# GETTING A PERSPECTIVE ON NOISE IN AUDIO

a limited number of ways to realize each of these controls. Choosing the most appropriate means or combination of means and the optimal location for these may make the difference between a short-term fix and one that withstands the test of time.

## Controlling Different Types of EMI

Reading textbooks on EMI reveals that there are only a few well-known ways of controlling it: shielding; grounding & bonding; balancing & twisting; separation & routing; and isolation.

These means are to some extent under the control of the system designer. Other EMI controls such as circuit impedance and configuration, and internal RF filtering, are the province of electronic equipment designers — and only insofar as the designer may or may not choose to use certain equipment. (Most equipment is chosen on the basis of operational facilities, not on the basis of EMI immunity.)

## Shielding

Stated simply, shielding controls electric fields by placing a conductor in the path of an impinging EMI field. In general, when an electric field strikes a shield which is grounded, the voltage the field tries to create is drained away to ground and does not affect the conductors on the protected side of the shield. Shielding can be done anywhere, but is normally done close to the source of the noise or the device affected by the noise.

Shielding has little or no effect on magnetic fields except where the shield is very thick (2mm) or made of high permittivity material such as Mu-metal. For a shield to be effective, it must be a good conductor, be well grounded, and have no discontinuities, such as openings or slots, in its surface.

For these reasons, foil shields are generally the best. Some foil shielded cables are better then others depending on the details of how it is made and the conductivity (thickness) of the aluminum foil.

## Grounding & Bonding

In audio, technical grounding is connecting a circuit or a shield to the earth using a dedicated conductor. Bonding is connecting various elements of a system together using low impedance conductors so that they are at the same electrical reference voltage — this is a *reference common.*

Grounding allows shields to work by draining away potentials. Grounding and bonding mean that any equipment which is referenced to it is at a similar, and likely stable, reference. Thus ground reference noise will not enter the system.

For grounding and bonding to work well, all equipment in a system must be connected with a low-noise and low-impedance ground network that ultimate-terminates to the earth. (The connection to the earth should also be low-impedance.) For the system to be low-noise, it is normally made of insulated conductors so that it is not shorted to other noise containing ground systems. For it to be low impedance, heavy-gauge conductors are used. (They should be as short and straight as possible to minimize impedance.) In critical designs, braid or foil are used as ground conductors, as these have lower impedances at high frequencies.

## Balancing & Twisting

Balanced interconnecting wiring is an in-polarity and an out-of-polarity voltage pair that form a differential signal. This distinguishes them from unbalanced (single-