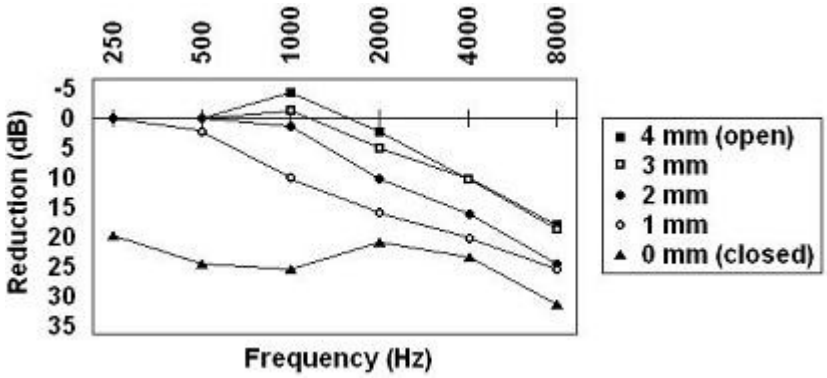
Vented/Tuned Earplugs: SAV or Acoustic Resistor

There are many non-industrial uses for a type of earplug that would yield minimal low-frequency attenuation. Certain woodwind musicians, dentists, and even teachers who are susceptible to vocal strain, can all benefit from such an earplug.

We know from earmold acoustics that the use of a vent in the earmold reduces the amount of low-frequency gain that the hearing aid user receives. A vent allows the long-wavelength, low-frequency sound to leak out and in doing so, tends to improve voice quality and essentially acts as an acoustic low tone cut control. In most cases, the vent diameter can be altered by the use of a select-a-vent (SAV) insert.

Using an SAV in the main sound bore of a custom earplug can also be useful to reduce the amount of low-frequency attenuation or sound blockage. The smaller the SAV size, the greater is the overall attenuation, until it becomes identical to a standard fully occluded earplug. This style of hearing protector is called a **Vented/Tuned Earplug**. Figure 1 shows a series of attenuation curves with SAV inserts in a custom earplug. The top curve (with closed squares) is an earplug with the SAV completely open (4 mm diameter vent), while the bottom curve (with triangles) is completely plugged (0 mm). The completely plugged result is similar to the one which would be obtained with a standard industrial custom earplug.

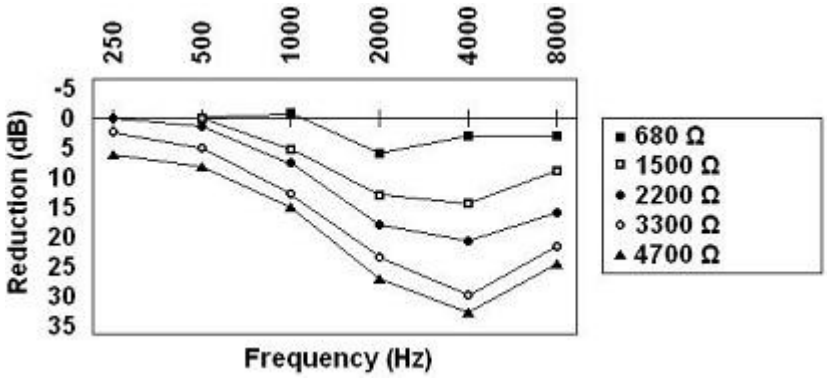


The vented/tuned earplug that is completely open (no SAV insert) is ideal for dentists, and some woodwind musicians. Dentists can still hear their patients, hygienist, and talk on the phone, while receiving protection from the annoying dental drill and other office clattering noises.

An interesting feature should be noted with the vented/tuned earplugs; this feature also being found with vented earmolds with hearing aids. There is a slight amplification of sound in the 1000 Hz region. The amplification is caused by a mass of air resonating in the vent. This vent associated resonance is technically called an “acoustic inertance”. Many vocalists and classroom teachers who report vocal strain can benefit from this. This small resonance causes the wearer to hear their own voice slightly louder, with the result that they will speak and sing slightly less loudly. A significant reduction in vocal strain has been reported in many singers who have to sing in smoky environments, or with teachers who have a tendency to yell louder than their students.

With the use of all variable sized vents (such as an SAV), the increase in attenuation as the vent size is reduced is not linear. That is, minimal differences are typically observed for the first three sizes of vent cover, but a significan increase in attenuation is observed once the vent size is reduced below 2 mm in diameter. For this reason, a vented/tuned earplug is usually specified in the open position (with no SAV cover being used). The client is then given an SAV tree and they can experiment trying various SAV covers in different situations.

The question arises whether this same type of tuned earplug for non-industrial noise can be accomplished with acoustic resistors, such as those found in many behind-the-ear hearing aids. Figure 2 shows the attenuation pattern where Knowles acoustic filters of varying resistances are placed in the main sound bore of custom earplugs. **(Acoustic Filtered Plug)**.



With acoustic resistors, a similar, but not identical attenuation pattern is observed, namely minimal low-frequency attenuation, but significant attenuation for the higher frequency sounds. Unlike the SAV based vented/tuned earplugs, there is a more gradual, and linear increase in the amount of overall attenuation from the 680Ω resistor up to the 4700Ω resistor.

Most of the uses of the vented/tuned style of earplug are to allow the low-frequency sound to be unaltered, while providing significant protection from unwanted high-frequency sound, essentially creating a mild high-frequency conductive hearing loss. The use of acoustic resistors in the earplugs tends to create too much loss of sound energy and as such, may alter the detection of the important speech cues. The SAV approach however, tends to provide the best clinical compromise between too much loss of sound energy and too little attenuation.

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