Acoustic Doppler Velocimetry

Part I: Principles of Operation

An acoustic Doppler velocimeter (ADV) operates by the principle of Doppler shift. This concept is illustrated by a simple example: if you are standing at a railroad crossing and a train blares its horn as it passes by, you hear the horn at a higher pitch as the train approaches, and then a lower pitch as it leaves. As the train moves toward you, sound waves from the horn are compressed (meaning higher frequency) and you perceive the sound at a higher pitch. As the train leaves you, sound waves are no longer compressed and you hear a lower-pitched, lower frequency noise.

This shift in frequency can be calculated using the equation:

$$F_{doppler} = -F_{source}\frac{V}{C} \tag{1}$$

where $F_{doppler}$ = change in received frequency (Doppler shift); F_{source}= frequency of transmitted sound; V = velocity of source relative to receiver; C = speed of sound. For there to be a Doppler shift, there must be relative motion between the sound and the observer; if you were on the train and moving with it, you would hear the train's horn at one pitch for the entire trip. This is evidenced in the equation – if relative velocity between the sound and observer is zero (V=0), there is zero shift of frequency.

The ADV uses this principle to measure the velocity of water in three dimensions. The device sends out a beam of acoustic waves at a fixed frequency from a transmitter probe. These waves bounce off of moving particulate matter in the water and three receiving probes "listen" for the change in frequency of the returned waves. The ADV then calculates the velocity of the water in the *x*, *y*, and *z* directions. A general schematic of the ADV is shown in *Figure 1*.

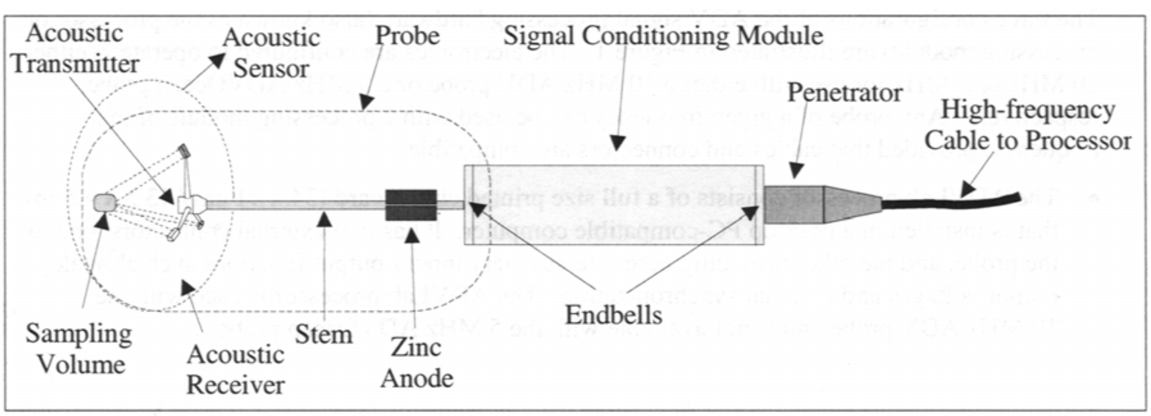

Figure 1: Schematic of Sontek ADV Probe. (courtesy of Sontek[1])