Acoustic Source of a Drive Unit

A well designed drive unit, operating over its intended band, correctly mounted in the right size of cabinet will radiate spherical sound waves as shown in Fig. 3. This applies to drivers with wide dispersion over their operating band. If we could measure the radius of the sound waves we could easily predict the origin or virtual source. Hence we could specify where the acoustic source was in relation to the hardware of the drive unit. However, life is rarely this simple. Figure 3 shows the concept and Figure 4 shows how we can measure the position of the source.

The Measuring Principle

Unfortunately we can't just put a microphone in front of a loudspeaker and measure the phase response. What we would measure is the phase response of the acoustic radiation present at the microphone after traversing a distance 'D' from the loudspeaker. Because sound travels at a constant speed in air the effect on the phase of the various components is drastic. Consider a low frequency signal traversing the space with a wavelength of say 500 mm. (approx. 700 Hz) compared with say a higher frequency signal with a wavelength of say 125 mm. (2800 Hz.) If the microphone were 1000mm from the drive unit then the phase of the low frequency signal (with respect to the input voltage) would have rotated through $(1000/500) \times 360^{\circ} = 720^{\circ}$. The higher frequency signal would have phase rotated by $(1000/125) \times 360^{\circ} = 2880$. Also by the time the microphone measured the radiation the drive unit, it would be doing something entirely different because of the delay in the radiation traversing the distance to the microphone at the speed of sound (speed of sound = 345 µ sec. therefore the microphone measures the drive unit 2.9 milliseconds after the event). The microphone would measure a phase difference between 700 Hz and 2800 Hz of $(2880 - 720)^{\circ}$ even though the radiation left the cone of the driver perfectly in phase.

In the bicycle analogy this is rather like trying to assess the phase of the valves on a bicycle whose frame length increases with the distance travelled.

So to compensate for this effect we introduce a similar delay of electronic origin into the reference input of the phase meter. The reference delay is adjusted to exactly compensate for the acoustic delay caused by the distance between driver and microphone and therefore cancel the effect out. As far as the phase meter is concerned it now thinks that the microphone is exactly at the acoustic centre of the sound source. By measuring the delay accurately (and knowing the air temperature) the distance from the microphone to the acoustic source can be found and referred to some point on the driver chassis or magnet assembly.)

For the Jupiter J40 bass unit the acoustic source is 62 mm from the front chassis surface which puts it on a plane coincident with the front surface of the magnet ceramic. For the treble unit the source is 20 mm behind the front mounting plate surface. Both sources are on the axis of symmetry of the units.

So by measuring techniques we can determine the acoustic source with a high degree of accuracy. In the bicycle analogy if we could compensate for the varying frame length, knowing the phase relationship between the valves and the phase change at a point in the journey together with the difference in diameter of the wheels we could calculate where the bike started off from.