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Custom Cables Embrace a World of Conductors

by Larry Gillard, LEONI Tailor-Made Cable USA

From electrical energy and precise analog or digital signals to high-pressure gaseous and liquid media, today's custom cables transmit almost anything. Cable manufacturers now offer a wide selection of conductor materials ranging from classical copper wires in a wealth of varieties and fiber optics to all kinds of hoses and tubes and even semi-conductive materials such as carbon fiber.

Prior to making the final decision on a specific conductor, a bit of "profile matching" takes place. The questions that usually have to be answered are "What has to be transmitted?", "What are the constraints?", and "Which conductor(s) is/are appropriate to get the job done?". In the optimization stage, additional environmental aspects are to be considered, including possible electromagnetic interference, mechanical stress factors such as torsion and/or abrasion, and chemical and/or thermal attacks.

Fine Stranded Copper Conductors

When it comes to transmitting larger amounts of electrical energy, first-class metal conductors — copper, in most cases — are the material of choice. Although this sounds like an easy prediction, a number of detailed decisions have to be made by the cable designers. The "pick and choose" list includes the right conductor size as well as the appropriate stranding type, the number of strands, plating, stranding pitch to match electrical and mechanical requirements with the most cost-effective conductor variant. The processability of the various conductors must also be considered.

In addition to conventional copper, custom cables use a wide selection of differently plated copper conductors. It ranges from tinned and silver plated copper to various copper alloys, which may be used in applications that require superior mechanical strength from the conductors. The ultimate design decision is made with the final application in mind: while tinned copper conductors resist corrosion and increase the ease of soldering connectors, silver plating is appropriate for high temperature exposure or low-loss RF cables.

Copper conductors comprised of many fine strands make a suitable choice for cables subjected to continuing mechanical stresses. They are insulated and again tidily cabled into bundles that can easily cope with demanding bending and torsional stress.

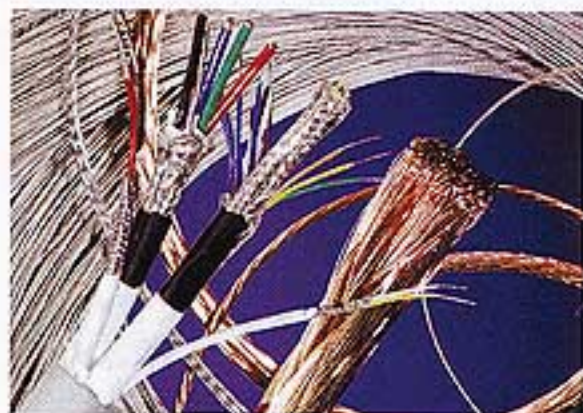
High strand counts are used to increase the flexibility and longevity of a cable. Super-fine stranded conductors contain thousands of strands of bare or tin-plated copper, with each strand having a diameter as fine as AWG 40. Incorporating high conductor stranding and putting unique bundling designs to work, the outside diameter of tailor-made cables can be reduced by 30 to 40 percent compared to standard products. Designed for life spans of up to 25 million bending cycles, diameter-reduced, high-flex automation cables can withstand a bending

radius as small as five times the outside diameter.

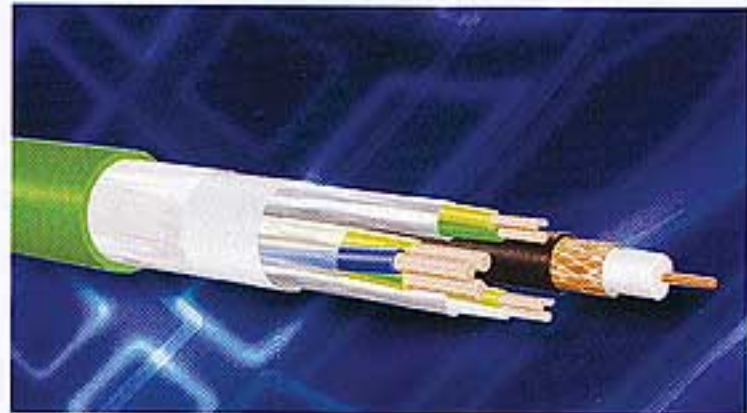
High Performance Coaxials

Custom-made coaxial components are appropriate for cabling applications needed in industrial automation, visual inspection or in medical electronics. Here, demanding applications call for crisp video performance or high-speed data acquisition without any disturbances.

In coaxial cables, the concentric outer conductor (screen) protects the inner conductor from interfering with outside electromagnetic fields over a wide frequency spectrum. High-performance coaxial cables can be used up to frequencies in the



Today's custom cables are available in a wide range of copper conductors.



These coaxial cables are slim and ultra-fast.

Gigahertz range. In digital communications, high bandwidth cabling yields very low bit error rates, even in EMI polluted environments.

Braided outer conductors are most common. For very high shielding requirements, outer conductors comprising multiple layers are put to work. Noise signals induced by cable movement can be greatly suppressed by adding semi-conductive layers between conductors and dielectrics.

In high-frequency applications, the dielectric contributes to cable attenuation. Pure virgin plastics from the polyolefinic and fluorocarbon families offer low dielectric loss and excellent processability, allowing for precise extrusion of thin walls.

Customized coaxial cables with physically foamed dielectrics — a process available through a handful of cabling makers worldwide — come with substantial weight reduction plus superfast signal transmission speed, reaching up to 85 percent of the speed of light.

Flexible Polymer Fibers and "Invisible" Carbon Conductors

For high-speed data transmission, fiber optic components are on the rise. New, flexible polymer compounds make them strong contenders in high-flex robotics applications. In general, optical fibers offer a

very large bandwidth. That is why polymer optical fibers (POFs) can be employed in quite simple control devices as well as to very high frequencies.

Superior EMI performance and extremely reliable signal transmission are among the strongest assets of fiber optics. While fiber optic cables provide perfect EMC without a need for shielding, they rely on cautious handling and lead to higher interconnect cost.

A fascinating new offering is cables with "semi-conducting" conductors. Usually made from carbon, these cables may well transmit low bandwidth electrical signals and/or small quantities of electrical energy. These cables are distinguished by their non-reflective characteristics for external fields. Instead, they offer an absorptive "stealth-like" behavior. Due to the absence of backscatter, little disturbance is imposed on external incident fields. Given their "invisible" performance, semi-conducting carbon cables are geared to work in highly sensitive medical imaging equipment.

Hybrid Cables Offer a Variety of Conductors

Most customers of tailor-made cables require hybrid designs bundling a host of different conductors into one single round or flat cable. The individual "mix and match" approach allows the integration of components for all kinds of media: electrical power, control wires, data-lines (symmetrical and coaxial), tubes and hoses for air and/or fluids, optical fibers for light and data, and even strength members. Hybrids require less space and are easier to install than conventional cabling.

Designed and built to a specific application, hybrid tailor-made cables can merge most of the above components into a handy and useful entity. One example for this "all-in-one" approach is the patented pneumo-optical cable, recently introduced by the LEONI Tailor-Made Cable group for operation in handling robots. The all-inclusive hybrid cable comprises one 3/8" polyurethane (PUR) pneumatic tube for the gripper, two optical fiber conductors for high-speed data transmission and five conventional fine-stranded-wires for power and control. A tough outer jacket protects

the entire ensemble from wear and tear. Finally, a patented hybrid connector was composed for this "universal supply cable", allowing for connecting and disconnecting the combined components and media — power, air, and light — with a single click.



Plug-and-play, all-in-one pneumo-optical hybrid cable for handling robots.

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