

MECHANICAL SHEAR-BOLT CONNECTORS

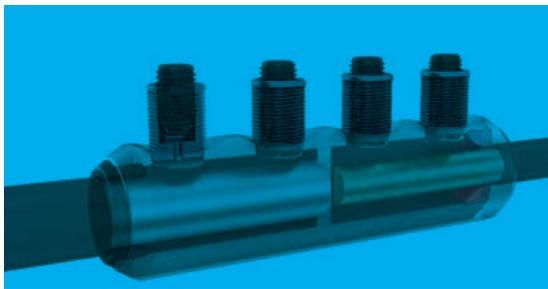
A “Best Fit” Solution for Jointing Cable Conductors



INTRODUCTION

Cable accessories have many decades of outstanding performance around the world. The technology for jointing two conductors in cables has changed many times during this period. Before the introduction of mechanical connectors, experience showed that the reliability of the conductor connection depended highly on the skill of the installer and the quality of the tools used.

This paper presents the latest developments in connector technology which lead to improved reliability in cable accessories and is independent of the skill of the installers and the tools used by them.



The mechanical connector technology which is the “Best-Fit” solution for jointing cable conductors is achieved by using the latest state-of-the-art technology, having shear-off bolted connectors in which the head of the bolt shears off at a predetermined torque and hence not dependent on the installer’s skill. These connectors are called “Mechanical Connectors” or “Shear bolt connectors” and are manufactured from special alloys.

Advantages of these connectors include:

- Wide cross section application range: Three connectors cover the range of conductors from 25 sq.mm to 400 sq.mm
- Suitable for Copper as well as for Aluminum conductors
- Suitable for all conductor types and shapes
- High clamping forces
- Reduces inventory levels
- Easy installation, requiring no special tools (Hydraulic pump & heads), reducing the total cost of Ownership (TCO).
- Simple and consistent installation:

Independent of skill levels, this “Best-Fit” connector system of joining two conductors using a Mechanical Connector is a technology leap in the field of LV and MV Cable Accessories, enhancing the reliability of networks. An installer no longer needs to determine a cable specific connector for the jointing task. The three connector sizes provide a simple selection for ‘best-fit’ jointing of any cable type and conductor size.

EVOLUTION OF THE DESIGN OF THE CABLES

Over the last few years several new technologies in cable designs have been introduced into the electrical network.

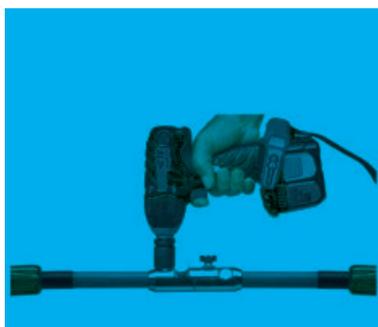
The emerging trends in worldwide cable design are:

- Reduced conductor diameters (cable cores are progressively compacted retaining the same cross-section)
- Reduced insulation thickness due to improved manufacturing processes and upgraded materials
- Use of XLPE instead of paper insulated cable. Cable end users have also rationalized and standardized the products they install. These developments and requirements have introduced major obstacles for installers who are now facing daily compatibility challenges when jointing different sizes and types of conductors together. The solution is to use mechanical connectors designed to address these challenges.



Benefits of mechanical connectors

There are a number of benefits in using mechanical connectors. These include a simpler decision-making process; stock reduction; efficiency in installation time and cost savings. An installer no longer needs to decide what connector should be used for which cable in the jointing process: No special crimping tool is required and installation mistakes by not using the appropriate crimping insert are impossible. Most mechanical connectors perform at a lower maximum operating temperature compared to crimp connectors. Since the connector design is based on the largest X-section to be considered, the connection for all smaller cross-sections is oversized providing a major safety margin for the cable accessory and the network. Stock levels are reduced because of the ability of the mechanical connector to take a wide range of cables. Three connector sizes provide a simple selection for 'best-fit' jointing of any size and type of cable and conductor. Installation time is minimized because there is only one method of jointing when using mechanical connectors, and both maintenance and tooling costs are reduced. The crimp installation tool can be eliminated as a failure source. No special tools or crimping dies are required. The shear bolt system eliminates installation variance and improves system performance



The IEC-60228 standard defines the conductor diameters for conductors from 10 mm² to 630 mm².

So, there is no standard requirement for larger conductor cross-sections; the cable manufacturers choose the conductor dimensions on their own and it is therefore quite critical to find the right crimp connector. In these cases, the mechanical connectors are a perfect solution due to their range taking capability.

Connector description

The mechanical connectors consist of sleeve and lug bodies, typically made from a high-tensile aluminum alloy. The internal surfaces of the connectors are grooved. Sleeves are suitable for underground applications. Lugs are suitable for outdoor and indoor applications and are available with several palm hole sizes. The mechanical connectors have been developed for use in low voltage, medium voltage and high voltage accessories.



Bolt design and material: The bolt design is very important for the reliability. Different manufacturers have different designs to achieve this consistency in performance and each with patent protection. That's why there are a large number of different bolt designs in use. Most of these bolts are shear bolts with a special construction to guarantee no excess length over the outer.

Features	Benefits
Wide application range	<ul style="list-style-type: none"> • Only three connectors cover all conductor cross-sections from 25 mm² to 400 mm² • Can be used for almost every type of conductor and conductor material, for instance from 10 mm² to 1000 mm²
High-tensile, tin-plated aluminium alloy	<ul style="list-style-type: none"> • Optimum contact properties • Connection between copper and aluminium conductors is possible
Compact design	<ul style="list-style-type: none"> • Require little installation space and short joint designs, particularly for larger sizes
Grooved inner surface	<ul style="list-style-type: none"> • Excellent electrical performance • Conductor oxide film is disrupted
Shear bolts with predetermined shear torque, inner or outer hexagon head	<ul style="list-style-type: none"> • No torque wrench necessary • Head shears off by design at the required torque value • High tensile strength

CONCLUSION AND OUTLOOK

This “Best-Fit” connector system of jointing two conductors using the Mechanical Connector is a boon in the field of MV and LV cable accessories, enhancing the reliability of networks.

In an era of rapidly changing cable designs there is no better alternative to mechanical shear bolt connectors. A general conclusion for these connectors for aluminium conductors is not strictly possible, but this technology is today use by all Utilities for more than 20 years, without major incidents: mechanical connectors are usually tested according to IEC 61238, which is an electrical + mechanical test standard, compared to the former dimensional DIN standard of crimp products (DIN 46235 / DIN 46329). To give a more accurate prediction of life time will require further study in this field.

Another important point are the newer demands on network design: the development of smart grids and renewable energy. MV network operators throughout Europe are facing new challenges. Indeed, in addition to the increase of the average load there is also the demand of widely ranging current levels. This is especially true for the connection of wind farms where, for economic reasons, the cables are used close to their current limits when the maximum power is produced and close to zero loads in the absence of wind. This increasing average load level and of widely ranging load profiles could lead to expensive failures in networks in future, if not properly considered by the accessory manufacturers.