

## Selecting the Proper Wire Size for 4 and 8 Ohm Speakers

Wire size selection is determined by the total impedance of the load at the end of the wire. Selecting the proper wire size for speakers that are connected directly as a 4 or 8Ω load is relatively simple. We need to know the speaker impedance, the length of the wire run, the amplifier output impedance, and the desired total *damping factor*. As an example, consider the case of an 8Ω speaker with a wire run length of 100 ft. The total damping factor should be no lower than 20. The output impedance of an amplifier can be determined by finding the amplifier damping factor and nominal load impedance on the manufacturer's specification sheet. Dividing the nominal load impedance by the amplifier damping factor gives us the amplifier output impedance. Most amplifiers have a damping factor of 200, and we will use this for our example. The amplifier output impedance is  $8 (\Omega) \div 200 = 0.04\Omega$ . The final piece of information we need is the resistance per foot for commonly used wire sizes:

<u>Wire size AWG</u>	<u>Resistance per foot (Ω/ft)</u>
18	0.0064
16	0.0040
14	0.0025
12	0.0016
10	0.0010
8	0.00063

Now we can select the proper wire size. Our example wire run length is 100 ft. The wire run actually consists of two 100 ft individual wires to the speaker, so the actual length of the wire is (2 wires x 100ft =) 200 ft. We begin by determining the maximum source resistance for a system damping factor of 20 or higher.

Divide the load impedance by the desired damping factor:  $8 (\Omega) \div 20 = 0.4 (\Omega)$ .

Subtract the amplifier source impedance:  $0.4 (\Omega) - 0.04 (\Omega) = 0.36 (\Omega)$

Divide the result by the wire run length:  $0.36 (\Omega) \div 200 (\text{ft}) = 0.0018 (\Omega/\text{ft})$

From the table of wire resistances, we find that 12AWG wire, at 0.0016 Ω/ft, will exceed our system damping factor requirement.

We can verify our work:

Multiply the wire run size by the resistance per foot:

$$200 (\text{ft}) \times 0.0016 (\Omega/\text{ft}) = 0.32 (\Omega)$$

Add the amplifier output impedance:  $0.32 (\Omega) + 0.04 (\Omega) = 0.36 (\Omega)$

Divide the load impedance by the total source impedance:

$$8 (\Omega) \div 0.36 (\Omega) = 22.2$$

The resultant system damping factor is 22.2, and our minimum requirement was 20, so using 12AWG wire in this system exceeds our requirement. A damping factor of 20 simply means that the load impedance is no less than 20 times the source (amplifier output impedance + wire resistance) impedance.

## **Wire for 25/70/100Volt Constant Voltage Systems**

Wire size in a constant voltage system is less critical than in a direct ( $4/8\Omega$ ) system, especially when total system power is low. The calculations are the same as in a direct system except that the impedance of the transformer/speaker combination must be calculated.

As an example, we will assume two speakers in a 70 Volt system each tapped at 15 Watts. We must first compensate for the 1dB maximum insertion loss of the transformer. The total power is  $15 \text{ (Watts)} \times 2 \text{ (speakers)} \times 1.26 \text{ (1dB)} = 37.8 \text{ Watts}$ . Next, we find the impedance at 70 Volts:  $70 \text{ (Volts)}^2 \div 37.8 \text{ (Watts)} = 4900 \div 37.8 = 129.6\Omega$ . Notice that the impedance is much higher than in the  $8\Omega$  example. Even an 18AWG wire would result in a high system damping factor. Keep in mind, however, that 25/70/100 Volt amplifiers sometime have higher output impedances than  $4/8\Omega$  amplifiers.