluded 170 2AR
Pressure (kPa)
0.05
0
-0.05
-0.1
-0.15
0
0.1
0.2
0.3
Time (seconds)

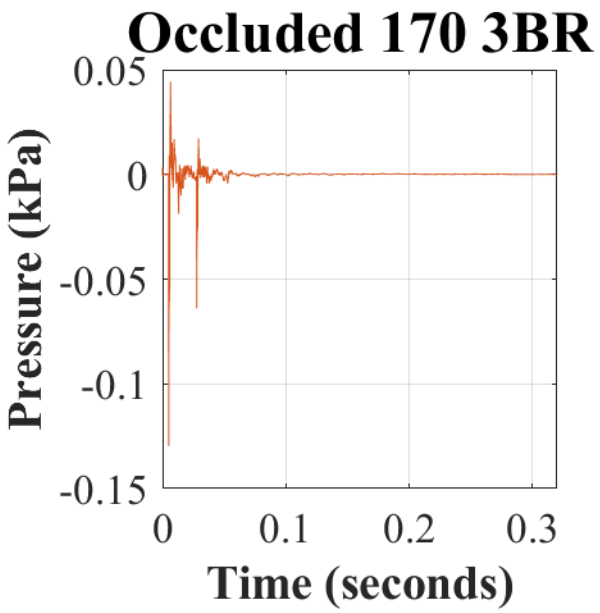

Occluded 170 2BL
Pressure (kPa)
0.05
0
-0.05
-0.1
-0.15
0
0.1
0.2
0.3
Time (seconds)

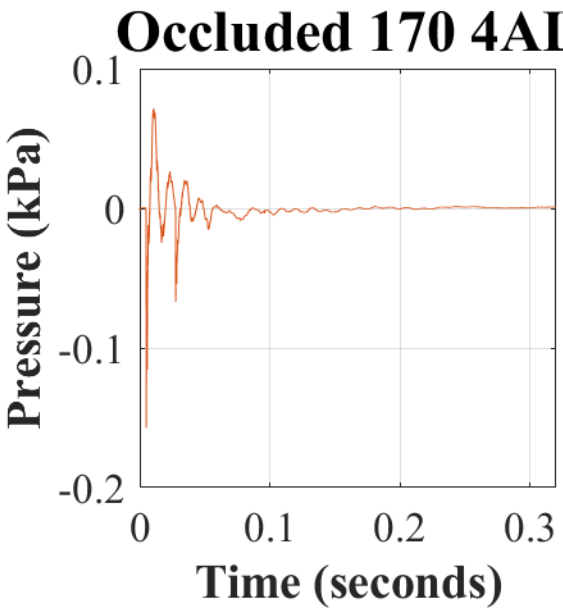

Occluded 170 2BR
Pressure (kPa)
0.05
0
-0.05
-0.1
-0.15
0
0.1
0.2
0.3
Time (seconds)

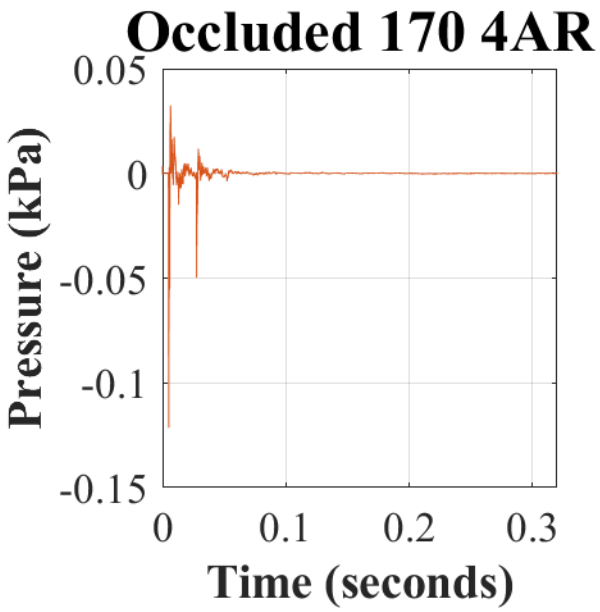

Occluded 170 3AL
Pressure (kPa)
0
-0.05
-0.1
0
0.1
0.2
0.3
Time (seconds)

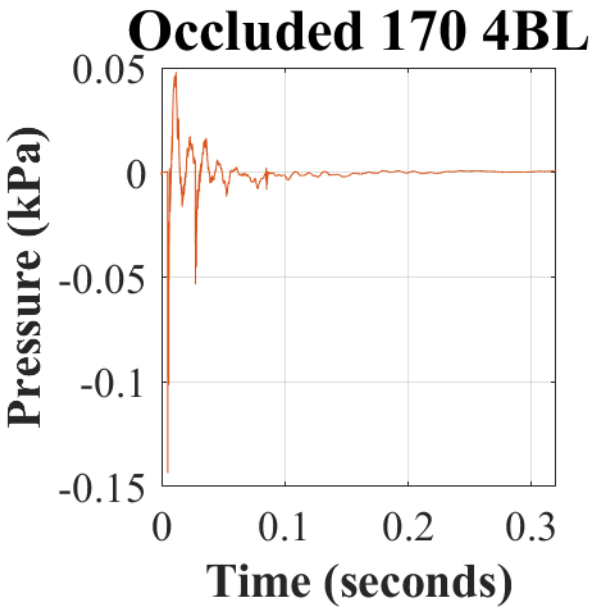

Occluded 170 3AR
Pressure (kPa)
0.05
0
-0.05
-0.1
-0.15
0
0.1
0.2
0.3
Time (seconds)

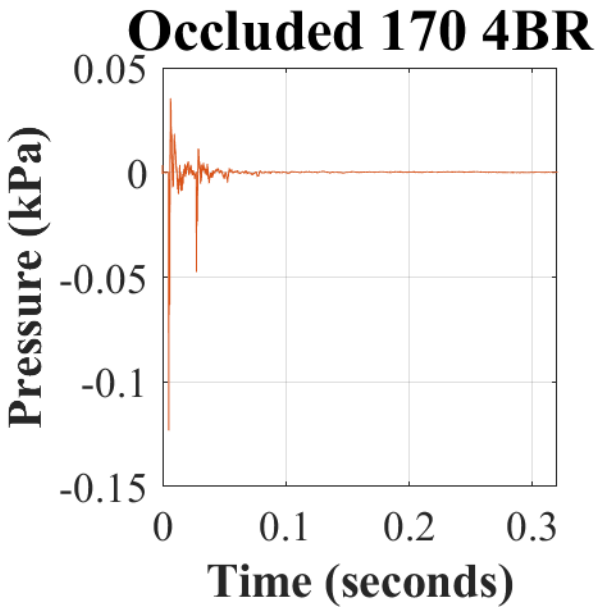

Occluded 170 3BL
Pressure (kPa)
0
-0.05
-0.1
0
0.1
0.2
0.3
Time (seconds)

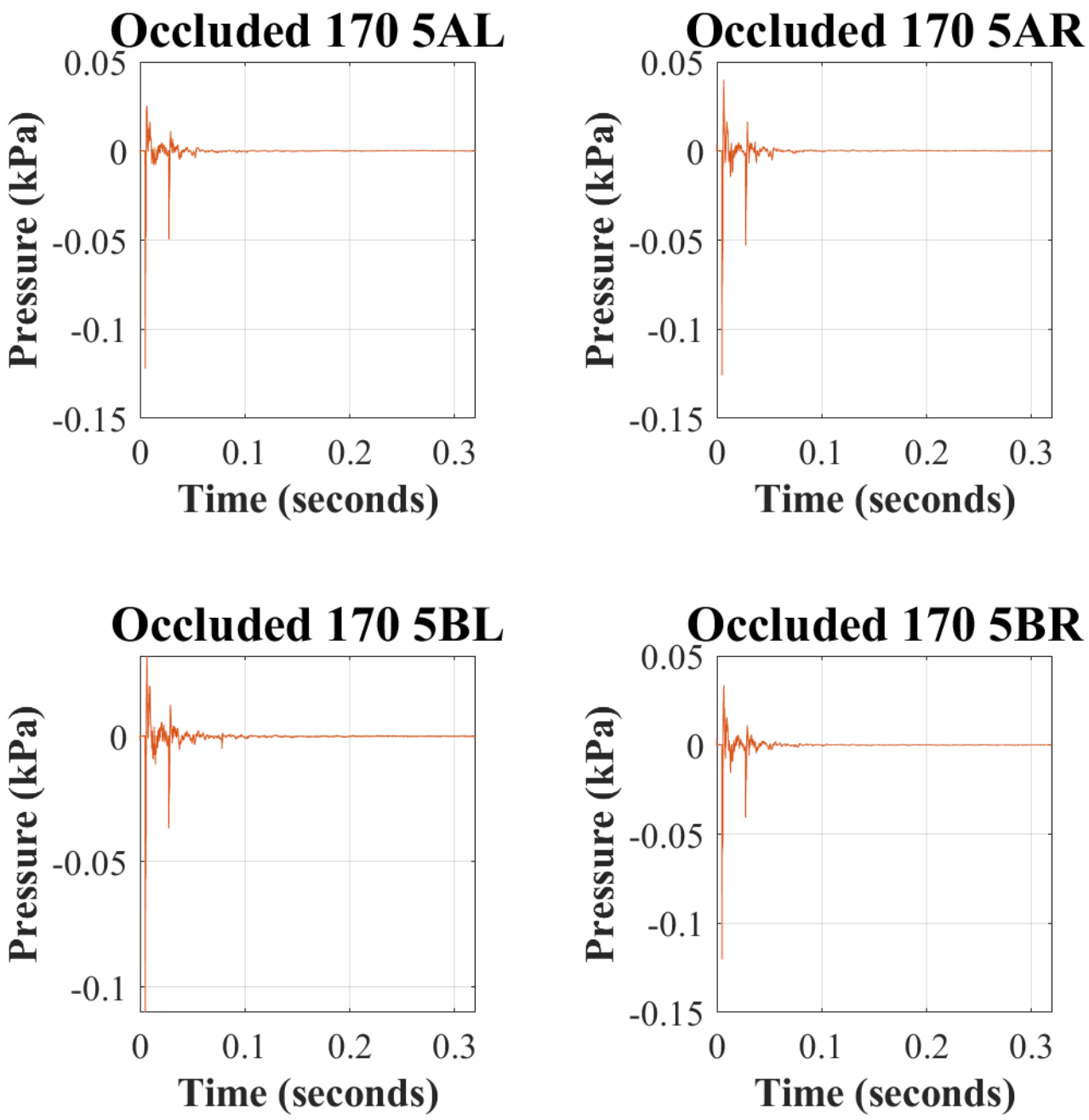

Occluded 170 3BR
Pressure (kPa)
0.05
0
-0.05
-0.1
-0.15
0
0.1
0.2
0.3
Time (seconds)


Occluded 170 4AL
Pressure (kPa)
0.1
0
-0.1
-0.2
0
0.1
0.2
0.3
Time (seconds)


Occluded 170 4AR
Pressure (kPa)
0.05
0
-0.05
-0.1
-0.15
0
0.1
0.2
0.3
Time (seconds)

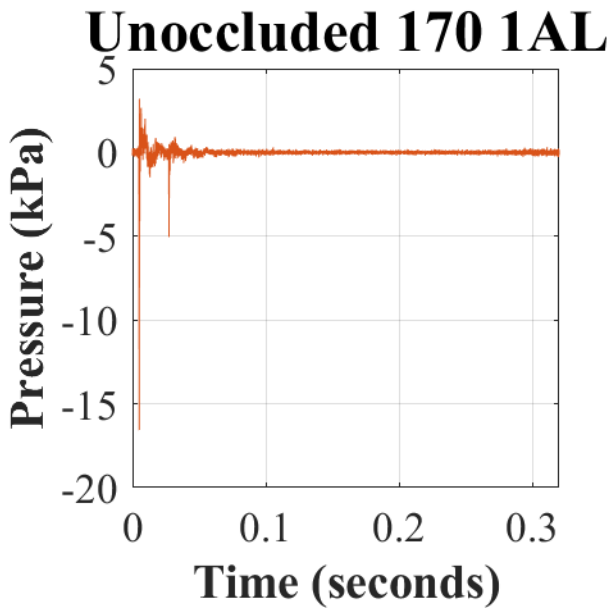

Occluded 170 4BL
Pressure (kPa)
0.05
0
-0.05
-0.1
-0.15
0
0.1
0.2
0.3
Time (seconds)

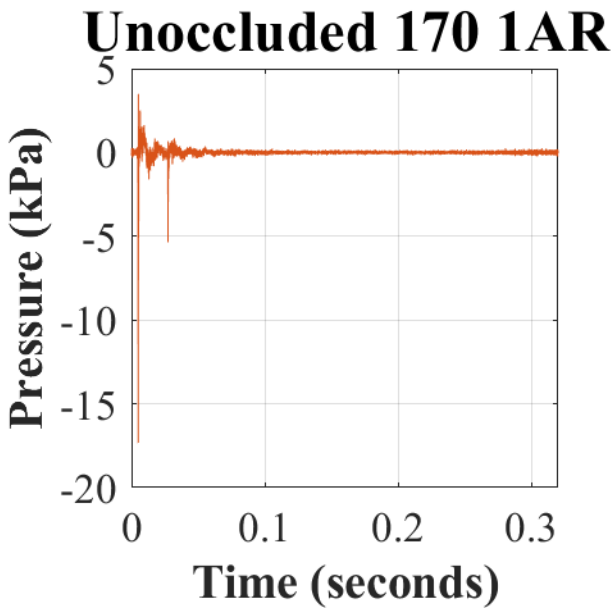

Occluded 170 4BR
Pressure (kPa)
0.05
0
-0.05
-0.1
-0.15
0
0.1
0.2
0.3
Time (seconds)

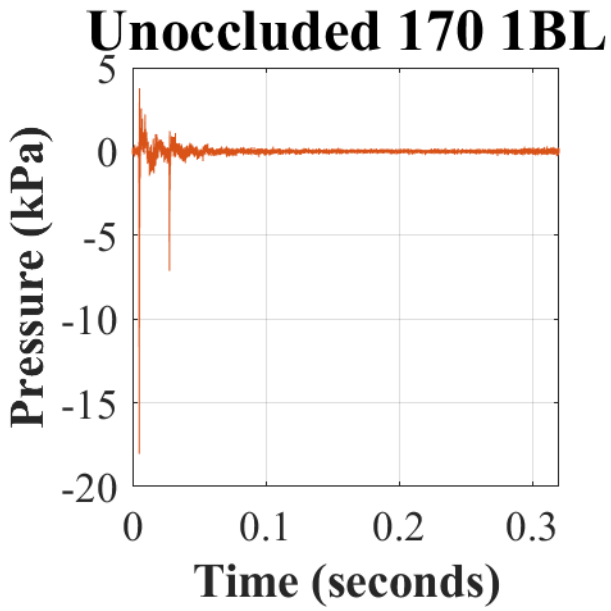


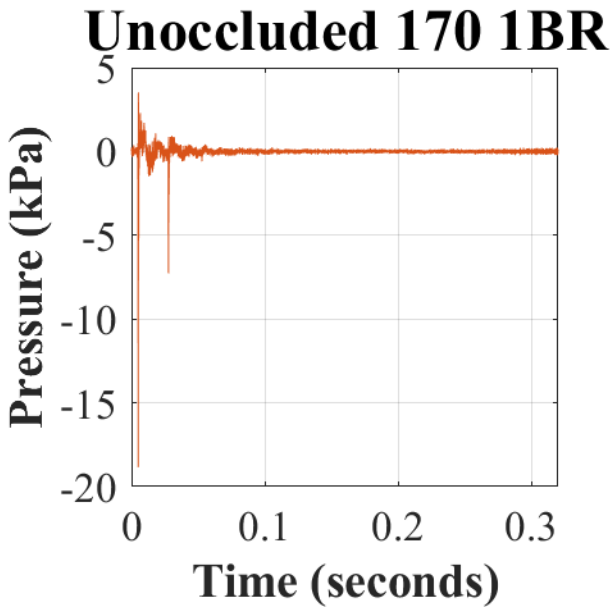
Note. The naming convention for all occluded waveforms is “Occluded LvL NnX”, where ‘Occluded’ is the test condition (i.e., ATF has the HPD donned), ‘LvL’ is the nominal test level (i.e., 150, 160 or 170 dBP), ‘N’ is the sample number (i.e., 1 to 5) of the device tested, ‘n’ is the trial (i.e., A or B) indicating HPD fit (i.e., first or second, respectively), and ‘X’ indicates from what ATF microphone the recording is from (i.e., right [R] or left [L] pinnae).

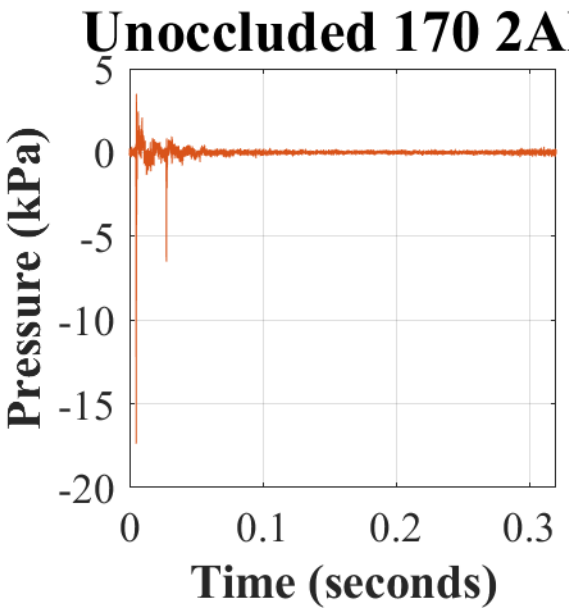
Appendix O. Estimated unoccluded (open-ear) waveforms (in kilopascals [kPa]) over time (in seconds [s]) in response to 170 dBP with the EP7 in the cap closed mode.

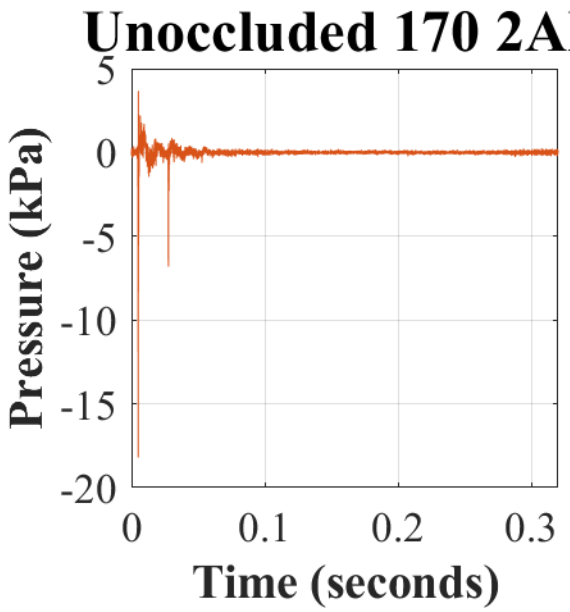


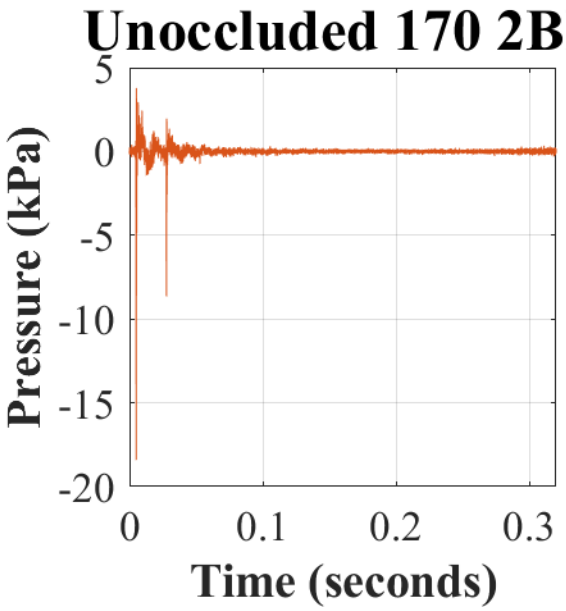


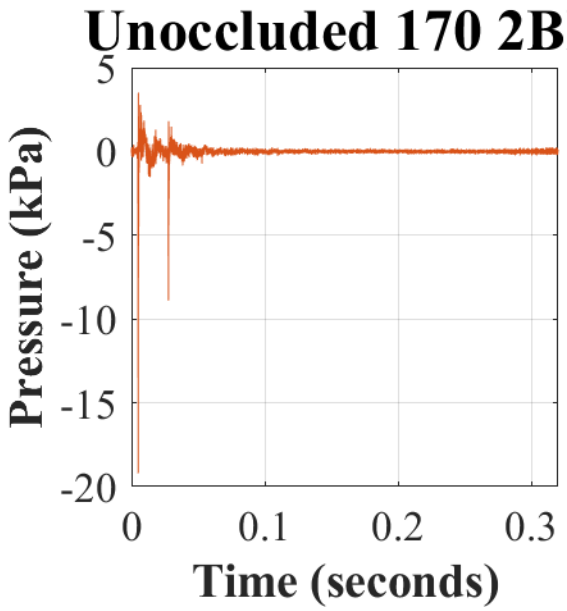


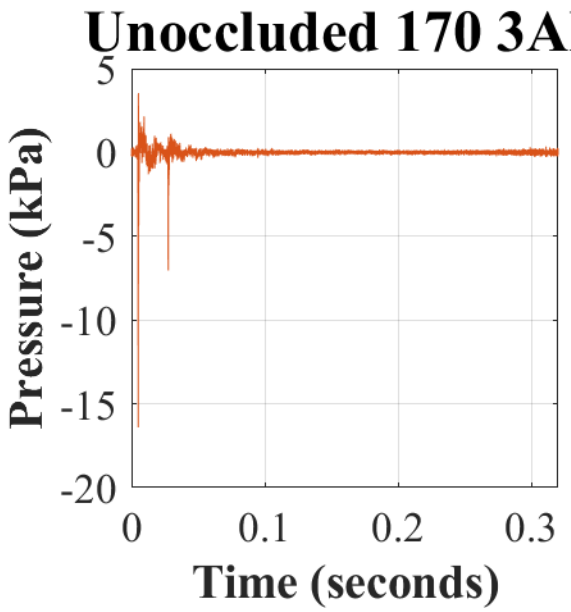


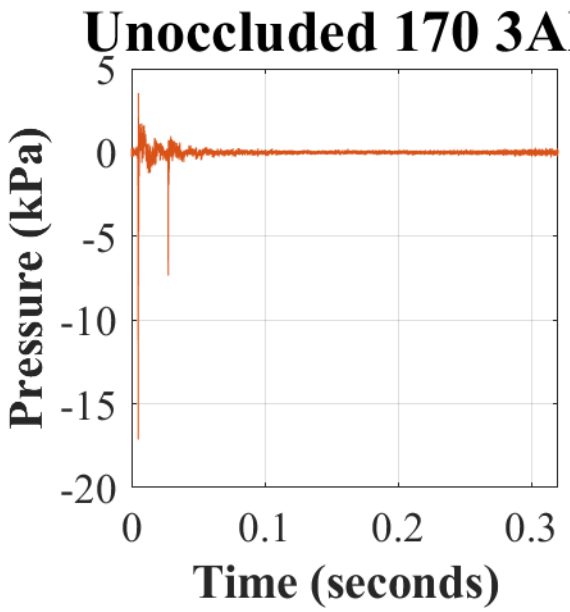

Unoccluded 170 2AL
Pressure (kPa)
5
0
-5
-10
-15
-20
0
0.1
0.2
0.3
Time (seconds)

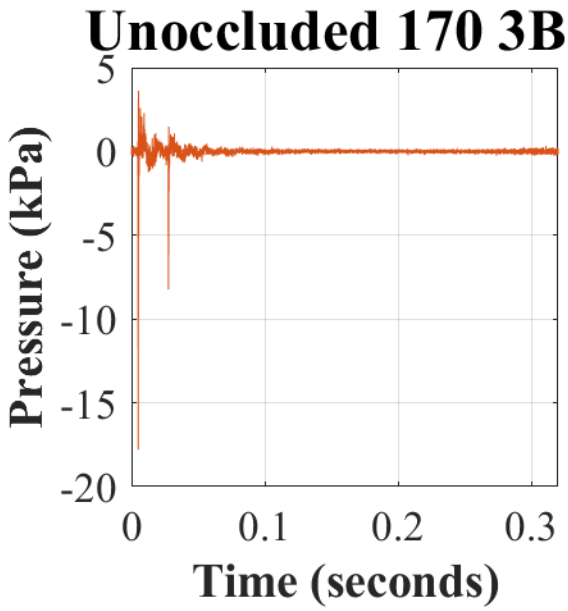

Unoccluded 170 2AR
Pressure (kPa)
5
0
-5
-10
-15
-20
0
0.1
0.2
0.3
Time (seconds)

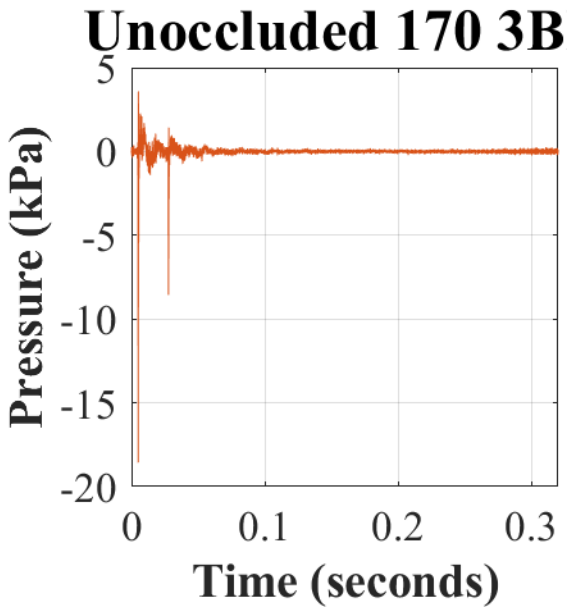

Unoccluded 170 2BL
Pressure (kPa)
5
0
-5
-10
-15
-20
0
0.1
0.2
0.3
Time (seconds)

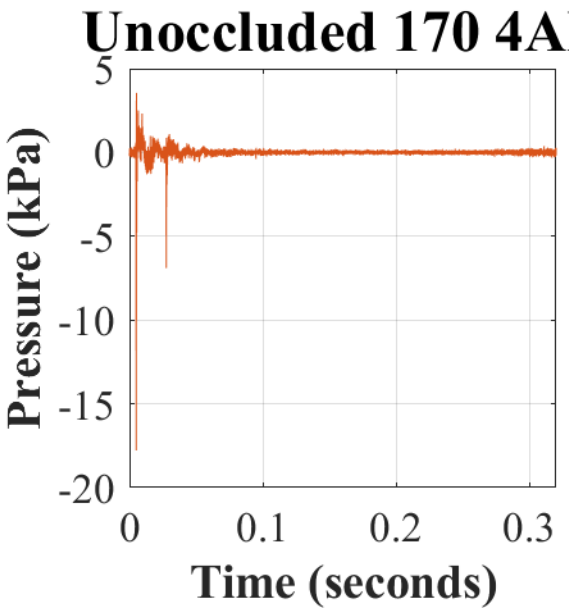

Unoccluded 170 2BR
Pressure (kPa)
5
0
-5
-10
-15
-20
0
0.1
0.2
0.3
Time (seconds)

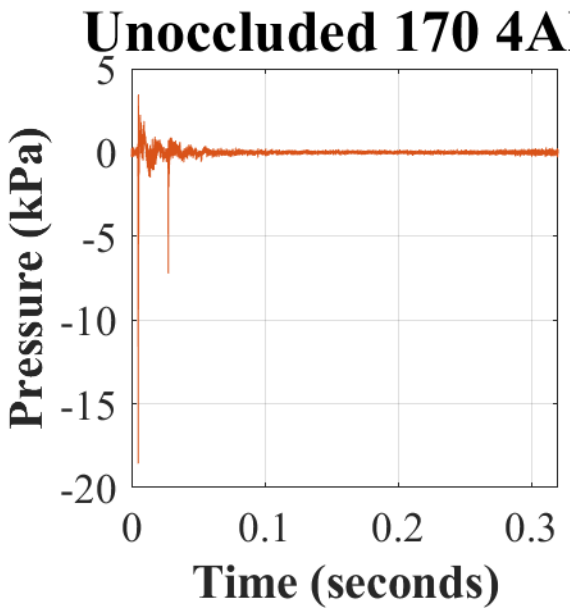

Unoccluded 170 3AL
Pressure (kPa)
5
0
-5
-10
-15
-20
0
0.1
0.2
0.3
Time (seconds)

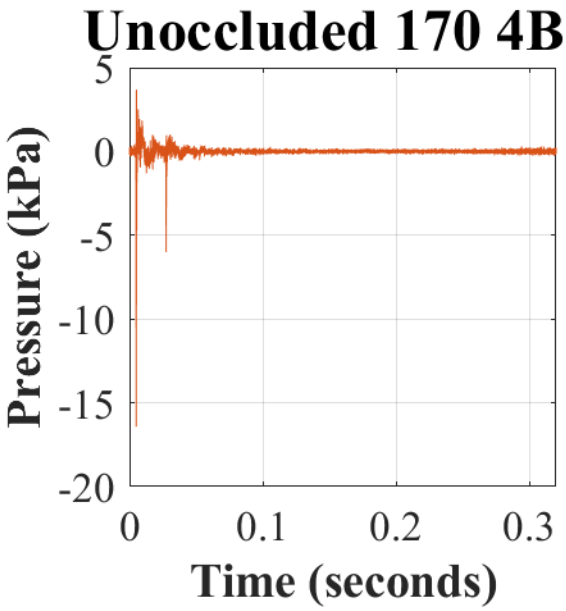

Unoccluded 170 3AR
Pressure (kPa)
5
0
-5
-10
-15
-20
0
0.1
0.2
0.3
Time (seconds)

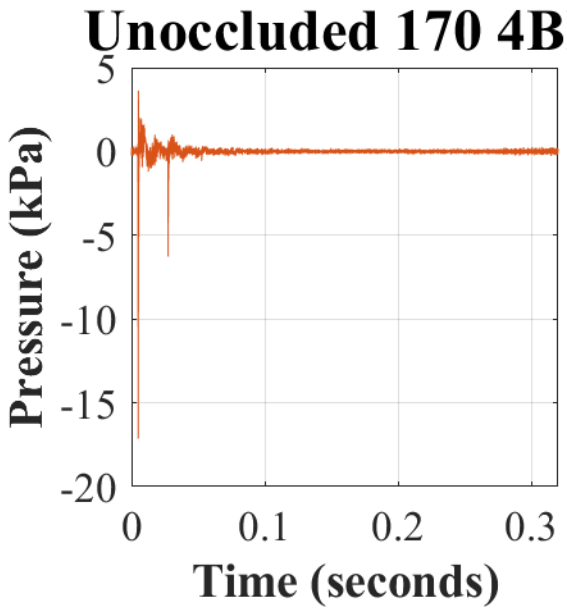

Unoccluded 170 3BL
Pressure (kPa)
5
0
-5
-10
-15
-20
0
0.1
0.2
0.3
Time (seconds)

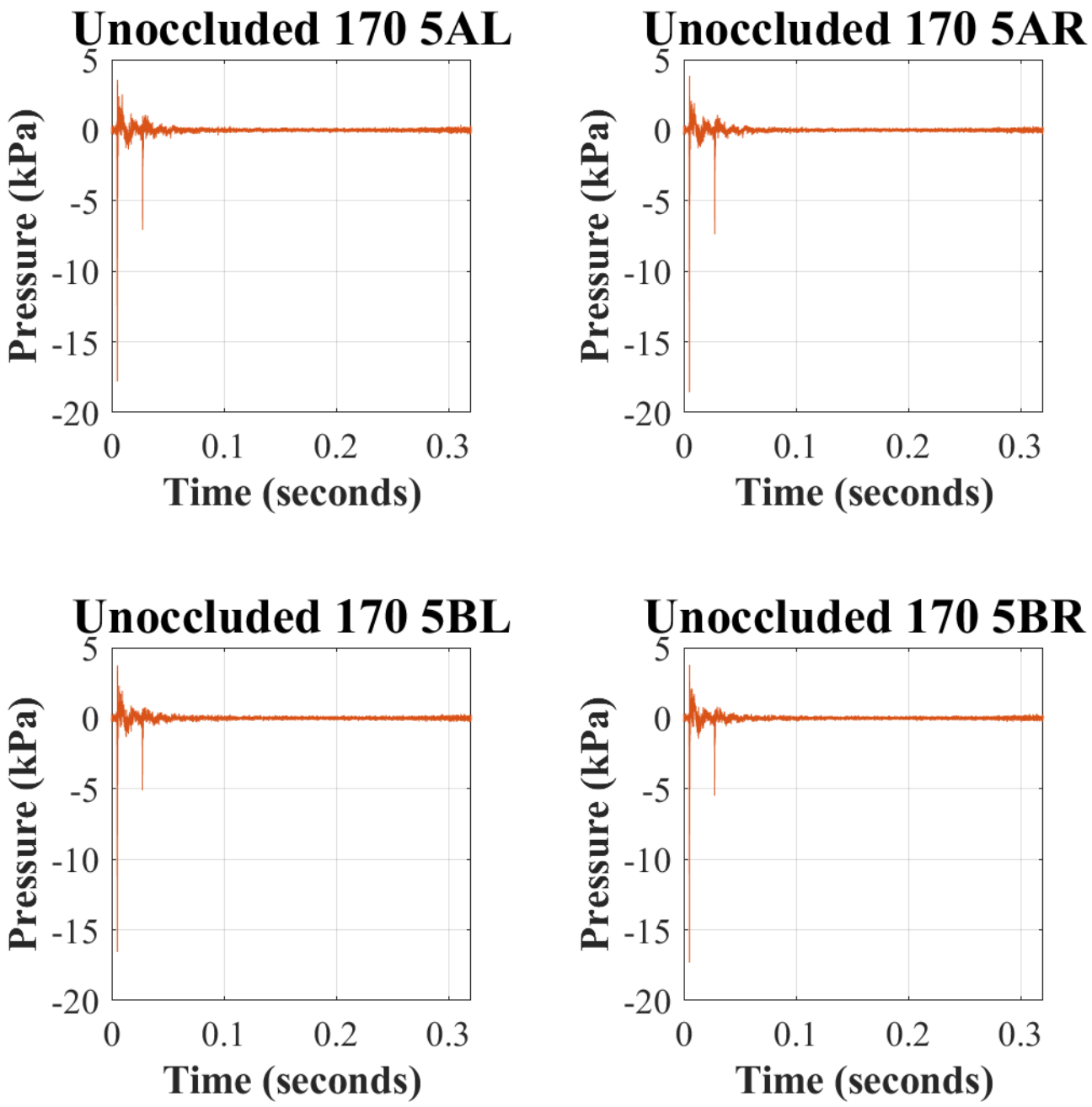

Unoccluded 170 3BR
Pressure (kPa)
5
0
-5
-10
-15
-20
0
0.1
0.2
0.3
Time (seconds)


Unoccluded 170 4AL
Pressure (kPa)
5
0
-5
-10
-15
-20
0
0.1
0.2
0.3
Time (seconds)


Unoccluded 170 4AR
Pressure (kPa)
5
0
-5
-10
-15
-20
0
0.1
0.2
0.3
Time (seconds)

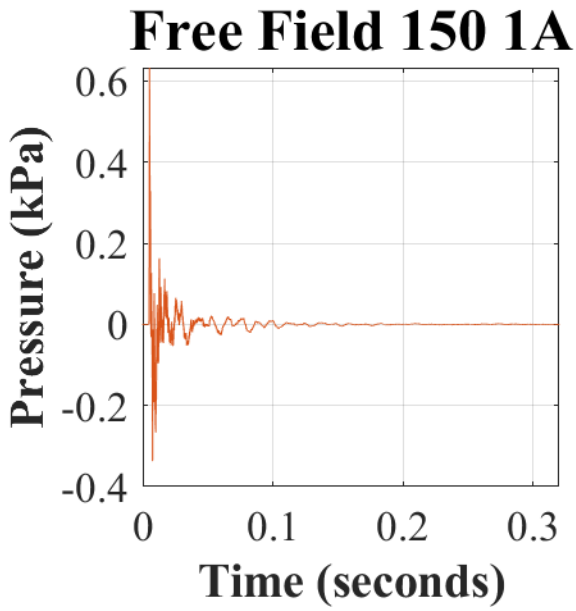

Unoccluded 170 4BL
Pressure (kPa)
5
0
-5
-10
-15
-20
0
0.1
0.2
0.3
Time (seconds)

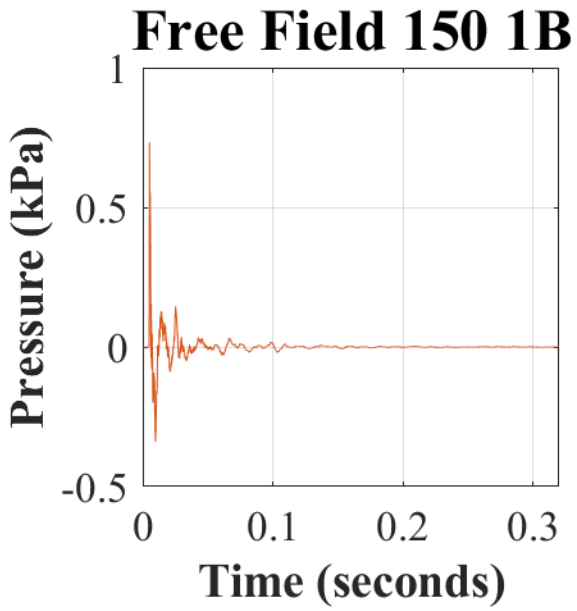

Unoccluded 170 4BR
Pressure (kPa)
5
0
-5
-10
-15
-20
0
0.1
0.2
0.3
Time (seconds)

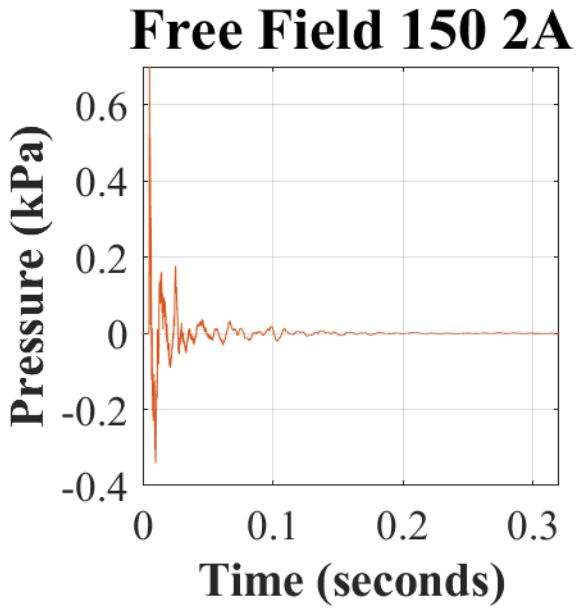


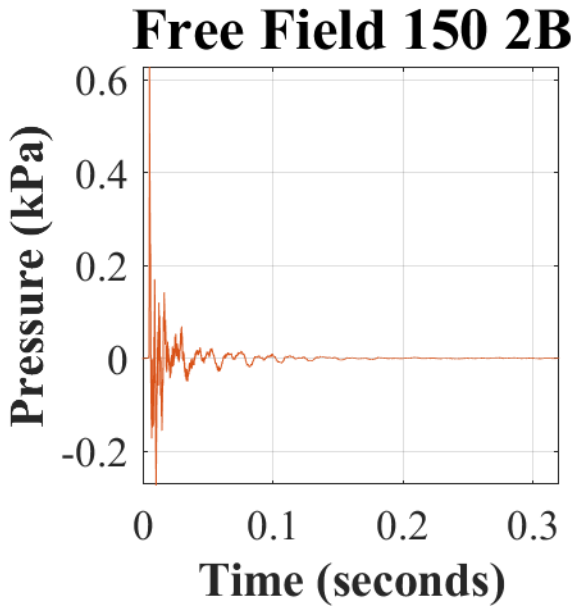
Note. The naming convention for all unoccluded waveforms is "Unoccluded LvL NnX", where 'Unoccluded' is the test condition (i.e., ATF has the HPD doffed), 'LvL' is the nominal test level (i.e., 150, 160 or 170 dBP), 'N' is the sample number (i.e., 1 to 5) of the device tested, 'n' is the trial (i.e., A or B) indicating HPD fit (i.e., first or second, respectively), and 'X' indicates from what ATF microphone the recording is from (i.e., right [R] or left [L] pinnae).

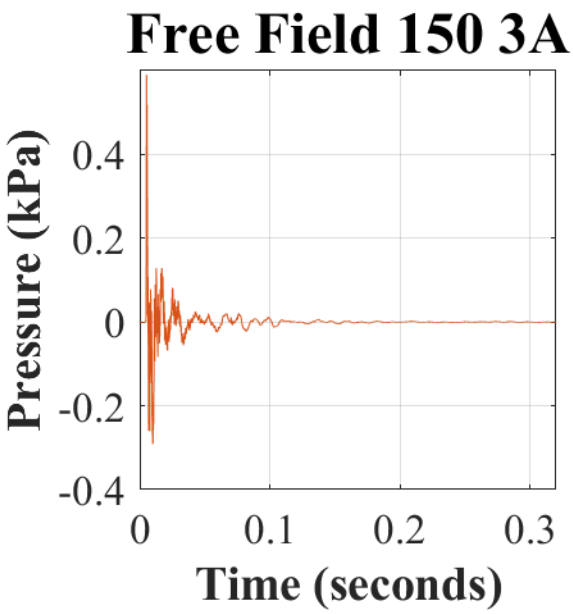
Appendix P. Recorded waveform (in kilopascals [kPa]) over time (in seconds [s]) of the impulse measured with the free-field probe at 150 dBP and the EP7 donned in the cap closed mode.

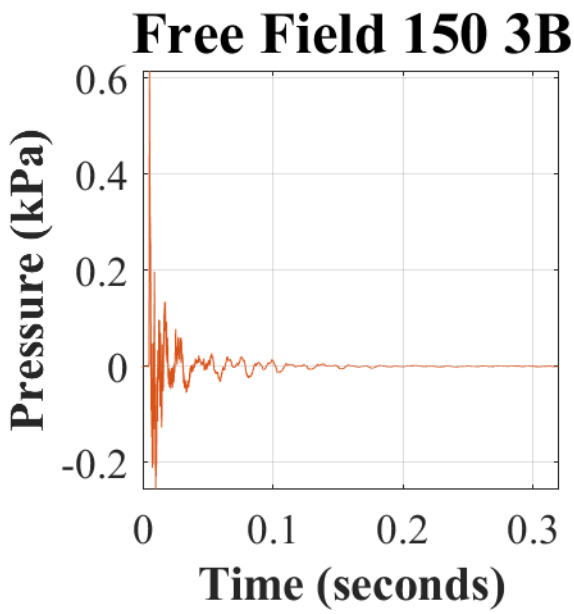


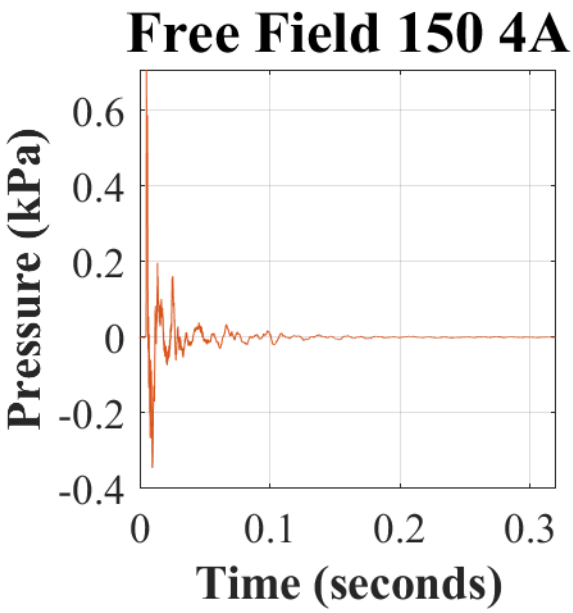


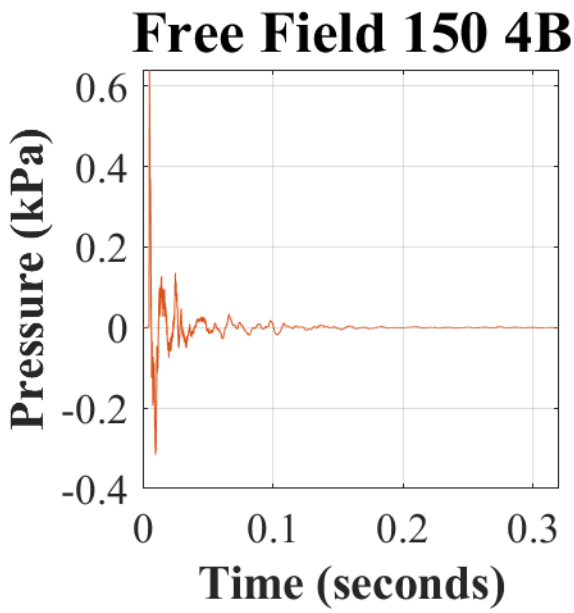


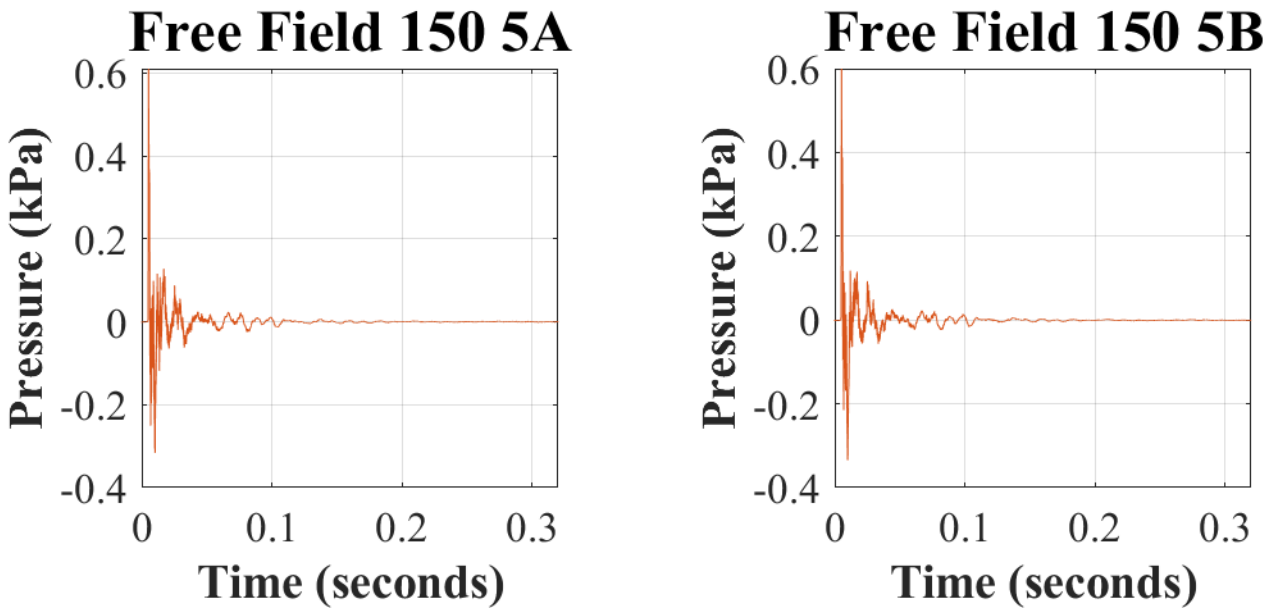



Free Field 150 3A
Pressure (kPa)
0.4
0.2
0
-0.2
-0.4
0
0.1
0.2
0.3
Time (seconds)


Free Field 150 3B
Pressure (kPa)
0.6
0.4
0.2
0
-0.2
0
0.1
0.2
0.3
Time (seconds)

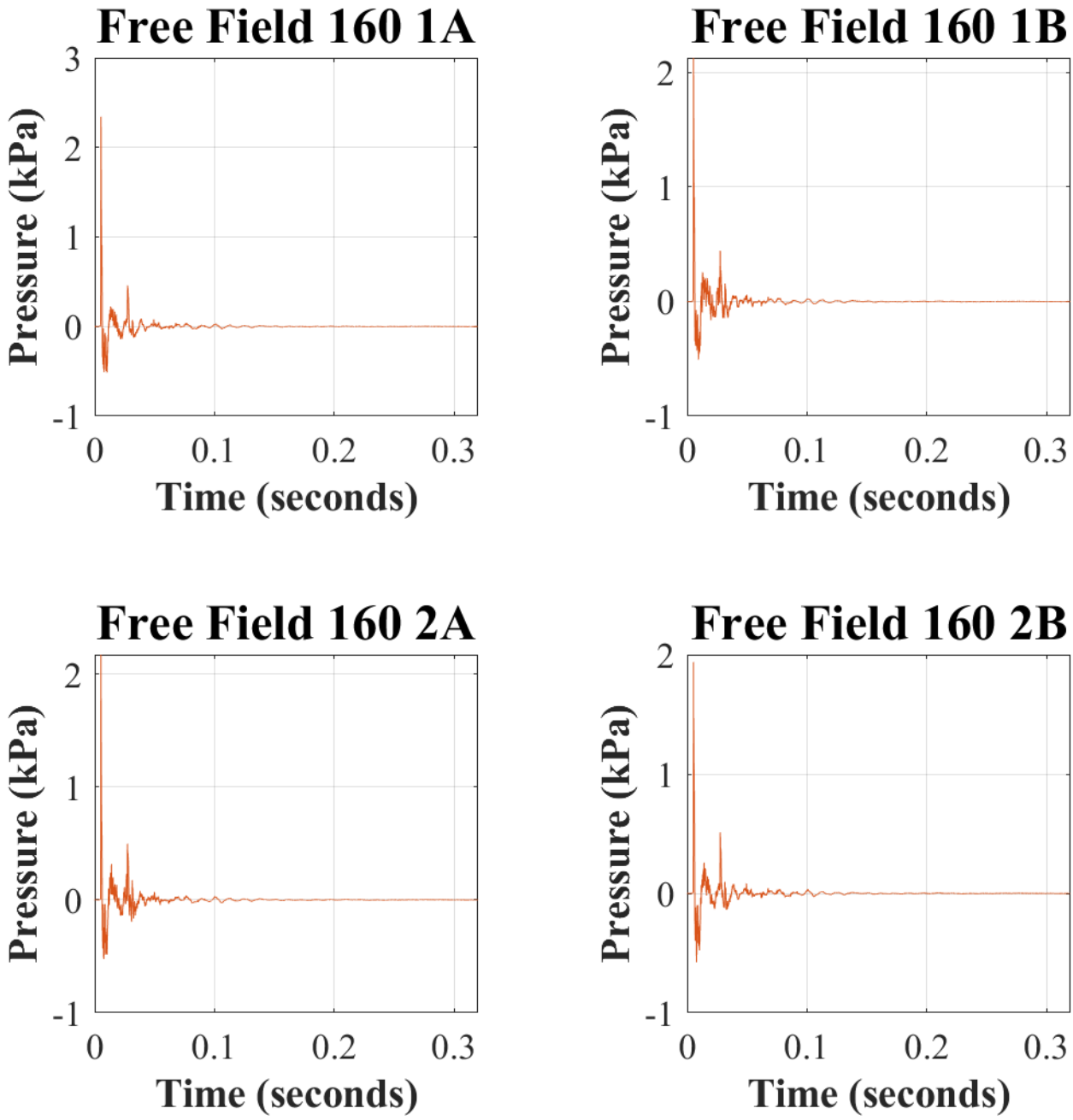

Free Field 150 4A
Pressure (kPa)
0.6
0.4
0.2
0
-0.2
-0.4
0
0.1
0.2
0.3
Time (seconds)

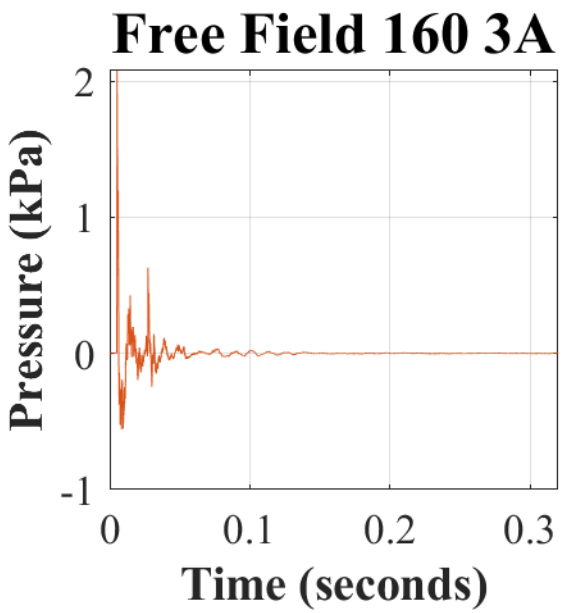

Free Field 150 4B
Pressure (kPa)
0.6
0.4
0.2
0
-0.2
-0.4
0
0.1
0.2
0.3
Time (seconds)

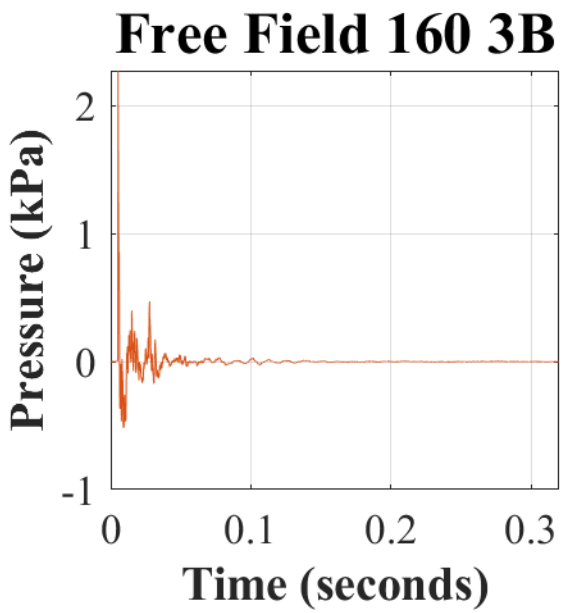


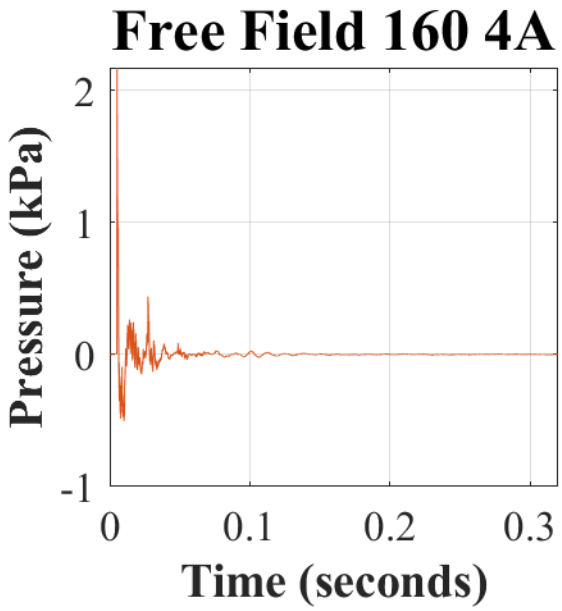
Note. The naming convention for all free-field waveforms is “Free Field LvL Nn”, where ‘Free Field’ indicates that the recording was obtained using the PCB reference microphone, ‘LvL’ is the nominal test level (150 dBP), ‘N’ is the device sample number (1 to 5), and ‘n’ is the device trial (i.e., A or B).

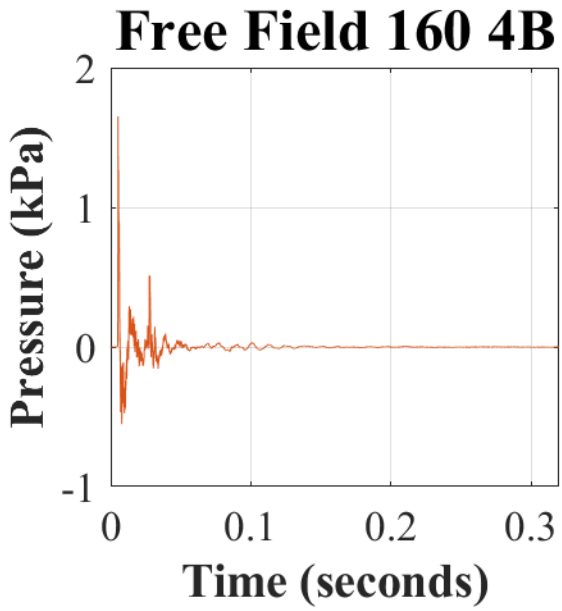
Appendix Q. Recorded waveform (in kilopascals [kPa]) over time (in seconds [s]) of the impulse measured with the free-field probe at 160 dBP and the EP7 donned in the cap closed mode.

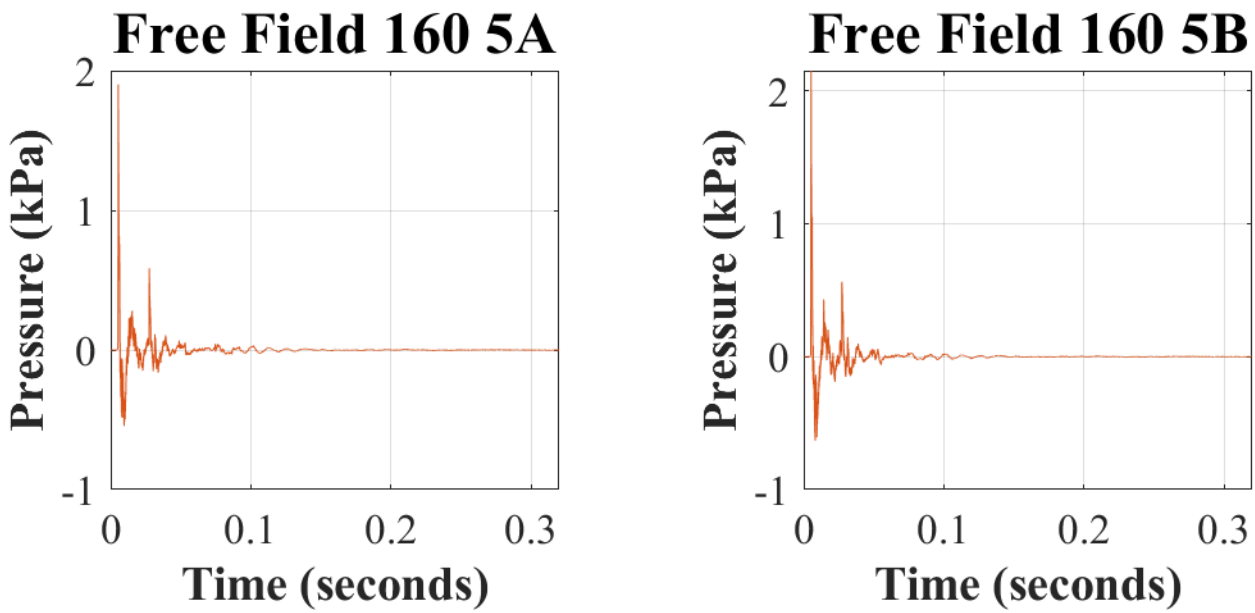



Free Field 160 3A
Pressure (kPa)
2
1
0
-1
0
0.1
0.2
0.3
Time (seconds)


Free Field 160 3B
Pressure (kPa)
2
1
0
-1
0
0.1
0.2
0.3
Time (seconds)

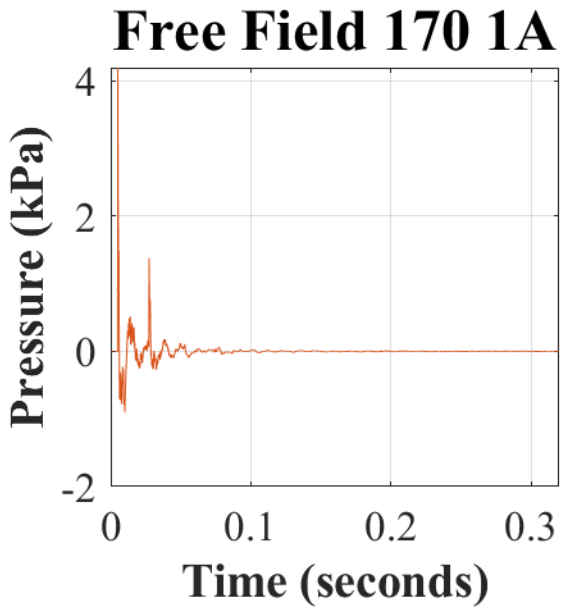

Free Field 160 4A
Pressure (kPa)
2
1
0
-1
0
0.1
0.2
0.3
Time (seconds)

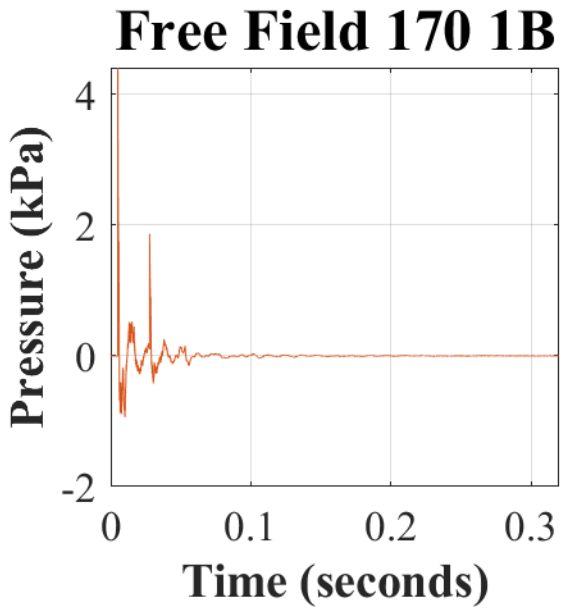

Free Field 160 4B
Pressure (kPa)
2
1
0
-1
0
0.1
0.2
0.3
Time (seconds)

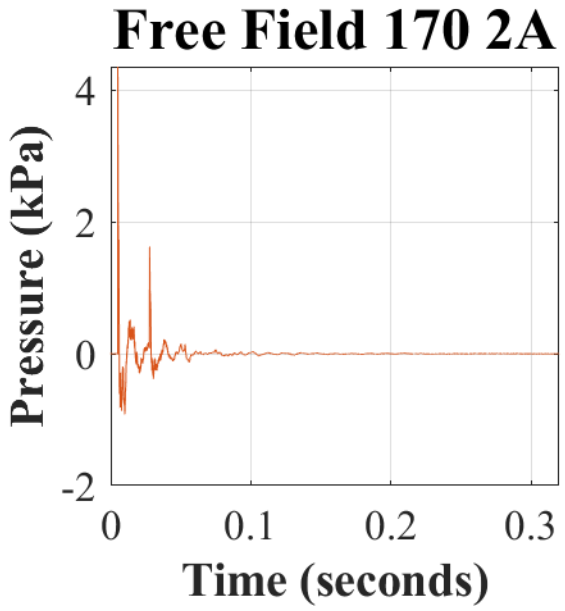


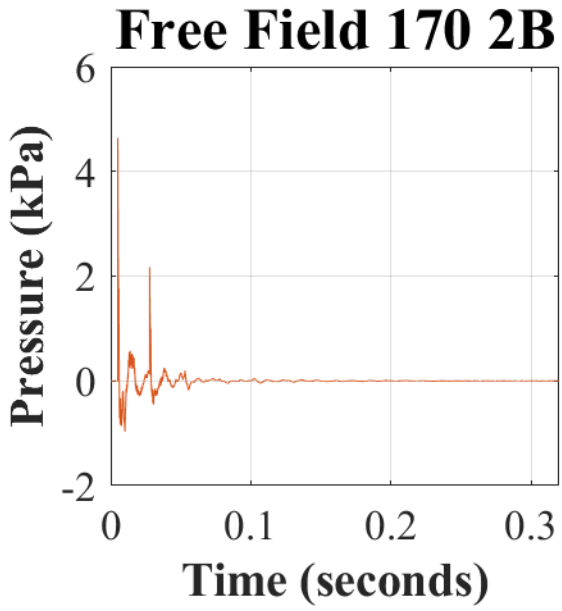
Note. The naming convention for all free-field waveforms is “Free Field LvL Nn”, where ‘Free Field’ indicates that the recording was obtained using the PCB reference microphone, ‘LvL’ is the nominal test level (160 dBP), ‘N’ is the device sample number (1 to 5), and ‘n’ is the device trial (i.e., A or B).

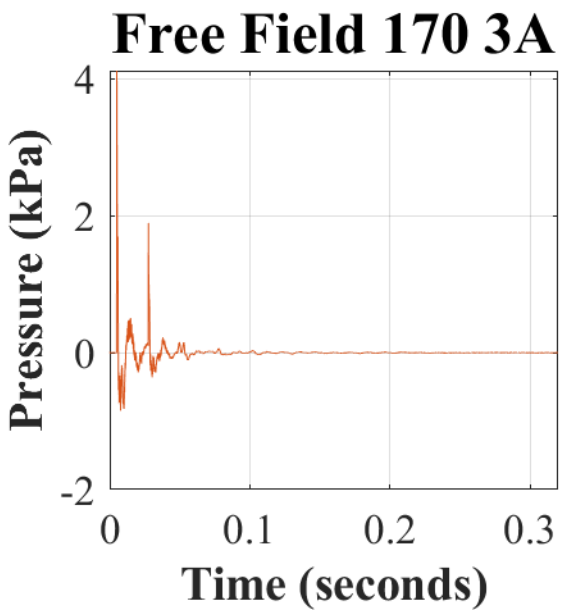
Appendix R. Recorded waveform (in kilopascals [kPa]) over time (in seconds [s]) of the impulse measured with the free-field probe at 170 dBP and the EP7 donned in the cap closed mode.

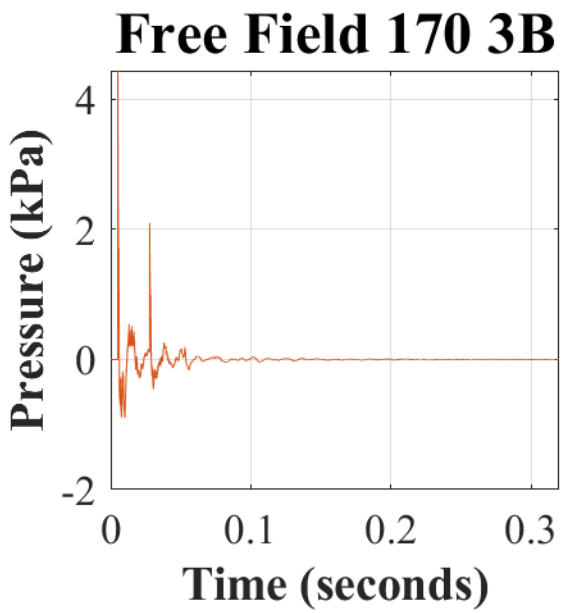


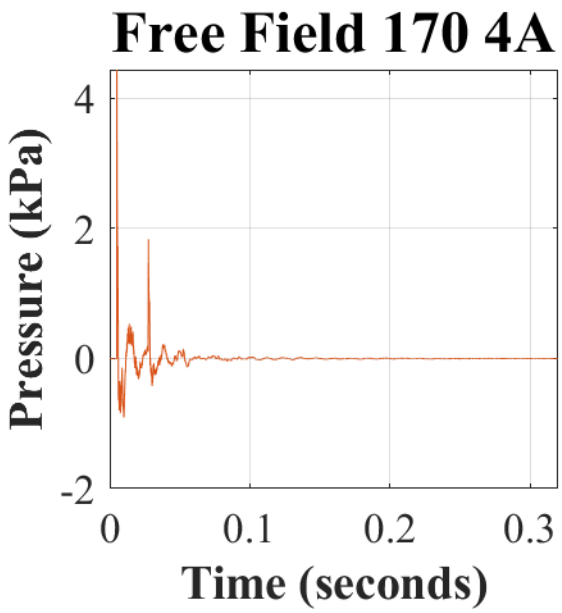


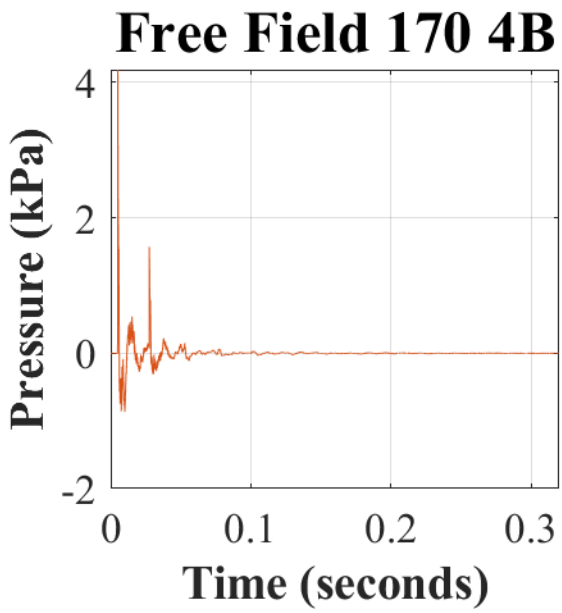


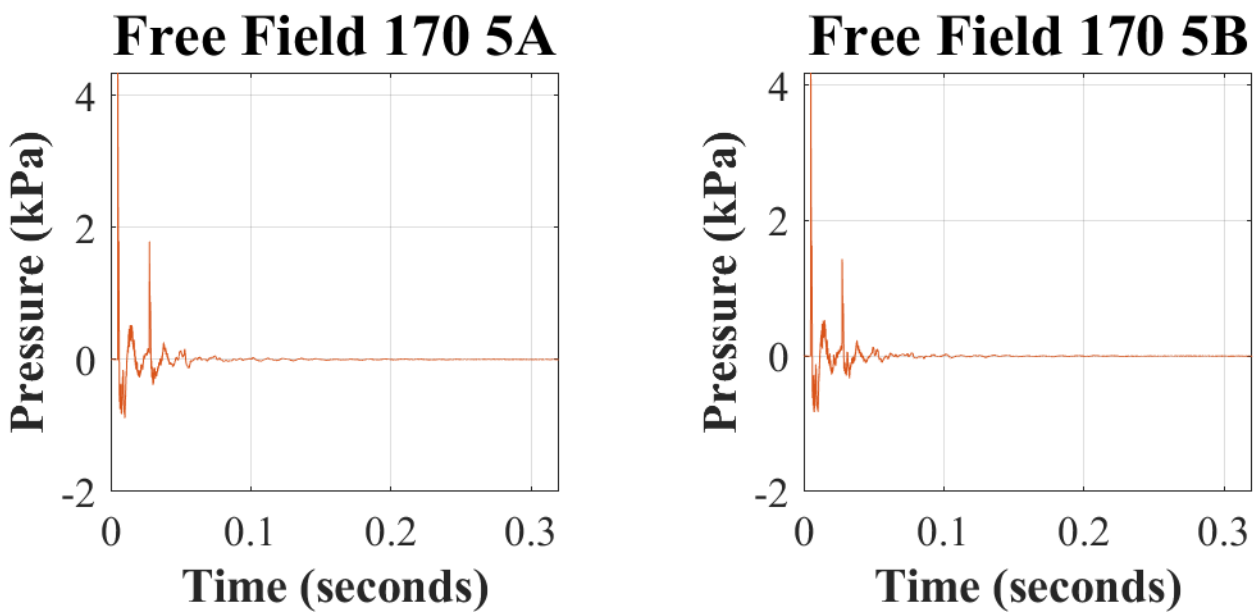



Free Field 170 3A
Pressure (kPa)
4
2
0
-2
0
0.1
0.2
0.3
Time (seconds)


Free Field 170 3B
Pressure (kPa)
4
2
0
-2
0
0.1
0.2
0.3
Time (seconds)


Free Field 170 4A
Pressure (kPa)
4
2
0
-2
0
0.1
0.2
0.3
Time (seconds)


Free Field 170 4B
Pressure (kPa)
4
2
0
-2
0
0.1
0.2
0.3
Time (seconds)



Note. The naming convention for all free-field waveforms is “Free Field LvL Nn”, where ‘Free Field’ indicates that the recording was obtained using the PCB reference microphone, ‘LvL’ is the nominal test level (170 dBP), ‘N’ is the device sample number (1 to 5), and ‘n’ is the device trial (i.e., A or B).