Speaker Wire

ONE IMPORTANT BUT OFTEN OVERLOOKED PART OF ANY SYSTEM IS THE QUALITY OF THE WIRING.

Introduction

One important but often overlooked part of any system is the quality of the wiring. In this article we will look at speaker wire. In particular we will look at speaker wire that goes into the wall sometimes referred to as bulk-wire because it typically comes on reels of 500' and larger. However many of the concepts discussed here will apply to speaker wire that does not go into the wall as well.

Background

The primary goal of music or movie reproduction is to provide the audience with an experience most like the real thing. For music that means hearing the music just as if you were hearing the band play live. For movies it means seeing and hearing it the way the director meant you to. For this goal to be reached the source device, CD or Blu-Ray player, must extract every bit of detail. For all cables and components downstream from the source device you need to do no harm. In other words do not add distortion and noise or omit audio or video information.

Quality equipment and cabling do a much better job of delivering the audio & video signals from the source to its destination without degradation to the signal. Better sound and pictures are a direct result of adding less noise and distortion.

Cables can contribute a great deal of noise and distortion to both the sound and the image as a result of the way the cable is designed (type of copper, gauge, lengths) and how well the cable is shielded (designed to reject noise from outside interference.) Reducing the noise anywhere within the system will increase the overall performance of the system. As cables are less expensive than major components – money spent on better cables is the most cost effective performance upgrade available.

Definition

Speaker wire consists of equal numbers of electrical conductors insulated from each other surrounded by a protective jacket. One conductor (or group of conductors) is referred to as the positive conductor (red) and the other is referred to as the negative conductor (black). Copper is the most common conductor metal.

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For whole-house wiring (multi-room audio) four-conductor wire is most often pulled to reduce both the amount of cable used and the amount of labor. The color code for four-conductor wire is speaker one: Red (positive), Black (negative) speaker two: White (positive), Green (negative).

Purpose

Its purpose is to carry an electrical signal (voltage and current) from the amplifier (or the amplifier section of a receiver) to the speakers.

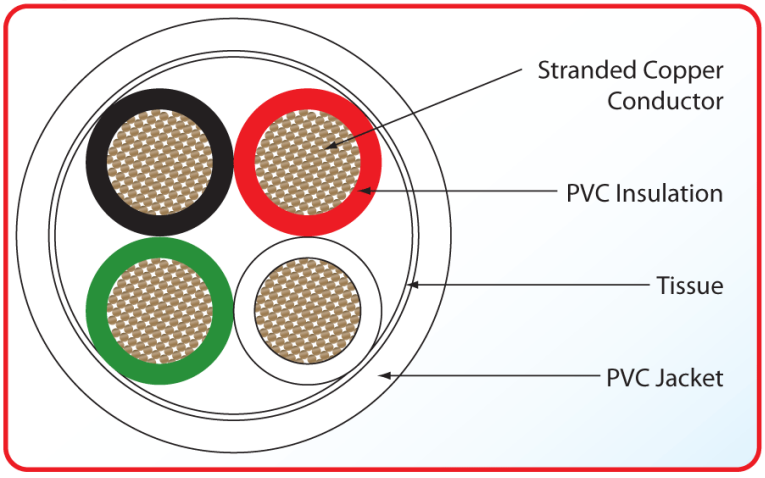
How it's Made

Wire is produced by drawing metal bars through ever smaller holes in a succession of dies reducing it to the desired size. When two or more wires are combined the resulting product is referred to as a cable. Most in-wall whole house speaker cables are made by using multi-stranded conductors.

Composition and Construction

For in-wall speaker wire the conductors are almost always copper. Typically the conductors are made up of many smaller strands of copper. Stranded cables are much more flexible and therefore much easier to run through the walls in a house. Insulators and jackets are often made out of PVC.

Speaker Wire Cross Section



Picture of 4 Conductor Speaker Wire

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Copper
There are a number of different price/performance levels of copper. Other in-wall cables, such as doorbell wire and electrical wire (Romex) are made with electrical grade wire. It's great for door bells, but not good enough for audio reproduction. The next level is referred to in the industry as tough-pitch copper. Because that sounds almost as appealing as dirt – most companies that use it call it something like high purity copper. Most "emergency cables" that are provided free with inexpensive equipment use this type of copper. This is also the type of copper that inexpensive in-wall speaker cables use. It's typically better than door bell wire, but there is still better wire out there. The more quality in-wall speaker cables utilize higher purity coppers; coppers which are contaminated with fewer other metals and made with a process that reduces the amount of oxygen that is present in the molten metal. This reduced oxygen cable is more stable over time because with less oxygen – it is inherently resistant to corrosion (becoming oxidized – and turning bright orange and eventually green). Copper oxide is a semi conductor which distorts, resists and eventually blocks the electrical signal. The metal used in these better cables are called OFC (oxygen free copper) or HC-OFC (high conductivity oxygen free copper).

While OFC and HC-OFC are better conducting metals and therefore cause less resistance – the real benefit of utilizing them in audio or video cables is that they create less distortion.

Cable Twist
Inexpensive speaker cables are made by using one + and one – conductor parallel to each other. This is often referred to as zip-cord. In-wall speaker cables are rarely made like this. Instead, the conductors are twisted. Twisted conductors are much less susceptible to picking up noise (common mode noise rejection). Twisting the conductors also lowers the inductance of the cables making it easier for the amplifier to drive the signal down the cable. You could say that lowering the inductance of a speaker cable helps it to … sonically get out of the way, adding less noise and distortion.

Star Quad
A significant sonic improvement is possible by simply using a second four conductor cable. Rather than use one four conductor cable for both left and right channel signals – we give each channel its own cable. Some of the improvement is had by simply getting the magnetic fields that surround a cable, when a signal is present, away from each other. By combining the conductors across from each other (if looking at the conductors like numbers on the face of a clock, we would combine the 12:00 and 6:00, and then the 3:00 and 9:00. This star quad design further reduces the cable's inductance – again, improving the cables electrical performance and reducing the distortion it produces. Lastly, by doubling the amount of metal – we reduce the distortion further (less resistance) and sonically gain bass-weight and fullness.

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AWG and Resistance Chart

Speaker cable size is designated by a number labeled either "gauge" or AWG (for American Wire Gauge). The smaller the number, the thicker the cable, and the lower the resistance.

AWG	Diameter (mm)	Area (mm^2)
10	2.588	5.26
12	2.053	3.31
14	1.628	2.08
16	1.291	1.31
18	1.024	0.82

Larger cables are used for longer runs and fuller sound (bass-weight, body and fullness are desired.) For multi-room audio we recommend no less than 14 gauge and prefer 12 gauge. For home theater applications we recommend 12 gauge, 10 gauge or better yet, 4 conductor 12 AWG cable in a star quad design as described above

Speaker wire has three parameters which determine its performance: resistance, capacitance, and inductance. If a perfect wire were possible, it would have no resistance, no capacitance, and no inductance. Inductance is a combination of resistance and capacitance – and it's advantage was explained above.

A thicker wire is a better conductor of electricity (your sound signal) and yields better performance because it exhibits less resistance to the electrical signal passing through the wire. Less resistance also is beneficial to your receiver/amplifier because it does not have to work as hard to drive the signal down the line. The longer the wire, the more resistance and hence the more important it is to use a heavier gauge.

Resistance in ohms/1,000ft for Stranded Wire

AWG	Resistance	Increase in Resistance over next larger gauge	Cumulative Increase in Resistance Over 12 gauge
18	6.9	57%	306%
16	4.4	63%	159%
14	2.7	59%	59%
12	1.7	55%	
10	1.1		

System performance is also affected by the nominal speaker impedance at the speaker. The lower a speaker's nominal impedance the greater the speaker cables loss. Speaker cable loss is in the neighborhood of 1% to 7% depending on the gauge or the wire and the impedance of the speaker. For instance for a 14-gauge wire if you go from 8-ohm to 6-ohm speakers you will increase your speaker cable loss percentage by 50% (1.3% to 2.7%.) Therefore, all things equal, the lower the speaker's nominal impedance the bigger the speaker wire you should use.

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Cost Comparison

Wire, once run through the wall, is very hard to upgrade so we advise getting the best wire you can given your budget. You can always upgrade components later.
Increase from 16 to 14 gauge is approximately: $0.45/ft (four-conductor)
Increase from 14 to 12 gauge is approximately: $0.75/ft (four-conductor)
Increase from 12 to 10 gauge is approximately: $0.50/ft (two-conductor)

Considerations When Installing (Pulling) In-Wall Speaker Wire

- **Pull strength** – don't use excess force when pulling wire through the wall
- **Minimum Bend Radius** – do not create severe bends or 90 degree angles in speaker wire
- **Running in relation to high voltage** - Avoid running wires in close proximity to other electrical lines. Try not to run speaker wires parallel to electrical lines. If you do not have a choice and need to run parallel to high voltage wiring try to be at least three feet way. If you need to cross a high voltage line do so at a right angle at a minimum of 24" away.

CL Ratings

If installing speaker cable in the wall you should use a UL rated cable with the designation CL-3. This will be stamped on the cable's outer jacket or on the spool it comes on. The CL-3 rating indicates the jacket is suitable for pulling through walls and the cable itself can handle the voltage from the receiver or amplifier.

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