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Improving The Performance And Useful Life Of Medical Cable Assemblies >

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Given the unique specifications and environmental conditions in which medical devices operate, the performance of the cable assemblies that connect such devices is critical. They must perform optimally under stressful hospital, clinical and emergency care situations.

To meet this challenge, many device manufacturers utilize a strain relief for their cable assemblies. A strain relief improves electrical and mechanical integrity, as well as overall performance by providing a transition from a flexible cable to a rigid connector or connection point. A properly designed strain relief, sometimes referred to as a bend relief, prevents mechanical forces applied to the cable from transferring to the electrical terminations within the connector and the device.

This attribute serves a critical purpose since the mechanical forces could lead to the medical cable assembly unit failing and the medical device itself emitting incorrect output. The strain relief essentially improves healthcare delivery by helping ensure devices provide medical professionals with accurate patient data.

The Benefits of Pre-Manufactured and Custom Strain Reliefs

Strain reliefs can be either pre-manufactured or custom designed and manufactured for a specific application. For example, a custom strain relief functioning as a separate unit can slip onto a cable or be molded over a cable, commonly capturing a portion of the connector.

Pre-manufactured strain reliefs are typically slipped over the cable before the connector is terminated. After the cable conductors are terminated to the connector, the strain relief is screwed or glued onto the connector assembly. Most off-the-shelf connectors have corresponding pre-manufactured strain reliefs for a variety of cable diameters and are often available in different colors.

In most instances, a well-designed, custom, over-molded strain relief offers superior benefits compared to pre-manufactured strain reliefs:

- Increased flex life
- Improved tensile strength
- Advanced moisture protection

A grommet, with an integrated strain relief, is commonly used when a cable is permanently attached to a device. Cables that pass through an opening into a device typically employ a grommet to anchor the cable to the device and provide protection against damage from an axially applied load. If the cable will be flexed, it is common to use a combination grommet and strain relief for through-hole applications.

Design Considerations for Longer Flex Life and Greater Tensile Strength

Typically, raw cable and wire withstand a higher number of flex cycles and feature a higher tensile strength than cable assemblies. The point where the cable or wire is terminated is generally considered the most likely point of failure. A well-designed strain relief addresses this challenge by isolating electrical terminations to prevent force from impacting these points.

Additional design considerations for a strain relief include the geometry of the part, the interaction of the strain relief and the cable jacket material. Tensile strength will be increased further if the strain relief chemically bonds to both the cable jacket and connector body. The strength of the union of the strain relief to the connector can be improved even further by providing features that allow the strain relief to physically bond to the connector body.

Cable assembly designers can achieve additional tensile strength by incorporating a clamp, crimped onto the cable jacket prior to molding. When the strain relief is over molded, embedding the clamp into the mold material significantly increases the assembly tensile strength.

Design Options: Solid or Segmented

Strain reliefs also offer the flexibility of a solid and smooth design or a segmented design. A solid strain relief is easier to clean, which can be an important consideration for many medical applications. Conversely, if the material, size and geometry are the same, a segmented strain relief typically offers greater flexibility, but with the trade-off of a more challenging cleaning process.



Smooth Strain Relief: A smooth, solid strain relief is typically less flexible but is easier to clean as compared to a segmented strain relief

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Segmented Strain Relief: A segmented strain relief can be more difficult to clean as compared to a smooth strain relief

Properly designed segmented strain reliefs feature walls and spaces that allow the bend radius to increase a greater distance from the connector or connection point. The size of the solid sections and the size of the gaps between solid portions vary to achieve the desired bend radius. Such strain reliefs are designed such that the segment closest to the fixed point closes first and the segment furthest from the fixed point closes last. This provides the greatest amount of bend relief and protects the electrical terminations within the connector.

Strain reliefs typically flex on either one axis (uni-directional) or on two axes (multi-directional). A uni-directional strain relief works best when the cable or wire exiting the strain relief is not round. This

is commonly the case with bonded cable or wire. In this instance, the flex is limited to one axis by the cable design, not by the strain relief design.

The length of a strain relief also contributes to performance. Generally, a longer strain relief is more effective than a shorter strain relief. However, consideration should be given to how the cable is stored in clinical use. Experience shows that cables left attached and wound around portable devices place continuous strain on the assembly. In this instance, a shorter strain relief may be more effective because the bend radius at the cable end of the strain relief may be larger.

Choosing Custom vs. Off-the-Shelf Reliefs

Strain relief molded over cable offers superior performance on several levels when compared to a pre-manufactured strain relief:

- A higher degree of moisture resistance due to physical and chemical bonding of the overmold to the cable jacket and connector – an important consideration for cables cleaned often or otherwise subjected to contact with liquids.
- Improved tensile strength compared because of the bonding achieved by molding.

However, two additional factors may lead to designers selecting a pre-manufactured strain relief instead of a custom, overmolded strain relief: the lead-time to design and produce the tooling and the cost of fabricating the tooling.