What you should know about ferrules

Ferrules

Why ferrules?!

An automated sheath will fray over time and be ineffective in preventing the hardening of a shoe. Therefore, to protect against falling and thus ensure easy threading, the shoe is fitted with metal tails or plastic tips.

Flexible wire tips also serve as a result of stripping, making it difficult to insert the wires into the terminal blocks. Ferrule bundles also have the lower price in comparison to the corresponding conductor in addition to the standardized color series; however, there are also various color series.

The advantages of ferrules

- Process reliability and fast wiring
- Reliable connection, even with repeated rewiring
- Time and cost-saving with automated devices
- Increased, long-term operational safety and contact reliability
- Permanently low contact resistance
- Easy cross-section detection
- Increased vibration resistance
- Individual litz wires are protected (particularly for screw terminal blocks)

Ferrule types

Non-insulated ferrules

In accordance with DIN 46228-4, UL 486F-A

Insulated ferrules

In accordance with DIN 46228-4, UL 486F-A

Insulated ferrules with extended plastic collar (GB)

For AWM, multiconductor, and LV conductors

Insulated ferrules with polarized extended plastic collar (XL)

For short-circuit current-proof conductors and PV conductors

Insulated ferrules for 2-wire connection (TWIN)

In accordance with UL 486F for crimping two conductors of the same cross-section

UL certification

Phoenix Contact has had ferrules certified in accordance with the UL 486F standard in connection with a selection of crimping tools and crimping devices (ZPLZ/E486001).

Together with conformity with the DIN 46228-4 standard, this means the global market requirements for quality, safety, and compatibility. Offering a system that is accepted worldwide to export-oriented users.

Materials

Insulation collar

Polyolefin (PP) with a heat hardness of up to +120°C is corrugated

Stainless

Copper with a purity of >99.9% (preferably Cu-DHP or Cu-ETP) and a hardness of max. 155 HV

Coating

Tin-plated, at least 3 µm

Coloring

The color of the plastic collar indicates the cross-section of the ferrule and the litz wires assigned to the corresponding conductor in addition to the standardized color series; however, there are also various color series.

Conductors

Conductor definition

The DIN EN IEC 60238 standard lays out the definition of a conductor. In addition to the insulation, it consists of a conductor aluminum or copper core, which is limited into four common conductor classes.

<table>
<thead>
<tr>
<th>Cross-section</th>
<th>DIN EN IEC 60238</th>
<th>AWG</th>
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<th>l1</th>
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Conductors: Insulated ferrules in accordance with UL 486F-E

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<tr>
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<tr>
<td>Stripping</td>
<td>Class 2: multi-strand</td>
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<tr>
<td>Diameter</td>
<td>Class 5: fine-strain</td>
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<tr>
<td>Height</td>
<td>Class 6: extra-fine-strain</td>
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Crimping

Crimping tools

Various types of tools are available for processing ferrules. The tools should be equipped with a pressure tool that ensures that the crimping cycle is completed at full force.

The widely used universal type of crimping tool is based on the concept principle and is suitable for crimping both solid and stranded conductors. With these tools, each cross-section has its own set of dies. The choice of this tool depends on the desired application. A crimping tool may be used for stranded conductors.

The self-adjusting crimping tools have just one insertion slot, which adjusts itself automatically to the cross-section to be processed when actuated. Based on this, they are also suitable for other conductor standards (IISW/VW) and for TWIN ferrules. The special material allows square and hexagonal crimp forms to be achieved.

Crimp forms

What crimp form is the best? There is no clear answer to this question. In principle, all the forms shown are permissible and work in all crimping spaces.

However, at the maximum cross-section the form can become problematic. A square crimp, for example, will not necessarily fit into a round crimping space with the same cross-section specification.

The rather flat, oval crimp form is common for small cross-sections of 0.04 to 1 mm².

The rectangular crimp form is the classic for crimping up to 10 mm². On the other hand, it is also common for larger cross-sections up to 120 mm². Depending on the length-width ratio, this form offers high compatibility with square and rectangular crimping spaces.

The remaining crimp forms are unsuitable for crimping such cross-sections.

Conductor pull-out test

The pull-out test is a relatively simple, yet destructive, method of evaluating the quality of a crimping. The requirements and basic principles can be found in the UL 486F and DIN 46228-6/9291 standards.

Remove the insulation to a length sufficient to enable you to place a steel washer suitable for crimping over the end of the ferrule. Make sure that the tips of the wires are not damaged or broken off.

After crimping the ferrule, the conductor is pulled so that the crimped ferrule and the conductor are separated. The pull-out test is passed if the crimped ferrule can be pulled off.

Conductor pull-out values

For conductors from 6 mm² and the corresponding TWIN ferrules, the almost rectangular VM crimp form is common.

The square crimp form has become established as a standard for cross-sections from 0.14 to 6 mm². It offers optimum compatibility and high contact force in rectangular and square crimping spaces.

The hexagonal crimp form is also considered universal. It also offers optimum compatibility with round crimping spaces, as it is in direct contrast to rectangular crimping spaces.

The cross-section range is usually between 0.14 and 10 mm².

Quality

Visual inspection

- No exposed litz wires visible
- No cracks visible
- Litze wires at least flush with the plastic collar
- No deformation of the plastic collar
- No excessive burn formation
- No exposed or damaged contacts
- No exposed contact under the ferrule
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