Thin Mic™ family microphones

Introduction

The Thin Mic microphones are a family of transducers that offer a low noise omnidirectional and a directional microphone combined in a single small package, the TP microphone. The assembly has only two ports which simplifies mounting and saves space on the faceplace and within the hearing aid shell. The TP microphone assembly offers substantial size and space savings compared to traditional omni/uni mic pairs with require two discrete microphones and three port openings.

The combination of a directional microphone and a low noise omnidirectional microphone will provide the signal-to-noise benefit of directionality in noisy situations as well as a low noise signal for use in quiet environments or situations where important sounds may come from all directions. These features and the basic operating principles of directional microphones have been previously described in detail in the references listed at the end of this application note.

TP microphone pair

The TP microphone pair consists of a TO series omnidirectional microphone and a TD series two-port directional microphone. The port of the omnidirectional microphone is combined with the rear port of the directional microphone into a single tube. The overall size of the TP microphone pair is only slightly larger than that of a single Knowles' EM microphone (3.58mm x 3.58mm x 2.62mm for TP vs. 3.58mm x 3.58mm x 2.28mm for EM). The positive and negative (ground) terminals of the two microphones are combined via jumper wires; only four (4) wires are required for full omni-plus-directional operation rather than six (6) wires needed for other more traditional omni-plus-direction designs.

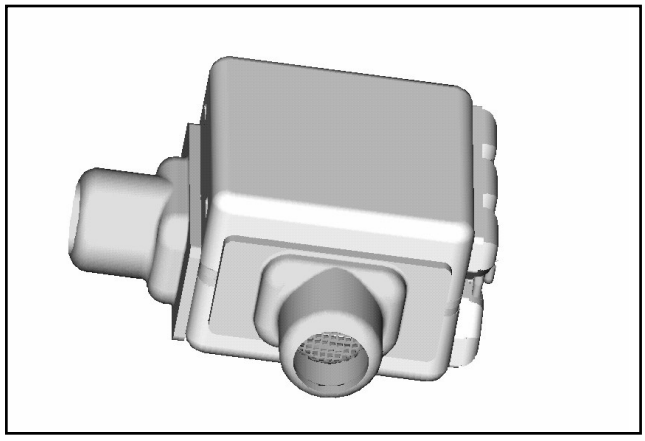

Figure 1: TP-4612 microphone. The tube to the left is the directional mic port; the tube facing frontwards is the tube combining the directional mic rear port and the omnidirectional mic port.

TD directional microphone

The TD directional microphone, which forms half of the TP microphone pair, is available as a stand-alone unidirectional microphone. The TD is 3.58mm x 3.58mm x 1.3mm. Different internal delays are available so that different polar patterns and port spacing requirements can be accommodated. Various ports configurations are also possible to facilitate mounting in all types of BTE and ITE hearing instruments.

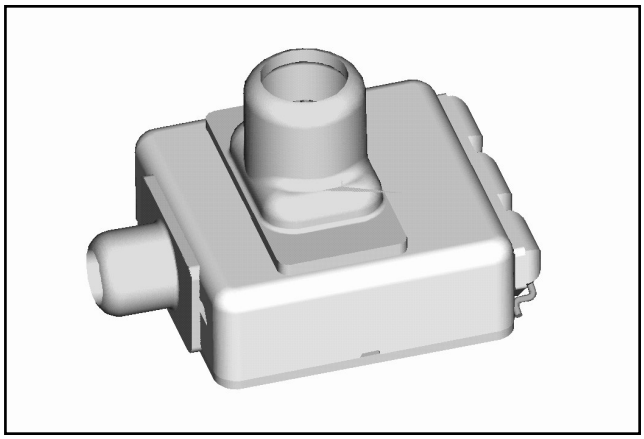

Figure 2: TD-4610 directional microphone. A 12S front port and 0Jp rear port configuration is shown.

TO omnidirectional microphone

The TO omnidirectional microphone, which forms the other half of the TP microphone pair, is the same physical size as the TD directional microphone, 3.58mm x 3.58mm x 1.3mm. With low self noise (26dB SPL ENP), the TO microphone is the perfect omnidirectional compliment for quiet environments and is also ideal for use in match-pair multi-microphone applications. The TO microphone is also available in a wide variety of port locations to suit varied mounting requirements.

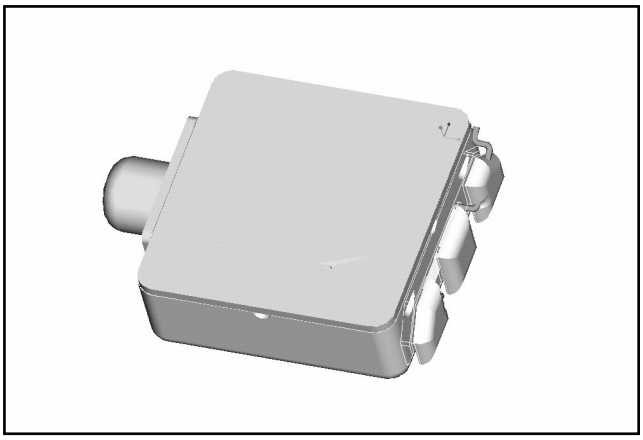

Figure 3: TO-4609 omnidirectional microphone. A 12S port configuration is shown.

Combination of ports and mutual loading effects

When selecting port locations for a TP microphone pair, designers should be aware that the combination of two microphone ports into one tube results in an acoustical interaction that could significantly affect the response of both microphones. For example, the combination of the front port of a TD directional microphone with the port of a TO omnidirectional microphone typically leads to a deep notch in the frequency response of the directional microphone at the resonance peak frequency of the omnidirectional mic. Figure 4, next page, illustrates this phenomenon.

TP microphone pairs combine the rear port of the TD directional microphone with the port of the TO omni microphone. In this configuration, a small amount of internal damping applied to the TO omni microphone makes the interaction effect at resonance negligible. The internal volume of the TO omnidirectional microphone also

interacts with the TD directional microphone to add to the internal delay, allowing a lower screen resistance to be used to achieve the desired polar pattern. This can improve the performance of microphones with long internal delays. Figure 5, below, shows the beneficial interaction of TO microphone internal volume upon TD directional microphone response at resonance.

The internal construction of the TD and TO microphones leads to roughly equivalent sized acoustic volumes on both sides of the diaphragm. Consequently, front and rear ports can be interchanged to communicate with either side of the diaphragm, providing adding port location and mounting flexibility for hearing instrument designers. However, it is important to remember that the phase of the electrical output signal (relative to the input pressure signal) would be reserved as result of switching front port / rear port locations.

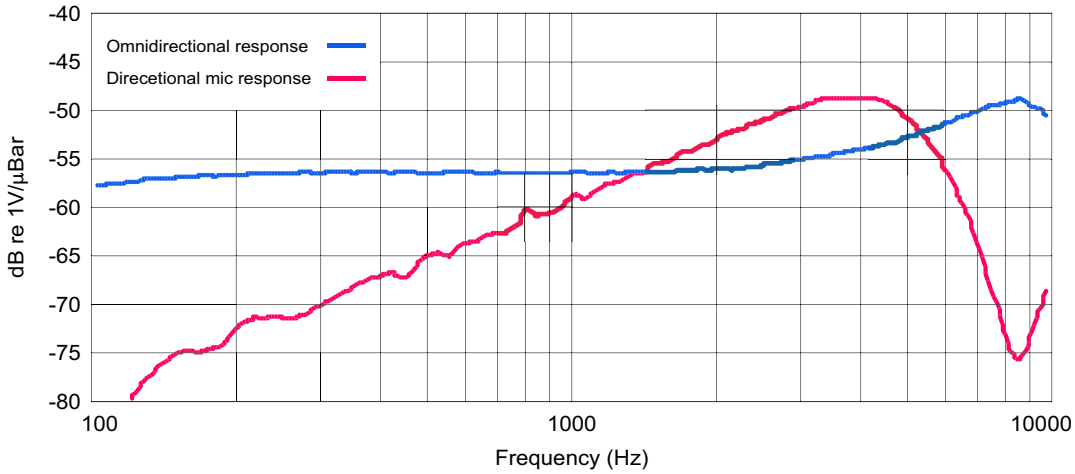

Figure 4: Front port of directional microphone combined with port of omnidirectional microphone. Note destructive loading interactions on directional mic response at omni mic peak frequency.

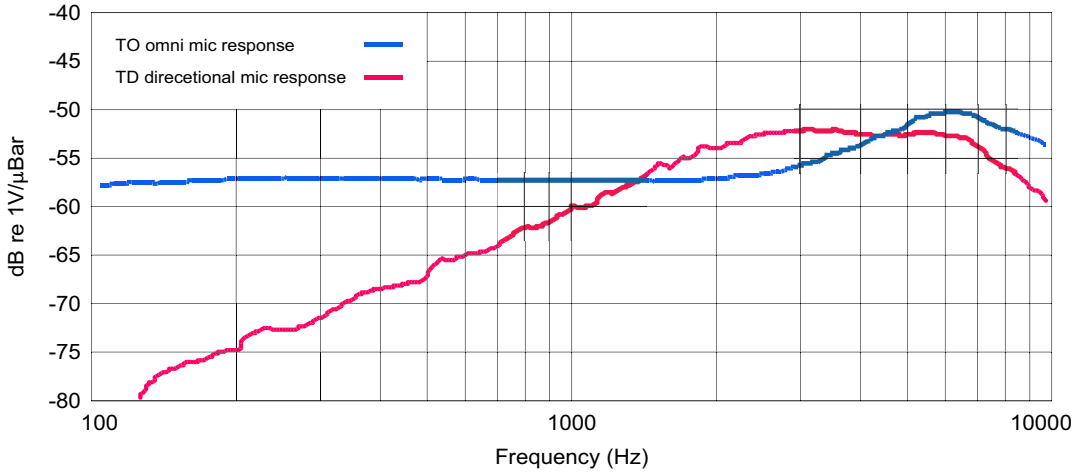

Figure 5: Rear port of TD directional microphone combined with port of TO omni-directional microphone with peak damping. Note smooth response of TD directional microphone at omni mic resonance peak even with TO microphone loading.

Mounting suggestions and extension tubing considerations

The ports of a directional microphone must be arranged on the hearing aid exterior so that they orient the directional pattern correctly and have the desired spacing. This typically requires some form of extension tubing. Although increasing port spacing will increase external delay and increase the sensitivity of a directional microphone, a long extension tube will load down the microphone port to which it is connected. High frequency directionality will be reduced and the resonance frequency of an omnidirectional microphone will also be reduced if it is connected to long extension tubing.

Port locations can be chosen which minimize the overall depth of the microphone package in the hearing aid. In an ITE instrument, it may also be desirable to minimize the microphone footprint (plan area) as well.

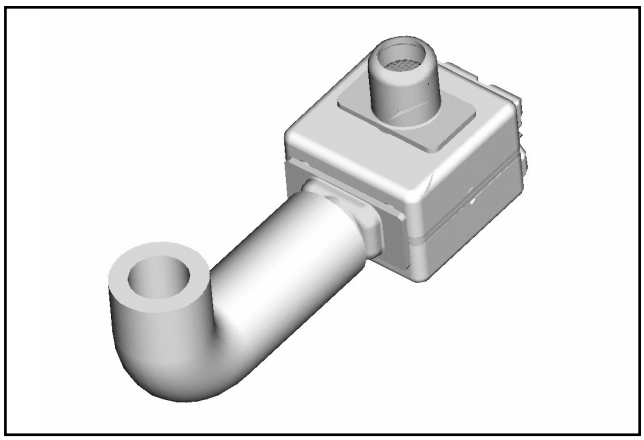

Figure 6: TP-4605 microphone pair with extension tubing for a typical BTE hearing aid.

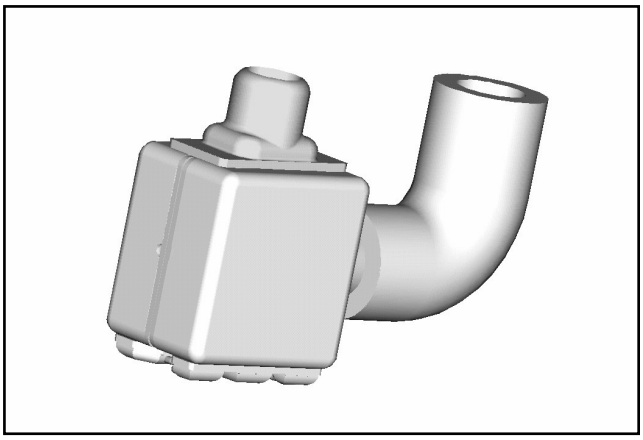

Figure 7: TP-4612 microphone pair with extension tubing for a typical ITE hearing aid.

If the rear port of a TD directional microphone is blocked, its sensitivity is the same as that of a corresponding TO omnidirectional microphone. With the rear port open, the sensitivity of the directional microphone is determined by the port spacing. If the port spacing is increased, the sensitivity increases at frequencies below the resonance peak. The resonance peak moves downward in frequency with increases in port spacing and/or longer lengths of extension tubing. See Figures 8 and 9, next page, for details.

The performance of directional microphones can be well controlled within known bounds. The ultimate performance of a directional hearing aid is less predictable due to the complex acoustic interactions and diffraction patterns of a hearing aid in-situ and the variability of individual fittings. Knowles Electronics is committed to working with our customers to provide effective solutions for all types of directional hearing instruments to ensure the maximum possible performance of the Thin Mic family of TO, TD, and TP microphones.

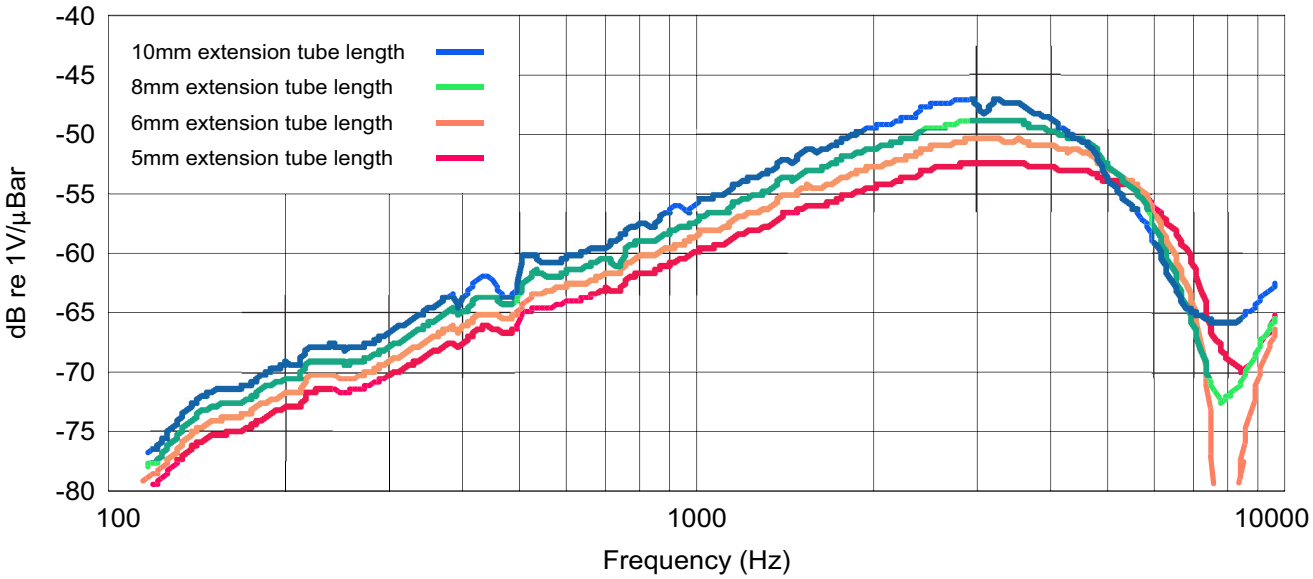

Figure 8: Impact of various lengths of extension tubing on TD directional microphone response.

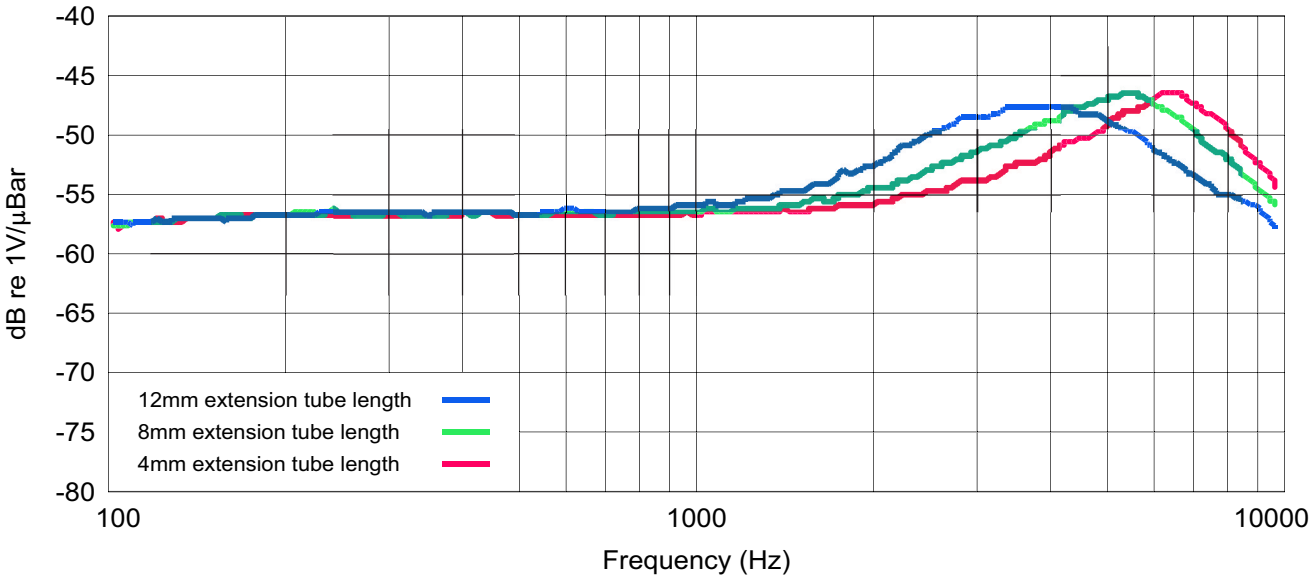

Figure 9: Impact of various lengths of extension tubing on TO omnidirectional microphone response.

Further information

Additional technical information on directional microphones, directivity, and Knowles Electronics' products can be can found in:

Knowles Technical Bulleting TB-21: "EB Directional Hearing Aid Microphone Application Notes"

Knowles Application Note: "Application of Multiple Microphones in Hearing Aids"

Knowles Application Note AN-4: "Directional Microphone Applications"

Knowles Engineering Report: "Directional Patterns Obtained from Two or Three Microphones" (available at ftp://pubftp.knowles.com)

Knowles Electronics, Inc.
1151 Maplewood Drive
Itasca, Illinois 60143
Phone: (630) 250-5100
Fax: (630) 250-0575
www.knowles.com

Knowles Europe
York Road, Burgess Hill
West Sussex, RH15 9TT, England
Phone: (44) 1444 235432
Fax: (44) 1444 248724

Knowles Electronics Taiwan, Ltd.
53 Pao Hsing Road
Hsin Tien City, Taipei, Taiwan
Republic of China
Phone: (886) 2 2911 4931
Fax: (886) 2 2918 6868

Knowles Electronics Japan KK
Kyodo Bloom Building
19-1 Miyasaka 2-Chome
Setagaya-Ku, Tokyo 156-0051, Japan
Phone: (81) 3 3439 1151
Fax: (81) 3 3439 8822

Micromax Pty. Ltd.
P.O. Box 1238
Wollongong N.S.W.
2500, Australia
Phone: (61) 2 4226 6777
Fax: (61) 2 4226 6602

NOTE: Specifications are subject to change without notice. The information on this Application Note reflects typical applications. Specific test specifications defining each model are available by requesting Outline Drawing Sheets 1.1 and Performance Specifications Sheets 2.1 of that model number. Knowles' responsibility is limited to compliance with the Outline Drawing and the Performance Specification application to the subject model at time of manufacture.