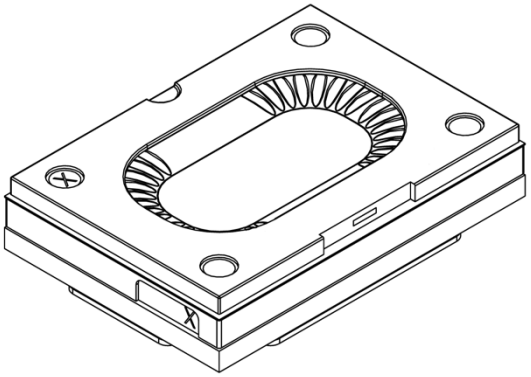
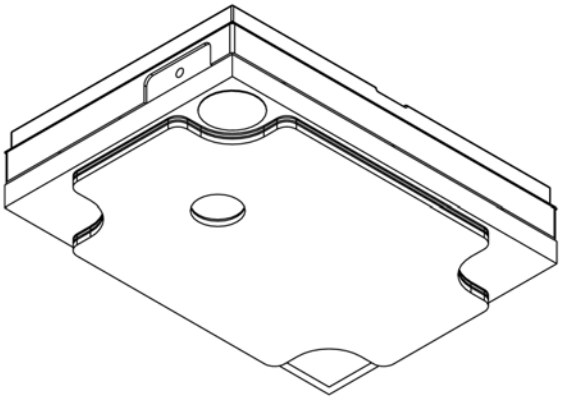
ADAP

MEMS SPEAKERS
UT-P 2017 | DATASHEET



Adap MEMS speaker is ideal for free-field audio solutions such as wearables. Thanks to its small size and lightweight, Adap offers maximum flexibility for outstanding design approaches. As a speaker with a wide bandwidth it enables high-res audio applications. Adap produces tangible, clear and rich sound, immersing the listener into their personal audio environment.

FEATURES



- Enables modern, lightweight and ergonomic designs for sophisticated wearables
- Seamless integration into acoustic devices for everyday use
- Longer battery life due to the speaker low power consumption
- Competitive sound pressure level
- No magnetic field
- Low heat generation

APPLICATIONS

- Free-field audio systems
- Wearables

TABLE OF CONTENT

REVISION HISTORY

COMPONENTS

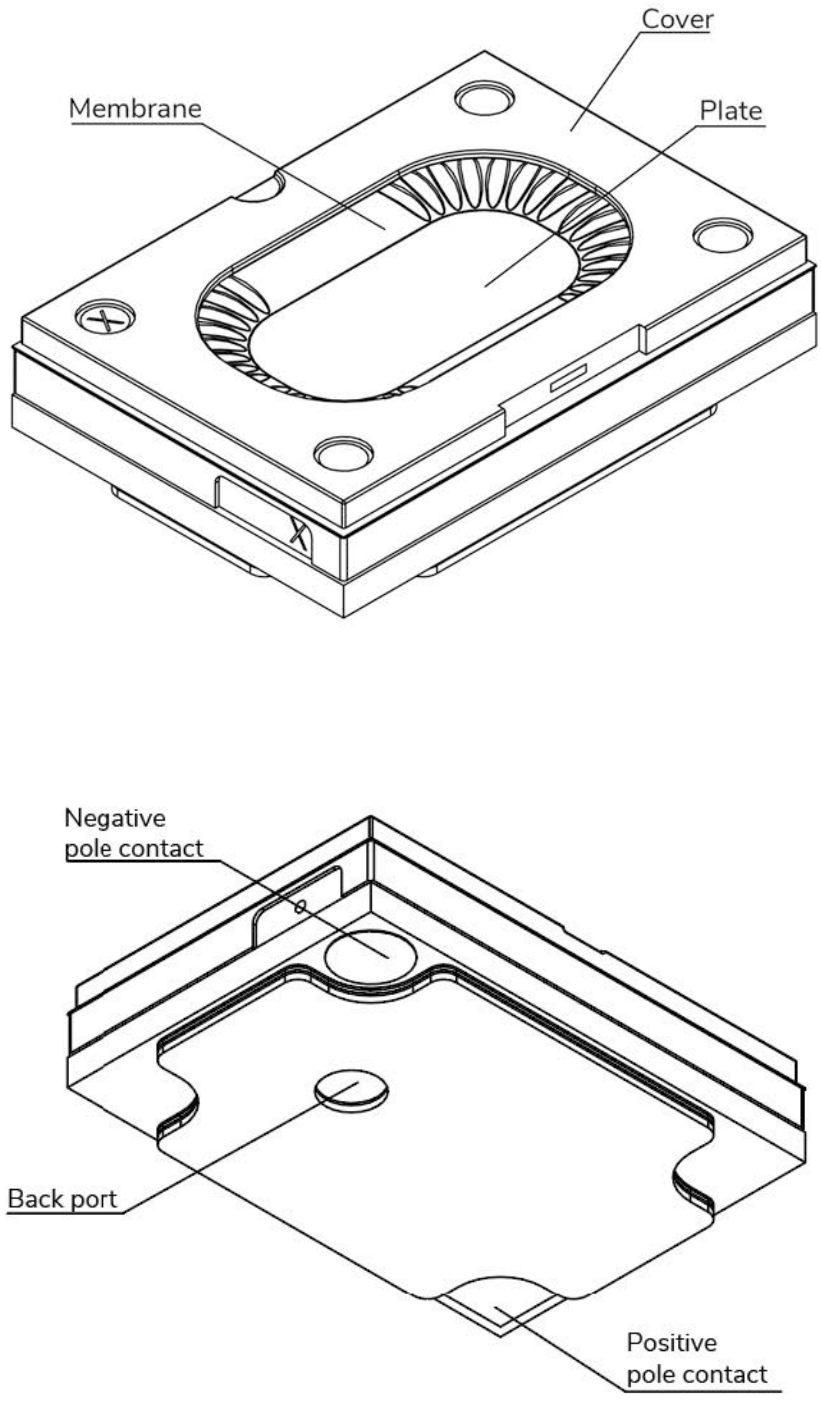


Figure 1: Adap MEMS speaker components.

SPECIFICATIONS

MECHANICS

Size	[mm]	6.7 x 4.7 x 1.56
Total speaker weight	[mg]	47
Total speaker cubic volume	[mm³]	49

ACOUSTICS

General			
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	

Baffle (IEC 60268-5)			
SPL @ 1 kHz / 15 V_P	[dB]	52	±3.0
SPL @ 4 kHz / 15 V_P	[dB]	71	±3.0
SPL @ 10 kHz / 15 V_P	[dB]	73	±3.0
SPL @ 1 kHz / 5 V_P	[dB]	42	±3.0
SPL @ 4 kHz / 5 V_P	[dB]	60	±3.0
SPL @ 10 kHz / 5 V_P	[dB]	63	±3.0
THD @ 1 kHz / 5 V_P	[%]	19	+20
THD @ 4 kHz / 5 V_P	[%]	4	+3
THD @ 10 kHz / 5 V_P	[%]	4	+3

ELECTRONICS

Capacity @ 1 kHz / 15 V_P	[nF]	40	±20%

OPERATING CONDITIONS

Maximum AC voltage (peak) – up to 20 kHz	[V_P]	15
Maximum AC voltage (peak) – up to 40 kHz	[V_P]	5
Maximum DC voltage	[V]	15
Maximum AC current (peak)	[mA_P]	200

POWER CONSUMPTION

Power consumption is measured with one Adap MEMS speaker, including the typical driving circuitry with the DC boost converter TPS61046 and the amplifier TI LM4858. The main blocks are presented on Figure 2 and Figure 3.

Condition: Supply voltage 3.6 V; speaker placed in baffle; all noise signals with high pass filter 2nd order @ 2 kHz.

Power consumption with white noise @ 60 dB	[mW]	27
Power consumption with pink noise @ 60 dB	[mW]	32
Power consumption with IEC noise (60268-1) @ 60 dB	[mW]	33
Power consumption with sinus 4 kHz @ 60 dB	[mW]	37
Power consumption with sinus 4 kHz @ 70 dB	[mW]	57

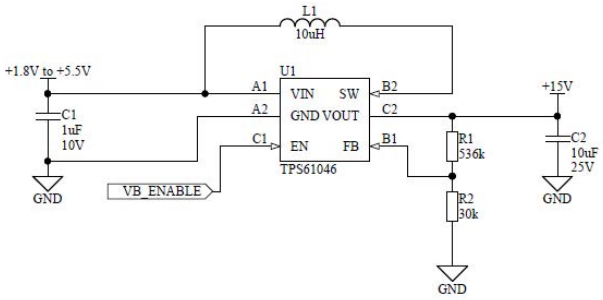


Figure 2: TPS61046 boost converter including needed passive components.

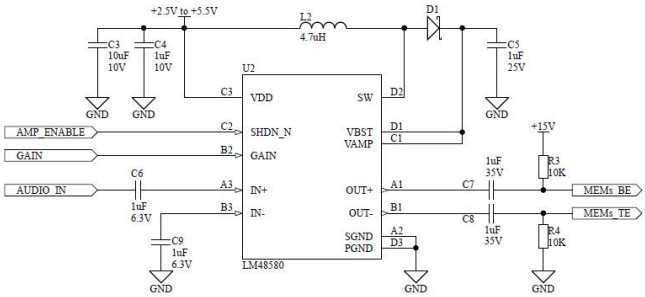


Figure 3: LM48580 amplifier including needed passive.

The boost converter is configured to provide a constant 15 V_{DC} offset for the amplifier. 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 be also modified according to the datasheet to a differential input.

The circuit has three pins for configuration. These can be switched via a microcontroller or logic, or simply hard wired.

- **Enabling the boost converter:** The boost converter can be enabled/disabled using the VB_ENABLE signal. If no microcontroller or logic is available, the pin can be pulled high so that the boost converter is always enabled as soon as the supply voltage is present.
- **Enabling the amplifier:** The amplifier can be enabled/disabled using the AMP_ENABLE signal. If no microcontroller or logic is available, the pin can be pulled high so that the boost converter is always enabled as soon as the supply voltage is present.
- **Amplifier gain:** The LM48580 has three different gain settings which can be configured using the GAIN signal. The gain pin can be either ground, floating or VDD depending on the needed gain.

Gain Pin Voltage	Resulting Gain Setting
GND	24 dB
Float	18 dB
V_{DD}	30 dB

TEST CONDITIONS

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

BAFFLE MEASUREMENT ADAPTER

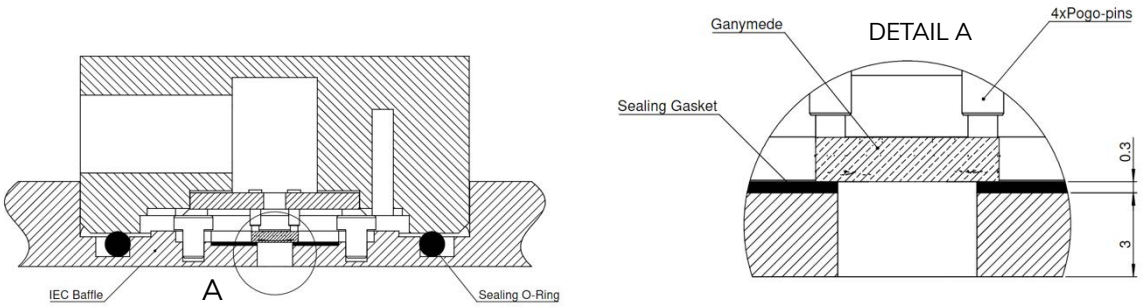


Figure 4: The outlet through the baffle for the speaker has the same shape as the inside of the speaker cover.

ACOUSTIC PERFORMANCE IN BAFFLE (IEC 60268-5)

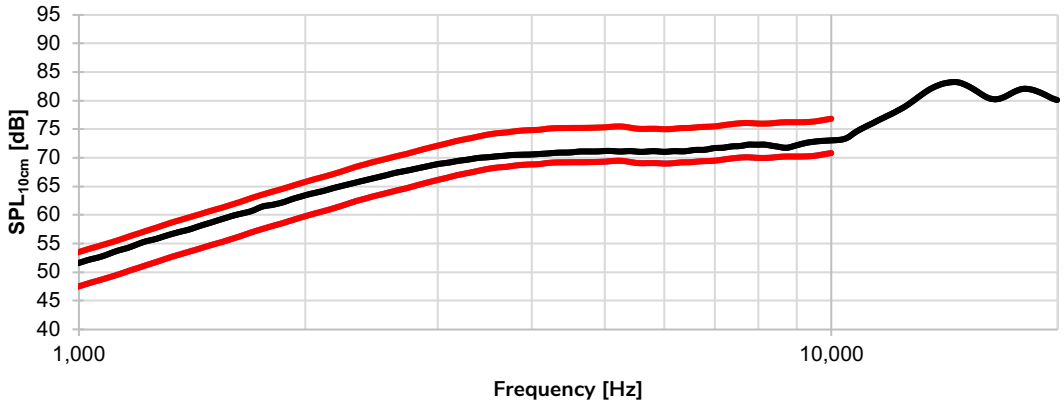


Figure 5: SPL @15 V_P drive

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

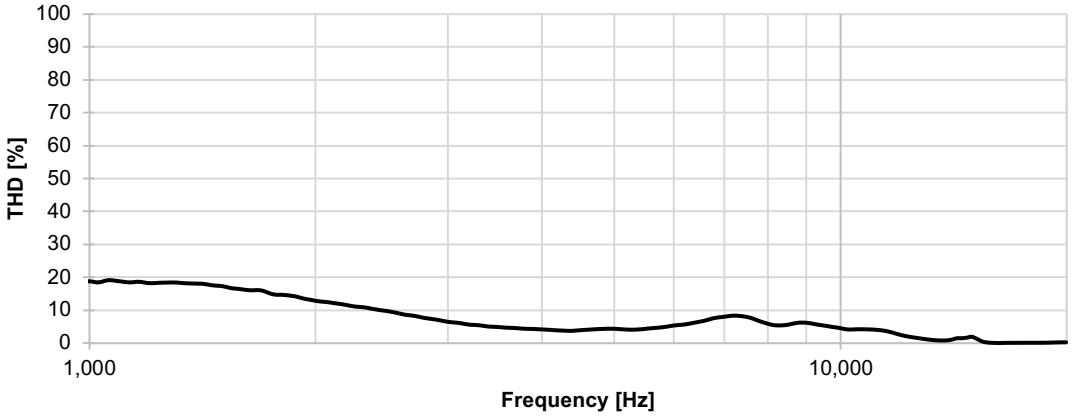


Figure 6: The THD 60 dB SPL @ 4 kHz, corresponds to 5 V_P

ACOUSTIC PERFORMANCE USING THE CARME TEST BOX IN FREE FIELD

Figure 6: Positive input (BE) blue and negative input (TE) green. The colour coding matches the outputs of Amalthea.

To analyse the performance of the Adap MEMS speakers, the test box Carme is available. 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 to USound's linear amplifier, Amalthea.

In order to set up Carme, unscrew and separate the PCB from the shell. Remove the housing gasket and place the Adap MEMS speaker with the contact side up. Place the PCB matching the orientation marks to the speaker. Tighten the screws for proper sealing. Using the Carme test box, Adap MEMS speakers can be measured in free field.

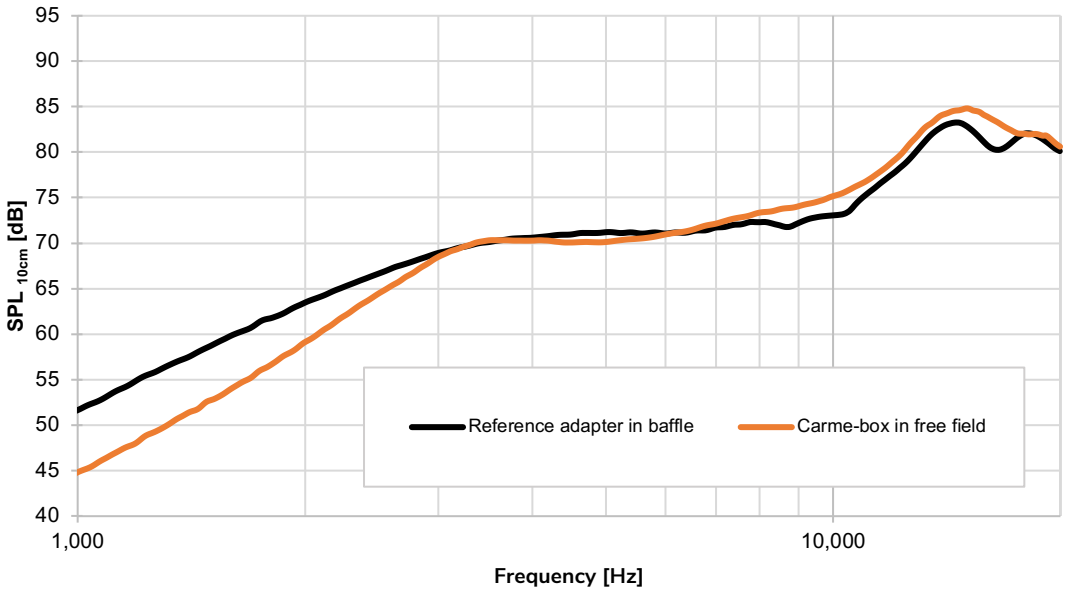
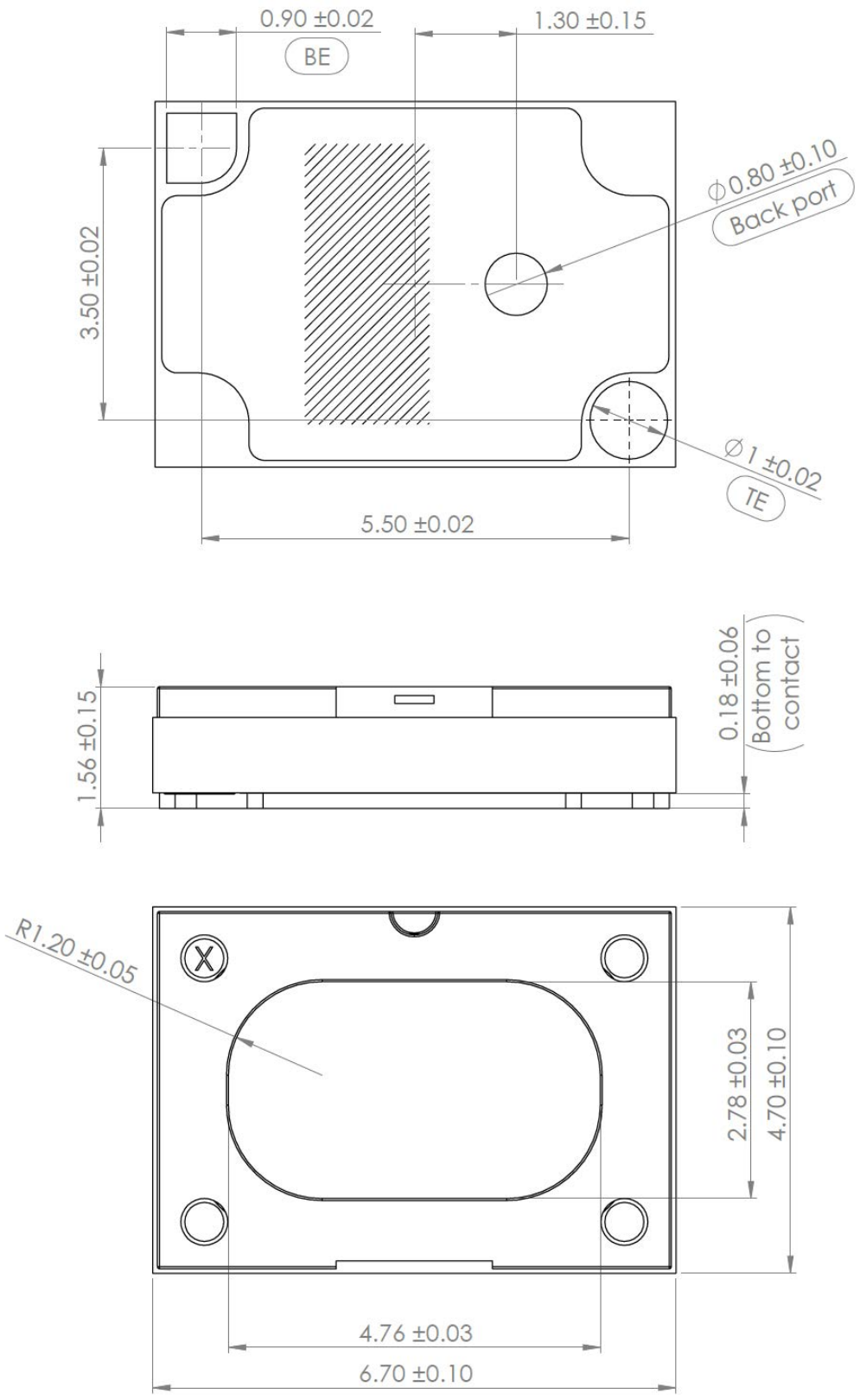


Figure 7: ADAP SPL measurement in the Carme test box (10 cm) in free field.

MECHANICAL DIMENSIONS

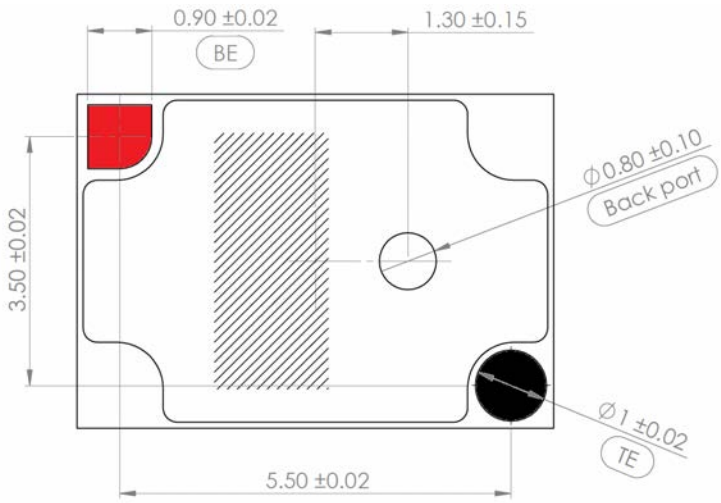


CONNECTIVITY

The speaker is driven by applying voltage between the connections for the top electrode (TE) and the bottom electrode (BE). The potential of BE has to be always equal or higher than the TE. To ensure that, a DC voltage together with the AC signal have to be applied on BE.

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

Connections from amplifier	Connections on the speaker
Positive voltage	BE (bottom electrode)
Negative voltage	TE (top electrode)

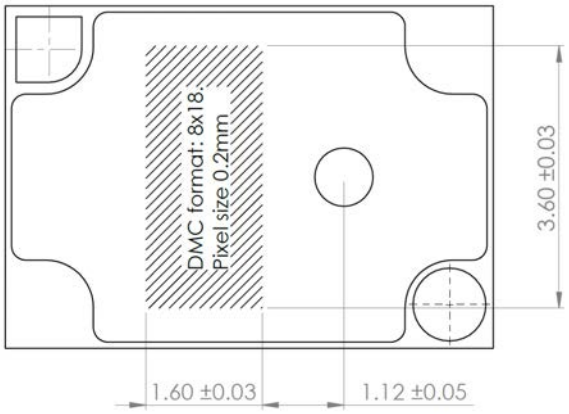


Further information on how to electrically connect MEMS speakers can be found on https://athena.usound.com/how-is-ganymede-connected-electrically/

TRACKING

Each speaker is equipped with an 8x18 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



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

HANDLING AND ASSEMBLY RECOMMENDATIONS

- The plate and membrane of Adap MEMS speakers are sensitive to deformation and must not be touched. Picking the speaker from the side with tweezers is recommended.

- Using a gasket on the front side of Adap MEMS speaker for sealing and cushioning impacts is advised. Additional information on mounting can be found on https://athena.usound.com/how-is-ganymede-connected-mechanically/.

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