WEST PENN WIRE Since 1971

AV, SECURITY & NETWORKING SOLUTIONS

BASIC CABLE CONSTRUCTION

A cable type is determined by the specifications of the system installed, basic electronic principles, and environment and regulatory agencies. These various criteria dictate the type of conductor(s), gauge of wire, type of insulation, twisted or cabled construction, type of jacket and if any shielding is required. A basic understanding of cable construction should be helpful in selecting and installing the proper cable for a particular system.

Conductors

Conductors for electronic cables can vary greatly from stranded conductors for maximum flexibility to copper covered steel which provides a stronger cable that will withstand a greater physical strain than copper. The American Society For Testing and Materials (ASTM) standards are followed for all of West Penn Wire conductor material. The ASTM standard defines standard requirements such as tensile strength, elongation, resistivity, dimensions, permissible variations, finish, inspection, and testing.

Conductor Material

There are several types of material that conduct electricity well (aluminum, nickel, gold, silver). However, copper is the most popular due to its excellent conductivity compared to other material cost. West Penn Wire uses a variety of conductors in our cable. Material used can be bare copper, tinned copper, and copper covered steel. The conductor can consist of solid or stranded construction. The type of conductor selected is determined by the application the cable will be used for.

Solid Conductors

A copper rod provides a solid conductor for a wire. A solid conductor offers lower cost and is easily formed to any shape desired. A solid conductor does not have much flexibility and may break if flexed too much in one place. For these reasons, a solid conductor is best suited for use in a fixed or permanent installation.

Stranded Conductors

By combining several strands together a stranded conductor can be formed. A stranded conductor is easy to pull, flexible, and is less likely to break if subjected to frequent bending. The finer the strands and the more strands used to assemble a conductor, the more flexible the conductor becomes. Therefore, stranded cable is ideal for installations where frequent movement of the cable is required.

Bare and Tinned Conductors

Conductors can be either tinned or plain bare copper. Most electronic connectors today are designed to be used with bare copper. In cables that are terminated with soldered connectors, tinned plated conductors can help in soldering the wire to the connector.

Copper-Covered Steel

This type of conductor uses a steel conductor covered with copper. This type of conductor make-up is used for RF applications that require a cable to withstand added tension. The steel provides added strength, and the copper provides good conductivity for higher RF signals. This type of conductor is not good for low frequency transmission.

Conductor Size (AWG)

Conductors are measured in size/diameter through a gauging system. There is no industry standard. However, the American Wire Gauge (AWG) system has been generally accepted as the standard in the wire and cable industry. The sizes are derived through a logical, geometric progression. The smaller the number, the larger the wire, and likewise, the larger the number the smaller the wire. The AWG system is important because it provides a standard reference for comparison of various conductor materials based technically on the cross-sectional area of the wire.

Example: A #22 AWG wire is smaller than a #18 AWG wire.
A #14 AWG wire is larger than a #24 AWG wire.

Dielectric

Insulation is a highly resistive material that is applied to the conductor to resist the flow of electric current to other conductors and provide protection to the conductor. There are many types of insulation materials used and each has its advantages and limitations. The type of insulation selected is based upon the application of the cable. Insulation is also referred to as the dielectric of a cable.

Dielectric Strength

This is the amount of voltage that insulation can withstand before it "breaks down". The material type and thickness determines the insulation's dielectric strength. The application and environment the cable will be used in will determine the dielectric strength required.

Protection

Insulation also must provide flame retardancy in case of fire, provide resistance to abrasion and provide protection from electrical shock.

Dielectric Categories

Electrical insulations can be divided into four categories. Thermoplastics, Thermosets, Fluoropolymers, and Elastomers. Insulations are normally applied by an extrusion process. The extrusion process forces pre-heated plastic through dyes which forms a continuous covering over the conductor. This is usually called the primary insulation.

Thermoplastics

Thermoplastic compounds are compounds that are softened by mechanical pressure and applied heat, and maintain their altered shape when cooled and/or the mechanical force is removed.

Polyvinylchloride (PVC)

This is probably the most widely used insulation for low voltage insulation. This compound is offered in a variety of formulations. Through different manufacturing processes, PVC can be made to resist sunlight, ozone, flames, oil, and most solvents. PVC insulation is fairly consistent, allowing for bright colors, and is very flexible and easy to strip.

Polyethylene

This compound offers excellent electrical properties such as low capacitance and low loss of a signal. Polyethylene is lightweight, water-resistant, and fairly chemical resistant. Polyethylene offers good abrasion resistance and is somewhat harder to strip than PVC.

Polypropylene

This material is similar to polyethylene as to electrical properties providing low loss properties with less material. Polypropylene also provides excellent mechanical properties and is very abrasion resistance although stiffer than Polyethylene. Of the four compounds listed in this category, polypropylene is the most difficult to strip.

Copolene

Copolene is a West Penn Wire Trademark. This insulation offers a low dielectric constant enabling low capacitance. Excellent electrical properties allow high speed, low distortion signal transmission.

BASIC CABLE CONSTRUCTION

Fluoropolymers

These compounds are commonly used for high temperature applications and areas such as plenums that require flame retardancy and low smoke characteristics. The NEC mandates the use of these types of materials in ducts, plenums, and other space used for environmental air. Using these types of compounds will allow for reduced cost in installation because there is no need to install conduit.

Halar®

A premium insulation with excellent electrical and mechanical properties. This compound offers a stable low dielectric constant over a wide range of frequencies. It is also chemical resistant, abrasion and impact resistant, and can withstand high temperatures.

Teflon®

A premium insulation with excellent electrical and mechanical properties. This compound is widely used as a solid or foamed dielectric, allowing for an extremely low loss cable. This compound can withstand high temperatures and has low flame and smoke characteristics.

Copolymer

Polyvinylidene Fluoride (PVDF). This compound has rather poor electrical properties. However, this compound has a very high temperature rating and excellent mechanical properties such as cut-through resistance, corrosion resistance, abrasion resistance, and high tensile strength.

Elastomers

This is a group of compounds that are "rubber-like" in appearance. They can be compressed or even stressed and will snap back to their original shape with the release of tension.

TPE - Thermo-Plastic Elastomer

Shielding

There are basically three types of shielding techniques: foil shielding, braid shielding, and combination shielding. Shielding is utilized to prevent radiation and signal loss of high frequencies used in electronic circuits and to reduce EMI/RFI interference. However, shielding tends to increase the overall capacitance of the cable.

Foil Shield

Foil shields are usually made of a thin layer of aluminum bonded to a polyester film. A foil shield allows for 100% coverage if applied with an appropriate overlap construction. A drain wire is used in conjunction with the foil shield to connect the shield to ground. This permits extraneous signals to be "drained off" to ground. It is very good in reducing Radio Frequency (RF) interference, but does not perform as well in blocking Electro Magnetic Interference (EMI). Foil shields do provide easy termination and low cost protection, although fragile (low tensile strength and impact resistance).

BiFoil

This type of foil shield allows for added protection by increasing the metallic coverage without adding increased thickness to the diameter of the cable. Mainly used in coaxial cable, the BiFoil shield is an aluminum-polyester-aluminum tape with 100% coverage.

Bonded BiFoil

This type of foil shield has the same aluminum-polyester-aluminum construction as the BiFoil shield, but is also bonded to the dielectric with adhesive. This allows for better shielding capabilities as well as providing excellent ease of stripping because the foil does not pull away from the dielectric.

Braid Shield

Braided shields can be constructed in various coverages, 95–98% being about the highest coverage available with this type of shielding. The material can be bare copper, tinned copper, or aluminum. Depending on the amount of coverage, braid shields reduce EMI interference well, but are not as reliable in the RF range. Braid shields also allow for a much lower shield D.C. resistance than foil shields.

Combination Shielding

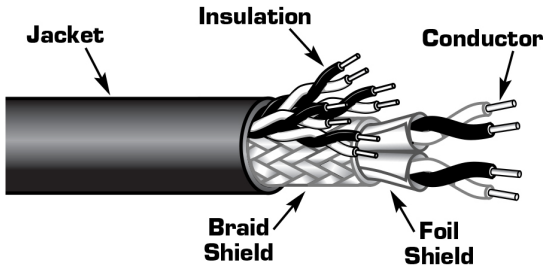
This technique offers the best of both types of shielding. First, a foil shield is applied around the primary conductors and then a braided shield is placed on top of the foil shield. This allows for greater coverage in blocking both EMI and RFI signals while allowing for a low D.C. resistance in the shield. There are also various versions of this basic technique such as triaxial and quad shielding.

Foil/Braid

This is the most common type of combination shielding. The aluminum foil is wrapped around the cabled or twisted primaries and then a braided shield is applied over top of the aluminum foil. The metallic side of the foil shield is usually in contact with the braid. The braid is then used for shielding as well as ground termination eliminating the need for a drain wire.

Triaxial - A Braid-Separator-Braid combination shield construction.

Quad - A Foil-Braid-Foil-Braid combination shield construction. This provides for maximum shielding against EMI/RFI interference.



Jackets

The cable jacket is for strength, integrity, and overall protection of the primaries and/or shield inside the jacket. There are a variety of jacketing materials that are used in cable construction. Standard compounds and special variations of these compounds can be used in making the jacket. Selecting a cable with the proper jacket for the environment it will be installed in is an important consideration. Environmental parameters that should be considered include temperature variations, chemical reactance, sunlight resistance, mechanical and abrasion impact. Jackets are usually made up of the same material as insulation used on primaries. To learn more about the various compound properties, please refer to the Insulation Section.