TECHNOLOGY WHITE PAPER

IntriCon
The Body-Worn Device Company

Audion™ 16plus

Audion 16+ Enhanced Acous-Tap™

History

Acous-Tap™ is an innovative feature that uses pressure waves in place of a physical momentary switch to activate a program change sequence in the hearing aid. The need for an alternate way to change programs became evident while designing the IntriCon APT open ITC hearing aid. Space limitations of the small ITC didn't allow the use of a conventional momentary switch.

Pressure waves can easily be generated by cupping your hand and gently tapping the ear (Figure 1).

Figure 1
Directions: Tap twice on the outer part of the ear to change the program. The number of beeps indicate the program selected.

These pressure waves are detected by the hearing aid microphone, converted to an electrical signal, digitized and ultimately monitored by the Acous-Tap™ algorithm.

Figure 2 shows the Electrical Signature generated by tapping the ear. In this case there were two taps.

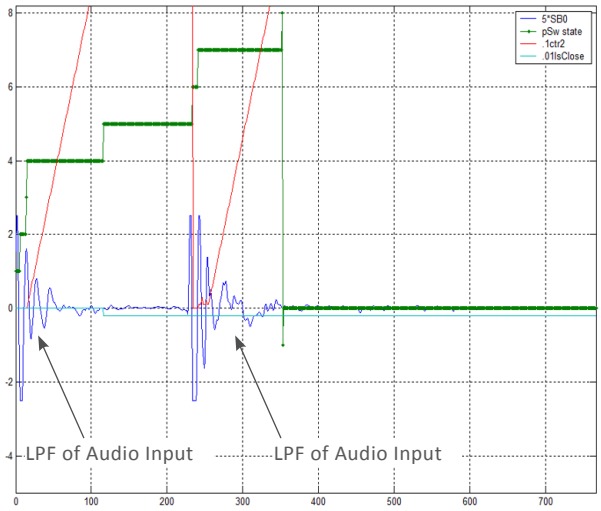

Figure 2

While a novel idea there are some acoustic signals that match the acoustic signature obtained by tapping on the ear and as such, the Acous-Tap™ was fooled into changing programs.

To minimize those Acous-Tap™ false triggers, an additional requirement was added to the master Acous-Tap™ algorithm in the Audion 16+. The additional requirement that we added to the Enhanced Double Tap feature specifies that there must be a change in the acoustic feedback path in addition to the acoustic signature of the taps. In an open ITC device like the APT™, the act of using the hand to generate the pressure wave also significantly changes the acoustic feedback path.

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Figure 3 shows the Enhanced Double Tap where the feedback change is monitored to discriminate true hand taps. In the cases of a false trigger, like the ones you might get when hammering a nail into a board, the acoustic signature closely matches, but because there was no activity next to the ear there was no sudden change in the acoustic feedback path. The enhanced double tap algorithm will identify this as a false trigger and not initiate a program change event.

Figure 4 shows the False Tap Low Feedback activity results in tap rejection, even though the input otherwise looks valid.

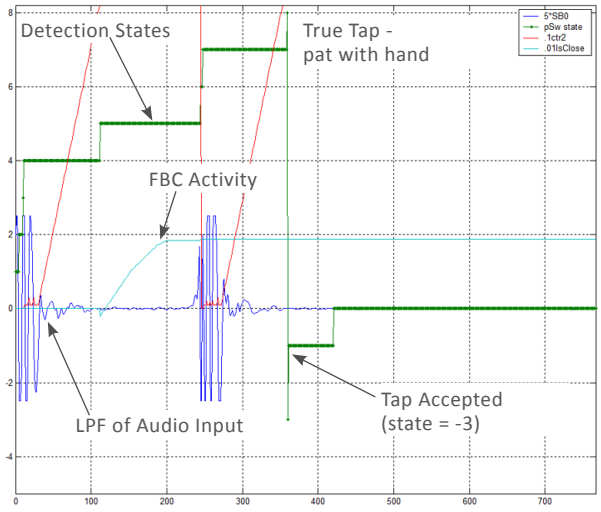

Figure 3

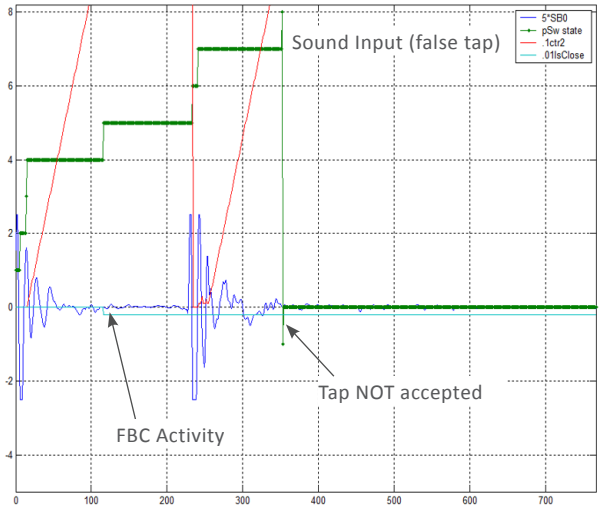

Figure 4

Use Case: APT Open ITC

Development and testing of the Acous-Tap™ was primarily done using the IntriCon APT open ITC device. The APT uses a standard electric microphone with a flat response and a sensitivity of -54dB rel 1v/0.1Pa and a DSP preamp setting of 21dB. With this hearing aid setup, informal subjective testing done on KEMAR (Knowles Electronic Mannequin for Acoustic Research) and R&D staff members showed that the new enhanced Double Tap reduced the false triggers. We also found that in some instances it was harder to get the device to trigger (i.e. change programs) with a valid double tap.

Improving the Chances of a Successful Tap

Referring to Fig 3, you can see that the state in which the Acous-Tap™ algorithm looks for a change in the feedback path falls between the two states that look for the acoustic tap signature. This suggests a certain sequence for the Enhanced Double Tap that goes like this; Tap – Hold – Tap.

When tapping the ear to generate the first pressure wave, leave the hand covering the ear for a fraction of a second. This is the hold portion of the sequence that causes the abrupt change in the feedback path. Then tap the ear again to generate the second pressure wave. The algorithm allows for some variance in the timing of the Tap – Hold – Tap sequence, but the complete sequence should be completed in under 3 seconds.

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OTHER CONSIDERATIONS

Generating a Good Tap (Pressure Wave)
Position of the hand relative to the ear during the tap sequence has a big impact on the pressure wave generated. If you don't fully cover the ear during the tap sequence, a portion of the pressure wave can leak out the uncovered portion of the ear resulting in a smaller pressure wave getting transferred to the microphone. In a similar sense, not having the fingers of the tap hand pressed together will allow leakage.

Feedback Path
Because the Enhanced Double Tap requires a measurable change in the feedback path, when building custom ITC or CIC devices, you must assure that the device has adequate venting. The closer a fitting is to an occluded state, the less likely the feedback path will be affected and thus decreasing the likelihood of a successful program change.

Microphone Position
Position of the microphone affects the sensitivity of the Acous-Tap™ system. For CIC's (i.e. deeper mic position in the ear canal) you may have to change to the high sensitivity mode to improve your Acous-Tap™ success rate.

Preamp Gain
Reducing the preamp gain of the DSP also reduces the sensitivity of the Acous-Tap™ system. When decreasing the preamp gain below 21dB, changing to the Acous-Tap™ high sensitivity mode may improve your tap success rate.

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