Engineering Techbits

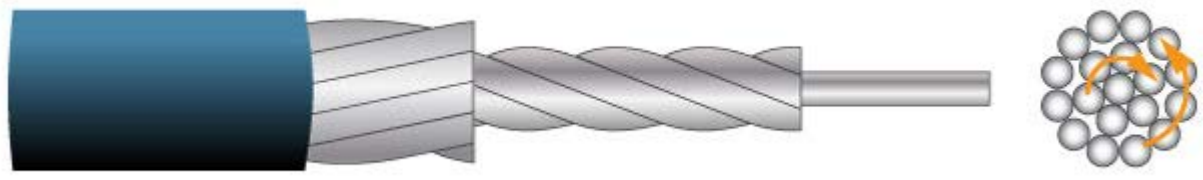
VOLUME 8 | APRIL 2021

CABLE SELECTION: CONDUCTOR AND INSULATION MATERIAL

In this engineering TechBit, we will discuss important considerations when selecting the type of conductor and insulation material required for your multi-conductor cable application. We will focus on the common types of conductor material and the different aspects of common insulation materials used in custom and off-the-shelf cable solutions.

The conductors of a cable can be found at the center of the cable. The conductors themselves can consist of multiple small strands of metal wire bundled together make a flexible single conductor or a solid core of metal. The selection between these two conductor types depends heavily on the application. Generally, a solid core conductor is a better electrical conductor and provides superior, stable electrical characteristics over a wider range of frequencies. They are also considered more rugged and less likely affected by vibration or susceptible to corrosion, but with this style of conductor you also get the rigidity of the wire, resulting in a lack of flexibility.

Stranded conductors however, are extremely flexible and are the go to choice for electronic cable assembly manufacturing. The stranded wires are often bundled together allowing them to be configured to meet specific design requirements A few common types of stranded wire arrangements that can be arranged to optimize the performance of your final product include: **concentric stranding, bunch stranding and rope stranding.**



CONCENTRIC STRANDING

Concentric stranding is where the individual wires are subject to an exact positioning around a core wire, which ensures an all-out uniform structure. The exact positioning consists of a central core wire encapsulated by one or more layers of helically laid wires. The conductors are arranged in concentric circles, with each layer after the initial one having six more wires than the preceding layer. Concentric stranded wire arrangements reduce the need for filler material.

BUNCH STRANDING

Bunch stranding is the most common type of conductor arrangement for smaller gauge wires. This type of arrangement does not have a specific positioning of the wire but instead is collected or bunched together in the same direction. This grouping of wires is then twisted together tightly to ensure they remain uniformly packed. The popularity of bunched stranding is directly related to their durability and flexibility. Smaller gauge wires in this configuration offers very good resistance power, and the high malleability makes them ideal for bending around tight corners and spaces.

ROPE STRANDING

Rope stranding arrangement groups wires together into several small bundles. Each respective bundle is individually bunched and then arranged into concentric circles to form a rope-like cable. The roping increases flexibility and allows for greater movement in applications that require frequent moving or flexing in multiple directions. For larger gauge wires, this type of arrangement is also used adding to the durability and functionality of the application.

The material for the conductor is generally made out of metal because of the electrical transference properties, but not all metals are created equal. Some types of metal like aluminum, copper, and high strength alloys have greater conductive properties and are the most common type of conductor material. Aluminum is lightweight, affordable, and can be used in diverse applications. However, the conductivity of aluminum is not as efficient as the other options. Copper can move electricity efficiently and is both somewhat inexpensive and versatile. This will be the most common type of conductor found in the market today. High strength alloys are solutions made with one or more metallic elements. They are generally stronger than the element(s) used alone.

Conductors can be plated with other metals to increase or improve desirable characteristics. Plating is defined as a surface covering in which a metal is deposited on a conductive surface, thereby improving the conductive properties. Some of the more common types of plating offered are nickel and silver plated conductors. Nickel plated conductors are applied in order to increase corrosion resistance and to expand the operating temperature range of a cable. Additionally, nickel plating can increase the mechanical strength of the conductor if required to be in extreme environments or conditions. Another common type of plating is silver, which is one of the most conductive metals available, but rather expensive. This is one of the reasons you will not see silver stranded conductors readily available in the market. However, silver is more often used as a plating to greatly improve the conductivity and significantly increases the operating temperature of a conductor and/or cable. This type of conductor coating is often seen in aerospace and medical applications.

Once the conductor material has been determined, the next step in cable construction is the insu-

lation. Insulation is a nonconductive material that resists electrical leakage, prevents direct contact between conductors and preserves the material integrity of the wire by protecting against potential environmental hazards. The safety and effectiveness of the wire depend on its insulation. Some common types of insulation can be found below:

- **Polyvinyl Chloride** or **PVC** is a relatively inexpensive and easy-to-use material with the potential to be used in diverse applications. In general PVC is resistant to flame, moisture, abrasions, gasoline, ozone, acids and solvents. It can also be used for medical- and food-related purposes as it is odorless, tasteless and nontoxic, but specialized formulas are necessary if biocompatibility is required. PVC is not recommended for applications where flexibility and an extended flex life are required at low temperatures. When used in retractile cord applications, it also shows below-average flexibility. PVC insulation displays high attenuation and capacitance loss, meaning that power is lost when used in an electrical system.
- **Thermoplastic elastomers** or **TPEs** are a type of copolymer created by mixing a thermoplastic with an elastomer (e.g., rubber). This combination adds some of the durability of a thermoset to the manufacturability of a thermoplastic. TPE wire jacketing is commonly found in re-usable device applications. Disadvantages of TPE include poor chemical and heat resistance, low thermal stability and higher cost than other types of insulation.
- **Polytetrafluoroethylene** or **PTFE** is a fluorocarbon polymer material that is resistant to lubricants and fuels, is very flexible, and has excellent thermal and electrical properties. This makes PTFE a great choice for extremely demanding environments, but its natural resistance to adhesion makes manufacturing impossible if your solution requires adhesives, like epoxy, to be added to the insulation material.
- **Neoprene** is a synthetic thermoset rubber that must be vulcanized to obtain its desired qualities. It exhibits supreme abrasion, oil and solvent resistance. Neoprene is also known for its long service life and wide ranges of temperature and usability. It is remarkably flame retardant and self-extinguishing. Military products often incorporate neoprene. This material is especially desirable for hand-held cordsets.

Please note that it is always recommended to talk to an expert regarding cable selection. Look for the next TechBit in this series, which will cover choosing the right type of shield for your cable.

ASK OUR ENGINEERS TODAY
Email us at sales@odu-usa.com

sales@odu-usa.com
www.odu-usa.com

Get connected
+1 805 484 0540

ODU-USA 300 Camarillo Ranch Road, Suite A
Camarillo, CA 93012