

Loudspeaker connections

Many hi-fi enthusiasts may not realise that significant distortion may be introduced into an audio signal by the connections between the amplifier output and the loudspeakers. In the first place, output current from the amplifier has to travel across several non-soldered metal-to-metal contacts, for example plug and socket connections at the amplifier outputs and the loudspeaker inputs, and loudspeaker switches within the amplifier (of which more later). For minimum distortion these contacts should not only have a very low resistance, but must also have a constant, linear resistance.

Oxidation of the metal surfaces of plugs, sockets and switch contacts can produce a non-linear resistance which varies with the current flowing through it, thus distorting the signal fed to the loudspeakers. DIN loudspeaker plugs and sockets are particularly bad in this

respect due to their very small contact area, and should be avoided. Where non-soldered connections must be made the use of screw terminals or robust 4 mm 'banana' plugs and sockets is to be preferred.

The second area which can cause degradation of the audio signal is the connecting cable itself. When a loudspeaker is being driven by an amplifier the loudspeaker cone should move exactly in sympathy with variations of the amplifier output voltage. Ideally, if a loudspeaker is fed with, say, a step input, the cone should move quickly to the appropriate position and stop. In practice, of course, this does not happen. A loudspeaker possesses inertia and compliance, so that the cone will tend to oscillate about its final position before settling down. Whilst this 'ringing' is in progress the loudspeaker acts as a generator and tries to pump current back into the amplifier output. If the amplifier output impedance is low (and it generally is) the loudspeaker sees a short-circuit and the cone movement is quickly damped by electromagnetic braking. The 'damping factor' of an amplifier is defined as the ratio of the load impedance to amplifier output impedance. As the output impedance of a modern transistor amplifier is generally a fraction of an ohm, damping factors are typically between 50 and 200 with an 8 ohm load. However, the resistance of the loudspeaker connecting cable appears in series with the amplifier output and must be considered as part of the amplifier output impedance. If the loudspeaker cable is thin its resistance will be high and the damping

factor will be considerably reduced. In addition, some of the amplifier's output voltage will be dropped across the cable resistance rather than appearing across the loudspeaker.

Thus the second rule when connecting loudspeakers is to use heavy-duty cable. Fuses, which are sometimes inserted in series with amplifier outputs for loudspeaker protection, should also be avoided since they can have a significant resistance.

Recent research, particularly by Japanese manufacturers, seems to indicate that the inductance of loudspeaker cables has a significant effect on transient response, and Hitachi, JVC, Pioneer and Sony are all introducing special loudspeaker cables which are claimed to give an improved sound. Whether or not these claims are true is still a matter for conjecture.

Returning to the subject of loudspeaker switching, figures 1 and 2 show two typical switching arrangements which allow two sets of speakers to be connected to an amplifier, either independently or simultaneously. One channel only is shown and the circuits are identical for the other channel. Although such switching arrangements offer convenience of use, they may not be such a good idea from a sound quality point of view due to the contact resistance of the switches. If loudspeaker switching is employed in an amplifier then the switches used should be rated at several amps to ensure minimum contact resistance.

Both the switching arrangements shown in figures 1 and 2 have their advantages and disadvantages. In figure 1 both speakers appear in parallel across the amplifier output in the A + B position. Whilst this does mean that the damping factor is maintained the reduced load impedance can cause overloading.

In figure 2 the speakers are connected in series in the A + B position. Assuming that both speakers have the same impedance this connection, of course, doubles the load impedance, so there is no risk of overload. However the available output power is halved (since $P = U^2/R$) and the damping factor is reduced to less than unity, since each loudspeaker has the other in series with it as a source impedance.

In conclusion, anyone contemplating the building of an audio amplifier and/or loudspeakers would be well advised to bear in mind all the points raised in this article. To summarise:

1. Connection to the loudspeakers should be made with the minimum number of non-soldered connections (plug and socket connections and switches) in series with the signal path.
2. The cable to the loudspeakers should have as low a resistance as possible. Fuses in series with the loudspeakers, although seemingly desirable from a circuit protection point of view, have a detrimental effect on sound quality and should be avoided.

