MEMS SPEAKER

CONAMARA UA-C0603-3F
DATASHEET

The 6 mm Conamara UA-C0603-3F speaker is designed for a wide variety of products, such as over-the-counter (OTC) hearing aids and true wireless stereo (TWS) earbuds. Its state-of-the-art MEMS technology allows reaching maximum efficiency, covering the high frequency range at the smallest speaker thickness available on the market. Due to its round form factor, low weight, and thickness, Conamara UA-C0603-3F can be easily integrated into miniaturized devices.

FEATURES

- Extended audio bandwidth (20 Hz – 40 kHz)
- Designed for Hi-Res audio
- Ultra-slim form factor: ⌀ 6.0 x 1.49 mm
- Low temperature reflow solderable (200°C)
- Possibility for sealing speaker to PCB by reflow soldering
- IPX8 waterproof
- No magnetic field
- Negligible heat generation

APPLICATIONS

Conamara UA-C0603-3F is the ideal speaker for a wide range of applications, such as in-ear monitors (IEMs), over-the-counter (OTC) hearing aids, true wireless systems (TWS), wearables and miniaturized devices.

CONTENT

REVISION HISTORY

June 2024: Release

September 2024: Baffle measurements added

SPECIFICATIONS

Nominal driving conditions, if not otherwise noted: 1.1 V_{RMS} (1.6 V_P) + 10 V_{DC}

General Acoustics			
f_{res}	[kHz]	2.3	±10%
Q-factor	[-]	1.5	
Effective membrane surface – S_D	[mm²]	13.6	
Equivalent volume – V_{AS}	[mm³]	60	
Internal back volume of the speaker	[mm³]	9.4	

Acoustics in coupler (IEC 60318-4)			
SPL @ 250 Hz / 1.1 V_{RMS} (1.6 V_P) + 10 V_{DC}	[dB]	92	±3
SPL @ 1 kHz / 1.1 V_{RMS} (1.6 V_P) + 10 V_{DC}	[dB]	94	±3
SPL @ 2.5 kHz / 1.1 V_{RMS} (1.6 V_P) + 10 V_{DC}	[dB]	102	±3
SPL @ 5 kHz / 1.1 V_{RMS} (1.6 V_P) + 10 V_{DC}	[dB]	93	±3
SPL @ 250 Hz / 7.1 V_{RMS} (10 V_P) + 10 V_{DC}	[dB]	108	±3
SPL @ 1 kHz / 7.1 V_{RMS} (10 V_P) + 10 V_{DC}	[dB]	111	±3
SPL @ 2.5 kHz / 7.1 V_{RMS} (10 V_P) + 10 V_{DC}	[dB]	117	±3
SPL @ 5 kHz / 7.1 V_{RMS} (10 V_P) + 10 V_{DC}	[dB]	109	±3
SPL @ 250 Hz / 9.5 V_{RMS} (13.5 V_P) + 10 V_{DC}	[dB]	111	±3
SPL @ 1 kHz / 9.5 V_{RMS} (13.5 V_P) + 10 V_{DC}	[dB]	113	±3
SPL @ 2.5 kHz / 9.5 V_{RMS} (13.5 V_P) + 10 V_{DC}	[dB]	120	±3
SPL @ 5 kHz / 9.5 V_{RMS} (13.5 V_P) + 10 V_{DC}	[dB]	112	±3
THD @ 250 Hz / 1.1 V_{RMS} (1.6 V_P) + 10 V_{DC}	[%]	0.5	+0.3
THD @ 1 kHz / 1.1 V_{RMS} (1.6 V_P) + 10 V_{DC}	[%]	1	+0.6
THD @ 2.5 kHz / 1.1 V_{RMS} (1.6 V_P) + 10 V_{DC}	[%]	0.1	+0.1
THD @ 5 kHz / 1.1 V_{RMS} (1.6 V_P) + 10 V_{DC}	[%]	0.3	+0.2

Electronics			
Capacitance (with LCR-Meter at 1V/1kHz)	[nF]	11	±2.0
SPL @1 kHz / 1 mW	[dB]	105	±3

Operating conditions			
Maximum AC voltage	[V_P]	13.5	
DC voltage	[V]	10	
Upper operating frequency limit	[kHz]	80	

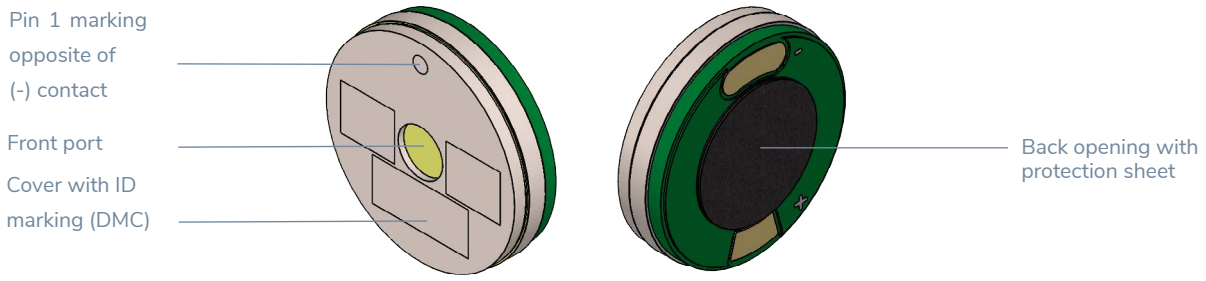

Figure 1: **Speaker perspective view.**

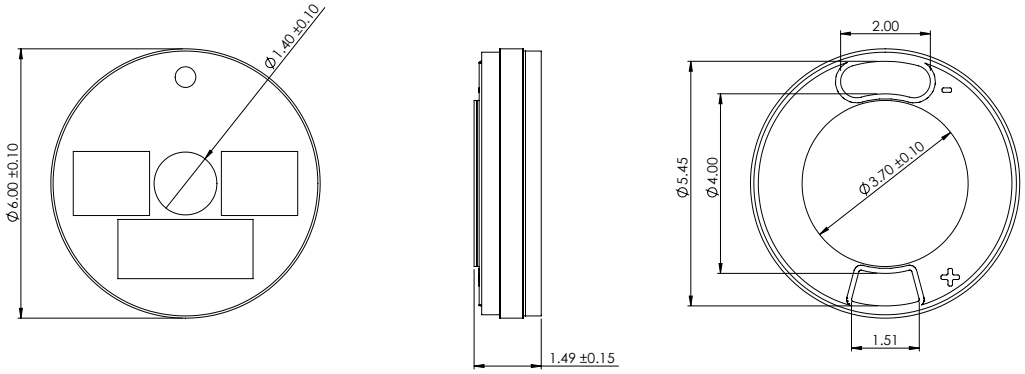

Figure 2: **Speaker top/side/bottom views. Dimensions in mm.**

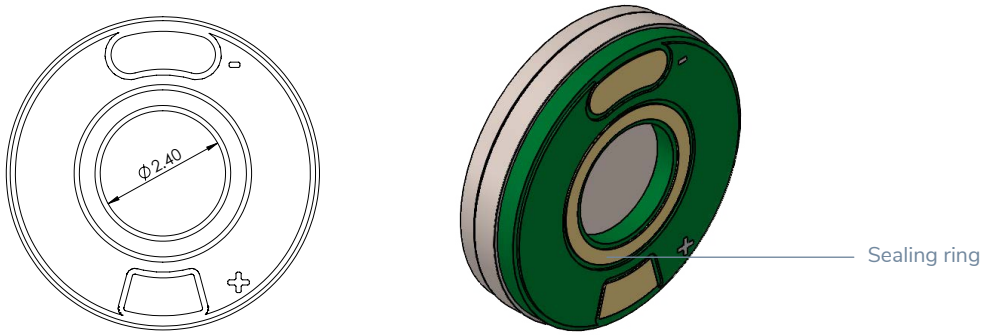

Figure 3: **Speaker without protection sheet bottom view. Dimensions in mm.**

Dimensions			
Diameter	[mm]	⌀ 6.0	±0.1
Thickness	[mm]	1.49	±0.15
Total speaker weight	[mg]	99	±10%

TEST CONDITIONS

General	
Measurement system	Audio Precision APx
Measurement signal	Exp. Sweep
Voltage level $V_{AC} + V_{DC}$	1.1 V_{RMS} (1.6 V_P) + 10 V_{DC} // 9.5 V_{RMS} (13.5 V_P) + 10 V_{DC}
Applied back volume	Open (infinite)

Coupler (IEC 60318-4)	
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

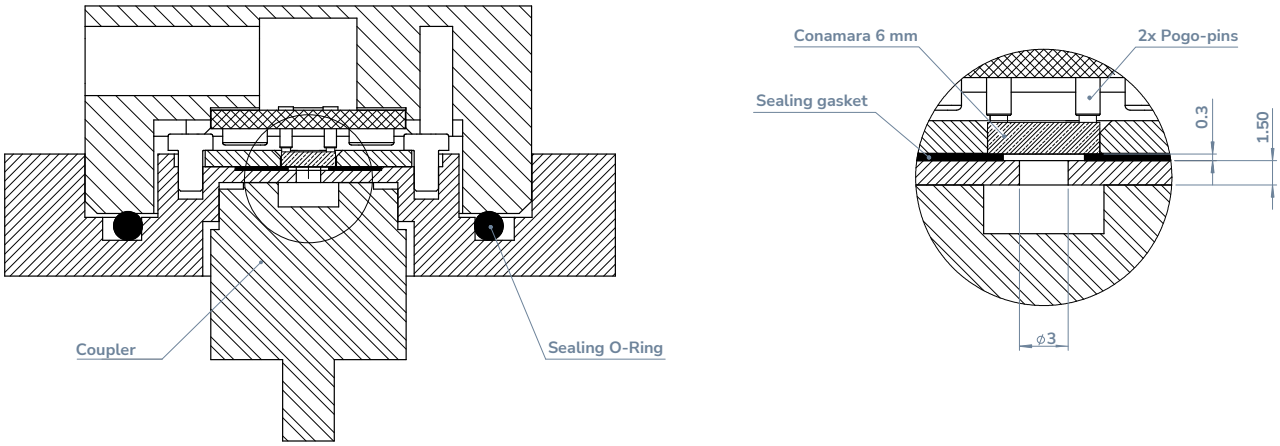

Figure 4: **Coupler adapter cross-section. The speaker adapter is directly screwed onto the coupler; the ear mould adapter is not used. The outlet for the speaker is round with a diameter of 3 mm and length of 1.5 mm.**

USound offers a speaker evaluation kit (Carme kit UJ-E1040C06) to replicate the coupler adapter design above. The datasheet measurements can be reproduced by using Carme kit.

ACOUSTIC PERFORMANCE

ACOUSTIC PERFORMANCE IN COUPLER

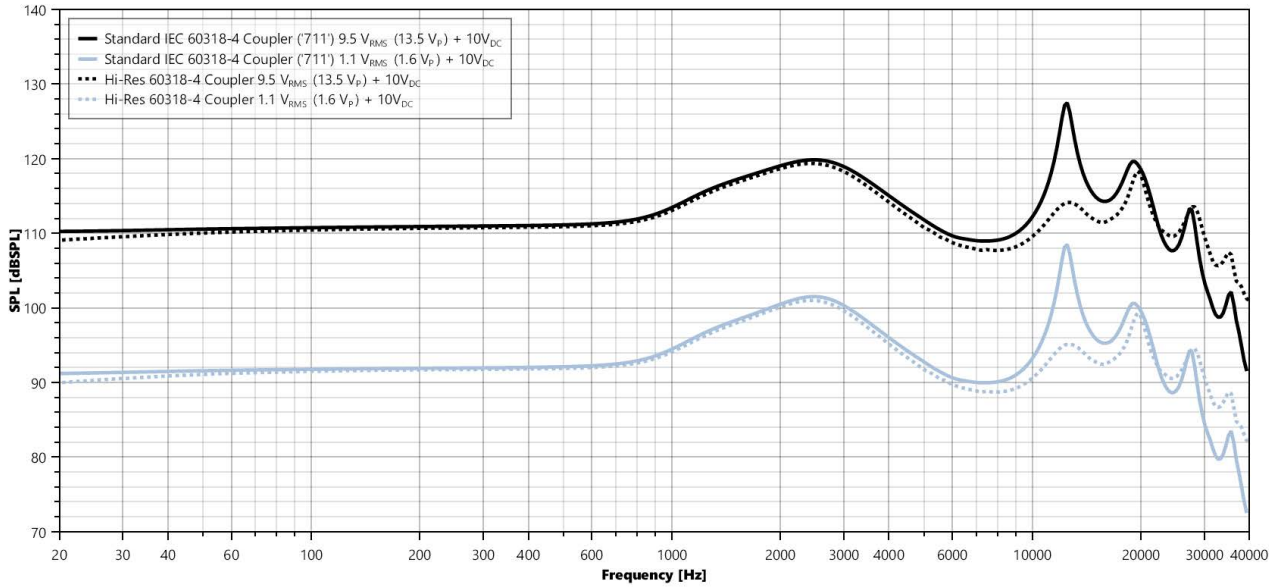

Figure 5: **SPL at 1.1 V_{RMS} (1.6 V_P) + 10 V_{DC} drive and at 9.5 VRMS (13.5 V_P) + 10 V_{DC} drive, measured with the standard 711-coupler (IEC 60318-4) and with the Hi-Res Coupler from GRAS. The latter replicates the frequency response above 10 kHz more accurately.**

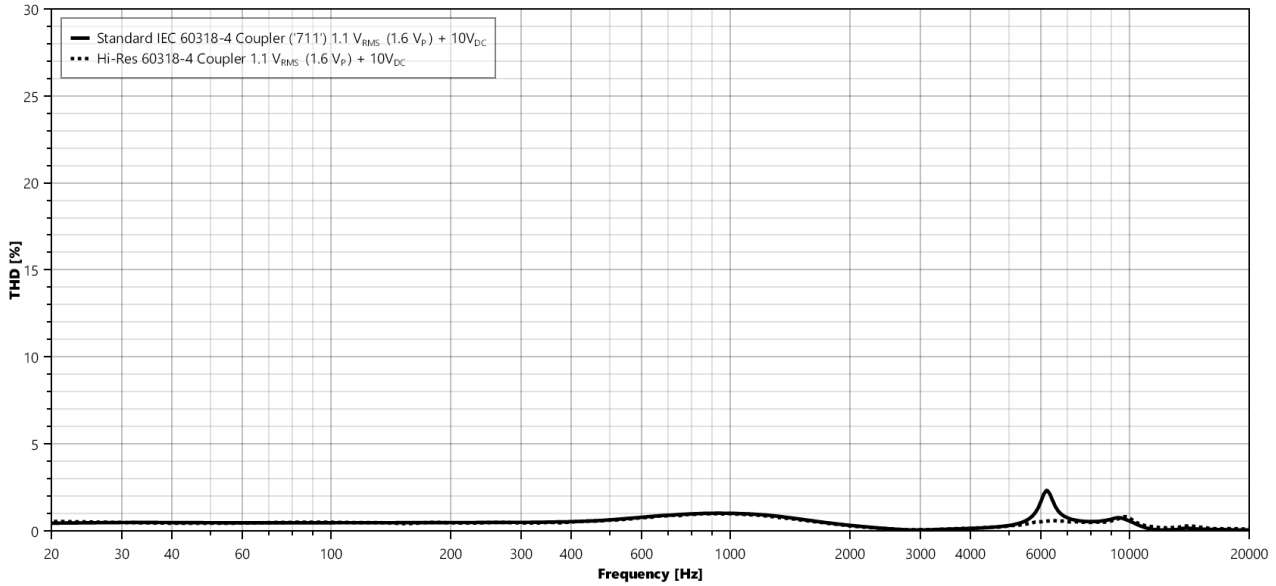

Figure 6: **THD at 1.1 V_{RMS} (1.6 V_P) + 10 V_{DC} drive, measured with the standard 711-Coupler (IEC 60318-4) and with the Hi-Res coupler from GRAS. The latter replicates the THD above 3 kHz more accurately (see GRAS Whitepaper).**

ACOUSTIC PERFORMANCE IN BAFFLE

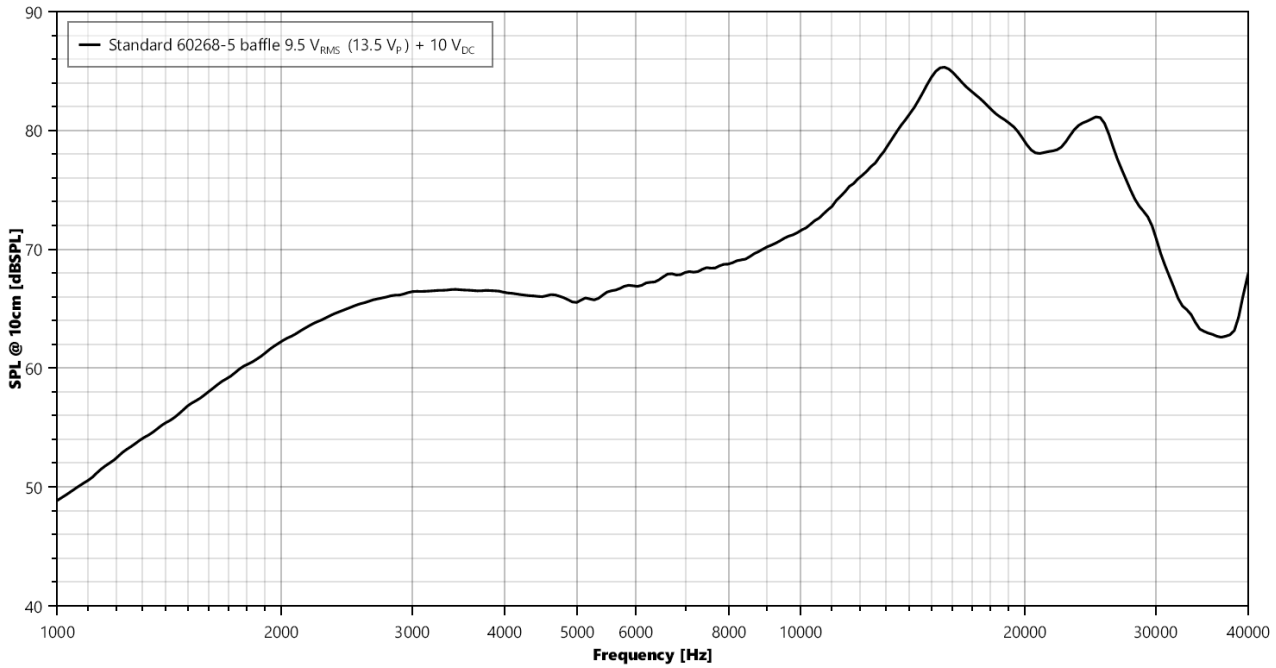

Figure 7: SPL at 9.5 V_{RMS} (13.5 V_P) + 10 V_{DC} drive, measured with the standard baffle (IEC 60268-5).

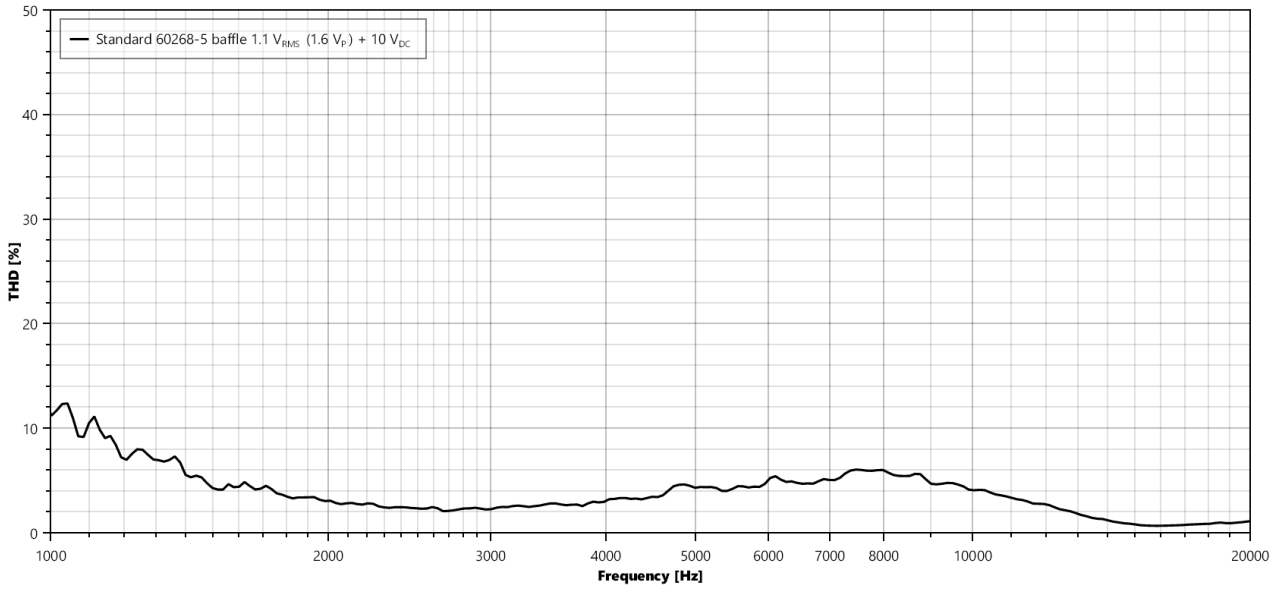

Figure 8: THD at 1.1 V_{RMS} (1.6 V_P) + 10 V_{DC} drive, measured with the standard baffle (IEC 60268-5).

CONNECTIVITY

The speaker is driven by applying a voltage between the (+) and the (-) contacts. The bigger pad corresponds to the negative input, the smaller pad to the positive (Figure 1). The AC and DC voltage needs to be applied between (+) and (-) with the (+) being at the higher potential. The recommended DC level is 10 V_{DC}.

A positive voltage on the positive pad will result in the membrane moving up (away from the pads).

The default driving conditions for MEMS speakers require a 10 V_{DC} bias. USound Conamara MEMS speakers, however, can be driven without DC bias, resulting in small changes in the acoustic and electrical performance of the product. This development reduces the supply current, while achieving higher absolute SPL levels with a slight increase in THD. Additionally, it results in a 20% reduction in the footprint of external components needed for Tarvos 1.0 linear ASIC amplifier. For more information, please get in contact with USound's sales team for support (sales@usound.com).

REFERENCE DRIVING CIRCUIT

Tarvos 1.0 UC-P3010 is the recommended linear audio amplifier for driving USound MEMS speakers. The reference driving circuit and layout design guidelines are included in the Tarvos 1.0 datasheet. Designed for capacitive loads, Tarvos 1.0 is the ideal solution for integrating USound MEMS speakers and other piezo transducers in a wide range of audio products.

HANDLING

GENERAL

MEMS devices consist of silicon structures and should be handled with care. Bending of the MEMS speakers must be avoided during the assembly process to avoid any damages.

TWEEZERS

It is recommended to gently grip the speakers from the sides with blunt curved tweezers (Figure 9). Touching the MEMS chip from the back side needs to be avoided. Using sharp tweezers must be avoided.

Figure 9: **Left: not recommended tweezer type. Right: recommended tweezer type.**

HAND SOLDERING

Improper soldering of MEMS speakers at high temperatures can potentially damage the component. Apply soldering iron only on the electrical pads on the bottom side of the speaker during the soldering process. It is recommended to follow the standard IPC J-STD-001 “Requirements for Soldered Electrical and Electronic Assemblies.” For inspection, it is suggested to follow IPC-A-610G.

RECOMMENDATIONS

Type	Recommended Parameters	Comments
Soldering Temperature	340°C (Possible range: 290 - 400°C)	Adjust with the soldering station
Soldering Time	1-2 s (maximum 5 s)	Keep contact duration short
Soldering Iron Tip	Weller LT 1S 0.2 mm – 0.4 mm	Fine solder tip for precise soldering
Soldering Station	JBC DDE 2 Tools	User preference
Soldering Wire	RS-756-884 0.71 mm Lead Free EDSYN SU35100 with Flux EDSYN SSAC2010 0.2 mm Lead Free	Use lead-free soldering wire
Flux	Chemtronics CW8100 Flux Dispensing Pen	Avoid excess application

REFLOW SOLDERING

REFLOW SOLDERING PROFILE

USound's Conamara MEMS speakers are suitable for low temperature reflow soldering with a peak temperature of 200°C with negligible change of performance. The reflow profile used for this classification is specified in the table below and on Figure 10.

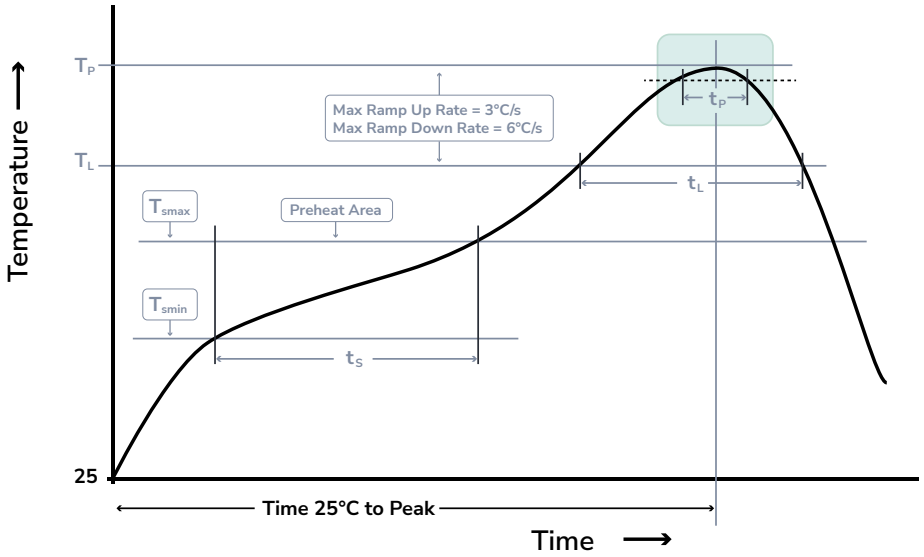

Figure 10: **Reflow soldering profile.**

Step		Temperature		Duration
Preheat	[°C]	T_{Smin} = 110 T_{Smax} = 145	[s]	t_{Smax} = 60
Liquidous	[°C]	T_{Lmax} = 157	[s]	t_{Lmax} = 120
Peak	[°C]	T_{Pmax} = 200	[s]	t_{Pmax} = 20
Time 25 °C to Peak	[°C]	-	[s]	t_{max} = 240

HOST PCB DESIGN GUIDELINES FOR REFLOW SOLDERING

To execute the reflow soldering process with negligible performance change we recommend adhering to the following guidelines when designing the host PCB. The dimensions of the speaker's connection pads and the sealing ring (under the protection sheet) for the host PCB are shown in Figure 11.

For matching the rotational orientation of the speaker to the host PCB, the orientation marker shown in the MARKING section can be utilized.

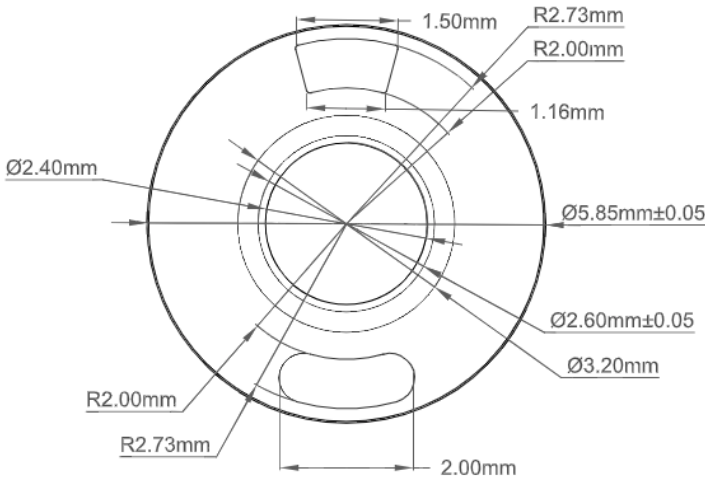

Figure 11: **Dimensions and positions of the connection pads, sealing ring and back opening for the speaker on the host PCB.**

WITH PROTECTION SHEET IN PLACE (RECOMMENDED)

It is recommended to leave the protection sheet untouched. In this case, the minimum distance between the connection pads of the speaker and host PCB connection pads is determined by the thickness of the protection sheet, which is 110 µm.

A through hole (acoustic port) with a diameter larger than 2 mm must be placed on the host PCB fully within the confinements of the 2.4 mm back opening of the speaker.

PROTECTION SHEET REMOVED

The copper sealing ring around the back opening of the speaker is covered by the protection sheet upon delivery. If a stronger mechanical bonding between the speaker and host PCB is required, the protection sheet can be carefully peeled off the speaker to utilize the sealing ring. In this case a through hole with a diameter larger than 1.2 mm must be placed on the host PCB fully within the confinements of the 2.4 mm back opening of the speaker.

Avoiding any contamination to enter the opening of the speaker is essential for maintaining the performance and usability of the speaker.

For volume orders delivery without the protection sheet can be requested. Please get in contact with USound sales team for support (sales@usound.com).

MARKING

The speaker cover contains a Data Matrix Code (DMC) with a unique ID for each speaker. Additionally, human readable numbers indicate production date and speaker type. Also present on the cover is an orientation marker which marks the center point of the negative connection pad on the bottom side of the speaker.

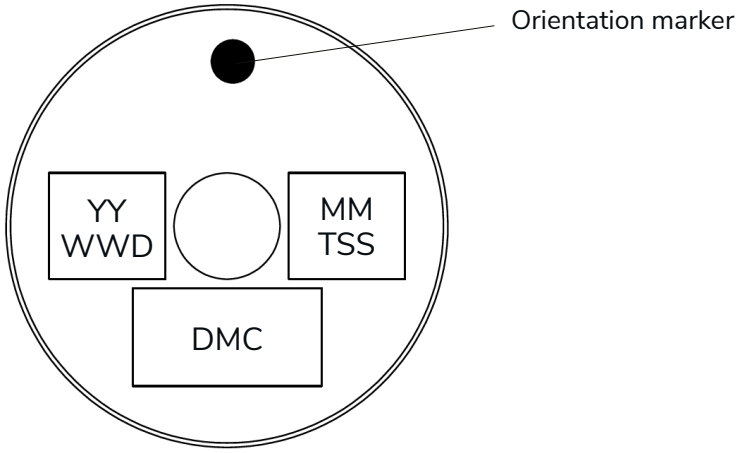

Figure 12: **Front view of the speaker describing the marking.**

Labelling		
YY	2 digits	Year (00-99)
WW	2 digits	Calendar week (01-52)
D	1 digit	Weekday (1-7)
MM	2 digits	Manufacturing information
T	1 letter	Speaker type (F: Full range, T: Tweeter)
SS	2 digits	Speaker size (06/05: 6/5 mm diameter)
DMC	10 digits (ECC200)	Serial number

SIMILAR PRODUCTS

Product Name	Description
Conamara UA-C0503-3T	MEMS tweeter for 2-way speaker solution in wearables and hearables, ultrasonic applications, tweeter, 5 mm diameter.
Conamara UA-C0603-3T	MEMS tweeter for 2-way speaker solution in wearables and hearables, ultrasonic applications, tweeter, 6 mm diameter.

COMPATIBLE PRODUCTS

Product Name	Description
Amalthea 1.0 UA-R3010	MEMS speaker array amplifier with a frequency range up to 80 kHz, can drive up to 40 MEMS speakers, including heatsink housing.
Carme kit UJ-E1040C06	A speaker evaluation kit for testing the acoustic performance of the USound MEMS speaker Conamara 6 mm.
Tarvos 1.0 UC-P3010	ASIC linear audio amplifier with analog input to drive the USound MEMS speakers.
Tarvos Evaluation Board 1.0 UC-E3010	Evaluation board for testing key features of the USound ASIC linear audio amplifier.

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