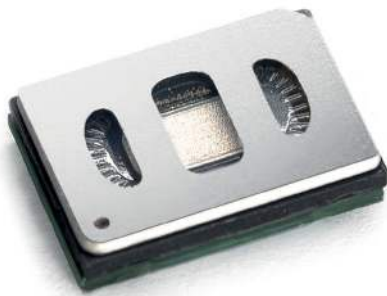


MEMS SPEAKERS

ACHELOUS UT-P2020 | DATASHEET

U))) SOUND



Achelous UT-P2020 MEMS speakers are ideal for in-ear audio solutions such as wired earphones or true wireless systems (TWS). Thanks to its small size and low weight, Achelous UT-P2020 offers maximum flexibility for outstanding design approaches. As a wide bandwidth speaker, it enables high-res audio applications. Achelous UT-P2020 produces vivid, clear and rich sound, immersing the listener into their personal audio environment.

FEATURES

- Full bandwidth achieved with a single MEMS speaker
- Enables modern, lightweight and ergonomic designs for wired earphones and TWS
- Seamlessly integrates into audio devices
- Extends battery life due to the speaker's low power consumption
- Enhanced cover for handling protection
- Competitive sound pressure level
- No magnetic field
- Low heat generation

APPLICATIONS

The Achelous UT-P2020 speakers can be used for in-ear audio systems such as wired earphones and true wireless systems (TWS).

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REVISION HISTORY

February 2021: Release

May 2021: Updated section "Acoustic performance using the Carme UJ-R1020/UJ-R1030 test box on coupler", page 10; power consumption values added, page 3; capacity value adjusted, page 3; added section "Speaker gaskets", page 14

SPECIFICATIONS

General acoustics			
$f_{res} @ 15 V_p$	[kHz]	2.7	±10%
$Q @ f_{res} / 15 V_p$	[-]	0.6	
Effective membrane surface – S_D	[mm ²]	12	
Equivalent volume – V_{AS}	[mm ³]	60	
Front volume inside speaker	[mm ³]	5.6	
Back volume inside speaker	[mm ³]	20	
Acoustics in coupler (IEC 60318-4)			
SPL @ 250 Hz / 15 V_p	[dB]	116	±3.0
SPL @ 1 kHz / 15 V_p	[dB]	118	±3.0
SPL @ 5 kHz / 15 V_p	[dB]	115	±3.0
SPL @ 250 Hz / 1 V_{rms} (1.4 V_p)	[dB]	94	±3.0
SPL @ 1 kHz / 1 V_{rms} (1.4 V_p)	[dB]	95	±3.0
SPL @ 5 kHz / 1 V_{rms} (1.4 V_p)	[dB]	92	±3.0
THD @ 250 Hz / 1 V_{rms} (1.4 V_p)	[%]	0.3	+0.3
THD @ 1 kHz / 1 V_{rms} (1.4 V_p)	[%]	0.4	+0.3
THD @ 5 kHz / 1 V_{rms} (1.4 V_p)	[%]	0.6	+0.3
Lower bandwidth (-3 dB)	[Hz]	<20	
Electronics			
Capacity	[nF]	27	±5
Operating conditions			
Maximum AC voltage (peak) – up to 20 kHz	[V_p]	15	
Maximum DC voltage	[V]	15	
Power consumption			
With 1 kHz @ 94 dB	[mVA]	0.13	
With IEC noise (60268-1) @ 94 dB	[mVA]	0.25	
With IEC noise (60268-1) @ 94 dB – including amplifier*	[mW]	13.6	

*Power consumption measured with the reference driving circuit, shown on page 7; Supply voltage: 3.6 V.

MECHANICAL DIMENSIONS

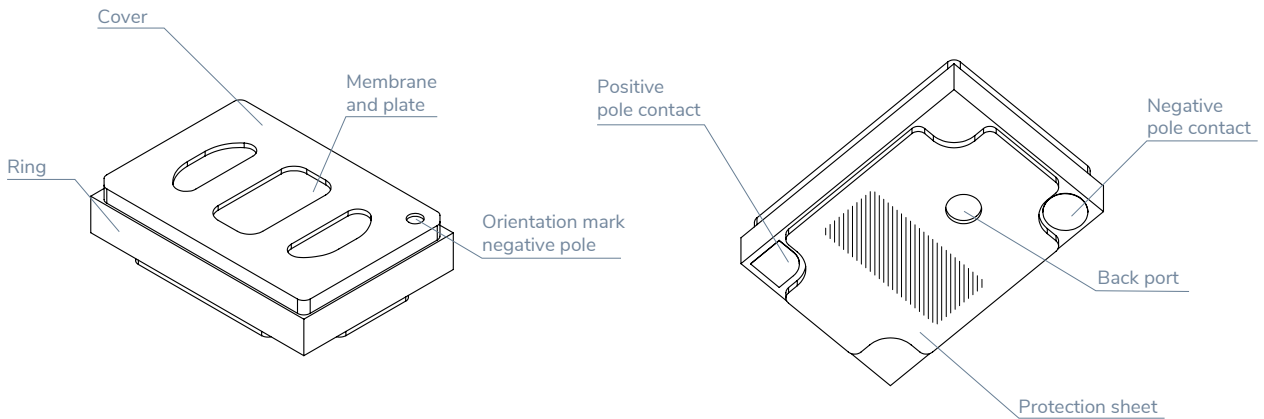


Figure 1: Mechanical drawings: perspective view

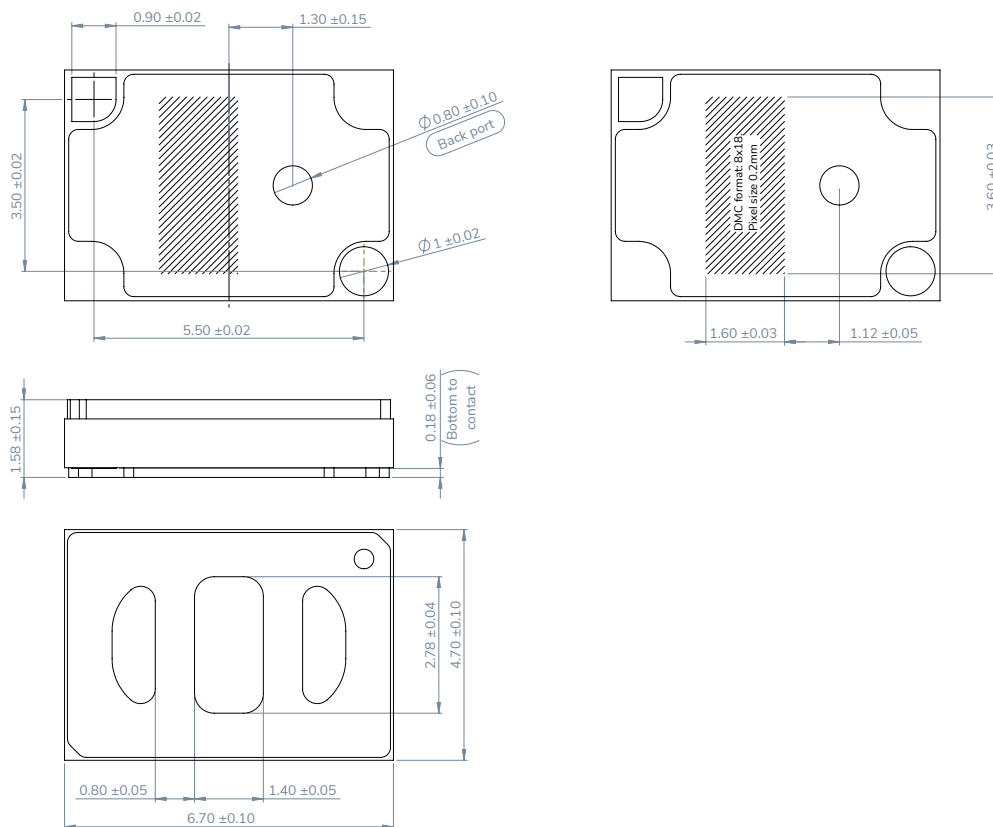


Figure 2: Mechanical drawings: top/down/side view

Mechanics		
Size	[mm]	6.7 x 4.7 x 1.58
Total speaker weight	[mg]	80
Total speaker cubic volume	[mm ³]	50

FORCE ON SPEAKER

Type of stress	Maximum handling force [N]	Maximum permanent force [N]
Front face compression	20	13
Side face compression	20	13
3 point bending	10	5
Force on membrane	0	0

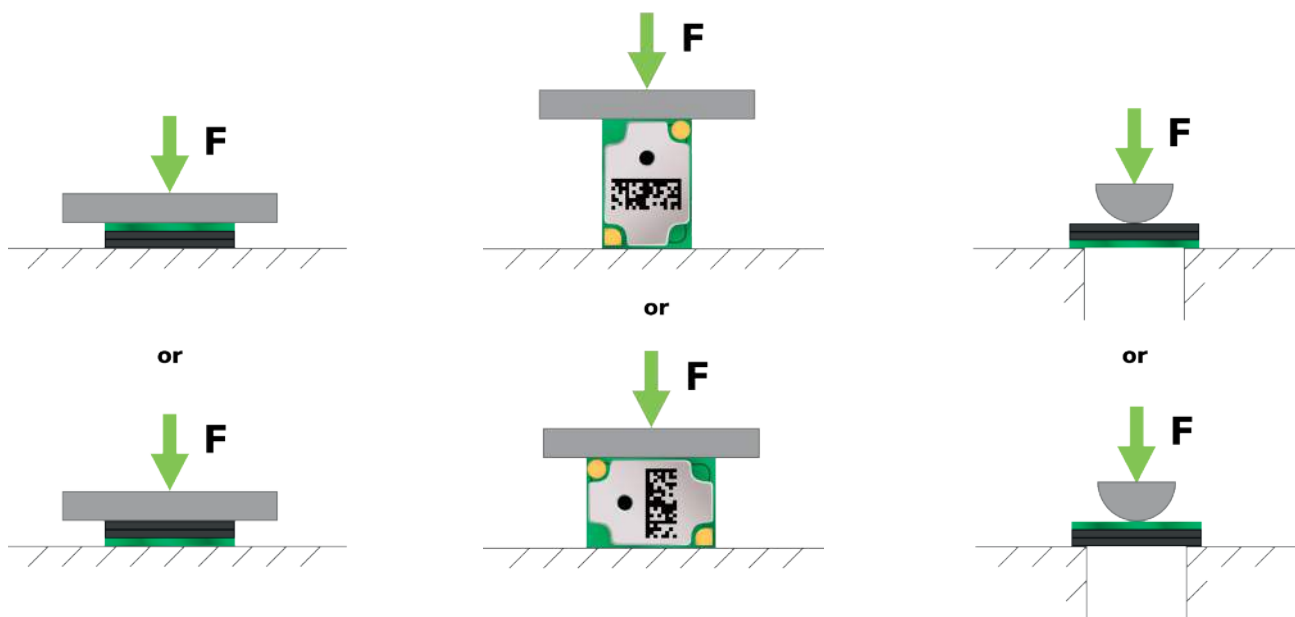


Figure 3: Left: front face compression, centre: side face compression, right: 3-point bending

TEST CONDITIONS

ACOUSTICS

General	
Measurement system	Audio Precision APx
Measurement signal	Exp. Sweep
Voltage levels – audio $V_{DC} + V_{AC}$	15 V + 15 V _p
Applied back volume	Open (infinite)

Coupler	
Coupler type	IEC 60318-4 (711)
Coupler volume	1.26 cm ³
Connection tube length	1.5 mm
Connection tube diameter	3.0 mm
Microphone	GRAS 43AC

COUPLER MEASUREMENT ADAPTER

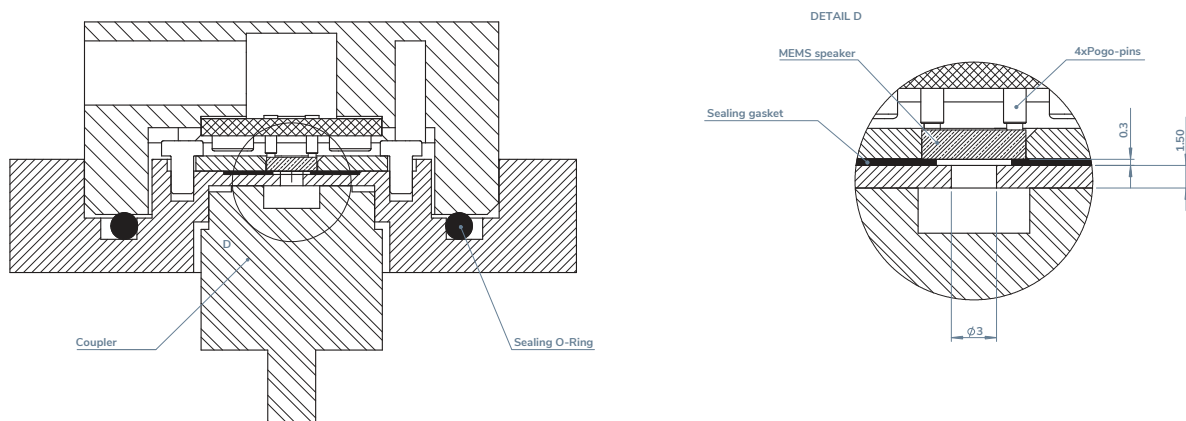


Figure 4: Coupler adapter cross-section. The speaker adapter is directly screwed onto the coupler; the earmould adapter is not used. The outlet for the speaker is round with a diameter of 3 mm and length of 1.5 mm, as shown in Detail D

REFERENCE DRIVING CIRCUIT

In Figure 5 and Figure 6 the reference driving circuit is shown. It includes the amplifier TI LM48580 and the DC boost converter TPS61046.

The boost converter is configured to provide a constant 15 V_{DC} offset for the speaker. The amplifier circuit is based on the typical application diagram from the LM48580 datasheet. It is based on a single-ended input signal but can be also modified according to the datasheet to a differential input.

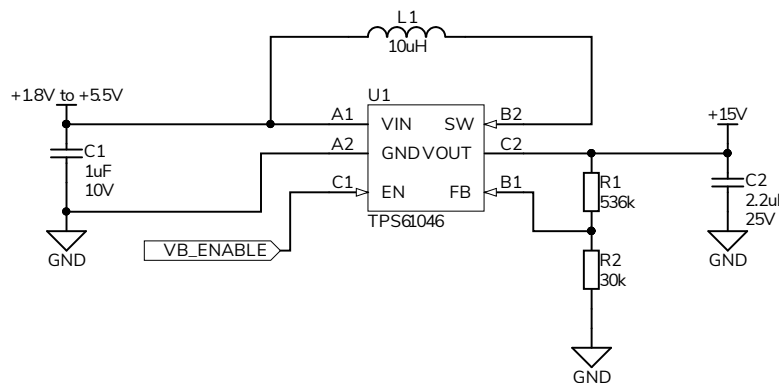


Figure 5: TPS61046 boost converter, including required passive components

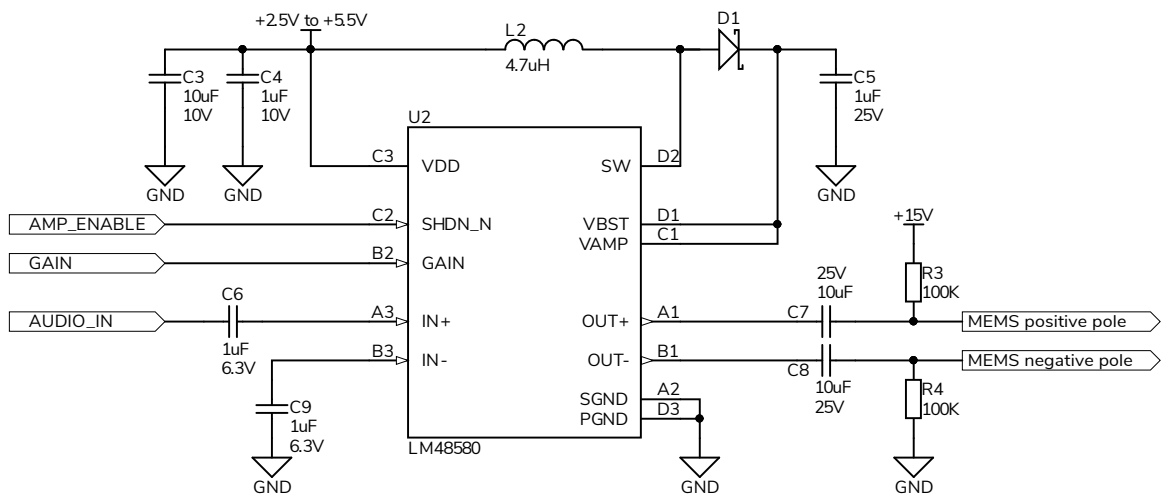


Figure 6: LM48580 amplifier including required passive components

ACOUSTIC PERFORMANCE

ACOUSTIC PERFORMANCE IN COUPLER (IEC 60318-4)

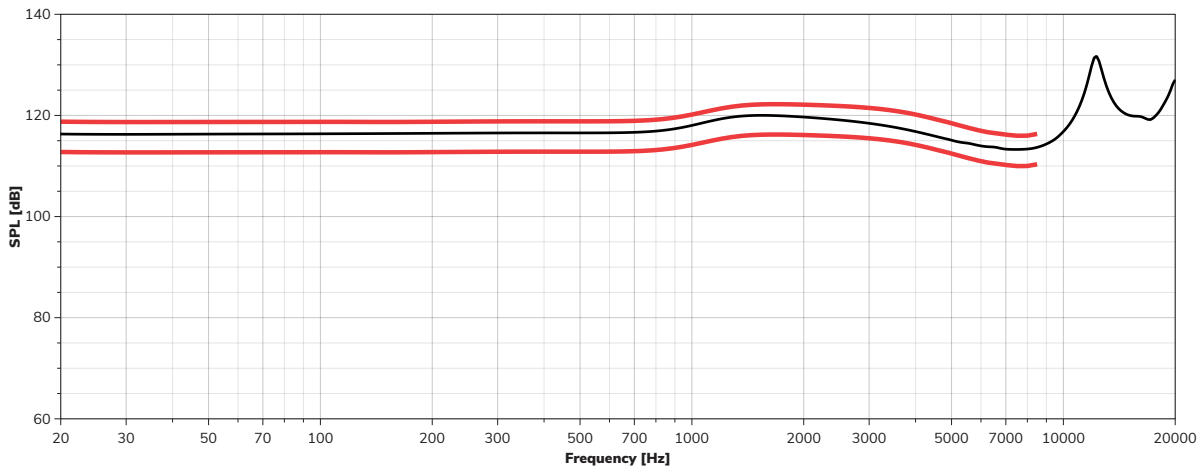


Figure 7: SPL @ 15 V_p drive*

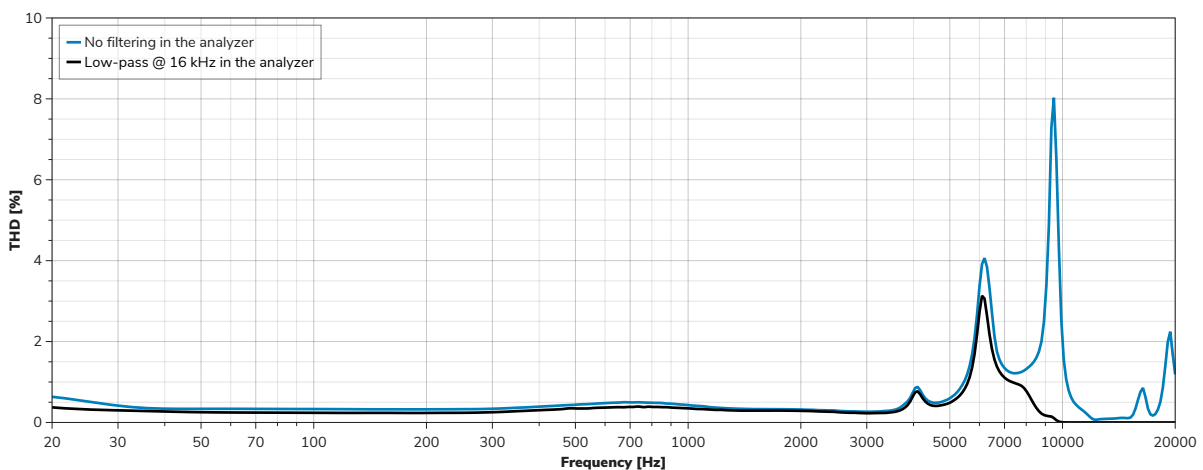


Figure 8: THD 94 dB SPL @ 1 kHz, corresponds to 1 V_{rms} (1.4 V_p)**

*Red lines in figure 7 indicate the limits. Test limits are used to establish incoming inspection acceptance / rejection criteria, correlation of test equipment with USound is also required for elimination of equipment and test method variation.

**Low pass filter @ 16 kHz (see figure 8) is added due to the typical audible frequency range of adults.

GROUP DELAY

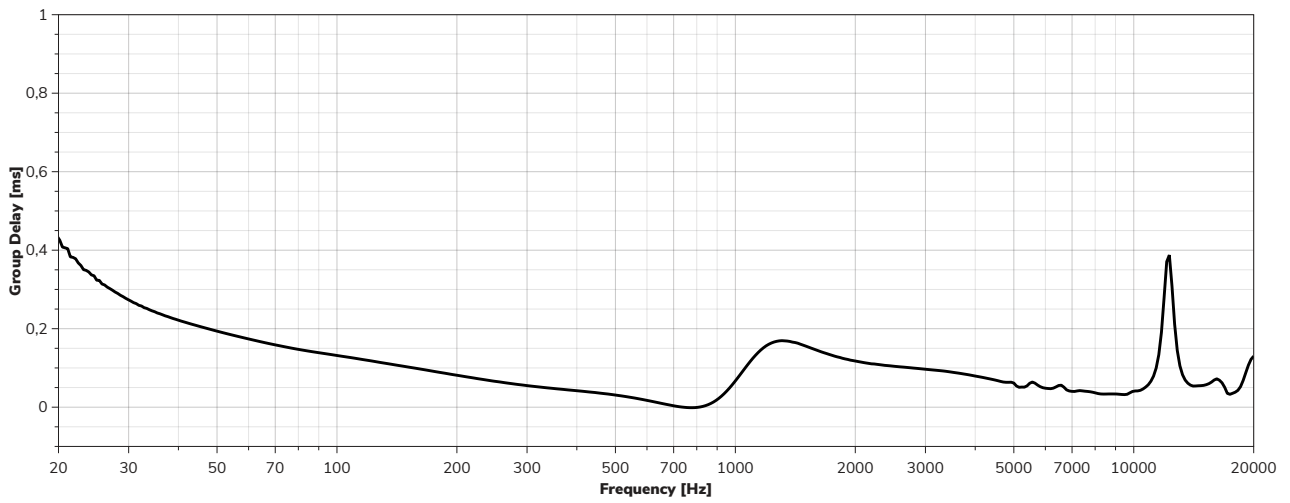


Figure 9: Group delay; sampling frequency 96 kHz

IMPULSE RESPONSE

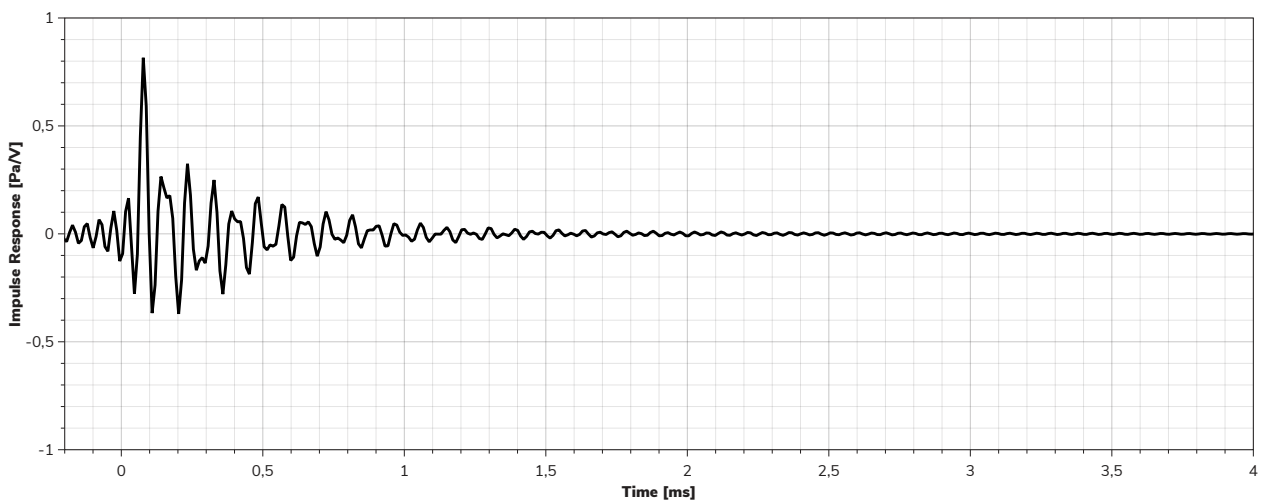


Figure 10: Impulse response, measured @ 15 V_p; sampling frequency 96 kHz

ACOUSTIC PERFORMANCE USING THE CARME UJ-R1020/UJ-R1030 TEST BOX ON COUPLER

The speaker test box ‘Carme’ is available to analyse the performance of Achelous UT-P2020 MEMS speakers. With a back volume of 100 mm³, Carme provides the necessary sealing to avoid an acoustic short circuit and offers a convenient way to connect Achelous UT-P2020 to Sound’s amplifiers. Two versions of Carme are available

- Carme UJ-R1020 has the proper electrical connection to combine it with the linear Amplifier Amalthea UA-R3010
- Carme UJ-R1030 has the proper electrical connection to combine it with the USound’s evaluation board Helike UA-E3010

To set up the Carme test box, unscrew and separate the PCB from the shell. Remove the housing gasket and place the MEMS speaker inside the box with the contact side up. Place the PCB by taking care to match the orientation marks with those on the speaker. Tighten the screws for proper sealing. To obtain the measurements below, a gasket needs to be added on the front surface of Carme.

There are two ways of placing Carme on the coupler. Either it is placed directly on the coupler (like the reference adapter in figure 4) or it is placed on the earmould adapter, which is attached to the coupler. See Figure 14 for reference.



Figure 11: Carme UJ-R1020 for Amalthea UA-R3010. The colour coding matches the outputs of Amalthea UA-R3010

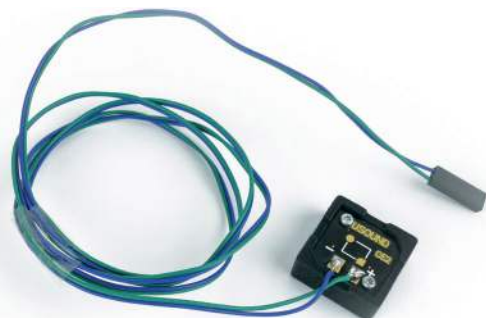


Figure 12: Carme UJ-R1030 for Helike UA-E3010

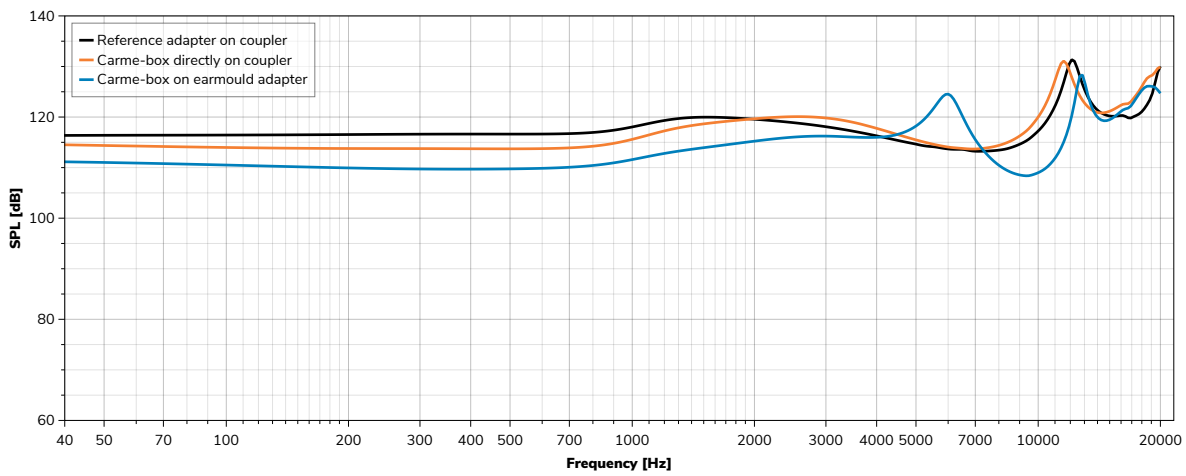


Figure 13: Achelous UT-P2020 SPL measurement in the Carme UJ-R1020/UJ-R1030 test box on the coupler

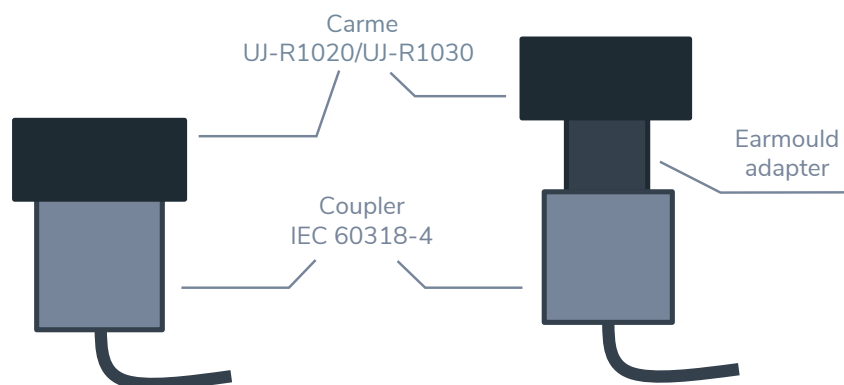


Figure 14: Placement options of Carme UJ-R1020/UJ-R1030 on the coupler. Left picture, directly on the coupler. Right picture, using the earmould adapter on the coupler.

HANDLING

GENERAL

It needs to be considered that MEMS devices consist of silicon structures and therefore, they should be handled with care. Any bending of the MEMS speakers must be avoided while handling during the assembly process and when permanently inside an application, otherwise the speaker can be damaged.

TWEEZERS

It is recommended to gently grip the speakers from the sides with blunt curved tweezers and avoid touching the membrane under any circumstances to preserve its functionality and form. Using sharp tweezers while manipulating the speakers can lead to accidentally piercing the membrane and to a loss of functionality.

The risk to damage the speaker can be further minimized if the speaker is handled with the membrane facing down, as shown in the picture below.



Figure 15: Left: Recommended tweezer type. Right: Not recommended tweezer type

INTEGRATION

It needs to be considered that MEMS devices consist of silicon structures and therefore, they should be handled with care. Any bending of the MEMS speakers must be avoided while handling during the assembly process and when permanently inside an application, otherwise the speaker can be damaged.

To avoid bending of the speaker, it's recommended that just the defined contact areas are in contact with the application at front side and back side of the speaker.

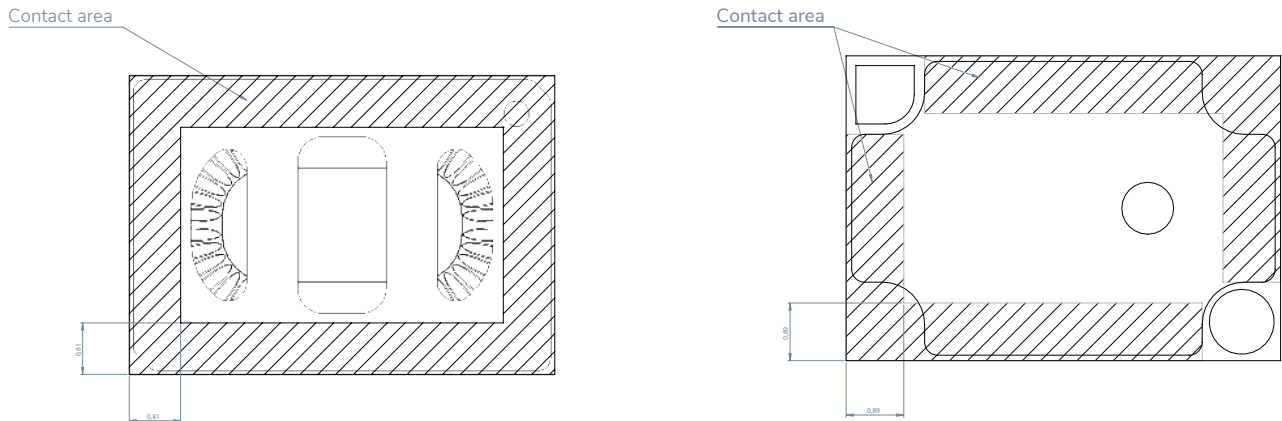


Figure 16: Recommended contact surfaces at the front side (left) and back side (right) of the MEMS speaker

SPEAKER GASKETS

In most applications the speakers need to be sealed to deliver the proper performance. This can be attained by various means, gaskets being the most prominent. USound offers two standard gaskets optimized for different applications. Both designs have the same footprint as the speaker and an opening similar to the cover opening.

Name	UG-P201G	UG-P202G
Description	Open cell foam gasket with a glue layer on one side.	Closed cell foam gasket with a glue layer on each side.
Material	Poron 4701-50-30020-04 & TESA 4983	TESA 75635
Thickness uncompressed (compressed for proper sealing)	0.53 mm (0.30 mm)	0.35 mm (0.35 mm)
Application recommendations	<p>Suitable for prototyping</p> <p>The speaker needs to be pushed on the gasket in order to be sealed, some mechanical tolerance can be absorbed.</p> <p>Main application is prototyping and evaluation, where the speaker can be exchanged.</p>	<p>Suitable for mass production</p> <p>The speaker does not need to be pressed against the gasket; sticking it to the gasket during assembly is enough.</p> <p>Main application is mass production where the speaker is mounted permanently. Disassembly will not be possible.</p>
Drawings		

CONNECTIVITY

The speaker is driven by applying voltage between the + and the - connection. The potential of + has to be always equal or higher than the -. To ensure this a DC voltage together with the AC signal has to be applied on +.

Attention: The AC peak voltage must always be smaller than or equal to the DC voltage.

The membrane will move downwards/inside by applying a positive voltage on the + connection.

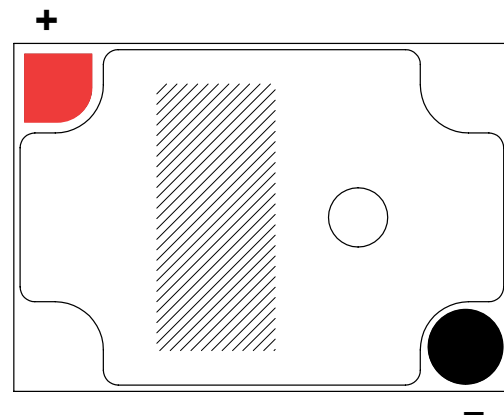


Figure 17: Electrical connections of speaker back side

LABELLING

Each speaker is equipped with an 8 x 18 digital matrix code (DMC).

- DMC Size: 3.6 mm x 1.6 mm
- Pixel size: 0.2 mm
- Data format corresponds to the production date: NNYCCDSSSS. For example: 0291024022

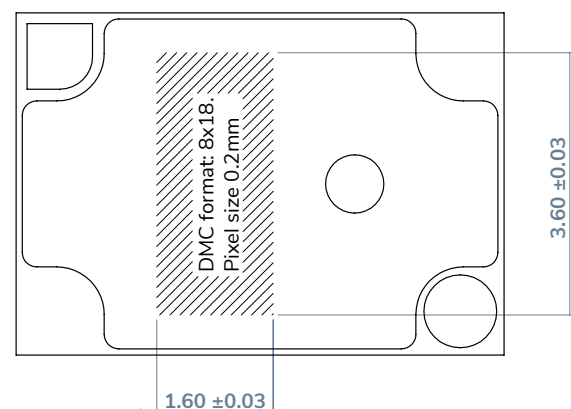


Figure 18: DMC at speaker backside

02	9	10	2	4022
NN	Y	CC	D	SSSS
Speaker type (01 = Adap UT-P2023; 02= Achelous UT-P2020)	Year (Last digit of the year)	Calendar week	Week day (First day starts on Sunday)	Serial number

PACKAGING

Thickness: 0.5 mm
QTY 150 PCS

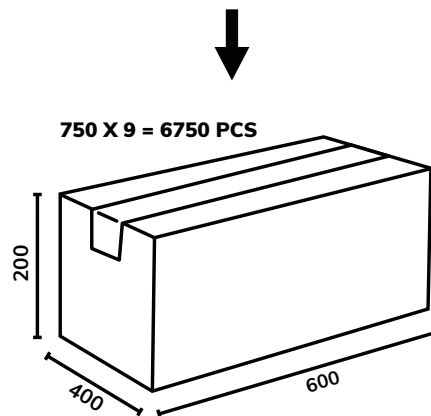
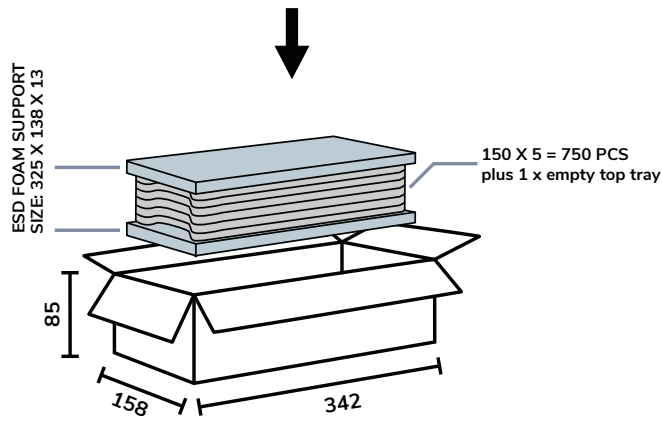
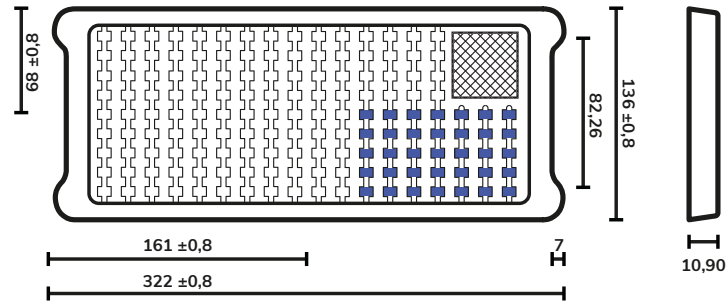


Figure 19: Packaging in tray and carton

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