Overmolding Circular Connectors in Cable Assemblies

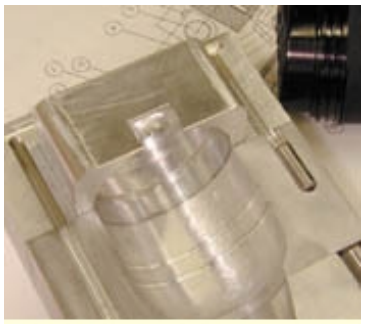
By Steve Burk

Overmolding of cables and circular connectors provides opportunities within the interconnect industry to improve and, in many cases, reduce the total cost of ownership in cable assemblies. Cables and connectors have been overmolded in the electronics and electrical industries for just about as long as insulation has been extruded onto copper conductors, first in rubber with transfer molding (still used in many industrial applications), and then with injection molding of thermoplastic materials such as PVC beginning in the 1950s. Overmolding is an effective means of providing strain relief for wire terminations. In addition to the obvious cosmetic benefits, it offers mechanical advantages with options such as mounting hardware and angled cable exits.

Earlier medical applications were prime candidates for overmolding, with companies such as Component Manufacturing Services (CMS) spawning the use of overmold technology in early medical and computer cable assemblies. In the late 1970s and into the 1980s, companies such as Tri-Tec Engineering, Mold-Con and Tessco were among the early pioneers when the personal computer and video game markets brought high-volume demands to the cable assembly industry for D-subminiature, small computer system interface (SCSI) and other computer-related connector types. Because of FCC-imposed rulings, unique shielding requirements needed to be met.

Overmolding grew increasingly popular and cost-effective compared to the metal backshells commonly used for standard RS232 and other computer-interface protocols. The predominance of metal backshells used in the computer industry helped to fuel the growth of overmolding of connectors in many other industries. Around 1985, the connector industry began developing all types of connectors with moldable backshells, recognizing the trend toward lower cost interconnect solutions.

As overmold capacity expanded within the contract assembly industry, many companies came to the forefront and added the internal capabilities to do overmolding. Today, about 150 to 200 cable assembly companies worldwide include overmolding as part of their manufacturing capabilities. While the number of companies that do overmolding is relatively small, the number continues to grow rapidly.



Typical mold and overmolded connector.

Overmolding in the industrial market has not seen the same growth, primarily because of more specialized applications and lower production volumes. With the expanded use of interconnects in all industries, however, the need for customized interconnects continues to grow, along with the opportunities to provide custom solutions such as overmolding of circular connectors.

Although circular connectors come in many sizes and shapes, the most common types fall into audio, MIL-Spec, power, signal and radio frequency (RF) categories. These serve all the typical electronic and industrial marketplaces, with a high concentration in machine tool, rail, industrial

automation, medical and automotive diagnostics.

Overmolding Advantages

Overmolding is 90 percent mechanical and 10 percent cosmetic. The heart of a properly designed and manufactured molded cable assembly is a fully encapsulated contact and wire termination point for strain relief and mechanical advantage. Typically, molded circular connectors have an internal "premold," which is the part of a molded connector body that is not seen but is nonetheless integral to the part structure. The design of the premold is imperative in a properly molded cable assembly.

The Premold

Premold polypropylene.

The back-end structure of the circular connector dictates the design approach of the premold. The preferred method is to mold fully around the back section of the connector with full encapsulation of the individual conductors and the cable jacket. In situations where there is a screw-on backshell, the ideal configuration is to mold fully over the threads. At this point, there is full attachment to the connector with the premold providing for a mechanical bond between the cable and the connector. Each style of connector is different and in certain instances, modification of the connector body is necessary for structural bond between the premold and connector.

Using appropriate methods, a completed premold provides a significant mechanical bond between the cable and circular connector and considerable environment sealing of the terminations. In addition to the structural advantages of a premold, it is often possible to eliminate the internal use of heat-shrink tubing and other wire prep devices, as the contact area is fully molded and provides isolation of the contacts and wires. Another advantage of a premold is the elimination of pushed pins in the connector because the premold fills this section of the overmold, capturing the contacts and not permitting them to push out of the connector housing. This premold also provides a surface around which to shield the connector body with copper tape for shielding, if needed.

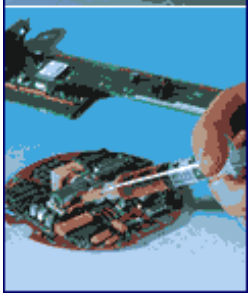
The Final Mold

The overmold is the aesthetic part of the equation, but it offers some interesting opportunities for performance additives and cost-reduction benefits. The overmold can be where product identification, color-coding and connector orientation features are applied. The primary mechanical advantage of the overmold is that of final form and, most importantly, flex relief.

Various color molded ends.

Flex relief in a molded cable assembly is most easily defined as improvement to the flex life of the cable itself. Flex life in a finished cable assembly starts with the flex life characteristics of the actual wire and cable. As a rule, if the actual flex life of the cable is 25,000 cycles, users can generally enhance this flex life by a factor of 2 times (i.e., 50,000 cycles). Enhancements beyond this are possible with a good engineering design of the actual strain relief and with proper material selections.

Material selections for overmolds are important. Normally, the best solution is to use the same material in the overmold as the cable jacket; if the cable is extruded with an insulating material such as thermoplastic elastomer (TPE), then the overmold material should be TPE. This will permit some bonding of the materials to one another if molded properly. In extreme situations, addition of solvents and adhesion exciters can improve the bond between the overmold and cable jacket materials for enhanced performance.



Various circular overmolded connectors.

Overmold shape and design offers many opportunities for "artistic impression," but from a design-for-manufacturability point of view, the key element to consider is molding good parts. The most important rule is to design the premold and final mold such that the overmold wall thickness is as uniform as possible to minimize mold sinks and imperfections. This alone does a lot in producing a consistent product that is cosmetically acceptable and mechanically strong.

Applications that use a range of circular types of connectors present the mold designer with the option of designing an overmold configuration that covers a broad range of connector configurations. If done properly, it is possible to have one mold-cavity design that works with five to 10 different connector types. This is less true in conventional rectangular overmold situations because of the unique backsection designs of the connectors themselves.

Why Overmold?

Right-angle overmold.

Overmolding is not always the best solution. Although it makes the connection look better, the most common fear is that if it the connector is molded, how is the user going to get inside to fix it. The question then becomes, "What needs to be fixed?" Broken terminations or pushed pins are the most common problem. Other problems may be fractured or broken wire terminations because of the cable pulling away from the connector and its mounting hardware in the backshell.

A properly constructed premold solves these problems by fully encapsulating the pin or contact so that it cannot move backward. Anchoring the cable clamp to the premold provides significant pull strength. If more pull strength is needed, a Kevlar strength member (a stranded fiber of Kevlar) can be added to the cable or stainless steel messenger.

Environmental improvements are an additional benefit of a molded configuration, with many ways to provide for moisture relief and sealing of the backside of the connector. Properly molded connector ends can usually pass stringent industry standards, such as specifications for moisture and water resistance.

Situations where overmolding is not a good solution are when production lot sizes are too small, or the experience of the cable assembly company is inadequate to provide quality parts. Also, shell sizes larger than a typical 32 begin to stretch the size limitations of the molding equipment and platen/mold base configurations on most C-frame-type molding machines. The injection-molding equipment typically used in cable assemblies of this type is 30 to 35 ton C-frame machines.

Conclusion

Overmolding circular connectors offers significant opportunities for product improvements with improved strain and flex relief. Manufactured properly, it can improve performance and reduce total cost. Overmolding benefits provide the user with interesting opportunities for strain relief and improved pull strength not available with conventional backshell designs.

The trend toward overmolding circular connectors continues to expand as the use of military-style circular connectors gains popularity in industrial environments. This trend will gain momentum. Overmolding is a plus because it enhances an already good product and, in many instances, can make it better at a lower cost.

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SPEC SHEET

End Applications: Electronic and industrial markets, including computer, medical, industrial automation and auto diagnostic fields

Related Products: Circular connectors, cable assemblies, backshells

Main Point: Overmolding circular connectors in cable assemblies offers a significant opportunity for product enhancement with improved strain and flex relief. Manufactured properly, overmolding can improve performance and reduce total cost, providing users with opportunities not available with mechanical backshell designs. The trend toward overmolding circular connectors continues to grow as the use of military-style connectors expands in industrial environments.

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