EFFECTS OF SOUND INLET VARIATIONS ON MICROPHONE RESPONSE

SOUND INLETS OFFER CONTROL OVER RESPONSE

In audio design, it's important to have every possible means of control over response. The transducer environment offers several ways to affect control.

Other Knowles bulletins discuss the effects of coupling tube and source impedance on the response of receivers. They show how varying the acoustic termination changes frequency response traits. This bulletin describes analogous results with microphone inlet changes. In this case a change in inlet path alters the microphone response.

The test set-ups cannot match real life, but the results will give an idea of what happens when the dimensions of the sound inlet path are changed. (All lengths and diameters are measured as in Figure 5. Measurements are length from end of tube to body of transducer and inner diameter for tube.)

Knowles offers simulation models for microphones (and receivers) for customer wishing to predict the effects of sound path on acoustic performance. Contact Knowles Applications Engineering for assistance.

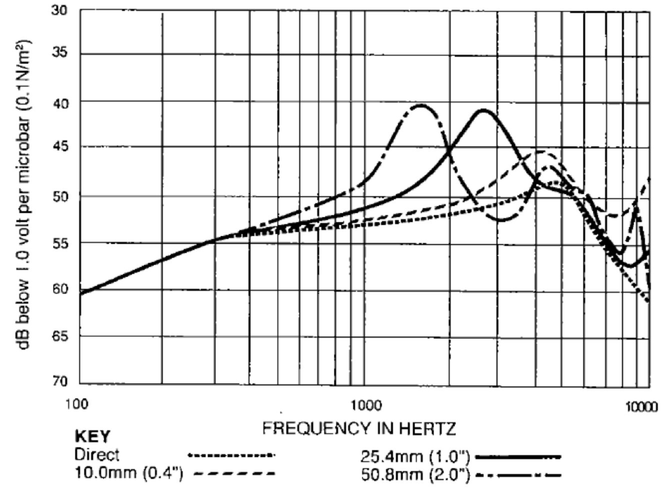
WITH LONGER TUBE, RESPONSE PEAKS AT LOWER FREQUENCY

When the inlet path is lengthened, the peaks in response shift downward in frequency, as in Figure 1. At any one frequency, there will be a change in output voltage for a constant sound pressure input; that is, a change in sensitivity.

Thus, though resonance frequency shift is the principal result of a change in microphone inlet tube length, amplitude changes as well. Increased inlet tubing length (that is, the length relative to the diameter) usually increases the amplitude at lower frequencies by shifting the response peaks to those frequencies.

Test curves of 3 other Knowles microphones with sound inlet tubes of 3 different lengths are shown on page 4.

FIGURE 1: Effect of tube length on Knowles EK-23024-C36 microphone. NAEL No. 13 tubing. ID 1.91 mm (0.075 inch)



LARGER DIAMETER INCREASES AMPLITUDE

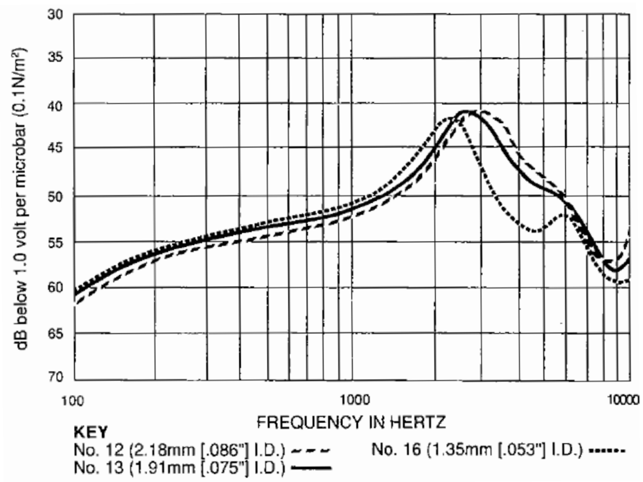
In general, the dimension of the outside diameter of the inlet tube influences the amplitude of the response in the higher frequencies.

As Figure 2 shows, response peaks do not shift much in frequency due to a change in diameter (when the length is several times the diameter).

Note in Figure 2 that the increase in the output voltage, due to the increase in inside diameter (from No. 16 to No. 13 tubing), is about 5 dB in the 3000-5000 Hz range. (Again, these effects are similar to those described in the receiver response bulletin.)

The curves show the usual minimal effect of a change in diameter on response in the lower frequencies.

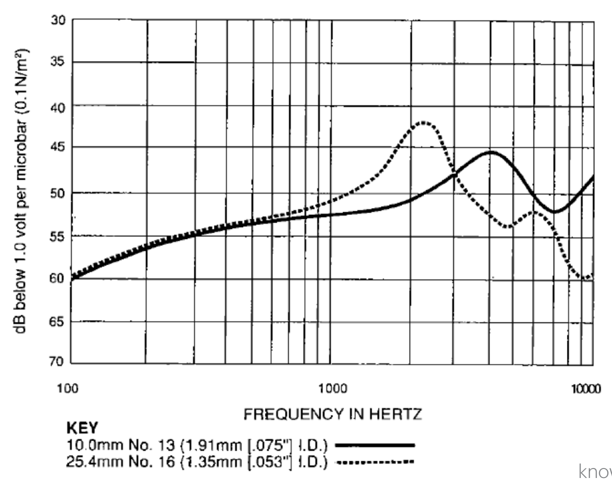
FIGURE 2: Effect of tube diameter on EK-23024-C36 microphone.
25.4 mm (1 inch) tube length



THE LONG, SMALL-DIAMETER VS. THE SHORT, LARGE-DIAMETER TUBE

It is interesting to note what happens when both the length and inside diameter are varied. As the ratio of tube length to cross-sectional area is increased, the response peaks shift downward in frequency and sensitivity drops in the higher frequencies. These results, shown in Figure 3, are consistent with those obtained when only one of the parameters is varied. They are also consistent with the results of similar tests on receiver coupling tubes.

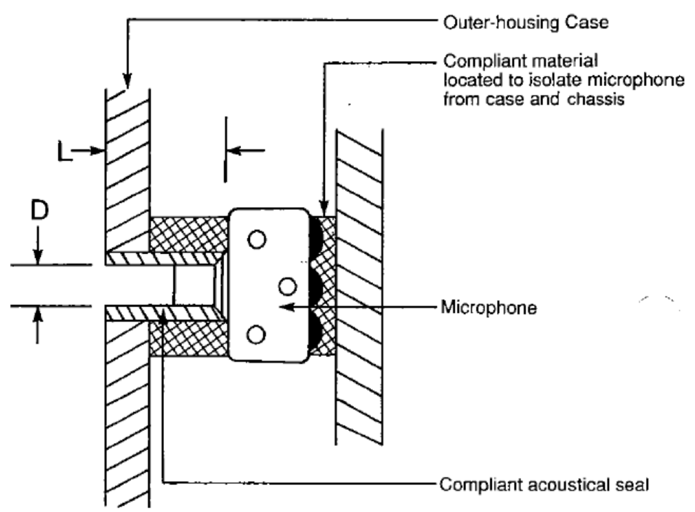
FIGURE 3: Effects of tube length and diameter combined.
EK-23024-C36 microphone.



Conversely, as the ratio of tube length to diameter decreases, the effect on response becomes smaller and smaller until, when the length is less than the diameter, there is no effect at all.

Thus, in mounting a microphone in a case as in Figure 4, there is no effect on response until the length of the inlet path, L, exceeds the diameter, D. As L is increased from that point, the second peak will tend to move downward in frequency and lower in sensitivity. The first peak will not begin to shift until L is several times D (similar to the results in Figure 2).

FIGURE 4: Microphone mounting cross-section.

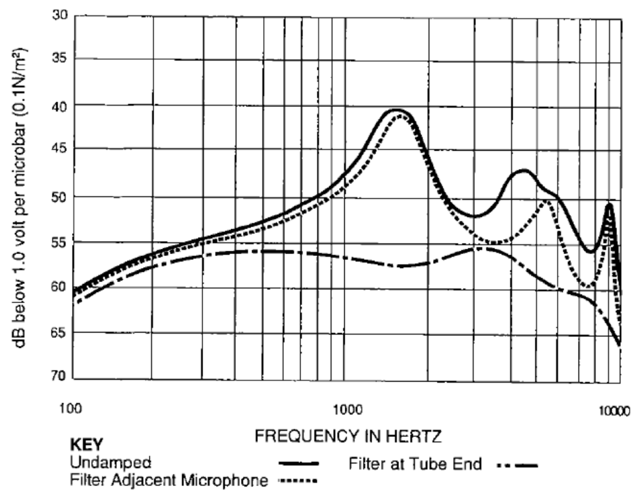


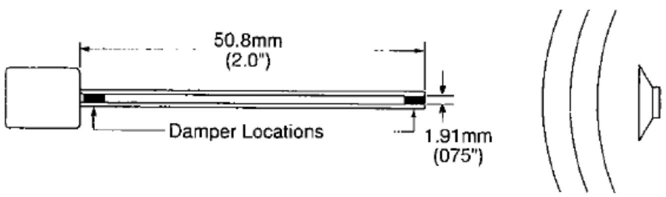
EFFECT OF ACOUSTIC RESISTANCE INCREASED WITH DISTANCE FROM MICROPHONE

The analogy between receiver outlet and microphone inlet tubes continues to hold for the use of filters or other acoustic resistances. That is, the result of inserting a restriction in the acoustic transmission system is similar to that obtained when tube diameter is reduced high frequency sensitivity is reduced.

In addition, as the tests in Figure 5 show, the further the filter is moved away from the microphone, the greater its damping effect. The filter used in the test is a Knowles BF-1921, but similar effects can be obtained by incorporating an orifice restriction or similar acoustic resistance in the sound inlet path.

FIGURE 5: Effect of damping in 50.8 mm (2 inches) of No. 13 tubing





CONCLUSION: FINAL RESPONSE A MATTER OF CHOICE

Through sound inlet path variations, filters, tubes, etc., transducer response characteristics can be altered. If aesthetics dictate the special location of a microphone or a receiver, the total system response can still be shaped. With a complete understanding of how acoustic impedance can be varied, one has a high degree of flexibility in design. In particular, it is helpful to remember the general rules:

1. A change in the ratio of length to cross sectional area of the tube or duct will principally affect the frequency of the first (and major) resonance peak and the frequency and amplitude of high frequency peaks.

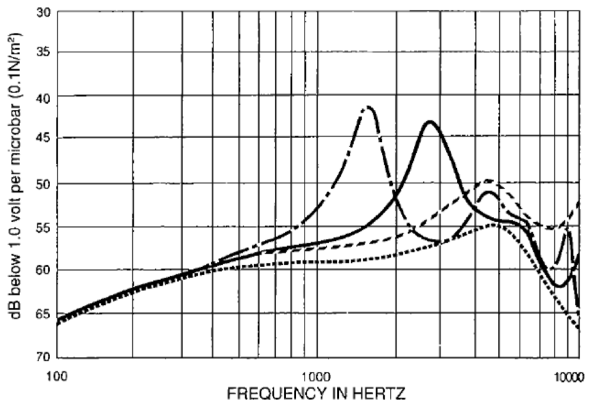
2. The length of the tube principally controls the number of additional peaks introduced into the frequency response characteristic and the frequencies at which they occur. Long tubes tend to shift these resonance peaks down to lower frequencies. However, some of the high-frequency peaks are not shifted in frequency by the addition of tubing.

3. In a minor way, the cross-sectional area of the tube controls the sharpness of the resonance peaks.

4. The addition of a tube will cause a loss in average sensitivity at frequencies higher than the first (and major) resonance peak.

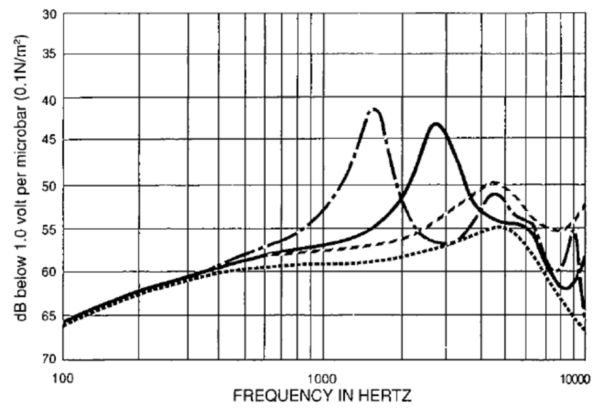
5. Acoustic damping is most effective in smoothing the peaks in the frequency response characteristic when inserted at the open (or sound access) end of the tubing or duct.

Effect of tube length on EG-23000-000 microphone. No. 13 tubing.



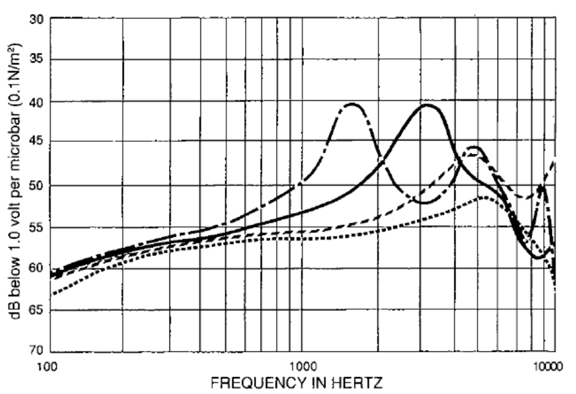
KEY
Direct
10.0mm (0.4")
25.4mm (1.0")
50.8mm (2.0")

Effect of tube length on EA-21842-C36 microphone. No. 13 tubing.



KEY
Direct
10.0mm (0.4")
25.4mm (1.0")
50.8mm (2.0")

Effect of tube length on EM-23046-C36 microphone. No. 13 tubing



KEY
Direct
10.0mm (0.4")
25.4mm (1.0")
50.8mm (2.0")

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Model/Reference Number:
TECHNICAL BULLETIN TB-3