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New Medical Robots Place Higher Demands on Cables

Today's small, ultra-flexible robots require cabling designed specifically for each application. Here are guidelines to keep in mind when selecting wires and cables for medical applications.

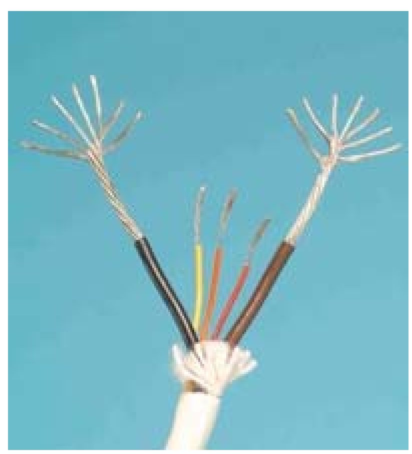
AT A GLANCE

- Medical robot trends
- Beginning with conductors
- Key design factors
- Jacketing materials

Often the conductor has the highest resistance that the designer can allow in order to keep the cable small. Don Dodge is the vice president of research at Calmont Wire and Cable Inc., 420 E. Alton Ave., Santa Ana, CA 92707. He joined the company 20 years ago as chief engineer after working as quality control manager and chief engineer at Pacific Electricord. Dodge also has served as the chairman of the Flexible Cords Technical Committee of NEMA and the chairman of the U.S. Delegation for IEC SC20B for wires and cables. He can be reached at 714-549-0336, ext. 115, or ddodge@calmont.com.

By Don Dodge

Modern medical robots are increasing in complexity while decreasing in size. Such changes are calling for cables and wires that are smaller and more flexible while containing a greater number of conductors.



This medical robot cable has five conductors in two sizes. The brown and black conductors provide power to the device at the end of the robot arm. The red,

The design of a cable revolves around its conductors. Size is usually stated in AWG, which stands for American Wire Gage, but it can be given in millimeters squared. However, before considering size, the materials now required for small medical robots must be examined.

Although copper has been the material of choice for many years, it lacks the tensile strength for small, flexible wires. High-strength copper alloys are now the minimum required. And as size decreases, the use of stainless steel and titanium is increasing.

The plating on a conductor is used to improve corrosion resistance and enhance solderability. Traditional tin plating is giving way to silver because most high-strength alloys cannot be coated with tin. However, stainless steel and titanium, which have very poor conductivity, can be gold plated to restore enough conductivity for small wires.

orange, and yellow conductors provide control signals. All conductors are twisted together with polyester fillers to keep the cable round. The cable requires no shield because the carrier on the robot arm provides the necessary shielding. The jacket is white polyurethane with a 0.025-in. wall.

The size of the conductor is determined by the current or resistance values that the circuit requires. Often the conductor has the highest resistance that the designer can allow in order to keep the cable small. Tables are available in most handbooks for copper; these must be corrected—by using the %IACS factor—when using alloys. This factor is a percentage of the conductivity of the alloy compared to copper. Because it is expressed as a percentage of copper, it must be used as the divisor to correct the ohm/foot for copper to that of the alloy.

The stranded conductor used on robotic cables must be a "bunch" type. Most hook-up wire and commercial cables use concentric stranding. Typically, 7, 19, or 37 strands characterize concentric stranding, but bunch stranding contains any number of strands that are randomly twisted together. When the strand count gets higher than 50, it is common to use a combination of groups of bunch-stranded wires. The adjacent photo illustrates this point. In the photo, both the brown and black 18 AWG conductors contain 168 strands of 40 AWG wire constructed as seven groups of 24 bunch strands. The strands are made of silver-plated high-strength alloy. Insulation is FEP Teflon with a wall thickness of 0.01 in. The red, orange, and yellow conductors are made from 28 AWG with 41 strands of 44 AWG silver-plated high-strength copper-alloy strands. The insulation is 0.005 in. FEP Teflon.

Following is a look at several other key factors that must be considered when reviewing cables and wires for medical robots.

Insulation

When choosing insulation, consider dielectric strength and physical properties. For long-life robotic cables, insulation must be capable of sliding against other components of the cable. PVC and PU are not used often for insulation in smaller cables because they tend to stick to each other when the cable is flexed, decreasing the flex life. Teflon, FEP, and PFA are most common, but polypropylene can be a low-cost alternative for slightly larger cables. Wall thicknesses, which are based on the mechanical requirements of the cable rather than the electrical requirements, can be reduced. High-voltage cables are the exception.

Cabling

Ultra-flexible cables are engineered to twist with a small lay length—the length along the cable of one twist. This capability reduces the torque forces required to bend the cable and places less stress on the conductors. The use of fillers and slippery tapes, such as TFE Teflon, also reduces torque forces. A planetary cabler is required to keep back twist out of the cable.

Shields

Most cables need to be shielded against electromagnetic interference or EMI. The aluminized Mylar that is used often for standard cables is not suitable for flexible robotic cables. Spiral shields are the most flexible but can move under the cable jacket, which hurts their effectiveness. The best shield is a braid shield. The "weaving" of its strands in the shield holds it together. Also, the shield wires are made with high-strength copper alloys. Stainless steel, which has poor conductivity, is used only as armor rather than a shield. In addition, plating is used to improve solderability.

Jackets or Sheaths

The choice of a jacket material is often limited because of the medical requirements for USP Class VI materials. While meeting Class VI requirements, PVC does not meet long-term flexibility and sterilization needs and, thus, is not used for most of these applications. PU is a tough, flexible material that can be used when cables are not autoclave sterilized. However, there are TPEs available that can be autoclaved and that are tough and flexible. The most flexible jacket is silicone rubber. It can be sterilized many times, but it is not as tough as PU or TPE and is not used when cables are in a track. In addition, coil cords are used when additional flexibility is required and space for them is available.

ONLINE

For additional information on the technologies discussed in this article, see *Medical Design Technology* online at www.mdtmag.com and Calmont Wire and Cable Inc. at www.calmont.com.

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