MEMS SPEAKERS

ADAP UT-P2023 | DATASHEET

Adap UT-P2023 MEMS speakers are ideal for free-field audio solutions such as wearables. Due to its small size and low weight, Adap UT-P2023 offers maximum flexibility for outstanding design approaches. Providing a wide bandwidth, it enables high-res audio applications. Adap UT-P2023 produces a tangible, clear, and rich sound that immerses the listener into their personal audio environment.

FEATURES

- Enables modern, lightweight and ergonomic designs for sophisticated wearables
- Seamlessly integrates into acoustic devices for everyday use
- 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

Adap UT-P2023 speakers can be used for free-field audio systems as well as wearables. For 2-way earphones Adap UT-P2023 speakers are suitable as tweeters.

Released in February 2021, updated in May 2021
USound GmbH | www.usound.com | sales@usound.com

CONTENT

REVISION HISTORY

February 2021: Release
May 2021: Capacity value changed, page 3; speaker gasket information added, page 13

U))SOUND

SPECIFICATIONS

General acoustics			
f_{res} @ 15 V_P	[kHz]	2.9	±15%
Q @ f_{res} / 15 V_P	[-]	0.7	
Effective membrane surface – S_D	[mm²]	12	
Equivalent volume – V_{AS}	[mm³]	40	
Front volume inside speaker	[mm³]	5.6	
Back volume inside speaker	[mm³]	20	

Acoustics in baffle (IEC 60268-5)			
SPL @ 1 kHz / 15 V_P	[dB]	53	±3.0
SPL @ 4 kHz / 15 V_P	[dB]	71	±3.0
SPL @ 10 kHz / 15 V_P	[dB]	76	±3.0
SPL @ 1 kHz / 5 V_P	[dB]	43	±3.0
SPL @ 4 kHz / 5 V_P	[dB]	60	±3.0
SPL @ 10 kHz / 5 V_P	[dB]	65	±3.0
THD @ 1 kHz / 5 V_P	[%]	16	+8
THD @ 4 kHz / 5 V_P	[%]	5	+3
THD @ 10 kHz / 5 V_P	[%]	4	+3

Electronics			
Capacity	[nF]	26	±5

Operating conditions		
Maximum AC voltage (peak) – up to 40 kHz	[V_P]	15
Maximum DC voltage	[V]	15
Maximum AC current (peak)	[mA_P]	200

Power consumption*		
With IEC noise (60268-1) incl. high pass @ 2 kHz @ 60 dB	[mW]	46

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

MECHANICAL DIMENSIONS

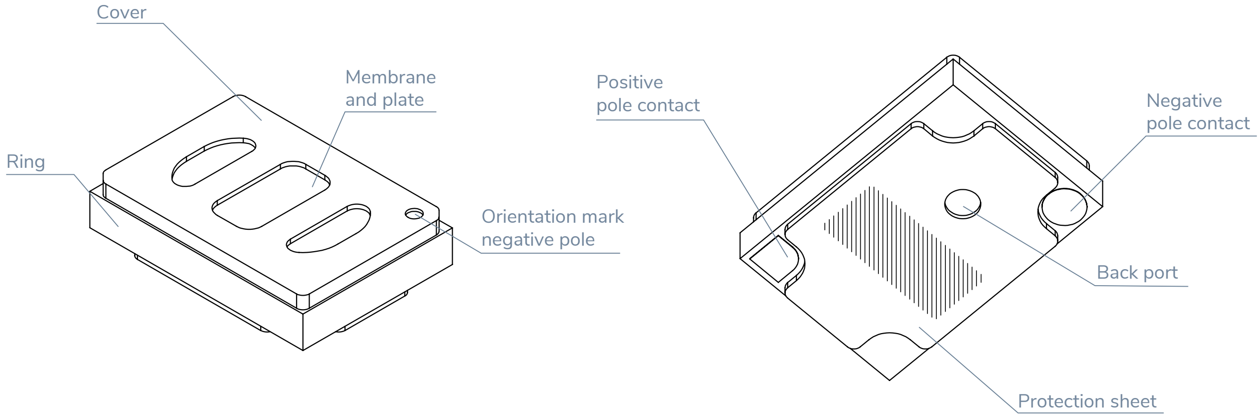


Figure 1: Mechanical drawings: perspective view

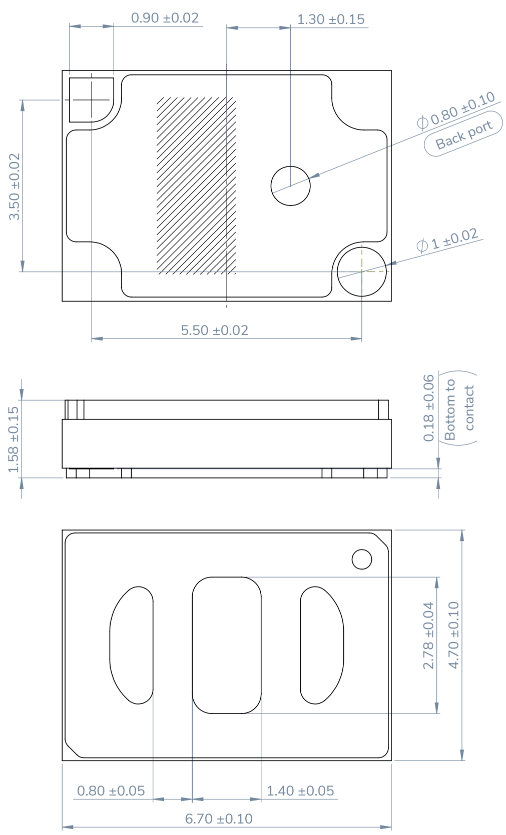


Figure 2: Mechanical drawings: top/down/side view

Mechanics		
Size	[mm]	6.7 x 4.7 x 1.58
Total speaker weight	[mg]	80
Total speaker cubic volume	[mm³]	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

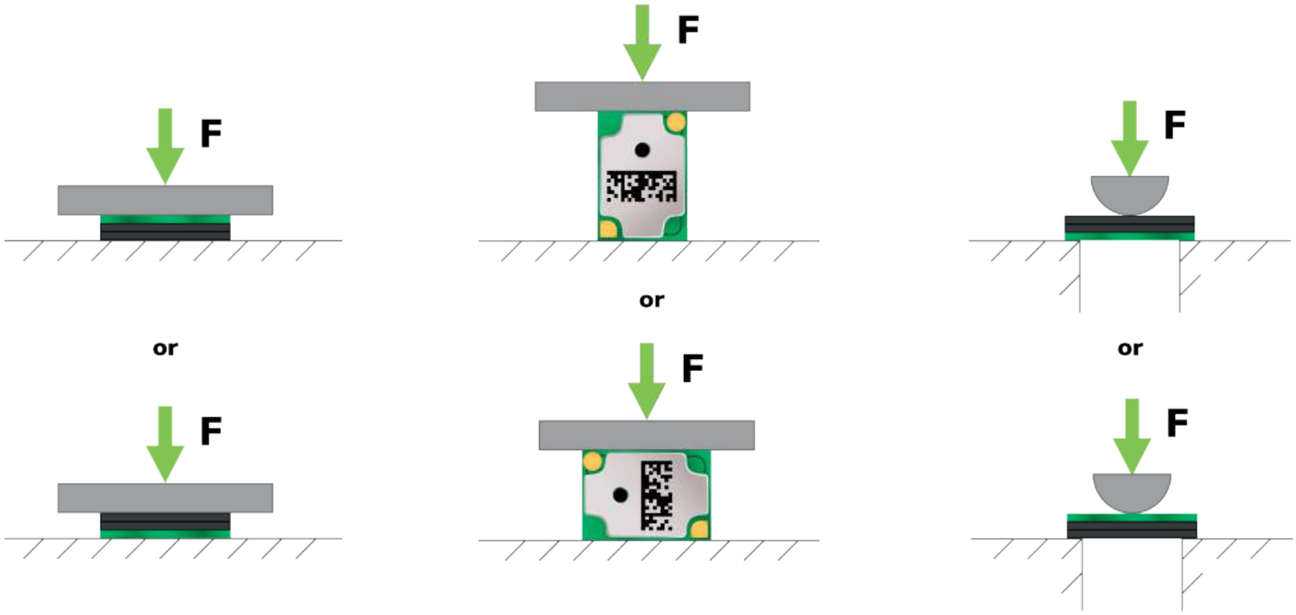


Figure 3: **Left: front face compression, centre: side face compression, right: 3-point bending**

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)

Baffle	
Baffle type	IEC 60268-5
Mic distance	3 cm
Reference distance	10 cm
Microphone	GRAS 46AC
Microphone diameter	1/2”

BAFFLE MEASUREMENT ADAPTER

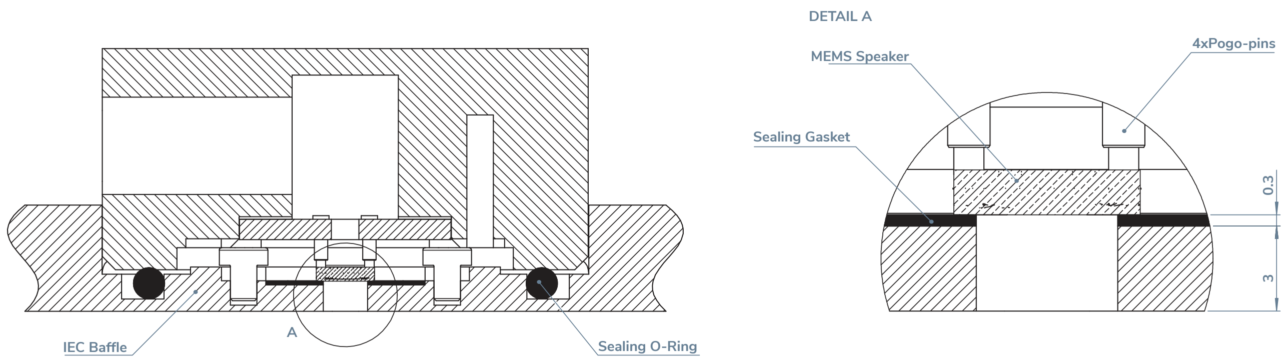


Figure 4: **The outlet through the baffle for the speaker has the same shape as the inside of the speaker cover**

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 itself is based on the typical application diagram from the LM48580 datasheet. It is based on a single-ended input signal but can also be modified according to the datasheet to a differential input.

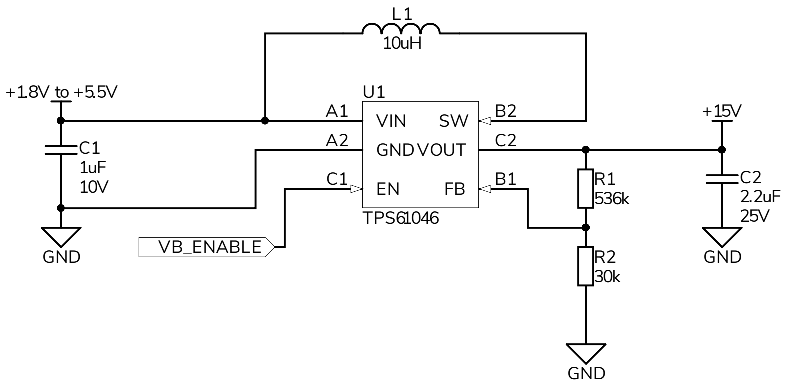


Figure 5: TPS61046 boost converter including required passive components

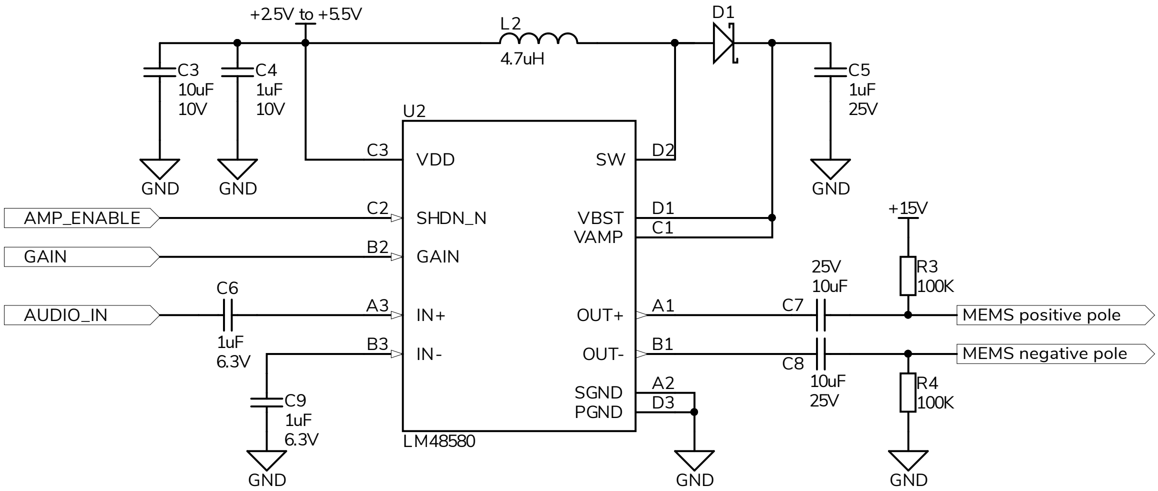


Figure 6: LM48580 amplifier, including required passive components

ACOUSTIC PERFORMANCE

ACOUSTIC PERFORMANCE IN BAFFLE (IEC 60268-5)

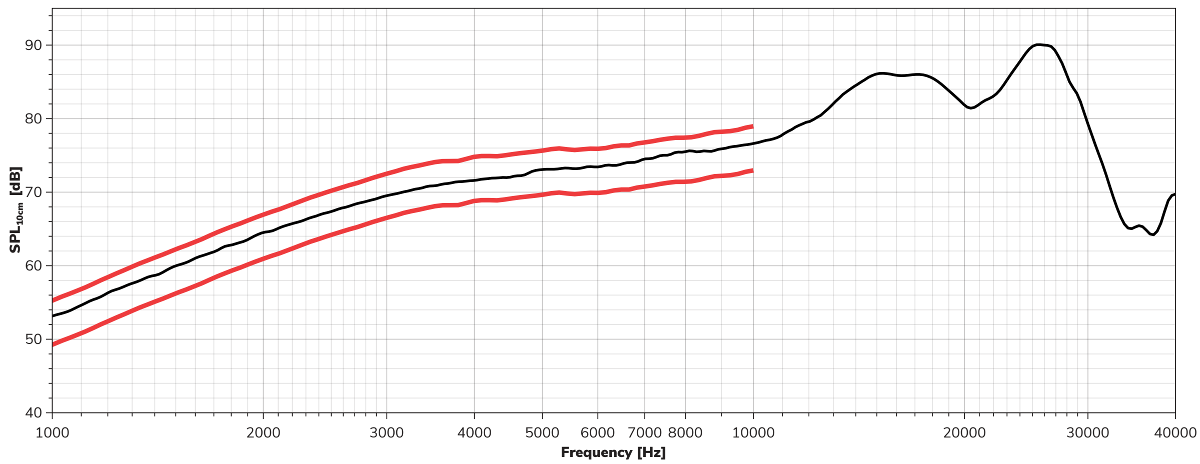


Figure 7: **SPL @ 15 V_P drive***

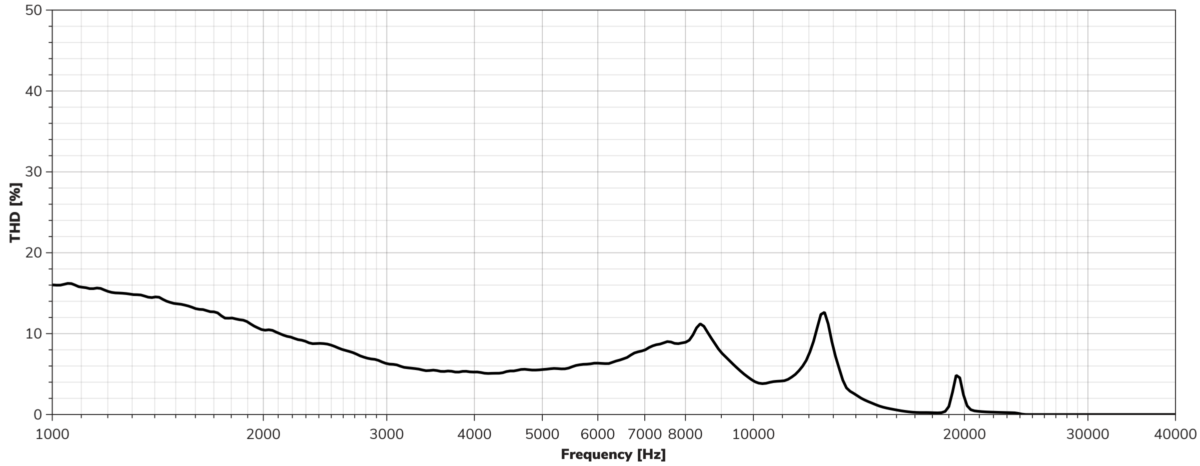


Figure 8: **THD 60 dB SPL @ 4 kHz, corresponds to 5 V_P**

*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 a requirement for elimination of equipment and test method variation.

GROUP DELAY

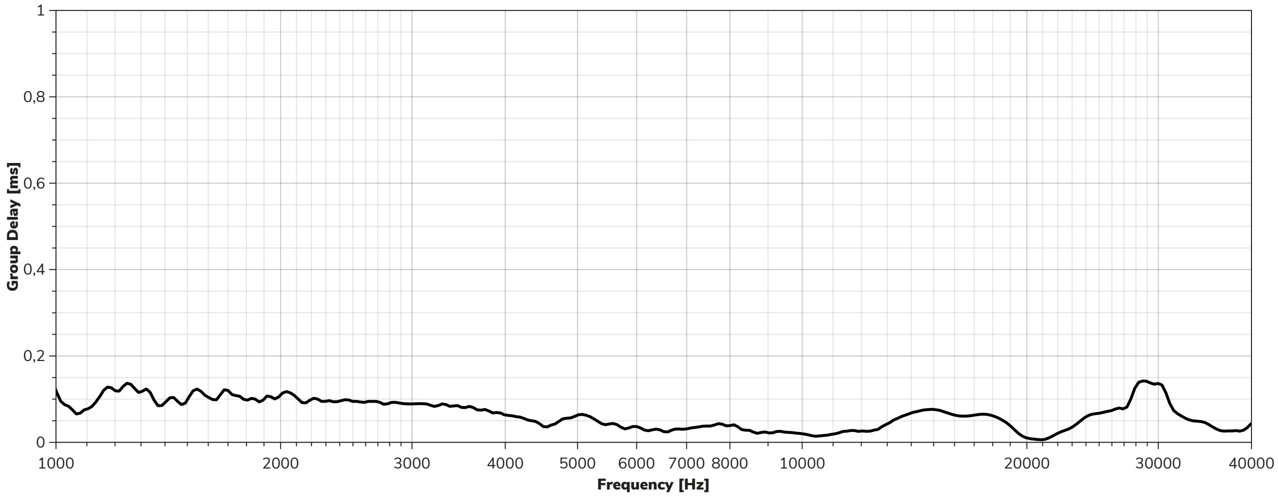


Figure 9: Group delay; sampling frequency 96 kHz.
Time delay between speaker and microphone compensated.

IMPULSE RESPONSE

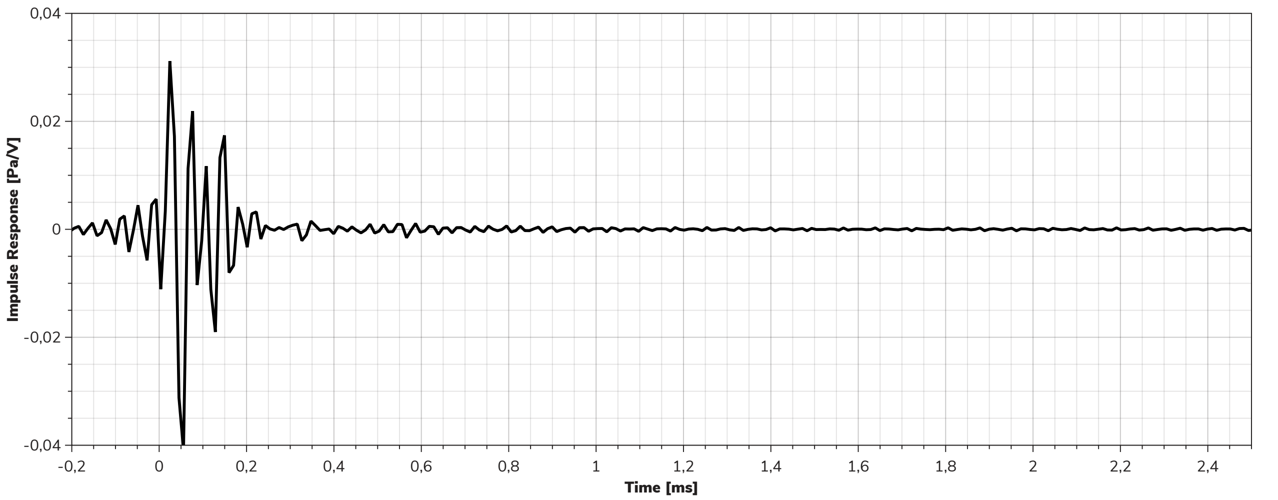


Figure 10: Impulse response; sampling frequency 96 kHz.
Time delay between speaker and microphone compensated.

ACOUSTIC PERFORMANCE USING THE CARME UJ-R1020/UJ-R1030 TEST BOX IN FREE FIELD

The speaker test box ‘Carme’ is available to analyse the performance of Adap UT-P2023 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 Adap UT-P2023 to USound’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. Using the Carme test box, Adap UT-P2023 MEMS speakers can be measured in free field.

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

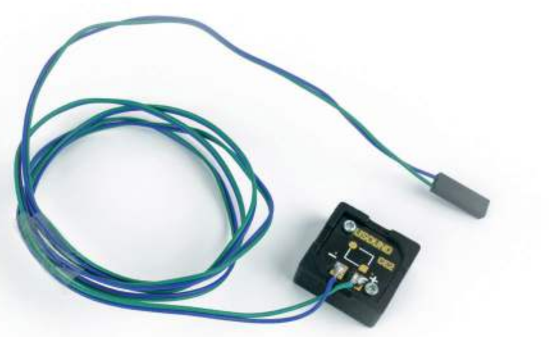


Figure 12: Carme UJ-R1030 for Helike UA-E3010

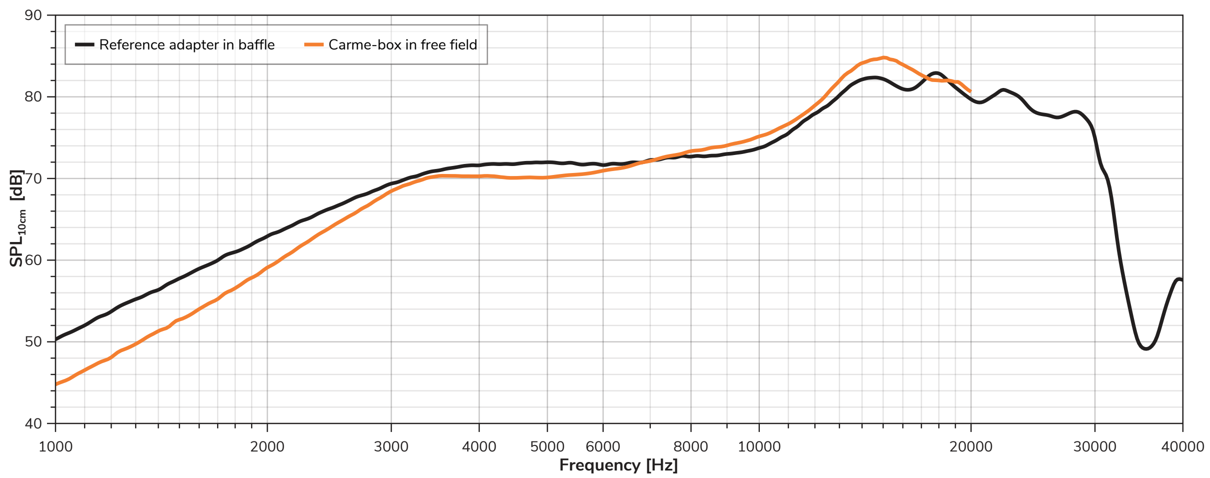


Figure 13: Adap UT-P2023 SPL measurement in the Carme UJ-R1020/UJ-R1030 test box (10 cm) in free field

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.

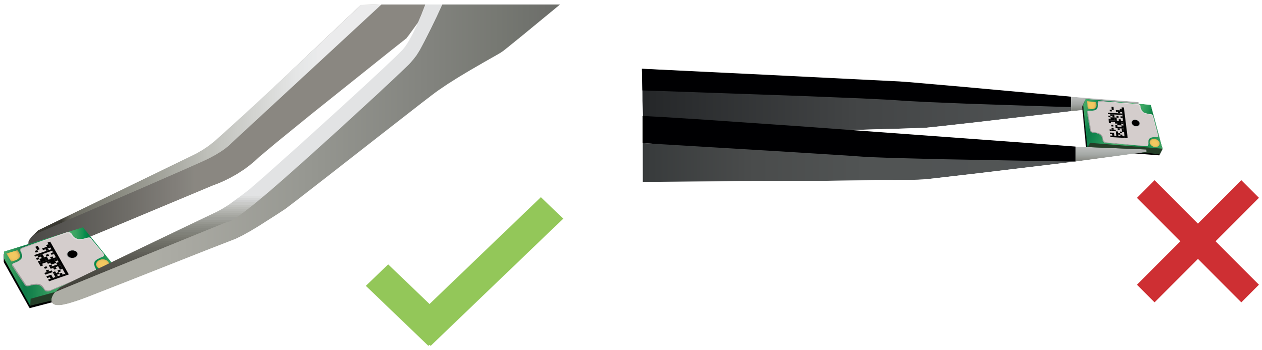


Figure 14: **Left: Recommended tweezer type. Right: Not recommended tweezer type**

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.

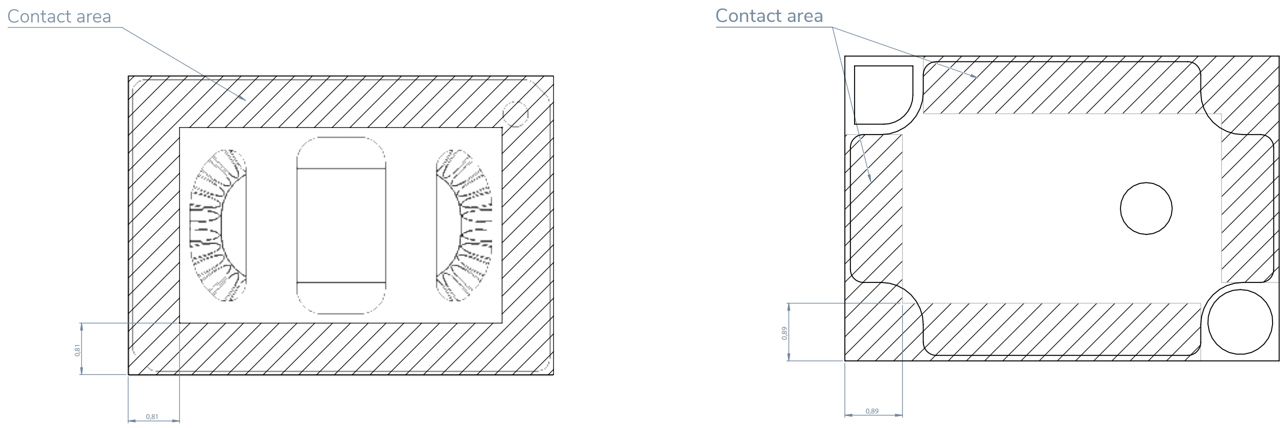
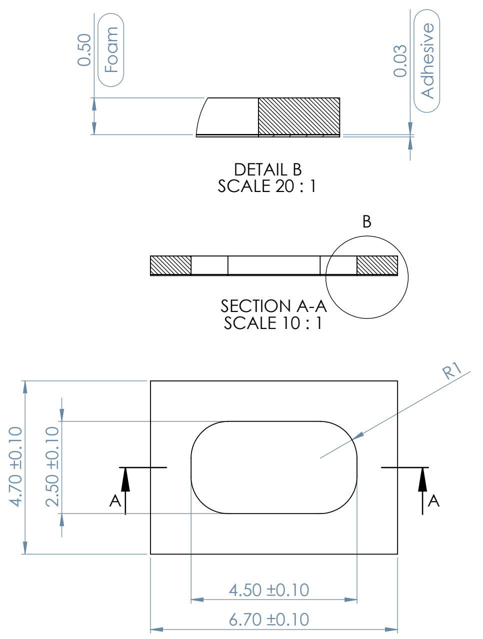
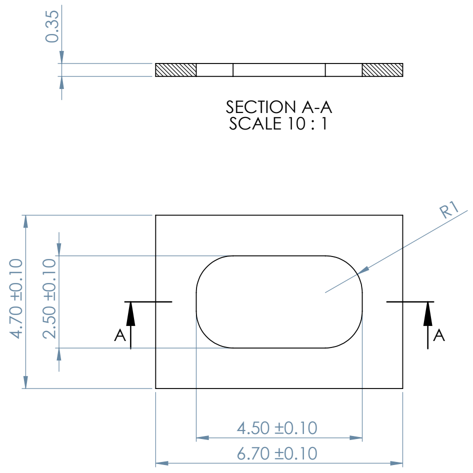


Figure 15: Recommended contact surfaces at the front side (left) and back side (right) of MEMS speaker

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	Suitable for prototyping The speaker needs to be pushed on the gasket in order to be sealed, some mechanical tolerance can be absorbed. Main application is prototyping and evaluation, where the speaker can be exchanged.	Suitable for mass production The speaker does not need to be pressed against the gasket; sticking it to the gasket during assembly is enough. Main application is mass production where the speaker is mounted permanently. Disassembly will not be possible.
Drawings	 *Delivery on carrier sheets (matrix distribution).	 *Delivery on carrier sheets (matrix distribution).

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.

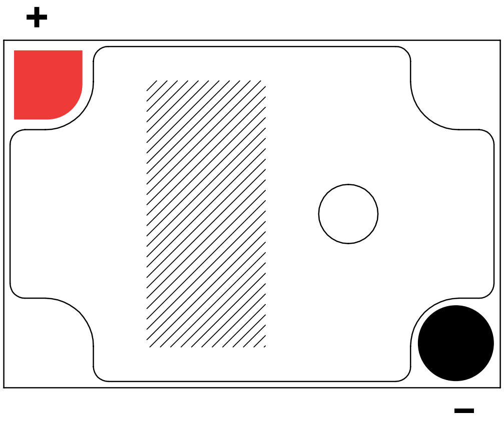


Figure 16: **Electrical connections of the speaker back side**

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: 0191024022

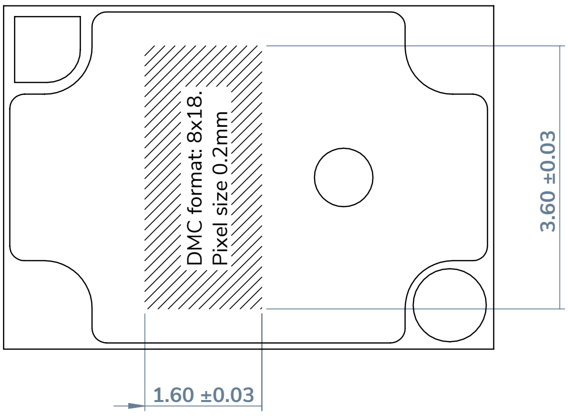


Figure 17: **DMC at speaker backside**

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

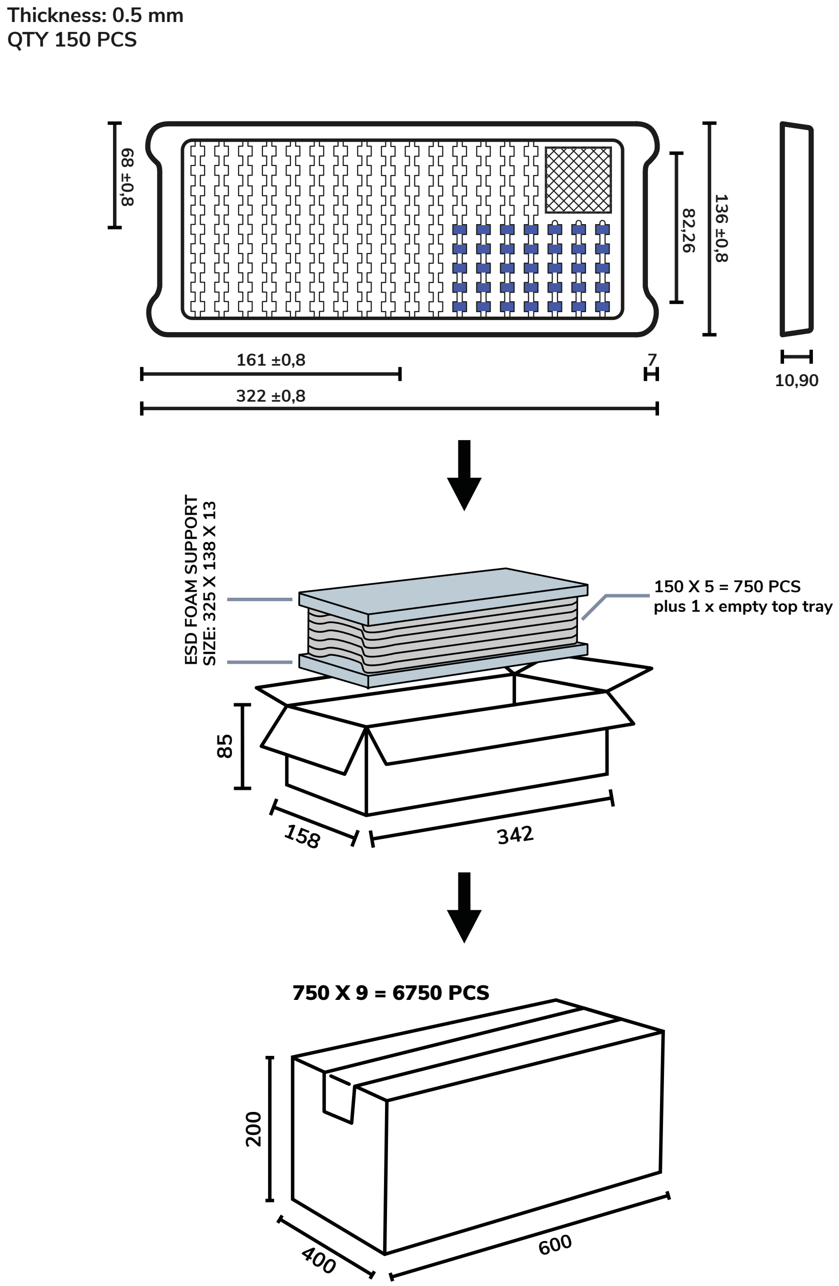


Figure 18: **Packaging in tray and carton**

IMPORTANT NOTICE AND DISCLAIMER

USound GmbH ("USound") makes no warranties for the use of USound products, other than those expressly contained in USound's applicable General Terms of Sale, located at www.usound.com. USound assumes no responsibility for any errors which may have crept into this document, reserves the right to change devices or specifications detailed herein at any time without notice, and does not make any commitment to update the information contained herein. No license to patents or other intellectual property rights of USound are granted in connection with the sale of USound products, neither expressly nor implicitly.

In respect of the intended use of USound products by the customer, the customer is solely responsible for observing existing patents and other intellectual property rights of third parties and for obtaining, as the case may be, the necessary licenses. For more information about USound patents visit https://www.usound.com/patents/.

Important note: The use of USound products as components in medical devices and/or medical applications, including but not limited to, safety and life supporting systems, where malfunctions of such USound products might result in damage to and/or injury or death of persons is expressly prohibited, as USound products are neither destined nor qualified for use as components in such medical devices and/or medical applications. The prohibited use of USound products in such medical devices and/or medical applications is exclusively at the risk of the customer.