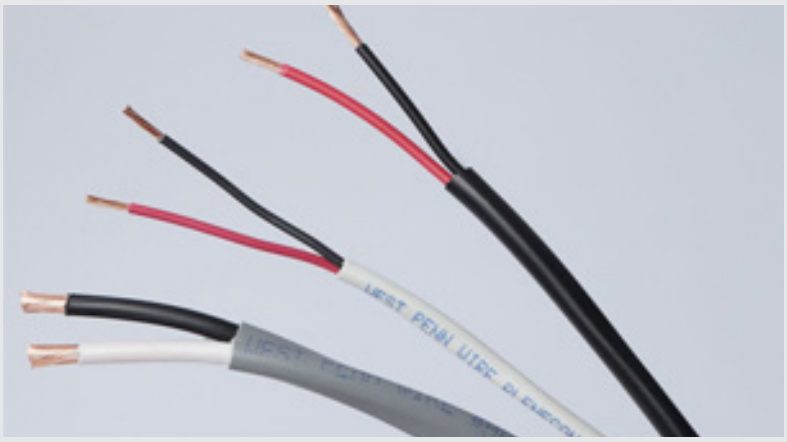
WEST PENN WIRE Since 1971

AV, SECURITY & NETWORKING SOLUTIONS

Product Guide

Speaker Audio System Cables



Loudspeaker Cable Distance

Speaker (Loudspeaker) Levels:

	Power (%)/Loss (dB)								
	4Ω Systems			8Ω Systems			70V System		
AWG	11% 0.5	21% 1	50% 3	11% 0.5	21% 1	50% 3	11% 0.5	21% 1	50% 3
8	180	370	1250	360	740	2495	9780	18000	61000
10	115	235	795	230	470	1585	5590	11495	38870
12	70	150	500	145	295	1000	3520	7245	24500
14	45	95	315	90	185	630	2220	4565	15430
16	32	60	195	55	115	395	1385	2855	9650
18	20	35	125	33	75	250	875	1795	6070

* 70 volt line drive systems, while considered a potential for Hi-Fi performance, follow same cable loss physics as the higher current (lower Impedance) system. For sake of this calculation, a 25 watt 70 volt system (196 ohm) was used.

Damping Factor:

Another reason to use a large gauge size when running speaker wires involves transferring of power from the amplifier to the speaker. There is the damping factor specification speaker impedance, divided by the output impedance of the amplifier. A smaller gauge with a greater resistance add to the speaker impedance and affect the damping factor. Damping factor starts as a large number and drops as frequencies get higher. At higher frequencies the resistance of the speaker cable can add to the damping factor. This can also affect the slew rate, which is the ability of the amplifier to deliver very fast rise time (higher frequency) signals.

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Introduction

Speaker Levels: (loudspeaker loads)
Low Impedance System - 4Ω and 8Ω
High Impedance System - 70.7 V

The cable is used to drive loudspeaker loads that are normally between 2 and 32Ω, although most systems are 4 and 8Ω. If the concern is to deliver amplifier power to the loudspeaker, as the case for most commercial sound applications, the design procedure is straightforward, with cable resistance being the only concern. If the highest audio fidelity is needed, the cable construction will become an issue.

The resistance of the cable is the most important electrical issue in loudspeaker installations. The effects of capacitance and inductance are negligible.

Low Impedance Systems: output impedance is low, the current must be high in order to get a given amount of power to the speaker. The lower the resistance of the cable, the more power gets to the speaker.

High Impedance- Distributed Loudspeaker System- Constant Voltage System: Impedance of 4 and 8Ω are most common in amplifier outputs. Manufacturers of commercial amps might also supply an output transformer with a number of secondary's, one may be marked 8Ω and the other marked 70.7 V. The impedance of a 70 V output transformer depends upon the wattage of the amp. A 25-watt, 70 V amp has an output impedance of 196Ω.

Actual speakers are still 4 or 8Ω, however, so when the wire is connected to each speaker, there must first be a small transformer to reconvert from 70-volt to 4 or 8Ω. The quality of the transformer is critical. Distributed systems are used where quality is not the primary consideration, such as, public address, background music, or paging systems.

- High impedance loudspeaker distribution systems being higher voltage and lower current than low impedance (4/8Ω) loudspeaker systems have the following features:
  - higher operating voltage means less power is consumed by copper resistance
  - longer lines can be run before wire resistance becomes a concern
  - lower operating current means that thinner wire can be used

When installing large systems it is worthwhile to test the impedance of the loudspeaker lines prior to connection to the amplifier. Many possible errors in installation can be found this way.

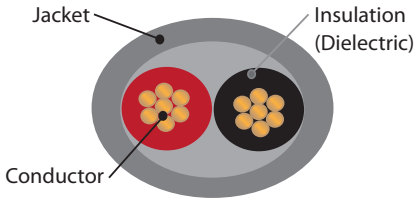
70.7 V High Impedance Systems		
Power (W)	Impedance (Z)	Current (I)
1000	5	14.1
500	10	7.07
250	20	3.54
200	25	2.83
150	33.32	2.12
100	50	1.41
75	66.5	1.06
50	100	.71
25	200	.35
16	312.4	.23
10	499.9	.14
8	624.8	.11
5	999.7	.071
4	12500	.057

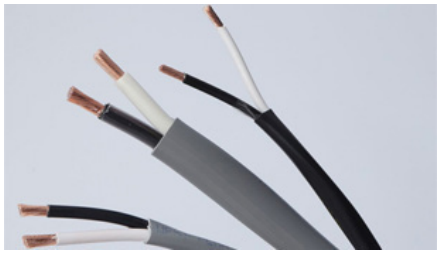
The impedance expected on a 70.7 V line is 5000 divided by the total watts. This should not exceed the rating of the amplifier drive line.

$W = E^2/R$

$W = 70^2/20 = 250W$

Speaker Cable Design





Conductor:

Speaker level cables are driven by the conductivity or DCR of a conductor -A bare copper conductor is utilized.

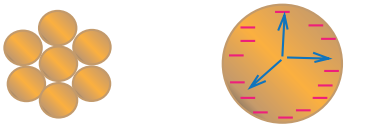
Electro-tough-pitch (ETP) 99.95% Conductivity
Oxygen Free O2 Free - 99.99% Conductivity

Over the last few years standard ETP copper processes has become much better. The process that gets most of the oxygen out of standard ETP, making it almost as pure as Oxygen Free.

Testing Conductivity: Our laboratory testing has determined that there is very little audible difference between Oxygen Free and ETP. There are still some Audio Engineers that say that there is a difference. The debate will continue.

Skin Effect: At high frequencies the electrons become magnetized and shoot to the outside of the conductor.
Skin effect may not be an issue for audio frequencies. Audio frequencies are low frequencies, hence the entire bare copper conductor is used to pass the electrons. Even at the highest audio frequencies, some skin effect will occur.

Stranded vs. Solid - Speaker level cables are stranded conductors. The strands will help in the flexibility and audio conductivity. (There is more surface area in a stranded conductor than a solid conductor of the same gauge size.)



Stranded Conductor
7 Strands

Solid Conductor

Insulation - Dielectric:

The insulation on a speaker level cable is not an important electrical part of the cable construction. The insulation is to provide dielectric strength between conductors. In a speaker level cable, the conductivity is important, but inductance is also important. The inductance can be determined by the conductor and also the insulation.

Because most electrical characteristics of a speaker level cables are not critical, the dielectric material is not critical. Most speaker level cables utilize a PVC(Polyvinylchloride) or PP (Polypropylene) insulation. Both are inexpensive material, with good flexibility, and good electronic performance.

Shield:

Shielding is not needed in most speaker level cable.

Jacket:

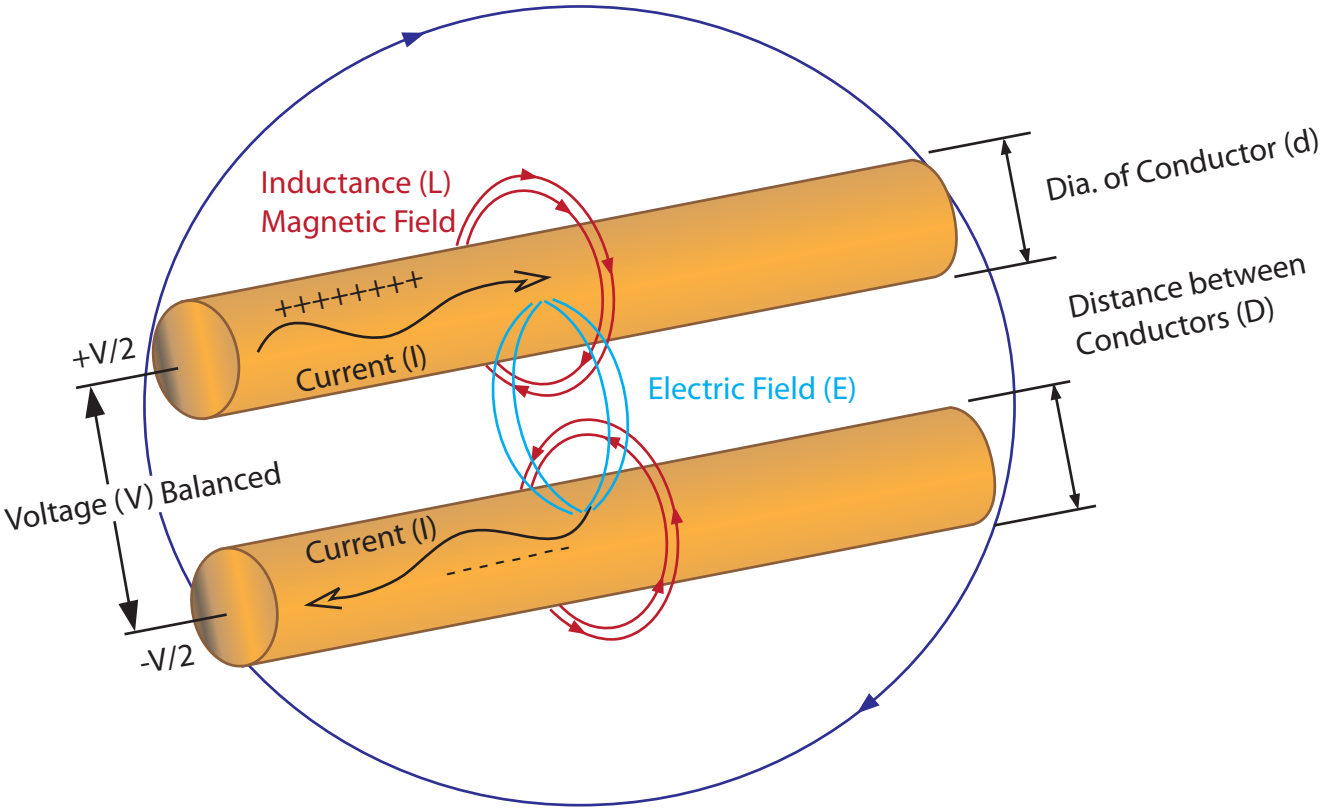
The jacket is dependent on the environment the cable is used:

- Portable Mic Cables: Rubberized, Flexible-type Matte PVC - Usually not a UL Rating
- Permanent Mic/ Line Level Cables: Non-Plenum - PVC - CM or CMR Rated
  Plenum - Low Smoke PVC - CMP Rated

Electrical Properties of Conductors

Inductance

Inductance is the electrical property of storing energy in the magnetic field that surrounds a wire. There must be electricity flowing to create this field. As soon as the electricity stops, the field will collapse, and energy will flow out of the wire. The inductance can change depending on the twisting of the conductor, and the amount and type of insulation. Inductance can be ignored in most audio signal applications



AQUASEAL - Indoor/Outdoor Cables

Aquaseal®
Water Resistant Cables

Aquaseal power-limited water-resistant cables are designed to be used for indoor/outdoor fire alarm systems. Aquaseal products are manufactured using a premium grade jacket compound. These cables are flame retardant, sunlight and water resistant, and employ an abrasion and crush-resistant construction. This durability allows the Aquaseal power-limited water-resistant cables to be direct burial.

The internal cable construction employs a dry water blocking barrier instead of a messy gel. Unlike many other outdoor cables which cannot be placed indoors, Aquaseal cables carry both indoor and outdoor ratings.

Aquaseal cable retains consistent electrical characteristics compared to standard cable when immersed in water. The moisture blocking barrier used in this cable has proven itself in various tests where standard outdoor cable has failed. This can be verified by monitoring the capacitance levels of both cables. Aquaseal water-resistant cables will consistently have lower capacitance values and remain stable over the long haul enabling the lowest signal loss.

Speaker Cable List

	Commercial Audio
224	18/2 Unshielded CMR
225	16/2 Unshielded CMR
226	14/2 Unshielded CL3R
226	12/2 Unshielded CL3R
	Commercial Audio Plenum
25224B	18/2 Unshielded CMP
25225B	16/2 Unshielded CMP
25226B	14/2 Unshielded CL3P
25227B	12/2 Unshielded CL3P
	Large Venue
C208	8/2 Unshielded TC
HA210	10/2 Unshielded CL2
25210	10/2 Unshielded CL2P
	Aquaseal Direct Burial
AQ225	16/2 Unshielded Indoor/Outdoor DB CL3
AQ226	14/2 Unshielded Indoor/Outdoor DB CL3
AQ227	12/2 Unshielded Indoor/Outdoor DB CL3
	Aquaseal In-Conduit
AQC224	18/2 Unshielded Indoor/Outdoor CM
AQC225	16/2 Unshielded Indoor/Outdoor CM
AQC226	14/2 Unshielded Indoor/Outdoor CL3

Speaker System Accessories

Commerical Speaker Connectors

The speakON cable connectors are the industry-standard connectors for amplifer / loudspeaker connections. The entire family of 2, 4 and 8 pole cable connectors has been designed to operate in high current, inductive load environment of loudspeakers.

SpeakON Connectors	
CN-NL4FC	Neutrik 4 Pole Standard
CN-NL4MP	SpeakON Panel Mount
CN-NL4MPST	SpeakON Panel Mount Screw Terminal

Commerical Speaker Assemblies

The speakON cable assemblies are produced with either 12, 14 and 16AWG with lengths of 6, 10, 25, and 50ft.

SpeakON Connectors	
CN-SS12-xx	12AWG SpeakON Assemblies
CN-SS14-xx	14AWG SpeakON Assemblies
CN-SS16-xx	16AWG SpeakON Assemblies

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