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Impulse Assessment of the ComTac™ V Hearing Defender Headset and the Howard Leight™ MAX® Small Earplug

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This technical memorandum describes the IPIL testing conducted on a combined configuration that included the Howard Leight™ MAX® Small Earplug and the ComTac™ V Headset. Testing included two test modes for the ComTac™ V: passive and active. Testing was completed in accordance with the ANSI standard S12.42-2010. All device samples were tested at the nominal levels of 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 test modes. The mean and standard deviation (SD) IPIL values at 160 dBP were 53.1 (2.5) dB SPL for the passive mode, and 53.9 (1.7) dB SPL for the active mode. Results at 170 dBP showed mean (SD) IPIL values of 55.0 (2.1) dB SPL for the passive mode, and 55.8 (1.9) dB SPL for the active mode. These results suggest that the ComTac™ V Headset, when functioning properly and fitted in combination with the Howard Leight™ MAX® Small earplugs can adequately protect against impulses below 180.0 dBP in both the passive and the active test modes.

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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 on a combined configuration that included the Honeywell Howard Leight™ MAX® Small Earplug (Howard Leight™ MAX® Small; Model: MAX-1S) and the 3M™ PELTOR™ ComTac™ V Hearing Defender (headband model) Headset (ComTac™ V; Model: MT20H682FB-09 CY). Testing included two test modes for the ComTac™ V: passive (i.e., turned OFF) and active (i.e., turned on and set to MAX). In all occluded conditions, the Howard Leight™ MAX® Small was in situ. 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 160 and 170 decibel peak (dBP, re: 20 µPa). A total of five samples (one headset plus left and right earplug pair) were fitted to an acoustic test fixture two times each for a total of 10 trials per test level in both the passive (i.e., OFF) and active (i.e., on and set to MAX) test modes. No samples of either HPD were rejected. The mean and standard deviation (SD) IPIL values at 160 dBP were 53.1 (2.5) dB SPL for the passive (i.e., OFF) mode, and 53.9 (1.7) dB SPL for the active (i.e., MAX) mode. Results obtained at the 170 dBP presentation level showed mean (SD) IPIL values of 55.0 (2.1) dB SPL for the passive (i.e., OFF) mode, and 55.8 (1.9) dB SPL for the active (i.e., MAX) mode. These results suggest that the ComTac™ V Hearing Defender Headset, when functioning properly and fitted in combination with the Howard Leight™ MAX® Small earplugs can adequately protect (i.e., reduce exposure to less than 140 dBP) against impulses below 180.0 dBP in both the passive (OFF) and the active (on and set to MAX) test modes.

Table 1.
ComTac™ V with Howard Leight™ MAX® Small mean (SD) IPIL value (in dB) for all test conditions.

	160 dBP	**170 dBP**
OFF	53.1 (2.5)	55.0 (2.1)
MAX	53.9 (1.7)	55.8 (1.9)

Introduction

The 3M™ PELTOR™ ComTac™ V Hearing Defender Headset (ComTac™ V; 3M, St. Paul, MN) is an active earmuff-style communications headset currently fielded by the U.S. Navy and U.S. Marine Corps. The ComTac™ V Hearing Defender has two ear-level, omni-directional microphones and a level dependent, electronic hearing protection signal processor powered by two AAA batteries. The signal processor function amplifies low level sounds (e.g., speech), and attenuates loud, continuous (e.g., vehicle engines, air compressors) and impulsive noises (e.g., weapon fire) (3M Personal Safety Division, n.d.). The headset is available as either a headband or neckband model, but can also be mounted on a helmet rail system when used with the 3M™ PELTOR Accessory Rail Connector (ARC) attachment. The ComTac™ V Hearing Defender Headset described herein is intended for face-to-face communications, and not radio communications. As it is common to don a pair of earmuffs combined with a pair of earplugs in high noise environments (Department of the Navy, 2007), the amount of protection provided to users when the ComTac™ V is worn in combination with an earplug was tested.

The earplug selected for this testing was the Honeywell Howard Leight™ MAX® Small Single-Use Earplug (Howard Leight™ MAX® Small; Honeywell International Inc., Charlotte, NC). The Howard Leight™ MAX® Small is an uncorded, passive, bell-shaped plug made of polyurethane foam intended for single use and should be discarded, if compromised. The earplug is intended to provide comfort in smaller ear canals (Honeywell Industrial Safety, 2018). Separate calculated impulse peak insertion loss (IPIL) values for both the ComTac™ V and the Howard Leight™ MAX® Small have been previously reported by the Naval Submarine Medical Research Laboratory (NSMRL; Silvia et al, 2021, Kolias et al, 2021).

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).

To calculate whether an HPD or HPD combination will reduce the impulse noise exposure below the 140 dBP limit, the impulse peak insertion loss (IPIL) value of the HPD is 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. At the time of this writing, the IPIL value of the Howard Leight™ MAX® Small combined with the ComTac™ V at 160, and 170 dBP was unknown. This report describes the methods and results used to determine the IPIL value for the ComTac™ V Hearing Defender Headset in both the passive (i.e., OFF) and active (i.e., turned on and set to MAX) test modes used in combination with the Howard Leight™ MAX® Small earplug. 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 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, a 7 in. (17.8 cm) by 7 in. (17.8 cm), acetate sheet (Grafix Plastic, Maple Heights, OH) was used as a membrane between the pressurized chamber and the catenoidal tube horn to enable pressurization of the air chamber. Each acetate sheet was 0.002 in. (2 mil, 50.8 micrometer [µm]) thick.

All waveforms were recorded with the ANSI/ASA S12.42 (2010) compliant GRAS 45CB-S2 acoustic test fixture (ATF) along with GRAS RA0045-S9 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 at 124 dB sound pressure level (SPL) using a 250 hertz (Hz) tone. 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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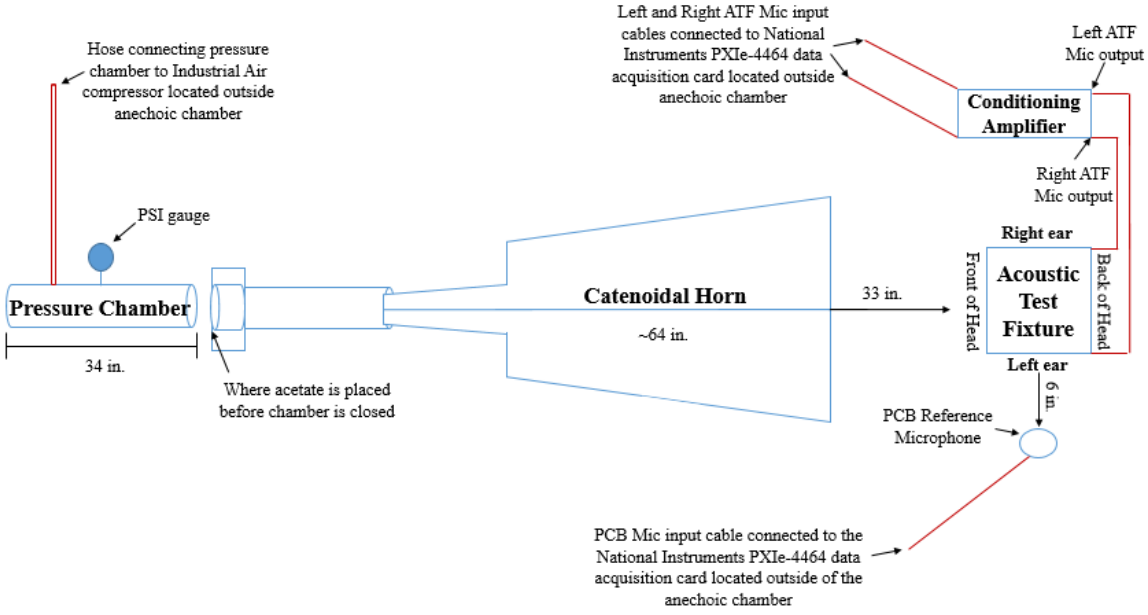
Figure 1.
Diagram of the NSMRL Acoustic Shock Tube and ATF.



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). The data acquisition system 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 microphone, right ATF microphone, and a reference microphone) 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 (6^{th} order, corner frequency 20.0 kHz [3 dB down]) 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. A second digital Butterworth filter (6th 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. This deviation was made due to equipment and software limitations.

The custom-written software program saved all recorded waveforms as files (*.tdms), which were exported from the software for conversion into 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 160 dBP and 170 dBP data (see Data Analysis below).

Hearing Protection Device Samples. Five samples (See Figure 2 for example) of the ComTac™ V Hearing Defender Headset (Manufacturer Product Number: MT20H682FB-09 CY) with foam ear cushions and headband, and five samples of the uncorded Honeywell Howard Leight™ MAX® Small Single-Use Earplugs (Manufacturer Product Number: MAX-1S) were tested in accordance with ANSI/ASA S12.42-2010. Each sample, consisting of one headset and 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.
Sample of the ComTac™ V Hearing Defender Headset (Headband Model) and Howard Leight™ MAX® Small Earplugs

Procedure

Because the ComTac™ V employs active technology, it was tested in both the passive (OFF) and active (i.e., the headset turned on and the sound output level set at its maximum limit [MAX]) modes. Each HPD sample combination (headset plus left and right earplug pair) was fitted to the ATF twice, resulting in two trials (trials A and B) per sample combination, and 10 total trials per nominal level test condition (160 and 170 dBP) for each HPD mode. ComTac™ V functionality and settings were confirmed via a listening check prior to each trial. No samples of either HPD were rejected.

To achieve an appropriate fit that would provide maximum attenuation, each sample was expertly fitted to the ATF following the instructions provided on the device packaging. The Howard Leight™ MAX® Small fitting guidelines stated that all samples be inspected for any wear, extreme hardness, or damage prior to use. Once inspected, each earplug was rolled down avoiding creases, inserted into the ear canal, and held in place until fully expanded. Earplugs were given at least two minutes to fully expand in

the ATF ear canal before a ComTac™ V was fitted and testing was performed. The ComTac™ V manufacturer fitting guidelines stated that all samples should be inspected for any wear, cracks, or damage prior to use. Once inspected, earmuffs were placed over the ears to encompass the pinnae, and the headband adjusted to just rest on the head of the ATF.

Impulses generated with the NSMRL 4 in. (10.2 cm) shock tube at 130 and 150 dBP were found to be without a shock front. This resulted in the omission of testing at the 130 and 150 dBP nominal levels and the addition of the 160 dBP nominal level to the test protocol. Measuring the IPIL at 160 dBP was included in order to provide accurate guidance for exposures between 150 and 170 dBP. All test impulses generated at 160 and 170 dBP had a shock front. Inclusion of the 160 dBP nominal level allowed the range of applicability to be extended down to 150 dBP in accordance with ANSI 12.42-2010. Specifically, due to non-linear effects 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 the occluded (i.e., HPDs donned) and unoccluded (i.e., HPDs doffed) test configurations. For all occluded measures, the earmuffs 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. 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 160 dBP (19.5 to 22.1 psi, 134 to 152 kilopascals (kPa)) or 170 dBP (28.5 to 29.5 psi, 197 to 203 kPa) nominal level impulses. The acetate was then punctured with 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 and 150 dBP, six calibration impulses were generated at the 160 dBP nominal level in the unoccluded (i.e., without HPD) test configuration. Three of these impulses were generated before testing, and three were generated after testing at 160 dBP. Calibrations were not completed at the 170 dBP nominal level due to exposure limitations of the ATF right and left microphones.

Clamping force of each ComTac™ V sample earmuff was measured using Michael & Associates, Inc.'s Muff-type HPD Force Measurement System (S/N: 00001). Per ANSI/ASA S12.42-2010, each headset was fit to the measurement device, and left in place for two minutes before clamping force was recorded in pounds force (lbf).

Data Analysis

MATLAB (Natick, MA) was used to calculate the IPIL values at the 160 and 170 dBP nominal levels and to generate all waveform graphs (See Appendices A to L). 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 level. The mean transfer function for each ear was then

calculated, and the first element of the transfer function was 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 160 dBP nominal level. The difference of the maximum absolute values of the calculated values and the measured values was then calculated, 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 displayed 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

As shown in Table 2, the overall mean (SD) IPIL values for the ComTac™ V combined with the Howard Leight™ MAX® Small at 160 dBP were 53.1 (2.5) dB in the passive (i.e., OFF) test mode and 53.9 (1.7) dB in the active (i.e., MAX) test mode. At 170 dBP, the calculated overall mean (SD) IPIL values were 55.0 (2.1) dB in the OFF mode and 55.8 (1.9) dB in the MAX mode. Calculated IPIL values for all sample trials in the OFF mode ranged between 49.2 to 57.5 dB at 160 dBP and 51.2 to 58.4 dB at 170 dBP, while all tested sample trials in the MAX mode ranged between 50.9 to 56.5 dB at 160 dBP and 52.1 to 59.0 dB at 170 dBP.

Table 2.
Mean (SD) IPIL values (in dB) for Tested ComTac™ V with Howard Leight™ MAX® Small Samples.

	160 dBP				**170 dBP**			
	OFF		***MAX***		***OFF***		***MAX***	
	Right	*Left*	*Right*	*Left*	*Right*	*Left*	*Right*	*Left*
HPD 1, Trial A	50.8	53.7	52.6	54.3	51.9	57.0	53.9	55.7
HPD 1, Trial B	52.7	56.1	52.0	53.6	53.3	56.6	54.5	55.9
HPD 2, Trial A	54.0	53.5	55.8	54.7	55.3	54.7	57.1	56.5
HPD 2, Trial B	55.4	51.3	50.9	54.1	56.8	55.7	55.2	58.6
HPD 3, Trial A	49.9	51.5	52.8	55.4	54.2	55.5	55.0	56.3
HPD 3, Trial B	49.2	54.4	56.5	55.8	54.6	56.7	57.6	57.4
HPD 4, Trial A	50.1	57.0	53.0	56.0	51.2	57.7	54.2	58.4
HPD 4, Trial B	52.1	54.6	52.1	54.5	54.1	56.3	53.0	55.4
HPD 5, Trial A	51.0	55.3	51.5	54.4	52.0	55.4	52.1	55.5
HPD 5, Trial B	50.9	57.5	51.6	55.9	51.9	58.4	53.8	59.0
Ear Specific Mean (SD)	51.6 (1.9)	54.5 (2.1)	52.9 (1.8)	54.9 (0.8)	53.5 (1.8)	56.4 (1.1)	54.6 (1.7)	56.9 (1.4)
Level Overall Mean (SD)	53.1 (2.5)		53.9 (1.7)		55.0 (2.1)		55.8 (1.9)	

As shown in Table 3, the measured clamping force of the ComTac™ V samples ranged from 2.6 to 2.8 lbf, with a mean (SD) of 2.7 (0.1) lbf.

Table 3.
Mean (SD) Band Force (lbf) for Tested ComTac™ V Samples.

	Band Force
HPD 1	2.8
HPD 2	2.8
HPD 3	2.6
HPD 4	2.6
HPD 5	2.7
MEAN (SD)	2.7 (0.1)

The waveforms for the passive (i.e., OFF) test mode for all trials of the ComTac™ V plus the Howard Leight™ MAX® Small are provided in Appendices A to F and are color-coded green. The waveforms for the active (i.e., MAX) test mode of the ComTac™ V plus the Howard Leight™ MAX® Small are provided in Appendices G to L and are color-coded orange.

Discussion

As required by ANSI/ASA S12.42-2010, when measuring the IPIL of an active HPD, the ComTac™ V Hearing Defender was tested in both its passive and active modes. The ComTac™ V uses an external microphone, an amplifier, a signal limiting circuit, and an internal loudspeaker to pass low-level sounds through the HPD. When a signal exceeds 82 dB A-weighted (dBA), the limiting circuit automatically turns off the amplifier (3M Personal Safety Division, 2015). Once the amplifier is turned off, the headset acts as a passive HPD, attenuating all incoming noise above 82 dBA. Therefore, when the active technology is functional and the ear cups are fitted properly, it is anticipated that the passive (i.e., OFF) and active (i.e., MAX) test modes will perform similarly. One possible mode of failure could occur if the limiting circuit fails to turn off quickly enough. This would allow some portion of the impulse noise to be amplified and actively passed through the device. To test for this possibility, the ComTac™ V Hearing Defender Headset was tested both powered off and with the unit powered on and volume set to its maximum setting.

As anticipated, the calculated mean IPIL values were greater at the 170 dBP nominal level than at the 160 dBP nominal level for both tested HPD modes. Results revealed overall mean IPILs across nominal test levels (160 to 170 dBP) within 0.8 dB of each other for both test modes (i.e., OFF, MAX). Across ears, the individual trial mean IPIL values were found to vary as much as 8.3 dB at 160 dBP and 7.2 dB at 170 dBP in the OFF test mode, while all individual trial mean IPIL values varied as much as 5.6 dB at 160 dBP and 6.9 dB at 170 dBP in the MAX test mode. These results may be explained by a combination of inherent variance within the impulse system, variability

in passive (i.e., OFF) and active (i.e., MAX) attenuation, and/or variability in fit as a result of each HPD sample being fitted twice.

In addition, results consistency across the passive (i.e., OFF) and active (i.e., MAX) test modes could be explained by proper function of the active limiting circuit, or, alternatively, a ComTac™ V device complete failure (i.e., device complete failure would be equivalent to passive mode). Variance in the data could also be explained by intermittent function or digital signal processing algorithms contained in the active electronics. However, device complete failures were accounted for via a listening check before each test trial to confirm that the active electronics were functioning and set at the appropriate maximum sound output level. Further, based on the results obtained, there is little reason to conclude that the active limiting circuit was intermittent in any tested samples of the ComTac™ V. However, additional testing of the ComTac™ V's signal processing and subsequent effects on input and output signals was outside of the scope of this report.

It is important to note that these results do not guarantee similar performance of the tested products across all users and environments. Product performance may be impacted by factors such as variability in physical fit of the device, integrity of the acoustic seal around the ear, HPD configuration (e.g., single, double- or triple-configuration), and/or use with other head worn protective devices like that of eye protection.

Conclusions

This report described the determination of the mean impulse peak insertion loss (IPIL) values provided by the ComTac™ V Hearing Defender Headset worn with the Howard Leight™ MAX® Small at the nominal levels of 160 dBP and 170 dBP. The calculated overall mean (SD) IPIL values for the Howard Leight™ MAX® Small with the ComTac™ V Hearing Defender Headset in the passive (OFF) mode were found to be 53.1 (2.5) dB at 160 dBP and 55.0 (2.1) dB at 170 dBP. When the Howard Leight™ MAX® Small was worn with the ComTac™ V in the active mode (turned on, and volume set to MAX), the overall mean (SD) IPIL values were 53.9 (1.7) dB at 160 dBP and 55.8 (1.9) dB at 170 dBP.

The results of testing suggest that, when properly fit and functional, the ComTac™ V worn in concert with the Howard Leight™ MAX® Small can adequately protect (i.e., reduce the exposure level below 140 dBP) the user from impulse noises below 180.0 dBP in both the passive (i.e., OFF) and the active (i.e., MAX) modes. This value is restricted by the 180 dBP limit of the applicability of IPIL values measured at 170 dBP in MIL-STD-1474E B.5.3.3 (Department of Defense, 2015).

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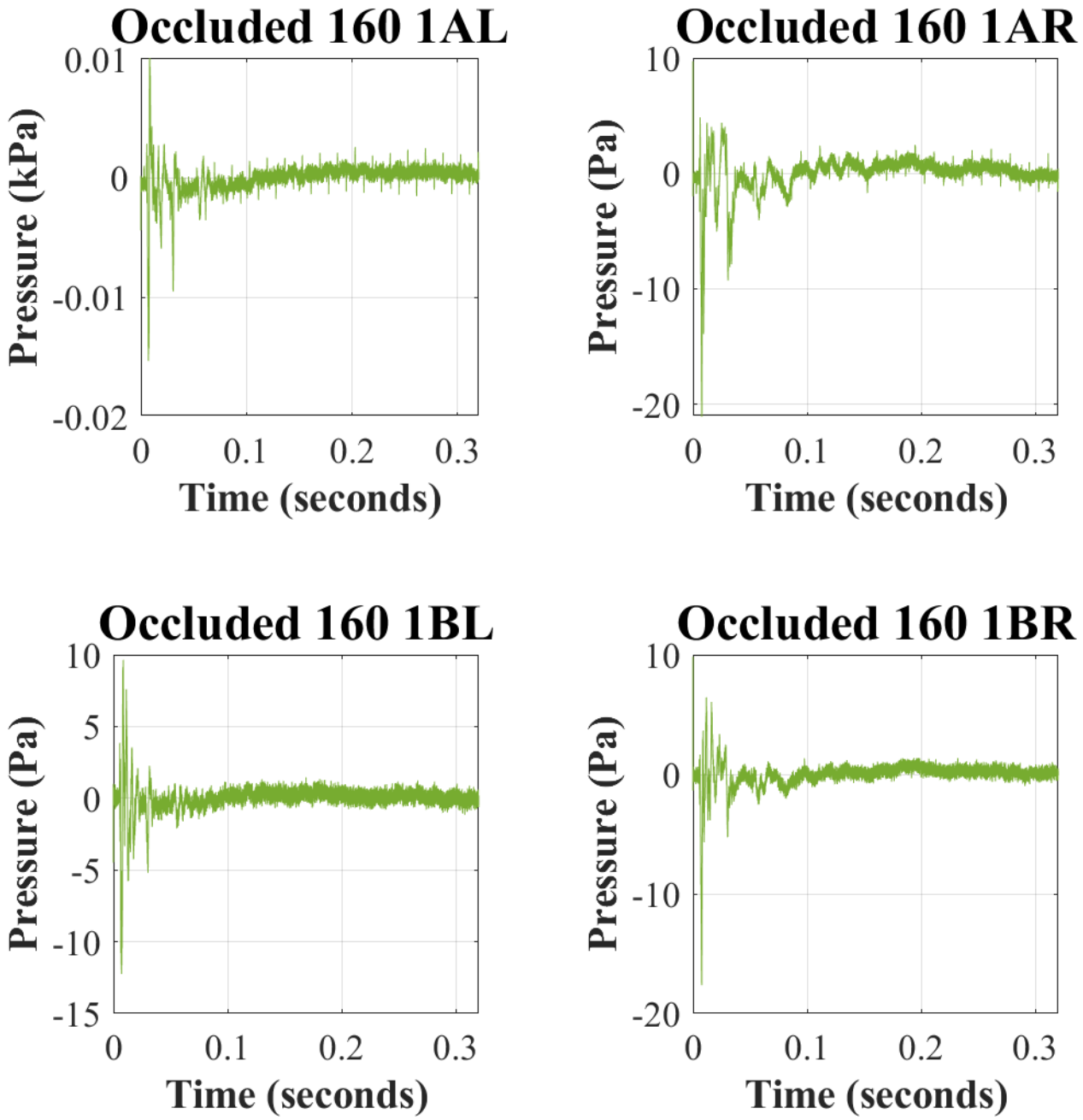
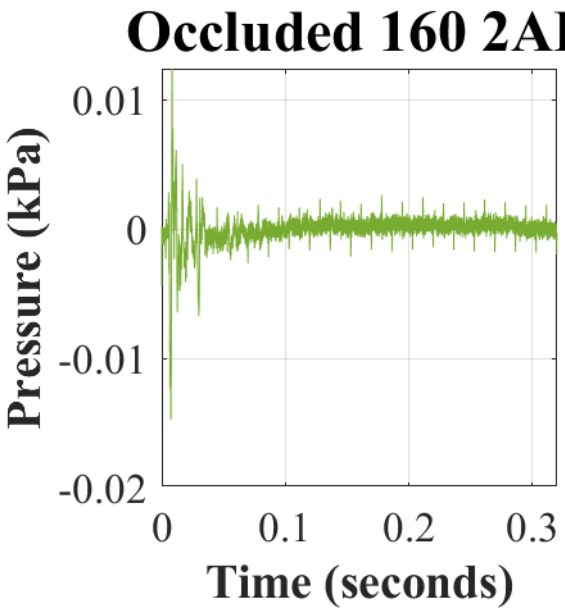
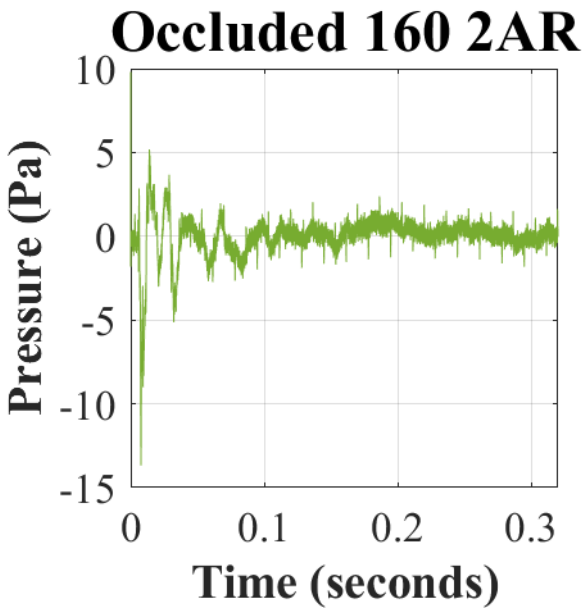
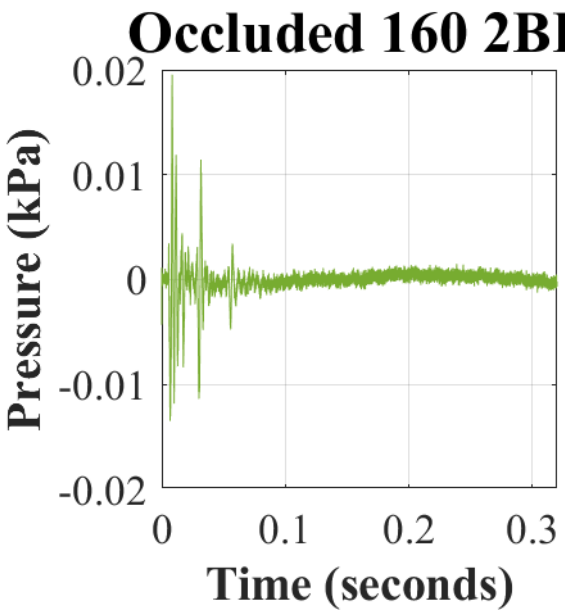
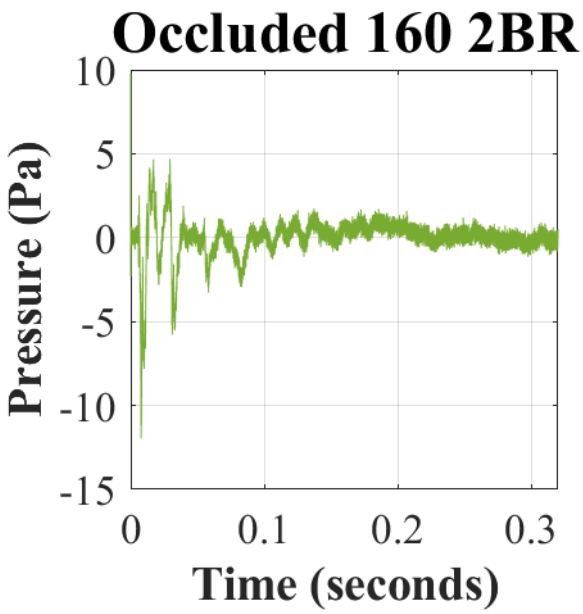
Appendix A. Recorded occluded (HPDs donned) waveforms (in pascals [Pa] or kilopascals [kPa]) over time (in seconds [s]) in response to 160 dBP with the ComTac™ V (OFF).

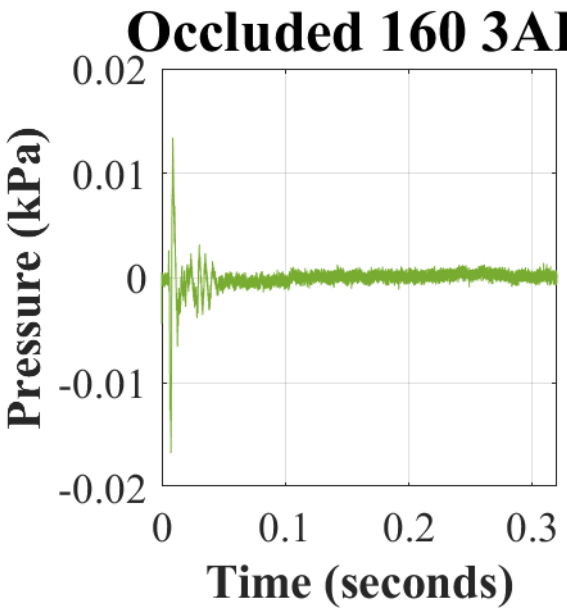


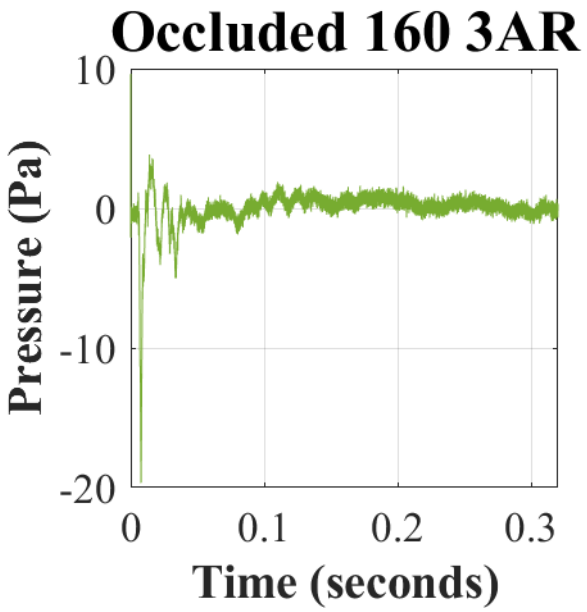

Occluded 160 2AL
Pressure (kPa)
0.01
0
-0.01
-0.02
0
0.1
0.2
0.3
Time (seconds)

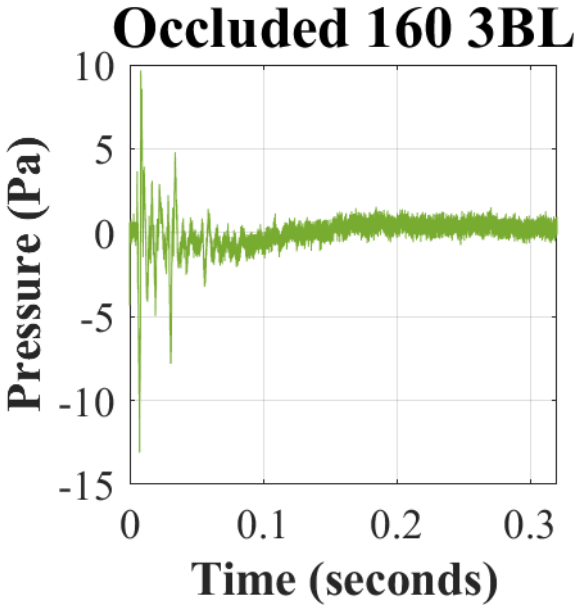

Occluded 160 2AR
Pressure (Pa)
10
5
0
-5
-10
-15
0
0.1
0.2
0.3
Time (seconds)

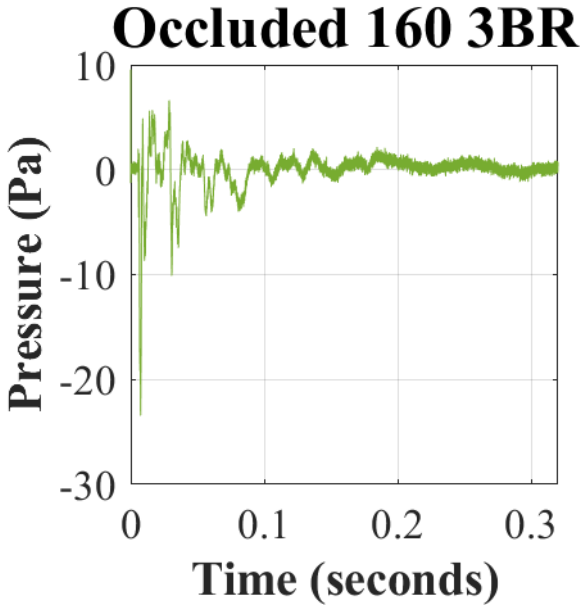

Occluded 160 2BL
Pressure (kPa)
0.02
0.01
0
-0.01
-0.02
0
0.1
0.2
0.3
Time (seconds)

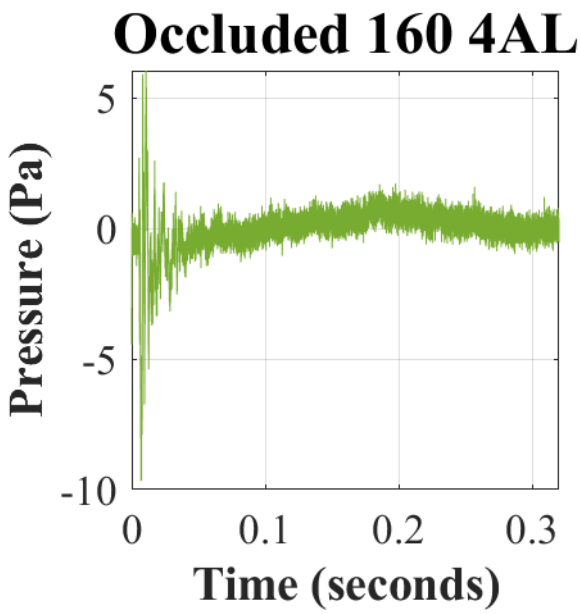

Occluded 160 2BR
Pressure (Pa)
10
5
0
-5
-10
-15
0
0.1
0.2
0.3
Time (seconds)

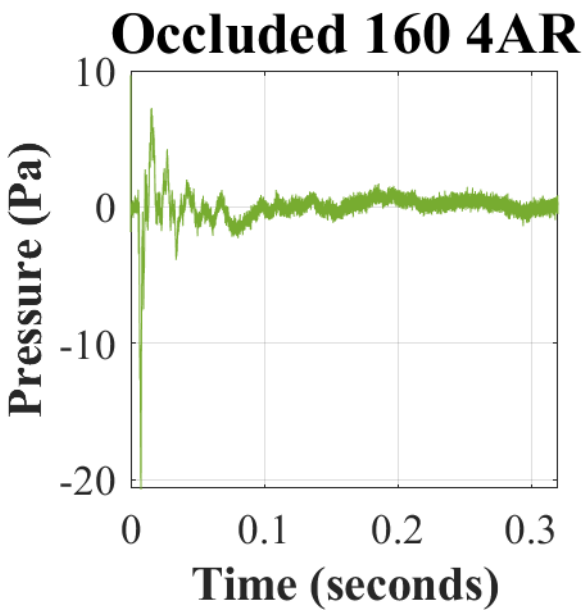

Occluded 160 3AL
Pressure (kPa)
0.02
0.01
0
-0.01
-0.02
0
0.1
0.2
0.3
Time (seconds)

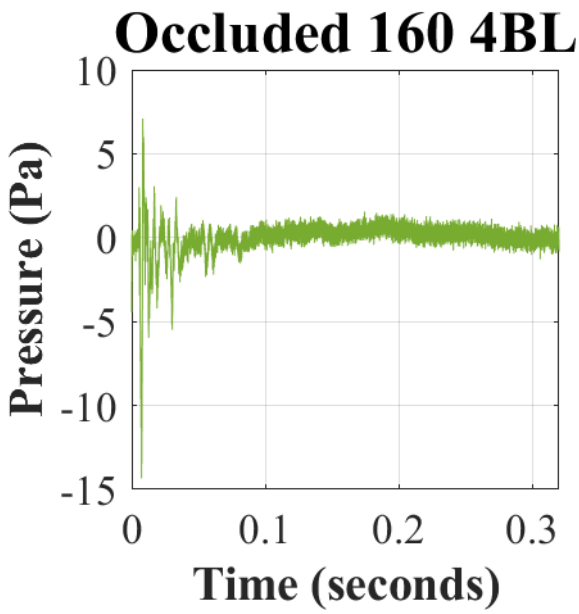

Occluded 160 3AR
Pressure (Pa)
10
0
-10
-20
0
0.1
0.2
0.3
Time (seconds)

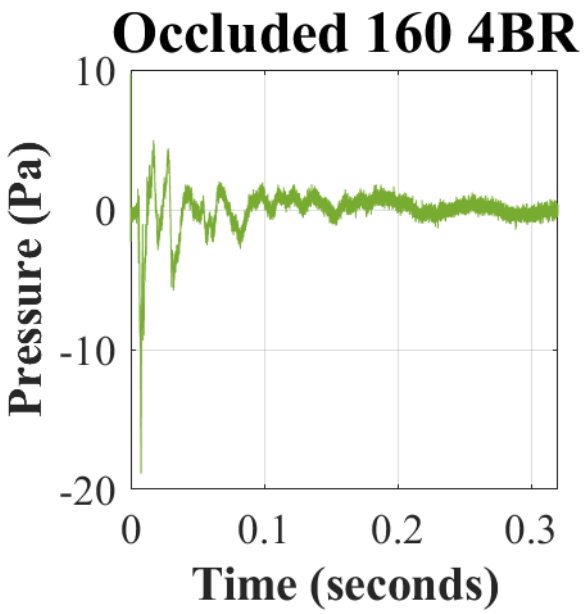

Occluded 160 3BL
Pressure (Pa)
10
5
0
-5
-10
-15
0
0.1
0.2
0.3
Time (seconds)

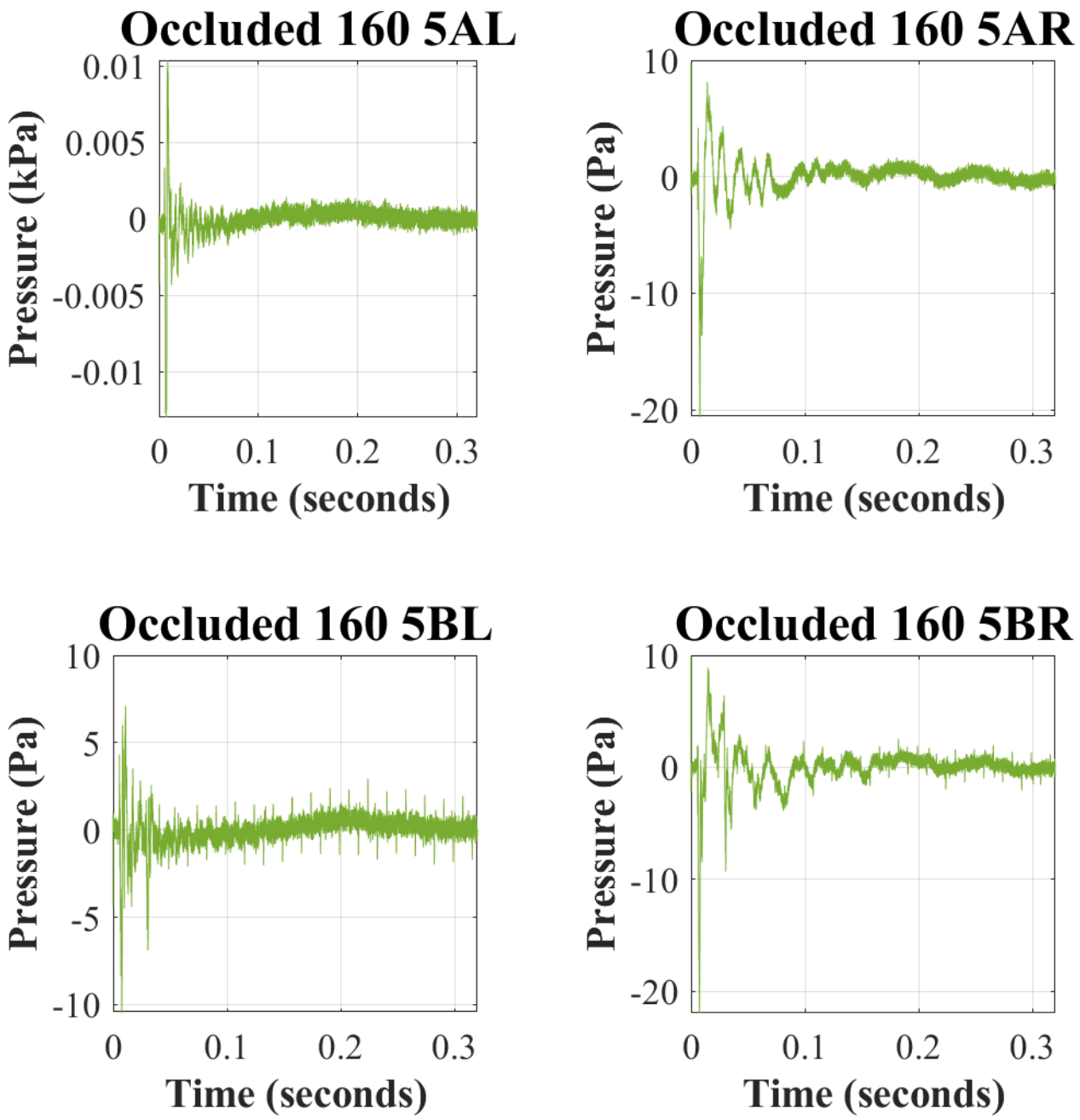

Occluded 160 3BR
Pressure (Pa)
10
0
-10
-20
-30
0
0.1
0.2
0.3
Time (seconds)


Occluded 160 4AL
Pressure (Pa)
5
0
-5
-10
0
0.1
0.2
0.3
Time (seconds)


Occluded 160 4AR
Pressure (Pa)
10
0
-10
-20
0
0.1
0.2
0.3
Time (seconds)

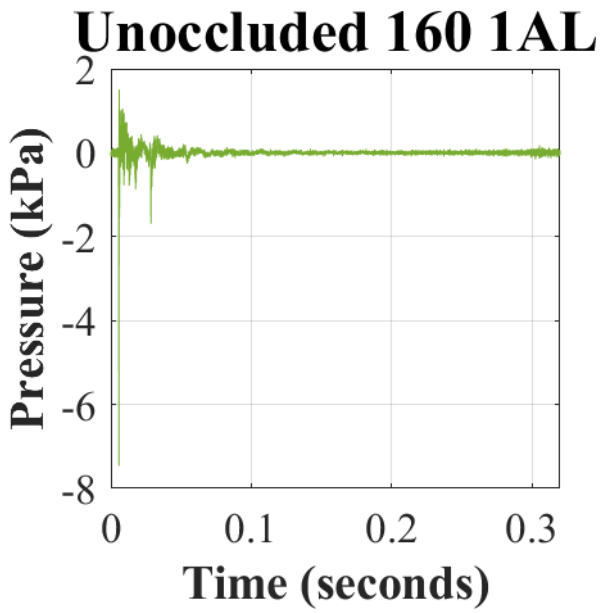

Occluded 160 4BL
Pressure (Pa)
10
5
0
-5
-10
-15
0
0.1
0.2
0.3
Time (seconds)

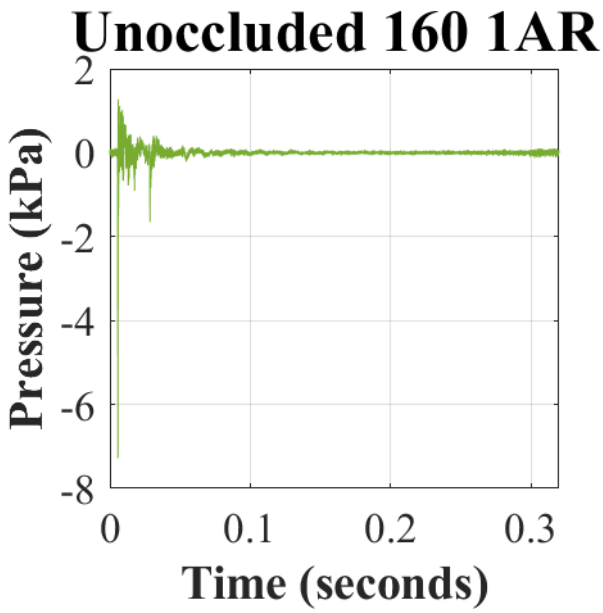

Occluded 160 4BR
Pressure (Pa)
10
0
-10
-20
0
0.1
0.2
0.3
Time (seconds)

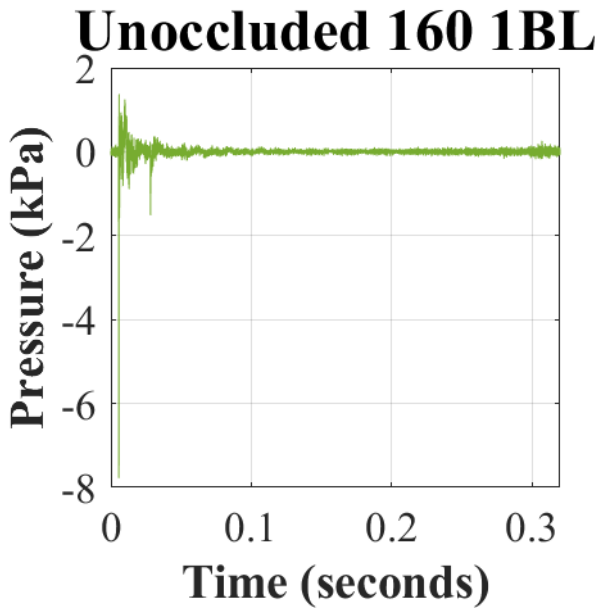


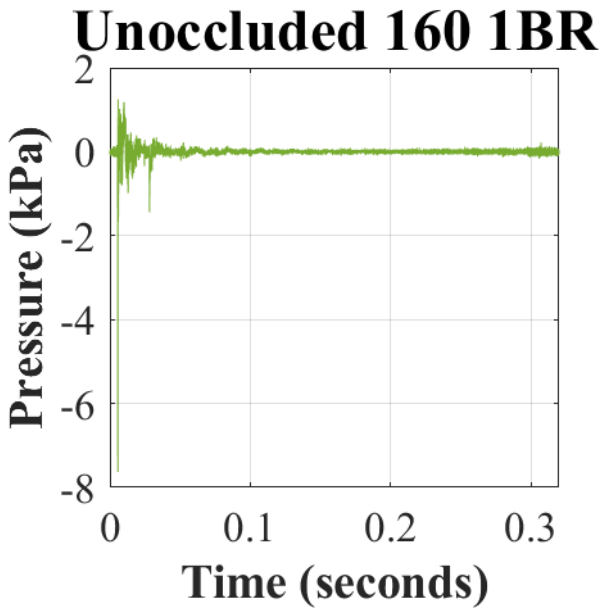
Note. The naming convention for all occluded waveforms is "Occluded LvL NnX", where 'Occluded' is the test condition (i.e., ATF has the HPDs donned), 'LvL' is the nominal test level (i.e., 160 or 170 dBP), 'N' is the sample number (i.e., 1 to 5) of the device tested, 'n' is the trial (i.e., A or B) indicating 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).

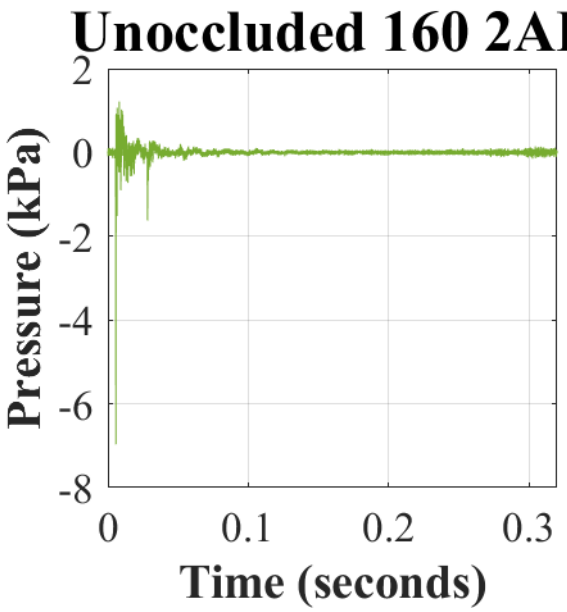
Appendix B. Estimated unoccluded (HPDs doffed) waveforms (in kilopascals [kPa]) over time (in seconds [s]) in response to 160 dBP with the ComTac™ V (OFF).

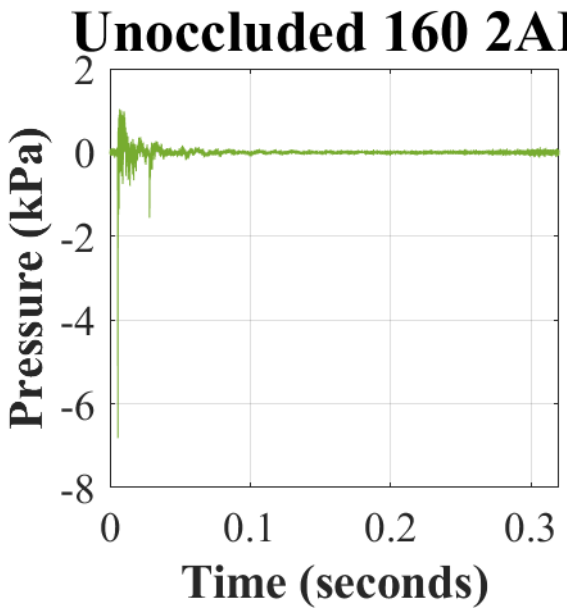


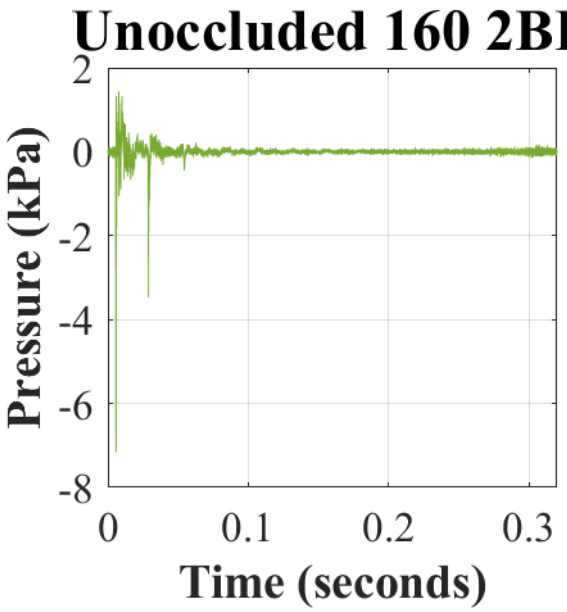


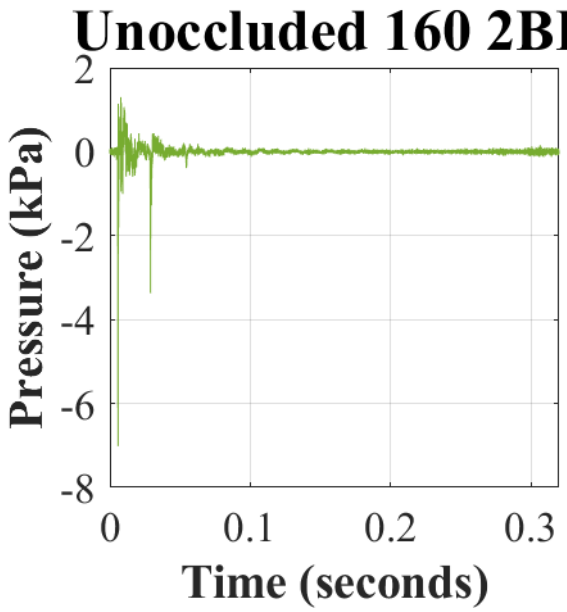


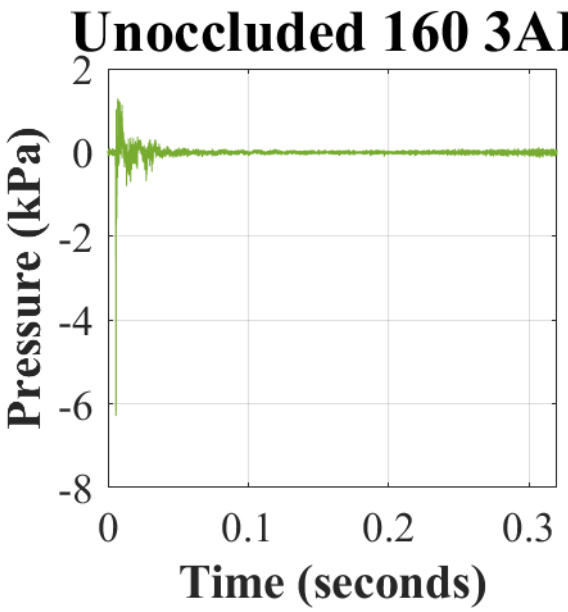


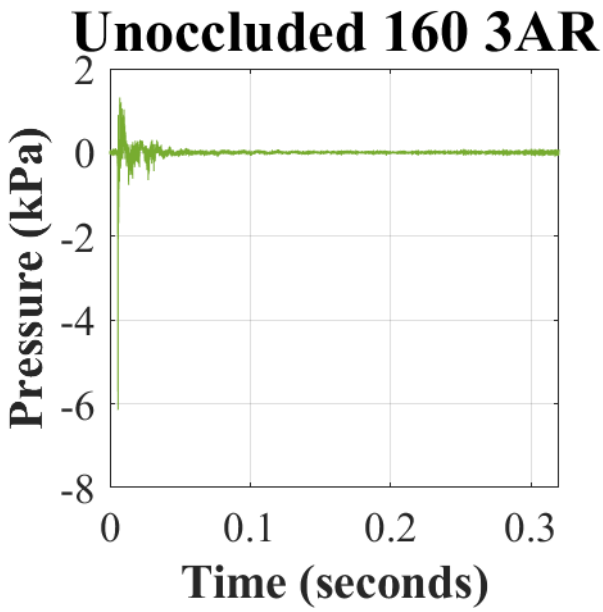

Unoccluded 160 2AL
Pressure (kPa)
2
0
-2
-4
-6
-8
0
0.1
0.2
0.3
Time (seconds)

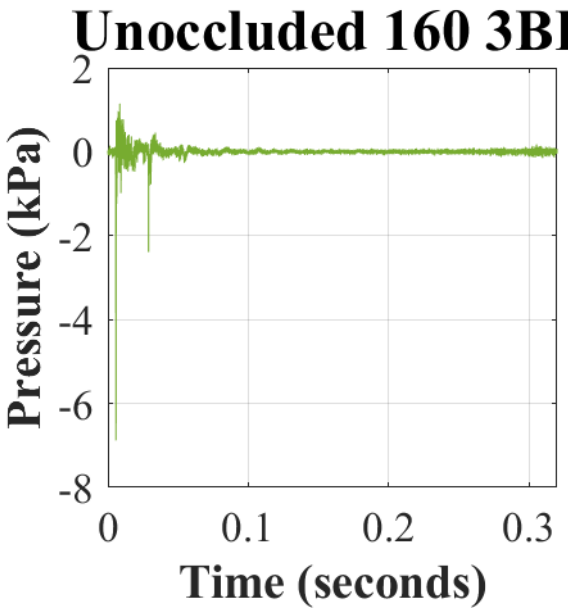

Unoccluded 160 2AR
Pressure (kPa)
2
0
-2
-4
-6
-8
0
0.1
0.2
0.3
Time (seconds)

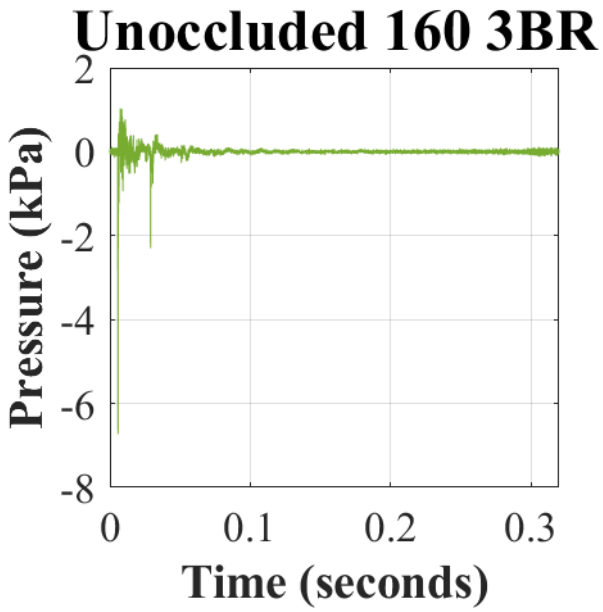

Unoccluded 160 2BL
Pressure (kPa)
2
0
-2
-4
-6
-8
0
0.1
0.2
0.3
Time (seconds)

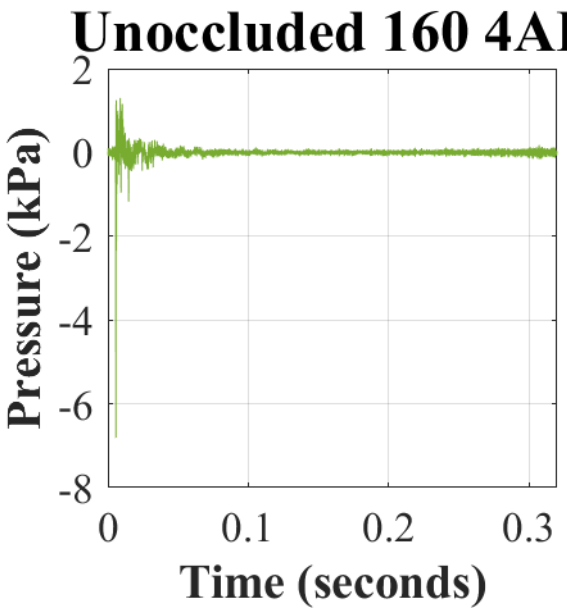

Unoccluded 160 2BR
Pressure (kPa)
2
0
-2
-4
-6
-8
0
0.1
0.2
0.3
Time (seconds)

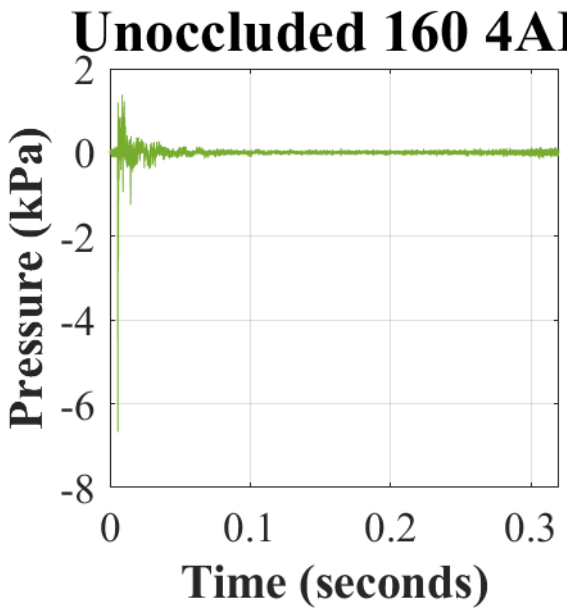

Unoccluded 160 3AL
Pressure (kPa)
2
0
-2
-4
-6
-8
0
0.1
0.2
0.3
Time (seconds)

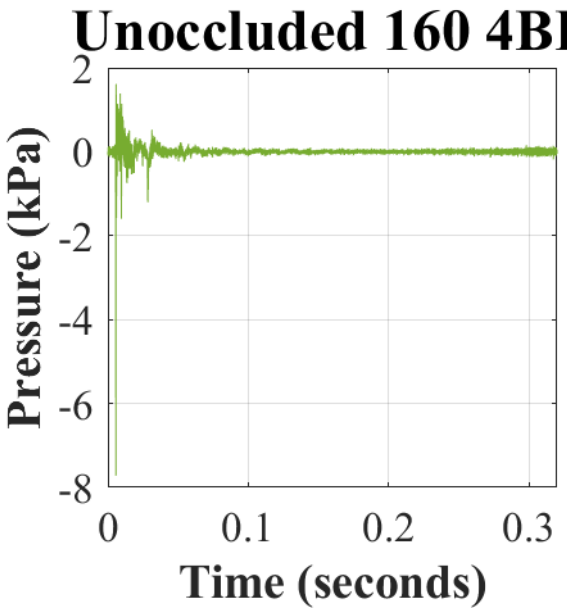

Unoccluded 160 3AR
Pressure (kPa)
2
0
-2
-4
-6
-8
0
0.1
0.2
0.3
Time (seconds)

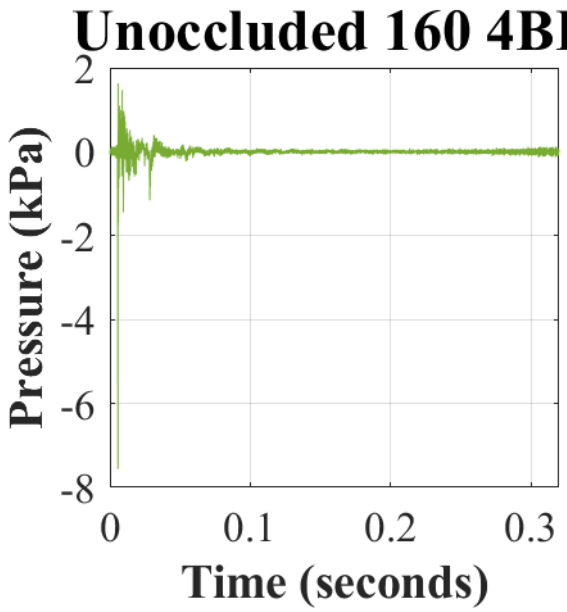

Unoccluded 160 3BL
Pressure (kPa)
2
0
-2
-4
-6
-8
0
0.1
0.2
0.3
Time (seconds)

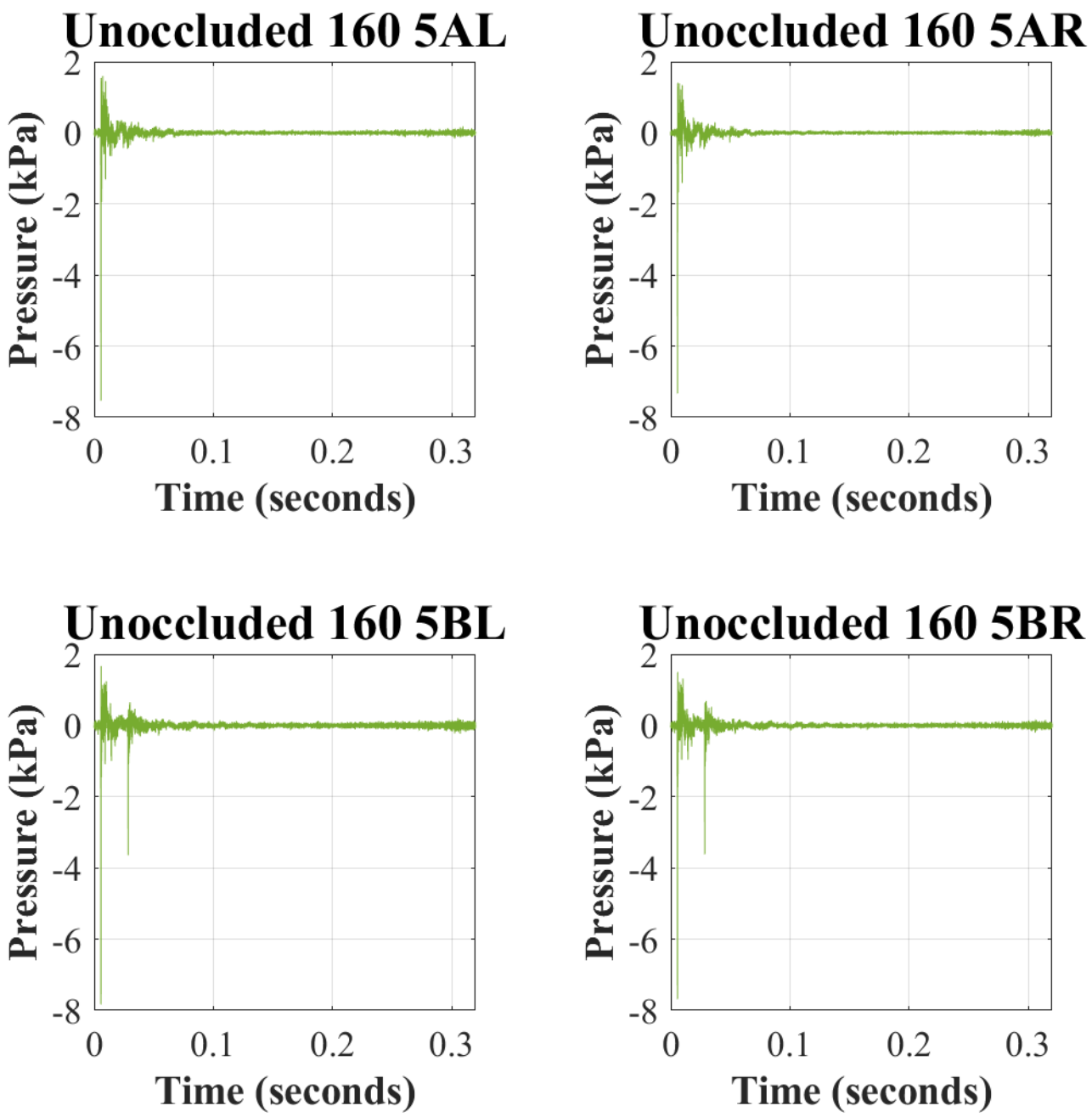

Unoccluded 160 3BR
Pressure (kPa)
2
0
-2
-4
-6
-8
0
0.1
0.2
0.3
Time (seconds)


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)
2
0
-2
-4
-6
-8
0
0.1
0.2
0.3
Time (seconds)

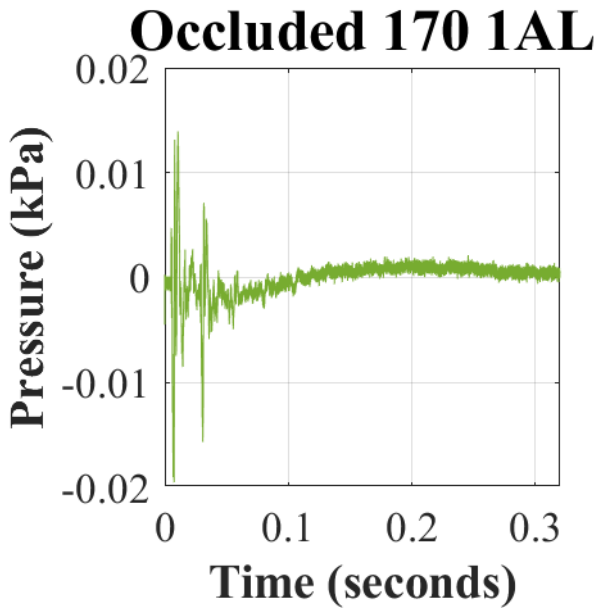

Unoccluded 160 4BL
Pressure (kPa)
2
0
-2
-4
-6
-8
0
0.1
0.2
0.3
Time (seconds)

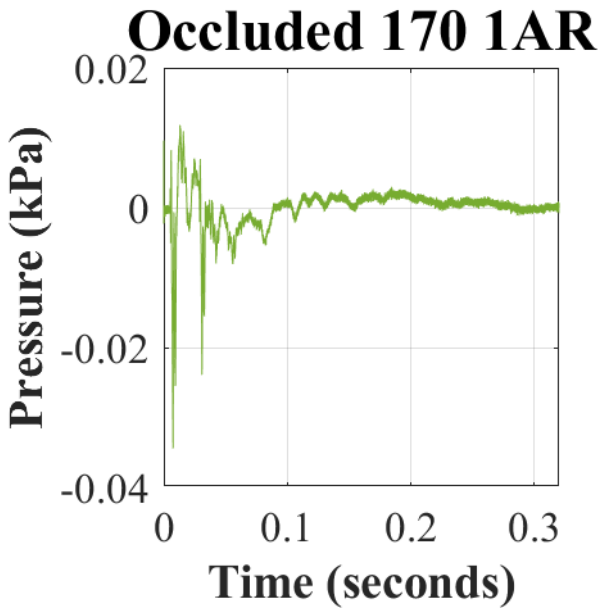

Unoccluded 160 4BR
Pressure (kPa)
2
0
-2
-4
-6
-8
0
0.1
0.2
0.3
Time (seconds)

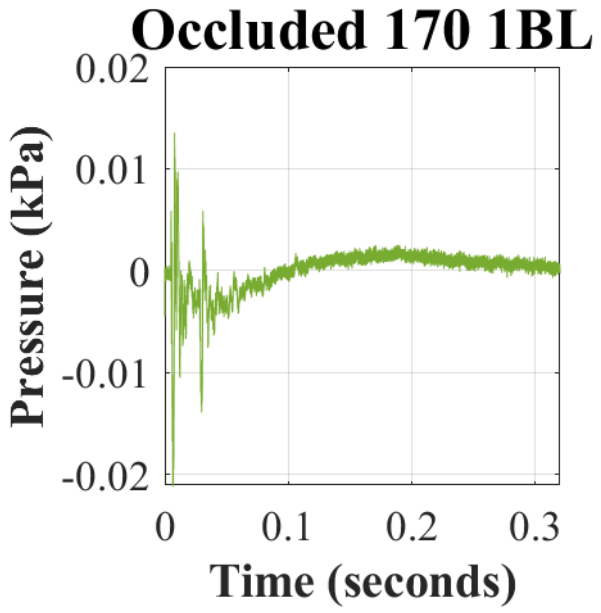


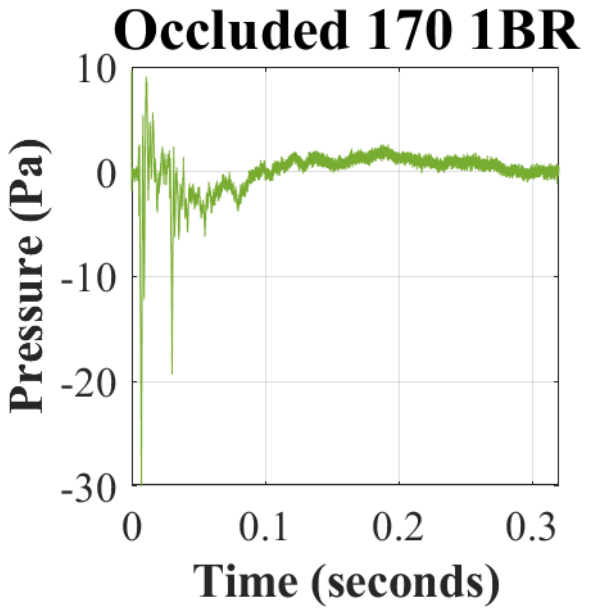
Note. The naming convention for all unoccluded waveforms is “Unoccluded LvL NnX”, where ‘Unoccluded’ is the test condition (i.e., ATF has the HPDs doffed), ‘LvL’ is the nominal test level (i.e., 160 or 170 dBP), ‘N’ is the sample number (i.e., 1 to 5) of the device tested, ‘n’ is the trial (i.e., A or B) indicating 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).

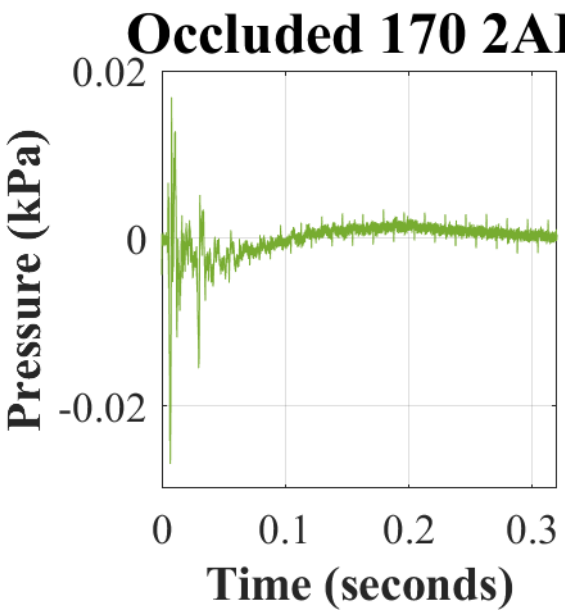
Appendix C. Recorded occluded (HPDs donned) waveforms (in pascals [Pa] or kilopascals [kPa]) over time (in seconds [s]) in response to 170 dBP with the ComTac™ V (OFF).

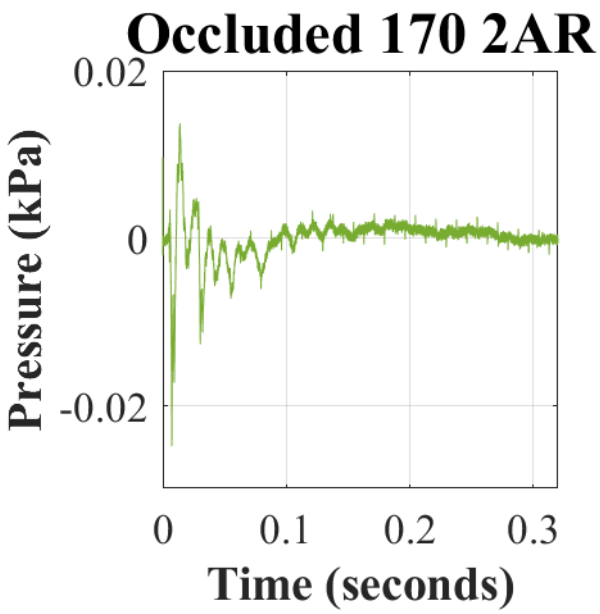


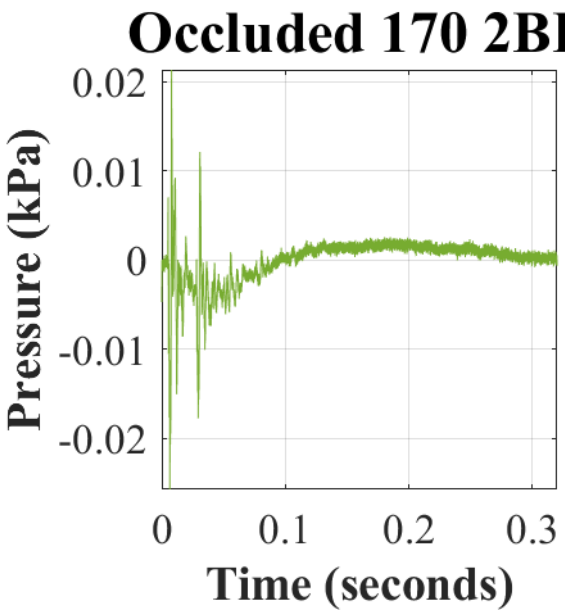


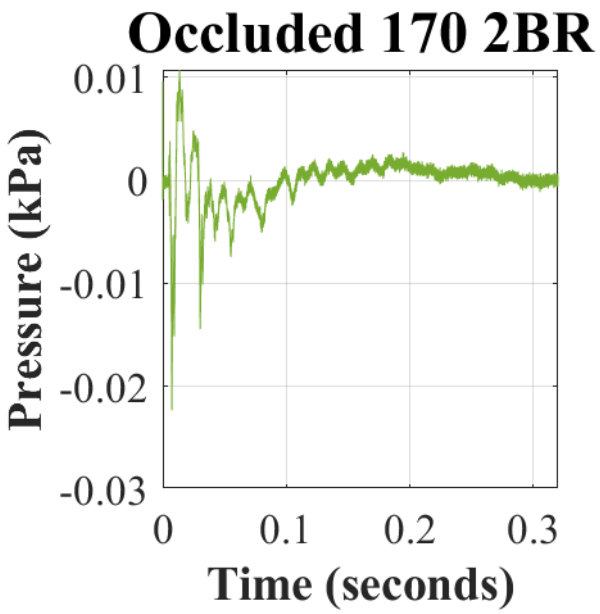


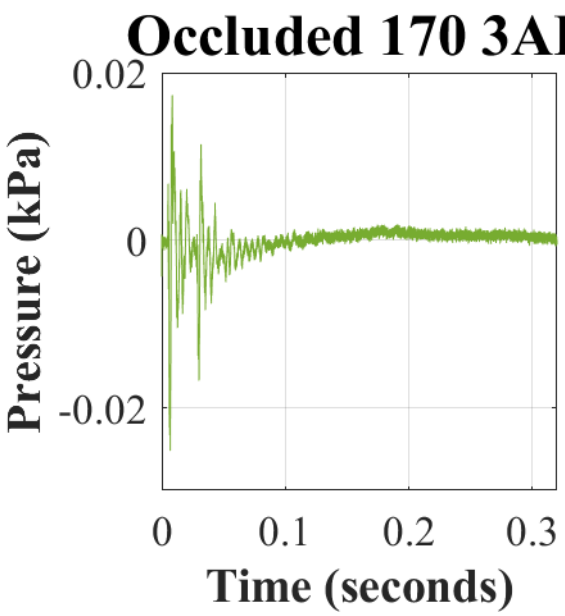


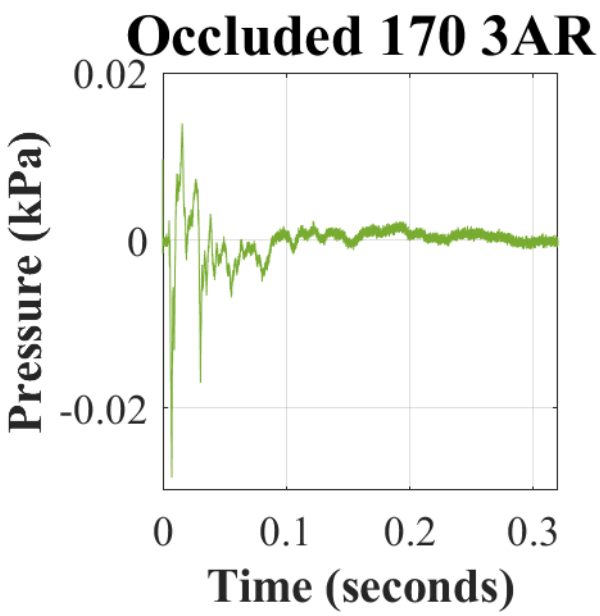

Occluded 170 2AL
Pressure (kPa)
0.02
0
-0.02
0
0.1
0.2
0.3
Time (seconds)

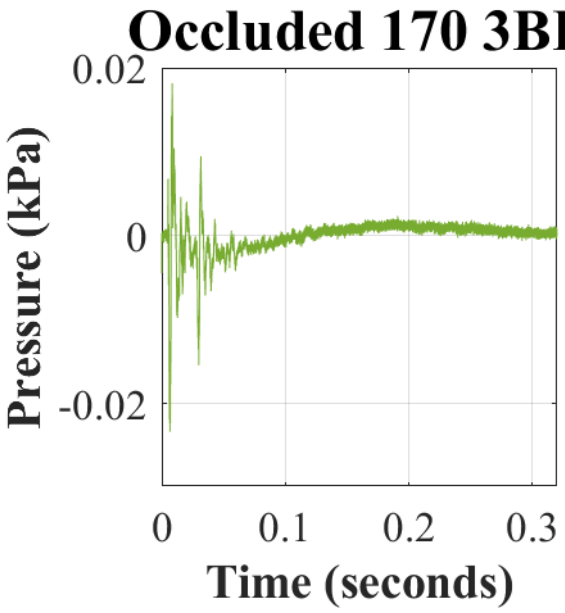

Occluded 170 2AR
Pressure (kPa)
0.02
0
-0.02
0
0.1
0.2
0.3
Time (seconds)

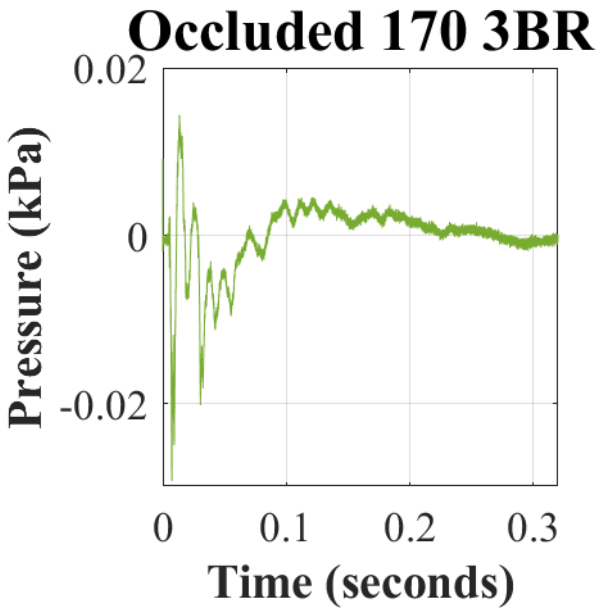

Occluded 170 2BL
Pressure (kPa)
0.02
0.01
0
-0.01
-0.02
0
0.1
0.2
0.3
Time (seconds)

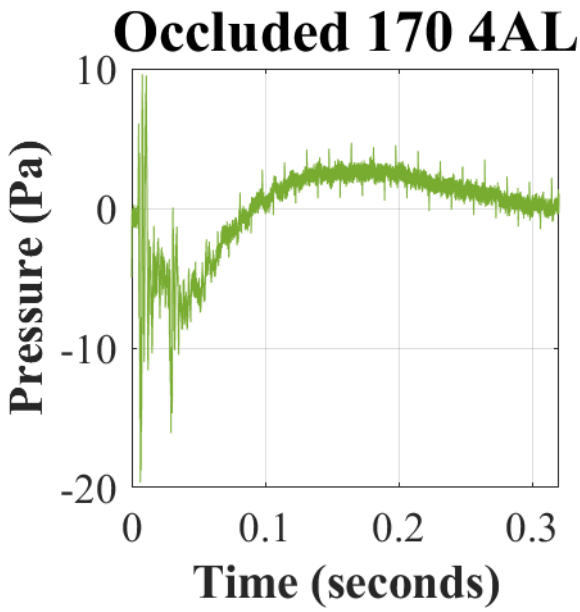

Occluded 170 2BR
Pressure (kPa)
0.01
0
-0.01
-0.02
-0.03
0
0.1
0.2
0.3
Time (seconds)

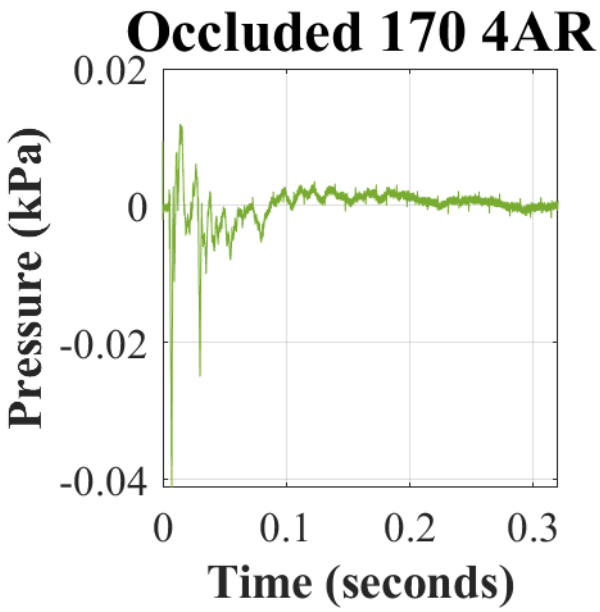

Occluded 170 3AL
Pressure (kPa)
0.02
0
-0.02
0
0.1
0.2
0.3
Time (seconds)

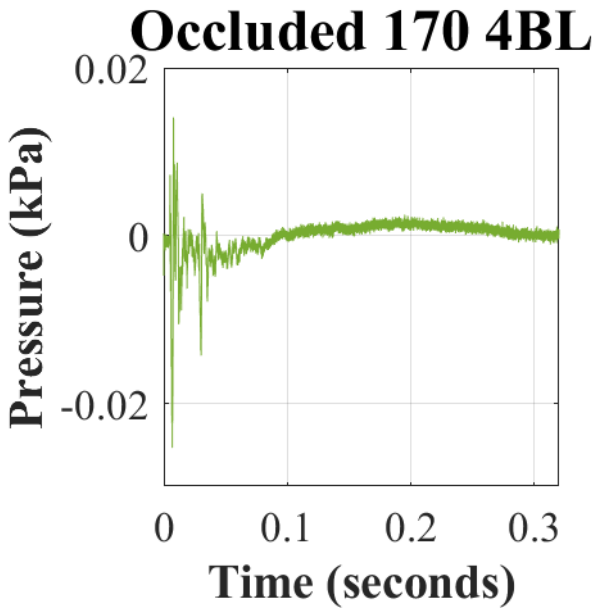

Occluded 170 3AR
Pressure (kPa)
0.02
0
-0.02
0
0.1
0.2
0.3
Time (seconds)

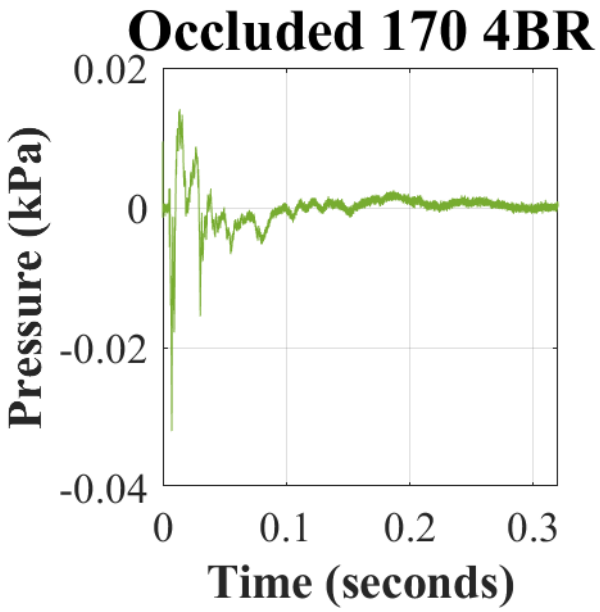

Occluded 170 3BL
Pressure (kPa)
0.02
0
-0.02
0
0.1
0.2
0.3
Time (seconds)

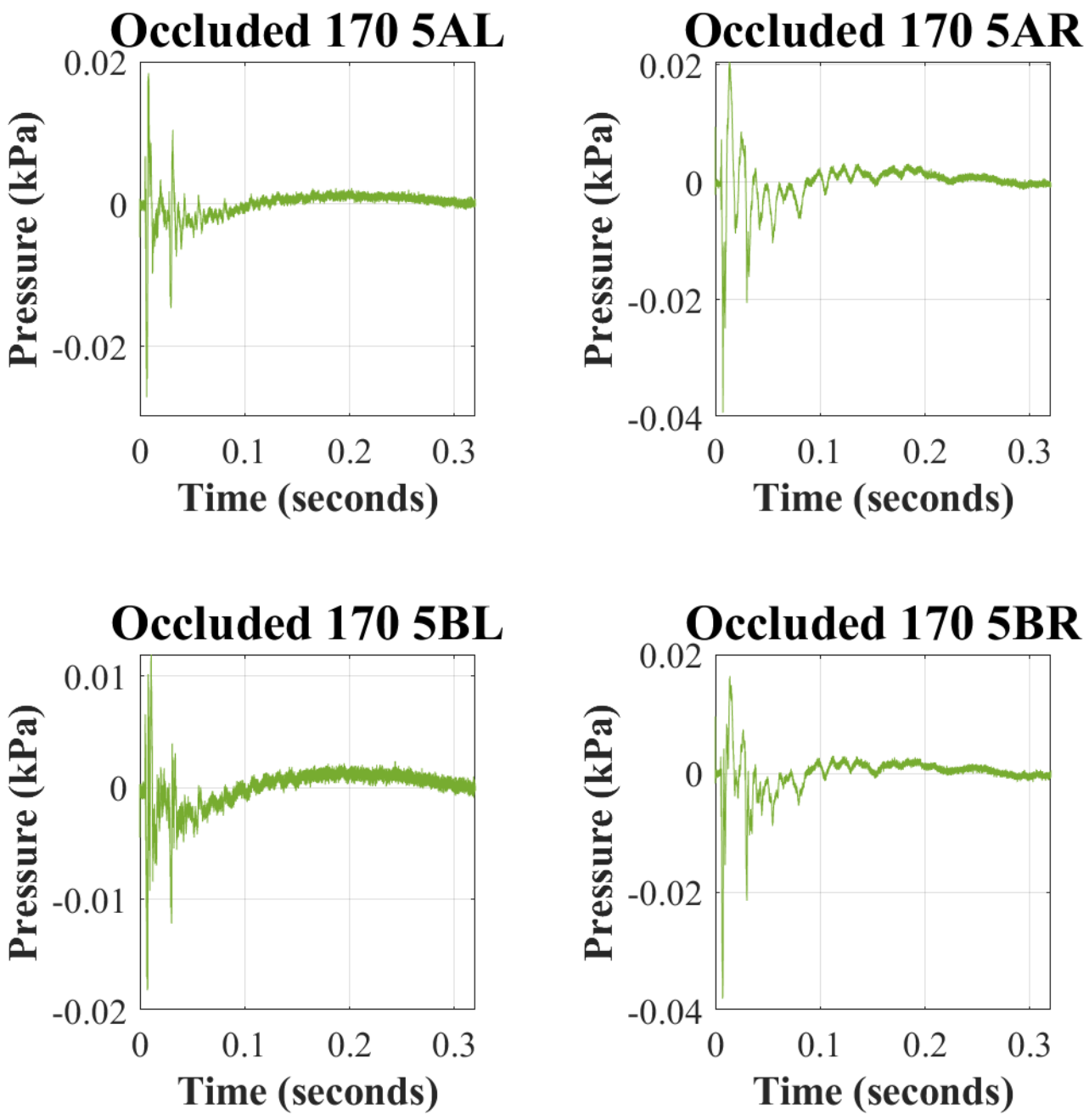

Occluded 170 3BR
Pressure (kPa)
0.02
0
-0.02
0
0.1
0.2
0.3
Time (seconds)


Occluded 170 4AL
Pressure (Pa)
10
0
-10
-20
0
0.1
0.2
0.3
Time (seconds)


Occluded 170 4AR
Pressure (kPa)
0.02
0
-0.02
-0.04
0
0.1
0.2
0.3
Time (seconds)

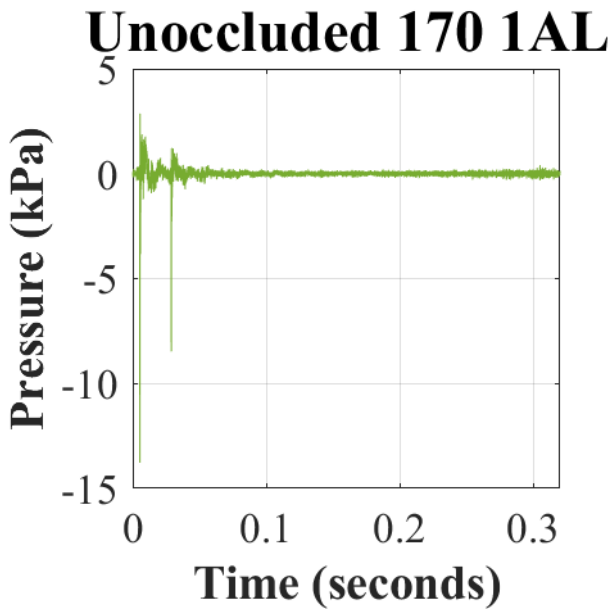

Occluded 170 4BL
Pressure (kPa)
0.02
0
-0.02
0
0.1
0.2
0.3
Time (seconds)

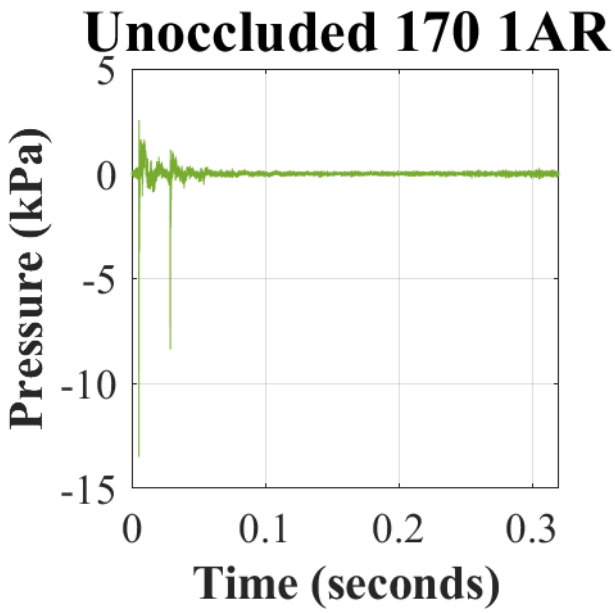

Occluded 170 4BR
Pressure (kPa)
0.02
0
-0.02
-0.04
0
0.1
0.2
0.3
Time (seconds)

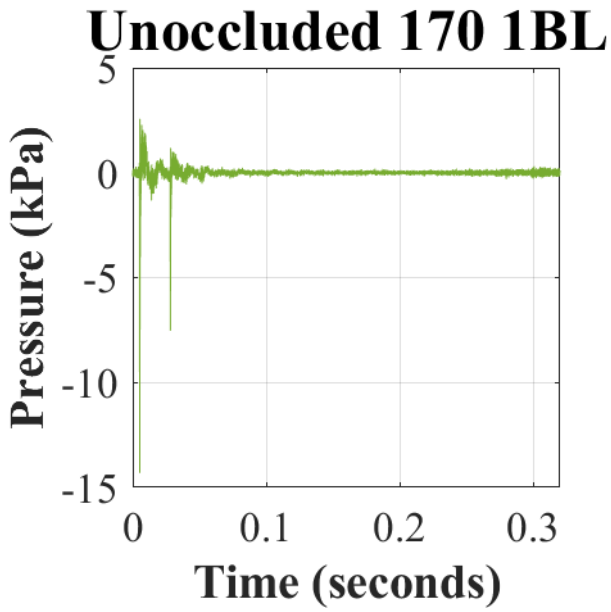


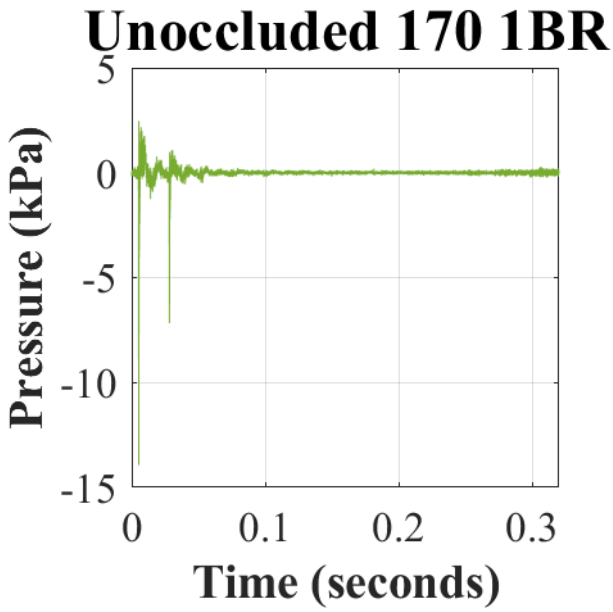
Note. The naming convention for all occluded waveforms is “Occluded LvL NnX”, where ‘Occluded’ is the test condition (i.e., ATF has the HPDs donned), ‘LvL’ is the nominal test level (i.e., 160 or 170 dBP), ‘N’ is the sample number (i.e., 1 to 5) of the device tested, ‘n’ is the trial (i.e., A or B) indicating 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).

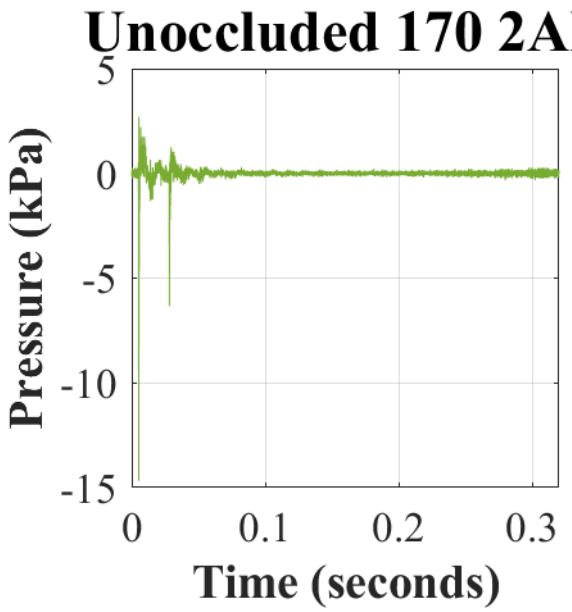
Appendix D. Estimated unoccluded (HPDs doffed) waveforms (in kilopascals [kPa]) over time (in seconds [s]) in response to 170 dBP with the ComTac™ V (OFF).

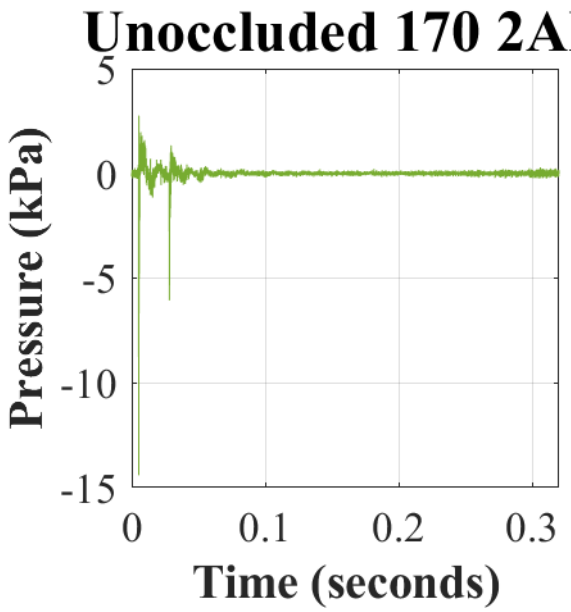


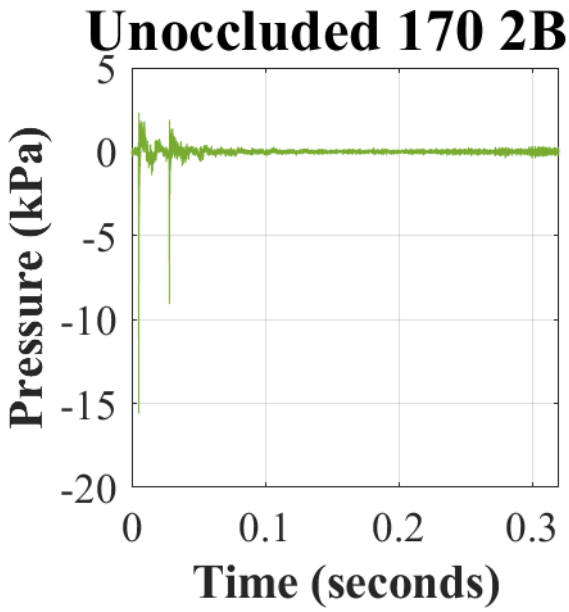


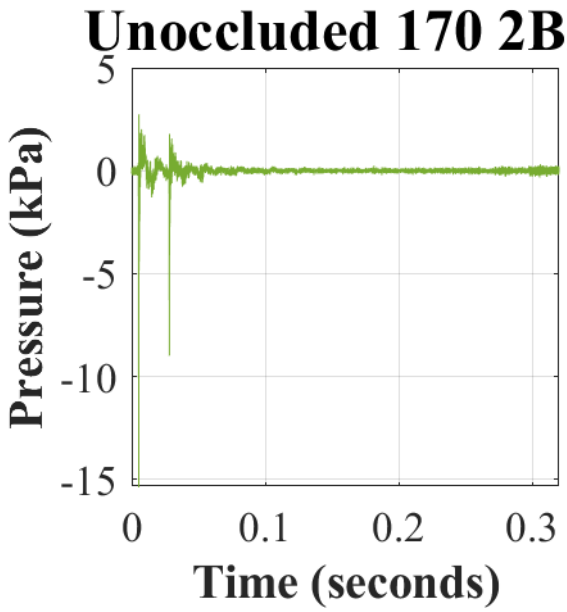


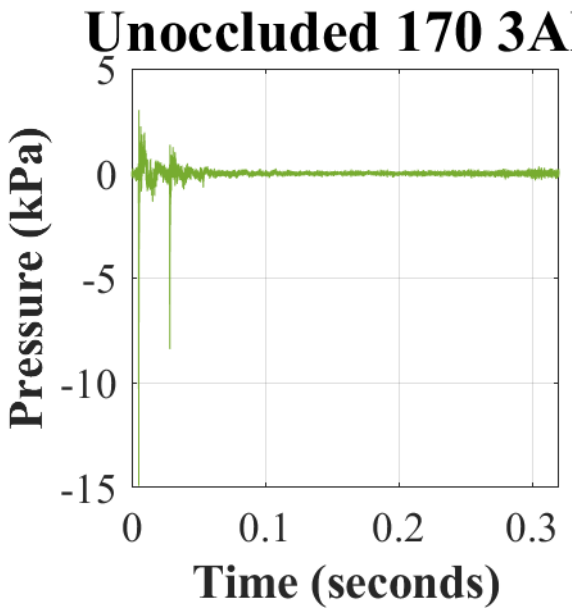


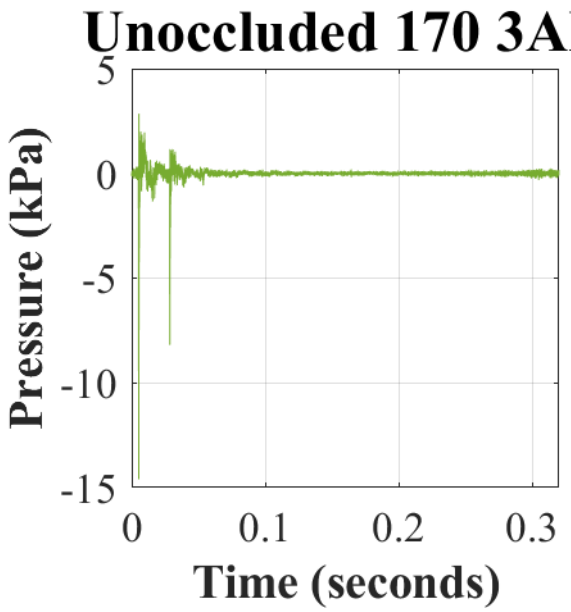

Unoccluded 170 2AL
Pressure (kPa)
5
0
-5
-10
-15
0
0.1
0.2
0.3
Time (seconds)

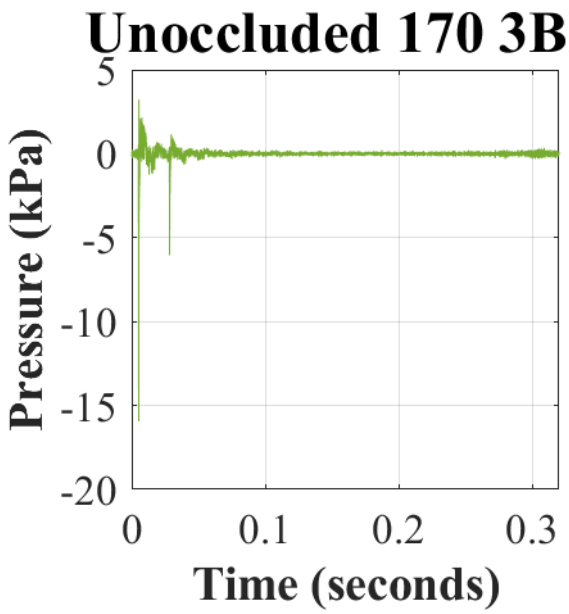

Unoccluded 170 2AR
Pressure (kPa)
5
0
-5
-10
-15
0
0.1
0.2
0.3
Time (seconds)

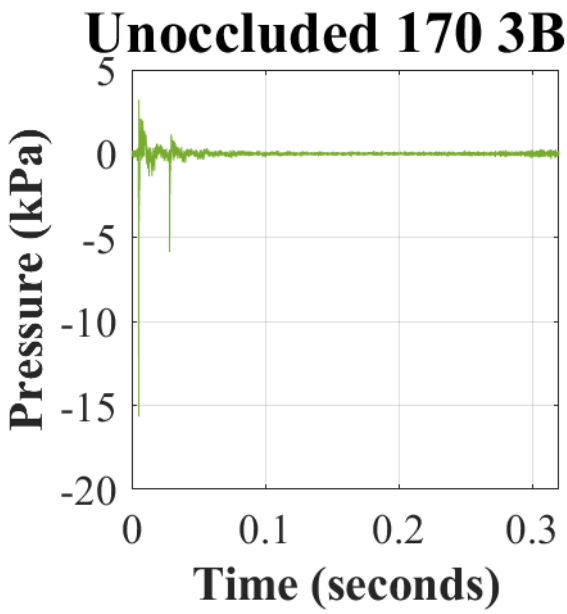

Unoccluded 170 2BL
Pressure (kPa)
5
0
-5
-10
-15
-20
0
0.1
0.2
0.3
Time (seconds)

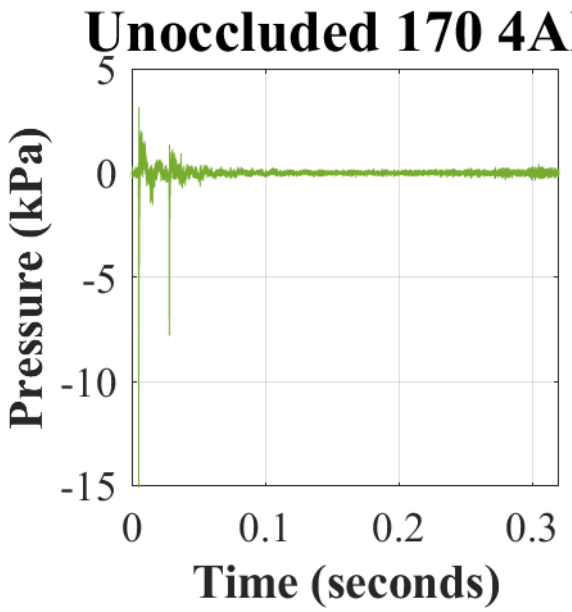

Unoccluded 170 2BR
Pressure (kPa)
5
0
-5
-10
-15
0
0.1
0.2
0.3
Time (seconds)

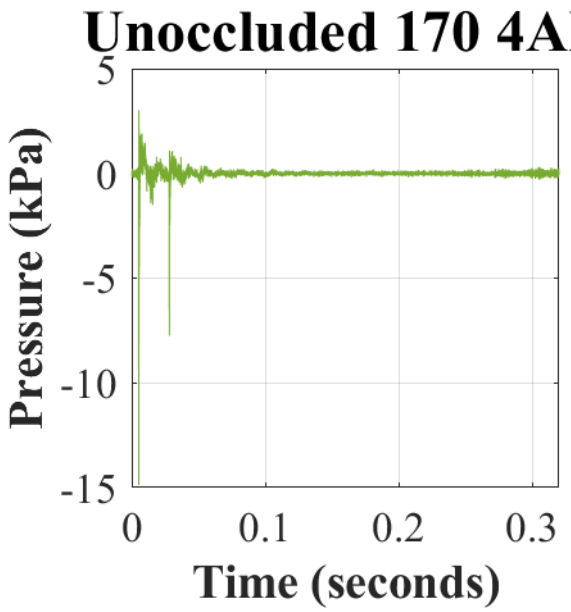

Unoccluded 170 3AL
Pressure (kPa)
5
0
-5
-10
-15
0
0.1
0.2
0.3
Time (seconds)

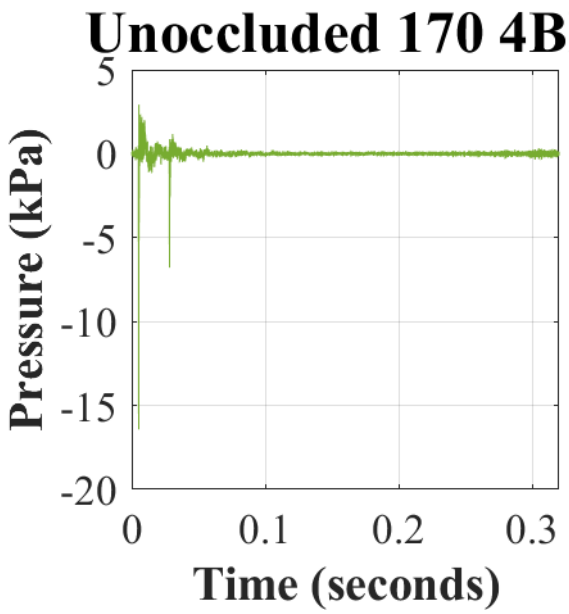

Unoccluded 170 3AR
Pressure (kPa)
5
0
-5
-10
-15
0
0.1
0.2
0.3
Time (seconds)

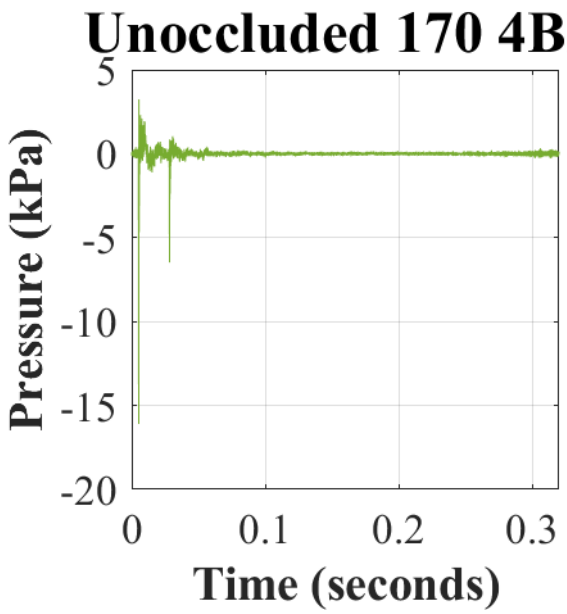

Unoccluded 170 3BL
Pressure (kPa)
5
0
-5
-10
-15
-20
0
0.1
0.2
0.3
Time (seconds)

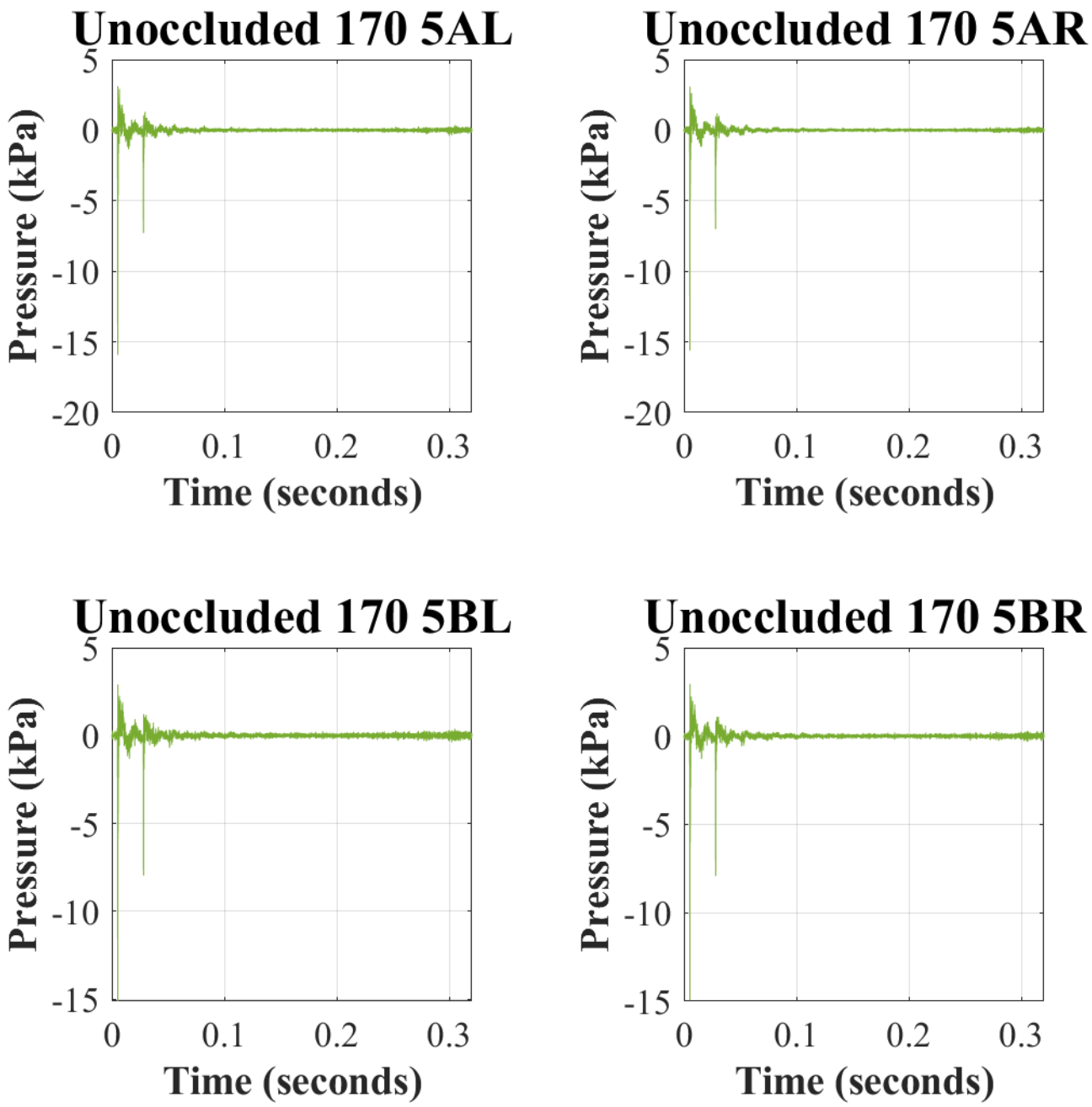

Unoccluded 170 3BR
Pressure (kPa)
5
0
-5
-10
-15
-20
0
0.1
0.2
0.3
Time (seconds)


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


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

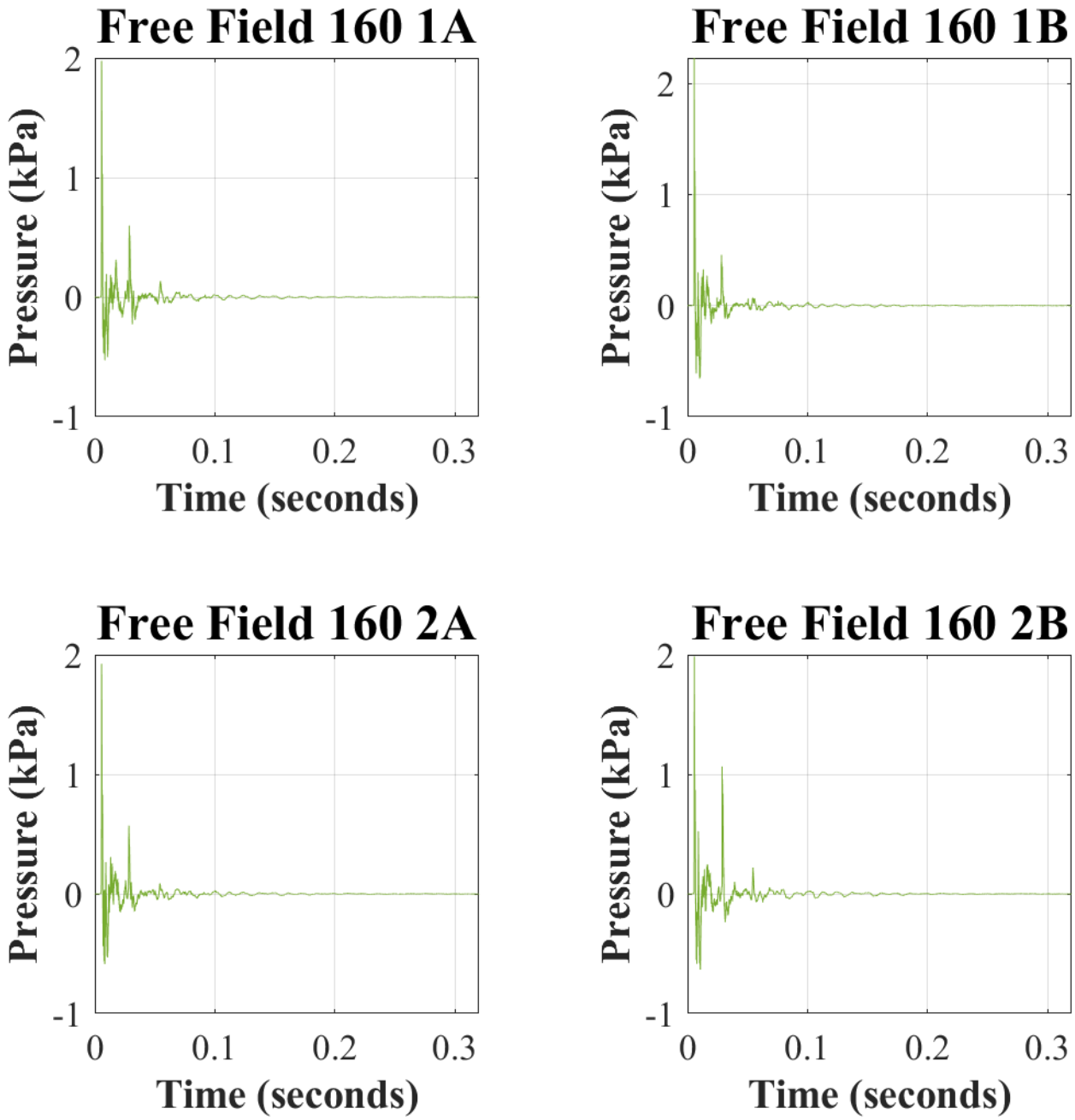

Unoccluded 170 4BL
Pressure (kPa)
5
0
-5
-10
-15
-20
0
0.1
0.2
0.3
Time (seconds)

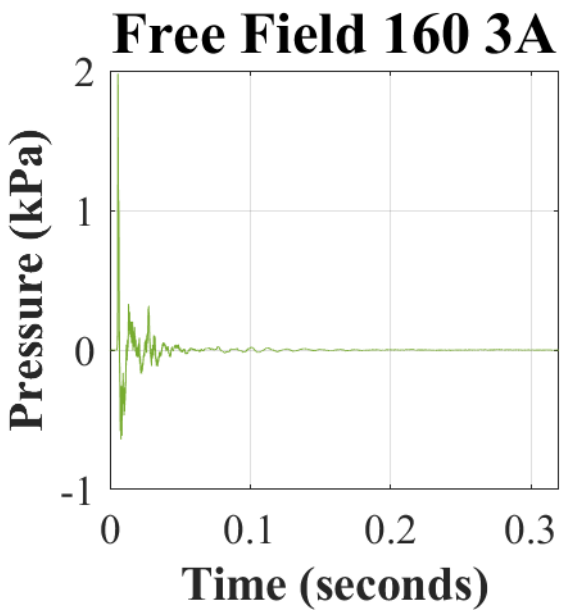

Unoccluded 170 4BR
Pressure (kPa)
5
0
-5
-10
-15
-20
0
0.1
0.2
0.3
Time (seconds)

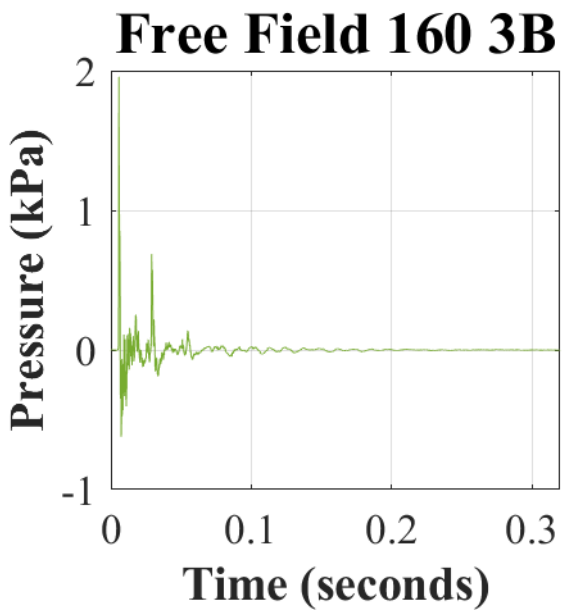


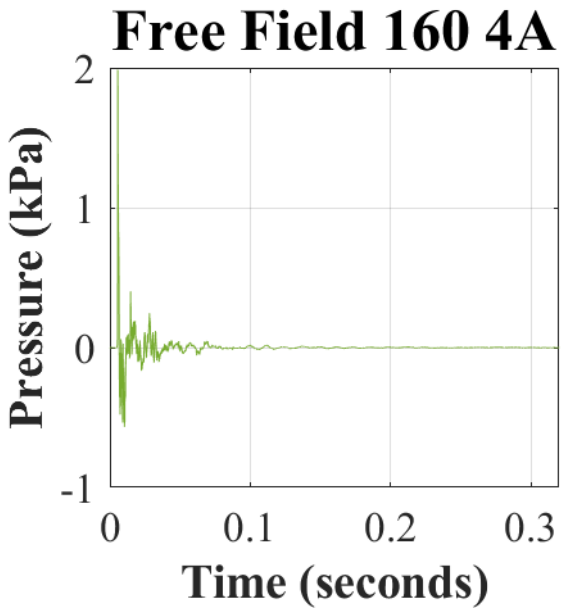
Note. The naming convention for all unoccluded waveforms is "Unoccluded LvL NnX", where 'Unoccluded' is the test condition (i.e., ATF has the HPDs doffed), 'LvL' is the nominal test level (i.e., 160 or 170 dBP), 'N' is the sample number (i.e., 1 to 5) of the device tested, 'n' is the trial (i.e., A or B) indicating 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).

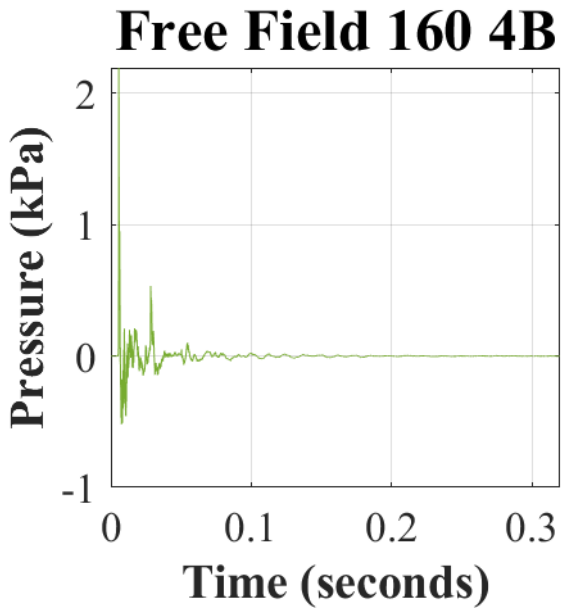
Appendix E. Recorded waveform (in kilopascals [kPa]) over time (in seconds [s]) of the impulse measured with the free-field probe at 160 dBP and the ComTac™ V (OFF) donned.

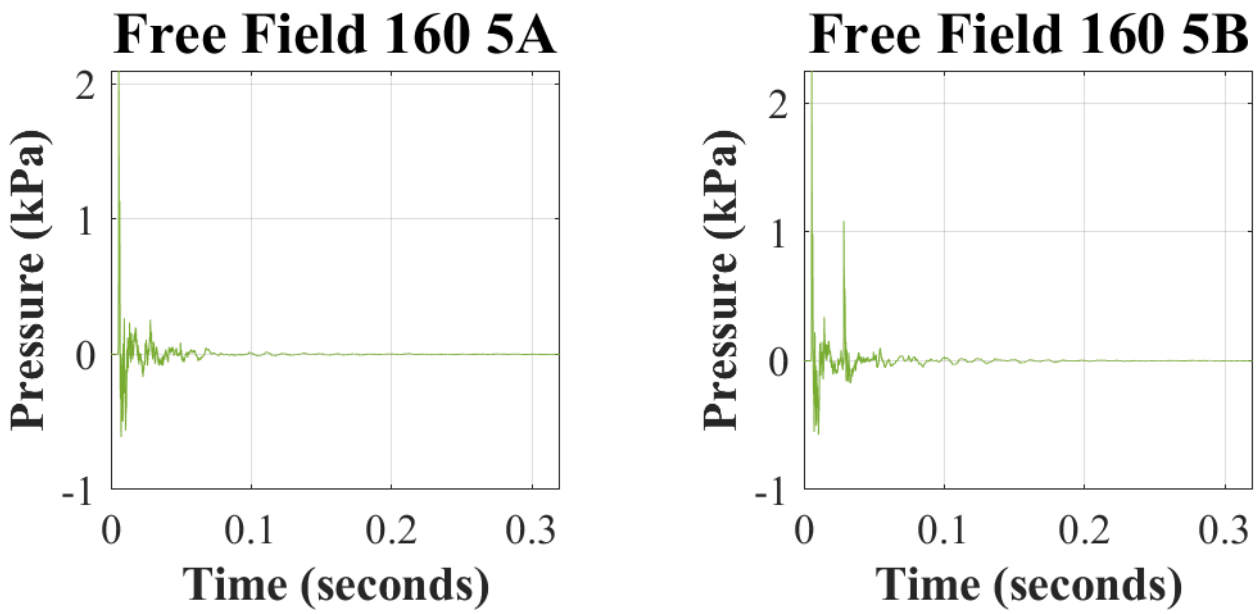



Free Field 160 3A
Pressure (kPa)
2
1
0
-1
0
0.1
0.2
0.3
Time (seconds)


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

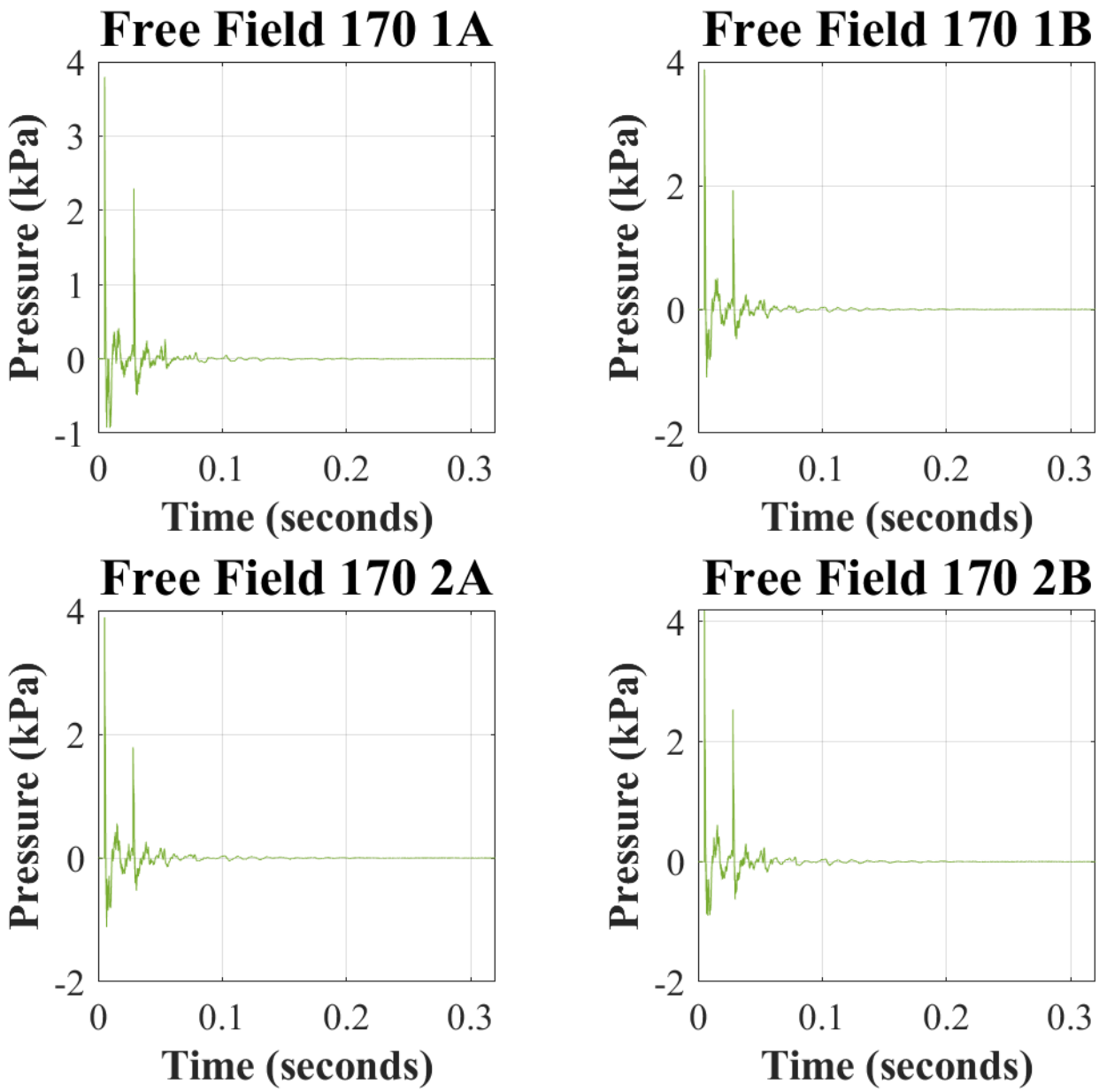

Free Field 160 4A
Pressure (kPa)
2
1
0
-1
0
0.1
0.2
0.3
Time (seconds)

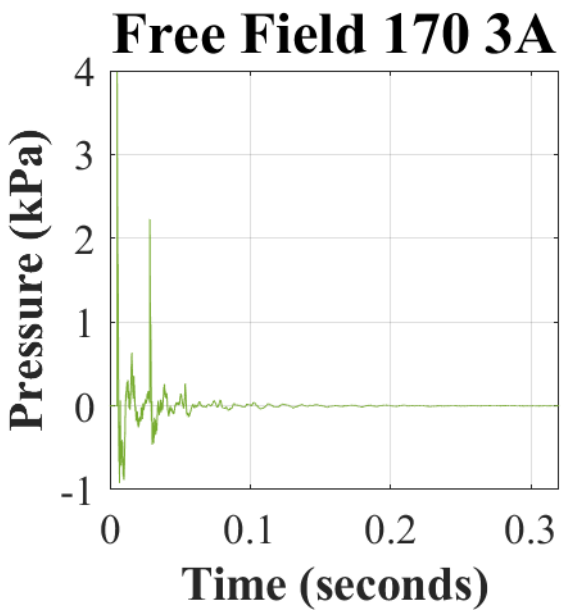

Free Field 160 4B
Pressure (kPa)
2
1
0
-1
0
0.1
0.2
0.3
Time (seconds)

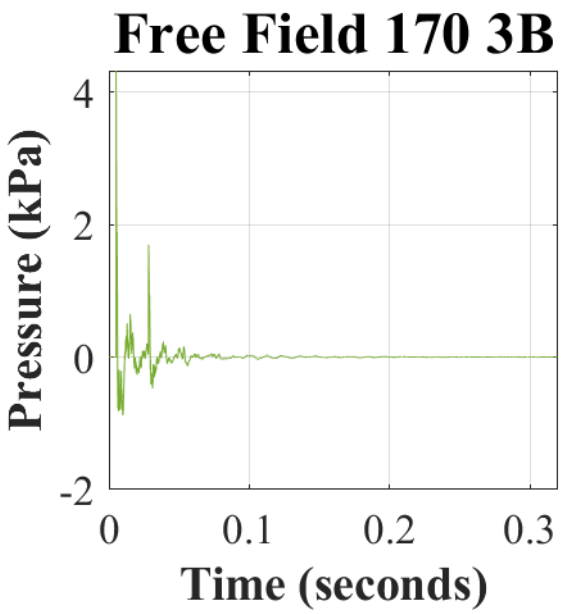


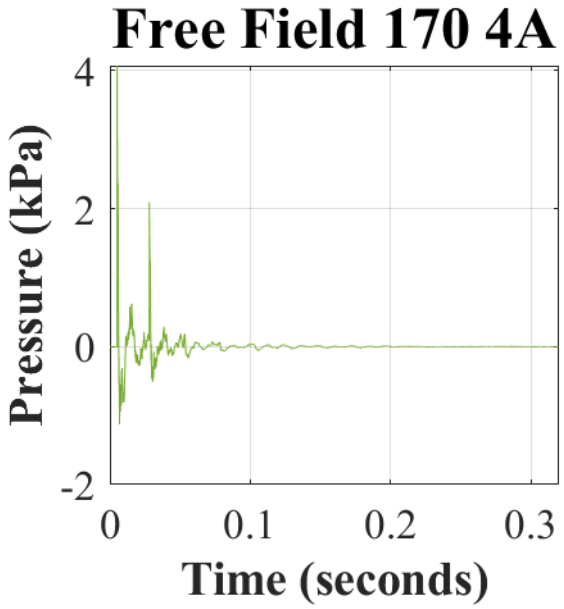
Note. The naming convention for all free-field waveforms is “Free Field LvL Nn”, where ‘Free Field’ indicates that the recording was obtained using the PCB reference microphone, ‘LvL’ is the nominal test level (160 dBP), ‘N’ is the device sample number (1 to 5), and ‘n’ is the device trial (i.e., A or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

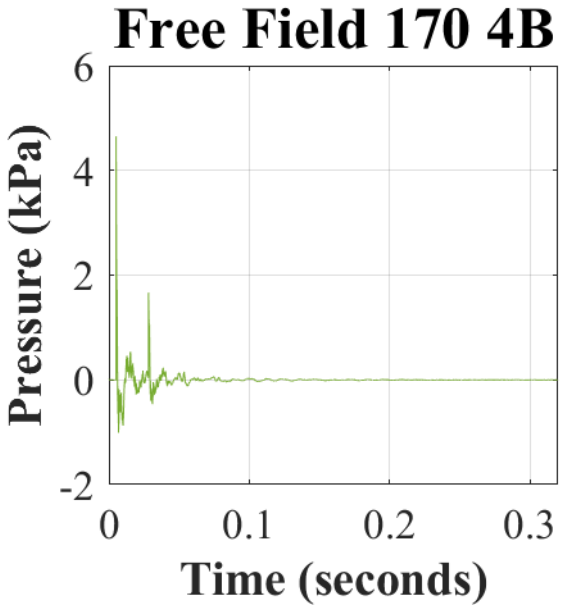
Appendix F. Recorded waveform (in kilopascals [kPa]) over time (in seconds [s]) of the impulse measured with the free-field probe at 170 dBP and the ComTac™ V (OFF) donned.

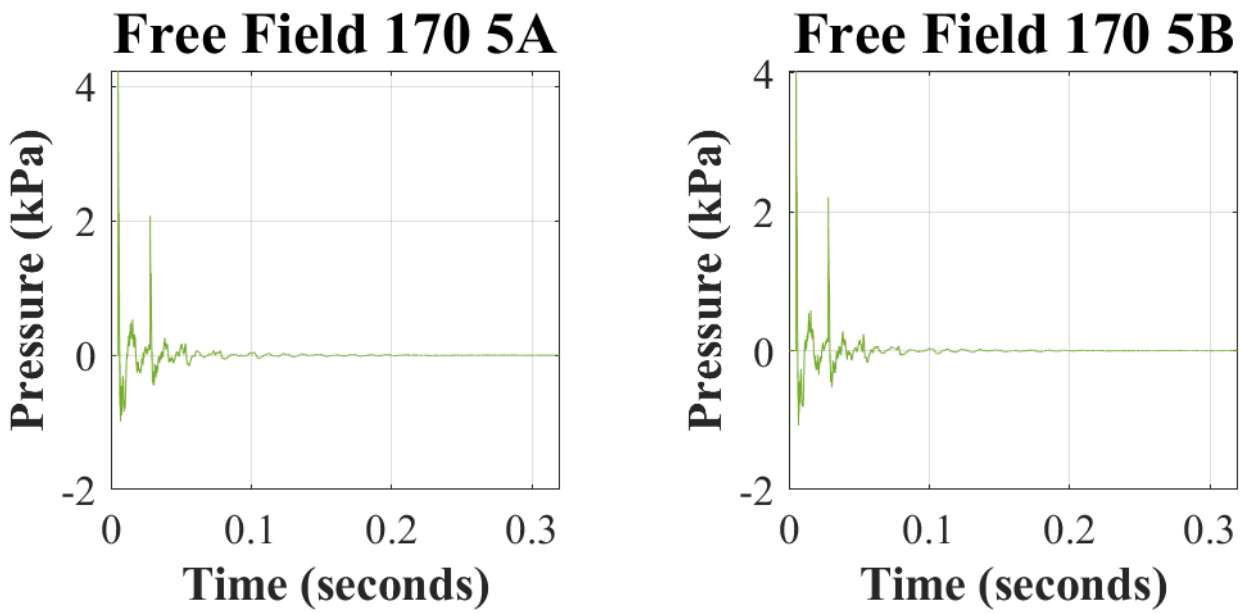



Free Field 170 3A
Pressure (kPa)
Time (seconds)
4
3
2
1
0
-1
0
0.1
0.2
0.3


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

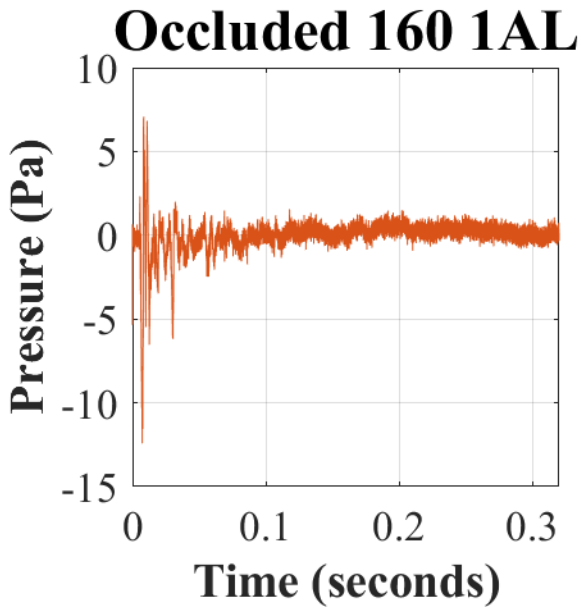

Free Field 170 4A
Pressure (kPa)
Time (seconds)
4
2
0
-2
0
0.1
0.2
0.3

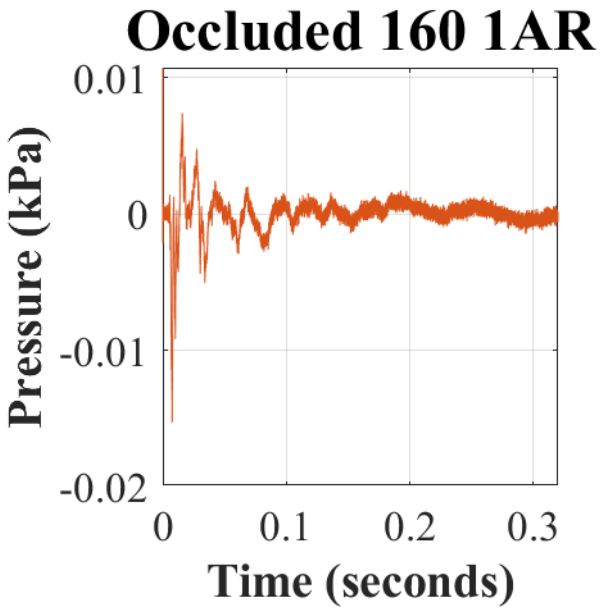

Free Field 170 4B
Pressure (kPa)
Time (seconds)
6
4
2
0
-2
0
0.1
0.2
0.3

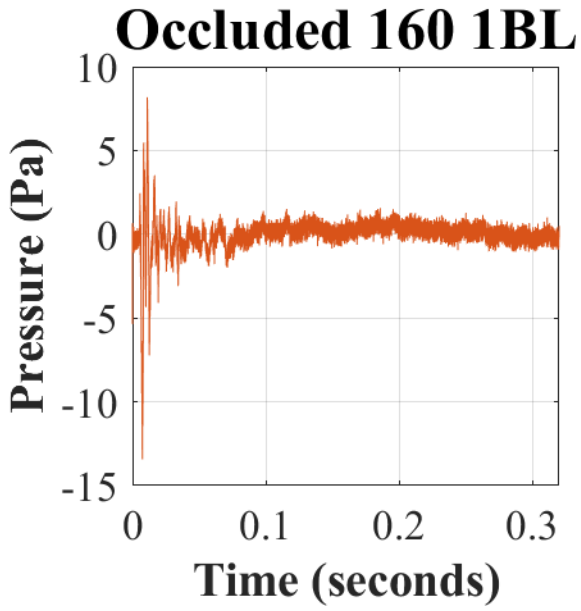


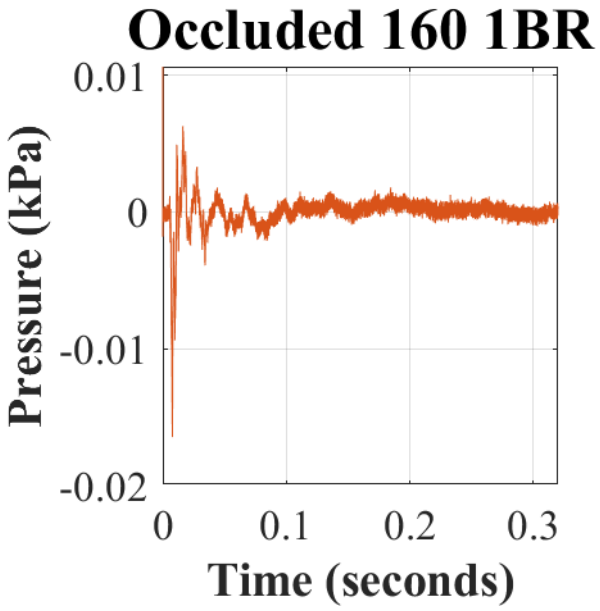
Note. The naming convention for all free-field waveforms is “Free Field LvL Nn”, where ‘Free Field’ indicates that the recording was obtained using the PCB reference microphone, ‘LvL’ is the nominal test level (170 dBP), ‘N’ is the device sample number (1 to 5), and ‘n’ is the device trial (i.e., A or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

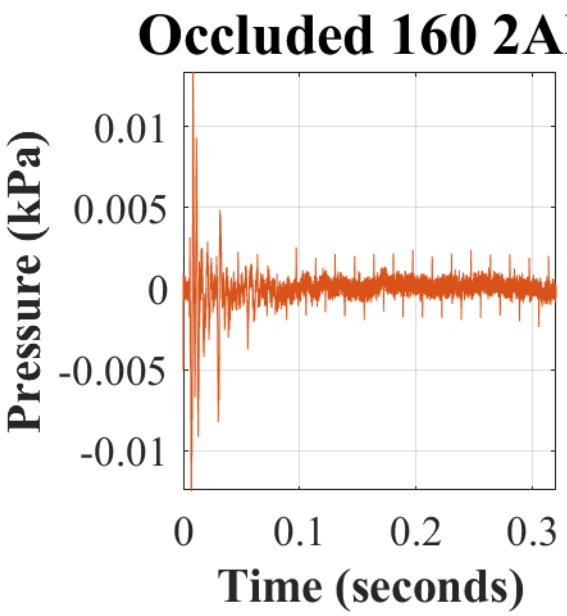
Appendix G. Recorded occluded (HPDs donned) waveforms (in pascals [Pa] or kilopascals [kPa]) over time (in seconds [s]) in response to 160 dBP with the ComTac™ V (MAX).

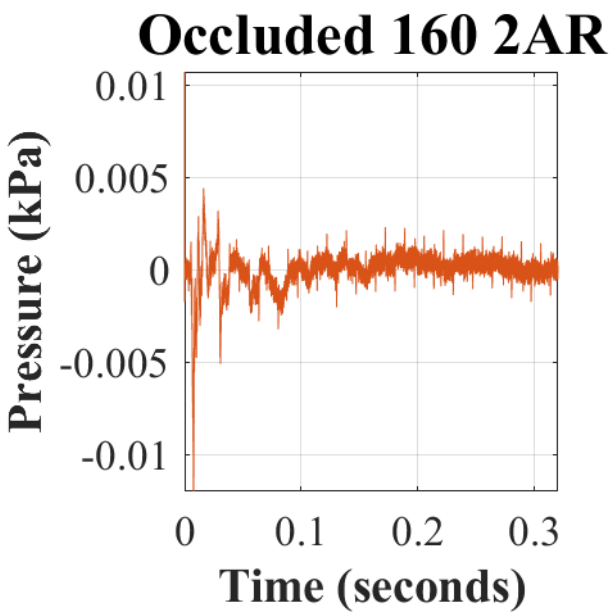


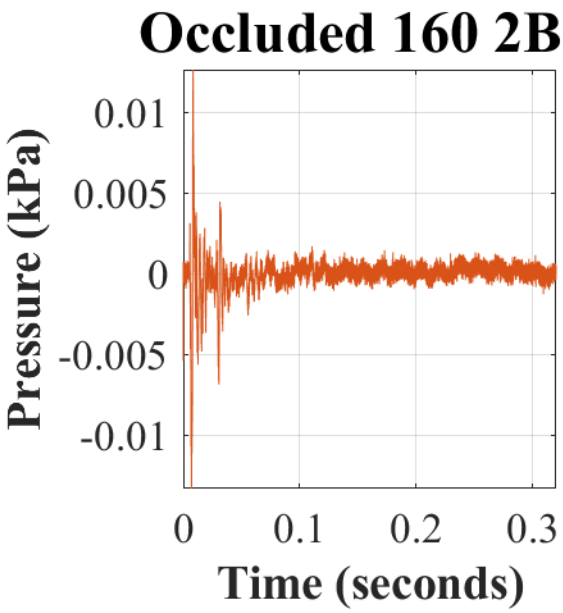


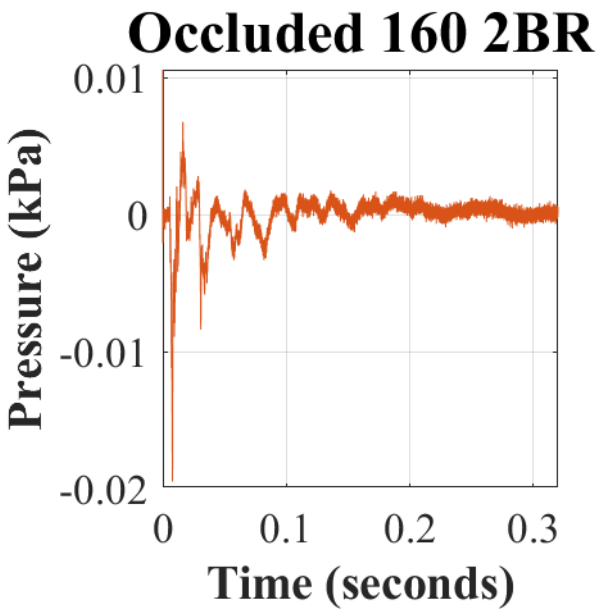


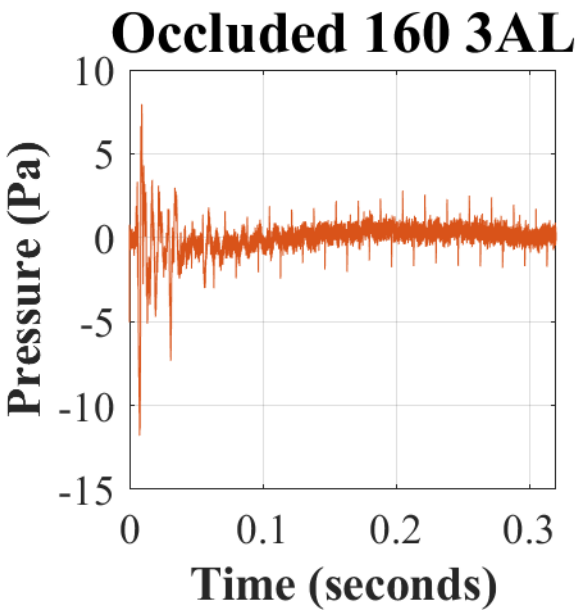


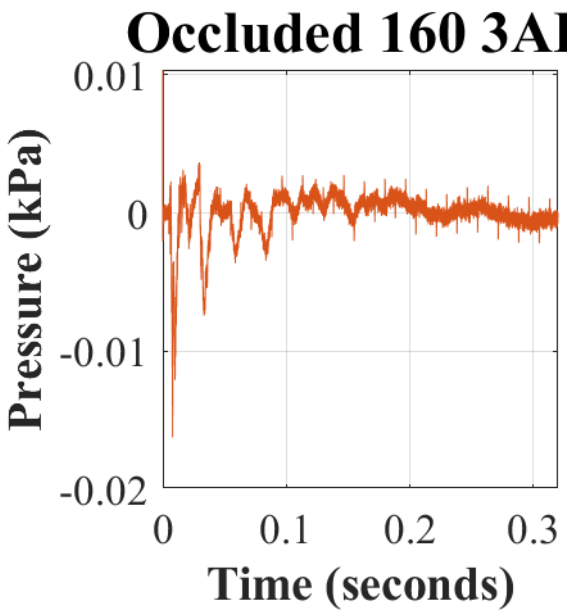

Occluded 160 2AL
Pressure (kPa)
0.01
0.005
0
-0.005
-0.01
0
0.1
0.2
0.3
Time (seconds)

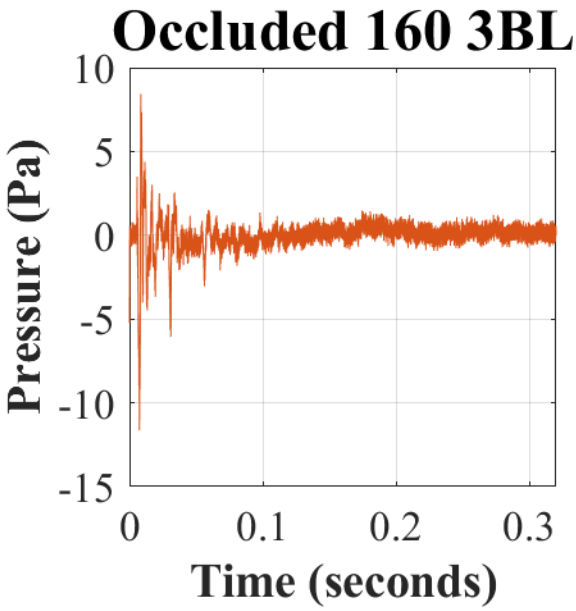

Occluded 160 2AR
Pressure (kPa)
0.01
0.005
0
-0.005
-0.01
0
0.1
0.2
0.3
Time (seconds)

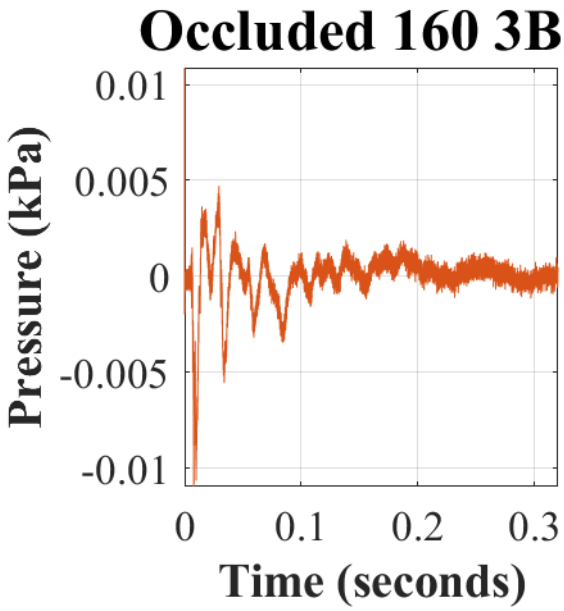

Occluded 160 2BL
Pressure (kPa)
0.01
0.005
0
-0.005
-0.01
0
0.1
0.2
0.3
Time (seconds)

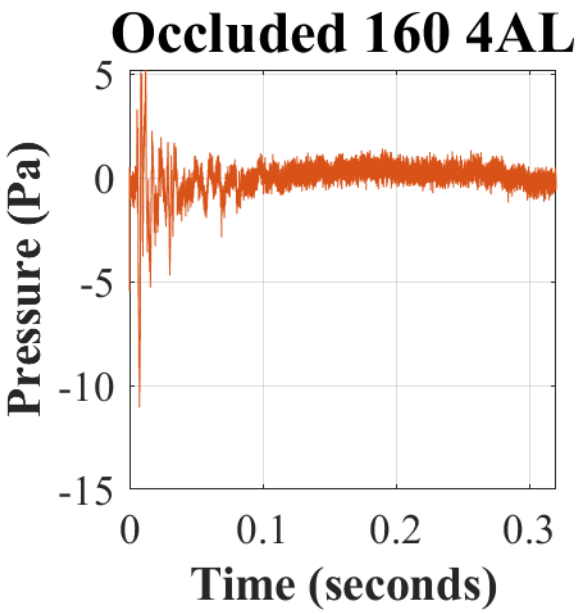

Occluded 160 2BR
Pressure (kPa)
0.01
0
-0.01
-0.02
0
0.1
0.2
0.3
Time (seconds)

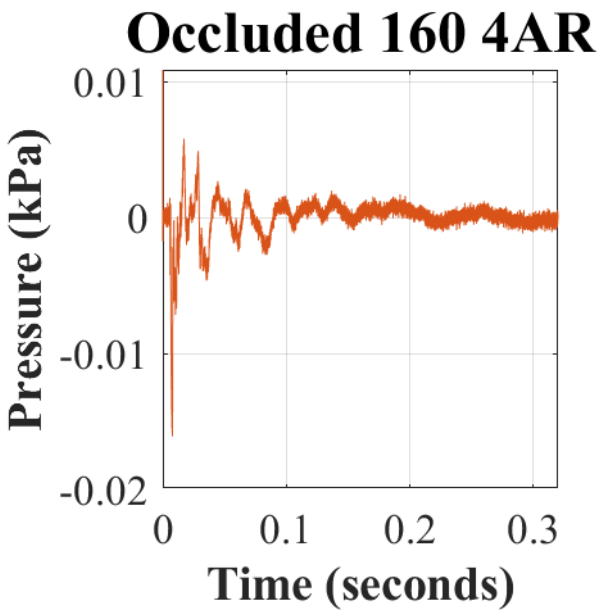

Occluded 160 3AL
Pressure (Pa)
10
5
0
-5
-10
-15
0
0.1
0.2
0.3
Time (seconds)

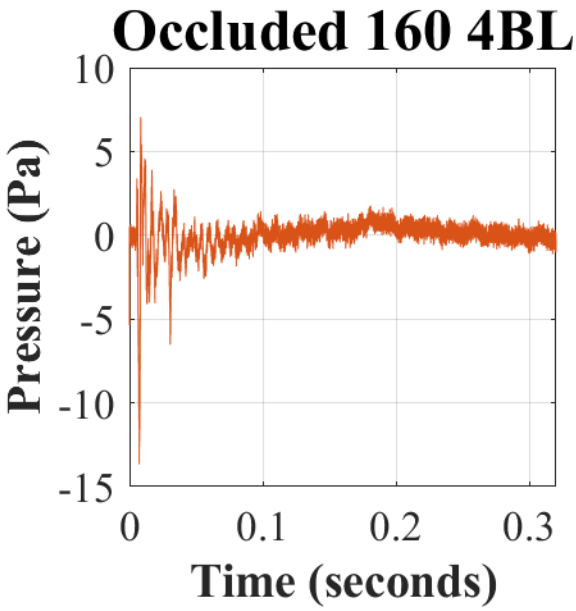

Occluded 160 3AR
Pressure (kPa)
0.01
0
-0.01
-0.02
0
0.1
0.2
0.3
Time (seconds)

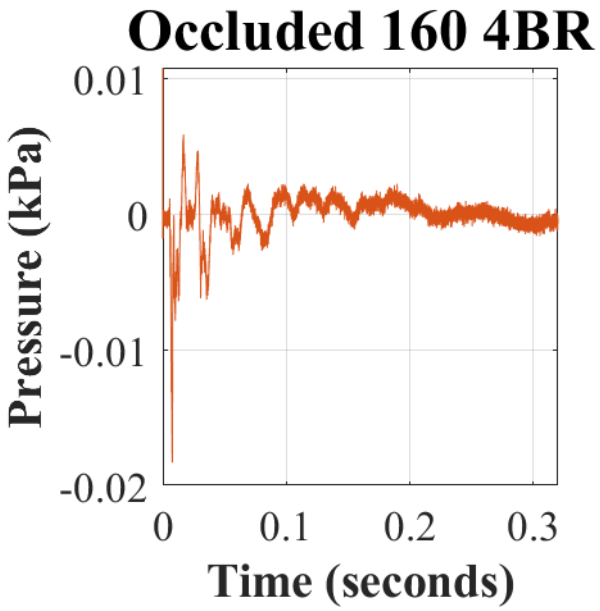

Occluded 160 3BL
Pressure (Pa)
10
5
0
-5
-10
-15
0
0.1
0.2
0.3
Time (seconds)

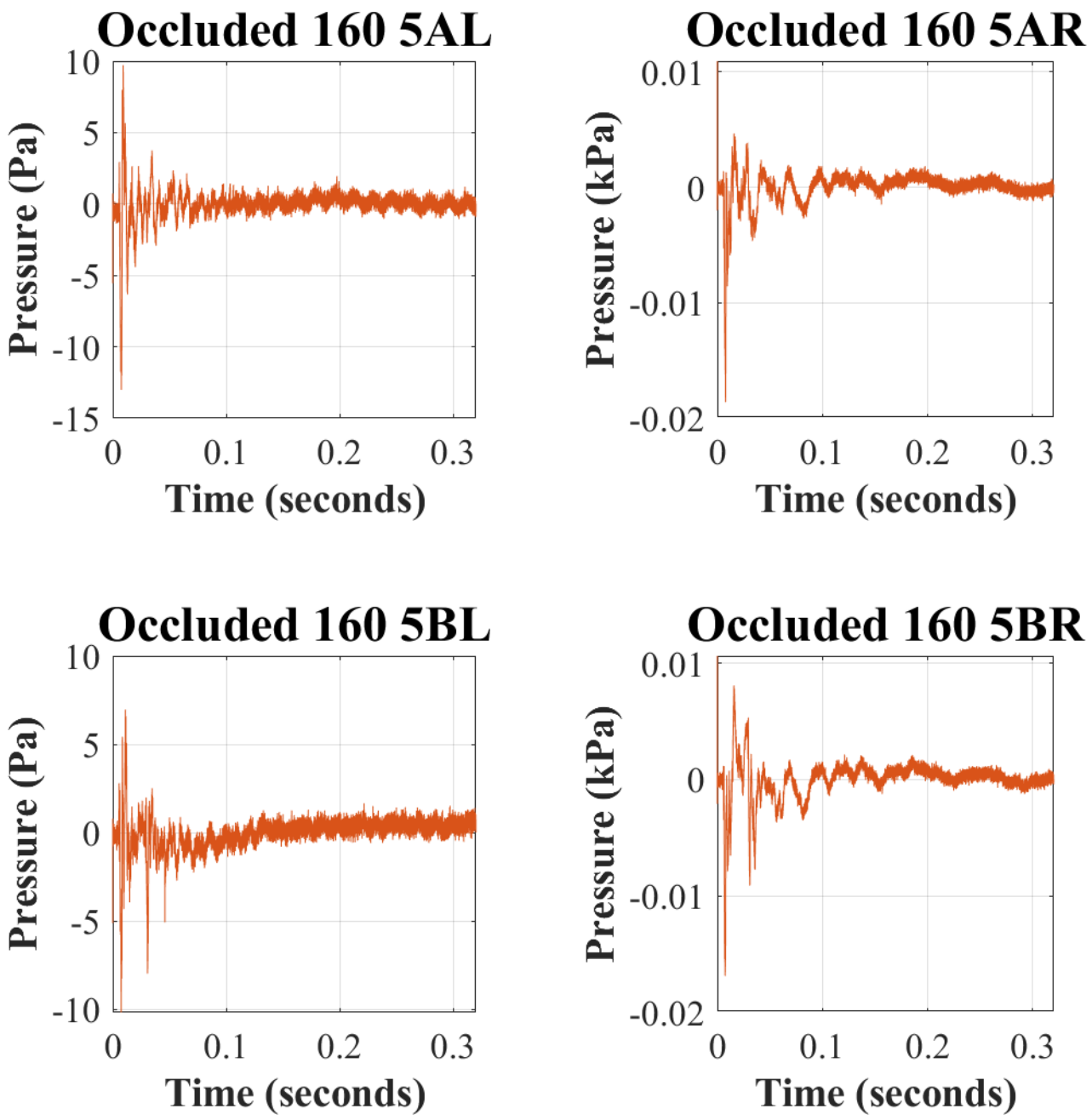

Occluded 160 3BR
Pressure (kPa)
0.01
0.005
0
-0.005
-0.01
0
0.1
0.2
0.3
Time (seconds)


Occluded 160 4AL
Pressure (Pa)
5
0
-5
-10
-15
0
0.1
0.2
0.3
Time (seconds)


Occluded 160 4AR
Pressure (kPa)
0.01
0
-0.01
-0.02
0
0.1
0.2
0.3
Time (seconds)

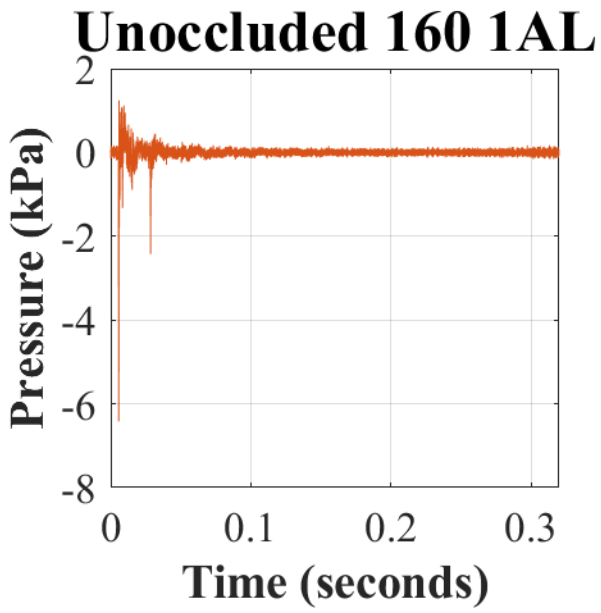

Occluded 160 4BL
Pressure (Pa)
10
5
0
-5
-10
-15
0
0.1
0.2
0.3
Time (seconds)

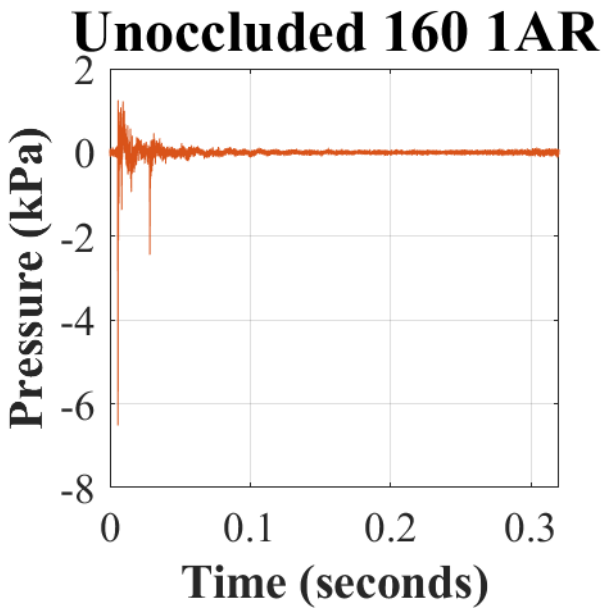

Occluded 160 4BR
Pressure (kPa)
0.01
0
-0.01
-0.02
0
0.1
0.2
0.3
Time (seconds)

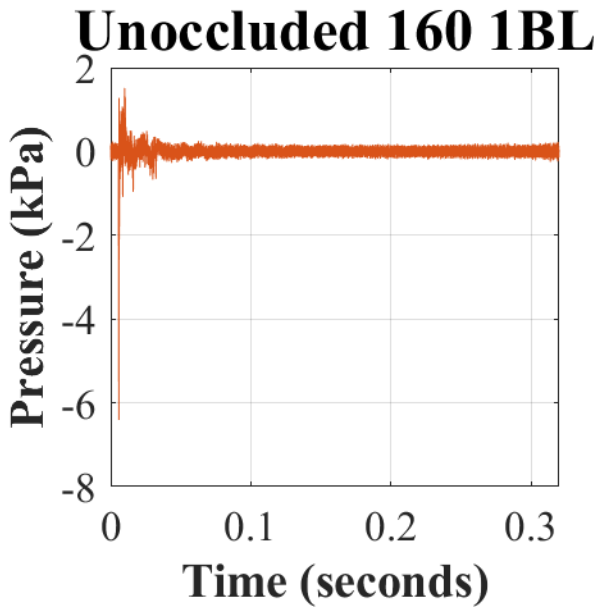


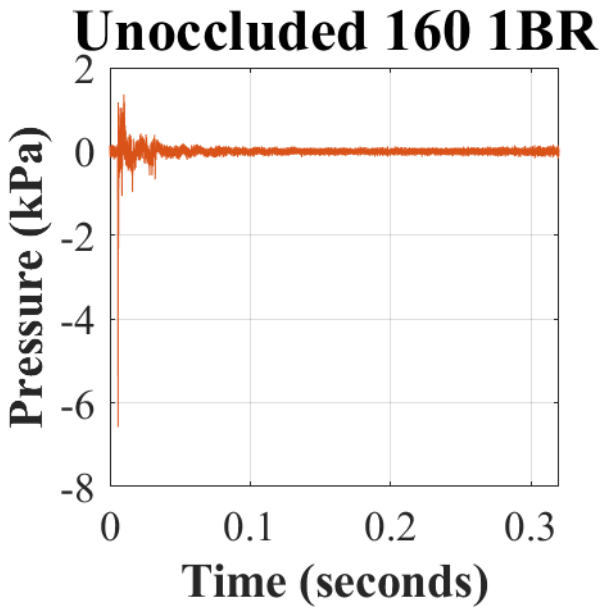
Note. The naming convention for all occluded waveforms is "Occluded LvL NnX", where 'Occluded' is the test condition (i.e., ATF has the HPDs donned), 'LvL' is the nominal test level (i.e., 160 or 170 dBP), 'N' is the sample number (i.e., 1 to 5) of the device tested, 'n' is the trial (i.e., A or B) indicating 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).

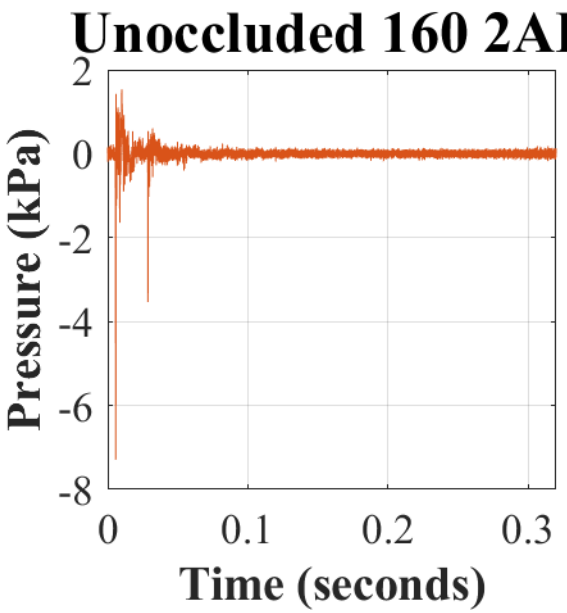
Appendix H. Estimated unoccluded (HPDs doffed) waveforms (in kilopascals [kPa]) over time (in seconds [s]) in response to 160 dBP with the ComTac™ V (MAX).

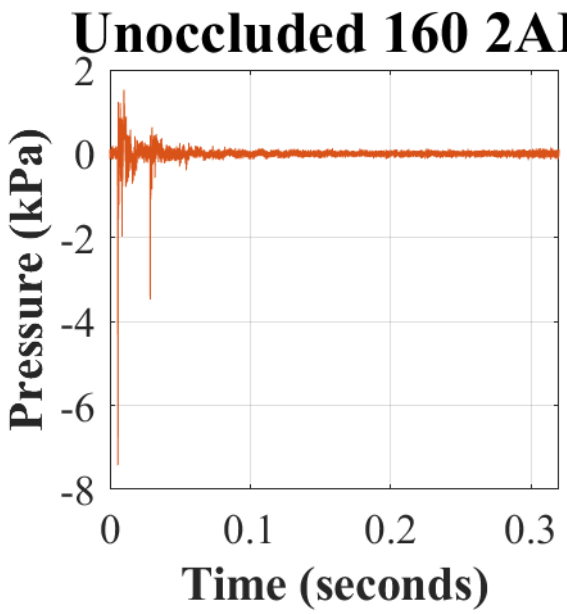


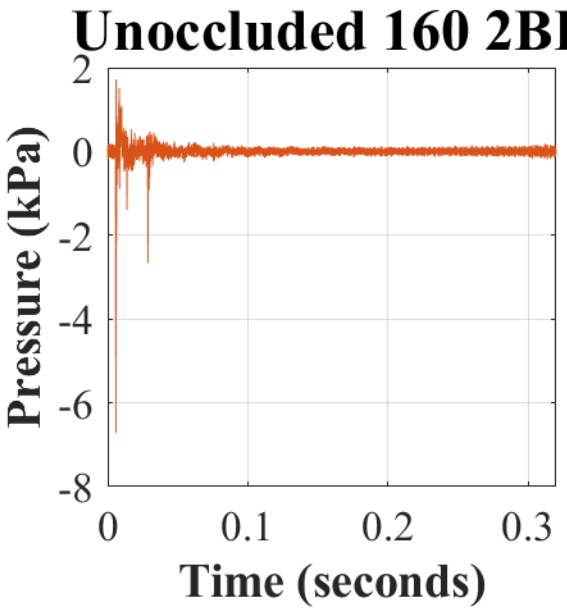


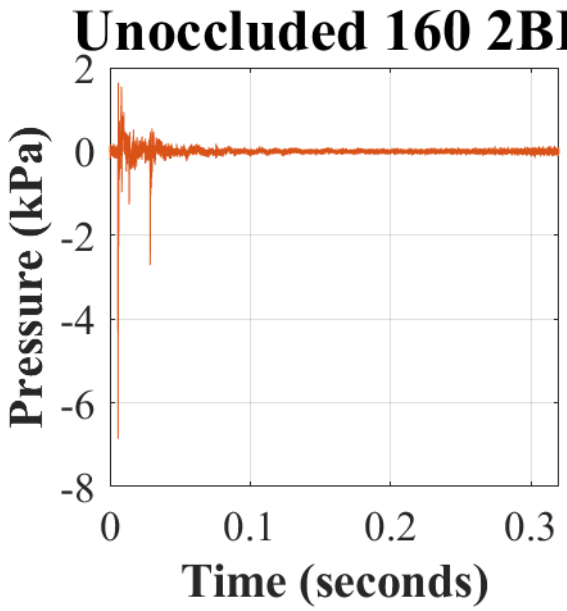


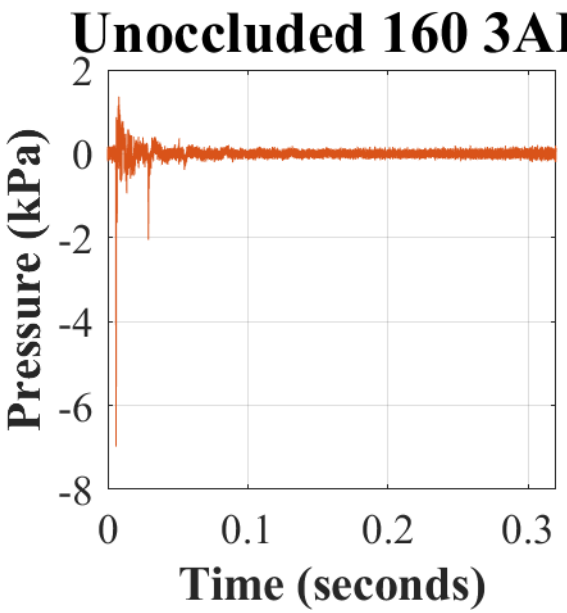


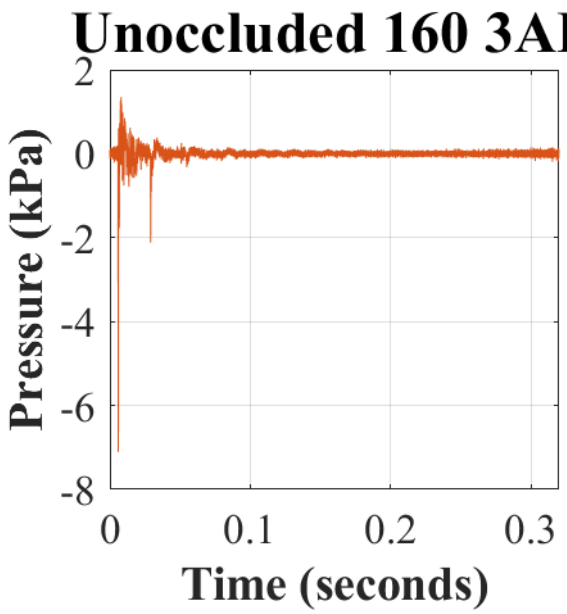

Unoccluded 160 2AL
Pressure (kPa)
2
0
-2
-4
-6
-8
0
0.1
0.2
0.3
Time (seconds)

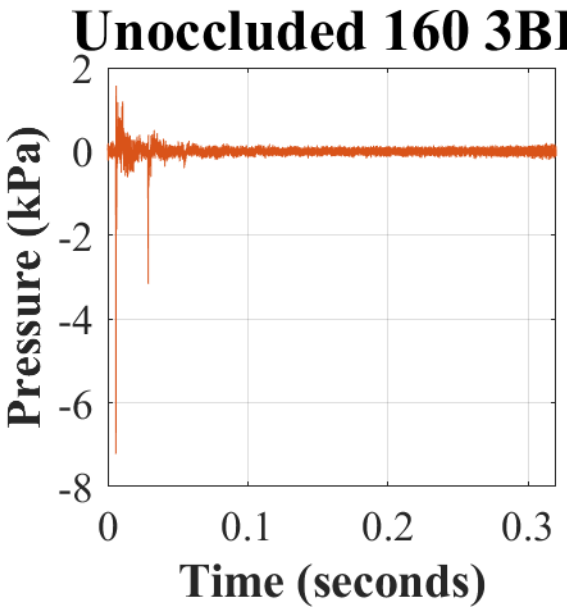

Unoccluded 160 2AR
Pressure (kPa)
2
0
-2
-4
-6
-8
0
0.1
0.2
0.3
Time (seconds)

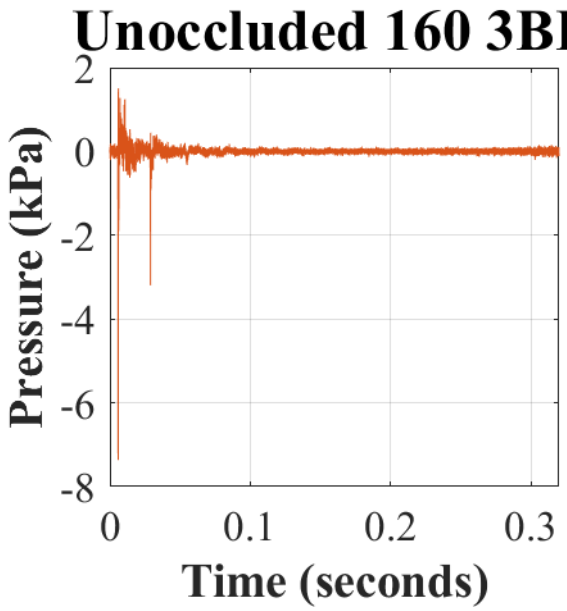

Unoccluded 160 2BL
Pressure (kPa)
2
0
-2
-4
-6
-8
0
0.1
0.2
0.3
Time (seconds)

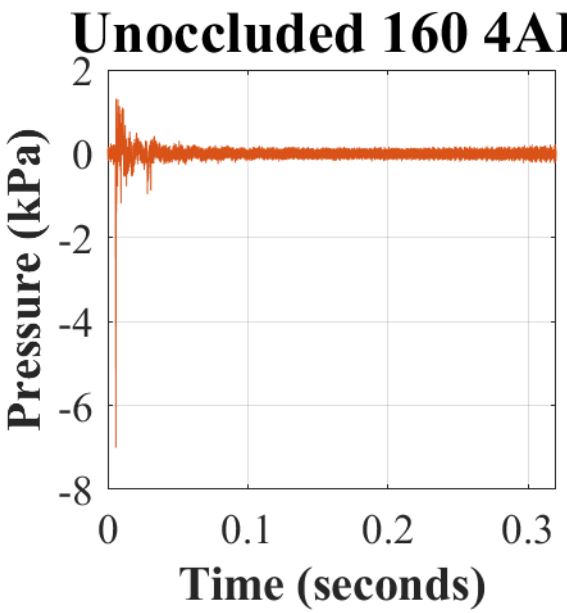

Unoccluded 160 2BR
Pressure (kPa)
2
0
-2
-4
-6
-8
0
0.1
0.2
0.3
Time (seconds)

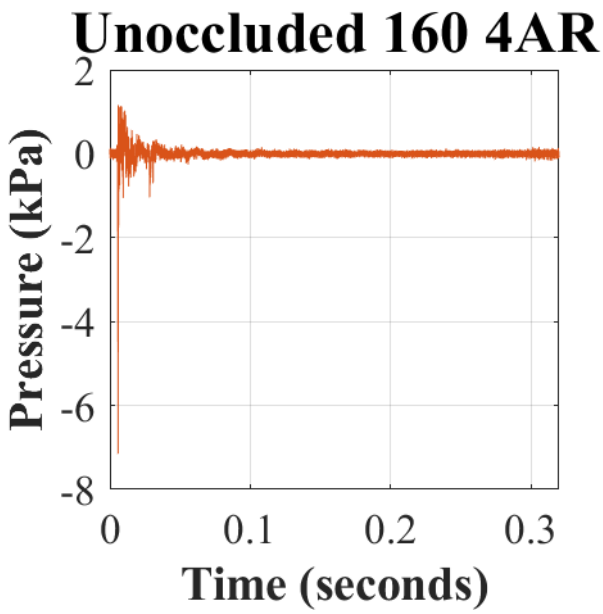

Unoccluded 160 3AL
Pressure (kPa)
2
0
-2
-4
-6
-8
0
0.1
0.2
0.3
Time (seconds)

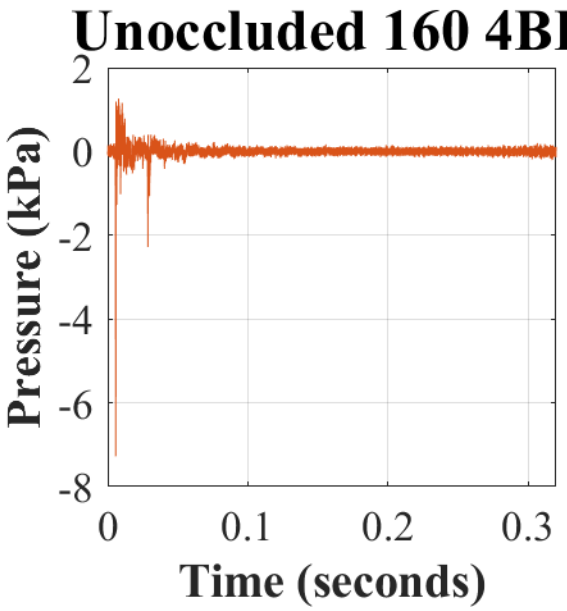

Unoccluded 160 3AR
Pressure (kPa)
2
0
-2
-4
-6
-8
0
0.1
0.2
0.3
Time (seconds)

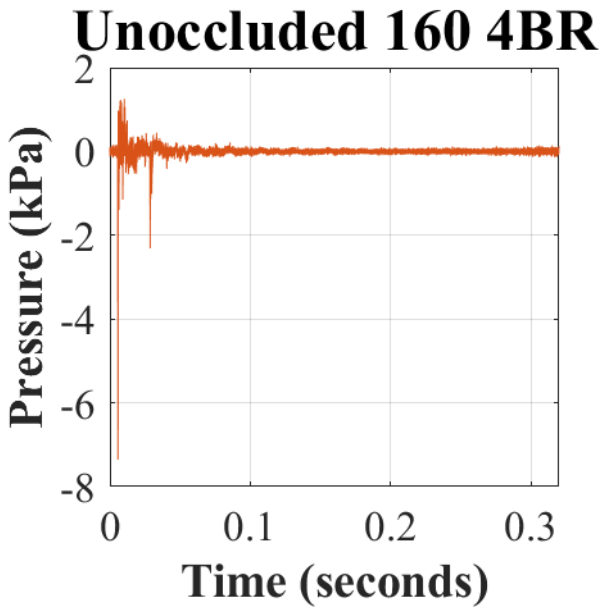

Unoccluded 160 3BL
Pressure (kPa)
2
0
-2
-4
-6
-8
0
0.1
0.2
0.3
Time (seconds)

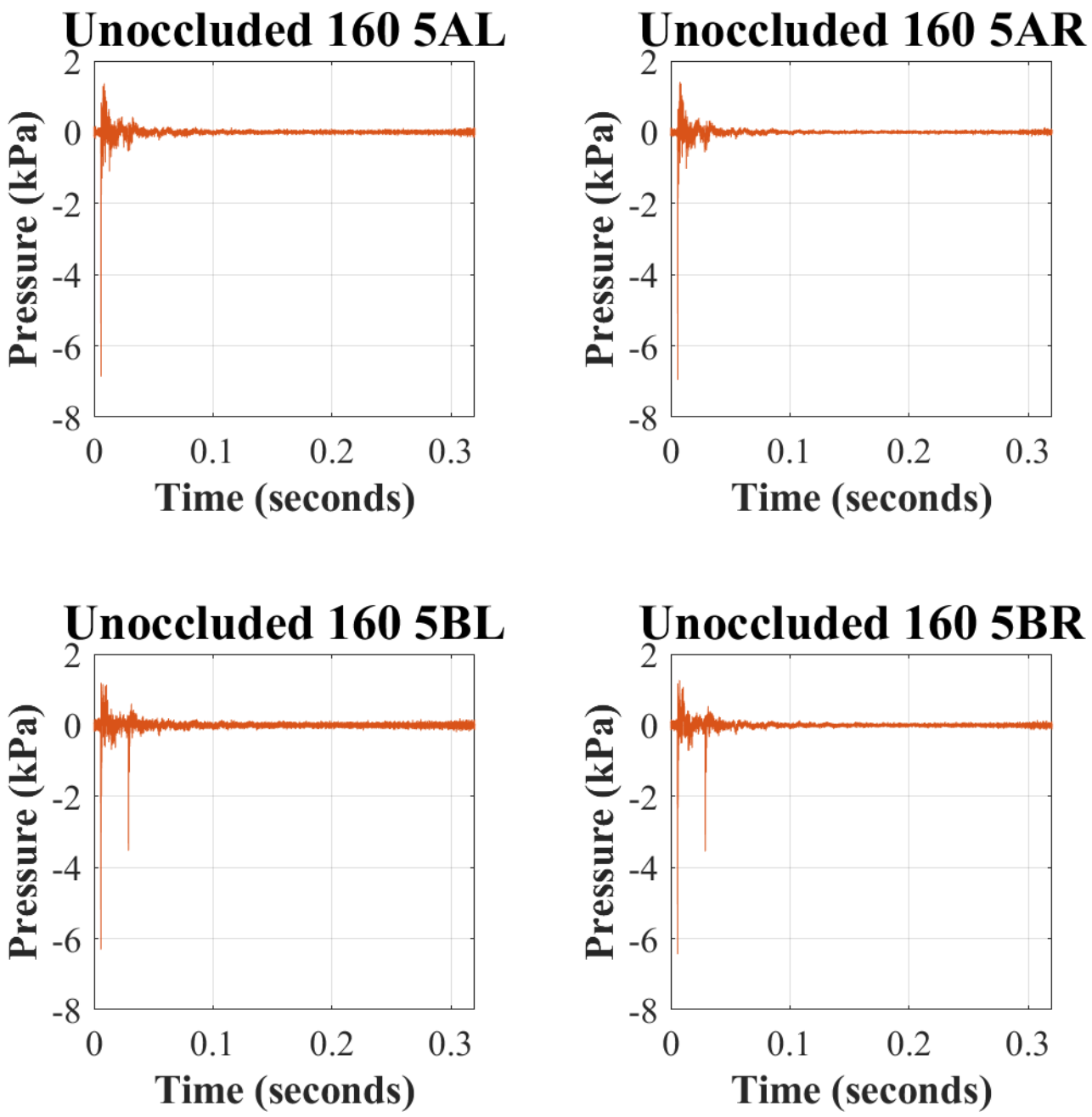

Unoccluded 160 3BR
Pressure (kPa)
2
0
-2
-4
-6
-8
0
0.1
0.2
0.3
Time (seconds)


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)
2
0
-2
-4
-6
-8
0
0.1
0.2
0.3
Time (seconds)

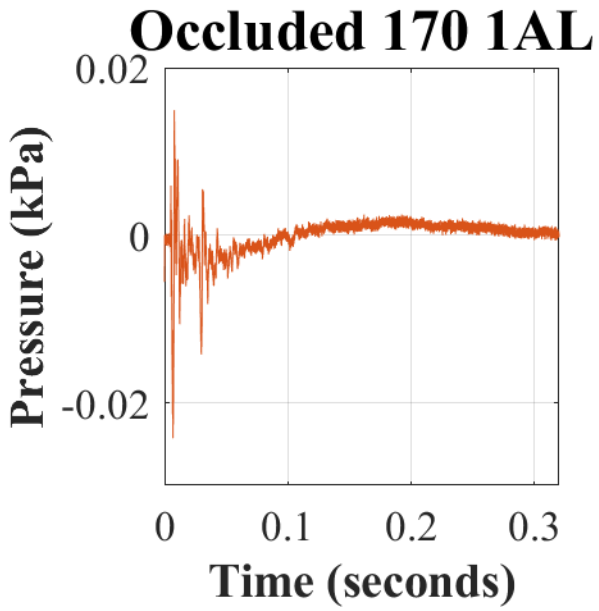

Unoccluded 160 4BL
Pressure (kPa)
2
0
-2
-4
-6
-8
0
0.1
0.2
0.3
Time (seconds)

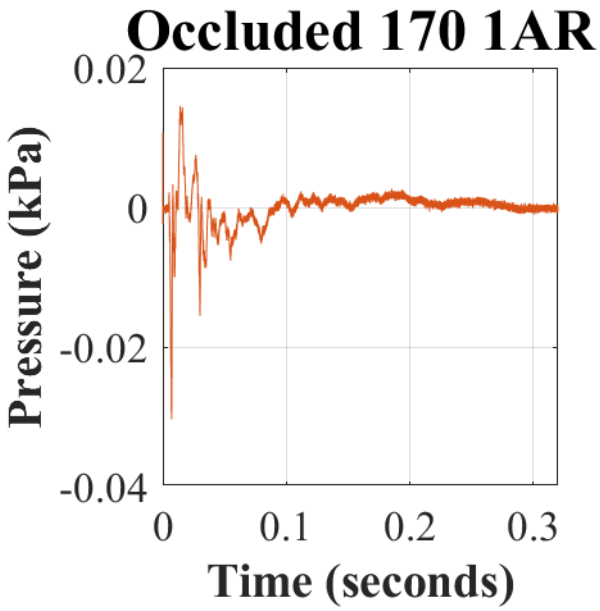

Unoccluded 160 4BR
Pressure (kPa)
2
0
-2
-4
-6
-8
0
0.1
0.2
0.3
Time (seconds)

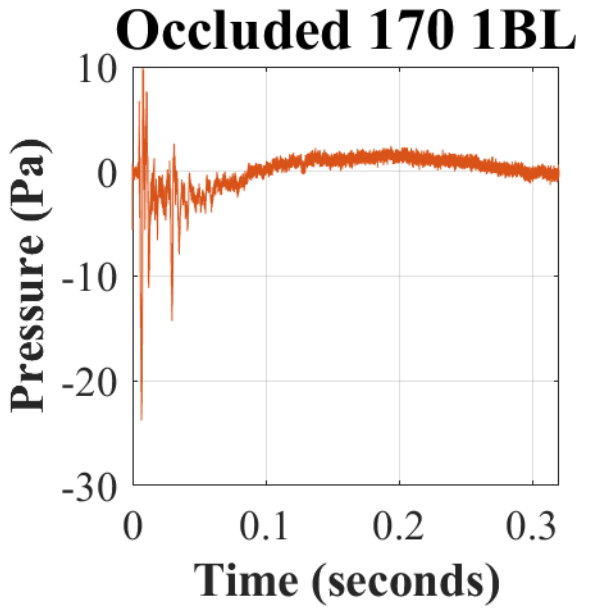


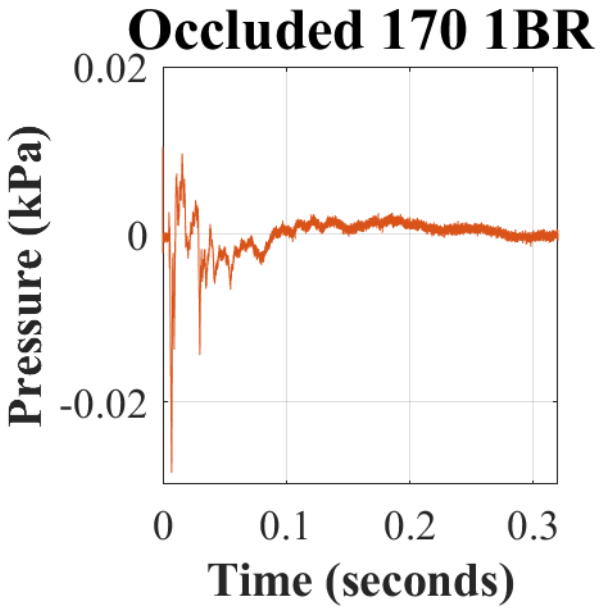
Note. The naming convention for all unoccluded waveforms is “Unoccluded LvL NnX”, where ‘Unoccluded’ is the test condition (i.e., ATF has the HPDs doffed), ‘LvL’ is the nominal test level (i.e., 160 or 170 dBP), ‘N’ is the sample number (i.e., 1 to 5) of the device tested, ‘n’ is the trial (i.e., A or B) indicating 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).

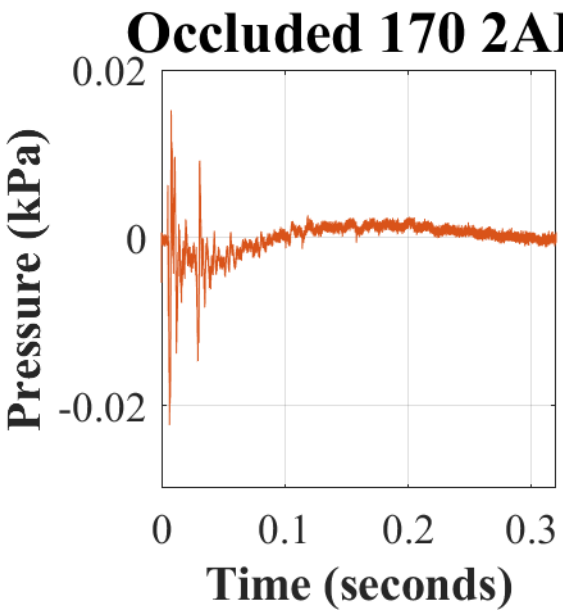
Appendix I. Recorded occluded (HPDs donned) waveforms (in pascals [Pa] or kilopascals [kPa]) over time (in seconds [s]) in response to 170 dBP with the ComTac™ V (MAX).

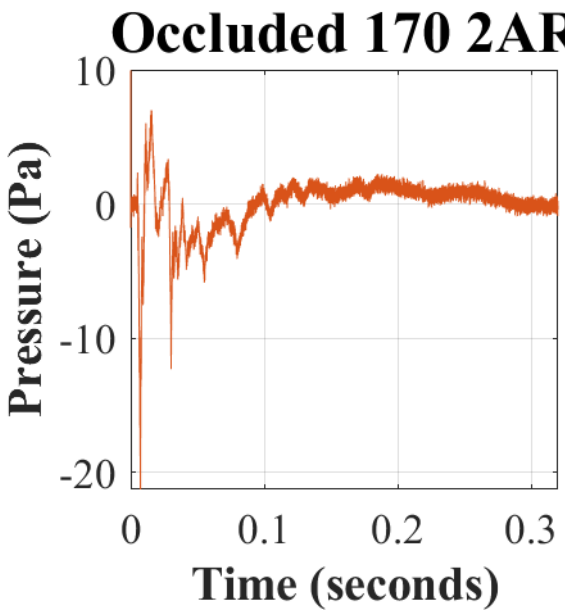


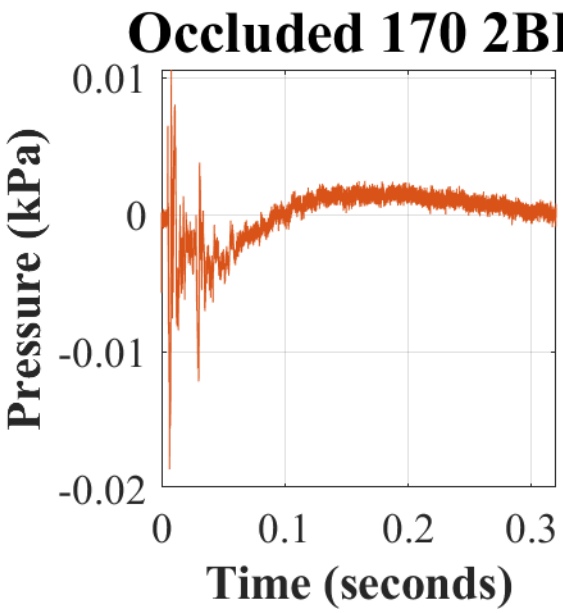


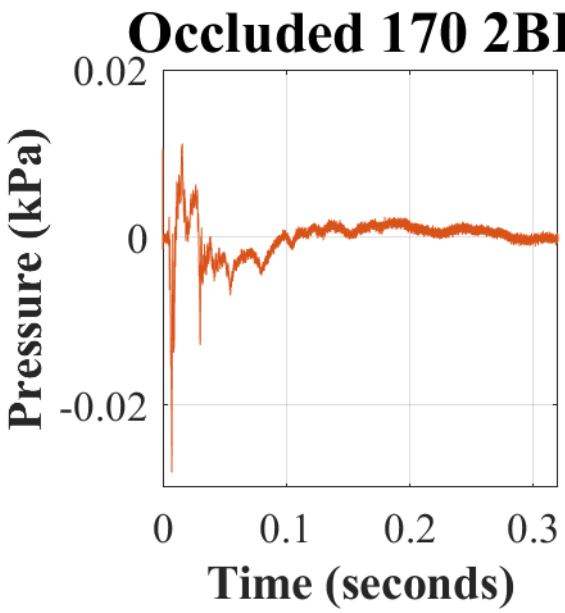


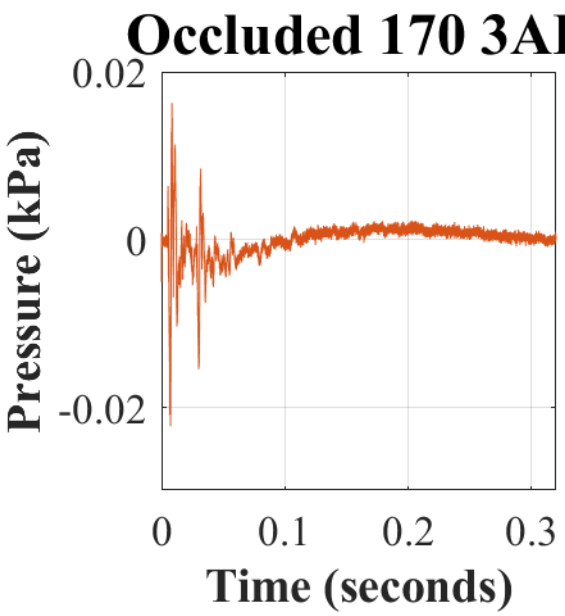


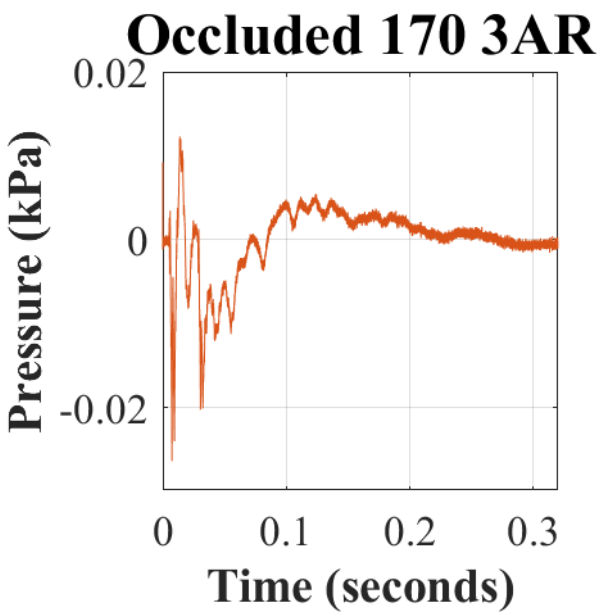

Occluded 170 2AL
Pressure (kPa)
0.02
0
-0.02
0
0.1
0.2
0.3
Time (seconds)

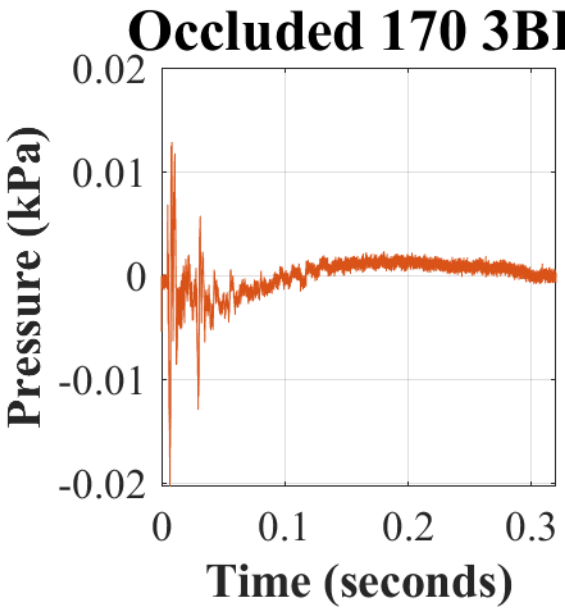

Occluded 170 2AR
Pressure (Pa)
10
0
-10
-20
0
0.1
0.2
0.3
Time (seconds)

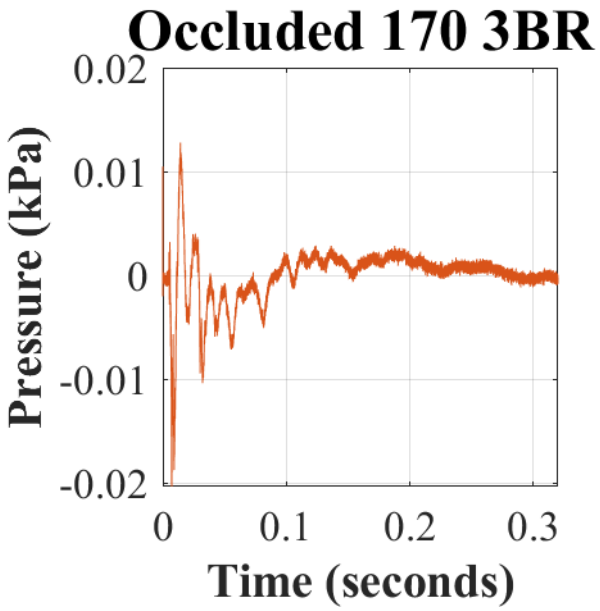

Occluded 170 2BL
Pressure (kPa)
0.01
0
-0.01
-0.02
0
0.1
0.2
0.3
Time (seconds)

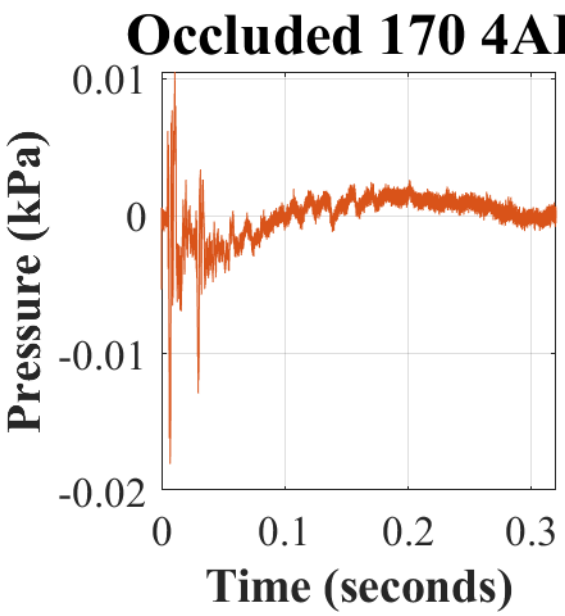

Occluded 170 2BR
Pressure (kPa)
0.02
0
-0.02
0
0.1
0.2
0.3
Time (seconds)

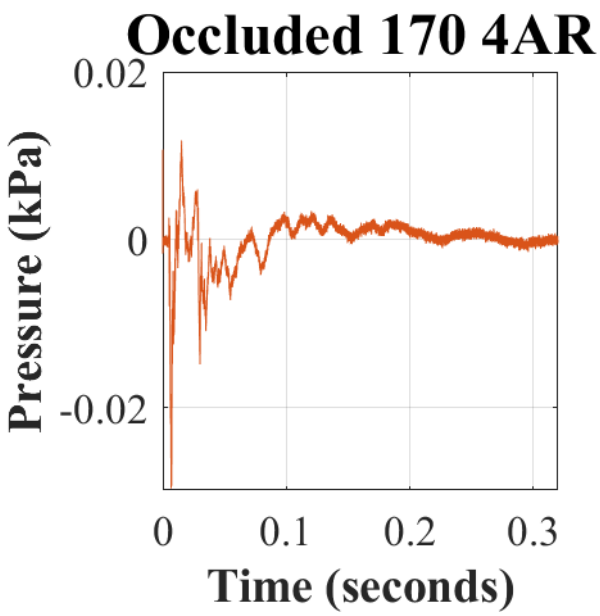

Occluded 170 3AL
Pressure (kPa)
0.02
0
-0.02
0
0.1
0.2
0.3
Time (seconds)

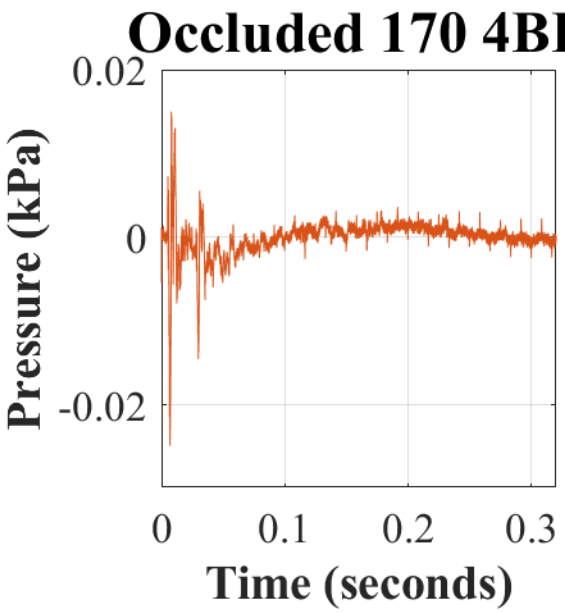

Occluded 170 3AR
Pressure (kPa)
0.02
0
-0.02
0
0.1
0.2
0.3
Time (seconds)

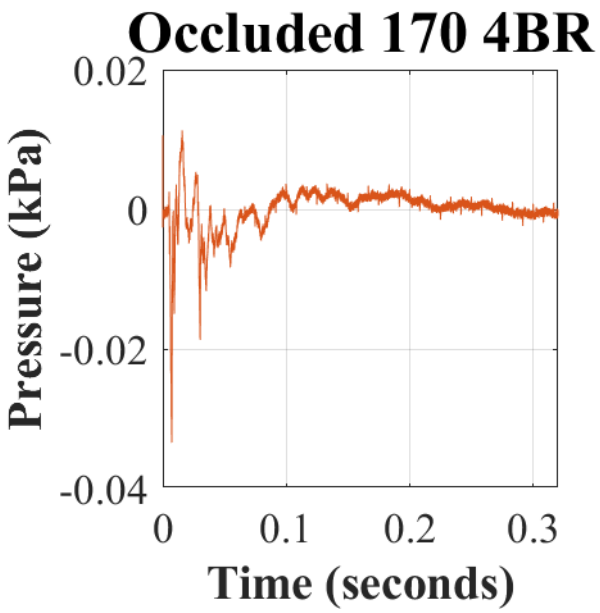

Occluded 170 3BL
Pressure (kPa)
0.02
0.01
0
-0.01
-0.02
0
0.1
0.2
0.3
Time (seconds)

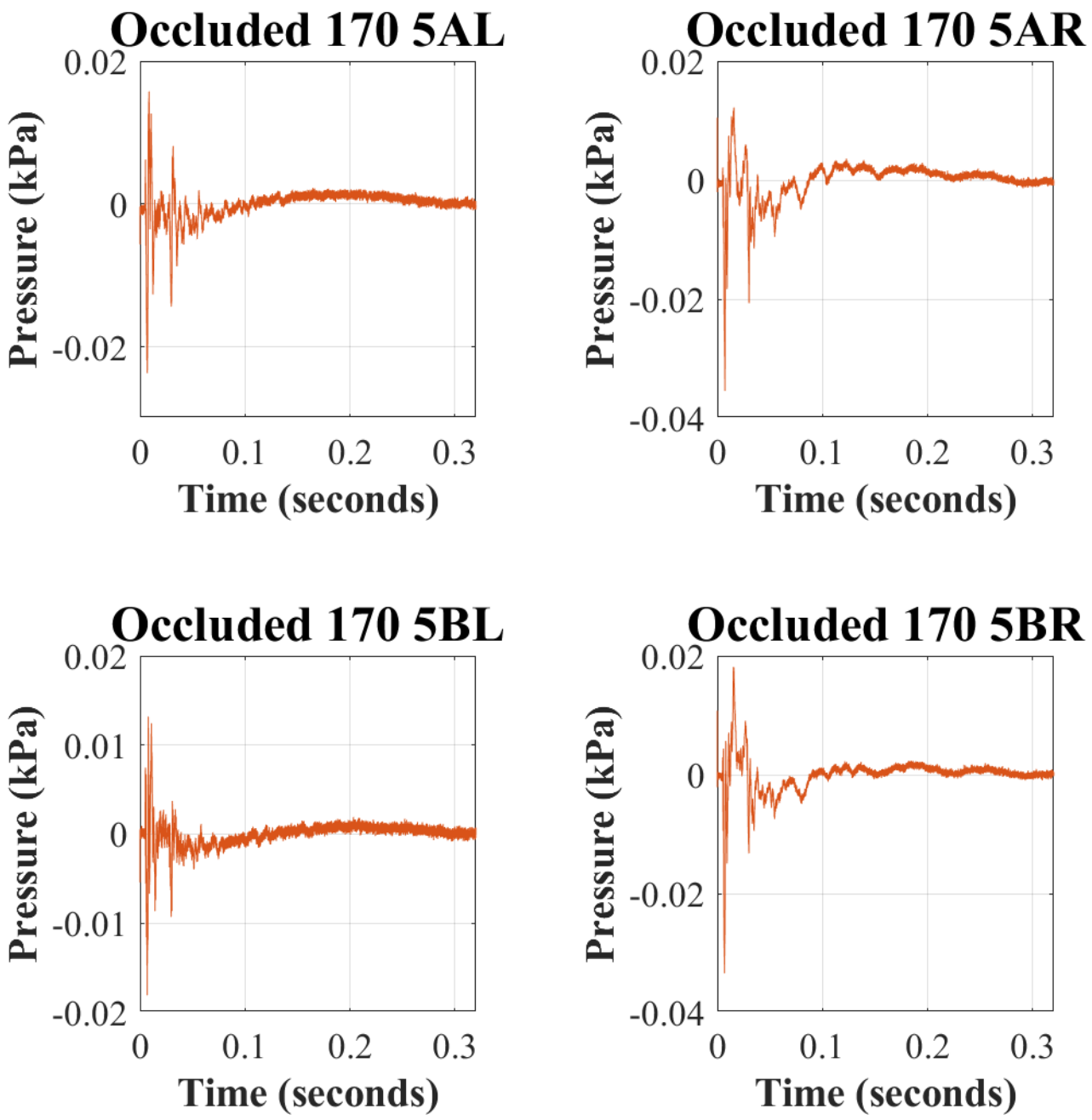

Occluded 170 3BR
Pressure (kPa)
0.02
0.01
0
-0.01
-0.02
0
0.1
0.2
0.3
Time (seconds)


Occluded 170 4AL
Pressure (kPa)
0.01
0
-0.01
-0.02
0
0.1
0.2
0.3
Time (seconds)


Occluded 170 4AR
Pressure (kPa)
0.02
0
-0.02
0
0.1
0.2
0.3
Time (seconds)

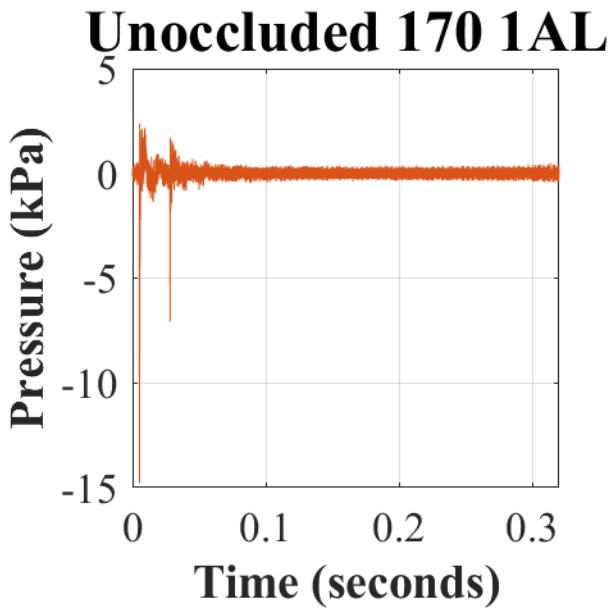

Occluded 170 4BL
Pressure (kPa)
0.02
0
-0.02
0
0.1
0.2
0.3
Time (seconds)

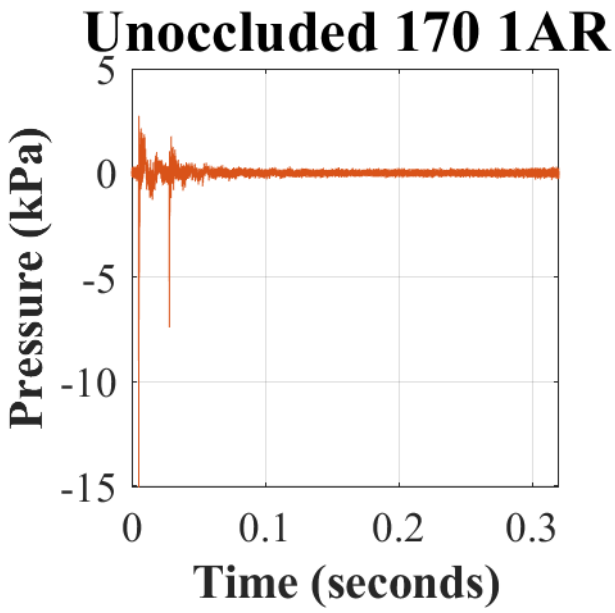

Occluded 170 4BR
Pressure (kPa)
0.02
0
-0.02
-0.04
0
0.1
0.2
0.3
Time (seconds)

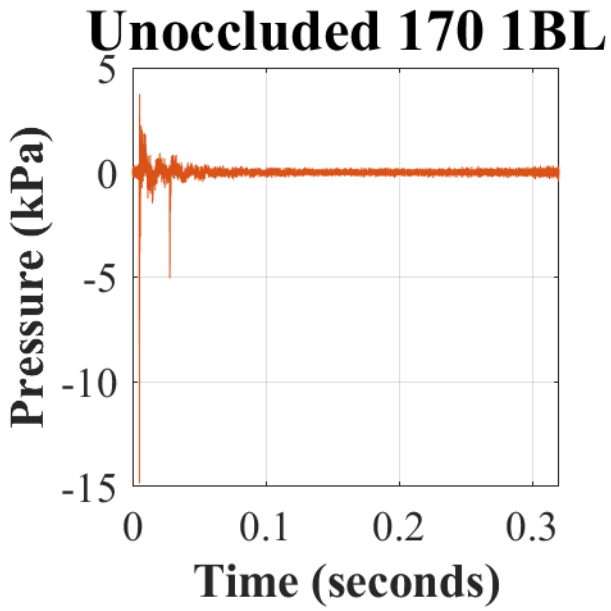


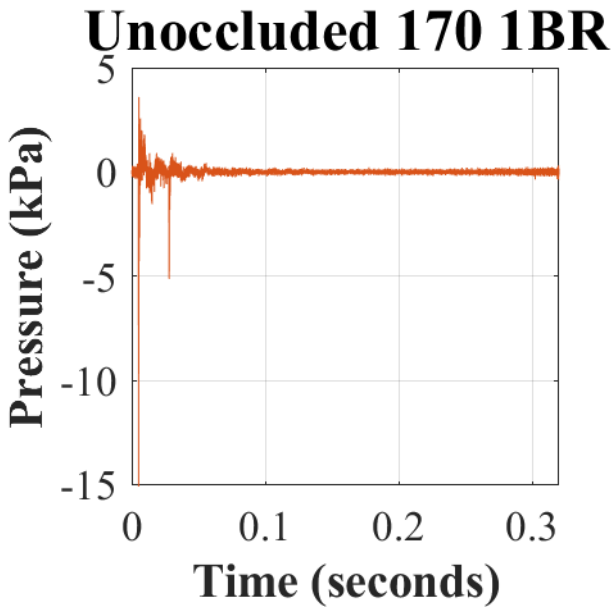
Note. The naming convention for all occluded waveforms is “Occluded LvL NnX”, where ‘Occluded’ is the test condition (i.e., ATF has the HPDs donned), ‘LvL’ is the nominal test level (i.e., 160 or 170 dBP), ‘N’ is the sample number (i.e., 1 to 5) of the device tested, ‘n’ is the trial (i.e., A or B) indicating 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).

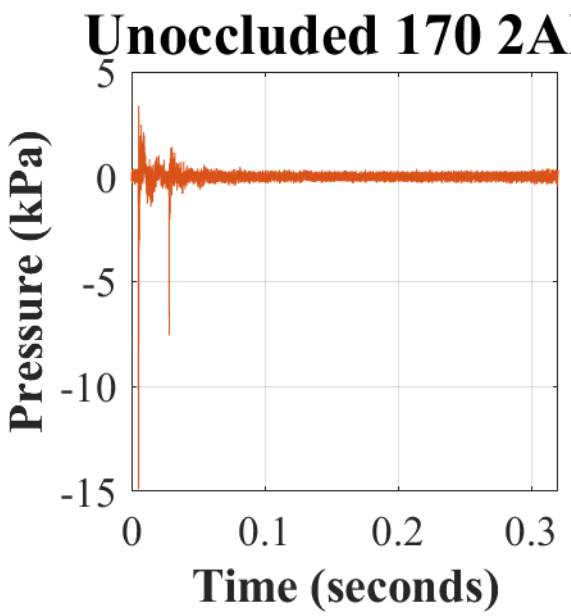
Appendix J. Estimated unoccluded (HPDs doffed) waveforms (in kilopascals [kPa]) over time (in seconds [s]) in response to 170 dBP with the ComTac™ V (MAX).

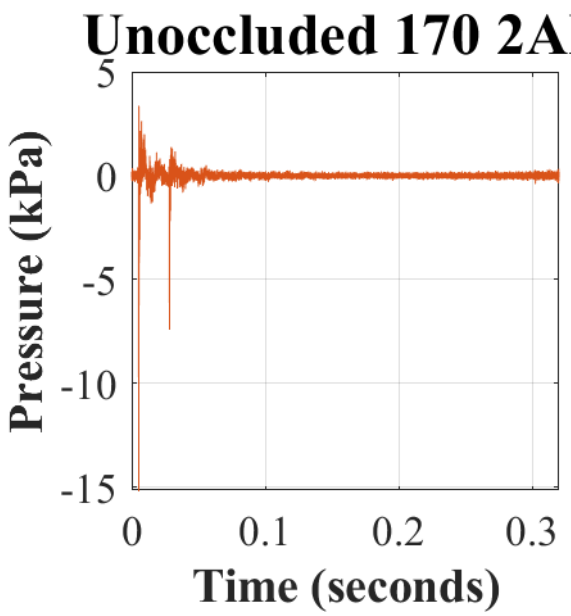


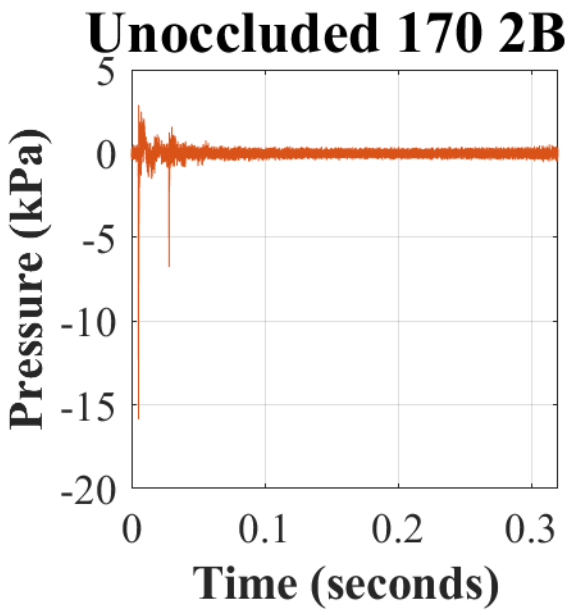


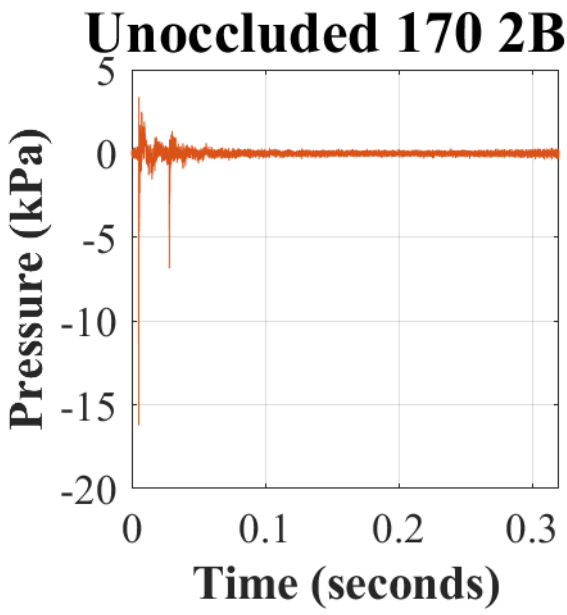


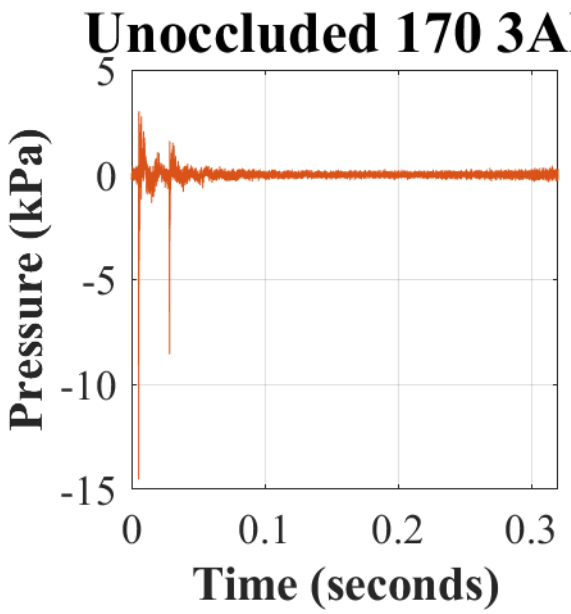


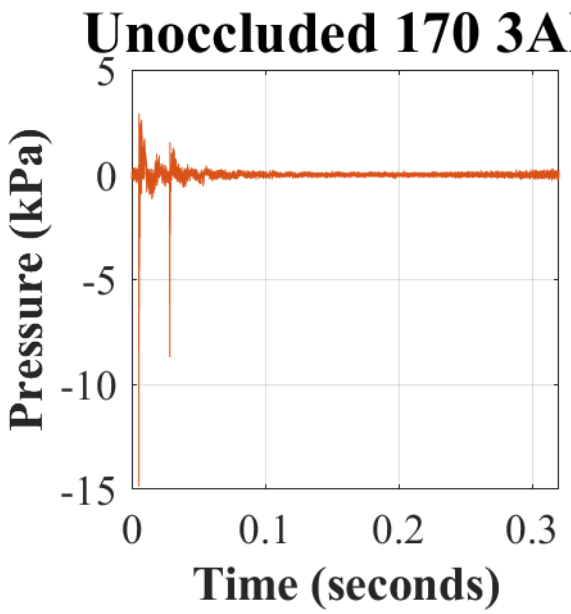

Unoccluded 170 2AL
Pressure (kPa)
5
0
-5
-10
-15
0
0.1
0.2
0.3
Time (seconds)

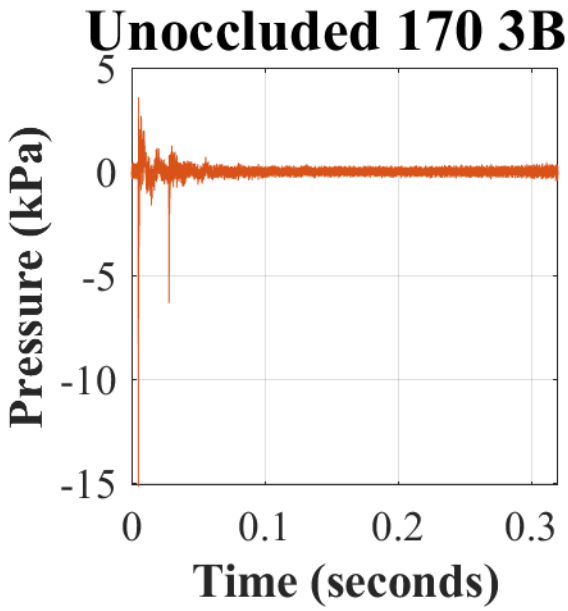

Unoccluded 170 2AR
Pressure (kPa)
5
0
-5
-10
-15
0
0.1
0.2
0.3
Time (seconds)

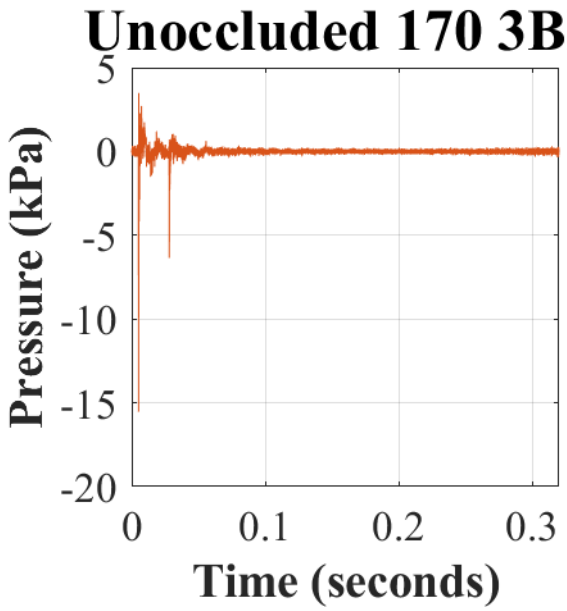

Unoccluded 170 2BL
Pressure (kPa)
5
0
-5
-10
-15
-20
0
0.1
0.2
0.3
Time (seconds)

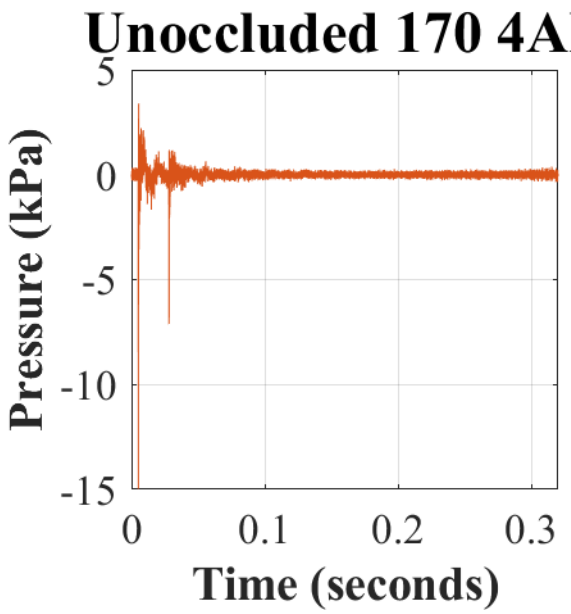

Unoccluded 170 2BR
Pressure (kPa)
5
0
-5
-10
-15
-20
0
0.1
0.2
0.3
Time (seconds)

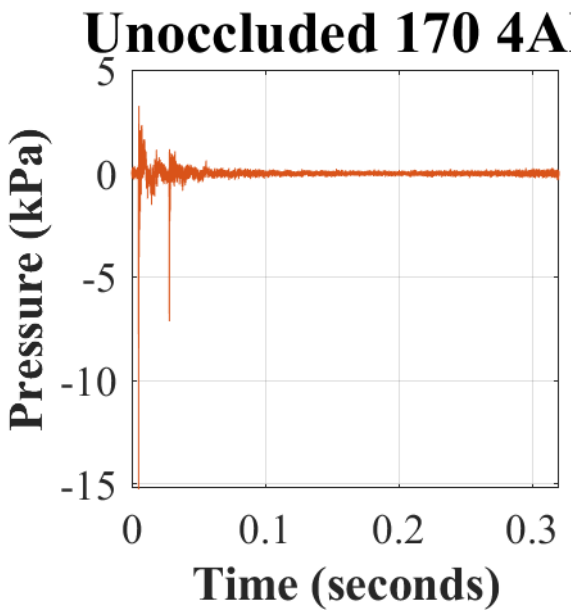

Unoccluded 170 3AL
Pressure (kPa)
5
0
-5
-10
-15
0
0.1
0.2
0.3
Time (seconds)

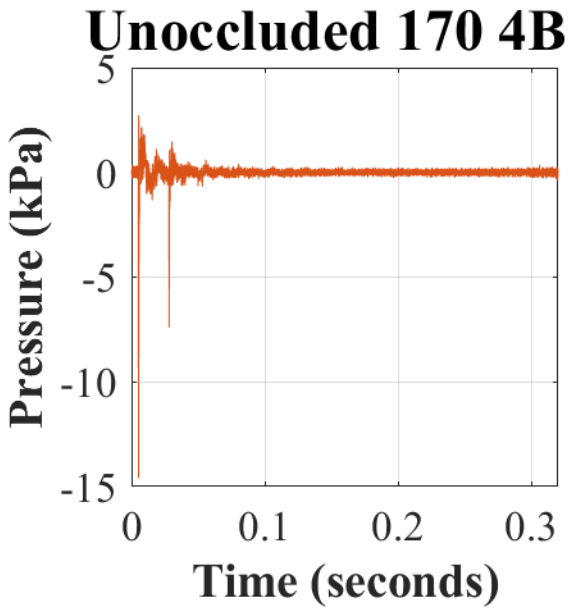

Unoccluded 170 3AR
Pressure (kPa)
5
0
-5
-10
-15
0
0.1
0.2
0.3
Time (seconds)

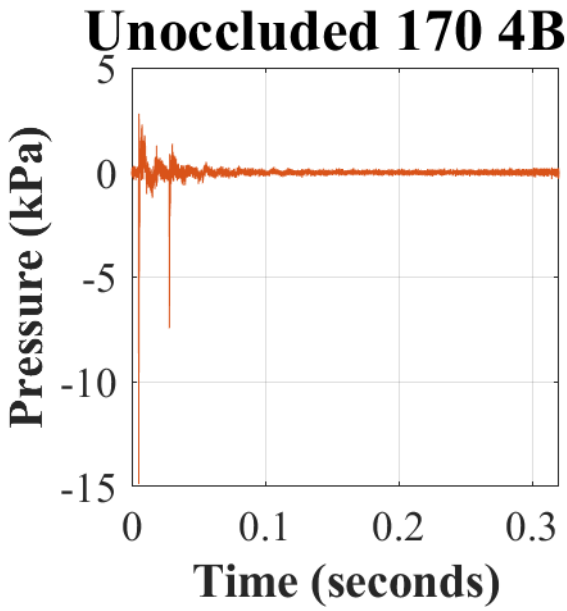

Unoccluded 170 3BL
Pressure (kPa)
5
0
-5
-10
-15
0
0.1
0.2
0.3
Time (seconds)

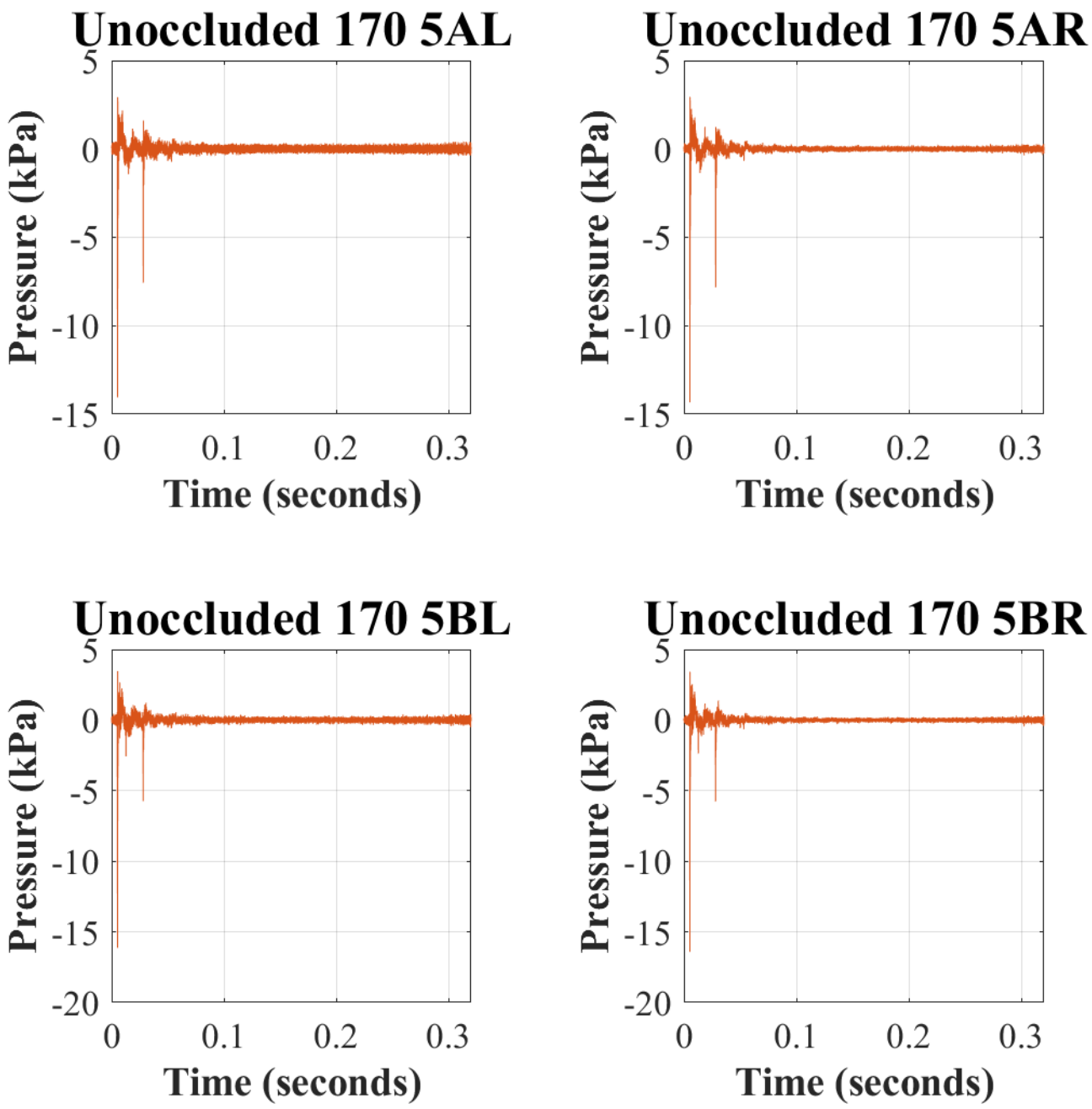

Unoccluded 170 3BR
Pressure (kPa)
5
0
-5
-10
-15
-20
0
0.1
0.2
0.3
Time (seconds)


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


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

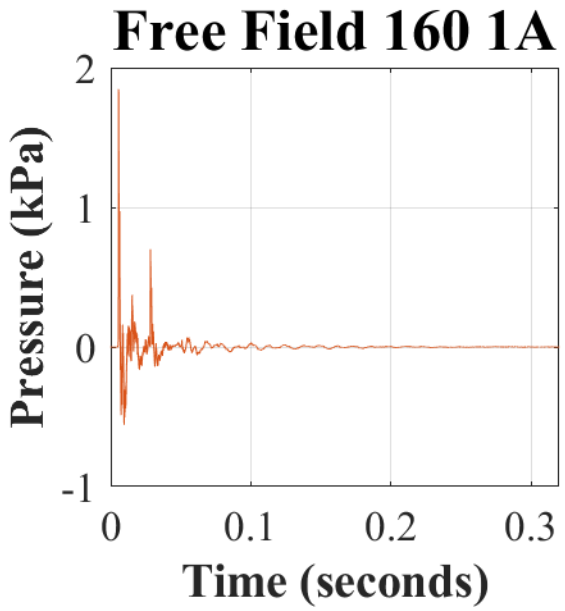

Unoccluded 170 4BL
Pressure (kPa)
5
0
-5
-10
-15
0
0.1
0.2
0.3
Time (seconds)

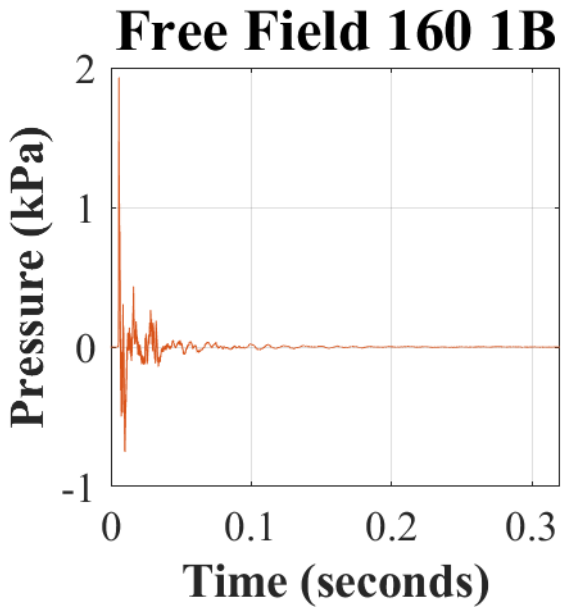

Unoccluded 170 4BR
Pressure (kPa)
5
0
-5
-10
-15
0
0.1
0.2
0.3
Time (seconds)

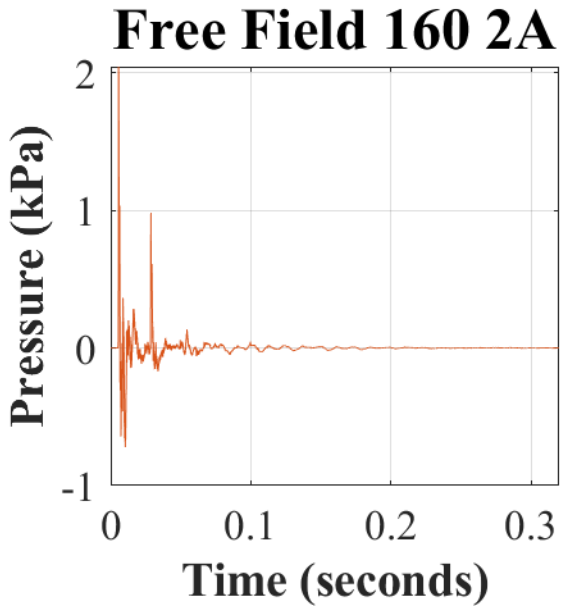


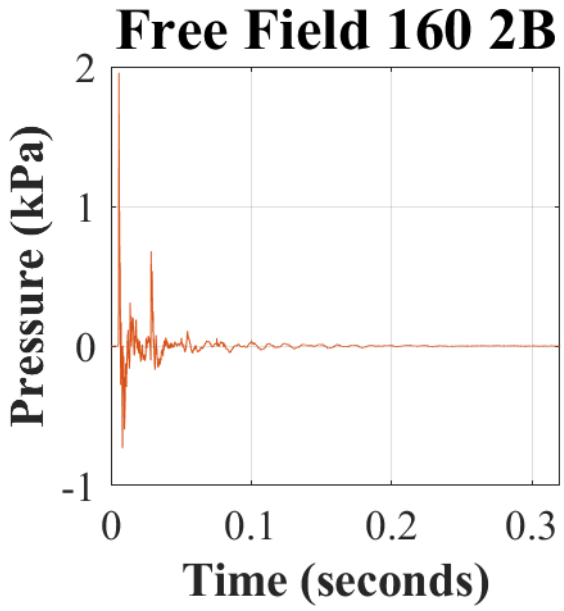
Note. The naming convention for all unoccluded waveforms is “Unoccluded LvL NnX”, where ‘Unoccluded’ is the test condition (i.e., ATF has the HPDs doffed), ‘LvL’ is the nominal test level (i.e., 160 or 170 dBP), ‘N’ is the sample number (i.e., 1 to 5) of the device tested, ‘n’ is the trial (i.e., A or B) indicating 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).

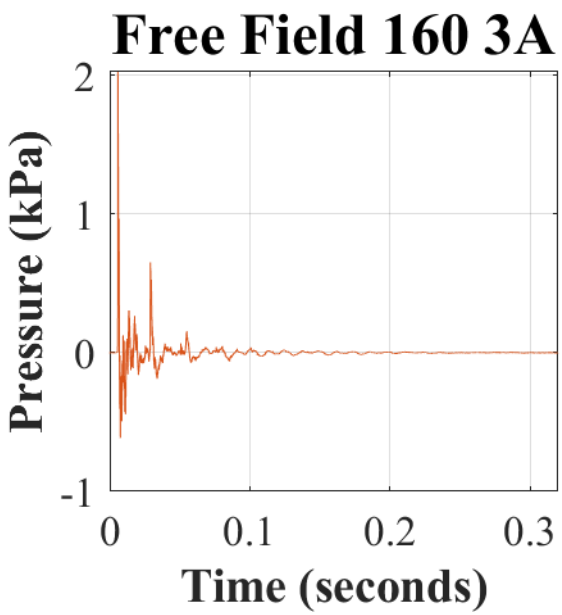
Appendix J. Recorded waveform (in kilopascals [kPa]) over time (in seconds [s]) of the impulse measured with the free-field probe at 160 dBP and the ComTac™ V (MAX) donned.

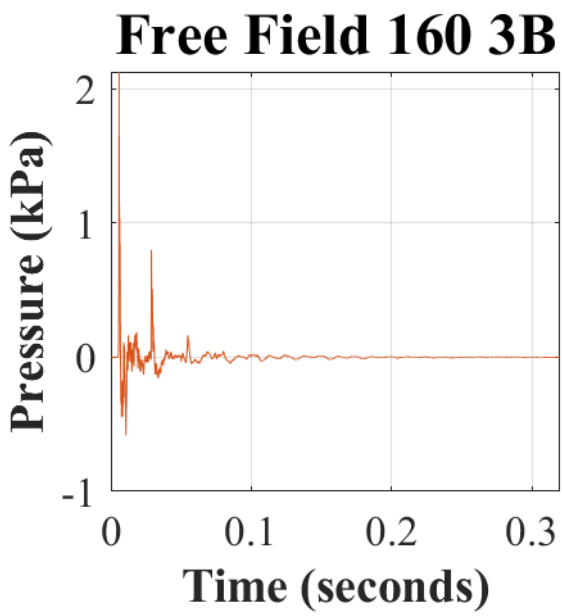


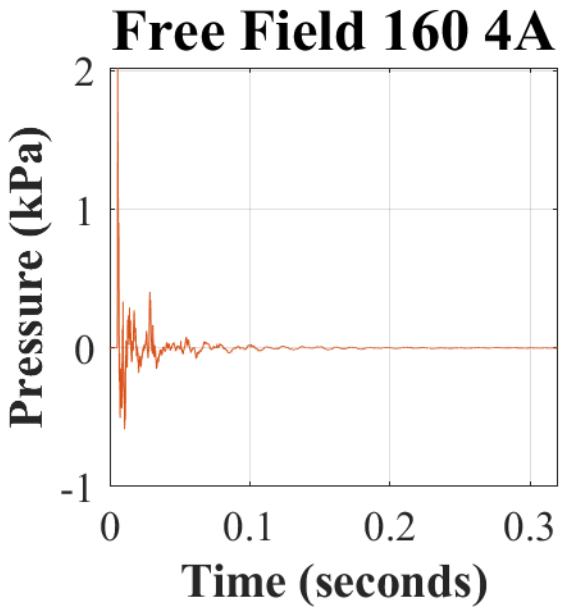


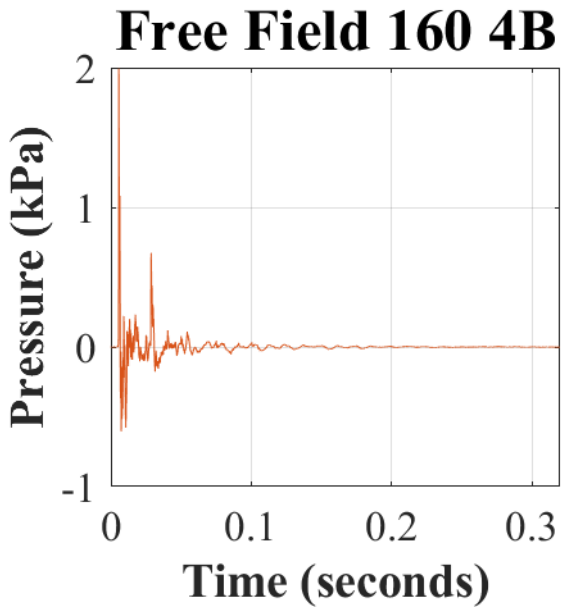


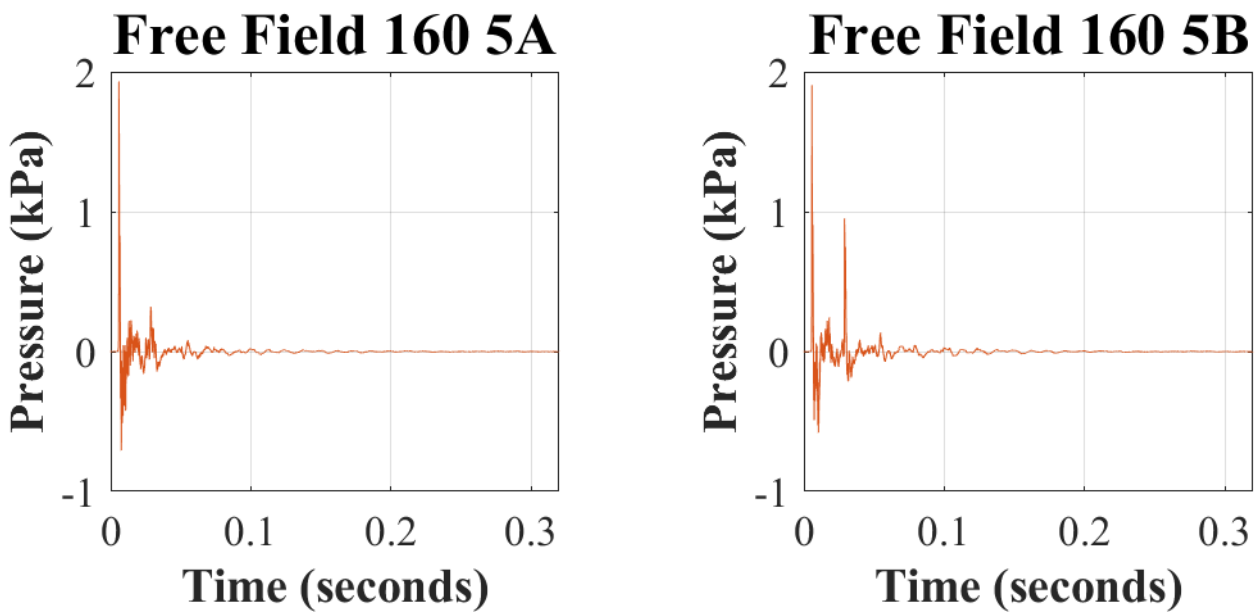



Free Field 160 3A
Pressure (kPa)
2
1
0
-1
0
0.1
0.2
0.3
Time (seconds)


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

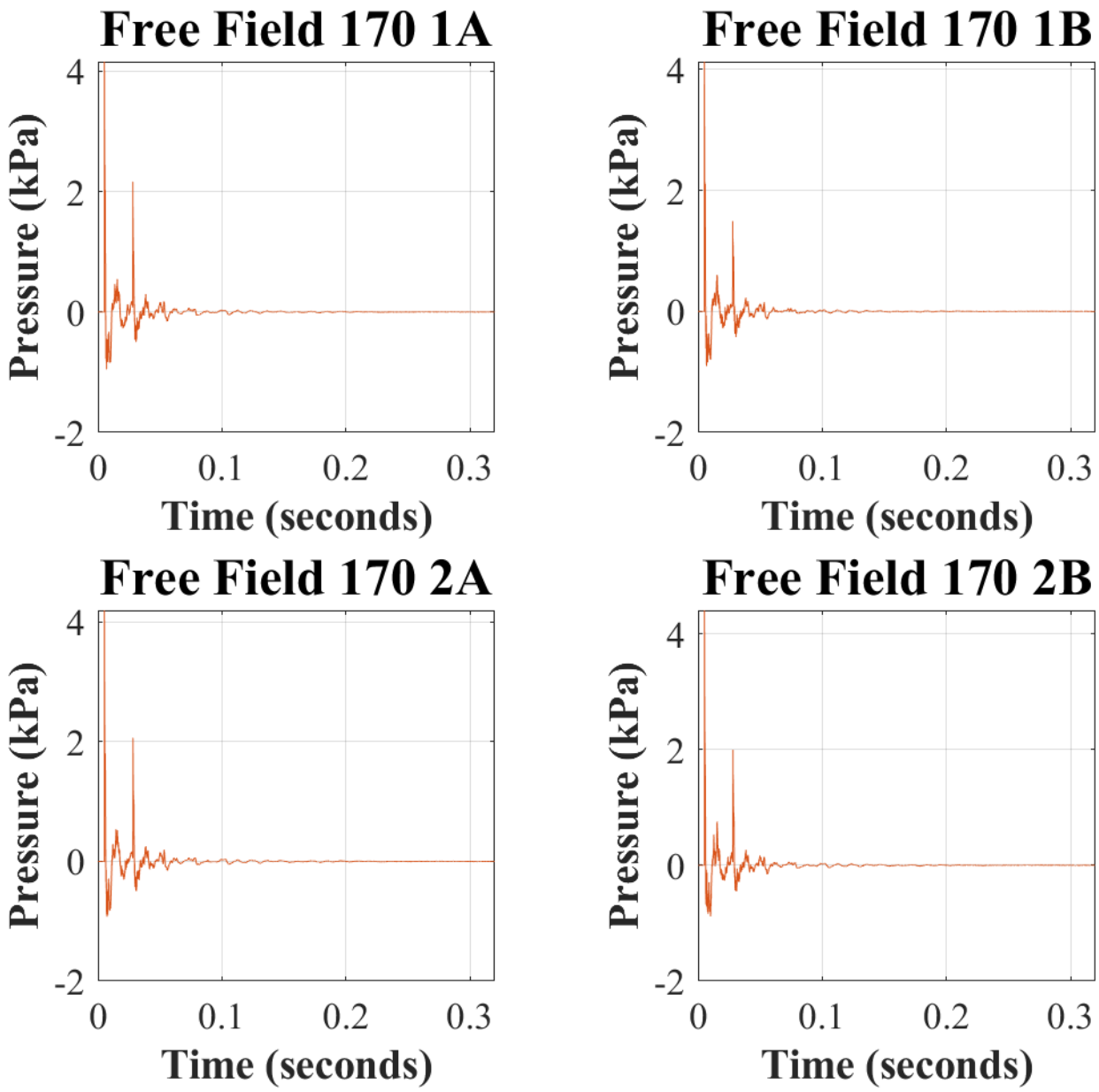

Free Field 160 4A
Pressure (kPa)
2
1
0
-1
0
0.1
0.2
0.3
Time (seconds)

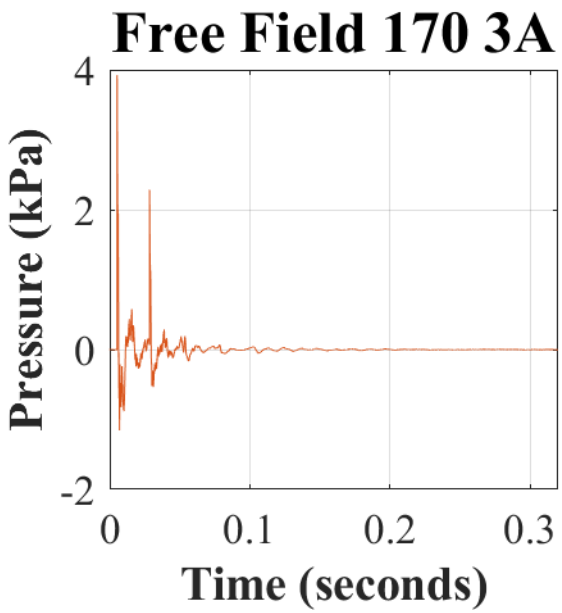

Free Field 160 4B
Pressure (kPa)
2
1
0
-1
0
0.1
0.2
0.3
Time (seconds)

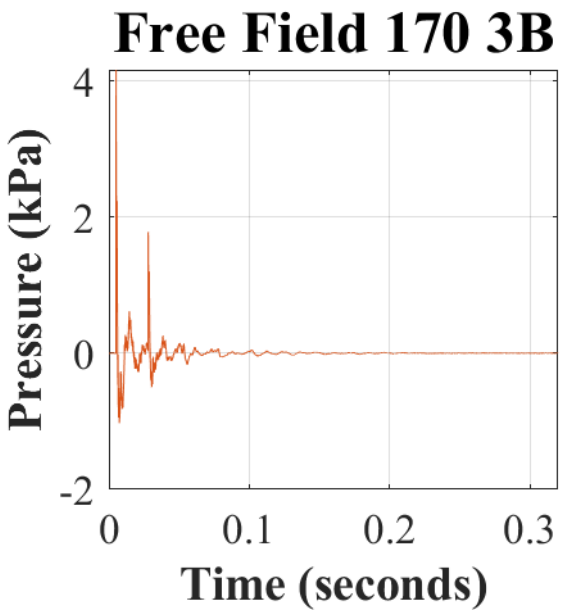


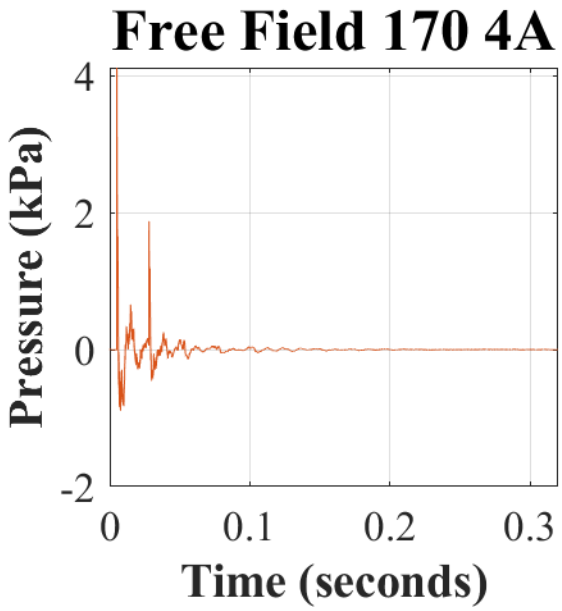
Note. The naming convention for all free-field waveforms is “Free Field LvL Nn”, where ‘Free Field’ indicates that the recording was obtained using the PCB reference microphone, ‘LvL’ is the nominal test level (160 dBP), ‘N’ is the device sample number (1 to 5), and ‘n’ is the device trial (i.e., A or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

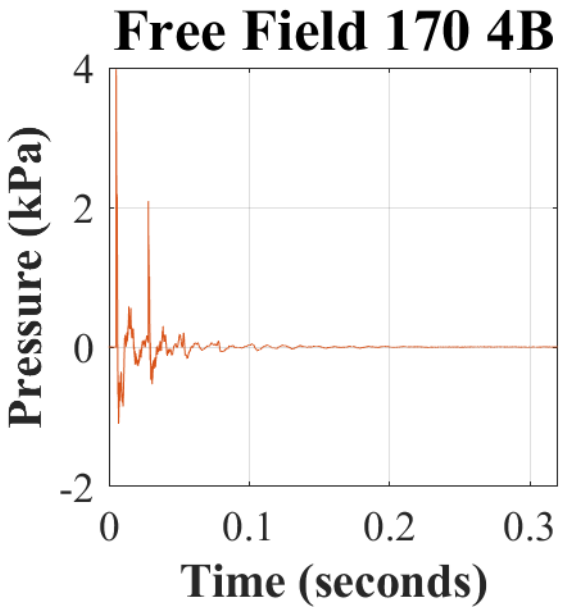
Appendix L. Recorded waveform (in kilopascals [kPa]) over time (in seconds [s]) of the impulse measured with the free-field probe at 170 dBP and the ComTac™ V (MAX) donned.

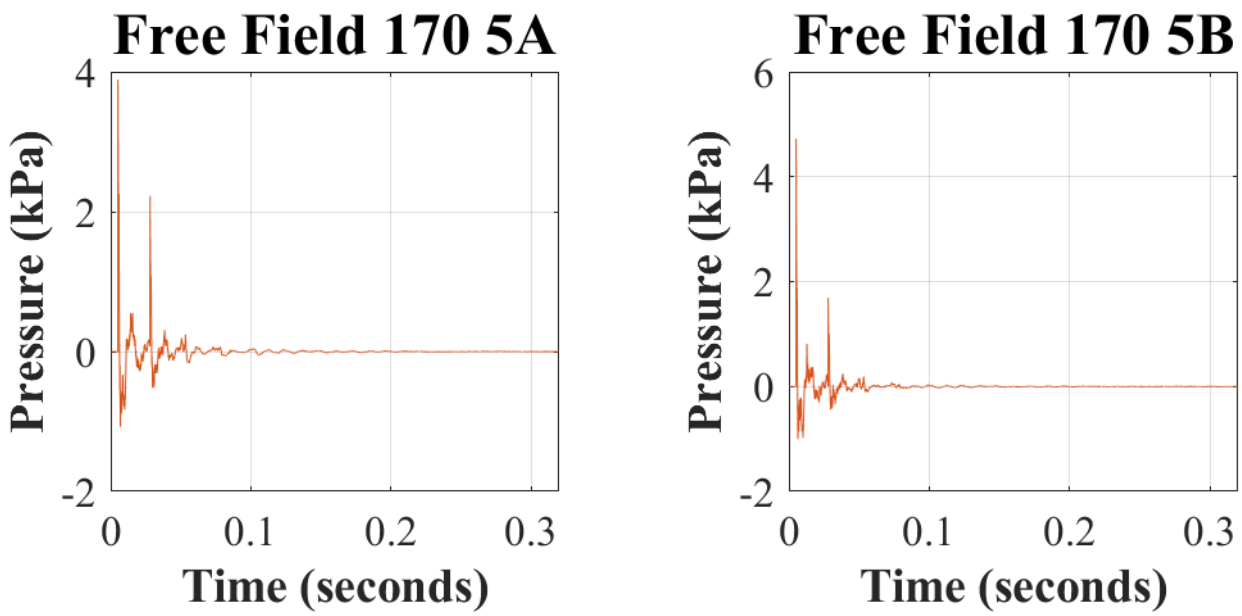



Free Field 170 3A
Pressure (kPa)
4
2
0
-2
0
0.1
0.2
0.3
Time (seconds)


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).