# TECHNICAL NEWS BULLETIN

## WIRING LOSS IN SPEAKER LINES

(Little Things Mean a Lot)

You would not charge a customer for a large power amplifier and then install a smaller unit. Yet, quite often the customer receives only a portion of the power that they paid for because of power loss in the speaker wiring. We tend to forget that wire has resistance and that part of the output voltage is lost in the wire between the amplifier and the speaker load because of this resistance.

This loss may seem small at first glance but when we look at the equivalent wattage loss it is quite surprising. Example: The standard clear 2-conductor speaker wire available at electronic stores is a 75 foot roll of #20 gauge stranded. Suppose you buy a roll to connect up a pair of 8 ohm speakers to a stereo amp. You cut the wire in two equal lengths of 37 feet (one for each speaker). This seems like a typical installation. But how efficient is it? If we look up the resistance of 20 gauge wire in a wire table, we find that it is 1.04 ohms per 100 feet. That is for one wire. The speaker line has two wires. So, the total resistance of each speaker line is 0.78 ohms. That means that almost one tenth of the voltage out of the amplifier will be lost in the wire. But, wattage is proportioned to the SQUARE of the voltage. That means that a 10% voltage loss represents a 20% power loss. In this example the loss is 17%. If the amplifier in this example is rated at 100 watts per channel, this means that only 83 watts per channel will be delivered to each speaker! The only way to reduce speaker line loss is to use larger gage wire or a shorter speaker line.

The losses in such an example quickly show why direct speaker wiring is impractical in large sound systems. Instead, a 70 volt "constant voltage" line is used for power distribution to the speakers. This increases the output impedance, thus reducing the loss in long lines.

PLEASE NOTE — The expression "constant voltage" does NOT mean that there is a steady voltage always present on this line. By definition, the AC voltage across this line is 70.7 volts when the amplifier delivers rated power output into a matching load. "Constant" in the expression means that the speaker line voltage is always a constant numerical value for any amplifier delivering full power output no matter what its wattage rating. This simplifies the mathematics required to calculate speaker matching transformer values. We no longer have to calculate square roots and reciprocal values as required when the transformers were rated in ohms. Instead, the transformer is rated for the wattage that it will demand from the line. This allows us to simply add up the sum of these wattage ratings to determine the total wattage required from the amplifier.

This allows easy calculation of wattage distribution in complex systems. However, it does not simplify the calculation of wire loss because the load is no longer rated as an impedance. Total impedance of the 70 volt output is included on the panel marking of Raymer amplifiers and receivers. For unmarked equipment or when calculating a "branch circuit", the impedance can be calculated by dividing 5000 ohms by the line wattage (for a 70 volt line). Example: The impedance of a 70 volt line at 10 watts is 5000 ohms divided by 10 or 500 ohms. In the case of a 25 volt line the impedance is 625 ohms divided by the wattage. In the example of a 10 watt amplifier this is 62.5 ohms.

An easy rule of thumb for calculating power loss in the speaker line is: power loss is 20% when the total wire resistance is 10% of the load.

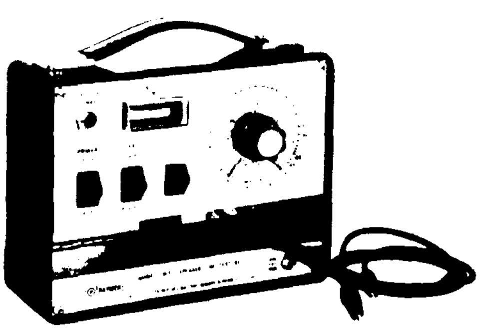
The loss can be calculated using a Wire Table. Remember that a speaker line has two wires so that a single wire resistance is doubled for a line. The following chart shows the maximum line length for 20% wire loss. For higher wattage divide the length by the amount of wattage increase. Example: The length for a 300 watt line is 1/3 the length of a 100 watt line.

Looking at the chart it is obvious that in some installations the wire gauge requirement becomes so large that it is impractical. In such cases it is adviseable to split the load into separate "home runs" which allows a smaller gauge wire to be used to drive the lower wattage speaker groups.

Maximum Length of Line in Feet for 20% Power Loss

| LOAD \ WIRE | | #24 | #22 | #20 | #18 | #16 | #14 | #12 | #10 | #8 |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 ohms | | 8 | 12 | 19 | 31 | 49 | 78 | 124 | 196 | 312 |
| 8 ohms | | 15 | 24 | 39 | 61 | 98 | 155 | 247 | 393 | 625 |
| 25 VOLT LINE | 10 W | 119 | 190 | 302 | 480 | 763 | 1214 | 1930 | 3070 | 4879 |
| | 20 W | 60 | 95 | 151 | 240 | 382 | 607 | 965 | 1535 | 2440 |
| | 40 W | 30 | 48 | 76 | 120 | 191 | 303 | 483 | 767 | 1220 |
| | 60 W | 20 | 32 | 50 | 80 | 127 | 202 | 322 | 512 | 813 |
| | 100 W | 12 | 19 | 30 | 48 | 76 | 121 | 193 | 307 | 488 |
| 70 VOLT LINE | 10 W | 955 | 1518 | 2415 | [illegible] | 6106 | 9709 | 15442 | 24558 | 39038 |
| | 20 W | 478 | 759 | 1208 | 1920 | 3053 | 4854 | 7721 | 12279 | 19516 |
| | 40 W | 239 | 379 | 604 | 960 | 1527 | 2427 | 3860 | 6139 | 9758 |
| | 60 W | 159 | 253 | 403 | 640 | 1018 | 1618 | 2574 | 4093 | 6506 |
| | 100 W | 96 | 152 | 242 | 384 | 611 | 971 | 1544 | 2456 | 3903 |

Shaded areas subject to high frequency loss due to wire capacitance



LWT

**MODEL LWT PORTABLE SPEAKER/LINE TESTER.** Model LWT is a self-contained portable direct reading test instrument for instant determination of the wattage requirement of a 25 or 70 volt speaker line from 0.5 watt to 200 watts, the impedance of an unknown speaker line from 1 ohm to 10K ohms, the wattage requirement and/or impedance of a speaker with a 25 or 70 volt transformer, or the impedance of a speaker voice coil. Uses self-contained 9-volt battery or external AC adaptor supplying 9 volts DC. Simple one-step operation with no graphs or charts necessary. Incorporates Wien bridge oscillator for stable operation at 100Hz and 400Hz test frequencies. Provision for external audio generator for tests over entire audio spectrum 20Hz to 20KHz. Low battery consumption. Zero center-null indicator. Push-to-Test spring-loaded power switch. Compact: rugged plastic case measures 6-7/8" x 5-3/8" x 2-3/8". **Shipping Weight:** 3 lbs. including self-contained battery.

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